Agenda:

- Introductions
- Treasurer's Report
- "Flathead Valley Amateur Radio Club (FVARC)" Facebook Group
  - Special thanks to Kyle Shank, KK7LOY
  - Will provide technical assistance and information sharing between members
  - Paid members only
  - https://www.facebook.com/groups/193718170249952/?notif_id=1710523819947579&notif_t=group_r2j_approved&ref=notif
- Flathead Big Frequency List (Kerry Johnston, KJ7SIR)
  - Frequency Agile comm skills
- Presentation (W7YP)

Digital Voice in Amateur Radio

Rick Fletcher, W7YP

March 19, 2024

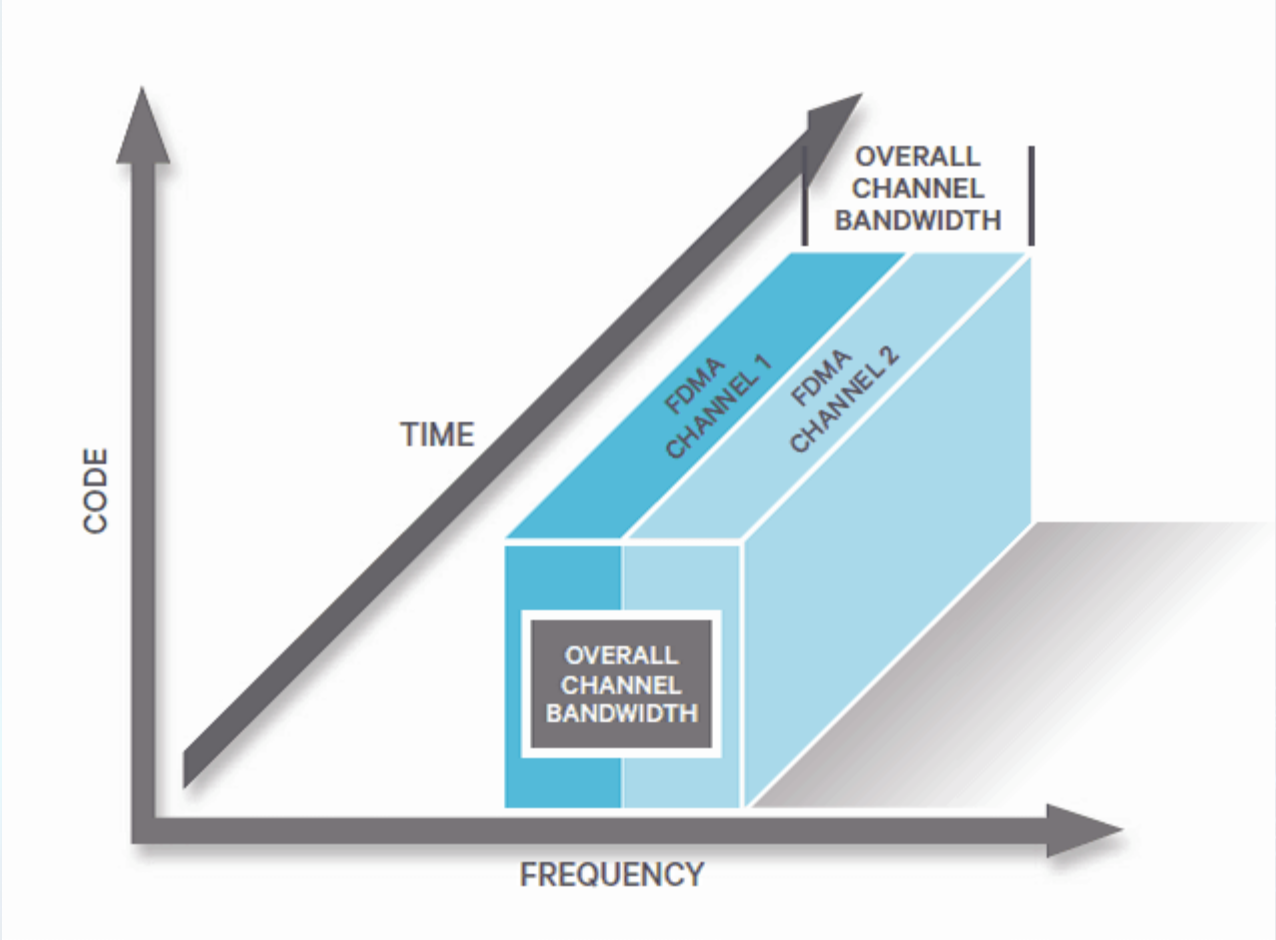
Flathead Valley Amateur Radio Club

Digital Voice Types Used by Amateurs

- FDMA (Frequency Division Multiple Access)
  - D-Star
  - Yaesu System Fusion (YSF) – C4FM
  - P25 Phase 1 – C4FM
  - NXDN
- TDMA (Time Division Multiple Access)
  - DMR
  - P25 Phase 2
- CDMA (Code Division Multiple Access)
  - Some use in spread spectrum packet radio networks
    - Very efficient
    - Far more complicated and expensive
    - Requires time-synchronization like that in cellular networks

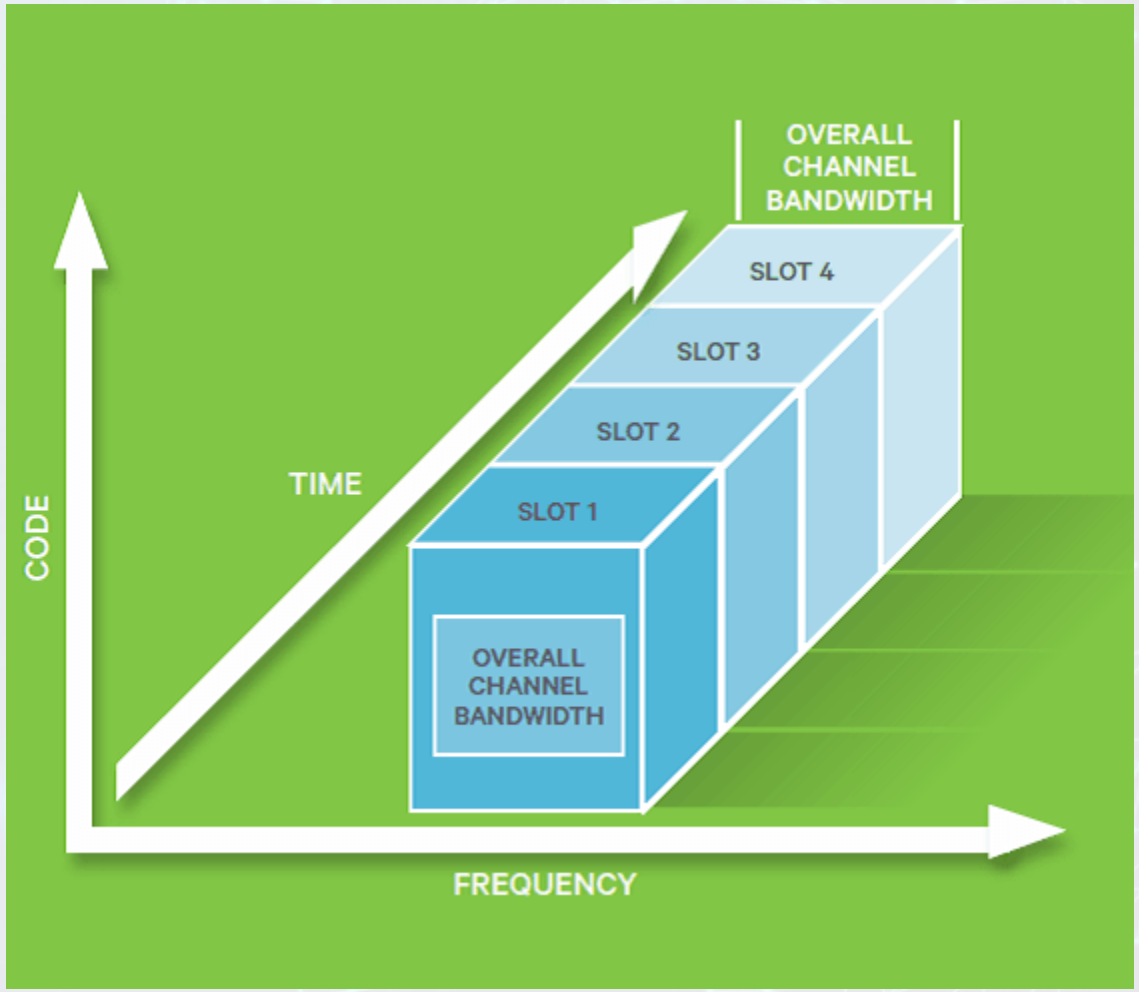
FDMA

- The RF channel is split into smaller sub-channels
  - A 12.5 kHz wide narrowband FM channel that previously carried only one conversation becomes two 6.25 kHz sub-channels
    - Each could carry a separate conversation
    - Both could carry one side of a duplex call
    - Or, one could carry a conversation while the other carried data



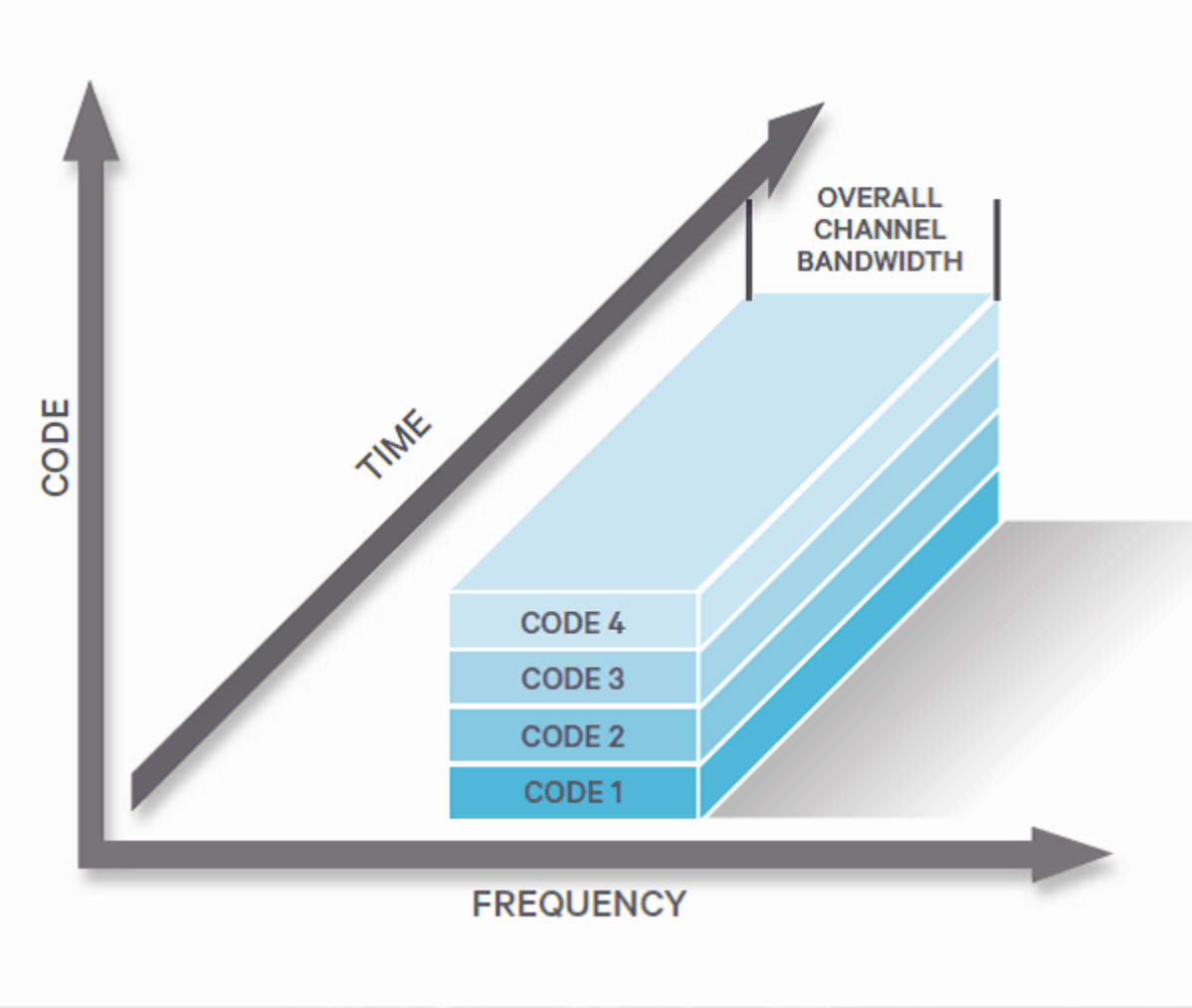
TDMA

- One RF channel is divided into two or more time slots
- Each slot can carry a separate conversation
- Digital speech compression is often used to boost efficiency and voice quality
- In this example, there's four time slots
  - Speech is transmitted in 1/4th the time taken to say it
  - DMR uses just two time slots



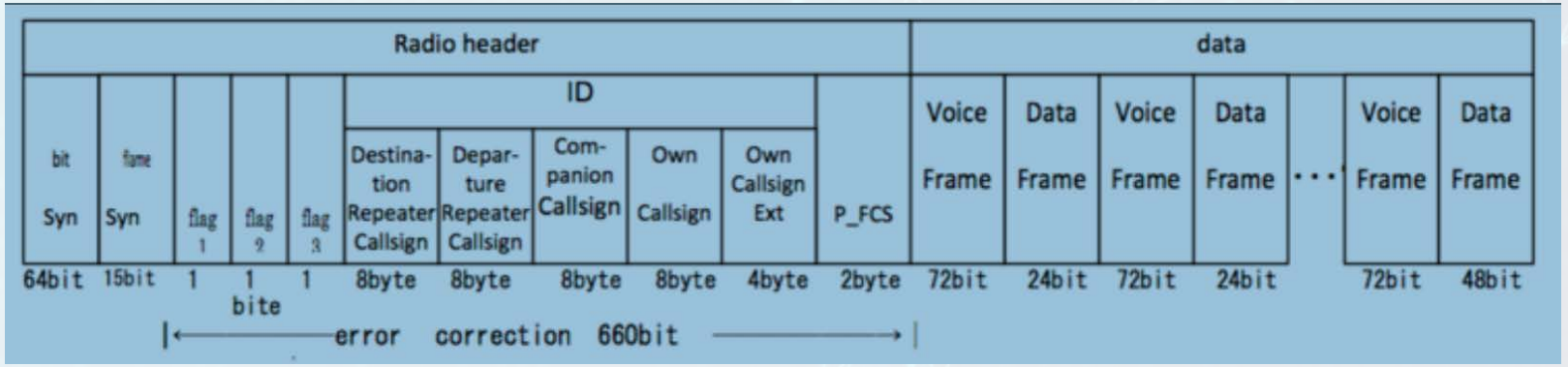
CDMA

- Instead of splitting the RF channel into sub-channels or time slots, each slot has a unique code
  - Unlike FDMA, the transmitted RF frequency is the same in each slot
  - Unlike TDMA, the slots are transmitted simultaneously
- Each code can carry a separate conversation or data
- The technology for CDMA is more complex and expensive
- In this example, four codes are transmitted and received simultaneously

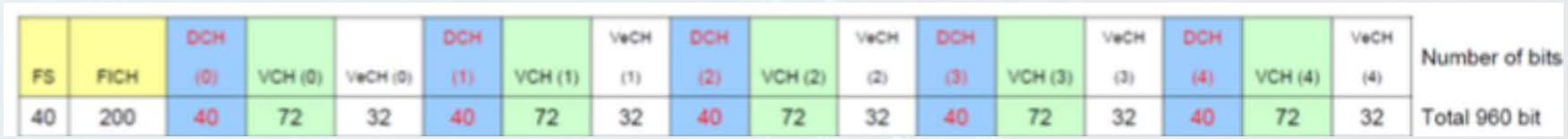


DV Protocols

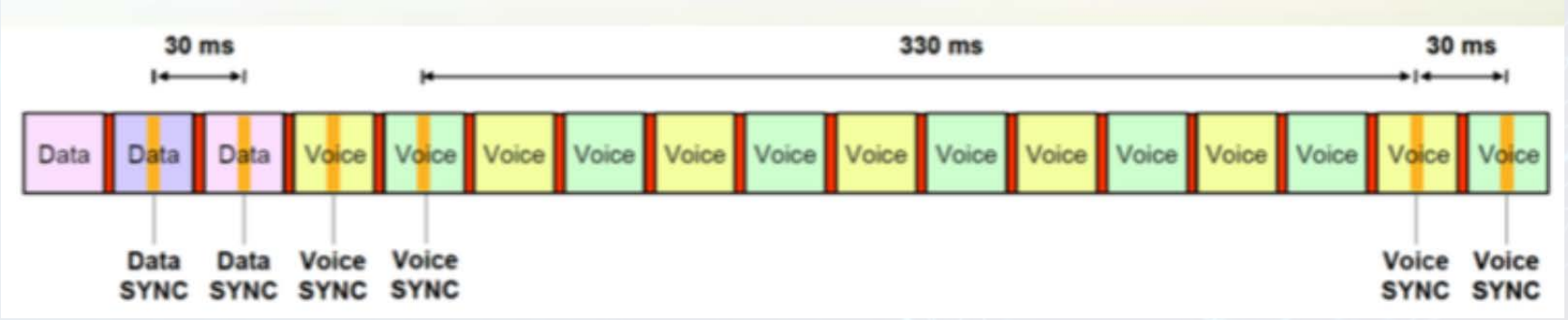
- D-Star



- YSF



- DMR



Why The Club Embraced DMR

- Why not D-Star?
  - Repeaters expensive and only available from Icom
  - Greatest voice degradation over distance
- Why not YSF?
  - Single manufacturer
  - Proprietary protocol
  - Repeaters are not commercial grade (basically 2 interconnected mobiles)
  - Wires-X interface is a kluge and not amenable to remote repeater deployment
- Why DMR?
  - Good sound quality
  - Open protocol
  - Battery longevity
  - Easy connection to the global Brandmeister network
    - Gateways/bridges to D-Star and Wires-X networks
  - Many manufacturers of radios and repeaters
    - Many low cost imported radios available which work quite well
    - Big used equipment marketplace

What is DMR?

- Digital radio standard developed by the European Telecommunications Standards Institute (ETSI)
  - First ratified in 2005 and improved since then
  - Improved voice quality versus analog FM under many circumstances
    - Retains the ability to do analog FM
  - Improved power efficiency = longer battery life (transmitter is idle 50% of the time)
  - Increased functionality (e.g., location information, messaging)
  - Improved channel efficiency
  - Totally open standard
- Now defines 3 tiers of service:
  - Tier I – unlicensed
  - Tier II – licensed conventional
  - Tier III – licensed trunked

DMR Tier I

- Unlicensed service
- DMR Tier I equipment works in “Direct Mode”
  - Unit-to-unit on public frequencies
- Best suited for:
  - Individuals
  - Recreational use
  - Small retail
  - Any situation not requiring wide area coverage

DMR Tier II

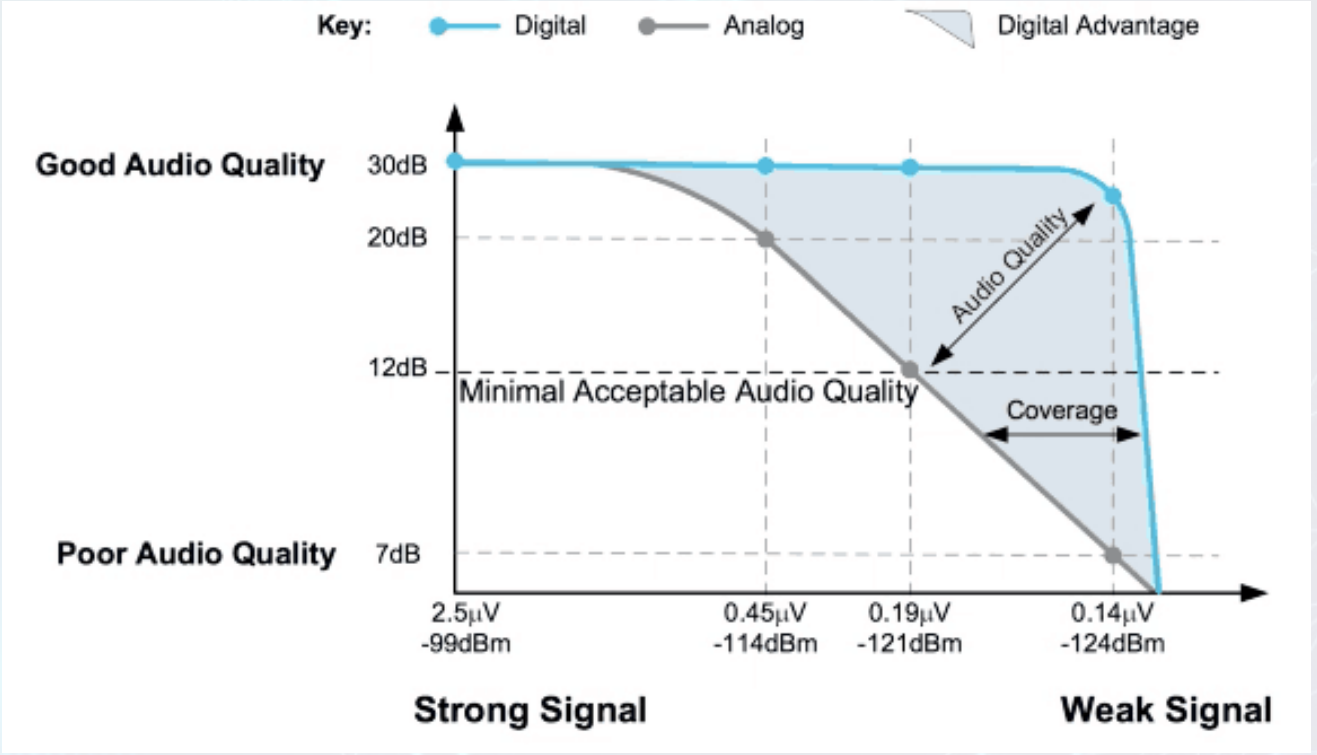
- Licensed conventional services such as land mobile commercial use
- Designed to be a direct replacement for conventional analog FM radio systems
- Supports Direct Mode (unit-to-unit) or use with repeaters for wider coverage
- Provides
  - Enhanced spectral efficiency
    - 2 talk/data paths per 12.5 kHz channel (narrowband FM)
  - Advanced voice features
  - Integrated IP Data Services
    - Text messaging
    - GPS
    - Telemetry
- Also used by amateur radio operators

DMR Tier III

- Licensed Trunked Radio Service
  - Includes a controller function which regulates communications
  - Includes data services of Tier II
  - Supports advanced packet data services using IPv4 and IPv6
- Designed to replace logic trunked radio systems for those who want the added benefits of managed trunking of voice and data

DMR – Digital Audio Quality

- An analog FM signal will weaken and become harder to understand with distance
  - Increased “hiss and crackle”
- A digital signal will remain clear to the edge of coverage and DSP processing can remove background noise
  - Sirens
  - Engine/cab noise
  - Wind noise



Talk Groups (TG)

- Talk Groups enable groups of users to share a Time Slot (one-to-many) without distracting other users of that Time Slot
  - Only one Talk Group (TG) can be using a Time Slot at the same time
  - If your radio is not programmed to receive at least one Talk Group, you won't hear anything
  - Talk Groups are numbered
    - Some popular Brandmeister Amateur Radio Talk Groups in the U.S.:
      - TG91 – World Wide
      - TG3100 – USA
      - TG310 – TAC310 USA
      - TG3130 – Montana Statewide
- Some TGs are used for local/regional/national nets
- Other TGs are focused on hobbies or other interests
- TGs can be statically or dynamically assigned to a Time Slot

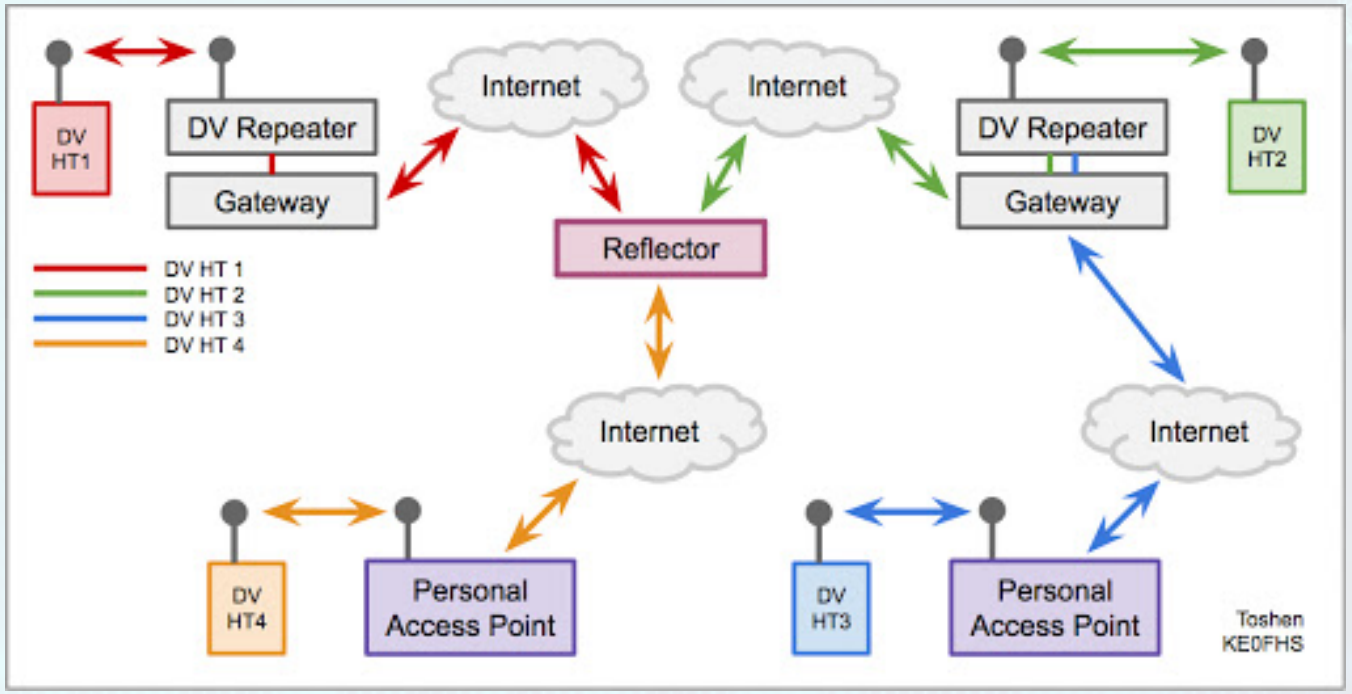
DMR Repeaters

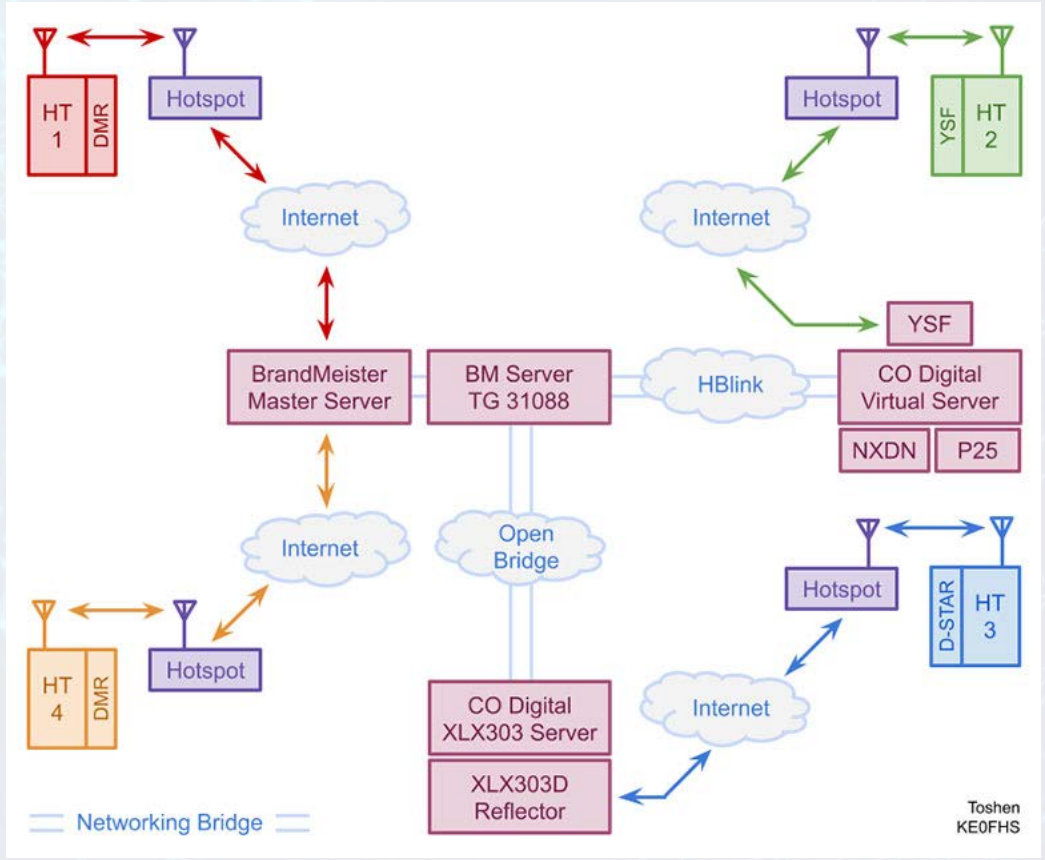
- Use Color Codes (CC) much like the way analog repeaters use CTCSS
  - Unlike analog repeaters where CTCSS is not required, using CCs is NOT optional with DMR
  - Your radio must be programmed to use the same CC as the repeater you wish to use
  - There are 16 different Color Codes (0-15)
  - The only reason to use different CCs is when multiple repeaters on the same frequency have overlapping areas of coverage
  - Most amateur radio DMR repeaters use CC = 1

Amateur Radio Use of DMR

- While DMR was not originally intended to support the Amateur Radio Service, it has become very popular with hams for the same reasons it became popular with land mobile and public safety users
- Hams have created global networks of Internet and microwave interconnected DMR repeaters/HotSpots (27,349 as of 3/18/24) and “reflectors” (repeats traffic on a TG), with these being the “Big Three”:
  - DMR-MARC (established in 2009)
    - First in USA
    - Uses C-Bridges
    - Repeater and Hotspot access
      - Primarily repeaters
  - BrandMeister (established in 2015)
    - Master Server owned by BrandMeister
    - Repeater and Hotspot access
    - Some Talk Groups (TG) are interconnected
    - Rarely uses reflectors as all TGs are accessible from all repeaters and Hotspots
    - APRS enabled
    - Probably the most popular DMR network at this point and the one we’ll discuss today
  - DMR+
    - Connects DV4Mini USB Hotspots to DMR-MARC network

BrandMeister DMR Repeater and Hotspot Network

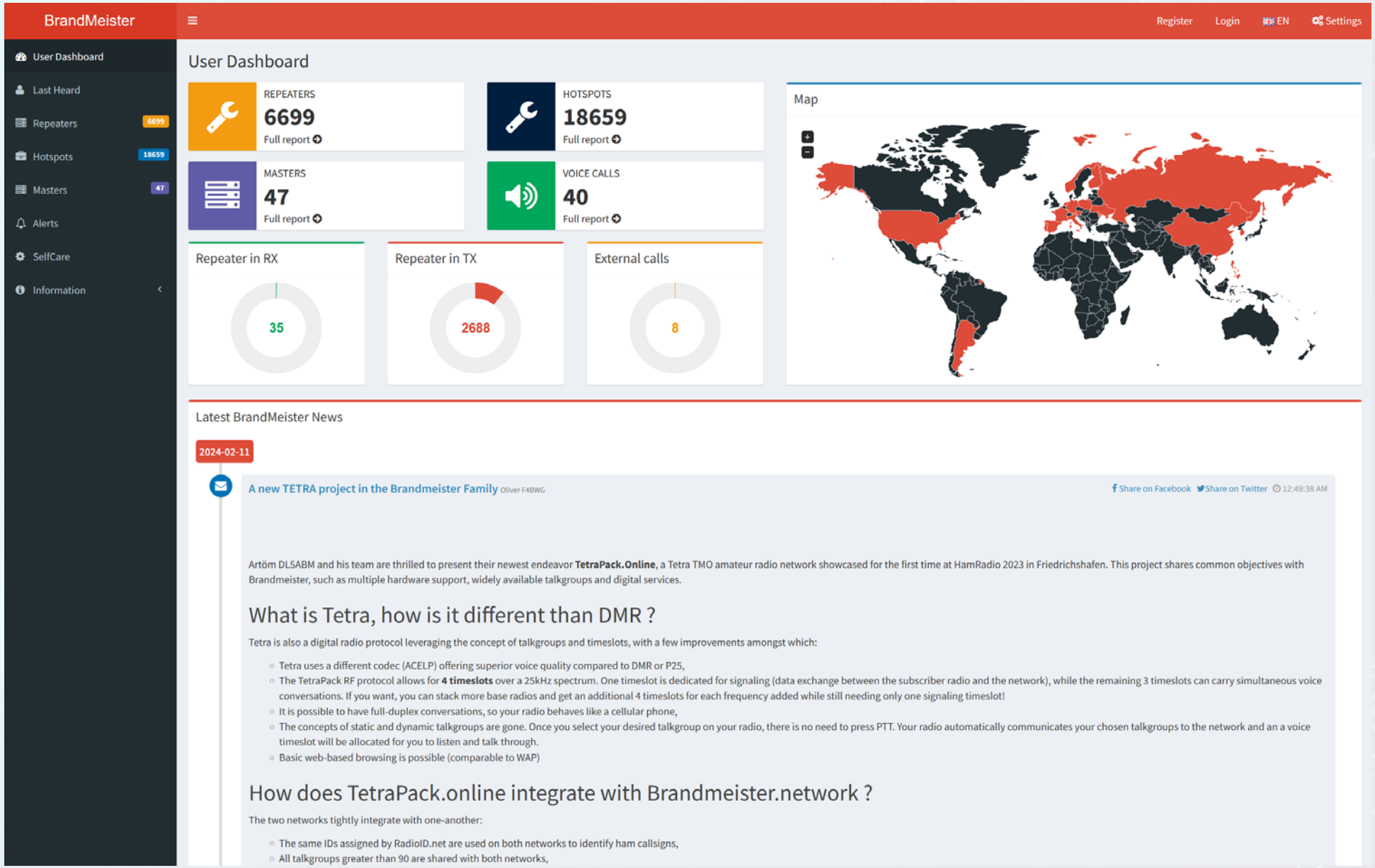




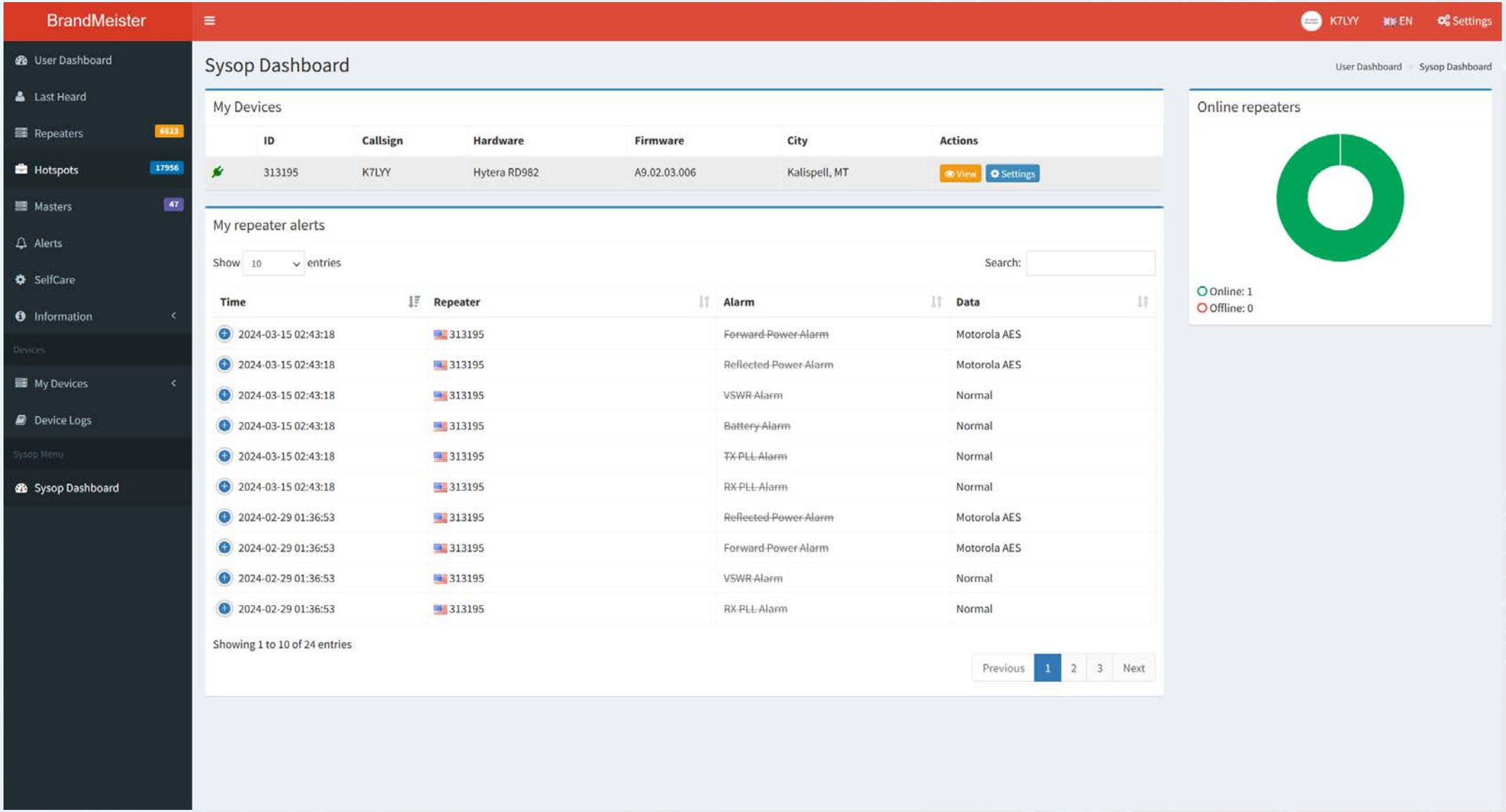
BrandMeister Network Features

- Talkgroups
- Private calls
- APRS
- SMS text messaging
- D-Star gateway
- Yaesu System Fusion bridging
- Echolink gateway
- Autopatch call gateway
- BrandMeister Dashboard and SelfCare
- https://brandmeister.network/

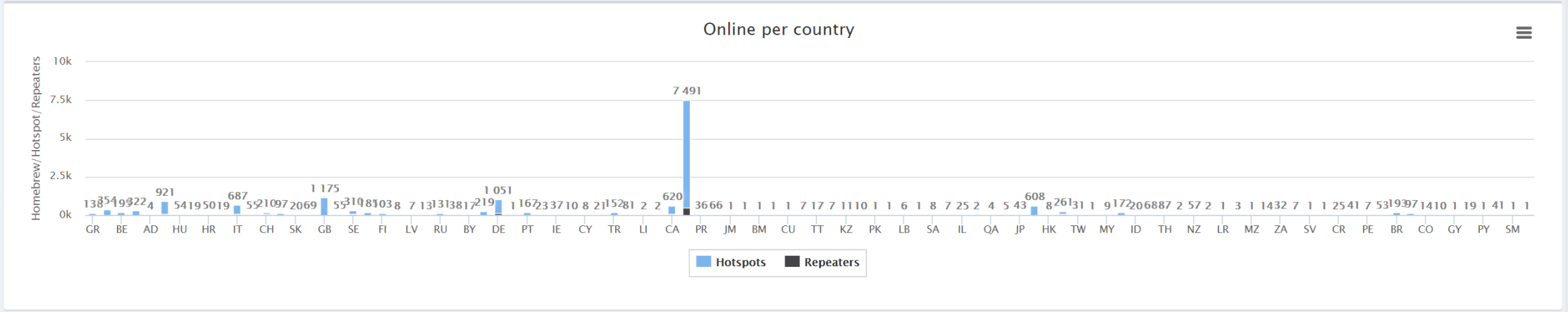
BrandMeister Dashboard

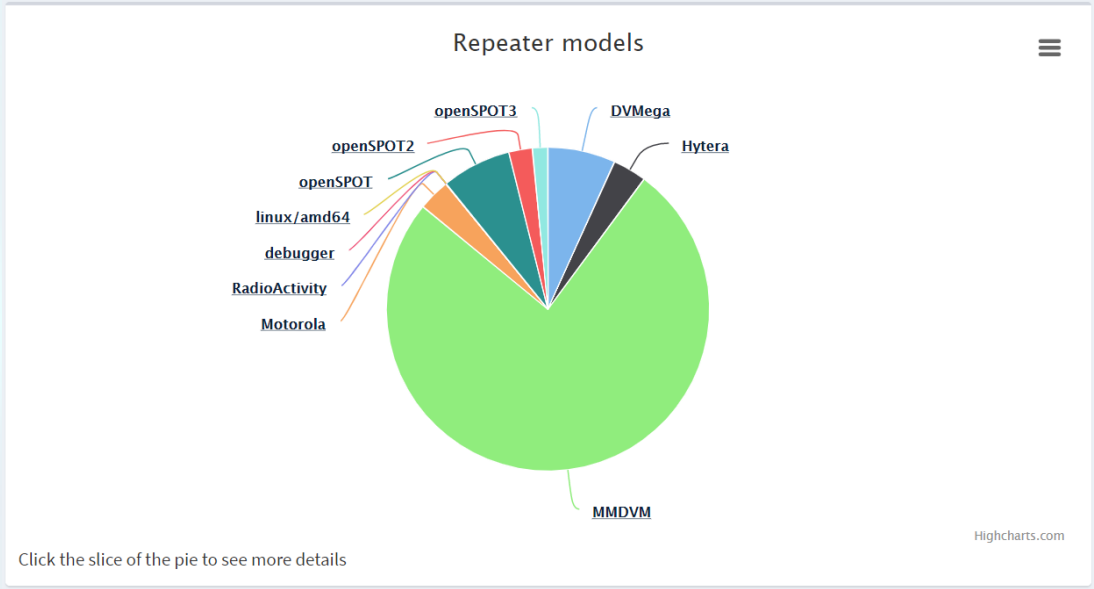


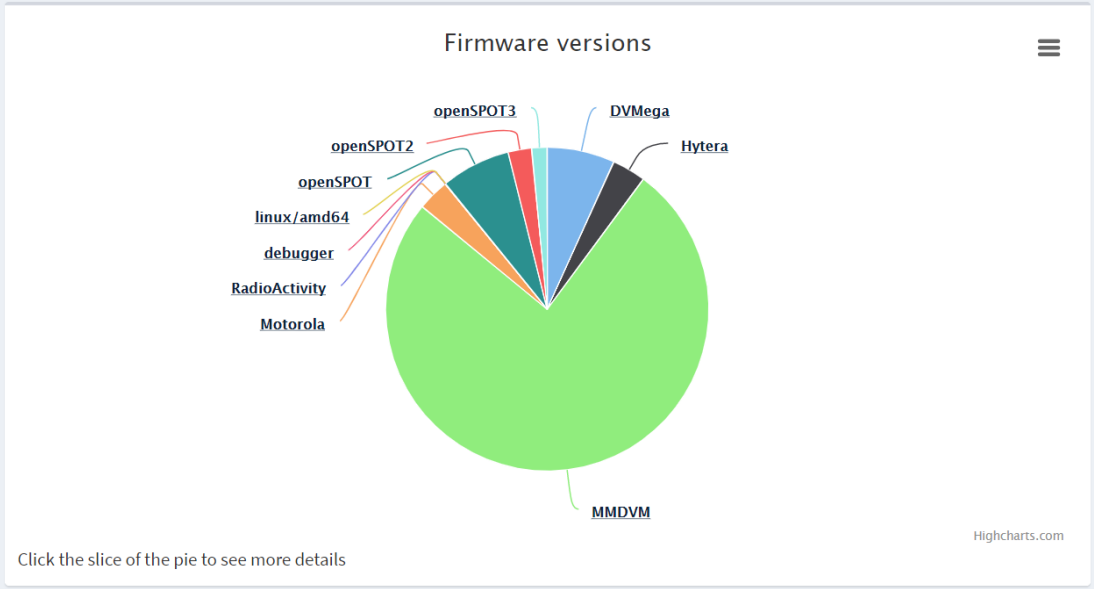
BrandMeister Sysop Dashboard



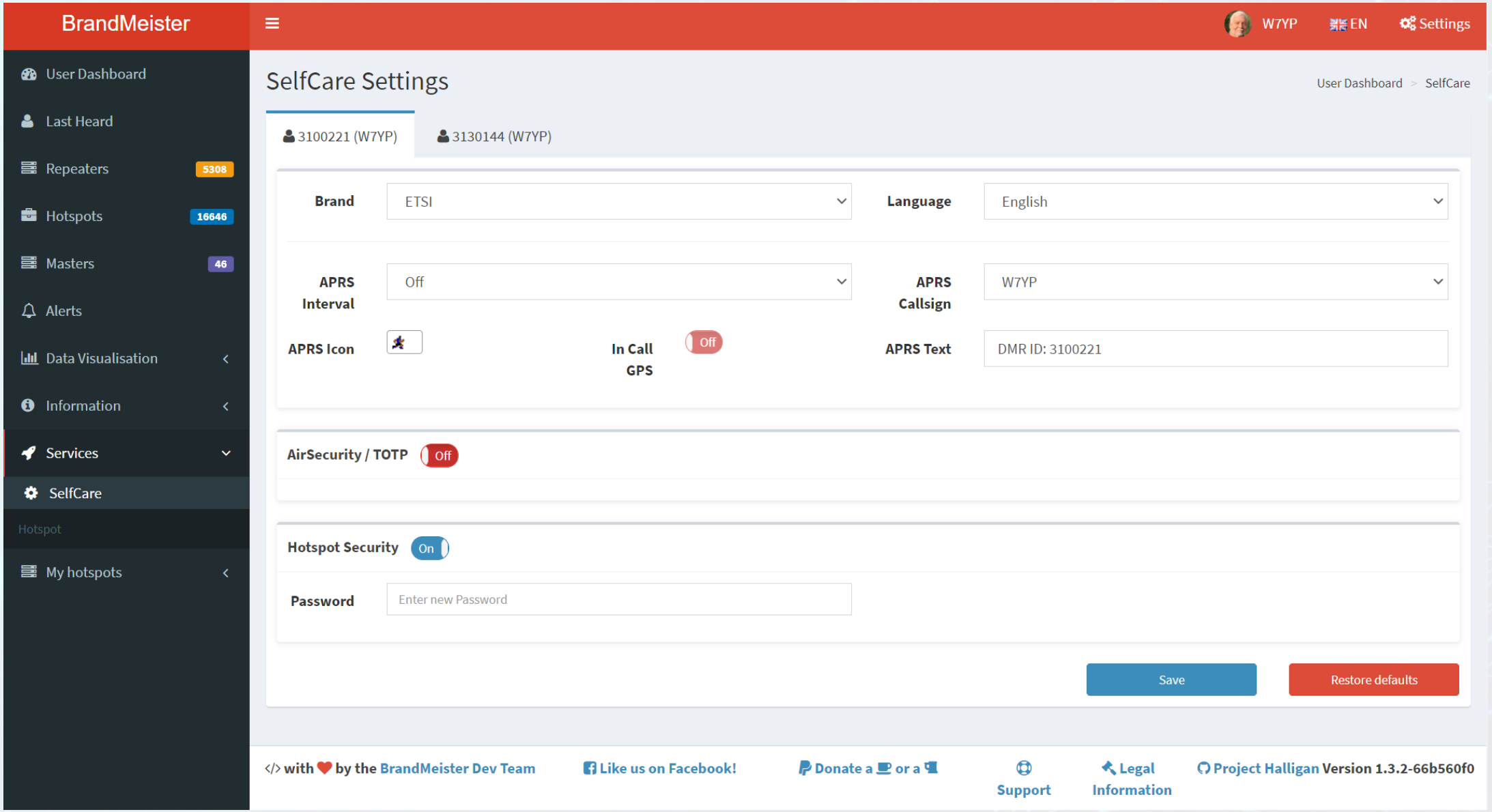
BrandMeister Usage And Hotspot Data





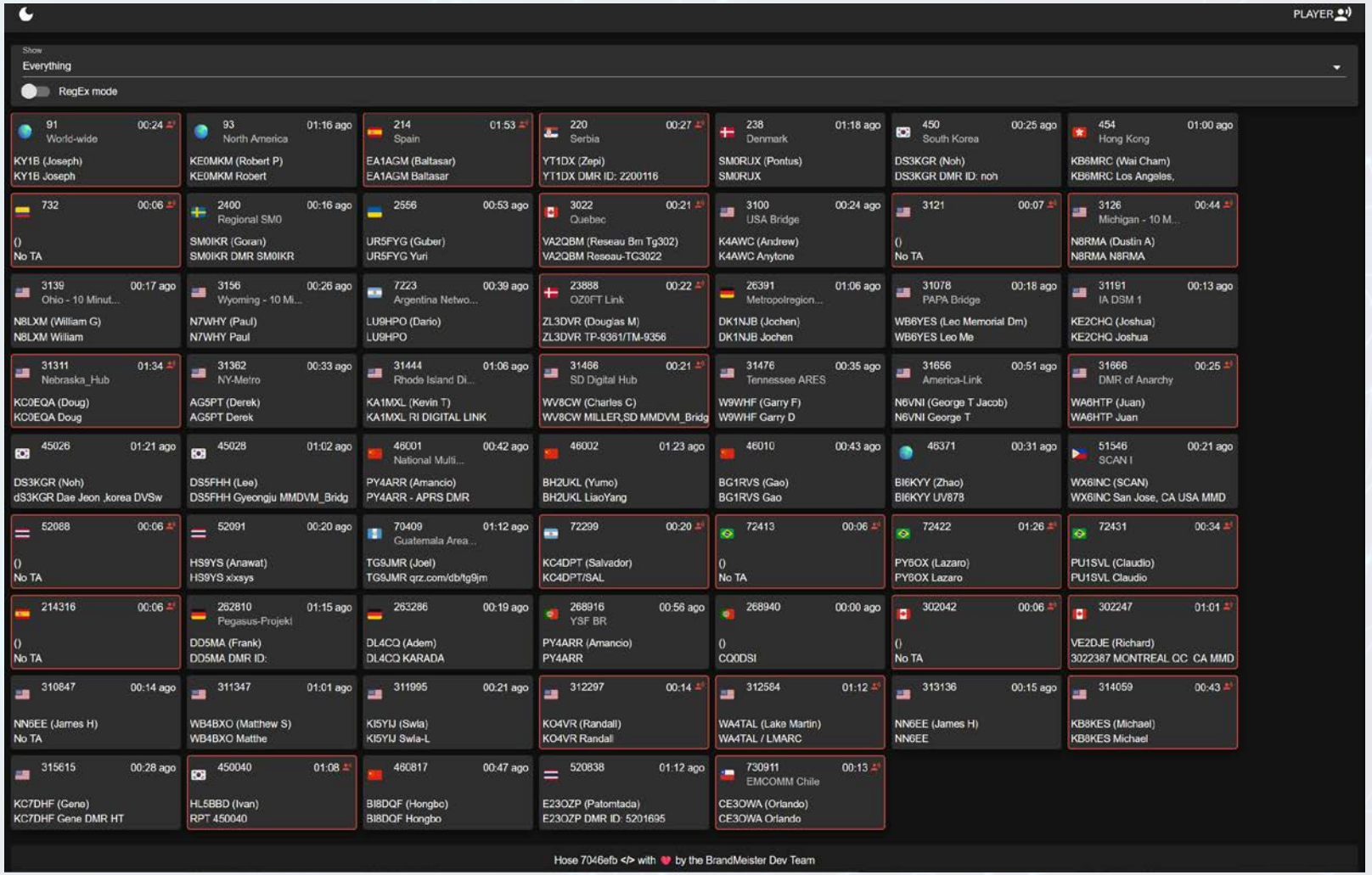


BrandMeister SelfCare



BrandMeister Hoseline

- A real time streaming Web-based application for the BrandMeister network
  - Receives real time streams from the master nodes in the network
    - Relays them to subscribers who are listening via a browser
- https://hose.brandmeister.network/



NW Montana Repeater Group (NW7RG)

- Mission is to link member-owned repeaters in NW Montana, Ohio and elsewhere in the U.S.
- Membership open to all amateurs and their immediate families
- Group consists of a number of repeaters with active portals
  - IRLP
  - AllStar
  - Echolink
  - Telephone
- Brandmeister talkgroup NW7RG (31304)
  - Static assignment to Time Slot 1 on Buffalo Hill (K7LYY) and W7YP DMR repeaters (both Hytera RD982i)
- http://www.nw7rg.org/NW7RG/index.html

Mac[Donald] Pass Repeater Group (MPRG)

- Large network of DMR repeaters throughout Montana, New Mexico, and Texas
  - All interconnected via the Brandmeister global DMR network
  - Our local DMR repeaters are part of this group
- Brandmeister Talkgroups MPRG1 (31301) and MPRG2 (31302)
  - Statically assigned to Timeslot 1 on the Buffalo Hill (K7LYY) and W7YP DMR repeaters (both Hytera RD982i)
  - A call to these Talkgroups on any of the member repeaters will be retransmitted on all the linked repeaters on the Timeslot to which they're statically assigned
- http://www.macpassradio.com/mprg/
- Repeater list: https://www.dmr-montana.net/

Getting Started with DMR

- The first thing you need to do is get a unique numerical DMR ID if you want to use networked DMR resources and you don't already have one (if you're building your own private DMR radio system, you can make up your own IDs for each radio)
  - DMR IDs should be unique for a particular DMR network and radio unless only one radio sharing the same ID will be used at any given time
    - BrandMeister's central server forces compliance with this requirement
  - This operates similarly to your Call Sign in D-Star and Yaesu System Fusion
  - You can get one from BrandMeister or DMR-MARC and doing so will usually take a few days
    - As of 2018, the sole source for DMR IDs is "Radioid.net" ("Register.ham-digital.org" for EU hams)
    - Both BrandMeister and DMR-MARC now use Radioid.net as the source for DMR IDs
- Periodically update your radio(s) with DMR-ID <-> CallSign List available from RadioId.net so that you'll see who you're talking to on your radio's display instead of just a 7-digit DMR ID

Apply for a DMR ID

- Go to https://www.radioid.net
  - If you don't yet have an account, register for one
    - You will not be able to register for a DMR ID without an account
    - Registering for an account will require uploading a PDF of your FCC Amateur Radio License (you can download one from the FCC's ULS web site)
    - After completing registration and license validation, you will receive an email within a few days with your new DMR ID (DO NOT LOSE THIS EMAIL!)
- Register your new DMR ID with the BrandMeister network and create an account there if necessary
  - In a few days you will receive a verification email
  - Be sure to check out the "SelfCare" section on their website which offers an array of services to their users
- Program your DMR radio with your new ID and enjoy world wide communications over DMR!

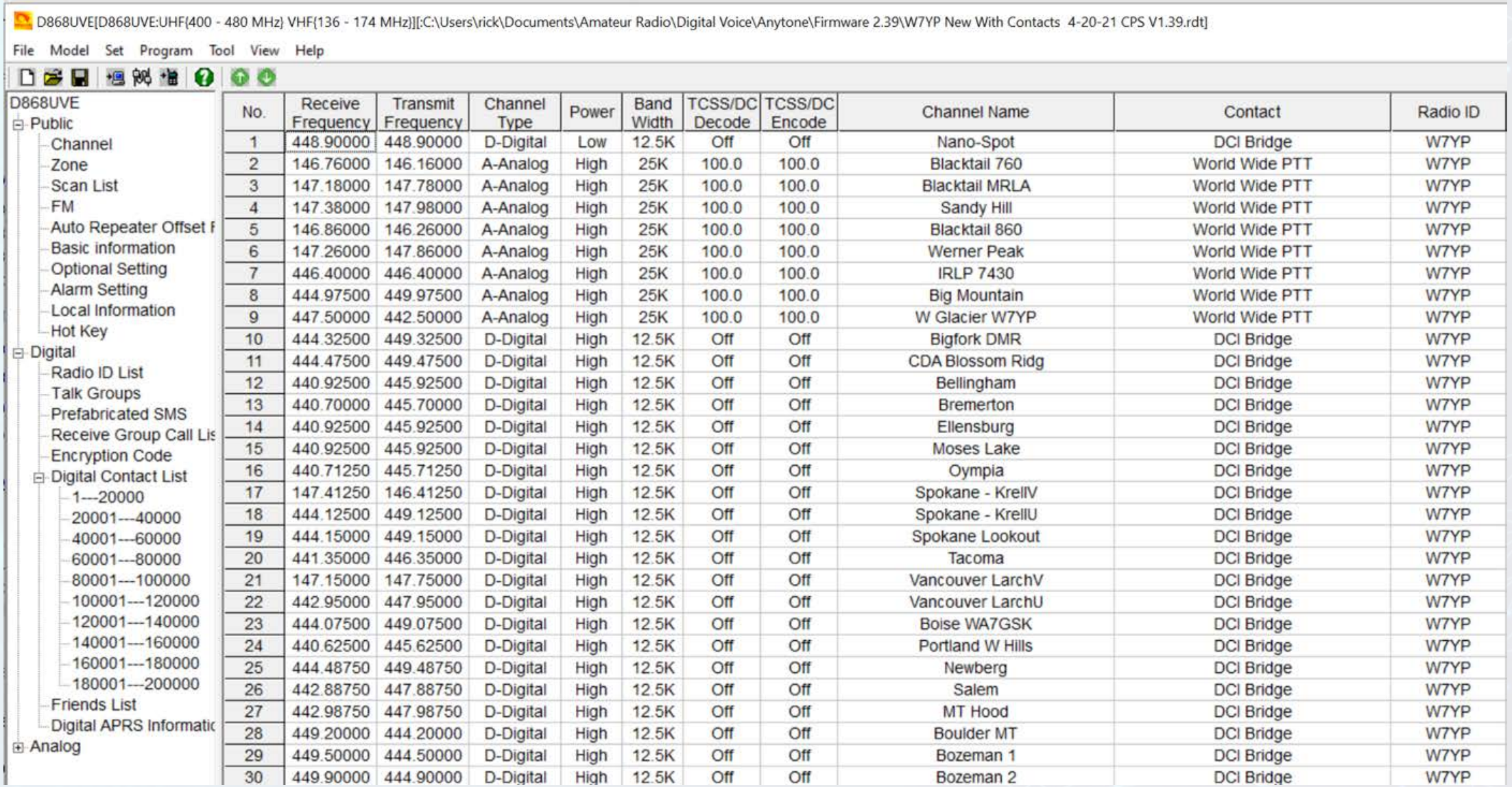
WTH is a “Code Plug”?

- Every DMR radio requires a “Code Plug” in order to operate
  - This is just a fancy name for the software configuration file that gets loaded into your DMR radio, telling it what you want it to support
- A Code Plug minimally contains:
  - Talk Groups/Digital Contacts
    - Well over 1,600 TGs worldwide
      - Add those you want to use to your Digital Contacts list
  - Channels
    - Everything specific to a channel: TX and RX frequencies; Power level; time out value; CC; TG; Time Slot
  - Zones
    - Groups together related channels (e.g., local repeaters; simplex channels; frequently used; etc.)
  - Admit Criteria
    - Color Code (CC) – preferred
    - Channel Free – admitted when the channel is clear
    - Always – Rather impolite and should only be used if on a simplex channel or in analog mode

Setting Up A Basic Code Plug

- This will be done with the programming software and cable that came with the DMR radio
  - Step 1 – Transmit Talk Groups
    - Suggested: TG9 (local repeater); TG2 (local repeater and local network cluster); TG3130 (MT state); TG3100 (Nationwide US); TAC channels for long conversations or group chats (TG310/311/312); TG9998 TS2 (Parrot/Echo test)
  - Step 2 – Channel Information
  - Step 3 – Zones
- I highly recommend starting with a working code plug you can download, then modify it with your DMR ID, TGs, desired Channels and Zones:
  - https://www.miklor.com/DMR/DMR-CodePlugs.php
- Don’t worry – you can’t break the radio no matter how badly you might screw up creating a code plug

EXAMPLE: AT-D868UV Programming SW



No.	Receive Frequency	Transmit Frequency	Channel Type	Power	Band Width	TCSS/DC Decode	TCSS/DC Encode	Channel Name	Contact	Radio ID
1	448.90000	448.90000	D-Digital	Low	12.5K	Off	Off	Nano-Spot	DCI Bridge	W7YP
2	146.76000	146.16000	A-Analog	High	25K	100.0	100.0	Blacktail 760	World Wide PTT	W7YP
3	147.18000	147.78000	A-Analog	High	25K	100.0	100.0	Blacktail MRLA	World Wide PTT	W7YP
4	147.38000	147.98000	A-Analog	High	25K	100.0	100.0	Sandy Hill	World Wide PTT	W7YP
5	146.86000	146.26000	A-Analog	High	25K	100.0	100.0	Blacktail 860	World Wide PTT	W7YP
6	147.26000	147.86000	A-Analog	High	25K	100.0	100.0	Werner Peak	World Wide PTT	W7YP
7	446.40000	446.40000	A-Analog	High	25K	100.0	100.0	IRLP 7430	World Wide PTT	W7YP
8	444.97500	449.97500	A-Analog	High	25K	100.0	100.0	Big Mountain	World Wide PTT	W7YP
9	447.50000	442.50000	A-Analog	High	25K	100.0	100.0	W Glacier W7YP	World Wide PTT	W7YP
10	444.32500	449.32500	D-Digital	High	12.5K	Off	Off	Bigfork DMR	DCI Bridge	W7YP
11	444.47500	449.47500	D-Digital	High	12.5K	Off	Off	CDA Blossom Ridg	DCI Bridge	W7YP
12	440.92500	445.92500	D-Digital	High	12.5K	Off	Off	Bellingham	DCI Bridge	W7YP
13	440.70000	445.70000	D-Digital	High	12.5K	Off	Off	Bremerton	DCI Bridge	W7YP
14	440.92500	445.92500	D-Digital	High	12.5K	Off	Off	Ellensburg	DCI Bridge	W7YP
15	440.92500	445.92500	D-Digital	High	12.5K	Off	Off	Moses Lake	DCI Bridge	W7YP
16	440.71250	445.71250	D-Digital	High	12.5K	Off	Off	Oympia	DCI Bridge	W7YP
17	147.41250	146.41250	D-Digital	High	12.5K	Off	Off	Spokane - KrellV	DCI Bridge	W7YP
18	444.12500	449.12500	D-Digital	High	12.5K	Off	Off	Spokane - KrellU	DCI Bridge	W7YP
19	444.15000	449.15000	D-Digital	High	12.5K	Off	Off	Spokane Lookout	DCI Bridge	W7YP
20	441.35000	446.35000	D-Digital	High	12.5K	Off	Off	Tacoma	DCI Bridge	W7YP
21	147.15000	147.75000	D-Digital	High	12.5K	Off	Off	Vancouver LarchV	DCI Bridge	W7YP
22	442.95000	447.95000	D-Digital	High	12.5K	Off	Off	Vancouver LarchU	DCI Bridge	W7YP
23	444.07500	449.07500	D-Digital	High	12.5K	Off	Off	Boise WA7GSK	DCI Bridge	W7YP
24	440.62500	445.62500	D-Digital	High	12.5K	Off	Off	Portland W Hills	DCI Bridge	W7YP
25	444.48750	449.48750	D-Digital	High	12.5K	Off	Off	Newberg	DCI Bridge	W7YP
26	442.88750	447.88750	D-Digital	High	12.5K	Off	Off	Salem	DCI Bridge	W7YP
27	442.98750	447.98750	D-Digital	High	12.5K	Off	Off	MT Hood	DCI Bridge	W7YP
28	449.20000	444.20000	D-Digital	High	12.5K	Off	Off	Boulder MT	DCI Bridge	W7YP
29	449.50000	444.50000	D-Digital	High	12.5K	Off	Off	Bozeman 1	DCI Bridge	W7YP
30	449.90000	444.90000	D-Digital	High	12.5K	Off	Off	Bozeman 2	DCI Bridge	W7YP

Examples of Dualband DMR HT Radios Available

- Anytone AT-D868UV/AT-D878UV/AT-D878UV Plus
- BTECH DMR-6X2
- Baofeng DM-1801
- Radioddity GD-77
- TYT MD-380
- Prices range from around $80 to $330, depending on features
  - APRS
  - GPS
  - Bluetooth
  - Color touchscreen
  - Number of contacts supported (100,000 – 500,000)
    - Almost 200,000 registered IDs already

Examples of VHF/UHF DMR Mobile/Base Radios

- Anytone AT-D578UV Pro
- Anytone AT-D578UV III Pro
- Retevis RT73
- TYT MD-9600
- Connect Systems CS800D
  - Detachable face
- Prices from $200-$400
- Bridgecom sells Anytone products and will build your code plug for you
  - Radio will be ready to go right out of the box
  - Bridgecom DMR University can be really handy for the DMR novice

Q & A