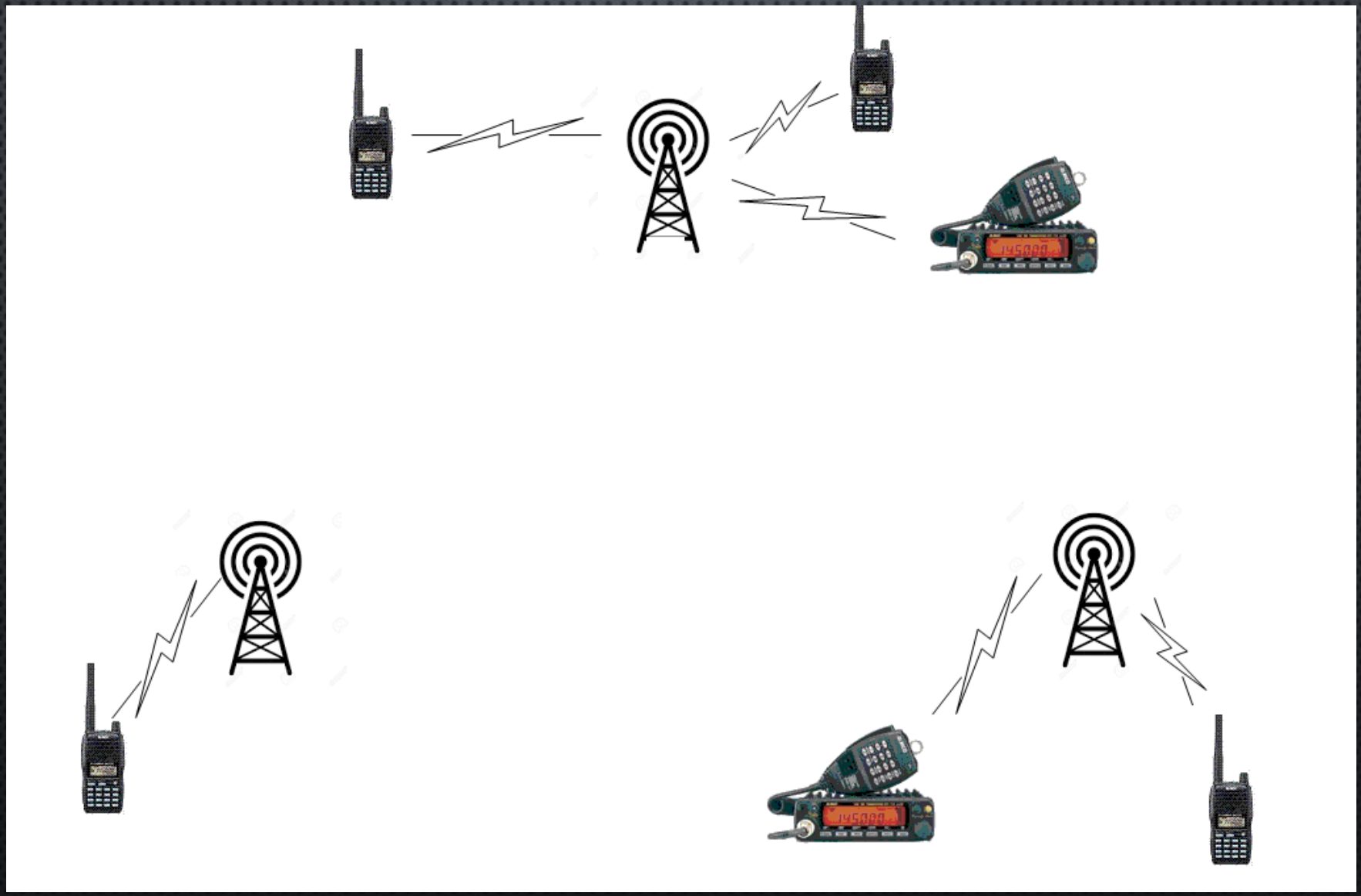
DIGITAL MODE RADIO (DMR) SETTING UP YOUR OWN SIMPLEX HOTSPOT/REPEATER

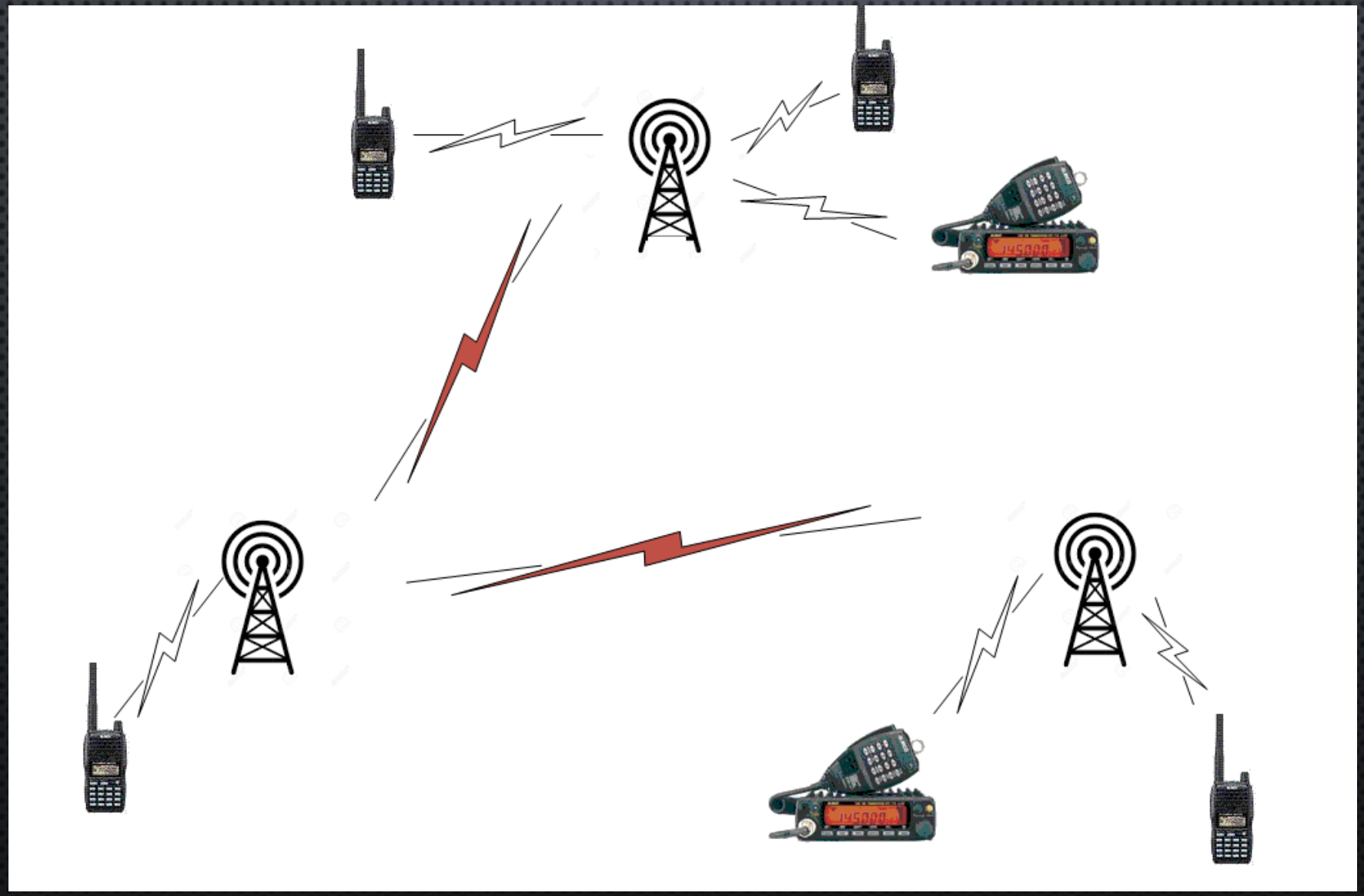
N5DDW- Daniel Weatherly

ARVARF hamfest 2020

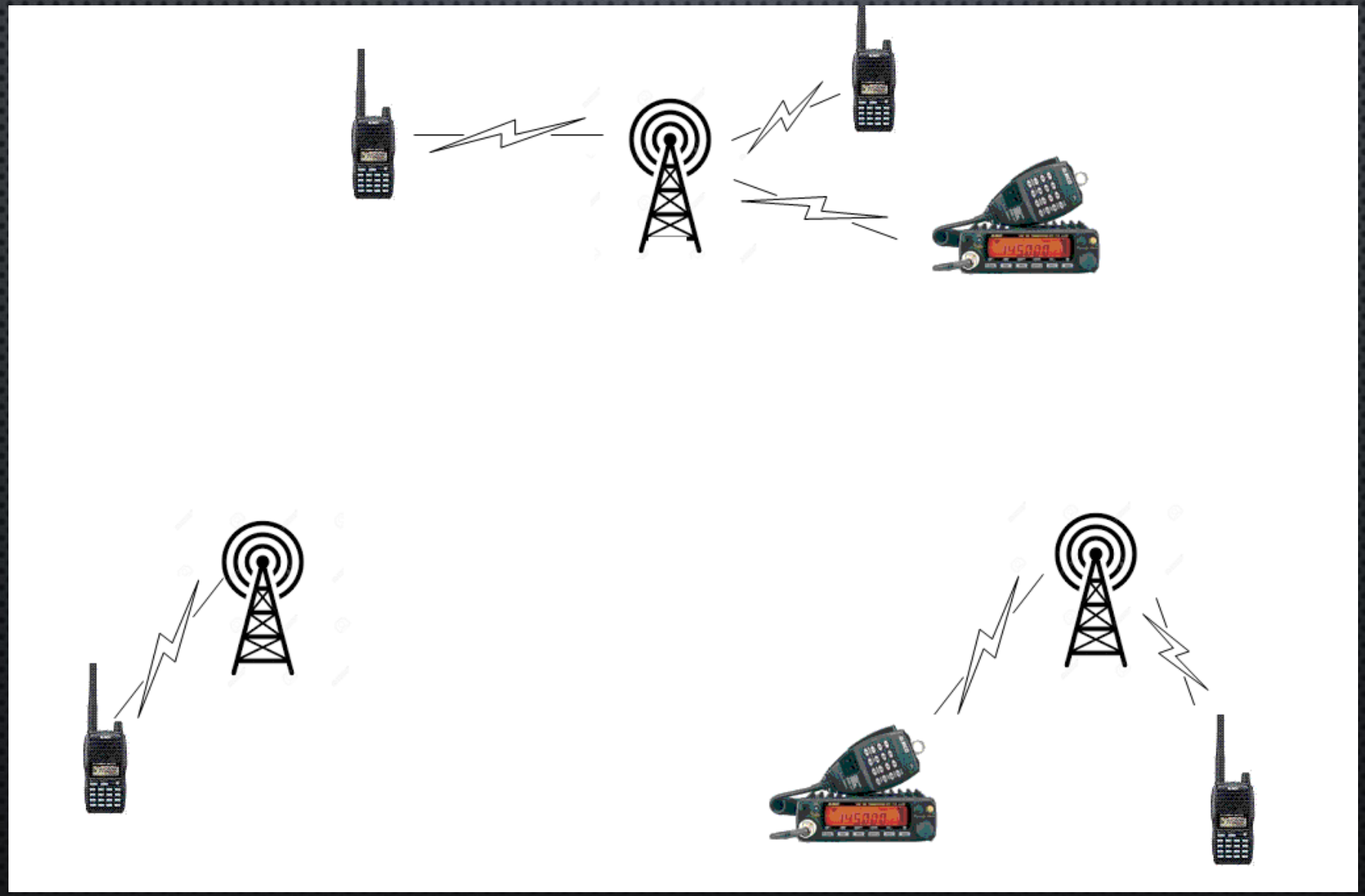
REPEATER'S - ANALOG - WHAT WE THINK OF



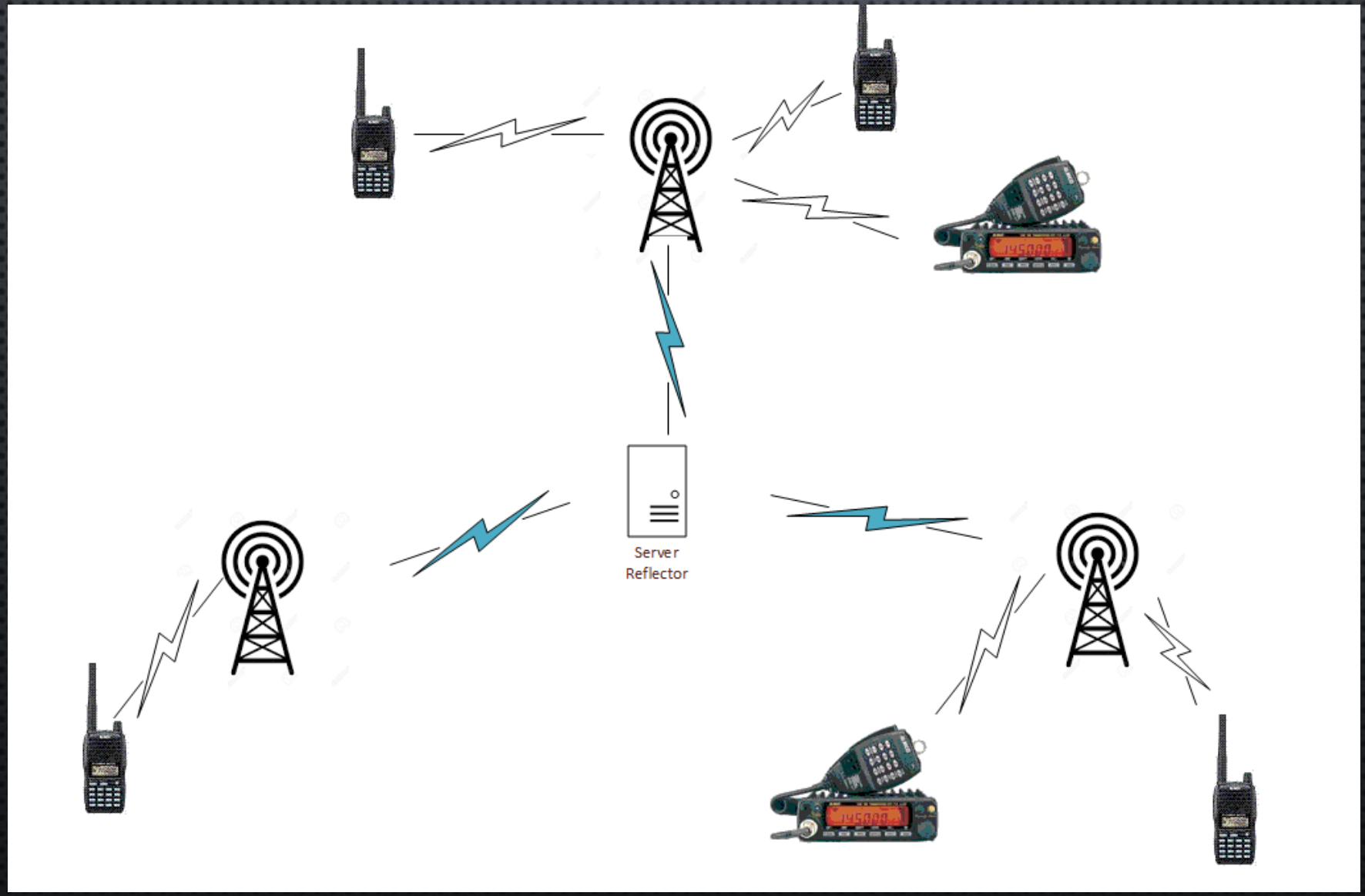
REPEATER'S - ANALOG - LINKED TOGETHER



REPEATER'S - DMR



REPEATER'S - DMR – LINKED TOGETHER



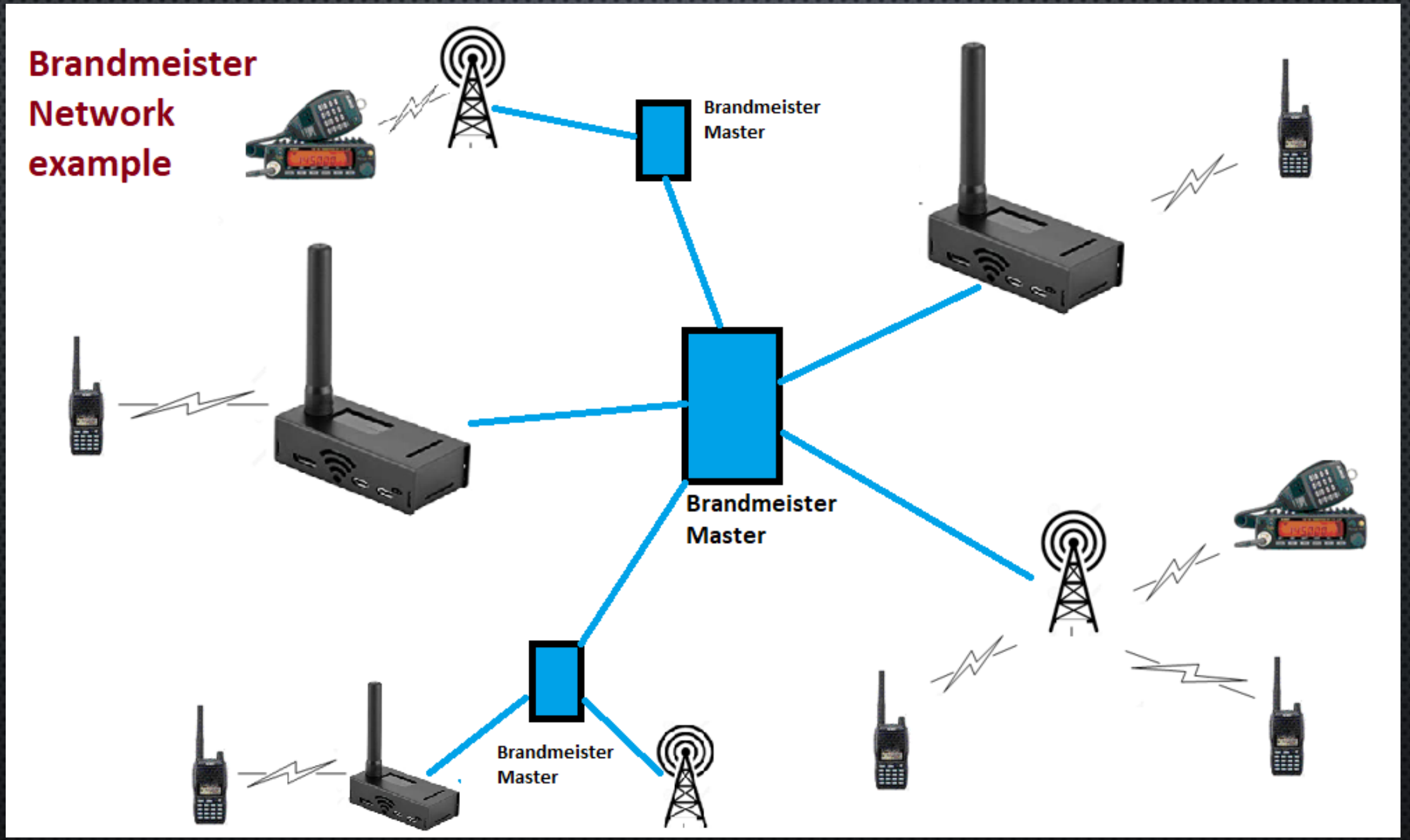
WHY?

- Taking DMR with you when you travel without having to pre-program repeaters at your destination.
- There may not be any DMR repeaters at your destination
- No need to compete on local repeater for talk time, or consume time or timeslot on shared repeater
- You can choose your own static talk groups, and their timeouts
- Ability to participate on multiple DMR networks such as Brandmeister, TGIF
- Cross-over capability between YSF, DMR, P15, NXDN
- Some repeaters will not let you PTT on any talk group you want
- Using a repeater to direct-call a person is often frowned upon

HOW?

- Setting up a MODEM to convert your analog radio waves that carry a digital signal to digital signals to be sent over the internet and vise versa.
- You also need the hardware voice codec for encoding and decoding voice
- Running free software called Pi-Star to control the modem

Brandmeister Network example



THE PARTS

- MMDVM BOARD
  - SIMPLEX IS ALL YOU NEED
  - DUPLEX IS AVAILABLE
  - HAS CODEC NEEDED
  - HAS OLED DISPLAY
- RASPBERRY PI
  - CAN BE PI-ZERO-W, PI3, PI3B
- MICRO SD CARD
  - 2GIG

UHF/VHF MMDVM hotspot OLED+ Antenna+ Case Support P25 DMR YSF for Raspberry pi B

★★★★★ 7 product ratings

Condition: New

Sale ends in: 07d 09h 15m

Quantity: 1 — 10 available

32 sold / See feedback

Was: ~~US $34.81~~

You save: $1.74 (5% off)

Price: US $33.07

Buy another

Add to cart

Raspberry Pi Zero W

PRODUCT ID: 3400

ADD TO CART

$10.00

IN STOCK

Micro SD Card 32GB 16GB 8GB Mini SD Card TF Card Memory Card for Smartphone #M

Condition: New

Color: Black

Size: 2GB

Quantity: 1 — 5 available

202 sold / See feedback

Price: US $3.91

Buy It Now

Add to cart

MMDVM kit <$35
Pi-zero-W -$10
TF memory card <$5
Pi-Star -$0

Total <$50

The Software

- Pi-Star https://www.pistar.uk
- Works on Raspberry pi Zero, Pi 3b, Nano Pi, OrangePi, Odroid XU3/4
  - Beta works on Pi4B+, Pi3B+,Pi3A+, but wireless has issues, wired is fine
- Supports multiple MMDVM boards simplex and duplex
- Can handle Many digital modes including
  - D-Star
  - DMR (such as Brandmeister)
  - P25
  - YSF/FCS
  - NXDN
- Supports cross-mode https://amateurradionotes.com/pi-star-cross-modes.htm
  - YSF2DMR
  - YSF2NXDN
  - DMR2YSF
  - DMR2NXDN

Online accounts

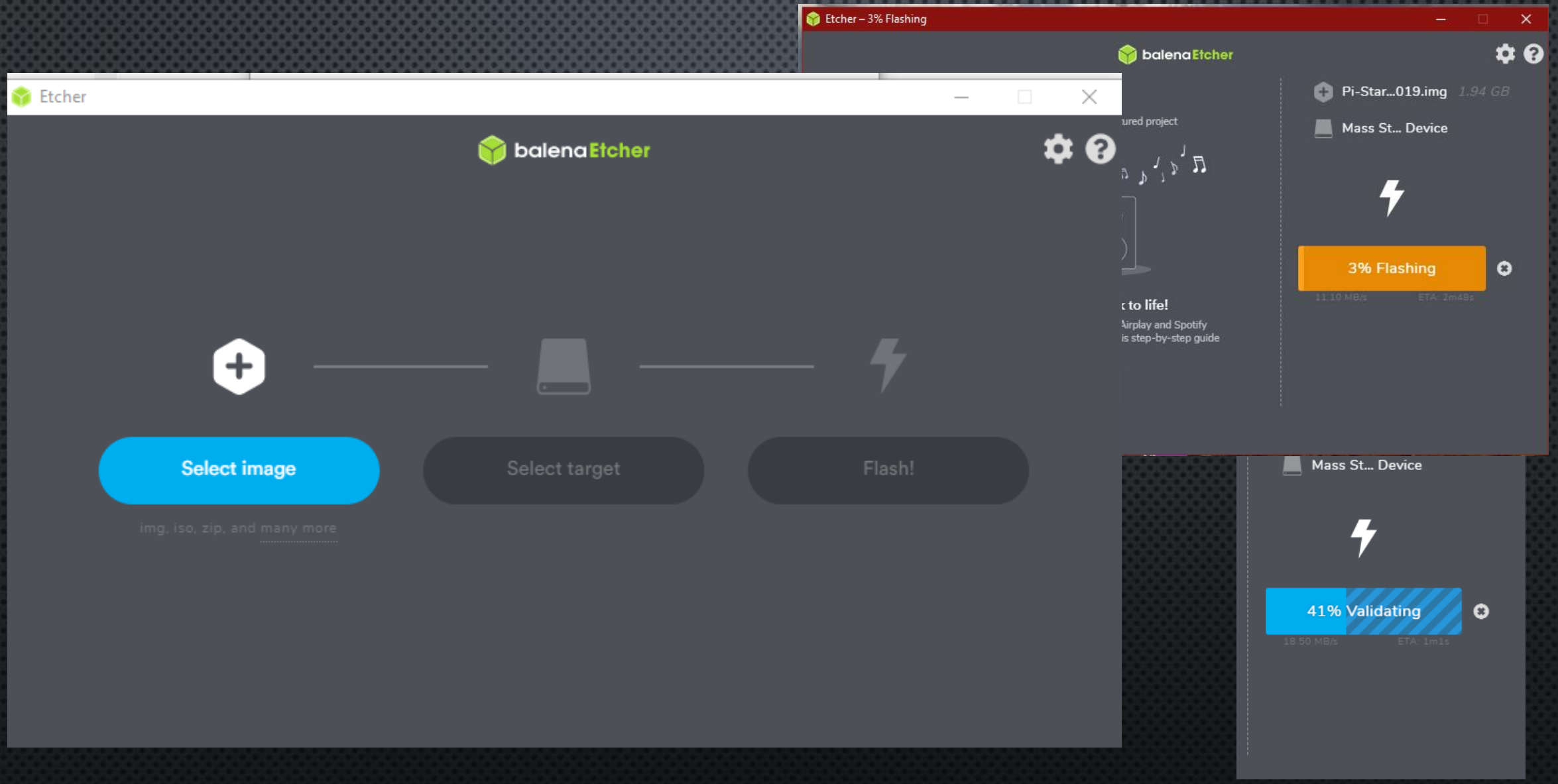
- You need a DMR ID from RadioID.net. You can(should) share the same ID between your radio and hotspot if you are the only one using it. You can request an additional ID, but please don't unless you need to.
- You will need a brandmeister user account to manage the hotspot. All static talk group management is done via the brandmeister web site and the hotspot pulls that information over the Internet

Setting it all up

- Download the pi-star for your platform at http://pistar.uk
- Flash the pi-star image to your microSD card using one of the suggested tools
- Solder headers to Pi-Zero if needed
- Mount the MMDVM board on the pi in the case
- Stick the micro SD into the pi
- Power it up (min 2amp USB power needed)

- You can connect a monitor to see the boot process if you want, but this is not needed.

FLASHING THE MICRO-SD CARD

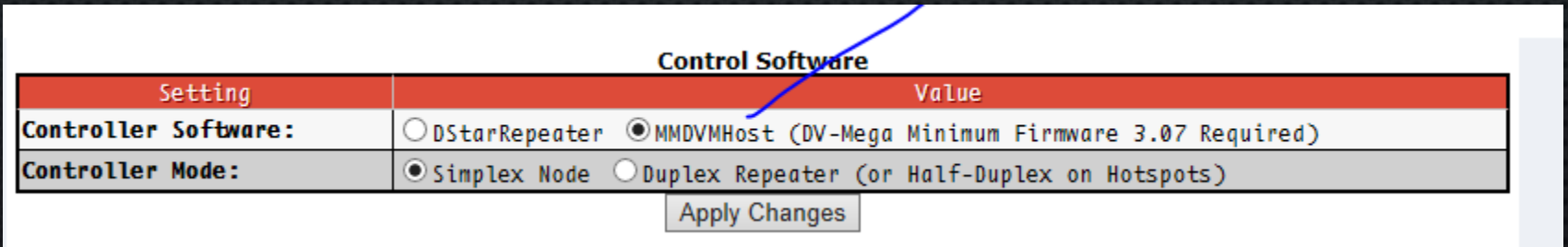


Assemble the parts

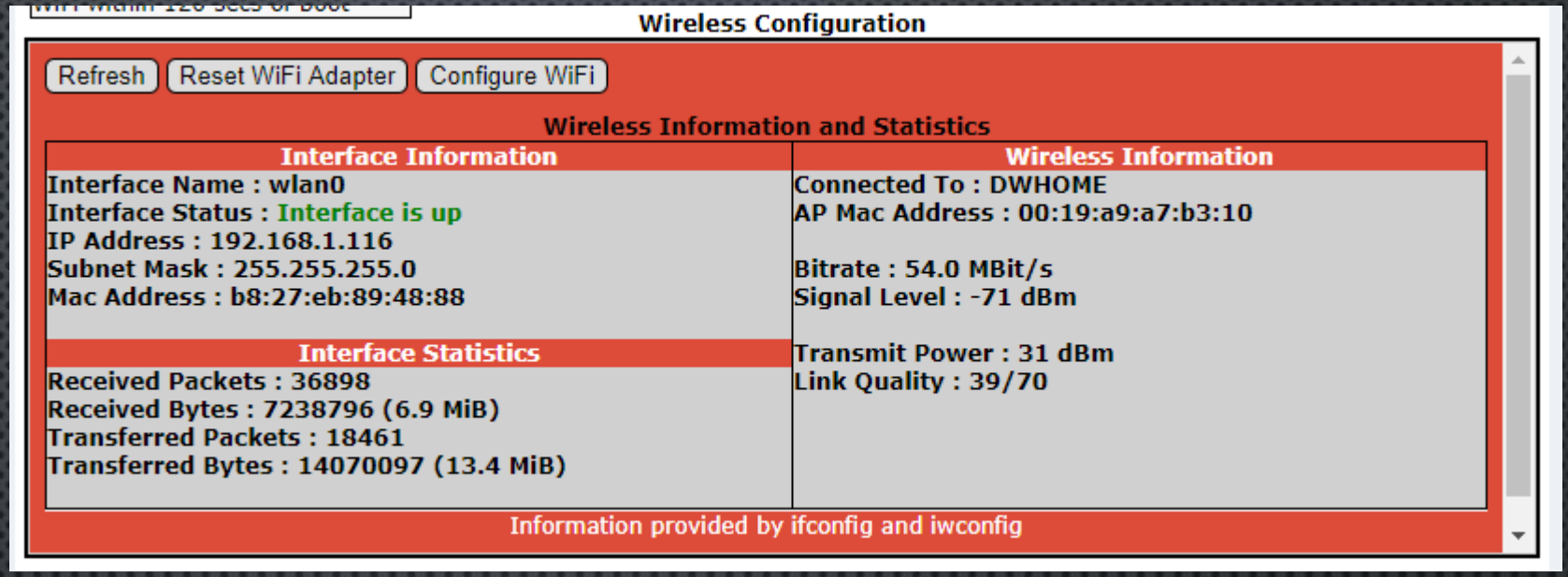
- Live video

FIRST BOOT

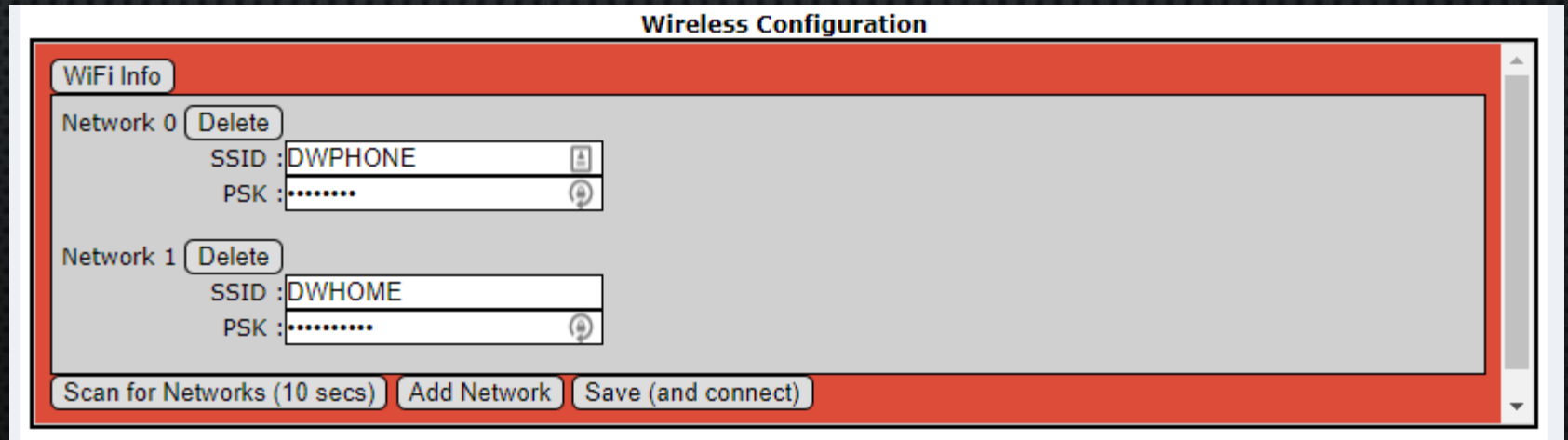
- If the hotspot does not detect a configured wifi after 2 minutes, it will turn itself into a wifi AP and broadcast the SSID pi-star (or Pi-Star-Setup for 4.1RC7) allowing you to connect to it to configure it, password is raspberry (lower case)
- Navigate to http://pi-star OR http://192.168.50.1 once you are on the same network
- You will see a no-mode defined message.
- Login with default user **pi-star** and password raspberry (lower case)
- Select MMDVMHost as the controller software and hit apply

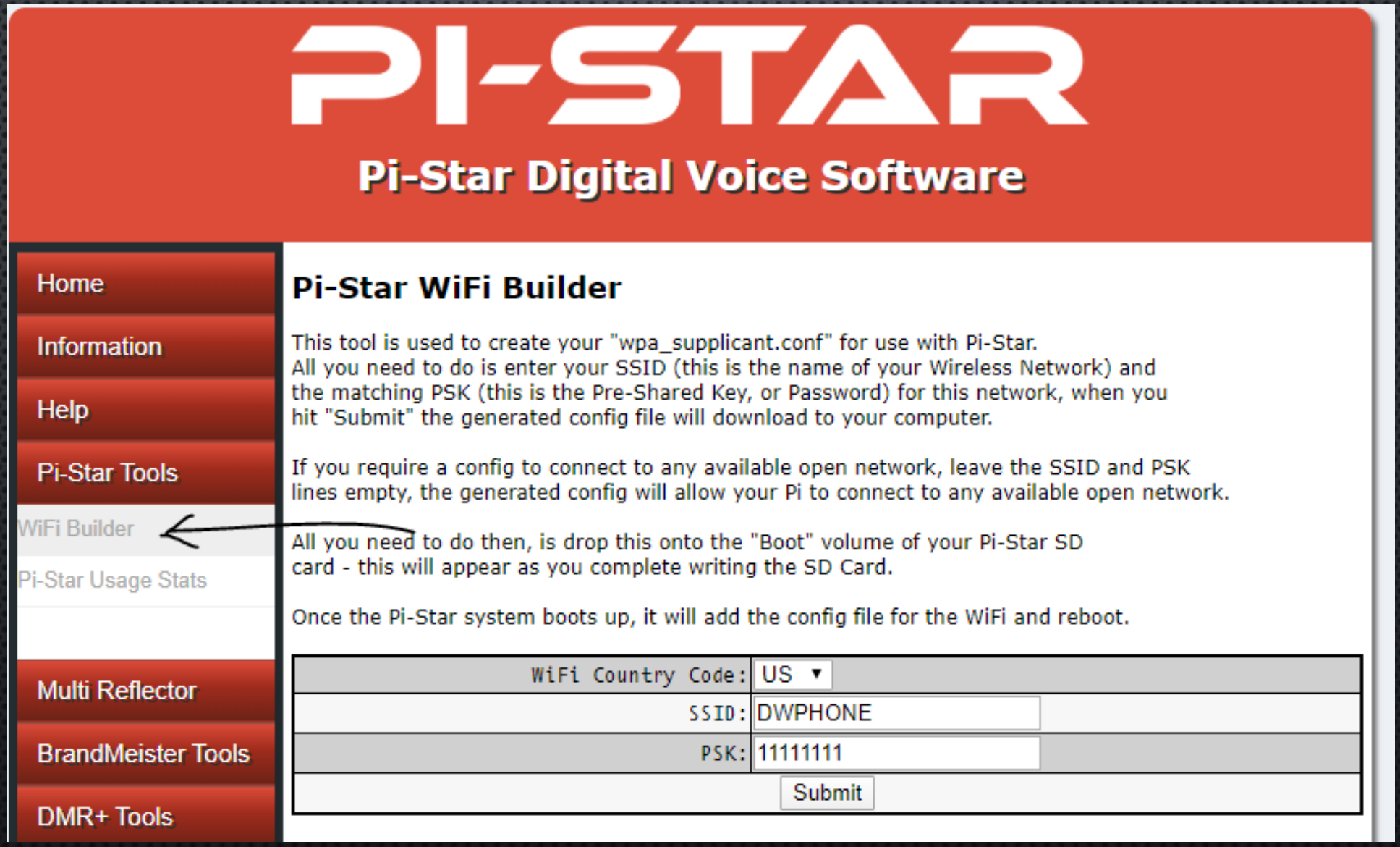


SETUP WIRELESS

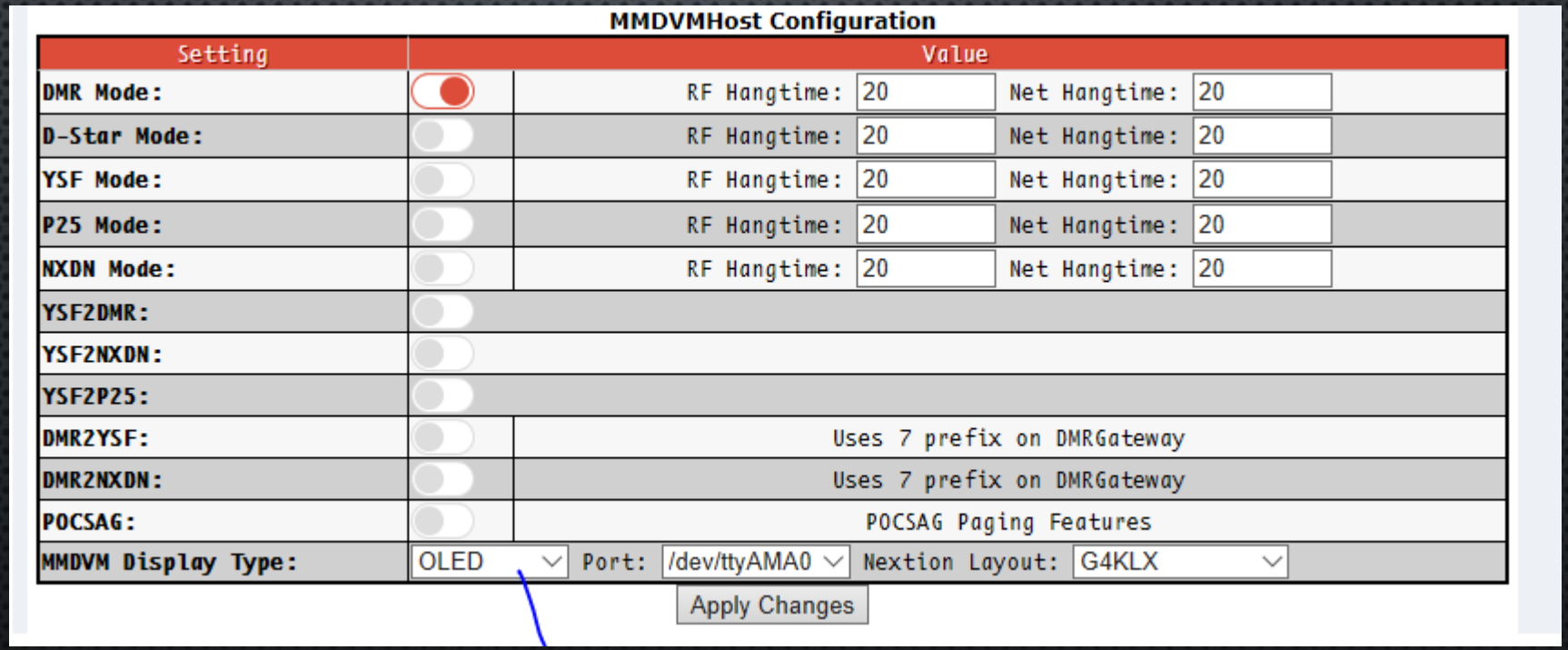


- YOU CAN USE THE HOTSPOT WIRED OR WIRELESS.
- ADD THE WIFI YOU WANT IT TO TRY IN ORDER.
- I HAVE MINE SET TO TRY MY PHONE TETHER FIRST, THEN MY HOUSE WIFI
- SUPPORTS BROWSING FOR SSID'S, CLICK CONFIGURE WIFI




PI-STAR
Pi-Star Digital Voice Software
Home
Information
Help
Pi-Star Tools
WiFi Builder
Pi-Star Usage Stats
Multi Reflector
BrandMeister Tools
DMR+ Tools
Pi-Star WiFi Builder
This tool is used to create your "wpa_supplicant.conf" for use with Pi-Star.
All you need to do is enter your SSID (this is the name of your Wireless Network) and the matching PSK (this is the Pre-Shared Key, or Password) for this network, when you hit "Submit" the generated config file will download to your computer.
If you require a config to connect to any available open network, leave the SSID and PSK lines empty, the generated config will allow your Pi to connect to any available open network.
All you need to do then, is drop this onto the "Boot" volume of your Pi-Star SD card - this will appear as you complete writing the SD Card.
Once the Pi-Star system boots up, it will add the config file for the WiFi and reboot.
WiFi Country Code: US
SSID: DWPHONE
PSK: 11111111
Submit

- Turn on DMR
- Select your display type-OLED
- Apply changes



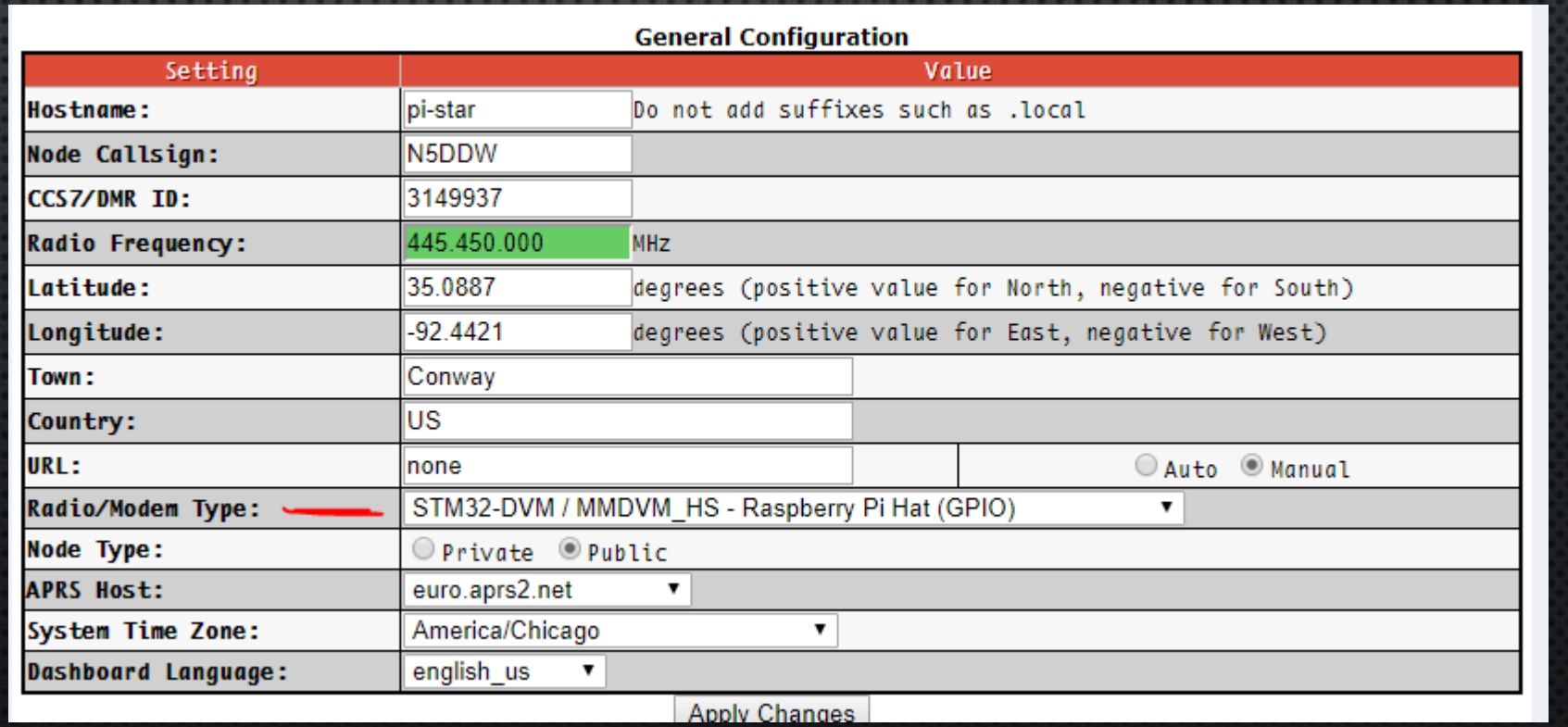
MMDVMHost Configuration

Setting	Value
DMR Mode:	RF Hangtime: 20 Net Hangtime: 20
D-Star Mode:	RF Hangtime: 20 Net Hangtime: 20
YSF Mode:	RF Hangtime: 20 Net Hangtime: 20
P25 Mode:	RF Hangtime: 20 Net Hangtime: 20
NXDN Mode:	RF Hangtime: 20 Net Hangtime: 20
YSF2DMR:	
YSF2NXDN:	
YSF2P25:	
DMR2YSF:	Uses 7 prefix on DMRGateway
DMR2NXDN:	Uses 7 prefix on DMRGateway
POCSAG:	POCSAG Paging Features
MMDVM Display Type:	OLED Port: /dev/ttyAMA0 Nextion Layout: G4KLX

Apply Changes

General settings

- The board I am using, choose STM32-DVM/MMDVM_HS -Raspberry Pi Hat.
- You will need to enter your callsign, and DMR ID. If this hotspot is just for you, you can reuse your radio ID, or apply for an additional one.
- If will share your hotspot with others, choose Public Node type
- We'll choose a frequency next



General Configuration

Setting	Value
Hostname:	pi-star — Do not add suffixes such as .local
Node Callsign:	N5DDW
CCS7/DMR ID:	3149937
Radio Frequency:	445.450.000 MHz
Latitude:	35.0887 degrees (positive value for North, negative for South)
Longitude:	-92.4421 degrees (positive value for East, negative for West)
Town:	Conway
Country:	US
URL:	none — Auto / Manual
Radio/Modem Type:	STM32-DVM / MMDVM_HS - Raspberry Pi Hat (GPIO)
Node Type:	Private / Public
APRS Host:	euro.aprs2.net
System Time Zone:	America/Chicago
Dashboard Language:	english_us

Apply Changes

Choosing a Frequency

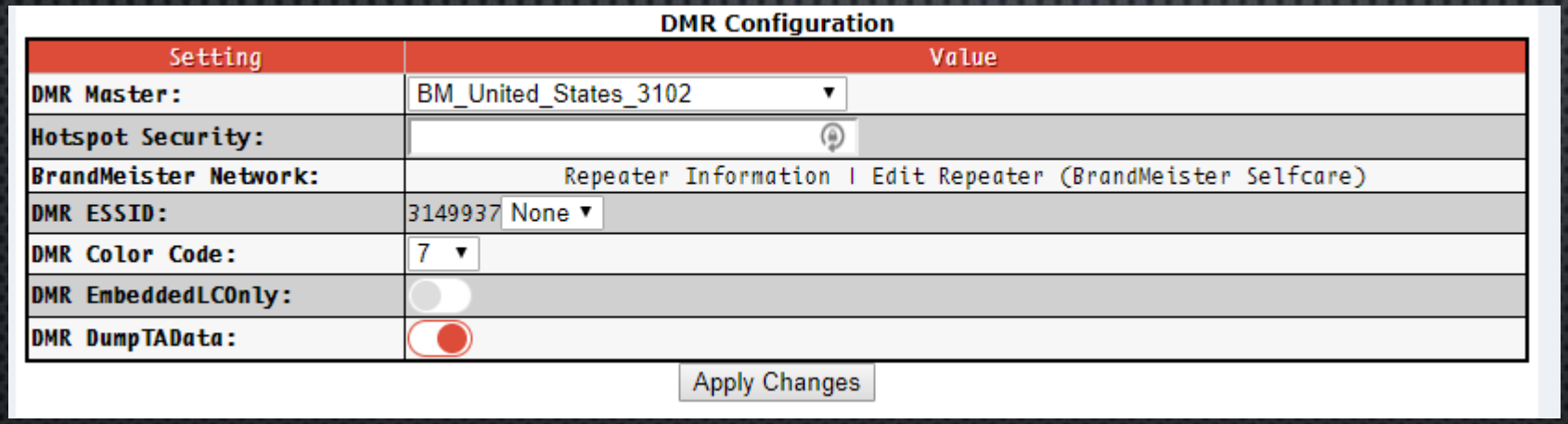
Block within the 70cm band (445.00 - 447.00 MHz) is reserved for auxiliary and control links, repeaters, and simplex (local option)

- **Auxiliary and Control Links, Repeaters, and Simplex (Local Option) 445-447 (12.5 kHz Steps)**

  445.0125 445.2625 445.5125 445.7625 446.0125 446.2625 446.5125 446.7625
  445.0250 445.2750 445.5250 445.7750 446.0250 446.2750 446.5250 446.7750
  445.0375 445.2875 445.5375 445.7875 446.0375 446.2875 446.5375 446.7875
  445.0500 445.3000 445.5500 445.8000 446.0500 446.3000 446.5500 446.8000
  445.0625 445.3125 445.5625 445.8125 446.0625 446.3125 446.5625 446.8125
  445.0750 445.3250 445.5750 445.8250 446.0750 446.3250 446.5750 446.8250
  445.0875 445.3375 445.5875 445.8375 446.0875 446.3375 446.5875 446.8375
  445.1000 445.3500 445.6000 445.8500 446.1000 446.3500 446.6000 446.8500
  445.1125 445.3625 445.6125 445.8625 446.1125 446.3625 446.6125 446.8625
  445.1250 445.3750 445.6250 445.8750 446.1250 446.3750 446.6250 446.8750
  445.1375 445.3875 445.6375 445.8875 446.1375 446.3875 446.6375 446.8875
  445.1500 445.4000 445.6500 445.9000 446.1500 446.4000 446.6500 446.9000
  445.1625 445.4125 445.6625 445.9125 446.1625 446.4125 446.6625 446.9125
  445.1750 445.4250 445.6750 445.9250 446.1750 446.4250 446.6750 446.9250
  445.1875 445.4375 445.6875 445.9375 446.1875 446.4375 446.6875 446.9375
  445.2000 445.4500 445.7000 445.9500 446.2000 446.4500 446.7000 446.9500
  445.2125 445.4625 445.7125 445.9625 446.2125 446.4625 446.7125 446.9625
  445.2250 445.4750 445.7250 445.9750 446.2250 446.4750 446.7250 446.9750
  445.2375 445.4875 445.7375 445.9875 446.2375 446.4875 446.7375 446.9875
  445.2500 445.5000 445.7500 446.0000 446.2500 446.5000 446.7500

MASTER SERVER

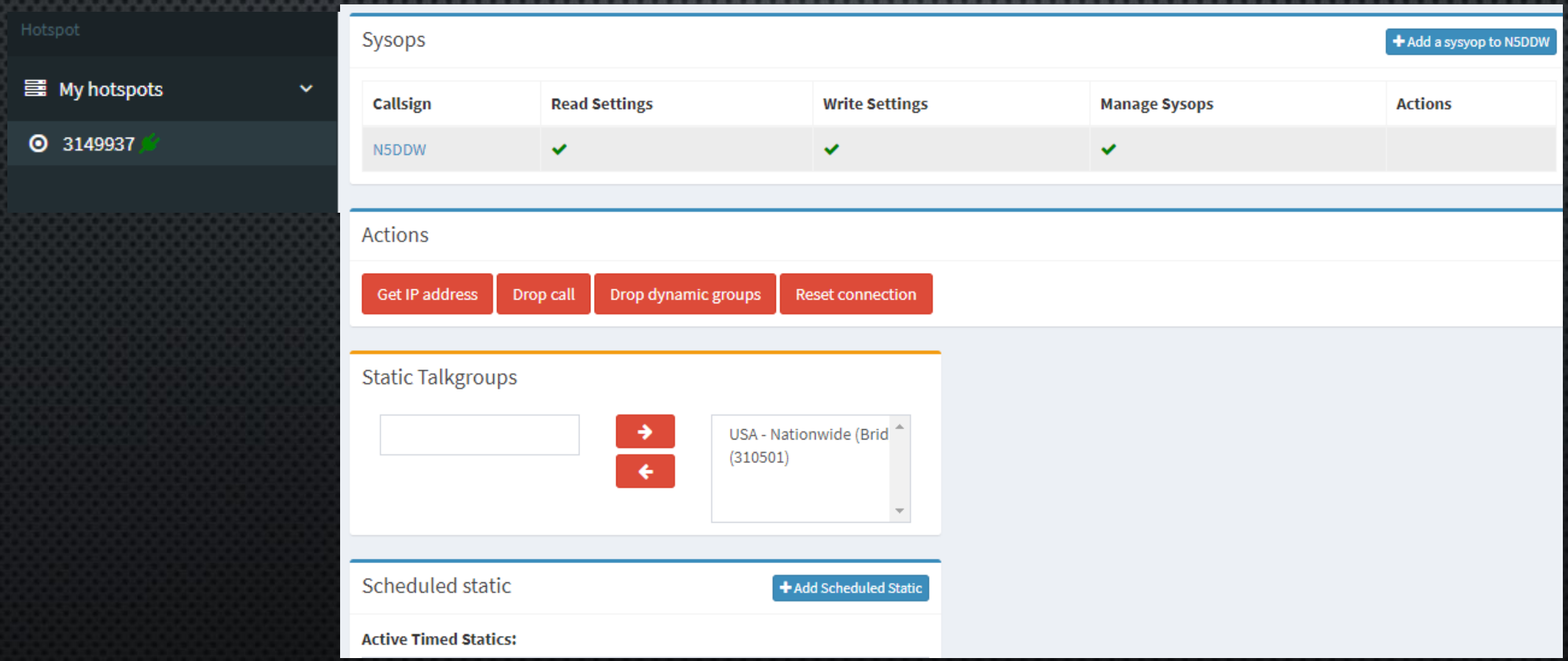
- DMR WORKS BY INTERCONNECTED MASTER SERVERS ON THE INTERNET. YOU SHOULD TRY TO CHOOSE THE ONE CLOSEST TO YOU, OR ONE WITH THE LOWEST LATENCY.
- I CHOSE THE MASTER SERVER IN TEXAS.



DMR ID	Managed by	Location
3101	W9DRR,	New York, NY
3102	N3FE,	Dallas, TX.
3103	N6BMW, N2NUO, WX7M,	San Jose, CA.
3108	N2NUO, N4IRS,	Atlanta, GA

REBOOT THE HOTSPOT AND YOU ARE UP AND RUNNING

- THE NEXT TIME YOU BOOT THE HOTSPOT IT SHOULD COME UP AND REGISTER ITSELF WITH THE BRANDMEISTER NETWORK.
- GOTO HTTPS://BRANDMEISTER.NETWORK AND LOGIN TO VERIFY



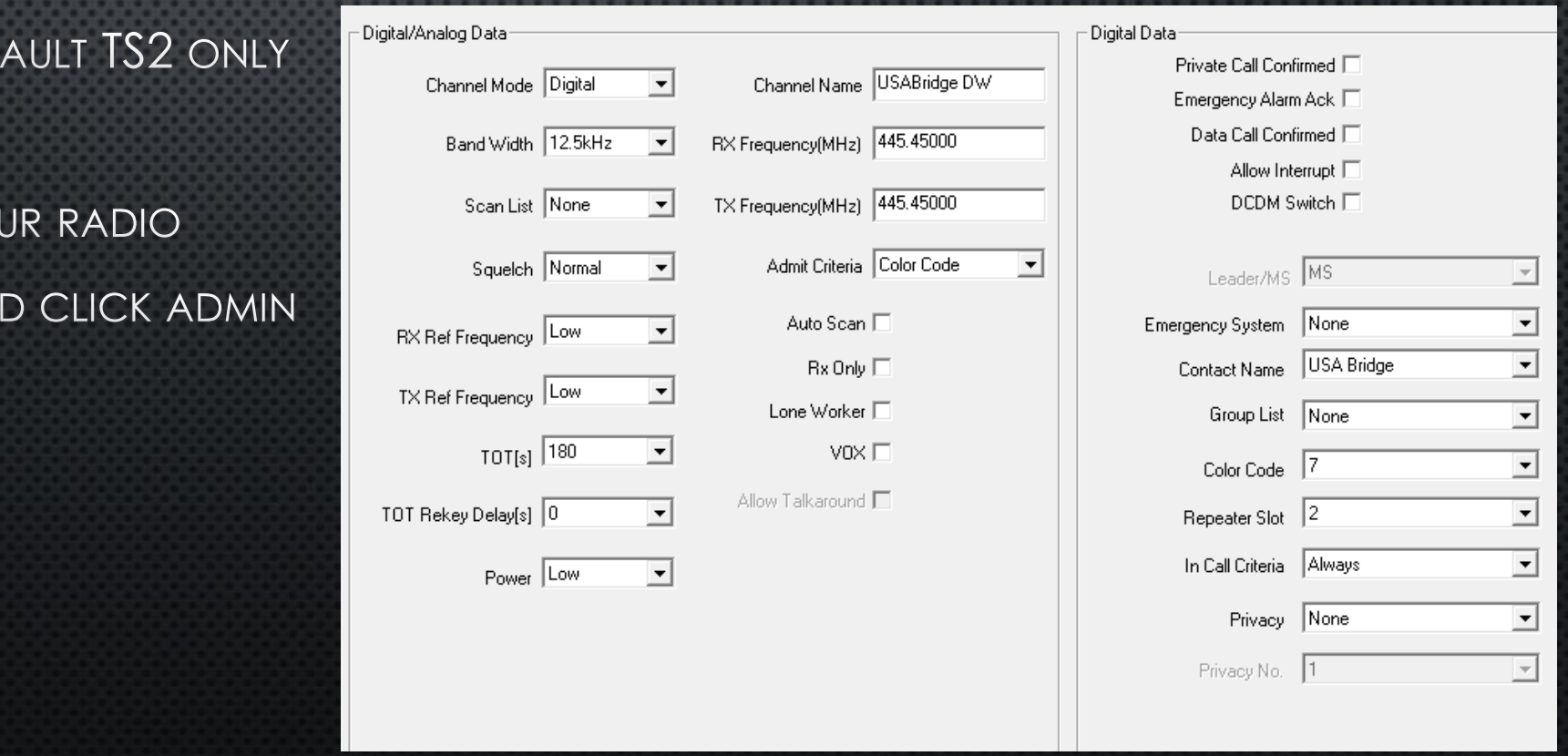
Static vs Dynamic talkgroups

- Static groups are always on. You can schedule these to be active on a schedule in the brandmeister portal.
- Dynamic groups are added on the fly. But they do not timeout
  - You can setup a brandmeister interface via API with pi-star to manage the static and dynamic groups from the hotspot's web interface
- Benefits and drawbacks of setups

- Observed issue with pi-star-Dynamic talkgroups: They do not go away
  - Setup private call to DMR ID 4000 to disconnect all dynamic talk groups

SETUP YOUR RADIO

- ADD CHANNELS FOR YOUR HOTSPOT AND ASSIGN THE TALK GROUPS YOU WANT
- USE THE FREQUENCY YOU SETUP FOR BOTH RX AND TX
- CHOOSE THE COLORCODE YOU SETUP IN PI-STAR (DEFAULT IS 1)
- TIMESLOT FOR MY BOARD IS DEFAULT TS2 ONLY
- ADD THE CHANNELS TO A ZONE
- LOAD THE CODE PLUG INTO YOUR RADIO
- PULL UP THE PI-STAR PORTAL AND CLICK ADMIN



- Pi-Star admin page
- See the status of the hotspot
- Watch traffic live
- See what talk groups are active on your hotspot
- See static vs dynamic talk groups

Pi-Star Digital Voice Dashboard for N5DDW

Dashboard | Admin | Live Logs | Power | Update | Configuration

Gateway Hardware Information

Hostname	Kernel	Platform	CPU Load	CPU Temp
pi-star	4.9.35-v7+	Pi 3 Model B (1GB) - Sony, UK	0.07 / 0.06 / 0.08	45.6°C / 114.1°F

Service Status

MMDVMHost	DMRGateway	YSFGateway	YSFParrot	P25Gateway	P25Parrot
DStarRepeater	ircDDBGateway	TimeServer	PiStar-Watchdog	PiStar-Remote	PiStar-Keeper

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	TX DMR Slot 2
Tx	445.450000 MHz
Rx	445.450000 MHz
FW	HS_Hat:v1.4.17
TCXO	14.7456 MHz

DMR Repeater	
DMR ID	3149937
DMR CC	7
TS1	disabled
TS2	enabled
TG 3100/No Ref	
DMR Master	
BM United States ..	

Active BrandMeister Connections

BrandMeister Master	Default Ref	Timeout(s)	Active Ref	Static TGs	Dynamic TGs
BM United States 3102	Not Set	Not Set	None	TG3100	None

Gateway Activity

Time (CDT)	Mode	Callsign	Target	Src	Dur(s)	Loss	BER
15:41:56 Oct 6th	DMR Slot 2	DF7CD	TG 3100	Net	TX		
15:41:42 Oct 6th	DMR Slot 2	KD6QCZ	TG 3100	Net	8.4	4%	0.0%
15:41:35 Oct 6th	DMR Slot 2	N5DDW	9990	RF	5.0	0%	0.5%
15:40:07 Oct 6th	DMR Slot 2	KE0TYM	TG 3100	Net	0.5	0%	0.0%
15:39:36 Oct 6th	DMR Slot 2	N9MIC	TG 3100	Net	2.3	0%	0.0%
15:38:43 Oct 6th	DMR Slot 2	K7DJM	TG 3100	Net	0.8	0%	0.0%
15:37:52 Oct 6th	DMR Slot 2	WX4BEG	TG 3100	Net	0.8	0%	0.0%
15:37:22 Oct 6th	DMR Slot 2	WA1ZEV	TG 3100	Net	0.5	0%	0.0%
15:36:14 Oct 6th	DMR Slot 2	M0UTC	TG 3100	Net	0.5	0%	0.0%
15:35:47 Oct 6th	DMR Slot 2	W0RLR	TG 3100	Net	0.5	0%	0.0%
15:35:27 Oct 6th	DMR Slot 2	KC1LPT	TG 3100	Net	2.6	0%	1.8%
15:34:28 Oct 6th	DMR Slot 2	K2GFY	TG 3100	Net	0.5	0%	0.0%
15:33:31 Oct 6th	DMR Slot 2	KG5DGG	TG 3100	Net	5.2	0%	0.0%
15:32:47 Oct 6th	DMR Slot 2	W3HDB	TG 3100	Net	4.1	1%	0.0%
15:32:27 Oct 6th	DMR Slot 2	3152401	TG 3100	Net	7.9	0%	0.0%
15:31:39 Oct 6th	DMR Slot 2	KX4PA	TG 3100	Net	1.9	0%	0.0%
15:30:49 Oct 6th	DMR Slot 2	KC3MWK	TG 3100	Net	0.5	0%	0.0%
15:30:30 Oct 6th	DMR Slot 2	WB8LLN	TG 3100	Net	0.5	0%	0.0%
15:29:40 Oct 6th	DMR Slot 2	AB3BO	TG 3100	Net	2.3	0%	0.0%
15:28:14 Oct 6th	DMR Slot 2	OZ1G	TG 3100	Net	0.5	0%	0.0%

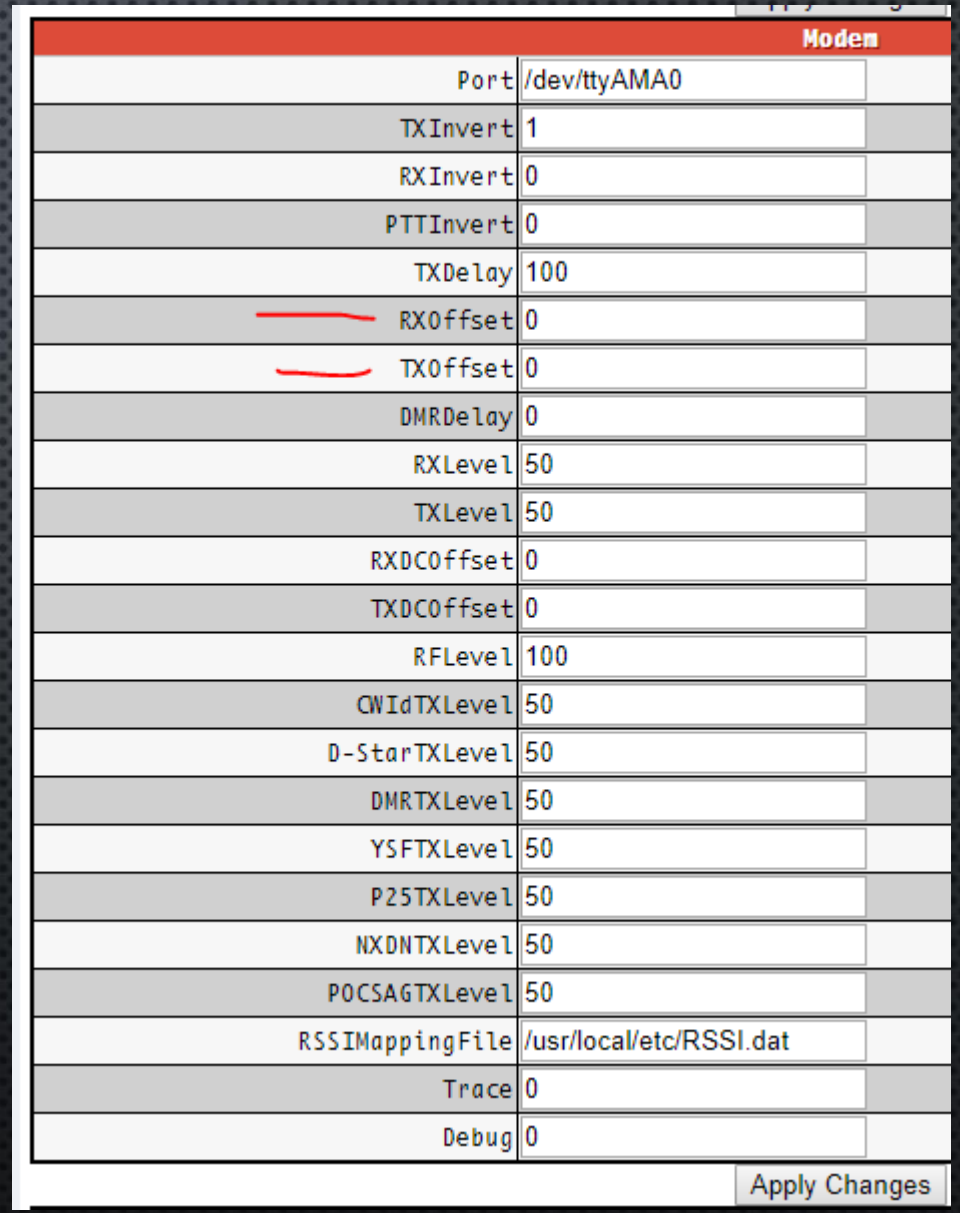
Local RF Activity

Time (CDT)	Mode	Callsign	Target	Src	Dur(s)	BER	RSSI
15:41:35 Oct 6th	DMR Slot 2	N5DDW	9990	RF	5.0	0.5%	S9+46dB

BER (BIT ERROR RATE)

- If your bit error rate is >1% you will need to adjust
- Visit http://pi-star/admin/expert/
- Some boards have a RxOffset sticker on them
- Adjust RXoffset up and down to see effect

- https://amateurradionotes.com/Pi-Star-Notes.htm #9
- For instructions
- OR
- http://www.k9npx.com/2019/02/hotspot-offset-calibration.html?m=1



Modem	
Port	/dev/ttyAMA0
TXInvert	1
RXInvert	0
PTTInvert	0
TXDelay	100
RXOffset	0
TXOffset	0
DMRDelay	0
RXLevel	50
TXLevel	50
RXDCOffset	0
TXDCOffset	0
RFLevel	100
CWIdTXLevel	50
D-StarTXLevel	50
DMRTXLevel	50
YSFTXLevel	50
P25TXLevel	50
NXDNTXLevel	50
POCSAGTXLevel	50
RSSIMappingFile	/usr/local/etc/RSSI.dat
Trace	0
Debug	0

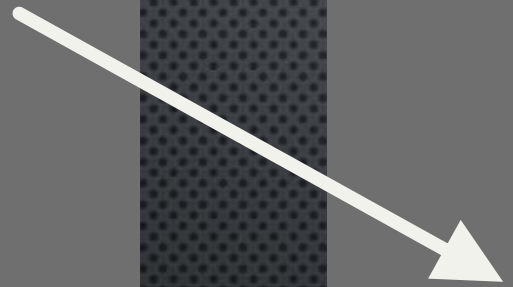
Apply Changes

DMR CODEPLUG -OVERVIEW

- Digital Contacts
  - TalkGroupID
  - User RadioID
  - name

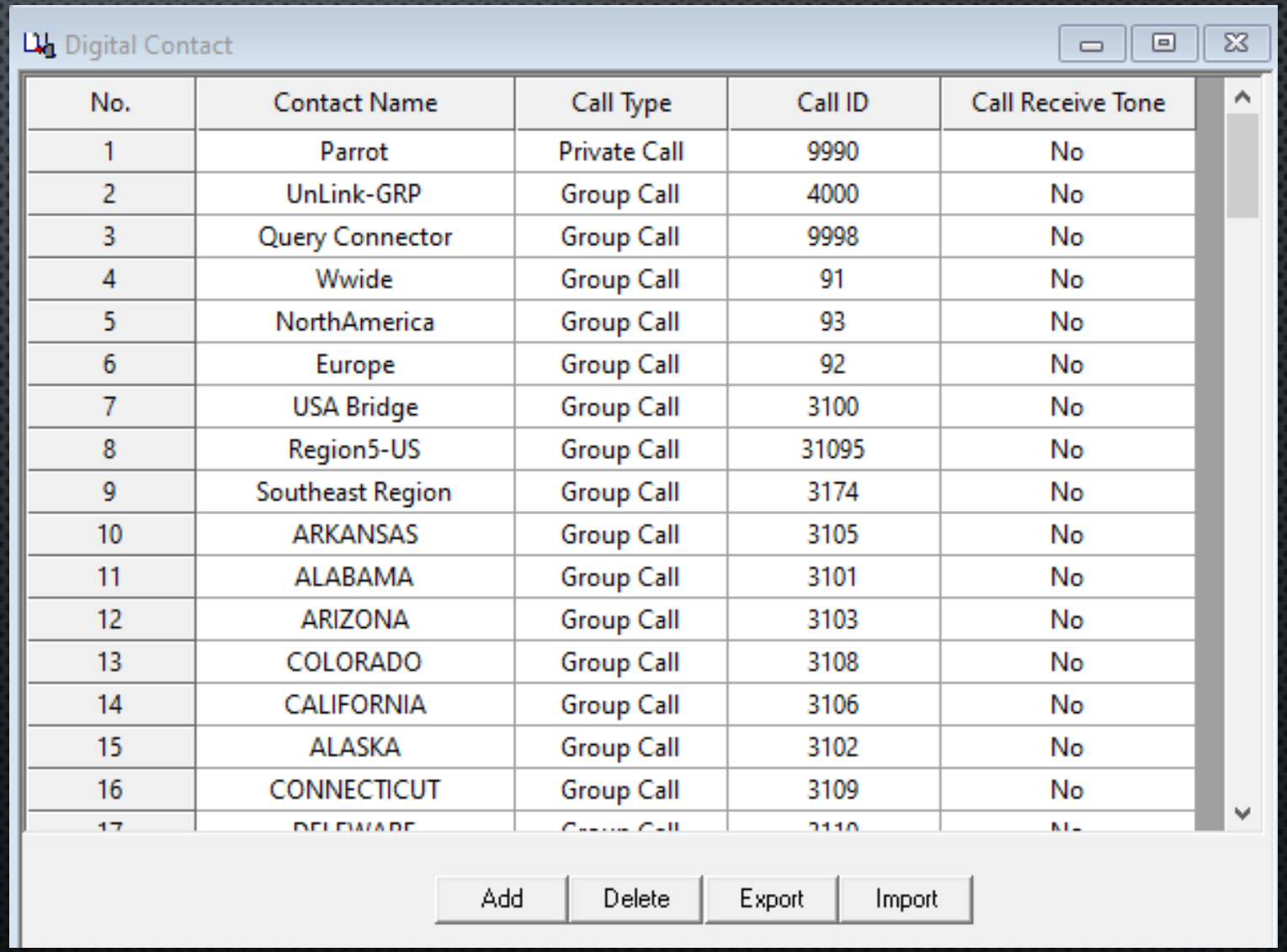
- Channels
  - Repeater Frequency
  - Color Code
  - Digital Contact ID

- Zone
  - Channels



DIGITAL CONTACTS

- NAME
  - WHATEVER YOU WANT TO CALL IT
- CALL TYPE
  - TALKGROUP IS A GROUP CALL
  - INDIVIDUAL IS A PRIVATE CALL
- CALL ID
  - TALKGROUP DMR-ID
  - PERSONS DMR-ID
  - SPECIAL DMR-ID
- RECEIVE TONE
  - DO NOT NEED TO USE



No.	Contact Name	Call Type	Call ID	Call Receive Tone
1	Parrot	Private Call	9990	No
2	UnLink-GRP	Group Call	4000	No
3	Query Connector	Group Call	9998	No
4	Wwide	Group Call	91	No
5	NorthAmerica	Group Call	93	No
6	Europe	Group Call	92	No
7	USA Bridge	Group Call	3100	No
8	Region5-US	Group Call	31095	No
9	Southeast Region	Group Call	3174	No
10	ARKANSAS	Group Call	3105	No
11	ALABAMA	Group Call	3101	No
12	ARIZONA	Group Call	3103	No
13	COLORADO	Group Call	3108	No
14	CALIFORNIA	Group Call	3106	No
15	ALASKA	Group Call	3102	No
16	CONNECTICUT	Group Call	3109	No

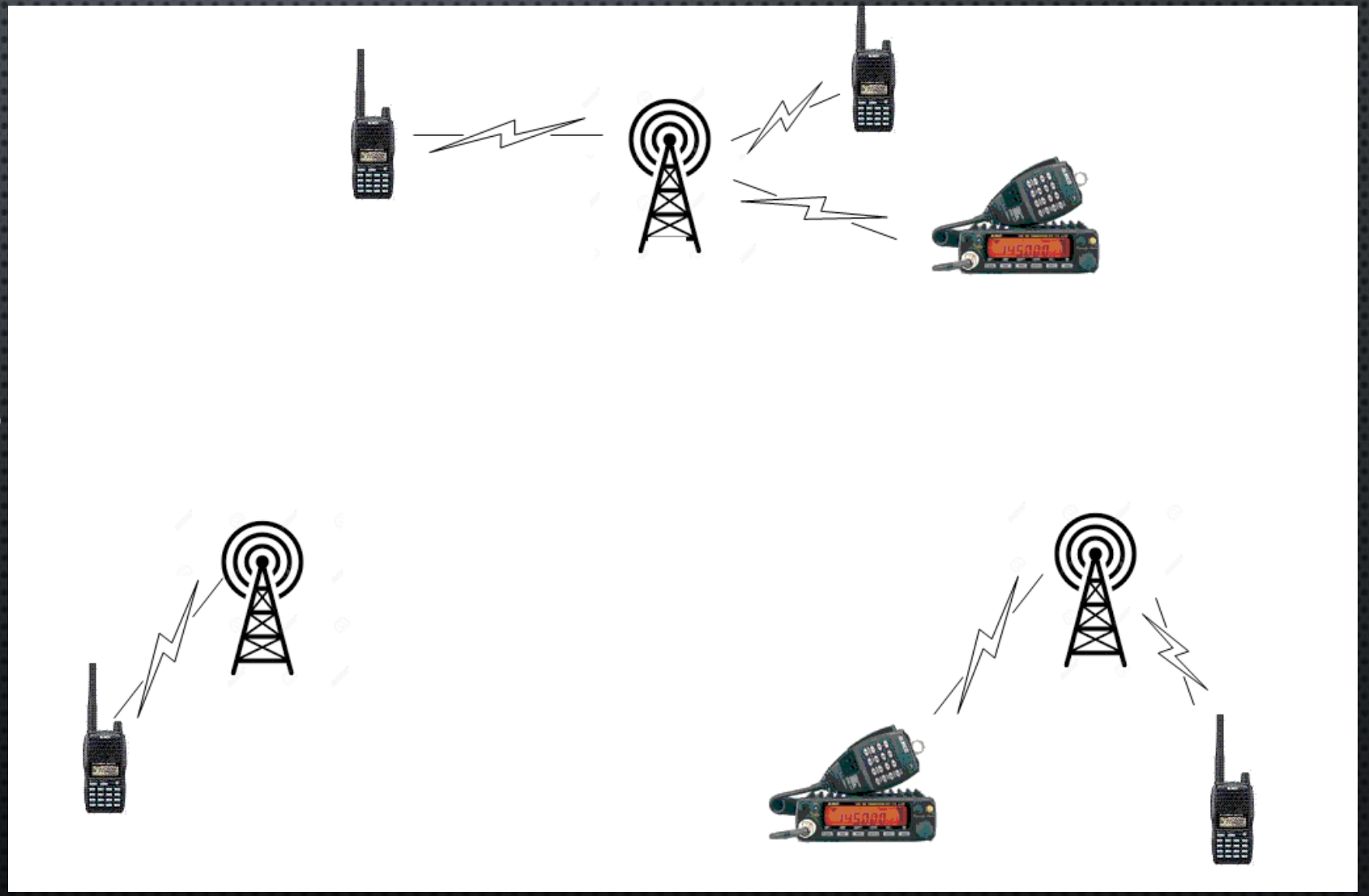
Understanding Channels
An Important Note

- A channel is repeater specific
- If the analog repeater supports multiple PL/CTCSS tones, you would have a channel for each one
- If the DMR repeater supports multiple TalkGroups, you would have to have a channel for each one

- If you want to use the same TalkGroup on two different repeaters, then each will need it's own channel
  - If you want to listen to talkgroup WoldWide-91 on 6 different repeaters, you need 6 different channels, 1 for each repeater and each assigned the same digital contact Worldwide-91

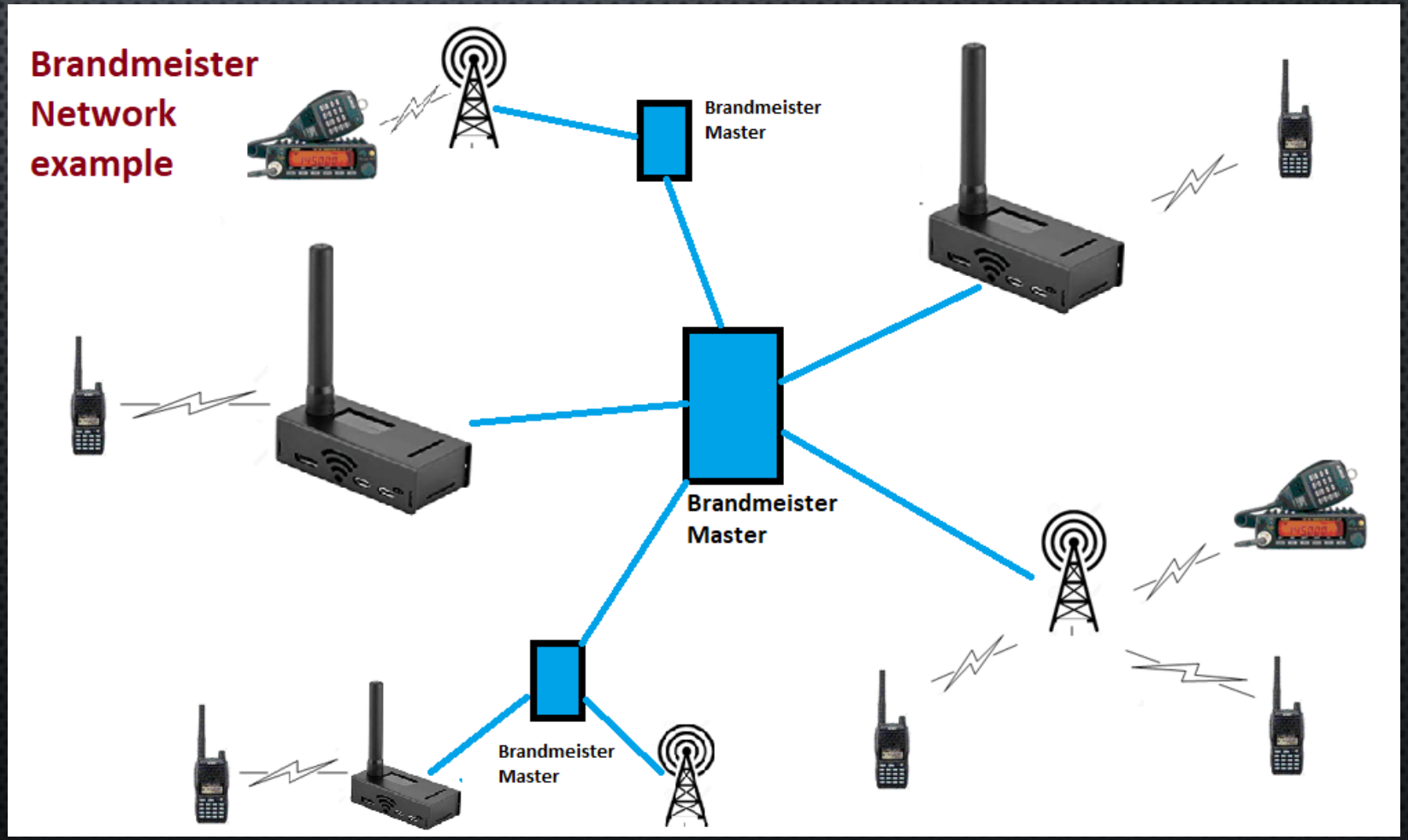
UNDERSTANDING CHANNELS -ANALOG

- IF YOU ROAM BETWEEN ANY OF THESE REPEATERS, YOU WILL NEED A CHANNEL/FREQUENCY DEFINED FOR EACH ONE.



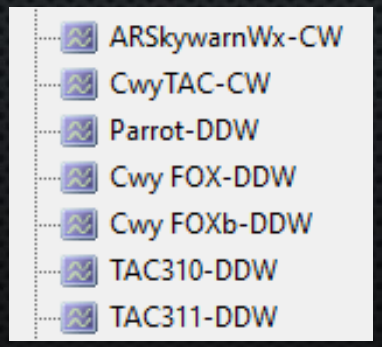
UNDERSTANDING CHANNELS

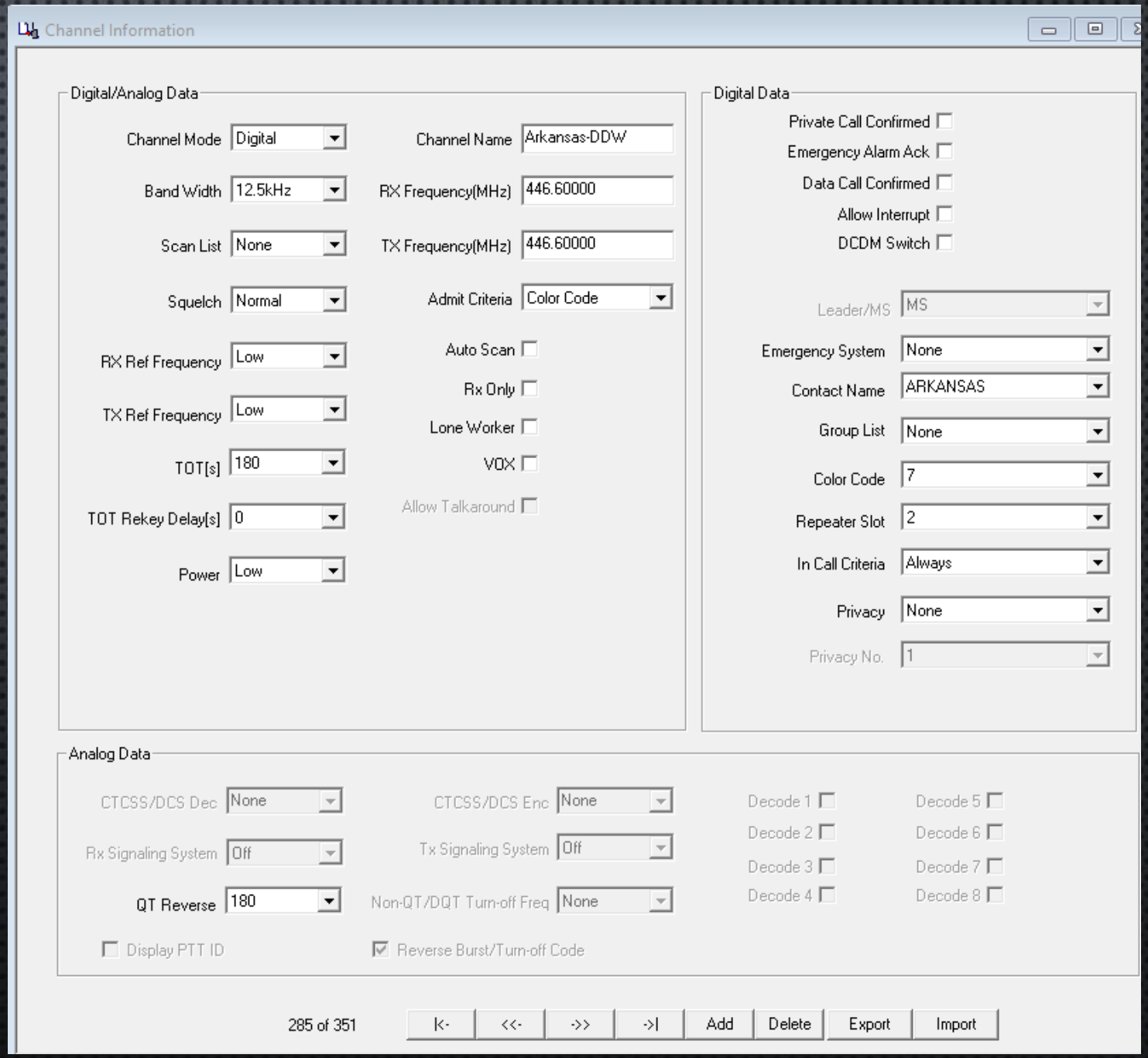
- IF YOU ROAM BETWEEN ANY OF THESE REPEATER/HOTSPOTS YOU WILL NEED A CHANNEL/FREQUENCY DEFINED FOR EACH ONE.
- ADDITIONALLY, YOU WILL NEED A CHANNEL FOR EACH TALKGROUP YOU WANT TO USE ON EACH REPEATER/HOTSPOT



CHANNEL SETUP-DMR

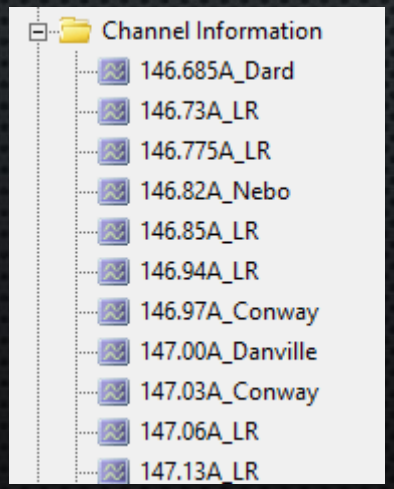
- MODE: DIGITAL
- BANDWIDTH: 12.5KHZ
- POWER: LOW
- CHANNEL NAME IT SOMETHING MEANINGFUL
  - SUGGEST INCLUDING REPEATER
- ADMIT-CRITERIA: COLOR CODE
- CONTACT NAME: DIGITAL CONTACT
- COLORCODE: ?
- REPEATER SLOT: 2

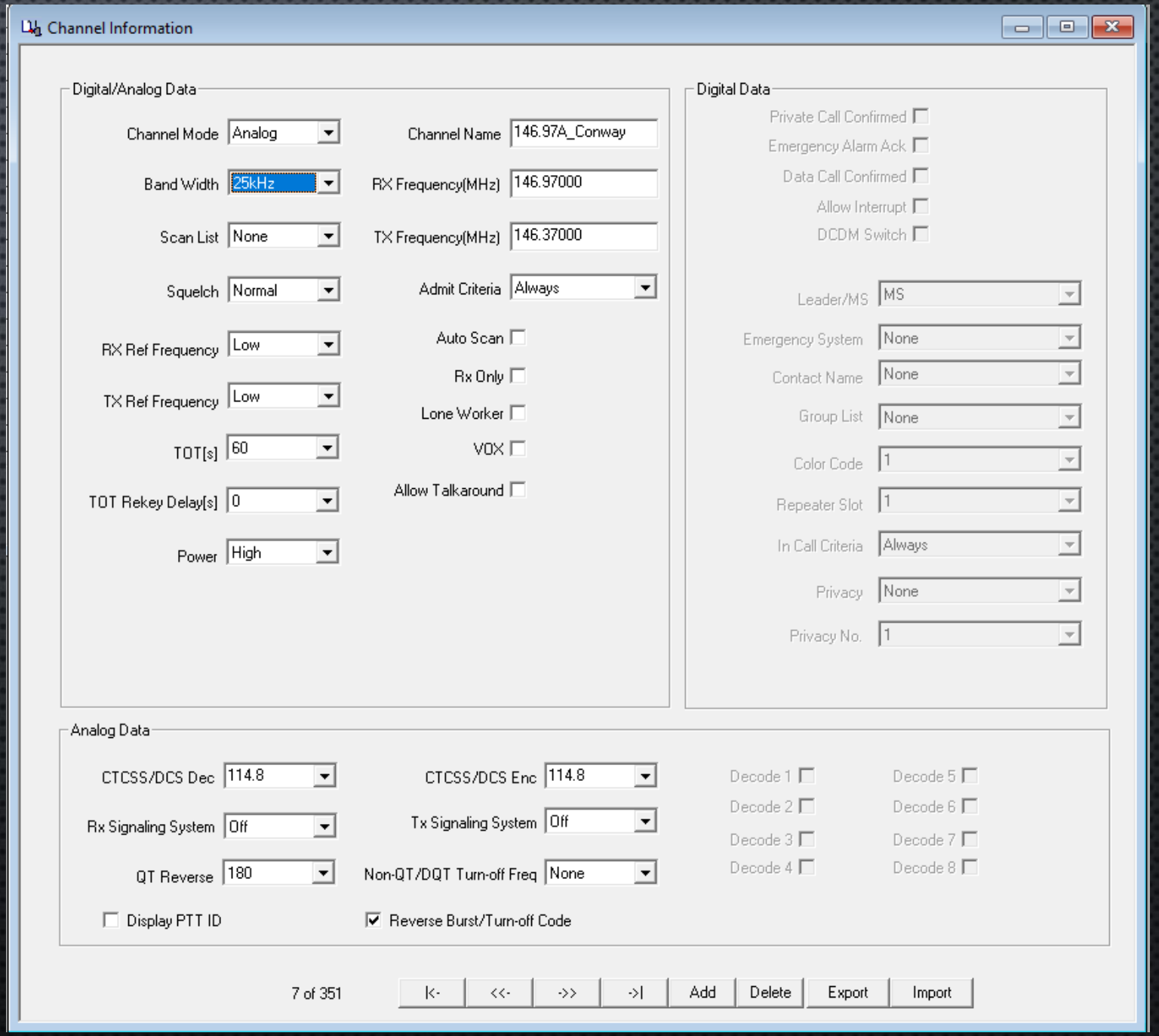




CHANNEL-ANALOG

- CHANNELS CAN ALSO BE ANALOG
  - NOTE GREYED OUT SECTIONS FOR DIGITAL DATA
  - 25KHZ WIDE IN MOST CASES
  - RX/TX OFFSET FOR DUPLEX REPEATERS
  - CTCSS/DCS USUALLY REQUIRED



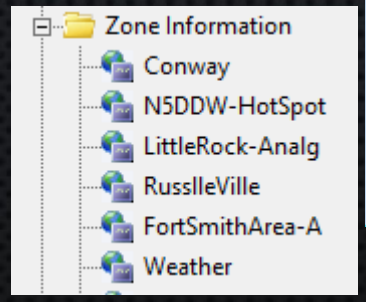


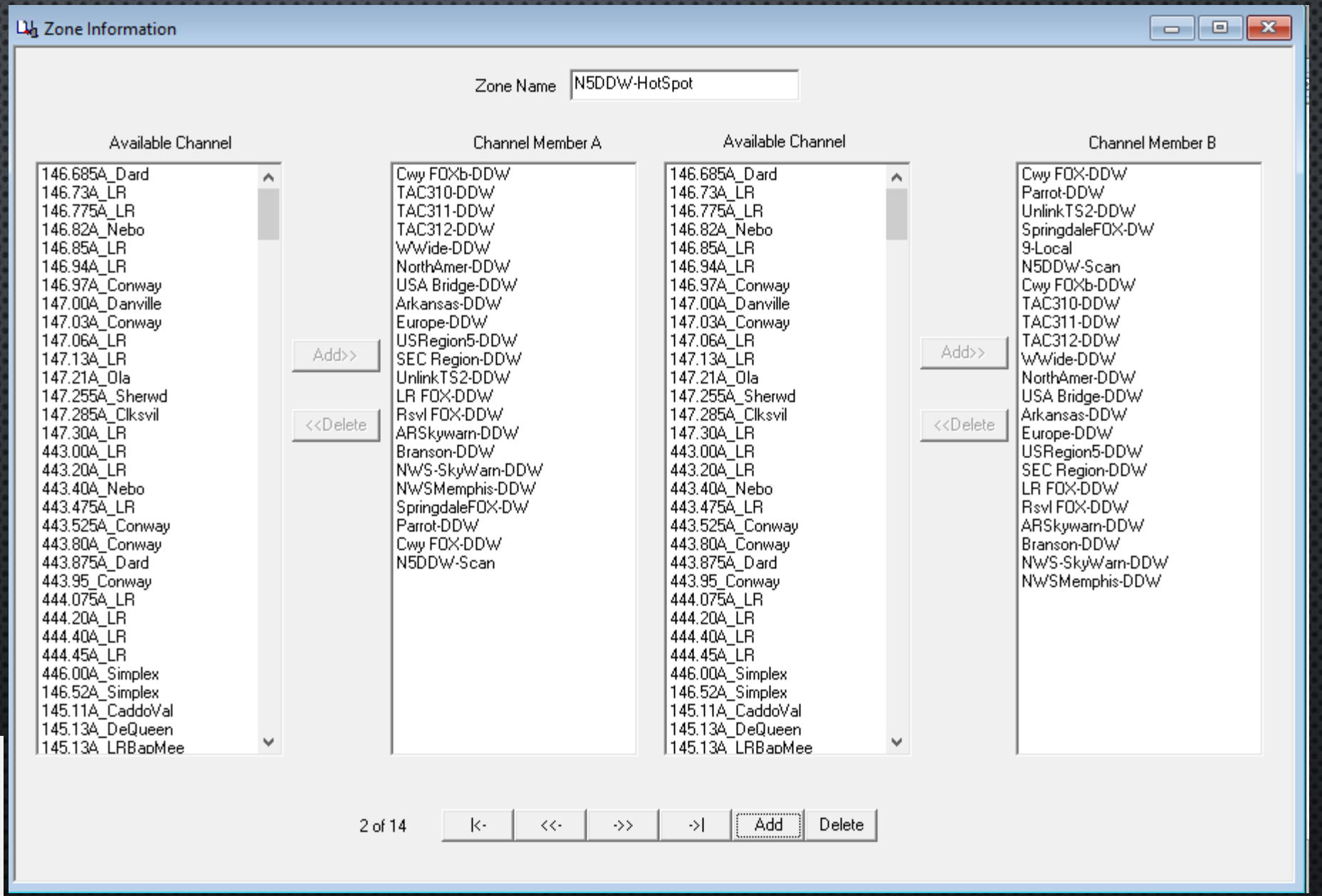
ZONE

A WAY TO ORGANIZE CHANNELS FOR YOUR RADIO

A CHANNEL CAN BE IN MULTIPLE ZONES

I LIKE TO ORGANIZE ZONES BY REPEATER, THOUGH I ALSO HAVE SOME FOR GEOGRAPHIC AREAS THAT CONTAIN MULTIPLE REPEATERS.





CREDITS

- https://amateurradionotes.com/pi-star.htm
- https://www.pistar.uk/
- https://brandmeister.network