MT REVIEW

RadarBox by AirNav Systems

Decoding the New ADS-B Aircraft Communications System

By John Catalano

If you have done any aircraft tracking using the ACARS (Aircraft Communication Addressing and Reporting System) signal from your receiver, or even just using an Internet connection, you probably know the name AirNav Systems. Over the years the *Computers & Radio* column in *MT* has covered a number of their products including AirNav ACARS Decoder, AirNav Suite and Live Flight Tracker.

AirNav System was the first company that I know of to produce a product that allowed the user to process and display their off-air ACARS intercept data along with intercept data from others via the Internet. RadarBox takes this concept one step further with very interesting results. This new product builds on the recent introduction of a new type of aircraft reporting system call ADS-B.

ADS-B enables Air Traffic Control and pilots a real-time "global" view of the air traffic patterns by providing a more precise and *much* wider area of coverage than normal radar.

Radar

Radar is an acronym for Radio Detection and Ranging. It was developed in the United Kingdom in the 1930s as an offshoot of a failed program that attempted to disable aircraft using high power radio waves.

Radar transmits a pulse of radio waves and then listens. What's it listening for? When a radio wave hits an object, especially a metal object, a portion of the signal is reflected back off the object. Think of light reflecting from a mirror or a piece of glass.

The radar system listens for this return reflection signal and then calculates the position and velocity of the object. As we can see, the transmitter power, near line-of-sight signal propagation, "reflect-ability" of the target, and the radar receiver's sensitivity all combine to limit the resulting range and accuracy. Therefore, air traffic radar is very limited in range to usually less than 50 miles and has problems with low flying aircraft.

Since the late 1970s, another system has also been used by ATC (air traffic control) that does not rely on a passive reflective signal. Instead, all aircraft are required to have on board a transponder operating at 1030 MHz. In operation ATC transmits "interrogation" pulses. Once the aircraft's transponder receives this signal, it responds by transmitting a signal back to ATC.

I happened to be piloting an aircraft in the New York Terminal Control Area (TCA) the day encoding altimeter transponders became mandatory to enter TCA airspace. That day was a mess, with lots of aircraft being denied entry into the airspace, resulting in rerouting and chaos. However, by day three, everything was back to normal.

This was a major improvement to the ATC capability for two reasons. One, since the aircraft actually transmitted a return signal, weak reflection signals no longer limited the system. But even better, using an encoding altimeter, the aircraft's transmitted signal was digitally encoded with its altitude. This 1970s system ushered ATC into the digital data age.

Building upon the use of digital data, many other ATC system developments have been implanted since the introduction of transponders thirty years ago. RadarBox utilizes the latest, ADS-B.

A New "Radar"

Automatic Dependent Surveillance Broadcast type B, ADS-B, was a concept developed around 2000 to be a low cost replacement for radar. In addition to being lower cost, ADS-B provides the aircraft community many other benefits.

Still centered around 1000 MHz, over the years the system has been tested at frequencies of 978 MHz for general aviation and 1090 MHz for commercial aircraft. The standards seem to still be in flux. Early this year Raytheon proposed to the FAA (Federal Aviation Authority) a single 1090 MHz system for all aircraft.

Think of this system as the 21st century transponder system. The ADS-B signal incorporates on-board GPS generated exact position, as well as speed, heading, altitude and flight number and other aircraft specific data.

ATC, as well as other aircraft in the air and on the ground can receive this in-flight ADS-B signal and instantly decode all the information. Even satellites can get in on the action and receive and decode ADS-B signals.

So Can RadarBox!

RadarBox from AirNav Systems consists of a 12 inch long whip antenna, a small 5 x 4 x 0.75 inch metal box, a USB cable and a CD containing the control program. The metal box houses the 1000 MHz receiver and the data decoder hardware and connects to the PC via a supplied USB cable. Connecting the hardware could not be easier.

PC Requirement

AirNav Systems gives the minimum system requirements as Microsoft Windows, 400

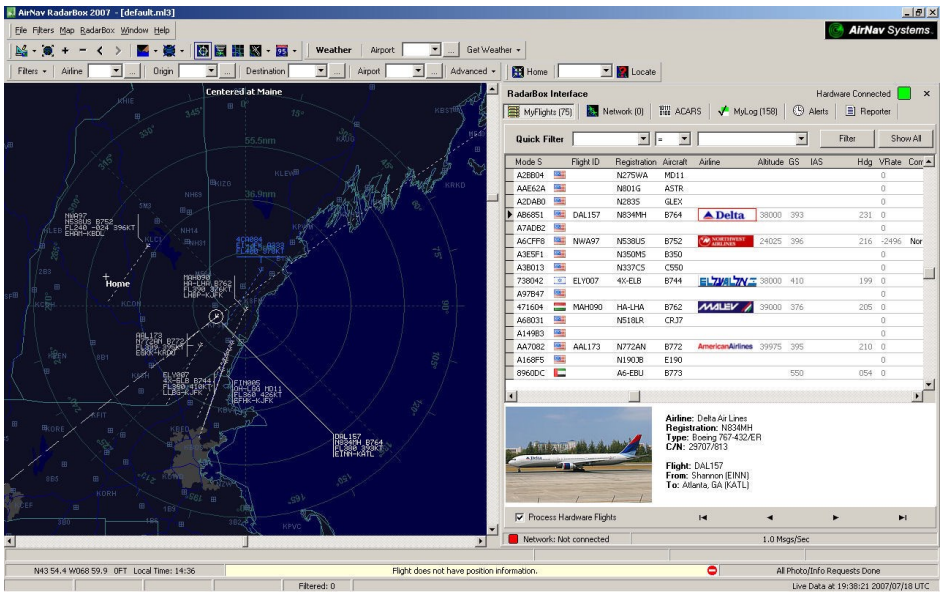

Figure 1 – RadarBox's main map and interface screens shown together

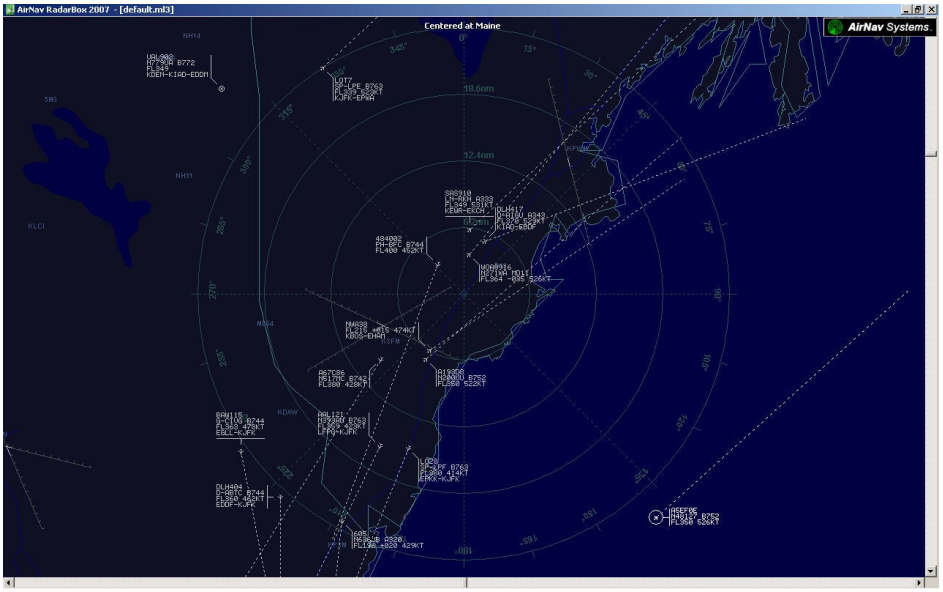

Figure 2 – Full screen map display showing aircraft coming from Europe and going to Europe over the state of Maine and over the Atlantic!

MHz processor, 128 MB RAM, 50 MB hard drive space and CD-ROM drive. Curiously, no Windows or CPU types are specified. We ran it on a PC with a 1.6 GHz Duo Core T2060 CPU, 1.4GB of RAM with a Vista Home Basic operating system. It was very well behaved.

Installation - Careful

Trained as a scientist, I always follow printed directions … to start. The "Quick Installation Guide" printed on the CD cover has the user connecting the box to the PC via the USB before installing its hardware driver or control program. I dutifully followed this and ran into problems!

However, the excellent detailed instructions, which are available on the CD in the "Manual" folder, warns, "**DO NOT CONNECT THE HARDWARE USB CABLE TO YOUR COMPUTER BEFORE INSTALLING THE SOFTWARE.**" Following the instruction on the CD resulted in a quick, easy, and painless installation. The program was up and running within a minute.

Running RadarBox

RadarBox really has two main screens: a map screen and an interface screen. The map screen takes the decoded positional data of each aircraft and displays it on a map. The map contains over one million location details. The interface screen lists the time of each aircraft ADS-B signal intercepted, along with flight number, aircraft registration number, aircraft type, altitude, ground speed, indicated airspeed, heading company name, route, where it's flying over, vertical rate, and longitude and latitude. As you'll soon see, not all aircraft will broadcast all data fields.

Let's start by looking at a simple RadarBox display. Here, in Figure 1, the two screens, map and interface, are presented together. On the left is the map screen where we can track the aircraft whose ADS-B signal RadarBox was received. Here we can see the outline of the coast of Maine, New Hampshire, and Massachusetts at the right. Boston appears as a lighter gray area in the lower part of the map. The northernmost tip of Cape Cod can be seen at the very bottom right. OK, now that we are geographically oriented, what can RadarBox show us?

On the right side of Figure 1 is the Interface screen displaying line readouts of the data obtained from each airline's transmission received.

Looking back at the map, we can see that one aircraft symbol has a circle round it. This corresponds to the line entry on the Interface screen that we have selected using the mouse. From the arrowhead seen at the left side of the interface screen and the box around "Delta," we see this circle is a Delta airlines flight DAL157. Also from this line we can tell that it is a Boeing 764 aircraft, flying at 38000 feet, with a ground speed of 393 and a heading of 231 degrees.

The line on the interface screen can be scrolled to the right to display more flight data. If available from an on-line site, a picture of the exact aircraft is displayed at the bottom of the interface screen. In Figure 1 we can see the aircraft, registration (tail) number N834MH. To the right of the picture is route information that indicates that this flight originated in Shannon, Ireland, and is en-route for a landing in Atlanta, Georgia.

Remember, all this info has been gleaned from radio reception of a quick spurt of data from an aircraft over 80 miles away. Pretty amazing stuff!

Going back to the map at the end of the solid line, which extends from the circled aircraft to the lower right (over the ocean), we can see the flight number, DAL 157, and a summary of the line data. This aircraft symbol also has a dotted line extending through it roughly going from upper right (Northeast) of the map to the lower left (Southwest) showing its flight path.

Get'em All

Looking carefully at Figure 1 we can see that six additional aircraft are visible. If the user places the cursor over an aircraft symbol, RadarBox will immediately locate that aircraft's information on the Interface screen by moving the arrowhead indicator to that aircraft. AirNav Systems has created a very, very nice user interface.

Using the Command line at the top of Figure 1, the map can be customized by color, and can display radar distance rings and expected maximum received signal range lines. In addition, a whole myriad of aviation and general symbols can be displayed on the map including airports, radio navigational beacons, roads, railroads and many more.

Filtering the Data

If the user is only interested in tracking specific aircraft, RadarBox includes a com-

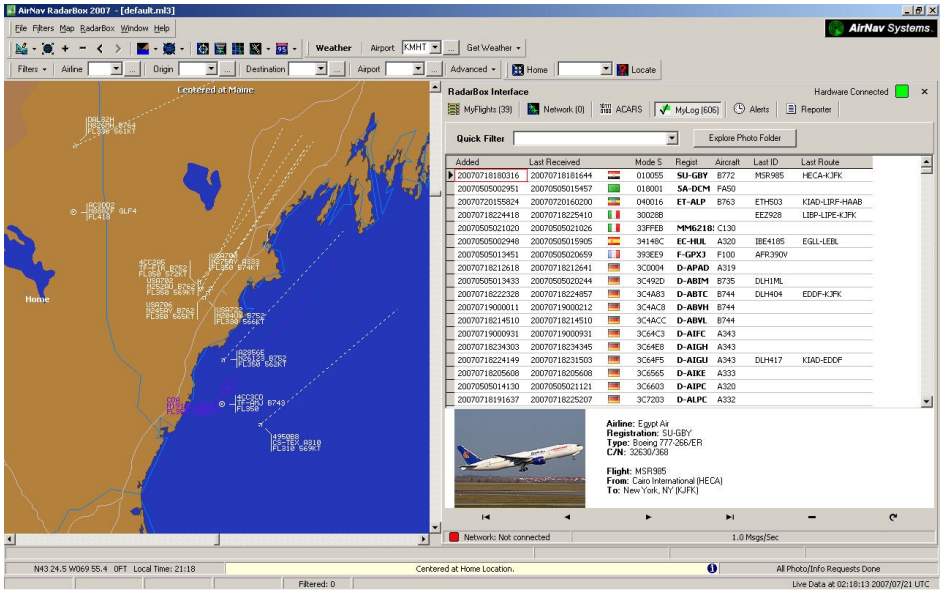

Figure 3 – Some of the 606 logged aircraft displayed on the right. Also a different map view and color scheme on left. Taken at a different time than figures 1 &2.

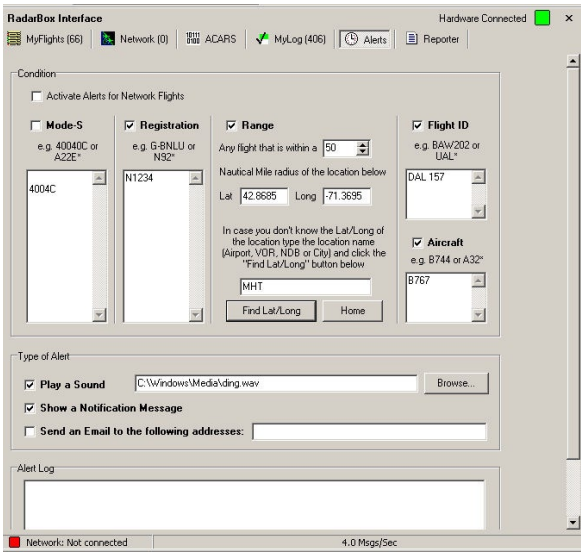

Figure 4 – The very useful "Alert" setting screen.

prehensive, but easy to use array of filtering routines. These can be accessed in a number of ways. The simplest is via the three (currently empty) boxes which sit at the top right in Figure 1 labeled Airlines, Origin and Destination. For example, if these were set to DAL, JFK and LAX, only Delta flights originating at Kennedy Airport in NY and flying to Los Angles would be displayed. This is a very important and useful feature for commercial airline applications.

The screen can also be used to filter the displayed aircraft using a similar method, but using the information found in the columns on the interface screen, such as altitude and registration number. Multiple custom filters and be stored and easily retrieved for later use.

For simplicity, Figure 1 was created without any filtering. And in my location in the boonies of New Hampshire, that was necessary to obtain a visually interesting display.

Actually, two factors resulted in my low volume of received traffic. One was my quiet rural location 40 miles from any airport and 60 miles from a major airport. The second was the indoor whip antenna. When you consider that all the signals were received by this little whip sitting on my desk on the ground floor of a three-story house, that's a pretty hot receiver in the little RadarBox!

Europe – Both Ways

The highest air traffic volume that RadarBox received from my location using the indoor whip is shown in Figure 2. Here we have expanded the map display to full screen. From the direction of tiny aircraft symbols and their flight path lines, about half of these aircraft are European flights making US landfall in Northern Maine. Most of the others are US flights with transatlantic destinations.

RadarBox DX

Take a look at the extreme right of Figure 2. That is an aircraft out over the Atlantic whose ADS-B signal RadarBox received and decoded. The distance from the location of the RadarBox's little whip antenna (off the screen to the northeast) to this aircraft cruising at 35,000 feet, is a surprising 80 miles!

What will an outside antenna do? Well, even if the coax attenuation at 1000 MHz does reduce the signal, reception may be quite good in my rural location. Let's keep that comparison for a future *Computers & Radio* column.

Logging Aircraft

When an aircraft's data is decoded and displayed on the interface screen, it is also automatically entered into a log file called My Log. This file is accessed from Commands above the line entries on the Interface screen. Notice that the "My Log (606)" is selected. The right side of Figure 3 displays the first group of the 606 entries in the My Log. Scrolling allows access to all log entries.

Also notice that the left side of Figure 3 shows a different map color scheme. This map was taken at a different time from Figure 1 & 2, and therefore does not display the same data.

Saving Your Efforts

The program includes two simple ways of saving your intercepts. The first actually makes a recoding of the all screen activity from the time the user starts it until he stops it. When a recorder file is played back, the programs acts as if it is live signal data. This feature works great and is easy to use from the File menu in the Command line located at top left of Figure 1.

If you just want an image file of an interesting map screen, the "Screen Shot" function, found in the same File Menu, will do the job. These applications work great and are a pleasure to use.

Yet Another Filter

The "Alerts" function accessible from the top of the Interface screen, Figure 1, provides another filter of sorts. The user can set five types of alert conditions. Clicking on the Alerts function opens the screen shown in Figure 4. Alerts are generated when a user-defined mode-S is received, aircraft registration is decoded, and/or an aircraft is within a user prescribed distance.

If an aircraft transmission is decoded which meets any of these conditions, a sound is played and a box appears with the aircraft's flight data. No matter what other application you are running, the Alert box appears.

Additional Features

For this review, we have used just RadarBox in the off-air mode; that is, using the output of the receiver. However, RadarBox can also utilize an AirNav Systems server network to provide in-flight aircraft data from all other users. The price of RadarBox includes a one-year subscription to this server network. However, after the first year it will cost the user $240 per year to access this network feature.

Looking at the top right of Figure 1 you'll notice the word "Weather." If the user enters the name of an airport in the box to the right of "Weather" – for example, Manchester – the current weather for that airport will be displayed. The program even gives you three choices of display format: METAR, TAF and decoder METAR.

Unanswered Questions

I had unexplained situations having to do with the USB and Signal lights on the "box." The blue USB light is continuously blinking, but in a seemingly random pattern. Also the white signal light flashes at times with neither screen showing any activity. Perhaps this just indicates an update of existing display data. Neither appeared to result in an operational problem.

Summary

Although we touched on the major features of RadarBox, we could not cover them all. For example, RadarBox also decodes ACARS. You can check them out on the AirNav Systems website at **www.airnavsystems.com/RadarBox/index.html**

I found using RadarBox in the off-air mode easy to use and very enjoyable. Every feature that I tried worked as advertised. It is an excellent product.

At $899, almost $900, this is the most expensive software package that I have reviewed. But remember, RadarBox is not simply a decoder program. It is a complete system from antenna to 1000 MHz receiver to hardware decoder to control software. And it utilizes a newly introduced communications technology.

Perhaps AirNav System's next product should be a lower cost ADS-B decoder that utilizes our existing scanners and receivers capable of 1000 MHz. However, the data pick off from the receiver could not simply be via the audio. It would probably require the owner to find and connect to a point in the receiver's circuit. With most receivers utilizing tiny surface mounted device (SMD) construction, this approach would definitely not be for everyone. But it would allow lower cost decoding of the newly emerging ADS-B traffic for those of us with a steady hand and SMD experience.

Today, AirNav Systems at **www.airnavsystems.com/RadarBox/index.html** and Kinetic Avionics Products **www.kinetic-avionics.co.uk/sbs-1.php** are the only two companies currently marketing ADS-B decoding products to our non-commercial market. AirNav's comparison of the two systems is available at **www.airnavsystems.com/forum/index.php?topic=54.0**.

My experience with RadarBox can be summed up with one word – Great! If you need/want to monitor the ADS-B mode, and you are willing to spend $900, then RadarBox, is for you.

There is no question that we are witnessing the dawning of a new era of aircraft communications and control.