DIGITAL MOBILE RADIO
THE VERY BASICS

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The DMR Difference

The areas covered here will be:

- Brief History
- Audio Quality Difference
- Spectrum Efficiency
- The Local and Worldwide Network
- Repeaters vs. Hotspots
- Code Plugs Basics

Brief History

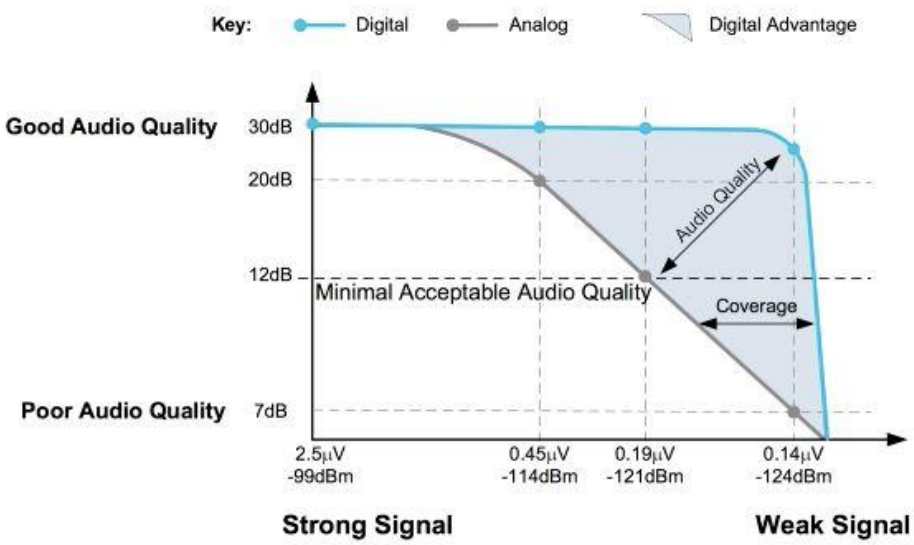
DMR was developed in Europe by ETSI, European Telecomm Standards Institute and was adopted as Commercial Standard 20 years ago.

Initially, Commercial Business Equipment was the only source of DMR handhelds and mobiles.

In 2016, several vendors entered the Ham Radio DMR market. These radios are a bit more affordable and designed to be more Ham Friendly.

Audio Quality Digital vs Analog

Where an analog signal will lose quality and readability as the signal strength is decreased, a digitally processed signal will remain clear until the signal is lost.



Spectrum Efficiency (Time Slots)

Where the bandwidth of an Analog FM signal is 25.0 kHz, the DMR (TDMA) bandwidth is only 12.5 kHz.

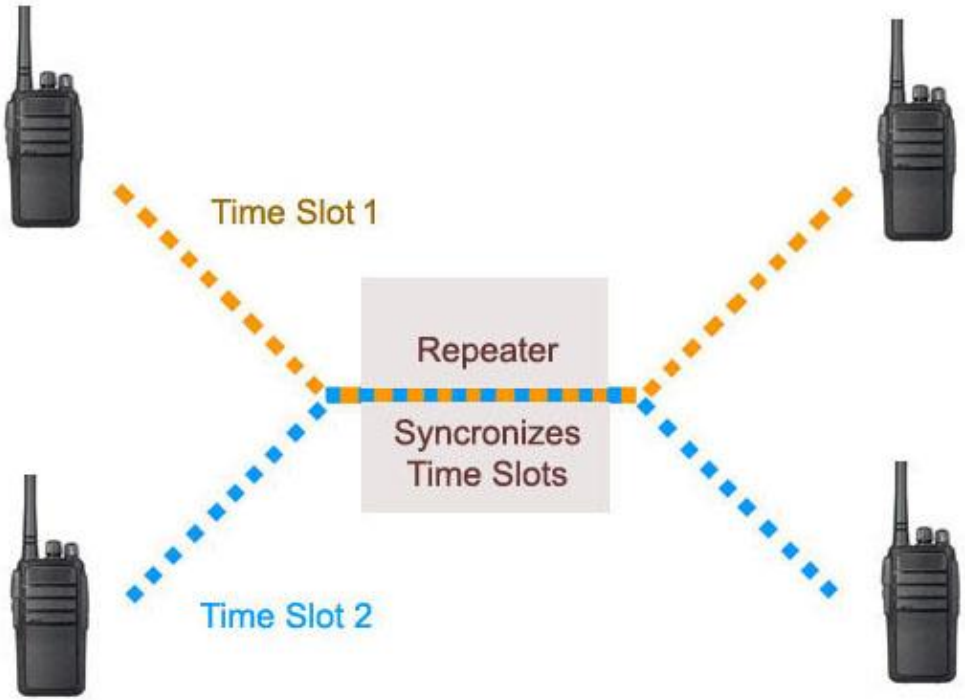
Not only does it occupy half of the required spectrum, but it has the ability to transmit two separate conversations at the same time. This is accomplished by digitally splitting a transmitted signal into alternating 30 millisecond slices referred to as **Time Slots**.

Tier II TDMA 30ms Time Slots

TDMA = Time-Division Multiple Access

Spectrum Efficiency 30ms Time Slices

The repeater interweaves the incoming signals based on the Time Slot requested.



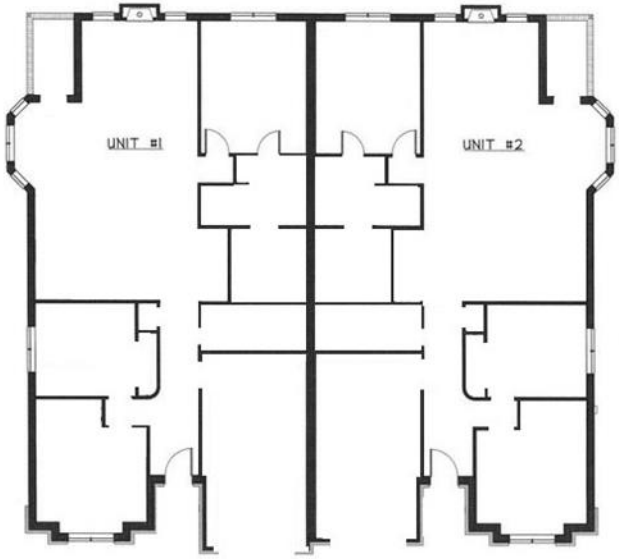
Time Slots

Much like a Duplex House, two totally separate families can reside in one structure.

These divisions are referred to as Time Slots.

Each house has its own set of rooms.
These are referred to as Talk Groups.

TS1 TS2



Talk Groups

There are currently over 1500 Talk Groups, ranging from:

- Local Repeater Only
- Local Network Repeaters
- Statewide Groups
- Regional Groups
- Country Specific Groups
- Worldwide Groups
- Special Interest Groups

Examples of these groups include:

- Public Safety
- Outdoor Adventure
- JOTA (Scouting)
- EmComm
- Handi-Hams
- etc.

Talk Groups

Not all repeaters carry all Talk Groups (TG) depending on their network connection. The repeater's owner assigns the TG and TS structure most beneficial for your area. This is to permit the most activity with the least amount of interference.

A 'typical' configuration might be:

		TG	*Time Slot*
• Local 2	Local Cluster of Repeaters	2	2
• Local 9	Local Repeater Only	9	2
• TAC 310, 311	Secondary Chat Groups	310, 311	2
• Nationwide	National Calling Channel	3100	1
• PA State	PA Statewide	3142	1
• MD State	MD Statewide	3124	1
• NE Reg'l	Northeast Regional	3172	1

Full Time vs Part Time (Repeater)

A Full Time (FT) group is one that is always available for monitoring. If the TG becomes active, you will hear the traffic immediately. These are normally Local and State groups.

A Push-to-Talk TG is one that requires activation and only stays active for a predefined amount of time. These would be high traffic groups, such as Nationwide, Worldwide, etc. The TG remains active for a given amount of time after your last PTT. It will then release the TS for other potential users. Only one TG can be active for each TS.

		TG	*Time Slot*	
• Local 2	Local Cluster of Repeaters	2	2	FT
• Local 9	Local Repeater Only	9	2	FT
• TAC 310, 311	Secondary Chat Groups	310, 311	2	PTT (10 min)
• Nationwide	National Calling Channel	3100	1	PTT (10 min)
• PA State	PA Statewide	3142	1	FT
• MD State	MD State	3124	1	PTT (15 min)

Sample Repeater Configuration

The tiny dot indicates a Full Time group.

Time Slot 1	PA TAC 31421	PA State 3142	MD State 3124	NE Reg'l 3172
	Mid Atlan 3173	National 3100		
Time Slot 2	Local 2 2	Local 9 9	TAC 310 310	TAC 311 311
	TAC 312 312	KY State 3132	OH State 3139	

Local / Worldwide Network

A sample repeater is shown here. By itself, it can cover a local area of several miles, but when connected to a DMR network server, it can provide worldwide access.

Note: Repeater cost and operation can be quite expensive. Please support your local club or repeater owner.

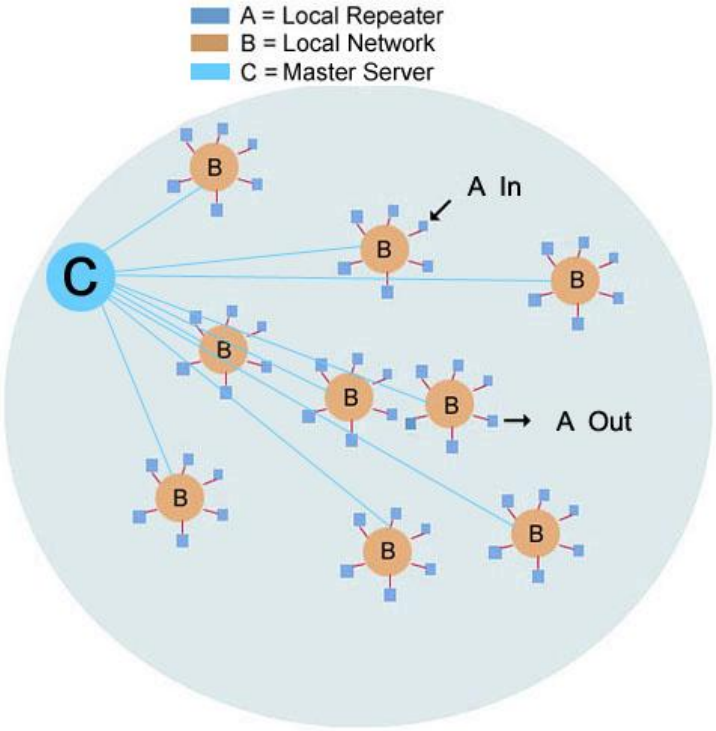
BridgeCom SYSTEMS

The World Wide Network Latency

An example of the complexity of the network is shown here.
Although the internet is fast, it is not instant.
Your audio is digitally processed in your handheld, forwarded to the repeater, then to a regional server to worldwide servers where it is distributed.

The process is then reversed before it is delivered to the receiving station. This is referred to as latency, a delay of your signal getting to the other end by as much as 2 seconds.

For this reason, it is advisable to pause for two or three seconds before making a return transmission to give a breaking station a chance to enter.



Push-to-Talk Analog vs Digital

Because of the number of TGs that are assigned, it's very possible someone might be using a TG other than the one you are listening to. If this occurs, your signal could interfere with theirs. This is avoided by the way DMR handles the PTT function.

With Analog, pressing the PTT keys the transmitter and you're ready to go.
Not so on DMR. When the PTT is pressed, a signal is sent to the repeater which checks to see if the Time Slot is available. If it is, a data stream is sent back to the radio giving you the All Clear, sometimes generating a beep tone.
This occurs in just under a second.

It is highly recommend that the BCLO (Busy Channel Lock Out) function is enabled. This prevents a station from transmitting on a Time Slot if it is currently active.

Another indicator that the TG is in use is an activity light on the handheld. If lit, the TS is in use.

When pressing the PTT, wait 1 or 2 seconds before speaking.

Networks

You may hear reference to various networks.

The MARC network was developed several years ago by the Motorola ARC.
More recently, the Brandmeister network was developed in Europe.
Although their roots are totally different, they are much like two pine trees planted side by side.
As time evolves, more of the branches (talk groups) become common to both.

Some examples are shown on the next page.

Also, it should be noted that not all networks support the same features, such as GPS and APRS.

Network Activity

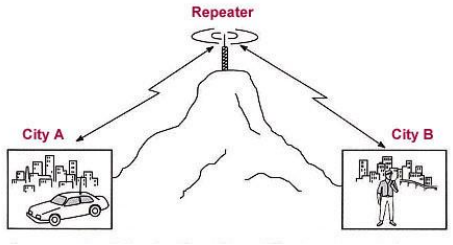
DMR-MARC		BrandMeister
TAC 310, 311, 312	shared	TAC 310, 311, 312
313 > 319	x	313 > 319
State Groups	shared	State Groups
Regional Groups	x	n/a
Nationwide 3100	shared	Nationwide 3100

Some examples of TG sharing are shown above.

There are 10 ‘TAC’ channels. While TAC 310, 311and 312 are common to both networks, 313-319 are not.
US State Groups are common to both networks, while Regional Groups are not.

Repeater vs. Hotspot

There are two main pieces of equipment used to access the DMR network. One is a repeater which is normally located at a high elevation with wide area coverage. The repeater is then linked to an internet connection allowing it to access a DMR network.



The other is known as a Hot Spot. These were developed for short range access to the network when there is no repeater available. It is not a repeater, but rather a low power device that receives a digital signal and passes it to a DMR network via the internet.

Activity Levels

This varies by Talk Group. Local groups usually carry the lowest level of activity, where State and Regional activity is a bit heavier.
The bulk of the activity can be found on the National and World Wide TGs

		TG	*Activity*
• Local 2	Local Cluster of Repeaters	2	**Low**
• Local 9	Main Repeater Only	9	**Low**
• PA State	PA Statewide	3142	**Med**
• MD State	MD Statewide	3124	**Med**
• NE Reg'l	Northeast Regional	3172	**Med**
• Mid Atlantic	Mid Atlantic	3173	**Med**
• TAC 311, 312	Chat Groups	311, 312	**Med**
• Nationwide	National Calling Channel	3100	**High**
• TAC 310	Main Secondary Chat Group	310	**High**

Important Operating Note TG-3100 Nationwide

- **TG 3100** was created as a shared Nationwide Calling Channel.
It is designated as a Full Time Talk Group.
If you are using a hotspot, once activated, the group remains Static and will remain continuously active until another TG is selected..

- **TG 310, 311, and 312** are secondary TAC channels.
They are set up as PTT groups requiring activation (kerchunk) once every 10 minutes to reactivate.

- TG 3100 is for establishing an initial contact. If the conversation continues for more than 2 or 3 minutes, stations should move to one of the three TAC channels to clear 3100 as a courtesy to those monitoring.

Note: Also remember, there are 1,500 special purpose and statewide groups available as well. If the activity is spread out, there is plenty room for everyone to enjoy the DMR experience.

Repeater Operating Notes

- **3 second pause before PTT**
  This allows for network latency as well as a courtesy pause for those wanting to enter the conversation.

- **1 second pause after PTT**
  This is required for your radio to sync with the repeater and network

- **Time Slot in use**
  This is usually shown by an indicator light or a time slot busy tone on your radio.

- **Talk Group in use**
  You may not immediately hear an active Talk Group. When switching to a different TG, your radio may need to sync to a conversation already in progress.

- **Announce your presence**
  By simply announcing your call sign and the talk group, this will allow someone who is scanning to identify your talk group so they can answer your call.

Network Activity Monitoring

- Netwatch allows you to see the network activity Real Time. The data shown is the stations name, location and callsign, as well as the TG, source and time.

- **Netwatch** http://cbridge.wr3irs.com:2135/MinimalNetwatch

  Allows you to view DMR network activity Real Time

- **Miklor.com** www.miklor.com/DMR/

  K3NXU.com (DMR Section) www.K3NXU.com

Netwatch

Rayfield Communications

Control Center K4USD Network

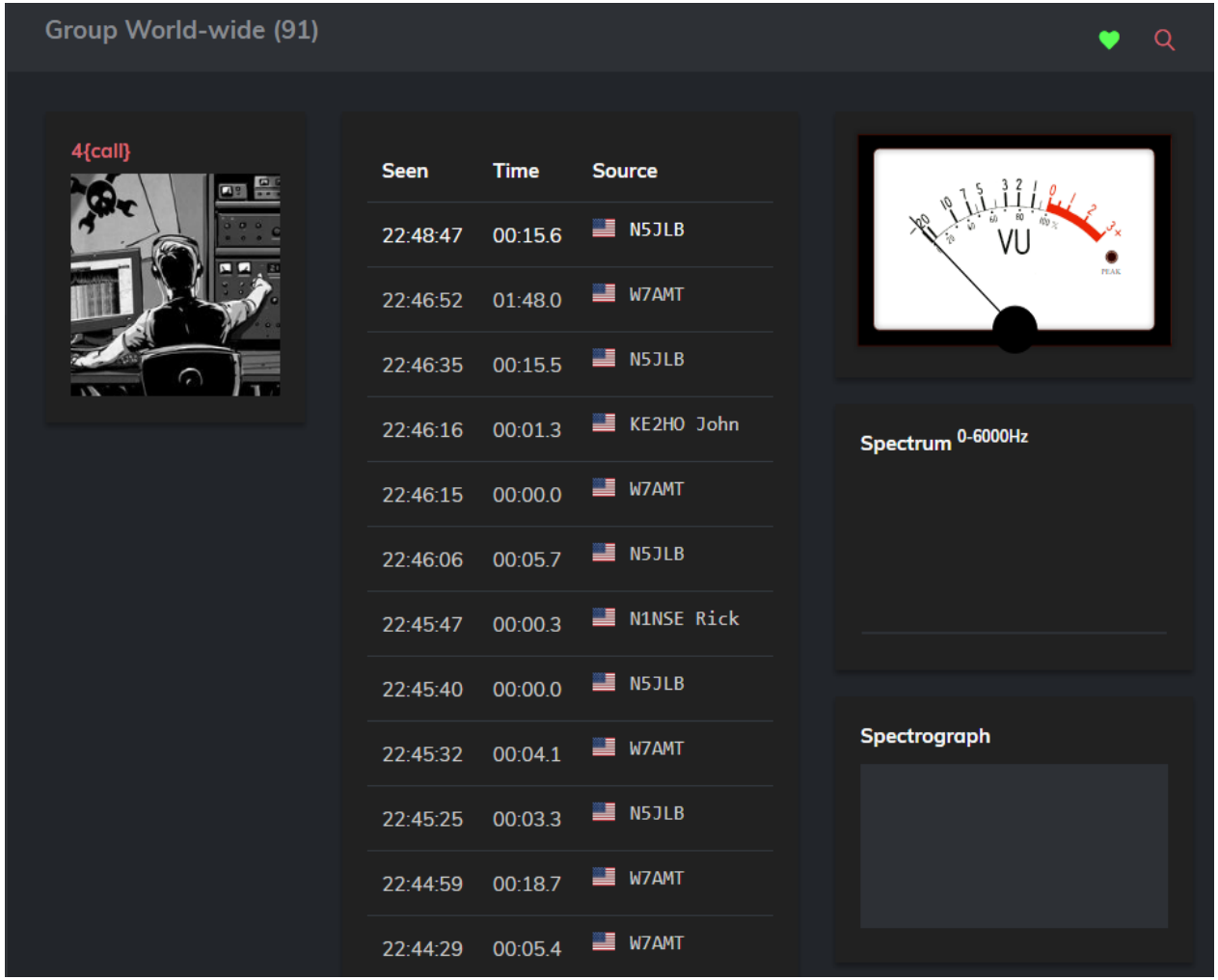
03:24:04 January 02, 2018 UTC

Active calls and History filter

start time	duration	source peer alias	source radio alias	dest. bridge group	RSSI (dBm)	site name	loss rate
03:24:02.537 Jan 2	1.0	BM Unknown or HotSpot (ID1)	CE1RJK - Nelson - Tome Bio Bio CHL -- 7305031	BM-WW CC	0.000	BM-US-3102	0.0%

start time	duration	source peer alias	source radio alias	dest. bridge group	RSSI (dBm)	site name	loss rate
03:23:47.241 Jan 2	15.8	3113735	K4IOB - James - Mansfield GA USA -- 3113735	Bridge CC	0.000	DMRX-P	0.0%
03:23:56.230 Jan 2	0.5	BM Unknown or HotSpot (ID1)	CE1RJK - Nelson - Tome Bio Bio CHL -- 7305031	BM-WW CC	0.000	BM-US-3102	0.0%
03:23:52.838 Jan 2	1.5	BM Unknown or HotSpot (ID1)	AJ3C - Christopher - Albrightsville PA USA -- 1142055	TAC310 CC	0.000	DMRX-P	0.0%
03:23:11.525 Jan 2	31.1	BM Unknown or HotSpot (ID1)	KN4CHY - Keith - Seneca SC USA -- 3145646	Bridge CC	0.000	DMRX-P	0.0%
03:23:23.959 Jan 2	0.8	BM Unknown or HotSpot (ID1)	WH6L - Ed - San Benito Tx -- 3148861	BM-WW CC	0.000	BM-US-3102	0.0%
03:23:01.351 Jan 2	1.5	BM Unknown or HotSpot (ID1)	WH6FIX - Daryl - Kaneohe HI USA -- 3115212	TAC310 CC	0.000	DMRX-P	0.0%
03:22:19.635 Jan 2	41.0	3113735	K4IOB - James - Mansfield GA USA -- 3113735	Bridge CC	0.000	DMRX-P	0.0%
03:22:48.427 Jan 2	1.2	BM Unknown or HotSpot (ID1)	AB9LF - Gary - Memphis IN USA -- 1118195	TAC311 CC	0.000	DMRX-P	0.0%
03:22:49.098 Jan 2	1.3	BM Unknown or HotSpot (ID1)	WA2HQL - John - Kannapolis NC USA -- 1137054	BM-WW CC	0.000	BM-US-3102	0.0%
03:22:33.823 Jan 2	6.6	AF7PR - Olympia WA USA -- 315323	N7EKB - Ed - Rainier WA USA -- 3153410	TAC310 CC	-98.5	DMRX-P	0.7%
03:22:21.443 Jan 2	3.2	BM Unknown or HotSpot (ID1)	KI7SZZ - Toby - Rainier WA USA -- 3153710	TAC310 CC	0.000	DMRX-P	0.0%

Hoseline


Group World-wide (91)
4{call}
Seen Time Source
22:48:47 00:15.6 N5JLB
22:46:52 01:48.0 W7AMT
22:46:35 00:15.5 N5JLB
22:46:16 00:01.3 KE2HO John
22:46:15 00:00.0 W7AMT
22:46:06 00:05.7 N5JLB
22:45:47 00:00.3 N1NSE Rick
22:45:40 00:00.0 N5JLB
22:45:32 00:04.1 W7AMT
22:45:25 00:03.3 N5JLB
22:44:59 00:18.7 W7AMT
22:44:29 00:05.4 W7AMT
VU
Spectrum 0-6000Hz
Spectrograph

Network Activity Links

- **Netwatch** http://cbridge.wr3irs.com:2135/MinimalNetwatch

  Allows you to view DMR network activity Real Time

- **Hoseline** http://hose.brandmeister.network/group/91/

  Listen to Brandmeister network talk groups Real Time

- **Miklor.com**
  www.miklor.com/DMR/

  K3NXU.com (DMR Section)
  www.K3NXU.com

References

- Miklor – DMR Section
- The Amateur Radio Guide to DMR
- Applying for a DMR user ID

Code Plug (CP)

Don’t let the name scare you. A Code Plug (CP) is nothing more than the data file that is loaded to your DMR radio that sets the operating parameters. (Frequency, power, etc.)

You will also see reference to the CPS. This is simply the Code Plug Software.

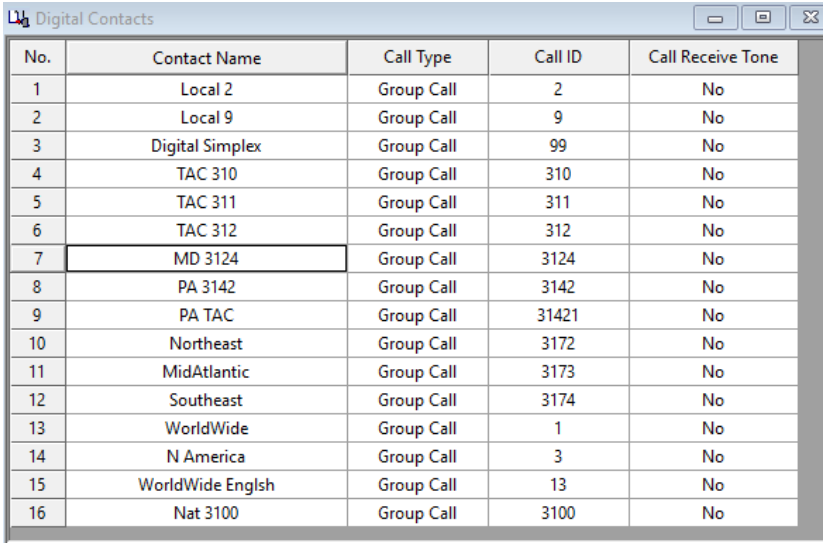
Code plugs consist of 3 main parts

(1) Contact List (the Talk Groups to be assigned)
(2) Channel Information
(3) Zones (Channel groups or clusters)

Let take a look at the three pieces and how they tie together.

Code Plug – The Contact List

Before you start the trip, you need to know where you want to go.
This is done by creating a Contact List. This is where the desired Talk Group information can be found.



No.	Contact Name	Call Type	Call ID	Call Receive Tone
1	Local 2	Group Call	2	No
2	Local 9	Group Call	9	No
3	Digital Simplex	Group Call	99	No
4	TAC 310	Group Call	310	No
5	TAC 311	Group Call	311	No
6	TAC 312	Group Call	312	No
7	MD 3124	Group Call	3124	No
8	PA 3142	Group Call	3142	No
9	PA TAC	Group Call	31421	No
10	Northeast	Group Call	3172	No
11	MidAtlantic	Group Call	3173	No
12	Southeast	Group Call	3174	No
13	WorldWide	Group Call	1	No
14	N America	Group Call	3	No
15	WorldWide Englsh	Group Call	13	No
16	Nat 3100	Group Call	3100	No

There are 2 main elements.

- **Talk Group Name**
Names you create for the desired DMR groups.

- **Talk Group Number**
This is the number assigned to each specific group.

The Call Type will always be “Group Call”

Code Plug – The Contact List

Digital Contacts

No.	Contact Name	Call Type	Call ID	Call Receive Tone
1	Local 2	Group Call	2	No
2	Local 9	Group Call	9	No
3	Digital Simplex	Group Call	99	No
4	TAC 310	Group Call	310	No
5	TAC 311	Group Call	311	No
6	TAC 312	Group Call	312	No
7	MD 3124	Group Call	3124	No
8	PA 3142	Group Call	3142	No
9	PA TAC	Group Call	31421	No
10	Northeast	Group Call	3172	No
11	MidAtlantic	Group Call	3173	No
12	Southeast	Group Call	3174	No
13	WorldWide	Group Call	1	No
14	N America	Group Call	3	No
15	WorldWide Englsh	Group Call	13	No
16	Nat 3100	Group Call	3100	No

Code Plug – The Channel Information

This looks more complex than it actually is

Mode	Digital
Frequency	The repeater's Rx / Tx frequency
Color Code	1 (The digital equivalent of CTCSS, normally 1)
Bandwidth	12.5 kHz
Time Slot	1 or 2 (Whatever is assigned to that TG)
Tx Contact	Talk Group selected from the Contact List
Rx Contact	"None" will default to the Tx Contact
Power	High or Low
Tx Criteria	"Channel Free", Color Code, Always
Scan List	Optional

Code Plug – Channel Creation Hints

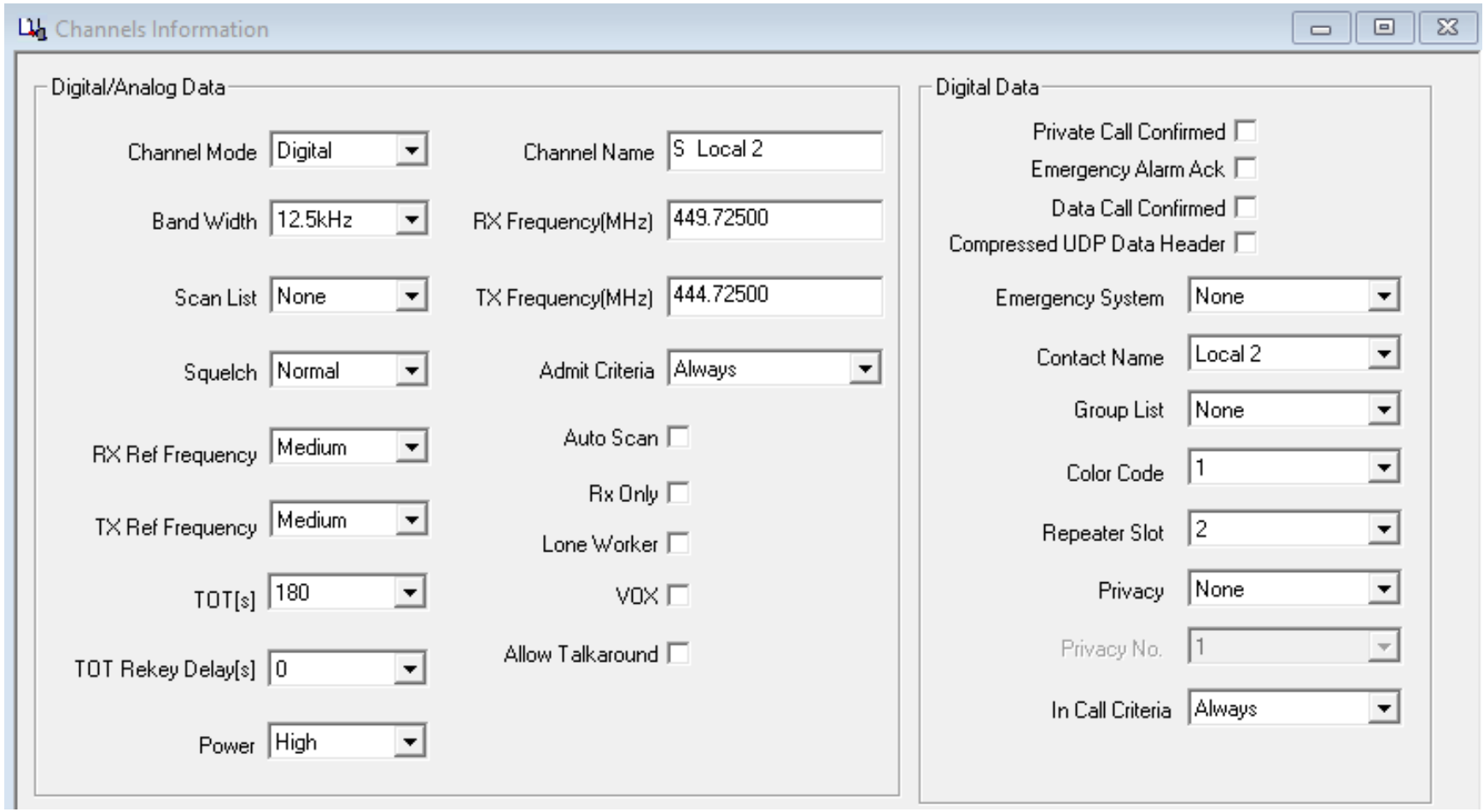
- A separate channel needs to be created for every TG desired.

- Not all repeaters carry every TG (over 1500 possibilities).
  This is at the discretion of the repeater owner.

- Start your initial channel list with only 5-10 channels.
  Until you become comfortable with code plugs, start small.
  It's much easier to correct 5 channels than 150.

- There is no Master CP.
  It's is recommended to start with reviewing a Sample CP.
  From there you can get a feel for how one is assembled.

Code Plug – The Channel Information



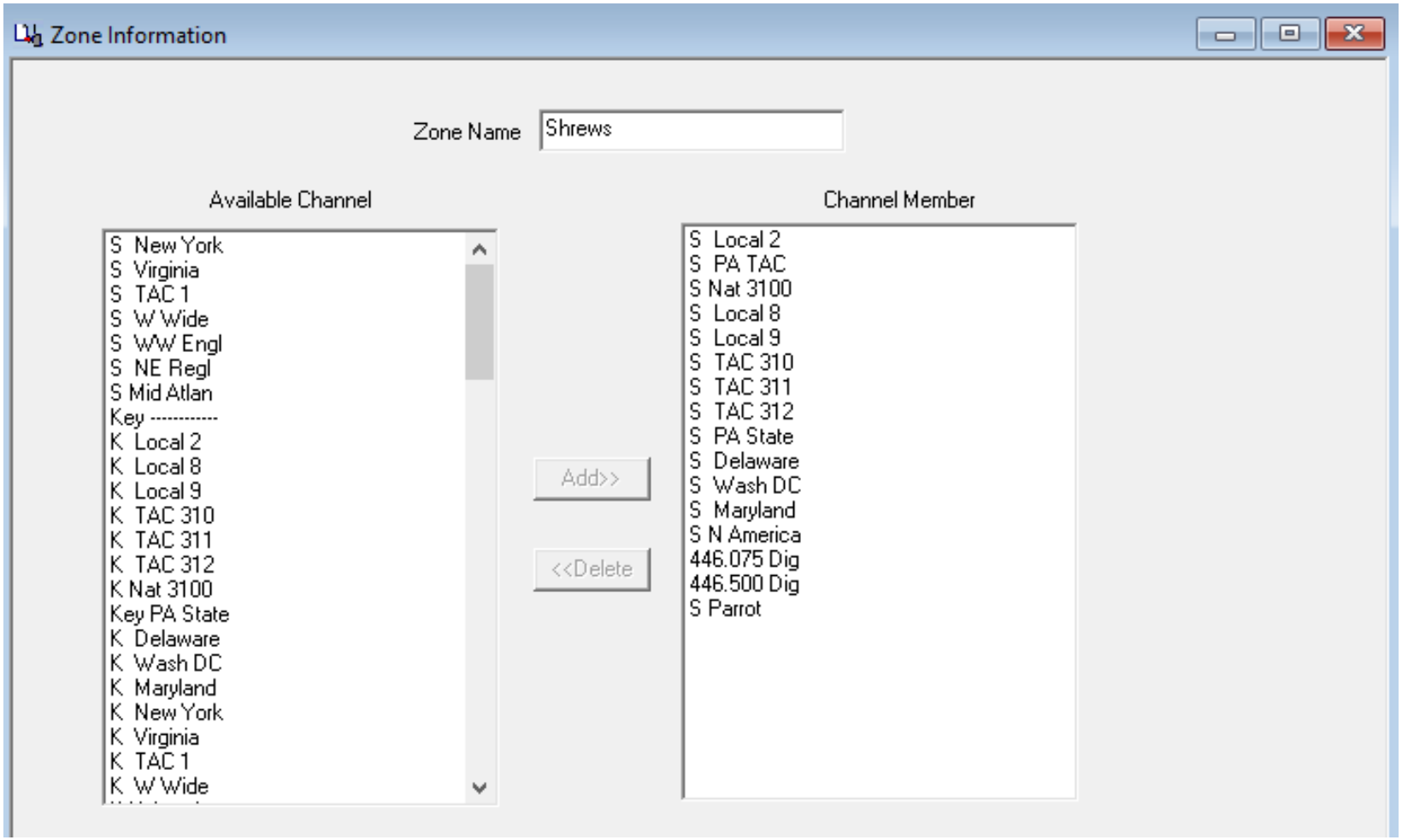
Code Plug – The Zone

The Zone is where you group channels together by category. For instance, if you want the channels for a particular repeater in one group, you would assign them to their own Zone (channel bank).

They can be grouped by:

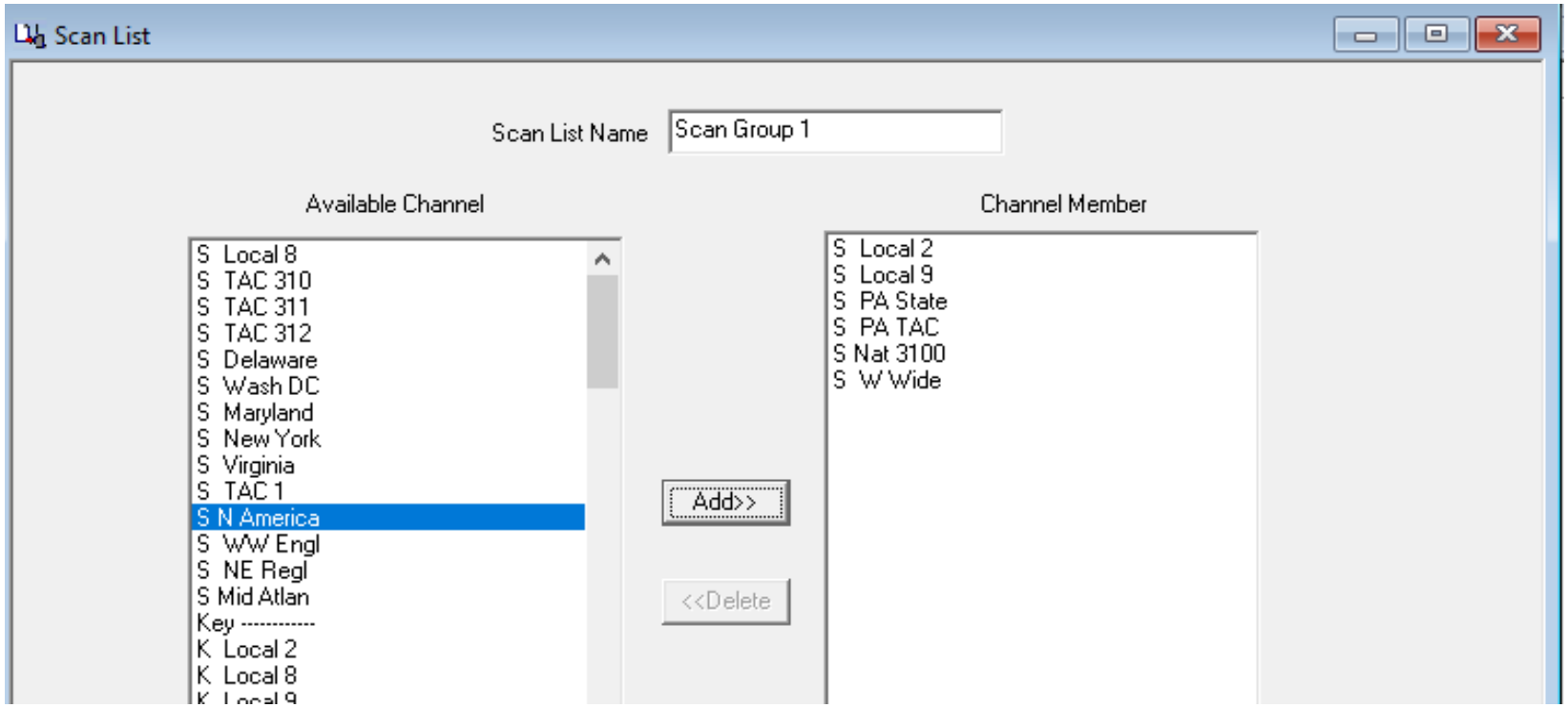
- Repeater
- Location
- Activity
- Analog Repeaters
- Simplex
- etc. You can mix and match. The choice is yours.

Code Plug – The Zone



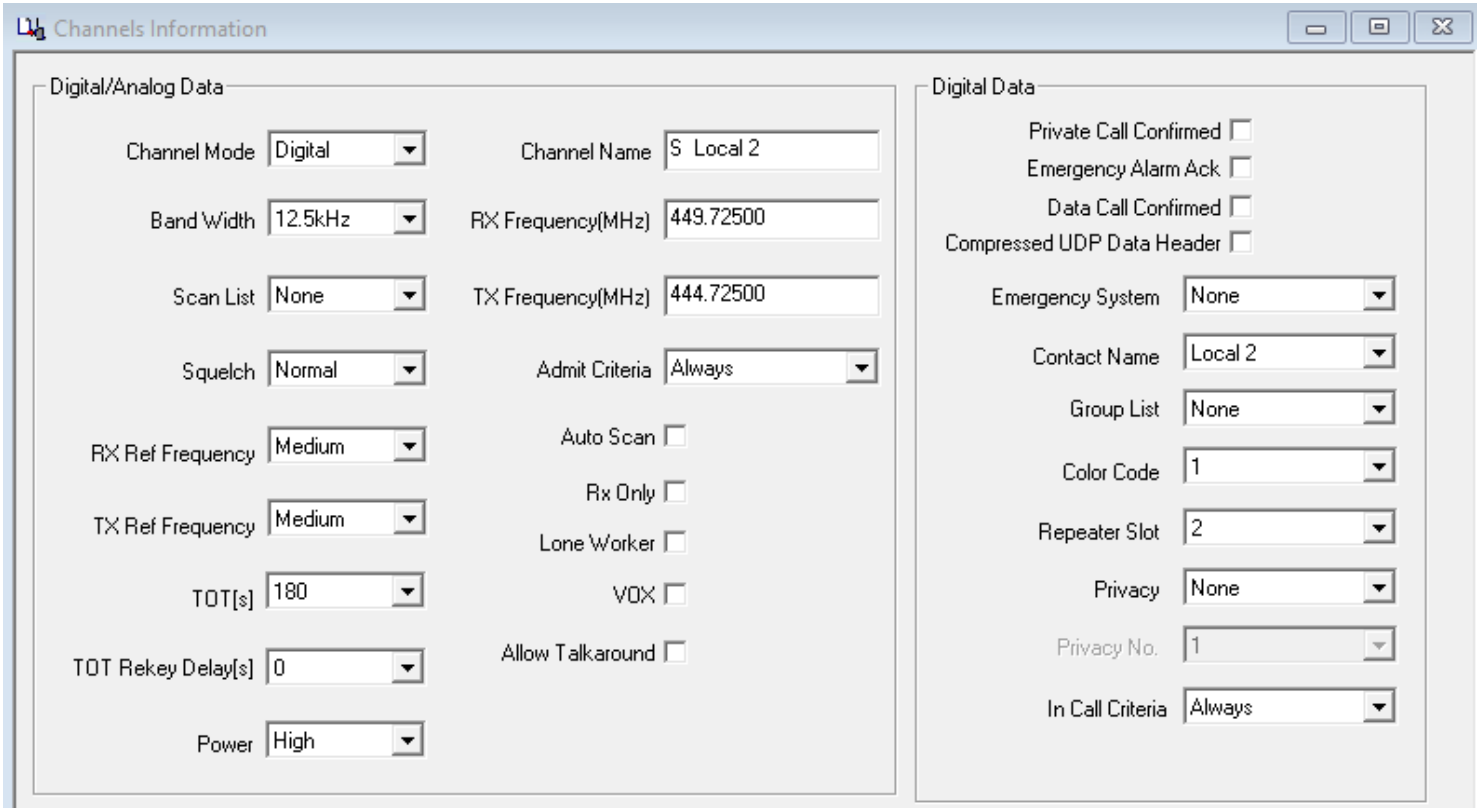
Code Plug – The Scan List

After the channels are set up, consider using Scan Lists. This is where you create a group of channels that you would like to Scan when selected. Give the Scan List a name describing the included channels. The list can now be assigned to one or more channels.



Code Plug – The Scan List

You can now assign this list to a channel in the drop down labeled Scan List. When that channel is selected, using the programmable key assigned to Scan will start the scanning function for the specified group.



Summary

- First and foremost, never forget that this is a hobby.
- Individuals have invested many hours and dollars in support of this network. Repeaters, servers and networks require maintenance. Support your local club whenever possible.
- If a network or online software develops a temporary issue, be patient. These volunteers have families and jobs which is their first priority.
- Take the time to say Thank You.

Conclusion

- I hope I was able to answer a few of your entry level questions. The purpose of this presentation was to help you feel a bit more comfortable with some of the basics and terminology used in the DMR world.

- Don’t expect to become a master at this in a few days. Experiment by creating your own code plugs. Have fun and I’ll see you on DMR.

John ‘Miklor’
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Miklor.com/DMR Support Miklor