Digital Voice Radio just became a lot easier

"In the not so distant past"
Sounds like the preamble of a book or movie. If you, are about to make the move into digital radio, you will be presented with choices, these will have an impact on your pocket and whom you will be able to talk to. Looking for what gives you the best bang for your bucks, depends on what services are in your area, (what repeaters and what protocols.)

In the past year in the open source arena, there have been some exiting developments happening, this the implementation of multimode repeaters, owners, all over the world are installing systems that provide cross platform communication, such that you are not aware of what is going on, add to this the proliferation of Open/ Hot spots (Devices that connect to the Internet) and the exiting world of digital radio opens right up. No longer matters what radio protocol you have, you will be able to communicate cross platforms in a seamless manner.

Icom F9511 P25 Radio

The Digital Modes
In the commercial world of two way radio communication, the quest to provide more channels to the used spectrum, has largely been the driver for the use of digital techniques used and under development. With pure FM, as the bandwidth is reduced the Signal to Noise Ratio decreases, there is a limitation of how narrow the bandwidth can get. Already it's mandated that the channel spacing is to be 12.5 KHz, there is proposals to reduce this further to 6.25 KHz in the near future. Digital modes, presently is the only way to achieve the more efficient utilization of the radio spectrum,
Audio quality is largely dependent of modulation scheme and bandwidth, cant get away from the fact that bandwidth and audio quality remain linked, even under the digital modes.

For more detailed explanations. (Can be found in the Club Archive) or Google the title
This article: "Understanding Modern Digital Modulation Techniques"

These protocols will not normally talk to each other.

P25 - This is a commercial protocol that was adopted by Motorola, offers high quality audio.

C4FM - Yeasu propriety protocol, uses two modes Wide and Narrow, in wide mode, audio is as good as P25

D-Star - Digital voice and data protocol specification for amateur radio.
The system was developed in the late 1990s by the Japan Amateur Radio League and uses minimum-shift keying in its packet-based standard.

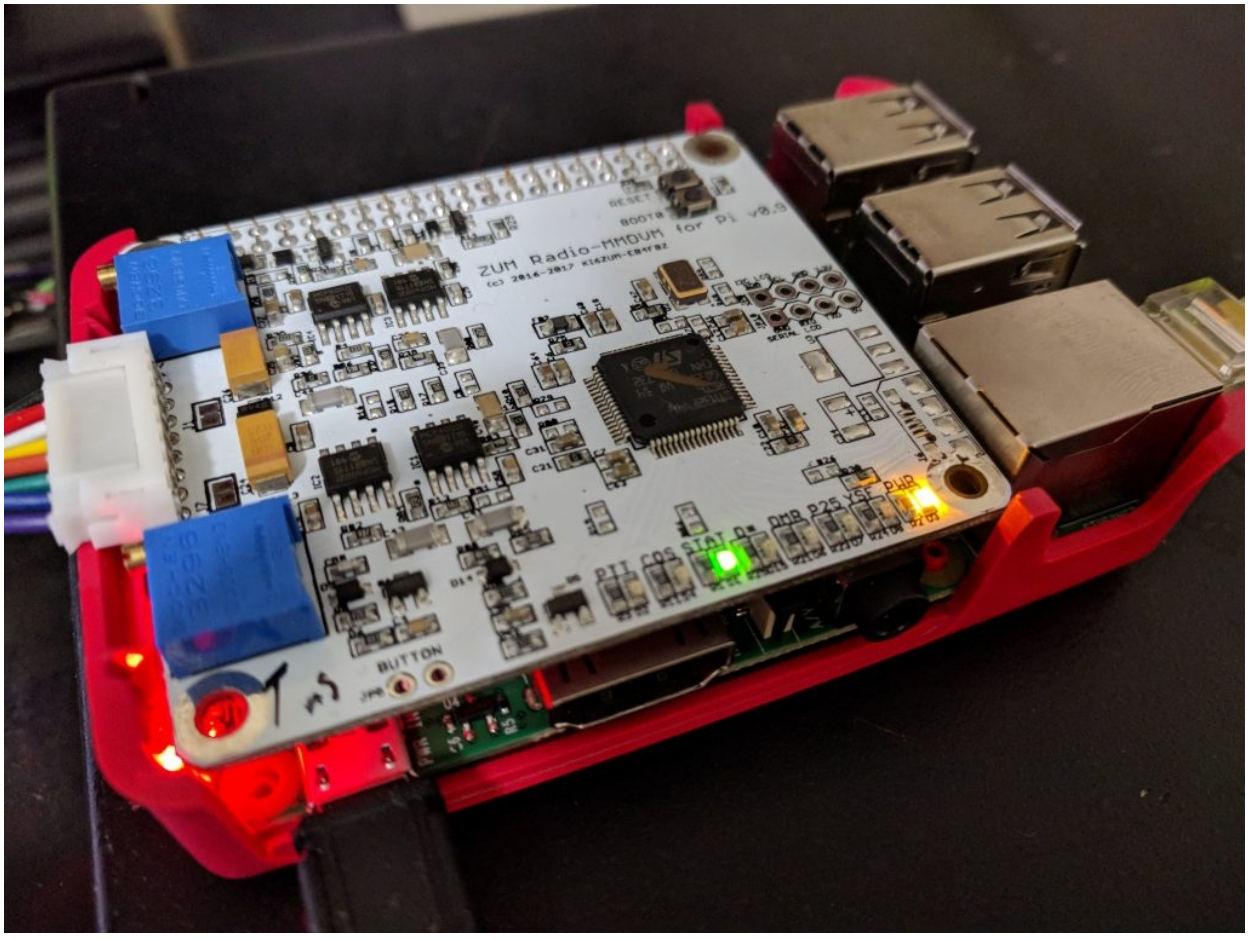
NXDN Open standard Common Air Interface (CAI) technical protocol for mobile communications.
It was developed jointly by Icom Incorporated and Kenwood Corporation.

DMR - Open digital mobile radio standard defined in the European Telecommunications Standards Institute

Links for further information on the modes.

https://en.wikipedia.org/wiki/NXDN
https://en.wikipedia.org/wiki/Project_25
https://systemfusion.yaesu.com/what-is-system-fusion/
https://en.wikipedia.org/wiki/D-STAR
https://en.wikipedia.org/wiki/Digital_mobile_radio

MMDVM (Multi-Mode Digital Voice Modem)



In 2016 the magic began
The MMDVM software, an open-source Multi-Mode Digital Voice Modem, that utilises the power of an ARM processor with a simple analogue interface board, with software developed to handle all amateur digital voice modes.
An analogue radio is used for the digital modes, with the ability to have digital multimode operation.

The analogue radio must be such that the receive and transmit have a linear flat audio response, this is a must for the modulation schemes used, failure in this will result in high bit error rates, (BER). Some radios are more suitable than others for the modification to achieve a linear audio.

OPEN SPOT
Also know as a Shark RF is a device that allows cross linking from one mode to another

DVMega
RPI Dual band radio is a radio module that fits without a modem or node adapter directly on the Raspberry PI. The combination RPI and RPI DVMEGA radio is a complete D-Star compatible hotspot with an output power of 10mW. ... There are 2 radio's available, configured to operate in the VHF and UHF band.
(Raspberry Pi is a microcomputer)

Pi-Star
I mentioned the above systems as they are the precursors to a piece of software called Pi-Star. what Pi-Star does is to integrate the many modules in software, allowing a very flexible platform to either have a personal device or to build a digital repeater.

The Pi-Star platform integrates the following open source modules
ircDDBGateway
Time Server
MMDVMHost
DMR Gateway
YSF Gateway
P25 Gatewy
NXDN Gateway

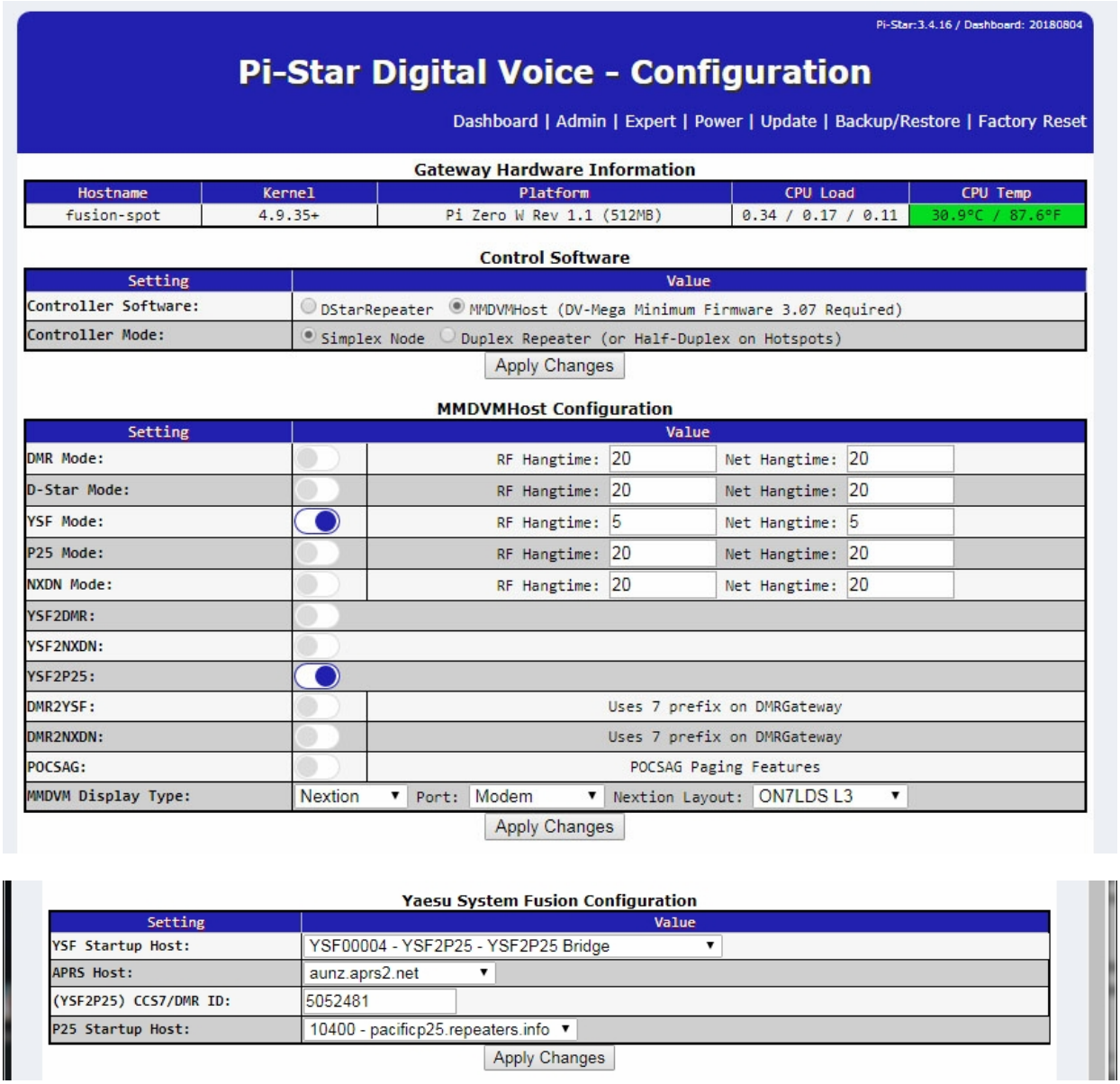
The above program structures allow you to operate any of the modes, more importantly it allows cross linking of one mode to another.

Presently as the development stands at this time of writing this article, the cross linking available are
C4FM to DMR
C4FM to P25
C4FM to NXDN
DMR to C4FM
DMR to NXDN

A new feature was recently added to the platform, is to do with Paging
if you are so inclined. (I am not)

What does all of the above do for a new comer into digital modes?
Presently the DMR mode is experiencing rapid growth, largely due to the minimal cost of radios and hot spots, making possible to communicate all over the world.
I have not spoken about a Hot Spot so far, this is a device similar to an Open Spot, uses the above mentioned Pi-Star system, way cheaper than Open Spot, plus provides far superior audio when used to cross from one mode to other.

Jumbo Spot with OLED display



Images show a Pi-Star Hot spot configured such to use a Fusion (C4FM) radio on P25

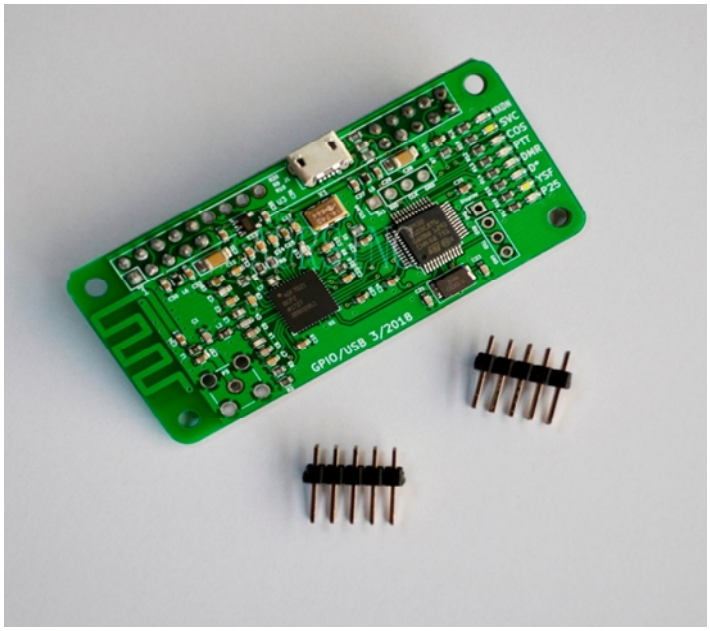
If like me, you have no access to a digital repeater, an Hot spot with the aid of the internet provides you the ability to connect to the world of digital radio, when I say the world, its just that, far more that what D-Star or C4FM can do on their own.

More importantly is the ability to have cross modes, add to that the connectivity using a mobile phone to the internet, one can access the many reflectors in the world networks, making the system a very powerful mobile access point device.

On offer today is either the Zum Spot or the Jumbo Spot, both are very similar to each other, also know as Hot Spot, both use a Raspberry Pi processor, the utilization of the Pi-Star software, all of the above is realised.

Zum Spot

A Hot Spot can either be purchased assembled, or built using ready available assemblies, consisting of a Pi-Zero, a Zum or Jumbo board.



Jumbo Spot (There is others made in china that work the same)
The assembly and loading of software to the Raspberry Pi is relatively easy to do.

Reflectors and Talk groups
As amateurs we don't like to be parcelled into groups, at least I don't, I naturally dislike any propriety system that excludes others.

I must not be the only one, as many have been working to make cross linking as easy it can be, so easy in fact that unless you are told, you can be having a contact with a D-Star station on your C4FM radio without knowing what the other mode is.
The devices I mentioned above allow one to appear on any of the protocol defined networks as if using a native radio, for example, with a C4FM radio connect and talk on a DMR reflector with out either party knowing of what is been used. There is another in the mix that makes this even easier, reflectors known as XLX reflectors.

XLX Reflector
I researched this implementation for a definition only to find that it was first developed for D-Star
The following is obtained from GitHub
"XLX Multiprotocol Gateway Reflector Server is part of the software system for the D-Star Network. The sources are published under GPL Licenses."
Open source software, so designed to handle other protocols other than D-Star. Someone decided that he wanted his D-Star radio to talk to a C4FM radio.
This has become so popular that there exist just under 1000 of these special reflectors

The reflector is configured such to provide cross linking to other modes, also can provide regional channels to sectionalise the traffic into areas. The operator will receive traffic from all the other cross linked modes, when sending he will do so to all the other modes, the owner of the reflector, decides what group and modes the type of traffic mode, thus one will find differing configurations in the XLX world.

For example the Australian XLX389 Channel D cross connects P25 TG 10400, to C4FM YSF001, to NXDN TG 505, DMR Brandmeister 50599 TG6 and D-Star 50599 505.
So any anyone can talk to any other, the only thing that we can't bridge is the C4FM Wirex as Yaesu is resisting the open source community in not opening their system up as others have done.

XLX 389 current configuration

Channel	DMR+	Brandmeister	
XLX389-A	4001	505	Call Group Aus 505
XLX389-C	4003	5058	NT
XLX389-D	4004	50599	VK4TUX
XLX389-N	4014	5052	NSW
XLX389-Q	4017	5054	QLD
XLX389-S	4019	5055	SA
XLX389-T	4020	5057	TAS
XLX389-V	4022	5053	VIC
XLX389-W	4023	5056	WA
XLX389-X	4024	5303	New Zealand Christchurch
XLX389-Y	4025	5304	New Zealand Invercagill
XLX389-Z	4026	530	New Zealand Call Group

The table shows the reflector (XLX389) constructed and run br Adrian VK4TUX, his work continues and more cross linking is taking place.

The way of how to change from one channel to another is specific to the radio been used.
How to do this is outside the scope of this article.

Radioddity *GD-77*

Model	GD-77
Frequency （MHz）	136-174 / 400-470
Power Output	5W
Channel	1024
Working Time	**18H**
Standby Time	48H
Battery Capacity	2200mAh
Mototrbo Tier	II
Compatible with Mototrbo	YES
Time slot	**DUAL**
Text Messages	YES

GD-77 considered as an entry point DMR Radio. It has some limitations as to the number of contacts that can be stored in the radio, this is not an operational limitation, you can communicate with any that have a DMR ID, just that the call sign will not be displayed if not in the contact name file, will just show as a DMR ID number instead.
These radios can be purchased for as little as $110.00 delivered
Dual band, dual mode (FM/DMR)

There is a bunch of commercial radios, too many to list here that can be used on our VHF/UHF bands, requiring no modifications, they can be P25, or DMR, I think even NXDN was used in commercial radios, but not 100% sure.

Talking to others soon reveals the so many things happening and evolving, what hardware is usable, for digital modes.

For example just DMR with BrandMaister, DMR Mark and DMR + You can spend considerable time reading listening and learning.

This article has been a brief introduction in a set of modes that initially I had no interest in, once I got involved the proverbial getting hooked took place.

The local inactivity and interaction with other amateurs is now replaced with the many friends I have made, sharing a common interest, that of electronics and communication modes all over the world.

You don't have to be an electronics wiz kid or a computer expert, but all you need is the desire to learn, many operators of the digital modes understand the difficulties for any starter to the modes, they have been there and done that, are keen to help and get you going saving you the pain they experienced.

Disclaimer:
I am new and learning about these digital modes, the information in this article is a reflection of my understanding, derived from observations and reading the many sources of material on the subject. I apologise in advance for any errors, but if you spot some, you are either an expert or have learned more than me.

73's VK2YMU