Flight Tracking with RTL-SDR

SDR and ADS-B

Software defined radio (SDR) introduces highly affordable and portable means to operate radios using simple USB-connecting chipsets to receive and transmit radio signals. Paired with computer software to perform the audio, video, and data processing, we have a vast toolkit to perform radio operations with high versatility. One of the most affordable and dependable SDR solutions is the RTL-SDR USB dongle.

We will use the RTL-SDR V3 software defined radio module to track aircraft via Automatic Dependent Surveillance-Broadcast (ADS-B). Aircraft are mandated by the Federal Aviation Administration (FAA) to transmit certain information. These data include airframe make and model, operating carrier, altitude, bearing, location (latitude and longitude), origin and destination, and much more.

ADS-B transmits at 1090 MHz, using the 1090 Extended Squitter (1090ES) message type link for commercial air and private operators. Since this information is transmitted in the clear, anyone can receive it. Using a RTL-SDR USB dongle, basic telescoping aerial antennas, a computer to process the received data, and some simple software, we can assemble a flight tracker.

Hardware Needed

- **RTL-SDR V3 software defined radio USB module**
- **“Rabbit ears” telescoping aerial antennas + coaxial cable with male SMA connection**
- **Computer with USB A port running a 32-bit operating system or higher (for advanced users, ARM platforms like the Raspberry Pi make good SDR systems)**

Software Needed

- **Windows 10/11** (the process for **MacOS** is similar, though research is required to ensure compatibility and presence of essential drivers; **GNU/Linux** users would follow a similar process, but with slightly different software options)
- **Airspy SDR# (SDRSharp)**
- **Zadig**
- **Dump1090**
- **Virtual Radar Server**

Installing the Software

SDR# (SDRSharp)

A good guide to installing SDR#, a graphic user interface for viewing, analyzing, and manipulating radio frequencies, exists here: https://www.rtl-sdr.com/rtl-sdr-quick-start-guide/. A very brief summary of the steps involved follows, as a quick guide or refresher.

Step 1 – Download **SDR#** - https://airspy.com/?ddownload=3130 -- once downloaded, extract the archive.

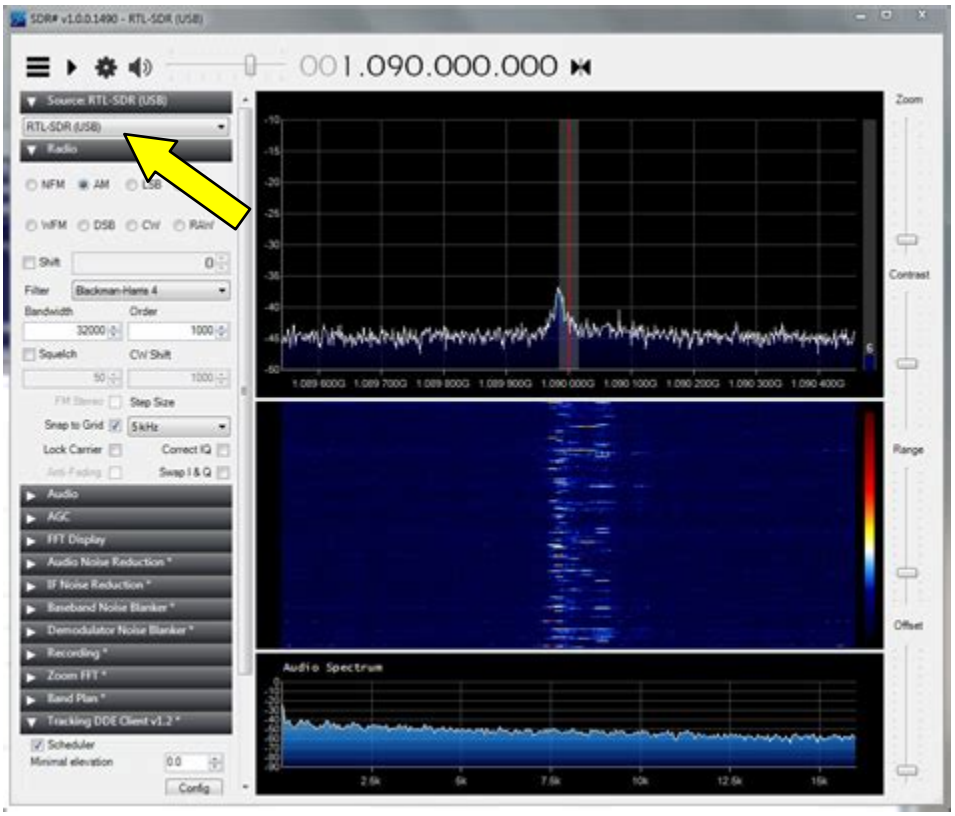
Step 2 – Install **SDR#.**

Step 3 – plug in the RTL-SDR.

Step 4 – Install the correct drivers via **Zadig.exe.**

Step 5 – Open **SDR#** and select RTL-SDR as the source.

Step 6 – Press the play button and find a frequency to listen to – this is a good test to make sure the RTL-SDR is functioning.



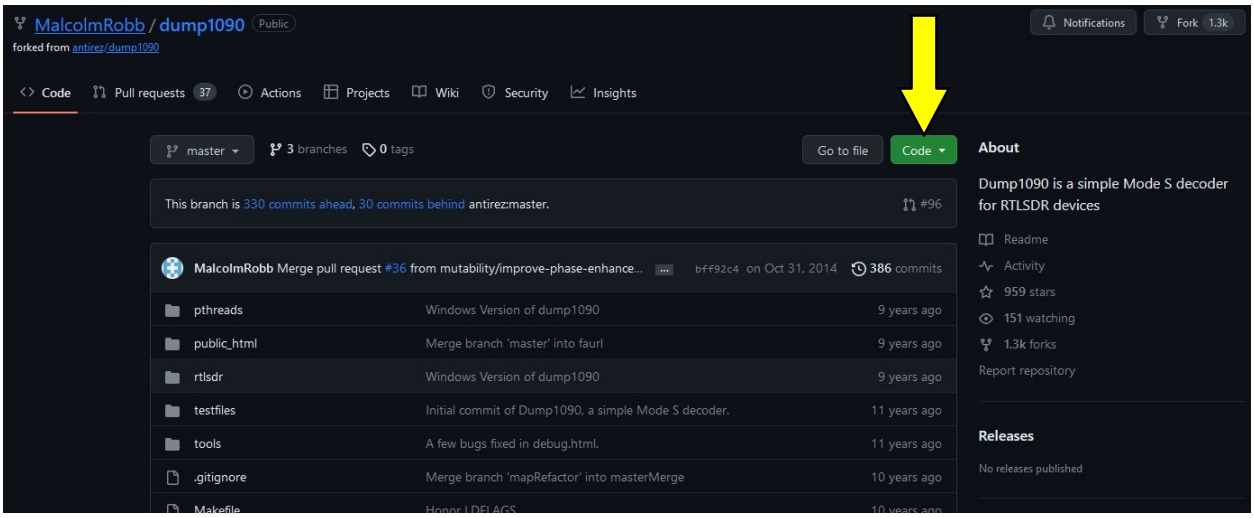
ADS-B data is transmitted at 1090 MHz. Using SDR#, we can tune to that frequency and observe received signals. To decode the data received, more software is required.

Dump1090

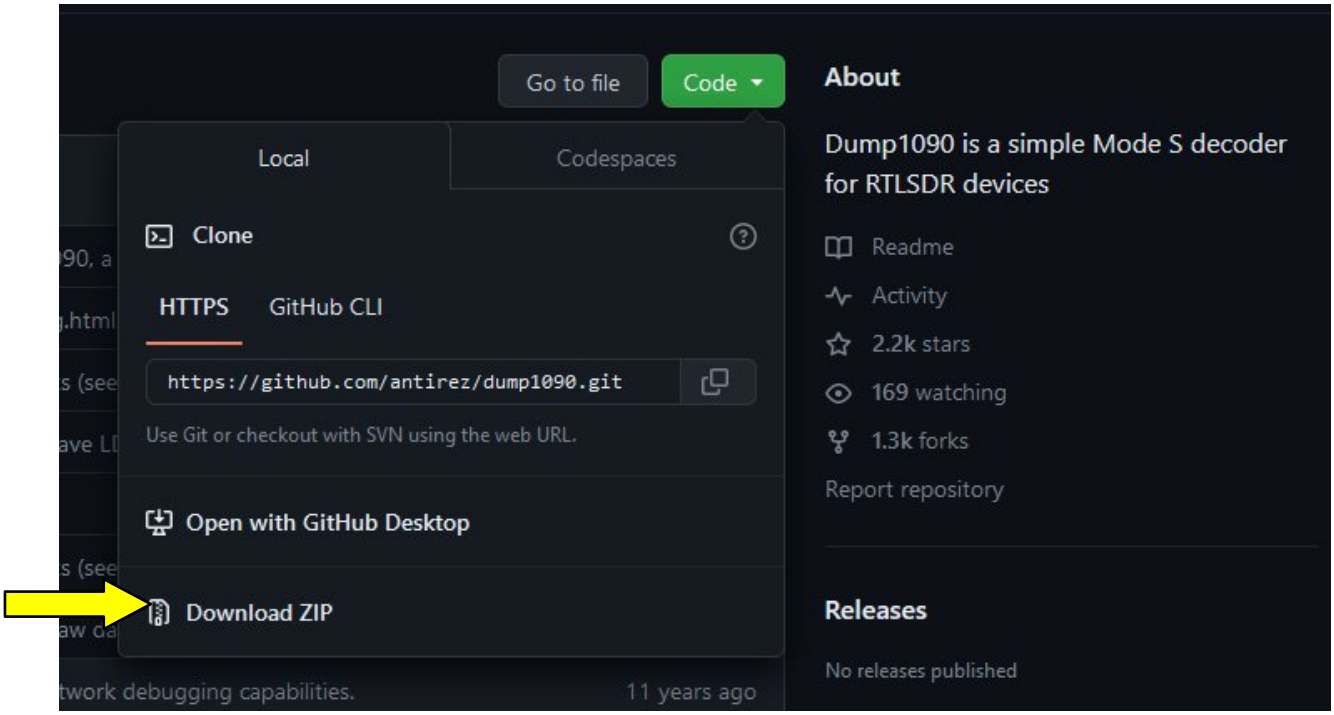
Dump1090 is software that processes aircraft transponder signals from the SDR source to the user's preferred user interface.

Step 1 – go to https://github.com/MalcolmRobb/dump1090.

Step 2 – Click on "**Code**".



Step 3 – From the pulldown, select "**Download ZIP**".



Step 4 – Extract the ZIP file.

Step 5 – Find the ZIP file named **dump1090-win.1.10.3010.14** (version number may be different) and extract it.

Step 6 – In that folder, find the file **dump1090.bat** (you may need to enable file name extensions in the WINDOWS Explorer view settings menu).

Step 7 – Right-click dump1090.bat and select **Open.**

A **cmd** window will open showing the Dump1090 welcome screen. If the RTL-SDR is plugged in and operating, Dump1090 will find it and select it as the primary source for received signals. You'll then see a near-real time list of received transponder signals line by line, if any aircraft are in the receiver range.

Virtual Radar Server

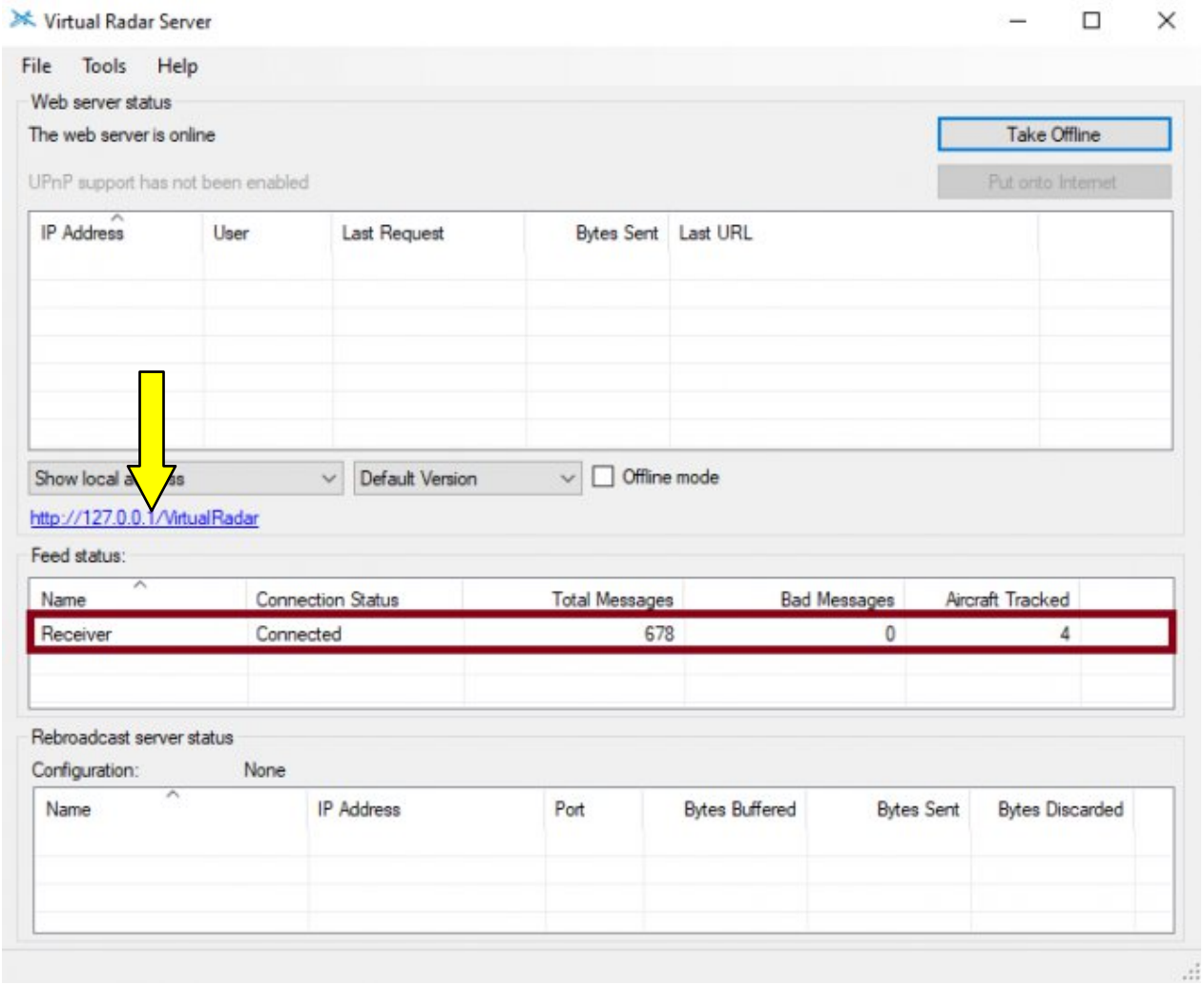
This software converts the captured signals from the RTL-SDR, and processed through Dump1090, into a graphical user interface (GUI).

Step 1 – Download Virtual Radar Server: https://www.virtualradarserver.co.uk/Files/VirtualRadarSetup.exe.

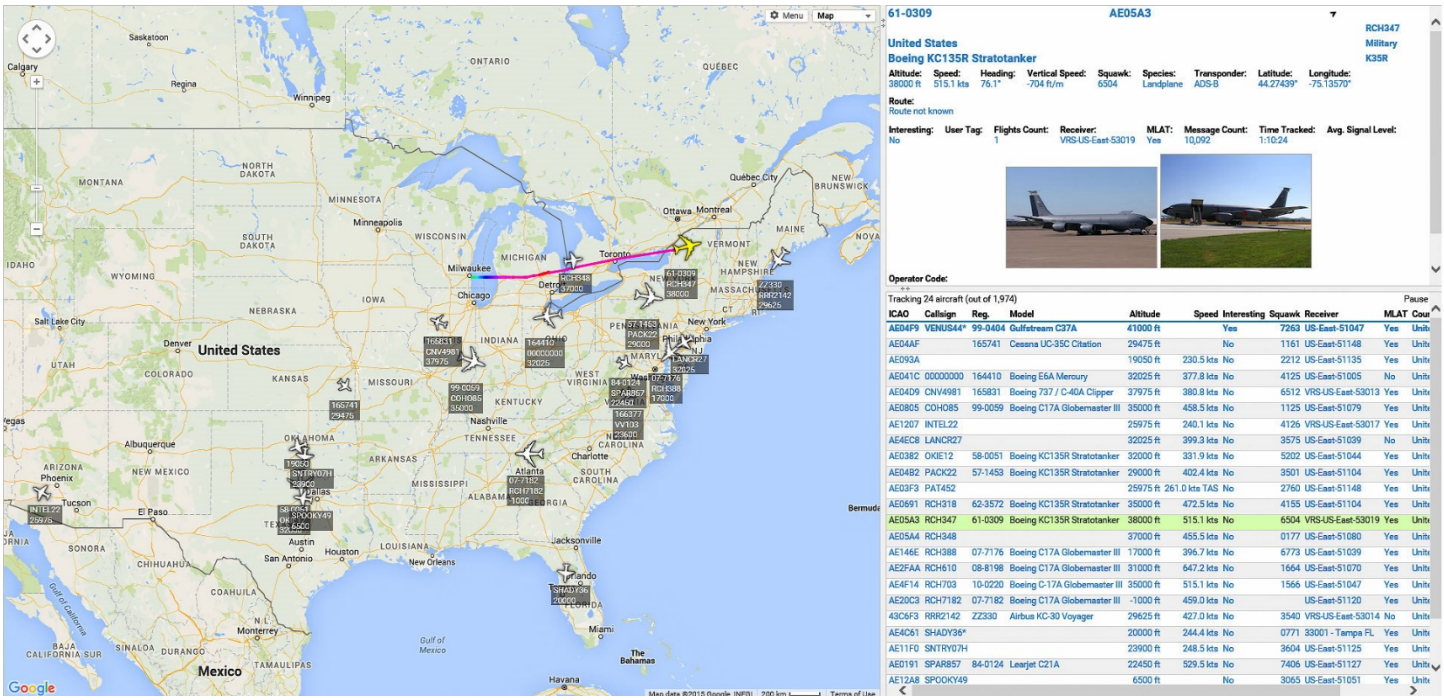
Step 2 – Run the installer – for typical users, click through all the default settings and click "Finish".

Step 3 – Start the program – if the RTL-SDR is plugged in and operating, you'll see the receiver's name and status as "Connected".

Step 4 – Click the server address URL – this opens the server's graphic user interface on your default browser. NOTE: the browser does not need internet access to access the application server.



Once the browser tab is open, ADS-B data will populate. Each flight is represented by an aircraft icon, typically representing the airframe type. Clicking on an icon will populate the flight's transmitted data to the right of the map.



Now that all the required steps are taken, setting up the Virtual Radar Server only requires plugging in the SDR dongle, connecting an antenna, running the dump1090.bat script, running Virtual Radar Server, and opening the browser tab for the GUI.

Next Steps

For more serious operations, higher quality and functionality SDR dongles will improve the experience. **Nooelec** offers mid-level SDR packages that offer slightly improved efficiency and signal reception ranges. Higher quality SDR chipsets also offer compatibility with more refined RF filters and modulation options.

Dedicated 1090 MHz antennas greatly improve ADS-B reception and flight tracking operations. Insert a USB extension cable from the SDR dongle to the USB port to separate the SDR from any computer-based RF interference. Minimize the coaxial cable length between the SDR and the antenna. Coaxial cable is inherently lossy, and less cable length means less signal loss.

Several manufacturers produce aircraft transmissions band (978 MHz UAT and 1090 MHz ADS-B) low-noise amplifiers and band pass filters to improve signal reception. Be sure to research which connectors and adapters are necessary to link the SDR, amps and filters, and coaxial cable feeding the antenna.

Dedicated stand-alone ground receivers allow operators to contribute collection to online servers, feeding ADS-B data to public-facing websites. The **PiAware Ground Receiver** feeds data to FlightAware (www.flightaware.com), an online search tool for flight traffic.

Happy hunting!