Making Global Air Traffic Surveillance a Reality!

Space-based ADS-B data distribution through REDDIG

ICAO RCC/20 Meeting

March 22nd, 2017

Aireon

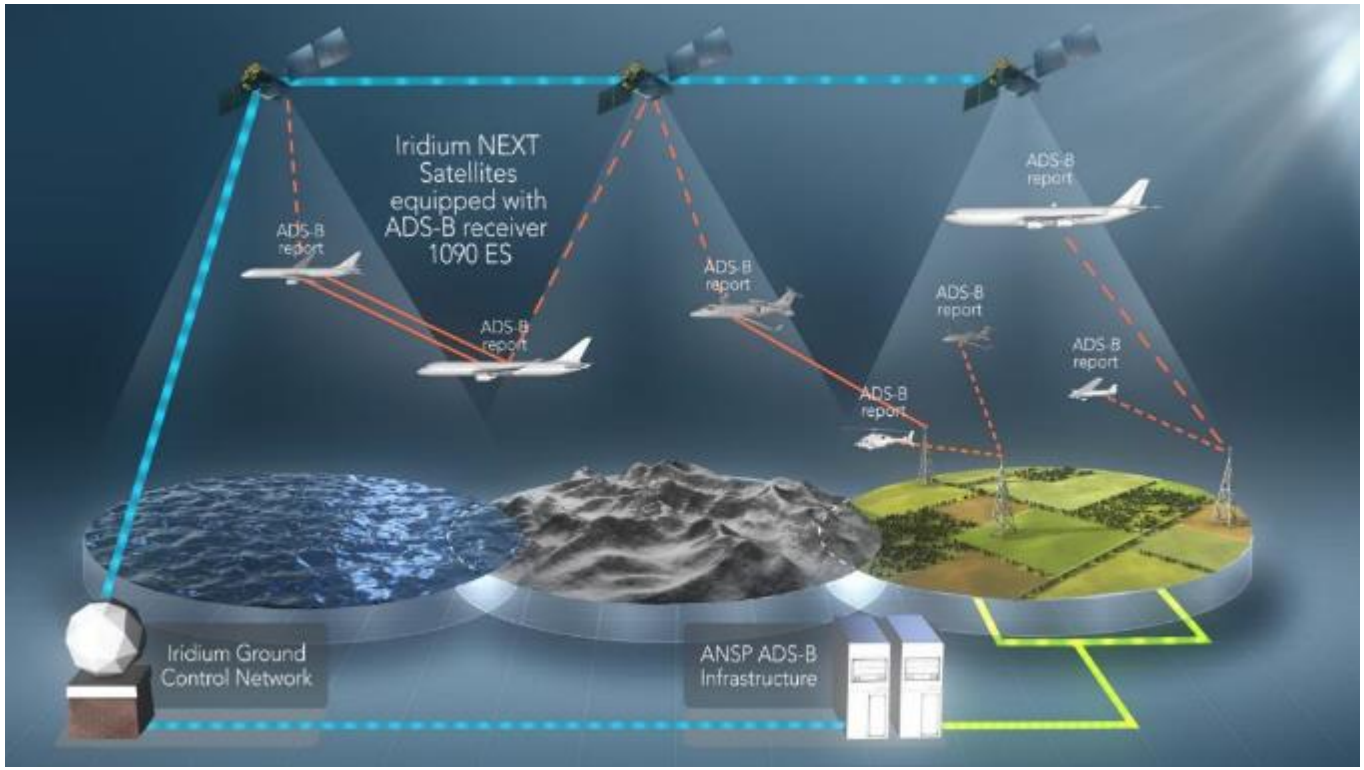
Space-based ADS-B System Overview

Aireon

Investors, Customers and Innovators:

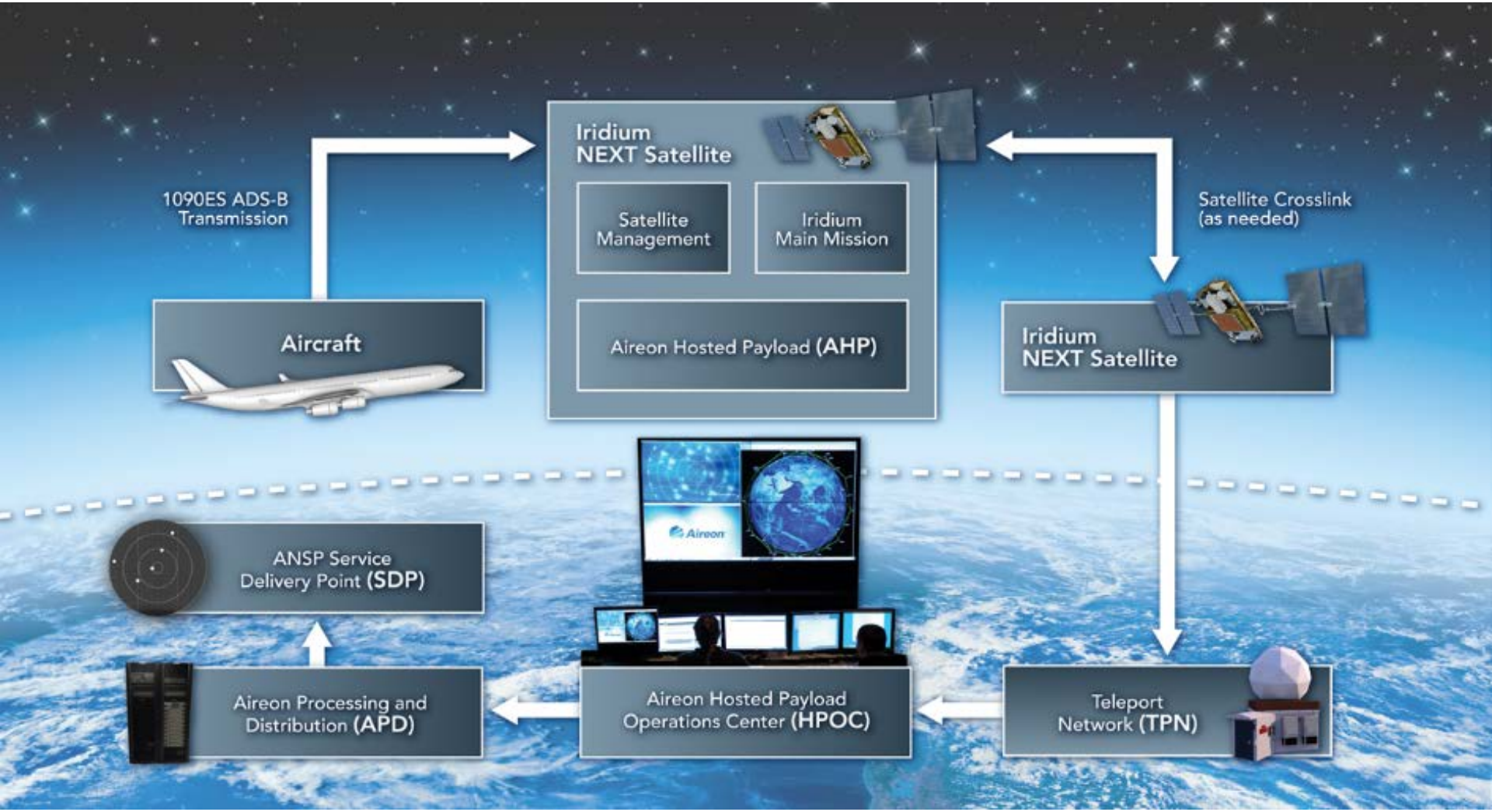
A company created by ANSPs for ANSPs and Airlines

Space-based ADS-B Concept



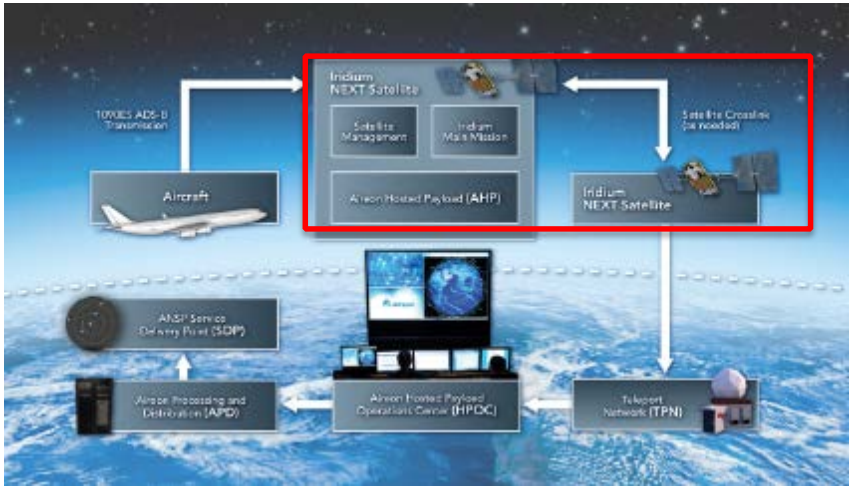
- Augments current radar systems with oceanic and remote air space coverage
- Delivers true pole-to-pole global coverage, with near real-time delivery of "ADS-B Out" data to Air Navigation Service Providers (ANSPs)
  - No additional aircraft equipage by using 1090 MHz ES
  - Adheres to all current and future ADS-B standards

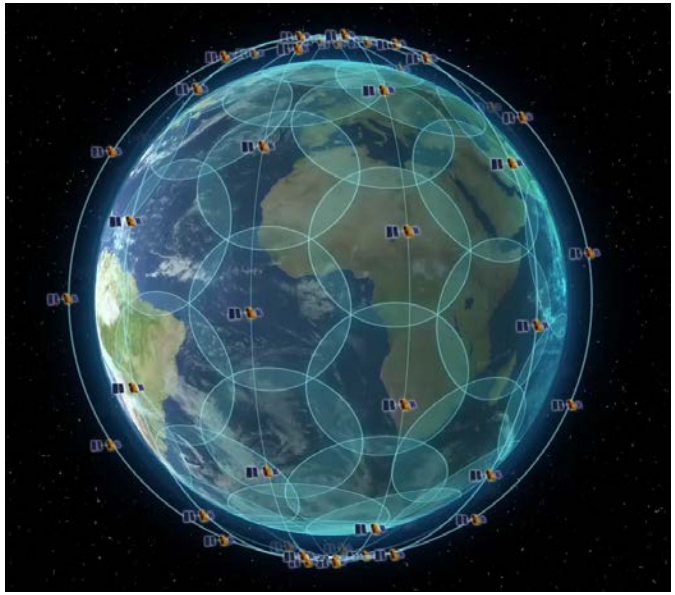
The Aireon System



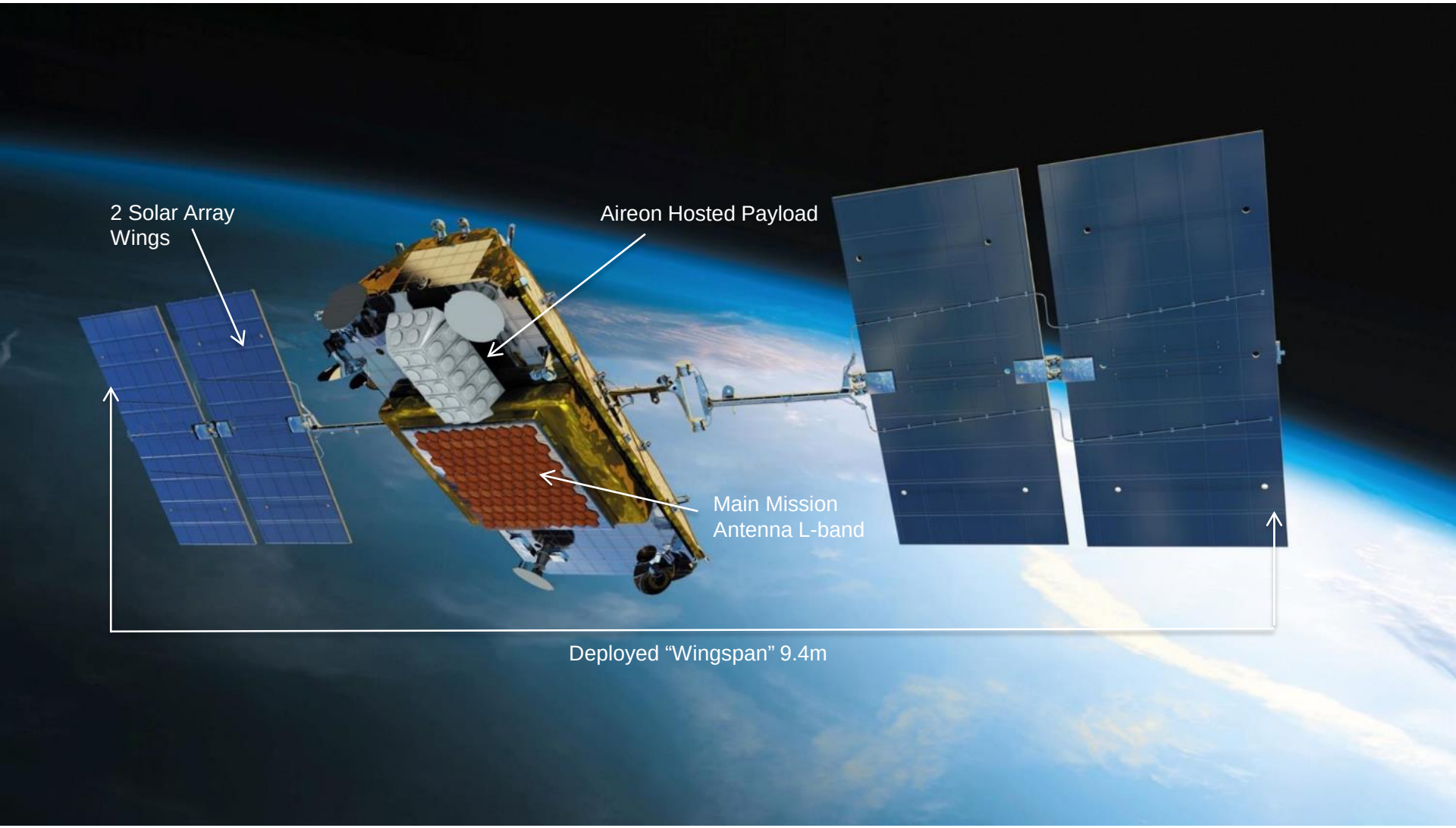
Iridium NEXT Constellation

- Satellites in orbit: 66
  - 11 satellites per plane
  - Plus 6 in-orbit spare satellites
  - 9 ground spare satellites
- Orbital Planes: 6
- Operational altitude: approximately 485 miles (780 km)
- Availability: ≥ 0.999
- Latency: ≤ 2s
- Update Interval: ≤ 8s
- En-route Services
- Typical Lifecycle: 14 years

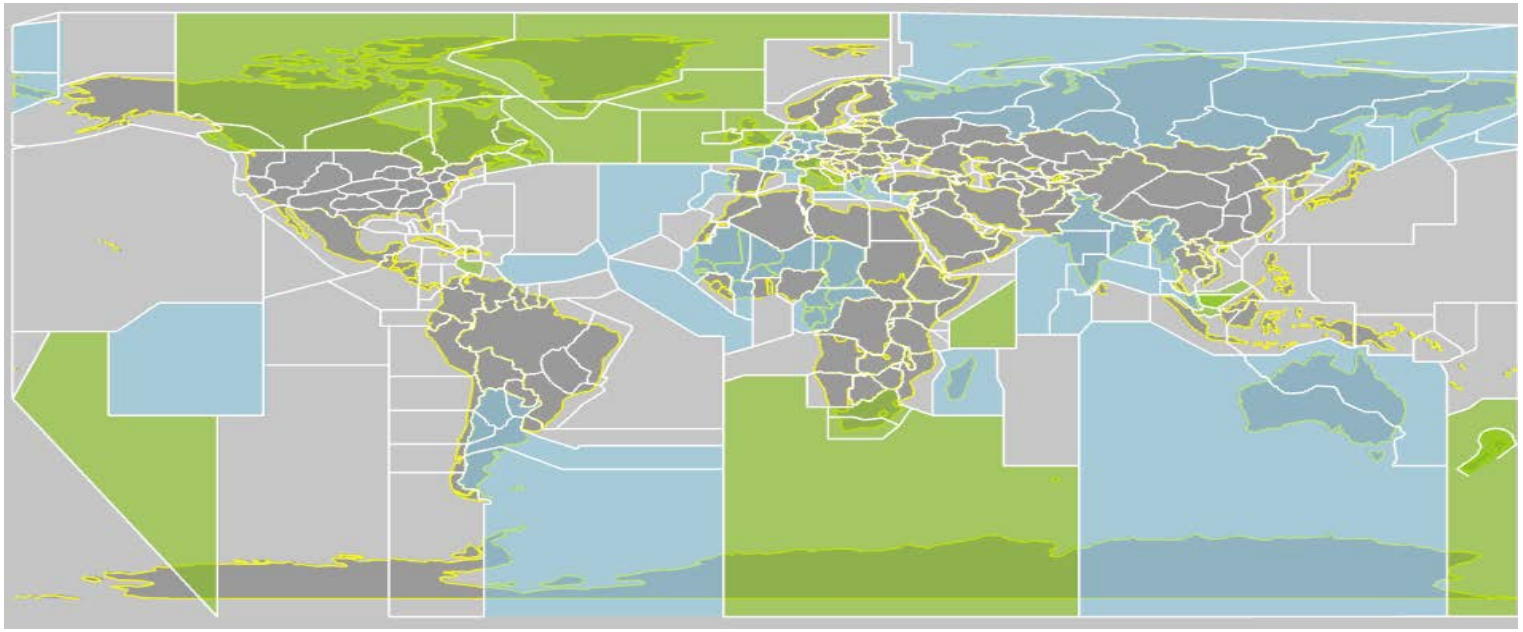




Iridium NEXT Satellite



Global ANSP Customers Supporting Rollout



Data Services Agreement	Service Delivery Point Complete or Nearing Completion
• NAV CANADA • NATS (United Kingdom) • Enav (Italy) • IAA (Ireland) • Naviair (Denmark) • DC-ANSP (Curacao) • Air Traffic Navigational Services Co. Ltd (South Africa) • CAAS (Singapore) • SCAA (Seychelles) • ISAVIA (Iceland)	• NAV CANADA • NATS (United Kingdom) • Enav (Italy) • IAA (Ireland) • Naviair (Denmark) • Air Traffic Navigational Services Co. Ltd (South Africa) • Thales

Aireon System Status

March 2017

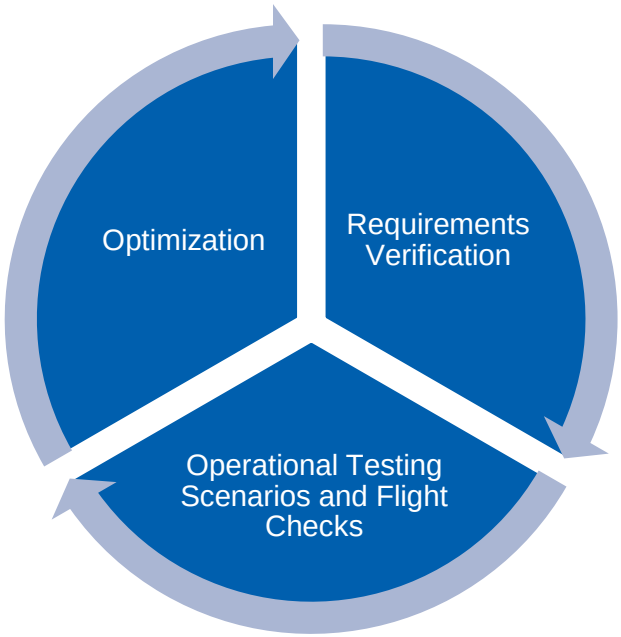
Launch Status

- First Launch: January 14, 2017
- Second Launch: June 2017
- Service Operational: 2018

Photos: SpaceX

On Orbit Test Campaign

- Detailed antenna pattern measurement with ground transmitters
- Time Stamp Accuracy
- Bandwidth Characterization



- Commanding:
  - Test target message rate
  - Antenna schedule dwell
  - Payload Redundancy
- Status:
  - ADS-B target processing
  - Payload Redundancy

- Low-power target performance
- Track Aircraft in high-FRUIT regions
- TPM Collection (Update Interval and Latency)

Flight Test Aircraft and Tools

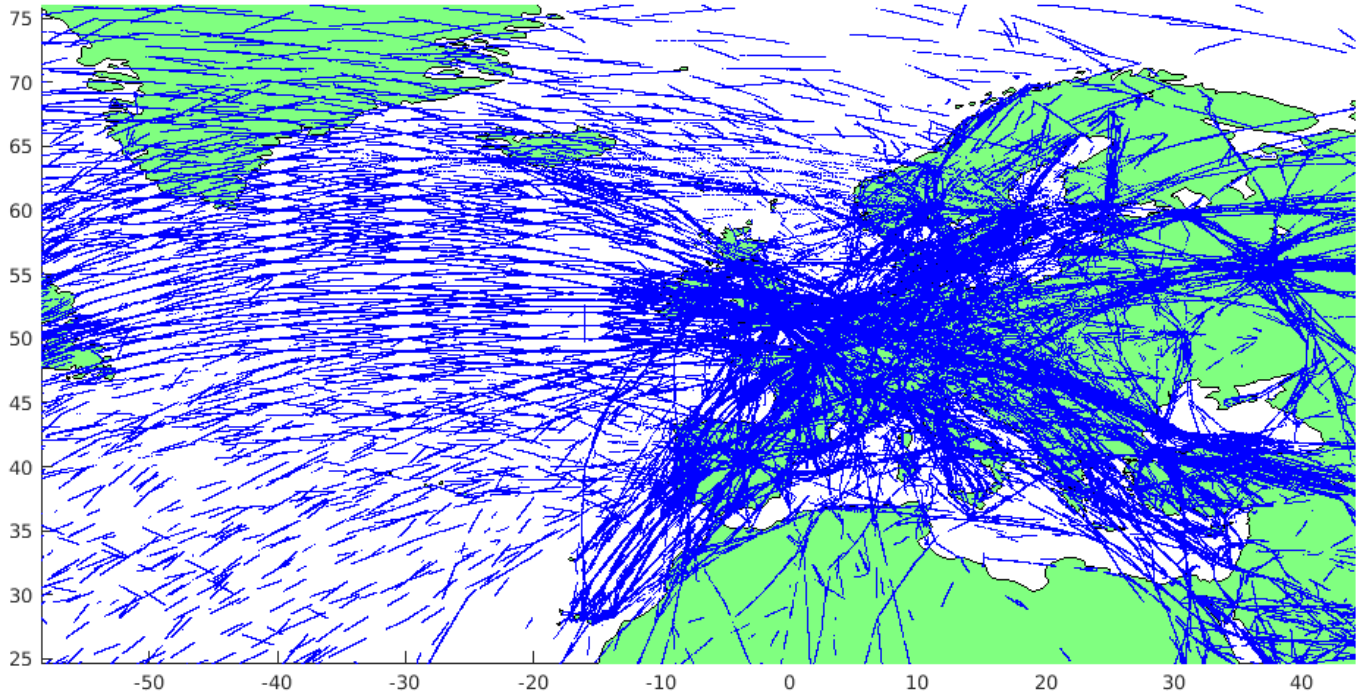
NAV CANADA

Iqaluit GBRT

Polaris

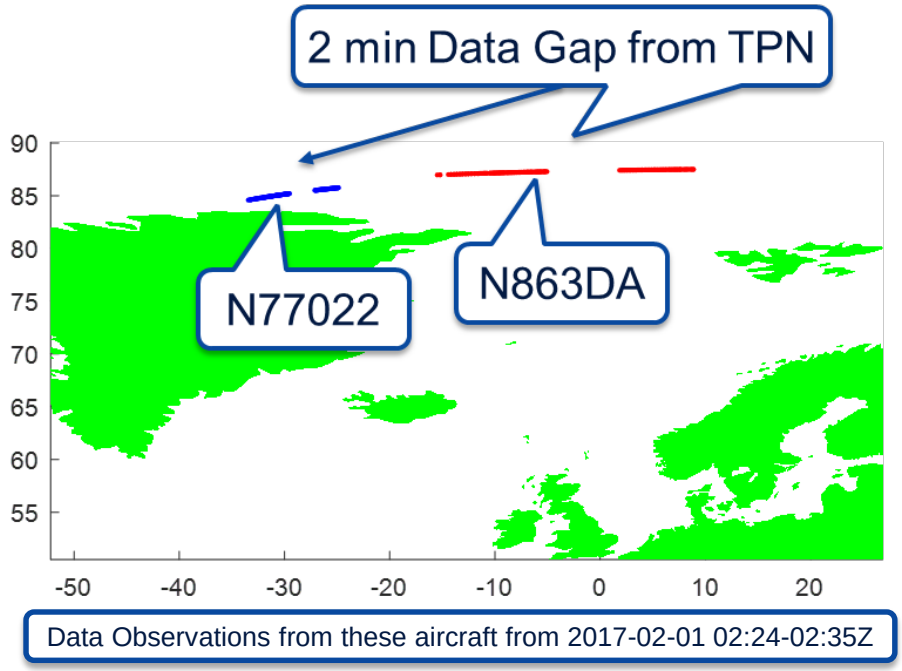
FAA

Preliminary Data



Date / Duration	2017-02-25 to 2017-02-27 / 62 Hours
Unique Aircraft	17,229
Data Points	4,825,579 (256MB of CPR decoded mission data)
Max Slant Range	3,500 km
Types of Aircraft	Commercial Jets, Business Jets, General Aviation, Helicopters
Airspace Domains	Polar, Oceanic, En Route, Terminal, and Surface

Preliminary Data: Polar Traveling Aircraft



These two aircraft are travelling Eastbound together at about 490 knots at the same altitude (35,000') with a separation distance of ~155 NM

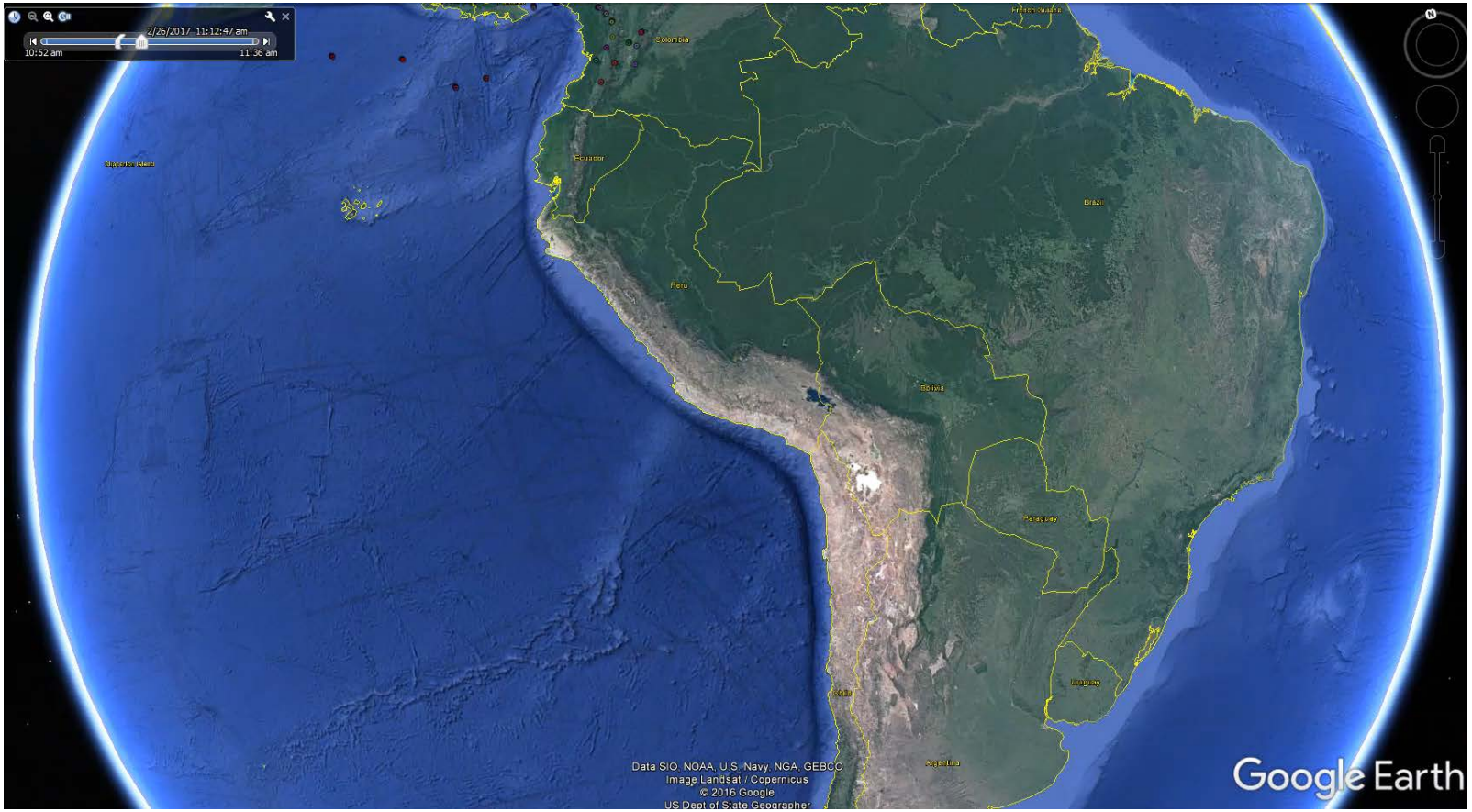
Preliminary Data: Surface

Commercial Aircraft Landing in the Azores

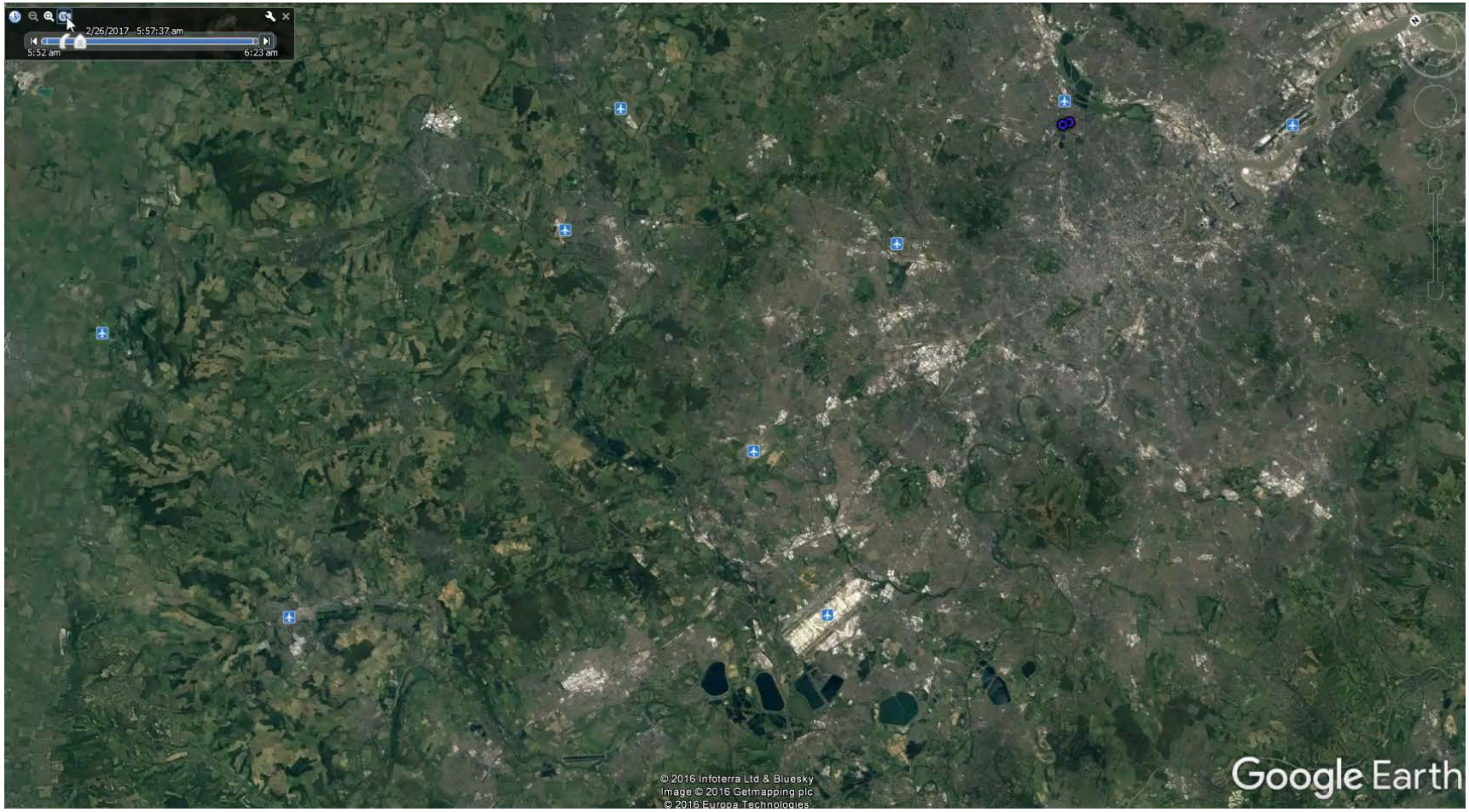
Commercial Aircraft landing in Addison, Texas

Caribbean

South America

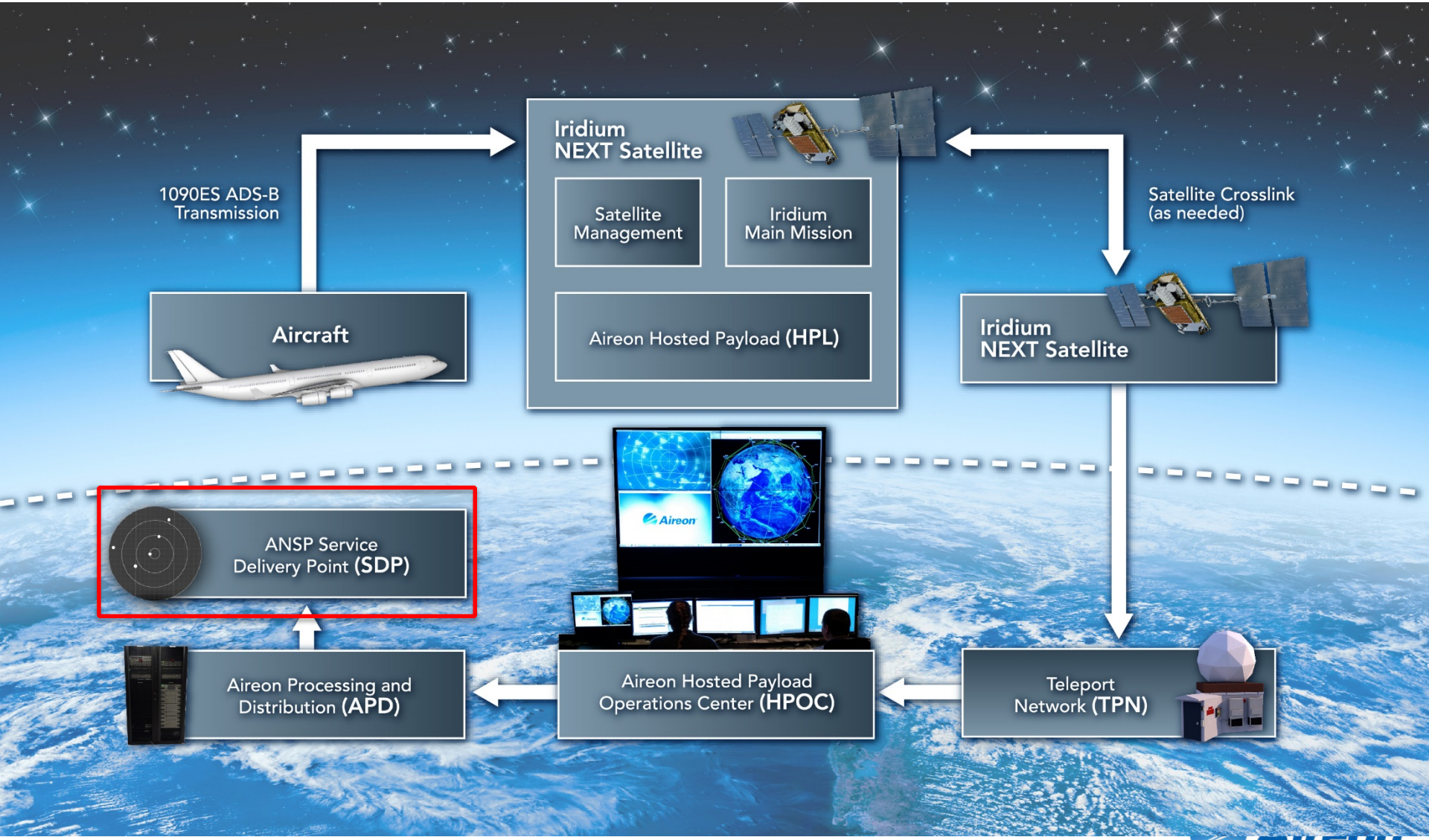


Landings at Heathrow, UK



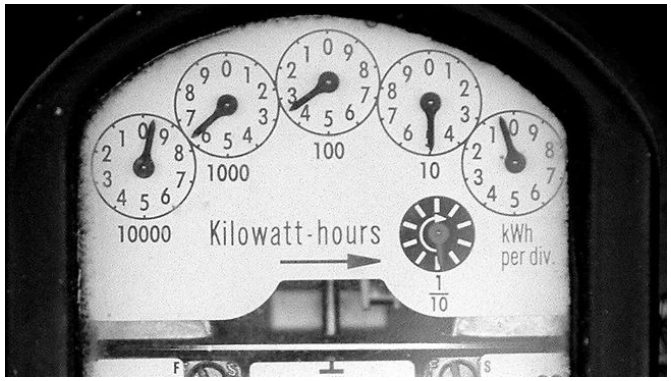
Service Delivery Point (SDP) and Space-based ADS-B data distribution

Service Delivery Point (SDP)



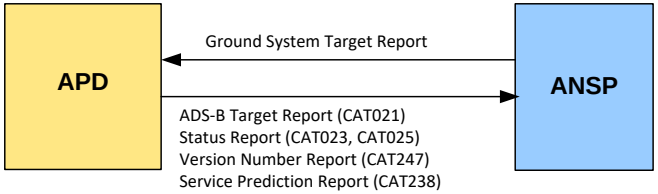
Service Delivery Point (SDP)

- The SDP is the demarcation point for Aireon ADS-B Data
- The SDP consists of a router and monitoring server – both have redundant backups.
- The monitoring server is the TPMM, or Technical Performance Measure Monitor.
  - Determines Update Interval for each target.
  - Determines Latency for each target.
  - Monitors availability.
- The TPMM is like a power meter, but for ADS-B data



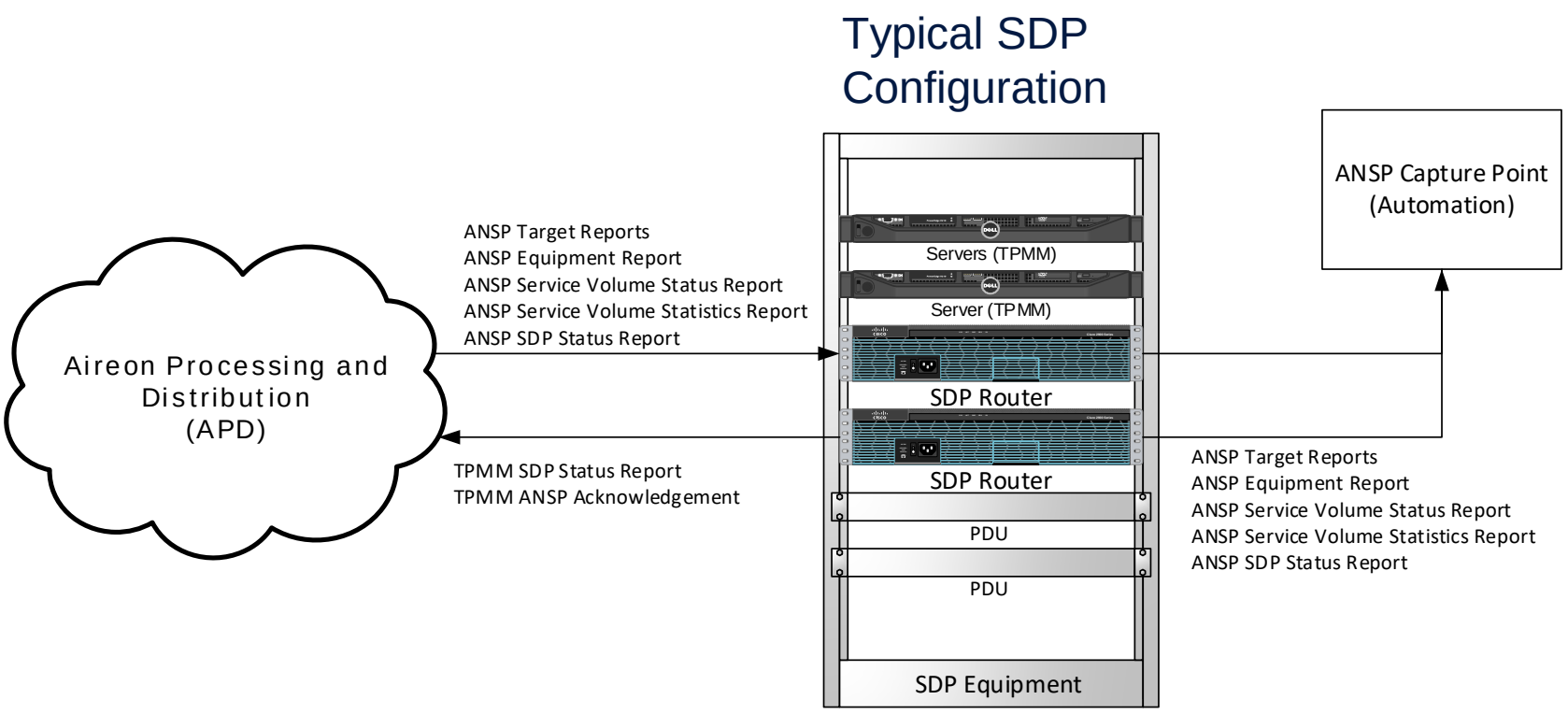
ASTERIX Overview

- Examples of common categories:



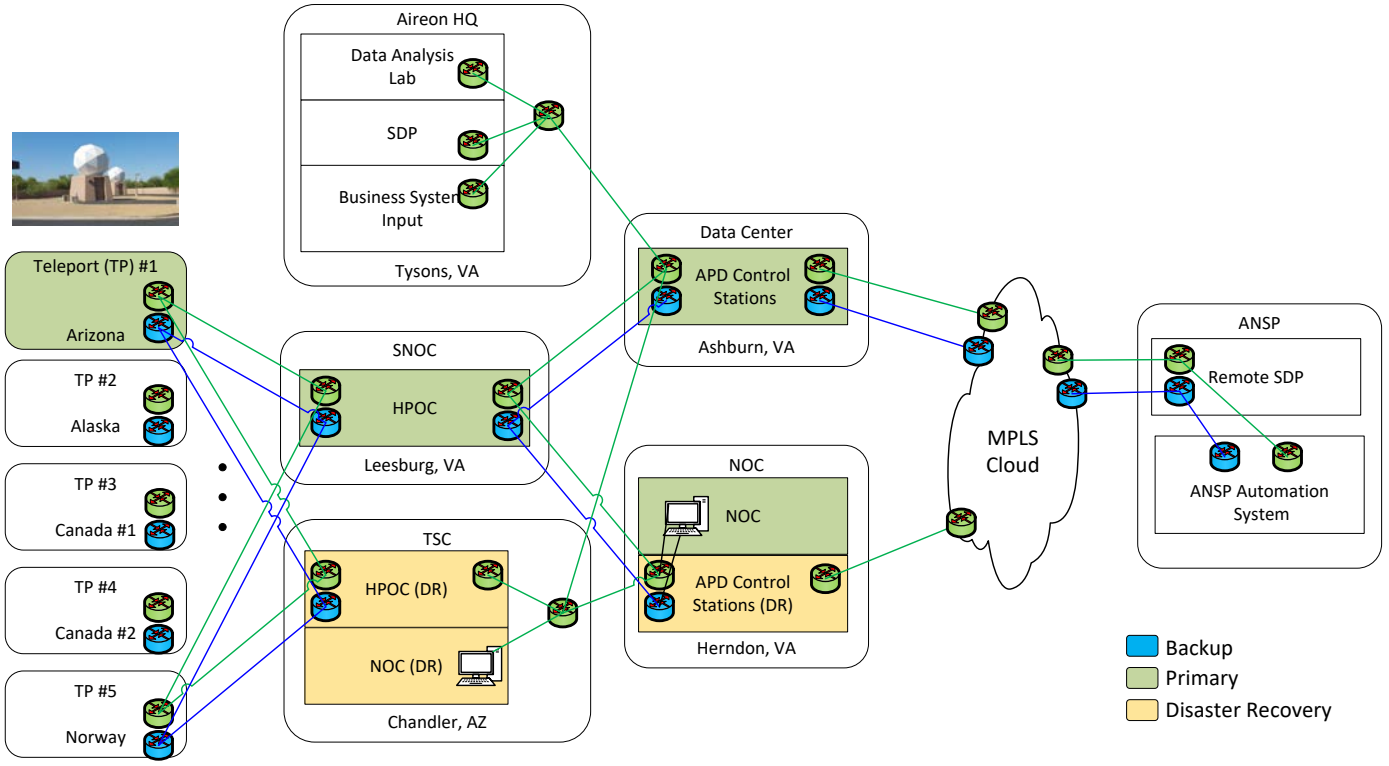
Category	ASTERIX Message
CAT021	ADS-B position and velocity reports
CAT023	Ground station (equipment) status
CAT025	Surveillance system status reports (In progress, new for ED-129B)
CAT247	Version number exchange
CAT238	Service Prediction reports
CAT253	Two-Line Element (TLE) report

Typical SDP Architecture (Single Node)

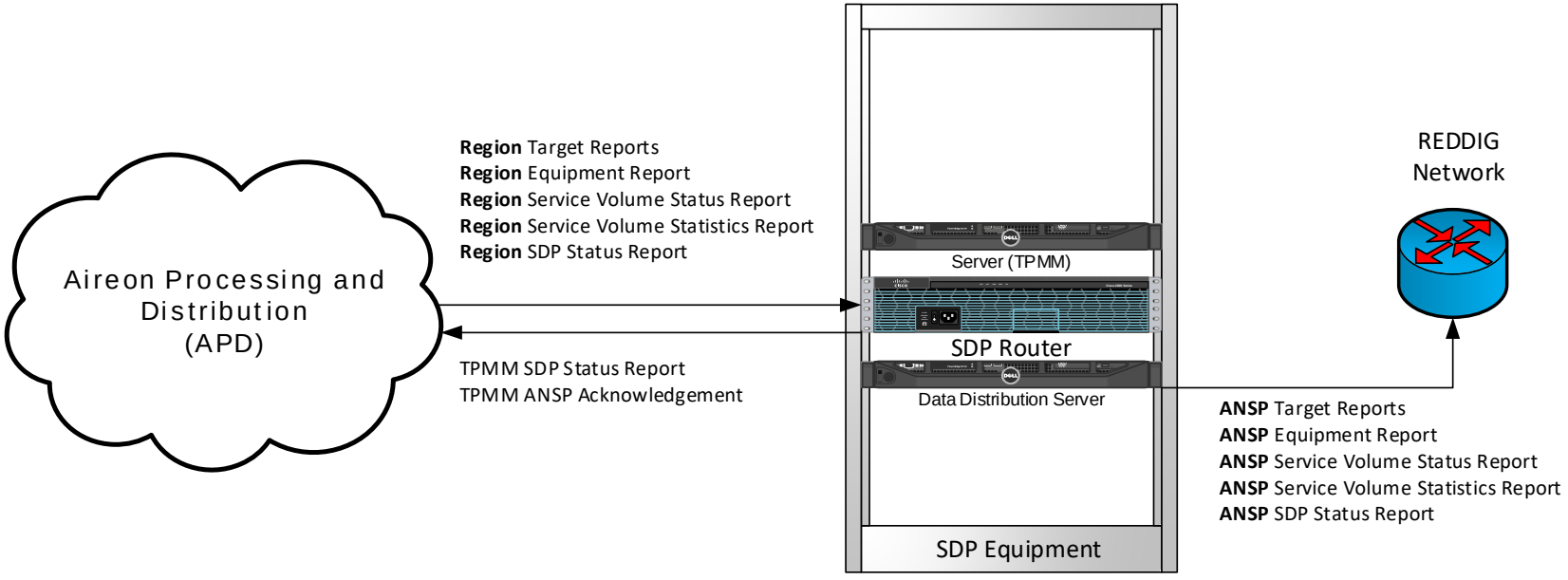


Typical SDP Network Diagram

Aireon Global Surveillance Network Overview

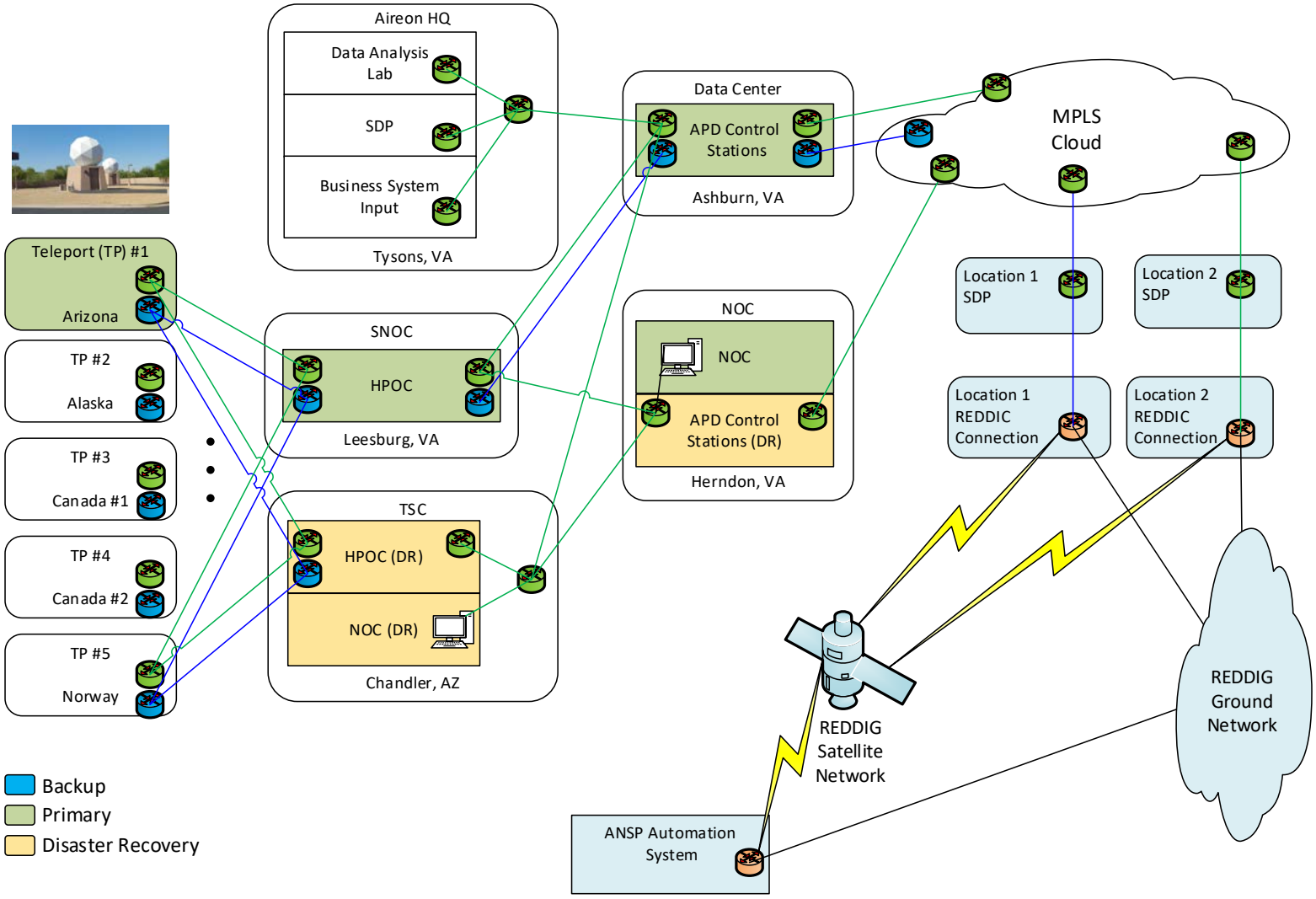


REDDIG SDP Architecture (Dual Nodes)



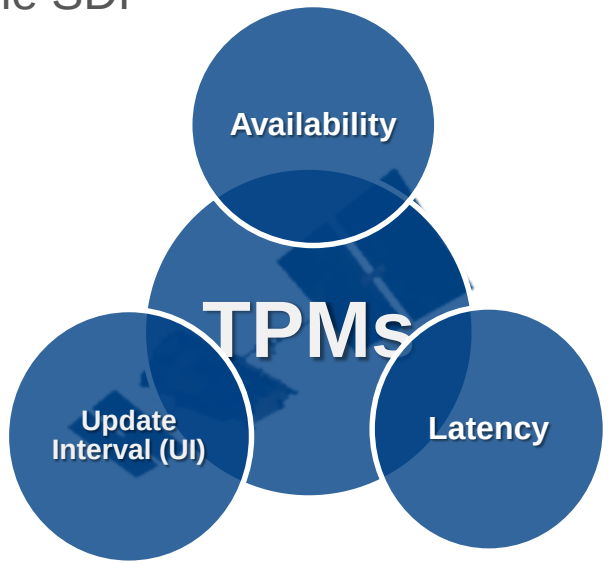
REDDIG SDP Network Diagram

Aireon Global Surveillance Network Overview

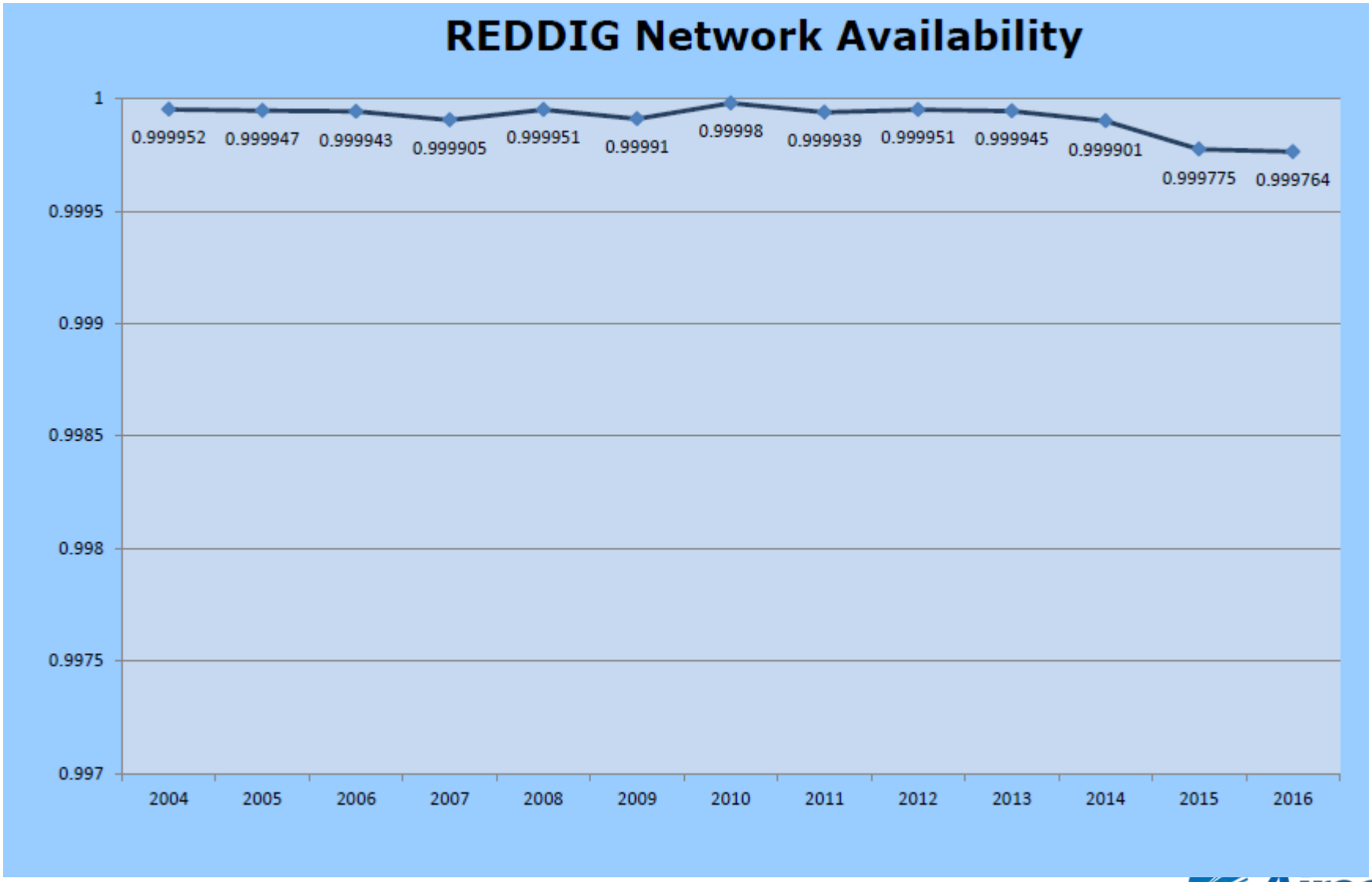


Things to Note about using the REDDIG Network

- TMPs are measured at the SDP
  - Availability - 0.999
  - Update Interval – 8s, ≥ 96%
  - Latency - ≤ 2s
    - Availability and Latency will be affected by the REDDIG network and is not included
- Data billing is calculated on what is delivered to the SDP
- Aireon will maintain configuration of all system components up to the SDP
- Aireon will maintain security up to the SDP
- We need to rely on REDDIG's system to deliver data to ANSPs across SAM region

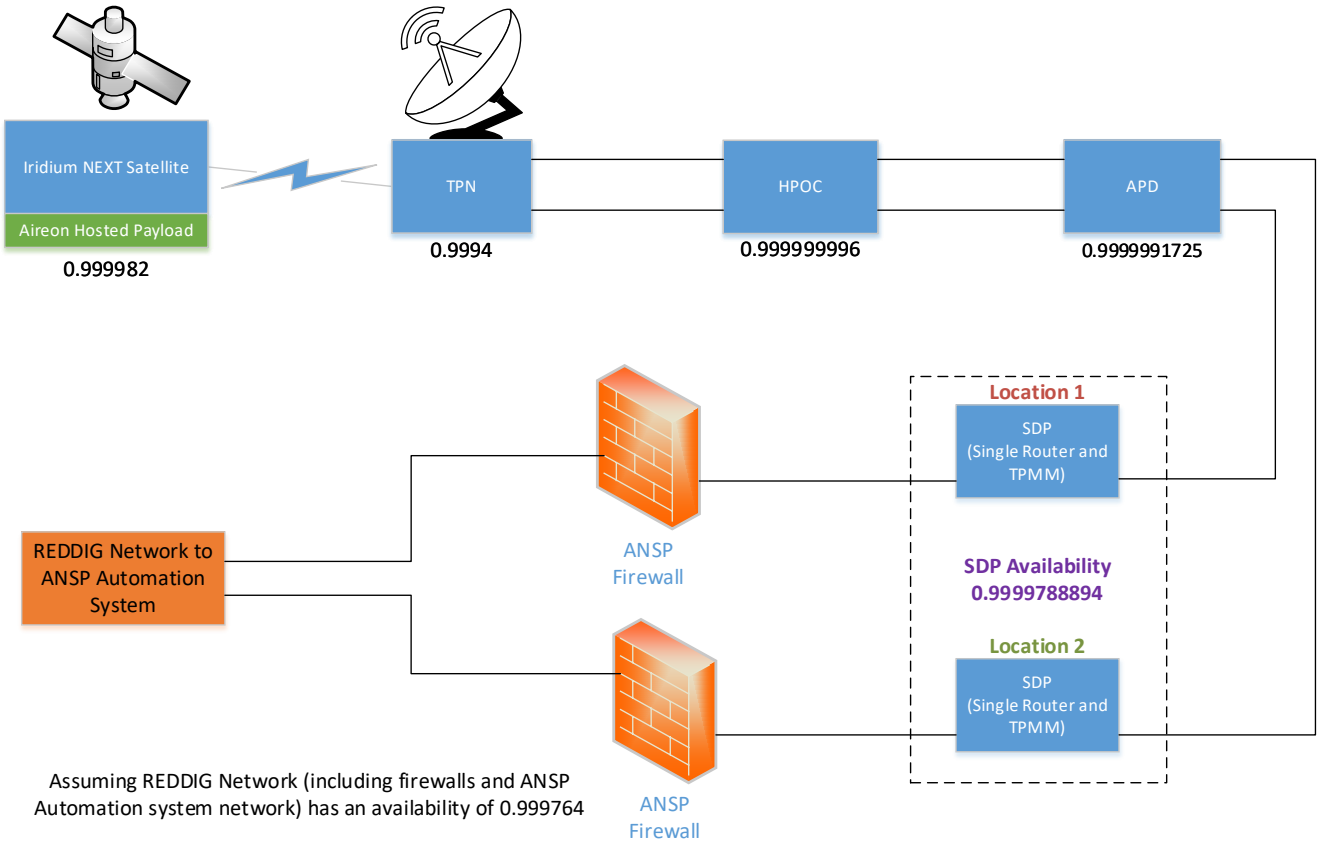


REDDIG AVAILABILITY



Calculated Availability System using REDDIG Network

Availability using two single string SDPs that feed a single Automations Systems



System Availability is 0.99912

REDDIG Network Requirement

- System Availability > 0.999
- Accepts Multicast Data
- Delivery to Automation system in low latency
- Surveillance data segregation for each of the connected ANSP
- Bandwidth:
  - Argentina: estimated traffic for all FIRs 170,000 flight hours/year -> 170MB/year
  - Bolivia: estimated traffic 79,530 flight hours/year -> 80MB/year
  - Brazil: estimated traffic for all FIRs 1,600,000 flight hours/year -> 1600MB/year
  - Chile: estimated traffic for all FIRs 100,000 flight hours/year -> 100MB/year
  - Colombia: estimated traffic for all FIRs 374,000 flight hours/year -> 374MB/year
  - Ecuador: estimated traffic for all FIRs 78,000 flight hours/year -> 78MB/year
  - Guyana: estimated traffic 10,000 flight hours/year -> 10MB/year
  - Paraguay: estimated traffic 14,000 flight hours/year -> 14MB/year
  - Peru: estimated traffic for all FIRs 248,000 flight hours/year -> 248MB/year
  - Suriname: estimated traffic 7,000 flight hours/year -> 7MB/year
  - Uruguay: estimated traffic for all FIRs 36,000 flight hours/year -> 36MB/year
  - Venezuela: estimated traffic for all FIRs 160,000 flight hours/year -> 160MB/year

Conclusions

- Initial assessment shows it is feasible to distribute space-based ADS-B air traffic surveillance data, through REDDIG
  - Reduction in SDP and Telco costs for ANSPs
- Aireon would guarantee availability to the SDP and REDDIG system guarantees availability to ANSPs sites
- Suggested Action:
  - Develop detailed architecture for distribution of Space-based ADS-B surveillance data through REDDIG
  - Test and validate through implementation of a Service Delivery Point (SDP) in one or two nodes in the SAM region:
    - Connect interested States to Aireon's Processing and Distribution Center data through the REDDIG network to test their own airspace data
    - Perform an evaluation of ADS-B surveillance data distribution through the network

Thank you

Questions?

Aireon