THEORY & PRACTICE

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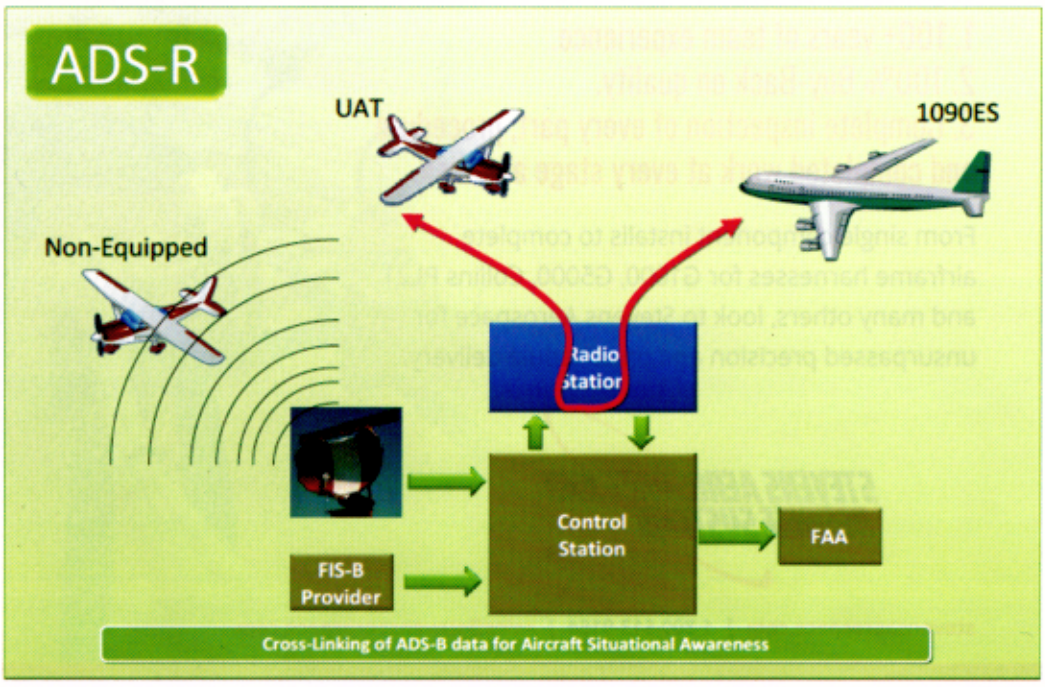
ADS (more than) B

It's the law. Automatic Dependent Surveillance Broadcast-Out is required now, everywhere transponders were required previously. There's more to this than meets the eye. In the avionics classes I teach at Pennsylvania College of Technology, I refer to it as Automatic Dependent Surveillance, or ADS, because there is more going on than the broadcast. Over the last few years during the rush to equip aircraft with the new technology, technicians in schools and in the field are learning new things.

ADS offers several advantages over transponder-based secondary surveillance radar, which relies on a transponder in the aircraft. The original transponder would respond to air traffic control interrogations with a reply of a four-digit code, and possibly, pressure altitude. In the 1990s, Mode-S transponder (S for sequential) came into being and became a requirement for some but not all aircraft. Mode-S had an advantage over the original transponder system because it could report whether or not the aircraft was airborne and if the aircraft was flying. Moreover, it could report a speed range for the aircraft. Advanced Mode-S transponders could help airliner collision avoidance systems negotiate solutions to potential collision threats. All Mode-S transponders broadcast an electronic beacon called a squitter, which would transmit once per second.

ADS takes the capabilities of the Mode-S transponder a step further. We can consider ADS a datalink. From the



When we talk of ADS-B In, we are actually describing ADS-R.

aircraft, ADS broadcasts the four-digit code, a unique identifier assigned to the aircraft, position, velocity (both vertical and horizontal), pressure altitude, whether the aircraft is on the ground or airborne, emergency status, and quality indicators.

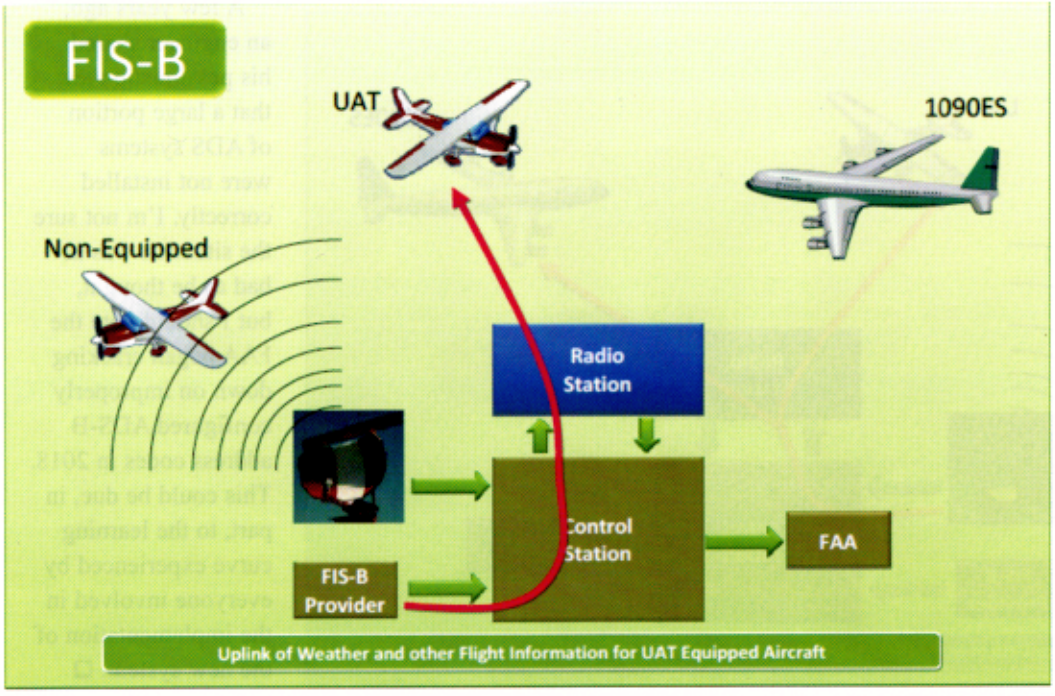
No original ATC transponder and none of the first generation of Mode-S transponders can do all of these things. One choice for compliance with the ADS-B mandate is with a Mode-S extended squitter transponder, which is also known as a 1090ES transponder. The "1090" is a reference to the frequency on which the transponder transmits.

An important difference between previous transponders and those that satisfy the ADS requirement is position reporting. For position reporting to work, the 1090ES transponder must include or be connected to a GPS receiver augmented by the wide area augmentation system. Some aircraft owners who wish to upgrade their system need to purchase a WAAS-enabled GPS along with the 1090ES transponder. Many general aviation owner/operators wanted a less-expensive compliance solution. Fortunately for owners in the United States, there is a less-expensive option, which can be used below 18,000 feet.

For aircraft in the United States, a device called a universal access transceiver, known widely as a 978 UAT, is another way to comply with the ADS mandate. Like the transponder described previously, the "978" is a reference to the frequency on which the unit transmits. Knowledgeable readers will realize this is one of the frequencies used for distance measuring equipment. Fortunately, DME and 978 UAT use different code formats. In other words, they speak completely different languages. As a result, it's unlikely the two systems could interfere with each other. Like the 1090ES transponder, the 978 UAT must include or be connected to a WAAS-enabled GPS. In addition, the 978 UAT must sense the transponder outputs. The Federal Aviation Administration requires systems to be unable to transmit conflicting data. One can imagine the confusion and danger, which would occur if the 978 UAT broadcast 1200 at 3,500 feet, while the transponder broadcast 0461 at 4,000 feet. I had a conversation with an aircraft owner who told me about a flight when he spent a considerable amount of time looking for an aircraft reported to be following him closely. As it turned out, the other aircraft was a second instance, offset, of his own data. There was no other aircraft. This story points out the importance of everything working together properly.

Overall, ADS works better than SSR. Air traffic controllers get updated information on their screens nearly five times faster than the older system. In addition, the ADS data is more precise, which enables controllers to allow air traffic to fly closer safely.

Within the United States, for air traffic control purposes, the FAA uses SSR along with ADS receivers to collect data from traditional ATC transponders, 1090ES transponders and 978 UATs. This data is provided to the air traffic controllers.



Flight Information Services-Broadcast is part of ADS-R for 978 UAT equipped aircraft.

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To take a bit of the sting out of spending money on new equipment, the FAA offered ADS-B In. This is a system that provides users of ADS-B Out data, which prior to the rule change was only available by subscribing to a service provider. Both 1090ES transponders and 978 UATs are able to receive ADS-B In, which consists of traffic information called TIS-B, and flight information called FIS-B. Pilots using moving map displays can see TIS-B data on their screens, which gives them greater awareness of nearby traffic. FIS-B provides pilots with weather information, notices to airmen, pilot reports of turbulence or weather, and information about temporary flight restrictions or special use airspace.

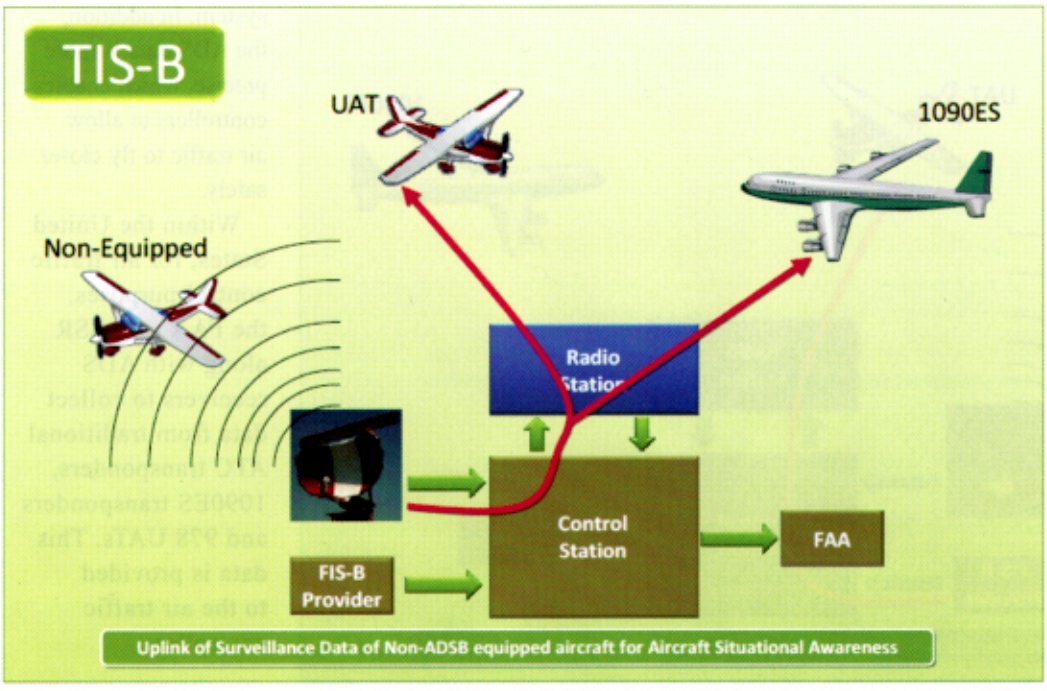
You may be wondering about the other ADS. What most people know generally as ADS-B In is officially Automatic Dependent Surveillance-Rebroadcast, or ADS-R. All the data collected from the various sources mentioned previously gets broadcast out to the 1090ES transponders and the 978 UATs. The only operators left out of this data are those without ADS-B, who in one sense are flying blind.

Everything described so far works between aircraft and ground stations or in aircraft equipped with collision avoidance systems, aircraft to aircraft. For aircraft far from air traffic control sites such as over the ocean, there is another ADS called ADS-C. The "C" in ADS-C stands for contract. A contract is the link between the ADS system in the aircraft through a satellite communication system to the air traffic controller.

Not only did we all need to learn about the proper setting of the unique identifier code for ADS-B equipment, but we also need to learn some (new to many of us) terms about navigation quality. The link between the 1090ES or the 978 UAT must be accurate and reliable. To define accuracy and reliability, there are four parameters that must be monitored. Each quality indicator uses a numbered scale to represent reliability or accuracy. Technicians will need to learn about:

- Navigation integrity category, which reports a number that indicates the radius to which position errors are contained. For example, an NIC of 11 tells us errors are contained to be within a 7.5 meter circle. In contrast, an NIC of 0 tells us the errors could be more than 20 nautical miles.
- There are two types of NIC, one for position and one for velocity. NIC_P for position must be a level 10 for ADS-B and 11 for precision approaches. NIC_V, for velocity ranges from 0 for unknown speed to 4 for speed accuracy of less than 0.3 meters per second.
- System design assurance indicates the probability an undetected fault will cause false information to be transmitted. The numbers range from 3, which is less than 1 per 10 million flight hours, down to 0, which is unknown.
- Like SDA, system integrity level also calculates odds. In this case, SIL is calculating the chances of exceeding the NIC radius and has the same number scale as SDA.

A few years ago, an engineer shared his pessimistic view that a large portion of ADS systems were not installed correctly. I'm not sure the situation was as bad as he thought, but I should note the FAA began cracking down on improperly configured ADS-B address codes in 2018. This could be due, in part, to the learning curve experienced by everyone involved in the implementation of the new system. ❑



Traffic Information Services-Broadcast is part of ADS-R for both 978 UAT and 1090 ES equipped aircraft.