

Digital Radio

How does it work?

Topics

- Digital Radio
- Multi Mode Digital Voice Modems
- Digital Repeaters
- Reflectors
- System Overview

Acronyms

- D-STAR - Digital Smart Technologies for Amateur Radio
- DMR - Digital Mobile Radio
- YSF - Yaesu System Fusion
- P25 - Project 25
- NXDN - Next Generation Digital Narrowband
- FSK - Frequency-shift keying
- MMDVM – Multimode Digital Voice Modem

Digital FM

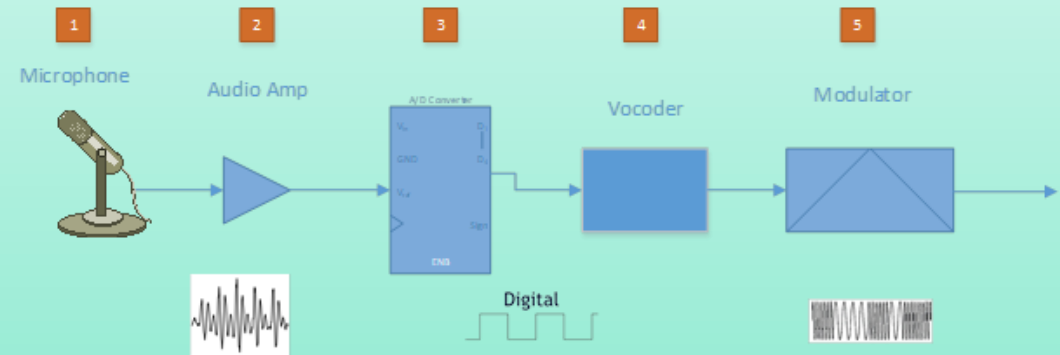
- Digital FM amateur radio refers to the use of frequency modulation (FM) in conjunction with digital technology for amateur radio communications.
 - Normally in the UHF and VHF bands
- Unlike traditional analog FM, which transmits voice, digital FM encodes data into digital formats, which can transmit voice and data at the same time.
- Digital radio offers improved signal quality, error correction capabilities, and the ability to handle various types of data transmissions, including text and images.

Digital Format

- Some popular digital FM modes include:
 - DMR: A widely used digital voice mode that offers features like group calling and text messaging.
 - D-STAR: is a digital voice and data protocol developed in the late 1990s by the Japan Amateur Radio League (open source).
 - System Fusion: a digital protocol developed by Yaesu that is open source.
- Each of these protocols use FSK is a modulation technique where the frequency of a carrier wave is varied in accordance with the digital signal being sent.
 - The simplest form of FSK is binary FSK (BFSK), which uses two discrete frequencies to represent binary '0s' and '1s'.

Digital Radio

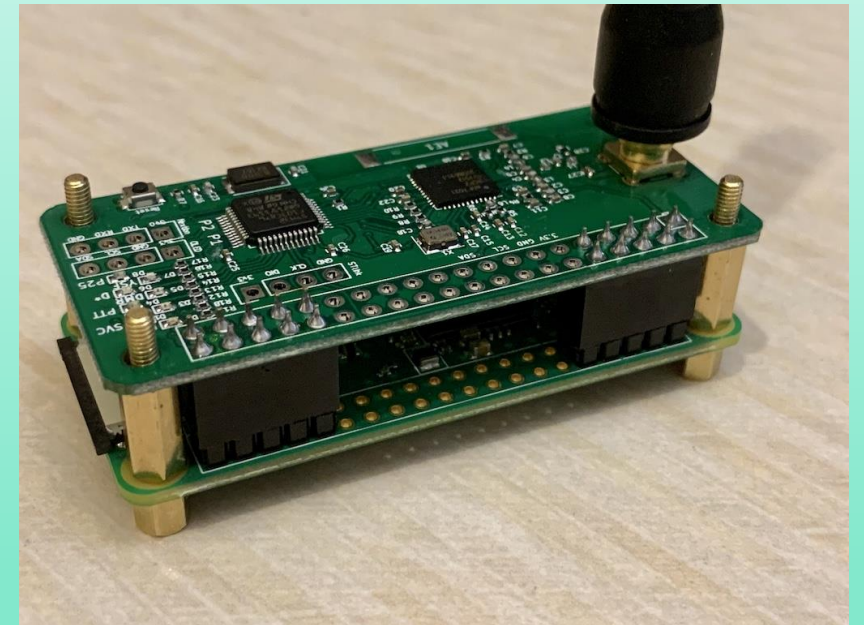
- A digital radio converts voice into a binary.
- The binary information is converted to a modulation that the radio can perform.
- The easiest method is to use FM, which the radio is currently capable of doing.
- In order to transmit digital data using an FM signal it is converted to FSK.
- Each frequency represents some form of binary code.



1. Analog audio input through microphone
2. Audio amplifier boost signal
3. The Audio to Digital (A/D) converter changes audio signal to digital
4. The Vocoder compresses the digital signal. It may also add forward error correction
5. Compressed digital signal is modulated onto the carrier wave.

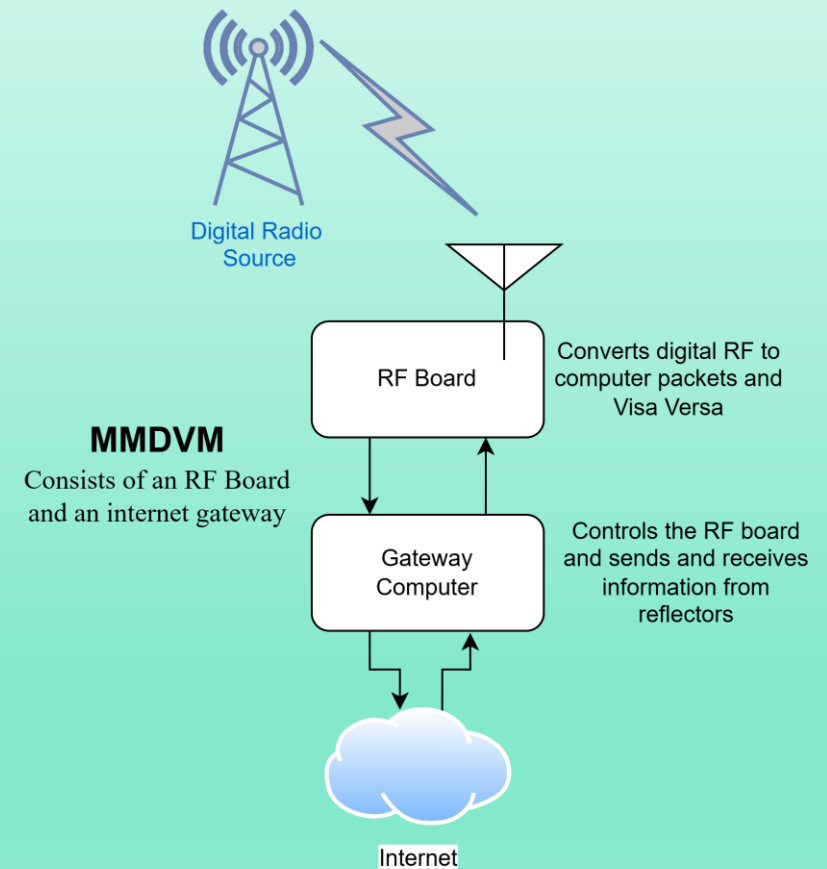
MMDVM

- An MMDVM is a device used to connect to various digital voice networks over the internet, often called a hotspot or radio hotspot.
- It basically a personal digital repeater that has an internet gateway.
- The MMDVM can work with several digital modes (D-STAR, DMR, YSF, P25, and NXDN) allowing communications globally with other hams.
- It's a combination of hardware and software, often including a Raspberry Pi and a radio frequency board, and is configured through a program like Pi-Star.
- Transmitter power of around 10mW.



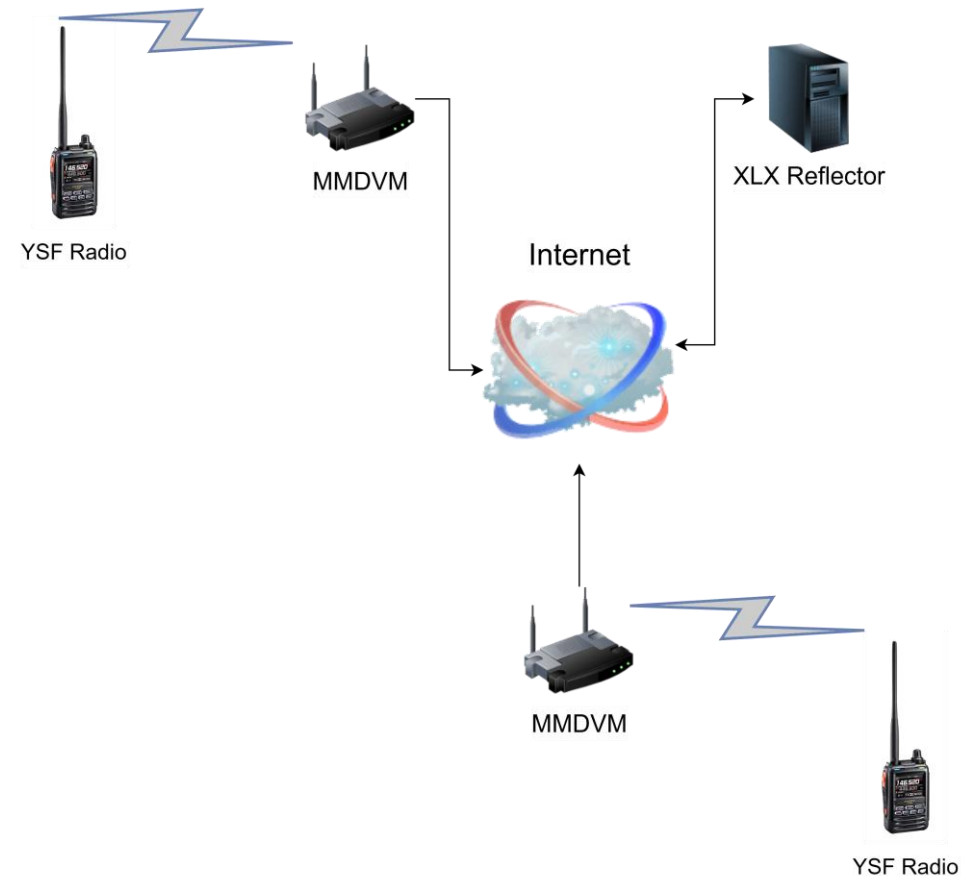
Hotspot

- The basic hotspot has two main components: a gateway and RF board
 - The gateway is computer side, usually Raspberry Pi Zero
 - RF board is often called a HAT—Hardware Attached on Top.
- Gateways are connected to internet and they send and receive data to reflectors
- RF board is connected to a gateway and Rx and TX digital RF to radios.
 - They also convert digital RF to computer packets and vice versa
- A miniature display shows you which mode is active if there is a station transmitting, and what their callsign and the IP address of the device.



MMDVM Function

- This is a simplified overview
 - Radio transmits a digital signal to the MMDVM.
 - The MMDVM converts the digital signal to computer packets and is sent out via internet to a reflector.
 - The reflector sends out the information to any MMDVMs connected.
 - The MMDVM takes the information and converts it to digital RF, which is received by the radio.



Digital Repeater

- Digital repeaters come in many types. There are D-STAR, YSF, and Multi Mode.
- Our three repeaters are Multi Mode repeaters and operate the same as a MMDVM. In fact ours are using the Pi-Star software, that same software us Hotspots.
- They connect to internet and are pointed towards a reflector or reflectors.
 - Pi-Star allows a user to select different reflectors depending on modes used

Dashboard Overview

Hostname: pi-star Pi-Star:4.1.8 / Dashboard: 20240307

Pi-Star Digital Voice Dashboard for K3VL

Dashboard | Admin | Configuration

Modes Enabled	
D-Star	DMR
M17	NXDN
P25	YSF
DMR XMode	YSF XMode
FM	POCSAG

Network Status	
D-Star Net	DMR Net
M17 Net	NXDN Net
P25 Net	YSF Net
DMR2NXDN	DMR2YSF
YSF2DMR	YSF2NXDN
YSF2P25	POCSAG Net

Radio Info	
Trx	Listening
Tx	443.725000 MHz
Rx	448.725000 MHz
FW	MMDVM:20190130
TCXO	12.0000 MHz

D-Star Repeater	
RPT1	K3VL B
RPT2	K3VL G

D-Star Network	
APRS	noam.aprs2.net
XLX814 D DCS/Out	

DMR Repeater	
DMR ID	3142409
DMR CC	1
TS1	enabled
TS2	enabled

DMR Master	
BM	3102 United St..

YSF Network	
XLX814	

Gateway Activity								
Time (EDT)	Mode	Callsign	Target	Src	Dur(s)	Loss	BER	
14:37:18 Aug 17th	YSF	AK3J (GPS)	DG-ID 0	RF	3.9	0%	0.1%	
14:02:04 Aug 17th	DMR TS1	9990	K3VL	Net	0.5	0%	0.0%	
14:02:01 Aug 17th	DMR TS1	K3VL (GPS)	9990	RF	0.4	0%	0.0%	
14:00:03 Aug 17th	D-Star	K3VL/TIME (GPS)	CQCQCQ	Net	3.6	0%	0.0%	
13:49:48 Aug 17th	DMR TS2	AK3J (GPS)	TG K3SMT	Net	0.5	0%	0.0%	
13:49:48 Aug 17th	DMR TS1	AK3J (GPS)	TG K3SMT	Net	0.5	0%	0.0%	
10:26:25 Aug 17th	DMR TS1	K3MV (GPS)	TG K3SMT	Net	3.0	0%	0.0%	
10:26:25 Aug 17th	DMR TS2	K3MV (GPS)	TG K3SMT	RF	2.9	0%	0.1%	
09:13:40 Aug 17th	YSF	K3VL (GPS)	DG-ID 0	Net	11.5	0%	0.0%	
09:13:25 Aug 17th	YSF	KD3RVR (GPS)	DG-ID 0	Net	40.2	0%	0.0%	
04:04:02 Aug 17th	D-Star	K3VL/INFO (GPS)	CQCQCQ	Net	6.3	0%	0.0%	
18:42:34 Aug 16th	YSF	K3VL (GPS)	DG-ID 0	Net	0.6	0%	0.0%	
16:12:29 Aug 16th	YSF	KR3L (GPS)	DG-ID 0	RF	9.9	0%	0.3%	
16:12:17 Aug 16th	YSF	W3EJE (GPS)	DG-ID 0	RF	53.4	0%	2.2%	
13:37:47 Aug 16th	YSF	KR3L (GPS)	DG-ID 0	Net	3.3	0%	0.0%	
12:09:59 Aug 16th	DMR TS2	K3VL (GPS)	TG 4003	RF	1.8	0%	0.1%	
12:08:14 Aug 16th	DMR TS1	K3VL (GPS)	TG K3SMT	Net	3.7	0%	0.0%	

Local RF Activity								
Time (EDT)	Mode	Callsign	Target	Src	Dur(s)	BER	RSSI	
14:37:18 Aug 17th	YSF	AK3J (GPS)	DG-ID 0	RF	3.9	0.1%	S8 (-102 dBm)	
14:02:01 Aug 17th	DMR TS1	K3VL (GPS)	9990	RF	0.4	0.0%	S6 (-113 dBm)	
10:26:25 Aug 17th	DMR TS2	K3MV (GPS)	TG K3SMT	RF	2.9	0.1%	S5 (-115 dBm)	
16:12:29 Aug 16th	YSF	KR3L (GPS)	DG-ID 0	RF	9.9	0.3%	S9 (-96 dBm)	
16:12:17 Aug 16th	YSF	W3EJE (GPS)	DG-ID 0	RF	53.4	2.2%	S9 (-95 dBm)	
12:09:59 Aug 16th	DMR TS2	K3VL (GPS)	TG 4003	RF	1.8	0.1%	S5 (-117 dBm)	

Pi-Star / Pi-Star Dashboard, © Andy Taylor (MW0MWZ) 2014-2024.
ircDDBGateway Dashboard by Hans-J. Barthen (DL5DI),
MMDVMDash developed by Kim Huebel (DG9VH).
Need help? Click here for the Facebook Group
or Click here to join the Support Forum
Get your copy of Pi-Star from here.

- The Pi-Star dashboard provides information on
 - Modules enabled and status
 - Network status
 - Tx and Rx frequency
 - Reflector information
 - Gateway activity
 - Information on what is coming in through the internet
 - Local RF Activity
 - Information on what is received by the repeater or hotspot

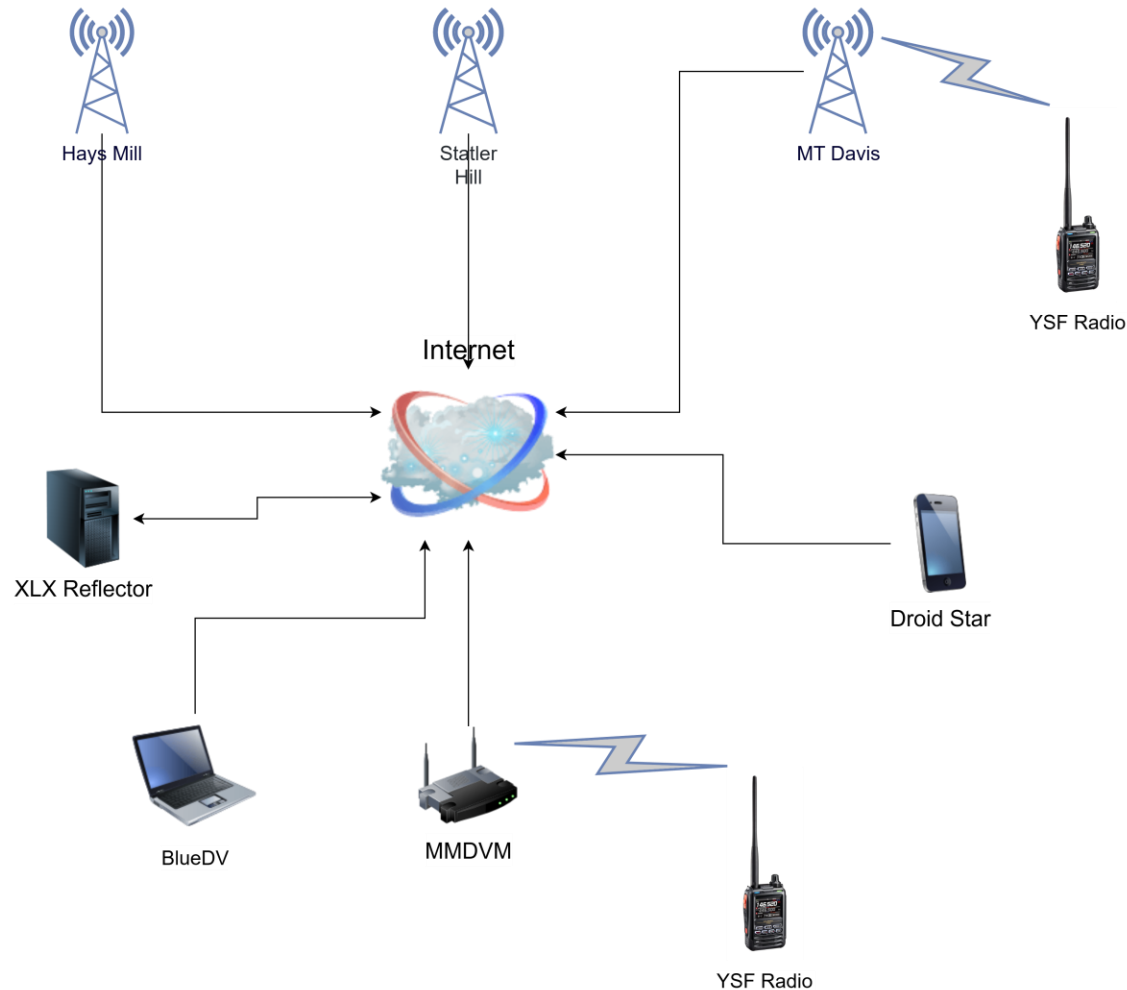
Reflectors

- A reflector is a computer that acts as a conferencing system that allows multiple amateur radio stations to communicate simultaneously.
 - Think of it as a virtual meeting room for radios, where each reflector has multiple channels, and each channel can facilitate a separate group conversation.
- Just like repeaters there are different types of reflectors (DMR, YSF, D-STAR, XLX)
- Radios cannot communicate directly with a reflector, only gateways can connect with other gateways.

XLX Reflector

- The XLX Reflector is a multi-protocol reflector that stands out in the D-Star world for its ability to connect various digital voice modes
- It supports D-Star, DMR, and System Fusion, and can be accessed using different linking protocols like DPLUS, DCS, and D-Extra
- This versatility allows for a wide range of communication possibilities through our repeaters
- Our reflector is XLX814 and currently support YSF, D-STAR, and DMR
 - The reflector support cross mode between DMR and YSF
 - We are planning to eventually add the cross mode capability so that D-STAR can talk with YSF and DMR

System Overview



- We currently have 3 repeaters that are Multi Mode capable
- The XLX reflector can support up to 99 connected gateways
- There are currently 10 modules or rooms that can be used
- Remote users can connect into our repeater system through XLX814
- Users also have the ability to connect using DroidStar, BlueDV, etc.

