ADS-B
A Defining Change

ALPA Works Closely with Other Aviation Stakeholders to Bring Surveillance Radar's Replacement to Maturity

By F/O Bill Riley (US Airways)
ALPA ADS-B Project Team Leader

On March 6, the National Aeronautic Association awarded its prestigious Robert J. Collier Trophy to—well, not a person or airplane this year, but a *concept* that, in many ways, is still in its infancy: Automatic Dependent Surveillance-Broadcast (ADS-B). ALPA was one of 22 private- and public-sector groups nominated to share the award for their diligent work during the last 12 years that has set the stage for wide-scale introduction of the next generation of airborne surveillance and cockpit avionics.

The NAA awards the Collier Trophy for "the greatest achievement in aeronautics or astronautics in America, with respect to improving the performance, efficiency, and safety of air or space vehicles, the value of which has been thoroughly demonstrated by actual use during the preceding year."

So what is ADS-B, and what makes it so deserving of the Collier Trophy?

The FAA, with industry consensus, has chosen ADS-B to replace radar as the air traffic surveillance system of the future, making it a critical "cornerstone" technology of the Next Generation Air Transportation System (NextGen) to increase the capacity of the U.S. National Airspace System (NAS).

ADS-B promises to give air traffic controllers a much higher update rate and better resolution of targets than today's groundbased air traffic surveillance radar. It also offers to give flight crews a powerful new tool with several applications that will improve situational awareness in the cockpit and may safely permit decreasing separation between aircraft.

Today, ATC radar transmits a radar interrogation pulse, and the aircraft's transponder sends back a reply. This reply contains information that is plotted on the air traffic controller's screen—aircraft position, altitude (to nearest 100 feet), and transponder code. Approximate groundspeed and track also are available. The radar updates the target every 5–12 seconds. The resolution of radar targets is about 0.3 nm enroute and 0.1 nm in the terminal area—at best.

ADS-B, using the aircraft's onboard navigation systems (usually GPS), automatically broadcasts the aircraft's position (lat/long), altitude, true airspeed, heading, call sign, positional accuracy and integrity category, vertical position change, and course once every second without requiring interrogation by a groundbased radar. The position accuracy of ADS-B is the same as the aircraft's navigation system—for some GPS units, that's 3 meters.

So ADS-B has a higher update rate than ground radar, is more accurate, and less expensive (for the FAA) than radar.

But what does this do for airline pilots?

ADS-B In and Out

In October 2007, the FAA issued a notice of proposed rulemaking (NPRM) to mandate that airlines equip airliners with ADS-B by 2020. Initially, the FAA will require the airlines to equip airliners with ADS-B *Out*—i.e., a requirement to *transmit* ADS-B messages used for surveillance. However, many of the advantages of ADS-B will come with fleetwide equipage with ADS-B *In*, which means receiving ADS-B transmissions directly from other aircraft.

With ADS-B In, flight crews will have the same information that air traffic controllers have. A Cockpit Display of Traffic Information (CDTI) will enable pilots to detect, identify, maneuver in relation to, and potentially ensure separation from other aircraft. One proposed design will show an aircraft traffic symbol with target altitude, vertical speed, track, and call sign. A pop-up box containing other information, such as the target's airspeed, heading, or closure rate would be available.

Meanwhile, the Traffic Alert and Collision Avoidance System (TCAS) will continue to play a vital role as the independent onboard system to prevent midair collisions. However, even when TCAS and CDTI displays are integrated, pilots cannot use TCAS for maintaining normal aircraft separation, which is the function of ATC. TCAS has inherent deficiencies that prevent pilots from using it for self-separation.

The first ADS-B applications will not significantly change our current rules or procedures, but will enhance our capabilities. The process of implementing ADS-B is following a "crawl, walk, then run" philosophy to maintain the current level of safety in the NAS. Let's take a brief look at what's in the works.

FDMS

Flight deck merging and spacing (FDMS) is an application based on ADS-B that allows flight crews to ensure spacing

Other ADS-B In Applications

Other cockpit applications of ADS-B*In* are envisioned. They include three improvements to visual approaches:

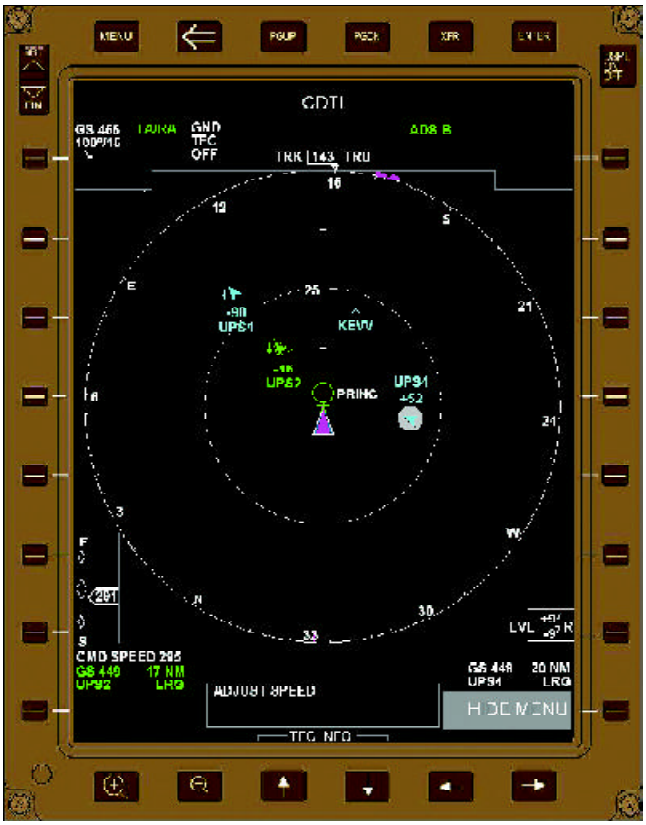
- Enhanced Visual Acquisition (EVAcq) is a very basic ADS-B application aimed at improving pilot situational awareness. EVAcq helps pilots find and *identify* other aircraft. Use of EVAcq is not expected to change current ATC procedures for visual approaches—pilots will use out-the-window procedures to find and follow the preceding aircraft.
- Enhanced Visual Approach (EVApp), an extension of the EVAcq application, will help pilots find and *track* the preceding aircraft during a visual approach. This application may give pilots closure rates and distance to the preceding aircraft during the approach. The pilots still must keep the preceding aircraft in sight during the visual approach.
- CDTI-Assisted Visual Approaches (CAVS) are another improvement on the visual approach. The flight crew identifies the traffic on the CDTI, then looks out the window to follow the traffic. This application may allow pilots to *temporarily* lose visual contact with another aircraft, regain contact with the help of the CDTI, and continue the approach to landing.

Another application involves the airport surface:

- Airport Surface Situational Awareness / Final Approach and Runway Occupancy Awareness (ASSA/FAROA) will enhance flight crew situational awareness of runway occupancy during landing, taxi, and takeoff by displaying ADS-B targets on the aircraft's CDTI. Pilots will have a moving map of the airport depicting the position of other aircraft. This application requires a high level of GPS/ADS-B accuracy to discriminate between aircraft on taxiways and those on adjacent runways.

Still another application involves all phases of flight:

- Conflict Detection (CD) is an ADS-B application that will make pilots aware of potential impending encounters with other aircraft, special-use airspace, and hazardous weather. The CD bubble will serve as a backup for ATC separation. ALPA policy calls for this bubble to be large enough to not conflict with TCAS TAs and RAs.



Cockpit Display of Traffic Information (CDTI) being used in the UPS B-757 fleet shows company traffic equipped with ADS-B.

while still under ATC separation. The goals of FDMS are to reduce controller transmissions, radio congestion, controller workload, and even fuel consumption and noise.

FDMS will increase ATC sector capacity: Ground computers using ADS-B information set their spacing from other aircraft during a continuous descent arrival (CDA)—i.e., the pilots reduce thrust to almost idle at cruise altitude and do not power up again until stabilizing on the final approach fix. The resultant reduction in low-altitude vectoring will lower fuel consumption, reduce noise, increase airport capacity, and offer a more expeditious approach to the runway.

With FDMS, the flight crew will follow the traffic ahead, maintaining a specified spacing in time. Two minutes, for example, equates to 16 nm spacing at a groundspeed of 480 knots. The in-trail spacing distance will decrease as the speeds of two aircraft decrease during descent, but the time behind the traffic to follow will remain constant. That's important because runway throughput (efficiency) is based on time intervals; and in this example, the 2 minutes equates to approximately the required wake separation (4 nm) for a heavy behind a heavy.

You might ask, "How do I maintain two-minute spacing on traffic? I can't see two minutes on my cockpit displays!"

Through a Class 3 electronic flight bag (EFB), the FDMS application hooks up ADS-B to provide pilots with commanded speeds that are displayed with traffic range and closure rate on an Airspeed Guidance Display (AGD). Flying these commanded speeds will maintain a 2-minute interval while the distance continues to decrease, but the distance is always greater than ATC separation minima.

How Brown gets down

This may sound like science fiction, but it's taking place today. The FAA is demonstrating FDMS procedures at Louisville Standiford International Airport (SDF) in Kentucky, us-

ALPA to FAA: Yes, Deploy ADS-B, But Increase Your Speed

In early March, ALPA submitted its response to a notice of proposed rulemaking (NPRM) that the FAA had issued for public comment regarding the agency's plans to implement ADS-B.

ALPA said it supports the FAA's plan to introduce ADS-B because the Association believes the system "will increase capacity and enhance safety through improved surveillance in the National Airspace System (NAS).... ADS-B is a cornerstone technology for NextGen. Therefore, it is critical that the FAA meets its commitments to deploy the ground infrastructure by 2013."

ALPA also agrees with the statement in the NPRM that ADS-B will enable "applications such as aircraft merging and spacing, and self-separation." In these applications, pilots will detect and identify other aircraft on the same air-to-air datalink without needing to use a link to the ground. Thus, as the FAA has said, the NextGen will be an "aircraft-centric" system that will "vastly improve [flight crews'] situational awareness. To achieve these benefits, however, all of the aircraft in a given volume of airspace will have to be using a common datalink."

Moreover, ALPA cautioned, "full realization of increased capacity and enhanced safety" cannot be obtained until the FAA mandates that aircraft be equipped with ADS-B In (information received by the aircraft on other aircraft positions) "for operations at designated locations, routes, and altitudes." The FAA must include a requirement for ADS-B In and a schedule for implementing this important technology as part of the final ADS-B rule.

Before the FAA issued the NPRM, ALPA said, very few airlines had invested in ADS-B Out (the aircraft broadcasting its own position and other data).

A significant factor in most airlines choosing not to invest in ADS-B Out was that a business case could not be made while the NAS was populated with a mixed fleet of aircraft, only some of which were equipped with ADS-B, the Association pointed out.

"Until all aircraft are equipped, the capacity benefits of ADS-B Out will not be realized," ALPA asserted.

Many of the applications planned for ADS-B on or near airports will need the high standards of accuracy and integrity already set by government/industry groups in which ALPA has been and continues to be actively involved.

ALPA also supports the NPRM's stated intent to maintain current transponder requirements. The FAA plans to continue to use secondary surveillance radar (i.e., Mode A, C, and S transponders) as the backup to ADS-B.

Moreover, the Traffic Alert and Collision Avoidance System (TCAS), "which is critical to collision avoidance in the NAS and worldwide," ALPA emphasized, "requires altitude-encoding transponders (Mode A/C or Mode S) in its independent solution to alert to potential collisions and the resolution maneuvers required to prevent these collisions. TCAS is a tried-and-trusted safety tool that must not be compromised."

The FAA has declared that it will finish installing the ADS-B ground infrastructure by the end of fiscal year 2013. However, the NPRM proposes to not mandate ADS-B on aircraft until Jan. 1, 2020; ALPA said that deadline is too distant.

Finally, the NPRM proposes requiring ADS-B only for aircraft operating at or above FL240. ALPA believes the equipment mandate should extend down to FL180, the floor of U.S. Class A ("positive control") airspace.

ing UPS as the demonstration airline. Air traffic controllers sequence the UPS arrival bank from the U.S. West Coast for CDAs, and UPS is achieving significant operational benefits as a result.

The UPS Air Operations Center gives pilots of enroute airplanes their sequence via ACARS in combination with the Airline-Based Sequencing System (ABESS). When the airplane is within range of the ADS-B ground receivers, the onboard systems begin supplying speed commands to establish 2-minute spacing.

ALPA representatives flew an FDMS simulation at MITRE Corporation in Northern Virginia January 2007 and the UPS FDMS simulator in Louisville in the fall of 2007. Our first impression was very favorable—this is a tool that line pilots can use.

The flight crew makes the transition approach with minimal radio transmissions. The CDTI helps the flight crew maintain situational awareness throughout the approach—no guessing which airplane you are following or the position of surrounding traffic.

If we're going to tighten up aircraft spacing in the years to come, we'll need ADS-B In *and* Out, and soon.

ALPA's ADS-B Team

Several ALPA members are actively involved in shaping the course of ADS-B development and implementation—from ALPA's NASMOD Committee, Capts. Brian Townsend (America West), chairman, and Larry Newman (Delta), vice-chairman; from ALPA's ADS-B Project Team, your author, Team leader, and Capts. Paul Nelson (Comair) and Rip Torn (Delta); Capt. Ana Vegega (United), ALPA TCAS Project Team leader; and First Officer Jim Duke (United), director of ALPA's Future Communication, Navigation, and Surveillance Initiatives.

Duke contributes a tremendous amount of knowledge and expertise to the NASMOD Committee and specifically to the ADS-B Team. While employed as an ALPA staff engineer during his furlough from United, Duke was submerged in all aspects of ADS-B and the projects surrounding this technology. He continues to serve ALPA 's members as a pilot safety representative.

Providing primary staff support for these line pilots are ALPA Engineering and Air Safety Department staff members Mark Cato, senior staff engineer; Russ Gold, staff engineer; and Mark Reed, staff engineer. ADS-B is one of many projects and activities these ALPA staff members support.