Editor’s Notes

The entire aviation industry is trying to get our collective arms around the subject of ADS-B. There are still a number of questions which have murky answers at this point; however we want to get as much information in front of our customers as possible. The retrofit of business aircraft with ADS-B-compatible equipment will be a significant event for all of us. To a certain degree, every aircraft in U.S. airspace will be affected and we want to arm you with the right information to answer the questions posed to you and make informed decisions based on that information.

Much has been written on the ADS-B topic and is available online. We believe our efforts in finding and condensing this information should address many of your concerns on ADS-B for your aircraft.

New information regarding TCAS change 7.1 software is available and included in the section near the end of this publication.

At Duncan Aviation, we consider ourselves to be on the cutting-edge of all avionics technology, and the subject of ADS-B is no different. We have done ample research and talked with hundreds of our customers to develop the most valuable information we can provide. We are the industry experts on ADS-B and what it means to our customers.

Duncan Aviation acknowledges the FAA ADS-B Groups, the FAA Engineering and Safety Groups, Aircraft Electronics Association and the avionics manufacturers who are working on the products to make your flying safer, easier and affordable.

As always, we look to improve ourselves and our knowledge. Feel free to contact our avionics experts to answer any of your questions and talk about your challenges when the subject of ADS-B arises.

Duncan Aviation Avionics Sales Team

Straight Talk About ADS-B
NextGen Initiative
NextGen Initiative

Most people in aviation have heard about the Federal Aviation Administration’s (FAA) vision for the future of national airspace management and control called Next Generation Air Transportation System, or NextGen. The concept evolved from modernization initiatives started during President Bill Clinton’s administration. NextGen relies, in part, on transforming Air Traffic Control (ATC) from a ground-based radar network to an aircraft and satellite-based system. This system is called Automatic Dependent Surveillance-Broadcast (ADS-B).

The terms NextGen and ADS-B have been thrown around over the last few years because the vision is quickly becoming a reality. The FAA is working with industry organizations and manufacturers to implement the plan, which it believes will increase safety and efficiency of airspace in the United States by providing more complete and reliable traffic and weather data to pilots and controllers.

The goal of the NextGen initiative is to create capabilities that make air transportation safer and more reliable while increasing the capacity of our airspace and reducing aviation’s environmental impact. Projections indicate that air traffic will increase by 20% over the next decade. The systems being implemented now and in the mid-term are needed to accommodate the increasing demands on our national airspace system. In addition, the FAA is working with its global counterparts to ensure that NextGen is compatible with future foreign airspace requirements.

With the increased traffic, very light jets, unmanned aerial vehicles, and commercial space flight in our near future, there is an imminent need to be proactive in upgrading the national airspace system.

Following are other technologies related to NextGen that are being developed and tested. Duncan Aviation will continue to track them as they are further developed. Expect to hear more about them in the future.
• **Ground Based Augmentation System (GBAS)** – This system is being tested in Memphis, Tennessee and Newark, New Jersey. GBAS is a precision Wide Area Augmentation System (WAAS) approach that will allow for decision height of 200 feet Above Ground Level (AGL) -- CAT I approach -- even at non-Instrument Landing System (ILS) airports.

• **Multilateration** – This is a transponder-based tracking system that relies on multiple ground-based receivers that calculate an aircraft’s position by measuring the time of arrival of the transponder signal at three or more fixed receiver locations. This system does not rely on embedded Global Positioning System (GPS) data or a Radar Beacon System (RBS). Wide Area Multilateration (WAM) is being tested in Seattle, Washington; Boston, Massachusetts; Philadelphia, Pennsylvania; Cleveland, Ohio and St. Louis, Missouri. WAM allows ATC to accurately track aircraft in the terminal airspace and on the surface even in zero-visibility conditions.

• **Airport Surface Detection Equipment model X (ASDE-X)** – This technology is in use at 27 U.S. airports. It allows ATC to manage surface movements more efficiently.

• **Data Comm Integrated with FMS** – Data Communication integrated with Flight Management Systems (FMS) is being developed to reduce pilot verbal communication and automate coordination between ATC and airborne and surface traffic.

The FAA will need cooperation from all participants in aviation to achieve its NextGen goals. Aircraft that are equipped for ADS-B In and Out, Reduced Vertical Separation Minima (RVSM), Wide Area Augmentation System with Localizer Performance and Vertical Guidance (WAAS-LPV), Required Navigational Performance (RNP) and Future Air Navigation System 1/A (FANS-1/A) will have greater and more efficient access to airspace and airports.
The Roots of ADS-B
The Roots of ADS-B

Calculating an Aircraft’s Position for ATC

Before the widespread use of radar for Air Traffic Control in the 1950s, an aircraft’s position was calculated by the crew and relayed to ATC by radio. As radar technology matured, it gave controllers a picture of the airspace around them. Initially, known as Primary Surveillance Radar (PSR), it only showed aircraft as dots on a screen.

With the addition of Mode C transponders, Air Traffic Controllers could assign a four-digit code to the dots on their screens, allowing them to identify each dot as a particular aircraft. This is known as Secondary Surveillance Radar (SSR).

Adding Mode S transponders gave each dot an aircraft-specific identifier tied to the aircraft’s registration number as well as its altitude.

All of the technology to this point was to locate the aircraft from the point of the Air Traffic Controller, who could then manage the traffic. This approach worked well for areas under air traffic control but did nothing for areas without radar. As the skies became more congested, a system for real-time traffic awareness for the pilots became a necessity.
Real-Time Awareness for Pilots

In 1981, the FAA launched the Traffic Collision Avoidance System (TCAS) program to give pilots a view of the aircraft around them and, with TCAS II, conflict resolution in the form of vertical resolution advisories. This system was better than anything used in the past but does have some significant limitations. The intruding aircraft must have at least Mode C transponders but does not work to its full potential unless both aircraft have TCAS. The TCAS computer must process advisories based on position reports and must calculate velocities. It also only separates aircraft vertically and does not provide any lateral guidance. This functionality was proposed for TCAS III, but the project was suspended in favor of ADS-B. TCAS software version upgrades and definitions have been added to this publication in the last section, named TCAS v7.1.
What Is ADS-B?
What is ADS-B?

ADS-B is an aircraft and satellite-based transmission system. ADS-B can be broken into two primary functions, ADS-B Out and ADS-B In. An aircraft equipped with ADS-B Out works by sending GPS-derived position and velocity data from the aircraft systems, through an ADS-B-modified Mode S Transponder or a Universal Access Transceiver (UAT) to other aircraft, ground vehicles and ground stations for the purpose of Air Traffic Control and coordination.

ADS-B Out allows an aircraft to transmit information to ATC ground stations and to properly equipped aircraft. Position data will be automatically broadcast from all ADS-B Out-equipped aircraft. ATC ground stations and ADS-B In-equipped aircraft will receive this data. ADS-B Out has been mandated by the FAA in the airspace that now requires Mode-C transponder.

ADS-B In is the ability of an aircraft to receive information from other transmitting aircraft and the ATC ground infrastructure. In addition to location data, it will provide traffic and weather information to pilots. Traffic information will be similar to that received from the current Traffic Information System (TIS), Traffic Advisory System (TAS), and TCAS technologies in use today. Weather information will be similar to the current XM Weather, except that it will be customized to the aircraft’s geographic location and it will not require a subscription. The information will be free to anyone who chooses to equip their aircraft with certified ADS-B In capability. And at this time, ADS-B In will be optional for most aircraft.
How ADS-B Works

Aircraft equipped with either 1090 MHz Extended Squitter (ES) or 978 MHz Universal Access Transceiver (UAT) receiver/transmitters gathers information from existing on-board aircraft sensors, such as the FMS/GPS, Inertial Reference System (IRS), Attitude and Heading Reference System (AHRS), and Air Data Systems (ADS) and transmit them. Ground stations receive these signals and rebroadcast them for other aircraft to see, effectively merging the 1090 and 978 MHz systems. This information is also processed and sent to Air Traffic Control and can be published online for flight tracking purposes. Other aircraft can directly receive these signals if both aircraft are equipped to do so. This service is referred to as Traffic Information Services-Broadcast (TIS-B). If you hear the term “ADS-C”, that term means “Automatic Dependent Surveillance – Contract”, and
is identical to ADS-B, although instead of transmitting its data to ground stations, the Mode S Transponder transmits the information over a Satcom, which is relayed to ground stations by satellites. ADS-C will be the same method of communication in areas without radar coverage, such as large bodies of water.

Another service, called Flight Information Services-Broadcast (FIS-B) provides the flight crew with weather in graphic and text format along with other information like ATIS and NOTAMS. This service will typically use the 978 MHz UAT format because it has a larger bandwidth. FIS-B will not require a subscription for use, giving flight crews more information than they have previously had using subscription-based products like satellite weather.

For older aircraft, a multi-function display can be used as a Cockpit Display of Traffic Information (CDTI) to replace a radar display. This will merge the existing radar with FIS-B, TIS-B, terrain and TCAS data. Newer avionics suites will fully integrate this information into the Electronic Flight Instrument System (EFIS) display.
**ADS-B Testing**

The concept of ADS-B goes back to an FAA-sponsored study in 1973. The standards it was based on were first proposed in the early 1990s and have been revised many times. International standards have been developed by the International Civil Aviation Organization (ICAO). Ground stations were installed in Alaska, Arizona, and on the East Coast to fully test the system. Eleven ground stations were deployed and activated in 2008, making Florida the first state to be officially set up by the FAA for ADS-B.

Full infrastructure deployment is expected to be complete by end of 2014 with an FAA mandate for all aircraft to be equipped by 2020 when flying in an airspace which currently requires a transponder.
International Implementation
Internationally, Australia was the first country with full ADS-B coverage. Canada, China, Sweden and the United Arab Emirates (UAE) all currently have ground stations in place with varying coverage and service. In addition to the U.S.’s NextGen, ADS-B will be the backbone for the Single European Sky (SES) being developed for Eurocontrol. Both systems are being developed in parallel and are planned to offer complete interoperability and a seamless transition for aircraft traveling between them. ADS-C will link the systems over the oceans and other large bodies of water.
What Equipment Is Required?

The minimum equipment requirements for the mandatory ADS-B Out capability will be a compatible form of GPS and a Mode S transponder or data link radio, called a UAT, and altitude encoder. All aircraft that need to operate in Class A airspace and most foreign airspace will require the Mode S transponder. Piston aircraft that operate below 18,000 feet in the U.S. can use the UAT, however Europe has opted for Mode S (ES) only.

ADS-B In will require the above-mentioned equipment as well as a display, such as a multi-function or multi-hazard display, or Electronic Flight Bag.

All equipment will have to meet new technical standards set by the FAA. Some newer existing equipment already meets these standards.

What About International Requirements?

The FAA is working with the International Civil Aviation Organization (ICAO), Civil Air Navigation Service Organization (CANSO) and foreign governments to develop standards for the equipage of aircraft capable of international travel. A Mode S transponder with Extended Squitter (ES) will be required for this capability and is already mandated in parts of Europe. The specific guidance from the Single Sky Committee of the European Commission is expected to approve the Surveillance and Performance Interoperability Implementing Rule (SPI-IR) identifying surveillance system performance and ground and airborne interoperability requirements for ADS-B in Europe very soon (and to be published by the end of 2011). The mandate for ADS-B in Europe will be for forward-fit aircraft to be equipped by January 2015, and retrofit to be required by December 2017. These provisions will apply to aircraft with an mtow with more than 12,566 pounds (5,700 kg), or with a cruising speed of more than 250 knots, including those operated by international carriers.
Benefits of ADS-B
The Benefits of ADS-B

• Real-time traffic in the cockpit at an effective range of more than 100 miles.

• Traffic avoidance with both lateral and vertical guidance, based on transmitted position and velocity data for greater precision.

• Surveillance in remote or inhospitable areas that do not currently have coverage with radar.

• Reduced separation and greater predictability in departure and arrival times, allowing Air Traffic Controllers to plan further in advance.

• Can be implemented rapidly for a relatively low cost and will reduce the cost of the infrastructure needed to operate air space in the United States.

• Further enhances aviation safety through features such as automatic traffic call-outs or warnings of imminent runway incursion.

• Can be scaled and adapted for use in general aviation and in ground vehicles. This will provide affordable, effective surveillance of all air and ground traffic, even on airport taxiways and runways.
Benefits: A Deeper Look

With ADS-B, both pilots and controllers will see radar-like displays with highly accurate traffic data from satellites. The displays will update in real-time and don’t degrade with distance or terrain.

Giving all of this information to the pilot will be a great benefit. The improved situational awareness will mean that pilots will be able to fly closer to each other at safe distances from one another with less assistance from Air Traffic Control.

Air Traffic Controllers will have a much better picture of the traffic they are managing, allowing them to space aircraft tighter. This, in turn, will allow for more aircraft capacity in the air and will decrease the use of holding patterns. It will also allow the use of Continuous Descent Arrival (CDA) procedures aimed to reduce fuel burn and emissions. ADS-B, combined with the increased position precision of GPS Rnav procedures will save operators time and money as it will shorten their time in the air.

ADS-B has also been designed to be much less expensive than any other infrastructure currently being used. The low cost of deployment and maintenance will allow the National Airspace System to increase capacity and safety while staying on a budget. It also allows for full United States coverage as ground stations can be located in remote locations such as the Alaskan Outback or on offshore oil rigs in the Gulf.

The gains in safety, capacity, and efficiency resulting from a satellite-based system will enable the FAA to meet predicted air traffic growth in the future. And because ADS-B is a flexible and expandable platform, it can change and grow as needed.

ADS-B will provide data links to receive flight information services such as graphical weather depiction and textual flight advisories. In the past, these services have been unavailable or too expensive for widespread use.
ADS-B FAA Mandate
The FAA began implementing NextGen in Fiscal Year 2009, starting with ADS-B. The FAA plans on having the ADS-B infrastructure operational by the end of 2014 and has mandated ADS-B Out compliance by January 1, 2020.


The mandated avionics perform the ADS-B Out function, which transmits precise location and other information about the aircraft to ground stations and other aircraft equipped with ADS-B.

The rule does not mandate ADS-B In avionics, which enable other services available with ADS-B. Aircraft outfitted with ADS-B In avionics can take advantage of broadcast services of data, like graphical and textual weather, traffic advisories, and other aeronautical information, in the flight deck.

The ADS-B rule mandates ADS-B Out avionics performance when operating within designated affected airspace, giving aircraft owners approximately 10 years to equip their aircraft.

The ADS-B rule, like current transponder operating requirements, requires operators to have ADS-B Out avionics installed and operating in order to fly their aircraft in the busiest airspace, as described below:

- Class A, B, and C airspace.
- All airspace at and above 10,000 feet Mean Sea Level (MSL) over the 48 contiguous United States and the District of Columbia.
• Within 30 nautical miles of airports listed in 14 CFR §91.225, from the surface up to 10,000 feet MSL.

• For Class E airspace over the Gulf of Mexico from the coastline of the United States out to 12 nautical miles, at and above 3,000 feet MSL.

It is important to note that current transponder or RVSM maintenance requirements are not changed or affected by the ADS-B rule.

FAA Technical Service Orders (TSOs) describe the equipment specifications approved for ADS-B operations. The ADS-B rule states that avionics must meet the standards of either TSO-C166b (for 1090 MHz ES link equipment) or TSO-C154c (for 978 MHz UAT link equipment). TSO-C166b is required in Class A airspace and either link can be used in all other airspace.
TCAS II version 7.1
While TCAS II is not an integral component in the ADS-B systems on-board aircraft, the two systems are very closely linked. TCAS involves communication between all aircraft equipped with an appropriate transponder. Each TCAS-equipped aircraft interrogates all other aircraft in a determined range about their position (via the 1030 MHz radio frequency), and all other aircraft reply to those interrogations (via 1090 MHz).

As previously discussed, ADS-B messages are transmitted from aircraft through 1090 (ES) transponders, containing the identity, location, and velocity information. The signals are broadcast on the 1090 MHz radio frequency.

TCAS equipment which is capable of processing ADS-B messages may use this information to enhance the performance of TCAS, using techniques known as “hybrid surveillance.” Some TCAS manufacturers will incorporate this capability as a part of their version 7.1 upgrade. See FAA Advisory Circular AC 20-151A for more information on Hybrid Surveillance.

As currently implemented, hybrid surveillance uses reception of ADS-B messages from an aircraft to reduce the rate at which the TCAS equipment interrogates that aircraft. This reduction in interrogations reduces the use of the 1030/1090 MHz radio channel, and will over time extend the operationally useful life of TCAS technology. The ADS-B messages will also allow lower cost technology to provide real time traffic in the cockpit for small aircraft.

Hybrid surveillance does not include the use any of the aircraft flight information in the TCAS conflict detection algorithms; ADS-B is used only to identify aircraft that can safely be interrogated at a lower rate.
In the future, prediction capabilities may be improved by using the state vector information present in ADS-B messages. Also, since ADS-B messages can be received at greater range than TCAS normally operates, aircraft can be acquired earlier by the TCAS tracking algorithms.

The identity information present in ADS-B messages can be used to label other aircraft on the cockpit display (where present), painting a picture similar to what an air traffic controller would see and improving situational awareness.

If a TCAS II system is installed in an aircraft to be fit with ADS-B equipment, the TCAS system will send a “message” to the ADS-B equipment telling the ADS-B system that the TCAS II system is “Installed and Operational.”

TCAS version 7.1 will be offered as an upgrade by all of the major TCAS manufacturers, and also makes two important safety enhancements. Version 7.1 changes the current TCAS II aural warning from “Adjust Vertical Speed, Adjust” to “Level Off, Level Off.” It also corrects missed and late TCAS reversals. TCAS reversals were introduced in TCAS version 7.0 to adapt to changing situations where the original sense had clearly become the wrong thing to do, in particular the situation when one of the pilots decides not to follow the Resolution Advisory (RA), or is instructed by ATC to perform a particular maneuver. The solution in Change 7.1 introduces improvements to the current reversal logic to address late issuance of reversal RAs and potential failures to initiate reversal RAs.

TCAS version 7.1 also makes four other minor enhancements to the system. Version 7.1 corrects an issue when descending through 1000 ft AGL. 7.1 also modifies the “Datalink Capability Report”
(the TCAS status report sent by the TCAS processor to the Mode S transponder) to tell the systems that the TCAS processor is Hybrid Surveillance-capable. And 7.1 also allows for the transmission of the TCAS processor part number and software level, and corrects TCAS multi-aircraft logic issues which reduces the risk of “close-encounters” of multiple aircraft in RVSM airspace.

The enhancements introduced in TCAS version 7.1 proved to be significant enough to warrant mandates by both the International Civil Aviation Organization (ICAO), and the European Aviation Safety Agency. ICAO has mandated TCAS version 7.1 by January 1, 2014 for forward fit aircraft, and January 1, 2017 for retrofit aircraft. EASA has stepped their time-table up by comparison with forward fit aircraft due by March 1, 2012, and retrofit aircraft by March 1, 2014.

The FAA is reportedly a “strong supporter” of TCAS version 7.1, and has issued the statement “The latest version of software for TCAS II is version 7.1. To ensure compatibility with international standards, the FAA encourages the installation of this software as soon as practical.” This statement has stirred thoughts among the avionics manufacturing community that version 7.1 may be mandated in the US.

The certification path for TCAS version 7.1-modified units will be via STC and TC. The change will be reflected in the aircraft TC for forward fit aircraft, and the system will need to be STC’d in a retrofit aircraft. This will add fairly significant cost to the upgrade. The original STC for the TCAS II system currently installed in your aircraft will need to be re-opened, amended for version 7.1, and recertified. STC’s require time, and money.
ADS-B FAQs
How will the upgrade path differ if the aircraft does or does not have Elementary or Enhanced Surveillance? Will I need to have both?

Elementary (ELS) and Enhanced (EHS) Surveillance are a European requirement, and not U.S. ADS-B takes Elementary and Enhanced Surveillance functions to the next level. While ELS and EHS functions are not required as a part of ADS-B, they will most likely be a by-product of it. If an aircraft already has ELS and EHS, it will be much easier to determine what steps are necessary to take the aircraft to ADS-B status.

How will ADS-B-In be displayed on my older MFD or Radar Indicator? Will I have to install a separate indicator?

Business and GA avionics manufacturers have yet to determine the methods and interfaces by which ADS-B-In will be displayed in the cockpit. Most likely, the interfaces available will be very similar to those developed for the display of TAWS and EGPWS systems. Examples would include Arinc 429, Arinc 453, and some analog interfaces. Separate indicators may be the only option for display in some aircraft.

How much will it cost to upgrade to ADS-B Out? How much for full ADS-B?

Costs for the equipment and certification paths have yet to be determined; however our research indicates that the costs will be significant. A rule-of-thumb may be that analog aircraft will be much more expensive to retrofit for ADS-B, and digital aircraft will be less.
How much will it cost to upgrade our TCAS for TCAS version 7.1?

Costs for the equipment upgrade have not been determined yet by the avionics manufacturers. For comparison, the previous upgrade from version 6.04 to 7.0 ranged from $10,000 to $15,000 for parts, and less than $5,000 for labor, depending on the make of the equipment. The certification path will be via STC. The original STC for the TCAS installation in your aircraft will need to be amended for the upgrade to 7.1. You will need to contact the STC holder to determine their timeline for the amendment, and the cost to purchase the amended STC.

How long will my plane be down for an ADS-B installation?

Downtime for an ADS-B retrofit will vary, depending on the difficulty of the interface. Analog aircraft will require more down-time, while digital will require less. Downtime for a digital aircraft will most likely be a week to two weeks. Some analog aircraft will also fall into this time-frame.

What if I wait until the deadline is nearing to install my ADS-B equipment?

If the deadline approaches, and your aircraft is not ADS-B-compliant, you can expect prices for the equipment to increase, simply due to market pressures and supply vs. demand. This can also be expected for the installation labor and engineering/certification costs. The biggest concerns as we get closer to implementation are extended downtime due to scheduling, and certification delays due to the heavy burden on FAA entities.
As an owner/operator, what can I do now to be compliant in 2020?

The avionics vendors will need to develop new units or modify their existing units either by Service Bulletins or by developing completely new units in order for owner/operators to become compliant. The advantage is that with any mandate, the avionics industry tries to be proactive and will create a path to meet this mandate. Now that the FAA has released TSOs for complying with the ADS-B Out mandate, the owner/operator has a path to meeting this requirement.

What kind of Certification path will be needed?

As with any new TSO or product that is required by the FAA, there becomes an issue in getting it certified as Airworthy on your aircraft. That is where the modification center or avionics service center you choose becomes extremely important—even when the new units or Service Bulletins (SBs) are completed and meet the new TSO established by the FAA. The new units and SBs do not constitute or grant approval for certification into a particular aircraft.

At the time of publication, the FAA indicated that all new installations will need to be performed through a Supplemental Type Certificate (STC) that amends the Type Certificate (TC) of the aircraft. This process increases costs and downtime for operators. Many of the larger modification centers will perform this function on behalf of owners and vendors. And in the future, the FAA has indicated that it is open to the possibility of implementing an Engineered Assisted Field Approval Process, which would eliminate the requirements for the STC process and be ideal for those operators that will fall outside the normal STC process either by design or original equipment on board the aircraft.
Do OEMs have a plan to provide solutions?

Most of the vendors playing a key role in this mandate have indicated they have a path in getting their equipment certified. However, some particular vendor units currently being offered are not scheduled for at least another year or two. Duncan Aviation will continue to keep you informed as new information becomes available.
Key Terms
Automatic Dependent Surveillance-Broadcast (ADS-B) – A cooperative system which transmits messages of position and flight profile information for the purposes of Air Traffic Control.

1090 MHz ES – A data link which uses 1090 MHZ Extended Squitter that supports ADS-B but does not support FIS-B, intended for use in air carrier, business, and other high performance aircraft. This link is capable of using an existing Mode S transponder with specific modifications.

978 MHz Universal Access Transceiver (UAT) – A data link that supports ADS-B as well as TIS-B and FIS-B for use in airspace below 18,000 feet.

Primary Surveillance Radar (PSR) – A ground-based radar system that measures distance and bearing to an aircraft based solely on radar reflection.

Secondary Surveillance Radar (SSR) – A ground-based system which makes use of an aircraft’s transponder(s) to relay the following information: a four-digit identification code (Mode A), altitude (Mode C), a unique identifier (Mode S), a flight identification number (Elementary Surveillance), and more detailed position and trajectory data (Enhanced Surveillance). It supplements PSR, giving Air Traffic Control more information.

Traffic Information Services (TIS-B) – A system which transmits traffic known to the ground-based ATC system to an aircraft. This fills the gap for aircraft equipped with transponders but not ADS-B.

Flight Information Services Broadcast (FIS-B) – A system which provides weather text and graphics, Notice to Airman (NOTAMs), Automatic Terminal Information Service (ATIS), and other information to be provided over the Universal Access Transceiver link.
Cockpit Display of Traffic Information (CDTI) – A stand-alone or integrated display which provides an aircraft crew with detailed information about other aircraft, specifically spacing intervals.

Ground Based Augmentation System (GBAS) – A system that supports regional augmentation through the use of terrestrial radio messages.

Satellite Based Augmentation System (SBAS) – A system that supports wide-area or regional augmentation through the use of satellite messages.

Wide Area Augmentation System (WAAS) – A system developed to augment Global Positioning Systems (GPS), with the goal of improving its accuracy, integrity, and availability. Intended to enable aircraft to rely on GPS for all phases of flight, including precision approaches to any airport within its coverage area.

Wide Area Multilateration (WAM) – Multilateration is the method of determining a target's position from the TDOA (Time Difference of Arrival) of Transponder replies at spatially separate receivers. With Wide Area Multilateration, the receivers are spread much further apart.

Airport Surface Detection Equipment, Model X (ASDE-X) – A runway safety tool which enables air traffic controllers to detect potential runway conflicts by providing detailed coverage of movement on runways and taxiways.

Continuous Descent Approach (CDA) – Known as Optimized Profile Descent (OPD) in the U.S. CDA involves maintaining a constant three degree descent angle during landing, instead of approaching an airport in a stair-step fashion.
TCAS version 7.1 – TCAS version 7.1 will be offered as an upgrade by all of the major TCAS manufacturers, and also makes two important safety enhancements. Version 7.1 changes the current TCAS II aural warning from “Adjust Vertical Speed, Adjust” to “Level Off, Level Off.” It also corrects missed and late TCAS reversals. TCAS reversals were introduced in TCAS version 7.0 to adapt to changing situations where the original sense had clearly become the wrong thing to do, in particular the situation when one of the pilots decides not to follow the Resolution Advisory (RA), or is instructed by ATC to perform a particular maneuver. The solution in Change 7.1 introduces improvements to the current reversal logic to address late issuance of reversal RAs and potential failures to initiate reversal RAs.
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