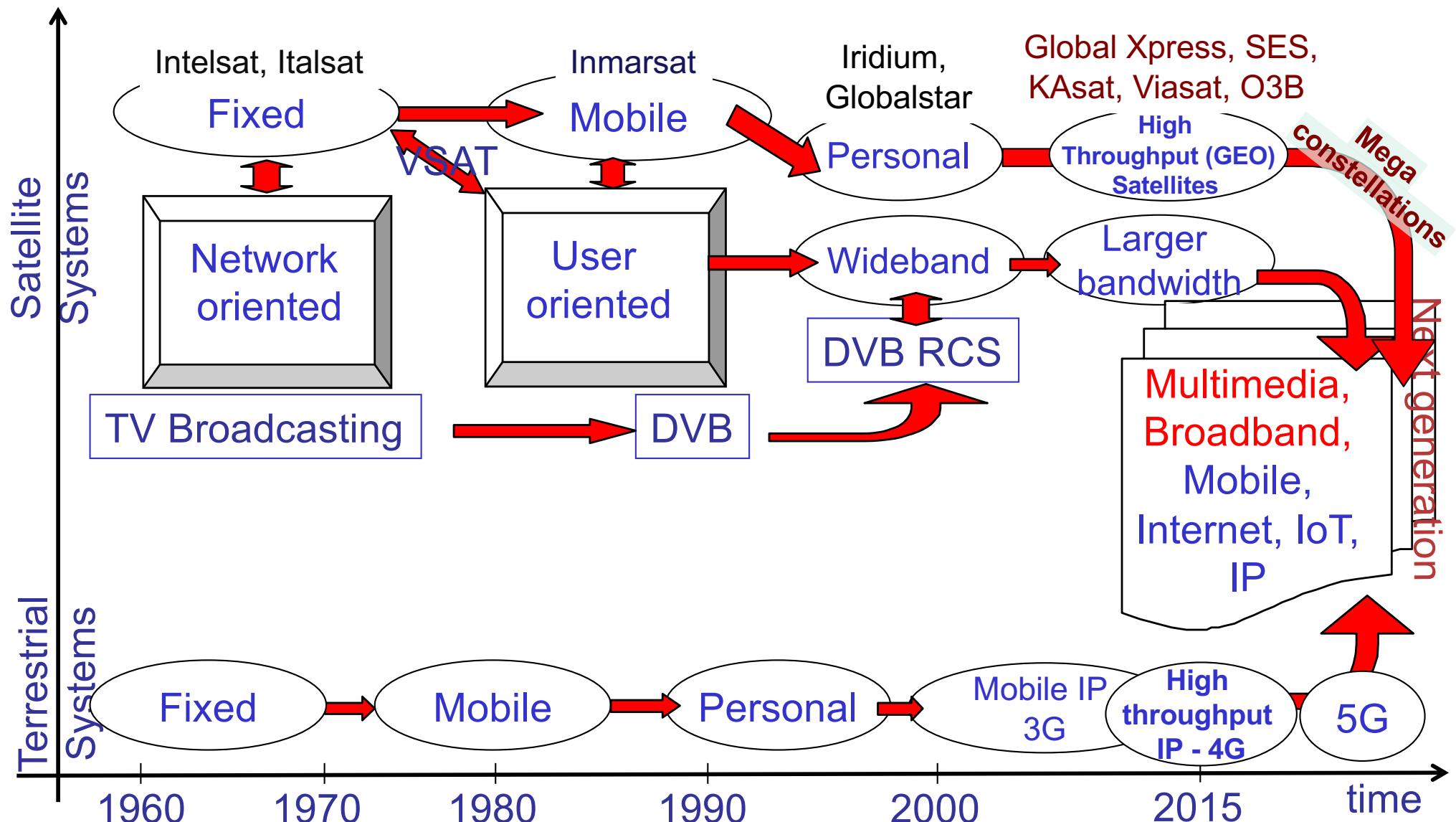




SET UP A SATELLITE COMMUNICATION SERVICE

Commercial systems and services



Survey of satellite systems

Service	Low data rate	High data rate Multimedia
Orbit		
LEO	OrbComm Globalstar Iridium	<i>Megaconstellations</i>
MEO		O3B
GEO	Inmarsat Thuraya	Intelsat, SES-Global, Eutelsat, Hispasat, Hellasat, Spaceway, Avanti, Inmarsat, Telenor, Viasat

Systems for low data rate services

- System and service: 1·2·1 relationship
- Only two freedom degrees
 - the operator
 - fare plan

Orbcomm

- Company: Orbcomm International
- Market: global (M2M)
- Implementation: operational
- Constellation: 31 satellites in 7 orbits
- Altitude: 825 km
- Antenna: linear (whip), single beam
- Communications: VHF/UHF bands

Uplink frequency: 148-150 MHz

Downlink frequency: 137-138 MHz and 400 MHz

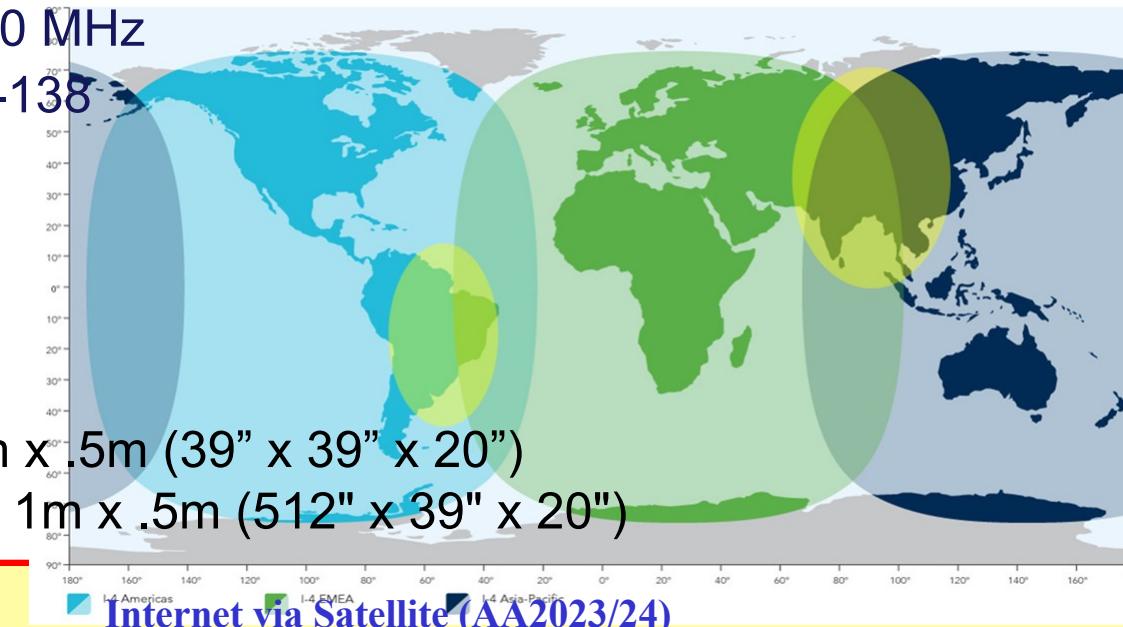
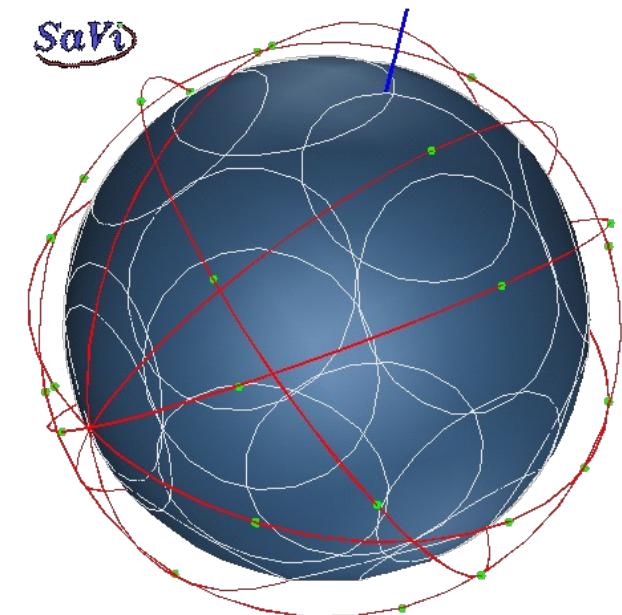
Satellite Specifications

Mass: 172 kg (380 lb)

Power: 400 Watts

Stowed Volume: 1m x 1m x .5m (39" x 39" x 20")

Deployed Volume: 13m x 1m x .5m (512" x 39" x 20")



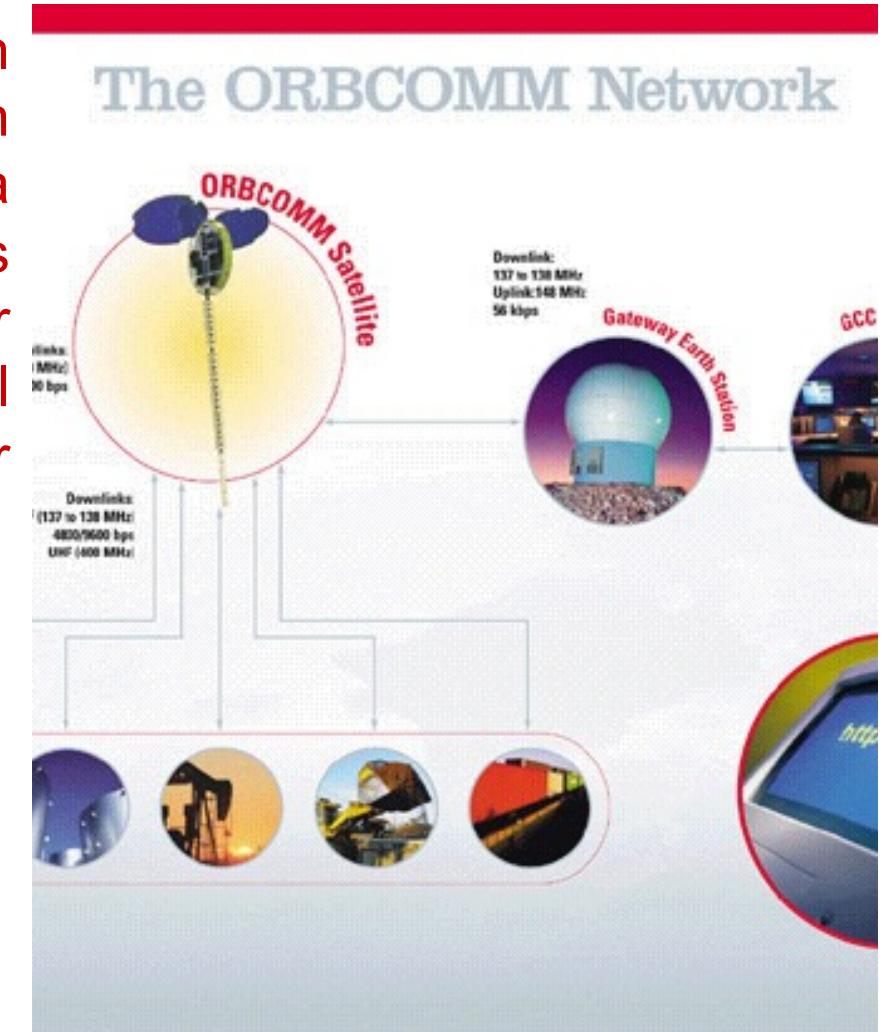
Mission and features

- ORBCOMM is a global satellite data communications company focused on Machine-to-Machine (M2M) communications. The company's satellite constellation includes spacecraft carrying Automatic Identification System (AIS) receivers, making ORBCOMM the first commercial provider of globally collected AIS data from space.
- By means of a global network of low-earth orbit (LEO) satellites and accompanying ground infrastructure, ORBCOMM's low-cost and reliable data communications products and services track, monitor and control mobile and fixed assets.
- ORBCOMM's core business is Machine-to-Machine (or M2M) two way satellite data communications for over 600,000 subscribers on its M2M network. They leverage existing global satellite network infrastructure (along with 16 ground earth stations around the world, including one in Italy) that allows to deliver fast and low cost AIS data.
- ORBCOMM is headquartered in Fort Lee, New Jersey and has a network control center in Dulles, Virginia.
- Now the second generation **OG2** is operational.

System architecture

The satellite relays messages to an ORBCOMM Gateway Earth Station (GES). The message is sent through a Gateway Control Center (GCC) to its destination, through the Internet or other terrestrial networks, to a personal computer, to a subscriber communicator or pager.

The ORBCOMM system enables businesses to track remote and mobile assets such as trailers, railcars, locomotives and heavy equipment; monitor remote utility meters and oil and gas storage tanks, wells and pipelines.



Ground Segment

Gateway Earth Station Locations

- Argentina
- Arizona (U.S.)
- Australia
- Brazil
- Curaçao
- Georgia (U.S.)
- Italy
- Japan
- Kazakhstan
- Korea
- Malaysia
- Morocco
- New York (U.S.)
- Norway
- South Africa
- Washington (U.S.)

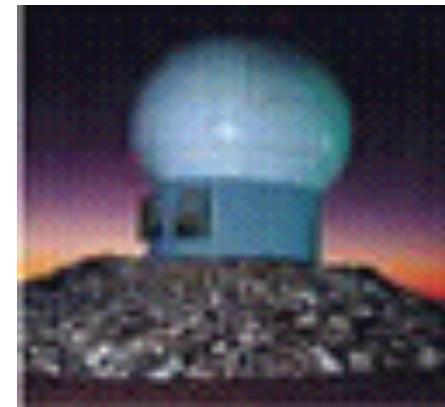
Gateway Control Center Locations

- Brazil
- Italy
- Japan
- Korea
- Malaysia
- United States

Terminals



MagellanOEM200



MagellanGSC100



Quacke



Stellar2500



asonic 7100



Stellar2000

Echo Flight

Echo Flight began in 1994 developing and licensing products in the General Aviation industry.

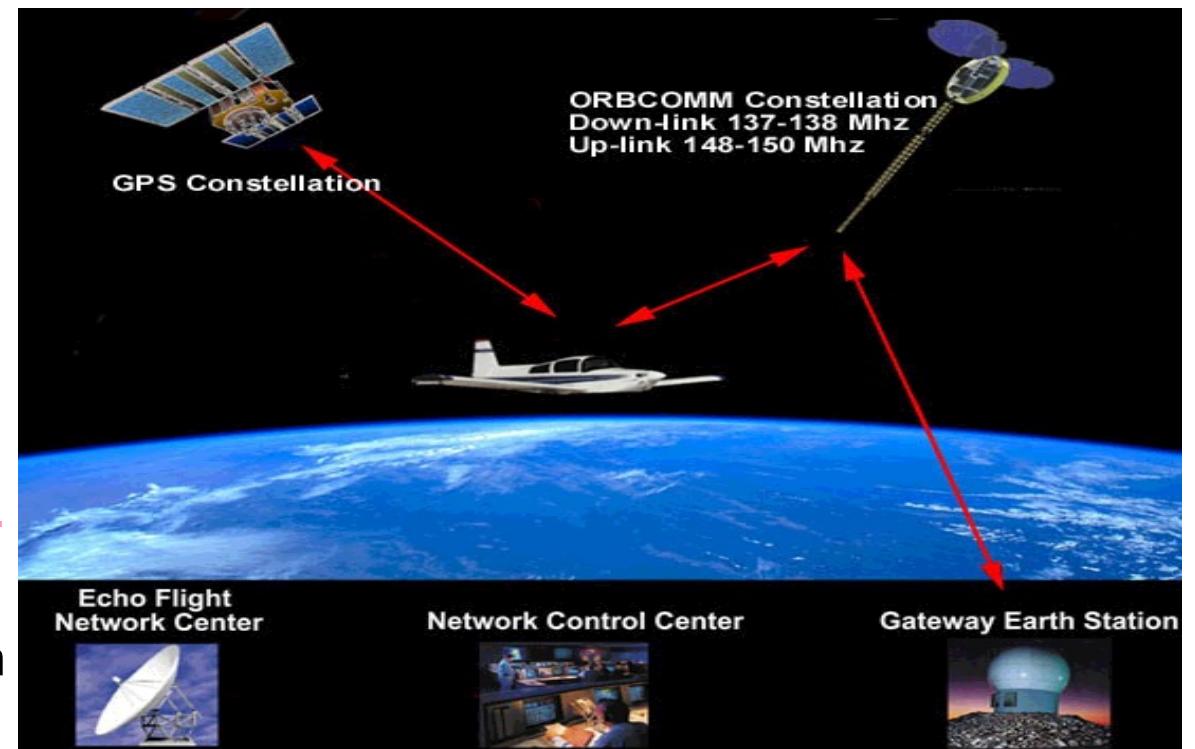
Echo Flight is the only company to incorporate ORBCOMM's satellite data-link capabilities into a data and messaging product for the aviation industry.

The three main components:

The Space Segment the constellation of ORBCOMM satellites.

Ground Segment network gateways located around the world.

Aircraft System the on-aircraft items required to communicate with the ORBCOMM system.



Aircraft System

The Subscriber Communicator (SC) is a two-way transceiver that provides in-flight access to weather, messaging and position reporting. The SC also receives GPS positions with its eight-channel GPS receiver.

The Subscriber Communicator uses two antennas, a portable GPS antenna, which can be placed upon the glareshield of the aircraft, and a VHF antenna mounted on the top of the fuselage for two-way communications with the ORBCOMM satellites.

StratoCHEETAH Flight Manager III

The **StratoCHEETAH Flight Manager III** combines GPS navigation and satellite-based data link weather.

Specifications:

- Power: 18~36 VDC (10~15 volt adapter available)
- Size: 7.75" x 5.5" x 2.13"
- Processor: Pentium® 233MHz MMX
- Memory: 64 Mbytes
- Operating System: Windows 95® or NT
- Class B emissions

Display

- Resolution: 640 x 480
- Size: 5.1"x 3.8" (6.4" diagonal)
- Brightness: maximum 650 nits

Integrated peripherals

- Hard drive: 6.0Gb
- CD-ROM: 32x or 48x speed,
- Ports: 2 RS-232 serial, 2 power.
- External 56 K Modem



Flight Cheetah FL180

The Flight Cheetah FL180 is the World's first flight computer to combine GPS navigation and satellite-based data link weather hand.

Specifications

- Housing: Solid aircraft-grade aluminium alloy.
- Power: 18~36 VDC (10~15 volt adapter available)
- Size: 7.85" x 3.4" x 1.5"
- Processor: Pentium® 233Mhz MMX
- Memory: 64 Mb
- Operating System: Windows NT®

Display

- Resolution: 320 x 240
- Size: 2.1" x 3.1" (3.8" diagonal)
- Brightness: maximum 650 nits

Integrated peripherals

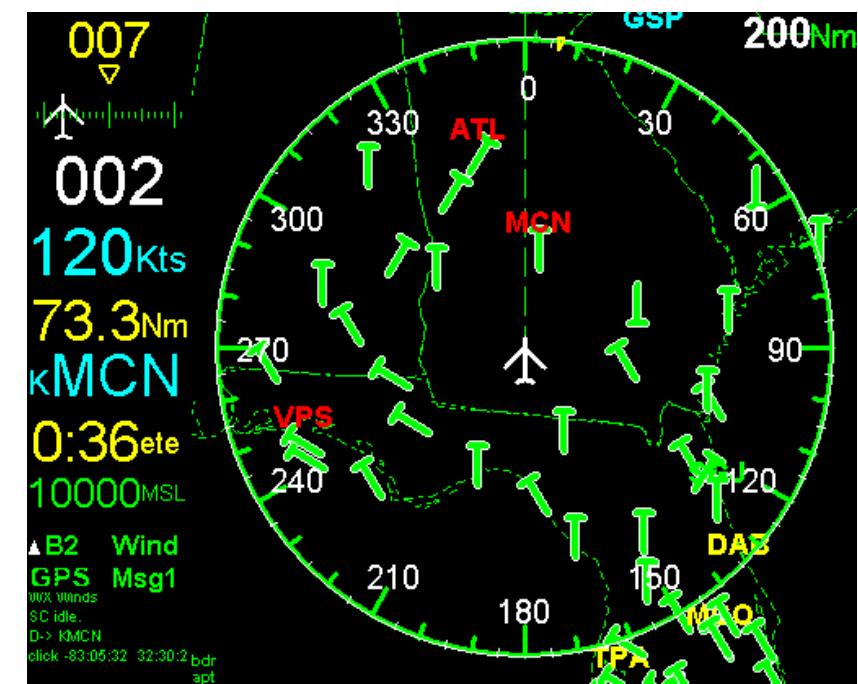
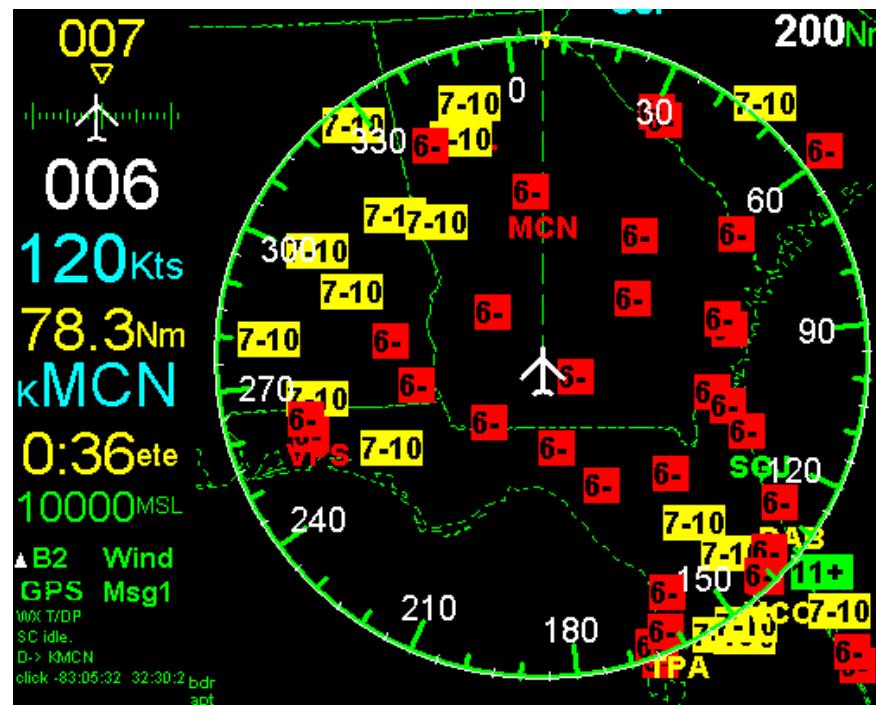
- Hard drive: 1.0Gb
- Ports: 1 proprietary plug supplies power and serial port.



Special services

There are two special services for both terminals:

- Temperature
 - Wind speed and direction



Satellite Comunicator

The Satellite Communicator or "SC" simultaneously links with two independent satellite constellations, one navigational and one for two-way messaging. For navigation, the unit incorporates an 8 channel parallel GPS engine receiver. SC is used for air telephone.

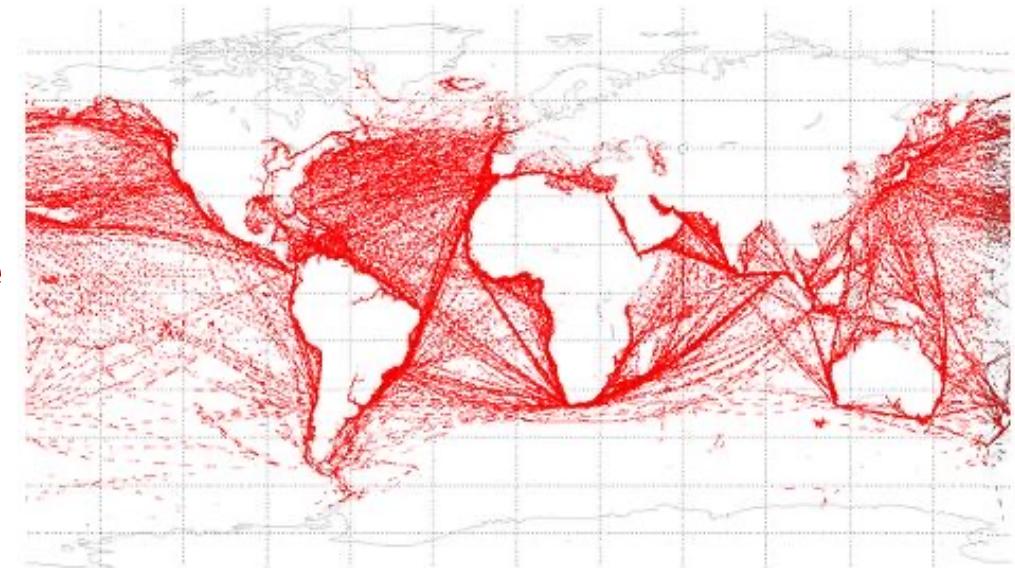


DataTrac System

- **DataTrac Systems** has developed an automatic remote tracking, 2-way messaging and data transfer system specifically for fixed and rotary winged aircraft. Including the Global Positioning System (GPS) location of the aircraft, via ORBCOMM Low Earth Orbiting (LEO) satellites to ORBCOMM'S Network Control Center (NCC) and then relays it anywhere in the world, via an Internet connection.
- SkyTrac hardware is a small transceiver (OSAT-100) that is mounted into the aircraft.
 - The OSAT-100 is an airborne data communications system that uses a VHF-FM satellite link to provide 2-way airborne information transfer. It also contains an integral GPS receiver that provides a source of continuously updated position data for "flight following" applications, and its own battery back up power to allow communication after airframe shut down.
 - RF Bands Used: Uplink: 148-150 MHz, Downlink: 137-138 MHz
 - GPS: 1575.42 MHz, 8 Channel parallel.
 - -130dBm sensitivity with 5m/16ft antenna cable.
 - 2 minute acquisition with current almanac data.

ORBCOMM AIS

- Automatic Identification System (AIS) is a shipboard broadcast system that transmits a vessel's identification, position and other critical data that can be used to assist in navigation and improve maritime safety.
- Most current terrestrial-based AIS systems provide only limited coverage nearby shorelines and are not able to provide global open ocean coverage.
- ORBCOMM overcomes many of these issues thanks to a fully satellite-based AIS data service, which is able to monitor maritime vessels well beyond coastal regions in a cost-effective and timely fashion.



AIS Constellation and services

- One equatorial satellite and one polar orbiting satellite by 2011
- ORBCOMM operates the largest space-based AIS network, with 18 total AIS-enabled satellites.
 - These satellites are for M2M satellite constellation replenishment, but will also have AIS receiver payloads on board
- With 16 ground earth stations around the world, average AIS data latency as short as one minute, which enables near real-time monitoring of vessels and increased analytics capabilities.
- Subscribers: 50 government and commercial organizations
- It brings the data down without post-processing, available in the same NMEA 0183 format of a standard AIS receiver.
- It works with terrestrial network operators such as IHS Fairplay, Lloyd's List Intelligence, and Portvision to provide bundled terrestrial and satellite AIS data, along with user applications, to customers. It just collects the data and delivering it to partners and customers.

Uses of Satellite AIS Data

- Maritime domain awareness
 - Provides details of vessel locations within an area or region for full operational picture
- Surveillance and security
- Correlation with other sensors
- Search and rescue
- Logistical tracking and reporting
- Energy and commodity management solutions
- Incident investigations
- Environmental monitoring
- Area of operation compliance
 - Governments –regulatory compliance
 - Fishing vessel, certain types of cargo vessels, etc.
 - 96 hour Notice of Arrival
 - Insurance companies –may have restrictions in policy
 - Environmental restrictions

Correlation to Other Sensors

ORBCOMM AIS

- AIS data (name, call sign, MMSI#, destination, etc) available in locations not supported by systems with which can provide specific vessel data and ship and voyage information

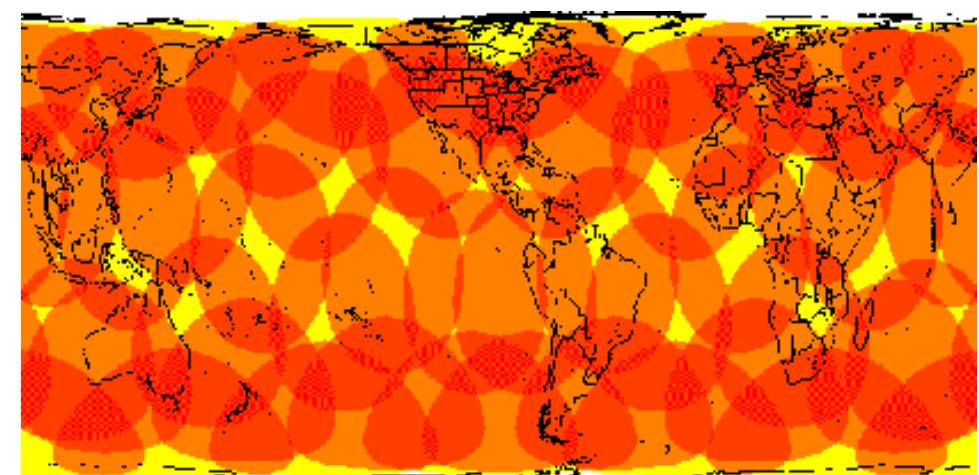
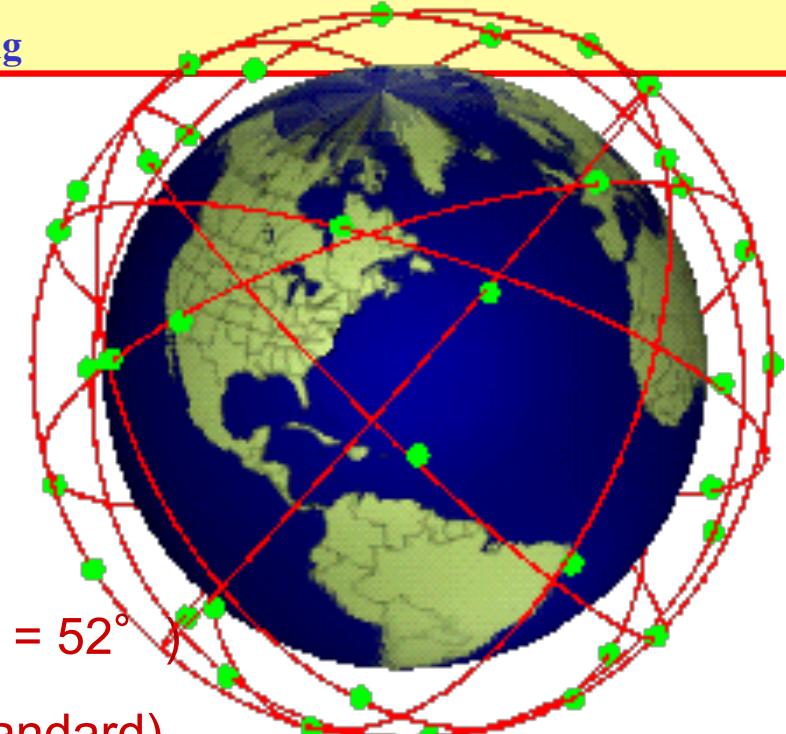
Spaceborne SAR Sensors

- RADARSAT-1 and RADARSAT-2 offer all weather, low illumination (day/night) imaging

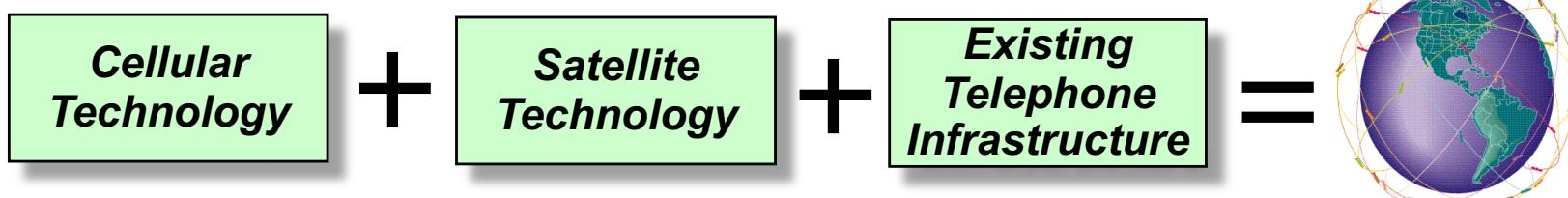
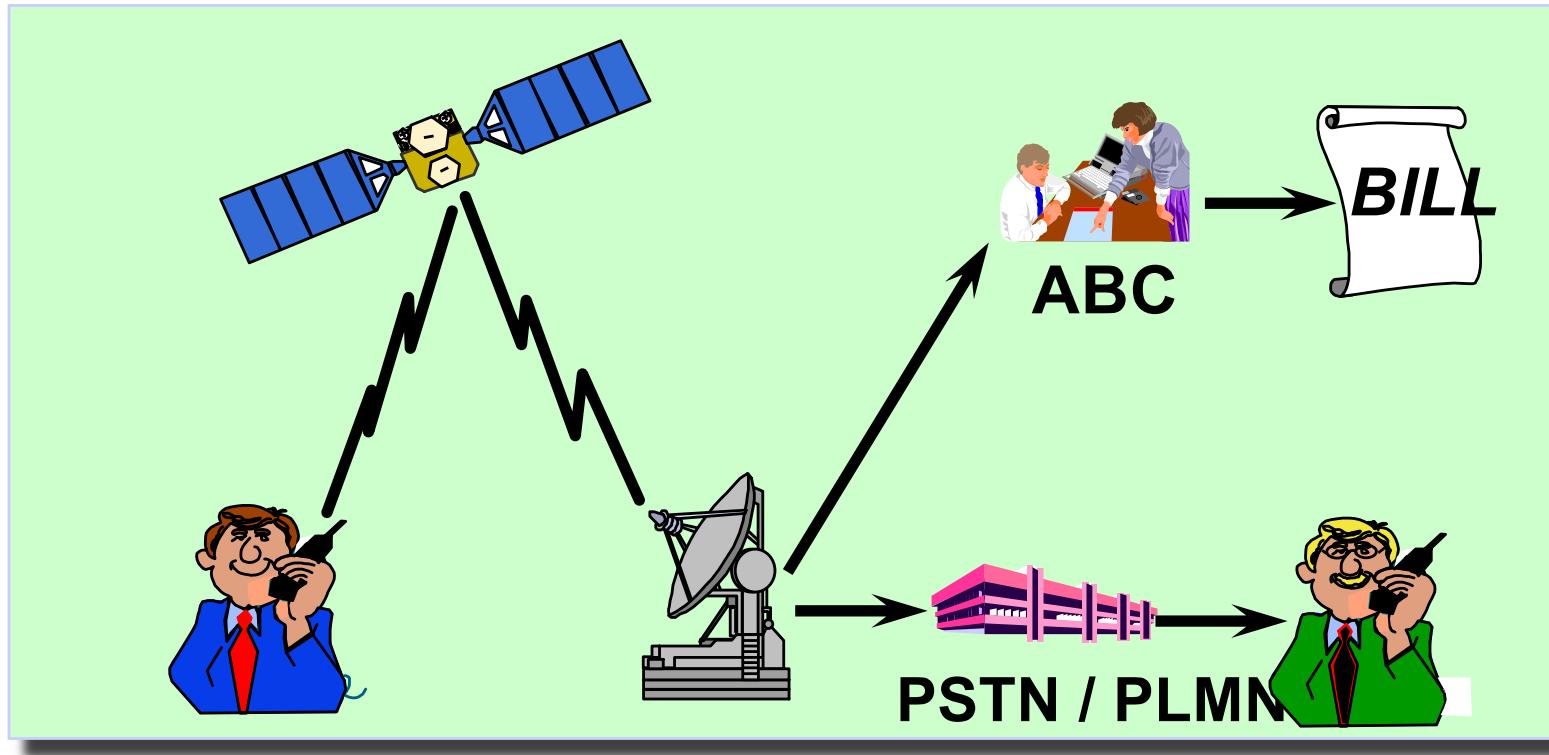
Combining SAR sensors with timely AIS data provided ability to reliably detect vessels which allowed for the rapid identification

Globalstar

- Company: Globalstar
- Market: global (voice)
- Implementation: operational
- Altitude: 1414 km
- Constellation: 48 satellites in 8 inclined orbits ($i = 52^\circ$)
- Communications: CDMA (based on the IS-95 standard)
- Antenna: 16 beams per satellite
- Frequency: L and S bands
- Other features: satellite diversity
- Services: fixed and cellular telephony, SMS, data.



System Architecture: satellite constellation, gateway, user terminal



Globalstar System Characteristics

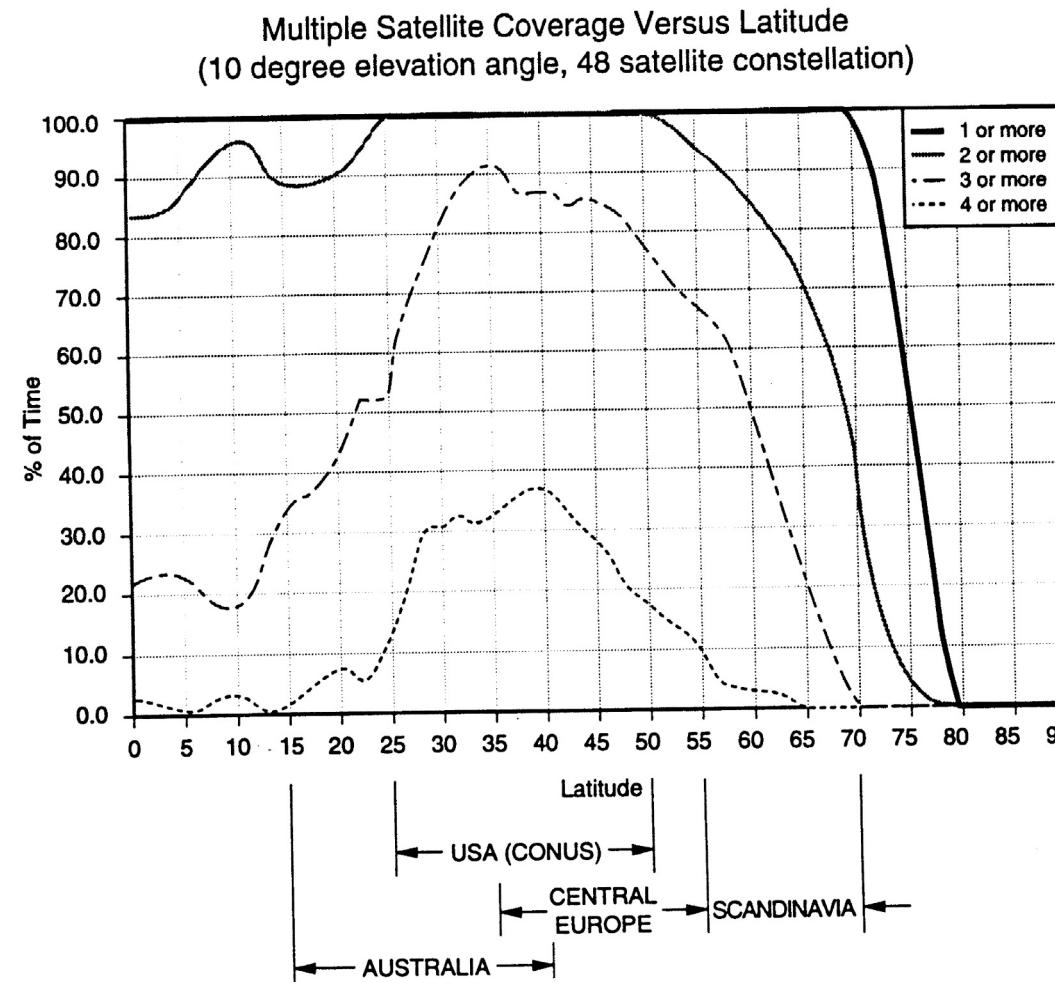


Services:

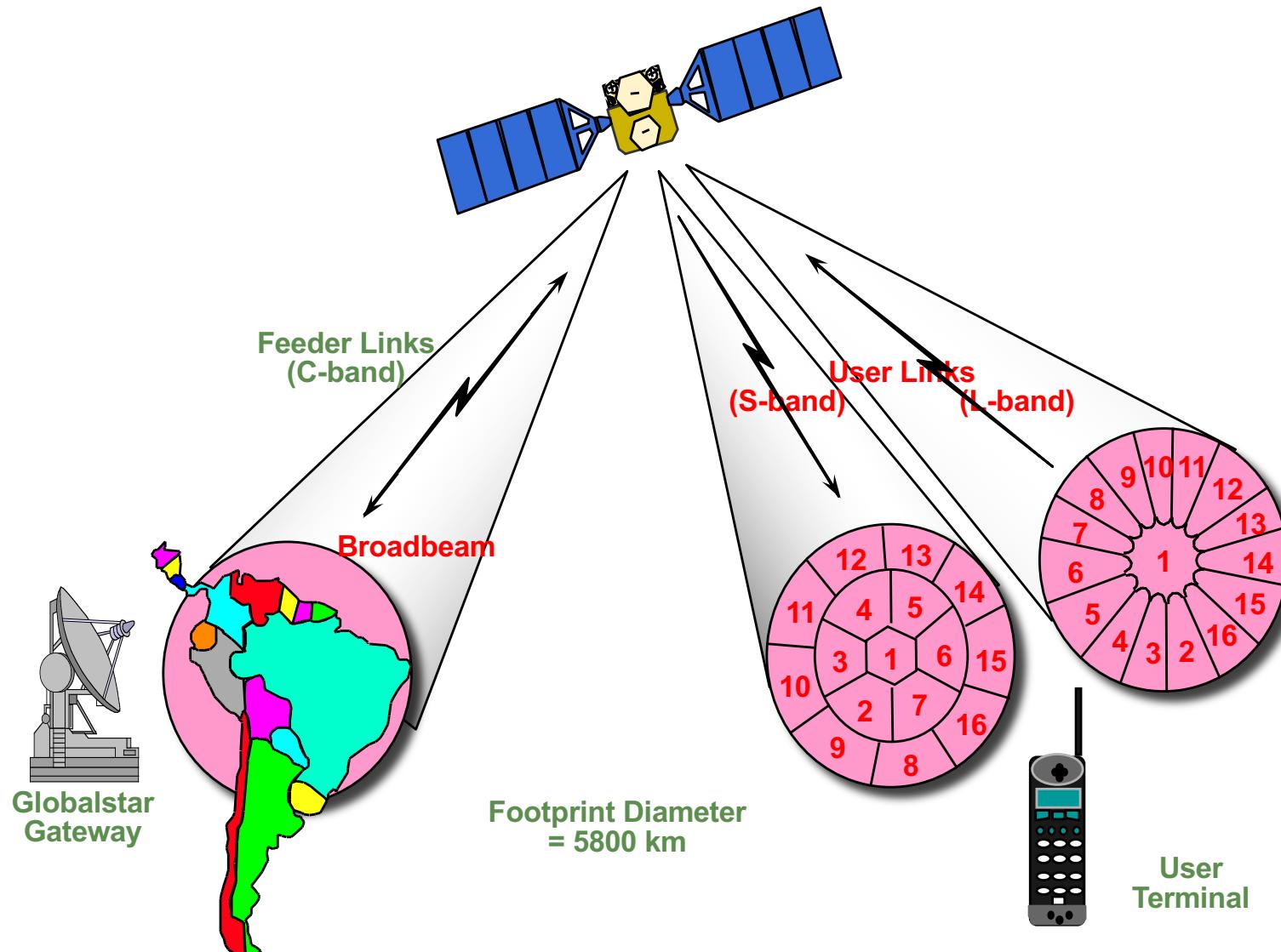
Digital voice up to 9600 bit/s
Data services up to 9600 bit/s
Localization

Messaging (SMS)
All services available on GSM network
Data

Enhanced coverage using diversity



Globalstar Footprint Patterns



Globalstar' s services

- One phone for both cellular and satellite call
- Voice calling
- Short messages service (SMS)
- Global roaming
- Data transmission

Gateway

Gateways are an integral part of the Globalstar ground segment, which also includes :

- Ground Operations Control Center (GOCC):

responsible for planning and controlling the use of satellite by gateway terminals and coordinating with the Satellite Operations Control Center (**SOCC**) the communications schedules for the gateway.

- Satellite Operations Control Center (SOCC) :

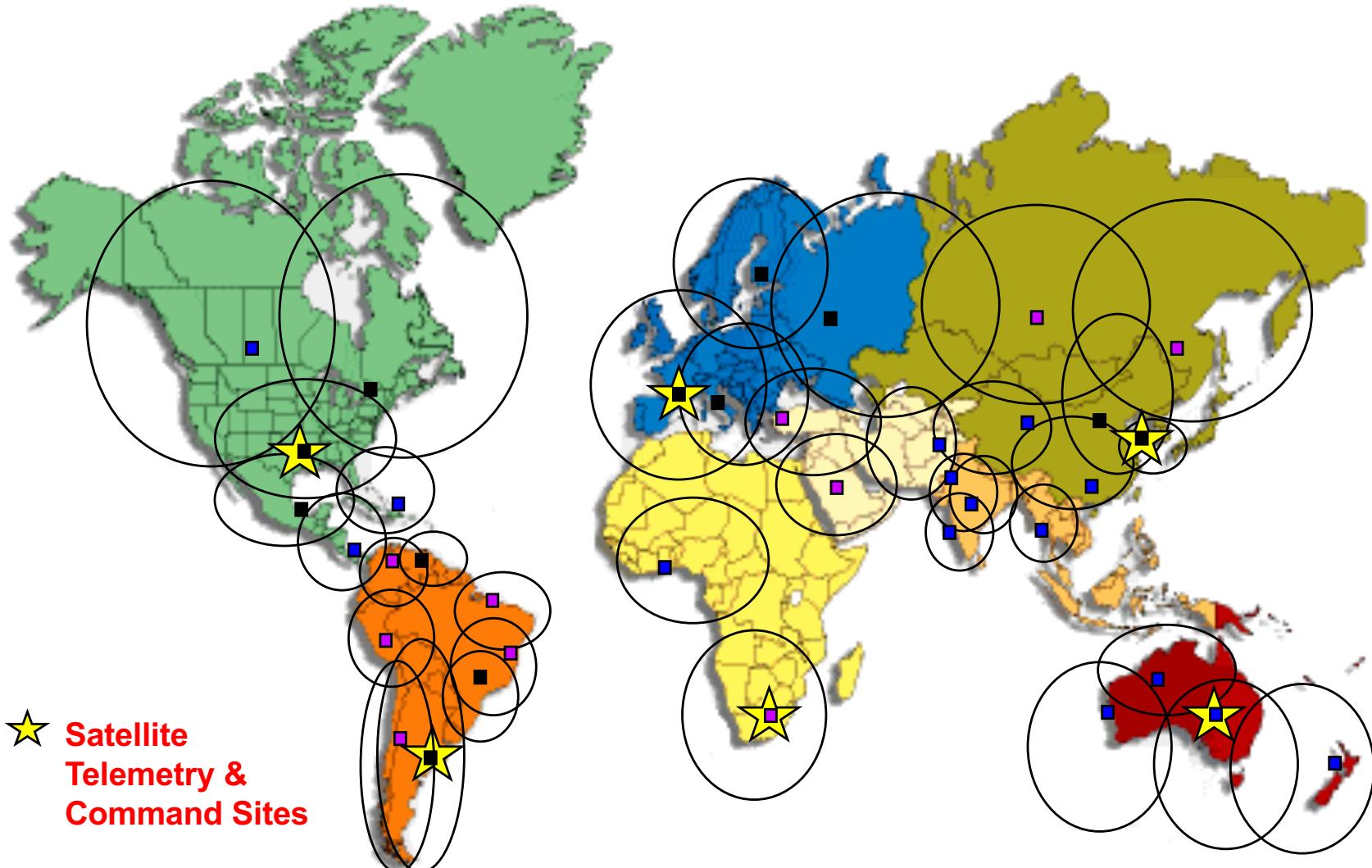
manages the Globalstar satellite constellation: The SOCC tracks satellites; control their orbit; and provides telemetry and command services for the constellation.

Globalstar data network (GND) is the connective network which provides wide-area intercommunications facilities for the gateways, the GOCC, and the SOCC.

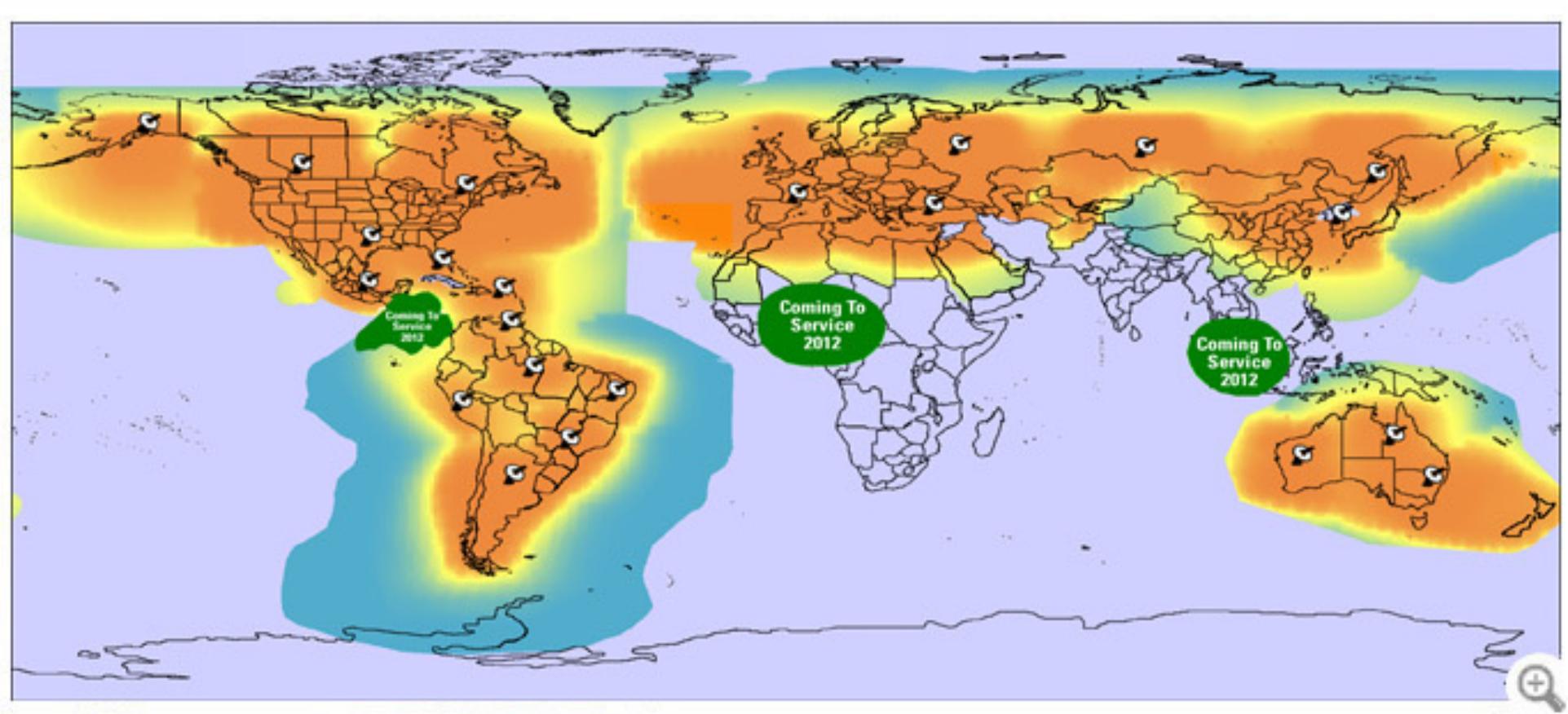
Globalstar Gateway



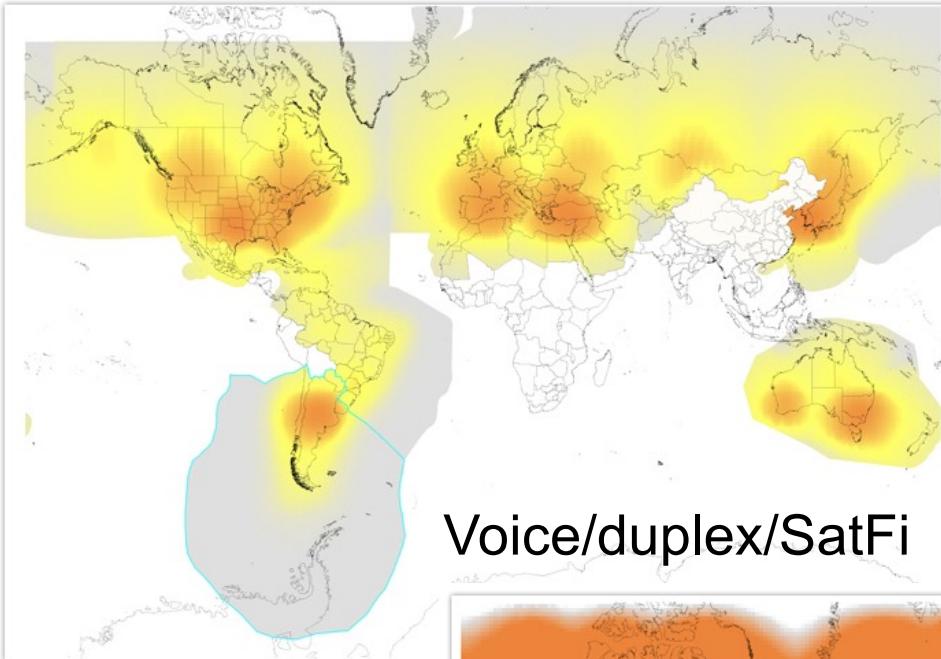
Globalstar Gateways



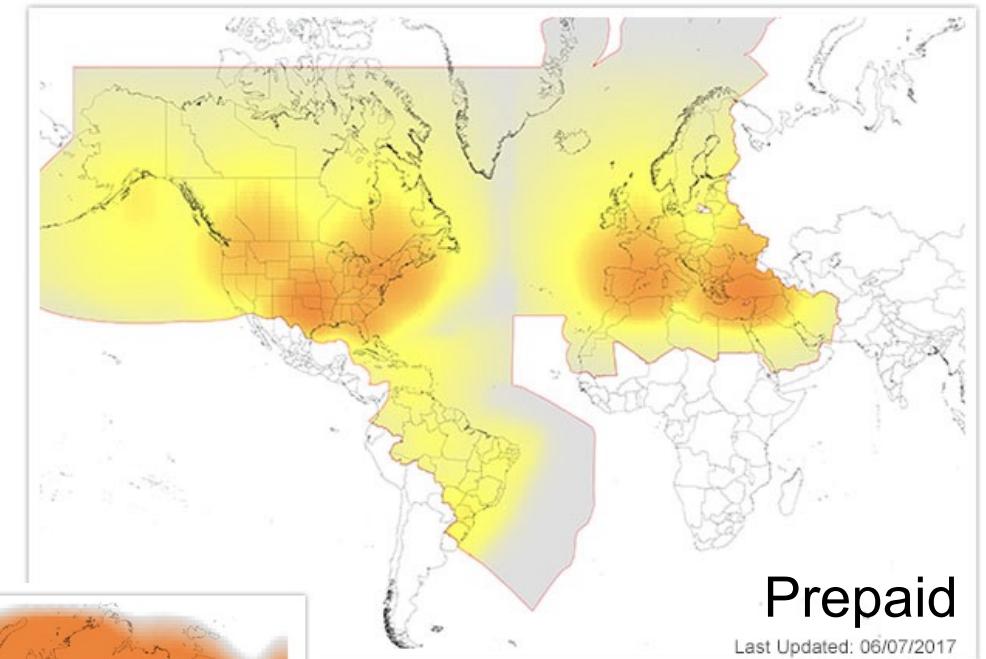
Real coverage



Coverage per service

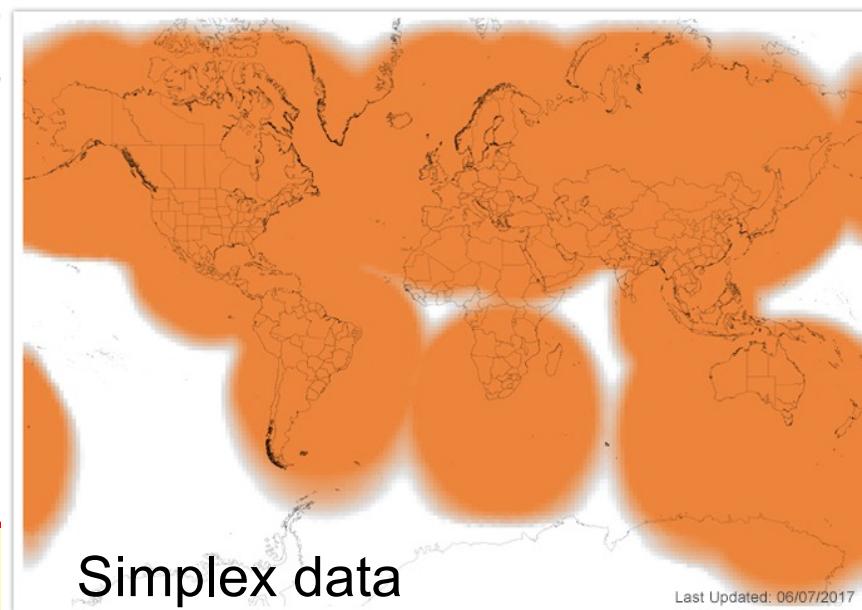


Voice/duplex/SatFi



Prepaid

Last Updated: 06/07/2017



Simplex data

Last Updated: 06/07/2017

Qualcomm GSP 1600 Tri-mode

Specifications:

- Dimensions: 224 x 65.5 x 50 mm
- Weight: 370 g
- Globalstar battery time: 3.5 / 9 hours

Phone Features:

- High contrast illuminated LCD
- Compatibility with existing AMPS and CDMA 800 MHz networks
- Built in modem for FAX and data transmission up to 9600 bit/s
- Short message service SMS



Telit SAT 950 Dual-Mode

Specifications:

- Dimensions: 224 x 65.5 x 50 mm
- Weight: 425 g
- Globalstar battery time: 2 / 10 hours

Phone Features:

- Dual mode GSM 900 Globalstar
- Voicemail message
- Built in modem for FAX and data transmission up to 9600 bit/s
- Short message service SMS



old

Ericsson R290 Dual- Mode



old

Specifications:

- Dimensions: 162 x 62 x 39 mm
- Weight: 350 g
- Globalstar battery time: 3.2 hours

Phone Features:

- Dual mode GSM 900 Globalstar
- Voicemail message
- Built in modem for FAX and data transmission up to 9600 bit/s
- Short message service SMS

Telit SAT 600

- Dimensions (HxLxD) 160x55x35 mm
- Weight (including battery) 340 grams
- Standard Battery Lithium Ions
- Autonomy - GSM mode
 - Standby: up to 95 hours
 - Conversation: up to 16.5 hours
- Autonomy - Satellite mode
 - Standby: up to 10 hours
 - Conversation: up to 3.5 hours
- Antenna Retractable
- Sim Card Plug-in
- Data Transmission (Asynchronous)



old

9600 bit/s (with data adapter DT 600)

P18/32

Fixed Satellite Phone

Globalstar fixed phones offer an innovative solution for quick, easy installation of communications in remote locations, and areas where traditional services are not economically feasible:

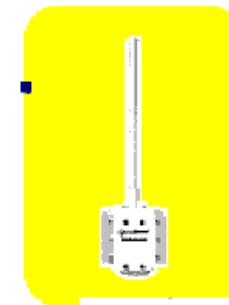
- Globalstar Payphone by Schulumberger

Globalstar Payphone GSP 2900

old

Specifications:

- Dimensions: 510 x 80 x 210 mm
- Weight: 3.3 kg
- Connections of 200 meters possible between AFU and telephone equipment.



Qualcom GSP 1700

- **Temperature range (Phone):**
 - Operational: -20 to +55°C (-4 to +131°F)
 - Non operational: -30 to +60°C (-22 to +140°F)
- **Vocoder: 8k variable rate vocoder for Globalstar mode**
- **Frequency Range:**
 - Globalstar Transmit: 1610.73 to 1620.57 MHz
 - Globalstar Receive: 2484.39 to 2499.15 MHz
- **Technology: Globalstar Satellite Mode (CDMA)**
- **Talk Time/Standby Time:**
 - Normal operation for four (4) hours of talk time (+26 dBm) Ten (10) hours of standby time (no slotted paging)
 - Thirty-six (36) hours of standby time (slotted paging) when not in ring while stow mode

\$399.00



ORBIT 150	ORBIT 200	ORBIT UNLIMITED
MONTHLY SERVICE PLAN \$79.99/mo.	MONTHLY SERVICE PLAN \$99.99/mo.	MONTHLY SERVICE PLAN \$199.99/mo.
12 month term applies	12 month term applies	12 month term applies
150 Minutes	200 Minutes	UNLIMITED
99¢ per Additional Voice Minute	99¢ per Additional Voice Minute	N/A
Free Voicemail	Free Voicemail	Free Voicemail
GALAXY 1800	GALAXY 2400	GALAXY UNLIMITED
ANNUAL SERVICE PLAN \$960/yr.	ANNUAL SERVICE PLAN \$1,200/yr.	ANNUAL SERVICE PLAN \$2,400/yr.
12 month term applies	12 month term applies	12 month term applies
1800 Minutes	2400 Minutes	UNLIMITED
99¢ per Additional Voice Minute	99¢ per Additional Voice Minute	N/A
Free Voicemail	Free Voicemail	Free Voicemail

Globalstar 9600

Globalstar 9600 and a Globalstar satellite phone, allow customers to use their existing Wi-Fi enabled devices to send and receive email over the newest, most modern satellite network.



Sat-Fi

- Up to 8 smartphones or any WiFi enabled devices can utilize typical services



\$1,799.00



\$499.00

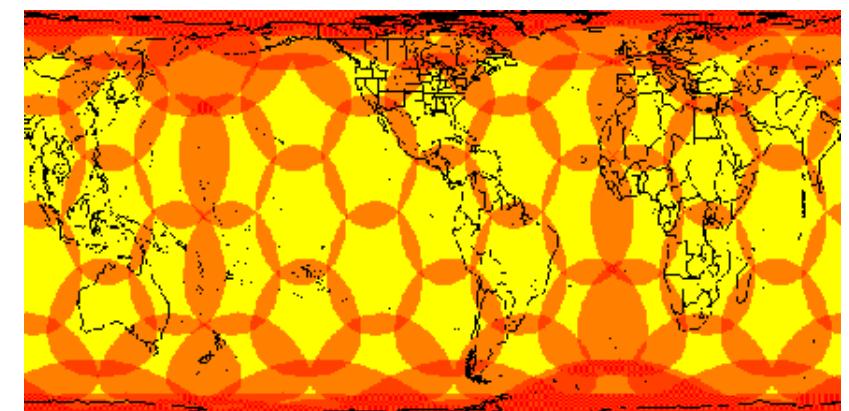
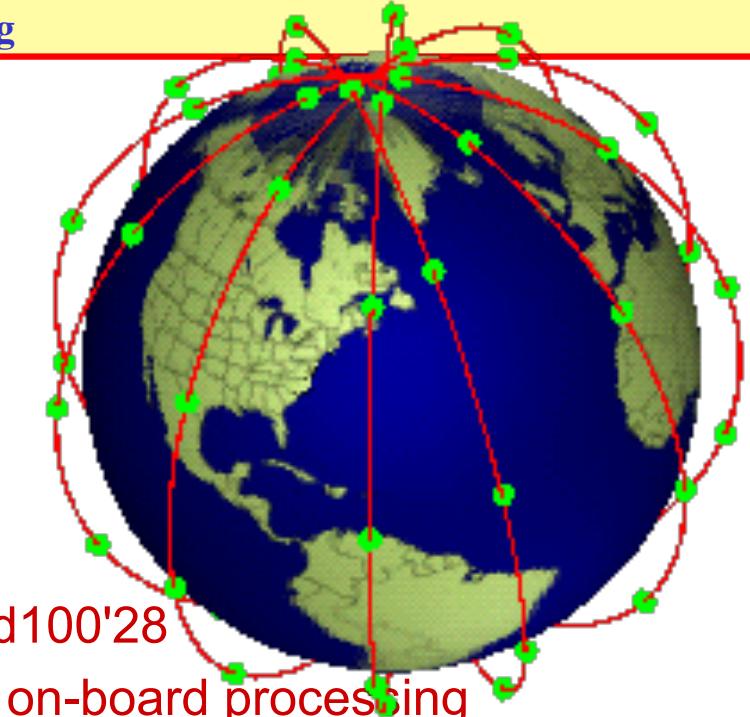
Internet

ADVANTAGE 40	ADVANTAGE 100	ADVANTAGE 250	ADVANTAGE 500
MONTHLY SERVICE PLAN \$39.99/mo. 12 month term applies	MONTHLY SERVICE PLANS \$64.99/mo. 12 month term applies	MONTHLY SERVICE PLAN \$99.99/mo. 12 month term applies	MONTHLY SERVICE PLANS \$199.99/mo. 12 month term applies
40 Minutes	100 Minutes	250 Minutes	500 Minutes
99¢ per Additional Voice Minute	99¢ per Additional Voice Minute	99¢ per Additional Voice Minute	99¢ per Additional Voice Minute
5 MB Data Included	15 MB Data Included	30 MB Data Included	75 MB Data Included
\$5 per Additional MB	\$4 per Additional MB	\$3.50 per Additional MB	\$3 per Additional MB
25 SMS Messages	75 SMS Messages	200 SMS Messages	500 SMS Messages
50¢ per Additional SMS	50¢ per Additional SMS	25¢ per Additional SMS	25¢ per Additional SMS
\$3.95 Voicemail	Included Voicemail	Included Voicemail	Included Voicemail
S.O.S.	S.O.S.	S.O.S.	S.O.S.
\$1.99 GEOS Search and Rescue	\$1.99 GEOS Search and Rescue	\$1.99 GEOS Search and Rescue	\$1.99 GEOS Search and Rescue

ENTERPRISE 480	ENTERPRISE 1200	ENTERPRISE 3000	ENTERPRISE 6000
ANNUAL SERVICE PLAN \$480/yr. 12 month term applies	ANNUAL SERVICE PLAN \$780/yr. 12 month term applies	ANNUAL SERVICE PLAN \$1200/yr. 12 month term applies	ANNUAL SERVICE PLAN \$2400/yr. 12 month term applies
480 Minutes	1200 Minutes	3000 Minutes	6000 Minutes
99¢ per Additional Voice Minute	99¢ per Additional Voice Minute	99¢ per Additional Voice Minute	99¢ per Additional Voice Minute
60 MB Data Included	180 MB Data Included	360 MB Data Included	900 MB Data Included
\$5 per Additional MB	\$4 per Additional MB	\$3.50 per Additional MB	\$3 per Additional MB
300 SMS Messages	900 SMS Messages	2400 SMS Messages	6000 SMS Messages
50¢ per Additional SMS	50¢ per Additional SMS	25¢ per Additional SMS	25¢ per Additional SMS
\$48 Voicemail	Included Voicemail	Included Voicemail	Included Voicemail
S.O.S.	S.O.S.	S.O.S.	S.O.S.
\$24 GEOS Search and Rescue	\$24 GEOS Search and Rescue	\$24 GEOS Search and Rescue	\$24 GEOS Search and Rescue

Iridium

- Company: Iridium
- Market: global (voice)
- Implementation: operational
- Altitude : 780 km
- Antenna: 48 beams per satellite
- Communications: TDMA-TDD, L band
- Constellation: 66 satellites in 11 polar orbits, period 100'28
- Other features: inter-satellite links (4 at 25 Mbit/s), on-board processing
- SATELLITE
 - SPOT BEAMS 3x16 per satellite for high signal quality and spectrum efficiency
 - STABILIZATION 3 axis
 - SATELLITE WEIGHT 689 kg.
 - LINK MARGIN 16 dB (average)
- First to be proposed and operational



Iridium space system

The IRIDIUM system is a **satellite-based, wireless personal communications network** designed to permit any type of telephone transmission - voice, paging, facsimile or data - to reach its destination anywhere on Earth.

Subscribers use hand-held IRIDIUM telephones transmitting through digital facilities to communicate with any other telephone in the world.

When an IRIDIUM telephone is activated, the nearest satellite - in conjunction with the IRIDIUM network - automatically determines account validity and the location of the user.

The call then is transferred from satellite to satellite through the network to its destination, either to another IRIDIUM telephone or to an IRIDIUM ground station.



Satellite constellation

The IRIDIUM system is based on a network of 66 satellites. The satellite constellation is distributed on 6 near polar planes and each plane carries 11 operational satellites, as well as one spare satellite.



Intersatellite and ground control links take place in the Ka-band frequencies. Telephone and messaging communications take place in the L-band frequencies.

Orbits specific:

Weigh: 689 kg

Altitude: 780 km

Time orbit: 100 min

Gateways

FREQUENCY BANDS

USER TERMINAL

Uplinks: 1616-1626.5 MHz, L-Band

Downlinks: 1616-1626.5 MHz, L-Band

INTERSATELLITE LINKS

23.18-23.38 GHz, Ka-Band

GATEWAY LINKS

Uplinks: 29.1-29.3 GHz, Ka-Band

Downlinks: 19.4-19.6 GHz, Ka-Band

CONNECTIVITY

CIRCUITS PER SAT. 3,840

**AVERAGE SATELLITE CONNECTION TIME 9
minutes**

MIN. ELEVATION ANGLE 8 degrees



The Fucino station (not operational)

The iridium telephone by MOTOROLA

Telephone Features

Lithium ion batteries 2 hours continuous talk time 24 hours standby time Fast charging time of 2.5 hours

- Weight: 453 g (16 oz.) with radio cassette
- Volume: 410cc (25 cu. in.)
- Power: 0.645 watts average

old



The iridium pager by MOTOROLA

Pager Features

Four line, 80 character alphanumeric display , International character sets

Electroluminescent backlight, Programmable prompts

Real-time clock, Dual time zone display

Message time/date

Message sequence numbering

Battery gauge Estimated 30 days



Iridium Extreme Satellite Phone



Iridium 9555 Satellite Phone



Iridium 9505A Satellite Phone



ASE ComCenter II Series



Iridium GO!® provides global voice calling and text messaging solutions for smartphone, as well as enhanced data capabilities offered through optimized apps.
No roaming charges. Just connected and in touch always and everywhere, with the smartphone.

Iridium services for Land Mobile

- **NARROWBAND 2.4 kbit/s**
 - Iridium Voice & Data
 - Voice Calls
 - Push-To-Talk (PTT)
 - Location-Based Services
 - SOS Emergency Response Coordination
 - Iridium-Optimized Email Access
 - Two-Way Messaging
- **MIDBAND 22 kbit/s**
 - Iridium Certus 20
 - High-Quality Voice Calls
 - Email Access
 - Weather Forecasts
 - Tracking
 - Optimized Messaging Apps
- **MIDBAND 88 kbit/s**
 - Iridium Certus 100
 - Enhanced Mobile App Connectivity
 - Text-Oriented Web Browsing
 - Standard Email with Attachments
 - Remote Diagnostics
 - Mobile Payment Transactions
 - VSAT Out-of-Band Management
- **BROADBAND 176 kbit/s**
 - Iridium Certus 200
 - Corporate Intranet Access
 - Mobile App Connectivity
 - Web Browsing & File Transfers
 - Public Safety Application Access
 - VSAT Backup & Failover
 - Environmental Monitoring
 - NGO Reporting & Compliance
 - Positive Train Control
 - Remote Monitoring, Sensing, and Surveillance
- **BROADBAND 352 kbit/s**
 - Iridium Certus 350
 - Media File Uploads
 - Military Situational Awareness
 - Workforce Management & Scheduling
 - Satellite Imagery Downloads
 - Video Conferencing
 - Job Progress Reporting
 - Medical Device Connectivity & Mobile Triage
 - Public Safety Incident Management
 - Location-Based Monitoring
- **BROADBAND 704 kbit/s**
 - Iridium Certus 700
 - Enhanced Web Browsing Experience
 - Accelerated File Downloading
 - View High Resolution Satellite Imagery Files
 - Monitor High Resolution Video Feeds

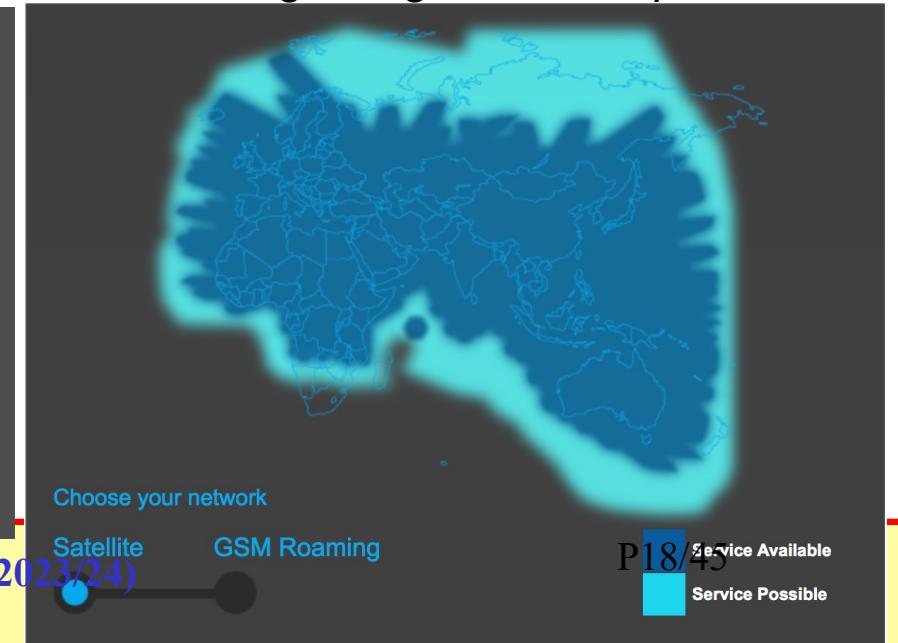
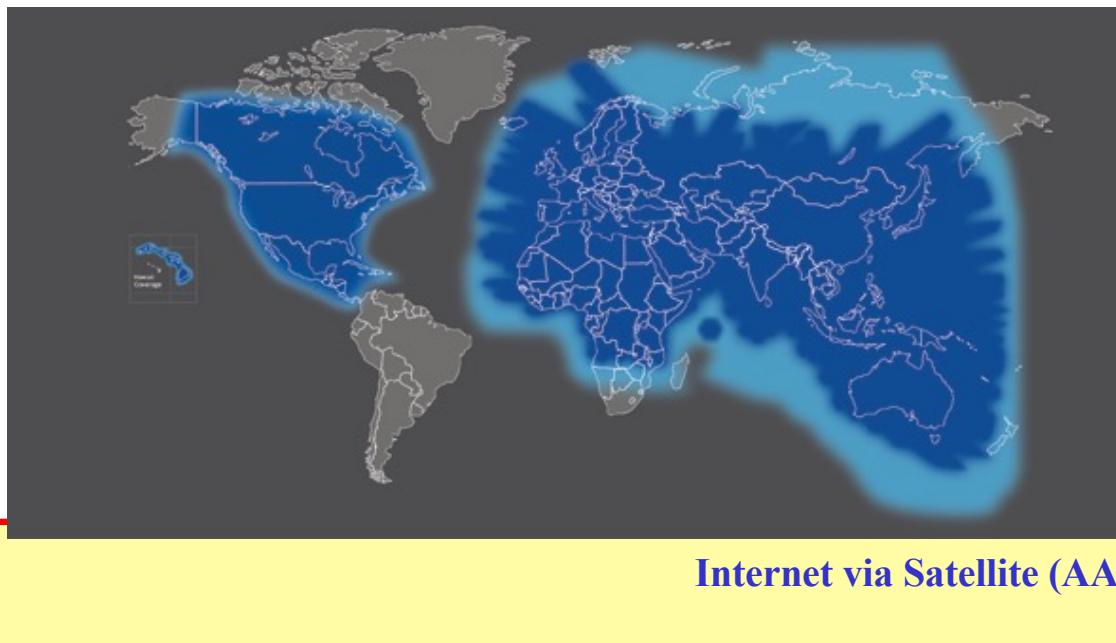
Thuraya

- 2 GSO satellites at 44° east and 98,5° east.
- Both GSM and satellite compatible.
- Reprogrammable payload.
- A digital BFN allows to dynamically allocate capacity where extra traffic demand occurs.
- Designed to support about 13.750 telephone channels each satellite
- **Dynamic Resource Allocation (DRA)**

Coverage

Thuraya's robust satellite network provides coverage in the most remote locations, ensuring congestion-free satellite communications to keep the connection at all times. From innovative satellite design to the reliability of each Thuraya device and accessory, it provides a truly superior satellite communication solution beyond the boundaries of terrestrial systems and cellular networks. Thuraya's M2M network covers more than 160 countries in North America, Europe, Africa, Asia and Australia.

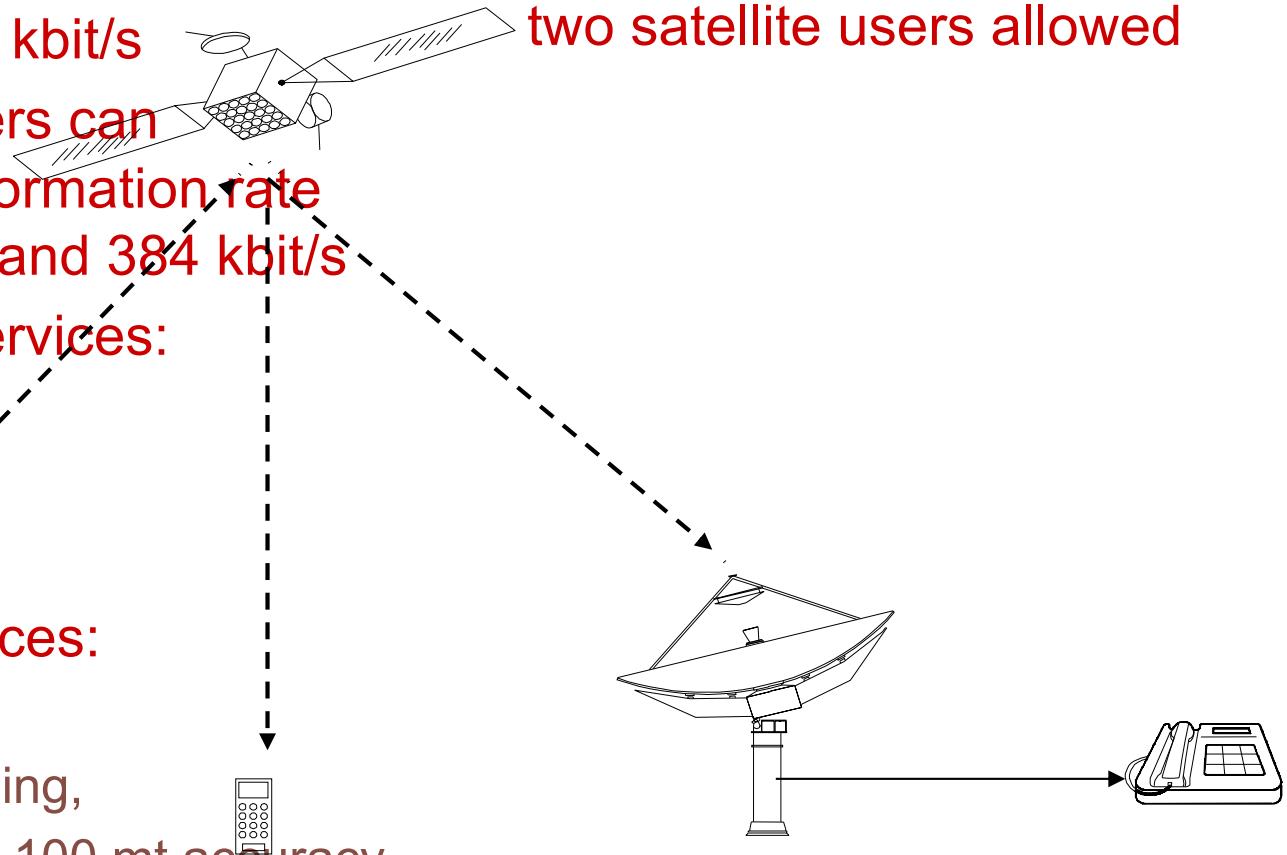
With roaming agreements established in 161 countries, Thuraya is able to provide reliable roaming services for our postpaid and prepaid customers onto more than 380 worldwide GSM networks. GSM subscribers from those networks can also insert their GSM SIM into a Thuraya handset to enjoy roaming services across Thuraya's satellite network, in order for them to remain connected when they are out of GSM coverage, or when they are traveling and terrestrial roaming charges are steep.



Services

Routing

- Voice and fax at 2.4, 4.8 and 9.6 kbit/s
- Data at 2.4, 4.8 and 9.6 kbit/s
- With IP terminal the users can configure committed information rate (CIR) between 16kbit/s and 384 kbit/s
- Supplementary GSM services:
 - Waiting call,
 - identification,
 - SMS, ecc.;
- Intelligent network services:
 - pre paid SIM
 - Voice message recording,
 - positioning (GPS) with 100 mt accuracy.



Products

 LAND VOICE	 LAND DATA	 MARINE	 AERO	 M2M	 LEGACY
Thuraya X5-Touch	Thuraya WE	Thuraya Atlas IP+	HDR Fixed - FLANGE	T2M-DUAL	Thuraya XT
Thuraya XT-PRO DUAL	Thuraya IP Commander	Thuraya Atlas IP	SDR Fixed - FLANGE	FT2225	Thuraya XT-DUAL
Thuraya SatSleeve+	Thuraya IP Voyager	Thuraya Orion IP	HDR HELI	Thuraya IP M2M	Thuraya IP
Thuraya SatSleeve Hotspot	Thuraya MCD Voyager	Thuraya SeaStar	SDR HELI		Thuraya PCO
Thuraya XT-PRO	Thuraya IP+	SF2500	HDR Fixed - ARINC		SatSleeve for iPhone
Thuraya XT-LITE	Thuraya GSM	Seagull 5000i	SDR Fixed - ARINC		SatSleeve for Android
Thuraya XT-Hotspot					
FDU-XT PLUS					
FDU-XT					
Indoor Repeaters					



Thuraya SatSleeve

Thuraya SatSleeve+ Hotspot



Thuraya
XT-PRO

Thuraya
GSM



Thuraya
MCD
Voyager



Thuraya
Payphone



Thuraya Orion IP

Thuraya terminals



SatSleeve
for Android



Thuraya XT



Indoor RepeatersThuraya
XT-Hotspot



Thuraya IP



Thuraya IP+



Thuraya PCO



Thuraya
IP
Commander



Thuraya
Atlas IP



SF2500



Seagull 5000i



FT2225

Services

- **Thuraya Aero**
 - Thuraya Aero enables in-flight connections for internet access, voice calls, text messaging, high-speed data applications such as video and audio conferencing, large file transfer (e.g. surveillance videos), Voice over IP, besides much more. Applications such as search and rescue, ISR (Intelligence, Surveillance and Reconnaissance), telemedicine, military operations, office-in-the-sky and border surveillance require real time airborne data.
 - Designed to operate at IP broadband speeds of up to 444 kbit/s in single channel configuration with a dual channel system also available giving 700 kbit/s. The Satellite Data Unit is configured for dual channel operation with upgrade via a software key.
 - Thuraya Aero also comes with a built-in video transmission capability that offers real time video streaming using on board HD camera systems.

Services (2)

- **Thuraya Talk**

- Thuraya Talk is a VoIP app that brings you closer to your loved ones when they are far away, in another country or even beyond the reach of regular terrestrial telecom networks.
- Thuraya makes it easy and within your means to share experiences with anyone across the globe. We keep you connected through the internet. You can operate Thuraya Talk anywhere in the world on Wi-Fi, mobile or satellite data. It is ideal for users who rely on landlines or mobile phones to call Thuraya numbers, or just simply want to make international calls with great quality and at low prices.
- Download Thuraya Talk from the App Store or Google Play. By going through an easy and immediate registration process, the prepaid account is ready within minutes. Start calling or send and receive messages. It can be used on both smartphones and tablets. Thuraya Talk syncs with your smartphone address book so that you can access all your contacts on the app. Service is quick and very straightforward.

Services (3)

- **Thuraya M2M**
 - Thuraya IP M2M is the newly launched product under **Thuraya M2M Services**.
 - Thuraya IP M2M meets the market demand for IoT connectivity even beyond traditional communications. IP M2M provides reliable, cost-effective connectivity for remote assets and operations that require the collection of higher volumes of data from remote and industrial sites. The service delivers various advanced functions for different applications:
 - **Utilities**: enabling the metering, monitoring and control of power grids in remote areas
 - **Renewable energy**: remote connectivity for the control and monitoring systems in wind and solar farms
 - **LPWAN IoT gateway connectivity**: rapid, reliable and cost-effective extension of IoT networks to remote and rural areas, enabling multiple applications for agriculture, utilities, logistics and cold chain transportation
 - **Oil and gas**: monitoring of operations and assets in remote Oil and Gas installations, oil rigs, pipelines, personnel and mobile assets
 - **Weather and telemetry**: connectivity for weather stations and sensors
 - Real-time, two-way communications utilizing the Thuraya standard IP service with speeds of up to 444 kbit/s and network latency of 800ms

Services (4)

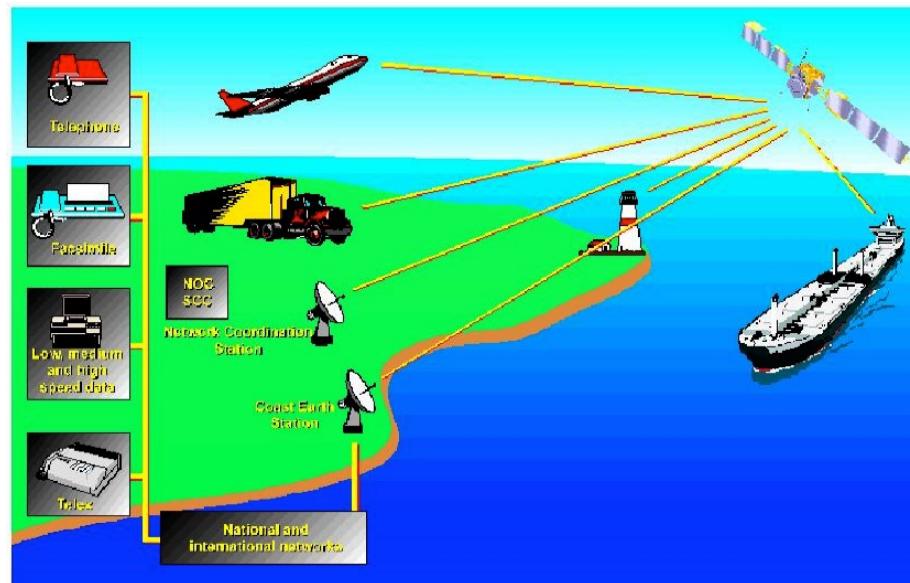
- **Satellite Capacity Leasing**
 - Dedicated satellite channels are available through existing or custom designed beams. Lease services are appealing to international news gathering corporations, enterprises' business and governmental organizations across the Thuraya coverage. Flexible power and bandwidth channels enable private network operation for relay data and IP traffic to support.
- **Thuraya Value Added Services**
- **Thuraya Recharge Services**



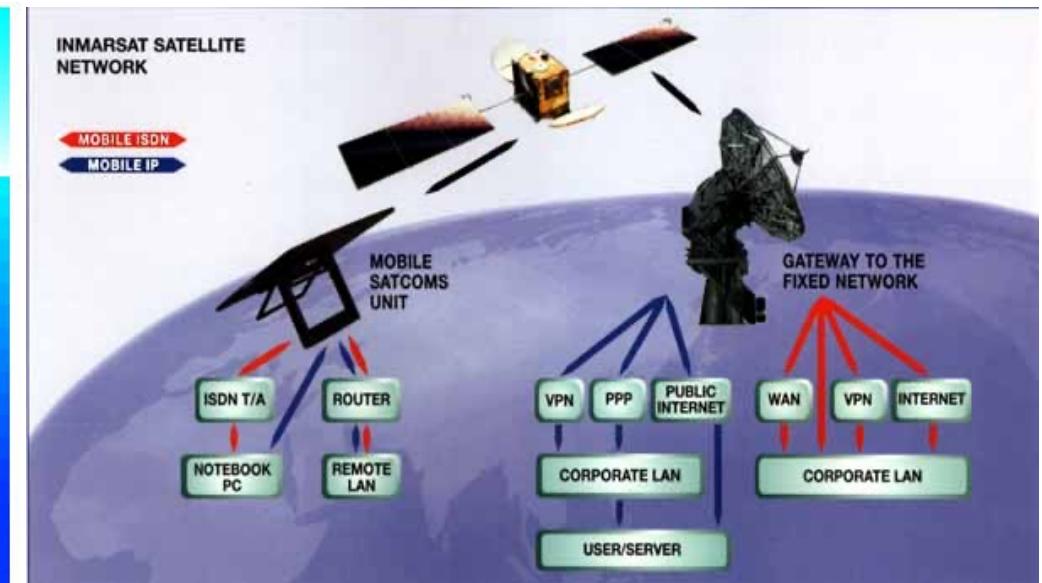
INMARSAT

Inmarsat space system

- The Inmarsat system consists of 13 satellites in geostationary orbit.
- Some satellites provide low/medium data rate services while others high data rate services



System components



Inmarsat satellite network

European Aviation Network

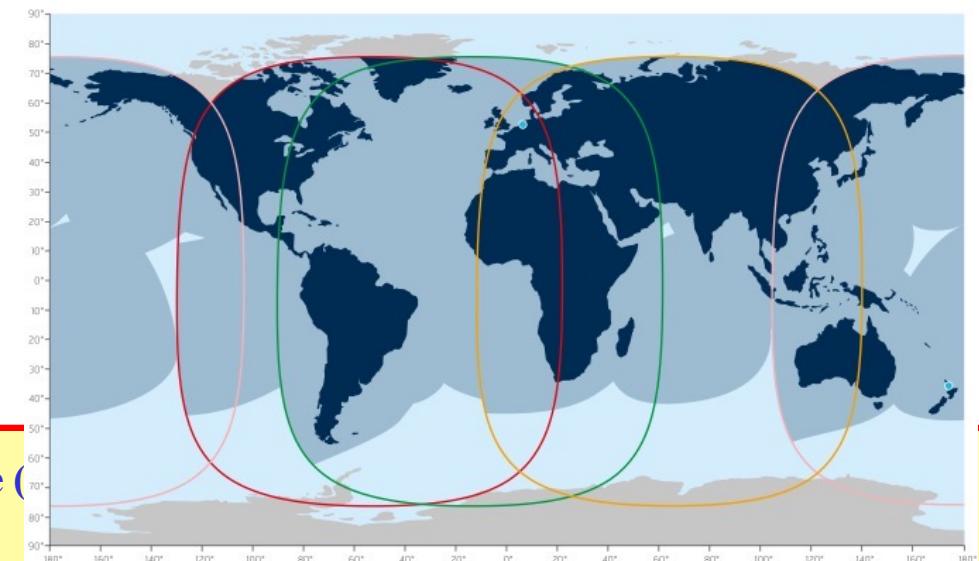
- S-band satellite offering high capacity coverage complemented by 4G LTE ground network to provide high-speed connectivity across all 28 European Union states.
- Designed specifically for high-traffic flight paths and busy airport hubs, the network delivers over 50 Gbit/s capacity.
- High bandwidth broadband service in the air comparable to the ground one.
- Initially combining Inmarsat's multi-beam S-band satellite with approximately 300 Deutsche Telekom ground towers, it's easily and cost-effectively scalable.

European Aviation Network

- Services
 - SwiftBroadband-Safety
 - next generation flight deck communications platform offering global, high-speed, secure, IP connectivity for the cockpit.
 - GX Aviation
 - high-speed Ka-band broadband service from a single, trusted operator. High-quality Wi-Fi with unrivalled capacity across worldwide flight routes.
 - Classic Aero
 - the standard for cockpit connectivity used by more than 95% of the world's transoceanic aircraft for communication and surveillance
 - Jet ConneX (on Global Xpress)
 - reliable, uninterrupted, high quality Wi-Fi experience with data speeds capable of supporting video-streaming, Voice over IP (VoIP), live TV, file transfer and VPN.
- Bandwidth requirements
- | Application | Bandwidth Required |
|---------------------------|--------------------|
| Voice over IP (VoIP) | 64 kbit/s |
| Internet / Email | 400 kbit/s |
| Video conferencing | 500 kbit/s |
| 480i Video/YouTube stream | 500 kbit/s |
| 1080p Video streaming | 2000 kbit/s |

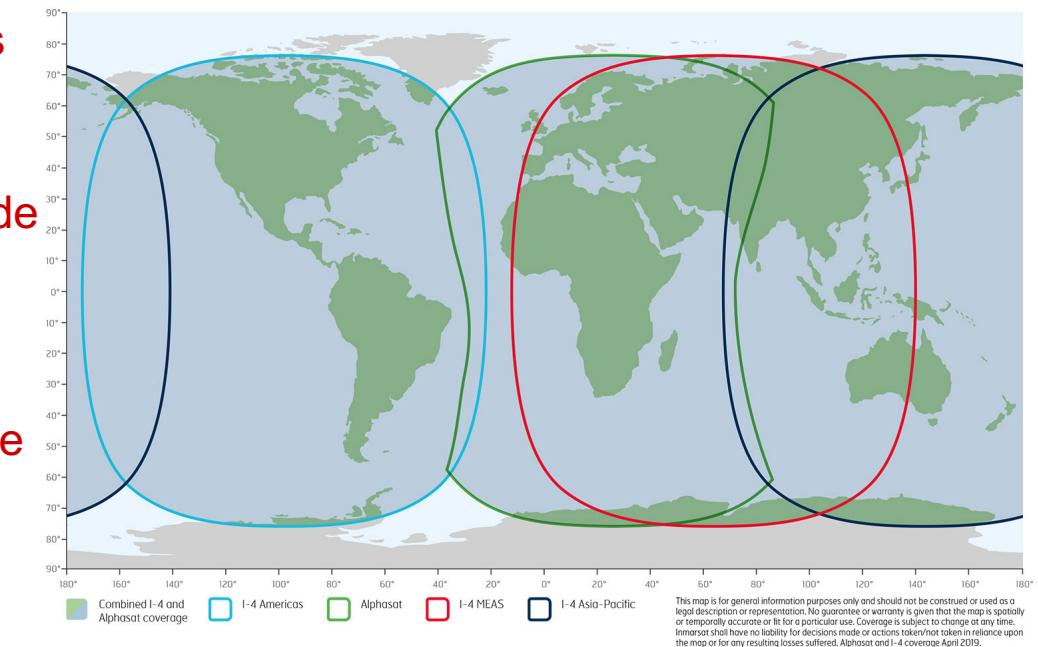
I3 satellites

- The Inmarsat-3s – the first generation to use spot-beam technology – were launched between April 1996 and February 1998.
- Four of the five Inmarsat-3 satellites are currently in service.
- Each I-3 can deliver an EIRP (radiated power) of up to 48 dBW, and can dynamically reallocate both RF power and bandwidth among a global beam and five spot beams, allowing greater reuse of the available spectrum.
- Each I-3 also carries a navigation transponder designed to enhance the accuracy, availability and integrity of the GPS and Glonass satellite navigation systems.
- The Inmarsat-3s are expected to remain in operation, providing communication and safety services in the L-band, until around 2018.



I4 satellites

- Inmarsat-4 (I-4) series of satellites established the world's first global 3G mobile network. They deliver L-band broadband services – BGAN, FleetBroadband and SwiftBroadband; IoT machine-to-machine (M2M); voice and legacy safety services.
- The first three Inmarsat-4 (I-4) satellites were launched into geostationary orbit from 2005-8.
- Each satellite can generate up to 19 wide beams and more than 200 narrow spot beams.
- The Inmarsat-4 fleet is expected to support our L-band services well into the 2020s.
- All services on our four Inmarsat-3 L-band satellites were successfully migrated to the I-4 fleet by the end of 2018.



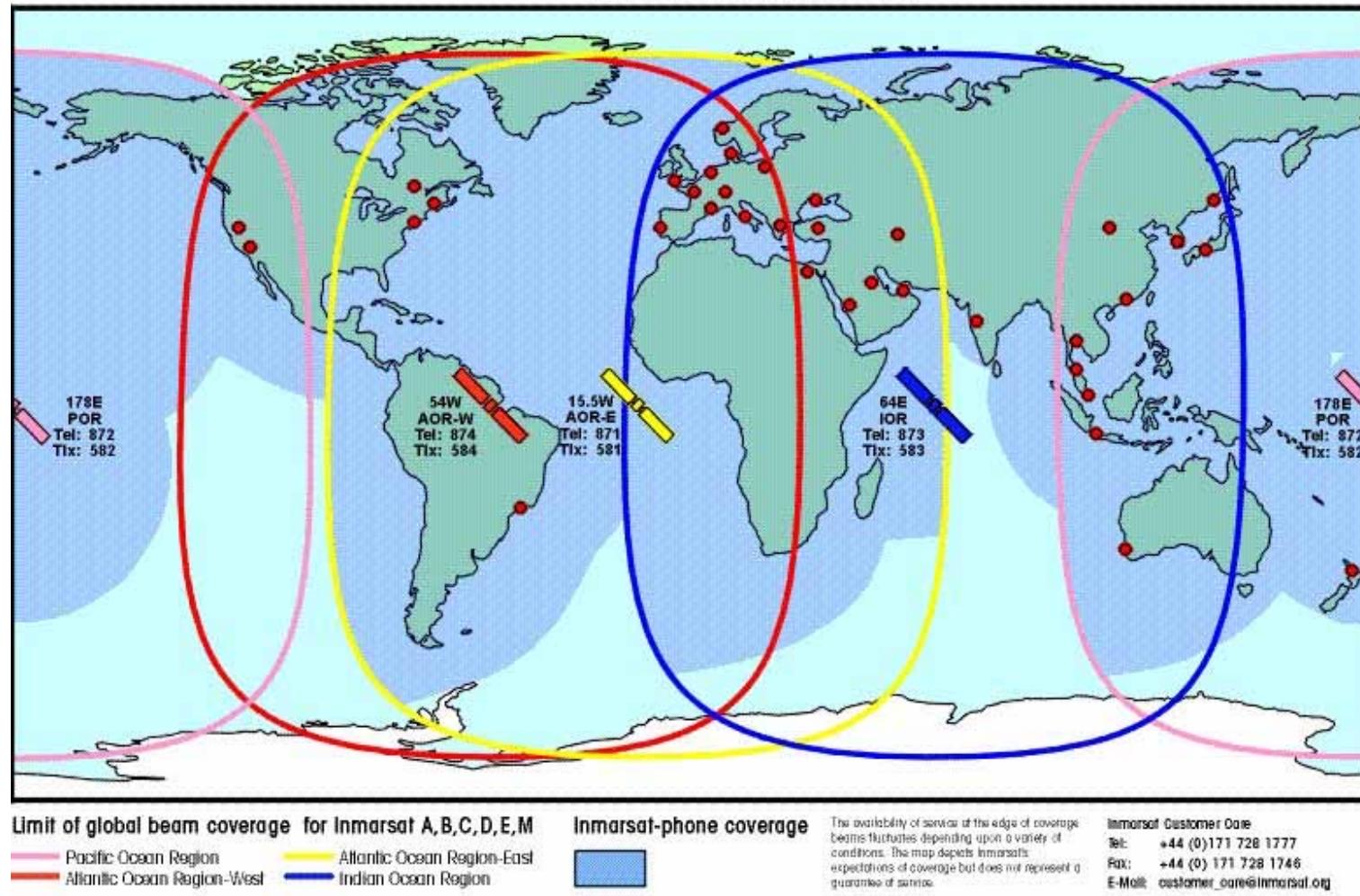
Alphasat

- Launched in July 2013
- With a total mass of more than 6.6 tons at launch (the size of a London double-decker bus), Alphasat is the largest European telecommunications satellite ever built.
- Alphasat supplements Inmarsat-4 (I-4) series, which established the world's first global 3G network.
- The Inmarsat-4 fleet supports the L-band services without the need for replacement until the early-2020s.

Coverage

Mobile Satellite Communications

Worldwide Coverage Map



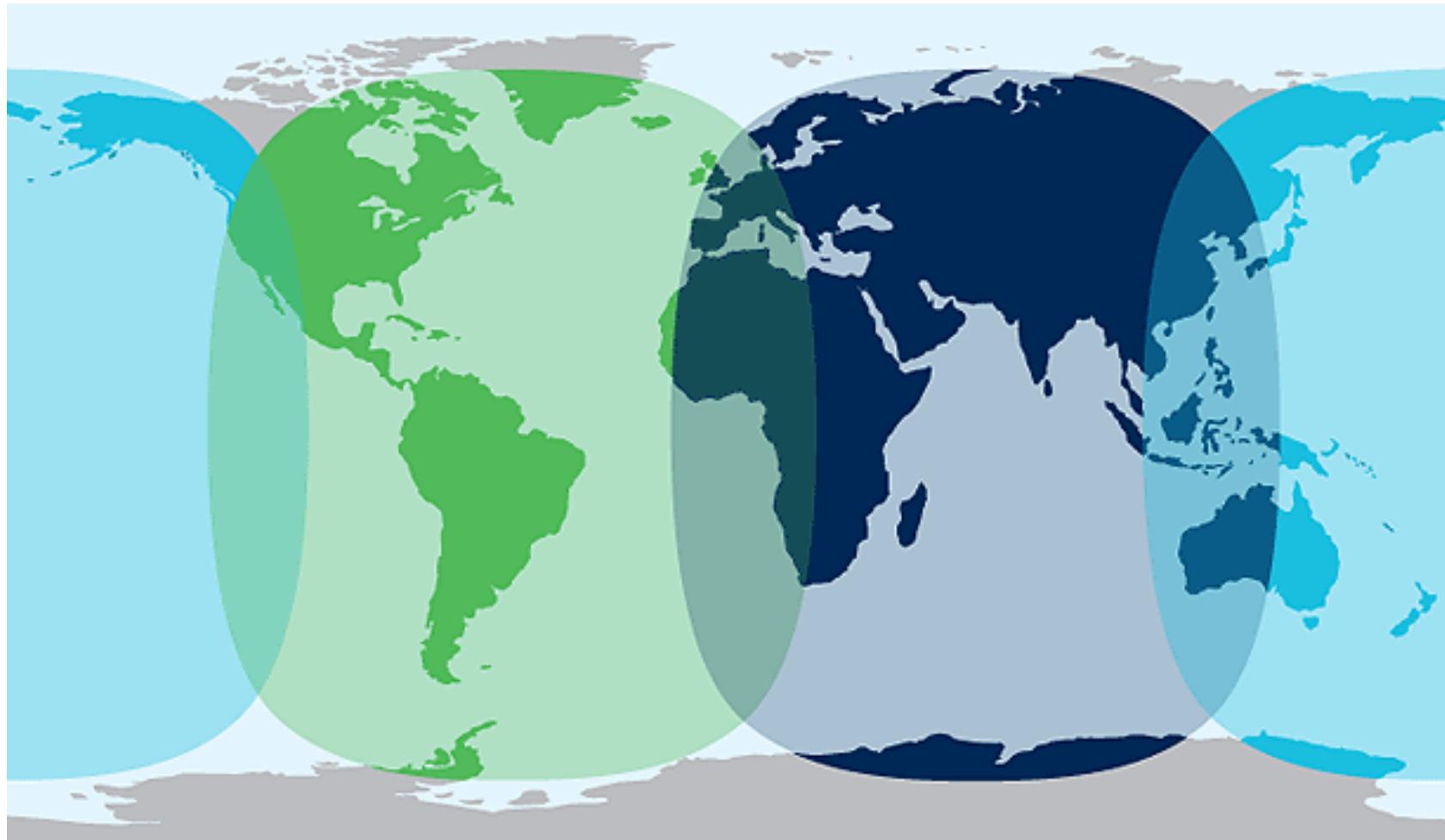
BGAN characteristics

- **Global coverage**
 - Seamless network coverage across most of the world's landmass.
 - Mobile broadband connectivity.
- **Simultaneous voice and broadband data**
 - Access data applications and make phone calls at the same time.
 - Guaranteed data rates on demand.
 - Network capacity can be re-directed to areas of heavy service usage to provide bandwidth availability.
- **Terminals compactness**
 - Lightweight terminals (the smallest BGAN terminal weighs less than a kg).
 - Set up a broadband mobile office in minutes.
- **Flexibility**
 - Supports both IP and circuit-switched voice and data.
 - Integrates seamlessly with your corporate network.
 - Choice of terminals for single users and small teams.
- **Reliability**
 - Robust terminals that withstand challenging environments.
- **Easy to use**
 - No specialist technical expertise required.
 - Same device can be used worldwide.
 - Standard user interface across all terminals.
 - Compatibility with local telecoms networks.
- **Security**
 - Inmarsat has vast experience in providing secure communications to military and government customers.
 - BGAN supports all major VPN products and encryption standards.

BGAN Services

- **Standard IP**
 - For email, internet and intranet access via a secure VPN connection, at speeds up to 492 kbit/s over a shared channel.
- **Streaming IP**
 - Guaranteed data rates on demand up to 256 kbit/s. Choose the data rate on a case by case basis, depending on your application. Also supports ISDN at 64 kbit/s.
- **Phone**
 - Make phone calls at the same time as accessing your data applications. Voicemail and other standard 3G mobile supplementary services are also available.
- **Text**
 - Send and receive text messages via your laptop – up to 160 characters – to or from any mobile phone.

BGAN coverage



Explorer 110

- The Explorer 110 combines an exceptionally compact design with performance and optimal flexibility. The terminal can be separated into two parts, so users can choose between indoor and outdoor use, with no need for an external antenna.
- Combined with the Explorer ISDN handset for voice telephony and text messages, it is ideal for single users, who need to set up a complete broadband mobile office at frequently changing locations



Manufacturer: [Thrane & Thrane](#)

Size: 200 x 150mm (< 1kg)

Standard IP: Up to 240/384 kbit/s (send and receive)

Streaming IP: 32 kbps or 64 kbit/s (send and receive)

ISDN: N/A

Voice: Via RJ-45 ISDN handset, or Bluetooth handset

Data Interfaces: USB, Bluetooth, Ethernet

Ingress protection: IP 44

Wideye Sabre 1

- Voice and data, single-user device
- The Wideye Sabre 1 combines a highly portable, robust design with all-round performance.
- It provides the single-user with a cost-effective voice and high-speed data solution for remote corporate network access.



Manufacturer: [Addvalue Communications](#)

Size: 259 x 195mm (1.6kg)

Standard IP: Up to 240/384 kbit/s (send and receive)

Streaming IP: 32kbps or 64 kbit/s (send and receive)

ISDN: N/A

Voice: Via RJ-11 or Bluetooth handset/headset

Data Interfaces: Bluetooth, Ethernet

Ingress protection: IP 54

Explorer 300

- The Explorer 300 comprises a single unit incorporating a transceiver and an integral antenna in a compact, robust design.
- The terminal combines performance with ultimate portability and is ideal for single users, who need to set up a complete broadband mobile office in frequently changing locations.



Manufacturer: [Thrane & Thrane](#)

Size: 217 x 168mm (1.4kgs)

Standard IP: Up to 240/384 kbit/s (send and receive)

Streaming IP: 32 or 64 kbit/s (send and receive)

ISDN: N/A

Voice: Via RJ-11 or Bluetooth

Data Interfaces: Bluetooth, Ethernet

Ingress protection: IP 54

Explorer 500

- The Thrane & Thrane Explorer 500 combines exceptional performance with portability. It meets the needs of the most demanding business traveller for remote, high-speed corporate network access.



Manufacturer: [Thrane & Thrane](#)

Size: 217 x 217mm (<1.5kgs)

Standard IP: Up to 448/464kbps (send and receive)

Streaming IP: 32, 64 or 128kbps (send and receive)

ISDN: via USB

Voice: Via RJ-11 or Bluetooth handset, 3.1 kHz audio

Data Interfaces: USB, Bluetooth, Ethernet

Ingress protection: IP 54

HNS 9201

- The HNS 9201 combines ultimate performance with an extremely rugged design. It provides access to the highest bandwidth available on the BGAN network, as well as WLAN connectivity.
- It is ideal for either single users using bandwidth-hungry applications, such as live video, or for small teams that need to set up a temporary office with high-speed connectivity to standard data applications.



Manufacturer: [Hughes Network Systems](#)

Size: 345 x 275mm (2.8kg)

Standard IP: Up to 492 kbit/s (send and receive)

Streaming IP: 32, 64, 128 or 256 kbit/s (send and receive)

ISDN: 1 x 64 kbit/s

Voice: Via RJ-45 ISDN handset, RJ-11

Data Interfaces: USB, Ethernet, WLAN 802.11b

Ingress protection: IP 55

Explorer 700

- The Thrane & Thrane Explorer 700 combines optimal performance with extensive functionality in an extremely flexible and robust design. It provides access to the highest bandwidth available on the BGAN network with multiple voice and data interfaces, including WLAN connectivity.
- It is ideal for live video applications or for teams to share in a temporary office environment, whatever the climate conditions.

Manufacturer: [Thrane & Thrane](#)

Size: 297 x 399mm (3.2kg)

Standard IP: Up to 492 kbit/s (send and receive)

Streaming IP: 32, 64, 128 or 256 kbit/s (send and receive)

ISDN: 2 x 64 kbit/s

Voice: Via RJ-11 (x2) or Bluetooth handset, 3.1 khz audio

Data Interfaces: USB, Bluetooth, Ethernet (x2), WLAN 802.11g, Digital I/O

Ingress protection: IP 52 (transceiver) IP 66 (antenna)



ViaSat AN/PSC-14c

- The ViaSat AN/PSC-14c has been built to a highly ruggedised, man-portable design specifically for tactical military use.
- It provides your entire force with a full range of secure and unsecure data and legacy voice, through a single military rucksack size and weight device that is also vehicle rack-mountable.



Manufacturer: [ViaSat](#)

Size: 292mm x 132mm (11.36kg)

Standard IP: Up to 258/422kbps (send/receive)

Streaming IP: 32, 64, 128 or 256kbps (send and receive)

ISDN: N/A

Voice: Via RJ-11 or Bluetooth handset/headset

Data Interfaces: Red and Black LAN Ethernet interfaces

Encryption: NSA-certified HAIPIS Type1

Ingress protection: IP 67

M2M services

- **BGAN M2M**
 - Global, two-way IP data service designed for long-term machine-to-machine management of fixed and mobile assets.
 - Connects monitoring and control applications in remote, unmanned locations, giving full visibility and management of dispersed assets across an entire operational area.
 - Send data using BGAN Standard IP at a rate of up to 448 kbit/s with a low latency from 800 milliseconds, assuring real-time visibility of critical data.
- **IsatM2MGlobal**
 - store-and-forward low data rate messaging to and from remote assets for tracking, monitoring and control operations.
 - IsatM2M supports critical applications such as transport vehicle security, industrial equipment monitoring and marine tracking, giving companies visibility and control of fixed or mobile assets.
 - Speeds of 10.5 or 25.5 bytes in the send direction and 100 bytes in the receive direction, with latency typically between 30 to 60 s.

M2M services (2)

- IsatData ProA
 - global two-way short message service for machine-to-machine (M2M) communication.
 - Enables companies to track and monitor their fixed or mobile assets, giving them increased visibility of business operations, enhanced efficiency, and greater safety and security for their assets, cargo and drivers – while lowering operational costs.
 - Send 6,400 bytes and receive 10,000 bytes, with a latency of 15-60 seconds depending on message size.

Safety

- **Maritime Safety**
 - Above and beyond the IMO's Safety of Life at Sea (SOLAS) and Global Maritime Distress and Safety System (GMDSS) requirements (exceeding the demand for satellite and ground network availability of 99.9%).
 - The L-band network supports both SOLAS and non-SOLAS vessels and some 1.2 million seafarers depend on it for a communications lifeline that is reliable and unaffected by bad weather.
 - Inmarsat shore-to-ship Maritime Safety Information urgency and distress priority communications are free of charge.
 - The GMDSS is an international safety system, which uses satellite and terrestrial technology and ship-board radio systems to prevent accidents from happening and to automatically alert the rescue authorities and nearby vessels quickly in an emergency.
 - Under the Safety of Life at Sea (SOLAS) convention, cargo ships of 300 GRT and upwards and all passenger ships on international voyages must be equipped with satellite and radio equipment that conforms to international standards.
 - Inmarsat is the only provider of GMDSS-approved satellite communication services – Inmarsat C and Fleet 77. We also offer safety services via FleetBroadband for non-SOLAS vessels.

Safety (2)

- Aviation Safety
 - With SwiftBroadband, over the Inmarsat-4 (I-4) satellites – enabling the simultaneous operation of both through a single antenna installation.
 - Global coverage over I-3 and I-4 satellites
 - Classic Aero services are accessible over both the I-3 and I-4 satellite systems. Both offer global coverage, with SwiftBroadband service provided over the I-4 constellation.
 - Classic services – Aero H
 - Aero H provides packet data rates of up to 10.5 kbit/s for ACARS, FANS and ATN communications and up to 9.6 kbit/s per channel for multi-channel voice, fax and data links through a high gain-antenna – anywhere in the global beams of the I-3 satellites. As well as safety, applications include passenger, operational and administrative communications.
 - Classic services – Aero H+
 - Offers all the features of Aero H, but uses the I-3 regional spot beams and 4.8 kbit/s voice codecs to deliver voice services at lower cost. Outside of regional spot beams, Aero H+ terminals operate in the global beams in the same way as standard Aero H systems. Aero H+ is also available in the full I-4 satellite footprint.
 - Classic services – Aero I
 - Uses intermediate-gain antennas and the I-3 regional beams, providing multi-channel voice and 4.8 kbit/s circuit-switched data services. Aero I packet data is also available in the full I-4 footprint.

Voice

- Operates over global I-4 satellite network, ensuring reliable call stability and seamless roaming worldwide.



Satellite telephony:	2.4 kbit/s voice codec
Voicemail:	Speed dial 1
Supplementary voice services:	Call history Caller ID Call waiting Call divert Call holding Conferencing Call barring Speed dialling Fixed number dialling
Text-to-text:	160 Latin / ~74 non-Latin characters Up to 10 concatenations Standard and predictive text
Web message-to-IsatPhone 2	Free from message.inmarsat.com
GPS location data:	View position Send as text or email

Traditional services

- **Inmarsat A**
 - Two-way direct-dial phone (high quality voice), fax, telex, electronic mail and data
 - Analogue technology. Data rates: 9.6 kbit/s up to 64 kbit/s
- **Inmarsat B**
 - Digital technology. High-speed data services (HSD): 64 kbit/s connections to the ISDN network.
 - High-speed file transfer, store-and-forward video, high-quality audio transmission, video-conferencing and multiplexed channels combining voice, fax and data.
- **Inmarsat Global Area Network**
 - Mobile ISDN and Mobile Packet Data
 - The user is charged for volume of data transmitted as opposed to length of time connected (as with Mobile ISDN)

Traditional services (2)

- Inmarsat mini-M
 - High-quality mobile office applications (voice fax and data)
- Inmarsat-C
 - Two-way low bit rate data communications
 - 600 bits/s
 - Messages up to 32 Kbytes in length
- Inmarsat D+
 - Global two-way data communications equipment no bigger than a personal CD player).
 - Complete with integrated GPS, ideally suited for tracking, tracing, short data messaging and SCADA applications. Point-to-multipoint broadcast of information.
- Inmarsat Aero

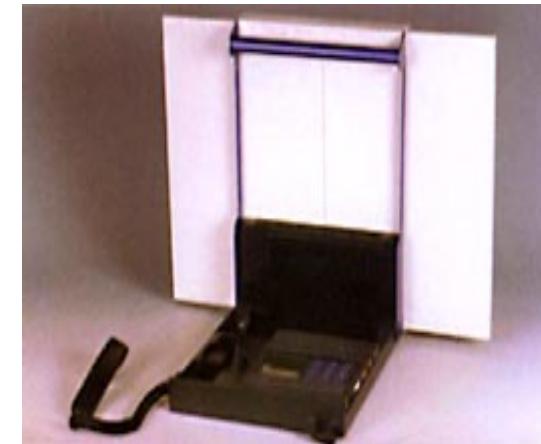
Equipment

The mobile satellite communications units needed to access the Inmarsat Global Area Network are small, completely portable and simple to operate, to link into the network.

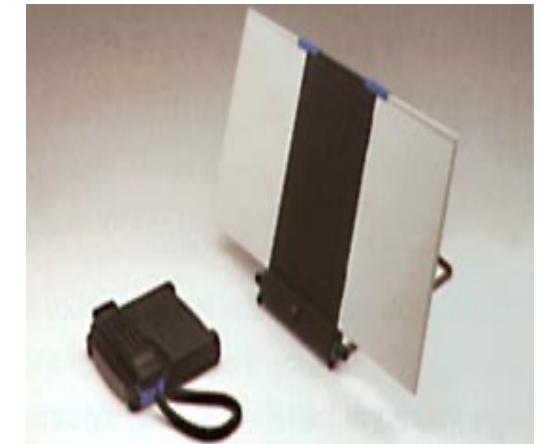
To switch on the unit, orientate the antenna in the general direction of an Inmarsat satellite, **plug in your pc.**



Sers Word Communicator



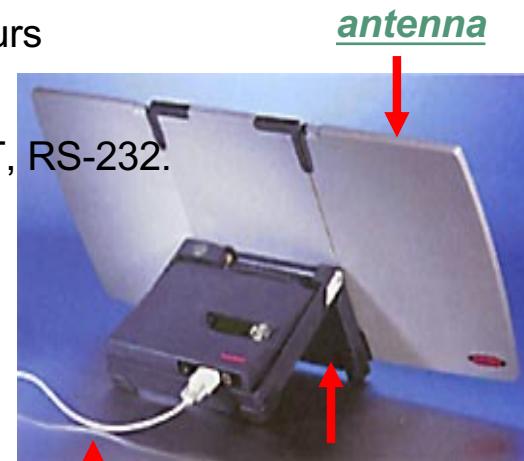
ECI netlink



TT 30 SCA

SERS Word Comunicator

- Specification
 - Weight
 - 4.1 kg including battery
 - Dimensions:
 - 68x275x355 mm (close)
 - 340x774x12 mm (open)
 - Antenna type:
 - folding 3 panel
 - antenna and RF receiver
 - Battery life
 - 50/1.5 hours
 - Connectors:
 - ISDN NTT, RS-232.
 - Band: C



Connector to PC

receiver
Internet via Satellite (AA2023/24)

ECI netlink

- Specification
 - Weight:
 - 5 kg including battery
 - Dimensions:
 - 410x300x90 mm (close)
 - 410x600 mm (open)
 - Antenna type:
 - sliding 2 panel antenna and RF receiver
 - Battery life:
 - 70 / 4 hours, or 1 for ISDN 64kbit/s
 - Connectors:
 - ISDN NTI, 2x RS232.
 - Band: C



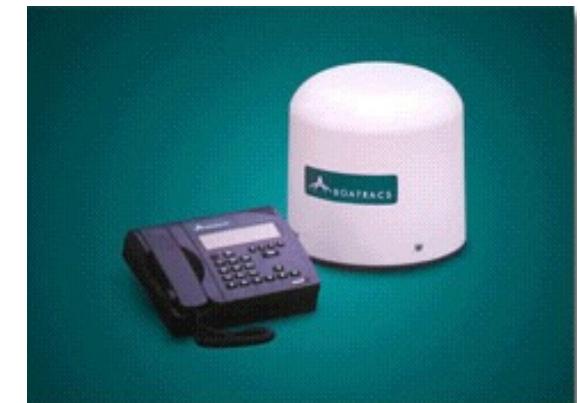
TT 30 SCA

- Specification
 - Weight
 - 4.8 kg including battery
 - Dimensions:
 - 437x271x41 mm (close)
 - 414x753x12 mm (open)
 - Antenna type:
 - folding 3 panel antenna and RF receiver
 - Battery life:
 - 70/4 hours or 1 for ISDN 64 kbit/s
 - Connectors
 - ISDN NTI, RS232.
 - Band: C



Boatracs Mini-M

- Consisting of three separate hardware units:
 - antenna
 - telephone
 - power supply
- This system keeps users connected via voice, facsimile or data services. Once a phone, fax machine transceiver and PC are connected, the user will have a complete, on board mobile office.



Inmarsat-C

- Communications via the Inmarsat-C system are data or message-based
- Anything that can be coded into data bits can be transmitted via Inmarsat-C
- Messages are transferred to and from an Inmarsat-C terminal at an information rate of 600 bit/s
- Frequencies
 - 1626.5 -1645.5MHz (transmit),
 - 1530.0-1545.0MHz(receive).



Inmarsat Orbcomm partnership (source: Via Satellite)

- Inmarsat and Orbcomm have extended their Internet of Things (IoT) partnership through at least 2035 to collaborate on product innovation, IoT satellite service distribution and telematics devices.
- Inmarsat is working with Orbcomm, an Industrial Internet of Things (IIOT) hardware and software company, to develop its OGx service.
 - The OGx network, which is expected to be available in 2022, will incorporate Inmarsat's current IDP service, and will be supported by Inmarsat's L-band constellations, including the current I-4 constellation and the upcoming sixth generation (I-6) constellation.
- The companies are developing two offerings for the service,
 - a high data rate service and
 - a service geared to remote monitoring and remote sensing applications that supports a daily message for multiple years on a satellite terminal utilizing a single AA battery.
- As part of the partnership, Inmarsat will also distribute Orbcomm's OGx telematics devices targeting Original Equipment Manufacturers (OEMs) and Value-Added Resellers (VARs).

Orchestra

- ORCHESTRA will integrate Inmarsat's existing geosynchronous (GEO) networks with terrestrial 5G and a new, targeted LEO satellite deployment.
 - ELERA: provides a critical layer of always-on connectivity with all-weather resilience.
 - Global Xpress: delivers reliable, high-speed, global coverage with security and full redundancy.
 - Terrestrial 5G: adds ultra-high capacity at specific high demand hot spots, such as busy ports, airports, straits and sea canals.
 - LEO: a small, targeted constellation of 150-175 satellites layering additional high capacity over further high demand areas.
- The layered approach is supplemented by a ‘dynamic mesh network’ and extends the range of direct links to others beyond that range, like ships beyond the reach of 5G for example.
- Time frame: end of the decade (2030)

Elera

- L band
- 8 satellites
- Small low cost terminals
- Inmarsat 6 constellation
- IoT services (autonomous transport, UAV, industry, agriculture)
- 1.7 Mbit/s
- Start of service in 2022
- I6-F1 (launched December 2021, 5500 kg, L and Ka band, electric propulsion, 9 m antenna, mobile maritime aeronautical services, call and messaging, governmental)
- I6-F2, twin of I6-F1, to be launched in 2022

Smartphone Manufacturers & Narrowband Satellite Systems

- Apple's new iPhone 14 will be able to send emergency SOS messages outside the reach of cellular networks, enabled by **Globalstar** satellite connectivity.
- The service is available on the iPhone 14 since November 2022 in the U.S. and Canada, free for two years.
- Globalstar confirmed in SEC filings they provide the satellite connectivity.
- Globalstar allocated 85% of its current and future network capacity to support the services and has agreed to prioritize the services on its network.
- Globalstar has completed several milestones with Apple including upgrading its ground network, constructing 10 new gateways, launching a ground spare satellite and in-field testing.
- Apple designed a feature that shows the user where to point the phone to establish a connection and stay connected as the satellite moves and created an algorithm to compress text messages so they can be sent in 15 s. A series of prompts designed to quickly convey important information to emergency services.
- The satellite connectivity can also be used to share a person's location via the “Find My” app.
- There is increasing momentum around cellular direct-to-satellite connectivity.
- Huawei Mate 50 series will be able to send short texts and utilize navigation with China's **BeiDou** sat network.
- Elon Musk announced that the second generation of **Starlink** satellites will be able to connect **T-Mobile's** subscribers in remote locations to fill gaps. The service could enter beta in late 2023 with messaging service.
- Satellite startups are also targeting this model of “cell towers in space.”
- **AST SpaceMobile** is preparing to launch its test BlueWalker 3 satellite to test its space-to-cell technology, and the company has partners with a number of MNOs including **Vodafone**.
- **Lynk Global** has six satellites in space and demonstrated satellite-direct-to-cell connectivity in pre-commercial tests earlier this year and also has partnerships with a number of MNOs.

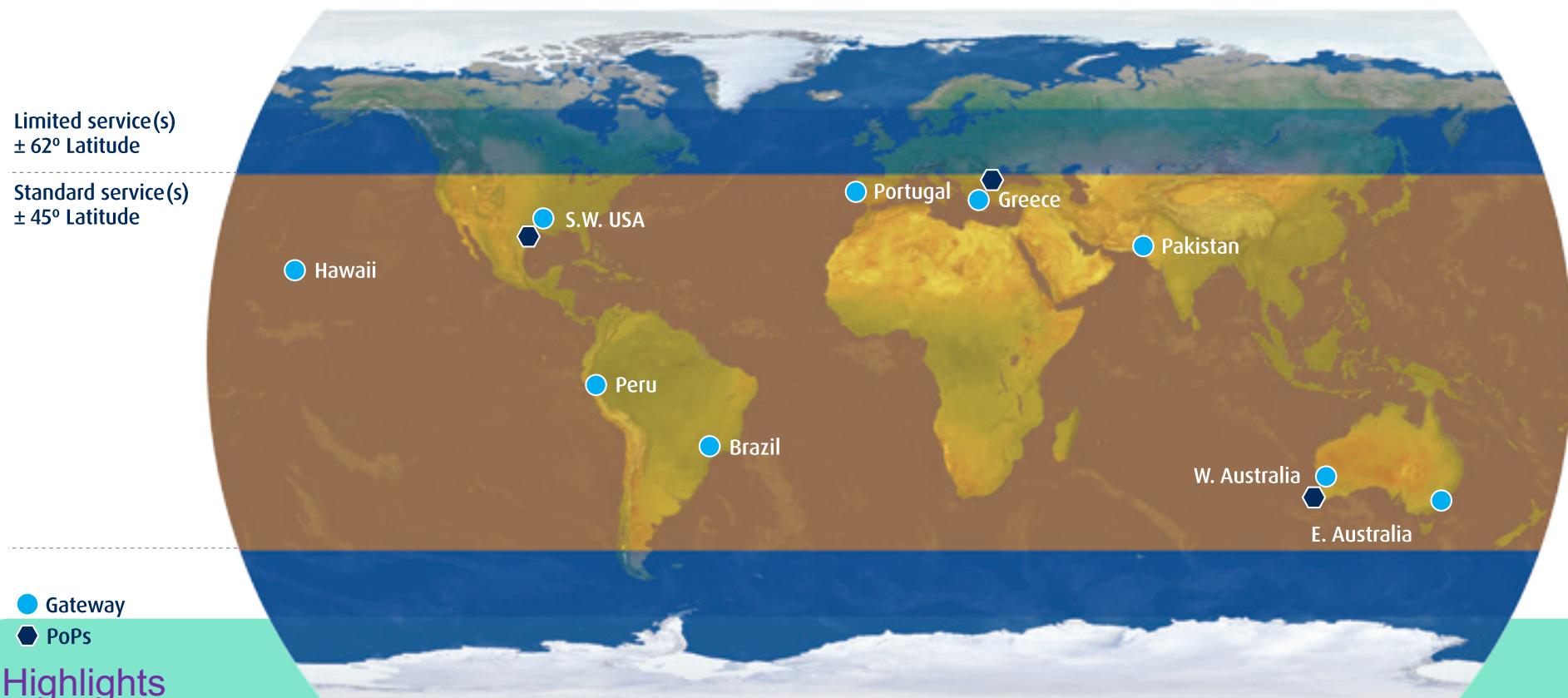
High data rate, Medium Earth Orbit:

O3B (Over 3 billion)

- Ka-band beams of 700 km diameter: steerable around the globe, each delivering up to 1.6 Gbit/s (800 Mbit/s x2) 84 Gbit/s per 8 sat constellation
- Transponder bandwidth: 216 MHz (2 x 216MHz per beam)
- High Bandwidth Scalable Options from 100 Mbit/s to 1.2 Gbit/s
- Initial constellation of 12 MEO (8,062 km altitude) satellites rotate the globe approximately four times a day (3560 min period)
- 10 beams per region (7 regions) totaling 70 remote beams per 8 satellite constellation
- Roundtrip latency of less than 150 ms enabling:
 - Crystal clear voice and HD video
 - Ultra-fast response time
 - Use of cloud based applications
- Continuous coverage: when one satellite leaves, another satellite takes over without transmission interruption
- Each beam is connected to a high throughput teleport, with multiple layers of redundancy, ensuring operators a reliable, high speed service
- Service model oriented to operators



Coverage and gateways



Highlights

- 4.8 GHz spectrum per satellite
- Links up to 1.2 Gbit/s
- Over 840 transponder equivalents of available capacity in the initial eight satellite constellation

Service market segments

- IP Trunking
- Mobile Backhaul
- Offshore Communications
- Maritime
- Government

Owned and operated by SES Global

Terminals

7.3 meter



4.5 meter



2.4 meter



1.8 meter



2.2 m stabilized



1.2 m stabilized

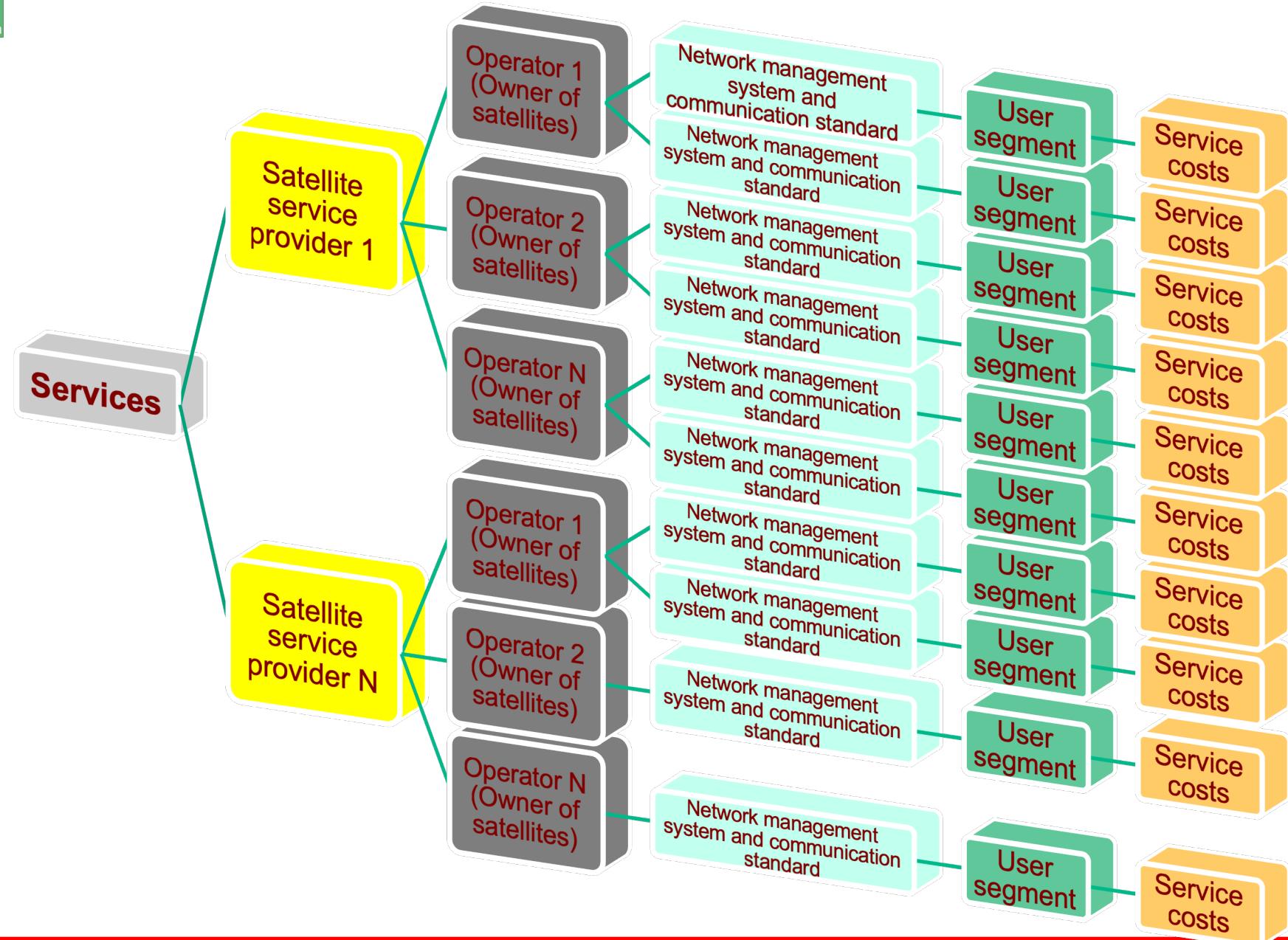


Transportable



Systems for high data rate and multimedia services

- Service ≠ System
 - Freedom degrees:
 - Service
 - Service provider
 - Satellite Operator
 - Satellite
 - Modem
 - RF front end and antenna
 - Costs
- 
- The diagram illustrates the components of a satellite system. It is divided into two main segments: the Space segment and the User segment. The Space segment includes the Service, Service provider, Satellite Operator (which itself includes the Satellite), and the Modem. The User segment includes the RF front end and antenna and the Costs.

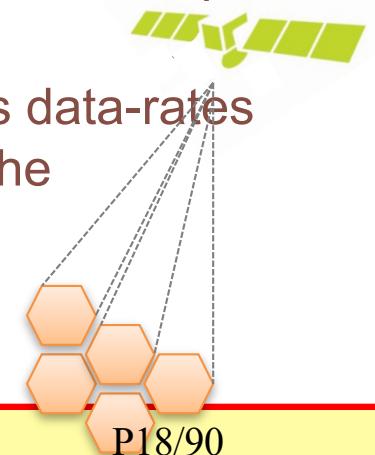


Available families of systems

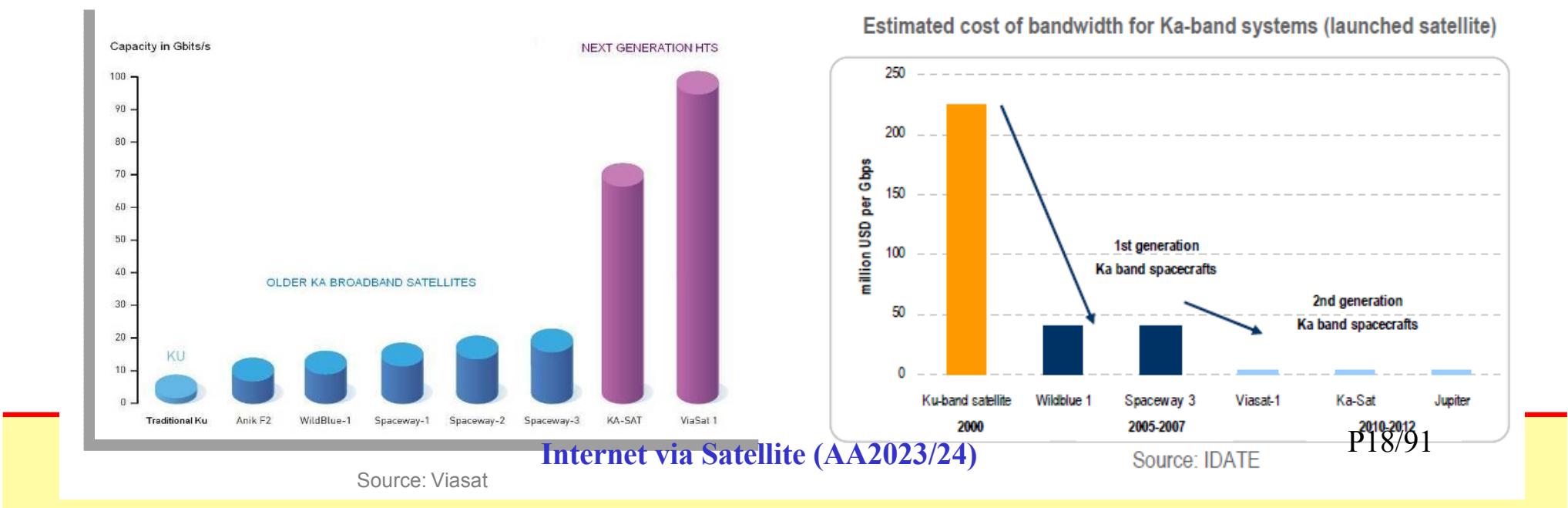
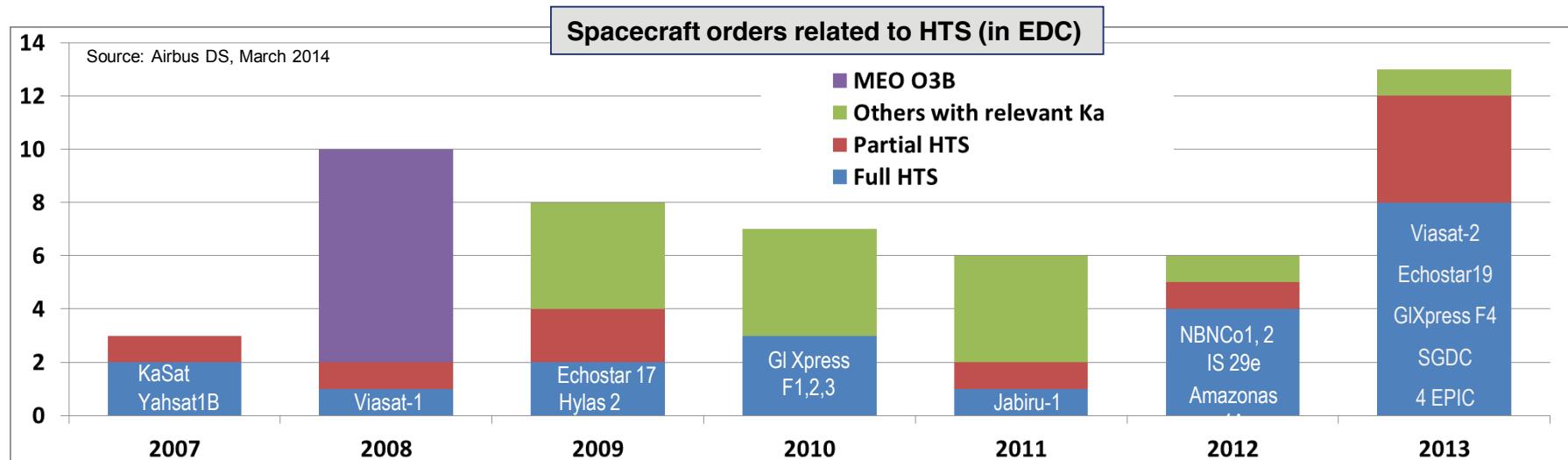
- C band
 - Big stations
 - Network oriented (service to operators)
- Ku band
 - First VSAT systems
 - Direct to user services
- Ka band
 - Higher capacity
 - HTS (High Throughput Satellites)

High throughput Satellites overview

- New generation of satellites that leverage higher bandwidth available in Ka band.
- Satellites are based on multi-spot beam payload and are optimized for delivering broadband services. The main advantages over conventional satellites include:
 - More efficiency on the ground which enables use of a smaller antenna size (75 cm) with low power amplifier driving down the cost of user equipment.
 - Cost effective bandwidth supply due to efficient frequency re-use in spot beams.
 - Faster access speeds with high reliability (Terminal supports data-rates of more than 15 Mbit/s on the downstream and 3 Mbit/s on the upstream)

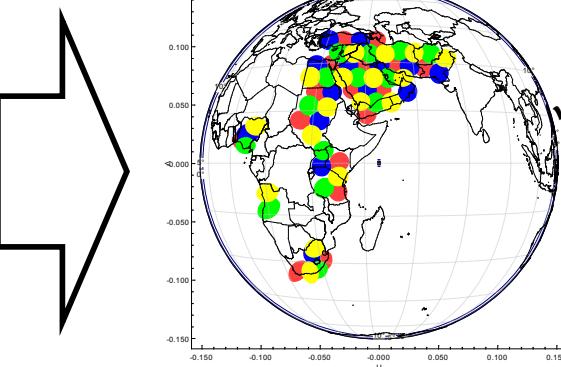
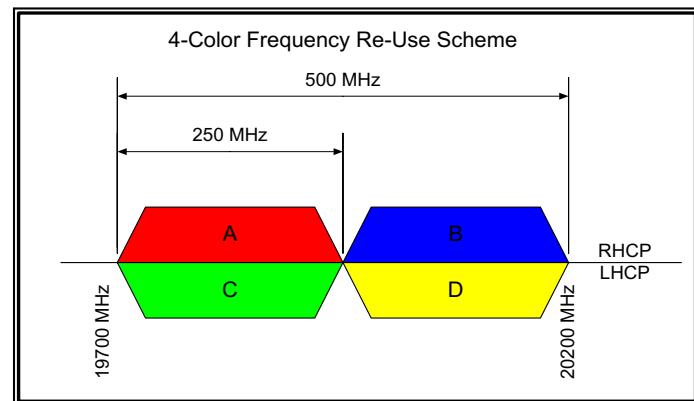


Missions, capacity and bandwidth costs



Frequency Re-use & Satellite Technology

Ka-band Frequency Re-use



- ✓ In a frequency re-use scheme, the same frequency is re-used numerous times over different geographical areas, much like cellular phone technology (GSM cells)

Frequency re-use increases spectrum efficiency which directly translates into increased throughput

Ka-band allows for frequency re-use on satellites because of its high frequency

- ✓ In the example shown, the “Yellow” frequency is used 17 times

Frequency Re-use

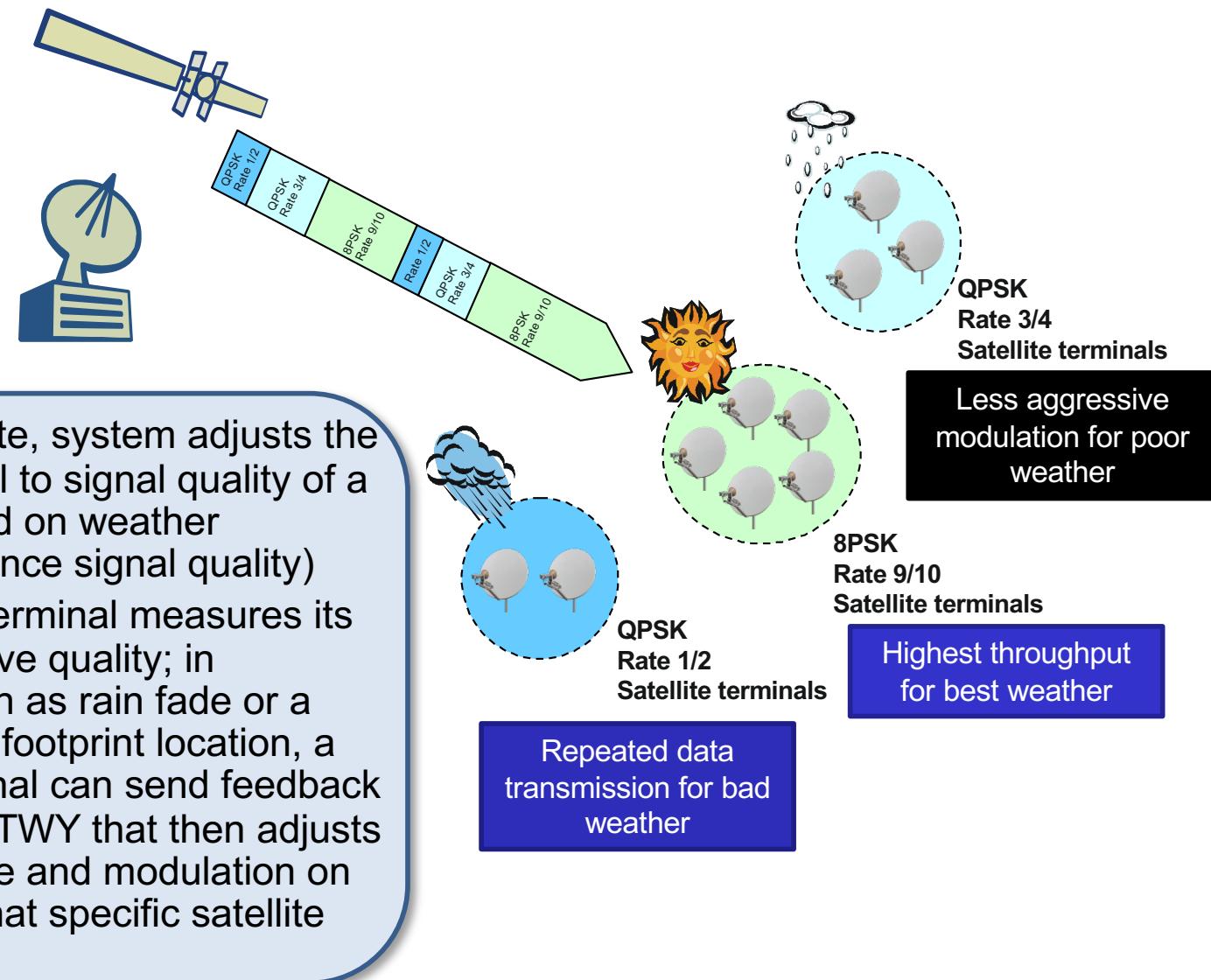


Higher Throughput



Lower cost per bit

Adaptive Coding and Modulation (ACM)



Main Ka-band systems in Europe

System	Commercial offer	Terminal	System availability	Link Availability*	Service Performance	Service Cost
Ka-SAT	Green	Green	Green	Green	Green	Green
Hylas 2	Yellow	Green	Green	White	Green	White
Inmarsat 5	White	Yellow	Green	White	Green	White
Athena Fidus	Red	Yellow	Green	Green	Yellow	White
Astra 2E/2F	Green	Green	Green	White	Yellow	Green
O3b	Red	Red	Yellow	White	Green	White

Good

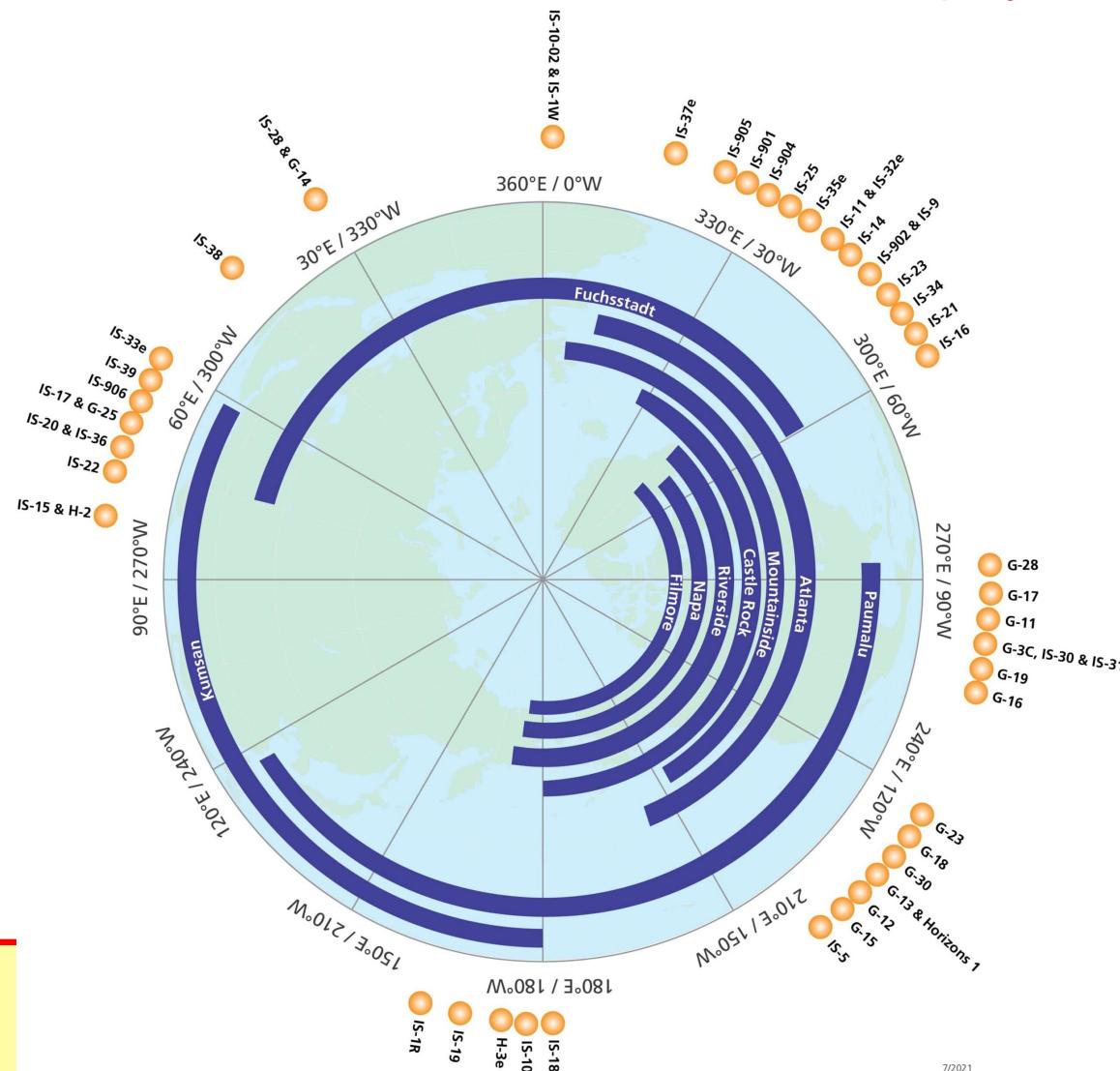
Fair

Bad

Intelsat

INTELSAT's global fleet consists of 50 geostationary satellites.

Total Revenue: \$2.472 billion in 2014. Employees Staff: 1100.



8 teleports

- Atlanta
- Castel Rock
- Fillmore
- Fuchsstadt
- Hagerstown
- Napa
- Paumalu
- Riverside

Atlantic Ocean Region		
Satellite	Orbital Location	Configuration
<u>Intelsat 10-02</u>	359°E	C- & Ku-band wide beams
<u>Intelsat 11</u>	317°E	C-band wide beams
<u>Intelsat 14</u>	315°E	C- & Ku-band wide beams
<u>Intelsat 16</u>	302°E	Customer Proprietary
<u>Intelsat 1W</u>	1W°	Ku-band wide beams
<u>Intelsat 21</u>	302°E	C- & Ku-band wide beams
<u>Intelsat 23</u>	307°E	C- & Ku-band wide beams
<u>Intelsat 25</u>	328.5°E	C- & Ku-band wide beams
<u>Intelsat 32e</u>	317°E	Ku-band High throughput Intelsat Epic spot beams
<u>Intelsat 34</u>	304.5°E	C- & Ku-band wide beams
<u>Intelsat 35e</u>	325.5°E	C-band High throughput Intelsat Epic spot beams, Ku-band wide beams
<u>Intelsat 37e</u>	342°E	Ku-band Multi-Spot, Algeria & Steerable Beams
<u>Intelsat 901</u>	332.5°E	C- & Ku-band wide beams
<u>Intelsat 902</u>	310°E	C- & Ku-band wide beams, KU-band spot beams
<u>Intelsat 904</u>	330.5°E	C-band Hemi, Ku-band spot beams
<u>Intelsat 905</u>	335.5°E	C- & Ku-band wide beams

Americas Region

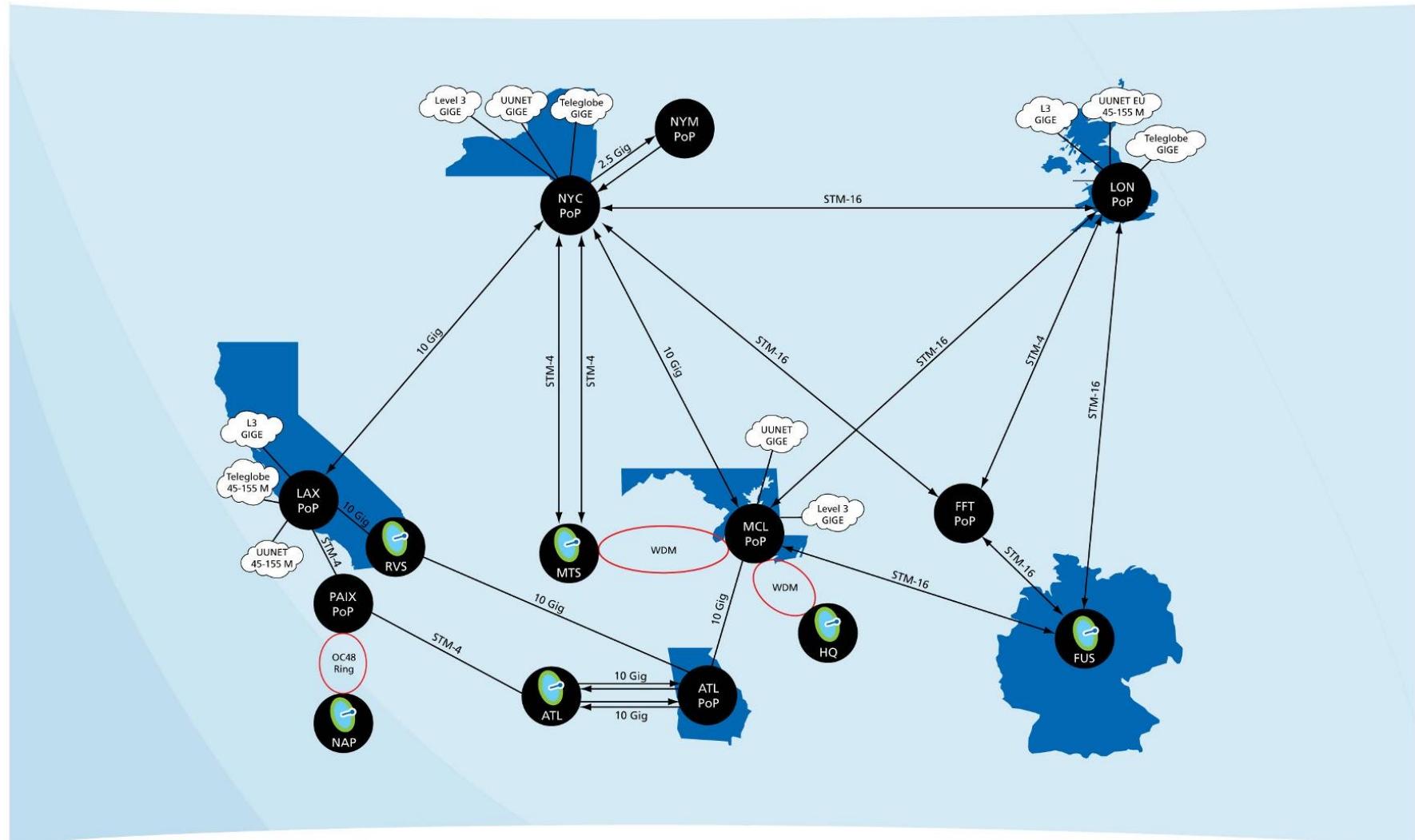
Satellite	Orbital Location	Configuration
<u>Galaxy 12</u>	129°W	C-band wide beams
<u>Galaxy 13</u>	127°W	C-band wide beams
<u>Horizons 1</u>	127°W	Ku-band wide beams
<u>Galaxy 11</u>	93°W	Ku-band wide beams
<u>Galaxy 14</u>	125°W	C-band wide beams
<u>Galaxy 15</u>	133°W	C-band wide beams
<u>Galaxy 16</u>	99°W	C- & Ku-band wide beams
<u>Galaxy 17</u>	91°W	C- & Ku-band wide beams
<u>Galaxy 18</u>	123°W	C- & Ku-band wide beams
<u>Galaxy 19</u>	97°W	C- & Ku-band wide beams
<u>Galaxy 23</u>	121°W	C-band wide beams
<u>Galaxy 28</u>	89°W	C- & Ku-band wide beams
<u>Galaxy 30</u>	125°W	C- band wide beams, Ka- & Ku-steerable spot beams
<u>Galaxy 3C</u>	95°W	C- & Ku-band wide beams
<u>Intelsat 30</u>	95°W	C-band global wide beams
<u>Intelsat 31</u>	95°W	C-band global wide beams
<u>Intelsat 5</u>	137°W	C- & Ku-band wide beams

Indian Ocean Region		
Satellite	Orbital Location	Configuration
<u>Intelsat 10</u>	47.5°E	C- & Ku-band wide beams
<u>Intelsat 17</u>	66°E	C- & Ku-band wide beams
<u>Intelsat 20</u>	68.5°E	C- & Ka- & Ku-band wide beams
<u>Intelsat 22</u>	72°E	C- & Ku-band wide beams
<u>Intelsat 28</u>	33°E	Ku-band wide beams
<u>Intelsat 33e</u>	60°E	Ku-band High throughput Intelsat Epic spot beams, C- & Ka-band wide beams
<u>Intelsat 36</u>	68.5°E	C- & Ka- & Ku-band wide beams
<u>Intelsat 38</u>	45°E	Ku-band spot &wide beams
<u>Intelsat 39</u>	62°E	Ku-band High throughput Intelsat Epic
<u>Intelsat 906</u>	64°E	C- & Ku-band wide beams, Ku-band spot beams
<u>Galaxy 25</u>	33°E	C- & Ku-band wide beams

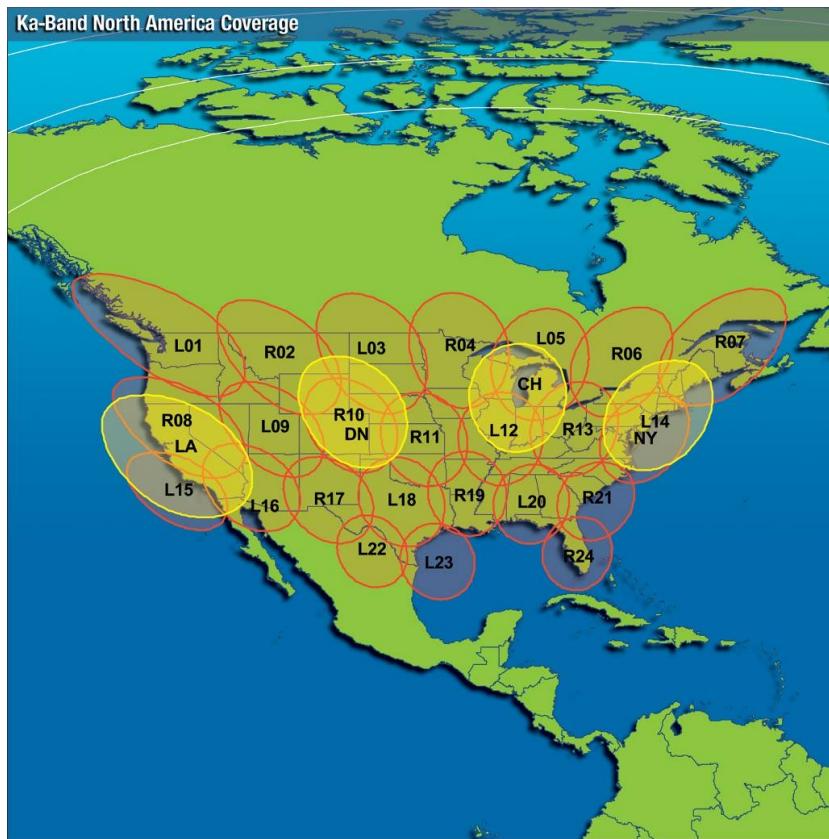
Asia Pacific Region		
Satellite	Orbital Location	Configuration
<u>Horizon 2</u>	85°E	C-band wide beams
<u>Intelsat 15</u>	85°E	Ku-band wide beams

Pacific Ocean Region		
Satellite	Orbital Location	Configuration
<u>Horizons 3e</u>	169°E	C- & Ku-band wide beams
<u>Intelsat 18</u>	180°E	C- & Ku-band wide beams
<u>Intelsat 19</u>	166°E	C- & Ku-band wide beams
<u>Intelsat 1R</u>	157°E	Ku-band wide beams

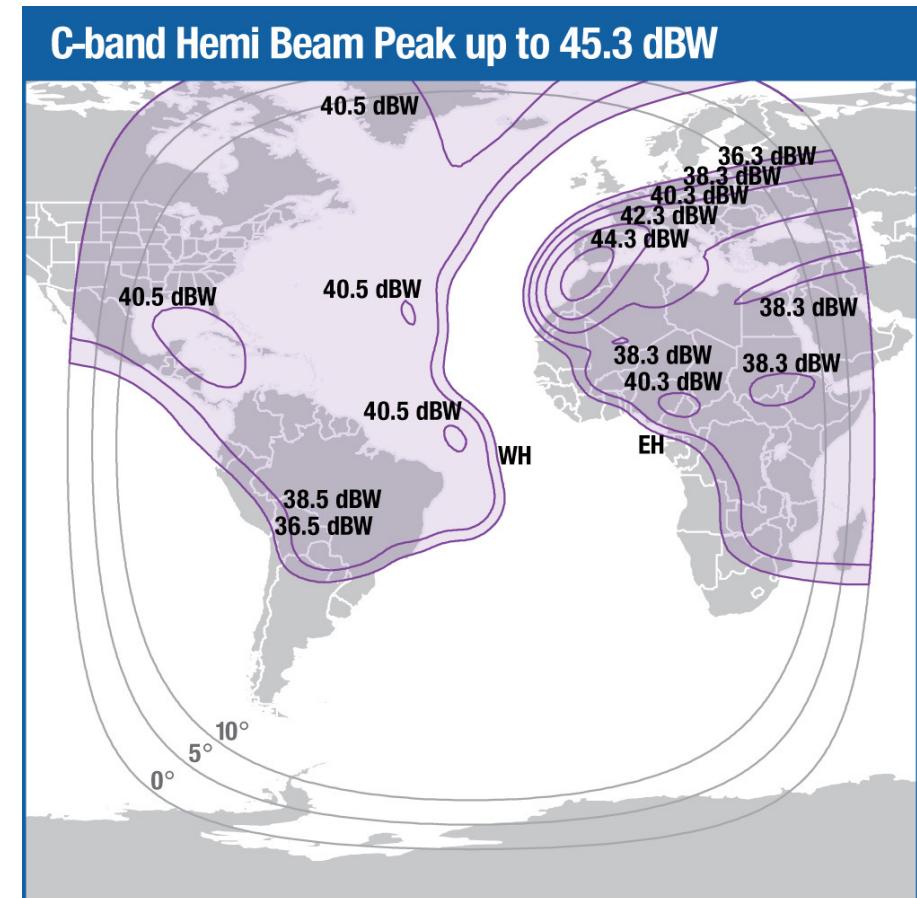
Intelsat GXS® Fiber Network



G-28 at 89° W – Ka-Band (Formerly IA-8)



904 at 330.5° E (C-Ku band)



Key parameters

- **Polarization** → C-Band: circular
Ku-Band: linear
- **Uplink Frequency** → C-Band: 5850 to 6425 MHz
Ku-Band: 14 to 14.5 GHz
- **Downlink frequency** → C-Band: 3700 to 4200 MHz
Ku-Band: 10.95 to 11.20 / 11.45 to 11.70 GHz
- **Typical G/T range** → Global beam: -7.2 to -11.2 dB/K
Hemi beam: -4.1 to -6.6 dB/K
Zone beam: +2.2 to +0.5 dB/K
Ku spot: +6 to +0 dB/K

Intelsat's gateways

More than 2000 fixed and transportable earth stations accessing INTELSAT's global connectivity and service. Earth stations are owned and operated by customers.

Depending on the earth station's size and service, the technical parameters it must meet will "qualify" it for acceptance within a particular INTELSAT "standard". The following is a list of INTELSAT standard earth stations and their typical capabilities.



INTELSAT's Earth station

Size and capabilities

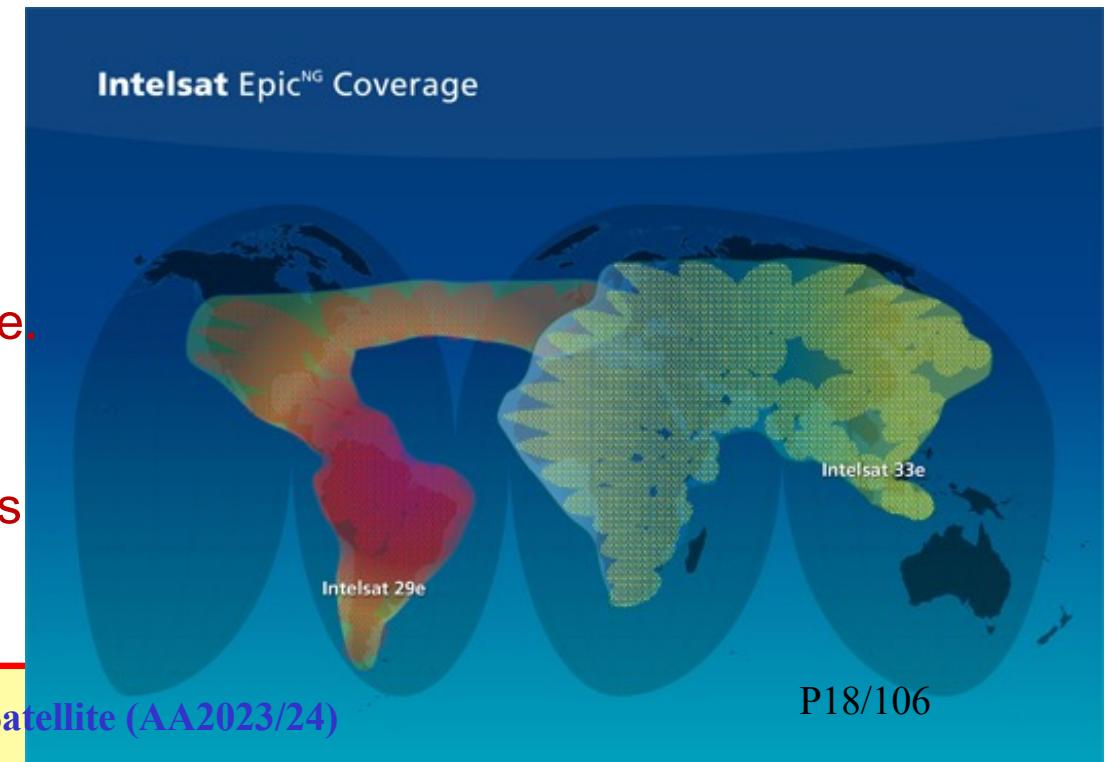
E/S standard	Antenna size	Type of service	Frequency band
A	15 – 18	Voice, TV, data , IBS and IDR	6/4
C	11 – 14	Voice, TV, data, IBS and IDR	14/11
F3	9 – 10	Voice, TV, data, IBS and IDR	6/4
G	All sizes	International and domestic lease service	6/4, 14/11 & 14/12

SIT/SUT space system

- Satellite Interactive Terminals (SIT) are used for receptions of audio-visual signals as well as data and for providing a return channel for interactive services the satellite. SIT using satellite in geostationary orbit operating.
 - SIT reception in the fixed satellite service frequency ranges from 10.7 to 11.7 GHz and from 12.5 to 12.75 GHz.
 - SIT transmission in the frequency band from 29.5 to 30 GHz.
- Satellite User Terminals (SUT) are used mainly for transmission and reception of data signals
 - SUT reception in the fixed satellite service frequency ranges from 19.7 to 20.2 GHz.
 - SUT transmission in the frequency band from 29.5 to 30 GHz.
- Satellite's orbit: geostationary
- Polarization: linear o circular
- Signal: analogue or digital
- Antenna diameter: not exceed 1.8 m

Intelsat Epic^{NG} High Throughput Satellite (HTS)

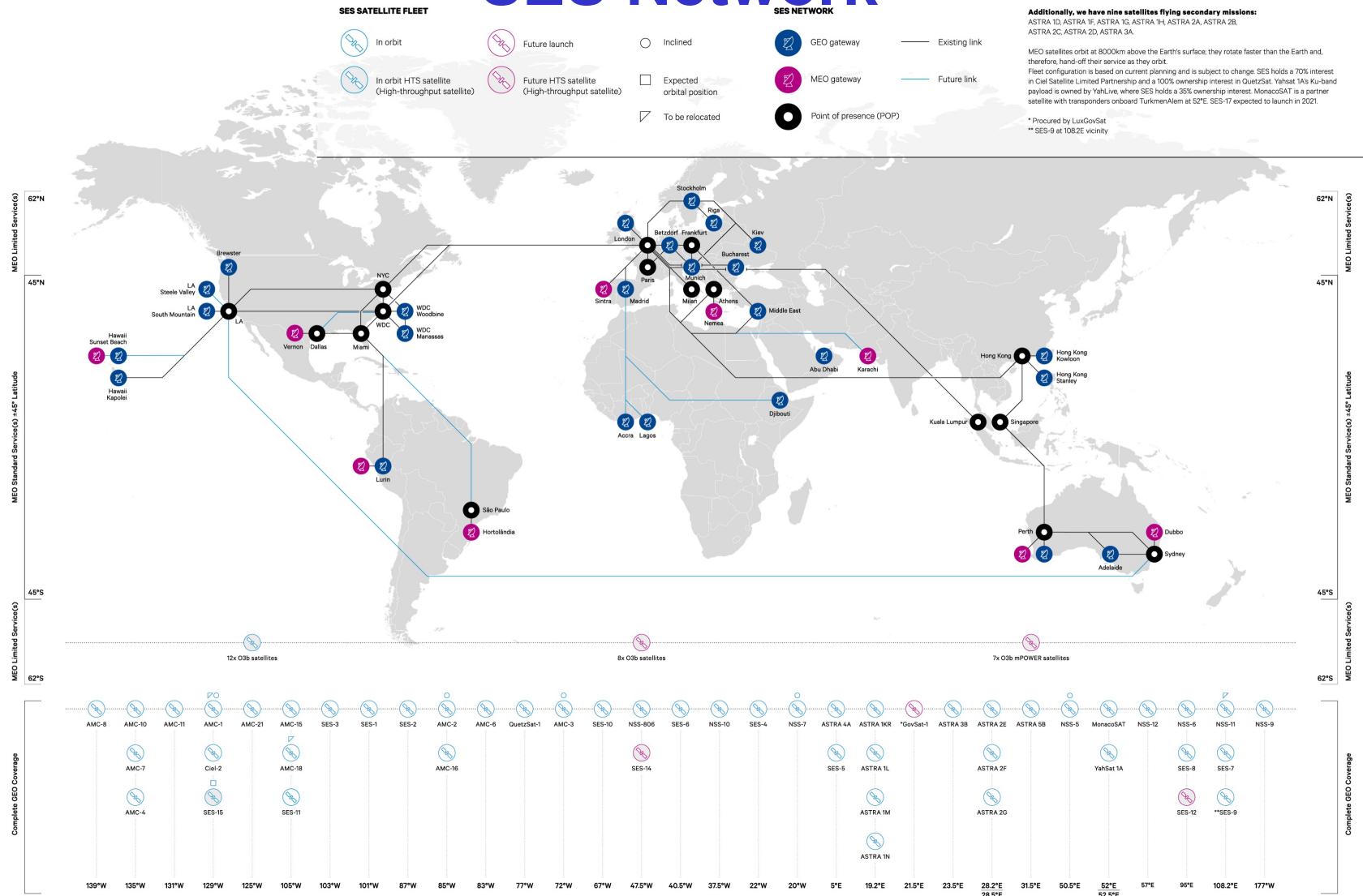
- High performance, next generation satellite platform that delivers global high-throughput technology.
- Innovative approach to satellite and network architecture utilizing C-, Ku- and Ka-bands, wide beams, spot beams, and frequency reuse technology to provide a host of customer-centric benefits.
- Complementary overlay to the world's largest fixed satellite network, it will be fully integrated with Intelsat's existing satellite fleet and global terrestrial network.
- Based on open architecture and engineered for backwards compatibility, allowing broadband, media, mobility and government organizations to realize the cost-efficiency of using existing hardware.
- Offers to end-users customized, differentiated solutions — even defining such service characteristics as speed, hardware and network topology.



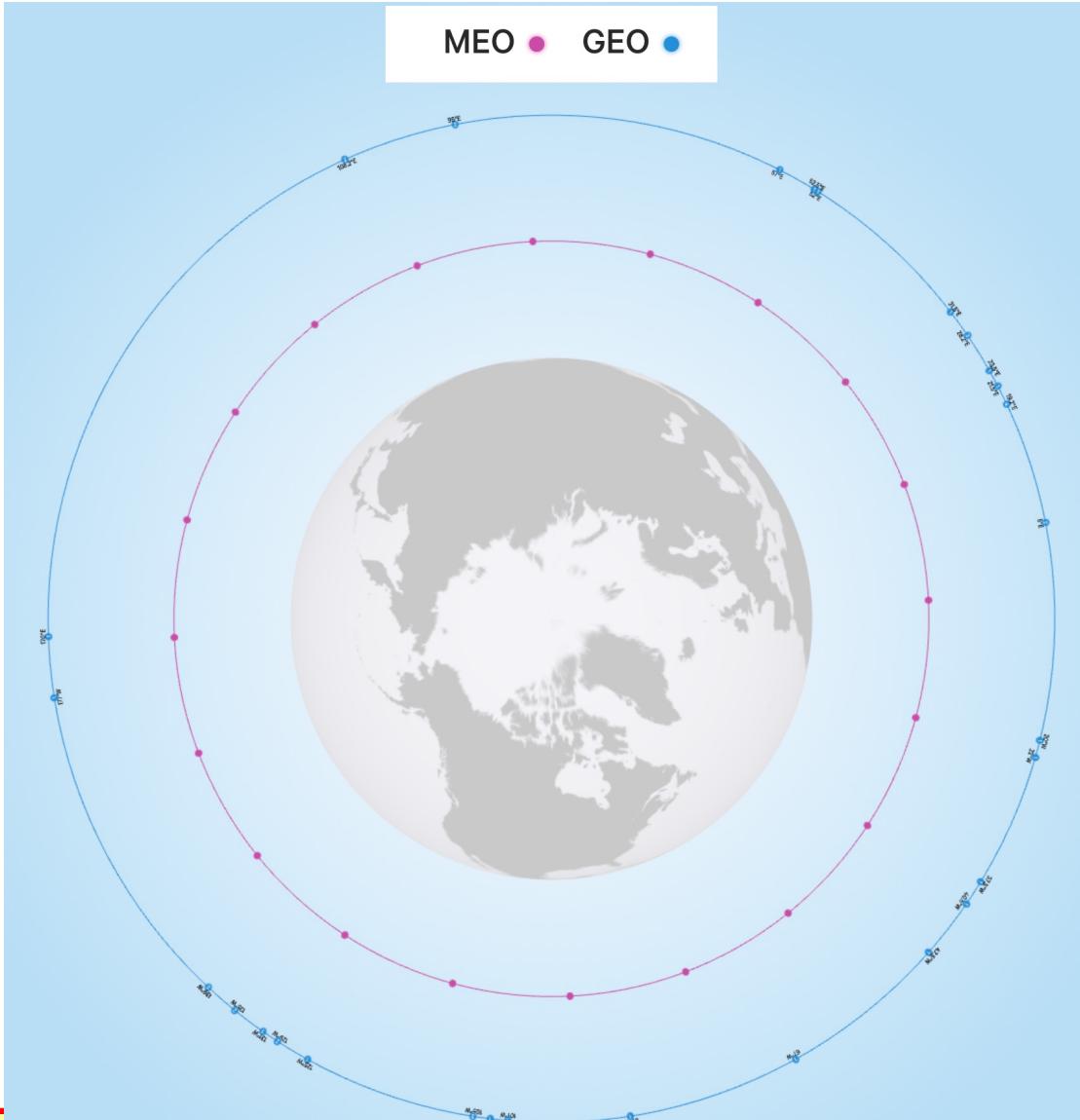
SES-GLOBAL

- SES Global is a network of satellite operators providing service in all the continents.
- They operate through
 - SES ASTRA in Europe,
 - SES NewSkies in Middle East, part of Asia, South America and Africa and
 - SES AMERICOM in North America.
- They also participate in satellite operators AsiaSat, SES Sirius, Nahuelsat and Star One.
- They offer a global coverage with a satellite fleet, composed of 50 satellites, reaching 99% of the world's population.

SES Network



SES Satellites



Internet via Satellite (AA2023/24)

Europe

ASTRA 1KR 19.2° E
ASTRA 1L 19.2° E
ASTRA 1M 19.2° E
ASTRA 1N 19.2° E
ASTRA 2E 28.2° E
ASTRA 2F 28.2° E
ASTRA 2G 28.2° E
ASTRA 3B 23.5° E
ASTRA 4A 5° E
GovSat-1 21.5° E
Monaco SAT 52° E
NSS-7 20° W
NSS-10 37.5° W
NSS-12 57° E
ASTRA 5B 31.5° E
GovSat-1 21.5° E
Monaco SAT 52° E
NSS-7 20° W
NSS-9 177° W
NSS-10 37.5° W
NSS-12 57° E
SES-4 22° W
SES-5 5° E

SES-6 40.5° W
SES-12 95° E
SES-14 47.5° W
YahSat 1A 52.5° E

Middle East

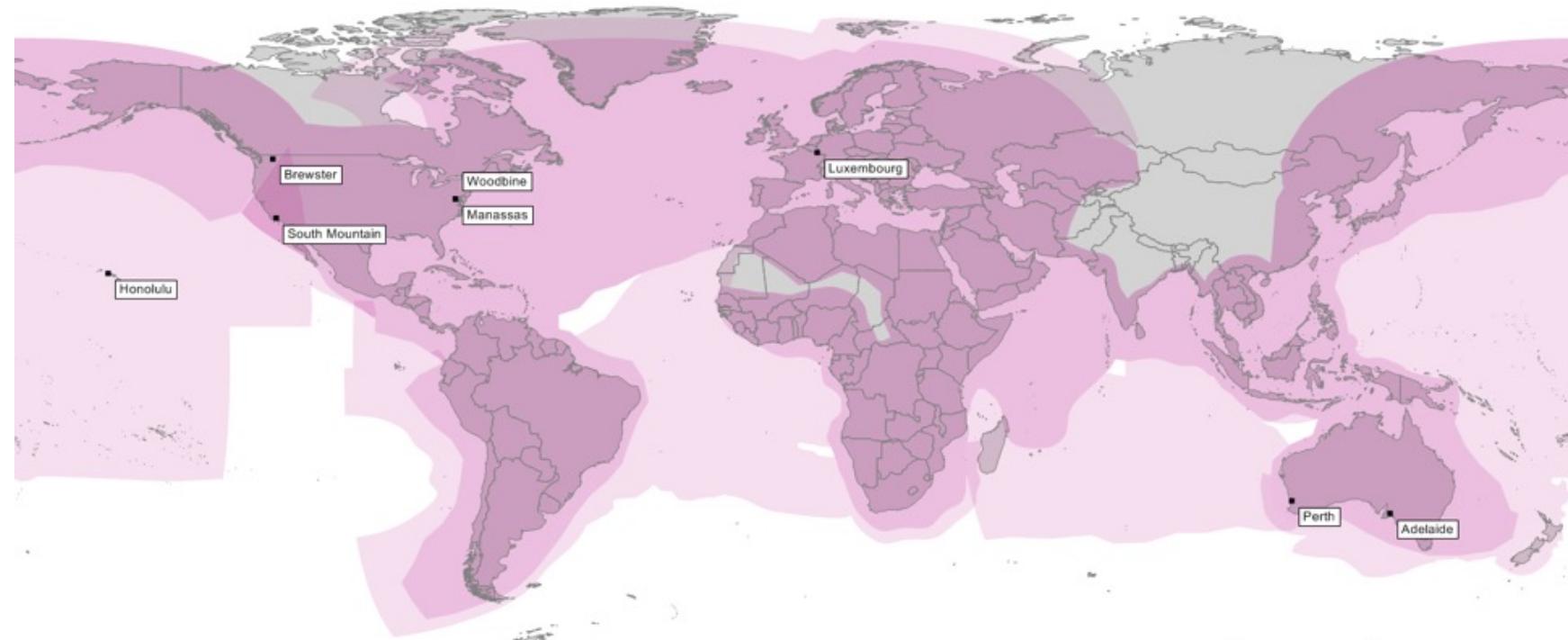
Africa

ASTRA 2E 28.2° E
ASTRA 2F 28.2° E
ASTRA 2G 28.2° E
ASTRA 3B 23.5° E
ASTRA 4A 5° E
GovSat-1 21.5° E
Monaco SAT 52° E
NSS-7 20° W
NSS-10 37.5° W
NSS-12 57° E
SES-4 22° W
SES-5 5° E
SES-12 95° E
SES-14 47.5° W
YahSat 1A 52.5° E

Asia Pacific

NSS-9 177° W
NSS-11 176° E
NSS-12 57° E
SES-7 108.2° E
SES-8 95° E
SES-9 108.2° E
SES-12 95° E

SES Ku band coverage



SERVICES

- SES Global mainly provides the following services:
 - Media broadcasting
 - Telecom
 - Maritime
 - Up to 8 Mbit/s high-speed internet access
 - Low-cost VOIP, data transfer, email and web browsing Maritime Ku-band antenna from 60 cm to 1.2m (KNS) or Ka-band 90 cm maritime antenna (EPAK), depending on service selection
 - Cutting-edge tracking antenna and compact below-deck equipment fitted by authorized marine dealers
 - Dedicated maritime solution with an always on connection
 - Aero
 - Energy
 - Mobile broadband solutions
 - Government services

SES-Astra services

- Broadcast Services, the analogical platform DTH is one of the largest in the world. It connects more than 102 million of homely customers with an access to 1.600 radio and TV channels.
- Broadband Services
- Services with Direct Cable, allows cable operators to offer broadband Internet services, high speed and low costs and to reach customers in all Europe.
- Governmental Services, satellite based specialized telecommunications solutions (bandwidth, infrastructures and network solutions) to governmental agencies, Public Administration and to their contractors;
- Technical Solutions, a large set of technical solutions to manufacturers in the satellite field, operators and to other typologies of customers involved in the engineering field;
- Support to the Customer,
- Total Solutions: broadcast audiovisual or broadband IP contents.

VIASAT

- **Viasat 1**
 - Ten times the throughput of any previous Ka-band satellite (140 Gbit/s total throughput capacity)
 - Covers North America and Hawaii, enabling a variety of new, satellite services beginning with Exede Internet in the U.S. and Xplornet in Canada
 - The only system to economically deliver internet multimedia
 - In-orbit costs per gigabyte only a fraction of other satellites
 - New ability to compete with terrestrial broadband IP services – about 40% of new residential subscribers have other alternatives
 - Always outpacing the capacity of Ku-band
- **Viasat 2**
 - designed to double the bandwidth economics advantage of Viasat-1, double the throughput, and provide seven times the coverage.
 - It will include coverage bridging the North Atlantic, adding contiguous high-capacity coverage over all of North America, Europe, and the Mediterranean basin.

VIASAT

- **Viasat 3**
 - Delivering a 100+ Mbit/s residential internet service, enabling 4K ultra-high definition video streaming.
 - Supporting aircraft with hundreds of Mbit/s of in-flight connectivity services and video streaming for commercial airlines, business jets, and high-value government transport.
 - Providing up to 1 Gbit/s speeds for use in maritime, oceanic and other corporate enterprise applications such as oil and gas platforms.
 - Offering affordable satellite Wi-Fi connectivity to the billions of unconnected people in emerging markets.
 - **ViaSat-3 satellite had a mechanical deployment issue with its reflector array after the satellite launched in April 2023**
 - They expect to recover less than 10% of the throughput of the satellite, but no replacement satellite will be built.
 - The company's stock fell precipitously after disclosing the issue. Pre-launch it was trading around \$35. After the launch it was trading around \$45 and then it's trading around \$16.

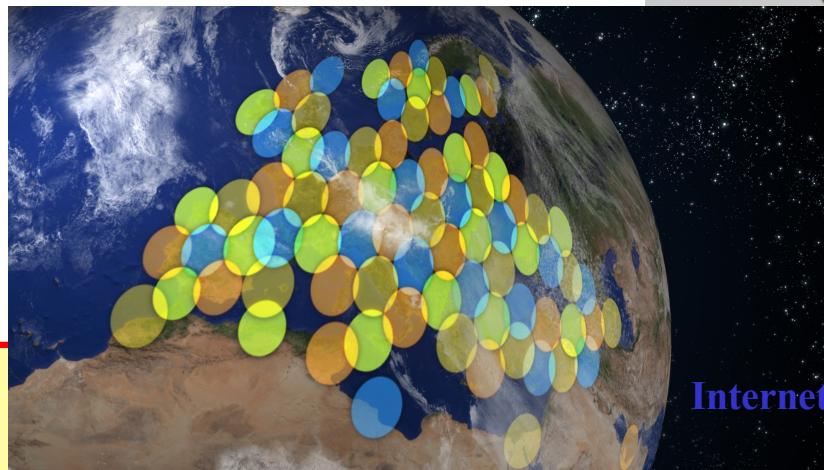
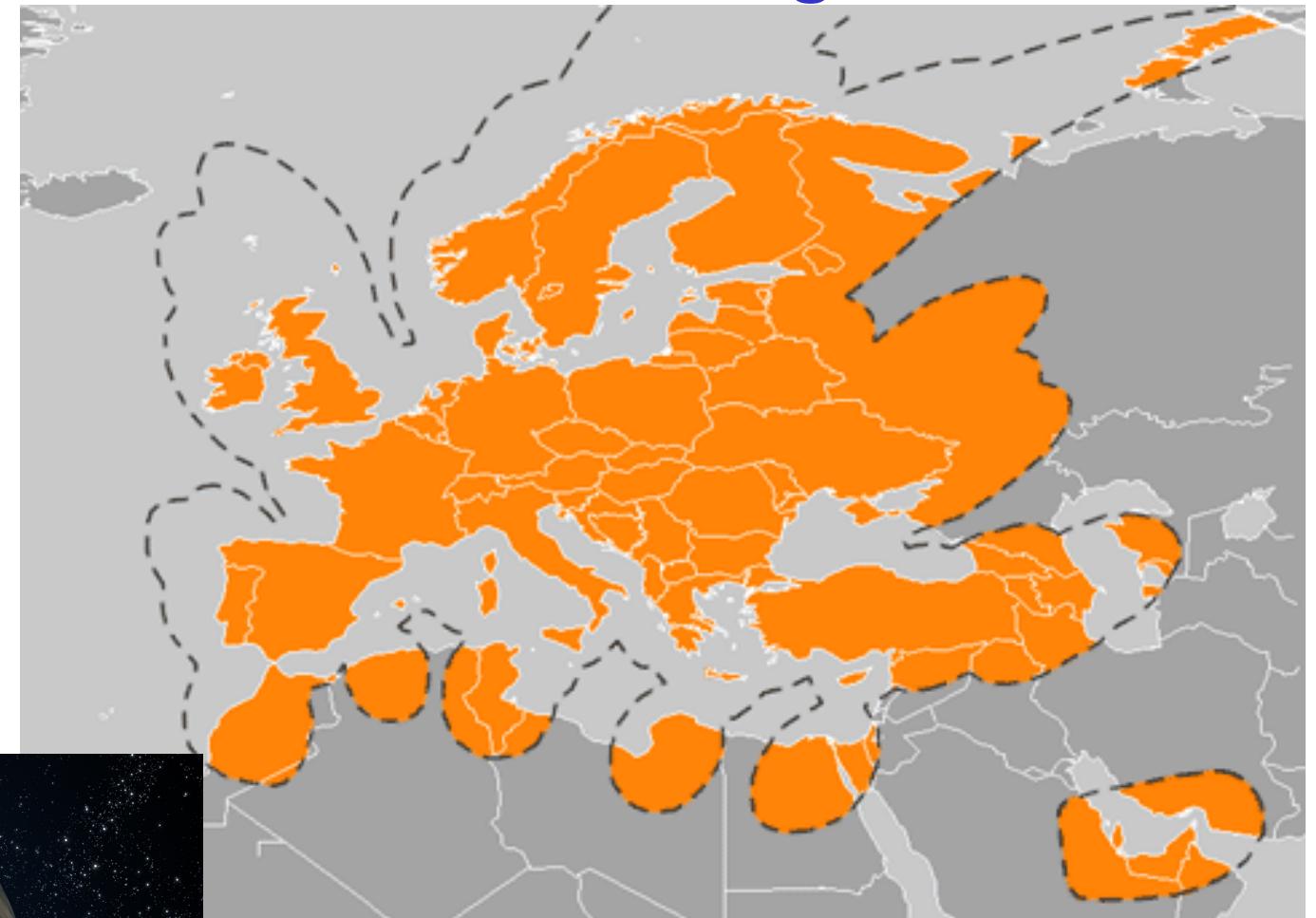
Ka Sat

- High Throughput Satellite (HTS)
- Multi-spotbeam high-capacity satellite
- 82 narrow Ka-band spot beams
- 10 ground stations
- Frequencies reused 20 times
- Total throughput to beyond 70 Gbit/s
- The ground network uses ViaSat's SurfBeam technology, similar to the solution powering broadband connectivity for almost 450,000 satellite homes in North America
- Fast internet
 - up to 10 Mbit/s downstream and 4 Mbit/s upstream
- professional for higher volume and bandwidth
 - up to 40 Mbit/s downstream and 10 Mbit/s upstream

Ka-Sat channelization

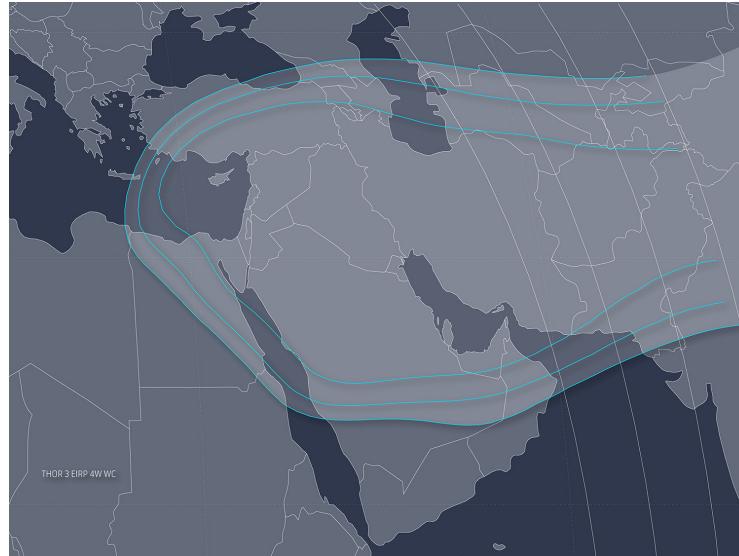
- The following Modulation/coding schemes are allowed on the return link:
 - 8PSK Rate 7/12, 2/3, 3/4;
 - QPSK Rate 3/8, 1/2, 5/8;
 - BPSK Rate 1/2.
- Therefore, typical Symbol rate to Bitrate mapping is the following:
 - 10 MSym/s → 20 Mbit/s (*) - 22.5 Mbit/s
 - 5 MSym/s → 10 Mbit/s - 11.25 Mbit/s
 - 2.5 MSym/s → 5 Mbit /s - 5.625 Mbit/s
 - 1.25 MSym/s → 2.5 Mbit/s
 - 0.625 MSym/s → 1.25 Mbit/s, 937 kbit/s, 625 kbit/s, 312.5 kbit/s
 - (*) default for pro terminals under good propagation condition
- On the other hand, the KASAT forward link is characterized by the following parameters:
 - Modulation/Coding
 - 16-APSK Rate 2/3, 3/4, 4/5, 5/6, 8/9;
 - 8PSK Rate 3/5, 2/3, 3/4, 5/6;
 - QPSK Rate 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5, 5/6
 - Adaptive Coding and Modulation (ACM)
 - Symbol Rate from 10 to 52 MSym/s

Ka band Down link coverage



TELENOR

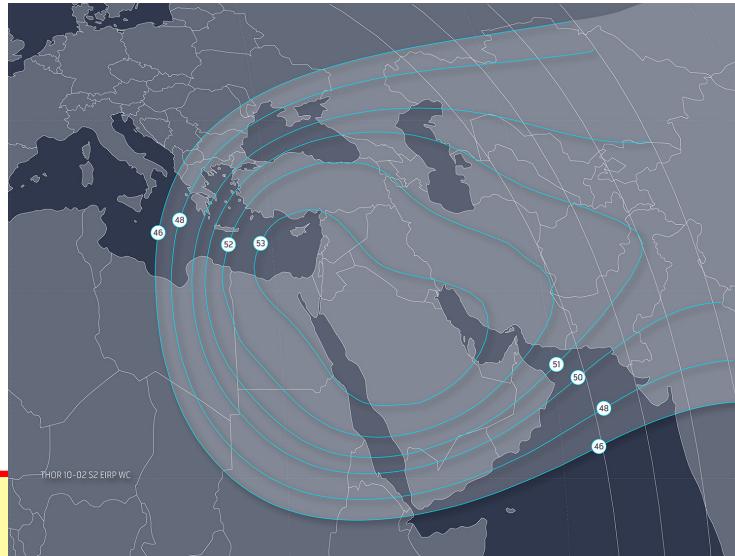
Thor III



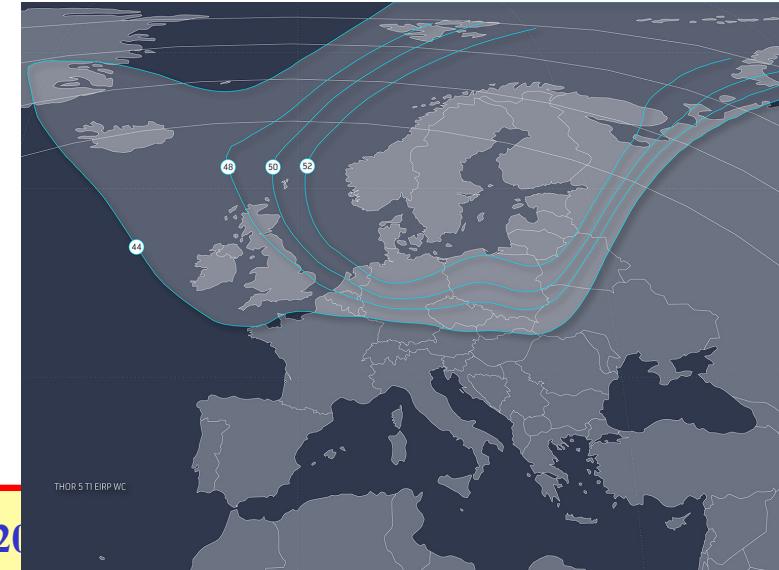
Thor 10 02 S1



Thor 10 02 S2



Thor 5 T1

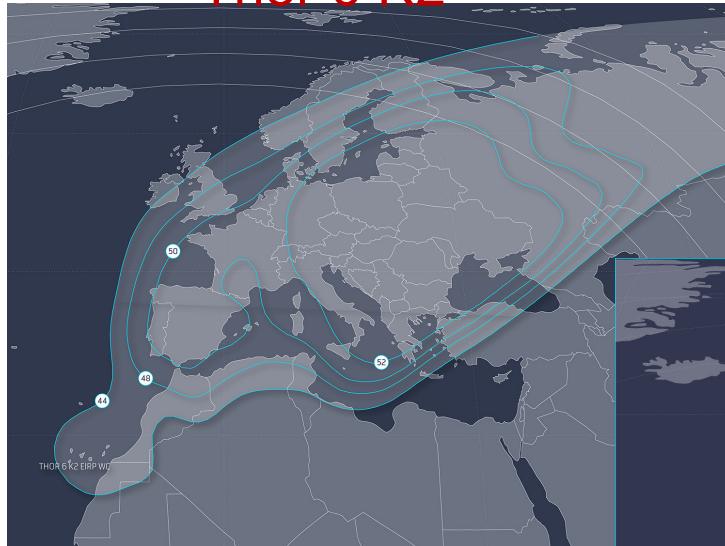


Satellite (AA20)

Thor 5 T2

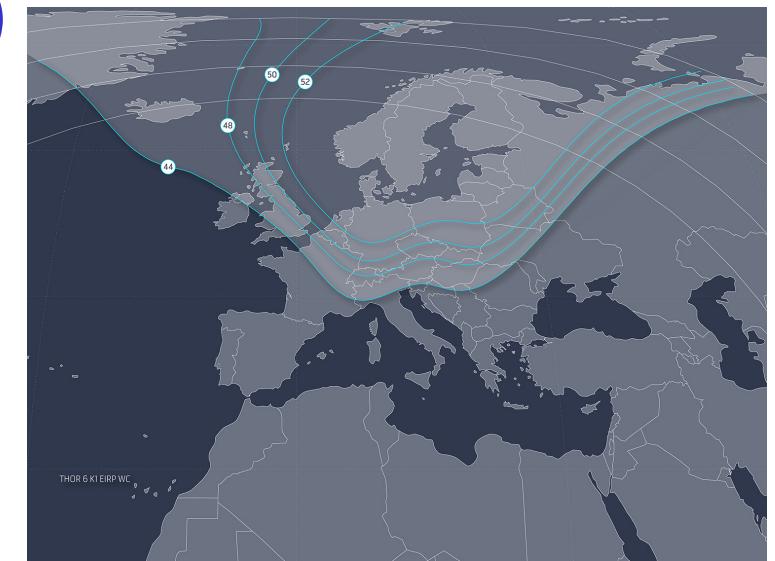


Thor 6 K2

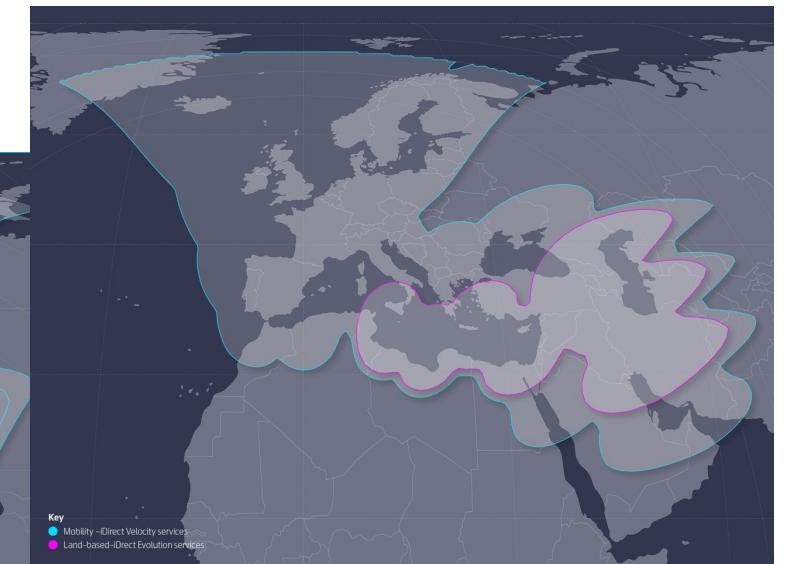
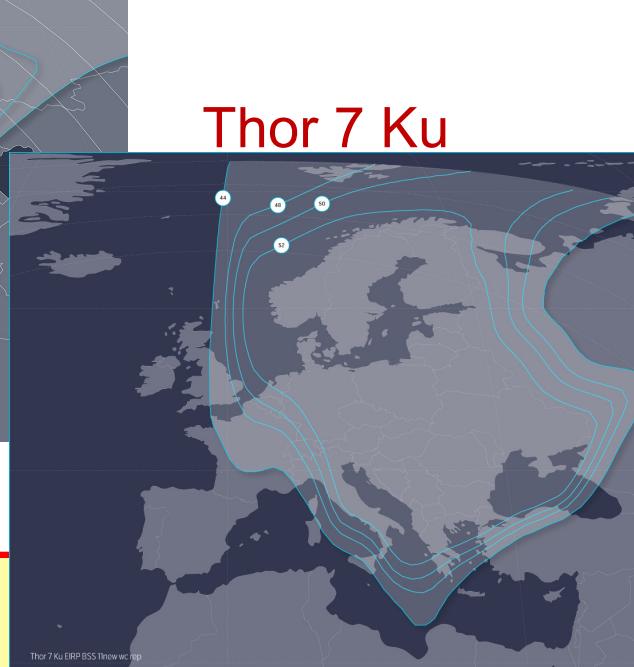


TELE NOR (2)

Thor 6 K1



Thor 7 Ka



Telenor teleports

- Nittedal
- London
- Cyprus



Eutelsat

- One of greater worldwide satellite infrastructures providers.
- It offers capacity with 36 satellites to more than 150 countries and more than 90% of the worldwide population.
- The Eutelsat satellites offer a wide set of services:
 - television and radio for public consumers,
 - professional video services,
 - networks corporative,
 - Internet services and
 - mobile communications.
- It also has developed a set of broadband services for local, individual and business communities,
- It has opened a teleport, Skylogic Italy, to support wideband services through multimedia platforms.
- Mainly from the orbital position of HOT BIRD™, Eutelsat transmits more than 1400 TV channels to about 110 million of customers connected to a network cable or equipped for the reception directed to house.

Services

- Broadcast & Media
- Video hotspots
- Broadcast services
- Data & Telecom
- Carrier networks
- Eutelsat Broadband
- Enterprise broadband
- Mobility
- Consumer broadband
- Government

The fleet (1)

133°W	117°W	115°W	113°W	65°W	12°W	8°W	7°W	5°W	3°E	7°E	10°E
133 West A	117 West A	115 West B	113 West A	65 West A	12 West B	8 West B	7 West A	5 West A	3B	7B	10A
	117 West B							5 West B		7C	
America s	Americas	America s	America s	America s	America s, Europe	Africa, MENA	Africa, MENA	Africa, Americ as, Europe, MENA	Africa, Americ as, Central Asia, Europe, MENA, Russia & CIS	Africa , Centr al Asia, Euro pe, MEN A	Africa , Centr al Asia, Euro pe, MEN A
Data, Mobility	Broadband , Data, Governme nt, Video	Broadba nd, Data, Govern ment, Mobility, Video	Video	Broadba nd, Data, Govern ment, Video	Mobility, Video	Data, Governm ent, Video	Data, Govern ment, Video	Broadb and, Data, Video	Data, Govern ment, Mobility, Video	Broadban d, Data, Gover nme nt, Video	Broadban d, Data, Gove rnme nt, Mobili ty, Video

The fleet (2)

13°E	16°E	21°E	28°E	33°E	36°E	48°E	53°E	56°E	70°E	140°E	172°E	174°E
Hotbird 13B	16A	21B	28E	33E	36B	48D	53A	Express AT1	70B	Express AT2	172B	174A
Hotbird 13C			28F		36C	AFGH ANSAT 1						
Hotbird 13E			28G									
Europe , MENA	Africa, Europe , MENA	Central Asia, Europe , MENA	Europe	Europe , MENA	Africa, Central Asia, Russia & CIS	Central Asia, MENA	Central Asia, Europe , MENA	Russia & CIS	Africa, Asia Pacific, Central Asia, Europe , MENA	Russia & CIS	Americas, Asia Pacific	Asia Pacific
Video	Data, Government, Video	Broadband, Data, Government, Video	Video	Data, Video	Broadband, Data, Video	Broadband, Data, Government, Video	Data	Video	Broadband, Data, Government, Mobility , Video	Video	Data, Government, Mobility	Data, Government, Mobility

Hotbird

- HOT BIRD family provides total coverage to Europe and also to part of Africa, including the entire Middle East.
- About 100 million homely customers are equipped in order to see channels from HOT BIRD satellite, through the reception directed to house or via cable.
- The system provides more than 560 radio and multimedia services on the same coverage area.

Eurobird

- The EUROBIRD satellites provide broadcasting and telecommunications services mainly to Central-Western Europe from the orbital positions of 28.5° and 25.5° East.
- EUROBIRD 1 provides continuity for telecommunication services, previously guaranteed from satellite EUTELSAT II-F4, including business services, news distribution, television and radio programs.
- The W satellites serve a wide set of business users, including telecommunication companies, radio and television service providers, agencies of international news, industries and multimedia services distributor. The W series is also the dorsal network of the Eurovision and Euroradio networks for the exchange of television and radio programs at international level.

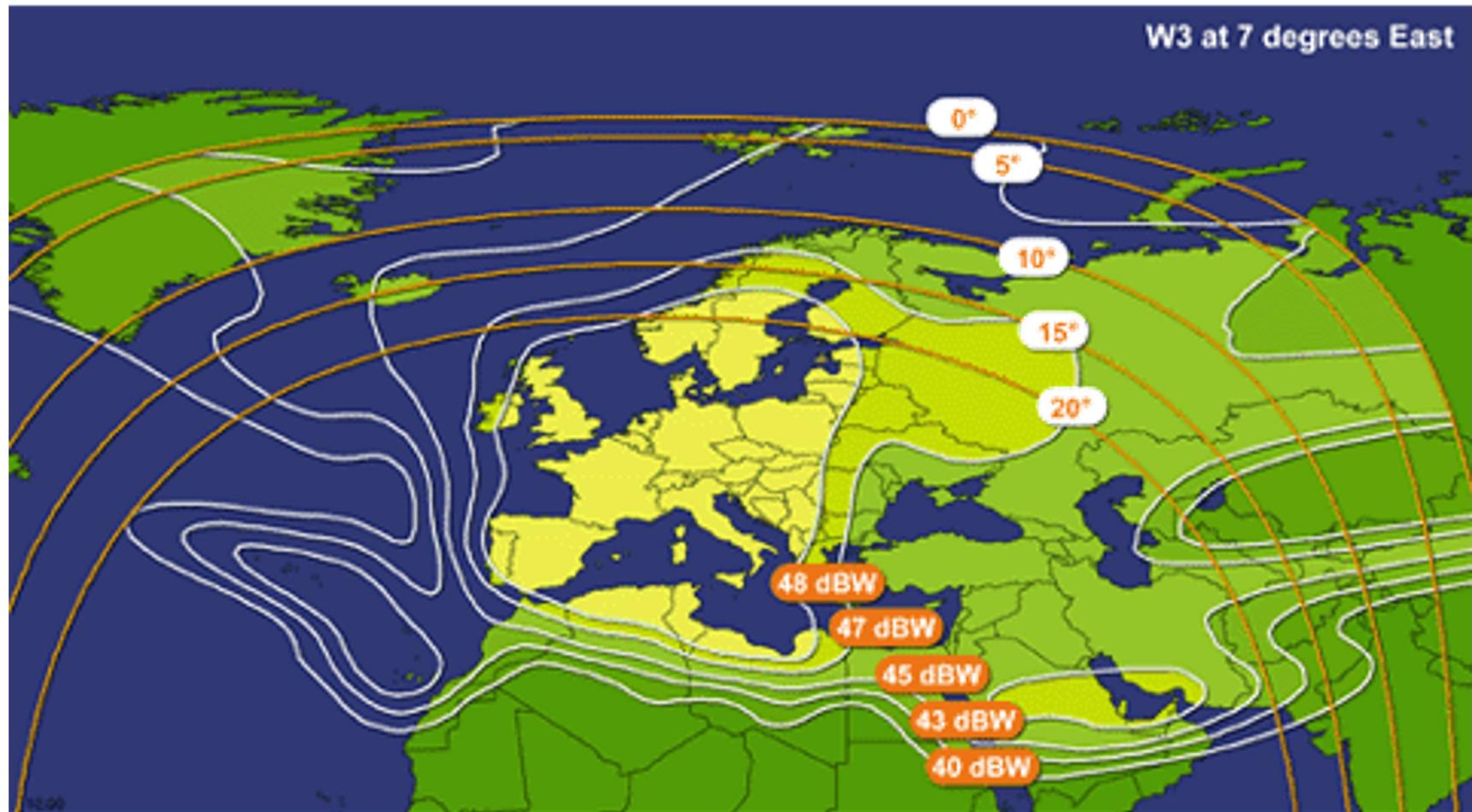
W series

- Composed of three telecommunications and television satellites to serve Europe, the Mediterranean basin and Central Asia. A fourth satellite, the W4, will serve Russia and Africa.
- Designed for direct-to-home television, cable headend delivery, terrestrial rebroadcast, satellite newsgathering, contribution services and special events, Internet backbone and distribution, multimedia services, VSAT networks, DAMA and TDMA services and EUTELTRACS mobile services.
- W1 and W3 can transmit at more than 48dBW over Western Europe and 45dBW within the Eurasian fixed coverage, enabling operation of digital services with small antennas, whilst W2, which has a reshaped antenna to provide higher inner-zone power, offers 50dBW over Western Europe.
- They also provide coverage of more than 53 dBW via steerable spot beams, enabling digital reception with 45 cm antennas

W series (cont'd)

- The initial three W satellites were used principally for telecommunications services, mainly public telephony, business services, satellite news gathering, television and radio programme exchanges by the European Broadcasting Union and the EUTELTRACS message and positioning land and maritime mobile service.
- W4 will provide new broadcasting capacity over Europe and Africa.
- The W satellites will also be used to complement EUTELSAT's offer for TV broadcast distribution services.
- W1 is designed to provide 28 channels, while W2 and W3 will offer 24 transponders. W4 will provide 32 transponders.

European Coverage Eutelsat W3 7° E (uplink)



SESAT

- SESAT satellites (Siberia and Europe) provide a wide set of services on a vast geographic area from the Atlantic Ocean to East Russia, including a great part of Siberia.
- The satellites offer also military services in the Indian sub-continent through directional beams.
- SESAT satellites, other than supporting new markets in East Europe and in South-Asia, guarantee also the inter-connection with central and western Europe.
- SESAT1, at 36° East (along with the satellite W4), contributes to the development of international, national and regional services, like the telephony and data services.
- SESAT2, at 53° East, distributes telecommunication, broadband and broadcasting services to Europe, Africa, Middle East and Central Asia.

Sesat

- Wide range of telecommunications and multimedia services over an enhanced wide beam coverage spanning from the Atlantic islands to eastern Russia and including North Africa and Saudi Arabia, with 18 transponders.
 - Distribution to cable head-ends and direct-to-home television
 - High-speed access to the Internet backbone
 - Delivery to UHF/VHF/MMDS retransmitters
 - Satellite news gathering and special events coverage
 - Trunk telephony services (TDMA and IDC) plus subscriber and rural telephony services delivered by new DAMA systems
 - Corporate communications via VSAT networks
 - The EUTELSAT mobile positioning and mobile service
- SESAT also ensures that EUTELSAT can supply continuity of service for telecommunications operators in western and central Europe already using the 36 degrees East position.

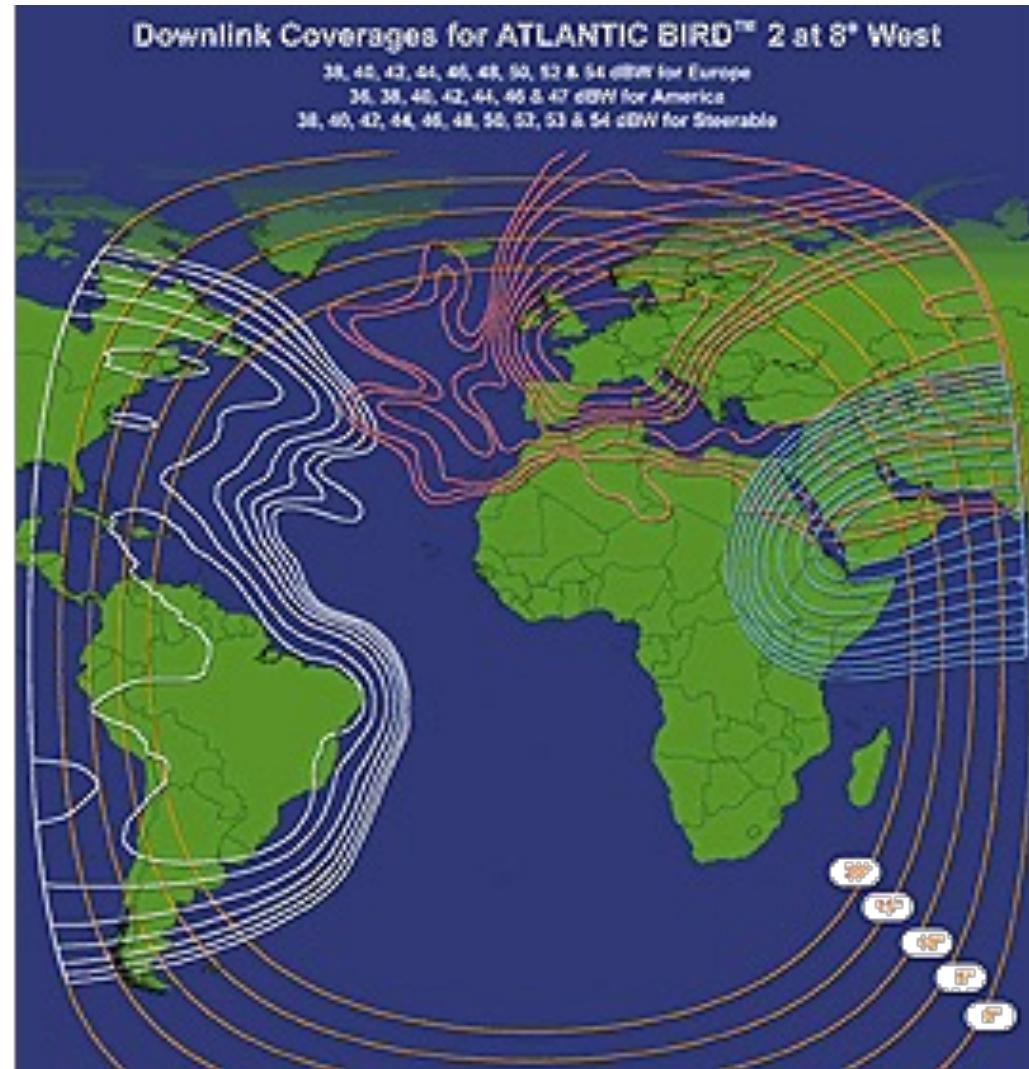
Sesat coverage



Atlantic gate

- Three satellite ATLANTIC BIRD in a region localized between 12.5° and 5° West
 - ATLANTIC BIRD 1, Ku band, 12.5° West,
 - ATLANTIC BIRD 2, Ku band, 8° West and
 - ATLANTIC BIRD 3, Ku and C band, 5° West.
- Wireless connection between the American continent, Europe, Africa and Western Asia.
- ATLANTIC BIRD 1 with 20 channels offers telecommunication services between Europe and America, connecting the two continents and providing a common virtual coverage.
- ATLANTIC BIRD 2 guarantees a coverage with high power in the American and European areas, allowing the coasts of the East America to reach directly the Central and Western Europe up to the Gulf.
- ATLANTIC BIRD 3 satellite allows to satisfy the market in C band with 10 transponders covering the entire African area.
- ATLANTIC GATE is suitable for video applications, IP and data.

Transatlantic coverage Eutelsat with AB2 8° W



e-Bird

- Launched in September 2003 at 33° East to provide coverage to Europe and Turkey through 4 beams with high power and 22 transponders in Ku band,
- It was the first satellite designed for broadband 2 way Internet services.
- Thanks to its position, it is able to offer broadband services also through small antennas.

Eutelsat Konnect VHTS

- Arianespace launched the Eutelsat Konnect VHTS satellite to support Eutelsat's expansion in the broadband business.
- Ariane 5 rocket from the Guiana Space Center in Kourou, French Guiana. The satellite was launched to Geostationary Transfer Orbit, and separated about 28 minutes after liftoff.
- This was one of the final missions for the workhorse Ariane 5 rocket. Only three Ariane 5 launches remain before its successor the Ariane 6 is set to enter service.
- “Eutelsat Konnect VHTS, built by Thales Alenia Space, offers capacity that will be able to connect underserved zones throughout Europe, providing them internet access, which underscores how Arianespace uses space to achieve a better life on Earth.
- Konnect VHTS is an important satellite for Eutelsat's plans in the broadband business. At 8.8 meters high weighing 6.4 metric tons, it is the largest satellite ever built by Thales Alenia Space, and will put 500 Gbps of capacity over Europe. It is based on the Thales Spacebus NEO all-electric propulsion platform, and Eutelsat said the payload has the most powerful digital processor in the world offering agile capacity allocation and optimized spectrum use.
- The satellite will provide broadband to underserved areas in Europe and support fixed and mobile telecommunications networks, on land, sea, or in the air. Konnect VHTS has several firmly committed customers for satellite broadband connectivity, including Orange via its Nordnet affiliate for the French coverage, Telecom Italia Mobile over Italy, and Thales Alenia Space to serve the government connectivity services.
- Eutelsat ordered the satellite in 2018 and it was originally due to enter into service in 2021, but has faced manufacturing delays from the pandemic. In February, Eutelsat delayed its planned entry into service to the second half of 2023, subsequently delaying the operator's return to growth strategy until 2023-2024.

Inmarsat Global Xpress

- Delivers seamless, high-speed broadband connectivity all around the world since December 2015.
- The GX constellation is made up of four Ka-band, high-speed mobile broadband communications satellites.
- Each I-5 satellite is expected to have a commercial life of 15 years.
 - I-5 F1 to serve Europe, the Middle East, Africa and Asia
 - I-5 F2 to serve the Americas and the Atlantic Ocean Region
 - I-5 F3 to serve the Pacific Ocean Region.
- The fourth Global Xpress satellite (I-5 F4) was launched to provide additional capacity.
- The fifth satellite in the Global Xpress fleet, GX5, launched on 26 November 2019 to deliver additional, focused capacity across Europe and the Middle East. GX5 will deliver more capacity than the entire GX1-GX4 fleet combined.
- Advanced Ka-band payloads (GX6A & 6B) will also be hosted on the next generation Inmarsat-6 (I-6) L-band satellites, scheduled for launch in 2020 and 2021. The I-6 fleet, together with advanced ground infrastructure technology, will support enhanced user devices and services for the coming 5G era.

Inmarsat GX family (GX5)

- Collaboration with Hughes for In Flight Connectivity (IFC)
- I6-F1 (launched December 2021, 5500 kg, L and Ka band, electric propulsion, 9 steerable antennas, video services)

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)
- 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.

HUGHES
SPACEWAY™

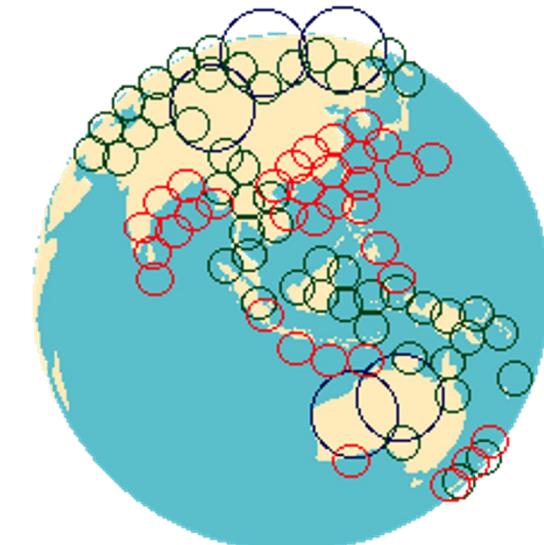
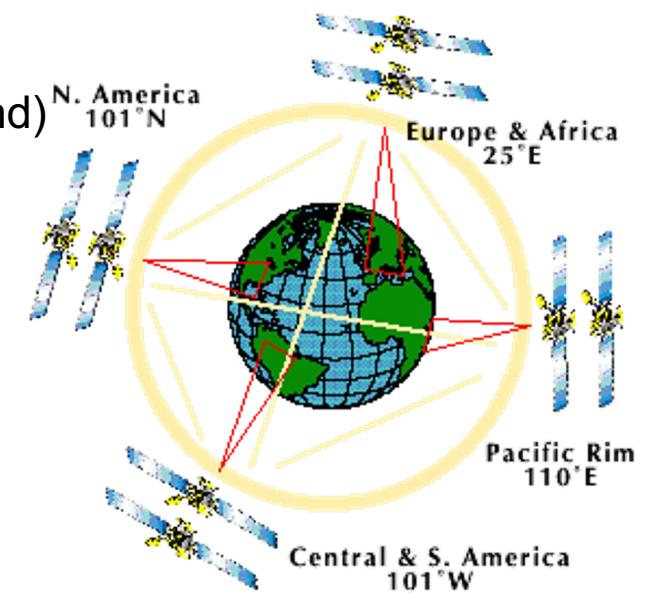


Figure 10: Aisa-Pacific
—Satellites 1, 2, 3, & 4



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.

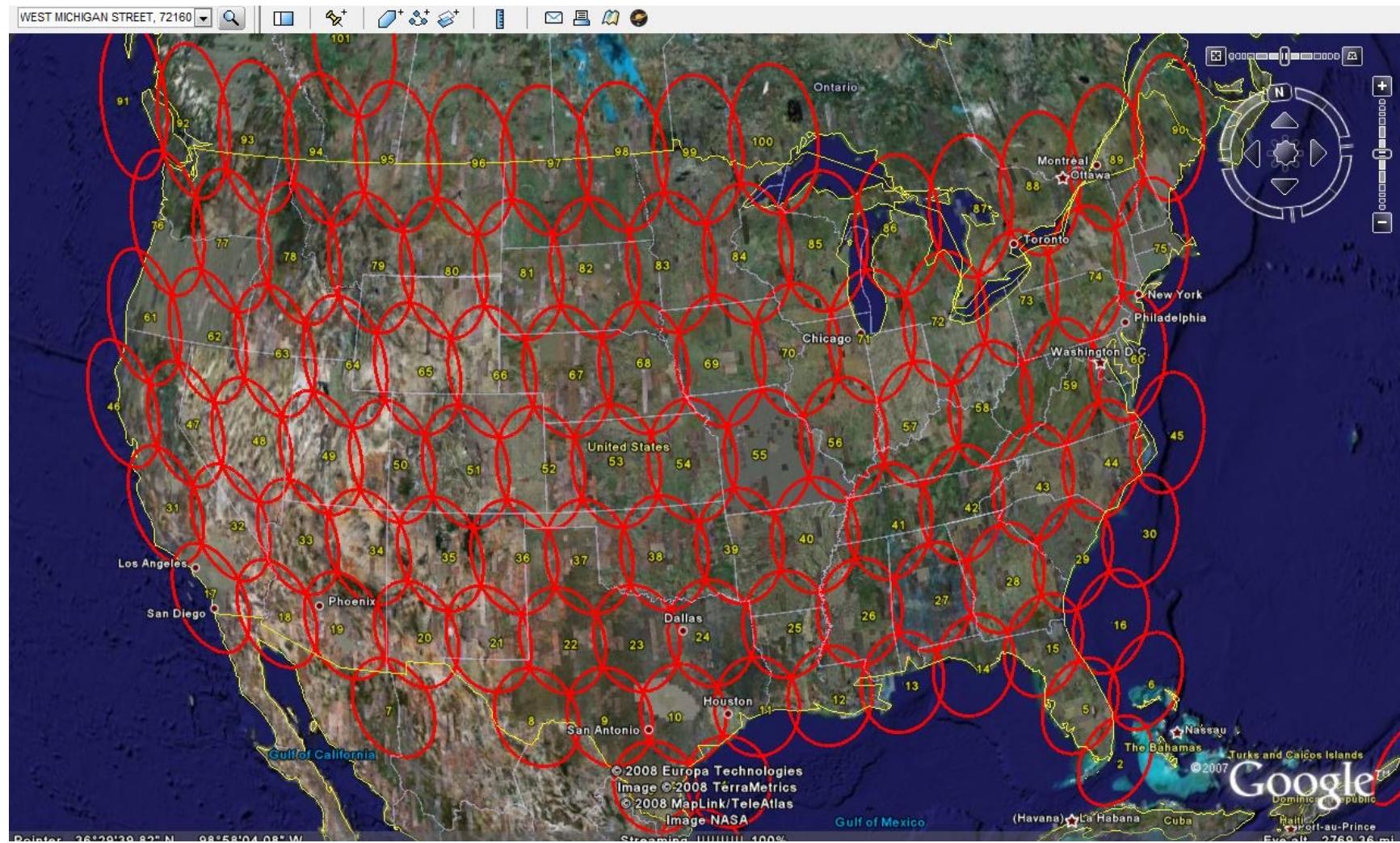
SPACEWAY 3

- 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

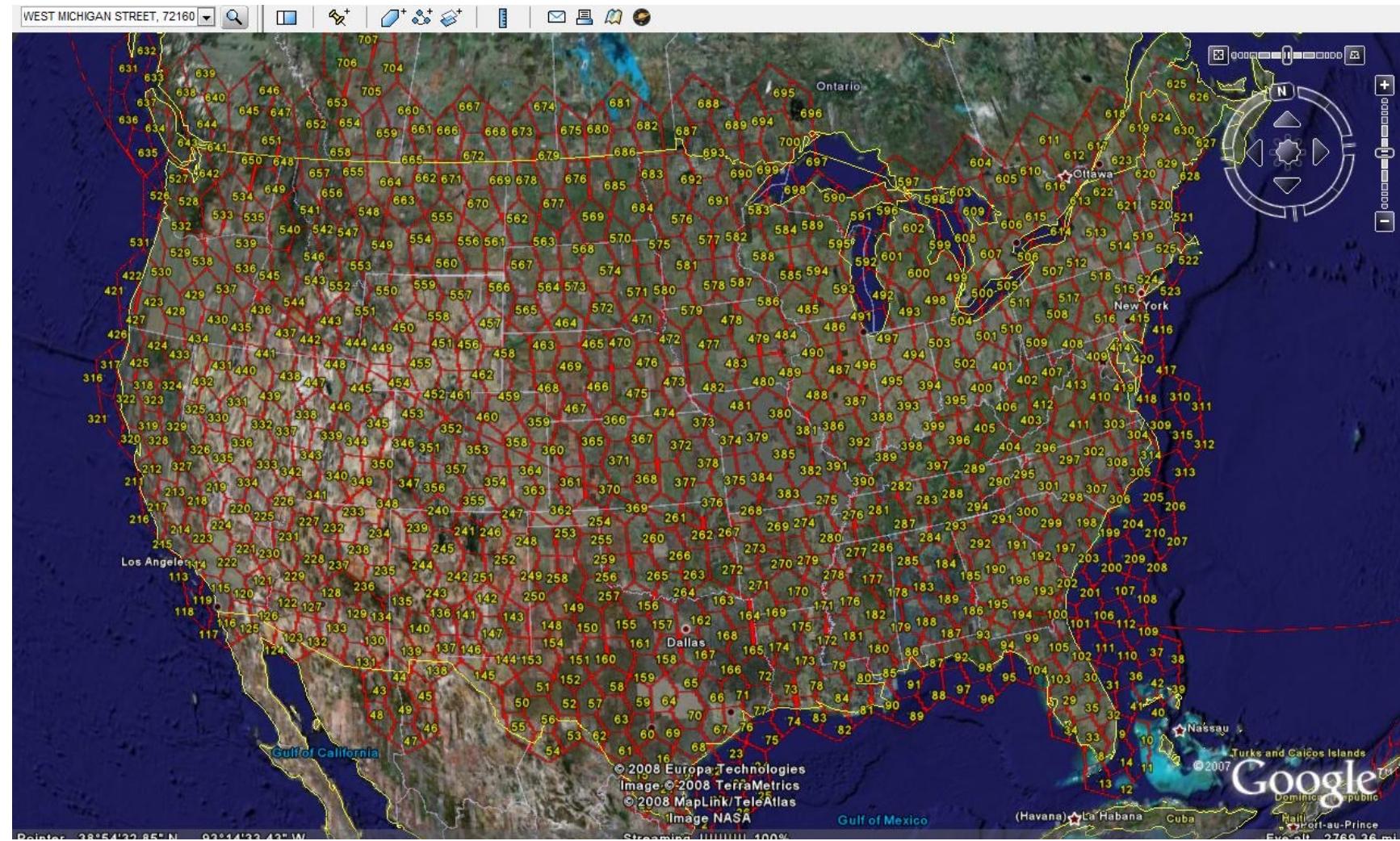
Spaceway 3 CONUS coverage



Up link coverage



Down link coverage



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
- 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 spot beams.

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 dentity (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

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

<i>From literature</i>	$C=SR \cdot Rc \cdot \log_2(M)$	$\eta=C/BW$	$Es/N_0=E_b/N_0+10 \cdot \log_{10}(\eta)$	$C/N_0=E_s/N_0+10 \cdot \log(SR, 10)$	
------------------------	---------------------------------	-------------	-------------------------------------------	---------------------------------------	--

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

<i>From literature</i>	$C=SR \cdot Rc \cdot \log_2(M)$	$\eta=C/BW$	$Es/N_0=E_b/N_0+10 \cdot \log_{10}(\eta)$	$C/N_0=E_s/N_0+10 \cdot \log(SR, 10)$	
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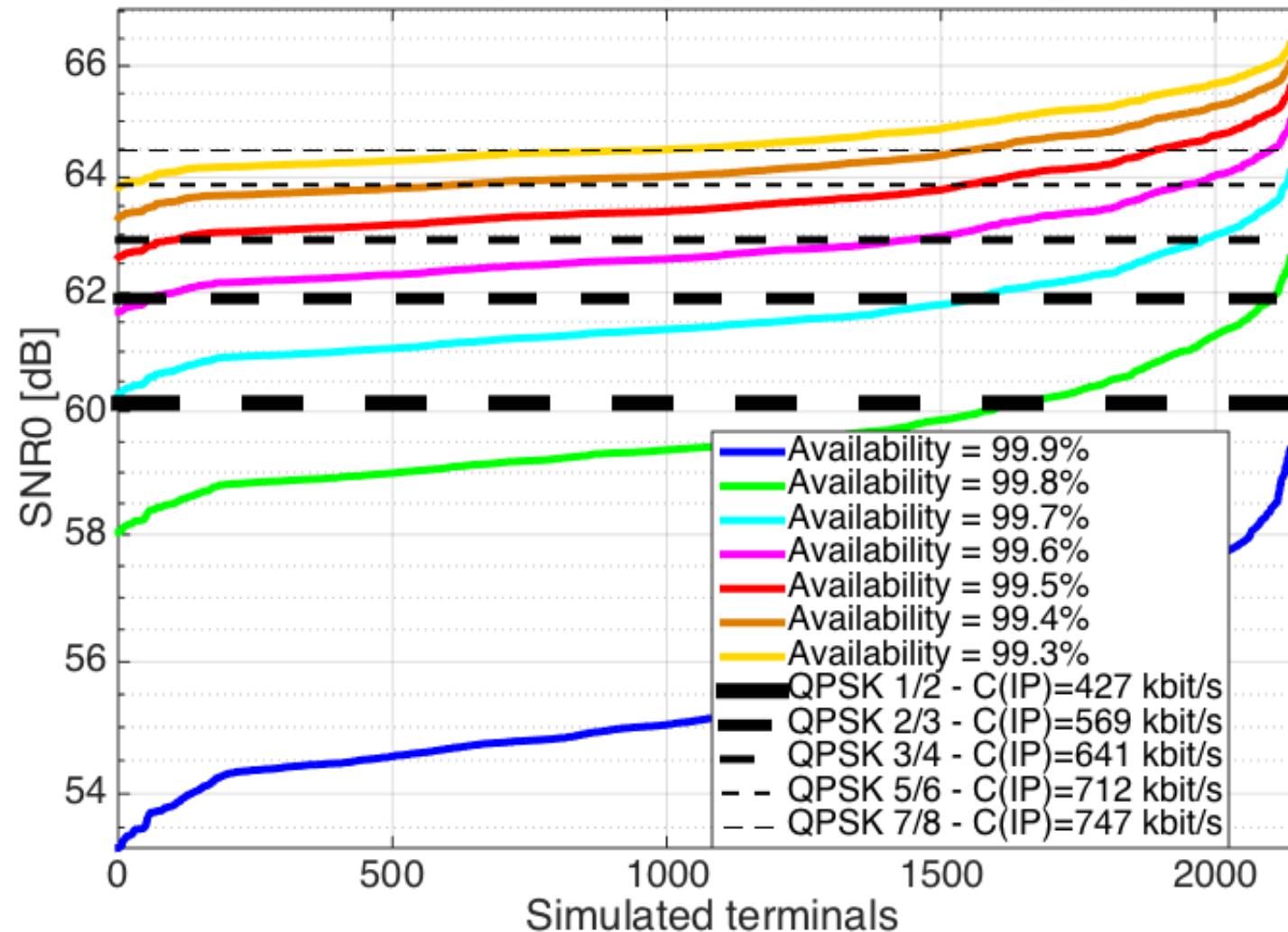
Athena Fidus: Return Link Channels (2/2)

Channel at 1.9 Msym/s

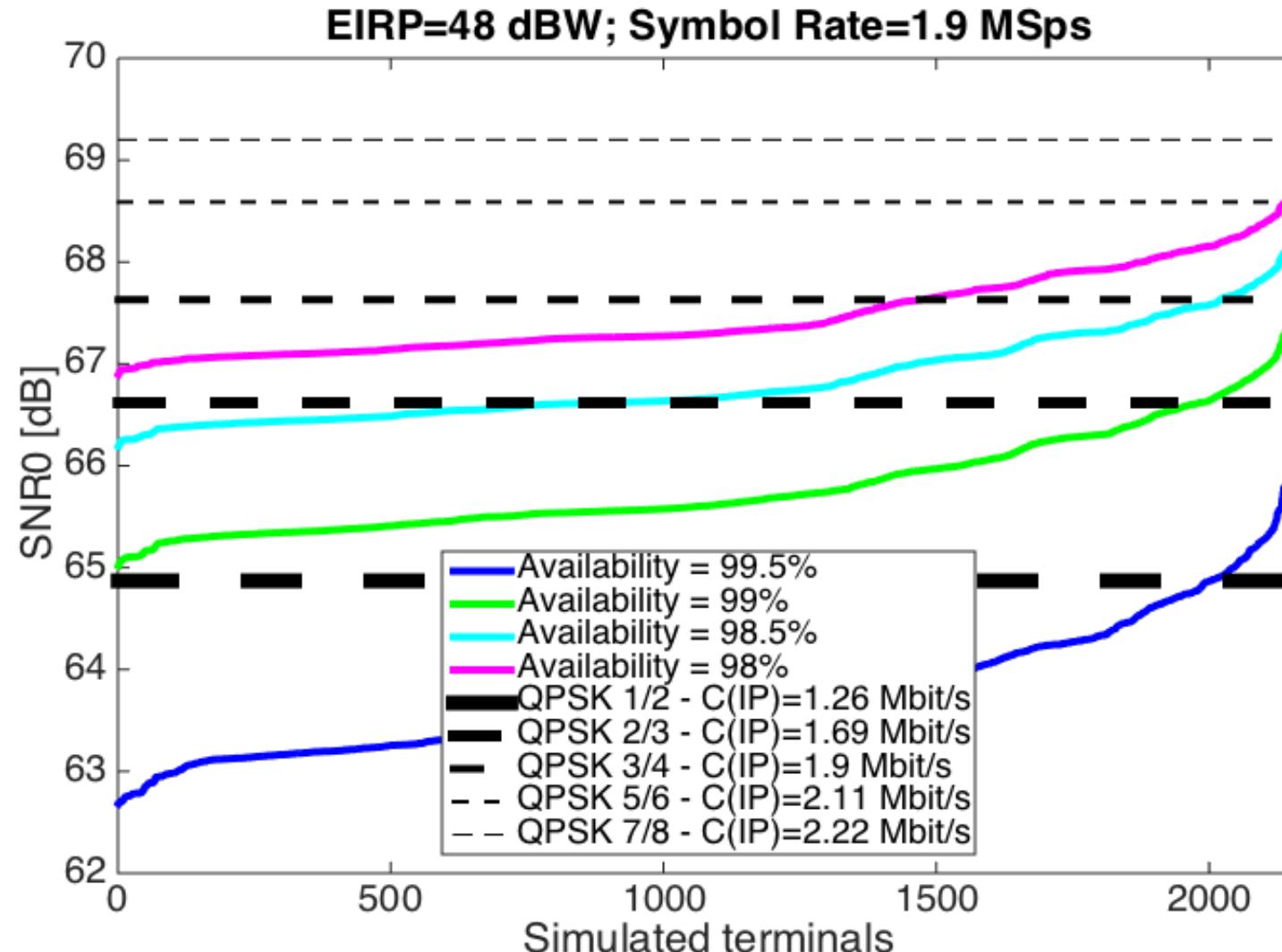
DVB-RCS link budget requirements							
Mode	Rc	Ideal Eb/N0	C interface (Mbit/s)	Spectral efficiency (η)	Ideal Es/N0	Ideal C/N0	C _{IP} (kbit/s)
QPSK 1/2	0.387	4.5	1.47	0.57	2.08	64.87	1268
QPSK 2/3	0.516	5	1.96	0.76	3.83	66.62	1691
QPSK 3/4	0.581	5.5	2.21	0.86	4.85	67.63	1903
QPSK 5/6	0.645	6	2.45	0.95	5.81	68.59	2114
QPSK 7/8	0.678	6.4	2.57	1.004	6.42	69.20	2220
<i>From literature</i>		$C = SR \cdot Rc \cdot \log_2(M)$		$\eta = C / BW$	$Es/N_0 = E_b/N_0 + 10 \cdot \log_{10}(\eta)$	$C/N_0 = E_s/N_0 + 10 \cdot \log_{10}(SR, 10)$	

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

EIRP=48 dBW; Symbol Rate=640 kSps



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		
84° West	Hispasat 84W-2		



(Future-Forthcoming) **MEGACONSTELLATIONS**

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-to-point connectivity with coverage growing from the Poles to the Equator on completion
- 2022 Full Worldwide Service Availability



OneWeb

- 648 satellites
- User terminal antenna phased array 36x16cm²
- 50 Mbit/s downlink
- 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 was acquired by UK Government (19%), Bharti Group (30%), **Eutelsat** (23%), Hanwha (8%, S-Korea) and additional investment from SoftBank (12%) and Hughes Network Group, a technology partner.
- Satellites in orbit 582 (March 9th, 2023)
- Full constellation was planned to be completed by 2022 while commercial service to start in 2021.
- Wholesale capacity provider
- 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).





electronically steerable,
flat-panel antenna

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 Network Systems, LLC

190 Mbit/s down

20 Mbit/s up

- Hughes said 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.

- Target: 12000 satellites
- 1440 to start service
- 5178 already launched (4827 operational, 7% lost)
- 21 satellites launched on Sept 25th 2023 from Vandenberg Space Force Base, following a launch of 22 satellites the day before from Cape Canaveral. Eight launches in September.
- H = 550 km (updated at 580km)
- Ku band
- 70-130 Mbit/s
- User terminal 19-inch (48.26 cm) phased array antenna, easy installing
- Intersatellite link (part RF and part Optical)
- Cost of the constellation: \$ 10 billion
- 499 \$ (418 €) installation kit
- 50 \$ (42 €) shipping;
- 48,73 \$ (41 €) taxes;
- 99 \$ (83 €) monthly fee.

Starlink

- September 2023: passed 2 millions subscribers (in 2015, SpaceX sent investors a presentation claiming that Starlink would have had 20 million subscribers by 2022)



The first Starlink community gateway on the remote island of Unalaska, Alaska. Photo: SpaceX

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.

Starlink (2)

- SpaceX is targeting direct-to-cell service that enables text messaging with the Starlink constellation in 2024, and voice and data and IoT service by 2025. SpaceX updated Starlink's website with a new page focusing on direct-to-cell service.
- Starlink announced the deal with T-Mobile in 2022, pitching the service as a way to close gaps in cellular networks in rural and remote areas and allow T-Mobile customers to send messages via Starlink satellites.
- Starlink has signed a number of other global cellular providers as partners — Rogers in Canada, Optus in Australia, One NZ in New Zealand, KDDI in Japan, and Salt in Switzerland.
- Starlink satellites with direct to cell capability have an onboard eNodeB modem that functions “like a cellphone tower in space”

Telesat Lightspeed

- Operator: Telesat
- Manufacturer: MDA
- 300 satellites (first plan)
- 198 satellites (current plan)
- 1600 satellites (future plan)
- $H = 1000 \text{ km}$
- Ka band
- Polar and inclined orbits
- Gbit/s per user, Terabit/s total capacity
- Optical Intersatellite link
- Phased Array Antennas
- On board processing
- Launches scheduled to commence in mid-2026
- Global services scheduled to begin in late 2027 (once the first 156 satellites are in orbit).

Kuiper (Amazon)

- 3236 satellites
- 578 satellites to launch service
- $H = 590 \text{ km}$ (10 km over Starlink, attention for interference)
- Estimated cost = \$ 10.000.000.000
- First two demonstration satellites launched the first week of October 2023
- Access to Amazon and Amazon Web Services (AWS) infrastructure.
 - take advantage of a lot of existing Amazon infrastructure through the Amazon Web Services on the fiber networks, to be able to quickly move traffic in and out of Amazon network into terrestrial networks.

RIVADA Networks

- 600 satellites (build by Terran Orbital)
- Ka band
- telecom, enterprise, maritime, energy and government services markets
- optical inter-satellite links
- Rivada Networks has a patented Dynamic Spectrum Arbitrage technology which it says allows for efficient use of spectrum
- Time to market: ???
- Service level agreements (guaranteed data rate, latency, security) and not best effort service

Mangata network

- Highly Elliptical Orbit (HEO) and Medium-Earth Orbit constellation, bundling backhaul connectivity with micro data centers.
- Maritime as a major target market to provide differentiated service offering universal coverage

List of Operators

Operator	Country	2001 Revenue (\$million)	Sats	Sats On Order
1. Intelsat	U.S.	1100	22	4
2. PanAmSat	U.S.	870.1	21	5
3. SES Astra (SES Global)	Luxembourg	655.5	13	1
4. Eutelsat	France	593.5	18	6
5. SES-Americom (GE Americom)	U.S.	506.7	16	6
6. Loral Skynet	U.S.	388.9	7	3
7. JSAT	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. Arabsat	Saudi Arabia	155	3	0
12. Star One	Brazil	130.5	5	1
13. Satmex	Mexico	128	2	1
14. AsiaSat	Hong Kong	124.3	3	1
15. Telenor	Norway	121.6	3	0
16. Shin Satellite	Thailand	116.8	3	1
17. Hispasat	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 Communications	Russia	61	11	5
21. Europestar	France	-	2	
22. Hellasat	Greece	-	1	