

Making Global Air Traffic Surveillance a Reality!

July 13th, 2016

Update to the PPRC/4 on Space-based ADS-B implementation

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Agenda

Introduction

The Aireon System

Regulatory Roadmap

Operational Concept

Safety Benefits of Space Based ADS-B

Conclusion

JWC6543
CRJX
310 525



YGD1723
A350
380 425



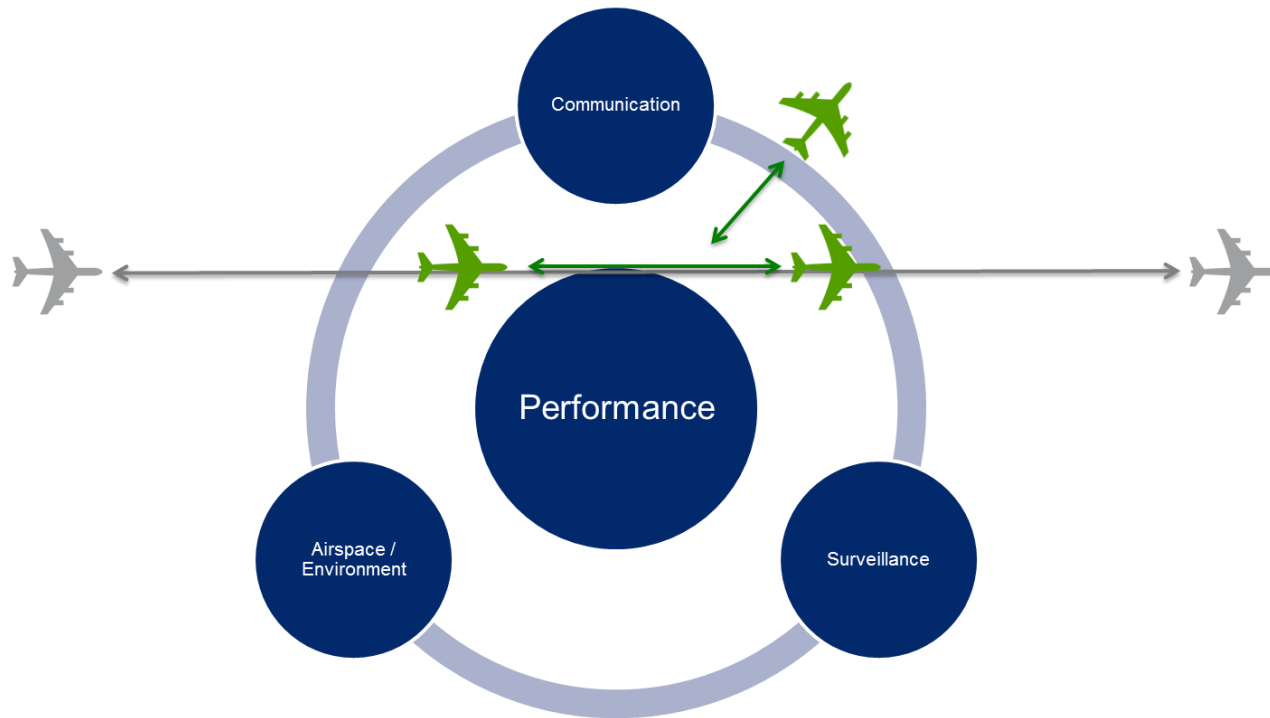
SLB3256
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AIREON LLC PROPRIETARY INFORMATION

Surveillance and Communication

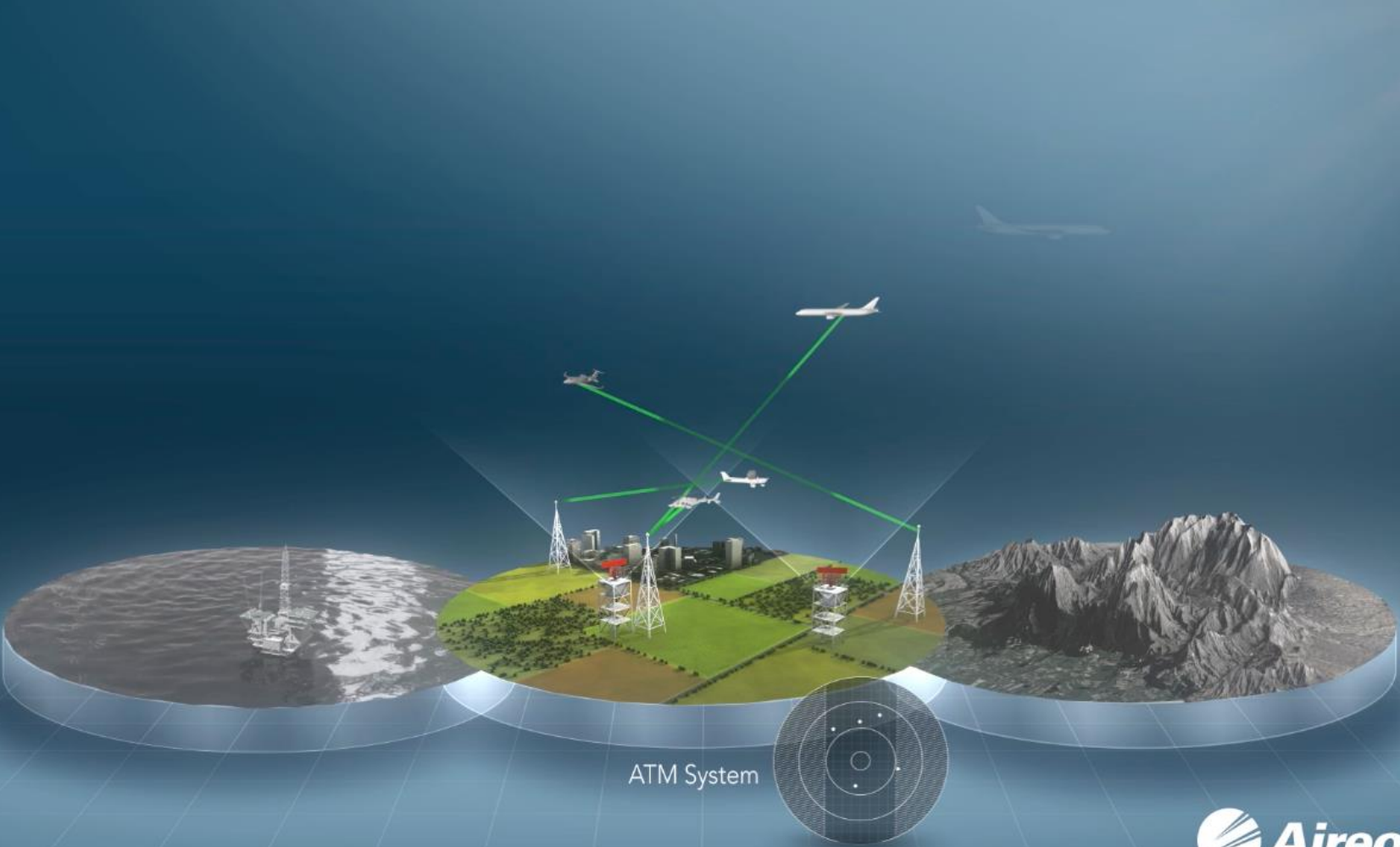
- For optimal operational ATM Performance a controller needs to be able to determine an accurate aircraft position (Surveillance) and relay information with the pilot (Communication)



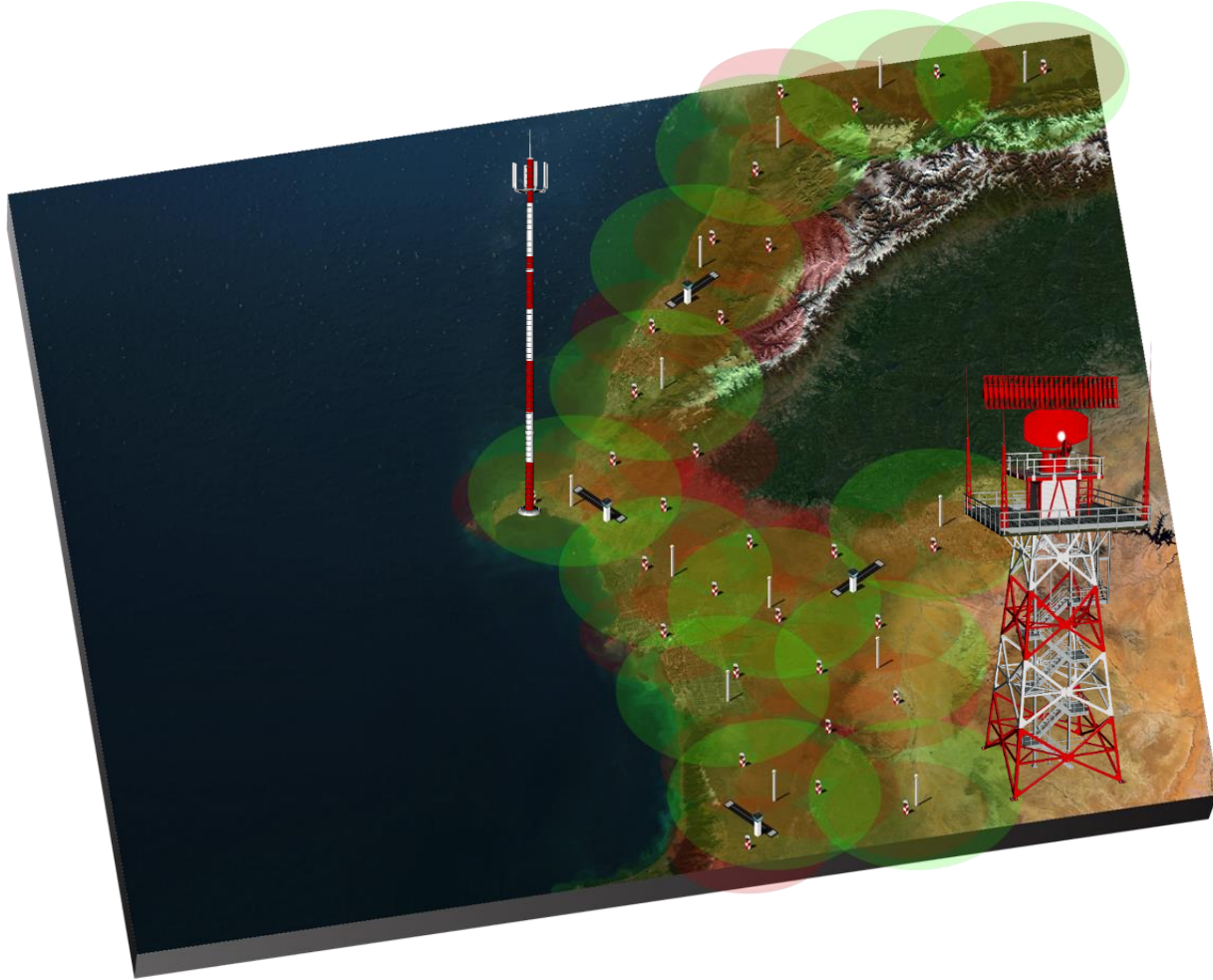
Over 70% of the World Remains Un-Surveilled



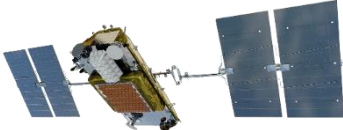
Current Surveillance is Limited to Line of Sight



Legacy Terrestrial Solution



In 2018...100% Global Air Traffic Surveillance



**AIREON
GLOBAL
COVERAGE**

Automatic Dependent Surveillance – ADS-B (out)

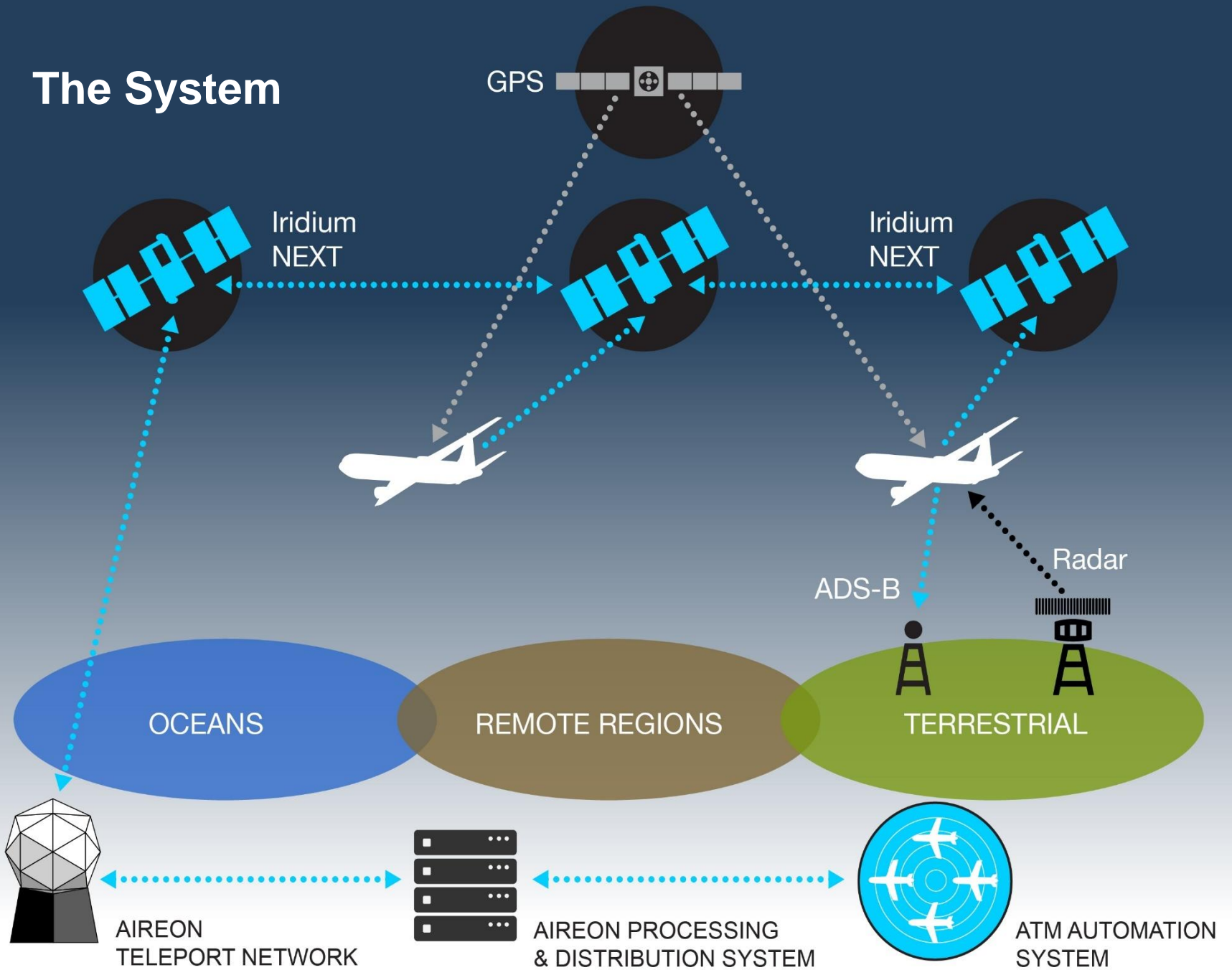
- An innovative and proven surveillance concept through ground based stations
- Radar “calculates” a target position, ADS-B broadcasts a GPS position
- More accurate than radar (higher update interval, GPS position)
- Much lower cost than radar (10% of the costs)
- ADS-B globally accepted as augmentation or replacement of radar
- Upcoming transponder mandate for all aircraft in Europe and US
- New aircraft are starting to be ADS-B equipped



The Aireon System



The System



Investors, Customers and Innovators:

A company created by ANSPs for ANSPs and Airlines



First Launch in September 2016, First Data by the End of 2016, Global Coverage in 2018

- A \$3 Billion US/Canadian/European satellite project, commissioned by Iridium, built by ThalesAlenia Space



- Space-qualified ADS-B receiver payload developed by Harris Corporation will fly in a 72 (66 operational, 6 spares) LEO satellite constellation with 9 ground spares
- Systems engineering and ground data processing system by Harris with significant expertise and existing ground based ADS-B infrastructure

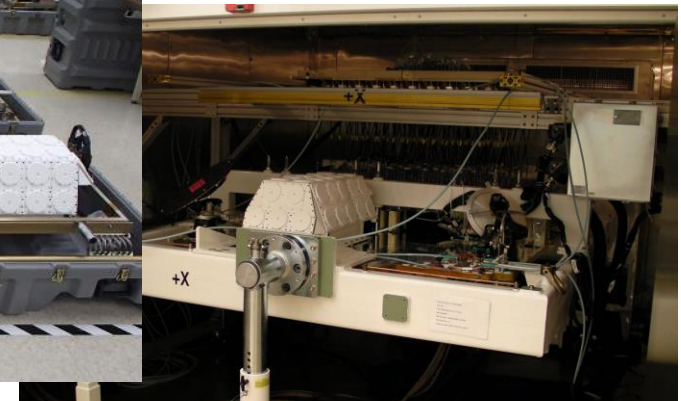
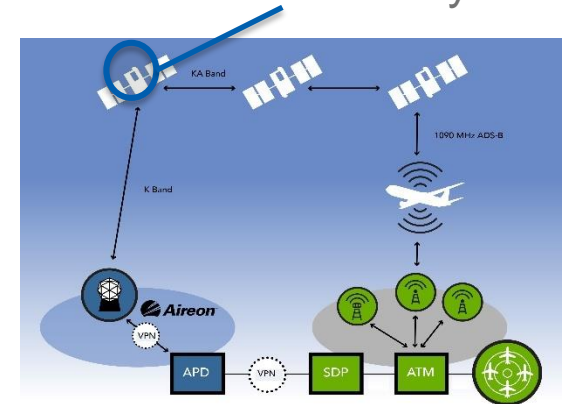


Harris Payload Way Ahead of Schedule

- 81 of 81 payloads complete
- Fully qualified
- Performance looks excellent

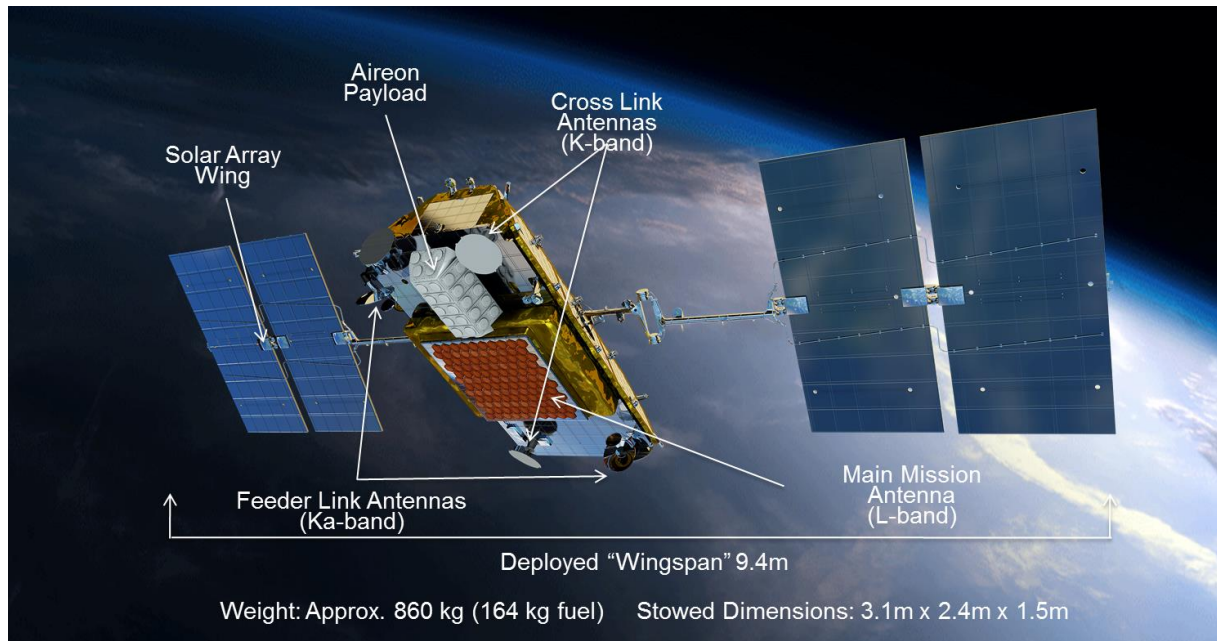
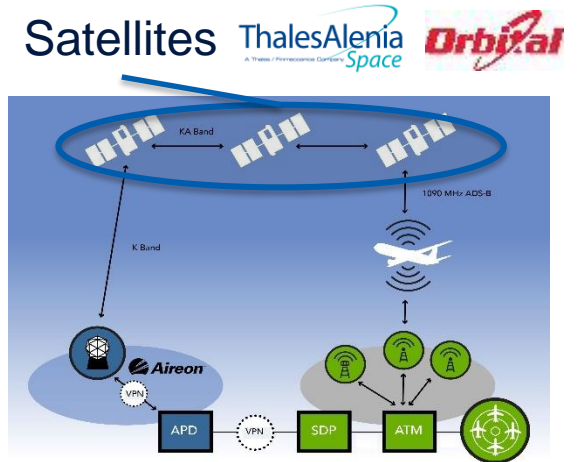


ADS-B Receiver Payload



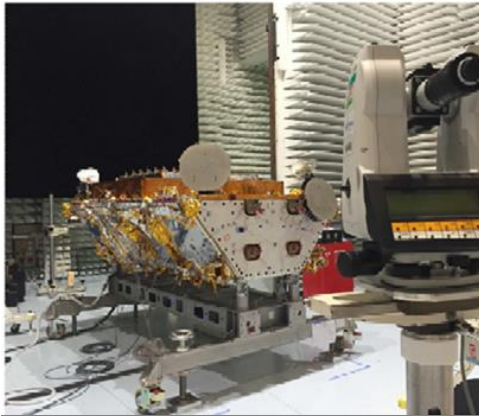
Satellite Development

- Thales Alenia Space is the prime contractor
- Orbital Sciences performs the assembly, test and launch preparations
- Over 30 subcontractors
- Iridium has team of 35 overseeing program



Satellite Production Well Underway

- The satellite design has completed full qualification testing
- Thirteen satellites in manufacture to support first launch (ten needed)
- Thales will achieve high rate production (5 per month) by summer



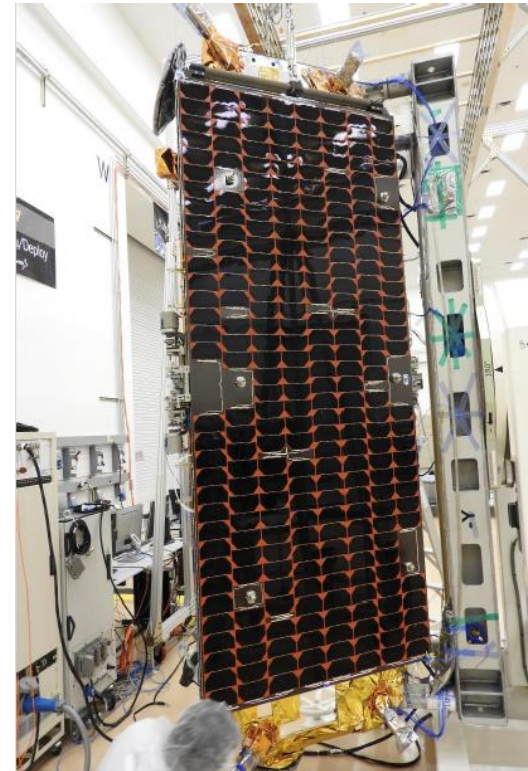
Antenna Testing



Thermal Vacuum Testing



Acoustic Testing



Solar Array Installation

The First Launch Is Now on Space X Falcon 9

- Russian Dnepr launch of 2 satellites put on hold due to uncertainty of the launch license from the Russian Ministry of Defense
- First launch will be 10 satellites on a Falcon 9 out of California this summer
- Second launch will be 3 months later, then every two months after that

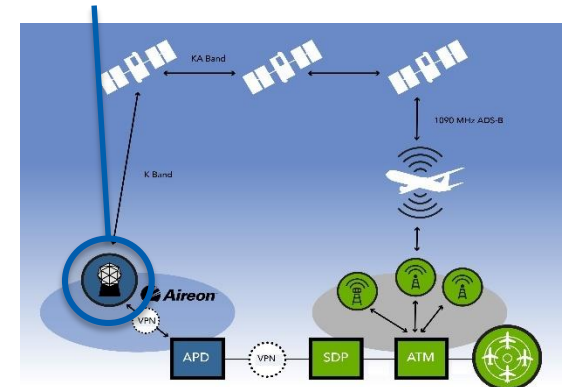


Schedule still supports constellation complete by end of 2017

Hosted Payload Operations Center (HPOC)

- HPOC complete and qualified
- Operations procedures are written
- Tightly integrated with Iridium satellite operations
- Launch readiness rehearsals underway

HPOC



Satellite Network Ops Center



HPOC



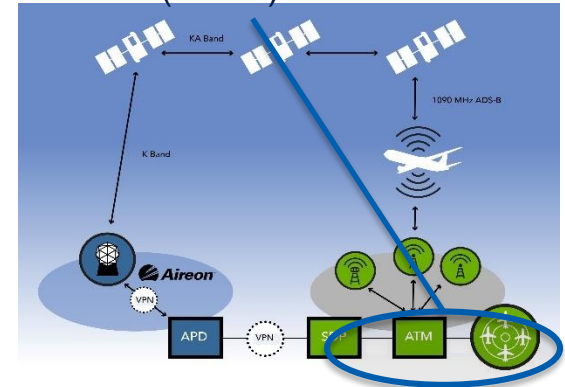
Launch & Early Ops Facility



Implementing Connections for ANSP Systems

- Initial test connection to NATS and NAV CANADA complete
- Early testing with ATM automation systems
- Test and validation of on-orbit data
- Connections to FAA, IAA, Naviair, ENAV, Singapore, ATNS and Curacao to follow in 2016/2017

ATM Service Delivery Points (SDPs)



Federal Aviation Administration

NATS

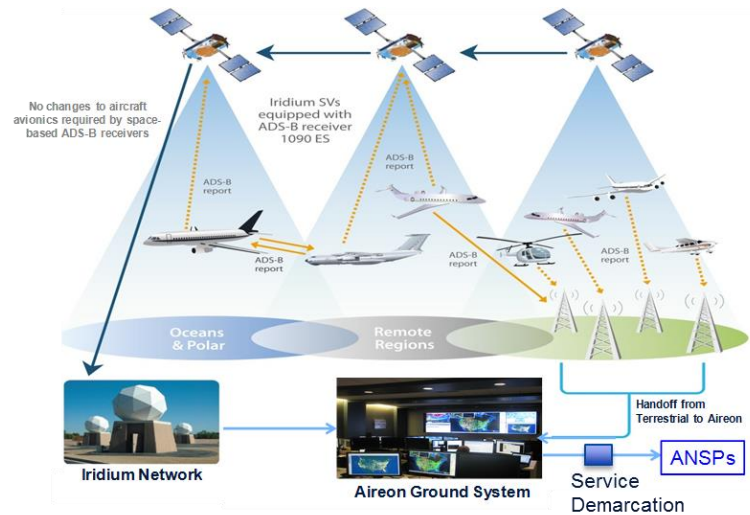


NAVIAIR



Aireon Service Delivery Point (SDP)

- Demarcation between the Aireon System and the ANSPs system(s)
- The only physical hardware on ANSP premises
- Aireon manages data delivery (including security) to the demarcation point through MPLS or independent Satellite
- Equipment can be procured by Aireon under the Data Services Agreement or by ANSP within Aireon specifications



Example: Racksource RACK-151-18U



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ANSP Agreements in Place

- **Launch Customers:**

Nav Canada	ENAV
NAVIAR	Irish Aviation Authority
UK-NATS	Curacao
Singapore	ATNS

- **MOA in place with:**

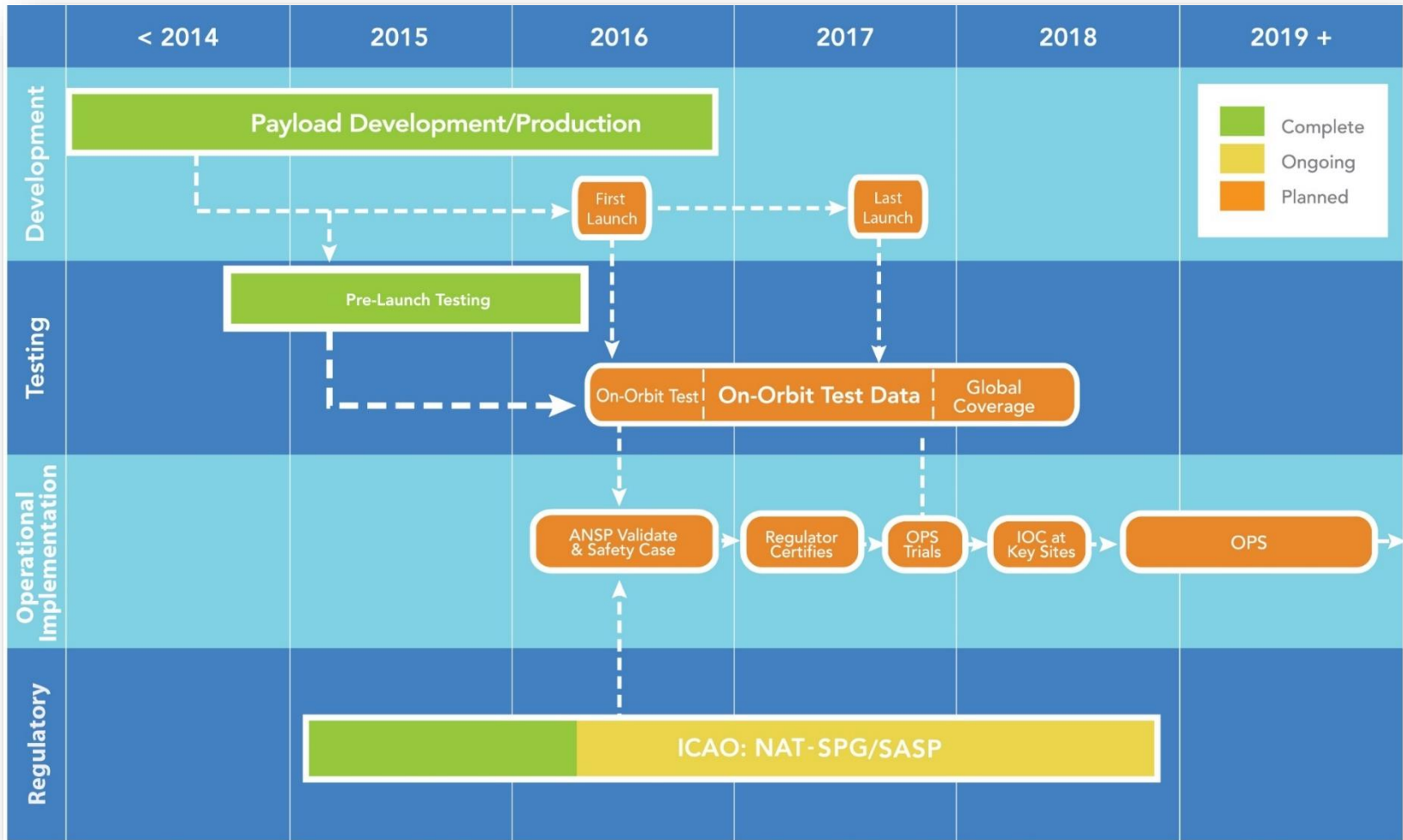
FAA	ASECNA
Nav Portugal	Blue Med Fab
New Zealand	Australia
Iceland	Russia



Regulatory Roadmap



Roadmap to Operational Capability



Strong Regulatory Support

- Strong Support at ICAO 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 for space-based ADS-B
- EASA certification as a Surveillance Service Provider underway



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

Safety Certification for Terrestrial Use

- **Certification:**

- Besides building safety cases with individual regulators such as FAA, UK-CAA and Transport Canada, Aireon is seeking EASA certification approval as a Surveillance Service Provider



- This will allow Aireon to be a provider for Pan-European services to multiple ANSPs
 - The EU ANSPs will have to submit their individual safety case, which will be supported by the Aireon certification
 - This certification will also help Aireon with non-EU states since EASA is considered a credible authority worldwide
- Certification application has been filed to EASA

Reduced Oceanic Separation Standards

- ICAO SASP (Separation and Airspace Safety Panel)
- Job Card SASP011 – Develop Standards & Recommended Practices and guidance material to support space-based ADS-B as appropriate
 - ◆ 2018 (i.e., implementation in 2018, procedures completed by end 2016)
 - 15 NM lateral separation standard possible
 - 15 NM or less longitudinal separation standard possible
 - ◆ 2020 (performance based separation)
 - Combination of RSP and RCP will determine possible separation
 - Reviewing the use of CPDLC and SATCOM voice as DCPC




Operational Use



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It's Just ADS-B!

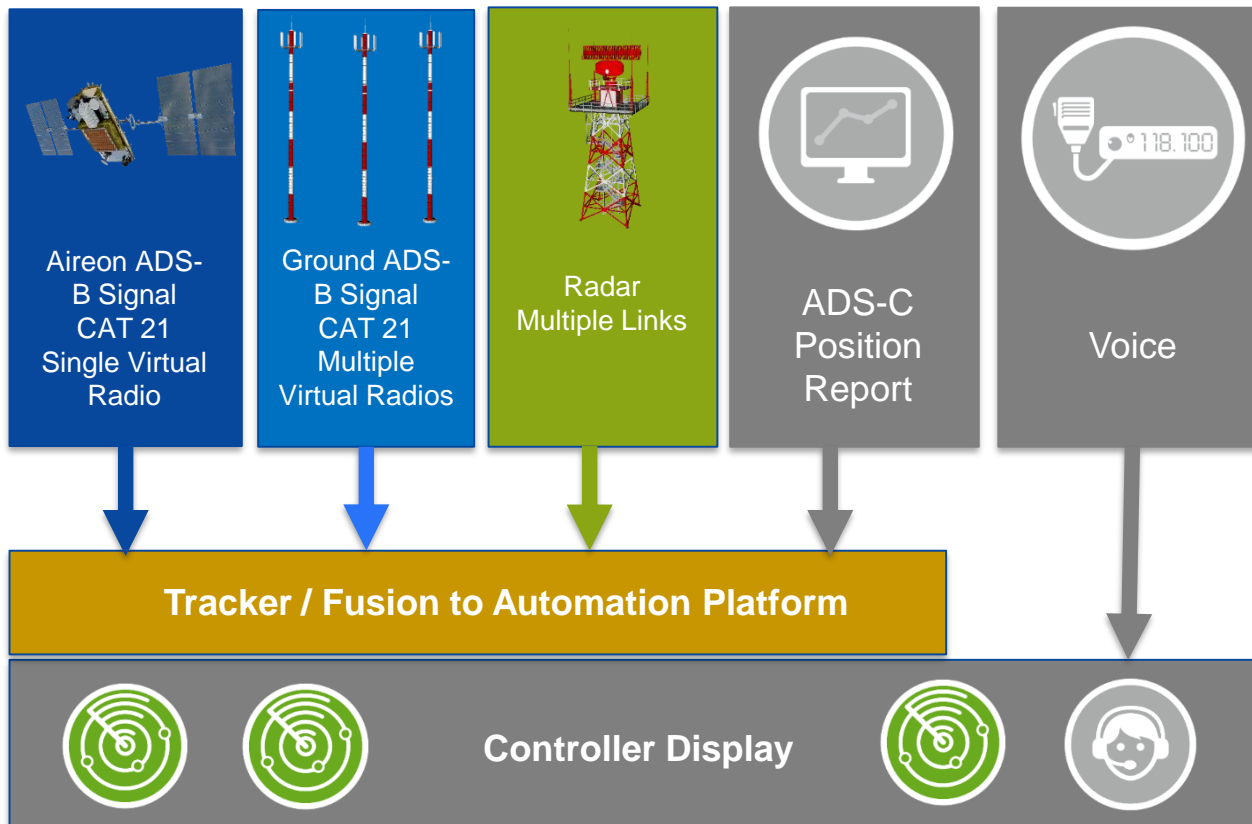
	ATS Surveillance Requirements (EUROCAE)	
Surveillance Data-link Requirements	Variable Per Region (DO-260 Version 0, 1, 2)	Accepts all 1090ES ADS-B (DO-260 Versions 0, 1, 2)
Aircraft Transmitter Classes Supported	A1 or Higher (125 Watt minimum)	A1 or Higher (125 Watt minimum, with a top-mount antenna (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



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ASTERIX-Based ADS-B Data Feeds to ATM Platform



Operational Use Scenarios

Scenarios	Capability	Communication	Navigation	Surveillance	Separation
Procedural Airspace	Base Case	SATCOM or HF only	RNP-10	Procedural	Long 10 min (80 nm) Lat: 60nm
	With Aireon	SATCOM or HF only	RNP-10	SB-ADSB Surveillance	Better than Long 10 min (80 nm) Lat: 60nm
	Example Airspace	Polar Region / Some remote areas in Africa / ASPAC			
ADS-C Airspace	Base Case	CPDLC with HF backup	RNP-4	ADS-C	30 nm
	With Aireon	CPDLC with HF backup	RNP-4	SB-ADSB Surveillance	<15 nm
	Example Airspace	North Atlantic / Pacific oceanic or Some remote areas in Africa / ASPAC			
Procedural Airspace with VHF	Base Case	DCPC Voice	RNP-10	Procedural	10 min (80 nm)
	With Aireon	DCPC Voice	RNAV 5 (Europe) RNAV 2 (U.S.)	SB-ADSB Surveillance	5 nm
	Example Airspace	VHF without surveillance. Common around small island States (Asia, Caribbean, Latin America) and large remote landmass (ASECNA)			
Currently Surveilled Airspace	Base Case	DCPC Voice	RNAV 5 (Europe) RNAV 2 (U.S.)	Radar, WAM, or Ground Based ADS-B	5 nm
	With Aireon	DCPC Voice	RNAV 5 (Europe) RNAV 2 (U.S.)	SB-ADSB Surveillance	5 nm
	Example Airspace	Terrestrial Europe, North America, Brazil, Australia etc.			

Atlantic Operations






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

The SAT ANSPs could potentially replicate the NAT initiative, so to reduce up to 15 nm the separation minima. Aireon has participated in the upcoming SAT/21 meeting in Lisbon, Portugal




























































Impacts & Benefits

Beneficiary

-  - ANSP
-  - Airline
-  - Society

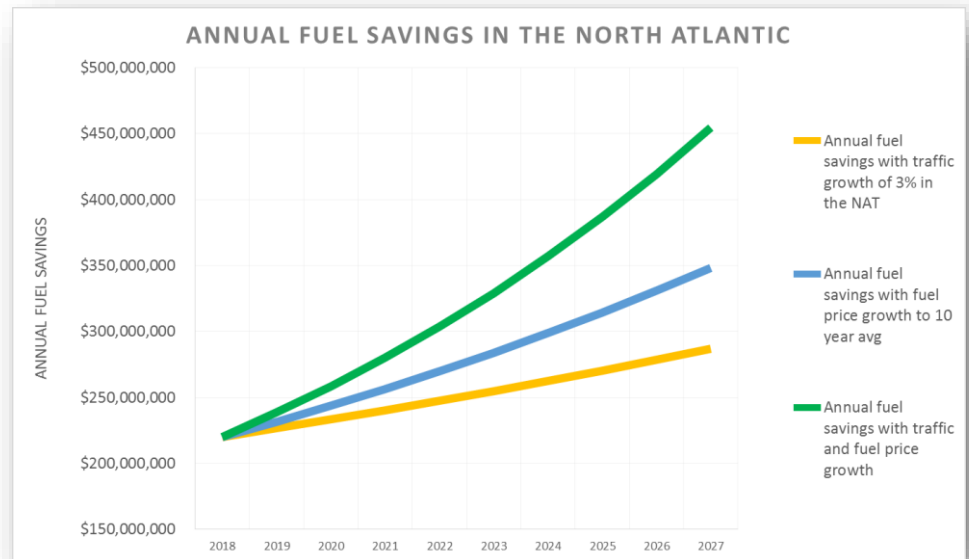
Impacts

Benefits

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						
Avoided legacy surveillance system expansion investment						
Avoided signal duplication and associated telecom costs						
Decreased infrastructure and signal costs through cross border contingency						
Improved data for flight billing and airspace route design purposes						
Reduced complexity through harmonization of operating environment		  				
Reduced likelihood of loss of separation events		  				
Reduction of gross navigation errors		  				
Early detection of emergency transponder codes		  				
Improved search and rescue services		  				
Improved airspace integration of UAS		  				
Enhanced military applications and situational awareness						
Minimized impact from operational and weather disruptions		  	 			
Reduced legacy surveillance (radar/WAM/ground ADS-B) outage disruptions		  	 			
Less restricted altitudes						
Less restricted air speeds			 			
Less restricted routing			 			
Reduced metering delay / improved flow			 			
Reduced excess contingency fuel loading						
More predictable airline operations planning						
Reduced frequency of pilot position reports						
Avoided avionics investment						

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

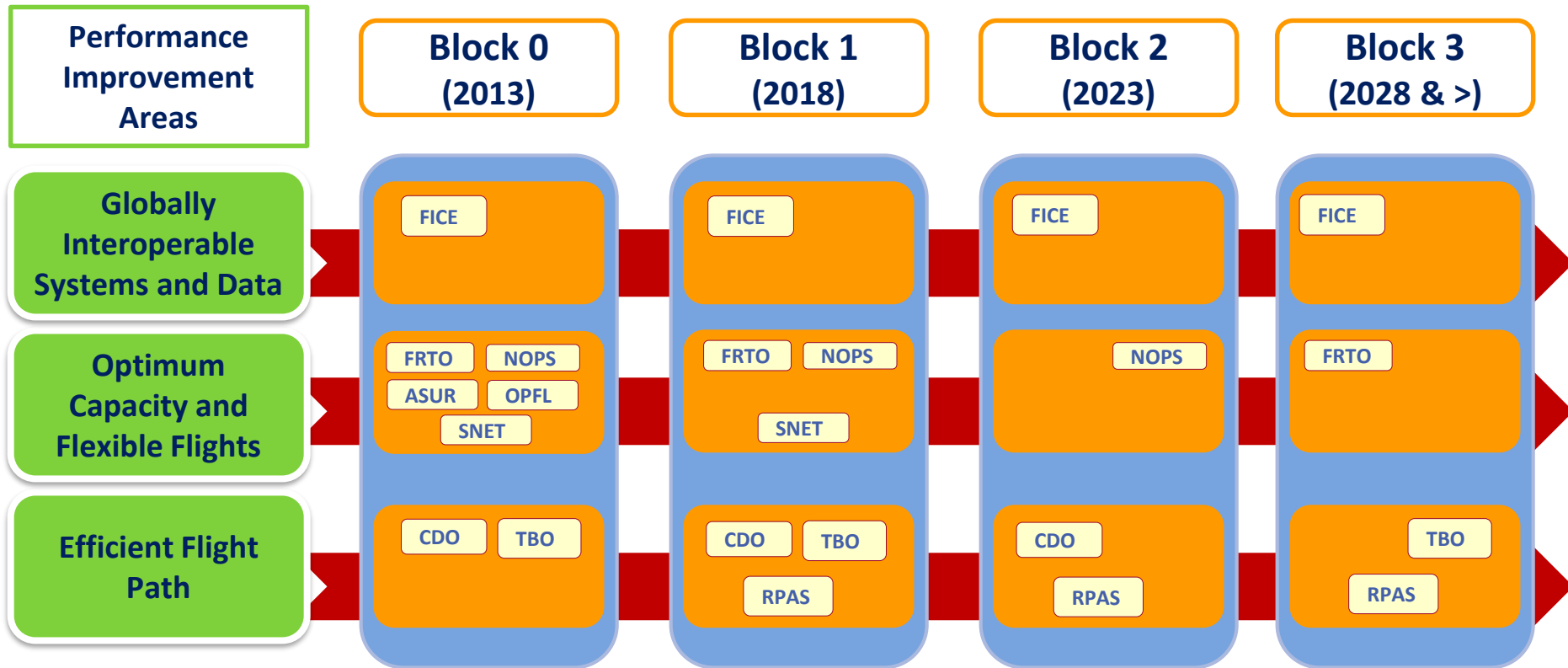


Flow Management / SWIM



Aireon & ICAO Aviation System Block Upgrades

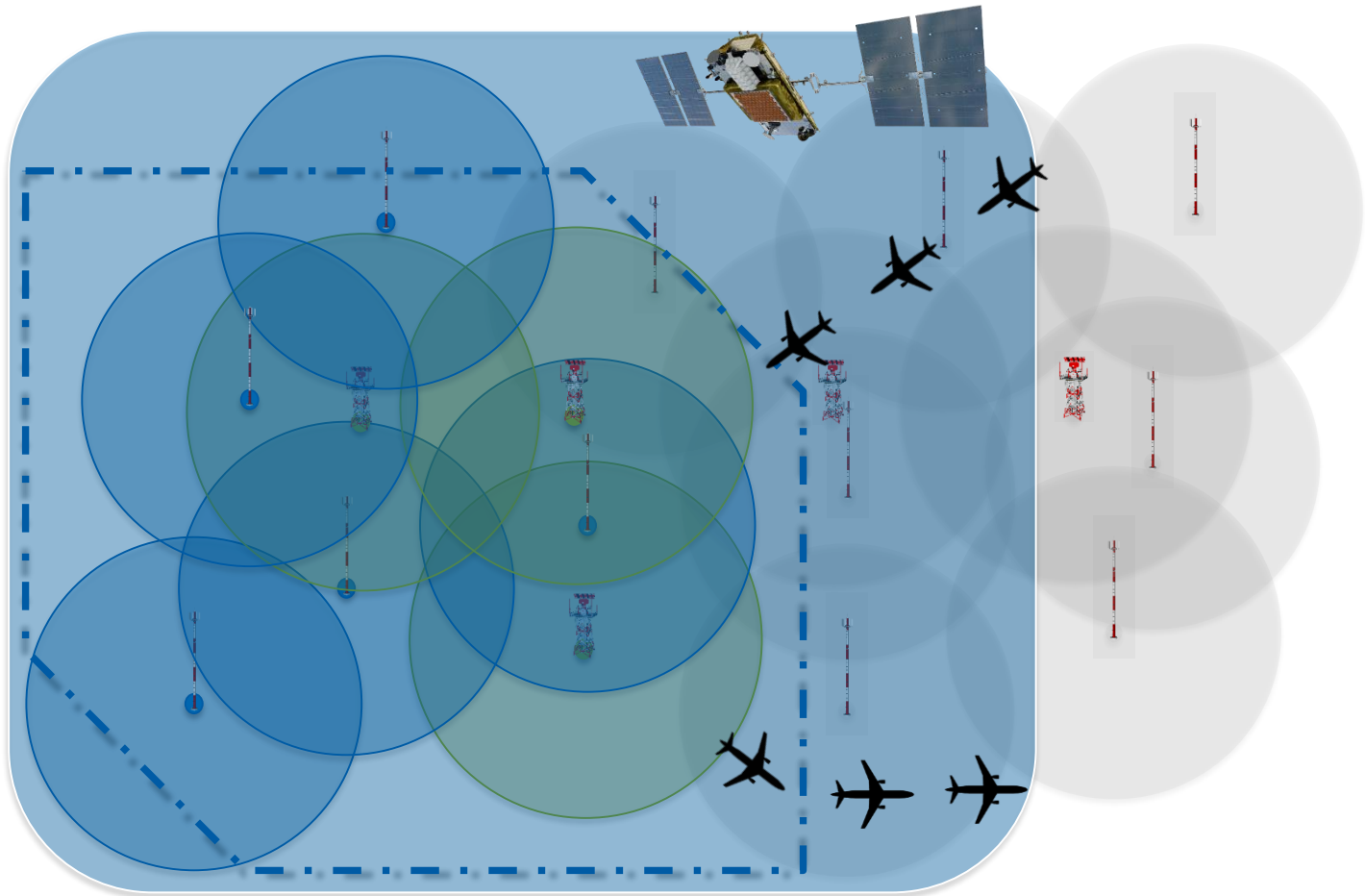
Space Based ADS-B will be a key enabler to GANP and ASBUs



Threads

FICE: Flight and flow Information for Collaborative Environments;
 FRTO: Free-Route Operations; NOPS: Network Operations; ASUR: Alternate Surveillance;
 OPFL: Optimum Flight Levels; SNET: Safety Nets; CDO: Continuous Descent Operations;
 TBO: Trajectory-Based Operations; RPAS: Remotely Piloted Aircraft Systems

Increasing Cross-Boundary Safety



Safety Benefits Of Surveillance and Space- based ADS-B



Options to detect an aircraft position

Position Accuracy / Update Interval



**Voice
Position
Reporting**



**ADS-C
Position
Reporting**



**Radar
Surveillance
/ MLAT**



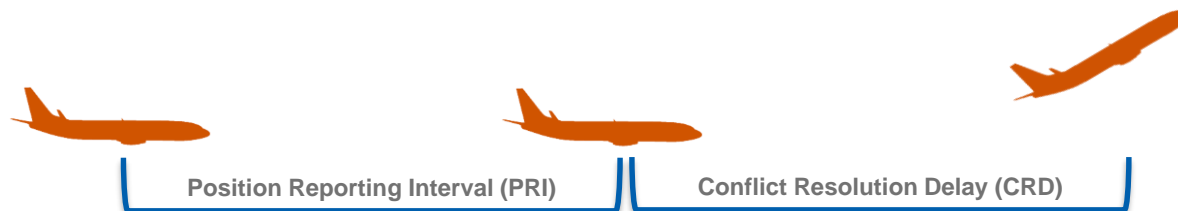
**Space
Based
ADS-B
Surveillance**



**ADS-B
Surveillance**

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:

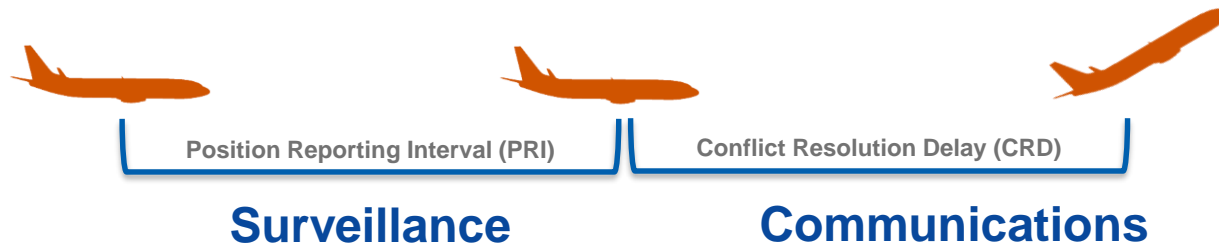
- The time between aircraft position updates
- Longer intervals mean less accurate aircraft position information for the controller
- Longer intervals result in a longer time to detect a problem that requires intervention

Communications

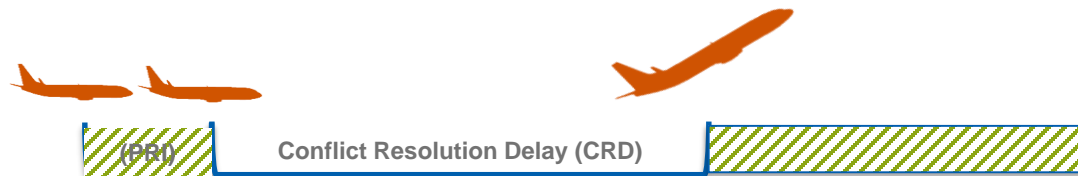
Conflict Resolution Delay:

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

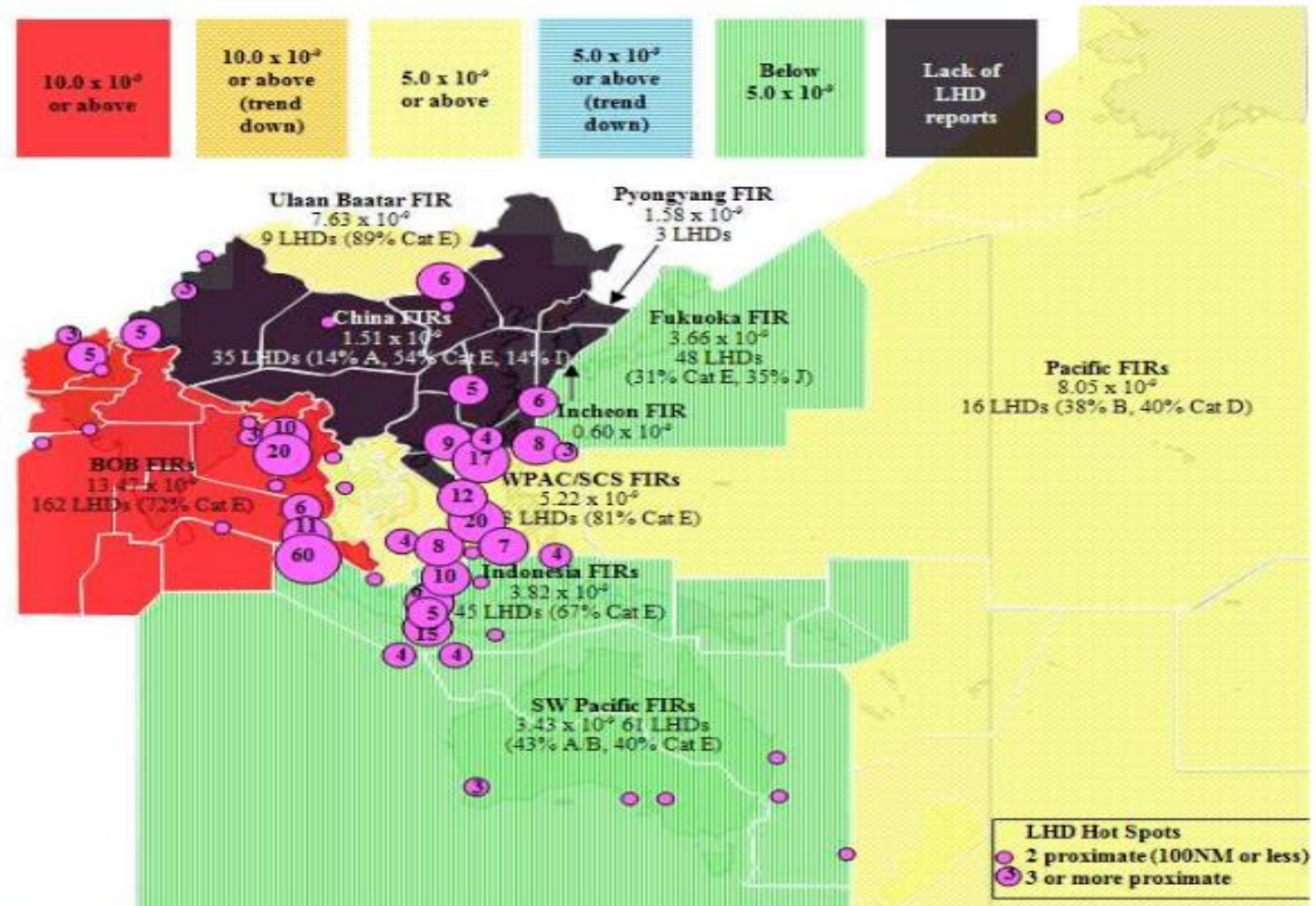
Reducing Position Reporting Interval with Fixed COM



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



Risk Management: As low as reasonably practical? What is the impact of technology on risk?



Flight Safety Foundation Study about Safety Benefits of Space-based ADS-B

- “Space-based ADS-B has the potential to improve safety and efficiency through an extensive range of short, medium and long-term benefits.”
- “Looking beyond the immediate aviation safety benefits that space-based ADS-B may introduce to countries where surveillance has not yet been deployed, there may be downstream economic, political and social benefits for some countries that could be considered, as noted. It is beyond the scope of this report to explore or quantify these likely benefits, but it is reasonable to highlight that this surveillance technology should enable many non-aviation benefits to flow beyond the immediate aviation industry, particularly in countries where surveillance is not available today.”

Source: Flight Safety Foundation



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Envisioned Immediate Safety Benefits

- A single global surveillance system.
- Reduced oceanic separation standards.
- Enhanced Situational Awareness.
- Enhanced global flight tracking.
- Enhanced Search and Rescue.
- Reduction in Pilot and ATC workload.
- Improved cross-flight information boundary error detection.
- Improved and earlier detection of off-track errors.
- Enhanced safety alerting.
- Improved weather avoidance.
- Enhanced Height Monitoring in RVSM airspace.
- Increased surveillance system augmentation and elimination of surveillance gaps.
- Enhanced safety for offshore helicopter operations.
- Enhanced incident and accident investigations.

Source: *Flight Safety Foundation*

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Source: *Flight Safety Foundation*

Envisioned Medium and Longer Term Safety Benefits

- Jumping a generation of surveillance technology and improving service in remote and difficult-terrain regions.
- Facilitating improved cooperation in contingency management.
- Greater interoperability (an ICAO harmonization enabler).
- Support for conflict zone and volcanic ash cloud management.
- Enabler for more regional and local data sharing.
- Reduced risk of controlled flight into terrain.
- Enabler for global safety performance monitoring and analysis.
- Supporting unmanned aircraft systems /remotely piloted aircraft systems.
- Driving safety through innovation.

Source: Flight Safety Foundation

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.



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



Next steps

- ICAO PPRC/4 to note of the presented update on the implementation of Space-based ADS-B and its operational and safety benefits as an air traffic surveillance system
- Possible joint cooperation between ICAO Member States & Aireon to:
 - Review a harmonized and global regional application of Space based ADS-B in South America, as a regional layer of surveillance to meet Safety & Operational targets
 - Analyze the technical & regulatory requirements of integrating Aireon's space based ADS-B signal into the region's ATM system
 - Work in cooperation with ICAO and its Member States, to evaluate the costs and benefits of using space-based ADS-B in the South American airspace.



3/16/2016

Let's unlock together your ATM potential!!!

