ETSI TS 102 744-3-6 V1.1.1 (2015-10)

Satellite Earth Stations and Systems (SES);
Family SL Satellite Radio Interface (Release 1);
Part 3: Control Plane and User Plane Specifications;
Sub-part 6: Adaptation Layer Operation

Reference
DTS/SES-00299-3-6

Keywords
3GPP, GPRS, GSM, GSO, interface, MSS, radio, satellite, TDMA, TDM, UMTS

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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 6 of a multi-part deliverable. Full details of the entire series can be found in ETSI TS 102 744-1-1 [i.4].

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 Adaptation Layer (AL) 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 Adaptation Layer (AL) peer-to-peer interface is described in TS 102 744-3-5 [11].

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 124 007: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Mobile radio interface signalling layer 3; General Aspects (3GPP TS 24.007 Release 4)".

[2] ETSI TS 125 304: "Universal Mobile Telecommunications System (UMTS); User Equipment (UE) procedures in idle mode and procedures for cell reselection in connected mode (3GPP TS 25.304 Release 4)".

[3] ETSI TS 124 008: " Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Mobile radio interface Layer 3 specification; Core network protocols; Stage 3 (3GPP TS 24.008 Release 4)".

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

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

[6] RSA Laboratories. PKCS #1: RSA Cryptography Standard, Version 2.0. 1998.

[7] 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".

[8] 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".

[9] 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".

[10] ETSI TS 102 744-3-4: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 4: Bearer Connection Layer Operation".

[11] 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".

[12] ETSI TS 122 011: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Service accessibility (3GPP TS 22.011 Release 4)".

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] Recommendation ITU-T X.200, "Information Technology - Open Systems Interconnection - Basic Reference Model: The Basic Model", July 1994.

[i.2] Recommendation ITU-T X.210, "Information Technology - Open Systems Interconnection - Basic Reference Model: Conventions for the Definition of OSI Services", November 1993.

[i.3] Robert Sedgewick, Algorithms, 2nd. Ed., Addison Wesley, New York, 1988. ISBN 0-201-06673-4.

[i.4] 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 [8], clause 3 apply.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI TS 102 744-1-4 [8], clause 3 apply.

4 General Architecture

The Adaptation Layer allows the Physical, Radio Link Control (RLC), and Media Access Control (MAC) layers of the terrestrial UMTS radio interface (Uu) between the RNC and UE to be replaced with their equivalents from the satellite network radio interface. The Adaptation Layer is a direct replacement for Radio Resource Control (RRC) in the UMTS protocol stack.

Figure 4.1 illustrates the position of the Adaptation Layer within the Family SL air interface protocol stack. An overview of the radio interface layering and relationship to the Adaptation Layer is provided in ETSI TS 102 744-1-3 [7], clause 4 and ETSI TS 102 744-3-5 [11], clause 4. An overview of the Adaptation Layer operation is provided in ETSI TS 102 744-1-3 [7], clause 5.

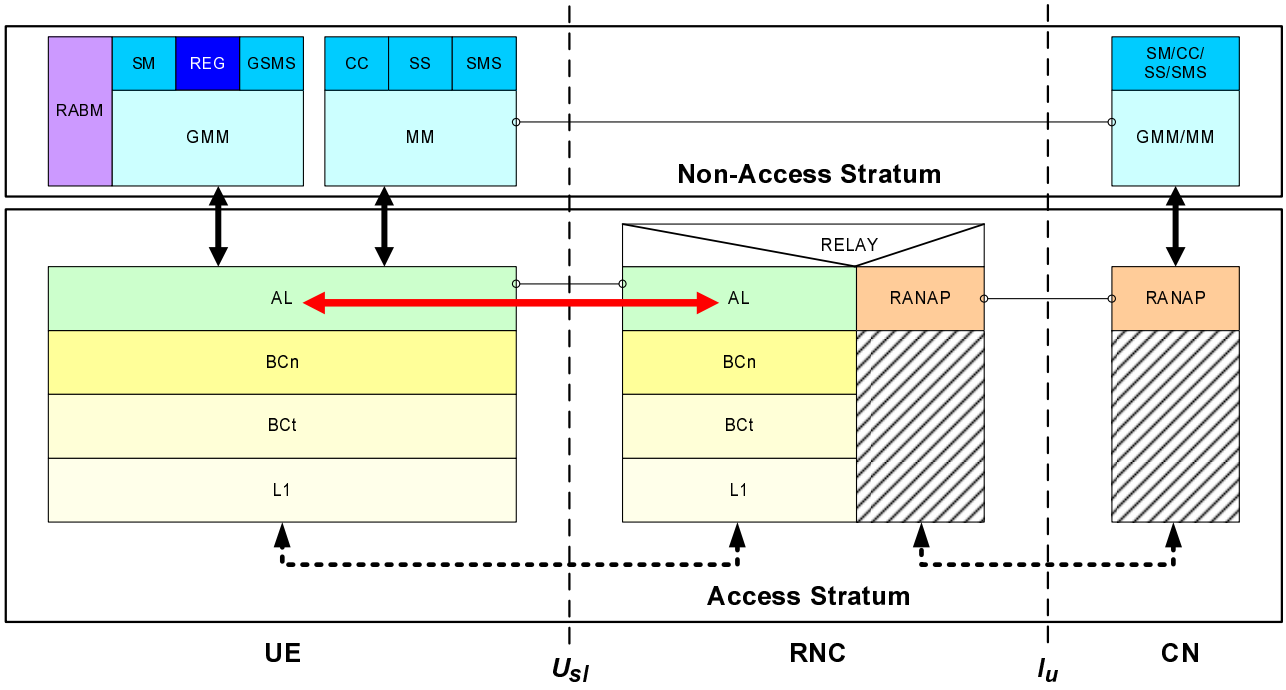

Figure 4.1: Adaptation Layer Position in Protocol Stack (Control Plane Illustrated)

The Adaptation Layer performs many of the same functions as RRC, namely:

- interpretation of system information related to the Access Stratum and forwarding of system information related to the Non-Access Stratum;
- Public Land Mobile Network (PLMN) and spot beam selection (initial and re-selection);
- establishment, maintenance and release of a UE-Specific Signalling Connection ("RRC Connection" in UMTS) between the UE and the RNC;
- Non-Access Stratum message transport;
- establishment, reconfiguration and release of radio bearer connections;
- connection mobility functions (handover);
- integrity protection and control of ciphering; and
- paging.

Unlike RRC, the Adaptation Layer does not provide a system information broadcast facility to UEs in idle mode, nor is it associated with power control (link adaptation), or radio resource management. In the satellite network, these functions are provided by the Bearer Control layer.

The Adaptation Layer is present only in the Control Plane. In the User Plane, the Bearer Connection layer directly provides the services and service access points required by higher layers (such as Packet Data Convergence Protocol (PDCP) in the Packet Switched (PS) domain and Circuit Switched User Plane Handler (CSH) in the Circuit Switched (CS) domain). Note however that some Adaptation Layer agents in the Control Plane are responsible for configuring agents in the User Plane.

The present document describes the principal architecture of the Adaptation Layer on both the UE and RNC side of the modified Uu interface in terms of abstract service primitives and Service Access Points (SAPs), using concepts from Recommendation ITU-T X.200 [i.1] and X.210 [i.2]. These concepts are not intended to unnecessarily constrain implementations. Figure 4.2 illustrates the Service Access Points to adjacent layers.

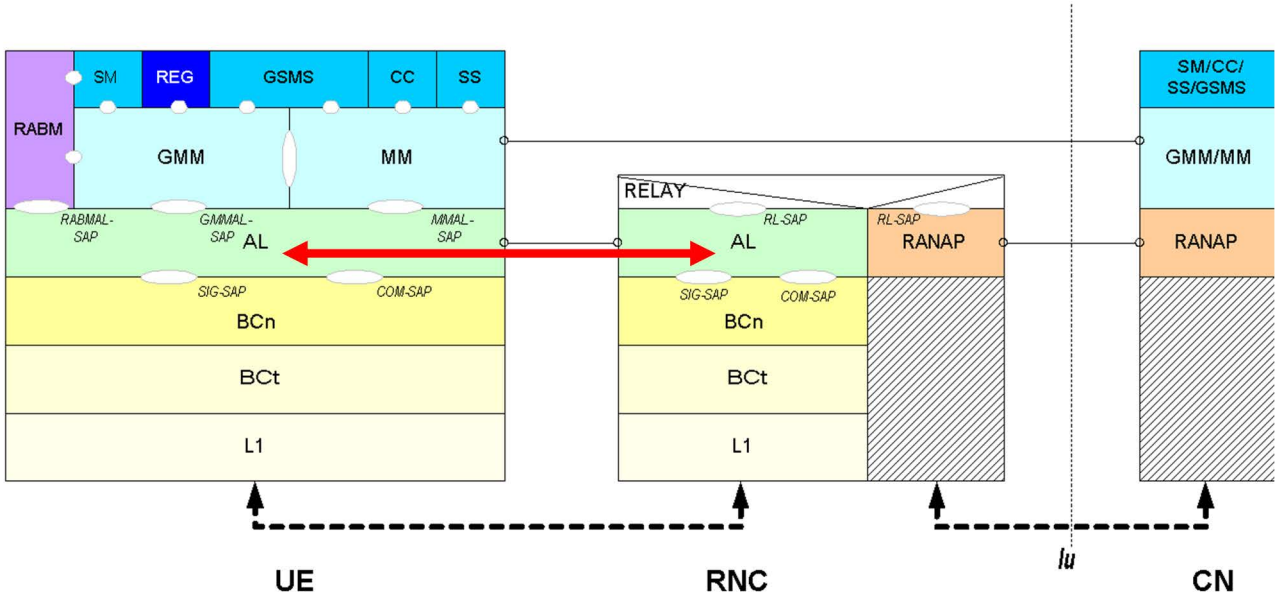

Figure 4.2: Adaptation Layer Position in Protocol Stack (Control Plane Illustrated)

5 AL Control Plane - UE Side

5.1 Services Provided to Upper Layers

The UE Adaptation Layer (AL) provides message transport and event notification services to the UMTS Layer 3 Mobility Management sublayer (GPRS Mobility Management (GMM), Mobility Management (MM), and Radio Access Bearer Management (RABM)) in the Non-Access Stratum via the Service Access Points (SAPs) defined in ETSI TS 124 007 [1], as shown in Figure 5.1:

- GMMAL-SAP: GMM to AL ("GMMAS-SAP" in UMTS)
- MMAL-SAP: MM to AL ("RR-SAP" in UMTS)
- RABMAL-SAP: RABM to AL ("RABMAS-SAP" in UMTS)

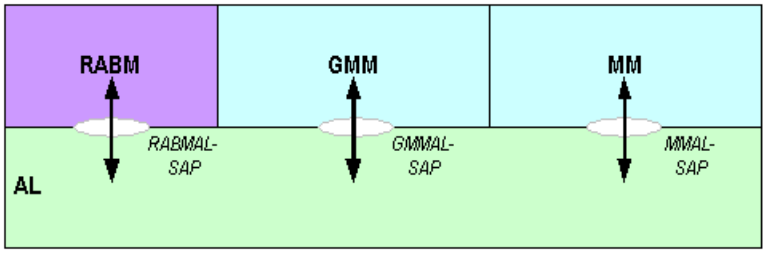

Figure 5.1: Service Access Points to Upper Layers [UE]

The UE Adaptation Layer also provides network (PLMN) discovery and selection services to the Non-Access Stratum via a General Control SAP (GC-SAP) as defined in ETSI TS 125 304 [2].

5.2 Services Expected from Lower Layers

The UE Adaptation Layer uses message transport services provided by the Bearer Connection layer to communicate with its peer in the RNC through two Service Access Points, as shown in Figure 5.2:

- Common Signalling Service Access Point (COM-SAP)
- UE-Specific Signalling Service Access Point (SIG-SAP). The SIG-SAP is a distinguished instance of the Acknowledged Mode Service Access Point (AM-SAP) as defined in ETSI TS 102 744-3-4 [10].

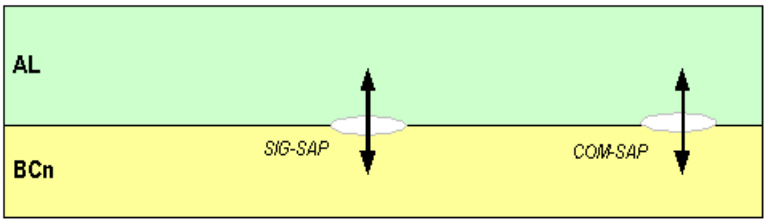

Figure 5.2: Service Access Points to Lower Layers

The Bearer Connection ID (BCnID) is the reference or handle to a particular SAP at the Adaptation Layer - Bearer Connection Layer boundary.

The UE Adaptation Layer also uses configuration and control services from both the Bearer Connection and Bearer Control Layers through two additional Service Access Points, as shown in Figure 5.3:

- Bearer Connection Service Access Point (CBCn-SAP)
- Bearer Control Service Access Point (CBCt-SAP)

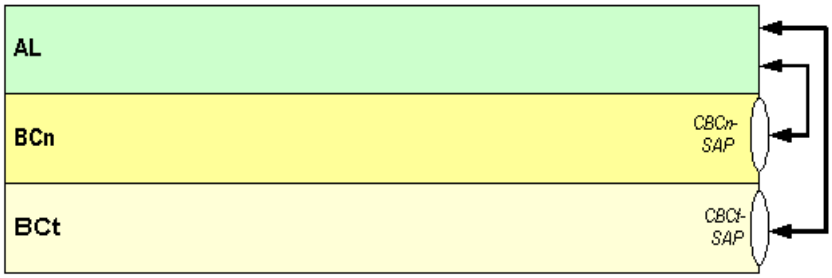

Figure 5.3: Control Service Access Points to Lower Layers [UE]

5.3 Agents in the Adaptation Layer

5.3.0 General

The Adaptation Layer in the UE contains four classes of agent:

- Registration Manager (REGM);
- GMM Service Access Point Handler (GMMH);
- MM Service Access Point Handler (MMH); and
- Radio Bearer Control (RBC).

There is one instance each of REGM, GMMH, and MMH and two instances of RBC (one for the PS domain and one for the CS domain) in the UE. For every UE Adaptation Layer agent, there is a corresponding peer in the RNC.

The UE Adaptation Layer also contains two routing functions associated with Service Access Points that are shared by more than one Adaptation Layer agent:

- SIG-SAP Router (SSR); and
- CBCn-SAP Router (CSR).

5.3.1 Registration Manager (REGM)

REGM is responsible for:

- establishing, maintaining, and releasing the UE Specific Signalling connection by performing the radio interface Registration, Handover, and Deregistration procedures with the RNC;

- reception and interpretation of System Information Broadcast messages from the RNC, as well as the forwarding of Non Access Stratum (NAS) System Information to GMM/MM;
- idle mode procedures, including PLMN and spot beam selection;
- paging notification (Type 1); and
- GPS position reporting and encryption.

REGM provides services to GMMH, MMH, RBC, and the NAS. REGM uses services provided by the Bearer Connection (via SSR or CSR) and Bearer Control Layers, as shown in Figure 5.4.

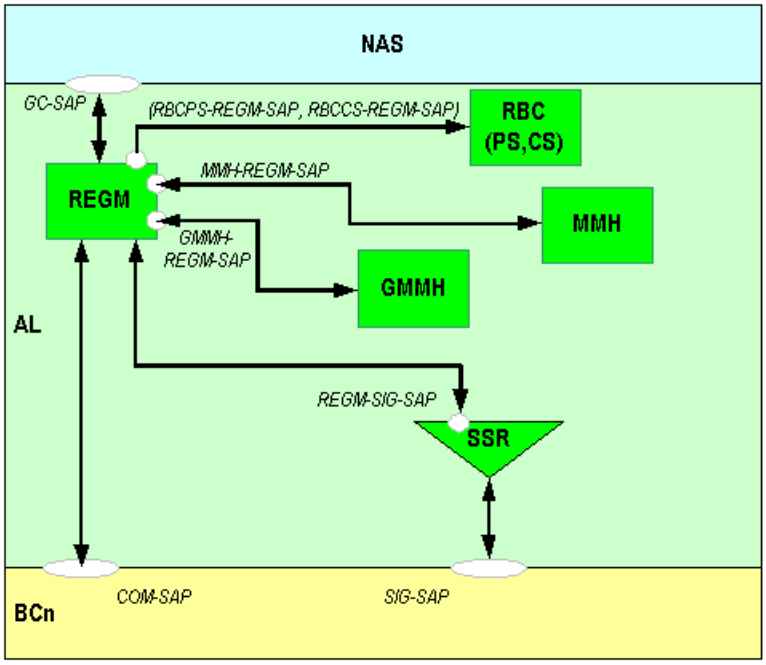

Figure 5.4: REGM Service Access Points [UE]
(REGM::CBCn and REGM::CBCt Connections Not Shown)

5.3.2 GMM Service Access Point Handler (GMMH)

GMMH provides RRC-like services to the GMM agent in the Non-Access Stratum. GMMH supports the full suite of service primitives through the GMMAS-SAP as defined in ETSI TS 124 007 [1] and expects GMM Layer 3 behaviour as defined in ETSI TS 124 008 [3]. GMMH is also responsible for integrity protection control and ciphering control functions.

GMMH uses services provided by REGM and the Bearer Connection Layer (via SSR or CSR).

5.3.3 MM Service Access Point Handler (MMH)

MMH provides RRC-like services to the MM agent in the Non-Access Stratum. MMH supports the full suite of service primitives through the RR-SAP, as defined in ETSI TS 124 007 [1], and expects MM Layer 3 behaviour as defined in ETSI TS 124 008 [3], as shown in Figure 5.5. MMH is also responsible for integrity protection control and ciphering control functions.

MMH uses services provided by REGM and the Bearer Connection Layer (via SSR or CSR).

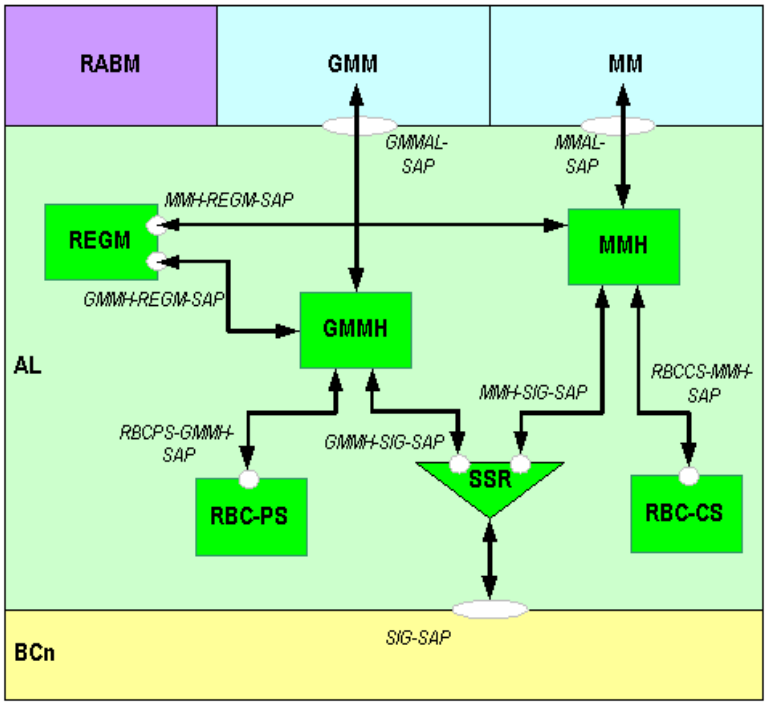

Figure 5.5: GMMH and MMH Service Access Points [UE]
(GMMH::CBCn and MMH::CBCn Connections Not Shown)

5.3.4 Radio Bearer Control (RBC)

RBC handles all signalling related to the establishment, modification, and release of radio bearers. RBC configures user plane protocol layers (such as PDCP and CSH) and agents and also provides resource assignment notification services to NAS agents (e.g. RABM and also MM via the MMH), as shown in Figure 5.6.

RBC uses services provided by REGM and the Bearer Connection Layer (via SSR or CSR).

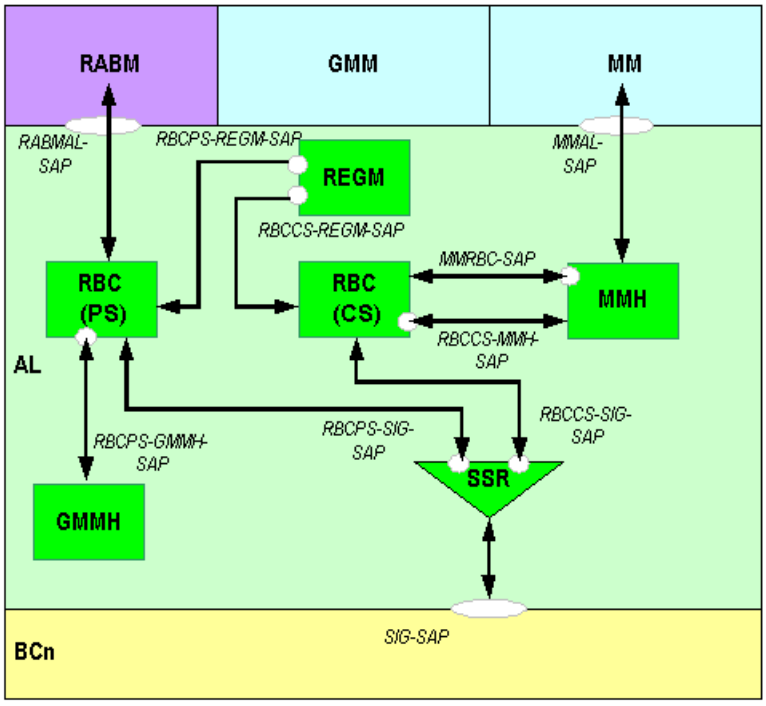

Figure 5.6: RBC Service Access Points [UE]
(RBC::CBCn Connections Not Shown)

5.3.5 SIG-SAP Router (SSR)

The Adaptation Layer contains a routing function at the SIG-SAP for Protocol Data Units (PDUs) exchanged between peer-to-peer AL agents. The SIG-SAP router is also responsible for the integrity protection of all dedicated signalling messages (see clause 7.1).

Routing between the SIG-SAP and AL agents is based on the 'Adaptation Layer Protocol Discriminator' (ALPD) information element (IE) of the PDU. The ALPD is defined as shown in Table 5.1.

Table 5.1: Adaptation Layer Protocol Discriminator (ALPD)

ALPD	AL Agent
0	Reserved
1	REGM
2	GMMH
3	MMH
4	RBC-PS
5	RBC-CS
6..8	Reserved

SSR provides services to REGM, GMMH, MMH, and RBC and uses services provided by the Bearer Connection layer, as shown in Figure 5.7.

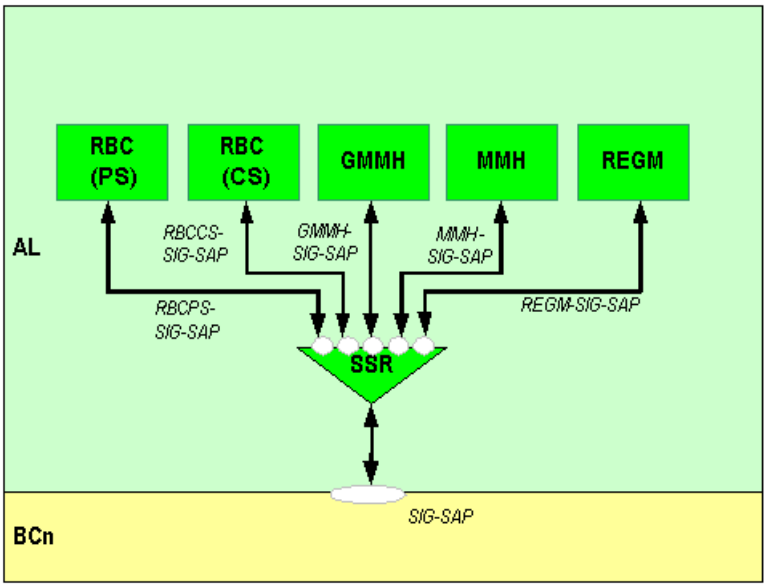

Figure 5.7: SSR Service Access Points

5.3.6 CBCn-SAP Router (CSR)

The Adaptation Layer contains a transparent routing function at the CBCn-SAP for all control service primitives exchanged between the Adaptation Layer and the Bearer Connection Manager (see ETSI TS 102 744-3-4 [10]), as shown in Figure 5.8. Routing between the CBCn-SAP and AL agents is based on the ALPD parameter, which is present in all service primitives.

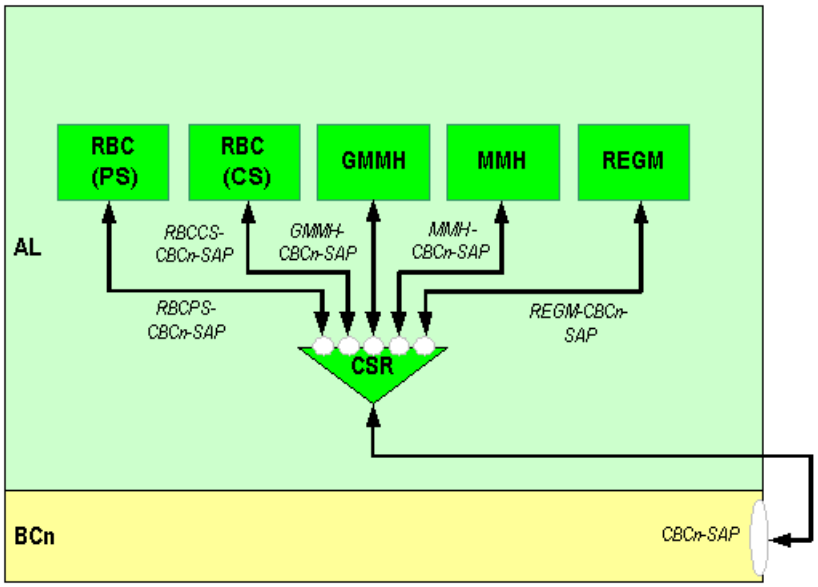

Figure 5.8: CSR Service Access Points

5.4 Protocol Definitions

5.4.1 REGM

5.4.1.1 REGM Protocol Data Units

The REGM Protocol Data Units are as shown in Table 5.2.

Table 5.2: REGM::REGM Protocol Data Units

PDU	SAP	Direction	Addressing	Information Elements
PagingType1	COM	To UE	UE NAS ID	CN Domain Identity, Paging Cause
Register	COM	From UE	UE NAS ID	Registration Reference, RI Version, CN Domain Identity, Registration Cause, UE Class
RegisterAck	COM	To UE	UE NAS ID	Registration Reference, BCnID (SIG-SAP), BCn Type, Number of (BCn) Parameters, BCn Parameter List, Control Flags, BCt Type, BCtID, BCt EPDU, Registration Mode
RegisterRej	COM	To UE	UE NAS ID	Registration Reference, CHOICE {Rejection Cause, Protocol Error Cause}
DeregisterCommon	COM	To UE	UE NAS ID	Registration Reference, CHOICE {Deregistration Cause, Protocol Error Cause}
RegisterComplete	SIG	From UE	BCnID	AL Signal Type, ALPD, Registration Reference, SEQUENCE OF {Chain Indicator, CN Domain Identity, START}, {UE Radio Access Capability} OPTIONAL
SystemInformation	SIG	To UE	BCnID	AL Signal Type, ALPD, SEQUENCE OF {BCt EPDU}
Deregister	SIG	To UE	BCnID	AL Signal Type, ALPD, Registration Reference, CHOICE{ Deregistration Cause, Protocol Error Cause}
DeregisterAck	SIG	From UE	BCnID	AL Signal Type, ALPD, Registration Reference
UEPositionRequest	SIG	To UE	BCnID	AL Signal Type, ALPD, CHOICE {RNC Public Key Index, RNC Public Key}
UEPositionResponse	SIG	From UE	BCnID	AL Signal Type, ALPD, CHOICE {GPS Position String, Encrypted GPS Position String, Spot Beam ID}
RegModeUpdate	SIG	To UE	BCnID	AL Signal Type, ALPD, Registration Reference, Registration Mode, {GPS Report Distance} OPTIONAL

PDU	SAP	Direction	Addressing	Information Elements
Handover	SIG	To UE	BCnID	AL Signal Type, ALPD, Control Flags, Transaction ID, BCt Type, BCtID, BCt EPDU
HandoverAck	SIG	From UE	BCnID	AL Signal Type, ALPD, Control Flags, Transaction ID
HandoverRequest	SIG	From UE	BCnID	AL Signal Type, ALPD, Control Flags, Transaction ID, Current Spot Beam Included, UE Position Included, Observe Target Preference, Target List Length, {Current Spot Beam} OPTIONAL, Target Spot Beam List, {UE Position} OPTIONAL
SignallingConnection Release	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity
SignallingConnection ReleaseReq	SIG	From UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, CHOICE {Connection Release Cause, Protocol Error Cause}

5.4.1.2 Service Primitives at COM-SAP

The service primitives at COM-SAP are as shown in Table 5.3.

Table 5.3: REGM::BCn Service Primitives at COM-SAP [UE]

Primitive	Direction	Information Elements
AL_COMDATA_REQ *REGM requests the BCn layer to send a PDU to its peer in the RNC*	To BCn	UE NAS ID and Type, {LAI} OPTIONAL, REGM PDU Type, REGM PDU, Retry Count
AL_COMDATA_IND *BCn indicates to REGM that it has received a PDU from the peer agent in the RNC*	To REGM	UE NAS ID and Type, REGM PDU Type, REGM PDU

5.4.1.3 Service Primitives at REGM-SIG-SAP

The service primitives at REGM-SIG-SAP are as shown in Table 5.4.

Table 5.4: REGM::SSR Service Primitives at REGM-SIG-SAP [UE]

Primitive	Direction	Parameters
SSR_SIGDATA_REQ *REGM requests SSR to send a PDU to its peer in the RNC.*	To SSR	REGM PDU
SSR_SIGDATA_IND *SSR indicates to REGM that it has received a PDU from the peer agent in the RNC.*	To REGM	REGM PDU
SSR_SIGDATA_CNF *Optional response to SSR_SIGDATA_REQ. SSR indicates to REGM that the peer agent in the RNC has received a PDU.*	To REGM	-
SSR_CONNECT_REQ *REGM requests SSR to initiate a connection to the specified SIG-SAP.*	To SSR	BCnID (SIG-SAP)
SSR_CONNECT_CNF *SSR confirms to REGM that it has connected to the specified SIG-SAP.*	To REGM	BCnID (SIG-SAP)
SSR_DISCONNECT_REQ *REGM requests SSR to disconnect from the specified SIG-SAP.*	To SSR	BCnID (SIG-SAP)
SSR_DISCONNECT_CNF *SSR confirms to REGM that it has disconnected from the specified SIG-SAP.*	To REGM	BCnID (SIG-SAP), Last COUNT-I

5.4.1.4 Service Primitives at REGM-SAP (GMMH-REGM-SAP, MMH-REGM-SAP, RBC-REGM-SAP)

The service primitives at REGM-SAP are as shown in Table 5.5.

Table 5.5: REGM::GMMH/MMH/RBC Service Primitives at REGM-SAP [UE]

Primitive	Direction	Parameters
REGM_CONN_REQ *GMMH/MMH requests REGM to initiate the Registration procedure and establish a UE-Specific signalling connection.*	To REGM	ALPD, Establishment Cause, UE NAS ID and Type, RAI/LAI
REGM_REL_REQ *GMMH/MMH requests REGM to initiate the Deregistration procedure and release the UE-Specific signalling connection.*	To REGM	ALPD, Release Cause
REGM_CONN_CNF *Response to REGM_CONN_REQ. REGM indicates that the UE-Specific signalling connection has been established.*	To GMMH/MMH	ALPD, BCnID (SIG-SAP), $START_{PS}$, $START_{CS}$, UE Security Capability
REGM_CONN_IND *REGM indicates that the UE-Specific signalling connection has been established.*	To RBC	ALPD, BCnID (SIG-SAP), $START_{PS}$, $START_{CS}$
REGM_CONN_REJ *Response to REGM_CONN_REQ. REGM indicates that the UE-Specific signalling connection has not been established.*	To GMMH/MMH	ALPD, Rejection Cause
REGM_REL_IND *REGM indicates that the network has caused the release of the UE-Specific signalling connection.*	To GMMH/MMH/ RBC	ALPD, Release Cause
REGM_REL_CNF *Response to REGM_REL_REQ. REGM indicates that the UE-Specific signalling connection has been released.*	To GMMH/MMH	ALPD
REGM_PAGE_IND *REGM indicates that a paging request (Type 1) has been received.*	To GMMH/MMH	ALPD, Paging Cause, CN Domain Identity, UE Identity Type
REGM_SIGNAL_CONN_REL_IND *REGM indicates that the Iu signalling connection for the indicated CN domain has been released, but the UE-Specific signalling connection **has not** been released.*	To GMMH/MMH	ALPD, CN Domain Identity
REGM_RAB_REL_IND *REGM instructs RBC to release all RABs pertaining to the indicated CN domain.*	To RBC	ALPD, CN Domain Identity

5.4.1.5 Service Primitives at GC-SAP

ETSI TS 125 304 [2] specifies a set of service primitives between RRC and the NAS for the purpose of PLMN Selection and NAS System Information Transport. These service primitives at GC-SAP are shown in Table 5.6.

Table 5.6: REGM::NAS Service Primitives at GC-SAP [UE]

Primitive	Direction	Parameters
SYSTEM_INFO_IND *REGM provides Non-Access Stratum (Core Network) System Information to NAS.*	To NAS	PLMN Identity, Registration Area, NAS System Information
PLMN_SEARCH_REQ *NAS requests REGM to determine if the indicated network is available (Specific PLMN Identity) or provide a list of available networks (All PLMNs).*	To REGM	Specific PLMN Identity or "All PLMNs"
PLMN_SEARCH_CNF *Response to PLMN_SEARCH_REQ (Specific PLMN Identity). REGM confirms to NAS that the specified network has been found.*	To NAS	PLMN ID
PLMN_LIST_IND *REGM provides NAS with a list of available networks (unsolicited).*	To NAS	PLMN ID List
PLMN_LIST_CNF *Response to PLMN_SEARCH_REQ (All PLMNs). REGM provides NAS with a list of available networks.* *Response to PLMN_SEARCH_REQ (Specific PLMN Identity). The requested PLMN is not available. REGM provides NAS with a list of available (alternative) networks.*	To NAS	PLMN ID List

5.4.1.6 Service Primitives at REGM-CBCn-SAP

The service primitives at REGM-CBCn-SAP are as shown in Table 5.7.

Table 5.7: REGM::CSR Service Primitives at REGM-CBCn-SAP [UE]

Primitive	Direction	Parameters
CBCn_CREATE_REQ *REGM requests the BCn layer to create the SIG-SAP with the specified handle (BCnID) and QoS attributes.*	To CSR	ALPD, BCnID (SIG-SAP), BCn/AL Parameter List, BCtID, {BCt EPDU} OPTIONAL
CBCn_CREATE_CNF *Response to CBCn_CREATE_REQ. BCn layer confirms that the SIG-SAP with the specified handle (BCnID) has been created.*	To REGM	ALPD, BCnID
CBCn_CREATE_REJ *Response to CBCn_CREATE_REQ. BCn layer confirms that the SIG-SAP with the specified handle (BCnID) has not been created for the specified reason.*	To REGM	ALPD, BCnID, Rejection Cause
CBCn_DESTROY_REQ *REGM requests the BCn layer to destroy the SIG-SAP with the specified handle (BCnID).*	To CSR	ALPD, BCnID (SIG-SAP)
CBCn_DESTROY_CNF *Response to CBCn_DESTROY_REQ. BCn layer confirms that the SIG-SAP with the specified handle (BCnID) has been destroyed.*	To REGM	ALPD, BCnID
CBCn_HANDOVER_REQ *REGM requests the BCn layer to perform an intra-RNC handover.*	To CSR	ALPD, BCnID, BCtID, BCt EPDU
CBCn_HANDOVER_CNF *Response to CBCn_HANDOVER_REQ. BCn confirms to REGM that the handover procedure in the lower layers (Bearer Connection/Bearer Control) has been completed.*	To REGM	ALPD, BCnID
CBCn_FAILURE_IND *BCn indicates a failure of the specified bearer connection to REGM.*	To REGM	ALPD, BCnID, Failure Cause

5.4.1.7 Service Primitives at CBCt-SAP

The service primitives at CBCt-SAP are as shown in Table 5.8.

Table 5.8: REGM::BCt Service Primitives at CBCt-SAP [UE]

Primitive	Direction	Parameters
CBCt_DISCOVER_REQ *REGM requests the BCt layer to find and camp on the identified PSAB. Where more than one PSAB is indicated, REGM requests the BCt layer to select and camp on to the most suitable PSAB in the list.*	To BCt	ALPD, Global Discover Flag, SEQUENCE OF {PSAB Information}
CBCt_DISCOVER_CNF *Response to CBCt_DISCOVER_REQ. The BCt layer confirms that it has camped on the identified PSAB.*	From BCt	ALPD, PSAB Information
CBCt_DISCOVER_REJ *Response to CBCt_DISCOVER_REQ. The BCt layer indicates that it cannot find or camp on to any of the identified PSABs.*	From BCt	ALPD, Rejection Cause
CBCt_POSITION_REQ *REGM requests the BCt layer to provide the UE GPS position.*	To BCt	ALPD
CBCt_POSITION_CNF *Response to CBCt_POSITION_REQ. The BCt layer provides the UE GPS position to REGM.*	From BCt	ALPD, GPS Position String
CBCt_POSITION_REJ *Response to CBCt_POSITION_REQ. The BCt layer indicates that it is unable to provide the UE GPS position to REGM for the specified reason.*	From BCt	ALPD, Rejection Cause
CBCt_SYSTEM_INFO_IND *The BCt layer provides received System Information to REGM.*	From BCt	ALPD, SEQUENCE OF {System Info Index Version, System Information AVP/SDU Set}

5.4.1.8 REGM States

The REGM states are as shown in Table 5.9.

Table 5.9: REGM States [UE]

Number	State	Description
1	IDLE ("RRC-IDLE")	The UE is not registered with the RNC and a UE-Specific signalling connection between the UE and RNC is not established. This state has five substates.
>1a	IDLE-AWAIT-PLMN-DISCOVERY ★Initial State	REGM has not initiated any idle mode procedure and it is waiting for a PLMN selection command from the NAS.
>1b	IDLE-AWAIT-PSAB-DISCOVERY	REGM has initiated the PSAB Discovery procedure and is waiting to receive a response from the Bearer Control layer.
>1c	IDLE-AWAIT-SYSTEM-INFORMATION	The PSAB Discovery procedure has completed successfully and REGM is waiting to receive System Information from the Bearer Control layer.
>1d	IDLE-AWAIT-POSITION	REGM has requested the Bearer Control layer to provide the UE GPS Position and is waiting for a response.
>1e	IDLE-NETWORK-FOUND	The UMTS network selected by the Non-Access Stratum has been found and REGM is ready to initiate the Registration procedure with the RNC.
2	REGISTERING	REGM has received a request to establish a UE-Specific signalling connection by either GMMH or MMH and is currently performing the Registration procedure. This state has four substates.
>2a	REGISTERING-AWAIT-RESPONSE	REGM has sent the Register message to its peer in the RNC and is waiting for a response.
>2b	REGISTERING-AWAIT-CREATE	REGM has requested the Bearer Control layer to create the SIG-SAP and is waiting for a response.
>2c	REGISTERING-AWAIT-CONNECT	REGM has requested SSR to connect to the SIG-SAP and is waiting for confirmation.
>2d	REGISTERING-AWAIT-GPS-POSITION	REGM has requested the Bearer Control layer to provide the UE GPS Position and is waiting for a response.

Number	State	Description
3	REGISTERED-CONDITIONAL	The UE is registered with the RNC and a UE-Specific signalling connection between the UE and RNC has been established but the RNC has indicated that validation of the UE position is required before the UE can access network services (Registration Mode 0). This state has three substates.
>3a	REGISTERED-CONDITIONAL-AWAIT-POS-REQ	REGM is waiting to receive the UEPositionRequest message from its peer in the RNC.
>3b	Void	
>3c	REGISTERED-CONDITIONAL-AWAIT-REG-MODE-UPDATE	REGM has received and responded to the UEPositionRequest message and is waiting for validation from the RNC.
>3d	REGISTERED-CONDITIONAL-AWAIT-HANDOVER-LEASE	REGM has informed the Bearer Connection layer of an intra-RNC handover to a bearer allocated to the current subscriber's Lease Group and is waiting for confirmation that the handover procedure in the lower layers (Bearer Connection/Bearer Control) has been completed.
4	REGISTERED ("RRC-CONNECTED")	The UE is registered with the RNC, a UE-Specific signalling connection between the UE and RNC has been established, and the UE has full access to network services (Registration Mode 3).
5	RELEASING	REGM is currently involved in a procedure to release the UE-Specific Signalling connection. This state has seven substates.
>5a	RELEASING-AWAIT-RELEASE	REGM has initiated the Signalling Connection Release procedure (for either the PS or CS service domain) and is currently waiting for a response from the peer in the RNC.
>5b	RELEASING-AWAIT-DESTROY	REGM has requested the Bearer Connection layer to destroy the SIG-SAP and is waiting for confirmation.
>5c	RELEASING-AWAIT-DISCONNECT	REGM has requested the SSR to disconnect from the SIG-SAP and is waiting for confirmation.
>5d	RELEASING-AWAIT-DESTROY-IMPLICIT	REGM has requested the Bearer Connection layer to destroy the SIG-SAP and is waiting for confirmation (implicit deregistration).
>5e	RELEASING-AWAIT-DISCONNECT-IMPLICIT	REGM has requested the SSR to disconnect from the SIG-SAP and is waiting for confirmation (implicit deregistration).
>5f	RELEASING-AWAIT-DISCONNECT-NO-COVERAGE	REGM has requested the Bearer Connection layer to destroy the SIG-SAP and is waiting for confirmation (UE is outside satellite/spot beam coverage area, implicit deregistration).
>5g	RELEASING-AWAIT-DISCONNECT-NO-COVERAGE	REGM has requested the SSR to disconnect from the SIG-SAP and is waiting for confirmation (UE is outside satellite/spot beam coverage area, implicit deregistration).
6	AWAIT-HANDOVER-RESPONSE	REGM has informed the Bearer Connection layer of an intra-RNC handover and is waiting for confirmation that the handover procedure in the lower layers (Bearer Connection/Bearer Control) has been completed.

5.4.1.9 REGM Behaviour

5.4.1.9.0 General

REGM behaviour in the UE is summarized in the signal-state diagram in Figure 5.9. Substates of the 'IDLE' state ("idle mode behaviour") are shown in Figure 5.10.

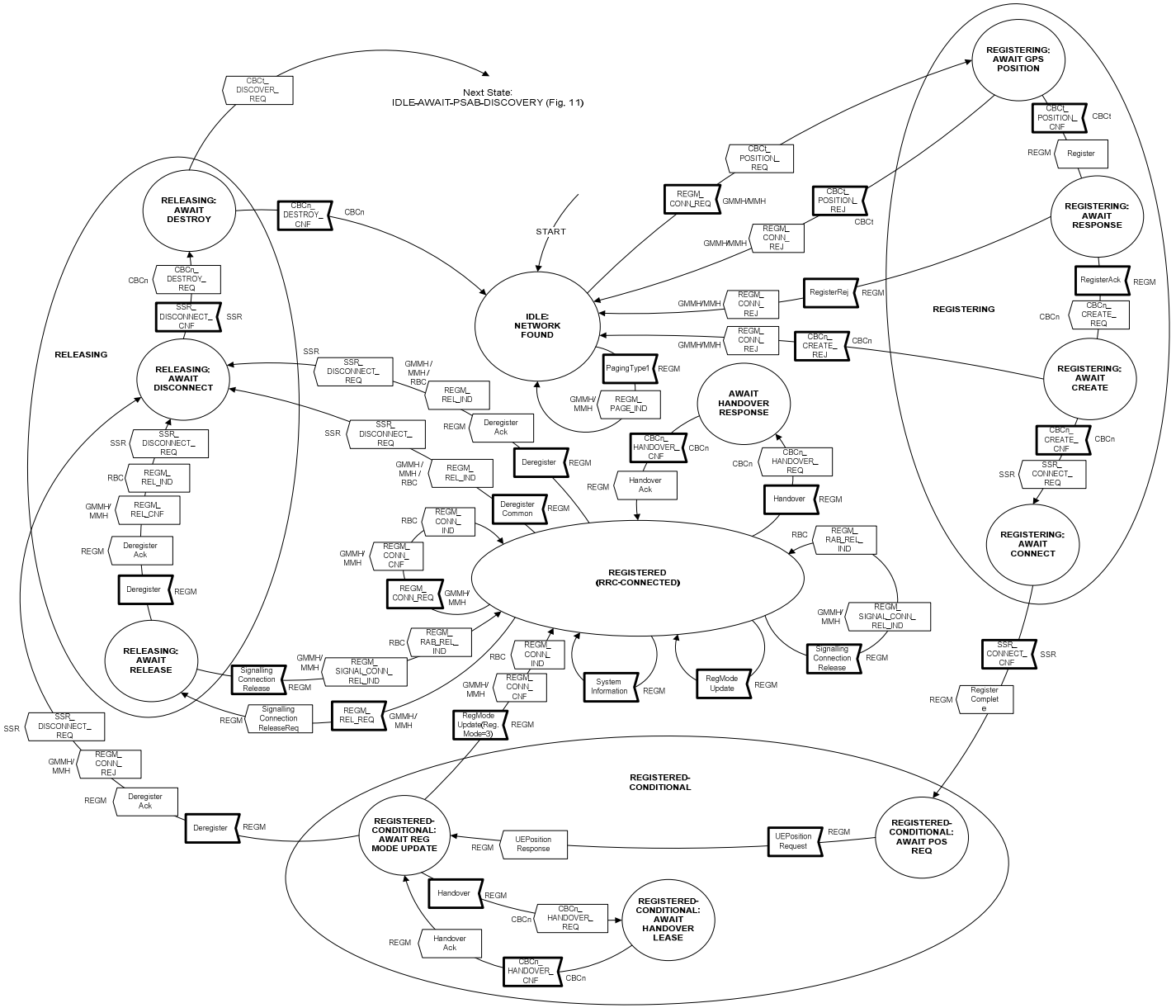

Figure 5.9: UE REGM Signal-State Diagram

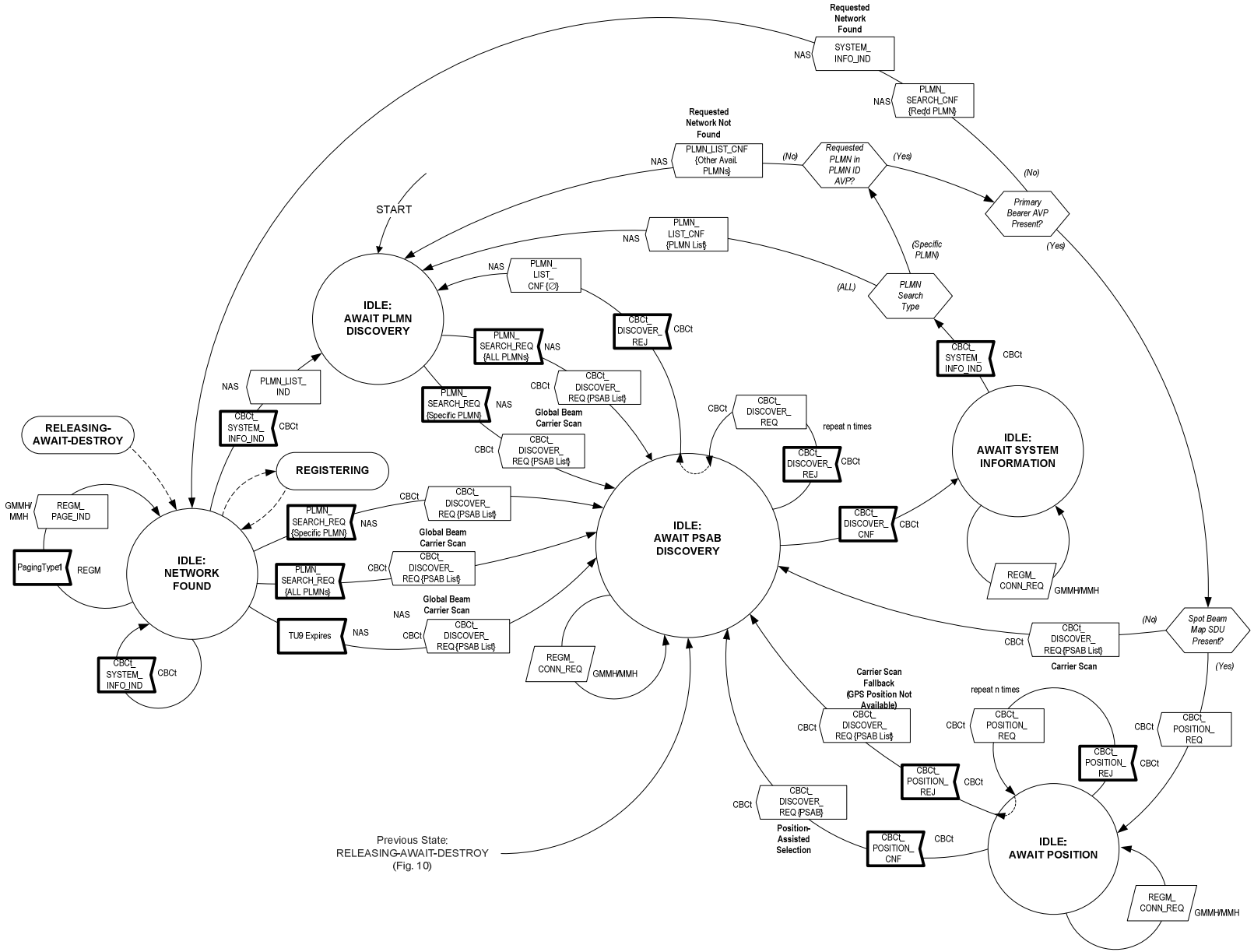

Figure 5.10: UE REGM Idle Mode Signal-State Diagram

5.4.1.9.1 Behaviour in State 'IDLE'

5.4.1.9.1.1 Behaviour in Substate 'AWAIT-PLMN-DISCOVERY'

On entry to this state (i.e. on REGM startup), REGM shall initialize CU13.

On receipt of the PLMN_SEARCH_REQ primitive from the Non-Access Stratum (NAS), REGM shall save the type of PLMN search requested (either "Specific PLMN ID" or "All PLMN IDs". In the case of a "Specific PLMN ID" search, REGM shall also save the PLMN ID specified by the NAS. REGM shall then request the Bearer Control layer to perform a global beam carrier scan by sending the CBCt_DISCOVER_REQ primitive to CBCt. The 'Global Discover Flag' shall be set to "TRUE" and the 'PSAB Information' parameter list shall be derived from the Satellite Table (see clause 5.4.1.11). REGM shall start timer TU1 and initialize the associated retry counter CU1. The REGM state shall change to 'IDLE-AWAIT-PSAB-DISCOVERY'.

5.4.1.9.1.2 Behaviour in Substate 'AWAIT-PSAB-DISCOVERY'

On receipt of CBCt_DISCOVER_REJ primitive from CBCt, or if timer TU1 expires before receiving a response from CBCt, REGM shall resend the CBCt_DISCOVER_REQ primitive to CBCt. This process may repeat up to the limit imposed by the retry counter CU1. After the maximum number of requests to the Bearer Control layer have been made, then REGM shall send the PLMN_LIST_CNF primitive to the NAS with a null 'PLMN ID List' parameter. The REGM state shall change to 'IDLE-AWAIT-PLMN-DISCOVERY'.

On receipt of the CBCt_DISCOVER_CNF primitive from CBCt layer, REGM shall stop timer TU1 and start timer TU8. The REGM state shall change to 'IDLE-AWAIT-SYSTEM-INFORMATION'.

REGM shall save the REGM_CONN_REQ primitive (for processing in substate 'NETWORK-FOUND') if received from GMMH or MMH.

5.4.1.9.1.3 Behaviour in Substate 'AWAIT-SYSTEM-INFORMATION'

On entry to this state, REGM shall consider the current System Information as invalid.

On receipt of the CBCt_SYSTEM_INFO_IND primitive from the BCt layer, REGM shall stop timer TU8 and unpack the encapsulated AVP list. The System Information received shall be considered the "current System Information":

- 1> if the AVP list contains the NAS System Info AVP, then REGM shall immediately forward this to the NAS using the SYSTEM_INFO_IND primitive via the GC-SAP.
- 1> if the AVP list contains the GPS Policy Info AVP, then REGM shall enable or inhibit the display of the UE GPS position to the user according to the value of the 'GPS Display Enable' IE. REGM may also invoke other procedures related to the acquisition of a GPS position fix depending on the values of the other IEs in this AVP, but these methods are implementation-dependent and considered outside the scope of the Adaptation Layer specification.
- 1> if the AVP list contains one or more instances of the Satellite Location AVP, then REGM shall update the Satellite Table according to the rules in clause 5.4.1.11.
- 1> if the AVP list contains the Randomized Initial Access Delay AVP
    - 2> if CU13 is equal to "0", then REGM shall set the value of timer TU13 to the sum of the value of the ‘Initial Fixed Delay’ IE and a random value between "0" and the value of the 'Randomized Delay Interval' IE. REGM then increments CU13 and starts timer TU13.
    - 2> if CU13 is not equal to "0", then this procedure terminates.

If the NAS had requested a search for "All PLMN IDs", then REGM shall send the PLMN_LIST_CNF primitive to the NAS. The 'PLMN ID List' parameter shall contain a list of PLMN IDs generated from every instance of the PLMN Info AVP. The REGM state shall change to 'IDLE-AWAIT-PLMN-DISCOVERY'.

If the NAS had requested a search for a "Specific PLMN ID" and if the PLMN requested by the NAS is not specified in any instance of the PLMN Info AVP, then REGM shall send the PLMN_SEARCH_CNF primitive to the NAS. The 'PLMN ID List' parameter shall contain a list of PLMN IDs generated from every instance of the PLMN Info AVP in the current System Information. The REGM state shall change to 'IDLE-AWAIT-PLMN-DISCOVERY'.

If the NAS had requested a search for a "Specific PLMN ID" and if the requested PLMN is specified in at least one instance of the PLMN Info AVP, then:

- 1> If the current System Information contains one or more instances of the Primary Bearer AVP, then:
  - 2> If the current System Information contains the Spot Beam Map SDU, then REGM shall send the CBCt_POSITION_REQ primitive to CBCt. REGM shall start timer TU2 and initialize the associated retry counter CU2. The REGM state shall change to 'IDLE-AWAIT-POSITION'.
  - 2> If the current System Information does not contain the Spot Beam Map SDU, then REGM shall compose a list of candidate bearers to scan from every instance of the Primary Bearer AVP in the current System Information (*except* those instances which specify a particular PLMN ID which is not the same as the PLMN ID requested by the NAS, or a particular UE Class which is not the same as the class of this UE):
    - 3> If the list of candidate bearers is empty then REGM shall send the PLMN_LIST_CNF primitive to the NAS with a null 'PLMN ID List' parameter. The REGM state shall change to 'IDLE-AWAIT-PLMN-DISCOVERY'.
    - 3> If the list of candidate bearers is not empty, then REGM shall send the CBCt_DISCOVER_REQ primitive to CBCt with the 'Global Discover Flag' set to "FALSE" and the 'PSAB Information' list parameter set to the list of candidate bearers. The list may be ordered such that the identifying frequency of the most recently used spot beam on the current satellite (if any) is first. The REGM state shall change to 'AWAIT-PSAB-DISCOVERY'.
- 1> If the current System Information does not contain at least one instance of the Primary Bearer AVP, then REGM shall start timer TU9 and send the PLMN_SEARCH_CNF primitive to the NAS with the 'PLMN ID' parameter set to the PLMN ID initially requested by the NAS. The REGM state shall change to 'IDLE-NETWORK-FOUND'.

If timer TU8 expires, then REGM shall send the PLMN_LIST_CNF primitive to the NAS with a null 'PLMN ID List' parameter. The REGM state shall change to 'IDLE-AWAIT-PLMN-DISCOVERY'.

REGM shall save the REGM_CONN_REQ primitive (for processing in substate 'NETWORK-FOUND') if received from GMMH or MMH.

5.4.1.9.1.4 Behaviour in Substate 'AWAIT-POSITION'

On receipt of the CBCt_POSITION_CNF primitive from CBCt, REGM shall store the value of the 'GPS Position String' parameter, stop timer TU2 and use the spot beam selection algorithm described in clause 8 to determine in which spot beam (or spot beams) the UE is currently located:

- 1> if the spot beam selection algorithm determines that the UE is located in one and only one spot beam, then REGM shall compose a list of candidate bearers to scan from every instance of the Primary Bearer AVP in the current System Information which corresponds to this beam, and:
  - 2> If the list is empty, then REGM shall start timer TU9 and send the PLMN_SEARCH_CNF primitive to the NAS with the 'PLMN ID' parameter set to the PLMN ID initially requested by the NAS. The REGM state shall change to 'IDLE-NETWORK-FOUND'.
  - 2> If the list is not empty then REGM shall compose a list of candidate bearers to scan from every instance of the Primary Bearer AVP in the current System Information which corresponds to this beam (except those instances which specify a particular PLMN ID which is not the same as the PLMN ID requested by the NAS, or a particular UE Class which is not the same as the class of this UE) and:
    - 3> If the list of candidate bearers is empty then REGM shall send the PLMN_LIST_CNF primitive to the NAS with a null 'PLMN ID List' parameter. The REGM state shall change to 'IDLE-AWAIT-PLMN-DISCOVERY'.
    - 3> If the list of candidate bearers is not empty, then REGM shall send the CBCt_DISCOVER_REQ primitive to CBCt with the 'Global Discover Flag' set to "FALSE" and the 'PSAB Information' list parameter set to the list of candidate bearers. The REGM state shall change to 'AWAIT-PSAB-DISCOVERY'.

- 1> if the spot beam selection algorithm determines that the UE is in an area where two or more spot beams overlap:
  - 2> If one of the overlapping beams has a higher preference level than the others, then REGM shall compose a list of candidate bearers to scan from every instance of the Primary Bearer AVP in the current System Information which corresponds to this beam, and:
    - 3> If the list is empty, then REGM shall start timer TU9 and send the PLMN_SEARCH_CNF primitive to the NAS with the 'PLMN ID' parameter set to the PLMN ID initially requested by the NAS. The REGM state shall change to 'IDLE-NETWORK-FOUND'.
    - 3> If the list is not empty then REGM shall compose a list of candidate bearers to scan from every instance of the Primary Bearer AVP in the current System Information which corresponds to this beam (except those instances which specify a particular PLMN ID which is not the same as the PLMN ID requested by the NAS, or a particular UE Class which is not the same as the class of this UE), and:
      - 4> If the list of candidate bearers is empty then REGM shall send the PLMN_LIST_CNF primitive to the NAS with a null 'PLMN ID List' parameter. The REGM state shall change to 'IDLE-AWAIT-PLMN-DISCOVERY'.
      - 4> If the list of candidate bearers is not empty, then REGM shall send the CBCt_DISCOVER_REQ primitive to CBCt with the 'Global Discover Flag' set to "FALSE" and the 'PSAB Information' list parameter set to the list of candidate bearers. The REGM state shall change to 'AWAIT-PSAB-DISCOVERY'.
  - 2> If two or more of the overlapping spot beams have a higher preference level than the others, then REGM shall compose a list of candidate bearers to scan from every instance of the Primary Bearer AVP in the current System Information which corresponds to any of the overlapping beams, and:
    - 3> If the list is empty, then REGM shall start timer TU9 and send the PLMN_SEARCH_CNF primitive to the NAS with the 'PLMN ID' parameter set to the PLMN ID initially requested by the NAS. The REGM state shall change to 'IDLE-NETWORK-FOUND'.
    - 3> If the list is not empty then REGM shall compose a list of candidate bearers to scan from every instance of the Primary Bearer AVP in the current System Information which corresponds to this beam (except those instances which specify a particular PLMN ID which is not the same as the PLMN ID requested by the NAS, or a particular UE Class which is not the same as the class of this UE), and:
      - 4> If the list of candidate bearers is empty then REGM shall send the PLMN_LIST_CNF primitive to the NAS with a null 'PLMN ID List' parameter. The REGM state shall change to 'IDLE-AWAIT-PLMN-DISCOVERY'.
      - 4> If the list of candidate bearers is not empty, then REGM shall send the CBCt_DISCOVER_REQ primitive to CBCt with the 'Global Discover Flag' set to "FALSE and the 'PSAB Information' list parameter set to the list of candidate bearers. The REGM state shall change to 'AWAIT-PSAB-DISCOVERY'.
- 1> If the spot beam selection algorithm determines that the UE is in an area which is not covered by any spot beam, then REGM shall request the Bearer Control layer to perform a global beam carrier scan by sending the CBCt_DISCOVER_REQ primitive to CBCt. The 'Global Discover Flag' shall be set to "TRUE" and the 'PSAB Information' parameter list shall be derived from the Satellite Table (see clause 5.4.1.11) *except* the identifying frequencies of the current satellite shall not be included. REGM shall start timer TU1 and initialize the associated retry counter CU1. The REGM state shall change to 'AWAIT-PSAB-DISCOVERY'.

On receipt of CBCt_POSITION_REJ primitive from CBCt, or if timer TU2 expires before receiving a response from CBCt, REGM shall resend the CBCt_POSITION_REQ primitive to CBCt. This process may repeat up to the limit imposed by the retry counter CU2. After the maximum number of requests to the Bearer Control layer have been made, REGM shall revert to spot beam selection by carrier scanning by sending the CBCt_DISCOVER_REQ primitive to CBCt with the 'Global Discover Flag' set to "FALSE" and the 'PSAB Information' list parameter generated from every instance of the Primary Bearer AVP in the current System Information (*except* those instances which specify a particular PLMN ID which is not the same as the PLMN ID requested by the NAS, or a particular UE Class which is not the same as the class of this UE). The list may be ordered such that the identifying frequency of the most recently used spot beam on the current satellite (if any) is first. The REGM state shall change to 'AWAIT-PSAB-DISCOVERY'.

REGM shall save the REGM_CONN_REQ primitive (for processing in substate 'NETWORK-FOUND') if received from GMMH or MMH.

5.4.1.9.1.5 Behaviour in Substate 'NETWORK-FOUND'

In the substate 'IDLE-NETWORK-FOUND', REGM is ready to accept requests from GMMH and MMH to initiate the Registration procedure and establish the UE-Specific Signalling connection.

On receipt of the REGM_CONN_REQ primitive from GMMH or MMH:

- 1> If timer TU13 is running, then REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH.
- 1> If timer TU13 is not running, then REGM shall check for the presence of the Access Control AVP in the current System Information and, if present, examine the "Access Class", "Emergency Call Access Class Override", and "SIM Control" IEs as follows:
  - 2> If the Access Control AVP is not present in the current System Information, then REGM shall request the Bearer Control layer to provide the current UE GPS position by sending the CBCt_POSITION_REQ primitive to CBCt. REGM shall stop timer TU9, start timer TU4, and initialize the associated retry counter CU4. The REGM state shall change to 'REGISTERING-AWAIT-GPS-POSITION'.
  - 2> If the Access Control AVP is present in the current System Information, then:
    - 3> if the 'Establishment Cause' parameter of the REGM_CONN_REQ primitive from GMMH/MMH indicates a request at normal priority, then:
      - 4> if the UE is a member of at least one of the Access Classes which are permitted in this network according to the Access Control AVP, and if the Access Class is applicable in this network (see ETSI TS 122 011 [12]), then:
        - 5> if the 'UE NAS Identity' parameter of the REGM_CONN_REQ primitive from GMMH/MMH is of type IMEI, then:
          - 6> If the 'SIM Card Control' IE in the Access Control AVP is set to "IMEI Permitted" then REGM shall request the Bearer Control layer to provide the current UE GPS position by sending the CBCt_POSITION_REQ primitive to CBCt. REGM shall stop timer TU9, start timer TU4, and initialize the associated retry counter CU4. The REGM state shall change to 'REGISTERING-AWAIT-GPS-POSITION'.
          - 6> If the 'SIM Card Control' IE in the Access Control AVP is not set to "IMEI Permitted" then REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH.
        - 5> If the 'UE NAS Identity' parameter of the REGM_CONN_REQ primitive from GMMH/MMH is not of type IMEI, then REGM shall request the Bearer Control layer to provide the current UE GPS position by sending the CBCt_POSITION_REQ primitive to CBCt. REGM shall stop timer TU9, start timer TU4, and initialize the associated retry counter CU4. The REGM state shall change to 'REGISTERING-AWAIT-GPS-POSITION'.
      - 4> If the UE is not a member of a permitted Access Class, then REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH.
    - 3> If the 'Establishment Cause' parameter of the REGM_CONN_REQ primitive from GMMH/MMH indicates a request at emergency priority, then:

- 4> if the 'Emergency Call Access Class Override' IE in the Access Control AVP is set to "TRUE", then:
  - 5> if the 'UE NAS Identity' parameter of the REGM_CONN_REQ primitive from GMMH/MMH is of type IMEI, then:
    - 6> if the 'SIM Card Control' IE in the Access Control AVP is set to "IMEI Permitted" or "IMEI Permitted Emergency Calls Only", then REGM shall request the Bearer Control layer to provide the current UE GPS position by sending the CBCt_POSITION_REQ primitive to CBCt. REGM shall stop timer TU9, start timer TU4, and initialize the associated retry counter CU4. The REGM state shall change to 'REGISTERING-AWAIT-GPS-POSITION'.
    - 6> if the 'SIM Card Control' IE in the Access Control AVP is not set to "IMEI Permitted" or "IMEI Permitted Emergency Calls Only", then REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH.
  - 5> if the 'UE NAS Identity' parameter of the REGM_CONN_REQ primitive from GMMH/MMH is not of type IMEI, then REGM shall request the Bearer Control layer to provide the current UE GPS position by sending the CBCt_POSITION_REQ primitive to CBCt. REGM shall stop timer TU9, start timer TU4, and initialize the associated retry counter CU4. The REGM state shall change to 'REGISTERING-AWAIT-GPS-POSITION'.
- 4> if the 'Emergency Call Access Class Override' IE in the Access Control AVP is set to "FALSE":
  - 5> if the 'UE NAS Identity' parameter of the REGM_CONN_REQ primitive from GMMH/MMH is of type IMEI, then REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH.
  - 5> if the 'UE NAS Identity' parameter of the REGM_CONN_REQ primitive from GMMH/MMH is not of type IMEI, and:
    - 6> if the UE is a member of at least one of the Access Classes which are permitted in this network according to the Access Control AVP, and if the Access Class is applicable in this network (see ETSI TS 122 011 [12]), then REGM shall request the Bearer Control layer to provide the current UE GPS position by sending the CBCt_POSITION_REQ primitive to CBCt. REGM shall stop timer TU9, start timer TU4, and initialize the associated retry counter CU4. The REGM state shall change to 'REGISTERING-AWAIT-GPS-POSITION'.
    - 6> if the UE is not a member of a permitted Access Class then REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH.

On receipt of the CBCt_SYSTEM_INFO_IND primitive from CBCt, REGM shall unpack the encapsulated AVP list and update the current System Information set as appropriate:

- 1> if the AVP list contains the NAS System Info AVP, then REGM shall immediately forward this to the NAS using the SYSTEM_INFO_IND primitive via the GC-SAP.
- 1> if the AVP list contains one or more instances of the PLMN Info AVP:
  - 2> if the current PLMN ID is no longer identified in any of the instances of the PLMN Info AVP, then REGM shall send the PLMN_LIST_IND primitive to the NAS. The 'PLMN ID List' parameter shall contain a list of PLMN IDs generated from every instance of the PLMN Info AVP in the current System Information. The REGM state shall change to 'IDLE-AWAIT-PLMN-DISCOVERY'.
- 1> if the AVP list contains the GPS Policy Info AVP, then REGM shall enable or inhibit the display of the UE GPS position to the user according to the value of the 'GPS Display Enable' IE. REGM may also invoke other procedures related to the acquisition of a GPS position fix depending on the values of the other IEs in this AVP, but these methods are implementation-dependent and considered outside the scope of the Adaptation Layer specification.

- 1> if the AVP list contains one or more instances of the Satellite Location AVP, then REGM shall update the Satellite Table according to the rules in clause 5.4.1.11.

On receipt of the AL_COMDATA_IND primitive from the COM-SAP, REGM shall examine the PDU type parameter. If the PDU type is REGM:PagingType1, then REGM shall send the REGM_PAGE_IND primitive to either GMMH or MMH depending on the value of the 'CN Domain Identity' IE. If it is any other PDU, the PDU shall be discarded.

On receipt of the PLMN_SEARCH_REQ primitive from the Non-Access Stratum (NAS), REGM shall save the type of PLMN search requested (either "Specific PLMN ID" or "All PLMN IDs". In the case of a "Specific PLMN ID" search, REGM shall also save the PLMN ID specified by the NAS. REGM shall then request the Bearer Control layer to perform a global beam carrier scan by sending the CBCt_DISCOVER_REQ primitive to CBCt. The 'Global Discover Flag' shall be set to "TRUE" and the 'PSAB Information' parameter list shall be derived from the Satellite Table (see clause 5.4.1.11). REGM shall start timer TU1 and initialize the associated retry counter CU1. The REGM state shall change to 'IDLE-AWAIT-PSAB-DISCOVERY'.

If timer TU9 expires while in this state, then REGM shall verify the availability of the current PLMN (as if the NAS had requested a "Specific PLMN" search for the current PLMN). REGM shall request the Bearer Control layer to perform a global beam carrier scan by sending the CBCt_DISCOVER_REQ primitive to CBCt. The 'Global Discover Flag' shall be set to "TRUE" and the 'PSAB Information' parameter list shall be derived from the Satellite Table (see clause 5.4.1.11). REGM shall start timer TU1 and initialize the associated retry counter CU1. The REGM state shall change to 'IDLE-AWAIT-PSAB-DISCOVERY'.

5.4.1.9.2 Behaviour in State 'REGISTERING'

5.4.1.9.2.0 General

The REGISTERING state has four substates: 'AWAIT-RESPONSE', 'AWAIT-CREATE', and 'AWAIT-CONNECT'.

5.4.1.9.2.1 Behaviour in Substate 'AWAIT-RESPONSE'

On receipt of the AL_COMDATA_IND primitive from the COM-SAP, REGM shall examine the PDU type parameter:

- 1> if the PDU type is REGM:RegisterAck, then:
  - 2> if the value of the 'Registration Reference' IE in the REGM:RegisterAck PDU matches any of the values in the stored list of pending registration references or is equal to "0", then REGM shall stop timer TU3 and request the Bearer Connection layer to create the SIG-SAP for the UE-Specific Signalling connection by sending the CBCn_CREATE_REQ to CBCn. The REGM state shall change to 'REGISTERING-AWAIT-CREATE'.
  - 2> if the value of the 'Registration Reference' IE in the REGM:RegisterAck PDU does not match any of the values in the stored list of pending registration references and is not equal to "0", then REGM shall ignore the received PDU.
- 1> if the PDU type is REGM:RegisterRej, then:
  - 2> if the value of the 'Registration Reference' IE in the REGM:RegisterRej PDU matches any of the values in the stored list of pending registration references or is equal to "0", then REGM shall stop timer TU3, start timer TU9, and send the REGM_CONN_REJ primitive to GMMH/MMH. The REGM state shall change to 'IDLE-NETWORK-FOUND'.
  - 2> if the value of the 'Registration Reference' IE in the REGM:RegisterRej PDU does not match any of the values in the stored list of pending registration references and is not equal to "0", then REGM shall ignore the received PDU.

If timer TU3 expires before the REGM:RegisterAck or REGM:RegisterRej PDU is received, then REGM shall resend the REGM:Register PDU to the peer REGM agent in the RNC using the AL_COMDATA_REQ primitive with the 'Retry Count' parameter incremented by one from its previous value. Each time the REGM:Register PDU is sent, REGM shall generate a new (and unused) random value for the 'Registration Reference' IE and add it to the list of pending registration references. This process may repeat up to the limit imposed by the retry counter CU3. After sending the REGM:Register PDU the maximum number of times, REGM shall start timer TU9 and send the REGM_CONN_REJ primitive to GMMH/MMH and the REGM state shall change to 'IDLE-NETWORK-FOUND'.

Note that the Common Signalling Retry AVP in the current System Information, if present, determines the number of times that the UE may repeat the Registration procedure and the timeout between attempts (i.e. the values of timer TU3 and counter CU3).

5.4.1.9.2.2 Behaviour in Substate 'AWAIT-CREATE'

On receipt of the CBCn_CREATE_CNF primitive from CBCn, REGM shall send the SSR_CONNECT_REQ primitive to SSR. The REGM state shall change to 'REGISTERING-AWAIT-CONNECT'.

On receipt of the CBCn_CREATE_REJ primitive from CBCn, REGM shall start timer TU9 and send the REGM_CONN_REJ primitive to GMMH/MMH. The REGM state shall change to 'IDLE-NETWORK-FOUND'.

5.4.1.9.2.3 Behaviour in Substate 'AWAIT-CONNECT'

On receipt of the SSR_CONNECT_CNF primitive from SSR, REGM shall examine the 'Registration Mode' parameter received in the REGM:RegisterAck PDU from the peer REGM agent in the RNC:

- If the 'Registration Mode' parameter is set to "0", then REGM shall compose the REGM:RegisterComplete PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE in the REGM:RegisterComplete PDU shall be set to the value of the same IE in the received REGM:RegisterAck PDU. REGM shall start timer TU5 and initialize the associated retry counter CU5. The REGM state shall change to 'REGISTERED-CONDITIONAL-AWAIT-POS-REQ'.

- If the 'Registration Mode' parameter is set to "3", then REGM shall compose the REGM:RegisterComplete PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE in the REGM:RegisterComplete PDU shall be set to the value of the same IE in the received REGM:RegisterAck PDU. REGM shall also send the REGM_CONN_CNF primitive to GMMH/MMH and the REGM_CONN_IND primitive to RBC. REGM shall initialize CU13. The REGM state shall change to 'REGISTERED'.

5.4.1.9.2.4 Behaviour in Substate 'AWAIT-GPS-POSITION'

On receipt of the CBCt_POSITION_CNF primitive from CBCt, REGM shall stop timer TU4, store the value of the 'GPS Position String' parameter, and:

- 1> if the current System Information contains the 'GPS Policy Info' AVP, then:
  - 2> if the 'Position Quality' IE is not set to "Spot Beam ID Only":
    - 3> if the 'Fix Quality' field of the 'GPS Position String' is set to "1" (GPS Fix) or "2" (DGPS Fix), then REGM shall evaluate the stored 'GPS Position String' against the 'Position Quality', 'Position Accuracy', 'Position Age', and 'LOA' IEs of the 'GPS Policy Info' AVP and:
      - 4> if the conditions of the 'GPS Policy Info' AVP are satisfied, then REGM shall compose the REGM:Register PDU and send to the peer REGM agent in the RNC using the AL_COMDATA_REQ primitive. The 'Registration Reference' IE of the REGM:Register PDU shall be set to a random value. REGM shall initialize a list (to null) of pending registration references and add the random value to the list. If the 'Establishment Cause' parameter of the REGM_CONN_REQ primitive from GMMH/MMH indicates a request at emergency priority, then the 'Registration Cause' IE of the REGM:Register PDU shall be set to "Emergency". Otherwise, the 'Registration Cause' IE shall be set to "Normal Registration". The 'Retry Count' parameter of the AL_COMDATA_REQ primitive shall be set to "0". After sending the REGM:Register PDU to its peer in the RNC, REGM shall start timer TU3 and initialize the associated retry counter CU3. The REGM state shall change to 'REGISTERING-AWAIT-RESPONSE'.
      - 4> if the conditions of the 'GPS Policy Info' AVP are not satisfied, then REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH. REGM shall start timer TU9. The REGM state shall change to 'IDLE-NETWORK-FOUND'.
    - 3> if the 'Fix Quality' field of the 'GPS Position String' is set to "3" (User-Specified Position Fix), then REGM shall evaluate the stored 'GPS Position String' against the 'Position Quality' and 'Position Age' IEs of the 'GPS Policy Info' AVP and:

- 4> if the conditions of the 'GPS Policy Info' AVP are satisfied, then REGM shall compose the REGM:Register PDU and send to the peer REGM agent in the RNC using the AL_COMDATA_REQ primitive. The 'Registration Reference' IE of the REGM:Register PDU shall be set to a random value. REGM shall initialize a list (to null) of pending registration references and add the random value to the list. If the 'Establishment Cause' parameter of the REGM_CONN_REQ primitive from GMMH/MMH indicates a request at emergency priority, then the 'Registration Cause' IE of the REGM:Register PDU shall be set to "Emergency". Otherwise, the 'Registration Cause' IE shall be set to "Normal Registration". The 'Retry Count' parameter of the AL_COMDATA_REQ primitive shall be set to "0". After sending the REGM:Register PDU to its peer in the RNC, REGM shall stop timer TU9, start timer TU3 and initialize the associated retry counter CU3. The REGM state shall change to 'REGISTERING-AWAIT-RESPONSE'.

- 4> if the conditions of the 'GPS Policy Info' AVP are not satisfied, then REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH. REGM shall start timer TU9. The REGM state shall change to 'IDLE-NETWORK-FOUND'.

▪ 3> if the 'Fix Quality' field of the 'GPS Position String' is set to "4" (IRS Fix), then REGM shall evaluate the received/previously stored 'GPS Position String' against the 'Position Quality' and 'Position Age' IEs of the 'GPS Policy Info' AVP and:

- 4> if the conditions of the 'GPS Policy Info' AVP are satisfied, then REGM shall compose the REGM:Register PDU and send to the peer REGM agent in the RNC using the AL_COMDATA_REQ primitive. The 'Registration Reference' IE of the REGM:Register PDU shall be set to a random value. REGM shall initialize a list (to null) of pending registration references and add the random value to the list. If the 'Establishment Cause' parameter of the REGM_CONN_REQ primitive from GMMH/MMH indicates a request at emergency priority, then the 'Registration Cause' IE of the REGM:Register PDU shall be set to "Emergency". Otherwise, the 'Registration Cause' IE shall be set to "Normal Registration". The 'Retry Count' parameter of the AL_COMDATA_REQ primitive shall be set to "0". After sending the REGM:Register PDU to its peer in the RNC, REGM shall stop timer TU9, start timer TU3 and initialize the associated retry counter CU3. The REGM state shall change to 'REGISTERING-AWAIT-RESPONSE'.

- 4> if the conditions of the 'GPS Policy Info' AVP are not satisfied, then REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH. REGM shall start timer TU9. The REGM state shall change to 'IDLE-NETWORK-FOUND'.

- 2> if the 'Position Quality' IE is set to "Spot Beam ID Only", then REGM shall compose the REGM:Register PDU and send to the peer REGM agent in the RNC using the AL_COMDATA_REQ primitive. The 'Registration Reference' IE of the REGM:Register PDU shall be set to a random value. REGM shall initialize a list (to null) of pending registration references and add the random value to the list. If the 'Establishment Cause' parameter of the REGM_CONN_REQ primitive from GMMH/MMH indicates a request at emergency priority, then the 'Registration Cause' IE of the REGM:Register PDU shall be set to "Emergency". Otherwise, the 'Registration Cause' IE shall be set to "Normal Registration". The 'Retry Count' parameter of the AL_COMDATA_REQ primitive shall be set to "0". After sending the REGM:Register PDU to its peer in the RNC, REGM shall stop timer TU9, start timer TU3 and initialize the associated retry counter CU3. The REGM state shall change to 'REGISTERING-AWAIT-RESPONSE'.

- 1> if the current System Information does not contain the 'GPS Policy Info' AVP, then REGM shall compose the REGM:Register PDU and send to the peer REGM agent in the RNC using the AL_COMDATA_REQ primitive. The 'Registration Reference' IE of the REGM:Register PDU shall be set to a random value. REGM shall initialize a list (to null) of pending registration references and add the random value to the list. If the 'Establishment Cause' parameter of the REGM_CONN_REQ primitive from GMMH/MMH indicates a request at emergency priority, then the 'Registration Cause' IE of the REGM:Register PDU shall be set to "Emergency". Otherwise, the 'Registration Cause' IE shall be set to "Normal Registration". The 'Retry Count' parameter of the AL_COMDATA_REQ primitive shall be set to "0". After sending the REGM:Register PDU to its peer in the RNC, REGM shall stop timer TU9, start timer TU3 and initialize the associated retry counter CU3. The REGM state shall change to 'REGISTERING-AWAIT-RESPONSE'.

On receipt of CBCt_POSITION_REJ primitive from CBCt, or if timer TU4 expires before receiving a response from CBCt, REGM shall resend the CBCt_POSITION_REQ primitive to CBCt. This process may repeat up to the limit imposed by the retry counter CU4. After the maximum number of requests to the Bearer Control layer have been made:

- 1> if a previously stored 'GPS Position String' is available, then REGM shall follow the same procedure as if the CBCt_POSITION_REQ primitive had been received.

- 1> if a previously stored 'GPS Position String' is not available, then REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH. REGM shall start timer TU9. The REGM state shall change to 'IDLE-NETWORK-FOUND'.

5.4.1.9.3 Behaviour in State 'REGISTERED-CONDITIONAL'

5.4.1.9.3.0 General

This state has three sub-states: 'AWAIT_POS_REQ', 'AWAIT-GPS-POSITION' and 'AWAIT-REG-MODE-UPDATE', and 'AWAIT-HANDOVER-LEASE'.

5.4.1.9.3.1 Behaviour in Substate 'AWAIT-POS-REQ'

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall unpack the encapsulated REGM PDU from the peer agent and examine the AL Signal Type IE. If the PDU type is REGM:UEPositionRequest, REGM shall stop timer TU5 and:

- 1> if the current System Information contains the 'GPS Policy Info' AVP, then:
  - 2> if the 'UE Position Quality' IE is set to "Spot Beam ID Only", then:
    - 3> if the current System Information contains the 'Spot Beam Map' SDU, then REGM shall use the spot beam selection algorithm described in clause 8 to determine in which spot beam the UE is currently located and compose the REGM:UEPositionResponse PDU with the 'Spot Beam ID' IE set to identify that spot beam. In the event that the spot beam selection algorithm determines that the UE is in an area where two or more beams overlap, REGM shall select the beam with the highest Preference Level (or any one of the beams with the highest Preference Level at random if there is more than one). REGM shall then send the REGM:UEPositionResponse PDU to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. REGM shall start timer TU6 and initialize the associated retry counter CU6. The REGM state shall change to 'REGISTERED-CONDITIONAL-AWAIT-REG-MODE-UPDATE'.
    - 3> if the current System Information does not contain the 'Spot Beam Map' SDU, then REGM shall compose the REGM:UEPositionResponse PDU with the 'Spot Beam ID' IE set to identify the current Spot Beam ID (obtained from the 'Beam Info' AVP in the current System Information). REGM shall then send the REGM:UEPositionResponse PDU to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. REGM shall start timer TU6 and initialize the associated retry counter CU6. The REGM state shall change to 'REGISTERED-CONDITIONAL-AWAIT-REG-MODE-UPDATE'.
  - 2> if the 'UE Position Quality' IE is not set to "Spot Beam ID Only", then REGM shall encrypt the 'GPS Position String' according to the method described in clause 7.4. REGM shall then compose the REGM:UEPositionResponse PDU using the encrypted 'GPS Position String' and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. REGM shall start timer TU6 and initialize the associated retry counter CU6. The REGM state shall change to 'REGISTERED-CONDITIONAL-AWAIT-REG-MODE-UPDATE'.
- 1> if the current System Information does not contain the 'GPS Policy Info' AVP, then REGM shall encrypt the 'GPS Position String' according to the method described in clause 7.4. REGM shall then compose the REGM:UEPositionResponse PDU using the encrypted 'GPS Position String' and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. REGM shall start timer TU6 and initialize the associated retry counter CU6. The REGM state shall change to 'REGISTERED-CONDITIONAL-AWAIT-REG-MODE-UPDATE'.

If timer TU5 expires before the REGM:UEPositionRequest PDU is received, then REGM shall resend the REGM:RegisterComplete PDU to the peer REGM agent in the RNC. This process may repeat up to the limit imposed by the retry counter CU5. After sending the REGM:RegisterComplete PDU the maximum number of times, REGM shall assume that implicit deregistration has occurred and shall send the REGM_CONN_REJ primitive to GMMH/MMH. REGM shall then request the Bearer Connection layer to destroy the SIG-SAP by sending the CBCn_DESTROY_REQ primitive to CBCn. The REGM state shall change to 'RELEASING-AWAIT-DESTROY-IMPLICIT'.

5.4.1.9.3.2 Behaviour in Substate 'AWAIT-REG-MODE-UPDATE'

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall unpack the encapsulated REGM PDU from the peer agent and examine the AL Signal Type IE:

- If the PDU type is REGM:RegModeUpdate and the 'Registration Mode' IE of the PDU is "3", REGM shall stop timer TU6 and start timer TU7. If the optional 'GPS Report Distance' IE is present, then REGM shall store the value of this IE. REGM shall then send the REGM_CONN_CNF primitive to GMMH/MMH and the REGM_CONN_IND primitive to RBC. REGM shall initialize counter CU13. The REGM state shall change to 'REGISTERED'.

- If the PDU type is REGM:Deregister, REGM shall stop timer TU6 and compose the REGM:DeregisterAck PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE in the REGM:DeregisterAck PDU shall be set to the value of the same IE in the received REGM:Deregister PDU. REGM shall send the REGM_CONN_REJ primitive to GMMH/MMH. After receiving the SSR_SIGDATA_CNF primitive from SSR (i.e. confirmation that the REGM:DeregisterAck PDU has been received by the peer REGM agent in the RNC), REGM shall send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.

- If the PDU type is REGM:Handover, then REGM shall request the Bearer Control layer to perform an intra-RNC handover by sending the CBCn_HANDOVER_REQ primitive to CBCn. The REGM state shall change to 'REGISTERED-CONDITIONAL-AWAIT-HANDOVER-LEASE'.

If timer TU6 expires before the REGM:RegModeUpdate PDU or REGM:Deregister PDU is received, then REGM shall resend the REGM:UEPositionResponse PDU to the peer REGM agent in the RNC. This process may repeat up to the limit imposed by the retry counter CU6. After sending the REGM:UEPositionResponse PDU the maximum number of times, REGM shall assume that implicit deregistration has occurred and shall send the REGM_CONN_REJ primitive to GMMH/MMH. REGM shall then send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT-IMPLICIT'.

5.4.1.9.3.3 Behaviour in Substate 'AWAIT-HANDOVER-LEASE'

On receipt of the CBCn_HANDOVER_CNF primitive from the Bearer Control layer, REGM shall compose the REGM:HandoverAck PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. The REGM state shall change to 'REGISTERED-CONDITIONAL-AWAIT-REG-MODE-UPDATE'.

5.4.1.9.4 Behaviour in State 'REGISTERED'

On receipt of the REGM_CONN_REQ primitive from GMMH/MMH, REGM shall respond with the REGM_CONN_CNF primitive. REGM shall also send the REGM_CONN_IND primitive to RBC.

On receipt of the REGM_REL_REQ primitive from GMMH/MMH, REGM shall start timer TU10. REGM shall compose the REGM:SignallingConnectionReleaseReq PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. The REGM state shall change to 'RELEASING-AWAIT-RELEASE'.

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall unpack the encapsulated REGM PDU from the peer agent and examine the AL Signal Type IE:

- 1> if the PDU type is REGM:SignallingConnectionRelease, then REGM shall send the REGM_SIGNAL_CONN_REL_IND primitive to GMMH/MMH and the REGM_RAB_REL_IND primitive to RBC.

- 1> if the PDU type is REGM:SystemInformation, then REGM shall unpack the encapsulated AVP list and update the current System Information set as appropriate:
  - 2> if the AVP list contains the NAS System Info AVP, then REGM shall immediately forward this to the NAS using the SYSTEM_INFO_IND primitive via the GC-SAP.
  - 2> if the AVP list contains one or more instances of the Satellite Location AVP, then REGM shall update the Satellite Table according to the rules in clause 5.4.1.11.
- 1> if the PDU type is REGM:Deregister, then REGM shall compose the REGM:DeregisterAck PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE in the REGM:DeregisterAck PDU shall be set to the value of the same IE in the received REGM:Deregister PDU. REGM shall send the REGM_REL_IND primitive to GMMH/MMH/RBC. After receiving the SSR_SIGDATA_CNF primitive from SSR (i.e. confirmation that the REGM:DeregisterAck PDU has been received by the peer REGM agent in the RNC), REGM shall send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.
- 1> if the PDU type is REGM:Handover, then REGM shall stop timer TU12 (if it is running) and then request the Bearer Control layer to perform an intra-RNC handover by sending the CBCn_HANDOVER_REQ primitive to CBCn. The REGM state shall change to 'AWAIT-HANDOVER-RESPONSE'.
- 1> if the PDU type is REGM:RegModeUpdate:
  - 2> if the value of the 'Registration Mode' IE is "3":
    - 3> if the optional 'GPS Report Distance' IE is present, then REGM shall store the value of this IE and restart timer TU7. The REGM state shall change to 'REGISTERED'.
    - 3> if the optional 'GPS Report Distance' IE is not present, then the REGM state shall change to 'REGISTERED'.
  - 2> if the value of the 'Registration Mode' IE is "0", then REGM shall discard this PDU and the REGM state shall change to 'REGISTERED'.

On expiry of timer TU7, REGM shall restart timer TU7 and request the Bearer Control layer to provide the current UE GPS position by sending the CBCt_POSITION_REQ primitive to CBCt. Note that there is no state change or supervisory timer associated with the transmission of this primitive to CBCt.

On receipt of the CBCt_POSITION_CNF primitive from CBCt, REGM shall examine the 'Fix Quality' field of the 'GPS Position String' parameter received in the primitive:

- 1> if the 'Fix Quality' field is set to "1" (GPS Fix) or "2" (DGPS Fix) or "4" (IRS Fix):
  - 2> if this UE is a member of the Land Class then:
    - 3> if the peer REGM agent in the RNC had enabled unsolicited position reporting by specifying the optional 'GPS Report Distance' IE in the REGM:RegModeUpdate PDU, then REGM shall calculate the great circle distance between the position contained in the received 'GPS Position String' and the position contained in the previously stored 'GPS Position String':
      - 4> if the distance is more than the 'GPS Report Distance' specified by the RNC in the REGM:RegModeUpdate PDU, then REGM shall encrypt the received 'GPS Position String' according to the method described in clause 7.4. REGM shall compose the REGM:UEPositionResponse PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. REGM shall store the new value of the 'GPS Position String' parameter. This procedure then terminates.
      - 4> if the distance is not more than the 'GPS Report Distance' specified by the RNC in the REGM:RegModeUpdate PDU, then this procedure terminates.
    - 3> if the peer REGM agent in the RNC had not enabled unsolicited position reporting by specifying the optional 'GPS Report Distance' IE in the REGM:RegModeUpdate PDU, then this procedure terminates.

- 2> if this UE is a member of the Extension Class then:
  - 3> if the current System Information contains the Spot Beam Map SDU, then REGM shall use the spot beam selection algorithm described in clause 8 to determine the candidate target spot beams for handover at the position in the received 'GPS Position String':
    - 4> if there are no target spot beams (i.e. a handover is required because the UE has moved outside the coverage area of the beams advertised in the Spot Beam Map):
      - 5> if timer TU11 is not running, then REGM shall start timer TU11. REGM shall encrypt the received 'GPS Position String' according to the method described in clause 7.4. REGM shall then compose the REGM:HandoverRequest PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. REGM shall include the 'Current Spot Beam' IE, the 'Target Spot Beam List' IE (an empty list since there are no candidate target spot beams) and the 'UE Position' IE. REGM shall set the 'Observe Target Preference' IE to "FALSE". REGM shall store the new value of the 'GPS Position String' parameter. This procedure then terminates. Note that there is no state change associated with the transmission of the REGM:HandoverRequest PDU to the peer agent in the RNC.
      - 5> if timer TU11 is running, then REGM shall encrypt the received 'GPS Position String' according to the method described in clause 7.4. REGM shall compose the REGM:HandoverRequest PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. REGM shall include the 'Current Spot Beam' IE, the 'Target Spot Beam List' IE (an empty list since there are no candidate target spot beams) and the 'UE Position' IE. REGM shall set the 'Observe Target Preference' IE to "FALSE". REGM shall store the new value of the 'GPS Position String' parameter. This procedure then terminates. Note that there is no state change associated with the transmission of the REGM:HandoverRequest PDU to the peer agent in the RNC.
    - 4> if there are one or more target spot beams, then REGM shall stop timer TU11 (if it is running), and:
      - 5> if one of the target spot beams is the same as the current spot beam (obtained from the 'Beam Info' AVP in the current System Information), then a handover is not required, REGM shall stop timer TU12 (if it is running), and:

        6> if the peer REGM agent in the RNC had enabled unsolicited position reporting by specifying the optional 'GPS Report Distance' IE in the REGM:RegModeUpdate PDU, then REGM shall calculate the great circle distance between the position contained in the received 'GPS Position String' and the position contained in the previously stored 'GPS Position String':

            7> if the distance is more than the 'GPS Report Distance' specified by the RNC in the REGM:RegModeUpdate PDU (or if no previously stored UE GPS position is available), then REGM shall encrypt the received 'GPS Position String' according to the method described in clause 7.4. REGM shall compose the REGM:UEPositionResponse PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. REGM shall store the new value of the 'GPS Position String' parameter. This procedure then terminates.

            7> if the distance is not more than the 'GPS Report Distance' specified by the RNC in the REGM:RegModeUpdate PDU, then this procedure terminates.

        6> if the peer REGM agent in the RNC had not enabled unsolicited position reporting by specifying the optional 'GPS Report Distance' IE in the REGM:RegModeUpdate PDU, then this procedure terminates.

- 5> if none of the target spot beams are the same as the current spot beam (obtained from the 'Beam Info' AVP in the current System Information) then a handover is required. REGM shall start timer TU12 (if it is not already running). REGM shall then encrypt the received 'GPS Position String' according to the method described in clause 7.4. REGM shall compose the REGM:HandoverRequest PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. REGM shall include the 'Current Spot Beam' IE, the 'Target Spot Beam List' IE (the list shall contain all of the candidate target spot beams) and the 'UE Position' IE. REGM shall set the 'Observe Target Preference' IE to "FALSE" unless it has a preference for one of the candidate target spot beams; in this case the elements of the 'Target Spot Beam List' IE shall be ordered such that the preferred spot beam is first in the list and the 'Observe Target Preference' IE shall be set to "TRUE". REGM shall store the new value of the 'GPS Position String' parameter. This procedure then terminates. Note that there is no state change associated with the transmission of the REGM:HandoverRequest PDU to the peer agent in the RNC.

- 3> if the current System Information does not contain the Spot Beam Map SDU, then this procedure shall terminate.

- 1> if the 'Fix Quality' field is set to "0" (Invalid/Not Available) or "3" (User- Specified Position), then the 'GPS Position String' shall be discarded and this procedure terminates.

On receipt of the CBCt_SYSTEM_INFO_IND primitive from CBCt, REGM shall unpack the encapsulated AVP list and update the current System Information set as appropriate.

- 1> if the AVP list contains the NAS System Info AVP, then REGM shall immediately forward this to the NAS using the SYSTEM_INFO_IND primitive via the GC-SAP.

- 1> if the AVP list contains one or more instances of the Satellite Location AVP, then REGM shall update the Satellite Table according to the rules in clause 5.4.1.11.

On expiry of timer TU11, REGM shall assume that the UE has been implicitly deregistered. REGM shall send the REGM_REL_IND primitive to GMMH/MMH/RBC. REGM shall then send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT-NO-COVERAGE'.

"On expiry of timer TU12, REGM shall assume that the UE has been implicitly deregistered. REGM shall send the REGM_REL_IND primitive to GMMH/MMH/RBC. REGM shall then send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT-IMPLICIT'.

5.4.1.9.5 Behaviour in State 'RELEASING'

5.4.1.9.5.0 General

The RELEASING state has seven substates.

5.4.1.9.5.1 Behaviour in Substate 'AWAIT-RELEASE'

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall unpack the encapsulated REGM PDU from the peer agent and examine the AL Signal Type IE:

- 1> if the PDU type is REGM:Deregister, then REGM shall compose the REGM:DeregisterAck PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE in the REGM:DeregisterAck PDU shall be set to the value of the same IE in the received REGM:Deregister PDU. REGM shall send the REGM_REL_CNF primitive to GMMH/MMH and the REGM_REL_IND primitive to RBC. After receiving the SSR_SIGDATA_CNF primitive from SSR (i.e. confirmation that the REGM:DeregisterAck PDU has been received by the peer REGM agent in the RNC), REGM shall send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.

- 1> if the PDU type is REGM:SignallingConnectionRelease, then REGM shall send the REGM_SIGNAL_CONN_REL_IND primitive to GMMH/MMH and the REGM_RAB_REL_IND primitive to RBC. The REGM state shall change to 'REGISTERED'.

If timer TU10 expires before the REGM:SignallingConnectionRelease PDU is received, then REGM shall send the REGM_SIGNAL_CONN_REL_IND primitive to GMMH/MMH and the REGM_RAB_REL_IND primitive to RBC. The REGM state shall change to 'REGISTERED'.

If timer TU7 expires, then REGM shall save the TU7 expiry signal (for processing in state 'REGISTERED').

5.4.1.9.5.2 Behaviour in Substate 'AWAIT-DISCONNECT'

On receipt of the SSR_DISCONNECT_CNF primitive from SSR, REGM shall request the Bearer Connection layer to destroy the SIG-SAP by sending the CBCn_DESTROY_REQ primitive to CBCn. The REGM state shall change to 'RELEASING-AWAIT-DESTROY'.

5.4.1.9.5.3 Behaviour in Substate 'AWAIT-DESTROY'

On receipt of the CBCn_DESTROY_CNF primitive from the Bearer Control layer, REGM shall verify the availability of the current PLMN (as if the NAS had requested a "Specific PLMN" search for the current PLMN). REGM shall request the Bearer Control layer to perform a global beam carrier scan by sending the CBCt_DISCOVER_REQ primitive to CBCt. The 'Global Discover Flag' shall be set to "TRUE" and the 'PSAB Information' parameter list shall be derived from the Satellite Table (see clause 5.4.1.11). REGM shall stop timer TU7, start timer TU1 and initialize the associated retry counter CU1. The REGM state shall change to 'IDLE-AWAIT-PSAB-DISCOVERY'.

5.4.1.9.5.4 Behaviour in Substate 'AWAIT-DISCONNECT-IMPLICIT'

On receipt of the SSR_DISCONNECT_CNF primitive from SSR, REGM shall request the Bearer Connection layer to destroy the SIG-SAP by sending the CBCn_DESTROY_REQ primitive to CBCn. The REGM state shall change to 'RELEASING-AWAIT-DESTROY-IMPLICIT'.

5.4.1.9.5.5 Behaviour in Substate 'AWAIT-DESTROY-IMPLICIT'

On receipt of the CBCn_DESTROY_CNF primitive from the Bearer Control layer, REGM shall verify the availability of the current PLMN (as if the NAS had requested a "Specific PLMN" search for the current PLMN). REGM shall request the Bearer Control layer to perform a global beam carrier scan by sending the CBCt_DISCOVER_REQ primitive to CBCt. The 'Global Discover Flag' shall be set to "TRUE" and the 'PSAB Information' parameter list shall be derived from the Satellite Table (see clause 5.4.1.11). REGM shall stop timer TU7, start timer TU1 and initialize the associated retry counter CU1. The REGM state shall change to 'IDLE-AWAIT-PSAB-DISCOVERY'.

5.4.1.9.5.6 Behaviour in Substate 'AWAIT-DISCONNECT-NO-COVERAGE'

On receipt of the SSR_DISCONNECT_CNF primitive from SSR, REGM shall request the Bearer Connection layer to destroy the SIG-SAP by sending the CBCn_DESTROY_REQ primitive to CBCn. The REGM state shall change to 'RELEASING-AWAIT-DESTROY-NO-COVERAGE'.

5.4.1.9.5.7 Behaviour in Substate 'AWAIT-DESTROY-NO-COVERAGE'

On receipt of the CBCn_DESTROY_CNF primitive from the Bearer Control layer, REGM shall verify the availability of the current PLMN (as if the NAS had requested a "Specific PLMN" search for the current PLMN). REGM shall request the Bearer Control layer to perform a global beam carrier scan by sending the CBCt_DISCOVER_REQ primitive to CBCt. The 'Global Discover Flag' shall be set to "TRUE" and the 'PSAB Information' parameter list shall be derived from the Satellite Table (see clause 5.4.1.11) *except* the identifying frequencies of the current satellite shall not be included. The 'PSAB Information' parameter list shall also associate the satellite longitude corresponding to each identifying frqeuency. REGM shall stop timer TU7, start timer TU1 and initialize the associated retry counter CU1. The REGM state shall change to 'IDLE-AWAIT-PSAB-DISCOVERY'.

5.4.1.9.6 Behaviour in State 'AWAIT-HANDOVER-RESPONSE'

On receipt of the CBCn_HANDOVER_CNF primitive from the Bearer Control layer, REGM shall compose the REGM:HandoverAck PDU and send it to the SSR for transmission to the peer REGM agent in the RNC using the SSR_SIGDATA_REQ primitive. The REGM state shall change to 'REGISTERED'.

If timer TU7 expires, then REGM shall save the TU7 expiry signal (for processing in state 'REGISTERED').

5.4.1.9.7 Behaviour in Any State (Not State 'IDLE')

On receipt of the AL_COMDATA_IND primitive from the COM-SAP, REGM shall examine the PDU type IE. If the PDU type is REGM:DeregisterCommon, then REGM shall send the REGM_REL_IND primitive to GMMH/MMH/RBC. REGM shall send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.

On receipt of the CBCn_FAILURE_IND primitive from CBCn, REGM shall examine the 'Failure Cause' parameter of the primitive:

- 1> if the 'Failure Cause' parameter indicates a radio resource layer failure ("Conn Failure", "Max Unack Reached", "No Forward Bearer" or "Incorrect Forward Bearer"), then REGM shall assume that the UE has been implicitly deregistered. REGM shall send the REGM_REL_IND primitive to GMMH/MMH/RBC. REGM shall then send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT-IMPLICIT'.

- 1> if the 'Failure Cause' parameter indicates connection inactivity ("Max Idle Reached"), then REGM shall discard the CBCn_FAILURE_IND primitive.

5.4.1.9.8 Behaviour in Any State (Not State 'IDLE' or State 'REGISTERED')

On receipt of the REGM_CONN_REQ primitive from GMMH/MMH, REGM shall follow the procedure described in clause 5.4.1.9.9.

5.4.1.9.9 Common Procedures

REGM shall maintain a SERVICE DOMAIN state variable which implicitly tracks the state of GMMH and MMH. The variable allows REGM to determine which AL agents need to receive notification of change in state of the UE-Specific Signalling connection via the REGM_CONN_CNF, REGM_CONN_IND, REGM_CONN_REJ, REGM_REL_CNF, and REGM_REL_IND primitives. The variable affects REGM behaviour in all states except 'IDLE':

- 1> if the variable is set to "Both Domains", then REGM shall send any of the above primitives to GMMH, RBC-PS, MMH, and RBC-CS.

- 1> if the variable is set to "PS Domain", then REGM shall send any of the above primitives to GMMH and RBC-PS.

- 1> if the variable is set to "CS Domain", then REGM shall send any of the above primitives to MMH and RBC-CS.

- 1> if the variable is set to "No Domain", then REGM shall not send any of the above primitives.

The variable shall be set to "No Domain" on entry to state 'IDLE-NETWORK-FOUND' and shall be updated according to the following rules:

- 1> on receipt of the REGM_CONN_REQ primitive:
  - 2> if the variable is currently "No Domain" and:
    - 3> if the 'CN Domain Identity' parameter of the REGM_CONN_REQ primitive indicates a request from the PS service domain, then the variable shall be set to "PS Domain".
    - 3> if the 'CN Domain Identity' parameter of the REGM_CONN_REQ primitive indicates a request from the CS service domain, then the variable shall be set to "CS Domain".
  - 2> if the variable is currently "PS Domain" and:
    - 3> if the 'CN Domain Identity' parameter of the REGM_CONN_REQ primitive indicates a request from the PS service domain, then the variable shall be set to "PS Domain".
    - 3> if the 'CN Domain Identity' parameter of the REGM_CONN_REQ primitive indicates a request from the CS service domain, then the variable shall be set to "Both Domains".

- 2> if the variable is currently "CS Domain" and:
  - 3> if the 'CN Domain Identity' parameter of the REGM_CONN_REQ primitive indicates a request from the PS service domain, then the variable shall be set to "Both Domains".
  - 3> if the 'CN Domain Identity' parameter of the REGM_CONN_REQ primitive indicates a request from the CS service domain, then the variable shall be set to "CS Domain".
- 2> if the variable is currently "Both Domains" then the variable shall be set to "Both Domains".

- 1> **after** REGM has sent the REGM_CONN_REJ, REGM_REL_CNF, or REGM_REL_IND primitive, the variable shall be set to "No Domain".

5.4.1.10 REGM Timers and Counters

Default values in Table 5.10 apply to all UE Classes unless otherwise indicated. Figure 6.4 contains a summary of REGM timers in the RNC and UE. REGM Counters are defined in Table 5.11.

Table 5.10: REGM Timers [UE]

Timer	Default Value	[Min, Max] Value	State	Comments
TU1	30 s	[0, 600 s]	'IDLE-AWAIT-PSAB-DISCOVERY'	Supervisory Timer for BCt PSAB Discovery Procedure
TU2	8 s	[0, 60 s]	'IDLE-AWAIT-POSITION'	Supervisory Timer for BCt Position Request Procedure
TU3	5 s	[0, 16 s]	'REGISTERING-AWAIT-RESPONSE'	Supervisory Timer for Registration Procedure. Common Signalling Retry AVP (System Information) overrides default settings
TU4	5 s	[0, 60 s]	'REGISTERING-AWAIT-GPS-POSITION'	Supervisory Timer for BCt Position Request Procedure
TU5	60 s	[0, 360 s]	'REGISTERED-CONDITIONAL-AWAIT-POS-REQ'	Supervisory Timer for UE Position Request Procedure
TU6	60 s	[0, 360 s]	'REGISTERED-CONDITIONAL-AWAIT-REG-MODE-UPDATE'	Supervisory Timer for UE Position Request Procedure (Registration Mode Update)
TU7	300 s	[0, 3 600 s]	'REGISTERED'	Periodic Position Update Timer: All UE Classes Except Aeronautical Class
TU7	120 s	[0, 3 600 s]	'REGISTERED'	Periodic Position Update Timer: Aeronautical Class UE Only
TU8	90 s	[0, 3 600 s]	'IDLE-AWAIT-SYSTEM-INFORMATION'	System Information Deadlock Timer
TU9	180 s	[0, 3 600 s]	'IDLE-NETWORK-FOUND'	Automatic Network Reselection Timer
TU10	3 s	[0, 60 s]	'RELEASING-AWAIT-RELEASE'	Signalling Connection Release Deadlock Timer
TU11	1 260 s	[0, 3 600 s]	'REGISTERED'	Satellite Reselection Timer: All UE Classes Except Aeronautical Class
TU11	540 s	[0, 3 600 s]	'REGISTERED'	Satellite ReselectionTimer: Aeronautical Class UE Only
TU12	1 260 s	[0, 3 600 s]	'REGISTERED'	Supervisory Timer for Handover Request Procedure: All UE Classes Except Aeronautical Class
TU12	540 s	[0, 3 600 s]	'REGISTERED'	Supervisory Timer for Handover Request Procedure: Aeronautical Class UE Only
TU13	0 s	[0, 6 330 s]	'IDLE'	Registration Storm Timer. Randomized Initial Access Delay AVP (System Information) overrides default settings

Table 5.11: REGM Counters [UE]

Counter	Default Value	[Min, Max] Value	Comments
CU1	3	[0, MAXINT]	This counter is associated with timer TU1.
CU2	3	[0, MAXINT]	This counter is associated with timer TU2.
CU3	3	[0, 7]	Common Signalling Retry AVP (System Information) overrides default settings. This counter is associated with timer TU3.
CU4	3	[0, MAXINT]	This counter is associated with timer TU4.
CU5	0	[0, MAXINT]	This counter is associated with timer TU5.
CU6	0	[0, MAXINT]	This counter is associated with timer TU6.
CU13	0	[0, MAXINT]	This counter is associated with timer TU13.

MAXINT is the maximum value of an unsigned long integer (2^{64}-1 assumed).

5.4.1.11 Satellite Table

REGM shall maintain a table of satellite identifying frequencies in non-volatile programmable memory. Each row of the table contains data for one satellite and includes the satellite id, satellite longitude, primary identifying L-band frequency, and alternate identifying L-band frequency. Each row may optionally contain the elevation angle to the corresponding satellite from the current UE position (see below). REGM also stores the version number of the entire Satellite Table.

The Satellite Table may contain up to eight rows (i.e. data for up to eight satellites). An example configuration is shown in Table 5.12.

The Satellite Table may be updated by the 'Satellite Location' AVP set (System Information) as follows:

- 1> if the version number of the 'Satellite Location' AVP set is not the same as the stored version number, then:
  - 2> if a satellite (primary key is the 'Satellite ID') is present in the old 'Satellite Location' AVP set but is not present in the new 'Satellite Location' AVP set, then REGM shall delete this satellite from the Satellite Table.
  - 2> if a satellite is present in the new 'Satellite Location' AVP set but is not present in the old 'Satellite Location' AVP set, then REGM shall add this satellite to the Satellite Table.
  - 2> if a satellite is present in both the old and new 'Satellite Location' AVP sets, then REGM shall modify the information in the Satellite for this satellite (if the 'Satellite Longitude' and/or 'Primary/Alternate L-band Frequency' has changed).

Table 5.12: Example Satellite Table

Satellite ID	Satellite Longitude	Primary L-band Frequency (MHz)	Alternate L-band Frequency (MHz)
5	143,5 ºE	1 540,825	1 537,485
6	25,1 ºE	1 537,920	1 541,115
7	97,6 ºW	1 537,070	1 540,730

REGM shall optionally calculate and store the elevation angle to each satellite in the Satellite Table from the current UE position whenever the CBCt_POSITION_CNF primitive is received.

REGM reads the Satellite Table during the PSAB Discovery procedure in order to compose a list of frequencies to scan (CBCt_DISCOVER_REQ primitive). If REGM performs the optional calculation of elevation angles (see above), the list shall contain the primary L-band frequencies of all satellites in the Satellite Table, ordered by elevation angle to the corresponding satellite (highest angle first), followed by the alternate L-band frequencies of all satellites, similarly ordered by elevation angle.

Otherwise, the list shall contain the primary L-band frequencies of all satellites in the Satellite Table (the frequency corresponding to the most recently used satellite, if any, may be placed at the head of the list), followed by the alternate L-band frequencies of all satellites.

Rows of the Satellite Table may be locked by REGM for the purpose of cooperative operation (see clause 5.4.1.12). Locked rows shall not be read by REGM when composing a list of frequencies to scan (for PSAB Discovery using the CBCt_DISCOVER_REQ primitive).

5.4.2 GMMH

5.4.2.1 GMMH Protocol Data Units

The GMMH Protocol Data Units are shown in Table 5.13.

Table 5.13: GMMH::GMMH Protocol Data Units

PDU	SAP	Direction	Addressing	Information Elements
PagingType2	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, Paging Cause, Paging Record Type ID
InitialDirectTransfer	SIG	From UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
UplinkDirectTransfer	SIG	From UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
DownlinkDirectTransfer	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
SecurityModeCommand	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, Security Capability, {Ciphering Mode Info AVP, Integrity Protection Mode Info AVP} OPTIONAL
SecurityModeComplete	SIG	From UE	BCnID	AL Signal Type, ALPD, {UL Integrity Protection Activation Info AVP, RB Activation Time Info } OPTIONAL
SecurityModeFailure	SIG	From UE	BCnID	AL Signal Type, ALPD, CHOICE {Security Failure Cause, Protocol Error Cause}

NOTE: "NAS Message" is called a Layer 3-PDU in ETSI TS 124 007 [1].

5.4.2.2 Service Primitives at GMMH-SIG-SAP

The service primitives at GMMH-SIG-SAP are shown in Table 5.14.

Table 5.14: GMMH::SSR Service Primitives at GMMH-SIG-SAP [UE]

Primitive	Direction	Parameters
SSR_SIGDATA_REQ *GMMH requests SSR to send a PDU to its peer in the RNC.*	To SSR	GMMH PDU, {SUSP} OPTIONAL
SSR_SIGDATA_IND *SSR indicates to GMMH that it has received a PDU from the peer agent in the RNC.*	To GMMH	GMMH PDU
SSR_SIGDATA_CNF *Optional response to SSR_SIGDATA_REQ. SSR indicates to GMMH that the peer agent in the RNC has received a PDU.*	To GMMH	-
SSR_SECURITY_REQ *GMMH requests SSR to start (or modify) integrity protection.*	To SSR	UIA, IK, START, {FRESH} OPTIONAL
SSR_SECURITY_CNF *SSR confirms to GMMH that integrity protection has been started (or modified).*	To GMMH	-
SSR_SECURITY_REJ *SSR indicates to GMMH that integrity protection could not be started (or modified) for the specified reason.*	To GMMH	Rejection Cause

5.4.2.3 Service Primitives at GMMAL-SAP

The GMMAL-SAP and associated service primitives are functionally identical to the GMMAS-SAP and associated service primitives defined in ETSI TS 124 007 [1]; only the names have changed for clarity. The service primitives at GMMAL-SAP are shown in Table 5.15.

Table 5.15: GMM::GMMH Service Primitives at GMMAL-SAP [UE]

Primitive	Direction	Parameters
GMMAL_EST_REQ *GMM requests the AL to establish a PS signalling connection and transport the initial NAS Message to its peer in the network.*	To GMMH	NAS Message, Establishment Cause, Priority, CN Domain Identity, UE NAS ID and Type, RAI
GMMAL_REL_REQ *GMM requests the AL to release the PS signalling connection.*	To GMMH	CN Domain Identity
GMMAL_DATA_REQ *GMM requests the AL to transport a NAS Message to its peer in the network (a PS signalling connection has already been established).*	To GMMH	NAS Message, Priority, CN Domain Identity
GMMAL_SECURITY_RES *Response to GMMAL_SECURITY_IND. GMM assigns ciphering and integrity keys to the AL to enable ciphering and integrity protection. GMM also provides the value START to the AL.*	To GMMH	CK, IK, START
GMMAL_EST_CNF *Response to GMMAL_EST_REQ. AL confirms to GMM that a PS signalling connection has been established.*	To GMM	-
GMMAL_EST_REJ *Response to GMMAL_EST_REQ. AL indicates to GMM that it is unable to establish a PS signalling connection.*	To GMM	-
GMMAL_REL_IND *AL indicates to GMM that the network has released the PS signalling connection.*	To GMM	Cause
GMMAL_DATA_IND *AL indicates to GMM that a NAS Message has been received from the peer GMM agent in the network.*	To GMM	NAS Message
GMMAL_PAGE_IND *AL indicates to GMM that a paging request from the network has been received.*	To GMM	Paging Cause, UE Identity Type
GMMAL_STATUS_IND *AL indicates a failure condition to GMM*	To GMM	Cause
GMMAL_SECURITY_IND *Indication from the AL that ciphering (and integrity protection) shall be started; AL requests GMM to provide ciphering and integrity keys.*	To GMM	-

5.4.2.4 Service Primitives at GMMH-REGM-SAP

See clause 5.4.1.4.

5.4.2.5 Service Primitives at GMMH-CBCn-SAP

The service primitives at GMMH-CBCn-SAP are shown in Table 5.16.

Table 5.16: GMMH::CSR Service Primitives at GMMH-CBCn-SAP [UE]

Primitive	Direction	Parameters
CBCn_SECURITY_REQ *GMMH requests BCn to start, or modify ciphering for all PDUs received at the indicated SAPs (BCnID).*	To CSR	ALPD, Mode (Start/ Modify), CK, START, SEQUENCE OF {BCnID, UL Activation Time, DL Activation Time}
CBCn_SECURITY_CNF *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated SAPs (BCnID) has been started/modified.*	To GMMH	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_REQ *GMMH requests BCn to suspend the indicated connections (UE Specific Signalling connection and all PS domain RABs).*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_CNF *Response to CBCn_SUSPEND_REQ. BCn confirms that the indicated connections are suspended.*	To GMMH	ALPD, SEQUENCE OF {BCnID, Next BCn Send Sequence Number}
CBCn_SUSPEND_REJ *Response to CBCn_SUSPEND_REQ. BCn indicates that one or more connections have not been suspended.*	To GMMH	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_REQ *GMMH requests BCn to resume the indicated connections (UE Specific Signalling connection and all PS domain RABs).*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_CNF *Response to CBCn_RESUME_REQ. BCn confirms that the indicated connections have resumed.*	To GMMH	ALPD, SEQUENCE OF {BCnID}

5.4.2.6 Service Primitives RBCPS-GMMH-SAP

See clause 5.4.4.8.

5.4.2.7 GMMH States

The GMMH states are shown in Table 5.17.

Table 5.17: GMMH States [UE]

Number	State	Description
1	IDLE ★Initial State	A UE-Specific signalling connection has not been established and GMMH is unable to route messages between GMM and the BCn layer.
2	AWAIT-SIG-CONN-EST	GMMH has requested REGM to establish a UE-Specific signalling connection and is awaiting a response.
3	CONNECTED	A UE-Specific signalling connection has been established and GMMH is able to route messages between GMM and the BCn layer. The corresponding Iu-PS signalling connection (between the RNC and CN) is established when in this state. This state has four substates.
>3a	CONNECTED	No GMMH security procedures are in progress.
>3b	CONNECTED-KEYS-REQUESTED	GMMH has requested GMM to provide ciphering and integrity keys and is waiting for a response.
>3c	CONNECTED-INTEGRITY-REQUESTED	GMMH has requested the SSR to start integrity protection and is waiting for confirmation.
>3d	CONNECTED-CIPHERING-REQUESTED	GMMH has requested the BCn layer to start ciphering and is waiting for confirmation.
>3e	CONNECTED-SUSPEND-REQUESTED	GMMH has requested the Bearer Connection layer to suspend all active PS domain RABs and the UE-Specific Signalling connection and is awaiting a response.

Number	State	Description
>3f	CONNECTED-RESUME-REQUESTED	GMMH has requested the Bearer Connection layer to resume all suspended PS domain RABs and the UE-Specific Signalling connection and is awaiting a response.
4	CONNECTED-IU-REL	A UE-Specific signalling connection has been established but the corresponding Iu-PS signalling connection (between the RNC and CN) has been released.
5	AWAIT-SIG-CONN-REL	GMMH has requested REGM to release the UE-Specific signalling connection and is awaiting confirmation.

5.4.2.8 GMMH Behaviour

5.4.2.8.0 General

GMMH behaviour in the UE is summarized in the signal-state diagrams in Figure 5.11 and Figure 5.12.

5.4.2.8.1 Behaviour in State 'IDLE'

On receipt of the GMMAL_EST_REQ primitive from GMM, GMMH shall save the encapsulated Layer 3-PDU (NAS Message). GMMH shall then request REGM to establish the UE-Specific Signalling connection by sending the REGM_CONN_REQ primitive. The GMMH state shall change to 'AWAIT-SIG-CONN-EST'.

On receipt of the REGM_PAGE_IND primitive from REGM, GMMH shall notify GMM of the paging event by sending the GMMAL_PAGE_IND primitive.

5.4.2.8.2 Behaviour in State 'AWAIT-SIG-CON-ESTABLISH'

On receipt of the REGM_CONN_REJ primitive from REGM, GMMH shall notify GMM of the failure to establish the UE-Specific Signalling connection by sending the GMMAL_EST_REJ primitive. The GMMH state shall change to 'IDLE'.

On receipt of the REGM_CONN_CNF primitive from REGM, GMMH shall save the value of the 'UE Security Capability' parameter (list of supported integrity protection and ciphering algorithms). GMMH shall notify GMM of the establishment of the UE-Specific Signalling connection by sending the GMMAL_EST_CNF primitive. GMMH shall then compose the GMMH:InitialDirectTransfer PDU, including the saved Layer 3-PDU (NAS Message), and send it to the SSR for transmission to the peer GMMH agent in the RNC using the SSR_SIGDATA_REQ primitive. The GMMH state shall change to 'CONNECTED'.

5.4.2.8.3 Behaviour in State 'CONNECTED'

5.4.2.8.3.1 Behaviour in Substate 'CONNECTED'

On receipt of the GMMAL_DATA_REQ primitive from GMM, GMMH shall use the encapsulated Layer 3-PDU (NAS Message) to compose the GMMH:UplinkDirectTransfer PDU and send it to the SSR for transmission to the peer GMMH agent in the RNC using the SSR_SIGDATA_REQ primitive.

On receipt of the SSR_SIGDATA_IND primitive from SSR, GMMH shall unpack the encapsulated GMMH PDU from the peer agent in the RNC and examine the AL Signal Type IE:

- 1> If the PDU type is GMMH:DownlinkDirectTransfer, then GMMH shall forward the encapsulated Layer 3-PDU (NAS Message) to GMM using the GMMAL_DATA_IND primitive.
- 1> If the PDU type is GMMH:PagingType2, then GMMH shall notify GMM of the paging event by sending the GMMAL_PAGE_IND primitive.
- 1> If the PDU type is GMMH:SecurityModeCommand, then GMMH shall compare the security capabilities information in the received PDU with the saved security capabilities information (saved from REGM_CONN_CNF) and:
  - 2> if the saved and received security capabilities information are the same, then GMMH shall request the ciphering and integrity keys from GMM by sending the GMMAL_SECURITY_IND primitive. The GMMH state shall change to 'CONNECTED-KEYS-REQUESTED';

- 2> if the saved and received security capabilities information are not the same, then GMMH shall compose the GMMH:SecurityModeFailure PDU and send it to the SSR for transmission to the peer GMMH agent in the RNC using the SSR_SIGDATA_REQ primitive. The 'Security Failure Cause' IE shall be set to "Unsupported or Mismatched Security Configuration". The GMMH state shall change to 'CONNECTED'.

On receipt of the REGM_SIGNAL_CONN_REL_IND primitive from REGM, GMMH shall inform GMM of the release of the PS signalling connection by sending the GMMAL_REL_IND primitive. The GMMH state shall change to 'CONNECTED-IU-REL'.

On receipt of the REGM_REL_IND primitive from REGM, GMMH shall inform GMM of the release of the PS signalling connection by sending the GMMAL_REL_IND primitive. The GMMH state shall change to 'IDLE'.

On receipt of the GMMAL_REL_REQ primitive from GMM, GMMH shall request REGM to release the UE-Specific Signalling connection by sending the REGM_REL_REQ primitive. The GMMH state shall change to 'AWAIT-SIG-CONN-REL'.

On receipt of the RBC_CK_INFO_REQ primitive from RBC-PS, GMMH shall respond by sending the requested Ciphering Key (CK) in the RBC_CK_INFO_RSP primitive.

5.4.2.8.3.2 Behaviour in Substate 'KEYS-REQUESTED'

On receipt of the GMMAL_SECURITY_RES primitive from GMM, GMMH shall request the SSR to start integrity protection by sending the SSR_SECURITY_REQ primitive. The GMMH state shall changed to 'CONNECTED-INTEGRITY-REQUESTED'.

5.4.2.8.3.3 Behaviour in Substate 'INTEGRITY-REQUESTED'

On receipt of the SSR_SECURITY_CNF primitive from SSR:

- 1> if the GMMH:SecurityModeCommand PDU indicates that ciphering is also to be started, then GMMH shall request the Bearer Connection layer to suspend all active PS domain RABs and the UE-Specific Signalling connection by sending the CBCn_SUSPEND_REQ primitive to CBCn. The GMMH state shall change to 'CONNECTED-SUSPEND-REQUESTED';

- 1> if the GMMH:SecurityModeCommand PDU does not indicate that ciphering is also to be started, then GMMH shall compose the GMMH:SecurityModeComplete PDU and send it to the SSR for transmission to the peer GMMH agent in the RNC using the SSR_SIGDATA_REQ primitive (with the 'SUSP' parameter set to "TRUE"). The GMMH state shall change to 'CONNECTED'.

On receipt of the SSR_SECURITY_REJ primitive from SSR, GMMH shall compose the GMMH:SecurityModeFailure PDU and send it to the SSR for transmission to the peer GMMH agent in the RNC using the SSR_SIGDATA_REQ primitive. The GMMH state shall change to 'CONNECTED'.

5.4.2.8.3.4 Behaviour in Substate 'CIPHERING-REQUESTED'

On receipt of the CBCn_SECURITY_CNF primitive from CBCn, GMMH shall request the Bearer Connection layer to resume all suspended PS domain RABs and the UE-Specific Signalling connection by sending the CBCn_RESUME_REQ primitive to CBCn. The GMMH state shall change to 'CONNECTED-RESUME-REQUESTED'.

5.4.2.8.3.5 Behaviour in State 'CONNECTED-SUSPEND-REQUESTED'

On receipt of the CBCn_SUSPEND_CNF primitive from CBCn, GMMH shall compose the GMMH:SecurityModeComplete PDU and send it to the SSR for transmission to the peer GMMH agent in the RNC using the SSR_SIGDATA_REQ primitive (with the 'SUSP' parameter set to "TRUE"). After receiving the SSR_SIGDATA_CNF primitive from SSR (i.e. confirmation that the GMMH:SecurityModeComplete PDU has been received by the peer GMMH agent in the RNC), GMMH shall compose the CBCn_SECURITY_REQ primitive and send it to CBCn. The GMMH state shall change to 'CONNECTED-CIPHERING-REQUESTED'.

On receipt of the CBCn_SUSPEND_REJ primitive from CBCn, GMMH shall compose the GMMH:SecurityModeFailure PDU and send it to the SSR for transmission to the peer GMMH agent in the RNC using the SSR_SIGDATA_REQ primitive. The GMMH state shall change to 'CONNECTED'.

5.4.2.8.3.6 Behaviour in State 'CONNECTED-RESUME-REQUESTED'

On receipt of the CBCn_RESUME_CNF primitive from CBCn, the GMMH state shall change to 'CONNECTED'.

5.4.2.8.4 Behaviour in State 'CONNECTED-IU-REL'

On receipt of the GMMAL_EST_REQ primitive from GMM, GMMH shall use the encapsulated Layer 3-PDU (NAS Message) to compose the GMMH:InitialDirectTransfer PDU and send it to the SSR for transmission to the peer GMMH agent in the RNC using the SSR_SIGDATA_REQ primitive. GMMH shall notify GMM of the establishment of the UE-Specific Signalling connection by sending the GMMAL_EST_CNF primitive. The GMMH state shall change to 'CONNECTED'

On receipt of the REGM_REL_IND primitive from REGM, the GMMH state shall change to 'IDLE'.

5.4.2.8.5 Behaviour in State 'AWAIT-SIG-CON-RELEASE'

On receipt of the REGM_REL_CNF primitive from REGM, GMMH shall inform GMM of the release of the PS signalling connection by sending the GMMAL_REL_IND primitive. The GMMH state shall change to 'IDLE'.

On receipt of the REGM_SIGNAL_CONN_REL_IND primitive from REGM, GMMH shall inform GMM of the release of the PS signalling connection by sending the GMMAL_REL_IND primitive. The GMMH state shall change to 'CONNECTED-IU-REL'.

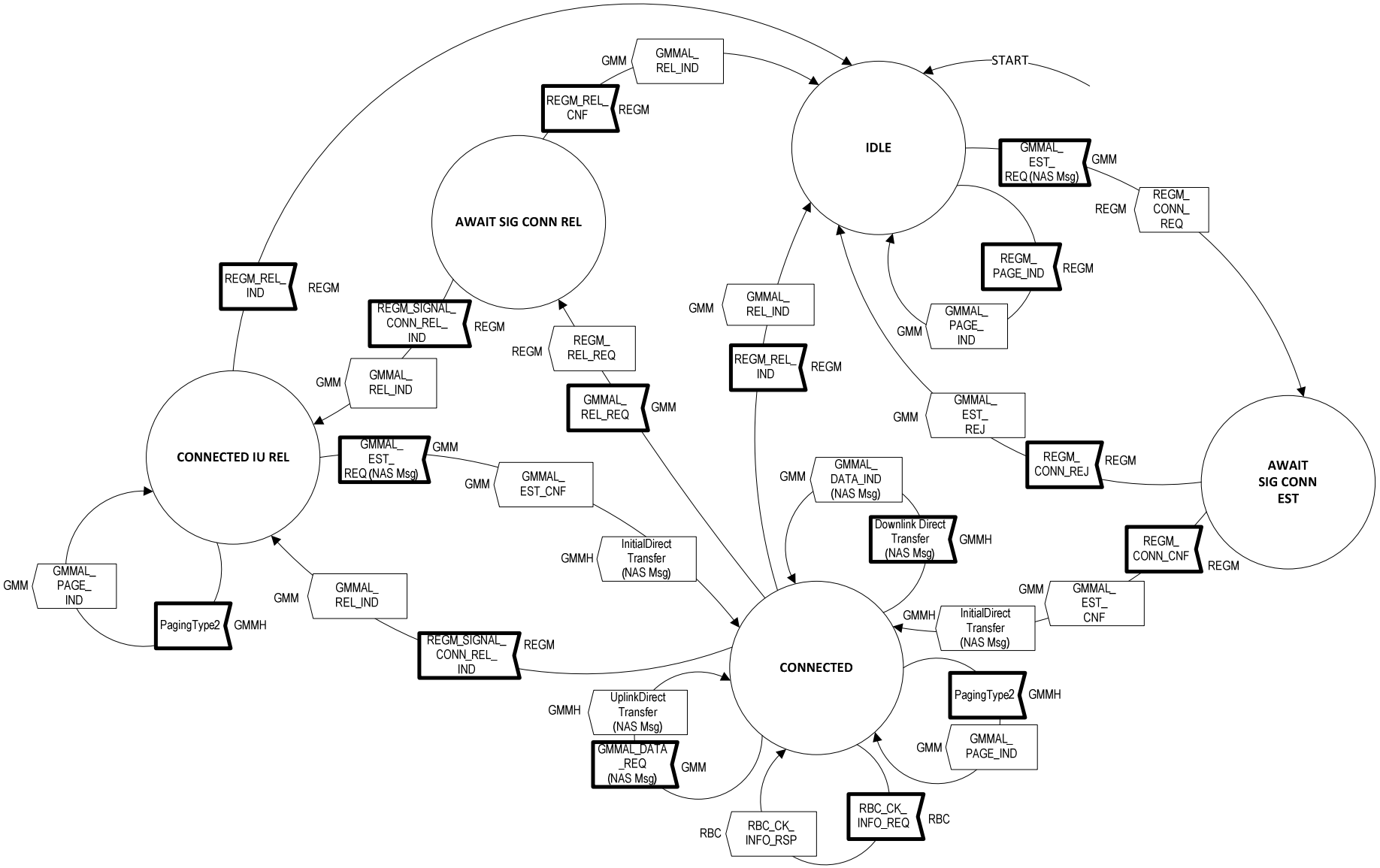

Figure 5.11: UE GMMH Signal-State Diagram (Security and Status Functions Not Shown)

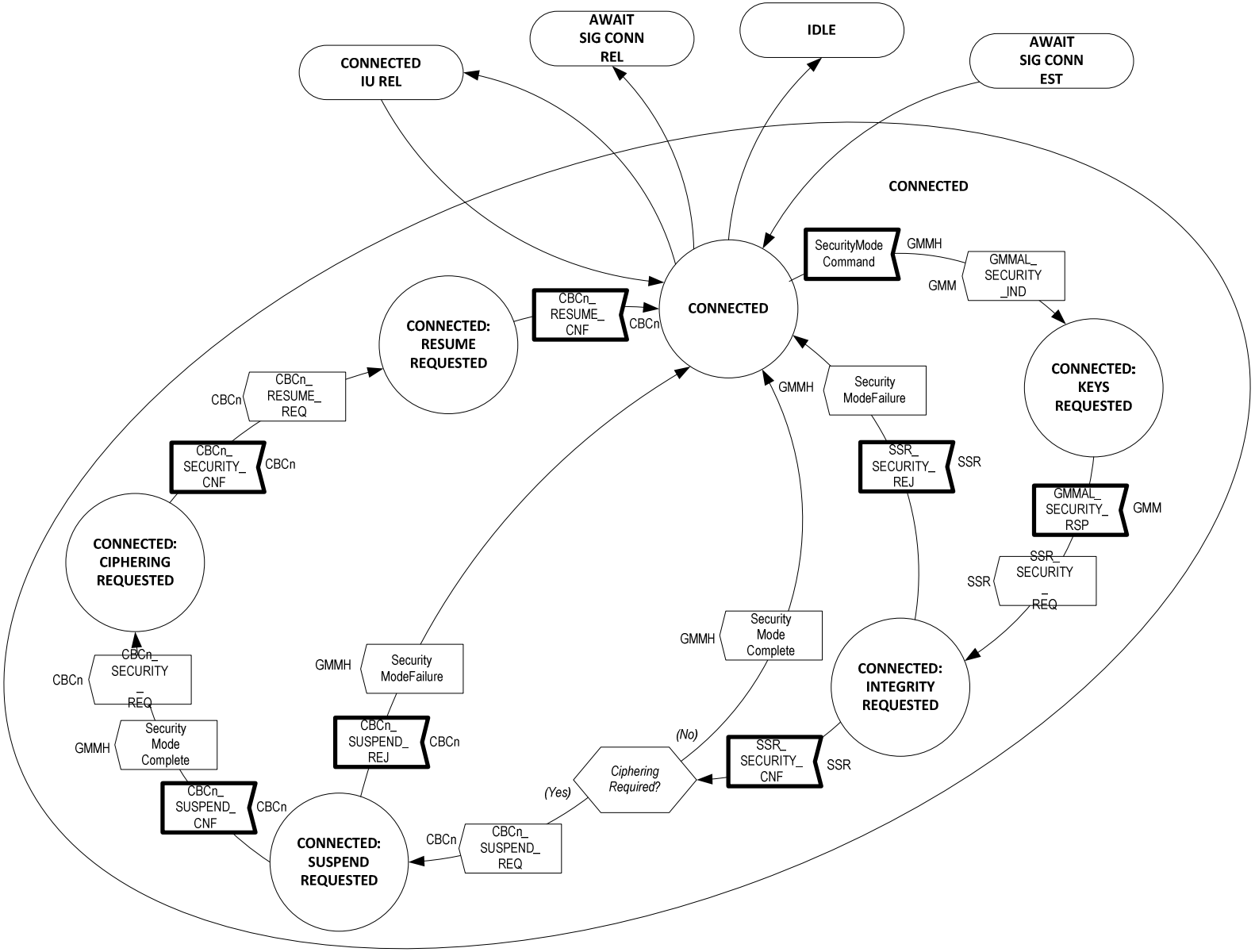

Figure 5.12: UE GMMH Signal-State Diagram - Security Functions

5.4.3 MMH

5.4.3.1 MMH Protocol Data Units

The MMH Protocol Data Units are shown in Table 5.18.

Table 5.18: MMH::MMH Protocol Data Units

PDU	SAP	Direction	Addressing	Information Elements
PagingType2	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain, Paging Cause, Paging Record Type ID
InitialDirectTransfer	SIG	From UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
UplinkDirectTransfer	SIG	From UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
DownlinkDirectTransfer	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
SecurityModeCommand	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, Security Capability, {Ciphering Mode Info AVP, Integrity Protection Mode Info AVP} OPTIONAL
SecurityModeComplete	SIG	From UE	BCnID	AL Signal Type, ALPD, {UL Integrity Protection Activation Info AVP, RB Activation Time Info} OPTIONAL
SecurityModeFailure	SIG	From UE	BCnID	AL Signal Type, ALPD, CHOICE {Security Failure Cause, Protocol Error Cause}

NOTE: "NAS Message" is called a Layer 3-PDU in ETSI TS 124 007 [1].

5.4.3.2 Service Primitives at MMH-SIG-SAP

The service primitives at MMH-SIG-SAP are shown in Table 5.19.

Table 5.19: MMH::SSR Service Primitives at MMH-SIG-SAP [UE]

Primitive	Direction	Parameters
SSR_SIGDATA_REQ *MMH requests SSR to send a PDU to its peer in the RNC.*	To SSR	MMH PDU, {SUSP} OPTIONAL
SSR_SIGDATA_IND *SSR indicates to MMH that it has received a PDU from the peer agent in the RNC.*	To MMH	MMH PDU
SSR_SIGDATA_CNF *Optional response to SSR_SIGDATA_REQ. SSR indicates to MMH that the peer agent in the RNC has received a PDU.*	To MMH	-
SSR_SECURITY_REQ *MMH requests SSR to start (or modify) integrity protection.*	To SSR	UIA, IK, START, {FRESH} OPTIONAL
SSR_SECURITY_CNF *SSR confirms to MMH that integrity protection has been started (or modified).*	To MMH	-
SSR_SECURITY_REJ *SSR indicates to MMH that integrity protection could not be started (or modified) for the specified reason.*	To MMH	Rejection Cause

5.4.3.3 Service Primitives at MMAL-SAP

The service primitives at MMAL-SAP are shown in Table 5.20. The MMAL-SAP and associated service primitives are functionally identical to the RR-SAP and associated service primitives defined in ETSI TS 124 007 [1]. Some modifications have been made to the service primitives to suit the Adaptation Layer model or provide similar functionality as the equivalent SAP for the PS service domain (GMMAL-SAP). Any modifications are noted in the text to follow.

Table 5.20: MM:MMH Service Primitives at MMAL-SAP [UE]

Primitive	Direction	Parameters
MMAL_EST_REQ *MM requests the AL to establish a CS signalling connection and transport the initial NAS Message to its peer in the network.*	To MMH	NAS Message, Establishment Cause, CN Domain Identity, UE NAS ID and Type, LAI
MMAL_DATA_REQ *MM requests the AL to transport a NAS Message to its peer in the network (a CS signalling connection has already been established).*	To MMH	NAS Message, [Local Flow Identifier], CN Domain Identity
MMAL_ABORT_REQ *MM requests the AL to abort an existing CS signalling connection establishment which is in progress or to release the CS signalling connection (after it has been established).*	To MMH	Cause
MMAL_EST_IND	To MM	-
MMAL_EST_CNF *Response to MMAL_EST_REQ. AL confirms to MM that a CS signalling connection has been established.*	To MM	-
MMAL_REL_IND *AL indicates to MM that the network has released the CS signalling connection.*	To MM	Cause
MMAL_SYNC_IND *AL to indicates to MM that ciphering has been started, integrity protection has been started, a traffic channel has been assigned (resource assignment), or the channel mode has been modified.*	To MM	Cause (Ciphering, Res. Assgt., Channel Mode Modify), SEQUENCE OF {RAB ID, NAS Synchronization Indicator}
MMAL_DATA_IND *AL indicates to MM that a NAS Message has been received from the peer MM agent in the network.*	To MM	NAS Message, CN Domain Identity
MMAL_ABORT_IND *AL informs MM that the establishment of a CS signalling connection has been aborted by a lower layer failure.*	To MM	Cause

The RR_EST_REQ primitive in ETSI TS 124 007 [1] does not contain the 'Establishment Cause', 'UE NAS ID and Type', and 'LAI' parameters. The parameters have been added to the MMAL_EST_REQ primitive to align it with the corresponding GMMAL_EST_REQ primitive. The additional information is required by MMH (and REGM) for the radio interface Registration procedure.

NOTE 1: ETSI TS 124 007 [1] does not specify an explicit method which would allow MMH to request security keys from MM via the MMAL-SAP (similar to the GMMAL_SECURITY_IND/RSP primitive pair defined between GMMH and GMM at the GMMAL-SAP; see Table 5.15). A practical implementation may use a MMAL_SECURITY_IND/RSP primitive pair at the MMAL-SAP for this purpose, as shown in Table 5.21, or alternatively assume that GMM is aware of both the PS and CS service domain security keys and use the GMMAL_SECURITY_IND/RSP service primitives at the GMMAL-SAP.

Table 5.21: MM:MMH Service Primitives at MMAL-SAP based on a MMAL_SECURITY_IND/RSP primitive pair at the MMAL-SAP

MMAL_SECURITY_IND *Indication from the AL that ciphering (and integrity protection) shall be started; AL requests MM to provide ciphering and integrity keys.*	To MM	-
MMAL_SECURITY_RES *Response to MMAL_SECURITY_IND. MM assigns ciphering and integrity keys to the AL to enable ciphering and integrity protection. MM also provides the value START to the AL.*	To MMH	CK, IK, START

NOTE 2: Similarly, ETSI TS 124 007 [1] does not specify an explicit method which would allow MMH to inform MM via the MMAL-SAP that a paging request from the network has been received (similar to the MMAL_PAGE_IND primitive defined between GMMH and GMM at the GMMAL-SAP; see Table 5.15). A practical implementation may use a MMAL_PAGE_IND primitive pair at the MMAL-SAP for this purpose, as shown in Table 5.22.

Table 5.22: MM:MMH Service Primitives at MMAL-SAP based on MMAL_PAGE_IND primitive pair at the MMAL-SAP

MMAL_PAGE_IND *AL indicates to MM that a paging request from the network has been received.*	To MM	Paging Cause, UE Identity Type

5.4.3.4 Service Primitives at MMH-REGM-SAP

See clause 5.4.1.4.

5.4.3.5 Service Primitives at MMH-CBCn-SAP

The service primitives at MMH-CBCn-SAP are as shown in Table 5.23.

Table 5.23: MMH::CSR Service Primitives at MMH-CBCn-SAP [UE]

Primitive	Direction	Parameters
CBCn_SECURITY_REQ *MMH requests BCn to start, or modify ciphering for all PDUs received at the indicated SAPs (BCnID).*	To CSR	ALPD, Mode (Start/ Modify), CK, START, SEQUENCE OF {BCnID, UL Activation Time, DL Activation Time}
CBCn_SECURITY_CNF *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated SAPs (BCnID) has been started/modified.*	To MMH	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_REQ *MMH requests BCn to suspend the indicated connections (UE Specific Signalling connection and all CS domain RABs).*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_CNF *Response to CBCn_SUSPEND_REQ. BCn confirms that the indicated connections are suspended.*	To MMH	ALPD, SEQUENCE OF {BCnID, Next BCn Send Sequence Number}
CBCn_SUSPEND_REJ *Response to CBCn_SUSPEND_REQ. BCn indicates that one or more connections have not been suspended.*	To MMH	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_REQ *MMH requests BCn to resume the indicated connections (UE Specific Signalling connection and all PS domain RABs).*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_CNF *Response to CBCn_RESUME_REQ. BCn confirms that the indicated connections have resumed.*	To MMH	ALPD, SEQUENCE OF {BCnID}

5.4.3.6 Service Primitives RBCCS-MMH-SAP

See clause 5.4.4.8.

5.4.3.7 MMH States

The MMH states are as shown in Table 5.24.

Table 5.24: MMH States [UE]

Number	State	Description
1	IDLE ★Initial State	A UE-Specific signalling connection has not been established and MMH is unable to route messages between MM and the BCn layer.
2	AWAIT-SIG-CONN-EST	MMH has requested REGM to establish a UE-Specific signalling connection and is awaiting a response.
3	CONNECTED	A UE-Specific signalling connection has been established and MMH is able to route messages between MM and the BCn layer. The corresponding Iu-CS signalling connection (between the RNC and CN) is established when in this state.
>3a	CONNECTED	No MMH security procedures are in progress.
>3b	CONNECTED-KEYS-REQUESTED	MMH has requested MM (or GMM; see note in clause 5.4.3.3) to provide ciphering and integrity keys and is waiting for a response.
>3c	CONNECTED-INTEGRITY-REQUESTED	MMH has requested the SSR to start integrity protection and is waiting for confirmation.
>3d	CONNECTED-CIPHERING-REQUESTED	MMH has requested the BCn layer to start ciphering and is waiting for confirmation.
>3e	CONNECTED-SUSPEND-REQUESTED	MMH has requested the Bearer Connection layer to suspend all active CS domain RABs and the UE-Specific Signalling connection and is awaiting a response.
>3f	CONNECTED-RESUME-REQUESTED	MMH has requested the Bearer Connection layer to resume all suspended CS domain RABs and the UE-Specific Signalling connection and is awaiting a response.
4	CONNECTED-IU-REL	A UE-Specific signalling connection has been established but the corresponding Iu-PC signalling connection (between the RNC and CN) has been released.
5	AWAIT-SIG-CONN-REL	MM has requested REGM to release the UE-Specific signalling connection and is awaiting confirmation.
6	ABORT-REQUESTED	MM has requested MMH to abort the establishment of the UE-Specific signalling connection which is in progress.

5.4.3.8 MMH Behaviour

5.4.3.8.0 General

MMH behaviour in the UE is summarized in the signal-state diagrams in Figures 5.13 and 5.14.

5.4.3.8.1 Behaviour in State 'IDLE'

On receipt of the MMAL_EST_REQ primitive from MM, MMH shall save the encapsulated Layer 3-PDU (NAS Message). MMH shall then request REGM to establish the UE-Specific Signalling connection by sending the REGM_CONN_REQ primitive. The MMH state shall change to 'AWAIT-SIG-CONN-EST'.

On receipt of the REGM_PAGE_IND primitive from REGM, MMH shall notify MM of the paging event by sending the MMAL_PAGE_IND primitive.

5.4.3.8.2 Behaviour in State 'AWAIT-SIG-CON-ESTABLISH'

On receipt of the REGM_CONN_REJ primitive from REGM, MMH shall notify MM of the failure to establish the UE-Specific Signalling connection by sending the MMAL_EST_REJ primitive. The MMH state shall change to 'IDLE'.

On receipt of the REGM_CONN_CNF primitive from REGM, MMH shall save the value of the 'UE Security Capability' parameter (list of supported integrity protection and ciphering algorithms). MMH shall notify MM of the establishment of the UE-Specific Signalling connection by sending the MMAL_EST_CNF primitive. MMH shall then compose the MMH:InitialDirectTransfer PDU, including the saved Layer 3-PDU (NAS Message), and send it to the SSR for transmission to the peer MMH agent in the RNC using the SSR_SIGDATA_REQ primitive. The MMH state shall change to 'CONNECTED'.

On receipt of the MMAL_ABORT_REQ primitive from MM, the MMH state shall change to 'ABORT-REQUESTED'.

5.4.3.8.3 Behaviour in State 'CONNECTED'

5.4.3.8.3.1 Behaviour in Substate 'CONNECTED'

On receipt of the MMAL_DATA_REQ primitive from MM, MMH shall use the encapsulated Layer 3-PDU (NAS Message) to compose the MMH:UplinkDirectTransfer PDU and send it to the SSR for transmission to the peer MMH agent in the RNC using the SSR_SIGDATA_REQ primitive.

On receipt of the SSR_SIGDATA_IND primitive from SSR, MMH shall unpack the encapsulated MMH PDU from the peer agent in the RNC and examine the AL Signal Type IE:

- 1> If the PDU type is MMH:DownlinkDirectTransfer, then MMH shall forward the encapsulated Layer 3-PDU (NAS Message) to MM using the MMAL_DATA_IND primitive.
- 1> If the PDU type is MMH:PagingType2, then MMH shall notify MM of the paging event by sending the MMAL_PAGE_IND primitive.
- 1> If the PDU type is MMH:SecurityModeCommand, then MMH compare the security capabilities information in the received PDU with the saved security capabilities information (saved from REGM_CONN_CNF) and:
  - 2> if the saved and received security capabilities information are the same, then MMH shall request the ciphering and integrity keys from MM by sending the GMMAL_SECURITY_IND primitive. The MMH state shall change to 'CONNECTED-KEYS-REQUESTED';
  - 2> if the saved and received security capabilities information are not the same, then MMH shall compose the MMH:SecurityModeFailure PDU and send it to the SSR for transmission to the peer MMH agent in the RNC using the SSR_SIGDATA_REQ primitive. The 'Security Failure Cause' IE shall be set to "Unsupported or Mismatched Security Configuration". The MMH state shall change to 'CONNECTED'.

On receipt of the REGM_SIGNAL_CONN_REL_IND primitive from REGM, MMH shall inform MM of the release of the CS signalling connection by sending the MMAL_REL_IND primitive. The MMH state shall change to 'CONNECTED-IU-REL'.

On receipt of the REGM_REL_IND primitive from REGM, MMH shall inform MM of the release of the CS signalling connection by sending the MMAL_REL_IND primitive. The MMH state shall change to 'IDLE'.

On receipt of the MMAL_ABORT_REQ primitive from MM, MMH shall request REGM to release the UE-Specific Signalling connection by sending the REGM_REL_REQ primitive. The MMH state shall change to 'AWAIT-SIG-CONN-REL'.

On receipt of the RBC_SYNC_REQ primitive from RBC-CS, MMH shall notify MM of the resource assignment by sending the MMAL_SYNC_IND primitive.

On receipt of the RBC_CK_INFO_REQ primitive from RBC-CS, MMH shall respond by sending the requested Ciphering Key in the RBC_CK_INFO_RSP primitive.

5.4.3.8.3.2 Behaviour in Substate 'KEYS-REQUESTED'

On receipt of the MMAL_SECURITY_RES (or GMMAL_SECURITY_RES) primitive from MM, MMH shall request the SSR to start integrity protection by sending the SSR_SECURITY_REQ primitive. The MMH state shall changed to 'CONNECTED-INTEGRITY-REQUESTED'.

5.4.3.8.3.3 Behaviour in Substate 'INTEGRITY-REQUESTED'

On receipt of the SSR_SECURITY_CNF primitive from SSR,

- 1> if the MMH:SecurityModeCommand PDU indicates that ciphering is also to be started, then MMH shall request the Bearer Connection layer to suspend all active CS domain RABs and the UE-Specific Signalling connection by sending the CBCn-SUSPEND_REQ primitive to CBCn. The MMH state shall change to 'CONNECTED-SUSPEND-REQUESTED';

- 1> if the MMH:SecurityModeCommand PDU does not indicate that ciphering is also to be started, then MMH shall compose the MMH:SecurityModeComplete PDU and send it to the SSR for transmission to the peer MMH agent in the RNC using the SSR_SIGDATA_REQ primitive (with the 'SUSP' parameter set to "TRUE"). MMH shall also indicate the start of integrity protection to MM by sending the MMAL_SYNC_IND primitive. The MMH state shall change to 'CONNECTED'.

On receipt of the SSR_SECURITY_REJ primitive from SSR, MMH shall compose the MMH:SecurityModeFailure PDU and send it to the SSR for transmission to the peer MMH agent in the RNC using the SSR_SIGDATA_REQ primitive. The MMH state shall change to 'CONNECTED'.

5.4.3.8.3.4 Behaviour in Substate 'CIPHERING-REQUESTED'

On receipt of the CBCn_SECURITY_CNF primitive from CBCn, MMH shall indicate the start of integrity protection and ciphering to MM by sending the MMAL_SYNC_IND primitive. The MMH state shall change to 'CONNECTED'.

5.4.3.8.3.5 Behaviour in State 'CONNECTED-SUSPEND-REQUESTED'

On receipt of the CBCn_SUSPEND_CNF primitive from CBCn, MMH shall compose the MMH:SecurityModeComplete PDU and send it to the SSR for transmission to the peer MMH agent in the RNC using the SSR_SIGDATA_REQ primitive (with the 'SUSP' parameter set to "TRUE"). After receiving the SSR_SIGDATA_CNF primitive from SSR (i.e. confirmation that the MMH:SecurityModeComplete PDU has been received by the peer MMH agent in the RNC), MMH shall compose the CBCn_SECURITY_REQ primitive and send it to CBCn. The MMH state shall change to 'CONNECTED-CIPHERING-REQUESTED'.

On receipt of the CBCn_SUSPEND_REJ primitive from CBCn, MMH shall compose the MMH:SecurityModeFailure PDU and send it to the SSR for transmission to the peer MMH agent in the RNC using the SSR_SIGDATA_REQ primitive. The MMH state shall change to 'CONNECTED'.

5.4.3.8.3.6 Behaviour in State 'CONNECTED-RESUME-REQUESTED'

On receipt of the CBCn_RESUME_CNF primitive from CBCn, the MMH state shall change to 'CONNECTED'.

5.4.3.8.4 Behaviour in State 'CONNECTED-IU-RELEASED'

On receipt of the MMAL_EST_REQ primitive from MM, MMH shall use the encapsulated Layer 3-PDU (NAS Message) to compose the MMH:InitialDirectTransfer PDU and send it to the SSR for transmission to the peer MMH agent in the RNC using the SSR_SIGDATA_REQ primitive. MMH shall notify MM of the establishment of the UE-Specific Signalling connection by sending the MMAL_EST_CNF primitive. The MMH state shall change to 'CONNECTED'.

On receipt of the REGM_REL_IND primitive from REGM, the MMH state shall change to 'IDLE'.

5.4.3.8.5 Behaviour in State 'AWAIT-SIG-CON-RELEASE'

On receipt of the REGM_REL_CNF primitive from REGM, MMH shall inform MM of the release of the CS signalling connection by sending the MMAL_REL_IND primitive. The MMH state shall change to 'IDLE'.

On receipt of the REGM_SIGNAL_CONN_REL_IND primitive from REGM, MMH shall inform MM of the release of the CS signalling connection by sending the MMAL_REL_IND primitive. The MMH state shall change to 'CONNECTED-IU-REL'.

5.4.3.8.6 Behaviour in State 'ABORT-REQUESTED'

On receipt of the REGM_CONN_CNF primitive from MM, MMH shall request REGM to release the UE-Specific Signalling connection by sending the REGM_REL_REQ primitive. The MMH state shall change to 'AWAIT-SIG-CONN-REL'.

On receipt of the REGM_CONN_REJ primitive from REGM, MMH shall send the MMAL_REL_IND primitive to MM. The MMH state shall change to 'IDLE'.

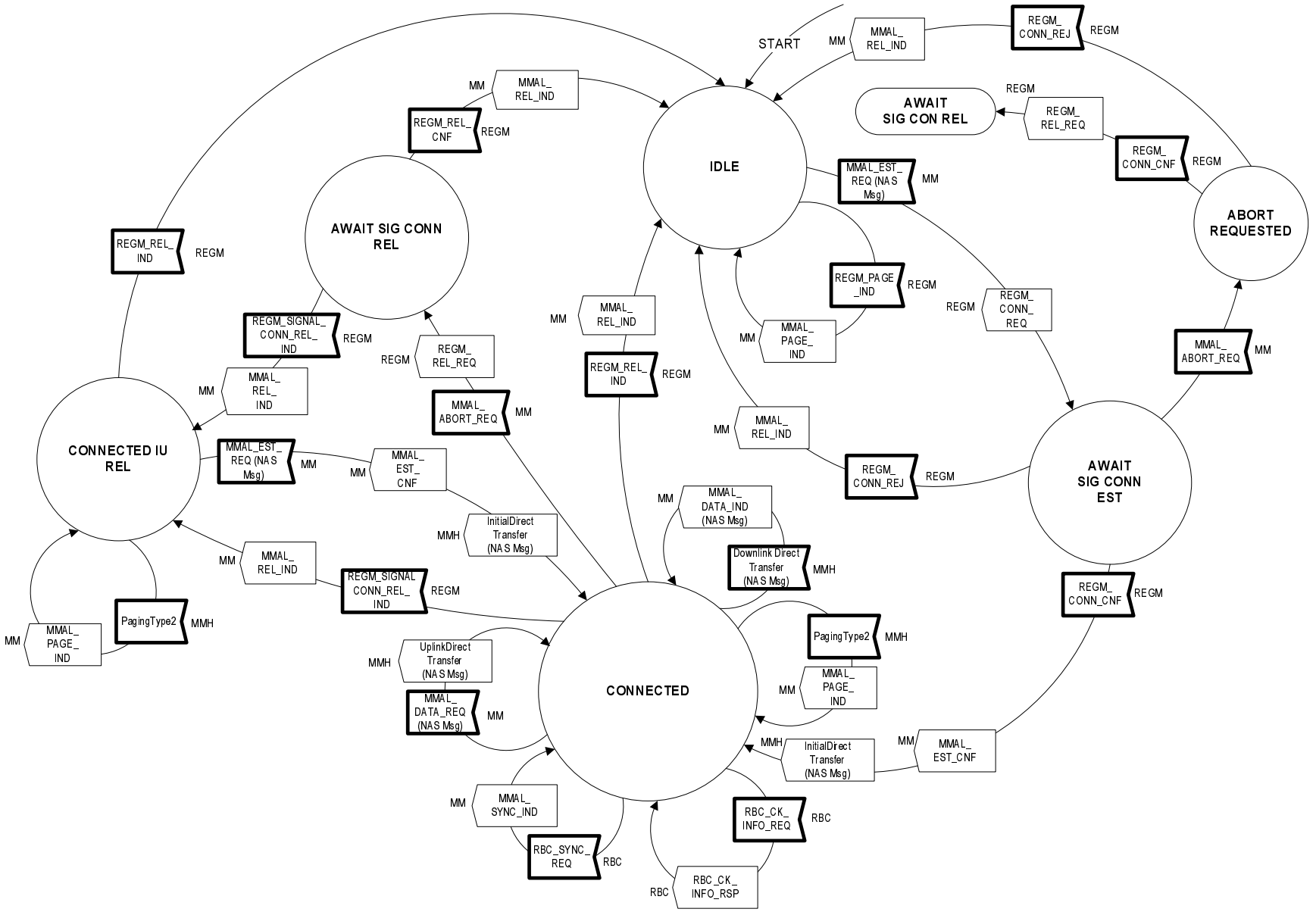

Figure 5.13: UE MMH Signal-State Diagram *(Security Functions Not Shown)*

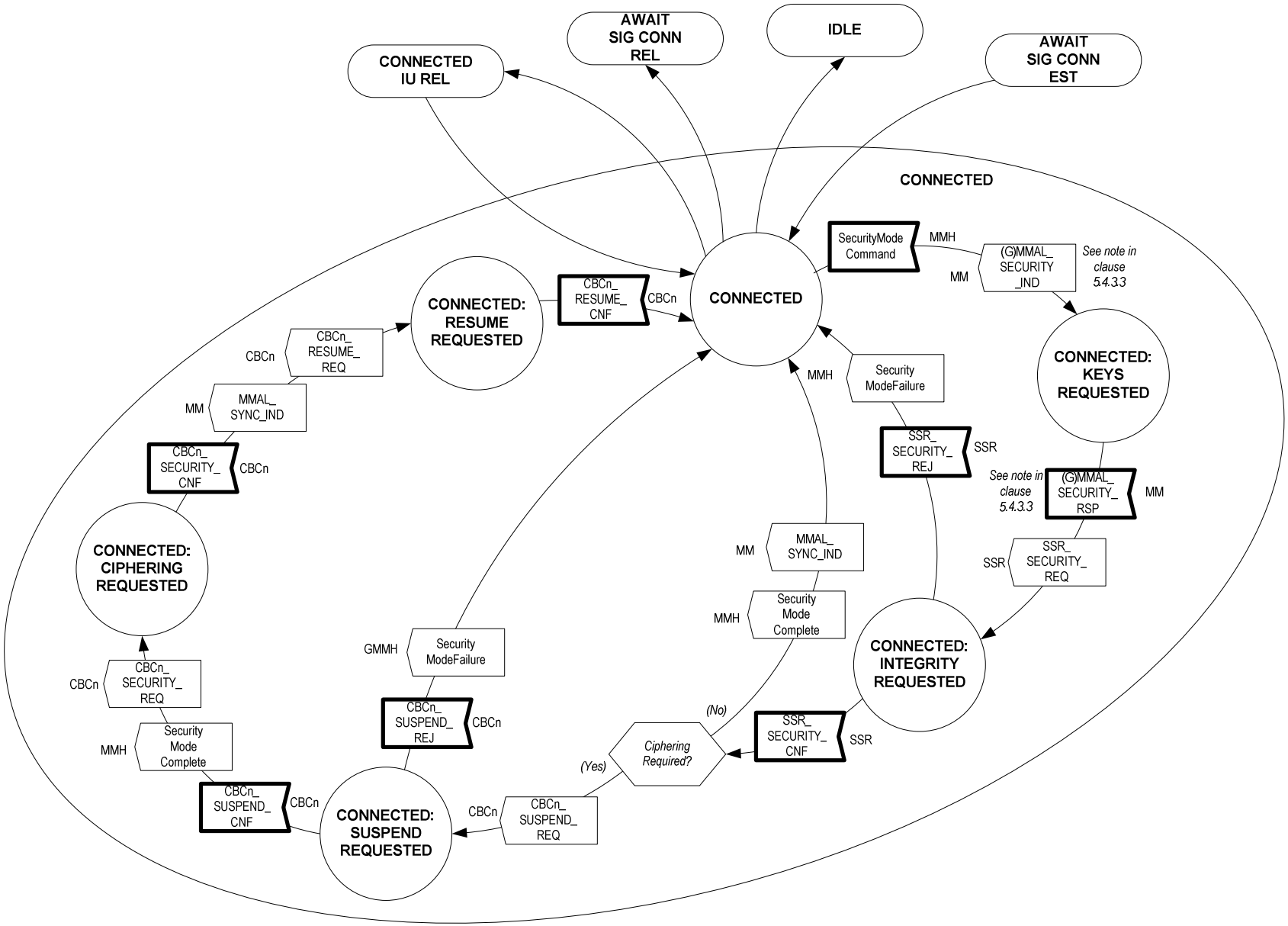

Figure 5.14: UE MMH Signal-State Diagram - Security Functions

5.4.4 Radio Bearer Control (RBC)

5.4.4.1 RBC Protocol Data Units

The RBC Protocol Data Units are as shown in Table 5.25.

Table 5.25: RBC::RBC Protocol Data Units

PDU	SAP	Direction	Addressing	Information Elements
Establish	SIG	To UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), BCn Type, Number of (BCn) Parameters, BCn Parameter List, Control Flags, Transaction ID, BCt Type, BCtID, BCt EPDU
EstablishAck	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, {Adaptation Layer AVP List} OPTIONAL
EstablishReject	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, CHOICE {Failure Cause, Protocol Error Cause}
Modify	SIG	To UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), BCn Type, Number of (BCn) Parameters, BCn Parameter List, Control Flags, Transaction ID, BCt Type, BCtID, BCt EPDU
ModifyAck	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, {Adaptation Layer AVP List} OPTIONAL
ModifyReject	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, CHOICE {Failure Cause, Protocol Error Cause}
Release	SIG	To UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, Release Cause, {BCt Type, BCtID, BCt EPDU} OPTIONAL
ReleaseAck	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, {Adaptation Layer AVP List} OPTIONAL
ReleaseReject	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, CHOICE {Failure Cause, Protocol Error Cause}

5.4.4.2 Service Primitives at RBC-REGM-SAP (RBCPS-REGM-SAP, RBCCS-REGM-SAP)

See clause 5.4.1.4.

5.4.4.3 Service Primitives at RBC-SIG-SAP (RBCPS-SIG-SAP, RBCCS-SIG-SAP)

The service primitives at RBC-SIG-SAP are as shown in Table 5.26.

Table 5.26: RBC::SSR Service Primitives at RBC-SIG-SAP [UE]

Primitive	Direction	Parameters
SSR_SIGDATA_REQ *RBC requests SSR to send a PDU to its peer in the RNC*	To SSR	RBC PDU
SSR_SIGDATA_IND *SSR indicates to RBC that it has received a PDU from the peer agent in the RNC*	To RBC	RBC PDU
SSR_SIGDATA_CNF *Optional response to SSR_SIGDATA_REQ. SSR indicates to RBC that the peer agent in the RNC has received a PDU.*	To RBC	-

5.4.4.4 Service Primitives at RABMAL-SAP (RBC PS Domain Only)

The service primitives at RABMAL-SAP are as shown in Table 5.27. The RABMAL-SAP and associated service primitives are functionally identical to the RABMAS-SAP and associated service primitives defined in ETSI TS 124 007 [1]; only the names have changed for clarity.

Table 5.27: RABM::RBC-PS Service Primitives at RABMAL-SAP [UE]

Primitive	Direction	Parameters
RABMAL_RAB_EST_IND *RBC indicates to RABM that radio access bearer setup for the indicated list of RAB IDs (contains NSAPI) has commenced.*	To RABM	SEQUENCE OF {RAB ID}
RABMAL_RAB_EST_RES Response to RABMAL_RAB_EST_IND. RABM informs RBC that the indicated NSAPI (in RAB ID) is currently or has been activated by the SM.	To RBC (PS Domain Instance)	-
RABMAL_RAB_EST_REJ *Response to RABMAL_RAB_EST_IND. RABM informs RBC that all of the NSAPI indicated by RAB ID list in the received RABMAL_RAB_ESTABLISH_IND, have not been activated by the SM-layer and the attempt to setup the radio access bearers shall be rejected.*	To RBC (PS Domain Instance)	-
RABMAL_RAB_REL_IND *RBC indicates to RABM that a radio access bearer for the indicated NSAPI (in RAB ID) has been released.*	To RABM	SEQUENCE OF {RAB ID}
RABMAL_RAB_REL_RES *Response to RABMAL_RAB_REL_IND. RABM agent informs RBC that the indicated RAB ID has been released in the RABM.*	To RBC (PS Domain Instance)	RAB ID
RABMAL_STATUS_IND *RBC indicates transfer failures to RABM.*	To RABM	Cause

5.4.4.5 Service Primitives at MMRBC-SAP (RBC CS Domain Only)

The service primitives at MMRBC-SAP are as shown in Table 5.28.

Table 5.28: RBC-CS::MMH Service Primitives at MMRBC-SAP [UE]

Primitive	Direction	Parameters
RBC_SYNC_REQ *RBC requests MMH to send the MMAL_SYNC_IND message (resource assignment or channel mode modification) to the MM agent, indicating the assigned RAB ID and optionally the NAS Synchronization Indicator*	To MMH	Cause, SEQUENCE OF {RAB ID, NAS Sync Indicator}

5.4.4.6 Service Primitives at RBC-CBCn-SAP (RBCPS-CBCn-SAP, RBCCS-CBCn-SAP)

The service primitives at RBC-CBCn-SAP are as shown in Table 5.29.

Table 5.29: RBC::CSR Service Primitives at RBC-CBCn-SAP [UE]

Primitive	Direction	Parameters
CBCn_CREATE_REQ *RBC requests the BCn layer to create the DATA-SAP with the specified handle (BCnID) and QoS attributes.*	To CSR	ALPD, BCnID (DATA-SAP), BCn/AL Parameter List, BCtID, {BCt EPDU} OPTIONAL
CBCn_CREATE_CNF *Response to CBCn_CREATE_REQ. BCn layer confirms that the DATA-SAP with the specified handle (BCnID) has been created.*	To RBC	ALPD, BCnID
CBCn_CREATE_REJ *Response to CBCn_CREATE_REQ. BCn layer confirms that the DATA-SAP with the specified handle (BCnID) has not been created for the specified reason.*	To RBC	ALPD, BCnID, Rejection Cause
CBCn_MODIFY_REQ *RBC requests the BCn layer to modify the QoS attributes of the specified DATA-SAP (BCnID).*	To CSR	ALPD, BCnID (DATA-SAP), BCn/AL Parameter List, BCtID, {BCt EPDU} OPTIONAL
CBCn_MODIFY_CNF *Response to CBCn_MODIFY_REQ. BCn layer confirms that the QoS attributes of the specified DATA-SAP (BCnID) have been modified.*	To RBC	ALPD, BCnID
CBCn_MODIFY_REJ *Response to CBCn_MODIFY_REQ. BCn layer confirms that the QoS attributes of the specified DATA-SAP (BCnID) have not been modified for the specified reason.*	To RBC	ALPD, BCnID, Rejection Cause
CBCn_DESTROY_REQ *RBC requests the BCn layer to destroy one or more DATA-SAP(s) with the specified handle(s) (BCnID).*	To CSR	ALPD, SEQUENCE OF {BCnID (DATA-SAP)}
CBCn_DESTROY_CNF *Response to CBCn_DESTROY_REQ. BCn layer confirms that the DATA-SAP(s) with the specified handle(s) (BCnID) has (have) been destroyed.*	To RBC	ALPD, SEQUENCE OF {BCnID}
CBCn_SECURITY_REQ *RBC requests BCn to start, or modify ciphering for all PDUs received at the indicated DATA-SAP (BCnID).*	To CSR	ALPD, Mode (Start/ Modify), CK, START, BCnID, UL Activation Time, DL Activation Time
CBCn_SECURITY_CNF *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated DATA-SAP (BCnID) has been started/modified.*	To RBC	ALPD, BCnID
CBCn_SECURITY_REJ *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated DATA-SAP (BCnID) has not been started/modified for the specified reason.*	To RBC	ALPD, BCnID, Rejection Cause
CBCn_FAILURE_IND *BCn indicates a failure of the specified bearer connection to RBC.*	To RBC	ALPD, BCnID, Failure Cause

5.4.4.7 Service Primitives at CPDCP-SAP (RBC PS Domain Only)

The service primitives at CPDCP-SAP are as shown in Table 5.30.

Table 5.30: RBC::PDCP Service Primitives at CPDCP-SAP [UE]

Primitive	Direction	Parameters
CPDCP_CONFIG_REQ	To PDCP	PDCP Info, BCnID (DATA-SAP), SN Sync, R/I
CPDCP_RELEASE_REQ	To PDCP	BCnID (DATA-SAP)

5.4.4.8 Service Primitives at RBCPS-GMMH-SAP (RBC PS Domain Only) or RBCCS-MMH-SAP (RBC CS Domain Only)

The service primitives at RBCPS-GMMH-SAP are as shown in Table 5.31.

Table 5.31: RBC::GMMH/MMH Service Primitives [UE]

Primitive	Direction	Parameters
RBC_CK_INFO_REQ *RBC requests GMMH to provide the PS domain ciphering key and the value $START_{PS}$ or MMH to provide the CS domain ciphering key and the value $START_{PS}$.*	To GMMH/ MMH	ALPD
RBC_CK_INFO_RSP *Response to RBC_CK_INFO_REQ. GMMH/MMH provides the requested ciphering key and the value START to RBC.*	To RBC	ALPD, CK, START

5.4.4.9 Service Primitives at CSH-RBC-SAP (RBC CS Domain Only)

The service primitives at CSH-RBC-SAP are as shown in Table 5.32.

Table 5.32: RBC::CSH Service Primitives at CSH-RBC-SAP [UE]

Primitive	Direction	Parameters
CSH_CONFIG_REQ	To CSH	BCnID (DATA-SAP), Forward CS Frames Per PDU, Return CS Frames Per PDU, Return DTX
CSH_CONFIG_CNF	To RBC-CS	BCnID (DATA-SAP), Circuit Switched Call Type
CSH_RELEASE_REQ	To CSH	BCnID (DATA-SAP)

5.4.4.10 RBC States

The RBC states are as shown in Table 5.33.

Table 5.33: RBC States

Number	State	Description
1	IDLE ★Initial State	A UE-Specific signalling connection has not been established. No RBC procedure is in progress.
2	CONNECTED	A UE-Specific signalling connection has been established. No RBC procedure is in progress.
>2a	CONNECTED-AWAIT CREATE	RBC has requested CBCn to create a DATA-SAP and is waiting for confirmation.
>2b	CONNECTED-AWAIT RAB REL	RBC has indicated the release of a RAB to RABM and is waiting for a response. This state has two numbered substates.
>2c	CONNECTED- AWAIT DESTROY	RBC has requested CBCn to delete a DATA-SAP and is waiting for confirmation. This state has five numbered substates.
>2d	CONNECTED- AWAIT RAB EST	RBC has indicated the establishment of a RAB to RABM and is waiting for a response.
>2e	CONNECTED- AWAIT KEYS	RBC has requested GMMH/MMH for a ciphering key and is waiting for a response.
>2f	CONNECTED- AWAIT SECURITY	RBC has requested CBCn to initiate ciphering and is waiting for confirmation.
>2g	CONNECTED-AWAIT-CSH	RBC has configured CSH and is waiting for confirmation.
>2h	CONNECTED-AWAIT-MODIFY	RBC has requested CBCn to modify the QoS attributes pertaining to a DATA-SAP and is waiting for conformation.

5.4.4.11 RBC Behaviour

5.4.4.11.0 General

RBC behaviour in the UE is summarized in the signal-state diagrams in Figures 5.15 and 5.16. RBC maintains a "RAB Table" which relates DATA-SAP handles (BCnID) to their corresponding RAB IDs.

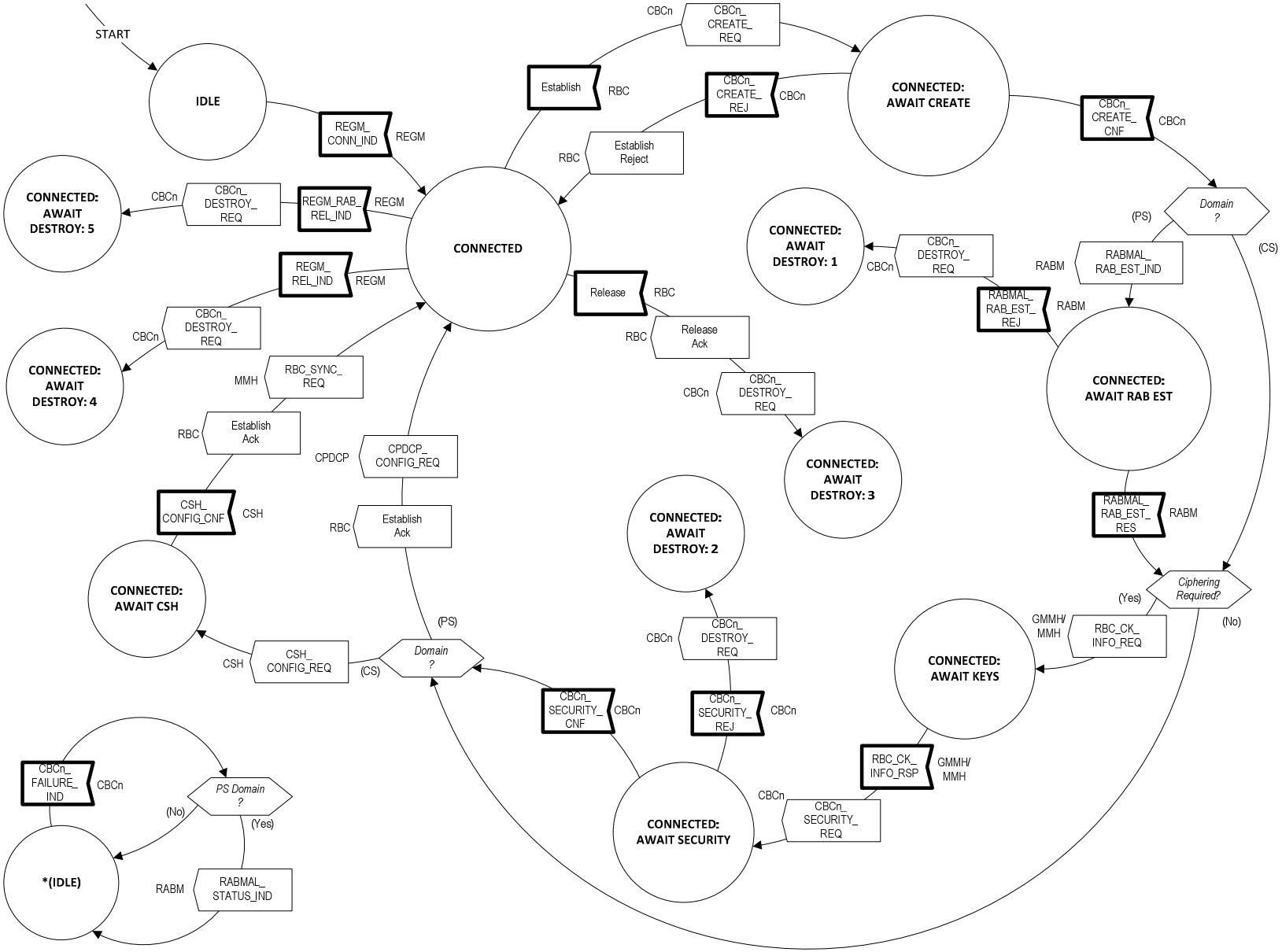

Figure 5.15: UE RBC Signal-State Diagram - Establish and Release Functions

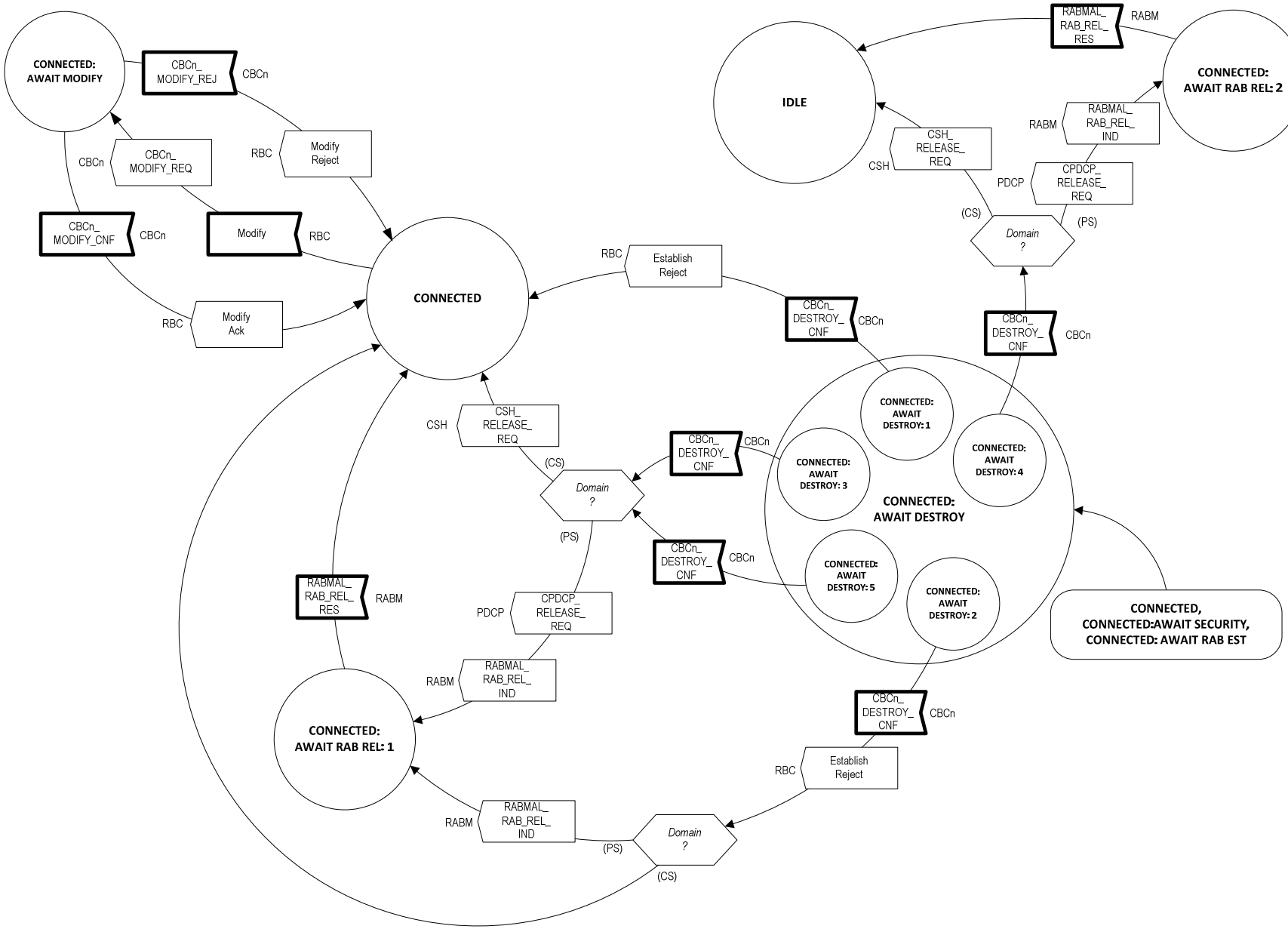

Figure 5.16: UE RBC Signal-State Diagram - Modify and Destroy Functions

5.4.4.11.1 Behaviour in State 'IDLE'

On receipt of the REGM_CONN_IND primitive from REGM, the RBC state shall change to 'CONNECTED'.

5.4.4.11.2 Behaviour in State 'CONNECTED'

On receipt of the SSR_SIGDATA_IND primitive from SSR, RBC shall unpack the encapsulated RBC PDU from the peer agent in the UE and examine the AL Signal Type IE:

- 1> If the PDU type is RBC:Establish, then RBC shall create a new entry in the RAB Table with the indicated values of BCnID (DATA-SAP) and RAB ID. The RNC shall compose the CBCn_CREATE_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-CREATE'.

- 1> If the PDU type is RBC:Modify, then RBC shall compose the CBCn_MODIFY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-MODIFY'.

- 1> If the PDU type is RBC:Release and

  - 2> if the RAB identified by the 'BCnID' IE of the RBC:Release PDU is present in the RAB table, then RBC shall compose the RBC:ReleaseAck PDU and send it to the SSR for transmission to the peer RBC agent in the RNC using the SSR_SIGDATA_REQ primitive. REGM shall then compose the CBCn_DESTROY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-3'.

  - 2> if the RAB identified by the 'BCnID' IE of the RBC:Release PDU is not present in the RAB table, then RBC shall compose the RBC:ReleaseReject PDU (with the 'Failure Cause' IE set to "Invalid BCnID") and send it to the SSR for transmission to the peer RBC agent in the RNC using the SSR_SIGDATA_REQ primitive.

On receipt of the REGM_REL_IND primitive from REGM, RBC shall send the CBCn_DESTROY_REQ primitive to CBCn, specifying the Bearer Connection IDs of any remaining entries in the RAB Table and then purge the RAB Table. The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-4'.

On receipt of the REGM_RAB_REL_IND primitive from REGM, RBC shall send the CBCn_DESTROY_REQ primitive to CBCn, specifying the Bearer Connection IDs of any remaining entries in the RAB Table and then purge the RAB Table. The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-5'.

5.4.4.11.3 Behaviour in State 'CONNECTED-AWAIT-CREATE'

On receipt of the CBCn_CREATE_CNF primitive from CBCn (via CSR),

- 1> PS Domain only: RBC shall compose the RABMAL_RAB_EST_IND primitive and send it to RABM. The RBC state shall change to 'CONNECTED-AWAIT-RAB-EST'.

- 1> CS Domain only:

  - 2> if ciphering is enabled, then RBC shall compose the RBC_CK_INFO_REQ primitive and send it to MMH. The RBC state shall change to 'CONNECTED-AWAIT-KEYS'.

  - 2> if ciphering is not enabled, then RBC shall compose the CSH_CONFIG_REQ primitive and send it to CSH. The RBC state shall change to 'CONNECTED-AWAIT-CSH'.

On receipt of the CBCn_CREATE_REJ primitive from CBCn (via CSR), RBC shall remove the corresponding entry from the RAB Table. The RBC shall also compose the RBC:EstablishReject PDU and send it to the SSR for transmission to the peer RBC agent in the RNC using the SSR_SIGDATA_REQ primitive. The RBC state shall change to 'CONNECTED'.

5.4.4.11.4 Behaviour in State 'CONNECTED-AWAIT-RAB-REL'

5.4.4.11.4.0 General

This state has two numbered substates.

5.4.4.11.4.1 Behaviour in State 'CONNECTED-AWAIT-RAB-REL-1'

On receipt of the RABMAL_RAB_REL_RES primitive from RABM, the RBC state shall change to 'CONNECTED'.

5.4.4.11.4.2 Behaviour in State 'CONNECTED-AWAIT-RAB-REL-2'

On receipt of the RABMAL_RAB_REL_RES primitive from RABM, the RBC state shall change to 'IDLE'.

5.4.4.11.5 Behaviour in State 'CONNECTED-AWAIT-DESTROY'

5.4.4.11.5.0 General

This state has five numbered substates.

5.4.4.11.5.1 Behaviour in State 'CONNECTED-AWAIT-DESTROY-1'

On receipt of the CBCn_DESTROY_CNF primitive from CBCn via CSR, the RBC shall remove the corresponding entry from the RAB Table. RBC shall compose the RBC:EstablishReject PDU and send it to the SSR for transmission to the peer RBC agent in the RNC using the SSR_SIGDATA_REQ primitive. The RBC state shall change to 'CONNECTED'.

5.4.4.11.5.2 Behaviour in State 'CONNECTED-AWAIT-DESTROY-2'

On receipt of the CBCn_DESTROY_CNF primitive from CBCn via CSR, the RBC shall remove the corresponding entry from the RAB Table. RBC shall compose the RBC:EstablishReject PDU and send it to the SSR for transmission to the peer RBC agent in the RNC using the SSR_SIGDATA_REQ primitive:

- 1> PS Domain only: RBC shall also compose the RABMAL_RAB_REL_IND primitive and send it to RABM. The RBC state shall change to 'CONNECTED-AWAIT-RAB-REL-1'.
- 1> CS Domain only: The RNC state shall change to 'CONNECTED'.

5.4.4.11.5.3 Behaviour in State 'CONNECTED-AWAIT-DESTROY-3'

On receipt of the CBCn_DESTROY_CNF primitive from CBCn via CSR, the RBC shall remove the corresponding entry from the RAB Table:

- 1> PS domain only: RBC shall compose the CPDCP_RELEASE_REQ primitive and send it to PDCP. RBC shall also compose the RABMAL_RAB_REL_IND primitive and send it to RABM. The RBC state shall change to 'CONNECTED-AWAIT-RAB-REL-1'.
- 1> CS domain only: RBC shall compose the CSH_RELEASE_REQ primitive and send it to CSH. The RBC state shall change to 'CONNECTED'.

5.4.4.11.5.4 Behaviour in State 'CONNECTED-AWAIT-DESTROY-4'

On receipt of the CBCn_DESTROY_CNF primitive from CBCn via CSR, the RBC shall remove the corresponding entry from the RAB Table:

- 1> PS domain only: RBC shall compose the CPDCP_RELEASE_REQ primitive and send it to PDCP. RBC shall also compose the RABMAL_RAB_REL_IND primitive and send it to RABM. The RBC state shall change to 'CONNECTED-AWAIT-RAB-REL-2'.
- 1> CS domain only: RBC shall compose the CSH_RELEASE_REQ primitive and send it to CSH. The RBC state shall change to 'CONNECTED'. The RBC state shall change to 'IDLE'.

5.4.4.11.5.5 Behaviour in State 'CONNECTED-AWAIT-DESTROY-5'

On receipt of the CBCn_DESTROY_CNF primitive from CBCn via CSR, the RBC shall remove the corresponding entry from the RAB Table:

- 1> PS domain only: RBC shall compose the CPDCP_RELEASE_REQ primitive and send it to PDCP. RBC shall also compose the RABMAL_RAB_REL_IND primitive and send it to RABM. The RBC state shall change to 'CONNECTED-AWAIT-RAB-REL-1'.
- 1> CS domain only: RBC shall compose the CSH_RELEASE_REQ primitive and send it to CSH. The RBC state shall change to 'CONNECTED'.

5.4.4.11.6 Behaviour in State ' CONNECTED-AWAIT-RAB-EST'

On receipt of the RABMAL_RAB_EST_RES primitive from RABM:

- 1> if ciphering is enabled then RBC shall compose the RBC_CK_INFO_REQ primitive and send it to GMMH. The RBC state shall change to 'CONNECTED-AWAIT-KEYS'.

- 1> if ciphering is not enabled then RBC shall compose the RBC:EstablishAck PDU and send it to the SSR for transmission to the peer RBC agent in the RNC using the SSR_SIGDATA_REQ primitive. In addition, RBC shall compose the CPDCP_CONFIG_REQ primitive and send it to PDCP. The RBC state shall change to 'CONNECTED'.

On receipt of the RABMAL_RAB_EST_REJ primitive from RABM, RBC shall compose the CBCn_DESTROY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-1'.

5.4.4.11.7 Behaviour in State 'CONNECTED-AWAIT-KEYS'

On receipt of the RBC_CK_INFO_RSP from GMMH or MMH, RBC shall compose the CBCn_SECURITY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-SECURITY'.

5.4.4.11.8 Behaviour in State 'CONNECTED-AWAIT-SECURITY'

On receipt of the CBCn_SECURITY_CNF primitive from CBCn (via CSR):

- 1> PS Domain only: RBC shall compose the RBC:EstablishAck PDU and send it to the SSR for transmission to the peer RBC agent in the RNC using the SSR_SIGDATA_REQ primitive. RBC shall also compose the CPDCP_CONFIG_REQ primitive and send it to PDCP. The RBC state shall change to 'CONNECTED'.

- 1> CS Domain only: RBC shall compose the CSH_CONFIG_REQ primitive and send it to CSH. The RBC state shall change to 'CONNECTED-AWAIT-CSH'.

On receipt of the CBCn_SECURITY_REJ primitive from CBCn (via CSR), the RBC shall compose the CBCn_DESTROY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-2'.

5.4.4.11.9 Behaviour in State 'CONNECTED-AWAIT-CSH'

On receipt of the CSH_CONFIG_CNF primitive from CSH, REGM shall compose the RBC:EstablishAck PDU and send it to the SSR for transmission to the peer RBC agent in the RNC using the SSR_SIGDATA_REQ primitive. RBC shall also compose the RBC_SYNC_REQ primitive and send it to MMH. The RBC state shall change to 'CONNECTED'.

5.4.4.11.10 Behaviour in State 'CONNECTED-AWAIT-MODIFY'

On receipt of the CBCn_MODIFY_CNF primitive from CBCn (via CSR), RBC shall compose the RBC:ModifyAck PDU and send it to the SSR for transmission to the peer RBC agent in the RNC using the SSR_SIGDATA_REQ primitive. The RBC state shall change to 'CONNECTED'.

On receipt of the CBCn_MODIFY_REJ primitive from CBCn (via CSR), RBC shall compose the RBC:ModifyReject PDU and send it to the SSR for transmission to the peer RBC agent in the RNC using the SSR_SIGDATA_REQ primitive. The RBC state shall change to 'CONNECTED'.

5.4.4.11.11 Behaviour in Any State (Not 'IDLE')

On receipt of the CBCn_FAILURE_IND primitive from CBCn (via CSR), RBC shall examine the 'Failure Cause' parameter of the primitive:

- 1> If the 'Failure Cause' parameter indicates a radio resource layer failure ("Conn Failure" or "Max Unack Reached"):
  - 2> PS domain only: RBC shall compose the RABMAL_STATUS_IND primitive and send it to RABM.
  - 2> CS domain only: RBC shall discard the CBCn_FAILURE_IND primitive.

- 1> If the 'Failure Cause' parameter indicates connection inactivity ("Max Idle Reached"), then RBC shall discard the CBCn_FAILURE_IND primitive.

5.4.4.11.12 Common Procedures

RBC PDUs contain a 4-bit 'Transaction ID' IE which allows RBC (in the RNC) to associate a response or acknowledgement with a request and allows multiple requests to be in transit at any one time. RBC shall repeat the value the of the 'Transaction ID' IE received in any request (e.g. RBC:Establish) in the corresponding response (e.g. RBC:EstablishAck).

5.4.5 SSR

5.4.5.1 Service Primitives at REGM-SIG-SAP

See clause 5.4.1.3.

5.4.5.2 Service Primitives at GMMH-SIG-SAP

See clause 5.4.2.2.

5.4.5.3 Service Primitives at MMH-SIG-SAP

See clause 5.4.3.2.

5.4.5.4 Service Primitives at RBC-SIG-SAP

See clause 5.4.4.3.

5.4.5.5 Service Primitives at SIG-SAP

The service primitives at SIG-SAP are shown in Table 5.34. See ETSI TS 102 744-3-5 [11], clause 6.2 for the definition of the parameter 'AL PDU'. The Message Unit Identifier (MUI) is used to indicate which AL PDU is confirmed by the BCn_AM_DATA_CNF primitive.

Table 5.34: SSR::BCn Service Primitives at SIG-SAP [UE]

Primitive	Direction	Parameters
BCn_AM_DATA_REQ *SSR requests the BCn layer to send a PDU to its peer in the RNC*	To BCn	BCnID, AL PDU, CNF, Discard Req, MUI, SUSP
BCn_AM_DATA_IND *BCn indicates to SSR that it has received a PDU from the peer agent in the RNC*	To SSR	AL PDU, Discard Info
BCn_AM_DATA_CNF *BCn confirms to SSR that the peer agent in the RNC has received a PDU*	To SSR	Status, MUI

The SSR shall always set the 'CNF' (Confirmation Request) parameter of the BCn_AM_DATA_REQ primitive to "TRUE". The SSR shall set the 'SUSP' (Queue Suspend) parameter of the BCn_AM_DATA_REQ primitive according to the presence and value of the 'SUSP' parameter of the corresponding SSR_SIGDATA_REQ primitive.

5.4.5.6 SSR States

The SSR states are as shown in Table 5.35.

Table 5.35: SSR States [UE]

Number	State	Description
1	IDLE ★Initial State	The SSR is unable to route messages between the SIG-SAP and AL agents because the SIG-SAP has not been created (i.e. the UE has not completed the Registration procedure with the RNC).
2	CONNECTED	The SSR is able to route messages between the SIG-SAP and AL agents. Integrity Protection is not enabled.
3	CONNECTED-INTEGRITY	The SSR is able to route messages between the SIG-SAP and AL agents. Integrity protection is enabled.

5.4.5.7 SSR Behaviour

5.4.5.7.0 General

SSR behaviour in the UE is summarized in the signal-state diagram in Figure 5.17.

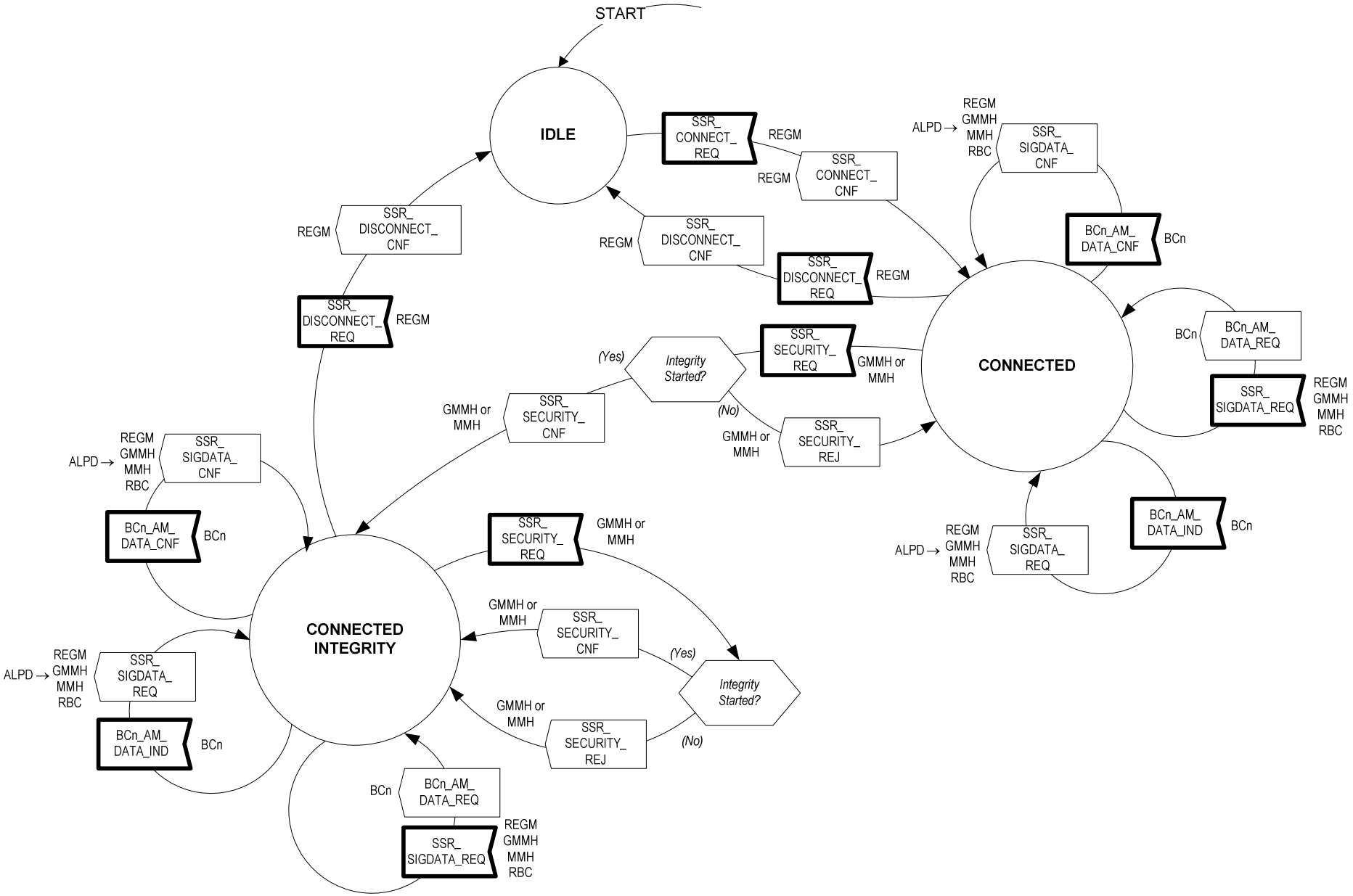

Figure 5.17: SSR Signal-State Diagram

5.4.5.7.1 Behaviour in State 'IDLE'

On receipt of the SSR_CONNECT_REQ primitive from REGM, the SSR shall initiate a connection to the specified SIG-SAP (BCnID) and send the SSR_CONNECT_CNF primitive to REGM. The SSR state shall then change to 'CONNECTED'.

5.4.5.7.2 Behaviour in State 'CONNECTED'

On entry to state 'CONNECTED', the SSR shall initialize the Message Unit Identifier (MUI) counter to "0".

On receipt of the SSR_SIGDATA_REQ primitive from any AL agent, the SSR shall increment the MUI by one and compose the AL PDU as shown in Figure 5.18 with the 'Integrity Check Included' IE set to "0". The SSR shall then forward the result to the Bearer Connection Layer using the BCn_AM_DATA_REQ primitive. The SSR shall store the MUI along with the identity of the sending agent in a list of AL PDUs which are awaiting confirmation.

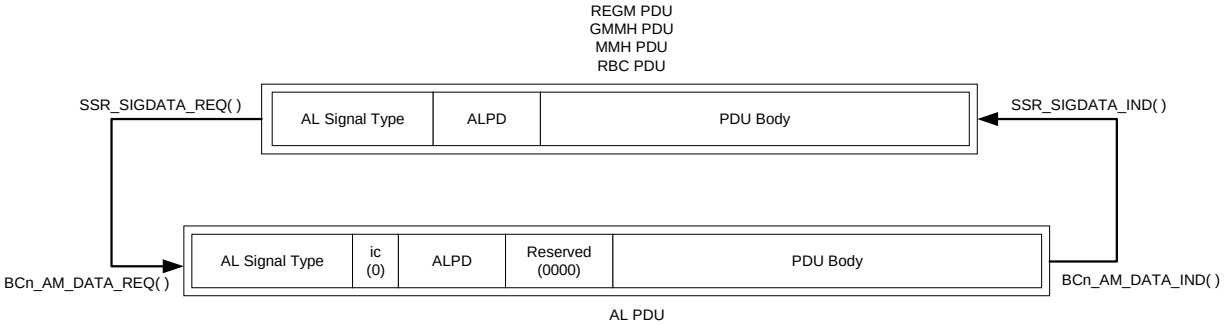

Figure 5.18: SSR Message Composition/Decomposition (see also ETSI TS 102 744-3-5 [11])

On receipt of the BCn_AM_DATA_IND primitive from the Bearer Connection Layer, the SSR shall examine the 'Integrity Check Included' IE of the AL PDU:

- if "FALSE", then the SSR shall decompose the AL PDU as shown in Figure 5.18, and forward the result to the appropriate AL agent on the basis of the ALPD using the SSR_SIGDATA_IND primitive;
- if "TRUE", then the SSR shall store the AL PDU in a list of unverified PDUs. The SSR shall then decompose the AL PDU as shown in Figure 5.19 and forward the result to the appropriate AL agent on the basis of the ALPD using the SSR_SIGDATA_IND primitive.

On receipt of the BCn_AM_DATA_CNF primitive from the Bearer Connection Layer, SSR shall check the list of AL PDUs which require confirmation and if the 'MUI' parameter of the BCn_AM_DATA_CNF primitive is in the list, then SSR shall remove this MUI from the list and send the SSR_SIGDATA_CNF primitive to the appropriate AL agent.

On receipt of the SSR_SECURITY_REQ primitive from either GMMH or MMH, the SSR shall start integrity protection using the specified integrity protection algorithm and initialization parameters (see also clause 7.1). If the list of unverified AL PDUs is not empty, then the SSR shall authenticate each of the AL PDUs in the list in turn as described in clause 7.1. If the authentication is successful for **all** of the AL PDUs in the list, then the SSR shall purge the list and send the SSR_SECURITY_CNF primitive to GMMH or MMH (whichever agent had sent the SSR_SECURITY_REQ primitive).The SSR state shall change to 'CONNECTED-INTEGRITY'. If the authentication fails for any of the AL PDUs in the list, then the SSR shall purge the list and send the SSR_SECURITY_REJ primitive to GMMH or MMH. If the SSR is unable to start integrity protection for any other reason, then it shall also purge the list of unverified AL PDUs and send the SSR_SECURITY_REJ primitive to GMMH or MMH.

On receipt of the SSR_DISCONNECT_REQ primitive from REGM, the SSR shall disconnect from the specified SIG-SAP (BCnID), purge all messages from its transmit and receive queues, and send the SSR_DISCONNECT_CNF primitive to REGM. The SSR state shall then change to 'IDLE'.

5.4.5.7.3 Behaviour in State 'CONNECTED-INTEGRITY'

On receipt of the SSR_SIGDATA_REQ primitive from any AL agent, the SSR shall increment the MUI by one and compose the AL PDU as shown in F with the 'Integrity Check Included' IE set to "1". The SSR shall perform integrity protection as described in clause 7.1 and append the Message Authentication Code for Integrity (MAC-I) to the AL PDU before forwarding the result to the Bearer Connection Layer using the BCn_AM_DATA_REQ primitive. The SSR shall store the MUI along with the identity of the sending agent in a list of AL PDUs which are awaiting confirmation.

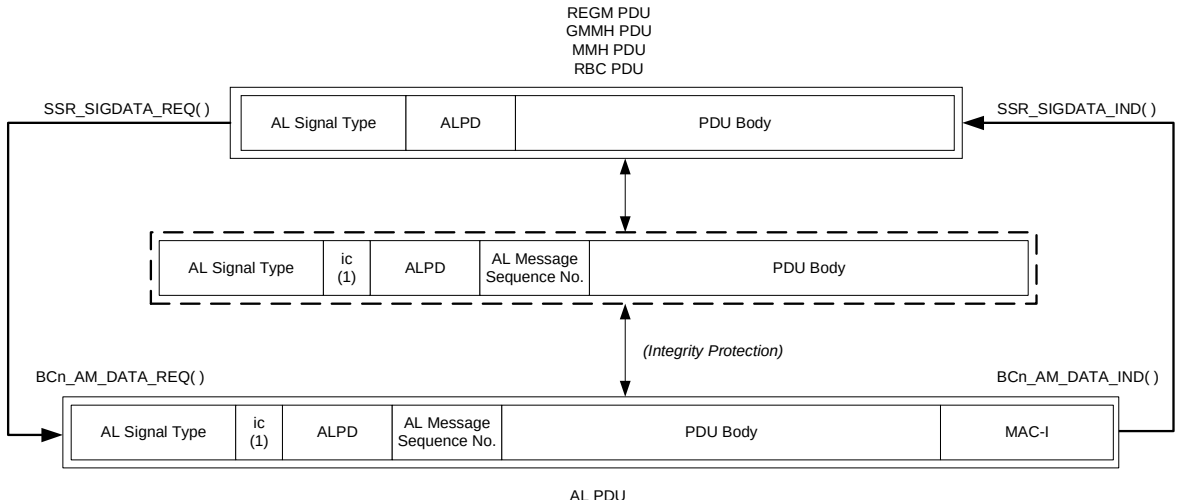

Figure 5.19: SSR Message Composition/Decomposition with Integrity Protection (see also ETSI TS 102 744-3-5 [11])

On receipt of the BCn_AM_DATA_IND primitive from the Bearer Connection layer, the SSR shall authenticate the PDU as described in clause 7.1. If the authentication is successful, the SSR shall decompose the PDU as shown in Figure 5.19 and forward the result to the appropriate AL agent on the basis of the ALPD using the SSR_SIGDATA_IND primitive.

On receipt of the BCn_AM_DATA_CNF primitive from the Bearer Connection Layer, SSR shall check the list of AL PDUs which require confirmation and if the 'MUI' parameter of the BCn_AM_DATA_CNF primitive is in the list, then SSR shall remove this MUI from the list and send the SSR_SIGDATA_CNF primitive to the appropriate AL agent.

On receipt of the SSR_SECURITY_REQ primitive from either GMMH or MMH, the SSR shall restart integrity protection using the new integrity protection algorithm and initialization parameters (see also clause 7.1). The SSR shall then send the SSR_SECURITY_CNF primitive to GMMH or MMH (whichever agent had sent the SSR_SECURITY_REQ primitive). The SSR state shall then change to 'CONNECTED-INTEGRITY'. If the SSR is unable to start integrity protection, then it shall send the SSR_SECURITY_REJ primitive to GMMH or MMH and the SSR state shall change to 'CONNECTED-INTEGRITY'.

On receipt of the SSR_DISCONNECT_REQ primitive from REGM, the SSR shall disconnect from the specified SIG-SAP (BCnID), purge all messages from its transmit and receive queues, and send the SSR_DISCONNECT_CNF primitive to REGM. The SSR state shall then change to 'IDLE'.

5.4.6 CSR

5.4.6.1 Service Primitives at REGM-CBCn-SAP

See clause 5.4.1.6.

5.4.6.2 Service Primitives at GMMH-CBCn-SAP

See clause 5.4.2.5.

5.4.6.3 Service Primitives at MMH-CBCn-SAP

See clause 5.4.3.5.

5.4.6.4 Service Primitives at RBC-CBCn-SAP

See clause 5.4.4.6.

5.4.6.5 Service Primitives at CBCn-SAP

The service primitives at CBCn-SAP are shown in Table 5.36.

Table 5.36: CSR::BCn Service Primitives at CBCn-SAP [UE]

Primitive	Direction	Parameters
CBCn_CREATE_REQ *AL agent (via CSR) requests the BCn layer to create the SIG-SAP or DATA-SAP with the specified handle (BCnID) and QoS attributes.*	To BCn	ALPD, BCnID (SIG-SAP/DATA-SAP), BCn/AL Parameter List, BCtID, {BCt EPDU} OPTIONAL
CBCn_CREATE_CNF *Response to CBCn_CREATE_REQ. BCn layer confirms that the SIG-SAP or DATA-SAP with the specified handle (BCnID) has been created.*	To CSR	ALPD, BCnID
CBCn_CREATE_REJ *Response to CBCn_CREATE_REQ. BCn layer confirms that the SIG-SAP or DATA-SAP with the specified handle (BCnID) has not been created for the specified reason.*	To CSR	ALPD, BCnID, Rejection Cause
CBCn_MODIFY_REQ *AL agent (via CSR) requests the BCn layer to modify the QoS attributes of the specified SIG-SAP or DATA-SAP (BCnID).*	To BCn	ALPD, BCnID (SIG-SAP/DATA-SAP), BCn/AL Parameter List, BCtID, {BCt EPDU} OPTIONAL
CBCn_MODIFY_CNF *Response to CBCn_MODIFY_REQ. BCn layer confirms that the QoS attributes of the specified SIG-SAP or DATA-SAP (BCnID) have been modified.*	To CSR	ALPD, BCnID
CBCn_MODIFY_REJ *Response to CBCn_MODIFY_REQ. BCn layer confirms that the QoS attributes of the specified SIG-SAP or DATA-SAP (BCnID) have not been modified for the specified reason.*	To CSR	ALPD, BCnID, Rejection Cause
CBCn_DESTROY_REQ *AL agent (via CSR) requests the BCn layer to destroy the SIG-SAP or DATA-SAP(s) with the specified handle(s) (BCnID).*	To BCn	ALPD, SEQUENCE OF {BCnID (SIG-SAP/DATA-SAP)}
CBCn_DESTROY_CNF *Response to CBCn_DESTROY_REQ. BCn layer confirms that the SIG-SAP or DATA-SAP(s) with the specified handle(s) (BCnID) has (have) been destroyed.*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_SECURITY_REQ *AL agent (via CSR) requests BCn to start, or modify ciphering for all PDUs received at the indicated SAPs (BCnID).*	To BCn	ALPD, Mode (Start/ Modify), CK, START, SEQUENCE OF {BCnID, UL Activation Time, DL Activation Time}
CBCn_SECURITY_CNF *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated SIG-SAP or DATA-SAP (BCnID) has been started/modified.*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_SECURITY_REJ *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated SIG-SAP or DATA-SAP (BCnID) has not been started/modified for the specified reason.*	To CSR	ALPD, SEQUENCE OF {BCnID}, Rejection Cause-
CBCn_HANDOVER_REQ *AL agent (via CSR) requests the BCn layer(via CSR) to perform an intra-RNC handover.*	To BCn	ALPD, BCnID, BCtID, BCt EPDU
CBCn_HANDOVER_CNF *Response to CBCn_HANDOVER_REQ. BCn confirms to an AL agent (via CSR) that the handover procedure in the lower layers (Bearer Connection/Bearer Control) has been completed.*	To CSR	ALPD, BCnID
CBCn_FAILURE_IND *BCn indicates a failure of the specified bearer connection to an AL agent (via CSR).*	To CSR	ALPD, BCnID, Failure Cause
CBCn_SUSPEND_REQ *AL agent (via CSR) requests BCn to suspend the indicated connections (UE Specific Signalling connection and all CS domain RABs).*	To BCn	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_CNF *Response to CBCn_SUSPEND_REQ. BCn confirms to AL agent (via CSR) that the indicated connections are suspended.*	To CSR	ALPD, SEQUENCE OF {BCnID, Next BCn Send Sequence Number}

Primitive	Direction	Parameters
CBCn_SUSPEND_REJ *Response to CBCn_SUSPEND_REQ. BCn indicates to AL agent that one or more connections have not been suspended.*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_REQ *AL agent (via CSR) requests BCn to resume the indicated connections (UE Specific Signalling connection and all PS domain RABs).*	To BCn	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_CNF *Response to CBCn_RESUME_REQ. BCn confirms to AL agent (via CSR) that the indicated connections have resumed.*	To CSR	ALPD, SEQUENCE OF {BCnID}

5.4.6.6 CSR Behaviour

CSR behaviour in the UE is summarized in the signal-state diagram in Figure 5.20. The CSR is a transparent routing function. All primitives received from any Adaptation Layer agent are forwarded to the CBCn-SAP without modification; primitives received from the CBCn-SAP are routed to the correct Adaptation Layer agent on the basis of the ALPD parameter of the primitive.

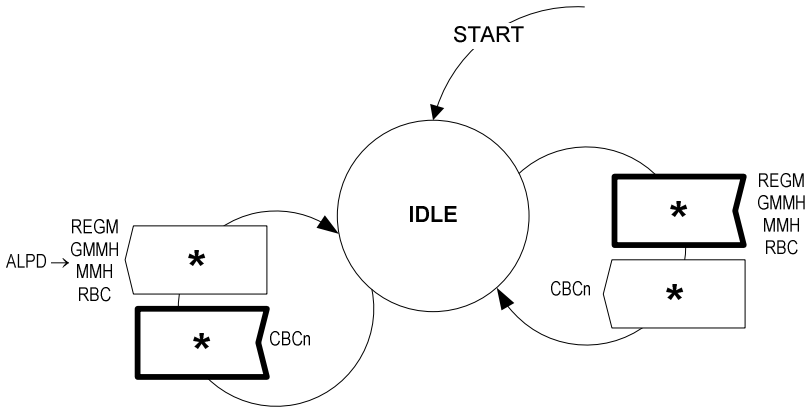

Figure 5.20: CSR Signal State Diagram

6 AL Control Plane - RNC Side

6.1 Relay Function

The RNC Adaptation Layer uses a Relay Function to associate or map the elementary procedures and signalling used on the Uu interface and the Iu interface. In the present document, interaction between the Relay Function and the Adaptation Layer is described by service primitives exchanged through the Relay Service Access Point (RL-SAP).

6.2 Services Expected from Lower Layers

The RNC Adaptation Layer uses message transfer services provided by the Bearer Connection layer through two Service Access Points:

- Common Signalling Service Access Point (COM-SAP)
- UE-Specific Signalling Service Access Point (SIG-SAP)

There is one and only one permanent instance of the COM-SAP. There are zero or more instances of the SIG-SAP; instances are created as part of the radio interface Registration procedure and destroyed as part of the radio interface Deregistration procedure. An instance of the SIG-SAP is associated with one and only one UE. The Bearer Connection ID (BCnID) is the reference or handle to a particular SAP at the Adaptation Layer - Bearer Connection Layer boundary.

The RNC Adaptation Layer also uses configuration and control services from the Bearer Connection Layer through one additional Service Access Point:

- Bearer Connection Service Access Point (CBCn-SAP).

There is one and only one instance of the CBCn-SAP in the RNC Adaptation Layer.

6.3 Agents in the Adaptation Layer

6.3.0 General

The Adaptation Layer in the RNC contains four classes of agent:

- Registration Manager (REGM);
- GMM Service Access Point Handler (GMMH);
- MM Service Access Point Handler (MMH); and
- Radio Bearer Control (RBC).

There is one instance each of REGM, GMMH, and MMH and two instances of RBC (one for the PS domain and one for the CS domain) in the RNC for every UE (instantiation of AL agents in conjunction with the radio interface Registration and Deregistration procedures is an implementation issue and not described in the present document).

The RNC Adaptation Layer also contains three routing functions associated with Service Access Points that are shared by more than one Adaptation Layer agent:

- SIG-SAP Router (SSR);
- CBCn-SAP Router (CSR); and
- RL-SAP Router (RSR).

6.3.1 Registration Manager (REGM)

REGM in the RNC is responsible for:

- establishing, maintaining, and releasing the UE Specific Signalling connection by performing the radio interface Registration, Handover, and Deregistration procedures with the UE;
- radio interface access control, including geographical barring based on UE position;
- paging notification (Types 1 and 2); and
- system information provision to UEs in connected mode.

REGM provides services to GMMH, MMH, and RBC, as shown in Figure 6.1. REGM uses services provided by the Bearer Connection Layer (via SSR or CSR) and the Relay Function (via RSR).

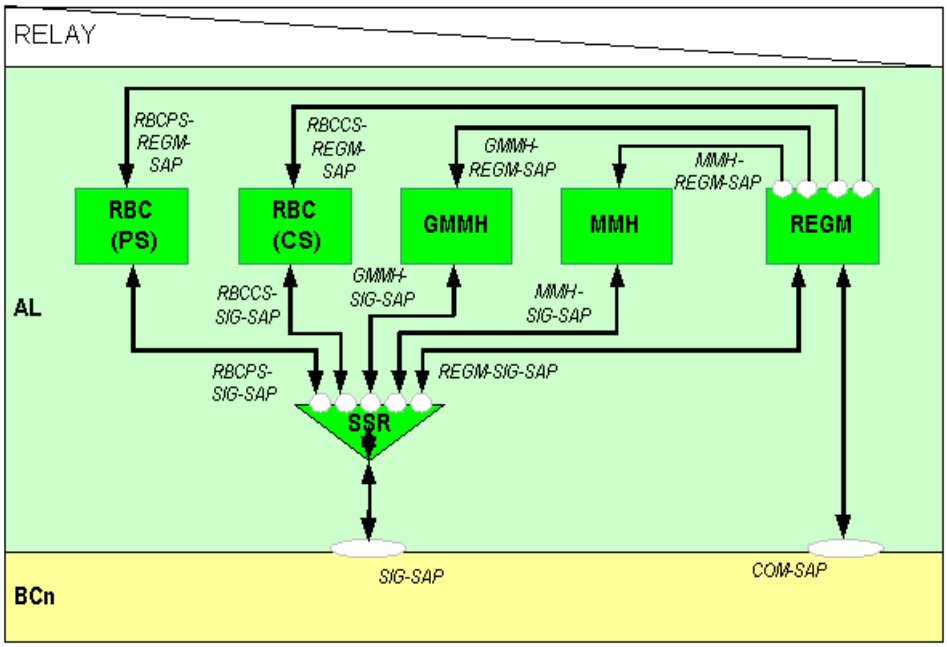

Figure 6.1: REGM, GMMH, MMH, and RBC Service Access Points [RNC]
(CBCn Connections Not Shown, see Figure 5.8)

6.3.2 GMM and MM Service Access Point Handlers (GMMH, MMH)

GMMH and MMH provide a transparent conduit for Mobility Management messages sent between the UE and Core Network (Serving GPRS Support Node (SGSN) and Mobile Switching Centre (MSC) respectively). GMMH and MMH are also responsible for integrity protection control and ciphering control functions.

GMMH and MMH use services provided by REGM, the Bearer Connection Layer (via SSR or CSR), and the Relay Function (via RSR).

6.3.3 Radio Bearer Control (RBC)

RBC handles all signalling related to the establishment, modification, and release of radio bearers. RBC also configures user plane protocol layers (such as PDCP and CSH).

RBC uses services provided by the REGM, the Bearer Connection Layer (via SSR or CSR), and the Relay Function (via RSR).

6.3.4 SIG-SAP Router (SSR)

See clause 5.3.5.

6.3.5 CBCn-SAP Router (CSR)

See clause 5.3.6.

6.3.6 RL-SAP Router (RSR)

The Adaptation Layer in the RNC contains a transparent routing function at the RL-SAP for all control service primitives exchanged between the Adaptation Layer and the Relay Function, as shown in Figure 6.2. Routing between the RL-SAP and AL agents is based on the ALPD and (SIG-SAP) Bearer Connection ID (BCnID), which are present in all service primitives.

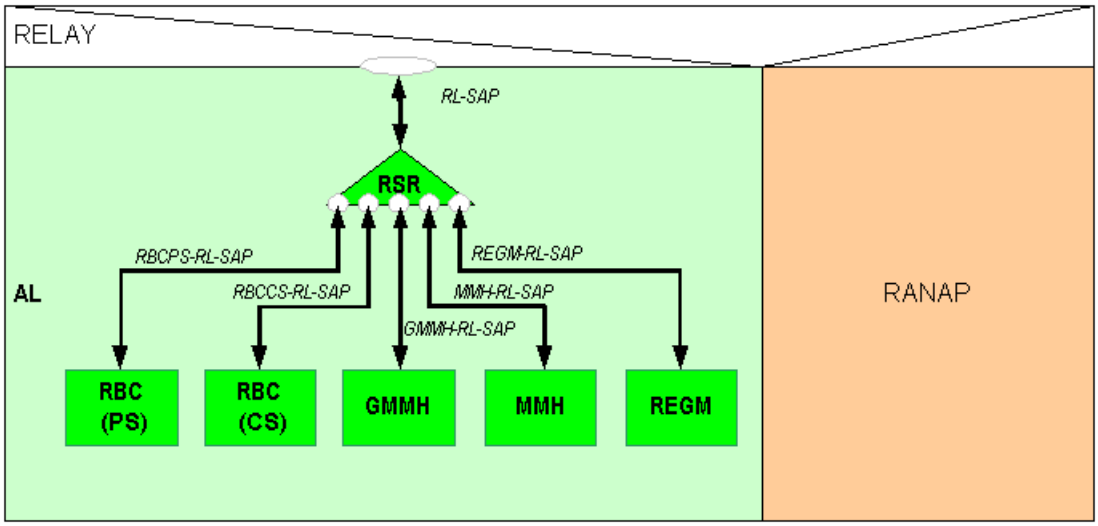

Figure 6.2: RSR Service Access Points [RNC]

6.4 Protocol Definitions

6.4.1 REGM

6.4.1.1 REGM Protocol Data Units

The REGM Protocol Data Units are as shown in Table 6.1.

Table 6.1: REGM::REGM Protocol Data Units

PDU	SAP	Direction	Addressing	Information Elements
PagingType1	COM	To UE	UE NAS ID	CN Domain Identity, Paging Cause
Register	COM	From UE	UE NAS ID	Registration Reference, RI Version, CN Domain Identity, Registration Cause, UE Class
RegisterAck	COM	To UE	UE NAS ID	Registration Reference, BCnID (SIG-SAP), BCn Type, Number of (BCn) Parameters, BCn Parameter List, Control Flags, , BCt Type, BCtID, BCt EPDU, Registration Mode
RegisterRej	COM	To UE	UE NAS ID	Registration Reference, CHOICE {Rejection Cause, Protocol Error Cause}
DeregisterCommon	COM	To UE	UE NAS ID	Registration Reference, CHOICE {Deregistration Cause, Protocol Error Cause}
RegisterComplete	SIG	From UE	BCnID	AL Signal Type, ALPD, Registration Reference, SEQUENCE OF {Chain Indicator, CN Domain Identity, START}, {UE Radio Access Capability} OPTIONAL
SystemInformation	SIG	To UE	BCnID	AL Signal Type, ALPD, SEQUENCE OF {BCt EPDU}
Deregister	SIG	To UE	BCnID	AL Signal Type, ALPD, Registration Reference, CHOICE {Deregistration Cause, Protocol Error Cause}
DeregisterAck	SIG	From UE	BCnID	AL Signal Type, ALPD, Registration Reference
UEPositionRequest	SIG	To UE	BCnID	AL Signal Type, ALPD, CHOICE { Public Key Index, RNC Public Key }
UEPositionResponse	SIG	From UE	BCnID	AL Signal Type, ALPD, CHOICE {GPS Position String, Encrypted GPS Position String, Spot Beam ID}
RegModeUpdate	SIG	To UE	BCnID	AL Signal Type, ALPD, Registration Reference, Registration Mode, {GPS Report Distance} OPTIONAL
Handover	SIG	To UE	BCnID	AL Signal Type, ALPD, Control Flags, Transaction ID, BCt Type, BCtID, BCt EPDU

PDU	SAP	Direction	Addressing	Information Elements
HandoverRequest	SIG	From UE	BCnID	AL Signal Type, ALPD, Control Flags, Transaction ID, Current Spot Beam Included, UE Position Included, Observe Target Preference, Target List Length, {Current Spot Beam} OPTIONAL, Target Spot Beam List, {UE Position} OPTIONAL
HandoverAck	SIG	From UE	BCnID	AL Signal Type, ALPD, Control Flags, Transaction ID
SignallingConnectionRelease	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity
SignallingConnectionReleaseReq	SIG	From UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, CHOICE {Connection Release Cause, Protocol Error Cause}

6.4.1.2 Service Primitives at COM-SAP

The service primitives at COM-SAP are as shown in Table 6.2.

Table 6.2: REGM::BCn Service Primitives at COM-SAP [RNC]

Primitive	Direction	Information Elements
AL_COMDATA_REQ *REGM requests the BCn layer to send a PDU to its peer in the UE*	To BCn	UE NAS ID and Type, {LAI} OPTIONAL REGM PDU Type, REGM PDU
AL_COMDATA_IND *BCn indicates to REGM that it has received a PDU from the peer agent in the UE*	To REGM	UE NAS ID and Type, {LAI} OPTIONAL REGM PDU Type, REGM PDU

6.4.1.3 Service Primitives at REGM-SIG-SAP

The service Primitives at REGM-SIG-SAP are as shown in Table 6.3.

Table 6.3: REGM::SSR Service Primitives at REGM-SIG-SAP [RNC]

Primitive	Direction	Parameters
SSR_SIGDATA_REQ *REGM requests SSR to send a PDU to its peer in the UE.*	To SSR	REGM PDU
SSR_SIGDATA_IND *SSR indicates to REGM that it has received a PDU from the peer agent in the UE.*	To REGM	REGM PDU
SSR_SIGDATA_CNF *Optional response to SSR_SIGDATA_REQ. SSR indicates to REGM that the peer agent in the RNC has received a PDU.*	To REGM	-
SSR_CONNECT_REQ *REGM requests SSR to initiate a connection to the specified SIG-SAP.*	To SSR	BCnID (SIG-SAP)
SSR_CONNECT_CNF *SSR confirms to REGM that it has connected to the specified SIG-SAP.*	To REGM	BCnID (SIG-SAP)
SSR_DISCONNECT_REQ *REGM requests SSR to disconnect from the specified SIG-SAP.*	To SSR	BCnID (SIG-SAP)
SSR_DISCONNECT_CNF *SSR confirms to REGM that it has disconnected from the specified SIG-SAP.*	To REGM	BCnID (SIG-SAP)

6.4.1.4 Service Primitives at REGM-SAP (GMMH-REGM-SAP, MMH-REGM-SAP, RBC-REGM-SAP)

The service primitives at REGM-SAP are as shown in Table 6.4.

Table 6.4: REGM::GMMH/MMH/RBC Service Primitives at REGM-SAP [RNC]

Primitive	Direction	Parameters
REGM_CONN_IND *REGM indicates that a UE-Specific signalling connection with the handle BCnID has been created for the identified UE.*	To GMMH/MMH/ RBC	ALPD, UE NAS ID and Type, BCnID (SIG-SAP), $START_{PS}$, $START_{CS}$, UE Security Capability
REGM_REL_IND *REGM indicates that the UE-Specific signalling connection with the handle BCnID has been released.*	To GMMH/MMH/ RBC	ALPD, BCnID (SIG-SAP), Release Cause
REGM_SIGNAL_CONN_REL_IND *REGM indicates that the Iu signalling connection for the indicated CN domain has been released, but the UE-Specific signalling connection has not been released.*	To GMMH/MMH	ALPD, CN Domain Identity
REGM_PAGE_REQ *REGM requests GMMH/MMH to send a paging request (Type 2).*	To GMMH/MMH	ALPD, CN Domain Identity, Paging Cause
REGM_INIT_MSG_IND *GMMH/MMH indicates to REGM that the UE-Specific Signalling connection is in use by the identified domain.*	To REGM	ALPD, CN Domain Identity
REGM_RAB_REL_IND *REGM instructs RBC to release all RABs pertaining to the indicated CN domain.*	To RBC	ALPD, CN Domain Identity

6.4.1.5 Service Primitives at REGM-CBCn-SAP

The service primitives at REGM-CBCn-SAP are as shown in Table 6.5.

Table 6.5: REGM::CSR Service Primitives at REGM-CBCn-SAP [RNC]

Primitive	Direction	Parameters
CBCn_CREATE_REQ *REGM requests the BCn layer to create the SIG-SAP with the specified handle (BCnID) and QoS attributes.*	To CSR	ALPD, BCnID (SIG-SAP), BCn/AL Parameter List
CBCn_CREATE_CNF *Response to CBCn_CREATE_REQ. BCn layer confirms that the SIG-SAP with the specified handle (BCnID) has been created.*	To REGM	ALPD, BCnID, BCtID, {BCt EPDU} OPTIONAL
CBCn_CREATE_REJ *Response to CBCn_CREATE_REQ. BCn layer confirms that the SIG-SAP with the specified handle (BCnID) has not been created for the specified reason.*	To REGM	ALPD, BCnID, Rejection Cause
CBCn_DESTROY_REQ *REGM requests the BCn layer to destroy the SIG-SAP with the specified handle (BCnID).*	To CSR	ALPD, BCnID (SIG-SAP)
CBCn_DESTROY_CNF *Response to CBCn_DESTROY_REQ. BCn layer confirms that the SIG-SAP with the specified handle (BCnID) has been destroyed.*	To REGM	ALPD, BCnID
CBCn_HANDOVER_REQ *UE-Initiated Handover Procedure: REGM requests the BCn layer to initiate the intra-RNC handover procedure on behalf of the peer agent in the UE. Lease Mode Handover Procedure: REGM requests the BCn layer to determine if a bearer assigned to the Lease Group specified by the UE is available, and if so initiate the intra-RNC handover procedure.*	To CSR	ALPD, BCnID, Observe Target Preference, Target Spot Beam List, Lease Group ID, Elevation Angle
CBCn_HANDOVER_IND *The BCn layer indicates to REGM that the intra-RNC handover procedure has been initiated by the lower layers (Bearer Connection/Bearer Control) and requests REGM to inform the peer REGM entity in the UE.*	To REGM	ALPD, BCnID, BCtID, BCt EPDU

Primitive	Direction	Parameters
CBCn_HANDOVER_RSP *Response to CBCn_HANDOVER_IND. REGM informs the BCn layer that the handover procedure in the UE has been completed.*	To CSR	ALPD, BCnID
CBCn_HANDOVER_REJ *Response to CBCn_HANDOVER_REQ. REGM indicates to the BCn layer that the handover procedure in the UE has not been completed.*	To CSR	ALPD, Rejection Cause
CBCn_FAILURE_IND *BCn indicates a failure of the specified bearer connection to REGM.*	To REGM	ALPD, BCnID, Failure Cause

6.4.1.6 Service Primitives at REGM-RL-SAP

The service primitives at REGM-RL-SAP are as shown in Table 6.6.

Table 6.6: REGM::RSR Service Primitives at REGM-RL-SAP [RNC]

Primitive	Direction	Parameters
RL_PAGING	To REGM	BCnID, ALPD, UE NAS ID, Paging Cause, CN Domain Identity
RL_SIGNAL_CONN_REL	To REGM	BCnID, ALPD, CN Domain Identity, Cause
RL_ SIGNAL_CONN_REL_REQ	To RSR	BCnID, ALPD, CN Domain Identity, Cause
RL_NEW_BCNID	To RSR	BCnID, ALPD, UE NAS ID, CN Domain Identity
RL_UPDATE_UE_NAS_ID	To REGM	BCnID, ALPD, UE NAS ID
RL_RESET	Both	BCnID, ALPD, Cause, CN Domain Identity, Global RNC ID
RL_RESET_ACK	Both	ALPD, CN Domain Identity
RL_RESET_RESOURCE	Both	BCnID, ALPD, Cause, CN Domain Identity, Global RNC ID
RL_RESET_RESOURCE_ACK	Both	ALPD, CN Domain Identity

6.4.1.7 REGM States

The REGM states are as shown in Table 6.7.

Table 6.7: REGM States [RNC]

Number	State	Description
1	IDLE ("RRC-IDLE") ★Initial State	The UE is not registered with the RNC and a UE-Specific signalling connection between the UE and RNC is not established. In the RNC, this state is temporal.
2	CONFIGURING	REGM has received a Registration request from its peer in the UE and is currently configuring the Adaptation Layer and Bearer Control Layer. This state has two substates.
>2a	CONFIGURING-AWAIT-CREATE	REGM has requested the Bearer Control Layer to create the SIG-SAP (UE-Specific Signalling connection) and is waiting for a response.
>2b	CONFIGURING-AWAIT-CONNECT	REGM has requested SSR to connect to the SIG-SAP and is waiting for confirmation.
3	REGISTERED-AWAIT-COMPLETE	The UE is registered with the RNC and a UE-Specific signalling connection between the UE and RNC has been established; REGM is waiting to receive the RegisterComplete message from its peer in the UE.
4	REGISTERED-AWAIT-UE-POS	The UE is registered with the RNC and a UE-Specific signalling connection between the UE and RNC has been established but the RNC has indicated that validation of the UE position is required before the UE can access network services (Registration Mode 0). REGM has sent the UEPositionRequest message to its peer in the UE and is waiting for a response.
5	REGISTERED ("RRC-CONNECTED")	The UE is registered with the RNC, a UE-Specific signalling connection between the UE and RNC has been established, and the UE has full access to network services (Registration Mode 3).

Number	State	Description
6	RELEASING	REGM in the RNC has initiated the Deregistration procedure. This state has four substates.
>6a	RELEASING-AWAIT-DEREIGSTER-ACK	REGM has sent the Deregister message to its peer in the UE and is waiting to receive the DeregisterAck message in response.
>6b	RELEASING-AWAIT-DISCONNECT	REGM has requested the SSR to disconnect from the SIG-SAP and is waiting for confirmation.
>6c	RELEASING-AWAIT-DESTROY	REGM has requested the Bearer Connection Layer to destroy the SIG-SAP and is waiting for confirmation.
>6d	RELEASING-AWAIT-DELAY	REGM has received the DeregisterAck message from its peer in the UE and is delaying the destruction of the SIG-SAP (to ensure the UE receives confirmation that the DeregisterAck has been received).
7	AWAIT-HANDOVER-ACK	REGM has informed the peer entity in the UE that an intra-RNC handover has been initiated and is waiting for a response.
8	LEASE	The RNC has initiated the Lease Mode procedure. This state has three substates.
>8a	LEASE-AWAIT-UE-POS	The UE is registered with the RNC and a UE-Specific signalling connection between the UE and RNC has been established but the RNC has indicated that validation of the UE position is required before the UE can access network services (Registration Mode 0). REGM has sent the UEPositionRequest message to its peer in the UE and is waiting for a response.
>8b	LEASE-AWAIT-RESOURCE	REGM has informed the lower layers (Bearer Connection/Bearer Control) that an intra-RNC handover to a bearer allocated to the current subscriber's Lease Group is required and is waiting for confirmation that resources are available.
>8c	LEASE-AWAIT-HANDOVER-ACK	REGM has informed the peer entity in the UE that an intra-RNC handover to a bearer allocated to the current subscriber's Lease Group has been initiated and is waiting for a response.

6.4.1.8 REGM Behaviour

6.4.1.8.0 General

REGM behaviour in the RNC is summarized in the signal-state diagram in Figure 6.3.

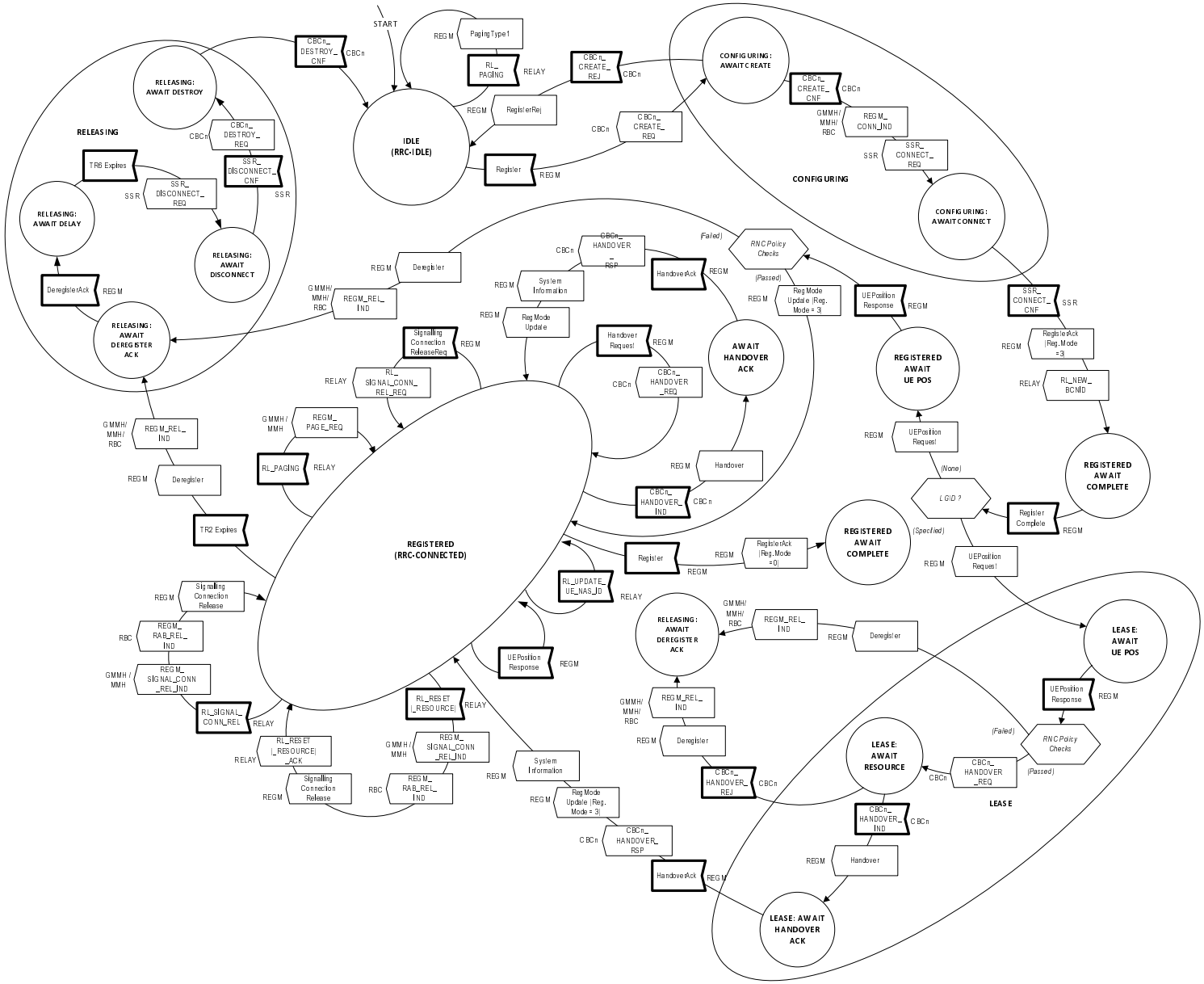

Figure 6.3: RNC REGM Signal-State Diagram

6.4.1.8.1 Behaviour in State 'IDLE'

On receipt of the RL_PAGING primitive from Relay, REGM shall compose the REGM:PagingType1 PDU and send it to the peer agent in the UE using the AL_COMDATA_REQ primitive via the COM-SAP.

On receipt of the AL_COMDATA_IND primitive from the COM-SAP, REGM shall examine the PDU type parameter. If the PDU type is REGM:Register, REGM shall store the values of the 'Registration Reference' IE (the value shall replace any previously stored value for this UE) and the value of the 'Registration Cause' IE.

If the RNC is unable to accept new registrations at the time the REGM:Register PDU is received (for example due to congestion or lack of resources), then REGM shall compose the REGM:RegisterRej PDU (with the 'Rejection Cause' IE set to "Congestion" and the 'Registration Reference' IE set to the value currently stored for this UE) and send it to the peer REGM agent in the UE using the AL_COMDATA_REQ primitive via the COM-SAP.

If the RNC does not support either the 'RI Version' or the 'UE Class' specified in the REGM:Register PDU, then REGM shall compose the REGM:RegisterRej PDU (with the 'Rejection Cause' IE set to "Unsupported RI Version" or "Unsupported UE Class" as appropriate) and send it to the peer REGM agent in the UE using the AL_COMDATA_REQ primitive at the COM-SAP.

If the RNC is able to accept new registrations and if the 'RI Version' and 'UE Class' specified by the UE are supported, then REGM shall then request the BCn layer to create the UE-Specific Signalling connection (SIG-SAP) by sending the CBCn_CREATE_REQ primitive via the CBCn-SAP with the 'BCn Type' parameter set to "2" (AM connection with in-sequence delivery). The REGM state shall change to 'CONFIGURING-AWAIT-CREATE'.

6.4.1.8.2 Behaviour in State 'CONFIGURING'

6.4.1.8.2.0 General

The state 'CONFIGURING' has two sub states: 'CONFIGURING-AWAIT-CREATE' and 'CONFIGURING-AWAIT-CONNECT'.

6.4.1.8.2.1 Behaviour in Substate 'AWAIT-CREATE'

On receipt of the CBCn_CREATE_REJ primitive from CBCn, REGM shall compose the REGM:RegisterRej PDU (with the 'Rejection Cause' IE set to "RNC Failure" and the 'Registration Reference' IE set to the value currently stored for this UE) and send it to the peer REGM agent in the UE using the AL_COMDATA_REQ primitive via the COM-SAP. The REGM state shall change to 'IDLE'.

On receipt of the CBCn_CREATE_CNF from CBCn, REGM shall notify GMMH, MMH, and RBC of the establishment of the UE-Specific Signalling connection by sending the REGM_CONN_IND primitive to all agents. REGM shall also request the SSR to connect to the created SIG-SAP by sending the SSR_CONNECT_REQ primitive to SSR. The REGM state shall change to 'CONFIGURING-AWAIT-CONNECT'.

On receipt of the AL_COMDATA_IND primitive from the COM-SAP, REGM shall examine the PDU type parameter. If the PDU type is REGM:Register, REGM shall store the value of the 'Registration Reference' IE (the value shall replace any previously stored value for this UE).

6.4.1.8.2.2 Behaviour in Substate ' AWAIT-CONNECT'

On receipt of the SSR_CONNECT_CNF primitive from SSR, REGM shall compose the REGM:RegisterAck PDU and send it to the peer REGM agent in the UE using the AL_COMDATA_REQ primitive via the COM-SAP.

The 'Registration Mode' IE shall be set to "0" and the 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). After sending the REGM:RegisterAck PDU, REGM shall start timer TR1 and initialize the associated retry counter CR1. REGM shall then send the RL_NEW_BCNID primitive to Relay. The REGM state shall change to 'REGISTERED-AWAIT-COMPLETE'.

On receipt of the AL_COMDATA_IND primitive from the COM-SAP, REGM shall examine the PDU type parameter. If the PDU type is REGM:Register, REGM shall store the value of the 'Registration Reference' IE (the value shall replace any previously stored value for this UE).

6.4.1.8.3 Behaviour in State 'REGISTERED-AWAIT-COMPLETE'

On receipt of the AL_COMDATA_IND primitive from the COM-SAP, REGM shall examine the PDU type parameter. If the PDU type is REGM:Register, REGM shall store the value of the 'Registration Reference' IE (the value shall replace any previously stored value for this UE). Receipt of the REGM:Register PDU in this state shall not affect the state or value of timer TR1.

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall unpack the encapsulated REGM PDU from the peer agent and examine the AL Signal Type IE. If the PDU type is REGM:RegisterComplete then REGM shall stop timer TR1 and:

- 1> if the 'Bearer Table Capability' AVP is present in the REGM:RegisterComplete PDU, then REGM shall store the value of the 'Current Bearer Table Version' for this UE.
- 1> if the 'Lease Mode Capability' AVP is present in the REGM:RegisterComplete PDU:
  - 2> if the value of the 'Lease Group ID' IE is not equal to "0" then REGM shall compose the REGM:UEPositionRequest PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. REGM shall start timer TR3 and initialize the associated retry counter CR3. The REGM state shall change to 'LEASE-AWAIT-UE-POS';
  - 2> if the value of the 'Lease Group ID' IE is equal to "0" then REGM shall compose the REGM:UEPositionRequest PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. REGM shall start timer TR3 and initialize the associated retry counter CR3. The REGM state shall change to 'REGISTERED-AWAIT-UE-POS'.
- 1> if the 'Lease Mode Capability' AVP is not present in the REGM:RegisterComplete PDU, then REGM shall set the value of the 'Lease Group ID' for this subscriber to "0". REGM shall then compose the REGM:UEPositionRequest PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. REGM shall start timer TR3 and initialize the associated retry counter CR3. The REGM state shall change to 'REGISTERED-AWAIT-UE-POS'.

If timer TR1 expires before REGM receives the REGM:RegisterComplete PDU from the peer agent in the UE, then REGM shall resend the REGM:RegisterAck PDU to the peer REGM agent in the UE using the AL_COMDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). This process may repeat up to the limit imposed by the retry counter CR1.

After sending the REGM:RegisterAck PDU the maximum number of times, REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Register Complete Not Received") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.

6.4.1.8.4 Behaviour in State 'REGISTERED-AWAIT-UE-POS'

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall unpack the encapsulated REGM PDU from the peer agent and examine the AL Signal Type IE. If the PDU type is REGM:UEPositionResponse then REGM shall stop timer TR3 and:

- 1> if the REGM:UEPositionResponse PDU contains the 'Encrypted GPS Position String' IE, then REGM shall attempt to decrypt the string:
  - 2>if the decryption fails, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Decryption Error") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK';

- 2> if the decryption is successful, then REGM shall store the decrypted 'GPS Position String' and REGM behaviour proceeds as if the unencrypted 'GPS Position String' IE had been received initially.

- 1> if the REGM:UEPositionResponse PDU contains the 'GPS Position String' IE, then REGM shall store the string, and:
  - 2>if the 'Fix Quality' field is set to "1" (GPS Fix) or "2" (DGPS Fix), then REGM shall calculate the age of the position fix using the 'GPS Fix Date' and 'GPS Fix Time' fields of the 'GPS Position String':
    - 3>if the age is greater than the maximum age allowed by the UE Position Age Policy, then:
      - 4> if the value of the 'LOA Time' field of the 'GPS Position String' is greater than the setting of the Loss of Acquisition Policy or if the 'LOA Time' field is not present in the 'GPS Position String', then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Position Age Exceeds Maximum") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK';
      - 4> if the value of the 'LOA Time' field of the 'GPS Position String' is less than or equal to the setting of the Loss of Acquisition Policy, then:
        - 5> if the value of the 'Number of Satellites Tracked' field of the 'GPS Position String' is greater than or equal to the setting of the UE Position Accuracy policy, then REGM shall look up the Service Area which corresponds to the UE position, and look up the current Service Barring Policy for that Service Area:

          6> If service is allowed in the current UE Service Area, then REGM shall change the current Registration Mode for this UE to "3". REGM shall then compose the REGM:RegModeUpdate PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The value of the 'GPS Report Distance' IE shall be set according to the Position Update Reporting Policy for the current UE Location Area. REGM shall also send the [CBCn_UPDATE_REQ] primitive to CBCn with the 'Elevation Angle' parameter set to the elevation angle to the current satellite at the UE position. The REGM state shall change to 'REGISTERED'.

          6> If service is not allowed in the current UE Service Area, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Service Area Barred") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

        - 5> If the value of the 'Number of Satellites Tracked' field of the 'GPS Position String' is less than the setting of the UE Position Accuracy policy, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Number of Tracked Satellites Below Minimum") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

- 3> If the age is less than or equal to the maximum age allowed by the UE Position Age Policy then:
  - 4> if the value of the 'Number of Satellites Tracked' field of the 'GPS Position String' is greater than or equal to the setting of the UE Position Accuracy policy, then REGM shall look up the Service Area which corresponds to the UE position, and look up the current Service Barring Policy for that Service Area:
    - 5> If service is allowed in the current UE Service Area, then REGM shall change the current Registration Mode for this UE to "3". REGM shall then compose the REGM:RegModeUpdate PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The value of the 'GPS Report Distance' IE shall be set according to the Position Update Reporting Policy for the current UE Location Area. REGM shall also send the [CBCn_UPDATE_REQ] primitive to CBCn with the 'Elevation Angle' parameter set to the elevation angle to the current satellite at the UE position. The REGM state shall change to 'REGISTERED'.
    - 5> If service is not allowed in the current UE Service Area, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Service Area Barred") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.
  - 4> If the value of the 'Number of Satellites Tracked' field of the 'GPS Position String' is less than the setting of the UE Position Accuracy policy, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Number of Tracked Satellites Below Minimum") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

- 2> If the 'Fix Quality' field is set to "3" (User-Specified Position) then:
  - 3> If the UE Position Quality Policy for the current UE Location Area is set to either "GPS Fix or User-Specified Position" or "Any", then REGM shall look up and store the Service Area which corresponds to the UE position, and look up the current Service Barring Policy for that Service Area:
    - 4> if service is allowed in the current UE Service Area, then REGM shall change the current Registration Mode for this UE to "3". REGM shall then compose the REGM:RegModeUpdate PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The value of the 'GPS Report Distance' IE shall be set according to the Position Update Reporting Policy for the current UE Location Area. REGM shall also send the [CBCn_UPDATE_REQ] primitive to CBCn with the 'Elevation Angle' parameter set to the elevation angle to the current satellite at the UE position. The REGM state shall change to 'REGISTERED'.
    - 4> If service is not allowed in the current UE Service Area, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Service Area Barred") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

- 3> If the UE Position Quality Policy for the current UE Location Area is set to "GPS Fix Only" then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "User-Specified Position Not Permitted") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

- 2> If the 'Fix Quality' field is set to "4" (IRS Fix) then REGM shall calculate the age of the position fix using the 'GPS Fix Date' and 'GPS Fix Time' fields of the 'GPS Position String':

  - 3> if the age is greater than the maximum age allowed by the UE Position Age Policy, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Position Age Exceeds Maximum") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK';

  - 3> if the age is less than or equal to the maximum age allowed by the UE Position Age Policy then REGM shall look up the Service Area which corresponds to the UE position, and look up the current Service Barring Policy for that Service Area:

    - 4> If service is allowed in the current UE Service Area, then REGM shall change the current Registration Mode for this UE to "3". REGM shall then compose the REGM:RegModeUpdate PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The value of the 'GPS Report Distance' IE shall be set according to the Position Update Reporting Policy for the current UE Location Area. REGM shall also send the [CBCn_UPDATE_REQ] primitive to CBCn with the 'Elevation Angle' parameter set to the elevation angle to the current satellite at the UE position. The REGM state shall change to 'REGISTERED'.

    - 4> If service is not allowed in the current UE Service Area, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Service Area Barred") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

- 1> If the REGM:UEPositionResponse PDU contains the 'Spot Beam ID' IE, and:

  - 2> if the UE Position Quality Policy for the current UE Location Area is set to "GPS Fix or Spot Beam ID" or "Spot Beam ID Only" or "Any Quality", then REGM shall assume that the UE is located at the default centre of the spot beam identified by the 'Spot Beam ID' IE. REGM shall look up the Service Area which corresponds to the UE position, and look up the current Service Barring Policy for that Service Area:

- 3> if service is allowed in the current UE Service Area, then REGM shall add 0x8000 to the Service Area Code (SAC) value (i.e. set the Most Significant Bit (MSB) of the SAC to "1") corresponding to the UE position, and store the result for this UE. REGM shall change the current Registration Mode for this UE to "3". REGM shall then compose the REGM:RegModeUpdate PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The REGM:RegModeUpdate PDU shall not contain the 'GPS Report Distance' IE. REGM shall also send the [CBCn_UPDATE_REQ] primitive to CBCn with the 'Elevation Angle' parameter set to the lowest elevation angle to the current satellite from the set of all positions within the spot beam identified by the 'Spot Beam ID' IE. The REGM state shall change to 'REGISTERED';

- 3> if service is not allowed in the current UE Service Area, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Service Area Barred") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

- 2> If the UE Position Quality Policy for the current UE Location area is not set to "GPS Fix or Spot Beam ID" or "Spot Beam ID Only" or "Any Quality", then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Position Required") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

If timer TR3 expires before REGM receives the REGM:UEPositionResponse PDU from the peer agent in the UE, then REGM shall resend the REGM:UEPositionRequest PDU to the peer REGM agent in the UE. This process may repeat up to the limit imposed by the retry counter CR3. After sending the REGM:UEPositionRequest PDU the maximum number of times, REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Position Response Not Received") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.

6.4.1.8.5 Behaviour in State 'REGISTERED'

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall stop timer TR2 (if it is running), unpack the encapsulated REGM PDU from the peer agent, and examine the AL Signal Type IE:

- 1> if the PDU type is REGM:SignallingConnectionReleaseReq, then REGM shall send the RL_ SIGNAL_CONN_REL_REQ primitive to Relay;

- 1> if the PDU type is REGM:UEPositionResponse, then:

  - 2> if the REGM:UEPositionResponse PDU contains the 'Encrypted GPS Position String' IE, then REGM shall attempt to decrypt the string:

    - 3> if the decryption fails, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Decryption Error") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK';

- 3> if the decryption is successful, then REGM shall store the decrypted 'GPS Position String' and REGM behaviour proceeds as if the unencrypted 'GPS Position String' IE had been received initially.

- 2> If the REGM:UEPositionResponse PDU contains the 'GPS Position String' IE, then REGM shall store the string and:

  - 3> if the 'Fix Quality' field is set to "1" (GPS Fix) or "2" (DGPS Fix) or "4" (IRS Fix), then REGM shall look up and store the Service Area which corresponds to the UE position, and look up the current Service Barring Policy for that Service Area:

    - 4> if service is allowed in the current UE Service Area, REGM shall also send the [CBCn_UPDATE_REQ] primitive to CBCn with the 'Elevation Angle' parameter set to the elevation angle to the current satellite at the UE position. This procedure then terminates.

    - 4> If service is not allowed in the current UE Service Area, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Service Area Barred") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

  - 3> If the 'Fix Quality' field is set to "3" (User-Specified Position), then this procedure terminates.

- 1> If the PDU type is REGM:HandoverRequest:

  - 2> if the REGM:HandoverRequest PDU contains the 'UE Position IE':

    - 3> if the REGM:HandoverRequest PDU contains the 'Encrypted GPS Position String' IE, then REGM shall attempt to decrypt the string:

      - 4> if the decryption fails, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Decryption Error") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

      - 4> If the decryption is successful, then REGM shall store the decrypted 'GPS Position String' and REGM behaviour proceeds as if the unencrypted 'GPS Position String' IE had been received initially:

    - 3> If the REGM:HandoverRequest PDU contains the 'GPS Position String' IE REGM shall store the 'GPS Position String' contained in the 'UE Position' IE and:

      - 4> if the 'Fix Quality' field of the 'GPS Position String' is set to "1" (GPS Fix) or "2" (DGPS Fix) or "4" (IRS Fix), then REGM shall look up and store the Service Area which corresponds to the UE position, and look up the current Service Barring Policy for that Service Area:

        - 5> if service is allowed in the current UE Service Area:

          6> if the 'Target Spot Beam List' IE is empty then REGM shall generate a list of candidate target spot beams for handover at the UE position (excluding those spot beams which are not appropriate given the value of the 'Current Spot Beam' IE) and:

            7> if there are no candidate target spot beams then this procedure terminates;

7> if there is at least one candidate target spot beam, then REGM shall request the BCn layer to initiate the intra-RNC handover procedure by sending the CBCn_HANDOVER_REQ primitive to CBCn. REGM shall set the 'Target Spot Beam List' parameter to the list of candidate target spot beams at the UE position. The 'Observe Target Preference' parameter shall be set to "FALSE". The 'Lease Group ID' parameter shall be set to the value of the 'Lease Group ID' for this UE (subscriber). The 'Elevation Angle' parameter shall be set to the elevation angle to the current satellite at the UE position. This procedure then terminates. Note that there is no state change associated with the transmission of this primitive to CBCn.

6> If the 'Target Spot Beam List' IE is not empty then REGM shall validate each of the target spot beams in the list and remove any beams (preserving the order of the list) that do not correspond to the UE position or are not appropriate targets for handover given the value of the 'Current Spot Beam' IE:

7> if the validated 'Target Spot Beam List' IE is not empty then REGM shall request the BCn layer to initiate the intra-RNC handover procedure by sending the CBCn_HANDOVER_REQ primitive to CBCn. The 'Target Spot Beam List' parameter shall be set to the validated 'Target Spot Beam List' IE. The 'Observe Target Preference' parameter shall be set according to the value of the 'Observe Target Preference' IE in the REGM:HandoverRequest PDU. The 'Lease Group ID' parameter shall be set to the value of the 'Lease Group ID' for this UE (subscriber). The 'Elevation Angle' parameter shall be set to the elevation angle to the current satellite at the UE position. This procedure then terminates. Note that there is no state change associated with the transmission of this primitive to CBCn.

7> If the validated 'Target Spot Beam List' IE is empty then this procedure terminates.

- 5> If service is not allowed in the current UE Service Area, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Service Area Barred") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

  - 4> if the 'Fix Quality' field is set to "3" (User-Specified Position), then this procedure terminates.

- 2> If the HandoverRequest PDU does not contain the 'UE Position' IE:

  - 3> If the 'Target Spot Beam List' IE is empty then this procedure terminates.

  - 3> If the 'Target Spot Beam List' IE is not empty then REGM shall validate each of the target spot beams in the list and remove any beams (preserving the order of the list) that do not correspond to the UE position or are not appropriate targets for handover given the value of the 'Current Spot Beam' IE:

    - 4> if the validated 'Target Spot Beam List' IE is empty then this procedure terminates;

- 4> if the validated 'Target Spot Beam List' IE is not empty then REGM shall check the 'UE Position Quality' policy of each beam in the list and remove any beams (preserving the order of the list) where the Policy is not set to either "GPS Fix or IRS Fix or Spot Beam ID", "Spot Beam ID Only", or "Any Quality":

  - 5> If the 'Target Spot Beam List' IE is empty then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Position Required") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

  - 5> If the 'Target Spot Beam List' IE is not empty then, REGM shall assume that the UE is located at the default centre of the spot beam identified by [the first element of] the 'Target Spot Beam List' IE. REGM shall look up the Service Area which corresponds to the UE position, and look up the current Service Barring Policy for that Service Area:

    6> If service is allowed in the current UE Service Area, then REGM shall add 0x8000 to the SAC value (i.e. set the MSB of the SAC to "1") corresponding to the UE position, and store the result for this UE. REGM shall request the BCn layer to initiate the intra-RNC handover procedure by sending the CBCn_HANDOVER_REQ primitive to CBCn. The 'Target Spot Beam List' parameter shall be set to the validated 'Target Spot Beam List' IE. The 'Observe Target Preference' parameter shall be set according to the value of the 'Observe Target Preference' IE in the REGM:HandoverRequest PDU. The 'Lease Group ID' parameter shall be set to the value of the 'Lease Group ID' for this UE (subscriber). The 'Elevation Angle' parameter shall be set to the lowest elevation angle to the current satellite from the set of all positions within the spot beam identified by [the first element of] the 'Target Spot Beam List' IE. This procedure then terminates. The 'Elevation Angle' parameter shall be set to the elevation angle to the current satellite at the UE position Note that there is no state change associated with the transmission of this primitive to CBCn.

    6> If service is not allowed in the current UE Service Area, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Service Area Barred") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

On receipt of the AL_COMDATA_IND primitive from the COM-SAP, REGM shall stop timer TR2 (if it is running) and examine the PDU type parameter. If the PDU type is REGM:Register and if the value of the 'Registration Reference' IE of the PDU is the same as the value currently stored for this UE, then REGM shall ignore the PDU. Otherwise, REGM shall store the new value of the 'Registration Reference' IE (replacing the value previously stored). REGM shall then compose the REGM:RegisterAck PDU and send it to the peer REGM agent in the UE using the AL_COMDATA_REQ primitive via the COM-SAP. The value of the 'Registration Mode' IE shall be set to "0". The REGM state shall change to 'REGISTERED-AWAIT-COMPLETE'.

On receipt of RL_SIGNAL_CONN_REL primitive from Relay, REGM shall compose the REGM:SignallingConnectionRelease PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. REGM shall send the REGM_SIGNAL_CONN_REL_IND primitive to either GMMH or MMH, depending on the service domain indicated in the 'CN Domain Identity' parameter of the RL_SIGNAL_CONN_REL primitive. REGM shall also send the REGM_RAB_REL_IND to the appropriate instance of RBC. If the value of the SERVICE DOMAIN state variable is "No Domain" (see clause 6.4.1.8.11), then REGM shall start the timer TR2.

On receipt of the REGM_INIT_MSG_IND primitive from GMMH or MMH, REGM shall stop timer TR2 (if it is running).

On receipt of the RL_PAGING primitive from Relay, REGM shall send the REGM_PAGE_REQ primitive to GMMH or MMH (depending on the service domain which is identified in the RL_PAGING primitive).

On receipt of the RL_UPDATE_UE_NAS_ID primitive from Relay, REGM shall update its variables pertaining to UE identities.

If timer TR2 expires while in this state, REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "UE Inactivity") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

On receipt of the CBCn_HANDOVER_IND primitive from CBCn, REGM shall notify its peer in the UE of the intra-RNC handover by composing the REGM:Handover PDU and sending it to the SSR for transmission using the SSR_SIGDATA_REQ primitive. REGM shall start timer TR5 and initialize the associated retry counter CR5. The REGM state shall change to 'AWAIT-HANDOVER-ACK'.

6.4.1.8.6 Behaviour in State 'RELEASING'

6.4.1.8.6.0 General

The 'RELEASING' state has four substates.

6.4.1.8.6.1 Behaviour in Substate 'AWAIT-DEREGISTER-ACK'

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall unpack the encapsulated REGM PDU from the peer agent and examine the AL Signal Type IE. If the PDU type is REGM:DeregisterAck then REGM shall stop timer TR4 and start timer TR6. The REGM state shall change to 'RELEASING-AWAIT-DELAY'. REGM shall expect the value of the 'Registration Reference' IE in the received REGM:DeregisterAck PDU to match the value currently stored for this UE (i.e. the value sent to the UE in the REGM:Deregister PDU), but a mismatch shall not be considered a protocol error or cause the REGM:DeregisterAck PDU to be discarded.

If timer TR4 expires before REGM receives the REGM:DeregisterAck PDU from the peer agent in the UE, then REGM shall resend the REGM:Deregister PDU to the peer REGM agent in the UE. This process may repeat up to the limit imposed by the retry counter CR4. After sending the REGM:Deregister PDU the maximum number of times, REGM shall send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.

6.4.1.8.6.2 Behaviour in Substate 'AWAIT-DISCONNECT'

On receipt of the SSR_DISCONNECT_CNF primitive from SSR, REGM shall request the Bearer Connection layer to destroy the SIG-SAP by sending the CBCn_DESTROY_REQ primitive to CBCn. The REGM state shall change to 'RELEASING-AWAIT-DESTROY'.

6.4.1.8.6.3 Behaviour in Substate 'AWAIT-DESTROY'

On receipt of the CBCn_DESTROY_CNF primitive from CBCn, the REGM state shall change to 'IDLE'.

6.4.1.8.6.4 Behaviour in Substate 'AWAIT-DELAY'

On expiry of timer TR6, REGM shall send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.

6.4.1.8.7 Behaviour in State 'AWAIT-HANDOVER-ACK'

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall unpack the encapsulated REGM PDU from the peer agent and examine the AL Signal Type IE. If the PDU type is REGM:HandoverAck then REGM shall stop timer TR5 and notify the Bearer Control layer that the handover procedure in the UE is complete by sending the CBCn_HANDOVER_RSP primitive to CBCn. REGM shall compose the REGM:SystemInformation PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The AVP list shall contain the NAS System Info AVP appropriate for the new (target) beam. If the setting of the Position Update Reporting policy in the target Location Area is not the same as the setting in the source Location Area, then REGM shall compose the REGM:RegModeUpdate PDU and send it to the SSR for transmission to the peer REGM agent in the UE. The 'Registration Mode' IE shall be set to "3" and the 'GPS Report Distance' IE shall set according to the Position Update Reporting policy for the target Location Area. The REGM state shall change to 'REGISTERED'.

If timer TR5 expires before REGM receives the REGM:HandoverAck PDU from the peer agent in the UE, then REGM shall resend the REGM:Handover PDU to the peer REGM agent in the UE. This process may repeat up to the limit imposed by the retry counter CR5. After sending the REGM:Handover PDU the maximum number of times, REGM shall send the CBCn_HANDOVER_REJ primitive to CBCn. The REGM state shall change to 'REGISTERED'.

6.4.1.8.8 Behaviour in State 'LEASE'

6.4.1.8.8.0 General

The 'LEASE' state has three substates.

6.4.1.8.8.1 Behaviour in Substate 'AWAIT-UE-POS'

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall unpack the encapsulated REGM PDU from the peer agent and examine the AL Signal Type IE. If the PDU type is REGM:UEPositionResponse then REGM shall stop timer TR3 and:

- 1> If the REGM:UEPositionResponse PDU contains the 'Encrypted GPS Position String' IE, then REGM shall attempt to decrypt the string:
  - 2> If the decryption fails, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Decryption Error") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.
  - 2> If the decryption is successful, then REGM shall store the decrypted 'GPS Position String' and REGM behaviour proceeds as if the unencrypted 'GPS Position String' IE had been received initially.
- 1> If the REGM:UEPositionResponse PDU contains the 'GPS Position String' IE, then REGM shall store the string. REGM shall look up the Service Area which corresponds to the UE position, and look up the current Service Barring Policy for that Service Area:
  - 2> If service is allowed in the current UE Service Area, then REGM shall generate a list of candidate target spot beams for handover at the UE position (excluding those spot beams which are not appropriate for the lease mode service) and:
    - 3> If there are no candidate target spot beams then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Lease Group Not Available") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

- 3> If there is at least one candidate target spot beam, then REGM shall send the CBCn_HANDOVER_REQ primitive to CBCn to initiate the intra-RNC handover procedure if a bearer assigned to the Lease Group specified by the UE is available. The 'Target Spot Beam List' parameter shall be set to the list of candidate target spot beams at the UE position. The 'Observe Target Preference' parameter shall be set to "FALSE". The 'Lease Group ID' parameter shall be set to the value of the 'Lease Group ID' for this UE (subscriber). The 'Elevation Angle' parameter shall be set to the elevation angle to the current satellite at the UE position. The REGM state shall change to 'LEASE-AWAIT-RESOURCE'.

- 2> If service is not allowed in the current UE Service Area, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Service Area Barred") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

- 1> If the REGM:UEPositionResponse PDU contains the 'Spot Beam ID' IE, then REGM shall assume that the UE is located at the default centre of the spot beam identified by the 'Spot Beam ID' IE. REGM shall look up the Service Area which corresponds to the UE position, and look up the current Service Barring Policy for that Service Area:

  - 2> If service is allowed in the current UE Service Area, then REGM shall add 0x8000 to the SAC value (i.e. set the MSB of the SAC to "1") corresponding to the UE position and store the result for this UE. REGM shall determine if the target spot beam identified by the 'Spot Beam ID' IE is appropriate for the lease mode service and:

    - 3> If the target spot beam is not appropriate for the lease mode service then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Lease Group Not Available") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

    - 3> If the target spot beam is appropriate for the lease mode service then REGM shall send the CBCn_HANDOVER_REQ primitive to CBCn to initiate the intra-RNC handover procedure if a bearer assigned to the Lease Group specified by the UE is available. The 'Target Spot Beam List' parameter shall be set to the 'Spot Beam ID' IE. The 'Observe Target Preference' parameter shall be set to "FALSE". The 'Lease Group ID' parameter shall be set to the value of the 'Lease Group ID' for this UE (subscriber). The 'Elevation Angle' parameter shall be set to the lowest elevation angle to the current satellite from the set of all positions within the spot beam identified by the 'Spot Beam ID' IE. the 'Target Spot Beam List' IE. The REGM state shall change to 'LEASE-AWAIT-RESOURCE'.

  - 2> If service is not allowed in the current UE Service Area, then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Service Area Barred") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

If timer TR3 expires before REGM receives the REGM:UEPositionResponse PDU from the peer agent in the UE, then REGM shall resend the REGM:UEPositionRequest PDU to the peer REGM agent in the UE. This process may repeat up to the limit imposed by the retry counter CR3. After sending the REGM:UEPositionRequest PDU the maximum number of times, REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Position Response Not Received") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.

6.4.1.8.8.2 Behaviour in Substate 'AWAIT-RESOURCE'

On receipt of the CBCn_HANDOVER_IND primitive from CBCn, REGM shall notify its peer in the UE of the intra-RNC handover by composing the REGM:Handover PDU and sending it to the SSR for transmission using the SSR_SIGDATA_REQ primitive. REGM shall start timer TR5 and initialize the associated retry counter CR5. The REGM state shall change to 'AWAIT-HANDOVER-ACK-LEASE'.

On receipt of the CBCn_HANDOVER_REJ primitive, REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Lease Group Not Available") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

6.4.1.8.8.3 Behaviour in Substate 'AWAIT-HANDOVER-ACK'

On receipt of the SSR_SIGDATA_IND primitive from SSR, REGM shall unpack the encapsulated REGM PDU from the peer agent and examine the AL Signal Type IE. If the PDU type is REGM:HandoverAck then REGM shall stop timer TR5 and notify the Bearer Control layer that the handover procedure in the UE is complete by sending the CBCn_HANDOVER_RSP primitive to CBCn. REGM shall change the current Registration Mode for this UE to "3". REGM shall then compose the REGM:RegModeUpdate PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The value of the 'GPS Report Distance' IE shall be set according to the Position Update Reporting Policy for the current UE Location Area. REGM shall then compose the REGM:SystemInformation PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The AVP list shall contain the NAS System Info AVP appropriate for the new beam. The REGM state shall change to 'REGISTERED'.

If timer TR5 expires before REGM receives the REGM:HandoverAck PDU from the peer agent in the UE, then REGM shall resend the REGM:Handover PDU to the peer REGM agent in the UE. This process may repeat up to the limit imposed by the retry counter CR5. After sending the REGM:Handover PDU the maximum number of times, REGM shall send the CBCn_HANDOVER_REJ primitive to CBCn. REGM shall then compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Lease Group Handover Failed") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall start timer TR4 and initialize the associated retry counter CR4. The REGM state shall change to 'RELEASING-AWAIT-DEREGISTER-ACK'.

6.4.1.8.9 Behaviour in Any State

On receipt of the RL_RESET primitive from Relay, REGM shall compose the REGM:SignallingConnectionRelease PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. REGM shall send the REGM_SIGNAL_CONN_REL_IND primitive to either GMMH or MMH, depending on the service domain indicated in the 'CN Domain Identity' parameter of the RL_SIGNAL_CONN_REL primitive. REGM shall also send the REGM_RAB_REL_IND to the appropriate instance of RBC. REGM shall then compose the RL_RESET_ACK primitive and send it to Relay. If the value of the SERVICE DOMAIN state variable is "No Domain" (see clause 6.4.1.8.11), then REGM shall start the timer TR2.

On receipt of the RL_RESET_RESOURCE primitive from Relay, REGM shall compose the REGM:SignallingConnectionRelease PDU and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. REGM shall send the REGM_SIGNAL_CONN_REL_IND primitive to either GMMH or MMH, depending on the service domain indicated in the 'CN Domain Identity' parameter of the RL_SIGNAL_CONN_REL primitive. REGM shall also send the REGM_RAB_REL_IND to the appropriate instance of RBC. REGM shall then compose the RL_RESET_RESOURCE_ACK primitive and send it to Relay. If the value of the SERVICE DOMAIN state variable is "No Domain" (see clause 6.4.1.8.11), then REGM shall start the timer TR2.

6.4.1.8.10 Behaviour in Any State (Not State 'IDLE')

On receipt of the CBCn_FAILURE_IND primitive from CBCn, REGM shall examine the 'Failure Cause' parameter of the primitive:

- 1> If the 'Failure Cause' parameter indicates a radio resource layer failure ("Conn Failure" or "Adj Channel Attach Fail"), then REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Radio Failure") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. REGM shall then send the SSR_DISCONNECT_REQ primitive to SSR. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.

- 1> If the 'Failure Cause' parameter indicates a radio resource layer failure ("UE Chk Limit Reached Release"), then REGM shall send RL_RESET_RESOURCE to Relay (for the CS and/or PS domain, depending on the value of the SERVICE DOMAIN state variable). REGM shall compose the REGM:Deregister PDU (with the 'Deregistration Cause' IE set to "Radio Failure") and send it to the SSR for transmission to the peer REGM agent in the UE using the SSR_SIGDATA_REQ primitive. The 'Registration Reference' IE shall be set to the value currently stored for this UE (i.e. the value in the most recently received REGM:Register PDU). REGM shall also notify GMMH, MMH, and RBC of the release of the UE-Specific Signalling connection by sending the REGM_REL_IND primitive to all agents. The REGM state shall change to 'RELEASING-AWAIT-DISCONNECT'.

- 1> If the 'Failure Cause' parameter indicates connection inactivity ("Max Idle Reached"), then REGM shall discard the CBCn_FAILURE_IND primitive.

6.4.1.8.11 Common Procedures

REGM shall maintain a SERVICE DOMAIN state variable which implicitly tracks the state of GMMH and MMH. The variable allows REGM to determine which AL agents need to receive notification of change in state of the UE-Specific Signalling connection via the REGM_CONN_IND and REGM_REL_IND primitives. The variable affects REGM behaviour in all states except 'IDLE':

- 1> if the variable is set to "Both Domains", then REGM shall send any of the above primitives to GMMH, RBC-PS, MMH, and RBC-CS;

- 1> if the variable is set to "PS Domain", then REGM shall send any of the above primitives to GMMH and RBC-PS;

- 1> if the variable is set to "CS Domain", then REGM shall send any of the above primitives to MMH and RBC-CS;

- 1> if the variable is set to "No Domain", then REGM shall not send any of the above primitives.

The variable shall be set to "No Domain" on entry to state 'IDLE-NETWORK-FOUND' and shall be updated according to the following rules:

- 1> on receipt of the REGM:Register PDU or the REGM_INIT_MSG_IND primitive:

  - 2> if the variable is currently "No Domain" and:

    - 3> if the 'CN Domain Identity' IE of the REGM:Register PDU or the 'CN Domain Identity' parameter of the REGM_INIT_MSG_IND primitive indicates the PS service domain, then the variable shall be set to "PS Domain";

        - 3> if the 'CN Domain Identity' IE of the REGM:Register PDU or the 'CN Domain Identity' parameter of the REGM_INIT_MSG_IND primitive indicates the CS service domain, then the variable shall be set to "CS Domain";

    - 2> if the variable is currently "PS Domain" and:

        - 3> if the 'CN Domain Identity' IE of the REGM:Register PDU or the 'CN Domain Identity' parameter of the REGM_INIT_MSG_IND primitive indicates the PS service domain, then the variable shall be set to "PS Domain";

        - 3> if the 'CN Domain Identity' IE of the REGM:Register PDU or the 'CN Domain Identity' parameter of the REGM_INIT_MSG_IND primitive indicates the CS service domain, then the variable shall be set to "Both Domains"

    - 2> if the variable is currently "CS Domain" and:

        - 3> if the 'CN Domain Identity' IE of the REGM:Register PDU or the 'CN Domain Identity' parameter of the REGM_INIT_MSG_IND primitive indicates the PS service domain, then the variable shall be set to "Both Domains";

        - 3> if the 'CN Domain Identity' IE of the REGM:Register PDU or the 'CN Domain Identity' parameter of the REGM_INIT_MSG_IND primitive indicates the CS service domain, then the variable shall be set to "CS Domain";

    - 2> if the variable is currently "Both Domains" then the variable shall be set to "Both Domains".

- **After** REGM has sent the REGM_REL_IND primitive:

    - 2> if the variable is currently "PS Domain" and:

        - 3> if the 'CN Domain Identity' parameter of the REGM_SIGNAL_CONN_REL_IND primitive indicates the PS service domain, then the variable shall be set to "No Domain";

    - if the variable is currently "CS Domain" and:

        - 3> if the 'CN Domain Identity' parameter of the REGM_SIGNAL_CONN_REL_IND primitive indicates the CS service domain, then the variable shall be set to "No Domain";

    - if the variable is currently "Both Domains" and:

        - 3> if the 'CN Domain Identity' parameter of the REGM_SIGNAL_CONN_REL_IND primitive indicates the PS service domain, then the variable shall be set to "CS Domain";

        - 3> if the 'CN Domain Identity' parameter of the REGM_SIGNAL_CONN_REL_IND primitive indicates the CS service domain, then the variable shall be set to "PS Domain".

6.4.1.9 REGM Timers, Counters, and Policies

REGM Timers are as shown in Table 6.8.

Table 6.8: REGM Timers [RNC]

Timer	Default Value	[Min, Max] Value	State	Comments
TR1	7 s	[0, 120 s]	'REGISTERED-AWAIT-COMPLETE'	Supervisory Timer for Registration Procedure
TR2	3 600 s	[0, MAXINT]	'REGISTERED'	UE Inactivity Timer
TR3	60 s	[0, 360 s]	'REGISTERED-AWAIT-UE-POS', 'LEASE-AWAIT-UE-POS'	Supervisory Timer for UE Position Request Procedure
TR4	3 s	[0, 60 s]	'RELEASING-AWAIT-DEREGISTER-ACK'	Supervisory Timer for Deregistration Procedure
TR5	15 s	[0, MAXINT]	'AWAIT-HANDOVER-ACK', 'LEASE-AWAIT-HANDOVER-ACK'	Supervisory Timer for Handover Procedure
TR6	2 s	[0, 60 s]	'RELEASING-AWAIT-DELAY'	Destruction Delay Timer for SIG-SAP

MAXINT is the maximum value of an unsigned long integer (2^{64}-1 assumed).

Figure 6.4 contains a summary of REGM timers in the RNC and UE. REGM Counters are as shown in Table 6.9, and REGM Policies are as shown in Table 6.10.

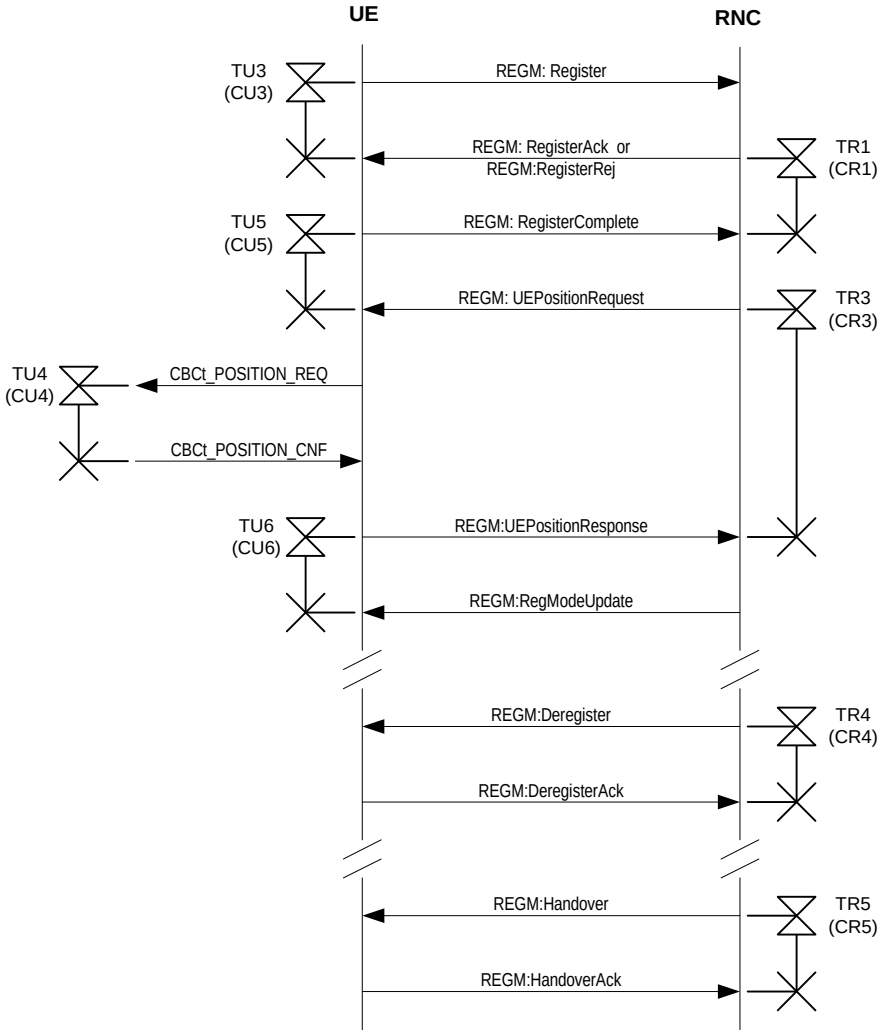

Figure 6.4: REGM Timer Summary

Table 6.9: REGM Counters [RNC]

Counter	Default Value	[Min, Max] Value	Comments
CR1	3	[0,MAXINT]	This counter is associated with timer TR1.
CR3	0	[0,MAXINT]	This counter is associated with timer TR3.
CR4	0	[0,MAXINT]	This counter is associated with timer TR4.
CR5	0	[0,MAXINT]	This counter is associated with timer TR5.

Table 6.10: REGM Policies [RNC]

Policy	Type {Values}	Comments	Scope
Service Barring	BOOLEAN	Determines if RNC permits network access at a given UE position (Service Area).	SAC, UE Class
UE Position Quality	CHOICE {"GPS Fix or IRS Fix Only", "GPS Fix or IRS Fix or User-Specified Position", "GPS Fix or IRS Fix or Spot Beam ID", "Spot Beam ID Only", "Any Quality"}	Determines the quality of the UE position which is required to access the network.	LAC
UE Position Age	INTEGER (0 ... MAXINT)	Determines the maximum allowable age (in minutes) of a UE GPS position fix.	LAC
Loss of Acquisition (LOA)	INTEGER (0 ... 999)	Determines the maximum contiguous LOA period (in minutes) that may be associated with a UE GPS position fix. This policy is only evaluated if the UE Position Age Policy is violated.	LAC
UE Position Accuracy	INTEGER (3 ... 9)	Determines the minimum number of tracked satellites needed to derive a UE GPS position fix.	LAC
Encryption Key	CHOICE {"Pre-Defined", "Generated"}	Determines if the RNC uses pre-defined keys or generates keys for UE GPS position encryption. If set to "Generated", the policy includes key lifetime and cryptographic variables as parameters.	LAC
Position Update Reporting	BOOLEAN	Determines if the RNC requires the UE to send unsolicited GPS position updates when in the REGISTERED state. If set to "TRUE", the policy includes the reporting distance threshold as a parameter.	LAC, UE Class
GPS Position Display	BOOLEAN	Determines if the UE is permitted to display GPS position information to the user.	LAC

6.4.2 GMMH

6.4.2.1 GMMH Protocol Data Units

GMMH Protocol Data Units are as shown in Table 6.11.

Table 6.11: GMMH::GMMH Protocol Data Units

PDU	SAP	Direction	Addressing	Information Elements
PagingType2	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, Paging Cause, Paging Record Type ID
InitialDirectTransfer	SIG	From UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
UplinkDirectTransfer	SIG	From UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
DownlinkDirectTransfer	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
SecurityModeCommand	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, Security Capability, {Ciphering Mode Info AVP, Integrity Protection Mode Info AVP} OPTIONAL
SecurityModeComplete	SIG	From UE	BCnID	AL Signal Type, ALPD, {UL Integrity Protection Activation Info AVP, RB Activation Time Info } OPTIONAL
SecurityModeFailure	SIG	From UE	BCnID	AL Signal Type, ALPD, CHOICE {Security Failure Cause, Protocol Error Cause}

NOTE: "NAS Message" is called a Layer 3-PDU in ETSI TS 124 007 [1].

6.4.2.2 Service Primitives at GMMH-SIG-SAP

The service primitives at GMMH-SIG-SAP are as shown in Table 6.12.

Table 6.12: GMMH::SSR Service Primitives at GMMH-SIG-SAP [RNC]

Primitive	Direction	Parameters
SSR_SIGDATA_REQ *GMMH requests SSR to send a PDU to its peer in the UE.*	To SSR	GMMH PDU, {SUSP} OPTIONAL
SSR_SIGDATA_IND *SSR indicates to GMMH that it has received a PDU from the peer agent in the UE.*	To GMMH	GMMH PDU
SSR_SIGDATA_CNF *Optional response to SSR_SIGDATA_REQ. SSR indicates to GMMH that the peer agent in the RNC has received a PDU.*	To GMMH	-
SSR_SECURITY_REQ *GMMH requests SSR to start (or modify) integrity protection.*	To SSR	UIA, IK, FRESH, START
SSR_SECURITY_CNF *SSR confirms to GMMH that integrity protection has been started (or modified).*	To GMMH	-
SSR_SECURITY_REJ *SSR indicates to GMMH that integrity protection could not be started (or modified) for the specified reason.*	To GMMH	Rejection Cause
SSR_REVERT_REQ *GMMH requests SSR to revert to the previous integrity protection configuration.*	To SSR	-
SSR_REVERT_CNF *SSR confirms to GMMH that it has reverted to the previous integrity protection configuration.*	To GMMH	-

6.4.2.3 Service Primitives at GMMH-RL-SAP

The service primitives at GMMH-RL-SAP are as shown in Table 6.13.

Table 6.13: GMMH::RSR Service Primitives at GMMH-RL-SAP [RNC]

Primitive	Direction	Parameters
RL_INIT_DIRECT_TRANSFER	To RSR	BCnID, ALPD, LAI, SAI, RAC, CN Domain Identity, NAS Message
RL_UL_DIRECT_TRANSFER	To RSR	BCnID, ALPD, LAI, SAI, RAC, CN Domain Identity, NAS Message
RL_DL_DIRECT_TRANSFER	To GMMH	BCnID, ALPD, CN Domain, SAPI, NAS Message
RL_SECURITY_MODE_COMMAND	To GMMH	BCnID, ALPD, Integrity Protection Info, Ciphering Info, Key Status
RL_SECURITY_MODE_COMPLETE	To RSR	BCnID, ALPD, Integrity Protection Activation Info, Ciphering Activation Info
RL_SECURITY_MODE_REJECT	To RSR	BCnID, ALPD, Cause

6.4.2.4 Service Primitives at GMMH-REGM-SAP

See clause 6.4.1.4.

6.4.2.5 Service Primitives at RBCPS-GMMH-SAP

See clause 6.4.4.5.

6.4.2.6 Service Primitives at GMMH-CBCn-SAP

The service primitives at GMMH-CBCn-SAP are as shown in Table 6.14.

Table 6.14: GMMH::CSR Service Primitives at GMMH-CBCn-SAP [RNC]

Primitive	Direction	Parameters
CBCn_SECURITY_REQ *GMMH requests BCn to start, or modify ciphering for all PDUs received at the indicated SAPs (BCnID).*	To CSR	ALPD, Mode (Start/ Modify), CK, START, SEQUENCE OF {BCnID, UL Activation Time, DL Activation Time}
CBCn_SECURITY_CNF *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated SAPs (BCnID) has been started/modified.*	To GMMH	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_REQ *MMH requests BCn to suspend the indicated connections (UE Specific Signalling connection and all CS domain RABs).*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_CNF *Response to CBCn_SUSPEND_REQ. BCn confirms that the indicated connections are suspended.*	To GMMH	ALPD, SEQUENCE OF {BCnID, Next BCn Send Sequence Number}
CBCn_SUSPEND_REJ *Response to CBCn_SUSPEND_REQ. BCn indicates that one or more connections have not been suspended.*	To GMMH	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_REQ *MMH requests BCn to resume the indicated connections (UE Specific Signalling connection and all PS domain RABs).*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_CNF *Response to CBCn_RESUME_REQ. BCn confirms that the indicated connections have resumed.*	To GMMH	ALPD, SEQUENCE OF {BCnID}

6.4.2.7 GMMH States

The GMMH states are as shown in Table 6.15.

Table 6.15: GMMH States [RNC]

Number	State	Description
1	IDLE ★Initial State	A UE-Specific signalling connection has not been established and GMMH is unable to route GMM messages between the Relay Function (RANAP) and the BCn layer.
2	CONNECTED	A UE-Specific signalling connection has been established and GMMH is able to route GMM messages between the Relay Function (RANAP) and the BCn layer. This state has three substates.
>2a	CONNECTED	No GMMH security procedures are in progress.
>2b	CONNECTED-INTEGRITY-REQUESTED	GMMH has requested the SSR to start integrity protection and is waiting for confirmation.
>2c	CONNECTED-AWAIT-UE-SECURITY	GMMH is waiting for its peer in the UE to confirm that the security mode set-up procedure in the UE is completed. This state has two numbered substates.
>2d	CONNECTED-CIPHERING-REQUESTED	GMMH has requested the BCn layer to start ciphering and is waiting for confirmation.
>2e	CONNECTED-AWAIT-RAB-LIST	GMMH has requested the RBC to identify all active PS domain RABs and is awaiting a response.
>2f	CONNECTED-SUSPEND-REQUESTED	GMMH has requested the Bearer Connection layer to suspend all active PS domain RABs and the UE-Specific Signalling connection and is awaiting a response.
>2g	CONNECTED-RESUME-REQUESTED	GMMH has requested the Bearer Connection layer to resume all suspended PS domain RABs and the UE-Specific Signalling connection and is awaiting a response. This state has two numbered substates.
>2h	CONNECTED-REVERT-REQUESTED	GMMH has requested the SSR to revert to the previous integrity protection configuration and is waiting for confirmation. This state has two numbered substates.
3	CONNECTED-IU-REL	A UE-Specific signalling connection has been established but the corresponding Iu-PS signalling connection (between the RNC and CN) is not established.

6.4.2.8 GMMH Behaviour

6.4.2.8.0 General

GMMH behaviour in the RNC is summarized in the signal-state diagrams in Figures 6.5 and 6.6.

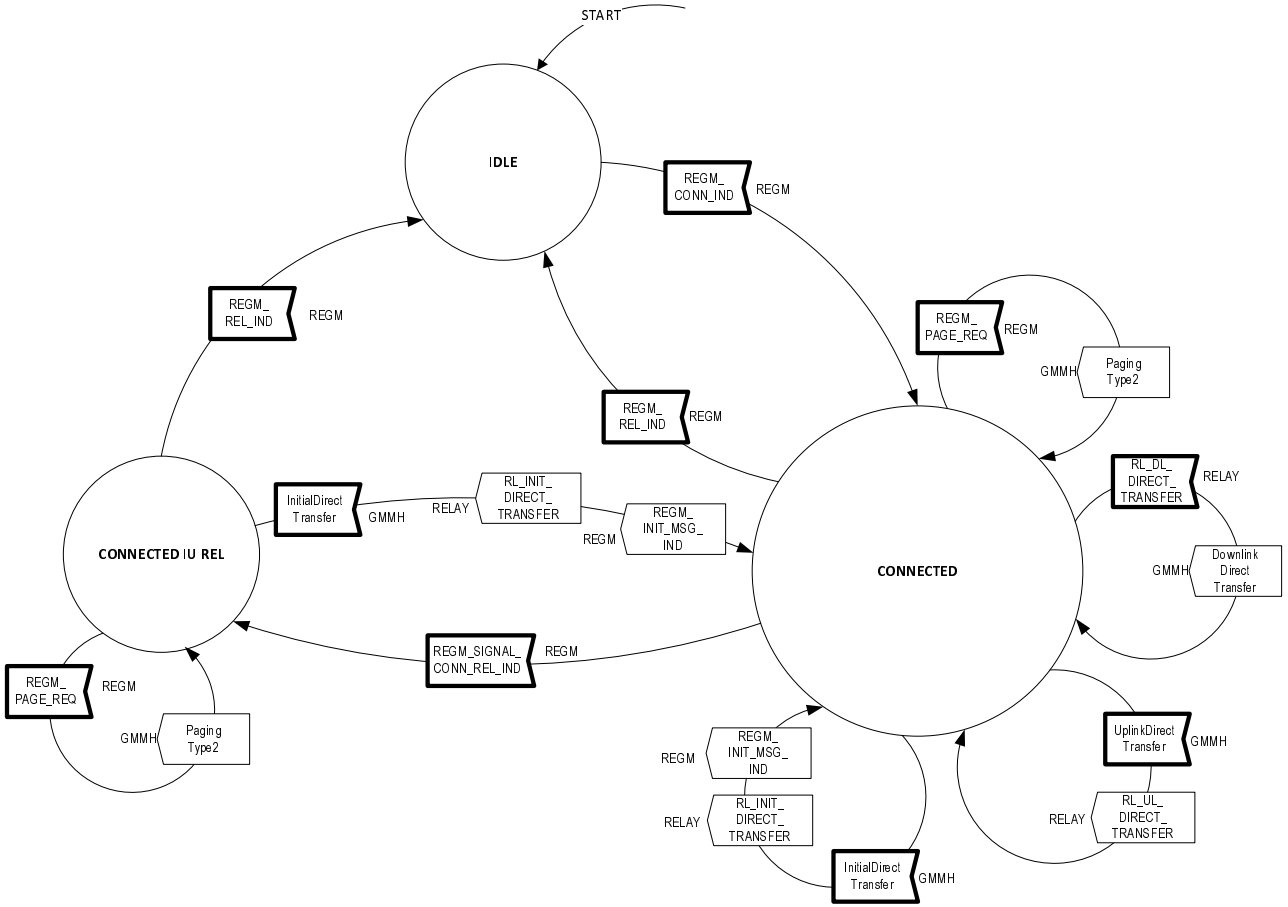

Figure 6.5: RNC GMMH Signal-State Diagram *(Security Functions Not Shown)*

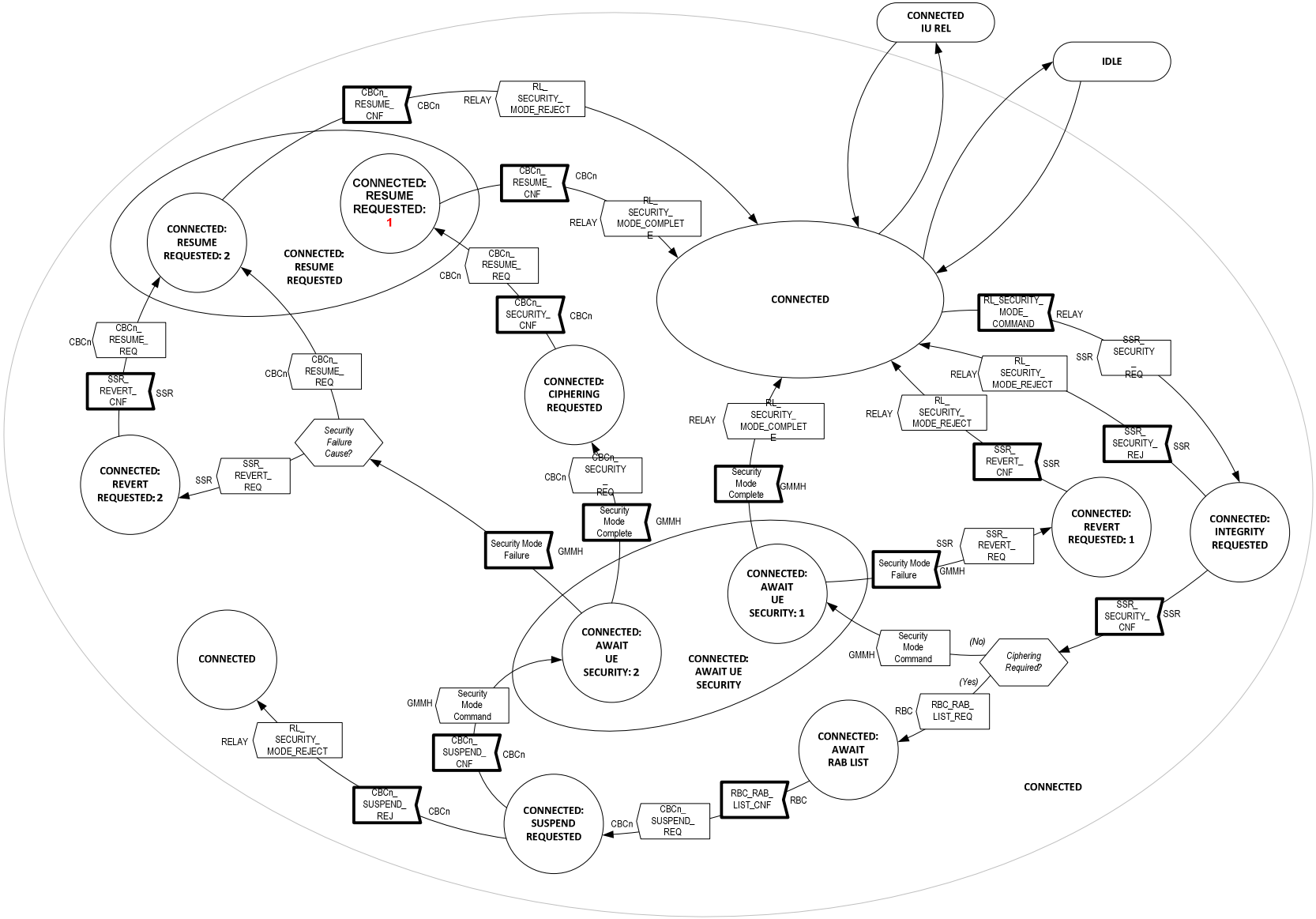

Figure 6.6: RNC GMMH Signal-State Diagram - Security Functions

6.4.2.8.1 Behaviour in State 'IDLE'

On receipt of the REGM_CONN_IND primitive from REGM, the GMMH state shall change to 'CONNECTED'.

6.4.2.8.2 Behaviour in State 'CONNECTED'

6.4.2.8.2.1 Behaviour in Substate 'CONNECTED'

On receipt of the RL_DL_DIRECT_TRANSFER primitive from RELAY (via the RSR), GMMH shall use the encapsulated Layer 3-PDU (NAS Message) to compose the GMMH:DownlinkDirectTransfer PDU and send it to the SSR for transmission to the peer GMMH agent in the UE using the SSR_SIGDATA_REQ primitive.

On receipt of the REGM_PAGE_REQ primitive from REGM, GMMH shall compose the GMMH:PagingType2 PDU and send it to the SSR for transmission to the peer GMMH agent in the UE using the SSR_SIGDATA_REQ primitive.

On receipt of the SSR_SIGDATA_IND primitive from SSR, GMMH shall unpack the encapsulated GMMH PDU from the peer agent in the UE and examine the AL Signal Type IE:

- If the PDU type is GMMH:UplinkDirectTransfer, then GMMH shall forward the encapsulated Layer 3-PDU (NAS Message) to RELAY (via the RSR) using the RL_UL_DIRECT_TRANSFER primitive.
- If the PDU type is GMMH:InitialDirectTransfer, then GMMH shall forward the encapsulated Layer 3-PDU (NAS Message) to RELAY (via the RSR) using the RL_INIT_DIRECT_TRANSFER primitive. GMMH shall also notify REGM that the UE-Specific Signalling connection is in use by the PS service domain by sending the REGM_INIT_MSG_IND primitive.

On receipt of the RL_SECURITY_MODE_COMMAND primitive from RELAY (via the RSR), GMMH shall request the SSR to start integrity protection by sending the SSR_SECURITY_REQ primitive. The GMMH state shall changed to 'CONNECTED-INTEGRITY-REQUESTED'.

On receipt of the REGM_SIGNAL_CONN_REL_IND primitive from REGM, the GMMH state shall change to 'CONNECTED-IU-REL'.

On receipt of the REGM_REL_IND primitive from REGM, the GMMH state shall change to 'IDLE'.

On receipt of the RBC_CK_INFO_REQ primitive from RBC-PS, GMMH shall respond by sending the requested Ciphering Key in the RBC_CK_INFO_RSP primitive.

6.4.2.8.2.2 Behaviour in Substate 'INTEGRITY-REQUESTED'

On receipt of the SSR_SECURITY_CNF primitive from SSR:

- 1> If the RL_SECURITY_MODE_COMMAND primitive indicated that ciphering is not to be started, then GMMH shall compose the GMMH:SecurityModeCommand PDU and send it to the SSR for transmission to the peer GMMH agent in the UE using the SSR_SIGDATA_REQ primitive (with the 'SUSP' parameter set to "TRUE"). The GMMH state shall change to 'CONNECTED-AWAIT-UE-SECURITY-1'.
- 1> If the RL_SECURITY_MODE_COMMAND primitive indicated that ciphering is to be started (or modified), then GMMH shall request RBC to identify all active PS domain RABs by sending the RBC_RAB_LIST_REQ primitive. The GMMH state shall change to 'CONNECTED-AWAIT-RAB-LIST'.

On receipt of the SSR_SECURITY_REJ primitive from SSR, GMMH shall compose the RL_SECURITY_MODE_REJECT primitive and send it to RELAY via the SSR. The GMMH state shall change to 'CONNECTED'.

6.4.2.8.2.3 Behaviour in Substate 'CONNECTED-AWAIT-UE-SECURITY'

6.4.2.8.2.3.0 General

This state has two numbered substates.

6.4.2.8.2.3.1 Behaviour in Substate 'CONNECTED-AWAIT-UE-SECURITY-1'

On receipt of the SSR_SIGDATA_IND primitive from SSR, GMMH shall unpack the encapsulated GMMH PDU from the peer agent in the UE and examine the AL Signal Type IE:

- 1> If the PDU type is GMMH:SecurityModeComplete, then GMMH shall compose the RL_SECURITY_MODE_COMPLETE primitive and send it to RELAY via the SSR. The GMMH state shall change to 'CONNECTED'.

- 1> If the PDU type is GMMH:SecurityModeFailure, then GMMH shall request the SSR to revert to the previous integrity protection configuration by sending the SSR_REVERT_REQ primitive. The GMMH state shall changed to 'CONNECTED-REVERT-REQUESTED-1'.

6.4.2.8.2.3.2 Behaviour in Substate 'CONNECTED-AWAIT-UE-SECURITY-2'

On receipt of the SSR_SIGDATA_IND primitive from SSR, GMMH shall unpack the encapsulated GMMH PDU from the peer agent in the UE and examine the AL Signal Type IE:

- 1> If the PDU type is GMMH:SecurityModeComplete, then GMMH shall send the CBCn_SECURITY_REQ primitive to CBCn. The GMMH state shall change to 'CONNECTED-CIPHERING-REQUESTED'.

- 1> If the PDU type is GMMH:SecurityModeFailure, then GMMH shall examine the 'Failure Cause' IE:

  - 2> If the 'Failure Cause' IE is set to "Unsupported Security Configuration" or "Integrity Protection Algorithm Failure" then GMMH shall request the SSR to revert to the previous integrity protection configuration by sending the SSR_REVERT_REQ primitive. The GMMH state shall changed to 'CONNECTED-REVERT-REQUESTED-2'.

  - 2> If the 'Failure Cause' IE is set to "Ciphering Algorithm Failure" then GMMH shall request the Bearer Connection layer to resume all suspended PS domain RABs and the UE-Specific Signalling connection by sending the CBCn_RESUME_REQ primitive to CBCn. The GMMH state shall change to 'CONNECTED-RESUME-REQUESTED-2'.

6.4.2.8.2.4 Behaviour in Substate 'CIPHERING-REQUESTED'

On receipt of the CBCn_SECURITY_CNF primitive from CBCn, GMMH shall request the Bearer Connection layer to resume all suspended PS domain RABs and the UE-Specific Signalling connection by sending the CBCn_RESUME_REQ primitive to CBCn. The GMMH state shall change to 'CONNECTED-RESUME-REQUESTED-1'.

6.4.2.8.3 Behaviour in State 'CONNECTED-IU-RELEASED'

On receipt of the SSR_SIGDATA_IND primitive from SSR, GMMH shall unpack the encapsulated GMMH PDU from the peer agent in the UE and examine the AL Signal Type IE:

- If the PDU type is GMMH:InitialDirectTransfer, then GMMH shall forward the encapsulated Layer 3-PDU (NAS Message) to RELAY (via the RSR) using the RL_INIT_DIRECT_TRANSFER primitive. GMMH shall also notify REGM that the UE-Specific Signalling connection is in use by the PS service domain by sending the REGM_INIT_MSG_IND primitive. The GMMH state shall change to 'CONNECTED'.

On receipt of the REGM_REL_IND primitive from REGM, the GMMH state shall change to 'IDLE'.

On receipt of the REGM_PAGE_REQ primitive from REGM, GMMH shall compose the GMMH:PagingType2 PDU and send it to the SSR for transmission to the peer GMMH agent in the UE using the SSR_SIGDATA_REQ primitive.

6.4.2.8.4 Behaviour in State 'CONNECTED-AWAIT-RAB-LIST'

On receipt of the RBC_RAB_LIST_CNF primitive from RBC, GMMH shall request the Bearer Connection layer to suspend all active PS domain RABs and the UE-Specific Signalling connection by sending the CBCn_SUSPEND_REQ primitive to CBCn. The GMMH state shall change to 'CONNECTED-SUSPEND-REQUESTED'.

6.4.2.8.5 Behaviour in State 'CONNECTED-SUSPEND-REQUESTED'

On receipt of the CBCn_SUSPEND_CNF primitive from CBCn, GMMH shall compose the GMMH:SecurityModeCommand PDU and send it to the SSR for transmission to the peer GMMH agent in the UE using the SSR_SIGDATA_REQ primitive (with the 'SUSP' parameter set to "TRUE"). The GMMH state shall change to 'CONNECTED-AWAIT-UE-SECURITY-2'.

On receipt of the CBCn_SUSPEND_REJ primitive from CBCn, GMMH shall compose the RL_SECURITY_MODE_REJECT primitive and send it to RELAY via the RSR. The GMMH state shall change to 'CONNECTED'.

6.4.2.8.6 Behaviour in State 'CONNECTED-RESUME-REQUESTED'

6.4.2.8.6.0 General

This state has two numbered substates.

6.4.2.8.6.1 Behaviour in State 'CONNECTED-RESUME-REQUESTED-1'

On receipt of the CBCn_RESUME_CNF primitive from CBCn, GMMH shall compose the RL_SECURITY_MODE_COMPLETE primitive and send it to RELAY via the RSR. The GMMH state shall change to 'CONNECTED'.

6.4.2.8.6.2 Behaviour in State 'CONNECTED-RESUME-REQUESTED-2'

On receipt of the CBCn_RESUME_CNF primitive from CBCn, GMMH shall compose the RL_SECURITY_MODE_COMPLETE primitive and send it to RELAY via the RSR. The GMMH state shall change to 'CONNECTED'.

6.4.2.8.7 Behaviour in State 'CONNECTED-REVERT-REQUESTED'

6.4.2.8.7.0 General

This state has two numbered substates.

6.4.2.8.7.1 Behaviour in State 'CONNECTED-REVERT-REQUESTED-1'

On receipt of the SSR_REVERT_CNF primitive from SSR, GMMH shall compose the RL_SECURITY_MODE_REJECT primitive and send it to RELAY via the RSR. The GMMH state shall change to 'CONNECTED'.

6.4.2.8.7.2 Behaviour in State 'CONNECTED-REVERT-REQUESTED-2'

On receipt of the SSR_REVERT_CNF primitive from SSR, GMMH shall request the Bearer Connection layer to resume all suspended PS domain RABs and the UE-Specific Signalling connection by sending the CBCn_RESUME_REQ primitive to CBCn. The GMMH state shall change to 'CONNECTED-RESUME-REQUESTED-2'.

6.4.3 MMH

6.4.3.1 MMH Protocol Data Units

The MMH Protocol Data Units are as shown in Table 6.16.

Table 6.16: MMH::MMH Protocol Data Units

PDU	SAP	Direction	Addressing	Information Elements
PagingType2	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, Paging Cause, Paging Record Type ID
InitialDirectTransfer	SIG	From UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
UplinkDirectTransfer	SIG	From UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
DownlinkDirectTransfer	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, NAS Message
SecurityModeCommand	SIG	To UE	BCnID	AL Signal Type, ALPD, CN Domain Identity, Security Capability, {Ciphering Mode Info AVP, Integrity Protection Mode Info AVP} OPTIONAL
SecurityModeComplete	SIG	From UE	BCnID	AL Signal Type, ALPD, {UL Integrity Protection Activation Info AVP, RB Activation Time Info } OPTIONAL
SecurityModeFailure	SIG	From UE	BCnID	AL Signal Type, ALPD, CHOICE {Security Failure Cause, Protocol Error Cause}

NOTE: "NAS Message" is called a Layer 3-PDU in ETSI TS 124 007 [1].

6.4.3.2 Service Primitives at MMH-SIG-SAP

The service primitives at MMH-SIG-SAP are as shown in Table 6.17.

Table 6.17: MMH::SSR Service Primitives at MMH-SIG-SAP [RNC]

Primitive	Direction	Parameters
SSR_SIGDATA_REQ *MMH requests SSR to send a PDU to its peer in the UE.*	To SSR	MMH PDU, {SUSP} OPTIONAL
SSR_SIGDATA_IND *SSR indicates to MMH that it has received a PDU from the peer agent in the UE.*	To MMH	MMH PDU
SSR_SIGDATA_CNF *Optional response to SSR_SIGDATA_REQ. SSR indicates to MMH that the peer agent in the RNC has received a PDU.*	To MMH	-
SSR_SECURITY_REQ *MMH requests SSR to start (or modify) integrity protection.*	To SSR	UIA, IK, FRESH, START
SSR_SECURITY_CNF *SSR confirms to MMH that integrity protection has been started (or modified).*	To MMH	-
SSR_SECURITY_REJ *SSR indicates to MMH that integrity protection could not be started (or modified) for the specified reason.*	To MMH	Rejection Cause
SSR_REVERT_REQ *MMH requests SSR to revert to the previous integrity protection configuration.*	To SSR	-
SSR_REVERT_CNF *SSR confirms to MMH that it has reverted to the previous integrity protection configuration.*	To MMH	-

6.4.3.3 Service Primitives at MMH-RL-SAP

The service primitives at MMH-RL-SAP are as shown in Table 6.18.

Table 6.18: MMH::RSR Service Primitives at MMH-RL-SAP [RNC]

Primitive	Direction	Parameters
RL_INIT_DIRECT_TRANSFER	To RSR	BCnID, ALPD, LAI, SAI, RAC, CN Domain Identity, NAS Message
RL_UL_DIRECT_TRANSFER	To RSR	BCnID, ALPD, LAI, SAI, RAC, CN Domain Identity, NAS Message
RL_DL_DIRECT_TRANSFER	To MMH	BCnID, ALPD, CN Domain, SAPI, NAS Message
RL_SECURITY_MODE_COMMAND	To MMH	BCnID, ALPD, Integrity Protection Info, Ciphering Info, Key Status
RL_SECURITY_MODE_COMPLETE	To RSR	BCnID, ALPD, Integrity Protection Activation Info, Ciphering Activation Info
RL_SECURITY_MODE_REJECT	To RSR	BCnID, ALPD, Cause

6.4.3.4 Service Primitives at MMH-REGM-SAP

See clause 6.4.1.4.

6.4.3.5 Service Primitives at MMH-CBCn-SAP

The service primitives at MMH-CBCn-SAP are as shown in Table 6.19.

Table 6.19: MMH::CSR Service Primitives at MMH-CBCn-SAP [RNC]

Primitive	Direction	Parameters
CBCn_SECURITY_REQ *MMH requests BCn to start, or modify ciphering for all PDUs received at the indicated SAPs (BCnID).*	To CSR	ALPD, Mode (Start/ Modify), CK, START, SEQUENCE OF {BCnID, UL Activation Time, DL Activation Time}
CBCn_SECURITY_CNF *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated SAPs (BCnID) has been started/modified.*	To MMH	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_REQ *MMH requests BCn to suspend the indicated connections (UE Specific Signalling connection and all CS domain RABs).*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_CNF *Response to CBCn_SUSPEND_REQ. BCn confirms that the indicated connections are suspended.*	To MMH	ALPD, SEQUENCE OF {BCnID, Next BCn Send Sequence Number}
CBCn_SUSPEND_REJ *Response to CBCn_SUSPEND_REQ. BCn indicates that one or more connections have not been suspended.*	To MMH	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_REQ *MMH requests BCn to resume the indicated connections (UE Specific Signalling connection and all PS domain RABs).*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_CNF *Response to CBCn_RESUME_REQ. BCn confirms that the indicated connections have resumed.*	To MMH	ALPD, SEQUENCE OF {BCnID}

6.4.3.6 Service Primitives RBCCS-MMH-SAP

See clause 6.4.4.5.

6.4.3.7 MMH States

The MMH states are as shown in Table 6.20.

Table 6.20: MMH States [RNC]

Number	State	Description
1	IDLE ★Initial State	A UE-Specific signalling connection has not been established and MMH is unable to route MM messages between the Relay Function (RANAP) and the BCn layer.
2	CONNECTED	A UE-Specific signalling connection has been established and MMH is able to route MM messages between the Relay Function (RANAP) and the BCn layer.
>2a	CONNECTED	No MMH security procedures are in progress.
>2b	CONNECTED-INTEGRITY-REQUESTED	MMH has requested the SSR to start integrity protection and is waiting for confirmation.
>2c	CONNECTED-AWAIT-UE-SECURITY	MMH is waiting for its peer in the UE to confirm that the security mode set-up procedure in the UE is completed. This state has two numbered substates.
>2d	CONNECTED-CIPHERING-REQUESTED	MMH has requested the BCn layer to start ciphering and is waiting for confirmation.
>2e	CONNECTED-AWAIT-RAB-LIST	MMH has requested the RBC to identify all active CS domain RABs and is awaiting a response.
>2f	CONNECTED-SUSPEND-REQUESTED	MMH has requested the Bearer Connection layer to suspend all active CS domain RABs and the UE-Specific Signalling connection and is awaiting a response.
>2g	CONNECTED-RESUME-REQUESTED	MMH has requested the Bearer Connection layer to resume all suspended CS domain RABs and the UE-Specific Signalling connection and is awaiting a response. This state has two numbered substates.
>2h	CONNECTED-REVERT-REQUESTED	MMH has requested the SSR to revert to the previous integrity protection configuration and is waiting for confirmation. This state has two numbered substates.
3	CONNECTED-IU-REL	A UE-Specific signalling connection has been established but the corresponding Iu-CS signalling connection (between the RNC and CN) is not established.

6.4.3.8 MMH Behaviour

6.4.3.8.0 General

MMH behaviour in the RNC is summarized in the signal-state diagrams in Figures 6.7 and 6.8.

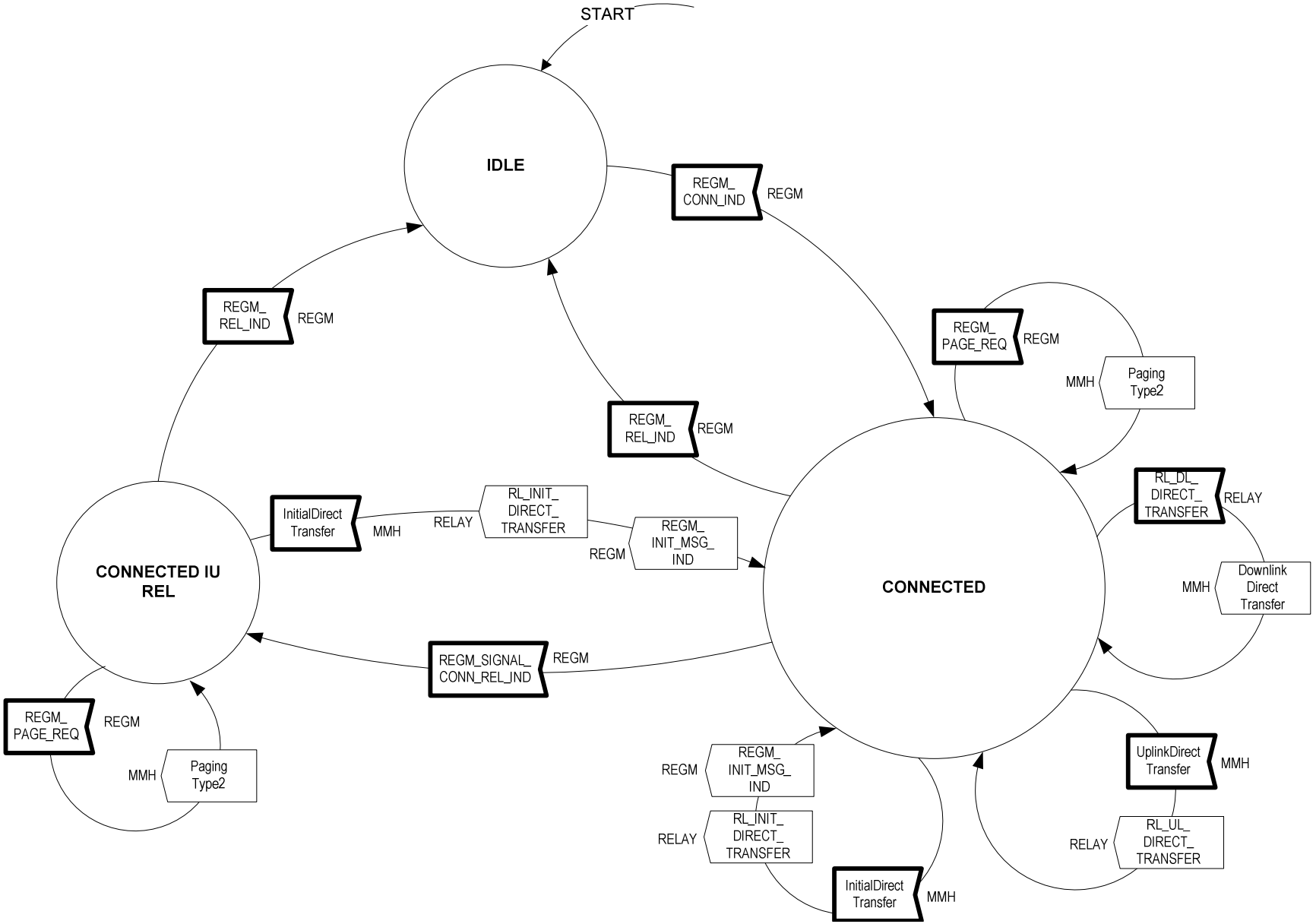

Figure 6.7: RNC MMH Signal-State Diagram *(Security Functions Not Shown)*

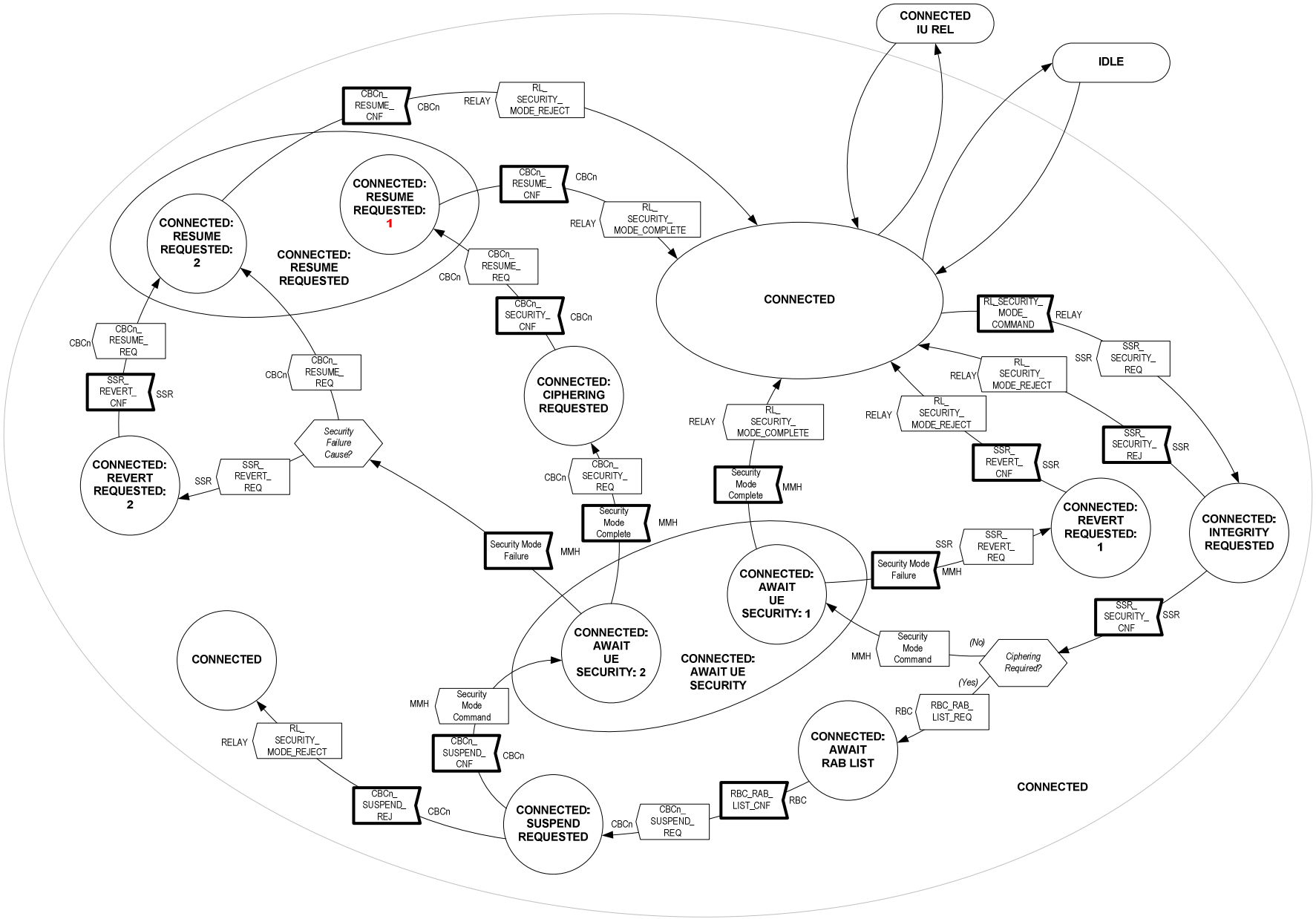

Figure 6.8: RNC MMH Signal-State Diagram - Security Functions

6.4.3.8.1 Behaviour in State 'IDLE'

On receipt of the REGM_CONN_IND primitive from REGM, the MMH state shall change to 'CONNECTED'.

6.4.3.8.2 Behaviour in State 'CONNECTED'

6.4.3.8.2.1 Behaviour in Substate 'CONNECTED'

On receipt of the RL_DL_DIRECT_TRANSFER primitive from RELAY (via the RSR), MMH shall use the encapsulated Layer 3-PDU (NAS Message) to compose the MMH:DownlinkDirectTransfer PDU and send it to the SSR for transmission to the peer MMH agent in the UE using the SSR_SIGDATA_REQ primitive.

On receipt of the REGM_PAGE_REQ primitive from REGM, MMH shall compose the MMH:PagingType2 PDU and send it to the SSR for transmission to the peer MMH agent in the UE using the SSR_SIGDATA_REQ primitive.

On receipt of the SSR_SIGDATA_IND primitive from SSR, MMH shall unpack the encapsulated MMH PDU from the peer agent in the UE and examine the AL Signal Type IE:

- If the PDU type is MMH:UplinkDirectTransfer, then MMH shall forward the encapsulated Layer 3-PDU (NAS Message) to RELAY (via the RSR) using the RL_UL_DIRECT_TRANSFER primitive.
- If the PDU type is MMH:InitialDirectTransfer, then MMH shall forward the encapsulated Layer 3-PDU (NAS Message) to RELAY (via the RSR) using the RL_INIT_DIRECT_TRANSFER primitive. MMH shall also notify REGM that the UE-Specific Signalling connection is in use by the CS service domain by sending the REGM_INIT_MSG_IND primitive.

On receipt of the RL_SECURITY_MODE_COMMAND primitive from RELAY (via the RSR), MMH shall request the SSR to start integrity protection by sending the SSR_SECURITY_REQ primitive. The MMH state shall changed to 'CONNECTED-INTEGRITY-REQUESTED'.

On receipt of the REGM_SIGNAL_CONN_REL_IND primitive from REGM, the MMH state shall change to 'CONNECTED-IU-REL'.

On receipt of the REGM_REL_IND primitive from REGM, the MMH state shall change to 'IDLE'.

On receipt of the RBC_CK_INFO_REQ primitive from RBC-CS, MMH shall respond by sending the requested Ciphering Key in the RBC_CK_INFO_RSP primitive.

6.4.3.8.2.2 Behaviour in Substate 'INTEGRITY-REQUESTED'

On receipt of the SSR_SECURITY_CNF primitive from SSR:

- 1> If the RL_SECURITY_MODE_COMMAND primitive indicated that ciphering is not to be started, then MMH shall compose the MMH:SecurityModeCommand PDU and send it to the SSR for transmission to the peer MMH agent in the UE using the SSR_SIGDATA_REQ primitive (with the 'SUSP' parameter set to "TRUE"). The MMH state shall change to 'CONNECTED-AWAIT-UE-SECURITY-1'.
- 1> If the RL_SECURITY_MODE_COMMAND primitive indicated that ciphering is to be started (or modified), then MMH shall request RBC to identify all active CS domain RABs by sending the RBC_RAB_LIST_REQ primitive. The MMH state shall change to 'CONNECTED-AWAIT-RAB-LIST'.

On receipt of the SSR_SECURITY_REJ primitive from SSR, MMH shall compose the RL_SECURITY_MODE_REJECT primitive and send it to RELAY via the SSR. The MMH state shall change to 'CONNECTED'.

6.4.3.8.2.3 Behaviour in Substate 'CONNECTED-AWAIT-UE-SECURITY'

6.4.3.8.2.3.0 General

This state has two numbered substates.

6.4.3.8.2.3.1 Behaviour in Substate 'CONNECTED-AWAIT-UE-SECURITY-1'

On receipt of the SSR_SIGDATA_IND primitive from SSR, MMH shall unpack the encapsulated MMH PDU from the peer agent in the UE and examine the AL Signal Type IE:

- 1> If the PDU type is MMH:SecurityModeComplete, then MMH shall compose the RL_SECURITY_MODE_COMPLETE primitive and send it to RELAY via the SSR. The MMH state shall change to 'CONNECTED'.

- 1> If the PDU type is MMH:SecurityModeFailure, then MMH shall request the SSR to revert to the previous integrity protection configuration by sending the SSR_REVERT_REQ primitive. The GMMH state shall changed to 'CONNECTED-REVERT-REQUESTED-1'.

6.4.3.8.2.3.2 Behaviour in Substate 'CONNECTED-AWAIT-UE-SECURITY-2'

On receipt of the SSR_SIGDATA_IND primitive from SSR, MMH shall unpack the encapsulated MMH PDU from the peer agent in the UE and examine the AL Signal Type IE:

- 1>If the PDU type is MMH:SecurityModeComplete, then MMH shall send the CBCn_SECURITY_REQ primitive to CBCn. The MMH state shall change to 'CONNECTED-CIPHERING-REQUESTED'.

- 1> If the PDU type is MMH:SecurityModeFailure, then MMH shall examine the 'Failure Cause' IE:

    - 2> If the 'Failure Cause' IE is set to "Unsupported Security Configuration" or "Integrity Protection Algorithm Failure" then MMH shall request the SSR to revert to the previous integrity protection configuration by sending the SSR_REVERT_REQ primitive. The MMH state shall changed to 'CONNECTED-REVERT-REQUESTED-2'.

    - 2>If the 'Failure Cause' IE is set to "Ciphering Algorithm Failure" then MMH shall request the Bearer Connection layer to resume all suspended CS domain RABs and the UE-Specific Signalling connection by sending the CBCn_RESUME_REQ primitive to CBCn. The MMH state shall change to 'CONNECTED-RESUME-REQUESTED-2'.

6.4.3.8.2.4 Behaviour in Substate 'CIPHERING-REQUESTED'

On receipt of the CBCn_SECURITY_CNF primitive from CBCn, MMH shall request the Bearer Connection layer to resume all suspended CS domain RABs and the UE-Specific Signalling connection by sending the CBCn_RESUME_REQ primitive to CBCn. The MMH shall change to 'CONNECTED-RESUME-REQUESTED-1'.

6.4.3.8.3 Behaviour in State 'CONNECTED-IU-RELEASED'

On receipt of the SSR_SIGDATA_IND primitive from SSR, MMH shall unpack the encapsulated MMH PDU from the peer agent in the UE and examine the AL Signal Type IE:

- If the PDU type is MMH:InitialDirectTransfer, then MMH shall forward the encapsulated Layer 3-PDU (NAS Message) to RELAY (via the RSR) using the RL_INIT_DIRECT_TRANSFER primitive. MMH shall also notify REGM that the UE-Specific Signalling connection is in use by the CS service domain by sending the REGM_INIT_MSG_IND primitive. The MMH state shall change to 'CONNECTED'.

On receipt of the REGM_REL_IND primitive from REGM, the MMH state shall change to 'IDLE'.

On receipt of the REGM_PAGE_REQ primitive from REGM, MMH shall compose the MMH:PagingType2 PDU and send it to the SSR for transmission to the peer MMH agent in the UE using the SSR_SIGDATA_REQ primitive.

6.4.3.8.4 Behaviour in State 'CONNECTED-AWAIT-RAB-LIST'

On receipt of the RBC_RAB_LIST_CNF primitive from RBC, MMH shall request the Bearer Connection layer to suspend all active CS domain RABs and the UE-Specific Signalling connection by sending the CBCn_SUSPEND_REQ primitive to CBCn. The MMH state shall change to 'CONNECTED-SUSPEND-REQUESTED'.

6.4.3.8.5 Behaviour in State 'CONNECTED-SUSPEND-REQUESTED'

On receipt of the CBCn_SUSPEND_CNF primitive from CBCn, MMH shall compose the MMH:SecurityModeCommand PDU and send it to the SSR for transmission to the peer MMH agent in the UE using the SSR_SIGDATA_REQ primitive (with the 'SUSP' parameter set to "TRUE"). The MMH state shall change to 'CONNECTED-AWAIT-UE-SECURITY-2'.

On receipt of the CBCn_SUSPEND_REJ primitive from CBCn, MMH shall compose the RL_SECURITY_MODE_REJECT primitive and send it to RELAY via the RSR. The MMH state shall change to 'CONNECTED'.

6.4.3.8.6 Behaviour in State 'CONNECTED-RESUME-REQUESTED'

6.4.3.8.6.0 General

This state has two numbered substates.

6.4.3.8.6.1 Behaviour in State 'CONNECTED-RESUME-REQUESTED-1'

On receipt of the CBCn_RESUME_CNF primitive from CBCn, MMH shall compose the RL_SECURITY_MODE_COMPLETE primitive and send it to RELAY via the RSR. The MMH state shall change to 'CONNECTED'.

6.4.3.8.6.2 Behaviour in State 'CONNECTED-RESUME-REQUESTED-2'

On receipt of the CBCn_RESUME_CNF primitive from CBCn, MMH shall compose the RL_SECURITY_MODE_REJECT primitive and send it to RELAY via the RSR. The MMH state shall change to 'CONNECTED'.

6.4.3.8.7 Behaviour in State 'CONNECTED-REVERT-REQUESTED'

6.4.3.8.7.0 General

This state has two numbered substates.

6.4.3.8.7.1 Behaviour in State 'CONNECTED-REVERT-REQUESTED-1'

On receipt of the SSR_REVERT_CNF primitive from SSR, MMH shall compose the RL_SECURITY_MODE_REJECT primitive and send it to RELAY via the RSR. The MMH state shall change to 'CONNECTED'.

6.4.3.8.7.2 Behaviour in State 'CONNECTED-REVERT-REQUESTED-2'

On receipt of the SSR_REVERT_CNF primitive from SSR, MMH shall request the Bearer Connection layer to resume all suspended CS domain RABs and the UE-Specific Signalling connection by sending the CBCn_RESUME_REQ primitive to CBCn. The MMH state shall change to 'CONNECTED-RESUME-REQUESTED-2'.

6.4.4 Radio Bearer Control (RBC)

6.4.4.1 RBC Protocol Data Units

The RBC Protocol Data Units are as shown in Table 6.21.

Table 6.21: RBC::RBC Protocol Data Units

PDU	SAP	Direction	Addressing	Information Elements
Establish	SIG	To UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), BCn Type, Number of (BCn) Parameters, BCn Parameter List, Control Flags, Transaction ID, BCt Type, BCtID, BCt EPDU
EstablishAck	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, {Adaptation Layer AVP List} OPTIONAL
EstablishReject	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, CHOICE {Failure Cause, Protocol Error Cause}
Modify	SIG	To UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), BCn Type, Number of (BCn) Parameters, BCn Parameter List, Control Flags, Transaction ID, BCt Type, BCtID, BCt EPDU
ModifyAck	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, {Adaptation Layer AVP List} OPTIONAL
ModifyReject	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, CHOICE {Failure Cause, Protocol Error Cause}
Release	SIG	To UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, Release Cause, {BCt Type, BCtID, BCt EPDU} OPTIONAL
ReleaseAck	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, {Adaptation Layer AVP List} OPTIONAL
ReleaseReject	SIG	From UE	BCnID	AL Signal Type, ALPD, BCnID (DATA-SAP), Control Flags, Transaction ID, CHOICE {Failure Cause, Protocol Error Cause}

6.4.4.2 Service Primitives at RBC-REGM-SAP (RBCPS-REGM-SAP, RBCCS-REGM-SAP)

See clause 6.4.1.4.

6.4.4.3 Service Primitives at RBC-SIG-SAP (RBCPS-SIG-SAP, RBCCS-SIG-SAP)

The service primitives at RBC-SIG-SAP are as shown in Table 6.22.

Table 6.22: RBC::SSR Service Primitives at RBC-SIG-SAP [RNC]

Primitive	Direction	Parameters
SSR_SIGDATA_REQ *RBC requests SSR to send a PDU to its peer in the UE.*	To SSR	RBC PDU
SSR_SIGDATA_IND *SSR indicates to RBC that it has received a PDU from the peer agent in the UE.*	To RBC	RBC PDU
SSR_SIGDATA_CNF *Optional response to SSR_SIGDATA_REQ. SSR indicates to RBC that the peer agent in the RNC has received a PDU.*	To RBC	-

6.4.4.4 Service Primitives at RBC-RL-SAP (RBCPS-RL-SAP, RBCCS-RL-SAP)

The service primitives at RBC-RL-SAP are as shown in Table 6.23.

Table 6.23: RBC::RSR Service Primitives at RBC-RL-SAP [RNC]

Primitive	Direction	Parameters
RL_ESTABLISH	To RBC	BCnID, ALPD, RAB ID, NAS Synchronization Indicator, User Plane Information, Transport Layer Information, PDP Type Info, RAB Parameters, DL GTP Sequence Number, UL GTP Sequence Number
RL_ESTABLISH_ACK	To RSR	BCnID, ALPD, RAB ID, Transport Layer Info, Iu Transport Association, Data Volume Report
RL_ESTABLISH_REJ	To RSR	BCnID, ALPD, RAB ID, Cause
RL_MODIFY	To RBC	BCnID, ALPD, RAB ID, NAS Synchronization Indicator, RAB Parameters, Transport Layer Information
RL_MODIFY_ACK	To RSR	BCnID, ALPD, RAB ID, Transport Layer Info, Iu Transport Association, Data Volume Report
RL_MODIFY_REJ	To RSR	BCnID, ALPD, RAB ID, Cause
RL_RELEASE	To RBC	BCnID, ALPD, RAB ID, Cause, Data Volume Report Indicator
RL_RELEASE_ACK	To RSR	BCnID, ALPD, RAB ID
RL_RELEASE_REJ	To RSR	BCnID, ALPD, RAB ID, Cause
RL_RAB_RELEASE_REQ	To RSR	BCnID, ALPD, RAB ID, Cause

6.4.4.5 Service Primitives at RBCPS-GMMH-SAP (RBC PS Domain Only) or RBCCS-MMH-SAP (RBC CS Domain Only)

The service primitives at RBCPS-GMMH-SAP are as shown in Table 6.24.

Table 6.24: RBC::GMMH/MMH Service Primitives [RNC]

Primitive	Direction	Parameters
RBC_CK_INFO_REQ *RBC requests GMMH to provide the PS domain ciphering key and the value $START_{PS}$ or MMH to provide the CS domain ciphering key and the value $START_{CS}$.*	To GMMH/ MMH	ALPD
RBC_CK_INFO_RSP *Response to RBC_CK_INFO_REQ. GMMH/MMH provides the requested ciphering key and the value START to RBC.*	To RBC	ALPD, CK, START
RBC_RAB_LIST_REQ *GMMH/MMH requests RBC to provide a list of all active PS domain RABs (RBC-PS) or all active CS domain RABs (RBC-CS).*	To RBC	ALPD
RBC_RAB_LIST_CNF *Response to RBC_RAB_LIST_REQ. RBC provides the requested list of RABs to GMMH/MMH.*	To GMMH/ MMH	ALPD, Sequence of {BCnID}

6.4.4.6 Service Primitives at RBC-CBCn-SAP (RBCPS-CBCn-SAP, RBCCS-CBCn-SAP)

The service primitives at RBC-CBCn-SAP are as shown in Table 6.25.

Table 6.25: RBC::CSR Service Primitives at RBC-CBCn-SAP [RNC]

Primitive	Direction	Parameters
CBCn_CREATE_REQ *RBC requests the BCn layer to create the DATA-SAP with the specified handle (BCnID) and QoS attributes.*	To CSR	ALPD, BCnID (DATA-SAP), BCn/AL Parameter List
CBCn_CREATE_CNF *Response to CBCn_CREATE_REQ. BCn layer confirms that the DATA-SAP with the specified handle (BCnID) has been created.*	To RBC	ALPD, BCnID, BCtID, {BCt EPDU} OPTIONAL
CBCn_CREATE_REJ *Response to CBCn_CREATE_REQ. BCn layer confirms that the DATA-SAP with the specified handle (BCnID) has not been created for the specified reason.*	To RBC	ALPD, BCnID, Rejection Cause
CBCn_MODIFY_REQ *RBC requests the BCn layer to modify the QoS attributes of the specified DATA-SAP (BCnID).*	To CSR	ALPD, BCnID (DATA-SAP), BCn/AL Parameter List
CBCn_MODIFY_CNF *Response to CBCn_MODIFY_REQ. BCn layer confirms that the QoS attributes of the specified DATA-SAP (BCnID) have been modified.*	To RBC	ALPD, BCnID, BCtID, {BCt EPDU} OPTIONAL
CBCn_MODIFY_REJ *Response to CBCn_MODIFY_REQ. BCn layer confirms that the QoS attributes of the specified DATA-SAP (BCnID) have not been modified for the specified reason.*	To RBC	ALPD, BCnID, Rejection Cause
CBCn_DESTROY_REQ *RBC requests the BCn layer to destroy one or more DATA-SAP(s) with the specified handle(s) (BCnID).*	To CSR	ALPD, SEQUENCE OF {BCnID (DATA-SAP)}
CBCn_DESTROY_CNF *Response to CBCn_DESTROY_REQ. BCn layer confirms that the DATA-SAP(s) with the specified handle(s) (BCnID) has (have) been destroyed.*	To RBC	ALPD, SEQUENCE OF {BCnID}
CBCn_SECURITY_REQ *RBC requests BCn to start, or modify ciphering for all PDUs received at the indicated DATA-SAP (BCnID).*	To CSR	ALPD, Mode (Start/ Modify), CK, START, BCnID, UL Activation Time, DL Activation Time
CBCn_SECURITY_CNF *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated DATA-SAP (BCnID) has been started/modified.*	To RBC	ALPD, BCnID
CBCn_SECURITY_REJ *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated DATA-SAP (BCnID) has not been started/modified for the specified reason.*	To RBC	ALPD, BCnID, Rejection Cause
CBCn_FAILURE_IND *BCn indicates a failure of the specified bearer connection to RBC.*	To RBC	ALPD, BCnID, Failure Cause

6.4.4.7 Service Primitives at CPDCP-SAP (RBC PS Domain Only)

The service primitives at CPDCP-SAP are as shown in Table 6.26.

Table 6.26: RBC::PDCP Service Primitives at CPDCP-SAP [RNC]

Primitive	Direction	Parameters
CPDCP_CONFIG_REQ	To PDCP	PDCP Info, BCnID (DATA-SAP), SN Sync, R/I
CPDCP_RELEASE_REQ	To PDCP	BCnID (DATA-SAP)

6.4.4.8 Service Primitives at CSH-RBC-SAP (RBC CS Domain Only)

The service primitives at CSH-RBC-SAP are as shown in Table 6.27.

Table 6.27: RBC::CSH Service Primitives at CSH-RBC-SAP [RNC]

Primitive	Direction	Parameters
CSH_CONFIG_REQ	To CSH	BCnID (DATA-SAP), Forward CS Frames Per PDU, Return CS Frames Per PDU, Forward DTX, Circuit Switched Call Type
CSH_RELEASE_REQ	To CSH	BCnID (DATA-SAP)

6.4.4.9 RBC States

The RBC states are as shown in Table 6.28.

Table 6.28: RBC States

Number	State	Description
1	IDLE ★Initial State	A UE-Specific signalling connection has not been established. No RBC procedure is in progress.
2	CONNECTED	A UE-Specific signalling connection has been established. No RBC procedure is in progress.
>2a	CONNECTED-AWAIT CREATE	RBC has requested CBCn to create a DATA-SAP and is waiting for confirmation.
>2b	CONNECTED-AWAIT RELEASE ACK	RBC is waiting for its peer in the UE to confirm that the RAB Release procedure in the UE has completed.
>2c	CONNECTED- AWAIT ESTABLISH ACK	RBC is waiting for its peer in the UE to confirm that the RAB Establish procedure has completed.
>2d	CONNECTED- AWAIT DESTROY	RBC has requested CBCn to delete a DATA-SAP and is waiting for confirmation. This state has five numbered substates.
>2e	CONNECTED- AWAIT KEYS	RBC has requested GMMH/MMH for a ciphering key and is waiting for a response.
>2f	CONNECTED- AWAIT SECURITY	RBC has requested CBCn to initiate ciphering and is waiting for confirmation.
>2h	CONNECTED-AWAIT-MODIFY	RBC has requested CBCn to modify the QoS attributes pertaining to a DATA-SAP and is waiting for conformation.
>2j	CONNECTED-AWAIT-MODIFY-ACK	RBC is waiting for its peer in the UE to confirm that the RAB Modify procedure has completed.

6.4.4.10 RBC Behaviour

6.4.4.10.0 General

RBC behaviour in the RNC is summarized in the signal-state diagrams in Figures 6.9 and 6.10. RBC maintains a "RAB Table" which relates DATA-SAP handles (BCnID) to their corresponding RAB IDs.

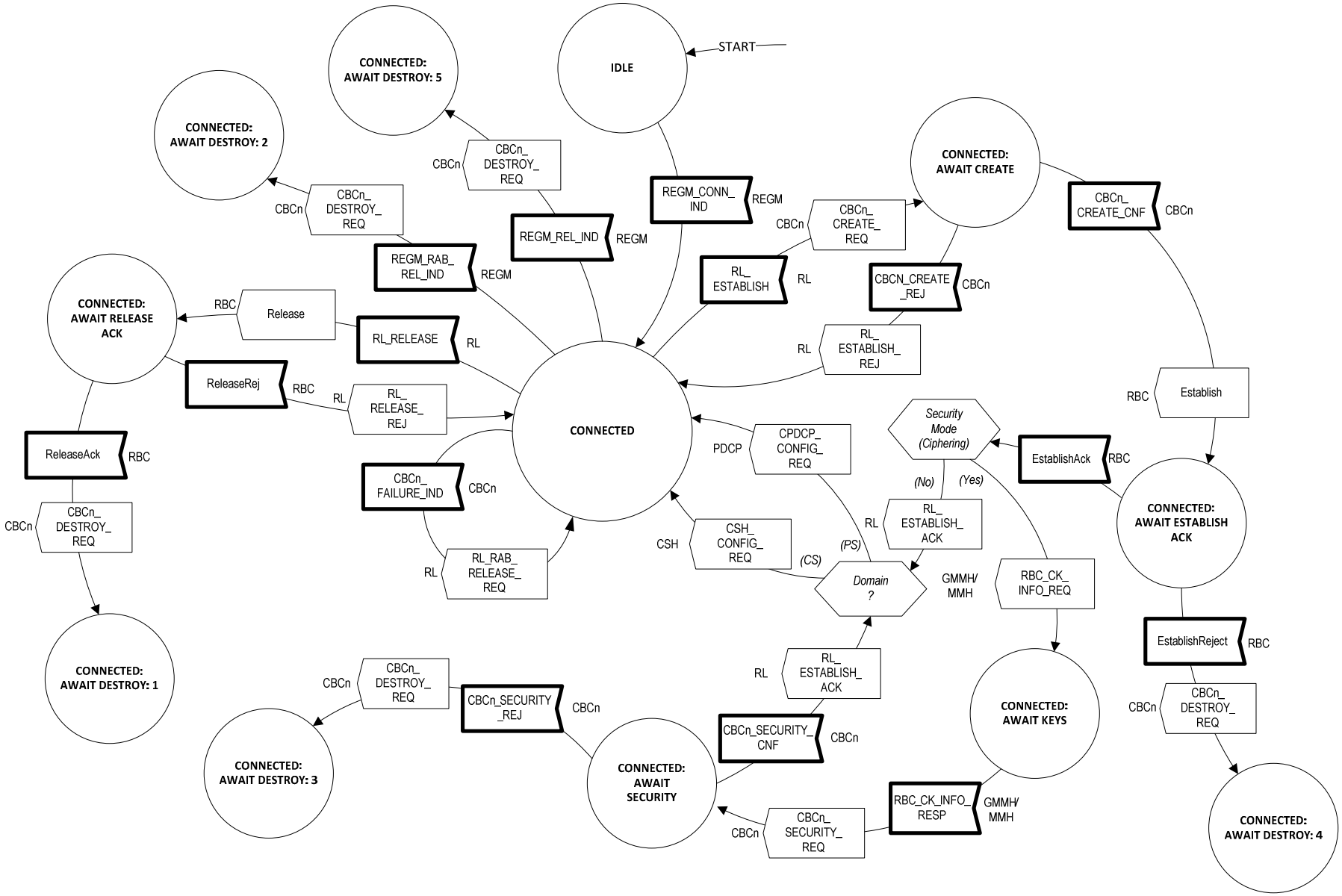

Figure 6.9: RNC RBC Signal-State Diagram - Establish and Release Functions

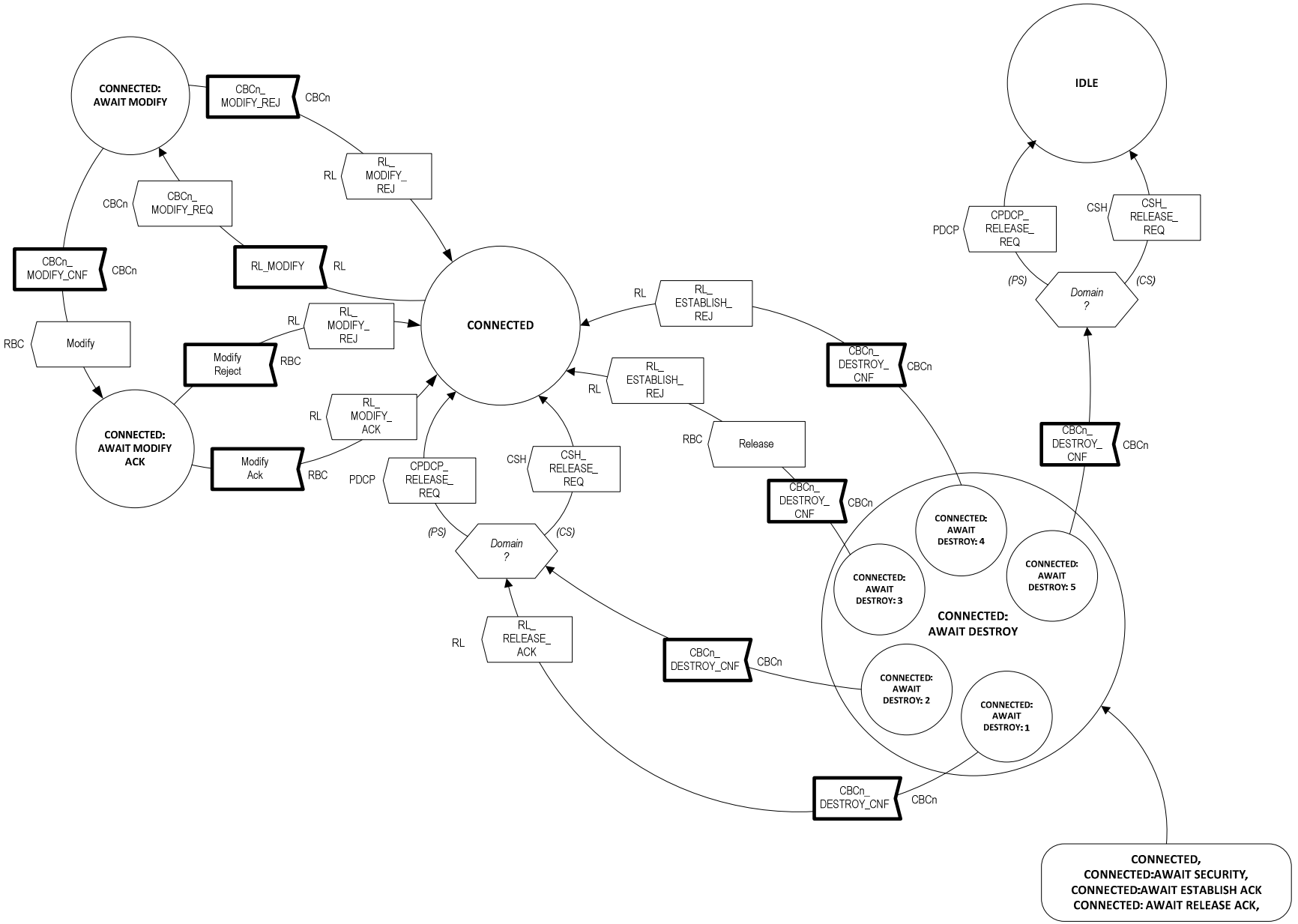

Figure 6.10: RNC RBC Signal-State Diagram - Modify and Destroy Functions

6.4.4.10.1 Behaviour in State 'IDLE'

On receipt of the REGM_CONN_IND primitive from REGM, the RBC state shall change to 'CONNECTED'.

On receipt of the RBC_RAB_LIST_REQ primitive from GMMH or MMH, RBC shall identify all active RABs from the RAB Table and respond with the RBC_RAB_LIST_CNF primitive.

6.4.4.10.2 Behaviour in State 'CONNECTED'

On receipt of the RL_ESTABLISH primitive from Relay (via RSR), RBC initially determines whether this is a Multicast Radio Access Bearer (MRAB). If this is an MRAB and the request indicates that ciphering is required then the RBC shall reject the RAB establishment request and return to the CONNECTED state if the UE has not already completed security mode procedure and is operating in ciphering mode. For all other cases, the RBC shall proceed to invoke a routine to generate a unique BCnID (DATA-SAP) and create a new entry in the RAB Table with the values of BCnID (DATA-SAP) and the associated RAB ID. RBC shall also compose the CBCn_CREATE_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-CREATE'.

On receipt of the RL_MODIFY primitive from Relay (via RSR), RBC shall compose the CBCn_MODIFY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-MODIFY'.

On receipt of the RL_RELEASE primitive from Relay:

- 1> If the RAB identified by the 'RAB ID' parameter of the RL_RELEASE primitive is present in the RAB table, then REGM shall start timer TR9. RBC shall compose the RBC:Release PDU with the 'Release Cause' IE set to "Normal Release CN Initiated" and send it to the SSR for transmission to the peer RBC agent in the UE using the SSR_SIGDATA_REQ primitive. The RBC state shall change to 'CONNECTED-AWAIT-RELEASE-ACK'.

- 1> If the RAB identified by the 'RAB ID' parameter of the RL_RELEASE primitive is not present in the RAB table, then RBC shall compose the RL_RELEASE_REJ primitive (with the 'Cause' parameter set to indicate "Invalid RAB ID") and send it to Relay.

On receipt of the REGM_REL_IND - primitive from REGM, RBC shall send the CBCn_DESTROY_REQ primitive to CBCn, specifying the Bearer Connection IDs of any remaining entries in the RAB Table and then purge the RAB Table. The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-5'.

On receipt of the REGM_RAB_REL_IND primitive from REGM, RBC shall send the CBCn_DESTROY_REQ primitive to CBCn, specifying the Bearer Connection IDs of any remaining entries in the RAB Table and then purge the RAB Table. The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-2'.

On receipt of the RBC_RAB_LIST_REQ primitive from GMMH or MMH, RBC shall identify all active RABs from the RAB Table and respond with the RBC_RAB_LIST_CNF primitive.

On receipt of the CBCn_FAILURE_IND primitive from CBCn, RBC shall examine the 'Failure Cause' parameter of the primitive:

- 1> If the 'Failure Cause' parameter indicates a radio resource layer failure ("Conn Failure") or ("UE Chk Limit Reached Release"), then RBC shall send the RL_RAB_RELEASE_REQ primitive to Relay.

- 1> If the 'Failure Cause' parameter indicates connection inactivity ("Max Idle Reached"), then:

  - 2> PS Domain only: RBC shall send the RL_RAB_RELEASE_REQ primitive to Relay.

  - 2> CS Domain only: RBC shall discard the CBCn_FAILURE_IND primitive.

6.4.4.10.3 Behaviour in State 'CONNECTED-AWAIT-CREATE'

On receipt of the CBCn_CREATE_CNF primitive from CBCn (via CSR), RBC shall start timer TR7. REGM shall compose the RBC:Establish PDU and send it to the SSR for transmission to the peer RBC agent in the UE using the SSR_SIGDATA_REQ primitive. The RBC state shall change to 'CONNECTED-AWAIT-ESTABLISH-ACK'.

On receipt of the CBCn_CREATE_REJ primitive from CBCn (via CSR), RBC shall remove the corresponding entry from the RAB Table. RBC shall also compose the RL_ESTABLISH_REJ primitive and send it to Relay via RSR. The RBC state shall change to 'CONNECTED'.

6.4.4.10.4 Behaviour in State 'CONNECTED-AWAIT-RELEASE-ACK'

On receipt of the SSR_SIGDATA_IND primitive from SSR, RBC shall unpack the encapsulated RBC PDU from the peer entity in the UE and examine the AL Signal Type IE:

- 1> If the PDU type is RBC:ReleaseAck, then RBC shall stop timer TR9. REGM shall compose the CBCn_DESTROY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-1'.
- 1> If the PDU type is RBC:ReleaseReject, then RBC shall stop timer TR9. REGM shall examine the 'Failure Cause' IE:
  - 2> if the 'Failure Cause' IE is "Invalid BCnID" (inconsistency in the UE and RBC RAB Tables) then RBC shall compose the CBCn_DESTROY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-1';
  - 2> if the 'Failure Cause' IE is not "Invalid BCnID" then RBC shall compose the RL_RELEASE_REJ primitive and send it to Relay (via RSR). The RBC state shall change to 'CONNECTED'.

If timer TR9 expires before the RBC:ReleaseAck or RBC:ReleaseReject PDU is received, then RBC shall compose the RL_RELEASE_REJ primitive and send it to Relay (via RSR). The RBC state shall change to 'CONNECTED'.

6.4.4.10.5 Behaviour in State 'CONNECTED-AWAIT-ESTABLISH-ACK'

On receipt of the SSR_SIGDATA_IND primitive from SSR, RBC shall unpack the encapsulated RBC PDU from the peer entity in the UE and examine the AL Signal Type IE:

- 1> If the PDU type is RBC:EstablishAck and if ciphering is enabled then RBC shall stop timer TR7. REGM shall compose the RBC_CK_INFO_REQ primitive and send it to GMMH or MMH. The RBC state shall change to 'CONNECTED-AWAIT-KEYS'.
- 1> If the PDU type is RBC:EstablishAck and if ciphering is not enabled then RBC shall stop timer TR7 and instruct the BCn layer to start processing incoming data. REGM shall compose the RL_ESTABLISH_ACK primitive and send it to Relay via RSR:
  - 2> PS Domain only: RBC shall compose the CPDCP_CONFIG_REQ primitive and send it to PDCP. The RBC state shall change to 'CONNECTED'.
  - 2> CS Domain only: RBC shall compose the CSH_CONFIG_REQ primitive and send it to CSH. The RBC state shall change to 'CONNECTED'.
- 1> If the PDU type is RBC:EstablishReject then RBC shall stop timer TR7. REGM shall compose the CBCn_DESTROY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-4'.

If timer TR7 expires before the RBC:EstablishAck or RBC:EstablishReject PDU is received, then RBC shall compose the CBCn_DESTROY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-4'.

6.4.4.10.6 Behaviour in State 'CONNECTED-AWAIT-DESTROY'

6.4.4.10.6.0 General

This state has five numbered substates.

6.4.4.10.6.1 Behaviour in State 'CONNECTED-AWAIT-DESTROY-1'

On receipt of the CBCn_DESTROY_CNF primitive from CBCn via CSR, RBC shall remove the corresponding entry from the RAB Table. RBC shall compose the RL_RELEASE_ACK primitive and send it to Relay (via RSR):

- 1> PS Domain only: RBC shall compose the CPDCP_RELEASE_REQ primitive and send it to PDCP. The RBC state shall change to 'CONNECTED'.
- 1> CS Domain only: RBC shall compose the CSH_RELEASE_REQ primitive and send it to CSH. The RBC state shall change to 'CONNECTED'.

6.4.4.10.6.2 Behaviour in State 'CONNECTED-AWAIT-DESTROY-2'

On receipt of the CBCn_DESTROY_CNF primitive from CBCn via CSR, RBC shall remove the corresponding entry from the RAB Table:

- 1> PS Domain only: RBC shall compose the CPDCP_RELEASE_REQ primitive and send it to PDCP. The RBC state shall change to 'CONNECTED'.
- 1> CS Domain only: RBC shall compose the CSH_RELEASE_REQ primitive and send it to CSH. The RBC state shall change to 'CONNECTED'.

6.4.4.10.6.3 Behaviour in State 'CONNECTED-AWAIT-DESTROY-3'

On receipt of the CBCn_DESTROY_CNF primitive from CBCn via CSR, RBC shall remove the corresponding entry from the RAB Table. RBC shall compose the RBC:Release PDU with the 'Release Cause' IE set to "RNC Security Failure" and send it to the SSR for transmission to the peer RBC entity in the UE using the SSR_SIGDATA_REQ primitive. The RBC shall also compose RL_ESTABLISH_REJ primitive and send it to Relay via RSR. The RBC state shall change to 'CONNECTED'.

6.4.4.10.6.4 Behaviour in State 'CONNECTED-AWAIT-DESTROY-4

On receipt of the CBCn_DESTROY_CNF primitive from CBCn via CSR, RBC shall remove the corresponding entry from the RAB Table. RBC shall compose the RL_ESTABLISH_REJ primitive and send it to Relay (via RSR). The RBC state shall change to 'CONNECTED'.

6.4.4.10.6.5 Behaviour in State 'CONNECTED-AWAIT-DESTROY-5'

On receipt of the CBCn_DESTROY_CNF primitive from CBCn via CSR, RBC shall remove the corresponding entry from the RAB Table:

- 1> PS Domain only: RBC shall compose the CPDCP_RELEASE_REQ primitive and send it to PDCP. The RBC state shall change to 'IDLE'.
- 1> CS Domain only: RBC shall compose the CSH_RELEASE_REQ primitive and send it to CSH. The RBC state shall change to 'IDLE'.

6.4.4.10.7 Behaviour in State 'CONNECTED-AWAIT-KEYS'

On receipt of the RBC_CK_INFO_RSP primitive from GMMH or MMH, RBC shall compose the CBCn_SECURITY_REQ primitive and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-SECURITY'.

6.4.4.10.8 Behaviour in State 'CONNECTED-AWAIT-SECURITY'

On receipt of the CBCn_SECURITY_CNF primitive from CBCn (via CSR), RBC shall compose the RL_ESTABLISH_ACK primitive and send it to Relay (via RSR). The RBC state shall change to 'CONNECTED' and instruct the BCn layer to start processing incoming data. In addition, for the PS Domain only, RBC shall compose the CPDCP_CONFIG_REQ primitive and send it to PDCP. For the CS Domain only, RBC shall compose the CSH_CONFIG_REQ primitive and send it to CSH.

On receipt of the CBCn_SECURITY_REJ primitive from CBCn (via CSR), RBC shall compose the CBCn_DESTROY_REQ and send it to CBCn (via CSR). The RBC state shall change to 'CONNECTED-AWAIT-DESTROY-3'.

6.4.4.10.9 Behaviour in State 'CONNECTED-AWAIT-MODIFY'

On receipt of the CBCn_MODIFY_CNF primitive from CBCn (via CSR), RBC shall start timer TR8. REGM shall compose the RBC:Modify PDU and send it to the SSR for transmission to the peer RBC agent in the UE using the SSR_SIGDATA_REQ primitive. The RBC state shall change to 'CONNECTED-AWAIT-MODIFY-ACK'.

On receipt of the CBCn_MODIFY_REJ primitive from CBCn (via CSR), RBC shall compose the RL_MODIFY_REJ primitive and send it to Relay via RSR. The RBC state shall change to 'CONNECTED'.

6.4.4.10.10 Behaviour in State 'CONNECTED-AWAIT-MODIFY-ACK'

On receipt of the SSR_SIGDATA_IND primitive from SSR, RBC shall unpack the encapsulated RBC PDU from the peer entity in the UE and examine the 'AL Signal Type' IE:

- 1> if the PDU type is RBC:ModifyAck then RBC shall stop timer TR8. REGM shall compose the RL_MODIFY_ACK primitive and send it to Relay via RSR. The RBC state shall change to 'CONNECTED';
- 1> if the PDU type is RBC:ModifyReject then RBC shall stop timer TR8. REGM shall compose the RL_MODIFY_REJ primitive and send it to Relay via RSR. The RBC state 'shall change to 'CONNECTED'.

If timer TR8 expires before the RBC:ModifyAck or RBC:ModifyReject PDU is received, then RBC shall compose the RL_MODIFY_REJ primitive and send it to Relay via RSR. The RBC state 'shall change to 'CONNECTED'.

6.4.4.10.11 Common Procedures

RBC PDUs contain a 4-bit 'Transaction ID' IE which allows RBC to associate a response or acknowledgement with a request (for example, RBC:RegisterAck with RBC:Register) and allows multiple requests to be in transit at any one time.

RBC shall maintain a table of the 'Transaction ID' values of RBC PDUs which are awaiting a response. The receipt of a PDU for which the value of the 'Transaction ID' IE does not match any entry in this table shall be considered a protocol error and the PDU shall be discarded.

6.4.4.11 RBC Timers

RBC Timers are as shown in Table 6.29.

Table 6.29: REGM Timers [RNC]

Timer	Default Value	[Min, Max] Value	State	Comments
TR7	15 s	[0, 120 s]	'CONNECTED-AWAIT-ESTABLISH-ACK'	Supervisory Timer for Establish Procedure
TR8	15 s	[0, 120 s]	'CONNECTED-AWAIT-MODIFY-ACK'	Supervisory Timer for Modify Procedure
TR9	15 s	[0, 120 s]	'CONNECTED-AWAIT-RELEASE-ACK'	Supervisory Timer for Release Procedure

6.4.5 SSR

6.4.5.1 Service Primitives at REGM-SIG-SAP

See clause 6.4.1.3.

6.4.5.2 Service Primitives at GMMH-SIG-SAP

See clause 6.4.2.2.

6.4.5.3 Service Primitives at MMH-SIG-SAP

See clause 6.4.3.2.

6.4.5.4 Service Primitives at RBC-SIG-SAP

See clause 6.4.4.3.

6.4.5.5 Service Primitives at SIG-SAP

The Service Primitives at SIG-SAP are as shown in Table 6.30. See ETSI TS 102 744-3-5 [11], clause 6.2 for the definition of the parameter 'AL PDU'. The Message Unit Identifier (MUI) is used to indicate which AL PDU is confirmed by the BCn_AM_DATA_CNF primitive.

Table 6.30: SSR::BCn Service Primitives at SIG-SAP [RNC]

Primitive	Direction	Parameters
BCn_AM_DATA_REQ *SSR requests the BCn layer to send a PDU to its peer in the UE*	To BCn	BCnID, AL PDU, CNF, Discard Req, MUI, SUSP
BCn_AM_DATA_IND *BCn indicates to SSR that it has received a PDU from the peer agent in the UE*	To SSR	AL PDU, Discard Info
BCn_AM_DATA_CNF *BCn confirms to SSR that the peer agent in the UE has received a PDU*	To SSR	Status, MUI

The SSR shall always set the 'CNF' (Confirmation Request) parameter of the BCn_AM_DATA_REQ primitive to "TRUE". The SSR shall set the 'SUSP' (Queue Suspend) parameter of the BCn_AM_DATA_REQ primitive according to the presence and value of the 'SUSP' parameter of the corresponding SSR_SIGDATA_REQ primitive.

6.4.5.6 SSR States

The SSR states are as shown in Table 6.31.

Table 6.31: SSR States [RNC]

Number	State	Description
1	IDLE ★Initial State	The SSR is unable to route messages between the SIG-SAP and AL agents because the SIG-SAP has not been created (i.e. the RNC has not completed the Registration procedure with the UE).
2	CONNECTED	The SSR is able to route messages between the SIG-SAP and AL agents. Integrity Protection is not enabled.
3	CONNECTED-INTEGRITY	The SSR is able to route messages between the SIG-SAP and AL agents. Integrity protection is enabled.

Figure 6.11 contains a signal-state diagram for the SSR in the RNC.

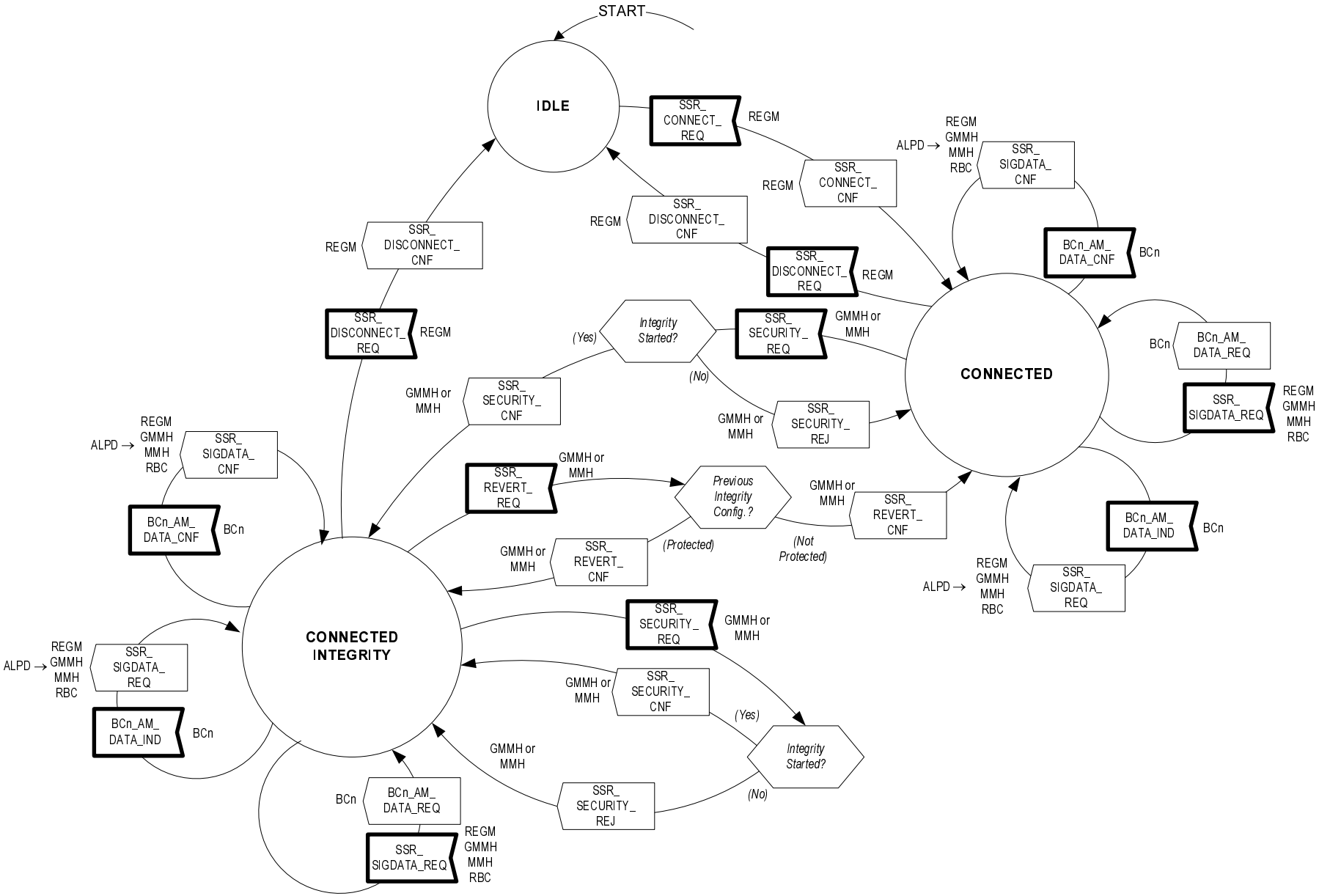

Figure 6.11: SSR Signal-State Diagram

6.4.5.7 SSR Behaviour

6.4.5.7.1 Behaviour in State 'IDLE'

On receipt of the SSR_CONNECT_REQ primitive from REGM, the SSR shall initiate a connection to the specified SIG-SAP (BCnID) and send the SSR_CONNECT_CNF primitive to REGM. The SSR state shall then change to 'CONNECTED'.

6.4.5.7.2 Behaviour in State 'CONNECTED'

On entry to state 'CONNECTED', the SSR shall initialize the Message Unit Identifier (MUI) counter to "0".

On receipt of the SSR_SIGDATA_REQ primitive from any AL agent, the SSR shall increment the MUI by one and compose the AL PDU as shown in Figure 5.18 with the 'Integrity Check Included' IE set to "0". The SSR shall then forward the result to the Bearer Connection Layer using the BCn_AM_DATA_REQ primitive. The SSR shall store the MUI along with the identity of the sending agent in a list of AL PDUs which are awaiting confirmation.

On receipt of the BCn_AM_DATA_IND primitive from the Bearer Connection Layer, the SSR shall decompose the AL PDU as shown in Figure 5.18, and forward the result to the appropriate AL agent on the basis of the ALPD using the SSR_SIGDATA_IND primitive.

On receipt of the BCn_AM_DATA_CNF primitive from the Bearer Connection Layer, SSR shall check the list of AL PDUs which require confirmation and if the 'MUI' parameter of the BCn_AM_DATA_CNF primitive is in the list, then SSR shall remove this MUI from the list and send the SSR_SIGDATA_CNF primitive to the appropriate AL agent.

On receipt of the SSR_SECURITY_REQ primitive from either GMMH or MMH, the SSR shall save the current integrity protection configuration (i.e. not protected) and then start integrity protection using the specified integrity protection algorithm and initialization parameters (see also clause 7.1). The SSR shall then send the SSR_SECURITY_CNF primitive to GMMH or MMH (whichever agent had sent the SSR_SECURITY_REQ primitive). The SSR state shall then change to 'CONNECTED-INTEGRITY'. If the SSR is unable to start integrity protection, then it shall send the SSR_SECURITY_REJ primitive to GMMH or MMH.

On receipt of the SSR_DISCONNECT_REQ primitive from REGM, the SSR shall disconnect from the specified SIG-SAP (BCnID), purge all messages from its transmit and receive queues, and send the SSR_DISCONNECT_CNF primitive to REGM. The SSR state shall then change to 'IDLE'.

6.4.5.7.3 Behaviour in State 'CONNECTED-INTEGRITY'

On receipt of the SSR_SIGDATA_REQ primitive from any AL agent, the SSR shall increment the MUI by one and compose the AL PDU as shown in Figure 5.19 with the 'Integrity Check Included' IE set to "1". The SSR shall perform integrity protection as described in clause 7.1 and append the Message Authentication Code for Integrity (MAC-I) to the AL PDU before forwarding the result to the Bearer Connection Layer using the BCn_AM_DATA_REQ primitive. The SSR shall store the MUI along with the identity of the sending agent in a list of AL PDUs which are awaiting confirmation.

On receipt of the BCn_AM_DATA_IND primitive from the Bearer Connection layer, the SSR shall authenticate the PDU as described in clause 7.1. If the authentication is successful, the SSR shall decompose the PDU as shown in Figure 5.19 and forward the result to the appropriate AL agent on the basis of the ALPD using the SSR_SIGDATA_IND primitive.

On receipt of the BCn_AM_DATA_CNF primitive from the Bearer Connection Layer, SSR shall check the list of AL PDUs which require confirmation and if the MUI 'parameter' of the BCn_AM_DATA_CNF primitive is in the list, then SSR shall remove this MUI from the list and send the SSR_SIGDATA_CNF primitive to the appropriate AL agent.

On receipt of the SSR_SECURITY_REQ primitive from either GMMH or MMH, the SSR shall save the current integrity protection configuration and then restart integrity protection using the new specified integrity protection algorithm and initialization parameters (see also clause 7.1). The SSR shall then send the SSR_SECURITY_CNF primitive to GMMH or MMH (whichever agent had sent the SSR_SECURITY_REQ primitive). The SSR state shall then change to 'CONNECTED-INTEGRITY'. If the SSR is unable to start integrity protection, then it shall send the SSR_SECURITY_REJ primitive to GMMH or MMH and the SSR state shall change to 'CONNECTED-INTEGRITY'.

On receipt of the SSR_DISCONNECT_REQ primitive from REGM, the SSR shall disconnect from the specified SIG-SAP (BCnID), purge all messages from its transmit and receive queues, and send the SSR_DISCONNECT_CNF primitive to REGM. The SSR state shall then change to 'IDLE'.

On receipt of the SSR_REVERT_REQ primitive from either GMMH or MMH, the SSR shall discard the current configuration and restore the old (previously saved) integrity protection configuration. The SSR shall then send the SSR_REVERT_CNF primitive to GMMH or MMH (whichever agent had sent the SSR_REVERT_REQ primitive). The SSR state shall then change to 'CONNECTED-INTEGRITY' (unless the old configuration was no integrity protection, in which case the state shall change to 'CONNECTED' instead).

6.4.6 CSR

6.4.6.1 Service Primitives at REGM-CBCn-SAP

See clause 6.4.1.5.

6.4.6.2 Service Primitives at GMMH-CBCn-SAP

See clause 6.4.2.6.

6.4.6.3 Service Primitives at MMH-CBCn-SAP

See clause 6.4.3.5.

6.4.6.4 Service Primitives at RBC-CBCn-SAP

See clause 6.4.4.6.

6.4.6.5 Service Primitives at CBCn-SAP

The service primitives at CBCn-SAP are as shown in Table 6.32.

Table 6.32: CSR::BCn Service Primitives at CBCn-SAP [RNC]

Primitive	Direction	Parameters
CBCn_CREATE_REQ *AL agent (via CSR) requests the BCn layer to create the SIG-SAP or DATA-SAP with the specified handle (BCnID) and QoS attributes.*	To BCn	ALPD, BCnID (SIG-SAP/DATA-SAP), BCn/AL Parameter List
CBCn_CREATE_CNF *Response to CBCn_CREATE_REQ. BCn layer confirms that the SIG-SAP or DATA-SAP with the specified handle (BCnID) has been created.*	To CSR	ALPD, BCnID, BCtID, {BCt EPDU} OPTIONAL
CBCn_CREATE_REJ *Response to CBCn_CREATE_REQ. BCn layer confirms that the SIG-SAP or DATA-SAP with the specified handle (BCnID) has not been created for the specified reason.*	To CSR	ALPD, BCnID, Rejection Cause
CBCn_MODIFY_REQ *AL agent (via CSR) requests the BCn layer to modify the QoS attributes of the specified SIG-SAP or DATA-SAP (BCnID).*	To BCn	ALPD, BCnID (SIG-SAP/DATA-SAP), BCn/AL Parameter List
CBCn_MODIFY_CNF *Response to CBCn_MODIFY_REQ. BCn layer confirms that the QoS attributes of the specified SIG-SAP or DATA-SAP (BCnID) have been modified.*	To CSR	ALPD, BCnID, BCtID, {BCt EPDU} OPTIONAL
CBCn_MODIFY_REJ *Response to CBCn_MODIFY_REQ. BCn layer confirms that the QoS attributes of the specified SIG-SAP or DATA-SAP (BCnID) have not been modified for the specified reason.*	To CSR	ALPD, BCnID, Rejection Cause
CBCn_DESTROY_REQ *AL agent (via CSR) requests the BCn layer to destroy the SIG-SAP or DATA-SAP(s) with the specified handle(s) (BCnID)*	To BCn	ALPD, SEQUENCE OF {BCnID (SIG-SAP/DATA-SAP)}
CBCn_DESTROY_CNF *Response to CBCn_DESTROY_REQ. BCn layer confirms that the SIG-SAP or DATA-SAP(s) with the specified handle(s) (BCnID) has (have) been destroyed.*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_SECURITY_REQ *AL agent (via CSR) requests BCn to start, or modify ciphering for all PDUs received at the indicated SAPs (BCnID).*	To BCn	ALPD, Mode (Start/ Modify), CK, START, SEQUENCE OF {BCnID, UL Activation Time, DL Activation Time}
CBCn_SECURITY_CNF	To CSR	ALPD, SEQUENCE OF {BCnID}

Primitive	Direction	Parameters
Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated SAPs (BCnID) has been started/modified.		
CBCn_SECURITY_REJ *Response to CBCn_SECURITY_REQ. BCn confirms that ciphering for all PDUs received at the indicated SAPs (BCnID) has not been started/modified for the specified reason.*	To CSR	ALPD, SEQUENCE OF {BCnID}, Rejection Cause-
CBCn_HANDOVER_REQ *UE-Initiated Handover Procedure: AL agent requests the BCn layer(via CSR) to initiate the intra-RNC handover procedure on behalf of the peer agent in the UE.* *Lease Mode Handover Procedure: AL agent requests the BCn layer (via CSR) to determine if a bearer assigned to the Lease Group specified by the UE is available, and if so initiate the intra-RNC handover procedure.*	To BCn	ALPD, BCnID, Observe Target Preference, Target Spot Beam List, Lease Group ID, Elevation Angle
CBCn_HANDOVER_IND *The BCn layer indicates to an AL agent (via CSR) that the intra-RNC handover procedure has been initiated by the lower layers (Bearer Connection/Bearer Control) and requests the AL agent to inform the peer REGM entity in the UE.*	To CSR	ALPD, BCtID, BCt EPDU
CBCn_HANDOVER_RSP *Response to CBCn_HANDOVER_IND. AL agent informs the BCn layer (via CSR) that the handover procedure in the UE has been completed.*	To BCn	ALPD, BCnID
CBCn_HANDOVER_REJ *Response to CBCn_HANDOVER_REQ. AL agent indicates to the BCn layer (via CSR) that the handover procedure in the UE has not been completed.*	To BCn	ALPD, BCnID, Rejection Cause
CBCn_FAILURE_IND *BCn indicates a failure of the specified bearer connection to an AL agent (via CSR).*	To CSR	ALPD, BCnID, Failure Cause
CBCn_SUSPEND_REQ *AL agent (via CSR) requests BCn to suspend the indicated connections (UE Specific Signalling connection and all CS domain RABs).*	To BCn	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_CNF *Response to CBCn_SUSPEND_REQ. BCn confirms to AL agent (via CSR) that the indicated connections are suspended.*	To CSR	ALPD, SEQUENCE OF {BCnID, Next BCn Send Sequence Number}
CBCn_RESUME_REQ *AL agent (via CSR) requests BCn to resume the indicated connections (UE Specific Signalling connection and all PS domain RABs).*	To BCn	ALPD, SEQUENCE OF {BCnID}
CBCn_SUSPEND_REJ *Response to CBCn_SUSPEND_REQ. BCn indicates to AL agent that one or more connections have not been suspended.*	To CSR	ALPD, SEQUENCE OF {BCnID}
CBCn_RESUME_CNF *Response to CBCn_RESUME_REQ. BCn confirms to AL agent (via CSR) that the indicated connections have resumed.*	To CSR	ALPD, SEQUENCE OF {BCnID}

6.4.6.6 CSR Behaviour

Figure 5.20 contains a signal-state diagram for the CSR in the RNC. The CSR is a transparent routing function. All primitives received from any Adaptation Layer agent are forwarded to the CBCn-SAP without modification; primitives received from the CBCn-SAP are routed to the correct Adaptation Layer agent on the basis of the ALPD parameter of the primitive.

6.4.7 RSR

6.4.7.1 Service Primitives at REGM-RL-SAP

See clause 6.4.1.6.

6.4.7.2 Service Primitives at GMMH-RL-SAP

See clause 6.4.2.3.

6.4.7.3 Service Primitives at MMH-RL-SAP

See clause 6.4.3.3.

6.4.7.4 Service Primitives at RBC-RL-SAP

See clause 6.4.4.4.

6.4.7.5 Service Primitives at RL-SAP

The service primitives at RL-SAP are as shown in Table 6.33.

Table 6.33: RSR::RELAY Service Primitives at RL-SAP [RNC]

Primitive	Direction	Parameters
RL_PAGING	To RSR	BCnID, ALPD, UE NAS ID, Paging Cause, CN Domain Identity
RL_SIGNAL_CONN_REL	To RSR	BCnID, ALPD, Cause, CN Domain Identity
RL_ SIGNAL_CONN_REL_REQ	To RELAY	BCnID, ALPD, Cause, CN Domain Identity
RL_NEW_BCNID	To RELAY	BCnID, ALPD, UE NAS ID, CN Domain Identity
RL_UPDATE_UE_NAS_ID	To RSR	BCnID, ALPD, UE NAS ID
RL_INIT_DIRECT_TRANSFER	To RELAY	BCnID, ALPD, LAI, SAI, RAC, CN Domain Identity, NAS Message
RL_UL_DIRECT_TRANSFER	To RELAY	BCnID, ALPD, LAI, SAI, RAC, CN Domain Identity, NAS Message
RL_DL_DIRECT_TRANSFER	To RSR	BCnID, ALPD, CN Domain Identity, SAPI, NAS Message
RL_SECURITY_MODE_COMMAND	To RSR	BCnID, ALPD, Integrity Protection Info, Ciphering Info, Key Status
RL_SECURITY_MODE_COMPLETE	To RELAY	BCnID, ALPD, Integrity Protection Activation Info, Ciphering Activation Info
RL_SECURITY_MODE_REJECT	To RELAY	BCnID, ALPD, Cause
RL_ESTABLISH	To RSR	BCnID, ALPD, RAB ID, NAS Synchronization Indicator, User Plane Information, Transport Layer Information, PDP Type Info, RAB Parameters, DL GTP Sequence Number, UL GTP Sequence Number
RL_ESTABLISH_ACK	To RELAY	BCnID, ALPD, RAB ID, Transport Layer Info, Iu Transport Association, Data Volume Report
RL_ESTABLISH_REJ	To RELAY	BCnID, ALPD, RAB ID, Cause
RL_MODIFY	To RSR	BCnID, ALPD, RAB ID, NAS Synchronization Indicator, RAB Parameters, Transport Layer Information
RL_MODIFY_ACK	To RELAY	BCnID, ALPD, RAB ID, Transport Layer Info, Iu Transport Association, Data Volume Report
RL_MODIFY_REJ	To RELAY	BCnID, ALPD, RAB ID, Cause
RL_RELEASE	To RSR	BCnID, ALPD, RAB ID, Cause, Data Volume Report Indicator
RL_RELEASE_ACK	To RELAY	BCnID, ALPD, RAB ID
RL_RELEASE_REJ	To RELAY	BCnID, ALPD, RAB ID, Cause
RL_RAB_RELEASE_REQ	To RELAY	BCnID, ALPD, RAB ID, Cause
RL_RESET	Both	BCnID, ALPD, Cause, CN Domain Identity, Global RNC ID
RL_RESET_ACK	Both	ALPD, CN Domain Identity
RL_RESET_RESOURCE	Both	BCnID, ALPD, Cause, CN Domain Identity, Global RNC ID
RL_RESET_RESOURCE_ACK	Both	ALPD, CN Domain Identity

6.4.7.6 RSR Behaviour

Figure 6.12 contains a signal-state diagram for the RSR in the RNC. The RSR is a transparent routing function. All primitives received from any Adaptation Layer agent are forwarded to the RL-SAP without modification; primitives received from the RL-SAP are routed to the correct Adaptation Layer agent on the basis of the ALPD and BCnID parameters of the primitive.

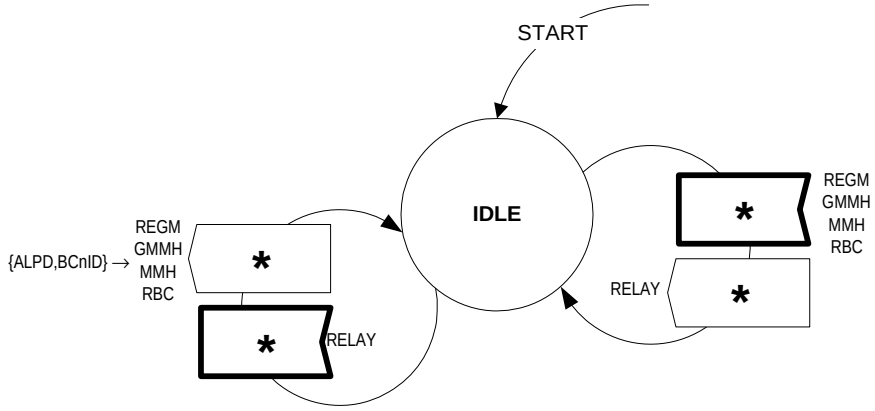

Figure 6.12: RNC RSR Signal-State Diagram

7 Adaptation Layer Security Functions

7.1 Integrity Protection

7.1.0 General

The Adaptation Layer uses the UMTS Integrity Algorithm (UIA) f9 as defined in ETSI TS 133 102 [4] and ETSI TS 133 105 [5] to authenticate AL PDUs transmitted over the radio interface via the UE-Specific Signalling Connection (via the SIG-SAP). A centralized integrity protection function resides within the SIG-SAP router (SSR). GMMH and MMH in the Adaptation Layer both control and configure the integrity protection function in the SSR.

7.1.1 UIA Input Parameters

7.1.1.1 IK (INTEGRITY KEY)

The integrity key is 128 bits long. There are two integrity keys, one for the PS service domain (IK_{PS}) and one for the CS service domain (IK_{CS}). The Integrity Key, IK, which is used for integrity protection depends on which service domain initiates the integrity protection.

7.1.1.2 COUNT-I

The integrity sequence number COUNT-I has length 32 bits. SSR maintains separate COUNT-I parameters for messages transmitted (COUNT-I_{TX}) and messages received (COUNT-I_{RX}). SSR increments COUNT-I_{TX} by one immediately after a message which requires integrity protection is received from any AL agent via the SSR_SIGDATA_REQ primitive. Similarly, SSR increments COUNT-I_{RX} by one immediately after a message which requires integrity checking is received from the Bearer Control layer via the AL_SIGDATA_IND primitive.

The initial value of COUNT-I depends on the value $START_{CS}$ or $START_{PS}$ (depending on which service domain initiates the integrity protection); see clause 7.3.2. The 20 most significant bits of COUNT-I are initialized to the value START, the remaining 12 least significant bits are initialized to zero. SSR initializes COUNT-I whenever it receives the SSR_SECURITY_REQ primitive from GMMH or MMH.

The Adaptation Layer Message Sequence Number (AL MSN) is defined as the four least significant bits of COUNT-I. Since COUNT-I is different in each direction, the AL MSN will also be different in each direction. A consequence of the above rules for initializing and incrementing COUNT-I and the definition of the AL MSN is that whenever a new integrity protection configuration is initialized, the first PDU to be protected by the new configuration will have an AL MSN equal to "1".

7.1.1.3 FRESH

FRESH is a random 32-bit number. There is a different random FRESH parameter value associated with each UE-Specific Signalling connection; FRESH is generated by REGM when the UE Specific Signalling (UESS) is created (at registration) and it is used by both the RNC and UE throughout the lifetime of the connection (until deregistration).

7.1.1.4 DIRECTION

DIRECTION is a 1-bit parameter which has the value 0 for messages from the UE to RNC and 1 for messages from the RNC to UE.

7.1.1.5 MESSAGE

The definition of the parameter MESSAGE is illustrated in Figure 7.1 (see also ETSI TS 102 744-3-5 [11]).

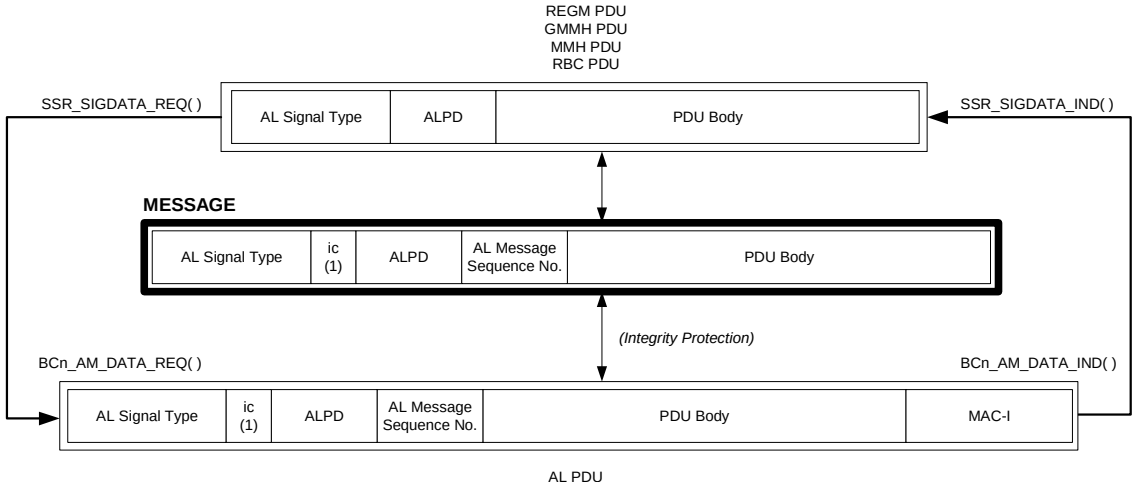

Figure 7.1: Definition of MESSAGE Parameter

The maximum length of the MESSAGE parameter is [X19]-1 octets (the variable X19 is defined in [5]).

7.1.2 Method

On receipt of the SSR-SIGDATA-REQ primitive from any AL agent, the (sending) SSR increments COUNT-I $_{TX}$ by one, composes the MESSAGE as shown in Figure 7.2, and computes the Message Authentication Code for Integrity (MAC-I) using the integrity algorithm f9 and the input parameters IK, COUNT-I, FRESH, DIRECTION, and MESSAGE. SSR then appends the MAC-I parameter to the MESSAGE before forwarding the AL PDU to the Bearer Connection Layer via the BCn_AM_DATA_REQ primitive.

On receipt of the BCn_AM_DATA_IND primitive from the SIG-SAP, the (receiving) SSR increments COUNT-I $_{RX}$ by one, removes the MAC-I parameter from the end of the AL PDU, and computes XMAC-I on the remaining MESSAGE in the same way as the sending AL agent computed MAC-I. If the calculated XMAC-I and received MAC-I are the same, then SSR shall decompose the MESSAGE as shown in Figure 7.2 and forward the result to the correct AL agent (on the basis of the ALPD) using the SSR_SIGDATA_IND primitive; otherwise the MESSAGE shall be discarded.

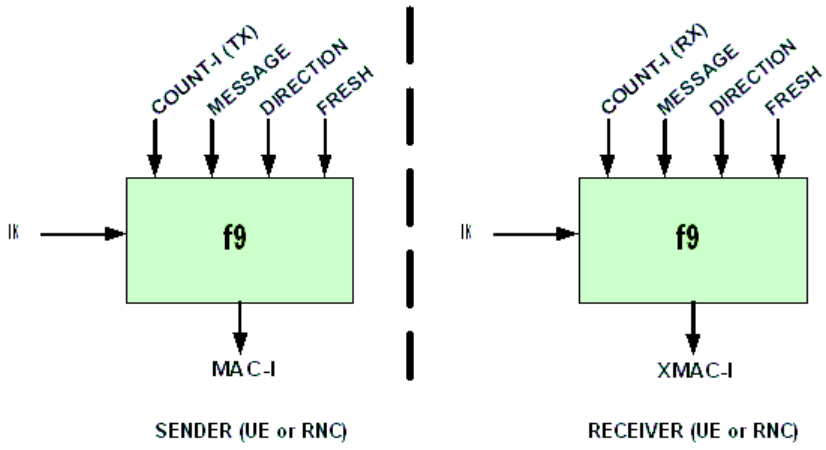

Figure 7.2: Computation of Message Authentication Code (adapted from ETSI TS 133 105, Figure 2 [5])

7.2 Ciphering Control

The Bearer Connection Layer uses a modified version of the UMTS Encryption Algorithm (UEA) f8 as defined in ETSI TS 133 102 [4] and ETSI TS 133 105 [5] to cipher AL PDUs transmitted over the radio interface via the UE-Specific Signalling Connection (via the SIG-SAP). GMMH and MMH in the Adaptation Layer both control and configure the ciphering function in the Bearer Connection Layer for the SIG-SAP. See clause 7.3 and also ETSI TS 102 744-3-4 [10].

7.3 Security Mode Set-Up Procedure

7.3.1 Common Procedure

The security set-up procedure in the Adaptation Layer is illustrated in Figure 7.3 and described in the text which follows.

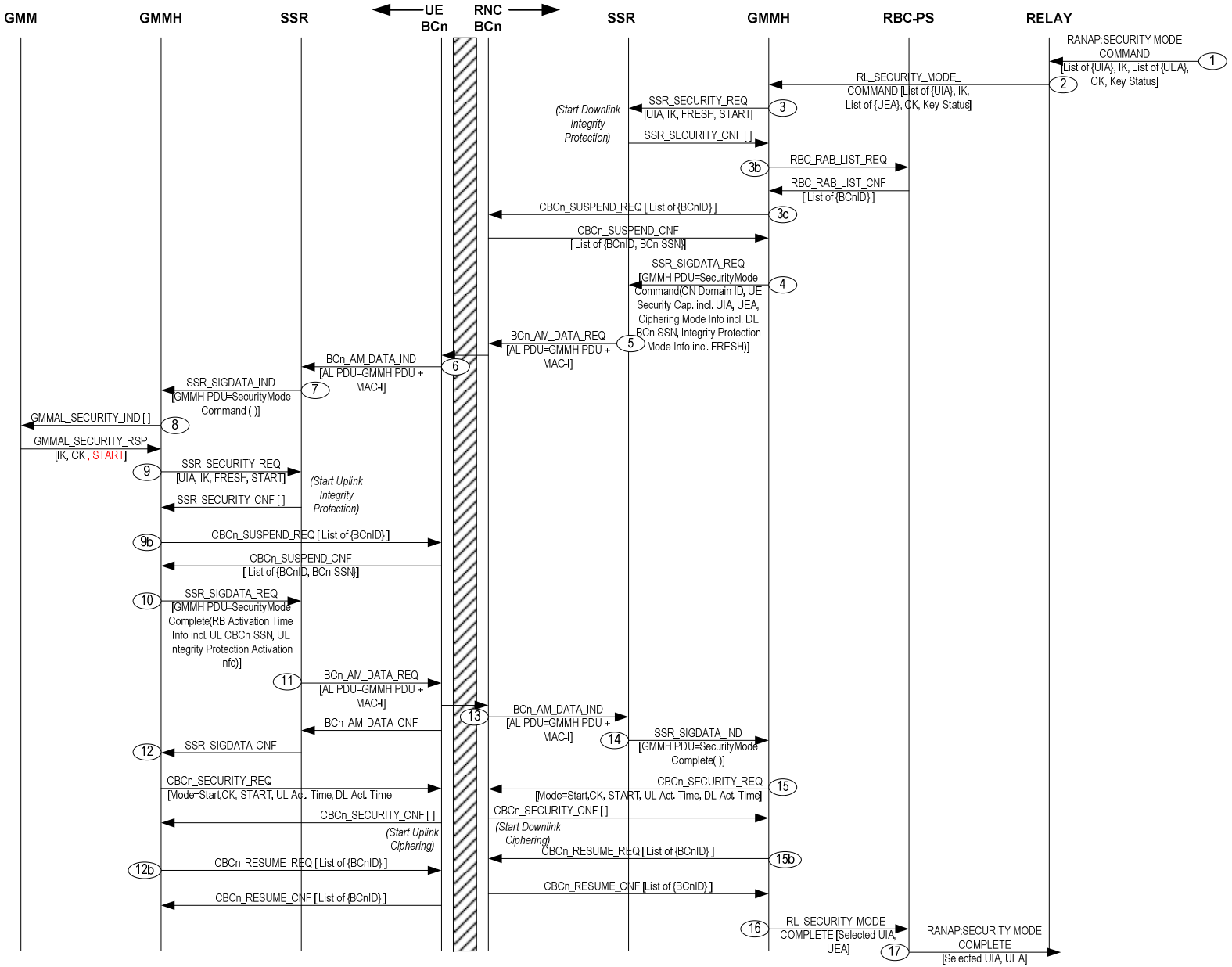

Figure 7.3: Security Mode Set-Up Procedure

1) The Visitor Location Register (VLR) or SGSN initiates the security mode (integrity protection and optionally ciphering) by sending the RANAP:Security Mode Command message to the SRNC. The message contains a list of the permitted integrity algorithms and the integrity key, IK, to be used (either IK_{PS} if the SGSN initiates security or IK_{CS} if the VLR initiates security). If ciphering is to be started, then the message also contains a list of the permitted ciphering algorithms and the ciphering key, CK, to be used (either CK_{PS} or CK_{CS}). The Key Status IE in the RANAP:Security Mode Command message also indicates whether or not a new set of integrity keys have been generated.

2) The RNC RELAY function provides the integrity protection information from the RANAP:Security Mode Command message to the RNC Adaptation Layer in the RL_SECURITY_MODE_COMMAND primitive from the RL-SAP. The receiving AL agent depends on the service domain which initiated the integrity protection. GMMH receives the indication if the SGSN initiated security; MMH receives the indication if the VLR initiated security.

   (The remainder of this description assumes integrity protection and ciphering are initiated by the SGSN.)

   GMMH selects an integrity algorithm (UIA) and a ciphering algorithm (UEA) that are present in both the list of permitted algorithms and the list of algorithms supported by the UE. If the key status information indicates that a new set of integrity keys have been generated, then GMMH resets the value of $START_{PS}$ (see clause 7.3.2).

3) GMMH sends the SSR_SECURITY_REQ primitive to SSR, which includes the selected UIA and the values of IK_{PS}, FRESH, and $START_{PS}$. In response, the SSR initializes and starts the UIA using the specified integrity protection configuration parameters and sends the SSR_SECURITY_CNF primitive to GMMH.

3b) GMMH next sends the RBC_RAB_LIST_REQ primitive to RBC-PS. In response, RBC-PS sends the RBC_RAB_LIST_CNF primitive to GMMH, identifying all of the active Radio Access Bearers (RAB) in the PS domain by BCnID.

3c) GMMH next suspends all PS domain RABs **and** the UE-Specific Signalling connection by sending the CBCn_SUSPEND_REQ primitive to the Bearer Connection layer. The Bearer Connection layer responds with the CBCn_SUSPEND_CNF primitive which contains the next Bearer Connection Send Sequence Number (BCn SSN) to be used for each connection which is now suspended. GMMH shall increment the BCn SSN for the UE-Specific Signalling connection by one.

4) GMMH composes the GMMH:SecurityModeCommand message which includes the UE Security Capability, the UIA and UEA algorithms selected by GMMH, Ciphering Mode Info including the downlink ciphering activation times (next BCn SSN) for the UE-Specific Connection and each active PS domain RAB, and Integrity Protection Mode Info, including the value of FRESH. GMMH sends the PDU to SSR using the SSR_SIGDATA_REQ primitive.

5) SSR integrity protects the GMMH PDU using the method described in clause 7.1.2 (the AL MSN associated with this PDU will be equal to "1"). The resulting Adaptation Layer PDU is forwarded to the Bearer Connection layer for transmission over the radio interface using the BCn_AM_DATA_REQ primitive at the SIG-SAP.

6) The Bearer Connection Layer in the UE delivers the GMMH PDU to the SSR using the BCn_AM_DATA_IND primitive.

7) The UE SSR unpacks the Adaptation Layer PDU and forwards the GMMH PDU to GMMH using the SSR_SIGDATA_IND primitive.

8) GMMH sends the GMMAL_SECURITY_IND primitive to GMM in the Non-Access Stratum, indicating that integrity protection and ciphering are to be started. In response, GMM provides GMMH with the ciphering and integrity keys, CK_{PS} and IK_{PS}, and the current value of $START_{PS}$ in the GMMAL_SECURITY_RSP primitive.

9) GMMH sends the SSR_SECURITY_REQ primitive to SSR, which includes the selected UIA and the values of IK_{PS}, FRESH, and $START_{PS}$. In response, the SSR initializes and starts the UIA using the specified integrity protection configuration parameters and sends the SSR_SECURITY_CNF primitive to GMMH.

9b) GMMH next suspends all of the connections identified in the GMMH:SecurityModeCommand PDU (i.e. PS domain RABs **and** the UE-Specific Signalling connection) by sending the CBCn_SUSPEND_REQ primitive to the Bearer Connection layer. The Bearer Connection layer responds with the CBCn_SUSPEND_CNF primitive which contains the next Bearer Connection Send Sequence Number (BCn SSN) to be used for each connection which is now suspended. GMMH shall increment the BCn SSN for the UE-Specific Signalling connection by one.

10) GMMH composes the GMMH:SecurityModeComplete message which includes RB Activation Time Info including the uplink ciphering activation times (next BCn SSN) for the UE-Specific Connection and each active PS domain RAB, and UL Integrity Protection Mode Info. GMMH sends the PDU to the SSR using the SSR_SIGDATA_REQ primitive.

11) SSR protects the GMMH PDU using the method described in clause 7.1.2 (the AL MSN associated with this PDU will be equal to "1"). The Adaptation Layer PDU is forwarded to the Bearer Connection layer for transmission over the radio interface using the BCn_AM_DATA_REQ primitive at the SIG-SAP.

12) On receipt of the SSR_SIGDATA_CNF primitive from SSR, GMMH enables ciphering by sending the CBCn_SECURITY_REQ primitive to the Bearer Connection Layer (via the CSR). The primitive includes the ciphering key, CK, to be used, and the parameter $START_{PS}$. In response, the Bearer Connection Layer initializes and starts the UEA using the specified ciphering parameters and sends the CBCn_SECURITY_CNF primitive to GMMH.

12b) GMMH allows all PS domain RABs **and** the UE-Specific Signalling connection to resume by sending the CBCn_RESUME_REQ primitive to the Bearer Connection layer. The Bearer Connection layer responds with the CBCn_RESUME_CNF primitive.

13) The Bearer Connection Layer in the RNC delivers the Adaptation Layer PDU to the SSR using the BCn_AM_DATA_IND primitive.

14) The RNC SSR then unpacks the Adaptation Layer PDU and authenticates it using the method described in clause 7.1.2. If authentication is successful, the SIG-SAP router forwards the GMMH PDU to GMMH using the SSR_SIGDATA_IND primitive.

15) GMMH enables ciphering by sending the CBCn_SECURITY_REQ primitive to the Bearer Connection Layer (via the CSR). The primitive includes the ciphering key, CK, to be used, and the parameter $START_{PS}$. In response, the Bearer Connection Layer initializes and starts the UEA using the specified ciphering parameters and sends the CBCn_SECURITY_CNF primitive to GMMH.

15b) GMMH allows all PS domain RABs **and** the UE-Specific Signalling connection to resume by sending the CBCn_RESUME_REQ primitive to the Bearer Connection layer. The Bearer Connection layer responds with the CBCn_RESUME_CNF primitive.

16) GMMH sends the RL_SECURITY_MODE_COMPLETE primitive to the RL-SAP, indicating the chosen ciphering and integrity protection algorithms. Arrival of this primitive at the RL-SAP results in the transmission of the RANAP:Security Mode Complete message from the SRNC to the SGSN.

17) When the SGSN receives the RANAP:Security Mode Complete message, the Security Mode Set-Up procedure is completed.

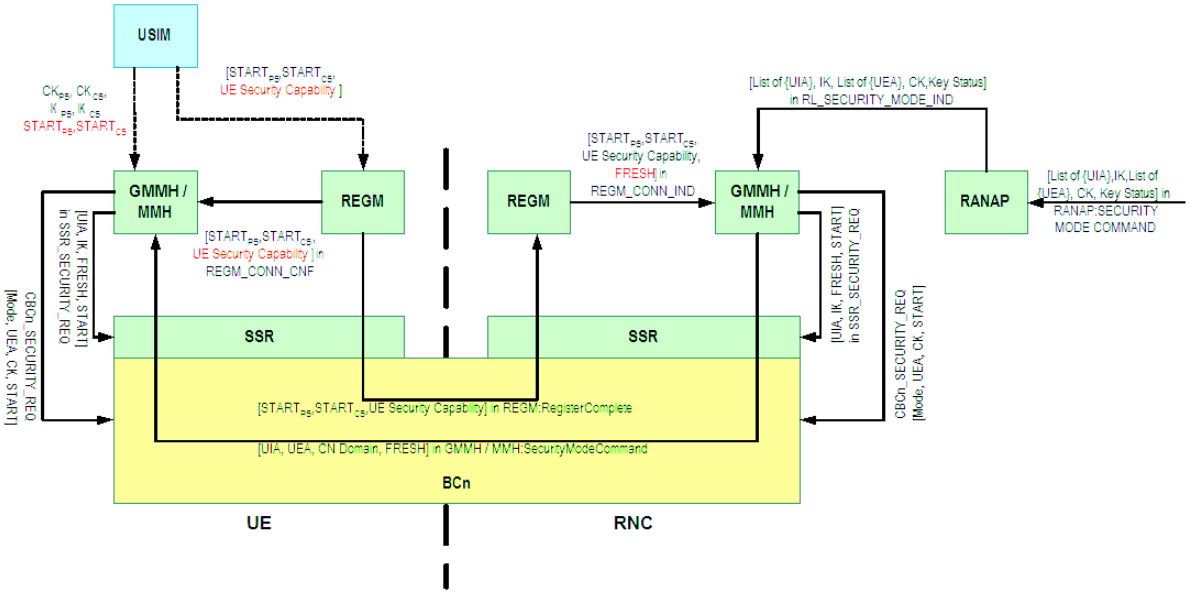

Figure 7.4: Security Parameter Flow in Adaptation Layer

7.3.2 Initialization of Synchronization for Ciphering and Integrity Protection

This section contains a summary of clause 6.4.8 of ETSI TS 133 102 [4], changed where required for the satellite network context. See also Figure 7.4.

The ciphering and integrity protection algorithms are driven by counters (COUNT-C and COUNT-I) that at connection establishment need to be initialized. For that purpose the UMTS Subscriber Identity Module (USIM) and the Adaptation Layer (REGM, GMMH, and MMH) have the ability to store a START value. The USIM and the Adaptation Layer store a $START_{CS}$ value for the CS cipher/integrity keys and a $START_{PS}$ value for the PS cipher/integrity keys. The length of START is 20 bits.

When the UE is powered on and a USIM is inserted, the USIM sends its START values to REGM in the Adaptation Layer where they are stored. During the radio interface Registration procedure (to establish the UE-Specific Signalling connection), REGM in the UE sends the $START_{CS}$ and the $START_{PS}$ value to its peer in the RNC in the REGM:RegisterComplete message. REGM then marks the START values in the USIM as invalid by setting $START_{CS}$ and $START_{PS}$ to "THRESHOLD".

REGM in the UE and RNC provide the values of START to GMMH and MMH, and in turn GMMH and MMH use START to initialize integrity protection in the SSR (Adaptation Layer) and ciphering in the Bearer Connection Layer. The 20 most significant bits of COUNT-I (for integrity protection) and COUNT-C (for ciphering) are initialized to the START value of the corresponding service domain; the remaining bits are initialized to "0".

When the UE-Specific Signalling connection is released at the conclusion of the radio interface Deregistration procedure, REGM updates $START_{CS}$ and $START_{PS}$ in the USIM with their "current" values defined as follows:

- the $START_{CS}$ value is defined as the 20 most significant bits of COUNT-I $_{TX}$ or COUNT-I $_{RX}$ (whichever is the greater) for the UE-Specific Signalling connection, incremented by 2. The $START_{CS}$ value is changed only if the current value is greater than the previous value;

- the $START_{PS}$ value is defined as the 20 most significant bits of COUNT-I $_{TX}$ or COUNT-I $_{RX}$ (whichever is the greater) for the UE-Specific Signalling connection, incremented by 2. The $START_{PS}$ value is changed only if the current value is greater than the previous value.

Whenever a new set of keys is generated (during authentication and key agreement, see ETSI TS 133 102 [4]) the START value associated with the new key set of the corresponding service domain is set to "0" in the USIM. GMMH and MMH obtain the current value of START (along with the current integrity protection and ciphering keys) from the NAS every time the RNC initiates the Security Mode Control procedure with the UE.

7.3.3 Common Procedure - RNC Considerations

7.3.3.1 Integrity Protection

Clause 7.3.1 describes the first time the Common Security Mode Command procedure is being performed. A variation to the Common Procedure is required for the second and subsequent times. This variation applies to the RNC only.

When integrity protection is enabled for this first time (i.e. the SSR_SECURITY_REQ primitive is received in SSR state 'CONNECTED'), the RNC SSR protects the GMMH/MMH:SecurityModeCommand PDU with the new integrity protection configuration.

When integrity protection is being modified (i.e. the SSR_SECURITY_REQ primitive is received in SSR state 'CONNECTED-INTEGRITY'), if the RNC SSR protected the GMMH/MMH:SecurityModeCommand PDU with the new integrity protection configuration, it would fail the integrity check at the UE SSR and would therefore be discarded (the UE SSR would expect PDUs to be protected with the old configuration until it processes the GMMH/MMH:SecurityModeCommand PDU).

In order to ensure that the UE can receive the GMMH/MMH:SecurityModeCommand PDU when integrity protection is being modified, the RNC SSR shall protect it with the old configuration. The AL MSN associated with the GMMH/MMH:SecurityModeCommand PDU will be the next MSN in sequence for the old configuration. The GMMH/MMH:SecurityModeComplete PDU will arrive at the RNC SSR protected with the new configuration. Once this PDU is received, the new integrity protection configuration shall take effect (i.e. the next PDU to be sent to the UE will be protected with the new integrity protection configuration and the AL MSN associated with this PDU will be "1").

7.3.3.2 Integrity Protection Activation Failure at UE

If integrity protection activation fails at the UE, and if integrity protection is being enabled for the first time, then the GMMH/MMH:SecurityModeFailure PDU will arrive at the RNC SSR unprotected. Therefore, when integrity protection is being enabled for the first time, the RNC SSR shall be prepared to accept a PDU from the UE which is either unprotected (GMMH/MMH:SecurityModeFailure) or protected with the new integrity protection configuration (GMMH/MMH:SecurityModeComplete).

If integrity protection activation fails at the UE, and if integrity protection is being modified, then the GMMH/MMH:SecurityModeFailure PDU will arrive at the RNC SSR protected with the old configuration and the AL MSN associated with this PDU will be the next in sequence for the old configuration. Therefore, when integrity protection is being modified, the RNC SSR shall be prepared to accept a PDU from the UE which is either protected with the old integrity protection configuration (GMMH/MMH:SecurityModeFailure) or protected with the new integrity protection configuration (GMMH/MMH:SecurityModeComplete).

In either case, on receipt of the GMMH/MMH:SecurityModeFailure PDU, the RNC SSR shall revert to the previous integrity protection configuration.

7.3.3.3 Ciphering Activation Failure at UE

If integrity protection activation is successful, but ciphering activation fails at the UE, then the GMMH/MMH:SecurityModeFailure PDU will arrive at the SSR protected with the new integrity configuration (and the AL MSN associated with this PDU will be "1").

If integrity protection is being modified by the current procedure, then the new integrity protection configuration shall take effect once this PDU is received (i.e. the next PDU to be sent to the UE will be protected with the new integrity protection configuration and the AL MSN associated with this PDU will be "1").

7.4 UE Position Encryption

REGM in the Adaptation Layer shall use the RSA Encryption Scheme - Optimal Asymmetric Encryption Padding (RSAES-OAEP) [6] public key cryptosystem to ensure confidentiality of the UE geographical position in transit over the radio interface. Initially, the satellite network shall use a 640-bit key, but the structure of the REGM:UEPositionRequest and REGM:UEPositionResponse messages allow keys of any length to be used.

The REGM:UEPositionRequest message contains either an index to one of up to 256 elements in an array of pre defined 640-bit RNC public keys (hardcoded in the UE) or a RNC public key of length greater than or equal to 640 bits. The Encryption Key Policy (whether to use pre-defined keys or generated keys, and the frequency of key generation) shall be configurable in the RNC with scope of a Location Area.

On receipt of the REGM:UEPositionRequest message, REGM in the UE shall use the RNC public key referenced by the index or the specified RNC public key to encrypt its position and return the result to the RNC in the REGM:UEPositionResponse message. On receipt of the REGM:UEPositionResponse message, REGM in the RNC shall use the associated private key to decrypt the UE position.

REGM in the UE shall also use the encryption parameters from the REGM:UEPositionRequest parameters whenever it sends an unsolicited REGM:UEPositionResponse message or a REGM:HandoverRequest message. The encryption parameters are valid throughout the lifetime of the UESS (i.e. until deregistration).

8 Spot Beam Selection Algorithm

8.0 General

The Spot Beam Map SDU (System Information) contains information about the boundaries of one or more spot beams in the satellite network. REGM performs spot beam selection using this method only when the Spot Beam Map SDU is present in the current System Information.

The structure of the Spot Beam Map SDU allows a number of different methods of spot beam boundary description; two methods are currently defined and the UE shall be able to interpret both. In the first method ("Great Circle Polygon"), each spot beam is described by a list of vertex coordinates (latitude and longitude). REGM constructs the boundary of the spot beam by connecting the vertices in sequence with great-circle arcs; the resulting spherical polygon is the nominal coverage area of the spot beam. In the second method ("Centre/Radius"), the spot beam boundary is described as a circle (beam centre and radius) in a satellite-centred coordinate system (azimuth and elevation). REGM forms the circle in the satellite-centred coordinate system and projects the result on to the surface of the Earth to determine the nominal coverage area of the spot beam.

REGM shall have access to a source of geographical position information (for example a GPS receiver) so that it can compare its position with each of the spot beam boundaries described in the Spot Beam Map SDU. The present document assumes that the position source is present in the Bearer Control layer and REGM can request the current UE position on demand via the CBCt-SAP. ETSI TS 102 744-3-1 [9] contains advice on the interpretation of the Spot Beam Map SDU data structure.

Spot beam selection algorithms (along with pseudocode) are described in the following clauses but this does not necessarily specify or constrain practical implementations.

8.1 Spot Beam Boundary Generation (Great Circle Polygon)

A great circle is formed by the intersection of the earth with a plane containing the centre of the earth and any two points on the surface of the earth. When a spot beam is described using the Great Circle Polygon method, REGM shall extract the number of vertices (n), and the list of longitude and latitude coordinates $P(\theta, \phi)$ [0,1,…,n-1] from the spot beam map. Before constructing the great circle arcs between vertices, REGM shall "close" the polygon by increasing the number of vertices in polygon P by one and copying the coordinates of the first vertex to the last.

```
n=n+1;
P_THETA[n-1]=P_THETA[0];        # longitude
P_PHI[n-1]=P_PHI[0];        # latitude
```

where:
n = number of vertices in the polygon from spot beam map
P_THETA = array of vertex longitude values (in degrees) from spot beam map
P_PHI = array of vertex latitude values (in degrees) from spot beam map

REGM shall then generate great circle arcs between each pair of adjacent vertices. Rather than generate the great circle arc to infinite precision, REGM shall approximate the great circle arc by calculating 9 intermediate points along each arc and inserting them between each pair of adjacent vertices.

```
for (i=0; i<=n-2; i++) {
    startlong=P_THETA[i];
    startlat=P_PHI[i];
```

```
    endlong=P_THETA[i+1];
    endlat=P_PHI[i+1];

    for (t=0; t<=10; t++) {
        if (t==0) {
            PX_THETA[(10*i)+t]=P_THETA[i];
            PX_PHI[(10*i)+t]=P_PHI[i];
        } elsif (t==10) {
            PX_THETA[(10*i)+t]=P_THETA[i+1];
            PX_PHI[(10*i)+t]=P_PHI[i+1];
        } else {
            sx=cos(startlat)*cos(startlong);
            sy=cos(startlat)*sin(startlong);
            sz=sin(startlat);

            ex=cos(endlat)*cos(endlong);
            ey=cos(endlat)*sin(endlong);
            ez=sin(endlat);

            mags=sqrt((sx^2)+(sy^2)+(sz^2));
            mage=sqrt((ex^2)+(ey^2)+(ez^2));
            dot=(sx*ex)+(sy*ey)+(sz*ez);

            gamma=acos(dot/(mags*mage));
            delta=(t/10)*gamma;

            num=(sin(gamma-delta)*sin(startlat))+(sin(delta)*sin(endlat));

            PX_PHI[(10*i)+t]=asin(num/sin(gamma));

            num=sin(endlong-startlong);
            denom1=(sin(gamma-delta)*cos(startlat))/
             (sin(delta)*cos(endlat));

            denom2=cos(endlong-startlong);

            PX_THETA[(10*i)+t]=atan(num/(denom1+denom2))+ startlong;
        }
    }
}
```

where:
n = number of vertices in the polygon
P_THETA = array of vertex longitude values (in degrees)
P_PHI = array of vertex latitude values (in degrees)
PX_THETA = array of vertex longitude values (in degrees) after expansion
PX_PHI = array of vertex latitude values (in degrees) after expansion

The resulting polygon PX(θ, ϕ) [0,1,…,10n-9] shall be used with the inclusion algorithm described in clause 8.3 to determine if the UE is inside the spot beam boundary.

8.2 Spot Beam Boundary Generation (Centre/Radius)

Satellite-centred azimuth (Az) and elevation (El) are polar angles similar to longitude and latitude, respectively, except the origin of the right-handed Cartesian coordinate system is at the centre of the satellite instead of the centre of the earth. The positive x-axis points in the direction of north, the positive y-axis points in the direction of east, and the positive z-axis points at the subsatellite point (on the surface of the earth). When a spot beam is described using the Centre/Radius method, the UE shall extract the beam centre azimuth and elevation angles (Az, El) and radius R from the spot beam map. Treating satellite-centred azimuth and elevation as if they formed the axes of a two-dimensional Cartesian coordinate system, REGM shall approximate the circle with its centre at the point (Az, El) and radius R as a polygon P with 37 vertices P(Az, El) [0, 1, …, 36].

```
for (i=0; i<=36; i++) {
    P_AZ[i]=(r*cos(10*i))+az
    P_EL[i]=(r*sin(10*i))+el

    if (sqrt(P_AZ[i]^2+P_EL[i]^2) > 8.68413) {
        alpha=atan(P_EL[i]/P_AZ[i]);
        P_AZ[i]=8.68413*cos(alpha);
        P_EL[i]=8.68413*sin(alpha);
    }
}
```

where:
az = azimuth angle to centre of spot beam (in degrees) from spot beam map

```
el = elevation angle to centre of spot beam (in degrees) from spot beam map
r = spot beam radius (in degrees) from spot beam map
P_AZ = array of vertex azimuth values (in degrees)
P_EL = array of vertex elevation values (in degrees)
```

Once the approximating polygon has been formed, REGM shall project the vertices on to the surface of the earth (i.e. convert each vertex of the polygon from satellite-centred azimuth and elevation P(Az, El) [0, 1, …, 36] to longitude and latitude P(θ, ϕ) [0, 1, …, 36]).

```
for (i=0; i<=36; i++) {

    P_EL[i]=90-P_EL[i];
    rsex=sin(P_EL[i])*cos(P_AZ[i]);
    rsey=sin(P_EL[i])*sin(P_AZ[i]);
    rsez=cos(P_EL[i]);

    alpha=acos(rsex);
    beta=180-asin((42242*sin(alpha))/6378);
    gamma=180-alpha-beta;

    d=sqrt((42242^2)+(6378^2)-(2*42242*6378*cos(gamma)));

    rex=42242-(rsex*d);
    rey=(rsey*d);
    rez=(rsez*d);

    P_THETA[i]=atan(rey/rex)+satlong;       # longitude
    P_PHI[i]=90-acos(rez/6378);     # latitude
}
```

where:
satlong = satellite longitude (in degrees, positive values indicate east)
P_THETA = array of vertex longitude values (in degrees)
P_PHI = array of vertex latitude values (in degrees)

The resulting polygon P(θ, ϕ) [0, 1, …, 36] shall be used with the inclusion algorithm described in clause 8.3 to determine if the UE is inside the spot beam boundary.

8.3 Inclusion Algorithm

This algorithm determines whether or not the UE with longitude θ and latitude φ is inside a polygon with k vertices, P(θ, ϕ) [0, 1, …, k-1]. REGM shall assume that longitude and latitude form a Cartesian coordinate system (i.e. lines of constant latitude and lines of constant longitude intersect at right angles) and that the range of latitude values is not restricted to [-90, 90].

The inclusion algorithm considers a "test line" drawn from the UE position in any direction to a point known to be well outside the boundary of the spot beam, for example (θ, 100). Straight lines in the Cartesian longitude-latitude coordinate system are drawn between each consecutive pair of vertices in polygon P(θ, ϕ) [0, 1, …, k-1], and the number of times that the test line crosses any of the boundary line segments is calculated. The UE is inside the spot beam boundary if the total number of boundary crossings is odd and outside the spot beam boundary if the number is even. The inclusion algorithm should be suitable for all simple, closed, polygonal curves and not make any assumptions as to the position of the starting vertex of the polygon (i.e. east-most point) and subsequent order of vertices (i.e. clockwise or anti-clockwise). The algorithm should also be able to handle the special case where the polygon intersects the meridian at 180° W.

A number of algorithms for determining the intersection between line segments are in the public domain (for example, see [i.3]).

9 Signalling Examples

9.1 PLMN/Spot Beam Selection

Figure 9.1 illustrates an example message sequence for PLMN/Spot Beam Selection.

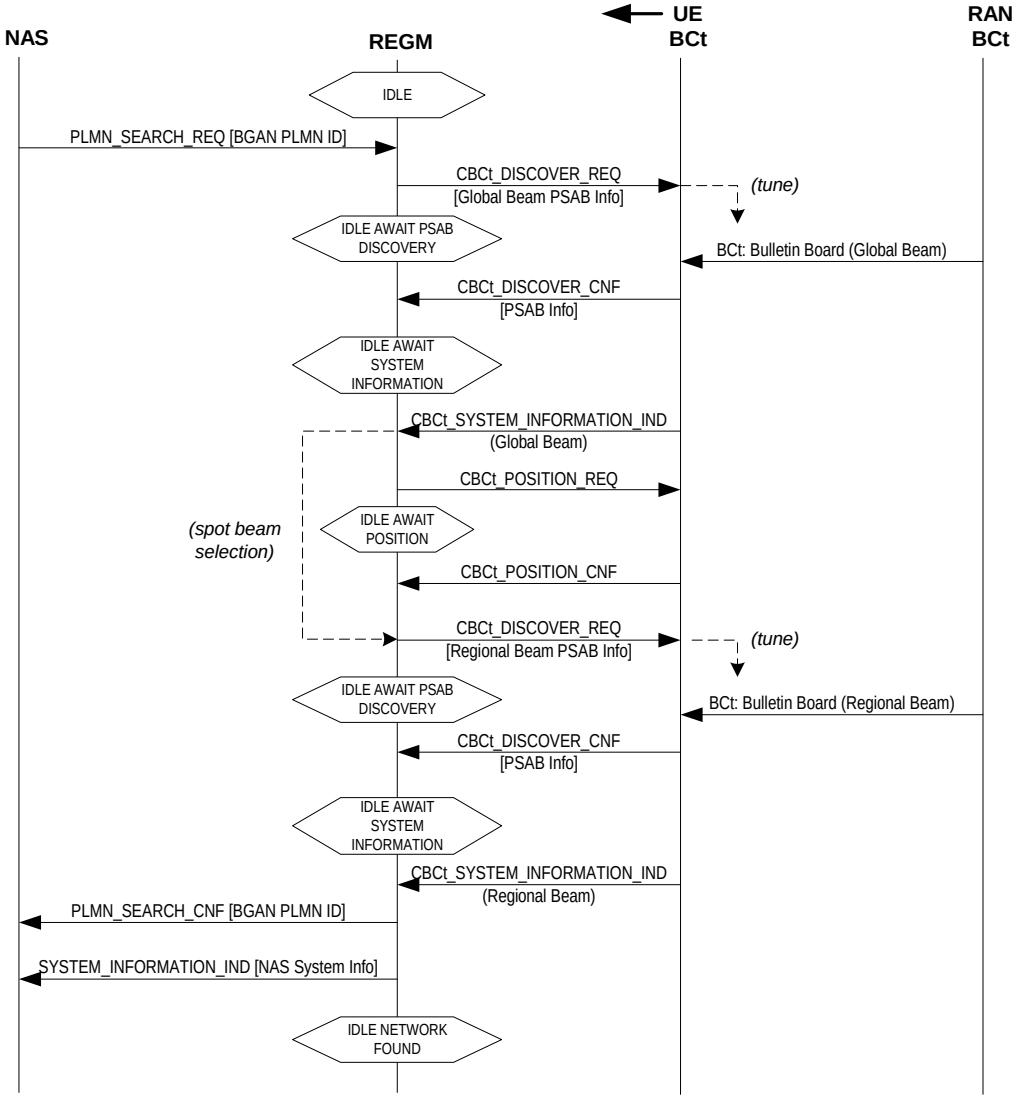

Figure 9.1: Message Sequence for PLMN/Spot Beam Selection

9.2 Registration and First NAS Message

Figure 9.2 illustrates an example message sequence for Registration and Initial NAS Message Transfer.

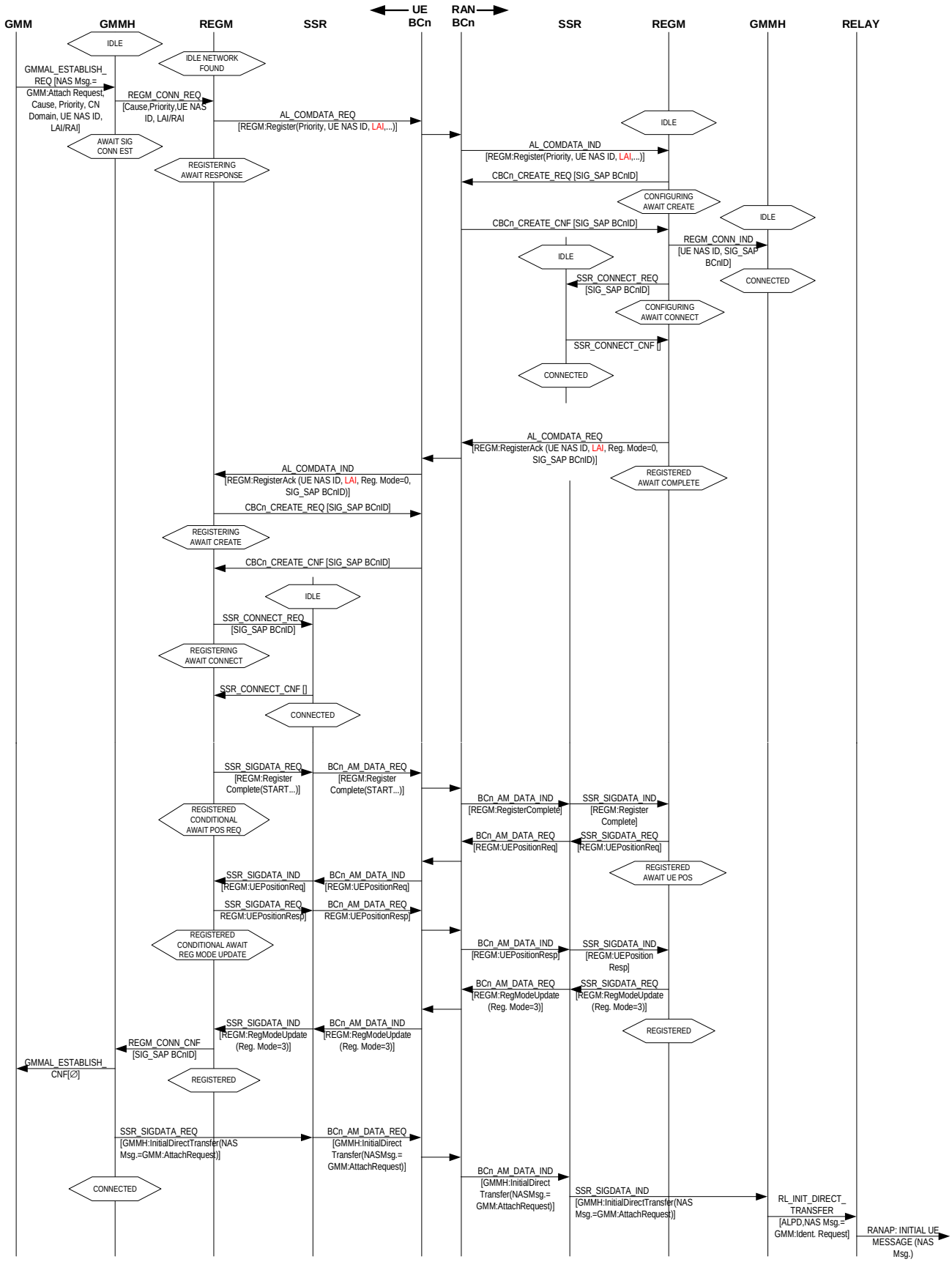

Figure 9.2: Message Sequence for Registration and Initial NAS Message Transfer *(CSR Not Shown)*

9.3 Subsequent NAS Messages

Figure 9.3 illustrates an example message sequence for subsequent NAS Message Transfer (following the Initial NAS Message Transfer shown in Figure 9.2).

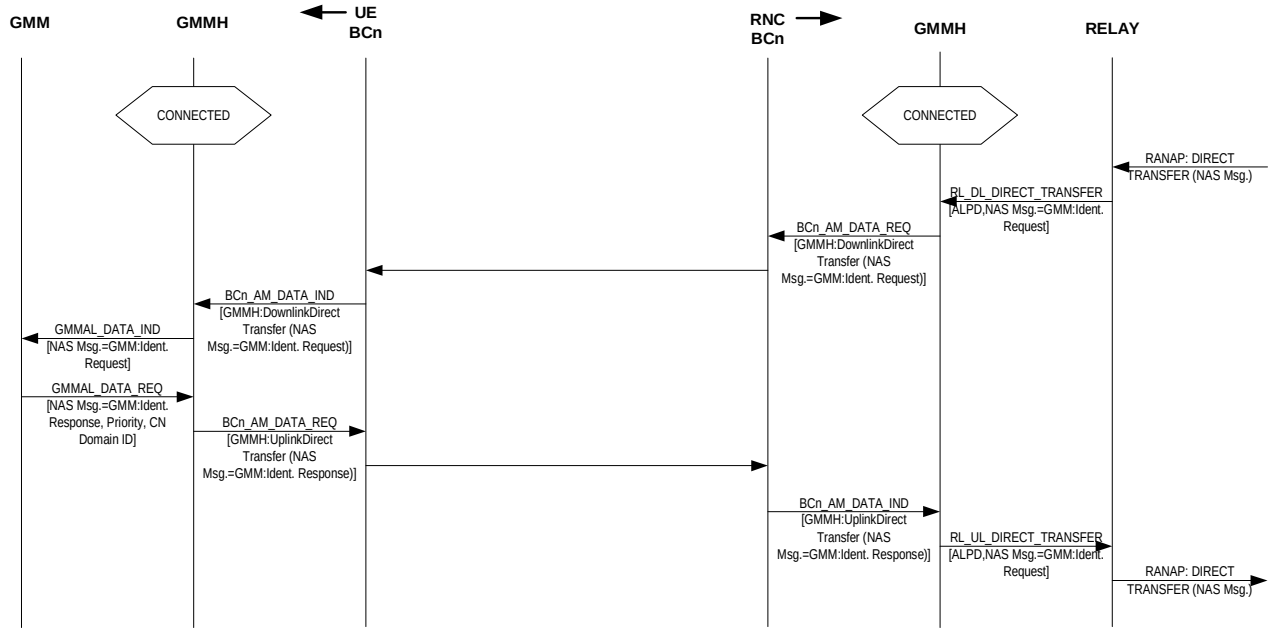

Figure 9.3: Message Sequence for NAS Message Transfer (Subsequent)
(GMMH::SSR Primitives Not Shown)

9.4 Handover

9.4.1 RNC-Initiated

Figure 9.4 illustrates an example message sequence for RNC-Initiated Handover.

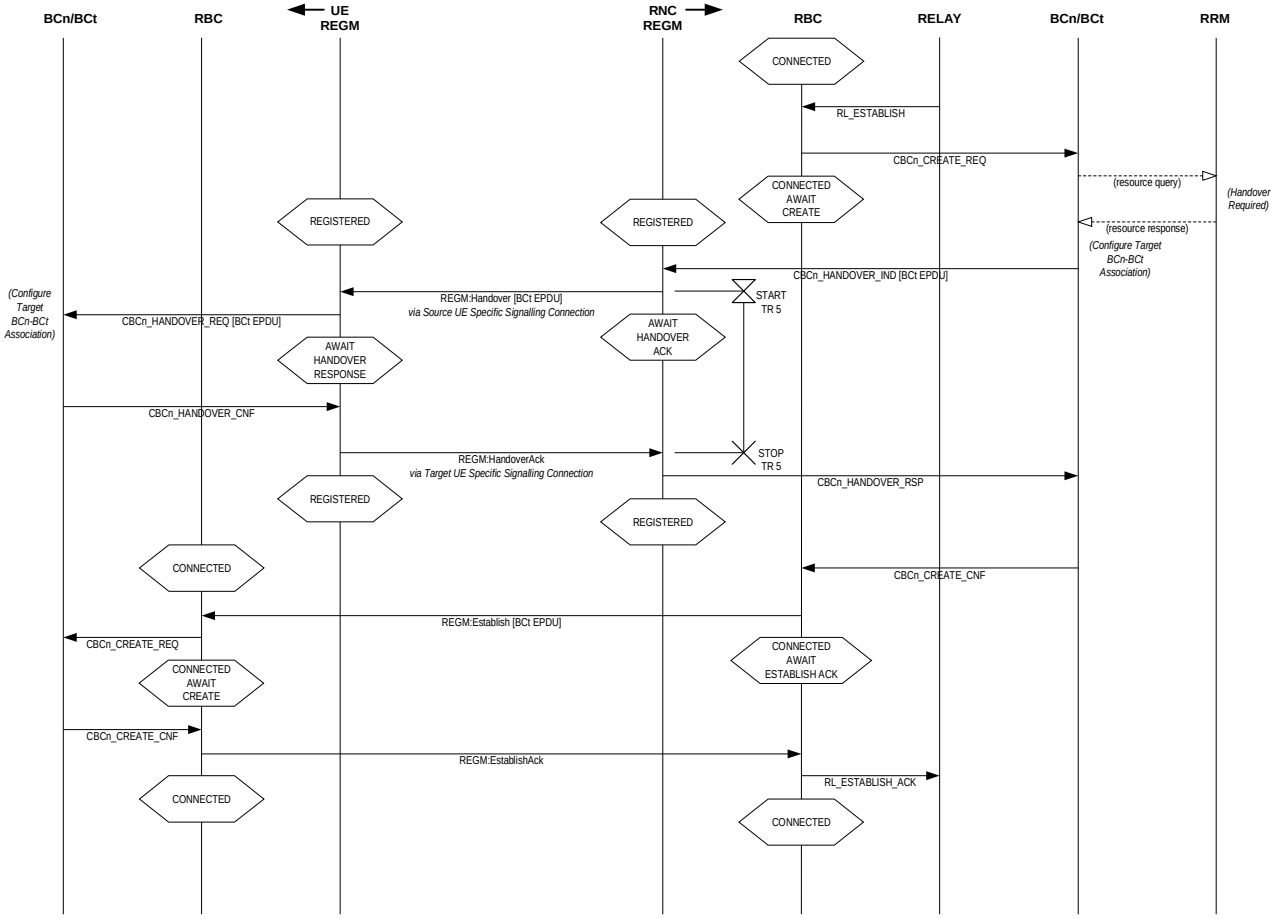

Figure 9.4: Message Sequence for RNC-Initiated Handover

9.4.2 UE-Initiated

Figure 9.5 illustrates an example message sequence for UE-Initiated Handover.

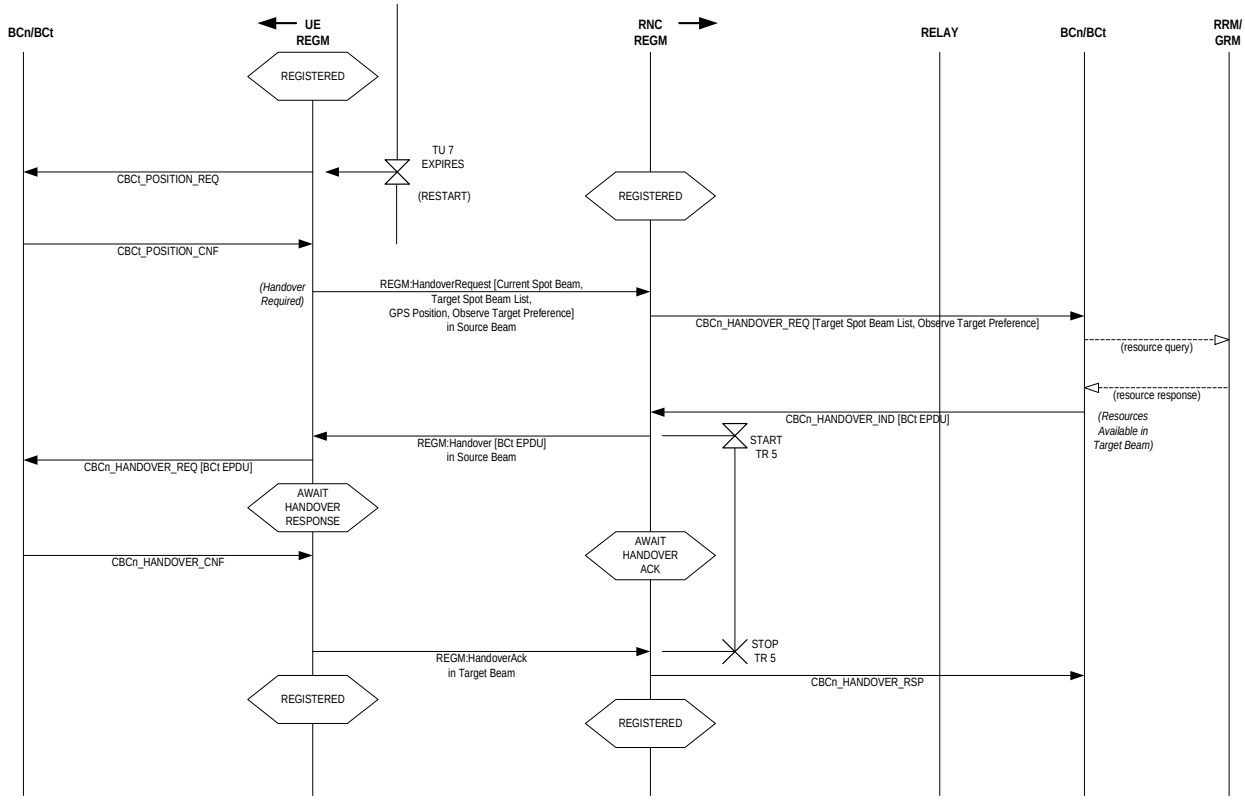

Figure 9.5: Message Sequence for UE-Initiated Handover

History

Document history		
V1.1.1	October 2015	Publication