

# HANGER TALK

NEWSLETTER OF EAA CHAPTER 58

OGDEN, UTAH

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Chapter 58 meets monthly on the **SECOND Thursday of the month**. Meetings are held at 7:00pm at Ogden Hinkley Airport Terminal. Other meetings are held "on site" in members' hangers, shops, or garages. Onsite meeting locations are announced in the newsletter.

This Month's Meeting: "On Site"

Location: Ogden Airport Terminal Building

Subject: Preflighting your preflight and Electronic Charts

Thursday, 11 August 2011 1730 HRS, 0030 Z, or 5:30 PM

***PREZ SEZ:***

I know a few of you were able to make Oshkosh this year. Perhaps a few of you will tell us what you saw that interested you, awed you, or whatever the rest of us missed by not being there. I enjoyed listening to Oshkosh radio and ATC a few times during the week and it almost made me feel like I was there as the war birds landed and the canards and Bonanzas came in. Having been there several times helps with the visualization. There were a few seminars, forums, and talks I would have enjoyed participating in as well as walking the aisles full of unique aircraft and vendor displays. Alas, not this year. I was

there in spirit however and some of my work was there as well. Honda Aircraft contracted with X-Plane to have a model of their jet built and a special version of X-Plane created that would allow them to pass out DVD's of X-Plane that would allow you to fly their Jet anywhere in the United States. I was contracted to build the model of the jet. I really had to hurry to finish it in time for the show. I was only given 5 days to get it done. Eventually I was given a few more days to touch it up, but I did make the original deadline. Did anyone happen to pick up one of these DVD'S? I would love to know how it turned out. Well, hopefully some of you will share your experiences with us.

We had a great time with the ORAA last month at the BBQ, there weren't many of us there, but we had a great time, good food, and outstanding weather for the event. The ORAA enjoyed our company so much they have invited us to join them on August 19<sup>th</sup> for a Corn Bust. I assume it will start at 5:30 pm like the last event, so if you would like to join them, you are invited.

This month Ed McKenney is going start a series of short classes to help prepare for our Biennial reviews. His first will be on Preflighting our Preflight. After he is done, we will have a presentation by Rene' Felker on electronic flight bags. It should be a great meeting!

Another date to remember is Friday and Saturday, September 2-3 at Heber City, Utah, Russ McDonald Field Fly-In on Labor Day Weekend that is being organized by our local Commemorative Air Force Utah Wing Museum and EAA Chapter 1519. There will be activities on both Friday and Saturday, September 2-3, as briefly below.

Arrivals welcome Friday the 2nd...BBQ/Dance Friday night starting at 5:30pm...Dance starts about 7:00 pm till whenever. Saturday events...lots of flying!! B-17..B-25..PV-2..P-51..TBM..C-45..T-28..Stearmans ..L-birds etc. Military vehicles and vintage cars...vendor booths...and as many visiting aircraft as we can get. EAA member fuel discounts for our fly-in guests. They need to make accommodation arrangements early as this is a busy weekend...or they can camp by the aircraft.

Please contact Dave if you have any questions at [rv4us@prodigy.net](mailto:rv4us@prodigy.net) or (435) 671-3509 or (435) 657-0009.

As always we are looking for volunteers for project visits as well as ideas for meeting topics, I would like to thank Ed and Rene' for their ideas and contributions in this regard for the month of August. I know there are more of you with ideas, knowledge, or stories to be told. Please share them with us.

Todd Parker, Prez

## FROM THE EDITOR:

**PLEASE NOTE THAT THE ADDRESS HAS CHANGED!!!** The old address has been given to another party and so we got reassigned. The box number is C-3.

The official mailing address for the chapter is:

EAA CHAPTER 58  
3815 AIRPORT ROAD  
OGDEN, UTAH 84405

The location of the Chapter web is [www.eaa58.org](http://www.eaa58.org),

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Young Eagles

POC: Tom Holt ([tom.holt@zionsbank.com](mailto:tom.holt@zionsbank.com)) (801-497-0364)

Flights Through December 2010: 500

Flights In 2011: 63

Next Event: ~ September

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**Honda Jet in X-Plane....created by Todd Parker**



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## **Automatic Dependent Surveillance-Broadcast (ADS-B)**

ADS-B is a surveillance technology for tracking aircraft as part of the [Next Generation Air Transportation System](#) (NextGen). The United States will require the majority of aircraft operating within its airspace to be equipped with some form of ADS-B Out by January 1, 2020.

### **Description**

ADS-B, which consists of two different services ADS-B Out and ADS-B In, will be replacing radar as the primary surveillance method for controlling aircraft worldwide. In the United States, ADS-B is an integral component of the NextGen National Airspace strategy for upgrading/enhancing aviation infrastructure and operations. The ADS-B system can also provide traffic and government generated graphical weather information through TIS-B and FIS-B applications. ADS-B enhances safety by making an aircraft visible, realtime, to ATC and to other appropriately equipped ADS-B aircraft with position and velocity data transmitted every second. ADS-B data can be recorded and downloaded for post flight analysis. ADS-B also provides the data infrastructure for inexpensive flight tracking, planning and dispatch.

The system relies on two avionics components—a high-integrity GPS navigation source and a datalink (ADS-B unit). There are several types of certified ADS-B data links, but the most common ones operate at 1090 MHz, essentially a modified Mode S transponder, or at 978 MHz (USA only). The FAA would like to see aircraft that operate below 18,000' use the 978 MHz link since this will help alleviate further congestion of the 1090 MHz frequency. To obtain ADS-B capability at 1090 MHz, you can install a new transponder or modify an existing one if the manufacturer offers an ADS-B upgrade. You will also need to add a certified GPS.

### **Benefits of the System**

**Interactive Site Explaining Benefits ADS-B:** <http://www.faa.gov/nextgen/ads-b/broadcastservices/>

### **Safety**

ADS-B makes flying significantly safer for the aviation community. When using this system both pilots and controllers will see the same radar picture. With past systems such as the Traffic Collision Avoidance System (TCAS) aircraft could only see other aircraft equipped with the same technology. With ADS-B, information is sent to aircraft using ADS-B In, which displays all aircraft in the area, even those not equipped with ADS-B technology.

## **New Services**

**A.) Traffic** - When using an ADS-B In system a pilot is able to pull up traffic information on surrounding aircraft. This information includes altitude, heading, speed, and distance to aircraft.

**B.) Weather** - Aircraft equipped with UAT ADS-B In technology will be able to receive weather reports, and weather radar through Flight Information Service-Broadcast (FIS-B).

**C.) Terrain** - ADS-B In technology, broadcasts a terrain overlay for pilots to view in the cockpit.

**D.) Flight information** - Not to be confused with FIS-B, Traffic Information Service-Broadcast (TIS-B) transmits readable flight information such as TFRs and NOTAMs to aircraft equipped with either UAT or 1090 Squitter ADS-B systems.

**Free Services** --- No Subscription Fees - Unlike some services being offered by companies currently, there will be no subscription fees to use ADS-B or its various benefits. The aircraft owner will pay for the equipment, and for it to be installed while the FAA will pay for administering and broadcasting all the services related to the technology.

## **Other Benefits Described**

Listing of ADS-B (Out/In) benefits as described by General Aviation aircraft owners from a 2007 online survey conducted by MIT's International Center for Air Transportation.

- Radar-like IFR separation in non-radar airspace
- Increased VFR flight following coverage
- ATC final approach and runway occupancy
- Better ATC traffic flow management
- More accurate search and rescue response
- Enhance visual acquisition in VFR or MVFR
- Cockpit final approach and runway occupancy
- Visual separation in VFR and MVFR conditions
- Merging and spacing
- VFR-like separation in all weather conditions
- Self-separation or station keeping
- Real-time cockpit weather display
- Real-time cockpit airspace display

## Theory of operation

ADS-B system has three main components: 1) Ground Infrastructure, 2) Airborne Component, and 3) Operating Procedures.

- A transmitting subsystem that includes message generation and transmission functions at the source, e.g. airplane.
- The transport protocol, e.g. [VHF](#) (VDL mode 2 or 4), 1090ES, or 978 MHz UAT.
- A receiving subsystem that includes message reception and report assembly functions at the receiving destination, e.g. other airplanes, vehicle or ground system.

The source of the state vector and other transmitted information as well as user applications are not considered to be part of the ADS-B system.

## Relationship to surveillance radar

[Radar](#) directly measures the range and bearing of an aircraft from a ground-based [antenna](#). Bearing is measured by the position of the rotating radar antenna when it receives a response to its interrogation from the aircraft, and range is measured by the time it takes for the radar to receive the interrogation response.

The antenna beam becomes wider as the aircraft gets farther away, making the position information less accurate. Additionally, detecting changes in aircraft velocity requires several radar sweeps that are spaced several seconds apart. In contrast, a system using ADS-B creates and listens for periodic position and intent reports from aircraft. These reports are generated based on the aircraft's navigation system, and distributed via one or more of the ADS-B data links. The integrity of the data is no longer susceptible to the position of the aircraft or the length of time between radar sweeps.

[Primary Surveillance Radar](#) does not require any cooperation from the aircraft. It is robust in the sense that surveillance outage failure modes are limited to those associated with the ground radar system. [Secondary Surveillance Radar](#) depends on active replies from the aircraft. Its failure modes include the [transponder](#) aboard the aircraft. Typical ADS-B aircraft installations use the output of the navigation unit for navigation and for cooperative surveillance, introducing a common [failure mode](#) that must be accommodated in air traffic surveillance systems.

Type	Independent?	Cooperative?
<a href="#">Primary surveillance radar</a> (PSR)	Yes: surveillance data derived by radar	No: does not depend on aircraft equipment
<a href="#">Secondary surveillance radar</a> (SSR)	Yes: surveillance data derived by radar	Yes: requires aircraft to have a working <a href="#">ATCRBS</a> transponder

## **Automatic dependent surveillance (ADS-B)**

No: surveillance data provided by aircraft  
Yes: requires aircraft to have working ADS-B function

Source:DO-242A

Today's [ATC](#) systems do not rely on coverage by a single radar. Instead a multiradar picture is presented via the ATC system's display to the controller ([ATCO](#)). This improves the quality of the reported position of the airplane, provides a measure of redundancy, and makes it possible to verify the output of the different radars against others. This verification can also use sensor data from other technologies, such as ADS-B and [multilateration](#).

### **Relationship to ADS-A/ADS-C**

There are two commonly recognized types of ADS for aircraft applications:

- ADS-Addressed (ADS-A), also known as ADS-Contract (ADS-C), and
- ADS-Broadcast (ADS-B).

ADS-B differs from ADS-A in that ADS-A is based on a negotiated one-to-one peer relationship between an aircraft providing ADS information and a ground facility requiring receipt of ADS messages. For example, ADS-A reports are employed in the Future Air Navigation System ([FANS](#)) using the Aircraft Communication Addressing and Reporting System ([ACARS](#)) as the communication protocol. During flight over areas without radar coverage (e.g. oceanic and polar), reports are periodically sent by an aircraft to the controlling air traffic region.

The transmission delay caused by protocol, satellites, etc., is significant enough that significant aircraft separations are required. The cost of using the satellite channel leads to less frequent updates. Another drawback is that no other aircraft can benefit from the transmitted information as ACARS information is not re-broadcast from ground facilities to other aircraft.

### **Relationship to other broadcast services**

The ADS-B link can be used to provide other broadcast services, such as TIS-B and FIS-B (see below).

Another potential aircraft-based broadcast capability is to transmit aircraft measurements of meteorological data.

### **ADS-B and General Aviation**

The Automatic Dependent Surveillance-Broadcast system (ADS-B ) is an essential part of the planned NextGen [airspace upgrade](#) and will create better [aircraft visibility](#) at a lower overall cost than before. ADS-B equipment is built to meet one of two sets of US

government standards, DO-260B and DO-282B.

By the year 2020 all [aircraft](#) operating in the airspaces listed below will be required to carry [equipment](#) that produces an ADS-B out broadcast. The FAA has published a rule requiring ADS-B transmitters in many types of airspace (ADS-B Out) to take effect on January 1, 2020, but there is no mandate for ADS-B In, which receives data and provides it to in-cockpit displays. The FAA's airspace requirements intentionally exclude some airspace that is frequently used by general aviation.

<b>Airspace</b>	<b>Altitude</b>
A	All Aircraft Equipped
B	All Aircraft Equipped
C	All Aircraft Equipped
E	Above 10,000 ft MSL but Not Below 2,500 ft AGL

ADS-B will offer increased [safety](#), [efficiency](#) and [environmental awareness](#) for [pilots](#) and [air traffic controllers](#) at a lower overall cost than the current [radar](#) system. Companies have already begun selling and developing aircraft [hardware](#) systems to allow general aviation aircraft owners to equip at an affordable cost. These companies include [Avidyne](#), [Aviation Communication and Surveillance Systems](#) (a joint venture of [L-3 Communications](#) and [Thales](#)), [Garmin](#) and [Rockwell Collins](#). Since the FAA has passed its final ruling on ADS-B, the uncertainty that prevented companies from producing hardware has been removed. The industry is seeing products being developed for all price points, low to high, and competitively priced equipment is nearing approval. As the technology matures more features are also becoming available creating even greater benefits for general aviation users.

### **ADS-B physical layer**

Two link solutions are being used as the physical layer for relaying the ADS-B position reports:

- [Universal Access Transceiver](#) (UAT)
- 1090 MHz [Mode S](#) Extended Squitter (ES);

### **Universal Access Transceiver (UAT)**

The term Universal Access Transceiver refers to a [data link](#) intended to serve the majority of the [general aviation](#) community. The data link is approved in the US [FAA's](#) "Final Rule" for use in all airspace except class A (above 18,000 ft. [MSL](#)). UAT is intended to support not only ADS-B, but also [Flight Information Service - Broadcast](#) (FIS-B), [Traffic Information Service - Broadcast](#) (TIS-B), and, if required in the future, supplementary ranging and positioning capabilities. Due to the set of standards required for this rule, it is seen as the most effective application for general aviation users. UAT will allow aircraft

equipped with "out" broadcast capabilities to be seen by any other aircraft using ADS-B "in" technology as well as by FAA ground stations. Aircraft that are equipped with ADS-B "in" technology will be able to see detailed altitude and vector information from other ADS-B "out" equipped aircraft as well as FIS-B and TIS-B broadcasts. The FIS-B broadcast will allow receiving aircraft to see weather and flight service information including AIRMETs, Convective SIGMETs, SIGMETs, METARs, SPECI, National NEXRAD, Regional NEXRAD, D-NOTAMs, FDC-NOTAMs, PIREPs, Special Use Airspace Status, Terminal Area Forecasts, Amended TAFs, Winds and Temperature Aloft. These broadcasts serve to provide early adopters of the technology with benefits as an incentive for more pilots to use the technology before the required 2020 date. Aircraft receiving traffic information through the TIS-B service will see other aircraft in a manner that is similar to how all aircraft will be seen after they have equipped by 2020. The availability of a non-subscription weather information service, FIS-B, provides general aviation users with a useful alternative to other monthly or annual fee-based services.

The UAT system is specifically designed for ADS-B operation. UAT is also the first link to be certified for "radar-like" ATC services in the U.S. Since 2001, it has been providing 5 [NM](#) en-route separation (the same as radar) in Alaska. UAT is the only ADS-B link standard that is truly bi-directional: UAT users have access to ground-based aeronautical data (FIS-B) and can receive reports from proximate traffic (TIS-B) through a multilink gateway service that provides ADS-B reports for 1090ES equipped aircraft and non-ADS-B equipped Radar traffic. UAT equipped aircraft can also observe each other directly with high accuracy and minimal latency. Viable ADS-B UAT networks are being installed as part of the U.S. FAA NextGen air traffic system.

## **1090ES**

In 2002, the [Federal Aviation Administration](#) (FAA) announced a dual link decision using 1090 MHz ES and UAT as media for the ADS-B system in the United States, with the 1090 MHz extended squitter ADS-B link for air carrier and private/commercial operators of high performance aircraft, and Universal Access Transceiver (UAT) ADS-B link for the typical general aviation user.

Europe has not officially chosen a physical layer for ADS-B. A number of technologies are in use. However, the influential [Eurocontrol](#) CASCADE program uses 1090ES exclusively.

With 1090ES, the existing Mode S transponder (TSO C-112 or a stand alone 1090 MHz transmitter) supports a message type known as the extended squitter (ES) message. It is a periodic message that provides position, velocity, time, and, in the future, intent. The basic ES does not offer intent since current flight management systems do not provide such data – called trajectory change points. To enable an aircraft to send an extended squitter message, the transponder is modified ([TSO C-166A](#)) and aircraft position and other status information is routed to the transponder. ATC ground stations and aircraft equipped with [Traffic collision avoidance system](#) (TCAS) already have the necessary 1090 MHz (Mode S) receivers to receive these signals, and would only require

enhancements to accept and process the additional Extended Squitter information. As per the FAA ADS-B link decision and the technical link standards 1090ES does not support FIS-B service.

## **Equipping Aircraft**

Fleet: 250,000 GA aircraft that will need ADS-B by 2020 of which 165,000 aircraft subject to ADS-B Out (Class I and Class II aircraft that generally fly below 18,000 feet). FAA forecasts an increase in the GA fleet from 224,172 aircraft in 2010 to 270,920 aircraft in 2031, growing an average of 0.9% per year.

## **Cost**

2007 - Early estimates stated the cost to equip a general aviation aircraft ranged from \$7,644 to \$10,920 for ADS-B Out and from \$10,444 to \$29,770 for ADS\_B Out and ADS-B In, depending on aircraft type.

2009 - Using 2009 current market prices for individual system components a UAT retrofit was estimated at \$18,000 and new at \$25,000. For a 1090ES retrofit \$4,200 and new at \$18,000.

## **Sources**

There are several avionics manufacturers who are in developing ADS-B systems for general aviation that focus on cost and value.

- NavWorx, Inc. of Rowlette, TX offers ADS-B UATs in the \$1K-3K price range.
- FreeFlight Systems of Irving, TX is developing systems that provide a complete air traffic picture in the range of \$5k - \$7k.
- Radenna of Revere, MA is developing portable ADS-B receiver hardware for iPad display for approximately \$2k with additional monthly service fees for airport/airspace updates.
- SkyVision Xtreme, LLC of Asheboro, NC has an ADS-B traffic and weather display which offers control of a UAT via touchscreen interface, 3D traffic, and all available ADS-B weather products. This product interfaces with an ADS-B transceiver to display traffic and weather or an ADS-B receiver to display weather.
- Essential Flight Technology of Atlanta, GA has an electronic flight bag product, Chartflir, with PC integration for ADS-B weather and traffic display. Additional GPS and ADS-B hardware are required for this portable concept.

## Resources

Recent (April 2011) US Federal legislation via House Bill for FAA reauthorization includes language for an "equipping fund" that includes a portion for some general aviation aircraft. The fund would provide financing at competitive rates back by loan guarantees. A public-private partnership has been formed as the NextGen Equipage Fund, LLC which is managed by NEXA General Partnership, LLC.

## Final Rule Background

While there is currently a drop in [air travel](#) due to a general [economic downturn](#), delay and congestion continue to build in the US' busiest [airports](#) and the surrounding airspace. The [FAA](#) must not only address current congestion, but also be poised to handle future demand that will surely return as the nation's economy improves. The FAA has been developing the Next Generation Air Transportation System (NextGen) for the purpose of changing the way the [National Airspace System](#) (NAS) operates. NextGen will allow the NAS to expand to meet future demand and support the [economic viability](#) of the system. In addition, NextGen will improve safety and support environmental initiatives such as reducing congestion, noise, emissions and fuel consumption through increased [energy efficiency](#).

## System

ADS-B consists of two different services: ADS-B Out and ADS-B In. ADS-B Out periodically broadcasts information about each aircraft, such as identification, current position, [altitude](#), and [velocity](#), through an onboard transmitter. ADS-B Out provides air traffic controllers with real-time position information that is, in most cases, more accurate than the information available with current radar-based systems. With more accurate information, ATC will be able to position and separate aircraft with improved precision and timing.

ADS-B In is the reception by aircraft of FIS-B and TIS-B data and other ADS-B data such as direct communication from nearby aircraft.

## Summary of Final Rule

This final rule will add equipage requirements and performance standards for ADS-B Out avionics. ADS-B Out broadcasts information about an aircraft through an onboard transmitter to a ground receiver. Use of ADS-B Out will move air traffic control from a radar-based system to a satellite-derived aircraft location system. Operators will have two options for equipage under this rule—the 1090 megahertz (MHz) extended squitter (ES) broadcast link or the Universal Access Transceiver (UAT) broadcast link. Generally, this equipment will be required for aircraft operating in Classes A, B, and C airspace, certain Class E airspace, and other specified airspace.

The FAA has concluded that this rule will require only the performance requirements necessary for ADS-B Out. While certain requirements adopted in this rule will support some ADS-B In applications, the FAA is not adopting the higher performance standards that would enable all of the initial ADS-B In applications. Pilots should be aware that in accepting the FAA's positions regarding antenna diversity and position source accuracy, compliance with this rule alone may not enable operators to take full advantage of certain ADS-B In applications. Operators may voluntarily choose equipment that meets the higher performance standards in order to enable the use of these applications.

This system will make radar based ATC obsolete, moving the nation to a [satellite](#) derived aircraft location system.

This will make ADS-B the backbone of the NextGen ATC system coming online in 2020.

### **Benefits of ADS-B for General Aviation**

#### Improved [situational awareness](#)

Pilots in an ADS-B equipped cockpit will have the ability to see, on their in-cockpit flight display, other traffic operating in the airspace as well as access to clear and detailed weather information. They will also be able to receive pertinent updates ranging from temporary flight restrictions ([TFR's](#)) to runway closings.

#### Improved visibility

Even aircraft only equipped with ADS-B out will be benefited by air traffic controllers ability to more accurately and reliably monitor their position. Other fully equipped aircraft using the airspace around them will be able to more easily identify and avoid conflict with ADS-B out equipped aircraft.

ADS-B provides better surveillance in fringe areas of radar coverage. ADS-B does not have the siting limitations of radar. Its accuracy is consistent throughout the range.

#### Reduced environmental impact

ADS-B technology provides a more precise report of an aircraft's position. This allows controllers to guide aircraft into and out of crowded airspace with smaller separation standards than it was previously possible to do safely. This reduces the amount of time aircraft must spend waiting for clearances, being vectored for spacing and holding. Estimates show that this is already having a beneficial impact by reducing pollution and fuel consumption.

ADS-B is intended to increase safety and efficiency. Safety benefits include:

- Improved visual acquisition especially for [general aviation](#) under visual flight rules ([VFR](#)).
- Reduced [runway incursions](#) on the ground.

ADS-B enables increased capacity and efficiency by supporting:<sup>1</sup>

- Enhanced visual approaches
- Closely spaced parallel approaches
- Reduced spacing on final approach
- Reduced aircraft separations
- Enhanced operations in high altitude airspace for the incremental evolution of the "[free flight](#)" concept
- Surface operations in lower visibility conditions
- Near visual meteorological conditions ([VMC](#)) capacities throughout the airspace in most/all weather conditions
- Improved [ATC](#) services in non-radar airspace
- Trajectory-based operations providing a gently ascending and descending gradient with no step-downs or holding patterns needed. This will produce optimal trajectories with each aircraft becoming one node within a system wide information management network connecting all equipped parties in the air and on the ground. With all parties equipped with NextGen equipment, benefits will include reduced gate-to-gate travel times, increased runway utilization capacity, and increased efficiency with carbon conservation.

### **Traffic information services-broadcast (TIS-B)**

TIS-B supplements ADS-B air-to-air services to provide complete situational awareness in the cockpit of all traffic known to the ATC system. TIS-B is an important service for an ADS-B link in airspace where not all aircraft are transmitting ADS-B information. The ground TIS-B station transmits surveillance target information on the ADS-B data link for unequipped targets or targets transmitting only on another ADS-B link.

TIS-B uplinks are derived from the best available ground surveillance sources:

- ground radars for primary and secondary targets
- multi-lateration systems for targets on the airport surface
- ADS-B systems for targets equipped with a different ADS-B link

### **Multilink gateway service**

The multilink gateway service is a companion to TIS-B for achieving interoperability in low altitude terminal airspace. In some airspaces, aircraft that primarily operate in high altitude airspace are equipped with 1090ES, and aircraft operating primarily in low altitude airspace are equipped with UAT. These aircraft cannot directly share air-to-air ADS-B data. In terminal areas, where both types of ADS-B link are in use, ADS-B/TIS-B ground stations use ground-to-air broadcasts to relay ADS-B reports received on one link to aircraft using the other link.

## **Flight information services-broadcast (FIS-B)**

FIS-B provides weather text, weather graphics, [NOTAMS](#), [ATIS](#), and similar information. FIS-B is inherently different from ADS-B in that it requires sources of data external to the aircraft or broadcasting unit, and has different performance requirements such as periodicity of broadcast.

In the US, FIS-B services will be provided over the UAT link in areas that have a ground surveillance infrastructure.

## **ADS-B supported applications**

The ADS-B data link supports a number of airborne and ground applications. Each application has its own operational concepts, algorithms, procedures, standards, and user training.

## **Cockpit display of traffic information**

A Cockpit Display of Traffic Information (CDTI) is a generic display that provides the flight crew 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. Direct air-to-air transmission of ADS-B messages supports display of proximate aircraft on a CDTI.

In addition to traffic based on ADS-B reports, a CDTI function might also display current weather conditions, terrain, airspace structure, obstructions, detailed airport maps, and other information relevant to the particular phase of flight.

## **Airborne collision avoidance**

ADS-B is seen as a valuable technology to enhance [ACAS](#) operation. Incorporation of ADS-B can provide benefits such as:

- Decreasing the number of active interrogations required by ACAS, thus increasing effective range in high density airspace.
- Reducing unnecessary alarm rate by incorporating the ADS-B state vector, aircraft intent, and other information.
- Use of the ACAS display as a CDTI, providing positive identification of traffic.
- Extending collision avoidance below 1000 feet above ground level, and detecting runway incursions.

Eventually, the ACAS function may be provided based solely on ADS-B, without requiring active interrogations of other aircraft transponders.

**Conflict management**  
**ATS conformance monitoring**  
**Other applications**

Other applications that may benefit from ADS-B include:

- Improved [search and rescue](#) - although ADS-B can transmit "aircraft down" data, the [FAA](#) has stated that there is no intention to perform even a study of ADS-B's effectiveness in an "aircraft down" situation simply based on the fact that ADS-B equipment has no requirement to be crash worthy, as compared to the current ["black box"](#) recorder.

ADS-B was demonstrated to the Civil Air Patrol (CAP) in March 2003 by AOPA via flight demonstrations for possible integration of the technology in CAP activities.

- Enhanced flight following
- Lighting control and operation
- Airport ground vehicle and aircraft rescue and firefighting vehicle operational needs
- Altitude height keeping performance measurements
- [General aviation](#) operations control

**U.S. implementation timetable**

The [Federal Aviation Administration](#) (FAA) ADS-B implementation is broken into three segments each with a corresponding time line. Ground segment implementation and deployment is expected to begin in 2009 and be completed by 2013 throughout the [National Airspace System](#) (NAS). Airborne equipment is user-driven and is expected to be completed both voluntarily based on perceived benefits and through regulatory actions (Rulemaking) by the FAA. The cost to equip with ADS-B Out capability is relatively small and would benefit the airspace with surveillance in areas not currently served by radar. The FAA intends to provide similar service within the NAS to what radar is currently providing (5 [NM](#) en route and 3 NM terminal radar standards) as a first step to implementation. However, ADS-B In capability is viewed as the most likely way to improve NAS throughput and enhance capacity.

In December 2008 Acting FAA Administrator Robert Sturgell gave the go-ahead for ADS-B to go live in southern Florida. The south Florida installation, which consists of 11 ground stations and supporting equipment, is the first commissioned in the USA, although developmental systems have been online in Alaska, Arizona and along the East Coast since 2004. The completed system will consist of 794 ground station transceivers. The December 2008 action is in compliance with a late-term [Executive Order](#) from [George W. Bush](#) which mandated accelerated approval of NextGen.

### **FAA segment 1 (2006-2009)**

ADS-B deployment and voluntary equipment, along with rule making activities. Pockets of development will exploit equipment deployment in the areas that will provide proof of concept for integration to ATC automation systems deployed in the NAS. It is being developed at the FAA's technical center in [Egg Harbor, New Jersey](#).

### **FAA segment 2 (2010-2014)**

ADS-B ground stations will be deployed throughout the NAS, with an In-Service Decision due in the 2012-13 time frame. Completed deployment will occur in the 2013-2014 time frame. Equipment rules have been finalized and the current standards are DO-282B for UAT and DO-260B for 1090ES.

- Airport Situational Awareness – A combination of detailed airport maps, airport multilateration systems, ADS-B systems and enhanced aircraft displays have the potential to significantly improve Airport Surface Situational Awareness (ASSA) and Final Approach and Runway Occupancy Awareness (FAROA).
- Oceanic In-trail – ADS-B may provide enhanced situational awareness and safety for Oceanic In-trail maneuvers as additional aircraft become equipped. [\[citation needed\]](#)
- **Gulf of Mexico** – In the Gulf of Mexico, where ATC radar coverage is incomplete, the FAA is locating ADS-B (1090 MHz) receivers on oil rigs to relay information received from aircraft equipped with ADS-B extended squitters back to the Houston Center to expand and improve surveillance coverage.
- ADS-B is currently in service for two terminal airspace areas, Louisville, KY and Philadelphia, PA.

### **FAA segment 3 (2015-2020)**

ADS-B In equipment will be based on user perceived benefit, but is expected to be providing increased situational awareness and efficiency benefits within this segment. Those aircraft who choose to equip in advance of any mandate will see benefits associated with preferential routes and specific applications. Limited radar decommissioning will begin in the time frame with an ultimate goal of a 50% reduction in the Secondary Surveillance Radar infrastructure.

On May 27, 2010 the FAA published its final rule mandating that by 2020 all aircraft owners will be required to have ADS-B Out capabilities when operating in any airspace that currently requires a transponder ([airspace classes](#) A, B, and C, and airspace class E at certain altitudes).

### **Historical Perspective**

2002 - Overview of FAA decision on the ADS-B link architecture for use in the National Airspace System (NAS)

## [Overview of the FAA ADS-B Link Decision by John Scardina, June 7, 2002](#)

### Worldwide

- **Australia** - Australia is the first country with full, continental ADS-B coverage, though only above FL300. There are 57 ground stations operating at 28 sites.
- **Canada** - [Nav Canada](#) commissioned operational use of ADS-B in 2009 and is now using it to provide coverage of its northern airspace around Hudson Bay, most of which currently has no radar coverage. The service is also being extended to cover some oceanic areas off the east coast of Canada and Greenland. The service is expected to be later extended to cover the rest of the [Canadian Arctic](#), and to the rest of Canada.
- **China** - An American Company, [ADS-B Technologies](#) created one of the largest and most successful ADS-B system in the world (an 8 station, 350+ aircraft network that spans more than 1,200 [NM](#) across Central China). This was also the first UAT installation outside the U.S.. As of March, 2009, more than 1.2 million incident/failure free flight hours have been flown with these ADS-B systems.<sup>1</sup>
- **Sweden** - LfV Group in Sweden has implemented a nationwide ADS-B network with 12 ground stations. Installation commenced during spring 2006, and the network was fully (technically) operational in 2007. An ADS-B supported system is planned for operational usage in Kiruna during spring 2009. Based on the VDL Mode 4 standards, the network of ground stations can support services for ADS-B, TIS-B, FIS-B, GNS-B (DGNS augmentation) and Point-to-Point communication, allowing aircraft equipped with VDL 4-compliant transceivers to lower fuel consumption and reduce flight times.
- **United States**
  - **Cargo Airline Association** - Cargo carriers, notably [United Parcel Service](#) (UPS). They operate at their hub airports largely at night. Much of the benefit to these carriers is envisioned through merging and spacing the arriving and departing traffic to a more manageable flow. More environmentally friendly and efficient [area navigation](#) (RNAV) descent profiles, combined with [CDTI](#), may allow crews to eventually aid controllers with assisted visual acquisition of traffic and limited cockpit-based separation of aircraft. The benefits to the carrier are fuel and time efficiencies associated with idle descent and shorter traffic patterns than typical radar vectoring allows.
  - **Embry-Riddle Aeronautical University** - ERAU has equipped their training aircraft at its two main campuses in Florida and Arizona with UAT ADS-B capability as a situational safety enhancement. The University has been doing this since May 2003, making it the first use in general aviation. With the addition of the [G1000](#) to their fleet in 2006, ERAU became the first fleet to combine a glass cockpit with ADS-B.

- [University of North Dakota](#) - UND has received an FAA grant to test ADS-B, and has begun to outfit their Piper Warrior fleet with an ADS-B package.
- **United Arab Emirates** - [UAE](#) commissioned three operational redundant ADS-B ground stations in early 2009 and is now using ADS-B to provide enhanced coverage of its upper airspace in combination and integrated with conventional surveillance radars.
- Use of ADS-B and CDTI may allow decreased approach spacing at certain airports to improve capacity during reduced-visibility operations when visual approach operations would normally be terminated (e.g. ceilings less than MVA +500).

### **System design considerations of ADS-B**

A concern for any ADS-B protocol is the capacity for carrying ADS-B messages from aircraft, as well as allowing the radio channel to continue to support any legacy services. For 1090ES, each ADS-B message is composed of a pair of data packets. The greater the number of packets transmitted from one aircraft, the lesser the number of aircraft that can participate in the system, due to the fixed and limited channel data bandwidth.

System capacity is defined by establishing a criterion for what the worst environment is likely to be, then making that a minimum requirement for system capacity. For 1090ES, both [TCAS](#) and [ATCRBS/MSSR](#) are existing users of the channel. 1090ES ADS-B must not reduce capacity of these existing systems.

The FAA national program office and other International aviation regulators are addressing concerns about ADS-B non-secure nature of ADS-B transmissions. ADS-B messages can be used to know the location of an aircraft, and there is no means to guarantee that this information is not used inappropriately. Additionally, there are some concerns about the integrity of ADS-B transmissions. ADS-B messages can be produced, with simple low cost measures, which spoof the locations of multiple phantom aircraft to disrupt safe air travel. There is no foolproof means to guarantee integrity, but there are means to monitor for this type of activity. This problem is however similar to the usage of [ATCRBS/MSSR](#) where false signals also are potentially dangerous (uncorrelated secondary tracks).

There are some concerns about ADS-B dependence on [satellite navigation systems](#) to generate state vector information, although the risks can be mitigated by using redundant sources of state vector information, e.g. [GPS](#), [GLONASS](#), [Galileo](#) or [multilateration](#).

There are some General Aviation concerns that ADS-B removes anonymity of the VFR aircraft operations. The ICAO 24-bit [transponder](#) code specifically assigned to each aircraft will allow monitoring of that aircraft when within the service volumes of the Mode-S/ADS-B system. Unlike the Mode A/C transponders, there is no code "1200"/"7000", which offers casual anonymity. Mode-S/ADS-B identifies the aircraft uniquely among all in the world, in a similar fashion as a MAC number for an Ethernet

card or the IMEI ([International Mobile Equipment Identity](#)) of a GSM phone.<sup>[*citation needed*]</sup>  
However, the FAA is allowing UAT equipped aircraft to utilize a random self-assigned temporary ICAO address in conjunction with the use of beacon code 1200. 1090ES equipped aircraft using ADS-B will NOT have this option.