• Originally designed for the commercial market
• Has advantages and disadvantages for Amateur Radio use
• Open source system, anyone can design and build DMR radio equipment
• DMR initially can be difficult to wrap your head around because as Amateur Radio operators we aren’t familiar with the terminology used and how it all goes together
Here is your brain on analog:
Here is your brain on Digital Mobile Radio:
What is Digital Mobile Radio (DMR)?

- A European Telecommunications Standards Institute (ETSI) standard first ratified in 2005 and is the standard for “professional mobile radio” (PMR) users. Motorola designed their MotoTrbo line of radios based upon the DMR standards.
- Meets 12.5kHz channel spacing and 6.25kHz regulatory equivalency standards.
- Two slot Time Division Multiple Access (TDMA).
- 4 level FSK modulation.
- Cutting edge Forward Error Correction (FEC).
- Commercial ETSI/TIA specs mean rugged performance and excellent service in RF congested urban environments (no intermod and other RF “hash”).
- Equipment interoperability is certified by the DMR Association.
DMR Tier 1 - Unlicensed

Tier 1 is a single channel specification originally for the European unlicensed dPMR 446 service. The standard supports peer-to-peer (mode 1), repeater (mode 2) and linked repeater (mode 3) configurations. The use of Tier 1 standard has been expanded into radios for use in other than the unlicensed dPMR 446 service.
DMR Tier 2 – Conventional DMR

Tier 2 is 2-slot TDMA 12.5KHz peer-to-peer and repeater mode specification, resulting in a spectrum efficiency of 6.25KHz per time slot. Each time slot can carry voice and/or data, depending on system needs. Most amateur radio implementations of DMR are using voice on both time slots.
DMR Tier 3 - Trunked

Tier 3 builds upon Tier 2, adding trunking operation involving multiple repeaters at a single site. Not all manufacturers' trunking implementation is Tier 3 compatible. Vendor specific protocols have expanded the trunking to multiple site operations.
How many users in Ohio?

There are approximately 2695 registered users in the database for Ohio. (5353 – California, 3499 – Florida, 3278 – Texas)

There are currently just over 53,047 registered users in the US and over 117,119 worldwide.

This database is available from the [AmateurRadio.digital website](http://amateurradio.digital/)

Using the Digital Contacts Wizard
Are we growing?

You betcha...

In the last 30 days 1796 new DMR ID’s have been assigned and 88 new DMR repeaters have been added.

In the last 7 days 386 new DMR ID’s have been assigned and 25 new DMR repeaters have been added.

There are currently 109 DMR repeaters listed in the database for Ohio and over 5600 DMR repeaters worldwide.
Superior Audio Performance

• DMR digital technology provides better noise rejection and preserves voice quality over a greater range than analog, especially at the farthest edges of the transmission range.

• One of the reasons for this increase in performance is due to the effort put into the FEC and CRC coders when developing the standard. Receivers can detect and automatically correct transmission errors by analyzing the FEC bits inserted into the message packets enabling the radio to tell if there is an error. The DMR standard specifies more than 14 encoding and decoding techniques that are applied to the digital signal.

• Using these, and other techniques, digital processing is able to screen out noise and re-construct signals from degraded transmissions, allowing users to hear everything much clearer.
Range Improvement with Digital

![Graph showing the improvement of audio quality with digital technology. The graph plots signal strength against audio quality, illustrating the coverage area where digital technology offers improved performance over analog.]
Timeslots (TS)

- DMR (Tier 2) utilizes 2 separate timeslots, called TS1 and TS2.
- Each timeslot is independent from the other meaning both can be used at the same time with no interference from each other.
- TS2 is typically reserved for wide-area operation, while TS1 is typically more localized. But that is not always the case and it is left up to the repeater owner to decide what time slots are to be used for a talk group. Because of this you will need to find out what TS is used for a specific talk group on any given repeater.
- The radio transmits a very short burst on the time slot that it is using leaving “time” for the other slot to use. Since the transmitter is keyed for a very short duration as it sends the packet data an overall increase in battery life is also realized. In most cases up to 40% longer battery life than that of a traditional analog radio.
2-Slot TDMA
2-Slot TDMA vs Traditional System

Two-channel Analog or Digital FDMA System

- Repeater 1
- Combining Equipment
- Frequency 1
- Frequency 2

Two-channel Digital TDMA System

- Repeater
- Frequency 1

TDMA saves licensing and equipment costs by enabling the equivalent of two 6.25 kHz channels within a single licensed 12.5 kHz channel.

One call per repeater and channel
Radio Groups

Two calls per repeater and channel
Radio Groups
Color Codes (CC)

- DMR repeaters use Color Codes much like analog repeaters use CTCSS or DCS, you can think of a Color Code as nothing more than a digital PL tone.
- To access a DMR repeater, you must use the same CC as the repeater.
- There are 16 different CCs (CC0-CC15)
- The use of Color Codes is not optional on DMR repeaters.
- If the Color Code on your transceiver is not set correctly for the repeater you wish to use, you will not be able to access the repeater.
Talk Groups (TG)

• Talk Groups (TG) are a way for groups of users to share a time slot without distracting or disrupting other users of the time slot (one TS can have many TG’s).

• It should be noted that only one TG can be using a time slot at a time. This means that you can have access to dozens (hundreds) of TG’s per timeslot, but they will all be competing with each other for usage.

• You will always hear traffic on the TS and TG that you radio is programmed for and set on. If you want to monitor other TG’s on the same TS your radio must be programmed to listen for other TG traffic on that TS. (Group Lists allow you to hear all active TG’s on the repeater TS) If your radio is not programmed for a specific TG, you will not hear that TG’s traffic.
Talk Groups – the “network”

- There are 2 major “networks” in the US that carry the TG’s across the internet. The DMR-MARC network (rigid) and the Brandmeister network (open). There are also “C-Bridges” connecting them.

- Depending upon the network the repeater is connected to, the TG may have a different TG number.

- There are two different ways that repeaters are linked to TG’s, Full Time (FT or static) or Push To Talk (PTT or dynamic).

- FT: On a FT or static TG the repeater is always linked to the TG so anyone keying up on a FT group will “open” every repeater statically linked to that TG.

- PTT: In order to link a repeater to a PTT or dynamic TG you must first key-up on that TG which then links the repeater to that TG. So “kerchunking” is allowed and expected on DMR. By default PTT TG’s are linked on a repeater for up to 15 minutes of local inactivity.
TG Examples

- Local2 (TG2) ("cluster" connects all repeaters in a local city / area), always FT
- Local9 (TG9) (local to the repeater) always FT
- Statewide (usually FT on TS2, connects all repeaters in the State) – Ohio Statewide (TG3139)
- Regional (US is divided into 7 multi-state groups) – (MW TG3169)
- USA (TG3100)

- North America (D-MARC TG3) (BM TG 93) usually FT on TS1
- Worldwide English “WWE” (D-MARC TG13) (BM 913)
- Worldwide (D-MARC TG1) (BM TG91)
- TAC310 (TG310)...TAC319 (TG319) always PTT
- Parrot (D-MARC TG9998, Brandmeister TG9990)
- Cactus (TX, AZ, CA TG3185)
Programming a DMR radio

Because the DMR standard was designed to be a commercial system there is really no good way to program any DMR radio from the keypad. All DMR radios require some form of programming software and programming cable in order to properly program the device.

Additionally a DMR ID is required and transmitted. However this ID is **NOT** adequate for use as your FCC ID (amateur call sign) meaning that you must ID with your amateur call sign when using DMR, unlike System Fusion or D-Star.
Code Plugs

• A code plug is simply a radio's configuration file.
• Using your manufacturer's programming software, you configure the channels and operating parameters of a radio using a code plug file. This file is then uploaded to the radio.
• Building a code plug can take many hours, especially if you want to program hundreds of channels.
• You can find copies of configured code plugs on the internet for different models of radios. Search Facebook, Yahoo or Google Groups for various DMR groups. The ARRL Ohio Section has codeplugs for several different radio models, VHF, UHF and dual band.
What you need to do first...

• Before you can use the DMR network you MUST request, at no cost, a DMR ID

• This can be done through the website:

• Go to: **https://www.radioid.net** and at the top of the page click on “Register”

• Agree to the “Terms and Conditions” and click the green “Register” button

• Follow the instructions to register for a DMR ID
- Building a Codeplug, steps involved -

1. You must apply for a DMR ID. You will need to enter this ID into the “General Settings” section of your codeplug.

2. You must program a list of “Contacts” consisting of Talk Groups and Private Calls (other user ID’s) you want to connect to.

3. You must build a channel list of repeaters, or simplex frequencies you are going to use including its transmit and receive frequency, Color Code, Time Slot, and Contact.

4. You must build a list of “Zones” or memory banks with sixteen (16) channels per Zone using the channels you just created.

5. You should program a group of “Digital Receive Groups” with the channels you have added to each Zone.

6. You will need to update each channel in a Zone with the Digital Receive Group you created for that Zone.
Contact List

• A Contact List is a list of ID’s assigned either to a Talk Group or to a single user. When entering a new contact you will need to define the “Type” of contact, either All Call, Group or Private, the contact’s ID and how you wish the radio to react when that ID is heard.

• Update your user database from this site:
  AmateurRadio.digital
Channels

• Channels are how you program the repeaters or simplex channels that you want to use. In analog this is similar to entering the repeater information or simplex information into your radio, RX Freq, TX Freq, PL tone etc...

• For DMR the exact same holds true for TX and RX frequencies and PL tone (color code) except in addition you need you set which TS to use, scan list to use, group list to use, contact (talkgroup) to use and how you wish to access the repeater (admit criteria).
Zones

• DMR radios support Zones, a Zone is just a grouping of individual channels. Some radio models may limit the number of channels per Zone and the number of Zones allowed.
RX Groups

• All DMR radios allow you to configure RX Groups.
• On the repeater you can use RX Groups to monitor all talkgroups on a single timeslot by adding each Group Contact or Group Call to an RX Group.
• A typical RX Group may contain the following:
  • Local
  • Statewide
  • Regional
  • Simplex
Scanning

• All DMR radios support channel scanning. However you will ONLY hear traffic on the frequency, time slot, and talkgroup that you have programmed for that channel.

• Scanning is S...L...O...W... and consumes a lot of battery power.

• Scanning is good for analog or digital simplex, or to scan multiple repeaters but is really not necessary for talkgroup scanning, that is what Group Lists are for.
Simplex

On the professional side of DMR, *talk-around* refers to operating simplex on a repeater output channel.

- This allows direct communication while still being able to hear the repeater.

- This allows users to directly contact other users listening on the repeater output frequency.

• Amateurs typically use dedicated simplex channels so as not to interfere with repeaters.
Simplex - Amateur

• The amateur DMR community has published a list of recommended simplex frequencies:

UHF
1. 441.000
2. 446.500
3. 446.075
4. 433.450

VHF
1. 145.790
2. 145.510

• Use TG99 / CC1 / TS1 / Admit Criteria: Always or In Call Criteria: TX or Always
DMR Radios

- Alinco
- Anytone
- Aselsan
- Avtec
- BFDX
- Celetra
- CML Microcircuits
- Connect Systems
- DAMM
- Eastcom
- EMC Romulus
- Entropia
- Excera
- Flyde Micro
- Haige Communication
- Harris
- HQT
- Hytera
- JVC Kenwood
- Kirisun
- Kydera (KYD)
- Lishing Fujian
- Motorola
- OMSK
- Puxing
- Quanzhou Keci
- Radio Activity
- Radiodata
- RCA
- Rexon Technology
- Samhoo
- Selex ES
- Simoco
- Tait
- Tytera (TYT)
- Vertex Standard
- Wouxon
- Yantong
- Zastone
- Zetron
- ZTE
DMR Hotspot - DVMega

The DVMega Raspberry Pi radio hotspot is a module that you can install on your RPi directly. The module has a modem and 10mW transceiver that will allow you to do D-Star, DMR and System Fusion directly from your home network.
DMR Hotspot - openSpot

The openSpot by SharkRF (Tallin, Estonia) is a standalone radio IP gateway/hotspot that currently supports D-Star and DMR or Yaesu C4FM cross modem modes. Talk with your System Fusion radio on DMR or with your DMR radio on System Fusion.
Jumbo Spot (China Spot)
MMDVM
Zumspot
Nano-Spot
BlueDV - BlueStack
DV4 Home
Brandmeister

https://brandmeister.network
ARRL Ohio Section web site:
www.arrl-ohio.org (go to What’s Inside / DMR)
Amateur Radio Guide to Digital Mobile Radio:
Building a code plug how-to:
References

http://www.radioshop.com/upgrade-to-digital/

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