Repeaters

General theory, block diagram

some definitions

Local Repeaters

pictures

Island Trunk System
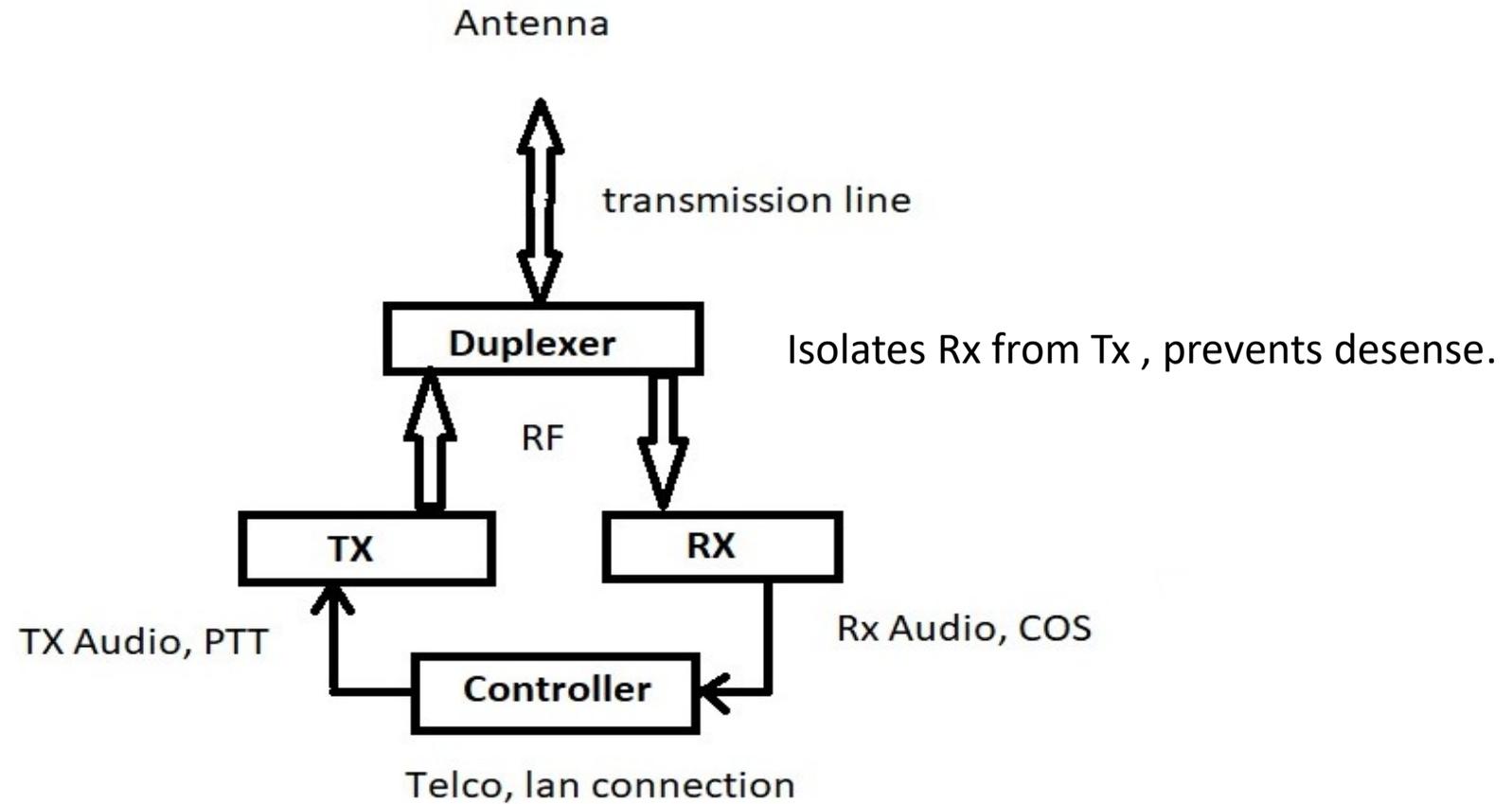

Digital Repeater

Hotspots

Why we use repeaters

- Because VHF and UHF communication is line-of-site, simplex communication can be blocked. Placing a repeater at a higher elevation can overcome these problems.

- Repeaters can extend the reach of your communications. In essence you are adding an extra amplifier in the tx path as well as the rx path.

- Using the CTCSS in repeaters can help filter out unwanted traffic or interference.

Repeater(duplex) Block Diagram

Antenna

transmission line

Duplexer — Isolates Rx from Tx , prevents desense.

RF

TX   RX

TX Audio, PTT   Rx Audio, COS

Controller

Telco, lan connection

Block Diagram

- We use a variety of antennas at our sites. I believe the most common is a dual folded dipole.

- The duplexer is a unit in between the antenna and RX/TX. Its purpose is to isolate the Tx RF from the Rx RF. If you cannot isolate the Tx properly, the TX signal will desensitize the repeater receiver. There are two measurable parameters used in duplexers both expressed in dB. One is isolation, usually around 85dB. The other is insertion loss, typically around 0.8 to 1.2 dB.

- The receiver, transmitter and controller are contained in the transceiver unit. You can also add external controllers which we have done with the VE7RAP repeaters.

- Key to the operation of the repeater are two signals COS(Carrier Operated Switch) and PTT(Push To Talk). COS is just the receiver's way of informing the controller that a valid carrier has been received and that the squelch has opened. The controller will take the rx audio and initiate a PTT to send it out through the transmitter.

More Block Diagram

- The controller also may have external connections. In the case of the VE7RAP repeaters, this is the internet connection for the Pi-Star. For the other repeater the internet is connected to the IRLP/Echolink.

- The 70rptr(VE7NIR) has a connection to the island trunk, likely through a controller interface.

- The 62rptr(VE7NIR) has a phone patch connection.

Downlink 146.78

PL 141.3

Uplink 146.18

PL 141.3
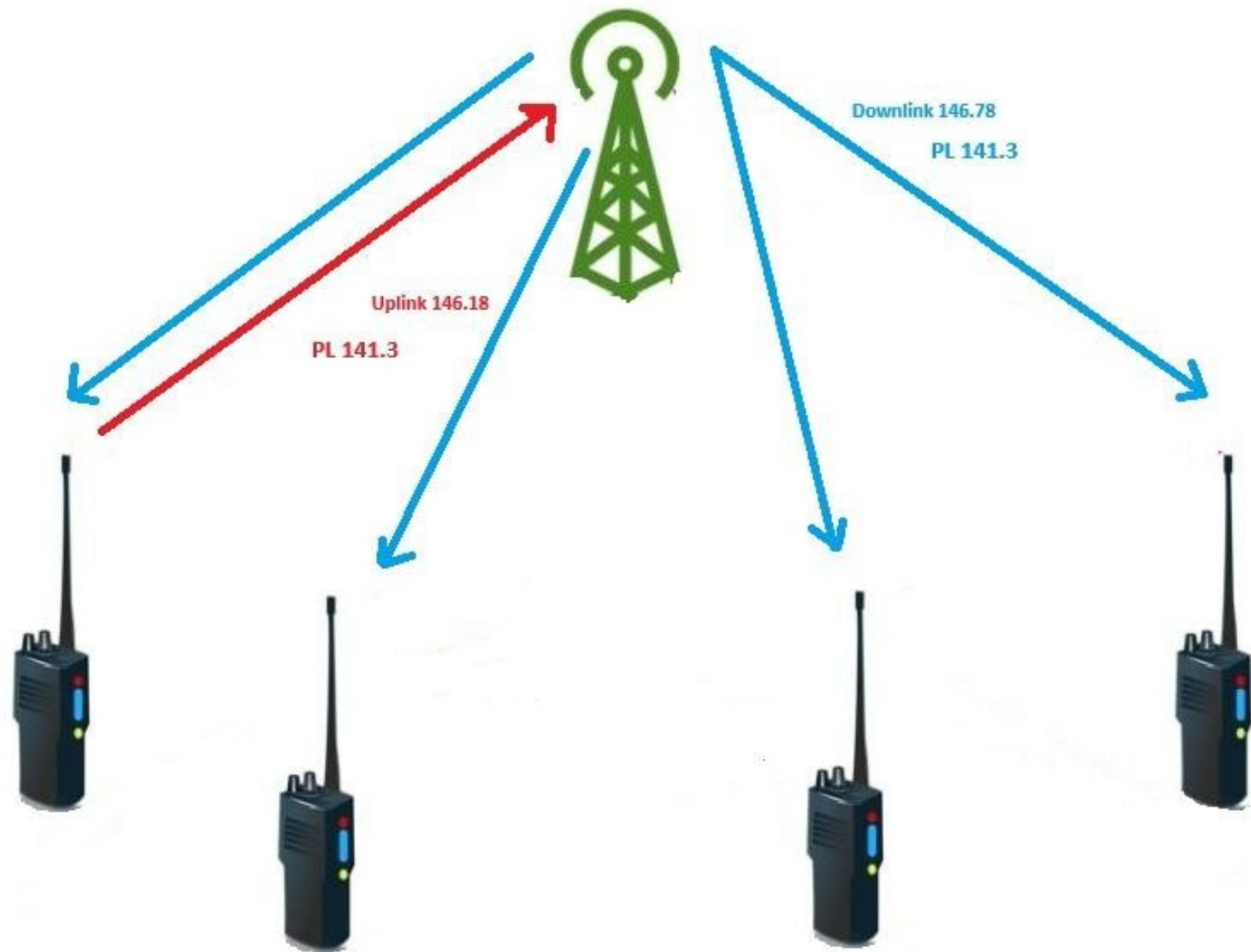
- **uplink/downlink** Uplink is repeater rx freq. Downlink is repeater tx freq.

- General rule of thumb is that repeater description uses downlink(repeater txfreq). IE, when you are looking at the repeater description in Repeaterbook, the frequency listed is the downlink frequency. Same for our descriptions on the club website.

- **duplex** or **simplex** These terms describe the type of communication with the repeater more so than describing the physical hardware. Most of our repeaters are duplex. Our communication to and from them is simultaneous through offset frequencies.   The crossband repeater may repeat across bands, but our connection to that repeater is simplex.

- **Standard offsets(shifts)** 600khz for VHF, 5mhz for UHF. Some radios have different ways of entering data. When programming some radios, you enter the downlink frequency, select duplex, and then select – or + shift. Other radios you may have to enter the uplink and downlink separately. Some radios also have the option of changing the standard offset values.

- **PL(private line), Tone, CTCSS(Continous Tone Coded Squelch System), CG (channel guard)** same thing… different terminology. Our repeaters, except for the 50rptr and the crossband use a 141.3 Hz tone. This is a sub-audible tone that is contained with transmissions. These tones are used to open the squelch on the repeater receiver, when you select **Tone** on your radio. When you select **Tone Squelch** in your radio, you are <u>also</u> using the tone transmitted(downlink) by the repeater to open the squelch in your own radio.

- Remember … Programming pl tones is a two-step process….select correct sub audible tone **<u>and</u>** enable tone or tone squelch.

Use of tone or tone squelch. Why would you use one over the other?

 When using Tone(**T**), you are sending a tone to open the squelch on the repeater receiver. For you own receiver, you are relying on the normal squelch function. Tone Squelch(**TSQ**) is meant to be used in situations where is a lot of traffic or interference affecting your reception. In commercial applications, you could have a repeater with multiple channels, each with a different tone. You could have all the Bobs using one channel, all of the Mikes using another channel, etc. So, Bob doesn't have to listen to chatter from the Mikes. In other situations, you could just have a lot of interference on or near the downlink frequency. If you have your radio set to **T**, this interference may occasionally break through your normal squelch setting. If you set your radio to **TSQ ,**you will filter it out. Occasionally when someone has programmed their radio incorrectly, your choice of **T** or **TSQ** can affect how you troubleshoot these scenarios. You can set your radio up anyway you want, but I tend to leave most of my channels on **T** except for channels that are prone to interference. Some radios use different nomenclature. They use Encode instead of Tone andEncode/Decode for Tone Squelch. When it is all set up correctly you should see an indication on your radio display such as **T** or **ENC** or **TSQ** or **ENC/DEC** or possibly nothing if you are not using any tones at all.

wideband or narrowband? Our repeaters are set for wideband(5khz dev/ 25khz spacing). Not to be confused with broadcast wfmhttps://www.hamradioschool.com/post/wideband-or-narrowband-fm

Meaning of full quieting . When you are conversing with another ham through a repeater, It is difficult to give a signal report for the originating ham radio. All you can do is report how well the repeater is repeating the transmission. If the other station has no noise on his signal when talking to you and your getting a good signal strength on the repeater, his transmission is said to have a "full quieting" signal.

What happens when you get it wrong -how to check your own radio and other radios(reverse function).

Some radios have the ability to reverse the receive and transmit frequencies. Essentially you are temporarily swapping the uplink and downlink frequencies on your radio. This is generally not a permanent swap. There will be some indication on your radio that the frequencies are swapped. This can be a useful tool when trying to troubleshoot a scenario where another ham is having trouble getting through the repeater. In reverse, you are setting your radio to listen on the same frequency that the repeater listens on. You can hear whether the other ham has set his uplink frequency correctly. Depending on whether you have T or TSQ set on your radio you might be able to determine if the faulty radio has the PL tone set correctly.

Checking your own Radio

Checking the setup on your own radio is fairly simple. If set up correctly…
The radio will display the frequency that it is listening to. (the repeater downlink freq) ie 146.78Mhz. If you have selected duplex and the correct offset you will likely see a – on the display indicating a shift down for the uplink frequency. You should also see a **T** or **ENC** or **TSQ** or **ENC/DEC** depending on the radio model. You should also see **H** or **M** or **L** for power levels and a mode indication such as **DN** (digital) or **FM** for analog. When you press the PTT on your radio, you should observe the frequency on the display switch to 146.18(uplink frequency). When you release the PTT you may hear the squelch tail of the repeater transmitter. If you hear this, it indicates that you have you have selected the correct sub audible tone that has opened the squelch on the repeater. You should be good to go.

91rptr
VE7RAP VHF repeater
Tx 146.91 Mhz
Rx 146.31 Mhz
Approx 20 W
141.3 squelch tone
Folded dipole antenna
Kenwood TKR-750
Duplexer
IRLP/Echolinkcontroller
Raspberry Pi

50rptr
VE7RAPUHF Digital repeater
Tx 449.50 Mhz
Rx 444.50 Mhz
Approx 20 W
No squelch tones
Folded dipole antenna
Sinclair Duplexer
Yaesu DR-1x
MMDVM-Pi controller
Raspberry Pi 3
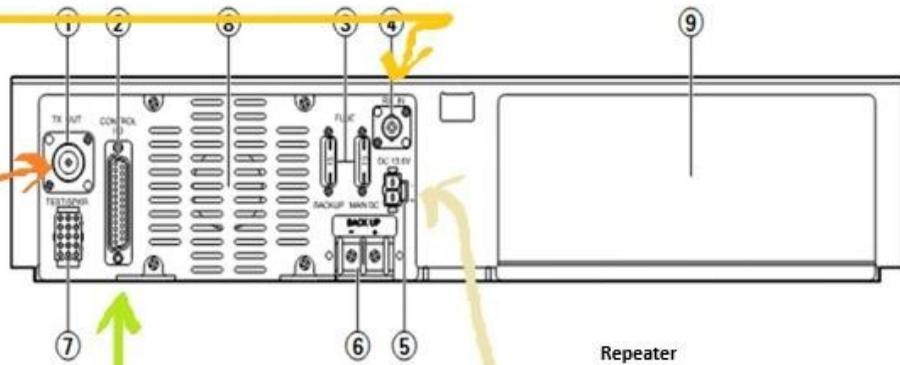
VHF/UHF FM Repeater-Base Units
TKR-750/850

● Zoom

KENWOOD
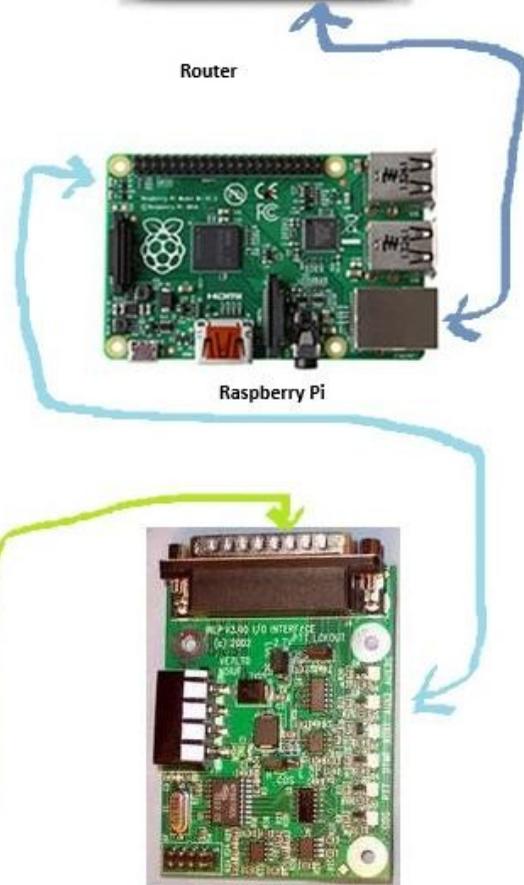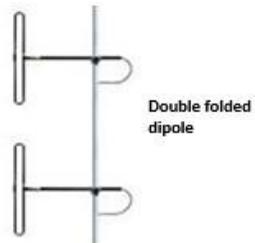
16
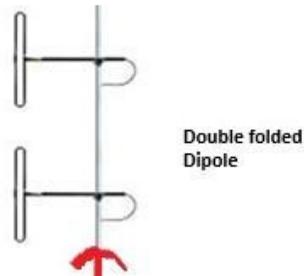
Double folded
Dipole

Router

Repeater

Raspberry Pi

Duplexer

12 volt battery

IRLP Controller
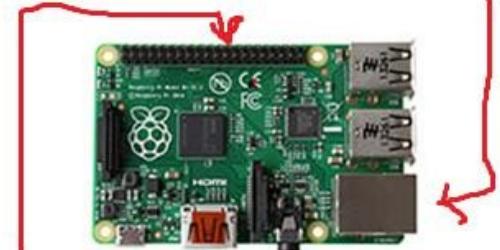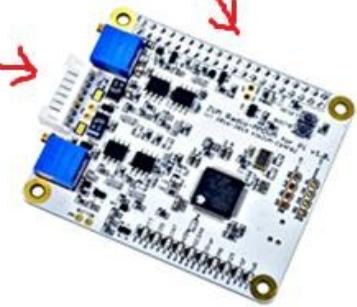
Double folded dipole

Repeater

Router
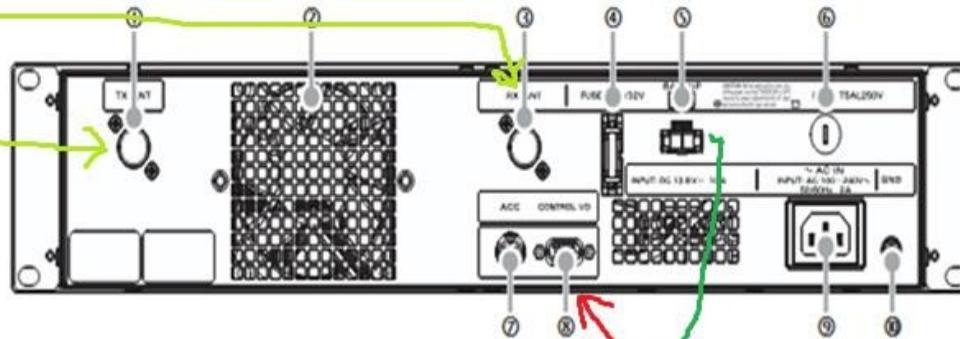
Duplexer

Battery

Raspberry Pi 3

MMDVM

Cercomm site

78rpter
VE7RCV

16rptr
VE7YQQ
All

local repeater

information available from club site.

78rptr/VE7RCV	Cercomm site	146.78 - shift, pl tone 141.3
16rptr/VE7YQQ	Cercomm site	146.16 + shift, pl tone 141.3
62rptr/VE7NIR	North Isl. Comm	146.62 – shift, pl tone 141.3, phone patch
70rptr/VE7NIR	North Isl. Comm	443.70 + shift, pl tone 141.3, Island Trunk link
91rptr/VE7RAP	NIC	146.91 – shift, pl tone 141.3, echolink/IRLP
50rptr/VE7RAP	NIC	449.50 – shift, no pl tone, YSF/DStar/DMR
xband repeater	Mark Isfeld Sch.	146.58 simplex, no pl tone, single destination use - (EOC) radio room

Other repeater info available from https://www.repeaterbook.com/repeaters/index2.php?state_id=CA02
Be wary of info on this website. Not always up-to-date. Also check local club websites to be certain.

Using a repeater

- Try not to Ker-chunk repeater

- Allow for delays in repeater infrastructure, especially the linked repeaters (ITS). Wait 1- 2 seconds after keying PTT before speaking. This is also an important consideration when using Echolink/IRLP and DMR/YSF/DSTAR.

- Be aware of **TOT** Time out Timer and Reset Timer. Most repeaters have a TOT of around 3 minutes. The 91rptr is currently set for 5 minutes. The phone patch 62rptr may have a longer TOT.

- Some remote repeaters rely on solar panels and batteries for power, so use them sparingly during winter months.

Island Trunk System- a system of linked repeaters across Vancouver Island
http://www.islandtrunksystem.org/cms/node/1

http://www.islandtrunksystem.org/cms/sites/islandtrunksystem.org/files/ITS%20System%20Map%20-%20Final%20V2%20-%2023.10.2024.png

The Island Trunk uses radio links to connect repeaters across Vancouver Island. When you use the 70rptr, you are sending your signal across the island to multiple repeaters. The linkage can be slow, so if you are keying the PTT on the 70rptr it may take a bit of time for that signal to reach the Victoria or other repeaters. Always pause before speaking to allow the infrastructure to catch up. It is not intended for hours-long conversations. However, it is helpful for extending the range of our communications out of our local area. There is a network that runs every morning on the Island Trunk at 8:15.   Join in if you can. When you are examining the map, make a note of the different repeaters in the different communities. Maybe the next time you are in Victoria for the weekend you can participate in the Island Trunk from that location or contact someone back here if needed.

The **50rptr** (VE7RAP/uhf) is a digital repeater utilizing a **MMDVM**(**M**ulti **M**ode **D**igital **V**oice **M**odem)board and a raspberry Pi processor running **Pi-Star** software to control the repeater. Currently the three enabled modes are **Dstar, YSF and DMR.**

Dstar is Digital Smart Technologies for Amateur Radio. It started in the early 2000's from work by the JARL and is currently supported by ICOM.

DMR is Digital Mobile Radio. The DMR standard was defined by ETSI in mid 2000's. There are three tiers(types). Tier II is the type used in amateur radio. This tier uses 2 slot TDMA. There are a lot of DMR radio suppliers.

YSFis Yaesu System Fusion. System Fusion is a proprietary technology of Yaesu developed around 2013. It uses C4FM. WIRES-X is the name of the Yaesu System Fusion Network(proprietary) as well as the name of the menu built into Yaesu radios for connection to the network. The YSF mode that is enabled on our repeater is a network(actually two networks, YSF and FCS) that operate outside of the proprietary Yaesu network, but built for Yaesu radios and their built-in Wires-X menu controls.

Pi-Star is the name of a software package that controls the repeater and using a hardware hat MMDVM, can convert various digital voice modes. Other disabled modes are NXDN and P25. It is designed to run on a Raspberry pi or other ARM-based processors. A lot of the development of Pi-Star is down to the work of Jonathan Naylor (G4KLX) and others. It is free opensourced software. There is another hotspot software called WPSD, which is a derivative of Pi-Star.

   You can build your own hotspot which works like a small digital repeater. The h/w requirements are: an ARM-based processor(usually a raspberry pi), a **MMDVM**, micro SD memory card, power supply and an internet connection. There are also vendors who will sell an assembled hotspot. The s/w requirements are free Pi-Star software, Balena Etcher, a DMR ID from https://www.radioid.net/ and an account at various networks Dstar, DMR Brandmeister, TGIF.   They are simple to build and setup.

Hostname: pi-star

Pi-Star:4.2.3 / Dashboard: 20251201

Pi-Star Digital Voice Dashboard for VE7RAP

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	449.500000 MHz
Rx	444.500000 MHz
FW	MMDVM:20190130
TCXO	12.0000 MHz

D-Star Repeater

RPT1	VE7RAP B
RPT2	VE7RAP G

D-Star Network

APRS	euro.aprs2.net
XRF103 A DExtra/Out	

DMR Repeater

DMR ID	302704
DMR CC	1
TS1	enabled
TS2	enabled

DMR Master

BM 3021 Canada

YSF Network

Gateway Activity

Time (PST)	Mode	Callsign		Target	Src	Dur(s)	Loss	BER
10:11:55 Feb 2nd	DMR TS1	VA7CGM	(GPS)	TG 30271	Net	10.6	1%	0.0%
10:11:37 Feb 2nd	DMR TS1	VE6TVE	(GPS)	TG 30271	Net	89.8	0%	0.0%
09:52:31 Feb 2nd	DMR TS1	VE7CQF	(GPS)	TG 30271	Net	7.0	0%	0.0%
09:46:54 Feb 2nd	DMR TS1	VA7FX	(GPS)	TG 30271	Net	4.4	24%	6.1%
09:06:05 Feb 2nd	DMR TS1	VA7MD	(GPS)	TG 30271	Net	0.8	0%	0.0%
09:00:04 Feb 2nd	D-Star	VE7RAP/TIME	(GPS)	CQCQCQ	Net	4.1	0%	0.0%
08:56:30 Feb 2nd	D-Star	VE3OOL/MOB	(GPS)	CQCQCQ	Net	0.0	0%	0.0%
08:36:59 Feb 2nd	DMR TS1	VA7UW	(GPS)	TG 30271	Net	0.5	12%	0.0%
08:33:22 Feb 2nd	DMR TS1	VA7CGM	(GPS)	TG 30271	RF	9.4	0%	0.9%
08:31:51 Feb 2nd	DMR TS2	VA7CGM	(GPS)	TG 3026	RF	8.3	0%	0.2%
08:27:41 Feb 2nd	D-Star	VE3LNU/DCS	(GPS)	CQCQCQ	Net	0.0	0%	0.0%
08:27:41 Feb 2nd	D-Star	VE3LNU	(GPS)	CQCQCQ	Net	2.0	0%	0.0%
08:05:00 Feb 2nd	D-Star	DG1MG/PNUT	(GPS)	CQCQCQ	Net	0.0	0%	0.0%
08:03:13 Feb 2nd	D-Star	VE3OK/2820	(GPS)	CQCQCQ	Net	0.0	0%	0.0%
05:49:32 Feb 2nd	D-Star	I5GJK/7100	(GPS)	CQCQCQ	Net	0.0	0%	0.0%
05:28:36 Feb 2nd	D-Star	K8BMC/DMR	(GPS)	CQCQCQ	Net	0.0	0%	0.0%
04:56:25 Feb 2nd	D-Star	VE7RAP/INFO	(GPS)	CQCQCQ	Net	6.9	0%	0.0%
01:47:54 Feb 2nd	YSF	VE7RAP	(GPS)	DG-ID 0	Net	0.6	0%	0.0%
01:47:53 Feb 2nd	YSF	VE7NZN	(GPS)	DG-ID 0	RF	0.4	0%	??%
01:38:49 Feb 2nd	D-Star	IZ5IOS/9700	(GPS)	CQCQCQ	Net	0.0	0%	0.0%

Local RF Activity

Time (PST)	Mode	Callsign		Target	Src	Dur(s)	BER	RSSI
08:33:22 Feb 2nd	DMR TS1	VA7CGM	(GPS)	TG 30271	RF	9.4	0.9%	S9+50dB (-43 dBm)
08:31:51 Feb 2nd	DMR TS2	VA7CGM	(GPS)	TG 3026	RF	8.3	0.2%	S9+50dB (-43 dBm)
01:47:53 Feb 2nd	YSF	VE7NZN	(GPS)	DG-ID 0	RF	0.4	??%	S9+50dB (-43 dBm)

Pi-Star / Pi-Star Dashboard, © Andy Taylor (MW0MWZ) 2014-2026.
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.

Screen shot of VE7RAP digital dashboard

Using a digital capable radio, we can connect across the world. Some of the cheaper DMR radios may cost you around $125.

Digital communication through our repeater or a hotspot is different from analog repeater comms. It is basically a two stage process, where by you establish a connection to the repeater or hotspot first, then connect to a talkgroup or node. The talkgroups or nodes could be anywhere. They are not necessarily assigned to a specific geographic location, but can be. The DMR BC-3 talkgroup is designated as a Vancouver Island talkgroup, but the actual server could be anywhere.   Some talkgroups are theme–based such as Chatterbox, which I think is in the UK but has people checking in from around the world.   It is possible to do some local(repeater- like) communications with the digital repeater, but typically people use these devices to go further afield. There are a number of digital nets that you can try when you get your digital radio. Can Net which runs out of Ontario on Friday 6 pm and BC DMR net that runs around 8 pm Friday nights.

In terms of which mode you should try, there is a link to a web page which discusses the pro and cons at the end of the presentation. Of the three modes we have enabled, I suspect Dstar might be the most expensive to try. DMR is probably the cheapest. DMR is the most complex in terms of programming and ease-of-use. YSF is the easiest to program and use. DMR might have a slight edge in popularity but that might be debateable by others.

If you are going to go down this road, you will want to get or make your own hotspot. The repeater works fine, but it is available for everyone to use so you could run in to a situation where it is busy at the same time you want to get on to your favorite net. You will also get a better understanding of it all if you build and use your own hotspot.

This is a hotspot dashboard from home. This one is set up for YSF and YSF2DMR connections. I can connect to YSF, FCS and DMR Brandmeister talkgroups with this hotspot and my Yaesu FT70 radio.

Links https://www.repeater-builder.com/rbtip/repeater101.html

https://www.antenna-theory.com/antennas/foldeddipole.php

https://www.youtube.com/watch?v=POTXrTRmAIo

https://www.hamradioschool.com/post/wideband-or-narrowband-fm

https://www.ylab.ca/repeaters/

https://www.hamuniverse.com/repeaterterminology.html

https://hamshackreviews.com/digital-voice-modes/

https://www.icomjapan.com/explore/d-star/

https://en.wikipedia.org/wiki/D-STAR

https://en.wikipedia.org/wiki/Digital_mobile_radio

https://systemfusion.yaesu.com/what-is-system-fusion/

https://evoham.com/dmr-vs-fusion-vs-dstar/

https://www.pistar.uk/

https://www.youtube.com/watch?v=LbJZkW3ZGms

https://www.radioid.net/

https://brandmeister.network/

https://amateurradionotes.com/images2/1-Playing_with_Pi-Star.pdf

https://w0chp.radio/wpsd/