DMR and Digital Voice Modes

Presented by N7MOT – Lenny Gemar

Amateur radio began with spark gap transmitters, evolving to Morse code and analog voice communications, all originally in the Low Frequency (LF) and High Frequency (HF) bands. Since those early days, many new modes, both analog and digital have been developed. These modes now span from the Very Low Frequencies (VLF) to the Extra High Frequencies (EHF).

This presentation is designed to acquaint amateur radio operators with the Digital Mobile Radio or DMR format of digital audio communications, used primarily in the VHF and UHF bands. We'll briefly discuss the other four Common Air Interface formats (CAI) before diving into the specifics of DMR.

DMR and Digital Voice Modes

Digital Voice Modes used in Amateur Radio Interconnected Systems

- D-Star – Digital Smart Technologies for Amateur Radio (FDMA)
- Wires-X/System Fusion - Wide-coverage Internet Repeater Enhancement System (FDMA)
- NXDN (IDAS/NEXEDGE) – Icom/Kenwood Collaboration (FDMA)
- DMR – Digital Mobile Radio (TDMA 2-TS)
- P25 (Phase 1) – Project 25 or APCO P25 (Phase 1 FDMA, Phase 2 TDMA 2-TS)
- TETRA - Terrestrial Trunked Radio, formerly known as Trans-European Trunked Radio (TDMA 4-TS) No known U.S./Canada amateur deployments.

DMR and Digital Voice Modes

Digital Voice Modes used in Amateur Radio Interconnected Systems.

Repeaters in service as reported by RepeaterBook.com on 8/14/2017 @ 12:00 PDT

for the U.S. and Canada.

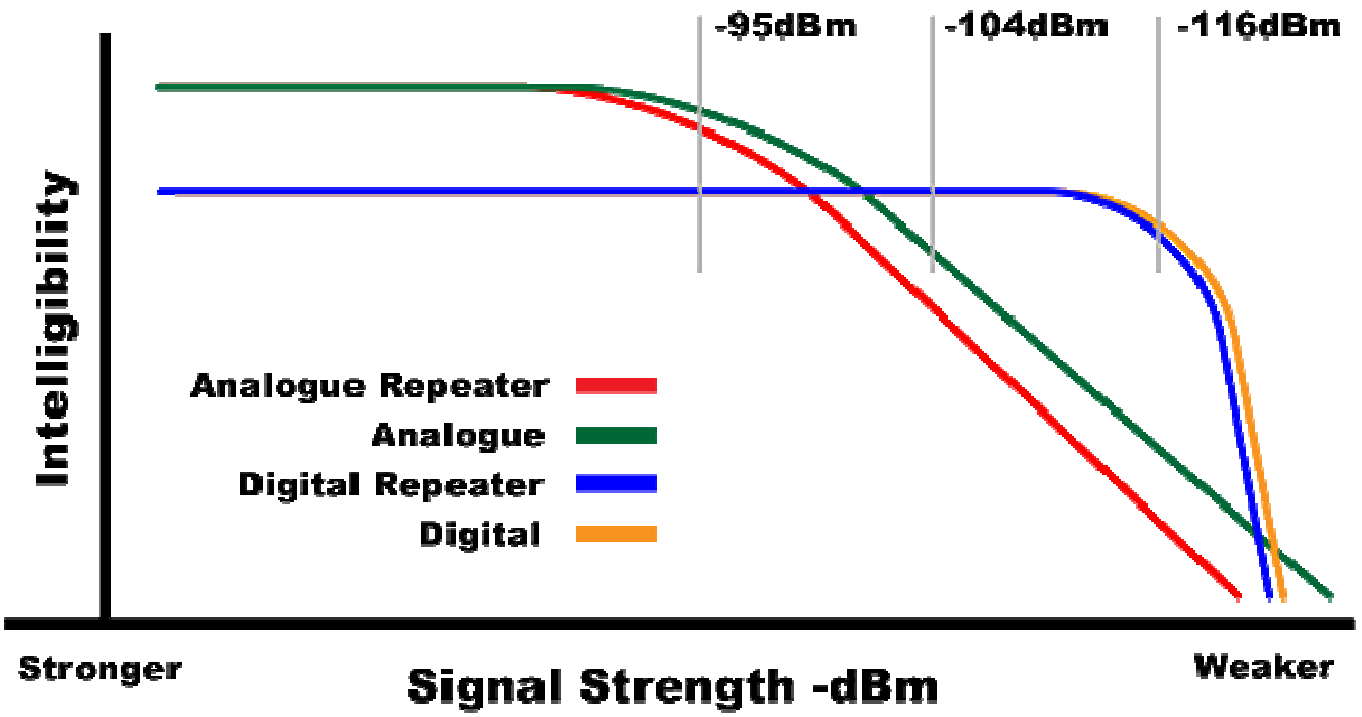
# of Repeaters	System Type
1,165	DMR
1,143	D-Star
314	Wires-X/Fusion*
248	P25
93	NXDN

**** Notes***

- *There are over 1,500 System Fusion repeaters listed in Repeater Book. This table only counts the number of repeaters that are interconnected.*
- *As our focus is on U.S. and Canada, the TETRA European format is not included.*
- *As Repeater Book allows user self-maintenance, its accuracy is always suspect.*

DMR and Digital Voice Modes

Signal Strength vs Audio Quality Comparing Analog to Digital



DMR and Digital Voice Modes

FDMA (Frequency Division Multiple Access) and **TDMA** (Time Division Multiple Access) technologies are used in P25 and in business and industrial digital radios (FDMA for P25 Phase I & NXDN™; TDMA for P25 Phase II & DMR).

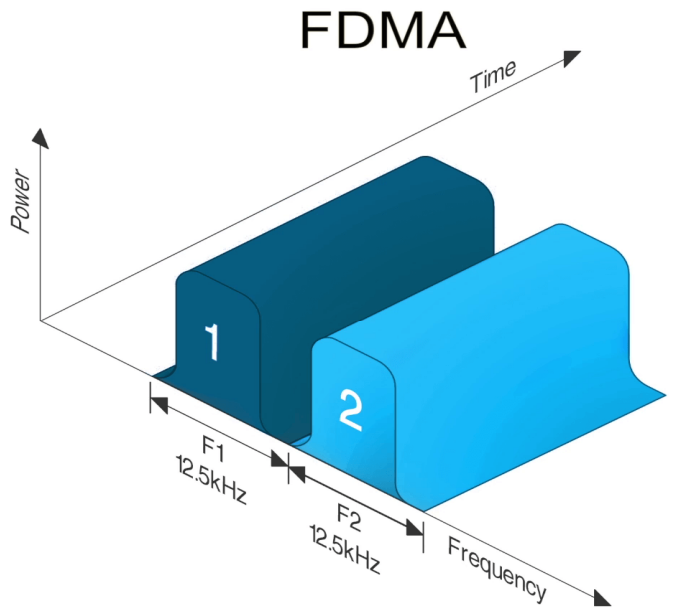
The basic difference between **FDMA** and **TDMA** is the definition of a channel and how it is used.

In **FDMA**, a particular bandwidth (e.g. 12.5 kHz) at a particular frequency (e.g. 150.000 MHz) is used to define a channel.

This is the way channels have been allocated in analog land mobile radios (**LMR**) for decades. All information is contained in the channel – compressed to the smallest frequency footprint. Analog radio bandwidth has recently shrunk from 25 kHz to 12.5 kHz in the commercial radio bands, which is about the limit for analog technology without seriously degrading radio voice quality. With digital technology, channel bandwidth can be compressed to a spectrum-efficient 6.25 kHz by using vocoders and error correction.

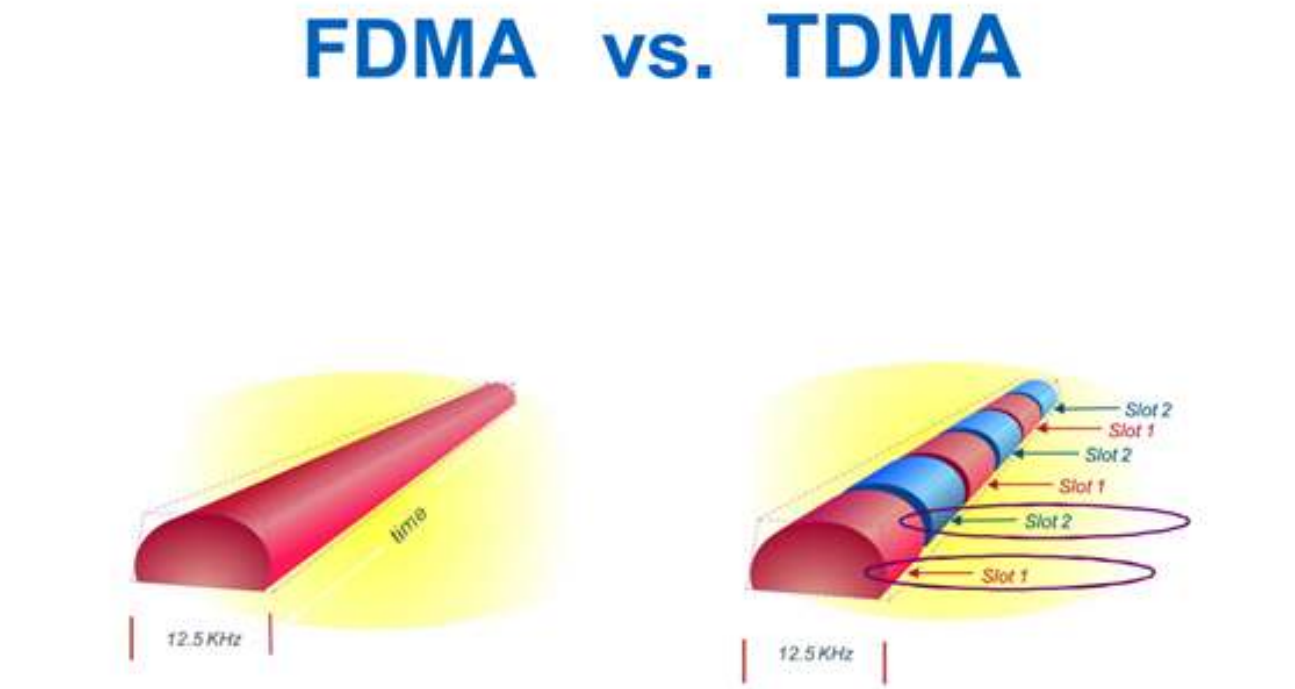
DMR and Digital Voice Modes

The basic difference between **FDMA** and **TDMA** is the definition of an RF channel and how it is used. In **FDMA**, a particular bandwidth (e.g. 12.5 kHz) at a particular frequency (e.g. 150.000 MHz) is used to define an RF channel.

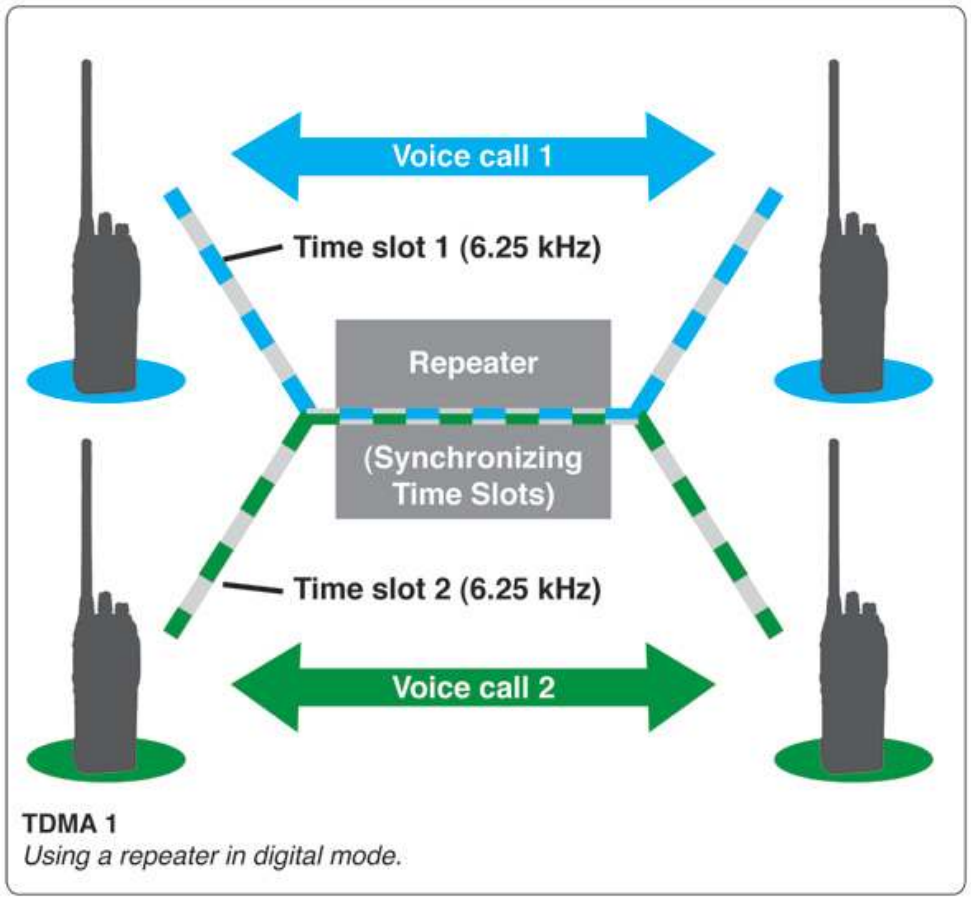


DMR and Digital Voice Modes

In regard to TDMA and digital technology, the 12.5 kHz RF channel bandwidth is maintained. The RF spectrum efficiency is achieved when two voice channels share time to create a 6.25 kHz equivalency. TDMA technology is possible only by using intelligent infrastructure to make and control the time slots.



DMR and Digital Voice Modes



TDMA 1
Using a repeater in digital mode.

DMR and Digital Voice Modes

Digital **M**obile **R**adio (DMR) is an open digital mobile radio standard defined in the **E**uropean **T**elecommunications **S**tandards **I**nstitute (ETSI) Standard TS 102 361 parts 1–4 and used in commercial products around the world.

Tier II DMR occupies 12.5Khz of channel space and is a two "slot" TDMA-based system that uses an AMBE+2 vocoder. This same vocoder is used in Yaesu Fusion radios.

DMR, along with P25 phase II and NXDN are the main competing LMR technologies in achieving 6.25 kHz equivalent bandwidth using the proprietary AMBE+2 vocoder. DMR and P25 II both use two-slot TDMA in a 12.5 kHz channel, while NXDN uses discrete 6.25 kHz channels using Frequency Division (FDMA).

DMR and Digital Voice Modes

DMR Definitions

- **Color Code** – A number that denotes a specific repeater when two or more repeaters have overlapping coverage areas. Normally "1". This is somewhat like a repeater requiring PL.
- **Time Slot (TS)** – Any particular conversation will be on either TS1 or TS2. This is determined by the repeater owner/system operator. This allows two simultaneous conversations.
- **Talk Group (TG)** – A specific voice conduit or channel routed through the repeater and to the Internet. There are hundreds currently in use, based on geography or special interest.
- **Zone** – Think of these as banks of memory channels. Subscriber radios allow you to divide analog channels and digital TGs into groups for easier access. Most radios are limited to 16 channels/TGs per zone. In DMR, the terms "channels" and "TGs" are often used interchangeably.

DMR and Digital Voice Modes

DMR Definitions cont.

- Radio ID – A unique decimal ID number allocated per user/radio and assigned by DMR-MARC.net. Unlike D-Star, you cannot use your callsign as your Radio ID so you must vocally ID as on any other analog channel.
- Code Plug – This is a generic term for the programming in the radio. Originally, code plugs were actual memory modules or chips that were programmed external to the radio and then inserted. Today you can program a code plug without opening the radio, generally using your computer USB port and a cable to the radio's microphone jack or accessory connector. Most area DMR groups provide a repository of code plug files or images for your use.

DMR and Digital Voice Modes

DMR Definitions cont.

- TG Types – A repeater owner has the ability to determine (through the system server) the priority and accessibility of TGs. There are two TG types: Static and Dynamic.
  - Static – A static TG is always enabled, available for use. If there is activity on that TG anywhere across the system, it will be transmitted out that repeater on its assigned TS. This type is also known as Full-Time (FT).
  - Dynamic – Also known as Part-Time (PT), it is only active if someone on the repeater has keyed up on that TG. These TGs will normally time-out, turning off after a defined period of no local activity. On some repeaters, they may also be commanded on/off with an MCT (Master Control Talk group).

DMR and Digital Voice Modes

DMR Subscriber Radios

As DMR is an international ETSI standard, there are a host of manufacturers providing subscriber radio equipment, both **portables** and **mobiles**. The most abundant radios on our DMR networks are manufactured by **Tytera, Hytera, Connect Systems (BFDX),** and **Motorola**. Other manufacturers include Kenwood, RCA, and Vertex Standard, though it may be more difficult finding pre-made codeplugs for these latter manufacturers.

IMPORTANT NOTE - Due to the complexity in configuring DMR radios, Front Panel Programming (FPP) is generally not available, unlike analog VHF and UHF ham radios. Don't let this scare you away, however. Just treat this as if the radio could only operate from memory channels rather than rotating a frequency dial. You've probably grown used to programming your radio using Chirp, so this won't be much different.

DMR and Digital Voice Modes

DMR Tier II Subscriber Radios - Portables

Tytera
MD380
~$100

Tytera
MD2017
Dual-Band
~$220

CSI
CS-580
~$130

Hytera
PD-782
~$720

Motorola
XPR-7550
~$700+

DMR and Digital Voice Modes

DMR Tier II Subscriber Radios - Mobiles

CSI
CS-800
Single Band
~$280

CSI
CS-800D
Dual-Band
~$400

Hytera
MD782
Single Band
~$740

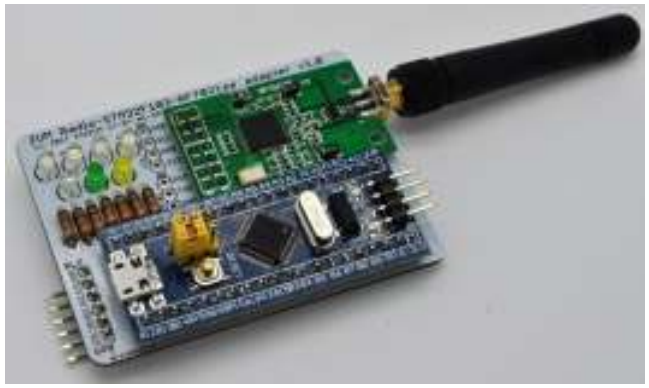
Motorola
XPR-7550
Single Band
~$600+

DMR and Digital Voice Modes

Hot Spots, or when you aren't in range of a repeater.

A hot spot allows you to access DMR TGs that either may not be available on your local repeater, or when you are not in range of any repeaters.

New products and methods are invented nearly daily, so I'll only touch on the MMDVM and RF Shark Open Spot, which are just two of the most popular methods.



DMR and Digital Voice Modes

Now What? Steps to Getting Started.

1. Purchase a radio. Be sure it is a Tier II compatible radio.
2. Procure your radio ID from **DMR-MARC.net**. It's free, but may take a day or two to get to you. You only need one per person, not one per radio.
3. While waiting for your radio to arrive, read all you can about DMR. 
4. Program your radio. The two inland northwest repeaters (Spokane and Coeur d'Alene) are included in code plugs available at http://www.pnwdigital.net/
5. Lenny, N7MOT is the local DMR Elmer for north Idaho. Feel free to contact him when you need personal help. Also listen to the PNW "Not-A-Net Gathering" Wednesdays @ 19:00 Pacific Time on TG PNW 2 (PNWR 2 if on a Brandmeister hot spot connection.)
6. Enjoy the DMR system.

DMR and Digital Voice Modes

Coeur d'Alene Blossom Mtn DMR Repeater - N7MOT 444.475 MHz - CC1

Talkgroup Matrix

TALKGROUP	BM	ZONE	CH	RX LIST	TG ID	TS	F/PT	TIMER
Local 1*		CDA DMR	1	1	3181	1	**F**	F/5
Local 2		CDA DMR	2	2	3166	2	**F**	F/5
Washington 1	BM	CDA DMR	7	1	3153	1	**F**	F/3
Washington 2		CDA DMR	8	2	103153	2	**F**	F/3
PNW 1		CDA DMR	5	1	3187	1	**F**	F/m
PNW 2		CDA DMR	6	2	103187	2	**F**	F/m
Idaho 1	BM	CDA DMR	3	1	3116	1	**F**	F/3
PNWR 2	BM	CDA DMR	9	2	31771	2	P	P15/m
MPRG1	BM	CDA DMR	10	2	31301	2	**P***	P15/m
SNARS	BM	CDA DMR	11	2	31328	2	P	P15/m
Montana 2	BM	CDA DMR	12	2	3130	2	P	P15/m
Oregon 1	BM	CDA DMR	13	1	3141	1	P	P15/3
Mountain Reg 2	BM	CDA DMR	14	2	3177	2	P	P15/m
Bridge 2	BM	CDA DMR	15	2	3100	2	P	P5/m
Parrot 1		CDA DMR	14	1	9998	1	P	P2/0

TALKGROUP	BM	ZONE	CH	RX LIST	TG ID	TS	F/PT
TAC 1	BM	CDA TAC	1	3	8951	2	P
TAC 2	BM	CDA TAC	2	3	8952	2	P
TAC 3	BM	CDA TAC	3	3	8953	2	P
TAC 310	BM	CDA TAC	4	3	310	2	P
TAC 311	BM	CDA TAC	5	3	311	2	P
TAC 312	BM	CDA TAC	6	3	312	2	P
TAC 313		CDA TAC	7	3	313	2	P
TAC 314		CDA TAC	8	3	314	2	P
TAC 315		CDA TAC	9	3	315	2	P
TAC 316		CDA TAC	10	3	316	2	P
TAC 317		CDA TAC	11	3	317	2	P
TAC 318		CDA TAC	12	3	318	2	P
TAC 319		CDA TAC	13	3	319	2	P
Audio Test 2		CDA TAC	15	3	9999	2	P

Local 1 - Linked to Local 1 on Spokane DMR Repeaters*
Local 2 - Standalone CDA-only Repeater
MPRG1 is PT but generally enabled
BM = Cross connected to Brandmeister Talkgroups
This sheet describes the creation of three zones, three RX group lists, 28 talk groups, and one scan list to access the CDA Blossom Mtn DMR repeat
Latest information always available at ***http://www.pnwdigital.net/***

Show and Tell and Questions

- Types of radios on display
- Initiating and answering a call
- Pausing for system setup, break-in traffic, and repeater ID (BSI)
- Changing Zones
- Netwatch – An informational diagnostic tool
- Accessing the DMR network via a "hot spot"
- Touring the PNW web site: http://www.pnwdigital.net/

DMR and Digital Voice Modes

References

There's a lot to learn and it can be daunting at first. Since we are in the Pacific Northwest, your best, first resource is the PNW web site at http://www.pnwdigital.net/. TG matrixes, TG usage guidelines, and sample code plugs are all readily available. Feel free to click around in the web site and learn all you can. You can't break it and I highly recommend bookmarking it.

Presentations by other DMR-supportive groups are on that web site as well, so you can learn more detailed information that couldn't be covered this evening. One particularly good presentation for new users is http://www.n4hsv.net/assets/digital-mobile-radio-(dmr)-intro.pdf. Just be aware that this one has some region-specific information not pertinent to the Pacific Northwest.

In addition to the PNW network, there are other DMR networks, the largest being Brandmeister. It is less controlled and will likely be what you connect through if you purchase a hot spot.