FlyQ EFB from Seattle Avionics

ADS-B Primer

A pilot's guide to practical ADS-B information without the acronyms

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Summary

FlyQ EFB includes support for in-flight weather and traffic through ADS-B receivers. ADS-B is a complex topic including a myriad of acronyms (such as "ADS-B" itself), frequencies, and technical concepts. This document attempts to translate the important ADS-B concepts to English.

ADS-B ("Automatic Dependent Surveillance-Broadcast") is a system that the FAA is in the process of deploying across the country that provides weather and, in some cases, traffic information while in-flight. There is no charge to use the system other than purchasing an ADS-B receiver (typically $600-$1400).

ADS-B is broadcast from ground-based stations not satellites (like XM). Thus, reception is limited by terrain and altitude. In addition, the national roll-out of ADS-B is not yet complete so coverage is better on the East and West coasts than in the Midwest.

Although ADS-B is broadcast in a standard data format and there is a commonly accepted basic standard for devices to communicate with each other (Garmin GDL-90 format), each device vendor takes a few liberties and adds their own take on the offerings. Thus, unlike the case with GPS devices, iPad apps need to be specifically programmed for each and every different device; there is no universal connectivity.

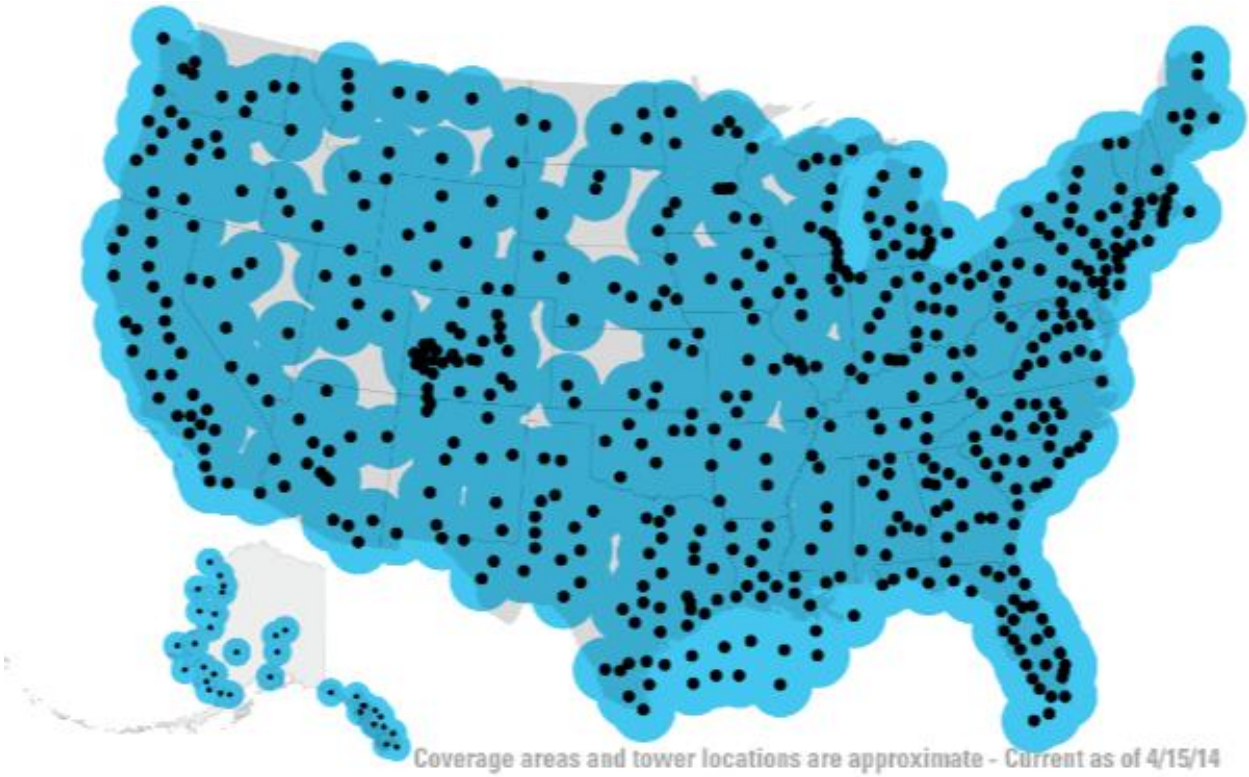
The most popular devices for iPad use are the XGPS 170 from Dual (the makers of the red hockey-puck GPS), Stratus from Appareo, Clarity from Sagetech, GDL-39 from Garmin, SkyRadar from SkyRadar Corporation, and iLevil from Levil Technologies. Many of the units work only with one iPad application. Thus, unlike with an external GPS, pilots cannot always use an existing device on a new app.

ADS-B provides for sending traffic information to aircraft but it is dangerous to rely upon. Because of limitations that the FAA imposed regarding when a ground station may send traffic information to an aircraft, it is likely that all traffic data will not be available to most aircraft using ADS-B receivers. Specifically, traffic information is only broadcast to an aircraft when a certified, in-dash ADS-B OUT transmitter is within 15 NM of the ground station. The FCC does not allow any portable ADS-B device to transmit. Thus, users of iPad-connected portable ADS-B receivers only see traffic if another aircraft with an installed ADS-B OUT system is nearby. The problem is that the ADS-B receiver can't differentiate between there really being no other planes in the area and lots of planes in the area but none with a certified, in-dash ADS-B transmitter causing traffic information to flow. Thus, pilots must be very aware of the risks of relying on ADS-B traffic.

Coverage Area

The FAA planned to have ADS-B coverage available for the entire United States by the end of 2013. They didn't quite make it but came close. In March of 2014 the FAA announced that they had completed all the planned stations (about 570).

The graphic below shows where the operational stations are located as of March 2014. Dots represent each of the operational stations. Each station broadcasts over a fairly large distance so you should visualize "clouds" of coverage around each dot. Therefore, the East Coast, West Coast, and the South are well-covered now. Some small gaps exist, generally in mountainous areas.

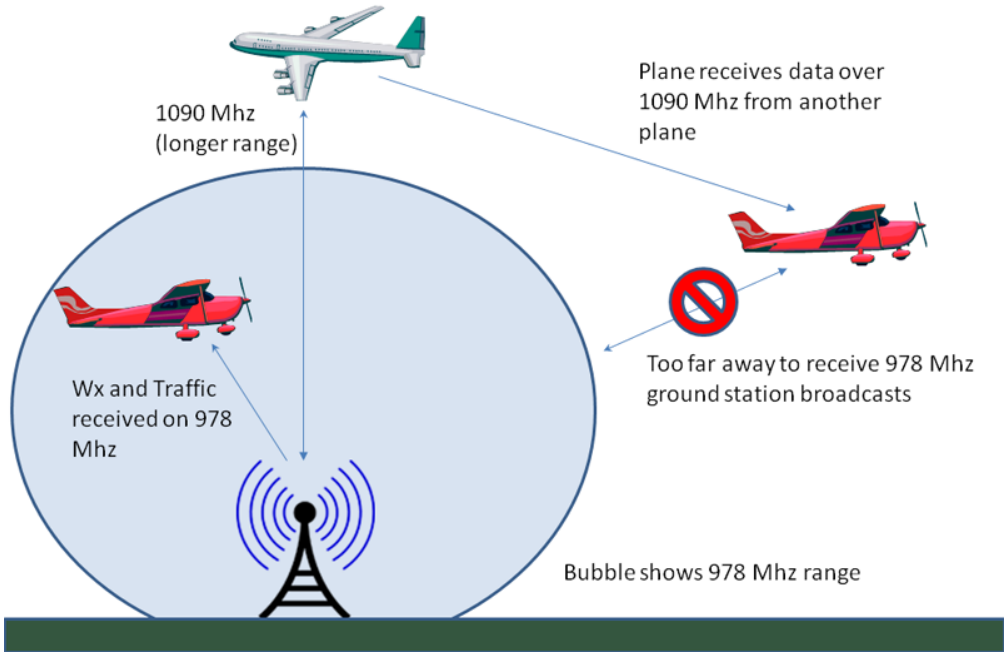


Acronyms and Frequencies

ADS-B is filled with acronym after acronym. Some of the more commonly-used ones are TIS-B, FIS-B, UAT, 978 and 1090ES. None of them are especially critical to understanding how to get weather in the cockpit.

TIS-B refers to traffic information while FIS-B refers to weather.

UAT and 978 MHz refer to the frequency used to communicate between ground stations and aircraft flying at normal GA altitudes. 1090 ES (or 1090 MHz) refers to the frequency used to transmit from aircraft to aircraft. Currently, it's primarily used for commercial airline data rather than GA information.



All ADS-B receivers work on the 978 MHz frequency to receive ground-based weather and traffic. Some of the more expensive units also receive (but not transmit) on the 1090 MHz frequency. These units can receive traffic from an effectively larger area because they can receive "relayed" information from other aircraft. Weather is never sent over the 1090 band. In other words, if Plane A is equipped with a 1090 MHz receiver but is too far from a ground station to receive data, it might receive traffic (but not weather) data from Plane B if Plane B is between Plane A and the ground station and Plane B has a 1090 transmitter (ADS-B Out).

Weather

By far the most common use for ADS-B is to receive weather updates while flying. Obviously this dramatically enhances in-flight safety, especially for IFR flights. The FAA's ADS-B broadcast provides several weather products but some weather products are broadcast more frequently than others.

The following table describes the maximum range of the coverage (that is, how far away is the weather you see) and the best-case time between weather updates. It is very important to note that the actual coverage area (especially for radar) may less and the transmission frequency is best-case. In real-world use, the information may come quite a bit less often due to reception issues and such. There is also considerable difference in the radio sensitivity of different models of ADS-B receivers so one receiver may see weather data that another receiver model will miss.

Weather Product	Maximum Coverage Area (radius)	Approximate transmission frequency
Regional Nexrad Radar	250 NM	2.5 minutes
US Nexrad Radar	N/A	15 minutes (usually less often)
METARs	100 NM	5 minutes
TAFs	100 NM	10 minutes
AIRMETs/SIGMETs	100 NM at airport surface, 500 NM inflight	5 minutes
Winds/temps Aloft	1000 NM	10 minutes
TFRs and NOTAM (D)	100 NM	10 minutes
PIREPs	500 NM	10 minutes
SUAs	500 NM	10 minutes

Do not confuse frequent transmission with more accurate information. In particular, NOAA only updates TAFs and Winds Aloft every 6 hours. Thus, although you'll see data come in every 10 minutes, the data is usually exactly the same as the last broadcast.

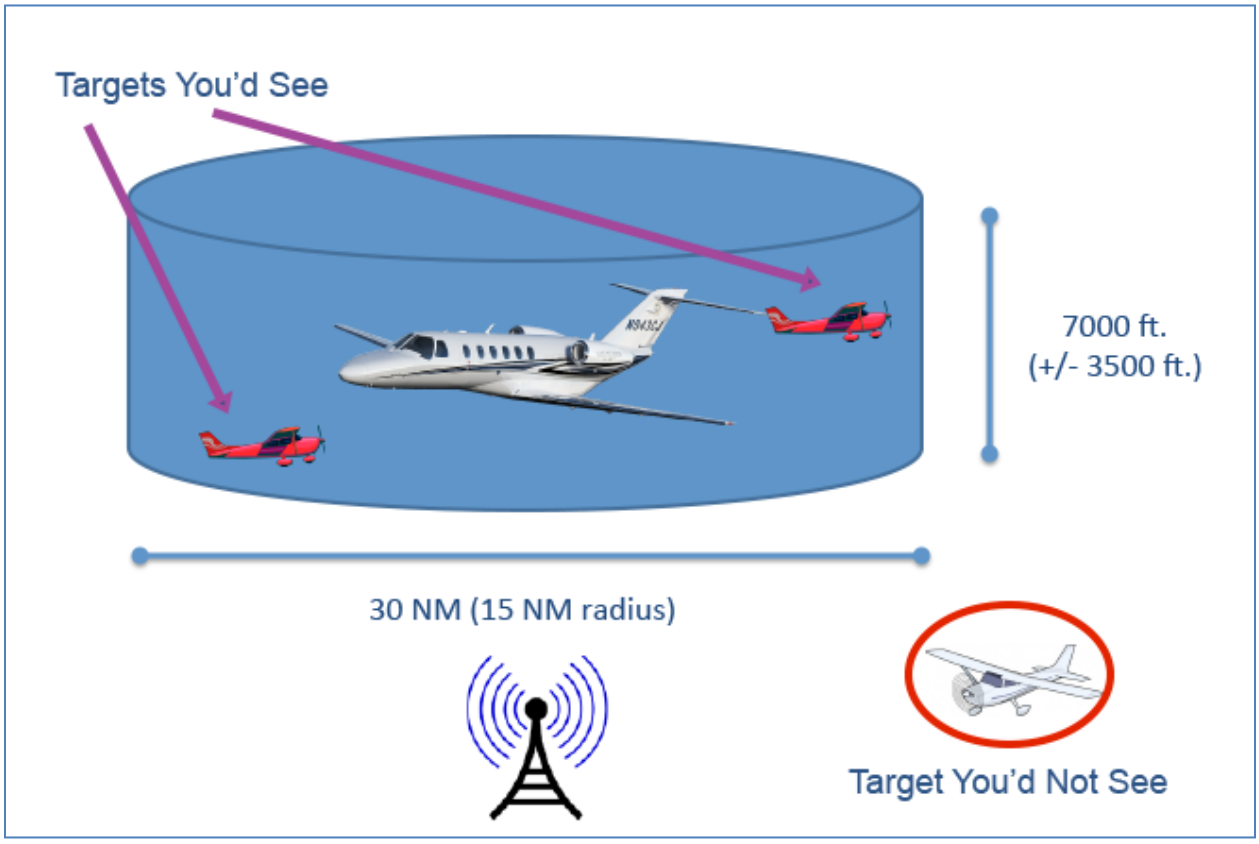
It is important to realize that METARs and TAFs flow into the system slowly; you do not get the entire country with each data burst. Thus, especially when the ADS-B system has been running for less than 30 minutes, you may not see METARs or TAFs from your nearest airports. When you select weather for a particular airport in FlyQ EFB, the app will find the nearest current METAR or TAF from the selected airport; this may not be the selected airport itself. Thus, it is possible, especially when the system is starting up, that you'll see METARs or TAFs from airports other than the selected one. This is clearly marked on the FlyQ EFB display but pilots should be careful to notice the airport from where the METAR or TAF is coming.

Traffic

ADS-B's original purpose was to provide better traffic information to pilots and to ground-based controllers to allow more efficient use of the national airspace (NAS). Weather data was added later, as something of a "sweetener," to encourage adoption of the system.

The basic concept was to mandate that all aircraft have what was essentially a more sophisticated transponder that sends more information to the controllers. This is now the law and all aircraft are required to have such a system by 2020 (unless Congress later delays the deadline, of course). This system, called ADS-B "Out," transmits information from the aircraft to ground stations. Upon receipt of this data, the ground station replies by sending a stream of traffic information to the transmitting aircraft and, because it's broadcast not point-to-point, to all other aircraft in the area.

Crucially, no traffic information is broadcast from a ground station (978 frequency) unless there is an aircraft nearby (within a 15 NM radius and within 3,500 ft AGL) that is equipped with an ADS-B Out system.



ADS-B Out requires a transmitter. However, the FCC and FAA only allow transmitters on certified systems. The FAA does not allow any portable system (like one connected to an iPad) to be certified. Thus, it is impossible to purchase a portable ADS-B Out system; you must purchase a much more expensive certified system and have it installed in your plane to get ADS-B Out.

In other words, although the ground stations have traffic information, they will only broadcast it when an aircraft with a certified ADS-B Out system is within 15 NM of the ground station; there can be several ADS-B In receivers in an area and the ground station will not transmit traffic unless there is also an ADS-B Out system in the area. Moreover, the data transmitted from the ground stations is not all the traffic in the area; it is specifically tailored for the aircraft that broadcast its location to the ground station so the ground station only sends targets near that aircraft (+/- 15 NM, +/- 3500 ft) not necessarily near you. Thus, it's entirely possible that an aircraft eavesdropping on traffic meant for another plane may not see a target that is very close to it.

The problem this creates cannot be understated. An ADS-B receiver that is not receiving traffic information may not be receiving it either A) Because there is no other plane in the area or B) Because there is simply no ADS-B Out plane in the area. The receiver cannot tell the difference. Thus, a pilot looking at an iPad screen with ADS-B traffic can be misled into believing there is no traffic when, in fact, there is considerable traffic but none with ADS-B Out. Even worse, it's possible to see some traffic on the iPad but not see targets that are dangerously close to you simply because those targets are not close enough to the ADS-B Out equipped plane that triggered the transmission. We believe this is dangerous and, therefore, strongly advise that pilots rely primarily on their eyes, not their iPad, when looking for traffic.

In our testing, we see far more reliable traffic from dual-band (978 and 1090) receivers so if traffic is important to you, we suggest you purchase a dual-band receiver such as the Clarity or the SkyRadar. This is because these receivers get the same limited traffic from 978 as single-band receivers but also pick-up traffic data from airliners flying overhead on 1090. As no weather is sent via 1090, weather is reliant on ground stations and 978 and not directly affected by the use of a single versus dual –band receiver. That said, we find the radio sensitivity varies dramatically between different brands so some ADS-B receivers receive weather and traffic better than others. Thus, we suggest that pilots investigate each ADS-B unit carefully; unlike GPS units, there really is a significant difference between models.

Bluetooth vs. Wi-Fi

Most ADS-B systems use Wi-Fi to communicate with the iPad. This is because Apple tightly controls access to Bluetooth devices that want to connect to the iPad. Most manufacturers have not gone through the time and expense to get this Apple certification. Wi-Fi, on the other hand, is completely accessible to all iPads so it's commonly used to avoid Bluetooth certification.

Bluetooth uses less power than Wi-Fi thus helping to preserve the iPad's battery life. More importantly, an iPad may only connect to one Wi-Fi device at a time while it may connect to multiple Bluetooth devices (plus a Wi-Fi device). Thus, if the ADS-B receiver is using the Wi-Fi connection, the iPad cannot connect to the Internet via Wi-Fi and cannot connect to other devices that also use Wi-Fi. Bluetooth is also easier to use in practice as once configured (which takes about one minute), Bluetooth automatically connects the iPad to the device when the device is turned on. With a Wi-Fi based ADS-B system, the pilot must use the Settings app in the iPad to manually select the Wi-Fi network created by the ADS-B receiver each time he flies.

A good example of this problem is trying to use an ADS-B receiver along with a separate AHRS device. AHRS units provide yaw, pitch, and roll information that is crucial to accurate Synthetic Vision, such as the one included with FlyQ EFB. The most common standalone AHRS unit is made by Levil and uses Wi-Fi. If a pilot chooses an ADS-B system that also uses Wi-Fi, he cannot connect to both devices at the same time. If, on the other hand, the pilot chooses a Bluetooth ADS-B receiver, he may also add the Levil unit. Of course, this specific problem goes away if the pilot chooses an ADS-B receiver that also includes an integrated AHRS. Clarity, SkyRadar, Levil, Appareo, and Garmin (the GDL 39 3D) make such a device but they cost more and, if you already have a Levil AHRS, it means not using a device you already own.

Wi-Fi based systems can generally connect to multiple iPads in the cockpit at the same time. Bluetooth systems may or may not be able to do this reliably. Also, while using the Wi-Fi connection of the iPad to connect to the ADS-B receiver prohibits the iPad from connecting to the Internet via Wi-Fi, cellular-enabled iPads can still connect to the Internet via their cellular service if the iPad is on the ground.

Common ADS-B Receivers

There are no FAA-certified portable ADS-B transmitters. The following are some of the more common portable ADS-B receivers. Prices are not listed as they change quickly. However, the general range is between $500 and $1,400 depending on the brand and the specific features of the device.

Dual XGPS 170

This unit is made by the same company (Dual) that makes what is probably the most popular aviation GPS for the iPad, the Dual XGPS 150 (the red hockey puck). Unlike most other ADS-B units, Dual has gone through the Apple Bluetooth certification process so this unit uses Bluetooth rather than Wi-Fi to connect to the iPad. This is a major benefit as it frees the iPad's Wi-Fi system to talk to the Internet or emerging in-cockpit systems such as the Aspen Connected Panel. It also means the iPad requires less power to communicate with the device.

FlyQ EFB works with the Dual XGPS 170. FlyQ EFB automatically detects the presence of a Dual ADS-B receiver and immediately begins receiving weather and traffic data from the device. No manual configuration is necessary once the one-time Bluetooth pairing between the iPad and the Dual unit is completed.

The unit itself is small, well-built, and battery powered. It includes a WAAS-enabled GPS but no AHRS. It works with FlyQ EFB and several other iPad apps so it's a safe investment.

The XGPS 170 is a single-channel (978 MHz) receiver so it receives data from ground stations but not from aircraft transmitting on the 1090 MHz frequency. As a single-channel receiver, its traffic is more limited than a dual-band receiver.

Clarity by Sagetech

Sagetech makes very precise, military-grade systems. Their new Clarity line of ADS-B receivers have exceptional technical specs, giving them superb reception and reliability characteristics.

There are two models, both of which include an internal 6-8 hour battery and use Wi-Fi to communicate with the iPad. Both units are physically small and very well-built.

The first model, simply called Clarity, is a WAAS-enabled GPS with a dual-channel (978 MHz and 1090 MHz) ADS-B receiver that receives data from both ground-based and in-flight systems. This effectively increases the range of coverage. The second unit, called Clarity SV (for Synthetic Vision), adds an AHRS unit so one device can also provide yaw, pitch, and roll data to systems such as FlyQ EFB that include Synthetic Vision (3D). Clarity works with a number of different iPad apps including FlyQ EFB.

Stratus by Appareo

There are two Stratus units. Both are battery-powered ADS-B / WAAS GPS systems that are sold exclusively by Sporty's and work exclusively with ForeFlight. They both use Wi-Fi rather than Bluetooth and have eight hour battery lives.

The original model is a single-channel receiver that works on the 978 MHz frequency only and does not receive data from other aircraft on the 1090 MHz frequency.

The newer model is smaller and includes an AHRS. It receives on the 1090 MHz frequency as well as the 978 MHz frequency.

SkyRadar by Radenna Systems

The original SkyRadar ADS-B was the first widely-used ADS-B system for the iPad. The original unit has been supplanted by newer units: SkyRadar DX and SkyRadar D. Each includes a WAAS-enabled GPS and use Wi-Fi to communicate with the iPad. Neither unit is battery-powered so must be plugged into ship's power.

The SkyRadar-DX is a dual-channel (978 and 1090) receiver that includes an AHRS at a very attractive price. It's an excellent choice for FlyQ EFB because the dual channels mean better traffic reception and the AHRS provides the data required for true synthetic vision. The lower-priced D unit is also dual channel but lacks the AHRS.

Garmin GDL-39

The Garmin GDL-39 is a Bluetooth GPS / ADS-B receiver that works exclusively with the Garmin Pilot iPad app.

The unit includes both 978 MHz and 1090 MHz support for both ground-to-ship and ship-to-ship reception. It requires a corded connection to ship's power or an optional battery pack. The base model does not have an AHRS but the new GDL-39 3D includes an AHRS.

iLevil from Levil Aviation

Levil pioneered the portable AHRS market with their AHRS-G device (which is supported by FlyQ EFB).

There are two iLevil units. The iLevil SW is a new and completely redesigned system that begins with the AHRS and WAAS GPS support in the older device and adds ADS-B capabilities. Like the older unit, it uses Wi-Fi to communicate with the iPad and runs for up to 3 hours on the internal battery or can be powered by a USB connection to a power source. It also includes photovoltaic solar cells to help charge the device but these solar cells do not provide enough power to replace USB charging.

The second iLevil unit is the iLevil AW and includes everything in the SW version (except the solar panel) and also includes a port for receiving pitot-static data from experimental aircraft to measure pressure. The iLevil AW is physically very different than the SW unit.

The iLevil units are supported by several iPad apps including FlyQ EFB.

Both iLevil units are single-channel (978 MHz) units so have limited traffic visibility.