



DVB-S2X benefits for High Data Rate Telemetry

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Reminder of DVB-S2X new features for HDRT

	DVB-S2	DVB-S2X
Modulations	QPSK, 8PSK, 16APSK, 32APSK	QPSK, 8PSK, 8APSK, 16APSK, 32APSK, 64APSK, 128APSK, 256APSK
Total number of MODCOD (for normal frame length)	28	28 (S2) + 39 (S2X)
MODCOD subset possibility	Yes	Yes
Efficiencies	From 0.48 to 4.35 bits per symbol	From 0.43 to 5.9 bits per symbol
Roll-off	0.2, 0.25, 0.35	0.05, 0.1, 0.15, 0.2, 0.25, 0.35
Retrocompatibility with DVB-S2	-	Yes for all S2 MODCOD and roll-off

21 new LDPC coding rates

Table 4 (see EN 302 307-1 [3], Table 5a): Coding Parameters (for normal FECFRAME $n_{ldpc} = 64\ 800$)

LDPC Code Identifier	BCH uncoded block K_{bch}	BCH coded block N_{bch} LDPC uncoded block k_{ldpc}	BCH t-error correction	LDPC coded block n_{ldpc}
2/9	14 208	14 400	12	61 560 (note)
13/45	18 528	18 720	12	64 800
9/20	28 968	29 160	12	64 800
90/180	32 208	32 400	12	64 800
96/180	34 368	34 560	12	64 800
11/20	35 448	35 640	12	64 800
100/180	35 808	36 000	12	64 800
26/45	37 248	37 440	12	64 800
18/30	38 688	38 880	12	64 800
28/45	40 128	40 320	12	64 800
23/36	41 208	41 400	12	64 800
116/180	41 568	41 760	12	64 800
20/30	43 008	43 200	12	64 800
124/180	44 448	44 640	12	64 800
25/36	44 808	45 000	12	64 800
128/180	45 888	46 080	12	64 800
13/18	46 608	46 800	12	64 800
22/30	47 328	47 520	12	64 800
135/180	48 408	48 600	12	64 800
7/9	50 208	50 400	12	64 800
154/180	55 248	55 440	12	64 800

New LDPC codes optimized for decoding optimization

Simulations parameters

Operational scenario: SENTINEL-1 like mission orbit

- Altitude ~693 km, Inclination ~98 deg, EESS X-Band 8025-8400 MHz, 99.9% availability

Directional antenna of 22 dBi gain

- Measured from on-going development (EQM) in CNES anechoic chamber

X-band modulator with integrated SSPA: 10W RF with back-off

Ground station from CNES CORMORAN network: Kiruna S+X 13 m

2 scenarios:

- Symbol rate = 300 MSps to allow comparisons with S2 (scenario 1)
- Symbol rate > 300 MSps to fully benefit from S2X (scenario 2)



Link budget tool

Variable Modulation and Coding rate

Statistical approach of elevations distribution

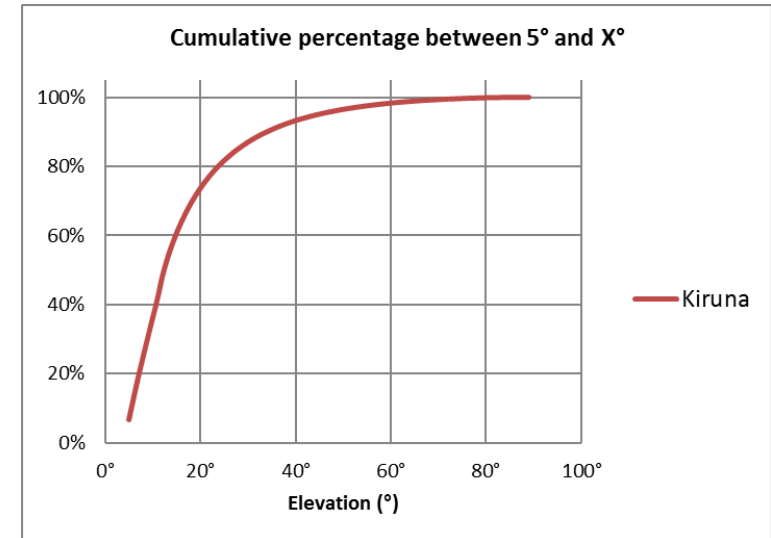
For selected ground station and altitude (Kiruna 700 km):

- Average on 26 days \Leftrightarrow 270 passes
- Average duration: 8 min 36 s

Additional losses taken into account to cover NL and other degradations (demodulation, ...)

Modulation	Demodulation losses
32APSK	2 dB
64APSK	3 dB
128APSK	4 dB
256APSK	5 dB

Comparison with theoretical AWGN thresholds + demod losses



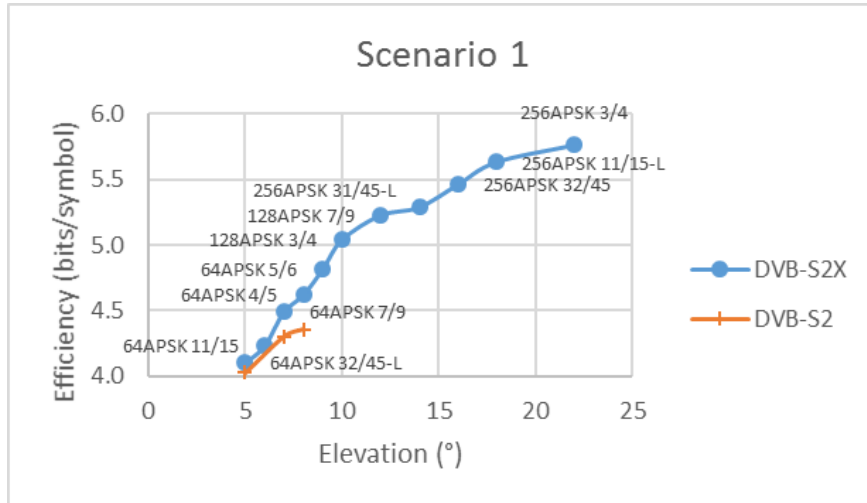
Results for scenario 1

DVB-S2

Elevation angle	Elevation usage	Modcod scheme	Spectral efficiency
°	%	DVB-S2	bits/symbol
5	13%	32APSK 5/6	4.03
7	6%	32APSK 8/9	4.30
8	81%	32APSK 9/10	4.36

DVB-S2X

Elevation angle	Elevation usage	Modcod scheme	Spectral efficiency
°	%	DVB-S2X	bits/symbol
5	7%	64APSK 32/45-L	4.11
6	6%	64APSK 11/15	4.23
7	6%	64APSK 7/9	4.49
8	6%	64APSK 4/5	4.62
9	6%	64APSK 5/6	4.82
10	11%	128APSK 3/4	5.04
12	11%	128APSK 7/9	5.23
14	8%	256APSK 31/45-L	5.29
16	6%	256APSK 32/45	5.46
18	9%	256APSK 11/15-L	5.63
22	24%	256APSK 3/4	5.76



Results for scenario 2

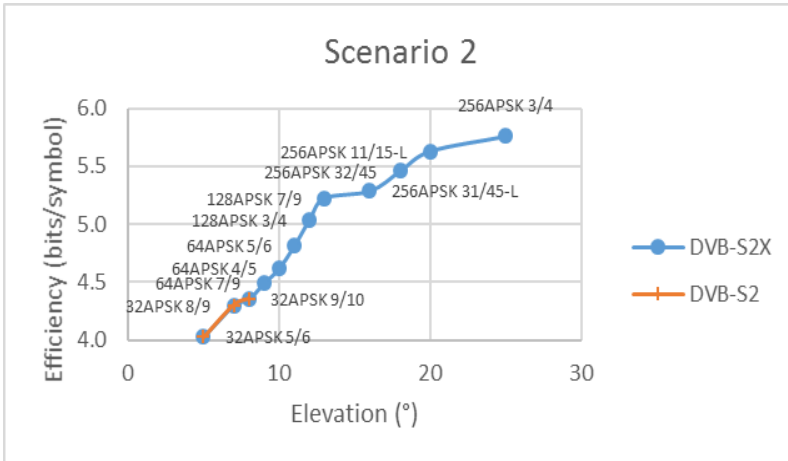
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20	9%	256APSK 11/15-L	5.63
25	20%	256APSK 3/4	5.76

Link budget degradation due to higher symbol rate for same available power. For low elevation angles, choice of Modcods more robust and less spectrally efficient.



Results

	DVB-S2	DVB-S2X	DVB-S2X
Roll-off	0.2	0.2	0.1
Symbol rate	300 MSps	300 MSps	340 MSps
Average bit rate	2586 Mbps	3089 Mbps	3405 Mbps
Data volume	1334 Gbits	1593 Gbits	1756 Gbits
Gain on volume	-	+19.4%	+31.6%
Number of MODCOD	3	11	12
Highest MODCOD elevation	8°	22°	25°

Conclusion

- **DVB-S2X can provide a substantial gain for HDRT when exploiting all the new features, increasing spectral efficiency (modulations, coding rates and roll-off) and optimizing the link budget margin during the passes.**
- **The coming telecom market exploiting this new standard will allow low cost high data rate receiver as the telecom customer useful data rates keep increasing to reach several hundreds of Mbps (330 Mbps already tested, 500 Mbps targeted, Inmarsat/iDirect).**