

# UPDATE TO COMNAP 2012 WORKSHOP ON SATELLITE COMMUNICATIONS

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# TOPICS

- ▶ Changes In Geosynchronous Satellite Service
- ▶ Emergent Satellite Communications Service
- ▶ Prospective Low Earth Orbit Satellite Service
- ▶ Satellite Based Aviation Flight Following
- ▶ Space Based Vessel Tracking

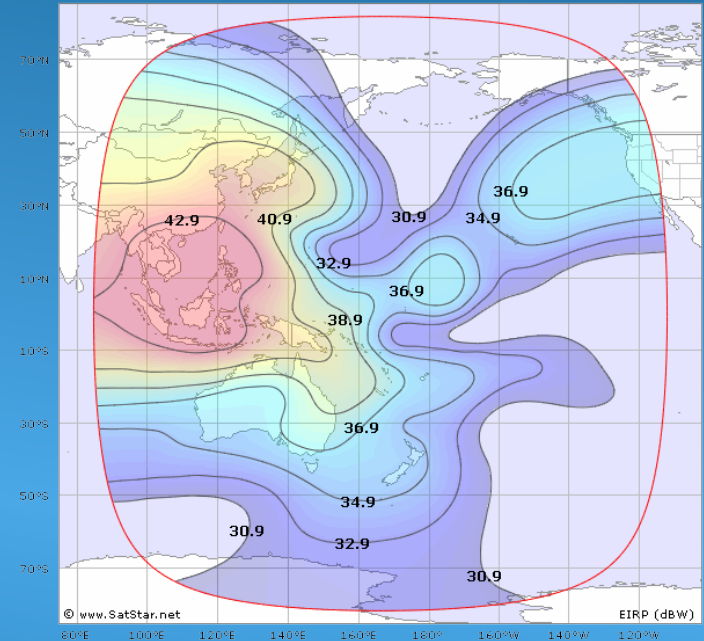
# CHANGES IN GEOSYNCHRONOUS SATELLITE SERVICE

# INTELSAT IS-19

- Satellite Name: Intelsat 19 (IS-19)
- Status: active
- **Position: 166° E**
- Operator: Intelsat
- **Launch date: 31-May-2012**
- Launch site: Sea Launch (Odyssey)
- Launch vehicle: Zenit 3SL
- Manufacturer: Space Systems Loral (SSL)
- Model (bus): LS-1300
- Orbit: GEO
- Expected lifetime: 15 yrs.
- Details:



C-band West Hemi (WHCH) beam (active)



24 C-Band and 34 Ku-Band transponders to provide telecommunication services and enhanced distribution of content throughout Asia-Pacific region with reach to the Western United States, Australia and New Zealand. Data received from the satellite indicate that the south solar array is damaged, and that the power available to the satellite will be reduced.

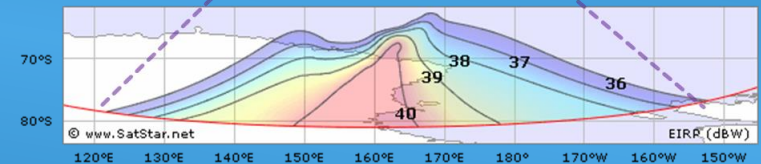
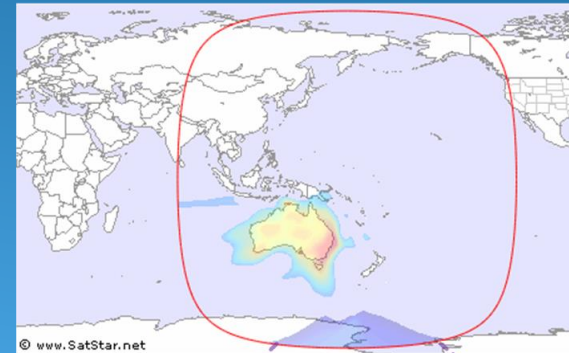
Spark NZ (formerly Telecom NZ) to migrate Scott Base service to IS-19 in coming months

# OPTUS 10



- Satellite Name: Optus 10
- Status: active
- **Position: 164° E**
- Operator: Optus Communications
- **Launch date: 11-Sep-2014**
- Launch site: Guiana Space Center
- Launch vehicle: Ariane 5 ECA
- Manufacturer: Space Systems Loral (SSL)
- Model (bus): LS-1300
- Orbit: GEO
- Expected lifetime: 15 yrs.
- 24 Ku-band transponders to provide high quality broadcast services to households, and two-way voice and data communication services to areas in and around Australia and NZ

Australia & McMurdo Sound B Beam



- Optus D1 beam coverage of Antarctica, **now in use at McMurdo**
- **Coverage similar for Optus 10**

# THOR 7



- Satellite Name: Thor 7
- Status: active
- **Position: 1° W (0.8° W)**
- Operator: Telenor Satellite Broadcasting
- **Launch date: 26-Apr-2015**
- Launch site: Guiana Space Center
- Launch vehicle: Ariane 5 ECA
- Manufacturer: Space Systems Loral (SSL)
- Model (bus): LS-1300
- Orbit: GEO
- Expected lifetime: 15 yrs.

- Details:
  - 11 Ku-band transponders, dedicated to expanded broadcast services in Europe.
  - Ka-band payload to meet the growing demand for high bandwidth broadband communications by the maritime industry.
- Payload Detail
  - Ku-Band: 21 BSS channels covering Continental Europe
  - Ka-Band: 30 forward and return link spot beams covering the maritime areas surrounding Europe including the North Sea, Norwegian Sea, Red Sea, Baltic Sea, the Persian Gulf, and the Mediterranean
    - **Single spot beam for Antarctica**
    - Single Steerable Spot Beam

**Telenor Satellite Broadcasting has sold capacity on THOR 7 to Space Norway – this is a lifetime lease and will provide Norway’s’ Troll research station in Antarctica with increased satellite capacity for the distribution of key meteorological data.**

<http://www.telenor.com/media/press-releases/2015/launch-success-for-thor-7/>

# EMERGENT SATELLITE COMMUNICATIONS SERVICE

# IRIDIUM

The Power of Global Push-to-Talk. In Your Hand.



The image features a black Iridium Extreme PTT mobile phone on the left. The phone's screen displays the Iridium logo and the text 'PTT'. The phone has a keypad with buttons labeled 1-9, \*, 0, #, and a PTT button. To the right of the phone, there are three circular callouts. The top callout points to a red helicopter in a snowy mountain landscape. The bottom-left callout points to a person in a red jacket and helmet in a snowy environment. The bottom-right callout points to a person in a red jacket and helmet inside a vehicle. Below the phone and callouts, the text 'Iridium Extreme PTT' is written in bold, with 'Push-to-Talk' in a smaller font below it.

**Iridium Extreme PTT**  
Push-to-Talk

- Global Push-to-talk (PTT) Service
- Commercially available now
- Enables private voice networks just like trunked land mobile radio
- Network members can be located anywhere world-wide
- Secure – transmissions are encrypted
- Over-the-air talk group programming
- Automatic network registration by subscriber
- Compatible with the current Iridium constellation and with IridiumNEXT

<https://www.iridium.com/SearchResults.aspx?q=Extreme%20PTT>



# IRIDIUM

- Model 9603 Short Burst Data Modem
- Introduced in May, 2012
- Latest Iridium modem offering
- Compatible with IridiumNEXT



## Specifications

### Mechanical

- Length: 31.5 mm
- Width: 29.6 mm
- Depth: 8.1 mm
- Weight: 11.4 g

### Environmental

- Operating temperature range: -40°C to +85°C
- Operating humidity range: ≤ 75% RH
- Storage temperature range: -40°C to +85°C
- Storage humidity range: ≤ 93 % RH

### RF Interface

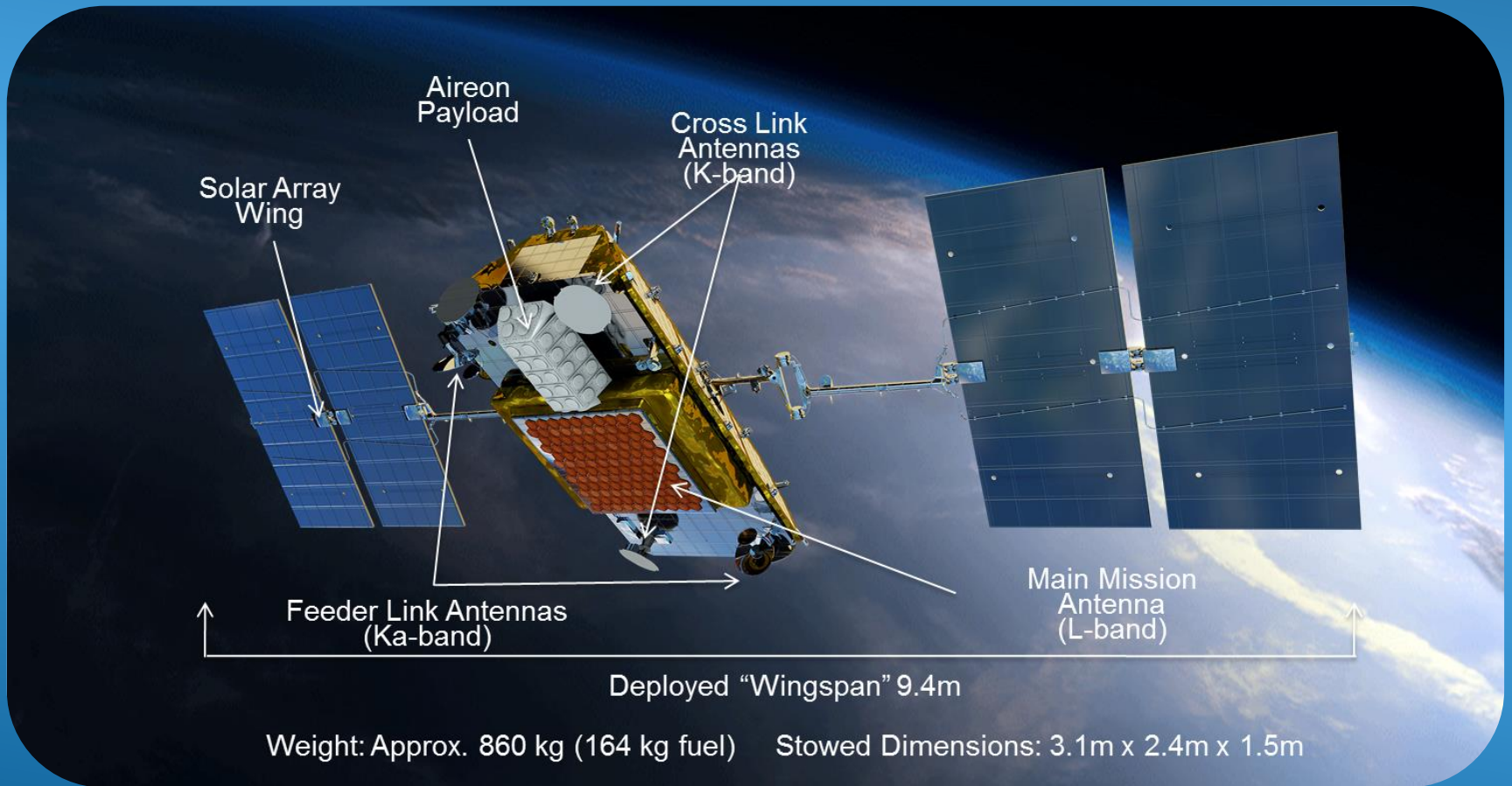
- Frequency range: 1616 to 1626.5 MHz
- Duplexing method: TDD (Time Domain Duplex)
- Input/output impedance: 50Ω
- Multiplexing method: TDMA/FDMA

### Power

- Supply input voltage range: 5.0V +/- .5V DC
- Supply input voltage ripple: <40mV pp
- Idle Current (peak): 156mA
- Idle Current (average): 34mA
- Transmit Current (peak): 1.3 A
- Transmit Current (average): 145mA
- Receive Current (peak): 156mA
- Receive Current (average): 39mA
- SBD message transfer - average current: 158mA
- SBD message transfer - average power: ≤ 0.8 W

<https://www.iridium.com/SearchResults.aspx?q=9603>

# IRIDIUM NEXT



# IRIDIUM NEXT

- ▶ Launch
  - ▶ December, 2015 – 2 satellites for on-orbit testing
  - ▶ 2016 (April) – 2017 total of 7 production launches
  - ▶ 10 satellites per launch
- ▶ Constellation
  - ▶ 66 operational satellites in 11 orbit planes
  - ▶ 6 on-orbit spares
  - ▶ 9 ground spares
- ▶ Phased replacement of legacy 1<sup>st</sup> gen constellation as NEXT launches
- ▶ Full NEXT constellation production service in 2018

# IRIDIUM NEXT

## ▶ Data rates:

- ▶ 128kb/s (Iridium Pilot) currently available,
- ▶ 352kb/s late 2016,
- ▶ 512 kb/s 2018,
- ▶ 88kb/s (handheld/manpack) late 2017,
- ▶ Voice and data will remain the same as for the current telephony devices
- ▶ Legacy phones and modem devices will continue to operate at the data rates of the 1<sup>st</sup> generation constellation

## ▶ Pricing:

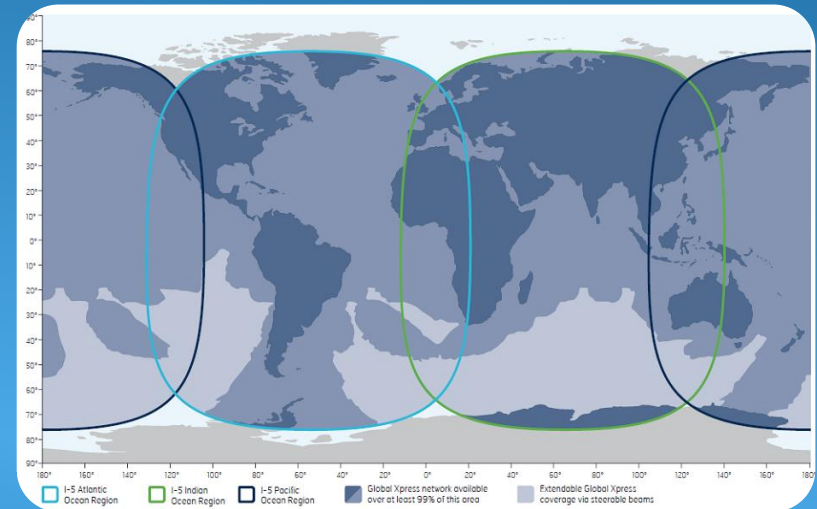
- ▶ Public pricing information available in 2016 for broadband services
- ▶ Legacy service pricing remains unchanged

# INMARSAT GLOBAL EXPRESS

- Satellite Operator: Inmarsat Plc
- Satellite Manufacturer: Boeing Satellite Systems
- Purpose: VSAT services
- Platform: BSS-702HP
- Launch site: Baikonur Cosmodrome, Kazakhstan
- Launch vehicle: ILS Proton M/ Breeze M
- Satellite Design Life: 15 years

- Details:

- Full global service begins ~ December, 2015
- 89 global spot beams (GSB) per satellite, with 72 dynamically active based on user demand
- Steerable high capacity (HC) beams for commercial and military service

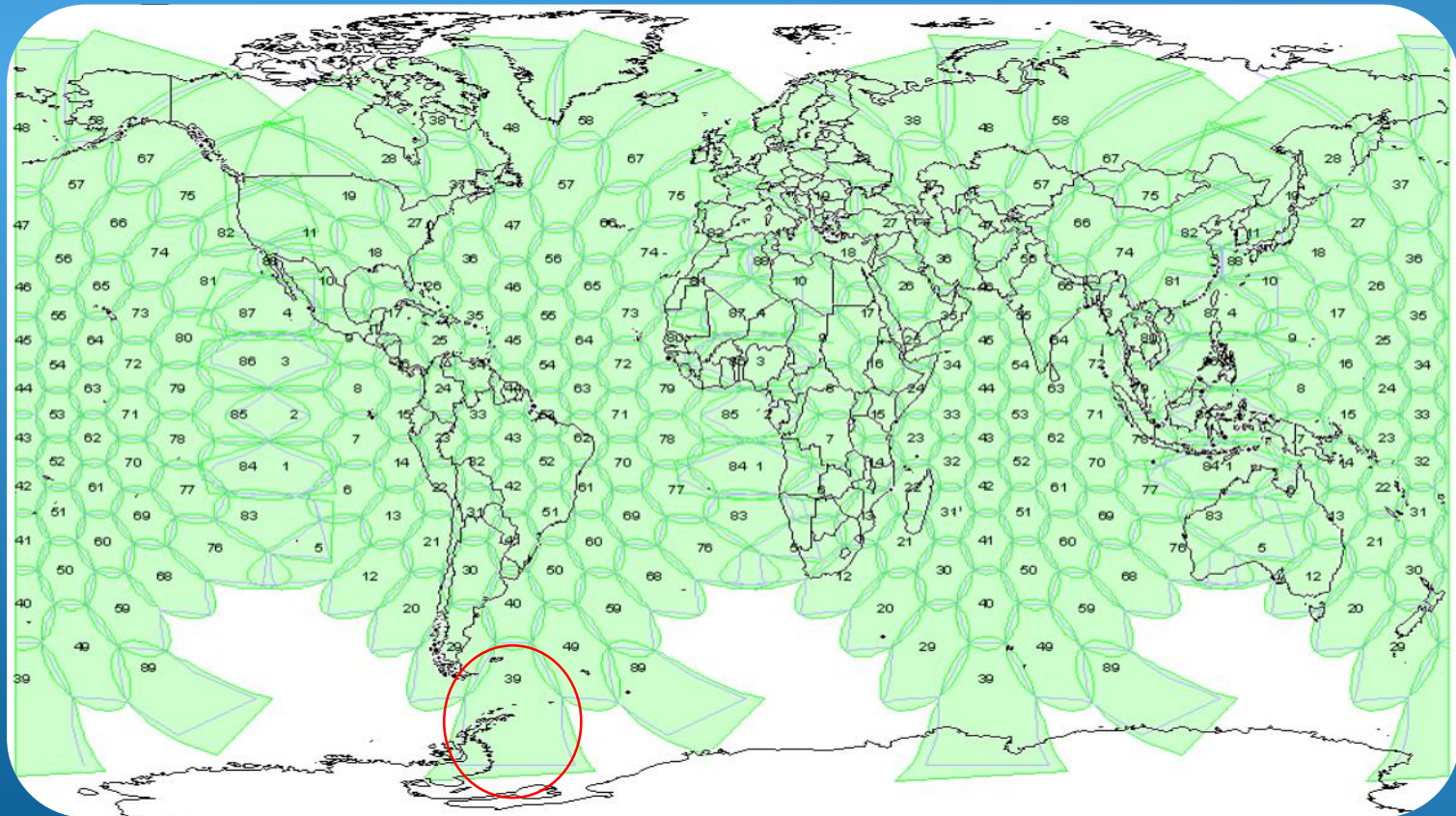


## Satellite Launch Schedule

- Indian Ocean (63° E): December 8, 2013
- Atlantic Ocean (55° W): February 1, 2015
- Pacific Ocean (180° E): August, 2015

# INMARSAT GLOBAL EXPRESS

- Not all GSB beams are active – activation depends on user demand and revenue stream generated
- At present, only Beam 39 covering the Antarctic Peninsula is likely to be active for the Antarctic region



# INMARSAT GLOBAL EXPRESS

- Priced in 64 kb/s increments
- Symmetric service shown as an example
- Asymmetric service can be provisioned

<b>Global Spot Beam Pricing (Notional) by Earth Terminal Size</b>			
	<b>Monthly Subscription Cost by Antenna Size (US\$)</b>		
<b>Two-way Data Rate</b>	<b>69 cm</b>	<b>1.0 m</b>	<b>1.8 m</b>
1 x 1 Mb/s	\$14,768	\$12,208	\$9,824
1.5 x 1.5 Mb/s	\$21,635	\$17,885	\$14,392
2 x 2 Mb/s	\$28,843	\$23,844	\$19,188

## High Capacity Beam Pricing Considerations

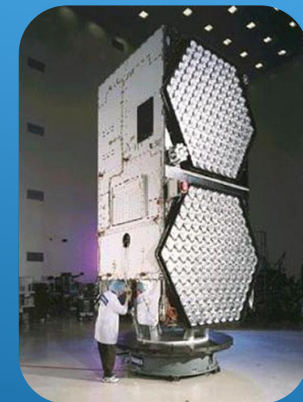
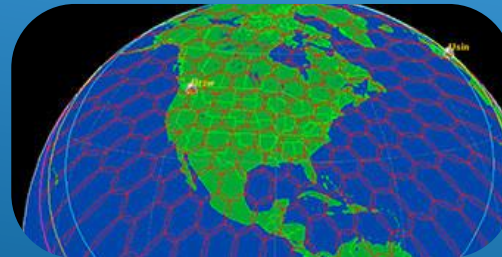
- Pricing for leased services on the High Capacity Beams (HCC, HCM and HCX) is done on a case by case basis depending on desired data rates (can exceed 100 Mb/s), antenna diameters (efficiency), transmit power, modulation scheme, etc.
- These will be custom designed leases



# OMNISPACE F-2

- Satellite name: F-2 satellite
- Status: Active, fully operational
- Position:
- Operator:
- Launch date: June 19, 2001
- Launch site: Cape Canaveral Air Force Station, United States
- Launch vehicle: Atlas 2AS
- Manufacturer: Boeing
- Model (bus): Boeing BSS-601
- Orbit: Circular MEO (45° inclination, 10,500 km altitude)
- Expected lifetime: 12 yrs.
  
- Former ICO-F2 satellite, one of a dozen built by Boeing for the former ICO Global Communications. ICO-F2 was purchased by Omnispace in 2012

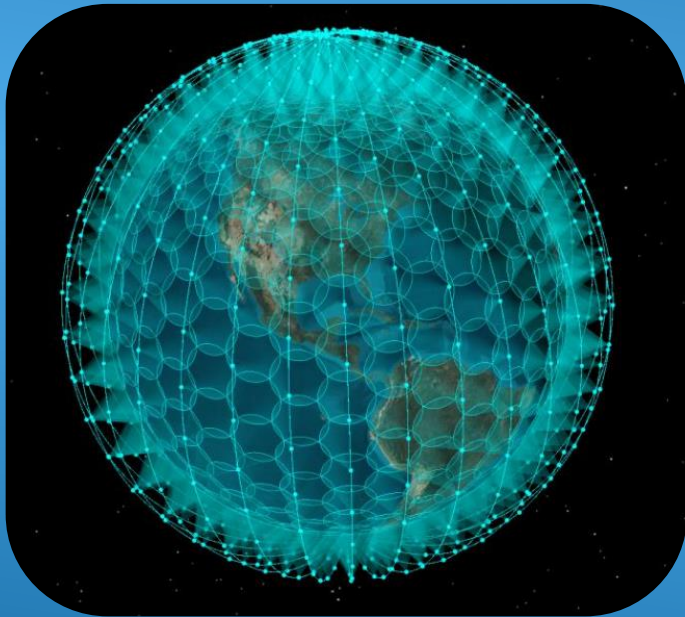
- Details:
  - Suited to a very broad range of Mobile Satellite Services (MSS) applications, Machine-to-Machine (M2M) and complimentary fixed services
  
  - S-band subscriber link
  - Data rates ~ 500 kb/s
  - Multiple satellite cell beams
  - 2-3 contacts per day at 4-6 hours per contact in polar regions
  
  - “Bent-pipe” link requires simultaneous view with gateway station
  - Three gateway stations: Washington State, USA; Usingen, Germany; Brisbane, Australia
  - Brisbane gateway supports Antarctic service





# PROSPECTIVE LOW EARTH ORBIT SATELLITE SERVICE

# ONEWEB LLC



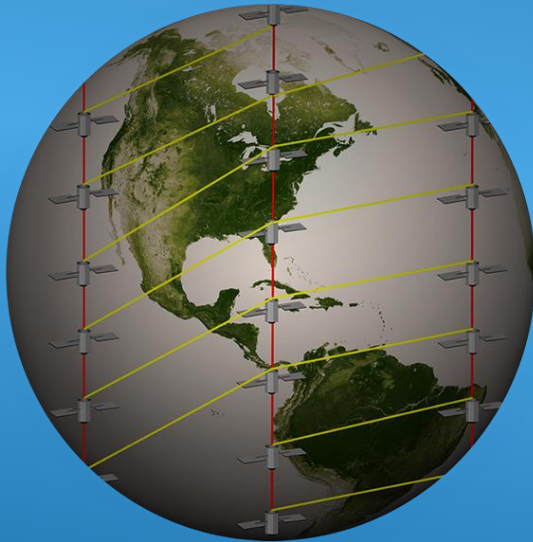
OneWeb Ltd.

Wholly owned subsidiary  
of WorldVu Satellites Ltd

<http://oneweb.world/#hero>

- 648 Polar Low Earth Orbit Satellites
- 18 Orbit Planes
- ~44 Satellites per Plane
- 1200 km Orbit Altitude
- Global Coverage
- Ka-band Inter-satellite Links
- Ku-band Service Links
- ~50 Mb/s Service Rate
- Global Teleport Facilities for Interconnection with Terrestrial Networks
  
- Small, low-cost user terminals provide local LTE, 3G and WiFi to the surrounding areas
  
- Target Start of Service: 2018
  
- Founded by Greg Wyler of O3b
- Estimated US\$3B System
- Recently Raised US\$500M Via Investors
- Intelsat Partnership, Including US\$25M Seed Investment
- Backed by Virgin Group (Sir Richard Branson) and Qualcomm
- Construction Joint Venture with Airbus Space & Defense

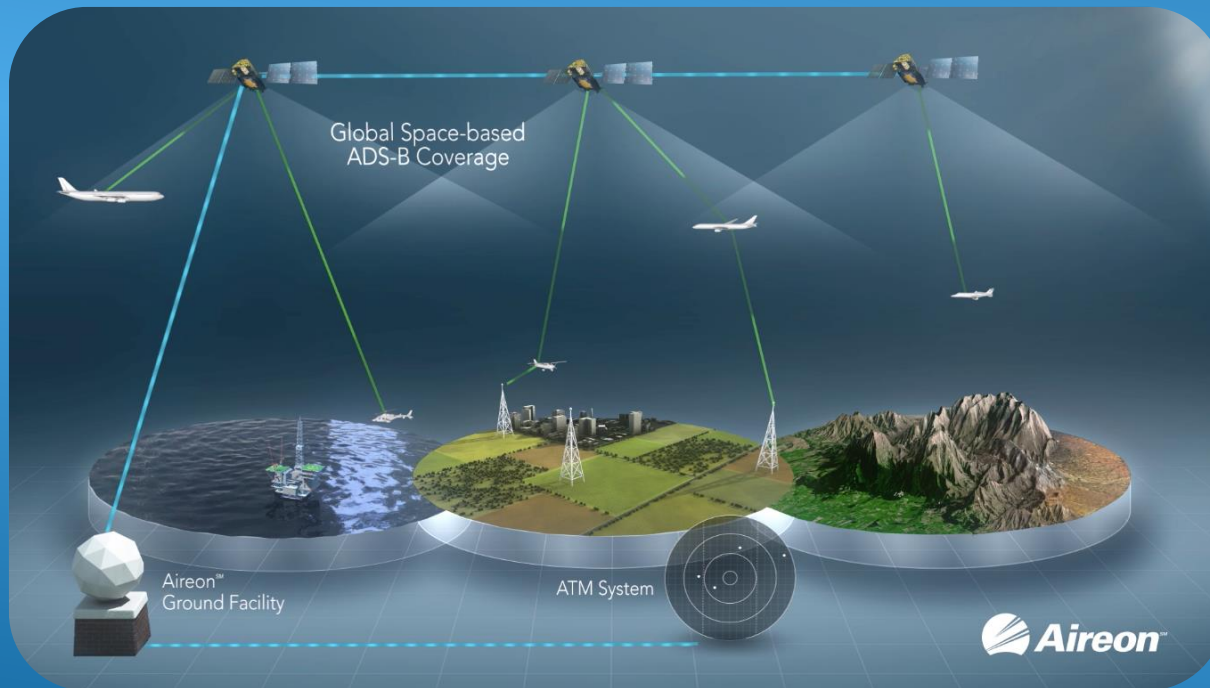
# LEOSAT INC.



<http://www.leosat.com/>

- 80 to 120 Polar Low Earth Orbit Satellites
- 1400 km Orbit Altitude
- Global Coverage
- Inter-satellite Links
- Ka-band Service Links
- 12 Spot Beams per Satellite
- Up to 1.2 Gb/s Service Rate
- Global Teleport Facilities for Interconnection with Terrestrial Networks
  
- All Solid State User Terminals with Electronic Beam Steering
  
- Service Targeted for Large Private Corporations and Governments for Point-to-Point Service Anywhere Without a Terrestrial Transport
  
- Launch Begins: 2019 or 2020
  
- Conducting Advanced Feasibility Study with Thales Alenia Space

# SATELLITE BASED AVIATION FLIGHT FOLLOWING



# AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST (ADS-B)

- ▶ What is ADS-B?

(From Wikipedia )

[https://en.wikipedia.org/wiki/Automatic\\_dependent\\_surveillance\\_%E2%80%93\\_broadcast](https://en.wikipedia.org/wiki/Automatic_dependent_surveillance_%E2%80%93_broadcast):

- ▶ An aircraft cooperates by determining its position via satellite navigation and periodically broadcasting it on a common frequency, enabling it to be tracked. The information can be received by air traffic control ground stations as a replacement for secondary radar.
- ▶ ADS-B is "automatic" in that it requires no pilot or external input. It is "dependent" in that it depends on data from the aircraft's navigation system.
- ▶ ADS-B is an element of the US Next Generation Air Transportation System (NextGen) and the Single European Sky ATM Research (SESAR).
- ▶ ADS-B equipment is currently mandatory in portions of Australian airspace, the United States requires some aircraft to be equipped by 2020 and the equipment will be mandatory for some aircraft in Europe from 2017. Canada is already using ADS-B for Air Traffic Control.

# AIREON: SATELLITE ADS-B

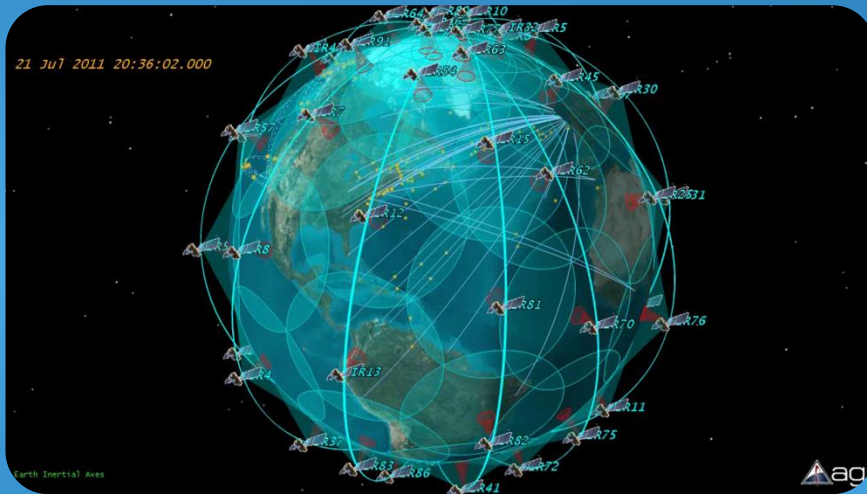
<http://www.aireon.com/Home>

- ▶ Hosted payloads on all IridiumNEXT 2<sup>nd</sup> generation communications satellites directly receive ADS-B broadcasts from all aircraft in view
- ▶ Global ADS-B coverage
- ▶ Uses IridiumNEXT satellite network for communications to ground for processing & delivery to Air Navigation Service Providers (ANSPs)
- ▶ Data delivered to ANSP can be filtered by aircraft registration, geographic location, etc.
- ▶ Aircraft Surveillance Applications:
  - ▶ Sole Source – where no surveillance currently exists
  - ▶ Augmented – filling gaps in or providing an additional layer for existing ADS-B or radar surveillance systems
  - ▶ Contingency – cost-effective back up to ground systems
- ▶ Real-time flight tracking without new avionics
- ▶ Position update available every 8 seconds or less

# AIREON: POLAR APPLICATIONS & BENEFITS

- ▶ Excellent aircraft surveillance performance of ADS-B equipped aircraft in high latitudes due to six overlapping satellites at the poles
- ▶ Ideally suited to support polar operations for air traffic control and flight following
- ▶ Sole source surveillance where communications is limited
- ▶ Supports reduced aircraft separation below current (Arctic) 10 min/80 nm
- ▶ Enables safety, predictability, cost avoidance benefits
- ▶ Can support polar operations and trials as early as 2017
- ▶ Full operational service in 2018 with completion of IridiumNEXT constellation deployment

# AIREON AIR NAVIGATION SERVICE PROVIDERS



## ANSP Customers at Launch

- NAV CANADA
- ENAV (Italy)
- Irish Aviation Authority
- UK-NATS
- Navair (Denmark, Greenland and the Faroe Islands)

## MOAs in Place

- FAA (USA)
- South Africa
- Portugal
- Singapore
- India
- ASECNA (Africa)
- New Zealand
- Iceland
- Blue Med Fab (Greece, Malta, Cyprus, Italy)

## MOAs in Development

- Australia
- Brazil

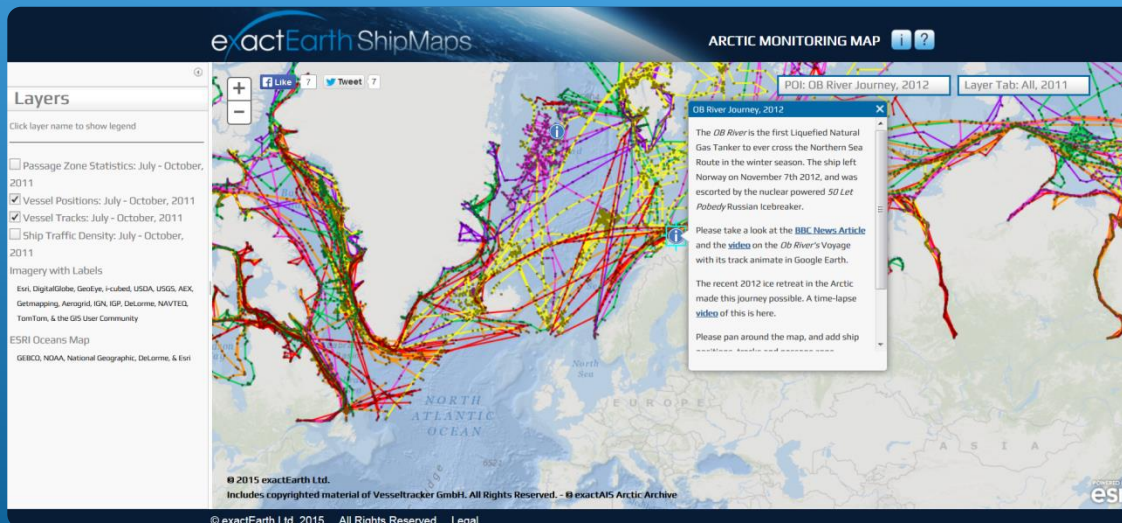


# SPACE-BASED VESSEL TRACKING

# exactEARTH

- ▶ The SOLAS Convention requires ships of 300 +gross tonnage engaged on international voyages, cargo ships of 500+ gross tonnage not engaged on international voyages, and all passenger ships irrespective of size to be fitted with automatic independent surveillance (AIS) transponders.
- ▶ Satellite AIS – satellite based reception of surface vessel AIS broadcasts
- ▶ Proprietary algorithms extract individual ship identity from received signals
- ▶ **Capable of tracking AIS Class B (low power) equipped vessels to extend coverage to the small vessel market**

<http://www.exactearth.com/technology/absea>



Sample product

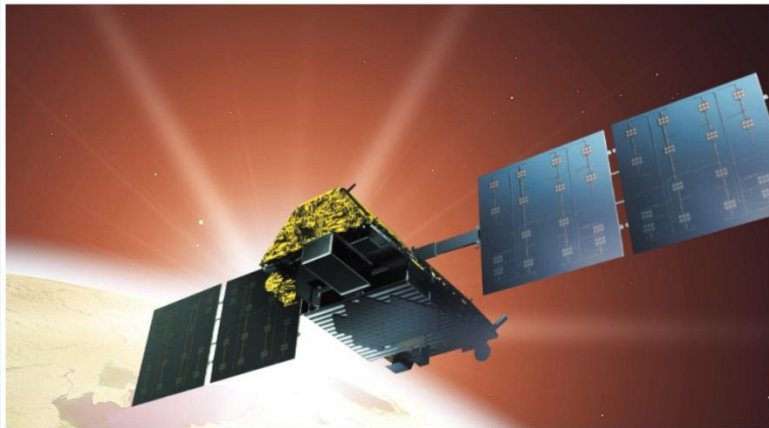
- Arctic vessel traffic

# exactEARTH + IRIDIUM NEXT

## SPACENEWS

### Harris, exactEarth To Place AIS Gear on Iridium Craft

by Peter B. de Selding — June 9, 2015



*ExactEarth said AIS terminals likely will be aboard at least some of the first 10 Iridium Next satellites to be launched aboard a SpaceX Falcon 9 rocket. Credit: Iridium*

“PARIS — Canada’s exactEarth Ltd. and Harris Corp. of the United States on June 9 announced a strategic partnership in which Harris will use exactEarth-patented technology to mount maritime ship-monitoring payloads on 58 next-generation Iridium mobile communications satellites. “

- AIS payloads expected on some of the initial launch of IridiumNEXT in 2017
- Harris Corp. has exclusive rights to market to the U.S.
- exactEARTH will market to the rest of the world

<http://spacenews.com/harris-exactearth-to-place-ais-gear-on-iridium-craft/#sthash.13sb5QTo.dpuf>

# QUESTIONS