History of digital voice for HF

 "Practical HF Digital Voice," by Charles Brain (G4GUO) and Andy Talbot (G4JNT), May/June 2000, QEX, was the first detailed article about HF digital voice for amateur radio. http://www.arrl.org/files/file/Technology/tis/info/pdf/0056x003.pdf. The authors described the development of an HF digital voice hardware adapter which they estimated at the time would cost roughly $300 to build. They used commercially-available vocoders to encode voice as a digital signal for transmission and decode the received digital signal back to analog. They noted that finding a relatively low bit rate vocoder (3,000 bits per second) suitable for use over HF radio (3,000 Hertz-wide channels) was a challenge.

Another challenge was that all of the popular vocoders contained some proprietary technology. Use of such vocoders would require obtaining licenses and paying licensing fees.

A breakthrough occurred in 2012 when David Witten and David Rowe collaborated to develop FreeDV. Witten handled the GUI and architecture, while Rowe focused on the vocoder, modem, and integration. A key goal was the development of a patent-free vocoder for HF use--now known as Codec 2--to keep down costs and to encourage experimentation within the amateur radio community. Fortunately, though all popular vocoders contained some patented technology, the bulk of the technology was public domain.

The FreeDV design and user interface is based on FDMDV (frequency Division Multiplex Digital Voice), developed by Francesco Lanza (HB9TLK) in the mid-2000s. Francesco received guidance on modem design from Peter Martinez G3PLX, who also advised David Rowe on the FDMDV modem used in FreeDV.

Mel Whitten (K0PFX) applied his experience developing, testing, and promoting digital voice systems to help shape the design of FreeDV. Namely, to meet the expectations of amateur radio operators accustomed to SSB, FreeDV needed to be a fast sync, low latency, system without the extra overhead of forward error correction (FEC). Mel and a team of alpha testers (Gerry, N4DVR; Jim, K3DCC; Rick, WA6NUT; and Tony, K2MO) also provided feedback on the usability of FreeDV.

Bruce Perens (K6BP) also deserves credit for helping to inspire and promote the development of Codec 2 and FreeDV.

DMR, D-Star, System Fusion, and M17 are also digital voice systems, but are mainly intended for VHF/UHF use. DMR was designed for private radio networks around 2005 and adapted to amateur radio in 2014. D-Star was developed in the late 1990s by the Japan Amateur Radio League. D-STAR has been used on HF frequencies, but it consumes about as much bandwidth (6 kHz) as an AM signal, uses a proprietary vocoder, and requires an Icom HF radio. System Fusion was introduced by Yaesu in 2013. FreeDV remains the only HF digital voice solution that consumes less bandwidth than SSB, uses an open source vocoder, and does not require special hardware.

In March of 2023, Amateur Radio Digital Communications (ARDC), a California-based foundation, announced a grant of $420,000 to the FreeDV Project to further HF digital voice development and use. One of the goals is to make "FreeDV performance superior to single-sideband (SSB) over poor high-frequency (HF) channels."

More details about FreeDV technology can be found at: https://github.com/drowe67/codec2/blob/main/README_freedv.md

How to configure your radio for push-to-talk (PTT)

Because FreeDV runs on a computer, you need to select a method for switching your radio between transmit and receive. Go to "PTT Config" under the "Tools" tab. If your radio is listed in the Hamlib library and you are set up to use CAT control, check "Use Hamlib PTT" and select your radio model and CAT port. Otherwise, the simplest alternative is to use your radio's VOX feature. FreeDV allows you to test your audio and PTT configuration choices during setup.

It's important to understand that once you press "PTT" you are transmitting a continuous signal. Depending on your radio model, you may need to reduce your transmit power. (Check with your radio's manufacturer.) Unlike SSB, the power of a digital voice signal does not vary with your voice. And if you use VOX as your PTT method, it will not turn off your transmitter during speech pauses. Your computer generates a digital signal when you press "PTT" and stops only when you switch back to receive.

An easy way to set up FreeDV if you are not currently using digital modes

A nice feature of FreeDV is that many hams already have the required hardware setup, due to the popularity of the FT-8 and PSK digital modes. But even if you aren't set up for popular digital modes, you only need to add a USB-based audio in/out device such as the USB Sound Adapter 7.1 Channel which sells for around $7 and is quite compact (see Figure). This sound card device is available from several suppliers. Walmart carries a similar device.

Let's use the Yaesu FT-857 as an example. This radio requires a single (6-pin) mini DIN plug (also around $7) for audio input. Therefore, cut one end off of a 1/8-inch audio jumper cable and connect a 6-pin DIN plug to that end using the DATA IN and GND pins (see Figure). Plug the other end into the headphone jack (the green jack) on the pictured USB sound adapter. The headphone jack of the Yaesu FT-857 connects to the microphone input jack (the yellow jack) on the USB sound adapter using an another 1/8-inch to 1/8-inch audio jumper cable. The total cost of the USB sound adapter, mini DIN plug, and two jumper cables is minimal (about $25).

Go to Audio Config under the Tools tab in the FreeDV software. Set the receive audio input and transmit audio output to the USB sound adapter. (Set the receive

audio output to use the computer's speaker and the transmit audio input to use the computer's microphone.)

Choose the desired digital voice mode (e.g., 700D) in FreeDV's main control panel. Put your radio in VOX mode. When you transmit digital voice (push the "PTT" button on FreeDV's main console), it will put your radio in transmit without any further connections.

Be aware that in digital mode when you push the "PTT" button your radio transmits continuously until you switch back to receive. The power does not vary with your voice, nor does the transmitter pause when you aren't speaking. Depending on your radio model, you may need to reduce your transmit power.

When you select the analog button on FreeDV's main console, it will pass through your audio, and your radio will operate normally, except that it will use your computer's microphone and speaker.

List of FreeDV software contributors

David Rowe (VK5DGR), develops and maintains FreeDV with the assistance of Mooneer Salem (K6AQ).

Others who have contributed in various ways to the FreeDV project include David Witten (KD0EAG), Richard Shaw (KF5OIM), Walter Holmes (K5WH), A. Maitland Bottoms (AA4HS), Francesco Lanza (HB9TLK), Peter Martinez (G3PLX), Mel Whitten (K0PFX), Gerry Helder (N4DV), Jim Gillespie (K3DCC), Rick Peterson (WA6NUT), Tony Bombardiere (K2MO), and Bruce Perens (K6BP).

Squelch

DATA Out
1200 (RXA)

DATA Out
9600 (DISCR)

PTT

GND

Data In (TXA)