2023-12-25 Hamlet Net - ACARS and ADS-B on a SDR

Announcements:

- Test Session Info
    - Next VE session is Saturday, January 27th in the Clover Building at the Boulder County Fairgrounds, and starts at 9 am. It is a Patriot VE team session, so pre-registration is recommended. For more info, and to pre-register, see the Licensing/Testing page on the club web site, https://w0eno.org/, under the Education menu.

- We have some volunteer opportunities available where you can help out LARC:

    - Photographer / videographer - record team activities and upload to web site / YouTube

    - LARC Fest Coordinator -

    - Newsletter Editor - put together the monthly Splatter newsletter

    - Activities Chairperson - member of the Board of Directors.

- Our sister club up in Nederland is looking for some help with events they are running. They have a weekly Monday night net with no predetermined agenda, so you can lead it however you want. They are also planning a Field Day site at Golden Gate State Park and are welcoming anyone who wants to participate. Finally, they are looking for operators for the Ned Gravel run on July 8th. They have signup links for all these events, so head over to their web site https://w0ned.org/ for more information!

- You can start earning your 2024 membership or future renewal by acting as NCS for at least 5 nets this year. You can run either this Tuesday night net or the Thursday night net (or both). We have scripts available for both, so all you need is a good connection into the repeater, and somewhere to keep track of names and call signs as people check in. If you're going to be on the net anyway, why not save some dough at the same time! There are four free memberships available for 2023, so don't wait to get started!

- Chuck has set a goal for the Club of running at least one activity a month. This can be a hands-on construction activity, an operating activity like Field Day, a fox hunt, or a special event station. The goal is to get people together to have fun with amateur radio! We have multiple locations at our disposal, as well as lots of Club equipment, so if you have an idea for something you think others hams would like to do, please let us know, and if you're willing to run it, even better!

- The Club is also looking for presentation topics for 2023. If you have any ideas, or better yet, would like to present, please let Chuck know and we'll get you on the schedule!

- All club activities are open to anyone - members and non-members. If you have questions, ask them on a net or **send email to elmer@w0eno.org**

Presenter: Bryan, AF0W

Topic: ACARS and ADB-S on a SDR

- There are many activities within amateur radio - some even have correlation to other hobbies
- One example is using a radio (typically a USB software-defined radio or SDR stick) to receive radio telemetry transmitted by non-amateur stations
- These devices were originally intended as a TV tuner for computers, but some enterprising experimenters found that they could receive the signals directly from the device and decode them themselves for both audio and data modulations.
- I've heard a number of club members discuss using flight simulator software, and imagine we have more than one with actual piloting experience
- While there are a lot of radios on a modern aircraft, there are systems which transmit location and other information which can be received and decoded
- One of these is ADS-B, which stands for Automatic Dependent Surveillance - Broadcast
- While you may think the entire US is blanketed by radar, this is not the case.
- Air traffic control utilizes "secondary radar" which is a system that transmits a special signal to the aircraft (called interrogation), where a device called a transponder replies with information like a 4-digit code (which is assigned by air traffic control) and altitude information
- A new type of transponder sends more data back, and also transmits this data even if they are not interrogated.
- This data is transmitted at 1090 MHz (which corresponds to a wavelength of approximately 10.8 inches)
- This frequency is not refracted by the atmosphere
- Once received, the signal can be decoded by software running on a computer, and a "map" of local aircraft can be shown
- Commercial aircraft were required to install ADS-B transmitters as of Jan 2020
- Not only are aircraft now visible to air traffic control, but any aircraft can be equipped with an ADS-B receiver and display a picture of the traffic in the local airspace

- Aircraft that operate below 18,000 feet may also run ADS-B on 978 MHz, to alleviate congestion on 1090 MHz
- Information that can be decoded includes position and altitude, heading, speed, and flight number
- Weather and flight information can be transmitted as well
- Each aircraft is permanently assigned a Mode S address - this allows individual planes to be identified
- An example can be seen at: https://globe.adsbexchange.com/
- While there are aviation-specific radio components meant for installation in airplanes, there are also various software packages that will allow you to decode these transmissions, including dump1090 for Windows, Linux, and Mac.
- You can read more about the protocol itself at: https://mode-s.org/
- So what can you do with this info?
- First of all, you can send it to a site like Flightaware (at flightaware.com) which aggregates reports and provides real-time flight information. Some of them will give you a premium account for free if you provide your data to them. You could leverage this during an upcoming flight to see if the plane is on time, etc.
- You can also run a program like dump1090 which will log the information, and can display it in a map format so you can see what is going on around you
- You can also use the information from aggregator sites to track specific planes. I've seen a Twitter account that has a bot which posts flights made by Elon Musk's jet.

ACARS

- Another aircraft system is ACARS or Aircraft Communications Addressing and Reporting System
    a. It is a digital communications system that aircraft use to send and receive short messages to and from ground stations
- It transmits at a frequency of 131.550 MHz which can also be received with many SDRs
- Any messages you receive will be from nearby ground stations or airplanes
- While many messages will be unreadable as they are intended for computer systems, they do contain aircraft registration data that can be decoded

- These transmissions do not include any position information - you'll have to use ADS-B for that

Remote ID

- The FCC has also implemented a requirement for Remote ID applying to unmanned vehicles, including hobbyist drones
- The drones must broadcast their identity or serial number, control station and drone positions, time and emergency status
- I looked for information on decoding these broadcasts, and it turns out that while the FCC requirements are spelled out pretty clearly, they leave the actual implementation up to individual manufacturers
    a. The information can be broadcast using anything that does not require a license
    b. This includes wifi, bluetooth, as well as proprietary systems in the 2.4 and 5 GHz range as well as 900 MHz
    c. Manufacturers of drone (or companies who manufacture tracking devices for drones) have to register the specifics of the protocol used with the FCC, but the FCC says they're not going to make these submissions public

Watch Duty

- Another interesting application of SDRs and aircraft data is a project run by volunteers called Watch Duty which has a goal of improving access to live public safety information regarding wildfires in California.
- Several populated regions of California are extremely prone to wildfires, and it's important that residents get timely notifications about nearby wildfires so they can evacuate early and/or prepare their defensible spaces.
- The system works by using Raspberry Pis and multiple RTL-SDRs to monitor public safety radio channels, and ADS-B aircraft positions of firefighting aircraft in order to gather information in real time about how wildfires are moving.
- Volunteers monitor this information and distribute anything of importance via a smart phone app to the public. Often the information is significantly more timely compared to official channels.

Other Transmissions

- Aircraft aren't the only vehicles which transmit information.

- Trains have a device called an End-of-Train device. It replaces the traditional caboose and crew, and transmits information such as brake pressure and whether the end of the train is moving to detect unwanted decoupling.
- These devices typically transmit on UHF frequencies of 457.9375 and 452.9375 MHz, which is above the 450 MHz top of the 70cm band, so your mobile radio may or may not be able to listen on these frequencies.
- Even if you don't decode the data stream, monitoring that frequency can let you know if there is a train nearby,
- Another vehicle, of which we don't have any locally, are ships. They use a system called Automatic Identification System, or AIS
- You can see a plot of ship locations on https://www.marinetraffic.com/
- Ships use AIS on VHF frequencies of 161.975 and 162.025 MHz in the maritime frequency allocations.
- A good place to find out more info about SDRs and their applications is https://www.rtl-sdr.com/
- The top article on that site is titled "MAPPING GPS/GNSS INTERFERENCE THROUGH ADS-B DATA"
    a. One piece of data returned by ADS-B is the accuracy of the position fix from GPS or GNSS (which stands for global navigation satellite systems)
    b. This can be used to determine areas of very accurate or very inaccurate position data - for example, around conflict zones
- The rtl-sdr.com site has a quick start guide which you can access using a button near the top of the screen
- They also have a link to their store, where they sell a SDR receiver along with a bunch of accessories like filters, antennas, and receive amplifiers.
- There are projects out there where you can hook an SDR directly into the intermediate frequency stage in your radio and provide a bandscope, similar to that on something like an ICOM 7300.
- If your radio doesn't have an IF output, and you don't want to mess around inside it, you can just use the SDR alone to display a waterfall - but you need to make sure you protect the SDR receiver from the signal transmitted by your radio.

- Sdr-rtl device is about $30, SDPPlay RSP1A is $140 both are receive-only. ICOM 7300 is an SDR, and there are also larger radios from FlexRadio if you have big bucks.
- Broadcast radio was mentioned - you can use the SDR software to look at a broadcast signal and see things like the additional info they use for sending data like the artist and title of the song they're playing (or in the case of the local rock station down here, advertising).
- If you want to check out SDRs without spending any money, there are receive-only SDRs available on the Internet that you can control and listen to
- http://websdr.org/ has a list to a bunch of these devices located around the world
- You can use them to check signal from your radio (LARC used this during Winter Field Day to make sure our antenna was getting out)

Questions:

- **The question for the week is:** Do you have an SDR receiver (or radio), and if so, do you use it for anything other than ham radio?
- **In my case,** I've got two rtl-sdr devices and one from NooElec that I bought before I found out about the rtl-sdr devices. The rtl-sdr devices have the capability to directly receive HF frequencies in addition to VHF and UHF signals.

More Info:

- Introductory RL-SDR video: https://youtu.be/pjoUpIlQEXk
- Genuine RTL-SDR.com dongles: https://www.rtl-sdr.com/buy-rtl-sdr-dvb-t-dongles/
- https://www.rtl-sdr.com/rtl-sdr-radio-scanner-tutorial-receiving-airplane-data-with-acars/
- Airplanes.live aggregation web site: https://airplanes.live/
- RL-SDR web site: https://www.rtl-sdr.com/
- ADS-B on Wikipedia: https://en.wikipedia.org/wiki/Automatic_Dependent_Surveillance%E2%80%93Broadcast
- FlightRadar air traffic aggregation site: https://www.flightradar24.com/
- ADS-B Exchange: https://adsbexchange.com/
- OpendroneID - https://github.com/opendroneid/opendroneid-core-c
- Watch Duty: https://www.rtl-sdr.com/a-technical-overview-of-the-watch-duty-wildfire-monitoring-project-powered-by-rtl-sdrs/

- NooElec: https://www.nooelec.com/store/
- WebSDR: http://websdr.org/
- Kraken SDR: https://www.crowdsupply.com/krakenrf/krakensdr#products

Backup Questions:

1. What hobbies do you have other than ham radio? Do you (or could you) use ham radio in these hobbies?
2. Share an "a-ha" moment you had with amateur radio?

Ham-related gifts purchased or requested

- If you have ideas for net topics or general meeting topics / presenters, please let us know! Tell us on a net, or send email to k0itp@w0eno.org

Email to elmer@w0eno.org

1. K0ITP - Chuck - Firestone
2. KE0EE - Don - Longmont
3. WB0AFA - Jeff - Frederick
4. W7PGF - Philip - Frederick.
5. AF0W - Bryan - El Paso via Echolink -
6. AE0DO - John - N of Longmont
7. WA0JJC - Bob - Boulder
8. W9MTN- Ryan - Boulder

End: 7:45