Surveillance and Broadcast Services

FAA ADS-B
Implementation Status

To: ICAO/FAA Workshop on ADS-B and Multilateration Implementation
By: Jim Linney, Program Manager - International
Date: September, 2011
ADS-B is a Vital Element of the Next Generation Air Transportation System

• Why Automatic Dependent Surveillance – Broadcast (ADS-B)
  – Lower cost, more accurate and more frequently updating surveillance infrastructure
  – Higher accuracy and update allows improved tracking and safety capabilities
  – Allows surveillance deployment where previously not possible, e.g. Gulf of Mexico, Alaska, and other areas
  – Enables of air traffic control procedures
  – Enables pilot control procedures and unprecedented pilot situational awareness
Background: Automatic Dependent Surveillance - Broadcast (ADS-B)

- **Automatic**
  - Periodically transmits information with no pilot or operator input required

- **Dependent**
  - Position and velocity vector are derived from the Global Positioning System (GPS)

- **Surveillance**
  - A method of determining position of aircraft, vehicles, or other asset

- **Broadcast**
  - Transmitted information available to anyone with the appropriate receiving equipment
ADS-B System Components
ADS-B Service Descriptions

**ADS-B**

- Non-Equipped
- UAT
- 1090ES
- UAT Provider
- FAA
- Surveillance of ADS-B equipped aircraft for Air Traffic Control and Aircraft Situational Awareness

**ADS-R**

- Non-Equipped
- UAT
- 1090ES
- Cross-Linking of ADS-B data for Aircraft Situational Awareness

**TIS-B**

- Non-Equipped
- UAT
- 1090ES
- Uplink of Surveillance Data of Non-ADS equipped aircraft for Aircraft Situational Awareness

**FIS-B**

- Non-Equipped
- UAT
- 1090ES
- Uplink of Weather and other Flight Information for UAT Equipped Aircraft
Aircraft System Approach

- Each STC/TC will include the entire ADS-B system

- Multiple interfaces may be approved with a single STC/TC
Generic FAA Automation Display of ADS-B

No circle = ADS-B equipped
Filled Circle = Not ADS-B equipped
Hollow circle = Equipped but not receiving / utilizing ADS-B for surveillance
ATC Separation/Advisory Services

<table>
<thead>
<tr>
<th>Service Delivery Points for ATC Separation Services</th>
<th>FY10</th>
<th>FY11</th>
<th>FY12</th>
<th>FY13</th>
<th>FY14</th>
<th>FY15</th>
<th>Operational</th>
</tr>
</thead>
<tbody>
<tr>
<td>En Route</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>15</td>
<td>3</td>
<td>0</td>
<td>2 of 24</td>
</tr>
<tr>
<td>Terminal</td>
<td>2</td>
<td>1</td>
<td>23</td>
<td>45</td>
<td>52</td>
<td>36</td>
<td>3 of 159</td>
</tr>
<tr>
<td>Surface (Advisory)</td>
<td>2</td>
<td>0</td>
<td>17</td>
<td>10</td>
<td>6</td>
<td>0</td>
<td>2 of 35</td>
</tr>
</tbody>
</table>

ATC Spacing Services

- Ground-Based Interval Mgmt - Spacing (GIM-S) (En Route only)

2011 - 2015

Pilot Applications

- Flight Deck Based Interval Mgmt - Spacing (FIM-S)
- In Trail Procedures (ITP)
- Traffic Situation Awareness with Alerts (TSAA)

Pilot Advisory Services

<table>
<thead>
<tr>
<th>Pilot Advisory Services</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Projected Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio Station Installations</td>
<td>11</td>
<td>78</td>
<td>207</td>
<td>58 of 114 Complete</td>
<td>160</td>
<td>160</td>
<td>730</td>
</tr>
<tr>
<td>Operational Radio Stations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>280</td>
</tr>
</tbody>
</table>

2011 - 2014

2011 - 2015

2020 Avionics Equipage

2015 ATC Sep/Adv Services

2017 ATC Spacing Services

Rule-Driven ADS-B Out Avionics Equipage (Quantity)

ADS-B Out/In Avionics Equipage (Quantity)

2010 - 2014

2015

Operational En Route

Operational Terminal

Operational Surface (Advisory)
FAA Acquisition Completed
ITT Awarded Contract for ADS-B Ground Infrastructure - August 30, 2007

• Cost effective and exceptional technical solution
  – Eighteen Year Contract valued at $1.8B

• Base contract for Segment One
  – 3-year period of performance, completed on September 23, 2010
  – Involves design, development and ‘Key Site’ Testing with significant Essential Services deployment
  – Approximately 300 ADS-B ground stations

• Segment Two began on October 1st
  – Segment Two implementation will complete national ground infrastructure by year end 2013, ~ 800 sites
  – After deployment, ITT will operate and maintain the ADS-B System through 2025
The Architectural Solution

Radio Station Segment

Radio Station

Radio Station Layout Provides RF Coverage Over a Set of Service Volumes

Network Segment (MPLS VPN)

Network Ops Center

Network Ops Center/ Ops Control Node

Control Segment

ESA Control Station
Data Center

WSA Control Station
Data Center

CSA Control Station
Data Center

Regional CS

Network Segment (MPLS VPN)

ADS-B Reports
Service Status Reports

ADS-B Reports
Service Status Reports
TIS-B/FIS-B Reports

FAA ATC Automation SDPs

FAA Service Monitor

FAA TIS-B Data SDP

Legend:

Radio Network Control FAA Weather

Surveillance and Broadcast Services
September, 2011

Federal Aviation Administration
The FAA’s ADS-B Architecture Has Networked Enabled NAS Surveillance

• The ADS-B Ground Infrastructure architecture routes all NAS surveillance to central control stations
  – ADS-B data is brought to control stations for target validation, duplicate removal, geographic filtering
  – Radar and surface surveillance data is brought to control stations for creation of the Traffic Information Service-Broadcast (TIS-B) service

• ADS-B data is put on the network as multicast protocol groups – any NAS facility or trusted user connected to the network requiring a data set need only subscribe to the multicast protocol group for the desired data set – great ease in distributing data

• Radar and surface surveillance data can be treated in the same way
Taking Commercial Advantage of Air Traffic Surveillance Data

• ITT has developed a Value Added Services Infrastructure to enable commercialization

• Network architecture allows commercialization of data - fully isolated from the operational network

• Provides:
  – Streaming of data - geographically or otherwise filtered / real-time or delayed
  – Archiving and retrieval of data for historical analysis
  – Web based tool for data visualization
  – Fleet tracking
  – Facilities for hosting value added applications, e.g. over-flight/airport billing
A Data Utility Has Been Created for external users

• Fully isolated from the operational network
• Provides:
  – Streaming of data - geographically or otherwise filtered/ real-time or delayed
  – Archiving and retrieval of data for historical analysis
  – Web based tool for data visualization
  – Fleet tracking
  – Facilities for hosting value added applications, e.g. over-flight/airport billing
Value Added Services Architecture

Each Control Station
- SBSS System
- Control Station Listener

VAS SDP
- Central Listener

Each En Route SDP
- SAFA
- SAFA Listener

VAS Facility
- VAS NOC
- Flight Enhancer
- NAS Data Processor
- Database
- Gateway
- Authentication Server
- Proxy Server
- Web Server
- Interior Firewall
- Exterior Firewall
- DMZ

VAS Servers
- Central Receiver

Customer
- ITT-AES
- Billing
- 3D Display Applet
- Customer Premise Applications
- Network
Critical Services Service Volume Roll-Out

Key Sites

Louisville 10/2009 ✓
- CARTS

Gulf of Mexico 12/2009 ✓
- HOST/ERAM

Philadelphia 03/2010 ✓
- STARS

Juneau 04/2010 ✓
- MEARTS

ISD 09/2010 ✓
Rulemaking Overview

- On May 27, 2010, the FAA published the Final Rule for ADS-B Out equipage
  - Mandates performance requirements for ADS-B avionics that will be required to fly in certain airspace
  - ADS-B Out transmits location to ADS-B ground stations and to other aircraft equipped to receive ADS-B broadcasts. The rule does not preclude non-GPS position sources
  - This rule does not mandate ADS-B In
    - A new Aviation Rulemaking Committee (ARC) was chartered in June 2010 to address ADS-B In strategy

- Establishes 2020 as the date by which all aircraft flying in the designated airspace must be equipped with ADS-B Out
  - Gives aircraft owners time to determine the most cost-effective solution for the mix of aircraft in their fleets.
  - FAA expects that most air-transport category aircraft will be equipped by 2015 (some stragglers waiting until the 2020 deadline)
Rule Airspace

- **ADS-B Performance is required in the following airspace:**
  - Class A, B, and C airspace
  - Class E airspace areas at or above 10,000 feet MSL over the 48 contiguous United States and the District of Columbia, excluding the airspace at and below 2,500 feet above the surface
  - Airspace within 30 nautical miles (NM) of certain identified airports that are among the nation’s busiest (based on annual passenger enplanements, annual airport operations count, and operational complexity) from the surface up to 10,000 feet MSL. These airports are listed in appendix D to part 91.
  - Above the ceiling and within the lateral boundaries of a Class B or Class C airspace area up to 10,000 feet mean sea level (MSL)
  - Class E airspace over the Gulf of Mexico at and above 3,000 feet MSL within 12 NM of the coastline of the United States
Required ADS-B Airspace (In Green)

Note: 1090MHz ES link is required above FL180
ADS-B Guidance Documents Completed

• The Technical Standard Orders (TSOs) for ADS-B avionics were approved in December 2009. The final rule requires:
  – Equipment designed for 1090ES (1090 MHz) must meet TSO-C166b or later versions of this order; and
  – Equipment designed for UAT (978 MHz) must meet TSO-C154c or later versions of this order

• Advisory Circulars
  – AC 20-165 provides installation guidance for ADS-B Out systems
  – DRAFT AC 90-ADSB
    • provides guidance and information on ADS-B Out in accordance with 14 CFR 91.225 and 91.227. No OPS approval is required for ADS-B “Out”.

Surveillance and Broadcast Services
September, 2011
# ADS-B Services and Applications

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(1) Merging and Spacing and Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS) are a part of the Enhanced Visual Approaches Application

(2) Also known as Airborne Situational Awareness and Alerting (ATSA AIRB) or Conflict Detection (CD)
SBS External Agreements: Model for Collaboration

- Alaska Airlines MOA
  January 2011
- Boeing MOA
  January 2011
- JetBlue MOA
  November 2010
- NATCA MOU
  September 2010
- SSA MOA
  December 2009
- AOPA MOA
  October 2009
- Auburn University MOA
  September 2009
- United MOA
  April 2009
- U.S. Airways/ACSS
  MOA
  January 2009
- NetJets MOU
  December 2008
- Honeywell
  October 2008
- Aviation Communication
  and Surveillance Systems
  October 2008
- Alaskan Aviation
  Community & State
  Representative MOA
  February 2007
- UPS MOA
  November 2006
- Colorado DOT
  September 2006
- HAI & Gulf of Mexico
  Helicopter/Platform
  Owners MOA
  May 2006
# ADS-B Services and Applications

## Services:

| ATC Separation Services (En Route, Terminal, Surface): ADS-B and ADS-R |
| Cockpit Services: Traffic / Flight Information Broadcast Services (TIS-B / FIS-B) |

## Situational Awareness Applications:

| Enhanced Visual Acquisition |
| Enhanced Visual Approaches (1) |
| Final Approach and Runway Occupancy Awareness |
| Airport Surface Situational Awareness |
| Traffic Situational Awareness with Alerts (2) |

## Advanced Applications:

| In Trail Procedures (ITP) |
| Interval Management (IM) |
| Surface Indications and Alerts (SURF-IA) |

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ADS-B In Aviation Rulemaking Committee

Member Affiliation

First meeting held July 1, 2010

FAA-requested Deliverables:

- **Task 1**: Endorsement (or not) of continued work on 3 ADS-B-In application standards development projects
  -> by Oct 2010

- **Task 2**: Final ARC ADS-B-In Strategy Recommendations
  -> by Sep 2011

- **Task 3**: Delivery of products from any activities that follow up ADS-B-In Strategy Recommendations
  -> by Jun 2012
Advisory Services - Airborne Applications

Enhanced Visual Acquisition

Enhanced Visual Approach

Final Approach and Runway Occupancy

Airport Surface Situational Awareness
Pilot Applications

Situational Awareness

In Trail Procedure

Indications and Alerts

Traffic SA with Alerts

Spacing

Interval Management

Indications and Alerts

SURF-IA
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Advisory Services System

Flight Information Services Source

Control Station

Existing Infrastructure

ADS-B Infrastructure

Airborne

Radars

Service Delivery Point

Greenfield

Cell on Wheels

Airborne

Flight Information Services Source

Control Station

Existing Infrastructure

ADS-B Infrastructure

Airborne

Flight Information Services Source

Control Station

Existing Infrastructure

ADS-B Infrastructure

Airborne

Federal Aviation Administration

Surveillance and Broadcast Services
September, 2011
New Free Broadcast Services Available

Cockpit Services

Traffic Information Services – Broadcast (TIS-B) is a service which provides ADS-B equipped aircraft with position reports from secondary surveillance radar on non-ADS-B equipped aircraft.

Flight Information Services – Broadcast (FIS-B) is a service which transmits graphical National Weather Service products, pilot reports, and special use airspace.

<table>
<thead>
<tr>
<th>Free Products</th>
<th>Update Interval</th>
<th>Transmission Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIRMET</td>
<td>As Available</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Convective SIGMET</td>
<td>As Available then at 15 minute intervals for 1 hour</td>
<td>5 minutes</td>
</tr>
<tr>
<td>METAR / SPECI</td>
<td>1 minute (where available) as available otherwise</td>
<td>5 minutes</td>
</tr>
<tr>
<td>NEXRAD Reflectivity (CONUS)</td>
<td>~ 5 minutes (10 minutes for clear air mode)</td>
<td>15 minutes</td>
</tr>
<tr>
<td>NEXRAD Reflectivity (Regional)</td>
<td>~ 5 minutes (10 minutes for clear air mode)</td>
<td>2.5 minutes</td>
</tr>
<tr>
<td>NOTAMs - D/FDC</td>
<td>As Available</td>
<td>10 minutes</td>
</tr>
<tr>
<td>PIREP</td>
<td>As Available</td>
<td>10 minutes</td>
</tr>
<tr>
<td>SIGMET</td>
<td>As Available, then at 15 minute intervals for 1 hour</td>
<td>5 minutes</td>
</tr>
<tr>
<td>SUA Status</td>
<td>As Available</td>
<td>10 minutes</td>
</tr>
<tr>
<td>TAF / AMEND</td>
<td>8 hours</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Temperature Aloft</td>
<td>12 hours</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Winds Aloft</td>
<td>12 hours</td>
<td>10 minutes</td>
</tr>
</tbody>
</table>
ADS-B Air to Air Traffic
Weather - Text
Traffic Information Service - Broadcast

TIS-B is a service which provides ADS-B equipped aircraft with position reports from secondary surveillance radar on non-ADS-B equipped aircraft.
ATC Separation Services System

Airborne
- Aircraft
- Routes

ADS-B Infrastructure
- Greenfield
- Cell on Wheels

ATC Facilities
- Control Station
- Service Delivery Point

Display

 Audrey M. Lias

Surveillance and Broadcast Services
September, 2011
Typical ADS-B Site

“Green Field”
ADS-B Off Shore
Oil Platform Installation (ADS-B and Automated Weather)
Transportable Installation
Gulf of Mexico: Low Altitude

- Increased ability to fly part 135 operations
- Fewer encounters with hazardous weather
- Improved search and rescue
Gulf of Mexico: High Altitude

- More efficient separation, increased capacity
- Increase availability of more fuel efficient altitudes and routings
- Accommodate weather deviations without impacting adjacent routes
- Eliminate lengthy delays in issuing clearances through a third party
Gulf of Mexico
ADS-B Surveillance
An Architecture Delivering Network Enabled Surveillance – Miami FIR
Delivering Terminal and En Route Surveillance Performance – Orlando
Delivering Airport Surface Surveillance Performance – Louisville
Implementation Status
August 1, 2011

- Year-End Plan for 2011 – 410 Radio Stations Reporting on the SBS Network (377 in CONUS; 33 AK)
- 358 Radio Stations Constructed (327 in CONUS; 31 in Alaska)
- 354 Radio Stations Reporting on the SBS Network (324 in CONUS; 30 in AK)
- 73 Radio Stations Under Construction or in Final Design (71 in CONUS; 2 in AK)
- 34 IOC Service Volumes comprised of 280 IOC Radio Stations

http://www.faa.gov/nextgen/flashmap/
Broadcast Services Coverage Map

http://www.faa.gov/nextgen/flashmap/
## Benefits Summary

<table>
<thead>
<tr>
<th>AIR TRANSPORT</th>
<th>GENERAL AVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reduction &amp; more efficient maneuvers in response to URET</td>
<td>• Fewer aircraft to aircraft conflicts</td>
</tr>
<tr>
<td>• More efficient metering based on improved TMA accuracy</td>
<td>• Fewer encounters with hazardous weather</td>
</tr>
<tr>
<td>• Increased safety on the surface by controllers</td>
<td>• More efficient routes in adverse weather</td>
</tr>
<tr>
<td>• More efficient spacing on approach in VMC</td>
<td>• Reduction in user costs to obtain weather info</td>
</tr>
<tr>
<td>• Continuation of Visual Approaches in marginal conditions</td>
<td>• Fewer aircraft to terrain conflicts</td>
</tr>
<tr>
<td>• Increased ability to allow continuous descent approaches</td>
<td>• Fewer aviation accidents in Alaska</td>
</tr>
<tr>
<td>• Increased safety on the surface by pilots</td>
<td>• Access to lower altitude routes in Alaska</td>
</tr>
<tr>
<td>• High altitude - Increased capacity in Gulf of Mexico</td>
<td>• Improved search and rescue services in Alaska</td>
</tr>
<tr>
<td>• High altitude - optimal routing in Gulf of Mexico</td>
<td>• Increase access to remote villages in Alaska</td>
</tr>
<tr>
<td>• Increased IFR capacity (Alaska and Gulf of Mexico)</td>
<td>• Increased medevac access to remote villages in Alaska</td>
</tr>
</tbody>
</table>
Summary

• FAA suggests the following:
  – ADS-B ground infrastructure is complex - systems integration and integrity is critical to achieve approval for safe separation
  – Assuming older standards of ADS-B for 5 Mile separation in non-radar airspace will limit benefits
  – Benefits possible with ADS-B in 3 Mile terminal operations, airport surface operations, and the numerous - highly beneficial ADS-B In applications which require high performance avionics and high integrity ground infrastructure (FAA has shared data through the Requirements Focus Groups and in RTCA and EUROCAE)
  – Use of FAA Final Rule and standards (DO-260B) which provide maximum benefits possible for applications (ADS-B In) as known today through via FAA safety analysis

• FAA is:
  – Committed to maximizing interoperability between air navigation service providers
  – Willing to enter into agreements for studies to assist (operational, scientific and economic)
  – On schedule and on budget for completing radios by 2013
  – Operating Essential Services which provide high value to General Aviation users
  – Operating Critical Services in 4 locations with more planned in 2011
  – Working with industry and stakeholders on ADS-B In applications to benefit early users
Coverage from Radio Stations

More than 300 radio stations are collecting data

Data from September 23, 2010
Jim Linney
Program Manager - International, Surveillance & Broadcast Services

(W) 817-222-5655
(W) 202-385-6284 - HQ support
(schedule, link to Program Office & data management)

Jim.Linney@faa.gov

www.adsb.gov
ITT can Perform Full Operations and Maintenance Monitoring

Network Operations Center

- 24 hours-7days a week remote maintenance monitoring

Integration and Operational Control Labs

- End-to-end upgrade testing and trouble-shooting
ITT Conducts System Integration and Test Activities to Meet Development and Customer Needs

Integration Test Environment

FAT Test Environment

SAT Test Environment

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Sensor Characteristics for Fusion

**ASR-9/Mode S**
- Update Rate: 4.61 seconds
- Range Accuracy: +/- 180 feet (68%)
- Azimuth Accuracy: +/-637 feet (68%) at 60NM
- Range: 60NM

**ARSR-4/ATCBH6**
- Update Rate: 12 seconds
- Range Accuracy: +/- 180 feet (68%)
- Azimuth Accuracy: +/- 2652 feet (68%) at 250NM
- Range: 250NM
Sensor Characteristics for Fusion

**ADS-B**
- Update Rate: once per second
- Accuracy: ±150 feet (68%)
- Range: Worldwide

**ADS-B via GPS Constellation**
Fusion of Different Sensors

Fusion of Multiple Surveillance Sources

- ADS-B via GPS Constellation
- ASR-9 Mode S
- Radar Range Error
- LRR Azimuth Error
- SRR Azimuth Error
- ADS-B Error

Surveillance and Broadcast Services
September, 2011

Federal Aviation Administration