DMR

Danny KN4BEM

Blue Ridge Amateur Radio Society (BRARS)

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What is DMR? Wikipedia definition:

- **Digital Mobile Radio** is:
- “Open standard”
- digital radio
- Defined by ETSI standard (European Telecommunications Standards Institute)
- DMR is one of the main technologies achieving 6.25 kHz-equivalent bandwidth
  - P.25 Phase II and NXDN are the other main competitors
  - DMR and P.25 Phase II use a 12.5 kHz channel split into two time slots
  - NXDN uses discrete 6.25 kHz channels
- Uses the **proprietary** AMBE+2 vocoder
  - “Vocoder” is an audio codec designed for voice
- DMR has become popular within the Amateur Radio community due to:
  - relative lower cost and complexity compared to other commercial digital modes

Comparing DMR with other digital modes

- **DMR**
  - Codec: AMBE+2 codec
  - Modulation: C4FM TDMA
- **Fusion**
  - Codec: AMBE+2 codec
  - Modulation: C4FM FDMA
- **D-STAR**
  - Codec: AMBE (Older codec, been around longer)
  - Modulation: GMSK (similar to GSM)
- **NXDN** / Kenwood Next Edge
  - Similar to D-STAR
  - Kenwood also makes DMR radios but not sold in US.

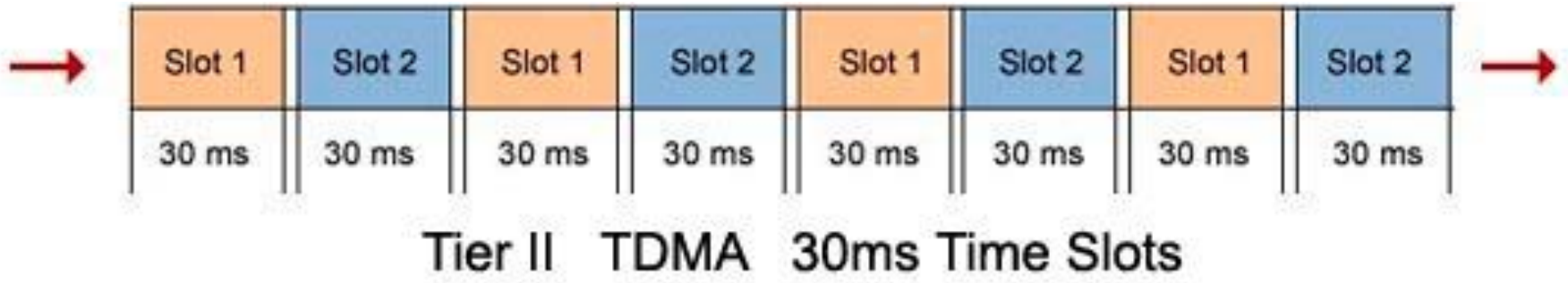
Types of DMR (DMR "Tiers")

- **Tier I** – single channel specification (published in 2005)
  - Originally for the European dPMR 446 service
  - Supports peer to peer (Mode I), repeater (Mode 2), and linked Repeater (Mode 3) configurations
  - Has been expanded to more than just unlicensed 446 spectrum

- **Tier II** – 2 slot TDMA peer to peer and repeater Mode specification (published in 2005)
  - IP Site Connect (IPSC) for interconnecting repeaters over the internet
  - **Amateur Radio primarily (exclusively?) uses Tier II**
  - The rest of the presentation refers to DMR Tier II

- **Tier III** – Builds on Tier II, adds trunking (published in 2012)
  - Not typically used in amateur radio

Time Slots



- **TDMA** (Time-division multiple access) is a *channel access method* for *shared-medium networks*
  - It allows several users to ***share*** the same frequency channel by ***dividing*** the signal into different *Time Slots*
  - Users transmit in rapid succession, one after the other, each using its own time slot
  - This allows multiple stations to share the same *transmission medium* (e.g. radio frequency channel) while using only a part of its *channel capacity*
- The signal is divided into alternating 30ms slices known as *Time Slots*
  - This allows two signals to interweave on the same frequency, so:
  - **Two different conversations can take place independently, at the same time, and on the same frequency**
- (This is very similar to T-carrier/SONET used to multiplex 24 channels on a T1/PRI, 28 channels on a DS3, etc.)

http://www.miklor.com/DMR/DMR-Tier1-2.php
https://en.wikipedia.org/wiki/Time-division_multiple_access

Talk Groups

- Talk Groups (TG) are a way for groups of users to share a Time Slot (one-to-many) without distracting and disrupting other users of the Time Slot
- Talk Groups can be local (single repeater only) or networked (multiple repeaters connected to each other or to a larger network)
- Multiple Talk Groups can be configured on a Time Slot, but:
  - Only one Talk Group can be active/using a Time Slot at a time
- If your radio is not programmed to listen to a Talk Group, you will not hear that Talk Group's traffic*
- (You can think of TGs as similar to CTCSS in analog: If someone is transmitting with a tone of 88.5 and you're set to receive 118.8, you won't hear their transmission, even though it's using the same frequency)

https://www.dmr-marc.net/media/Amateur_Radio_Guide_to_DMR_Rev_I_20150510.pdf

Talk Groups

- Talk Groups can be Static or Dynamic:
  - **Static**: Talk Group is active all the time
  - **Dynamic**: Repeater connects to Talk Group when needed
- Different Talk Groups for different purposes:
  - **Calling**: Used to initiate contact (think of this as 146.520 on 2m FM)
  - **Tactical**: Used for talking
- Can have **local** Talk Groups just for your repeater
- TGs can be bridged between multiple networks or even multiple modes:
  - DCI Bridge between MARC and BM DMR networks
  - DCI Fusion Link for interconnection with D-STAR

Talk Groups

- **Dynamic** Talk Groups: PTT-activated
  - A way to talk across a wide area without tying up every repeater
  - If Time Slot isn’t in use, kerchunk to connect
  - Stay active ten or fifteen mins after last key up
  - If time slot is in use, you can't key up on another talk Group
    - Can set up Rx Group to hear everything on time slot; if you don't hear anything, TS isn't in use
- **Tactical** Talk Groups
  - “TAC 310” – “TAC” means Tactical, and “310” means Talk Group 310
  - There are several TAC groups available, depending on what network your repeater is on
  - Use a TAC group to talk to another ham on a different repeater without tying up dozens/hundreds of other repeaters or even multiple DMR networks
    - Only the repeaters with that TAC group activated are linked together
  - These Talk Groups are not for calling, they are a *destination* for talking
  - To be used after making contact on a wide area/calling TG (such as SC Call or North America)
    - or via another mode of communication (text message/email) or by way of a schedule.
  - Must kerchunk to connect to it

Code Plug: Channel Configuration

- When configuring a channel, you set:
  - Tx/Tx frequencies
  - Time Slot
  - Talk Group
  - Color Code

- For repeater operation, each of these settings must match the repeater’s configuration
  - If not, when you PTT you’ll get an error tone

Advantages over analog

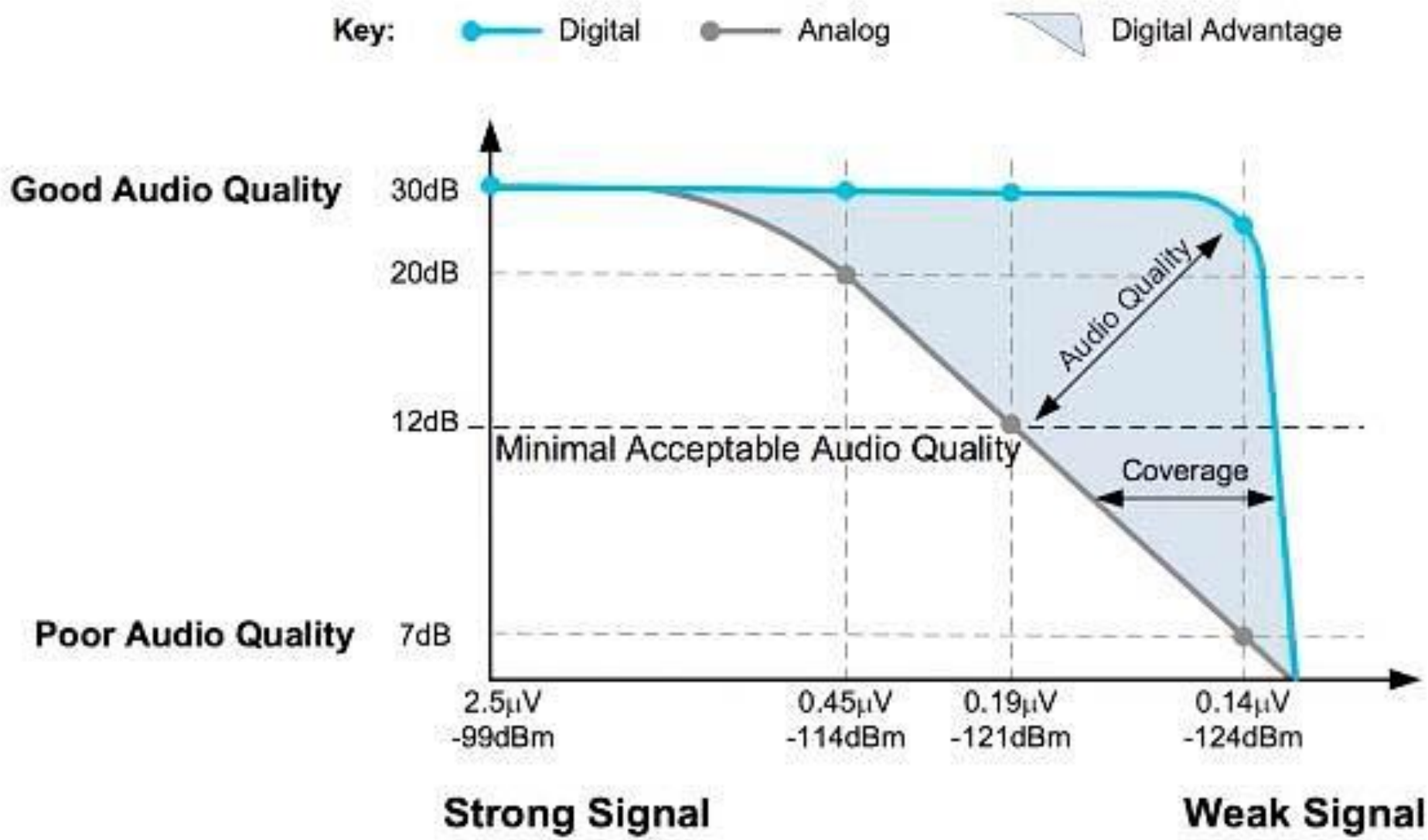
- Incoming calls can display calling ham's call sign, name, county, state, and country
  - Every ham has a unique ID (like a phone number)
  - Some hams have multiple (if they have multiple radios operating at the same time)
  - ~100k DMR IDs in Amateur Radio worldwide. Every contact can be programmed into even a cheap $85 radio.

Display:

- Trunk Group (27500)
- DMR ID (3138660)
- Callsign (KM4RGX)
- Name
- City
- State
- Country

DMR Advantages over analog

- Audio quality
  - No background noise or static
  - No squelch tail/tail tone/roger beep
  - Digital compression
- DMR maintains audio quality over a greater difference
  - Forward Error Correction accounts for a certain amount of lost data
  - At the limits of distance, audio does become garbled, then cuts off completely
- FM audio quality degrades somewhat more “gracefully”
- When you PTT, if repeater isn’t reachable (or config is wrong), you’ll get error tone



http://www.miklor.com/DMR/DMR-Analog.php

DMR Radio Basics

- Front-Panel Programming: Commercial radios cannot be programmed from the radio itself, per FCC regulations
  - Some radios can be configured via PC software to allow FPP
- 40+ manufacturers of DMR radios
  - Competition drives price down
  - Other digital modes typically have one (or two) manufacturers (and thus higher price)
- Most radio manufacturers provide free software (except Motorola)

How to get started with DMR

- Learn about DMR activity in your area
  - UHF or VHF?
- Choose a radio:
  - Dual-band (or UHF only, though 2m FM is awfully handy!)
  - Tier II-compatible
    - Some cheap Baofeng/Btech and Radioddity radios are NOT compatible! Read specs & reviews CAREFULLY!
  - 100k contacts
  - Optional: GPS (IMO, this isn't valuable without analog APRS)
  - Optional: APRS
  - Optional: DPRS (APRS over DMR. Doesn't seem especially useful at this time.)
  - Optional: DMR roaming
- Example radios:
  - TYT MD-UV380 ($85) – Be sure to get the ***UV***380
  - Anytone D868UV or D878UV (~$220) – APRS &DPRS, DMR roaming
  - There are MANY others! Many manufacturers! Compare prices, features, and reviews
  - Highly recommend LifeFromTheHamShack.tv

TYT MD-UV380


CAUTION
MD-UV380 USER'S MANUAL
DMR


434.42500
145.52500
Zone1
25/07/2018 03:28:26
Menu

AnyTone D868UV

How to get started

- Sign up for DMR ID when you buy your radio – https://www.radioid.net/register

- Decide your approach:
  - Start with an existing code plug (from SC HEART, from a friend, or from me) – Get started right away. Harder to edit if you don't understand how code plugs are built.
  - Build code plug from scratch – IMO, best way to learn. Takes patience.

DMR Networks

- **MARC** – Motorola Amateur Radio Club
  - First to use DMR for Amateur Radio in the US
- **BrandMeister**
  - Newer, with some interesting features.
- **SC HEART**
  - Local Talk Group
  - Statewide Talk Groups for emergencies
  - [Only DMR repeaters I’m aware of in the area, so presentation focuses here]
- **NC PRN** – North Carolina Private Repeater Network
  - Accessible via SC HEART system
  - Covers NC, SC, and parts of adjacent states

DMR Networks

- Repeater owners have come together and built networks that cover different areas of the world.
- Example networks: DCI, NorCal, PRN, DMR-IL, GeorgiaDMR, and MIT
- These groups have agreed to use DMR-MARC as the central registration point and therefore DMR-MARC handles the ID numbers for the radios.

SC HEART & NC PRN

- SC HEART has UHF DMR repeaters, in addition to VHF and UHF FM repeaters
- The SCHEART DMR repeaters are integrated with the NCPRN network
  - The wide area talk group covers South Carolina, North Carolina, and parts of adjacent states
  - Local talk group (time slot 1) and a wide area talk group (PRN time slot 2)
  - Stations on the local talk group hear only local traffic, while stations on the PRN talk group will hear any traffic on the multi-state network
- Additional talk groups are available that share time slot 1 on a dynamic basis
  - If a user keys one of the dynamic talk groups, that talk group shares time slot 1 with local
  - Several dynamic talk groups are available, including “tactical” channels:
    - English worldwide
    - North America
    - DCI BrandMeister, which provides interoperability with D-STAR and Fusion systems
    - Echo Test – Good way to test your radio: repeats your audio back to you

Simplex

- In professional side of DMR, Talk-Around refers to operating simplex on a repeater output channel
  - Allows direct communication while still being able to here the repeater
  - Allows users to directly contact other users listening on the repeater output frequency
- Amateurs typically use dedicated simplex frequencies (such as 444.000) so as not to interfere with repeaters
  - Use TG 99, CC 1, and TS 1
  - Would be surprised the distance you can talk on DMR simplex

Definitions

- DMR = Digital Mobile Radio
- ETSI = European Telecommunications Standards Institute
- TDMA = Time-division multiple access
- AMBE+2 = Advanced Multiband Excitation
- Vocoder = Audio codec designed for voice
- FEC = Forward Error Correction – Audio codec designed for voice
- CC = Color Code (similar to CTCSS/DCS)
- TG = Talk Group
- TS = Time Slot
- CPS = Customer Programming Software
- Code Plug = Configuration file for your digital radio
- IPSC = IP Site Connect

References & Resources

I “borrowed” much of this presentation from several resources listed here. Many thanks to the hams who created these resources:

- LiveFromTheHamShack.tv / Jason KC5HWB
  - Highly recommend his videos!
  - DMR Presentation at the M.A.R.S. Club in Texas
  - How to Write a DMR Codeplug / N0GSG Contact Manager Demo
- DMR Tier I vs. Tier II – http://www.miklor.com/DMR/DMR-Tier1-2.php
- DMR vs. Analog – http://www.miklor.com/DMR/DMR-Analog.php
- SC HEART page
  - Frequencies & Talk Groups – https://scheart.us/repeater-system-frequency-talk-groups/
  - DMR Article by Matthew Littleton, KN4SWB – https://scheart.us/dmr-article-by-matthew-littleton-kn4swb/
- NC PRN Last Heard – https://ncprn.net/last-heard/
- http://dmr-marc.net/
- Amateur Radio Guide to DMR – http://www.trbo.org/docs/Amateur_Radio_Guide_to_DMR.pdf

Possible future programs: Intermediate Topics

- Promiscuous Mode, Receive Groups, and Scanning
  - Can monitor all TGs on a single TS
  - lets you listen to anything on that time slot without changing the knob on your radio
  - Rx Groups are per TS
  - (Scan works across Time Slots)
- Using CPS to program your radio / create Code Plugs from scratch
  - Create Contact with TG
  - Create Channel (associate Contact with TS, CC, and Frequency)
  - Create Zone (group multiple Channels together)
- N0GSG Contact Manager
  - Converting Code Plugs to different formats (for other radios)
  - Mass updating channels
  - Creating multiple zones

Advanced Topics – Learn these yourself, then you can present!

- C-Bridge – Gateway between repeater and the Internet/worldwide IP network for DMR
- DMR Roaming
- Sending GPS location
- Data channels
- APRS over DMR (DPRS)
- DMR text messaging

Skunk Works projects

- DMR hotspot
- Establish a weekly DMR net

Possible future programs

- DMR Part 2
  - Q&A with Alex K4BAN
- Radio programming
  - Code plugs (building from scratch / editing existing)
  - DMR ID database and uploading to radio
  - RepeaterBook & RFinder
  - CHIRP & RT Systems
- EchoLink & IRLP

Questions? Feedback?

If you have questions or feedback, email me at KN4BEM@ARRL.net