AirNav RadarBox Preview

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The introduction of ADS-B by the aviation authorities has revolutionised aircraft surveillance and spawned a new range of communication equipment such as the AirNav RadarBox.

The AirNav RadarBox and antenna.

The days of traffic controllers poring over a screen that's just displaying a few smudged dots have long since vanished and modern systems are extremely sophisticated. To properly appreciate current systems, it's important to have an understanding of how radar has developed over the years, so let's start with a look at the background.

Early Radar

In the very early days of radar, the system comprised a very powerful microwave transmitter that used a rotating directional antenna to emit a focussed beam of RF energy. When the beam encountered something substantial (such as an aircraft), part of the signal was reflected back to the radar station and a blip was displayed on the operator's screen. Whilst the brightness of the blip would give some indication of the size of the aircraft and the blip's position would show range and direction, that was about all the information available. When it was introduced, radar was a real boon and it was soon realised that radar would be just as useful for directing friendly aircraft as it would be for detecting the enemy. The main problem with the system was the very short range caused by the square law characteristics of radio wave losses. This meant that for every doubling of distance, the reflected signal dropped to a quarter of its original value.

The solution to this problem was to change over to an interactive system known as Secondary Surveillance Radar (SSR), where friendly aircraft carried a dedicated receiver and transmitter combination known as a transponder. When the aircraft's receiver detected a radar pulse, it would respond by transmitting a simple code to help identify the aircraft. The formalised version of this system was known as Air Traffic Control Radio Beacon System (ATCRBS).

The early system used just two pulses from the transmitter and the spacing of the pulses was used to indicate the type of interrogation – military, civil and so on. The reply from the aircraft (Mode A) was limited to just 12 bits and comprised an identity code that was set by the pilot but directed by air traffic control. The system was enhanced with the inclusion of another interrogation type (Mode C) that could request the aircraft's height data. Although crude by modern standards, SSR did provide the air traffic controller with range, bearing, identity and height, allowing the aircraft to be pinpointed in space. The frequencies used for SSR and the later radar systems are **1030MHz** ground-to-air and **1090MHz** air-to-ground.

A new problem introduced by transponders was false responses from aircraft that are not in the focus of the main antenna beam. Radar transmitter antennas are not perfect and they will almost certainly have a number of side lobes. These are smaller directional peaks that could be significantly separated from the main directional lobe. These lobes can cause the radar signal to be received by other aircraft and they will consequently send a response from their transducer that could make the wanted signal unreadable.

The solution to this problem was to include an omni-directional antenna at the transmitter and then send one pulse through the main antenna quickly followed by another through the omni-directional antenna. All the airborne transponders were set to respond only if the first signal was at least 9dB stronger than the second one. The system worked extremely well, providing a significant reduction in false responses. The final refined system has enjoyed successful operation for many years.

Mode-S

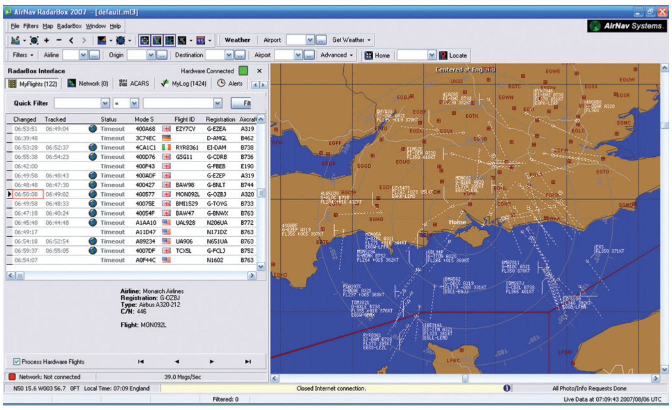
The rapidly increasing amount of air traffic put huge demands on the Mode A/C SSR radar systems and a more sophisticated data link was required. Mode-S provided the solution to the problem with a number of important enhancements. The first was the assignment by the ICAO of a unique ID to every aircraft. This ID is sent as the 24 bit address near the start of each message. In addition, Mode-S messages are constructed in packet radio format with an address at the front, the message in the middle and a parity check at the end. In this way, each packet is clearly marked and can also be error checked. The modulation mode employed is Continuous Phase Shift Keying (CPSK) with an occupied bandwidth of 1.3MHz. The use of this wide bandwidth and high data rate explains why you won't see any soundcard based decoders for this mode! An additional feature of Mode-S is finer altitude graduations providing 25 foot increments.

Introducing new systems on the same frequency is always difficult and one of the problems that had to be solved was preventing the older Mode A/C transponders from falsely responding to Mode-S interrogations. The ingenious solution was to make use of the Mode A/C side-lobe suppression feature by sending two pulses at the start of the transmission. These would be received by Mode A/C systems at the same level – not the 9dB difference that normally triggers a response. This simple trick resulted in Mode A/C equipment ignoring all Mode-S transmissions.

At this point in the development, Mode-S is still a selective system that has to be interrogated before it provides a response thus making it a sophisticated transponder. In order for the radar station to find new aircraft, Mode-S includes an All Call interrogation code that causes all aircraft within the transmit beam to identify themselves.

Enter ADS-B

Automatic Dependent Surveillance - Broadcast (ADS-B) is a new approach to radar and introduces transponders that broadcast aircraft information regardless of whether or not they are interrogated by a radar station. The name is a bit odd so let's just quickly explain the acronym. Automatic means no intervention by the pilot. Dependent means the information is dependent on reliable data sources – GPS data plus instrumentation. Surveillance means position, altitude, velocity vector plus other details such as flight number and destination are included. Broadcast simply means the information is available for reception by any station – including



RadarBox Main Screen.

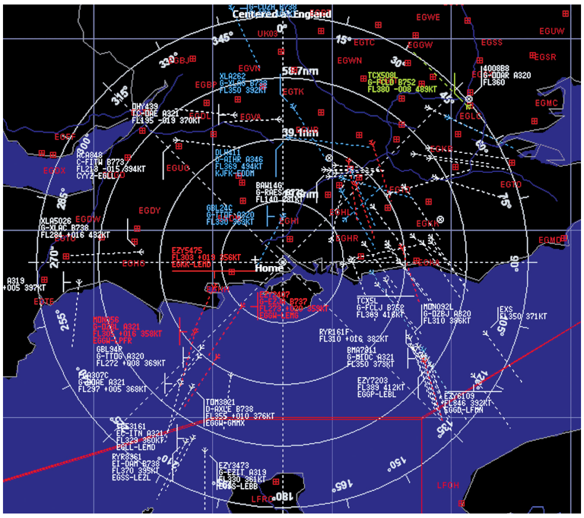
you and me. It is this latter point that has brought about the revolution in aircraft tracking for enthusiasts. Carrying ADS-B kit is now mandatory and most ADS-B systems send full position reports at a rate of about 2 per second, so just about every commercial aircraft can be tracked easily with a suitably equipped station. To ensure general compatibility, ADS-B uses Mode-S as the physical layer for ADS-B signals so that provides high speed data over a well proven system. In addition to overcoming some of the overcrowding problems of earlier radar systems, ADS-B broadcasts are received by other aircraft so they too have a much better view of the aircraft that are nearby. The broadcast system also facilitates accurate tracking of aircraft whilst on the ground – something that is very difficult with conventional systems. For enthusiasts, ADS-B makes available a mass of real-time information. All you need is a dedicated 1090MHz receiver and decoder – just like the AirNav RadarBox that I'll take a quick look at next.

AirNav RadarBox

AirNav have considerable experience in the field of aircraft monitoring for enthusiasts and have produced a number of very successful software packages over the years. The RadarBox is the very latest development that combines features of their other software with a very compact ADS-B receiver and hardware decoder. The receiver measures just 130 x 105 x 25mm and has only USB and antenna connectors on the rear panel. The front panel has three LEDs to show power and USB/Signal activity. As there are no user controls on the RadarBox itself, it can be safely tucked away in the shack. The RadarBox consumes very low power and what little it does need is supplied via the computer's USB port. The small size and simple connections make the RadarBox ideal for portable operation so if you like to spot planes, you can take the RadarBox along and find out so much more about the aircraft movements around the airfield.

RadarBox comes with dedicated drivers to run the hardware and these are supplied on a CD, along with the main software package.

Getting started with RadarBox is extremely easy – once the software is installed you just enter the supplied username and password and you're in business. ADS-B signals are abundant



RadarBox in Real Radar Mode.

throughout most of the UK and you will find that the signal LED immediately starts flickering with received signals.

AirNav have integrated features from their other software very well and as soon as an aircraft ADS-B signal is received, RadarBox plots the position and adds a tag with relevant data such as flight number, callsign, aircraft type, altitude, airspeed and route. As an added bonus, the details are captured in a text log and if you are connected to the Internet, RadarBox even downloads a photo of the aircraft! All this is completely automatic.

The simplicity of use combined with a well thought through mix of information make the RadarBox easy to use. It was fascinating to be able to sit in the garden with my laptop and track aircraft as they flew overhead on their way to exotic destinations.

Whilst initial operation of the RadarBox was very simple, the software contains a host of customisable features and advanced options. These include networking where you can share your logs and import other people's via the RadarBox network, plus a whole range of alerts, filters and other refinements so you can fine-tune the RadarBox for your own requirements.

The unit I've been using is a preview sample and it's still at the beta testing stage. As soon as a production model is available, I'll bring you a full review. In the meantime, if you want to know more about the AirNav RadarBox, contact **Martin Lynch & Sons, Outline House, 73 Guildford Street, Chertsey, Surrey, KT16 9AS. Telephone: 0845 2300 599. Fax: 01932 567 222 or E-mail sales@hamradio.co.uk**

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