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).
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
Today’s Oceanic / Remote Reality

- HF / CPDLC
- 60/80NM 10min
- Tracks / Random
- ADS-C Tracking
A common oceanic reality
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…
Current surveillance is limited to line of sight
Over 70% of the world remains un-surveilled
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
A short term reality
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

- 2 Solar Array Wings
- Aireon Hosted Payload
- Main Mission Antenna L-band
- Deployed “Wingspan” 9.4m
Significant Progress in Production
Global Developments

ANSP engagement in space based ADS-B
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
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*
Aireon Performance Simulation

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

- Update Interval
- Latency
- Availability
Designed Latency from Receiver to ATM Automation Platform ≤ 1.5 seconds

- Space Transport: 200ms
- Satellite Processing: 68ms
- Downlink: 11ms
- Ground Service: 150ms
- APD: 205ms
- Telco: 600ms
It's Just ADS-B!

<table>
<thead>
<tr>
<th>Surveillance Data-link Requirements</th>
<th>Variable Per Region (DO-260 Version 0, 1, 2)</th>
<th>Accepts all 1090ES ADS-B (DO-260 Versions 0, 1, 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft Transmitter Classes Supported</td>
<td>A1 or Higher (125 Watt minimum)</td>
<td>A1 or Higher (125 Watt minimum, with a top-mount antenna (TCAS))</td>
</tr>
<tr>
<td>Data Format to ANSP</td>
<td>ASTERIX CAT021, CAT023, CAT025 and FAA CAT033 and CAT023</td>
<td>ASTERIX CAT021, CAT023, CAT025 and FAA CAT033 and CAT023</td>
</tr>
<tr>
<td>Capacity</td>
<td>Minimum 250 within a high density service volume</td>
<td>≥10,000 simultaneous aircraft globally</td>
</tr>
<tr>
<td>System Coverage</td>
<td>Enroute Service Volume (200 NM)</td>
<td>Continuous Global Coverage</td>
</tr>
<tr>
<td>Availability</td>
<td>≥ 99.9%</td>
<td>≥ 99.9%</td>
</tr>
<tr>
<td>Latency</td>
<td>≤ 1.5s to the ATM Automation Platform</td>
<td>≤ 1.5s to the ATM Automation Platform</td>
</tr>
<tr>
<td>Update Interval</td>
<td>≤ 8s at 95%</td>
<td>Simulation and testing shows that targets will be delivered at an UI of ≤ 8s* at 95%</td>
</tr>
</tbody>
</table>

* ASIM Simulation & Component Testing
# ATM Performance

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

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

Integration in Automation Platforms
Augmenting Existing Surveillance

- 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
Single Source Oceanic / Remote

Aireon ADS-B Signal
CAT 21
Single Virtual Radio

Automation Platform

Controller Display

ADS-C Position Report

Voice
Increasing cross boundary safety
Increasing cross boundary safety
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
Rationalization multiple layers of existing surveillance
Rationalization multiple layers of existing surveillance
Rationalization multiple layers of existing surveillance
Allowing for infrastructure rationalization

Aireon ADS-B Signal
CAT 21
Single Virtual Radio

MLAT

Tracker / Fusing / Automation Platform

Controller Display
Increasing cross boundary safety
A Controller’s Perspective: Sector / Center Contingency
A Controller’s Perspective: Sector / Center Contingency
Independent Contingency Surveillance

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
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**
Tiered ANSP Surveillance Data Pricing

**Dense Oceanic / Remote Airspace**
High Fuel Benefits from Variable Speed / Altitude / Routes
Safety Gains

**Less Dense Oceanic / Remote Airspace**
Variable Speed / Altitude / Routes
Safety Gains

**Radar / MLAT Surveilled Terrestrial Airspace**
Lower cost augmentation or alternative to radar/MLAT.
Similar costs as ground based ADS-B

**Less Dense ADS-B Surveilled Airspace**
Low cost contingency layer, augment ADS-B, WAM or radar

**Dense ADS-B Surveilled Terrestrial Airspace**
Low cost contingency layer, augmented with ADS-B, WAM or radar
The Key Aireon Benefits

ANSP

Airlines

Society
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
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
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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<tr>
<th>Impacts</th>
<th>Beneficiary</th>
<th>Benefits</th>
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<td>- ANSP</td>
<td>Reduced ANSP Costs</td>
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<tr>
<td>Avoided legacy surveillance system expansion investment</td>
<td>- ANSP</td>
<td>Enhanced Safety &amp; Security</td>
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<tr>
<td>Avoided signal duplication and associated telecom costs</td>
<td>- Airline</td>
<td>Reduced Fuel and Travel Time (ADOC/PVT)</td>
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<tr>
<td>Decreased infrastructure and signal costs through cross border contingency</td>
<td>- Society</td>
<td>Reduced Environmental Impact (CO2)</td>
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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.

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

Visit www.aireon.com to discover the future of global aviation.
Transforming the way you see the sky