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BY DAVID BJELLOS

Early adopters — including corporate operators — take an optimistic view of the near-term benefits of ADS-B.

Practical Necessity

The next decade will bring profound changes in the way corporate aircraft operators begin to share a more scheduled and predictable U.S. National Airspace System (NAS) with air carriers, and all flight crews take on new responsibilities. Although many operators have yet to be persuaded that the time has come to invest in automatic dependent surveillance–broadcast (ADS-B) technology, the U.S. Federal Aviation Administration (FAA) and many industry leaders see voluntary aircraft equipage as a major step to be accomplished as soon as possible. As part of a worldwide move to a new air traffic management paradigm, ADS-B can deliver near-term safety benefits, and often cost savings, in each phase of flight.

In the United States, a major push is under way for the ADS-B-based Next Generation Air Transportation System (NextGen) to be fast-tracked, much like the country's Interstate Highway System in the 1950s. Urgency about ADS-B equipage among operators would help make the transition to NextGen's aircraft performance-based navigation infrastructure as seamless as possible. The global context includes early adopter civil aviation authorities in countries and regions including Australia, China, Europe, Fiji, India and Russia.[1]

In about 12 months, 340 ADS-B ground stations — about half of the eventual U.S. system — will be in place, FAA Administrator Randy Babbitt said in June, emphasizing that NextGen must be accelerated through many successful flight demonstrations of ADS-B to build user confidence that major investments in avionics and training will have tangible returns for corporate operators and other industry stakeholders. Data from flight operations with ADS-B and required navigation performance (RNP) area navigation (RNAV) will help make the NextGen results measurable.[2]

As of mid-July, the latest proposal to fund the FAA's activities during fiscal year 2010 included significant directives on ADS-B. If the bill is enacted in its present form, Congress would require the FAA to develop a plan to provide runway incursion information directly to pilots in the cockpit and accelerate implementation of NextGen technologies — specifically, integration of *ADS-B Out* on all aircraft by 2015 and *ADS-B In* on all aircraft by 2018, and of RNP RNAV at the 35 busiest U.S. airports by 2014 and throughout the NAS by 2018.[3]

Corporate aircraft could adapt quickly to ADS-B and assimilate into NextGen airspace — and its Single European Sky Air Traffic Management Research (SESAR) counterpart — but fewer than 100 aircraft currently are equipped to do so. The corporate fleet lags behind commercial carriers in ADS-B equipage; cost of retrofit, implementation methods and airline demand for avionics are key issues for corporate aviation.

Several ADS-B-equipped corporate jet aircraft already are operating, with more U.S. corporate operators adding ADS-B this year. By comparison, operators of Boeing Commercial Airplanes and Airbus types have installed ADS-B on roughly 40 to 50 percent of the U.S. airline fleet, and some data show the percentages for non-U.S.-registered airliners to be higher.

Avionics manufacturers have made major investments developing equipment with fleet-type commonality that provides airlines a reasonable return on investment from fuel savings and reduced block times. The largest corporate-aircraft manufacturers also currently see operators beginning to specify ADS-B for their new aircraft and to retrofit existing aircraft.

Seeing Like ATC

Essentially, ADS-B takes flight crew confidence to a higher level by providing unprecedented positioning accuracy in congested airspace, enabling clear and immediate recognition that a conflicting aircraft is maintaining its flight path, turning, climbing/descending or accelerating/decelerating. The value of this information will become evident, especially for those operating in today's most challenging U.S. environments — such as those in the Northeast, Los Angeles basin and Dallas/Fort Worth metropolitan areas — and will continue while further increases in air traffic density occur as projected.

By 2020, adoption of NextGen technologies will support safe ground and airborne separation despite the traffic growth in the United States and many other countries. Even before the FAA's 2010–2013 completion of the ADS-B ground station infrastructure, early adopters can expect significant risk reduction in parts of the NAS.

Enhanced safety on airport surfaces ranks as the most compelling argument for rapid adoption. With ADS-B and cockpit display of traffic information (CDTI), flight crews track the movement of the own-ship, other aircraft and vehicles, and electronic flight bag (EFB) software alerts the flight crew to potential conflicts with traffic, imminent runway incursions and runway/taxiway misidentifications.

If a runway is occupied and a flight crew approaches a taxiway hold line, for example, the runway area on the EFB display turns yellow. If they proceed past the hold line, the runway display turns red, accompanied by an aural warning. The 2009 edition of the U.S. National Transportation Safety Board's "most wanted" safety improvements says, among measures to improve runway safety, that aircraft systems should "give immediate warnings of probable collisions/incursions directly to cockpit flight crews."

UPS Airlines flight crews arriving at the company's Louisville, Kentucky, U.S., hub routinely adhere to accurate and predictable separation criteria based on Mode S transponders upgraded to add ADS-B. Using merging and spacing software functions on Class 3 EFBs, the crews track, capture and maintain precise in-trail spacing with other company aircraft in all weather conditions (*ASW,* 11/07, p. 44).

Separation responsibility shifts during these arrivals from FAA controllers to the UPS flight crews. When instructed by air traffic control (ATC) to merge with another aircraft, the flight crew enters on the EFB the number of minutes or seconds to follow in-trail. Once the target ship has been acquired, the own-ship speed command continuously indicates the fast/slow trailing speed trend for pilot monitoring. The functions work in conjunction with an RNP RNAV continuous descent arrival, and with a cockpit moving map display.

As of mid-2009, another of several NextGen test programs was under way. US Airways began using Aviation Communications and Surveillance Systems' SafeRoute software applications for merging and spacing, surface area movement management, CDTI, CDTI-assisted visual separation and continuous descent arrivals. Under a two-year contract, the airline will install ADS-B Out and ADS-B In upgrades/new avionics and Class 2 EFBs on as many as 20 Airbus A330s, develop standards and prototypes, conduct flight demonstrations at Philadelphia International

Airport (PHL) and provide data from line operations to the FAA. ATC facilities at PHL are scheduled to add ADS-B in February 2010.[4]

ADS-B in the United States emerged from validation trials in 2001–2007 during the FAA's two-phase Capstone Project in Alaska and other research. The project confirmed for U.S. and European regulators that pilots safely could maintain 3 nm to 5 nm (5.6 km to 9.3 km) separation. In August 2007, the FAA agreed to accelerate the installation of 38 ADS-B ground stations if the government of Alaska and industry associations independently raised funds to help equip 4,091 Alaskan aircraft over a five-year period.[5]

Benefit Package

Stand-alone ADS-B avionics, or an ADS-B Out upgrade to almost any Mode S transponder made in the past 17 years, *squitters* data — that is, broadcasts messages without interrogation — to other aircraft and ADS-B ground stations within 200 nm (370 km). This gives an ADS-B–equipped flight crew an accurate, near-real-time view of potential aircraft and vehicle conflicts — and more time to perceive them and respond — before they are detected by a traffic-alert and collision avoidance system (TCAS II).

Some corporate operators question what they stand to gain from ADS-B compared with existing avionics — especially TCAS II (*ASW*, 4/09, p. 34). A key point is that ADS-B Out using 1090 MHz extended squitter (1090ES) — used above Flight Level 240 (approximately 24,000 ft) — is about 10 times more accurate than the transponder data used by TCAS II.

The FAA has yet to propose a requirement for ADS-B In, but operators that voluntarily install a transmitter/receiver or transceiver to receive ADS-B messages gain optimal situational awareness. Unlike TCAS II, no recommended avoidance maneuvers are provided or authorized as a direct result of an ADS-B display or an ADS-B alert. ADS-B In does provide two advisory aids to visual acquisition. The primary aid is once-per-second CDTI updates, based on the data received directly from other

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Among major FAA demonstration projects, Airbus A330s at US Airways are being equipped with ADS-B avionics.

ADS-B–equipped aircraft. The second — traffic information system–broadcast (TIS-B) — is a free FAA service providing a more complete traffic picture in situations where some nearby aircraft lack ADS-B Out. TIS-B enables the display, nominally every three to 13 seconds, of any aircraft with an operating Mode S or Mode A/C transponder that is also within ATC radar or multilateration coverage.

Achieving ADS-B In capability using a 1090ES transceiver for the data link may involve spending $55,000 to $100,000 more per aircraft than ADS-B Out equipage, typically to retrofit the 1090 MHz receiver of an existing TCAS II. Operators of these aircraft will begin receiving TIS-B data at a later stage of the FAA's ADS-B implementation.

Similarly, an operator that meets FAA criteria to use the lower-cost 978-MHz universal access transceiver (UAT) technology for ADS-B Out voluntarily can install a UAT transceiver and multi-function display to provide ADS-B In. This allows flight crews to receive the messages from other ADS-B–equipped aircraft, TIS-B service and the flight information system–broadcast (FIS-B) service. The FIS-B service — comprising aviation routine weather reports, special aviation reports, terminal area forecasts and next-generation radar (NEXRAD) precipitation maps — also operates at the nominal 200 nm line-of-sight distance from any ground-based transceiver in the FAA's ADS-B network. Eleven ADS-B ground-based transceivers in Florida currently broadcast TIS-B and FIS-B data, for example.

Flying With ADS-B

Consistent with safe practices and assimilation into the NAS, the FAA plans to provide air traffic services on a "best equipped, best served" basis during ADS-B implementation.[6] A look at benefits by phase of flight during hypothetical future operations at a major airport gives a sense of what is in store.[7]


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Electronic flight bags or multi-function displays typically are used for ADS-B–based cockpit display of traffic information.

At the flight planning stage, the algorithms built into NextGen and SESAR will be capable of customizing departure routes and downloading them directly to a flight management system based on the flight crew's pre-departure clearance request, and communicating operator flight path intent.

For airport surface movement, from engine start to takeoff, airport surface detection equipment, model X (ASDE-X), will remain the critical infrastructure for ATC to reduce risk while controlling aircraft and ground vehicles. Small Mode S transponders on all ground vehicles will identify them for ready observation by flight crews and ATC. Tracking will be accomplished partly by surface radar and ADS-B backed up by multilateration systems using a network of ground sensors.[8]

Before the taxi phase, the flight crew typically will receive electronically the entire ATC clearance for taxi, takeoff, a precise departure flight path and the assigned route, called the flight path trajectory route. The flight crew also will select the transponder "ON" to reply to Mode S interrogations and broadcast ADS-B messages during taxi, with those settings retained until engine shutdown at the destination airport. Just before takeoff, the ATC terminal flow management system will assign a calculated takeoff time for the most efficient spacing.

During the en route phase, the flight crew will fly the RNP RNAV departure route that — based on the preflight departure clearance request — typically will have been tailored specifically to their preferred route and initial heading. The EFB also will tap NextGen's four-dimensional weather data cube system to display the latest available weather data, including continuous monitoring of physical dimensions and predicted times of weather activity.

Also during en route operation, the FAA's enhanced integrated traffic management adviser software automatically will help controllers re-route the flight crew around significant weather using ADS-B Out messages from each aircraft and controller-pilot data link communications. The newly assigned course, often an offset to a published route, will turn the single airway into a "multi-lane highway" onto which multiple aircraft simultaneously can be routed with 5 nm (9.3 km) in-trail spacing.

If the en route phase involves oceanic operation, the future air navigation system (FANS) 1/A+ or FANS 2/B–equipped airliner or corporate aircraft will fly optimized trajectories.[9] Aircraft equipped with ADS-B In and Out also will be able to conduct trans-oceanic flights on heavily used routes, such as New York–London routes, with safe and more efficient in-trail spacing.

Worldwide Solution

ADS-B in NextGen parallels transformations about to occur elsewhere in the world. As NextGen and SESAR integrate, in roughly the 2015–2020 timeframe, a gradual but crucial shift will occur: air traffic *control* will give way to air traffic *management.*

U.S. and non-U.S. airlines have recognized an urgent need to overhaul the underlying infrastructure that creates extremely congested airports and terminal areas such as London Heathrow Airport, Amsterdam Airport Schiphol and New York John F. Kennedy International Airport. ADS-B promises to help reduce cockpit mistakes, mitigate fatigue-related events through better situational awareness and increase pilot confidence during high rates of low-visibility approach procedures.

From today's mostly non-equipped aircraft to full ADS-B conformity, the NextGen transformation will take years. Early CDTI equipage, however, also prepares operators to take full advantage of various local ATC technologies such as multilateration, whether used as a runway incursion countermeasure or for accurate ATC surveillance and vectoring in mountainous airspace and airspace not covered by radar, whether it be over the vast Australian outback, Hudson Bay in northeastern Canada or mountains in the Czech Republic.

For example, Air Navigation Services of the Czech Republic since 2002 has provided local and wide-area multilateration systems to improve safety in the mountainous terrain of Ostrava and in other areas that lack radar coverage. Civil aviation authorities in the Netherlands and Taiwan also have the technology, which the FAA has applied to upgrade selected U.S. airports from radar-only ASDE-X to multilateration-based ASDE-X (*ASW,* 9/08, p. 46).[10]

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Notes

1. Proceedings of the Hearing of the Aviation Operations, Safety and Security Subcommittee. U.S. Senate Committee on Commerce, Science and Transportation. May 13, 2009.
2. Babbitt, Randy. "The Secret to Success." Speech to RTCA, June 10, 2009. Testimony before the U.S. House Appropriations Subcommittee on Transportation hearing on reauthorization of FAA for fiscal year 2010. June 16, 2009. Babbitt became FAA administrator on June 1.
3. U.S. Senate Committee on Commerce, Science and Transportation. "Rockefeller, Hutchison, Dorgan, DeMint Introduce Bipartisan Aviation Bill: Key Focus on Increasing Safety and Modernization." News release, July 14, 2009. ADS-B Out refers to the aircraft capability to broadcast messages; ADS-B In means its capability to receive messages.
4. Schofield, Adrian. "US Airways' A330s Slated to Test ADS-B." *Aviation Week & Space Technology.* Jan. 25, 2009. ACSS. "SafeRoute: ADS-B Solutions for Approach and Taxi." <www.acssonboard.com/products/Pages/SafeRoute.aspx>.
5. Alaska Air Carriers Association; Alaska Airmen's Association; Alaskan Aviation Safety Foundation. Letter to federal officials and legislators, and the governor of Alaska, Jan. 27, 2009. Under Alaska's five-year Surveillance and Broadcast Services Capstone Statewide Plan, the state's commitment of grants and loans is intended to help this many operators to equip their aircraft by October 2012. The associations said that some members were reluctant to acquire the new technology because of doubts as to whether the avionics specified would comply with future FAA requirements.
6. FAA. "NextGen Governing Principles for Avionics Equipage." Feb. 27, 2009.
7. The FAA has published scenarios for 2018 that preview other avionics uses by phase of flight at <www.faa.gov/about/initiatives/nextgen/2018>.
8. Era Systems Corp. "Improving Aircraft Tracking in the Air and on the Ground" and "Multilateration and ADS-B Surveillance System." <www.sra.com/era/era.php> May 2009. Multilateration systems enable ATC to receive, process and integrate transmissions of Mode A/C/S transponder data from civil aircraft or vehicles, ADS-B (1090ES or UAT) messages from civil aircraft and data from military aircraft.
9. FANS technology supports separation of aircraft in oceanic airspace and on polar routes using controller-pilot data link communications by satellite when out of VHF radio range, including automated reports of aircraft position, and RNP RNAV. First-generation standards comprise FANS 1 on Boeing airplanes and FANS A on Airbus airplanes; FANS 2/B is the second generation of flight management system software solutions.
10. Beechener, Jenny. "ANS CR Chief Jan Klas Is Spearheading Regional Cooperation." *Jane's Airport Review.* April 10, 2008. Reproduced on the Web site of Air Navigation Services of the Czech Republic, <www.ans.cz>.