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Technical Specification

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ETSI

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

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

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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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 the Broadband Satellite Multimedia (BSM) Regenerative Satellite Mesh - B (RSM-B); DVB-S / DVB-RCS family for regenerative satellites, as identified below:

Part 1: "System Overview";

Part 2: "Satellite Link Control layer";

Part 3: "Connection control protocol";

Part 4: "Specific Management Information Base".

1 Scope

The present document is an introduction to SES BSM Regenerative Satellite Mesh - B (RSM-B) system architecture. It contains the description of the overall network and layered architecture of the BSM Regenerative Satellite Mesh - B (RSM-B).

RSM-B network combines two standards, DVB-RCS for the uplink signal and DVB-S for the downlink signal. This document also describes the DVB-RCS and DVB-S profiles for the air interfaces so that Return Channel Satellite Terminals (RCSTs) have access to star services, meaning access to terrestrial networks, and mesh services, direct communication between RCSTs in only one hop.

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.
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[1] ETSI EN 301 790: "Digital Video Broadcasting (DVB); Interaction channel for satellite distribution systems".

[2] ETSI EN 300 421: "Digital Video Broadcasting (DVB); Framing Structure, Channel Coding and Modulation for 11/12 GHz Satellite Services".

[3] ETSI EN 301 192: "Digital Video Broadcasting (DVB); DVB specification for data broadcasting".

[4] ETSI EN 300 468: "Digital Video Broadcasting (DVB) ; Specification for Service Information (SI) in DVB systems".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Connection Control Protocol (C2P): protocol that provides the interaction between RCSTs and NCC to support set-up, modification and release of connections and channel bandwidth modification

Digital Video Broadcasting-Return Channel Satellite (DVB-RCS): protocol for an interaction (or return) channel in satellite links

Digital Video Broadcasting via Satellite (DVB-S): protocol for broadcasting TV signals and by extension data over satellite

management plane: plane which provides two types of functions, namely layer management and plane management functions

Management Station (MS): controls and manages the RSM-B network

NOTE: It is composed of three elements:

- the Network Control Center (NCC);
- the Network Management Center (NMC);
- the satellite terminal of the MS (NCC_RCST), which supports the modulation and demodulation functions to access to the satellite.

multicast: communication capability which denotes unidirectional distribution from a single source access point to a number of specified destination access points

Network Control Center (NCC): RSM-B network element which controls the Interactive Network, serves users satellite rquests and manages the OBP configuration

Network Management Center (NMC): RSM-B network element composed in charge of element management functions and for the network and service provisioning and management

On Board Processor (OBP): satellite payload digital processor on-board the satellite that allows MPEG packets switching from up-link to down-link beams in a flexible way

Return Channel Satellite Terminal (RCST): RSM-B network element installed in the user premises

NOTE: It is a low cost and high-performance satellite terminal that provides interfaces with final users. It allows its users access to users of others RCSTs or to external users of terrestrial networks through the RSGW, or to services delivered by the Service Provider attached to the RSGW

GateWay Return Channel Satellite Terminal (GW_RCST): RSM-B network element installed inside an RSGW

NOTE: It corresponds to an RCST with enhanced properties in routing, IP multicast, connection control and management.

Regenerative Satellite GateWay (RSGW): RSM-B network element that interfaces the RSM-B network with external users of terrestrial networks such as PSTN or ISDN and with external Service Providers

NOTE: A Gateway and one or several GW_RCST (Gateway Return Channel Satellite Terminal) compose the RSGW. A Gateway includes all the network elements that will assure the interface with terrestrial networks (e.g. IP router, Voice gateway, Video gateway, Gatekeeper, etc.).

Quality of Service (QoS): measure of the parameters of a network that influence perceived quality of communications, including the delay, jitter, bandwidth, and packet loss that packets sent by the application experience when being transferred by the network

user plane: plane which has a layered structure and provides user information on flow transfer, along with associated controls for flow control and recovery from errors

3.2 Symbols

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

T	Interface User terminal - RCST interface
N	Interface NCC - RCST interface
M	Interface NMC - RCST interface
U	Interface Satellite payload - RCST interface
P	Interface RCST - RCST logical interface
O	Interface OBP - NCC interface

3.3 Abbreviations

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

ACQ	ACQuisition burst
BAT	Bouquet Association Table
BSM	Broadband Satellite Multimedia
CA	Conditional Access
CAT	Conditional Access Table
CLI	Command Line Interface
CMT	Correction Message Table
CRC	Cyclic Redundancy Check
CSC	Common Signalling Channel
CVR	ConVolutional Rate
DiffServ	Internet Differentiated Services
DULM	Data Unit Labelling Method
DVB	Digital Video Broadcasting
DVB-RCS	Digital Video Broadcast-Return Channel Satellite
DVB-S	Digital Video Broadcasting via Satellite
EIT	Event Information Table
ETSI	European Telecommunications Standards Institute
FCT	Frame Composition Table
IDU	InDoor Unit
IETF	Internet Engineering Task Force
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
kbps	kilo bits per second (thousands of bits per second)
MAC	Medium Access Control
Mbps	Mega bits per second (millions of bits per second)
MF-TDMA	Multi Frequency Time Division Multiple Access
MIB	Management Information Base
MMT	Multicast Map Table
MPE	Multi Protocol Encapsulation
MPEG	Moving Picture Experts Group
MPEG2-TS	MPEG2 Transport Stream
MS	Management Station
NCC	Network Control Center
NCR	Network Clock Reference
NIT	Network Information Table
NMC	Network Management Center
OBP	On Board Processor
ODU	OutDoorUnit
PAT	Program Association Table
PCR	Program Clock Reference
PID	Packet IDentifier
PMT	Program Map Table
PNP	Phase Noise Power
PSI	Program Service Information
PSTN	Public Switched Telephone Network
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RCST	Return Channel Satellite Terminal
RF	Radio Frequency
RMT	RCS Map Table
RS	Reed Salomon
RSGW	Regenerative Satellite GateWay
RSM	Regenerative Satellite Mesh
SAC	Satellite Access Control
SCT	Superframe Composition Table
SDT	Service Description Table

SI	Service Information
SLA	Service Level Agreement
SNMP	Simple Network Management Protocol
SP	Service Provider
SPT	Satellite Position Table
SYNC	Synchronization burst type
TBTP	Terminal Burst Time Plan
TC	Turbo Code
TCP	Transmission Control Protocol
TCT	Time-slot Composition Table
TDM	Time Division Multiplex
TDMA	Time Division Multiple Access
TDT	Time and Date Table
TIM	Terminal Information Message
TIM-b	Terminal Information Message-Broadcast
TIM-u	Terminal Information Message-Unicast
TRF	Traffic (burst type)
TS	Transport Stream
TSS	Transparent Satellite Star
UI	User Interface
UW	Unique Work
WGS84	World Geodetic System 84

4 System overview

The RSM-B system shall be compliant with the widespread standards DVB-S (see [2] and [4]) and DVB-RCS [1]. The compatibility with these two standards is combined together with multispot capabilities and full cross-connectivity between the different Up-Link and Down-Link in the system. Figure 4.1 illustrates the previous concept.

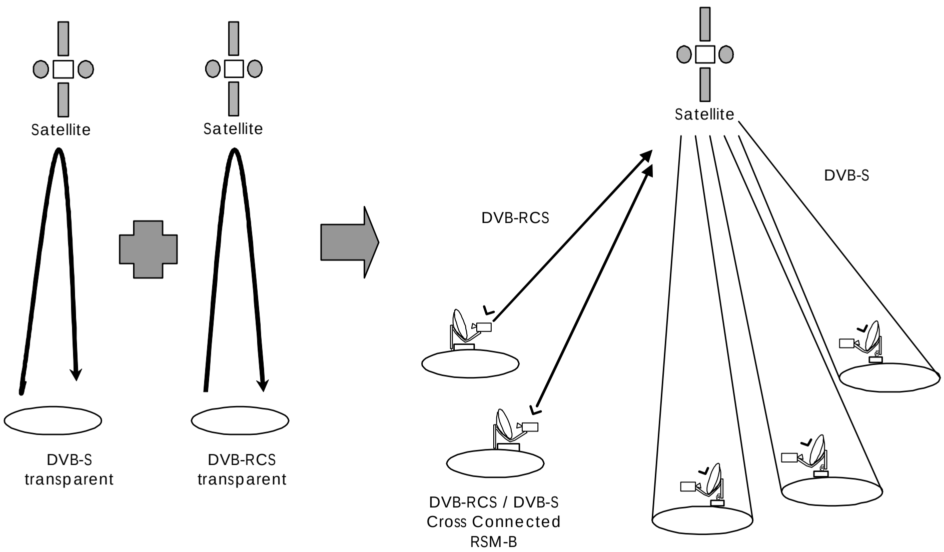

Figure 4.1: RSM-B system concept

The RSM-B network is configured to fit both Star and Mesh topologies. The RSM-B network is based on DVB-RCS specification for the return channel (uplink) and DVB-S specification for the forward channel (downlink) communications.

The RSM-B network provides broadband data services and access to terrestrial networks, mainly IP network and PSTN through gateways, star communications. RSM-B system may also be seen as a broadband multimedia platform oriented to mesh communications based in only one hop, very especially for those scenarios where broadband services and real-time communications are desired in a single and unique offer.

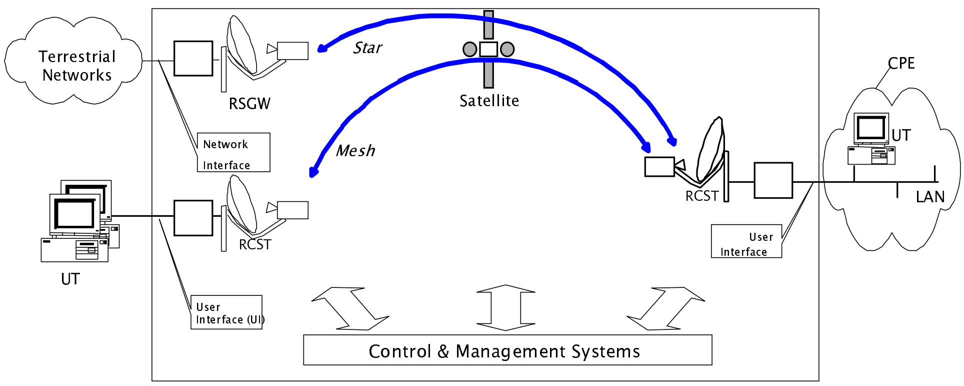

Figure 4.2: RSM-B network contour

4.1 Network architecture

Figure 4.3 illustrates the network architecture representing the different network elements and interfaces.

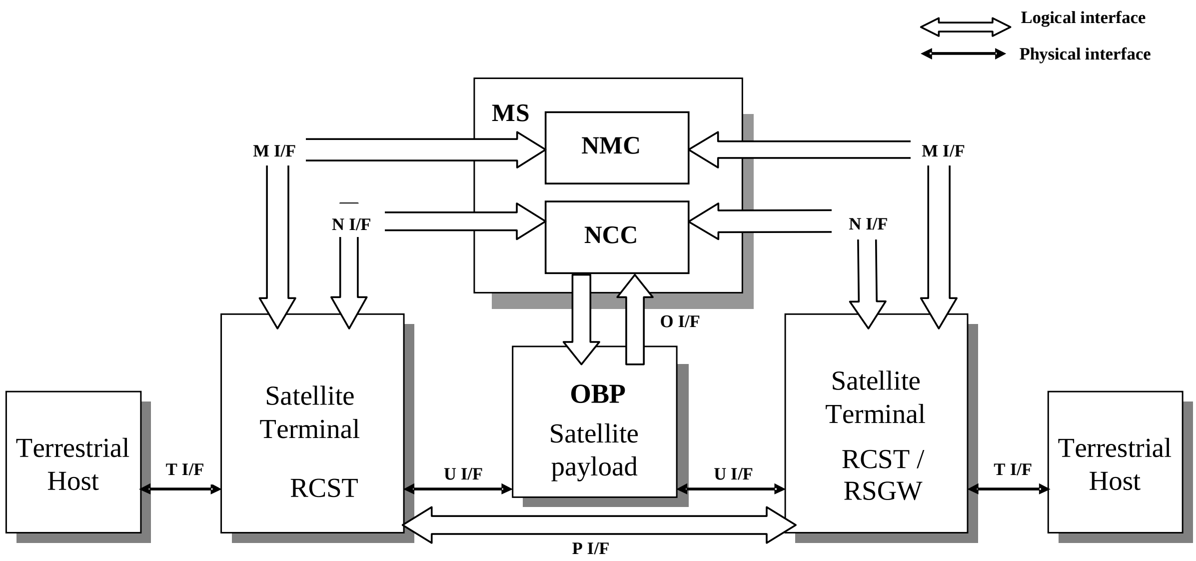

Figure 4.3: Network architecture

The RSM-B System includes the following elements :

- The On-Board Processor (OBP).
- The Management Station (MS).
- Regenerative Satellite GateWay (RSGW).
- Return Channel Satellite Terminal (RCST).

4.1.1 The On Board Processor (OBP)

The OBP is the core of the RSM-B system. The OBP combines the two existing satellite transmission standards, DVB-RCS and DVB-S, into a single regenerative multi-spot satellite system allowing a full cross-connectivity between the different up link and down link beams. It may include N transponders, each one of them composed of:

- Down conversion chain: RF IF down converter (DOCON), in charge of transposing the input channel from RF to BB frequency.

- Base-Band Processor (BBP) module whose role is to demultiplex, demodulate and decode carriers located within a transponder channel bandwidth in order to generate a single multiplex of MPEG-2 packets following the DVB-S standard using carriers information coming from any input transponder uplink.
- Modulator and up conversion chain: in charge of modulating the information into QPSK constellations and of placing it into the suitable frequencies according to the satellite frequency plan.

4.1.2 The Management Station (MS)

The MS is composed of two main components, the Network Control Center (NCC) and the Network Management Center (NMC):

- The Network Management Center (NMC) is in charge of the management of all network elements, and the network and service provisioning.
- The Network Control Center (NCC) is in charge of the control of the Interactive Network, e.g. serves satellite access requests from the users of the system, and manages the OBP configuration.

The MS satellite terminal, NCC_RCST, composed of:

- The NCC_RCST ODU which encompasses the NCC_RCST radio functions.
- The NCC_RCST IDU which supports the modulation and demodulation functions to access to the satellite.

4.1.3 The Regenerative Satellite GateWay (RSGW)

The RSGW provides the interface with external networks. This includes internetworking with the telephony oriented group networks such as PSTN or ISDN and the Internet/Intranet oriented ground networks. The RSGW could be interpreted as part of the Hub's functionality in star topology of a TSS access network. The RSGW is able to provide service guarantees to subscribers based on different quality-of-service criteria and different subscription levels. The peak uplink transmission raw bit rate of the RSGW is at least of 8 Mbps (2x4Mbps terminals). The RSGW maximum downlink throughput at IP level is at least of 8 Mbps. Low-cost RSGW for small ISPs can be provided only offering voice/video service reducing the peak uplink rate to 2 Mbps.

The RSGW is composed of different and configurable elements depending on the needs of connectivity. As for an example a RSGW may consist of:

- One or several GW_RCSTs.
- One or several IRDs.
- An IP router.
- An MCU (MultiConference Unit).
- Voice GW.
- Video GW.
- Gatekeeper.
- Multicast Satellite Adapter.
- QoS Module (SLA enforcer).

4.1.4 The Return Channel Satellite Terminal (RCST)

The RCST consists of two main units, the indoor unit (IDU) and the outdoor unit (ODU). The IDU contains the DVB-S/DVB-RCS modem and the interface to the local network. The ODU consist of the RF transmitter, one or more RF receivers, along with the antenna.

The RCST allows the RSM-B users to access:

- other RSM-B users either in single satellite hop (mesh connectivity) or with a double satellite hop through the RSGW (star connectivity);
- other external users to RSM-B network through the RSGW in a single satellite hop, e.g. PSTN or ISDN users or any IP-based internet services.

The peak uplink raw bit rates for different terminal classes can vary from 0,5 Mbps up to 8 Mbps. An RCST can support both guaranteed rate and delay as well as best-effort classes of service. The network quality of service mechanism in the RCST is based on prioritization of IP flows and the selection of the most suitable DVB-RCS transmission parameters for the application. The RCST may be connected to a LAN, made of one or several IP subnets.

4.1.5 Network interface

The interfaces identified in figure 4.3 Network Architecture are:

T Interface: User Interface (UI) between RCST IDU and user terminals (hosts) or LANs.

N Interface: NCC and RCST interface for control and signalling to support the U-plane (user) services (synchronization, DVB tables and connection control signalling).

M Interface: NMC and RCST interface for management purposes (SNMP and MIB interactions).

U Interface: Satellite payload and RCST physical interface (the air interface).

P Interface: Logical interface between two RCSTs for transaction of peer layer signalling traffic and user data traffic.

O Interface: NCC and OBP interface for OBP control and management.

4.2 System characteristics

The main characteristics of the system are:

- The up-link uses MF-TDMA according to the DVB-RCS standard, MPEG profile.
- The down-link is fully DVB-S compatible.
- A digital processor on-board the satellite allows to route MPEG packets from up-link to down-link beams in a flexible way with data replication on board for multicast applications support.
- The system supports single hop connectivity between RSM-B users and external users through the RSGW (star connectivity).
- The system supports single hop connectivity between RSM-B users (mesh connectivity).
- The system supports symmetric predictive traffic, as well as bursty traffic generated by a large number of users, owing to dynamic allocation.
- The system supports access to external networks such as PSTN and ISDN as well as private IP networks belonging to SPs (Service Providers).
- The system supports integrated IP based data services together with native MPEG video broadcasting.

4.3 Protocol stack architecture

The RSM-B protocol stack architecture represented in figure 4.4 is derived from the general protocol stack architecture as defined in the BSM functional architecture for IP interworking.

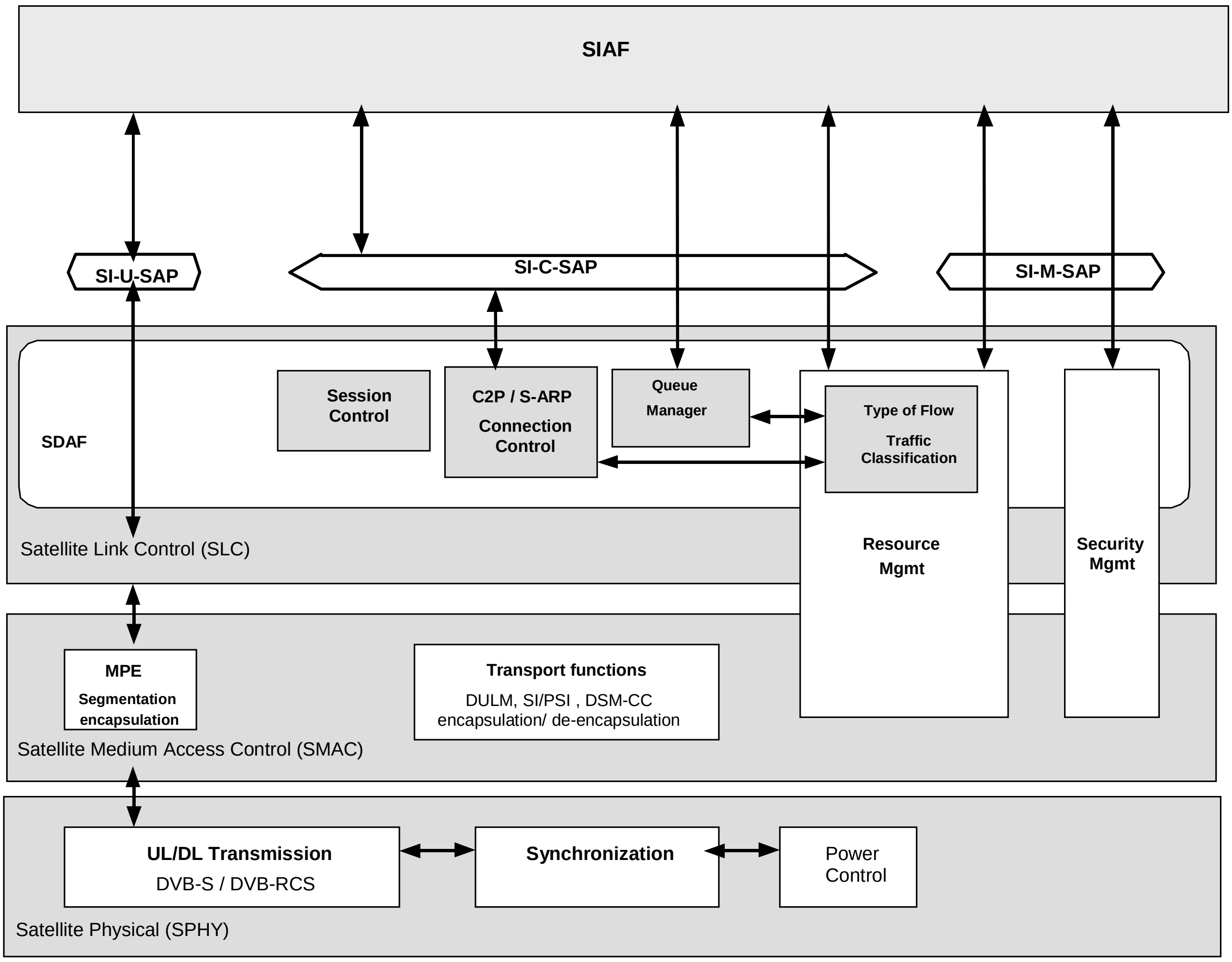

Figure 4.4: RSM-B functional protocol architecture

From the network point of view, RSM-B network is an IP network, where RCSTs act as IP routers, and the OBP acts as a circuit switch at MPEG2 level. Figure 4.5 represents the protocol stack for a mesh communication between two RCSTs through the satellite OBP.

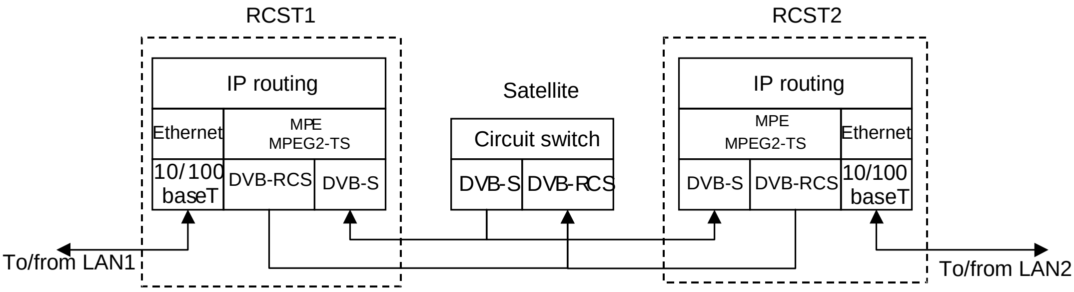

Figure 4.5: RSM-B protocol architecture

4.4 Air interface protocol architecture

The RSM-B network architecture is derived from the general protocol architecture as defined in the BSM services and architectures report. The RSM-B network architecture provides a split between Satellite dependent functions and Satellite independent functions.

Figure 4.6 illustrates the User plane (U-plane) from the RCST point of view.

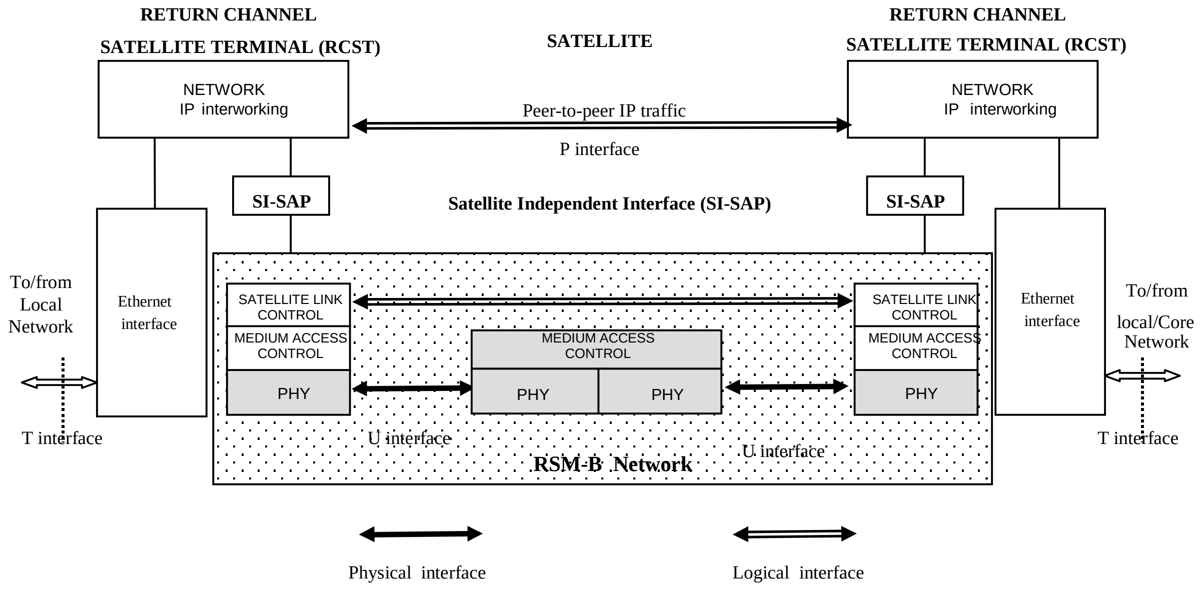

Figure 4.6: Air interface architecture

The RCST may have peer to peer communications with other RCST for mesh communications, or with other RSGW, for star communications.

In the OSI layering model, the SI-SAP is positioned between the link and network layers. The RSM-B core layers consist of the SLC (Satellite Link Control), SMAC (Satellite Medium Access Control) and PHY (Physical) layers.

The data link layer provides the actual transport service over the RSM-B network, as defined in the OSI layering model, the data link layer defines the access strategy for sharing the physical medium. It is divided in two sublayers:

- Satellite Link Control sub-layer exchanges IP datagrams with the Network layer.
- Satellite Medium Access Control sub-layer, responsible of transport functions: transmission traffic bursts of N MPEG packets and reception of MPEG packets contained in the TDM.

The present document defines the RCST Physical layer (clause 5) and Satellite Medium Access Control layer (clause 6) for these communications peer to peer. The rest of the multi-part specification describes the interface with upper layers:

- The Satellite Link Control Layer (see TS 102 429-2 - bibliography).
- C2P (see TS 102 429-3 - bibliography) corresponding to the N interface, required for the control and signalling for the U-plane (user) services.
- MIB description (see TS 102 429-4 - bibliography) corresponding to the M interface, required for the management interactions.

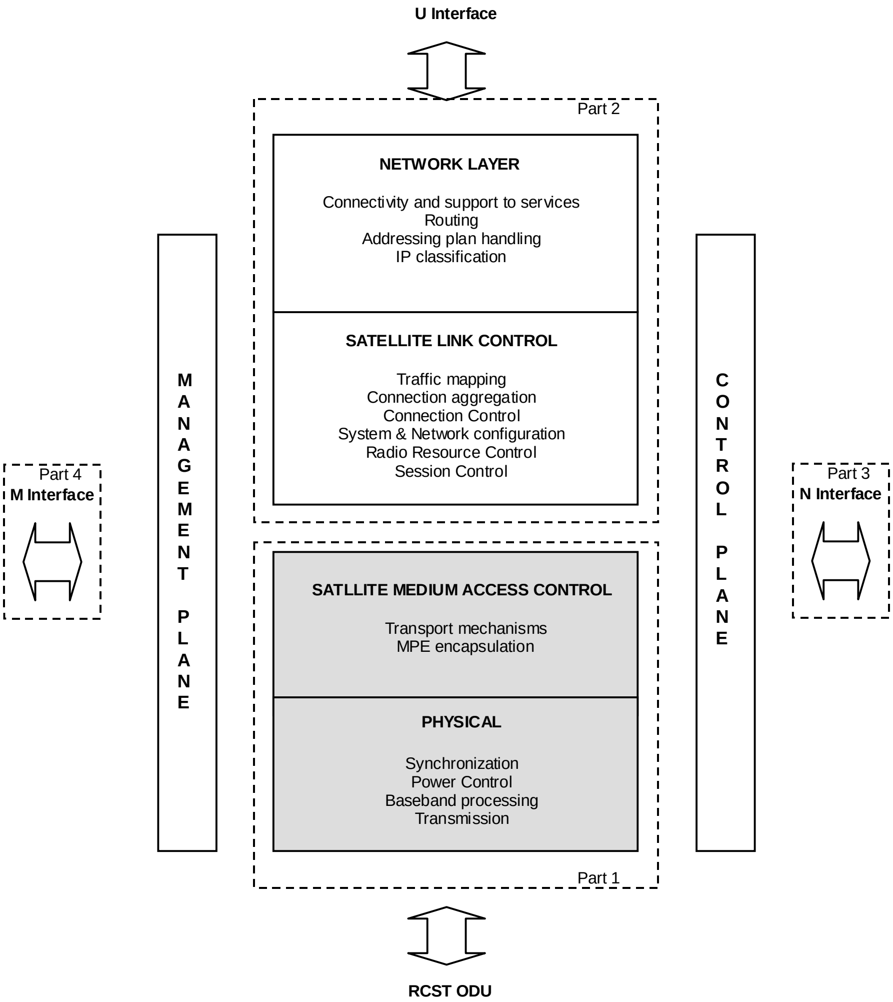

Figure 4.7: Architecture of the RCST functional layers

5 Physical Layer (PHY) overview

5.1 General

The physical layer provides the mean to transmit the data issued from the access layer, using the physical medium.

The physical layer is composed of three main functions in order to provide mechanisms and parameters to allow the Satellite Medium Access Control (SMAC) to correctly transmit the data flow on the physical means.

The physical layer functions are:

- Transmission function: This function performs signal baseband processing and radio transmission between the satellite and RCSTs. (clause 5.4).
- Synchronization function: The MF-TDMA access requires a very tight synchronization in time and frequency of RCSTs and the satellite OBP. The RCST synchronization function provides the physical layer with a stable timing and frequency reference that is used for downlink reception and accurate synchronization (both timing and frequency) of the uplink transmissions. (clause 5.5).
- Power control function: The main objective of the power control function is to compensate for variations of the radio channel and to minimize interference between signals received at satellite level, in order to optimize the system capacity and availability. (clause 5.6).

The complete RCST physical layer functions and their interfaces with the other layers are sketched in figure 5.1.

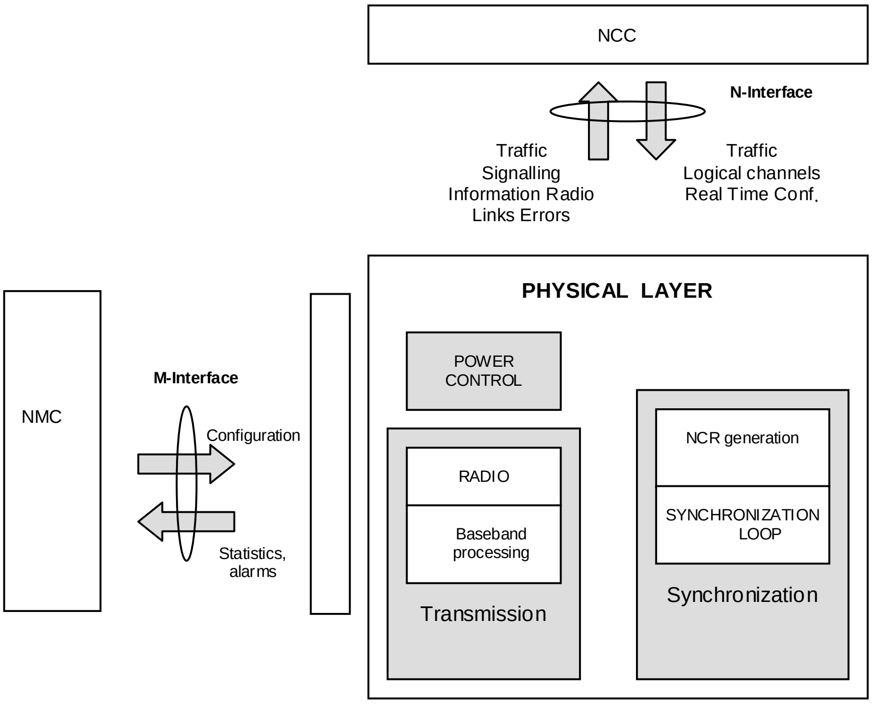

Figure 5.1: RCST physical layer functional breakdown

The above functions shall all conform to DVB-RCS (see EN 301 790 [1]) and DVB-S (see EN 300 421[2] and EN 300 468 [4]) specifications. The compliance with the standards requirements lead to a specific DVB-RCS waveform and DVB-S waveform, described in clauses 5.2 and 5.3.

The physical layer interfaces with:

- The management plane (M-plane): The RCST reports alarms and statistics to the NMC and is managed and configured by the NMC (based on SNMP and MIB interactions).
- The Control Plane (C-plane): The RCST reports physical parameter values to the NCC to allow the traffic and signalling flows monitoring (synchronization and power control functions). In reply, the Satellite Link Control Layer (SLC) provides real-time configuration parameters, logon parameters and traffic packets to be transmitted on the air interface.

In the RSM-B RCST user plane, the Physical layer is split in two independent parts:

- Uplink transmission : uplink signal or return channel based on the standard DVB-RCS (see EN 301 790 [1]).
- Downlink transmission: downlink signal or forward channel based on DVB-S standard (see EN 300 421 [2]).

In the RSM-B RCST control plane, the Physical layer includes control functions linked to synchronization and power control. The control plane functions of the RCST Physical layer includes:

- Generation of a local time, frequency reference in the RCST according to the received NCR.
- Alignment of bursts transmit time, frequency and power level according to the received corrections.

5.2 Up-link (DVB-RCS compliant)

The uplink waveform is compliant with the DVB-RCS standard. The uplink satellite access scheme is Multi-Frequency Time Division Multiple Access (MF-TDMA).

The MF-TDMA uplink is based on the transport of:

- MPEG packets (N MPEG packets per burst with N ≤ 24).
- Customized packets for the log-on and synchronization processes conforming to the DVB-RCS standard.

The encoding may use any of the Turbo Codes defined in EN 301 790 [1] and TR 101 790, but for the examples and values given through the present document only two TC (Turbo Codes) have been use (4/5 and 3/4). The pulse shape of the QPSK modulated signal is based on a root raised cosine filtering with a 0,35 roll-off.

The signal structure, i.e. the segmentation of physical resources into superframes, frames and time slots, follows the recommendation of the DVB-RCS standard. This segmentation is distributed over a pools of carriers, which constitutes the MF-TDMA channel.

The NCC allocates to each active RCST a series of bursts, each defined by a frequency, a bandwidth, a start of time and duration following the MF-TDMA schema.

The following clauses will describe a possible Time slot/Frame/Superframe hierarchy and carriers types for an RSM-B system.

5.2.1 Time slots

Each timeslot comprises one single burst plus guard time at each edge of the burst.

The guard time described hereafter for each burst corresponds to the minimum guard time required to cope with system timing errors and RCST power switch off transient.

Three types of bursts are considered: TRF bursts, CSC bursts and SYNC bursts.

The three types of bursts contain a fixed length preamble for timing recovery and for phase ambiguity suppression, set to 255 symbols.

5.2.1.1 TRF Time slot format

TRF bursts are used for carrying data traffic as well as signalling and other control messages. They are composed of several concatenated MPEG2-TS packets, each one of 188 bytes length. MPEG2-TS packets are randomized and coded and a preamble is added for burst detection. The number of MPEG-2 packets in one burst will depend on the code and number of bursts selected for the uplink frame.

Each MPEG2 packet includes a 1 472-bits (184 bytes) payload data field and a 32-bits (4 bytes) header.

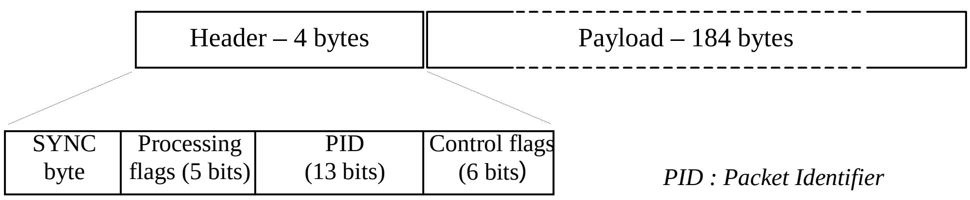

Figure 5.2: MPEG-2 transport packet

Each transport MPEG-2 packet includes a 4-byte header, which starts with a well-known synchronization byte. A set of flag bits is used to indicate how to process the payload.

A 13-bit Packet Identifier (PID) is used to uniquely identify each received stream. The PID allows the receiver to differentiate each stream from the other streams.

A TRF burst is made of a preamble and an encoded data packet. The last 48 symbols of the preamble constitute the Unique Work (UW) used for burst detection. The encoded packet consists of N MPEG-2 packets with N ≤ 24.

A TRF timeslot format is described hereafter:

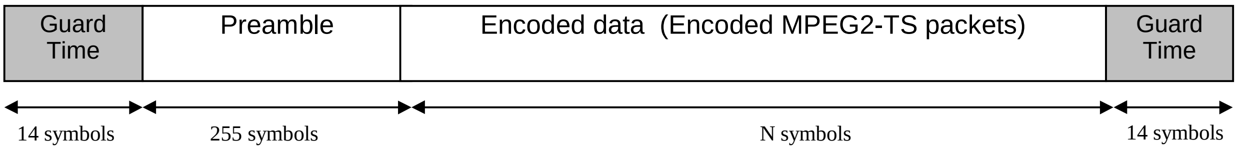

Figure 5.3: TRF timeslot format

The encoded data length N is given in table 5.1 according to the coding rate and number of TRF bursts for the uplink frame:

Table 5.1: Encoded TRF burst

Encoded data length	TC = 4/5	TC = 3/4
Configuration 1: Case 6 TRF bursts per frame or sub-frame	3 760	3 009
Configuration 2: Case 18 TRF bursts per frame or sub-frame	940	1 003
Configuration 3: Case 1 TRF burst per frame or sub-frame	22 560	24 072

5.2.1.2 SYNC Time slot format

SYNC bursts are required to accurately position RCST bursts transmission during fine synchronization and synchronization maintenance procedures, as well as to send capacity requests.

SYNC bursts are composed of a 16 bytes SAC field (OBP design constraint) consisting of:

- 4 requests (4 × 16-bits = 64-bits).
- A 16-bits MAC field.
- A group/logon ID (24-bits).
- A 16-bits CRC for error detection.
- 8 Stuffing bits to achieve a SAC of 16 bytes (inserted before CSC).

The SAC is randomized and coded and a preamble is added for burst detection.

SYNC timeslot format is described hereafter:

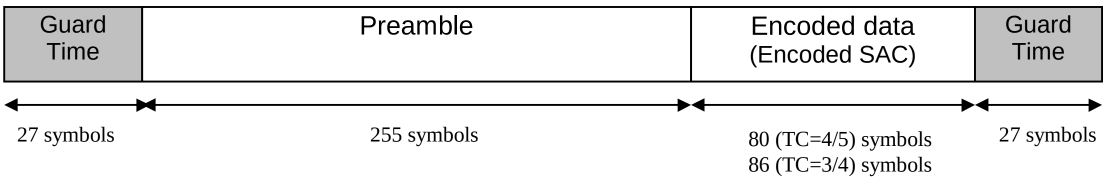

Figure 5.4: SYNC timeslot format

5.2.1.3 CSC Time slot format

CSC bursts are used by a RCST to identify itself during logon. They are composed of:

- a field describing the RCST capabilities (24-bits);
- the RCST MAC address (48-bits);
- a reserved field (40-bits);
- a CRC field (16-bits).

These fields are randomized and coded and a preamble is added for burst detection. The CSC burst total length is 16 bytes (including the 2 bytes of CRC).

CSC timeslot format is described hereafter:

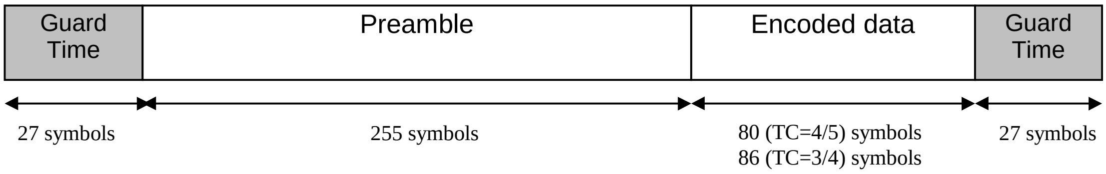

Figure 5.5: CSC timeslot format

5.2.2 Frames

A frame is a portion of time and frequency on the uplink and is composed of timeslots.

The uplink frame duration is fixed regardless the carrier data rate and Turbo-Coding rate. As a default value the frame duration is 69,632 ms, which corresponds to 1880064 PCR count intervals.

A frame spans over a pool of carriers. According to the carrier rate the frame will be structured in sub-frames. Table 5.2 gives an example of pool of carriers rate and the sub-frame composition:

Table 5.2: Frame composition in sub-frames

Carrier rate	Sub-frames
C1	1
C2	2
C3	4
C4	8
C5	16

In the present document, the frame is described for a C1 carrier rate. A frame is configured in terms of number of MPEG-2 packets per burst and number of bursts per frame. Other possible carrier types are composed of sub-frames that have the same structure as the C1 carrier rate.

The following tables describe the frame composition based on the Turbo Coding rate and the number of TRF bursts contained in the frame. Each TRF burst contains an integer number of MPEG packets and is allocated to a single RCST.

Table 5.3: Frame constitution

TRF Bursts per frame (for C1) or per sub-frame (for other data rates)	TC = 4/5		TC = 3/4	
	MPEG packets per burst	MPEG packets per frame	MPEG packets per burst	MPEG packets per frame
Configuration 1: 6 TRF	4	24	3	18
Configuration 2: 18 TRF	1	18	1	18
Configuration 3: 1 TRF	24	24	24	24

NOTE: The possible Turbo Code are detailed in DVB-RCS standard (see EN 301 790 [1]), clause 8.5.5.4, but only two (4/5 and 3/4) have been used for this example of frame composition.

The usage of the configuration of 1 TRF burst per frame or per sub-frame is oriented for video services.

In the case of 6 TRF bursts per frame, each TRF burst may be replaced by a group of 8 SYNC timeslots or by a group of 8 CSC timeslots (only for the C1 carrier).

In the case of 18 TRF bursts per frame, each group of 3 TRF bursts may be replaced by a group of 8 SYNC timeslots or by a group of 8 CSC timeslots (only for the C1 carrier).

The following tables detail the main parameters of different possible carriers according to the number of TRF packets per frame for two different TRF packets per frame configurations. Table 5.6 gives the parameters for the case of 24 TRF packets per frame and table 6.7 gives the parameters for the case of 18 TRF packets per frame.

Table 5.4: Carrier main parameters (24 TRF packets per frame)

Carrier type	C1	C2	C3	C4
Max Information bit rate per carrier (kbps)	518,38 = 1Ri	1 036,76 = 2Ri	2 073,53 = 4Ri	4 147,06 = 8Ri
Transmission QPSK Symbol rate (ksps)	350,99	701,98	1 403,95	2 807,90
Number of carriers per MF-TDMA Channel	64	32	16	8
MF-TDMA Channel information bit rate (Mbps)	33,18	33,18	33,18	33,18

Table 5.5: Carrier main parameters (18 TRF packets per frame)

Carrier type	C1	C2	C3	C4
Max Information bit rate per carrier (kbps)	388,79	777,57	1 555,15	3 110,29
Transmission QPSK Symbol rate (ksps)	350,99	701,98	1 403,95	2 807,90
Number of carriers per MF-TDMA Channel	64	32	16	8
MF-TDMA Channel information bit rate (Mbps)	24,88	24,88	24,88	24,88

5.2.3 Superframes

A superframe is defined by the DVB-RCS as a portion of time and frequency. A superframe consists of a number of consecutive frames. In the RSM-B system each superframe may be composed from 1 to 31 frames, by default 2. A superframe is defined for each 36 MHz transponder.

Figure 5.6 describes the superframe organization in time and frequency.

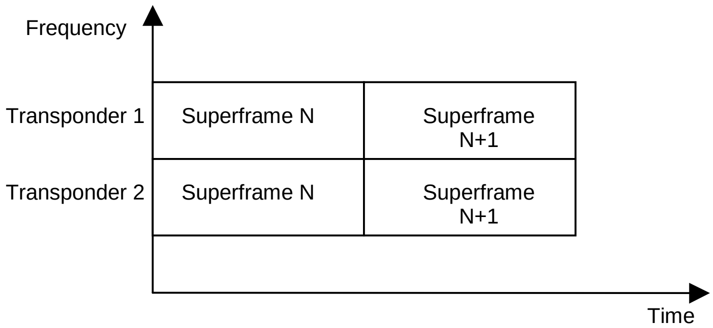

Figure 5.6: Superframes organization

Within a RSM-B Network, a Superframe_ID identifies the uplink resources accessed by a given set of RCSTs, so that different sets of RCSTs can be managed separately by using different Superframe_ID.

For each superframe, the allocation of timeslots is communicated to the RCST via the TBTP (Time Burst Table Plan) as described in DVB-RCS standard (see EN 301 790 [1]). An RCST is allowed to transmit bursts only in timeslots which were allocated to it (dedicated access) or on random-access timeslots (contention access). Some timeslots (like SYNC bursts) may be assigned to the RCSTs on the basis of a period much longer than one superframe. The period for these timeslots will be system dependent, but typically in the order of one second.

5.2.4 Carrier type and frame composition

An MF-TDMA channel is defined as a certain bandwidth divided in N sub-bands Each sub-band may be composed of a particular or combination of several carrier types.

Three types of carriers are considered:

- Logon carrier comprising either a CSC bursts and TRF bursts, or CSC bursts and SYNC bursts.
- Synchronization carrier constituted of SYNC bursts and TRF bursts, or only SYNC bursts.
- Traffic carried constituted only of TRF bursts.

Logon and synchronization carriers are C1 carriers.

Different traffic carrier may be defined. The number of carrier per sub-band depends on the bandwidth occupied by each class of carrier.

The following clauses describe as an example, what could be the timeslots partition per frame duration according to a certain carrier type (CSC, SYNC, TRF), carrier rate (C1, C2, C3 and C4) and carrier configuration (number of MPEG-2 packets per burst).

Examples of C1 carrier configurations is depicted in figure 5.7.

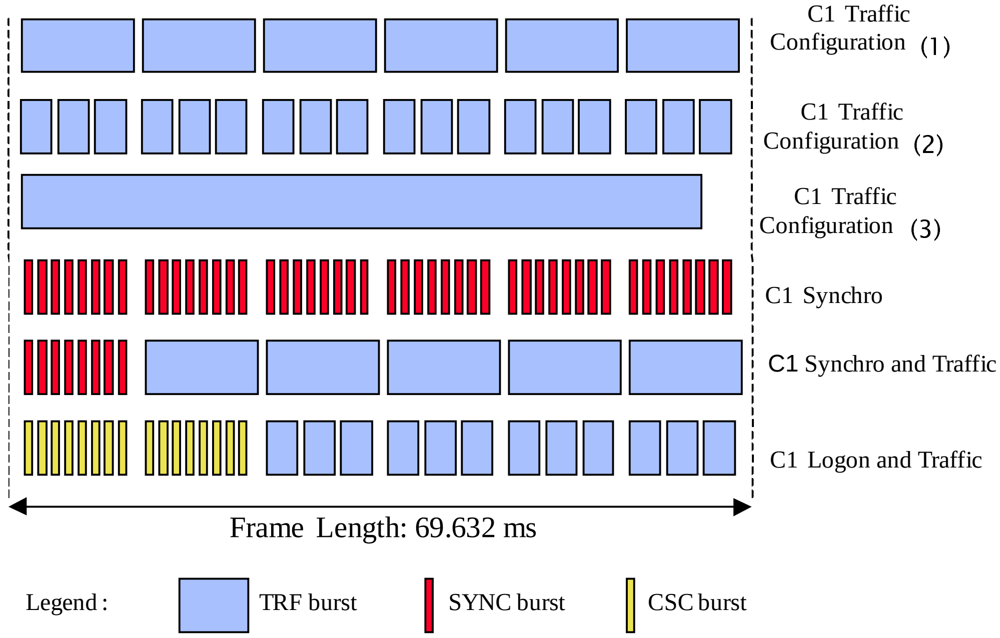

Figure 5.7: Examples of C1 carrier configurations

5.2.5 Uplink MF-TDMA channel frequency plan

In the following examples of the MF-TDMA composition a bandwidth of 36 MHz has been considered.

Uplink carriers are QPSK modulated using a roll-off factor of 0,35. A carrier spacing factor of 1,5 has been considered.

The total occupied bandwidth is independent of carrier class.

The 36 MHz band is divided into N sub-bands. As for example, in figure 5.8, the 36 MHz is divided into 4 sub-bands of 9 MHz. Each of these sub-bands may be configured independently. In this example the sub-bands are configured with 16 C1 carriers, 8 C2 carriers, 4 C3 carriers or 2 C4 carriers as shown in figure 5.8.

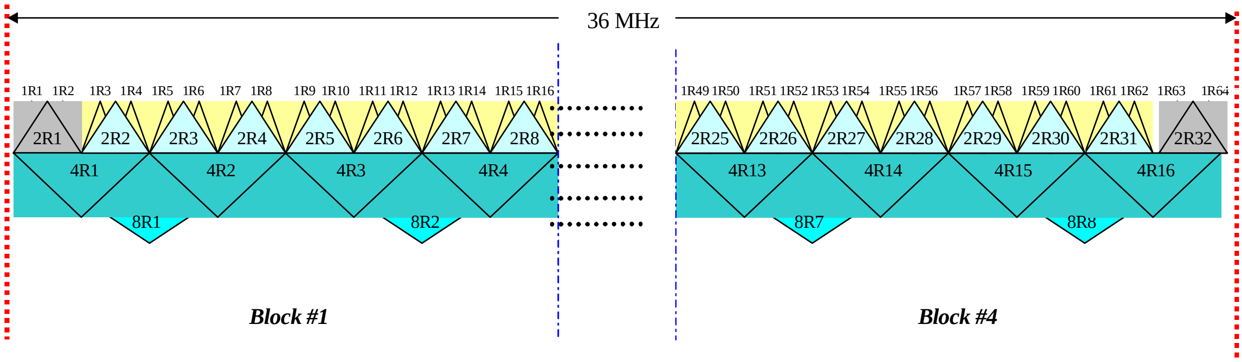

Figure 5.8: Uplink MF-TDMA channel frequency plan

At least one sub-band is configured with C1 carriers for logon and synchronization needs.

5.3 Down-link (DVB-S compliant)

The RSM-B downlink completely satisfies DVB-S standard (see EN 300 421 [2]). The On-Board DVB-Processor performs synchronous multiplexing of different MF-TDMA uplink channels into a TDM downlink signal. The considered framing is the same one as in uplink.

Once a TDM bit stream is obtained from the multiplexer section, it will be encoded in accordance with the DVB-S standard. The result will be a 27 Msym/s (QPSK symbols) DVB-S compliant stream.

5.3.1 Traffic rates

5.3.1.1 Transmission rate

The transmission rate selected for the downlink is 54 Mbps. This rate includes both the Reed-Solomon and Convolutional Codes. All the possible convolutional rates defined in the DVB-S standard (see EN 300 421 [2]) could be used (1/2, 2/3, 3/4, 5/6 and 7/8).

5.3.1.2 Downlink format

The downlink format is DVB-S standard (see EN 300 421 [2]) compliant. That means that the downlink waveform is constituted in fixed length MPEG-2 packets multiplexed on MPEG-2/DVB-S TDM streams.

Taking into account the premise of allocating an integer number of uplink channels within the downlink frame independently of the CVR code selected, the number of C1 (518,3 Kbps) uplink carriers that are mapped in the downlink and the maximum number of MPEG-2 packets during a frame as function of the convolutional rate (CVR) are as described in table 5.6.

Table 5.6: Packets per frame in a downlink TDM

CVR	Packets per frame
1/2	48 carriers (i.e. 96 × 1/2) × 24 = 1 152 packets
2/3	64 carriers (i.e. 96 × 2/3) × 24 = 1 536 packets
3/4	72 carriers (i.e. 96 × 3/4) × 24 = 1 728 packets
5/6	80 carriers (i.e. 96 × 5/6) × 24 = 1 920 packets
7/8	84 carriers (i.e. 96 × 7/8) × 24 = 2 016 packets

NOTE: The value of the minimum information data rate within an uplink carrier C1 has been selected taken into account two constraints:

- to be around 500 kbps;
- to be independent of the coding rate used in the downlink signal.

5.3.1.3 TDM capacity

Table 5.7 defines the maximum bit rate per TDM according to the CVR.

Table 5.7: Downlink TDM bit rate

D/L CVR	1/2	2/3	3/4	5/6	7/8
Raw data rate per TDM including RS and CVR (Mbps)	54	54	54	54	54
Reed-Solomon coding factor = 188/204	0,92	0,92	0,92	0,92	0,92
TDM data rate excluding RS (Mbps)	49,76	49,76	49,76	49,76	49,76
TDM data rate excluding RS, and CVR (Mbps)	24,88	33,18	37,32	41,47	43,54

As the maximum MF-TDMA channel bit rate is 33,18 Mbps (see tables 5.6 and 5.7), the downlink TDM data rate is greater than the uplink one in most cases, allowing on board packet duplication.

5.4 Transmission

The RCST transmission functions encompass the radio function and the baseband processing function for each link (uplink and downlink).

5.4.1 Uplink transmission functions

Uplink transmission functions consist of:

- DVB-RCS modulation and coding.
- Uplink RF transmission.

5.4.1.1 DVB-RCS modulation and coding

The RCST DVB-RCS modulation and coding function is fully compliant with DVB-RCS standard and consists of the functions described in figure 5.9.

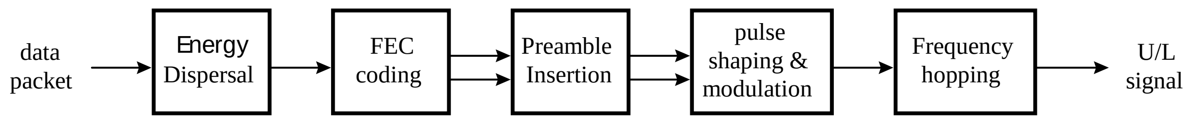

Figure 5.9: RCST DVB-RCS modulation and coding function

5.4.1.2 Uplink RF transmission

Uplink RF transmission function consists of:

- Baseband to RF up conversion: The baseband signal is up-converted from baseband to RF-band.
- RF amplification and emission: The signal is amplified before transmission via the transmit antenna. The achieved EIRP must cope with the link budget requirements.

5.4.1.3 Uplink RF reception

Uplink RF reception function consists of:

- RF reception and amplification: The RF-band signal is received via the satellite antenna filtered and amplified.
- RF to baseband down conversion: The signal is down-converted from RF-band to baseband.

5.4.1.4 Uplink transmission parameters

Uplink transmission configuration parameters are as follows:

Table 5.8: Uplink transmission configuration parameters

	CSC bursts	SYNC bursts	TRF bursts
Payload	16 bytes	16 bytes	MPEG packet basis
Modulation	QPSK		
Coding	CRC-16 and Turbo Code (see note)		CRC-32 and Turbo Code (see note)
Inner coding order	Natural		
Filtering	Root Raised Cosine filtering/Roll off 0,35		
NOTE : The possible Turbo Code values are detailed in DVB-RCS standard (see EN 301 790 [1]), clause 8.5.5.4.			

5.4.2 Downlink transmission functions

The RCST downlink transmission functions consist of:

- Downlink RF reception.
- DVB-S demodulation and decoding.

5.4.2.1 Downlink RF reception

Downlink RF reception function consists of:

- RF reception and amplification: The RF-band signal is received via the receive antenna, filtered and amplified.
- RF to baseband down conversion: The signal is down-converted from RF-band to baseband.

5.4.2.2 DVB-S demodulation and decoding

DVB-S demodulation and decoding function is fully compliant with the DVB-S standard and consists of the functions depicted in figure 5.10.

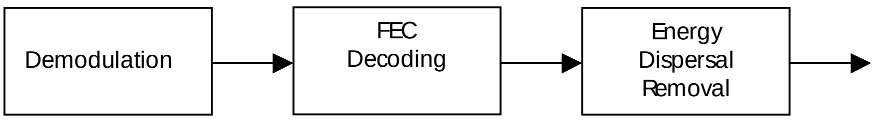

Figure 5.10: DVB-S demodulation and decoding function

5.5 Synchronization

5.5.1 Principles

The MF-TDMA access requires a tight synchronization in time and frequency between the OBP, the RCSTs, and the NCC to minimize interference and maximize throughput.

Conforming with the DVB-RCS standard, the synchronization objectives are:

- Carrier synchronization: each RCST reconstructs the reference clock from the received NCR. Each time the RCST receives a new NCR count, it compares it to its local NCR (from preceding reconstruction) to determine the offset to be applied to its local NCR to adjust its transmit frequency.

- Burst synchronization: the aim is to avoid contention between bursts from different RCSTs. The NCR is used to align the local absolute time reference, i.e. superframe start time, which is the basis for capacity segmentation and allocation through the TBTP (Terminal Burst Time Plan). The centre frequency, start time and duration of each transmit burst are defined in the DVB-RCS tables (SCT, FCT, TCT). The reference start of superframe is defined at OBP level.

- Symbol clock synchronization: The transmit symbol clock is locked to the NCR.

- Carrier, burst and symbol clock synchronization aim also to limit the time and frequency uncertainties in a suitable range for the on-board MF-TDMA demodulator.

5.5.2 Synchronization procedure

The synchronization function principle is described hereafter:

- The time reference called NCR (Network Clock Reference) is generated by the satellite.

- The OBP distributes periodically the NCR to all system elements through each DVB-S TDM using special PCR MPEG-2 TS packets.

- RCSTs perform time and frequency alignment to the reference. This includes the following functions:

  - Generation of a local time and frequency reference in every RCST. This local reference is controlled by the NCR reference received from the satellite.

  - Transmission by ground RCSTs of CSC and SYNC bursts on the MF-TDMA uplink.

  - The RCST computes the round trip delay (Tr) according to the current position of the satellite P(x,y,z) defined in the SPT and the RCST location set at installation as following:

$$T_r = 2\left(\sqrt{(x-x_0)^2+(y-y_0)^2+(z-z_0)^2}\right)\Big/c$$

  where c = 299 792 458 m/s and the used referential is WGS84.

- The OBP measures the timing error and frequency error from the CSC and SYNC bursts.

- The OBP forwards these measurements to the NCC.

- The NCC generates the related corrections. These corrections are looped-back to the RCSTs through the CMT and the TIM-u. The CMT and the TIM-u are transmitted to RCSTs through the air interface without on board processing.

- The alignment of transmit time and frequency is done by the RCSTs, according to received corrections.

- The RCSTs shall be able to apply the time and frequency corrections at the beginning of the frame just following the time of reception of CMT/TIM-u plus to 90 ms and does not apply the time and frequency corrections during transmission of a burst.

In the frame of the DVB-RCS standard, the information required for a synchronization process in addition to the NCR are composed of the CSC, ACQ (optional) and SYNC bursts. In RSM-B system, ACQ burst is not considered.

The general function of each burst is:

- CSC burst enables initial access to the interactive network in a contention mode through Slotted Aloha accesses.

- SYNC burst allows to achieve the fine synchronization procedure, with a first step of synchronization achieved through successive ground RCSTs transmission/OBP measurements/NCC corrections generation/RCSTs corrections application. Then SYNC burst also allows to maintain the synchronization by periodically checking the RCST synchronization during the session.

These bursts (CSC, SYNC) are consistent with the closed loop timing and frequency synchronization defined for the DVB-RCS standard. These bursts are necessary to enable the feedback of the signal corrections towards the RCSTs.

The architecture of the timing and frequency synchronization system for RCSTs is depicted in figure 5.11.

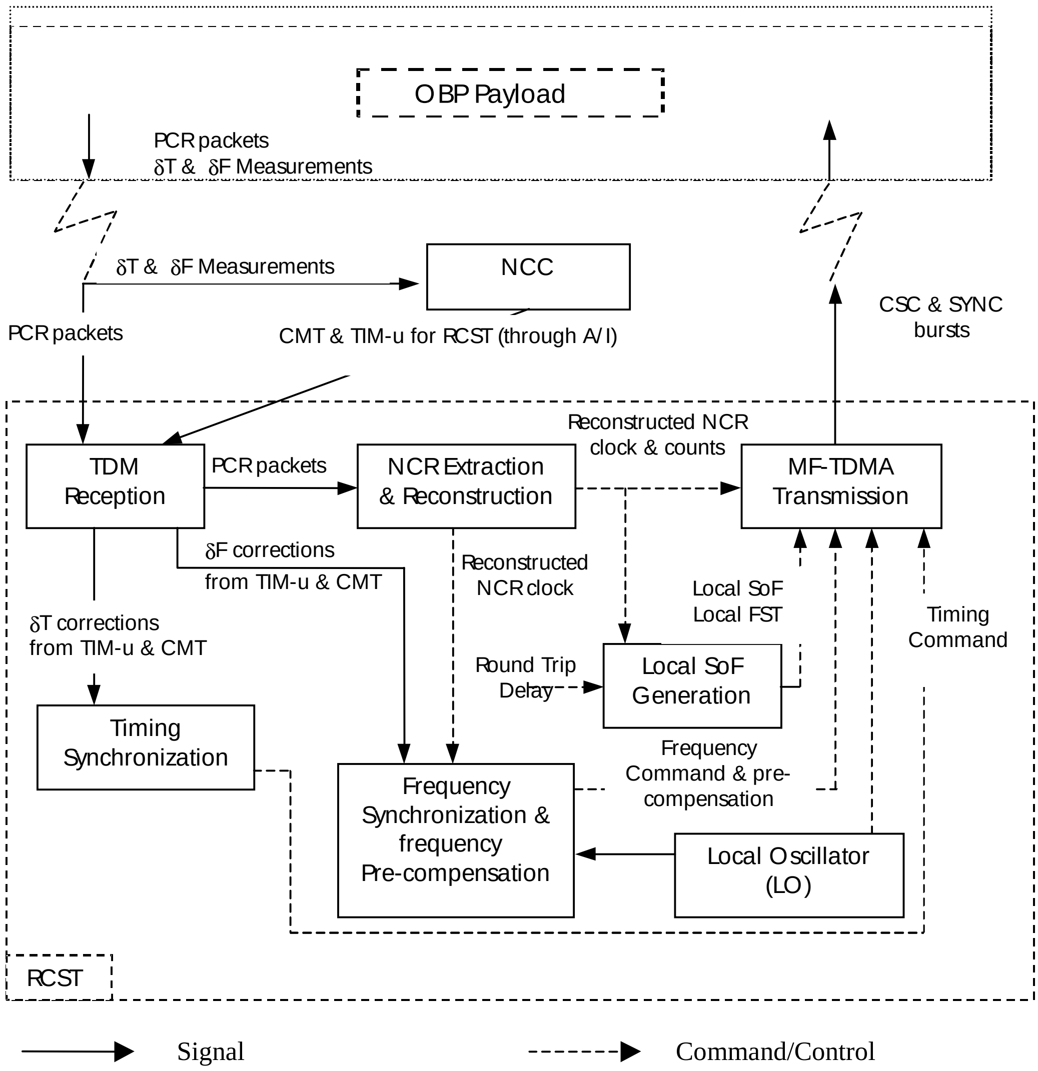

Figure 5.11: Timing and frequency synchronization architecture

5.6 Up-link power control

The power control is performed on the uplink only. On the downlink, signals are always sent, by the satellite, at maximum power.

The aim is to maintain the power flux received at satellite input at a constant level, which corresponds to the required operating point. It uses a feedback loop between the satellite and each RCST.

At OBP stage, the following measurements are performed over CSC and SYNC bursts:

- Power measurements.
- Phase noise power measurements.

These measurements are sent to the NCC to produce the correction information. The correction information corresponds to the measured Eb/No deduced from phase noise power (PNP) measurements as following:

$$\frac{E_b}{N_o}(dB) = -10\log(2\cdot Coding\_rate\cdot\pi) - 2\cdot PNP(dB) \quad \text{(for Es/No} \geq 6 \text{ dB)}$$

where the Coding_rate corresponds to any of the possible values in DVB-RCS standard (see EN 301 790 [1]).

The measured Eb/No is fed back to RCSTs through the TIM-u for CSC bursts and the CMT for SYNC bursts. The CMT and the TIM-u are transmitted through the air interface without on board processing.

The RCST transmits the CSC burst at :

$$Power(CSC) = MaxPowerLevelCSC$$

The RCST must compute the power correction according to the received Eb/N0 and the target Eb/No. This measurement is received in the TIM-u for logon.

The resulting correction from CSC bursts measurement is referred as $\Delta P(0)$. $\Delta P(0)$ is computed as following:

$$\Delta P(0) = Received\ Eb/N0 - TargetEbN0$$

The RCST transmits the first SYNC burst at:

$$Power(SYNC\#0) = MaxPowerLevelSYNC - \Delta P(0)$$

with a limitation to MaxPowerLevelSYNC.

Note that MaxPowerLevelSYNC = MaxPowerLevelCSC as SYNC and CSC bursts have the same waveform characteristics (same bit rate and same required Eb/No).

More generally, MaxPowerLevelSYNC = MaxPowerLevelCSC + offset , this offset corresponds to the following ratio: [Required Eb/N0 × Bit rate]SYNC / [Required Eb/N0 × Bit rate]CSC.

The following SYNC bursts are transmitted at:

$$Power(SYNC\ \#\ k) = MaxPowerLevelSYNC - \Delta P(0) - \Delta P(1) - \ldots - \Delta P(k)$$

with $\Delta P(k)$ the last power correction received in CMT corresponding to the last SYNC burst #(k-1) :

$$\Delta P(k) = Received\ Eb/No\ (SYNC\ \#k-1) - Target\ Eb/No$$

Power(SYNC#k) is limited to MaxPowerLevelSYNC.

The RCST transmits TRF bursts at:

$$Power(TRF) = MaxPowerLevelSYNC + PowerLevelOffsetSYNC\text{-}TRF - \Delta P(0) - \Delta P(1) - \ldots - \Delta P(k)$$

with $\Delta P(k)$ the last power correction corresponding to the last SYNC burst #(k-1):

$$\Delta P(k) = Received\ Eb/No\ (SYNC\ \#k-1) - Target\ Eb/No$$

Power(TRF) is limited to MaxPowerLevelTRF.

The RCST must apply the power corrections at:

- The end of the current frame + one frame duration, if the CMT/TIM-u are received in the following window: [Current frame beginning, Current frame beginning + 90 ms - one frame duration].
- The end of the current frame + 2 frames duration, if the CMT/TIM-u are received in the following window: [Current frame beginning + 90 ms - one frame duration, Current frame end].

The values MaxPowerLevelCSC, MaxPowerLevelSYNC, MaxPowerLevelTRF, PowerLevelOffsetSYNC and TargetEbN0 must be configured (either in the RCST MIB or by CLI/HTTP interface).

The description of these parameters is depicted in table 5.9.

Table 5.9: RCST configurable power correction parameters

Parameter	Description
TargetEbN0	Wanted Eb/N0 value that enables operation of the return link with the required error performance. The targetEbN0 corresponds to the required theoretical Eb/N0 with an additional margin taking into account channel variations, on board measurement errors… Only one targetEbN0 is defined per RCST and it corresponds to the required EbN0 for SYNC bursts.
MaxPowerLevelCSC	Corresponds to the maximum level for CSC bursts and is used as the reference level for these bursts
MaxPowerLevelSYNC	Corresponds to the maximum level for SYNC bursts and is used as the reference level for these bursts.
MaxPowerLevelTRF	Corresponds to the maximum level for TRF bursts and is used as the reference level for these bursts only when the power control is disabled
PowerLevelOffsetSYNC-TRF	This Offset (expressed in dB) corresponds to the following ratio: $[\text{Required Eb/N0} \times \text{Bit rate}]_{TRF}$ **/** $[\text{Required Eb/N0} \times \text{Bit rate}]_{SYNC}$
Enable/Disable measured Eb/N0	Enable/disable measured Eb/N0 from TIM-u/CMT

6 SMAC layer

The SMAC (Satellite Medium Access Control) layer is the sub-layer responsible for transmission and reception of MPEG packets to/from the physical layer. The transport function is in charger of:

- MPE-MAC address filtering;
- local PID's configuration;
- protocol stacks handling and the Segmentation;
- re-assembly mechanisms.

In the user plane, the SMAC layer interfaces the PHY layer in order to send traffic bursts of n MPEG and to receive all the MPEG packets contained in the TDM, filtering the packets according to their packet identifier, before sending them to the upper layer. The user plane functions of the SMAC layer includes MPEG2 formatting and MPE.

In the control plane, the SMAC layer sends logon content (specific CSC bursts) and capacity requests (specific SYNC bursts) to the Physical layer. The control plane functions of the SMAC layer includes the logon and synchronization of the RCST.

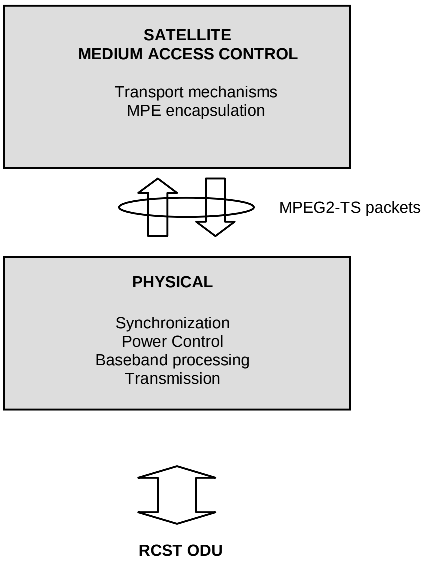

Figure 6.1: SMAC Layer interface with PHYSICAL layer

6.1 Transport mechanisms

The RCST transport mechanism protocol stack for traffic messages is based on DVB-RCS standard for the uplink (MPEG-2 packets mapped onto MF-TDMA bursts) and on the MPEG-2 standard in the downlink (MPEG-2 Transport Stream). Uplink and downlink use DVB Multi Protocol Encapsulation (MPE) packing to send IP datagrams over MPEG-2 packets.

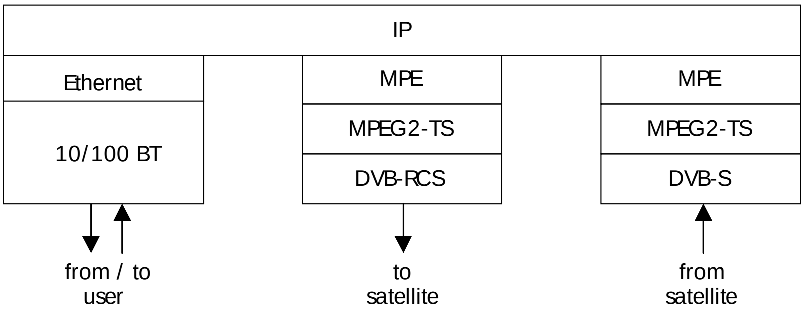

Figure 6.2: RCST user plane protocol stack

Return signalling message formats are defined in DVB-RCS standard. Signalling messages are composed of CTRL/MNGM messages mainly dedicated to the connection control protocol message, which are DULM encapsulated, and specific logon (CSC) and synchronization (SYNC) bursts. Capacity Requests are transmitted via the SAC field associated to each SYNC burst.

Forward signalling tables are encapsulated in PSI or SI, according to DVB-S standard. RCST specific messages (TIM) use DSM-CC encapsulation as defined in DVB-RCS standard. The on-board reference clock is transported in the adaptation field of dedicated PCR MPEG-2 packet.

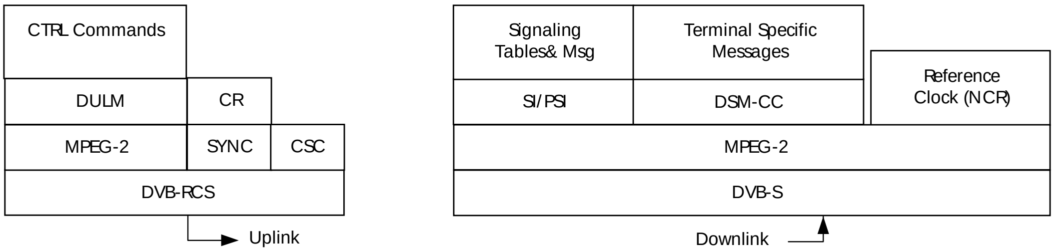

Figure 6.3: RCST control plane protocol stack

6.1.1 MPEG-2, DVB-S, DVB-RCS Tables description

The RSM-B network is a "DVB-RCS oriented" network. The Forward Link Signalling Information is therefore based on the mechanisms and the procedures such as described by the DVB-RCS standards, and based on the use of MPEG-2, DVB-S and DVB-RCS tables and messages.

This clause classifies the tables and messages used by RSM-B network (see figure 6.4).

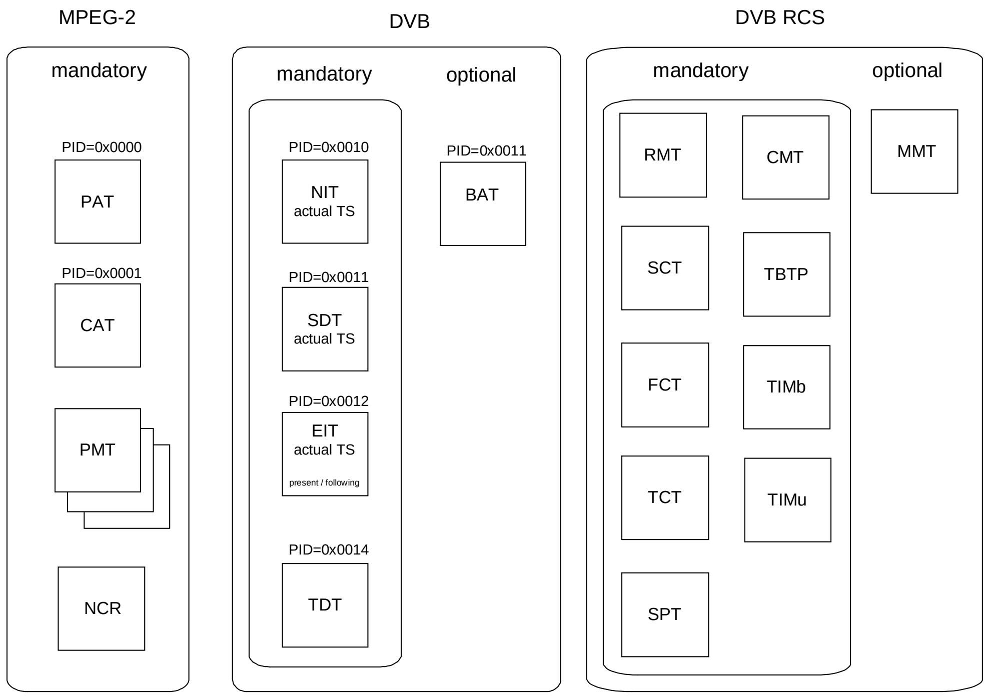

Figure 6.4: MPEG2 and DVB tables used in RSM-B network

6.1.1.1 MPEG-2 and DVB-S Tables description

The ISO/IEC 13818-1 (see bibliography) specifies the SI (Service Information) which is referred as PSI (Program Specific Information). The PSI data provides the information to enable automatic configuration of a receiver to demultiplex and decode various streams of programs within the multiplex. The PSI data is structured in four types of tables:

- **Program Association Table (PAT):** For each service in the multiplex, the PAT indicates the location (the Packet Identifier (PID) values of the Transport Stream (TS) of the corresponding Program Map Table (PMT).
- **Conditional Access Table (CAT):** This table provides information on the CA (Conditional Access) used in the multiplex.
- **Program Map Table (PMT):** The PMT identifies and indicates the location of the streams that make up each service, and the location of the Program Clock Reference fields for a service.
- **Network Information Table (NIT):** The NIT describes the Transport Streams participating to a DVB Network (identified by its network_id), and carries information to find the RCS service_id and its related TS_id and satellite link parameters.

In addition to the PSI, data is needed to provide identification of services and events to users. This data is structured in tables, but only the ones listed below are required for RSM-B:

- **Bouquet Association Table (BAT):** The BAT provides information regarding bouquets. As well as giving the name of the bouquet, it provides a list of services for each bouquet. This table is optional in RSM-B.
- **Service Description Table (SDT):** The SDT contains data describing the services in the system e.g. names of services, the service provider, etc.
- **Event Information Table (EIT):** The EIT contains data concerning events or programmes such as event name, start time, duration, etc.. The use of different descriptors allows the transmission of different kinds of event information e.g. for different service types.
- **Time and Date Table (TDT):** The TDT gives information relating to the present time and date. This information is given in a separate table due to the frequent updating of this information.

The syntax and semantics of these tables is detailed in DVB-S standard (see EN 300 468 [4]).

6.1.1.2 DVB-RCS Tables description

These tables format and semantics follow the DVB-RCS standard specification (see EN 301 790 [1]).

- **RCS Map Table (RMT):** The RMT describes transport streams tuning parameters to access to Forward Link Signalling services. The RCS Map Table may contain one or multiple linkage descriptors each pointing to one FLS service. Each FLS service shall carry a set of signalling tables (SCT, TCT, FCT, SPT, TBTP, CMT) and TIMs for a defined RCST population. Its usage and contents are described in detail in part 2 of the multi-part specification.

- **Superframe Composition Table (SCT):** This table describes the sub-division of the entire RSM-B network into superframes and frames. The table contains for each superframe, a superframe identification, a center frequency, an absolute start time expressed as an NCR value and a superframe count.

- **Frame Composition Table (FCT):** This table describes the partitioning of the frames into time-slots.

- **Time-slot Composition Table (TCT):** This table defines the transmission parameters for each time-slot type identified by the time-slot identifier. It provides information about the timeslot properties such as symbol rate, code rate, preamble, payload content (TRF, CSC, ACQ, SYNC) and others.

- **Satellite Position Table (SPT):** This table contains the satellite ephemeris data required to update the burst position at regular intervals.

- **Correction Message Table (CMT):** The NCC sends the CMT to groups of RCSTs. The purpose of CMT is to advise the logged-on RCSTs what corrections shall be made to their transmitted bursts. The CMT provides correction values for burst frequency, timing and amplitude. More details on the usage and format of CMT are given in part 2 of the RSM-B multi-part specification.

- **Terminal Burst Time Plan (TBTP):** This message is sent by the NCC to a group of terminals. It contains the assignment of contiguous block of timeslots. Each traffic assignment is described by the number of the start timeslot in the block and a repetition factor giving the number of consecutive timeslots allocation. More details on the usage and format of TBTP are given in part 2 of the RSM-B multi-part specification.

- **Multicast Map Table (MMT):** This table provides the RCST with the PID to decode to receive a certain IP multicast session.

- **Terminal Information Message (TIM):** This message is sent by the NCC either to an individual RCST addressed by its MAC address (unicast message) or broadcast to all RCSTs using a reserved broadcast MAC address and contains static or quasi static information about the forward link such as configuration. More details on the content of this type of message are described in part 2 of the RSM-B multi-part specification.

6.1.2 MPEG-2, DVB-S, DVB-RCS Tables construction and distribution

In RSM-B system, all the tables and messages, except the NCR, are formatted and distributed by the NCC. However, depending on the source of information (NCC, NMC or Service Provider), the type of tables (PSI, SI or DVB-RCS) and the way for updating content the following classification is proposed.

6.1.2.1 NCR constructed by the OBP

The NCR is derived from a on-board reference clock. It is conveyed in the PCR insertion TS packet and distributed by the OBP. There is one NCR counter per down-link TDM. These counters must by aligned in order to ensure system synchronization. Alignment is performed by simultaneously resetting the 4 counters through a command sent by the NCC.

6.1.2.2 Tables dynamically constructed by the NCC

CMT, TIM-u, TBTP and MMT DVB-RCS tables are assembled from dynamic interactive network information. They are entirely constructed and distributed by the NCC using configuration parameters transmitted by the NMC, and refreshed information returned by the OBP (measurements, burst payload extraction, ...) and the RCSTs (capacity and logon request, etc.).

6.1.2.3 Tables quasi-static assembled by the NCC

NIT, RMT, PAT and PMT are tables assembled by the NCC from quasi-static configuration information. This information is transmitted to the NCC by the NMC for satellite and RSM-B configuration purpose.

6.1.2.4 Tables partially assembled by the NCC

SCT, FCT, TCT and TIM-b are tables partially assembled from quasi-static configuration information. These xCT describe the segmentation in superframes, frames and timeslots of the uplink MF-TDMA capacity. They are used at the RCST forwards link acquisition and in case of a modification of the MF-TDMA channel composition.

The TIM-b mainly allows informing the RCST on the parameters linked to the logon and synchronization.

6.1.2.5 Table assembled from external information

The NCC receives from the NMC the satellite position expressed in meter and the time of application expressed in UTC format. In case of change of the Ephemeris file of the satellite notified by the NMC, the NCC loads the new Ephemeris file from the File Server. The NCC periodically updates the content of SPT according to the content of the current Ephemeris file and UTC time.

6.1.2.6 Table assembled from external information

The NMC may receive information from Video Service Providers to contribute to the constitution of specific tables (CAT, EIT, SDT) associated to video programs. The PIDs of these video programs need to be referenced in a PMT and the PID of such PMT must be indicated in the PAT.

6.1.3 Synthesis

Table 6.1: RSM-B MPEG-2, SI and DVB-RCS tables

Table	Type	Source info	Assembling	Insertion period (max)
CMT	RCS	NCC	NCC	every frame
FCT	RCS	NCC	NCC	10 s
NIT	SI	NMC	NCC	10 s
NCR	RCS	OBP	OBP	every frame
RMT	RCS	NCC	NCC	10 s
SCT	RCS	NCC	NCC	10 s
SDT	SI	SP for Video Services	NCC	10 s
SPT	RCS	NCC	NCC	10 s
TBTP	RCS	NCC	NCC	1 (or 2) frame
TCT	RCS	NCC	NCC	10 s
TDT	SI	NCC	NCC	30 s
TIM-u	RCS	NCC	NCC	
TIM-b	RCS	NCC	NCC	10 s
PAT	PSI	NMC	NCC	10 s
FLS-PMT	PSI	NMC	NCC	10 s
PMT	PSI	SP for Video Service	SP for Video Service	10 s
MMT	RCS	NCC	NCC	10 s

NOTE: The version number of the SI/PSI tables and of DVB-RCS tables is updated as follows:

- PAT, FLS-PMT, RCS-PMT, NIT, RMT, CAT, BAT, SDT, EIT, RST: updated each time a new version of the table is provided to the NCC.
- PMT : managed directly by Video Service Providers.
- SCT, FCT: updated automatically by the NCC when changed, for example after a modification of a frequency plan (BBP configuration).

- TCT: contains all timeslot types, not updated.
- SPT, CMT, MMT, TBTP, TIMu, TIMb: these tables are generated dynamically by the NCC, and therefore are updated at each modification.

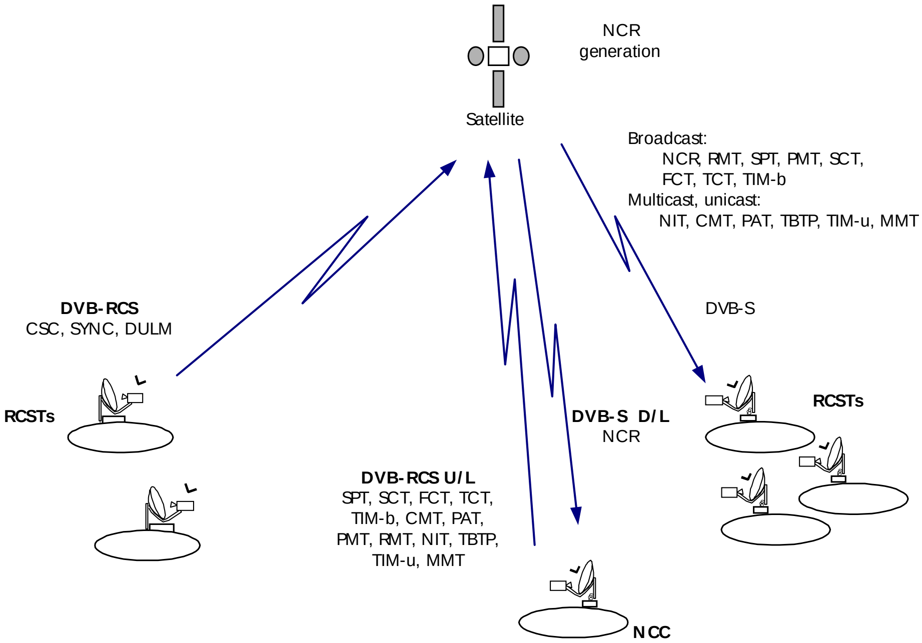

Figure 6.5: RSM-B signalling flow exchange

6.2 Multi Protocol Encapsulation (MPE)

In most cases, a section length will not be an exact multiple of MPEG packet payload(s), and it is possible that the last MPEG packet of a MPE section may be almost empty. The Multi Protocol Encapsulation (MPE) [3] provides a mechanism for transporting data network protocols on top of the MPEG-2 Transport Streams in DVB networks by emulating a LAN. It has been optimized for carriage of the Internet Protocol, but can be used for transportation of any other network protocol by using the LLC/SNAP encapsulation. It covers unicast, multicast and broadcast. The encapsulation allows secure transmission of data by supporting encryption of the packets.

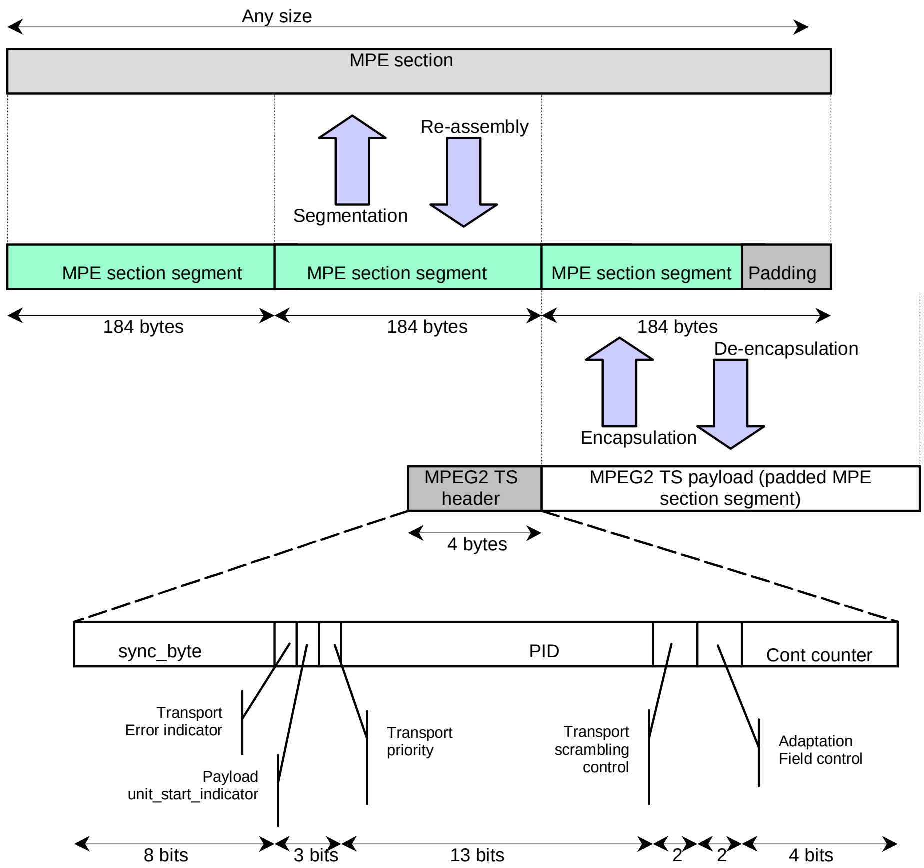

Figure 6.6: MPE section encapsulation within MPEG2-TS

MPE section packing is used so that the payload portion of the MPEG packet is fully used, leading to a better satellite bandwidth utilization. The packing idea is to replace the padding by the beginning of a (several) new MPE sections(s).

This implies that a new section will start in the middle of a MPEG packet, right after the end of the previous section. This may be done thanks to the PUSI (Payload Unit Start Indicator) flag of the MPEG2-TS header and a one-byte pointer occupying the first byte of the MPEG2-TS payload:

- The PUSI indicates the presence or not of a MPE section beginning and then of the pointer.
- The pointer gives the position of the first MPE section beginning. In the case of several section beginnings, their position can be deduced from the first one and the MPE section length given in each MPE section header.

Their usage is described below:

- PUSI = 0 indicates that that no MPE section begins in the packet.
- PUSI = 1 indicates that at least one MPE section begins in the packet.
- It is possible that the section header or CRC be split over two consecutive.
- The Padding bytes with the value 0xFF are added whenever there is no more section available to complete the MPEG packet payload.

Outside the section end case, the packing MPE/MPEG2 layer acts as the standard one, without any pointer.

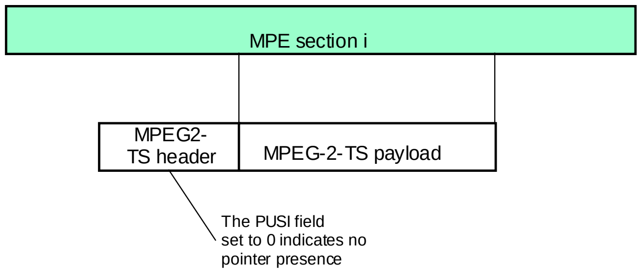

Figure 6.7: Packing MPE/MPEG2 layer behaviour (no section beginning)

In the section beginning case, the PUSI field indicates that the first payload byte is a pointer giving the position of the new section beginning.

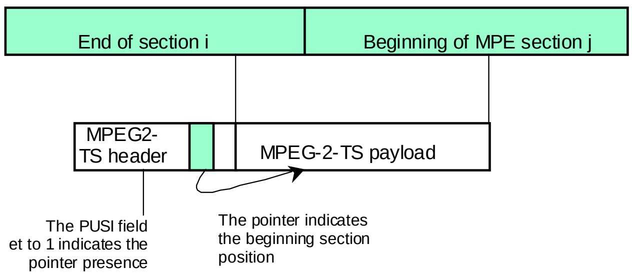

Figure 6.8: Packing MPE/MPEG2 layer behaviour (beginning of a new MPE section)

In the case of small MPE sections (small IP packets such as TCP ack or control packets) several sections may begin within the same MPEG2-TS. In that case, the PUSI field indicates that the first payload byte is a pointer giving the position of the first section beginning: the beginning of the other section can be deduced from the section_length MPE header field, the position of which is well known.

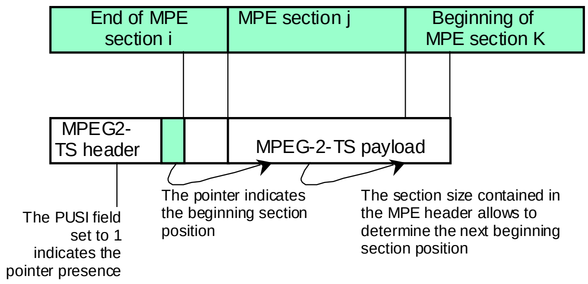

Figure 6.9: Packing MPE/MPEG2 layer behaviour (beginning of a several MPE sections)

Annex A (informative): Bibliography

- ETSI TR 102 187: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; Overview of BSM families".
- ETSI TR 101 202: "Digital Video Broadcasting (DVB); Implementation guidelines for data broadcasting".
- ETSI TR 101 984: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia ; Services and Architectures".
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- ETSI TS 102 429-2: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Regenerative Satellite Mesh - B (RSM-B); DVB-S/ DVB-RCS family for regenerative satellites; Part 2: Satellite Link Control layer".
- ETSI TS 102 429-3: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Regenerative Satellite Mesh - B (RSM-B); DVB-S/ DVB-RCS family for regenerative satellites; Part 3: Connection control protocol".
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- IETF RFC 1901: "Introduction to Community-based SNMPv2".

History

Document history		
V1.1.1	October 2006	Publication