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Technical Specification

**Satellite Earth Stations and Systems (SES);
Regenerative Satellite Mesh - A (RSM-A) air interface;
MAC/SLC layer specification;
Part 1: General description**

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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 1 of a multi-part deliverable covering Regenerative Satellite Mesh - A (RSM-A) air interface MAC/SLC layer specification, as identified below:

    Part 1:   **"General description";**

    Part 2:   "MAC layer";

    Part 3:   "SLC layer".

1 Scope

The present document is an introduction to the SMAC/SLC layer specification for the TC-SES BSM Regenerative Satellite Mesh - A (RSM-A) air interface family. In particular it contains the description of the overall network and SMAC/SLC protocol architecture of the BSM Regenerative Satellite Mesh - A (RSM-A) air interface as seen from the ST. It also describes the various interfaces between the ST and other network elements and the relation between the layers in the ST logical protocol architecture as are discussed in the present document as well as the interactions with other layers in the BSM Regenerative Satellite Mesh - A (RSM-A) protocol architecture.

2 References

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

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

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies.

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

[1] ETSI TS 102 188-1: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 1: General description".

[2] ETSI TS 102 188-5: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 5: Radio transmission and reception".

[3] ETSI TS 102 189-2: "TC-SES; Broadband Satellite Multimedia; Regenerative Satellite Mesh - A (RSM-A); Air Interface; SMAC/SLC Layer Specification; Part 2: Satellite Media Access Control and Satellite Link control".

[4] ETSI TR 101 984: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; Services and Architectures".

[5] ETSI TS 102 189-3: "TC-SES; Broadband Satellite Multimedia; Regenerative Satellite Mesh - A (RSM-A); Air Interface; SMAC/SLC Layer Specification; Part 3: ST-SAM interface specification".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Network Operations Control Centre (NOCC): centre that controls the access of the satellite terminal to an IP network and also provides element management functions and control of the address resolution and resource management functionality

satellite payload: part of the satellite that provides air interface functions

NOTE: The satellite payload operates as a packet switch that provides direct unicast and multicast communication between STs at the link layer.

Satellite Terminal (ST): terminal that is installed in the user premises

terrestrial host: entity on which application level programs are running

NOTE: It may be connected directly to the Satellite Terminal or through one or more networks.

3.2 Abbreviations

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

ACF	Access Control Field
ARP	Address Resolution Protocol
BoD	Bandwidth-on-Demand
BSM	Broadband Satellite Multimedia
CoS	Class of Service
CRC	Cyclic Redundancy Check
EDU	Extended Data Unit
ESN	Equipment Serial Number
GEO	Geosynchronous Earth Orbit
HVUL	High Volume UpLink
IP	Internet Protocol
LLDC	Link Layer Data Confidentiality
MAC	Medium Access Control
MGID	Multicast Group IDentity
MIP	Management Information Packet
NIP	Network Information Packet
NOCC	Network Operations Control Centre
O&M	Operations and Maintenance
PDS	Packet Delivery Service
PDU	Protocol Data Unit
PEP	Performance Enhancing Proxy
PHY	PHYsical
PLR	Packet Loss Ratio
PTO	Packet Transmission Opportunity
PTP	Point-To-Point
QoS	Quality of Service
RRM	Radio Resource Management
RSM	Regenerative Satellite Mesh
SAM	Security Access Module
SAP	Service Access Point
SAR	Segmentation And Reassembly
SDU	Service Data Unit
SI-SAP	Satellite Independent-SAP
SLC	Satellite Link Control
SMAC	Satellite Medium Access Control
ST	Satellite Terminal
TCP	Transmission Control Protocol
TIP	Transmission Information Packet
UDP	User Datagram Protocol
UDTS	User Data Transport Services
ULPC	UpLink Power Control

4 Network definition and protocol architecture

This clause provides a network architecture that captures the main semantics of the BSM Regenerative Satellite Mesh - A (RSM-A) system as well as a protocol architecture that provides a logical framework in which to partition the functionality performed by an ST. The network architecture describes the main network elements which interface with the ST and provides reference points and reference interfaces. The protocol architecture provides a means to decompose the ST overall functionality into individual procedures that take place over the different interfaces. The protocol architecture defines layers in association with procedures and protocols only. The sublayer definition, functionality and interaction are informative. The protocol and procedures defined herein are normative.

4.1   Regenerative Satellite Mesh - A network architecture

4.1.1   Network elements

Figure 4.1 describes the RSM-A network architecture from the satellite terminal viewpoint and also provides the different interfaces as seen by the satellite terminal. Both external and internal interfaces are shown in the figure. Each of these interface points might translate to a reference point for integration verification and testing.
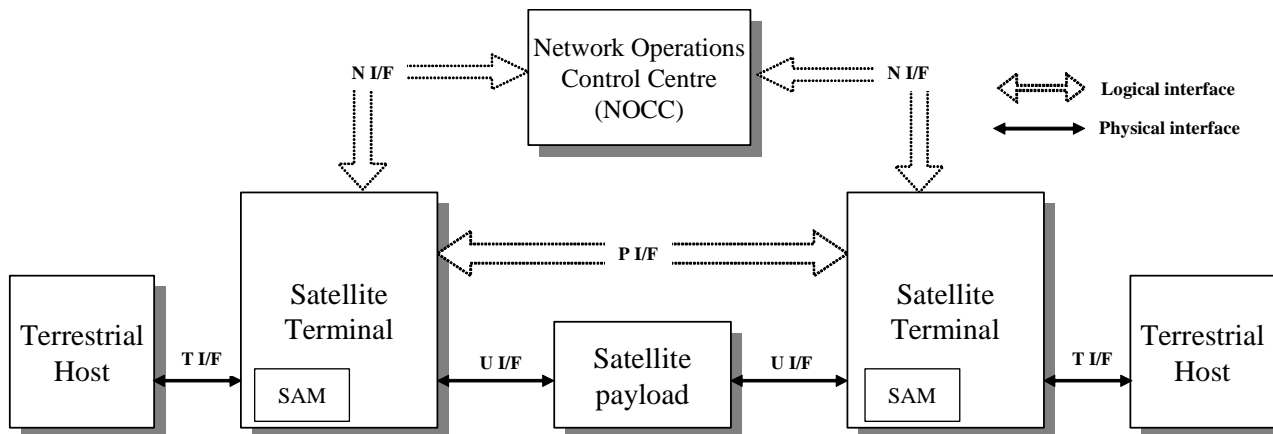
Figure 4.1: RSM-A Network interfaces

The network elements are described below.

Network Operations Control Centre (NOCC): The NOCC controls the access of the satellite terminal to an IP network and also provides element management functions and control of the address resolution and resource management functionality.

Satellite payload: The satellite payload is the part of the satellite that provides air interface functions. The satellite payload operates as a packet switch that provides direct unicast and multicast communication between STs at the link layer.

Satellite Terminal (ST): The ST is the terminal that is installed in the user premises. It offers an IP data transportation service over the satellite network.

Terrestrial host: This is the entity on which application level programs are running. It may be connected directly to the Satellite Terminal or through one or more networks. It maintains an IP route to one or more STs and uses their services to transmit IP data over the satellite network to destination IP hosts.

Security Access Module (SAM): The security access module is an independent module physically resident in the Satellite Terminal. It contains authentication and identification data in a physically safe manner. The SAM is required by the ST to use the services of the RSM-A network.

4.1.2   Network interfaces

The network interfaces are briefly described below.

U Interface: This is the physical interface (the air interface) between a ST and the Satellite payload. All data transactions to and from the terminal including all user data to the destination ST, all management data to the NOCC and all signalling go over this interface. The same physical interface is used for both the BSM I.5 and I.6 interfaces [4].

N Interface: This is a logical interface between the ST and NOCC for transaction of management and signalling data between a ST and the NOCC.

P Interface: This is a logical interface between two STs for transaction of peer layer signalling traffic and user data traffic.

T Interface: This is the physical interface between the ST and the hosts. Multiple hosts can be connected to a single ST. The same physical interface is used for both the BSM I.2 and I.10 interfaces [4].

4.2   ST functional description

The Satellite Terminal performs certain functions with regards to the host terminals and the network. These can be broadly categorized as described in the subsequent clauses.

4.2.1   Network access control functions

The ST shall perform a number of functions in order to access the network and use its resources to provide a data path to a host. The functions are categorized as:

- **Registration** is the function whereby an individual ST is made a part of the RSM-A network when it is powered on for the first time or after an explicit deregistration operation.

- **Authentication and Authorization** is the function whereby the network authenticates the ST and determines the amount and category of services that it is entitled to.

- **Admission control** is the function whereby the ST admits user data into the system and calculates the QoS to be associated with these user data and the appropriate combination of network resources required to provide this QoS.

- **Network access** is the function whereby an individual ST accesses specific radio resources as per requirement and subscription.

- **Usage tracking and charging** is the function whereby the system tracks the usage each ST has made of the radio resources and converts it to charging information.

4.2.2   Packet routing and transfer functions

The ST shall perform a number of functions in order to transfer the user packets over the RSM-A network to the correct endpoint. The functions are categorized as:

- **Identification and Classification** is the function whereby the ST classifies packets from a user port and assigns QoS parameters to each packet.

- **Routing** is the function whereby the ST determines the next node in the network to which the packet stream must be forwarded in order for it to reach its final destination. This may be another terrestrial route, an egress ST or a gateway ST (in a dual-satellite network or multi-hop route).

- **Address Resolution** is the function whereby the ST determines the MAC address of the next node that has been determined by the routing function.

- **Compression** is the function whereby the ST optimizes radio path capacity by performing lossless compression of the SDU.

- **Ciphering** is the function whereby the ST protects the user data from eavesdropping and other security issues.

4.2.3   Radio Resource Management functions

The ST shall manage radio resources that it can use so as to protect the network and make the best use of its resources. The Radio Resource Management functions are identified as follows:

- **Radio path management** is the function whereby the ST acquires and manages the physical radio paths that it can use, both dedicated and contention mode for its data transmission purposes in a manner which is compliant to the network configuration and rules and also to the QoS levels of the data that is going to be transferred over the system.

- **Radio path transfer** is the function whereby the ST forwards packets over the radio path. This function must be able to manage the following:

  -      Medium Access Control.

  -      Packet multiplexing over common or shared channels.

- Packet classification within the ST.

- Error detection and correction (optional).

- Flow control procedures.

4.2.4   Network management functions

Network management functions are those that the ST executes for maintaining the Operations and Maintenance (O&M) requirements of the network. Some examples are configuration and download, performance reporting, alarm reporting, etc.

4.3   ST operational states

The ST has different categories of operational states, the port-level state and the ST-level state. Conceptually, the ST offers services to the end-user through its ports. Thus the state of the port determines whether it can offer a specific function to the networks connected to that port. There is also a main state associated with the ST system as a whole. This determines, for example, whether the ST can contact the network, whether the ST has transmit/receive capability, whether the ST is configured, etc. Each ST-level state is characterized by the functions the ST has to perform to reach that state, the functions (if any) it has to perform while in that state, and finally the services that it can offer while in that state. The association between the ST states and the port states are also specified below.

4.3.1   ST level states

4.3.1.1   ST state description

There are three states for the entire ST at any given time. These states are shown in figure 4.2.

- **DEREGISTERED:** In this state the ST is not registered with the satellite system. This state has five substates.

  - **IDLE:** This is the initial substate of the ST after purchasing and installation. No services are available at this time. The ST is incapable of transmission or reception.

  - **RECEIVE:** This is the substate of the ST after it has been installed with its antenna pointed correctly and its uplink polarization set correctly. It is able to receive the satellite beacon signal after powering on. The ST has performed cell and microcell selection and has determined the downlink destination ID, which it monitors for system information. At this point, the ST can receive system information and general data transmitted to it, but has no transmit capability. The ST is required to monitor the system information to determine whether it is required to upgrade its commissioning software to the appropriate software version. In case it does, it waits for the next round of transmission of the commissioning software from the network. Since the ST has no transmit capability, it passively obtains the commissioning software. In case of an error, it has to wait for the next round of transmission to recover.

  - **COMMISSIONED:** In this substate the ST has enough information to start the registering process. It is still not an addressable entity. The commissioning software resident in the ST has been determined to be of the correct compatibility level. The ST has basic network access and transmission capability, but it is prohibited from carrying user-traffic.

  - **BARRED-GROUP:** In this substate, the ST shall not transmit but shall continue to receive the beacon and all system information. The ST shall enter this substate upon receiving a command from the NOCC. The ST may leave this substate either upon receiving a command from the NOCC, which bars a group to which the individual ST belongs, or upon timer expiry as per clause 4.3.1.3.

  - **BARRED-IND:** In this substate, the ST shall not transmit but shall continue to receive the beacon and all system information. The ST shall enter this substate upon receiving a command from the NOCC. The ST shall only leave this substate upon receiving a command from the NOCC, which bars the individual ST, as per clause 4.3.1.3.

- **REGISTRATION INITIATED:** In this state the ST is attempting to register with the satellite system. This state has no substates.

- **REGISTERED:** This is the state after the ST has successfully completed the registration and authentication process. This state has nine substates.

  - **RECONFIGURATION:** In this substate the ST carries out three subtasks, software reconciliation, profile configuration and security key updating. No data services are available in this substate. The ST enters this state when powered-on.

  - **ACTIVE:** In this substate the ST has reconciled its software versions, has valid configured profiles and updated security keys. The ST can securely transfer management data to the network. All user data services are available. The ACTIVE substate has several on-going subtasks such as acquisition of system information. The ST shall provide a visual indication to the user when it is in this substate and shall provide a visual indication to the user when it is not in this substate.

  - **POWERED OFF:** In this substate, the ST has been powered off from any REGISTERED substate.

  - **NOLINK:** This is a substate of the REGISTERED state whereby the ST loses physical connectivity to the network. User services are not available in this state. The ST shall reset the value of "current PTP slot number" to "2" until it requires a valid value in a Transmission Information Packet (TIP) message.

  - **BARRED-GROUP:** In this substate, the ST shall not transmit but shall continue to receive the beacon and all system information. The ST shall enter this substate upon receiving a command from the NOCC. The ST may leave this substate either upon receiving a command from the NOCC or upon timer expiry as per clause 4.3.1.3.

  - **BARRED-IND:** In this substate, the ST shall not transmit but shall continue to receive the beacon and all system information. The ST shall enter this substate upon receiving a command from the NOCC. The ST shall only leave this substate upon receiving a command from the NOCC as per clause 4.3.1.3.

  - **SUSPENDED:** In this substate the ST shall not transmit user data but shall be able to transmit management signalling, including performance of diagnostic test messages. The ST shall only enter and leave this state upon command from the NOCC.

  - **MAINTENANCE:** In this substate, the ST shall not transmit user data but shall respond to management signalling, including performance of diagnostic testing but shall not initiate unsolicited management signalling such as status, performance, and alarms reporting. The ST shall only enter and leave this state upon comment from the NOCC as per clause 4.3.2.1.

  - **OUT-OF-SERVICE:** In this substate, the ST shall not transmit user data but shall respond to management signalling, excluding the performance of diagnostic testing but shall not initiate unsolicited management signalling such as status, performance, and alarms reporting. The ST shall only enter and leave this state upon command from the NOCC as per clause 4.3.2.1.

NOTE: User data is only allowed in the Registered State/Active substate. User data in this context includes IP layer diagnostics but does not include ST-NOCC management signalling that is at IP layer.

4.3.1.2   State transitions relative to system information reception

An ST shall not transmit in any state except Registered, Substate Active, unless all system information including TIP, NIP, indirect MIP and direct MIP is current. This requirement implies that the ST cannot proceed from state Deregistered, Substate Commissioned to state Registration initiated or from state Registered, substate reconfiguration to state registered, substate active, unless all system information is current.

The ST shall not transmit in state registered, substate active if TIP, NIP and indirect MIP are not current but may be able to transmit indefinitely without reception of direct MIP. In this substate, the ST shall use last received configuration parameters.

4.3.1.3   ST transmission barring

The NOCC may enable and disable ST transmission via an Indirect or Direct MIP. Disabling transmission is called "barring" Barring may be applied to an individual ST specified by the ST Equipment Serial Number (ESN) or barring may be applied to a group of STs within a scope specified by the NOCC. Scopes for group barring include: a microcell, a geographic region specified by latitude and longitude coordinates, or a range of ST ESNs.

Group barring by microcell is done via the Indirect MIP. Other group barring scopes are specified via a Direct MIP. Individual barring is applied by a different Direct MIP. At any time, an ST may fall within the scope of one or more barred groups and/or may be individually barred.

If an ST detects that it is within the scope of a barred group it transitions to the BARRED-GROUP substate. On the transition, the ST shall set a 5 minute timer. The ST shall exit the BARRED-GROUP substate upon receipt of an explicit indication from the NOCC that the group(s) is no longer barred or upon timer expiry. The timer is required for barring by Direct MIP but optional for barring by Indirect MIP.

If an ST transitions to BARRED-IND substate, it shall only exit this state upon receipt of an explicit command from the NOCC to do so.

If an ST is individually barred and also belongs within the scope of a barred group, it shall transition to the BARRED-IND substate.
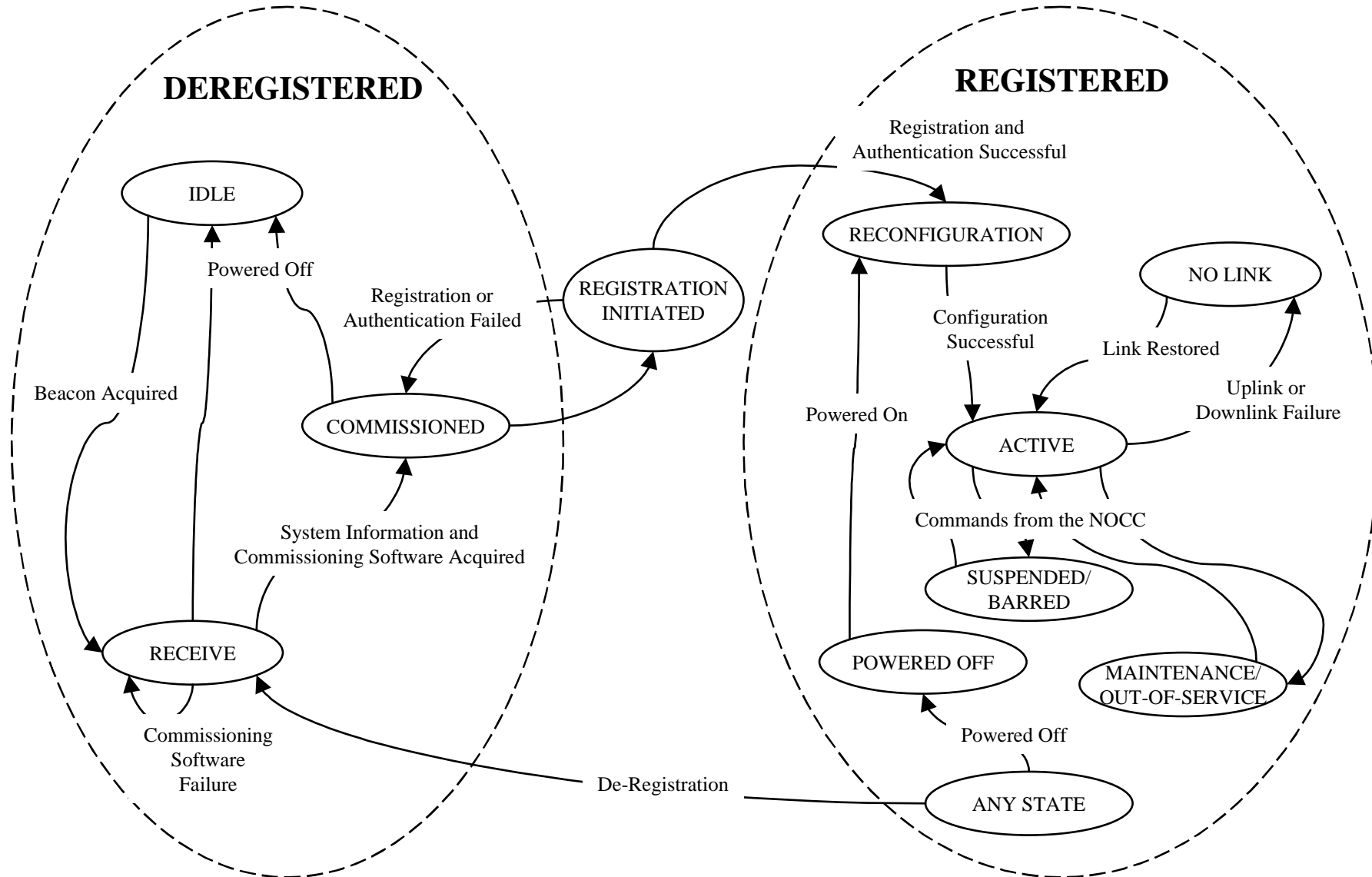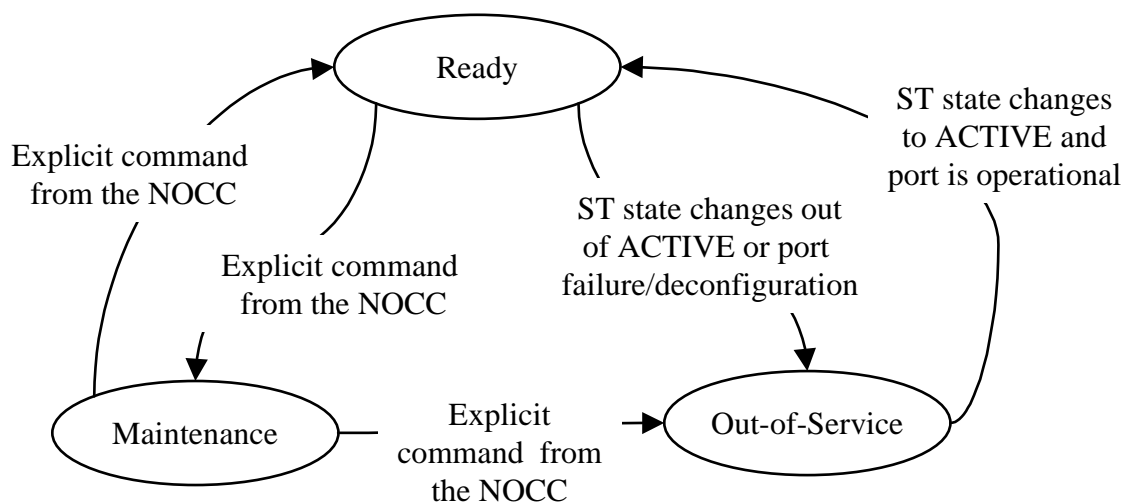
Figure 4.2: Network Access State Transition Diagram

4.3.2   Port level states

An ST port is defined to be a virtual port instance of the SI-SAP.

4.3.2.1   State description

Each ST port has a state variable associated with it which can be in one of three different states. The state of a given ST port is independent of the state of other ports in the same ST but is tied to the current state of the ST.

Figure 4.3: ST port state transition diagram

- **READY:** In this state, the port may offer services to the networks connected to it directly, if there is a valid profile existing for that port. The services available are listed below. The ST port can be in READY only if the ST state is NA_ACTIVE (state = REGISTERED; substate = ACTIVE).

- **MAINTENANCE:** The ST port goes into this state on direct command from the NOCC. In this state it can still do connection setup/teardown, routing etc, but is prohibited from advertising these services to the local networks or to other STs. This state is to be used for diagnostic purposes only.

- **OUT-OF-SERVICE:** An ST port goes into out-of-service state when the ST overall goes out of the active state or into one of the inactive substates of the active state or due to failure/deconfiguration of the port itself. In this state, the ST does not provide any services to either a local user or a remote ST.

4.3.2.2   Port level services

- **Packet Transit:** The service of delivering packets over the RSM-A system to other networks with/without QoS guarantees.

- **Routing:** The service of identifying routes available over the RSM-A system and advertising them locally. Interaction with terrestrial routing protocols to allow seamless IP routing over the RSM-A system.

- **Connection setup:** The service of setting up pre-scheduled/on-demand connections providing "virtual circuit-like" channels over the RSM-A system by negotiating with the network.

- **Multicast group setup:** The service of setting up multicast groups for efficient point to multipoint communication over the RSM-A system.

4.4   ST protocol architecture

4.4.1   Data plane architecture

The RSM-A network architecture provides a split between Satellite dependent functions and Satellite independent functions. The purpose of this split is as follows:

- separate the satellite specific aspects (i.e. a Ka-band GEO satellite with a packet switch) from the satellite independent higher layer. This separation is designed to permit future market developments, in particular IP enhancements;

- provide flexibility for the addition of more complex market segment-based solutions (e.g. PEPs and Application Gateways).

With some exceptions, functions in a satellite terminal can be conceptually categorized as link-specific and link-non-specific. RSM-A provides an interface to its transport core that is common for all network services, applications, and market segments. This interface is termed the Satellite Independent-Service Access Point (SI-SAP).

In the OSI layering model, the SI-SAP is positioned between the link and network layers. With the SI-SAP so positioned, elements above the SI-SAP can, and indeed should, be designed without specific knowledge of the supporting link layer. Hence the introduction of the SI-SAP into the system design affords the following benefits:

- Elements above the SI-SAP can be ported with greater ease to new satellite systems.

- Extensibility to support new higher-layer functionalities without major re-engineering of existing designs.

This clause describes the user data transmission plane in the RSM-A ST. The functions of the various layers and the various SAPs are described below.

The architecture for the baseline ST configurations is shown in figure 4.4. The RSM-A Core Layers consist of the SLC, MAC and PHY layers. The IP Adaptation layers include the IP Plus Layer and the Transport Layer Performance Enhancing Proxies (PEP).
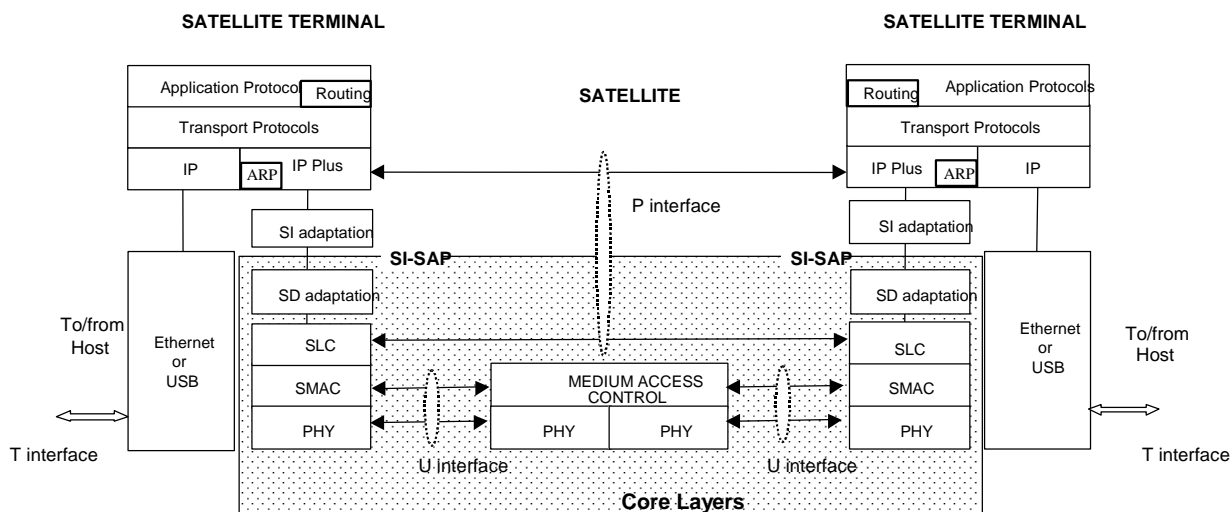
Figure 4.4: Simplified general RSM-A User Data Protocol reference architecture

4.4.2   CoS and related concepts

Quality of Service (QoS) is the abstract notion of how well a particular sort of traffic is carried to its destination, relative to the needs of that traffic. Because, in general, different kinds of traffic have different QoS requirements, traffic is categorized into different Classes of Service (singular: CoS). Traffic of a given CoS may be carried in different ways with the goal of providing the appropriate QoS for such traffic.

In RSM-A the CoSes are directly supported by User Data Transport Services (singular: UDTS), which are general characterizations of how traffic is queued and sent. The specific method by which a RSM-A packet is sent is termed a Packet Delivery Service (PDS). The PDS selected for transmitting a packet is related to the UDTS of the associated data traffic, but not in a strictly one-to-one fashion.

STs may operate in High Volume UpLink (HVUL) or Bandwidth-on-Demand (BoD) mode. Both modes of operation are described in BSM RSM-A SMAC/SLC Layer Specification TS 102 189-2 [3]. The association of these concepts is shown in figure 4.5 for BoD. The complete set of rules for mapping UDTS to PDS are given in BSM RSM-A SMAC/SLC Layer Specification TS 102 189-2 [3].
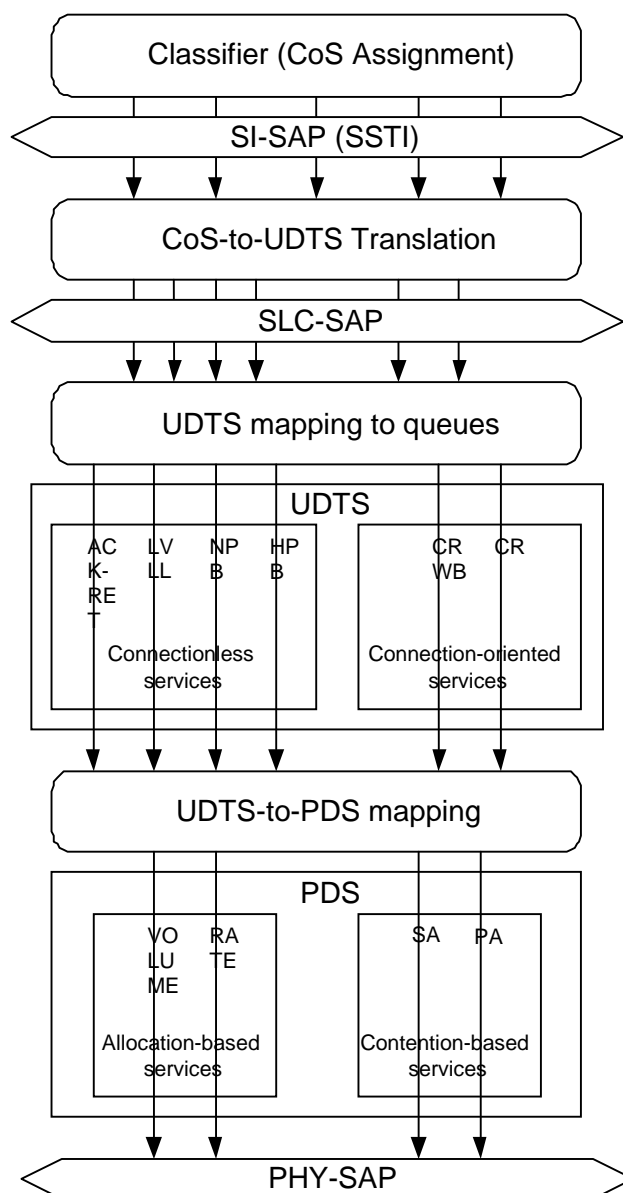

Figure 4.5: CoS, UDTS and PDS relationships

4.5 Layer-wise functional partitioning

This clause gives the functional responsibilities for each layer.

4.5.1 Data link layer

The data link layer provides the actual transport service over the RSM-A network. It is divided into two sublayers.

4.5.1.1 Satellite Link Control sublayer

The Satellite Link Control (SLC) layer is the sublayer of the Data link layer that is responsible for transmission and reception of packets from one ST to the other. Two modes of delivery are defined, unack-mode and ack-mode. Support of ack-mode delivery mode is optional.

The functional responsibilities of the SLC are:

- Generation of session ids and mapping incoming packets into the corresponding session.

- Encryption and decryption of specific SDUs for user to user data privacy or Link Layer Data Confidentiality (LLDC) and conditional access.

- Computation of an error detecting CRC.

- Construction of Extended Data Units (EDUs) from SDUs.

- Segmentation of EDUs into segments and attaching of appropriate SLC headers. At the receiving ST, the corresponding SLC entity has to reassemble application EDUs.

- Construction of SLC-packet data units (PDUs).

4.5.1.2 Satellite Medium Access Control sublayer

The Satellite Medium Access Control (SMAC) layer controls the way the ST uses uplink resources. The uplink resources described here are a combination of contention channels and dedicated resources. The SMAC has the following responsibilities:

- The SMAC examines the UDTS and priority of the SDU and maps the SDU to a Packet Delivery Service (PDS).

- The SMAC creates a RSM-A packet by adding a MAC header to an SLC-PDU.

- The SMAC layer shall mark drop-classes appropriately as indicated in the associated CoS Profile.

- The SMAC operates on the basis of queues. For each PDS there may be one or more queues. Each RSM-A packet, on the basis of the PDS and internal configuration information is queued in one queue. In order to retain in-order delivery RSM-A packets may not be moved between queues, but the way they are serviced may vary.

- The SMAC continuously executes the appropriate algorithm to get resources from the network.

- The SMAC layer combines RSM-A packets into blocks and allocates slots for individual blocks. Blocks are passed to the transmission layer for burst building together with the slot information. The reverse process is done on the receive side.

- The SMAC interacts with the SAM to generate the Access Control Field (ACF) function for all MAC blocks that are transmitted on the U interface.

- On the receive side, the SMAC layer receives incoming RSM-A packets and discriminates them on the basis of the destination RSM-A address. Packets may use either the unicast destination address of any of the ST ports and/or certain Multicast Group IDentities (MGIDs). These MGIDs are a combination of pre-reserved MGIDs for NOCC to ST transmission (which have to be monitored at all times) and MGIDs used for user-user multicast transmission.

4.5.2 Physical layer

The physical layer is described in more detail in BSM RSM-A Physical Layer Specification TS 102 188-1 [ ] and has the following functions.

- The physical layer executes the initial acquisition and synchronization procedure with the network.

- The physical layer builds bursts (modulation, coding and power control functions) and transmits them on particular slots and channels as instructed by SMAC.

- The physical layer receives incoming packets and passes them to the SMAC for filtering.

- The physical layer does dead link detection.

- The physical layer adjusts the uplink transmission power.

4.6 Procedure definitions

The clause below identifies and defines procedures to be used over the Air Interface.

Various procedures are defined in the following clauses. The procedures described below are divided into idle mode procedures, transmission side procedures in active mode and receive side procedures in active mode. They are invoked at different layers of the ST network architecture as described.

4.6.1 Procedures in idle mode

4.6.1.1 System information reception

The ST shall monitor all System Information broadcasts. System information packets include the following:

- Transmission Information Packet (TIP) messages (see BSM RSM-A SMAC/SLC Layer Specification TS 102 189-2 [3]);

- UpLink Power Control (ULPC) status messages (see BSM RSM-A SMAC/SLC Layer Specification TS 102 189-2 [3]);

- Network Information Packets (NIP), including:

    - bandwidth assignment messages (see BSM RSM-A SMAC/SLC Layer Specification TS 102 189-2 [3]);

    - negative acknowledgement messages (see BSM RSM-A SMAC/SLC Layer Specification TS 102 189-2 [3]);

    - dynamic contention channel assignment messages (see BSM RSM-A SMAC/SLC Layer Specification TS 102 189-2 [3]); and

- Management Information Packets (MIP).

The TIP, NIP and ULPC status messages are received by the MAC layer. Management information packets are delivered to the appropriate agent in the control plane.

4.6.1.2 Transfer and reception of management traffic

Management packets may be transmitted either on the contention channel or on the traffic channel. This is a local decision of the Media Access control function. Some management traffic is transmitted in secure mode using a key that is provided by the NOCC as part of the registration process.

4.6.1.3 SLC session initiation on destination side

The ST has an internal packet discrimination and demultiplexing function as part of the Relay function that maps incoming packets to particular sessions. When a packet is received that cannot be mapped to any session, it is the trigger to create a new local SLC session to receive these packets. Whether this session be associated with the user plane (i.e. user data) or with the management plane is determined by its IP and RSM-A destination address. Management plane traffic uses a fixed set of multicast group ids or the management IP address.

4.6.2 Procedures - transmission side

The following clause describes the main procedures on the transmission side to deliver IP packets from a source ST to the destination ST.

4.6.2.1   Address resolution

Terrestrial packets are received in the ST and routed over the RSM-A system to their final destination. For each packet, based on the destination IP address, the transmitting ST must identify the remote ST SMAC address to deliver the packet to that it can reach its final destination. The process of identifying the destination SMAC address of the appropriate remote ST is called address resolution. This may be static, where the information is pre-loaded into the ST or dynamic.

The route and address resolution step must be undertaken before the IP packet is delivered across the SI-SAP. If the information is not available in the local cache an address resolution is requested across the interface. The address resolution function maps a next hop IP address to the next-hop ST-port RSM-A destination address, if the next hop to that destination is available over the RSM-A system and allowed by Community of Interest restrictions. For the first access to resolve a next hop IP address, the ST may query the network directly to identify the mapping. In subsequent accesses, the ST caches the network reply internally in its address resolution table. The table may be updated as part of the address resolution function by sending a "Satellite ARP" to the network for an IP address that does not exist in its internal table. If an address resolution query is answered in the negative by the network, this answer must also be stored internally to prevent spurious queries to the network.

4.6.2.2   Connection setup, modification, and release

Connection setup is either invoked by a request across the SI-SAP (on-demand) or by the arrival of an internal timing trigger (scheduled). If a new connection has to be setup, the connection management entity is invoked to execute the required signalling and setup the connection with the NOCC. Once the connection is setup, this information is passed back across the SI-SAP to the classifier, which automatically creates the appropriate classification rules so as to map specific categories of packets to this connection.

Once the connection is setup, signalling across the SI-SAP or another time trigger may request modifications which may result in further signalling with the NOCC.

A connection may be deleted if there are no sessions using it, or, in the case of a scheduled fixed time connection, when the time is up. Connection release is normally ST initiated, but can be network initiated in certain scenarios.

4.6.2.3   Segmentation and packetization

This function is executed at the SLC level for each SLC entity. EDUs are segmented to fit into fixed-size RSM-A packets.

4.6.2.4   Satellite Link Control session setup and teardown

Data is transmitted from a transmitting ST to a receiving ST by the satellite link control layer in individual sessions. A session is started when a new set of data has to be transmitted from a given ST port to another port and there are no existing sessions of the same mode to the same destination ST/port combination.

The SLC entity is a half-duplex entity that transfers packets in one direction. In acknowledged mode, it receives Acks and processes them to take care of Backward Error Correction. Support of the acknowledged mode is optional.

SLC sessions may be released when the corresponding data stream terminates, or the session is inactive for a given period of time or due to internal protocol failure. There is no explicit signalling associated with SLC session termination other than in acknowledged mode.

4.6.2.5   Bandwidth management - resource allocation and queue management

The bandwidth management function takes packets from the SLC sub-layer and identifies the appropriate Packet Transmission Opportunity (PTO) to transmit these packets on.

The bandwidth management function operates on the basis of queues. All outgoing packets are mapped into one of many queues, based on their destination and the associated UDTS. Each queue has an assigned PDS. Depending on the queue state for each PDS, the SMAC executes the appropriate protocol and to garner radio resources in the form of PTOs for transmitting the queue contents. When PTOs are available, the SMAC layer uses a defined algorithm to identify which queue is to be serviced on each particular PTO.

4.6.2.5.1   Rate transmissions

The ST maintains queues on a per connection basis with an associated rate and flow-control information. Each connection that has been negotiated with the NOCC is mapped to one queue.

4.6.2.5.2   Volume oriented uplink data channels

The ST maintains queues for volume transmissions. The queues are on the basis of priorities and destination region. Packets are mapped into the appropriate queue when they are delivered from SLC to SMAC.

4.6.2.5.3   Contention mode access

Contention channels are available for use both for data transfer as well as for control signalling i.e. resource requests. The contention channels are broken up into pools for data transfer or for contention mode resource requests. These divisions are partially statically configured and partially dynamically indicated by the network. Some pools may be reserved for certain groups of STs. The SMAC layer manages access to these resources as per the rules given in BSM RSM-A SMAC/SLC Layer Specification TS 102 189-2 [3].

4.6.2.5.4   Persistent aloha

This is a modification of the standard Slotted Aloha procedure whereby a single terminal can grab a slot in a frame or a set of frames using the Aloha protocol and then continue using it once every frame (or every set of frames) till it relinquishes the slot by not transmitting in this slot. This protocol is used for low-latency, low-volume periodic/quasi-periodic traffic such as TCP Ack packets. The initial slot acquisition is similar to the Slotted Aloha/Contention method-details are provided in BSM RSM-A SMAC/SLC Layer Specification TS 102 189-2 [3].

4.6.3   Procedures - reception side

The following clause defines the behaviour of the ST at the Network level for data reception.

4.6.3.1   Connection setup

Connection setup takes place when the ST receives a Connection Create message from the network indicating that some other ST is trying to setup a connection. The Connection Manager makes the decision as to whether the connection is to be setup or not. Once the connection setup procedure is initiated and the connection is setup, the Connection Manager keeps track of the connection and invokes the appropriate procedures.

4.6.3.2   Session initiation

A new SLC session is initiated by receipt of a packet or a burst of packets from the network with no corresponding SLC session existing. The packets are received by the SMAC layer discrimination function. An SLC session is created if no new session exists.

4.6.3.3   Reassembly

The reassembly procedure reassembles RSM-A packets into SDUs.

4.6.4   Power control

The objective of the Uplink Power Control (ULPC) function is to control the power of each ST transmitter so that Ec/ (No+ Io) for each channel is adequate to meet the Packet Loss Ratio (PLR) objectives. Fine power control is done for those advantaged terminals (those in the clear sky) such that their interference to the disadvantaged terminals (those in rain fade) would be minimum. The major portion of the ULPC process is distributed between the network and the ST. Each ST adjusts its uplink (U/L) transmit power per carrier frequency based on beacon power measurements and feedback in the form of response packets. The network is, therefore, responsible for maintaining a stable beacon signal over time, and for performing power measurements on U/L packets from the STs.

4.7 Security Access Module - functional description

The SAM is the primary security component of a satellite terminal. Physically it is a secure chip embedded in the terminal. The SAM contains secret key material and authenticates every RSM-A packet sent out by the terminal by generating an Access Control Field the can be verified by other authorized components of the system. The SAM will only sign requests that are valid within the policies set forth for that particular ST. On the receive side it verifies that management messages are authentic messages from the NOCC. See BSM RSM-A SMAC/SLC Layer Specification TS 102 189-3 [5] for a complete description of this interface.

The SAM's areas of responsibility to the RSM-A system are as follows:

- Authentication.

- Authorization protection.
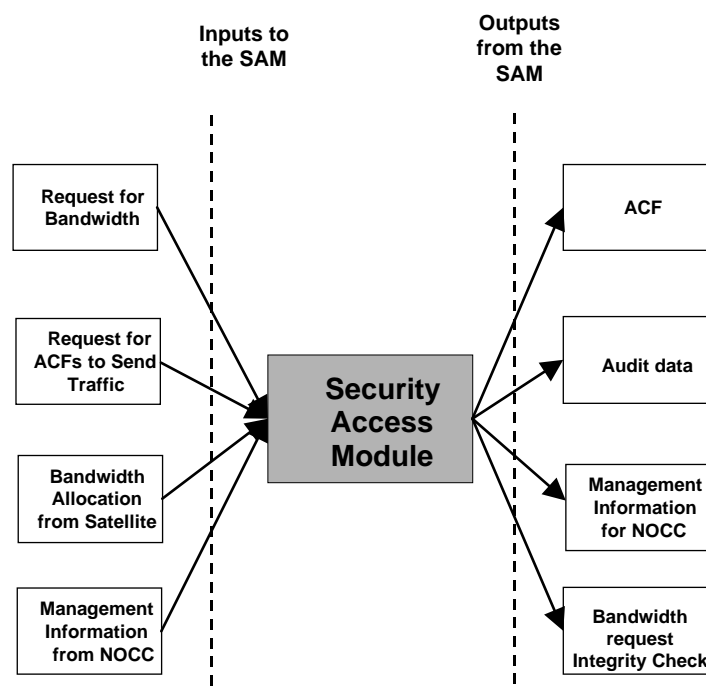
- Registration.

- Usage audit.

Figure 4.6: Security function interactions between the SAM and the ST

4.8 ST types

The RSM-A system supports multiple types of STs. The different types of STs differ in terms of functions, bit-rates and capabilities; the table below describes the different types of STs. ST type (MAC mode) corresponds to ST power class (phy mode). See BSM RSM-A TS 102 188-5 [2] for EIRP and G/T requirements per power class.

Type	Supported carrier modes (required)	MAC Mode supported	Other special features
1	128 kb/s, 512 kb/s	BoD (required) /HVUL (optional)	
2	128 kb/s, 512 kb/s	BoD (required) /HVUL (optional)	Additional EIRP for adverse weather environments
3	512 kb/s, 2 Mb/s	BoD (required) /HVUL (optional)	
4	512 kb/s, 2 Mb/s	BoD (required) /HVUL (required)	Open interface for user platform
5	512 kb/s, 2 Mb/s, 16 Mb/s	BoD (optional) /HVUL (required)	

Annex A (informative):
Bibliography

ETSI TS 102 188-2: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 2: Frame structure".

ETSI TS 102 188-3: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 3: Channel coding".

ETSI TS 102 188-4: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 4: Modulation".

ETSI TS 102 188-6: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 6: Radio link control".

ETSI TS 102 188-7: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 7: Synchronization".

History

Document history		
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