The ADS-B Experience

By Stu Simpson

I really enjoy flying in the US. I try to do at least one trip south each year, preferably, two. That country's vast array of places and landscapes offer unlimited exploration opportunities. The many flights I've flown through the US with other club members have just left me wanting more.

However, new US rules have forced a change in how pilots deal with certain types of controlled airspace in that country. Basically, any US airspace that requires a Mode C transponder now requires aircraft to have an ADS-B (automatic dependent surveillance – broadcast) out system. I like to think of it simply as another type of transponder, but one that broadcasts more information than a typical Mode C device. There is also something called ADS-B in, but more on that later.

So, this new rule affects places like Spokane, Billings, and Portland, which have Class C control zones, and of course the larger Class B centers like Seattle, Minneapolis, and San Francisco. The Class B areas all have a 30 NM Mode C area, called a veil, surrounding them.

This ADS-B stuff isn't simple, but I'll try my best to make it so. Bear with me, please.

Air traffic control is concerned with ADS-B out. That means information that an airplane is transmitting <u>from</u> an ADS-B unit. Those units come in three types:

- UAT (universal access transceiver) on 978 MHz. It talks with US-based ground stations and other aircraft.
- Mode S ES (extended squitter) on 1090 MHz. It talks both to satellites and radar stations. These satellites in turn also talk to ground stations. Mode S ES also talks to other aircraft. It's used worldwide, including the US.
- Units that use both frequencies, known as dual-band systems.

Extended squitter means a regular transponder signal with some extra info about your plane, such as its ICAO type code and a unique identifier called a hex code. If you equip your plane with a Mode S transponder with that "extended squitter", you are now ADS-B out compliant anywhere in the world.

Both UAT and 1090 ES systems also transmit precise GPS position info. Thus, they each need a properly certified GPS source to provide that position information.

A huge benefit of ADS-B, both in and out, is that of traffic avoidance, which has become increasingly important to me. In the last two years, even with reduced air traffic during the pandemic, I've had five near mid-air collisions *that I know about.* This is because of increased training traffic in Alberta, as well as new IFR GPS approaches at High River, Drumheller, Olds-Didsbury, Three Hills, and other surrounding airports, not to mention other guys just flying around on beautiful days. A well-equipped ADS-B system displays traffic on a mobile device such as cell phone or tablet, or on a compatible EFIS unit.

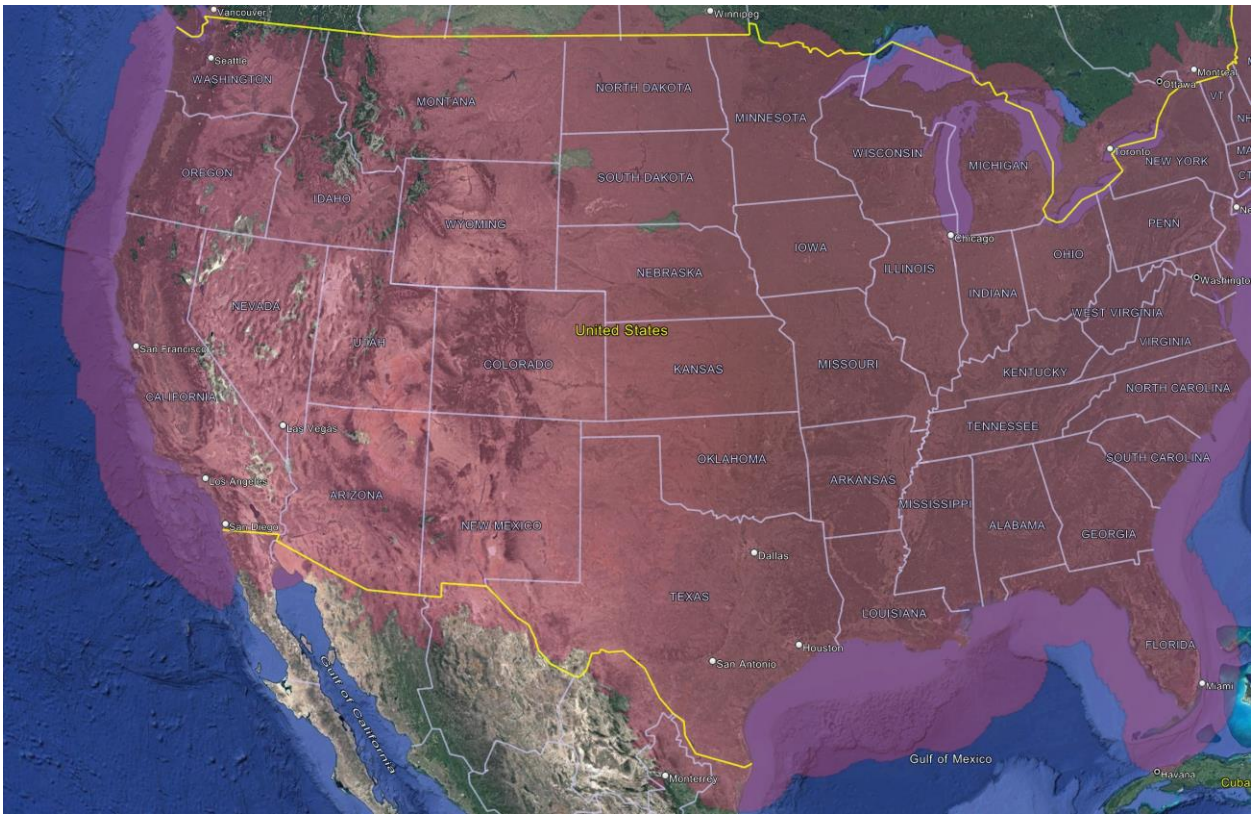
Just a word on receiver only devices. There are a number of manufacturers making what are known as ADS-B in receivers. They range in price from a couple of hundred dollars for easily user-assembled ones, up to more than a thousand dollars for some higher end units.

ADS-B in units don't transmit anything. They have a GPS receiver/processor for position data, and two other antennas, one each to pick up 978 MHz and 1090 MHz ADS-B signals. They then wifi, Bluetooth or hardwire their data to a phone, tablet or EFIS to show the receiver aircraft's location, and the position of other in-range aircraft shooting out ADS-B signals.

Remember that these receivers only detect ADS-B out signals, not regular Mode C transponder signals. Some ADS-B out systems also have this receive function, but not all of them.

Finally, there's one additional advantage to having a UAT receiver. South of the border UAT ground stations, which have vast coverage through most of the country, also broadcast METARs, TAFs, PIREPs, NOTAMs, weather radar, and more. UAT receivers can display all this data on compatible phones, tablets and EFIS systems if you select it. That doesn't happen on the 1090 MHz satellite system.

The 1090 MHz system is the one Canada is moving to for its Class C airspace, but no one knows when or how that will happen. Canada has very few Class C control zones that extend down to the ground. They're only found in places like the Lower Mainland of BC, Calgary, Edmonton, Winnipeg, and southern Ontario and Quebec.



The pink shading represents the ADS-B coverage area over the Continental US at 5000’ AGL. Courtesy of Google Earth and the US FAA.

Which Way to Go?

When I started looking into it I had the impression an ADS-B out system would cost somewhere between four and five thousand dollars. This struck me as outrageous and not really doable for my Cavalier. So, I started browsing mostly out of curiosity mixed with a sprinkle of hope that maybe something new had come along that was more affordable.

As with most new aircraft technology, there are a number of choices for equipping with ADS-B out. What I hoped for was a reasonably priced system that allows me to fly anywhere in the US. Spoiler alert here. Reasonably priced isn’t really reasonable, so I’d likely have to settle for the lowest cost option, if one existed at all. If not, I’d simply have to go commando, if you know what I mean.

I started my search at Aircraft Spruce & Specialty’s website comparing various systems, features and costs. I was quite pleasantly surprised that each product’s Q&A section turned out to be a terrific repository of knowledge and information on how these systems work, and how they work with other devices.

My options for a full ADS-B out system were these:

- A complete 1090 MHz Mode S ES transponder, plus a separate GPS receiver/processor, plus an additional ADS-B in receiver that pairs with my phone or a tablet to show traffic data. Cost $3000 - $6000.
- Either a 978 MHz UAT, or a 1090 MHz Mode S ES system from a company called Uavionix, each with a tail-mounted module and included GPS receiver/processor. Plus, I'd have to buy an additional device to control the transponder function. Then, I'd need another separate ADS-B in receiver to talk to my phone or tablet to show traffic. Cost $4400 - $6000.
- A 978 MHz Garmin UAT system that plugs in between the existing transponder and its antenna and includes a separate GPS receiver/processor. But I'd need an ADS-B in receiver to display other traffic. Cost $3000.
- A 978 MHz in & out system from Uavionix, called the EchoUAT bundle, complete with a GPS receiver/processor, and a module that also talks to my phone or tablet. It's only permitted on homebuilts & ultralights. Cost $2000 delivered on my doorstep.

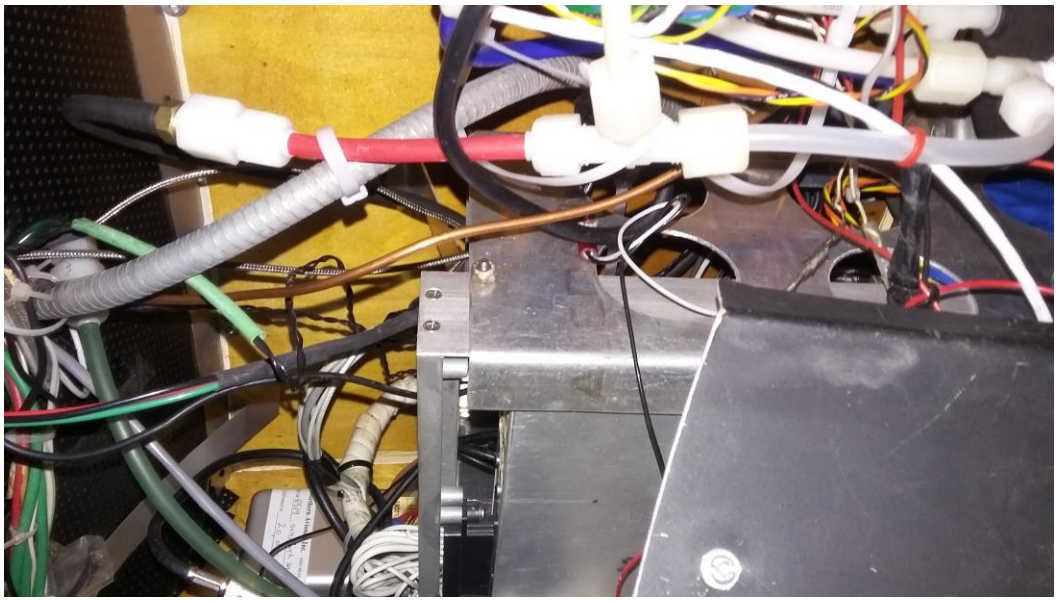
Hmmm…. $2000 isn't really reasonable, as I've said, but it is much cheaper than other options. I talked it over with my wife and decided to go ahead with it.

The Uavionix EchoUAT bundle. Each component, the so-called transcoder and the certified GPS antenna, are each about the size of a folded flip phone. Courtesy of Uavionix.

It took a month for the system to arrive, and I felt a bit guilty seeing how small it all was compared to the cost. Still, it's cheaper than a funeral if it ever helps me avoid a mid-air collision.

Installation

Make no mistake, I absolutely adore my Cavalier. But I loathe the jungle that grows behind the Cav's panel. Honestly, the only thing missing is quicksand and monkeys. I'm forever beholden to Bob Kirkby for his help with the installation. I was pretty impressed with all the remarkable calisthenics he performed while wiring up the connections that needed to be made under there. Installation on a more organized airplane would be much simpler!



Welcome to the jungle! The morass of wiring behind the Cav's panel. By Stu Simpson

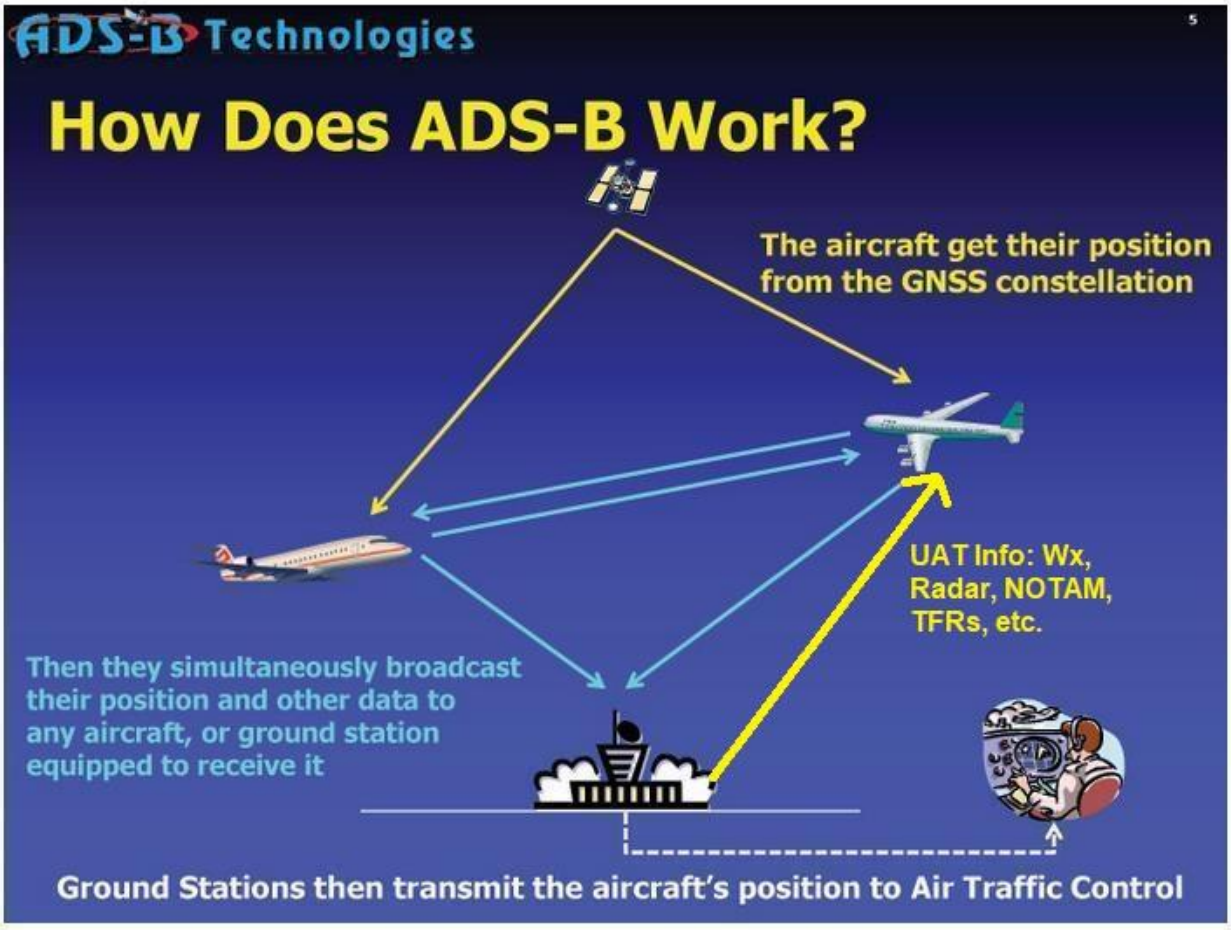
The EchoUAT's antenna mounts beneath the Cav's fuselage on a conveniently located metal access panel. Since the Cav is wood and fabric, I added some metal strips to increase the size of the antenna's ground plane. Interestingly, the antenna is identical to a normal transponder antenna. The GPS antenna/processor sits atop my panel, and the EchoUAT processor module sits on a rack behind my panel mounted Garmin 496.

Here's how the Uavionix EchoUAT system works:

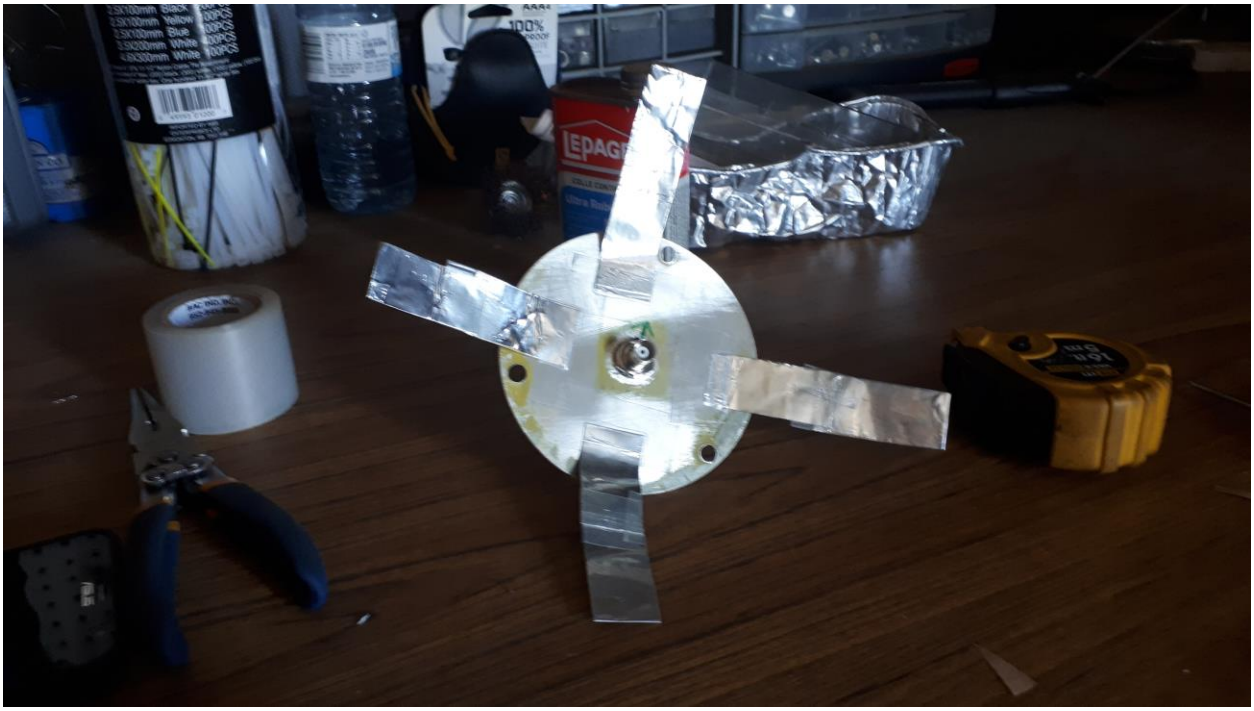
- The Cav's Mode C transponder sends out its usual signal through its antenna.
- The EchoUAT module senses that data via its own antenna.

- At the same time, the Uavionix GPS antenna and processor gets signals from space and gives very precise position data to the EchoUAT module.
- The EchoUAT combines all that data and shoots it out to ATC and other aircraft via its antenna to say, “Here’s who we are, and where we are!”
- The antenna is also busy receiving 978 MHz signals from ground stations (in the US only), plus 978 and 1090 MHz signals from aircraft with either system.
- Then the EchoUAT combines all the incoming GPS, 978, and 1090 signals, processes them, and zaps that data to my phone or tablet on wifi.
- Finally, the phone displays my position and other traffic on FltPlan.go. Other apps, like Foreflight, work, too.

Again, these systems only show traffic broadcasting on 978 MHz or with Mode S ES on 1090 MHz. I’ve tracked traffic well over 50 NM away, so range isn’t an issue.



As you can see, there's a lot going on with all these transactions. No wonder it's so complex!



The small metal access panel from the Cav's belly with foil tape used to extend the ground plane. Crude, but simple and effective. The BNC coax cable connector is part of a normal transponder antenna on the other side. By Stu Simpson

Testing

Ok, now that it was installed, how would I know if it's actually working as I described above? I followed the instructions that came with the EchoUAT and programmed in the proper parameters via a wifi connection through my phone. Then I made a local flight one morning out to Three Hills.

I was definitely picking up traffic in the area. It was pretty cool seeing things like airliners, corporate jets and smaller aircraft flying around YYC and elsewhere. I had no way of knowing, though, if my airplane was visible to others with ADS-B receivers.

Part of the testing process involves completing an ADS-B performance report with the US FAA. To do that, you need to fly within range of an ADS-B ground station. A check with the FAA's website showed where ADS-B stations are located. For us in southern Alberta, the nearest ones are a pair located east and west, respectively, of Great Falls, Montana.

The FAA has added an overlay on Google Earth that shows the various areas of their ADS-B coverage based on position and altitude. From that overlay I saw that if I was at 8500' about ten miles south of Cardston, I

should be visible to one of the towers near Great Falls, and I'd still be inside Canadian airspace.

I lit out one evening in late May for the Cardston area, and Gary Abel joined me in his RV-7. When we got close to Cardston I bumped up to 8600' and turned east to stay within the projected coverage area and not impinge on the border. My display showed that I was detecting only one ADS-B tower, albeit intermittently. I was also receiving a flurry of METAR, TAF and NOTAM data if I chose to access it. We turned back north and rode the tailwind home.

Gary Abel and his fiery red RV-7 with the Cava at Kirkby Field after an ADS-B test flight. By Stu Simpson

Later that night I entered my flight data into the FAA's automated online form and waited for my reply. Within half an hour, I received a note saying the system had not detected the Cav. I was disappointed. I was certainly detecting aircraft and one station in the US, so why was it ignoring me?

I did some more investigation and talked to Uavionix the next day. I learned that I was about 140 NM from Great Falls and because I was at the outer limits of the coverage area at my altitude, I was likely too far away for my signals to be detected.

Bad weather precluded making another flight that way. But Bob Kirkby has an ADS-B receiver and offered to use it to at least check if I was

broadcasting anything at all. We met in my hangar and each fired up our respective systems. Sure enough, he showed my airplane on his tablet broadcasting the correct ident. A real verification trip to the US would have to wait, but I was now confident knowing things were working at their most basic level.

A few days later, Gary and I made a day trip to Grande Cache and back. I was seeing lots of aircraft on my screen, so my system, as I'd hoped, proved useful for traffic awareness. On the return leg as I was approaching Olds-Didsbury, I listened to a Mooney that was inbound from above and behind me. I also gave my required position reports and at one point spoke directly to the Mooney pilot to let him know I had him on my screen. He replied that he'd been tracking me, too.

That was a big relief for me, and as I looked at the Mooney's track I suspected that he'd chosen it specifically because his receiver told him exactly where I was. Maybe I'd avoided near mid-air number six, or maybe actual mid-air number one.

The Cav's primary nav system – Fltplan.go on a dedicated cell phone with GPS. The brown circle at the Cav's eleven o'clock is another aircraft transmitting. In this case it's Beech King air at 17,075 feet descending into Calgary.

I still wanted a bit more information about how and what I was broadcasting, and the quality of the signal. I got that information a week

later with Gary's help. He acquired a Stratux brand user-assembled ADS-B receiver.

I was on the return leg of an out and back trip to southern BC and I was tracking Highway 22 northbound from the Crowsnest Pass. Gary and I were texting and he agreed to switch on his Stratux to see if and when the Cav's signal showed up on his iPad.

Gary drove to an overpass near his house to get maximum line of sight visibility. I was between High River and Okotoks descending from 6000' when he finally started seeing the Cav on his display. That worked out to me being about 25 NM away. He tracked my progress back to Kirkby's and all the way down to the ground.

With that knowledge, I'm satisfied my system is working as required. I reckon that the detection range will increase if a receiver antenna is mounted higher up, like at a ground station, or if it's on another aircraft. I may still try to increase the antenna ground plane size with hopes of getting a bit better transmission range, but that's more of a nice to have than a need to have at this point.

So, is my ADS-B system worth the money I spent on it? Well, sort of. On one hand, even with the relatively lower price I paid, it was still too expensive. Part of that falls to the exchange rate. On the other hand, the system is *incredibly* capable and compact. It'll certainly add value to the Cav and to my whole flying experience.

The traffic awareness component alone is really valuable, even though not all planes are ADS-B or Mode S ES equipped. However, the number of planes with those systems is growing. The Cav and I are now set to fly south again to take advantage of all that the US has to offer for itinerant aircraft and pilots. And I'll be glad to do so with few more layers of safety to make it even more enjoyable.