Surveillance and Broadcast Services (SBS) Program Office

Concept of Operations (ConOps)

SBS-006, Revision 06



June 26, 2012

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6/27/12
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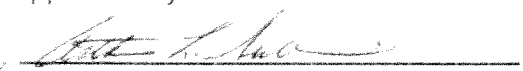
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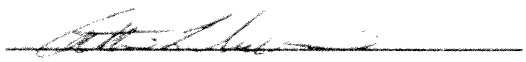
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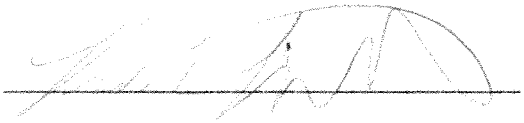
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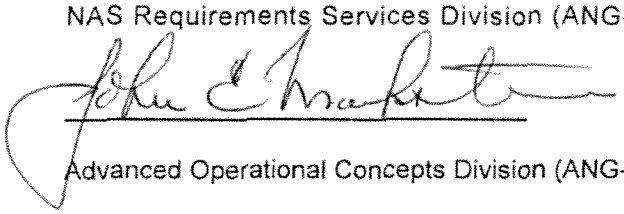
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Revision History for
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Revision #	Description	Document Date
Rev. 06	CM Baseline Version, DCR-PMO-018	June 26, 2012

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Concept of Operations

1. INTRODUCTION
   1.1. Operational Use
   1.2. System Overview
   1.3. Document Overview
   1.4. References
2. OPERATIONAL NEED
   2.1. Current Environment
   2.2. Capability Shortfalls
3. SYSTEM JUSTIFICATION
   3.1. Description of Desired Change
   3.2. Potential Benefit of New or Modified System
4. OPERATIONAL DESCRIPTION
   4.1. Surveillance and Broadcast Services
   4.2. ADS-B Applications
   4.3. Proposed Environment
5. SYSTEM DESCRIPTION
   5.1. Surveillance and Broadcast Services System
   5.2. Functional Description
   5.3. Modes of Operation
6. ASSUMPTIONS, CONSTRAINTS, AND DEPENDENCIES
   6.1. Organizational Impacts
   6.2. Operational Impacts
   6.3. Service Provider and User Impacts
   6.4. Other Considerations

APPENDIX A – Definitions and Glossary

APPENDIX B – Cockpit Display of Traffic Information (CDTI)

APPENDIX C – Future ADS-B Enabled Applications

APPENDIX D– Record of Changes from previous versions of SBS Concept of Operations

NATIONAL AIRSPACE SYSTEM
SURVEILLANCE AND BROADCAST SERVICES

1. INTRODUCTION.

Recent advancements in surveillance techniques, satellite-based navigation technologies, avionics, and communication data links have combined to offer an opportunity to use Automatic Dependent Surveillance-Broadcast (ADS-B) as a surveillance source and to broadcast aeronautical information. Using these new ADS-B technologies, various ADS-B-enabled operational applications have been developed which has led to the establishment of a Surveillance and Broadcast Services system to support ADS-B operations throughout the National Airspace System (NAS).

ADS-B is an advanced surveillance technology that allows avionics to broadcast an aircraft's identification, position, altitude, velocity, and other information. Since the aircraft's position is normally derived from the Global Positioning System (GPS) and transmitted at least once per second, the broadcasted position information is more accurate and timelier than most current rotating radar-based position information. Additionally, the avionics provides uniquely specific flight parameter information with the broadcast of its surveillance position. The greater positional accuracy and ability to provide aircraft-derived additional flight parameters, in addition to position data, defines ADS-B as enhanced surveillance. These other parameters, such as directional vector, velocity, mid-term and long-term intent, and other data are limited only by the equipment's capability, the communication data link capacity, and the receiving system's capability. The accuracy and broadcast characteristics of ADS-B supports numerous cockpit-based and air traffic control (ATC) applications. ADS-B-equipped aircraft and vehicles with displays (see Appendix B) can receive ADS-B messages from other suitably equipped aircraft and vehicles within the reception range resulting in an aircraft-to-aircraft and airport surface surveillance capability. ADS-B surveillance broadcasts can also be received by ground-based transceivers to provide air-to-ground and airport surface surveillance information for ATC and Traffic Flow Management (TFM) services and other functions such as, fleet operations management, collaborative decision making, and security functions.

In the United States, two different data links have been adopted for ADS-B, 1090 MHz Extended Squitter (1090ES) and the 978 MHz Universal Access Transceiver (978 UAT). The 1090ES link will be required for aircraft that operate in Class A airspace and the 978 UAT link is primarily intended for general aviation aircraft that operate in other controlled airspace. In addition to ADS-B, the data links also support receipt of uplink services. These uplink broadcast services are Traffic Information Service-Broadcast (TIS-B) supported on both data links, and Flight Information Service-Broadcast (FIS-B) supported only on the 978 UAT data link.

TIS-B is a surveillance service that derives traffic information from one or more radar-based surveillance sources, ASDE-X, and wide area multilateration (WAM), and uplinks this traffic information to ADS-B-in equipped aircraft. TIS-B enables ADS-B-in equipped aircraft to receive position reports on non-ADS-B-equipped aircraft during the transition period to full ADS-B equipage in the NAS. Both the 978 UAT and 1090ES links support the TIS-B service.

Similar to TIS-B is the Automatic Dependent Surveillance-Rebroadcast (ADS-R). ADS-R translates and uplinks ADS-B Messages received from aircraft with different data

links (1090ES and 978 UAT) making it possible for each aircraft and vehicle to receive the information being transmitted by the other. Both the 978 UAT and 1090ES links support the ADS-R service.

FIS-B is an uplink service that provides weather and non-control advisory information such as textual and graphical weather and other aeronautical information (i.e., METARs, TAFs, SIGMETs, PIREPs, NOTAMs, NEXRAD, Special Use Airspace status, etc.) by use of a cockpit display. Only the 978 UAT link supports the FIS-B service.

1.1 Operational Use.

The purpose of the Surveillance and Broadcast Services functions are to provide ADS-B, ADS-R, TIS-B, and FIS-B services. These broadcast services provide new or improved operational capabilities. Service providers will use the new surveillance capability to provide ATC services and more accurate data for TFM services. Users will use the surveillance and broadcast services capability to support flight operations. The SBS functions will also support the implementation of the Air Traffic Management expectations and benefits as referenced in Appendices D and E respectively of ICAO doc 9854. In addition, under the office of Surveillance and Broadcast Services, the FAA has implemented complimentary surveillance capabilities in the form of Wide Area Multilateration, or WAM. This technology uses signals transmitted from Air Traffic Control Beacon System (ATCRBS) (Modes A and C) and Mode S transponders, in response to interrogations and unsolicited replies, to calculate an aircraft's position. Wide Area Multilateration has been deployed in some isolated Non Radar Airspace areas where conventional radar solutions are not cost-effective.

1.1.1 NAS Service Providers. The Surveillance and Broadcast Services will provide service providers with new or improved surveillance capability. ADS-B surveillance information will provide the ability to use radar-like air traffic services in areas not covered by primary or secondary radar surveillance. ADS-B will supplement or improve surveillance information in existing radar coverage areas, and may provide cost effective replacement or improvement to existing surveillance technologies used for traffic flow management, airport surface, terminal, and en route air traffic control operations. Service Providers will use the new operational enhancements to improve safety, capacity, and efficiency in the following manner:

- **To Improve Surveillance.** ADS-B information will provide airspace and surface surveillance in areas not currently served. The high accuracy and greater update rate ADS-B surveillance provides will supplement and improve existing surveillance information.

- **To Improve Air Traffic Control Automation and Safety Functions.** The information provided by ADS-B will improve surveillance system performance and support implementation of advanced ATC automation functions and TFM decision support tools.

- **To Improve Separation Services.** ADS-B will support surveillance-based separation standards in non-radar coverage areas. High accuracy ADS-B surveillance information will facilitate the use of a common separation standard for all service domains and may lead to reduced separation standards in select situations.

- **To Improve Planning and Traffic Flow Management Services.** ADS-B surveillance (message set elements) provide accurate, real-time information for traffic flow management, fleet management, and other planning functions.

1.1.2 NAS Users. Users will be provided aircraft/vehicle traffic surveillance and near real-time access to aeronautical flight information in the cockpit. In the near term, user situational awareness in both Visual Meteorological Conditions (VMC) and Instrument Meteorological Conditions (IMC) will be enhanced. Flight crews operating aircraft in-flight (controlled or uncontrolled airspace) or on the airport surface will have the capability to detect conflicts or hazards created by aircraft, obstacles, weather areas, airspace restrictions, and airport surface vehicles. In the long-term end-state environment; select spacing, sequencing, and separation tasks may be performed by qualified and certified aircrews/aircraft within defined criteria and/or in designated situations or areas. Depending on the availability of ADS-B services, level of accuracy, and type of application, users will use the new operational enhancements to improve safety and efficiency in the following manner:

- **To Enhance Situational Awareness.** These ADS-B-enabled applications will enhance the pilot's knowledge of the weather, NAS status, and the surrounding traffic situation, both in the air and on the airport surface. No changes in separation tasks or responsibilities are required.

- **To Perform Airborne Spacing and Sequencing Operations.** These ADS-B-enabled applications will be used by pilots to achieve and maintain spacing from designated aircraft, as specified by ATC. Pilots have the capability to maintain the spacing task, however ATC retains separation responsibility.

- **To Perform Defined Interval Operations.** This will enable a range of applications where a closer interval spacing may be possible than that currently allowed by traditional separation standards, including spacing stream variations based on human and environmental factors.

- **To Perform Self-Separation Operations.** These ADS-B-enabled applications will be used by pilots to perform separation from all surrounding traffic in accordance with applicable separation standards and rules of flight

1.2 System Overview.

The Surveillance and Broadcast Services system consists of four major functions, as shown in Figure 1.1.

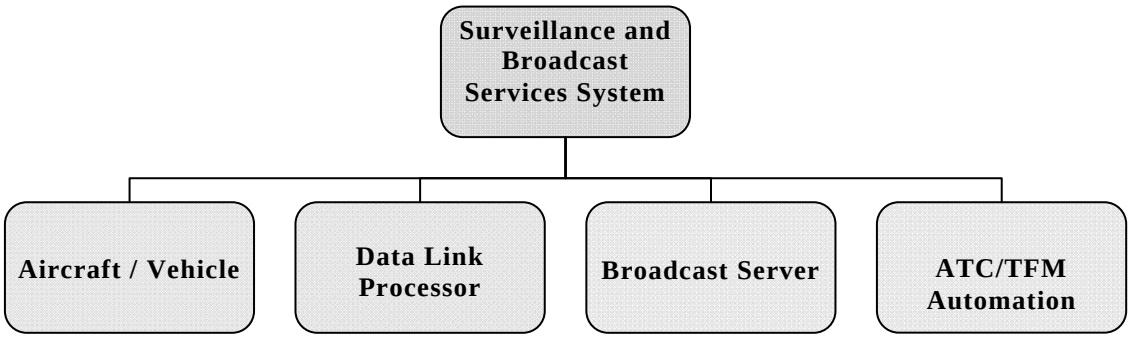


Figure 1.1 Surveillance and Broadcast Services System

The **Aircraft/Vehicle** function resides in participating aircraft and surface vehicles. This function broadcasts its ADS-B Messages and receives ADS-B Messages broadcast by other A*ircraft/ Vehicles*. It also receives ADS-R, TIS-B, and FIS-B Messages broadcast by the *Data Link Processor* and displays information based on those messages. User selectable ADS-B, TIS-B, and FIS-B (UAT 978 only) information is displayed to the pilot.

The **Data Link Processor** is a ground-based system that receives ADS-B Message transmissions from aircraft or surface vehicles, formats corresponding ADS-B Reports and distributes them to the *Broadcast Server* and *ATC Automation*. The *Data Link Processor* broadcasts ADS-R, TIS-B, and FIS-B Messages to aircraft.

The **Broadcast Server** is a ground-based system that provides the TIS-B and FIS-B services, performs monitoring and control of the *Data Link Processor*, and may also distribute ADS-B Reports to authorized external user systems. It receives surveillance reports from radar-based systems to support the TIS-B service, and receives weather/NAS status information to support the FIS-B services from potentially multiple government and commercial sources (see paragraph 6.4.6).

The **ATC/TFM Automation** functions reside in participating automation systems. The function receives ADS-B Reports, processes the reports, and then displays them. See Section 5 for a detailed description of the ADS-B System.

1.3 Document Overview.

Section 2 – ***Operational Need,*** presents the need for the system and the services that it provides by describing the current environment and examining the capability shortfalls that exist within that environment.

Section 3 – *System Justification*, discusses the introduction of the system into the NAS and the potential benefits that could be realized.

Section 4 – *Operational Description*, provides an understanding of the services, which support the operational capabilities. This section describes the ADS-B applications.

Section 5 – *System Description*, describes functional details on the proposed system including modes of operation and other system characteristics. The section also briefly discusses system maintenance and system backup concepts.

Section 6 – *Assumptions, Constraints, and Dependencies*, describes potential impacts and considerations for ADS-B applications implementation and system deployment.

1.4 References.

The primary source documents for this system-level concept of operations are the RTCA, "National Airspace System Concept of Operations and Vision for the Future of Aviation" and the FAA Mission Needs Statement #326, "Enhanced Surveillance." Concept source documents are included below:

1. "National Airspace System Concept of Operations and Vision for the Future of Aviation," RTCA, Inc., 2002.

2. Mission Need Statement #326, "Enhanced Surveillance Capability" version 3.0, FAA, May 2001.

3. "Automatic Dependent Surveillance-Broadcast (ADS-B) Concept of Use," Appendix to the AN/-Conf/11-WP/6, ICAO, April 2003.

4. NAS-SR-1000, "National Airspace System Requirements Specification," FAA.

5. "Overview of the FAA ADS-B Link Decision," FAA, June 7, 2002.

6. Final Report of RTCA Task Force 3, "Free Flight Implementation," RTCA, Inc., October 1995.

7. NAS Program Initiative (NPI) #0094, "Gulf of Mexico Program," FAA, April 1992, revised February 1999.

8. Mission Need Statement #42, "Aeronautical Data Link (ADL) System," FAA, April 1991.

9. Mission Need Statement #307, "Traffic Flow Management Integrated Product (TFMIP)," FAA, October 1995.

10. Mission Need Statement #323, “Airport Surface Movement Enhancement and Runway Incursion Prevention,” FAA, May 1998.

11. Mission Need Statement #172, “Flight Operations and Air Traffic Management Integration,” FAA, October, 1994.

12. DO-260B, “Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Services-Broadcast (TIS-B), Revision B,” RTCA, Inc., December 2, 2009.

13. DO-282B, “Minimum Operational Performance Standards for Universal Access Transceiver (978 UAT), Automatic Dependent Surveillance-Broadcast (ADS-B), Revision B,” RTCA, Inc., December 2, 2009.

14. DO-267A, “Minimum Aviation Systems Performance Standards (MASPS) for Flight Information Services-Broadcast (FIS-B) Data Link,” RTCA, Inc. April 29, 2004.

15. DO-286B, “Minimum Aviation Systems Performance Standards (MASPS) for Traffic Information Services-Broadcast (TIS-B), Revision B,” RTCA, Inc., October 11, 2007.

16. DO-242A, “Minimum Aviation System Performance Standards for Automatic Dependent Surveillance Broadcast (ADS-B), Revision A, Change 1” RTCA, Inc., December 13, 2006.

17. DO-289, “Minimum Aviation System Performance Standards for Aircraft Surveillance Applications (ASA), Change 1 ” RTCA, Inc., December 13, 2006.

18. ICAO Document 9854 “Global Air Traffic Management Operational Concept:” First Edition 2005

19. Surveillance/Positioning Backup Strategy Alternatives Analysis Dated January 8, 2007

20. DO-317A, “Minimum Operational Performance Standards (MOPS) for Aircraft Surveillance Applications System (ASAS)” RTCA, Inc. December 13, 2011

21. ADS-B In Aviation Rules Committee (ARC) report “Recommendations to define a strategy for incorporating ADS-B In technologies into the National Airspace System.” September 30, 2011.

22. Document 314 (RTCA DO–314), Safety, Performance and Interoperability Requirements Document for Enhanced Visual Separation on Approach (ATSA–VSA) December 6, 2008

23. Space Based ADS-B Surveillance in Oceanic Airspace Concept of Operations Draft 0.2 dated February 1, 2012.

24. Arrival Interval Management – Spacing (IM-S) Concept of Operations for the Mid-Term Timeframe Version 2.0 Dated December 16, 2011.

25. The Joint Planning and Development Office, (JPDO), Integrated Air Surveillance Concept of Operations, Dated Nov 2011

26. JPDO, NextGen Concept of Operations Version 3.2

27. Surveillance and Broadcast Services Architectures Overview and Summary Information (AV-1) Version 1.0 dated March 1, 2012

2. OPERATIONAL NEED

The Surveillance and Broadcast Services system offers a bundling of technologies directed at lowering the FAA's, and NAS users operating cost, while enhancing safety, capacity, productivity, and efficiency. The need for these improvements are identified in several government and industry documents: RTCA, "Final Report of RTCA Task Force 3, *Free Flight Implementation;*" FAA Mission Needs Statement (MNS) #42, *"Aeronautical Data Link (ADL) System;"* FAA MNS #307, *"Traffic Flow Management Integrated Product (TFMIP);"* FAA MNS #323, "*Airport Surface Movement Enhancement and Runway Incursion Prevention;"* FAA MNS #326, *"Enhanced Surveillance Capability;"* FAA National Initiative Program #0094, *"Gulf of Mexico Program;" and "* FAA MNS #172, *"Flight Operations and Air Traffic Management Integration (FTMI)."* Specifically, the RTCA Report and FAA MNS #326 identified ADS-B as a key technology for implementing Free Flight in the NAS enabling the common situational awareness necessary for air and ground shared responsibility. They called for "the definition of a surveillance architecture and infrastructure for en route and terminal airspace incorporating both dependent (e.g., ADS-B) and independent surveillance elements." The NAS Surveillance and Broadcast Services system architecture is evolving to address requirements for reduced separation standards, improved coverage, and lower-cost maintenance determined by other related studies and investigations, and should facilitate enhancing near-term surveillance capabilities and those required for mature "Free Flight." The Surveillance and Broadcast Services will enable the NAS to achieve many of these requirements.

2.1 Current Environment.

The FAA currently provides surveillance support to the NAS with a wide variety of surveillance systems in the en route and terminal domains. En route air-to-ground primary radar surveillance is currently provided by Air Route Surveillance Radar (ARSR), models ARSR-1/2/3/4. En route air-to-ground secondary surveillance is currently provided by the Air Traffic Control Beacon Interrogator (ATCBI), models ATCBI-4/5/6, and Wide Area Multilateration (WAM), as well as the Mode S sensor. Wide Area Multilateration surveillance systems have been installed in areas where the installation of radar would be cost prohibitive and/or the traffic density dictates the need for surveillance. WAM utilizes signals from legacy/traditional aircraft transponders. In the terminal domain, air-to-ground surveillance is provided (at those airports with a radar approach control) by Airport Surveillance Radar (ASR), models ASR-7/8/9/11. Terminal air-to-ground secondary surveillance is currently

provided by the ATCBI, models ATCBI-4/5/6, as well as by Mode S sensors. In the oceanic air-to-ground environment, there are no current capabilities for surveillance. Oceanic surveillance is currently accomplished using Automatic Dependent Surveillance-Contract (ADS-C) avionics with vendor-provided satellite communications relaying the data from the aircraft to the ground. ADS-C is based on a negotiated one-to-one peer relationship between an aircraft providing ADS information and a ground facility requiring receipt of the ADS messages. Note that ADS-C provides no aircraft-to-aircraft surveillance capability between aircraft. Airport Surveillance Detection Equipment Model 3 (ASDE-3) provides radar surveillance of aircraft and vehicles on airport taxiways and runways at high-activity airports. Radar monitoring of airport surface operations (ground movement of aircraft and vehicles) provides a means of directing and moving surface traffic. This is especially important during periods of restricted visibility, such as rain, fog, and night operations. ASDE-3 is subject to multi-path reflections, which may produce several ghost targets for one actual target. In addition the ASDE-3 is very susceptible to false target creation caused by medium intensity and higher levels of precipitation. The system is also subject to having blind spots due to obstructions causing non-surveillance areas. Most airports have no technology for surface surveillance and rely on controllers, pilots, and vehicle operators using visual methods to control and navigate on airport surfaces. The Airport SurveillanceDetection Equipment Model X (ASDE-X) system is a multi-sensor surveillance system capable of processing radar, multilateration, and ADS-B sensor data to be presented on a tower display for the purpose of providing seamless surface and approach corridor surveillance to air traffic controllers. The system employs a fusion tracker to provide a single system track from the various sensor inputs on each aircraft or vehicle target. ASDE-X is planned to be deployed to select US airports. Airport Surface Surveillance Capability (ASSC) is currently in the development stage and will be installed at no less than 9 airports. ASSC will use ADS-B and Multilateration for surface surveillance.

Separation services are provided by air traffic controllers to pilots via radio communication in today's NAS. There are no current civilian cockpit-based, air-to-air or airport surface traffic surveillance capabilities. The closest such capability, which exists today, is the Traffic Alert and Collision Avoidance System (TCAS). TCAS is a collision avoidance system, not a surveillance system, and is not used as a basis of separation. TCAS provides a warning of proximity indication to the flight crews of equipped aircraft, thereby supporting collision avoidance.

Today's Mode 3/A/C/S code allocations (4096) are unable to accommodate all users during moderate to heavy traffic periods and will become more problematic based on forecasted traffic growth.

In-flight access to aeronautical information (weather and NAS Status information) is limited to radio transmission, use of airborne weather radar systems, aircraft communications addressing and reporting system (ACARS), or by subscription fee services provided by commercial sources. Most general aviation aircraft do not have costly airborne weather radar equipment or ACARS capabilities. Automatic Terminal Information Service (ATIS) provides the continuous broadcast of recorded terminal non-control information and airport weather conditions in selected terminal areas. Digital Automatic Terminal Information Service (D-ATIS) provides text messages to participating aircraft outside the standard reception range of ATIS via data link communications to the cockpit. Automated Weather Observation Stations (AWOS)

are automated sensor suites designed to serve aviation and meteorological observing needs for safe and efficient aviation operations and weather forecasting. Automated Surface Observing System (ASOS), observe sky conditions, temperature and dew point, wind direction and speed, and barometric pressure. Terminal Weather Information for Pilots (TWIP) provides ACARS equipped aircraft with direct access to limited weather information from each of 46 TDWR sites via a commercial communications service provider. The Flight Information System-Data Link (FISDL) provides pilots with near real-time weather data through a service vendor operating on VHF frequencies that the FAA helped obtain. The assigned FISDL services frequencies are temporary. Not all areas are served by automated weather reporting systems such as ATIS, D-ATIS, AWOS, ASOS, TWIP, and FISDL

The FAA currently provides Traffic Flow Management (TFM) services and supports collaborative decision-making, information availability to industry and post-event analysis through a wide variety of automated systems. These systems include links to the en route and terminal domains along with established interfaces for customers.

Advanced operator schedule information is updated through the customer links, while en route, terminal and surface surveillance data (ARSR-1/2/3/4, ASR-7/8/9/11 and ASDE-3/ASDE-X) is provided in near real time via the automation systems in the respective domains. The resulting aggregate demand picture is continuously updated, shared with customers and serves as the basis for the collaborative development of operational response strategies to mitigate the impacts of weather, excess demand and other factors.
The specific flight impact of the strategy implementation is routed to ATC units (and participating operators) through their automation systems.

2.2 Capability Shortfalls.

The NAS is constrained by surveillance limitations leading to the inefficient use of airspace. The current system does not provide contiguous surveillance coverage with a consistent basis of performance. This leads to low confidence prediction characteristics that prevents highly improved deterministic estimation of aircraft location and intent. Table 2.2-1 provides a summary of the shortfalls to be addressed by the Surveillance and Broadcast Services system, and their respective impacts on the NAS. Each shortfall is listed by affected service area, along with the source document that identifies the related mission need.

Table 2.2-1: Shortfalls

Service Area	Shortfall	Impact
Surface	Inability to precisely predict demand and capacity values, accommodate user preferred trajectories, system inflexibility (MNS #307)	Arrival rates; Taxi times; Departure delays; Fleet management; Surface accidents
	Limited pilot, controller, and vehicular shared situational awareness (MNS #323)	
	Unusable runway capacity caused by increased terminal congestion (MNS #172)	
Terminal	Lack of shared situational awareness and limited aircraft information (MNS #326)	Arrival delays
	Inability to provide surveillance coverage at reduced cost (MNS #326)	FAA life cycle costs; Terminal airspace congestion; User and Service Provider workloads
	Decreasing flight efficiency due to domestic routes	
	Unusable airspace caused by increased terminal congestion (MNS #172)	
En Route / Oceanic	Lack of surveillance coverage within specific regions of the NAS, lack of shared situational awareness, and limited aircraft information (MNS #326)	Delays due to constraints; Reduce probability of mid-air collisions; Search & rescue
	Lack of communication coverage, limited ATC options for severe weather avoidance, sustained traffic growth and a unique and compressed demand (NPI #0094)	Inefficiencies due to constraints; Reduce probability of mid-air collisions; Weather-related accidents; User and Service Provider workloads
	Decreasing flight efficiency due to oceanic track restrictions and domestic routes (MNS #172)	
Broadcast Services	Inability to readily access in-flight weather data, congested voice channels (MNS #42)	Weather-related accidents; NOTAM related accidents; Reduce probability of mid-air collisions; Weather deviation
	Limited pilot situational awareness (MNS #326)	
TFM	Unusable runway capacity caused by increased terminal congestion (MNS # 172) Inability to precisely predict demand and capacity values, accommodate user preferred trajectories_system inflexibility (MNS #307)	Arrival rates; Taxi times; Departure delays Arrival delays
	Lack of surveillance coverage within specific regions of the NAS, lack of shared situational awareness, and limited aircraft information (MNS# 326)	Adverse impacts to service expectations predictability and efficiency.

The Surveillance and Broadcast Services system is supported by FAA Mission Needs Statement (MNS #326), *"Enhanced Surveillance Capability"* (May 2001). The purpose of

MNS #326 is to exploit ADS-B technological opportunities that increase the FAA's surveillance capabilities in the terminal, en route, and oceanic airspace environments and the airport surface movement area. MNS #326 states "by incorporating ADS-B information into the FAA's Air Traffic Control (ATC) automated surveillance data tracking systems, the surveillance capabilities of the NAS are significantly increased/enhanced." It further discusses the use of ADS-B in air-to-air, air-to-ground, and airport surface operations. Currently, there are shortfalls across all NAS domains relative to a lack of shared situational awareness, limited pilot situational awareness, limited aircraft information and insufficient surveillance coverage.

FAA NAS Program Initiative (NPI) #0094, *"Gulf of Mexico Program"* (April 1992, revised February 1999) describes the requirements and shortfalls for providing effective air traffic control services in the Gulf of Mexico. Specifically, NPI #0094 states that the "imposition of traffic management restrictions during peak demand times to maintain safety ... cause[s] significant delays during peak hours." It also identifies limitations in communications coverage, weather observance, and available surveillance contributes to these restrictions. Currently, there is a shortfall in the Gulf of Mexico relative to the lack of communication coverage, limited ATC options for severe weather avoidance, and an inability to effectively support the sustained traffic growth and a unique and compressed demand.

FAA MNS #42, *"Aeronautical Data Link (ADL) System"* (April 1991) describes data link applications for improving air-to-ground data communications services. Specifically, MNS #42 states that "the ADS System will allow the provision of detailed real-time and near real-time weather products to pilots." This functionality will be supported by Flight Information Services-Broadcast (FIS-B) technology in the system. Currently, there is a shortfall across all NAS domains relative to the inability to readily access in-flight weather data; in this instance, the term "readily" is interpreted in terms of cost-effectiveness, especially for general aviation.

FAA MNS #307, *"Traffic Flow Management Integrated Product (TFMIP)"* (March 2003) describes the need for optimizing the flow of air traffic while maintaining a safe operating environment. Specifically, MNS #307 states that "current aircraft technologies permit pilots to plan and execute the best possible flight trajectory between two points; however, currently, air traffic control technologies are frequently unable to accommodate these potential efficiencies." The ADS-B System will provide the improved surveillance information (e.g., next way points) and the corresponding automation system changes necessary to accommodate these potential efficiencies. Currently, there is a shortfall in the NAS surface domain relative to the inability to precisely predict demand and capacity values, and in the en route/oceanic domain relative to the inability to consistently accommodate preferred trajectories and system flexibility.

FAA MNS #323, *"Airport Surface Movement Enhancement and Runway Incursion Prevention"* (May 1998) describes the need for preventing or reducing the possibilities of runway incursions. Specifically, it states that "a key to reducing (runway incursions) in the future will be to provide better situational awareness to all participants on the airport surface, including not only controllers but pilots and vehicular operators as well." Currently, there is a shortfall in the NAS surface domain relative to limited shared situational awareness between pilots, vehicle operators, and controllers.

FAA MNS #172, *"Flight Operations and Air Traffic Management Integration"* (November 1992, revised October 1994) describes the need to enhance air-ground data exchange and decision-making process. MNS #172 states a need to increase pilot, dispatcher, and

air traffic management productivity through use of more extensive automatic information exchange. Specifically it identifies deficiencies such as, “Unusable airspace and runway capacity caused by increased terminal congestion…”, “Decreased flight efficiency due to oceanic track restrictions and domestic routes…”, and “increasing human stress and workload…” which may be mitigated by the availability and sharing of information for operational decision-making by users and service providers.

3. SYSTEM JUSTIFICATION.

3.1. Description of Desired Change.

The Air Traffic Organization will use ADS-B surveillance information (airborne and airport surface) for air traffic control operations and traffic flow management and other services including situational awareness, separation assurance, and improved automation system safety functions. Other authorized facilities (ramp control, airline operations center, etc.) can use ADS-B surveillance information to track flight activities and optimize operations. The inherent accuracy and high update rate will provide service providers and users improvements in safety, capacity, and efficiency.

ADS-B surveillance data broadcast by aircraft in-flight and vehicles on the airport surface movement area is used by aircraft equipped with ADS-B in and a Cockpit Display of Traffic Information or a suitable Multi-Function Display (CDTI/MFD, see Appendix B) to support cockpit-based, situational awareness aircraft-to-aircraft applications. Aircraft and vehicles operating on the airport surface use ADS-B surveillance information for airport surface situational awareness. Flight safety improves when pilots can determine airborne and airport surface hazards.

Providing real-time, in-the-cockpit access to traffic and aeronautical information (weather, NOTAMS, Airspace status, etc.) will improve aviation safety, capacity, and efficiency. Pilots will have the ability to determine the type, intensity, and extent of weather areas provided by NEXRAD, TDWR, ITWS, and other weather sensors. Also, aircrews will be able to access NOTAM information and Special Use Airspace status. This will enable pilots to reduce the impacts from restricted/closed airspace areas or NAS resource outages (NAVAIDS, runways, lighting, etc.) and make timely adjustments to their route/flight path. Providing knowledge of changing conditions as they occur during the flight progress will improve pilot situational awareness and overall aviation safety and system capacity.

3.2. Potential Benefit of New or Modified System.

The following Surveillance and Broadcast Services capabilities will contribute to improved NAS and Oceanic safety, capacity, and efficiency:

Safety

- Provides aircraft-to-aircraft traffic surveillance capability.
- Provides ATC and in-the-cockpit, airport surface traffic surveillance capability.
- Provides surveillance capabilities in areas currently not served by ground-based surveillance systems.

- Provides near real-time, in-the-cockpit aeronautical information (weather, NOTAMs, Temporary Flight Restrictions, Special Use Airspace, etc.).
- Improves or supplements existing ground-based surveillance information.
- Improves air traffic control automation performance and safety features e.g., target accuracy improvement for MSAW and CA alerting capabilities.
- Provides cost effective, Controlled Flight Into Terrain (CFIT) awareness.

Capacity

- Provides radar-like separation procedures in remote or non-radar areas.
- Supports a potential common separation standard in select domains and airspace classifications.
- Supports a potential reduction in existing separation standards in all domains and airspace classifications.
- Supports increased airspace capacity through select user-executed airborne spacing, sequencing, and separation operations.

Efficiency

- Provides near real-time, in-the-cockpit aeronautical information during flight operations.
- Provides reduced cost infrastructure.
- Provides information not currently available resulting in enhanced sector & airport derived predictions.
- Provides improved information for traffic flow management, collaborative decision making, fleet management, and management by trajectory functions.
- Provides a rapidly deployable, mobile surveillance sensor for contingency operations.
- Provides precision surveillance and flight parameter information for unique operating areas.

4. OPERATIONAL DESCRIPTION.

4.1. Surveillance and Broadcast Services.

The Surveillance and Broadcast Services system provides two fundamental services: Surveillance Broadcast Services (includes En Route, Terminal, and Surface Surveillance) and Traffic/Flight Information Broadcast Services, which include, ADS-R, TIS-B, and FIS-B.

4.1.1. Automatic Dependent Surveillance-Broadcast (ADS-B). ADS-B equipped aircraft and vehicles periodically broadcast their state vector (horizontal and vertical position, horizontal and vertical velocity) and other information over either a 978 UAT or a 1090ES data link. The ADS-B message broadcasts are received by other properly equipped aircraft and vehicles in the vicinity and by the Surveillance and Broadcast Services *Data Link Processor*. These ADS-B Messages are processed and formatted into ADS-B Reports. The *Data Link Processor* provides these reports to the *Broadcast Server* and *ATC/TFM Automation* system for use by ATC in providing separation assurance, traffic flow management and other services. ADS-B is automatic because no pilot or operator input is required; it is dependent because position and velocity vector are derived from a Global Positioning System (GPS). The aircraft or vehicle originating the broadcast may or may not have knowledge of which users are receiving its broadcast; any user, either aircraft or ground-based, within range of this broadcast, may choose to receive and process the ADS-B surveillance information. ADS-B has the potential to provide surveillance data at a higher update rate and with improved accuracy over today's NAS radar systems. All four ADS-B functions, *Aircraft/Vehicle*, *Data Link Processor*, *Broadcast Server*, and *ATC/TFM Automation* are necessary to provide the ADS-B Service.

4.1.2 Surveillance Broadcast Services

4.1.2.1 ATC Surveillance. ATC will use ADS-B surveillance information in the same manner as current dependent/cooperative surveillance system information is used, e.g., to assist aircraft with navigation, to separate aircraft, and to issue safety alerts and traffic advisories. The ADS-B surveillance information will be used to enhance the quality of existing radar-based surveillance information for ATC automation system functions, i.e ., tracking, MSAW, Conflict Alert, and Mode-C Intruder Alert. The targeted implementation areas include surface, terminal, en route, offshore, and oceanic domains. ADS-B surveillance will allow ATC to provide separation services between ADS-B-to-ADS-B and ADS-B-to radar and fused targets. ADS-B can support a potential reduction in separation minima in certain En Route and some current non-radar environments.

4.1.3 Traffic Flight Information Broadcast Services

4.1.3.1. Automatic Dependent Surveillance-Rebroadcast (ADS-R). Equipped aircraft receive broadcast ADS-B Messages directly from other aircraft equipped with the same data link technology. An aircraft equipped with a particular data link will have surveillance information only on like-equipped aircraft. As aircraft equip with either 978 UAT or 1090ES data link technologies, ADS-R provides a service to rebroadcast ADS-B messages received down one link and back up the other link. In this way, ADS-R service provides traffic information for interoperability between both data links. The Aircraft/Vehicle and Data Link Processor are necessary to provide the ADS-R Service.

4.1.3.2 Traffic Information Service-Broadcast (TIS-B). During NAS-wide deployment of ADS-B, aircraft will begin equipping with ADS-B avionics. During this transition, ADS-B-equipped aircraft will lack surveillance information on aircraft that are not ADS-B equipped. The Surveillance and Broadcast Services ground infrastructure will support aircraft-to-aircraft and surface situational awareness operations by broadcasting TIS-B Messages on both the 978 UAT and 1090ES data links for targets detected and reported by radar, WAM, ASDE-X, or other surveillance systems. This, in conjunction with the ADS-R service, will provide equipped aircraft

the information needed for a more complete picture of the traffic situation. TIS-B service will be decommissioned in the end state when all aircraft are ADS-B-equipped. The Aircraft/Vehicle, Data Link Processor, and Broadcast Server are necessary to provide the TIS-B service.

4.1.3.3 Flight Information Service-Broadcast (FIS-B). FIS-B provides the broadcast of weather and non-control advisory information providing users aeronautical information supporting safe and efficient operations. FIS-B products include, but are not limited to, graphical and textual weather reports and forecasts, NEXRAD precipitation information, Special Use Airspace (SUA) information, Temporary Flight Restricted Airspace (TFR's), NOTAM's, electronic pilot reports (E-PIREPS), and other similar meteorological and aeronautical information. FIS-B products will be up linked using the 978 UAT from the Data Link Processor and will not be available on the 1090ES link. There are many potential future FIS-B products that may be provided as their concepts mature. Therefore, the FIS-B service and data link capacity should allow for growth to accommodate additional products. The up linked products will come from both government and commercial sources. The Aircraft/ Vehicle, Data Link Processor, and Broadcast Server are necessary to provide the FIS-B service.

4.2 ADS-B Applications.

The following are the abbreviated descriptions of the ADS-B applications that have been selected for NAS implementation by FY2020. These applications were chosen based on their maturity, cost and operational benefits, and an understanding of the performance requirements necessary for implementation. Additional applications have been identified and defined for requirements definition and validation by FY2020 and are listed in Appendix C. Other applications in appendix C are listed as well but have not been selected for requirements definition or validation. Refer to the Surveillance and Broadcast Services Program Plan for schedule information.

4.2.1 Application Descriptions.

4.2.1.1 Traffic Situation Awareness – Basic: The objective of this application is to provide enhanced traffic situational awareness to flight crews increasing the safety and efficiency of flight operations.
The application is the most basic Aircraft Surveillance (AS) application and is used as the foundation for all the other applications described in this document. The application uses a cockpit display to provide the flight crew with a graphical depiction of traffic using relative range and bearing, supplemented by altitude, flight ID and other information. It is used to assist the out-the-window visual acquisition of airborne and surface traffic for enhancing flight crew situational awareness and air traffic safety in the NAS.

Flight crews using this application will refer to the display during the instrument scan to supplement their visual scan. The display enables detection of traffic by the flight crew and aids in making positive identification of traffic advised by ATC. The information provided on the display also reduces the need for repeated air traffic advisories and is expected to increase operational efficiencies.

Traffic Situation Awareness–Basic is a background application that runs at all times without flight crew input. It does not require flight crew or automated traffic selection. However, specific traffic selection is permitted to enable the flight crew to determine additional information beyond that which is displayed by default, e.g., relative speed. This application was previously referred to as Enhanced Visual Acquisition

4.2.1.2 1 Airport Traffic Situation Awareness: The objective of this application is to provide enhanced traffic situational awareness to flight crews in the vicinity of an airport, increasing the safety and efficiency of flight operations.

This application adds an airport map to the Traffic Situation Awareness–Basic application capable of displaying traffic and own ship from the surface to 1500 feet above the airport encompassing the airport traffic pattern, generally within 5 miles of the airport.

The application will be used by the flight crew to aid in detection of traffic related safety hazards on taxiways and runways including aircraft on final approach. This assists the flight crew with early detection of traffic conflicts and runway incursions. The displayed information may assist the flight crew in the decision-making process in order to take the most effective action. The application may also be used in conjunction with controller use of aircraft flight ID to assist the flight crew in determining the position of other taxiing aircraft or ground vehicles simplifying taxi and sequencing instructions. The improved situational awareness will be most apparent in low visibility, at night, and/or where a portion of a runway is not visible from the takeoff or runway crossing position, even in good visibility. This application has elements of 2 applications previously known as Airport Surface Situational Awareness and Final Approach and Runway Occupancy Awareness.

4.2.1.3 Enhanced Visual Approach. This application is intended to enhance successive approaches for aircraft cleared to maintain visual separation from another aircraft on the approach. It closely follows the application specified in RTCA, Inc., Document 314 (RTCA DO–314), Safety, Performance and Interoperability Requirements Document for Enhanced Visual Separation on Approach (ATSA–VSA), in that the aircraft must remain in VMC. The definition of the Visual Separation Approach (VSA) application in DO–314 states that information provided by the Traffic Display is not a substitute to out the window information and the pilot must maintain visual contact with the Traffic To Follow (TTF) Aircraft throughout the VSA application operation.
The goal is to maintain visual approach procedure operation arrival rates even during periods of reduced visibility or obstructions to vision (haze, fog, sunlight, etc.). To achieve this objective, flight crews will be supported by a cockpit display of nearby traffic. This will provide continually updated identity and position information to assist the flight crew with achieving and maintaining visual contact with relevant traffic. Additional information such as range and speed will be provided to assist flight crews in monitoring their distance from the preceding aircraft. The display may also be used to monitor aircraft on approach to parallel runways.

4.2.1.4 Cockpit Display of Traffic Information (CDTI) Assisted Visual Separation (CAVS): The objective of this application is to augment the flight crew's ability to

maintain visual separation and traffic situational awareness by enabling selection of a target aircraft for tracking during visual approach operations, increasing the safety and efficiency of air traffic and flight operations.

The basic delegated separation task assigned to the pilot is expected to function as today's visual separation, with controllers managing the overall flow of traffic and delegating separation to the flight deck when it is operationally advantageous to do so. When pilots accept a CAVS clearance, they will operate at a safe interval behind Traffic To Follow (TTF) and use the CDTI tools to manage the interval. If the flight crew is unable to maintain a safe interval for any reason (for example, loss of the displayed TTF) they will immediately advise air traffic control (ATC), just as is done today during visual separation operations. . If runway separation is at risk, ATC will issue a go around as required.

CAVS enables pilots to accept separation responsibility from other aircraft with the aid of a CDTI. It is somewhat similar to the Airborne Traffic Situational Awareness for Enhanced Visual Separation on Approach (ATSA–VSA) however, the fundamental difference between CAVS and VSA is that in CAVS the flight crew is allowed to use the information provided by the CDTI for the traffic-to-follow (TTF), after visual TTF acquisition and cross correlation on the CDTI, as a substitute for out the window information. Therefore, once the TTF has been acquired by correlating the traffic on the CDTI with a visual acquisition of the traffic out-the-window, the CAVS can continue through the use of the traffic display when the traffic information out-the-window is no longer available (for example, lost in lights during approach at night).

CAVS can be conducted in conjunction with existing visual arrival clearances and will not require any additional infrastructure or modification to ATC procedures.

The CDTI will provide situational awareness and optimize the visual approach; providing the pilots with the ability to more readily and more positively identify TTF, and to help maintain visual separation requirements during day and night VMC.

Flight crews using this application will refer to the display during the instrument scan to supplement their out-the-window visual scan. The display enables detection of traffic by the flight crew and aids in making positive identification of traffic advised by ATC. The information provided on the display also reduces the need for repeated air traffic advisories and is expected to increase operational efficiencies.

4.2.1.5. **Traffic Situation Awareness with Alerts (TSAA):** The objective of this application is to provide pilots and flight crew of non-TCAS II equipped aircraft, specifically the general aviation, with enhanced traffic situation awareness in all classes and domains of airspace by providing timely alerts of qualified airborne traffic in the vicinity.
TSAA will provide alerts using voice annunciations and visual attention-getting cues to assist the pilot or flight crew with visual acquisition and avoidance of traffic in both Visual Meteorological Conditions and Instrument Meteorological Conditions. Indications of Nearby Airborne Traffic are also provided on a Traffic Display (if available). The application is applicable under both Visual Flight Rules (VFR) and Instrument Flight Rules (IFR). TSAA alerts and indications are for detected airborne conflicts and relevant nearby traffic status, respectively. In the airport environment, it is not necessary for own ship, or the target aircraft to be airborne at the time of the alert, only for the detected conflict to be where both aircraft will be airborne. When a Traffic Display is available, it builds on the

Basic Traffic Situational Awareness application. TSAA is also capable of providing alerts when a Traffic Display is not installed.
Nearby Airborne Traffic indications assist the flight crew in prioritizing activities and are expected to occur for normal traffic situations. The caution level alert acts as an attention-getting mechanism so the pilot or flight crew is not required to continually scan the traffic display to determine if and which aircraft are a conflict. After receiving the alert, the pilot or flight crew will take the necessary action in accordance with the operational rules in effect at the time. This application was previously referred to as Conflict Detection and is an ADS-B enabled application for properly equipped aircraft. It is not intended as a TCAS replacement.

4.2.1.6. Oceanic In-Trail Procedures (ITP): The objective of this application is to enable more frequent approval of flight level requests between properly equipped aircraft using a reduced separation standard in Oceanic Airspace, improving flight efficiency and safety.
Flight crews request flight level changes for various reasons to improve flight efficiency and safety including; optimum fuel burn, accessing favoring wind conditions, avoidance of turbulence. ITP enables flight level change maneuvers that are otherwise not possible using non-ADS-B based oceanic procedural separation standards. ITP allows ATC to approve these flight level change requests between properly equipped aircraft using reduced separation minima during the maneuver.

The ITP procedure requires the flight crew use information derived by the aircraft avionics and ADS-B data received from the target aircraft to determine if the criteria required for the ITP flight level request are met (maximum of two target aircraft). This information is then reported to ATC by the flight crew as part of the flight level change request. After ATC receives the flight level change request from the flight crew, ATC evaluates all relevant traffic for conflicts, including Non-ADS-B equipped aircraft prior to approving. ATC also checks to make sure the closing Mach differential between the aircraft is no more than 0.06. If no traffic conflict exists and the Mach check is satisfied, ATC may approve the request. Upon receiving the ITP flight level change request clearance the flight crew will reassess the ITP initiation criteria and if the criteria are still met, the flight crew will execute the procedure. Upon reaching the destination altitude the flight crew will report completion of the maneuver to ATC. If the flight crew is unable to initiate or complete the maneuver, they will advise ATC.

Safety of the ITP maneuver is based on an analysis of safe separation under the expected operating conditions. The flight crew should ensure the safety of the operation by detecting any changes in the environment that affect the ITP maneuver and taking appropriate actions.

4.2.1.7 Ground-based Interval Management-Spacing (GIM-S): The objective of this application is to assist air traffic controllers in delivering aircraft more consistently to the arrival meter point and meter fix and to increase the opportunities to conduct an Optimized Profile Descent (OPD). GIM freezes an aircraft's sequence and schedule further upstream to minimize vectoring and speed changes in the en route airspace. GIM provides air traffic controllers speed advisories to assist in the delivery of aircraft to the meter point and meter fix at their Scheduled Time of Arrival (STA).
GIM also supports FIM operations between properly equipped aircraft, where the lead aircraft has ADS-B out and trail aircraft is FIM equipped. GIM identifies the FIM pair, provides the spacing goal, determines the achieve by point, and monitors FIM compliance. FIM operation begins in en route airspace, after crossing the freeze horizon

for the meter fix, and may continue into terminal airspace. GIM passes active FIM operations from the en route automation platform to the terminal automation platform. GIM-S is expected to enable efficient and environmentally friendly arrivals that can reduce emissions, noise and fuel consumption.
This application was previously referred to as Merging and Spacing

4.2.2. Application Scenarios.

4.2.2.1. ATC and TFM Service Provider Scenarios. In order to support these applications, a ground equipment infrastructure will be necessary and aircraft will require ADS-B transmit capability.

4.2.2.1.1. IFR Aircraft Operations in Non-Surveillance Airspace. On a daily basis, Denver ARTCC serves a wide mix of aircraft, including B-757's, A-320's, high performance business jets, and single engine-type aircraft into and out of, the numerous airports in the Rocky Mountains. Radar coverage around most of these airports is very limited, requiring non-radar ATC procedures. IFR aircraft arriving to these airports during IMC must navigate via an instrument approach procedure. Eagle County is such an airport. The procedure to establish the aircraft for the approach, combined with the non-radar longitudinal separation minima, is much greater than radar-type separation.

Currently when weather permits the use of timed approaches, Eagle can accept 10 arrivals per hour. When the weather doesn't permit the use of timed approaches, only one aircraft can be on the approach at a time. Because of the large distances from the primary holding fix to the airport, the IFR arrival rate decreases to approximately 4 per hour. For successive IFR departures, non-radar vertical separation is used. An IFR departing aircraft must climb above 14,000 feet before ATC can issue a clearance for a successive IFR aircraft departing since ATC has no guarantee of surveillance coverage below this altitude. An IFR aircraft departing and climbing out at 1,000 FPM would take over 7 minutes to reach 14,000 (Eagle County elevation: 6535 ft), thus allowing only about 8-9 departures per hour. In a worst-case scenario with current procedures, Eagle can expect about 6-8 mixed (IFR arrivals and IFR departures) operations per hour. Within just a few hours on a peak afternoon, it's not uncommon for more than 50 aircraft to be competing for a space to depart.

In the Gulf of Mexico, a fleet of approximately 600 helicopters provide air transportation on 4000+ flights per day to approximately 3000 offshore structures. Currently, IFR flight involves inefficient routes and restrictions due to lack of communications and surveillance infrastructure. Houston Center is responsible for the majority of this offshore airspace. The current IFR route structure is composed of a grid system defined by 300 offshore waypoints and IFR instrument approach procedures known as Offshore Standard Approach Procedures. The offshore sector is a non-radar environment. Non-radar separation is established via parallel routes identified by waypoints in the grid system or the use of different altitudes. Controllers

monitor the aircraft's position via verbal position reports obtained from the pilot if direct pilot-to-controller communications exist, or through relays, e.g., (other pilots, Flight Service Stations, company personnel) because of insufficient communication coverage. Prior to the aircraft reaching the last en route waypoint, the pilot is issued an approach clearance and the airspace is unavailable to any other IFR aircraft until the pilot cancels the IFR clearance or an arrival time is received. During this situation, it's not uncommon for other aircraft awaiting an IFR clearance to encounter a delay up to 30 minutes.

Scenarios such as these are examples of the adverse impact of non-radar environments on the efficiency of the NAS. From Alaska to the Gulf of Mexico, aircraft are separated by non-radar procedures dating back to the 1930's. The use of non-radar separation limits airspace capacity and results in delays for succeeding IFR aircraft operations. Since ATC may have no way of knowing the position of the aircraft—the entire non-radar airspace for these areas is unavailable to other IFR operations until the pilot cancels IFR. In these scenarios, ATC may use procedural techniques to help expedite the traffic but the efficiency gains are relatively minor and these techniques are workload intensive for ATC. Delays increase when access must be shared between IFR arrival and IFR departure aircraft for the same non-radar airspace. The above situations are common daily occurrences throughout the NAS.

The restrictions in these situations could be reduced if the ATC facilities responsible for IFR service to these areas had surveillance capability. ATC could provide significantly reduced separation based on real-time surveillance resulting in radar-like separation between IFR operations. Furthermore, these large areas of airspace could be simultaneously shared by multiple aircraft with diverse IFR operations e.g., arrivals, departures, and over flights. Because of the remote locations and hostile terrain environment in these areas, it is cost prohibitive or even physically impossible to install and maintain a radar site. WAM has been installed at some of these sites. WAM supported surveillance allows for a rapid and cost effective secondary surveillance radar coverage solution. ADS-B service could be provided in these areas at a much lower cost providing ATC the ability to use radar-like separation and services to ADS-B equipped aircraft. This will result in higher IFR arrival acceptance rate and elimination of departure delays resulting from procedural requirements. In order to realize the full benefits of increased surveillance capabilities, additional equipment such as communication and automated weather stations may be needed.

4.2.2.1.2. Surface Surveillance. Control tower personnel will use the surveillance information to improve their situational awareness of airport surface operations, especially during periods of reduced visibility and at night. Controllers will use the ADS-B information to quickly determine airport utilization and movement area status. The precise position information provided by the Broadcast Services System results in extremely accurate target position reports, collated on an airport map, on the tower's surface surveillance displays. Also, ATC situational awareness is improved when ADS-B provided aircraft/vehicle identification and type information are associated with the displayed targets. Eventually, ADS-B provided aircraft "intent" data e.g., (gate number, start-up, push-back) could assist ATC in organizing priorities based on service and operational factors such as de-icing operations, aircraft/runway compatibility, etc.

Airport operations and service vehicles operating on the movement areas will use vehicle installed displays of ADS-B information to perform on a non-interference basis with aircraft operations. Ground vehicle operators will determine their relative position and the position of other traffic while operating on movement areas. Crash, fire, and rescue vehicles with installed displays will use the ADS-B information to rapidly respond to aircraft emergency locations on and off the airport movement area.

Surveillance and Broadcast Services system sensors could provide a cost effective surface surveillance capability for most airports. "Blind" surveillance areas are eliminated due to the placement flexibility of the ADS-B surveillance sensors.

4.2.2.1.3. Separation Standards Improvements. The higher accuracy and update rate provided by ADS-B may allow a reduction in the minimum separation standard across amny areas of the NAS.. Separation will be based on the quality of the surveillance information rather than the characteristics of the surveillance source. The highly accurate ADS-B surveillance information could result in a common separation standard and reduced separation minima. In the end state environment, using ADS-B provided information, flight crews will be able to use on-board displays and automated tools to determine another aircraft's type, speed, directional changes, etc. to support reduced separation standards for select types of operations.

4.2.2.1.4. Traffic Flow Management Improvements. Traffic Flow Management will use the Surveillance and Broadcast Services information to enhance NAS-wide demand projections. For example, TFM systems will use the information to continually update the projected demand on the taxiways, the order of aircraft in the departure service queue and projected airborne times. The systems will then identify and propose for TFM and ground control personnel runway/route balancing recommendations that are linked to corresponding arrival and overhead stream spacing – without adversely impacting flights on different routes.

Additionally, as the flight segment with the highest variability (surface movement) is reduced, TFM will more accurately predict the service demands both en route and at the arrival airport. The result will be fewer missed arrival slots and greater ATM efficiencies.

In a similar fashion, the ability to incorporate the new surveillance data from areas of limited NAS coverage (mountain airports, Gulf of Mexico, etc.) will also increase the accuracy of the TFM system outputs for both TFM and ATC planning functions.

4.2.2.2. User Scenarios. In order to support these applications, aircraft will require ADS-B out and in capability and an associated CDTI/MFD. Also the aircraft must be within the ADS-R, TIS-B, and FIS-B service areas.

4.2.2.2.1 Airport Surface and Taxi. While operating at the airport, flight crews use the Surveillance and Broadcast Services to enhance their situational awareness. The primary ADS-B surface application is Airport Traffic Situation Awareness.

At an airport, a 1090ES equipped Air Transport and a 978 UAT-equipped General Aviation aircraft are using the cockpit display (CDTI/MFD) to monitor ADS-B traffic, as well as traffic provided to the display through the ADS-R and TIS-B services from the Surveillance and Broadcast Services system.

Prior to taxi, the pilot in the 978 UAT-equipped General Aviation aircraft uses the CDTI/MFD to monitor weather and NAS status information provided by the system's FIS-B service. The pilot uses the CDTI/MFD interface to select weather and NOTAM information for the departure, en route, and arrival phases of flight. The crew may use the updated information to confirm the validity of the flight plan developed during the earlier flight planning process. If there are changes e.g., (NAVAID outages, temporary flight restrictions, or constraining weather), the pilot may request a revised IFR route clearance. In preparation for taxi, takeoff and departure phases of flight, the crew uses the CDTI/MFD to display airport traffic information with the Airport Traffic Situation Awareness application. At pushback, the Flight Crew in the 1090ES equipped Air Transport would also select the Airport Traffic Situation Awareness application at a reduced range on the CDTI/MFD to identify immediate potential hazards posed by other aircraft and vehicles in the ramp and gate area.

As either aircraft enters the airport movement area, the pilots select a greater display range to take advantage of the wider volume displayed and to use the airport moving map for increased positional and navigational situation awareness. As the aircraft taxi, the pilots use the display to integrate the traffic, position and navigation situational awareness to safely avoid hazards and mitigate errors such as turns onto the wrong taxiway, following the wrong aircraft or inadvertent entry to an active runway. The pilots uses the CDTI/MFD as part of their normal instrument scan, the crews monitor other traffic and vehicles operating on the airport surface. The pilots are now taxiing to the runway for takeoff.

To expedite traffic flow, Air Traffic Control instructs that the pilot pass behind and follow Trans American 123, a Trans American B737, at a specific intersection ahead. The pilot uses the Airport Traffic Situation Awareness application to verify Trans American 123 on the display and correlates the location and the specific aircraft visually to distinguish Trans American 123.

As these aircraft approach any runway, whether to cross, or use for takeoff, the surveillance volume of interest for the pilot can be expanded to include airborne traffic and any other traffic which may be using the runway for approach, landing and takeoff. The pilot of an aircraft with the Airport Traffic Situation Awareness application may select a larger scale to ensure that the final approach corridor and the full runway is clear of conflicting traffic and the runway is safe to operate on. The pilots use the display to observe a target on the display showing an aircraft approaching the runway and use the information to visually acquire the traffic.

The pilots use the traffic surveillance and airport moving map display on the CDTI/MFD to correlate visual observations, radio transmissions, airport signage, etc., on the airport and in the vicinity, to increase their overall situational awareness. The ability to prevent potential conflicts/collisions, minimize taxi intervals and flow disruptions, avoid wrong turns or incursions into an active runway, and determine final approach and runway occupancy has improved operational safety, efficiency, and capacity especially during periods of reduced visibility and at night.

4.2.2.2.2 Take-Off and Departure Climb. ATC directs the pilot to line up and wait on the runway and informs him of approaching traffic on a 4 mile final. As the pilot taxis his aircraft onto the runway, he observes on the display the target of a previous landing aircraft approaching an intersection further down the runway and the target of the arriving aircraft on final approach. As the pilot receives the takeoff clearance from

ATC, another aircraft is approaching the runway from an intersecting taxiway and the pilot hears ATC instruct that aircraft to hold short of the runway.

Prior to takeoff roll, the pilot includes the CDTI/MFD in his final scan and observes that the previous landing aircraft has exited the runway, the final approach aircraft is now 2.5 miles from touchdown, and the aircraft at the runway intersection is holding as instructed. This information supports his other awareness cues of the traffic situation (visual scan and party-line radio transmissions), and, if the pilot hasn't already done so, he expands the display range of the CDTI/MFD to a more appropriate range for the takeoff and departure phases. At these expanded ranges, the Airport Traffic Situation Awareness application runs concurrently with the Traffic Situation Awareness-Basic, background application for situational awareness of traffic beyond the vicinity of the airport. The aircraft takes off.

The aircraft is airborne and climbing on departure. The Traffic Situation Awareness-Basic application is running as a background application displaying a greater range and altitude stratum to be operationally useful for higher closure rates. This application will run through the entire flight as a background application. CDTI/MFD-equipped aircraft pilots refer to the display during their normal instrument scans to monitor other aircraft in proximity to their aircraft horizontally or vertically and along the route of flight.

The targets on the CDTI/MFD may be based on ADS-B messages received directly from ADS-B transmitting aircraft on the same link. They may also be from the Surveillance and Broadcast Services ADS-R or TIS-B service. This surveillance capability given to pilots increases the traffic situational awareness thereby improving flight safety.

4.2.2.2.3 En Route Cruise. During the flight, the pilots quickly acquire traffic visually that ATC has reported to them. Outside of Class A airspace, the crews are able to detect and identify other traffic that may or may not be under ATC jurisdiction or detection.
In addition to the Traffic Situation Awareness-Basic application, the General Aviation aircraft also has the Traffic Situation Awareness with Alerts application. The application provides visual and aural traffic advisories, regardless of the selected display modes (weather, aeronautical data, traffic), when the application determines that a conflicting aircraft is a potential threat. This enables the pilot to detect traffic conflicts and visually acquire the traffic greatly aiding the pilot's ability to comply with see and avoid responsibility.

Halfway through the flight, the General Aviation aircraft begins to encounter an area of reduced visibility due to clouds and precipitation. To supplement his situational awareness, the pilot uses the CDTI/MFD by selecting a FIS-B weather application to check current weather information for his route of flight. This geographical area is within the coverage of a ground-based weather radar site. The pilot selects a FIS-B NexRad application to see a display presentation provided by the ground-based weather radar. The pilot determines that a change in the aircraft's course is necessary and plans for a safer route. The pilot uses FIS-B to determine if the proposed new route penetrates any active special use airspace or temporary flight restriction areas. The FIS-B service also provides the pilot with the necessary NAVAID status information for the new route. Also, the pilot can check if there are

PIREP's detailing the flight conditions (visibility, turbulence, icing, winds aloft, etc.) for the proposed new route. The pilot makes an informed new route request and the controller issues a new clearance based on the pilot's requested route. The ability of the crew to access real-time aeronautical information in the flight deck reduces workload and frequency congestion that improves safety and efficiency benefiting all users in the area.

En Route in Class A airspace and several hundred miles from their destination, the Air Transport crew begins receiving air speed changes from a control facility as the controller manages the arrival sequence. ATC is aware that the flight is capable of the Ground Based Interval Management-Spacing application which will reduce the controller and pilot communications workload and permits the controller to manage his airspace more efficiently. The Aircraft is given Trans American 987 as his traffic to follow to the destination. Once the crew has identified Trans American 987 on the CDTI, ATC issues a spacing interval instruction behind Trans American 987 to achieve and maintain as it navigates to the same destination allowing the crew to optimize their descent and arrival to the destination airport on a common arrival. The GIM-S application provides the flight crew with speed guidance and cues to comply with the ATC spacing instruction on the specified aircraft. ATC still maintains the separation responsibility and may intervene at any time.

4.2.2.2.4 Descent and Landing. As in the climb and cruise phases of flight, the pilots of either the Air Transport or General Aviation aircraft continue to use the CDTI/MFD to monitor the traffic situation using the Traffic Situation Awareness-Basic application. In the case of the General Aviation aircraft, the Traffic Situation Awareness with Alerts application is also running continuously. The Air Transport aircraft's destination is a major commercial airport served by a Terminal Radar Approach Control (TRACON) and the General Aviation aircraft is arriving at a towered satellite airport served by the same TRACON.

As the aircraft descend for their destinations, the General Aviation pilot once again uses the CDTI/MFD to access the FIS-B service. The pilot obtains destination weather conditions and airport information (runway, winds, altimeter, etc.). As the aircraft approaches the airfield, the crew uses the CDTI/MFD to monitor traffic and utilize the Cockpit Display of Traffic Information/Multi Function Display (CDTI/MFD) Assisted Visual Separation (CAVS) application. As the aircraft descends below the base of the cloud layer, ATC advises the pilot to look for twin cessna traffic that is 7 miles ahead and 1500 feet below and to report when the traffic is "in sight" for the visual approach. After descending below the base of the cloud layer, the pilot quickly acquires the reported traffic visually and informs ATC who then instructs them to follow the aircraft and clears him for the visual approach.. On final approach, the pilot selects a range which provides Airport Traffic Situation Awareness and scans the CDTI/MFD to monitor traffic in the pattern and waiting for takeoff. The pilot makes an uneventful landing. After landing, the Airport Traffic Situation Awareness application continues to provide the airport moving map display and traffic situation awareness in the same manner as the taxi out phase of flight.

The Air Transport aircraft is now within 20 miles of the busy runway and is still sequenced behind Trans American 987. The crew has been instructed to intercept the ILS and is expecting to be able to follow Trans American 987 as they approach the airport after breaking out of the advertised 1200 ft ceiling and acquiring them visually.

This application provides the crew with identification, aircraft type, ground speed, and directional information on the other aircraft. ATC has assigned the landing runway and is vectoring the aircraft for a visual approach while simultaneous operations are being run to a parallel runway. At this time, the airport is experiencing the afternoon "rush" of intensified arrival and departure traffic from multiple air carriers making hub connections and top of the cloud layer is at 4000 feet As the flight approaches the base of the cloud layer, ATC advises the crew to look for Trans American 987 who is 5 miles ahead and to report when the traffic is "in sight" for the visual approach. After descending below the base of the cloud layer, the aircrew quickly acquires the reported traffic visually and informs ATC who then instructs them to follow the aircraft and clears the crew for the visual approach. The crew uses the CAVS application to couple to Trans American 987 to enable them to utilize the CAVS application after breaking out into VMC, and to more easily maintain visual contact throughout the visual approach procedure. The crew monitors the lead aircraft to landing roll.

On Final Approach, the crew selects the Airport Traffic Situation Awareness application. At approximately 3 nm from the runway the crew sees that the runway is still occupied by Trans American 987. As Trans American 987 clears the runway, the flight crew verifies with their visual scan that the runway is clear for the landing. The crew makes an uneventful landing. The Airport Traffic Situation Awareness application assists the crew with the airport moving map display as they clear the runway and taxi to the gate.

In these scenarios, each aircrew has used the Surveillance and Broadcast Services System to enhance their operational situational awareness. Overall flight safety, capacity and efficiency has been improved.

4.2.2.3 Other Scenarios

4.2.2.3.1 Fleet Management. Authorized aircraft operators will use the Surveillance and Broadcast Services System information to track fleet operations. Using real-time flight progress information provided by the system, airline operations centers and ramp control personnel will efficiently stage and choreograph their operations. The high volume of radio communication traffic used to relay operational coordination information among ground support personnel and between ground support and operating aircraft will be substantially reduced.

4.2.2.3.2 Collaborative Decision-Making (CDM). Users and Service Providers will have a shared situational awareness of the NAS operational status. Using Surveillance and Broadcast Services information, users will be able to determine and consider NAS resource constraints in operational decision-making. Authorized users will use automated CDM tools to communicate goals and negotiate operational adjustments with service providers to optimize NAS operations.

4.2.2.3.3 Department of Defense (DoD). The Surveillance and Broadcast Services provides a cost effective, single integrated surveillance sensor to provide highly accurate target position and direction information. The Broadcast Services System ground infrastructure components are well suited for contingency operations requiring an easily transportable surveillance system.

4.2.2.3.4 Department of Homeland Security (DHS). The Surveillance and Broadcast Services will allow authorized security personnel the ability to determine an aircraft's

identity, ownership, origin, destination, route of flight, and other intentions reducing the incidence of false intercept alerts. Also, during localized contingency operations, the system will provide command and control personnel surveillance information on support vehicles (helicopter, watercraft, and ground vehicles) that operate below conventional radar coverage.

4.2.2.3.5 Search and Rescue. ADS-B will enable more accurate and responsive search and rescue operations to augment current Emergency Locator Transmitter (ELT) technology.

4.3 Proposed Environment

The following sections highlight the transition to ADS-B in general terms and describe the end-state ADS-B environment. ADS-B will be usable in select airspace classes and ATC/TFM service areas and domains.

4.3.1 Near Term.(Present-2014) ADS-B ground equipment infrastructure begins deployment in the NAS to support ATC surveillance and limited cockpit-based, situational awareness applications. ATC uses ADS-B surveillance information to provide ATC services in the same manner traditional surveillance information is currently used. The near term goal is to provide users and service providers with improved surveillance while minimizing impacts to current computer-human interfaces and procedures.

4.3.2 Transition. (2014-2020) Aircraft begin to equip with ADS-B avionics. Throughout the NAS, some aircraft will equip with 978 UAT, some with 1090ES, and some will have no ADS-B equipment. TIS-B and ADS-R services will be required to provide a more complete surveillance capability to pilots and surface vehicle operators using the different link and radar-based surveillance reports. FIS-B services begin to provide aeronautical information, such as graphical weather depictions and textual flight advisories, to 978 UAT equipped aircraft. Users begin to use FIS-B services to determine NAS resources status and meteorological impacts. Users begin to use ADS-B and TIS-B services to improve pilot situational awareness in VMC and IMC or to enhance the pilot's visual acquisition ability during surface, terminal, en route, and oceanic operations in VMC and marginal VMC.

Also during the transition, automation system interfaces are designed and processing and display requirements necessary for the support of ADS-B are defined and implemented. ADS-B is used as a primary surveillance source in airspace that has no radar coverage. Radar-based systems continue to be the source of surveillance data in radar coverage areas, WAM is the source of surveillance in some areas where radar coverage is not available due to terrain but higher traffic density requires surveillance, ADS-B begins to provide enhanced surveillance in select areas. High quality ADS-B surveillance information begins to be integrated with existing radar and WAM data improving ATC automation performance and safety features. Authorized commercial sector enterprises begin to have access to Surveillance and Broadcast Services System source information for fleet management functions.

4.3.3 End State. (2020 and beyond)) Select secondary surveillance (beacon) systems are retired as ADS-B surveillance becomes the primary source of surveillance data in these areas. Per the airspace rule, all aircraft in designated airspace are ADS-B equipped with one of the two link technologies. ADS-B In will not be required but will be necessary for users voluntarily seeking operational benefits from cockpit-based

applications. TIS-B services begin to be decommissioned. ADS-R service continues to be required to provide interoperability for aircraft/vehicles using the different data links. Users rely on FIS-B service to provide NAS status and meteorological information. Users perform ADS-B-enabled spacing and separation applications thereby improving capacity and efficiency throughout the NAS.

High quality ADS-B surveillance information, combined with airborne and ground-based automation tools, begin to support reductions in spacing and separation minima improving capacity or managing workloads during increased air traffic demands and evolving airspace operations/complexities. FAA TFM functions use Surveillance and Broadcast Services information for the management of NAS resources. Authorized commercial sector enterprises use system information to collaborate with TFM for optimized operations in the NAS.

5. SYSTEM DESCRIPTION.

5.1 Surveillance and Broadcast Services System.

The Surveillance and Broadcast Services system's functions (*Aircraft/Vehicle, Data Link Processor, Broadcast Server,* and *ATC/TFM Automation*) provide the ADS-B services that support ADS-B applications. Figure 5.1 shows the relationship between the principle and sub-system components. The ADS-B surveillance service is supported by *Aircraft/Vehicle, Data Link Processor,* and *ATC Automation* functions. TIS-B and FIS-B services are supported by the *Aircraft/Vehicle, Data Link Processor,* and *Broadcast Server* functions. The ADS-B Rebroadcast (ADS-R) is implemented by the *Aircraft/Vehicle* and *Data Link Processor* functions.

The *Aircraft/Vehicle* function is identified by the components located in ADS-B equipped aircraft and vehicles at the top of the illustration. The *Data Link Processor* and *Broadcast Server* functions are identified by the uplink/downlink/ground interfaces, 1090ES and 978 UAT receive/transmit components and TIS-B and FIS-B processors located mid illustration. *ATC Automation* and other external user functions are identified at the bottom of the illustration.

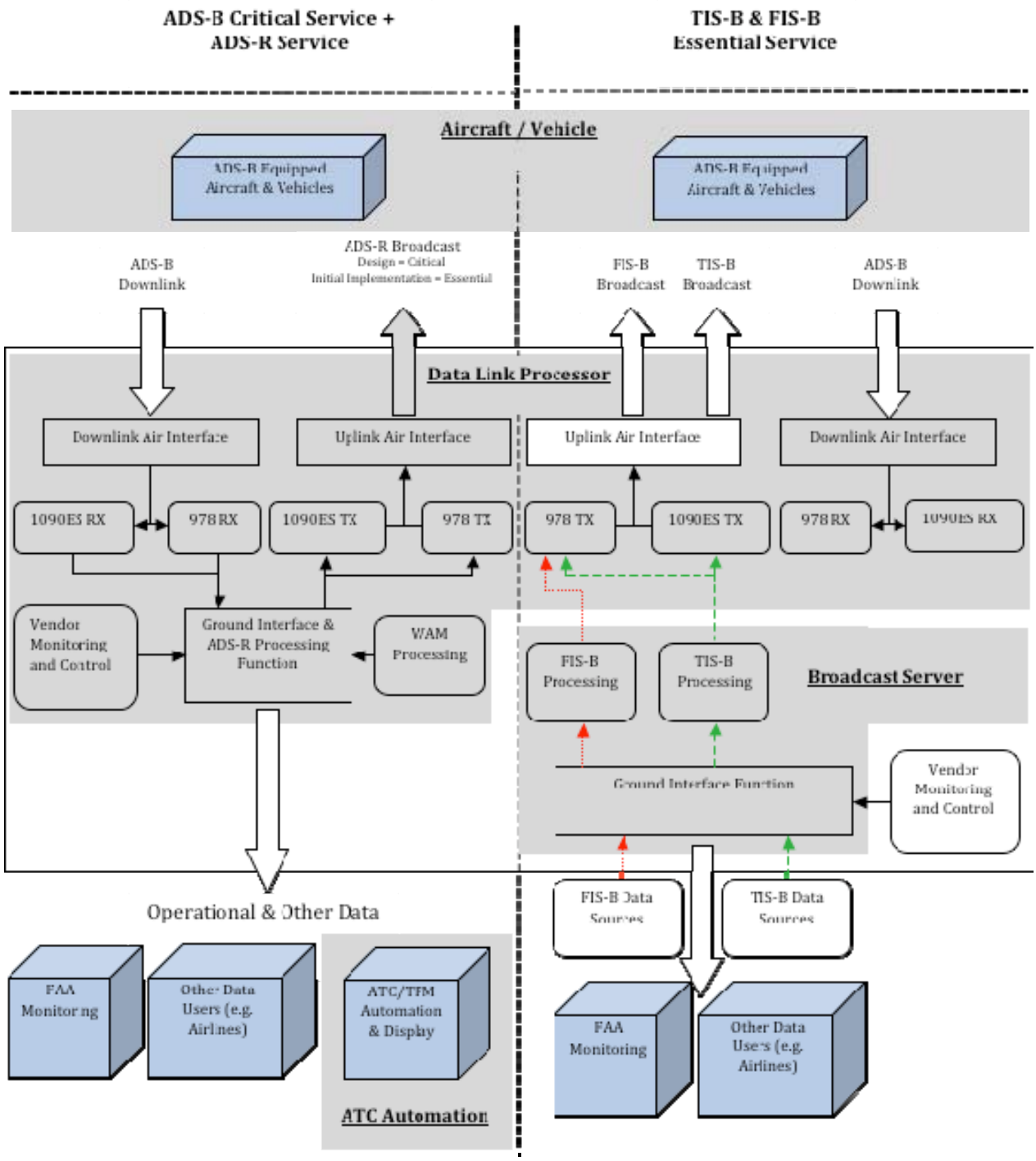


Figure 5.1 Surveillance and Broadcast Services System

5.2 Functional Description.

The purpose of each function of the Surveillance and Broadcast Services System, how they interoperate with each other, and how the Surveillance and Broadcast Services System fits into the NAS are described below.

5.2.1 Aircraft/Vehicle. The *Aircraft/Vehicle* is the source of ADS-B information. The *Aircraft/Vehicle* gathers information including position data from GPS or other navigation source, crew input, barometric altitude, vertical speed and aircraft identification data. The *Aircraft/Vehicle* processes the information gathered and determines the associated integrity and accuracy indicators. The *Aircraft/Vehicle* encodes and broadcasts all the information in an ADS-B Message.

The ADS-B system will monitor information broadcast by the aircraft avionics package. The quality of the data will be evaluated to ensure aircraft compliance with the mandated performance measurements and standards. Detailed reporting of compliant and non-compliant aircraft broadcast with the associated avionics package will be provided to Aviation Safety (AVS) for analysis.

The *Aircraft/Vehicle* receives and decodes ADS-B Messages transmitted by other *Aircraft/ Vehicles* equipped with the same data link and TIS-B and ADS-R Messages transmitted by the *Data Link Processor*. *Aircraft/Vehicles* equipped with the 978 UAT data link additionally receive and decode FIS-B Messages transmitted by the *Data Link Processor*.

The *Aircraft/Vehicle* may display ADS-B and TIS-B data on a CDTI/MFD. Properly equipped 978 UAT-equipped *Aircraft/ Vehicles* can display FIS-B data.

5.2.2 Data Link Processor. The *Data Link Processor* receives ADS-B Messages broadcast by *Aircraft/Vehicles* over both the 978 UAT and 1090ES data links. The *Data Link Processor* processes the received ADS-B Messages, formats them into ADS-B Reports and WAM Reports, and sends the reports to the *Broadcast Server* and *ATC Automation.* The *Data Link Processor* will rebroadcast ADS-B Messages received on one data link, over the other data link.

The *Data Link Processor* receives TIS-B Reports from the *Broadcast Server* and broadcasts TIS-B Messages up the 978 UAT and/or 1090ES data links, as directed in the report. The *Data Link Processor* receives FIS-B Reports from the *Broadcast Server* and broadcasts corresponding ground uplink messages over the 978 UAT data link.

The *Data Link Processor* broadcasts periodic messages on both the 978 UAT and 1090ES data links, as directed by the *Broadcast Server* in the Broadcast Services Management Report on a periodic basis, to indicate to aircraft that they are in ADS-B service coverage.

The *Data Link Processor* generates status reports, containing information on alarms and events in the *Data link Processor* subsystems and sends them to *ATC Automation* and the *Broadcast Server*. The *Data Link Processor* will also generate internal test target messages and send the resulting ADS-B Reports to *ATC Automation* and the *Broadcast Server*.

The *Data Link Processor* accepts and acts upon *Broadcast Server* information, including the changing of configuration items and alarm resets, from the *Broadcast Server*. The *Data Link Processor* provides monitor information, including alarms and read back of parameters, to the *Broadcast Server*.

5.2.3 Broadcast Server. The *Broadcast Server* receives ADS-B Reports and status reports from the *Data Link Processor*. The *Broadcast Server* provides Surveillance and Broadcast Services information to authorized external users.

The *Broadcast Server* includes a TIS-B Server function. The *Broadcast Server* receives surveillance data from radar and WAM systems and potentially other surveillance sources. The *Broadcast Server* processes the surveillance data, including tracking, filtering, and applying quality indicators to the data. The *Broadcast Server* generates TIS-B Reports and forwards them to the *Data Link Processor*.

The *Broadcast Server* includes a FIS-B function. The *Broadcast Server* receives textual and graphical weather information and other data that will be used in generating FIS-B Reports. The *Broadcast Server* sends FIS-B Reports to the *Data Link Processor*.

The *Broadcast Server* includes a control and monitoring function. The *Broadcast Server* provides an interface for control and monitor to the Maintenance Technician. The *Broadcast Server* provides control information to the *Data Link Processor* and receives monitor information from the *Data Link Processor*.

5.2.4 ATC Automation. *ATC Automation* receives ADS-B Reports and status reports from the *Data link Processor*. *ATC Automation* receives ADS-B Reports in both an ADS-B only environment as well as a mixed surveillance (e.g., radar, WAM and ADS-B) environments. *ATC Automation* performs Minimum Safe Altitude Warning (MSAW) and Conflict Alert (CA) processing using the ADS-B data and radar data if in a mixed surveillance environment. *ATC Automation* may be able to improve tracking and safety feature functions using the high accuracy and greater update rate of ADS-B Reports. ADS-B Reports will also feed targeted surface surveillance systems and support their alerting functions. *ATC Automation* tracks the targets given the information provided in the ADS-B Reports. *ATC Automation* displays target positions based on ADS-B Reports. The current FAA automation systems incorporate flight data processing subsystems that maintain the flight plan database for aircraft operating within the NAS. In addition, systems such as User Request Evaluation Tool (URET) will probe for conflicts between aircraft trajectories based on flight plan data and aircraft position information. In the future, new decision support tools will be implemented in the En Route, Terminal, and Surface Automation systems. These decision support tools may exchange information with the *Broadcast Server* to provide enhanced situational awareness to aircraft.

5.2.5 TFM Automation. TFM automation receives ADS-B reports as part of the surveillance data passed from the en route and terminal ATC systems. As the coverage areas increase, TFM decision support tools will incorporate the data to produce more accurate demand projections, operational response strategies, (such as traffic management initiatives (TMIs)) for periods of excess demand relative to capacity and weather. Additionally, the resultant aggregate demand data provided to the ATM community will reflect the increased accuracy and support better informed collaborative decision-making through traffic management.

5.2.6 NAS Integration. The functional elements of the Surveillance and Broadcast Services System provide the surveillance and broadcast services identified in the

introduction (ADS-B, ADS-R, TIS-B and FIS-B). How these services will operate in the NAS in order to support the applications identified in section 4.2 is shown in the *Integrated Definition for Function Modeling* diagram shown in Figure 5.2.

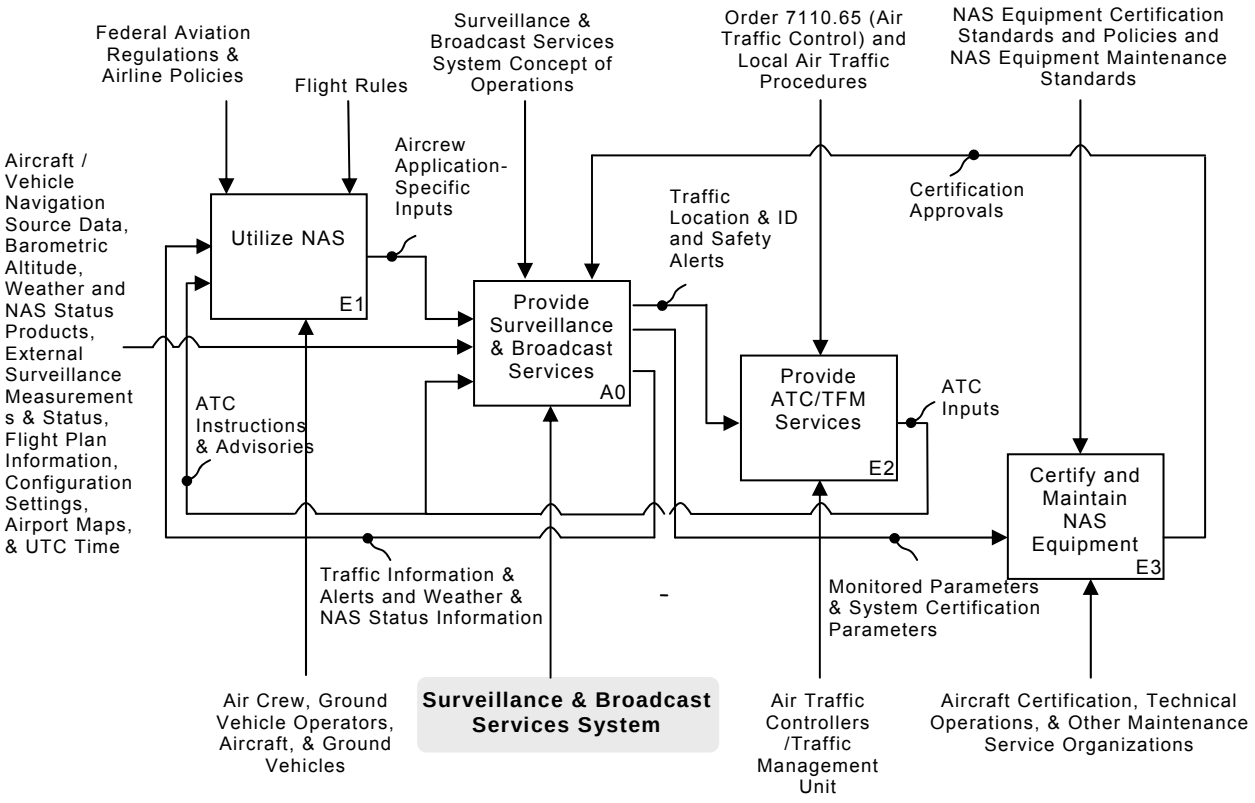


Figure 5.2 Surveillance and Broadcast Services System Integrated Definition for Function Modeling Diagram

5.3 Modes of Operation.

The Surveillance and Broadcast Services system is a system of systems, making the definition of modes of operation more complicated than those of a single system providing a single function. Applications are enabled by services provided by specific Surveillance and Broadcast Services system functions. Under normal operating conditions, all functions are available and operational, thus all services and applications are supported, depending upon the implementation segment.

Degradation or loss of a system function leads to degradation or loss of the services supported by that function, and ultimately of the applications enabled by the service. Table 5.3-1 shows the services that each system function supports. The following sections address the normal operating mode as well as degradation or loss of functions and the associated backup modes of operation in general terms.

Table 5.3-1 System Functions Required for Provision of Services

Function	Service				
	Surveillance			Broadcast	
	ADS-B	WAM	ADS-R	TIS-B	FIS-B
Aircraft /Vehicle (Para 5.2.1)					
Transmit	x	x			
Receive	x note		x	x	x
Data Link Processor (Para 5.2.2)					
Transmit			x	x	x
Receive	x	x	x		
Broadcast Server (Para 5.2.3)			x	x	x
ATC/TFM Automation (Para 5.2.4/5.2.5)	x	x			

Note: Need ADS-B receive capability to support cockpit-based applications, but not ATC Surveillance applications on the ground.

5.3.1 Normal Operations (All Services Available). When all Broadcast Services System functions are available and operational, all services can be provided, depending upon the implementation segment. In the case of the *Broadcast Server*, this also assumes that the interfacing systems providing the surveillance reports for TIS-B and weather and aeronautical data for FIS-B are operational and providing that data. Otherwise, the TIS-B and FIS-B services would not be available.

5.3.2 Aircraft/Vehicle Degradation or Loss. The *Aircraft/Vehicle* is required for all services and applications. The *Aircraft/Vehicle* could degrade such that transmit only, receive only, or both are lost. Additionally, this function can degrade or be lost on a per aircraft basis and also NAS wide or regionally. Each of these outages has a different impact.

5.3.2.1 Loss of Reception Capability (ADS-B air-to-ground available, ADS-B air-to-air, ADS-R, TIS-B, and FIS-B lost). Degradation or failure of the *Aircraft/Vehicle* reception functionality would result in loss of ADS-B, ADS-R, TIS-B, and FIS-B information in the cockpit. The cockpit-based applications could no longer be supported in the failed aircraft, but could continue for other equipped aircraft in the vicinity.

5.3.2.2 Loss of Transmit Capability (TIS-B and FIS-B available, ADS-B ground-to-air and ADS-R lost). Degradation or failure of the *Aircraft/Vehicle* transmit function would result in the loss of ADS-B information to the *Data Link Processor* and to other aircraft. If the aircraft is in coverage of another surveillance source, the TIS-B service would begin including that aircraft's information in TIS-B message transmissions. This would permit the continuation of cockpit-based situational awareness and spacing applications, but cockpit-based separation applications would not be supported for the failed aircraft. Additionally, other equipped aircraft in the vicinity could not perform cockpit-based separation applications involving the failed aircraft.

5.3.2.3 Loss of ADS-B Surveillance Source. Due to the criticality of aircraft surveillance data, a backup plan must be in place. In areas covered by other surveillance sources, including radar and WAM systems, data from the other system would be used as backup surveillance in *ATC/TFM Automation System* when this occurs. In non-radar areas, controllers would have to revert to procedural separation. In addition to the ground-based surveillance backup systems, navigational backup systems are also being considered.

The loss of the ADS-B surveillance source, GPS, would result in NAS-wide or regional loss of ADS-B and ADS-R services. This would result in the loss of the *Aircraft/Vehicle's* ability to transmit ADS-B state vector information. The *Aircraft/Vehicle* receive functionality would not be impacted. ATC controllers would lose all ADS-B surveillance data on all aircraft. Pilots would lose their own position reference, as well as, surveillance information on other ADS-B equipped aircraft in the vicinity. The *Aircraft/Vehicle* would be able to receive TIS-B and FIS-B transmissions, providing some situational awareness applications.

5.3.3 Data Link Processor Degradation or Loss.

5.3.3.1 **Loss of ADS-B Reception Capability** (TIS-B & FIS-B available, ADS-B air-to-ground & ADS-R lost). Degradation or loss of the *Data Link Processor* reception would result in the loss of ADS-B, supporting core surveillance applications. ADS-R would additionally be lost. As the TIS-B service continues to be available, information on all aircraft in coverage of another surveillance system would be broadcast, continuing support for cockpit-based situational awareness and spacing applications in that airspace. And, TIS-B would unnecessarily generate radar-based target reports on ADS-B aircraft resulting in aircraft receiving two reports (TIS-B generated and ADS-B aircraft generated) on a single aircraft.

5.3.3.2 Loss of ADS-B Transmit Capability (ADS-B available, ADS-R, TIS-B, & FIS-B lost). Degradation or failure of the *Data Link Processor* transmit would result in loss of ADS-R, TIS-B, and FIS-B, thus loss of all cockpit-based applications other than pair-wise applications for the airspace covered by that *Data Link Processor*.

5.3.4 Broadcast Server Degradation or Loss (ADS-B & ADS-R available, TIS-B & FIS-B lost). Degradation or loss of the *Broadcast Server*, or supporting data sources, would impact only the TIS-B and FIS-B services, supporting the cockpit-based situational awareness and spacing applications. It's expected that the *Broadcast Server* will have system-specific back-up strategies.

5.3.5 ATC Automation. Each *ATC Automation* system has system-specific backup strategies that will apply regardless of the source of surveillance data.

6. ASSUMPTIONS, CONSTRAINTS, AND DEPENDENCIES.

Numerous issues require resolution to ensure a successful initial transition to specific ADS-B-enabled applications and eventual transformation to NAS-wide, ADS-B-enabled operations. With the introduction of ADS-B-enabled applications, there will be a need to make corresponding changes to existing rules, procedures, and operations to support and realize the maximum benefits of a NAS supported by ADS-B technologies. During analysis of ADS-B impacts, the overriding goal for the system is safety. ADS-B procedures, phraseology, and separation minima must be standardized.

6.1 Organizational Impacts.

6.1.1 Staffing. The introduction of the ADS-B applications may require adjustments to current ATC facility staffing schemes to optimize facility operations. FAA Technical Operations personnel adjustments may need to be made to support and maintain local and remotely deployed ADS-B equipment, in addition to the maintenance responsibilities for existing NAS infrastructure equipment. An adequate number of field support facilities and personnel will be required to install, maintain, and certify ADS-B avionics equipment.

6.1.2 FAA Acquisition Management System (AMS). Surveillance and Broadcast Services ground infrastructure will require certification and acceptance by FAA Technical Operations. FAA organizations with acquisition and implementation responsibilities must complete FAA Acquisition Management System requirements.

6.1.3 Safety Management System/Safety Risk Management (SMS/SRM). The Surveillance and Broadcast Services **s**ystem must conform to Safety Management System and Safety Risk Management (SRM) processes. FAA organizations with

development and deployment responsibilities must comply with SMS/SRM requirements.

6.1.4 Regulation and Policy. Rules may be required and procedures will be necessary to support ADS-B-enabled spacing and separation operations. FAA may need to develop policy and performance standards for aircraft and operators to support the ADS-B technology. Any changes to flight rules may require public comment and resolution.

Other actions, such as airspace design, may be necessary to realize full operational benefits. It is expected that initial ADS-B applications will be informational, providing pilots with an improved situational awareness to enhance safety, and probably will not require rule or procedural changes. The FAA strategy initially depends on users voluntarily equipping for ADS-B. However, it is expected that over time more users will equip to gain the operational benefits. In line with the FAA and industry agreed policy of "Best-equipped, Best-served", the FAA may consider airspace rules or may designate areas to provide preferred service for users who are capable and equipped for ADS-B operations

6.1.5 Publication/Notices. Changes to current publications will be required to reflect operational and compliance changes. Development of new operational, procedural, and training documentation is required. Notices announcing changes to operational, procedural, and compliance requirements will need to be developed and distributed. Examples of documentation that may or may not be affected include, but are not limited to:

Code of Federal Regulations (CFR)

FAA Advisory Circulars (AC)

Maintenance and Technical Standard Orders (TSO)

FAAO 7110.65 Air Traffic Control

FAAO 7210.3 Facility Operations and Administration

Aeronautical Information Manual (AIM)

FAAO 8260.3 Terminal Instrument Approach Procedures (TERPS)

Instrument Approach Procedure Charts (IAP)

Standard Terminal Arrival Routes (STAR)

and Standard Instrument Departures (SID)

High/Low/Sectional Navigation Charts

Operator and Maintenance Training Manuals

Operations Specifications (OpSpecs)

8900.1 Handbook Guidance

Letters of Agreement (LOA)

6.2 Operational Impacts.

6.2.1 ATC Automation. For ATC surveillance application, Data Link Processors will provide ADS-B reports and status reports to all current and future ATC Automation Systems. ADS-B reports received by automation will include not only aircraft position and Mode 3A/C codes, but also additional surveillance related parameters such as, but not limited to, velocity, aircraft flight identification and accuracy/ integrity measure of ADS-B position report. ADS-B ground stations will provide surveillance reports to automation at a higher update rate than radar. ADS-B reports will also be used by automation to improve aircraft tracking accuracy and safety functions such as Conflict Alert and Minimum Safe Altitude Warning. Because of the additional surveillance provided by ADS-B, SBS has implemented the use of fusion on most ATC automation platforms. This fuses any available surveillance source (e.g., ADS-B, Radar, WAM) and displays a single tracked target to ATC. This allows automation to provide ATC with a faster synchronous display update and, when ADS-B surveillance is part of the fused target, a more accurate target position will be displayed to the controller.

6.2.2 TFM Automation. For TFM automation, ADS-B reports will be incorporated as elements of the already established provision of surveillance from en route and terminal systems. There are no anticipated significant operational impacts. The resolution of any asynchronous reporting/timing issues is expected to be resolved within the ATC automation systems prior to exchange with TFM (other than TMA and other metering systems). TMA and other higher resolution metering system may be impacted by the asynchronous reporting and changes to those systems may be necessary. The use of the improved surveillance by TFM systems, processes and personnel will be as described above.

6.2.3 Radar-based Surveillance Systems. A communication interface method with existing primary and secondary radars and existing surface and wide area multilateration systems will be required to provide sensor measurements and/or track data for the TIS-B uplink.

6.2.4 Service Provider and User Procedures. The introduction of ADS-B will necessitate Air Traffic Control procedural changes in order to optimize potential operational efficiency gains. New procedures should be designed to minimally impact current procedures. The goal is to minimize increase to cognitive workloads due to the implementation of ADS-B surveillance applications. New cockpit and ground automation capabilities provided by ADS-B give users the ability to achieve spacing and separation without fundamentally changing the overall responsibilities between pilots and controllers. Users may request or accept an ADS-B-enabled operation while service providers retain the authority for approving or applying a procedure depending on factors such as duty priorities and the operational situation at the time. However, procedures to clearly define the roles, responsibilities, and methods between users and service providers for initiating, executing, or terminating an ADS-B application will be required. Human factors analysis will be required to examine aircrew and controller workloads. Analysis will be required to develop rules and procedures defining all

factors associated with the application or operations. Examples include, but are not limited to:

- ADS-B specific phraseology for application/operations.
- Rules and procedures between pilot and controller for the positive transfer of separation responsibilities.
- Designated areas, conditions, and types of ADS-B operations authorized.
- Service provider procedures for mixed operations (ADS-B participants versus non-participants) environments.
- Rules governing airborne spacing and separation operations.
- Backup, contingency, and transition procedures when ADS-B surveillance is lost.

6.2.5 ADS-B Separation Standards

Analysis will be required to determine separation standards between mixed equipage targets received from different surveillance systems including the transition boundaries between these surveillance areas. Additional analysis is required to support reduced separation using ADS-B in En Route airspace. The goal is a common, standardized separation minimum for service providers. Future analysis will be undertaken to determine air-to-air separation standards for cockpit-based applications.

6.3 Service Provider and User Impacts.

The equipage decision will vary for different NAS users and consideration must be given on the effect ADS-B implementation and operations will have on those that do or do not equip. The FAA will define and enforce avionics and navigation equipment standards through Technical Standard Orders (TSO), Advisory Circulars, Airworthiness Inspections, etc.

The Department of Defense (DoD) will consider civil performance standards in determining aviation navigation needs. DoD aircraft must be equipped with instruments and navigation equipment appropriate to the routes to be flown. It is DoD policy that military aircraft conducting peacetime operations will conform to applicable rules to ensure interoperability and transparency within domestic and international controlled airspace. The FAA issues TSO's that prescribe minimum performance standards for navigation equipment used by the civil aviation community in the NAS. The ICAO issues standards and recommended practices for international civil aviation. The development of minimum performance standards for military users is the responsibility of the separate department Services. These military standards must conform to civil airspace required navigation performance requirements, prevent violation of civil air traffic clearances, and ensure safe separation of military and civil air traffic.

6.3.1 User and Service Provider Training. Users and service providers will require training to understand the new technology's capabilities, characteristics, and limitations. Users and service providers must have an understanding about one another's use of the ADS-B technologies and the Surveillance and Broadcast Services system. Both service providers and users will require training on the

operation of ADS-B equipment and knowledge of ADS-B-specific terms, phraseologies, and display symbology. Users and service providers will require training and certification/qualification on the use of ADS-B applications and operations. This will include, but not be limited to:

- Rules governing areas and conditions allowing an ADS-B application.
- Rules governing certified equipment levels and personnel qualifications.
- Rules and procedures for spacing and separation applications.

6.4 Other Considerations.

6.4.1 Application Portfolio. FAA and aviation industry interests will determine the compliment of applications in the deployment portfolio. The Surveillance and Broadcast Services system deployment strategy will be dependent on the operational readiness of the application/s selected. Applications selected for the portfolio will determine system requirements. This concept of operations identifies the seven applications that the FAA and industry have agreed to deploy. Additional applications will be placed into the portfolio as they become operationally mature.

6.4.2 User Interest. The interdependencies between airspace rulemaking, equipment requirements, and capital investment for the supporting ground infrastructure require government effort to develop stakeholder consensus. The FAA leadership will work with domestic aviation stakeholder input to identify and define what ADS-B applications have operational benefits, and which are feasible for implementation. RTCA recommendations will be considered by the FAA in determining rulemaking, mandates, and capital investment decisions to support system goals. The success of the Surveillance and Broadcast Services system is dependent on users equipping for operational benefits.

6.4.3 Standards and Procedures. ADS-B applications and operations will be dependent on development of equipment standards and operational procedures.

6.4.4 Cockpit Displays. A Cockpit Display such as a CDTI/MFD is necessary for cockpit-based ADS-B applications.

6.4.5 Global Navigation Satellite System. Currently the only available Global Navigation Satellite System (GNSS) is the GPS. However, any navigational source meeting the performance requirements can provide positional information. While GPS provides high availability and accurate position estimates, the system is vulnerable to interference that can cause large position errors or prevent a position from being generated by the GPS receiver. These sources of interference include jamming, RF interference, and ionosphere distortion. In addition, only a single civilian frequency is available for civilian use such as ATC. Therefore, the use of the civilian signal in ATC applications makes the service more susceptible to interference. Another factor affecting GPS is that some of the GPS satellites have exceeded their service life, but continue to be necessary components of the space infrastructure. While there is a GPS sustentation and modernization program in place, the near term potential for outages of a GPS satellite can disrupt service availability. When considered from an overall service availability perspective, the interference potential, single civil

frequency, and satellite service life issues of GPS represent a risk to an ADS-B infrastructure with a dependency to GPS for positioning.

As a result of the current GPS vulnerabilities and consistent with DOT studies as well as the Federal Radio Navigation Plan, a backup strategy for determining aircraft position is necessary to ensure that a GPS service disruption does not result in the loss of normal air traffic control service to one or more areas of airspace for an extended period of time. As other GNSS systems come on-line and GPS vulnerabilities are mitigated through the current GPS III modernization efforts, the backup strategy should migrate with the new capabilities provided by these systems.

6.4.6 FIS-B and TIS-B Sources. Cockpit-based applications, such as Traffic Situation Awareness for Visual Approach, depend on FIS-B and TIS-B service information to provide comprehensive awareness of operating hazards and constraints. The FIS-B source data will come from both government and commercial sources. The availability of the FIS-B service to an aircraft is dependent on whether the aircraft is operating within the coverage volume of Data Link Processor. The TIS-B source data consists of measurements from radars (primary and secondary), measurements or track reports from surface and wide area multilateration systems, and ADS-B reports. The availability of the TIS-B service to an aircraft is dependent on whether the aircraft is operating within the coverage volume of both radar or multilateration-based surveillance sensors and Data Link Processor.

6.4.7 International Harmonization. The 1090ES link is currently the internationally agreed upon common data link for ADS-B. However, there are other data links being used for ADS-B operations in the United States and internationally (i.e., UAT or VDL Mode4) . The successful implementation of ADS-B systems worldwide depends on common standards and agreement among service providers to adhere to the standards. International working groups, such as RTCA, EUROCAE, and ICAO must continue to work to achieve harmonization, interoperability and consistency in the ADS-B standards.

6.4.8 Manufacturing Source of Certified ADS-B Equipment. Adequate production sources of certified ADS-B equipment will be required to meet user demand for equipage mandates e.g., (Broadcast Services System ground infrastructure equipment and ADS-B avionics/navigation equipment).

6.4.9 Supporting NAS Infrastructure and Service. ADS-B applications may require supporting CNS infrastructure. Analysis will be required to determine infrastructure needs to support the targeted applications for the location.

6.4.10 Avionics. Avionics require periodic maintenance checks and will be subjected to corrective maintenance as needed to ensure continued airworthiness.

6.4.11 ADS-B Surveillance/Positioning Backup Strategy. A Surveillance/Positioning Backup Strategy Alternatives Analysis was conducted, with the final report dated January 8, 2007. The report recommended that ADS-B would be

the primary means of surveillance in the future. The backup will be a reduced secondary radar network to cover required airspace. The ADS-B backup strategy will be reassessed to reflect further ADS-B operational experience and emerging requirements prior to the FAA's commitment to radar-based surveillance investments beyond 2020. .

Appendix A – Definitions

Air Traffic Management (ATM): The aggregation of the airborne functions and ground-based functions (air traffic services, airspace management and air traffic flow management) required to ensure the safe and efficient movement of aircraft during all phases of operations.

Automatic Dependent Surveillance-Broadcast (ADS-B): A surveillance service using the automatic transmission of an aircraft's or surface vehicle's position and other state information. The source of ADS-B information is derived from the aircraft's navigation system (e.g., GNSS receiver, Flight Management Computer, etc.). Other aircraft may receive this information and compare it to their own position to accurately determine relative position. Ground systems may also use ADS-B information to augment or replace less accurate radar-based surveillance information, or to provide cost effective surveillance coverage in non-radar airspace.

ADS-B Report: An ADS-B Report contains the information elements assembled using messages received from a transmitting participant. These information elements are available for use by applications external to the ADS-B system.

ADS-B Message: An ADS-B Message is a block of formatted data that conveys the information elements used in the development of ADS-B Reports. Message contents and formats are specific to the ADS-B data link.

ADS-B Rebroadcast (ADS-R): The automatic rebroadcast of an ADS-B message received over one data link, translated directly onto other data links for the purpose of extending ADS-B connectivity to users of incompatible data links.

Broadcast Services Management Report: The Broadcast Server conveys information on the validity of ADS-B Report data to the Data Link Processor in the Broadcast Services Management Report.

Cockpit Display of Traffic Information (CDTI): A generic display that provides the pilot with surveillance information about other aircraft, including their position. Traffic information for a CDTI may be obtained from one or multiple sources (including ADS-B, TCAS and TIS-B) and it may be used for a variety of purposes. Any means of communicating the information is acceptable (aural, graphical, heads-up, etc.) as long as the information is conveyed effectively. Requirements for the CDTI information will vary based on intended use of the data (i.e., application).

Collaborative Decision Making (CDM): An (automated) information exchange and decision-making process for the purposes of coordination between users and service providers.

Critical Service Level: Functions or services which, if lost would prevent the NAS from exercising safe separation and control over aircraft.

Data Element: Separate field of information contained in a message set. The subject of each field contains aircraft information e.g., (identification, type, route of flight, mid and

long term intent, etc.) and aircraft performance parameters e.g., (trajectory, altitude, position, velocity, weight, airspeed, fuel, etc.).

Defined Interval: Under a defined interval task, an air traffic controller maintains separation responsibility while assigning pilots a spacing task that must be performed within defined boundaries. This will enable a range of applications where dynamic interval spacing, closer than that currently allowed by traditional separation standards, may be possible. Defined Interval Operations are planned for the 2017-2019 time frame.

Essential Service Level: Functions or services which, if lost, would reduce the capability of the NAS to exercise safe separation and control over aircraft.

Flight Information Service-Broadcast (FIS-B): The exchange of weather and non-control, aeronautical information (or products) using a broadcast communication system between ground systems and aircraft. FIS-B information is used for applications focused on enhancing flight safety and operational efficiency.

Flight Object: A set of flight-specific, data elements available throughout the duration of the flight both to the user and the affected service providers across the NAS. The flight object is contained in the message set which may contain Flight Profile and Flight Trajectory information. These message set data elements may consist of flight information such as flight route, discrete identification code, preferred trajectory, aircraft weight, type position, runway preference, gate assignment, etc. Flight Profile information includes a complete set of user preferences for climb, descent, cruise, and other operational preferences. Flight Trajectory information includes the four-dimensional path of the flight expressed at the level of performance the flight is capable of achieving.

Global Navigation Satellite System (GNSS): A space-based positioning, velocity and time system composed of space, control and user segments. The United States Global Positioning System (GPS) is the preeminent system with approximately 24 satellites in 6 orbital planes. The European Galileo is an emerging system that is compatible with GPS and could double the number of available satellites. Various GNSS augmentation systems are used to improve the accuracy and the availability of integrity to meet stringent aviation system requirements.

Instrument Flight Rules (IFR): A set of rules governing the conduct of flight under instrument meteorological conditions.

Instrument Meteorological Conditions (IMC): Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minima specified for visual meteorological conditions requiring instrument flight rules and procedures.

1090 Extended Squitter (En Route): A defined frequency of 1090 MHz dedicated for the transmission of ADS-B data link messages, primarily for air transport operators, containing a payload of user information (ADS-B, ADS-R, and TIS-B) and overhead coding that supports the transfer of data.

Management by Trajectory: Improvement concept for NAS system effectiveness through increased collaboration between service providers and users by use of advance technologies to identify NAS-wide constraints and to coordinate resolutions.

The collaboration requires timely distribution of relevant, validated, and up-to-date information to authorized users and service providers. The real-time information will afford users the ability to negotiate and contract for flexible and timely adjustments to their operations. Service providers will have access to users Flight Object information for real-time air traffic control and airspace management.

Message Set: A broadcast message which contains flight object data elements.

Mixed Equipage: An environment where aircraft are operating with different types of avionics.

Movement Area: The runways, taxiways, and other areas of an airport/heliport which are utilized for taxiing/hover taxiing, air taxiing, takeoff, and landing of aircraft, exclusive of loading ramps and parking areas. At those airports/heliports with a tower, specific approval for entry onto the movement area must be obtained from ATC.

(See ICAO term MOVEMENT AREA.)

Movement Area [ICAO]: That part of an aerodrome to be used for the takeoff, landing and taxiing of aircraft, consisting of the maneuvering area and the apron(s).

Pair-wise: An ADS-B application designed for use between two aircraft with ADS-B avionic compatible aircraft.

Radar-like Services: For the purposes of this document, “radar-like services” refers to the use of ADS-B surveillance information to provide separation and additional services in accordance with the radar-based procedures and separation minima prescribed in the FAAO 7110.65. This includes assisting aircraft with navigation and the issuance of traffic advisories and safety alerts.

Service Provider: An individual/facility that provides separation assurance, traffic management, NAS infrastructure management, navigation, airspace management, search and rescue, or other aviation services for NAS user operators.

State (Vector): An aircraft’s current horizontal position, vertical position, horizontal velocity, vertical velocity, turn indication, and navigational accuracy and integrity.

Target: The indication shown on an analog display resulting from a primary radar return or a radar beacon reply.

TFM: Traffic Flow Management is the regulation of air traffic in order to avoid exceeding airport or air traffic control capacity in handling traffic, and to ensure that available capacity is used efficiently.

Track: The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (True, Magnetic, or Grid).

Traffic Information Service-Broadcast (TIS-B): A collection of surveillance services that broadcasts traffic information derived from one or more ground surveillance sources to suitably equipped aircraft or airport surface vehicles, with the intention of supporting ADS-B applications.

Universal Access Transmitter (978 UAT): A 1MHz channel at the 978 MHz frequency dedicated for the transmission of ADS-B data link messages, primarily for general aviation operators, containing a payload of user information (ADS-B, ADS-R, TIS-B, or FIS-B) and overhead coding that supports the transfer of data.

User: An individual/entity that operates vehicles in the National Airspace System and uses or relies on the system's air traffic control, airspace, navigational aids, landing facilities, or other resources and services.

Visual Flight Rules (VFR): Rules that govern the procedures for conducting flight under visual conditions. The term "VFR" is also used in the United States to indicate weather conditions that are equal to or greater than minimum VFR requirements. In addition, it is used by pilots and controllers to indicate type of flight plan.

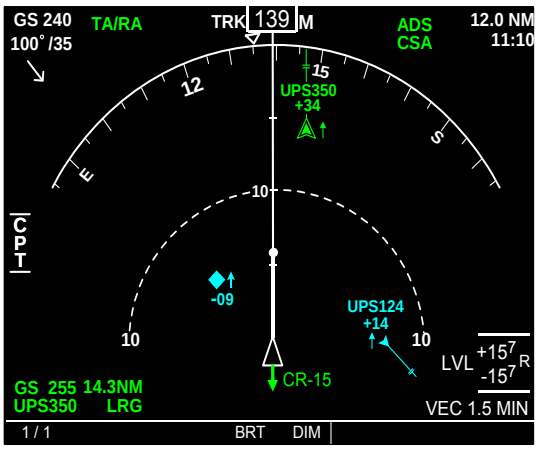
Visual Meteorological Conditions (VMC): Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling equal to or better than specified minima.

Visual Separation: A means employed by ATC to separate aircraft in terminal areas and en route airspace in the NAS. There are two ways to effect this separation. The tower controller sees the aircraft involved and issues instructions, as necessary, to ensure that the aircraft avoid each other, or the pilot sees the other aircraft involved and upon instructions from the controller provides his/her own separation by maneuvering his/her aircraft as necessary to avoid it. This may involve following another aircraft or keeping it in sight until it is no longer a factor.

Wide Area Multilateration (WAM): Wide Area Multilateration is a distributed surveillance technology that utilizes a constellation of ground stations to provide surveillance coverage within a defined region. This technology uses signals transmitted from Air Traffic Control Beacon System (ATCRBS) (Modes A and C) and Mode S transponders, in response to interrogations and unsolicited replies, to calculate an aircraft's position.

Appendix B – Cockpit Display of Traffic Information/Multi Function Display (CDTI/MFD)

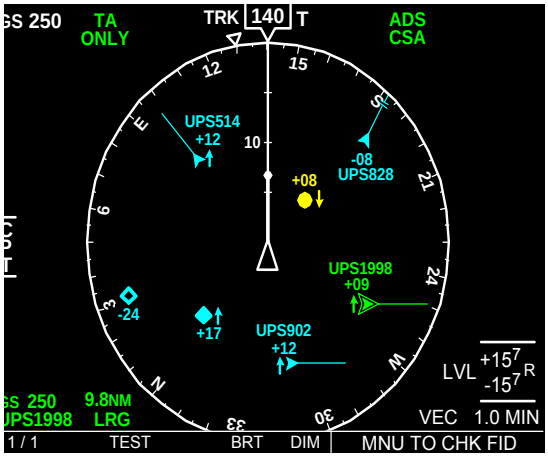
The CDTI/MFD is a multi-function ADS-B display device in the cockpit that is capable of displaying position information of nearby aircraft. It may also be capable of displaying ground reference points and navigation information to increase a pilot's situation awareness. The CDTI/MFD consolidates ADS-B traffic targets, terrain, weather, and other products relative to the pilot's own aircraft or flight operation. It allows pilots to display textual and graphical information provided by the ADS-B System. The CDTI/MFD display range and display modes (traffic weather, terrain, and aeronautical data) are selectable by the pilot.



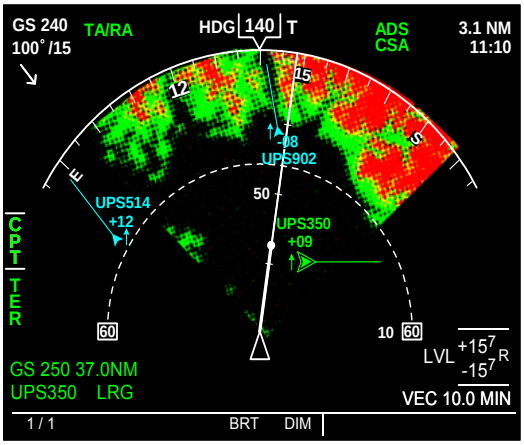
Arc or Sweeping Sector



Sector Display w/ Weather



Full Compass Rose



Sector Display w/ Terrain

Appendix C: Future ADS-B-Enabled Applications

The following is a brief description of the applications that have been selected for requirements definition and validation post FY2015.

Flight-Deck Based Interval Management–Spacing (FIM-S): FIM-S is a suite of functional capabilities that can be combined to produce operational applications to achieve or maintain an interval or spacing from a target aircraft. GIM identifies potential FIM pairs and their spacing goal. ATC provides the FIM data to aircraft via voice communications, instructions directing, for example, that the flight crew establish and maintain a given time-based interval spacing from a reference aircraft. The initiation of a FIM-S operation computes interval requirements and provides aircraft speed commands to the pilot, while ATC monitors the operation to ensure air traffic safety compliance. A FIM-S operation will reduce the use of ATC vectoring and speed control, which is expected to reduce the overall number of communications transmissions. These reductions are expected to reduce ATC workload per aircraft and increase the opportunities to conduct an OPD. In a mixed equipage environment, ATC will need the capability to readily identify aircraft with FIM capability. FIM-S is expected to enable efficient and environmentally friendly arrivals that can reduce emissions, noise and fuel consumption

Interval Management with Defined Interval – Oceanic (IMDIO) is the application of a new procedure where the flight crew would be given responsibility for maintaining a defined interval with assigned “same track” aircraft. The IMDIO application will allow aircraft to fly closer together at co-altitude resulting in increased capacity at a given flight level which would allow more aircraft to operate at their preferred altitude and track combinations. These more efficient operations will result in reduced individual aircraft and system wide fuel consumption which in turn can result in significant benefits for aircraft equipped for IMDIO operations.

IMDIO will make use of airborne ADS-B data and software tools which will allow appropriately equipped aircraft to achieve and maintain a controller defined interval with designated target aircraft. This defined interval can range from a distance on the order of existing co-altitude separation distances used in the airspace down to a minimum distance established by a newly developed IMDIO separation distance. This new IMDIO separation distance is based on an exchange of ADS-B data from the target aircraft and the IMDIO aircraft and is currently proposed to be 10 nm. This value will need to be verified through safety and performance analyses.

IMDIO aircraft will require a traffic display, alerting and resolution algorithms and IMDIO CPDLC message sets. Controllers will require CPDLC and an update to their automation platforms to account for IMDIO operations (to include display to ATC which aircraft are capable of performing IMDIO, monitoring of aircraft performing IMDIO operations and maintaining a defined interval, which are doing IMDIO with monitoring only, the assigned defined intervals and the lead aircraft Mach numbers)..

CDTI-Enabled Delegated Separation (CEDS) is a set of procedures in which controllers assign, and pilots accept, a separation task to maintain a safe distance from another aircraft on approach to achieve an operational advantage in the National Airspace System (NAS). ADS–B is the underlying technology being used, and the airplane performing the CEDS operation must have ADS–B In capability with an appropriate CDTI.

The overarching concept of CEDS mirrors visual separation as it is known today, augmented with appropriate cockpit displays that provide a more complete set of information about the traffic to follow (TTF) aircraft than can be derived from out the window contact. During CEDS operations, pilots are responsible for maintaining safe separation from the assigned aircraft just as in visual separation; controllers are responsible for separation from all other aircraft. CEDS operations will be developed and implemented by achieving an equivalent level of safety to current visual operations. However, CEDS is not a replacement for visual operations in the current air traffic system.

The initial implementation of CEDS intends to permit the use of the CDTI to acquire and follow traffic in weather conditions no less than 1,000 ft ceilings and visibility of no less than 3 statute miles in operations which end in a visual approach.. Once the minimum visual ceiling is reached the completion of the operation will be identical to a CAVS Approach. Until the aircraft has transitioned to a visual approach, a requirement for CEDS Approach will include radar vectors when at or above minimum safe altitudes (minimum en route IFR altitude (MEA), minimum obstruction clearance altitude (MOCA), grid minimum off route altitude (MORA), minimum safe altitude (MSA), etc.) or the use of a defined path, such as a RNAV or conventional procedure, that ensures obstruction clearance until the aircraft has transitioned to a visual or CAVS Approach.

Since aircraft equipped for CEDS will also be certified with ADS–B Out, the minimum vectoring altitude for these aircraft can be the minimum safe altitude (MEA, MOCA, grid MORA, MSA, etc.). In all cases, the actual separation provided will be based on pilot judgment as in visual separation, down to an approved specified minima.

In a mixed equipage environment, ATC will need the capability to readily identify aircraft with CEDS capability. Pilots will also have the option to request a CEDS Approach clearance.

Flight-Deck Based Interval Management-with Defined Interval (FIM-DI): The initial implementation of IM-DI is proposed to be the same as Interval Management - Spacing (IM-S) but with a smaller spacing interval between aircraft than is possible using today's (2012) technology, procedures and regulations. IM-DI takes advantage of the limited environments and encounter geometries inherent in IM operations, improved surveillance (i.e., ADS-B), additional automation and procedures, as well as the precise inter-aircraft spacing enabled by the FIM equipment to reduce the interval between aircraft while maintaining the same level of safety as today's operations.
In most cases, aircraft conducting an IM Operation will be merging onto a common path or following in-trail for most of the operation. This limits the possible encounters between the aircraft. Crossing encounters or uncoordinated maneuvers, such as one aircraft approaching the second and then turning away, are not expected in IM Operations.
The major components required for IM-DI to enable reduced spacing operations from those achieved by IM-S will be policies, procedures and perhaps ground automation, that

provide safe Assigned Spacing Goals with manageable and operationally acceptable tolerances. The IM-DI operation itself will be conducted almost identically to IM-S in which the flight crew flies the aircraft in compliance with the IM clearance based on speed and any turn guidance provided by the FIM equipment while the controller monitors the operation to ensure that the aircraft will remain outside the defined interval (or separation standard for IM-S operations). The controller will continue to provide separation services for the IM Aircraft from the Target Aircraft and from other traffic in the IM Aircraft's vicinity. It is assumed that the defined interval is only applied between the IM Aircraft and the Target Aircraft and not between the IM Aircraft and any other aircraft. The controller may require display changes and/or additional automation to manage having aircraft with both the standard separation standard and the defined interval requirements. No new procedures or failure modes are expected. The determination of the defined interval, and subsequent Assigned Spacing Goal, should ensure that the controller has adequate time and space to prevent a loss of the safety margin if the IM-DI Operation fails.
It is assumed that there will only be one defined interval value for an IM Operation and that there will likely be only one defined interval per phase of flight (i.e., level cruise; arrival and approach; departure and climb out). The defined interval will only apply for spacing between the IM Aircraft and the Target Aircraft and does not consider other traffic, airspace, or atmospheric phenomena.

FIM-DI for Closely Spaced Parallel Runway Operations ; (FIM-DI CSPO): The objective of this application is to allow flight crews to conduct instrument approach procedures simultaneously to closely spaced parallel runways increasing airport capacity and efficiency of ATC and flight operations.

The FIM-DI CSPO application enables dependent parallel instrument approach procedures flown to runways spaced less than 4000 centerline-to-centerline down to runway spacing of 2500 ft. in visibility conditions precluding visual approaches. This capability may allow closer to Visual Meteorological Conditions (VMC) airport acceptance rates during Instrument Meteorological Conditions (IMC), enhancing the capacity and efficiency of airport arrival operations.

At least the trailing aircraft and flight crew must be properly equipped and qualified to maintain the defined interval between paired aircraft during the approach. The procedure must be developed so that the defined interval mitigates the effects of wake turbulence. Another implementation would have one of the final approach courses offset from the runway centerline and the other course will be straight-in. The offset allows for protection from wake vortices for a longer period than if the final approach courses were straight-in.

The procedure availability will be limited by the maximum allowable airborne and surface crosswinds. To achieve minimum centerline-to-centerline runway spacing in lower visibility conditions, final approach guidance and surveillance using Differential Global Positioning System (DGPS) position source (or an equivalent capability) and ILS Category II or III capable auto-pilot may be required.

Airport Traffic Situation Awareness with Indications and Alerts (SURF-IA): The objective of this application is to provide flight-deck indications and alerts of potential or actual traffic conflicts on or near the airport surface reducing runway incursion risk and enhancing surface safety.

Airport Traffic Situation Awareness with Indications and Alerts is a flight-deck based application that adds to the Airport Traffic Situation Awareness application by graphically highlighting traffic or runways on the airport map to inform the flight crew of detected conditions that may require their attention. For detected non-normal—alert level—situations, which require immediate flight crew awareness, additional attention getting cues are provided. This application addresses the National Transportation Safety Board recommendation to "give immediate warnings of probable collisions/incursions directly to flight crews in the cockpit."
The Indications enhancement includes automated specific-traffic highlighting or relevant-runway status highlighting for normal situations that do not require immediate (Alert level) flight crew awareness but are contextually relevant to ownship operations. Each relevant runway's final approach and occupancy status is displayed to the flight crew in graphical format. This assists the flight crew in maintaining situational awareness of other traffic using the runway and suitability for ownship operations. This provides accurate and timely flight crew interpretation of potentially hazardous traffic situations to prevent runway incursions.

The Alert (cautions and warnings) enhancements provide immediate traffic and runway situational awareness cues directly to the flight crew should a runway incursion be predicted or occur when one or both aircraft involved are above taxi speed (i.e., on approach, landing, takeoff). These alerts increase the likelihood of hazard detection by the flight crew enabling more timely flight crew actions to remedy the unsafe situation and mitigate the severity of the hazard.

This application is a background application and does not require flight crew input to select specific traffic. However, specific traffic selection (designating) may be used to reduce nuisance alerts for Land and Hold Short Operations (LAHSO).

The following application has been selected for requirements definition by FY2020

Ground Based Interval Management with Wake Risk Mitigation. (GIM-S WRM) The objective of this application is to increase capacity by improving GIM to include the use of wake-related information from aircraft to determine spacing intervals adjusted to improve the throughput of the IM operation. Wake-related information could be used to reduce the wake turbulence separation down to the current radar separation standards. This application supports not only air-to-ground, but also future air-to-air, applications.
Wake Risk Management is a capability to reduce spacing intervals between aircraft, using the wake-related information transmitted by the aircraft. Additional weather related information transmitted by the aircraft will be collected and processed by the GIM system, which will determine the strength and transport of the wake vortices. Based on this determination, GIM may determine whether the intervals between aircraft can be safely reduced and will notify the air traffic controller for this potential reduction in separation.

The following applications have been identified but not selected for requirements definition or validation at this time

Flight-Deck Based Interval Management-with Delegated Separation (FIM-DS): The objective of this application is to enable FIM applications with a transfer of separation responsibility to the flight crew that improves the operational benefits through precise interval management further enhancing airspace and airport efficiency, optimizing

aircraft operations, and spacing closer to the separation standard and reducing the separation standard.

FIM-DS is a suite of functional capabilities that builds upon FIM-S and can be combined to produce operational applications that delegate responsibility for separation from a target aircraft to the flight crew. ATC will be provided with a new set of (voice or data link) instructions and clearances for flight crew to achieve and maintain an assigned spacing or interval including responsibility for separation. This interval may be assigned as an absolute value or may be an instruction to remain "no closer than" or "no further than".

The flight crew will perform these new tasks using new aircraft avionics e.g. airborne surveillance, display of traffic information, spacing functions with indications and alerts, along performance-based RNAV/RNP paths with curved segments. FIM-DS spacing functions conducted by flight crews are expected to deliver an enhanced operational performance than that achieved by ATC today while reducing ATC workload. These applications could be used to conduct flight operations in all airspace requiring specified spacing and interval.

In the mid-term, delegation is likely to be limited to a single target aircraft. A few examples of FIM-DS in various domains and phases of flight include:

- Oceanic and non-radar airspace – enabling reduced separation standards.
- Cruise–delivering metering or miles-in-trail prior to top-of-descent.
- Arrival–interval management during optimum profile descents (if applicable).
- Approach–achieve and maintain appropriate interval to stabilized approach point.

Departure –maintain no-closer-than interval to previous departure; may also enable applications such as dependent closely spaced parallel departures where blunder protection is offered by the stagger geometry, enabling reduced aircraft separation and track-to-track spacing of routes.

Independent Closely Spaced Routes (ICSR): The objective of this application is to increase airspace capacity and efficiency, while enabling optimal aircraft performance. This airborne capability is expected to facilitate closer spacing between routes, which will enable greater use of terminal, en route, and oceanic airspace.

In the ICSR application, ADS-B provides the necessary monitoring of the parallel routes by the flight crew while onboard algorithms aircraft deviations, provide alerts, and guide aircraft in achieving safe resolutions of conflicts caused by aircraft deviations. The monitoring of the routes would be realized in a distributed fashion, with each aircraft carrying its own deviation protection equipment. This allows for delegated separation between aircraft on closely spaced routes with an increased role for the flight crew in separation responsibility, relieving some of ATC's tasks.

Independent Closely Spaced Parallel Approaches: The objective of this application is to allow simultaneous independent instrument approaches to closely-spaced parallel runways down to 2500 feet runway centerline separation in instrument meteorological conditions (IMC), thereby maintaining an arrival rate close to that achievable in better weather conditions when visual approaches can be conducted. ICSPA is intended as a capacity enhancement, enabling independent closely-spaced parallel runway operations in visibility conditions when instrument approaches must be used.

When weather conditions dictate the use of instrument approaches, arrival rates decrease, resulting in delays. It is expected that Independent Closely Spaced Parallel Approaches (ICSPA) will be applicable to runways spaced between 2,500 and 4,300 feet. The lower limit on runway spacing is determined by wake vortex considerations. ICSPA could be used to permit independent approaches to runways spaced less than 4,300 feet, the current lower limit for simultaneous independent approach operations without the use of PRM. ICSPA begins when aircraft are established on the final approach course and have been cleared for the approach. It normally concludes when the aircraft lands. In the event of a missed approach, the ICSPA application continues until the aircraft is established on a missed approach course that diverges from the parallel runway.

Delegated Separation–Crossing: The objective of this application is to increase ATC operational efficiency for common flight level conflict resolution by delegating separation from a designated aircraft to the flight crew.

The Delegated Separation–Crossing procedure enables ATC to resolve a projected conflict by issuing either a lateral or vertical crossing clearance and delegating separation responsibility to the flight crew with respect to ATC designated target aircraft. These procedures are envisioned to facilitate cross-in-front, cross behind, cross above, or cross below maneuvers using flight crew procedures enabled by deconfliction guidance. ATC, assisted by ground automation and the flight crew, will decide on the best procedure for the specific air traffic situation. Once the decision is made and clearance has been issued by ATC, the flight crew will execute the applicable vertical or lateral maneuver, applying airborne separation criteria to maintain separation until completion of the procedure and ATC resumes separation. This is a coupled application.

Delegated Separation–Passing: The objective of this application is to increase efficiency of ATC and Flight Operations with resolution of projected lateral and vertical flight path conflicts by delegating separation responsibility to the flight crew during passing maneuvers where both aircraft are operating along a common path.

The Delegated Separation–Passing procedures enable ATC to resolve an along-track overtake conflict by issuing either a lateral or vertical passing clearance and delegating separation responsibility to the flight crew with respect to an ATC designated target aircraft. These procedures are envisioned to facilitate pass right, pass left, pass above or pass below maneuvers using flight crew procedures enabled by deconfliction guidance. ATC, assisted by ground automation and the flight crew, will decide on the best procedure for the specific air traffic situation. Once the decision is made and clearance has been issued by ATC, the flight crew will execute the applicable vertical or lateral maneuver, applying airborne separation criteria to maintain separation until completion of the procedure and ATC resumes separation. This is a coupled application.

Flight Deck Interval Management – Delegated Separation with Wake Risk Management (FIM-DS WRM): The objective of this application is to increase capacity by enabling reduced airborne separation minima within the current wake avoidance limits by providing aircraft-based tools for managing wake risk when conducting delegation separation with FIM-DS.

FIM-DS WRM is a capability which flight crews can use when performing FIM-DS in various meteorological conditions where the spacing achieved will be less than current ATC separation standards. It provides crews with the ability to assess when a potential wake encounter risk may exist in a particular interval management procedure, and provides the tools needed to mitigate such risk, including, but not limited to, wake avoidance techniques such as flying high and landing long. The capability does not involve the display of wake vortices in the cockpit, but rather formalizes techniques already used by flight crews in assessing wake risk, but with improved information that ADS-B facilitates. Examples of implementations of this capability are flight crew delivered (visual-like) separations for arrivals and departures during instrument meteorological conditions.

This is a coupled application which requires specific flight crew input by the trailing aircraft for along-track guidance. It may also require specific inputs and capabilities by both the leading and trailing aircraft to support flight trajectory deviation monitoring and detection capabilities, as well as meteorological information broadcasts, for wake encounter risk management.

ADS-B Integrated Collision Avoidance; The objective of this application is to further increase capacity by enabling reduced airborne separation minima. This is achieved by integrating ADS-B data with the TCAS system to create a more robust collision avoidance system (CAS) to enable applications which require delegated separation, and self separation applications in all conditions.

This is a capability that enables procedures that depend on protection from non-normal events from aircraft of interest, such as incursions, deviations, blunders or missed approaches. This may also include a capability to conduct applications in geometries where cockpit based protection is required and when invoking TCAS protection is not appropriate, not adequate, or not consistent with the procedure, by providing a more sophisticated, specialized CAS. This protection may be within TCAS RA envelopes. In this case, the protection required is integral to the procedure in that in normal operation no alerts should be issued, yet protection is expected in cases of non-normal operation. Consequently, TCAS is inhibited for the relevant aircraft and a new alerting scheme is necessary for the relevant aircraft. This application enables delegation of separation responsibilities to the cockpit in a larger set of circumstances than available without this capability. Examples of this application are flight crew provided separation for (well spaced) parallel runways as transition to visual rules, or flight crew provided separation for parallel tracks.

Note: Relevant to this application is that RTCA Special Committee 147 (SC-147) "Traffic Alert and Collision Avoidance System" has been tasked to "develop recommendations on future collision-avoidance system(s) that would be compatible with TCAS II, be more compatible with operations in congested airspace, and integrate ADS-B data effectively" by September 2011. After such recommendations are available, this application should be revisited and perhaps modified accordingly.

Flow Corridors: The objective of this application is to increase airspace capacity and efficiency, while enabling optimal aircraft cruise performance.

Flow corridors consist of tubes or "bundles" of near-parallel trajectories in the same direction, which consequently achieve a very high traffic throughput, while allowing traffic to shift as necessary to enable more effective weather avoidance, reduce

congestion, and meet special use airspace (SUA) requirements. The high traffic density achieved increases the airspace available to other traffic, and often eliminates the need for a Traffic Management Initiative (TMI); thus the flow corridor is implemented along the optimum routes and altitudes. Aircraft within the corridor are free to optimize their trajectory provided they maintain separation from other aircraft.

While optimizing the trajectory laterally, longitudinally and vertically within the corridor, the ADS-B enabled Flow Corridor application manages separation from other participating aircraft within the corridor. All aircraft within the flow corridor are equipped with Flow Corridor application to detect and resolve projected traffic conflicts with participating aircraft. The Flight Crew accepts separation responsibility from all aircraft in the corridor and ATC provides separation from Corridor Airspace and non-participating aircraft, which are excluded from the corridor.

Self Separation: The system objective of this application is to increase en-route capacity. The user objectives of this application are to reduce delays (ground and airborne), reduce fuel burned, and increase schedule predictability. These capacity and efficiency gains may be the result of a reduction in ATC workload.

The flight crew of a self-separating aircraft assumes responsibility from ATC for separation from all traffic for a defined segment of the flight. As part of its delegated separation responsibility, the flight crew is granted authority to modify its trajectory within defined degrees of freedom without renegotiating with ATC. The flight crew is supported by onboard automation that monitors the commanded trajectory for conflicts and provides decision support in the form of viable conflict resolution maneuvers consistent with the maneuvering authority. The automation also probes crew-proposed maneuvers for provisional conflicts, thus enabling the flight crew to modify the trajectory for non-conflict reasons without creating conflicts.

The self-separation portion of the flight generally terminates with an agreed time of arrival at the point where separation responsibility is transferred back to the ATC. The application can be implemented in either a homogeneous environment, in which all aircraft are self-separating, or in a mixed-operations environment, in which some aircraft are receiving a separation service from the ATC. In mixed operations, ATC is not responsible for separating any aircraft where any of the relevant aircraft includes a self-separating aircraft.

Appendix D: Changes from Previous versions of SBS Concept of Operations

Concept of Operations Change Control List

Change from Ver 1.0 to Ver 2.0
Introduction: para 2 line 12 The accuracy and broadcast characteristics of ADS-B supports numerous cockpit-based and Air Traffic Control (ATC) and Traffic Flow Management (TFM) applications. Added – “Traffic Flow Management “
1 Introduction: para 2 last line - …fleet operation management, collaborative decision making, and Added – “collaborative decision making”
1.1 Operational Use. line 3 …ATC services and, more accurate data for TFM services. Added – “more accurate data for TFM services “
1.1 Operational use. last line added
1.1.1 NAS Service Providers. Line 3 chg to begin sentence with ADS-B
1.1.1 NAS Service Providers. Line ….surveillance technologies used for traffic flow management… Added “traffic flow management”
Sec 1.4 References 18 and 19 added
2.1 added
2.1 Current Environment para 2 line 3 “TCAS” added
Table 2.2-1 Shortfalls added TFM Shortfalls and impact
3.1 Description of desired Change. “The Air Traffic Organization”…began the first sentence

Sec 3.2 Efficiency bullet 4 added
4 Operational Description. Para 4.2.2.1.4 – added to the section
Sec 5.2.1 Aircraft/Vehicle para's 2, 3 and 4 added
5.3.2.3 Loss of ADS-B Surveillance Source. The surveillance/positioning backup strategy interim report Sept 8, 2006 – added
Sec 6.1.5 publication/Notices. FAAO 8260.3 (TERPS) and Instrument Approach Procedure Chart added
6.2.1 ATC/TFM Automation – TFM deleted and became para 6.2.2 – para numbering changed respectively
Appendix A – Definitions. Air Traffic Management (ATM) added
Signed by all applicable parties
Table of Contents additions adding sub, sub-sub Paragraph formats in necessary Sections
1. Introduction. Last paragraph changed from: FIS-B is an uplink service that provides aeronautical and flight information Such as textual and graphical weather reports, NOTAMS, etc.
1. Introduction. Third para line 2. The words primarily To denote accuracy of use of equipment. The 1090ES link is "primarily" intended for air transport…
1.4 References 19 changed to added…Alternatives Analysis Dated January 8, 2007
Reference 20 added.
4 Operation Description. Paragraph 4.2.1.6 thru 4.2.1.8 added to the body of the Conceptual Operations from the Appendix
4.2.2.2.3 last para. added

4.2.2.2.4 3rd para 7th /8th sentence added “During the course of the visual approach visibility deteriorates from six to four miles. By using the CAVS application the crew is able to continue the visual approach.
4.2.2.2.4 3rd para sentence 9 ….use the CDTI/MFD to …- added
6.4.11 ADS-B Surveillance/Positioning Backup Strategy – added

Change from Ver 2.0 to Ver 3.0
Page 2 Removed Appendix D from Index
Page 7 Added Ref 20
Page 9 Para 1 Reworded TCAS description to clarify
Page 10 Deleted ref to MNS # 307 in En Route environment and left only reference in TFM
Page 16 Moved CAVS,M &S, and ITP from appendix C to current apps
Page 35 Added Backup strategy paragraph

Changes from v3.0 to v 4.0

Cover Page – Changed Approved to Reviewed next to Manager, Flight Technologies and Procedures Division, AFS-400
References #11 Publication Date changed from May 1993 to October 1994
2.1 Current Environment- 2nd paragraph REMOVED- “is not considered a surveillance system and is not used as the basis of separation.” Added “not a surveillance system, and is not used as a basis of separation”
3.1 Description of Desired Change Last paragraph the word “avoid” changed to “reduce” This will enable pilots to REDUCE the impact from restricted/ closed airspace areas or NAS resource outages…
3.2 Safety- Last bullet Removed “Avoidance” to “Awareness”

Provides cost effective, Controlled Flight Into Terrain (CFIT)
4.2.1.7 Merging and Spacing-Reworded Paragraph to clarify application description.
4.2.1.8 (ITP) In Trail Procedures- Moved to Appendix C
4.2.2.1.4 Traffic Flow Management Improvements – Third Paragragh Removed “Unnecessarily” Reads The result will be fewer “ “ missed arrival slots and greater ATM efficiencies. 4.2.2.2.1 Airport Surface and Taxi- Removed “Will” In first and second paragraph ADDED “are”
4.2.2.3.6 Search and Rescue Section “Added”
5.2.1 Aircraft/Vehicle Last paragraph Added “may” and “Properly equipped” to sentence
5.2.4 ATC Automation- Deleted:” and possibly obtained flight data from aircraft such as PIREPS”
5.2.6 Deleted “on the following page.” From end of last sentence in last para.
The Aircraft/Vehicle “may” display ADS-B and TIS-B data on a CDTI/MFD “Properly equipped” 978 UAT…
6.1.1 Staffing- Removed last sentence.
6.1.4 Regulations and Policy-Rewrote second sentence restructured
6.1.4 Last sentence in last paragraph "will" changed to "may"
6.2.4 Service Provider and User Procedures-Added second sentence "The goal is to minimize increase to" REMOVED "should not increase" in same sentence
6.3.1 User and Service Provider Training- Added "not to be limited to:"
6.4.3 Standards and Procedures- REMOVED "Application" Added "Operational"

6.4.4 Added: Sentence- “A Cockpit display such as …”
6.4.10 Avionics- REMOVED "Will"
Appendix A- Definitions- (TFM) Traffic Flow Management Definition Added
Appendix B- Cockpit Display of Traffic Information Added "Multi Function Display" to title. Now reads (CDTI/MFD) Second sentence Added "be capable of" DELETED "Include"
Appendix C Added: (ITP) In Trail Procedures Application in Procedural Airspace
Appendix C Added: (ITF) In Trail Follow Application in Procedural Airspace
Appendix C Added: Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts (ATSA-SURF IA)
Appendix C Added: Flight Deck Merging and Spacing
Added Appendix D

Changes from v4.0 to v 5.0

Section 1**; Page 3;Para 1- Reworded line 4**
Section 1; Page 3;Para 2 Reworded line 14 “aircraft to aircraft”

Section 1; Page 3;Para 3- Reworded line 3,4 and 5 "will be required for aircraft that operate in Class A **airspace and** the 978 UAT link is primarily intended for general aviation aircraft that operate in other controlled airspace."
Section 1; Page 3; Para. 4- Added Reference to ASDE-X and wide area multilateration. Line 5 clarified ADS-B "in"
Section 1;Page 4;Para 2- Reworded to clarify FIS-B products
Section 1.1 Added reference to Wide Area Multilateration
Section 1.1.2;Page 5; line 1 and 2-clarified traffic surveillance.
Section 1.4; Page 8; Updated reference documents to current revisions, added # 20
Section 2.1; Page 8; Para. 1- Added Reference to WAM.
Section 2.1; Page 9; Para. 3- Added AWOS and ASOS. .
Section 3.1; Page 13; Para 2 Line 1: changed to" and vehicles on the airport surface movement area is used by aircraft equipped with ADS-B in"
Section 3.2; page 13 Under safety, reworded bullets 1 and 2.
Section 4.1.2; page 15- Added section and subsection 4.1.2.1 and 4.1.3 to clarify SBS description.

Section 4.1.3.2; Page 14- Added ASDE-X and WAM as source for TIS-B
Section 4.2.1 Page 16,17.and 18- Reworded Application descriptions to match application descriptions in the Application Integrated Work Plan.
Section 4.2.2.2; Page 21-24, updated and reworded user scenarios to coincide with new application descriptions.
Section 4.2.2.1.1; Page 19; Para. 1- Added Reference to WAM.
Section 4.3.2; Page 25- Added Reference to WAM. Section 5.3.2.3; Page 32 - Added Reference to WAM.
Section 6.2.1; Page 34 Reworded to include fusion
Section 6.2.3; Page 35 - Added Reference to WAM and surface multilateration.
Section 6.4.6; Page 37 - Added Reference to WAM and surface multilateration.
Section 6.4.11 Page 38 - Added Reference to WAM.
Appendix A; Page 42 - Added WAM definition.
Appendix C; Page 44 Reworded entire appendix to match application descriptions from the Applications Integrated Work plan. **Changes from 5.0 to 6.0** 1.1.2 Page 5 - Replaced Delegated Separation with Defined Interval 1.3 -Page 8 - Added ADS-B In ARC Reference, Added DO-314 Reference 4.2.1.3- Page 18 - Reinserted Enhanced Visual Approach 4.2.1.4 – Page 18 – Reinserted CAVS description 4.2.1.6 - Page 20 – Moved ITP from Appendix C 4.2.2.2.4 – Page 29 – Added CAVS to Scenario

6.2.5 – Page 42 - Rewrote Paragraph
Appendix A – Page 47 – Added Defined Interval
Appendix C – Page 51 – Added GIM-S with Wake Risk Mitigation
Appendix C – Page 51 – Moved ITP to 4.2.1.6
Appendix C – Page 51 - Added FIM-DI
Appendix C - Page 52 - Added FIM-DI (CSPO)
Appendix C – Page 53 – Deleted (PCSPA)