MT REVIEW

COAA's Software Gold Mine:
OrbcommPlotter & PlanePlotter

By John Catalano

Finding new unique radio software on the Internet these days brings to mind Thomas Edison's 1-99 rule. When asked how easy it was to invent, he replied that the process was 1% inspiration and 99% perspiration. That ratio is about right when I consider how much effort it takes to find and then master unique, new radio programs.

Recently I came upon a website that is a literal treasure trove of novel, yet useful radio software. The site (**www.coaa.co.uk/software. htm)** is associated with *Centro de Observação Astronómica no Algarve* (*COAA*) – an observatory in Portugal – which naturally carries some very interesting professional astronomy programs as well. For this article, we will just concentrate on the radio software, of which there are eight applications.

The radio software varies from simple, helpful screens to full-blown radio-interfaced, computational and graphical suites. The latter are found in COAA's "Plotter" series of programs. Let's put a few of these programs through the paces and see what they can do for radio monitors.

❖ ORBCOMM PLOTTER

We are going to start with OrbcommPlotter, which allows decoding communications from a class of LEO satellites.

LEO - Pie in the Sky?

LEO is an acronym for **L**ow **E**arth **O**rbit satellites. The 1970s' LEO concept was to have a perpetual swarm of small communications satellites orbiting at a few hundred miles above the Earth. Unlike geosynchronous satellites which appear to stay in one position over the Earth, LEOs are constantly moving around the Earth.

Since LEO satellites did not need to be rocketed into a high geosynchronous Clarke Belt orbit (about 35,000 miles above the Earth), the launch costs were significantly less than normal communications satellites. The 100 times shorter radio path also reduced the satellites' on-board radio requirements, further reducing its costs.

Ironically, the upside of LEO was also its downside – its low orbit. At these low altitudes, atmospheric drag is considerable. This leads to significant orbit decay and, therefore, shorter lifetimes before de-orbit destruction. So, although cheap, the constellation of satellites required regular launches to replace the burned-up ones.

As we noted, LEO satellites do not stay in one position in the sky above the users. This means that as one satellite passes out of range it has to hand-off to the next satellite coming into range. This requires a very complex interactive network of communication between satellites – which bordered on science fiction in the 1970s! But microelectronic technology was advancing computing at an unbelievable pace.

A number of companies took on the challenge of exploiting the LEO concept. However, within a few years most resulted in economic failure. Motorola, with its deep pockets, managed to keep its Iridium series of LEOs going for quite a while. But in the early 1990s, it announced that they would be closed down. The story goes that the US government, the major user of Iridium at the time, stepped in and saved the operation.

Today, with more powerful and cheaper microelectronics, and with the explosion of worldwide communications via cell phones and the Internet, LEOs are once again attractive. In fact, after a shakeout of companies and a rash of Chapter 11 bankruptcies, the LEO communications business is once again growing.

Many weather satellites such as TIROS, as well as amateur radio satellites, qualify for LEO status and are in operation today. Between weather, communications, and ham satellites, LEO satellites now number in the several hundreds.

Where is LEO?

The Orbcomm company (**www.orbcomm. com/**) currently has 29 LEO satellites in their constellation. Orbcomm provides two-way control, condition, and position communications via their LEO satellites. The "messages" are between six bytes to several kilobytes in size. Ground users have transceivers mounted in trucks, trailers, railcars, containers, heavy equipment, fluid tanks, utility meters, pipelines, marine vessels, and oil wells.

If you live in a populated area of the Earth, there is probably an Orbcomm satellite is passing near you. That's where OrbcommPlotter comes in. According to the program's well-written Help menu: "OrbcommPlotter allows you to monitor and decode the telemetry data from the Orbcomm series of LEO communications satellites." In addition, it will provide us with a graphical satellite tracking of Orbcomm satellites in real-time.

All it takes is a PC with a Pentium proces-

sor running Windows 95/98/ME/2K/XP, and a compatible sound card. So just about any PC will do! We are going to run OrbcommPlotter version 1.3 on a PC with a 2.3 GHz Duo Core CPU and 2 GB of RAM. Departing from the instructions, we are using a Vista Home Basic operating system.

Radio Requirements

To maximize the possibility of reception, I suggest a reasonable quality receiver capable of 137 to 150 MHz in the FM narrow mode, using an outside coaxially fed antenna. I tried everything from a handheld scanner to an ICOM R7000. ICR-1000 and Uniden scanners were also tested with the program.

I found the major factor in my location was the antenna. Some say they can get strong Orbcomm signals indoors using a handheld with a whip. This may be possible in some locations. However, after many hours/days I found that a number of RF noise sources prevented me from achieving good satellite decoding. These RF interference sources included computers, monitors, TV, home security, light dimmers and local FM station image signals. Hence, the recommendation for an outdoor, coaxially fed antenna. One cut for around 139 MHz would help even more.

Clearly, radio requirements are very location dependent. However, in the mountains of New Hampshire, receiving these satellites was a real challenge.

Set-up

The download and installation of OrbcommPlotter's 900kb self-installing program is quick, and within a few minutes you should have the program operational. Before you start the program, it would be a good idea to synchronize your PC's clock to a time standard such as WWV. This will ensure accurate satellite tracking results.

OrbcommPlotter has a very useful Help file, which details all aspects of getting the program up and running. One of these is connecting the receiver to your PC. The blurb on the COAA website states, "The receiver audio output must be connected to the Line-In connector on your PC." However, the Help file recommends that the receiver's discriminator output be connected to the PC, not the audio output. Since I was using radios without discriminator outputs, I was forced to use their audio output.

Hands On

Start by selecting the "Options" menu on the main screen, as seen in Figure 1. Choose "Audio" then "Source" to tell the program to listen to the receiver audio on the soundcard's input jack. Once that is set, go to the "Options" - "Home" menu and enter your longitude and latitude.
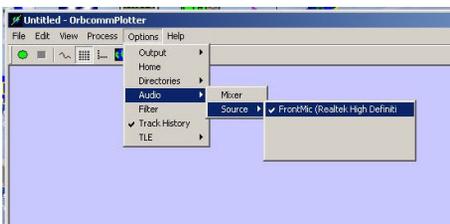

Figure 1 - OrbCommPlotter's main screen – Set-up menus

We'll have one more housekeeping chore to perform later. But now we are ready to try OrbcommPlotter.

Three screens are key to the program's operation. The first is the Chart display, seen in Figure 2. All screens are accessible from either their icon or from the "View" menu. Here the program displays Orbcomm satellite positions in real time as they orbit the earth. Your "Home" location will be displayed at the center of the screen.
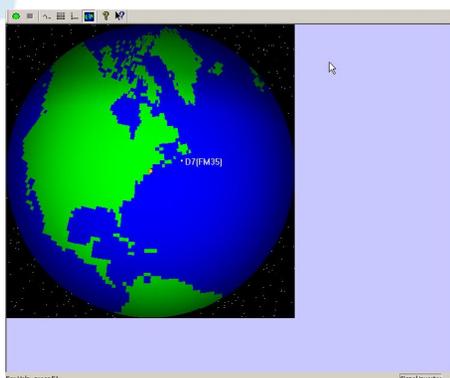

Figure 2 - The chart (map) view showing satellite FM-35's orbital position

Since satellite orbits decay or change, especially in low earth orbit due to atmospheric drag, we must update the satellite parameters often. This bit of housekeeping is made very easy by visiting **www.orbcomm.com/downloads/elementSets.htm**. Here you will find "ORBCOMM TLEs for" followed by a date. Below this will be a file with a ".tle" extension. TLE stands for Two Line Elements. These define the orbit parameters as of the given date.

Right click on the file hyperlink. Then select "Save Link as." Save this file in OrbcommPlotter's "log files" folder. Look for this folder in `C:\Program files\COAA\Orbcommplotter\`.

Now back to the "Option" menu and select "TLE," then "Define." The files in the log files folder will be displayed, including the one you just saved. Click on it and then choose OK. Then in the TLE menu select "Enable." This tells the program to use the data in this file to calculate the satellites' orbital positions. Now the Chart screen will display accurate satellite positions

relative to your location.

And NOW we are really ready to use OrbcommPlotter!

Operation

Open the "Messages" screen. When a satellite is about to come in range, the program displays a list of download frequencies for that specific Orbcomm satellite. See the bottom of Figure 3.

Now it's time to furiously tune each of these download frequencies until you hear the signal. Since this is very slow speed data, it will sound more like a dead carrier with very low-level video and periodic "klink," about once a second.

So that you can hear the signal for which you are hunting, COAA has provided us with a wave file of Orbcomm satellite audio. You can find on the *MT* site at **www.monitoringtimes.com/mtsubscriber/Orbcommsat.wav**

Once we are tuned to a solid satellite signal, open the "Signal" screen by using the "View" menu or its icon. Adjust the receiver's volume until the signal you see does not have flat tops or bottoms. Then lower it a touch more. Make it quick! Don't forget the satellite is moving at a very high speed.

Due to its velocity and the resulting Doppler effect, you will have to retune the frequency a few kilohertz during the pass.

Congratulations!

You are now monitoring low earth orbit satellite communications!

Go back to the "Message" screen and you will see the efforts of your work … a steady stream of message data from the satellite, including the latest downlink and uplink frequencies and much more. See the top of Figure 3.
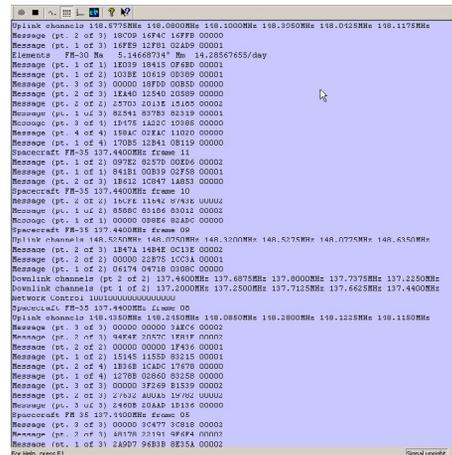

Figure 3 - The message screen. Notice the program-generated downlink frequencies at the bottom; decoded four groups of alphanumeric characters at the top.

As you can see, these "messages" consist of four groups of five alphanumeric characters, reminiscent of the format of the old shortwave number stations! Hm-m-m. Okay, so we cannot make sense of the message, but it is still a monitoring achievement!

Look closer at the messages and you will see satellite information. For example, we can see

that we are monitoring satellite FM 30 and FM 35. FM-35's downlink frequency is 137.4400 MHz. And FM-30 has given us its two line elements (TLE) orbit corrections.

A Personal Achievement

For me, it took quite a lot of work (days, in fact) to finally be able to get a solid signal. COAA's wav file was a tremendous help.

My newly acquired 2.3 GHz Duo Core PC really puts out some unwanted wideband signals! And then there is the new home wireless network I just installed. So for me, the shielded outside discone antenna was a must. But even taking these precautions, I found that only satellites almost directly overhead yielded reliable messages. (I belatedly remembered all the reception problems I had setting up my DISH satellite TV system.)

For the record, though, my problems had *nothing* to do with OrbcommPlotter. Once presented with even a reasonable signal, the OrbcommPlotter program did a great job of decoding and displaying the messages, and it is easy and enjoyable to use.

Once running, it's real fun watching the screen come alive as a "bird" passes overhead. Give OrbcommPlotter a try and expand your radio monitoring to small LEO satellites.

Getting OrbcommPlotter

You can download a free trial version, good for 21 days, from **www.coaa.co.uk/orbcommplotter.htm**. The registered version, which costs 25 Euros, was used for this article.

❖ PLANE PLOTTER

Ready for another "Plotter"? In the same mindset is another COAA program, PlanePlotter. The core of this program is a self-contained, software-based ACARS decoder program. But that's not the whole story.

In the usual manner, audio from the receiver is connected to the PC's soundcard input. I found that it did a great job decoding ACARS signals. Its performance seemed especially good decoding weak signals from over 200 air miles away.

It has OrbcommPlotter's very modest PC requirements. Your VHF receiver should be capable of AM reception in the 129 MHz to 137 MHz band. We primarily monitored 131.5500 for this article. Okay. So how do we set up this baby?

Basic ACARS decoding was up and running within a minute of installation. As in OrbcommPlotter, an almost live graphical trace of the audio signal screen is provided. However, for PlanePlotter I found this adjustment to be very non-critical with a wide range of settings resulting perfect ACARS message decoding. See Figure 4.

There is lots of data in the list in Figure 4 and the user can sort it out in a number of ways. The Review command found on the top of the screen does the job. Using it, all of today's ACARS intercepts can be listed by registration numbers or flight numbers as seen by the box in the center of Figure 4. Clicking on a flight number in the list brings up all the information from that flight. However, the information is
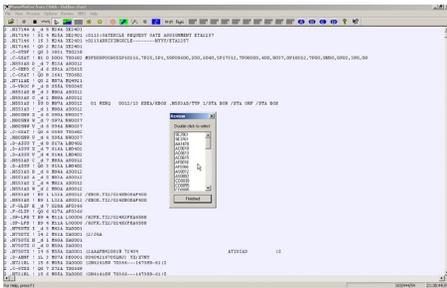
Figure 4 - PlanePlotter - Doing a great job decoding ACARS within minutes of installation.

displayed using a very basic format in Notepad. It's all there, but it takes some searching.

Map Display – Almost

Planeplotter does a very good job of decoding each aircraft's position from ACARS. However, although the name of the program is "Plotter," it does not contain any map files! Perhaps this is a copyright issue or other legal situation. It is a shame, because the mapping part of this program has lots of power! Of course, a third possibility is that I missed a step.

If the third possibility is not true, then the user has no recourse but to hunt the web for an "acceptable" map file. Although I tried to follow the instructions, I failed and gave up after an hour or so. Even after ran the calibration routines on a number of locations, only one relatively crude map gave me any meaningful results as displayed in Figure 5.

This is a map of the Boston, Massachusetts, airspace. If you look to the lower right you can discern the outline of Cape Cod, and below that Long Island, New York. Each triangle on the map represents an aircraft whose ACARS signal has been received and decoded. Can you see the line of aircraft west of Boston? This day was pure IFR, instrument flying rules. Heavy snow falling in the area had them stacked up pretty good.

If you left click on a triangle, a data bubble will appear with more flight detail as seen near the top center of Figure 5. Here we have clicked

on flight number CO0055. At the lower right of the screen the latitude and longitude of the aircraft's location will be displayed, one of the many nice details that has been included in PlanePlotter.

Right click on a triangle is even more interesting. Here, on the left side of Figure 5, we see the resulting "Aircraft Position Report" windows. There are some very powerful and useful tools in this unassuming looking window.

The "Local Photo" and the "Google Photo" functions really didn't yield much info for the aircraft that were flying on this day. But the "LookUp" button makes the aircraft "real" as opposed to just a triangle symbol on a map.

This button immediately brings you to the **airframes.org** website. Planeplotter automatically fills in the aircraft's registration number and then, with just one click of the Submit button, you are presented with an entire pedigree of the aircraft. The results usually include a picture, owner info, build date and other details, including the aircraft's selcal code if available. Very nice.

Lots More Customization

Take a look at Figure 6 to see the many ways that users can customize the map information presentation. The top number defines how long an aircraft will be displayed from its last received transmission. Here we have set it to 30 minutes, after which time its "triangle" will disappear. So the line of aircraft we previously observed west of Boston is really a time-lapse shot during a busy thirty minutes of traffic.

All we have done here is to use PlanePlotter's resident ACARS decoder and mapping functions, which worked very well. However, Planeplotter can do so much more. Here is a list of its many additional features:

- Process and display ADS-B position reports captured by the Kinetic SBS1(tm) mode-S receiver.
- Process and display ADS-B position reports captured by AirNav Systems RadarBox(tm) mode-S receiver.
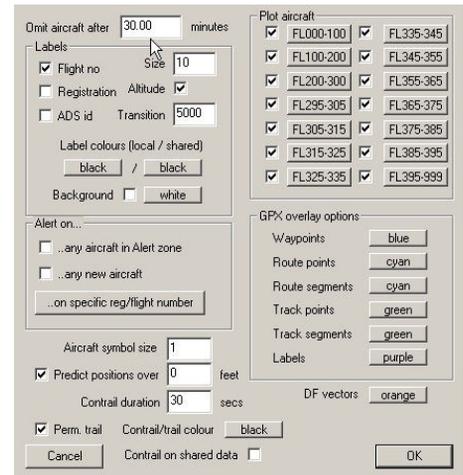
Figure 6 - Just look at all the ways the map displays can be customized!

- Work with PC-HFDL to plot position reports and shows a predicted position between reports.
- Interface to Google Earth to display aircraft positions over the Google Earth base map. Or display a dynamic real-time view from the flight deck of a selected aircraft.
- Generate audible "alerts" on detection of user-defined aircraft.
- Generate audible "alerts" if detected aircraft enter a user defined position "box"
- HF selcal decoding
- Internet exchange of data and audio between users.

Finally, the program claims that it can perform Direction Finding "using a simple passive antenna switch …allows aircraft to be located even if they are not equipped with ACARS or Mode-S/ADS-B." A detailed tutorial on the theory, construction, and use of the switched antenna array is included in the comprehensive Help file. A Yahoo PlanPlotters user group (**http://groups.yahoo.com/group/planeplotter/**) is active and another source of assistance.

The excellent Help file also contains very useful tutorials. Perhaps I should have used my time studying one of these to help me generate maps! (Alternatively, some maps could be included with the program).

Summary

Although I was up running in minutes, to explore all the features and functions of Plane-Plotter could take weeks! It's a movable feast. How much or how little of this powerful program you want to use is up to you.

PlanePlotterI can be downloaded and used free for 21 days, after which it costs 25 Euros for registration.

Plotting Next Month

So, there are our first two COAA programs. I hope you found them as unique and interesting as I did. Next month we'll continue digging at the COAA "goldmine."

CONTACT INFORMATION
COAA Centro de Observação Astronómica no Algarve
Poio, 8500 Portimão, Portugal
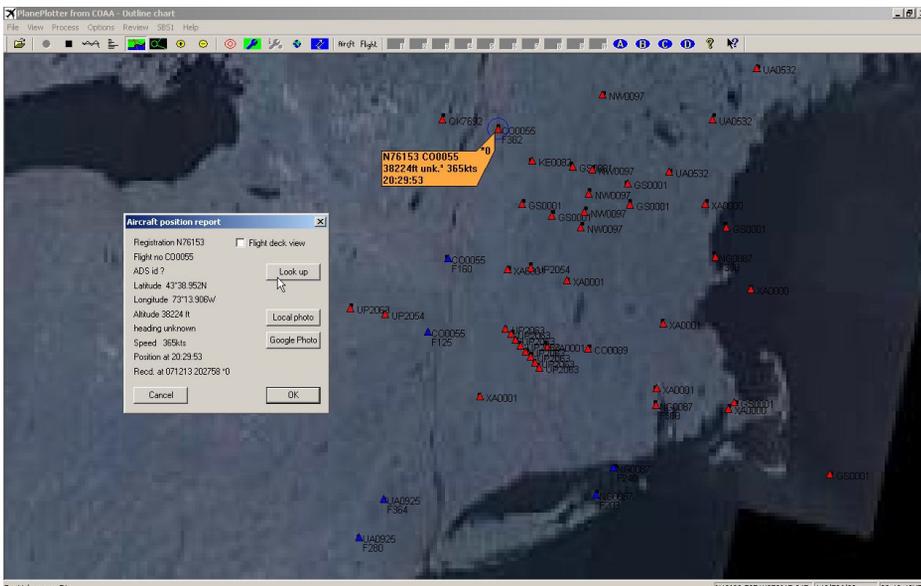Tel: + 351 282 471180 e-mail: info@coaa.co.uk

Figure 5 - Plotting aircraft seen as triangles. Left click an aircraft and the small data bubble seen at the top right appears. Right click and the aircraft position report is displayed.