DVB–S2X & RCS2

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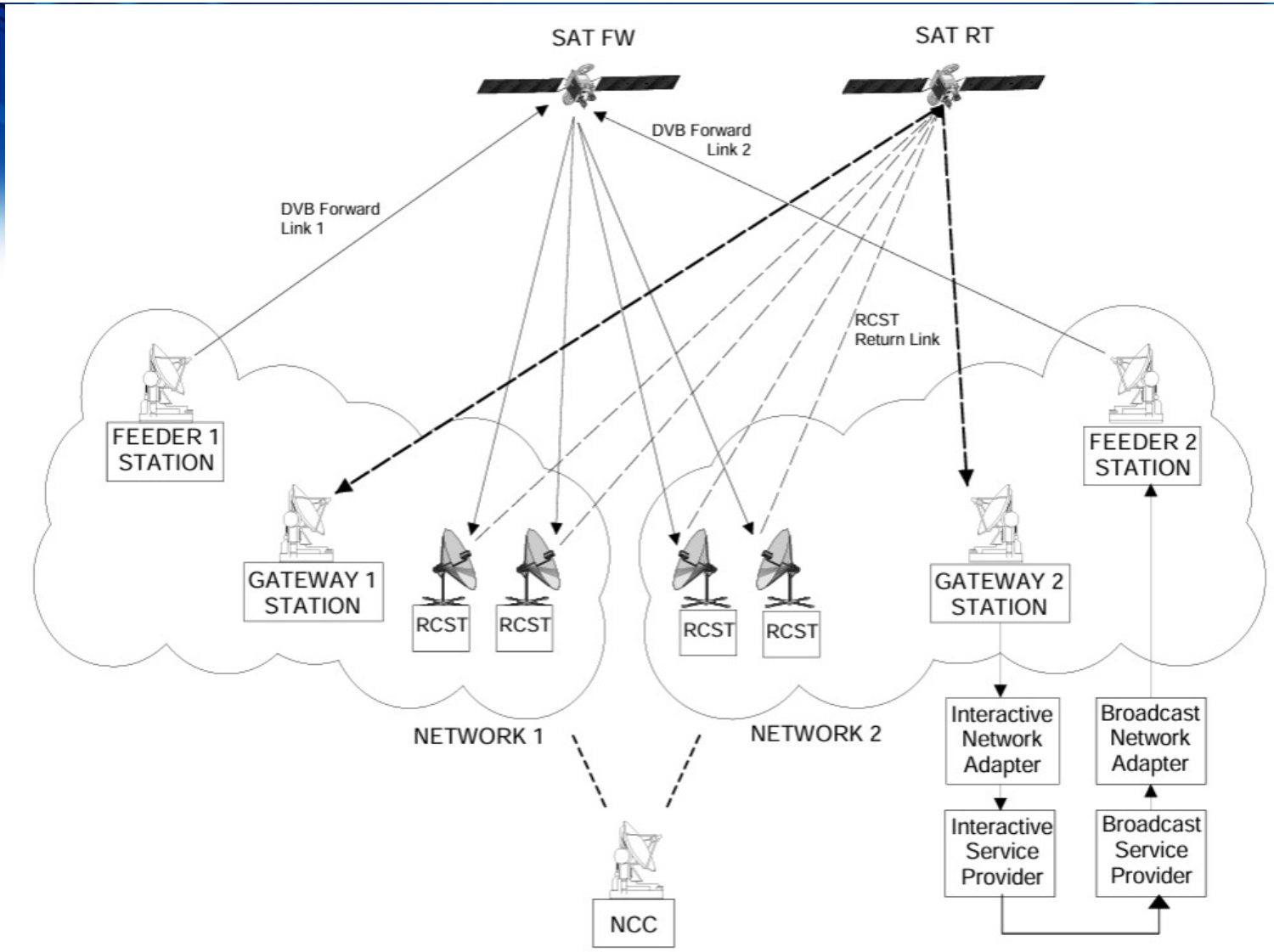
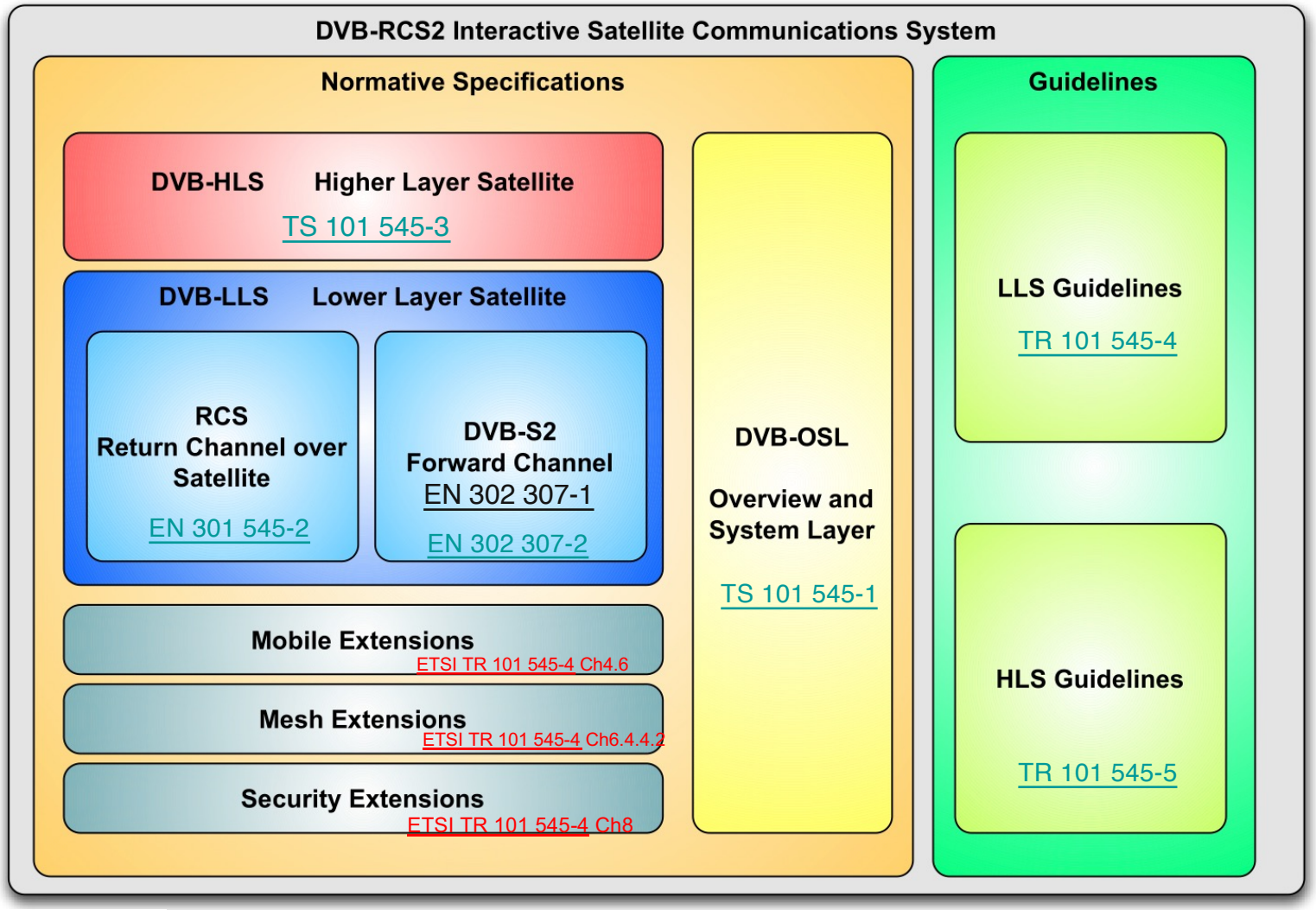


Source: ETSI EN 301 790 V1.5.1 (2009-05)) **e 3: Reference model for the Satellite Interactive Network**



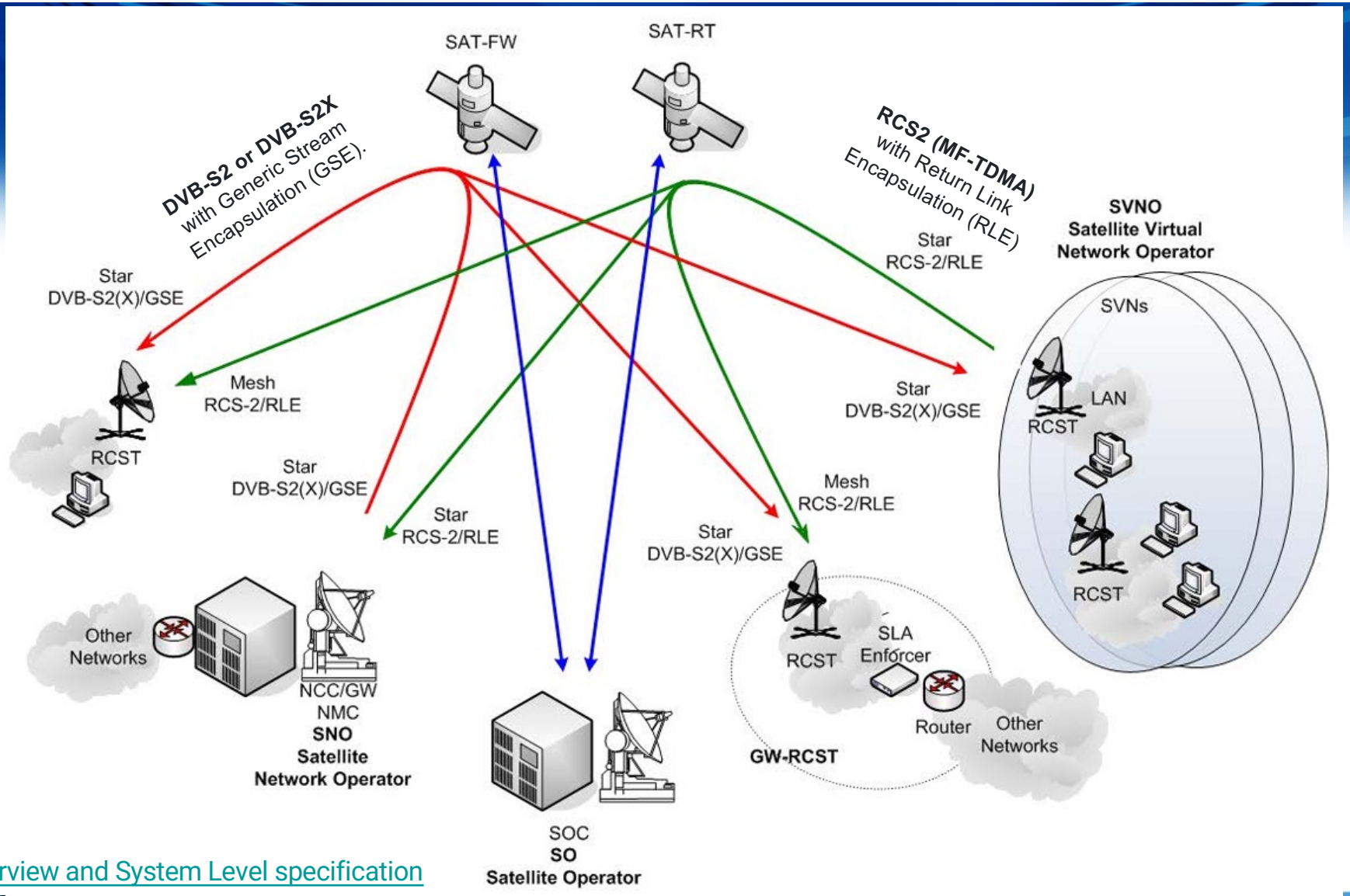
Source: DVB-RCS2 overview

Some key technological improvements from DVB-RCS to DVB-RCS2

	RCS1	RCS2
Harmonized management and control	None	Yes (optional)
Harmonized IP-level QoS	None	Yes
Multiple virtual network support	None	Yes
Security	Single solution	Support for multiple security systems, for applications with widely different requirements
Return link access scheme for traffic	TDMA, continuous carrier	TDMA, continuous carrier, random access
Modulation schemes	QPSK	Linear: BPSK, QPSK, 8PSK, 16QAM Constant-envelope: CPM
Channel coding	RS/convolutional, 8-state PCCC turbo code	16-state PCCC turbo code (linear modulation), SCCC (CPM)
Burst spread spectrum	Burst repetition	Direct sequence
Return link adaptivity	Limited support	Inherent in air interface (TDMA and continuous carrier)
Bandwidth efficiency	Improved about 30% from DVB-RCS to DVB-RCS2	

BPSK, Binary Phase Shift Keying; QPSK, Quaternary Phase Shift Keying; 8PSK, 8-ary Phase Shift keying; PCCC, Parallel Concatenated Convolutional Codes; SCCC, Serially Concatenated Convolutional Codes.

Source: DVB-RCS2 overview

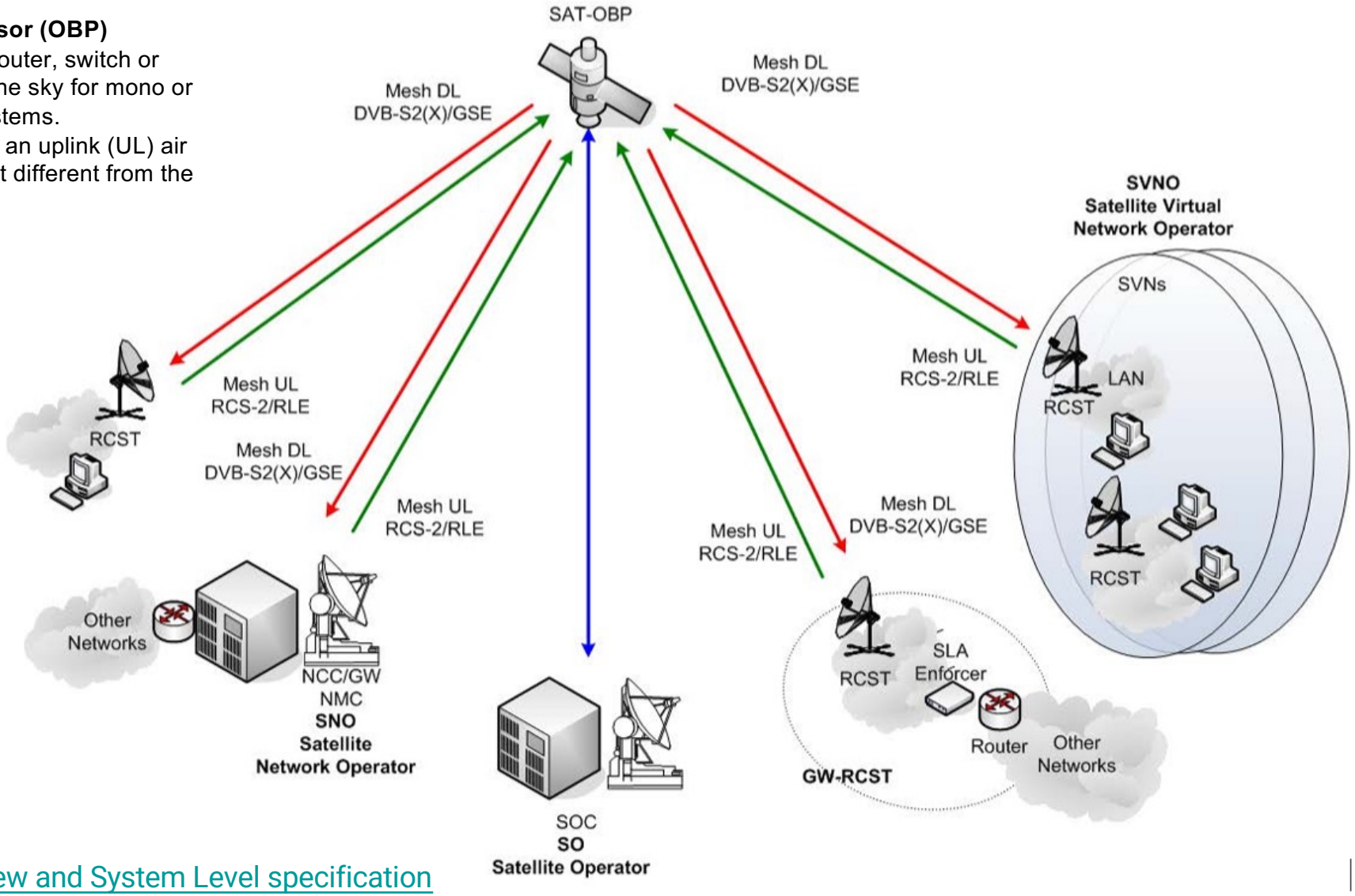


Source: Overview and System Level specification

Figure 1: Main roles in a DVB-RCS2 transparent satellite interactive network

on board processor (OBP)

- behaves as a router, switch or multiplexer in the sky for mono or multi-beam systems.
- It allows to use an uplink (UL) air interface format different from the downlink (DL)



Source: Overview and System Level specification

Figure 2: Main roles in a DVB-RCS2 regenerative satellite network implementing mesh topology

NGSO (non-Geosynchronous Orbit)

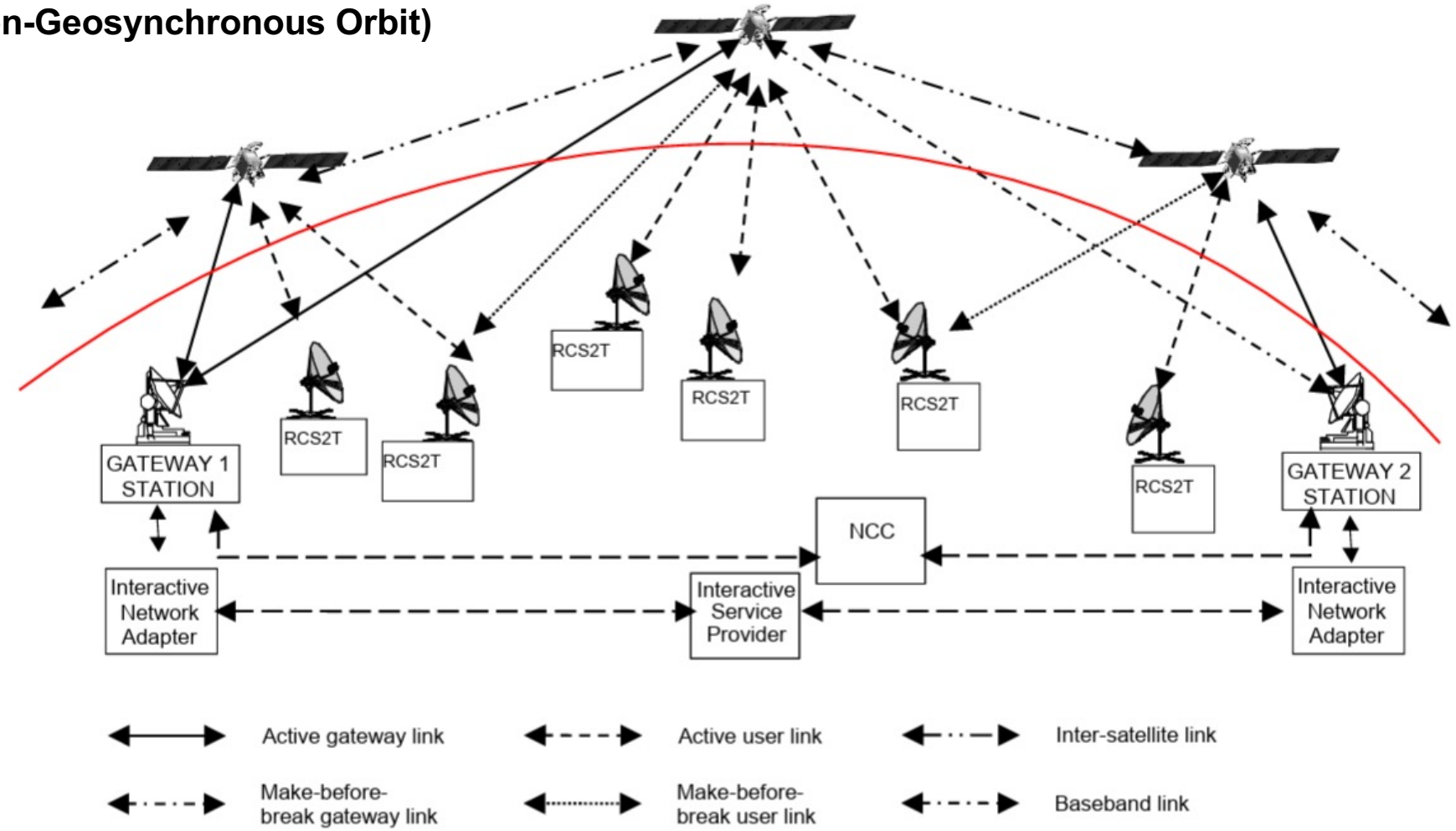
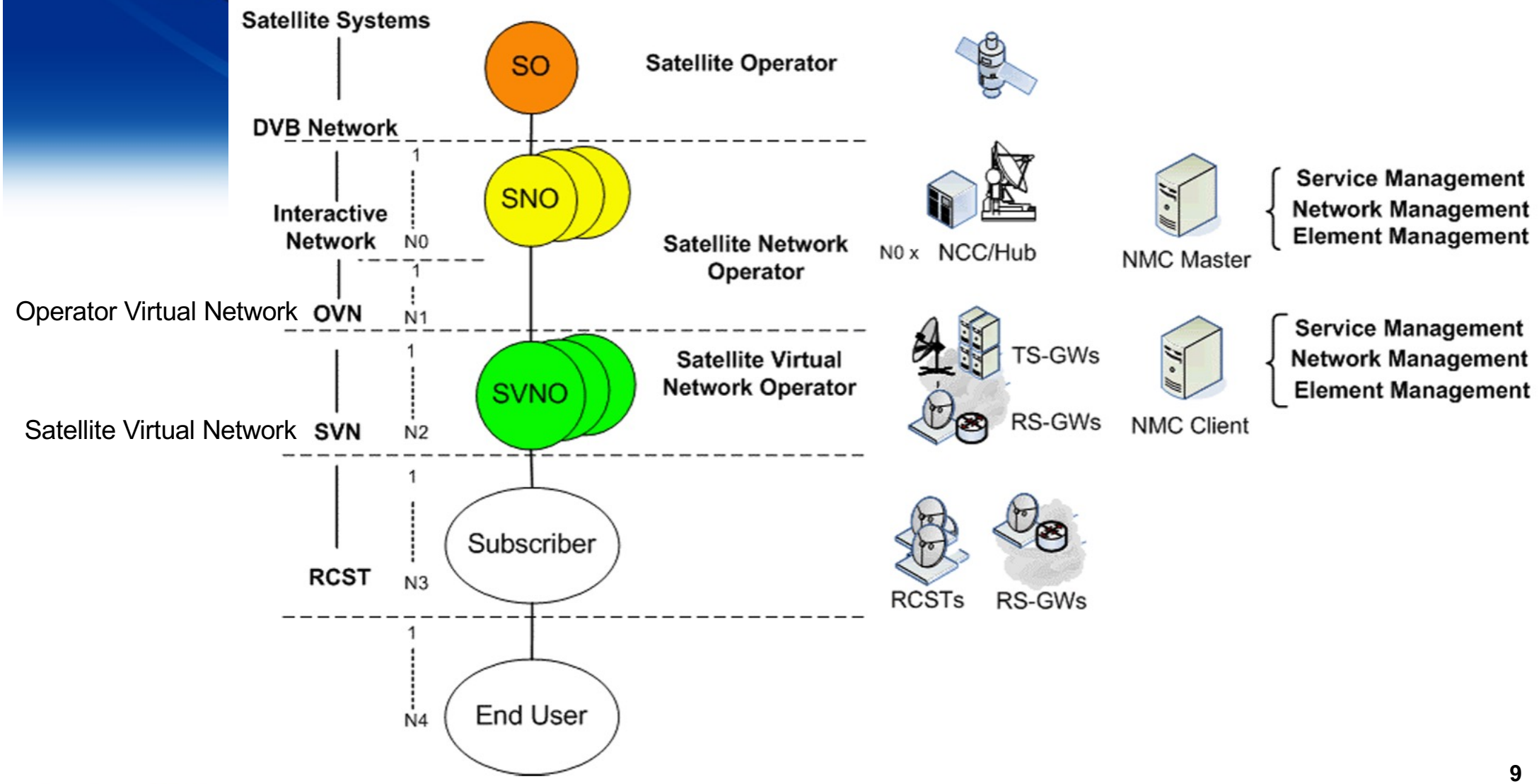


Figure 3 Reference Scenario of a DVB-RCS2 NGSO satellite network

Source: DVB BlueBook A155-1r3 (September 2024)

Layers

- Physical layer: ETSI EN 301 545-2
- Access layer: ETSI EN 301 545-2
- System architecture, ETSI TS 101 545-3
- Network layer: ETSI TS 101 545-3
- Management functions: ETSI TS 101 545-3
- Traffic interception
  - ETSI TS 101 545-3, ETSI EN 301 545-2



Source: Overview and System Level specification

Figure 3: DVB-RCS2 actors and roles

DVB-S2X

Forward Link L2S Components

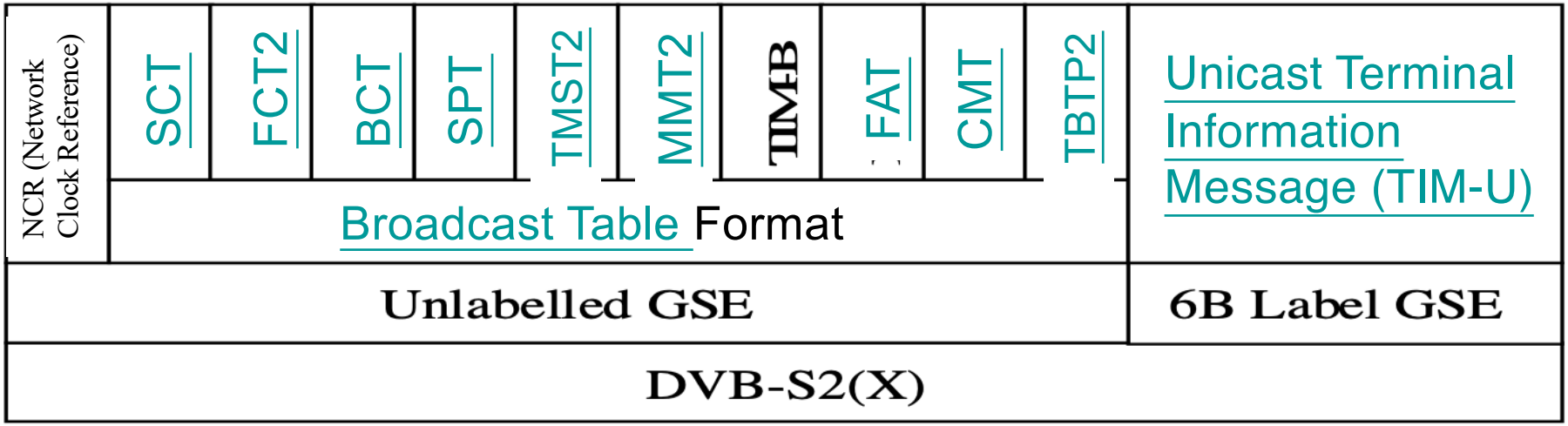


Figure 6-1: Protocol Stack for Lower Layer Signalling over a Continuous Generic Stream Forward Link

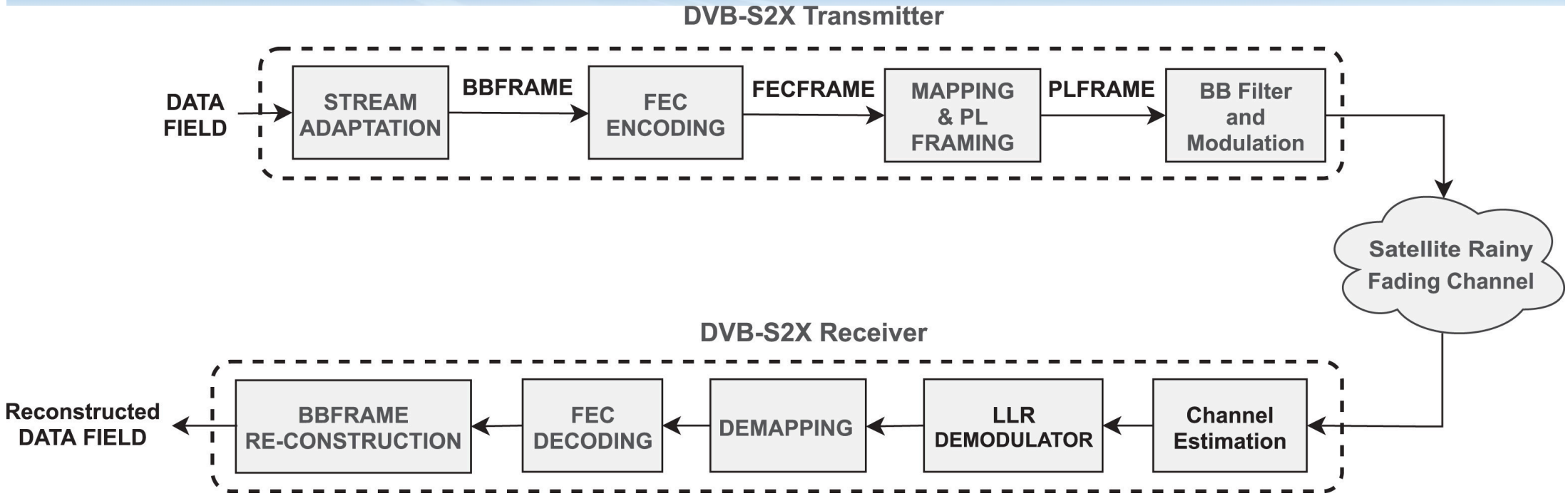
Source: Lower Layers for Satellite standard

Generic Stream Encapsulation (GSE) Protocol

- GSE encapsulation process
  - delineates the start and end of each network-layer PDU,
  - adds control information (e.g., network protocol type and address label), and
  - provides an overall integrity check when needed.
- Unlabelled GSE
- Label GSE

Source: ETSI TS 102 606-1 (V1.2.1)

DVB-S2X System Transceiver Block Diagram.



Source: End-to-end DVB-S2X system design

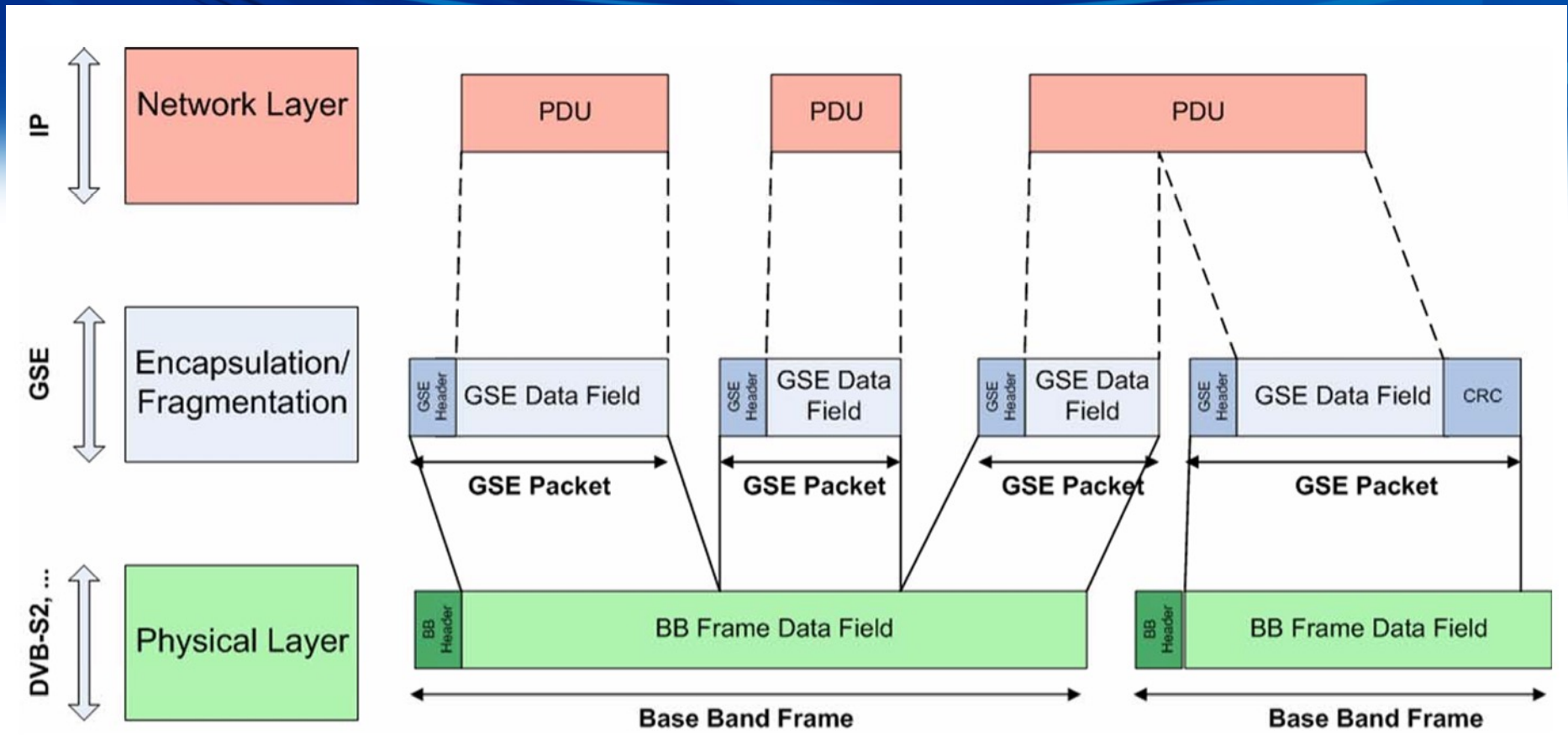


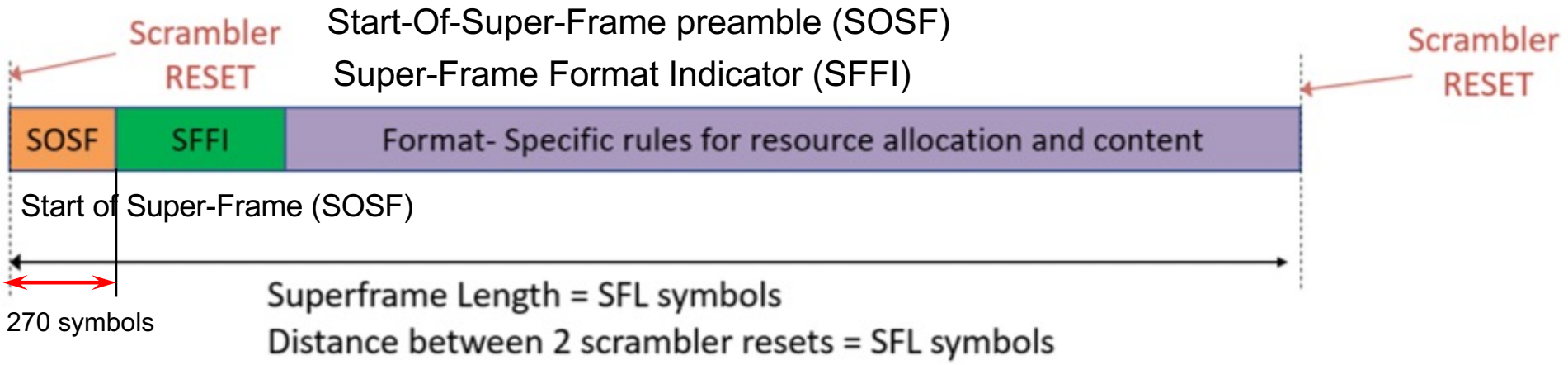
Figure 1: GSE encapsulation within DVB protocol stack

Source: ETSI TS 102 606-1 (V1.2.1)

DVB-S2X Super-frame Structure

- A resource allocation grid is "Capacity Unit" (CU)
- The payload structure unit is a SLOT.
  - SLOT content is inserted in CUs of size 90 symbols.
- The first 720 symbols per each super-frame are fixed with the Start of Super-Frame (SOSF) Field (270 symbols) and Super-Frame Format Indicator (SFFI) Field.
- The full super-frame can be scrambled, including also SOSF/SFFI.

DVB-S2X Super-frame Structure

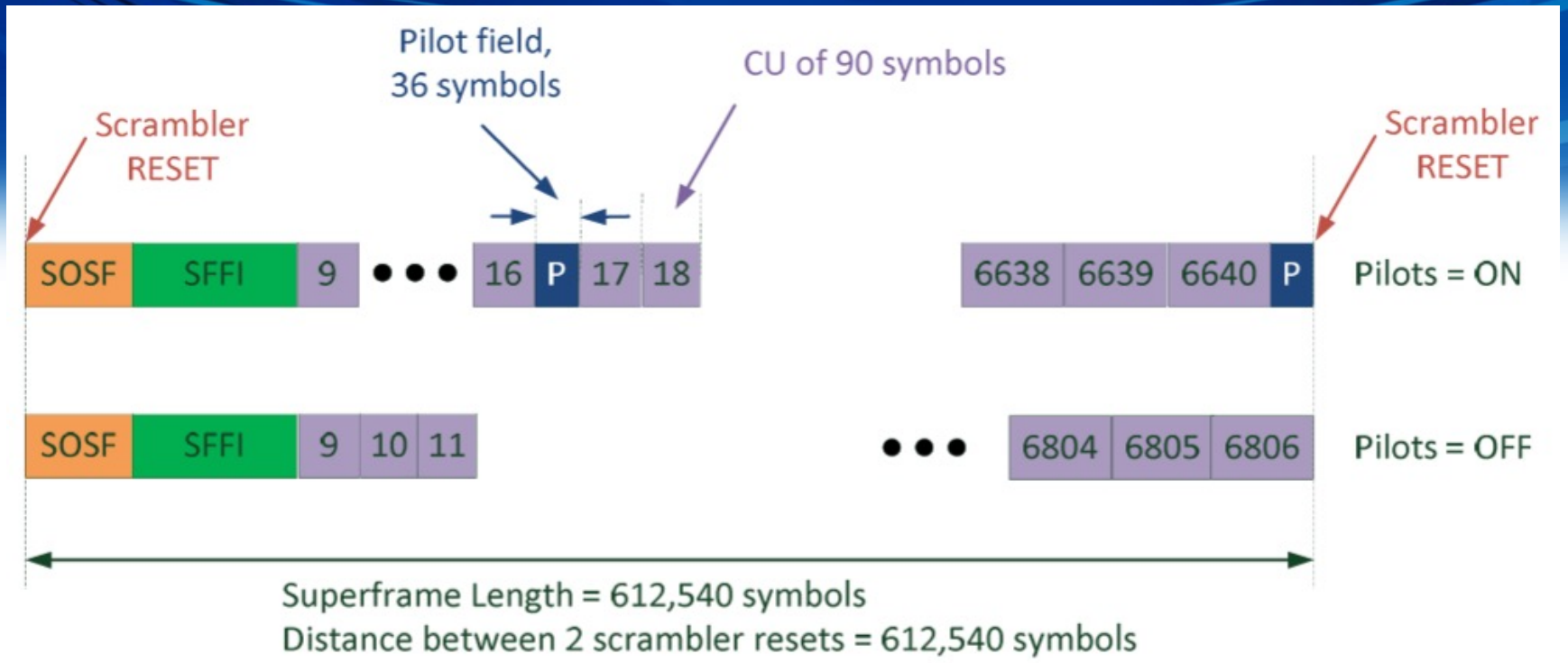


- 720 symbols for SOSF + SFFI
- Format Specific allocation of SFL-720 symbols

SFL=612,540 symbols for SFFI=0~4

Figure E.1: Super-frames of length SFL symbols - the super-frame format specifies the resource allocation and content

Source: EN 302 307-2



- 8 CUs or 720 symbols for SOSF + SFFI
- Pilots ON/OFF can be switched each superframe
- With Pilots == ON, 6640 - 8 = 6632 CUs can be allocated
- With Pilots == OFF, 6806 - 8 = 6798 CUs can be allocated

Figure E.3: Super-frames with resource allocation structure of format 0 or 1, where SF-pilots are ON (upper super-frame) and OFF (lower super-frame)

Source: EN 302 307-2

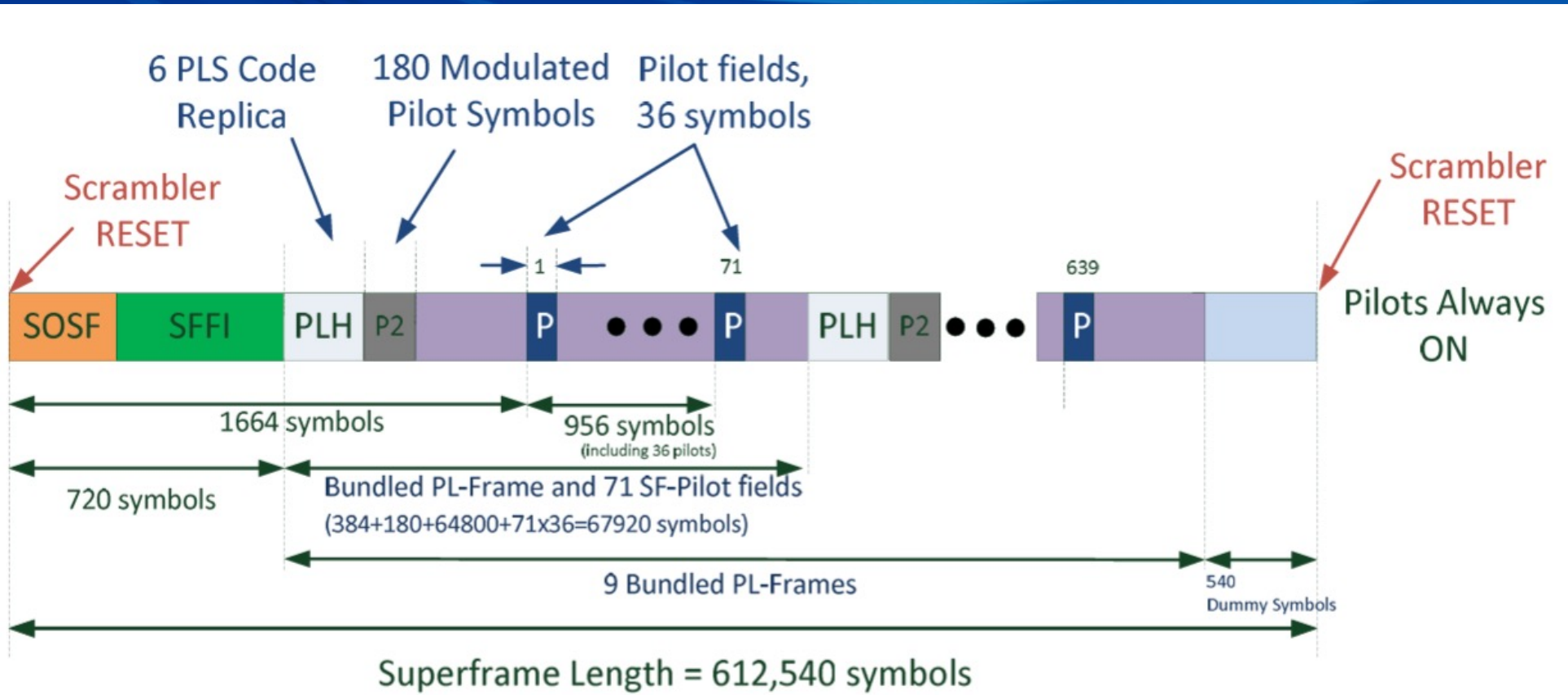


Figure E.5: Super-frames of format with bundled PLFRAMEs (64 800 payload size)

Source: EN 302 307-2

Mapping of PLFRAMEs to Super-frame

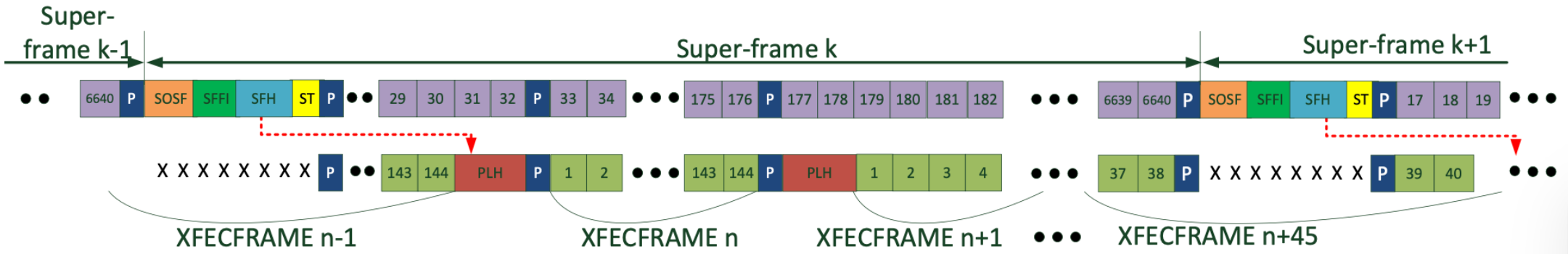


Figure C.6: Mapping of PLFRAMEs into super-frames (standard PLH protection)

Source: A171-2

Very Low - Signal to Noise Ratio (VL-SNR)

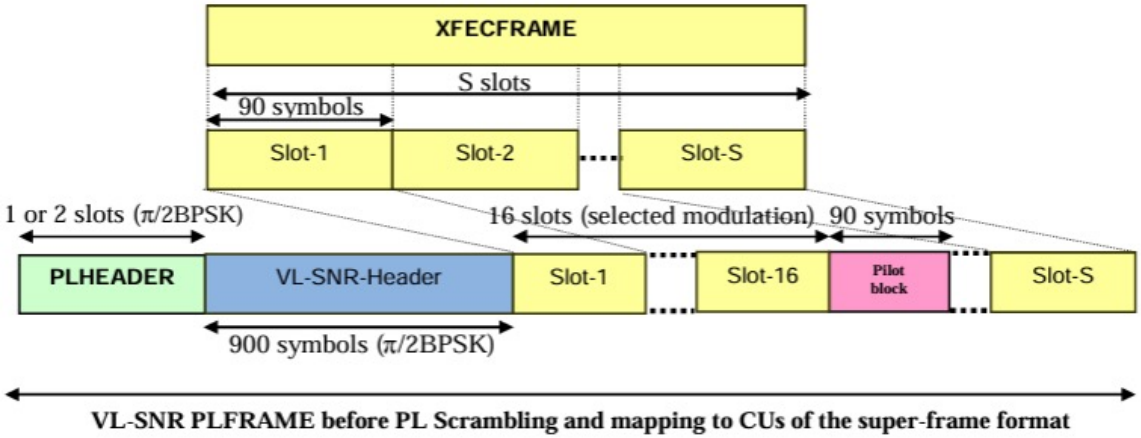


Figure E.4: Insertion of VL-SNR Headers and special VL-SNR pilots

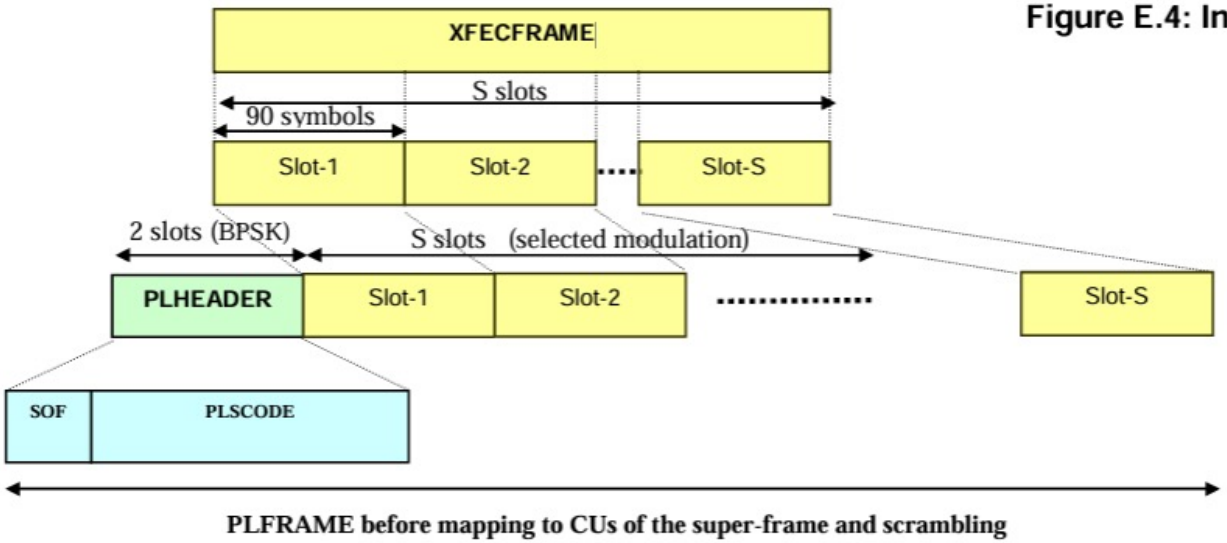


Figure E.11: Structure of a PLFRAME (without spreading and PLH protection level 0)

Source: EN 302 307-2

Forward Link L2S Components

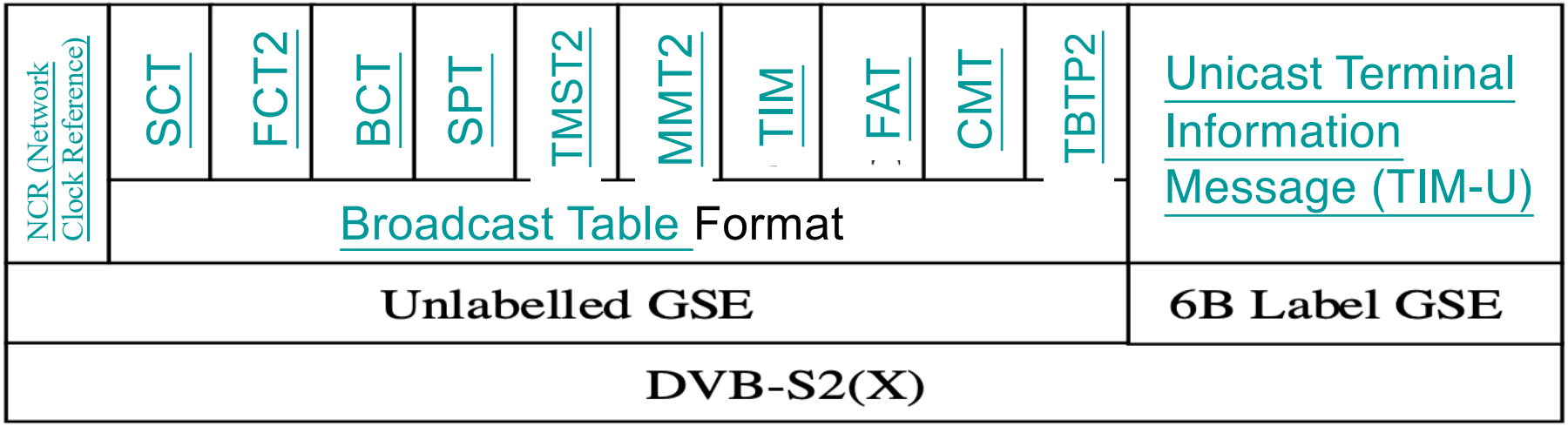


Figure 6-1: Protocol Stack for Lower Layer Signalling over a Continuous Generic Stream Forward Link

Source: Lower Layers for Satellite standard

Network Clock Reference Indication

- Synchronization scheme is based on information contained within the Forward Link Signalling:
  - broadcast NCR (Network Clock Reference)
  - regular adjustments in the RCST transmission timing to maintain sufficient alignment with the MF-TDMA structure.
- NCR broadcast is supported over a continuous generic stream as well as over a TS Packet stream by use of different transport formats.

Network Clock Reference(NCR)

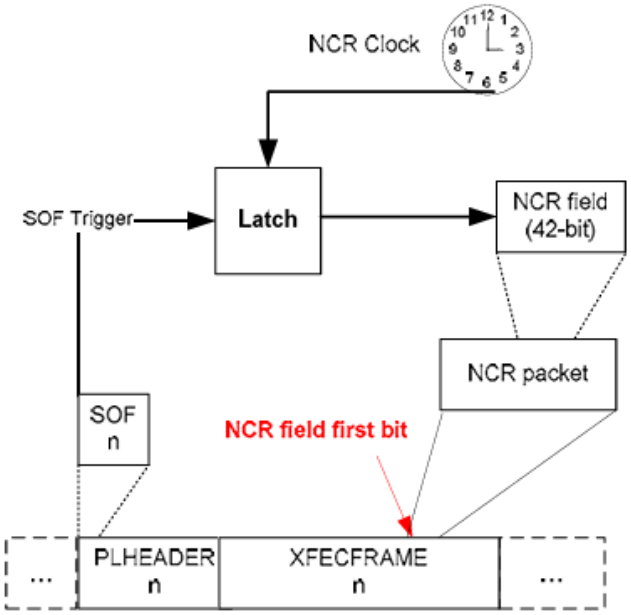


Figure 6-3: Association of NCR Value to SOF for NCRv2

- NCRv2 in DVB-S2X TDM
  - NCR is carried in an NCR packet inside the DVB-S2X Physical Layer Frame (PLHEADER + XFECFRAME).
- SOF and Latch
  - At each Start-of-Frame (SOF), the NCR Clock value is latched and written into the 42-bit NCR field.
- NCR field placement
  - The first bit of the NCR field is inserted in the XFECFRAME of the same frame.
  - Each NCR packet is transmitted within a single DVB-S2X frame, valid for both multi-stream and single-stream.

Source: Lower Layers for Satellite standard

Broadcast Table

- Network Information Table (NIT)
  - provides the RCST with the Original Network ID.
- RCS Map Table (RMT)
  - RMT provides the RCST with
    - Interactive Network ID.
    - NCC ID.
    - Satellite IDs for forward link and return link.
    - Beam IDs for forward link and return link.
    - GW ID.
    - Local link ID for each forward link.

Broadcast Table

- Superframe Composition Table (SCT)
  - specifies the resources in a superframe into frames.
  - Each superframe is associated with
    - a superframe sequence,
    - a centre frequency and an absolute start time expressed as an NCR value → position of the frame
    - a superframe count.

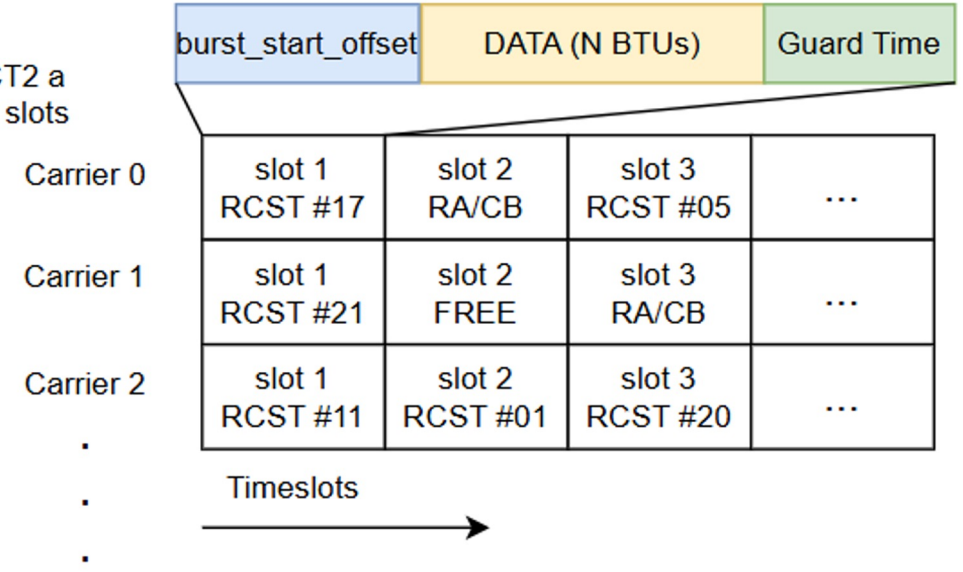
Broadcast Table

- Frame Composition Table version 2 (FCT2) defines the timeslot organization of the frame.
  - Each frame type is structured into a number of timeslots
  - Each timeslot consists of one or more bandwidth-time-unit (BTU)
  - Each BTU determines the symbol rate of the frame and the occupied BW.
  - A timeslot in the frame type may refer to a specific default transmission type (default_tx_type), and the specification of the transmission type is found in the BCT.

Frame Composition Table version 2 (FCT2)

FCT2 defines the slot structure, including the burst start offset, the duration for data transmission, and the guard time.

BCT assigns which FCT2 a carrier will use, and all slots on that carrier use the same FCT2.



TBTP2 maps each timeslot to a specific RCST according to the scheduling plan determined by the NCC.

FCT2 — Framing and Coding Type 2

TBTP2 — Type of BBFRAME Transport Protocol 2

BCT — Baseband Constellation Type

Broadcast Table

- Broadcast Configuration Table (BCT) defines the transmission parameters for each transmission type:
  - relative start/end of transmission,
  - modulation, code rate, preamble, postamble, pilot usage,
  - payload size, payload content and
  - others, depending on the transmission format class of the MF-TDMA frame

Broadcast Table

- Satellite Position Table (SPT) contains
  - the satellite ephemeris data for non-GSO satellites, which may be updated at regular intervals and
  - additional information about the system deployment, including
    - cell fragment definition, and
    - **beam-hopping time** plan description.

Broadcast Table

- Transmission Mode Support Table version 2 (TMST2) may be used to:
  - Indicate the system margin required in the ACM feedback when deciding the least margin MODCOD.
  - Indicate per MODCOD the additional margin to be applied when deciding the least margin MODCOD.
  - Indicate ISI to MODCOD mapping, allowing receivers to locate the streams with the wanted MODCODs when using a multiple-stream TDM.

Broadcast Table

- Multicast Mapping Table version 2 (MMT2) may be used by the NCC to indicate the mapping from a higher-layer multicast address to a MAC24 address, to be used within each SVN.

Broadcast Table

- Fast Access Table (FAT) may be used to indicate
  - the additional transmission timing offset to be added when sending the logon burst.
  - the random access back pressure level to be applied, per random access allocation channel.

Broadcast Table

- NCC sends Correction Message Table (CMT) to advise the corrections for the RCSTs with the most recently measured Control bursts.
- CMT provides correction values for
  - burst frequency,
  - timing
  - and amplitude

  to individual RCSTs identified by Logon ID & Group ID.

Broadcast Table

- Terminal Burst Time Plan Table version 2 (TBTP2) may be used to:
  - assign dedicated access timeslots to RCSTs;
  - assign to RCSTs carriers and formats for continuous transmission;
  - assign the transmission type to be used in the specific timeslots or series of timeslots by reference to the BCT;
  - allocate timeslots for random access and indicate the random access channel for a timeslot.
- Each TBTP2 instance is scoped for a logon group ID, a superframe sequence and a superframe within this sequence.
- Several TBTP2 instances may be used to assign all the timeslots of a superframe.

Broadcast Table

- Terminal Information Message (TIM) is either
  - a unicast (TIM-U): NCC → to a specific RCST using its MAC48 address, or
  - a broadcast (TIM-B): NCC → to all RCSTs connected to the forward link.
- TIM-U is sent as required to instruct the RCST.
  - NCC shall respond with a TIM-U to the RCST when receiving a legitimate logon request from the RCST.
- TIM-B should be transmitted sufficiently often that newly powered terminals can acquire necessary information within a reasonable time window.

Refresh and Update Intervals

- SCT, FCT2, BCT, SPT, SAT, TMST2 and TIM-B: at least every 10 s to allow newly activated RCSTs to rapidly acquire the necessary start-up state.
- TBTP2 shall be updated every superframe.
- CMT: once each dedicated control burst transmission interval.
- NCR: at least 10 times per second.
- Transmission Offset descriptor (in the FAT): once per second.
- FAT is dependent on the use of the optional random access load control and on the change rate of the optional transmission offset.
- The TIM-U will be updated as needed to reflect changes affecting a given RCST.

Return Link and Mesh Uplink

- Return Link access is based on the Multi-Frequency Time Division Multiple Access (MF-TDMA) scheme.
- MF-TDMA allows a group of RCSTs to communicate with the NCC and a gateway sharing a set of carrier frequencies. Each carrier frequency is divided into timeslots for burst transmission.
- Mesh Link access is based on the same type of MF-TDMA transmission aimed not necessarily at a gateway but directly towards another RCST.
  - RCST support of Mesh Link access is an option.

Timeslots Allocation for Return Link

- NCC may
  - Allocate timeslots for return link bursts for dedicated access and for random access, and
  - Indicate the type of burst and content to be transmitted.
  - Distribute the resulting Burst Time Plan (BTP) to the RCSTs via broadcast of SCT, FCT2, BCT, TBTP2 service information tables, and TIM-U,

DVB-RCS2

DVB-RCS2

- DVB-RCS2
  - defines the MAC and physical layer protocols
  - embraces the Generic Stream Encapsulation (GSE) and the DVB-S2(X) standards
  - The following network topologies are addressed
    - Transparent star network system
    - Transparent star network system with contention access
    - Transparent mesh overlay network system
    - Regenerative mesh network system.

Return Link Structure (MF-TDMA)

- A superframe
  - is composed of frames numbered from 0 (lowest burst centre frequency, first in start time, lowest in frame type ID) to N (highest carrier frequency, last in start time, highest in frame type), ordered in time then in frequency. (N<=255).
  - superframe duration is system dependent: RCST should support 25 ms to 750 ms

DVB-RCS2 Superframe Structure

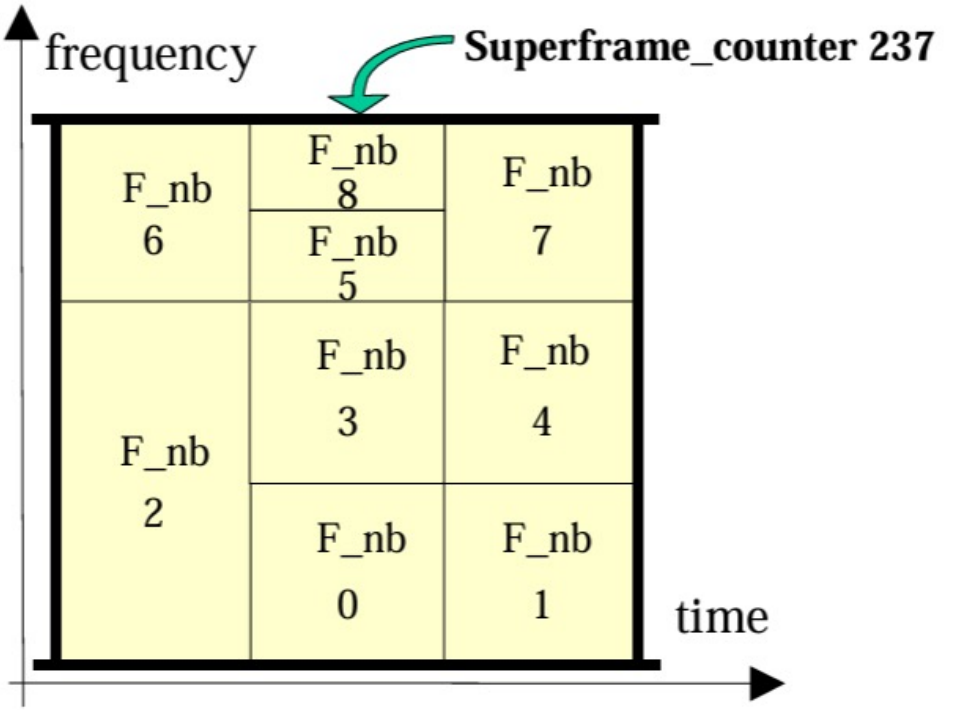


Figure 31: Example of superframe composition

Source: ETSI EN 301 790 V1.5.1

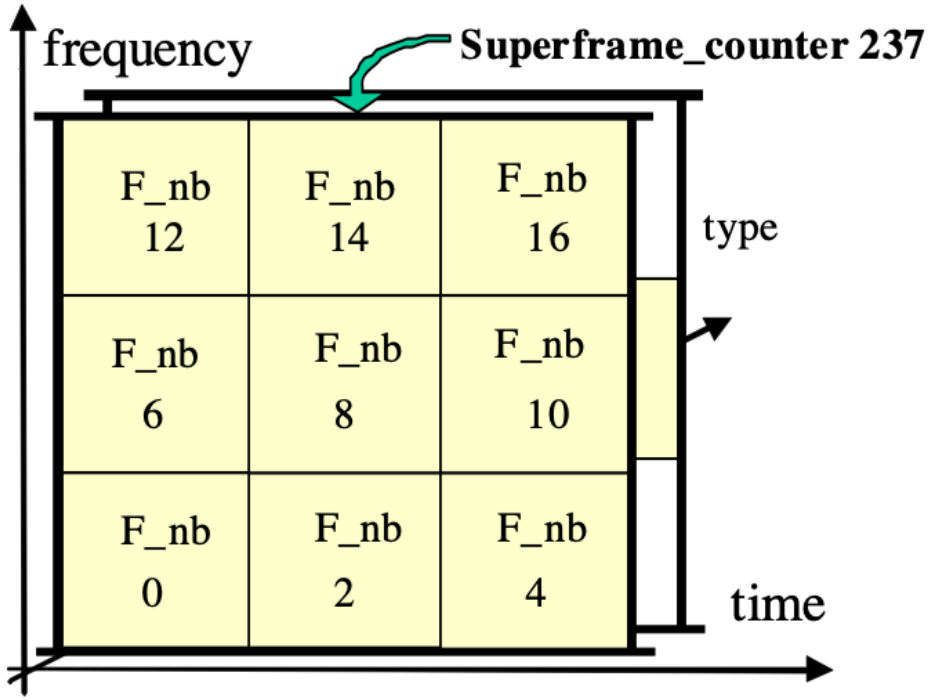


Figure 7-26: Example of superframe composition

Source: Lower Layers for Satellite standard

Superframe Sequene (SFS)

- A superframe sequence (SFS) is a portion of frequency bandwidth of the return link.

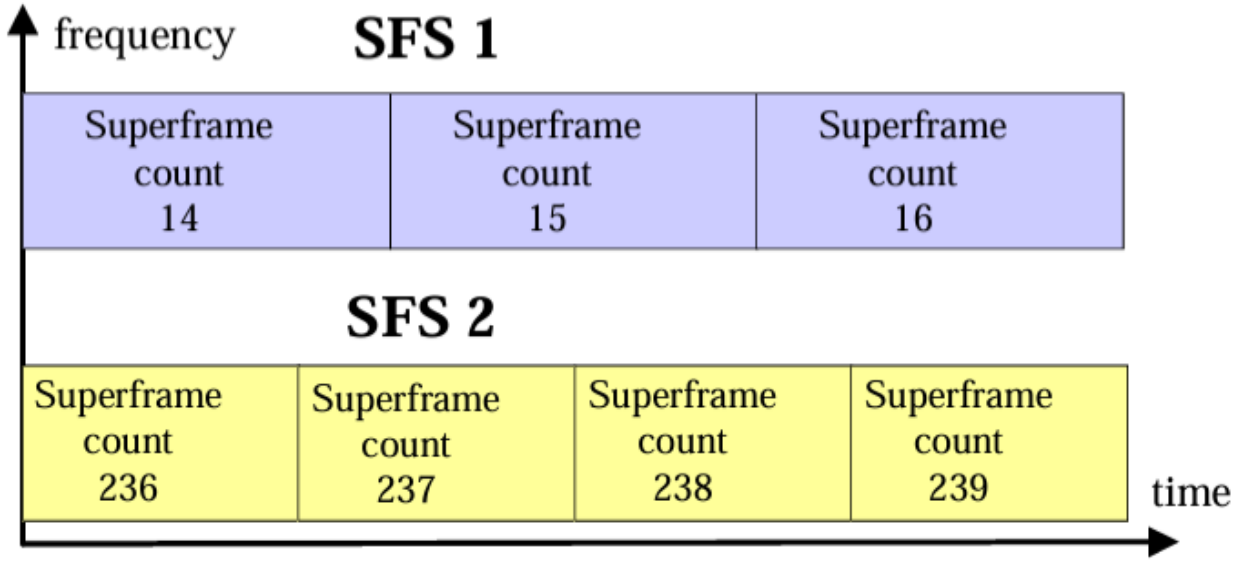


Figure 7-27: Example of superframe sequences

Source: Lower Layers for Satellite standard

Frame

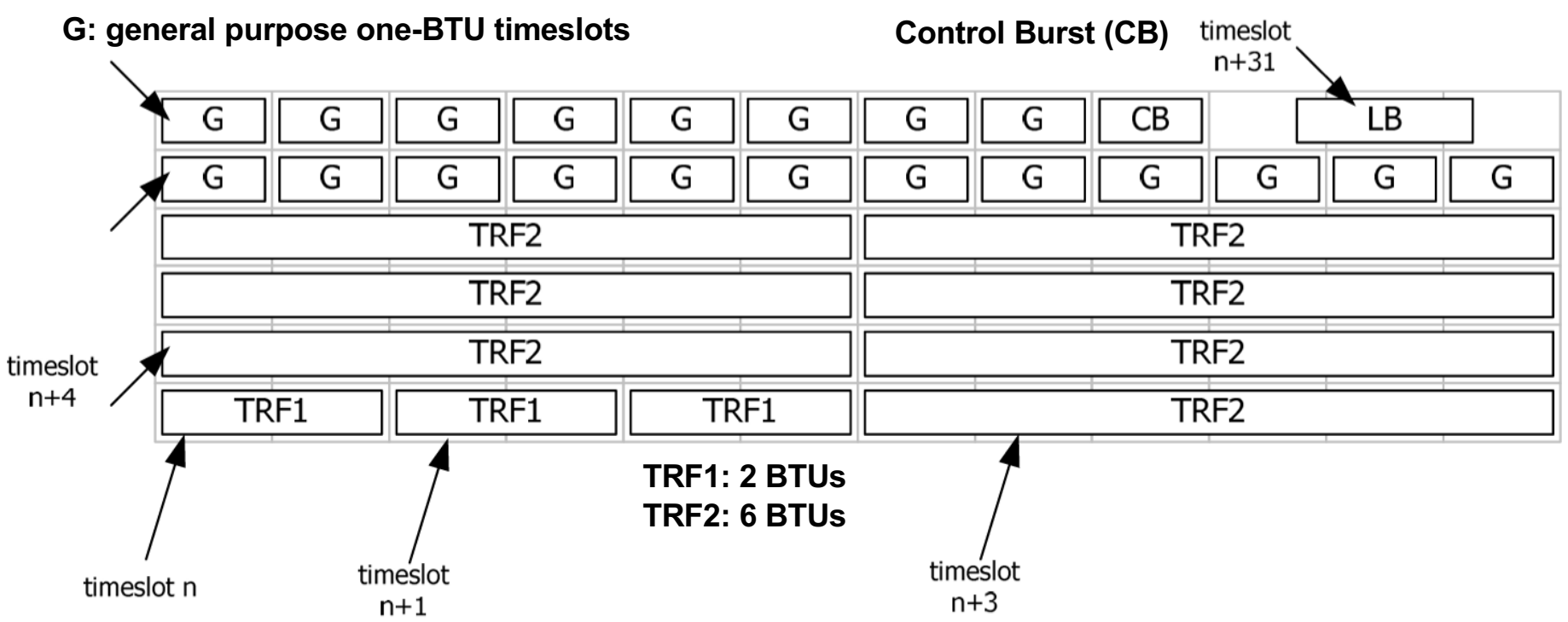


Figure 7-29: Example of the Composition of a Frame Type

Source: DVB-RCS2, Part 2: Lower Layers for Satellite standard

DVB-RCS2 Frame Structure

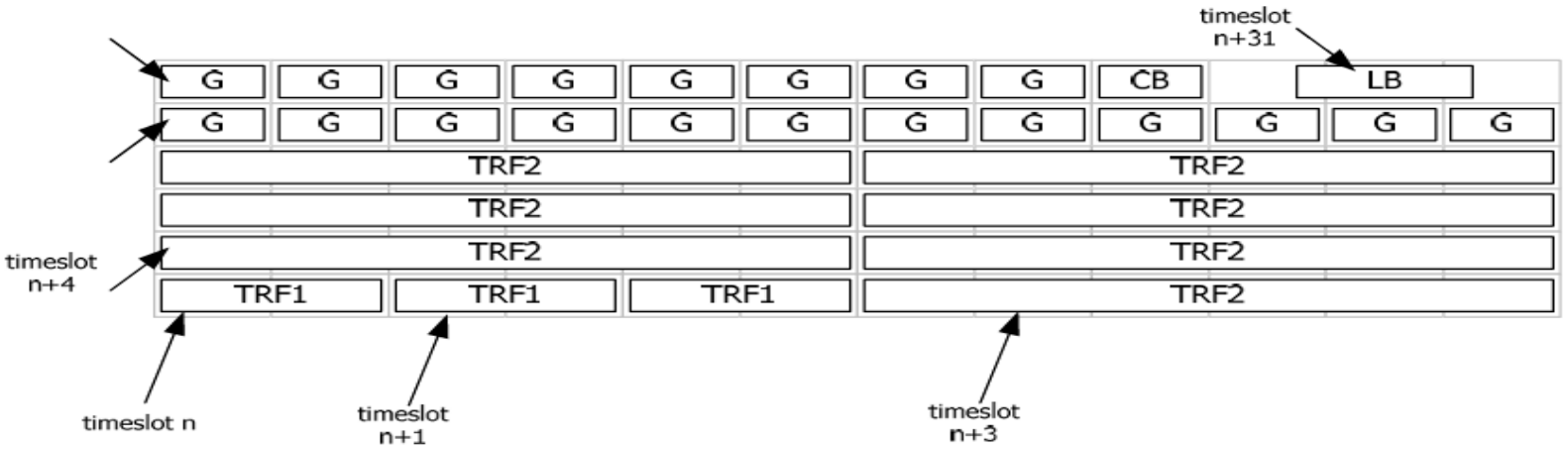


Figure 7-29: Example of the Composition of a Frame Type

- Timeslots: Numbered from 0, ordered by lowest frequency and earliest start time (range 0–2047).
- BTU (Burst Time Unit): The minimum time unit; frames are built from multiple BTUs.
- Assignment: NCC allocates timeslots to RCSTs using TBTP2 (Type of BBFRAME Transport Protocol 2) to avoid overlap.
- Special Slot Types
    - TRF1/TRF2 (Transmission Frame type 2): Transmission slots (with different coding or configuration).
    - CB (Contention Burst): Random access slots.
    - LB (Logon Burst): Slots reserved for new terminal logon.

Source: DVB-RCS2, Part 2: Lower Layers for Satellite standard

Frame

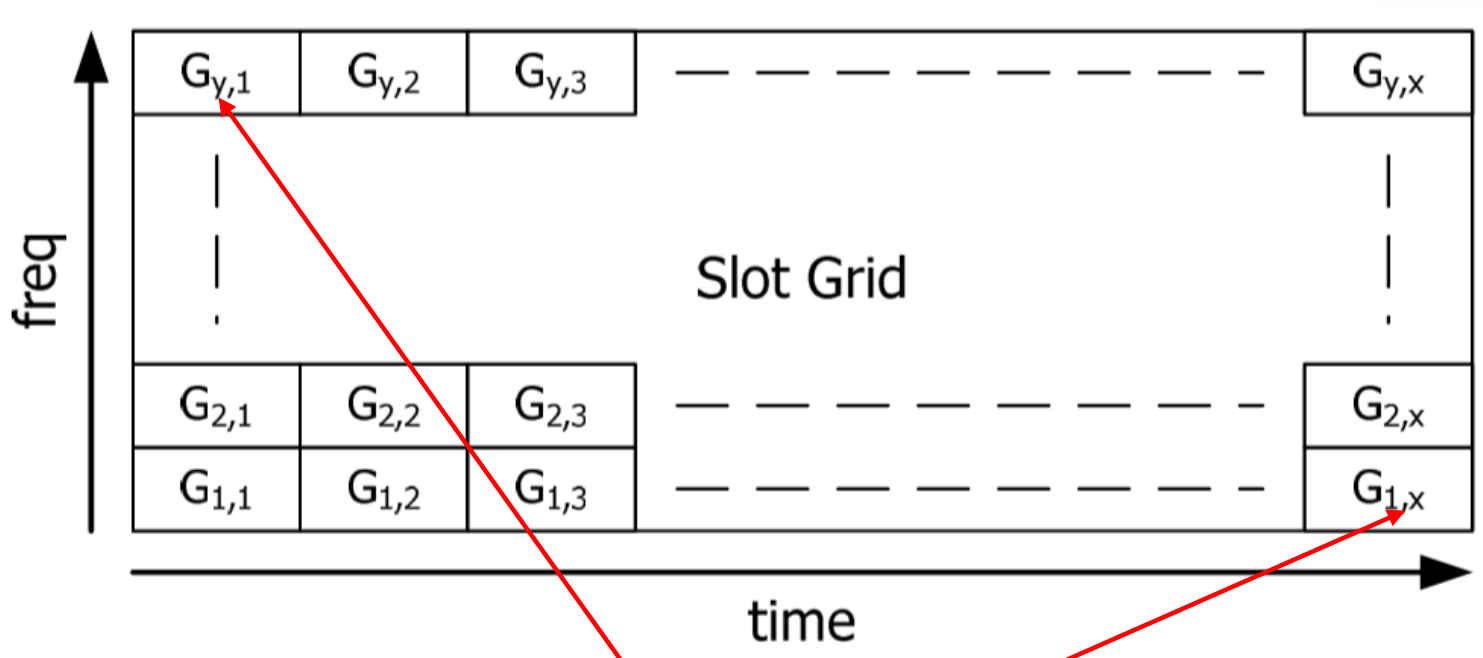


Figure 7-28: A Frame Implemented by 'x' BTUs of Type 'G' per Carrier in 'y' Adjacent Carriers

Source: DVB-RCS2, Part 2: Lower Layers for Satellite standard

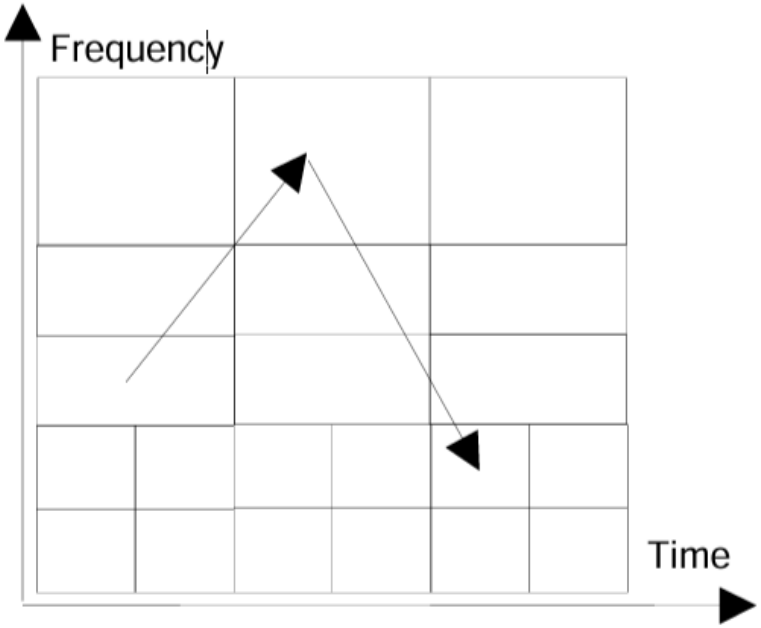
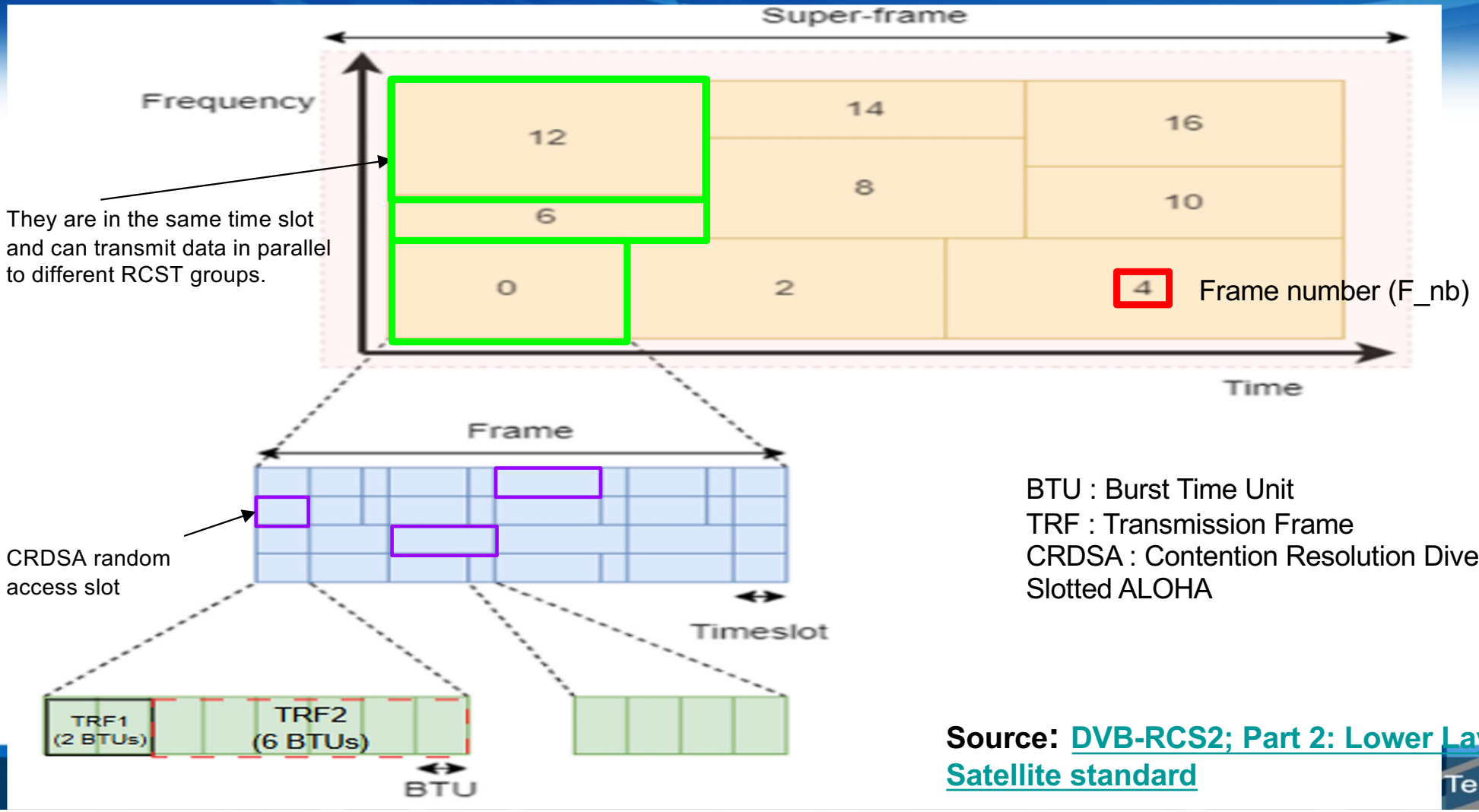


Figure 7-31: Dynamic MF-TDMA

Source: DVB-RCS2, Part 2: Lower Layers for Satellite standard

DVB-RCS2 super-frame structure



BTU : Burst Time Unit
TRF : Transmission Frame
CRDSA : Contention Resolution Diversity Slotted ALOHA

Source: DVB-RCS2; Part 2: Lower Layers for Satellite standard

Technology

Return Link Structure (MF-TDMA)

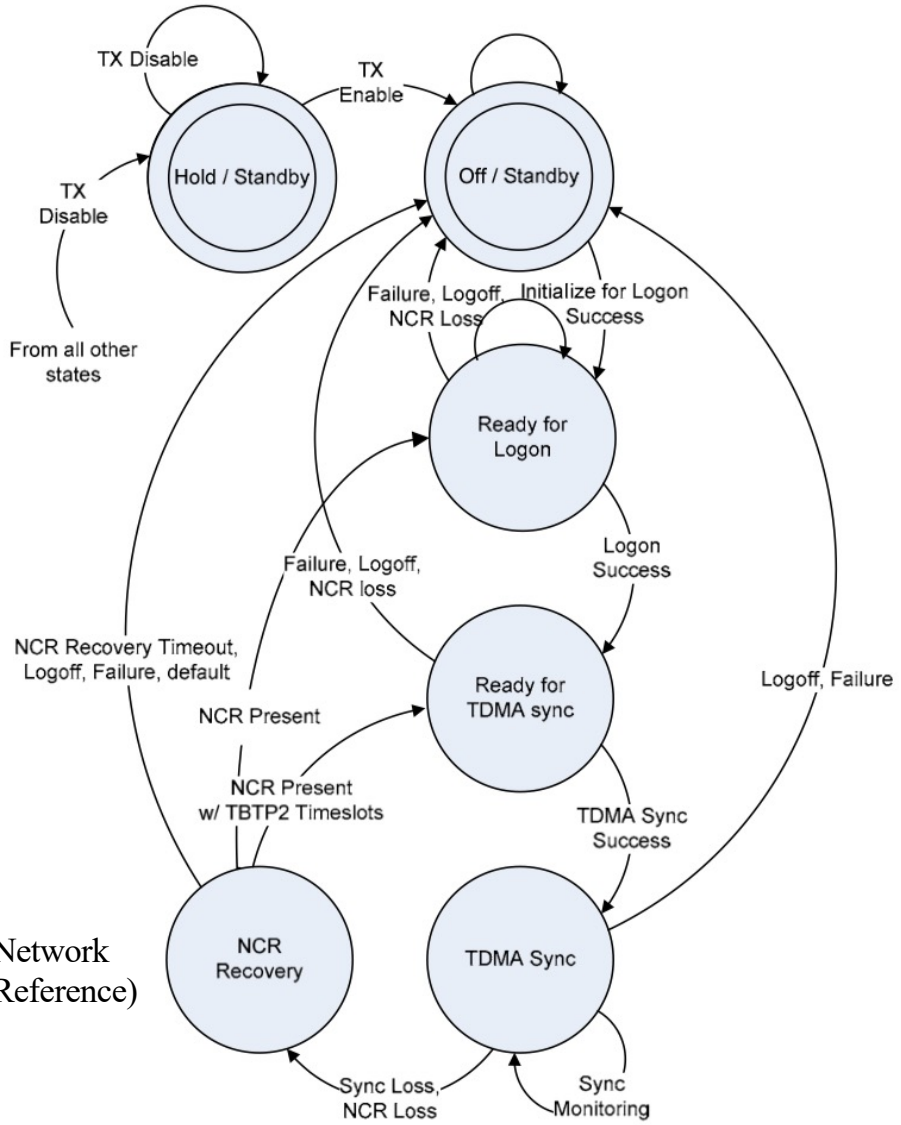
- Each frame is constructed of timeslots.
- Each timeslot is constructed from a number of equal Bandwidth-Time Units (BTU).

M&C Functions

1. **Start-up downlink TDM** as administratively configured and selected by the RCST
2. **Operational Population ID** as administratively configured for the RCST
3. **Original Network ID** as indicated by the NIT
4. **Interactive Network ID** as indicated by the RMT
5. **Network Control Centre (NCC) ID** as indicated by the Forward Link descriptor
6. **Satellite ID** as indicated by the Forward Link descriptor and by the Return Link descriptor
7. **Beam ID** as indicated by the Forward Link descriptor and by the Return Link descriptor
8. **Gateway ID** as indicated by the Return Link Descriptor
9. **Local Link ID** as specified by the Forward Link Descriptor

Return Link States and State Transitions

- RCST return link states:
  - Off/Standby
  - Hold/Standby
  - Ready for Logon
  - Ready for TDMA Sync
  - TDMA Sync
  - NCR Recovery



NCR (Network Clock Reference)

Figure 9-1: RCST State Diagram for MF-TDMA Operation

Connecting the Return Link

- RCST lower layers establish & maintain the connection to the interactive network through four procedures:
  - Lower layer logon procedure
  - TDMA synchronization procedure
  - Synchronization monitoring process
  - Logoff procedure

Broadcast Table
- Network Information Table (NIT): Original Network ID
- RCS Map Table (RMT): NCC/Satellite/Beam/GW/Local Link IDs

NCR (Network Clock Reference)
Satellite Position Table (SPT)
Superframe Composition Table (SCT): superframe → frames
Frame Composition Table version 2 (FCT2): frame→ timeslot → BTU
Terminal Information Message Broadcast (TIM-B)
Terminal Burst Time Plan Table version 2 (TBTP2): RA timeslots

NCC sends Correction Message Table (CMT) to advise the corrections for the RCSTs with the measured Control bursts

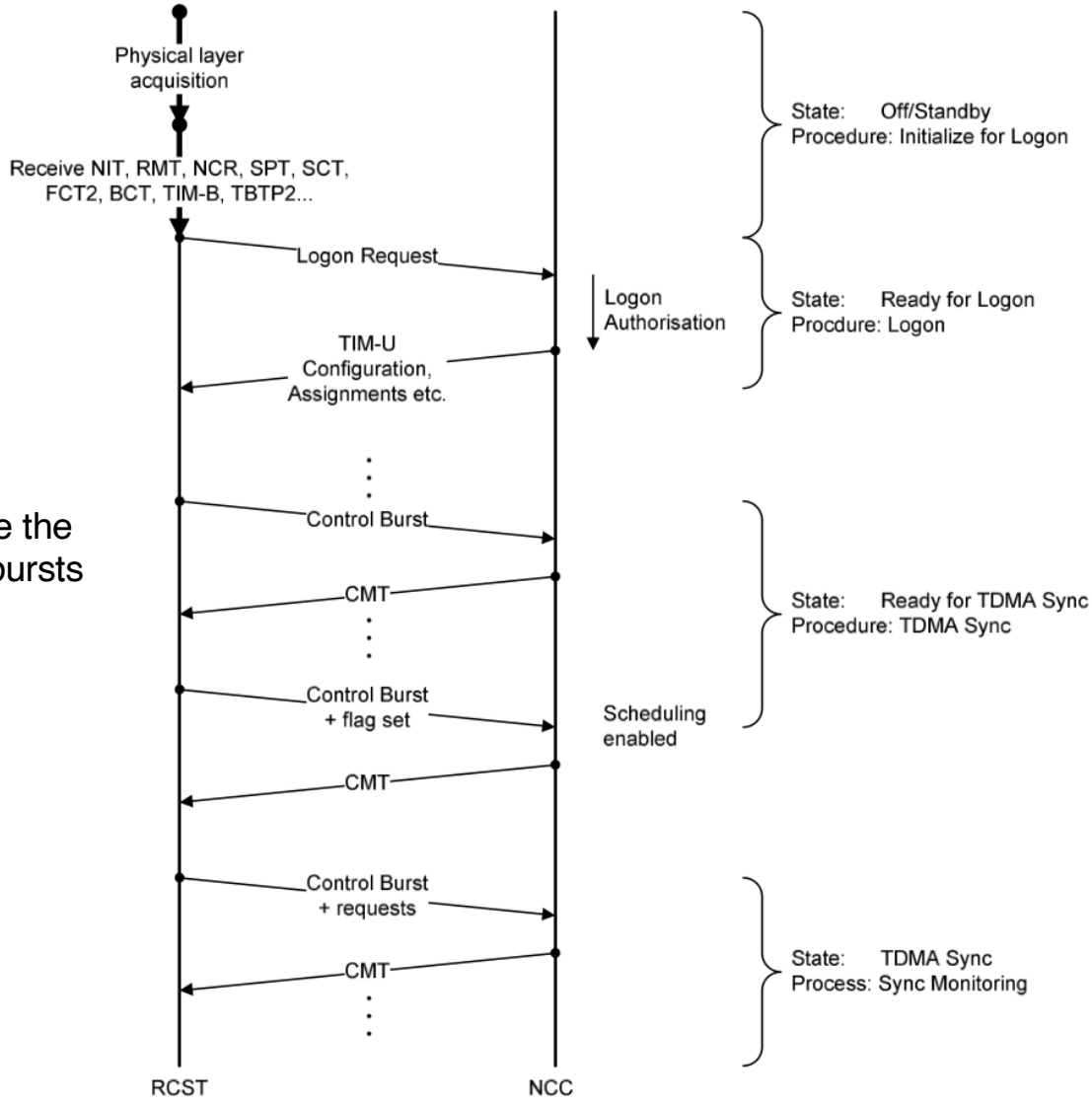


Figure 9-2: Example of Interactive Network Lower Layer Signalling Flow on the FL, the SFS to be Used for Logon and the SFS to be Used for Operation