

# ETSI TS 102 429-2 V1.1.1 (2006-10)

---

*Technical Specification*

**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**

---



---

Reference

DTS/SES-00241-2

---

Keywords

broadband, DVB, multimedia, satellite

**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  
Sous-Préfecture de Grasse (06) N° 7803/88

---

**Important notice**

Individual copies of the present document can be downloaded from:

<http://www.etsi.org>

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at

<http://portal.etsi.org/tb/status/status.asp>

If you find errors in the present document, please send your comment to one of the following services:

[http://portal.etsi.org/chaicor/ETSI\\_support.asp](http://portal.etsi.org/chaicor/ETSI_support.asp)

---

**Copyright Notification**

No part may be reproduced except as authorized by written permission.  
The copyright and the foregoing restriction extend to reproduction in all media.

© European Telecommunications Standards Institute 2006.  
All rights reserved.

**DECT**<sup>TM</sup>, **PLUGTESTS**<sup>TM</sup> and **UMTS**<sup>TM</sup> are Trade Marks of ETSI registered for the benefit of its Members.  
**TIPHON**<sup>TM</sup> and the **TIPHON logo** are Trade Marks currently being registered by ETSI for the benefit of its Members.  
**3GPP**<sup>TM</sup> is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.

# Contents

Intellectual Property Rights .....	5
Foreword.....	5
1 Scope .....	6
2 References .....	7
3 Definitions and abbreviations.....	7
3.1 Definitions .....	7
3.2 Abbreviations .....	8
4 Satellite Link Control Layer.....	10
4.1 Overview .....	10
4.2 Session control .....	11
4.2.1 Signalling messages .....	11
4.2.1.1 Forward link signalling from NCC to RCST .....	11
4.2.1.2 Return signalling from RCST to NCC .....	12
4.2.2 RCST Session Control procedure .....	12
4.2.2.1 Session Control procedures definition .....	12
4.2.2.2 Initial Synchronization procedure .....	14
4.2.2.2.1 Network Information Table (NIT).....	15
4.2.2.2.2 RCS Map Table (RMT).....	16
4.2.2.2.3 Program Association Table (PAT) .....	16
4.2.2.2.4 FLS Program Map Table (PMT) .....	17
4.2.2.2.5 Satellite Position Table (SPT) .....	17
4.2.2.2.6 Terminal Information Message broadcast (TIM_b) .....	18
4.2.2.2.7 Superframe/Frame/Timeslot Composition Table (SCT/FCT/TCT) .....	18
4.2.2.3 Logon procedure .....	18
4.2.2.3.1 RCST to NCC Logon request message (CSC burst) .....	19
4.2.2.3.2 NCC to RCST Logon response message (TIM-u).....	20
4.2.2.4 Fine Synchronization procedure.....	22
4.2.2.4.1 RCST to NCC Synchronization message (SYNC burst) .....	23
4.2.2.4.2 NCC to RCST Synchronization message (CMT) .....	23
4.2.2.5 Synchronization Maintenance procedure .....	24
4.2.2.6 Log-off procedure .....	24
4.2.2.6.1 Logoff sequence and timing .....	24
4.2.2.6.2 Logoff message .....	25
4.2.2.7 Hold mode procedure.....	26
4.2.2.8 Wake Up procedure.....	26
4.3 Resource Control.....	27
4.3.1 Overview .....	27
4.3.2 Definitions .....	27
4.3.2.1 Signalling definitions .....	27
4.3.2.1.1 Forward link signalling from NCC to RCST: TBTP (Terminal Burst Time Plan).....	27
4.3.2.1.2 Return signalling from RCST to NCC: SAC field (SYNC burst) .....	30
4.3.2.2 Capacity request categories definition .....	30
4.4 Connection control .....	31
4.4.1 Definitions .....	31
4.4.1.1 Connection .....	31
4.4.1.2 IP flow.....	31
4.4.1.3 Channel .....	31
4.4.1.4 Stream .....	31
4.4.1.5 Connection type .....	32
4.4.1.5.1 Signalling connections.....	32
4.4.1.5.2 Traffic connection .....	32
4.4.2 Signalling messages .....	33
4.4.2.1 Forward link signalling from NCC to RCST: TIM .....	33
4.4.2.2 Return link signalling from RCST to NCC: DULM .....	34

4.4.3	Major C2P attributes .....	34
4.4.3.1	Connection profile parameters .....	34
4.4.3.2	Capacity Request mapping.....	34
4.4.4	Functional mapping .....	35
4.4.5	Connection Control functions .....	36
4.4.5.1	On-demand connection control .....	36
4.4.5.1.1	On-demand connection establishment .....	36
4.4.5.1.2	On-demand connection release.....	39
4.4.5.2	Permanent connection control.....	42
4.4.5.2.1	Permanent connection establishment.....	43
4.4.5.2.2	Permanent connection release .....	43
4.4.5.2.3	Permanent connection channel modify.....	44
5	Quality of Service.....	44
5.1	Traffic classes.....	45
5.2	Flow classification.....	45
5.3	Link Layer connection QoS adaptation .....	45
6	Network Layer.....	46
6.1	Overview .....	46
6.2	IP addressing .....	47
6.2.1	Public IP address.....	47
6.2.2	Private IP address .....	47
6.3	RSM-B IP routing .....	47
6.3.1	Overview .....	47
6.3.2	IP routing and address resolution function .....	48
6.3.3	Default route .....	50
6.4	IP multicast.....	50
6.4.1	Star IP Multicast .....	50
6.4.1.1	Topology .....	51
6.4.1.2	Protocol stack.....	52
6.4.1.2.1	User Plane.....	52
6.4.1.2.2	Control Plane .....	52
6.4.1.3	RCST Star IP Multicast functions .....	53
6.4.1.3.1	RCST IGMPv2 Host.....	54
6.4.1.3.2	RCST IGMPv2 Querier .....	55
6.4.1.4	Connections for Star IP Multicast .....	56
6.4.1.4.1	Point-to-multipoint connection from the RSGW .....	57
6.4.1.4.2	Point-to-point connection from a RCST .....	57
6.4.2	Mesh IP Multicast.....	57
6.4.2.1	Topology .....	58
6.4.2.2	Protocol stack.....	59
6.4.2.2.1	User Plane.....	59
6.4.2.2.2	Control plane .....	59
6.4.2.3	RCST Mesh IP Multicast functions .....	60
6.4.2.4	Connections for Mesh IP multicast .....	61
6.4.2.4.1	On demand point-to-multipoint from an RCST.....	61
6.4.2.4.2	Permanent point-to-multipoint connection .....	62
	<b>Annex A (informative): Bibliography.....</b>	<b>63</b>
	History .....	64

---

## Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "*Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards*", which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (<http://webapp.etsi.org/IPR/home.asp>).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

---

## Foreword

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

The present document is part 2 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 defines the Satellite Link Layer and the Network Layer used within SES BSM Regenerative Satellite Mesh - B (RSM-B) to provide connections in a DVB-RCS network using Type A terminals. This corresponds to TS 102 429-2 as shown in the figure 1.1.

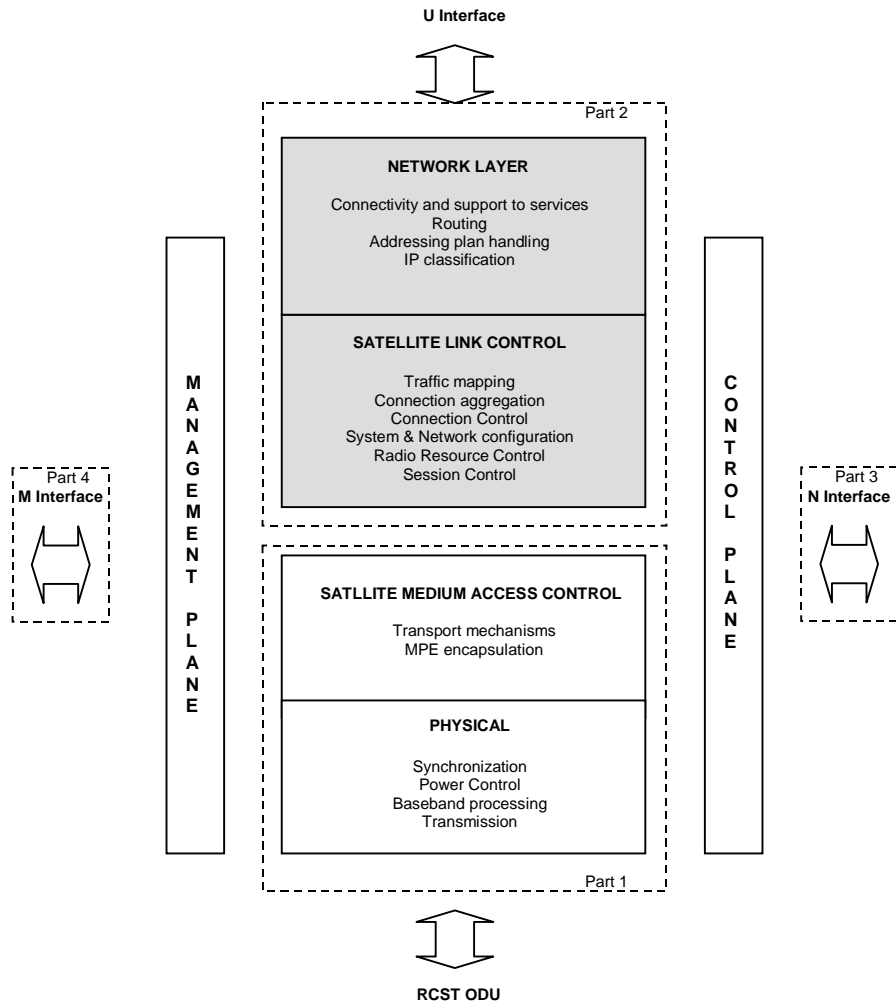


Figure 1.1: RCST functional layers architecture

---

## 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>.

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

- [1] ETSI EN 301 790: "Digital Video Broadcasting (DVB); Interaction channel for satellite distribution systems".
- [2] ISO/IEC 13818-1: "Information technology - generic coding of moving pictures and associated audio information; part 1: systems".
- [3] ETSI TS 102 429-1: "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 1: System overview".
- [4] IETF RFC 2113: "IP Router Alert Option".
- [5] IETF RFC 3376: "Internet Group Management Protocol, Version 3".
- [6] IETF RFC 1901: "Introduction to Community-based SNMPv2".
- [7] IETF RFC 1905: "Protocol Operations for Version 2 of the Simple Network Management Protocol (SNMPv2)".

---

## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in EN 301 790 [1] and the following 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

**control plane:** the control plane has a layered structure and performs the connection control functions; it deals with the signalling necessary to set up, supervise and release connections

**Digital Video Broadcasting Return Satellite Channel (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

**interactive network:** satellite interactive network where a certain DVB-RCS RCST belongs to

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

**Management Station (MS):** controls and manages the RSM-B network and 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 access, 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 downlink beams in a flexible way

**Return Channel Satellite Terminal (RCST):** low cost and high performance RSM-B network element installed in the user premises that provides interfaces with final users and 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 RCST installed inside an RSGW with enhanced properties in routing, IP multicast, connection control and management

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

NOTE: A RSGW is composed by a Gateway and one or several GW\_RCST. A Gateway includes all the network elements that will assure the interface with terrestrial networks (e.g. IP router, Voice gateway, Video gateway, Gatekeeper).

**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 Abbreviations

For the purposes of the present document, the abbreviations given in EN 301 790 [1] and the following apply:

BE	Best Effort
BSM	Broadband Satellite Multimedia
CAC	Connection Admission Control
ChModReq	Channel Modify Request
ChModResp	Channel Modify Response
CLI	Command Line Interface
CMT	Correction Message Table
cnx	connection
CnxEstReq	Connection Establishment Request
CnxEstResp	Connection Establishment Response
CnxRelReq	Connection Release Request
CnxRelResp	Connection Release Response
CRA	Constant Rate Assignment
CSC	Common Signalling Channel
D/L	DownLink
DAMA	Demand Assigned Multiple Access
DiffServ	Internet Differentiated Services
DSCP	DiffServ Code Point



DULM	Data Unit Labelling Method
DVB	Digital Video Broadcast
DVB-RCS	Digital Video Broadcast-Return Channel by Signalling
DVB-S	Digital Video Broadcast via Satellite
DVB-S2	Digital Video Broadcasting by Satellite transmission 2 <sup>nd</sup> Generation
ETSI	European Telecommunications Standards Institute
FCA	Free Capacity Assignment
FCT	Frame Composition Table
FEC	Forward Error Correction
FLS	Forward Link Signal
fwd	forward
GW_RCST	GateWay Return Channel Satellite Terminal
HP	High Priority
HPj	High Priority jitter sensitive
IDU	InDoor Unit
IE	Information Element
IETF	Internet Engineering Task Force
IGMP	Internet Group Management Protocol
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISO	International Standards Organisation
kbps	kilo bits per second (thousands of bits per second)
LP	Low Priority
lsb	least significant bit
M&C	Management and Control
MAC	Medium Access Control
MBGP	Multicast Border Gateway Protocol
Mbps	Mega bits per second (millions of bits per second)
MER	Multicast Edge Router
MF-TDMA	Multi-Frequency Time Division Multiple Access
MIB	Management Information Base
MMT	Multicast Map Table
MPEG	Moving Picture Experts Group
MPEG2-TS	MPEG2 Transport Stream
MS	Management Station
msb	most significant bit
MSDP	Multicast Source Discovery Protocol
NAT	Network Address Translation
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
PDR	Peak Data Rate
PID	Program IDentifier
PNP	Power Noise Phase
PSTN	Public Switched Telephone Network
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RBDC	Rate Based Dynamic Capacity
RCST	Return Channel Satellite Terminal
req	request
RMT	RCS Map Table
RS	Reed Salomon
RSGW	Regenerative Satellite GateWay
RSM	Regenerative Satellite Mesh
rtn	return
SAC	Satellite Access Control
SCT	Superframe Composition Table

SDR	Sustainable Data Rate
SI	Service Information
SLC	Satellite Link Control
SNMP	Simple Network Management Protocol
SP	Service Provider
SPT	Satellite Position Table
StrP	Streaming Priority
SYNC	SYNChronization burst type
TBTP	Terminal Bursts Time Plan
TC	Turbo Code
TCP	Transmission Control Protocol
TCT	Time-slit Composition Table
TDM	Time-Division Multiplex
TDMA	Time Division Multiple Access
TIM	Terminal Information Message
TRF	Traffic (burst type)
TS	Transport Stream
TTL	Time To Live
U/L	UpLink
UDP	User Datagram Protocol
UI	User Interface
UT	User Terminal
VPN	Virtually Private Network

---

## 4 Satellite Link Control Layer

### 4.1 Overview

In close connection with EN 301 790 [1], the Satellite Link Control (SLC) Layer, is constituted as a set of control functions and mechanisms which mainly ensure the access of IP flows to the physical layer and controls their transfer between distant points.

The functions identified are:

- **Session control function** (forward link acquisition, logon/logoff procedure, Synchronization procedure).
- **Connection control function** in charge of the establishment, release and modification of connections between two or several RCST's and between one RCST and the NCC. In the user plane, the connection control functions interfaces with the upper layers through interworking functions. These functions mainly insure a classification of incoming IP flows allowing their mapping on a certain connection (connection aggregation).
- **Resource control function** in charge of the capacity request generation, buffer scheduling and traffic emission control, allocation message processing (TBTP) and signalling emission control.

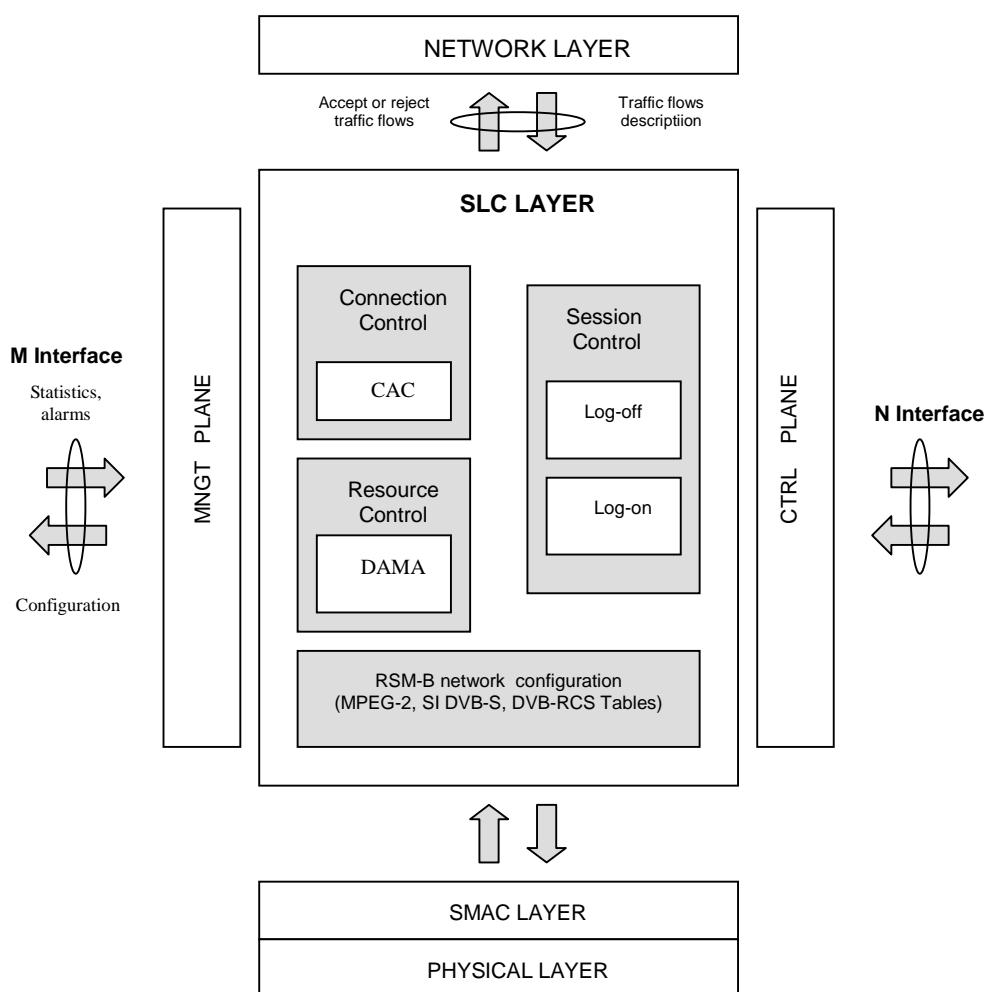


Figure 4.1: RCST SLC layer functional breakdown

## 4.2 Session control

The RSM-B Session Control procedures are based on EN 301 790 [1]. DVB-RCS is an open standard, therefore the particularization for RSM-B system are detailed in the following sections.

### 4.2.1 Signalling messages

This clause recalls the major messages exchanged between the RCSTs and the NCC in the session control context.

#### 4.2.1.1 Forward link signalling from NCC to RCST

**TIM-Terminal Information Message**, could be either Global (TIM\_b) or Individual (TIM\_u) message sent in DSM-CC (Digital Storage Media Command and Control) private section, using a reserved broadcast or RCST MAC address containing static or quasi static information about the forward and return link.

**CMT Correction Message Table** (and the Correction Message Descriptor attached to the TIM\_u) to include power, frequency and timing corrections to be applied by the RCST resulting from the SYNC burst preamble measurements (or the first CSC burst preamble during a logon process). The RCST identifier group\_id, logon\_id (MAC address) are extracted from the SYNC burst payload to identify the RCST measured.

### 4.2.1.2 Return signalling from RCST to NCC

The type of carrier authorized for the RCST logon and synchronization burst emission is always a C1 carrier, as described in TS 102 429-1 [3].

**The CSC burst , Common Signalling Channel**, is made of a preamble, followed by the CSC payload. The CSC burst is transmitted in random access by the RCST:

- To identify itself at logon via specific information (RCST capabilities and MAC address) extracted from the CSC burst payload.
- To initiate frequency and timing Synchronization and RF power adjustment via estimations on the CSC burst preamble and returned by the NCC (in the TIM\_u Correction Message Descriptor) for application if needed.

**The SYNC burst, Synchronization**, is made of a preamble, followed by the SAC field. The SYNC burst is:

- Used for fine Synchronization and to maintain it during session via repetitive frequency, timing and power estimations on the SYNC burst preamble and returned by the NCC (in the CMT) for application if needed.
- Used for capacity and logoff request, and Synchronization achievement notification via the SAC field extracted from the SYNC burst payload.

## 4.2.2 RCST Session Control procedure

The following specific principles have been followed:

- Session Control activity starts with Initial Synchronization (FLS acquisition).
- The DVB optional "coarse Synchronization" is not applied within the RSM-B system.
- Power control and Synchronization : the required corrections to apply are returned by the NCC to the RCST from estimations performed by the OBP on the CSC and SYNC burst preamble.

### 4.2.2.1 Session Control procedures definition

A Session is defined as the "time period" whereby the RCST is logged-on into the RSM-B network. To enter and quit the RSM-B network, the RCST has to logon and logoff into the network following the sequence of procedures detailed in EN 301 790 [1]. These phases are summarized below:

**Initial Synchronization procedure:** The RCST acquires the forward link signalling and the network clock (NCR) required to get all the information about the RSM-B network. Subsequently all the information about the RSM-B is received (see clause 4.2.2.2).

**Log-on procedure:** To allow the NCC to identify the RCST (via the MAC address) and to allow the RCST to receive its logical identifier valid for the duration of the session (Group\_id, Logon\_id, PIDs, SYNC burst, etc.). The RCST also starts its Synchronization and RF power adjustment (see clause 4.2.2.3).

**Fine Synchronization procedure:** For the RCST to achieve timing and frequency Synchronization and power adjustment. As soon as the RCST is logged, a SYNC slot on a Synchronization carrier is allocated to it up to log-off procedure (see clause 4.2.2.4).

**Synchronization Maintenance procedure:** Periodical repetition of the fine Synchronization (see clause 4.2.2.5).

**Log-off procedure:** To release all physical and logical resources, and exit from the network. The RCST will notify its logoff sending a SYNC SAC to the NCC (see clause 4.2.2.6).

Corresponding to these procedures, the RCST can be in one of the following states:

**Receive Sync state:** Initial Synchronization procedure achieved (forward link acquired) and ready for logon procedure initiation. The RCST may initiate the logon procedure based on:

- End-user request (through a CLI or HTTP interface), an stimulus transition.
- An NCC wake-up request (see clause 4.2.2.8) equivalent to Transmit\_Enable transition.

**Ready for fine sync state:** After logon procedure achieved (detected by the NCC), the RCST is ready for fine Synchronization procedure initiation.

**Fine sync state:** Fine Synchronization procedure is achieved and the RCST is ready for sending traffic.

**Stand-by state:** Anomalies have been detected during any one of procedures. Consequently, the RCST re-starts the initial Synchronization procedure.

**Off state:** The RCST is powered off (inactive) or has been logged off (out of the RSM-B network).

**Hold state:** This specific RCST state is activated by the NCC at any time of the RCST session (due to an operator decision). The NCC transmits the RCST status field `transmit_disable` set to 1 contained within the `TIM_u` (Transmit\_Disable transition) to force the RCST in the hold state (see clause 4.2.2.7). The RCST is authorized to proceed again the "Initial Synchronization" procedure only after receiving the "transmit\_disable" field set to 0 from the NCC (see clause 4.2.2.8). In case of power-off while being in the hold state, the RCST should remain in hold state after a new RCST power on. The RCST should then acquire the forward link and immediately returns into hold state to wait for a "transmit\_disable" field set to 0 from the NCC (transmit\_enable transition).

NOTE: The RCST must restart the initial synchronization procedure to enter into the "Receive Sync state" or "Hold state" (according the `Tx_disable` flag value) in the following cases:

- Logoff procedure initiated by the NCC.
- Logon\_fail\_(busy) notified by the NCC.
- Logon\_denied notified by the NCC (with `Tx_disable` set to 1).
- NCR not received for configurable seconds.
- Fine synchronization not achieved after consecutive SYNC attempts.
- Logon TIM\_u not received after configurable consecutive CSC attempts.
- CMT burst correction not received after configurable consecutive SYNCs.

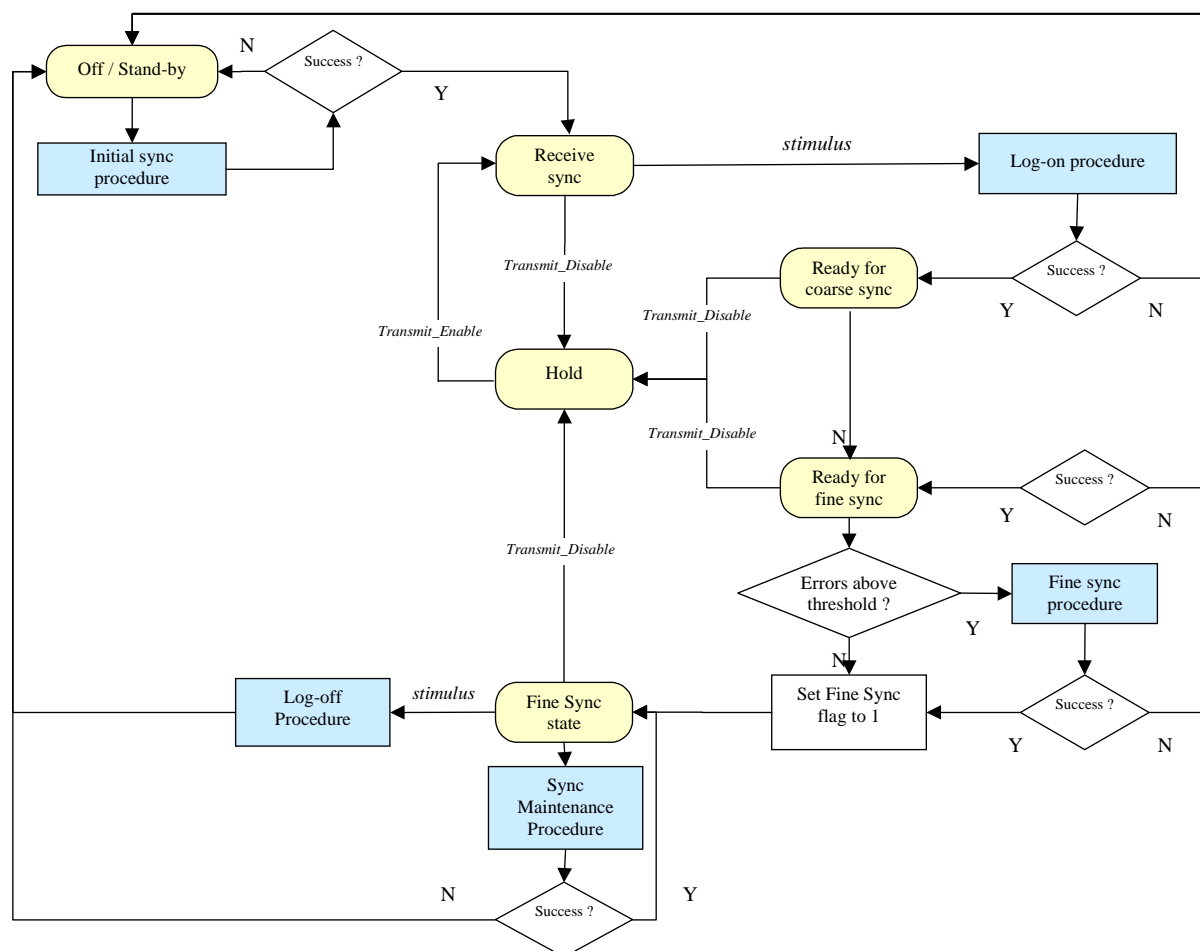
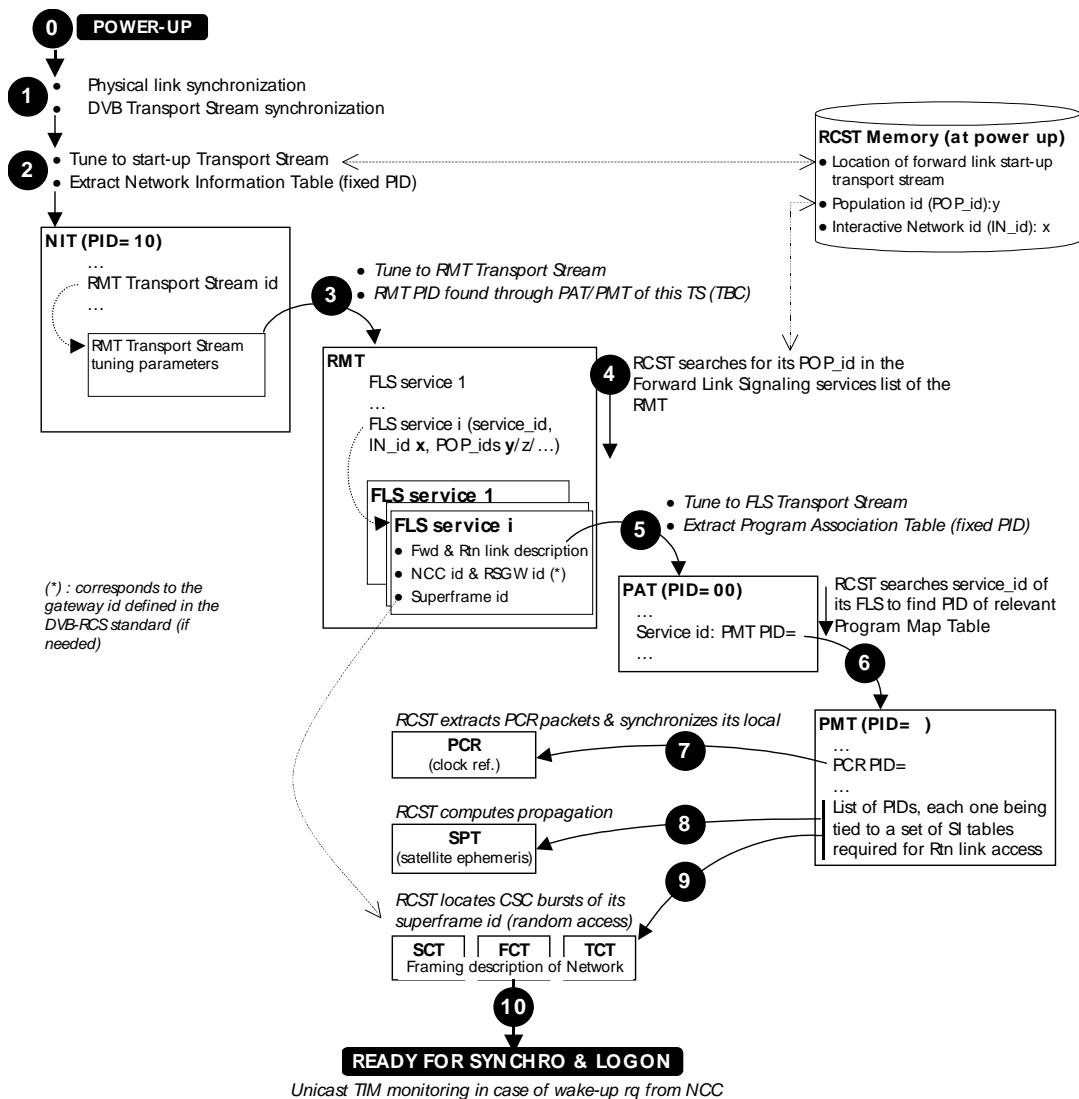


Figure 4.2: RCST Synchronization state diagram

#### 4.2.2.2 Initial Synchronization procedure

The initial Synchronization procedure of the RCST is performed according to the procedures defined in EN 301 790[1]. These procedures are described hereafter:

- RCST power up and software initialization.
- Physical link Synchronization (1).
- Loading network information from NIT (2) and localization of relevant Forward Link Signalling Service from RMT (3, 4).
- Extraction of the tables characterizing the service from PAT and PMT (5, 6).
- NCR Synchronization in order to lock ground local clock to the Satellite Network clock reference (7).
  - DVB-RCS specific tables loading, using PIDs listed in the PMT of relevant FLS service:
    - To get the satellite ephemeris for transmission error correction (8).
    - To get the framing structure of RSM-B network of the terminal and locate the dedicated time slots (random access) for logon request (9).



**Figure 4.3: Initial forward link acquisition procedure**

After these following steps, the terminal is in the "Receive Sync State". That means it is ready to transmit its CSC burst in slotted aloha mode for logon (10).

#### 4.2.2.2.1 Network Information Table (NIT)

As defined in EN 301 790 [1], the Network Information Table (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. The RCST is configured to tune to its start-up Transport Stream (TS), and locate the RMT from the NIT as follows:

*NIT header:* The RCST selects the NIT (PID = 0x0010, table\_id = 0x40), containing the RSM-B network\_id.

*NIT loop-1 (series of descriptors):* The RCST selects the linkage descriptor (descriptor\_tag = 0x4A) dealing with the RCS Map service (linkage\_type = 0x07).

- The RCST obtains the identifier of the transport stream carrying the RMT.
- The original\_network\_id shall be the RSM-B network.
- The RCST reads the service\_id assigned to the RCS Map service.
- The linkage descriptor dealing with RCS Map service is mandatory for the RCST, while others are ignored. The NIT shall contain only one linkage descriptor of this type.

- The network name descriptor (descriptor\_tag = 0x40) is mandatory and allowed only once.

NIT loop-2 (array of TS): The RCST selects the element dealing with this TS\_id found in RCS Map service linkage descriptor and with The original\_network\_id corresponding to RSM-B network\_id).

NIT loop-3 (series of descriptors, internal to loop-2): The RCST extracts the satellite delivery descriptor (descriptor\_tag = 0x43) and related parameters (frequency, orbital position, west\_east\_flag, polarization, modulation, symbol rate, FEC\_inner).

The satellite delivery descriptor is mandatory and allowed only once per loop-3, even when the RMT is always located in the start-up TS.

NOTE: When the RCS TS is physically different from start-up TS, the RCST has to tune to it as soon as NIT processing is completed.

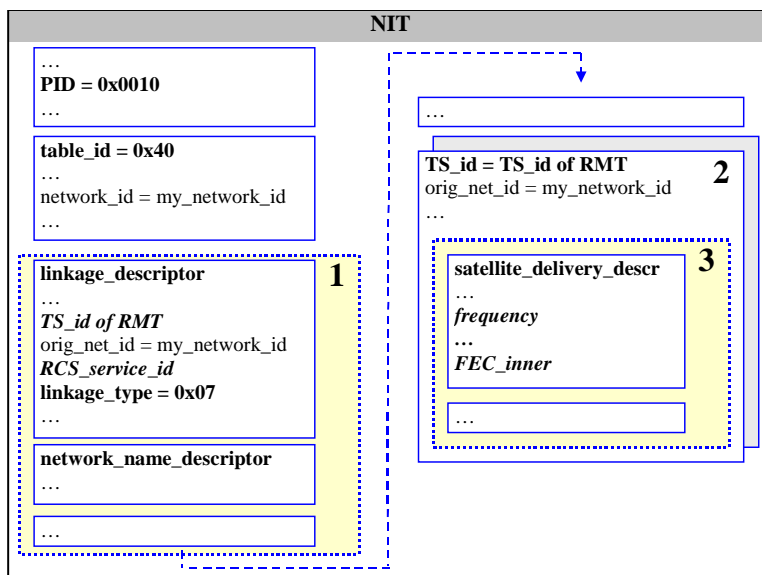


Figure 4.4: NIT: search for RMT

#### 4.2.2.2.2 RCS Map Table (RMT)

The RMT (RCS Map Table), whose Table\_ID is 0x41, describes transport streams tuning parameters to access to Forward Link Signaling services. It uses a linkage\_descriptor identified by a linkage\_type value of 0x81 (as defined in EN 301 790 [1]) that provides the association between one population\_id and a set of parameters:

- The original\_network\_id (equivalent to network\_id).
- The TS\_id.
- The service\_id, which carries the PID of the FLS service.
- The interactive\_network\_id (label that identifies the satellite network to which the table shall apply).

Each TS\_id tuning parameters are defined by the descriptors satellite forward link and satellite return link.

#### 4.2.2.2.3 Program Association Table (PAT)

A Program Association Table, whose format refer to ISO/IEC 13818-1 [2] exists in each Transport Stream and carries the location (PMT\_PID) of each program/service conveyed by this Transport Stream:

- the NIT\_PID fixed to 10 (Network\_program\_number 0).
- the PMT\_PID of the RMT, as defined in the NIT (TS acting as RCS TS).
- the PMT\_PID of the RCS FLS of the Interactive Network.



Each time access to a service is required, the RCST scans the PAT as follows to find relevant PMT:

- PAT header: The RCST selects the PAT (PID = 0x0000, table\_id = 0x00) of its current TS.
- PAT loop-1 (array of services): The RCST selects the service\_id of targeted service (RCS service\_id found in NIT, FLS service\_id found in RMT).

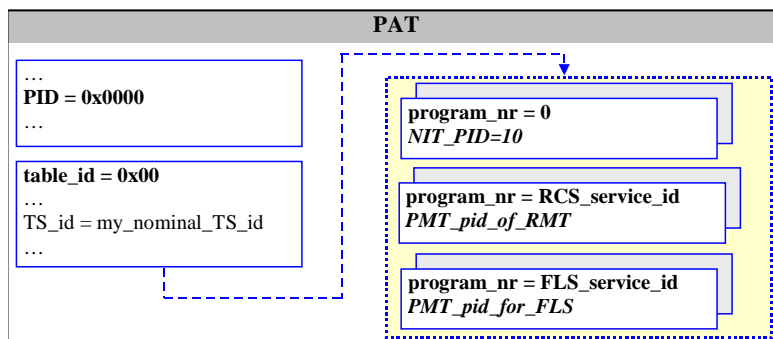


Figure 4.5: PAT: Search for services and PMT PIDs

#### 4.2.2.2.4 FLS Program Map Table (PMT)

The Forward Link Signaling service (FLS) conveyed by the Transport Stream, is described through the FLS-PMT which carries the PIDs of signaling tables. The PMT format shall refer to ISO/IEC 13818-1 [2].

The stream\_type of FLS-PMT table is set to 0x05 (private section).

The RCS\_content\_descriptor defines the following PID:

- PID for PCR.
- PID for: RMT, SPT, FCT, TCT corresponding to table\_id = 0xA1, 0xA3, 0xA1, 0xA2.
- PID for: SCT, corresponding to table\_id = 0xA0.
- PID for: CMT, TBTP, corresponding to table\_id = 0xA4, 0xA5.
- PID for: TIM\_u/TIM\_b, corresponding to table\_id = 0xB0.

#### 4.2.2.2.5 Satellite Position Table (SPT)

The SPT provides the RCST with the satellite ephemeris, to determine its emission instant, according to the distance between its own location and the satellite one. The SPT format shall refer to EN 300 421 (see bibliography).

The satellite co-ordinates, periodically refreshed, are cartesian coordinates defined in meter in the geodetic reference frame ITRF96 (IERS Terrestrial Reference Frame), in line with the WGS84 (World Geodetic System 84) reference system at the one meter level.

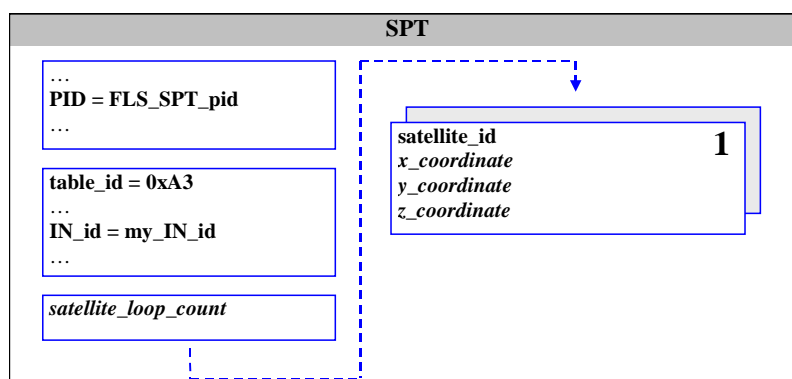


Figure 4.6: SPT: Search satellite coordinates

The RCST extracts the SPT (PID found in PMT or by configuration, table\_id = 0xA3), and selects the section dealing with its interactive network.

The RCST selects the element dealing with its satellite\_id (provided in RMT) and extracts the satellite coordinates.

#### 4.2.2.2.6 Terminal Information Message broadcast (TIM\_b)

TIM\_b is a message broadcasted to all the RCSTs. It contains the "Network\_status" and two descriptors, contention\_control\_descriptor and correction\_control\_descriptor given per superframe\_id.

The "Network status" of TIM messages are used to handle NCC restart and primary/back-up NCC switching.

**Table 4.1: TIM\_b Network Status**

Parameter	Size (bits)	Value/Comment
ID_encrypt	1 (msb)	"0"
Reserved	1	"0"
Reserved	1	"0"
CSC_link_failure	1	"0"
Link_failure_recovery	1	"1" once the synchronization of the NCC is achieved , the bit "link_failure_recovery" and during a configurable timeout, so as to smooth the logon attempts and minimize collisions through increase of RCSTs CSC response time out. "0" after configurable timeout and forward link recovery
Return_link_failure	1	"0"
NCC_receive_failure	1	"0"
Scheduler_Failure	1	"1" in case of primary NCC failure "0" no NCC failure When set to one, RCST shall suspend transmission of TRF burst, disable connection setup and internally release all traffic connections resources and flush buffers (meanwhile incoming traffic is discarded). It shall only maintain the control and management "connection" and the transmission of SYNC bursts with SAC field set to 0. The RCST shall wait for this bit to be set to 0 to enable connection setup.

#### 4.2.2.2.7 Superframe/Frame/Timeslot Composition Table (SCT/FCT/TCT)

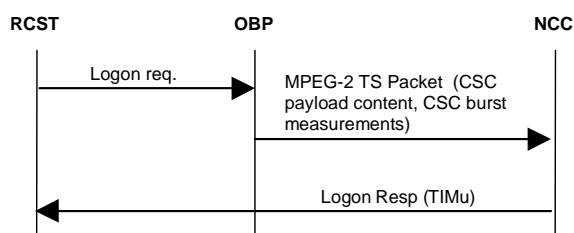
SCT/FCT/TCT tables shall be compliant with RSM-B waveform described in TS 102 429-1[3].

#### 4.2.2.3 Logon procedure

The logon procedure of the RCST is performed according to EN 301 790 [1] and is described hereafter.

The logon procedures are basically distributed over the RCST and the NCC as follows:

- RCST sends a logon request via CSC burst.
- NCC checks if registration allowed and logon response is sent back to RCST in the TIM\_u.



**Figure 4.7: Logon sequence**

RCSTs support dynamic connectivity and are provided at log-on with a default signalling connection towards the NCC. Hence during log-on they signal this capability using the "dynamic connectivity" flag in the CSC burst defined in EN 301 790 [1].

Upon successful log-on the RCST receives the Return\_CTRL\_MNGM\_PID which is used for control and management traffic towards the NCC (C2P signalling).

#### 4.2.2.3.1 RCST to NCC Logon request message (CSC burst)

The logon procedure relies on the random emission of a CSC burst activated by the session control of the RCST. It may also result from an NCC activation through a wake-up message.

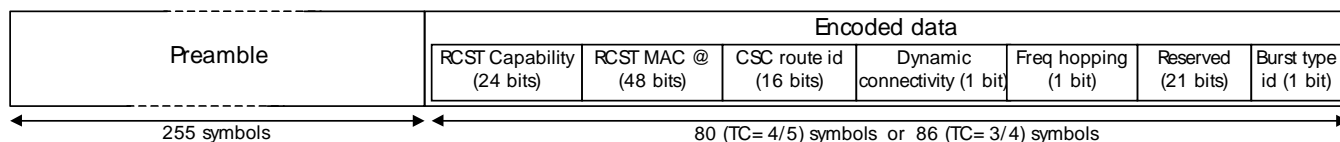
The RCST is able to estimate the transmission window of the CSC bursts (Slotted Aloha mode) from the satellite positions contained within the SPT (Satellite Position Table) and its own location.

Moreover, the RCST knows the CSC bursts position in the uplink MF-TDMA channel from the SCT (Superframe Composition Table), FCT (Frame Composition Table) and TCT (Timeslot Composition Table). This information has been acquired during the initial Synchronization procedure.

A CSC burst payload contains the RCST MAC address and its capabilities (security, supported protocols, radio characteristics, ...). The CSC burst preamble is used for Synchronization and power estimation purposes.

The terminals know the location of these CSC bursts thanks to the SCT, FCT and TCT. A CSC burst contains the terminal MAC address (physical address) and its capabilities (security, supported protocols, radio characteristics, ...).

The CSC burst is defined as follows, compliantly with EN 301 790[1]:



**Figure 4.8: CSC burst format**

The RCST capability parameters are described in the table 4.2:

**Table 4.2: RCST capability field of CSC burst**

Capability parameter	Size (bits)	Value/Comment
Security mechanism	1 (msb)	"0" (no security mechanism) "1" (security mechanism supported)
SNMP	1	"1" (SNMP supported)
ATM connectivity	1	"0" (Type A)
MPEG-TS TRF	1	"1" (supports MPEG2 TRF)
RCST boards	2	"00" (1 receiver)
RCST ACQ	1	"0" (ACQ not required)
Multi_IDU	1	"0" (single IDU per ODU) "1" (several IDU per ODU)
S/W Version	8	System dependent
Frequency Hopping Range	2	"10" (36 MHz system dependent pattern)
MF-TDMA	1	"0" (fixed MF-TDMA)
RCST Class	2	System dependent
Route_ID capable	1	"0" (route ID not used)
RCST Mode	2 (lsb)	"00": Installation mode "01": Operational mode "10": Reference RCST mode (measurements)
NOTE: This table defines all the permitted values. Any values that are not listed above shall not be used.		

Table 4.3: CSC burst data field parameters

Parameter	Size (bits)	Value/Comment
Preamble	255	
RCST capability	24	See table 4.2
RCST MAC address	48	RCST MAC address as per IEEE 802.3
CSC_Route_ID	16	"0" (not used)
Dynamic connectivity	1	"0" (supported)
Frequency hopping	1	"1" (frequency hopping supported between adjacent slots)
DVB-S capability	1	"1" (DVB-S capable)
DVB-S2 capability	2	"11" (DVB-S2 not capable)
Reserved	18	Reserved
Burst type identifier	1	"1" (identifies CSC burst)
NOTE: This table defines all the permitted values. Any values that are not listed above shall not be used.		

CSC burst re-transmission is conditioned by the following fields of TIM\_b Contention Control Descriptor:

- CSC-response-timeout.
- CSC-max-losses.
- Max-time-before retry.

The on-board Processor performs preamble estimations for each detected CSC burst and forward the CSC payload content with the measurements to the NCC through a specific MPEG-2 TS packet after translation into DULM Information Element.

#### 4.2.2.3.2 NCC to RCST Logon response message (TIM-u)

Before answering to a CSC payload successfully received by the NCC, a phase of admission control consisting of checking the subscriber identification, the access rights and system resources availability is performed by the NCC.

In case of admission, the reply is the unicast emission of a TIM\_u by the NCC (using DSM-CC private section mechanisms). The TIM\_u sections include the following information:

- RCST status.
- The Logon\_Initialise\_Descriptor that contains the Logon info : group\_ID and logon\_ID (logical address), MAC method, TRF burst type, and the Return\_CTRL\_MNGM\_PID for Connection Control Protocol (C2P) Messages.
- The Return\_TRF\_PID is not used by the RCST.
- The Correction\_Message\_Descriptor.
- The SYNC\_Assign\_Descriptor provided by the resource control (assignment of ACQ is not applicable in RSM-B).
  - The network\_layer\_information\_descriptor.

The Group\_ID and Logon\_ID sub-fields enable the NCC to identify the RCST that has transmitted a CSC burst in a contention timeslot. These are session parameters, and should remain valid during a logon session of the RCST.

The Forward Link descriptor and the Return Link descriptor are transmitted within the RMT.

The correction messages transmitted by the NCC contains frequency, time and power corrections to be applied on the next burst transmission, namely the first SYNC burst. To do this, the session control of the RCST extracts the Correction\_Message\_Descriptor of the received TIM\_u and applies the corrections.

The contents of TIM-u descriptors of a successful logon are described in the following tables:

**Table 4.4: Logon initialize descriptor**

Parameter	Size (bits)		Value/Comment
	Reserved	Information	
descriptor_tag		8	0xA2 (as defined in table 29 of EN 301 790 [1])
Descriptor_length		8	Number of bytes immediately after descriptor_length field
group_id		8	Assigned by the NCC
logon_id		16	Assigned by the NCC
security_handshake_required	3	1	"0"
prefix_flag		1	"0"
data_unit_labelling_flag		1	"1"
mini_slot_flag		1	"0"
contention_based_mini_slot_flag		1	"0"
capacity_type_flag	1	1	"0"
traffic_burst_type		1	"1"
return_TRF_PID		13	"0" (not used)
return_CTRL_MNGM_PID	3	13	Assigned by the NCC (used for RCST to NCC connection control signaling messages)

NOTE: This table defines all the permitted values. Any values that are not listed above shall not be used.

**Table 4.5: Sync assign descriptor**

Parameter	Size (bits)		Value/Comment
	Reserved	Information	
descriptor_tag		8	0xA4 (as defined in table 29 of EN 301 790 [1])
descriptor_length		8	"00001010" (10 byte long)
SYNC_achieved_time_threshold		8	configurable parameter
Max_SYNC_tries		8	configurable parameter
SYNC_achieved_frequency_thresh old		16	configurable parameter
SYNC_start_superframe		16	current Superframe_counter plus the SYNC_repeat_period
SYNC_frame_number	3	5	configurable parameter
SYNC_repeat_period		16	18 superframes
SYNC_slot_number	5	11	configurable parameter

NOTE: This table defines all the permitted values. Any values that are not listed above shall not be used.

**Table 4.6: Correction message descriptor**

Parameter	Size (bits)		Value/Comment
	Reserved	Information	
descriptor_tag		8	0xA1 (as defined in table 29 of EN 301 790 [1])
descriptor_length		8	"00000101" (5 byte long)
time_correction_flag		1	"1"
power_correction_flag		1	"1"
frequency_correction_flag		1	"1"
slot_type 2 bit field		2	"01" (CSC)
burst time scaling		3	"100"
burst time correction		8	Computed by NCC from burst time of arrival estimated by OBP (correction to be added by the RCST to previous value)
power_control_flag		1	"0"
Eb/N0		7	-10log (coding × $\pi$ ) 2 × PNP, based on Power Phase Noise sent by OBP to NCC, with coding as defined for C1_logon carriers
frequency_correction		16	frequency error estimated by the OBP and formatted by the NCC (correction to be added by the RCST to previous value)

NOTE: This table defines all the permitted values. Any values that are not listed above shall not be used.

Table 4.7: Network layer information descriptor

Parameter	Size (bits)		Value/Comment
	Reserved	Information	
descriptor_tag		8	0xAF (as defined in table 29 of EN 301 790 [1])
descriptor_length		8	depends on the message_body
message_body			Formatted as an SNMP message, intended to perform RCST MIB update. It shall not exceed 255 bytes and preferably fit within a single TS packet. It shall be formatted according to RFC 1901 [6] and RFC 1905 [7], and the PDU type shall be a SetRequestPDU.

Table 4.8: Network layer information descriptor parameters

Parameter	Size (bits)		Value/Comment
	Reserved	Information	
PIDmmt	3	13	PID Value dedicated for reception of MMT, as reserved per Group_ID
PIDtxMNGT	3	13	PID value used to transmit SNMP messages to the NMC
PIDrxMNGT	3	13	PID value used by the RCST to receive management messages from the NMC
IP_add_RCST_MNGT		32	management IP address of the RCST (air interface IP address)
IP_add_NMC		32	The IP address of the NMC for SNMP_trap sent by the RCST to the NMC
IP_subnet_NMC		32	IP subnet of the NMC
NMC_MAC_dest_MNGT		48	NMC Destination MAC address for RCST to transmit management messages
CRAsig		8	Guaranteed capacity assigned to the Control and Management Signaling connection
RBDC_max_sig		8	Maximum non guaranteed capacity assigned to the Control and Management Signaling connection
NOTE 1: When PIDtxMNGT is set to 0, the RCST shall not transmit any management messages on the air interface.			
NOTE 2: The message body of the NLID, according to EN 301 790 [1], shall be formatted as an SNMP message intended to the RCST MIB update process. It is formatted according to RFC 1901 and RFC 1905, and the PDU type shall be a SetRequestPDU. Several Variable Bindings with objects defined in the RCST MIB may be included in the Variable Bindings list of NLID, depending capabilities of the RCST, and the services requested by the RCST.			

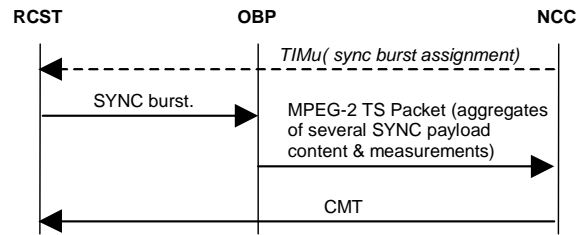
- When logon is rejected (Logon\_fail\_(busy) or Logon\_denied set to "1"), the TIM-u shall include the Correction\_message\_descriptor() with same format as for logoff except that slot\_type field is set to "01" (CSC burst type).

Once the TIM\_u message is correctly received, the RCST is ready for fine Synchronization.

#### 4.2.2.4 Fine Synchronization procedure

After the reception of a positive logon request, the Synchronization loop is started. The Synchronization is dealing with frequency, time and power control, namely the three items are synchronized within the same control loop.

The SYNC bursts, allocated to the RCST through the TIM-u returned by the NCC, are transmitted on a dedicated segment of the uplink MF-TDMA channel as referenced in the SCT, FCT and TCT.



**Figure 4.9: Fine Synchronization sequence**

The on-board Processor performs estimations on the preamble of each detected SYNC burst and forwards the SYNC payload content (SAC sub field : group/logon\_id) with the measurements to the NCC through a specific MPEG-2 TS packet after translation into DULM Information Element. At packet reception, the NCC assembles, reformats and transmits the CMT. Then the frequency, time and power corrections to be applied to the next burst transmission till reaching the required accuracy are returned to the RCST. The different configuration parameters as e.g. loop-counts, timeouts and thresholds are specified in the SYNC Assign Descriptor as received via TIM\_u and Correction Control Descriptor as received via TIM\_b.

The terminal extracts corrections to be applied from CMT and sends acknowledgement to NCC if corrections are within threshold limits (SAC field in Sync: M&C Message Def "Fine SYNC achieved").

Several successful correction cycles may be needed. This is pre-configured or set by management. The maximum number of Synchronization retries to achieve fine Synchronization is extracted from the SYNC Assign Descriptor contained within the TIM\_u).

If the corrections are within the threshold limits an acknowledgement is sent to NCC (SAC field in SYNC burst : M&C Message Def Fine sync achieved).

After fine Synchronization achievement, the RCST is in "fine sync" state and can request resource for communication.

#### 4.2.2.4.1 RCST to NCC Synchronization message (SYNC burst)

The SYNC message format and semantics shall be compliant with EN 301 790 [1]. The detail content of the SYNC burst should follow the description given in the TCT.

#### 4.2.2.4.2 NCC to RCST Synchronization message (CMT)

The CMT, Correction Message Table, format and semantics shall be compliant with EN 301 790 [1].

A CMT section addresses several RCSTs through a loop feedback to a given number of correction messages. The CMT Table\_ID is 0xA4.

Table 4.9: CMT individual correction message descriptor

Parameter	Size (bits)		Value/Comment
	Reserved	Information	
group_id		8	RCST identifier from SYNC_burst payload
logon_id		8	RCST identifier from SYNC_burst payload
time_correction_flag		1	"1" or "0" (enable/disable time correction application)
power_correction_flag		1	"1" or "0" (enable/disable power correction application)
frequency_correction_flag		1	"1" or "0" (enable/disable frequency correction application)
slot_type		2	"11" (sync)
burst_time_scaling		3	"100"
burst_time_correction		8	computed by NCC from burst time of arrival estimated by OBP (correction to be added by the RCST to previous value)
power_control_flag		1	"0" (Eb/N0)
Eb/No		7	-10 log (coding $\times \pi$ ) - 2 $\times$ PNP, based on Power Phase Noise returned by OBP to NCC
frequency_correction		16	frequency error estimated by OBP and formatted by the NCC (correction to be added by the RCST to previous value)
NOTE: This table defines all the permitted values. Any values that are not listed above shall not be used.			

NOTE: Time, power and frequency corrections flags allow to enable (value 1) or disable (value 0) the application of corrections according to timing, power and frequency correction enable/disable parameters configured in the MIB (logical AND).

#### 4.2.2.5 Synchronization Maintenance procedure

During all the communication session (from fine Synchronization achievement until logoff), the maintenance of Synchronization is ensured via the periodic transmission of SYNC bursts by the RCST, according to the allocation notified by the NCC at logon.

The process, based on SYNC burst transmission and CMT correction reply, is similar to the fine Synchronization procedure, with a periodicity defined in the section devoted to physical layer definition.

#### 4.2.2.6 Log-off procedure

The logoff is normally initiated by the RCST (although other triggers are also possible) and the logoff request is sent to the NCC in the SAC sub-field: M&C Message Definition set to 0x0002.

On reception, the NCC releases all the related RCST resources (SYNC burst, logical address and parameters). The NCC returns no confirmation.

The RCST goes to the "Stand-by" state (FLS must be re-acquired).

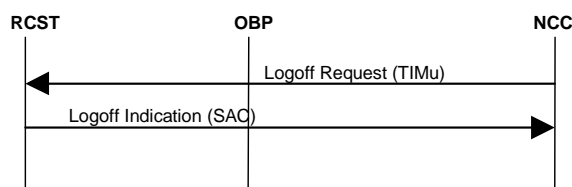
##### 4.2.2.6.1 Logoff sequence and timing

The RCST activates its logoff procedure as result of the following conditions:

- Upon NCC request (TIM-u logoff message).
- Upon end-user request.

The RCST must send a SYNC SAC field to notify its logoff without transmitting any connection release message.





**Figure 4.10: Logoff sequence**

After reception of a logoff request:

- The NCC releases all the related RCST resources.
- No confirmation is sent back by NCC.
- The RCST goes back to "Receive Sync State" (unless power down).

#### 4.2.2.6.2 Logoff message

TIM-u parameters and descriptors format shall be compliant with EN 301 790 [1]. The TIM-u Table\_ID is 0xB0.

**Table 4.10: Logoff message RCST Status**

Parameter	Size (bits)		Value/Comment
	Reserved	Information	
ID_encrypt		1 (msb)	"0" (no TBTP logon ID encryption)
Logon_fail_(busy)		1	"0"
Logon_denied		1	"0"
Log_off		1	"1" (logoff notification from NCC)
Transmit_Disable		1	"0": Transmission authorized "1": RCST shall cease transmission and enter hold mode till an uni-cast TIM resets this bit to "0"
Rain_Fade_release		1	"0" (no rain fade reconfiguration procedure)
Rain_Fade_detect		1	"0" (no rain fade reconfiguration procedure)
Wake_up		1 (lsb)	"0" (no wake-up notification from NCC)

NOTE: This table defines all the permitted values. Any values that are not listed above shall not be used.

Descriptor\_loop\_count: set to 0 (1 descriptor), detailed in table 4.11:

**Table 4.11: Logoff message correction message descriptor**

Parameter	Size (bits)		Value/Comment
	Reserved	Information	
descriptor_tag		8	0xA1 as defined in table 29 of EN 301 790 [1]
descriptor_length		8	"00000001" (1 byte long)
time_correction_flag		1	"0"
power_correction_flag		1	"0"
frequency_correction_flag		1	"0"
slot_type 2 bit field		2	"11" (SYNC)
burst time scaling		3	"000"
burst time correction		0	none
power_control_flag		0	none
Eb/N0		0	none
frequency_correction		0	none

NOTE: This table defines all the permitted values. Any values that are not listed above shall not be used.

#### 4.2.2.7 Hold mode procedure

The hold mode procedure of the RCST is performed according to EN 301 790 [1] and is described hereafter.

When receiving a TIM-u whose "transmit\_disable" flag is set to "1", the RCST shall cease transmission and enter the hold state whatever is its current state. Only Forward Link Signalling (FLS) acquisition and NCR Synchronization are maintained in "Hold mode" state. It remains in the hold state and cannot transmit till reception of a TIM-u message with the "transmit\_disable" flag is set to "0". In case of power off or reset in the "Hold mode" state, the RCST goes back to the "Hold mode" state after initial Synchronization procedure.

The TIM-u content for hold mode notification is the same as for logoff message (see clause 4.2.2.6.2) except for the "RCST status" field defined in table 4.12:

**Table 4.12: Hold mode TIM-u message RCST Status**

Parameter	Size (bits)		Value/Comment
	Reserved	Information	
ID_encrypt		1 (msb)	"0" (no TBTP logon ID encryption)
Logon_fail_(busy)		1	"0"
Logon_denied		1	"0"
Log_off		1	"0"
Transmit_Disable		1	"1" (Transmission inhibited)
Rain_Fade_release		1	"0" (no rain fade reconfiguration procedure)
Rain_Fade_detect		1	"0" (no rain fade reconfiguration procedure)
Wake_up		1 (lsb)	"0" (no wake-up notification from NCC)
NOTE: This table defines all the permitted values. Any values that are not listed above shall not be used.			

The RCST shall exit from hold state and enter the logon procedure when receiving a wake-up message.

The RCST shall exit from hold state and enter "receive sync" state with all "RCST status" flags set to "0", in which case it shall further receive a wake-up message to enter the logon procedure.

In any case, the TIM-u only includes the "correction\_message\_descriptor()", with correction flags set to "0" as for logoff.

#### 4.2.2.8 Wake Up procedure

The wake up procedure of the RCST is performed according to EN 301 790 [1] and is described hereafter.

When receiving a TIM-u whose "wake-up" flag is set to "1", the RCST shall enter the logon procedure.

The TIM-u content is the same as for logoff message (see clause 4.2.2.6.2) except for the "RCST status" field defined in table 4.13:

**Table 4.13: Wake Up TIM-u message RCST Status**

Parameter	Size (bits)		Value/Comment
	Reserved	Information	
ID_encrypt		1 (msb)	"0" (no TBTP logon ID encryption)
Logon_fail_(busy)		1	"0"
Logon_denied		1	"0"
Log_off		1	"0"
Transmit_Disable		1	"0" (Transmission authorized)
Rain_Fade_release		1	"0" (no rain fade reconfiguration procedure)
Rain_Fade_detect		1	"0" (no rain fade reconfiguration procedure)
Wake_up		1 (lsb)	"1" (wake-up notification from NCC)
NOTE: This table defines all the permitted values. Any values that are not listed above shall not be used.			

The TIM-u only includes the "correction\_message\_descriptor()" as for logoff (see clause 4.2.2.6.2).

NOTE: *The RCST shall restart the initial Synchronization procedure to enter into the "Receive sync" or "Hold mode" state (according to tx\_disable flag value) in the following cases:*

- *Logoff procedure initiated by the NCC.*
- *Logon\_fail\_(busy) notified by the NCC.*
- *Logon\_denied notified by the NCC (with transmit\_disable flag set to 1).*
- *NCR not received for configurable consecutive seconds.*
- *Fine Synchronization not achieved after configurable consecutive SYNC attempts.*
- *Logon TIM\_u not received after configurable consecutive CSC attempts.*
- *CMT burst correction not received after configurable consecutive SYNCs.*

## 4.3 Resource Control

### 4.3.1 Overview

The RSM-B resource control is based on the timeslot allocation procedure as defined in EN 301 790 [1]. Burst time composition plan is defined thanks to the BTP tables: SCT, FCT and TCT. Terminal burst time assignment is given by the TBTP table.

### 4.3.2 Definitions

#### 4.3.2.1 Signalling definitions

This clause presents the messages exchanged between the RCSTs and the NCC in the resource control context defined in RSM-B, in line with EN 301 790 [1].

##### 4.3.2.1.1 Forward link signalling from NCC to RCST: TBTP (Terminal Burst Time Plan)

The TBTP defines the dynamic timeslot assignment generated every superframe. The RCST uses the SCT, FCT and TCT to know the organization of the uplink MF-TDMA channels, and particularly the superframe, frame, and timeslot number. In the TBTP, in association with the absolute date (in PCR count) these references are used by the RCST to identify to which the allocation applies.

There is one TBTP section per group\_id and per downlink containing the following information:

- The group\_id.
- The superframe\_count (modulo 216) set by the NCC to its current value plus an integer number of superframes, taking into account 2 superframes for RCST reception and processing. The RCST shall be able to process a TBTP received at frame (n) to locate all its assigned bursts before end of frame (n+1), so as to apply it at frame (n+2), with respect to the superframe counter notified in the TBTP.
- The list of timeslots allocated to RCST per channel\_id.

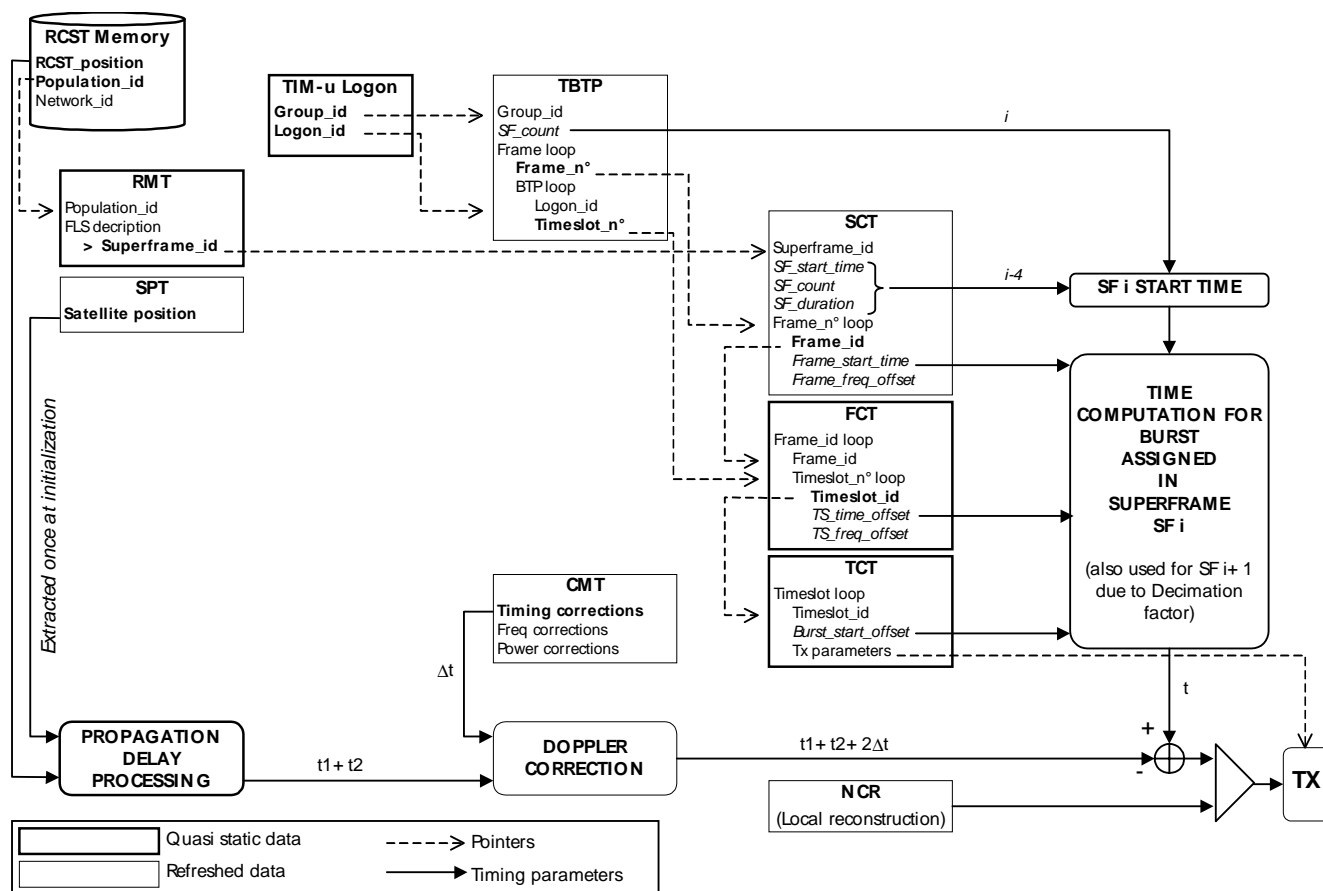
The burst allocation reference used by the RCST is given by the superframe start time and duration, which are updated and notified by the NCC through the SCT. Knowing the superframe\_start\_time associated to a superframe\_count, the RCST is able to retrieve the exact location of its assigned bursts through application of the time and frequency offsets extracted from the FCT and SCT.

Moreover, for burst transmission, the RCST anticipate the time assigned in the TBTP so as to take into account the shift of its local Network Clock Reference (D/L propagation delay) and the burst transmission delay (U/L propagation delay).

The RCST retrieves the transmission time of its assigned burst through the following steps:

- 1) At TBTP reception, the RCST extracts from the section corresponding to its Group\_id:
  - The superframe\_count to which the TBTP is attached.
  - The frame number and the slot number corresponding to its Logon\_id.
- 2) The RCST extracts from the previously received SCT:
  - The superframe\_start\_time attached to a superframe\_counter.
  - The superframe\_duration.
  - The frame\_start\_time, the frame\_center\_frequency offsets and the frame\_id corresponding to the frame\_number notified in the TBTP.
- 3) From the FCT, the RCST retrieves the description of relevant frame\_id, i.e. timeslot\_time\_offset, timeslot\_frequency\_offset and timeslot\_id (slot type) for allocated timeslot.
- 4) From the TCT, the RCST extracts information about relevant timeslot\_id:
  - The burst\_start\_offset.
  - The timeslot transmission structure plus some access flag.
- 5) The RCST can then deduce the transmission time, in PCR counts, of its assigned burst, from:
  - The SCT superframe\_start\_time.
  - The difference between TBTP and SCT superframe\_counter, multiplied by the superframe\_duration.
  - The frame, timeslot and burst time and frequency offsets.
  - The uplink and downlink transmission delay (computed at logon owing to SPT and RCST position, and periodically adjusted owing to returned CMT).
- 6) This value is compared to the current reconstructed NCR to activate burst transmission.

The figure below summarizes the process for burst transmission time retrieval and the required parameters stored in the RCST memory or extracted from the signalling tables:



**Figure 4.11: Timeslots allocation process**

The TBTP processing can be summarized in the following procedure:

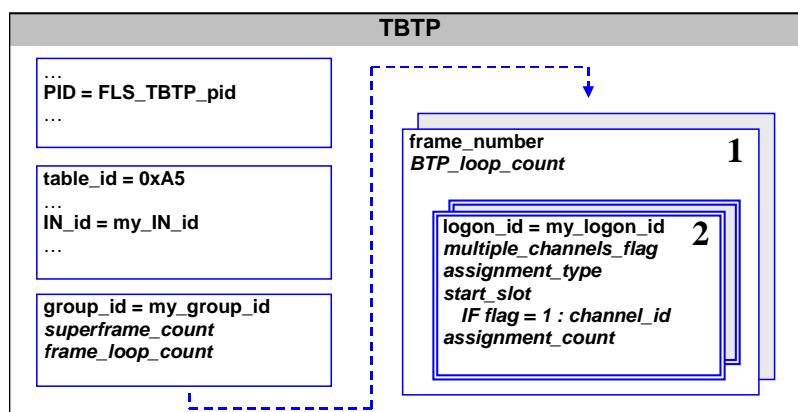
- 1) Analysis of TBTP section header (SI private section header):
  - The RCST extracts the TBTP (PID found in FLS-PMT, table\_id = 0xA5).
- 2) Analysis of TBTP section: the RCST checks its interactive network.

If the section corresponds to its group identifier:

- The RCST reads the superframe count to which the BTP applies.
- The RCST searches all occurrences of its logon\_id.
- The RCST reads the parameters describing the block of timeslots allocated to it.

Else:

- Skip to the next section.



**Figure 4.12: Description of timeslots assignment in TBTP**

The RCST shall be able to process a TBTP to be applied up to 16 superframe later, with respect to the superframe counter notified in the TBTP.

#### 4.3.2.1.2 Return signalling from RCST to NCC: SAC field (SYNC burst)

For the resource control, the SAC field is used for capacity request for dynamic allocation. In RSM-B, several capacity requests may be contained within the SAC field.

The request computation process is memory-less in the RCST, i.e. when computing a request the RCST does not take into account the previous request correlated with capacity allocation.

#### 4.3.2.2 Capacity request categories definition

The resource control in RSM-B combines three baseline DVB-RCS capacity categories:

- Continuous Rate Assignment (CRA).
- Rate-based Dynamic Capacity (RBDC).
- Volume-based Dynamic Capacity (VBDC).
- Free Capacity Assignment (FCA).

**CRA:** This capacity is allocated without a capacity request being sent by a terminal. This capacity is guaranteed. The granularity is based on the rate of the TRF\_burst mapped on a given carrier and depends on its coding rule 4/5 or 3/4.

**RBDC:** Rate capacity, dynamically requested by terminals on a per channel\_id basis through the SAC field of the SYNC burst, and fairly shared between terminals. Each request overrides any previous one from the same terminal. A request is subject to a time-out mechanism and a maximum rate parameter (set in RCST profile).

**VBDC:** Volume capacity, dynamically requested by terminals on a per channel\_id basis through the SAC field of the SYNC burst, and fairly shared between terminals. Each request overrides any previous one from the same terminal. A request is subject to a time-out mechanism and a maximum rate parameter (set in RCST profile).

**FCA:** Automatically assigned to a terminal according to its profile from unused capacity without any request. The availability of this bonus capacity per channel\_id is highly variable and just aims at reducing delays on any traffic, which can tolerate delay jitter.

The RCST supports dynamic radio resources control function, also referred to as DAMA (Demand Assignment Multiple Access) agent. It is assumed that the RCST is able to perform fast frequency hopping in at least a 36 Mhz MF-TDMA channel.

## 4.4 Connection control

The Connection Control Protocol (C2P), describes the mechanisms and messages required for the acceptance, the establishment, the modification and the release of connections. Full details of the protocol are described in TS 102 429-3 (see bibliography).

### 4.4.1 Definitions

#### 4.4.1.1 Connection

A connection is defined as the means to propagate packets (traffic or signaling) with the same priority from one RSM-B network reference point to one (unicast) or more (multicast or broadcast) distant RSM-B network reference points. These RSM-B network reference point correspond to RSM-B RCSTs or RSGWs.

Between two RCSTs/RSGWs there can be as many connections as different priority levels are defined in the System. In RSM-B system there are 4 different levels of priority. Therefore for RSM-B system a maximum of 4 connections may be established between two RCSTs/RSGWs.

Each connection is identified thanks to a `connection_reference_id`. This identifier allows each RCST/RSGW to locally identify all the active connections present.

The Connection Control Protocol (C2P) "IE" (Information Element) fields allow to associate various attributes to the connection according to end user service needs.

#### 4.4.1.2 IP flow

A connection may carry one or several unitary IP flows. Each RCST will be capable of identifying IP flows thanks to a multifield classification.

**EXAMPLE:** An IP flow may be identified in terms of IP source and destination addresses, DSCP value, protocol type and source and destination port numbers.

The multifield filtering criteria is configured thanks to a Type of Flow table on each RCST.

#### 4.4.1.3 Channel

Channel is the logical access link between an RCST and all its destination RCSTs sharing the same beam. A Channel is associated to a physical route and to a specific MF-TDMA uplink resource through the TBTP.

It is possible to map either a single or N connections to one Channel depending on quality of service and routing considerations. The whole capacity allocated per channel is shared between all the connections established on this channel.

Each channel is identified thanks to a `Channel_ID`.

#### 4.4.1.4 Stream

RSM-B system is based on the MPEG-2 TS profile of EN 301 790 [1]. Therefore each connection will be identified in terms of MPEG-2 TS stream identifiers.

In case of a bidirectional connection, two stream identifiers would uniquely identify the transmission and the reception of traffic. In case of a unidirectional connection, only one stream identifier is required to identify the transmission or the reception of traffic.

These stream identifiers are also called PIDs, Program IDentifier, following MPEG2 TS nomenclature.

As a summary, the following figure represents the relationship between all previous identifiers: connection, stream, channel, and spot beams.

Figure 4.13 illustrates a typical arrangement of unicast connections from one RCST-A attached to one single sub-net transmitting traffic towards the TDM 1:

- a high priority connection towards RCST3 is identified by (ch\_ID-1, PID A-1 HP, MAC address RCST3);
- a low priority connection towards RCST2 is identified by (ch\_ID-1, PID A-1 LP, MAC address RCST2).

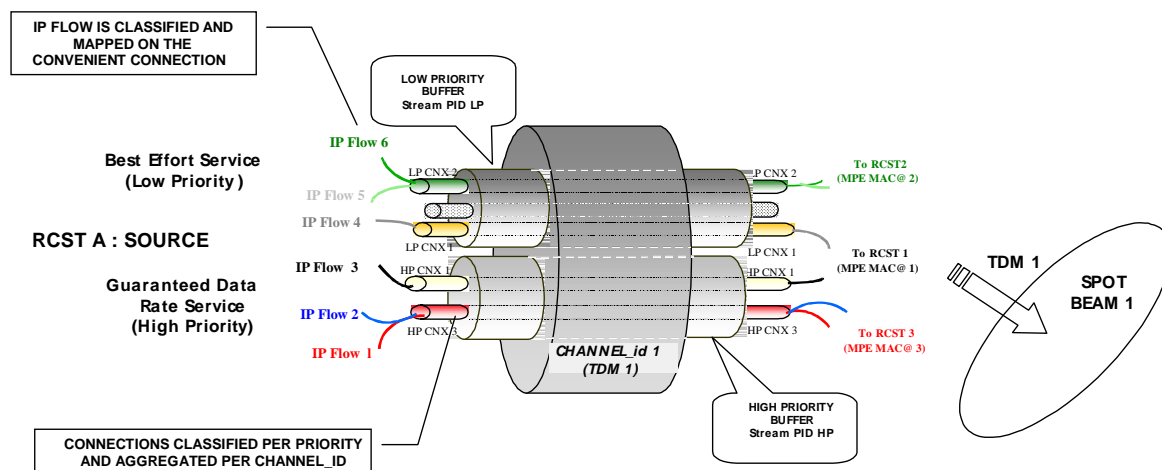


Figure 4.13: Connection, channel\_ID and PIDs arrangement

#### 4.4.1.5 Connection type

Signaling (control and management) connections are differentiated from user data traffic connections.

##### 4.4.1.5.1 Signalling connections

The communication between the MS (NCCandNMC) and the RCSTs is done thanks to signaling connections. This signaling connection may convey only control and management information.

Signalling connections are implicitly opened at terminal logon without the need of C2P messages. Therefore no real connection\_reference\_ID are assigned to them. All the information required for a signaling connection is contained in the logon messages received by the RCST.

Signalling connections are required to send:

- C2P control message to the NCC;
- management SNMP messages to the NMC.

Each connection will have different PID values for transmission and reception assigned thanks to the logon messages.

Different internal queue buffers will be assigned to each signaling connection in the RCST. Both connections will share the timeslots allocated on the reserved signaling channel\_ID 0.

These connections correspond to the control and management plane of the RCST.

##### 4.4.1.5.2 Traffic connection

These are mesh or star, bi-directional or uni-directional, unicast or multicast between two or more terminals (RCST or RSGW) and belong to the User Plane of the RCST. Traffic connection setup is based on the exchange of C2P between RCST/RSGW and the NCC.



#### 4.4.1.5.2.1 Permanent and on\_demand connections

Traffic connections may be established, or released :

- by management (NMC) initiated by the NCC: permanent connections;
- on-demand, initiated by the RCST (GW\_RCST).

**Permanent connection:** Established upon NMC initiative when peer terminals are synchronized. Permanent connection establishment and release procedures are performed using the C2P protocol [AD5]. C2P permanent connection establishment/release is initiated by the NCC Connection Control function (when indicated from the NMC) and never released by terminals.

**On-demand connection:** Established upon explicit request from the RCST or RSGW. On-demand connection establishment and release procedures are performed using the C2P protocol [AD5] and are initiated by the RCST or RSGW Connection Control function.

#### 4.4.1.5.2.2 Star and mesh connections

Traffic connections are differentiated depending if it involves a RSGW or not.

**Star connection:** Connection established between a RSGW and a RCST.

**Mesh connection:** Connection established between two user RCSTs.

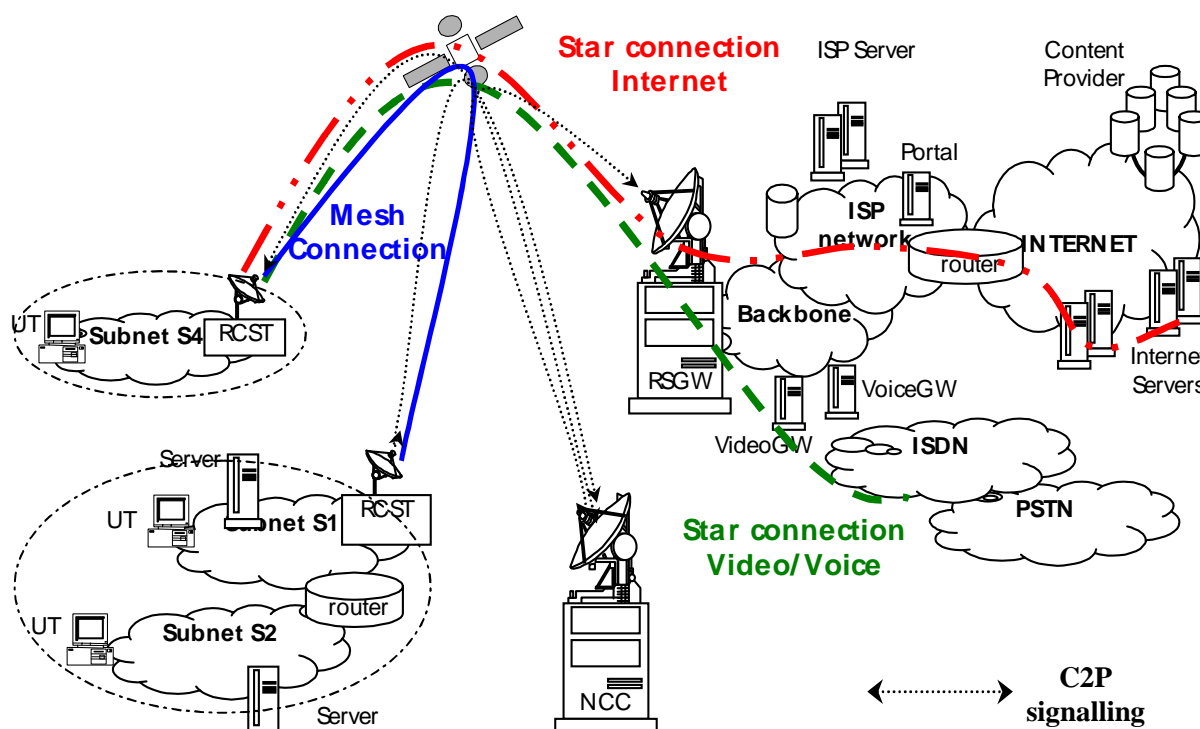


Figure 4.14: Star and Mesh connections

## 4.4.2 Signalling messages

This clause recalls the major messages exchanged between the RCSTs and the NCC in the connection control context. How this messages are build and exact details of the parameters used are described in TS 102 429-3 (see bibliography).

### 4.4.2.1 Forward link signalling from NCC to RCST: TIM

TIM\_u, is the Individual Terminal Information Message message used by the NCC to transmit the Connection Control Protocol (C2P) messages towards the RCST. It is sent in DSM-CC (Digital Storage Media Command and Control) private section, using the RCST MAC address.

#### 4.4.2.2 Return link signalling from RCST to NCC: DULM

The DULM Packet- Data Unit Labelling Method, is a message-based method that allows RCSTs to transmit the Connection Control Protocol (C2P) Messages towards the NCC. The Return\_CTRL\_MNGM\_PID is used in the header of the DULM packet. DULM packet payload is constructed starting by the Group\_id and Log-on\_id and followed by the connection control IEs.

#### 4.4.3 Major C2P attributes

##### 4.4.3.1 Connection profile parameters

C2P connection profile parameters are handled by the connection control and interpreted by the resource control to map a convenient allocation mode and resource to the connection.

These parameters are summarized in table 4.14:

**Table 4.14: C2P connection profile parameters**

C2P profile parameters	Description
SDR	Sustainable data rate expected by the connection Mapped on CRA: Guaranteed capacity $\geq 0$
PDR	Peak Data Rate, maximum data rate supported by the connection Mapped on RBDC: Un-guaranteed capacity $\geq 0$ based on Capacity request
Priority	Priority class: - Low Priority (LP): best effort - High Priority (HP): real time non-jitter sensitive - High Priority with jitter constraints (HPj): real time traffic with jitter constraints (typically VoIP) - Streaming priority (SP)

##### 4.4.3.2 Capacity Request mapping

The Resource Control is in close interaction with the connection control. The RCST radio resource control updates the channel information each time a connection is set up, modified or released.

For each RCST in the RSM-B network the following capacity categories are configured at NMC level:

**Table 4.15: Capacity Categories**

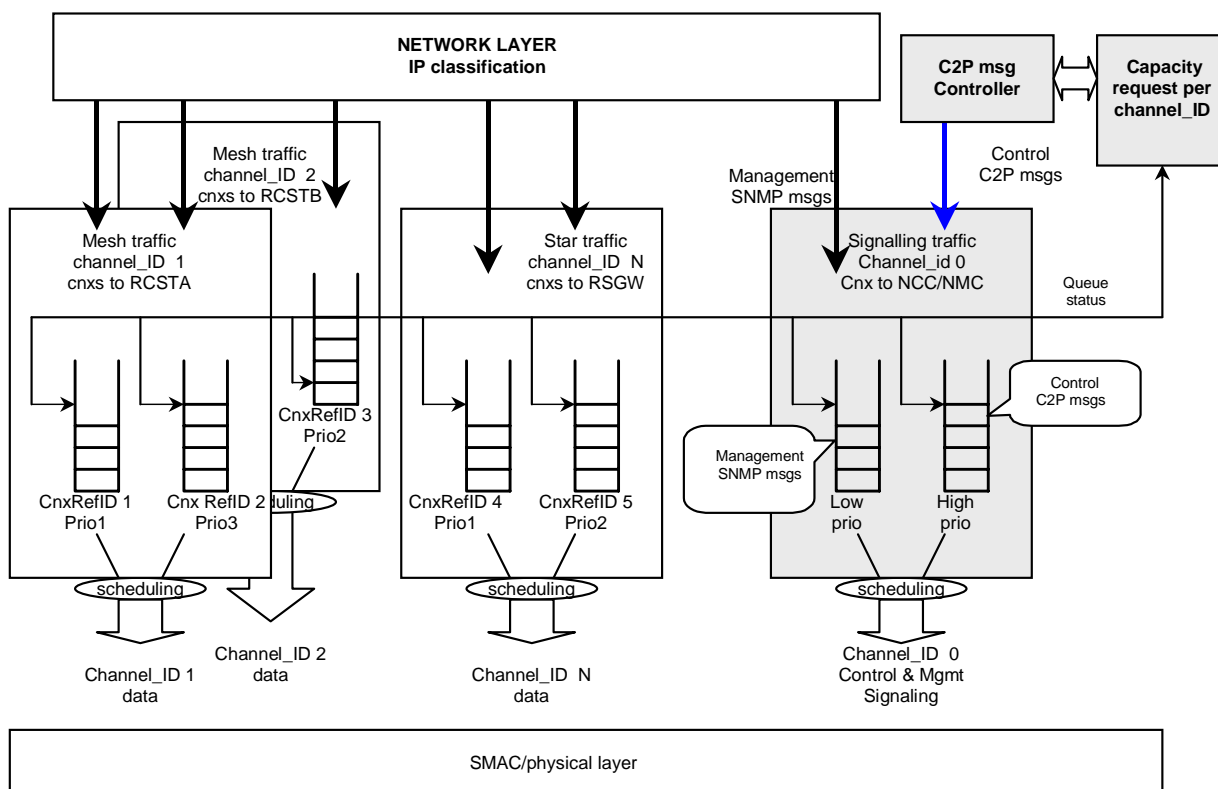
Capacity category	Description
CRA_sig	Average constant data rate ( $\geq 0$ ) for RCST to NCC control signalling (C2P messages) and RCST to NMC management signalling (SNMP messages).
CRA_star_max	Maximum guaranteed data rate ( $\geq 0$ ) for star connections Allocable in dynamic mode.
CRA_mesh_max	Maximum guaranteed data rate ( $\geq 0$ ) for mesh connection Allocable in dynamic mode.
RBDC_star_max	Maximum data rate ( $\geq 0$ ) for all star connections allocable in dynamic mode in response of Capacity Request (CR) sent by the RCST.
RBDC_mesh_max	Maximum data rate ( $\geq 0$ ) for all mesh connections allocable in dynamic rate in response of CR sent by the RCST.
VBDC_star_max	Maximum volume rate ( $\geq 0$ ) for all star connections allocable in dynamic mode in response of Capacity Request (CR) sent by the RCST.
VBDC_mesh_max	Maximum data rate ( $\geq 0$ ) for all mesh connections allocable in dynamic rate in response of CR sent by the RCST.
FCA_enabled	If set, the free capacity available on a given uplink is fairly distributed between RCSTs in dynamic mode and between channel_id mapped on the uplink on which the RCST belongs to.

#### 4.4.4 Functional mapping

The Resource control is in close interaction with the Connection control. After classification of incoming IP flows by the interworking functions, the MPE encapsulation and the MPEG-2 segmentation, the resource control function is responsible for the distribution of the assigned capacity between the different buffers per channel and requesting the extra capacity if needed.

NOTE: Traffic queuing may be done on IP, MPE or MPEG level depending on the RCST implementation.

The RCST resource and connection control functional architecture is presented in figure 4.15:



**Figure 4.15: RCST: resource and connection control functional architecture**

There may be various channel\_id dedicated to star/mesh traffic. The figure represents only two channel\_id for mesh traffic (traffic between RCSTs), and one channel for star traffic (traffic between an RCST and the RSGW).

According to the configuration, the RCST resource and connection control functional architecture includes:

- One queue buffer per connection. Each connection queue buffer will be assigned to a certain channel\_id.
- Zero or more connection queue buffer(s) per channel\_id. The maximum number of connection queue buffers per channel is given by the maximum number of traffic classes defined. For RSM-B, four different priority levels are defined.
- A control signalling process in charge of the C2P communication between the RCST and the NCC. This process that generates C2P messages and forwards it to the dedicated HP (High Priority) queue buffer of channel\_id 0.
- A management signaling process in charge of the snmp communication between the RCST and the NMC. This process generates the snmp responses forwarded through the LP queue buffer of channel\_id 0.
- A minimum signalling bandwidth capacity in terms of CRA\_sig is automatically allocated by the NCC on channel\_id 0 without generating initial request from the RCST. However, more capacity on this channel can be requested by the RCST via the conventional capacity request scheme. Management messages use also this channel\_id 0 (LP buffer).

- A classifier or interworking interface, that allows to forward IP datagrams to the right connection queue buffer.
- A scheduling mechanism between all the connection queue buffers per channel. The scheduling will mark which packet should be forwarded first towards the channel buffer and transmitted through the air interface. This means that it multiplexes together packets coming from the different connection queue buffers assigned to the same channel\_ID. Possible scheduling mechanisms are strict priority, token bucket or weight fair queuing.
- An access control process to manage the way data is transmitted towards the physical layer. This process regularly receives TBTP messages from the RCST's forward link reception. These messages describe the frequency/time windows on which the RCST is allowed to transmit its allocated timeslots. From the TBTPs, the Access Control knows per channel\_id the slots to be used.
- The connection queue buffers handle IP packets. The MPE segmentation and encapsulation is done afterwards. Interleaving must be assured.

## 4.4.5 Connection Control functions

The RCST connection control function shall support two activation modes:

- permanent connection establishment by the NCC at pre-defined date and time marked from the NMC;
- on-demand connection established on request from the RCST/RSGW.

NOTE: The connection control functions defined in the following sections, apply to any RCST present in the RSM-B network, not only to user RCST but also to GW\_RCST (as part of the RSGW). Only when is needed, special distinction is made for star or mesh scenarios, as it is case for multicast.

### 4.4.5.1 On-demand connection control

The RCST shall support the following connection control processes for on-demand connections:

- connection establishment;
- connection release;
- channel modify.

#### 4.4.5.1.1 On-demand connection establishment

##### 4.4.5.1.1.1 Calling RCST

The RCST shall send a new connection establishment upon detection of an IP flow:

- when the destination IP address in the IP header matches a routing entry (static entries);
- and there is no already open connection with the same priority class than the one of the detected IP flow.

The C2P connection establishment request will carry the source and destination IP address of the initiator IP packet, the C2P parameters attached to the IP type of flow obtained through classification of the packet and the connection\_reference\_id. When initiating a connection request, the RCST sets itself the connection reference field of the C2P message to be sent to the NCC.

This request is transmitted towards the NCC through the control signaling connection.

NOTE: One RCST may have several pending connection setup. This is limited to the maximum number of priority levels defined in the system. For RSM-B this number is four.

The RCST should then wait for the C2P Connection Establishment Response sent by the NCC.

In case of positive connection establishment, the RCST extracts the destination prefixes and connection parameters as the transmission and reception profiles and PIDs from the response message. It will update the routing table (dynamic entries) with the received destination prefixes not yet existing, will attach the connection parameters to relevant entries in an active connection database, and associate the `cnx_ref_id` to the connection queue buffer.

In case of negative connection establishment response, the RCST shall drop the corresponding pending request and initiator IP packet and wait an inhibition timeout before retrying to establish a connection with the same level of priority.

In case of C2P Connection Establishment Request time-out, the RCST could retry to send a new request up to a maximum of C2P Maximum number of retries. Once this maximum is reached the RCST shall drop the corresponding pending request and initiator IP packet and wait an inhibition timeout before retrying to establish a connection with the same level of priority.

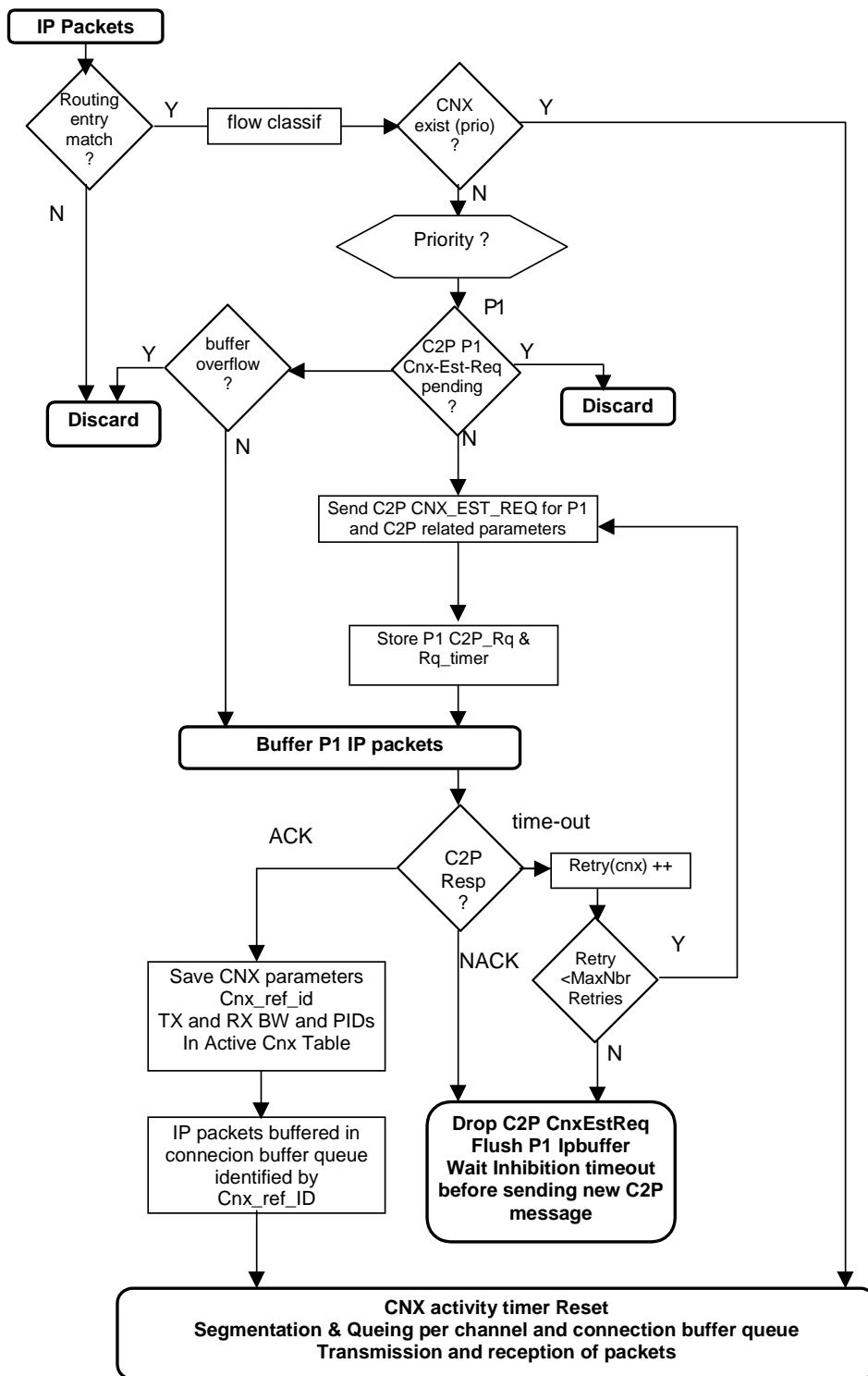


Figure 4.16: Establishment request procedure for on-demand C2P connection with priority P1

#### 4.4.5.1.1.2 Called RCST

As a called RCST, it will receive a C2P Connection Establishment Request message. The RCST will process the content of the message.

- If the connection is accepted, the RCST shall respond with a C2P Connection Establishment Response Successful and extract the destination prefixes and connection parameters. The RCST then updates the routing table (dynamic entries) with the received destination prefixes not yet existing, and will attach the connection parameters to relevant entries in an active connection data base.
- If the connection cannot be rejected, the called RCST will answer with a C2P Connection Establishment Response Reject, including the cause of the rejection.

NOTE: In case an RCST, that has already established a unidirectional connection with another RCST, receives a request for a bidirectional connection towards the same RCST, it should first release the unidirectional connection, and then accept the establishment of the bidirectional connection.

#### 4.4.5.1.2 On-demand connection release

On-demand connections have activity timers associated to them. The activity timer is restarted every time there is activity on the connection. In case of a bi-directional connection every time there is traffic either transmitted or received. If the timers associated to a connection expire, the corresponding connection is released. The calling or called RCST will send a connection release request for this connection. This way the RCST informs the NCC which removes all the resources associated at this connection.

At reception of connection release response, the RCST removes the related connection parameters and the relevant routing entries will be no longer attached to any connection. The RCST shall then release all the relevant resources and flush the associated connection queue buffer no longer used.

It is also possible to release on-demand connection by local management from the user interface or by request from the NCC.

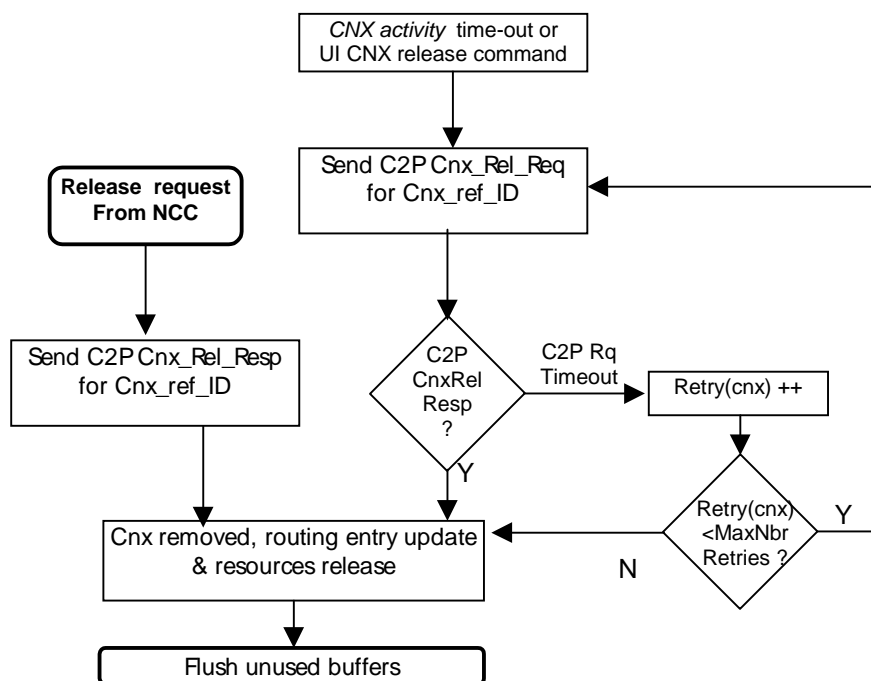


Figure 4.17: On-demand C2P cnx release request procedure from calling RCST

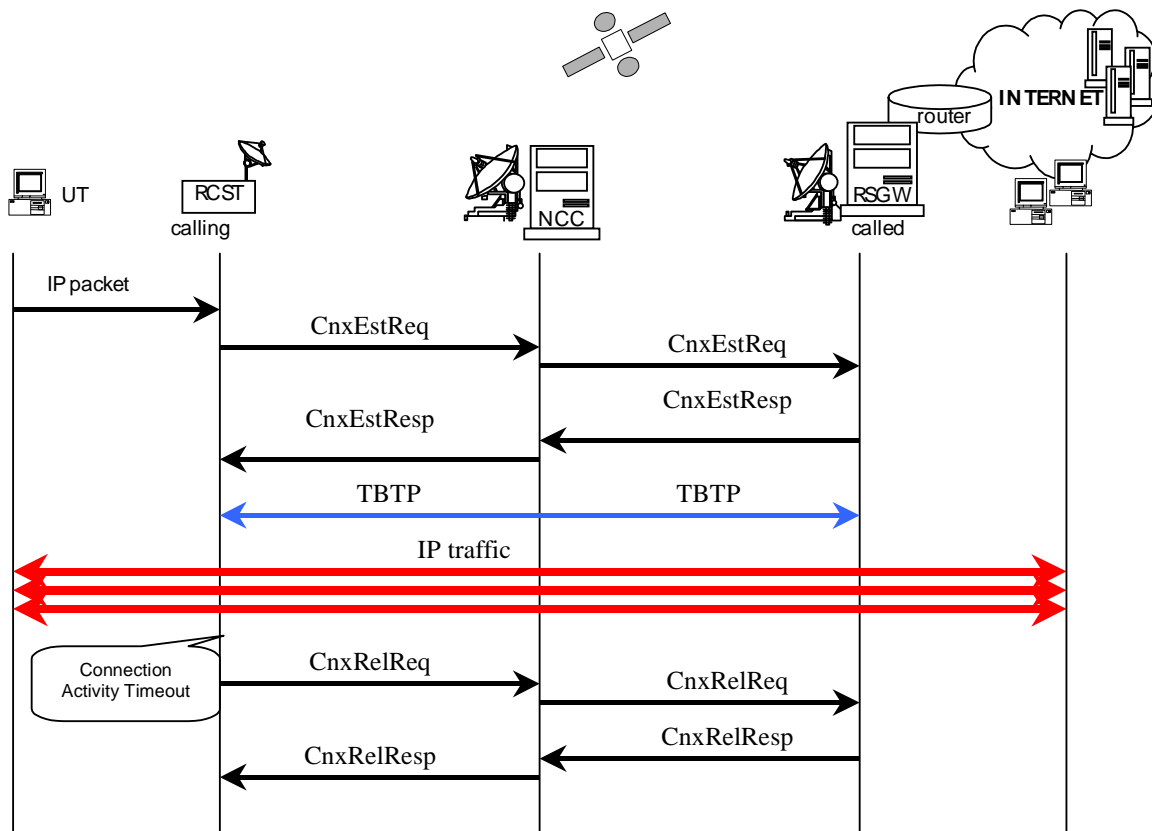


Figure 4.18: On-demand star connection scenario

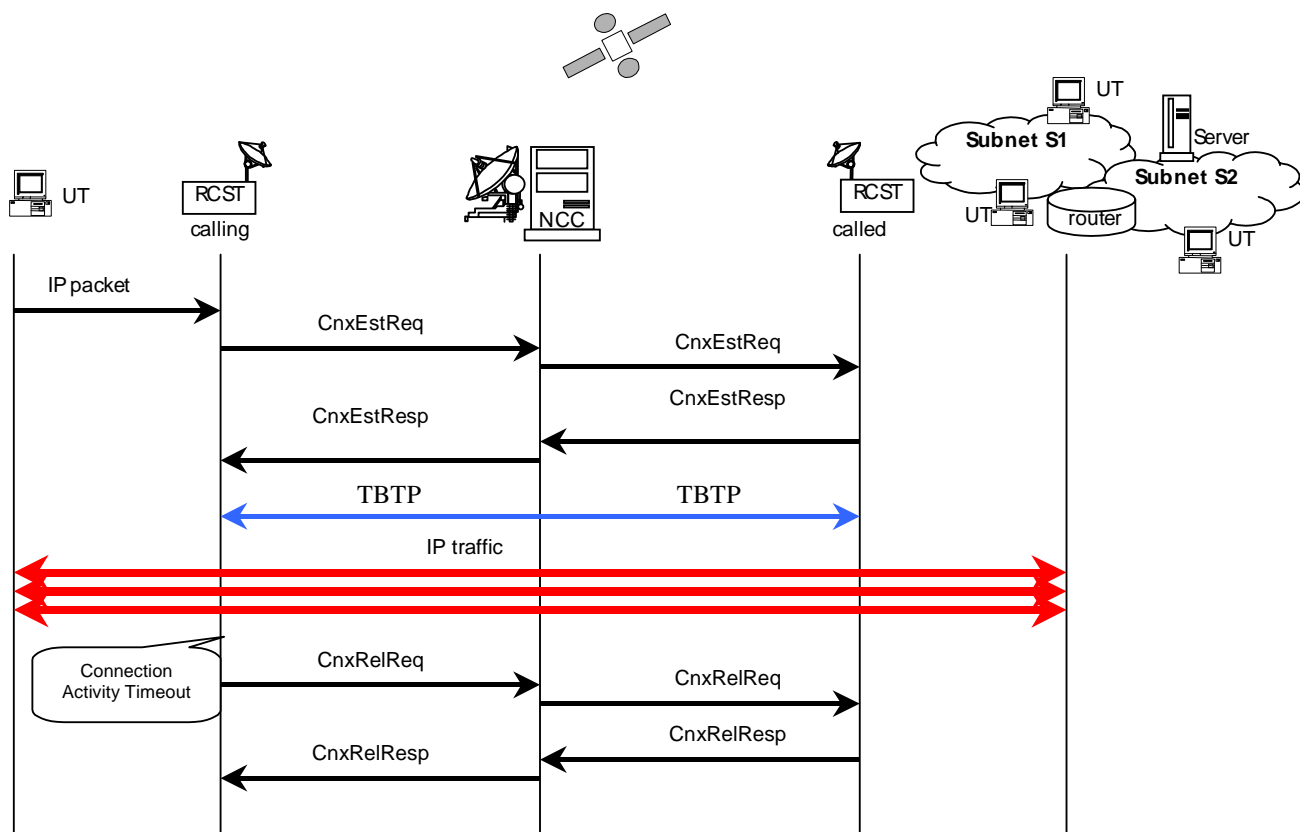


Figure 4.19: On-demand mesh connection scenario On-demand connections channel modify



The aim of the channel modify mechanism is to allow an RCST to ask for modification of the guaranteed capacity allocated to one channel. This extra capacity is relative to the status of all the connection queue buffers associated to this channel and should not exceed a certain maximum defined in their profiles.

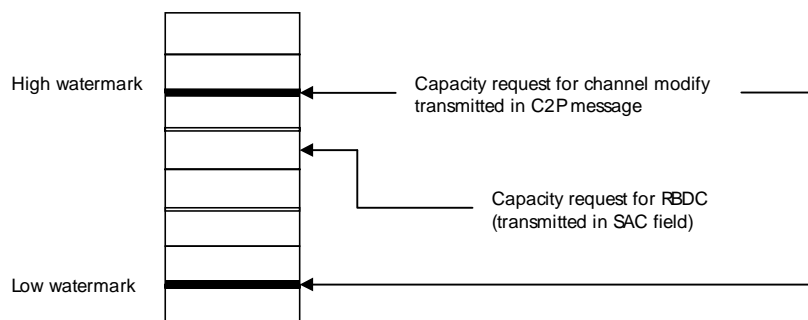
At connection set-up a certain amount of guaranteed capacity is requested. This value is given in the connection profile parameters. If the connection is successfully established, this guaranteed capacity will be provided and allocated in the TBTP.

For each channel\_id, the individual data queue buffer per connection has a configurable high and low watermark relative to the guaranteed capacity authorized for the considered RCST.

Allocation of additional guaranteed capacity per channel can be provided upon channel\_modify requests initiated by the RCST . Such capacity request is activated if the number of IP packets in the connection queue buffer rises above a configured threshold value (high watermark).

If the already extra capacity requested has not exceeded a certain maximum of capacity defined by the connection's profile, a C2P message Channel modify request will be sent towards the NCC requesting this additional capacity.

A dual mechanism is implanted to detect if the connection queue buffer does not more utilize its additional assigned capacity, namely when the number of IP packets cross a low threshold in the decreasing direction (low watermark).



**Figure 4.20: Channel modify mechanism**

These both high and low watermarks must be distinct for hysteresis purposes. The associated values (threshold and timer) are set in the subscriber profile and the guaranteed capacity is allocated up to the limit defined by the global SDR as set in the RCST profile.

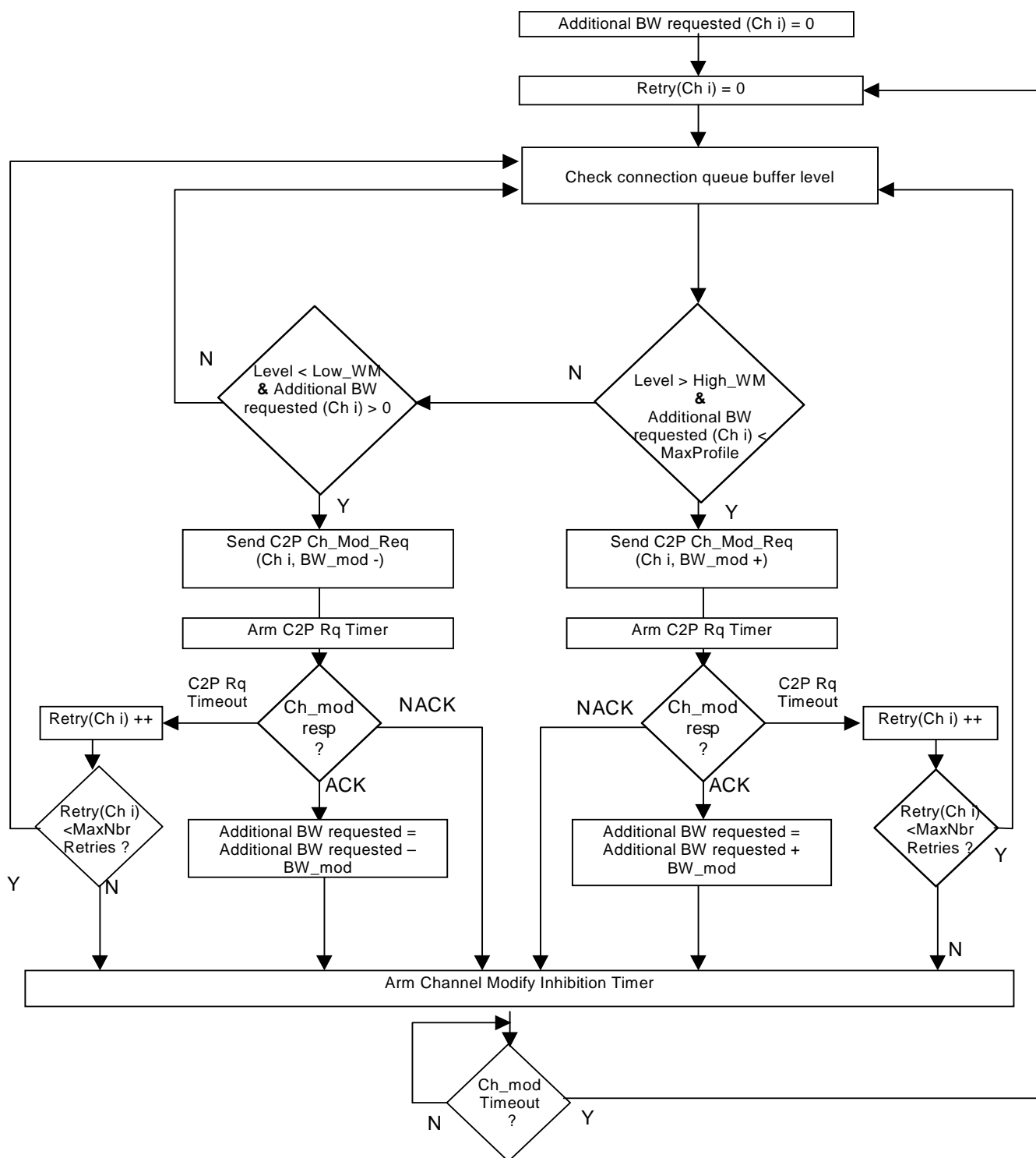


Figure 4.21: On\_demand Channel Modify procedure

#### 4.4.5.2 Permanent connection control

The establishment of permanent connections will be controlled and initiated by the NCC as configured by management in the NMC. Permanent connections may be star or mesh, unicast or multicast.

In case of unicast permanent connection, the connection becomes effective only if the two involved parties are logged and in fine sync state.

For permanent multicast, only the transmitting RCST is involved in the connection establishment/release process. The NCC updates the MMT in order to inform the other RCSTs and RSGWs in the satellite network willing to receive the multicast flow.

#### 4.4.5.2.1 Permanent connection establishment

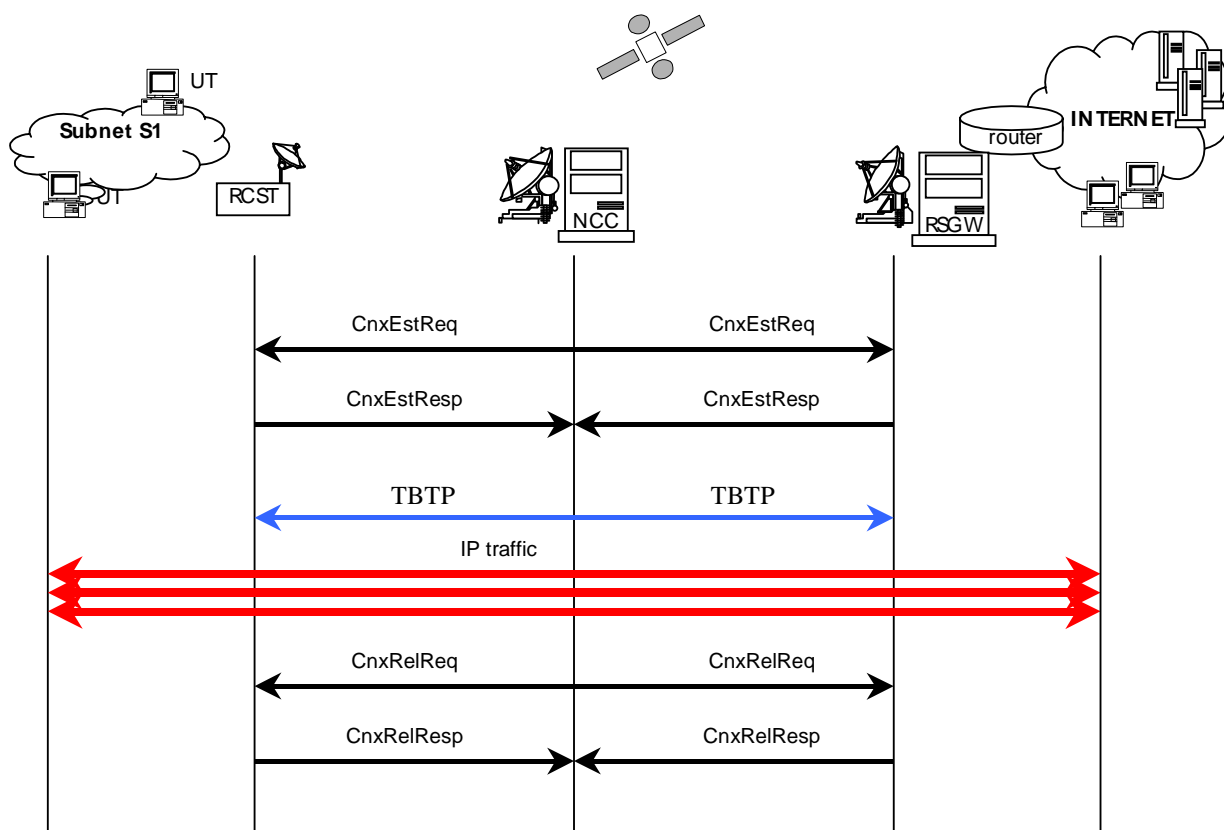
At reception of a C2P connection establishment request NCC initiated, the RCST will process the content of the messages, extract the destination prefixes and connection parameters, update the routing table and store the connection parameters as for an on-demand connection. The RCST will disable the activity timers of permanent connections. The RCSTs (or RSGW) involved in a permanent connection are considered as called parties.

**NOTE:** It may be possible to receive a permanent connection establishment request with the same parameters (same called parties and with the same priority level) as an already created on-demand connection. In this case, the connection should be accepted, and the traffic forwarded by the permanent connection. The on-demand connection will then be released thanks to timeout of activity timers.

#### 4.4.5.2.2 Permanent connection release

The permanent connection lifetime is fully controlled by the NCC. Therefore the release of a permanent connection may only be initiated by the NCC as configured in the NMC.

At reception of a connection release from the NCC, the RCST shall send a connection release response, remove related connection parameters and relevant routing entries no longer attached to any connection. The RCST should also release all relevant resources and flush the associated connection queue packet buffer no longer used.



**Figure 4.22: Permanent star connection scenario**

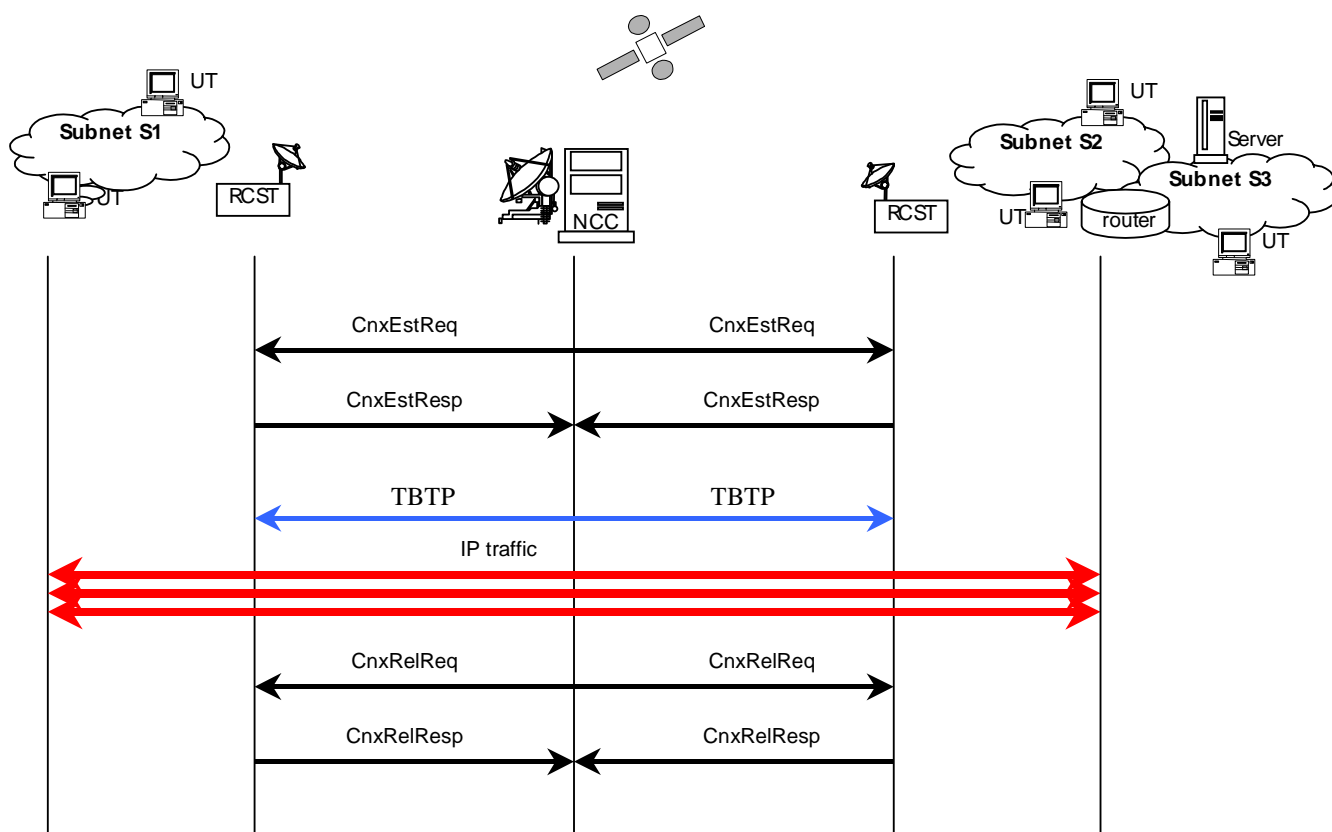


Figure 4.23: Permanent mesh connection scenario

#### 4.4.5.2.3 Permanent connection channel modify

For permanent connections, a daily profile can be defined allowing to vary the bandwidth parameters of the connection according to the period of the day. The channel modify procedure may affect one or several permanent connections per channel\_id. In this case the NCC sends a channel\_modify request to the involved parties at given time of the day as foreseen by the connection profile.

## 5 Quality of Service

The Network layer QoS may be defined as a probability of fully satisfying the QoS required by each user IP flow. The Network layer QoS depends on the traffic profile of the whole RSM-B system and the traffic profile of the RCST. The Network layer QoS figures can be defined only when these traffic profiles are agreed. The Network layer QoS mechanisms consist in performing prioritization of IP flows and asking the SLC layer for the most suitable transmission parameters for the considered application.

These mechanisms aim to provide priority to mission-critical data transactions or video or voice transmissions which require faster turnaround while providing service to less time - sensitive traffic (like e-mail or web surfing).

QoS on RCST level is based on adapting the satellite connection parameters to what the application requires. This requires identifying each application type and managing each of the application flows.

The QoS mechanisms on the RCST are based on traffic differentiation. The RCST is capable of classifying IP traffic into several IP flows. Each IP flow is identified thanks to a multifold filter definition. The queuing and scheduling between IP flows depends on the QoS strategy defined within the RCST.

## 5.1 Traffic classes

RSM-B is able to support the following traffic categories:

- **Best effort or Low Priority (LP):** Used by applications that do not have specific delay and jitter constraints. This traffic receives the lowest priority in the transmission scheduler of the terminal. A token bucket or WFQ algorithm is used in order to avoid that this queue gets blocked by real time non-jitter sensitive traffic queue.
- **Real time non-jitter sensitive or High Priority (HP):** Used by applications sensitive to delay but not to jitter. This traffic receives the highest priority in the transmission scheduler of the terminal.
- **Real time jitter sensitive or High Priority with jitter constraints (HPj):** Used by applications sensitive to both: delay and traffic. This traffic gets specific transmission resources ensuring that the jitter produced by the TDMA transmission scheme of DVB-RCS is minimized. These transmission resources are isolated from other type of traffic.
- **Streaming or Streaming Priority (StrP):** Typically used for Video traffic or volume based applications.

## 5.2 Flow classification

The flow classification mechanism will allow RCSTs and the RSGWs provision of different behaviours for different type of applications.

The IP data flow identification is performed by the RCST and the RSGWs upon the following information:

- IP source address.
- IP destination address.
- TCP/UDP source port numbers.
- TCP/UDP destination port numbers.
- DSCP value.
- Protocol type.

The RCST are configured with a set of masks on the six items listed above. The packets received on the RCST are classified according to these masks into different types of flow.

## 5.3 Link Layer connection QoS adaptation

Each time a new flow enters the RSM-B system, the RCST or the RSGW must determine if a suitable connection exists for carrying this flow and create it if it does not exist. In this case, the flow type is used to determine the connection parameters to be requested to the NCC, in particular the priority and the bandwidth parameters.

The association between flow types and connection parameters is configured in the RCST MIB. Up to five flow types plus a default can be defined. Table 5.1 shows the functional description of each entry in the MIB:

**Table 5.1: Flow type classification and SLC parameters**

	IP header "mask"	SLC - C2P parameters
Flow type	Source IP address and mask Destination IP address and mask DSCP range Source port number range Destination port number range Protocol type and mask	Activity timer Priority SDR return PDR return SDR forward PDR forward Unidir/Bidir

The default set of SLC parameters is defined by positioning each field of the "header mask" to "any value".

Based on the type of flow classification, the RCST automatically estimates:

- SLC - C2P parameters:
  - Type of connectivity (unicast/multicast).
  - Directionality (unidirectional/bi-directional).
  - Traffic type: priority level(LP, HP, HPj or SP).
  - Guaranteed Data Rate and Peak Data Rate for that traffic type reception and transmission.
  - Activity timeout to release radio resources when no more traffic is present.
- Different buffering queuing: distinction between HP and LP buffers (SMAC buffers).

For all traffic, it is possible to define a guaranteed and maximum bit rate. If a guaranteed bit rate is configured for a specific traffic category, as soon as a first packet of a flow requesting this level of QoS enters the satellite network, the guaranteed capacity is reserved. Once no more packets for this kind of traffic go through the network, the capacity allocation timeouts and the radio resources are freed.

If needed, the terminal requests more capacity. It will be assigned up to the maximum peak rate.

## 6 Network Layer

### 6.1 Overview

The network layer constitutes the external interfaces of the system for the traffic data; it contributes to the provision of services such as VoIP, IP multicast, Internet access and LAN interconnection.

The RCST network layer user plane interfaces are:

- IP datagrams with the SLC layer.
- IP datagrams between the RCST and the User Terminal (UT).

In the control plane the network layer implements a variety of control plane features as needed to support the provided services. The control plane of the network layer may be split up in two different parts:

- A service independent part that includes the interface between the RCST and the NCC to retrieve the MAC addresses corresponding to a given IP address.
- A service dependent part that includes:
  - IGMP signalling for multicast provision between RSGW and RCST.
  - IGMP signalling for multicast provision between the RCST and the UT.
  - For Internet access, exchanges between RCST and RSGW are necessary to get public IP addresses.
  - For LAN interconnection, no additional mechanism is necessary.

The control plane functions of the Network layer include:

- IGMP proxy functionality towards the RSGW: the RCST acts as IGMP host towards the RSGW.
- IGMP querier functionality towards the RCST's LAN.
- IP routing functionality linked to ARP embedded within the C2P.

## 6.2 IP addressing

The RCST may host several subscriber subnets. Each of these subnets may be composed of public or private IP addresses. The subscriber subnet interface with the RCST is called the UI. When several subnets can be reached through a RCST, the RCST however participates to a single one: the UI subnet. Reaching several subnets through the RCST requires that the subscriber use at least one router between these subnets.

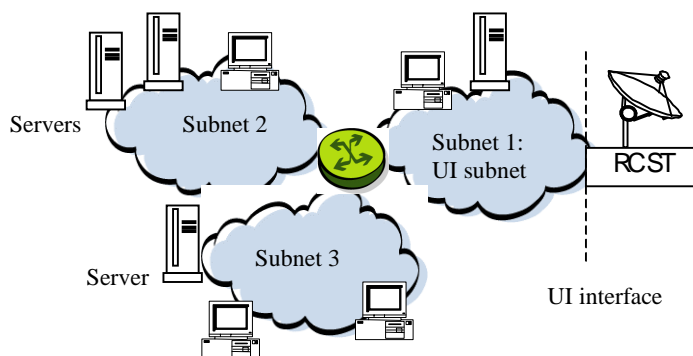


Figure 6.1: Several subnets at RCST user interface side

### 6.2.1 Public IP address

A subnet requires at least 4 IP addresses (/30). The upper and lower values are reserved for broadcast. The RSM-B network allows two subscribers to the same SP to communicate in a single satellite hop. The RSM-B network will prevent two subscribers belonging to two different SPs from communicating together in single hop. These subscribers must communicate through their respective SP ground network.

### 6.2.2 Private IP address

Using private IP addresses on the RCST User Interface subnet is cheaper (avoiding to request an IP public address), but does not provide the user with a way to reach Internet. If the user is willing to reach the Internet, this can be performed either through tunnel or through a NAT function as defined in RFC 1631 (see bibliography).

The Internet Assigned Numbers Authority (IANA) has reserved three blocks of the IP address space for private internets as defined in RFC 1918 (see bibliography). These are the three private unicast IP addresses ranges considered in RSM-B:

10.0.0.0	10.255.255.255 (10/8 prefix)	24 bit block (single Class A).
172.16.0.0	172.31.255.255 (172.16/12 prefix)	20 bit block (16 contiguous Class B).
192.168.0.0	192.168.255.255 (192.168/16 prefix)	16 bit block (256 contiguous Class C).

## 6.3 RSM-B IP routing

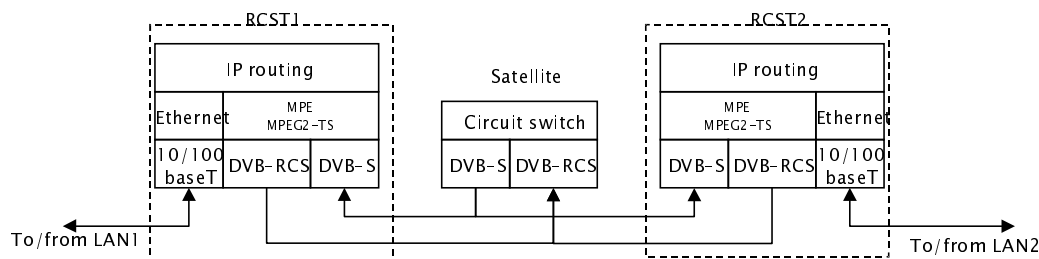
### 6.3.1 Overview

The RSM-B routing function is organized as a "decentralized router". Part of the routing functions are located in the RCSTs/RSGWs and the other part of them within the NCC, in a client/server like architecture. The NCC is the routing server and the RCSTs/RSGWs the clients. Each time a client needs to route an IP packet, it asks the server for the information required to route this packet. The routing information sent by the server, is saved in the client. Each client must also be configured with some "overall" subnet prefixes authorized for this client.

Each time an IP packet is incoming to the RSM-B system, the RCST or the RSGW determines where to send the packet, the final target being to get the destination equipment MAC address. The RCST or the RSGW look within their routing table and, if the route on the satellite path does not exist, issue an ARP toward the NCC, through the C2P connection request message.

### 6.3.2 IP routing and address resolution function

The RCST performs IP routing. Each time an IP packet enters the RCST, this one determines where to send the packet, aiming to get either the destination equipment MAC address or the Next Hop Router (NHR) MAC address.



**Figure 6.2: RCST RSM-B IP routing function**

There exists a close interaction between the routing and addressing functions, and the connection control and management. The connection interconnects distant points across the RSM-B network as a route across any type of network. And as for a route, the connection between end points is not possible without the knowledge of transit and end points (address), and paths linking these points (routing information). All this information is centralized in the NCC, which alone makes possible the connection between end points.

The end point can be any user equipment hosted on a sub-net located behind a RCST (User Interface side). These equipment are identified by a unique IP address belonging to one of the sub-net masks attached to the RCST. However, since the transmission across RSM-B is based upon the MPEG-2 TS packet format, the knowledge of MPE MAC addresses of end RCSTs is mandatory to establish a connection. That means that the NCC provides the mechanisms required to associate the IP address of a user equipment into the MPE MAC address corresponding to the hosting RCST (mechanism referred as "address resolution").

In order to speed-up the connection establishment procedure, the ARP function and the connection establishment is simultaneous : the connection establishment request from the RCST includes an ARP request, and the NCC response contains both ARP response (destination MAC address, and subnets) and connection parameters. There is only one step and one message sent in each direction.

The RCST routing table consists in two parts:

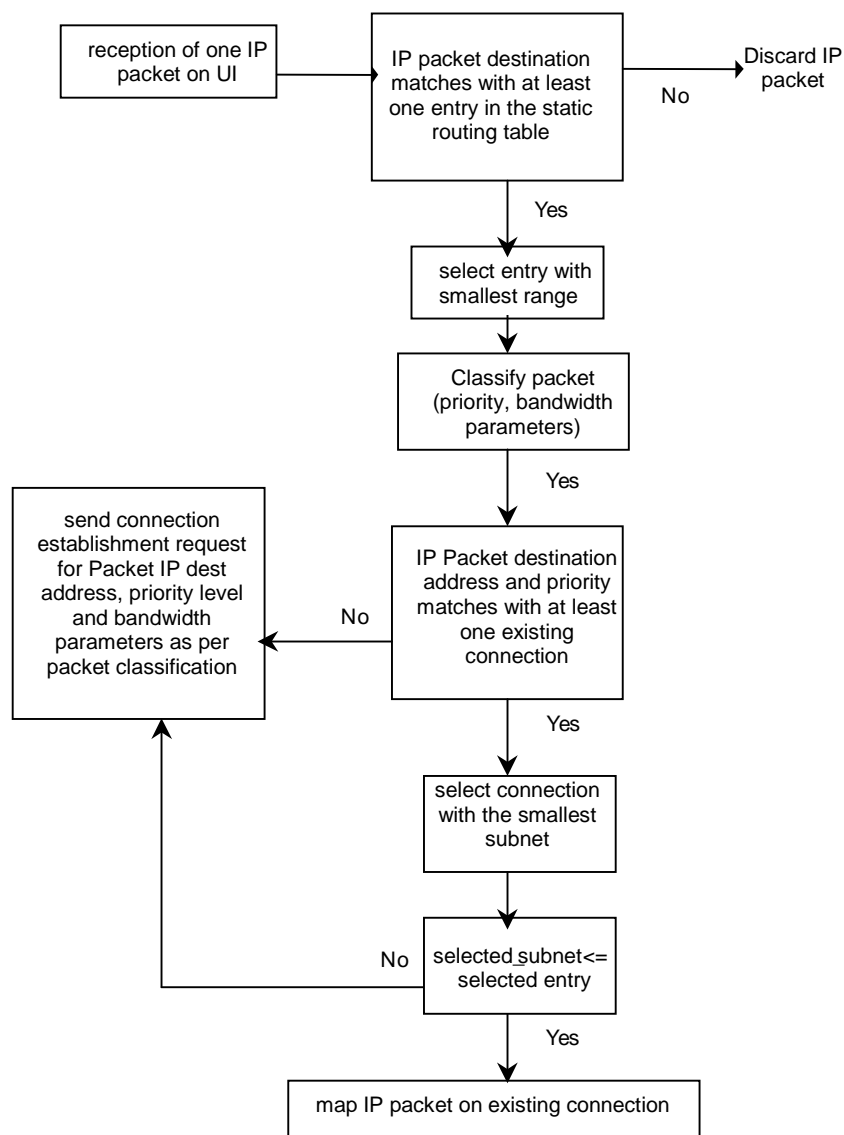
- The first part of the routing table is configured with routes depending on the subscription.
- The second part dynamically modifiable through C2P.

The configured entries may not be modified or removed by C2P but only through management (such as through SNMP or local management interface). The Next Hop squares of the corresponding line of the routing table, for these entries, are configured empty (dash) so that the RCST issues an ARP toward the NCC.



The following sequence presents the successive steps associated to a new point-to-point bi-directional connection set-up between two end points (other parameters than the addressing type are omitted for simplicity):

- 1) First of all, the calling RCST (hosting the calling equipment) needs to determine if a new connection should be requested or not as shown in figure 6.3:



**Figure 6.3: RCST RSM-B IP routing and connection set-up**

- 2) If the results is positive, the calling RCST propagates towards the NCC the request containing the called IP address to query the MPE MAC address of the corresponding end RCST (hosting the called equipment). The source RCST also transmits the IP address of the calling user equipment, the priority level and a requested bandwidth for the connection.
- 3) The NCC propagates the calling MPE MAC address and adds the mask addresses of the sub-net associated to the calling RCST. This mask obviously contains the IP address of the calling user equipment.
- 4) The NCC replies to the request with the called RCST MPE MAC address of the corresponding end RCST (hosting the called equipment) and the mask addresses associated to called RCST. This mask obviously contains the IP address of the called user equipment, confirmation of the priority level and bandwidth requested for the connection.
- 5) Each RCST caches the called MAC MPE address/IP sub-net masks pair avoiding to reiterate requests at each new incoming IP packet with an IP address belonging to one of the sub-net masks.

- 6) All the sub-nets prefix attached to one RCST are transmitted to the other RCST.
- 7) Once the calling RCST queried the called RCST MPE MAC address, it can encapsulate the data over MPEG-2 TS with the right MPE header and transmit the packets on the connection so established.

In case of multicast connection, the destination MPE MAC address is a multicast or broadcast MAC address.

### 6.3.3 Default route

The RCST routing table is configured with:

- one or several prefixes covering all the private IP address ranges of all the subscribers of the satellite network;
- one or several prefixes identifying the public IP address ranges allowed in the satellite network (this may also be specific to each RCST);
- optionally, a default route.

Depending on the satellite network-addressing plan, the RCST may have a default route or not. A single default route is authorized per RCST.

The usage to the default routing entry will depend on the type of services supported by the RCST.

- The routing table of a RCST involved in an Internet access subscription is configured with a default route toward a RSGW of the ISP.
- The routing table of a RCST involved in a corporate access is configured with a default route toward the RSGW of the telecom operator.
- The routing table of a RCST involved in a LAN interconnection access (VPN) may be configured with a default route toward another RCST of the same satellite network.

## 6.4 IP multicast

RSM-B system supports two types of IP multicast services based on two types of topologies:

- Star IP multicast.
- Mesh IP multicast.

In the Star IP multicast, multicast flows are dynamically forwarded from a RSGW to several RCSTs. Multicast sources are on the terrestrial network and forward their multicast flows towards the RSGW.

In the Mesh multicast, multicast flows are statically forwarded from a source RCST to several destinations RCSTs. Multicast sources are on terrestrial network and forward their multicast flows to a source RCST.

### 6.4.1 Star IP Multicast

Star IP Multicast implies distribution of worldwide available IP multicast data flows if the RSGW has Internet Access and distribution of MSP, ISP or Corporate dedicated IP multicast data flows.

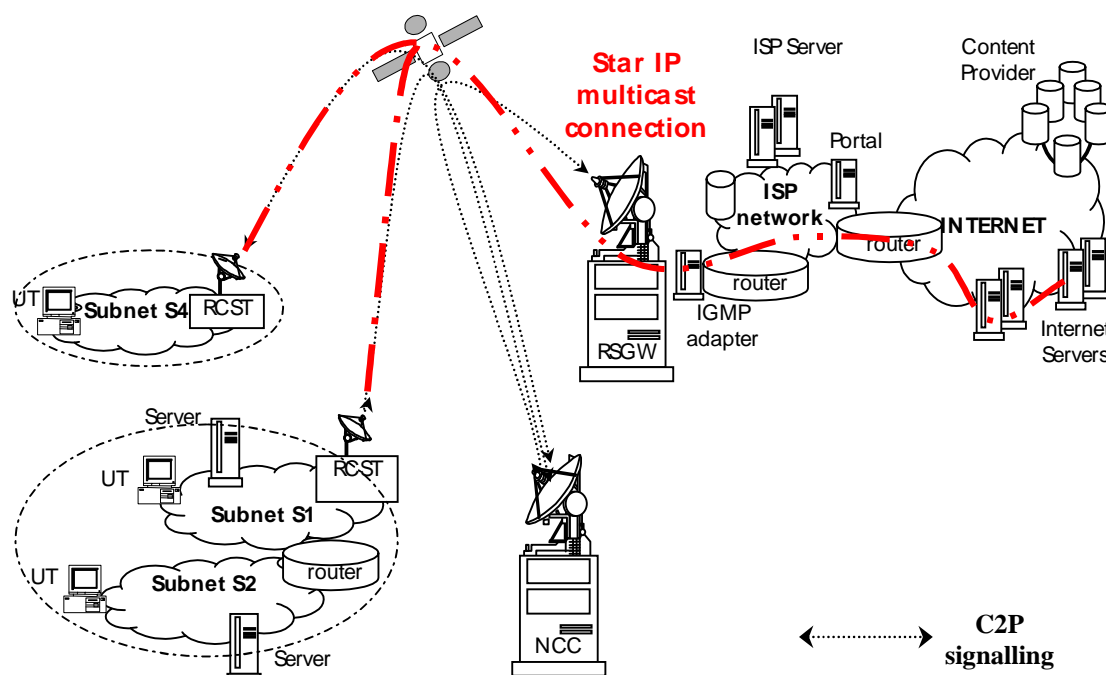
The forwarding of multicast flows is dynamic: the IGMPv2 protocol is running between the RCSTs and RSGW for multicast group membership set-up.

The RSGW forwards multicast flows on the uplink only if at least one RCST has requested to join the multicast group corresponding to this flow. The RSGW is in charge of managing the memberships so that to send each multicast flow only once.

### 6.4.1.1 Topology

RSM-B Star IP architecture follows the IGMP protocol architecture as defined in TS 102 294 (see bibliography).

The following figure shows in more detail the network topology for Star IP Multicast:



**Figure 6.4: Star IP Multicast network topology**

The network entities involved in the Star IP multicast network topology are hereafter overviewed:

- User Terminal (UT).

A User Terminal is on the IP subnet connected to the RCST through the User Interface. This UT has an IGMP v2 host function to subscribe/de-subscribe to a multicast group.

- Router on the IP subnet of a RCST.

If there is a router on the path between the RCST and User Terminal, this router is an IGMP v2 Proxy based on the Internet Draft Draft-ietf-magma-igmp-proxy-06.txt. The upstream interface is the interface towards the RCST and the downstream interface is the interface towards User Terminals.

- RCST.

An IGMP v2 Proxy based on the Internet Draft Draft-ietf-magma-igmp-proxy-06.txt is implemented in a RCST.

The RCST acts as an IGMP Router and Querier on its User interface and it acts as an IGMP Host on the satellite air interface. The IGMP proxy avoids the RSGW receiving request message for an IP multicast flow from an UT, on the LAN of a RCST, which has already been requested by another UT on the same LAN. The IGMP Proxy knows that the IP multicast flow is already transmitted on the TDM and provides it to the new UT without asking the RSGW. This enables to reduce the number of IGMP messages sent on the air interface.

The IGMP proxy forwards multicast data flow received from the satellite air interface to its User Interface according to its group membership table.

- RSGW.

The RSGW is composed of:

- a GW\_RCST;
- an IGMP adapter;

- a Multicast Edge Router.

The IGMP Adapter is an IGMP Proxy optimized to satellite environment following specification TS 102 293 (see bibliography). The IGMP adapter is based on IGMP v2 proxy and performs specific functions to improve the signalling load induced by the IGMP v2 protocol for the satellite networks. It has an interface towards GW-RCSTs and an interface towards a Multicast Edge Router. The IGMP host function is standard as defined in RFC 2236 [5]. The IGMP Querier function is optimized to the satellite environment having values of timers adapted to a satellite network.

The Multicast Edge Router is a multicast router with an IGMPv2 Router/Querier function on its interface towards the IGMP adapter and a multicast routing function on its other interface. The multicast routing function of the Multicast Edge Router is commonly based on PIM-SM. It is in charge of joining or pruning to the group-spanning tree.

All the IGMP messages are transparently forwarded no decrement of TTL (Time To Live) field value of IP packet, inside the RSGW till they reach the Multicast Edge Router. Therefore the GW\_RCST transparently forwards all IGMP messages without decreasing the TTL field value.

- Backbone network, ISP or MSP network, Internet, Corporate Network.

These networks have Multicast Core Routers with multicast routing protocol such as PIM-SM, MBGP, and MSDP.

## 6.4.1.2 Protocol stack

### 6.4.1.2.1 User Plane

The RCST User Plane protocol stack follows the structure defined in TS 102 429-1 [3].

In the User plane, the RCST is in charge of forwarding multicast packets according to a Group Membership Table. This table is used in the User Plane and it is generated and updated by the Control plane.

The format of the group membership table follows the structure:

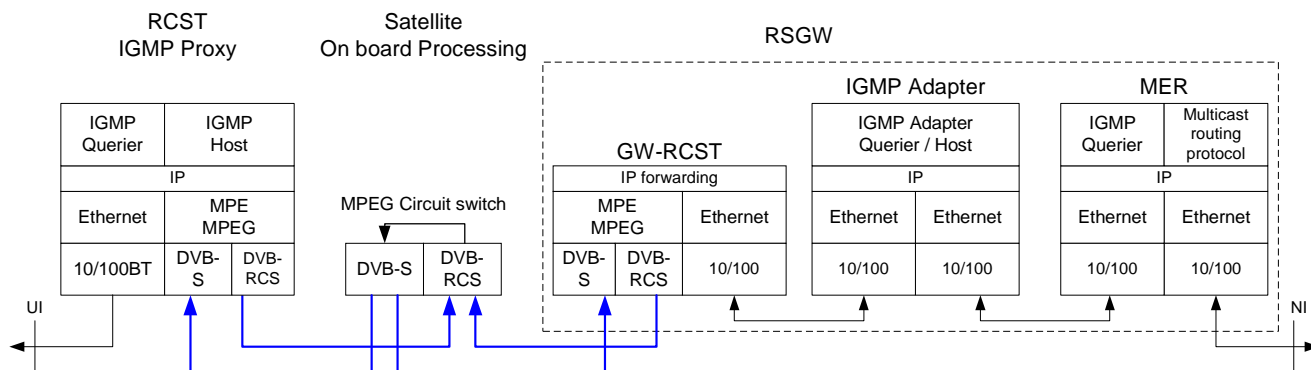
**Table 6.1: Group membership table**

Group address	Outgoing Interface
<IP group address>	<eth/sat interface>

This table has the list of multicast group addresses having at least one member. The outgoing interface is the interface toward group traffic is to be forwarded. In RSM-B system it is the User interface of the RCST.

### 6.4.1.2.2 Control Plane

In the control plane, IGMP v2 messages are exchanged between IGMP Proxy included into RCSTs and the IGMP Adapter of the RSGW, and between the IGMP Adapter of the RSGW and a Multicast Edge Router.



**Figure 6.5: Star IP multicast control plane protocol stacks**

The type of IGMP v2 messages exchanged over the air satellite interface is:

- IGMP v2 Generic Query and Specific Group Query are sent by the IGMP Adapter to RCSTs.
- IGMP v2 Report and Leave messages are sent by RCSTs to the IGMP Adapter.

The IGMP v2 format messages must be compliant to the RFC 2236 [5]. Particularly all IGMP v2 messages must be encapsulated into Ipv4 packets having the Router Alert Option in their IP headers as defined in the RFC 2113 [4].

At IP level IGMP v2 messages are characterized by:

**Table 6.2: Characteristics of IGMP v2 messages**

IP Header	Content
Source IP address	IP address of the IGMP Adapter on its interface towards GW-RCST Or the IP address of the RCST on its User interface.
Destination IP address	224.0.0.1 ALL-SYSTEM for IGMP v2 Generic Query message 224.0.0.2 ALL-ROUTERS for IGMP v2 Leave message Group address (Class D address) for IGMP v2 Report message and IGMP v2 Group specific Query.
TTL (Time-To-Live) field	1
Protocol number	2
IP header Option	Router Alert Option.

Moreover the NCC periodically sends the Multicast Map table. The MMT is described in annex I.6 of TR 101 790. This MMT gives multicast PID associated to IP multicast addresses.

**Table 6.3: Multicast Map Table for Star IP multicast**

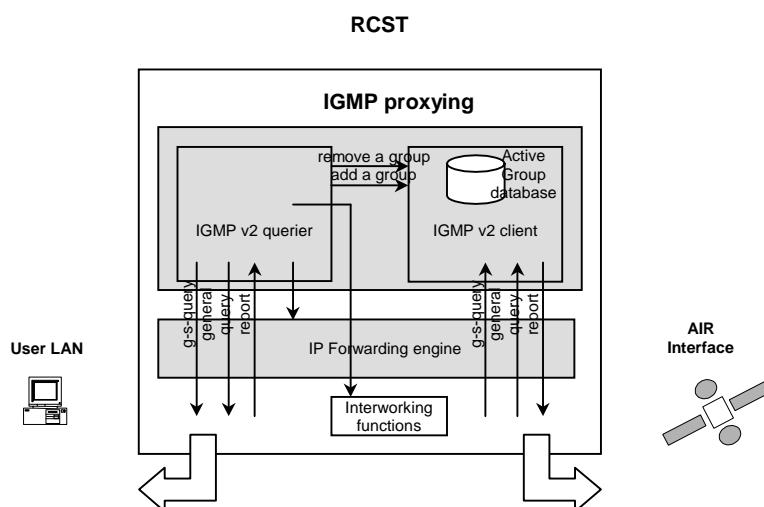
Multicast address	PID
ALL-SYSTEM (224.0.0.1)	Multicast PID
<IP group address>	Multicast PID
<IP group address>	Multicast PID

### 6.4.1.3 RCST Star IP Multicast functions

The IGMP Proxy included into the RCST has two interfaces. These interfaces must be configured as defined below:

- An IGMPv2 Host function on the satellite air interface.
- An IGMPv2 Querier on the User Interface.

The following figure shows the RCST IGMP Proxying functionality:



**Figure 6.6: IGMP proxying overview**

The IGMPv2 messages sent by the RCST towards the IGMP adapter has as IP source address the IP address of the RCST in its Air Interface.

The IGMP v2 proxy shall be configured to receive IGMP v2 Query messages from the IGMP adapter of the RSGW. It shall process IGMPv2 messages using the multicast address ALL-SYSTEM (224.0.0.1) without sending an IGMP report for this group address towards the IGMP adapter. This IGMP v2 proxy has a membership database consisting of the merge of all subscriptions on its downstream interface.

The IGMP Querier function on the User Interface is configured to be elected as Querier. This entity processes IGMP messages received from the User Interface.

The RCST star IP multicast functions follow the IGMP-specific BSM functional model defined in TS 102 293 (see bibliography).

#### 6.4.1.3.1 RCST IGMPv2 Host

The IGMP v2 host shall process as specified in clause 6 of RFC 2236 [5]. It shall process one state diagram per multicast address active in the Membership database.

The IGMPv2 Host must not respond for a group with an address included in 224.0.0.0/24. These are local sub-network multicast addresses that do not need to be controlled by IGMP.

The "Join group" event appears on reception of an "add a group" from the IGMPv2 Querier. In addition to the specified actions on the "Join group" event, the IGMPv2 Host shall:

- Send an IGMP report to the IGMP adapter. The unsolicited report must not be sent by the IGMPv2 Host if it receives a resent report before the unsolicited report timer expires.
- Add the group to the membership database.

The "Leave group" event appears on reception of a "remove a group" from the IGMPv2 Querier. In addition to the specified actions on the "Leave group" event, the IGMPv2 Host shall remove the group from the Membership database. The IGMPv2 Host shall send an IGMP Leave message if its flag is set. If the flag is not set, the IGMPv2 Host must not forward an IGMP leave message (silent leave).

When a General Query is received, the IGMPv2 Host shall act if it is a member of all groups present in the Membership database.

The unsolicited Report Interval of IGMPv2 Host shall be configurable.

#### 6.4.1.3.2 RCST IGMPv2 Querier

The IGMPv2 Querier shall process clause 7 of RFC 2236 [5] with the following extra actions:

On the "notify routing +" action, the IGMPv2 Querier shall:

- Change the group membership table used to forward multicast packets.
- Send a "add a group" to the IGMPv2 Host.

On the "notify routing -" action, the IGMPv2 Querier shall:

- Change the Group Membership table used to forward multicast packets.
- Send a "remove a group" to the IGMPv2 Host.

Some parameters of the IGMPv2 Querier shall be configurable:

- Robustness variable.
- Query Interval.
- Query Response Interval.

To receive IGMP messages and Multicast Traffic sent by the RSGW, the RCST needs to filter the multicast PID associated to these data. The multicast PID is indicated into the Multicast Map Table (MMT) forwarded by the NCC. The RCST keeps in memory a copy of the last received MMT. The RCST learns the PID use to decode the MMT from the Network Layer Information Descriptor received in the TIM\_u during the logon process.

The RCST shall first learn the PID used to forward IGMP messages (IP address 224.0.0.1). After upon creation of a group membership (first IGMP Report message on its User Interface) the IGMPv2 Proxy shall send an internal request to check the corresponding multicast PID in the MMT and then updates the list of PIDs to listen to. Upon suppression of a group membership, the IGMP Proxy shall send an internal request to retrieve the corresponding PID from the list of PIDs to listen to.

To check the multicast PID corresponding to an IP multicast address, the RCST shall parse the MMT from the beginning to end and shall select the first PID corresponding to the IP multicast address.

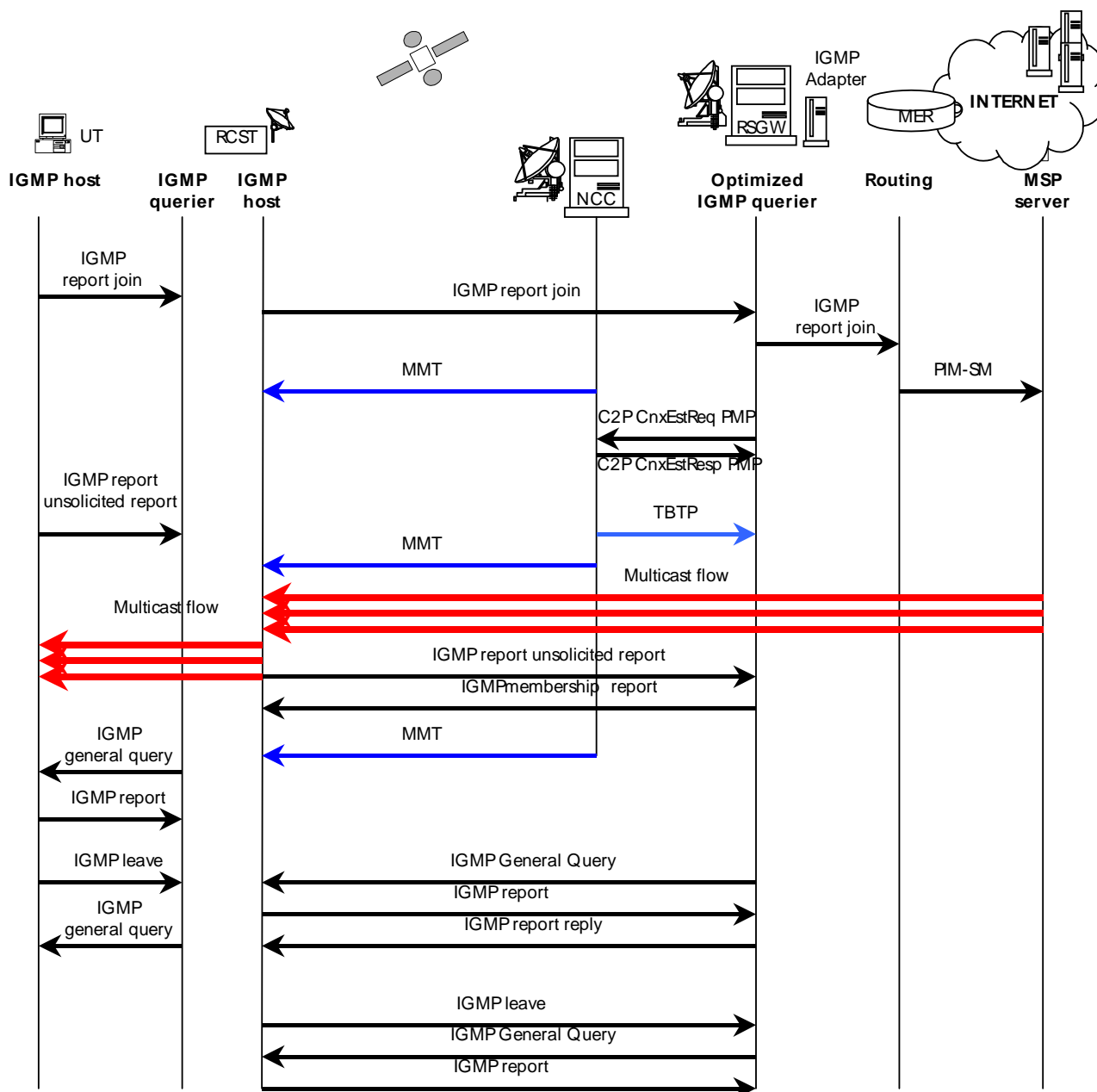


Figure 6.7: Star IP Multicast scenario example

#### 6.4.1.4 Connections for Star IP Multicast

The NCC is in charge of assigning a multicast PID to the RSGW and of periodically sending the Multicast Map Table of a satellite network. A typical refresh period for the MMT is 10s. This MMT is updated according to RSGW request (Connection Establishment Request for a point-to-multipoint connection).

IGMP v2 protocol needs a two-way communication:

- The RSGW sends IGMP v2 messages to all covered TDMs.
- The RCSTs send IGMP v2 messages to the RSGW.

Multicast flows need a unidirectional point-to-multipoint connection from the RSGW to all covered TDMs. Then the following connections are set-up:

- A point-to-multipoint connection from the RSGW to all covered TDMs to forward IGMP v2 messages and all multicast flows.



- A point-to-point connection from each RCST to the RSGW to forward IGMP v2 messages.

#### 6.4.1.4.1 Point-to-multipoint connection from the RSGW

This point-to-multipoint connection is set-up on demand by the RSGW upon reception an IP multicast packet (identified by a multicast IP address).

- Set-up of the connection by the RSGW:
  - When the RSGW receives a first multicast packet, the RSGW sends a C2P Connection Establishment Request.
  - The NCC processes this request and assigns a multicast PID. An entry [IP multicast address-PID] is added into the MMT. When the MMT has been updated the NCC sends a C2P Connection Establishment Response to the RSGW.
  - Once this connection is set-up all multicast IP packets using this IP multicast address are forwarded to RCSTs via this connection.
- Release of the connection initiated by the RSGW:
  - This point-to-multipoint connection could be released when the timer associated to this connection expires (no more multicast packets are sent by the RSGW).
  - The RSGW sends a C2P Connection Release Request to the NCC. The NCC processes this request and updates the Multicast Map Table. The NCC removes the entry [IP multicast address - PID] from the MMT.

#### 6.4.1.4.2 Point-to-point connection from a RCST

Upon reception of a multicast IP packet encapsulating IGMP messages (Router Alert option and protocol number 2 into the IP header), the IP forwarding function forwards this IP packet to the default gateway. The IP address of the default gateway is known by the RCST in its unicast routing table. The RCST checks if a connection with its default RSGW is already set-up or not.

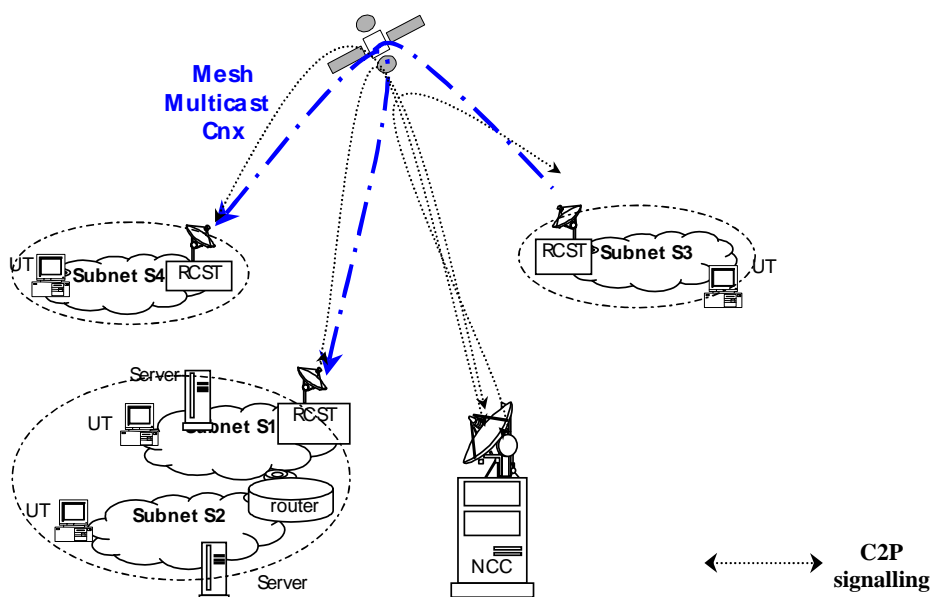
- No connection is set up between the RCST and its default RSGW: Connection set-up:
  - In this case the RCST sets up a point-to-point-connection with the RSGW. This connection has the same characteristics as the one used by to access star services (star connection).
- A star connection is already set-up between the RCST and its RSGW:
  - In this case IGMP messages are forwarded to the RSGW via this star connection. There is no connection set-up.
- Release of the connection:
  - This connection could be released when the activity timer associated to this connection either in the RCST or in the RSGW expires. The RCST (or the RSGW) could send a C2P Connection Release Request to the NCC.

### 6.4.2 Mesh IP Multicast

Mesh IP Multicast provides forwarding of multicast data between RCSTs having a LAN interconnection subscription over the RSM-B system. Mesh IP Multicast consists in the distribution of IP multicast flows from a source RCST over all TDMs in the same satellite network.

### 6.4.2.1 Topology

Figure 6.8 gives the network topology to offer Mesh IP Multicast service.



**Figure 6.8: Mesh IP multicast network topology**

- User Terminal (UT).

A User Terminal is on the IP subnet connected to the RCST through the User Interface. This UT has an IGMP v2 host function to subscribe/de-subscribe to a multicast group.

- Router on the IP subnet of a RCST.

If there is a router on the path between the RCST and User Terminal, this router is an IGMP v2 Proxy based on the Internet Draft Draft-ietf-magma-igmp-proxy-04.txt. The upstream interface is the interface towards the RCST and the downstream interface is the interface towards User Terminals.

Moreover this router is configured to forward some multicast flows to the RCST. The list of authorized multicast flows is the same as the one configured into the RCSTs.

- RCST.

The RCST is an IGMP v2 Querier to process subscription of UTs on the User Interface. On the air satellite interface a RCST has no IGMP function. It forwards multicast data flow received from the air satellite interface to its User Interface according to its group membership table when requested.

In addition a RCST has the list of IP multicast group addresses that authorized to be forwarded to the air satellite interface. This list is defined per RCST and is configured by management. An RCST forwards these authorized IP multicast flows from the User Interface to the air satellite interface over a point-to-multipoint connection.

- Multicast addresses.

Each satellite network managed by a service provider has a pool of IP multicast addresses assigned as recommended in the RFC 2365 (see bibliography). Each RCST has pool of IP multicast addresses authorized to be forwarded.

## 6.4.2.2 Protocol stack

### 6.4.2.2.1 User Plane

The RCST user plane protocol stack follows the structure defined in TS 102 429-1 [3].

In the User plane a RCST has a group membership table to forward multicast traffic packets from the air satellite interface to its User Interface. This table is used in the User Plane and it is generated and updated by the Control Plane.

The format of the group membership table follows this structure:

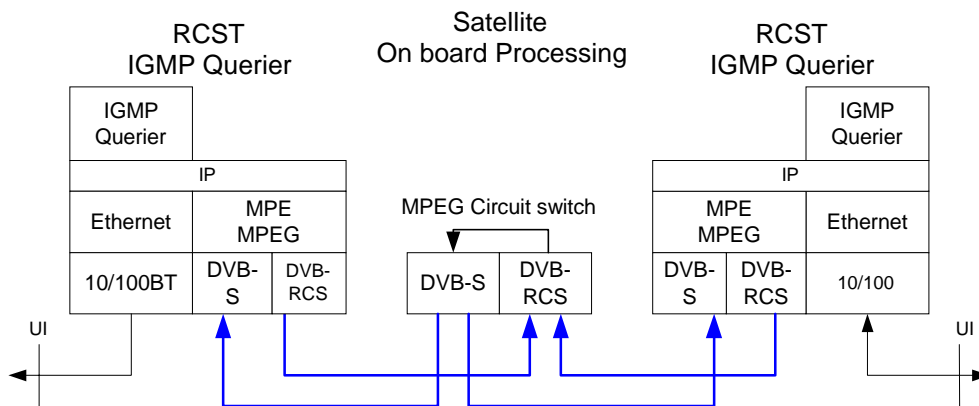
**Table 6.4: Group membership table**

Group address	Outgoing Interface
<IP group address>	<eth/sat interface>

This table has the list of multicast group addresses having at least one member. The outgoing interface is the interface toward traffic is forwarded. In RSM-B system it is the User interface of the RCST.

About IP multicast traffic packets received from the User Interface the RCST forwards them to the air satellite interface according to the list of authorized IP multicast addresses.

### 6.4.2.2.2 Control plane



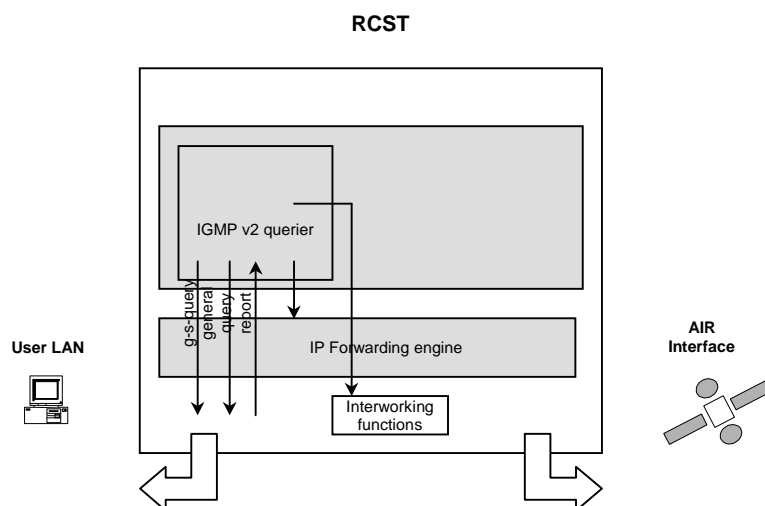
**Figure 6.9: Mesh IP multicast control plane protocol stack**

In the control plane, IGMP v2 messages are exchanged between IGMP Querier included into RCSTs and User Terminals. There is no IGMP Messages exchanged between the RCSTs on the air satellite interface.

### 6.4.2.3 RCST Mesh IP Multicast functions

Mesh IP Multicast functions require an IGMPv2 querier implemented in the RCST. This RCST querier implementation follows RFC 2236 [5].

An overview of IGMPv2 querier function is given in the following figure:



**Figure 6.10: IGMPv2 querier overview**

To receive multicast traffic sent by a RCST, the RCST needs to filter multicast PIDs associated to the traffic. These PIDs are indicated into the Multicast Map Table (MMT) forwarded by the NCC.

The NCC periodically sends a MMT. The MMT is described in the TR 101 790 annex I.6 and gives the multicast PID associated to a multicast IP address.

**Table 6.5: Multicast Map Table for Mesh IP multicast**

Multicast address	PID
<IP group address>	PID
<IP group address>	PID
<IP group address>	PID

Then the RCST processes the MMT and keeps in memory a copy of the last received MMT. The RCST learns use to decode the MMT from the Network Layer Info Descriptor into the TIM\_u table received during the log-on.

Upon creation of a group membership (first IGMP Report message on its User Interface) the IGMP Querier sends an internal request to look up the corresponding multicast PID in the MMT and then updates the list of PIDs to listen to. Upon suppression of a group membership, the IGMP Querier sends an internal request to retrieve the corresponding PID from the list of PIDs to listen to.

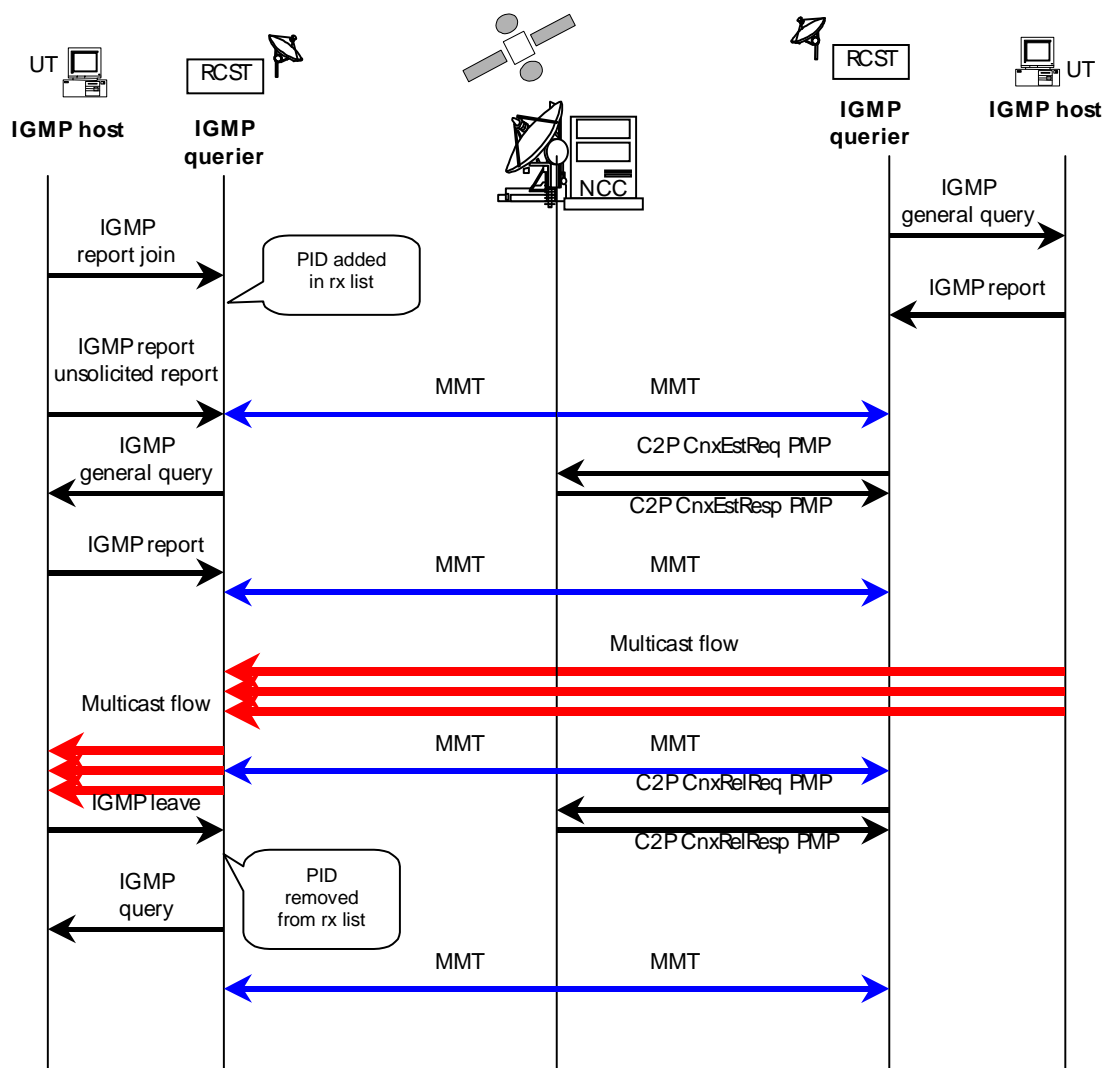


Figure 6.11: Mesh IP Multicast scenario example

#### 6.4.2.4 Connections for Mesh IP multicast

The Meshed IP Multicast data service delivery is unidirectional and uses a point-to-multipoint connection originated by a source RCST to all TDMs covered by the satellite network. This connection may be an on-demand connection or a permanent connection.

No signalling connection is required for this service because no multicast signalling protocol is running between RCSTs.

##### 6.4.2.4.1 On demand point-to-multipoint from an RCST

Upon reception of a multicast IP packet the source RCST checks if this IP multicast address belongs to the list of IP multicast addresses authorized to be forwarded on the air satellite interface.

If the multicast address belongs to this list, the RCST checks if a point-to-multipoint connection is already set-up for this group. If the connection is already set-up, the RCST forwards the multicast flow via this connection.

The NCC assigns a multicast PID for this group. The entry [multicast address -PID] is added into the MMT. When the MMT has been updated, the NCC sends a C2P Connection Establishment Response to the source RCST.

Once this connection is set-up all IP multicast packets using this IP multicast address are forwarded to RCSTs via this connection.

This multicast traffic connection could be released when the activity timer associated to this connection expires (no multicast traffic packets sent by the source RCST).

The RCST sends a C2P Connection Release Request to the NCC. The NCC processes this request and updates the Multicast Map Table. The NCC removes the entry [IP multicast address, multicast PID] from the MMT.

#### 6.4.2.4.2 Permanent point-to-multipoint connection

A permanent point-to-multipoint connection is characterized by:

- A start time.
- A stop time.
- A multicast group address.
- A source RCST.

The NCC is in charge of setting-up the permanent connection for the multicast group address at the start time. The NCC will assign a multicast PID for the group. The entry (multicast group address -PID) is added into the MMT. When the MMT has been updated, the NCC sends a C2P connection establishment message to the source RCST.

Once this connection is set-up all IP multicast packets using this IP multicast address are forwarded to RCSTs via this connection.

Upon reception of a multicast IP packet the source RCST checks if this IP multicast address belongs to the list of IP multicast addresses authorized to be forwarded on the air satellite interface.

If the multicast address belongs to this list, the RCST checks if a point-to-multipoint connection is already set-up for this group. If the connection is already set-up, the RCST forwards the multicast flow via this connection.

At the stop time, the NCC releases this permanent multicast traffic connection. When releasing the connection, the NCC updates the Multicast Map Table. The NCC removes the entry [IP multicast address, multicast PID] from the MMT.

---

## Annex A (informative): Bibliography

- ETSI TR 101 790: "Digital Video Broadcasting (DVB); Interaction channel for satellite distribution systems; Guidelines for the use of EN 301 790".
- draft-ietf-magma-igmp-proxy-04.pdf: "IGMP/MLD-based Multicast Forwarding ("IGMP/MLD Proxying")".
- draft-ietf-magma-igmp-proxy-06.txt: " IGMP/MLD-based Multicast Forwarding ("IGMP/MLD Proxying")".
- ETSI TR 101 202: "Digital Video Broadcasting (DVB); Implementation guidelines for data broadcasting".
- IETF RFC 1112: "Host Extensions for IP Multicasting".
- IEEE 802.3 CSMA/CD (ETHERNET)
- ETSI EN 300 421: "Digital Video Broadcasting (DVB);Framing structure, channel coding and modulation for 11/12 GHz satellite services".
- 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".
- ETSI TS 102 429-4: "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 4 : Specific Management Information Base".
- ETSI TS 102 293: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM) services and architectures; IP Interworking over satellite; Multicast group management; IGMP adaptation".
- ETSI TS 102 294: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM) services and architectures; IP interworking via satellite; Multicast functional architecture".
- IETF RFC 2365: "Administratively Scoped IP Multicast".
- IETF RFC 1918: "Address Allocation for private Internets".
- IETF RFC 1631: "The IP Network Address Translator (NAT)".

---

## History

<b>Document history</b>		
V1.1.1	October 2006	Publication