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REPORT OF FEDERAL AVIATION ADMINISTRATION (FAA) ADS-B ACTIVITIES

(Presented by the United States of America)

SUMMARY

This paper presents a brief summary of recent FAA activities in the implementation of ADS-B in the United States.

This paper relates to –

Strategic Objectives:

A: ***Safety*** *– Enhance global civil aviation safety*

C: ***Environmental Protection and Sustainable Development of Air Transport*** *– Foster harmonized and economically viable development of international civil aviation that does not unduly harm the environment*

Global Plan Initiatives:

GPI-1 Flexible use of airspace
GPI-5 RNAV and RNP (Performance-based navigation)
GPI-7 Dynamic and flexible ATS route management
GPI-9 Situational awareness
GPI-10 Terminal area design and management
GPI-12 Functional integration of ground systems with airborne systems
GPI-13 Aerodrome design and management
GPI-16 Decision support systems and alerting systems
GPI-17 Data link applications
GPI-18 Aeronautical information
GPI-19 Meteorological Systems
GPI-21 Navigation systems

1. INTRODUCTION

1.1 This information paper provides a summary of U.S. ADS-B development and implementation activities that may be of interest to meeting participants.

2. DISCUSSION

Surveillance and Broadcast Services (SBS) Program

2.1 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.

2.2 **ADS-B:** Aircraft with avionics certified and installed in accordance with FAA AC 20-165 (or an equivalent approved by FAA Aircraft Certification) will receive air traffic control (ATC) separation service in the U.S.

> ***Note**: Specifically-approved aircraft equipped with previously approved avionics (TSO-C154b/TSO-C166a) are currently receiving ADSB-only ATC separation services in Alaska and the Gulf of Mexico.*

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

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

2.4 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.

2.5 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.

2.6 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.

2.7 **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. 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.

2.8 **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 such as those used in Alaska/Colorado, and surface multilateration systems like Airport Surface Detection Equipment, Model X (ASDE-X). 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.

2.9 **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. 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.

2.10 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.

Service Delivery Approach and Implementation Status

2.11 As of 23 Mar 2012, 418 radio sites of over 700 planned sites were constructed and 371 radio sites have been declared operational by the FAA. The latest map of the operational radios can be found at: http://www.faa.gov/nextgen/flashmap.

FAA ADS-B Development Strategy

2.12 The tables below show the overall FAA ADS-B development strategy for 2011-2017. ATC Separation Services will be implemented on a facility-by-facility basis by declaring Initial Operational Capability (IOC) at each site. Most major facilities will achieve IOC by the end of 2013, but implementation will continue at some smaller terminal facilities until 2015, due to the need for automation system modernization at those facilities.

Service Delivery Points for ATC Separation Services									
	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	Operational
En route	2	0	4	15	3	0	0	0	2 of 24
Terminal	2	1	16	45	52	43	0	0	3 of 159
Surface (Advisory)	2	0	14	15	5	1	5	2	2 of 44

Pilot Advisory Services								
	FY08	FY09	FY10	FY11	FY12	FY13	FY14	Actual/Planned
Radio Station Installations	11	43	211	101	134	186	46	418/730

2.13 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. ASSC is referenced in section 4. Implementation of ATC Surface Advisory Services will continue until 2017 in conjunction with the deployment of ASSC.

2.14 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 declared operational.

Air Traffic Control Separation Services

2.15 Since late 2009, the FAA has been delivering ATC separation services to aircraft equipped with ADSB Version 1 avionics (TSO-C154b/TSO-C166a). 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; and
- Airspace in the vicinity of Juneau, Alaska.

2.16 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.

2.17 The initial terminal production sites are 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 are being completed for CARTS and STARS include updating the software baselines to support ATC terminal separation for ADS-B-only targets (for aircraft equipped with AC 20-165 avionics). End-to-end system testing is being conducted to validate the separation standards analyses for ADS-B-to-ADS-B and ADS-B-to-radar separation services.

2.18 The initial En Route Automation Modernization (ERAM) production site is ZHU. ZHU will implement ADS-B data integration with ERAM in phases. The first phase provides ADS-B data to ERAM via a "virtual radar" interface now being used by the ZHU En Route Host system to provide separation services in the Gulf of Mexico airspace. In the second phase, ERAM will be provided with ADS-B data to enable ATC separation services using a fused ADS-B and radar picture that will be used for additional Air Route Traffic Control Centers (ARTCCs) after ZHU.

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

Pilot Advisory Services

2.20 The deployment of Pilot Advisory Services (broadcast of TIS-B/ADS-R and FIS-B) continues. As of 23 Mar 2012, Pilot Advisory Services were operational in the following Service Volumes:

- 23 enroute transmission facilities (15 Centers, 6 special Alaska volumes, 2 special Gulf of Mexico volumes);
- 95 terminal transmission facilities; and
- 6 surface transmission facilities.

2.21 The latest updated information on FAA SBS deployment can be found on the FAA website as described previously.

Pilot Applications

2.22 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 and ground transmitters. 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.

2.23 The FAA is currently investing in development for three applications: Oceanic In-Trail Procedures (ITP), Flight-deck-based Interval Management - Spacing (FIM-S), and Traffic Situation Awareness with Alerts (TSAA).

Oceanic ITP

2.24 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.

2.25 The FAA and United Airlines are conducting initial operational evaluations of ADS-B ITP using 12 United Boeing 747-400 aircraft. The FAA developed ITP Interim Policy to support certification of the ITP functionality in various aircraft until TSO-C195a was published and appropriate AC' s were modified.

2.26 On 24 June 2011, FAA granted a Supplemental Type Certificate (STC) 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 ARTCC. FAA En Route and Oceanic Safety and Operations Support authorized Oakland ARTCC to initiate the operational evaluation on 15 August 2011. On the same day, United Airlines received Operational Approval from FAA Flight Standards to commence ITP operations.

2.27 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 by the end of 2012. 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.

Interval Management (IM)

2.28 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.

2.29 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.

2.30 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.

2.31 RTCA SC-186 and EUROCAE WG-51 have begun initial work on the Minimum Operational Performance Standards (MOPS) for FIM avionics. This effort is expected to conclude in late 2013.

TSAA

2.32 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.

2.33 The FAA has contracted with the Massachusetts Institute of Technology (MIT) to develop this application. The FAA has engaged the Aircraft Owners and Pilots Association, the General Aviation Manufacturers Association, and Helicopter Association International to participate with the FAA in periodic reviews of the MIT work. The goal of this activity is to work through RTCA/EUROCAE to produce MOPS for this application by the end of 2013.

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

2.34 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.

2.35 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.

2.36 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.

2.37 RTCA DO-323 documents the 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.

2.38 At this time, due to the above-described technical issues, funding limitations, and the challenging performance requirements of this application, the FAA does not currently plan to initiate MOPS development activities for SURF-IA until 2014 or later.

Vehicle ADS-B

2.39 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).

2.40 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.

2.41 The FAA has issued AC 150/5220-26 for Airport Ground Vehicle ADS-B-Out Squitter Equipment, which 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.

2.42 As of March 2012, the FAA was 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 Advisory Circular. Extensive operational testing and evaluations are expected to continue through April 2012 or until successful completion of all performance tests. The successful unit will be added to the Advisory Circular as a Qualified Product.

2.43 The FAA intends to make 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.

3NM En-Route Separation

2.44 The FAA conducted an analysis of the target level of safety for an ADS-B application that would enable 3 nautical mile (NM) ATC separation in domestic en route airspace where it is currently not permitted (in the U.S., 3 NM separation can only be applied below certain altitudes and under certain surveillance conditions).

2.45 The ICAO *Manual on Airspace Planning Methodology for the Determination of Separation Minima* outlines two methods for determining whether a proposed system is acceptably

safe: (1) comparison with a reference system (given no reduction in separation standards) and (2) evaluation of system risk against a threshold. Since this ADS-B application would reduce separation, the first approach cannot be used. The FAA is therefore evaluating system risk against a predetermined acceptable level of risk (threshold). This threshold is the maximum acceptable risk of collision, or target level of safety.

2.46 The FAA is currently analyzing data collected during flight testing in December 2011. This data was collected to validate/refine analytical models used for safety analyses.

Using ADS-B to Enhance ATC Separation Services

2.47 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.

2.48 The FAA has an agreement with JetBlue to explore the benefits of ADS-B surveillance in offshore airspace along the U.S. east coast. The FAA is discussing opportunities to explore benefits in similar type airspace with other airlines/operators.

2.49 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. The agency is planning to continue evaluating space-based ADS-B and decide by 2014 whether or not to proceed with an acquisition for this type of service.

ADS-B Service Availability Prediction Tool (SAPT)

2.50 The SAPT is being developed pursuant to an ADS-B Aviation Rulemaking Committee (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.

2.51 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.

2.52 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.

2.53 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.

3. ACTION BY THE MEETING

3.1 The meeting is invited to note the information contained in this paper.

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