

SpaceWay

- Geostationary system for interactive multimedia services:
- First proposed direct-to-user interactive multimedia satellite system (FCC filing: December 1993)
- Services: voce, video, data, multimedia (ATM, ISDN, Frame Relay)
- Constellation: 14 GEO satellites, 10 orbital positions (global coverage)
- Ka band satellites with ~ 8 Gbit/s capacity (bandwidth on demand)^{N. America}
- Other features similar to Astrolink: Inter-satellite links, on-board processing, high-gain multispot antennas, USATs, etc.)
- The SPACEWAY3 satellite was successfully launched on August 14, 2007 and commercial service in North America began April 8, 2008. 10 Gbit/s total throughput. 95° W.







SPACEWAY 3

- Approximately 5 to 8 times the capacity of Ku-band satellites.
- It enables a full-mesh digital IP network that interconnects with a wide variety of end-user equipment and systems.

The Mission

 High-performance, onboard digital processing, packet switching, and spot beam technology to offer high broadband speeds and capacity, bandwidth on demand, mesh connectivity.

Point-to-Point Communications

 Onboard switching capability enables the satellite to receive, process, and route traffic directly to and from customer locations in a single hop, not using a hub. Onboard switching reduces delay, increases overall transmission efficiency, enables mesh communications directly between customer sites at rates of from 512 kbit/s up to 16 Mbit/s.

Spot Beams

• Phased array antenna 24 hopping spot beams at 440 Mbit/s directly where the traffic needs to go.

Frequency Reuse

• It reuses frequencies across North America, yielding higher effective capacity.



SPACEWAY 3

- Satellite Owned and operated by Hughes
- Terminals and NOCC Developed and operated by Hughes
- Spacecraft and payload built by Boeing
- Launcher Ariane 5
- Weight 6.075 tons (13382 lbs) at launch
- Uplink cells 112
- Downlink hopping beams 24
- Downlink microcells 784
- Switch matrix 224 inputs x 256 outputs
- Elements in phased array 1500



Spaceway 3 CONUS coverage



Internet via Satellite (AA2021/22)



Up link coverage



Internet via Satellite (AA2021/22)



Down link coverage



Internet via Satellite (AA2021/22)



Athena Fidus

- Jointly developed by ASI (Italian Space Agency) and CNES (Centre National d'Etudes Spatiales)
 - Acronym: Access on THeaters for European allied forces Nations-French Italian Dual Use Satellite.
- Built to support/complement terrestrial networks for a large set of civil and institutional/military applications.
- Single geostationary satellite operating in the Ka and EHF bands.
- DVB-RCS for return and mesh links and DVB-S2 for forward links, to enhance transmission capacity and service availability (DVB-RCS, RCS-RCS o IPoS, with ACM).

- The overall expected data rate is over 1 GB/s.
- Bandwidth on Demand
- Value added services including Audio e Video
- SLA and QoS, DiffServ
- Up to 2 (4) Mbit/s uplink

ot beams

- As for the Italian Mission, the system is designed to provide:
 - Star and transparent mesh communication services over
 National coverage in the civilian Ka band
 - Star and transparent mesh communication services in EHF and Military Ka bands over National coverage and steerable

Internet via Satellite (AA2021/22)



Athena Fidus channalization

Channel #	Connectivity	F _{up} (MHz)	F _{down} (MHz)	Carriers	Symbol Rate (MSps)	Roll- Off	BW per carrier (MHz)	BW per channel (MHz)	EIRP dendity (dBW/MHz)	G/T (dB/K)
15+17	Star return (DVB-RCS)	29600	19520	10	1.9	0.35	2.565	25.65	28	9
15+17	Star return (DVB-RCS)	29600	19520	144	0.64	0.35	0.864	124.416	28	9
15+17	Star return (DVB-RCS)	29600	19520	116	0.32	0.35	0.432	50.112	28	9
	-							200		
16	Star forward (DVB-S2)	29427.5	19887.5	1	60	0.25	75	75	32.5	10

18	Star forward (DVB-S2)	29302.5	19762.5	1	100	0.25	125	125	32.5	10
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Athena Fidus: Return Link Channels (1/2) Channel at 320 Msym/s

DVB-RCS link budget requirements

Mode	Rc	Ideal Eb/N0	C interface (Mbit/s)	Spectral efficiency (η)	Ideal Es/N0	Ideal C/N0	C _{IP} (kbit/s)	
QPSK 1/2	0.387	4.5	0.247	0.57	2.08	57.14	213	
QPSK 2/3	0.516	5	0.330	0.76	3.83	58.89	284	
QPSK 3/4	0.581	5.5	0.371	0.86	4.85	59.90	320	
QPSK 5/6	0.645	6	0.413	0.95	5.81	60.86	356	
QPSK 7/8	0.678	6.4	0.434	1.004	6.42	61.47	373	
		From literature	C=SR*Rc*log₂(M)	η=C/BW	Es/N₀=E _b /N₀+10* log₁₀(η)	C/N₀=E₅/N0+10*log(SR,10)		

Channel at 640 Msym/s

DVB-RCS link budget requirements								
Mode	Rc	Ideal Eb/N0	C interface (Mbit/s)	Spectral efficiency (η)	Ideal Es/N0	Ideal C/N0	C _{IP} (kbit/s)	
QPSK 1/2	0.387	4.5	0.495	0.57	2.08	60.15	427	
QPSK 2/3	0.516	5	0.661	0.76	3.83	61.9	569	
QPSK 3/4	0.581	5.5	0.743	0.86	4.85	62.91	641	
QPSK 5/6	0.645	6	0.826	0.95	5.81	63.87	712	
QPSK 7/8	0.678	6.4	0.867	1.004	6.42	64.48	747	
$From \ literature \ C=SR^*Rc^*log_2(M) \qquad \eta=C/BW \qquad Es/N_0=E_b/N_0+10^*log_{10}(\eta) \qquad C/N_0=E_s/N0+10^*log(SR,10) \qquad D_1O/N_0$							1111	

Internet via Satellite (AA2021/22)



Athena Fidus: Return Link Channels (2/2)

Channel at 1.9 Msym/s

DVB-RCS link budget requirements									
Mode	Rc	Ideal Eb/N0	C interface (Mbit/s)	Spectral efficiency (η)	Ideal Es/N0	Ideal C/N0	C _{IP} (kbit/s)		
QPSK 1/2	0.387	4.5	1.47	0.57	2.08	64.87	1268		
QPSK 2/3	0.516	5	1.96	0.76	3.83	66.62	1691		
QPSK 3/4	0.581	5.5	2.21	0.86	4.85	67.63	1903		
QPSK 5/6	0.645	6	2.45	0.95	5.81	68.59	2114		
QPSK 7/8	0.678	6.4	2.57	1.004	6.42	69.20	2220		
		From literature	C=SR*Rc*log₂(M)	η=C/BW	Es/N₀=E♭/N₀+10*log₁₀(η)	C/N₀=E₅/N0+10*log(SR,10)			

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Athena Fidus – Link Budget on Return LINK, channel 640 kSps

EIRP=48 dBW; Symbol Rate=640 kSps



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Athena Fidus – Link Budget on Return LINK, channel 1.9 MSps





HISPASAT

- Three orbital positions
 - Trans Atlantic position (30° W) with Hispasat 1C, 1D, 1E and Spainsat
 - American position (61° W) with Amazonas 1 and 2
 - Oriental position (29° E) with Xtar-Eur
- Satellite Control Center, near Madrid, and two Payload Centres.
- The transponders are mainly transparent (there is also an OBP Amheris payload), for both analogical and digital connections.



The fleet and coverage areas





Orbital positions

Orbital position	Satellite	Transponders	Launch Year
30° West	Hispasat 30W-4	28 Ku	2002
30° West	Hispasat 30W-5	53 Ku, Ka	2010
30° West	Hispasat 30W-6	40 Ku, 7 Ka, 10 C	Forecast 2017
36° West	Hispasat 36W-1	20 Ku, Ka	2017
55.5° West	Hispasat 55W-2		
61° West	Amazonas 2	54 Ku, 10 C	2009
61° West	Amazonas 3	33 Ku, 19 C, 9 Ka	2013
61° West	Amazonas 4	-	2014
61° West	Amazonas 5	24 Ku, 34 Ka	2017
70° West	Hispasat 70W-1		
84º West	Hispasat 84W-2		



(Future-Forthcoming) MEGACONSTELLASTIONS



LEOSAT

- 108 satellites in polar orbits
- H = 1440 km
- Optical intersatellite link
- On board processing
- Ka band
- Flat panel antennas
- Each satellite in the LeoSat constellation supports:



- 10 Ka-band steerable user antennas, each of which is capable of providing customer terminals with between 50 Mbit/s and 1.6 Gbit/s of symmetrical data connectivity
- Two steerable gateway antennas, capable of an aggregated throughput of up to 10 Gbit/s (which can also be used for customer traffic when not over a gateway)
- 4 optical inter-satellite links
- 2019 Launch of two Early Birds offering GigaByte Store and Forward Services
- 2021 Start of launch of the constellation offering real-time, point-topoint connectivity with coverage growing from the Poles to the Equator on completion
- 2022 Full Worldwide Service Availability



OneWeb



50x43x10 cm

electronically

Outdoor unit

steered antenna

low-power, compact,

Intellian

- 648 satellites
- User terminal antenna phased array 36x16cm²
- 50 Mbit/s downlink _____ Intellian
- 2.1 Gbit/s
- Electric propulsion
- Ku band
- H = 1200 km
- Despite the bankruptcy process in the end of May 2020, OneWeb filed an application to FCC for increasing the number of satellites to 48000.

OneWeb

- OneWeb was acquired by UK Government, Bharti Group, Eutelsat (24%), Hanwha (8%, S-Korea) and additional investment from SoftBank and Hughes Network Group, a technology partner.
- In December 2020 the launches started again with 26 satellites
- Arianespace will provide 16 more launches, each placing another 34 to 36 satellites into OneWeb's constellation.
- Full constellation planned to be completed by 2022 while commercial service to start il 2021.
- In August 2020, the FCC granted OneWeb market access to expand its constellation to 2,000 satellites with a V-band payload in addition to its Ku- and Ka-band constellation. OneWeb petitioned to add a V-band payload to the 720 satellite Ku- and Ka-band constellation approved by the FCC in 2017, proposing 1,280 additional V-band satellites operating at a nominal altitude of 8,500 km. According to the FCC order, OneWeb must launch and operate 50% of the maximum number of proposed space stations, or 1,000 satellites, by Aug. 26, 2026. The remaining satellites must be launched and operated by Aug. 26, 2029. On 14th September 2021 10th launch (tot 322).



OneWeb & Hughes

- OneWeb has selected Hughes to develop and manufacture the ground system technology for its Low-Earth Orbit (LEO) constellation, restarting a prior agreement between the companies. Under the \$250 million three-year contract announced Wednesday, Hughes has agreed to produce the gateway electronics for the OneWeb system and the core module that will be used in every user terminal.
- Hughes said Wednesday that its gateway is capable of 10,000 hand-offs per second, and facilitate handover and tracking of "hundreds of gigabits of data across hundreds of beams and millions of users."
- In terms of the module for the user terminal, Hughes said the module is adaptable across fixed and aeronautical and maritime mobility terminals, for either electronically or mechanically steered antennas.
- OneWeb had a ground system partnership with Hughes since 2015 in its prior iteration before the company filed for bankruptcy in March. OneWeb has since emerged from Chapter 11 bankruptcy under ownership of a consortium led by the U.K. government and Bharti Enterprises, in which Hughes has agreed to invest \$50 million.
- This deal resumes that prior ground network work. Hughes said Wednesday that under the prior agreement, seven gateways had been installed with several others were in various stages of production. Hughes has now ramped up production on the gateway equipment and resumed testing on the installed systems.
- In a July conversation with Via Satellite shortly after Hughes announced its investment in the OneWeb, Hughes President Pradman Kaul said work on the contract stopped when OneWeb went into Chapter 11.
- "The basic technology has essentially been developed. We've already deployed a certain number of these gateways. The challenge now is getting the rest of them built and installed, and then running the network through the satellites and doing the normal stuff you do when you test a new system to make sure that everything is functioning properly. But it is a global network, it's going to cover every piece of the world. There'll be challenges, but I don't think they're insurmountable," Kaul said at the time.
- This announcement comes days before OneWeb will launch its first satellites since before it filed for bankruptcy. Arianespace is set to launch 36 OneWeb satellites on a Soyuz rocket from the new Russian launch site in Vostochny on Dec. 18.



Starlink

- 12000 satellites
- 1325 already launched (1261 operational)
 - Last launch September 13th (51 units)
- 1440 to start service
- H = 550 km (updated at 580km)
- Ku band
- 50-150 Mbit/s
- User terminal 19-inch (48.26 cm) phased array antenna, easy installing
- Intersatellite link (part RF and part Optical)

- 499 \$ (418 €) installation kit
- 50 \$ (42 €) shipping;
- 48,73 \$ (41 €) taxes;
- 99 \$ (83 €) monthly fee.

Viasat has taken issue with **SpaceX**'s request to lower the orbital altitude of its Starlink satellite constellation, and requested the **FCC** to prepare an environmental impact statement on Starlink. In an FCC filing on Dec. 22, Viasat outlined its environmental concerns with Starlink and with SpaceX's request to relocate the satellites to lower orbital altitudes, specifically arguing that the modification would accelerate the time period in which the satellites reenter the atmosphere; it would likely increase light pollution; and would likely increase space debris.



Telesat Lightspeed

- 300 satellites (current plan)
- 1600 satellites (future plan)
- H =
- Ka band
- Polar and inclined orbits
- Gbit/s per user, Terabit/s total capacity
- Intersatellite link
- On board processing



Kuiper (Amazon)

- 3236 satellites
- 578 satellites to launch service
- H = 590 km (10 km over Starlink, attention for interference)



List of Operators

Operator	Country	2001 Revenue	Sats	Sats On
		(\$million)		Order
1. Intelsat	U.S.	1100	22	4
2. <u>PanAmSat</u>	U.S.	870.1	21	5
3. <u>SES Astra</u> (SES Global)	Luxembourg	655.5	13	1
4. <u>Eutelsat</u>	France	593.5	18	6
5. <u>SES-Americom</u> (GE	U.S.	506.7	16	6
Americom)				
6. <u>Loral Skynet</u>	U.S.	388.9	7	3
7. <u>JSAT</u>	Japan	298.2	8	1
8. New Skies Satellites	Netherlands	209	6	2
9. Telesat Canada	Canada	201.6	5	2
10. Space Communications Corp.	Japan	170.8	4	1
11. <u>Arabsat</u>	Saudi	155	3	0
	Arabia			
12. <u>Star One</u>	Brazil	130.5	5	1
13. <u>Satmex</u>	Mexico	128	2	1
14. <u>AsiaSat</u>	Hong Kong	124.3	3	1
15. <u>Telenor</u>	Norway	121.6	3	0
16. Shin Satellite	Thailand	116.8	3	1
17. <u>Hispasat</u>	Spain	94.9	3	2
18. SingTel/Optus	Australia	85.9	5	1
19. Korea Telecom	South Korea	76.3	3	1
20. Russian Satellite	Russia	61	11	5
Communications				
21. Europestar	France	-	2	
22. Hellasat	Greece	-	1	