



The most restrictive ADS-B OUT mandate in the world takes effect in U.S. airspace after midnight on Dec. 31, 2019, and installation centers, STC developers and equipment manufacturers are scrambling to help aircraft owners and operators meet the deadline. The mandate means that any aircraft inadequately equipped to be flown in U.S. airspace where a transponder is required will be grounded on Jan. 1, 2020.

The mandate for ADS-B OUT (automatic dependent surveillance-broadcast) is part of the FAA's NextGen transformation of the National Airspace System and also global ADS-B implementation. ADS-B OUT takes onboard and highly accurate GPS information and transmits it to ground-based monitoring stations and other aircraft to provide a far more accurate display of aircraft location to both air traffic controllers and other

aircraft equipped to receive traffic information via ADS-B IN technology.

Other NextGen capabilities that will affect business aviation operators include future air navigation system (Fans), for automatic provision of position information and text-type messaging with ATC during oceanic operations; controller-pilot datalink communications (CPDLC or Link 2000+ in Europe), the messaging capability alone, which is already being implemented at some U.S. airports for pre-departure clearances but isn't mandatory except for European airspace above FL285 after February 2020; performance-based navigation (PBN) required navigation performance (RNP) approaches, currently available but mostly being flown by airlines; and Tcas II Change 7.1 software, required in Europe beginning Dec. 1, 2015, but available to any operator. (See chart for upcoming mandates, right.)

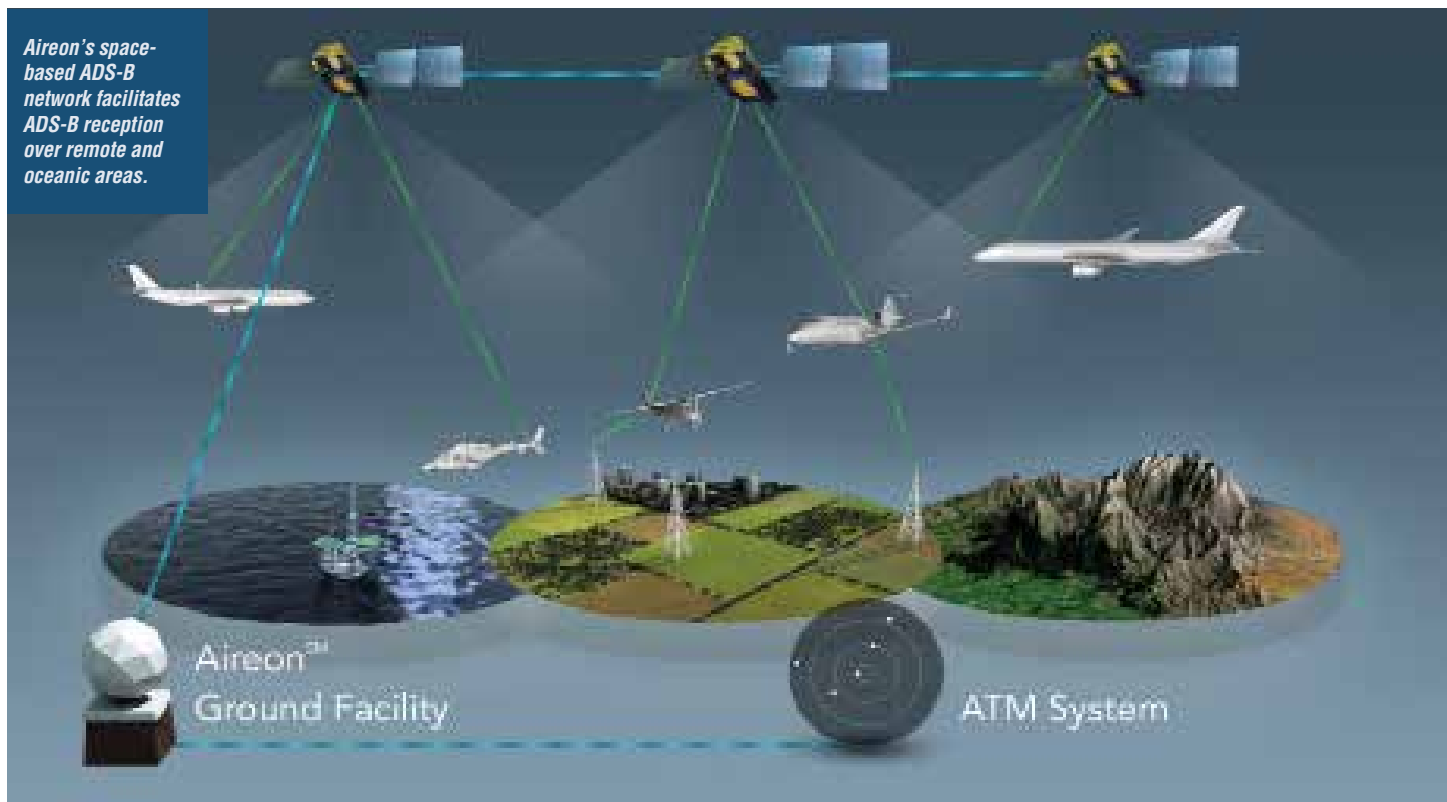
For business aircraft operators, there are a few ways to approach the upcoming NextGen mandates. In many cases, upgrading to the latest version of Fans (Fans 1/A+) makes ADS-B OUT compliance much easier. This is because ADS-B requires an accurate position source (generally equivalent to SBAS or Waas GPS), and once that is installed as part of a Fans upgrade and coupled to an ADS-B-OUT-compliant transponder and required indicators, the ADS-B requirement is met.

An important consideration for ADS-B compliance is that owners/operators should plan on meeting the latest RTCA standard. Some early ADS-B upgrades were to the DO-260A standard, but DO-260B is now applicable, and any DO-260A systems must be upgraded to the -B configuration. While some regions of the world still accept DO-260A, the U.S. and Europe mandates require DO-260B. Generally, the current Australian and other Asia-Pacific ADS-B OUT requirements start above FL290. Canada's Hudson Bay region inclusive of FL350-FL400 offers direct routing for ADS-B-equipped aircraft; while not mandatory, it is an example of preferential

NextGen Mandates	Retrofit deadline	New-aircraft deadline
ADS-B OUT U.S.	Jan. 1, 2020	Jan. 1, 2020
ADS-B OUT EASA (12,500+-pound mtow or true airspeed 250kt+)	June 8, 2020	June 8, 2016
ADS-B OUT Australia, Hong Kong, Singapore, Vietnam above FL290	In effect (Australia Feb. 4, 2016 for certain airspace; Feb. 2, 2017, all IFR ops)	In effect
Fans (all North Atlantic Organized Track System FL350-FL390)	In effect	In effect
Fans (all North Atlantic Tracks MNPS airspace FL350-FL390 inclusive)	Dec. 7, 2017	Dec. 7, 2017
Fans (all North Atlantic airspace FL290 and above)	Jan. 30, 2020	Jan. 30, 2020
Link 2000+ (CPDLC) (EASA, above FL285)	Feb. 5, 2020	Feb. 5, 2020
Tcas II Change 7.1 (EASA)	In effect	In effect

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Aireon's space-based ADS-B network facilitates ADS-B reception over remote and oceanic areas.



treatment for better equipment.

For ADS-B, this article focuses primarily on the needs of business aircraft, which fly above the 18,000-foot threshold in the U.S. that separates two ADS-B OUT standards. Above 18,000 feet, aircraft are required to have ADS-B OUT broadcasting on 1090 MHz (also known as 1090ES or extended squitter). Below 18,000 feet, aircraft can be equipped with 978 MHz ADS-B OUT systems (also known as 978 UAT or Universal Access Transceiver). This two-frequency ADS-B OUT setup is applicable only in the U.S. All other countries will use 1090ES exclusively.

Another wrinkle in this potentially confusing situation is that in the U.S., the FAA has created a system for aircraft equipped with ADS-B IN receivers to view traffic and weather data on compatible cockpit displays, EFBs or mobile devices. ADS-B IN features include traffic information services-broadcast (TIS-B) and flight information services-broadcast (FIS-B). These free services are delivered via 978UAT and only in the U.S., but reception is available within line-of-sight range of ADS-B ground

stations and works to fairly high altitudes.

Many business aircraft operators take advantage of ADS-B IN using inexpensive receivers that connect wirelessly to mobile devices. Avionics manufacturers are also offering permanently installed ADS-B IN receivers connected to cockpit displays. Garmin, Honeywell and Rockwell Collins, for example, have developed airborne and ground-based traffic displays using ADS-B IN. Like Rockwell Collins and Honeywell, ACSS, the Thales/L-3 Aviation joint venture, has developed software that extends ADS-B IN capabilities even further, with applications such as merging and spacing, in-trail procedures and more.

In the U.S. where ADS-B OUT surveillance is being implemented, the system works via ground stations that receive the 1090ES or 978UAT broadcast from equipped aircraft, then forwards the data to air traffic controllers, or bounces it back into the ether for other aircraft to receive via ADS-B IN. ADS-B IN-equipped aircraft can also receive ADS-B OUT signals directly from other aircraft, either 978UAT or 1090ES only (single-band) or both (dual-band).

ADS-B suffers from zero coverage over oceanic and remote areas, that is, until a company called Aireon (not to be confused with supersonic bizjet developer Aerion) started installing ADS-B receivers on low-Earth-orbit Iridium satellites. With the correct antenna installed on top of the aircraft and a 1090ES transponder with a minimum output of 125 watts, now ADS-B reception can be available anywhere in the world.

OEMs

For owners and operators of newer aircraft, NextGen mandates might not be much of a problem. Most new business aircraft now come equipped for DO-260B ADS-B OUT, and for jets that will fly outside the U.S., Fans is usually an option. If the added cost is not a factor, choosing Fans at the time of purchase will not only make the airplane more useful for international travel but also preserve its value better when it comes time to sell.

Business aircraft that are older and not first in line for factory upgrade programs will have to be modified by aftermarket

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repair stations, and fortunately there are quite a few options.

Bombardier

Similar to other OEMs, Bombardier has developed service bulletin upgrades for ADS-B OUT on in-production and recent models and is working with aftermarket providers for older Challengers and Learjets.

The pre-Vision flight deck Global 5000 and Global Express and XRS have had a DO-260B ADS-B OUT service bulletin since July 2013. Vision flight decks not already equipped will have a service bulletin early this year. New Vision Globals are already equipped with ADS-B, Fans and CPDLC as standard.

An ADS-B OUT service bulletin for the Challenger 300/350 will be available in 2016. The Challenger 605 service bulletin was released at the end of last year.

Learjet 70/75s are already ADS-B OUT equipped, thanks to their Garmin G5000

avionics. The Learjet 40/45 has had a service bulletin solution since 2013, and one will be available for the Learjet 60 this year.

For older Learjets, Bombardier has partnered with Butler National and Peregrine to serve ADS-B OUT customers.

A Fans and CPDLC service bulletin is available for Challenger 300 customers, who can also upgrade their cockpits to the Challenger 350 configuration, which also offers Fans and CPDLC. The Challenger 605 bulletin was available at the end of last year, while the Challenger 604 upgrade will be out in the first half of this year. Challenger 650 owners have the option of adding Fans/CPDLC during the purchase process. All new Globals, which have the Vision flight deck, have Fans/CPDLC as baseline equipment. Non-Vision Globals have had a service bulletin upgrade since 2012. The Learjet 40/45s have had CPDLC mods available since 2006, and 60XR and 70/75 customers have had this as an option.

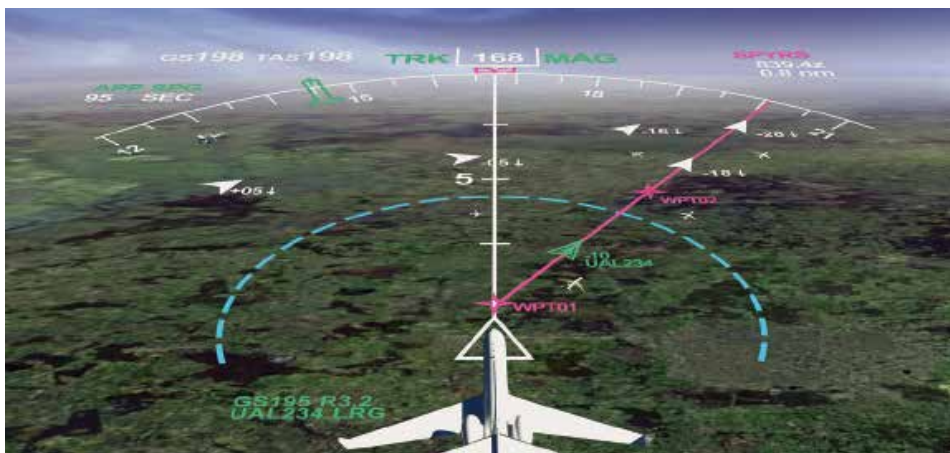
For older Bombardier models, the

company is working with partners that will offer Fans, although there has been “little demand” for it on the Learjet 31, 35 and 55 and Challenger 600/601, according to Bombardier.

“This is the biggest change of the airspace system since the advent of VORs,” said Andy Nureddin, Bombardier vice president and general manager of customer services. “We have been very emphatic with our customers, at every M&O session and gathering, to show the roadmap front and center. We’ve developed tools to help with budgeting and cost estimates, and came up with advisory wires that show in a single document what is Fans, why do I need it and when. It guides you through, ‘if you have this avionics suite, here is what you need.’”

To help operators through the maze of upgrades, Bombardier has created an options tool for each platform, which shows in spreadsheet format what added avionics are needed for each NextGen

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Rockwell Collins is implementing ADS-B in features, which show details about other traffic as well as employ functions such as in-trail procedures.



upgrade. Bombardier's service centers use this spreadsheet to help owners understand what is needed so they can make a business case for the upgrades with their companies. "We've made it fairly easy," he said. "We're relieving anxiety by making the answers readily available."

Bombardier is aware that the cost of some NextGen upgrades is hard to swallow for older jets that have relatively low values, and Nureddin said the company does welcome queries from owners of legacy jets, and there is no charge for responding to such inquiries. "We're just as committed to the out-of-production customer," he said. "The guy who operates a Lear 35 today is a poster child for buying a new 75. In a lot of cases, we've worked with some STC houses to facilitate a solution that makes sense."

Dassault Falcon

Dassault Falcon has developed STCs and service bulletins to help customers

meet NextGen mandates. The upgrades are available in five flavors: ADS-B, Waas GPS, LPV (for precision GPS approaches), Fans 1/A+ and ATN-B1 (same as CPDLC or Link 2000+). The latter is currently available only for recent models—the 900EX and 2000EX EASy and 7X—and these aircraft also are easiest to upgrade to all of the available NextGen capabilities, via service bulletins.

For the Falcon 900A/B and 900C/EX, STCs are available for all of the upgrades, but the 900A/B currently have a DO-260A transponder upgrade. According to a Falcon spokesman, the DO-260B upgrade should be available early this year. The same is true of the Falcon 2000 with Rockwell Collins Pro Line 4 avionics. That model's STCs are complete for Waas GPS and LPV, but Fans won't be available until this year's first quarter.

The Falcon 50 and 50EX have a fully rule-compliant DO-260B ADS-B OUT STC plus Waas GPS and LPV capability, and Fans will be added in the first quarter this year.

Embraer

Embraer is offering ADS-B OUT, CPDLC and other NextGen enhancements for all of its business jets, from the Phenom 100 through the Lineage 1000.

As a relatively recent entrant into the business jet market, Embraer enjoys an advantage when it comes to NextGen solutions, because avionics in even its oldest jets are relatively modern and easier to upgrade. The company's latest jets already

include ADS-B OUT, and other NextGen upgrades are available as options.

Gulfstream

Gulfstream was a relatively early adopter for ADS-B OUT, so some of its Aircraft Service Changes (ASCs) are to the DO-260A standard, but those early offerings are being upgraded to DO-260B. The GIV and GV DO-260B upgrade from earlier DO-260A will be available in this year's second quarter and is now available via ASC for the G450, G550 and G650.

Fans 1/A+ including CPDLC is standard on the G650, and available on the other models.

Tcas II version 7.1 is also standard on the G650 and available on the other models.

For midsize Gulfstreams, a G100 DO-260B ADS-B OUT program is under evaluation and available on the G150, G200 and G280. CPDLC is under evaluation for the G100, G150 and G200 and standard on the G280 (or retrofittable for early models).

Tcas II version 7.1 is standard on the G280 and available on the G150 and G200. A solution is in the works for the G100.

Textron Aviation

Textron Aviation's Cessna and Beechcraft brands have delivered an enormous number of airplanes, and bringing these all up to modern NextGen standards is a huge job. In some cases, ADS-B OUT upgrades will be available from aftermarket providers, and if Textron Aviation isn't developing its own service bulletin, Citation sales or customer service representatives will help customers find a fix.

Current production Citations are mostly all taken care of with regard to ADS-B OUT. The only Citation waiting for its upgrade is the Mustang, which is expected to have a service bulletin in the second quarter this year.

Out-of-production Citations will be upgraded as follows:

- CitationJet SPZ-5000 and G1000: to be determined.
- CJ1, CJ2 Pro Line 21: aftermarket STC

(contact sales or service representative).

- CJ1+, CJ2+, CJ3 Pro Line 21: Textron Zurich EASA STC available; service bulletin in the works.
- Bravo Primus 1000: to be determined (Cessna evaluating potential solutions).
- Ultra, Encore, Excel, XLS Primus 1000, Encore+ Pro Line 21: Q4 2015.
- Sovereign Primus Epic: 1Q/16
- Citation X Primus 2000: by end of last year.

For other older Citations, the aftermarket is going to be the sole solution. According to Textron Aviation, "Cessna does not currently have specific plans for other out-of-production models not shown in the table above. We will evaluate potential solutions for such models as we are able. It may be impractical for Cessna to develop ADS-B solutions for some models."

On the Beechcraft side, current production and older King Airs equipped with Pro Line 21 avionics all had ADS-B service bulletins available in the third quarter of last year. The Pro Line 21-equipped Premier I is in "to be determined" status, while the IA upgrade will be available in this year's second quarter. The Beechjet 400A/Hawker 400XP with Pro Line 4 will also be available in the second quarter of 2016. The Hawker 750 through 900XP models with Pro Line 21 all had service bulletin upgrades available in the fourth quarter last year. There was no mention of the Hawker 4000.

CPDLC upgrades for Citations and Beechcraft models are on hold. According to Textron Aviation, "In light of [problems implementing Link 2000+ in Europe], Cessna, Hawker and Beechcraft are ceasing development of Link 2000+ installations at the present time, as it does not serve our customers' interests to encourage installing a system that is not fully functional (because of provider aborts) and which has an uncertain future. This does not imply that we will permanently cease efforts on Link 2000+ altogether, but it does mean that we will pace our development efforts appropriately to match forthcoming schedules and technical requirements, which are currently in transition."

While new Citations with G3000/G5000 avionics have a Link 2000+ option, Textron Aviation isn't advocating its selection yet. "Cessna may continue to offer the system on these aircraft for the foreseeable future, but operators need to understand that provider aborts may occur with their use in Europe. For this reason, Cessna advises user discretion in using Link 2000+ systems at this point, assuming use of the current system continues in some areas of Europe."

"Customers ordering new Cessna or Beech aircraft who want to be as prepared as possible regarding future Link 2000+ deadlines may consider equipping their aircraft with the appropriate VHF datalink transceiver option. It is important to understand, however, that future CPDLC requirements could drive hardware changes to existing equipment."

Fans should be available this year as an option for G5000-equipped Citations (Sovereign+, X+ and Latitude). The company will consider making Fans upgrades available for other types. "However, the cost versus benefit for aircraft that do not regularly traverse the North Atlantic may not warrant extensive Fans development efforts, given the prospect of continued availability of far northerly routes located outside the affected NAT OTS region [north of 80 degrees north latitude]."

Aftermarket Upgrades - Avionics Manufacturers

Avionics manufacturers are busy not only making equipment for NextGen mandates but also working closely with OEMs and aftermarket service providers to develop and certify upgrades to meet the mandates.

Appareo Systems

Appareo Systems has introduced a new ADS-B OUT solution, the Stratus ESG 1090 extended squitter system. The unit includes an approved Waas GPS and transponder, and it is panel-mounted. The Stratus ESG package, including the transponder, GPS antenna and installation kit, will cost \$3,490. A unique feature of the Stratus ESG is integration with Appareo's Stratus ADS-B portable

receivers and the ForeFlight Mobile iPad app. According to Appareo, for typical piston aircraft, Stratus ESG will require about half the installation time of a remote-mounted 978UAT receiver, yielding a reduction in overall cost.

Aspen Avionics

Aspen's Evolution cockpit displays can be integrated with the L-3 Lynx NGT-9000 dual-band transceiver/transponder. Aspen also offers the ATX100/100G (978UAT OUT and IN, with or without GPS position source) and ATX200/200G (978UAT OUT, 1090ES and 978UAT IN, with or without GPS position source).

Avidyne

Avidyne's ADS-B solutions are designed primarily for customers with Avidyne displays installed. Equipment includes the AXP340 panel-mounted and AXP322 remote-mounted mode-S transponders for 1090ES ADS-B OUT. For the position source, Avidyne's IFD440/540 navigators can be interfaced with those transponders for full ADS-B OUT. ADS-B IN is also available, using the Avidyne MLX200/210 receiver.

FreeFlight Systems

"Our focus is to be able to provide solutions to a wide variety [of operators]," said Pete Ring, director of sales and marketing at FreeFlight Systems. The company's ADS-B products offer some of the lowest-cost ADS-B OUT-compliant systems for light aircraft owners, and a variety of ADS-B IN and ADS-B OUT products for any jet up to a Boeing 747.

"We are quite excited about the turboprop and lighter business jet market," said Tim Taylor, CEO. "We see some gaps in the landscape for easy-to-install, integrated and affordable but flexible 1090ES ADS-B OUT with the added benefits of ADS-B IN."

FreeFlight is hearing from customers with older aircraft who can't afford some of the more costly service bulletins or STCs from OEMs or other available options. The owner of a Premier, he said, was preparing to get rid of it. The hull value of the airplane just isn't that

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The Garmin ADS-B solution for the Learjet 60 can include ADS-B IN with installation of the Flight Stream 210.

high, and the cost of the ADS-B equipment—\$250,000—was a significant portion of the hull value. “He couldn’t make the math work,” Taylor said.

But FreeFlight was able to offer this owner a fix that will be available under an STC by a FreeFlight dealer, at a significantly lower cost. The kit includes a FreeFlight stand-alone position source coupled to the existing transponder, which needed to be upgraded, and installation of a new antenna. The equipment cost is about \$14,000, plus 40 hours of labor and the transponder upgrade.

For light aircraft owners, the lowest-cost ADS-B OUT from FreeFlight includes the Rangr Lite with built-in GPS source at \$1,995. Add a typical installation time of 12 to 20 hours, and an owner can be mandate legal for about \$3,200. But most buyers appreciate the benefits of ADS-B IN, and for another \$1,000 can add that capability, for display on a mobile device.

Garmin

Many Garmin avionics owners are facing a simple software and possibly hardware upgrade for G1000 glass cockpit ADS-B OUT upgrades. But for aircraft without a reasonably priced solution, especially older business jets, Garmin offers a relatively simple upgrade. Buyers

can opt for a Garmin 1090ES transponder if theirs isn’t upgradeable, but once the transponder meets the mandate requirements, simply adding a Garmin GDL 88, with its included Waas GPS, provides a relatively simple ADS-B OUT and IN upgrade.

The GDL 88 can deliver ADS-B IN information to compatible cockpit displays or to mobile devices. Garmin is working with dealers that are obtaining STCs for this package, and many are in process, including Part 25 business jets and Part 23 turboprops and jets under an approved model list (AML) STC. “That [package] minimizes downtime and cost to operate and achieves immediate benefits,” said senior business development manager Bill Stone.

Garmin also offers Fans and Link 2000+/CPDLC, but these are part of G5000 integrated cockpits and generally are options for new business jet purchases.

Garmin’s ADS-B IN package includes the TerminalTraffic feature, which displays position of ADS-B-equipped ground vehicles and aircraft on the airport environment as shown on Garmin SafeTaxi airport diagrams. Aircraft and ground vehicles are shown in colors and shapes distinct from those used for airborne traffic, and audible alerts are provided to prevent traffic conflicts. TerminalTraffic is available via

GDL88/84 ADS-B datalinks or GDL 39/39R/39D portable ADS-B receivers paired to compatible Garmin displays or mobile devices.

Honeywell

Honeywell’s Epic flight decks are already providing ADS-B IN services on Gulfstream G650s, through Honeywell’s SmartTraffic CAS 100 traffic computer. The advantage of ADS-B IN here is that while Tcas traffic is shown on the Epic displays, this traffic doesn’t have the same high position accuracy as ADS-B IN. So where ADS-B IN data is available for the same target identified on Tcas, Honeywell uses the more accurate ADS-B IN data to show pilots the position and trend vector of that traffic. Pilots can also click on the traffic target to get more information, similar to what controllers would see on their scopes. “All Epic cockpits will have this,” said Tom Dooling, Honeywell senior manager of technical sales for business and general aviation.

Honeywell has also demonstrated other ADS-B IN capabilities, such as in-trail procedures, but until more large aircraft are ADS-B IN equipped and can take advantage of this capability, there won’t be an urgent push for this technology. Display of ground vehicles on airport charts is also coming, but this, too, depends on technology adoptions, specifically the addition of ADS-B OUT to airport cars, trucks, tugs and so on.

Honeywell is working closely with OEMs and repair stations to help provide ADS-B OUT upgrades, and many are now available for Epic and Primus II cockpits. There was some delay because Honeywell started on the road to DO-260A compliance, and had to catch up when the FAA switched to DO-260B. This also affected BendixKing MST-67 transponders, but Honeywell expects to obtain TSO approval of the DO-260B upgraded MST-67 in this year’s second half, according to Dooling.

A variety of options are available to bring Primus II cockpits to ADS-B OUT standards. Cockpit indicators are required for ADS-B OUT, and these can be accommodated by either updating the RM-855 radio management unit or replacing the

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old RM-850 with a new RM-855.

For Falcons with EASy II or upgrading to that configuration, ADS-B OUT, CPDLC, Sbas/Waas LPV and Fans are available options. The upgrade is offered via Falcon service bulletins.

Gulfstream's PlaneView upgrade for the G450/G550 offers optional Fans and Waas LPV, among other capabilities. For the GIV/GIV-SP, GV, G300 and G400, the PlaneDeck upgrade replaces cathode-ray tube (CRT) displays with LCDs. This is similar to the Primus Elite upgrade offered for the Falcon 900C/EX, Global Express/XRS and Primus 2000-equipped Global 5000, and it makes possible the addition of Waas LPV, ADS-B OUT and Fans.

Older jets with Primus 1000 and 2000 cockpits can be upgraded with LCDs with the Primus Epic CDS/R system, which includes Waas LPV and ADS-B OUT. The CDS/R upgrade eliminates the expense and hassle of trying to maintain older CRTs.

L-3 Aviation Products/ACSS

Aviation Communication and Surveillance Systems (ACSS), the L-3 and Thales joint venture, is urging operators to complete the Tcas II version 7.1 upgrade, which became due in Europe this past December 1. ACSS products include the Tcas II, Tcas 3000 /SP, T2cas and T3cas. "The Change 7.1 upgrade delivers important enhancements to Tcas, including reversal logic, new aural alerting for adjust vertical speed and level-off resolution advisories. A lot of operators should want this upgrade even if they don't fly to Europe," explained Shane LaPlante, vice president of aftermarket sales for ACSS and L-3 Aviation Products.

L-3 Aviation Products already serves the Part 25 market with the NXT-600 and NXT-800 ADS-B OUT transponders, but one repair station—Contact Aviation—has certified a dual installation of the new Lynx NGT-9000 transponder/ADS-B OUT/IN Multilink Surveillance System for Part 25 aircraft.

Last year, L-3 introduced the Lynx series, which includes the \$6,800 NGT-9000 (starting price; the top-of-the line NGT-9000D+ with active traffic and antenna diversity is \$11,933) as well as the remote-mounted NGT-1000, -2000 and -2500 for



The Lynx NGT-9000 by L-3 Aviation Products combines a transponder with ADS-B OUT/IN.

smaller aircraft. The -1000 through -2500 are 978UAT systems, while the NGT-9000 is 1090ES OUT and dual-band 1090ES and 978UAT IN. The NGT-1000 offers one of the lowest-priced 978UAT ADS-B solutions, and is priced below \$2,000, with no ADS-B IN features. The NGT-2000 adds Wi-Fi capability for display of ADS-B IN on mobile devices. And the NGT-2500 includes an Arinc 429 and RS-232 interface to cockpit displays, so weather and traffic can be shown on compatible panel displays as well as via Wi-Fi on mobile devices.

Rockwell Collins

The DO-260B-compliant Rockwell Collins TDR-94D transponder that is installed in many business jets and turboprops is "widely available," according to Adam Evanschwartz, director of business and regional systems marketing. "We are delivering them routinely and in increasing volumes. For example, we have had multiple bulk orders from installers this quarter and are delivering on those so that they can fulfill the accelerating demand. One of our dealers recently purchased an inventory of 20 TDR-94Ds and reports that they took orders for eight installations immediately."

The number of NextGen upgrades is on the rise, he added. "We're seeing wide adoption of our recently certified Fans 1/A retrofit, we are still in a cycle of Tcas II upgrades for the European Change 7.1 compliance deadline, and ADS-B activity is by all accounts accelerating. One Rockwell Collins authorized dealer reports that its volume of ADS-B quote requests from operators has increased more than 50 percent in the past six months. Fans activity is also

picking up in line with the North Atlantic enforcement."

Rockwell Collins has all of the equipment available for NextGen upgrades for its products. And, said Evanschwartz, "There is a large and growing portfolio of STCs and OEM service bulletins available that enable aircraft applications." However, as mandate deadlines approach, he expects equipment and installation costs to increase. "This demand versus supply effect on price has occurred in virtually every historical airspace modernization program [RVSM, Tcas, ELS/EHS and so on]."

Sandia Aerospace

The new Sandia STX 360 Sentinel ADS-B IN and OUT transponder/transceiver is certified and will be available this year. The STX 360 is designed for the below-18,000-foot market, with 978UAT ADS-B-IN/OUT, but conveniently, the unit is also a mode-C transponder, so buyers with older transponders can upgrade to ADS-B and a new transponder at the same time, for a reasonable retail price of \$3,500.

The STX 360 also includes a display showing ADS-B IN Metars and traffic. Wi-Fi is built-in, too, for display of FIS-B weather and TIS-B traffic on mobile devices. Sandia also offers the STX 360 in a remote-mount version.



Trig Avionics is known for its compact series of 1090ES transponders, such as this TT22.

Trig Avionics

Trig Avionics manufactures the TT22 and TT31 1090ES transponders, which easily integrate with position sources such as Garmin's GNS and GTN series navigators to meet the ADS-B OUT mandate. Trig also manufactures its own Waas GPS, the TN70, which meets ADS-B OUT standards. The \$2,925 TT31

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is approved in 650 aircraft types, and the TT22 in 576 types. An advantage offered by the TT31 is that it installs in a Bendix-King KT76A or KT78A transponder tray, with no wiring changes and using the existing antenna.

Universal Avionics

As the time to meet NextGen mandates gets closer, industry experts worry that service centers will run out of capacity to handle the influx of work. To help persuade owners and operators, Universal Avionics is offering discounts on ADS-B programs. These range from \$13,000 to \$19,000 off for single-FMS and transponder systems to \$26,000 to \$38,000 discounts on dual-FMS and transponder packages, according to Carey Miller, manager of business development U.S. for Universal Avionics. "We're finally starting to see an uptick with these," he said. "[Discounts] are good through the middle of this year. We're pricing our solutions aggressively now to give benefit to early adopters."

For operators considering a Fans upgrade, updating a Universal FMS or equipping with one makes ADS-B OUT upgrading a simple process, because the FMS provides the compliant position source. Universal has also worked closely with Rockwell Collins to package the TDR-94D transponder with the Universal FMS. The modern FMS also enables Waas LPV and PBN RNP approach capability. "There will be a lot of benefits there," he said.



Universal Avionics FMSs and the UniLink CMU are popular options for Fans upgrades.

In March this year, Universal Avionics will release its CPDLC/Link 2000+ upgrade, which uses the Universal Waas FMS and UniLink communications management unit, the same setup as for Fans. Those aircraft already upgraded with Universal Fans will be able make a simple upgrade to CPDLC/Link 2000+. And this will benefit operators that want to take advantage of DataComm in the U.S., which is already available at some airports for pre-departure clearances (but is not mandatory).

Aftermarket Upgrades - Service Centers

Much of the work to modify all the aircraft that need to become NextGen compliant will be done by avionics shops and maintenance centers, as well as OEM factory service centers. The big push is for ADS-B OUT compliance for U.S.-based aircraft, and the mandate applies basically to any aircraft that will fly in airspace where a transponder is required on Jan. 1, 2020.

About 165,000 of the 200,000 aircraft in the general aviation fleet are currently transponder equipped, according to Jens Hennig, vice president of operations at the General Aviation Manufacturers Association. The current rate of ADS-B installations has reached 1,000 per month, with 48 months to go until the deadline. "The rate is slowly increasing," he said, from what was not too recently 400 to 500 per month. The current projection from the FAA is that 120,000 aircraft will be compliant by 2020.

There are about 18,684 business jets and turboprops in the U.S., according to Universal Avionics business development manager Carey Miller. He looked at the rate of RVSM installations to try to calculate the likelihood that the industry can upgrade all those airplanes to ADS-B in time for the 2020 mandate. RVSM installations, roughly the same complexity as ADS-B, averaged about 180 per month. By that measure, business aircraft ADS-B installations should have started in April 2011. This means that not all of those airplanes will make the deadline. "There is a big tidal wave of these aircraft coming," he said.

There might be owners who will decide that they don't plan to keep their aircraft past the 2020 deadline, but not complying with the ADS-B mandate could make the aircraft harder to sell. "Lack of NextGen technology has no choice but to affect the value of the airplane," said AEA vice president of government and industry affairs Ric Peri.

All the industry experts agree that the FAA is not going to extend the 2020 deadline for general aviation aircraft. Unlike previous FAA programs where the agency lacked the infrastructure to support a new technology and ended up extending deadlines, Peri pointed out, for ADS-B "the ground infrastructure is in place, ATC has transitioned [to the new technology] and we're on schedule to meet the deadline. The FAA is doing everything it can to minimize the impact of certification and installation."

One important message for any aircraft owner or operator is that even if they haven't selected a particular ADS-B solution or one isn't available yet, they should schedule a slot at the avionics shop or service center right away. "Talk to your shop and get it scheduled," Peri said. "You don't want to put it off until 2019 and not have a slot to get the work done."

Chicago Jet

Chicago Jet has pioneered Fans STCs for business jets and holds approvals for the Falcon 50/50EX and 900B/C/EX, GIV/GIV-SP and G300, G100/150 and Astra. The company has already done installations on and is waiting for FAA approval for the Falcon 2000/2000EX, GII/GIII and GV and Challenger 600 and 601. The company's Fans upgrades use Iridium satcom systems.

For standalone ADS-B upgrades, Chicago Jet is using STCs developed by Dan Buzz & Associates, using Garmin transponders and datalink units with built-in GPS sensors or the Universal Avionics Sbas FMS.

Chicago Jet is also working with Banyan Air Service to get Chicago Jet STCs approved for Latin American operators. "That's going to benefit Banyan and service their customer base they already have

established,” said Chicago Jet director of operations Mike Mitera.

Prices for Fans upgrades start at about \$100,000 if the aircraft is already satcom equipped, and if satcom needs to be added the cost can climb to about \$425,000. Each airplane’s avionics status has to be evaluated to see what needs to be done. “There is no such thing as Fans in a box, take it home and plug it onto the airplane,” said Mitera.

Chicago Jet is also developing an upgrade to modify the Falcon 50 and 900 with the Universal Avionics InSight integrated cockpit, with Safe Flight auto-throttles. This will include Fans, ADS-B and PBN RNP approach capability.

Clay Lacy Aviation

Clay Lacy Aviation’s avionics shop has certified a Fans package for the GIV/GIV-SP and is developing a Fans STC for the GV. The company has developed a Fans STC for the Challenger 601-3A/3R. The STCs add a third FMS, a Universal Avionics Sbas unit, which also can act as the position source for ADS-B OUT. Also included is Universal’s UL-801 communications management unit and CVR-120A cockpit voice recorder for storing Fans messages. For customers asking about standalone ADS-B OUT, director of avionics Jim Lauer recommends the Fans STC as it is easy to include ADS-B OUT when upgrading to Fans, and these airplanes typically fly to Europe, so Fans will be required soon.

Basic cost of Fans for the Gulfstreams is about \$216,000, “in a well qualified aircraft,” said Lauer. Adding ADS-B OUT can range from \$20,000 to \$40,000, depending on the dash numbers of the transponders and what is needed to bring them up to the ADS-B standard.

Clay Lacy is sharing its STCs with other qualified Universal Avionics dealers. While many of these shops are quoting upgrades to their customers, he said, “People aren’t rushing to the door now because they don’t feel the pressure.”

CMD Flight Solutions

CMD has developed an AML STC that covers more than 5,000 aircraft, business

jets among them. The approval is for aircraft equipped with Rockwell Collins TDR-94D transponders and either the Universal Avionics Sbas FMS or Collins GPS-4000. Many installers are using the CMD STCs.

Comlux

Comlux has developed a Fans STC for the Challenger 601 and installs the CMD ADS-B STC for the 601. For the Challenger 604, Comlux is installing the Rockwell Collins Fans STC and CMD ADS-B STC. Comlux is using Bombardier service bulletins to install Fans and ADS-B IN the Challenger 605.

For all Learjets, Comlux installs the CMD ADS-B STC.

In the Boeing 737, Comlux can install Boeing service bulletins for Fans and ADS-B compliance.

Constant Aviation

Constant Aviation is already installing ADS-B OUT solutions in the Falcon 50, GV, Beechjet 400A/Hawker 400XP and Nextant 400XT/XTi, using the CMD Flight Solutions STC. Constant is also installing Embraer’s ADS-B OUT service bulletin in the Legacy 600 and Bombardier’s Fans service bulletin in Global jets.

“Our engineering team is evaluating ADS-B OUT STC solutions on a handful of additional airframe types,” according to the company. “We are in the final stages of our STC for a Fans solution on the Legacy 600, which will be the only STC available outside the OEM.”

Contact Aviation

Contact Aviation has developed a solution to add ADS-B OUT to legacy Part 25 jets, as long as they aren’t equipped with Tcas II. The package includes two L-3 Lynx NGT-9000 transponder/ADS-B OUT/IN transceivers. This package can be far less expensive than upgrading an existing transponder and adding a compliant Waas/Sbas GPS position source. Cost of the Contact package is about \$50,000 to \$60,000.

The company has long experience with ADS-B, having done its first STC in 2011 for a Part 25 jet, according to managing director John Shirk. It turns out

that the Lynx NGT-9000 meets all Part 25 certification requirements, so Contact Aviation consulted with the FAA to use basically the same approval criteria from Part 23 jet AML STCs for the NGT-9000 to develop a follow-on STC process to install the units in Part 25 jets.

“I think there is a tremendous amount of opportunity,” Shirk said. By upgrading to ADS-B with the dual NGT-9000, owners of legacy jets worth less than \$1 million can preserve the value of their airplanes at a reasonable cost.

For jets with Tcas II, a Universal Avionics FMS upgrade is the way to go, according to Shirk. A single FMS upgrade would cost about \$150,000 and dual FMS \$200,000, plus about \$50,000 for ADS-B OUT/IN using the Rockwell Collins TDR-94D transponders.

Contact Aviation is also offering PBN RNP upgrades, using Garmin GTN 650/750 navigators for Part 23 and Universal FMSs for Part 25 airplanes.

Duncan Aviation

According to Duncan Aviation regional avionics sales manager Mark Francetic, about 60 to 70 percent of the business airplanes that will need ADS-B upgrades already have an available solution. Duncan Aviation has certified many of its own, and the minimum threshold for developing an STC is 10 airplanes that need the upgrade, he said. Duncan also shares its STCs with other qualified dealers. “It’s in your best interest to do that,” he said.

Duncan Aviation is seeing ADS-B installations for its customers coming in waves, with early adopters making the upgrade and others still waiting. Some aircraft owners are still confused about what can be done to bring their aircraft up to the DO-260B standard.

“Several operators have brought a brochure at the events I do that says they can get an installation for \$2,000,” Francetic said. “It’s not meant for Part 25. There’s misinformation in the industry. These people are in the generation that will wait for the last minute and then probably are speaking loudest, saying ‘We didn’t have time.’”

Francetic is already seeing operators

scheduling ADS-B installations out to 2018. "Customers want assurances that they'll have the slot," he said. "Not only at Duncan, but also West Star, StandardAero and so on. We just won't have the capacity, and neither will anybody else. We encourage operators to get an early slot. Typically when we run into capacity issues, the price will be higher.

Operators say the longer we wait, the lower the price will go. American people are procrastinators, and if they do that, they get less choice. If we have to work shifts triple time, that doesn't come cheap. Have a plan for your airplane, and schedule it with your next inspection because it will be easier and cheaper to put in."

Among many Duncan NextGen projects are ADS-B OUT STCs for the Citation 560/560XL and Hawker 800A/800XL equipped with Honeywell Primus avionics, and these will be available in the first quarter this year. Honeywell and Duncan are working together on the STCs.

Duncan Aviation also announced the industry's first Fans/CPDLC STC for the Challenger 601 with an upgraded Honeywell NZ-2000 FMS.

FlightStar

FlightStar is expecting STC approval of its Learjet 40/45 ADS-B OUT STC in the first quarter this year, according to avionics sales manager Greg Vail. The FlightStar upgrade will cost approximately \$65,000, depending on what equipment needs replacing. The FlightStar upgrade includes a single Universal Avionics UNS-1Ew, which adds Waas LPV capability. Another option will be an STC using a standalone Honeywell Waas GPS or single or dual Waas FMSs. FlightStar is looking into other NextGen STCs for the Learjet 40/45, but hasn't identified them yet.

Jet Aviation

Jet Aviation St. Louis has received approval for a Fans/CPDLC STC for the Challenger 604. "We can complete the fully integrated Fans I/A upgrade with minimal downtime and cost, all during a scheduled or unscheduled maintenance event," said Blake Hogge, senior manager for avionics sales at Jet Aviation St. Louis.

Jet Aviation Basel holds an EASA STC for the Tcas II version 7.1 upgrade.

JetTech

JetTech was issued an STC amendment to add ADS-B capability to 500-series Citations that have been modified by JetTech with Garmin GTN 650 and 750 navigators. JetTech can install the GTN 650/750 in Citation 500s Serial Number 1 through 274 that are fitted with Bendix FGS-70 autopilots. The JetTech STC covers more than 2,000 Citation 500s, 501s, 550s, 551s, S550s and 560s, according to the company.

The ADS-B portion of the STC uses Garmin's GDL 88 dual-link transceiver, which includes ADS-B IN, plus Garmin's GTX 33ES transponder.

KaiserAir

KaiserAir has been issued an STC for Fans with a third Universal Avionics FMS on the GIV/GIV-SP and GV, plus Universal's UL-801 communications management unit and CVR-120A cockpit voice recorder, which is required to store Fans messages. "The STC also incorporates an option to upgrade the existing Collins TDR-94D transponders to the DO-260B-compliant -501 version of the TDR-94D," according to KaiserAir, which facilitates adding ADS-B OUT.

The company's next Fans/ADS-B OUT projects will be the Boeing 737-700 (BBJ) and 737-500.

Peregrine

Peregrine received approval to expand the list of aircraft covered under its STC for the Tcas II version 7.1 upgrade.

The STC, obtained in August, originally covered an update of the Bendix-King CAS 67 transponder to support Change 7.1 on the Learjet 31A, Citation 650, Hawker 800A, GIV and Challenger 601-3A/3R.

This expansion now covers the CAS 67 on other legacy Gulfstreams, Falcons, Hawkers, Challengers and Learjets.

Pentastar Aviation

Pentastar Aviation is offering an ADS-B OUT upgrade for the GIV

equipped with Rockwell Collins avionics. The upgrade costs less than \$100,000 and includes installation of a Rockwell Collins GPS-4000A position source and upgrading of the existing transponder per a Rockwell Collins service bulletin. No changes are made to the flight management system.

Spirit Aeronautics

A new STC is available from Spirit Aeronautics for Fans I/A and CPDLC in the Challenger 604 equipped with Rockwell Collins Pro Line 4 avionics. The STC uses the existing FMSs and control display units and includes a new Rockwell Collins CMU-1000 communications management unit and L-3 FA2100 cockpit voice recorder.

StandardAero

StandardAero facilities are installing ADS-B OUT upgrades using the CMD Flight Solutions STCs or OEM service bulletins for most business jets equipped with Rockwell Collins transponders, except for the Challenger 601 and Honeywell-equipped Hawker 800XP.

StandardAero also plans to be able to offer Fans installations on "most, if not all the large-cabin aircraft that we work on" by the second quarter this year. Midsize jet Fans packages will also be available, although the company isn't planning to offer them for the Hawker 800XP or Learjet 60. The Fans approvals will be from OEM service bulletins or manufacturer or other companies' STCs.

A StandardAero STC for installation of the Rockwell Collins TSS-4100 should be available in this year's first quarter. The TSS 4100 combines Tcas II and mode-S transponder into a single LRU.

TAG Aviation

TAG Aviation has developed an STC for installation of the Rockwell Collins TTR-4100 Tcas II system on the Falcon 2000/2000EX, with Falcon 900 and 50 approvals to follow shortly. The TTR-4100 enables future ADS-B IN applications and includes Tcas II version 7.1 software. □