Digital Mobile Radio

Features & Radio Price Points

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November 15, 2022

Flathead Valley Amateur Radio Club

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

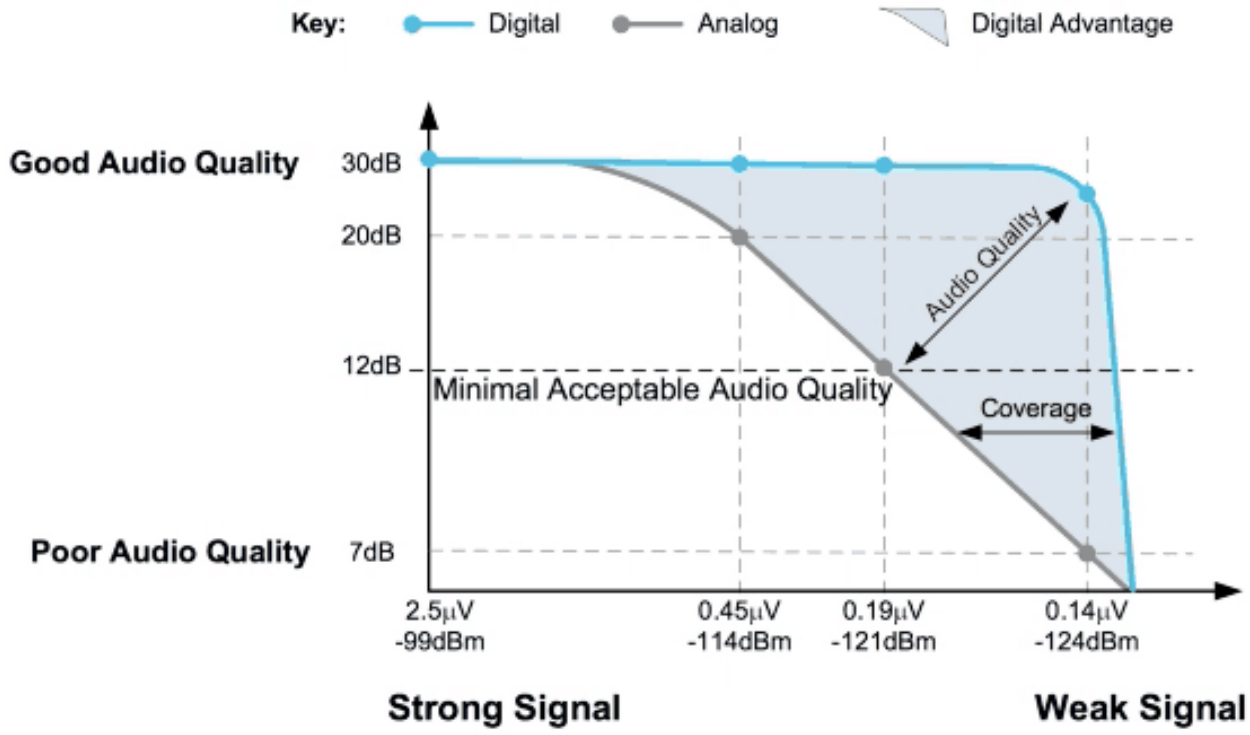
- Licensed conventional services such as land mobile commercial use
  - Amateur Radio has adopted this tier
- Designed to be a direct replacement for conventional analog FM radio systems
- Supports Direct Mode (unit-to-unit) or use with repeaters for wider coverage
- Provides
  - Enhanced spectral efficiency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

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
- Ham community is currently not doing anything in this space

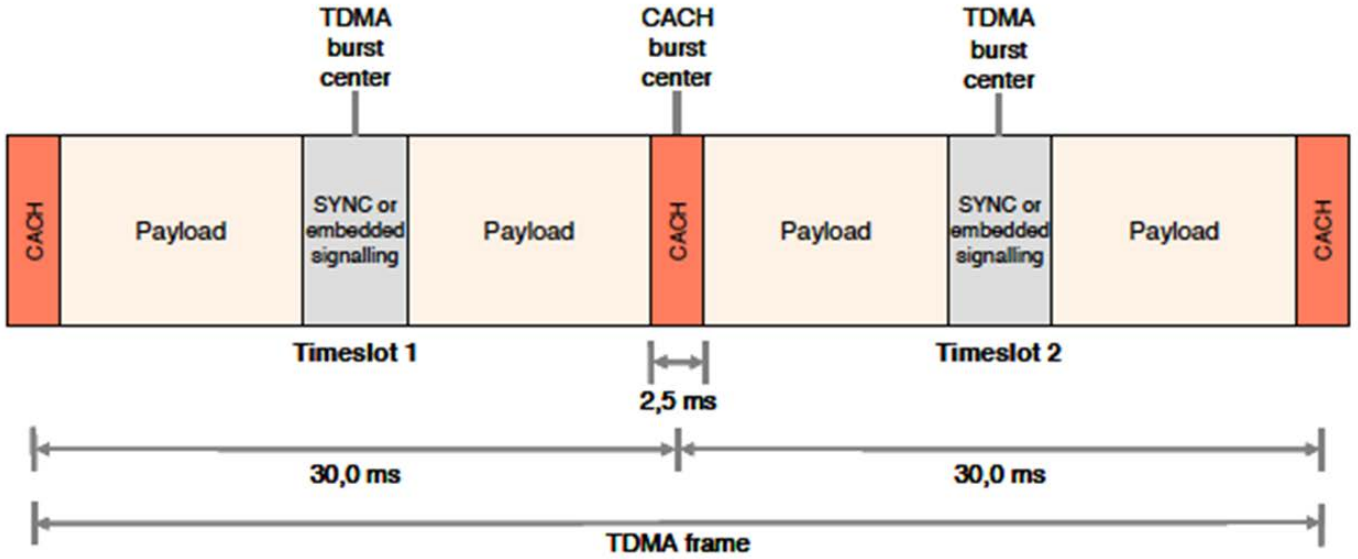
DMR – Digital Audio Quality

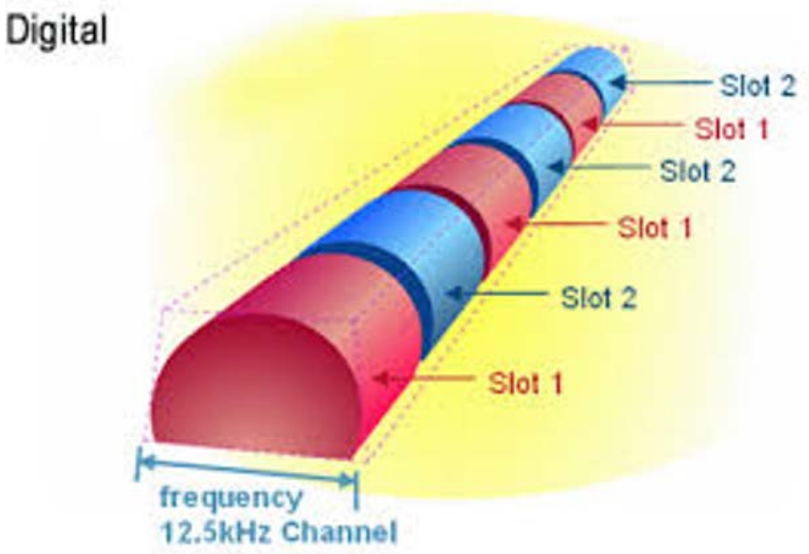
- An analog FM signal will weaken and become harder to understand with distance
  - Increased “hiss and crackle”
- A digital signal will remain clear to the edge of coverage and DSP processing can remove background noise
  - Sirens
  - Engine/cab noise
  - Wind noise



How It Works

- Digital Voice using Time Division Multiple Access (TDMA)
- There are 2 discreet time slots within the 12.5 kHz frequency allocation
  - Two simultaneous QSOs possible on the same repeater or hotspot
  - Supports multiple Talk Groups on one channel
  - One slot can be used for reverse channel signaling
    - Primarily used in Tier III





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 Amateur Radio Talk Groups in the U.S.:
      - TG91 – World Wide
      - TG3100 – USA
      - TG310 – TAC310 USA
    - In Montana (DMR Montana website: https://dmr-montana.net/)
      - TG3130 – Montana Statewide
      - TG31301 – MPRG 1 (Mac Pass Repeater Group - http://www.macpassradio.com/mprg/)
        - Network of Brandmeister-linked repeaters in Montana and New Mexico
      - TG31304 – NW7RG (Official TG of the Northwest Montana Repeater Group)
        - AllStarLink (Node 40668) connections as well

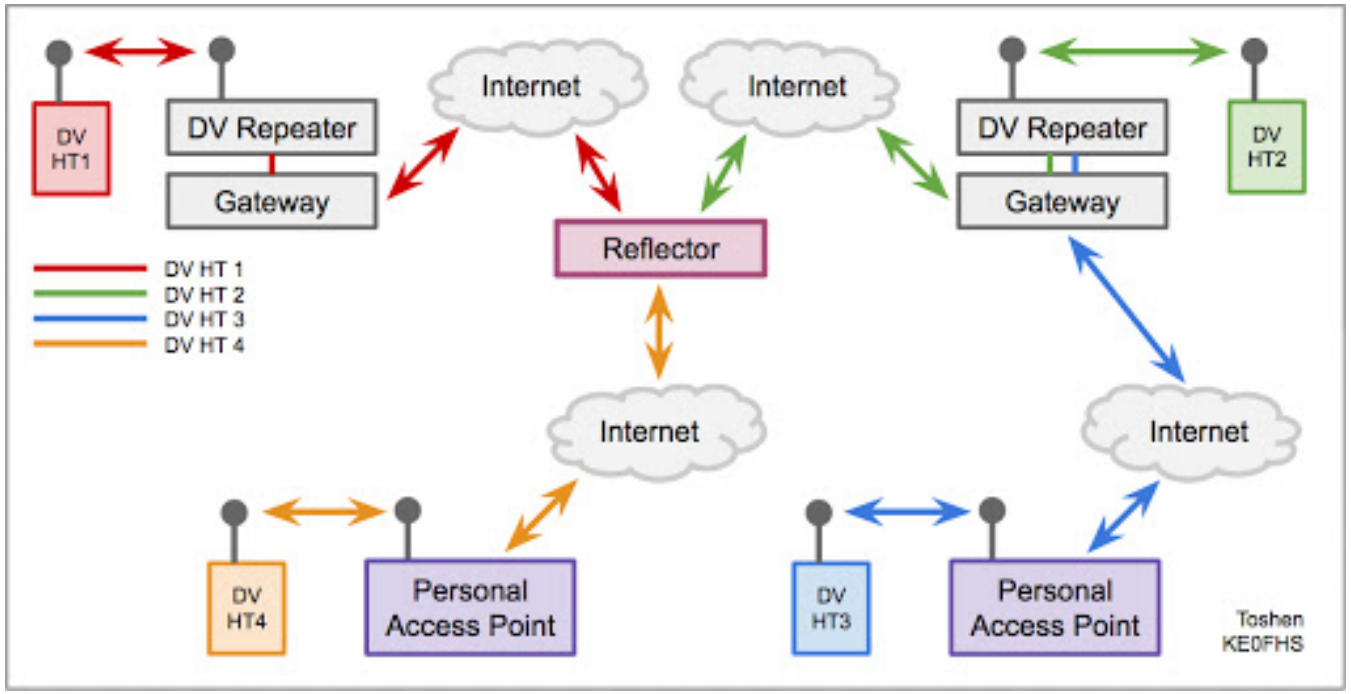
DMR Repeaters

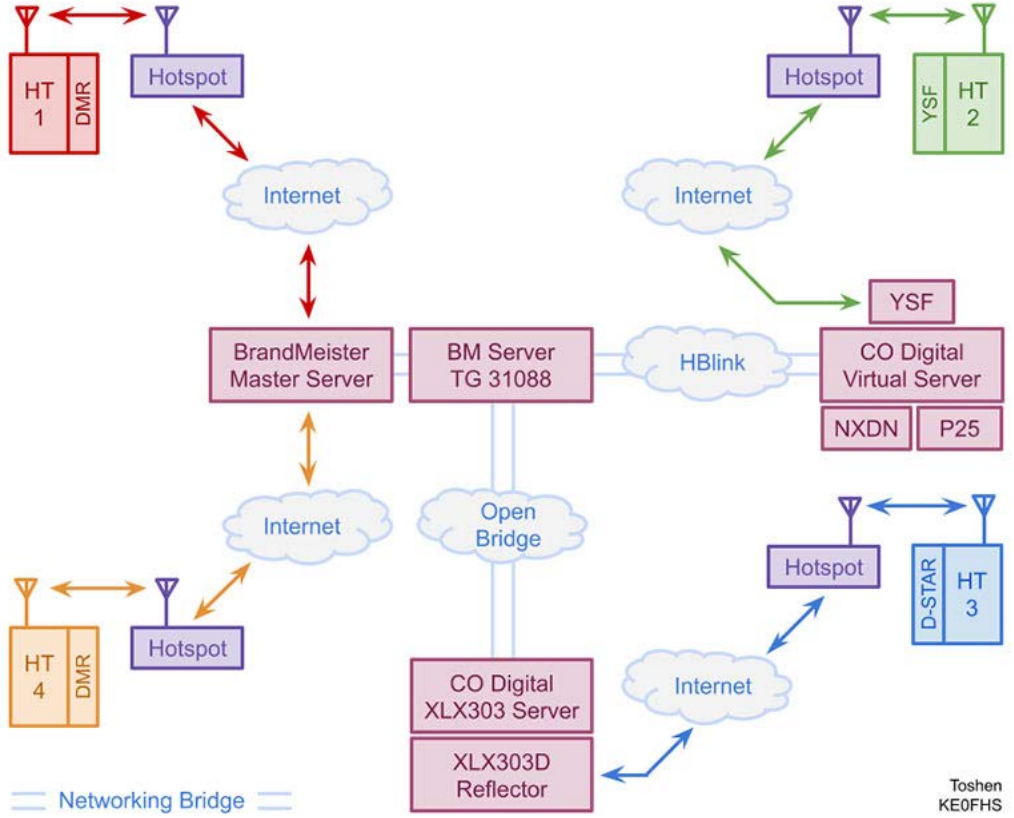
- Use Color Codes (CC) much like the way analog repeaters use CTCSS
  - Unlike analog repeaters where CTCSS is not required, using CCs is NOT optional with DMR
  - Your radio must be programmed to use the same CC as the repeater you wish to use
  - There are 16 different Color Codes (0-15)
  - The only 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 (over 10,000 as of 8/22) 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

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
  - As of 2018, the sole source for DMR IDs is "Radioid.net" ("Register.ham-digital.org" for EU hams)
- Periodically update your radio(s) with DMR-ID <-> CallSign List ("Contacts") 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
  - "Talker Alias", another way of ID'ing a talker is not yet widely available

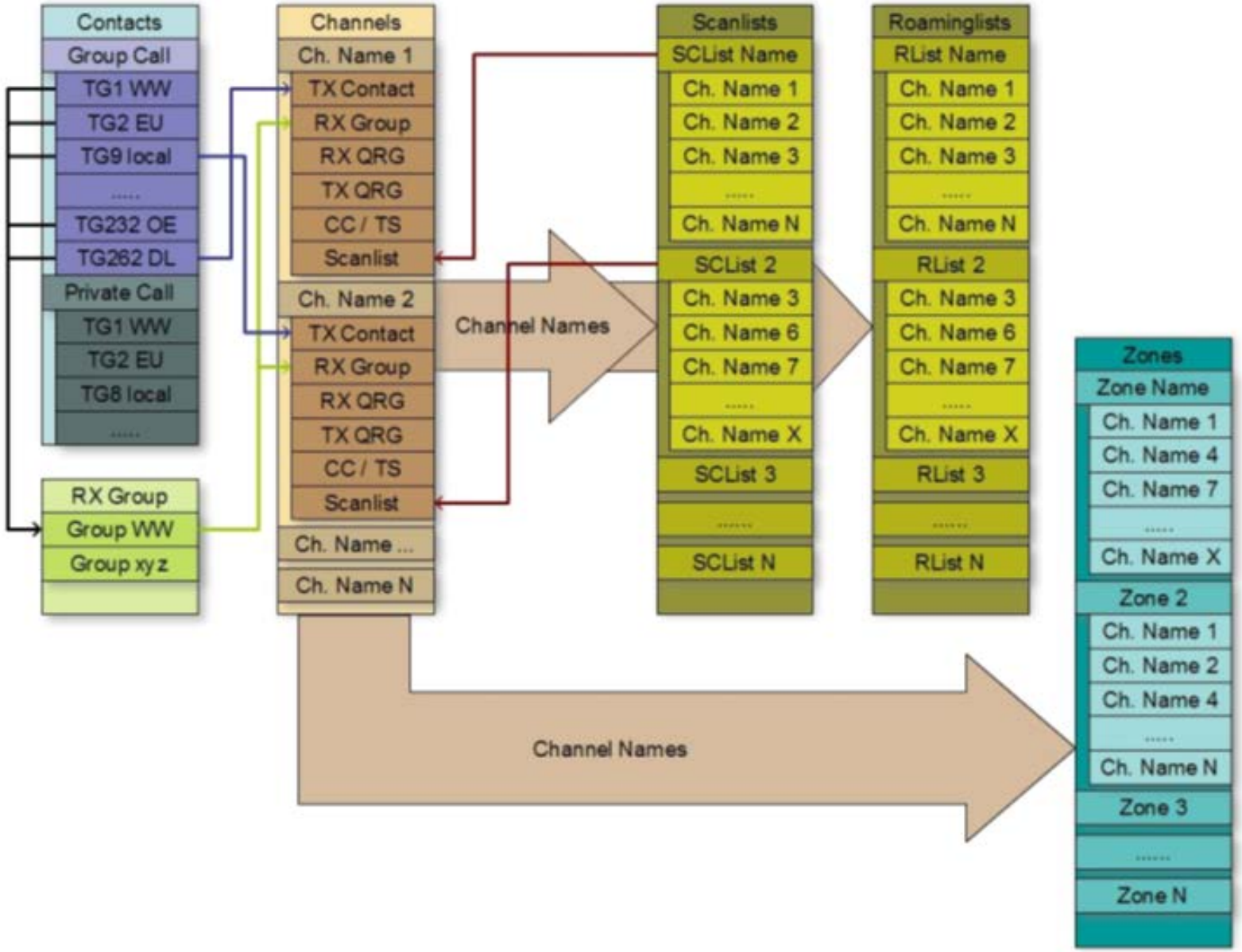
Apply for a DMR ID

- 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 official 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 file that gets loaded into your DMR radio telling it what you want it to support
- A Code Plug minimally contains:
  - Radio’s DMR ID
  - 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
    - Time Slot (TS), Color Code (CC) and TG for DMR channels
    - CTCSS/CDCSS codes for FM analog channels
  - Zones
    - Groups together related channels (e.g., local repeaters; simplex channels; frequently used; etc.)
  - Admit Criteria
    - Color Code – 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

Anatomy of a DMR Codeplug:



Setting Up A Basic Code Plug

- This will be done with the Customer Programming Software (CPS) and cable that came with the DMR radio
  - Step 1 – Radio ID (DMR ID and callsign)
  - Step 2 – 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 3 – Channel Information
  - Step 4 – 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

Buffalo Hill DMR Rptr (146.760-)

- Hytera RD982i VHF repeater
  - Mixed Mode
    - Analog 25 kHz WFM
      - If one or both DMR Timeslots are in use, WFM signal won't be admitted
      - Uses CDCSS (DCS) code 152(N) on the input and output
      - DMR transmissions sound like a buzz saw in FM mode unless blocked by CDCSS
    - DMR 12.5 kHz
      - If WFM is active, DMR won't be admitted
      - Otherwise, two DMR QSOs can occur simultaneously
  - Connected over the Internet to the Brandmeister network
    - Static assignments on TS1: MPRG1, MPRG2, NW7RG
    - Static assignment on TS2: Montana
      - Supports 15-minute long dynamic TG assignments, SMS and Private Calls

Examples of Affordable DMR HT Radios Available

- Anytone AT-D878UVII Plus
- BTECH DMR-6X2
- Baofeng DM-1801
- Radioddity GD-88
- TYT MD-380; MD-UV390
- Prices range from around $80 (single band only) to $320, depending on features
  - APRS (digital and analog)
  - GPS
  - Bluetooth
  - Color touchscreen
  - Number of contacts supported (100,000 – 500,000)
    - Over 228,000 registered IDs already

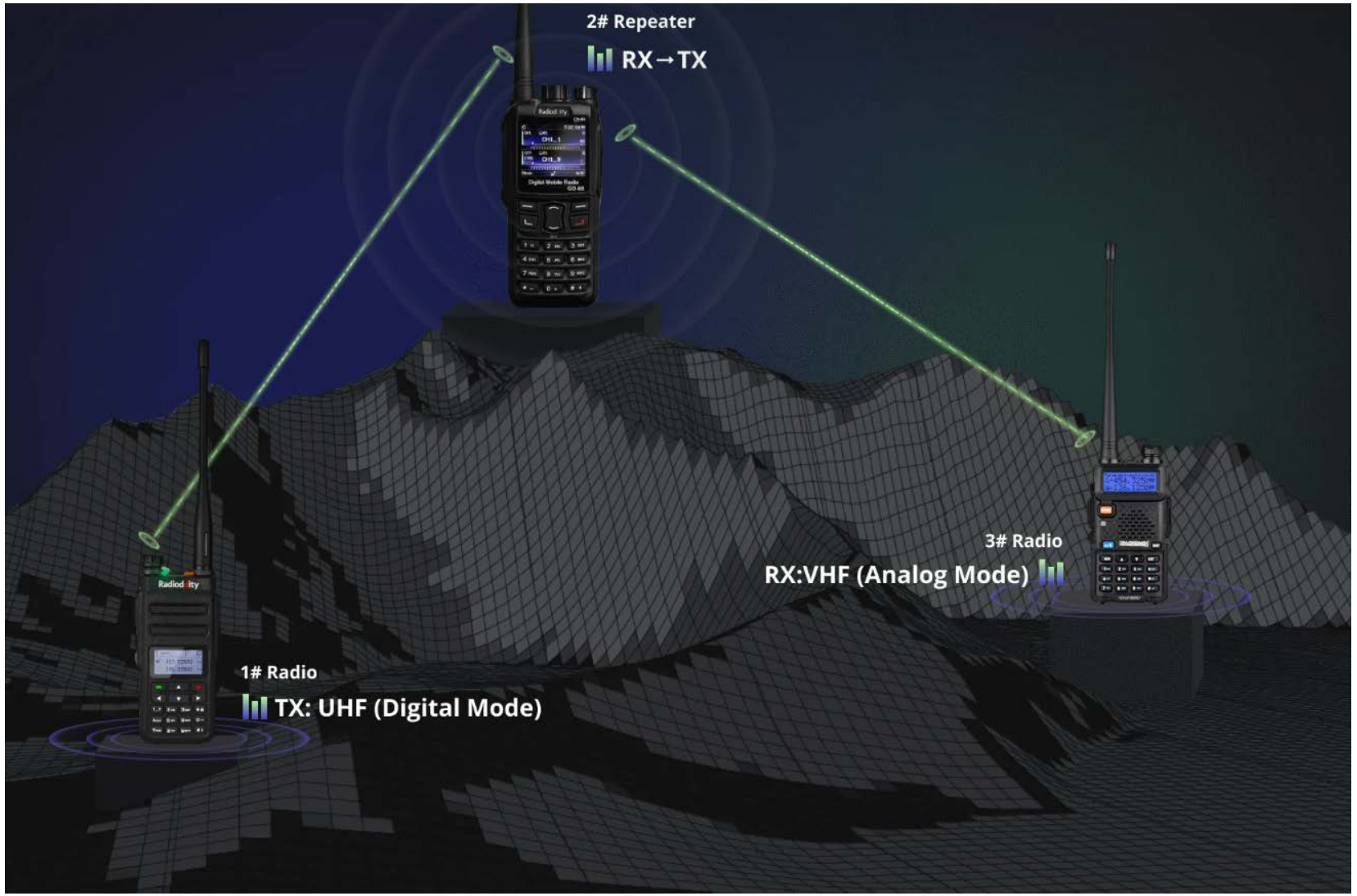
TYT MD-UV390 ($120)

- Compatible with MotoTRBO Tier I and Tier II
- VHF/UHF, analog FM (CTCSS and CDCSS) and DMR
- DTMF encode/decode
- 3,000 channels; 100,000 contacts
- 5/1W TX power
- IP67 rated (dustproof and waterproof to 1m depth for 30 minutes)
- Includes radio, charger, antenna, belt clip, 2000 mAh Li-ion battery, CPS software and programming cable, manual

Radioddity GD-88 ($220)

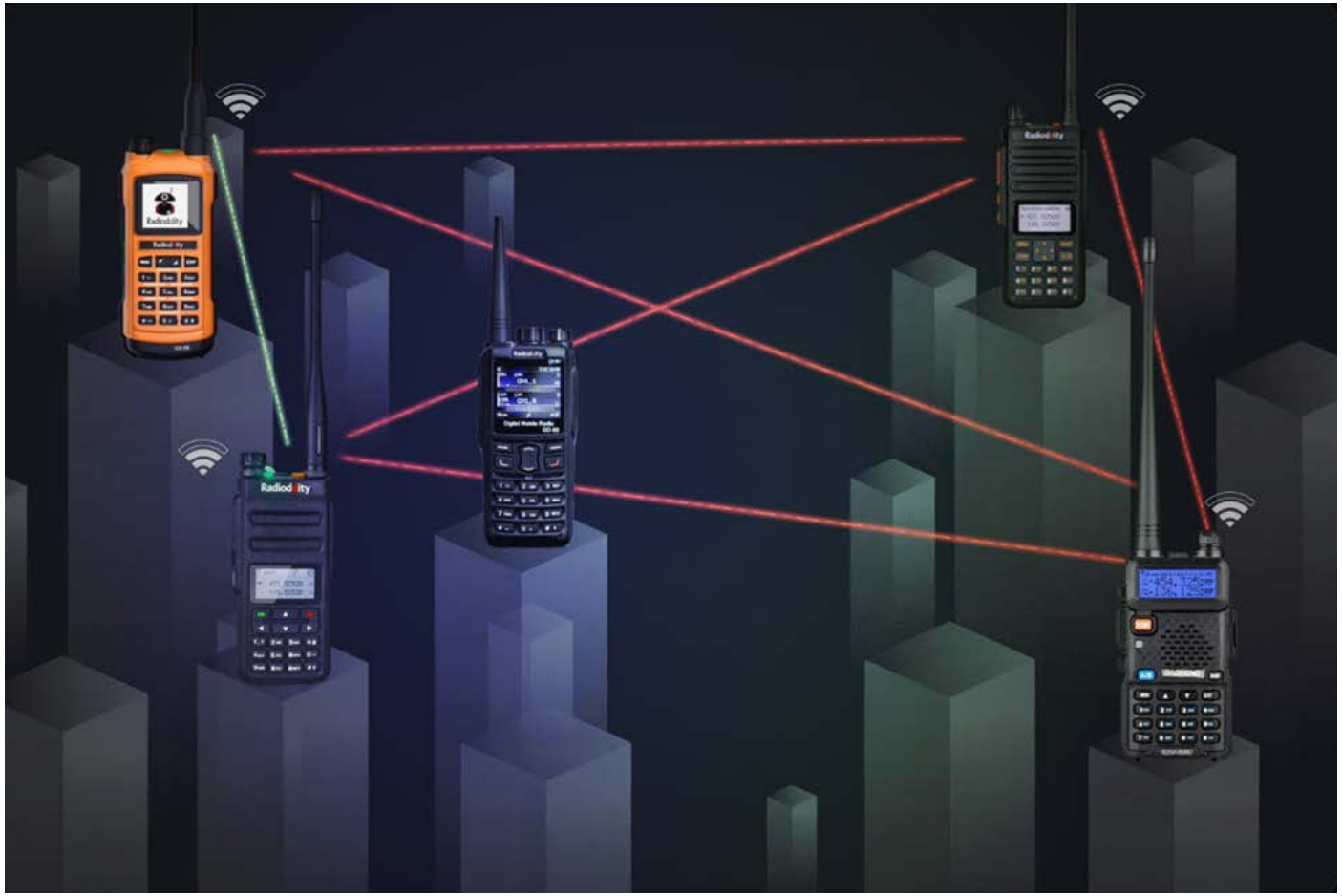
- Two independent receivers
  - dual band, dual mode, dual standby
- 7W maximum TX power
  - 2.5W low power setting
- 4,000 Channels (250 per zone); 16 Zones; 300,000 contacts
- GPS
- APRS (Analog and Digital; RX and TX)
- Cross-band repeat; same frequency repeat
- 2-in-one charger; 3,000 mAh battery
- IP54 rated
  - Limited ingress of dust; protected against water splashed from all directions with limited ingress permitted
- My one dislike: channels have to be defined within each zone definition rather than separately and then assigned to zones
  - If the same channel is to appear in different zones, it has to be redefined in each of those zones

GD-88 Cross-band Repeat



GD-88 Same Frequency Repeat (SFR)

- One TS is used for TX and RX with the second TS used in repeater mode
- Multiple GD-88s in a particular area can create their own emergency mesh network
  - Allows single-VFO radios to communicate with other radios bridged by GD-88's that are operating in SFR mode



Anytone AT-D878UVII Plus ($320)

- VHF: 7/5/2.5/0.2W; UHF: 6/5/2.5/0.2W
- WFM and DMR
- Dual VFO (V+V, U+U, V+U)
- GPS
- APRS RX and TX; digital and analog
- 4,000 channels; 10,000 TGs; 250 zones (up to 250 channels per zone)
- 500,000 contacts
- Bluetooth support
  - PTT button
  - Headphones
  - Speaker/Mic
- Solid CPS software
- IP54 rated
- Package includes: Radio, 3100 mAh Li-ion battery, desk charger, antenna, belt clip, Bluetooth PTT button and charging cable, USB programming cable, manual

Private Calls

- Create TG entries with your friends' DMR IDs
  - Call Type must be "Private Call"
  - Your DMR ID must also be a TG on their radio
  - Each radio must be monitoring the same channel or TG on at least one VFO
- Each DMR radio has a few ways to make a private call
  - With or without "alert" or "ring"
  - Display will show incoming or missed call
  - Call log records private call history
- DEMO (W7JAF 3110324 < == > W7YP 3100221)

Private Call Advanced Features

- Call Alert with Success/Failed status
- Remote Monitor – monitor sound near the target radio
- Get GPS location of target radio
- Check Radio – will confirm target radio is on and within range
- Kill – disable target radio with Success/Failed status
- Wake – wake up the ‘killed’ radio with status
- Ranging – detect distance and direction between the two radios

SMS Text Messaging

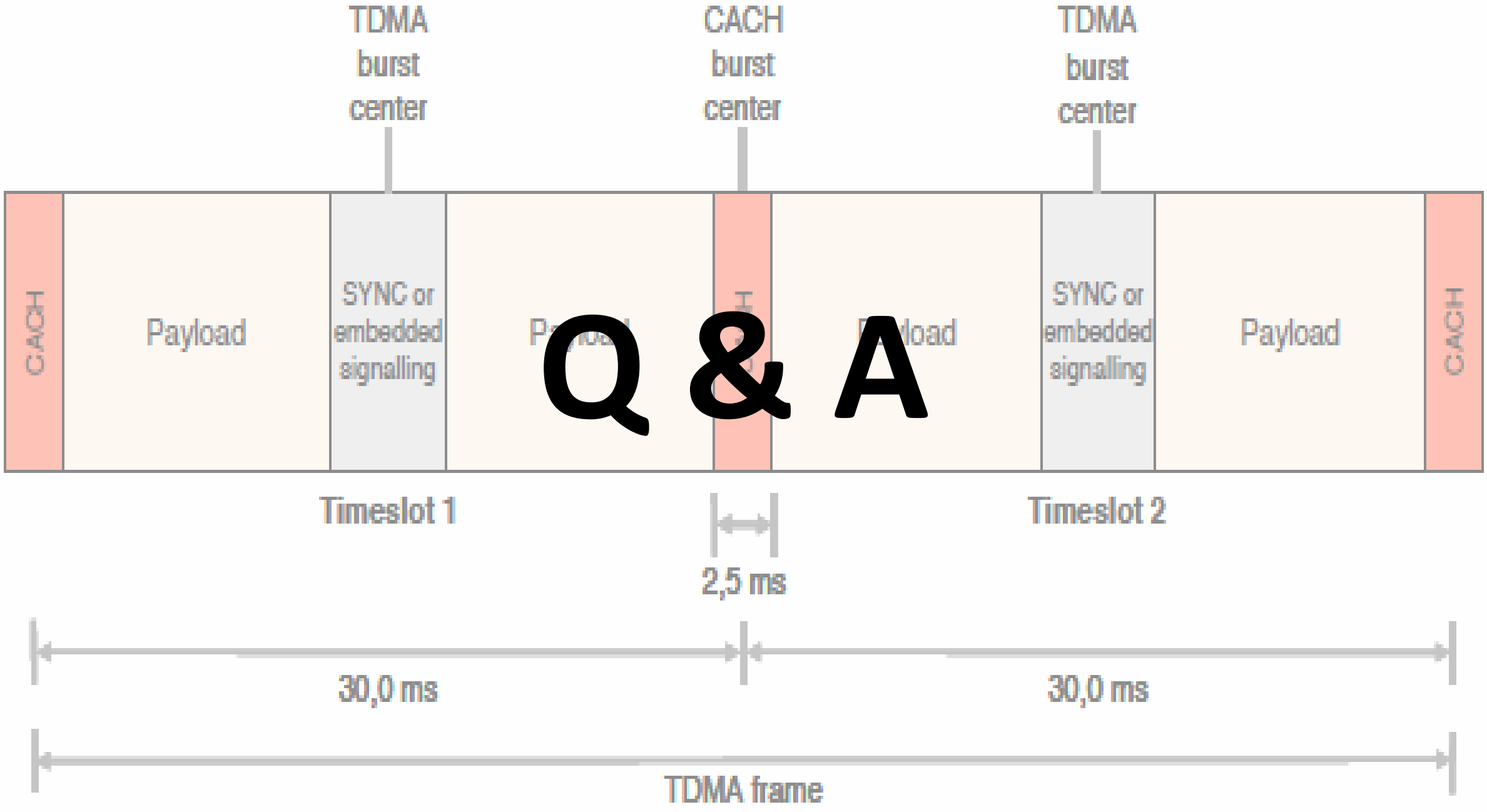
- Brandmeister APRS (SMSGTE - https://smsgte.org/)
  - Can send text messages to a cell phone and they can reply
    - Handy in areas not covered by cell service
      - Ongoing development and support relies on donations
    - Text will arrive from an Area Code 201 (New Jersey) number because that's where the Brandmeister gateway is located
    - SMSGTE will send an ACK message back to you if successfully delivered
  - Uses TG310999 (U.S.) to communicate with SMSGTE, which does all the work
    - FORMAT: SMSGTE[1 space]@5551234567[1 space]Your Message Text
      - Example: SMSGTE @5558675309 Hey!
      - Text strings with key messages (e.g., 'Help!') may be stored in the radio
      - Cellphone recipient may need to begin their reply with sender's ID (e.g., "@W7YP-7"), a space, and their text
  - Must configure APRS settings for your DMR ID in Brandmeister "SelfCare"
    - Add the appropriate suffix ("SSID") to your callsign in "APRS Callsign" (http://www.aprs.org/aprs11/SSIDs.txt)
      - Example: W7YP-7
    - Radio brand must also be specified (use "Motorola" for Anytones)
      - SMS Format must also be selected in the radio
        - For Anytone, this is under Option Setting => Digital Func

SMS Texting DMR Radio to DMR Radio

- Communicating radios must be connected to the same DMR repeater if the repeater is not connected to the Brandmeister network
  - They do not need to be connected to the same Talk Groups
- Process is similar but varies by radio manufacturer
  - This example uses an Anytone AT-D878UVII Plus HT:
    - Press MENU, then select SMS
    - Select either New Msg or Quick Text
    - Once the message has been entered or the canned message has been entered, select Confirm
    - Then select Send
    - From the next menu, select either TG List or Manual
      - If TG List, scroll to and select the user to be texted
      - If Manual, type in their DMR ID
      - Message will be sent and and confirmed, if delivered

Additional Brandmeister SMS Functions

- Functions by their SMS service number (private calls)
  - 262993 – GPS and weather
    - Send “GPS” to get your last location sent to the system
    - Send “WX GPS” to get the weather for your GPS location
    - Send “WX ZIPCODE TOWN” or “WX ZIP, CC” for current weather conditions
  - 262994 – Repeater query
    - Send “RPT” to query a repeater for its static and dynamic TGs
  - 262995 – SMSC (SMS via callsign)
    - The destinations callsign is used instead of their DMR ID
    - Format: Callsign message body
    - Example: W7YP Hey Rick, what TG are you on?
    - Unlike the other SMS examples, Brandmeister handles these texts in true store-and-forward fashion
      - Target station does not have to be online when the message is sent
      - When the target does come back on line, the message(s) can be retrieved then


TDMA burst center
CACH burst center
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CACH
Payload
SYNC or embedded signalling
Payload
SYNC or embedded signalling
Payload
CACH
Q & A
Timeslot 1
Timeslot 2
2,5 ms
30,0 ms
30,0 ms
TDMA frame