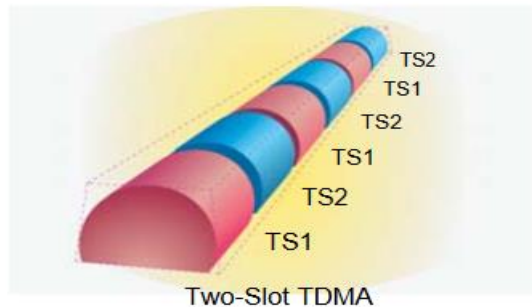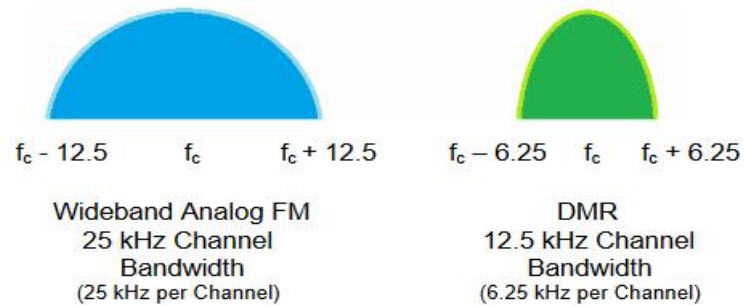# Hotspots For Digital Radio

By VE6PLC

Hotspots provide access to digital networks without the need of a repeater. Hotspots can be used to connect to various digital networks, including D-star, Fusion (YSF and FCS), DMR (multiple networks), NXDN, P25, and M17. Where a repeater is usually connected to only one digital network, a hotspot can be connected to various digital networks. Hotspots also have cross-mode capabilities. For example, they will connect a DMR radio to the Fusion network or a Yaesu digital radio to a DMR network. The Openspot 3 hotspot will also connect your DMR radio to D-star networks and the reverse. Using a hotspot really opens up the digital world. VE6RYC is connected to the CAN-TRBO MARC network, which doesn't allow hotspots to be directly connected to it. Hotspot friendly DMR networks include DMR Plus, Brandmeister, and TGIF. CAN-TRBO MARC and DMR Plus have some interconnected TG's, like Canada wide TG 302 and the provincial talkgroups, as well as many of the state and regional TG's in the US. Unlike with a repeater, the hotspot end user has complete control over what TG on what network they connect to. Similar features apply to the other digital modes (D-star, YSF, etcetera).

A feature of the DMR system is that all radios and repeaters have 2 "timeslots", 1 and 2. Timeslot 1 is typically used for "wide area" connections while timeslot 2 is used for local and provincial talkgroups. One user can be using the repeater for a province wide conversation on timeslot 2 at the same time as another user is talking Canada wide on timeslot 1. **The same applies to duplex DMR hotspots, but not simplex hotspots.**

DMR transmissions have a 30ms window for each time slot. That window is further divided into a 27.5ms frame followed by a 2.5ms gap. For each 60ms, the radio is only transmitting for 27.5ms, which results in extended battery life and less heat.

$f_c - 12.5$ f_c $f_c + 12.5$ $f_c - 6.25$ f_c $f_c + 6.25$

Wideband Analog FM
25 kHz Channel
Bandwidth
(25 kHz per Channel)

DMR
12.5 kHz Channel
Bandwidth
(6.25 kHz per Channel)

TS2
TS1
TS2
TS1
TS2
TS1

Two-Slot TDMA

Hotspots can go mobile quite easily by using the internet sharing ability of most smart cell phones. The data stream between the hotspot and the cell phone is relatively small, especially when compared to streaming video. If your hotspot has WiFi capability, it can be linked to your smartphone so that when you leave home with your DMR radio, your hotspot, and your smartphone, your favourite hotspot talkgroups can go with you.


The Raspberry Pi Zero with WiFi and the smaller MMDVM board is very popular and makes for a good mobile/portable hotspot. It is available under many names from multiple sources.

SharkRF Openspot (original). The original Openspot did not have WiFi. Later models added WiFi and removed the cabled ethernet capability.
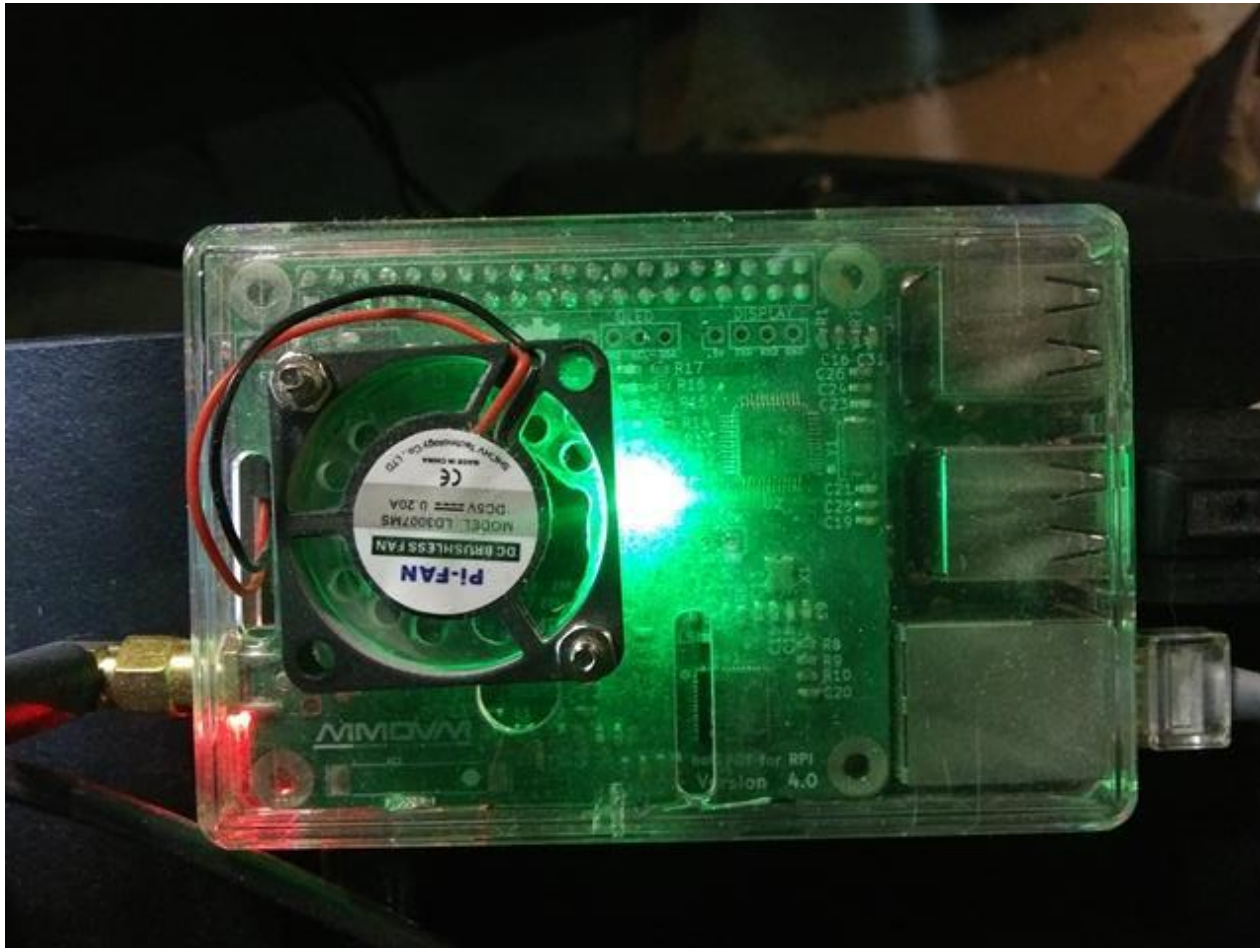
Raspberry Pi 3 with full size MMDVM simplex board. This particular hotspot is currently configured to work with Yaesu Fusion digital radios.
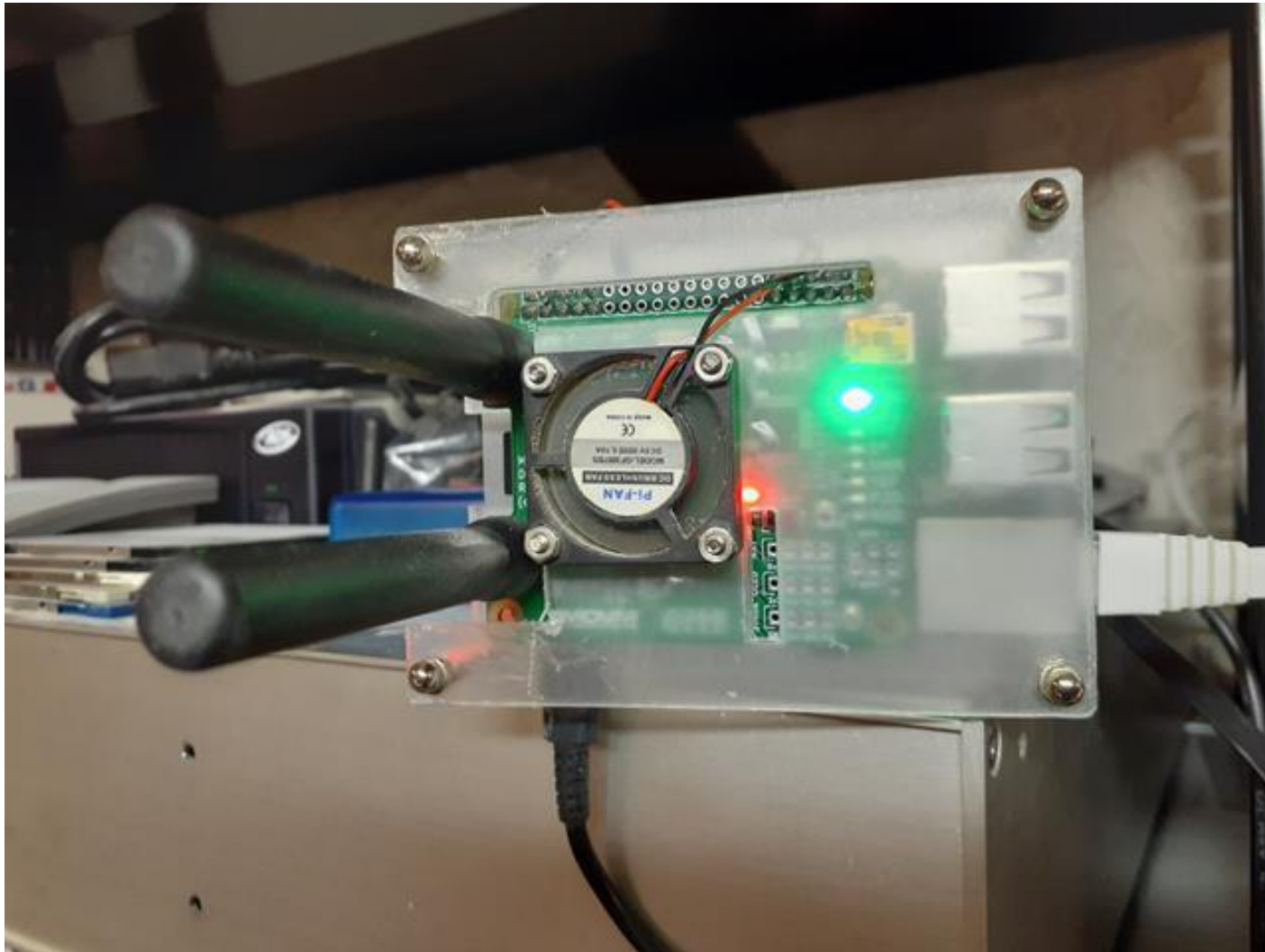
Raspberry Pi with Duplex MMDVM board, which provides separate Tx and Rx frequencies and under DMR, both timeslots. Note the 2 antennas.

Raspberry Pi in blue metal case using a GD-77 radio with OpenGD77 firmware instead of a simplex MMDVM board. Note the coax to an external antenna and the ferrite at both ends of the USB to radio cable to minimize RF getting into the Raspberry Pi. MMDVM boards typically put out 10 to 15 mW. The GD-77 radio can safely transmit up to 3 W. Anything over that could result in burning out the finals. I have found that 500 mW gives me several tenths of a kilometer of range.

Pi-Star Dashboards

Pi-star dashboard for simplex hotspot for YSF/FCS connections (Yaesu digital). It is also configured for YSF to DMR cross mode operation.

Pi-Star Digital Voice Dashboard for VE6PLC

Hostname: hs5duplex

Pi-Star:4.1.6 / Dashboard: 20221114

Dashboard | Admin | Configuration

Modes Enabled

D-Star	DMR
YSF	P25
YSF XMode	NXDN
DMR XMode	POCSAG

Network Status

D-Star Net	DMR Net
YSF Net	P25 Net
YSF2DMR	NXDN Net
YSF2NXDN	YSF2P25
DMR2NXDN	DMR2YSF

Radio Info

Trx	Listening
Tx	442.512500 MHz
Rx	447.512500 MHz
FW	HS_Hat:v1.5.2
TCXO	14.7456 MHz

DMR Repeater

DMR ID	3026053
DMR CC	1
TS1	enabled
TS2	enabled
DMR Master	
ipsc2.can-trbo.ca	
dmr.cokenet.org	
DMR2YSF Cross-over	
TGIF Network	

YSF Network

Not Linked

Gateway Activity

Time (MDT)	Mode	Callsign		Target	Src	Dur(s)	Loss	BER
14:03:20 Mar 22nd	DMR TS1	K3DCR	(GPS)	TG 8000320	Net	0.1	0%	0.0%
13:14:26 Mar 22nd	DMR TS1	K7GND	(GPS)	TG 8000320	Net	0.7	0%	0.0%
12:18:27 Mar 22nd	DMR TS1	W3XPT	(GPS)	TG 8000320	Net	0.5	0%	0.0%
10:32:25 Mar 22nd	DMR TS1	VE6VC	(GPS)	TG 302	Net	0.8	0%	0.0%
08:52:42 Mar 22nd	DMR TS1	KB2FJD	(GPS)	TG 8000320	Net	6.7	0%	0.0%
08:12:03 Mar 22nd	DMR TS1	K8PRO	(GPS)	TG 8000320	Net	0.1	0%	0.0%
06:36:52 Mar 22nd	DMR TS1	VE3RD	(GPS)	TG 302	Net	2.0	3%	0.1%
04:46:26 Mar 22nd	DMR TS2	4000		TG 9	Net	2.3	0%	0.0%
03:07:02 Mar 22nd	DMR TS1	N9OML	(GPS)	TG 8000320	Net	3.0	0%	0.0%
01:22:52 Mar 22nd	DMR TS1	W1JOP	(GPS)	TG 8000320	Net	39.7	0%	0.0%
01:19:01 Mar 22nd	DMR TS1	N9NJS	(GPS)	TG 8000320	Net	28.9	0%	0.0%
01:15:59 Mar 22nd	DMR TS1	VE6DV	(GPS)	TG 8000320	Net	7.0	0%	0.0%
01:15:22 Mar 22nd	DMR TS1	WX4QZ	(GPS)	TG 8000320	Net	71.8	0%	0.0%
01:06:42 Mar 22nd	DMR TS1	KL7RG	(GPS)	TG 8000320	Net	65.8	0%	0.0%
22:14:09 Mar 21st	DMR TS1	K1EDH	(GPS)	TG 8000320	Net	1.4	78%	0.0%
21:23:28 Mar 21st	DMR TS1	KN6YGU	(GPS)	TG 302	Net	19.0	5%	1.5%
19:50:57 Mar 21st	DMR TS1	KN4BYB	(GPS)	TG 8000320	Net	0.2	0%	0.0%
19:31:13 Mar 21st	DMR TS1	KN4WUH	(GPS)	TG 8000320	Net	0.5	0%	0.0%
16:39:51 Mar 21st	DMR TS1	KB2DSR	(GPS)	TG 8000320	Net	4.8	0%	0.0%

Local RF Activity

Time (MDT)	Mode	Callsign	Target	Src	Dur(s)	BER	RSSI

Pi-star duplex DMR hotspot dashboard.

Note the different Tx and Rx frequencies and that both timeslots are enabled. This Pi-star hotspot is configured to use DMR Gateway, which allows it to connect to 3 different DMR servers plus it allows DMR to YSF/FCS cross mode connections.

Pi-Star Digital Voice Dashboard for VE6PLC

Dashboard | Admin | Configuration

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

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

Radio Info	
Trx	Listening
Tx	434.000000 MHz
Rx	434.000000 MHz
FW	OpenGD77:v0.1.10

DMR Repeater	
DMR ID	3026053
DMR CC	1
TS1	disabled
TS2	enabled
DMR Master	
BM 3021 Canada	
DMR2YSF Cross-over	
TGIF Network	
FreestarX	

YSF Network
Not Linked

Gateway Activity

Time (MDT)	Mode	Callsign		Target	Src	Dur(s)	Loss	BER
14:26:09 Mar 22nd	DMR TS2	N9WPD	(GPS)	TG 31665	Net	1.9	0%	0.0%
14:24:03 Mar 22nd	DMR TS2	W4DCR	(GPS)	TG 31665	Net	0.8	0%	0.0%
14:17:25 Mar 22nd	DMR TS2	N9AJI	(GPS)	TG 31665	Net	1.2	0%	0.0%
14:14:09 Mar 22nd	DMR TS2	N4XV	(GPS)	TG 31665	Net	0.1	0%	0.0%
14:04:05 Mar 22nd	DMR TS2	AD2CH	(GPS)	TG 31665	Net	16.0	0%	0.0%
14:03:46 Mar 22nd	DMR TS2	K4WZV	(GPS)	TG 31665	Net	5.9	0%	0.0%
13:54:39 Mar 22nd	DMR TS2	N4BDJ	(GPS)	TG 31665	Net	0.5	0%	0.0%
13:36:46 Mar 22nd	DMR TS2	MI7DJT	(GPS)	TG 31665	Net	1.6	0%	0.0%
13:16:04 Mar 22nd	DMR TS2	N4HYK	(GPS)	TG 31665	Net	74.3	0%	0.0%
13:14:46 Mar 22nd	DMR TS2	NP4M	(GPS)	TG 31665	Net	24.2	0%	0.0%
13:07:27 Mar 22nd	DMR TS2	N6WAS	(GPS)	TG 31665	Net	2.6	0%	11.8%
13:02:26 Mar 22nd	DMR TS2	KV9Q	(GPS)	TG 31665	Net	0.5	0%	0.0%
12:30:20 Mar 22nd	DMR TS2	AJ6O	(GPS)	TG 31665	Net	0.5	0%	0.0%
12:17:26 Mar 22nd	DMR TS2	W6WDS	(GPS)	TG 31665	Net	8.4	0%	0.0%
12:09:43 Mar 22nd	DMR TS2	W2RFA	(GPS)	TG 31665	Net	0.1	0%	0.0%
12:04:23 Mar 22nd	DMR TS2	G4XCP	(GPS)	TG 31665	Net	3.4	0%	0.0%
11:47:40 Mar 22nd	DMR TS2	KC3PTC	(GPS)	TG 31665	Net	0.5	0%	0.0%
11:21:33 Mar 22nd	DMR TS2	WB3IHY	(GPS)	TG 31665	Net	0.5	0%	0.0%
11:03:23 Mar 22nd	DMR TS2	WV8T	(GPS)	TG 31665	Net	0.5	0%	0.0%
10:59:27 Mar 22nd	DMR TS2	N2CMD	(GPS)	TG 31665	Net	1.2	0%	0.0%

Local RF Activity

Time (MDT)	Mode	Callsign	Target	Src	Dur(s)	BER	RSSI

This simplex hotspot uses a GD-77 radio with OpenGD77 firmware instead of a simplex MMDVM board. Note the FW field under Radio Info shows the OpenGD77 version instead of the HS_Hat version of an MMDVM board.

Using DMR Gateway in Pi-star

The stock Pi-Star DMR Gateway uses prefixes with the Talkgroup numbers to differentiate Talkgroups among networks and for DMR to YSF/FCS cross mode operation. For example, in a DMR radio, the TG number to connect to YSF reflector 10832 would be 7010832. When the hotspot sees an incoming RF transmission with TG 7010832 it knows to create a connection to reflector 10832 on the YSF network. For connections to TG's on the TGIF network, a prefix of 40 is often used.

An Ontario ham, Phil VE3RD, has developed an alternate DMR Gateway that does not use prefixes. Instead, it looks for a TG number in the range of 9001 to 9006 to indicate which server to connect to, based on the Network numbers defined in the DMR Gateway configuration. Once the server to connect to has been defined, the Gateway looks for the standard 1 to 5 digit TG number in order to establish the connection to the particular TG.