

An artistic illustration of the Iridium satellite network. A central satellite is shown in the foreground, with several other satellites visible in the background. The satellites are connected by a network of blue lines, representing communication links. The background features a dark blue space with stars, a large yellow sun or moon, and a view of the Earth's horizon at the bottom. The overall scene is illuminated with a blue and green glow.

Iridium
**A Global
Communication
Network**

Dr. Om P. Gupta

Iridium Satellite LLC

 **iridium**

Introduction



World's largest and most sophisticated commercial satellite network providing global communications on the move – people, vehicles, aircraft, assets

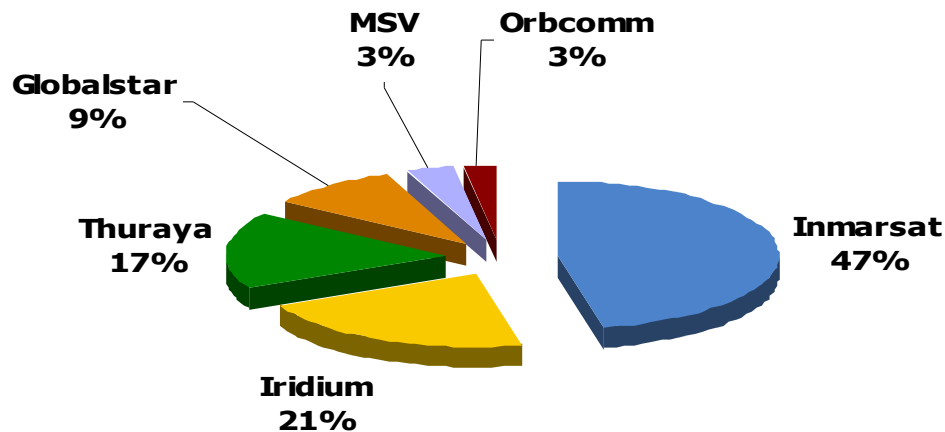
- 66 satellite polar orbiting constellation
- A single subscriber device works worldwide
- Ubiquitous coverage
 - All oceans & land masses including polar routes
 - Any terrain
 - Where terrestrial infrastructure is unavailable or undesirable
- Low time latency worldwide
- Satellite-to-satellite links create a secure mesh network in space



Iridium - Fastest Growing MSS provider

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- Fastest growing Mobile Satellite Service (MSS) player in a growing market
 - MSS market growing at 14% annually
 - Total market estimated to be \$1.2B in 2007
- Strong and consistent financial performance
 - Revenue and EBITDA growth through innovation and execution
 - Significant cash generation capability
- Number one provider of MSS to the US DoD
- FY 2007 revenue - \$260.4 M versus \$212.4 M in 2006, a 23 % increase
- FY 2007 EBITDA - \$73.6 versus \$53.8 M in 2006, a 37 % increase



Total 2007 Revenues:
\$1.2 billion

Total MSS Market Share 2007

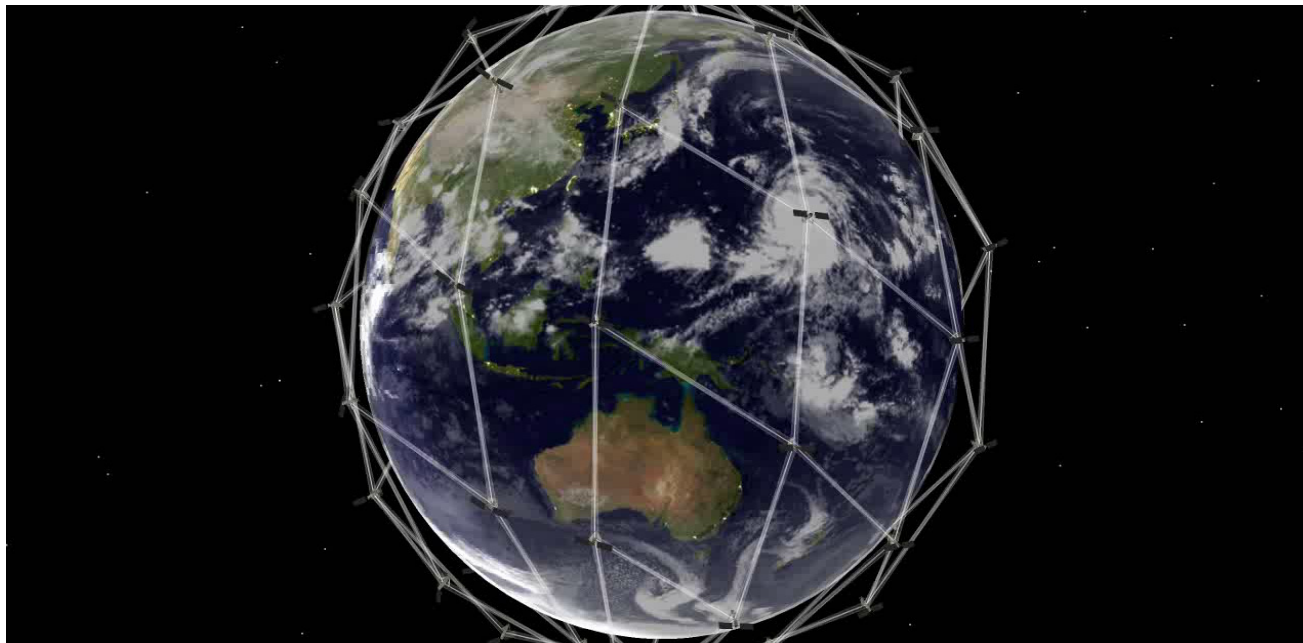
Network



Significant Benefits from Low Earth Orbit

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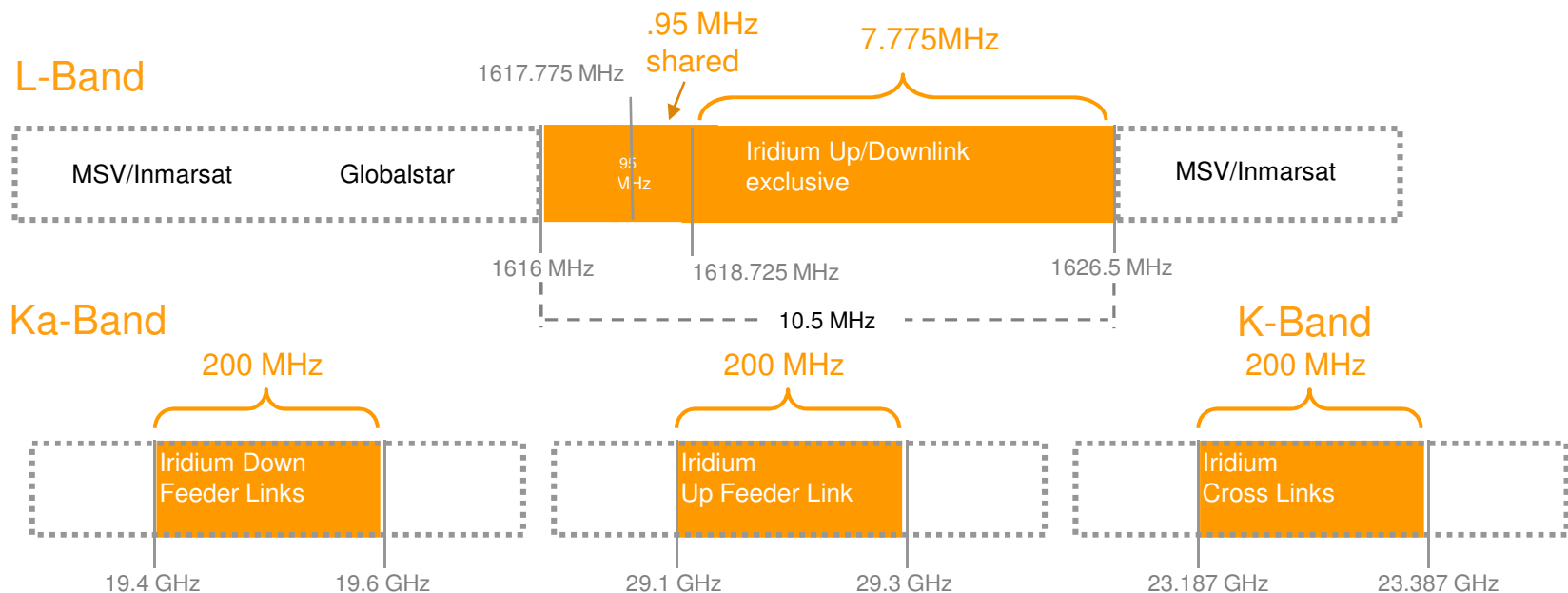
- Constellation of 66 Low Earth Orbit (LEO) satellites
- Inter-satellite links are key differentiator
- Global coverage – pole to pole
- High availability and built-in redundancy
- Cost effective ground infrastructure deployment
- Freedom from local ground stations



Global Spectrum Allocations

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- Iridium network designed to operate in 10.5 MHz of spectrum
 - Exclusive use of 7.775 MHz and shared use of 0.95 MHz
- Global spectrum licenses in L-Band, Ka-Band and K-Band



Constellation Supports the Business Model

Robust and flexible network provide significant operating advantages

Products



Services

Voice
Narrowband data
M2M data services
Paging
Broadband data
Netted

Integrated Network
Internet/IP
VOIP
PSTN
Pre-paid
Voicemail
Flexible billing

Iridium Call From Aircraft To PSTN

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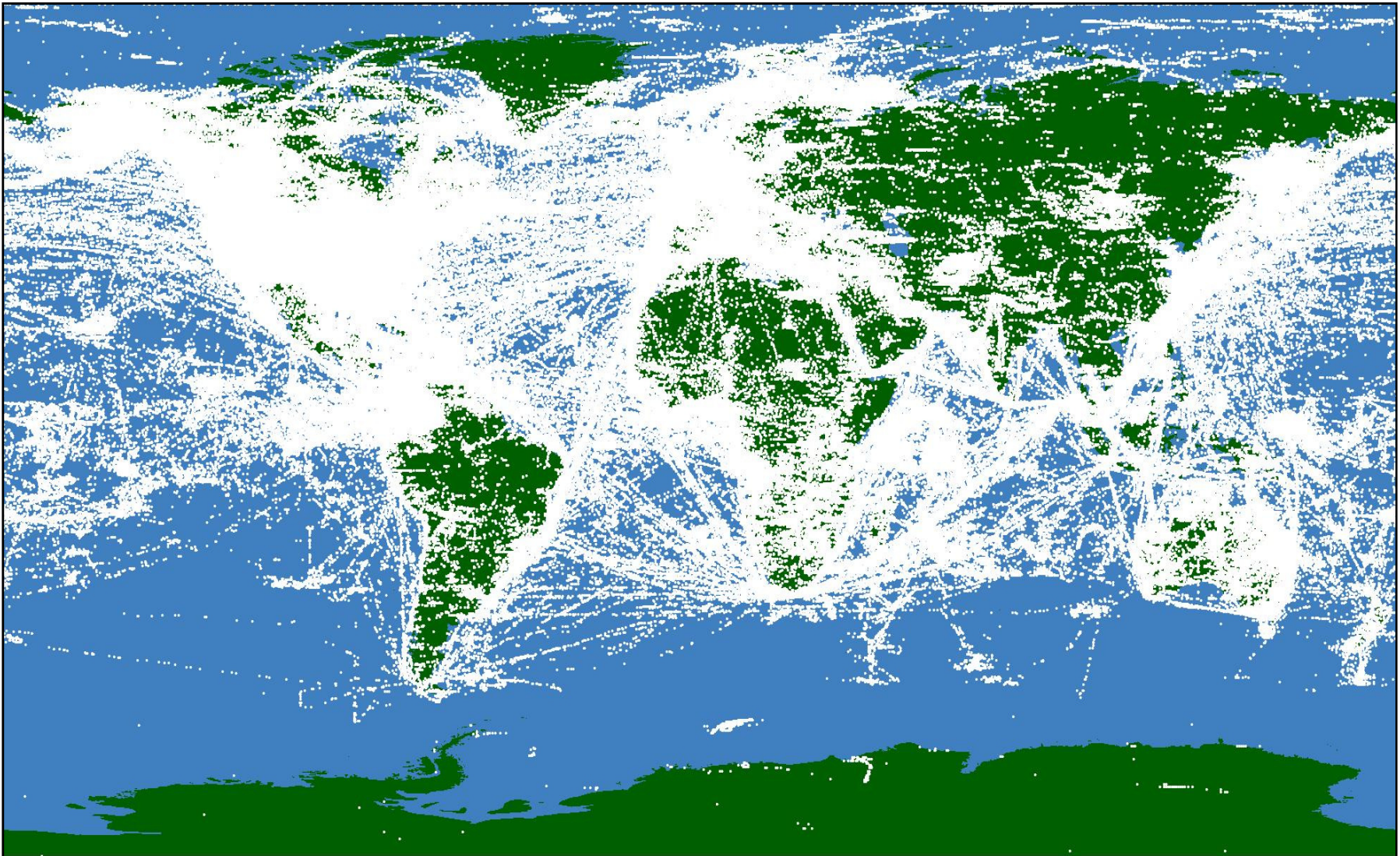


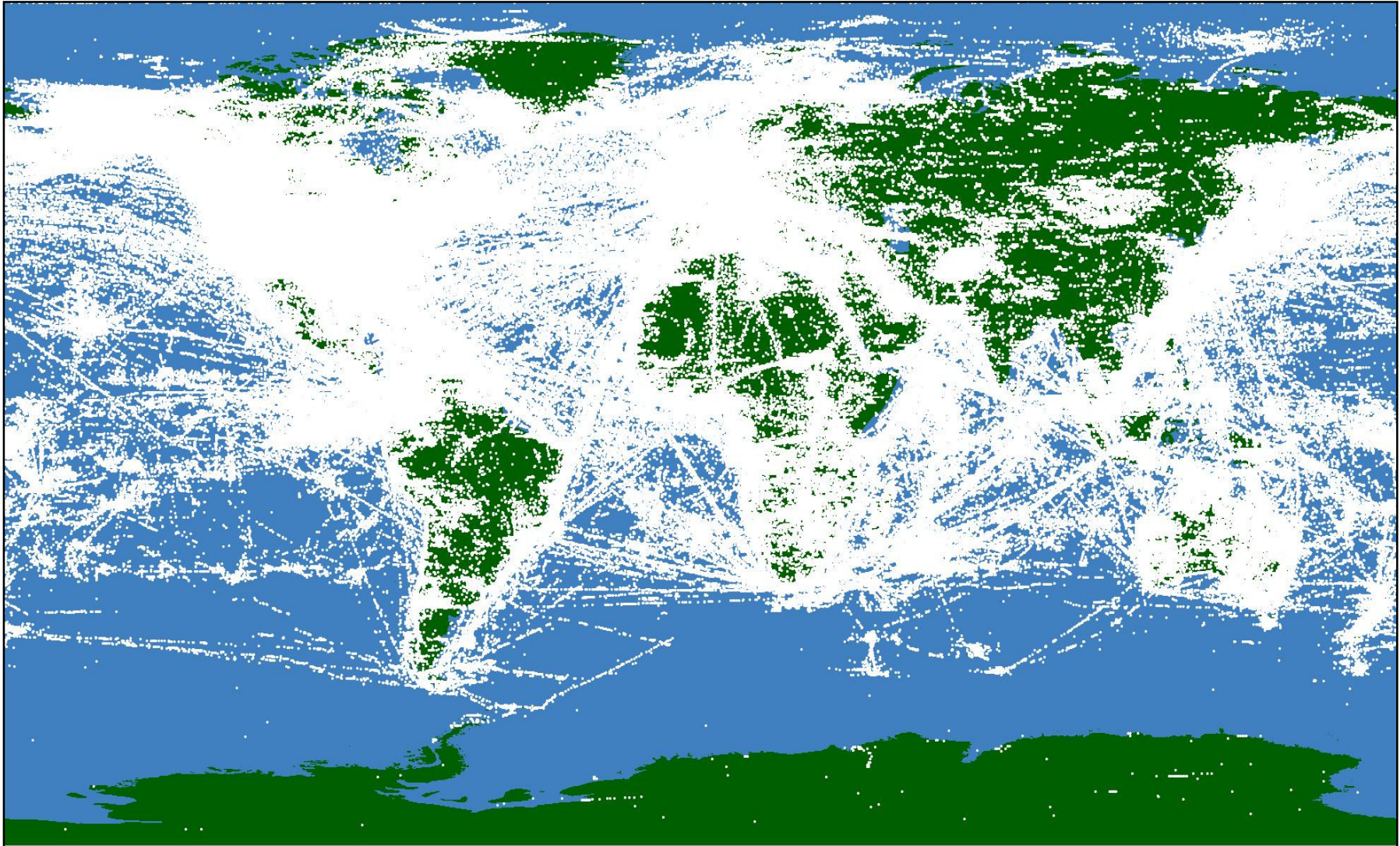
Iridium Service Growth





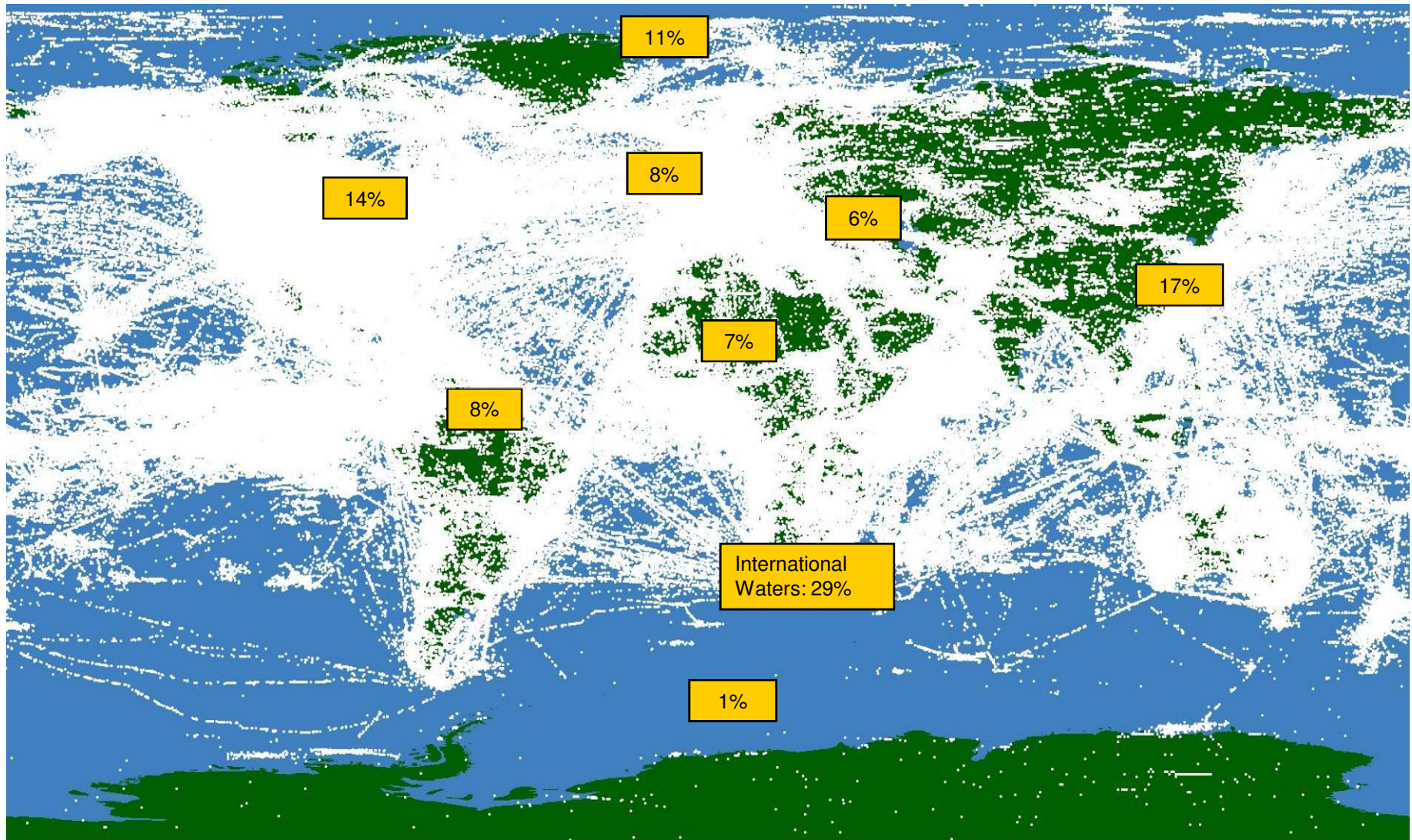
Note: Data based on origination of commercial voice and data transmissions only





Geographic Traffic Distribution – September 2007

14

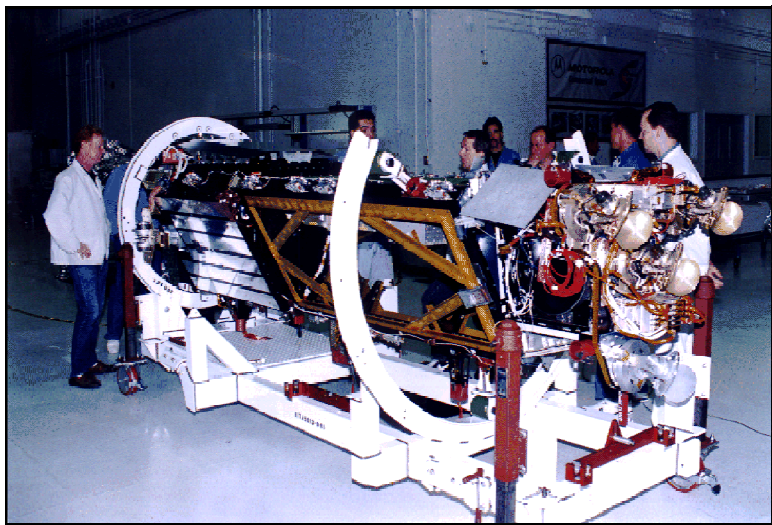


Note: Data based on origination of commercial voice and data transmissions only


- **Iridium was – and still is – a global telecommunications system representing a revolutionary new paradigm in the commercial communications industry**
 - Iridium ushered in the era of global mobile personal communications
- **Iridium overcame Herculean technical, financial and regulatory challenges in order to be financed, developed and built**
- **Iridium's ubiquitous L-band "canopy" connects any spot on the planet with any other**
 - Iridium. Everywhere.
- **Iridium is the world's largest satellite constellation**
 - Iridium is a baseband processing system in the sky
 - Iridium was the first commercial use of inter-satellite links
 - Iridium was the first truly mass-produced satellite
- **Iridium saves lives**

There's Never Been Anything Like Iridium ... Until NEXT

- Developed satellite mass production techniques borrowed from the automotive industry
 - Achieved satellite production cycle time of 25 days vs. industry standard of 12-18 months
 - Achieved satellite production pulse rate of 4.3 days inspired by adopted “mantra” of “5 Days Dock-to-Dock”



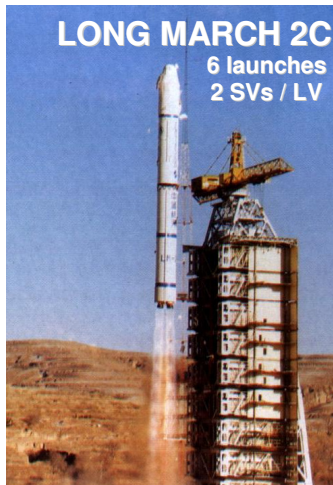
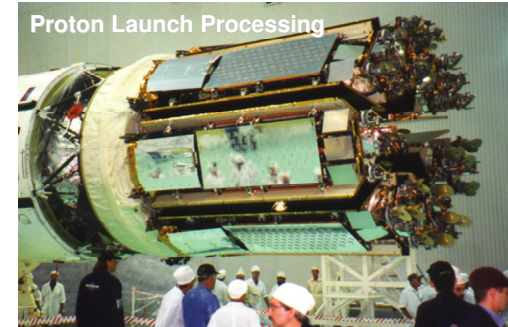
Station 0	Material Receipt
Station 1	Heat-pipe Bonding
Station 2	Nadir Panel Assy
Station 3	Gateway Panel Assy
Station 4	Comm Panel Assy
Station 5	Comm Panel Test
Station 6	Comm Equipment Test
Station 7	Gateway Panel Integration
Station 8	Comm Panel Assy Integration
Station 9	SV Test
Station 10	EMI Test/Shear Panel
Station 11	MMA Integration
Station 12	SV Test
Station 13	Solar Array Integration
Station 14	Launch Confidence Test
Station 15	SV Pack and Ship



**Management Set Unprecedented Reach-out Goals
... and Empowered the Team to Invent Creative Solutions**

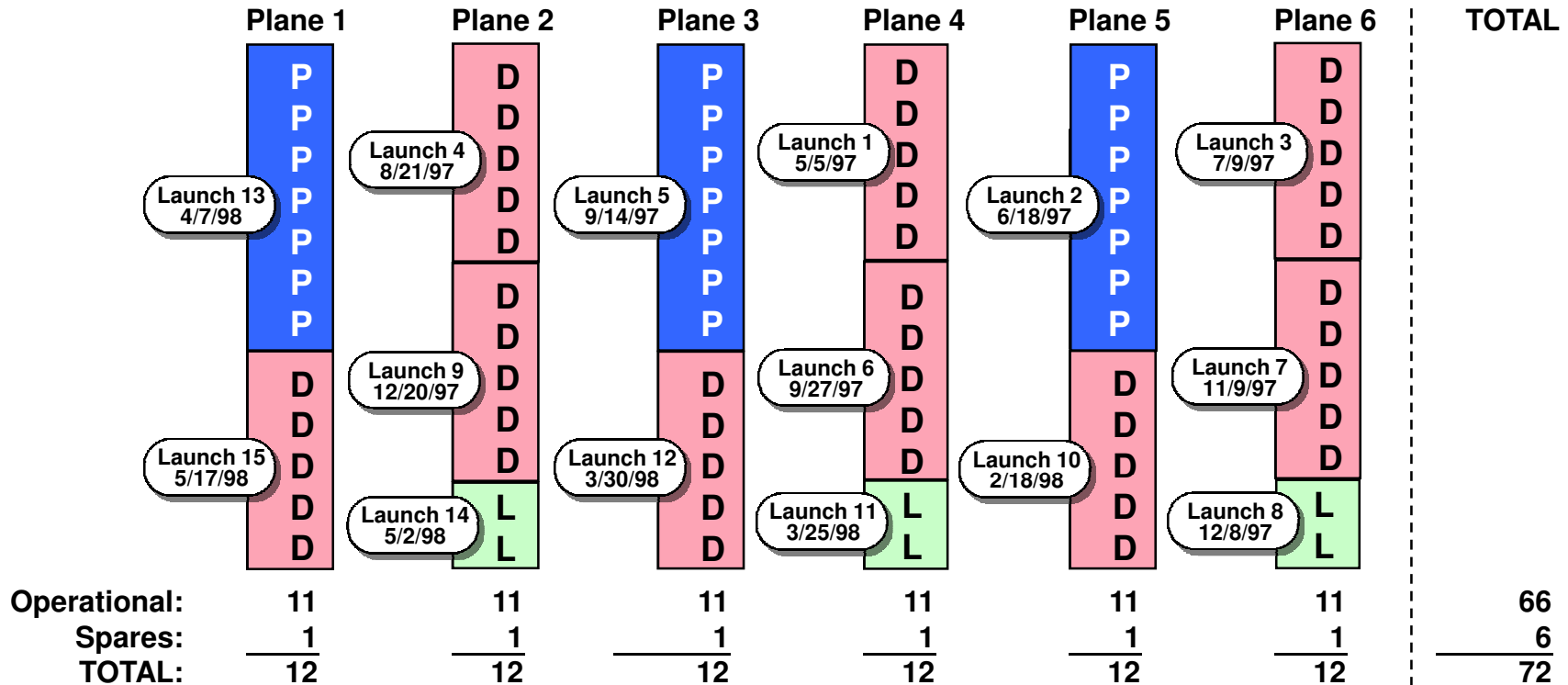
Constellation Launched at a Record Pace

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**Achieved 22 Consecutive Successful Launches of 95 Satellites:
Initial 72 Satellites Launched in Just 12 Months, 12 Days
14 Satellites Launched on 3 Launch Vehicles From 3 Countries in 13 Days**

Constellation Deployment Sequence



D = Delta (5 SVs per Launch Vehicle X 9 Launches)
P = Proton (7 SVs per Launch Vehicle X 3 Launches)
L = Long March (2 SVs per Launch Vehicle X 3 Launches)

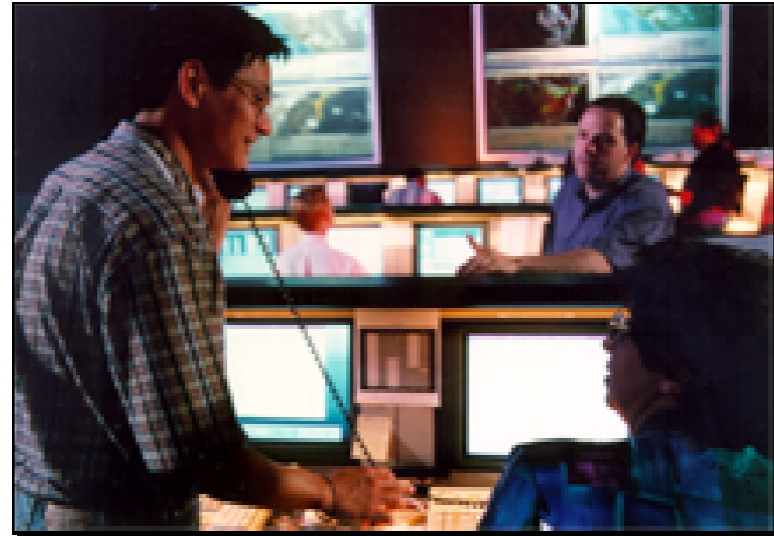
Initial 72 satellites launched in just 12 months, 12 days!!

Finding the “Right” Mix of Launch Vehicles, and the “Right” Number Of Satellites/Launch is Critical For Populating the Constellation:
 $7 + 5 = 5 + 5 + 2 = 12$

Mammoth & Rapid System Integration

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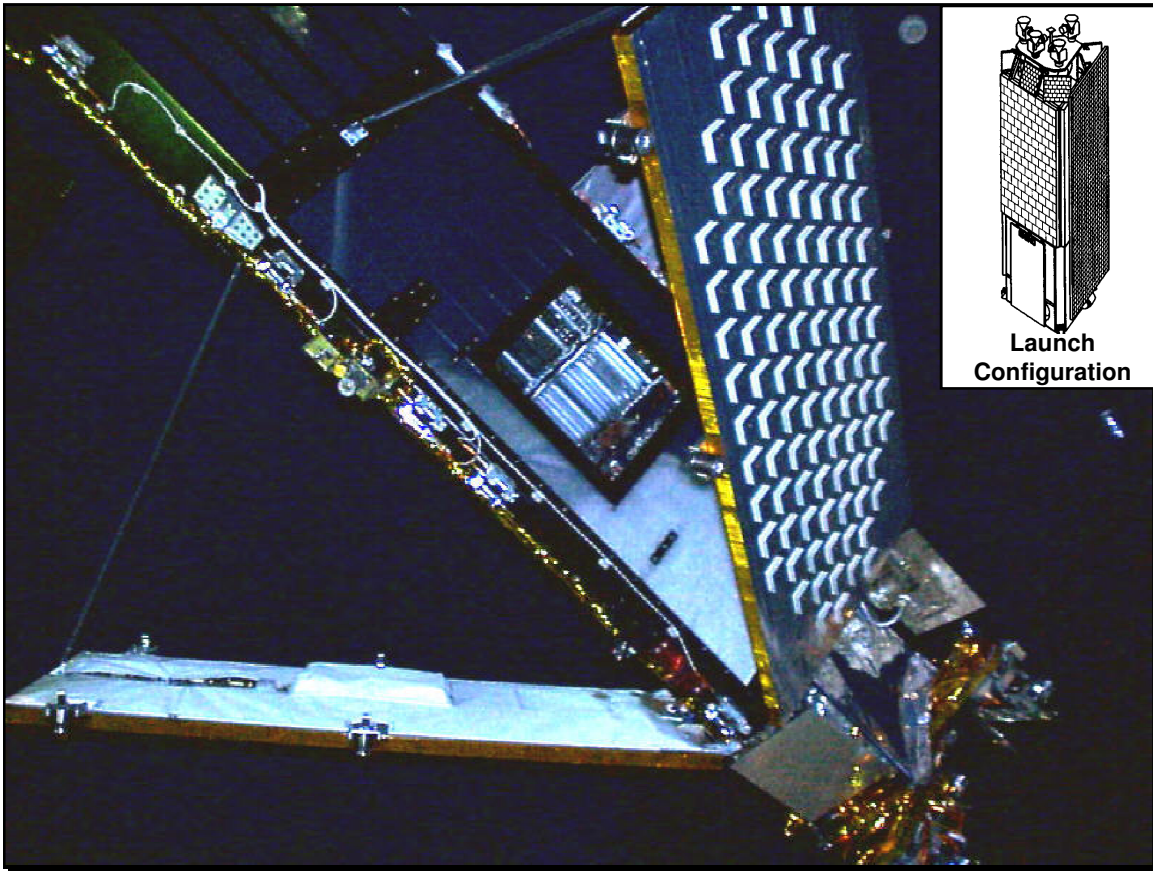
- Integrated entire Iridium system in 6 months, including nearly 20 million lines of software code
- Stood up 12 gateways in 11 countries in 18 months
- Deployed & operated world's largest satellite constellation
 - If Iridium were a country, it would be the world's #5 space power!



The Iridium Team Believed in – and Achieved – the Impossible

The Iridium "Block 1" Satellite is a Marvel

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Launch Configuration

Dry Mass.....525 kg
Wet Mass.....641 kg
Instant. Peak Power.....>4000 W
Avg. Power Load.....620 W
Vehicle Length.....4.1 m
Vehicle "Wingspan"8.4 m

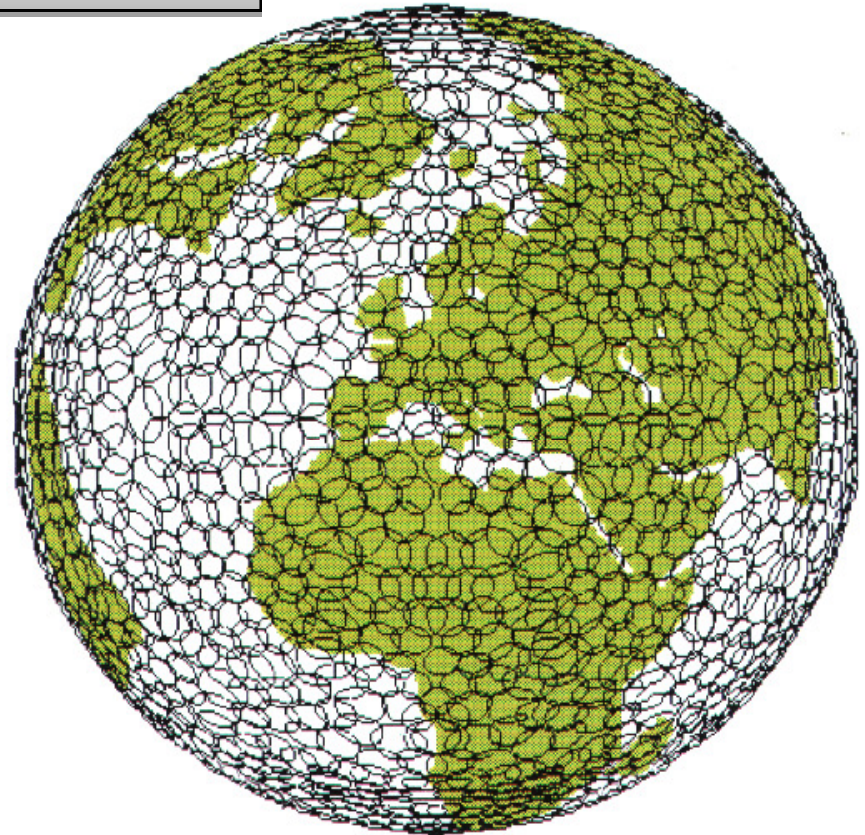
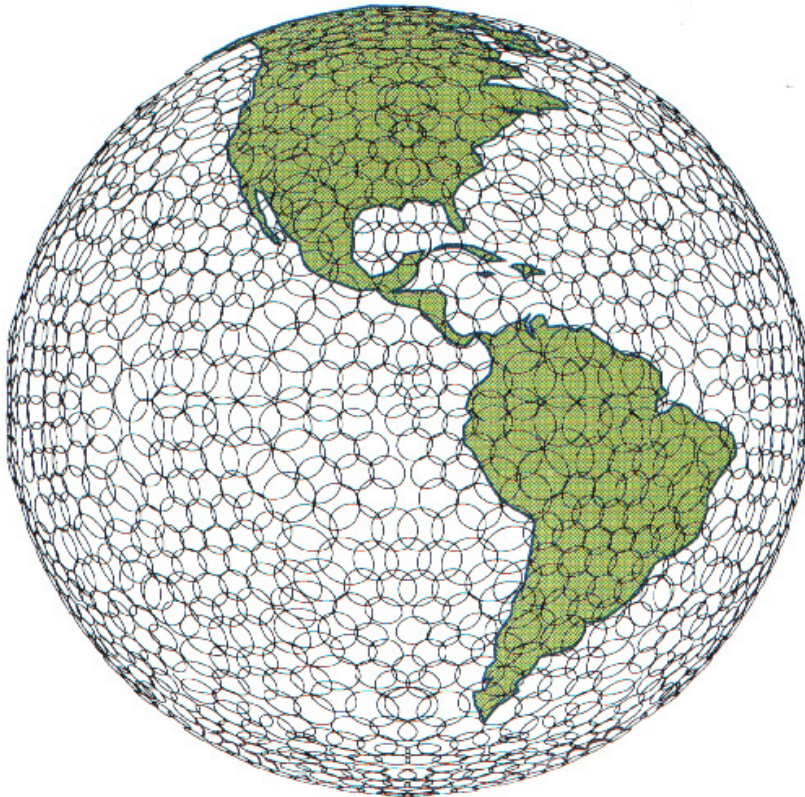
- Seven Power PC Processors
- Four Gimbaled K-Band Feederlinks
- Four K-Band Crosslinks
 - 2 Fixed & 2 Gimbaled
- Three L-Band Phased Arrays
- Two 4 m² GaAs Solar Arrays
- One 60A-hr SPV NiH₂ Battery
- Three-Axis Momentum-Biased Attitude Control System
- Redundant Orbit Adjust
- Graphite Epoxy Structure
- Active & Passive Thermal Control

The Iridium Satellite Design Achieved Unprecedented Price-to-Performance Ratios by Embracing Best Commercial Practices

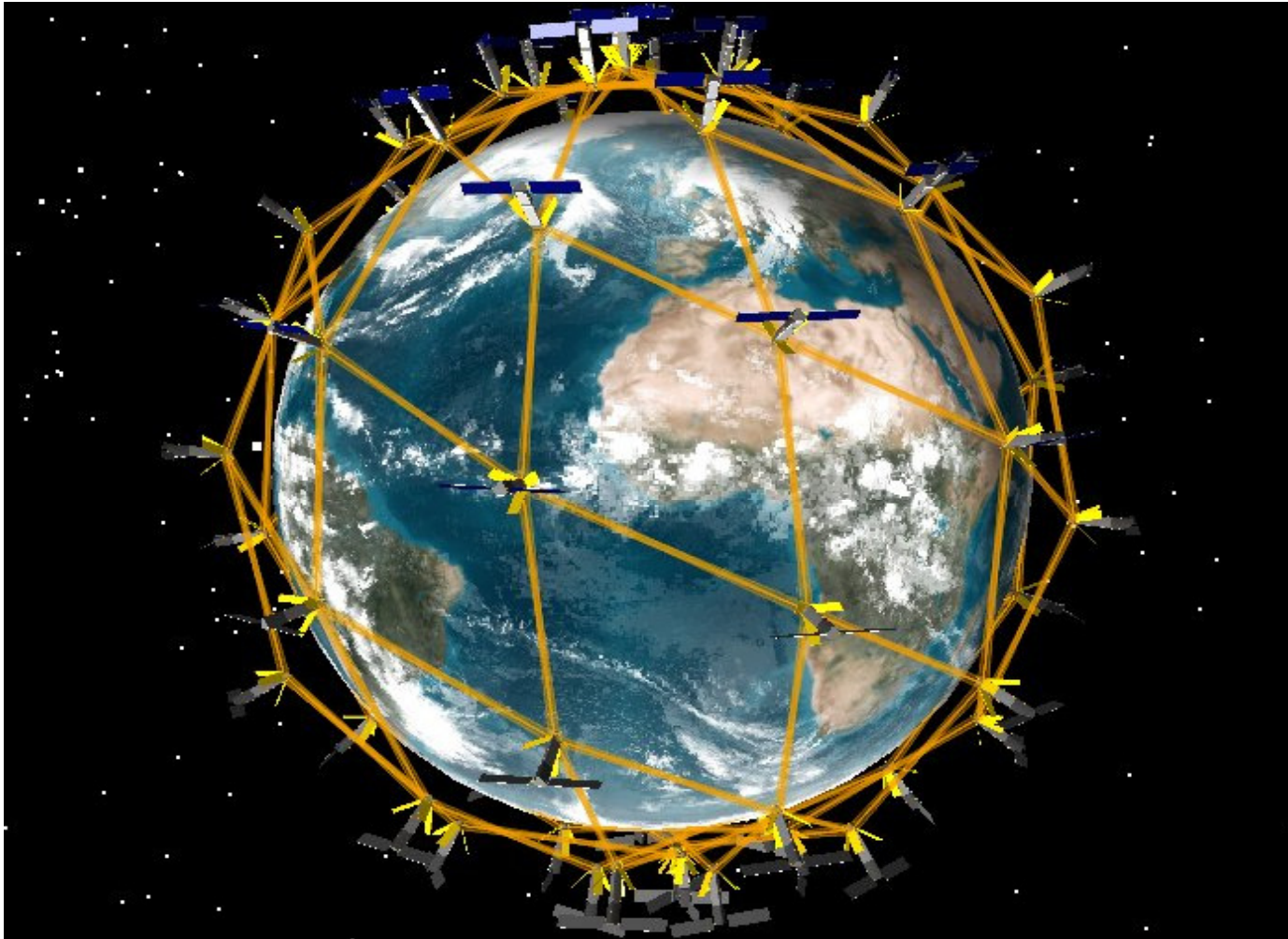
L-band Beams Provide Global Coverage

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Iridium ... Everywhere!



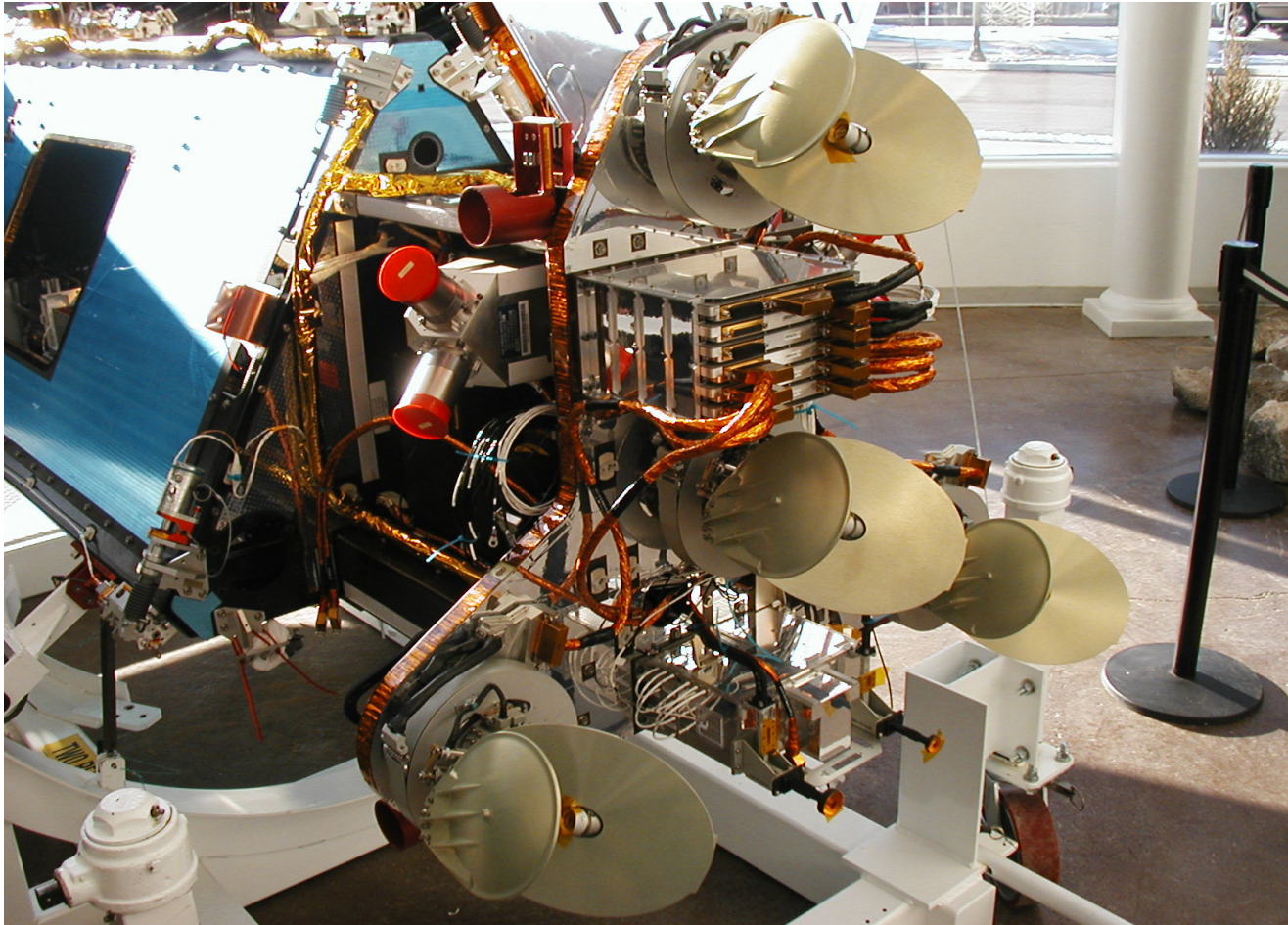
**Iridium's Fully Meshed Orbiting Satellite Network Provides
An Interconnected L-band "Canopy Over the Earth"**



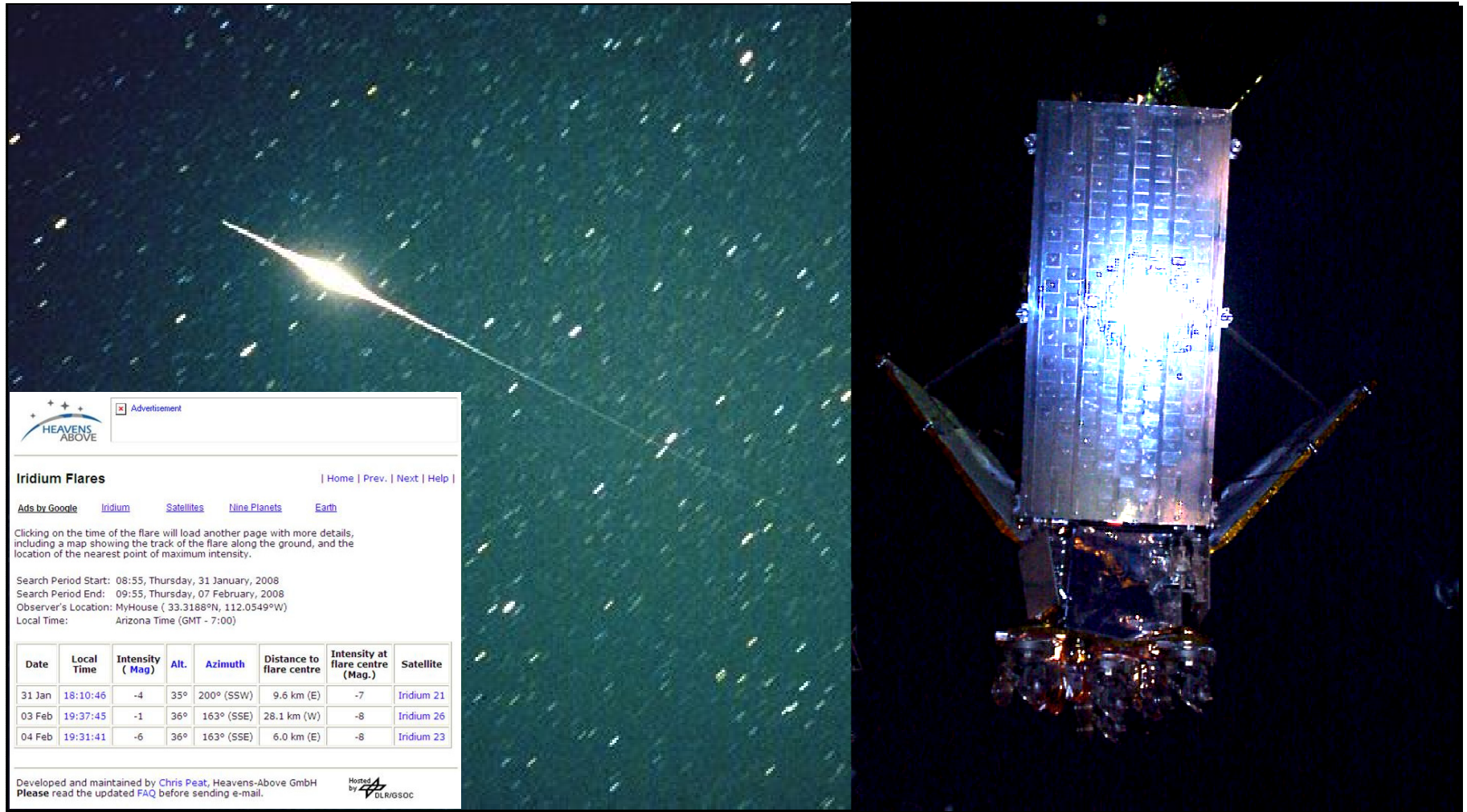
Iridium's Ka-Band Crosslinks Form the Comm Backbone of a First-of-its-Kind Global Interconnected Space-Based Mesh Network

Ka-Band Feeder Links

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Iridium's Ka-Band Feeder Links Provide Connectivity to the System's Ground Network Infrastructure (Gateways and TTACs)



HEAVENS ABOVE Advertisement

Iridium Flares

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Ads by Google [Iridium](#) [Satellites](#) [Nine Planets](#) [Earth](#)

Clicking on the time of the flare will load another page with more details, including a map showing the track of the flare along the ground, and the location of the nearest point of maximum intensity.

Search Period Start: 08:55, Thursday, 31 January, 2008
Search Period End: 09:55, Thursday, 07 February, 2008
Observer's Location: MyHouse (33.3188°N, 112.0549°W)
Local Time: Arizona Time (GMT - 7:00)

Date	Local Time	Intensity (Mag)	Alt.	Azimuth	Distance to flare centre	Intensity at flare centre (Mag.)	Satellite
31 Jan	18:10:46	-4	35°	200° (SSW)	9.6 km (E)	-7	Iridium 21
03 Feb	19:37:45	-1	36°	163° (SSE)	28.1 km (W)	-8	Iridium 26
04 Feb	19:31:41	-6	36°	163° (SSE)	6.0 km (E)	-8	Iridium 23

Developed and maintained by [Chris Peat](#), Heavens-Above GmbH
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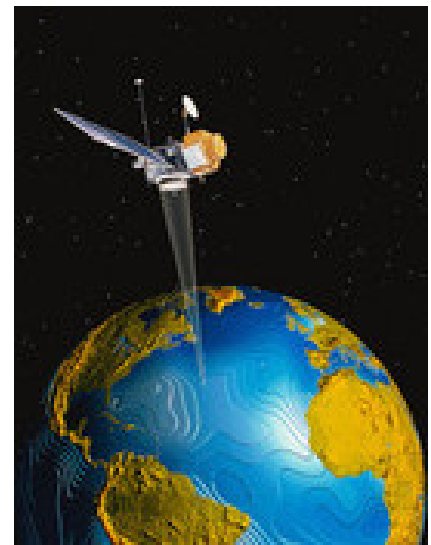
Hosted by 

Predict & View Iridium Flares: www.heavens-above.com

Iridium NEXT



- Plans underway to replace current constellation
 - Begin launching around 2013
- Backward compatible for existing customers
- Improved data speeds, subscriber technology, core technology improvements
- Maintain unique attributes -- global coverage, security, availability, LEO architecture
- New business opportunities with secondary payloads
 - New partnerships being discussed with commercial entities and governments



Exciting new applications and revenue streams

- NEXT will provide a variety of enhanced services
 - Voice 4.8 Kbps
 - Data services – 9.6 Kbps to 1 Mbps
 - Broadcast and Netted
 - Transportable terminals up to 10 Mbps service
 - Private Network Gateways

Commercial MSS Trends

- Largest growth in M2M land market
- Broadband data needs < 512 Kbps
- Key opportunities in chipsets devices
- Value added solutions with GPS

DoD MSS Market Trends

- Highest growth in <128kbps applications
- Strong potential in sensor and asset tracking applications
- IP applications (encryption)

NEXT offers new high performance global services;
Cost effective and flexible allocation of bandwidth

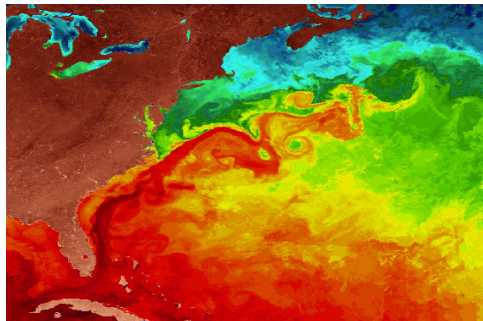
- A unique opportunity exists to host up to 66 climate instruments on the Iridium NEXT LEO constellation in a manner that can revolutionize Earth observations
- A constellation approach to sensing, using the real-time communications backbone of Iridium, will enable unprecedented geospatial and temporal sampling for now-casting
- Initial analysis shows that a significant number of the priority climate missions can be flown on the Iridium NEXT constellation
- Launches start in 2013 and the constellation operational life will extend beyond 2030

- Significant interest from Government and industry in sharing NEXT global networked communications infrastructure for space observation
- Secondary payloads deployed on NEXT can revolutionize Earth sensing
 - Unprecedented ***spatial and temporal coverage*** with 66 payloads
 - ***Real-time*** data acquisition
 - ***Cost effective*** - < 20% the cost of dedicated science missions
- New space services - global command, control and communications for independent satellites

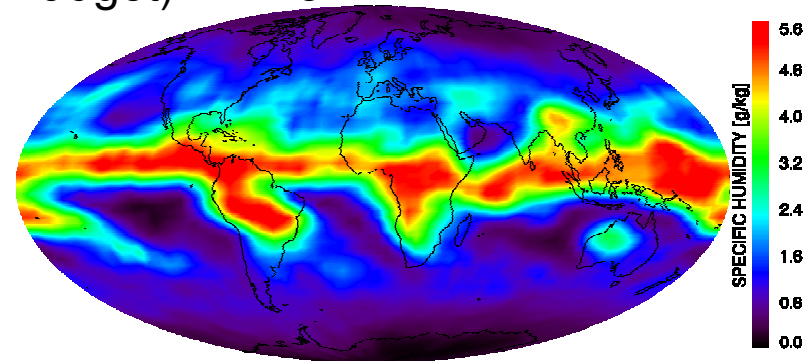
Potential to significantly offset NEXT infrastructure cost



- A list of Missions have been evaluated using a JPL study for suitability with Iridium NEXT
- JPL analysis assessed fit with NRC Decadal Survey recommendations
- International interest has also been encouraged through the Group on Earth Observations Secretariat (Geneva), ESA, CNES and CEOI
- Iridium has analyzed the cost/benefits from implementing these missions on Iridium NEXT
- There are a number of unique benefits to each of the missions
 - GPSRO including DoP (& nadir for altimetry)– 24 off
 - Altimeters (Ku preferred over Ka) – 24 off
 - Imagers (Ocean color, see IOCCG reports) – 6 off
 - Radiometers (Earth Radiation Budget) – 12 off

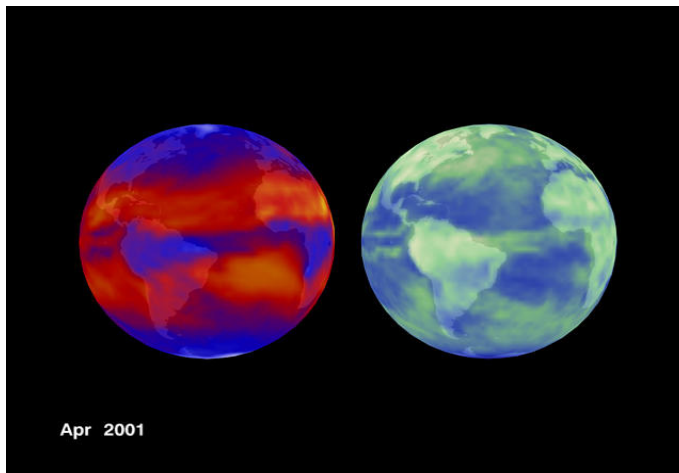


Radio Altimetry Ocean Currents

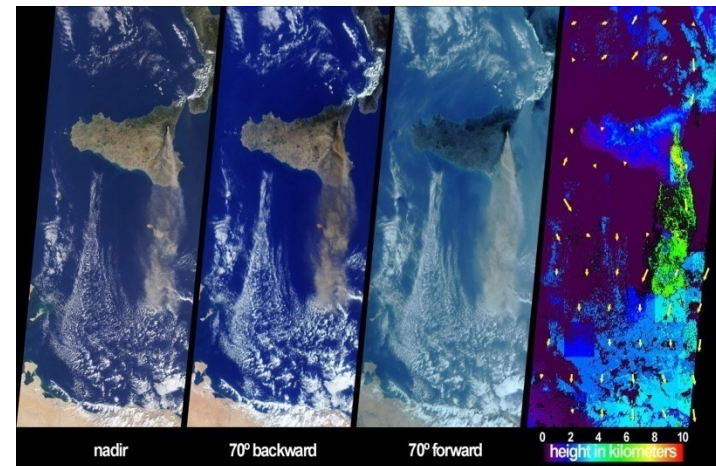


*CHAMP+GRACE+COSMIC
(2.5 °lat, 5 °lon)*

- Flying GPSRO (24 off) may allow for a second payloads
 - Cloud Wind Vector Monitor – 12 to 24 off
 - Atmospheric Chemistry (limb or nadir) – 6 off
 - Gamma radiation from space (zenith) – 6 off
 - Land imagers (set up specifically) – 6 off
- Space Weather Predictions - GPSRO in combination with Plasma Drift Meters



*Earth Radiation Budget
(LW and SW)*



Cloud Wind Vector Monitor

- Hosting climate sensors on a commercial communications satellite constellation such as Iridium NEXT has significant benefits for the climate community and the tax payer
- The benefits of hosting sensors in this manner fall into three areas:
 - **Capabilities of a constellation**
 - **Real-time access to data**
 - **Cost effective implementation**

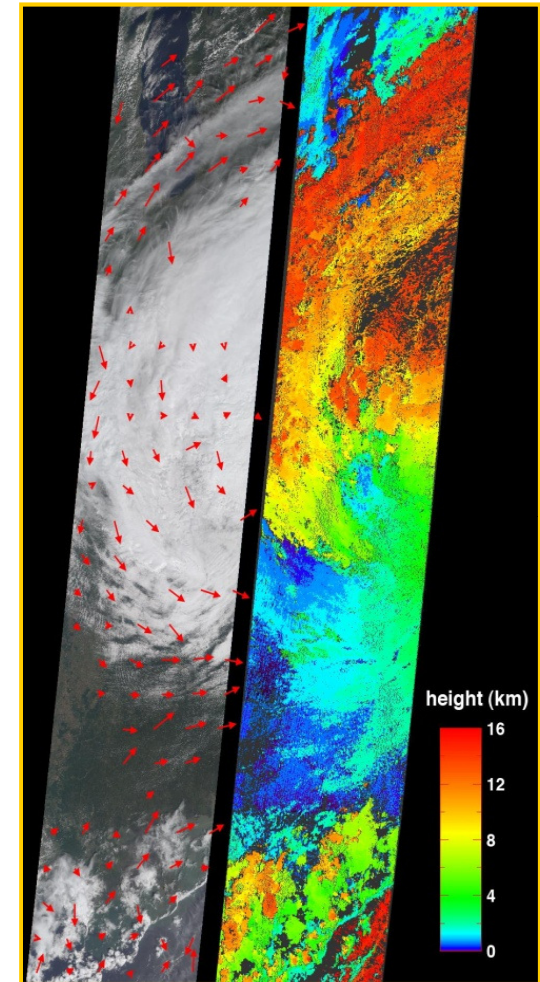
Unprecedented capability to fill data gaps, add new measurement capabilities and share the real-time communications network!

The benefits of flying climate sensors as part of a commercial communications satellite constellation are significant:

- **Geospatial coverage:** Iridium provides a simultaneous view of the entire globe including the poles
- **Temporal coverage:** This geospatial coverage and near real-time communications links provide unprecedented temporal coverage of the earth
- **New forms of measurement and science:** Selecting right combination of sensors and their placement will allow for the creation of new collaborative data sets and measurement techniques
- **Use of satellite bus capabilities:** Sensors will have access to capabilities of the satellite bus such as precision orbit determination information and pointing knowledge
- **Low cost satellite bus production line:** Many of the Iridium mass scale manufacturing techniques can be applied to the sensor manufacture including looking a low cost distributed sensors tailored for specific measurements
- **Redundancy and availability:** A network of sensors, the inter-satellite links, and spares provides a high degree of redundancy and availability for sensors missions.
- **Additional spares and flight opportunities:** Iridium plans to build additional spares to be deployed between 2017 and 2030 which create the opportunity to fly additional sensors that meet the secondary payload interface requirements beyond the initially chosen missions.

Use of a highly available, real time and redundant communications provide these additional benefits:

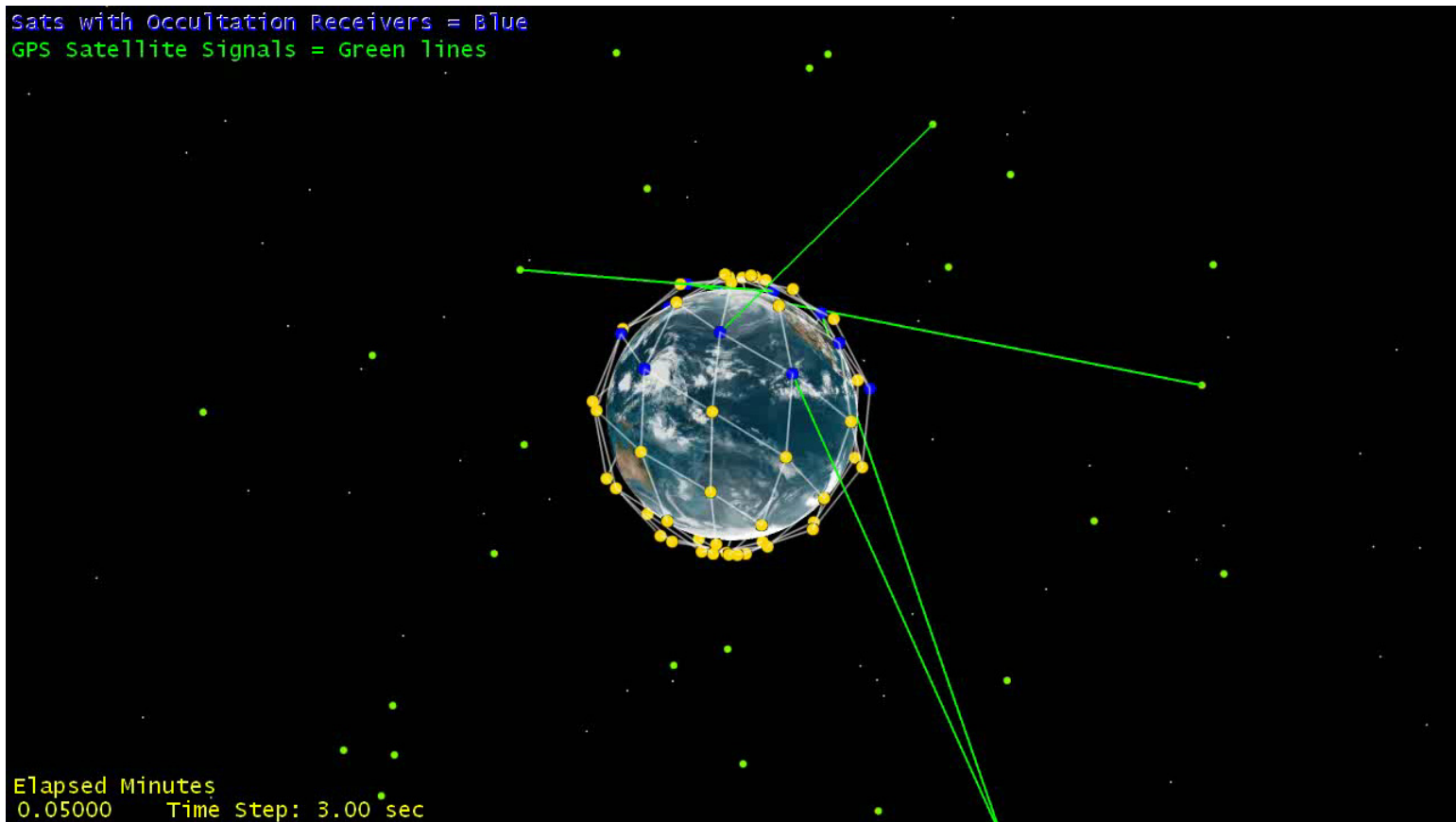
- **No need for dedicated ground facilities:** By sharing existing ground segment and infrastructure there is no need for dedicated ground facilities. A standard network interface protocol can be chosen to allow many sites to access the data
- **Multiple ground termination points:** Multiple Iridium earth stations will ensure redundancy of data paths
- **Commercial fiber backbone:** Iridium uses redundant commercial fiber backbone facilities to route data from the earth stations
- **Focus on data processing:** The user community can focus their efforts on reuse of existing and new data processing capabilities
- **Two-way communications:** Each sensor will have a two way communications link for command and control purposes



CLOUD HEIGHTS AND HEIGHT-RESOLVED CLOUD MOTION WINDS
HURRICANE KATRINA, 30th Aug 2005.
Source: Courtesy, JPL, USA

*Sounding of atmospheric
humidity & temperature;
Electron content of ionosphere
& density profiles*

Description:	GPS receivers; Limb antennas	
Number:	Min 12 sensors, 2 in each plane	
Swath:	Limb viewing; 800 soundings each per day	
Time scales:	<<1 hr	Tracking extreme weather events
	1 hr	Weather now-casting
	1 week	Weather forecasting
	1 year	Seasonal variations
	10 year	Climate variability; hydrologic cycle

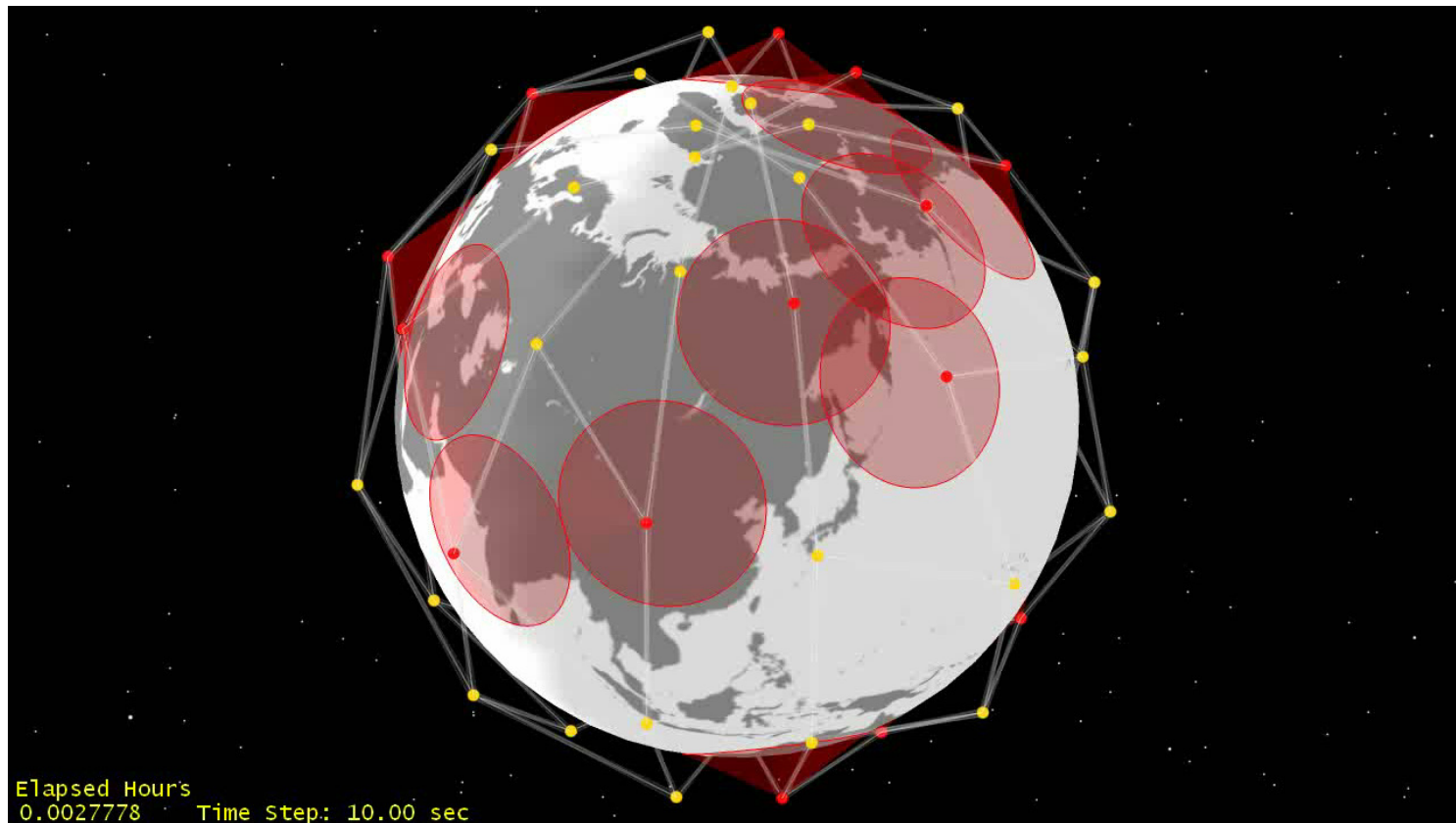


Measuring the Earth's radiation budget

Description: Broadband radiometer; 0.2 to 50 μm
Number: Up to 18 sensors, 3 in each plane
Swath: ~2000 km

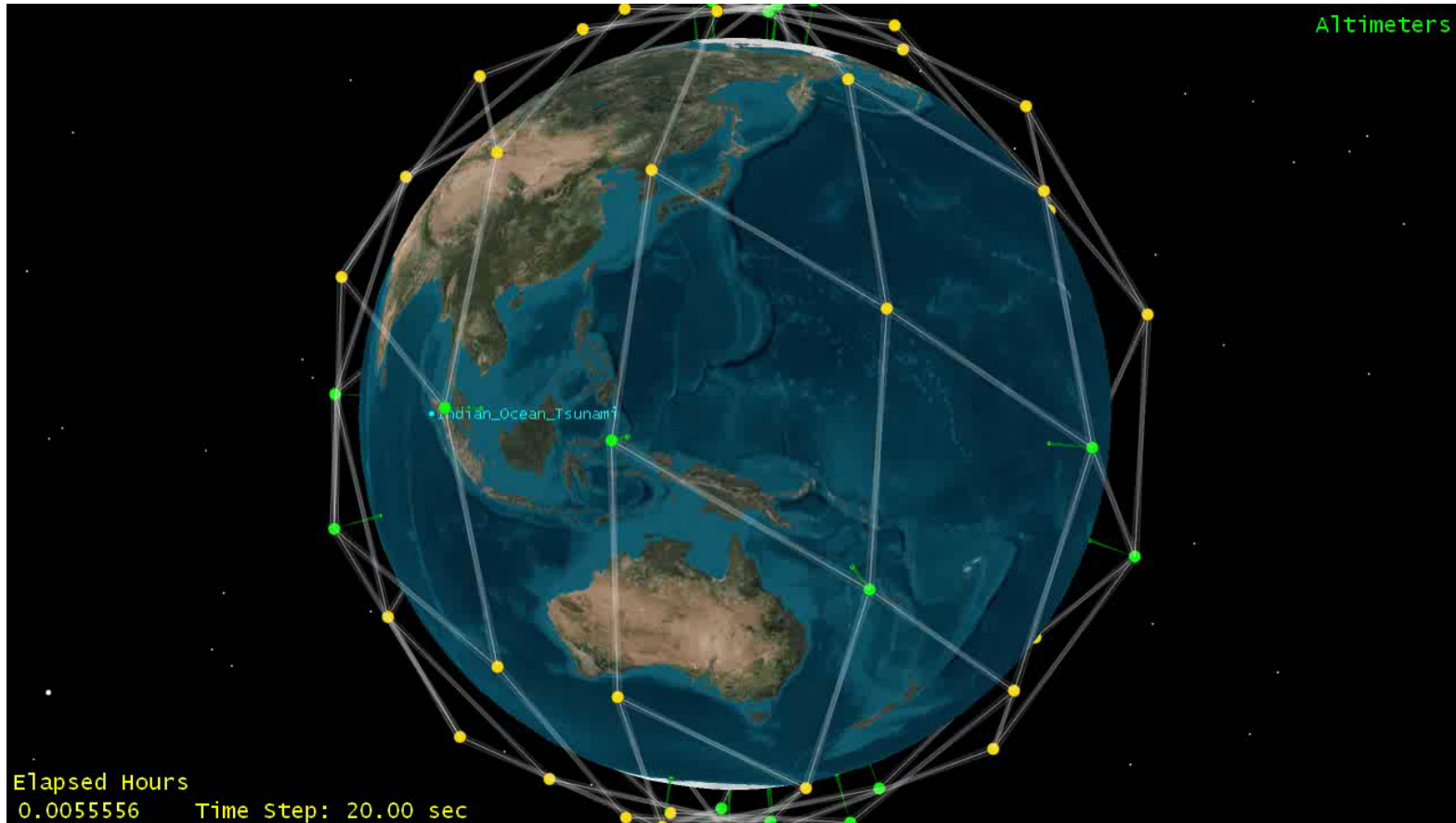
Time scales:

<1 hr	Data into weather forecasts
1 hr	Monitoring of heat waves
1 day	Day-night variation in radiative fluxes
1 week	Improved forecasting
1 year	Seasonal variations in ice and cloud albedo
10 year	Inter-annual variations
>10 year	Key parameter to monitor and predict global climate change



*Monitoring sea-surface height,
wave height,
wind speed; ice height*

Description:	Radar altimeter; Ka (or Ku) band
Number:	Up to 24 sensors, 4 in each plane
Swath:	5-10 km, nadir pointing
Time scales:	
<<1 hr	Tsunami early warning; flood & wave now-casting
1 hr	Sea surface & significant wave height, wind speed; storm surges
1 day	Tides, currents and eddies
1 month	Lunar cycles; El Niño events; hydrology
1 year	Ocean circulation patterns
10 year	Inter-annual variations and changes
>10 year	Prediction of sea level rise & changes in circulation



For ocean color and ice extent

Description: Spectral range dedicated or multi-spectral; UV-VIS-IR
Number: Minimum of 12 sensors, 2 in each plane
Swath: 80 to 240 km; 30 to 100m resolution

Time scales:

Ocean color (OC):

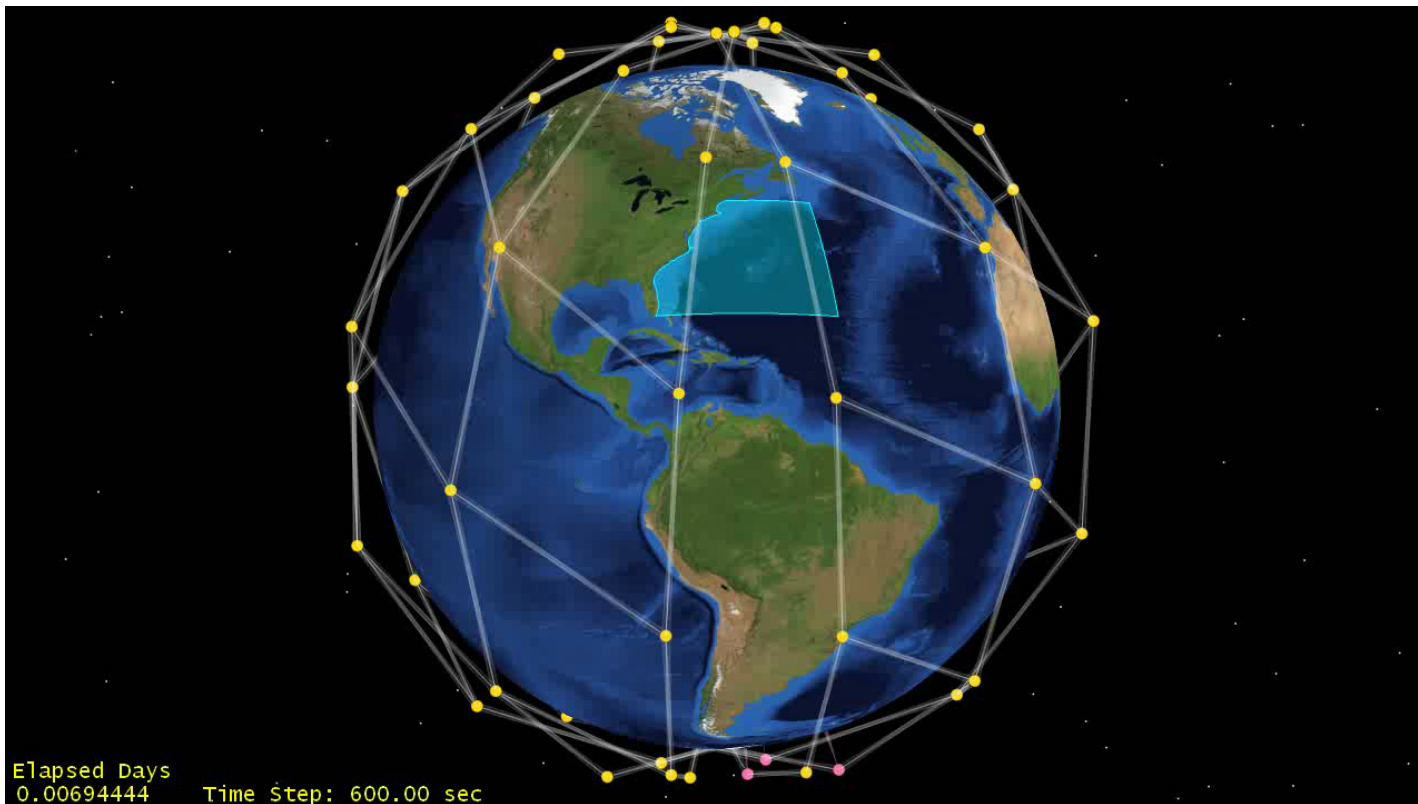
1 day Coastal diurnal variation; marine operations & fisheries
1 year Seasonal changes (N & S hemisphere)

Terrestrial:

1 day Disaster remediation; wildfires
1 year Deforestation; desertification; crops

Ice:

1 day Ice extent
1 year Seasonal and inter-annual changes in fields



For ocean color and ice extent

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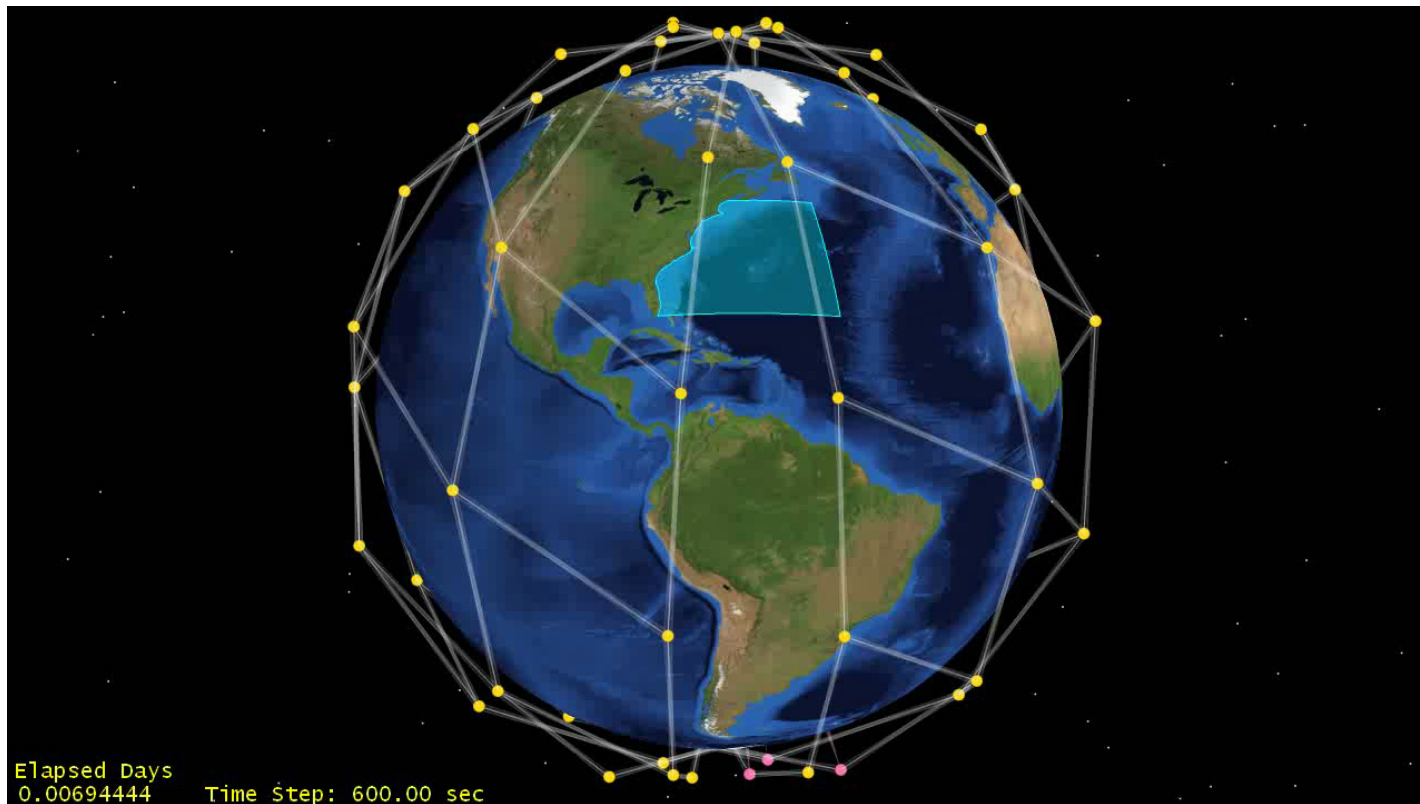
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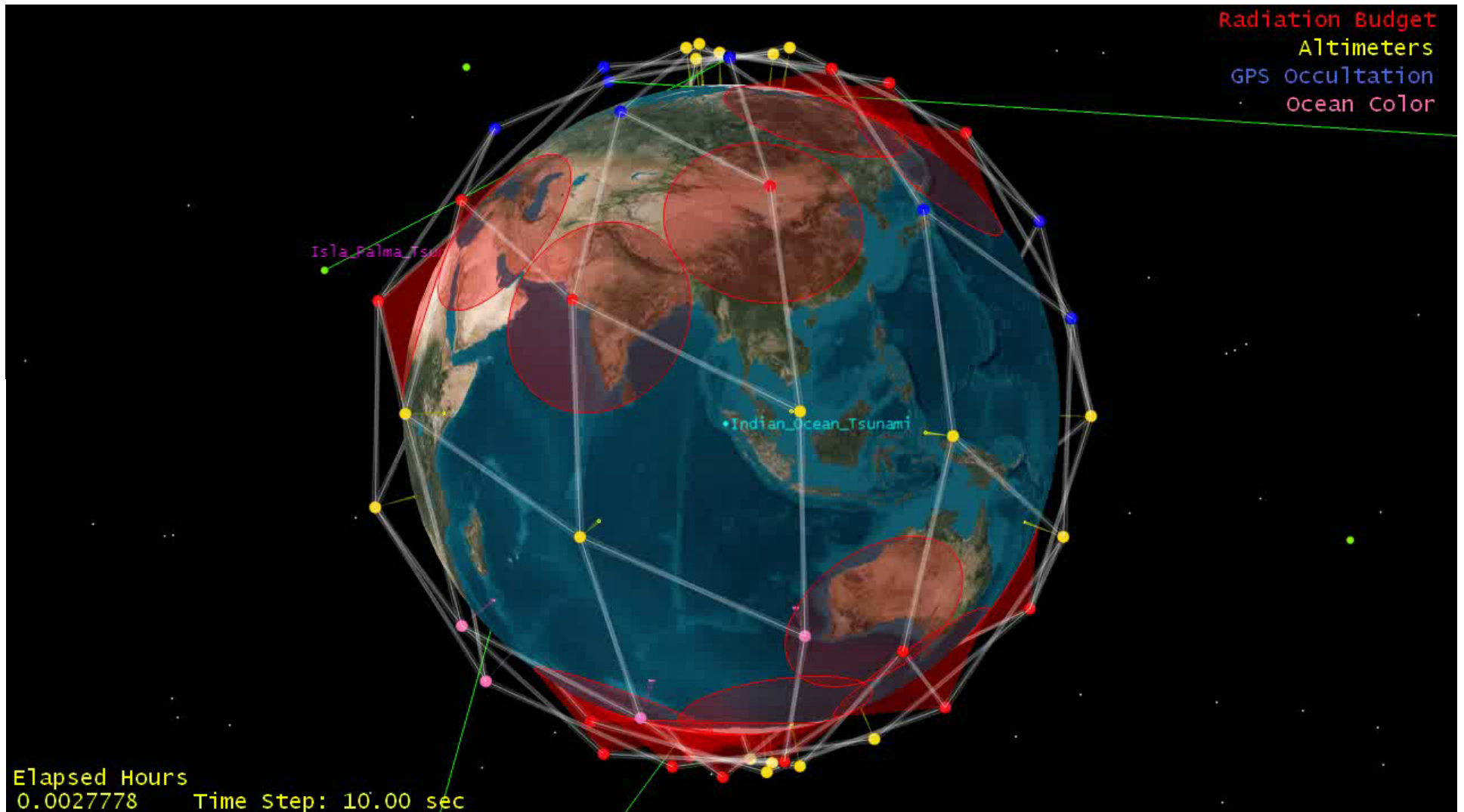
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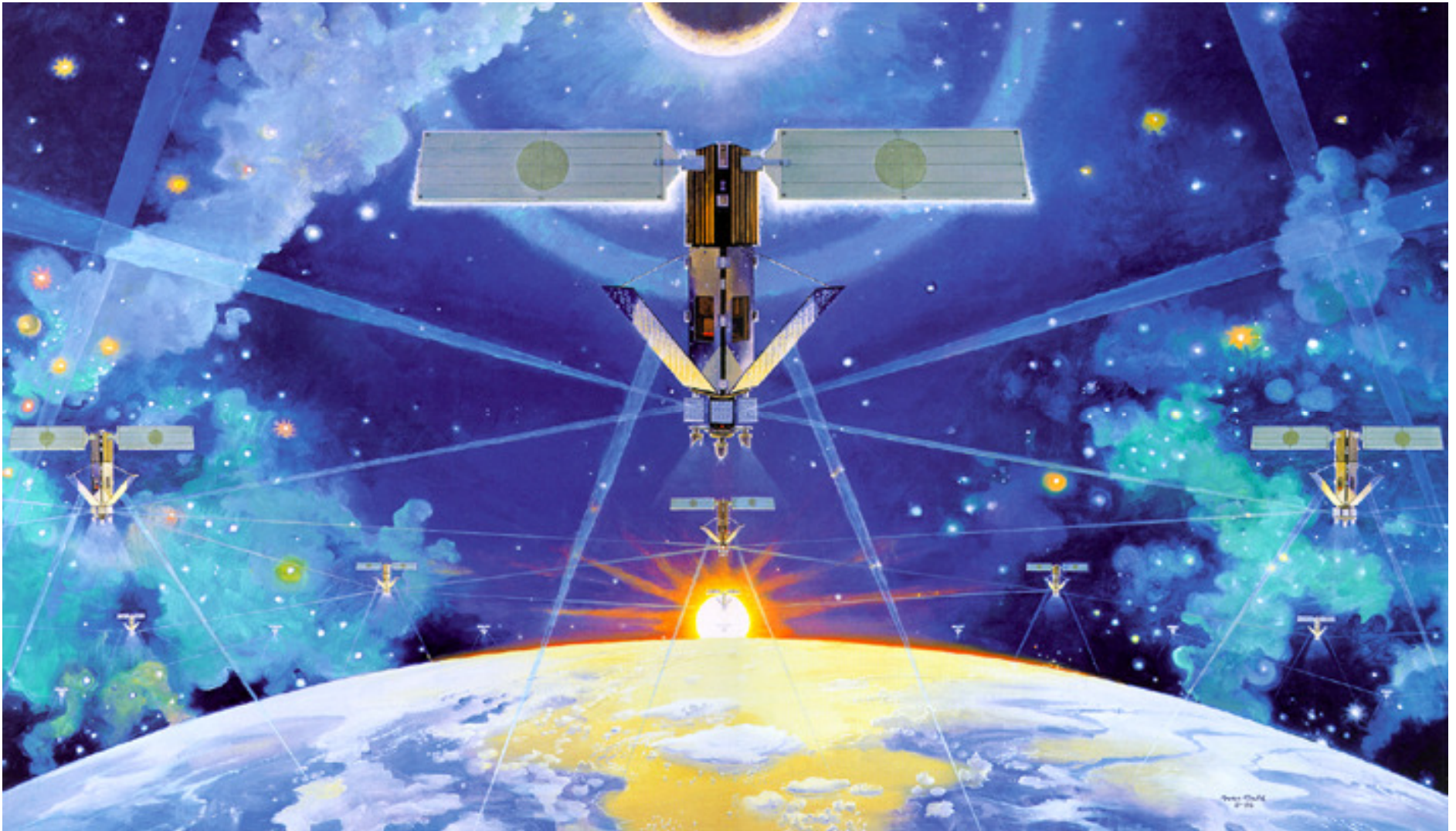
Multiple Mission Sensors

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“Spirit of Iridium” by Bob McCall

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Catch the Spirit!

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