# INTRODUCTION TO DIGITAL MOBILE RADIO



.

# Agenda

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

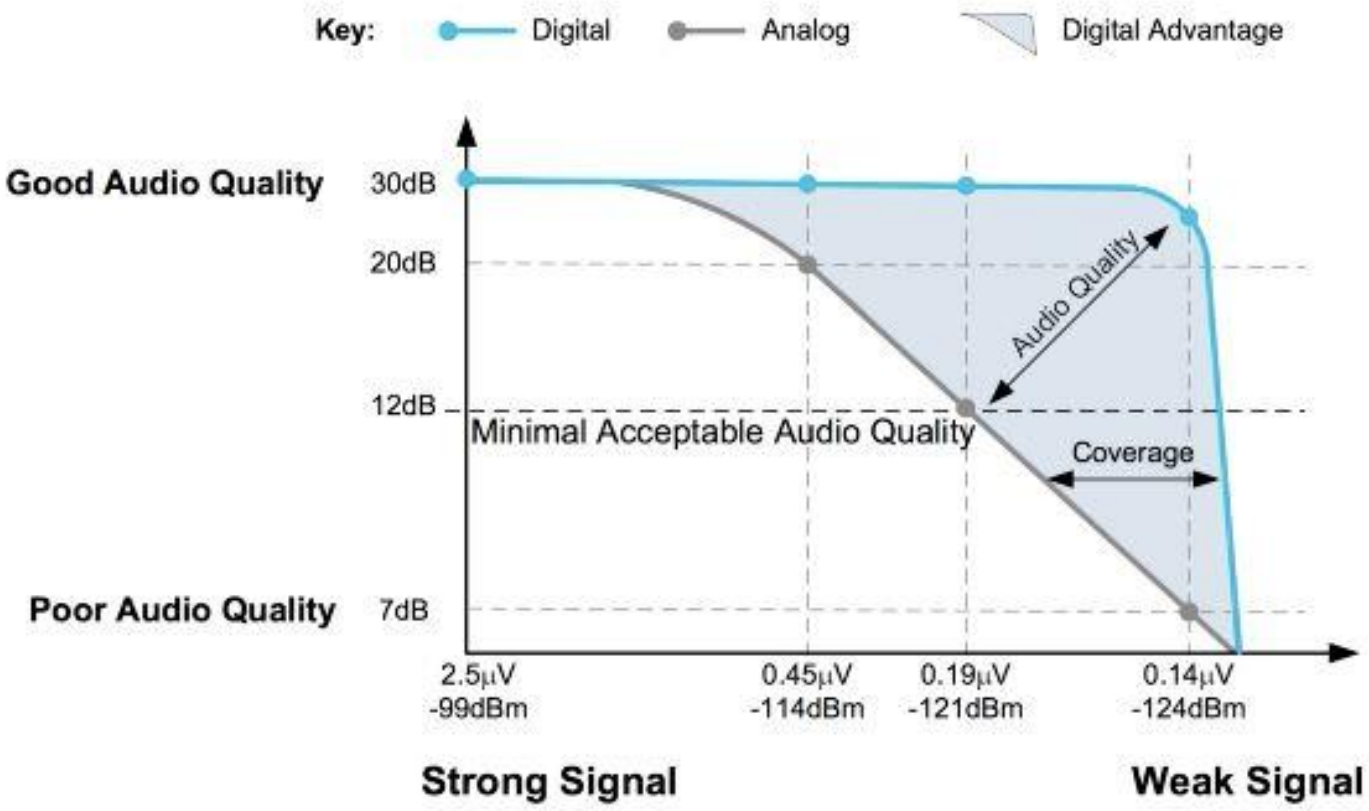
DMR was developed in Europe by ETSI, European Telecomm Standards Institute and was adopted as Commercial Standard 20 years ago.

Initially, Commercial Business Equipment was the only source of DMR handhelds and mobiles. Although their quality, durability and software is unsurpassed, it comes at a high price.

In 2016, several vendors entered the Ham Radio DMR market. These radios are a bit more affordable and vary in quality and features but were 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  is 4:1

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

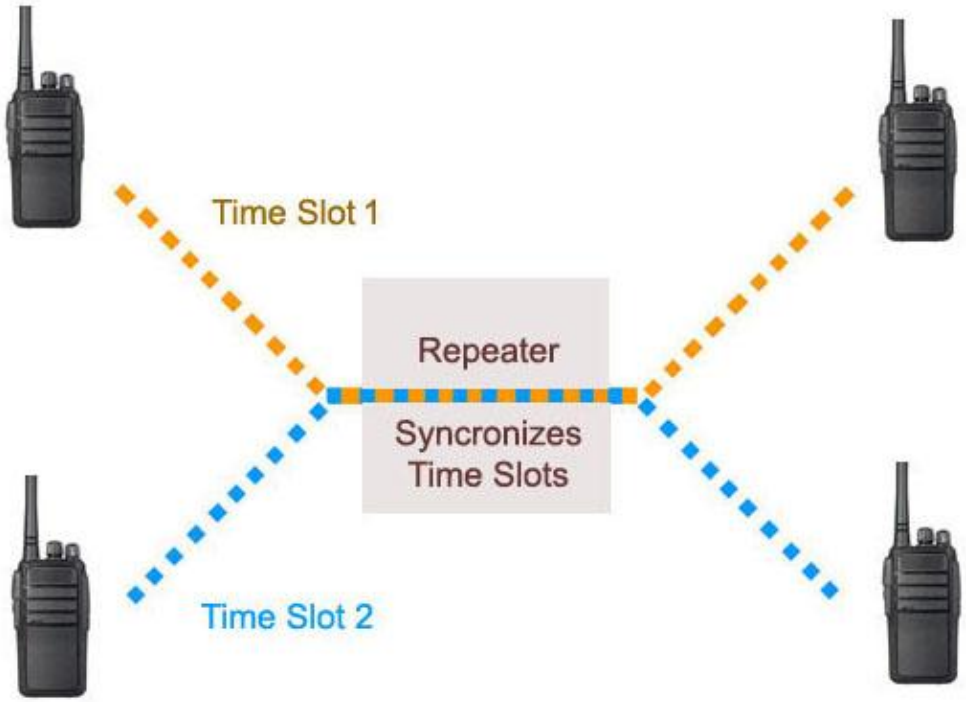
Not only does it occupy half of the required spectrum, but DMR can transmit two separate conversations at the *same time*. This is accomplished by digitally splitting a transmitted signal into alternating 30 millisecond slices called **Time Slots**.

Tier II  TDMA  30ms Time Slots

**TDMA** = Time-Division Multiple Access
Reference: Tier II  TDMA is the Commercial & Ham Standard

# Spectrum Efficiency 30ms Time "Slices"

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



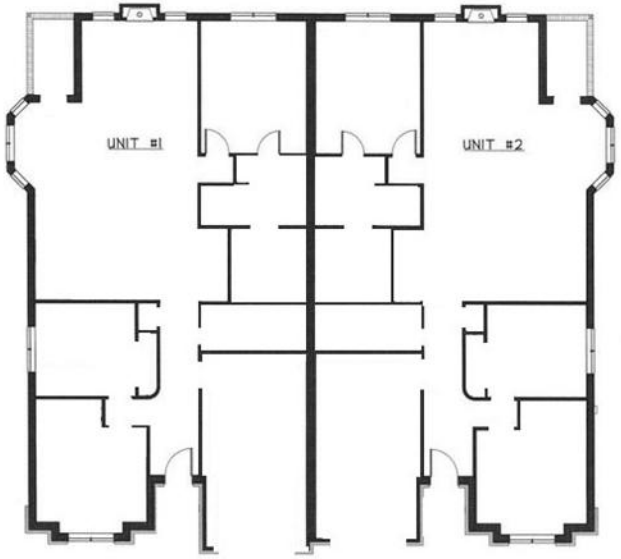
# Time Slots

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

These divisions are referred to as Time Slots.

TS1 TS2

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



# Talk Groups

There are currently over 1200 Talk Groups, ranging from:
- Local Repeater Only
- Local/Network Repeaters
- Statewide Groups
- Regional Groups
- Country Specific Groups
- Worldwide Groups
- Specialty Groups

Some of the specialty Groups include:
- Public Safety
- Outdoor Adventure
- JOTA (Scouting)
- EmComm

# 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

**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** is one that requires activation and will only stay open for a predefined amount of time. These would be your high traffic groups, such as Nationwide, Worldwide, etc. To activate these groups, a quick press of the PTT is required. The TG will remain 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 open at a time 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 (5 min) |
| • Nationwide | National Calling Channel | 3100 | 1 | PTT (5 min) |
| • PA State | PA Statewide | 3142 | 1 | FT |
| • MD State | MD State | 3124 | 1 | PTT (15 min) |

# Local / Worldwide Network

An example of a repeater is shown here. By itself, it can it can cover a local area well. When connected to a DMR network server, it can provide global access.

# 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 button 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.

Other indicators that the TG is in use is a light on the handheld. If lit, the time slot is in use.

# Two Main Networks

You will hear reference to two DMR networks. One is the MARC network, the other is Brandmeister. The DMR-MARC network was developed many years ago by the Motorola Amateur Radio Club and has served as the benchmark for DMR repeaters.

Years later, 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 talk groups are becoming common to both.

Some examples are shown on the next page.

# Network Activity

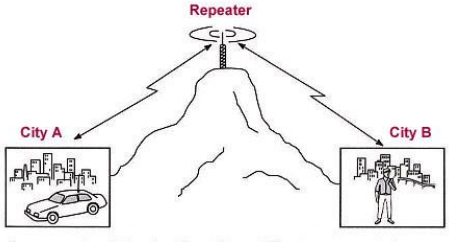
| DMR-MARC | | BrandMeister |
|---|---|---|
| TAC 310, 311, 312 | <---> | 310, 311, 312 |
| 313 > 319 | x | 313 > 319 |
| State Groups | <---> | State Groups |
| Regional Groups | x | n/a |
| Nationwide 3100 | <---> | Nationwide 3100 |

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, where 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 the 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 the 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 Talkgroup | 3142 | **Med** |
| • MD State | MD Statewide Talkgroup | 3124 | **Med** |
| • NE Reg'l | Northeast Regional Talkgroup | 3172 | **Med** |
| • Mid Atlantic | Mid Atlantic Talkgroup | 3173 | **Med** |
| • TAC | Chat Talkgroup | 313-319 | **Med** |
| • Nationwide | National Calling Talkgroup | 3100 | **High** |

# Repeater Operating Notes

- **3 second pause before PTT**
  This allows for the 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.

# Repeater Operating Notes

- **Avoid Calling CQ**
  This is not HF.  There is no DX, WAS, etc.
  Simply announce 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.

- **Avoid long QSOs on wide area talk groups**
  If you are on a Nationwide or Worldwide talk group, you may want to move to a less active TAC or Statewide channel to free up the channel for others.

# Dashboards

A Dashboard is a way to monitor activity using a computer or mobile device.
A very popular method is the Brandmeister Dashboard - https://brandmeister.network/

- Brandmeister allows you to see the network activity Real Time using its Hoseline page. The data shown is the station name, location and callsign, as well as the TG, source and time.

- This can be accessed at https://hose.brandmeister.network/

# 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.

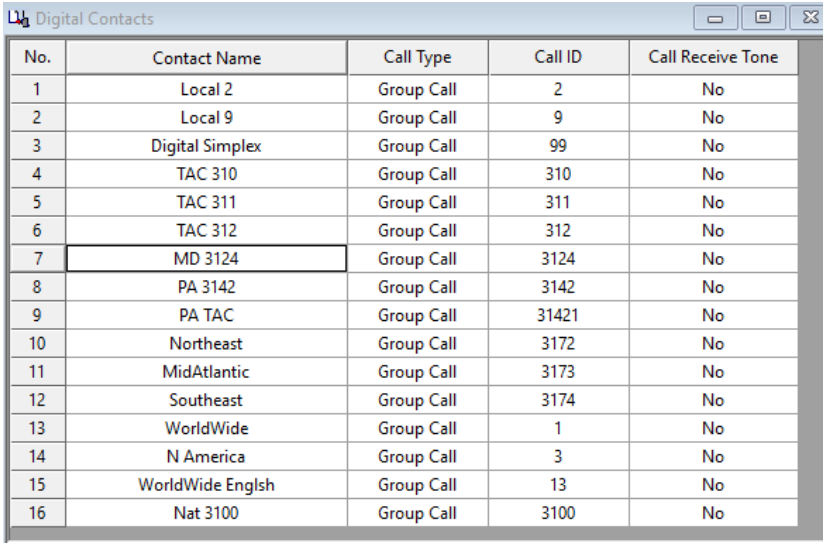
Code plugs consist of 3 main parts

(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

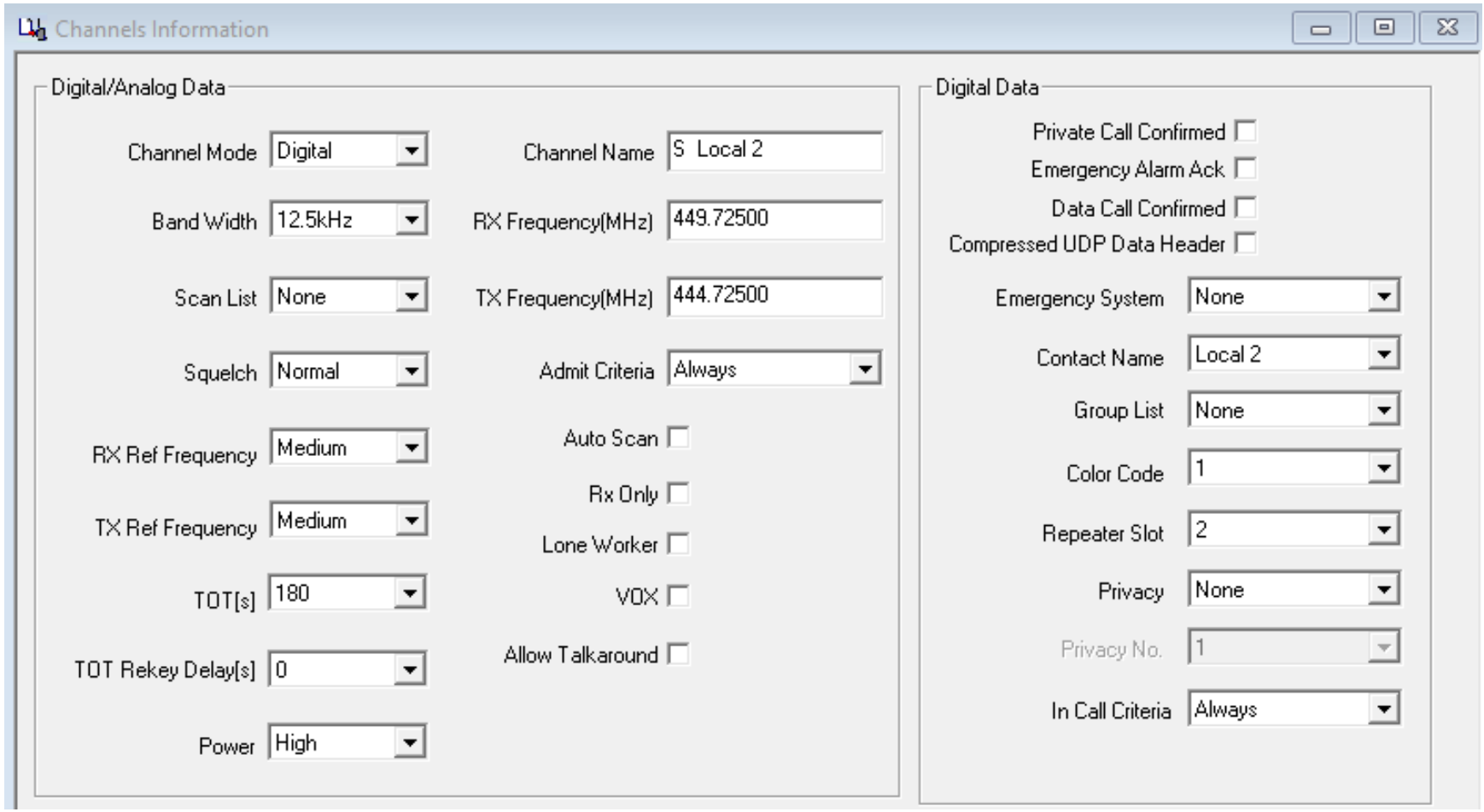
- A separate channel needs to be created for every TG desired.

- Not all repeaters carry every TG (over 1200 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

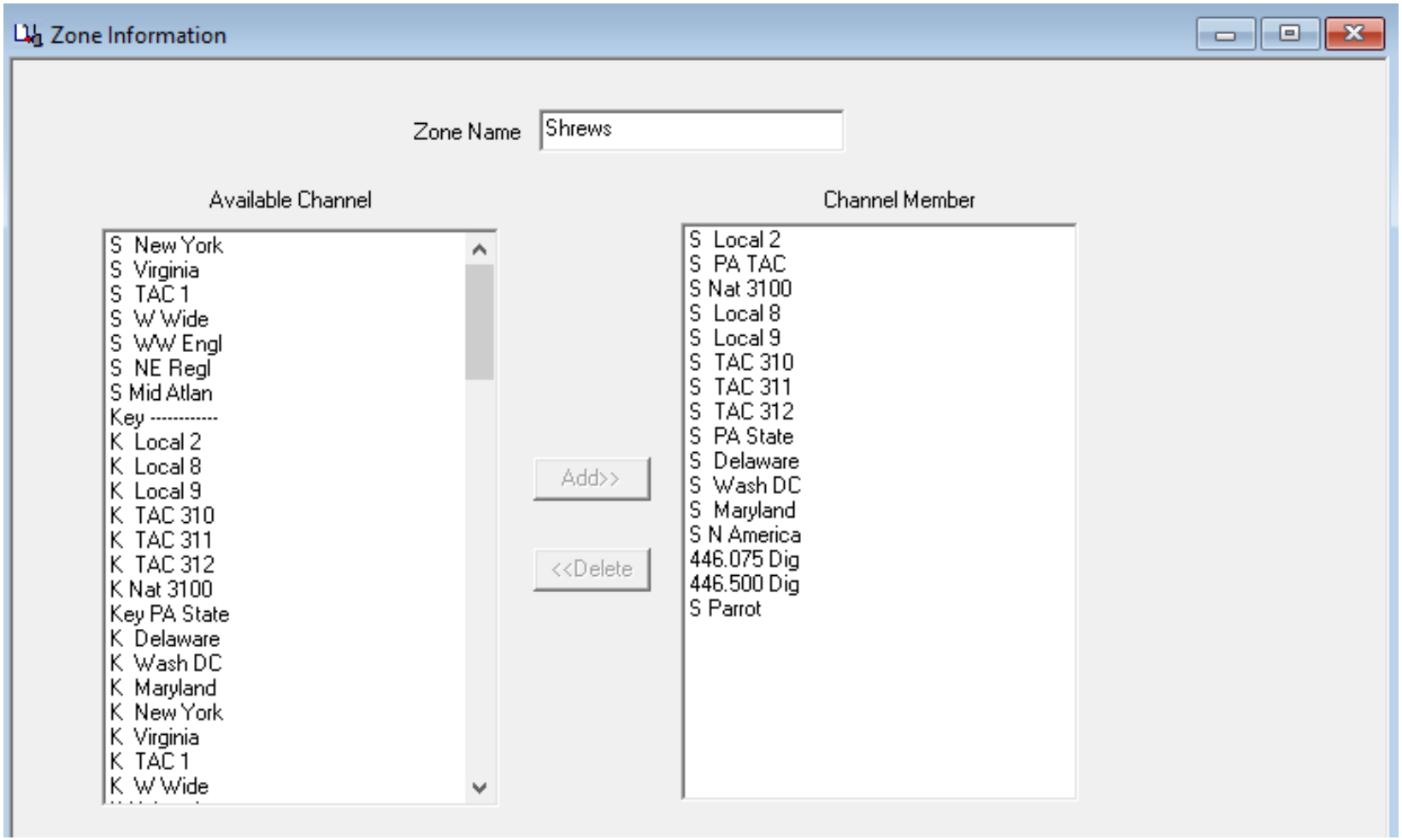
This is where you assign your favorite channels to a cluster or channel bank.

They can be grouped by:

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

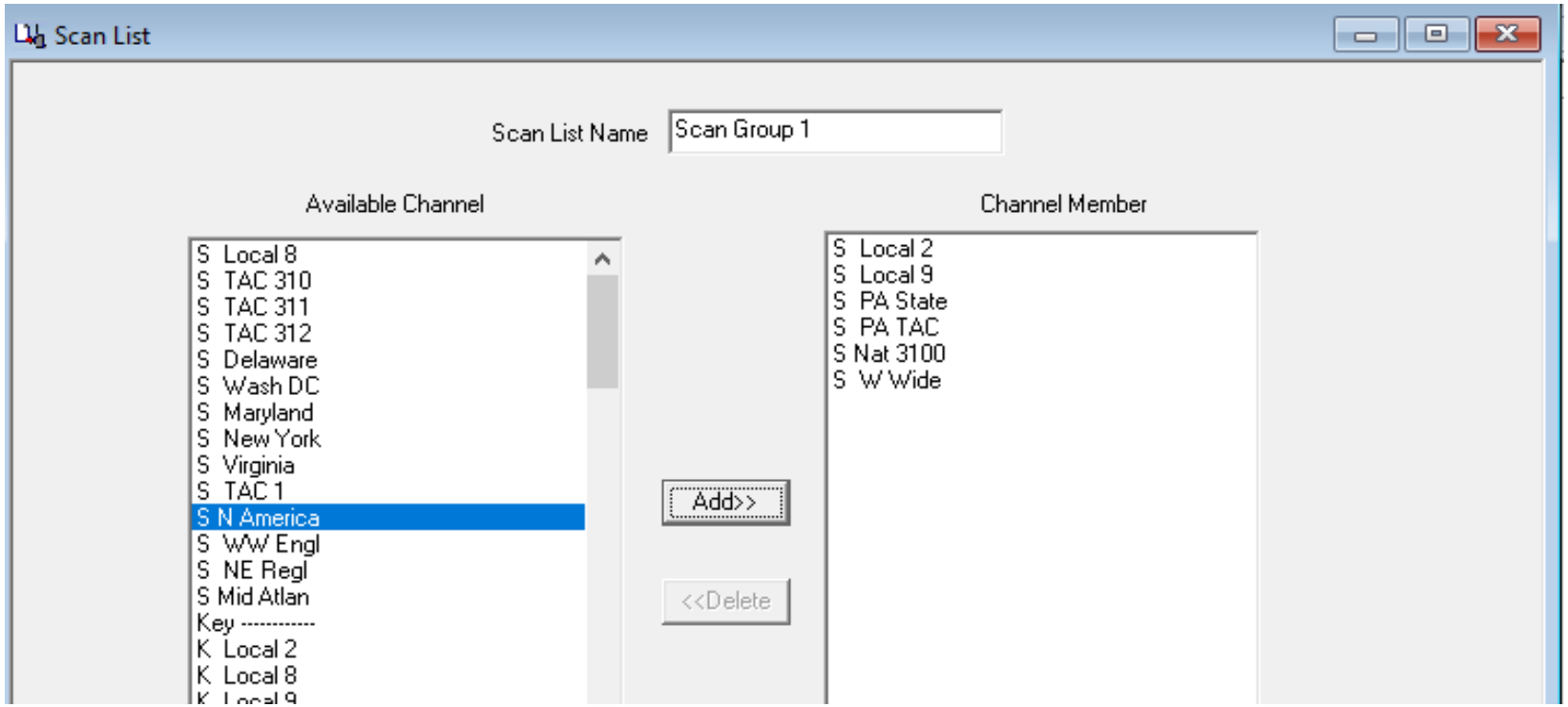
You can mix and match. The choice is yours.

# Code Plug – The Zone



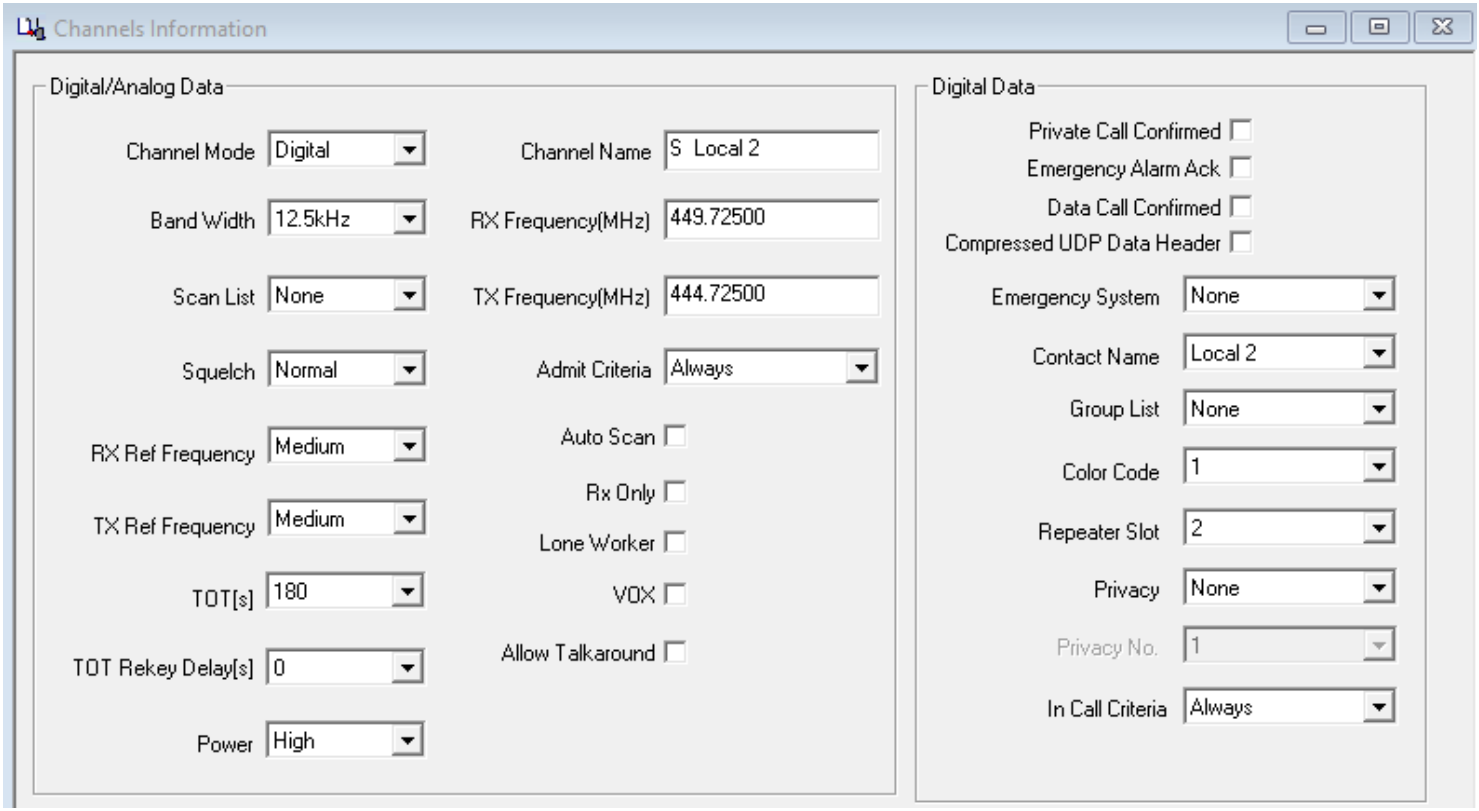
# Code Plug – The Scan List

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’
K3NXU

Miklor.com/DMR  Support Miklor

# Suggested Links

- Register at RadioID.net for a DMR ID
- Miklor Website – DMR Section
- DMR for Dummies
- Repeater Book