

## AIS Saves Lives!

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If you live near the coast and would like to be part of a global network making a voluntary contribution to the safety and security of shipping; or if you are just one of the millions of keen experimenters who bought a Raspberry Pi single board computer and still have it sitting in the bottom drawer at home, then this article might be of interest.

In September last year we were invited by Jeff 9V1AS to give a talk at the Singapore Amateur Radio and Transmitting Society (SARTS). The first speaker that evening was Mr. Will Ellison of Solis Marine Consultants. Will gave an excellent presentation about the work of his organisation, investigating maritime safety incidents and the need to expand the global network of coastal Automatic Identification System (AIS) receiving stations.

Will explained that AIS is a vessel tracking system, compulsorily fitted to vessels of 300 tonnes or more, used to send their position, course, speed etc. to nearby ships and to coastal shore stations. AIS, which is a secondary system to radar, is used extensively for navigation, collision avoidance, fleet monitoring, maritime security, accident investigation and search and rescue. It is a line-of-sight, VHF system, supported by Government, commercial and, incredibly, privately-owned shore-stations. These stations receive the ship's data over the air and then they upload it to AIS servers over the Internet. There are a number of AIS servers around the world including: [www.aishub.net](http://www.aishub.net), [www.marinetraffic.com](http://www.marinetraffic.com), [www.pocketmariner.com](http://www.pocketmariner.com), and [www.shipfinder.com](http://www.shipfinder.com) to name a few. Some share the data you upload for free, some provide receiving station information and some provide access to real-time and historical data for analysis. They also have web-based, desktop and mobile apps so that you can view your AIS data on a map. If you browse to any of these web sites you can experience this amazing system for yourself. Click on a ship, and you can see all its details. If the location or callsign of the receiving shore station is displayed, you can click on it to see its coverage and receiving statistics. An example is shown in Figure 1.

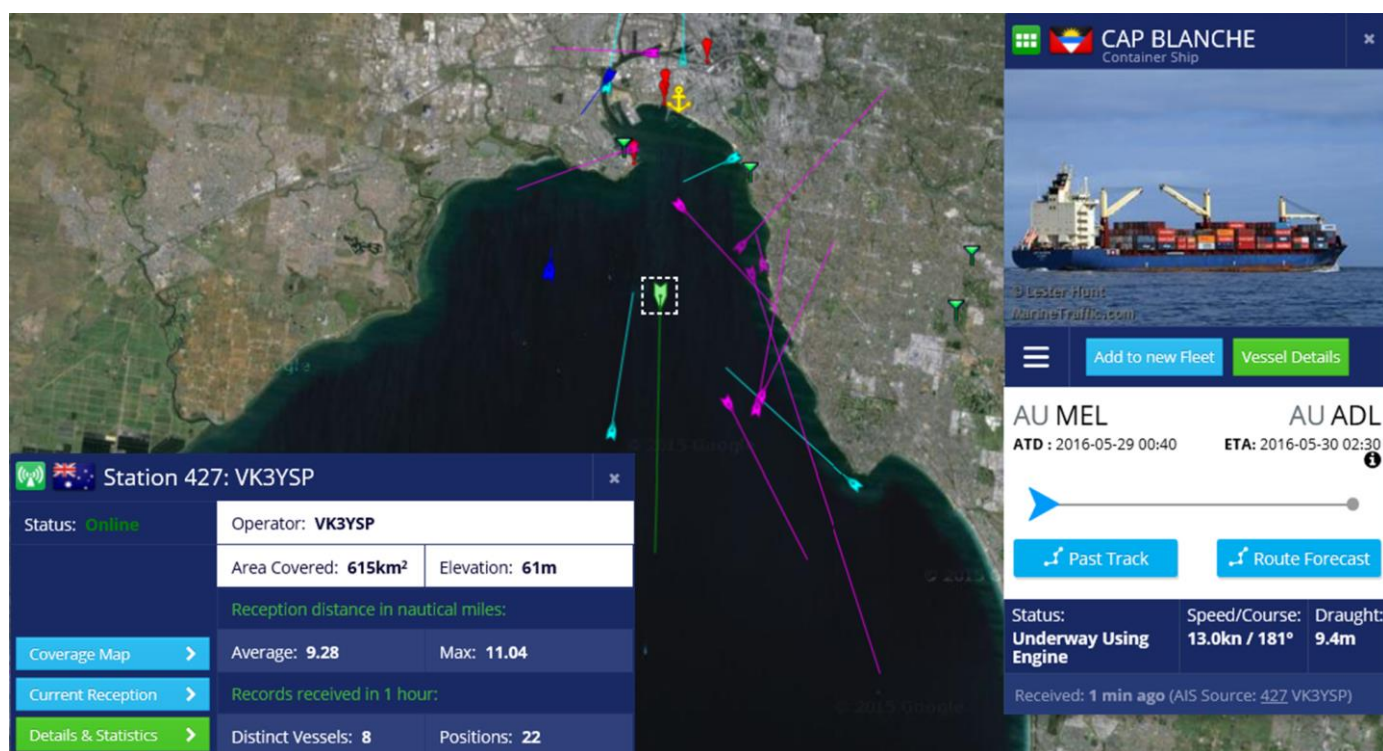


Figure 1 – AIS Vessel and Station Information

Now, it is true that the coastal system has recently been augmented by satellite-based AIS receivers, which now provide mid-ocean vessel tracking, but this emerging technology has yet to achieve the high availability and low latency of the fixed shore-stations. Coverage is so important that some AIS operators even offer free receivers to prospective stations located in poor-coverage areas.

After the presentation, we asked Will why this topic was applicable to Amateur Radio operators. He said quite simply that radio amateurs had the necessary antenna masts, time and expertise required to build and operate their own AIS receiving station. They are quite literally an untapped resource in the global quest for better maritime security and safety.

We then discussed the availability of suitable hardware and software and the complexity and cost of building an AIS receiver kit. Although DVB television dongles had been used for this in the past, at the time they suffered from poor frequency precision and temperature stability. And the software, typically based on the gnuradio suite, wouldn't run on the inexpensive Raspberry Pi computer. Although, more elaborate kits were commercially available for around \$300. So, at the time, it seemed to be beyond the scope of a typical Amateur Radio weekend project.

It wasn't until recently that we revisited the idea, and after a bit of Googling we happened upon a workable solution: These days, you can get RTL-SDR dongles with a temperature-compensated crystal oscillator (TCXO) with 1ppm frequency precision. So that takes care of the drift and tuning problems. Then we found an optimised RTL-AIS demodulator/decoder program, which didn't require gnuradio and sends AIS data directly to an AIS server. What's more, we tested it and found it would run reliably on our 2012-vintage Raspberry Pi version 1 board! The hardware setup we used is shown in Figure 2. The parts shown can be obtained new for under \$100.

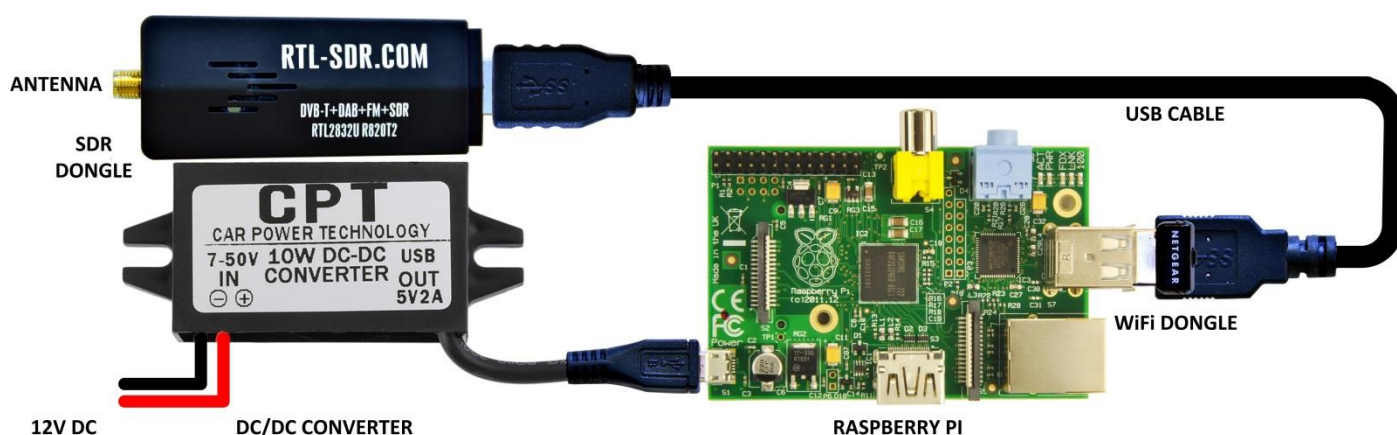


Figure 2 – AIS Receiver Project

So, we began our own AIS receiver project by first setting up a receiving station account on one of the AIS servers. It was quite simple. After entering your callsign and location they send you an e-mail providing the IP address and port number you need to use to send them your AIS data.

Then, we downloaded the latest Raspbian-Jessie disk image from [www.raspberrypi.org](http://www.raspberrypi.org) onto a PC and copied it to an 8GB SD card using Win32DiskImager. Note: You will need a micro SD card if you are using the Raspberry Pi 2 or 3. The Jessie distribution appears to contain a lot more support for RTL dongles than the original Wheezy one did.

We plugged the SD card into the Pi, connected up an HDMI monitor and then a USB keyboard, USB mouse and USB WiFi dongle via a small, powered, USB hub (a necessity for the Pi version 1 boards, as many will remember). The system was powered up and it booted to the desktop. After our locale and WiFi settings were entered, the system was configured to start up in terminal mode and was rebooted. Then, over the Internet via the WiFi dongle and our home WiFi router, the system software was updated and the RTL-AIS program and its dependencies were downloaded and compiled. Some auto-startup commands were added to the terminal profile and then the unit was shut down again.

All that remained was to remove the hub and to connect the WiFi and RTL-SDR dongles directly to the Pi. The system was powered up, this time via a 12V battery and a 12V to 5V USB DC/DC converter. With an antenna connected to the RTL-SDR dongle we could see the received AIS data, which are called NMEA sentences, displayed on the screen. By logging into the AIS server we verified that our data was also being uploaded correctly and we could review our receiving station coverage and statistics. The AIS receiver operation, including RTL-AIS output, message statistics, coverage area and pattern, is shown in Figure 3, along with Pocketmariner's Boat Watch mobile app.



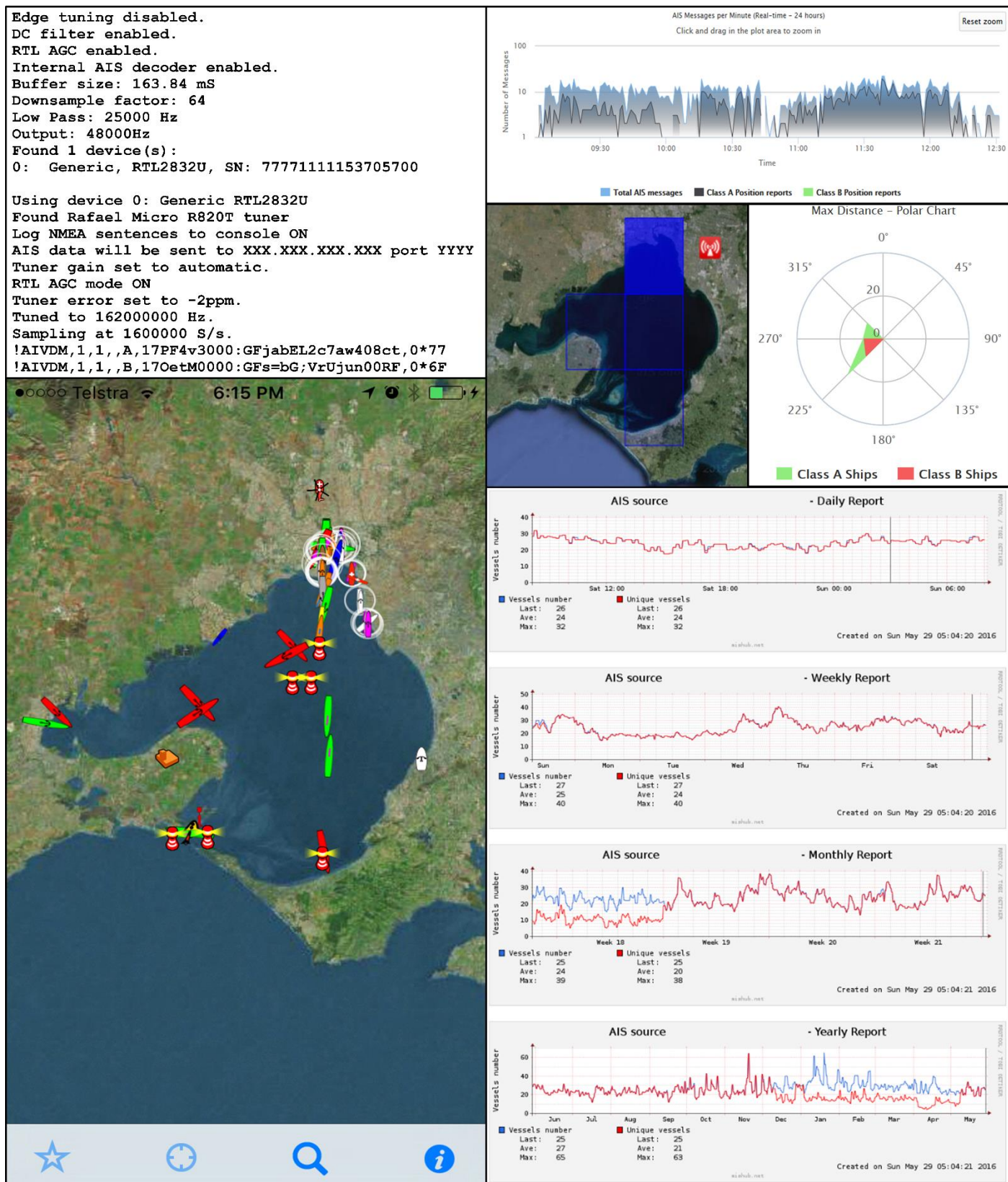


Figure 3 - AIS Receiver Operation

Although the new system worked “out of the box” some optimisation might not go astray. A quick frequency check with a program called “kalibrate”, using a local mobile phone tower as a frequency reference, showed that both of our two new RTL-SDR dongles were off frequency by +2ppm. The correction of -2ppm was entered on RTL-AIS command line and the device restarted. To confirm the value, we found by trial and error that the receiver would work with an offset from -7ppm to +4ppm, with a mean value of -1.5ppm. So -2ppm was actually close enough! It also indicated that other, lower precision, dongles might be pressed into service with a bit of “tuning around”.

Another useful optimisation is to run a program called AIS Dispatcher from AISHUB. This brilliant little program down-samples the AIS data by removing duplicate NMEA sentences before uploading them to the AIS server. Note that each vessel sends the same NMEA sentence on two different frequencies, 161.975MHz and 162.025MHz. The RTL-AIS receiver monitors both frequencies simultaneously. Removing the duplicate sentences can reduce your upload bandwidth by as much as 50%. AIS Dispatcher also lets you upload the data to as many as 12 different AIS servers. You might wonder why this is so important? Well, it turns out that some AIS servers don't like to share your AIS data for free. That's not fair, so with AIS Dispatcher you can create multiple AIS server accounts and upload to them all!

We decided to package our AIS receiver in an ABS weather-proof enclosure so that it could be mounted directly on the antenna mast. Since it uses WiFi, there was no need for routing long coaxial or Ethernet cables through the window. The unit, which draws only 2 watts, could be run from a 12V plug pack over a thin, two-core flex. Better still we could use a 25W solar panel, 2A solar charge controller and 20AH SLA battery to power the system continuously. The completed unit is shown in Figure 4.

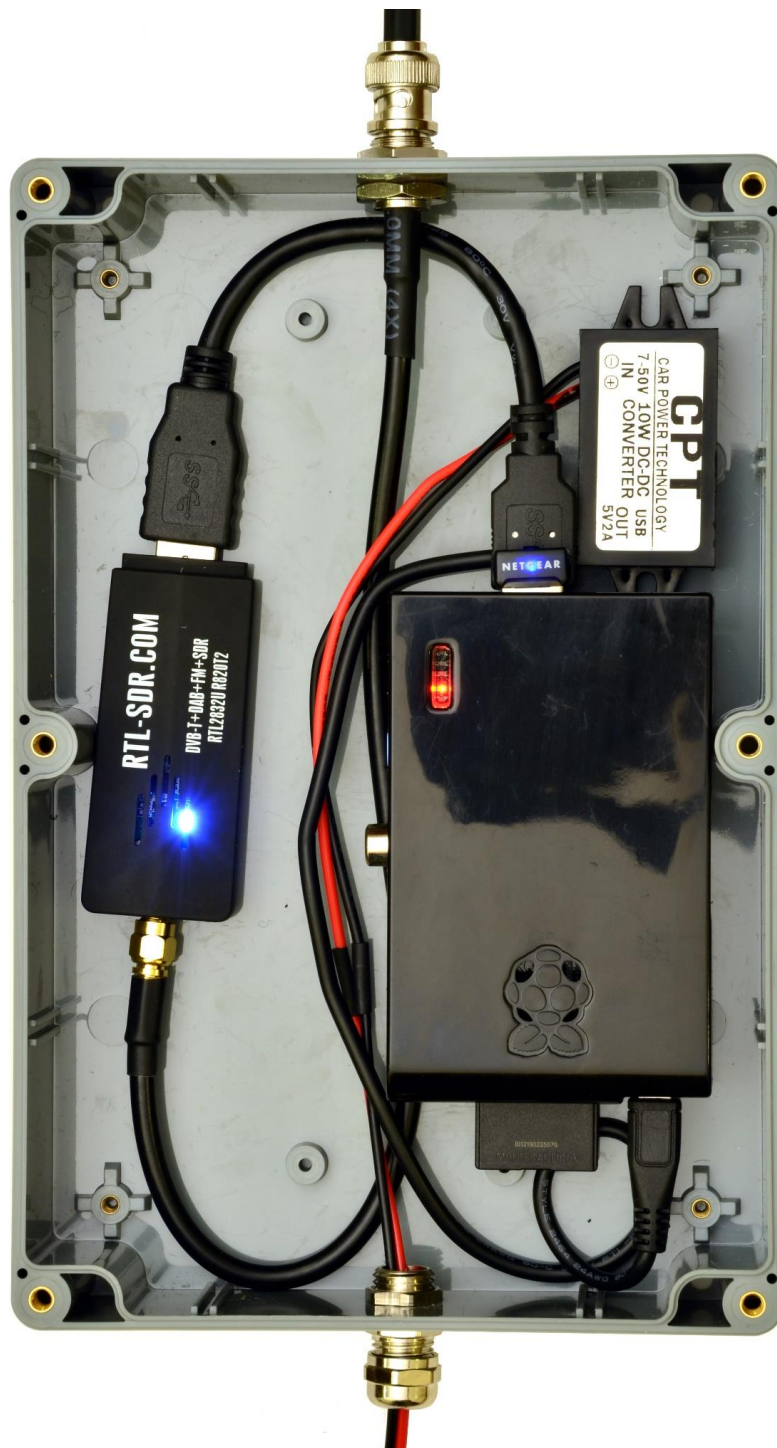


Figure 4 – Completed AIR receiver unit

The receiver requires a 162MHz vertically-polarised antenna. The antenna pattern (omni-directional or uni-directional) needs to suit your location. Again the Internet has numerous examples for home constructors, including a coax-collinear, a slim JIM and an assortment of yagis. A bandpass filter is also required if strong nearby interference is present. We mounted a collinear antenna and the enclosure on a 6.5m mast. The results have been completely satisfactory. For a parts list and more detailed, step-by-step, build instructions please visit us at [www.sarcnet.org](http://www.sarcnet.org).