



# DIGITAL MOBILE RADIO THE VERY BASICS



# 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

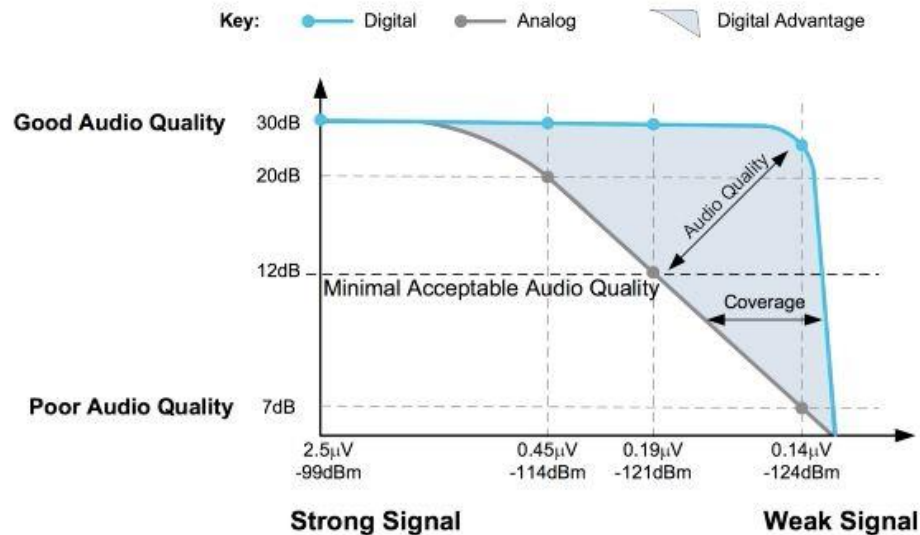
# Brief History

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. Several ham radio vendors have since entered the DMR market with radios that are a bit more affordable and designed more for ham radio use.

# 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.

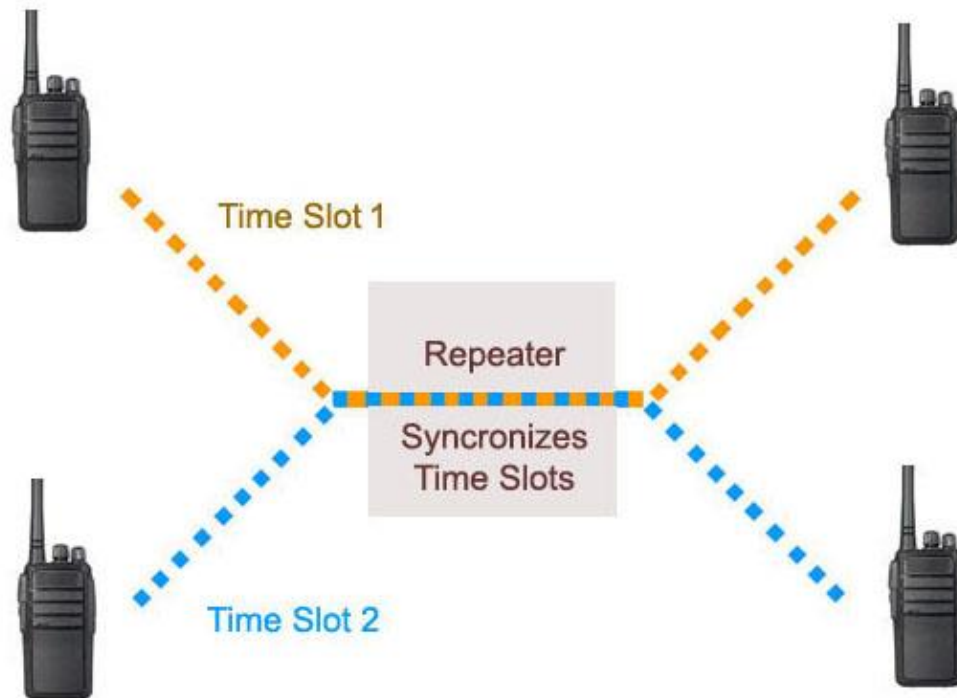
Not only does it occupy half of the required bandwidth, but it has the ability to transmit two separate conversations at the same time. This is accomplished by digitally splitting a transmitted signal into alternating 30 millisecond slices referred to as **Time Slots**.



TDMA = Time-Division Multiple Access

# Spectrum Efficiency 30ms Time Slices

A 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.

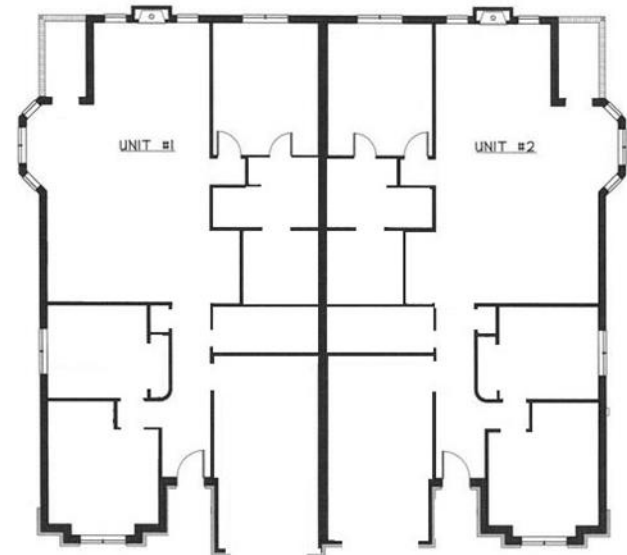
Each house has its own set of rooms.

These are referred to as Talkgroups (TG).



TS1

TS2



# Talkgroups

There are currently over 1500 Talkgroups, 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.





# Talkgroups

Not all repeaters carry all Talkgroups (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:

		<u>TG</u>	<u>Time Slot</u>
• 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.

		<u>TG</u>	<u>Time Slot</u>	
• 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.

Depending on its location, a 'stand alone' repeater 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

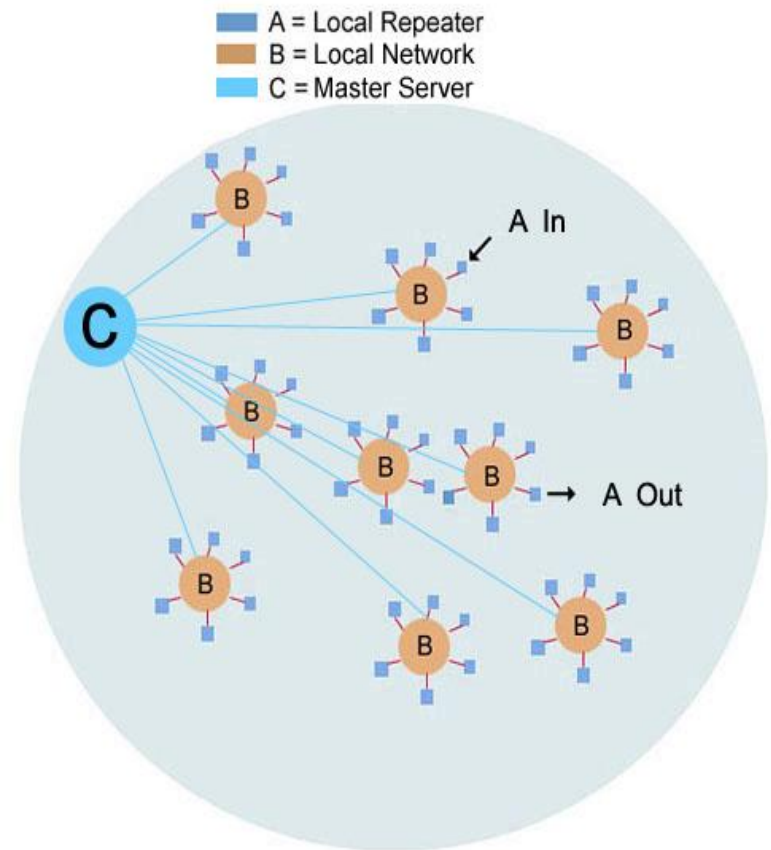
An example of the complexity of the network is shown here.

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 connected to a series of 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 available, it's very possible someone might be using a TG other than the one you are monitoring. 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 the LED is lit, the TS is in use.

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

# Busy Repeater Channel / Time Slot

You may see the Channel Busy indicator lit, but not hearing a conversation. This is caused by someone activating or using a repeater Talkgroup other than the one you are monitoring.

## Digital Monitor (DMR)

Your DMR radio may have a 'programmable key' function labeled Digi Monitor or Promiscuous mode. This open allows you to monitor all activity on one or both time slots regardless of the Talkgroup in use.

This is a monitoring function only.

## Monitor Mode (Analog)

This is an analog function which opens the squelch allowing you to listen to activity on that frequency.

The Monitor and Digital monitor modes are not interchangeable.

# Networks



You may hear reference to various networks.

The DMR-MARC network was developed several years ago by the Motorola ARC. The more recent 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 (Talkgroups) 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.





# Shared Network TG Activity



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, 311 and 312 are common to both networks, 313-319 are not.

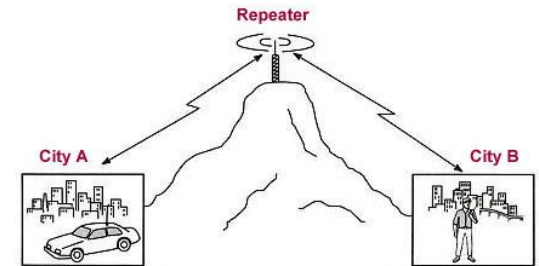
US State Groups are common to both networks, while Regional Groups are not.

# 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 the internet allowing it to access one or more DMR network servers.



Note: Not all repeaters share the same Talkgroups. This is determined by the repeater's owner.



The other is known as a Hot Spot. These were developed for short range access to a network when no repeater is available. This low power device receives a users digital signal and passes it to a DMR network via the internet.



# Activity Levels

This varies by Talkgroup (TG). 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

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

## Important Operating Note TG-3100 Nationwide

- **TG 3100** was created as a shared Nationwide Calling Channel.

It is designated as a Full Time Talkgroup.

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 over 1,500 available talkgroups. 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.
- **Talkgroup in use**  
You may not immediately hear an active Talkgroup. 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 Talkgroup, this will allow someone who is scanning to identify your Talkgroup so they can answer your call.

# Repeater Operating Notes

- **Brandmeister Network “User Blocked” (521)**

When using the Brandmeister Network, server access will be blocked for one hour if the following conditions are met:

- **5** transmissions of less than **2** seconds in a **1** minute time span.

This is part of the network loop prevention.

After one hour, access to that server will automatically be restored.

# 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.sxsco.com:42420/MinimalNetwatch>

Allows you to view DMR network activity Real Time

- **Miklor.com**      [www.miklor.com/DMR/](http://www.miklor.com/DMR/)
- **K3NXU.com** (DMR Section)      [www.K3NXU.com](http://www.K3NXU.com)

# Netwatch



## 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%



# References

- [Miklor – DMR Section](#)
- [The Amateur Radio Guide to DMR](#)
- [Applying for a DMR user ID](#)

## Amateur Radio Guide to Digital Mobile Radio (DMR)



By  
John S. Burningham, W2XAB  
February 2015

# 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 (Talkgroups 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 Talkgroup information can be found.

There are 2 main elements.

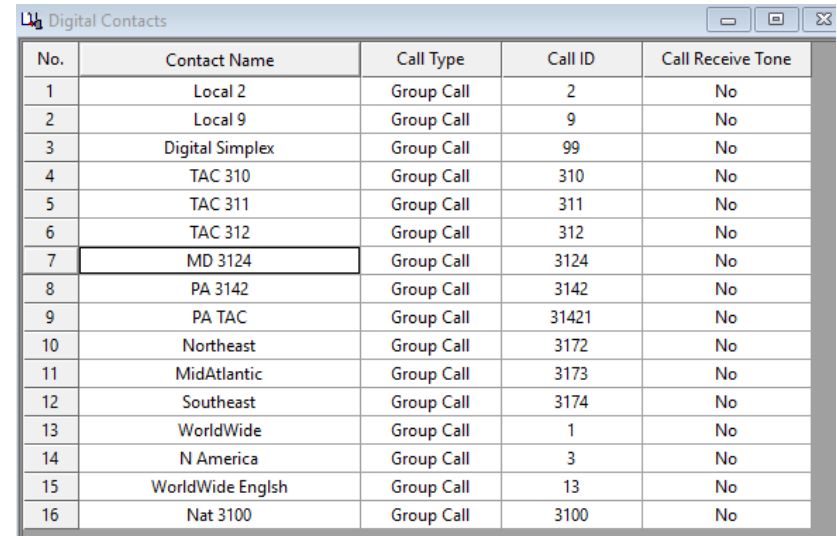
- **Talkgroup Name**

Names you create for the desired DMR groups.

- **Talkgroup Number**

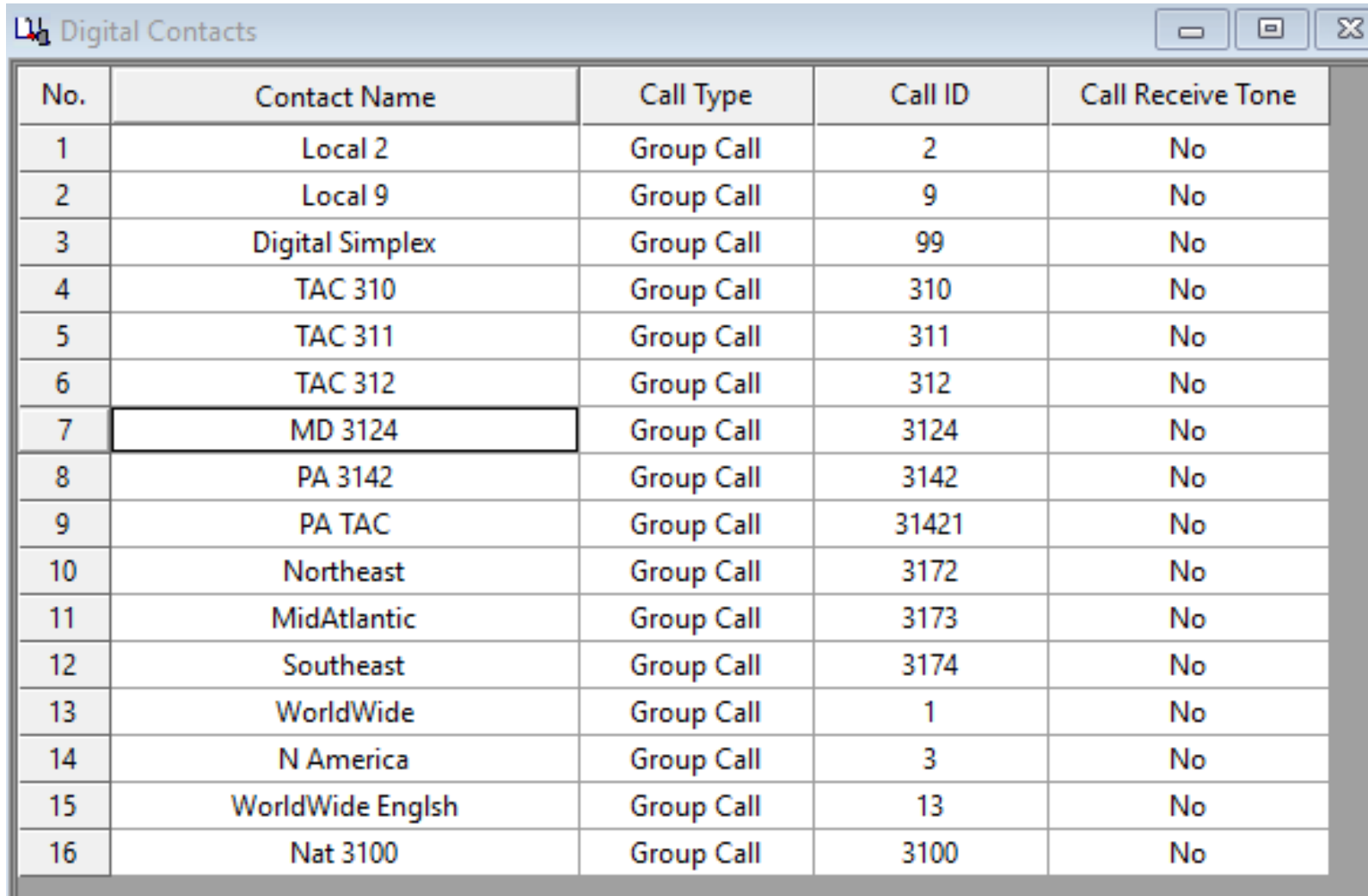
This is the number assigned to each specific group.

The Call Type will always be “Group Call”



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 English	Group Call	13	No
16	Nat 3100	Group Call	3100	No

## Code Plug – The Contact List



The image shows a screenshot of a software window titled "Digital Contacts". The window contains a table with 5 columns: "No.", "Contact Name", "Call Type", "Call ID", and "Call Receive Tone". The table lists 16 contacts, all of which are "Group Call" type. The contact with "No." 7, "MD 3124", is highlighted with a black border. The window has standard Windows-style window controls (minimize, maximize, close) in the top right corner.

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 English	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	Talkgroup selected from the Contact List
Rx Contact	<u>None</u> 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 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

Channels Information

Digital/Analog Data

Channel Mode	Digital	Channel Name	S Local 2
Band Width	12.5kHz	RX Frequency(MHz)	449.72500
Scan List	None	TX Frequency(MHz)	444.72500
Squelch	Normal	Admit Criteria	Always
RX Ref Frequency	Medium	Auto Scan	<input type="checkbox"/>
TX Ref Frequency	Medium	Rx Only	<input type="checkbox"/>
TOT[s]	180	Lone Worker	<input type="checkbox"/>
TOT Rekey Delay[s]	0	VOX	<input type="checkbox"/>
Power	High	Allow Talkaround	<input type="checkbox"/>

Digital Data

Private Call Confirmed	<input type="checkbox"/>
Emergency Alarm Ack	<input type="checkbox"/>
Data Call Confirmed	<input type="checkbox"/>
Compressed UDP Data Header	<input type="checkbox"/>
Emergency System	None
Contact Name	Local 2
Group List	None
Color Code	1
Repeater Slot	2
Privacy	None
Privacy No.	1
In Call Criteria	Always

# 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).

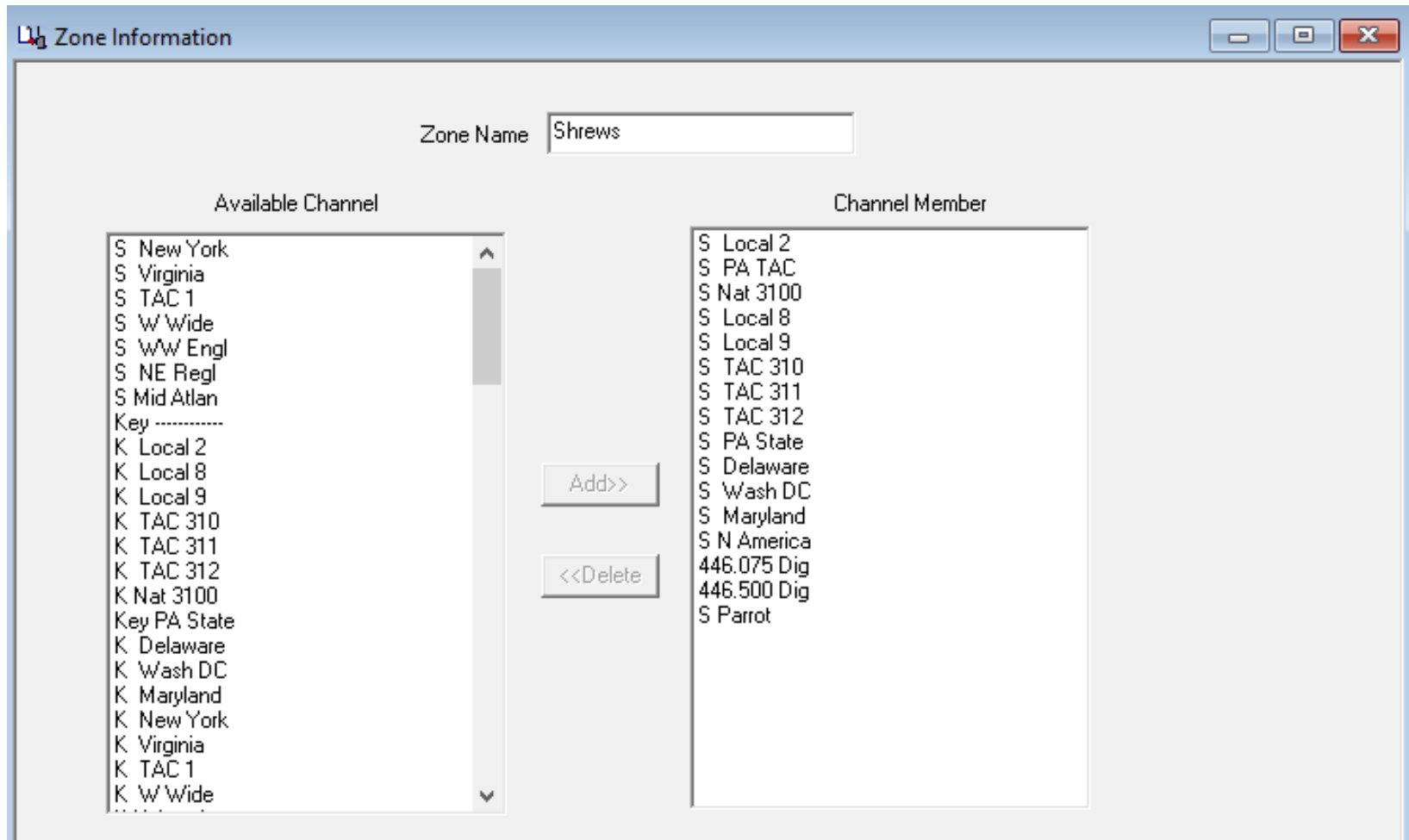
They can be grouped by:

- Repeater
- Location
- Activity
- Analog Repeaters
- Simplex
- etc.

You can mix and match. The choice is yours.

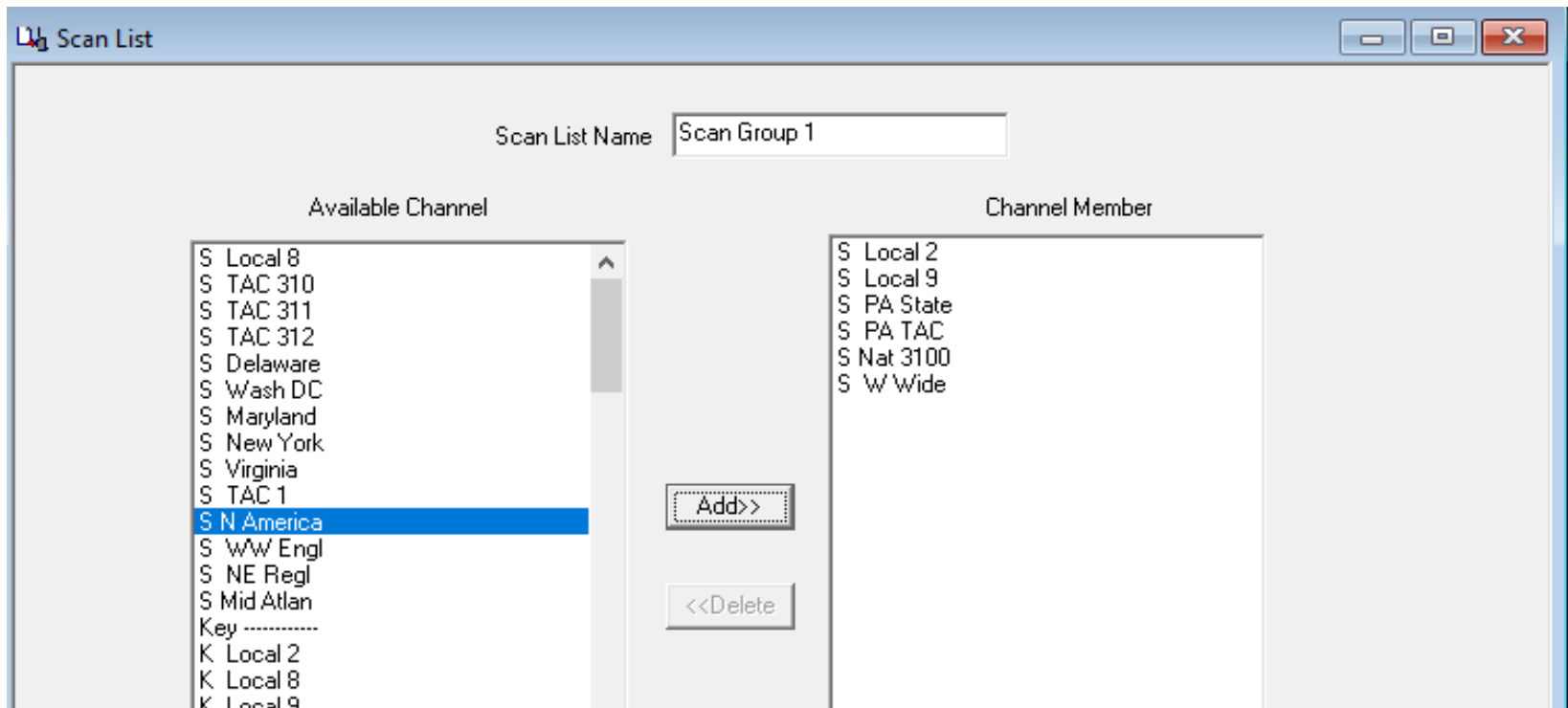


# Code Plug – The Zone



# 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.

The screenshot shows a software window titled "Channels Information" with two main sections: "Digital/Analog Data" and "Digital Data".

**Digital/Analog Data Section:**

- Channel Mode: Digital
- Band Width: 12.5kHz
- Scan List: None
- Squelch: Normal
- RX Ref Frequency: Medium
- TX Ref Frequency: Medium
- TOT[s]: 180
- TOT Rekey Delay[s]: 0
- Power: High
- Channel Name: S Local 2
- RX Frequency(MHz): 449.72500
- TX Frequency(MHz): 444.72500
- Admit Criteria: Always
- Auto Scan:
- Rx Only:
- Lone Worker:
- VOX:
- Allow Talkaround:

**Digital Data Section:**

- Private Call Confirmed:
- Emergency Alarm Ack:
- Data Call Confirmed:
- Compressed UDP Data Header:
- Emergency System: None
- Contact Name: Local 2
- Group List: None
- Color Code: 1
- Repeater Slot: 2
- Privacy: None
- Privacy No.: 1
- In Call Criteria: Always

# 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'  
K3NXU

[Miklor.com/DMR](http://Miklor.com/DMR)

[Support Miklor](#)