



International Civil Aviation Organization

**FIFTEENTH MEETING OF THE ADS-B STUDY AND
IMPLEMENTATION TASK FORCE (ADS-B SITF/15)**

Bangkok, Thailand, 18 - 20 April 2016

**Agenda Item 4: Review States' activities and interregional issues on implementation of
ADS-B and multilateralism**

STATUS OF ADS-B IMPLEMENTATION IN THE U.S.

(Presented by United States/Federal Aviation Administration)

SUMMARY

This information paper provides a status summary of U.S. ADS-B implementation activities.

1. Introduction

This paper provides a status summary of U.S. ADS-B implementation activities.

1.1 RTCA Special Committee 186

The RTCA Program Management Committee approved DO-328A and DO-361, the Safety, Performance and interoperability Requirements (SPR) and MOPS for Flight-deck-based Interval Management (FIM), respectively, on 22 September 2015. These were joint documents with EUROCAE, which have been approved by EUROCAE as ED-195A and ED-236, respectively. Currently, SC-186 is working on the SPR/MOPS for Advanced Interval Management (A-IM). Currently, this is not a joint activity with EUROCAE, but RTCA is working towards this goal, and several key stakeholders in Europe (Airbus, Thales, Eurocontrol, and NLR) are participating in A-IM meetings held by SC-186.

Additionally, SC-186 is simultaneously working in collaboration with SC-209, EUROCAE Working Group 49 and EUROCAE Working Group 51 in a joint group called the Combined Surveillance Committee, which is developing revisions to DO-181E/ED-73E and DO-260B/ED-102A, to correct reported deficiencies in the current MOPS, define new functionalities to support the A-IM application, and other longer-term operational needs.

The last meeting of RTCA SC-186 was held on 11 Mar 2016. A summary of SC-186 activities and products can be found on the internet at:

<http://www.rtca.org/content.asp?pl=108&sl=33&contentid=88> .

2. FAA Implementation Activities and Status

2.1 Regulatory Activities

The FAA has conducted a variety of ADS-B-related regulatory activities and has continued activities planned for the future as ADS-B-In avionics standards continue to evolve.

2.1.1 Advisory Circular (AC) 20-165B

The initial version of this AC, providing installation guidance for ADS-B Out avionics, was released by the FAA at the same time as the U.S. ADS-B Out final rule. This AC provides installation guidance for avionics that meet FAA Technical Standard Order (TSO)-C166b/C154c (DO-260B/DO-282B, also known as “ADS-B Version 2”) and was updated to AC 20-165B on 7 Dec 2015, as a result of FAA certification experience and feedback from industry. The U.S. ADS-B Final Rule, the Version 2 TSOs, and AC 20-165B are referenced in section 4.

2.1.2 AC 90-114A, Change 1

The FAA Flight Standards Service has determined that no operational approval is required for aircraft with avionics compliant with AC 20-165() to operate in U.S. airspace defined in Title 14 of the Code of Federal Regulation (14 CFR) § 91.225 (part of the U.S. ADS-B Final Rule). AC 90-114A, which provided users of the NAS guidance on a means of conducting flight operations in accordance with §§ 91.225 and 91.227 and which provided guidance for obtaining operational approval for use of the ITP and CAVS ADS-B-In applications, was published on 28 October 2014. AC 90-114A, Change 1 was published on 7 March 2016 (see section 4).

Future appendices to the AC will provide guidance for additional individual ADS-B-In applications as appropriate.

2.1.3 Technical Standard Order (TSO)-C195b

This TSO was released by the FAA on 29 September 2014. See section 4. This TSO invokes RTCA DO-317B (identical to EUROCAE ED-194A) and covers the following applications:

- (a) Enhanced Visual Acquisition (EVAcq)
- (b) Basic Airborne (AIRB) [ICAO ASBU B0-ASEP]
- (c) Visual Separation on Approach (VSA) [ICAO ASBU B0-ASEP]
- (d) Basic Surface (SURF) [ICAO ASBU B1-SURF]
- (e) In-Trail Procedures (ITP) [ICAO ASBU B0-OPFL]
- (f) ADS-B Traffic Advisory System (ATAS) [not in ICAO GANP; named Traffic Situational Awareness with Alerts (TSAA) in RTCA DO-317B]
- (g) CAVS [not in ICAO GANP]

2.1.4 AC 20-172B

This AC was published on 20 May 2015 and provides airworthiness guidance for ADS-B-In systems and applications. Revisions were made from prior AC versions to reflect feedback comments from the industry and to reflect the additional ADS-B-In applications included in TSO-C195b (DO-317B/ED-194A). See section 4.

2.2 Surveillance and Broadcast Services Program

The U.S. Federal Aviation Administration (FAA) is delivering Surveillance and Broadcast Services (SBS) as described in this section. SBS services are provided via a set of FAA-specified service volumes in en route airspace, terminal area airspace, and on airport surfaces.

ADS-B: Aircraft with ADS-B Version 2 avionics certified and installed in accordance with FAA Advisory Circular (AC) 20-165() (or an equivalent approved by FAA Aircraft Certification) will receive ATC separation services in the U.S., implementing ICAO ASBU B0-ASUR. See Figure 1 below.

Note: *Specifically-approved aircraft equipped with Version 1 avionics are currently receiving ADS-B-only ATC separation services in Alaska and the Gulf of Mexico.*

The U.S. is supporting two ADS-B links:

- The 978 MHz Universal Access Transceiver (UAT) link per FAA Technical Standard Order (TSO)-C154c [see References];
- The 1090 MHz Extended Squitter (1090ES) link per TSO-C166b [see References].

The U.S. ADS-B Final Rule [see References] requires aircraft that operate above FL180 to broadcast on the 1090ES link. The FAA is not prescribing the choice of link for aircraft flying below FL180; both links are supported and operators are free to choose whichever link meets their needs. Aircraft broadcasts go to other aircraft and to ground radio stations, where the information is processed and displayed to controllers. Where available, information from FAA radars is combined with ADS-B data to support ATC separation services.

Aircraft with ADS-B-In capability directly receive aircraft broadcasts on the same link around them, limited in range only by line-of-sight or received signal strength. Aircraft broadcasting on one link (example: UAT) are not received by aircraft using only the other link (example: 1090ES) and vice-versa, which establishes the need for the ADS-R service described below.

On 28 May 2010, the U.S. ADS-B Final Rule was published, requiring ADS-B Out equipage in U.S. airspace where a transponder is currently required, with compliance required after 1 Jan 2020. The U.S. ADS-B Final Rule also specifies requirements for broadcast information, including minimum thresholds for position/velocity accuracy and integrity.

ADS-R: ADS-Rebroadcast (ADS-R) is a pilot advisory service for situation awareness that receives data from aircraft on one link and immediately rebroadcasts it on the other link. See Figure 1 below. To minimize spectrum usage, the service identifies aircraft broadcasting that they are ADS-B-In equipped as "client" aircraft. The traffic broadcasting on the other link within a specified radius and altitude band around each client aircraft are then rebroadcast on the client's link via ADS-R. Note that ADS-R services are only available when both aircraft are within range of any ADS-B ground radio station. Since ADS-B ground stations are sited to cover current radar airspace, this means that there are regions of airspace (typically at lower altitudes) without ADS-R coverage. Various avionics manufacturers are considering the market opportunities for ADS-B avionics with dual-link receive capability.

TIS-B: Traffic Information Service - Broadcast (TIS-B) is a pilot advisory service for situation awareness, gathering data from U.S. ATC radars, Wide Area Multilateration (WAM) systems, and surface multilateration systems like ASDE-X [ICAO ASBU B0-SURF]. See Figure 1 below. This non-ADS-B surveillance information is broadcast as a TIS-B service through ground radio stations to participating aircraft on both links. Like ADS-R, appropriately equipped aircraft are identified as client aircraft and non-ADS-B traffic within a specified radius and altitude band around the client aircraft are selected for TIS-B. Unlike ADS-R, TIS-B messages are structured so that information about multiple aircraft can be packaged into a single TIS-B broadcast.

FIS-B: Flight Information Service - Broadcast (FIS-B) is a pilot advisory service supported by the FAA that is only broadcast on the UAT link. See Figure 1 below. The FIS-B message set contains Airman's Meteorological Information, Aviation Routine Weather Report (METAR) and Unscheduled Specials, Next Generation Radar (NEXRAD) precipitation reflectivity, Pilot Reports (urgent and routine), Significant Meteorological Information, Terminal Area Forecast and unscheduled

Amendments, Winds and Temperatures Aloft, Notices to Airmen (NOTAMs) important to flight safety, and Status of Special Use Airspace.

The FAA has tasked Harris¹ to provide additional products for the FIS-B service; these products are expected to be available in late 2016 or early 2017. The new products are Cloud tops, Lightning strikes, Icing (Current/Forecast Potential), Turbulence and 1-minute Automated Weather Observing System (AWOS) reports. In parallel, RTCA Special Committee 206 will revise the current FIS-B MOPS (DO-358), to include these new products, by December 2017.

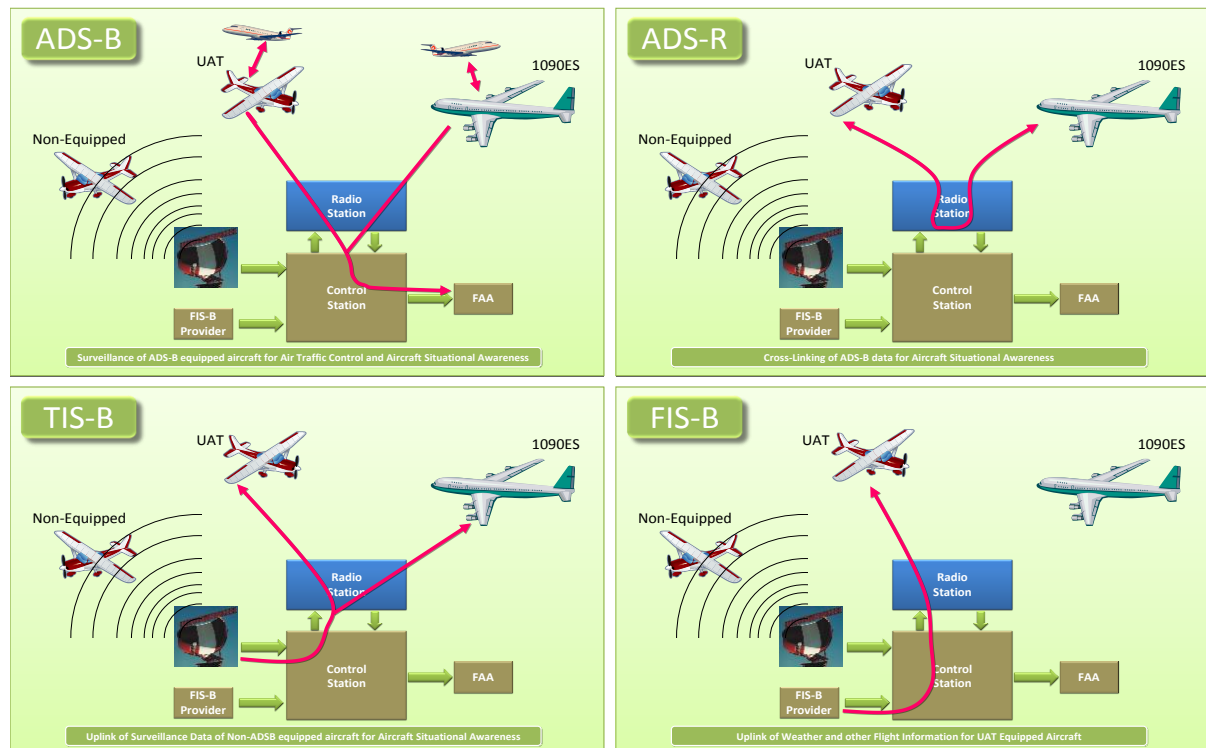


Figure 1

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2.2.1 Service Delivery Approach and Implementation Status

Harris is the prime contractor selected by the FAA under a service contract to provide surveillance and broadcast services. The Harris ground radio infrastructure receives/transmits messages from either ADS-B Version 1 or 2 avionics. The Harris infrastructure also receives messages from ADS-B Version 0 avionics, but does not transmit TIS-B/ADS-R uplink messages in ADS-B Version 0 format. At a point prior to 2020, ground station transmission of TIS-B/ADS-R/FIS-B messages in the ADS-B Version 1 format will be discontinued.

The “baseline” set of Service Volumes planned by the FAA in 2007 are operational, using data from radio sites installed by Harris. Since 2007, FAA has planned and funded activities to activate additional Service Volumes that Harris will service using additional radio sites. ADS-B coverage maps can be found at <http://www.faa.gov/nextgen/equipadsb/airspace/media/2020ADS-BAirspaceMap.kmz>.

¹ FAA’s service contract for Surveillance and Broadcast Services was awarded in 2007 to ITT Corporation. In 2011, ITT Corporation separated into three independent companies, one of which was Exelis Inc. In June 2015, Harris Corporation purchased Exelis Inc, so the FAA ADS-B service contract is now performed by Harris Corporation, referred to as “Harris” in this paper.

2.2.1.1 Gulf of Mexico Expansion Project with SENEAM

In May 2012, the FAA signed an agreement with the Government of Mexico that formed a cooperative project between FAA and Servicios a la Navegación en el Espacio Aéreo Mexicano (SENEAM). Under this cooperative project, the FAA has directed Harris to install three (3) ADS-B radio sites in Mexico, at Tampico, Merida and Cancun airports, allowing both the FAA and SENEAM to improve surveillance coverage of the airspace in the Gulf of Mexico. Additionally, Harris has installed Service Delivery Points (SDPs) at three (3) SENEAM Area Control Centers (Mexico City, Merida and Monterrey). These SDPs allow Harris to provide FAA ADS-B data to SENEAM from radio sites in Mexico and located on offshore oil platforms in the Gulf of Mexico. These radio sites became operational for use by Houston Center on 3 Mar 2016. The SDPs at SENEAM facilities are complete, awaiting the readiness of SENEAM's ATC automation system. FAA has tasked Harris to add an additional radio site on a new deep-water oil platform in late 2016. With FAA's ADS-B coverage and Mexico's plans to add its own ADS-B radio sites, SENEAM and the FAA expect to be able to provide continuous high-altitude ADS-B surveillance across the Gulf of Mexico by the end of 2016.

In March 2015, Mexico announced a proposal for an ADS-B mandate in its airspace (PROY-NOM-91/2-SCT3-2014), requiring the use of ADS-B avionics meeting the same requirements as FAA TSO-C166b (RTCA DO-260B) in similar airspace classes as the U.S. ADS-B mandate, with a similar compliance date (1 January 2020) for high-altitude operators. Harmonization of ADS-B mandates between the United States and Mexico should improve the efficiency of cross-border air traffic operations.

2.2.2 Service Monitoring

FAA has developed independent monitors that perform the following functions:

- 1) Contract Technical Performance Monitoring
Technical Performance Measures (TPMs) are monitored and nominally include the latency, availability, and update rate of the SBS services provided by Harris. The FAA uses TPMs to evaluate the quality of the SBS services provided by Harris.
- 2) Avionics Monitor
Aircraft ADS-B reports are monitored to measure equipage and compare observed performance with avionics performance requirements defined in 14 CFR §91.227.
- 3) Service Status Monitoring
This function provides real-time service status to FAA operations personnel, who notify users via NOTAMs about the current status of SBS services throughout the U.S.

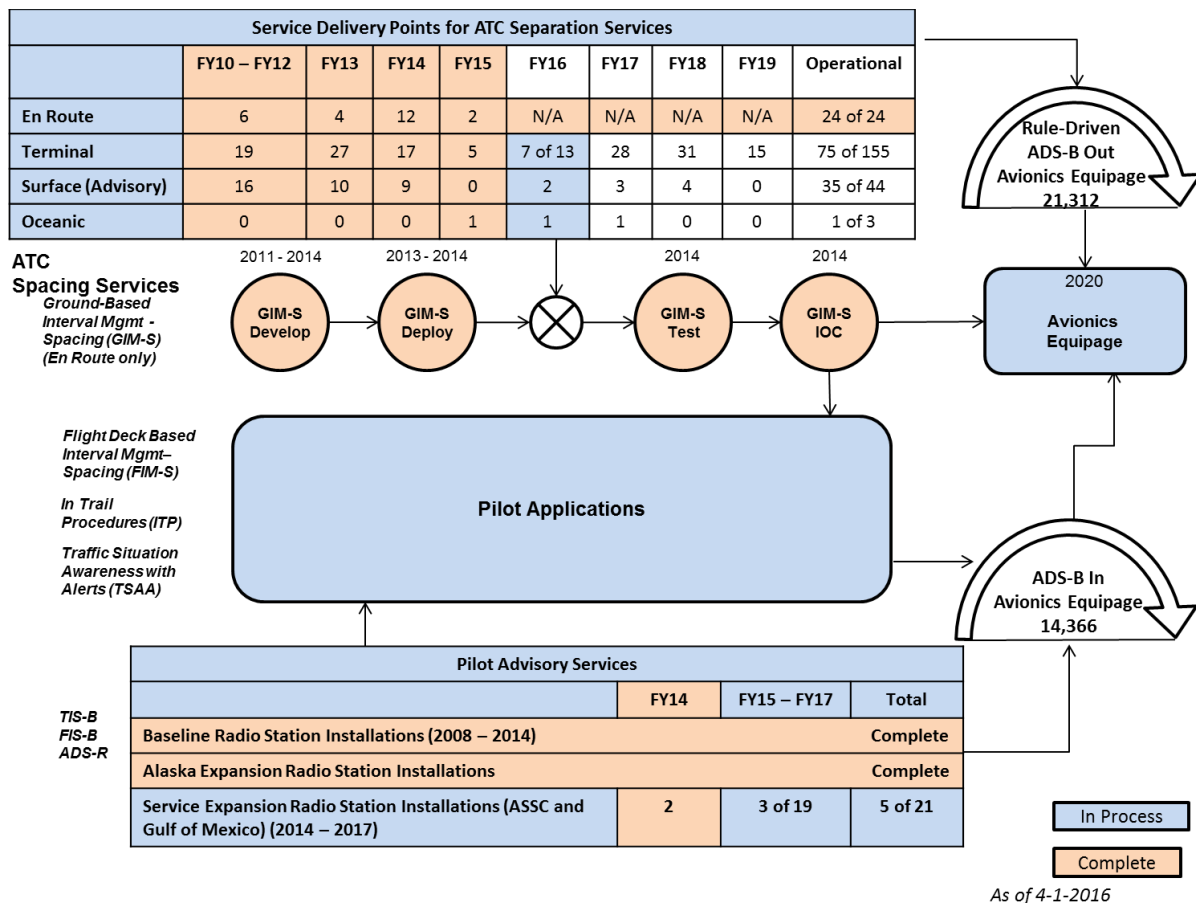
2.2.3 FAA ADS-B Development Strategy

The diagram below shows the overall FAA ADS-B development strategy through 2019. ATC Separation Services [ICAO ASBU B0-ASUR] will be rolled out on a facility-by-facility basis. Major en route and terminal facilities are now using ADS-B surveillance, but rollout will continue at the FAA's smaller terminal facilities until 2019, due to the need for ATC automation modernization to ingest and process ADS-B data at these ATC facilities.

ATC Surface Advisory Services [ICAO ASBU B0-SURF] refer to ADS-B services provided by FAA at those locations where surface surveillance systems exist, which include both the Airport Surface Detection Equipment, Model X (ASDE-X) and the new Airport Surface Surveillance Capability (ASSC).

The pilot applications and pilot advisory services are available to aircraft equipped with ADS-B-In capability. With the exception of the ADS-B ground stations in Mexico, Pilot Advisory Services

(ADS-R, TIS-B, and FIS-B) are activated everywhere that the SBS services provided by Harris are operational.



2.2.3.1 Avionics Upgrades to ADS-B Version 2 Avionics

The FAA worked with partners who were early adopters of ADS-B to upgrade those avionics (Version 1, DO-260A/DO-282A) to the avionics standards (Version 2, DO-260B/DO-282B) required by the U.S. ADS-B Final Rule. Specifically, these partners are UPS, US Airways (now American Airlines), operators in Alaska equipped with avionics under the FAA Capstone Program, and several helicopter operators in the Gulf of Mexico. The FAA contributed funding to upgrade transponders from Version 1 to Version 2 for most of the UPS fleet and 20 aircraft in the American Airlines A330 fleet. Additionally, the FAA contributed funding to upgrade transponders from Version 0 to Version 2 for 39 aircraft in the JetBlue A320 fleet. As part of these efforts, ACSS was one of the first applicants to exercise the provisions of AC 20-165, achieving an STC for an installation on UPS 767 and 747 aircraft in January 2012, for JetBlue A320 aircraft in July 2012, for US Airways (now American Airlines) A330 aircraft in August 2012 and for UPS A300 and MD-11 aircraft in January 2013. FAA also engaged with Gulf of Mexico helicopter operators to assist them in upgrading their ADS-B Version 1 avionics to Version 2, so that they can comply with the U.S. ADS-B Final Rule. FreeFlight Systems achieved an STC for an installation on an Agusta Westland 139 helicopter in June 2012; Rockwell Collins achieved an STC for installations on multiple Sikorsky helicopter models in March and April 2014. All of these upgrades have been completed. Separately, FAA awarded a contract to FreeFlight Systems in April 2013 to upgrade U.S. operators with Capstone ADS-B Version 1 avionics to U.S.-rule-compliant Version 2 ADS-B systems; over 95% of these operators are in Alaska. Equipage of these aircraft began in mid-2014 after FreeFlight Systems received approval for their

Approved Model List (AML) STC for a large number of general aviation aircraft; currently, over 225 aircraft have been upgraded.

2.2.3.2 Equip 2020

On 28 October 2014, FAA senior officials met with more than 80 industry representatives of pilots and operators, manufacturers and suppliers at an “ADS-B Call to Action” meeting to identify and address barriers to equipping with ADS-B Out by Jan. 1, 2020. The participants agreed that the aviation community must work together to meet the mandate’s schedule, and the industry participants identified a number of potential barriers to meeting the mandate and developed corresponding action plans in working sessions.

The NextGen Institute convened an Equip 2020 group consisting of FAA and industry representatives to address the barriers and the suggestions in the action plans. The first meeting of the Equip 2020 group was held on 18 November 2014. Five working groups were formed to address the suggestions made at the “ADS-B Call to Action” meeting; four working groups are still meeting as of March 2016:

- 1) Air Carrier Equipage: This working group coordinates and monitors the equipage of ADS-B Out in the Part 121 and 135 community, tackling issues relevant to availability of equipment and its installation.
- 2) General Aviation Equipage and Education: This working group coordinates and monitors the equipage of ADS-B Out in the General Aviation community, tackling issues relevant to availability of equipment and its installation.
- 3) ADS-B In Capabilities: This working group discusses ADS-B-In requirements and benefits. (new group established in December 2015)
- 4) Installation and Approvals: This working group addresses all of the issues associated with ensuring efficient and consistent installations and approvals.

Equip 2020 meetings (which include all working groups) were held monthly from November 2014 until June 2015. Since June 2015, Equip 2020 meetings are held quarterly; the last meeting occurred on 18 March 2016.

2.2.4 Air Traffic Control Separation Services

The FAA delivers ATC separation services to aircraft equipped with ADS-B Version 2 avionics (TSO-C154c/TSO-C166b). Between 2009 and 2011, the following key-sites achieved Initial Operating Capability (IOC):

- Louisville Terminal Radar Approach Control (TRACON);
- Houston Air Route Traffic Control Center (ZHU) Gulf of Mexico airspace;
- Philadelphia TRACON;
- airspace in the vicinity of Juneau, Alaska.

For the TRACONs, ATC separation services were provided using fused radar and ADS-B.

Based on this operational experience, FAA made an In-Service Decision (ISD) for SBS on 22 September 2010, indicating that the use of ADS-B and WAM are operationally suitable as surveillance sources for ATC Separation Services in the United States.

The initial terminal production sites were Houston TRACON for the Standard Terminal Automation Replacement System (STARS) and New York TRACON for the Common Automated Radar Terminal System (CARTS). The activities that were completed for CARTS and STARS include updating the software baselines to support ATC terminal separation for ADS-B-only targets (for aircraft equipped with Version 2 avionics). All major U.S. terminal ATC facilities now use these software baselines.

The initial En Route Automation Modernization (ERAM) production site was ZHU. ZHU implemented ADS-B data integration with ERAM in phases. The first phase provided ADS-B data to ERAM via a "virtual radar" interface as was used previously by the ZHU En Route Host system to provide separation services in the Gulf of Mexico airspace. In the second phase, ERAM was provided with ADS-B data to enable ATC separation services using a fused ADS-B and radar data. A third phase was implemented to enable separation for ADS-B-only targets after this safety case was approved. This ERAM software release is now deployed and operational at all U.S. Air Route Traffic Control Centers (ARTCCs).

The FAA has integrated ADS-B surveillance data in the Advanced Technologies and Oceanic Procedures (ATOP) automation platform to support ATC separation services in the Anchorage Flight Information Region (FIR). By 2017, the ATOP conflict probe and other functions will be modified to support In-Trail Procedures (ITP) in all oceanic FIRs for which FAA is responsible for providing ATC separation services. ITP is described in section 2.2.7.1.

2.2.4.1 Using ADS-B to Enhance ATC Separation Services

As a means of encouraging early ADS-B-Out equipage, the FAA is exploring opportunities to use ADS-B surveillance coverage to improve airspace access, enable more direct routings and more fuel-efficient altitudes, and circumvent constrained airspace. Currently, the focus is on offshore/oceanic airspace near the coasts of the continental U.S.

The FAA has an agreement with JetBlue to explore the benefits of ADS-B surveillance in offshore airspace along the U.S. east coast and in the Gulf of Mexico. JetBlue has equipped 39 A320 aircraft with Version 2 ADS-B avionics.

For east-west flights from Florida towards Texas and points west, traffic along routes Q100 and Q102 can be impacted by convective weather, resulting in deviations far to the north around military warning areas due to lack of radar surveillance to the south. ADS-B surveillance beyond the current radar limit now facilitates deviations south, for rule-compliant ADS-B Out equipped aircraft when the operator has a Letter of Agreement (LOA) with Houston Air Route Traffic Control Center (ZHU), and Miami Air Route Traffic Control Center (ZMA). This deviation to the south is referred to as the Gulf of Mexico (GOMEX) Q Route Alternative.

By the end of 2012, JetBlue had equipped 35 aircraft with rule-compliant ADS-B Out and used the GOMEX Q Route Alternative, per the requisite LOA, over a 2-month test period in 2013 for flights between Ft. Lauderdale, FL (KFL) and Los Angeles (KLAX) or San Francisco (KSFO). Results from the test period demonstrated that the ADS-B only routing offered benefits over the northern deviation routing under select convective weather conditions as well as "blue sky" adverse wind conditions. For the flights that demonstrated benefits, JetBlue averaged a savings of about 6 minutes per flight for westbound flights and about 8 minutes per flight for eastbound flights.

JetBlue has also worked with New York Center (ZNY) to allow ADS-B operations in East Coast offshore airspace when either of two U.S. long-range radars in Virginia (Oceana) and North Carolina (Fort Fisher) are out of service. These radars are critical for providing ATC surveillance along the M201 route (and intersecting routes, such as L453) along the U.S. East Coast. When Oceana or Fort Fisher radar outages are planned, ZNY closes those routes to non-ADS-B traffic, and JetBlue (and other operators equipped with ADS-B Version 2 avionics) is still able to operate along those routes, saving distance and time flown.

The FAA is assessing several options to support the reduction of oceanic separation minima in the FIRs that the US manages under agreement with ICAO. These options currently include improvements to the existing FANS-1A avionics, the use of Space Based ADS-B (ADS-B Out) and the development of ADS-B-In applications.

- 1) Space Based ADS-B. The FAA is working towards modifying the FAA's Advanced Technologies and Oceanic Procedures (ATOP) oceanic automation platform to ingest Space Based ADS-B data. This requires developing a concept of operations (CONOPS) and preliminary requirements for the use of space-based ADS-B to enhance situational awareness for controllers using ATOP. The FAA plans to make an investment decision in early FY17 to authorize the implementation effort and currently plans to enable space-based ADS-B for situational awareness in an operational environment in FY18 if the investment is approved.
- 2) FANS-1/A. The FAA is continuing to analyze increased ADS-C update rates to potentially obtain reductions in oceanic separation standards. The work to update CONOPS, develop requirements, conduct safety analyses, and conduct cost benefits of this and other alternatives are currently being performed in preparation for an FAA internal decision in mid-FY17.
- 3) ADS-B-In. This option is being considered for a future FAA investment as part of the Advanced Interval Management family of applications.

2.2.5 ATC Spacing Services (aka, Interval Management, IM) [ICAO ASBU B0-RSEQ]

Interval Management (IM) introduces a new method for flight crews and ATC to achieve a desired spacing between aircraft in all phases of flight. IM operations consist of ground automation and flight deck avionics that, when used in conjunction with one another, provide capabilities that allow the aircraft to efficiently manage the interval assigned by air traffic control.

The initial applications of these operations will take place for arriving aircraft in en route airspace to a terminal area metering fix consistent with today's instrument flight rules (IFR) procedures and criteria. Later implementations of these operations include having the flight crew execute (supported by aircraft avionics) an interval management clearance issued by ATC, potentially using a new separation standard with reduced separation minima.

The FAA has implemented the requirements for the ground automation, called Ground Interval Management - Spacing (GIM-S), via two FAA automation programs: Time-Based Flow Management (TBFM) and ERAM, to schedule/manage the arrival traffic flow. GIM-S is currently operating as an arrival manager that assists air traffic controllers in delivering aircraft more consistently to the arrival meter point and meter fix and increases the opportunities to conduct an Optimized Profile Descent (OPD). GIM-S provides the ability to meter traffic several hundred miles from an airport in sections of airspace that are about 150-200 miles each. The capability provides suggested speeds (speed advisories) to controllers to achieve metering objectives (absorbing delay slowly over a long distance, rather than all at once over a shorter distance).

Initial Operational Capability (IOC) of the GIM-S capability was achieved on September 22, 2014 at Albuquerque ARTCC (ZAB) to support metering operations into Phoenix Sky Harbor International Airport (KPHX). At ZAB, GIM-S has been adapted to only provide speeds in the en route segments when aircraft are in level flight. Once a controller clears an aircraft for the EAGUL arrival, the aircraft will fly the published arrival and approach procedures. This provides users with an optimal transition to continue use of the OPD into Phoenix.

In the next phase of operations after IOC, ZAB enabled GIM-S on other arrivals to KPHX coming from the south and southeast. However, GIM-S operations remained fully contained within ZAB airspace. In a subsequent phase, GIM-S functionality was used to manage traffic originating from an adjacent ARTCC. The multi-center metering expansion is currently operational between Denver ARTCC (ZDV) and ZAB, for support of KPHX metering operations. In March 2016, ZDV initiated GIM-S operations for the KOHOE arrival flow into KDIA airport.

FAA is continuing deployment of GIM-S capabilities for additional airport arrival operations. Specifically, teams have developed or are developing GIM-S metering designs for arrivals into Seattle (KSEA), Salt Lake City (KSLC), Houston Intercontinental (KIAH), and Minneapolis-St. Paul (KMSP) airports.

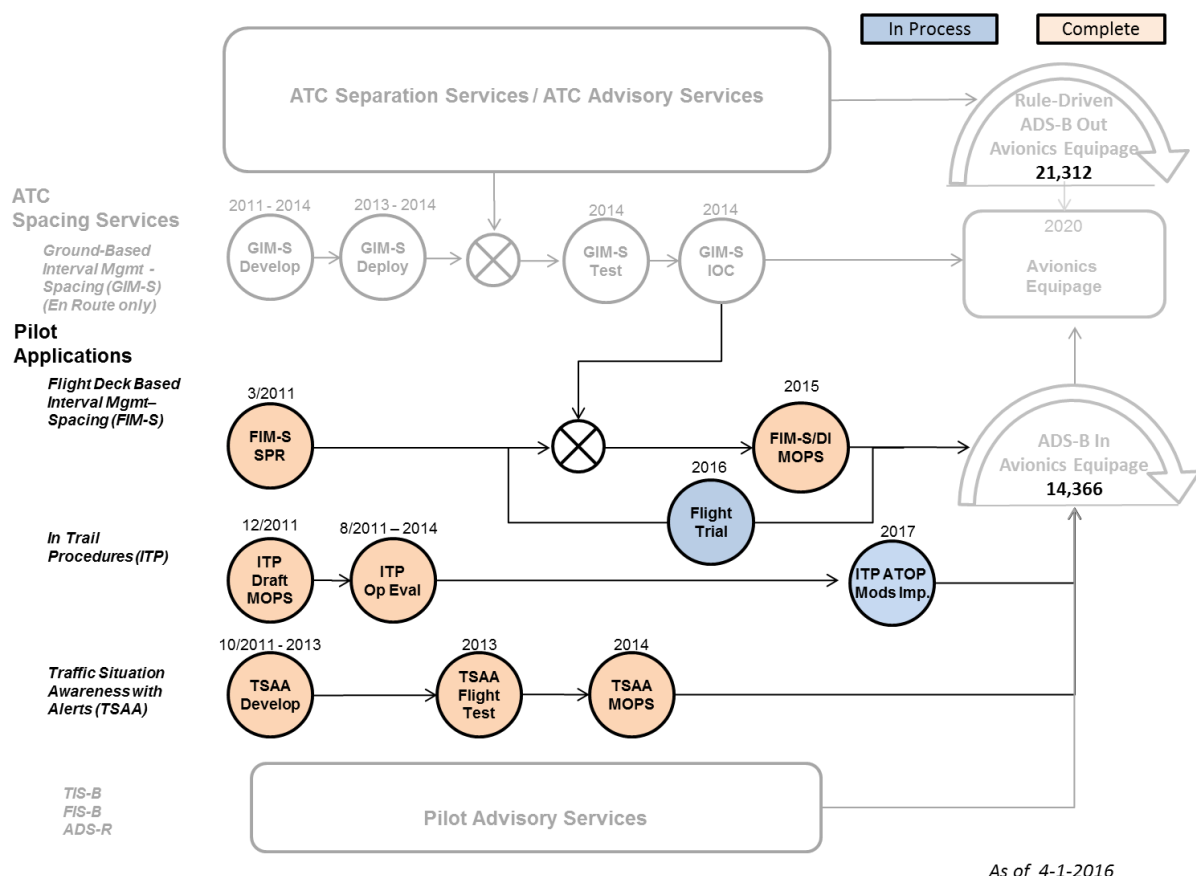
2.2.6 Pilot Advisory Services

Pilot Advisory Services (broadcast of TIS-B/ADS-R and FIS-B) are operational in all planned Service Volumes. TIS-B is only provided in airspace that is covered by secondary surveillance radar or an approved WAM system. As stated earlier, Pilot Advisory Services are not provided by the Harris ADS-B radios located in Mexico per the FAA's agreement with SENEAM.

2.2.7 Pilot Applications

The FAA is developing a number of pilot applications that are expected to provide benefits to operators who choose to equip their aircraft with appropriate ADS-B-In avionics which provide the capability to receive, process, and display ADS-B and TIS-B data from surrounding aircraft. In addition to providing benefits directly to customers who equip, these applications will help accelerate the understanding and acceptance of ADS-B and provide a path to future applications.

The FAA has or is currently investing in flight testing/trials for three applications: Oceanic In-Trail Procedures (ITP), a pre-cursor of Flight-deck Interval Management (FIM) known as Merging & Spacing, and CDTI-Assisted Visual Separation (CAVS). The FAA has completed its investment in developing the TSAA application as described in section 2.2.7.3. The figure below shows the plans for most of these applications as part of the FAA ADS-B Strategy.



2.2.7.1 Oceanic In-Trail Procedures (ITP) [ICAO ASBU B0-OPFL]

The objective of ITP is to increase the efficiency of long-haul flights in non-surveillance airspace while maintaining or enhancing the current level of safety. The concept takes advantage of ADS-B-In and a cockpit display of traffic information. In addition to increasing flight crew awareness of surrounding traffic, the ITP capability will enable climbs or descents in situations where the aircraft is currently blocked by traffic due to procedural separation standards. There is an expectation that once

flight crews gain experience with the on-board ITP system and procedures, they will reduce their discretionary fuel reserves, further reducing fuel burn (and carbon emissions).

The FAA and United Airlines have conducted an operational evaluation of ADS-B ITP using 12 United B747-400 aircraft. On 24 Jun 2011, a Supplemental Type Certificate (STC) was granted by FAA for the ITP system installation on the B747-400 model operated by United Airlines. On the same day, the FAA Air Traffic Organization received approval from its safety regulator to offer ADS-B ITP services to properly equipped aircraft in the Oakland Oceanic Flight Information Region (FIR). FAA En Route and Oceanic Safety and Operations Support authorized Oakland Center to initiate the operation evaluation on 15 August 2011; the FAA has put in place an Air Traffic Order under which Oakland Center continues to support ADS-B ITP operations. United Airlines received Operational Approval from FAA Flight Standards to commence ITP operations on 15 Aug 2011. FAA is currently modifying the Advanced Technologies & Oceanic Procedures (ATOP) ATC automation system to provide direct controller support for ADS-B ITP, including conflict probe changes; this capability is scheduled to become operational at Oakland Center in mid-2016 and available at all FAA oceanic centers by 2017.

FAA and United Airlines have collaborated to analyse and publish a summary of the operational economic benefits United Airlines experienced as a result of ADS-B ITP equipage. Also, FAA sponsored a study by human factors experts at the Volpe National Transportation Systems Center of the ITP procedure from both a flight crew and controller perspective. Links to these reports on the FAA website can be found in Section 4.

FAA worked with the Air Navigation Service Providers (ANSPs) in New Zealand and Fiji to expand the ITP operational evaluation to the Nadi FIR and Auckland Oceanic FIR and this occurred from late 2013 through March 2014, when United Airlines ceased operating 747-400s on routes from the U.S. West Coast to Australia. FAA has also held discussions with the Japan Civil Aviation Bureau about the potential for offering ITP services in Fukuoka FIR at some point in the future. FAA also participated extensively in the development of the ICAO amendments for ITP (modifications to Annex 10, PANS-ATM and PANS-OPS) and the accompanying ICAO Circular 325. Amendment 89 to Annex 10, Amendment 6 to both volumes of PANS-OPS, and Amendment 6 to PANS-ATM were applicable as of 13 November 2014.

All FAA certification and flight standards guidance material for ITP were published in TSO-C195a (and later versions), AC 20-172A (and later versions), and AC 90-114, Change 1 (and later versions).

2.2.7.2 Interval Management (IM) [ICAO ASBU B1-ASEP]

Interval Management was described earlier in section 2.2.5. This section briefly discusses the “pilot applications” aspect of these operations, which involve the flight crew executing (supported by aircraft avionics) an interval management clearance issued by ATC. When the controller is supported by Arrival Manager (A-MAN) automation, it is envisioned that IM clearances will be formulated as a time-based interval. For limited scenarios/clearances, this can occur via voice communications; the full capability is expected to require DataComm for the IM clearance. When the controller has no automation support, IM clearances can be formulated as a distance-based interval. The flight crew enters the IM clearance from ATC into their IM avionics, which will then provide speed guidance to the flight crew to achieve and maintain the ATC-assigned interval.

RTCA and EUROCAE completed development of the SPR and the MOPS for FIM-S avionics as described in section 1.1. Development of avionics standards for Advanced Interval Management (A-IM) has begun within RTCA as described in section 1.1. NASA plans to conduct flight testing in 2017 with an avionics prototype meeting key MOPS requirements to validate avionics performance and to evaluate proposed IM operational procedures. FAA is collaborating with NASA on this flight testing.

FAA is also engaging with the planners of the KDC (Knowledge & Development Center of Mainport Schiphol) IM flight trials.

2.2.7.3 Traffic Situation Awareness with Alerts

Traffic Situation Awareness with Alerts (TSAA) is aimed at improving a pilot's identification of conflicting traffic by providing on-board alerts for aircraft without Aircraft Alert and Collision Avoidance System (ACAS) equipment. Such traffic may or may not have been pointed out by air traffic control. This alert identifies conflicting traffic, but does not provide any resolution maneuver advice. TSAA was tailored to operate without excessive nuisance alerts when operated in the VFR traffic pattern at small general aviation airports, where most general aviation collision accidents occur.

The FAA worked over 3-4 years via RTCA SC-186 and EUROCAE WG-51 to complete the Safety, Performance and interoperability Requirements (SPR) document, which was published by RTCA as DO-348 in March 2014. TSAA avionics standards are included in DO-317B/ED-194A as described in section 1.1. Recently, L-3 Systems announced that they had added an option to their NGT-9000 product that complies with these standards.

2.2.7.4 Flight Trial of Merging & Spacing and CDTI-Assisted Visual Separation (CAVS)

As part of an agreement between the FAA, ACSS and US Airways (now American Airlines), American Airlines is conducting a phased flight trial evaluating CAVS and Merging & Spacing.

CAVS is an ADS-B-In application that assists the flight crew in acquiring and maintaining visual contact with a preceding aircraft (designated traffic) while performing a visual separation on approach procedure in Visual Meteorological Conditions (VMC). Because of the accuracy and integrity of displayed traffic on ADS-B In systems approved for CAVS, CAVS information may be used as a substitute for continuous visual observation of designated traffic under specified conditions. CAVS does not relieve the pilot of the responsibility to see and avoid other aircraft. ATC maintains separation responsibility from all other aircraft and for the orderly flow of traffic to the runway. There is no pilot-controller phraseology associated with CAVS, so ATC will be unaware that a flight crew is using CAVS.

Merging & Spacing (M&S) is the name of an ADS-B-In capability created and certified by ACSS and UPS for use in flight trials by UPS about 10 years ago. It is conceptually similar to the flight deck capability envisioned for Interval Management as described above in section 2.2.7.2.

Under a cooperative agreement with FAA and ACSS, American Airlines installed the ACSS SafeRoute ADS-B-In system and associated auxiliary traffic displays in twenty A330 aircraft. Each installed SafeRoute system supports multiple ADS-B-In applications, including both CAVS and M&S. In May 2014, US Airways (now American) began CAVS operations with the equipped A330s at Philadelphia International Airport (PHL). Results are still being analysed.

On 28 April 2015, American Airlines began M&S operations on A330s that are en route from Europe to PHL. The American Airlines Operational Control Center worked with Boston Center to identify potential M&S aircraft and communicate a time-based spacing goal (provided by Boston Center) and the Target Aircraft flight identification to the M&S aircraft via ACARS. Unfortunately, integration issues associated with the merger of US Airways and American Airlines caused the airline to cease M&S operations shortly thereafter. FAA is in discussions with American Airlines to determine when this trial might be resumed.

2.2.8 ADS-B on Airport Surface Vehicles

The FAA is promoting ADS-B for use with vehicles on airport surfaces to improve runway safety. Any vehicle (e.g., a tug, fuel truck, snowplow, or rescue-and-firefighting vehicle) can be equipped to

transmit location information to controllers, pilots, vehicle drivers, or airport operators. In the U.S., ADS-B transmissions are only permitted from airport ground vehicles in the airport movement area.

While not mandating vehicle ADS-B, the FAA is encouraging airport operators to equip appropriate vehicles. In addition to significant improvements in runway safety, airport managers could use the information to track assets more efficiently.

The FAA issued AC 150/5220-26 for Airport Ground Vehicle ADS-B Out Squitter Equipment as referenced in section 4. The AC helps airport managers understand how to determine which vehicle transponders meet FAA performance requirements, inform the FAA of the airport's intent to proceed with vehicle ADS-B, request unique ICAO identifying numbers for vehicles to be equipped, and request a transmit license.

ADS-B Vehicle Squitter Equipment is eligible for Airport Improvement Plan (AIP) Funding, which allows eligible U.S. airport authorities choosing to procure qualified Vehicle Squitter Units to use AIP funds to do so.

3. ACTION BY THE MEETING

The meeting is invited to:

- a) note the information contained in this paper; and
- b) discuss any relevant matters as appropriate.

4. REFERENCES

U.S. ADS-B Final Rule

<http://www.regulations.gov/#!documentDetail;D=FAA-2007-29305-0289>

FAA TSO-C154c (UAT Link)

[http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/0/e5a37977fbd8786b8625768200579728/\\$FILE/TSO-154c.pdf](http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/0/e5a37977fbd8786b8625768200579728/$FILE/TSO-154c.pdf)

FAA TSO-C166b (1090ES Link)

[http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/0/e70544d62a001f87862576820057970f/\\$FILE/TSO-166b.pdf](http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/0/e70544d62a001f87862576820057970f/$FILE/TSO-166b.pdf)

FAA AC 20-165B (ADS-B-Out Installation Guidance)

http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_20-165B.pdf

FAA AC 90-114A, Change 1 (ADS-B Operations)

http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_90-114A_CHG_1.pdf

FAA TSO-C195b (Aircraft Surveillance Applications)

[http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/0/45845cd583ad3cd686257d62006b3b3e/\\$FILE/TSO-C195b.pdf](http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/0/45845cd583ad3cd686257d62006b3b3e/$FILE/TSO-C195b.pdf)

FAA AC 20-172B (ADS-B-In Installation Guidance)

http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC20-172B.pdf

Report from the ADS-B Aviation Rulemaking Committee to the FAA, 26-Sep-2008

<http://www.faa.gov/nextgen/programs/adsb/media/arcReport2008.pdf>

Report from the ADS-B-In Aviation Rulemaking Committee to the FAA, 30-Sep-2011

<http://www.faa.gov/nextgen/programs/adsb/media/ADSb%20In%20ARC%20Report%20with%20transmittal%20letter.pdf>

Report from the ADS-B-In Aviation Rulemaking Committee to the FAA, 31-Oct-2012

<http://www.faa.gov/nextgen/programs/adsb/media/ADS-BInARCReportOct2012.pdf>

Final Letter from the ADS-B-In Aviation Rulemaking Committee to the FAA, 21-Nov-2012

<http://www.faa.gov/nextgen/programs/adsb/media/ADS-BInARCLetterToFAA.pdf>

FAA AC 150/5220-26 (Airport Ground Vehicle ADS-B Out Squitter Equipment)

http://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5220_26_consolidated.pdf

http://www.faa.gov/documentLibrary/media/Advisory_Circular/150-5220-26-chg1-errata-sheet.pdf

FAA ADS-B In-Trail Procedures (ITP) Operational Benefits Report

<http://www.faa.gov/nextgen/programs/adsb/media/ADS-BITPOpFlightEvalBenefitsReport.pdf>

Human Factors Considerations for ADS-B In-Trail Procedure Report

http://www.faa.gov/nextgen/programs/adsb/media/ITP_HF_16Mar2016.pdf
