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Digital Mobile Radio

Dustin Thomas

Call: N8RMA

DMR ID: 1126134

Not an expert, just a fan.

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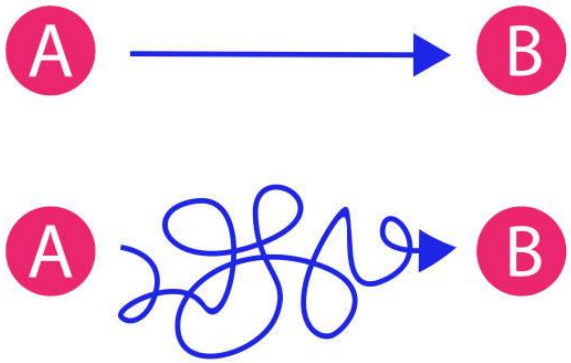
What we'll cover today

- What is DMR?
- DMR Characteristics
- Key terms & constructs
- Getting on DMR



Please, ask questions!
If I don't know the answer, I'll take it as an action and get back to you!

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What is DMR?

Digital Mobile Radio (DMR) was developed by the European Telecommunications Standards Institute (ETSI) as a digital radio communications standard.

Three Tier Standard

Tier I – dPMR446 service
Tier II – Current standard
Tier III – Adds trunking

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What is DMR to Amateur Radio?

A digital mode for use with HT's and mobile rigs that is:

- **F**un
- **C**heap
- **C**onvenient

With DMR you can:

- Talk around the world
- Report APRS data
- Easily make private calls
- Send SMS messages
- Avoid a second mortgage on your home

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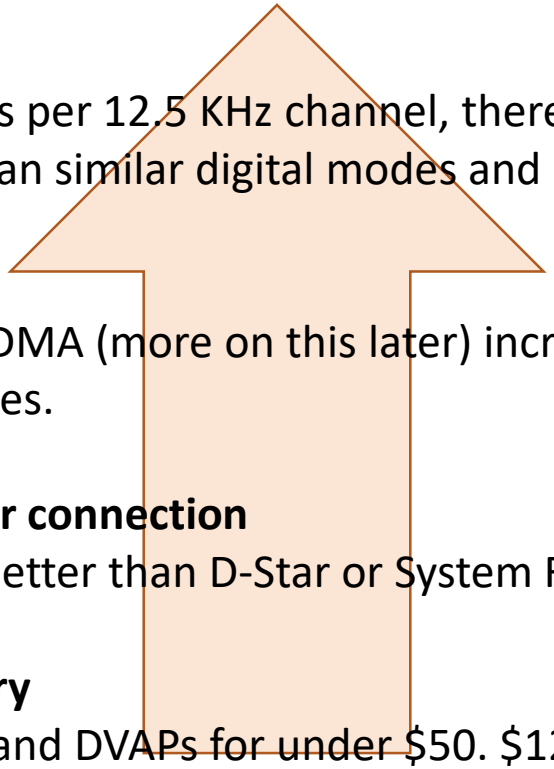
Why DMR?



Spectrum efficiency
With 2 distinct data streams per 12.5 KHz channel, there is more communication potential per bandwidth than similar digital modes and FM.

Power efficiency
Variable transmission via TDMA (more on this later) increases battery life by upwards of 40% for portables.

Receivable traffic with poor connection
Error correction is slightly better than D-Star or System Fusion.

Lower cost / barrier to entry
Handhelds for under $100 and DVAPs for under $50. $120 will get you on the air.

Wide availability
Commercially available radios and vast supply of fleet radios are available. DMR is manufacturer agnostic which helps availability.

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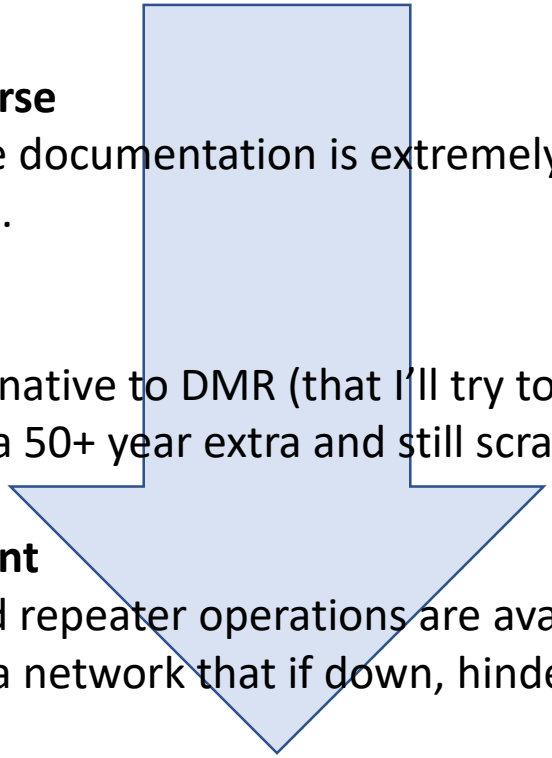
Why not DMR?



Documentation can be sparse
With many DMR radios, the documentation is extremely light and programming software can be unintuitive.

It's complicated
There are many constructs native to DMR (that I'll try to cover here) and there is a learning curve. You can be a 50+ year extra and still scratch your head.

It's infrastructure dependent
While simplex and standard repeater operations are available, the large majority is done through a network – a network that if down, hinders communication.

Another radio?
Yes, it's another radio but when did that ever stop us before? Plus, the right radio can be your new daily driver and might be bullet proof.

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Comparisons (D-Star, Fusion)

	DMR	D-STAR	System Fusion
Feature set	★ ★ ★	★ ★ ★	★ ★ ★
Cost	★ ★ ★	★	★ ★
Sound quality	★ ★ ★	★	★ ★
Ease of use	★	★ ★ ★	★ ★
Establishment	★ ★	★ ★ ★	★ ★
Interoperability	★ ★ ★	★	★ ★ ★

- D-Star is the most well established among amateurs, but is also the most expensive
- Fusion offers cheap repeaters, but uses DTMF commands with more artifacting
- DMR has the lowest barrier to entry, but can be complicated

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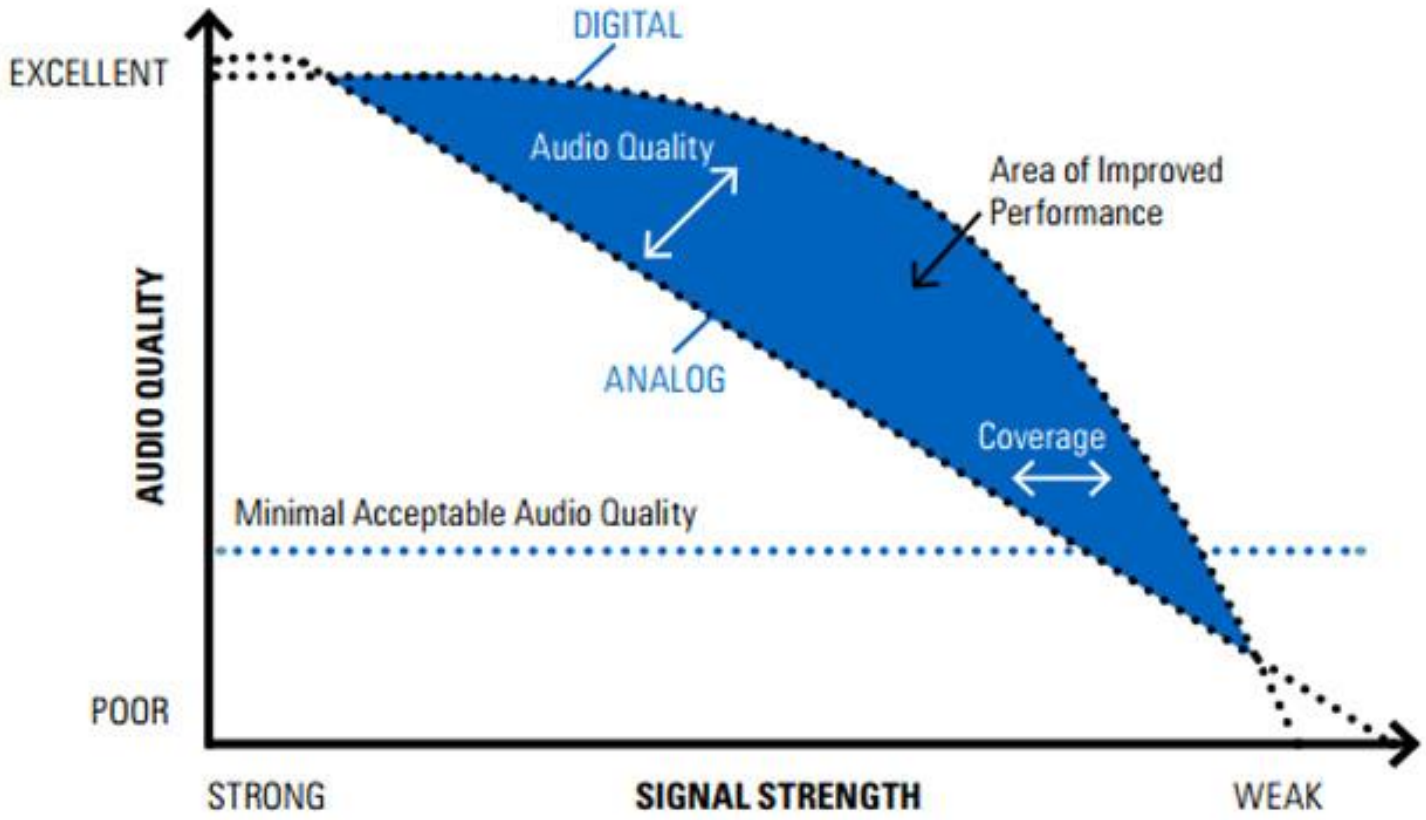
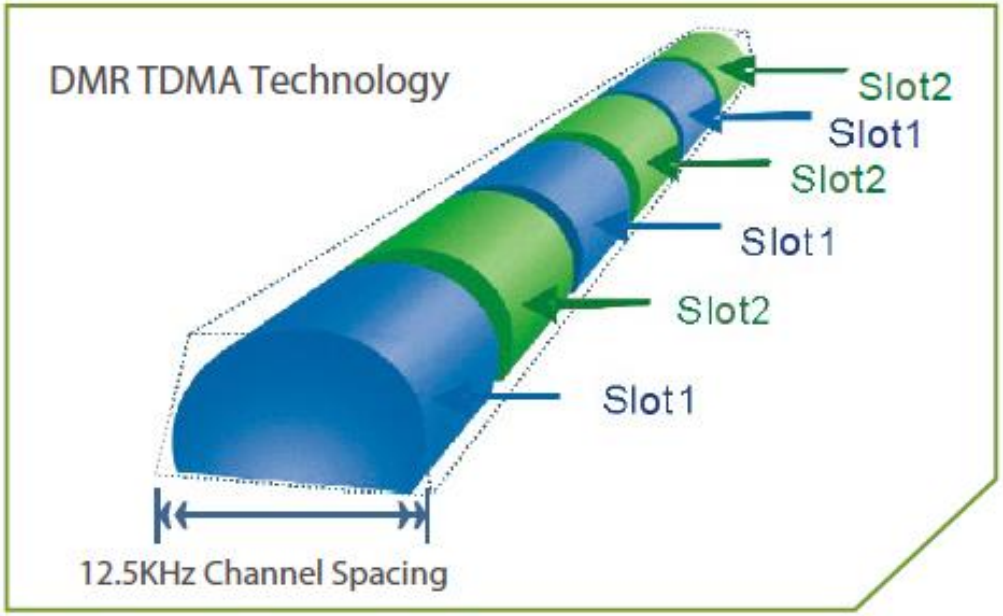
Digital Characteristics

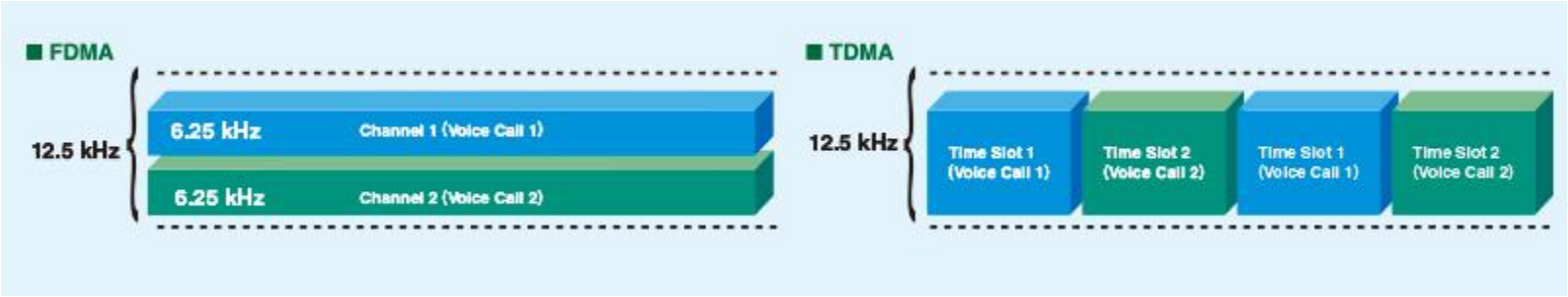


DMR Characteristics

- AMBE+2 encoder
- 4-state FSK modulation
- Digital xfer 9,600 bit/s
- 12.5 kHz channel spacing
- TDMA Technology

Time-Division Multiple Access
- 60ms timing structure
- 30ms per time slot





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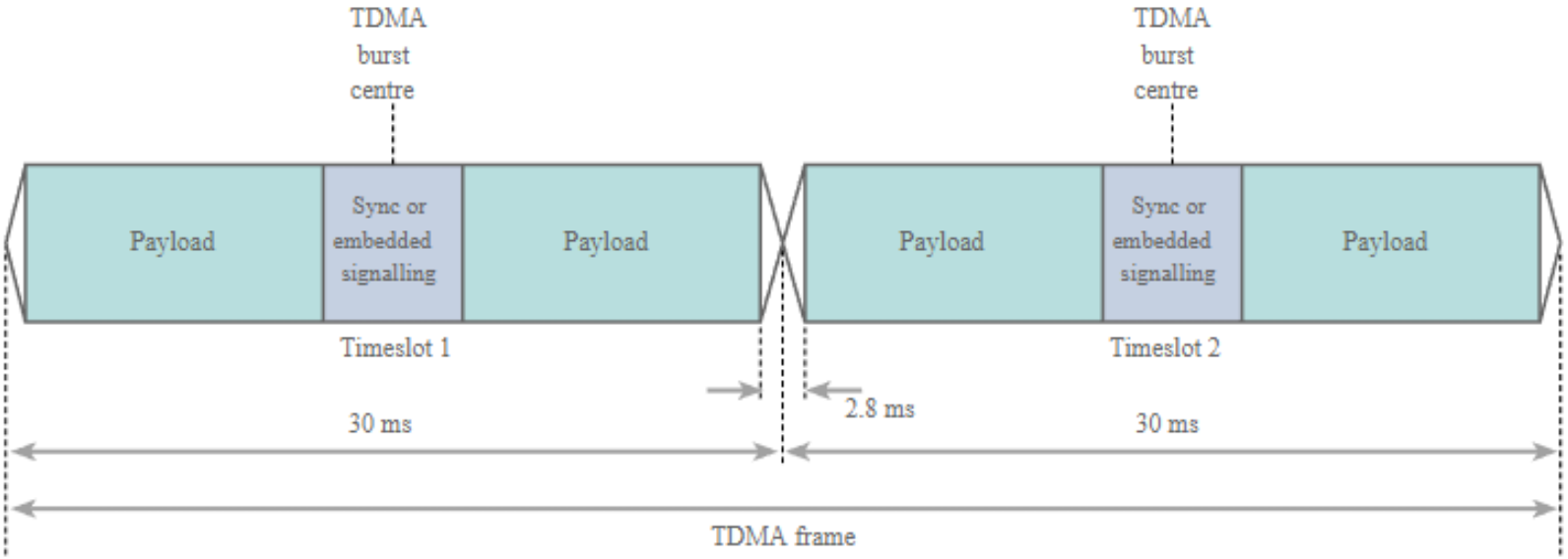
TDMA Frame

The frame is a 60ms section comprised of spacing, payloads and sync data.



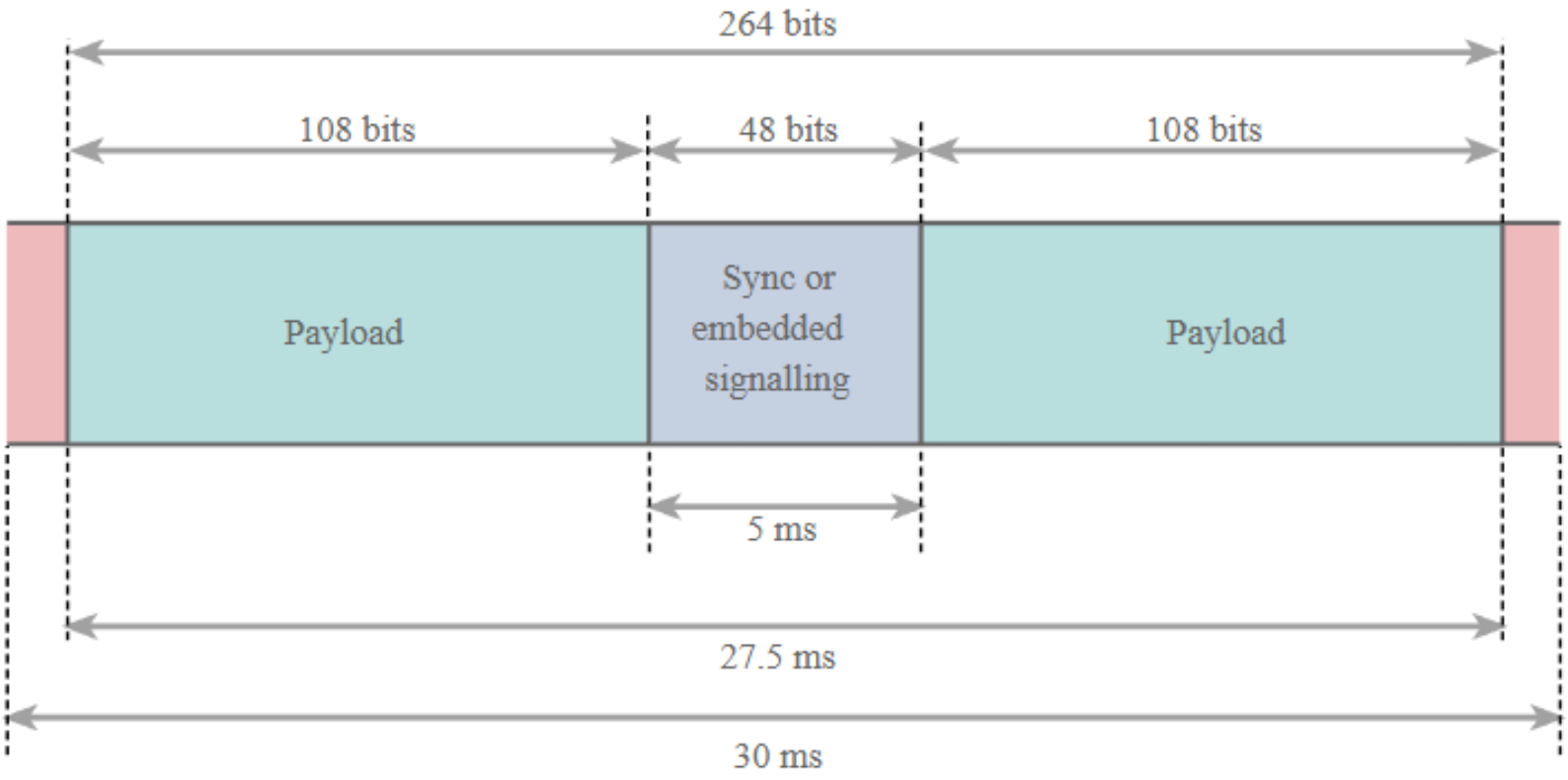
For reference:

33.36ms – one frame of a 29.97 FPS NTSC video

60ms – gear change on a Ferrari 458 Spider

120ms - the fastest blink of an eye

TDMA Timeslot



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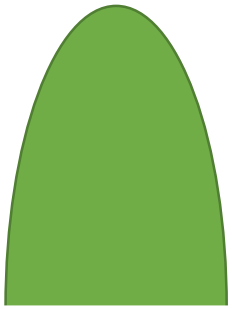
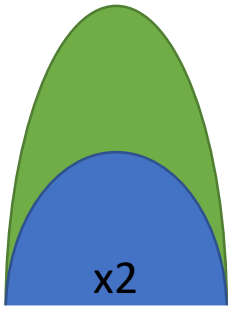
Spectrum Benefits

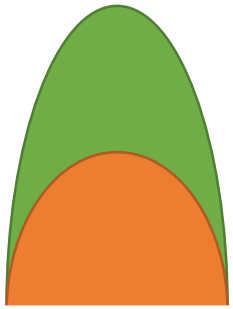
12.5 kHz Analog



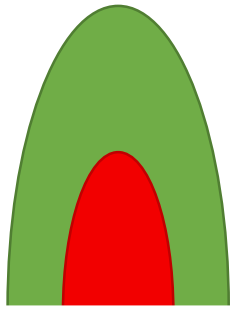
12.5 kHz TDMA



12.5 kHz FDMA



6.25 kHz FDMA



NFM

DMR – Amateur Radio Digital Mobile Radio Worldwide Networks

System Fusion

D-STAR

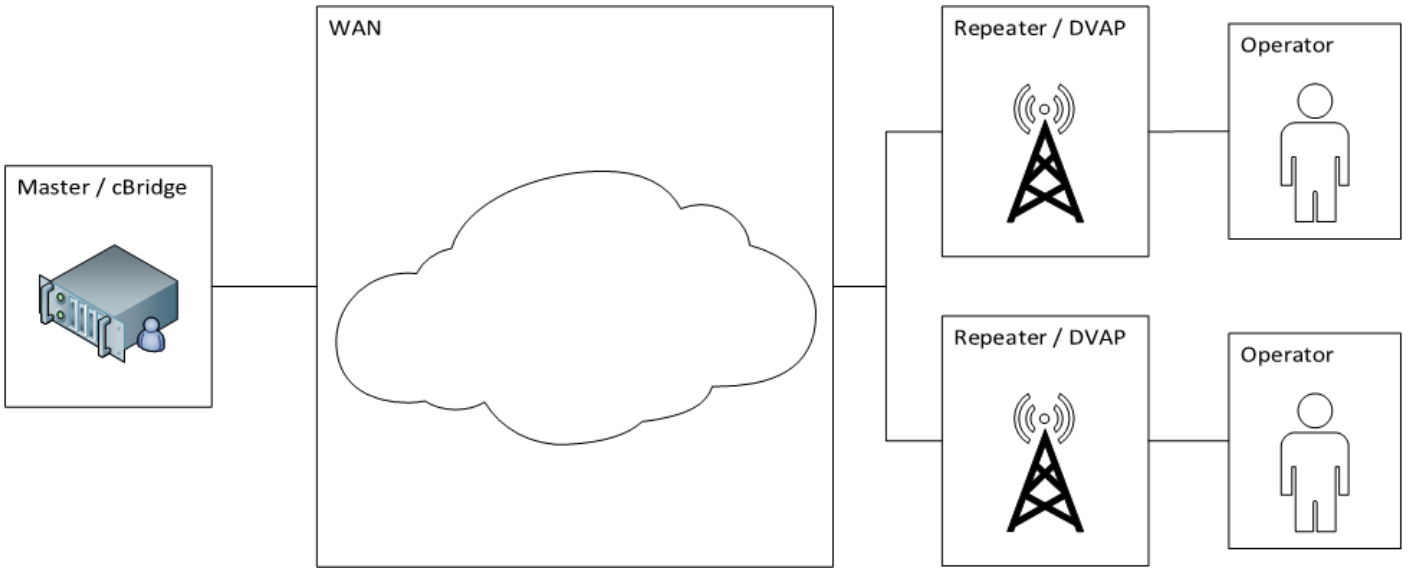
Due to spacing requirements, only 1 D-Star signal is possible per 12.5 kHz channel.

This makes DMR the most efficient of the 4!

DMR Networks

Networks are what make worldwide DMR communication possible:

- Connect operators from all over the world through infrastructure
- Servers and appliances that process and move the data
- Modeled after IP connected sites in the commercial space
- Many different networks, each system is individual



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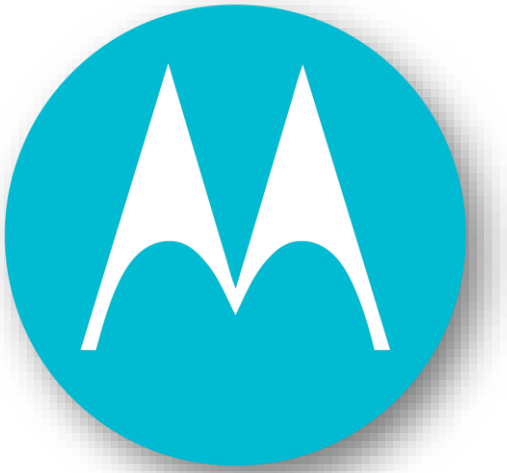
DMR-MARC

The oldest and original amateur radio DMR network:

- Motorola Amateur Radio Club
- Group of over 500 repeaters
- No messaging, or D-APRS
- Discourage experimentation
- Simple programming schema

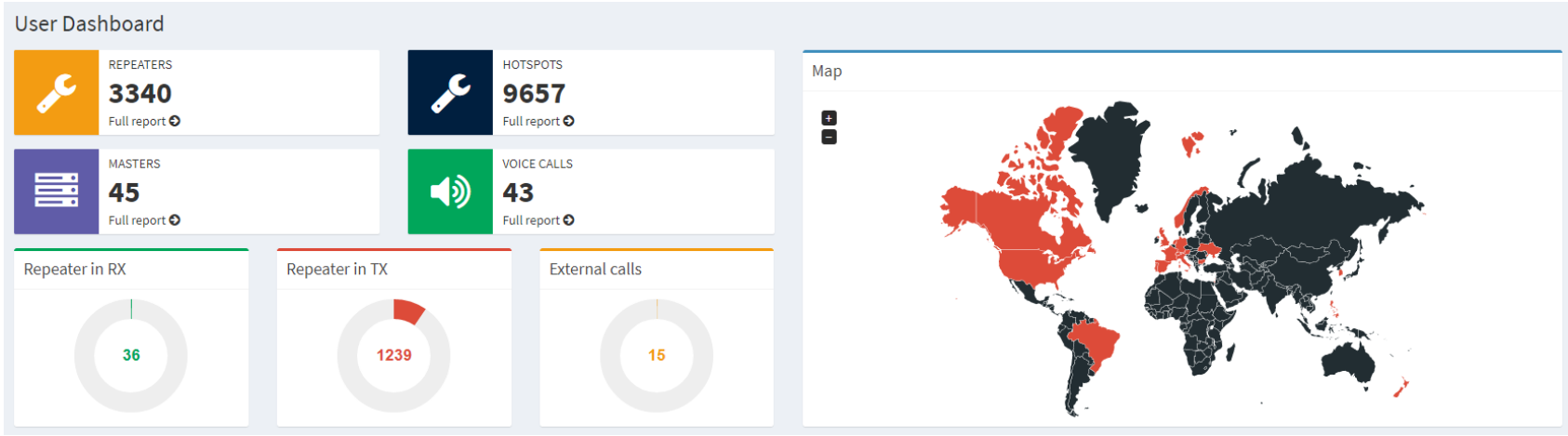


DMR-MARC
Motorola Amateur Radio Club Worldwide Network

BrandMeister

A splinter from DMR-MARC:

- Fastest growing DMR network
- Open to all radio types
- Encourage experimentation
- Dashboards and hoselines
- No DV4-mini support
- Infrastructure is less reliable under stress



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Other Networks

There are many other DMR Networks:

- TGIF
- K4USD
- DCI
- DMR Plus
- DMRX
- Chicagoland DMR
- Crossroads DMR

CMEN Mi5 System

Central Michigan Emergency Network – Mi5 System

- Michigan's largest digital voice network and first DMR network
- Uses IP SiteConnect and microwave to link repeater sites over the state
- 23 repeater sites across state of Michigan
- Limited linking to BrandMeister network

MICHIGANDMR Mi5

https://w8cmn.net/

Name	Talkgroup	BrandMeister
Mi5-STATEW1	51 (TS1)	31261
Mi5-STATEW2	52 (TS2)	31262
Mi5-EVENT1	53 (TS1)	31263
Mi5-EVENT2	54 (TS2)	
Mi5-EVENT3	55 (TS1)	31265
Mi5-EVENT4	56 (TS2)	

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Key Terms

- DMR ID
- Talkgroups (TG)
- Channels / Zones
- Time Slots (TS)
- Dynamic & Static
- Color Codes
- Admit Criteria
- Digital Contact List
- Codeplugs
- Promiscuous Mode
- Roaming / Beaconing

DMR ID

What is this DMR ID number?

- Identifies operators and repeaters to the network
- Routes traffic on behalf of operator or repeater
- Radios can be programmed with your DMR ID*
- Multiple hotspots require additional DMR ID's**

User Results: 22

Radio ID	CALLSIGN	Name	City	State/Prov	Country	Remarks
1126017	N8HQI	John P Phillips	Kalamazoo	Michigan	United States	DMR
1126018	AB8SP	Stephen Penix	Kalamazoo	Michigan	United States	DMR
1126036	K8LR	Robert H Tinney	Kalamazoo	Michigan	United States	CCS7
1126060	KD8NPV	Jeffrey R Romence	Kalamazoo	Michigan	United States	CCS7
1126363	KE8JVO	John J Vanoosterum	Kalamazoo	Michigan	United States	DMR
1126495	KE8ICM	Alexander J Stuart	Kalamazoo	Michigan	United States	DMR
1126570	KE8CBL	Barbara J Carmichael	Kalamazoo	Michigan	United States	DMR
1126572	KE8TJ	Jack L Koole	Kalamazoo	Michigan	United States	DMR
1126653	KE8HAA	Mark C Kerstetter	Kalamazoo	Michigan	United States	DMR
3100230	N8CM	David Weir	Kalamazoo	Michigan	United States	
3105949	KE8KOY	Andie Miller	Kalamazoo	Michigan	United States	DMR - HT
3122602	KC9LVT	Garrett Kaltenbach	Kalamazoo	Michigan	United States	DMR
3126017	KD8CJB	James Stewart	Kalamazoo	Michigan	United States	Mobile
3126852	KE8WGB	William Brown	Kalamazoo	Michigan	United States	DMR
3126864	K8IT	Neil Sablatzky	Kalamazoo	Michigan	United States	DMR
3126865	KJ8SEW	Kathy J Sablatzky	Kalamazoo	Michigan	United States	DMR
3126866	KJ8SEW	Kathy J Sablatzky	Kalamazoo	Michigan	United States	DMR
3126963	KD8NPV	Jeffrey R Romence	Kalamazoo	Michigan	United States	DMR
3128799	W8JVP	Ken Irish	Kalamazoo	Michigan	United States	DMR
3130348	N8YUI	Randy Tarantino	Kalamazoo	Michigan	United States	DMR
3131394	K8HB	John E Allgaier	Kalamazoo	Michigan	United States	DMR
3133722	N8YUI	Randy Tarantino	Kalamazoo	Michigan	United States	DMR

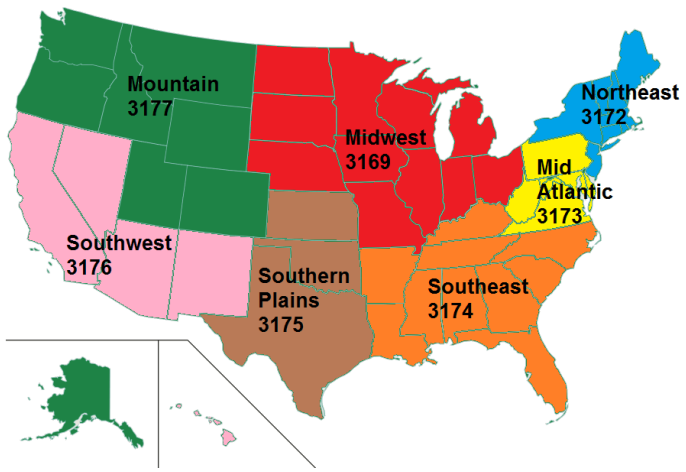
All DMR ID's are now centrally managed by RadioID.net

* Only 1 DMR ID is needed because it is assumed you are only using 1 radio at any given time.
** If running two hotspots concurrently, distinct ID's are required (e.g. DMRID01, DMRID02)

Talkgroups (TG)

What is a Talkgroup (TG)?

- Like a D-Star / Fusion reflector
- Are regional or topical in nature
- Identified by a unique number
- Can provide services:
  - APRS / parrot / disconnect
- Different among various networks



Talkgroup	DMR-MARC	BrandMeister	TGIF
Worldwide	1	91	114
North America	3	93	110
United States	311	3100	187
Michigan	3126	3126	318

BrandMeister | DMR-MARC | TGIF | K4USD

Channels & Zones

Channels

Memory entries on a radio. These are specific entries for a frequency, repeater input / output, talkgroups or private calls.

Zones

Channel groups on a radio. Used to sort channels into logical (or illogical) groups. Oftentimes each DMR repeater is a zone.

Zone 1
- Channel 1
- Channel 2
- Channel 3

Zone 2
- Channel 4
- Channel 5
- Channel 6

For DMR, channels must be in a zone!

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Channels & Zones

What does that look like in a realistic scenario?

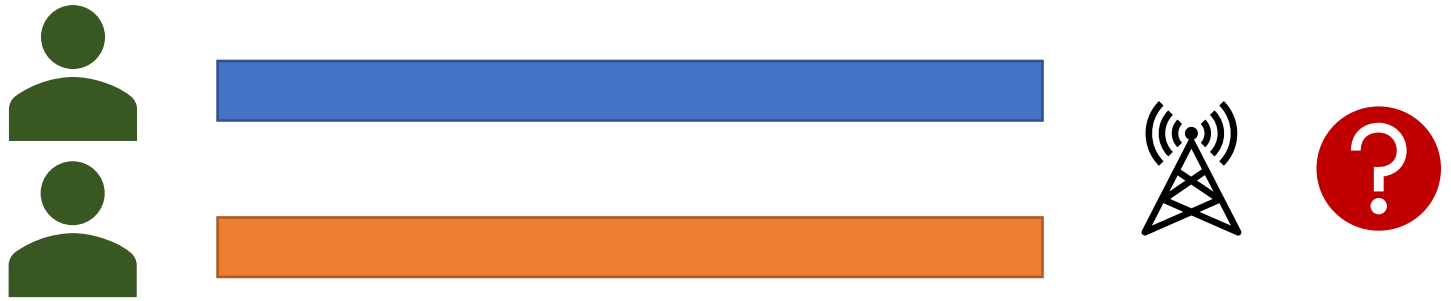
Zone	Channel	RX	TX	CC	TS	TG
Kalamazoo	Michigan	443.400	448.400	1	1	3126
	West Michigan	443.400	448.400	1	1	31269
	Local	443.400	448.400	1	2	9
	TAC310	443.400	448.400	1	2	310
	US Nationwide	443.400	448.400	1	2	3100
Detroit	Michigan	444.000	449.000	2	1	3126
	West Michigan	444.000	449.000	2	1	31269
	Local	444.000	449.000	2	2	9
	TAC310	444.000	449.000	2	2	310
	US Nationwide	444.000	449.000	2	2	3100

Time Slots (TS)

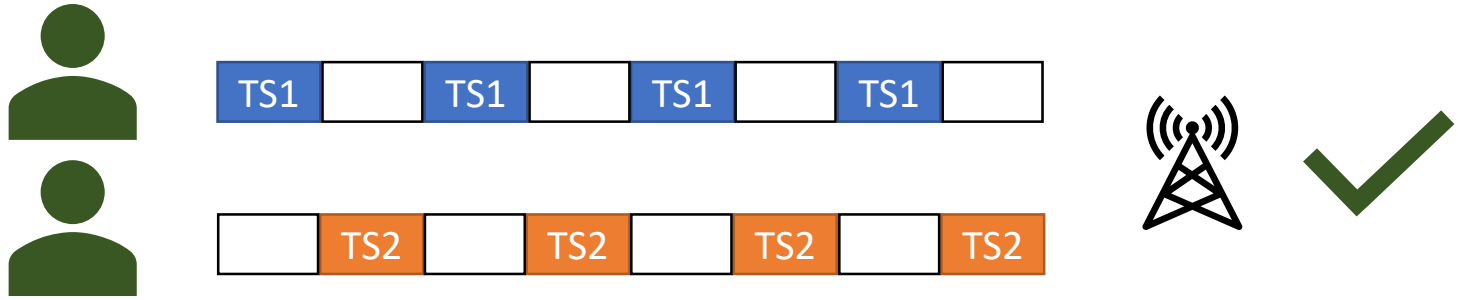
DMR has two time slots, cleverly named 1 and 2, based on TDMA.

A repeater or DVAP can send/receive two distinct data steams at the same time.

FM
D-Star
C4FM



DMR



Time Slot Management

DMR Repeaters may have special assignments for talkgroups and timeslots to better manage the repeater.

Repeaterbook is a good source of information, but sometimes you'll have to dig to find the information out.

Talkgroups: Open Talkgroup View

Assignment	TS	TG	Access
Michigan	1	3126	Full-Time
WMTG	1	31269	PTT
Local or Reflector	2	9	Full-Time
Worldwide English	2	91	PTT
North America	2	93	PTT
TAC 310	2	310	PTT
TAC 311	2	311	PTT
TAC 312	2	312	PTT
USA - Nationwide	2	3100	PTT
Illinois	2	3117	PTT
Indiana	2	3118	PTT
Kentucky	2	3121	PTT
Ohio	2	3139	PTT
Tennessee	2	3147	PTT
Midwest USA	2	3169	PTT

DVAPs can use different timeslots in much the same way as repeaters or more practically to monitor two different talkgroups.

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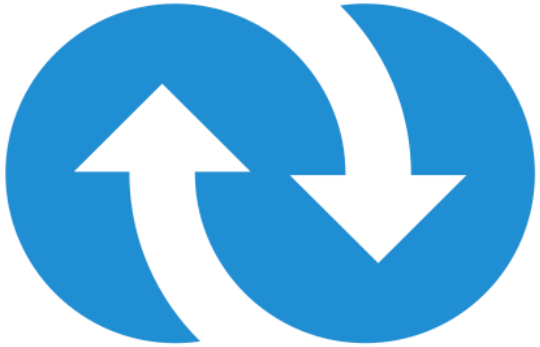
Dynamic & Static

Dynamic and static refers to how a talkgroup is configured on a repeater / DVAP:

Static – TG is “always on”

- Cannot be disconnected by users
- Easier to monitor talkgroup traffic
- Used to link repeaters in an area



Dynamic – TG must be activated

- Typically 15 minute, user activated
- Multiple dynamic TG’s can be active
- Can be disconnected by users
- Allows flexibility for repeater / DVAP

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Color Codes

What are color codes?

Color codes have nothing to do with a color.
In fact, it is a number between 0 and 15.

This is to DMR what **CTCSS** and **DCS** is to analog. Used when multiple repeaters have close or overlapping frequencies. Radio programming must match CC for a repeater or DVAP, otherwise it will be inaccessible.

The use of CC is **not optional** on DMR**.**

CC00	CC08
CC01	CC09
CC02	CC10
CC03	CC11
CC04	CC12
CC05	CC13
CC06	CC14
CC07	CC15

Admit Criteria

Determines when your radio will allow transmission.

Always
- When PTT is pressed, the radio will transmit
- Could interrupt a QSO
- Considered impolite, not recommended

Channel Free
- PTT will only transmit when there is no traffic
- Highly restrictive
- Not recommended

Color Code Free
- PTT will only transmit when the TS is available
- Considered to be “polite”
- Preferred option for amateur radio

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Digital Contact List

Unlike D-Star and Fusion, contact information is not sent digitally over DMR.

Because of this, many radio models have a digital contact list database, which will translate the DMR ID of the caller to their name, callsign, and location on screen. This database has well over 120,000 entries.

Some radios only hold a few, some 10k, with modern radios holding 100k+.

1126143
TG3126 CC1 TS1

Dustin A Thomas
N8RMA
Portage, Michigan
Michigan Statewide

AmateurRadio.digital

Codeplug

What is a codeplug?

- Programming file for a certain model radio
- Contains TG's, channels (color codes, TS), zones
- Can build your own from scratch
- Start with existing codeplugs and modify

Build Your Own

- Must add all TGs, channels and zones
- Must add the digital contact list database
- More time consuming
- More custom, greater control

Existing codeplug

- Download from source
- Must replace DMR ID with yours
- Typically programmed for an area
- Good to get started

Ohio Codeplugs | PAPA System Codeplug | K3NXU Codeplugs
MichiganONE DMR Net Codeplugs

Promiscuous / RX Groups

Listening to DMR traffic is not quite as straightforward as a FM system.

Promiscuous / Monitor Mode

Simplest and easiest way to listen.

With this mode, you can hear:

- Any talkgroup on frequency
- On single or dual time slot

Receive (RX) Groups

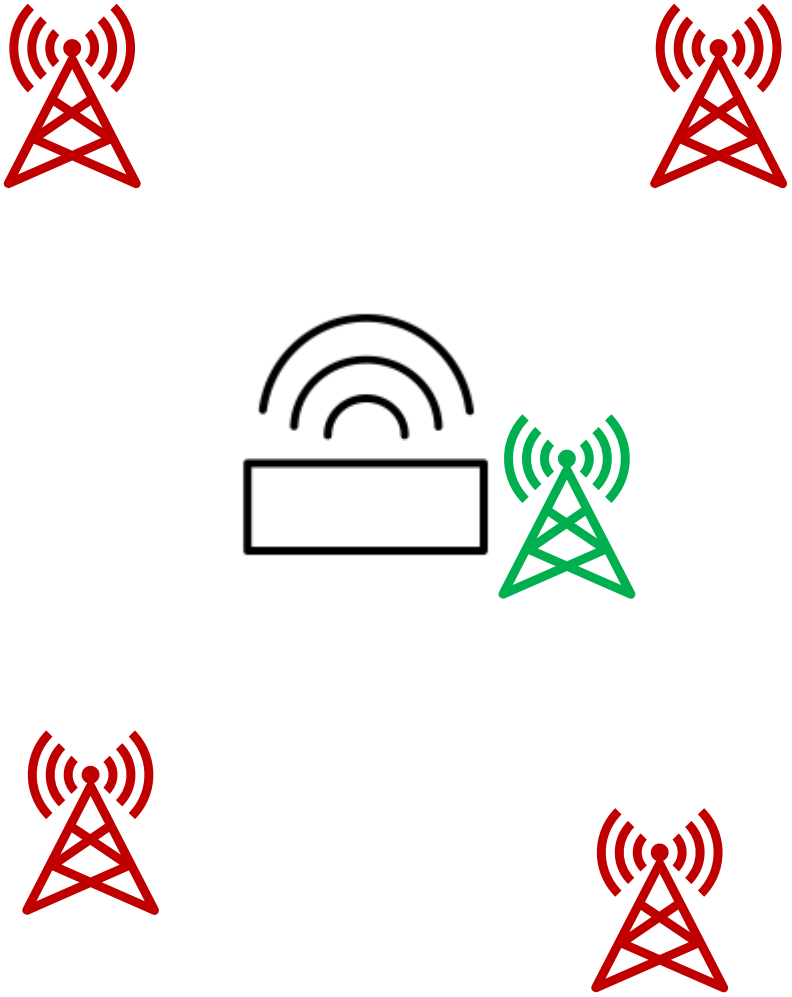
Greater flexibility and control.

With this mode, you can hear:

- Active talkgroups on the list
- On time slots for channels

Repeater ->	3100 (TS1)	91 (TS1)	3126 (TS2)	310 (TS2)
Normal Mode On 3100 (TS1)	✓	⊘	⊘	⊘
Promiscuous Mode	✓	✓	✓	✓
RX Group 3100 & 3126	✓	⊘	✓	⊘

Roaming / Beaconing



Roaming and beaconing is a feature that allows a radio to dynamically select the best channel based on **Received Signal Strength Indicator (RSSI)**.

This is helpful in areas where a group of repeaters are linked with the same TGs and TS.

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Key Terms

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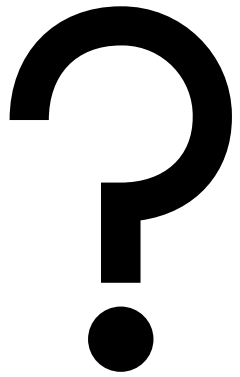

Getting on DMR

How does one get on DMR?

Step 1 – What you need:

- Amateur Radio License (any level)
- DMR ID from RadioID.net
- Access to a DMR repeater / DVAP
- A DMR capable radio

Step 2 – What to do:

- Read the manual a few times
- Program radio codeplug for:
  - DMR ID
  - Repeater / DVAP
  - Talkgroups
- Key up and have fun

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COTS / Consumer Radios

Radio	Cost
TYT MD-380 / UV	$80 / $95
TYT MD-2017	$155
TYT MD-9600	$275
AnyTone AT-868UV	$170
AnyTone AT-878UV	$218
Radioddity GD-77	$95
Ailunce HD1	$189
Baofeng DM-5R	$59
Baofeng DM-1801	$55
Retevis RT82	$156
Connect Systems CS580	$130

Fleet / Commercial Radios

Radio	Cost
Moto XPR6100	$100 - $155
Moto XPR6300	$200 - $400
Moto XPR6550	$150 - $300
Moto XPR7550	$300 - $550
Vertex EVX-261	$200 - $300
Moto XPR4550	$225 - $350

* Programming software for Mototrbo radios costs $180 every 3 years.

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What To Look For

Common comparison points:

- Screen or dial only
- Cost compared to interest
- Contact storage limit
- Dual or single band
- GPS / APRS capabilities
- CPS cost (Motorola)
- Ease / accessibility of programming
- Reviews from other DMR enthusiasts
- Channel and zone limitations

When in doubt, go cheap to try it out!

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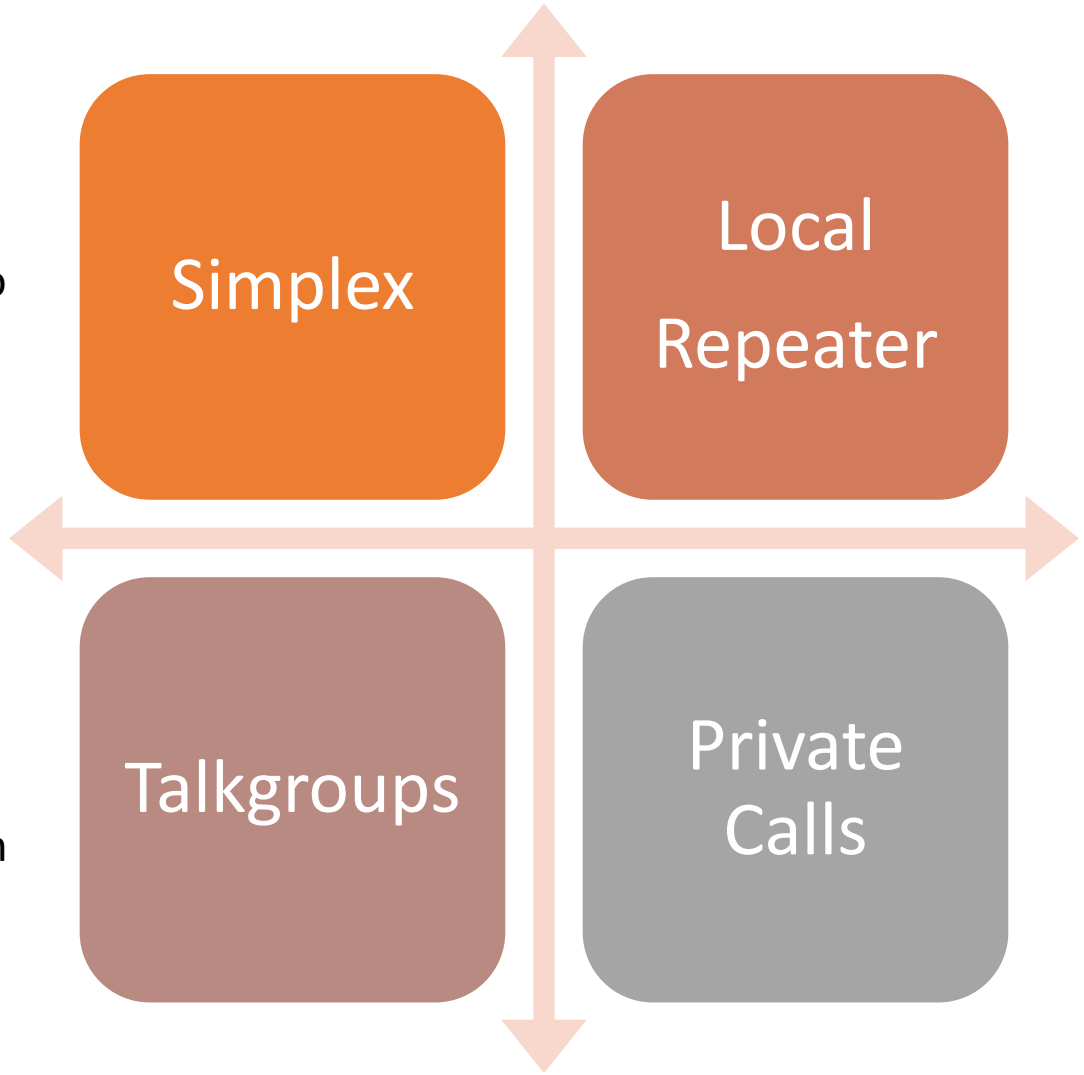
Making Contacts



Talk radio to radio

Talk locally on a repeater to those within range

Access static and dynamic TGs from repeater or DVAP

Direct to another DMR user via network

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Simplex

Simplex DMR operation is a great use of the mode and follows some standards:

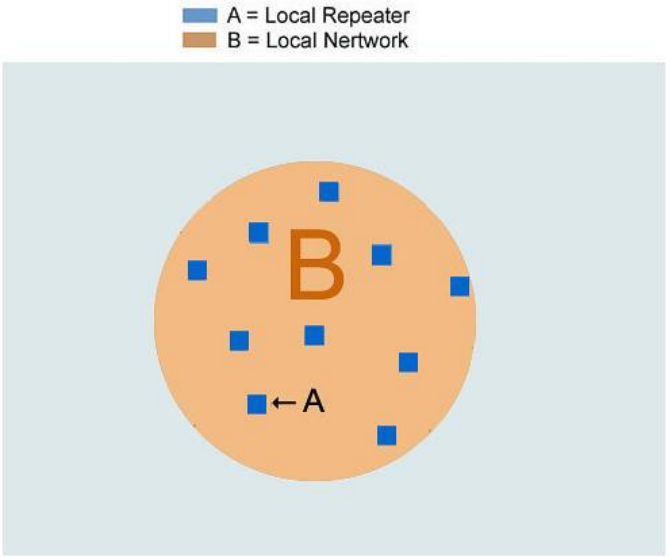
- Suggested frequencies
- Talkgroup 99
- Timeslot (TS) 1
- Color Code (CC) 1

Band	Frequency	Talkgroup	Timeslot	Color Code
VHF	145.790	99	1	1
	145.510	99	1	1
UHF	441.000	99	1	1
	446.500	99	1	1
	446.075	99	1	1
	433.450	99	1	1

Local Repeater

You can talk to local contacts on DMR, just as you would analog.

Local traffic is passed via the repeater, regional traffic via internet or microwave, extended via internet.



Number	Talkgroup	Network
1	Local	BrandMeister
2	Local / Network Cluster	BrandMeister
8	Regional	BrandMeister / DMR-MARC
9	Local Repeater	BrandMeister / DMR-MARC

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Talkgroup

Access to talkgroups can be done via repeater or DVAP.

TG	Name	Description
9	Local	Local repeater communications
91	Worldwide	Worldwide English
93	North America	Canada, US, Mexico
310	TAC310	US Tactical “10”, very active
3100	US Nationwide	Nationwide talkgroup
3169	Midwest	North Dakota, South Dakota, Nebraska, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Kansas, Michigan, Indiana, and Ohio
3126	Michigan One	Michigan Statewide chat
31269	West Michigan	Western side of Michigan

These examples are for BrandMeister

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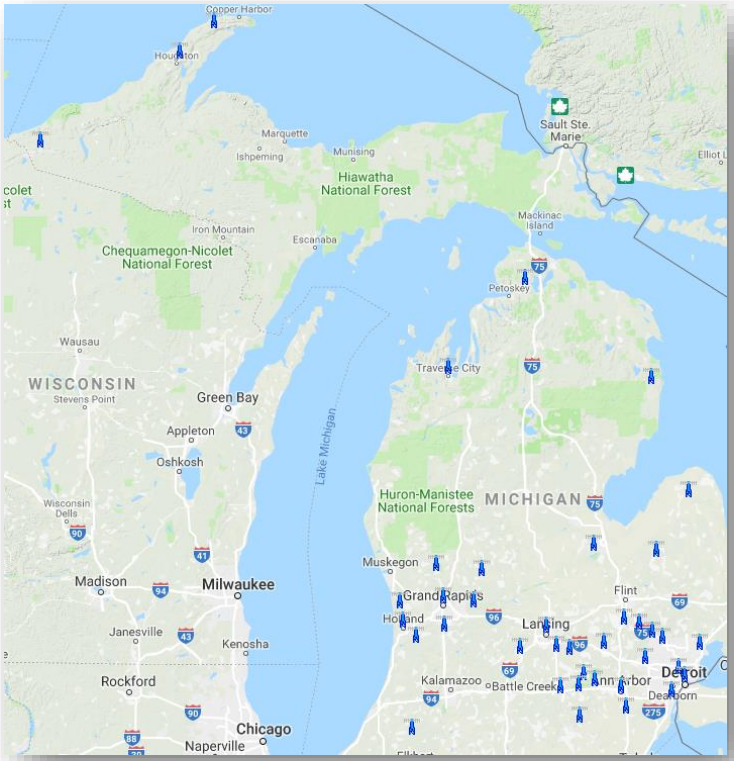
Repeaters



There are currently 43 DMR repeaters in Michigan.

RepeaterBook

[Michigan DMR Repeaters]

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DVAPs (hotspots)

DVAP	Build	Buy
MMDVM Simplex	$45	$75
MMDVM Duplex	$54	$125
ZUMspot	$165	N/A
ZUMspot USB	N/A	$109
DV4mini	N/A	$149
DVMEGA stick	N/A	$130
openSPOT2	N/A	$224
DVMEGA HotSpot	N/A	$240
NANO-SPOT	N/A	$300

These typically work for DMR, D-Star, Fusion, P25 and NXDN

Private Call

- A direct call from one DMR user to another via network
- Does not have to be on the same TG, just the same network
- Can be done from a repeater or DVAP
- Typically discouraged on repeaters (ties up a TS)

Not to be confused with simplex, which allows anyone to listen!

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MichiganONE DMR Net

Check it out for information, codeplugs, calendars and more!

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Questions?

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