ADS-B - A Boeing Perspective

ICAO 15th Meeting of the ADS-B Study and Implementation Task Force (ADS-B SITF/15)

Bangkok, Thailand

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Boeing Commercial Airplanes
Avionics/ Air Traffic Management

Agenda

- Air Transportation System Roadmap
- ADS-B Out Status
- GNSS / GPS Status
- Production / Retrofit Capabilities
- 787 ADS-B In
- Boeing Airspace Assessment Capabilities

Boeing's Eco-System Engagement

Boeing Commercial Airplanes – Avionics / Air Traffic Management

Safety, Efficiency, Capacity & Interoperability

Air Transportation System Roadmap

Airplane Population

2013 | 2018 | 2023 | 2028 | 2033

20,900

Growing Fleet of Highly Capable Aircraft

Growth (21.300)

Replacement (15,500)

Retained (5,400)

42,200

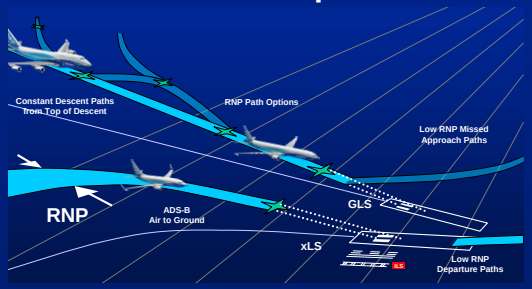
36,800 new

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

Airspace Operations

Manual ATC Intervention, Control by Radar

Pre-Defined Performance Based Airspace



Dynamic Performance Based Airspace

Key Capabilities

ATM Automation
Conflict Detection
Time-based Arrivals
Airspace Flow Program
CTOP
Surf Schedule
PDRR
IDAC
GIM-S
TFM Reroutes
TBM in Terminal
VCV
TBM w/Path
TFDM Datalink Taxi
Conflict Res.
4D Conflict Resolution
4D Negotiation
IM-S
DRNP Enroute
DRNP Terminal

Communication
Analog Voice
FANS-1
ACARS
ATN
Polar SATCOM
Oceanic RCP
FANS-2
Link 2000 (B1)
Continental RCP
Broadband IP
Future Subnetworks
FANS-3 (B2)
IPS
Dual SATCOM LRCS
PTT SATVOICE

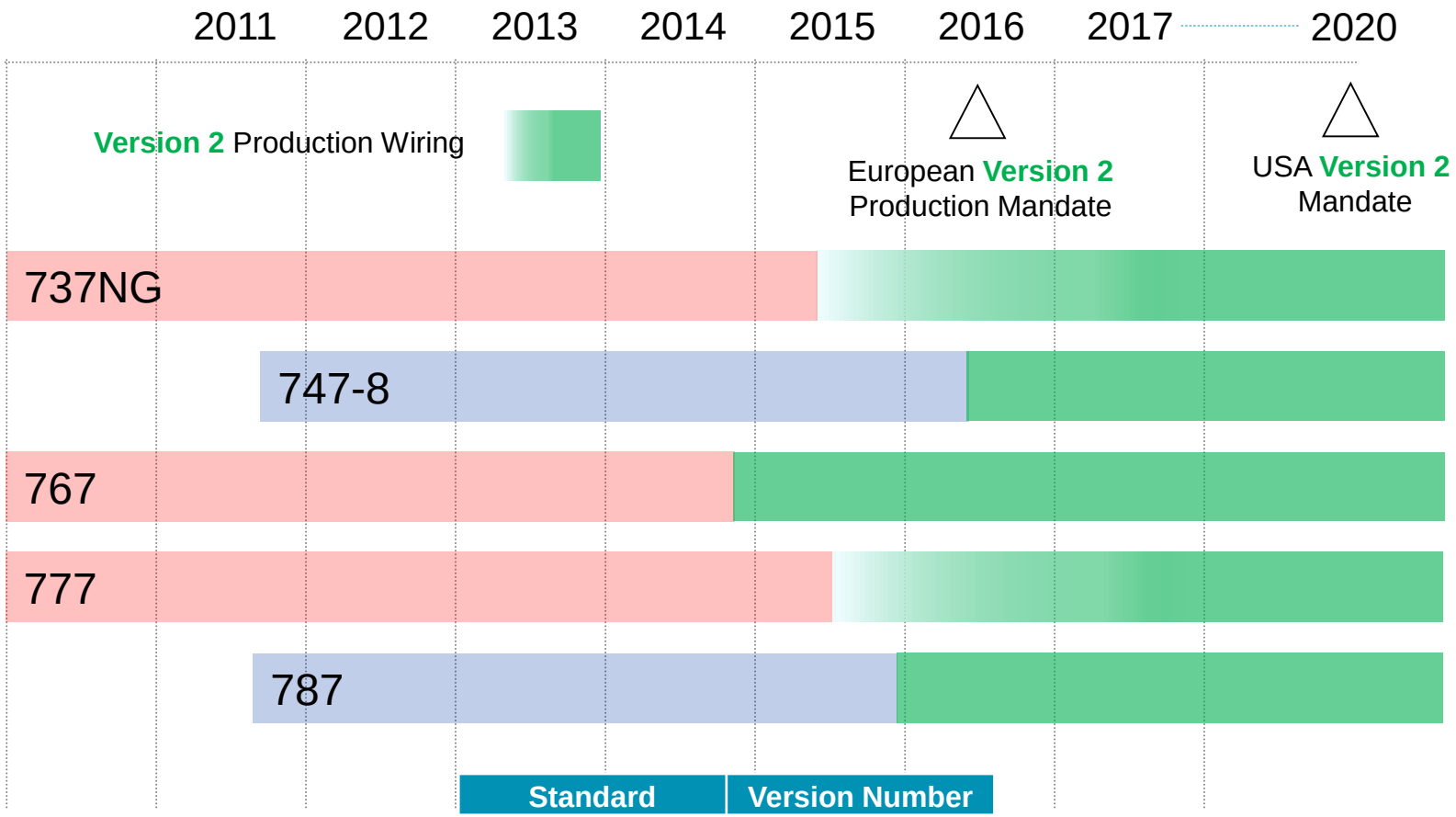
Navigation
RNP
RNP AR
Full Profile RTA
GLS CAT I
Airport Moving Map
GLS CAT III
Expanded Wind Field
Temp Comp
SBAS LPV
Multi Const GNSS
Global CAT I
Adv RTA
Graphical Taxi
GNSS Backup
DRNP

Surveillance
ADS-C
Radar
Wx Radar
Ext. Squitter
ADS-B DO260
ACAS 7.1
ADS-B Out DO260B
ADS-B In/CDTI
SURF SA
Distress Tracking
ACAS-X
SURF IA
Adv Interval Management
Adv ADS-C
ADS-B In w/CD&R

System Wide Information Management
OLDI
RADNET
AIDC
ETMS
FIXM
Aero/Met Info
Adv Inter-Facility Coord
Shared Trajectory & Surveillance Info

R10

ADS-B Out – Production Airplanes



Standard	Version Number
DO-260	0
DO-260A	1
DO-260B	2

ADS-B Out – Version 2 ATC Transponders

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

	737NG/MAX	747-8	767	777	787
Buyer Furnished Equipment (BFE)	ACSS (NXT 800) Honeywell (TRA 100B) RCI (TPR 901-205)		ACSS (NXT 800) Honeywell (TRA 100B) RCI (TPR 901-205)	ACSS (NXT 800) Honeywell (TRA 100B) RCI (TPR 901-205)	
Supplier Furnished Equipment (SFE)		RCI (1) (TPR 901-205)			RCI ISS 2100 (2)

(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

BFE – Equipment selected/provided by buyer
SFE - Equipment basic to airplane
RCI – Rockwell Collins Inc.

- **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

ADS-B Out Version 2 ATC Transponders Production Certification Schedule (by Model)

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	737NG		747-8	767		777		787
BFE	ACSS	April 2015 L/N 5389	N/A	ACSS	December 2014 L/N 1072	ACSS	May 2015 L/N 1309	N/A
	Honeywell	2Q 2017		Honeywell	No Customer	Honeywell	2Q 2017	
	RCI TPR 901	Nov 2015 L/N 5673		RCI TPR 901	No Customer	RCI TPR 901	Jan 2016 L/N 1365	
SFE	N/A		RCI TPR (1) May 2016 L/N 1531	N/A		N/A		RCI ISS 2100 (2) Dec 2015 L/N 369, 371 and on

(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

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Supplier	Model	Part No.
ACSS	NXT 800	9008000-10000
Honeywell	TRA 100B	066-01212-0301
Rockwell Collins	TPR 901-205	822-1338-205
Rockwell Collins	ISS 2100	822-2120-101 or -102*

*** Supports ADS-B In**

Boeing Service Bulletins available approx. 6 months after production certification

787 ADS-B Software Update / Service Bulletin

- **In Service Issue**
  - ADS-B Out position reports begin “coasting” at constant track
- **Root Cause**
  - Latitude / Longitude from Nav Radio contained within different network packets
  - Details available in Boeing Fleet Team Digest – 787-FTD-34-15001
- **Resolution**
  - Implement Boeing Service Bulletin B787-81205-SB340005-00
  - Updates Integrated Surveillance System (ISS) unit with loadable software
  - Available at no cost on MyBoeingFleet / < 2 hours (for both ISS units)
  - Software also compliant with US/European DO-260B mandates
  - Do not confuse with Boeing Service Bulletin B787-81205-SB340025-00
    - Updates ISS Hardware for ADS-B In capability (ISS Hardware Part No. 822-2120-102)

Recommend Implementation of
No Cost Software Upgrade As Soon As Possible

ADS-B Out – Multi-Mode Receivers (MMRs)

- **Boeing in-production Multi-mode receiver (MMR) capability**

	737NG	747-8	767	777	787
Buyer Furnished Equipment (BFE)	Honeywell (RMA-55B SA On) ACSS Transponder Certified with Honeywell SA On MMR Thales (TLS-755 SA Aware) Rockwell (RCI) (GLU-920-001/002 SA On) (GLU-920-004 SA Aware) (GLU-925 SA Aware)		Honeywell (RMA-55B SA On) Thales (TLS-755 SA Aware) Rockwell (RCI) (GLU-920-001/002 SA On) (GLU-920-004 SA Aware) (GLU-925 SA Aware)	Honeywell (RMA-55B SA On) ACSS Transponder Certified with Honeywell SA On MMR Thales (TLS-755 SA Aware) Rockwell (RCI) (GLU-920-001/002 SA On) (GLU-920-004 SA Aware) (GLU-925 SA Aware)	**Stopped production in 2015**
Supplier Furnished Equipment (SFE)		Rockwell(1) (RCI) (GLU-925 SA Aware)			Honeywell INR (2) (SA-Aware)

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

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

BFE – Equipment selected/provided by buyer
SFE - Equipment basic to airplane

To Maximize Dispatch Availability Boeing Recommends SA-Aware MMRs

ADS-B GNSS Requirements

- **Four Types of GNSS (GPS) Receivers**
  - SA-On – 1st Generation MMR
  - SA-Aware – 2nd Generation MMR
  - SBAS – 3rd Generation MMR (3GMMR)
  - Multi-constellation / Multi-frequency (L1/L5) – 4th Generation MMR (4GMMR)

SA – Selective Availability
SBAS – Space-Based Augmentation System

- **Regional Requirements**

CASA / Asia Pacific	Europe/Canada	United States (2020)
• SA-On acceptable • CASA SA-Aware Mandate	• SA-On acceptable	• SA-On or above acceptable • NIC>=7 for entire flight • Requires service availability prediction

- **United States (FAA)**
  - Exemption 12555 allows continued operation of SA-Aware without restriction until 2025

Equipment	2020 - 2024		After 2024
	Exemption 12555	No Exemption 12555	
SA ON	Yes	Yes	Yes
SA AWARE	No	Yes	Yes
SBAS	No	No	No

Boeing Receiver Recommendations

- **Install SA-Aware receiver in production -- get the best available receiver now**
- **Develop strategy to upgrade to SBAS (3GMMR) by 2025**
- **Not recommended to wait for Multi-Constellation / Multi-Frequency GNSS equipment (4GMMR) to satisfy 2025 ADS-B position source requirements**
  - Risk of standards and avionics development taking too long particularly if new GNSS hardware is required

Production ADS-B Out Capability

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Functionality	737NG	737MAX	747-8	767	777	777X	787	All Models Ready
SA-On GPS	HI RMA 55B 1998	HI RMA 55B	N/A	No customer	HI RMA 55B 1998	N/A	N/A	1998
SA-Aware MMR	RCI GLU-925 2005	RCI GLU-925	RCI GLU-925 At Entry Into Service	RCI GLU-925 2005	RCI GLU-925 2005	N/A	HI INR At Entry Intro Service	2005
3GMMR (SBAS/WAAS)	HI I-MMR (2017) RCI GLU-2100 (2018)	HI I-MMR (2017) RCI GLU-2100 (2018)	TBD	TBD	HI I-MMR (2017) RCI GLU-2100 (2018)	At Entry Into Service	TBD	TBD
4GMMR (Multi-Frequency / Multi-Constellation)	Not before 2025	Not before 2025	Not before 2025	Not before 2025	Not before 2025	Not before 2025	Not before 2025	Not before 2025
ADS-B Out Airplane Interface Wiring	2003 L/N 1394	At Entry Into Service	From Entry Into Service	2003 L/N 903	2003 L/N 455	At Entry Into Service	Not Required (on Common Data Network)	2003
Transponder Program Pin Wiring	6/3/13 L/N 4522	At Entry Into Service	10/7/13 L/N 1490	10/10/13 L/N 1063	8/1/13 L/N 1132	At Entry Into Service	Not Required (Option Selection Software)	Oct 2013
DO-260B (V2) Transponders	ACSS 4/15 (L/N 5389) HWI 2Q2017 RCI 11/15 (L/N 5673)	At Entry Into Service	RCI 5/16 L/N 1531	ACSS 12/14 (L/N 1072) HWI/RCI (No Customer)	ACSS 5/15 (L/N 1309) HWI 2Q2017 RCI 1/16 (L/N 1365)	At Entry Into Service	RCI 12/15 (L/N 369, 371 and on)	May 2016 (all suppliers ready 2Q2017)
Alerts	XPDR Control Panel	XPDR Control Panel	XPDR EICAS Msg and Pilot Procedure	XPDR EICAS Msg and Pilot Procedure	ADS-B Out EICAS Msg (AIMS V16 or later)	ADS-B Out EICAS Msg	ADS-B Out EICAS Msg	Part of ADS-B Function

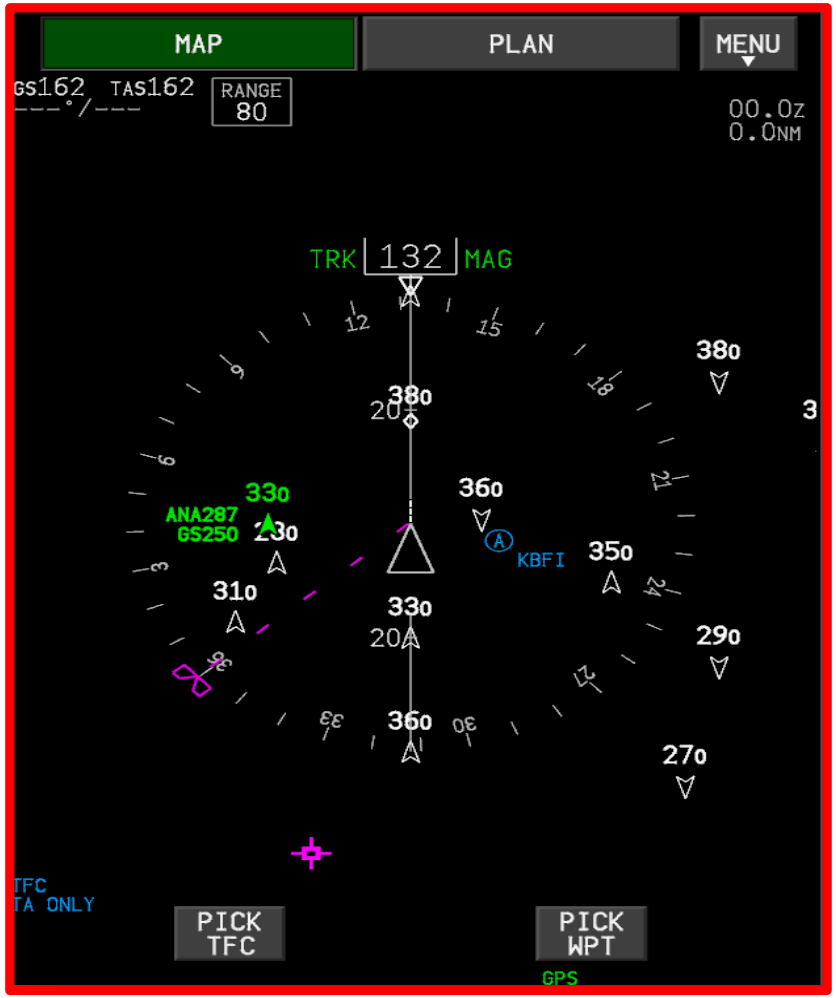
Retrofit ADS-B Out Capability

Boeing Commercial Airplanes – Avionics / Air Traffic Management

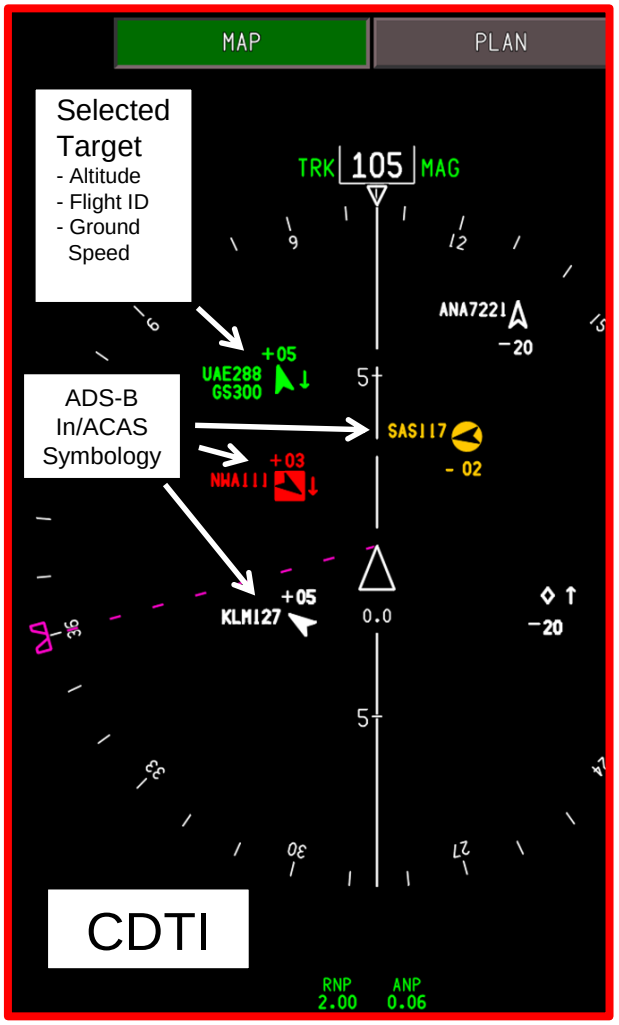
	In-Production Models					Out-of-Production Models					
Functionality	**737NG**	**747-8**	**767**	**777**	**787**	**717**	**737-300/ 400/ 500**	**747-400**	**757**	**MD 10/11**	**MD 80/90**
SA-On GPS	SB Avail	N/A	SB Avail	SB Avail	N/A	HI in Prod	SB Avail (Analog MMR)	SB Avail	SB Avail	SB Avail for MD-11	SB Avail (Analog MMR)
SA-Aware MMR	SB Avail	No SB Required (SA-Aware in Prod)	SB Avail	No SB (Avail for Purchase)	No SB Required (SA-Aware in Prod)	No SB (Avail for Purchase)	GPSSU SB Avail -300/-400 in 2015 (Avail for Purchase on -500)	No SB for GLU-925-002 (Avail for Purchase)	SB Avail	No SB (Avail for Purchase)	No SB
3GMMR (SBAS/WAAS)	SB 6 months after Prod Cert	TBD	TBD	SB 6 months after Prod Cert	TBD	No SB	No SB	No SB	No SB	No SB	No SB
4GMMR (Multi-Frequency / Multi-Constellation)	Not before 2025	Not before 2025	Not before 2025	Not before 2025	Not before 2025	No SB	No SB	No SB	No SB	No SB	No SB
ADS-B Out Airplane Interface Wiring	SB Avail	No SB Required	SB Avail	SB Avail w/ SA-On GPS	No SB Required	In Production 2005 SB Avail	SB Avail with RCI Analog MMR	In Production 2003 L/N 1336 SB Avail	SB Avail	SB Avail for MD-11	No SB
DO-260B Transponder Program Pin Wiring	SB Avail	SB Avail	SB Avail	SB Avail	N/A	No SB (Avail for Purchase)	No SB (Avail for Purchase)	No SB (Avail for Purchase)	No SB (Avail for Purchase)	No SB (Avail for Purchase)	No SB
DO-260B (V2) Transponders	SB 6 months after Prod Cert	SB 6 months after Prod Cert	SB 6 months after Prod Cert	SB 6 months after Prod Cert	SB 6 months after Prod Cert	No SB (Avail for Purchase)	No SB (Avail for Purchase)	No SB (Avail for Purchase)	No SB (Avail for Purchase)	No SB (Avail for Purchase)	No SB
Alerts	XPDR Control Panel	XPDR EICAS Msg and Pilot Procedure	XPDR EICAS Msg and Pilot Procedure	ADS-B Out EICAS Msg (AIMS V16 or later)	ADS-B Out EICAS Msg (DCA Common Block Point 2 (CBP2))	XPDR EAD Msg and Pilot Procedure	XPDR Control Panel and Pilot Procedure	XPDR EICAS Msg and Pilot Procedure	XPDR EICAS Msg and Pilot Procedure	XPDR EAD Msg and Pilot Procedure	XPDR Control Panel or MWCC or EOAP and Pilot Procedure

787 ADS-B In

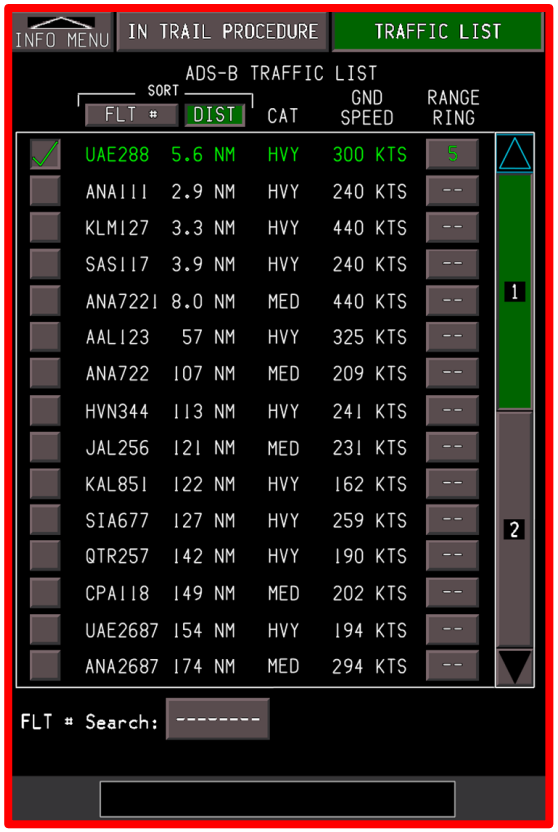
- **Provides suite of situational awareness applications**
  - Airborne Traffic Display (AIRB)
  - Visual Separation on Approach (VSA)
  - In Trail Procedure (ITP)
- **Offerable starting June 2013**
  - 787 Catalog Rev W
- **1st install in end of 2015**

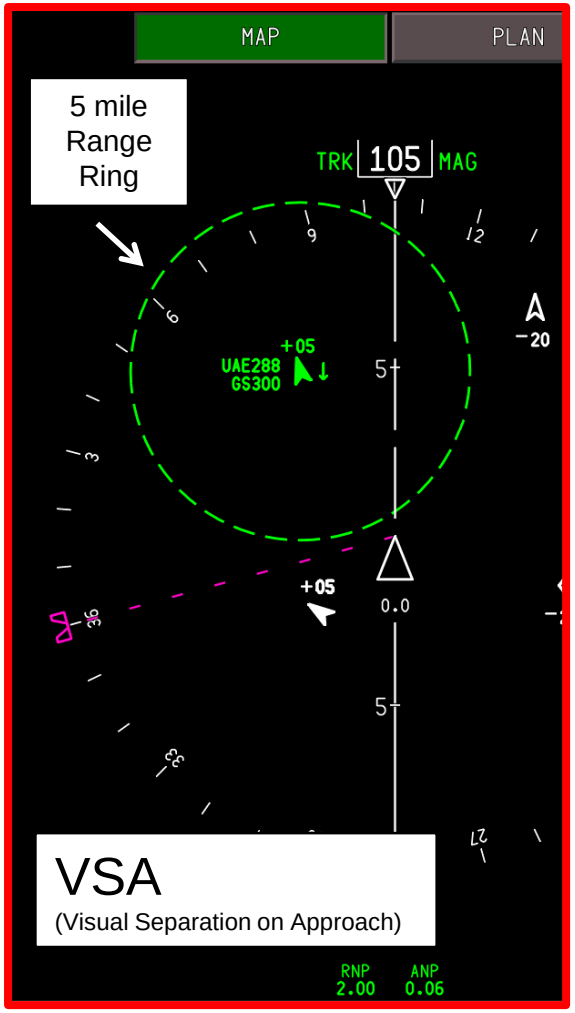


787 CDTI & VSA

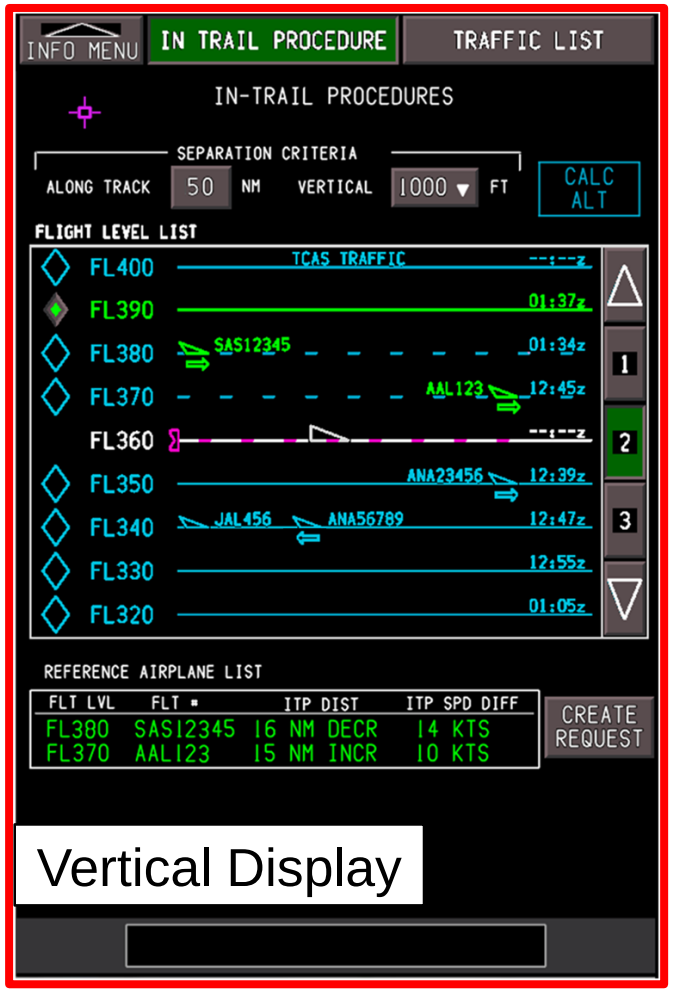


Traffic List

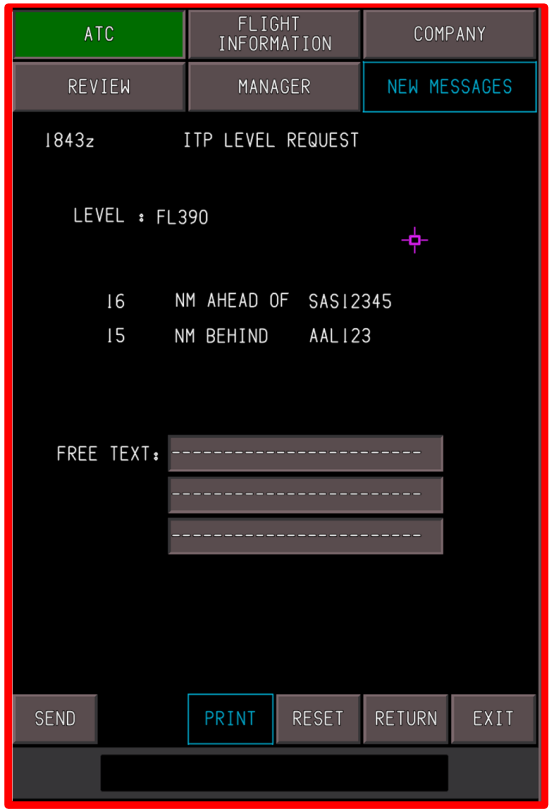


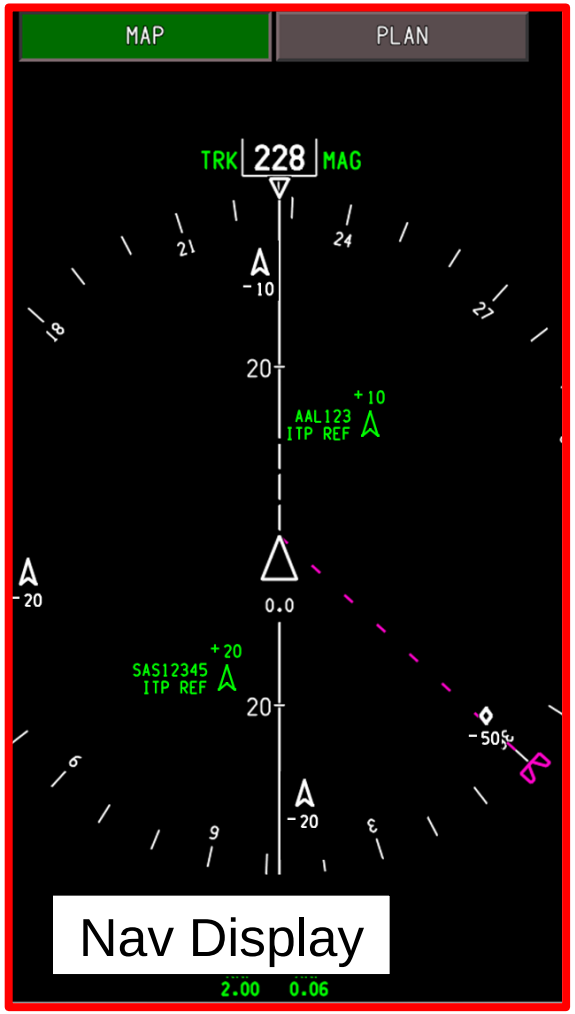


787 In Trail Procedure (ITP)



Comm Page





Boeing Airspace Assessment Capabilities

Boeing Commercial Airplanes – Avionics / Air Traffic Management

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 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

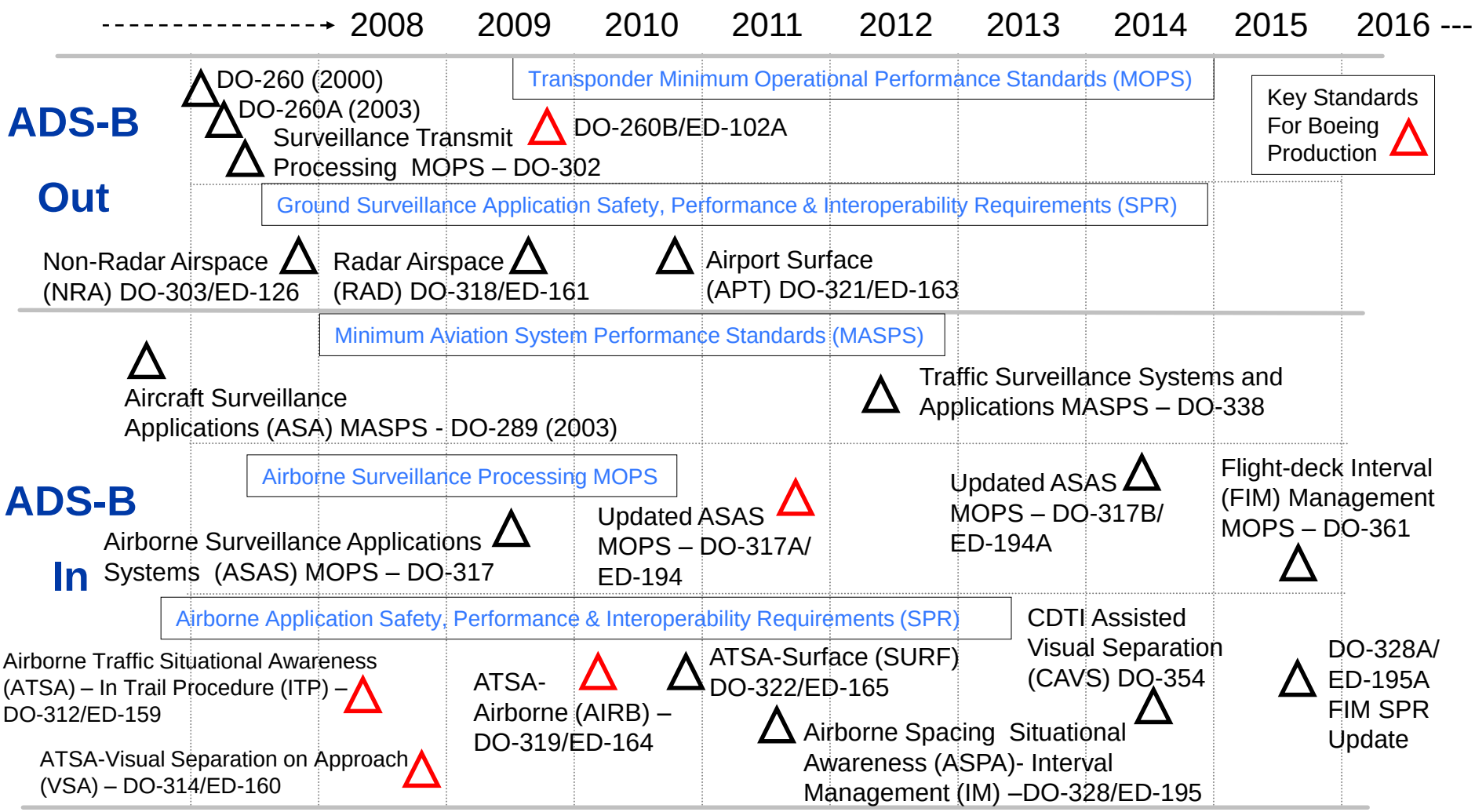
- Advanced Concepts, Procedures and Safety Case Analysis
- RNAV/RNP Route Structure Design
- Wake Vortex Mitigation
- Optimized Departure and Descent Profile Studies
- Trajectory Based Operations Simulations and Assessments
- Wind Update and Direct Route Services

Questions

Backup Charts

Standards Development

Boeing Commercial Airplanes – Avionics / Air Traffic Management



Certification Documents

Boeing Commercial Airplanes – Avionics / Air Traffic Management