
Space Based ADS-B
Transforming the Way you See the Sky
September 23, 2015
Investors Partners Innovators
iridium Everywhere
NAV CANADA
ENAV
IAA
NAVIAIR
Aireon SM
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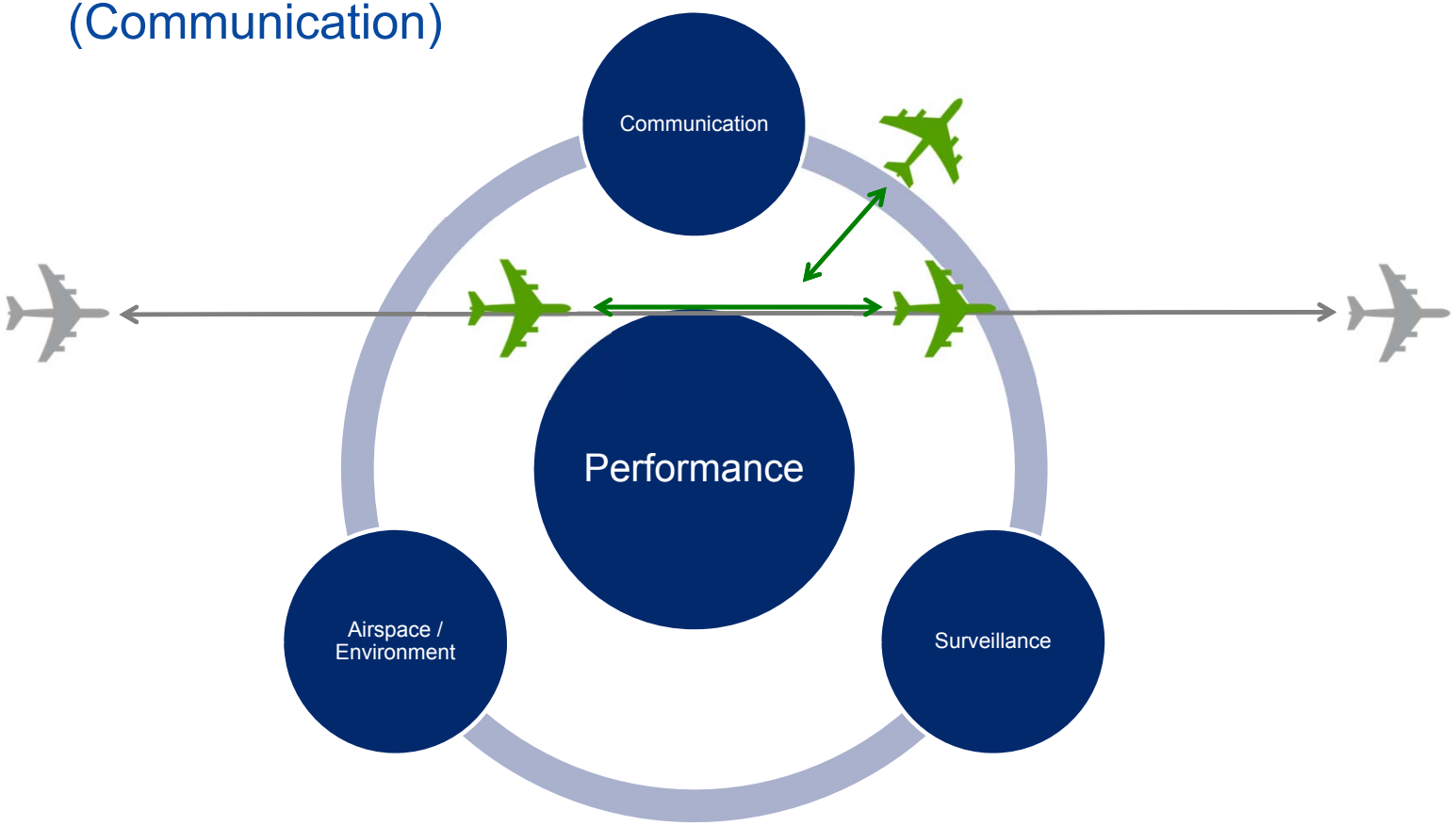
For optimal operational ATM Performance a controller needs to be able to determine an accurate aircraft position (Surveillance) and relay information with the pilot (Communication)



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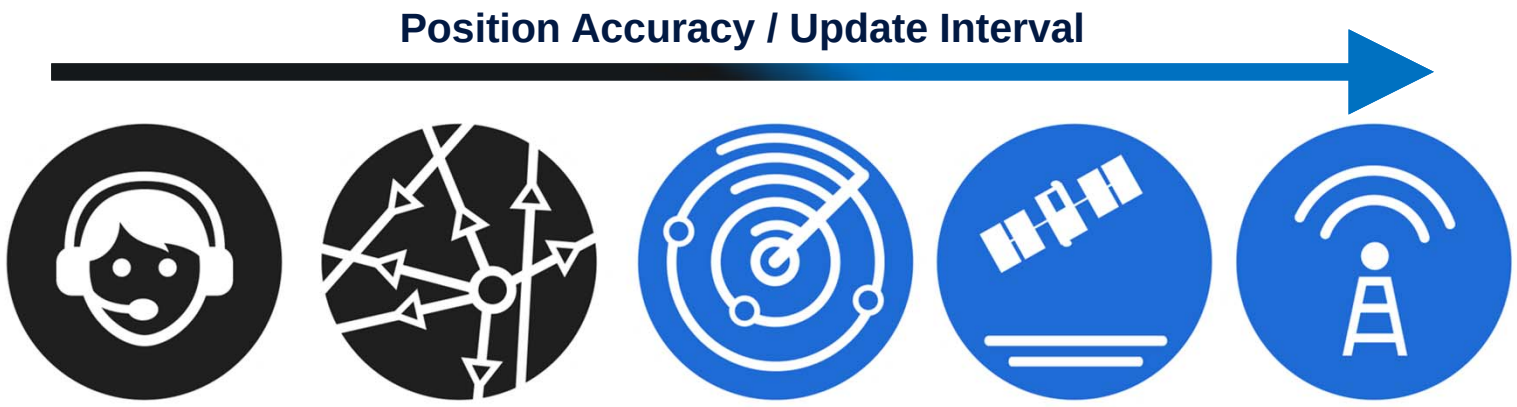
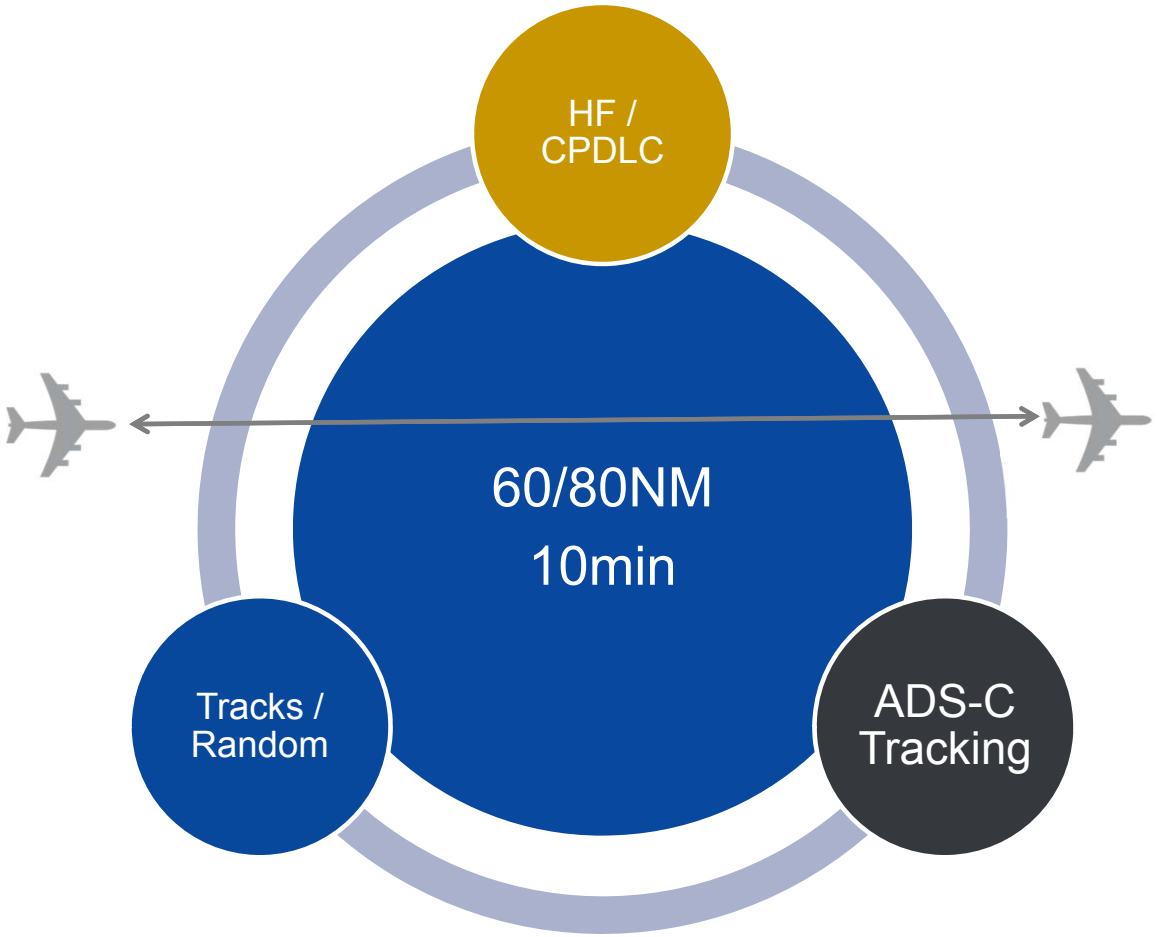
Options to detect an aircraft position



Today's Oceanic / Remote Reality



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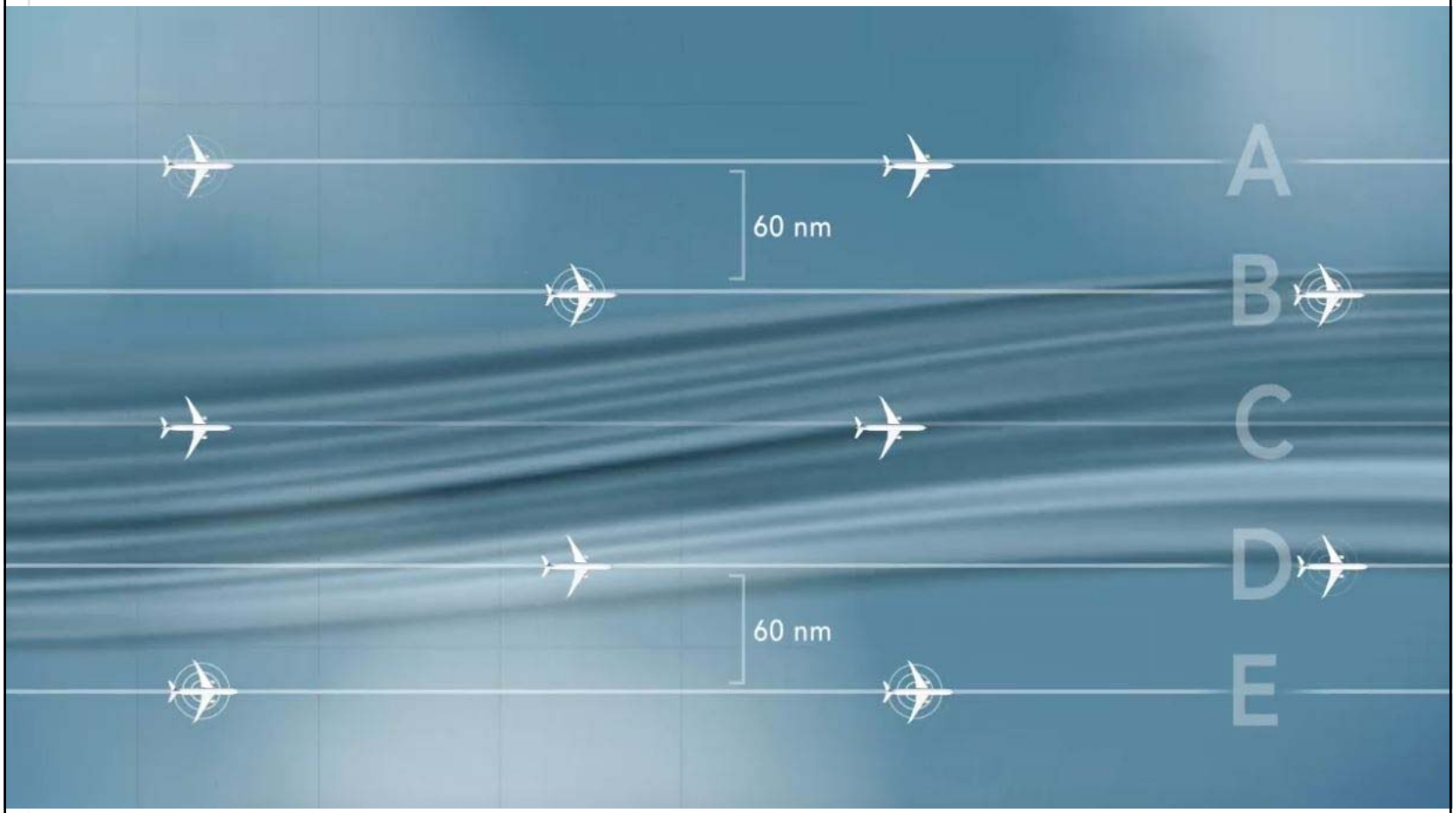
A common oceanic reality



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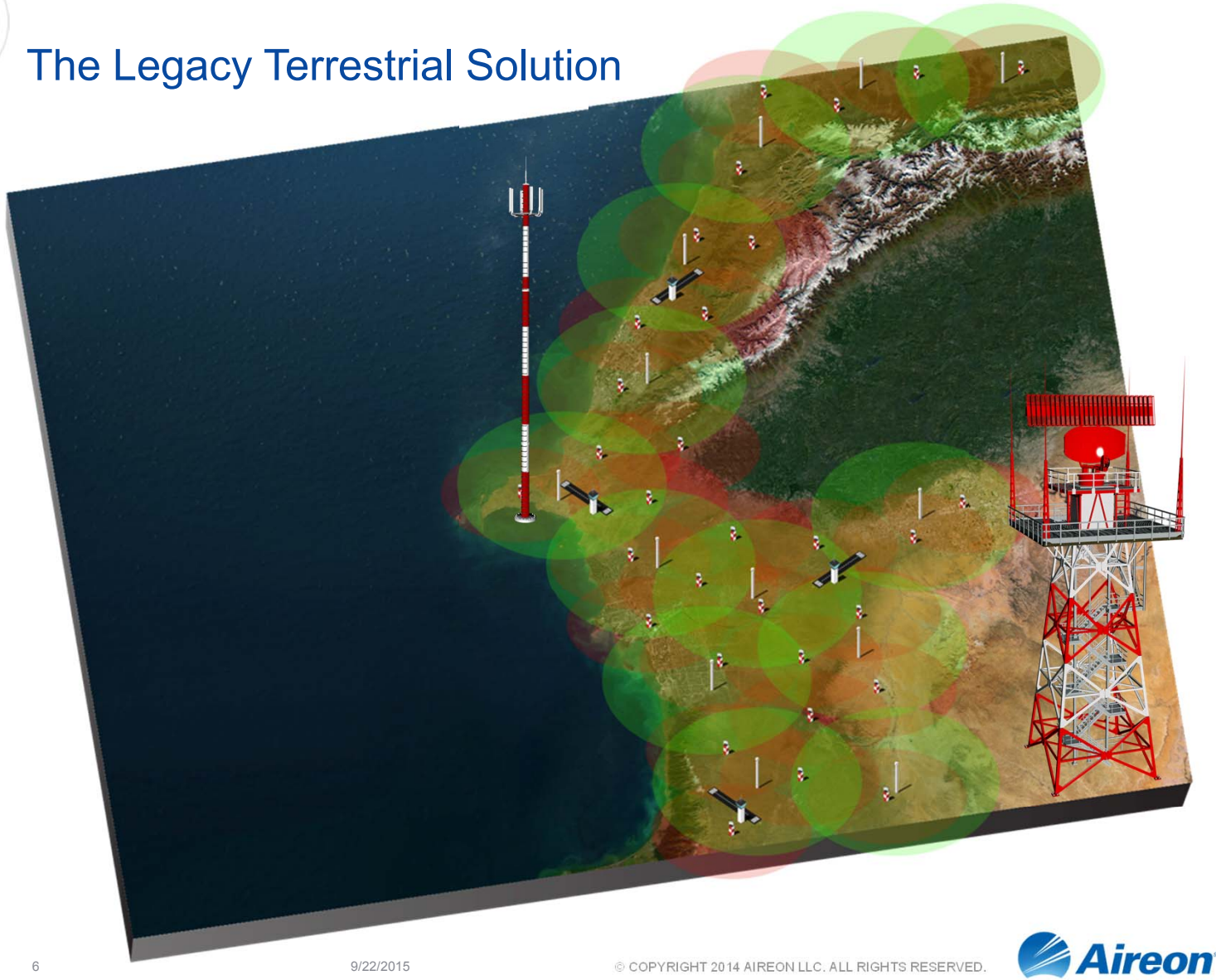
The Legacy Terrestrial Solution



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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

A quantum leap in aircraft surveillance — except…

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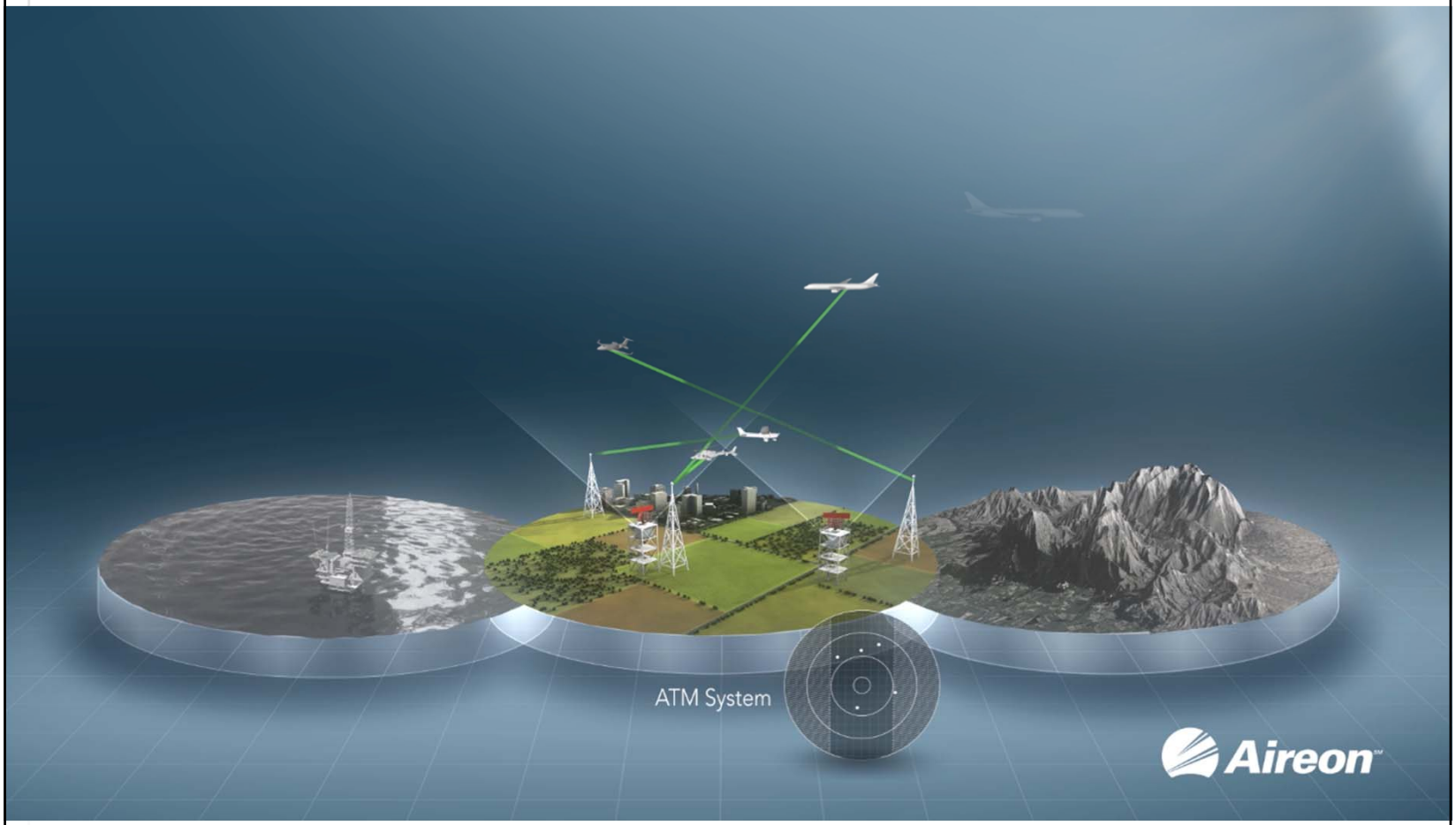
Current surveillance is limited to line of sight



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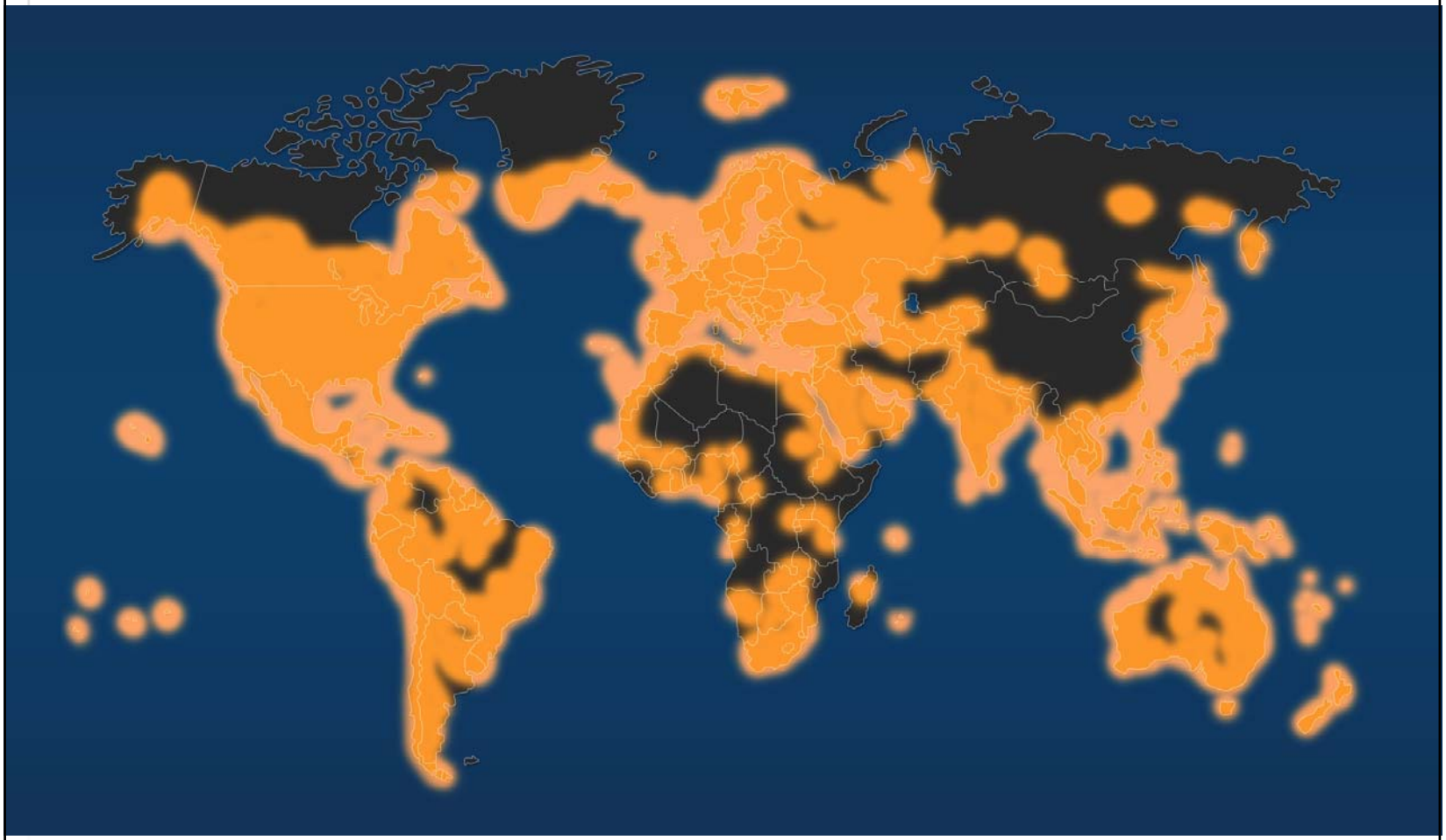
Over 70% of the world remains un-surveilled



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Challenging Airline Operations

Oceanic / Remote

- Restricted speeds, routes and altitude
- Limited operational and weather flexibility
- Restricted flow / metering delays
- Varying separation standards
- Complexity / no harmonized system
- Converging avionics requirements
- Safety risk of being in un-surveilled airspace

Terrestrial:

- High costs of surveillance signal duplication
- High costs of telecom / O&M
- Lack of cross-border signal sharing (flow restrictions)
- Contingency requires a full duplicate surveillance layer
- Significant time to implement large scale changes

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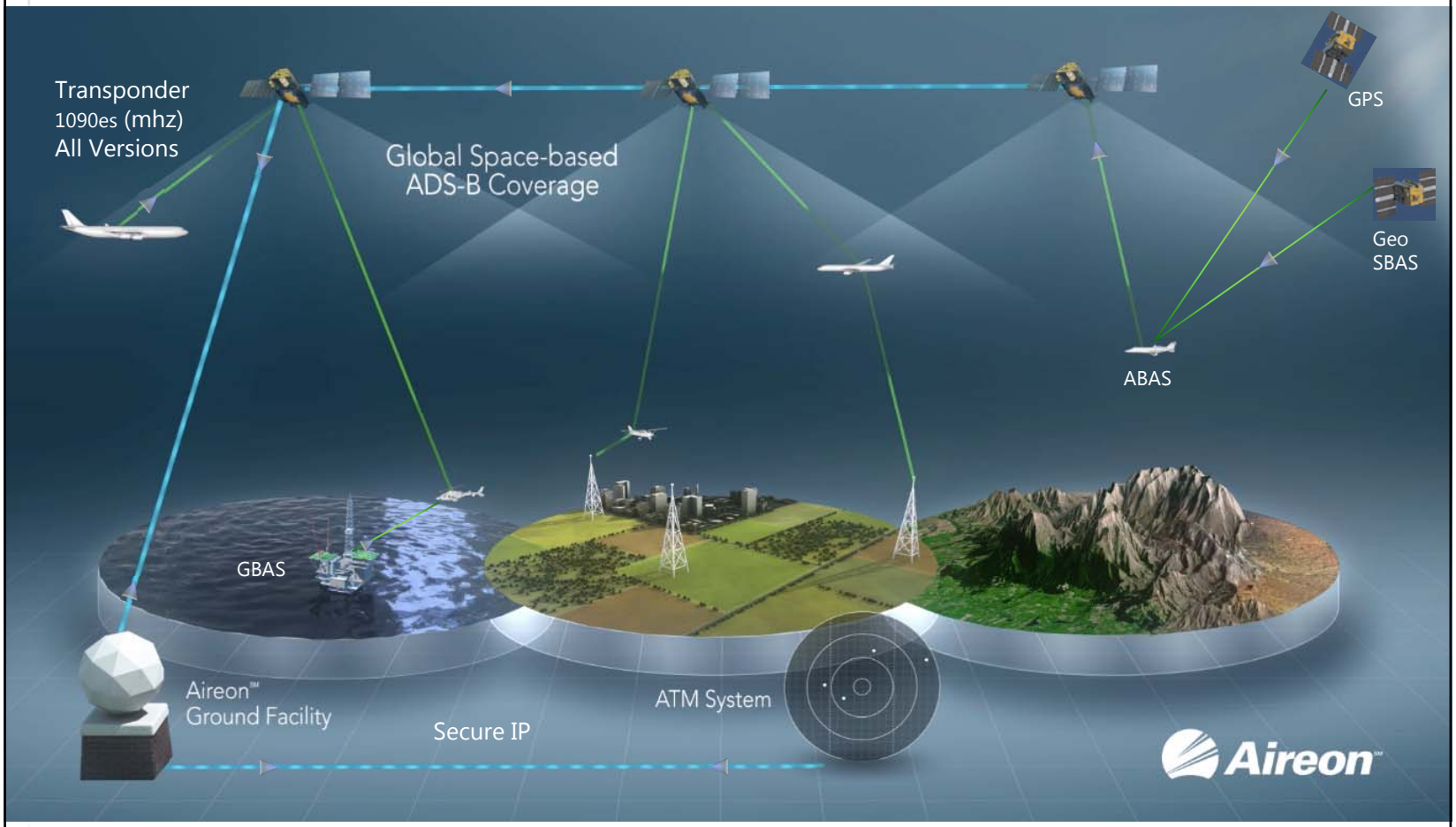
A short term reality



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Aireon System

Investors, Innovators and Customers

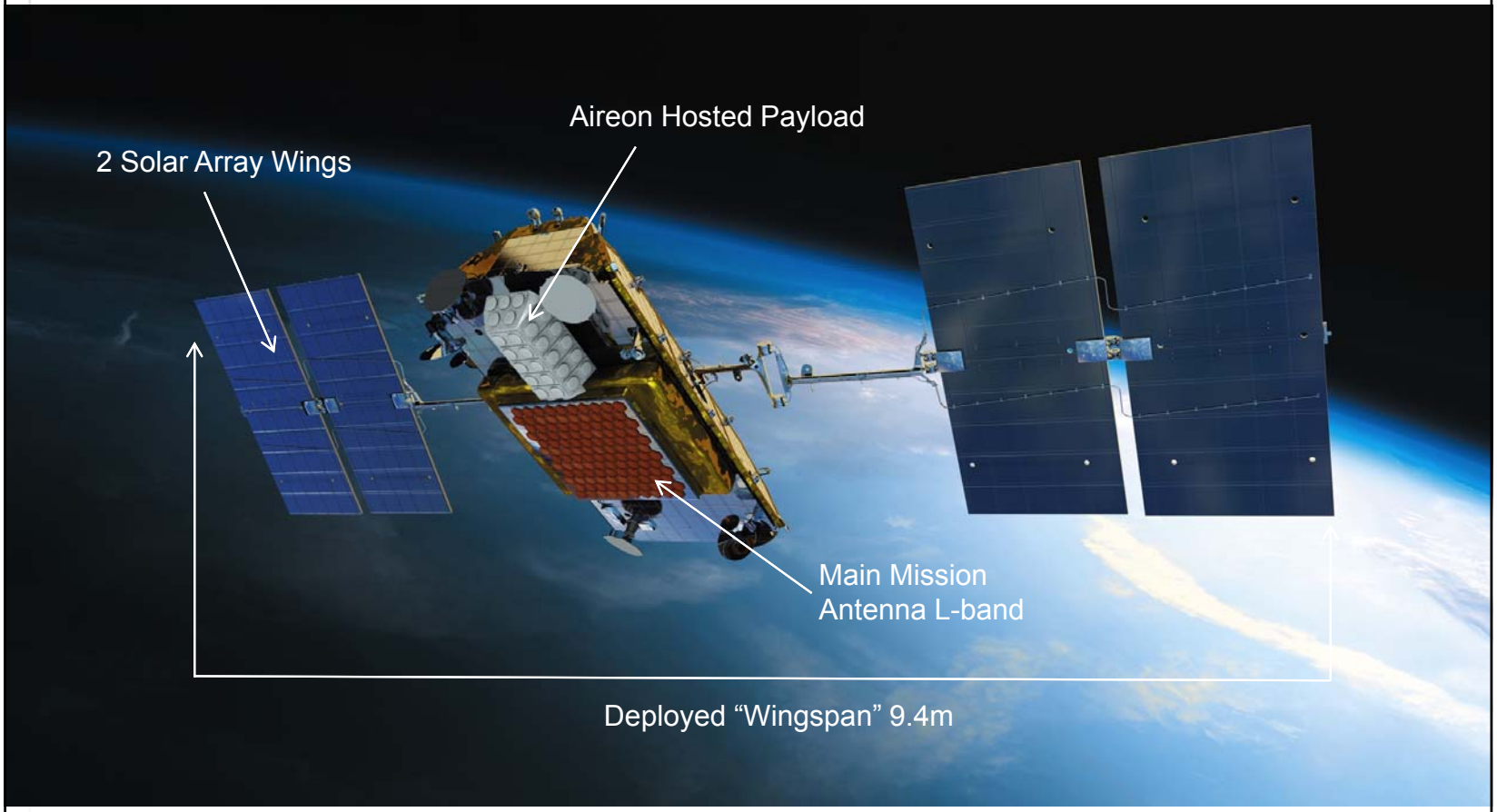
Investors, Customers and Innovators

Launch in 2015, Global Coverage in 2017

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

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

Iridium NEXT Satellite Configuration



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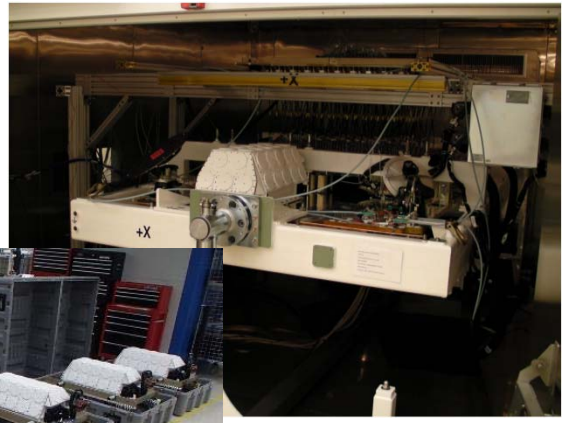
Significant Progress in Production



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Global Developments

ANSP engagement in space based ADS-B

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Broad support among major ANSPs

- **Launch Customers:**
  - Nav Canada, ENAV, NAVIAIR, Irish Aviation Authority
  - UK-NATS
- **MOA in place with:**
  - FAA, Nav Portugal
  - Singapore, India
  - ASECNA, South Africa
  - Blue Med Fab
  - New Zealand, Curacao
  - Australia, Iceland
- **Advance Data Service discussion**
  - A number of ANSP

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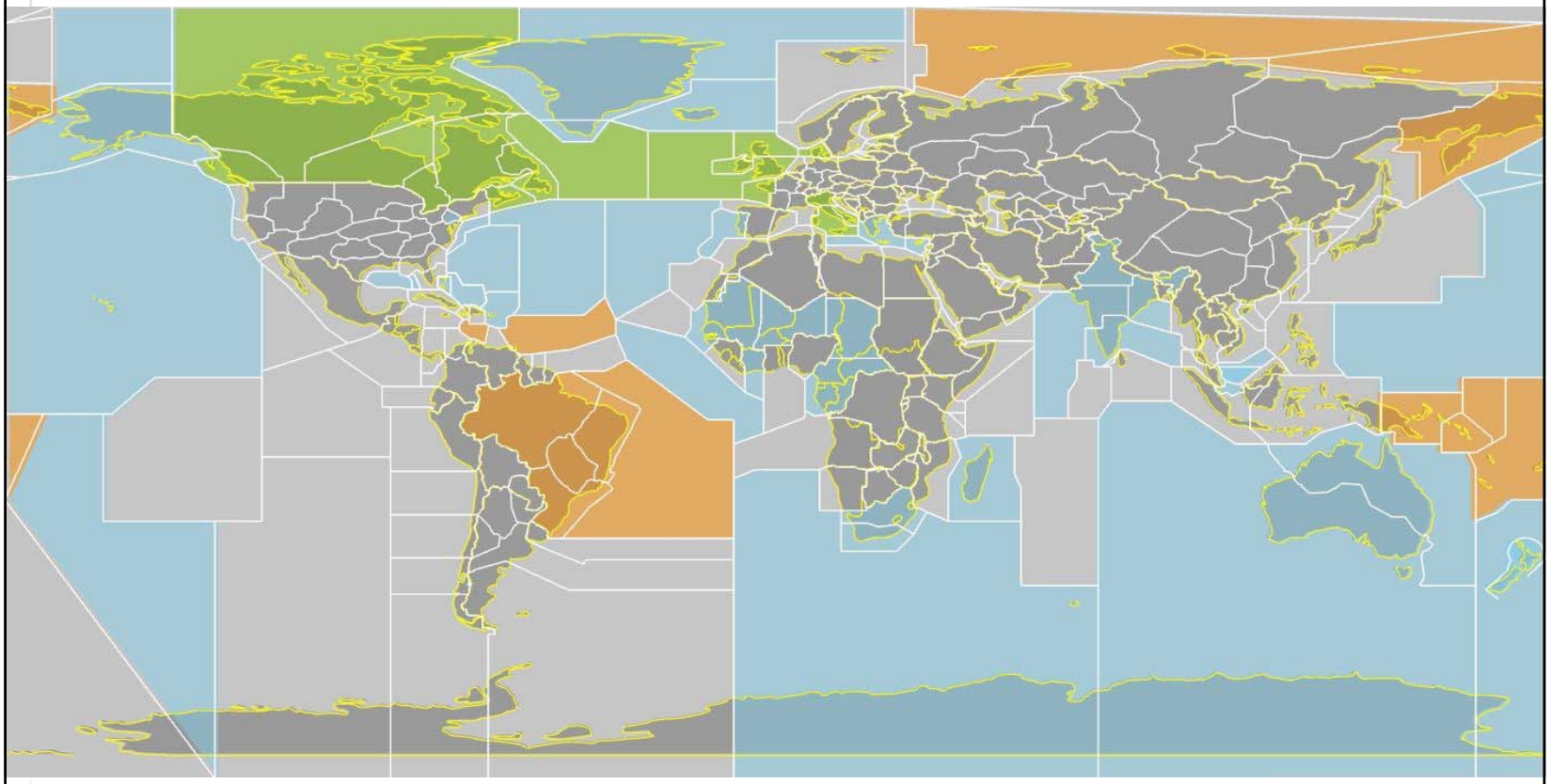
Significant support among major ANSPs



DSA
MOA to DSA
MOA Development
(Pre)-engaged

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Performance Update

Using space based ADS-B for surveillance

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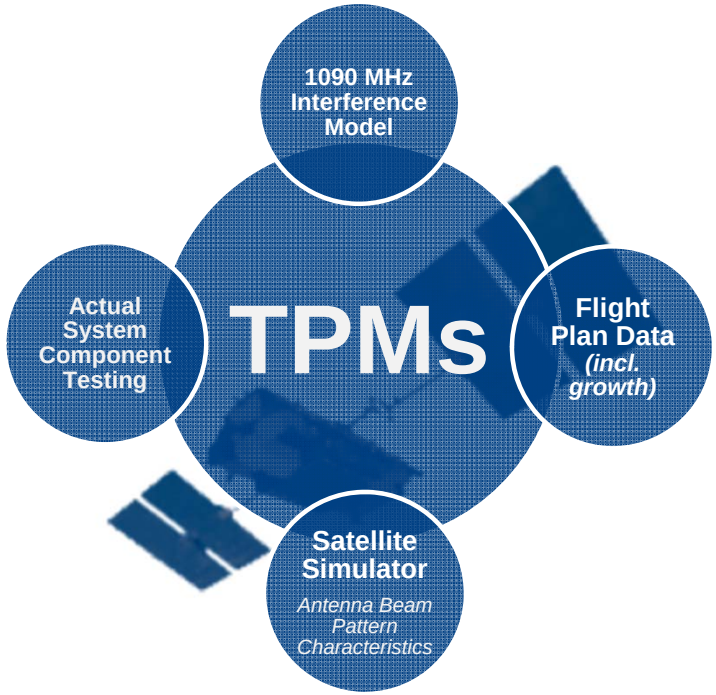
Aireon Performance Simulation

Aireon has created a global performance simulation tool called ASIM to calculate critical Technical Performance Metrics (TPM):

- **Update Interval**
- **Latency**
- **Availability**



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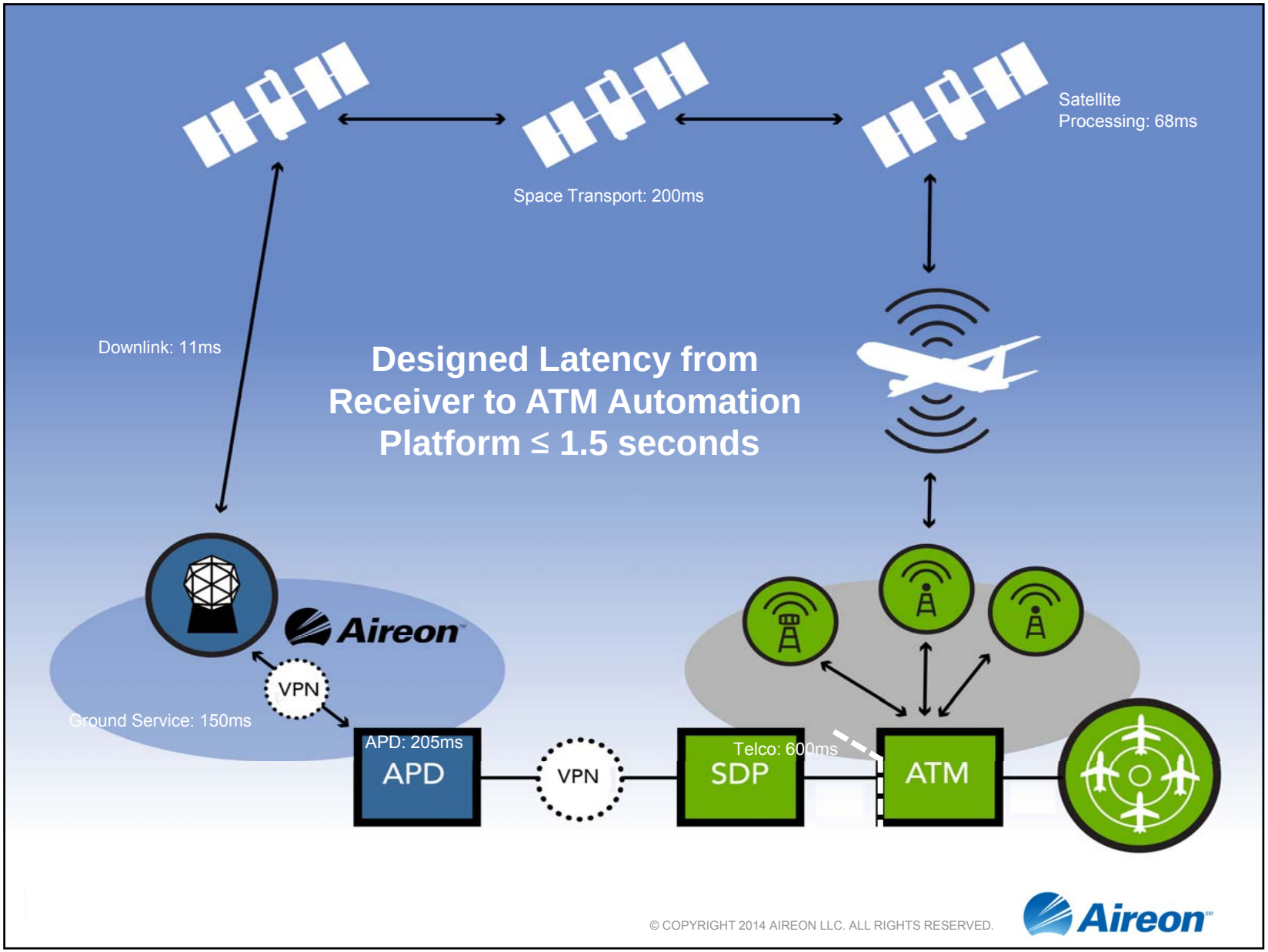
Satellite
Processing: 68ms
Space Transport: 200ms
Downlink: 11ms
Designed Latency from
Receiver to ATM Automation
Platform ≤ 1.5 seconds
Aireon
VPN
Ground Service: 150ms
APD: 205ms
APD
VPN
Telco: 600ms
SDP
ATM
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It's Just ADS-B!

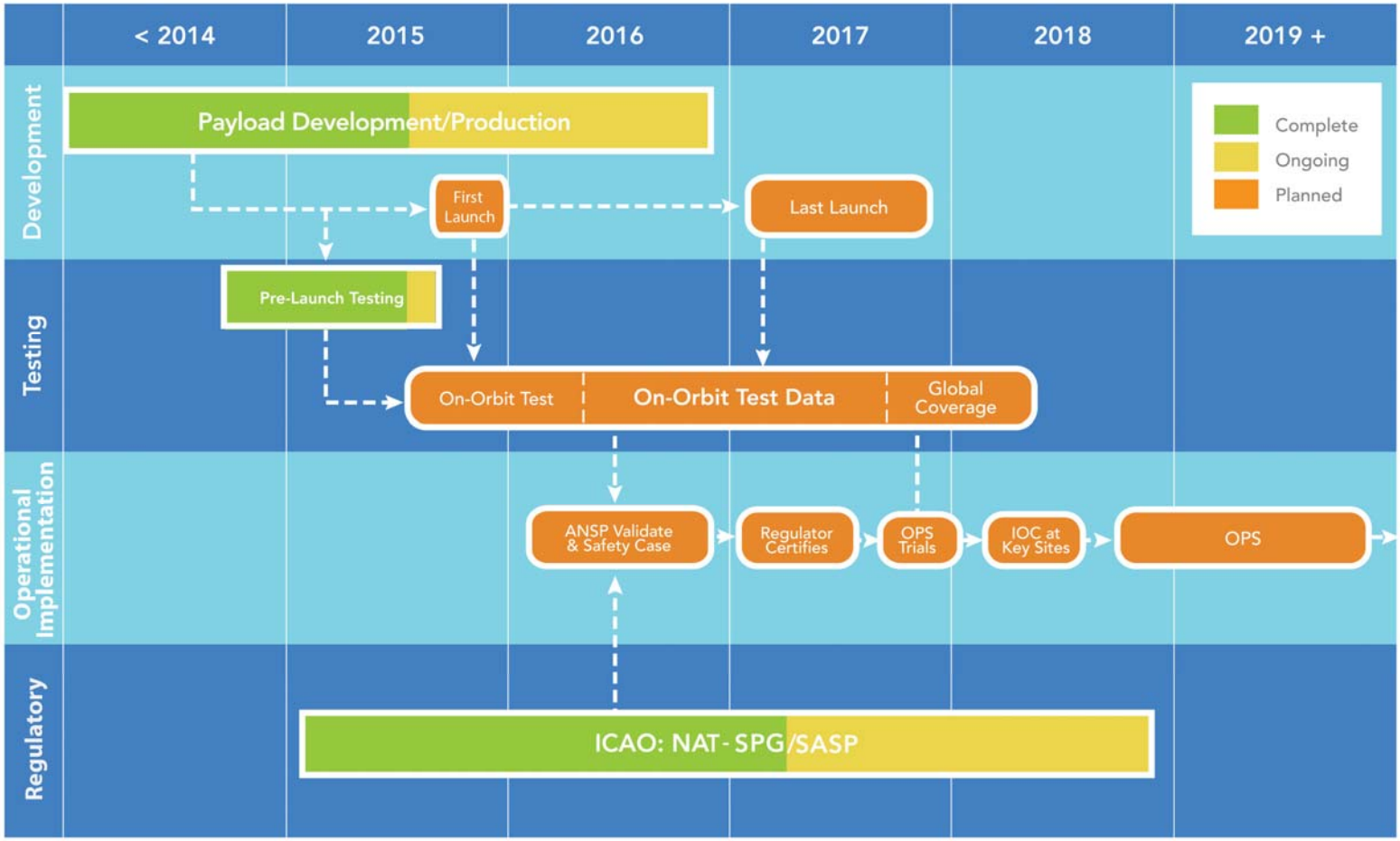
	ATS Surveillance Requirements (EUROCAE)	Aireon
Surveillance Data-link Requirements	Variable Per Region *(DO-260 Version 0, 1, 2)*	Accepts all 1090ES ADS-B (DO-260 Versions 0, 1, 2)
Aircraft Transmitter Classes Supported	A1 or Higher *(125 Watt minimum)*	A1 or Higher *(125 Watt minimum, with a top-mount antenna (TCAS)*
Data Format to ANSP	ASTERIX CAT021, CAT023, CAT025 and FAA CAT033 and CAT023	ASTERIX CAT021, CAT023, CAT025 and FAA CAT033 and CAT023
Capacity	Minimum 250 within a high density service volume	≥10,000 simultaneous aircraft globally
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

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

Roadmap to operational capability



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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.			

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Operational Use of Space Based ADS-B

Integration in Automation Platforms

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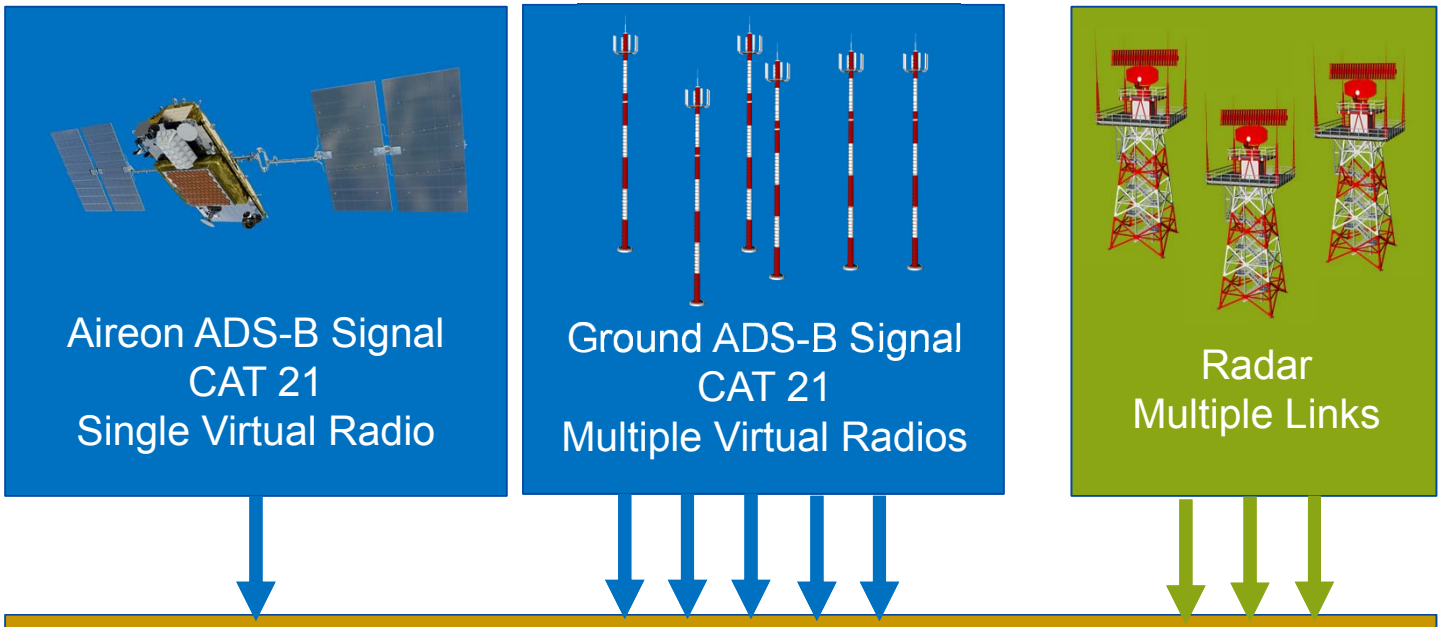
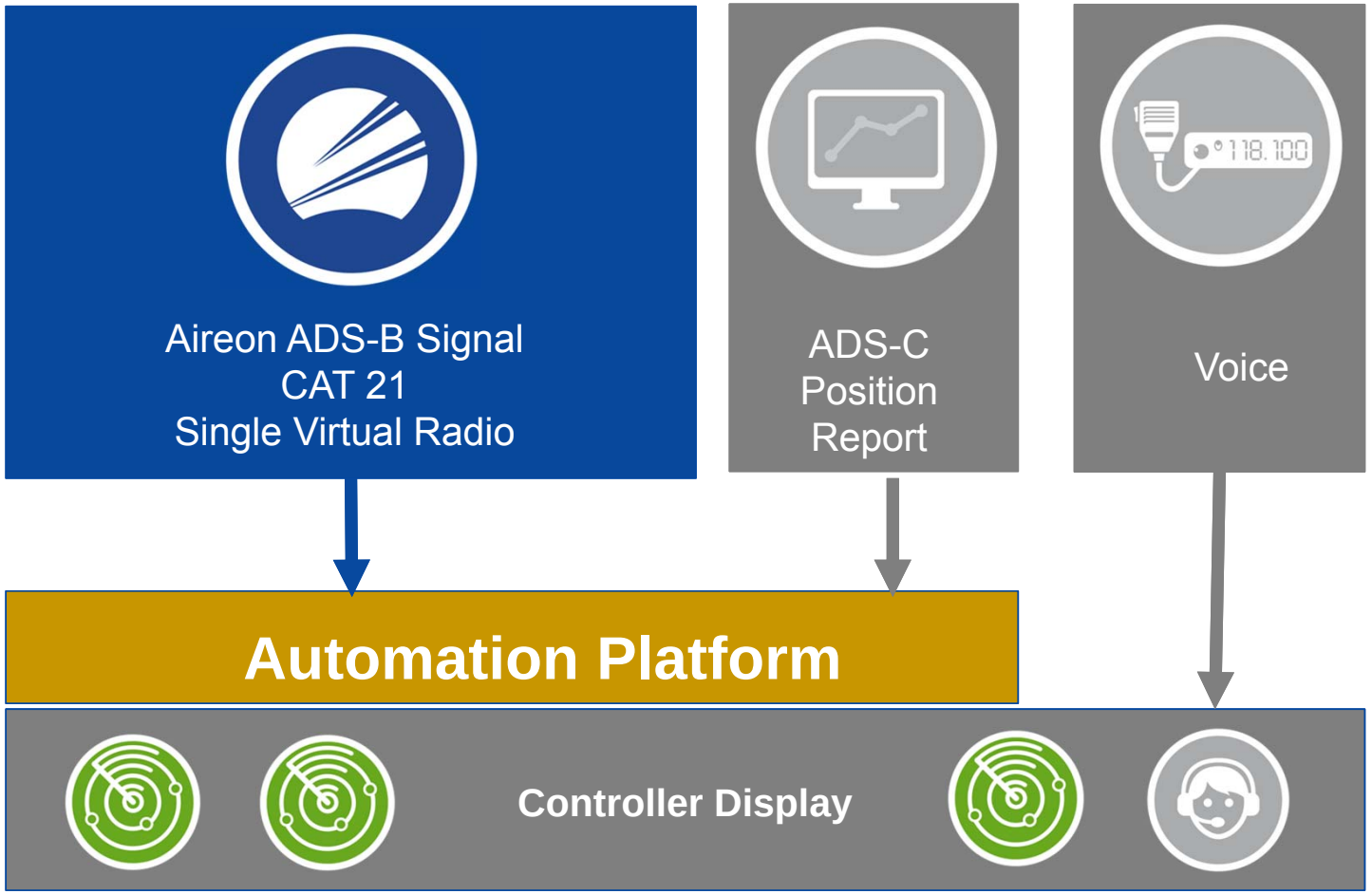
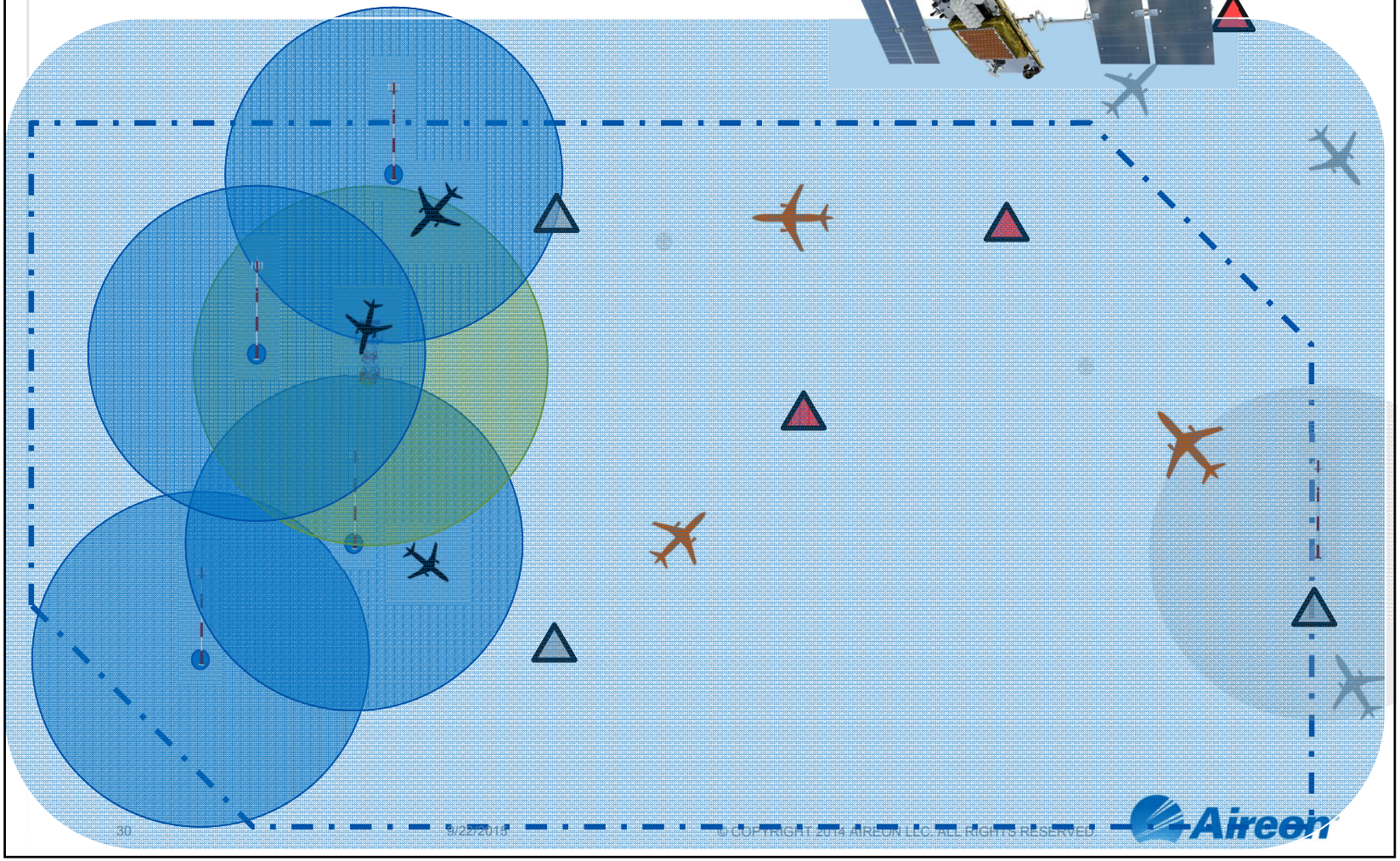
Augmenting Existing Surveillance



Single Source Oceanic / Remote



Increasing cross boundary safety



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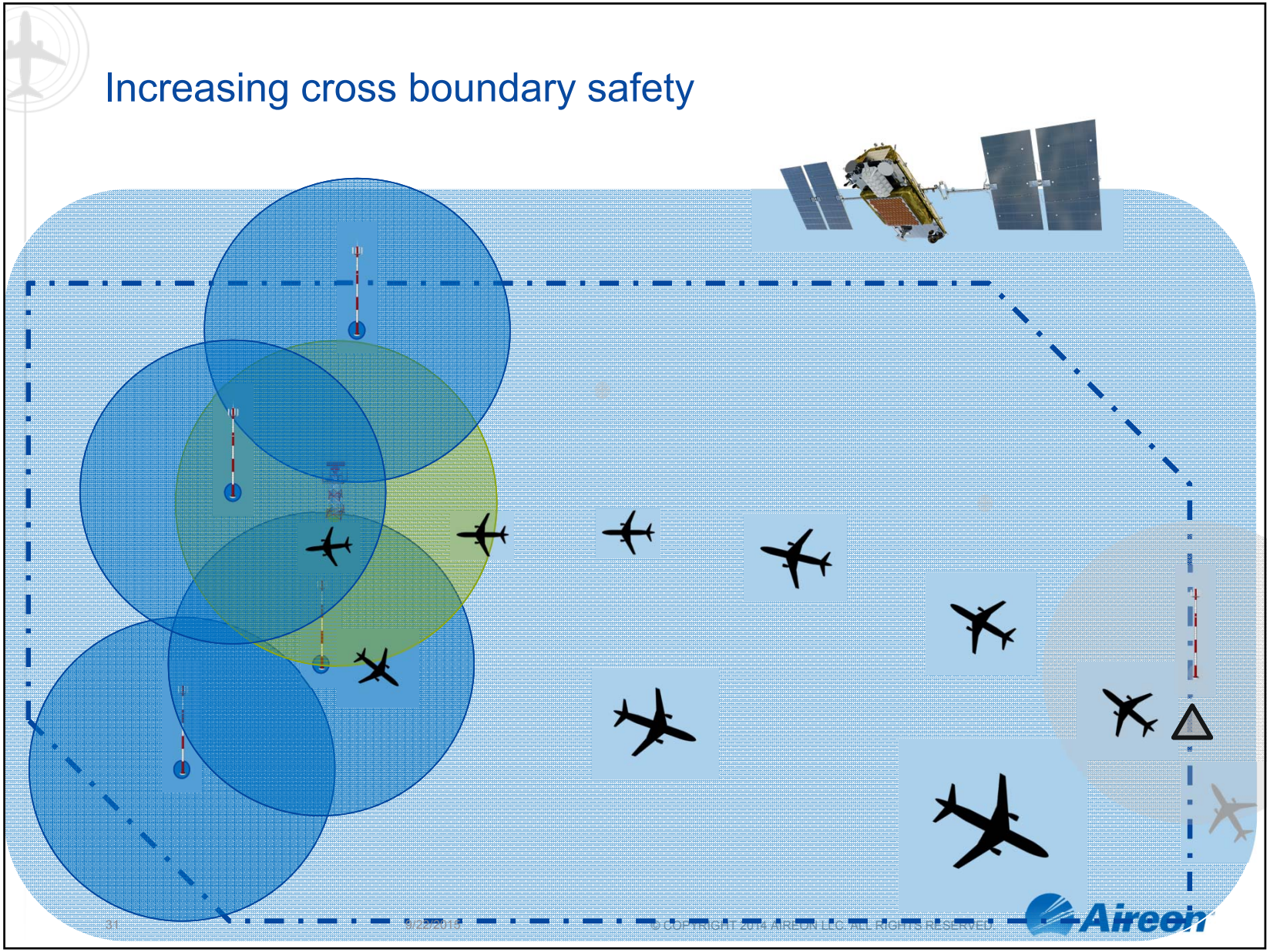
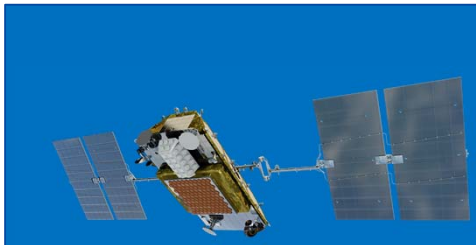
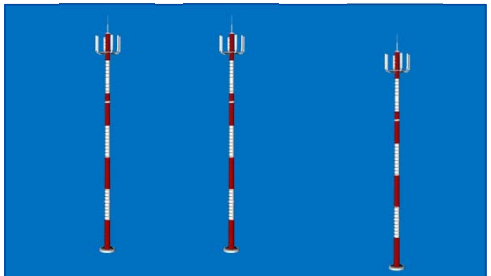


Allowing for infrastructure rationalization



Aireon ADS-B Signal
CAT 21
Single Virtual Radio



Ground ADS-B Signal
CAT 21
Multiple Virtual Radios

Radar
Multiple Links

Tracker / Fusing / Automation Platform


Controller Display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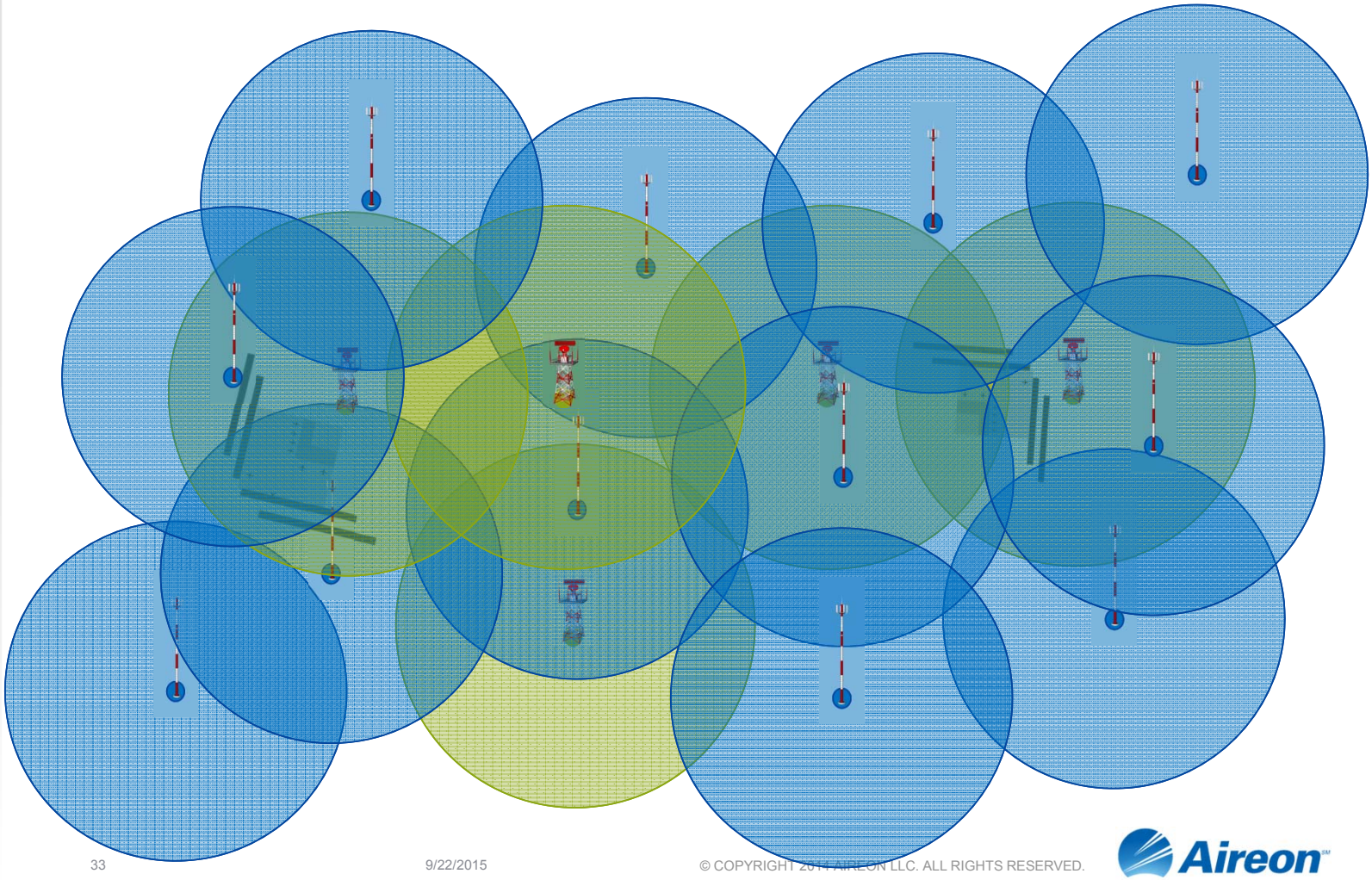
Rationalization multiple layers of existing surveillance

12

5



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Rationalization multiple layers of existing surveillance

12

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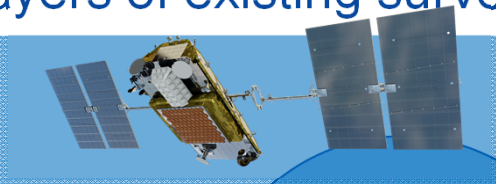
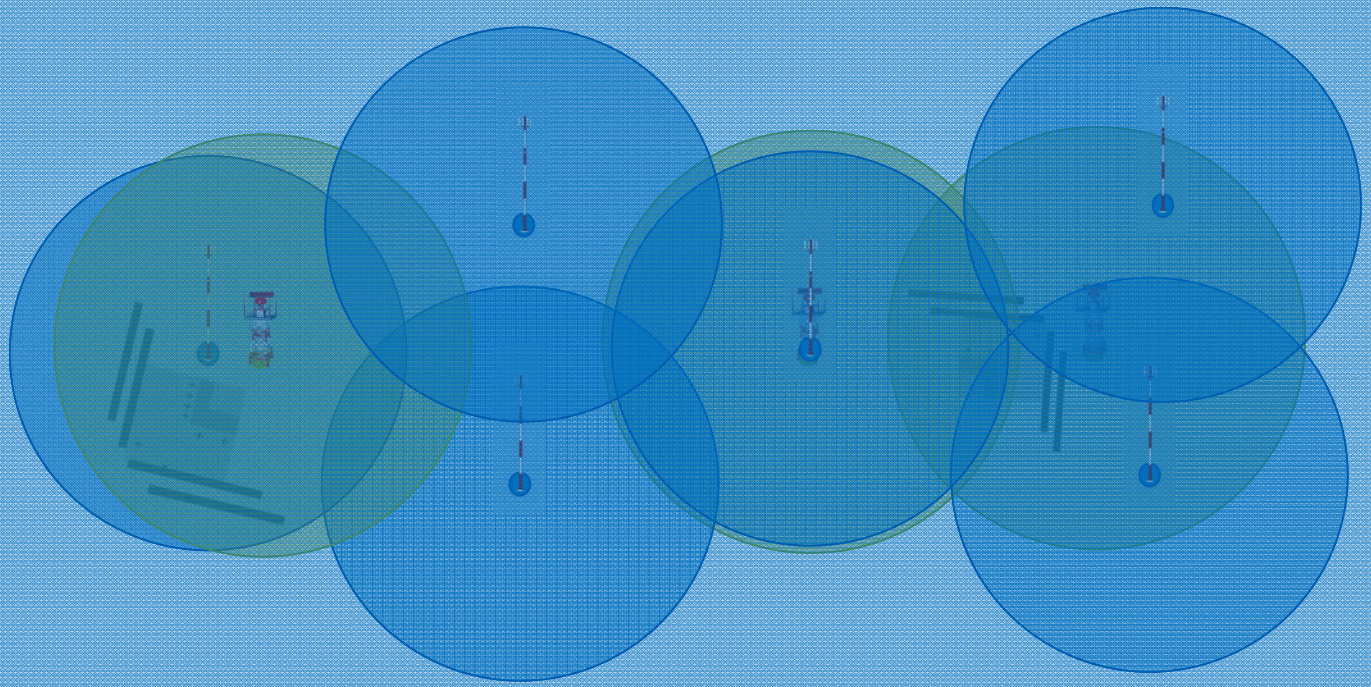


Aireon

Rationalization multiple layers of existing surveillance

6 3



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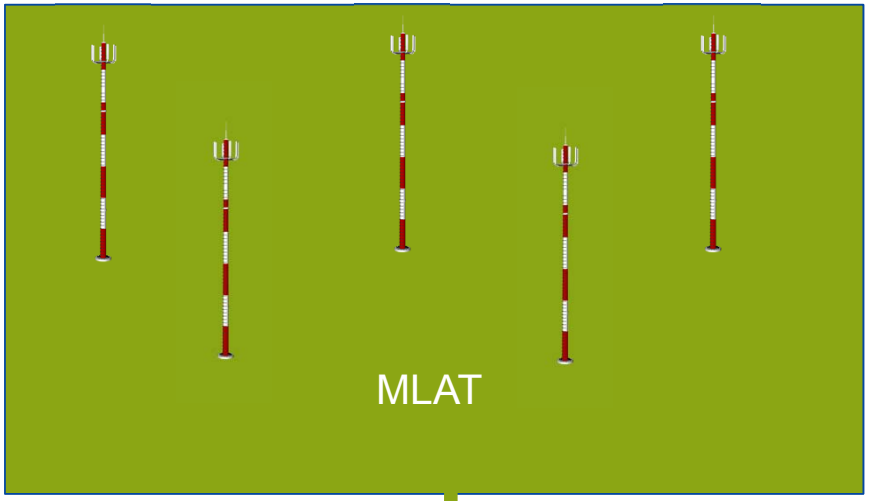

Tracker / Fusing / Automation Platform

Controller Display

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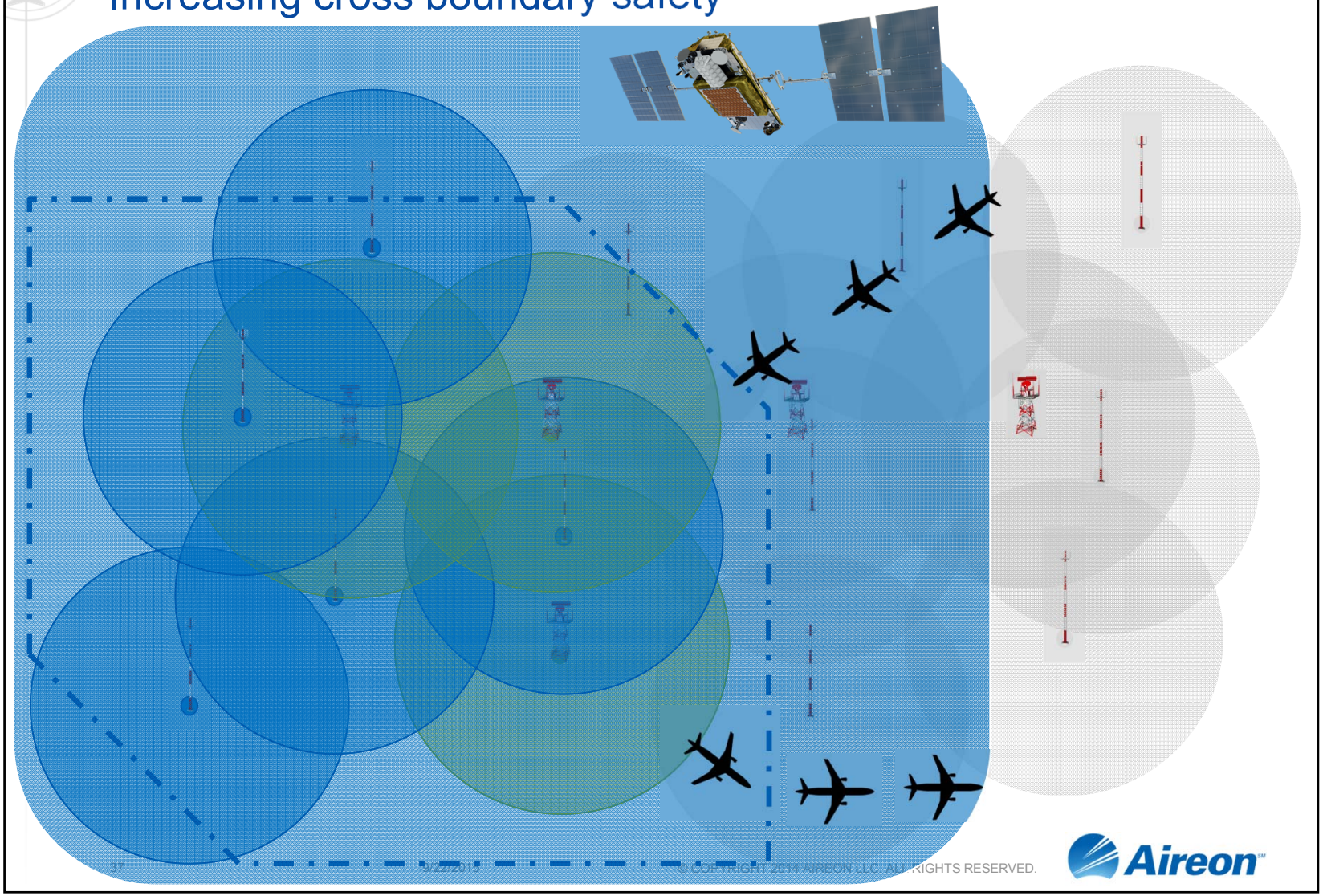
Increasing cross boundary safety



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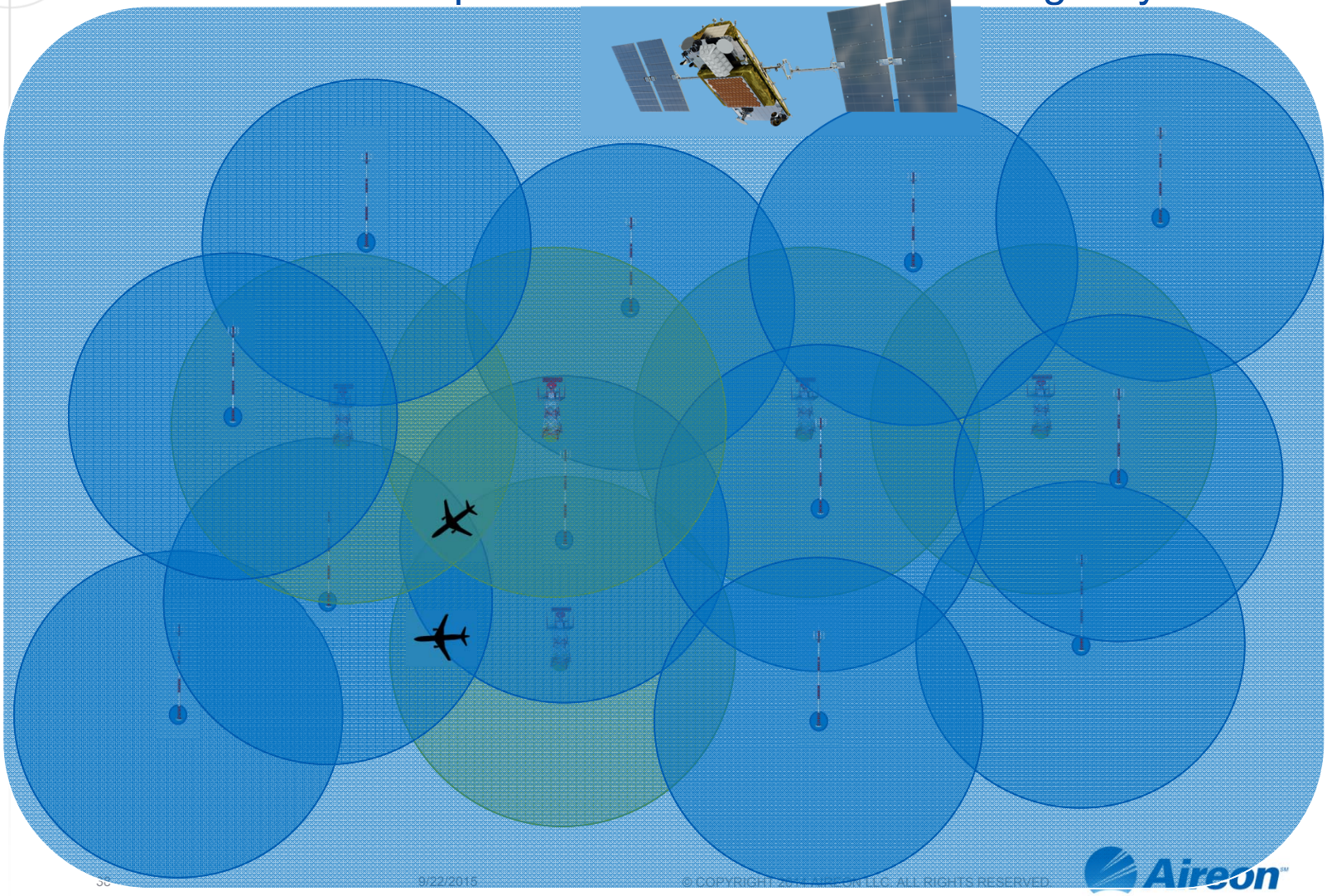
A Controller's Perspective: Sector / Center Contingency



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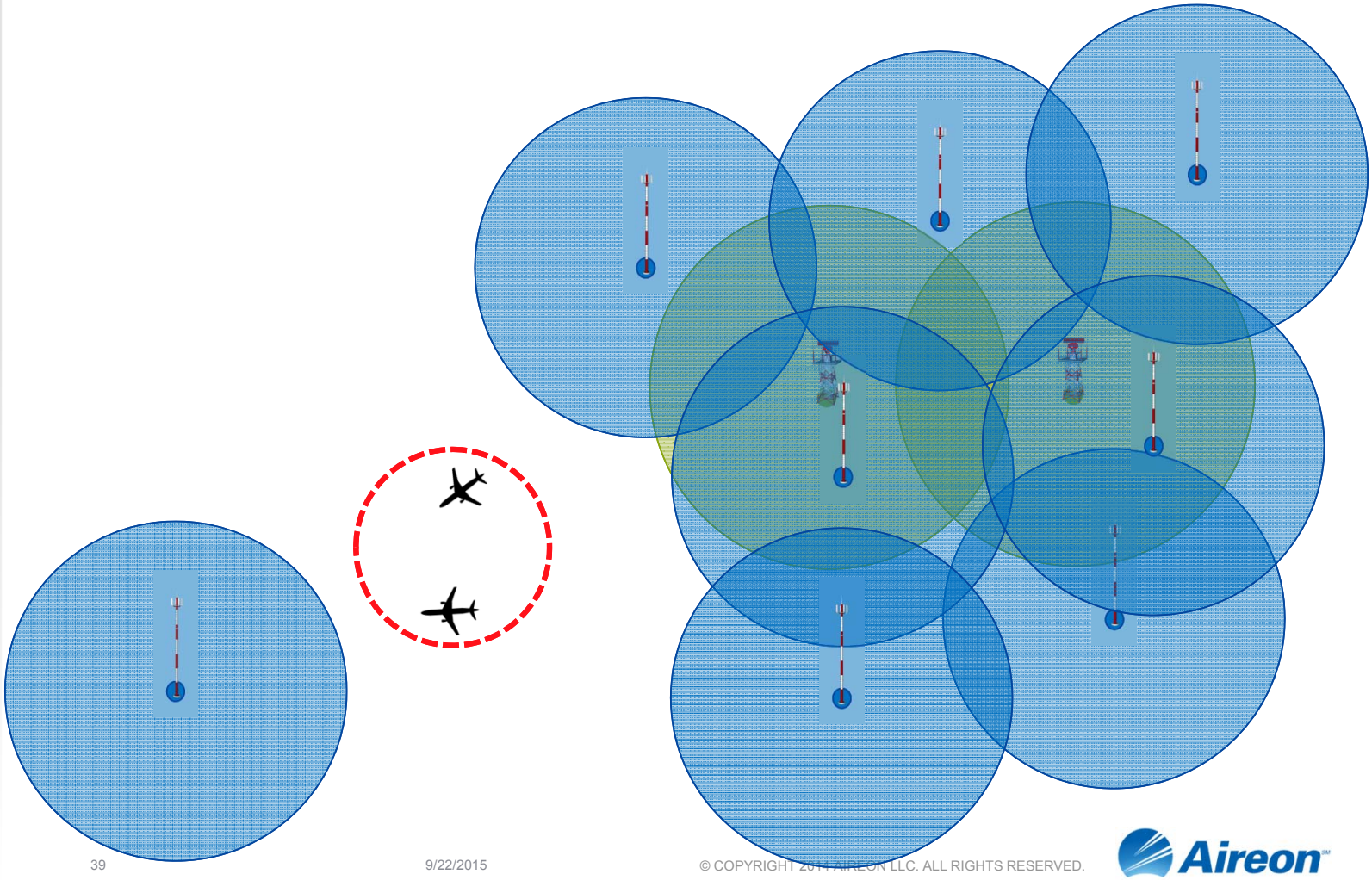

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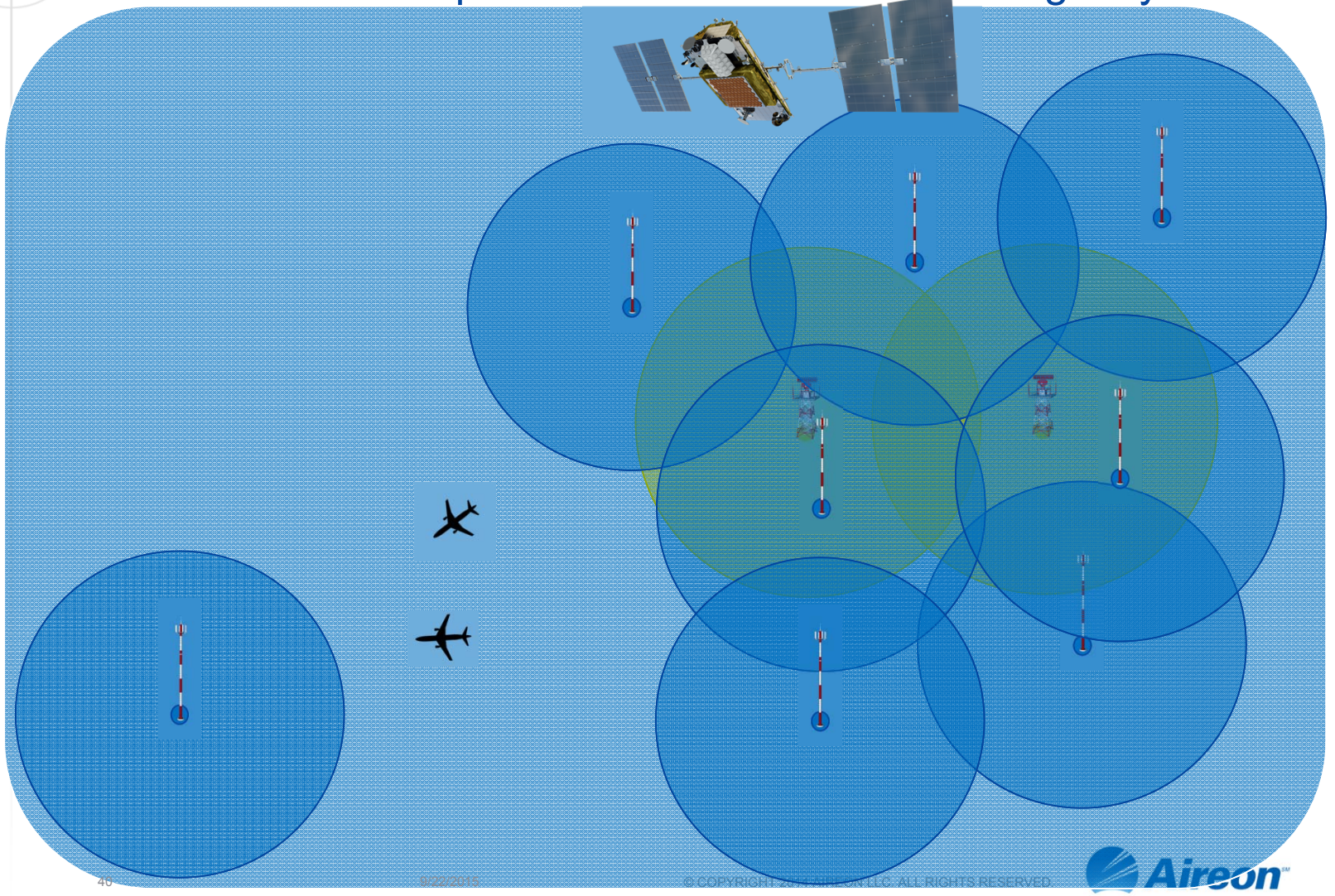
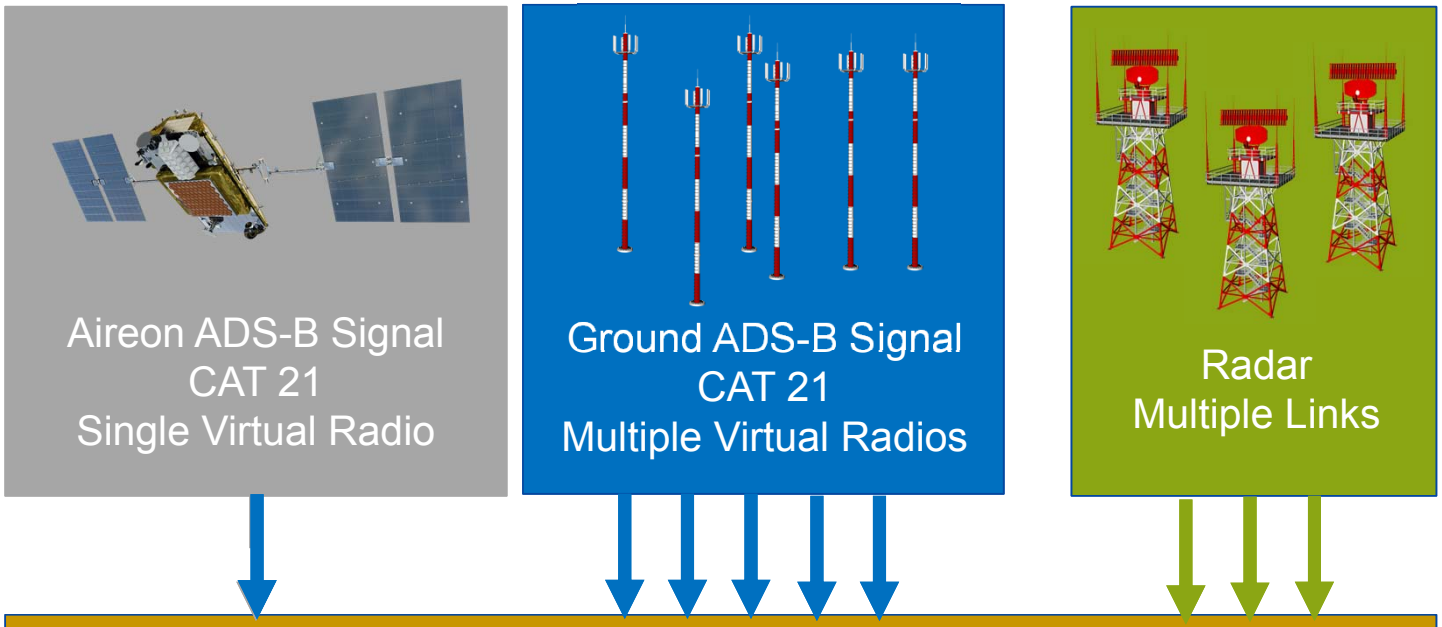


Independent Contingency Surveillance



Value Proposition

Benefits & Business Case

An Innovative Business Model

- Hosted payload model reduces costs
- By ANSPs for ANSPs and airlines
- Airline fuel benefits will significantly outweigh costs
- Safety gains through contingency and cross border data sharing
- No ground based infrastructure, reduced costs to ANSP's
- Terrestrial pricing competitive with ground based ADS-B alternative
- No significant project / lead time or upfront financing
  - It's just ADS-B
  - Pay per use
  - **Global coverage in 2018 in every FIR**

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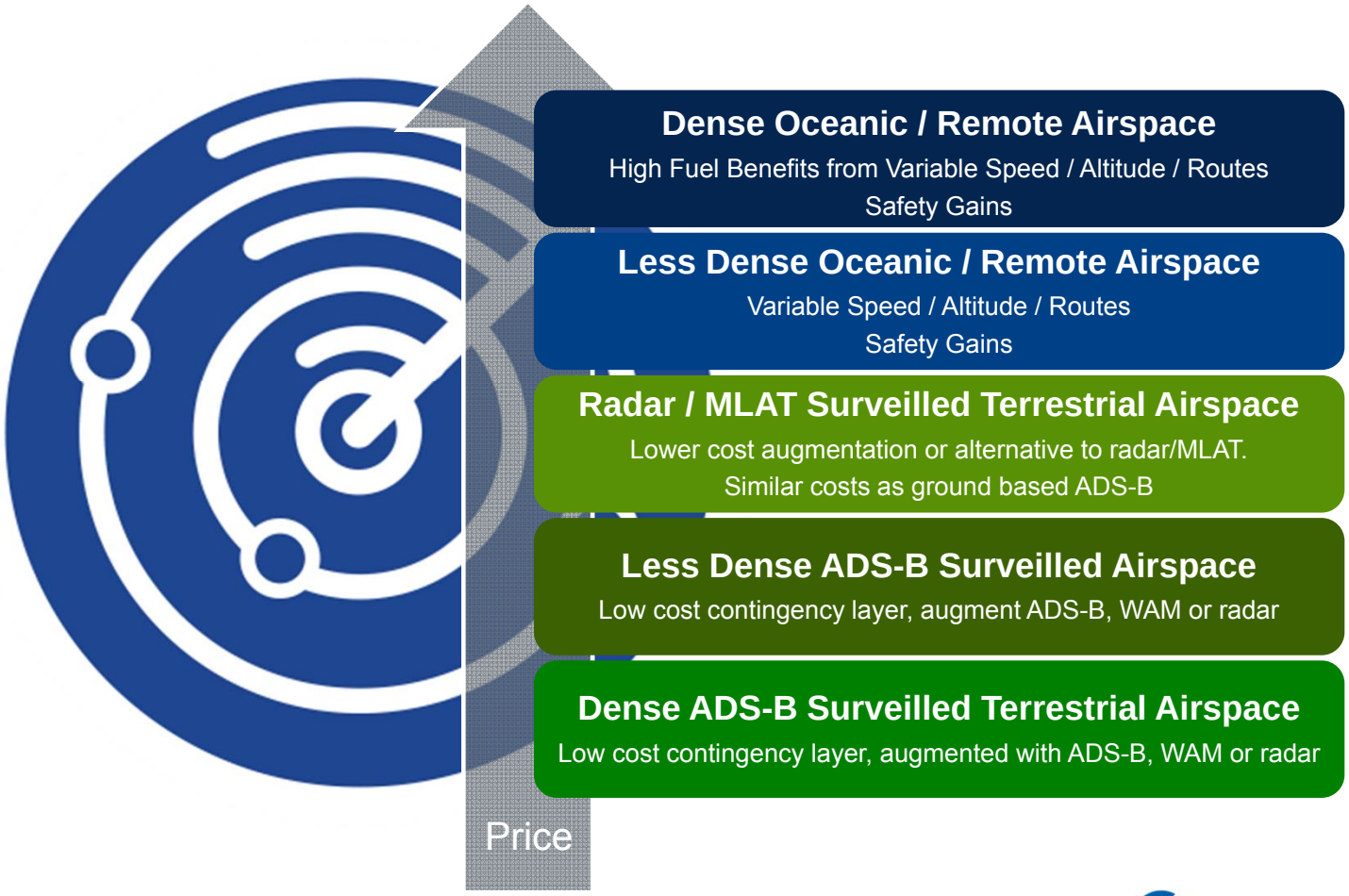
Tiered ANSP Surveillance Data Pricing



The Key Aireon Benefits

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Primary Airline Benefits

Reduced Fuel and Travel Time (Direct Operating Costs):

- Less restricted altitudes
- Variable speeds
- Less restricted routing
- Reduced metering delay / improved flow
- Minimized impact from oceanic weather disruptions
- Reduced disruption from legacy surveillance system outages
- Reduced excess contingency fuel loading

Reduced Airline Infrastructure Costs:

- Reduced complexity through harmonization of operating environment
- More predictable airline operations planning
- Reduced frequency of pilot position reports
- Avoided avionics investment

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Shared Benefits

Enhanced Safety and Security:

- 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
- Minimized impact from operational and weather disruptions
- Reduced disruption from legacy surveillance system outages
- Reduced complexity through harmonization of operating environment
- Enhanced military applications and situational awareness

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Primary ANSP Benefits

ANSP Cost Savings:

- 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
- Improved search and rescue services

Benefits to Society

Reduced Travel Time (Passenger Value of Time) and Reduced Environmental Impact :

- Less restricted altitudes
- Less restricted air speeds
- Less restricted routing
- Reduced metering delay / improved flow
- Minimized impact from operational and weather disruptions
- Reduced disruption from legacy surveillance system outages
- Reduced excess contingency fuel loading

Improved Passenger Comfort:

- Minimized impact from operational and weather disruptions
- Less restricted altitudes

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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

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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.

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SPACE BASED ADS-B
UNLOCK YOUR ATM POTENTIAL
The benefits of aircraft surveillance are well known but surveillance is limited to the line of sight of expensive ground installations. Imagine extending the safety and operational benefits of surveillance and the cost benefits of ADS-B to every Flight Information Region on the planet, without the investment costs and physical maintenance of ground infrastructure. That's exactly what Aireon global ADS-B surveillance can do.
Globally operational in 2018.
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Partners
Innovators
NAV CANADA
ENAV
IAA
NAVIAIR
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