Satellite Broadcasting

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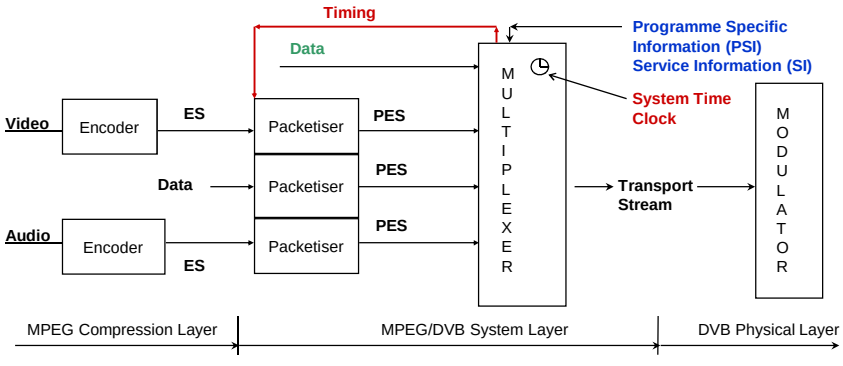
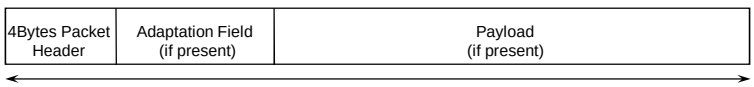
April 2020

Moving Picture Experts Group (MPEG)

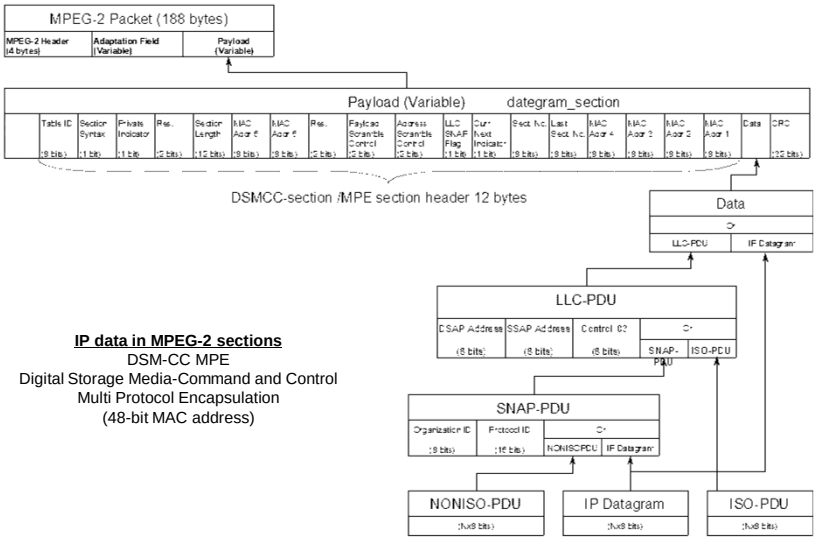


ES=Elementary Stream, PES=Packetized Elementary Stream



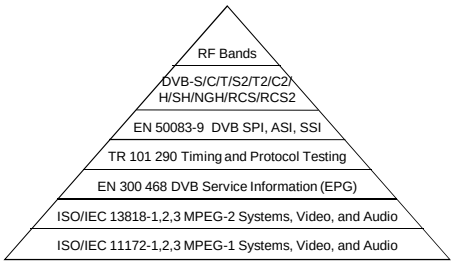
Packet of 188 Bytes a Synchronization Byte and a Packet IDentifier (PID) of 13 bits

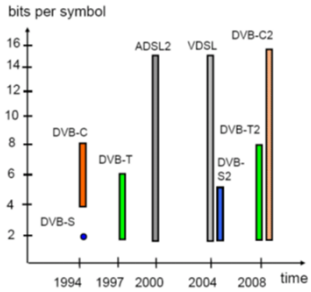
Data Encapsulation (MPEG DSM-CC)

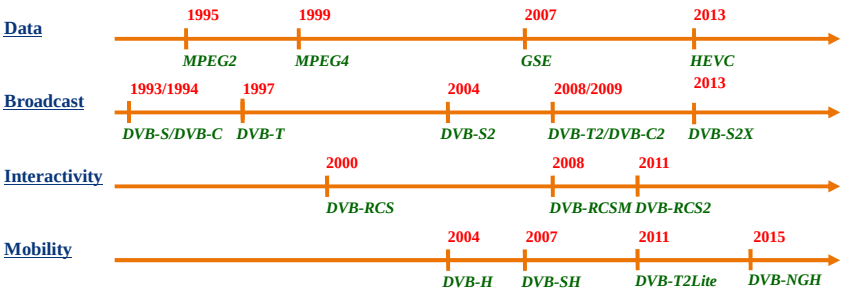


IP data in MPEG-2 sections
DSM-CC MPE
Digital Storage Media-Command and Control
Multi Protocol Encapsulation
(48-bit MAC address)

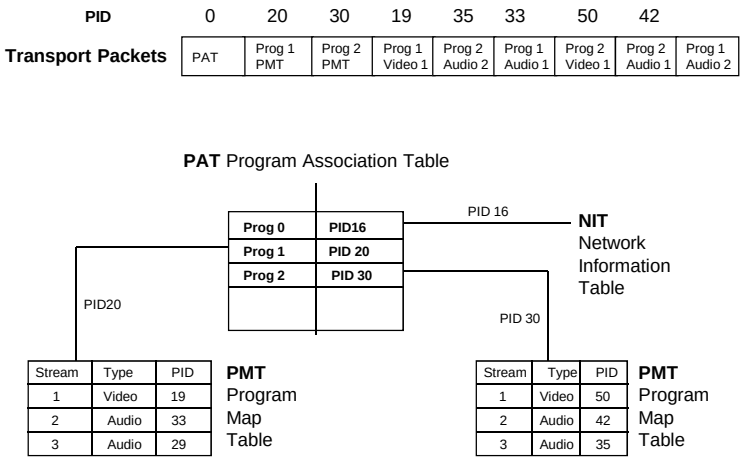
Digital Video Broadcasting (DVB)



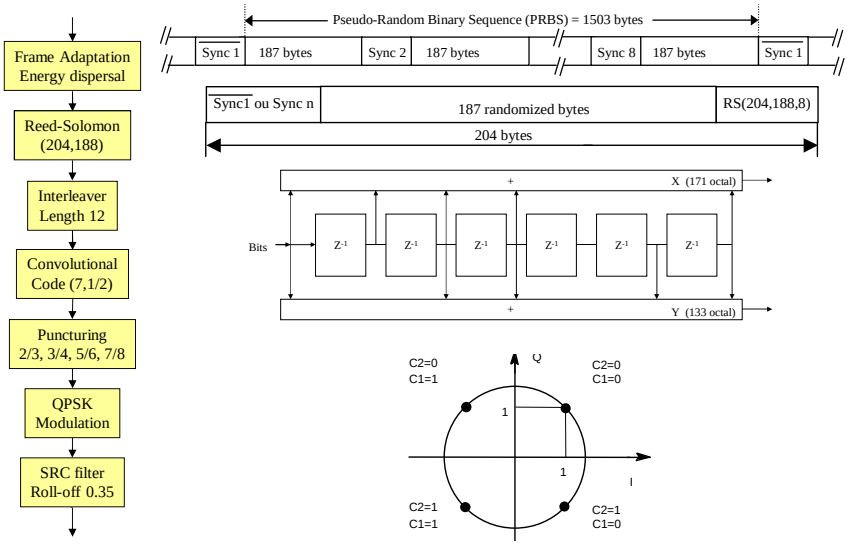




Service Information (DVB-SI)

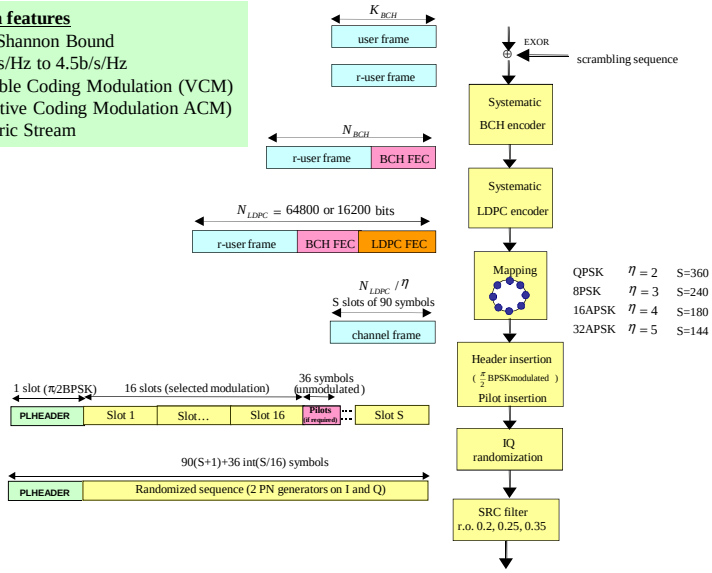


DVB-S Standard



DVB-S2 Standard

Main features
1dB Shannon Bound
0.5b/s/Hz to 4.5b/s/Hz
Variable Coding Modulation (VCM)
Adaptive Coding Modulation ACM)
Generic Stream



DVB-S2 Framing

- **BBFrame**
  - 80 bits for the BBHeader
  - 64800 or 16200 bits after BCH and LDPC coding of the BBHeader, data and stuffing
- **PLFrame**
  - 90 symbols of PLHeader in π/2BPSK including 26 symbols of SOF (Start Of Frame) and 64 symbols of corresponding to 7 information bits after a Reed-Müller coding (MODCOD, frame length, presence of pilots)
  - N symbols of data and optional pilots

	normal	short	normal	short	normal	short
	no pilots	no pilots	pilots	pilots	% pilot	%pilot
QPSK	32490	8190	33282	8370	2,38	2,15
8PSK	21690	5490	22194	5598	2,27	1,93
16APSK	16290	4140	16686	4212	2,37	1,71
32APSK	13050	3330	13338	3402	2,16	2,12

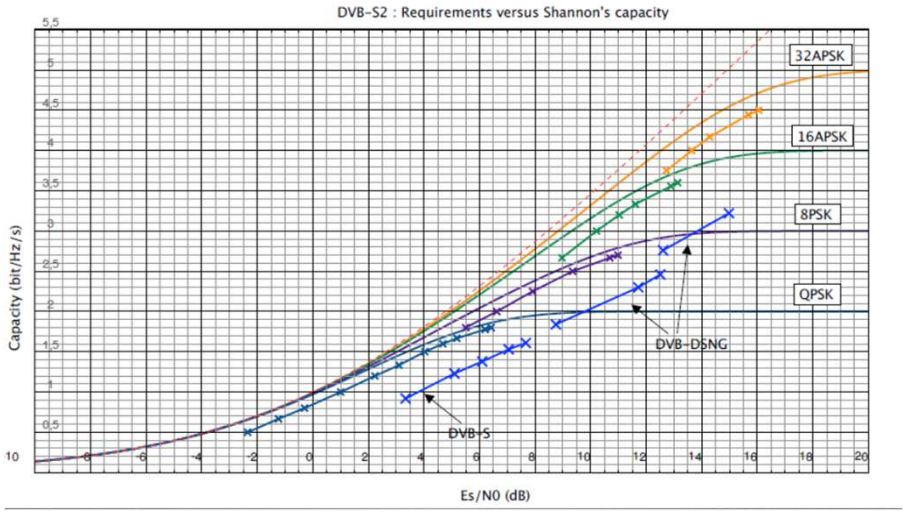
- **Dummy Frame**
  - PLHeader and 36*90 symbols without information

DVB-S2 Performances

Mode	Spectral efficiency	Ideal E_s/No (dB) for FECFRAME length = 64 800
QPSK 1/4	0,490243	-2,35
QPSK 1/3	0,656448	-1,24
QPSK 2/5	0,789412	-0,30
QPSK 1/2	0,988858	1,00
QPSK 3/5	1,188304	2,23
QPSK 2/3	1,322253	3,10
QPSK 3/4	1,487473	4,03
QPSK 4/5	1,587196	4,68
QPSK 5/6	1,654663	5,18
QPSK 8/9	1,766451	6,20
QPSK 9/10	1,788612	6,42
8PSK 3/5	1,779991	5,50
8PSK 2/3	1,980636	6,62
8PSK 3/4	2,228124	7,91
8PSK 5/6	2,478562	9,35
8PSK 8/9	2,646012	10,69
8PSK 9/10	2,679207	10,98
16APSK 2/3	2,637201	8,97
16APSK 3/4	2,966728	10,21
16APSK 4/5	3,165623	11,03
16APSK 5/6	3,300184	11,61
16APSK 8/9	3,523143	12,89
16APSK 9/10	3,567342	13,13
32APSK 3/4	3,703295	12,73
32APSK 4/5	3,951571	13,64
32APSK 5/6	4,119540	14,28
32APSK 8/9	4,397854	15,69
32APSK 9/10	4,453027	16,05

Transmission Mode	C_{SAT}/N loss [dB] no predistortion without Phase Noise	C_{SAT}/N loss [dB] with dynamic predistortion without Phase Noise	C_{SAT}/N loss [dB] with dynamic predistortion with Phase Noise
QPSK 1/2	0,62 (IBO = 0; OBO = 0,33)	0,5 (IBO = 0 dB; OBO = 0,38)	0,63
8PSK 2/3	0,95 (IBO = 0,5; OBO = 0,35)	0,6 (IBO = 0;OBO = 0,42)	0,85
16APSK 3/4	3,2 (IBO = 5; OBO = 1,7)	1,5 (IBO = 1; OBO = 1,1)	1,8
32APSK 4/5	6,2 (IBO = 9; OBO = 3,7)	2,8 (IBO = 3,6; OBO = 2,0)	3,5

DVB-S2 vs. DVB-S

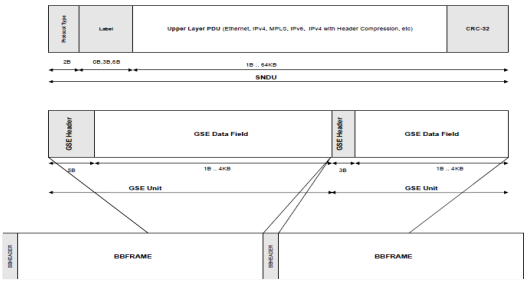


Examples on 36MHz

Frequency band	Ku	Ka
Satellite EIRP	48dBW	51dBW
Free Space Path Losses	-205.7dB	-210.1dB
Fading at 99.95%	-2.9dB	-8.5dB
Terminal G/T	16dB/K	18.7dB/K
Boltzmann Constant	228.6dB	228.6dB
Equivalent Noise Bandwidth (r.o. 0.2)	-74.8dBHz	-74.8dBHz
Implementation losses	-1.3dB	-1.3dB
$(C/N)_{Total}$	7.9dB	3.6dB
DVB-S data rate QPSK7/8&QPSK1/2	42.9Mbps	24.5Mbps
DVB-S2 data rate 8PSK3/4&QPSK2/3 (r.o. 0.2)	66.9Mbps	39.6Mbps

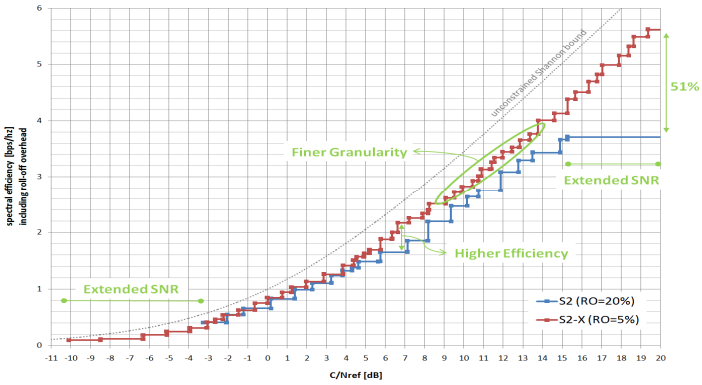
Satellite EIRP	51dBW	53.7dBW
DVB-S2 Useful Bitrate	46Mb/s QPSK3/4 r.o. 0.2	59Mb/s 8PSK2/3 r.o. 0.25
Number of SDTV Programmes	10 MPEG-2 21 MPEG-4	13 MPEG-2 26 MPEG-4
Number of HDTV Programmes	2 MPEG-2 5 MPEG-4	3 MPEG-2 6 MPEG-4
Number of UHDTV Programmes	1 MPEG-4 2 HEVC	1 MPEG-4 3 HEVC

Generic Stream Encapsulation (DVB-GSE)



- **Direct encapsulation of network-layer packets (IPv4, IPv6, Ethertype,..) over DVB-S2**
  - Network-layer packets, Protocol Data Units (PDUs) of less than 64kB, encapsulated in Subnetwork Data Units (SNDUs) by adding a header (Protocol Type – 2B, Label – optional 3B or 6B, CRC – optional 4B)
  - SNDUs encapsulated in one or more GSE units (GSE Header – 2B-5B, GSE Data Field – variable length) scheduled in BBFRAMEs (in order for units including fragments of the same PDU)
  - MPEG signalling not encapsulated and transmitted in separate BBFRAMEs with the most robust MODCOD or encapsulated in GSE units directly or in a sequence of MPEG packets
  - Low overhead (2-3 times better than MPE), fragmentation flexibility for ACM/VCM, transparency to network layer functions (protocols, encryption, header compression…), support of hardware filtering, integrity check…

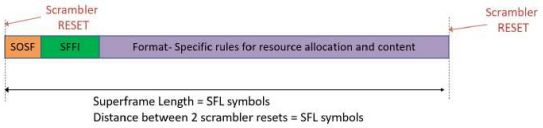
DVB-S2X Standard



S2X Characteristic		(1+roll-off) rule	Free symbol rate
Physical Layer	Better MODCODs	0% for SNR<10dB >5% for SNR>10dB	0% for SNR<10dB >5% for SNR>10dB
	Finer granularity	0% to 10%	0% to 3%
	Sharper roll-off (5% vs. 20%)	6%-7%	2%
System Layers	Channel bonding (2 or 3 transponders)	7% to 12%	
	VCM simulcast (UHDTV-1+SDTV)	Up to 20%	

Super-Frame DVB-S2X

- **Constant length super-frame (SF) comprising SFL symbols**
  - Super-Frame Formats 0, 1, 2, 3 and 4, SFL=612,540 symbols
  - Super-Frame Formats 5, 6 and 7, SFL selected by the network operator
  - Start-Of-Super-Frame preamble (SOSF) and a Super-Frame Format Indicator (SFFI), first 720 symbols
  - Resource allocation grid based on Capacity Units (CUs) and the payload structure based on slots (CU size can be the same as the slot size of 90 symbols)

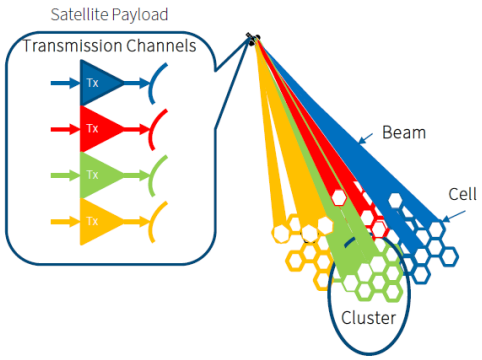


- 720 symbols for SOSF + SFFI
- Format Specific allocation of SFL-720 symbols

- **Format Specification**
  - Format 0: DVB-S2X
  - Format 1: DVB-S2 legacy
  - Format 2: Bundled PLFRAME (64 800 payload Size) with SF-Pilots
  - Format 3: Bundled PLFRAME (16 200 Payload Size) with SF-Pilots
  - Format 4: Flexible Format with VL-SNR PLH tracking with Super-Frame Header (SFH) and SFH-Trailer (ST)

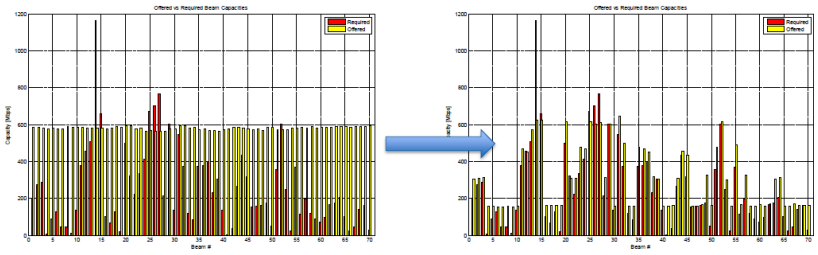
Beam-Hopping Overview

- **Definitions**
  - Beam: Directional radio signal transmitted from a satellite transmission channel towards a cell
  - Cluster: Group of cells served by the same transmission channel with only one cell illuminated at any given time
  - Beam-Hopping Time Plan: Cell dwell times and beam-hopping cycle within a cluster



Beam-Hopping Benefits

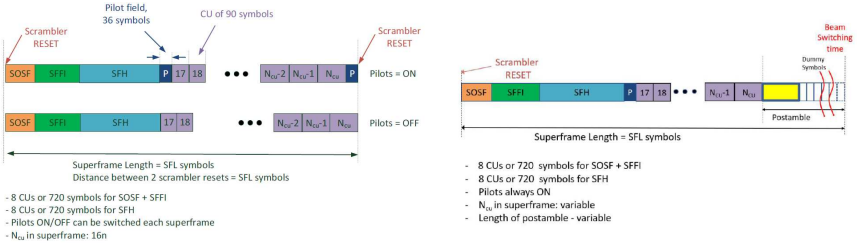
- **Concept**
  - Applicable to both Forward Link and Return Link
  - Time-multiplexing data traffic of multiple cells within each cluster with typically a wideband transmission
  - Satellite beam switching (hopping) to different cells reconfigurable according to traffic demands and user locations
- **Example of beam capacity management with beam-hopping**



Capacity increase by up to +15% & Reduction of the unmet and excess capacity by 20%
Better flexibility for beams with variable traffic demand & Lower DC power consumption

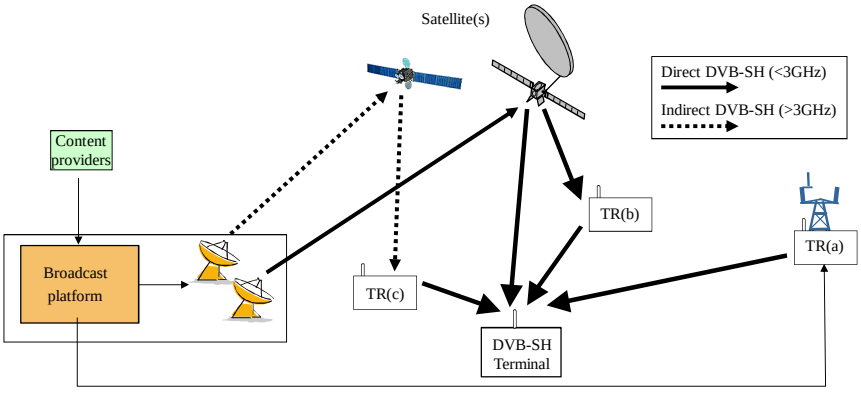
Beam-Hopping Implementation in DVB-S2X

- **Format 5: Periodic Beam Hopping Format with VL-SNR and fragmentation Support**
  - Flexible Super-Frame Length SFL to cope with Beam Hopping Time Plans with various dwell times



- **Format 6: Traffic Driven Beam Hopping Format with VL-SNR Support**
  - Modification of SFH to a composite 720 symbols carrying 2 protected bits
  - No fragmentation of PLFRAMES between superframes
- **Format 7: Simplified Traffic Driven Beam Hopping Format without VL-SNR Support**
  - No SFH and VL-SNR burst-mode operation
  - Fixed PLH protection level
- **Superframe example: 20-600ksymbols at 500MBds (40µs-1.2ms), ~250ms of hopping period**

Satellite System Handheld (DVB-SH)

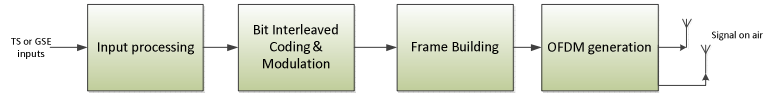


Complementary Ground Component (CGC) consisting of Terrestrial Repeaters (TR)
TR(a), Repeater collocated with mobile cell site or standalone providing local content insertion
TR(b), Gap-fillers providing local on-frequency re-transmission
TR(c), Gap-fillers on mobile platforms providing local translation of DVB-SH indirect transmission

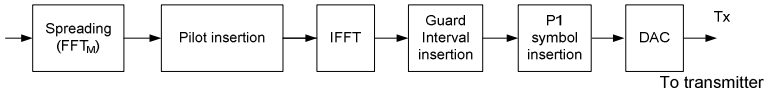
Terminal - Class 1
Physical layer protection (single-burst duration)
Multiple-burst link layer protection (Reed Solomon Codes)

Terminal - Class 2
Physical layer protection (single-burst / multiple-burst duration)
Multiple-burst link layer protection (Reed Solomon / Raptor)

New Generation Handheld (DVB-NGH)



- **Terrestrial standard improving DVB-T2 for mobile context**
  - MPEG or IP/GSE data
  - BBFrame as in DVB-S2
  - LDPC/BCH FEC with blocks of 16200 bits as in DVB-S2
  - Mapping, interleaving and OFDM adapted to multipath channel
- **Option for a hybrid terrestrial/satellite system**
  - Single Carrier OFDM (SC-OFDM) to reduce peak-to-average power ratio (PAPR)



Future Standard Updates

- **High layers**
  - DVB implementation guideline for 8K services using DVB-S2X and next generation coding
  - Native end-to-end IP delivery via satellite to set top boxes, gateways, flat screens and 5G infrastructure
  - mABR (Multicast Adaptive Bit Rate) delivery system in the satellite context
- **Optimization for High Throughput Satellites**
  - New signaling for a fully dynamic satellite bandwidth resource allocation
  - Control and management of flexible satellite resources (beam hopping time plan, flexible frequency allocation, adaptive beam size control, power allocation, etc.) for bidirectional terminals
  - Intra-system interference mitigation (linear precoding, on-board power allocation as flexible TWTA…)
- **Low cost end user equipment**
  - Set-Top Box integrated with other user equipment (TV set, Hybrid IP device…)
  - Multi-band and wide-angle LNB (BSS/FSS, inter-system interference mitigation)
  - Control of phased array type flat panel antennas of the terminal (independent of the manufacturers)