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
Iridium NEXT Satellite Configuration

2 Solar Array Wings

Aireon Hosted Payload

Main Mission Antenna L-band

Deployed "Wingspan" 9.4m
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

<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:</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></td>
<td></td>
<td>• 90 sec 95%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 180 sec Max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Update Interval</strong></td>
<td>30 – 60 minutes</td>
<td>~14 minutes</td>
<td>&lt; 8 – 12s</td>
<td>&lt; 8s</td>
<td>&lt; 8s*</td>
</tr>
<tr>
<td></td>
<td>(or at Compulsory Reporting points)</td>
<td></td>
<td></td>
<td></td>
<td></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</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Terrestrial En Route: 5NM</td>
</tr>
</tbody>
</table>
**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>
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</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>
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</tr>
<tr>
<td>Latency</td>
<td>≤ 1.5s to the ATM Automation Platform</td>
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<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
ASTERIX-Based ADS-B Data Feeds to ATM Platform

Aireon ADS-B Signal
CAT 21
Single Virtual Radio

Ground ADS-B Signal
CAT 21
Multiple Virtual Radios

Radar
Multiple Links

ADS-C Position
Report

Voice

Tracker / Fusion to Automation Platform

Controller Display
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 be 15 nm separation or less
• Significant efficiency and safety benefits
Optimized climb rates and routes
Maximized flight tracks and jet stream use
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

### Impacts
- 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

### Beneficiary
- ANSP
- Airline
- Society

### Benefits
- Reduced ANSP Costs
- Enhanced Safety & Security
- Reduced Fuel and Travel Time (ADOC/PVT)
- Reduced Environmental Impact (CO2)
- Improved Passenger Comfort
- Reduced Airline Infrastructure Costs
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 (PRI):**
    - 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 (CRD):**
    - 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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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.

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

<table>
<thead>
<tr>
<th></th>
<th>Example prop aircraft</th>
<th>Common turboprop in ASECNA airspace</th>
<th>Common jet in ASECNA domestic airspace</th>
<th>Common jet in ASECNA oceanic airspace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cessna C172</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cruise speed (knots)</td>
<td>122</td>
<td>360</td>
<td>444</td>
<td>493</td>
</tr>
<tr>
<td>Potential search area (sq km)</td>
<td>PIREP (30min)</td>
<td>12,763</td>
<td>111,129</td>
<td>169,039</td>
</tr>
<tr>
<td>ADS-C (15min)</td>
<td>3,191</td>
<td>27,782</td>
<td>42,260</td>
<td>52,102</td>
</tr>
<tr>
<td>SB ADS-B (8sec)</td>
<td>0.3</td>
<td>2.2</td>
<td>3.3</td>
<td>4.1</td>
</tr>
</tbody>
</table>