The Airscoop

K8PL

From the Editor

July and August seemed to fly by this year. This included parades, supporting the Firecracker 5K run, and the annual hamfest. We now look into fall activities to include the UP Stem and Gas Engine Show, Fall Family Fun Day, and Christmas in the Village. There is a new net on the 147.150 repeater every Wednesday at 7pm it is a 2 meter digital net using VN mode (Voice Narrow).
Here is an article that explains Voice Narrow Mode.

- Bob KØNR

Intro to Digital Voice

Ham radio on the VHF and UHF bands has been dominated by Frequency Modulation (FM), an analog mode invented in the 1930s. FM remains very popular today but in the past decade several digital formats have gained in popularity. These formats are referred to as Digital Voice (DV) modes.

What is Digital Voice (DV)?

Traditional FM transceivers transmit an analog signal over the air. DV transceivers convert the microphone audio to digital form which is then used to produce a digital stream of bits that goes out on the RF carrier (Figure1). The *Analog-to-Digital (A/D) Converter* samples the analog waveform and turns it into digital bits which the *Vocoder* compresses into a more compact digital format. The vocoder is a key piece of technology, with the AMBE decoders being the most common. The compressed digital audio is sent to the *modulator*, which modulates the RF carrier in the transmitter. At the receiver, these same functions are reversed to recreate the original microphone audio.

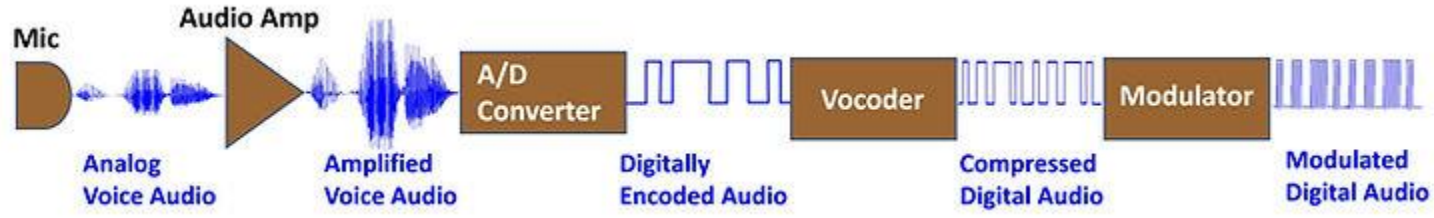

Figure 1. The audio processing chain of a digital voice transmitter.

There are several key advantages of DV radios.

- Digits are encoded at the originating radio, so as long as the bit stream does not encounter errors there is no degradation of the signal during transport
- Call sign and other information can be encoded into the digital stream. This can act like a "caller ID" with the name and call sign of the station you are talking to popping up on your radio display. Other information can be included such as GPS location, operator name or a short message.
- DV signals take up less bandwidth in the frequency spectrum, so they are said to be spectrally efficient. For a given frequency spectrum, more radio channels can be supported.

And, in general, digital is cool! In this day and age, why *wouldn't* we be using digital voice technology?

Internet Connectivity

A common thing to do with digital radio signals is to transfer them some distance over a digital network. Often the network used is the *internet* which allows the signal to go wherever there is an internet connection. This is often called *Voice Over Internet Protocol*, abbreviated VoIP.

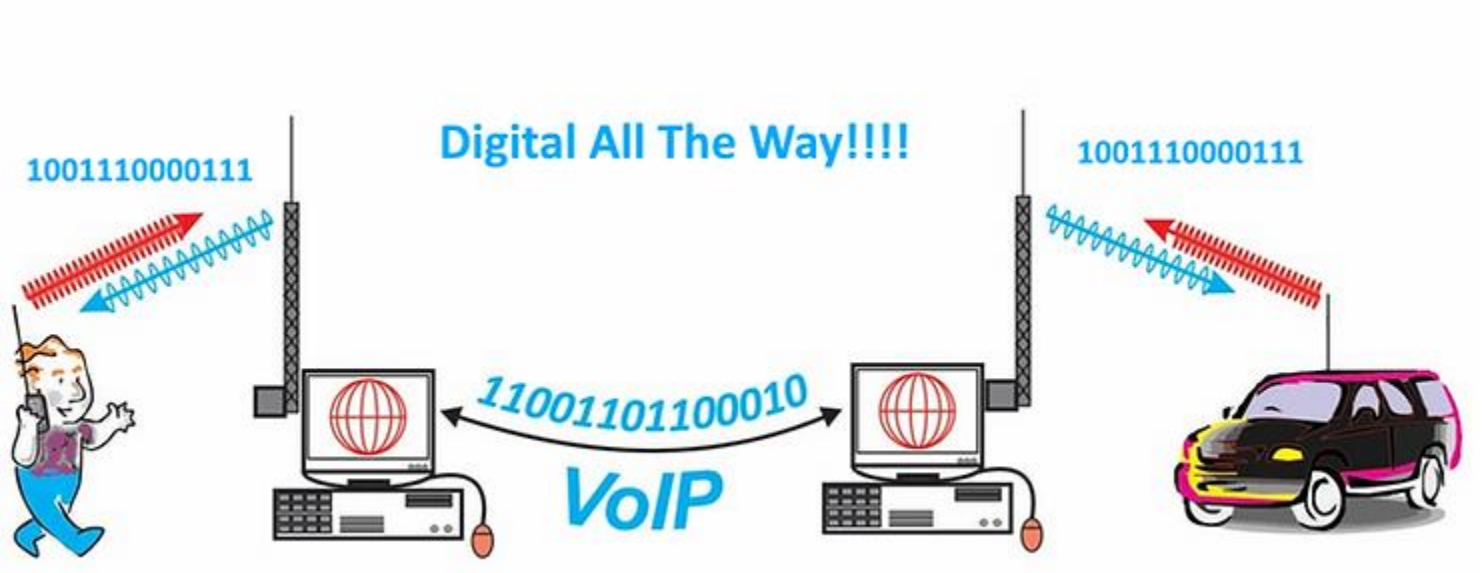

Figure 2. Using DV radios, the signal is transmitted in digital form all of the way through the system.

We can use VoIP technology to link up a set of repeaters, receive signals on our smartphones or computers, and connect up a personal *hotspot* station (more on that later).
And if the network is down (or you just don't want to use it), DV modes can also be used on digital repeaters and simplex channels.

Common Digital Voice Formats

We will discuss the main three DV formats used in ham radio (D-STAR, DMR, and YSF). There are other DV formats used but you are much less likely to encounter them. D-STAR (Digital Smart Technologies for Amateur Radio) was the first DV technology specifically made for ham radio, developed by the Japan Amateur Radio League in the late 1990s. ICOM adopted and promoted D-STAR technology and is still the main driving force behind it. (Kenwood now also offers radios with D-STAR capability.) Take a look at this older video from ICOM talking about the benefits of using D-STAR.

In 2005, the European Telecommunications Standards Institute (ETSI) published the commercial Digital Mobile Radio (DMR) standard. DMR is a very robust commercial standard, but not defined with amateur radio in mind. Still, many hams saw the potential for using DMR on the ham bands and it quickly gained traction. There are many manufacturers that make DMR equipment, selling to both the commercial and amateur markets (Motorola, Hytera, Anytone, TYT, Alinco, and many others).

In 2013, Yaesu introduced the third DV format, this one designed for amateur use, called System Fusion. (It is often called Yaesu System Fusion or simply YSF.) This technology was designed for amateur radio and is considered by some hams to be an improvement over D-STAR. Yaesu is currently the only major ham manufacturer producing YSF radios.

About now, you may be thinking that surely these three DV formats are compatible so that the various DV radios can be used to communicate. Well, unfortunately, that is not the case. At a high level, these three radio formats do the same basic thing: they use digital modulation to transmit voice signals over the air. However, these three DV formats are different enough that they are incompatible.

These digital radios are compatible in one way: they all support good old analog FM. This allows the radios to support their respective DV mode while remaining backward compatible with FM.

Let's take a closer look at these three DV formats. Our goal here is to give you a rough idea of how they work and how they are different. However, this short article won't make you an expert on them.

D-STAR

The most commonly used D-STAR mode is called "DV", which sends 4800 bps to support simultaneous voice and data transmissions. Digitized voice uses 3600 bps, leaving 1200 bps for data transmission. The data transmission is quite slow but it is enough to support things like call sign display ("Caller ID"), GPS position, and short messages. The D-STAR format includes the transmitting station's call sign and headers that indicate where the transmitted signal is intended to go (might be your local repeater or a ham on the other side of the world).

The original D-STAR system did not include the concept of many stations getting together on one channel to talk (using repeaters all over the world). So the amateur community created this capability, called a *reflector*. A reflector is basically a computer server sitting on the network that retransmits ("reflects") a transmitted signal to every repeater that is listening to that reflector. This supports the common ham usage of many people gathering on a particular communication channel.

For more info, D-STAR, take a look at this marketing brochure:
D-STAR-System-Introduction

.pdf

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Yaesu System Fusion
YSF has several DV formats to choose from but the most common is called DN, which means *digital normal*. This mode is similar to D-STAR in that the voice data is combined with a data stream that can carry the call sign, routing information, GPS coordinates, and short messages. The other YSF modes are *Voice Wide* (VW) which delivers improved audio quality but without the digital data stream and *Data Wide* (DW) which just supports data transmission, no voice.

Similar to D-STAR reflectors, YSF provides a communication network called *WIRES-X* , which supports a communication method called *rooms*, similar to D_STAR reflectors, which allows multiple ham operators to gather and communicate.

See this brochure from Yaesu for more info on Yaesu System Fusion:
Yaesu System_Fusion_brochure

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DMR

Of the three DV technologies, DMR is the most unique. As stated earlier, the DMR standard was created for commercial land mobile radio, not amateur radio. First off, DMR does not support call signs but instead uses a unique number called a *Radio ID* to tag each radio. The amateur radio community has adapted the Radio ID approach to support call signs by creating a worldwide database that assigns a unique Radio ID to a particular call sign. A user's radio can be loaded with this table of Radio IDs / Call signs so the radio can display the call sign associated with the signal being heard.

Because it is an industry standard developed by a formal standards body (ETSI), the DMR documentation is well-crafted and complete. DMR defines three Tiers of functionality (Tier I, Tier II, and Tier III), but amateur radio only uses Tier II.

DMR uses Time-Division Multiple Access (TDMA) to create two communication channels (called *slots)* on one RF carrier. Each time slot is 30 ms long, with one complete cycle lasting 60 ms. As shown in Figure 3, radios assigned to slot 1 transmit and receive during that 30 ms time interval. Similarly, radios assigned to slot 2 use the other 30 ms time interval. This requires tight synchronization between the repeater and the user's radios.

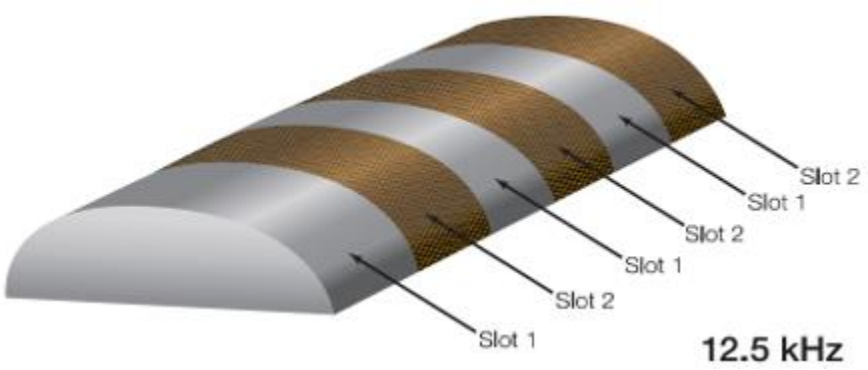

Figure 3. DMR uses Time Division Multiple Access to support two channels (slots) on one RF carrier.

A DMR repeater can support two sets of QSOs simultaneously, while only requiring one transmitter and one receiver. From a repeater owner's perspective, this is a "two for one" proposition...install one repeater and get two wireless channels.
DMR brought some commercial radio nomenclature into the amateur radio community. (Some of this terminology shows up on the Technician license exam.) The programming information for the radio is commonly called a *Code Plug*, but it is really just the concept of having a file that gets loaded into your radio to set the memory channels and other functions.

DMR has the concept of a *Color Code* which selects which repeater you are trying to access. If two repeaters overlap in coverage, they would be given unique color codes and the memory channel in your radio would match the repeater you are using.

A very important concept in DMR is the *Talk Group*, which selects which group of users you are in radio contact with. For example, on your local repeater, if you and your friends have Talk Group 100 programmed into your radios, then you will all hear each other but not any other radio transmissions. Another group of repeater users could choose Talk Group 101 for their communications, hearing Talk Group 101 but not Talk Group 100. Talk Groups can also be used with linked repeaters and VoIP systems.

There are several networking systems that support DMR VoIP communications, including DMR-MARC, DMRPlus, and Brandmeister. These systems have networked servers that connect multiple hams in many locations, selected by Talk Group. These networks are quite complex, essentially a collection of servers running network protocols that connect up thousands of users running DMR radios.

For more info on DMR, see the DMR for Dummies website .

Repeaters and Hotspots

To get the maximum benefit of these DV modes, you'll want to be able to use repeaters or hotspots to connect to worldwide networks. To find out about repeaters available in your area, use a repeater directory such as repeaterbook.com. The directory will let you see which repeaters support D-STAR, YSF, or DMR. The YSF repeaters from Yaesu can be setup to support both FM and YSF, automatically sensing the type of signal coming into the repeater and repeating the same format. This allows FM users and YSF users to share the same repeater (although they can't normally understand each other). DMR repeaters are normally DV only but sometimes you'll find a DMR repeater that also supports FM. D-STAR repeaters from ICOM only support D-STAR, so most D-STAR repeaters will be DV only.

Hotspots are another very popular option for accessing a DV network. A hotspot is a low-power transceiver (typically <100 mW of RF power) that connects a DV network via the internet. This is analogous to the WiFi access point that you may have in your house for internet access. In fact, a DV hotspot might connect to the internet using your WiFi router.
So a hotspot is your own personal DV access point with your call sign on it, under your control, configured the way you like.

The typical use for a hotspot is to connect it to your home internet (via LAN cable or WiFi), set up to transmit on a 2m or 70 cm simplex frequency. (70 cm is generally preferred and be sure to check your local bandplan for frequency recommendations.) You configure the hotspot to connect to the desired network (via a specific server address) and have it transmit whatever reflector (D-STAR), room (YSF), or talk group (DMR) that you want to communicate with. Typically, the hotspot is only transmitting a short distance to your handheld transceiver, allowing you to walk around the house and yard while talking to hams almost anywhere in the world.

Figure 4. Typical hotspot use is a handheld transceiver communicating locally to a low-power hotspot connected to the internet.

There are a number of hotspot available, such as the OpenSpot products from SharkRF and the ZumSpot from ZUMRadio. These hotspots typically support multiple DV formats. In many cases, they can translate from one DV format to another. For example, a YSF radio can be used to communicate with a hotspot which then connects to a DMR network. Along those same lines, ClearNode offers a hotspot that communicates with analog FM radios while connecting to DV networks. Many of these hotspots are built on the Raspberry Pi compute platform, a popular widget used for ham radio applications.

If hotspots sound complicated, that's because they are. There is a lot of innovation and experimentation going on with hotspots and DV networks which creates complexity and confusion. Some hams find this challenging and fun, while others just get frustrated with it. It is important to go into this with your eyes wide open.

Yaesu offers the HRI-200 interface box for its WIRES-X network that allows a Yaesu transceiver to be a hotspot. Yaesu says it is easy to configure but it works only on the WIRES-X system.

Summary

We've discussed the three most popular DV formats used in ham radio. These are largely incompatible digital modes but there are some cross-mode capabilities that can link them together (e.g., hotspots). So when you dive into using DV radios, you are typically signing up for a particular DV ecosystem (D-STAR, YSF, or DMR).

An obvious first step is to find out what format is most popular in your area and, especially, what repeaters are available. You may want to use a hotspot, which opens up many more possibilities along with some configuration challenges. Finding a mentor that has already figured this out for your local area is a really good idea.

You should enter the world of DV with the expectation of needing to learn some new things. (Don't expect it to be turn-key.) This is not a bad thing; learning new technology is an important part of ham radio and can be a lot fun!

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Welcome New Ham
Angelo G Sherville KE8YER

Secretary's Report

Secretary's report was not available at the time of this newsletter posting.

Treasurers Report

Website

I encourage you to check out our website www.k8pl.org for updated information. You can also check out our facebook page https://www.facebook.com/groups/dcars.k8pl for updates on current events. I will be working to develop a google chat account where people can post information and chat with other members.

Coming Events

Monday Aug 28 Project night at the telegraph office.
Saturday September 3rd Breakfast at Family Inn 9am