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Satellite Earth Stations and Systems;
Air Interface for S-band Mobile Interactive Multimedia (S-MIM);
Part 6: Protocol Specifications, System Signalling

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Foreword

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

The present document is part 6 of a multi-part deliverable. Full details of the entire series can be found in part 1 [2].

Introduction

The present document concerns the S-MIM (S-band Mobile Interactive Multimedia) system in which a standardised S-band satellite mobile broadcast system is complemented by the addition of a return channel.

The technology applied has been developed in the framework of the publicly funded project "DENISE" (ESTEC / Contract Number 22439/09/NL/US).

The S-MIM system specified herein is designed to provide:

- Interactive mobile broadcast services.
- Messaging services for handhelds and vehicular terminals, capable of serving millions of terminals due to a novel optimised air-interface in the RTN link.
- Real-time emergency services such as voice and file transfer, mainly addressing institutional users on-the-move such as fire brigades, civil protection, etc.

Inside the S-band, the 2 GHz MSS band is of particular interest for interactive multimedia, since it allows two-way transmission. Typically, the DVB-SH standard [i.5] is applied for broadcast transmission; ESDR [i.1] is an alternative. Essential requirements under the R&TTE directive are covered by the harmonized standard EN 302 574 [i.2], [i.3] and [i.4].

1 Scope

The present document is part 6 of the standard and concerns aspects of the air interface for the S-band Mobile Interactive Multimedia (S-MIM) system, and in particular it specifies the system signalling.

The other parts are listed in the foreword of part 1 [2].

2 References

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

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

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2.1 Normative references

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

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

[2] ETSI TS 102 721-1: "Satellite Earth Stations and Systems; Air Interface for S-band Mobile Interactive Multimedia (S-MIM); Part 1: General System Architecture and Configurations".

[3] ETSI TS 102 721-3: "Satellite Earth Stations and Systems; Air Interface for S-band Mobile Interactive Multimedia (S-MIM); Part 3: Physical Layer Specification, Return Link Asynchronous Access".

[4] ETSI TS 102 721-4: "Satellite Earth Stations and Systems; Air Interface for S-band Mobile Interactive Multimedia (S-MIM); Part 4: Physical Layer Specification, Return Link Synchronous Access".

[5] ETSI TS 102 721-5: "Satellite Earth Stations and Systems; Air Interface for S-band Mobile Interactive Multimedia (S-MIM); Part 5: Protocol Specifications, Link Layer".

[6] IETF RFC 4944: "Transmission of IPv6 Packets over IEEE 802.15.4 Networks".

2.2 Informative references

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

[i.1] ETSI EN 302 550 (all parts and sub-parts): "Satellite Earth Stations and Systems (SES); Satellite Digital Radio (SDR) Systems".

[i.2] ETSI EN 302 574-1: "Satellite Earth Stations and Systems (SES); Harmonized standard for satellite earth stations for MSS operating in the 1 980 MHz to 2 010 MHz (earth-to-space) and 2 170 MHz to 2 200 MHz (space-to-earth) frequency bands; Part 1: Complementary Ground Component (CGC) for wideband systems: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.3] ETSI EN 302 574-2: "Satellite Earth Stations and Systems (SES); Harmonized standard for satellite earth stations for MSS operating in the 1 980 MHz to 2 010 MHz (earth-to-space) and 2 170 MHz to 2 200 MHz (space-to-earth) frequency bands; Part 2: User Equipment (UE) for wideband systems: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.4] ETSI EN 302 574-3: "Satellite Earth Stations and Systems (SES); Harmonized standard for satellite earth stations for MSS operating in the 1 980 MHz to 2 010 MHz (earth-to-space) and 2 170 MHz to 2 200 MHz (space-to-earth) frequency bands; Part 3: User Equipment (UE) for narrowband systems: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[i.5] ETSI TS 102 585: "Digital Video Broadcasting (DVB); System Specifications for Satellite services to Handheld devices (SH) below 3 GHz".

3 Definitions and abbreviations

3.1 Definitions

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

2 GHz MSS band: 1 980 to 2 010 MHz (earth-to-space) and 2 170 MHz to 2 200 MHz (space-to-earth) frequency bands

NOTE: These paired bands are assigned to MSS.

architecture: abstract representation of a communications system

NOTE: Three complementary types of architecture are defined:

- Functional Architecture: the discrete functional elements of the system and the associated logical interfaces.
- Network Architecture: the discrete physical (network) elements of the system and the associated physical interfaces.
- Protocol Architecture: the protocol stacks involved in the operation of the system and the associated peering relationships.

collector: terrestrial components that "collect" return link transmissions from terminals and forward them towards the ground segment

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

repeater: terrestrial components that (mainly) repeat the satellite signal in the forward link

S-band: equivalent to 2 GHz MSS band

3.2 Abbreviations

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

CAC	Call Admission Control
CDMA	Code Division Multiple Access
CGC	Complementary Ground Component
CID	Context Identifier
DAMA	Dynamic Assignment Multiple Access
DVB-SH	Digital Video Broadcasting, Satellites services to Handhelds
EIRP	Equivalent Isotropic Radiated Power
EOC	Edge Of Coverage

FEC	Forward Error Correction
FLS	Forward Link Signalling
FWD	Forward (link)
GHz	Giga Hertz
ID	Identifier
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
IPSec	IP Security
Ipv6	Internet Protocol version 6
LLC/SNAP	Logical Link Control/Sub-Network Access Protocol
LLCT	Link Layer Configuration Table
LLMT	Link Layer Map Table
MAC	Medium Access Control
MAI	Multiple Access Interference
MPE	Multiprotocol Encapsulation
MPEG	Moving Pictures Experts Group
MPEG-TS	MPEG Transport Stream
MSS	Mobile Satellite Services
NIT	Network Information Table
PAT	Program Association Table
PCCH	Physical Control Channel
PDCH	Physical Data Channel
PID	Program Identifier
PMT	Program Map Table
PSI	Program Specific Information
QMT	QS-CDMA Map Table
QS-CDMA	Quasi Synchronous CDMA
QSCT	QS-CDMA Configuration Table
QSDT	QS-CDMA Dynamic Table
QSPCT	QS-CDMA Power Correction Table
QSTIM	QS-CDMA Terminal Information Message
R&TTE	Radio and Telecommunications Terminal Equipment
RACH	Random Access CHannel
RFC	Request For Comments
RLE	Return Link Encapsulation
RTN	Return (link)
SAT	SSA Access Table
SCT	SSA Configuration Table
SDR	Satellite Digital Radio
SDT	SSA Dynamic Configuration Table
SFN	Single Frequency Network
SI	Service Information
S-MIM	S-band Mobile Interactive Multimedia
SMT	SSA Map Table
SS1	Service Segment 1
SS2	Service Segment 2
SS3	Service Segment 3
SSA	Spread Spectrum Aloha
TMSI	Temporary Mobile Subscriber Identity
TS	Transport stream
UMTS	Universal Mobile Telecommunications System
USIM	Universal Subscriber Identity Module

4 General Description

The management of S-MIM resources concerns long term and short term aspects.

The Control Plane is concerned with dynamic (short term) resource management with the associated signalling needed to manipulate communication channels.

The clauses below deal with the Forward and Return Links separately.

5 Forward link

5.1 Forward link Control Plane Protocol Stack

In the Control Plane, most of the system signalling is provided through DVB-like signalling tables, see [1], encapsulated in MPEG-TS.

However, the signalling for authentication needs to communicate with the USIM. In order to allow reuse of existing technologies, UMTS data units are employed for authentication signalling going through the USIM. Hence, the protocol stack for the Control Plane has a specific branch to allow the transport of this type of data packets over MPE/MPEG. To achieve compatibility with the USIM, the use of MPE with the LLC/SNAP protocol is selected to transport data other than IP, as shown in Figure 5.1.

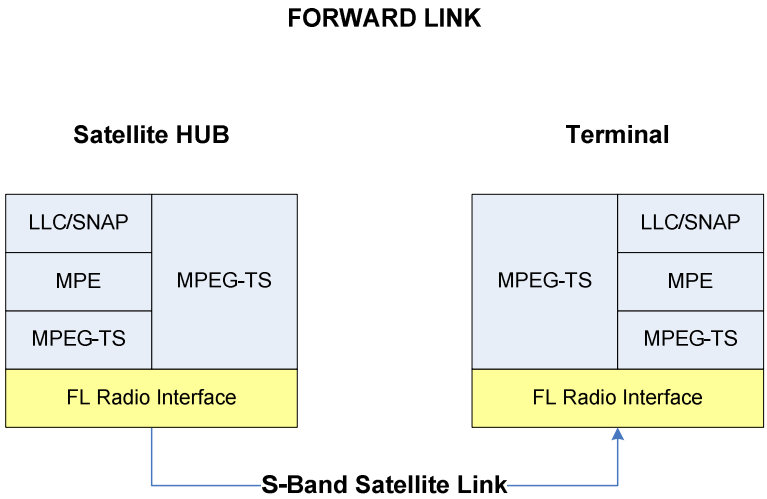

Figure 5.1: FWD link Control Plane Protocol Stack for SS1 and SS2

5.2 Forward link Signalling

The S-MIM system shall use DVB-SI tables to carry system signalling over the forward link in a similar way to DVB-RCS.

Hence, the Forward Link Signalling (FLS) shall consist in general SI tables, carrying general information about the satellite network, and more specific messages for support the SSA access scheme, the QS-CDMA access scheme and the Link Layer.

NOTE: The MPEG-2 standard has already standardized the Program Specific Information (PSI) tables which provide all the information required to recover the streams of interest within an MPEG2-TS multiplex.

The MPEG2-PSI and DVB-SI tables concern:

- Network Information Table (NIT). This is a DVB-SI table carrying information related to the physical organisation of the transport streams carried via the network, and the characteristics of the network itself. The NIT specifies how to receive other DVB-SI tables by means of linkage descriptors which basically give the PID in which these tables can be found.

- Program Association Table (PAT). This table provides a complete list of the programs (services, identified by their program number) that are available in a transport stream. In particular, it indicates where the PMT can be found in the transport stream for each of the identified programs. In the S-MIM system the signalling to support the return link and the Link Layer will be also listed as services as it will be explained later.

- Program Map Table (PMT). This table defines the elements needed for accessing a given service. It identifies the elementary streams that comprise the programme (PID).

NIT and PAT are sent with a fixed PID (0x0010 for NIT and 0x0000 for PAT). After power up, S-MIM terminals can scan the forward link to find the NIT and PAT tables, which are sent periodically. The NIT shall contain a suitable linkage descriptors pointing to the following tables:

- SSA Map Table (SMT- see clause 5.2.1.1)
- QS-CDMA Map Table (QMT - see clause 5.2.2.1)
- Link Layer Map Table (LLMT - see clause 5.2.3.1)

These three tables contain linkage descriptors to other tables which contain the signalling from the S-MIM system.

Alternatively, terminals can access the PAT table. In this table the SSA return link, the QS-CDMA return link and the Link Layer shall be listed as one or several services. For each of these services a linkage descriptor to the PMT of the service shall be present. The PMT of each of these services shall contain a linkage descriptor to all the tables associated with this service.

The organization of the DVB-SI tables in the S-MIM system is shown in Figure 5.2. The linkage descriptors are depicted as arrows and the signalling tables as rectangles.

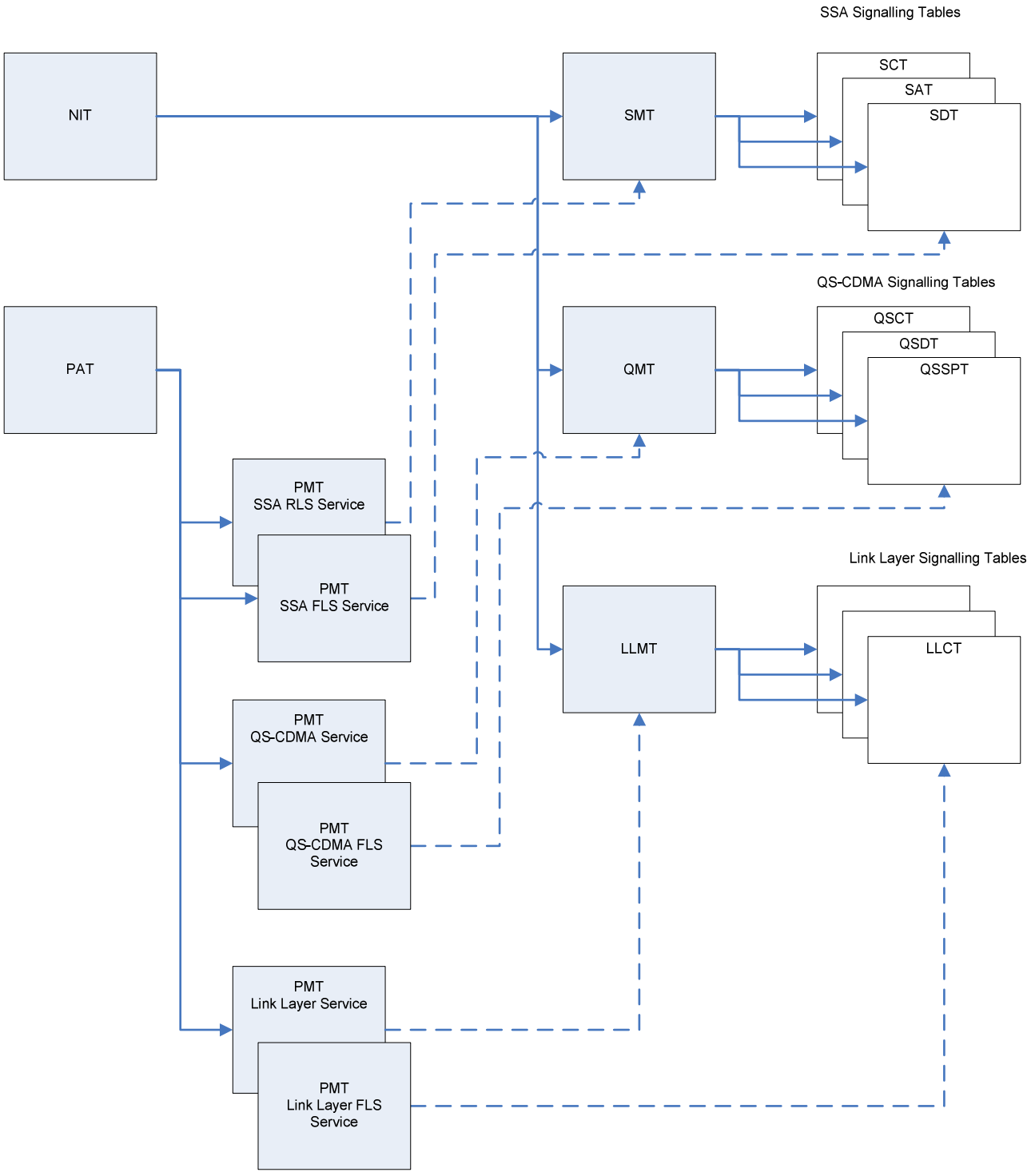

Figure 5.2: Organization of the Service Information tables in the S-MIM system

The format of all the signalling tables in the S-MIM system is introduced in the following clauses.

5.2.1 Forward link signalling for SSA support

The signalling over the forward link for SSA support shall be organized into DVB-SI tables.

This signalling shall be organized into two different services in the PAT table:

- SSA RLS Service, described through the SSA Map Table (SMT).
- SSA FLS Service, composed of the following tables: SSA Configuration Table (SCT), SSA Access Table (SAT), SSA Dynamic Table (SDT).

The following clauses show the organization of the different tables.

5.2.1.1 SSA Map Table

From the SSA PMT, the terminal can extract the PID over which the SSA Map Table is transmitted.

The SSA Map Table will in turn link the SSA terminals to one SSA Forward Link Signalling service through a linkage descriptor containing the transport_stream_id of the TS containing the SSA Forward Link Signalling and its corresponding service_id (i.e. the corresponding program_number in the PAT).

NOTE: If the transport_stream_id is different from that of the current carrier an optional satellite_delivery_system_descriptor for the referred TS (describing characteristics as the satellite position, carrier frequency, polarization modulation etc.) as well as an optional SH_delivery_system_descriptor can be present.

The linkage descriptor is defined in [1]. The linkage_type for the linkage to SSA Forward Link Signalling service is 0x80.

The PAT of the referred TS will then contain the PID of the PMT for the SSA Forward Link Signalling. Within such PMT the PIDS of all related SSA signalling tables will be contained.

5.2.1.2 SSA Configuration Table (SCT)

This table is carried in one or more section (each section is in fact limited to 1 024 bytes) with each section having the format described in Table 5.1.

Table 5.1: SSA Configuration Table

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
SSA_configuration_section(){			
SI_private_section_header		64	-
rl_carriers_loop_count	3	5	uimsbf
for(i=0;i<= rl_carriers_loop_count;i++){			
uplink_polarization	6	2	bslbf
centre_frequency		32	uimsbf
chip_rate	2	22	uimsbf
preamble_len		16	uimsbf
num_spreading_codes		8	uimsbf
preamble_s1_index		16	uimsbf
preamble_s2_index		16	uimsbf
data_scrambling_code_index		16	uimsbf
spread_factor_control		8	uimsbf
WH_code_control		8	uimsbf
WH_code_data		8	uimsbf
tfi_count	3	5	uimsbf
for(k=0,k<=tfi_count;k++){			uimsbf
tfi_value	3	5	uimsbf
spread_factor_data		8	uimsbf
Info_lenght		10	uimsbf
crc_lenght	2	2	uimsbf
control_spread		2	uimsbf
control_power		4	uimsbf
pilot_num		4	uimsbf
}			
}			
CRC_32		32	rpchof
}			
NOTE: Reserved bits are of type bslbf, and shall precede the Information bits on the same line.			

The SCT table parameters are:

- rl_carriers_loop_count. This represents the number of SSA return link carriers which are described in the table.
- up_link_polarization. This represents the tx polarization (see Table 5.1) which should be used by terminals accessing that carrier.
- centre_frequency. This is the centre frequency of the considered RL carrier in multiples of 100 Hz.
- chip_rate. It is the chip rate expressed in chips/s.
- preamble_len. It represents the preamble length in chips.
- num_spreading_codes. Number of different codes which can be used on that carrier.
- preamble_s1_index. This represents the index of the preamble signature sequence s1 (indicated with n in clause 7.2.1 of TS 102 721-3 [3]). If num_spreading_codes is greater than one the terminal will randomly select a signature code s1 with index between preamble_s1_index and (preamble_s1_index+ num_spreading_codes-1).
- preamble_s2_index. This is the index of the sequence s2 constituting the hierarchical preamble (indicated with n in annex A of TS 102 721-3 [3]).
- data_scrambling_code_index. It is the index of the scrambling code used in the data part of the message. If num_spreading_codes is greater than one the terminal will actually use a scrambling code index (indicated with n in clause 7.1.2 of TS 102 721-3 [3]) which is obtained as the concatenation of the 9 less significant bits of premble_s1_index with the 16 bits of data_scambling_code.

- spread_factor_control. Spreading factor of the control channel.
- WH_code_control. Walsh-Hadamard code index to be used for the control channel.
- WH_code_data. Walsh-Hadamard code index to be used for data channel.
- tfi_count. Number of allowed different bursts.
- tfi_value. It represents the TFI value corresponding to each allowed configuration. The terminal will use such value for its TFI field in the PCCH.
- spread_factor_data. It is the SF for the data channel.
- Info_lenght. Size of the RACH data burst (in 4 bits nibbles), including link layer encapsulation header but no CRC. For the currently defined RACH data burst lengths, the following correspondence apply:

  1 200 bits → Info_length=300

  600 bits → Info_length=150

  300 bits → Info_length=75

- crc_length. A value of 0 indicates that no CRC is appended to the message before FEC coding. Values of 1, and 2 indicate the use of a CRC of length respectively 8 bits, 16 bits. A value of 3 is reserved for future use, e.g. for a CRC of length 32 bits.
- control_spread. Number of frames in which the control channel is sent. A value of 0 means that the control channel is transmitted over all frames. A value > 0 indicates that the length of PCCH is equal to control_spread * FRAME_GROUP_LENGTH frames. The FRAME_GROUP_LENGTH = 6 for the 5 kbit/s PDCH channel and 3 for the 10 kbit/s PDCH. The FRAME_GROUP_LENGTH is not signalled but can be implicitly derived from the ratio of SF between the PCCH and PDCH which are instead signalled.
- control power. Indicate the voltage gain of the control channel relatively to the data channel (see Table 5.3).
- pilot_num. Number of pilot symbols in a slot of the control channel (the complement to ten are TFI bits).
- CRC_32: This is a 32-bit field that contains the CRC value that gives a zero output of the registers in the decoder defined in annex B of EN 300 468 [1] after processing the entire section.

Table 5.2: Polarization table

Polarization	Description
00	Linear-horizontal
01	Linear-vertical
10	Circular-left
11	Circular-right

Table 5.3: Quantization of the gain parameter

Signalling values for β	Quantized amplitude ratios (β)
15	1,0
14	0,9333
13	0,8666
12	0,8000
11	0,7333
10	0,6667
9	0,6000
8	0,5333
7	0,4667
6	0,4000
5	0,3333
4	0,2667
3	0,2000
2	0,1333
1	0,0667
0	Switch off

5.2.1.3 SSA Access Table (SAT)

This table is carried in one or more section (each section is in fact limited to 1 024 bytes) with each section having the format described in Table 5.4.

Table 5.4: SSA Access Table

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
SSA_access_section(){			
SI_private_section_header		64	-
FL_EIRP		8	uimsbf
K_factor		8	uimsbf
Rl_TX_EIRP_flag	6	2	bslbf
service_class_loop_count		8	uimsbf
for(i=0;i<= service_class_loop_count;i++) {			
service_class_id		8	uimsbf
allowed_rl_carrier_index		32	uimsbf
load_flag_count	2	6	uimsbf
for(i=0;i<load_flag_count; i++) {			
load_flag	2	6	uimsbf
Back_off_time		8	uimsbf
Persistence_index		16	uimsbf
ack_time_out		16	uimsbf
max_retransmissions		8	uimsbf
R_max		8	uimsbf
}			
}			
CRC_32		32	rpchof
}			
NOTE: Reserved bits are of type bslbf, and shall precede the Information bits on the same line.			

The SAT table parameters are:

- FL_EIRP. It is the FL carrier EIRP at EOC in multiples of 0,5 dBW.
- K_factor. It is a factor which shall be used by the terminal to compute its Tx EIRP. The parameter K is equal to $C/(N_0+ I_0)|_T - G_S$ where $C/(N_0+ I_0)|_T$ is the target value used for the desired $C/(N_0+ I_0)$ at the satellite transponder input. G_S is the satellite antenna gain at EOC. K is expressed in multiples of -0,5 dB.

- RI_tx_EIRP_flag. It defines the TX control strategy to be used by the terminal according to the options detailed in Table 5.5.
- service_class_id. It is the ID of the class of service for which the following parameters apply.
- allowed_rl_carrier_index. It is a 32 bit integer representing the RL carriers (described by the SCT table) which can be used for the SSA access by terminal_class_id terminals. The i-th bit of the integer, if 1, allow use of carrier i-th for the SSA access.
- load_flag. It is the value of the load flag for which the following access parameters apply.
- back_off_time. It is the number of time units for packet retransmission protocol. The time unit is one physical layer frame (10 ms).
- persistence_index. It is a value from which the probability of transmitting at the next time step (in unit of back_off time) is computed. The probability (persistence) is: persistence=1/2^(persistence_index/2).
- ack_time_out. Time out for ack expressed in physical layer frames (10 ms).
- max_retransmissions. Maximum number of retransmission of the same packet.
- R_max. It is a parameter used for computing the TX EIRP depending on the value of the Rl_tx_EIRP_flag as detailed in Table 5.5.
- CRC_32: This is a 32-bit field that contains the CRC value that gives a zero output of the registers in the decoder defined in annex B of EN 300 468 [1] after processing the entire section.

Table 5.5: Syntax of Rl_tx_EIRP_flag

Value of Rl_tx_EIRP_flag	TX control strategy	Meaning of R_max
00	No SSA terminal can TX	None
01	TX control strategy #1 from TS 102 721-3 [3]	Max value of the additional power randomisation in multiples of 0,5 dB
10	TX control strategy #2 from TS 102 721-3 [3]	Max value of the SNR fluctuation in multiples of 0,5 dB
11	All SSA terminals shall TX at maximum power level	None

5.2.1.4 SSA Dynamic Table (SDT)

This table is carried in one or more section (each section is in fact limited to 1 024 bytes) with each section having the format described in Table 5.6.

The SDT table parameters are self-describing except for:

- current_sat_noise. It is the current noise plus interference at the satellite transponder input expressed in multiples of -0,5 dBm for the considered RL carrier slots.

Table 5.6: SSA Dynamic Table

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Info	
SSA_dynamic_section(){			
SI_private_section_header		64	-
rl_carriers_loop_count	3	5	uimsbf
for(i=0;i<= rl_carriers_loop_count;i++){			
current_sat_noise		8	uimsbf
service_class_loop_count		8	uimsbf
for(i=0;i<=service_class_loop_count;i++){			
service_class_id		8	uimsbf
load_flag	2	6	uimsbf
}			
}			
CRC_32		32	rpchof
}			
NOTE: Reserved bits are of type bslbf, and shall precede the Information bits on the same line.			

5.2.1.5 SSA Signalling Load

Table 5.7: Recommended table parameters

Parameter	Recommended Value
SCT and SAT table transmit periodicity	about 10 seconds. (range 3 seconds to 30 seconds).
SDT transmit periodicity	about 1 second. (range 0,5 second to 2 seconds).
SCT minimum length	312 bits. (Assuming worst case of 5 MHz RL slot used by 16 carriers of 240 kchip/s and with 32 TFI values, the length of the SCT would become 4 072 bits).
SAT minimum length	240 bits. (Assuming 8 service classes and 4 load flags values, the length of SCT would become 2 560 bits).
SDT minimum length	136 bits. (Assuming 8 service classes and 16 RL carriers, the length of SDT would become 2 408 bits).

The overall impact of specific signalling for SSA would thus be in the order of a few kbit/s per 5 MHz channel.

5.2.2 Forward link signalling for QS-CDMA support

The signalling for QS-CDMA is sent partly using DVB-SI tables. System signalling that shall be broadcast to all terminals shall be organised into DVB-SI tables. Unicast signalling to specific terminals is enclosed in dedicated signalling messages, with dedicated PIDs.

The signalling over the forward link to support QS-CDMA over the return link shall be organised into two different services in the PAT table:

- QS-CDMA service, described through the QS-CDMA Map Table (QMT).
- QS-CDMA FLS service, described through the QS-CDMA Configuration Table (QSCT), QS-CDMA Dynamic Table (QSDT) and QS-CDMA Power Correction Table (QSPCT).

The following clauses show the organization of the different DVB-SI tables as well as the format of the signalling which is not mapped into DVB-SI tables.

5.2.2.1 QS-CDMA Map table

From the QS-CDMA PMT, the terminal can extract the PID in which the QS-CDMA Map table is transmitted.

This table contains linkage descriptor to the following signalling tables:

- QS-CDMA Configuration Table (QSCT).
- QS-CDMA Dynamic Table (QSDT).
- QS-CDMA Power Correction Table (QSPCT).
- QS-CDMA Terminal Information Message (QSTIM).

The linkage descriptor is defined in [1]. The linkage_type for the linkage to QS-CDMA Forward Link Signalling service is 0x81.

Additionally the QS-CDMA Map Table shall contain linkage descriptors to the PIDs which will carry the unicast signalling.

The assignment of PID to the tables shall consider the kind of information and its priority. That the following assignment policy is recommended:

- A PID is assigned to the set of QSCT and QSDT tables as they are small and low priority tables.
- A PID is assigned to QSPCT table because it conveys high priority information; essential for terminal synchronization. In addition the size of the table depends on the number of active links and may be high and it shall be scheduled with a low period in comparison to other tables.
- A PID is assigned to QSTIM which conveys QS-CDMA system signalling like CAC/DAMA requests. This table, as the QSPCT does, conveys high priority information. However, the size of the QSTIM is smaller than QSPCT so the first one may pre-empt the second.

5.2.2.2 QS-CDMA Configuration Table (QSCT)

The syntax of QSCT is shown in Table 5.8. It shall be segmented in QS-CDMA Configuration sections using the syntax described in EN 300 468 [1]. Any sections forming part of a QSCT shall be transmitted in TS packets with a PID value assigned in the PMT.

This table defines the static configuration of the QS-CDMA subsystem.

This table may be mapped either to the real time transport channel or into the non-real time transport channel of the FWD link radio interface.

Table 5.8: QS-CDMA Configuration Table (QSCT)

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_configuration_table () {			
SI_private_section_header ()		64	-
fwd_snir_total		16	uimsbf
flsl_timeout		8	uimsbf
lr_timeout		8	uimsbf
lr_max_time_before_retry		8	uimsbf
lr_max_retries		8	uimsbf
car_timeout		8	uimsbf
car_max_time_before_retry		8	uimsbf
car_max_retries		8	uimsbf
max_time_without_correction		8	uimsbf
nof_rl_spots		8	uimsbf
rl_spot_info_length		16	uimsbf
for (i=0; i<nof_rl_spots; i++) {			
rl_spot_id		8	uimsbf
polarization_id	1	2	bslbf

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
Rfu		5	uimsbf
nof_rl_slots		8	uimsbf
rl_slot_info_length		16	uimsbf
for (j=0; j<nof_rl_slots; j++) {			
rl_slot_id		8	uimsbf
center_frequency		32	uimsbf
chip_rate	1	3	bslbf
Rfu		4	uimsbf
rach_preamble_length		16	uimsbf
rach_preamble_seed		10	uimsbf
rach_pilot_seed	1	15	uimsbf
rach_scrambling_code		24	uimsbf
rach_spreading_i_code	3	9	uimsbf
rach_spreading_q_code	3	9	uimsbf
rach_ref_eirp_stationary		10	simsbf
rach_ref_eirp_mobile		10	simsbf
rach_ref_eirp_high_speed_mobile		10	simsbf
qscdma_small_power_step		4	uimsbf
qscdma_large_power_step		6	uimsbf
qscdma_pilot_seed	1	15	uimsbf
qscdma_pilot_gain_factor	2	4	
pattern_advantage_bias		8	simsbf
}			
}			
CRC_32		32	rpchof
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_configuration_table*:

- *fwd_snir_total*: Expected FWD link SNIR for a terminal located at the edge of coverage with the worst case G/T in clear sky conditions.
- *flsl_timeout:* Is the time the terminal uses to trigger the event "Forward link synchronization loss" as defined in AIS. It is expressed in steps of 100 ms.
- *lr_timeout:* The LogOn Request timeout is the time the terminal waits for a Hub ack upon a LogOn request. It is expressed in steps of 100 ms.
- *lr_max_time_before_retry:* Maximum time before LogOn Request retry as specified in AIS. It is expressed in steps of 100 ms.
- *lr_max_retries:* Maximum number of LogOn Request retries.
- *car_timeout:* The Capacity Allocation Request timeout is the time the terminal waits for a Hub ack upon a CA Request. It is expressed in steps of 100 ms.
- *car_max_time_before_retry:* Maximum time before Capacity Allocation Request retry as specified in AIS. It is expressed in steps of 100 ms.
- *car_max_retries:* Maximum number of Capacity Allocation Request retries.
- *max_time_without_correction:* This is the maximum time the terminal can keep transmitting a QS-CDMA carrier in absence of physical layer corrections generated by the Hub. It is expressed in steps of 100 ms.
- *nof_rl_spots*: Defines the number of the return link spots that the Hub manages.
- *rl_spot_info_length*: Is the length in bytes of the return link spot loop.
- *rl_spot_id*: The spot identifier.

- *polarization_id*: This signals the polarization used in the current return link spot. Its allowed values are shown in Table 5.9.

Table 5.9: Polarization

Polarization	Description
00	Linear Horizontal
01	Linear Vertical
10	Circular Left Hand
11	Circular Right Hand

- *nof_rl_slots:* Defines the number of return link slots described in the table.
- *rl_slot_info_length:* Is the length in bytes of the return link slot loop.
- *rl_slot_id:* Is the return link slot identifier that will be used further when resources are allocated.
- *center_frequency:* Is the center frequency if the current return link slot.
- *chip_rate:* This parameter states the chip rate being used in the current return link slot. The allowed values are shown in Table 5.10.

Table 5.10: QS-CDMA Chip rate

Chip Rate	Description
000	4 096 kchips/s
001	512 kchips/s
010	256 kchips/s
other	RFU

- *rach_preamble_length:* Is the preamble length that shall be used for the QS-CDMA random access mechanism. It is expressed in symbols.
- *rach_preamble_seed:* Is the seed for the PN sequence that generates the preamble as defined in TS 102 721-4 [4].
- *rach_pilot_seed:* Is the seed for the PN sequence that generates the RACH pilot symbols as defined in TS 102 721-4 [4].
- *rach_scrambling_code:* Is the scrambling code to use for the RA carrier.
- *rach_spreading_i_code:* Is the spreading code for the I branch.
- *rach_spreading_q_code:* Is the spreading code for the Q branch.
- *rach_ref_eirp_stationary:* The EIRP of the Random Access carrier transmitted by a terminal at the satellite reference contour for reception that results in the target Es/(No+Io) being received at the Hub in clear sky conditions and without MAI. This value is used in stationary scenarios. It is expressed in steps of 0,1 dB.
- *rach_ref_eirp_mobile:* Equal to *ssa_ref_eirp_stationary* but under moderate speed scenarios ($\leq$ 120 Km/h). It is expressed in steps of 0,1 dB.
- *rach_ref_eirp_high_speed_mobile:* Equal to *ssa_ref_eirp_stationary* but under moderate high scenarios (> 120 Km/h). It is expressed in steps of 0,1 dB.
- *qscdma_small_power_step:* This is the small step used for the power control closed-loop algorithm. It is expressed in steps of 0,1 dB.
- *qscdma_large_power_step:* This is the large step used for the power control closed-loop algorithm. It is expressed in steps of 0,1 dB.
- *qscdma_pilot_seed:* Is the seed for the PN sequence that generates the QS-CDMA pilot symbols as defined in TS 102 721-4 [4]. To be applied by mobile terminals.

- *qscdma_pilot_gain_factor:* Is the gain (β) of the pilot channel used by QS-CDMA carrier as defined in TS 102 721-4 [4]. To be applied by mobile terminals.
- *pattern_advantage_bias:* Estimated difference between the pattern advantages of the satellite transmitter and receiver antenna over the coverage area. It is expressed in steps of 0,1 dB.
- *CRC_32*: This is a 32-bit field that contains the CRC value that gives a zero output of the registers in the decoder defined in annex B of EN 300 468 [1] after processing the entire section.

5.2.2.3 QS-CDMA Dynamic Table (QSDT)

The syntax of QSDT is shown in Table 5.11. It shall be segmented in QS-CDMA Dynamic sections using the syntax described in EN 300 468 [1]. Any sections forming part of a QDT shall be transmitted in TS packets with a PID value assigned in the PMT. The QS-CDMA Configuration Table (QSDT) contains dynamic information regarding return link spots. This table shall be mapped to the real time transport channel of the FWD link radio interface.

Table 5.11: QS-CDMA Dynamic Table (QSDT)

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_dynamic_table () {			
SI_provate_section_header ()		64	-
nof_rl_spots		8	uimsbf
rl_spot_info_length		16	uimsbf
for (i=0; i<nof_rl_spots; i++) {			
rl_spot_id		8	uimsbf
nof_rl_slots		8	uimsbf
rl_slot_info_length		16	uimsbf
for (j=0; j<nof_rl_slots; j++) {			
rl_slot_id		8	uimsbf
rach_delta_eirp		8	uimsbf
}			
}			
CRC_32		32	rpchof
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_dynamic_table*:

- *nof_rl_spots*: Defines the number of the return link spots that the Hub manages.
- *rl_spot_info_length*: Is the length in bytes of the return link spot loop.
- *rl_spot_id*: The spot identifier.
- *nof_rl_slots*: Defines the number of return link slots described in the table.
- *rl_slot_info_length:* Is the length in bytes of the return link slot loop.
- *rl_slot_id:* Is the return link slot identifier that will be used further when resources are allocated.
- *rach_delta_eirp:* This is the delta EIRP to apply to the RACH carrier transmitted through the return link spot. It is expressed in steps of 0,1 dB.
- *CRC_32*: This is a 32-bit field that contains the CRC value that gives a zero output of the registers in the decoder defined in annex B of EN 300 468 [1] after processing the entire section.

5.2.2.4 QS-CDMA Power Correction Table (QSPCT)

The syntax of QSPCT is shown in Table 5.12. It shall be segmented in QS-CDMA power corrections sections using the syntax described in EN 300 468 [1]. Any sections forming part of a QSPCT shall be transmitted in TS packets with a PID value assigned in the PMT.

This table defines the power correction that any terminal with allocated resources shall apply to keep its return link power balanced. This table shall be mapped to the low latency profile of the FWD link radio interface.

Table 5.12: QS-CDMA Power Correction Table (QSPCT)

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_power_correction_table () {			
SI_private_section_header		64	-
entry_loop_count		14	uimsbf
rfu		2	bsblf
for (i=0; i<=entry_loop_count; i++) {			
link_id		14	uimsbf
power_correction_idx		2	bslbf
}			
CRC_32		32	rpchof
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_power_correction_table* section:

- *entry_loop_count:* This field specifies one less than the number of power correction message loops that follow. A zero count indicates one loop.
- *link_id:* This value is used by the terminal to resolve whether the corrections are targeted to them. This value shall be assigned by the Hub in response to a capacity request.
- *power_correction_idx*: Defines the power correction to apply by the terminal, and shall be coded as defined in Table 5.13. The values of qscdma_*small_power_step and qscdma_large_power_step* shall be resolved from Table 5.8.
- *CRC_32*: This is a 32-bit field that contains the CRC value that gives a zero output of the registers in the decoder defined in annex B of EN 300 468 [1] after processing the entire section.

Table 5.13: Power correction

carrier_type	Description
00	+ qscdma_small_power_step
01	+ qscdma_large_power_step
10	- qscdma_small_power_step
11	- qscdma_large_power_step

5.2.2.5 QS-CDMA Terminal Information Message (QSTIM)

This message is sent by the Hub either to an individual terminal addressed its MAC address (unicast message) or broadcast to all terminals using a reserved broadcast MAC address. The selection of unicast or broadcast method of transmission depends on the nature of the information to be sent.

Table 5.14: QS-CDMA QSTIM Table

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_terminal_information_message () {			
DSM-CC_private_section_header ()		96	
descriptor_loop_count		8	uimsbf
for (i=0; i<=descriptor_loop_count; i++) {			
descriptor ()	1	8	simsbf
}			
CRC_32		32	rpchof
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_terminal_information message* descriptor:

- *DSM-CC_provate_section_header*: This is the standard DSM-CC private section header and occupies a total of 96 bits.
- *descriptor_loop_count*: This 8 bit field defines one less than the number of descriptors in the following loop. A zero count indicates one loop.
- *descriptor*: The descriptors that may be inserted into the TIM are defined in clause 5.2.2.6.
- *CRC_32*: This is a 32 bit field that contains the CRC value that gives a zero output of the registers in the decoder defined in annex B of [1] after processing the entire section.

5.2.2.6 Descriptor Coding

5.2.2.6.1 Descriptor identification

Table 5.15 lists the descriptors, available in the FWD link to provide support to the QS-CDMA sub system, defined within the present document giving their descriptor-tag values:

Table 5.15: FLS QS-CDMA Descriptor Tags

descriptor	Tag value
QS-CDMA Correction Message	0xB0
QS-CDMA RoHC Feedback Message	0xB1
QS-CDMA Capacity Allocation Hub Req	0xB2
QS-CDMA Capacity Allocation Ack	0xB3
QS-CDMA Capacity Release Hub Req	0xB4
QS-CDMA Capacity Release Ack	0xB5
QS-CDMA Capacity Reallocation Req	0xB6
QS-CDMA Capacity Reallocation Ack	0xB7
QS-CDMA LogOn Ack	0xB8
QS-CDMA Handover Ack	0xB9

5.2.2.6.2 QS-CDMA Correction Message

The correction Message descriptor defines a transmit parameter correction set for one terminal. It shall be as defined in Table 5.12 and shall be encapsulated in unicast QSTIM for terminals having allocated resources.

This descriptor shall be mapped to the real time transport channel of the FWD link radio interface.

Table 5.16: QS-CDMA Correction Message Descriptor

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_correction_message_descriptor () {			
descriptor_tag		8	Uimsbf
descriptor_length		8	Uimsbf
time_correction_flag		1	Bsblf
freq_correction_flag		1	Bsblf
power_correction_flag		1	Bsblf
sync_status	1	2	Bslbf
reserved		2	Bsblf
if (time_correction_flag == '1') {			
chip_freq_corr	1	8	Simsbf
chip_phase_corr	2	13	Simsbf
}			
if (freq_correction_flag == '1') {			
carrier_freq_corr		16	Simsbf
}			
if (power_correction_flag == '1') {			
power_correction		8	Simsbf
}			
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_correction_message* descriptor:

- *time_correction_flag, freq_correction_flag and power_corr_flag*: This three flags are used to indicate the presence of time, frequency and power correction fields, respectively, in the remainder of the descriptor.
- *sync_status*: This field indicates the synchronization status of the QS-CDMA carrier. This field shall be coded as specified in Table 5.17.

Table 5.17: Sync Status

carrier_type	Description
00	Fine Synch
01	Coarse Synch
10	rfu
11	Synch lost

- *chip_frequency_corr*: Is the chip frequency correction to apply. It is expressed in steps 1/16 chips/s.
- *chip_phase_corr*: Is the chip phase correction to apply. It is expressed in steps 1/16 chips.
- *carrier_frequency_corr*: Is the frequency correction to apply. It is expressed in steps of 1 Hz.
- power_correction: Is the power correction to apply by the terminal. It is expressed in steps of 0,1 dB.

5.2.2.6.3 QS-CDMA RoHC Feedback Message

The QS-CDMA RoHC Feedback Message descriptor is used to send RoHC feedback messages to the terminal's side compressor. It shall be as defined in Table 5.12 and shall be encapsulated in unicast QSTIM for terminals having allocated resources.

Table 5.18: QS-CDMA RoHC Feedback Message

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_rohc_feedback_message () {			
descriptor_tag		8	uimsbf
descriptor_length		8	uimsbf
for (i=0; i<length;i++) {		8	uimsbf
rohc_feedback_msg_byte		note	
}			
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_allocation_ack* descriptor:

- *descriptor_tag*: The descriptor tag is an 8 bit field which identifies each descriptor. Its value is given in Table 5.15.
- descriptor_length: The descriptor length is an 8 bit field specifying the number of bytes of the descriptor immediately following the *descriptor_length* field.
- *rohc_feedback_msg_byte*: The RoHC feedback message as defined in clause 5.2.2.6.2.

5.2.2.6.4 QS-CDMA Capacity Allocation Hub Req

This descriptor is sent, attached to a QSTIM message, to a terminal whenever the Hub initiates the capacity allocation.

Table 5.19: QS-CDMA Capacity Allocation Hub Req

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_capacity_allocation_hub_ack () {			
descriptor_tag		8	uimsbf
descriptor_length		8	uimsbf
fwd_data_rate_min		12	uimsbf
fwd_data_rate_max		12	uimsbf
rtn_data_rate_min		12	uimsbf
rtn_data_rate_max		12	uimsbf
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_allocation_hub_ack* descriptor:

- *descriptor_tag*: The descriptor tag is an 8 bit field which identifies each descriptor. Its value is given in Table 5.15.
- *descriptor_length*: The descriptor length is an 8 bit field specifying the number of bytes of the descriptor immediately following the *descriptor_length* field.
- *data_rate_fwd_min* and *data_rate_fwd_max*: This field indicates the requested amount of BW requested in the forward link. It is expressed in kbps.
- *data_rate_rtn_min* and *data_rate_rtn_max:* This field indicates the requested amount of BW requested in the return link. It is expressed in kbps.

5.2.2.6.5 QS-CDMA Capacity Allocation Ack

This descriptor is sent, attached to a QSTIM message, to a terminal that has requested some capacity allocation. For positive ACK, the Hub shall generate a QS-TIM packet conveying this Capacity Allocation Ack as well as a QS-CDMA Correction Message as defined in clause 5.2.2.6.2.

Table 5.20: QS-CDMA Capacity Allocation Ack

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_capacity_allocation_ack () {			
descriptor_tag		8	uimsbf
descriptor_length		8	uimsbf
ack_code		8	uimsbf
if (ack_code == 'Ok') {			
spot_id		8	
slot_id		8	
link_id		14	uimsbf
qscdma_scrambling_code		24	uimsbf
qscdma_spreading_i_code	3	9	uimsbf
qscdma_spreading_q_code	3	9	uimsbf
fwd_data_rate		12	uimsbf
rtn_data_rate		12	uimsbf
fwd_sec_mode	1	2	bslbf
rtn_sec_mode	1	2	bslbf
Reserved		2	
}			
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_allocation_ack* descriptor:

- *descriptor_tag*: The descriptor tag is an 8 bit field which identifies each descriptor. Its value is given in Table 5.15.
- descriptor_length: The descriptor length is an 8 bit field specifying the number of bytes of the descriptor immediately following the *descriptor_length* field.
- *ack_code*: This field identifies the result of the terminal's capacity request.
- *spot_id*: This field identifies the satellite return link spot that the terminal shall use to send information towards the Hub. See clause 5.2.2.2.
- *slot_id*: This field identifies the slot (for a given satellite return link spot) that the terminal shall use to send information towards the Hub. See clause 5.2.2.2.
- *link_id*: This field is used to identify the QS-CDMA link. It may be used by the terminal to resolve whether to parse of ignore a particular information carried in a broadcasted message/table, see clause 5.2.2.4 as an example.
- *qscdma_scrambling_code*: Is the scrambling code to use for the being allocated QS-CDMA carrier.
- *qscdma_spreading_i_code*: Is the spreading code for the I branch.
- *qscdma_spreading_q_code*: Is the spreading code for the Q branch.
- *fwd_data_rate*: Is the effective physical layer BW allocated in the FWD link. It is expressed in kbps.
- *rtn_data_rate*: Is the effective physical layer BW allocated in the synchronous RTN link. It is expressed in kbps.
- *fwd_sec_mode*: This flag indicates the FWD link security mode as specified in Table 5.21.

Table 5.21: FWD Link Security Mode

Terminal class	Description
00	Link Layer
01	IP Sec
10	Reserved
11	None

- *rtn_sec_mode:* This flag indicates the RTN link security mode as specified in Table 5.22.

Table 5.22: RTN Link Security Mode

Terminal class	Description
00	Link Layer
01	Reserved
10	Reserved
11	None

5.2.2.6.6 QS-CDMA Capacity Release Hub Req

This descriptor is sent, attached to a QSTIM message, to a terminal that has to release the allocated capacity. The Terminal shall release their allocated resources immediately.

Table 5.23: QS-CDMA Capacity Release Hub Req

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_capacity_allocation_hub_ack () {			
descriptor_tag		8	uimsbf
descriptor_length		8	uimsbf
reason		8	uimsbf
fwd_link_release_flag		1	uimsbf
rtn_data_release_flag		1	uimsbf
reserved		6	
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_release_hub_req* packet:

- *descriptor_tag*: The descriptor tag is an 8 bit field which identifies each descriptor. Its value is given in Table 5.15.
- *descriptor_length*: The descriptor length is an 8 bit field specifying the number of bytes of the descriptor immediately following the *descriptor_length* field.
- *reason:* This field conveys some code to inform the terminal about the reason of the capacity release.
- *fwd_link_release_flag*: This flag filed indicates whether already allocated resources in the FWD link shall be released or not.
- *rtn_link_release_flag*: This flag filed indicates whether already allocated resources in the synchronous RTN link shall be released or not.

5.2.2.6.7 QS-CDMA Capacity Reallocation Hub Req

This descriptor is sent, attached to a QSTIM message, to a terminal that has requested some capacity allocation in order to inform and/or request some capacity reallocation.

Table 5.24: QS-CDMA Capacity Reallocation Hub Req

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_capacity_reallocation_hub_req () {			
descriptor_tag		8	uimsbf
descriptor_length		8	uimsbf
capacity_req_fwd_min		12	uimsbf
capacity_req_fwd_max		12	uimsbf
capacity_req_rtn_min		12	uimsbf
capacity_req_rtn_max		12	uimsbf
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_reallocation_hub_req* packet:

- *descriptor_tag*: The descriptor tag is an 8 bit field which identifies each descriptor. Its value is given in Table 5.15.
- *descriptor_length*: The descriptor length is an 8 bit field specifying the number of bytes of the descriptor immediately following the descriptor_length field.
- *data_rate_fwd_min* and *data_rate_fwd_max*: This field indicates the requested amount of BW requested in the forward link. It is expressed in kbps.
- *data_rate_rtn_min* and *data_rate_rtn_max*: This field indicates the requested amount of BW requested in the return link. It is expressed in kbps.

5.2.2.6.8 QS-CDMA Capacity Reallocation Ack

This descriptor is sent, attached to a QSTIM message, as an acknowledgement to a terminal that has requested some capacity reallocation.

Table 5.25: QS-CDMA Capacity Allocation Ack

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_capacity_reallocation_ack () {			
descriptor_tag		8	uimsbf
descriptor_length		8	uimsbf
ack_code		8	uimsbf
if (ack_code == 'Ok') {			
qscdma_scrambling_code		24	uimsbf
qscdma_spreading_i_code	3	9	uimsbf
qscdma_spreading_q_code	3	9	uimsbf
fwd_data_rate		12	uimsbf
rtn_data_rate		12	uimsbf
}			
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_reallocation_ack* packet:

- *descriptor_tag*: The descriptor tag is an 8 bit field which identifies each descriptor. Its value is given in Table 5.15.
- *descriptor_length*: The descriptor length is an 8 bit field specifying the number of bytes of the descriptor immediately following the descriptor_length field.

- *ack_code*: This field identifies the result of the terminal's capacity request.
- *qscdma_scrambling_code*: Is the scrambling code to use for the being allocated QS-CDMA carrier.
- *qscdma_spreading_i_code*: Is the spreading code for the I branch.
- *qscdma_spreading_q_code*: Is the spreading code for the Q branch.
- *fwd_data_rate*: Is the effective physical layer BW allocated in the FWD link. It is expressed in kbps.
- *rtn_data_rate*: Is the effective physical layer BW allocated in the RTN link. It is expressed in kbps.

5.2.2.6.9 QS-CDMA Handover Ack

This descriptor is sent, attached to a QSTIM message, as an acknowledgement to a terminal that has requested a handover procedure.

Table 5.26: QS-CDMA Handover Ack

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_handover_ack () {			
descriptor_tag		8	uimsbf
descriptor_length		8	uimsbf
ack_code		8	uimsbf
if (ack_code == 'Ok') {			
qscdma_scrambling_code		24	uimsbf
qscdma_spreading_i_code	3	9	uimsbf
qscdma_spreading_q_code	3	9	uimsbf
fwd_link_switch_flag		1	bsblf
reserved		7	
if (fwd_link_switch_flag) {			
link_id	2	14	uimsbf
}			
}			
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_handover_ack* packet:

- *descriptor_tag*: The descriptor tag is an 8 bit field which identifies each descriptor. Its value is given in Table 5.15.
- *descriptor_length*: The descriptor length is an 8 bit field specifying the number of bytes of the descriptor immediately following the descriptor_length field.
- *ack_code*: This field identifies the result of the terminal's capacity request.
- *qscdma_scrambling_code*: Is the scrambling code to use for the being allocated QS-CDMA carrier.
- *qscdma_spreading_i_code*: Is the spreading code for the I branch.
- *qscdma_spreading_q_code*: Is the spreading code for the Q branch.
- *forward_link_switch_flag*: This flag indicates whether the handover request implies a FWD link handover.
- *link_id*: This field is used to identify the QS-CDMA link in the new forward link. It may be used by the terminal to resolve whether to parse of ignore a particular information carried in a broadcasted message/table, see clause 5.2.2.4 as an example.

5.2.2.6.10 QS-CDMA LogOn Ack

This descriptor is sent, attached to a QSTIM message, as an acknowledgement to a logon request.

Table 5.27: QS-CDMA LogOn Ack

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_logon_ ack() {			
ack_code		8	uimsbf
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_allocation_req* packet:

- *ack_code*: This field identifies the result of the terminal's logon request.

5.2.2.7 Repetition Rates

All sections of the QSCT shall be transmitted often enough to allow newly activated terminals to acquire the necessary start-up state. We will assume that this table needs to be transmitted at least every 10 seconds.

All sections of the QSDT shall be transmitted every second to keep the power control information for the RACH carrier updated.

All sections of the QSPCT shall be as required to guarantee that QS-CDMA RLSS is properly power balanced. We will assume a repetition rate of 64 ms.

QS-CDMA Correction Information Message shall be sent to each terminal having dedicated resources at a repetition rate of 1,1 seconds (to guarantee that QS-CDMA RLSS is properly synchronized).

5.2.2.8 Signalling load

For the informative estimation of the QS-CDMA signalling load in the FLSS we will assume:

- L is the number of frequency slots for a given return link spot. In the baseline, where the BW occupied by the QS-CDMA subsystem is 5 MHz, the value of L is 1.
- P is the number of spots managed by the Hub.
- M is the number of simultaneous QS-CDMA links. From the assumptions on STL (worst case)
  - Daily average number of simultaneous eCalls: 21 sessions
  - Professional emergency: 4 sessions
  - Aggregated simultaneous sessions: 25 sessions

Informative computation of loads of the QS-CDMA signalling in the FWD radio interface:

- QSCT : 200 + P*(40 + L*208) bits every 10 seconds ➔ 44,8 bps
- QSDT: 120 + P*(32 + L*16) bits every 1 second ➔ 168 bps
- QSPCT: 112 + (M*16) bits every 64 ms ➔ 8 kbps
- QSCM: 144 + (M*64) bits every 1,1 seconds ➔ 1,6 kbps

NOTE: This assumes a TIM of 144 bits like DVB-RCS.

It is assumed that the signalling information generated by the Resource Management protocols is negligible.

Additionally, it is assumed that the Hub only broadcasts information about one FWD link beam and their respective RTN link spots. However, it may happen that Hub also broadcast information about the adjacent beams, which increases the signalling load.

5.2.3 Forward link signalling for Link Layer support

The broadcast signalling over the FWD link for link layer support shall be sent using DVB-SI tables. The signalling support for the link layer shall be advertised as two different services in the PAT table:

- Link Layer service, described through the Link Layer Map table (LLMT).
- Link Layer FLS service, described through the Link Layer Configuration Table (LLCT).

Apart from broadcast signalling, there is also unicast signalling which will not be sent into DVB-SI tables:

- Unequivocal Acknowledgements (uACK Mode). Unequivocal ACKs shall be sent in a dedicated PID (this PID shall be advertised in the DVB-SI signalling tables from the Link Layer). The message format is defined in Table 8.3 of [5].
- CRC-based Acknowledgements (ACK Mode). CRC based ACKs shall be sent in another dedicated PID (this PID shall be advertised in the DVB-SI signalling tables from the link layer). CRC-based Acknowledgements are sequentially carried into MPEG-TS packets, applying all-zero padding if necessary. The CRC calculation is defined in clause 8 of [5].
- Authentication messages and TMSI renewal. These messages shall be encapsulated into a MPE section, using a specific protocol number which identifies the signalling message.

5.2.3.1 Link Layer Map Table (LLMT)

From the Link Layer PMT, terminals can extract the PID in which the Link Layer Map Table (LLMT) is transmitted.

The LMLT table contains several linkage descriptors:

- Link Layer Configuration Table (LLCT).
- Unequivocal acknowledgements
- CRC based acknowledgements

The linkage descriptor is defined in [1]. The linkage_type for the linkage to Link Layer Forward Link Signalling service is 0x82.

5.2.3.2 Link Layer configuration Table (LLCT)

This table is carried into one or more sections, being the length of each section limited to 1 024 bits. Each section will have the format shown in the following.

Table 5.28: Link Layer configuration Table (LLCT)

Syntax	Number of bits	Identifier
Link_layer_configuration_section(){		
SI_private_section_header	64	
Location_Area_Identifier	16	uimsbf
FWD_Ipsec_capability	1	bslbf
FWD_MACsec_capability	1	bslbf
Sec_preference	2	bslbf
reserved_future_use	4	
SSA_demod_jitter	8	uimsbf
CRC_based_ACK	1	
CRC_based_ACK_length	6	uimsbf
RFC4944_default_CI	1	bslbf
If (! RFC4944_default_CI) {		
CID_count	8	uimbsf
For (k=0; k<CID_count; k++) {		
CID_number	8	uismbf
Terminal_port	16	uismbf
Server_port	16	uismbf
Server_address	128	uismbf
}		
}		
CRC_32	32	rpchof
}		

- Location_area_identifier: This 16 bit long field identifies unequivocally the location area. It is used for terminals to know when they move into a different location area.
- FWD_Ipsec_capability: This bit shall be set to "1" if the hub supports Ipsec in the FWD link.
- FWD_MACsec_capability: This bit shall be set to "1" if the hub support link layer security in the FWD link
- Sec_preference: This two bit are used to specify which is the preferred security scheme for the FWD link, the preferred security scheme depending on the value of this field is given in Table 5.29.

Table 5.29: Preferred security scheme

Sec_preference	Preferred security scheme
00	MAC layer security
01	Ipsec
10	Reserved for future use
11	Reserved for future use

- SSA_demod_jitter: This field gives the value of the SSA demodulation jitter time, that is the difference between the maximum and minimum SSA demodulation time in multiples of 0,1 second. Therefore a value ranging from 0 to 25,5 seconds can be encoded with a resolution of 0,1 second.
- CRC_based_ACK: If this field is set to 1, CRC based ACK can be used in the S-MIM system and its length is given in the CRC_based_ACK_length entry of this table. If this field is set to 0 CRC based ACK are disabled in this system. Unequivocal ACK shall be used instead.
- CRC_based_ACK_length: This fields gives the length of the CRC based ACK in the S-MIM system. The length of the CRC based ACK is encoded as a unsigned integer (the length ranges from 0 to 63 bits).
- RFC4944_default_CI: if this field is set to "1" the default RFC 4944 [6] context information is used. If default context information is used, the terminal and server port for a CID are the same and are calculated as 0x0F00+CID (the port number ranges therefore from 4096 to 4351). The server Ipv6 address for a CID is calculated by appending the prefix FE81:: to the CID number. This way for CID 0xFF the terminal and server port is 0x0FFF (4351 in decimal) and the server Ipv6 address is FE81::FF. If this filed is set to "0" the terminal and server ports as well as server IP address have to be specified in the table. If all active compression contexts in the system (active CIDs) do not fit in one section, they can be sent in consecutive sections.

- If RFC4944_default_CI==0
  - CID_count: number of Context identifiers specified in this section.
  - CID_number: CID for which the terminal port, server port and server address are given.
  - Terminal_port: port associated to the CID_number in terminals.
  - Server_port: port associated to the CID_number in the server.
- CRC_32: This is a 32-bit field that contains the CRC value that gives a zero output of the registers in the decoder defined in annex B of [1] after processing the entire section.

5.2.3.3 Unequivocal ACK

After receiving the Link Layer Map table (LLMT) terminals are aware of which PID is transporting unequivocal ACK in the FWD link.

In this PID each MPEG-TS carries a concatenation of unequivocal ACKs. Unequivocal ACK have a fixed length of 51 bits. Therefore one MPEG-TS can carry up to 29 unequivocal ACKs. Unequivocal ACKs are not fragmented, if one ACK does not fit into one MPEG-TS it must be transmitted in the next one. If unused space is left in MPEG-TS it is padded with all zeros.

5.2.3.4 CRC based ACK

After receiving the Link Layer Map table (LLMT) terminals are aware of which PID is transporting CRC based ACK in the FWD link. The length of the CRC based ACK is variable and it is advertised to terminals in the Link Layer Configuration Table (LLCT).

Each MPEG-TS in the PID for CRC based ACK carries a concatenation of CRC based ACKs, each of them of the same length as advertised in LLCT. CRC based ACKs are not fragmented, if one ACK does not fit into one MPEG-TS it must be transmitted in the next one. If unused space is left in MPEG-TS it is padded with all zeros. Note that all zeros is not a valid CRC based ACK.

5.2.4 SSA Signalling Considerations for CGC

FWD CGC clusters will operate in SFN mode, meaning that all repeaters within the cluster will transmit in the same frequency slot. These clusters will transmit up to two different multiplexes in the FWD link. The first multiplex is a replica of the content distributed by the satellite FWD radio interface; if required, all repeaters will append an additional multiplex with local content.

The satellite multiplex sent by the all repeaters will be identical to the one sent over satellite, except for the content transported in the real time transport channel, which is not repeated by the repeaters.

On the contrary, the additional multiplex is used to deliver different services from those distributed over the satellite and will therefore also include its own signalling tables, independent from that of the satellite multiplex. Inside one CGC cluster, all repeaters shall transmit the same content, except for the following signalling tables which may be different:

- SSA Configuration Table (SCT)
- SSA Access Table (SAT)
- SSA Dynamic Table (SDT)

Two scenarios are possible:

1) All repeaters co-located with collectors will transmit dedicated SCT, SAT and SDT tables to indicate the presence of a co-located collector and its access parameters configuration. Repeaters not co-located with any collector must not transmit SCT, SAT and SDT tables.

2) All repeaters will transmit the same SCT, SAT and SDT tables, regardless whether they are co-located with collectors or not.

Note that both scenarios require that the entire CGC cluster includes only one collector or that all collectors have the same access parameters configuration.

If DVB-SH is applied as FWD link radio interface, the SCT, SAT and SDT tables shall be placed in reserved codewords that shall not transport any other content but these tables. These codewords must be reserved in the same location of the multiplex for all repeaters belonging to the same CGC cluster. It shall be noted that one DVB-SH codeword can transport up to 8 MPEG-TS. If some MPEG-TS are left unused within one of these codewords, dummy MPEG-TS shall be inserted.

6 Return link

6.1 Return link Control Plane Protocol Stacks

In the Control Plane, the signalling is carried by RLE, as shown in Figure 6.1 and Figure 6.2, indicating in the RLE header that the payload corresponds to signalling information rather than to user data. In the case of the RTN link, the authentication and CAC/DAMA signalling is also carried directly on RLE, as RLE can transport any packet data units.

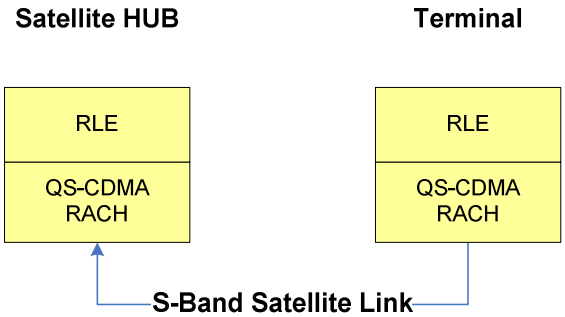

Figure 6.1: RTN link Control Plane Protocol Stack (for SS3)

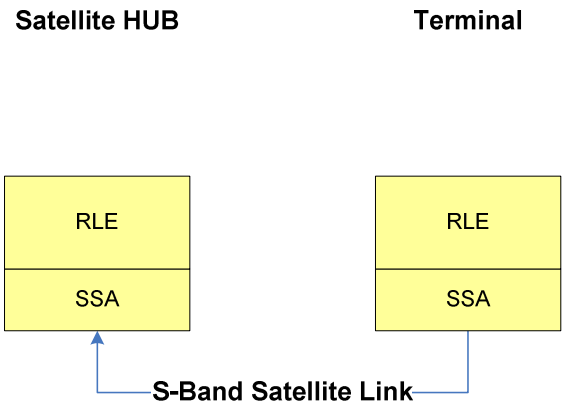

Figure 6.2: RTN link Control Plane Protocol Stack (for SS1 and SS2)

6.2 Return link Signalling

As described in TS 102 721-3 [3] and TS 102 721-4 [4], each return link air interface has specific resource management:

1) DAMA-like resource management for QS-CDMA.

2) load control techniques for the random access of SSA.

Hence only the QS-CDMA link employs signalling and this is described below.

The QS-CDMA signalling in the return link is sent through both RACH and QS-CDMA carriers using a dedicated RLE protocol (see Table 6.1 of [5]).

6.2.1 QS-CDMA Signalling Unit

The structure of the signalling information conveyed through the QS-CDMA return link subsystem is shown in Table 6.1. This structure is the equivalent to the QS-TIM wrapper that is used in the forward link, see clause 5.2.2.5.

Table 6.1: QS-CDMA Signalling Unit

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_signalling_unit () {			
su_id_ext_flag		1	bsblf
if (su_id_extended_flag == '0') {			
su_id		7	uimsbf
}			
else			
su_id		15	uimsbf
}			
su_version		5	uimsbf
crc_flag		1	bsblf
reserved		1	
for (i=0; i<length(su_id); i++) {			
su_payload ()			
}			
if (crc_flag == '1')			
CRC		16	rpchof
}			
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_signalling_unit* packet:

- *su_id_ext_flag:* This flag indicates whether a short or large *su_id* is used. This flag provides a mechanism to extend the number of identifiers if required.
- *su_id:* This value allows identifying the information carried in the packet. Receivers shall derive the length of the *su_payload* from the value of this field in combination with the *su_version* field. This information may be complemented (double checked) with the overall packet length provided by the link layer decapsulator.
- *su_version:* This field provides a mechanism to identify different version (i.e. addition of new parameters) to a given *su_payload*.
- *crc_flag:* This flag indicates whether a CRC is added at the end of the *qscdma_signalling_unit*.
- *su_payload*: This field contains the signalling packet as described in next sections.
- *CRC*: This is an error detection field that protects the content of the *qscdma_signalling_unit*. It is based in a standard CRC-16 polynomial:

$$C(x) = x^{16} + x^{15} + x^2 + 1$$

6.2.2 Descriptor Coding

6.2.2.1 Descriptor identification

Table 6.2 lists the descriptors, available in the FWD link radio interface to provide support to the QS-CDMA sub system, defined within the present document giving their descriptor-tag values.

Table 6.2: RLS QS-CDMA Descriptor Tags

descriptor	Tag value
QS-CDMA Correction Message	0xB0
QS-CDMA LogOn	0xB1
QS-CDMA Capacity Allocation Req	0xB2
QS-CDMA Capacity Release Req	0xB3
QS-CDMA Capacity Reallocation Ack	0xB4
QS-CDMA Handover Req	0xB5

6.2.2.2 QS-CDMA Logon

This descriptor is sent, within a QS-CDMA Signalling Unit as defined in clause 6.2.1, by a terminal in order to logon the network. This descriptor shall always be mapped to the RACH where the MAC address (IMSI/TMSI) is located in the physical header, see TS 102 721-4 [4], so that the Hub could identify the terminal.

Table 6.3: QS-CDMA Capacity Allocation Request

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_capacity_allocation_req () {			
sending_count		8	uimsbf
latitude		24	uimsbf
longitude		24	uimsbf
terminal_class	2	4	bslbf
enabled_services_mask	2	8	bsblf
if (terminal_type == 'terminal D') {			
terminal_prefix		16	uimsbf
}			
rohc_cids		16	uimsbf
rohc_profiles_mask		16	bsblf
fwd_Ipsec_capability		1	bsblf
fwd_MACsec_capability		1	bsblf
rtn_MACsec_capability		1	bsblf
eCall_flag		1	bsblf
reserved		4	
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_allocation_req* packet:

- *sending_count:* This is a counter that controls the number of times this request has been sent. See *lr_timeout, lr_max_time_before_retry and lr_max_retries* in clause 5.2.2.2.
- *latitude:* This field indicates the latitude of the terminal at the time the request is generated. It is coded following the WGS-84 decimal format in the range of [-90, 90]:

$$latitude = \left| \frac{(Lat + 90) \cdot (2^{24} - 1)}{180} \right|$$

- *longitude*: This field indicates the longitude of the terminal at the time the request is generated. It is coded following the WGS-84 decimal format in the range of [-180, 180]:

$$longitude = \left| \frac{(Lon + 180) \cdot (2^{24} - 1)}{360} \right|$$

- *terminal_class*: This field identifies the terminal class and shall be formatted as shown in Table 6.4.

Table 6.4: Terminal classes

Terminal class	Description
0000	Terminal A
0001	Terminal B0
0010	Terminal B1
0011	Terminal B2
0100	Terminal B3
0101	Terminal C
0110	Terminal D
0111	Terminal E
1000	Terminal F

- *enabled_service_mask*: This field indicates the services the terminal provides support to:
  - b_0: SS3 eCall
  - b_1: SS3 2 way IP connection
- *terminal_prefix*: This is the prefix assigned to the terminal D class as specified in TS 102 721-1 [2].
- *rohc_nof_cid*: This is the number of RoHC context identifiers that the terminal is able to held.
- *rohc_profile_mask:* This is a mask field that indicates the RoHC profiles that the terminal supports. It shall be coded as specified in TS 102 721-5 [5].
- *fwd_Ipsec_capability:* This flag indicates whether the terminal is Ipsec enabled at the Link Layer of the FWD link.
- *fwd_MACsec_capability:* This flag indicates whether the terminal is MACsec enabled at the link layer of the FWD link.
- *rtn_MACsec_capacility:* This flag indicates whether the terminal is MACsec enabled at the link layer of the RTN link.
- *eCall_flag:* This flag indicates that the logon is tied to an eCall. This flag can only be active for terminals B3 and C.

6.2.2.3 QS-CDMA Capacity Allocation Req

This descriptor is sent, within a QS-CDMA Signalling Unit as defined in clause 6.2.1, by a terminal that wants to grant system resources. This descriptor shall always be mapped to the RACH where the MAC address (IMSI/TMSI) is located in the physical header (see TS 102 721-5 [5]) so that the Hub could identify the terminal.

Table 6.5: QS-CDMA Capacity Allocation Request

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_capacity_allocation_req () {			
sending_count		8	uimsbf
latitude		24	uimsbf
longitude		24	uimsbf
capacity_req_fwd_min		12	uimsbf
capacity_req_fwd_max		12	uimsbf
capacity_req_rtn_min		12	uimsbf
capacity_req_rtn_max		12	uimsbf
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_allocation_req* packet:

- *sending_count:* This is a counter that controls the number of times this request has been sent. See *car_timeout, car_max_time_before_retry and car_max_retries* in clause 5.2.2.2.
- *latitude:* This field indicates the latitude of the terminal at the time the request is generated. It is coded following the WGS-84 decimal format in the range of [-90, 90]. This field is coded as stated in clause 6.2.2.2.
- *longitude*: This field indicates the longitude of the terminal at the time the request is generated. It is coded following the WGS-84 decimal format in the range of [-180, 180]. This field is coded as stated in clause 6.2.2.2.
- *data_rate_fwd_min* and *data_rate_fwd_max:* This field indicates the requested amount of BW requested in the forward link. It is expressed in kbps.
- *data_rate_rtn_min* and *data_rate_rtn_max:* This field indicates the requested amount of BW requested in the return link. It is expressed in kbps.

6.2.2.4 QS-CDMA Capacity Release Req

This descriptor is sent, within a QS-CDMA Signalling Unit as defined in clause 6.2.1, by a terminal in case it wants to release their allocated resources. This descriptor shall always be mapped to the QS-CDMA as it is assumed that resources are already allocated.

Table 6.6: QS-CDMA Capacity Release Request

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_capacity_reallocation_req () {			
sending_count		8	uimsbf
fwd_link_release_flag		1	bsblf
rtn_link_release_flag		1	bsblf
reserved		6	
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_release_req* packet:

- *sending_count:* This is a counter that controls the number of times this request has been sent. See *car_timeout, car_max_time_before_retry and car_max_retries* in clause 5.2.2.2.
- *fwd_link_release_flag:* This flag filed indicates whether already allocated resources in the FWD link shall be released or not.
- *rtn_link_release_flag:* This flag filed indicates whether already allocated resources in the RTN link shall be released or not.

6.2.2.5 QS-CDMA Capacity Reallocation Req

This descriptor is sent, within a QS-CDMA Signalling Unit as defined in clause 6.2.1, by a terminal in case it wants to modify the already allocated bandwidth. This descriptor shall always be mapped to the QS-CDMA as it is assumed that resources are already allocated.

Table 6.7: QS-CDMA Capacity Reallocation Request

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_capacity_reallocation_req () {			
sending_count		8	uimsbf
capacity_req_fwd_min		12	uimsbf
capacity_req_fwd_max		12	uimsbf
capacity_req_rtn_min		12	uimsbf
capacity_req_rtn_max		12	uimsbf
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_reallocation_req* packet:

- *sending_count:* This is a counter that controls the number of times this request has been sent. See *car_timeout, car_max_time_before_retry and car_max_retries* in clause 5.2.2.2.
- *data_rate_fwd_min and data_rate_fwd_max:* This field indicates the requested amount of BW requested in the forward link. It is expressed in kbps.
- *data_rate_rtn_min and data_rate_rtn_max:* This field indicates the requested amount of BW requested in the return link. It is expressed in kbps.

6.2.2.6 QS-CDMA Handover Req

This descriptor is sent, within a QS-CDMA Signalling Unit as defined in clause 6.2.1, by a terminal in case it detects the requirement for a handover procedure. This descriptor shall always be mapped to the QS-CDMA as it is assumed that resources are already allocated.

Table 6.8: QS-CDMA Handover Request

Syntax	No. of bits		Information Mnemonic
	Reserved (see note)	Information	
qscdma_handover_req () {			
sending_count		8	uimsbf
latitude		12	uimsbf
longitude		12	uimsbf
}			
NOTE: Reserved bits are of type bsblf, and shall precede the information bits on the same line.			

Semantics for the *qscdma_capacity_reallocation_req* packet:

- *sending_count:* This is a counter that controls the number of times this request has been sent. See *car_timeout, car_max_time_before_retry and car_max_retries* in clause 5.2.2.2.
- *latitude:* This field indicates the latitude of the terminal at the time the request is generated. It is coded following the WGS-84 decimal format in the range of [-90 to 90]. See clause 6.2.2.2.
- *longitude*: This field indicates the longitude of the terminal at the time the request is generated. It is coded following the WGS-84 decimal format in the range of [-180 to 180]. See clause 6.2.2.2.

History

Document history		
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