International Civil Aviation Organization

AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST SEMINAR AND TWELFTH MEETING OF AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST (ADS-B) STUDY AND IMPLEMENTATION TASK FORCE (ADS-B SITF/12)

Kolkata, India, 15-18 April 2013

Agenda Item 6: **Review States' activities and interregional issues on trials and implementation of ADS-B and multilateration**

REPORT OF FAA ADS-B ACTIVITIES

(Presented by Federal Aviation Administration)

SUMMARY

This paper provides the status of FAA ADS-B implementation and development activities that may be of interest to meeting participants.

1. Introduction

1.1 This paper provides an overview of U.S. FAA Automatic Dependent Surveillance – Broadcast (ADS-B) activities that may be of interest to meeting participants.

2. Discussion

2.1 FAA IMPLEMENTATION ACTIVITIES

2.1.1 Regulatory Activities

2.1.1.1 Advisory Circular (AC) 20-165A

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 in May, 2010. 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 as a result of FAA certification experience to AC 20-165A on 7 Nov 2012. The U.S. ADS-B Final Rule, the Version 2 TSOs, and AC 20-165A are referenced in section 4.

Note: *RTCA/EUROCAE have produced and approved DO-260B/ED-102A, "Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)," which serves as the basis for TSO-C166b and its European equivalent.*

2.1.1.2 AC 90-114, Change 1

The FAA Flight Standards Service indicates that no operational approval is required for aircraft with avionics compliant with AC 20-165A 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). The original AC was published on 8 December 2011 and contained general guidance and operational consideration information regarding ADS-B. AC 90-114, Change 1, which added an appendix providing guidance for obtaining approval for In Trail Procedures (ITP) (see 2.1.2.6.1, below), was published on 21 September 2012 (see section 4). With the publication of AC 90-114, Change 1, the FAA ITP Policy Memo was withdrawn, as all of the FAA standards and guidance for ITP are implemented in TSO-C195a, AC 20-172A, and AC 90-114, Change 1.

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

2.1.1.3 Technical Standard Order (TSO)-C195a

This TSO was released by the FAA on 29 February 2012. This TSO invokes RTCA DO-317A (identical to ED-194) and covers the following applications:

a) Enhanced Visual Acquisition (EVAcq)
b) Basic Airborne (AIRB)
c) Visual Separation on Approach (VSA)
d) Basic Surface (SURF)
e) In-Trail Procedures (ITP)

Section 4 of this paper provides a reference for TSO-C195a.

2.1.1.4 AC 20-172A

This AC was published on 23 March 2012 and provides airworthiness guidance for ADS-B-In systems and applications. Revisions were made from AC 20-172 to reflect feedback comments from the ADS-B-In ARC and to reflect the additional applications (EVAcq and ITP) in TSO-C195a (versus TSO-C195). Section 4 of this paper provides a reference for AC 20-172A.

2.1.2 Surveillance and Broadcast Services (SBS) Program

The U.S. Federal Aviation Administration (FAA) is delivering 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 Version 2 avionics certified and installed in accordance with FAA AC 20-165A (or an equivalent approved by FAA Aircraft Certification) will receive air traffic control (ATC) separation service in the U.S. 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:

- 978 MHz Universal Access Transceiver (UAT) link per FAA TSO-C154c;
- 1090 MHz Extended Squitter (1090ES) link per TSO-C166b.

The U.S. ADS-B Final Rule requires aircraft that operate above Flight Level (FL) 180 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 ATC. 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 broadcasts from nearby aircraft on the same link, 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 justifies the Automatic Dependent Surveillance – Rebroadcast (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 January 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- R is a pilot advisory service that receives data from aircraft on one link and immediately rebroadcasts it on the other link. See Figure 1 below. To conserve spectrum, 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 will be 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: TIS-B is a pilot advisory service for situation awareness, gathering data from U.S. ATC radars, Wide Area Multilateration (WAM) systems such as those used in Alaska/Colorado, and surface multilateration systems like Airport Surface Detection Equipment, Model X (ASDE-X). 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.

Flight Information Service - Broadcast (FIS-B): 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 is considering additional products for the FIS-B service in the future. Products under consideration include Echo tops, Lightning strikes, Severe Weather Forecast Alerts and Severe Weather Watch Bulletin, Ceilings, Digital Automated Terminal Information Service, Icing (Current/Forecast Potential), Terminal Weather Information for Pilots, and Turbulence.

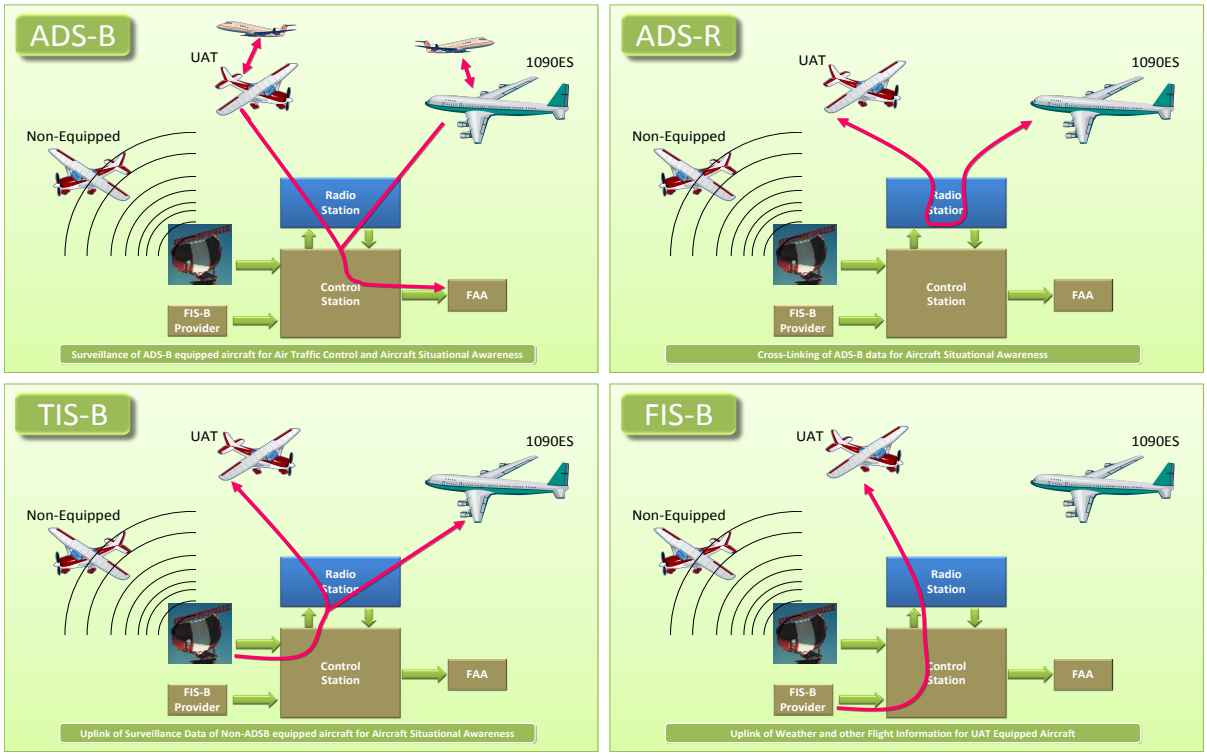

Figure 1

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2.1.2.1 **Service Delivery Approach and Implementation Status**

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

As of 6 March 2013, 450 radio sites of about 700 planned sites had been declared operational by the FAA. See Figure 2 below for a map of the operational radios as of 6 March 2013; the latest map can be found at:http://www.faa.gov/nextgen/flashmap

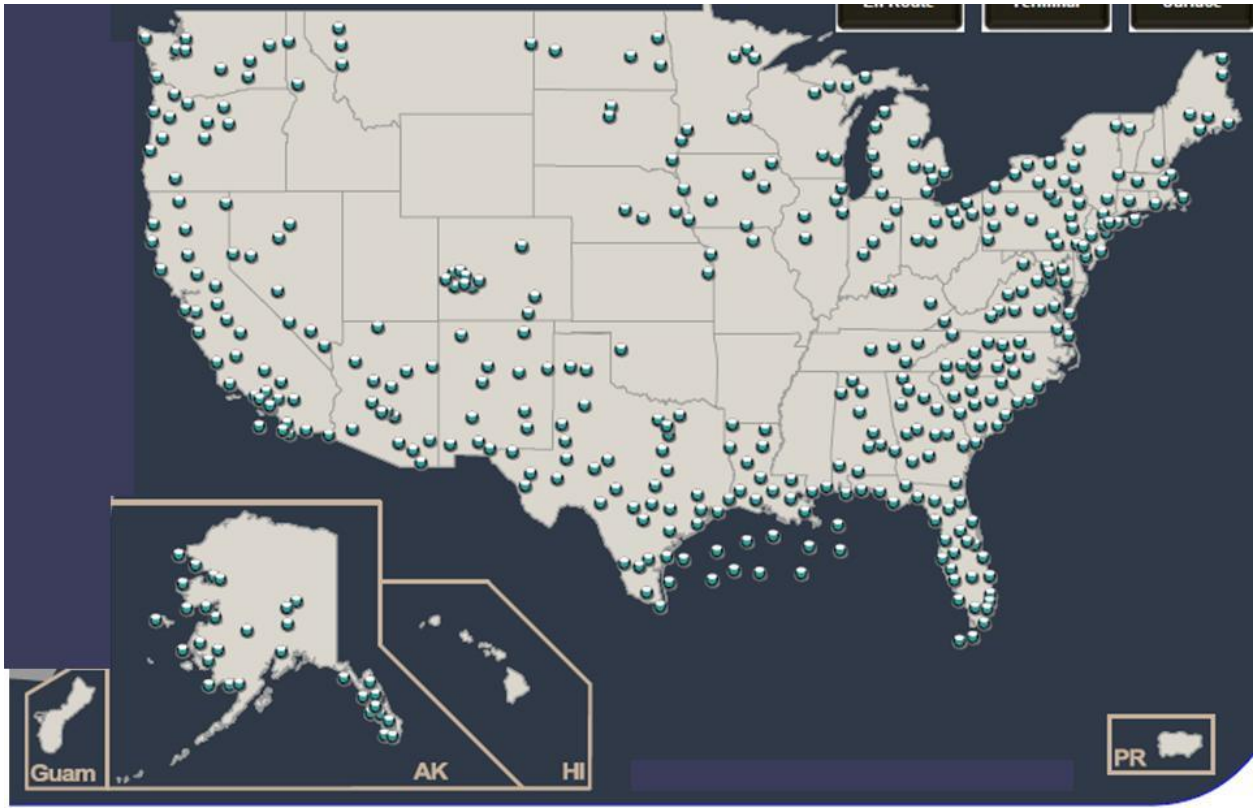


Figure 2

2.1.2.2 **SBS Monitor**

The SBS Monitor provides an FAA-developed independent monitor of the status of the ITT ground infrastructure and provides an assessment of ITT's performance in delivering services to the FAA. The SBS Monitor performs or will perform the following functions:

1) Contract Technical Performance Monitoring
These Technical Performance Measures (TPMs) nominally include the latency, availability, and update rate of the SBS services provided by ITT. The FAA Contracting Officer uses the TPMs to evaluate the quality of the SBS services provided by ITT.

2) Avionics Compliance Monitoring
These aircraft ADS-B reports measure equipage, characterize duplicate/invalid International Civil Aviation Organization (ICAO) address issues, and evaluate compliance with avionics performance requirements defined in 14 CFR §91.227.

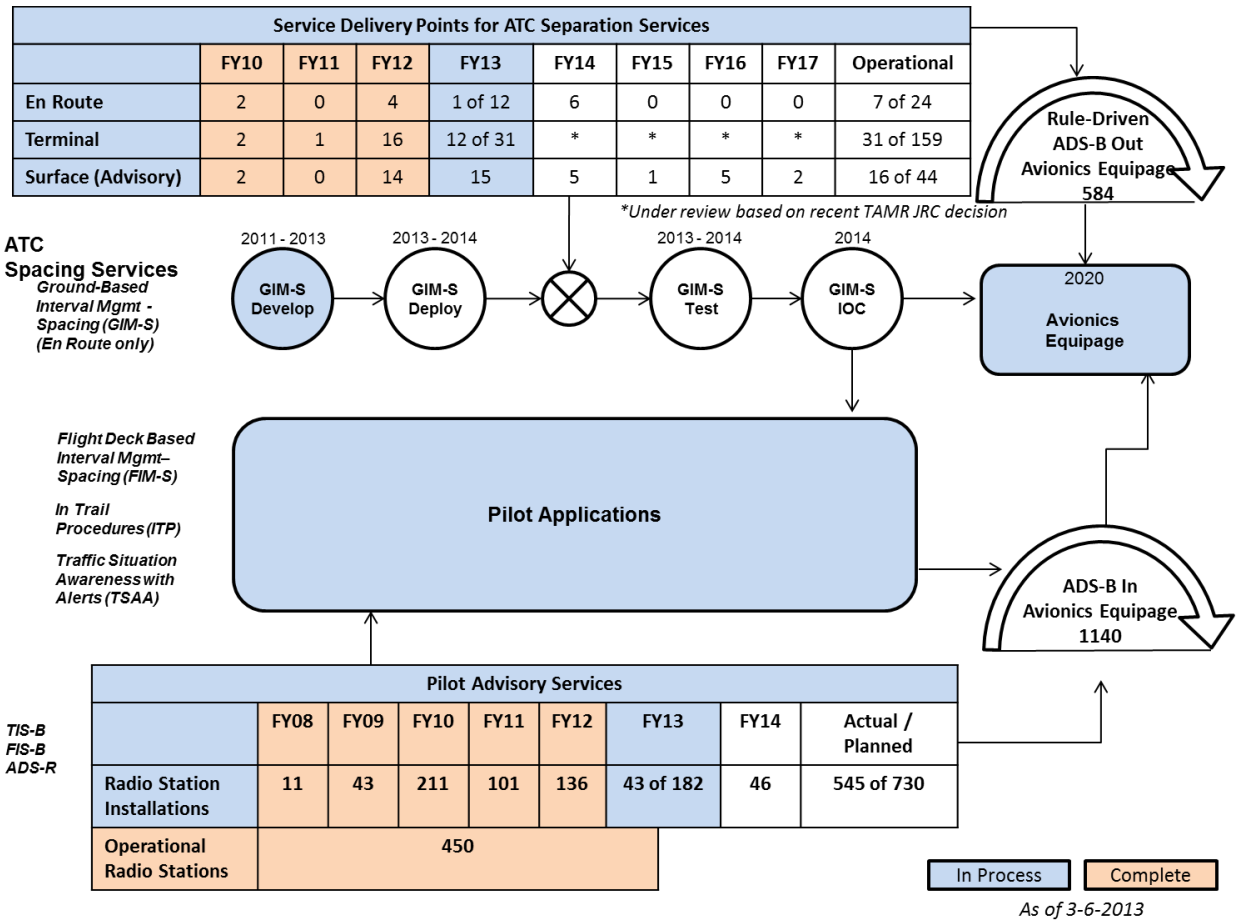
3) Service Status Monitoring
This function informs personnel at FAA Operations Control Centers, who notify users via NOTAMs about the current status of SBS services throughout the U.S.

2.1.2.3 **FAA ADS-B Development Strategy**

The diagram below shows the overall FAA ADS-B development strategy through 2017. ATC Separation Services will be rolled out on a facility-by-facility basis. Major en route and terminal facilities will be using ADS-B surveillance by early 2014, but rollout will continue at smaller terminal facilities until at least 2015, due to the need for automation system modernization at those facilities.

ATC Surface Advisory Services 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) that is currently under development and should be fully deployed by 2017.

The pilot applications and pilot advisory services are available to aircraft equipped with ADS-B-In capability. Pilot Advisory Services (ADS-R, TIS-B, and FIS-B) are activated as each ADS-B ground station is installed, tested, and declared operational.



2.1.2.4 **Air Traffic Control Separation Services**

Since late 2009, the FAA has been delivering ATC separation services to aircraft equipped with ADS-B Version 1 avionics (TSO-C154b/TSO-C166a) in limited locations. Between 2009 and 2011, the following key-sites achieved 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 TRACONs, ATC separation services are 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. As with any complex system, there were a set of issues raised during the testing and evaluation phase that are being addressed. These issues, documented in ISD Action Plans, are being resolved, as needed, to enable activation of ADS-B for ATC Separation Services in the initial production sites.

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 ircraft equipped with Version 2 ADS-B avionics. End-to-end system testing was conducted to validate the separation standards analyses for ADS-B-to-ADS-B and ADS-B-to-radar separation services.

The initial En Route Automation Modernization (ERAM) production site was ZHU. ZHU is implementing 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 using a preferred radar or ADS-B data for ATC separation services, adapted such that radar (when available) is the preferred sensor. In the third phase, ERAM will be provided with ADS-B data to enable ATC separation services using a fused ADS-B and radar track. Except for the Gulf of Mexico, all ERAM ATC separation services are only provided to aircraft equipped with Version 2 ADS-B avionics that report appropriate ADS-B quality parameters.

By 2015, the FAA plans to integrate ADS-B surveillance data in the Advanced Technologies and Oceanic Procedures (ATOP) automation platform to support ATC separation services in non-radar airspace for which the U.S. is responsible and able to provide ADS-B coverage.

2.1.2.5 **Pilot Advisory Services**

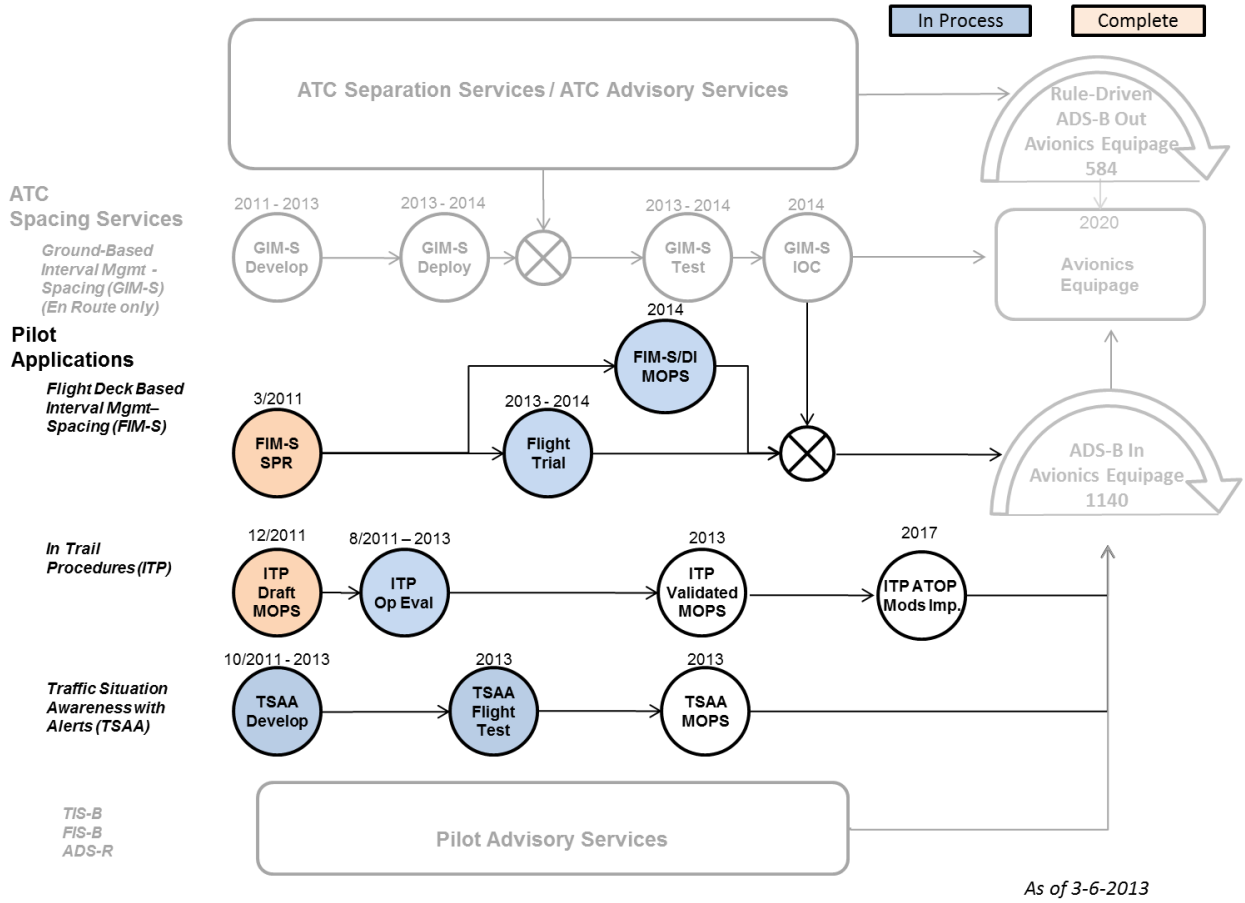
The continued deployment of Pilot Advisory Services (broadcast of TIS-B/ADS-R and FIS-B) continues. The number of Service Volumes in which Pilot Advisory Services are operational was 183 (57% of the total) as of the end of February 2013; they are too numerous to list here.

The latest updated information on operational Service Volumes can be found on the FAA website as described previously.

2.1.2.6 **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 ADS-B-In avionics which receive, process, and display ADS-B and TIS-B data from surrounding aircraft. In addition to providing benefits directly to operators, these applications will help accelerate the understanding of ADS-B and provide a path to future applications.

The FAA is currently investing in development for three applications: Flight-deck-based Interval Management - Spacing (FIM-S), Oceanic ITP, and Traffic Situation Awareness with Alerts (TSAA). The figure below shows the plans for these applications as part of the FAA ADS-B Strategy.



2.1.2.6.1 **Oceanic ITP**

The objective of ITP is to increase the safety and efficiency of long-haul flights in non-surveillance airspace. The concept takes advantage of 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.

2.0.1 The FAA and United Airlines are conducting initial operational evaluations 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 oceanic airspace managed by Oakland Center. Oakland Center controllers were trained the week of 25 – 29 Jul 2011. FAA En Route and Oceanic Safety and Operations Support authorized Oakland Center to initiate the operation evaluation on 15 August 2011; this has since been extended by another year. United Airlines received Operational Approval from FAA Flight Standards to commence ITP operations on 15 Aug 2011. FAA is engaged with the Air Navigation Service Providers (ANSPs) in New Zealand and Fiji about expanding the ITP operational evaluation to the Nadi FIR and Auckland Oceanic FIR and this is expected to occur in 2013. 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 in the development of the PANS-ATM amendment for ITP and the accompanying ITP Circular, and FAA continues to support the progression of the PANS-ATM amendment through the ICAO process.

All FAA certification and flight standards guidance material for ITP are published in TSO-C195a, AC 20-172A, and AC 90-114, Change 1. See section 4 for the references to these documents.

2.1.2.6.2 **Interval Management (IM)**

Interval Management (IM) introduces a new method for flight crews and ATC to achieve a desired spacing between aircraft in all phases of flight. 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. More advanced implementations of these operations were envisioned by the ADS-B-In ARC and are described in their report (referenced in section 4).

IM operations consist of a ground capability called Ground Interval Management - Spacing (GIM-S) to schedule/manage the arrival traffic flow, and a flight deck capability (FIM-S) to allow the aircraft to efficiently manage the interval assigned by air traffic control. The FAA is implementing the requirements for the capabilities in GIM-S via two FAA automation programs: Time-Based Flow Management (TBFM) and ERAM.

The FAA has several airline partners prepared to support operational data collection and benefits measurement as the initial FIM-S capabilities are established. The FAA supported the efforts of a joint RTCA/EUROCAE working group to develop the Safety, Performance and interoperability Requirements (SPR) document for FIM-S (also known as ASPA-IM), which resulted in RTCA DO-328.

RTCA SC-186 and EUROCAE WG-51 are working on the Minimum Operational Performance Standards (MOPS) for FIM-S avionics. This effort is expected to conclude in mid-2014.

2.1.2.6.3 **TSAA**

TSAA is aimed at improving a pilot’s identification of conflicting traffic by providing onboard alerts for aircraft without Traffic Alert and Collision Avoidance System (TCAS) equipment. Such traffic may or may not have been pointed out by ATC. This alert identifies conflicting traffic, but does not provide any resolution maneuver advice. TSAA will be tailored to operate without excessive nuisance alerts when operated in the visual flight rules (VFR) traffic pattern at small general aviation airports, where most collision accidents occur.

The FAA has contracted with the Massachusetts Institute of Technology (MIT) (and Avidyne as MIT's subcontractor) to develop this application. The FAA has engaged the Aircraft Owners and Pilots Association, the General Aviation Manufacturers Association, and Helicopter Association International stakeholders to participate with the FAA in periodic reviews of the MIT/Avidyne work. The joint RTCA/EUROCAE committee (SC-186/WG-51) agreed the Operational Services and Environment Definition (OSED) was “mature” enough to perform safety and performance analyses in October 2011. A series of piloted simulations to evaluate alerting algorithms and human factors considerations for a TSAA system has been completed and flight testing of a prototype system began in early February 2013. This project is working via RTCA SC-186 and EUROCAE WG-51 to produce Minimum Operational Performance Standards material for this application by the end of 2013.

2.1.2.6.4 **Airport Traffic Situation Awareness with Indications & Alerts (SURF-IA)**

The FAA funded multiple activities to support the development of an SPR for the surface situation awareness with indications and alerts (SURF-IA) application (published as RTCA DO-323). As part of this, Honeywell and ACSS conducted demonstrations of SURF-IA application prototypes in the Seattle area and the Philadelphia area. The FAA made the reports of these demonstrations available to SC-186 and other interested parties via the RTCA workspace for SC-186.

The demonstrations validated a suspected line-of-sight issue and identified an unexpected ADS-B "drop-out" issue for surface operations. The line-of-sight issue occurs for airports where terrain and/or buildings obstruct portions of intersecting runways that may be used simultaneously. The ADS-B drop-out issue can cause ADS-B transmissions of one aircraft within line-of-sight of another aircraft to not be received due to radio frequency multi-path interference. Both of these issues are being studied by the FAA to determine their scope and potential mitigations.

The FAA subsequently collected surface ADS-B data at Philadelphia International Airport (PHL) in October 2010 and confirmed that multipath was interfering with the incident ADS-B signals at multiple locations on the airport surface. This multipath phenomenon creates "blind spots" at which ADS-B-transmitting aircraft could not be seen by ADS-B-In systems. FAA is collecting additional data to characterize this problem and develop potential mitigation alternatives for consultation with industry and other nations.

2.0.2 RTCA DO-323 documents the demanding position accuracy/integrity performance requirements that are needed to minimize false alarm rates during surface operations. Depending on runway/taxiway geometries, the performance requirements are generally very demanding, exceeding the requirements of the U.S. ADS-B Final Rule. Many of the requirements can only be achieved with some form of augmentation (satellite-based or ground-based), or are projected to be achievable with future "dual-frequency" GPS and/or multi-constellation GNSS receivers.

At this time, due to the above-described technical issues, funding limitations, and the challenging performance requirements of this application, the FAA has no current plans to initiate MOPS development activities for SURF-IA.

2.1.2.7 **ADS-B-In Aviation Rulemaking Committee (ARC)**

The ADS-B ARC recommended that the FAA, in partnership with industry, should define a strategy for ADS-B-In by 2012, ensuring the strategy is compatible with ADS-B-Out avionics. The ADS-B ARC report is referenced in section 4.

In response to this recommendation, the FAA chartered an ADS-B-In ARC on 30 June 2010, with the following deliverables:

Deliverable	Due Date
Task 1: ARC endorsement (or not) of continuing near-term application development	Oct 2010
Task 2: Final ARC ADS-B-In strategy recommendations	Sept 30, 2011
Task 3: Delivery of products from any activities that follow up ADS-B-In strategy recommendations	Jun 1, 2012

The international members of the ARC included Christophe Maily (Airbus), David Bowen (SESAR JU), Greg Dunstone (AirServices Australia), Jeff Cochrane (NavCanada), and Ken Dunlap (IATA). Bryan Jolly of EASA and John Law of Eurocontrol also participated as observers.

The FAA Administrator kicked off the ARC's first meeting on 1 July 2010. At this meeting, the FAA provided the ARC with the following documents:

(1) ADS-B Application Integrated Work Plan (AIWP), version 2
(2) Boeing report on ADS–B capabilities in transport-category aircraft
(3) Airbus report on ADS–B capabilities in transport-category aircraft

All of these documents are available upon request.

On 1 November 2010, the ARC sent its Task 1 recommendations to the FAA. In summary, the ARC recommended that the FAA continue efforts to develop the SURF-IA and IM family of applications. After discussions between FAA and the ARC, the industry's interest in a FIM-S/DI MOPS became clear. In short, the industry would like to build avionics for FIM-DI and use them initially for FIM-S until enough confidence is gained to enable FIM-DI operations to begin.

The ARC delivered its Task 2 Report to the FAA on 30 September 2011. The FAA made this report public via the FAA website on 17 November 2011 and published a notice of this in the US Federal Register. The ADS-B-In ARC report is referenced in section 4.

U.S. Public Law 112-095, "FAA Modernization and Reform Act of 2012," section 211(b) directed the FAA to initiate a rulemaking within a year with guidelines and regulations for ADS–B In technology, and requires ADS-B In to be mandated by 2020 in the U.S. for congested airspace, congested airports, or in any other airspace deemed appropriate. Therefore, the FAA amended the ADS-B-In ARC's charter on 30 May 2012 to facilitate the agency's actions required by the statute as follows:

- By 31 October 2012, the ARC will submit additional recommendations on how to frame an ADS-B In equipage mandate such that the benefits exceed costs before 2035. The ARC shall identify: (a) in what airspace, and/or (b) at what airports, and/or (c) by what other criteria the FAA could apply to frame an ADS-B In mandate (examples including, but not limited to, by operator class or aircraft class). In addition, the ARC is requested to provide feedback on a 2020 compliance date for a potential ADS-B In mandate.
- By 30 November 2012, the ARC shall complete all follow on work related to the original submission and prepare a summary report detailing recommended next steps

The FAA has received the above deliverables from the ADS-B-In ARC and is studying them.

2.1.2.8 **Vehicle ADS-B**

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 fire fighting vehicle) can be equipped to transmit location information to ATC, pilots, vehicle drivers, or airport operators. In the U.S., ADS-B transmissions will only be permitted from ground vehicles that are in the airport movement area (and subject to ATC clearances).

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 ADS-B information to track assets more efficiently. This would be especially useful with rescue vehicles in case of an accident.

The FAA has 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.

The FAA has been evaluating the first vehicle ADS-B Out squitter unit for compliance to the FAA Vehicle Squitter Performance Specification. The first unit utilizes the UAT ADS-B link, which is the preferred Vehicle Squitter Unit link as stated in the FAA Advisory Circular. Extensive operational testing and evaluations were performed through April 2012, which provided data to update performance requirements and ensure interoperability with ASDE-X. The successful unit from FreeFlight Systems was added to the Advisory Circular as a Qualified Product in September 2012.

The FAA has made the ADS-B Vehicle Squitters eligible for Airport Improvement Plan (AIP) Funding. That will allow eligible airport authorities choosing to procure qualified Vehicle Squitter Units to use AIP funds to do so.

2.1.2.9 **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 U.S. mainland and Alaska. However, other opportunities exist in the Caribbean as well as at low altitudes in Alaska and the mountainous regions of the western U.S. What all of these regions have in common is either a lack of radar coverage or relatively unreliable radar coverage.

The FAA has agreements with JetBlue and United Airlines 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 35 A320 aircraft with Version 2 ADS-B avionics, and United is working with Boeing and Rockwell Collins to equip at least 110 737NG aircraft with Version 2 ADS-B avionics.

FAA is analyzing ADS-B surveillance coverage in current procedural airspace managed by the U.S. Alternatives include space-based ADS-B (orbiting satellites listen to aircraft ADS-B broadcasts and relay this information to an ATC facility) as well as potential installation of ADS-B radio stations in countries willing to collaborate with the U.S. to cover the airspace of interest. An advantage of space-based ADS-B is the potential for providing coverage in broad regions of oceanic airspace, where radio station installation is not possible. The technical and cost benefits of this approach are currently being studied.

2.1.2.10 **Avionics Upgrades to Version 2 Avionics**

The FAA is working 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, operators in Alaska equipped with avionics under the FAA Capstone Program, and several helicopter operators in the Gulf of Mexico. Currently, the FAA is funding the upgrade from Version 1 to Version 2 transponders for the UPS fleet and the US Airways A330 fleet. As part of this effort, ACSS is one of the first applicants to exercise the provisions of AC 20-165, achieving STCs for installations on UPS 767 and 747 aircraft in January 2012, for JetBlue A320 aircraft in July 2012, for US Airways A330 aircraft in August 2012, and for UPS A300 and MD-11 aircraft in January 2013. FAA is currently engaging 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 AC 20-165A and 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 is working toward an STC for installations on multiple Sikorsky helicopter models. In the next few years, FAA plans to engage with Alaska operators with Capstone equipment and support upgrading their ADS-B Version 1 avionics to Version 2.

2.1.2.11 **ADS-B Service Availability Prediction Tool (SAPT)**

The SAPT is being developed pursuant to an ADS-B ARC recommendation. The ARC's concern was the difficulty a user would have in predicting the expected availability of a given Global Positioning System (GPS) accuracy/integrity performance level over a planned route of flight.

The SAPT assumes the minimum performance requirements for Global Navigation Satellite System (GNSS) sensors, as required in the appropriate TSOs. The SAPT prediction is based upon; (1) the time, route and airspace of the planned flight; (2) ADS-B-related avionics on the subject aircraft; and (3) the announced status of the GPS satellite constellation.

Currently, FAA is considering the enhancement of adding further information to the SAPT about the availability of secondary surveillance radar coverage and wide-area multilateration surveillance coverage. Such an enhancement would allow operators to understand whether alternative surveillance sources could mitigate a temporary reduction in GPS accuracy/integrity performance within airspace along their planned route of flight.

SAPT is envisioned as one method for an operator to assess the availability of required ADS-B performance for a flight. Operators also may choose to use an alternative FAA-approved prediction tool.

2.1.2.12 **1090 MHz Spectrum Alternatives Study**

In 2006, the FAA identified the possibility that, without proper control of the 1090 MHz spectrum in the U.S., the addition of ADS-B to the current environment may reduce the performance of ADS-B and other 1090 MHz systems, reducing benefits and system performance. FAA determined that, unless two specific mitigations were put into place, ADS-B and TCAS would be unable to meet their respective performance requirements by 2020. The two mitigations now being implemented by the FAA are:

- The elimination of the "Terra Fix" that was implemented in SSRs to address improper functioning of a particular type of transponder, and
- A modification to the Mode S interrogation sequence (in Mode S SSRs).

Further analysis by the FAA in 2009 (see reference in section 4) revealed that, while these mitigations would allow continued use of the 1090 MHz spectrum in 2020, its viability much beyond this timeframe was not assured given the projected growth in potential users of the spectrum and the desire to implement more advanced NextGen capabilities. The report concluded that a viable long-term strategy must be formulated to sufficiently mitigate 1090 MHz spectrum congestion for all users to ensure a successful transition to NextGen.

As a result of the 2009 report, the ARC for ADS-B requested that the FAA work with the Air Traffic Management Advisory Committee (ATMAC) ADS-B Work Group to:

- Establish the necessary air-to-air ranges required to support planned "ADS-B-In" applications;
- Analyze the costs, benefits, and safety implications of the required 1090 MHz frequency congestion mitigations; and
- Help determine the appropriate spectrum mitigations to be implemented (beyond the previously identified mitigations above).

In response to this request, the FAA has initiated an analysis effort to address these concerns and recommend the most appropriate long-term strategy. This effort is being conducted in two phases – an Interim phase which was completed in September 2012 to inform FAA SBS Program planning, and a full phase targeted for completion by late 2013 or early 2014 to inform broader FAA efforts that may be required.

2.1.3 **TCAS/ACAS-X Program**

Recognizing the limitations of the TCAS II design, the Federal Aviation Administration's (FAA's) Traffic Alert and Collision Avoidance (TCAS) Program Office (PO) has funded the development of an advanced Airborne Collision Avoidance System (ACAS), called ACAS-X, since 2009. ACAS-X has the flexibility to reduce unnecessary alerts, support use of alternative surveillance sources, enable future Next Generation Air Transportation System (NextGen) airspace procedures (including several proposed ADS-B-In applications), and potentially provide a collision avoidance capability for new user classes.

Initial evaluations of the new ACAS-X logic have been conducted using the same Monte Carlo safety simulations employed in recent TCAS II v7.1 safety studies. These studies indicate that compared to existing TCAS II, the new logic significantly reduces the probability of a Near Mid-Air Collision (NMAC), while also significantly reducing the number of alerts and RA reversals (~50% respectively).

ACAS-X has reached a state of sufficient maturity that industry and international participation in development activities will facilitate acceleration of fielding a future collision avoidance capability. Standards development work within RTCA SC-147 is anticipated to begin in late 2013 and be completed by the 2018 timeframe. Following operational evaluation aboard participating partner aircraft operators, the first certified units could be in service as early as 2020.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) Note this information.

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/e5a37977fbdb786b8625768200579728/$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

FAA AC 20-165A (ADS-B-Out Installation Guidance)
http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC%2020-165A.pdf

FAA AC 90-114, Change 1 (ADS-B Operations)
http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/69fd8e2a5b3cb95b86257a850056c48d/$FILE/AC%2090-114%20CHG%201.pdf

FAA TSO-C195a (Aircraft Surveillance Applications)
http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/0/a742d5047d73c258862579b3005501d2/$FILE/TSO-C195a.pdf

FAA AC 20-172A (ADS-B-In Installation Guidance)
http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/a577ca07065f4a26862579cd007889e0/$FILE/AC%2020-172A.pdf

Airport Surface Surveillance Capability Market Survey
http://faaco.faa.gov/attachments/Airport_Surface_Surveillance_System_Market_Survey_020110.doc

Report from the ADS-B Aviation Rulemaking Committee to the FAA, 26-Sep-2008
http://www.faa.gov/nextgen/portfolio/trans_support_progs/adsb/media/arcReport2008.pdf

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

http://www.faa.gov/nextgen/portfolio/trans_support_progs/adsb/media/ADSB%20In%20ARC%20Report%20with%20transmittal%20letter.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

"Final Report on 1090 MHz Spectrum Congestion in 2035 and Performance of Systems Operating in the Band," Version 1.0, available on request from FAA.

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