ADS-B / FANS – A Boeing Perspective

ICAO Advanced Surveillance & Automated Systems Workshop
Panama City, Panama

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Technical Fellow
Boeing Commercial Airplanes
Avionics/ Air Traffic Management
Agenda

- Boeing Interest / Air Transportation System Roadmap
- FANS 1 Capabilities
- ADS-B Capabilities
  - Standards/Certification
  - Regional ADS-B Activities
  - Boeing Plan – ADS-B Out
  - Boeing Plan – ADS-B In
- Boeing Airspace Assessment Capabilities
- Conclusions
Boeing’s Eco-System Engagement

Deliver Airspace & ATM Solutions for our ANSP, Airline, and Airport Customers Globally

Safety, Efficiency, Capacity & Interoperability
Air Transportation System Roadmap

Key Capabilities

Airspace Operations

ATM Automation

Communication

Navigation

Surveillance

System Wide Information Management

Airplane Population

Growing Fleet of Highly Capable Aircraft

Airspace

Operations

Manual ATC Intervention, Control by Radar

Pre-Defined Performance Based Airspace

Dynamic Performance Based Airspace

2013

2018

2023

2028

2033

20,900

26% of today’s fleet will be operating 20 years from now.

2013 2018 2023 2028 2033

Growing Fleet of Highly Capable Aircraft

Growth (21,300)

Replacement (15,500)

Retained (5,400)

42,200

36,800 new

20,900

42,200

R10

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### Boeing FANS Equipage

#### Boeing Commercial Airplanes – Avionics / Air Traffic Management

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**Notes:**

1. FANS-1 and CMU LINK2000+ are mutually exclusive. Only one can be installed/enabled due to differences in HMI and host system.
2. FANS-2 (integrated) is FANS-1 + LINK2000+
3. FANS-3 (integrated) is FANS-1 + B2
4. Most 737 customers have selected non-integrated CMU LINK2000+.

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US/FAA Activities

- ADS-B Out mandate for Class A, B, C airspace and Class E airspace (≥10Kft MSL) effective 1 Jan 2020 (14 CFR 91.225/91.227)
  - Requires new 1090 MHz ADS-B standard (DO-260B) transponder
  - Requires GNSS position source NIC (Integrity) ≥ 7 (0.2nm) and NAC (Accuracy) ≥ 8 (0.05nm)
  - Exemption available for continued use of SA-On and SA-Aware receivers until 2025
  - FAA will require use of a service availability prediction tool (SAPT) to determine ability to dispatch for SA-On receivers after 2020 and SA-Aware receivers after 2025.
    - SAPT will take into account: Time and route of the planned flight, GPS constellation and satellite outage information, WAAS status, Operational status of SSRs (radar) and WAM along route, GPS Jamming and Interference (NOTAM), and the GNSS receiver capability (Selective Availability (SA), Barometric Aiding, and Mask Angle)
    - Use of radar backup in SAPT will no longer be available after 2025

- Current FAA ADS-B Projects/Trials
  - In Trail Procedure (ITP) operational evaluation (2012-2015)
    - Provide operational benefits in non-surveillance airspace
    - Validate operational performance and economic benefits
  - FAA Flight deck-based Interval Management – Spacing (FIM-S) trials
    - Flight test planned (2018)
    - Operational benefits validation planned (2020)
Regional Activities

- **Nav Canada providing preferential services to ADS-B Out equipped a/c over Hudson Bay between FL350 and FL400 inclusive (initiated Nov 2010)**
  - Current production transponder (started 2004) meets mandate (EASA AMC 20-24 certification basis)
  - Elementary/Enhanced/Extended Squitter (ELS/EHS/ES) surveillance capability with AFM Update
  - Service bulletins available for retrofit of in-production models
  - Starting 20 Oct 2011 non-equipped a/c must file for fixed route
  - Operational approval no longer required Nov 2014 (ENR 1.6.3) / Changed from “approved/white list” to “black list”

- **European Commission released EU 1028/2014 amending Implementing Regulation EU 1207/2011 changing ADS-B Out mandate to 8 June 2016 in production and 7 June 2020 for retrofit**
  - Initial mandate (EU 1207/2011) dates were 8 January 2015 in production and 7 December 2017 for retrofit
  - Requires transponder update to DO-260B standard
  - Final CS-ACNS/AMC released Dec 2013
  - No requirement for ground systems to use ADS-B Out
  - Comprehensive regulation review underway (extension to GA a/c, ANSP obligations, exemptions, cost/benefit)

- **Australia (CAO 20.18, Amend Order No. 3, dated Dec. 2009)**
  - Mandated ADS-B Out for upper airspace (≥FL290) in Dec 2013
  - 2 year exemption for Eastern Australia (radar coverage) and certain oceanic airspace (see details)
  - Current production transponder meets mandate (AMC 20-24)
  - SA-Aware GNSS receiver mandated in production starting 8 Dec 2016
  - Changed from “approved/white list” to “black list” in Aug 2012
Regional Activities (Cont)

- Hong Kong (Airworthiness Notice 102F, Issue 2, 28 Feb 2011)
  - Implement the use of Automatic Dependent Surveillance Broadcast (ADS-B) Out:
    - After 31 Dec 2013 for aircraft flying over PBN routes L642 or M771 between FL290 and FL410
    - After 31 Dec 2014 for aircraft flying within Hong Kong FIR between FL290 and FL410
  - Must meet DO-260 (Version 0) requirements of ICAO Annex 10 and ICAO Doc 9871 Chapter 2, or DO-260A (Version 1) requirements of ICAO Doc 9871 Chapter 3
  - Means of compliance per EASA AMC 20-24 or CASA CAO 20.18 Appendix XI
  - Current Boeing production equipage meets requirements

- Singapore (CAAS AIC 14, 28 Dec. 2010)
  - Implement the use of Automatic Dependent Surveillance Broadcast (ADS-B) Out after 12 Dec 2013 within certain parts of the Singapore FIR (≥FL290)
  - Must meet EASA AMC 20-24 or CASA CAO 20.18 Appendix XI, otherwise must fly at <FL290
  - Current Boeing production equipage meets requirements

- Other Asia Pacific Regulatory Agencies
  - Expected to follow ADS-B Avionics Requirements template per APANPIRG Conclusion 21/39
  - Template states: Must meet EASA AMC 20-24 or CASA CAO 20.18 Appendix XI
  - Vietnam (AIC A03/13, 20 Jun 2013)
  - Taipei FIR (AIC 02/12, 17 May 2012)
### ADS-B Out – Meeting the Mandates

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**United States**
- **2010**: Final ADS-B Out Rule
  - Transponder: Version 0
  - Standard: DO-260

**Europe**
- **2012**: Forward Fit Mandate Transponder
  - Revised Rule

**Australia**
- **2020**: European Retrofit Mandate Transponder

**Canada** (Hudson Bay)
- **2020**: European Retrofit Mandate Transponder

**Boeing Production**
- **Version 2** Transponder Program Pin Wiring Production Cutover
  - 737NG / 747-8 / 767 / 777
  - (Note: 787 ISS configured via a software program file)

**Boeing Retrofit**
- **Version 2** Transponder Production Cutover (all models)

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* 787-8/-9 & 747-8 aircraft have Version 1 transponder and SA-Aware GNSS receiver since Entry into Service (EIS)
## ADS-B Out – Version 2 ATC Transponders

### Planned Boeing in-production Version 2 (DO-260B) ATC transponder capability

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(1) Same unit as Buyer Furnished Equipment  
(2) Integrated Surveillance System (ISS) includes ATC Transponder, ADS-B Out, TCAS/ACAS, Terrain Awareness, and Weather Radar

### All units planned to be certified to TSO C112d/C166b
### Interfaces per ARINC 718A Supplement 4 (787 ARINC 768-2)
### Installation compliant with published regulatory requirements

- FAA AC 20-165A
- EASA Certification Specification/AMC (CS-ACNS)
  - Deviation Request CS-ACNS#1 resolves known issue with Continuity requirement of “Remote” (10E-05) which all aircraft cannot meet and allows installation compliant with 2x10E-4 per EU rule (EU1207/2011).

**DO-260B should be maintained as minimum ADS-B Out standard**
## Boeing in-production Multi-mode receiver (MMR) capability

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- **All units certified to TSO C129a**
- **Interfaces per ARINC 755-3**

(1) Same unit as Buyer Furnished Equipment
(2) Integrated Navigation Radio – SA Aware

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**To Maximize Dispatch Availability Boeing Recommends SA-Aware MMRs**
ADS-B-Out Operational Benefits Validation

Federal Aviation Administration

United

Boeing

Rockwell Collins
787 ADS-B In

- Provides suite of situational awareness applications
  - Airborne Traffic Display (AIRB)
  - Visual Separation on Approach (VSA)
  - In Trail Procedure (ITP)
- Offerable starting June 2013
  - 787 Catalog Rev W
- 1st install by end of 2015
787 CDTI & VSA

Selected Target:
- Altitude
- Flight ID
- Ground Speed

ADS-B In/ACAS Symbology

CDTI

Traffic List

VSA
(Visual Separation on Approach)

5 mile Range Ring
Flight Deck Considerations

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Forward fit of ADS-B In/CDTI targeted for forward field of view display systems
Boeing Airspace Assessment Capabilities

Greener Airport & Airspace Services

- On-Site Field and Operation Efficiency Studies
- Airport Capacity and Delay Assessment Studies
- Noise and Emissions Analysis
- Performance Based Navigation Tools and Services to perform TMA and Surface Movement Simulations and Analysis
- Closely-Spaced Parallel Runway Operations
- Established on RNP (RNPe)
- Safety Case Analysis
- Wake Vortex Mitigation Assessments & Studies
- Collaborative Decision Making Simulation Tools

Globally Interoperable Systems & Data Assessments - System-Wide Information Management & Development (SWIM)

- Stakeholder Interoperability, Efficiency and Capacity Assessment and Studies
- Integrated Data Management between AOC and ANSP and ANSP Simulation Services
- SWIM Compliance Roadmap Development Services
- Equipage Analysis to Enable Airborne Participation in Collaborative ATM

Optimum Capacity and Efficient Flights

- PBN – RNAV/RNP Route and Flight Procedure Design
- Airport and Airspace Modeling and Simulation & Analysis
- Airplane and UAV Trajectory Based Operations
- Weather Information Products and Services
- Oceanic Flow Coordination
- Air-Ground Systems Integration Analysis
- Equipage Analysis and Studies
  - FANS and ADS-B
- Navigation Services:
  - Collision Risk Analysis
  - Wake Encroachment
- Dual Angle Descent to Displaced Threshold

Efficient Flight Paths

- Advanced Concepts, Procedures and Safety Case Analysis
- RNAV/RNP Route Structure Design
- Wake Vortex Mitigation
- Optimized Departure and Descent Profile Studies
- Trajectory Based Operations Simulations and Assessments
- Wind Update and Direct Route Services
Conclusions

- Meeting production/retrofit mandates for ADS-B Out
- Implementing plan to upgrade from FANS-1 to FANS-2 to FANS-3
- Developing ADS-B In solutions which maximize value of equipage
- Coordinating with Air Navigation Service Providers (Latin America, Canada, Australia, Europe, US, others) to ensure common airborne requirements supporting global harmonization
- Engaging with airlines and industry partners on rulemaking around the world
- Continuing industry standards support
- Boeing capabilities can assist Latin America in ICAO ASBU compliance

Boeing is actively engaged in ADS-B and FANS development, key components for advanced surveillance
Questions