



ADS-B / FANS – A Boeing Perspective

ICAO Advanced Surveillance & Automated Systems Workshop

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Boeing Commercial Airplanes

Avionics/ Air Traffic Management

Agenda

Boeing Commercial Airplanes – Avionics / Air Traffic Management

- **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

Boeing Commercial Airplanes – Avionics / Air Traffic Management

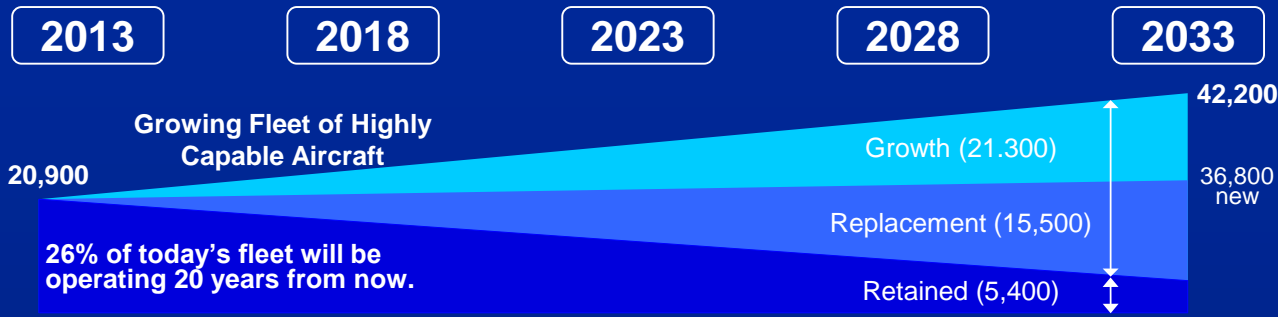


Safety, Efficiency, Capacity & Interoperability



Air Transportation System Roadmap

Airplane Population

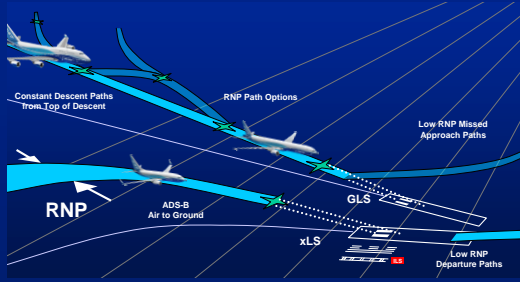


Airspace Operations

Manual ATC Intervention, Control by Radar



Pre-Defined Performance Based Airspace



Dynamic Performance Based Airspace



Key Capabilities

ATM Automation	Airspace Flow Program	CTOP	Surf Schedule	TFM Reroutes	TFDM Datalink Taxi
Conflict Detection		PDRR	IDAC	VCV	4D Conflict Resolution
Time-based Arrivals		GIM-S		TBM in Terminal	4D Negotiation
				TBM w/Path	DRNP Terminal
Communication	Oceanic RCP	Continental RCP			
Analog Voice	FANS-1 ACARS	Polar ATN SATCOM	FANS-2 Link 2000 (B1)	Broadband IP Future Subnetworks	FANS-3 (B2) IPS
					Dual SATCOM LRCS
					PTT SATVOICE
Navigation	GLS CAT I	GLS CAT III	SBAS LPV	Multi Const GNSS	Global CAT I Adv RTA
RNP	Full Profile RTA	Airport Moving Map	Expanded Wind Field	Temp Comp	GNSS Backup
RNP AR					DRNP
					Graphical Taxi
Surveillance	ADS-B DO260	ADS-B Out DO260B	SURF SA Distress Tracking	SURF IA Adv Interval Management	Adv ADS-C
Radar Wx Radar	Ext. Squitter	ADS-B In/CDTI	ACAS-X		ADS-B In w/CD&R
System Wide Information Management	FIXM	Adv Inter-Facility Coord	Shared Trajectory & Surveillance Info		
OLDI RADNET AIDC	ETMS	Aero/Met Info			

Boeing FANS Equipage

Boeing Commercial Airplanes – Avionics / Air Traffic Management

		2011	2012	2013	2014	2015-19	2020	2021	2022	2023	2024	
787	Forward Fit	FANS-1			FANS-2							FANS-3
	Retrofit	FANS-1			FANS-2							FANS-3
777	Forward Fit	FANS-1			FANS-1 + LINK2000+							FANS-3
	Retrofit	FANS-1			FANS-1 + LINK2000+							FANS-3
747	Forward Fit	FANS-1	FANS-2									FANS-3
	Retrofit	FANS-1										
757 767	Forward Fit	FANS-1										
	Retrofit	FANS-1										
737 EU Domestic OPS	Forward Fit	CMU LINK2000+					FANS-2					FANS-3
	Retrofit						CMU LINK2000+					
737 Oceanic OPS	Forward Fit	FANS-1					FANS-2					FANS-3
	Retrofit	FANS-1										
717 MD90 MD10 MD11	Forward Fit											
	Retrofit	FANS-1										

- 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+.

US/FAA Activities

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- **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

Boeing Commercial Airplanes – Avionics / Air Traffic Management

- **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 (\geq 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)

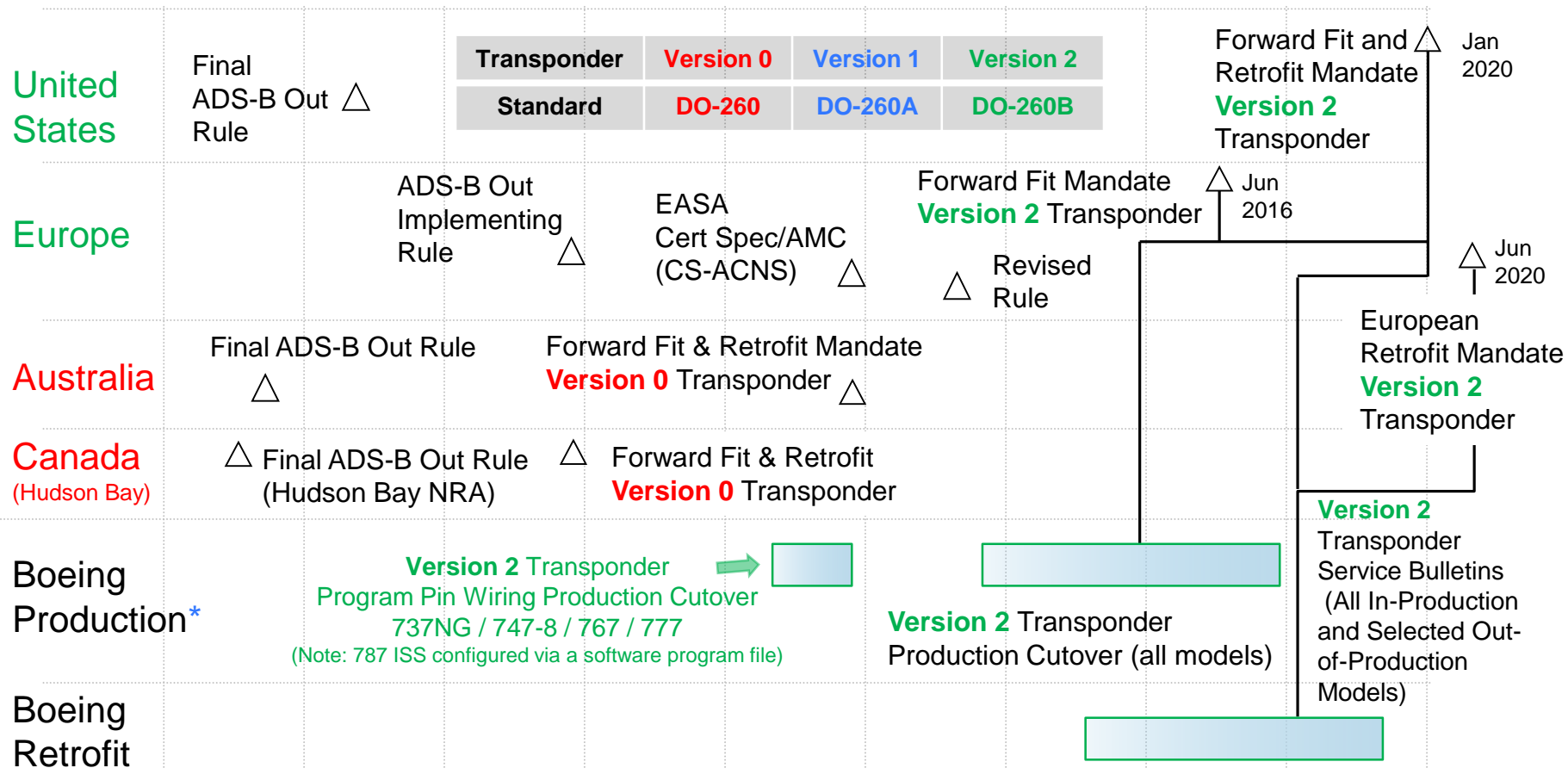
Boeing Commercial Airplanes – Avionics / Air Traffic Management

- 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 (\geq 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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2010 2011 2012 2013 2014 2015 2016 2020



* 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

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- 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

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

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

- 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 – Multi-Mode Receivers (MMRs)

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

	737NG/MAX	747-8	767	777	787
Buyer Furnished Equipment (BFE)	Honeywell (RMA-55B SA On)		Honeywell (RMA-55B SA On)	Honeywell (RMA-55B SA On)	Stop production in 2015
	ACSS Transponder To Be Certified with Honeywell SA On MMR				
	Thales (TLS-755 SA Aware)		Thales (TLS-755 SA Aware)	Thales (TLS-755 SA Aware)	
	Rockwell (RCI) (GLU-920-001/002 SA On) (GLU-920-004 SA Aware) (GLU-925 SA Aware)		Rockwell (RCI) (GLU-920-001/002 SA On) (GLU-920-004 SA Aware) (GLU-925 SA Aware)	Rockwell (RCI) (GLU-920-001/002 SA On) (GLU-920-004 SA Aware) (GLU-925 SA Aware)	
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-Out Operational Benefits Validation

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**Federal Aviation
Administration**

UNITED 



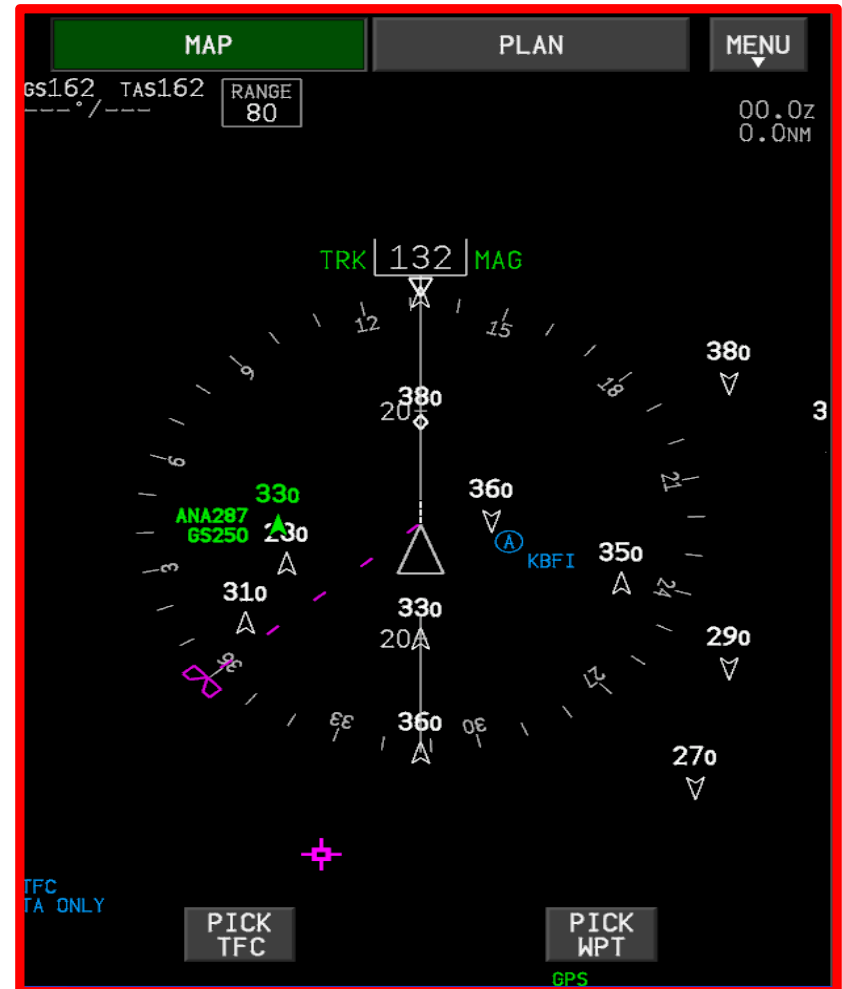
 **BOEING**

**Rockwell
Collins**

787 ADS-B In

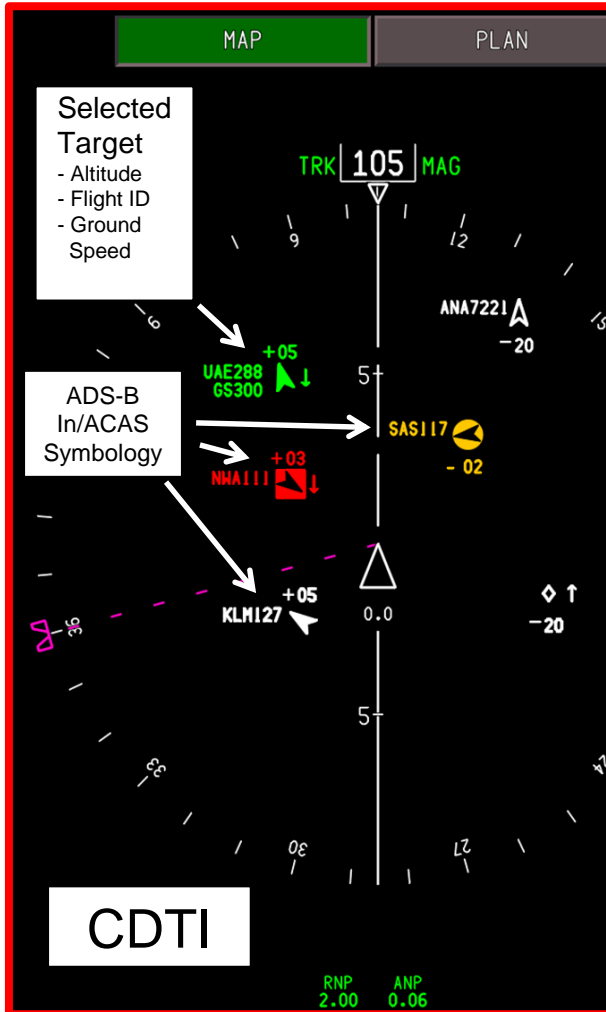
Boeing Commercial Airplanes – Avionics / Air Traffic Management

- **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

Boeing Commercial Airplanes – Avionics / Air Traffic Management



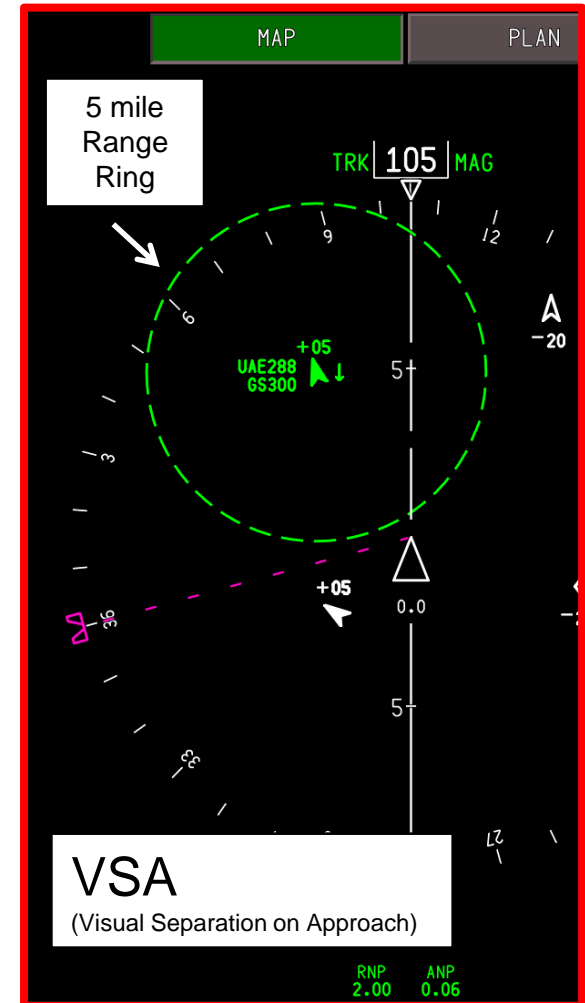
Traffic List

INFO MENU IN TRAIL PROCEDURE TRAFFIC LIST

ADS-B TRAFFIC LIST

FLY #	DIST	CAT	GND SPEED	RANGE RING
UAE288	5.6 NM	HVY	300 KTS	5
ANA111	2.9 NM	HVY	240 KTS	--
KLM127	3.3 NM	HVY	440 KTS	--
SAS117	3.9 NM	HVY	240 KTS	--
ANA7221	8.0 NM	MED	440 KTS	--
AAL123	57 NM	HVY	325 KTS	--
ANA722	107 NM	MED	209 KTS	--
HVN344	113 NM	HVY	241 KTS	--
JAL256	121 NM	MED	231 KTS	--
KAL851	122 NM	HVY	162 KTS	--
SIA677	127 NM	HVY	259 KTS	--
QTR257	142 NM	HVY	190 KTS	--
CPA118	149 NM	MED	202 KTS	--
UAE2687	154 NM	HVY	194 KTS	--
ANA2687	174 NM	MED	294 KTS	--

FLT # Search: -----



787 In Trail Procedure (ITP)

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INFO MENU
IN TRAIL PROCEDURE
TRAFFIC LIST

IN-TRAIL PROCEDURES

SEPARATION CRITERIA

ALONG TRACK 50 NM VERTICAL 1000 FT

CALC ALT

FLIGHT LEVEL LIST

FLT LVL	TCAS TRAFFIC	TIME
FL400	---	---
FL390	01:37z	
FL380	SAS12345	01:34z
FL370	AAL123	12:45z
FL360	---	---
FL350	ANA23456	12:39z
FL340	JAL456 ANA56789	12:47z
FL330		12:55z
FL320		01:05z

REFERENCE AIRPLANE LIST

FLT LVL	FLT #	ITP DIST	ITP SPD DIFF
FL380	SAS12345	16 NM DECR	14 KTS
FL370	AAL123	15 NM INCR	10 KTS

CREATE REQUEST

Vertical Display

Comm Page

ATC
FLIGHT INFORMATION
COMPANY

REVIEW
MANAGER
NEW MESSAGES

1843z ITP LEVEL REQUEST

LEVEL : FL390

16 NM AHEAD OF SAS12345

15 NM BEHIND AAL123

FREE TEXT : _____

SEND
PRINT
RESET
RETURN
EXIT

MAP
PLAN

TRK | 228 | MAG

2.00 0.06

Nav Display

Flight Deck Considerations

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737



747

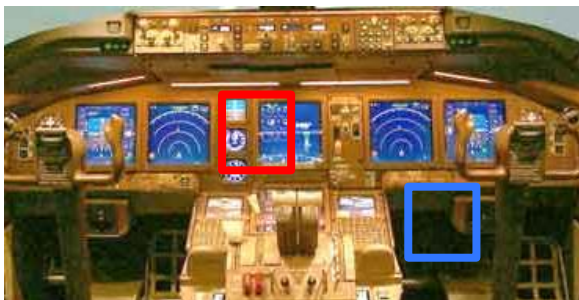


757/767

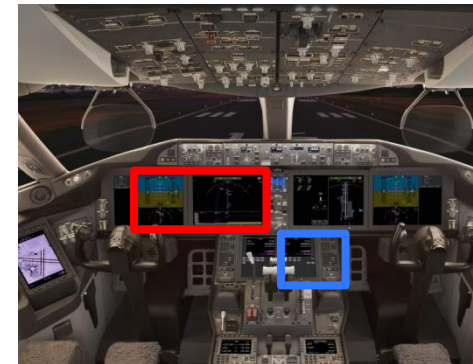
(Large Display System Upgrade Required)



777



787



Display

Control

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

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

Conclusions

Boeing Commercial Airplanes – Avionics / Air Traffic Management

- 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

