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Satellite Based ADS-B

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March 2014

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Outline

- Aireon Global ADS-B via LEO satellites
- Why the initial focus on the North Atlantic?
- Benefits Assessment
- Work Underway and Moving Forward
- Frequency Spectrum

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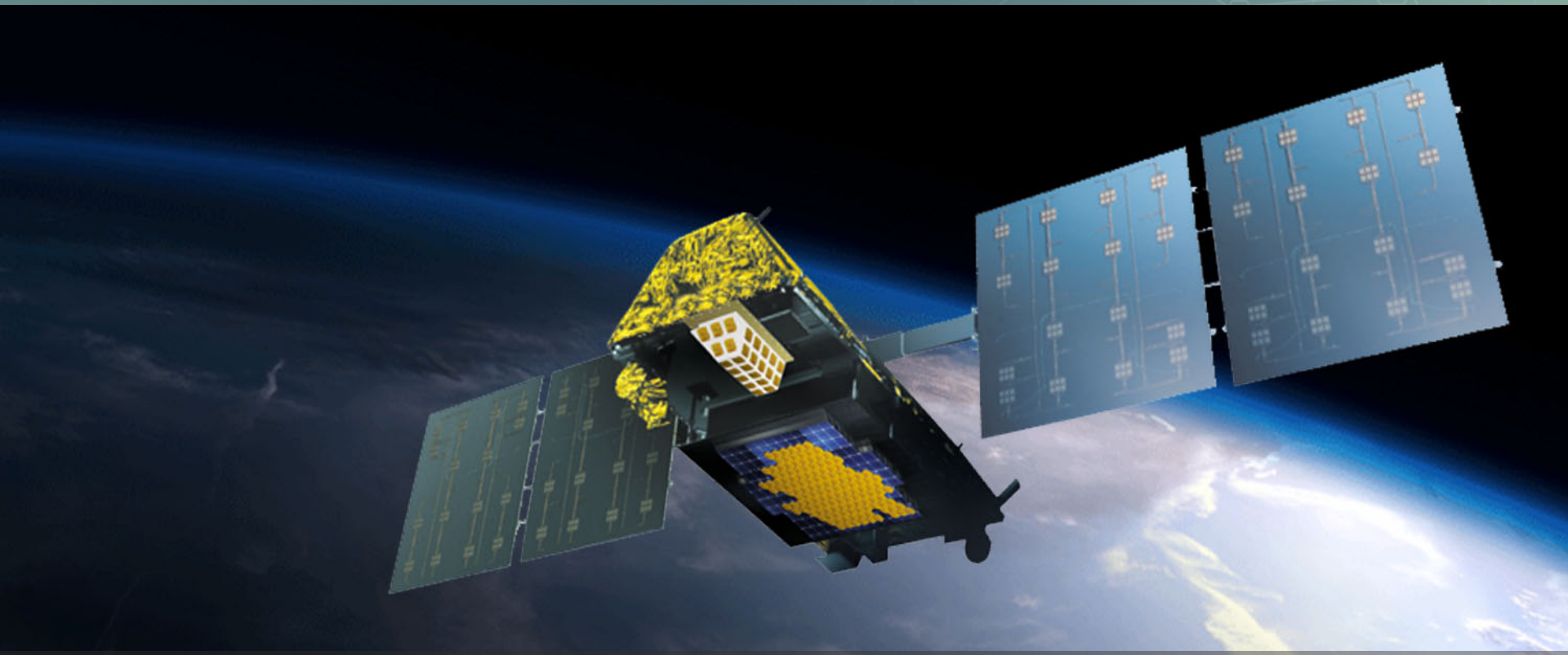

Goal

To reduce aircraft separation minima through ADS-B (out) via global Low Earth Orbiting (LEO) satellites

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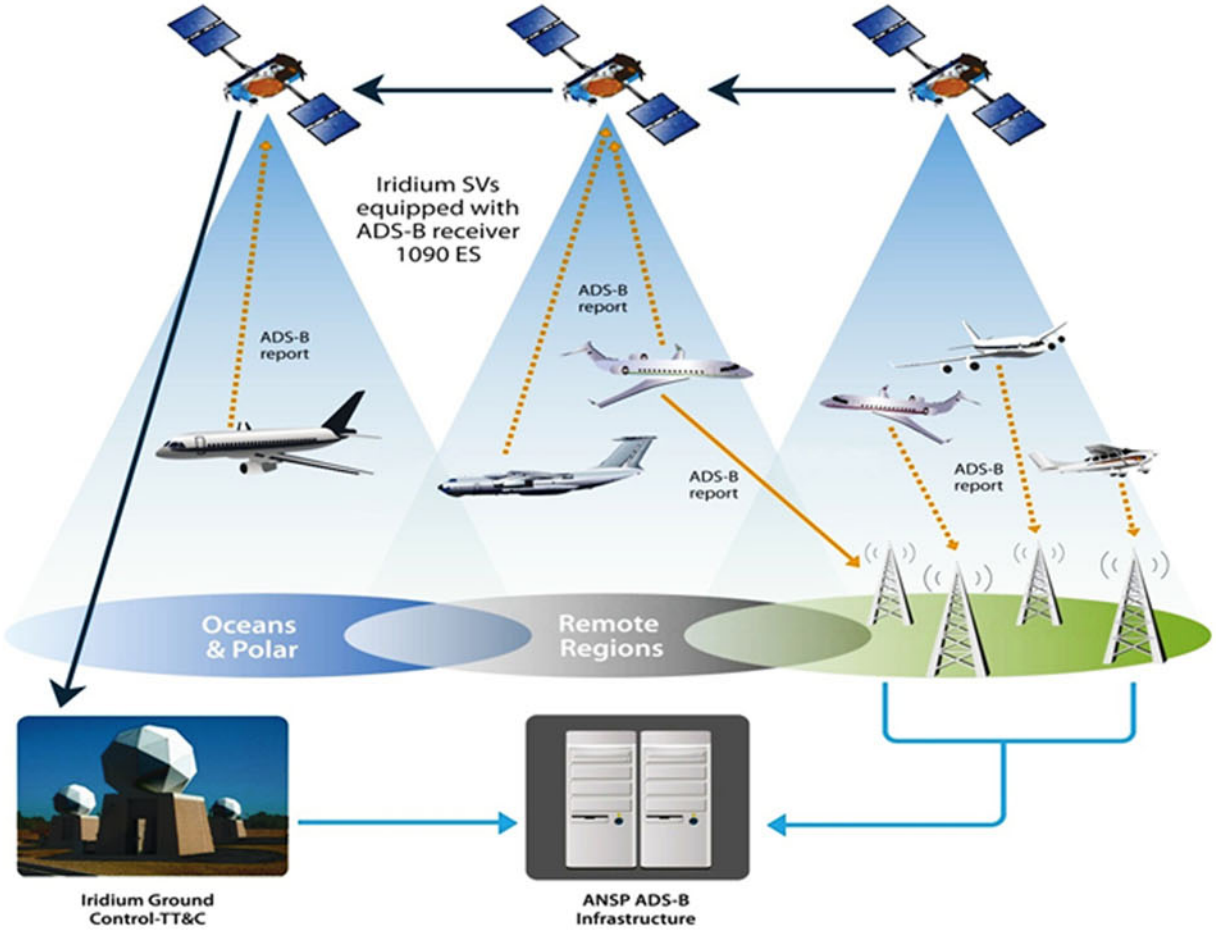
Aireon ADS-B via Low Earth Orbiting (LEO) Satellites



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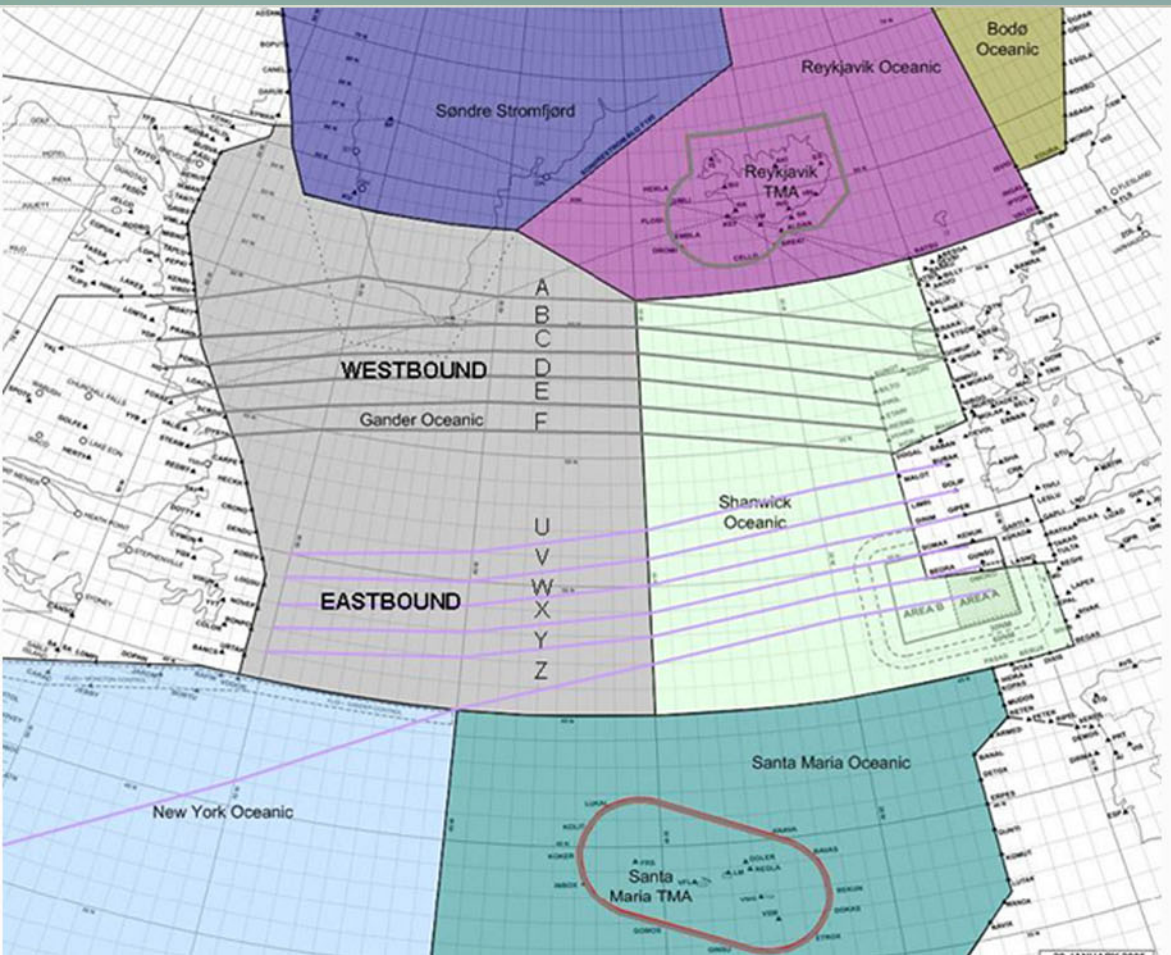
Focus on North Atlantic Oceanic Airspace



- Organized Track Structure NAT OTS
- Eastbound Tracks take advantage of tail winds
- Westbound Tracks avoid head winds
- Procedural Airspace = large distances
- Changes to flight levels, routes, speed by exception

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Gander/Shanwick Airspace Today

- **1,000** flights per day (1,300 peak summer day)
- **350,000** commercial flights per year
- **+23,000** military & GA flights per year

- **90%** of the flights are already ADS-B equipped
- **78%** of flights are Data Link (FANS 1/A) equipped
- **80%** are capable and use Controller Pilot Data Link Communications (CPDLC)

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Benefits Assessment

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Aireon ADS-B System Benefits

Safety

- ADS-B provides near real time aircraft surveillance
- Improves situational awareness, conflict detection and reaction/resolution
- Aircraft would have more flexibility in emergency situations
- Provides surveillance source separate from the communications (CPDLC) network sources
- More complete and accurate reporting of aviation occurrences, allowing better management of safety risk and better support of the Safety Management System

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Aireon ADS-B System Benefits

Environmental/Efficiency

- More efficient “domestic-like” flight trajectories in oceanic airspace
- More predictable airline cost planning
- Aircraft able to Climb/Descend and vary speed to chase wind push and avoid headwinds
- Improve opposite direction and crossing traffic profiles
- Significant worldwide reductions in greenhouse gas (GHG) emissions

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Aireon ADS-B System Benefits

Predictability/Reliability

- Access to ADS-B data could support traffic flow management-sequencing, merging and balancing for major cities in eastern North America and Western Europe
- Supports information sharing and collaborative process
- SWIM requires flight planning systems, dispatch, and airline gate-to-gate management to become more sophisticated and efficient. Surveillance via Low Earth Orbit satellite ADS-B will accommodate this.

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Aireon ADS-B System Benefits

Supporting ICAO ASBU implementation

- B1-SWIM: Performance Improvement through the application of System-Wide Information Management (SWIM)
- B0-FRTO: Improved Operations through Enhanced En-Route Trajectories
- B1-FRTO: Improved Operations through Optimized ATS Routing
- B0-NOPS: Improved Flow Performance through Planning based on a Network-Wide view
- B1-NOPS: Enhanced Flow Performance through Network Operational Planning
- B0-ASUR: Initial Capability for Ground Surveillance
- B0-SNET: Increased Effectiveness of Ground-based Safety Nets
- B1-TBO: Improved Traffic Synchronization and Initial Trajectory-Based Operation
- B1-RPAS: Initial Integration of Remotely Piloted Aircraft (RPA) Systems into non-segregated airspace

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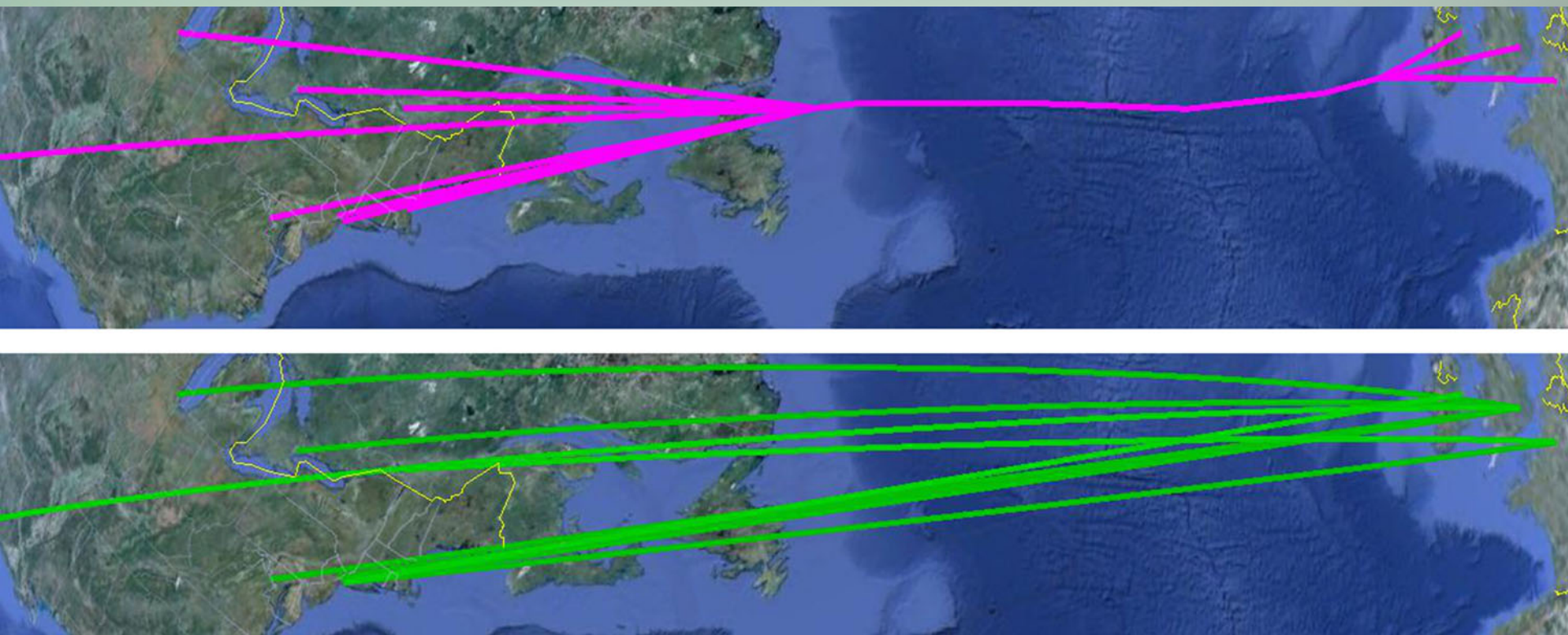
Overview of Traffic on Tracks and No Tracks



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Initial Oceanic Assessment

- High level assessment of 8 oceanic areas
- Based on 1,000’ climb fuel savings
- Up to 3 climbs per flight
- Vetted with IATA airline member familiar with oceanic operations
- Considered conservative and achievable

Google Earth

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Oceanic Assessment Benefits

Estimated $439 million in 2018

Major Oceanic FIRs	Commercial IFR Flights (000s)	Total Fuel Climb Savings (000s)	GHGs (000s Tonnes CO_2 Equivalent)
Shanwick / Gander	390	$127,000	332.8
Other Oceanic FIRs	514	$311,742	819.6
	904	$438,742	1,152.4

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Work Underway and Moving Forward

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Payload being developed by Harris Corporation

- Harris selected to build 81 space-qualified ADS-B receivers in June 2012
- 50+ years designing and manufacturing space hardware and major FAA contractor
- Design phase complete; production starting

Hosted Payload Operations Center to be supported by Iridium

- Developed by an Iridium/Boeing team in Virginia and Arizona

Systems engineering and ground data processing system by Exelis

- Exelis has significant expertise and existing infrastructure supporting the FAA ADS-B terrestrial system deployment
- Successful Preliminary Design Review completed in Sep 2013

On-track to meet first launch in early 2015
Initial Operations Capability late 2017

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Harris ADS-B Payload Development On Target

- Harris ADS-B Payload Critical Design Review successfully completed in May 2013
- Payload completed the Test Readiness and Production Readiness reviews in October 2013
- Payload Qualification Unit completed space qualification testing in March 2014
- Payload Qualification Unit will be shipped to Thales Alenia Space in France for further integration and testing with the satellite
- Production of Payload Units has begun

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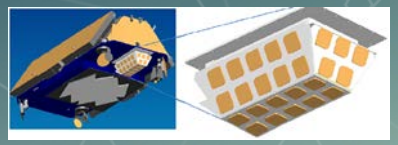
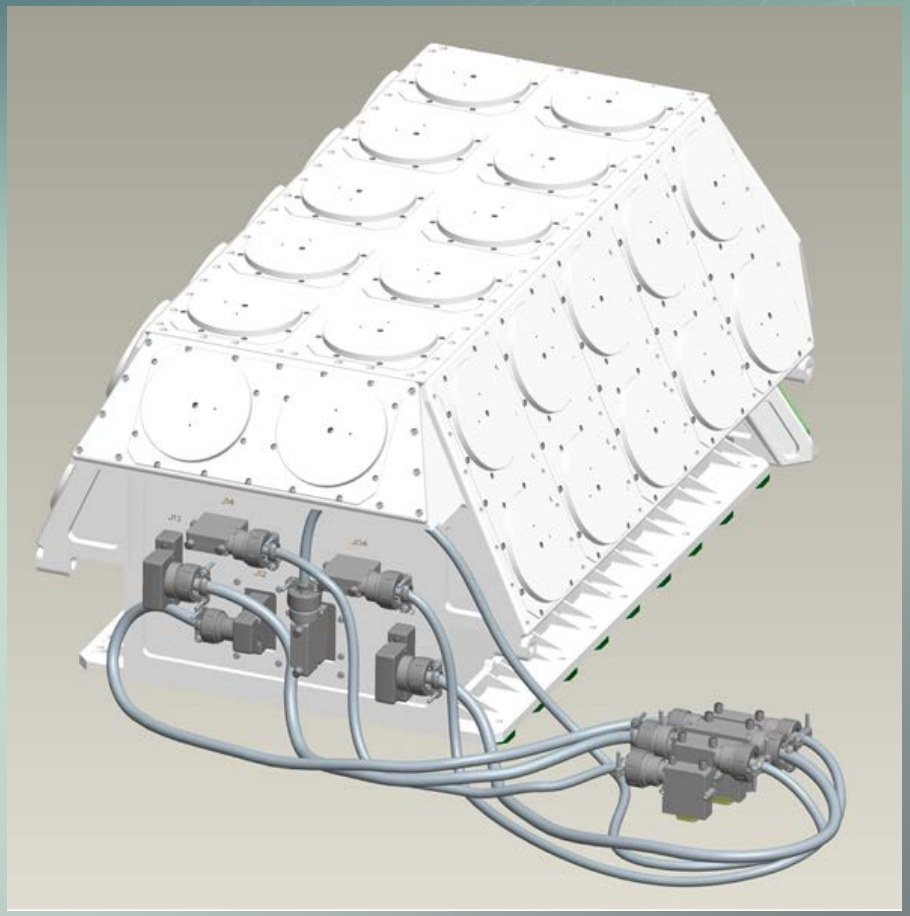
Hosted Payload





Inverted Hosted Payload

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Coverage

- No coverage gaps with 250 Watt transponders
- Interference from FRUIT (other ground based and airborne transmitters) has been minimized
- Software solution has mitigated the cone of silence (area directly above the aircraft antenna)

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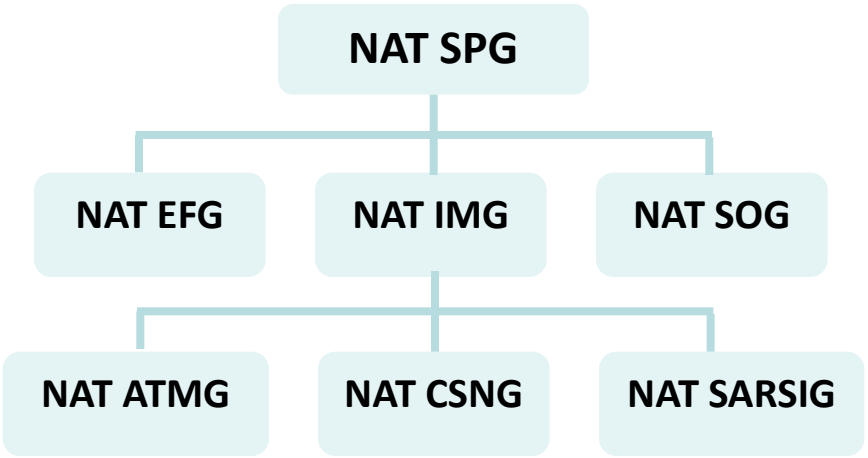
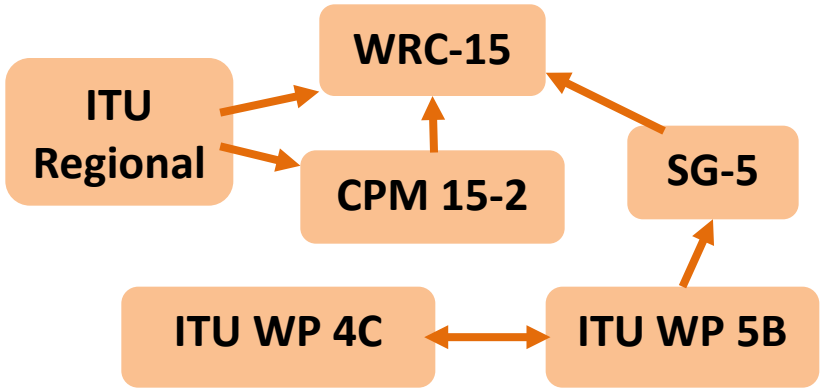
Regulatory Roadmap





ICAO Regional Groups

NAM/CAR ANI/WG/1
EANPG 55
NACC WG/4
SAM IG/13
MID ASBU Workshop
APAC ATM SG
APANPIRG
TRASAS/4

CPWG

Transport Canada
Industry Canada

Other/Related

NAT Surveillance Corridor
ADS-B 4G

ICAO

- Assembly
- 12th Air Navigation Conference
- BUDSS
- ACP WG-F
- SASP
- ATMOPSP
- OPLINKP

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Regulatory Roadmap

Focus on 4 Areas:

1. ICAO North Atlantic (NAT)
2. ICAO Global Assemblies and Panels
3. International Telecommunication Union (ITU)
4. Other Stakeholders – Transport Canada, CPWG (Cross Polar Working Group), ADS-B 4G, etc.

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1. ICAO North Atlantic (NAT)

- NAT SPG contributory groups (NAT IMG, NAT SOG & NAT EFG) have received initial CONOPS briefings
- NAT Economic and Financial Group (EFG) also received Benefits Analysis
- NAT EFG is further exploring overall NAT benefits
- Next contributory group meetings in May and June
  - Will focus on support and work to be done.
  - Will present high level safety plan (to NAT Safety Oversight Group – NAT SOG)

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2. ICAO Global Assemblies & Panels

- Presentations made to ICAO regional groups on the initiative
- Separation and Airspace Safety Panel (SASP) provided input on how to approach collision risk modelling
- CONOPS will be presented to new ICAO Air Traffic Management Operations Panel (ATMOPSP) in April
- ICAO Position for the International Telecommunication Union (ITU) World Radiocommunication Conference 2015 (WRC-15) currently DOES NOT include protection for 1090 MHz for aircraft to satellite
- Updated ICAO Position may include information about space-based ADS-B frequency allocation requirements

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3. International Telecommunication Union (ITU)

Goal is that the ITU will approve allocation of 1090MHz for Aircraft to Satellite ADS-B signal at the World Radio Conference (WRC) in November 2015

Industry Canada submitted a proposal that CITEL (a Regional ITU Group) recommend this subject be included in ITU Regional Director's Report so it can be added to WRC-15 agenda

Supporting Proposed Draft New Report (PDNR) has been developed by ITU Working Parties and may be included in updated ICAO Position

Briefing planned at Asia-Pacific Telecommunity (APT) Preparatory meeting for WRC-15

Working with as many ITU Regions as possible on the frequency allocation/WRC-15 agenda issue

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4. Other Stakeholders

Transport Canada

- Regular coordination meetings on ICAO working papers
- Good cooperation on numerous initiatives, particularly frequency spectrum issue

Cross Polar Working Group

- Presentation made on the Space Based ADS-B initiative with positive feedback from participants

ADS-B 4G meeting in Ottawa February 2014

- Presentation on concept positively received

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Actions Going Forward

- Continue to collaborate with ANSPs, IATA/industry and ICAO/regulator to demonstrate and validate incremental improvements.
- Leverage existing technology and continue to improve service, e.g., RLongSM and RLatSM.
- Operational trials involving airlines/ANSPs will be used to demonstrate capabilities and support the safety case

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In Advance of Satellite Based ADS-B

- RLongSM implemented in Gander and Shanwick OCAs March 21, 2011
- Prepping for RLatSM - Phase 1 2015, Phases 2 and 3 TBD
- Publishing Gander Oceanic Transition Area (GOTA) April 2014 and expanding use of ground-based ADS-B in Oceanic airspace
- Ground based ADS-B corridor Scotland to Greenland 2014-2015
- Mid-Late 2016: implementation of conformance monitoring using available space-based ADS-B data

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Application in the NAT: Principles

- Initially, no change to the Organized Track System (OTS) or Oceanic Clearances
- Initial application on core tracks in same direction only
- Use a phased approach

  - similar to Data Link
- Apply priority handling (best equipped best served)

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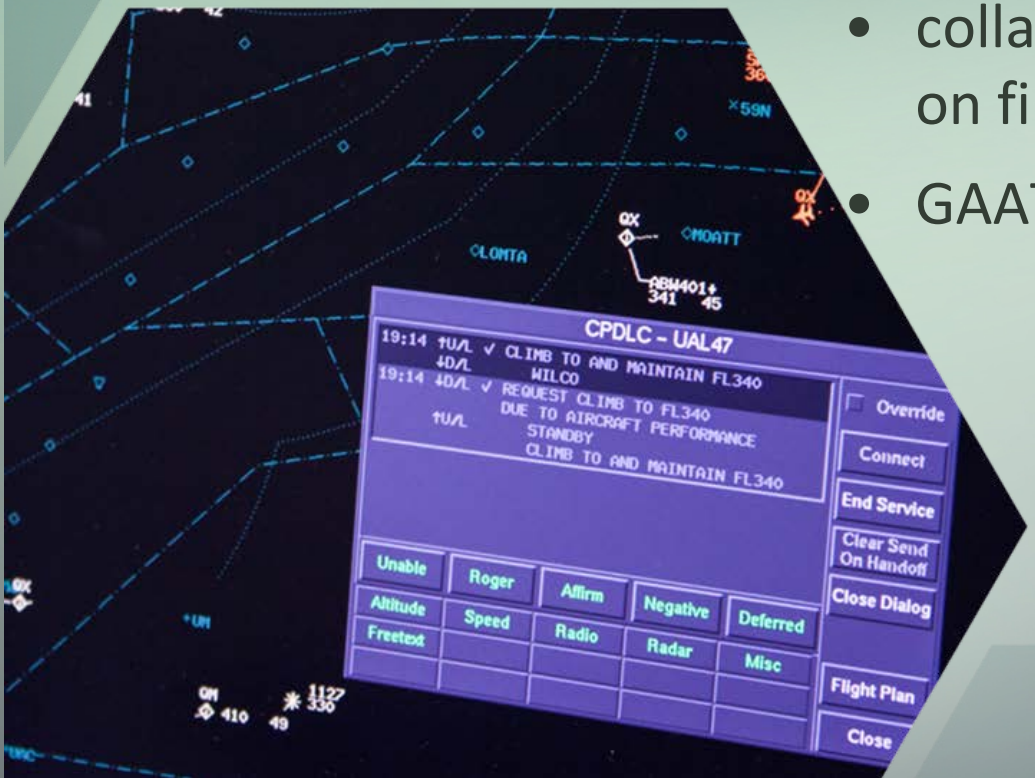
Operational Validation

- data collection on ADS-B and communications
- collaboration with stakeholders on final implementation CONOPS
- GAATS+ deployment in Prestwick



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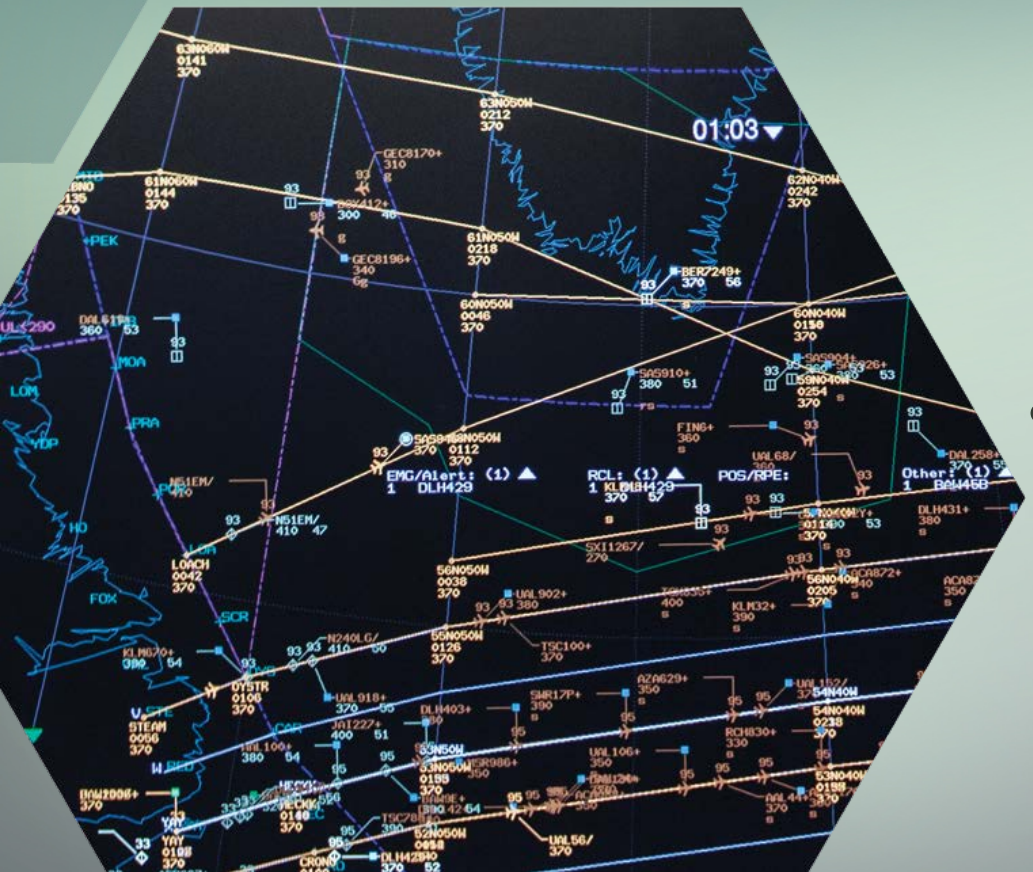
Initial Application in the NAT



- Late 2017: application of 15 NM longitudinal separation (with RLatSM) between surveillance-identified aircraft operating on the NAT OTS.
- Early 2018: 15 NM longitudinal separation expanded to aircraft operating off the NAT OTS.

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Future Procedure Changes in the NAT

- Mid 2018: allowing surveillance identified aircraft to operate on all tracks which do not intersect (still RLatSM).
- Late 2018: use of ATS surveillance to maintain 15 NM lateral separation between the tracks of surveillance-identified aircraft operating on non-intersecting tracks;
- Early 2019: application of 15 NM separation between surveillance-identified aircraft

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In summary

- Global ADS-B Surveillance is a “Game Changer” for aviation
- Fits with NEXT GEN / SESAR
- Significant fuel & GHG savings
- Avoids ADS-B ground based replacement or some initial installation costs
- Benefits to domestic traffic can be realized in remote areas or through improved air traffic flow management to and from oceanic airspace
- Public will benefit from safer + more expeditious flights in remote, polar and oceanic airspace worldwide
- Opportunity to boost aviation innovation & the environment globally

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Questions?