Space Based ADS-B

ICAO SAT meeting - June 2016

Options to Detect an Aircraft Position

Position Accuracy / Update Interval

Voice Position Reporting

ADS-C Position Reporting

Radar Surveillance / MLAT

Space Based ADS-B Surveillance

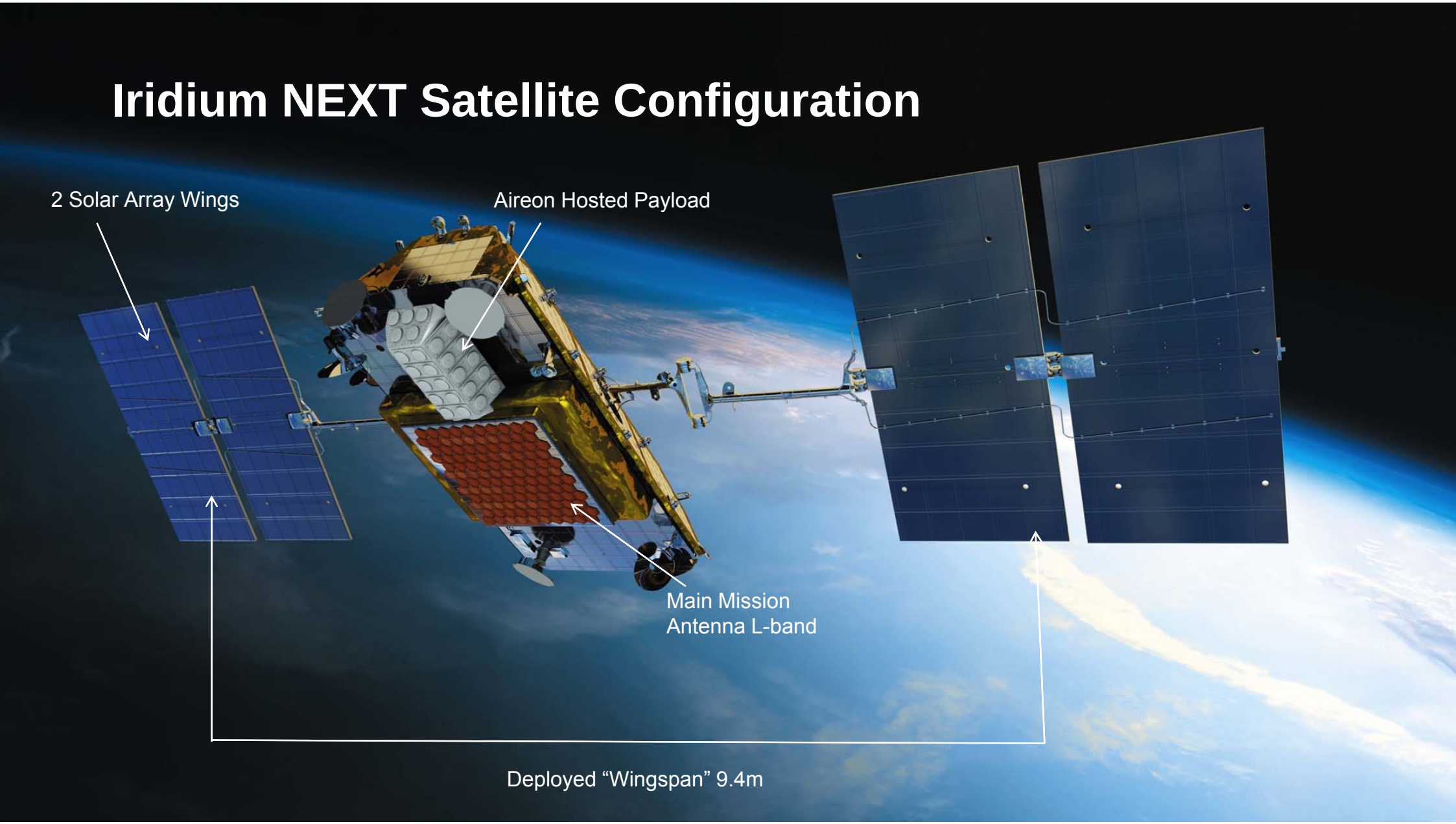
ADS-B Surveillance

Current Surveillance is Limited to Line of Sight

Over 70% of the World Remains Un-Surveilled

CURRENT
GLOBAL
SURVEILLANCE
COVERAGE

Iridium NEXT Satellite Configuration



Constellation Overview

- Satellites in orbit: 66
  - 11 satellites per plane
  - Plus 6 in-orbit spare satellites
  - 9 ground spare satellites
- Orbital Planes: 6
- Availability: ≥ 0.999
- Typical Lifecycle: 14 years
- Operational altitude: approximately 485 miles (780 km)
- Full global Air Traffic Surveillance without the need for additional equipage

Operational Use

Update on Concept of Operations from Aireon Customers

ATM Performance

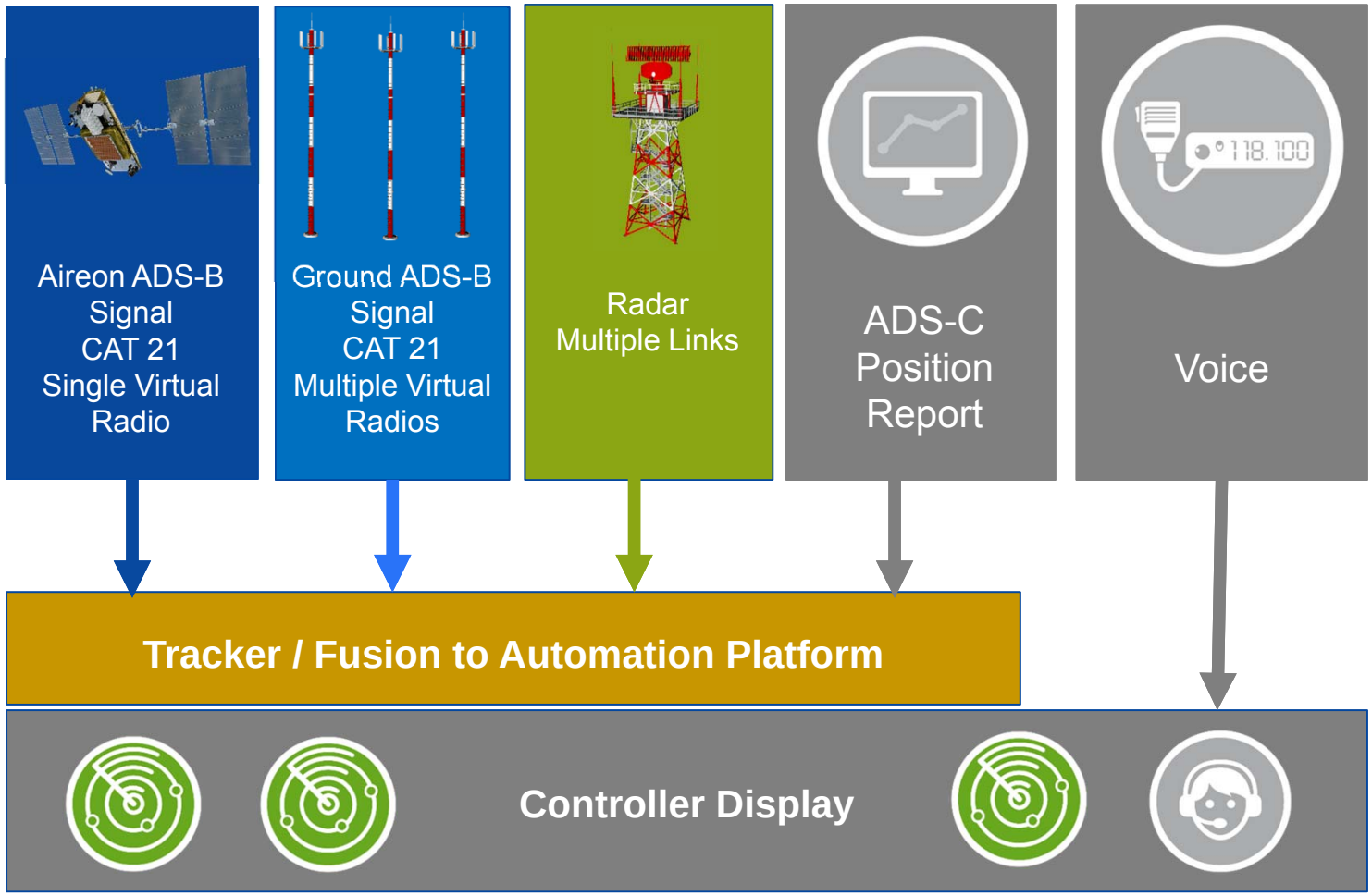
	Procedural	ADS-C	SSR	ADS-B Ground Station	Aireon
Avionics	HF for Pilot Position Reports	FANS 1/A	Mode S or ATCRBS Transponder	1090ES ADS-B (DO-260 versions 0, 1, 2)	1090ES ADS-B (DO-260 versions 0, 1, 2)
Range	Varies	1300 NM	200 NM (varies with altitude)	200 NM (varies with altitude)	1100 NM
System Coverage	HF Coverage Areas	No Polar / Subscribed Only	Line of Sight Limitation	Line of Sight Limitation	Continuous Global Coverage
Availability	< 98%	≥ 99.9%	≥ 99.9%	Same	≥ 99.9%
Latency	~ 400 seconds	RSP 180: • 90 sec 95% • 180 sec Max	≤ 1.5s to the ATM Automation Platform	Same	≤ 1.5s to the ATM Automation Platform
Update Interval	30 – 60 minutes (or at Compulsory Reporting points)	~14 minutes	< 8 – 12s	< 8s	< 8s*
Possible Separation	≥ 80 / 100 NM	≥ 30 / 45 NM	En Route: 5NM	En Route: 5NM	Oceanic: ≤ 15NM Terrestrial En Route: 5NM

It's Just ADS-B!

	ATS Surveillance Requirements (EUROCAE)	Aireon℠
Surveillance Data-link Requirements	Variable Per Region *(DO-260 Version 0, 1, 2)*	Accepts all 1090ES ADS-B (DO-260 Versions 0, 1, 2)
Aircraft Transmitter Classes Supported	A1 or Higher *(125 Watt minimum)*	A1 or Higher *(125 Watt minimum, with a top-mount antenna (TCAS)*
Data Format to ANSP	ASTERIX CAT021, CAT023, CAT025 and FAA CAT033 and CAT023	ASTERIX CAT021, CAT023, CAT025 and FAA CAT033 and CAT023
System Coverage	Enroute Service Volume (200 NM)	Continuous Global Coverage
Availability	≥ 99.9%	≥ 99.9%
Latency	≤ 1.5s to the ATM Automation Platform	≤ 1.5s to the ATM Automation Platform
Update Interval	≤ 8s at 95%	Simulation and testing shows that targets will be delivered at an UI of ≤ 8s* at 95%

* ASIM Simulation & Component Testing

ASTERIX-Based ADS-B Data Feeds to ATM Platform

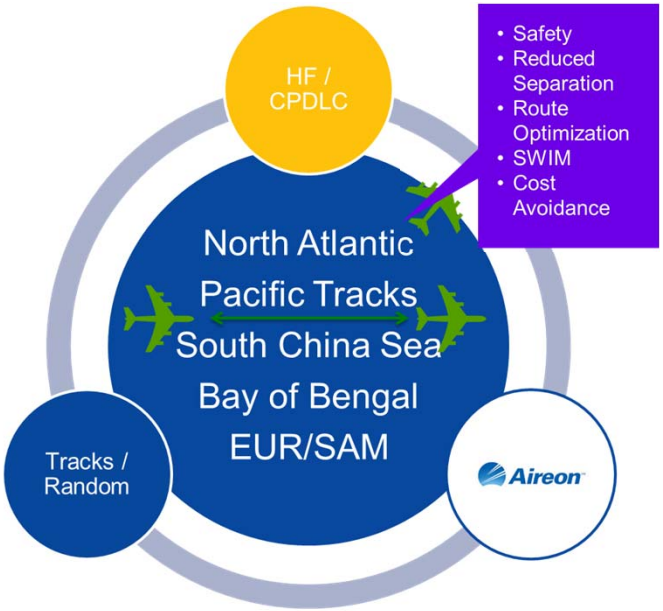


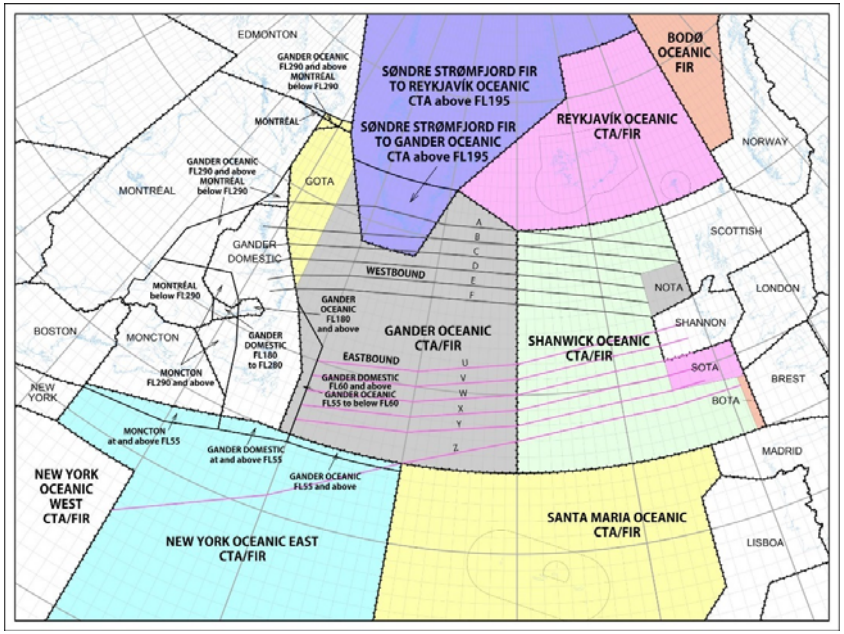
Space-Based ADS-B Integration into ATM Systems

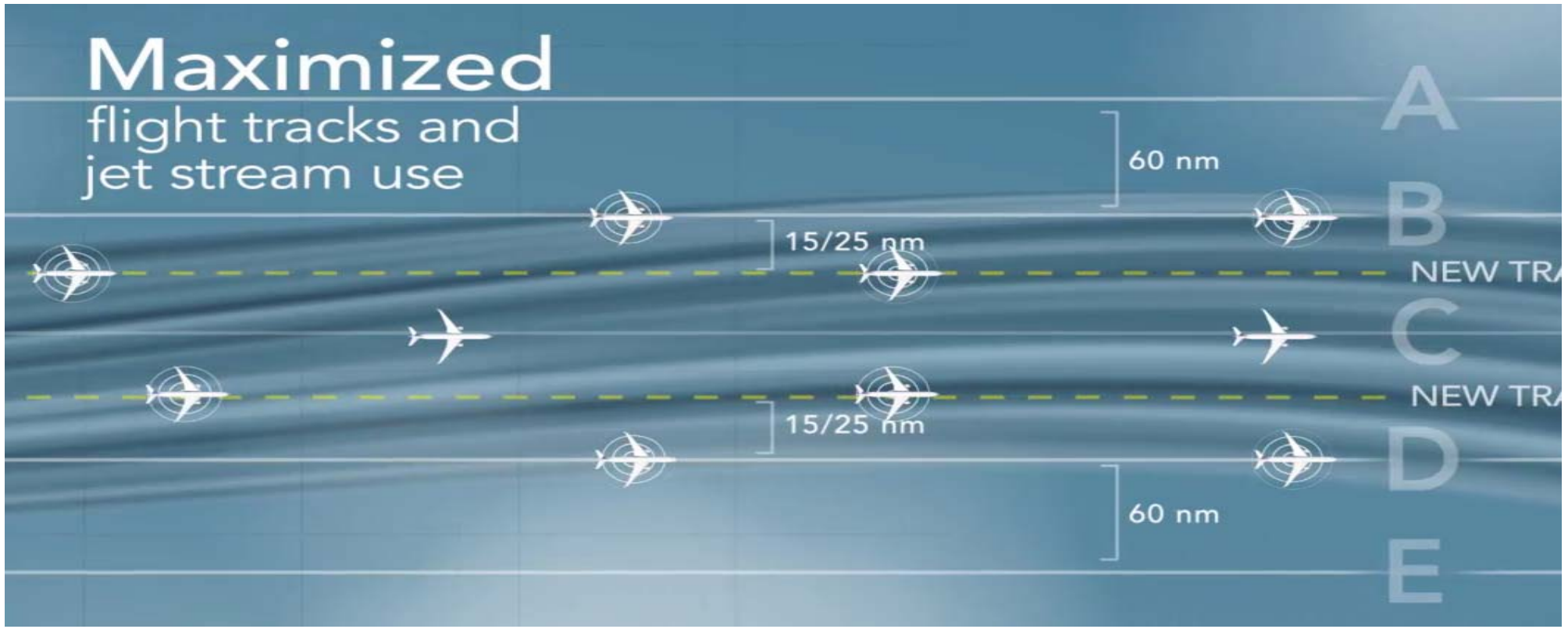
- Sole-Source Surveillance
  - Where no surveillance currently exists
- Augmented Surveillance
  - Filling gaps in or providing an additional layer for existing ADS-B or radar surveillance systems
- Contingency Surveillance
  - Cost-effective back up to ground systems

Oceanic / Remote Applicability

- Sole source surveillance with consistent communications
- Anticipated to be15 nm separation or less
- Significant efficiency and safety benefits





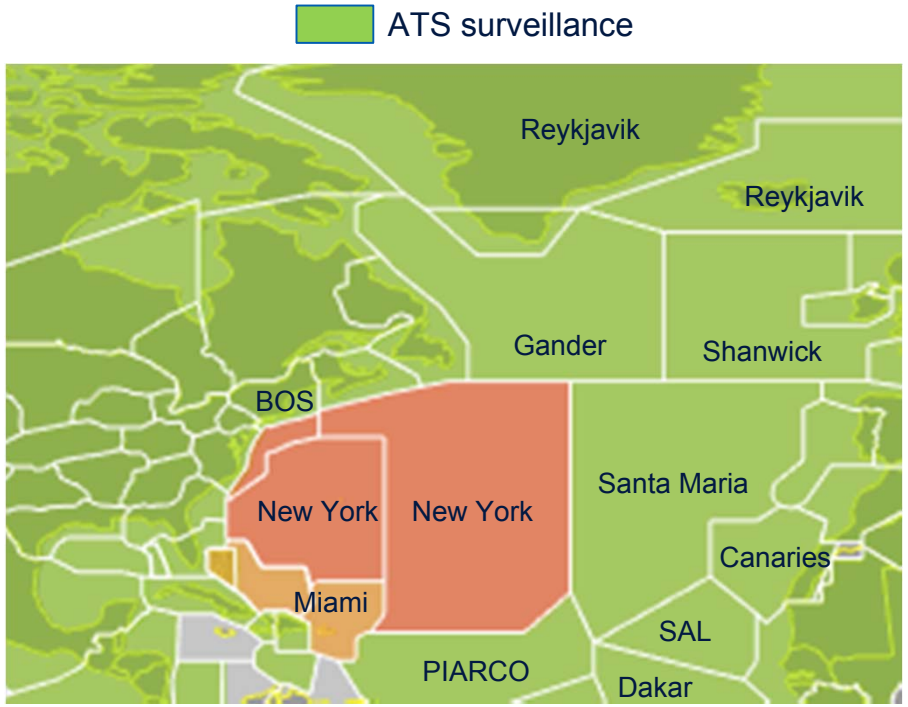


NAV CANADA Case Study

- Current surveillance limitations
  - Despite increases in surveillance coverage since 1996, NAV CANADA continues to have a significant amount of airspace without surveillance, notably in the Northern portions of Canada and over the North Atlantic
- Future plans for space-based ADS-B
  - NAV CANADA plans on implementing space-based ADS-B initially in the North Atlantic
    - Apply 15 NM longitudinal and lateral separation
    - Space-based ADS-B will immediately reduce the need for GAATS+ and will provide real-time, independent surveillance throughout Gander
  - Space-based ADS-B will also be evaluated for application in northern Canadian airspace where procedural rules requiring separation of 1,000 feet vertical, 60 NM lateral or 10 minutes in trail still apply and domestically, as a back-up capability for radar and terrestrial stations
- Benefits expected
  - In the North Atlantic alone, operators are anticipated to save over 125 million liters of fuel annually.
  - This translates to a reduction of greenhouse gas emissions of over 320,000 metric tons annually and savings of $75-125 million

North Atlantic Operations

- World's business oceanic corridor
- 400,000 airline flights per year
- Efficiency gains restricted by 30-80NM separation standards and expensive avionics



The NAT ANSPs are planning to implement 15 nm separation in 2018 using space-based ADS-B enabling significant improvements in operations

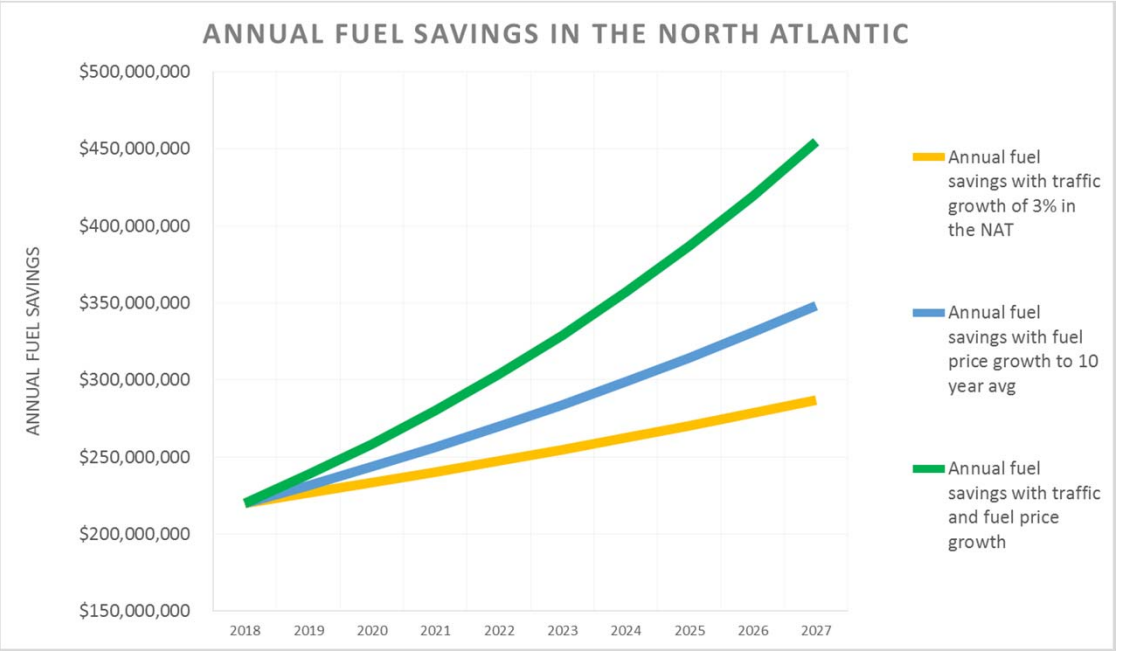
Impacts and Benefits

Beneficiary
- ANSP
- Airline
- Society

Impacts	Benefits: Reduced ANSP Costs	Enhanced Safety & Security	Reduced Fuel and Travel Time (ADOC/PVT)	Reduced Environmental Impact (CO_2)	Improved Passenger Comfort	Reduced Airline Infrastructure Costs
Decreased legacy surveillance system replacement or maintenance costs	ANSP					
Avoided legacy surveillance system expansion investment	ANSP					
Avoided signal duplication and associated telecom costs	ANSP					
Decreased infrastructure and signal costs through cross border contingency	ANSP					
Improved data for flight billing and airspace route design purposes	ANSP					
Reduced complexity through harmonization of operating environment	ANSP	ANSP, Airline, Society				Airline
Reduced likelihood of loss of separation events		ANSP, Airline, Society				
Reduction of gross navigation errors		ANSP, Airline, Society				
Early detection of emergency transponder codes		ANSP, Airline, Society				
Improved search and rescue services	ANSP	ANSP, Airline, Society				
Improved airspace integration of UAS		ANSP, Airline, Society				
Enhanced military applications and situational awareness		Society				
Minimized impact from operational and weather disruptions		ANSP, Airline, Society	Airline, Society	Society	Society	
Reduced legacy surveillance (radar/WAM/ground ADS-B) outage disruptions		ANSP, Airline, Society	Airline, Society	Society		
Less restricted altitudes			Airline	Society	Society	
Less restricted air speeds			Airline, Society	Society		
Less restricted routing			Airline, Society	Society		
Reduced metering delay / improved flow			Airline, Society	Society		
Reduced excess contingency fuel loading			Airline	Society		
More predictable airline operations planning						Airline
Reduced frequency of pilot position reports						Airline
Avoided avionics investment						Airline

Large Efficiency Gains Possible in the North Atlantic

- Airline flight operations analysis (UA, AC, AA, DL) estimate the average fuel savings to be **$550** per flight
- **$220M** annual savings possible in 2018 at current fuel prices and traffic level
- Fuel saving will double over 10 years to **$450M** based on fuel price growth to the 10 year average and traffic growth at historical rates



Regulatory Development

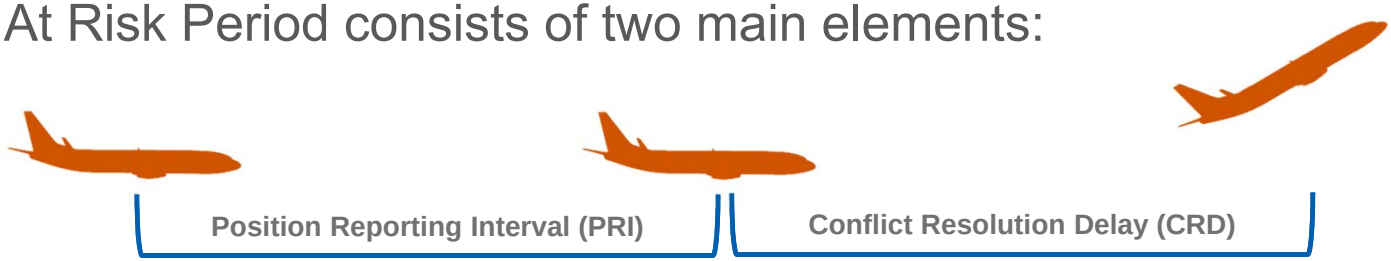
Safety Case

Strong Regulatory Support

- Support at 12th Air Navigation Conference
- Two approaches being developed
  - Reduced oceanic separation - initial modeling suggests 15 NM or less longitudinal separation possible using existing COM (HF/CPDLC)
  - 5 NM tactical separation with DCPC – analysis will be conducted
- ICAO SASP (Separation and Airspace Safety Panel) Job Card SASP011
- Included in RTCA and EUROCAE standards for surveillance
- ITU World Radio Conference (Nov.2015) 1090Mhz protection
- EASA certification as a Surveillance Service Provider underway

Safety Benefit of Real-Time Surveillance

- The two main elements affecting the performance of Air Traffic Control are the ability to “see” an aircraft to provide separation and to “communicate” to the pilot.
- Collision Risk Modeling is aimed at keeping an aircraft “At Risk Period” (ARP) within a target level of safety
- The At Risk Period consists of two main elements:



Surveillance

Position Reporting Interval:

- The time between aircraft position updates
- Longer intervals mean less accurate aircraft position information for the controller
- Longer intervals result in a longer time to detect a problem that requires intervention

Communications

Conflict Resolution Delay:

- The time between detecting a problem and resolution of the conflict
- This time includes communication (COM) to the pilot, pilot reaction and aircraft inertia

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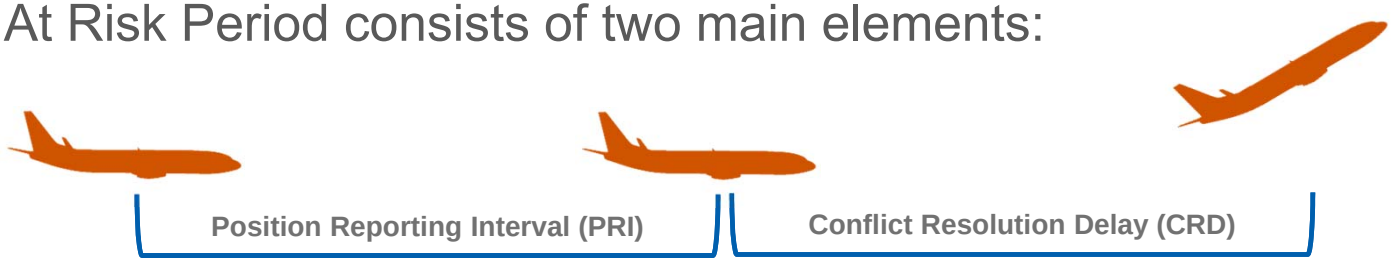

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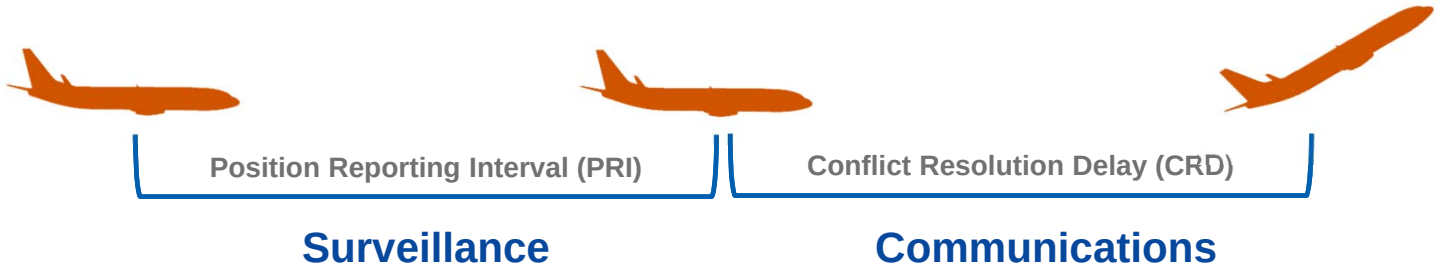
Reducing Position Reporting Interval with Fixed COM



Reducing the time it detects an aircraft (PRI) increases the available safety buffer using existing COM performance (CRD)

Aireon ALERT

Benefits

Aireon ALERT & Aircraft Flight Tracking

Aireon ALERT & Aircraft Flight Tracking

- Aireon ADS-B Flight Tracking
  - Aireon will have global ADS-B visibility
  - Enables real time flight tracking without new avionics
  - Position update available every 8 seconds or less
- Aireon ALERT
  - A 24/7 call center will be available through IAA's COM facility
  - A free of charge alert system will be made available as a public service
  - All airlines, States and Rescue Coordination Centers can pre-register
  - In the event of a distress or alert phase where there is no known aircraft position, Aireon will make the last known position or track available.

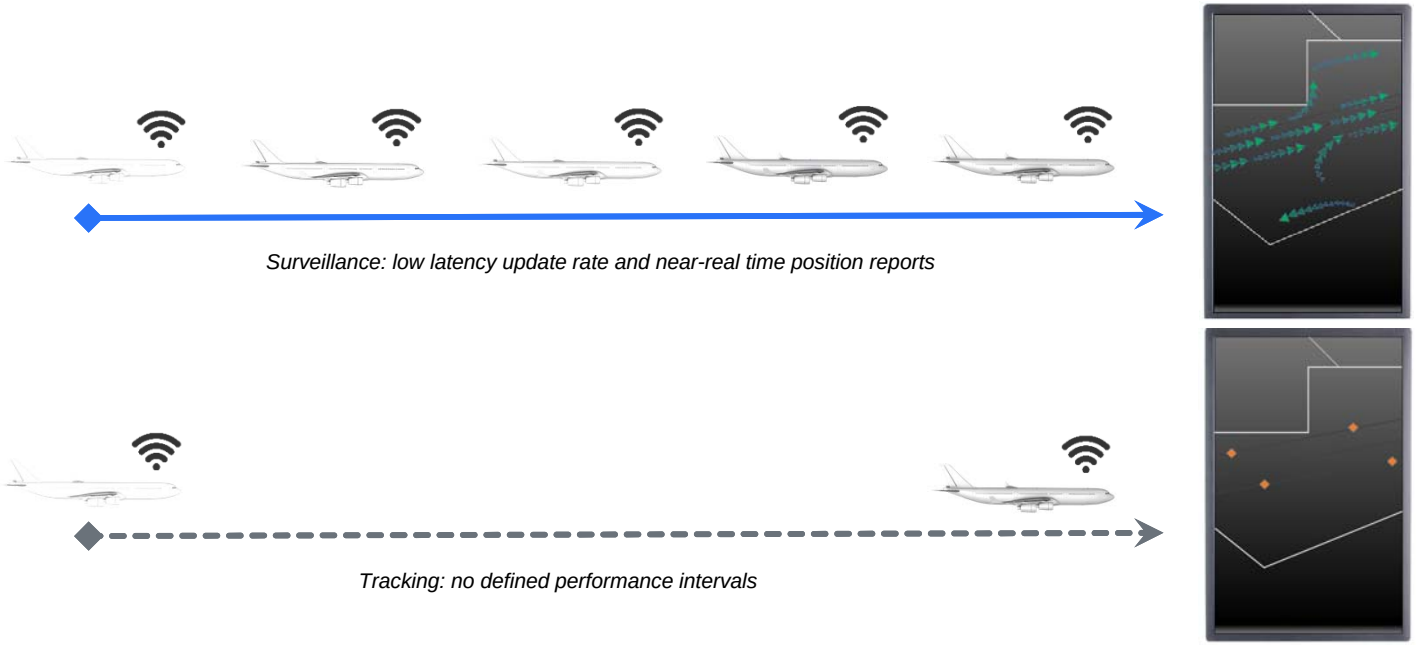
IAA

Aireon ALERT will globally satisfy the
ICAO 15 minute flight tracking recommendation
at every 8 seconds **without avionics costs**

Aireon

ICAO Global Distress and Safety System

- Requires airlines to track own aircraft at a max of 15 minute intervals – 1 minute intervals in distress situations
- Aircraft surveillance vs. tracking – no clear definition
  - Surveillance systems perform to technically high standards in latency/update rate (Radar, ADS-B)
  - Tracking systems have no defined performance criteria (FlightRadar24/SATCOM position exchange)



Aircraft Search Area - based on position update interval and Aircraft speed

		Example prop aircraft	Common turboprop in ASECNA airspace	Common jet in ASECNA domestic airspace	Common jet in ASECNA oceanic airspace
		Cessna C172	Bombardier Dash 8	Boeing 737	Boeing 777
	Cruise speed (knots)	122	360	444	493
Potential search area (sq km)	PIREP (30min)	12,763	111,129	169,039	208,409
	ADS-C (15min)	3,191	27,782	42,260	52,102
	SB ADS-B (8sec)	0.3	2.2	3.3	4.1