



**Federal Aviation
Administration**

ADS-B Out Avionics Equipage & Installation Issues

Presented to: ADS-B Implementation Workshop

Presented by: Alex Rodriguez (AIR-132)

Date: September 22-25, 2015



Agenda

- **What is ADS-B?**
- **ADS-B Airspace**
- **ADS-B Deployment Status**
- **ADS-B Initiatives**
- **Equipage Update**
- **STC/TC Approvals**
- **Lessons Learned**
- **Where Can I Go For Answers?**



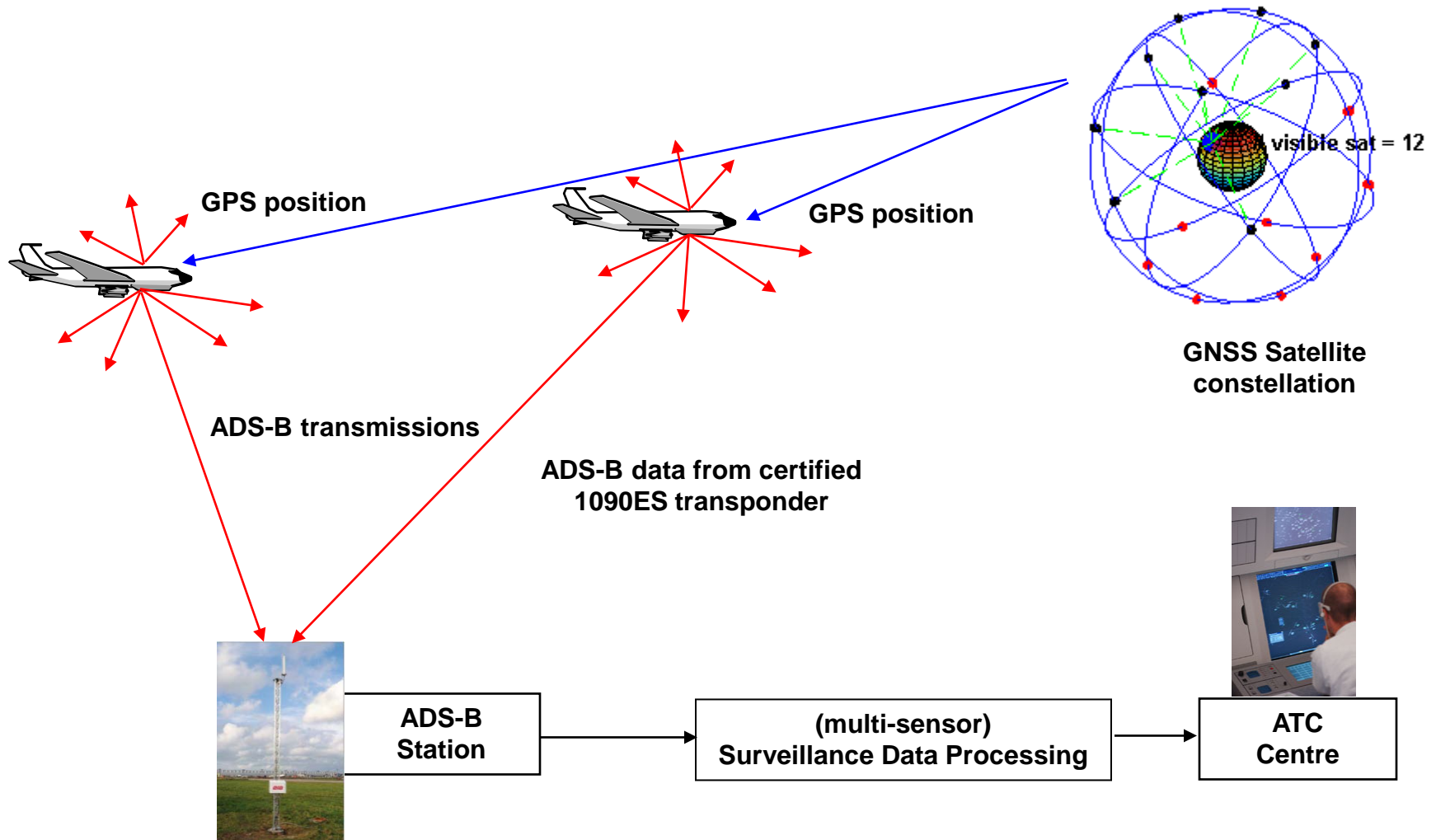
Automatic Dependent Surveillance - Broadcast (ADS-B)

- **A**utomatic
 - Periodically transmits information with no pilot or operator involvement required
- **D**ependent
 - Position and velocity vectors are derived from the Global Positioning System (GPS) or other suitable Navigation System (i.e., FMS)
- **S**urveillance -
 - A method of determining 3 dimensional position and identification of aircraft, vehicles, or other assets
- **B**roadcast
 - Transmitted information available to anyone with the appropriate receiving equipment

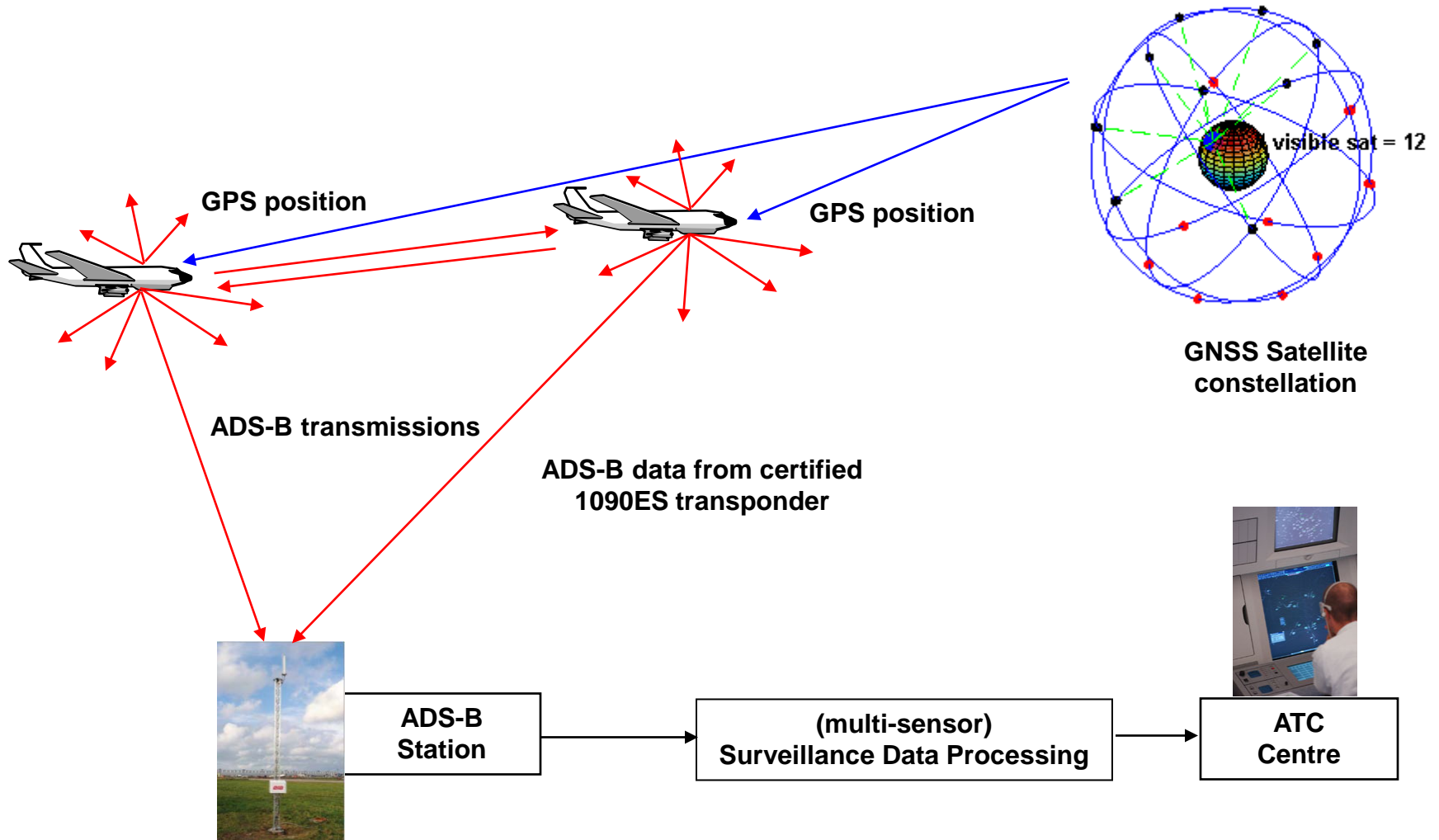


- **Satellite-based Cooperative Surveillance Technology**
- **Allows pilots and controllers to have a common picture of airspace.**
- **Allows for common situational awareness to all equipped users of the airspace.**

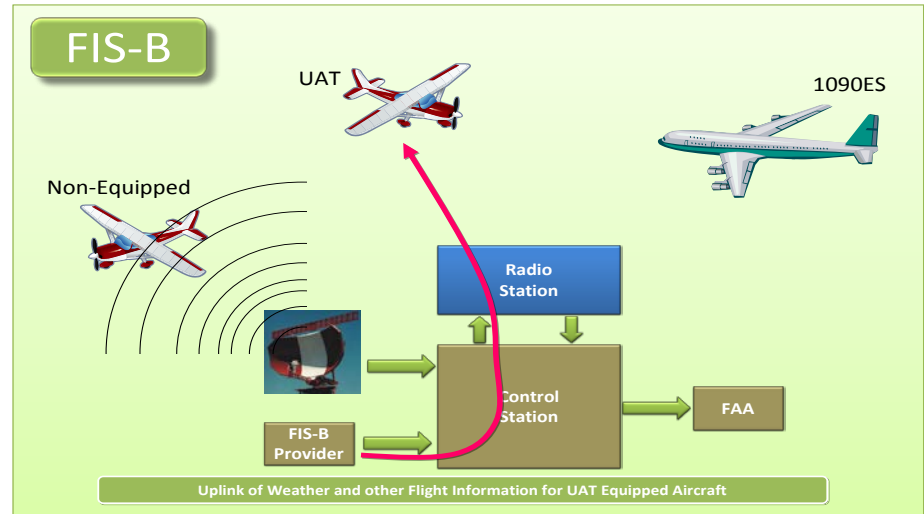
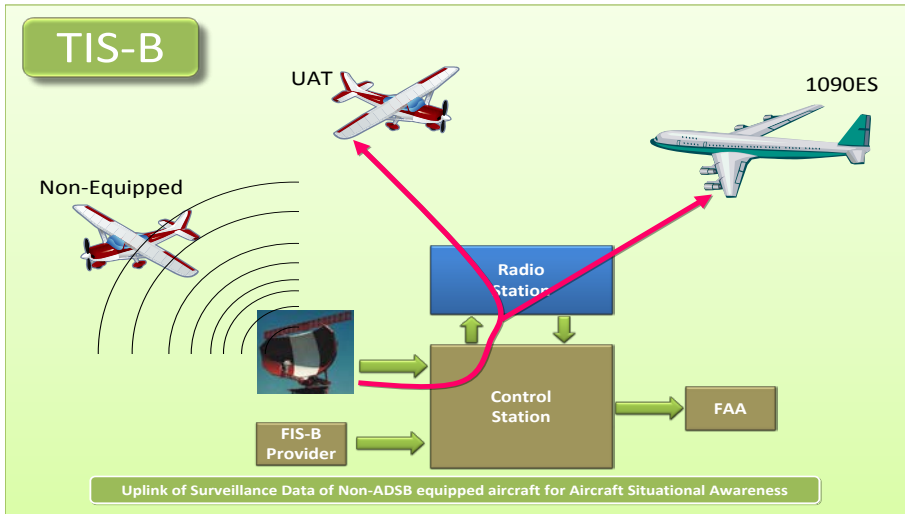
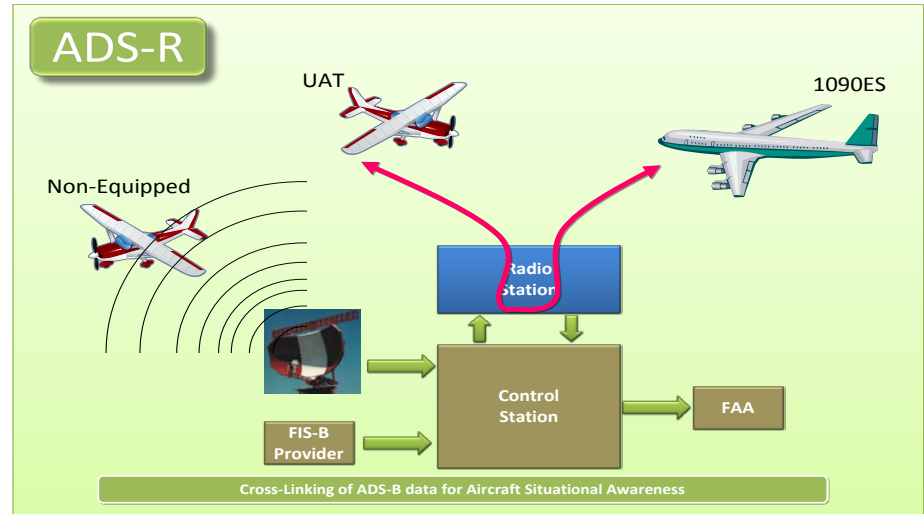
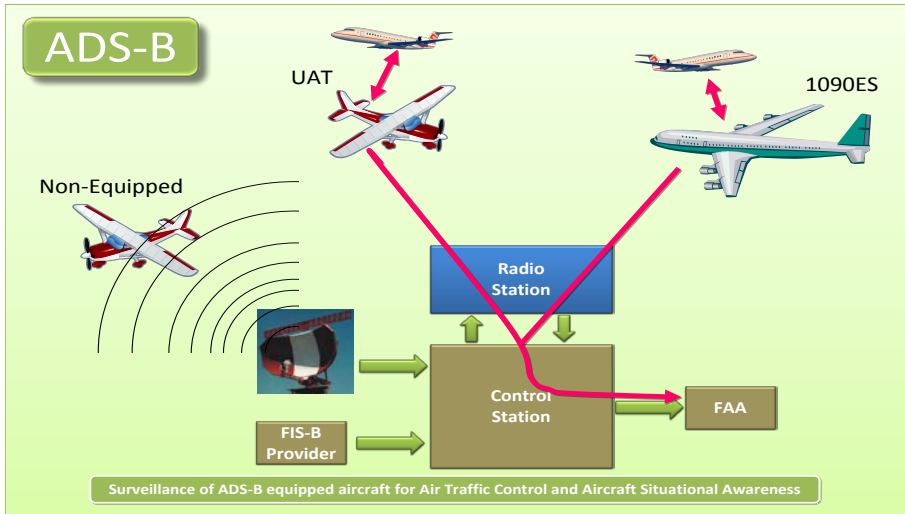
ADS-B 'OUT' Overview



ADS-B 'IN' Overview



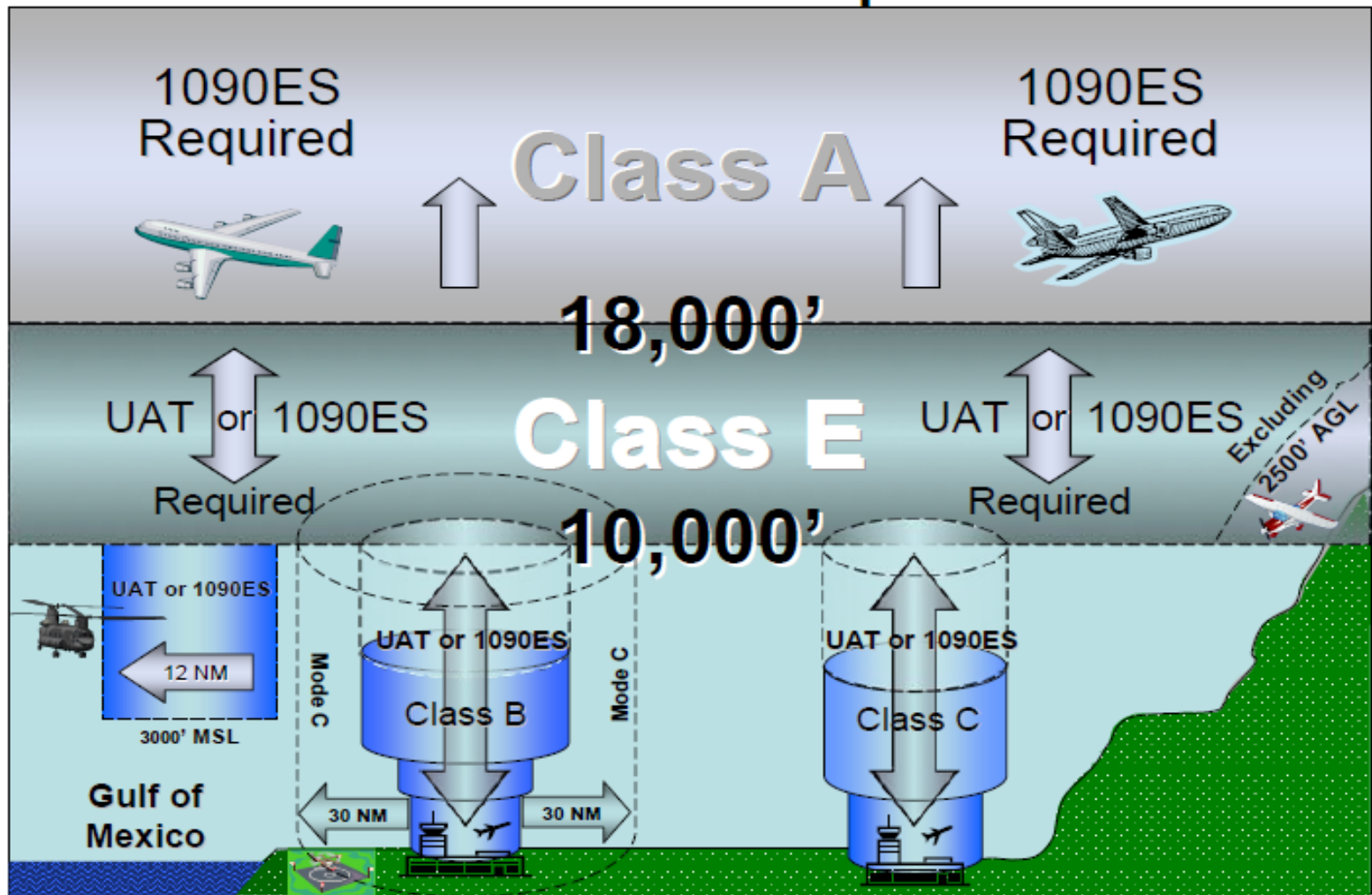
ADS-B IN Overview



ADS-B Airspace

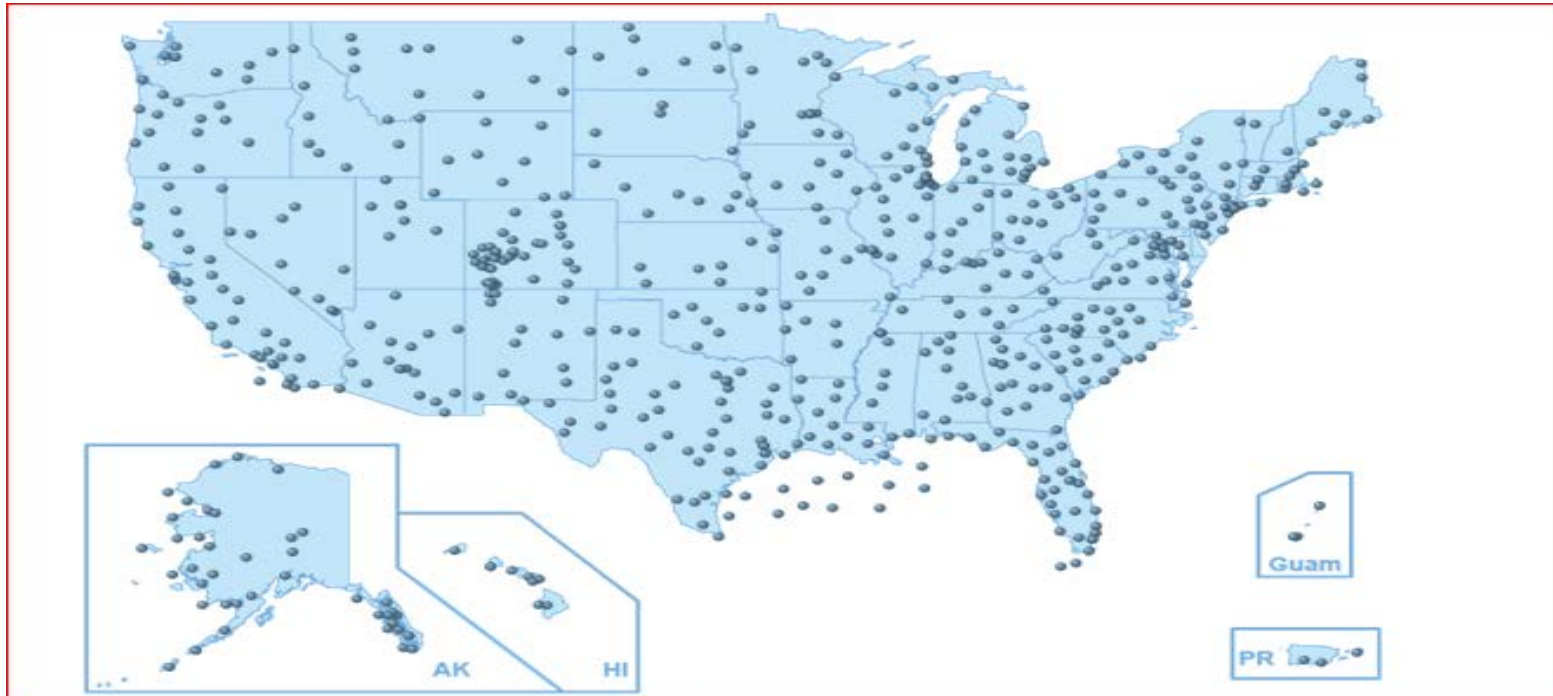
- **On May 27, 2010, the FAA published the Final Rule for ADS-B Airspace**
 - 14 CFR 91.225 mandates equipage of ADS-B avionics in the following airspace, ***effective January 1, 2020***
 - Class A, B, C (1090ES required in Class A)
 - Within 30NM of Part 91 Appendix D airports (40 Busiest)
 - Class E above 10,000' MSL in the contiguous US (Except below 2,500' AGL)
 - Above matches US transponder required airspace
 - In the GoMex above 3,000' MSL from the coast to 12NM offshore
 - 14 CFR 91.225 does **not** mandate ADS-B IN
- **14 CFR 91.227 was also published outlining the performance requirements for flying in ADS-B Airspace**

ADS-B Airspace



ADS-B Deployment Status

as of June 2015



TIS-B
FIS-B
ADS-R

Pilot Advisory Services			
	FY14	FY15 – FY17	Total
Baseline Radio Station Installations (2008 – 2014)			634 of 634
Alaska Expansion Radio Station Installations	4	3 of 4	7 of 8
Service Expansion Radio Station Installations (ASSC and Gulf of Mexico) (2014 – 2017)	2	0 of 19	2 of 21
Total Radio Station Installations (2008 – 2017)			643 of 663

ADS-B Deployment Status

- Can be seen by the ARTCC in many areas that are below radar coverage (e.g. ADS-B Only airspace)
- One area remains to be updated: New York (ZNY)

Facility	Area	ADS-B IOC	ADS-B Only Telcon	ADS-B Floor Removed	ADS-B Sort Cell Promotion
ZHU	CSA	1/30/2012	10/30/2014	11/20/2014	8/13/2015
ZID	CSA	3/15/2014	10/29/2014	1/11/2015	TBD
ZLA	WSA	5/30/2014	12/17/2014	2/5/2015	TBD
ZJX	ESA	2/8/2015	NA	2/8/2015	TBD
ZLC	WSA	9/29/2014	1/28/2014	3/9/2015	TBD
ZMA	ESA	8/20/2014	1/22/2015	3/16/2015	TBD
ZTL	ESA	8/24/2014	2/17/2015	4/23/2015	TBD
ZME	ESA	1/17/2014	2/10/2014	3/16/2015	TBD
ZKC	CSA	3/20/2014	2/3/2015	3/19/2015	TBD
ZAU	CSA	4/4/2013	2/23/2015	3/6/2015	TBD
ZBW	ESA	8/24/2013	2/11/2015	4/16/2015	TBD
ZOB	CSA	9/14/2013	2/10/2015	4/16/2015	TBD
ZFW	CSA	2/28/2014	3/16/2015	4/2/2015	TBD
ZMP	CSA	9/27/2012	3/17/2015	8/20/2015	TBD
ZAB	CSA	9/28/2012	3/24/2015	5/28/2015	TBD
ZDV	WSA	9/26/2012	NA	3/9/2015	TBD
ZOA	WSA	2/25/2014	4/7/2015	8/4/2015	TBD
ZNY	ESA	3/2/2013	5/21/2015	Sep-15	TBD
ZDC	ESA	4/14/2014	4/30/2015	5/21/2015	TBD
ZSE	WSA	9/27/2012	4/15/2015	4/28/2015	TBD
			KEY		
		as of 7/9/2015	Blue	complete	
			Green	scheduled	
			*	Change from last report	

ADS-B Deployment

- **The use of ADS-B has allowed the Controllers to use the airspace more efficiently.**
- **An example of ADS-B Only airspace is in the Gulf of Mexico.**
- **Before ADS-B, aircraft were required to fly routes using a grid separated into 20NM by 20NM squares.**
 - Only one aircraft was allowed in a grid at a given time.
- **ADS-B equipped aircraft are provided more efficient routes to the petroleum platforms.**
 - Faster and more efficient route.
 - Reduces cost of fuel.
 - Allows for IFR operations in harsher environmental conditions.

ADS-B Deployment



ADS-B Initiatives

- **Ground Based Surveillance Applications (ADS-B OUT)**
 - ADS-B surveillance for ATS in Non-Radar Areas (ADS-B-NRA)
 - Enhanced ATS in Radar-Controlled Areas using ADS-B surveillance (ADS-B-RAD)
 - ADS-B Airport Surface Surveillance Application (ADS-B-APT)
- **Airborne Surveillance Applications (ADS-B IN)**
 - Enhanced Visual separation on approach (VSA)
 - In-Trail procedures in procedural airspace (ITP)
 - Traffic Situation Awareness during flight operations (AIRB)
 - Traffic Situation Awareness for surface operations (SURF)
 - ADS-B Traffic Advisory System (ATAS)
 - Flight-deck Interval Management (FIM)

Equipage Update

Category	As of Aug 1 st , 2015	As of Sep 1 st , 2015	Increase	
Link Ver 2	14,279	15,116	+837	5.9%
1090ES	10,136	10,771	+635	6.3%
UAT	3,685	3,863	+178	4.8%
Dual	458	482	+24	5.2%
US General Aviation	12,407	13,161	+754	6.1%
US Air Carrier	338	349	+11	3.3%
Intl General Aviation	1,388	1,446	+58	4.2%
Intl Air Carrier	114	123	+9	7.9%
U.S. Military & U.S. Reserved	32	37	+5	15.6%

Data Source: www.compliancemonitor.faa.gov

*Aircraft incorrectly reporting outside US ICAO block are included in Intl GA count.

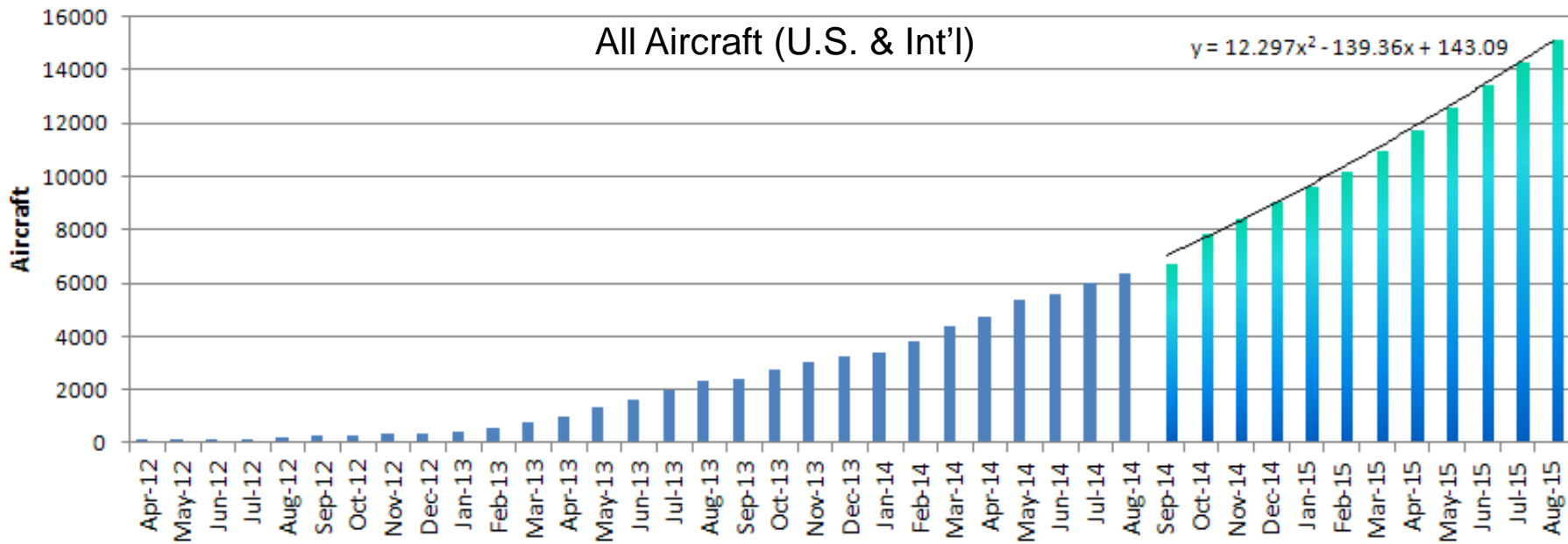


ADS-B Link Version 2 Equipage - Historical Data

April 2012 - Aug 2015

Curve Based on Sep '14 - Aug '15 data

Projected to 15,101 by end of Aug '15
Actual (+15)



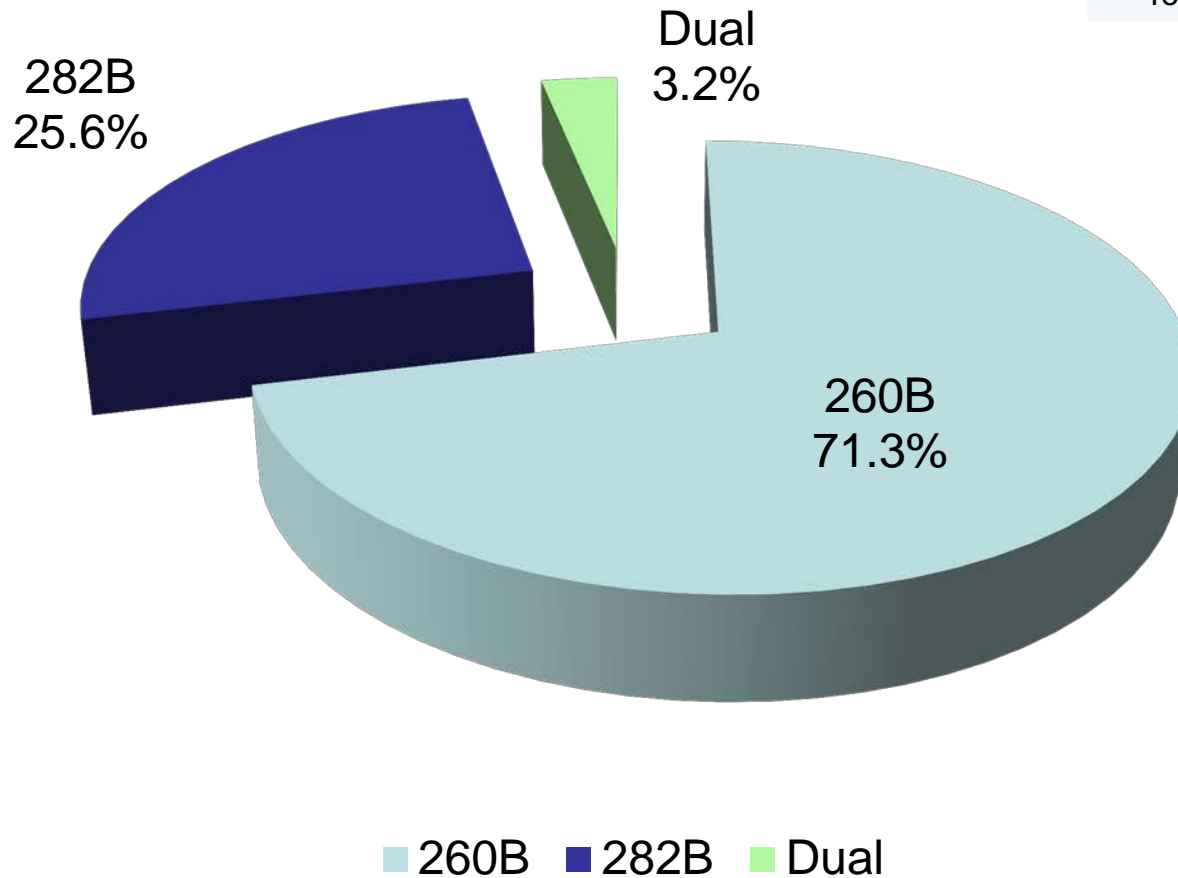
Date	Projected Equipage (based on 12-month equation above)
Jan 1 st , 2016	18,773
Jan 1 st , 2017	32,153
Jan 1 st , 2018	49,073
Jan 1 st , 2019	69,536
Jan 1 st , 2020	93,539

Projected to 15,982 by end of Sept '15



Equipage Update ADS-B Out by Link

Link Type	Count
260B	10,771
282B	3,863
Dual B	482
Total	15,116



FAA-Approved V2 ADS-B Out Avionics, 1 of 5

as of 31-Aug-2015

* multiple STC dates; only earliest shown

Surveillance Manufacturer	Model #	Approved Position Source(s)	Aircraft	Approval Date	AML Approved
Exelis / FreeFlight	FDL-978-TXG	Integrated in FDL-978-TXG	VEHICLE	May 2012	Massport
ACSS	XS-950	RCI GLU-920 , GLU-925	767, 747, A300, MD11	STC Jan 2012*	No
		RCI GLU-920	A320	STC Jul 2012	No
		Thales TLS755	A330	STC Aug 2012	No
		RCI GPS-4000S	757	STC Jul 2014	No
Honeywell	XS-852	CMC CMA-4024-1 SBAS	Embraer 145, Learjet 45, Hawker 800, and Citation X	Jan 2012*	No
Trig-Avionics	TT-31	FreeFlight WAAS 1201, Accord Technology NexNav Mini, Garmin GNS 400W/500W series, Garmin GTN 650/750, Trig TN70	Fixed Wing	STC May 2012*	Yes
FreeFlight	FDL-978-TX	FreeFlight WAAS 1201	Agusta Westland 139	STC Jun 2012*	No
			Fixed Wing		Yes
Honeywell	ISP-80A.1	Honeywell ADIRU Part#'s HG2030BE02, BE03 or BE04	A380	EASA TC Jul 2012	Yes via Production

Note: "Fixed Wing" indicates an AML STC that applies to many fixed-wing GA models – see manufacturer for models covered



FAA-Approved V2 ADS-B Out Avionics, 2 of 5

as of 31-Aug-2015

* multiple dates; only earliest shown

Surveillance Manufacturer	Model #	Approved Position Source(s)	Aircraft	Approval Date	AML Approved
Trig-Avionics	TT-22	FreeFlight WAAS 1201, Accord Technology NexNav Mini, Garmin GNS 400W/500W series, Garmin GTN 6xx/7xx, Trig TN70 (all require appropriate S/W rev)	Fixed Wing	STC Nov 2012*	Yes
Trig-Avionics	TT-22	FreeFlight WAAS 1201	S-76A/B/C (all variants)	STC Nov 2012*	No
Garmin	GDL-84, GDL-88 GTX-23 GTX-33x w/ES GTX-330x GTX-3000 (GTX models require appropriate S/W rev)	Garmin GTN 625/635/650, GTN 725/750, GPS 400W, GNC 420W/420AW, GNS 430W/430AW, GPS 500W/530W (w/ or w/o TAWS) (all require appropriate S/W rev)	Fixed Wing Multiple Gulfstream models^	STC Dec 2012* TC Dec 2014	Yes Yes via Production or Aircraft Service Change (ASC)
Honeywell	MRC XPDR w/ADS-B Out	CMC CMA-3024 SBAS GNSSU MK II and CMA-4024 SBAS GNSSU	Agusta Westland 139	EU TC Feb 2013	Yes via Production
Honeywell	XS-858B P/N 7517402-970	Honeywell GPS module (made by CMC), P/N 245-604067-100	Gulfstream 450/550	TC Feb 2013	Yes via Production or ASC

Note: "Fixed Wing" indicates an AML STC that applies to many fixed-wing GA models – see manufacturer for models covered

^ these are "dual out" installations (ADS-B Out on both UAT and 1090) of GDL-88 and GTX-330/3000



FAA-Approved V2 ADS-B Out Avionics, 3 of 5

as of 31-Aug-2015

* multiple dates; only earliest shown

Surveillance Manufacturer	Model #	Approved Position Source(s)	Aircraft	Approval Date	AML Approved
Honeywell	XS-858B P/N:7017401-970	CMC GNSS/MMR, P/N 245-604067-100	Falcon 2000EX/S, F900X	Mar 2013*	No
		Honeywell GNSS/MMR VIDL-G, P/N: 7026208-804	Falcon F7X	Apr 2013	No
FreeFlight	FDL-1090-TX	FreeFlight WAAS 1201	King Air C-90	STC Apr 2013	No
FreeFlight	FDL-978-XVR	FreeFlight WAAS 1201 (either external or internal), Garmin GNS 430W/530W	Bell-206 Fixed Wing	STC Feb 2014*	No Yes
FreeFlight	FDL-978-XVRL FDL-978-TXL	FreeFlight WAAS 1201 (internal only)	Bell-206 Fixed Wing	STC Feb 2014*	No Yes
Avidyne	AXP340	Garmin GNS 430W0/530W, Avidyne IFD 540	Fixed Wing	Apr 2014	Yes
Rockwell	TDR-94/94D-550/551	Universal UNS-1xw series (1Ew/1Espw/1Fw/1Lw)	S-92A	TC Feb 2014	Yes via Production
			S-76C, S-92A	STC Mar 2014*	No
BendixKing	KT-74	Accord Technology NexNav™ Mini, FreeFlight WAAS 1201, GNS 400W/500W series	Fixed Wing	STC Mar 2014	Yes

Note: "Fixed Wing" indicates an AML STC that applies to many fixed-wing GA models – see manufacturer for models covered



FAA-Approved V2 ADS-B Out Avionics, 4 of 5

as of 31-Aug-2015

** multiple dates; only earliest shown*

Surveillance Manufacturer	Model #	Approved Position Source(s)	Aircraft	Approval Date	AML Approved
Honeywell	KXP 2290A	Honeywell KGS200	PC-12/47E	EU TC Apr 2014	Yes via Production
NavWorx	ADS600-B	Accord Technology NexNav™ Mini	Fixed Wing	STC Jun 2014	Yes
ACSS	NXT-600	Universal UNS-1xw series (1Ew/1Espw/1Fw/1Lw); Thales Topstar 200 LPV or NG	Q400	Can TC Jul 2014	Yes via Production
			ATR 42/72-600	EU TC Mar 2015	Yes via Production
ACSS	T ³ CAS 9005000	RCI GLU-920/925, Honeywell RMA-55B, Thales TLS755	A319/320/321	EU TC Jul 2014	Yes via Production
			A330/A340	EU TC Jun 2015	Yes via Production
ACSS	NXT-800	RCI GLU-925	767	TC Nov 2014	Yes via Production
		RCI GLU-920/925	757, 767	STC Mar 2015	No
		RCI GLU-925	737NG	TC Apr 2015	Yes via Production
		RCI GLU-925	777	TC Jun 2015	Yes via Production
Garmin	GTX-330ES	Garmin GNS-430W	AS350	Dec 2014	No



FAA-Approved V2 ADS-B Out Avionics, 5 of 5

as of 31-Aug-2015

** multiple dates; only earliest shown*

Surveillance Manufacturer	Model #	Approved Position Source(s)	Aircraft	Approval Date	AML Approved
L-3 ACSS	NGT-2000/2500	Integrated in NGT-xxxx (SBAS)	Fixed Wing	Jan 2015	Yes
	NGT-9000D		Fixed Wing	Mar 2015	Yes
	NGT-1000		N/A	Apr 2015	N/A
Rockwell	TDR-94/94D-501	RCI GPS-4000S, Universal UNS-1(-)w series	Multiple turbine aircraft	Feb 2015*	Yes
Aspen Avionics	ATX100/100G	FreeFlight WAAS 1201 (either external or internal), Garmin GNS 430W/530W	Bell-206	Mar 2015	No
			Fixed Wing		Yes
Rockwell	TSS-4100	RCI GPS-4000S	G280	Apr 2015	Yes via Production

Note: "N/A" indicates equipment has received TSOA, but has not received any other certification



FAA-Sponsored Projects that will result in Version 2 ADS-B Out Avionics

Surveillance Manufacturer	Model #	Planned Position Source(s)	Aircraft	Planned STC Availability	Operator
FreeFlight	FDL-978-XVR	FreeFlight WAAS 1201 (either external or internal), Garmin GNS 430W/530W	Rotorcraft models other than Bell 206	Late-2015	Approximately 40 rotorcraft in Alaska
Rockwell	TPR 901-205	RCI GLU 925-001, RCI GLU 925-330	737-700/800/900 (aka "737NG")	Boeing Service Bulletin Q1 2016	United

Boeing provided UAL with a Service Bulletin to wire 737NG for ADS-B Version 2 in 2013; UAL has wired 69 aircraft as of 31-Aug-2015

All Boeing production aircraft have wiring provisions installed for ADS-B Version 2 as follows:
 737NGs beginning with Line Number 4522 (YS115, 03-Jun-2013)
 747-8 beginning with Line Number 1490 (RC510, 07-Oct-2013)
 767 beginning with Line Number 1063 (VT558, 10-Oct-2013)
 777 beginning with Line Number 1132 (WE166, 01-Aug-2013)

FAA-Approved V2 ADS-B-In Avionics, 1 of 2

* multiple dates; only earliest shown

as of 31-Aug-2015

Manufacturer	Model #	Aircraft	STC Date	AML Approved
ACSS	TCAS3000SP	B767-300	Jul 2008	No
Honeywell	TPA-100B	B747-400	Jun 2011	No
Honeywell	TPA-100B	A330/340 A318/319/320/321	Dec 2011**	Yes via Production
ACSS	T ³ CAS	A330/340 A318/319/320/321	Dec 2011**	Yes via Production
Garmin	GDL-88	King Air C-90	Dec 2012	Yes
ACSS	TCAS3000SP	A330-200/300	Jan 2013	No
ACSS	TCAS3000SP	A320-200	Aug 2014	No
NavWorx	ADS600-B	Fixed Wing	Jun 2014	No
FreeFlight	FDL-978-XVR, FDL-978-RX	Bell 206	Feb 2014*	No
		Fixed Wing		Yes
L-3 ACSS	NGT-2000/2500	Fixed Wing	Jan 2015	Yes
	NGT-9000	Fixed Wing	Mar 2015	Yes

**Airbus ATSAW (with and without ITP) received EASA approval in May 2011 as TC amendment; all A330/340s produced since Jan 2011 and all Airbus single-aisle aircraft produced since mid-2011 are ATSAW/ITP-capable



FAA-Approved V2 ADS-B-In Avionics, 2 of 2

as of 31-Aug-2015

Manufacturer	Model #	Aircraft	STC Date	AML Approved
Aspen Avionics	ATX100G	Bell 206	Mar 2015	No
		Fixed Wing		Yes

Note: "N/A" indicates equipment has received TSOA, but has not received any other certification



FAA-Sponsored Projects that will result in Version 2 ADS-B In Avionics

Manufacturer	Model #	Aircraft	Planned STC Availability	Operator
FreeFlight	FDL-978-XVR, FDL-978-RX	Rotorcraft models other than Bell 206	Late-2015	Approximately 40 rotorcraft in Alaska



Lessons Learned

- **The U.S. ADS-B regulation allows for aircraft to comply by using:**
 - 1) 1090ES Transponder (w/ADS-B capability)Or
 - 2) Universal Access Transceiver (UAT) operating on 978MHz
- **Due to the use of dual frequencies for ADS-B, the U.S. has implemented ADS-B In services for those equipped with both ADS-B Out and In equipment.**
- **Those with ADS-B Out and In are capable of receiving the following:**
 - ADS-B Air-to-Air
 - ADS-Rebroadcast (ADS-R)
 - Traffic Information Services-Broadcast (TIS-B)
 - Flight Information Services-Broadcast (FIS-B) on UAT In only

Lessons Learned

- **Aircraft equipped with ADS-B In will be capable of receiving ADS-B Out messages directly from other aircraft transmitting on the same frequency (e.g. 1090ES Out to 1090ES IN)**
 - Dual Receive equipment is capable of receiving both 1090ES and UAT ADS-B messages.
- **In order to receive ADS-R, an aircraft must be equipped with ADS-B Out and is capable of receiving ADS-B In on only one frequency.**
 - Allows the ADS-B ground station to determine what ADS-B traffic to transmit to the aircraft.
- **Due to the dual frequency implementation, the U.S. has faced a number of challenges:**
 - 1) Transponder is still required for TCAS acquisition.
 - 2) Mis-match between reported Mode 3/A on UAT and Transponder.
 - 3) Implementation of ADS-R.

Where Can I Go For Answers?

- The FAA NextGen office has developed an Equip ADS-B website:

<http://www.faa.gov/nextgen/equipadsb/>

- Topics on the website range from ADS-B Airspace through Ins and Outs of ADS-B.
- Examples of the kind of information you will find are:
 - ADS-B Out Required Airspace
 - Common Installation Errors
 - Frequently Asked Questions
 - What is TIS-B, ADS-R, and FIS-B?

Questions?

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