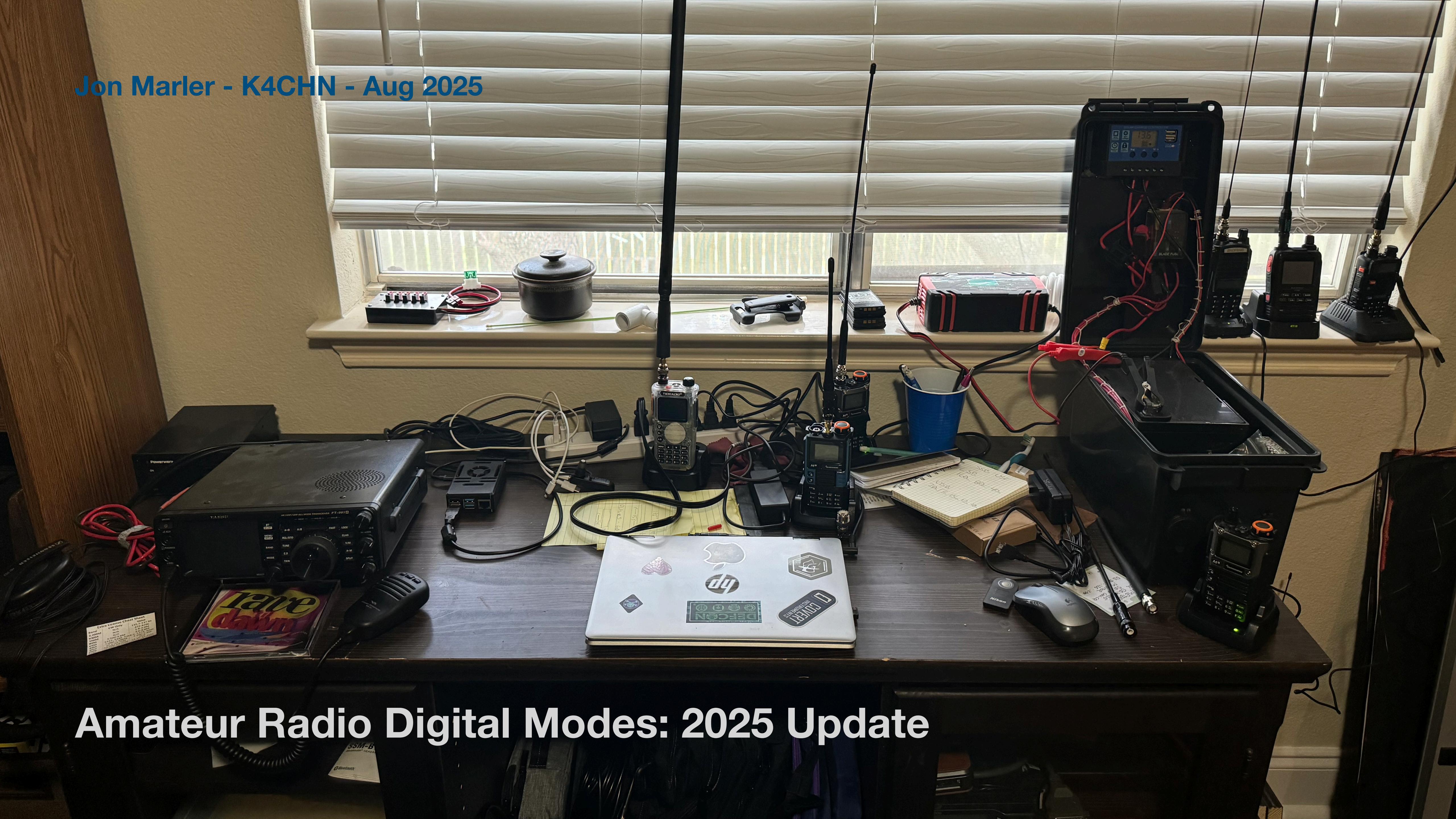


Jon Marler - K4CHN - Aug 2025

Amateur Radio Digital Modes: 2025 Update



K4CHN / Jon Marler

Amateur Radio Operator / Hacker

- First radio - Lafayette KT-200
- Passed Technician @ DefCon 27
- Passed General @ DefCon 28
- Passed Extra @ DefCon 29
- 40m voice
- Fairly active on 40m FT8
- Monitor 14.230 SSTV
- Breaker and fixer of all things
- May or may not be a robot cat from the future



Presentation Agenda

Amateur Radio Digital Modes: 2025 Update

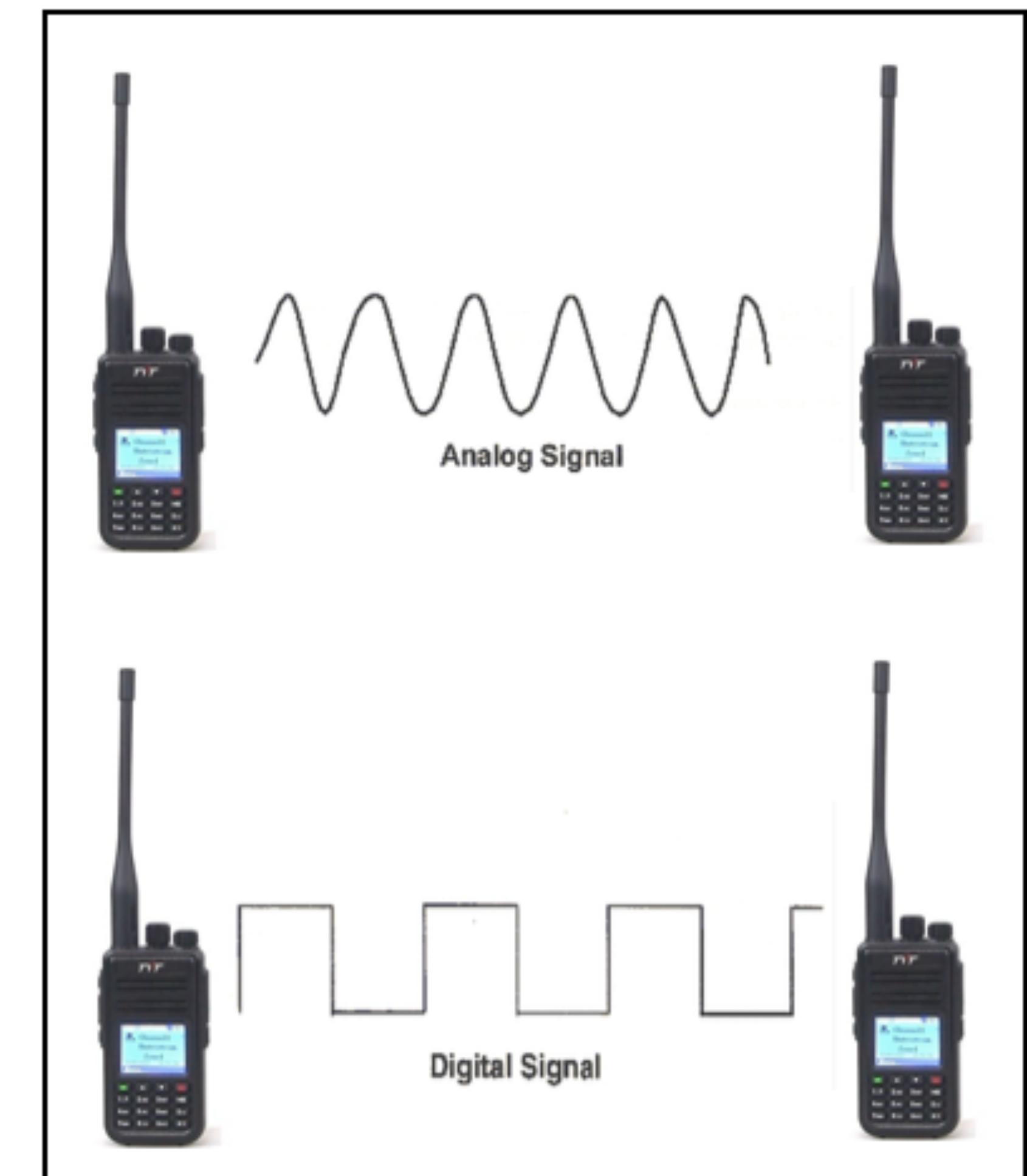
- What Are Digital Modes?
- Popular Digital Modes & Updates
- APRS
- Digital Voice Modes
- Beginner Hardware
- Getting Started
- Q&A

What Are Digital Modes?

Digital Modes 2025 - Analog vs Digital

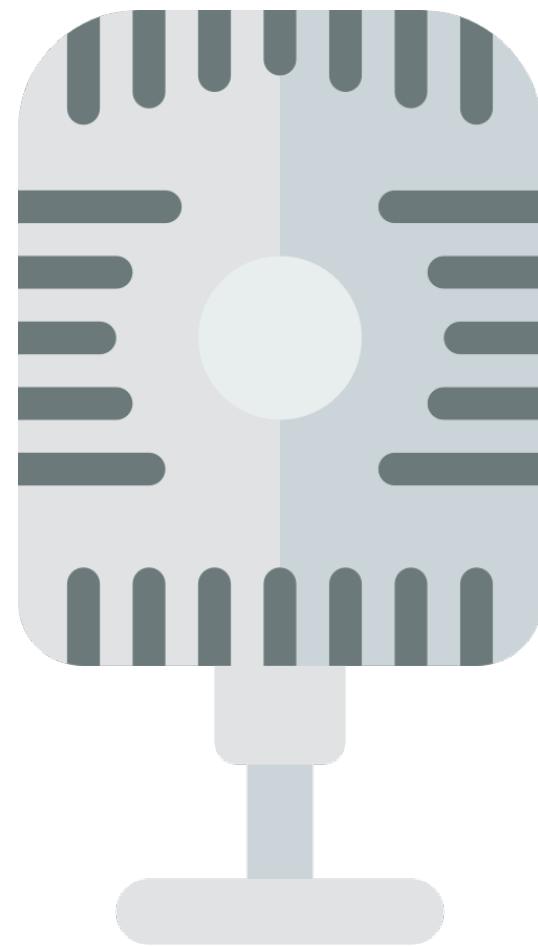
What is the difference?

- Analog - Continuous waveform
 - Modulation - AM, FM, SSB
- Digital - Discrete square wave signal
 - Modulation - PSK31, RTTY, FT8, DMR, D-STAR, System Fusion, Wires-X, M17, etc



Digital Modes 2025 - Digital Mode Types

What primary types of digital modes are there?



Voice

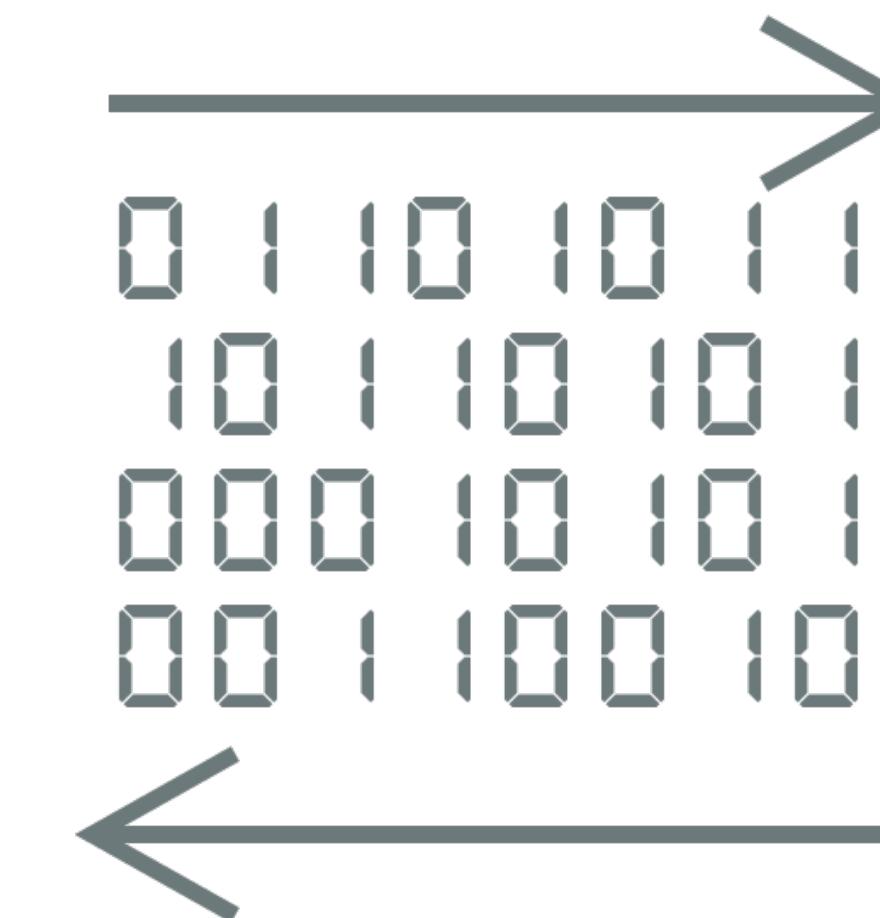
D-Star

DMR

WiresX

AMBE

FreeDV (RADE) - M17



Data

SSTV

APRS

PSK

RTTY

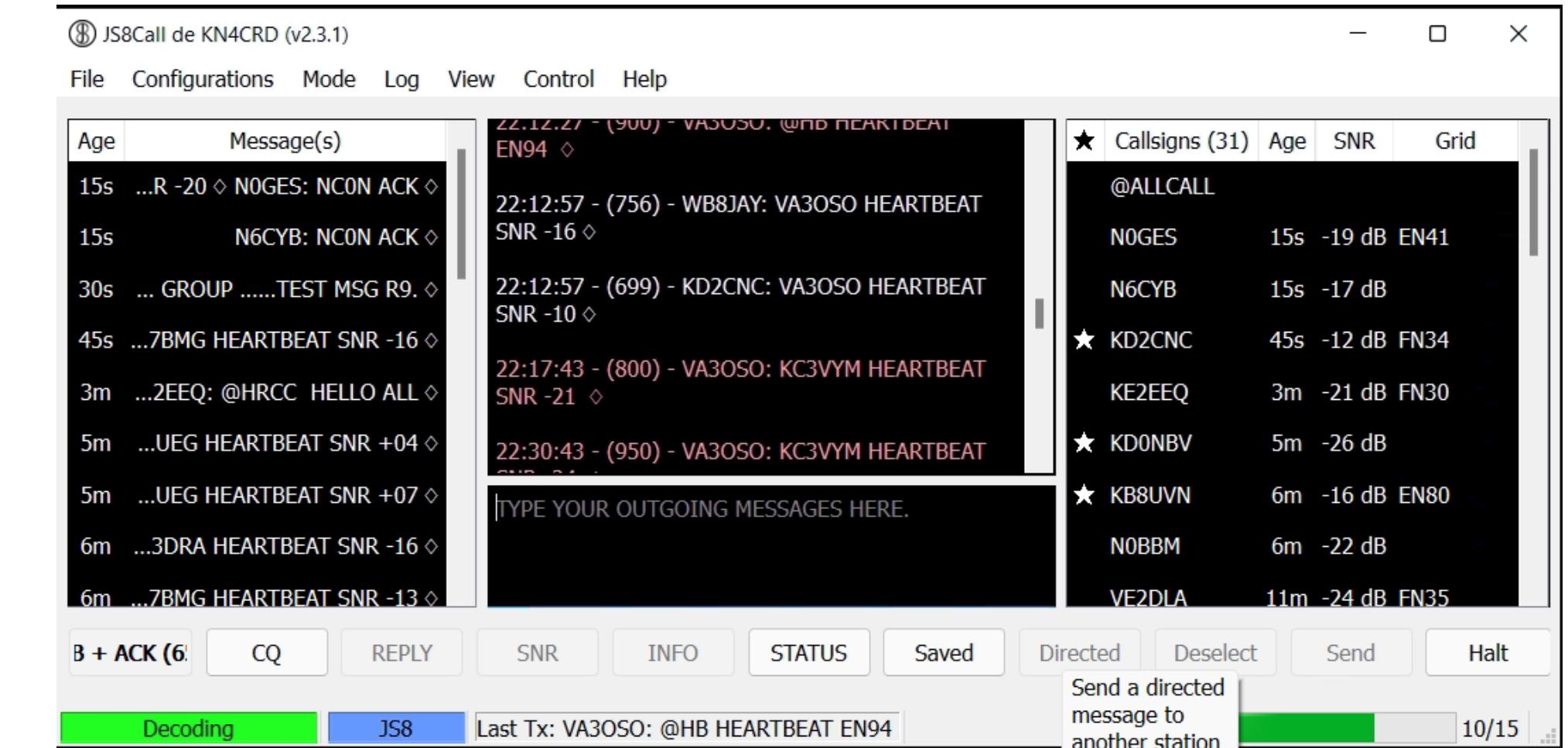
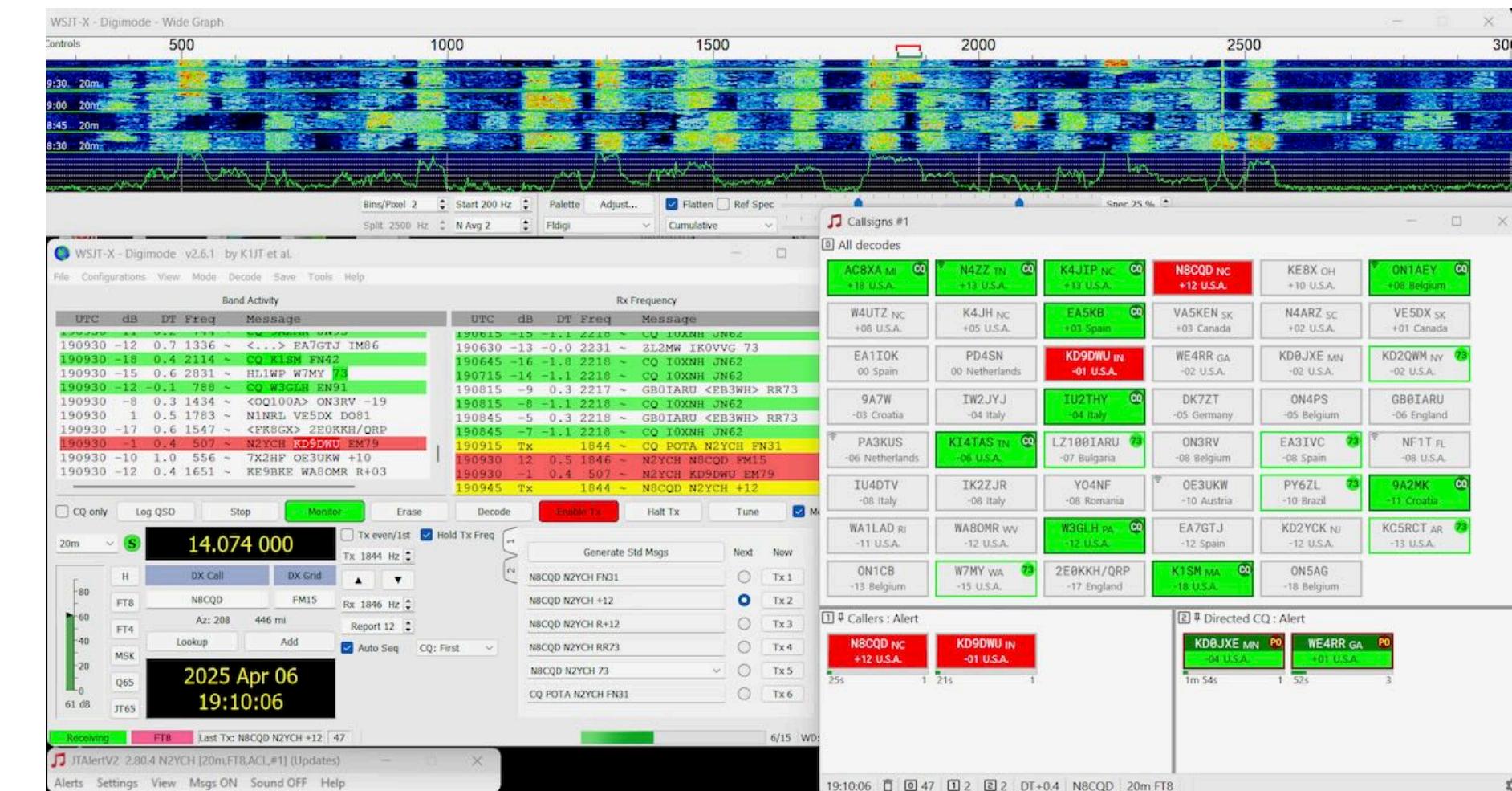
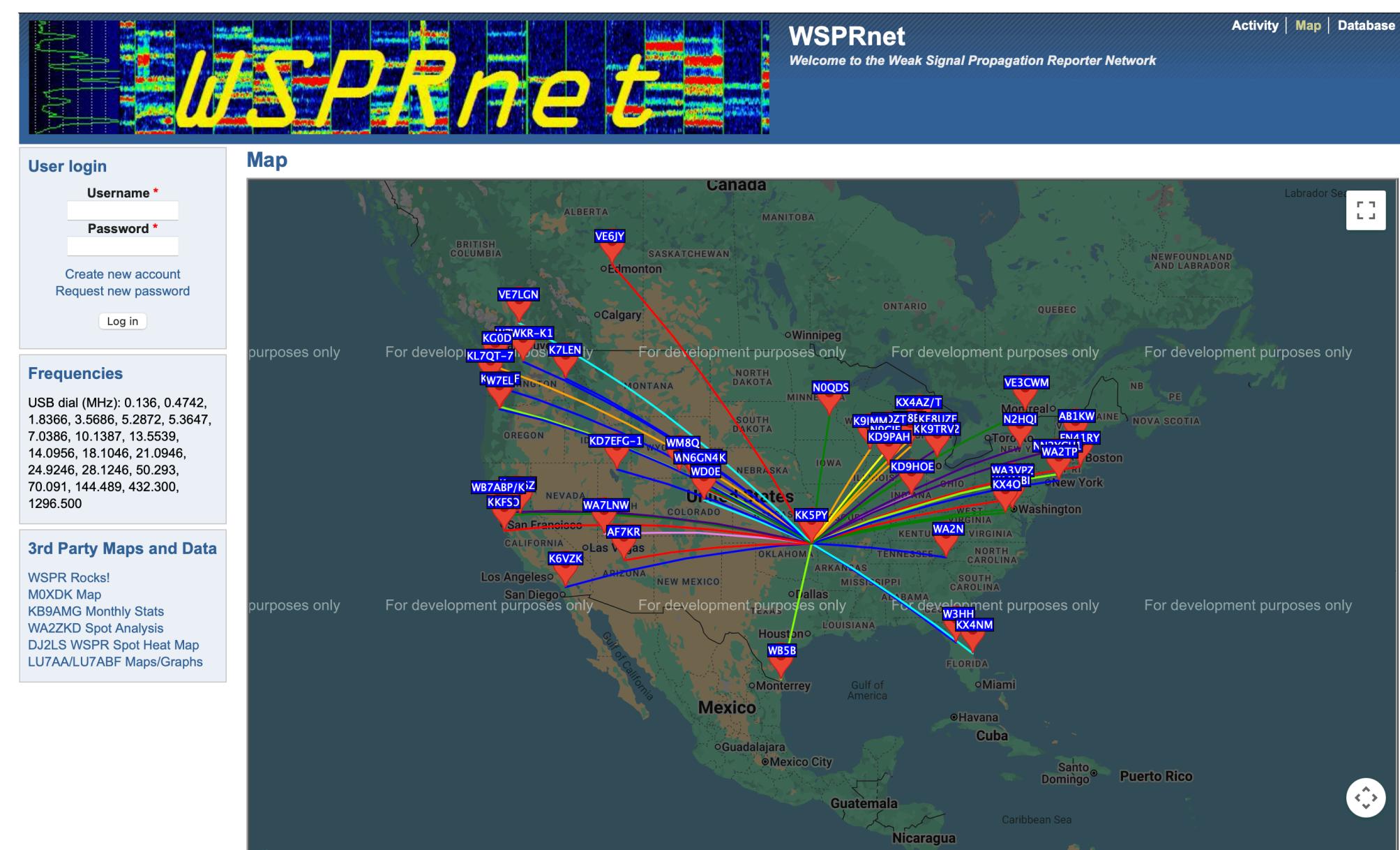
FT8

Popular Digital Modes & Updates

Digital Modes 2025 - Popular Digital Modes

What are a few of the more popular digital modes in 2025?

- FT8 & FT4
- JS8Call
- WSPR



Digital Modes 2025 - WSJT-X

What's new in WSJT-X? Anything? Bueler?

- WSJT-X Improved - <https://sourceforge.net/projects/wsjt-x-improved/>
 - Active Development
 - Improved UX
 - Enhanced Logging & Contesting
 - Better Rig Control
 - Frequent Releases
 - Dark Mode

Automatic Packet Reporting System

APRS

Digital Modes 2025 - APRS

What is APRS?

- Packet Radio (AX.25)
 - Traditionally VHF
- Real-time Position Tracking
- Messaging
- Telemetry
- Weather Data
- SMS Gateways (<https://aprs.wiki>)



Digital Modes 2025 - New APRS Hardware

What are some interesting new hardware for APRS?

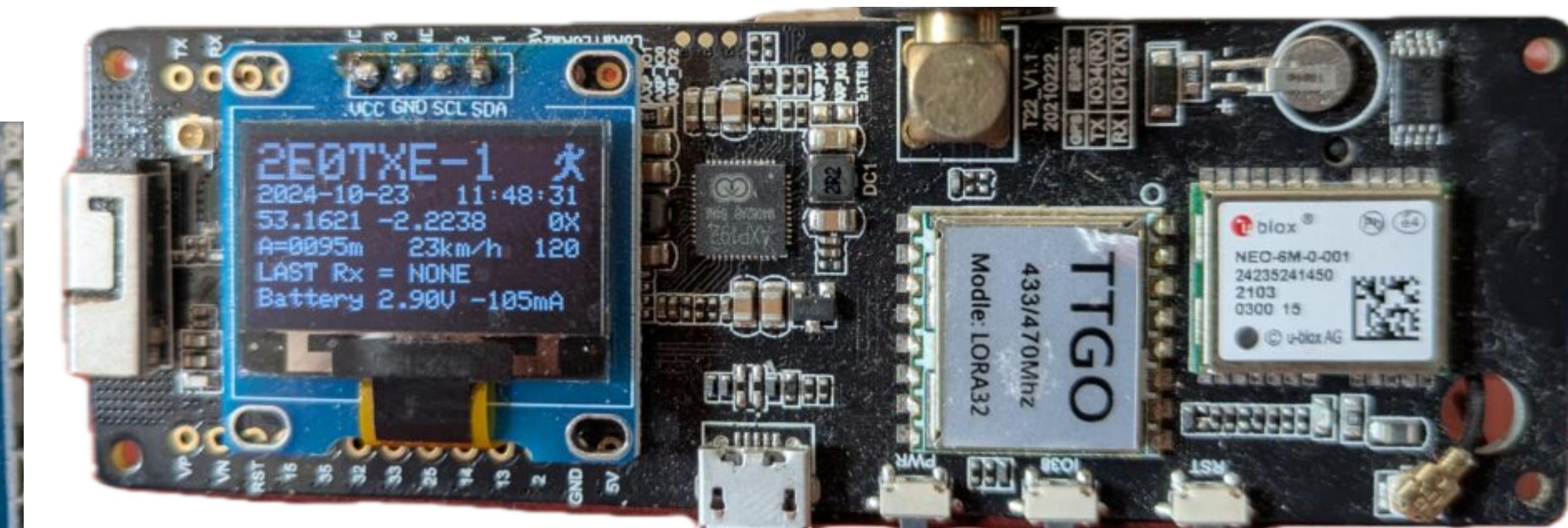
- WiMo PicoAPRS v4 (**\$399**)
 - Ultra-compact APRS Handheld
 - GPS, Bluetooth, WiFi, and Voice
- Kenwood TH-D75A Handheld (**\$639**)
 - Triband (VHF/Air/UHF) APRS
 - USB-C, GPS, Standalone Digipeater



Digital Modes 2025 - APRS Updates

What's new with APRS?

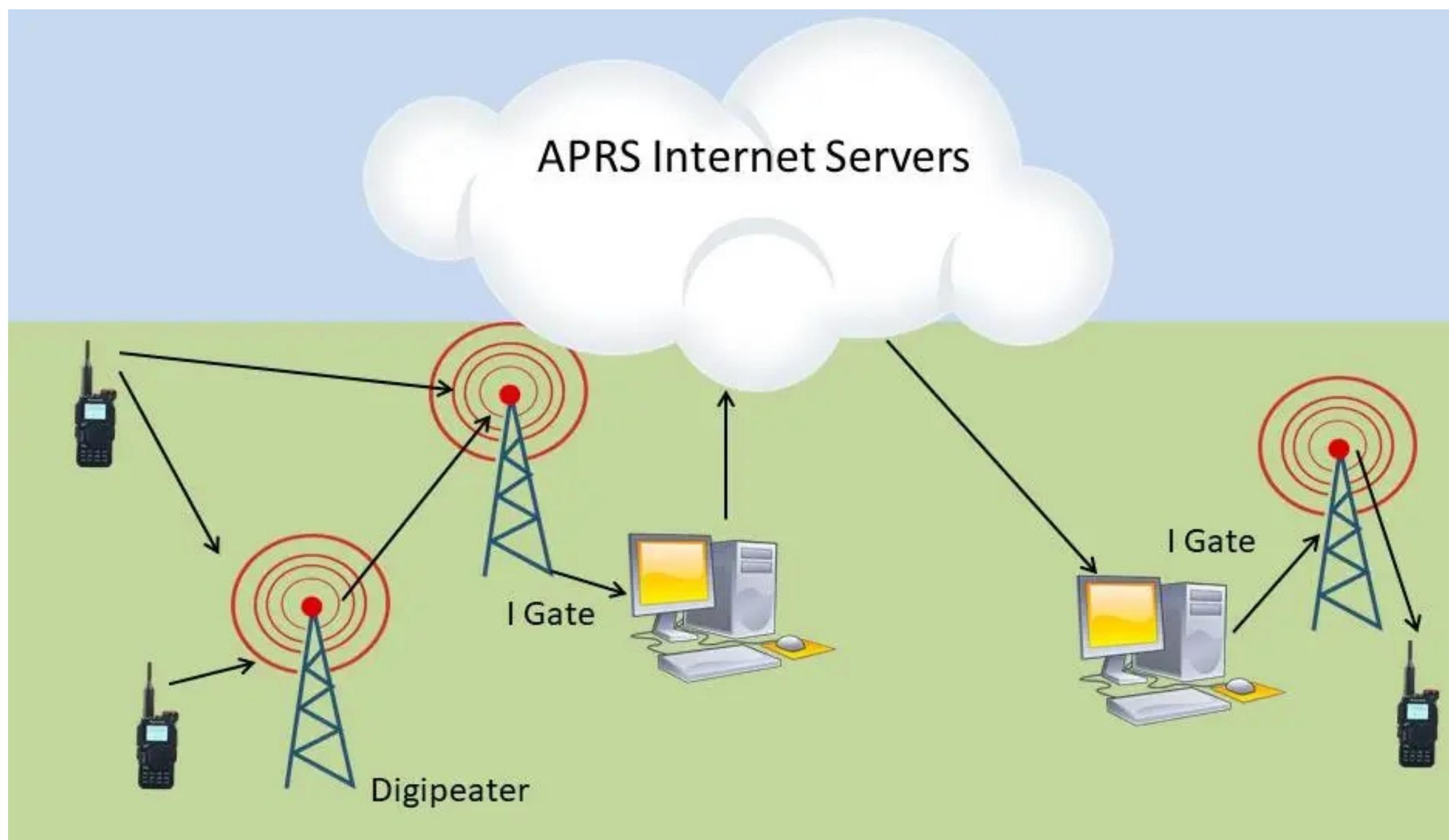
- LoRa APRS
 - Low-power and Long-range
 - Efficient Battery Use
 - Upcoming CubeSat Missions
 - Frequency: **439.9125 Mhz** or **433.475 Mhz**
- Useful Links
 - https://github.com/richonguzman/LoRa_APRS_Tracker
 - <https://www.gx4mws.uk/2024/10/23/lora-aprs-on-433mhz>



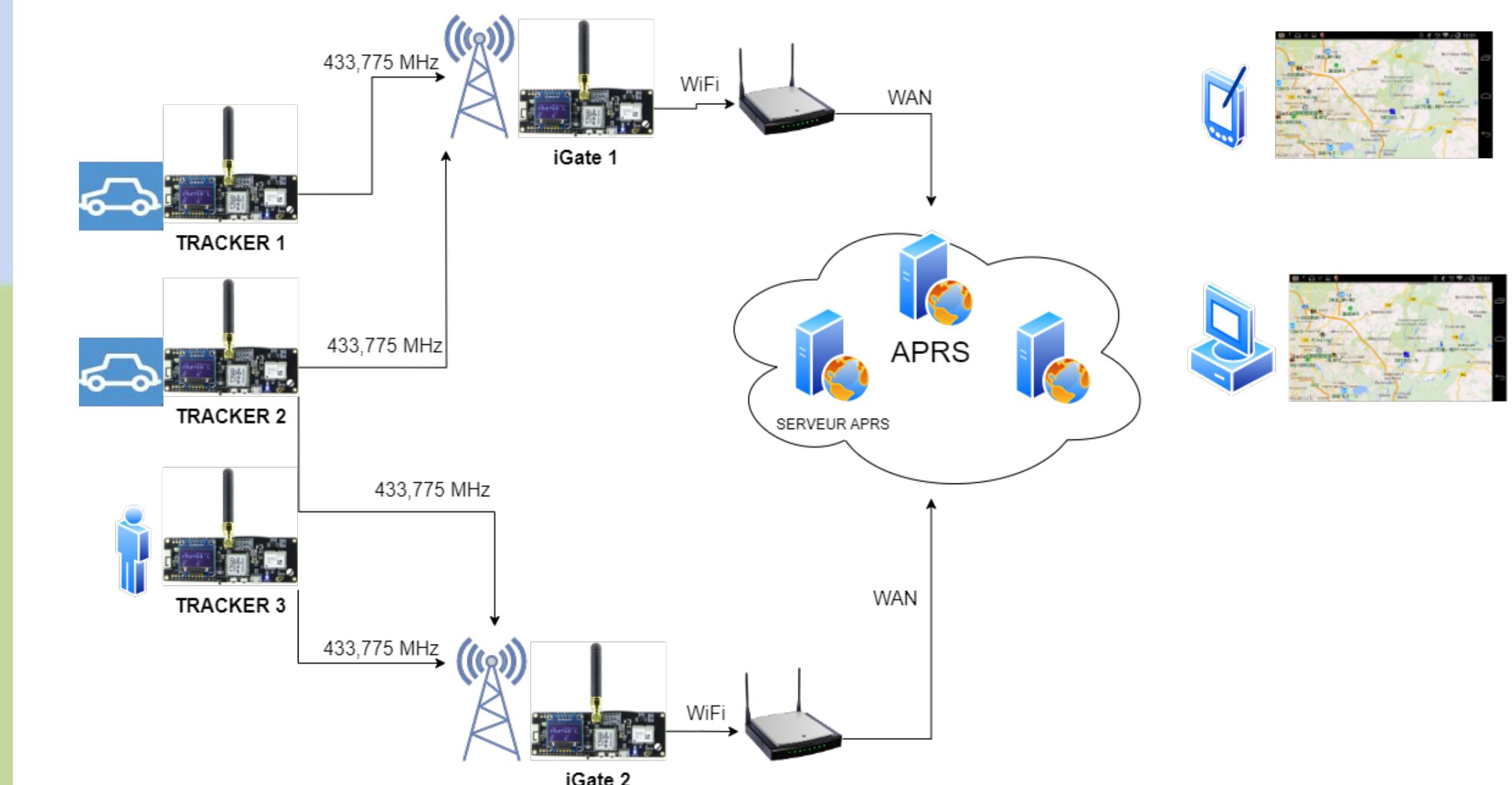
Digital Modes 2025 - LoRa APRS

How does it work?

VHF APRS



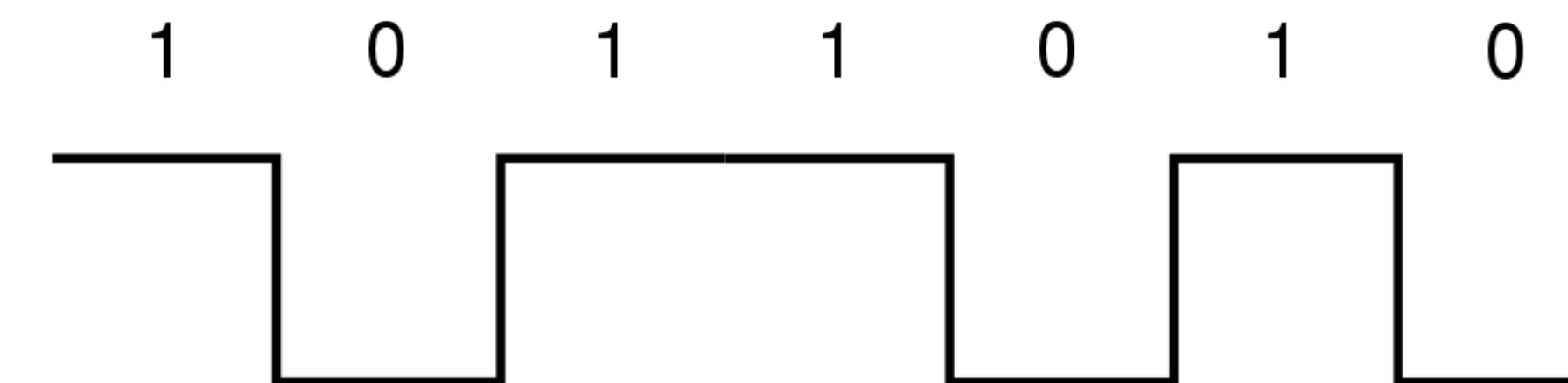
LoRa APRS



Digital Voice Modes

Digital Modes 2025 - Digital Voice Introduction

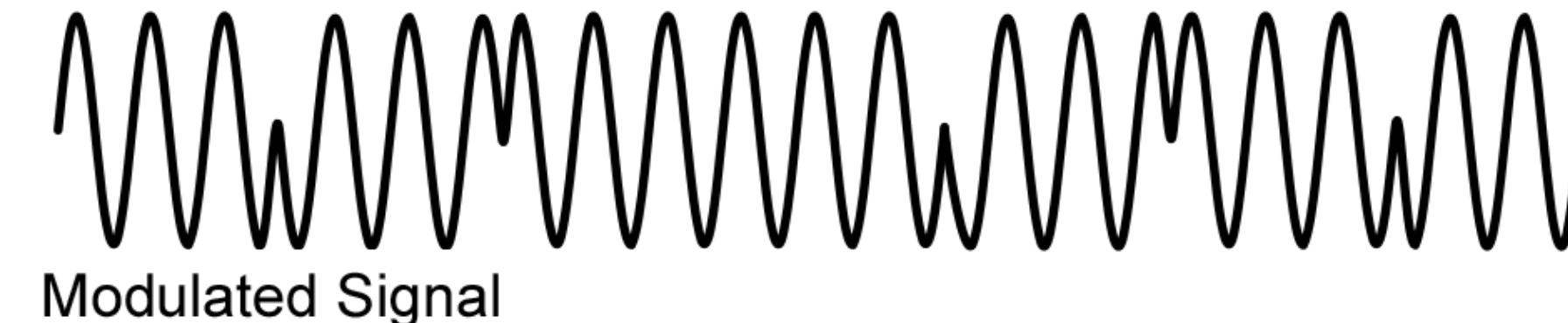
How do digital voice modes work at a high level



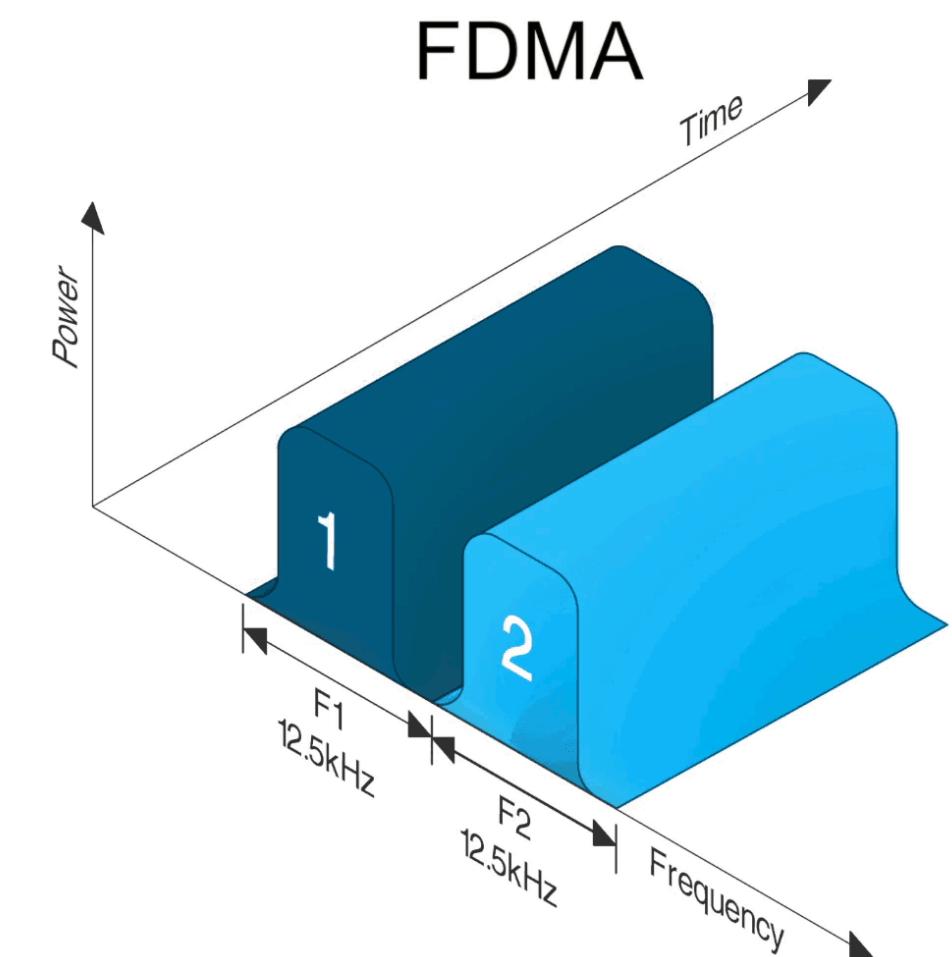
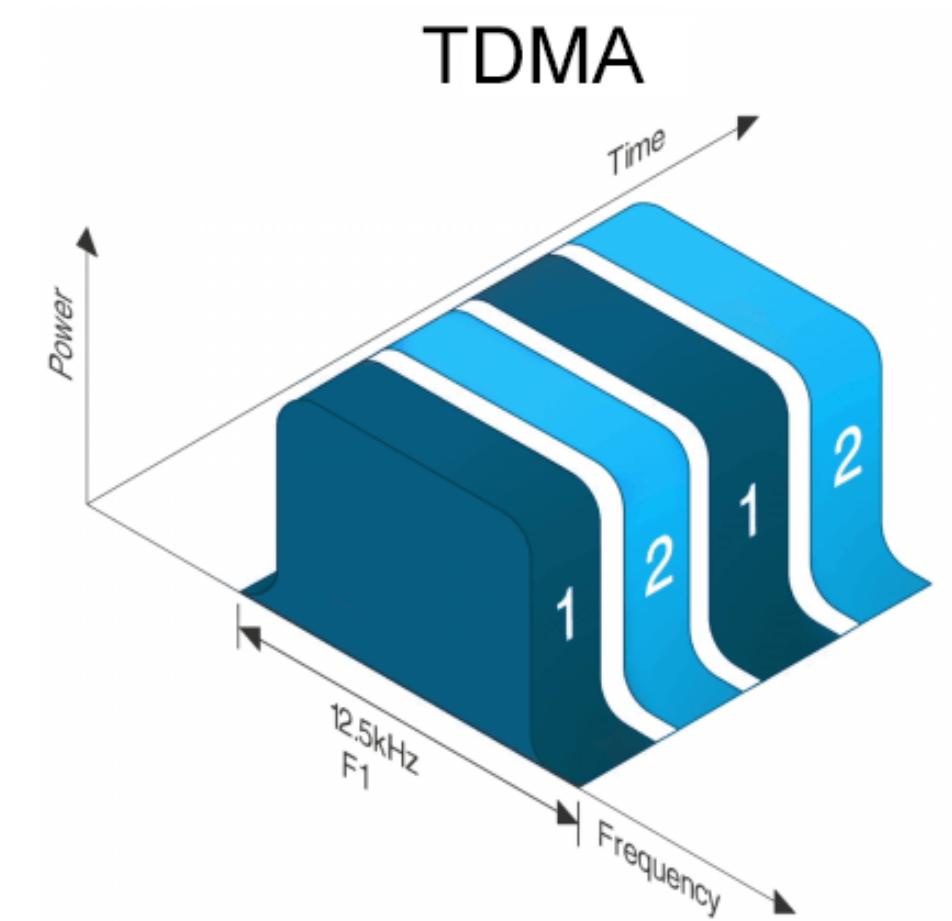
Encoded Digital Voice Signal



Carrier Wave Signal

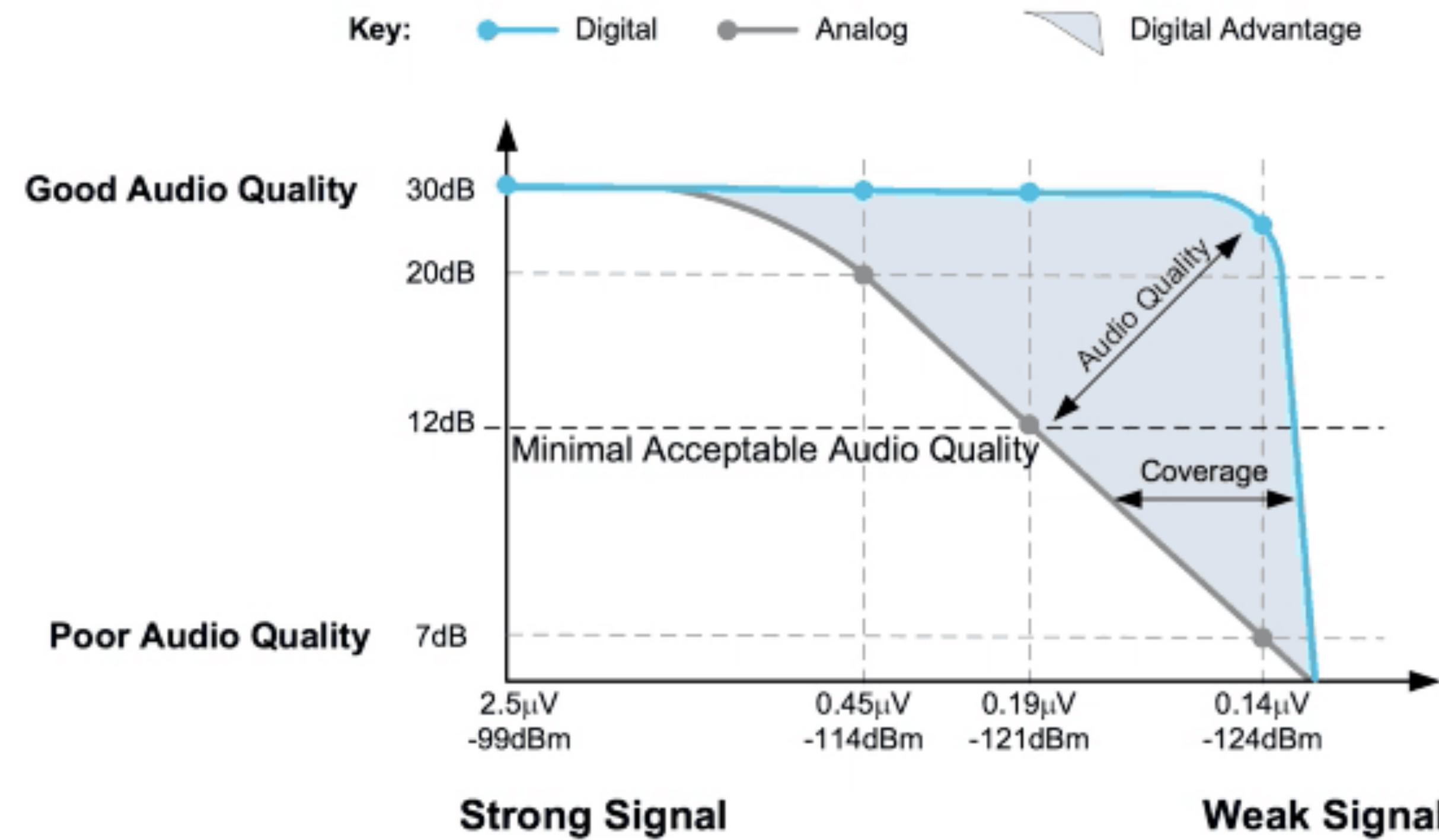


Modulated Signal



Digital Modes 2025 - Why Digital Voice?

What benefit does digital voice provide?



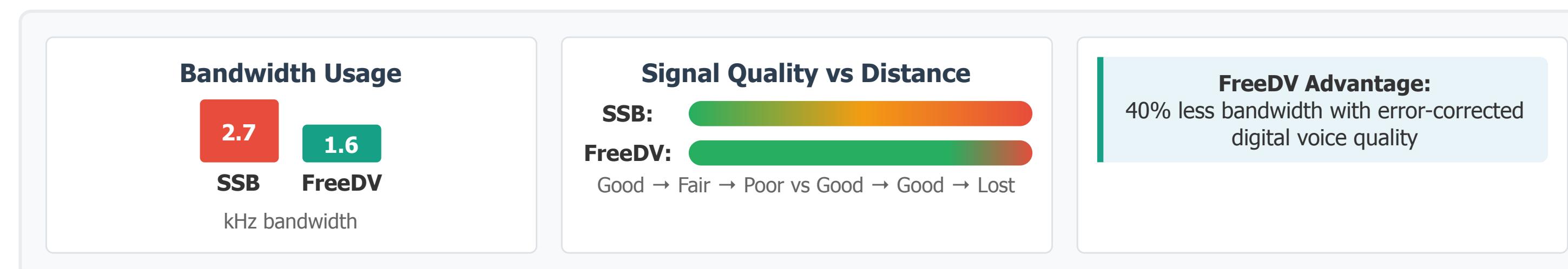
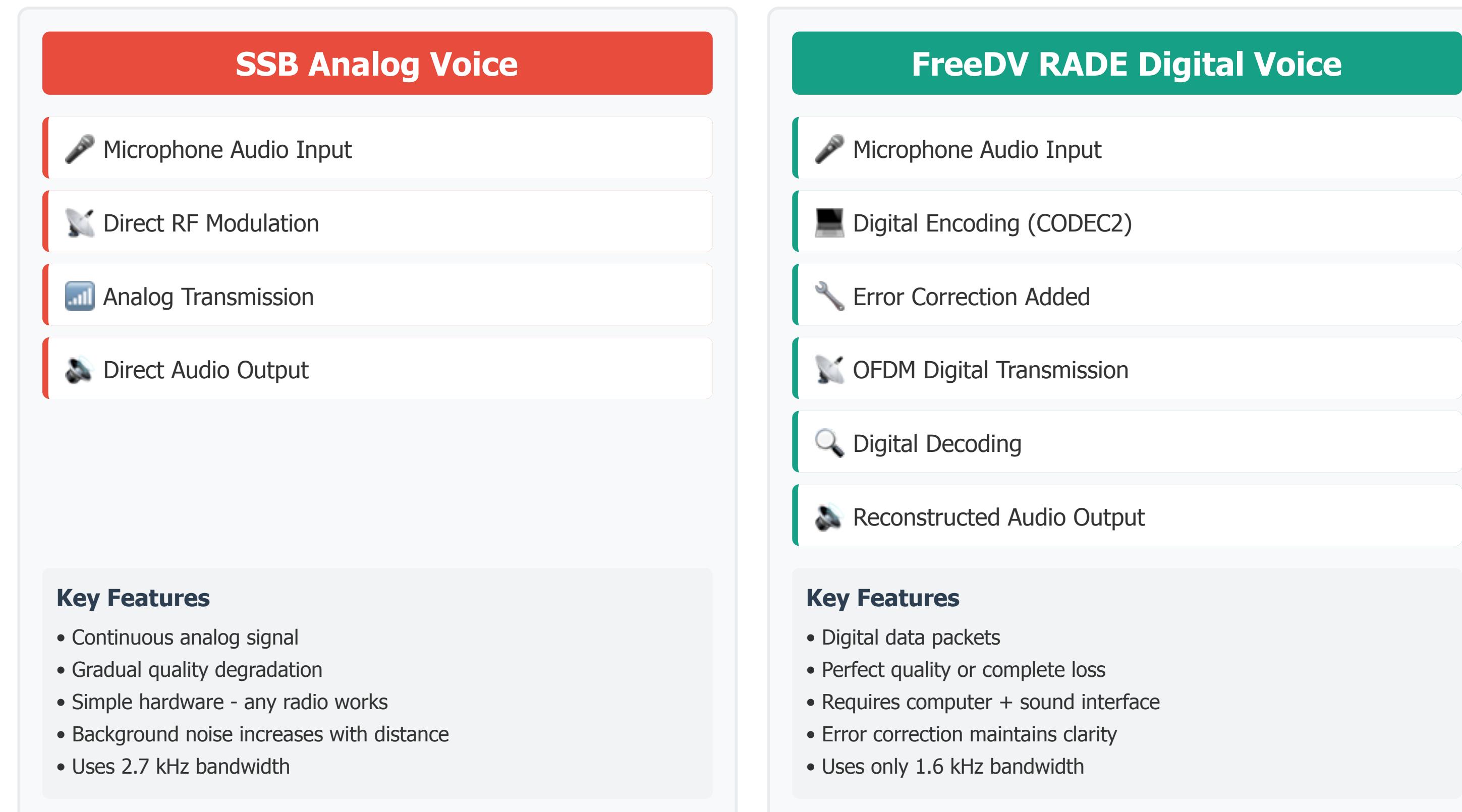
Digital Modes 2025 - FreeDV & RADE

A leap forward in HF Voice

- FreeDV = Open-Source Digital Voice on HF
 - Uses Codec2 w/ Any Radio & a Sound Card
- RADE (Radio Autoencoder) - Released June 3, 2025
 - Machine learning-based voice encoding
 - Clearer audio at lower signal-to-noise ratios
 - Outperforms analog SSB & older digital voice
- FM Quality Voice on HF using only ~1.5kHz
- No proprietary hardware or software licenses required

Digital Modes 2025 - FreeDV Advantages

FreeDV RADE vs SSB Analog Voice



Digital Modes 2025 - M17

Open Source Digital Voice for VHF/UHF



- M17 = fully open-source digital voice protocol
 - Uses Codec2 instead of proprietary AMBE+2 codec (DMR)
 - Occupies ~9 kHz and fits in standard FM bandwidth
 - Works with repeaters, hotspots, and even experimental hardware
- What's new (2024–2025):
 - Protocol officially released (v1.0)
 - M17 now supported in some handheld radios (CS7000 - \$299->\$499)

Beginner Hardware

Digital Modes 2025 - Getting Started

Easy mode

- Expensive gear not required!
- Most Common Setups:
 - Modern HF Radio w/ USB Sound Card (IC-7300, FT-991a, FT-710, etc.)
 - Analog only rig + USB interface (Digirig Mobile, Signalink USB)
 - QRP digital-only rigs (QDX, μ SDX kits, etc.)

Digital Modes 2025 - Radios & Interfaces

Beginner friendly radios and interfaces

- HF Digital Operation:
 - μSDX / Tr(u)SDX – Tiny QRP multiband HF rig, under \$150
 - QDX/QMX by QRP Labs – Digital-only HF transceivers with USB audio
 - Icom IC-7300 / Yaesu FT-710 or FT-991a – Integrated USB soundcard, easy CAT control
- VHF/UHF Digital & APRS:
 - Popular HTs - Yaesu FT5DR / FT-70DR, AnyTone AT-D878UVII+, Kenwood TH-D75A
 - Mobilinkd TNC – Bluetooth interface for APRS with Baofeng, Yaesu, and other BT HTs
 - LoRa APRS boards – T-BEAM, Heltec V3, RAK4631, and LightTracker Plus

Digital Modes 2025 - Mobile & Portable

Digital Modes On The Go

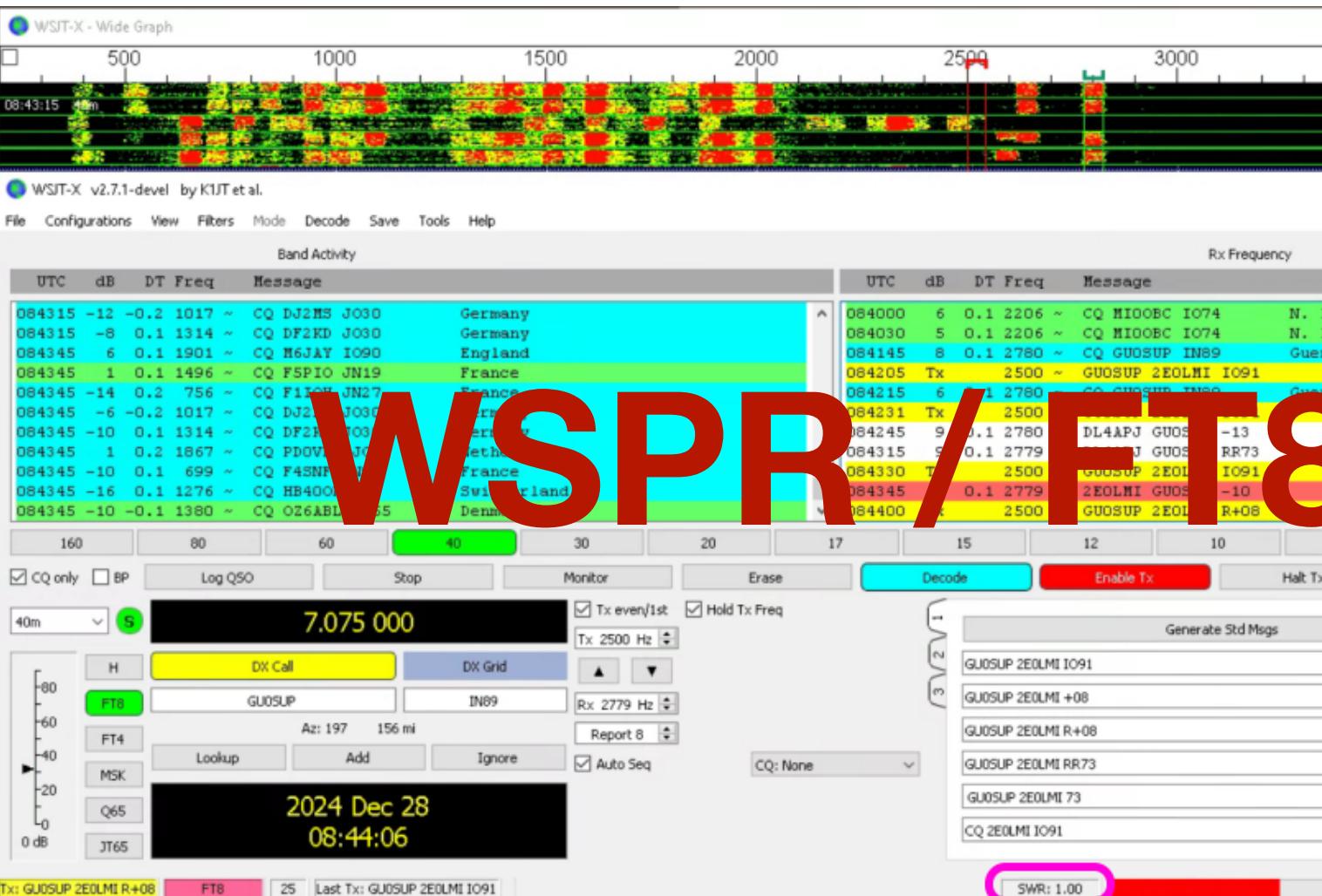
- Raspberry Pi + WSJT-X, M17, JS8Call, Direwolf, etc
 - Easy to power by battery for QRP
 - Can run headless or with small OLED touchscreen
- FT8 on Android (FT8CN)
 - Works w/ Bluetooth and USB Radios
- Bluetooth & USB Sound Cards
 - Digirig Mobile / Lite, SignaLink, USB dongles
 - Easy to connect to most HTs with a cheap cable



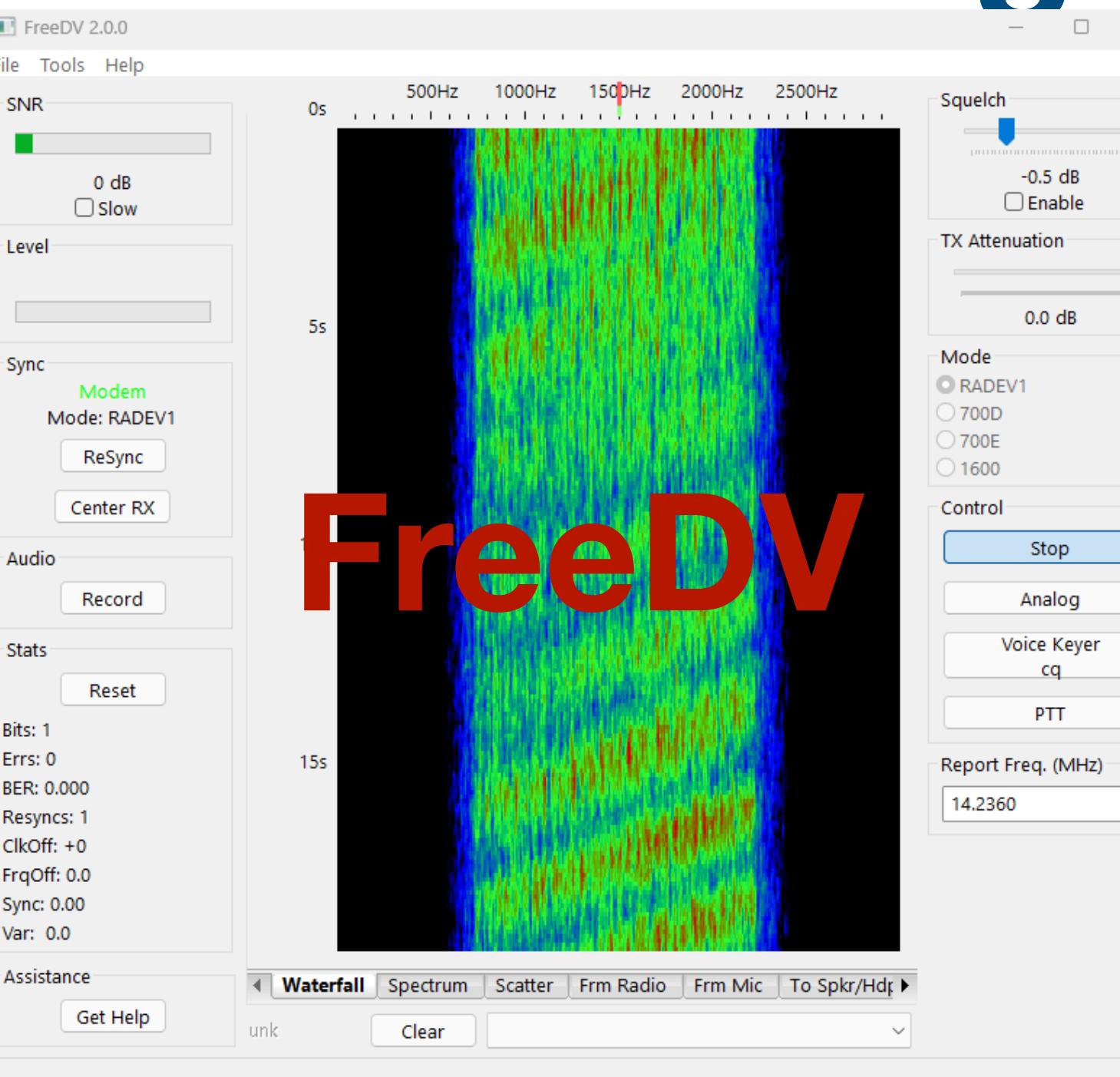
Getting Started

Digital Modes 2025 - Getting Started

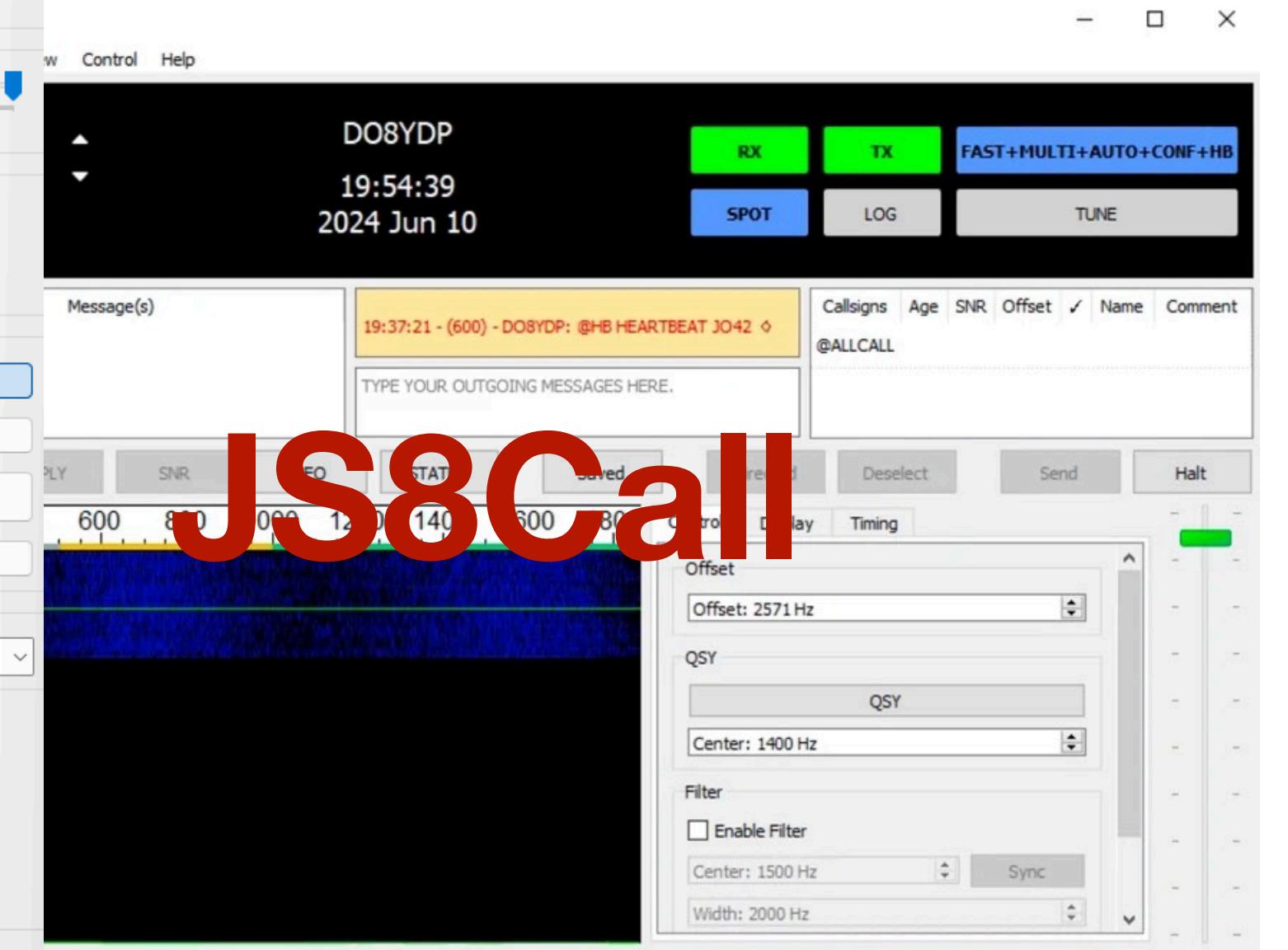
How do I get started?



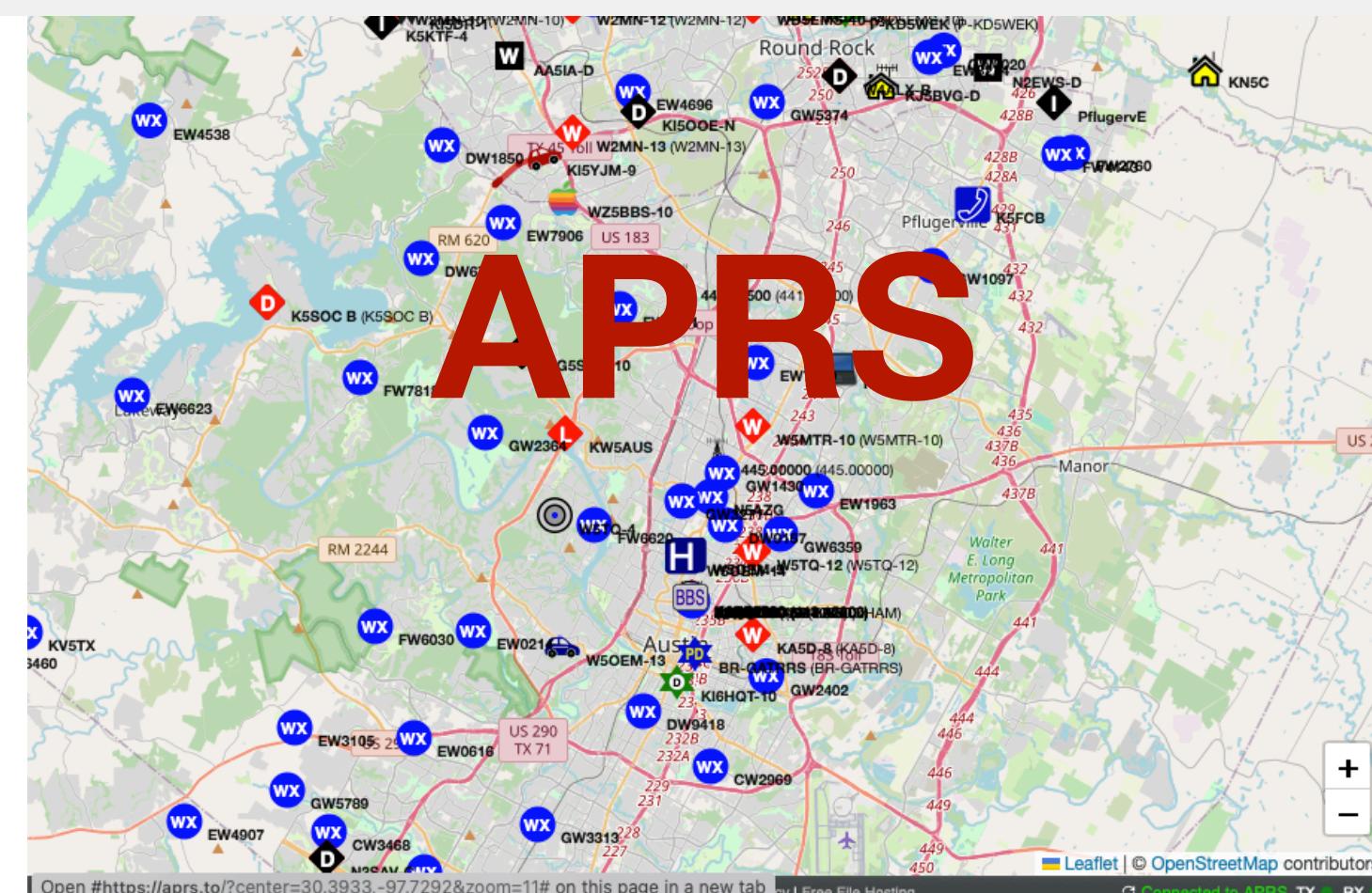
WSPR / FT8



FreeDV



JS8Call



APRS

Digital Modes 2025 - Recommended Tools

What tools / software should I use to get started?

- Software
 - WSJT-X Improved – FT8, FT4, WSPR
 - JS8Call – Live messaging
 - APRS.fi / aprs.to – APRS mapping and lookups
 - FreeDV – Open-source digital voice
 - FT8CN (Android) – FT8 on mobile
- Hardware
 - Digirig, QDX, µSDX, TH-D75A, PicoAPRS, etc.
 - Baofeng/Quansheng + Mobilinkd TNC = working APRS station

Stay in Touch

How to stay in touch with me

- QRZ - <https://www.qrz.com/db/K4CHN>
- Email: K4CHN@arrl.net
- Github: <https://www.github.com/jmarler>
 - <https://github.com/jmarler/DefCon33HRVPresentations>
 - Contains all links from presentation, the presentation itself, and more!

Q&A

Thank You!