Making Global Air Traffic Surveillance a Reality!

Space-based ADS-B data distribution through MEVA III

MEVA TGM/32 Meeting

May 11th, 2017

FREQUENTIS

Aireon

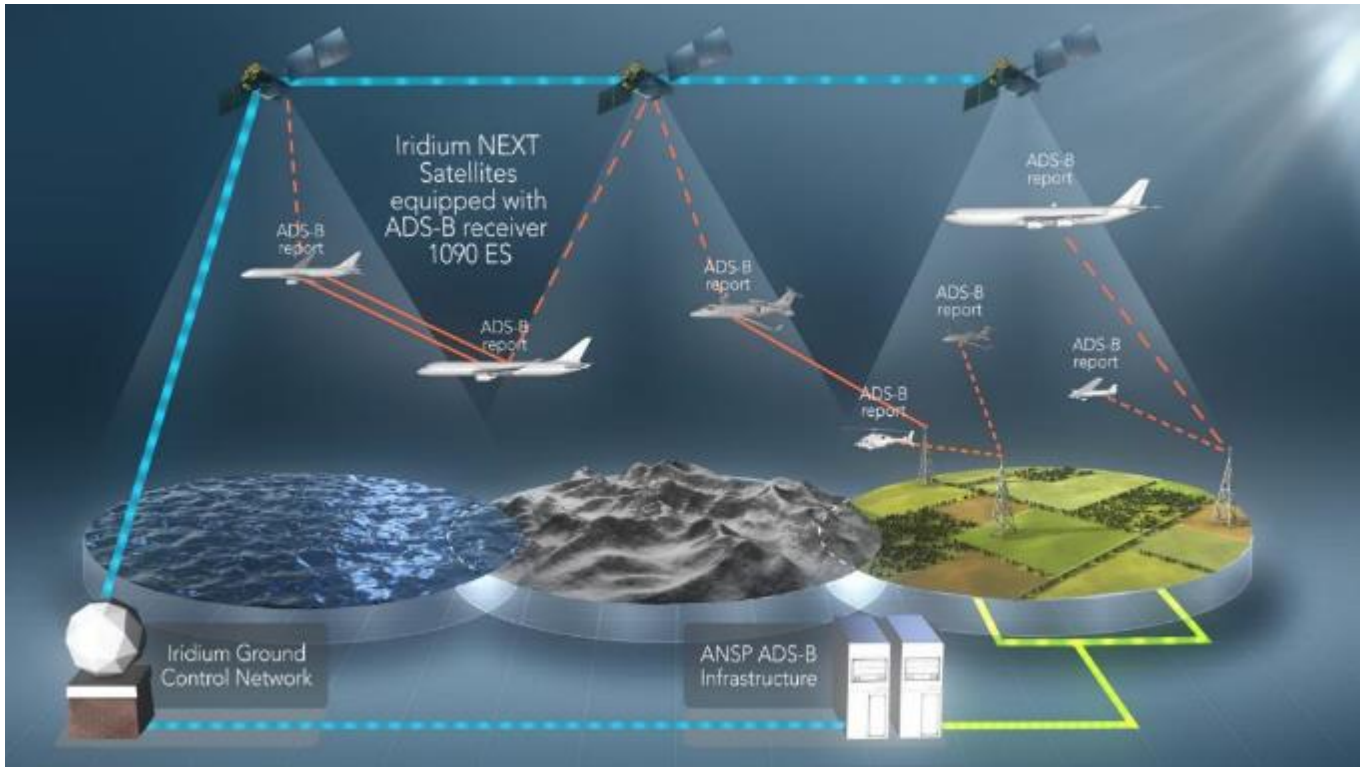
Space-based ADS-B System Overview and Implementation Status

Aireon

Investors, Customers and Innovators:

A company created by ANSPs for ANSPs and Airlines

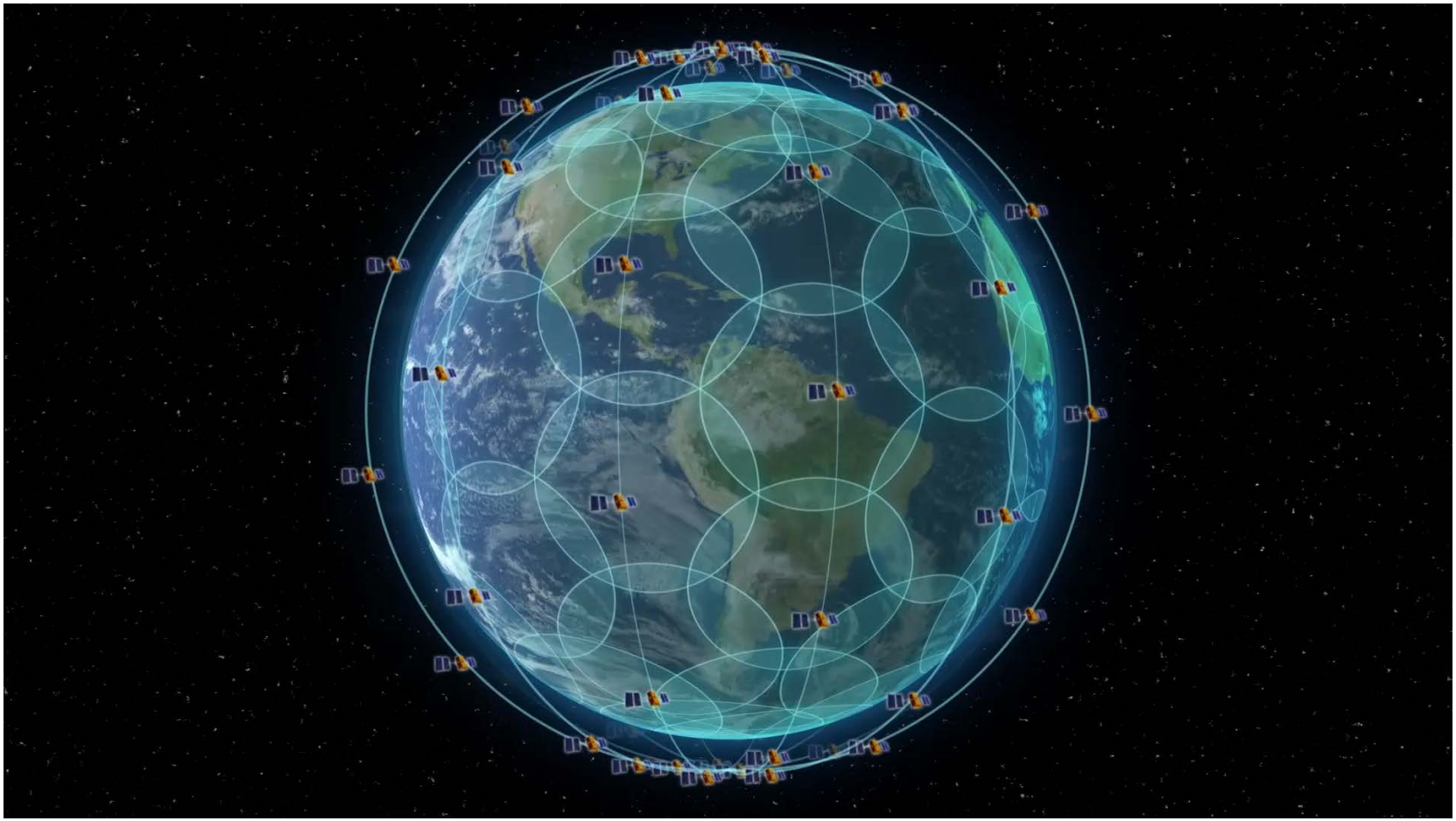
Space-based ADS-B Concept



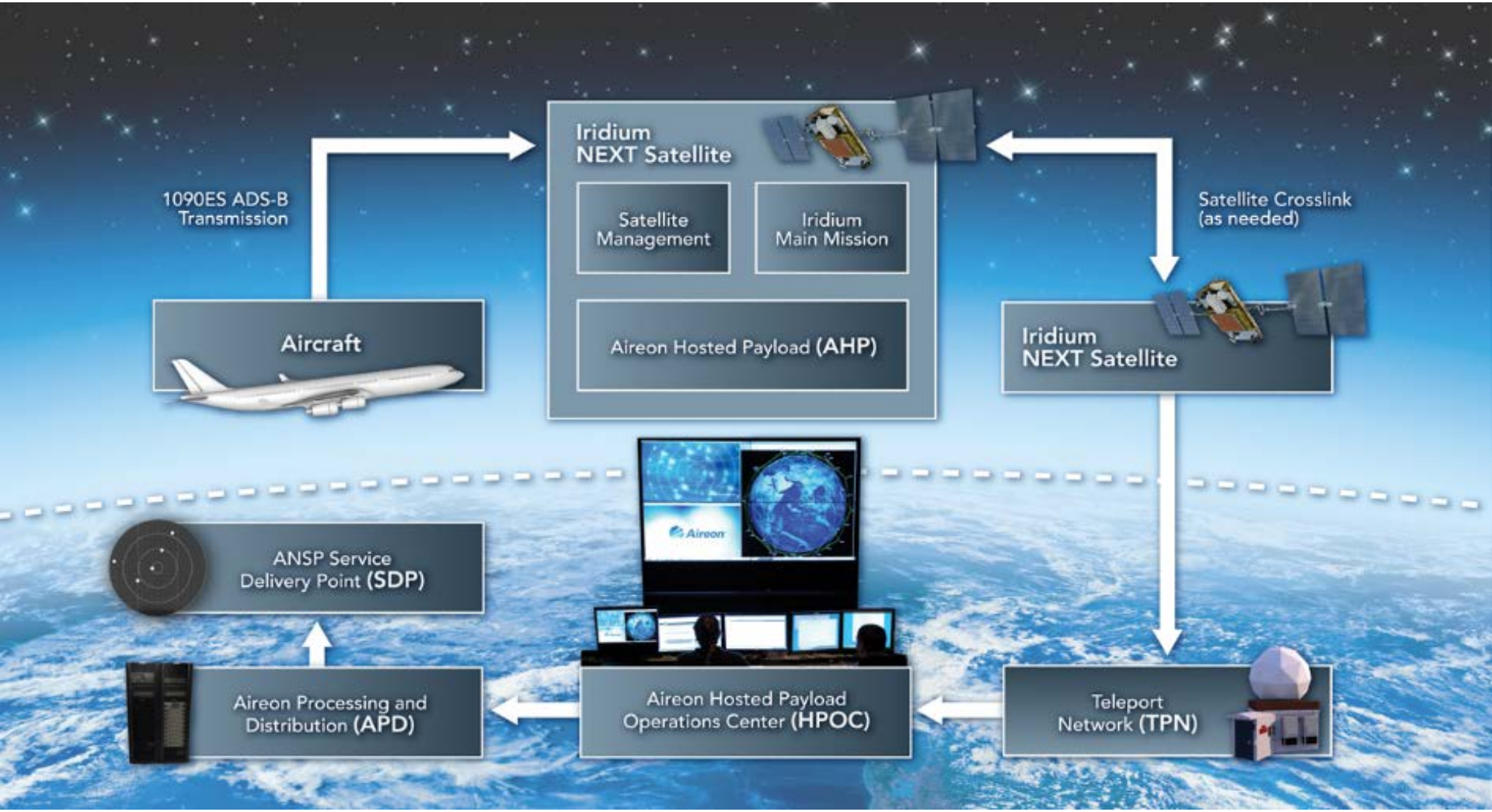
- Augments current radar systems with oceanic and remote air space coverage
- Delivers true pole-to-pole global coverage, with near real-time delivery of "ADS-B Out" data to Air Navigation Service Providers (ANSPs)
  - No additional aircraft equipage by using 1090 MHz ES
  - Adheres to all current and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

In 2018…100% Global Air Traffic Surveillance

Iridium NEXT Constellation



The Aireon System



Our launch customer for the LATAM/CAR region is DC-ANSP

DC ANSP
Dutch Caribbean Air Navigation Service Provider

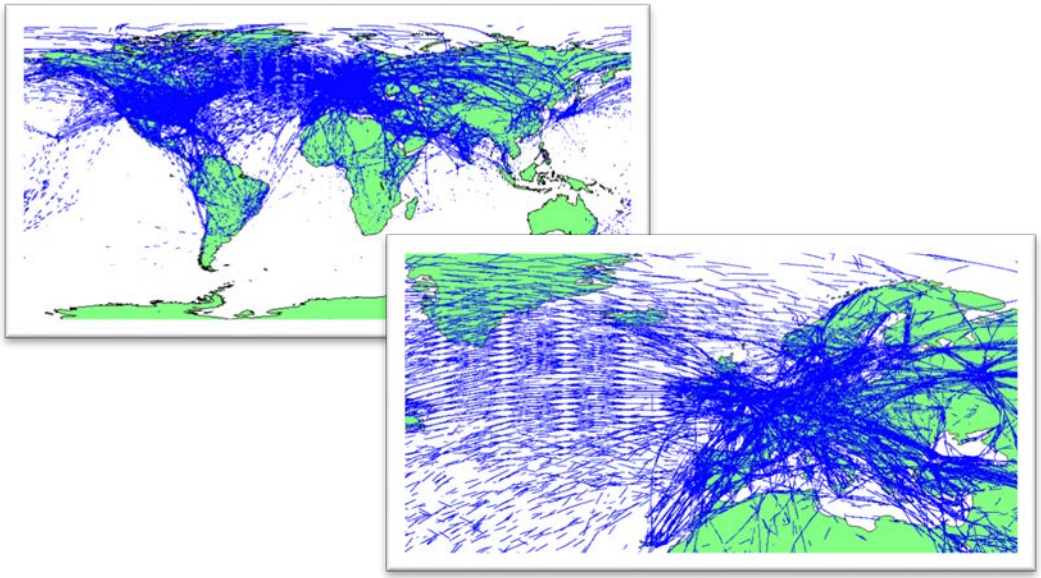
Launch Status

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

Photos: SpaceX

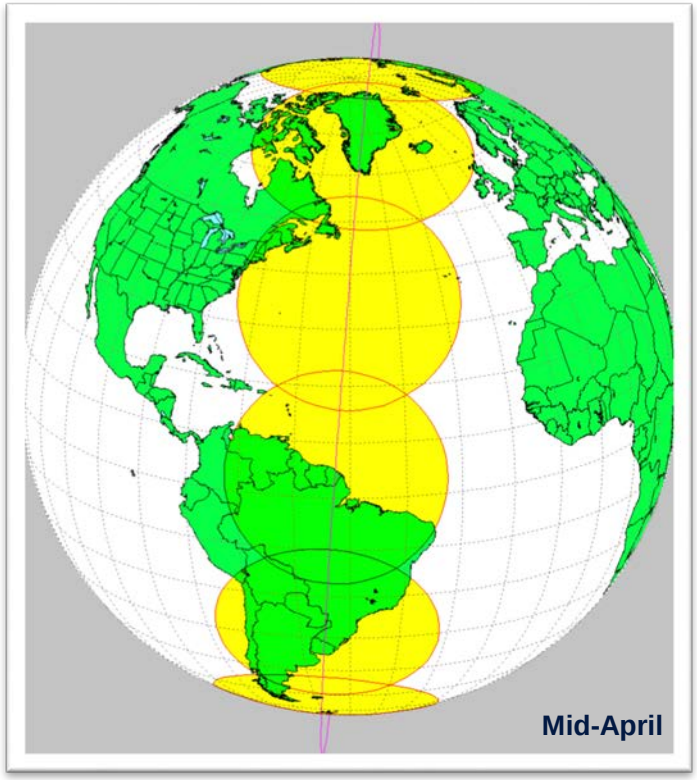
Launch 1 Coverage

Data from One Payload Stitched Over 62 Hours



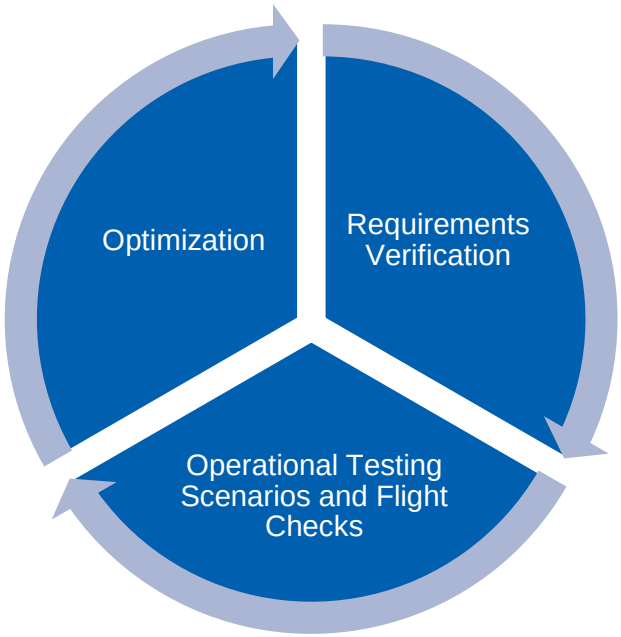
Date / Duration	2017-02-25 to 2017-02-27 / 62 Hours
Unique Aircraft	17,229
Max Range	3,500km
Types of Aircraft	Commercial Jets, Business Jets, General Aviation, Helicopters
Airspace Domains	Polar, Oceanic, En Route, Terminal, and Surface

Slots 1-7 and 11 are Filled



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: Successful Results

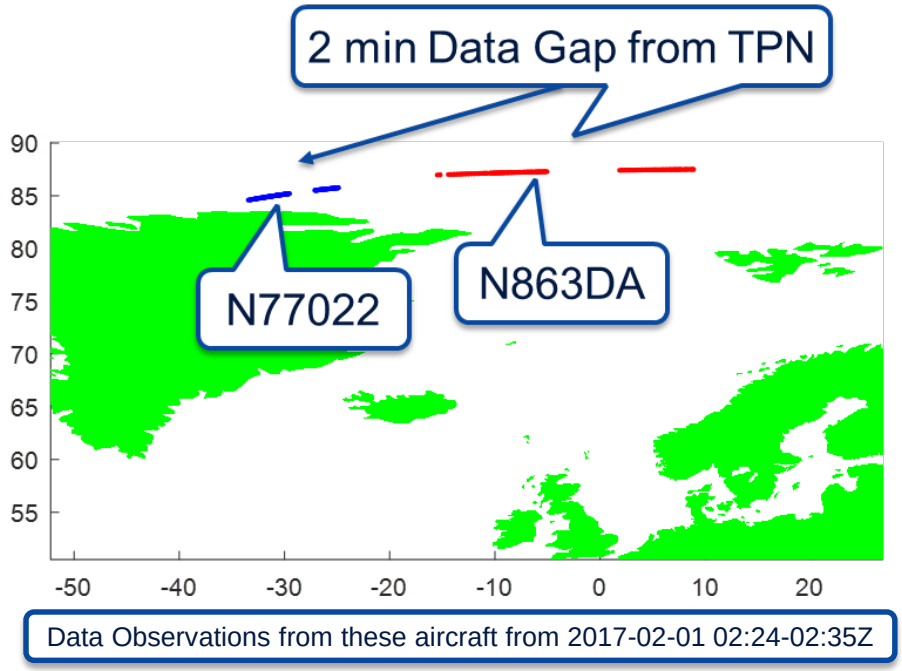
NAV CANADA

Iqaluit GBRT

Polaris

FAA

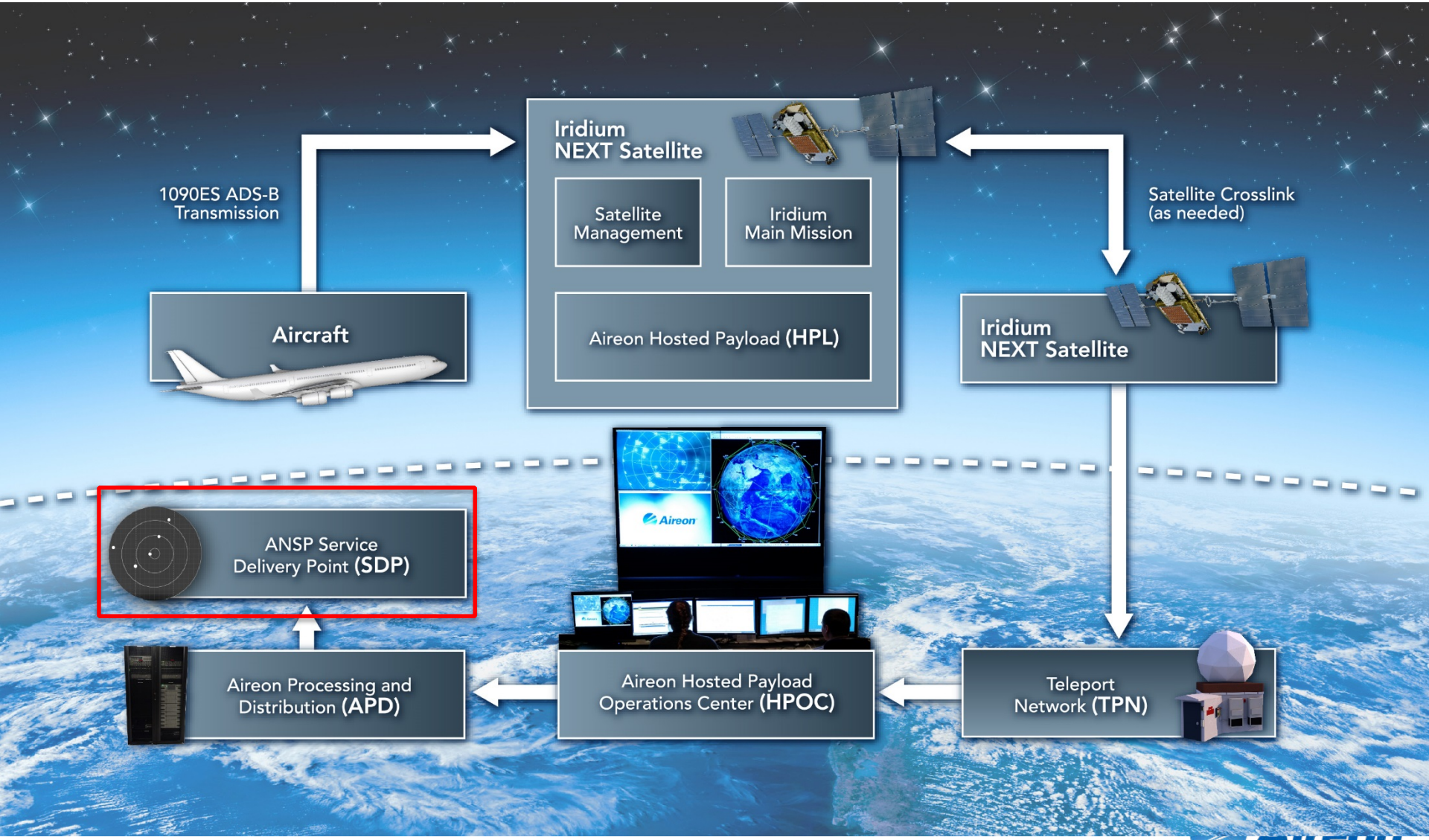
Preliminary Data: Polar Traveling Aircraft



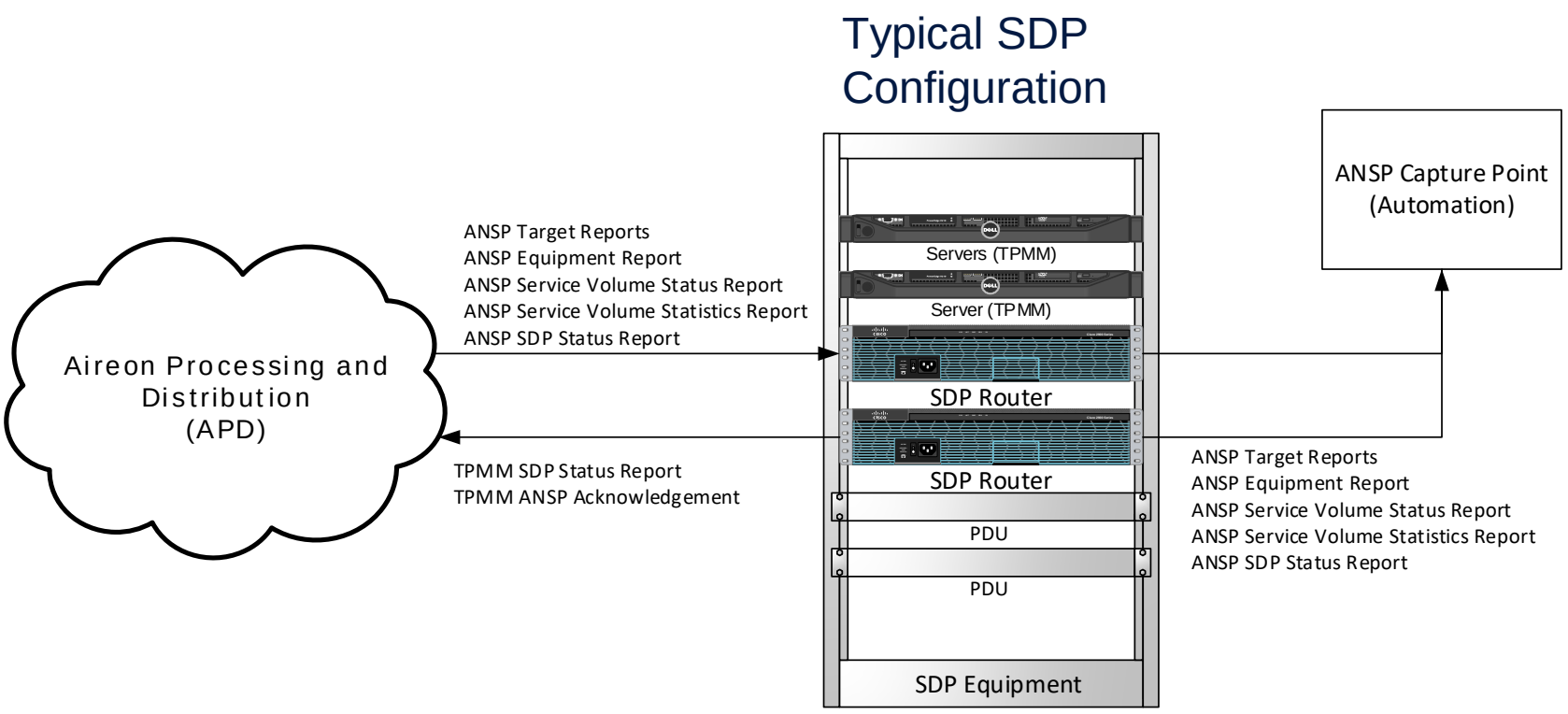
These two aircraft are travelling Eastbound together at about 490 knots at the same altitude (35,000') with a separation distance of ~155 NM

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

Service Delivery Point (SDP)

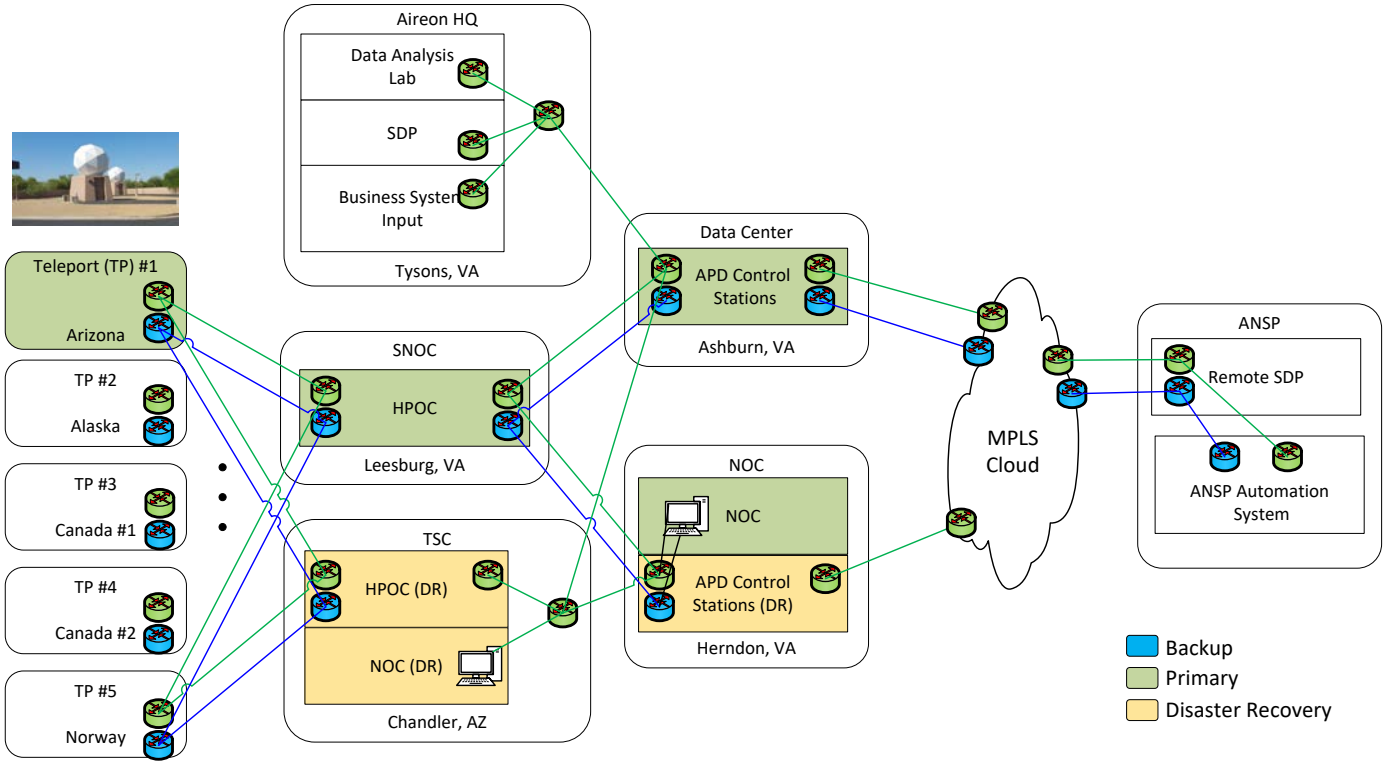


Typical SDP Architecture (Single Node)

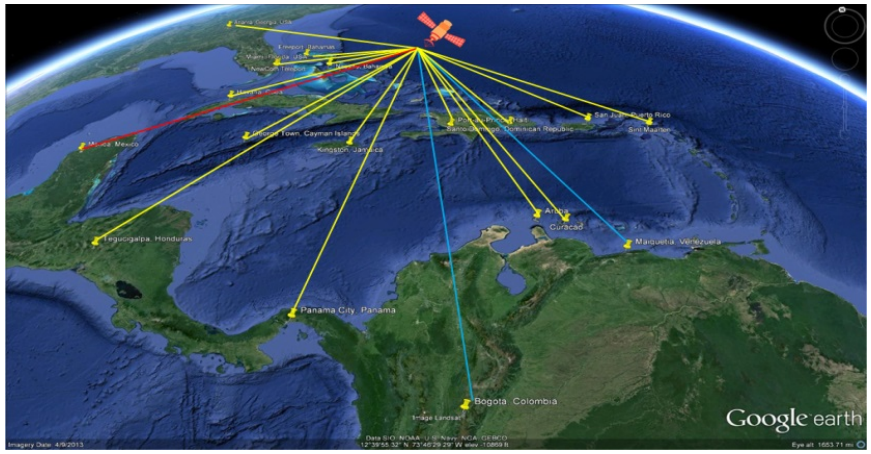


Typical SDP Network Diagram

Aireon Global Surveillance Network Overview



MEVA III Regional Network



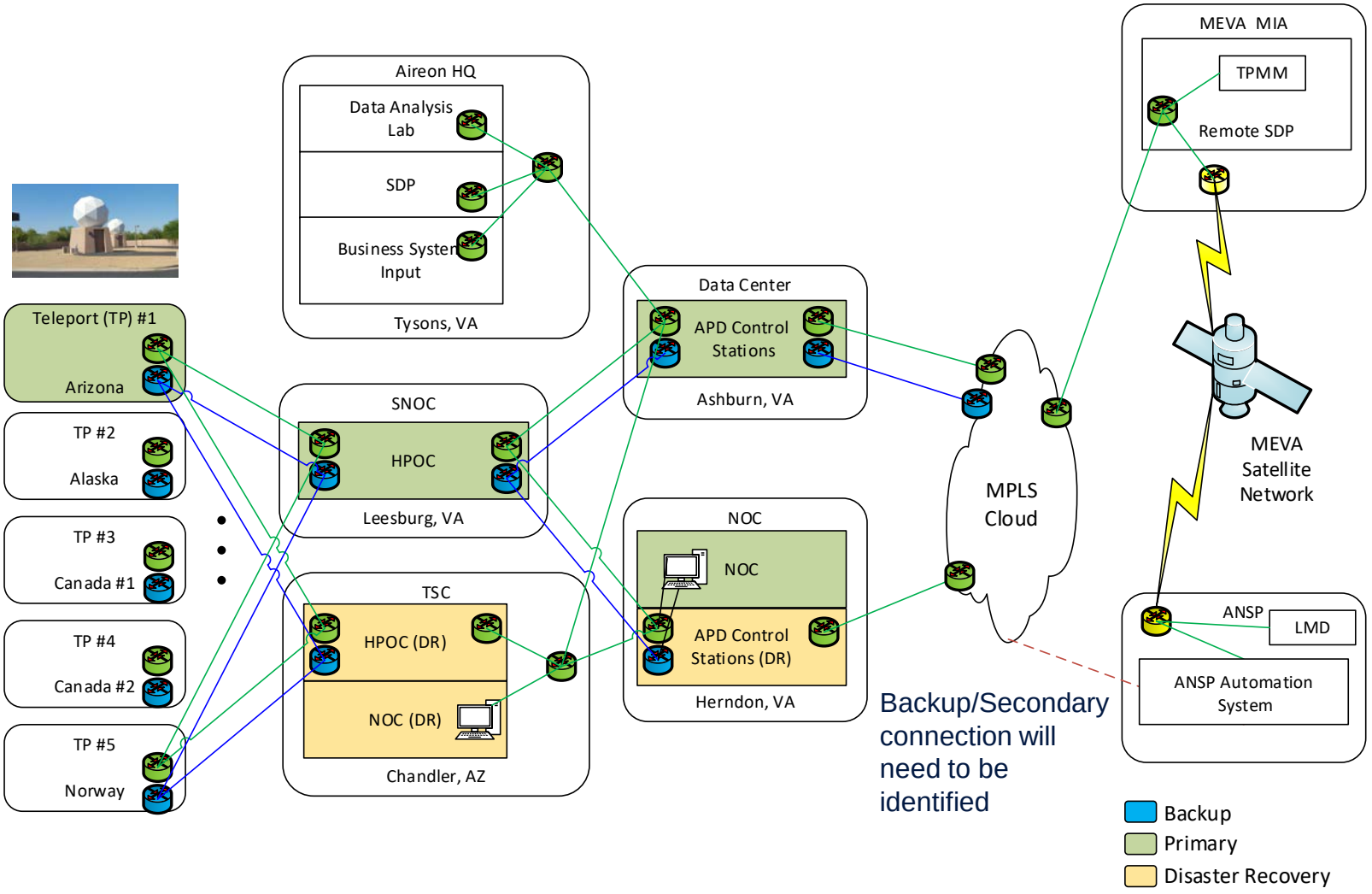
- **18 nodes**
- **19 States/ Territories**
- **6 fully redundant sites**
- Satellite: Intelsat 14 @ 315°E (expected lifetime: 2035)
- Overall bandwidth (customer usable): 1.820 kbps
- 2 REDDIG interconnection nodes (Colombia and Venezuela)
- 2 Master stations (Atlanta & Miami)

By using the Regional Network, States can benefit from:

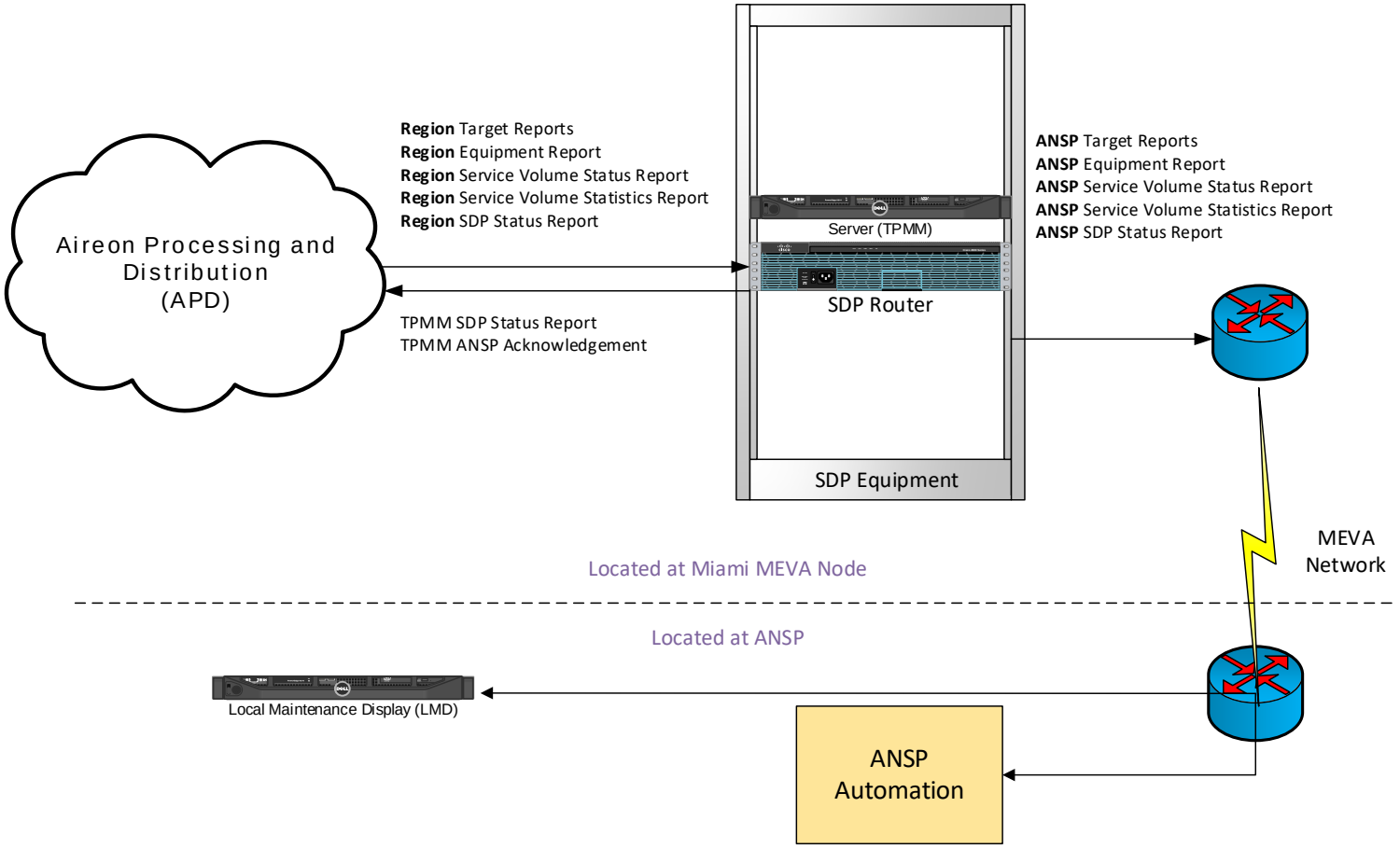
- Reduction of telco lines cost
- Reduction of SDP cost
- Platform for data sharing for ATFM, SWIM and other applications

MEVA SDP Network Diagram

Aireon Global Surveillance Network Overview



Aireon Hardware Needs to Support MEVA



Bandwidth Requirements for Connections

FIR	CAT021 Mean (kbps)	CAT021 Max (kbps)	CAT025 Mean (kbps)	CAT025 Max (kbps)	CAT238 Mean (kbps)	CAT238 Max (kbps)	CAT253 Mean (kbps)	CAT253 Max (kbps)	Total Mean (kbps)	Total Max (kbps)
MUFH	13	30	0	1	0	17	6	32	19	80
MMFR	37	69	0	1	0	39	6	32	43	141
MHTG	18	34	0	1	0	32	6	32	24	99
MKJK	8	23	0	1	0	17	6	32	14	73
TNCF	6	17	0	1	0	16	6	32	12	66
MTEG	1	9	0	1	0	15	6	32	7	57
MDCS	5	15	0	1	0	15	6	32	11	63
TJZS	11	27	0	1	0	18	6	32	17	78
SKED	25	51	0	1	0	22	6	32	31	106
TTZP	9	23	0	1	0	29	6	32	15	85
Total	**133**	**298**	**0**	**10**	**0**	**220**	**60**	**320**	**193**	**848**

Initial Testing Technical Scorecard – Update Interval

Metric	Design Goal	Measured	Performance Gauge
Update Interval 125 Watt Max UI 95%	8 seconds	**6.21 seconds** (using known targets)	
Update Interval 400+ Watt Max UI 95%	8 seconds	**7.01 seconds** (global, using targets of opportunity, SV109 excluded)	
Update Interval North Atlantic Max UI 95%	8 seconds	**6.99 seconds** (using targets of opportunity, SV109 excluded)	

Initial Testing Technical Scorecard – Latency

Metric	Design Goal	Measured	Performance Gauge
Latency Payload to APD Input Maximum	429 ms	**321.29 ms** (8 payloads, limited bandwidth, 11 April 2017)	
Latency Payload to APD Output Maximum	634 ms	**450.77 ms** (8 payloads, limited bandwidth, 11 April 2017)	

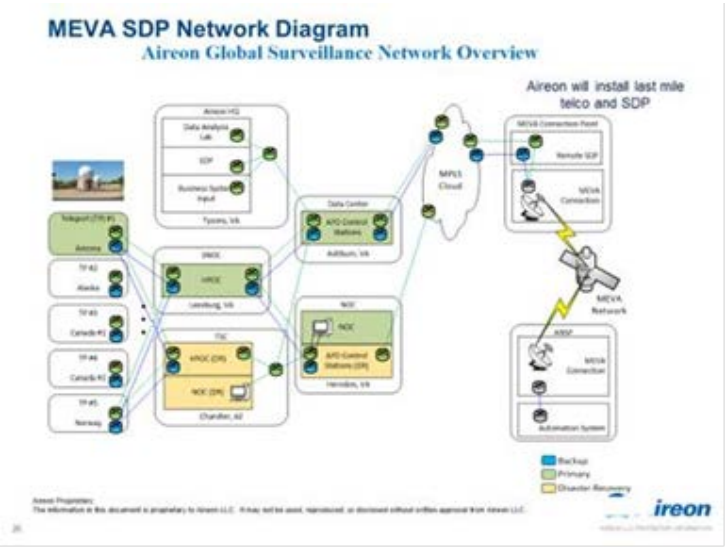
Network Requirement

- System Availability > 0.999 - This typically requires 2 connections
  - Backup/Secondary connection needs to be identified
- Multicast Data
- Delivery to Automation system with low latency
- Surveillance data segregation for each of the connected ANSP

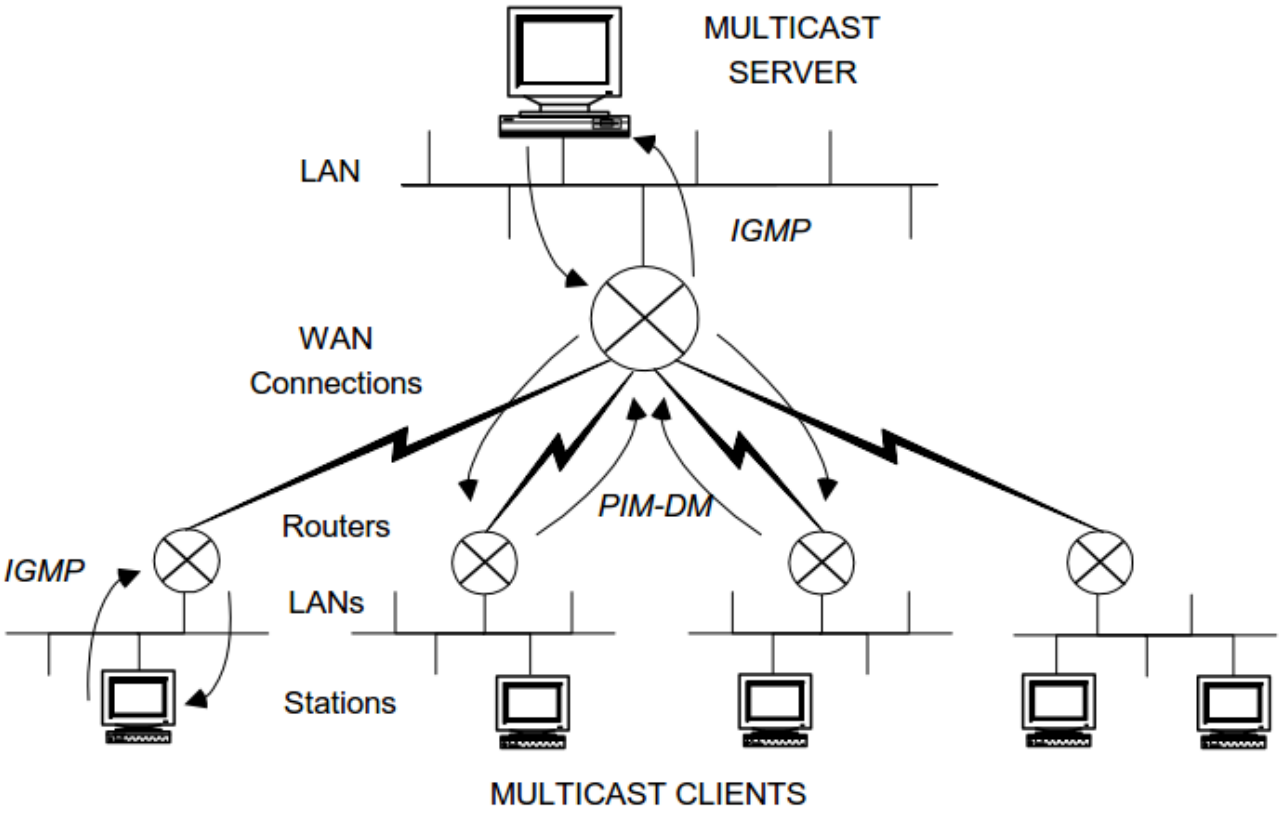
New MEVA III Circuits: AIREON Services

AIREON services request:

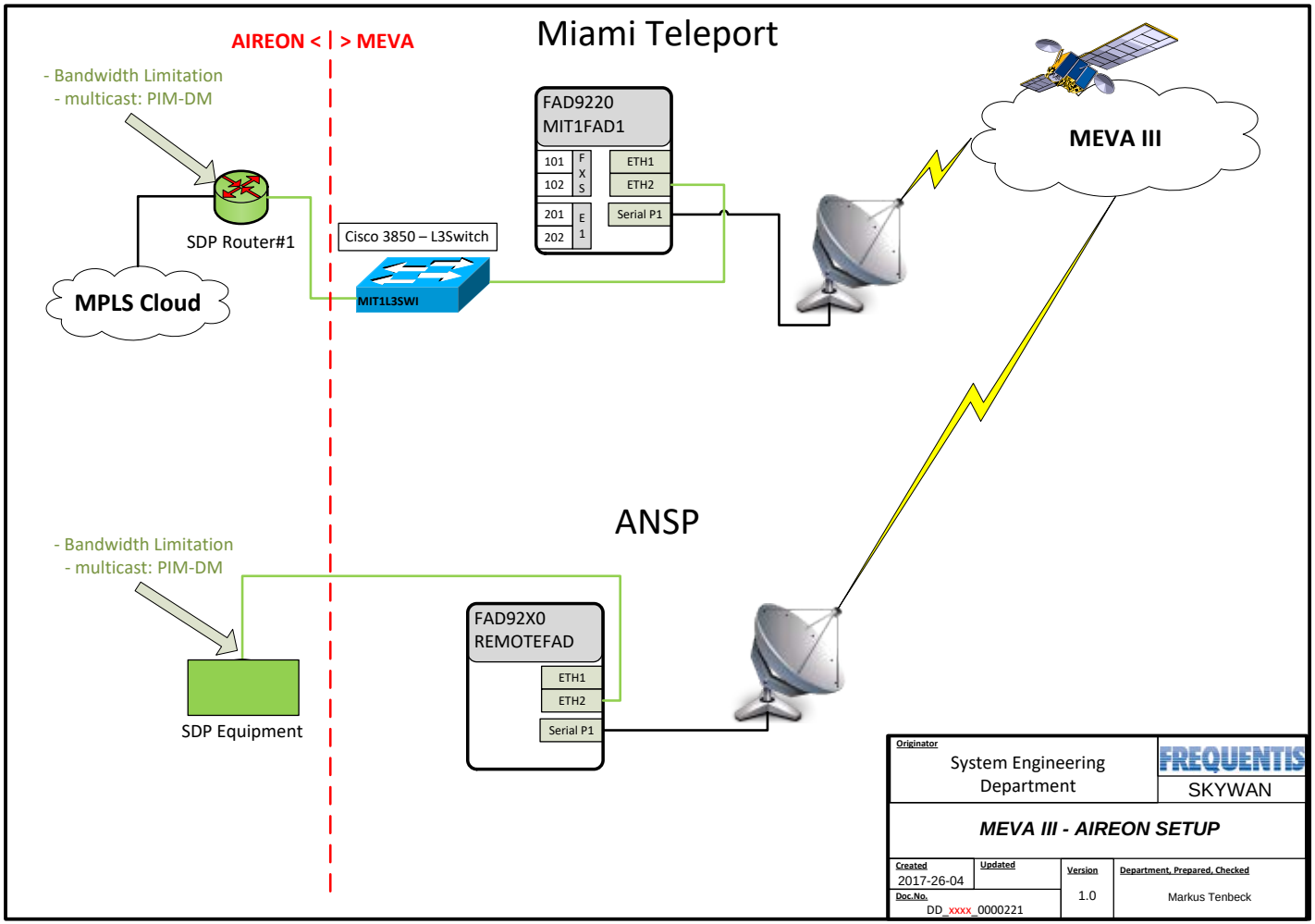
- To connect to the MEVA III network at Miami (TP) by Ethernet
- AIREON to deploy a Service Delivery Point (SDP)
  - by MPLS Ethernet connections from AIREON system to the SDP
- AIREON to send the SDP data for the region that would need to be sent to the correct ANSP
- AIREON SDP would connect to the MEVA III Network and provide Multicast data to each specific ANSP



Multicast principle in MEVA III network:



New MEVA III Circuits: AIREON Services



Multicast benefits in MEVA III network:

- Only one data stream for service
  - remote stations addressed by IP addresses and port numbers
  - no influence on existing services
    - parallel to future VLAN and monitoring/remote access IP network
    - network carrier upgrade per additional ANSP service delivery

- The FAD uses the PIM-DM protocol (Protocol Independent Multicast - Dense Mode)
  - This is a routing algorithm designed for multicast groups that are densely distributed across the network.

Conclusions

- It is feasible to distribute space-based ADS-B air traffic surveillance data, through MEVA III
  - Reduction in SDP and Telco costs for ANSPs that wish to use the network for implementing Space-based ADS-B
  - No additional cost for users of MEVA III not using Space-based ADS-B service
  - No interference with current services running over the MEVA III network
  - Platform to cooperate among States for other regional projects as ATFM
  - MEVA would be primary way to connect. Secondary line/backup to be identified with each State
- Aireon would guarantee availability to the SDP and Frequentis guarantees availability to ANSPs sites
- Suggested Action:
  - Develop detailed architecture for distribution of Space-based ADS-B surveillance data through MEVA III and define costs for interested States
  - Implementation in Curacao through MEVA III
    - Testing and validating for Curacao can help other States

FREQUENTIS

Aireon