DIGITAL MOBILE RADIO
THE VERY BASICS

The DMR Difference

The areas covered here will be:

- Brief History
- Spectrum Efficiency
- The Local and Worldwide Network
- Repeaters vs. Hotspots
- Code Plugs Basics
- The Tangled Web

Brief History

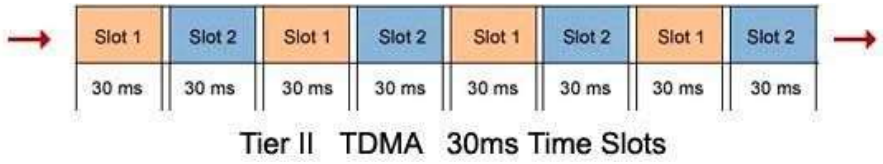
DMR was developed in Europe by ETSI, European Telecomm Standards Institute and was adopted as Commercial Standard 20 years ago.

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.

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**.

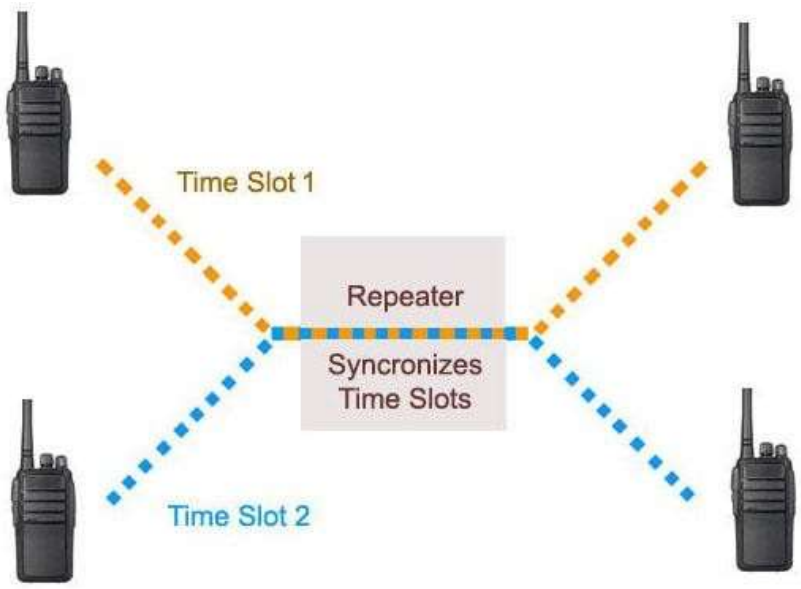


Tier II TDMA 30ms Time Slots

TDMA = Time-Division Multiple Access

Spectrum Efficiency 30ms Time Slices

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



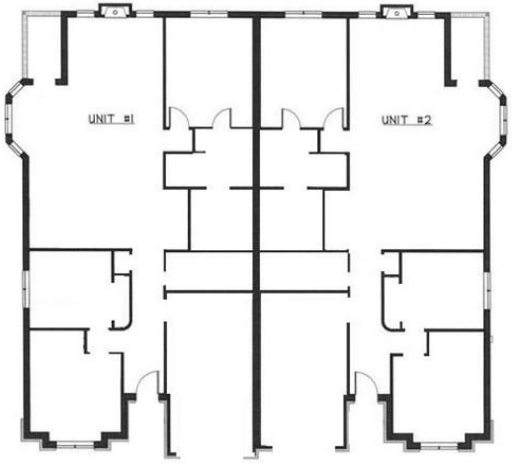
Time Slots

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:

		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	Secondary Groups	310	2	PTT (5 min)
• TAC 311, 312	Chat Groups	311, 312	2	PTT (15 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)

Sample Repeater Configuration

Timeslot 1			Timeslot 2		
Talkgroup Name	**Hold**	**Talkgroup ID**	**Talkgroup Name**	**Hold**	**Talkgroup ID**
Penna State	FT	3142	Local Repeater	FT	9
Penna TAC	15	31421	Local Area	FT	2
Maryland State	FT	3124	TAC 310	5	310
North East Reg'l	FT	3172	TAC 311, 312	15	311, 312
Mid Atlantic	FT	3173	Delaware State	FT	3110
Nationwide	5	3100	Kentucky State	15	3121

Sample from Interstate c-Bridge

FT = Fulltime 5/15 = PTT activation time

The configuration will vary from one repeater to another. Contact your local club or repeater owner to determine the exact configuration.

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.

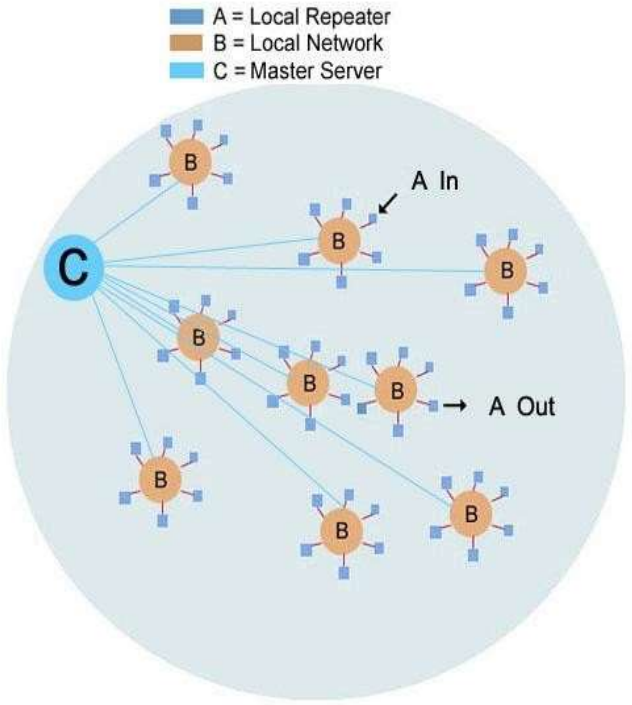
Note: Repeater cost and operation can be quite expensive. Please support your local club or repeater owner.

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 serve
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.

Several Networks Available

There are several networks available for ham radio use. It is recommended to investigate not only the available Talk Groups, but also the Location of the servers before making your selection.

Talk Groups - Not all servers share the same Groups.
[BrandMeister TGs] [TGIF TGs]

The location of the server is also important.
The further you are from a server, the longer the delay, or Latency.

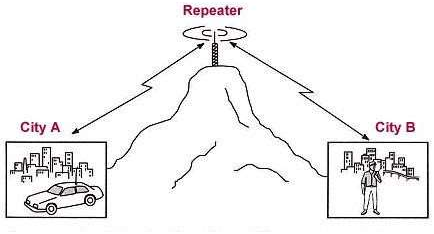
For example, if you are in the US, the TGIF network and BrandMeister are excellent choices.

BrandMeister
DMR Master Server

TGIF Network
DMR

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 local range access to a network when no repeater is available. These low power devices receive a users digital signal and passes it to a DMR network via the internet.

Repeater and Network 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.

- **Announcing your presence**
  Announce both your Call Sign and Talkgroup. This will allow someone who is scanning to identify your Talkgroup so they can answer your call.

Repeater and Network Operating Notes

- **Brandmeister Network "User Blocked" (521)** ***
  When using the Brandmeister Network, your server access will be **blocked** for one hour if the following conditions are met:

  - **5** transmissions of less then **2** seconds within **1** minute.

  This is part of the network loop prevention.

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

Network Activity Monitoring

- The following ‘Dashboards’ allow you to see the network activity Real Time. The data shown is the stations name, location and callsign, as well as the TG and time.

- **Netwatch** http://dmr.pakhams.com:8080/

- **Hoseline (BrandMeister)** https://hose.brandmeister.network/

Hose (BrandMeister)

Netwatch

Dashboard of PARS DMR network

.: Lastheard :.

Date	Time	Callsign (DMR-Id)	Name	TG#	TG Name	TX (s)	Slot	System
2022-05-20	00:26	KO4ZYJ (3190942)	Muhammad Durrani	410	410	3	1	BRIDGE_BM
2022-05-20	00:26	AP2AUM (4100008)	Asad Ullah Marwat	410	410	5	1	BRIDGE_BM
2022-05-20	00:25	AP2MHC (4100007)	Muhammad Hamid Chaudhary	410	410	5	1	BRIDGE_BM
2022-05-20	00:00	AP2CJ (4100001)	Shehzad Hamid	410	410	10	1	BRIDGE_BM
2022-05-19	23:38	AP2HD (4100011)	Muhammad Hayat Durrani	410	410	3	1	BRIDGE_BM
2022-05-19	22:27	LA3RIA (2420001)	Mushtaq Ahmed	410	410	28	1	BRIDGE_BM
2022-05-19	17:41	AP2MRC (4100010)	Musawir Rehman	410	410	13	1	AP5ARS_MASTER
2022-05-19	17:35	AP2AJM (4100003)	Muhammad Mubeen Ajmal	410	410	10	1	BRIDGE_BM
2022-05-19	15:04	AP2ARS (4100002)	Pars Pakistan Amateur Radio Society	410	410	5	1	AP5ARS_MASTER
2022-05-19	14:37	6493 (6493)		410	410	5	1	AP5ARS_MASTER

.: HBlink status :.

HB Protocol Master Systems	Callsign (DMR Id) Info	Time Connected	Slot	Source Subscriber	Destination
AP5ARS_MASTER repeat	IPSC_BRI (Id: 410000203) IPSC_HB_BRIDGE	21h 59m	TS1		
			TS2		

HB Protocol Peer Systems	Callsign (DMR Id) Info	Connected TX/RX/Lost	Slot	Source Subscriber	Destination
BRIDGE_BM Mode: PEER	AP2ARS(Id: 410000202) Islamabad, PK	21h 59m 15833 / 15822 / 11	TS1		
			TS2		

.: Bridge status :.

CJ_BM410_TS1_MESH

System	Slot	TG#	Status	Timeout	Timeout Action	Connect TG#	Disconnect TG#
AP5ARS_MASTER	1	410	Connected	N/A	None	2	9, 10
BRIDGE_BM	1	410	Connected	N/A	None	2	9, 10

CJ_BM41033_TS2__MESH

System	Slot	TG#	Status	Timeout	Timeout Action	Connect TG#	Disconnect TG#
AP5ARS_MASTER	2	41033	Connected	N/A	None	2	9, 10
BRIDGE_BM	2	41033	Connected	N/A	None	2	9, 10

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

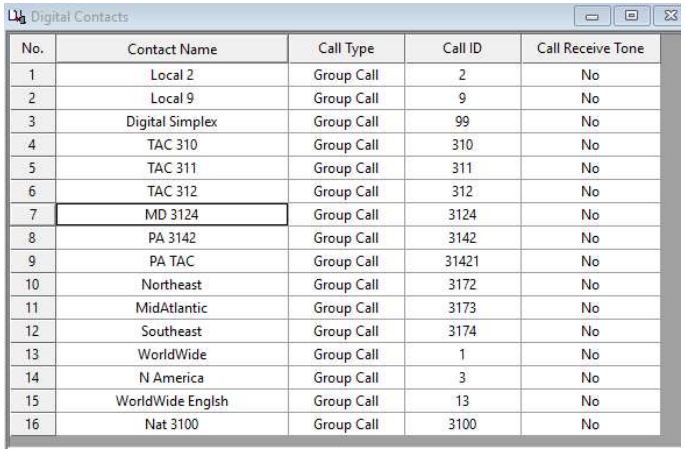
Before you start the trip, you need to know where you want to go.
This is done by creating a Contact List. This is where the desired Talkgroup information can be found.

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 Englsh	Group Call	13	No
16	Nat 3100	Group Call	3100	No

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 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	"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

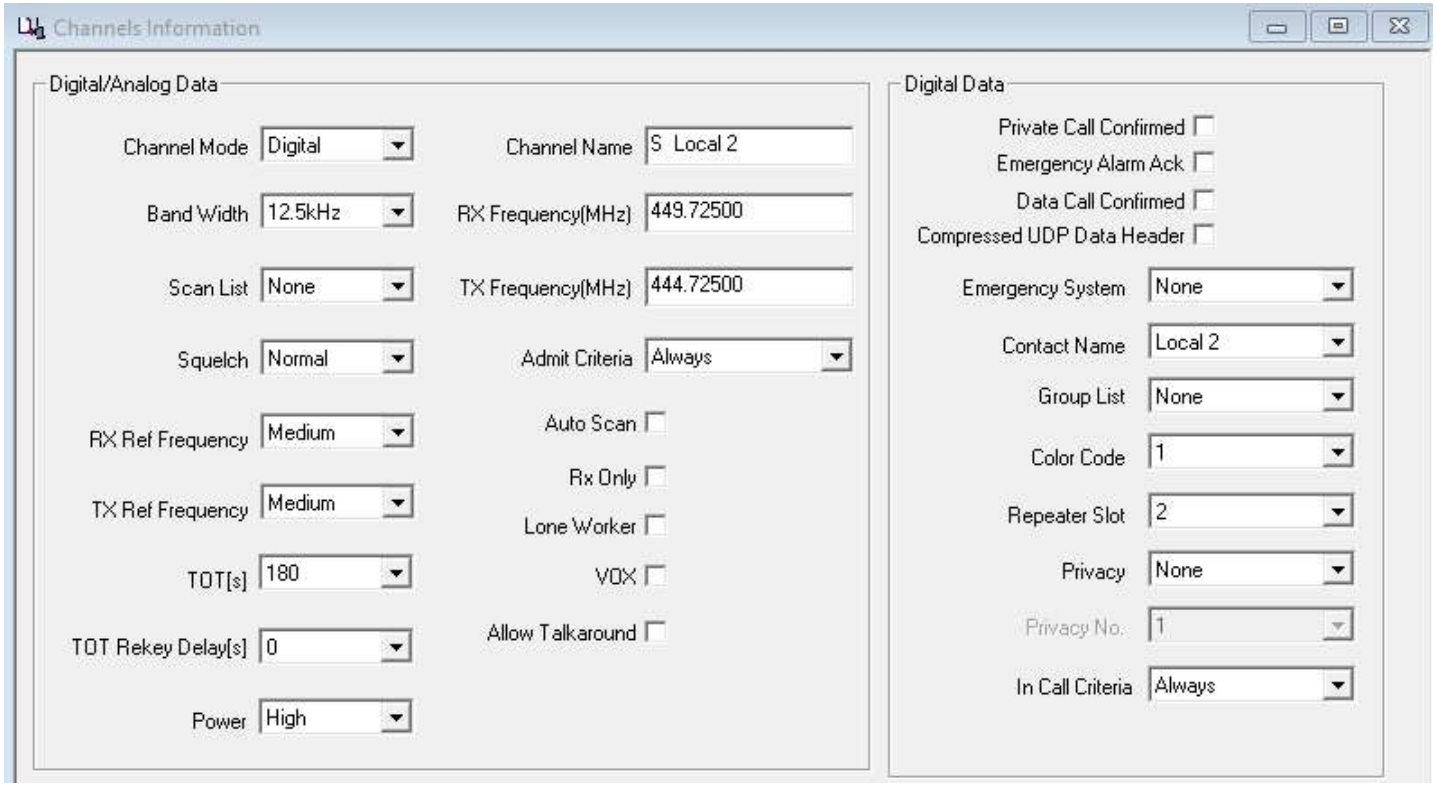
- A separate channel needs to be created for every TG desired.

- 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



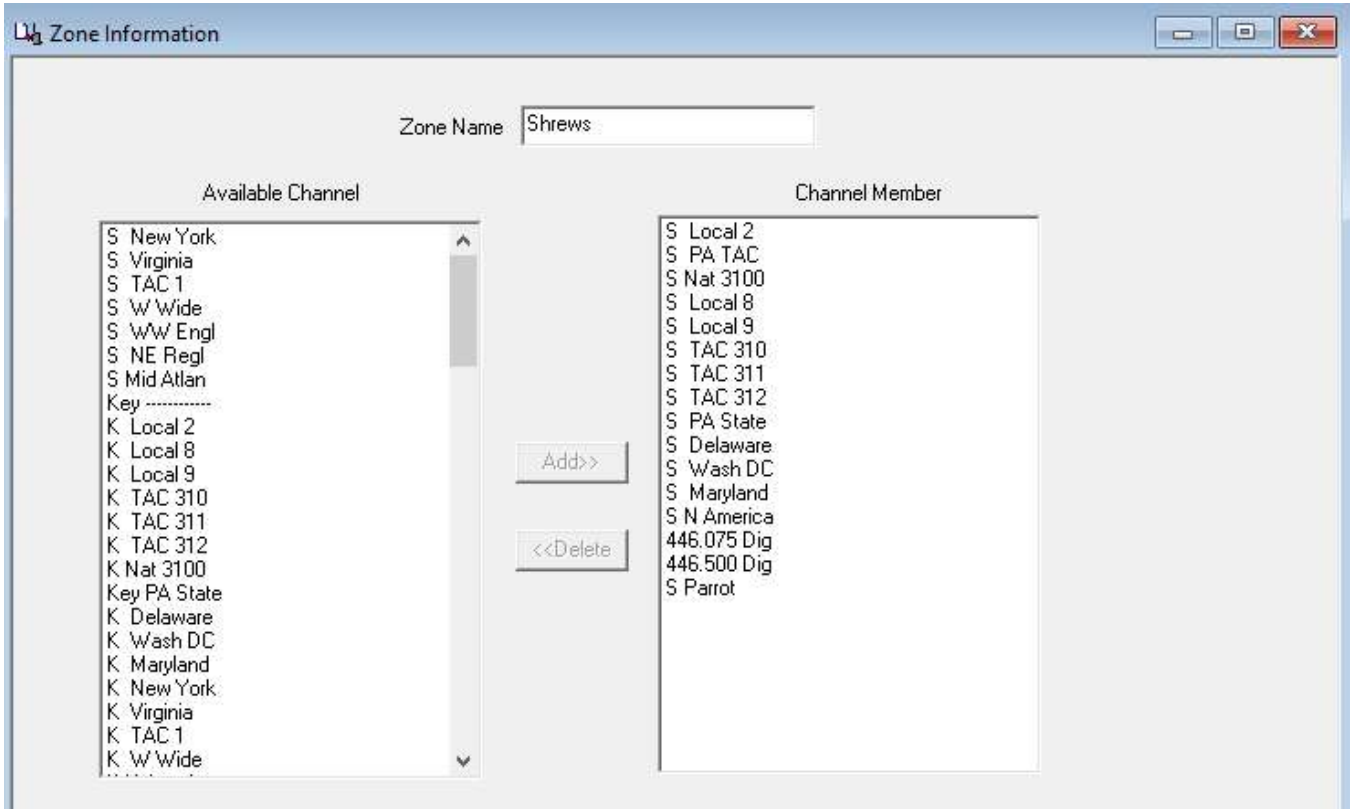
Code Plug – The Zone

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:

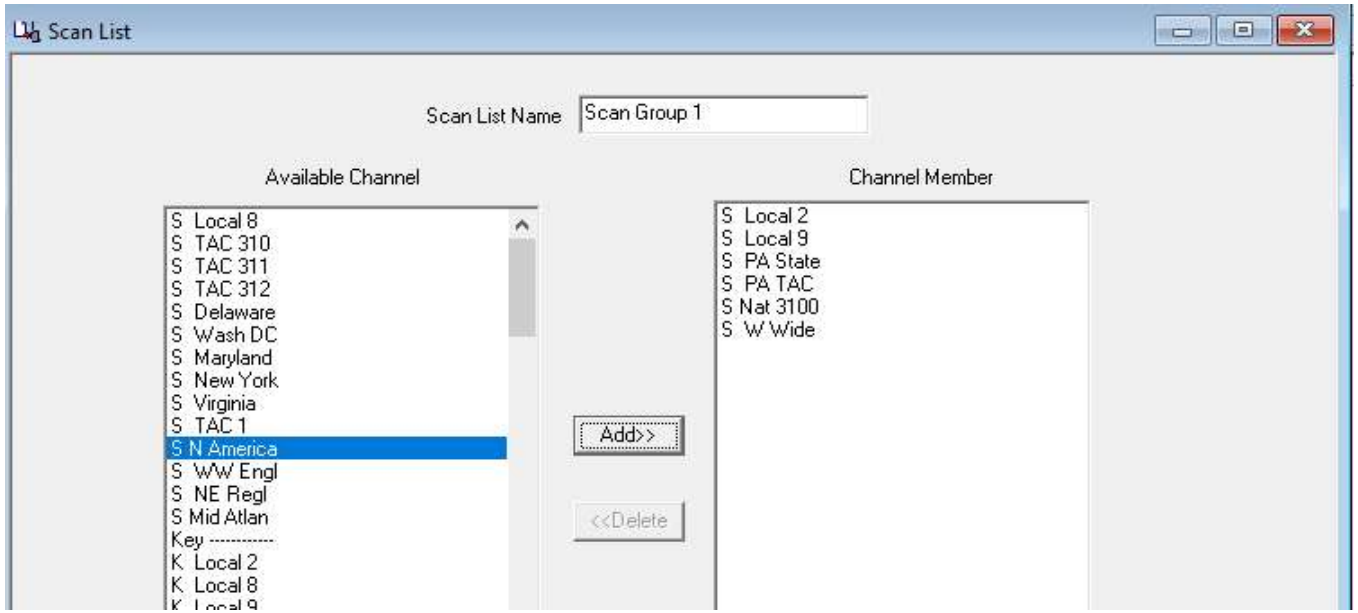
- Repeater
- Location
- Activity
- Analog Repeaters
- Simplex
- etc. You can mix and match. The choice is yours.

Code Plug – The Zone



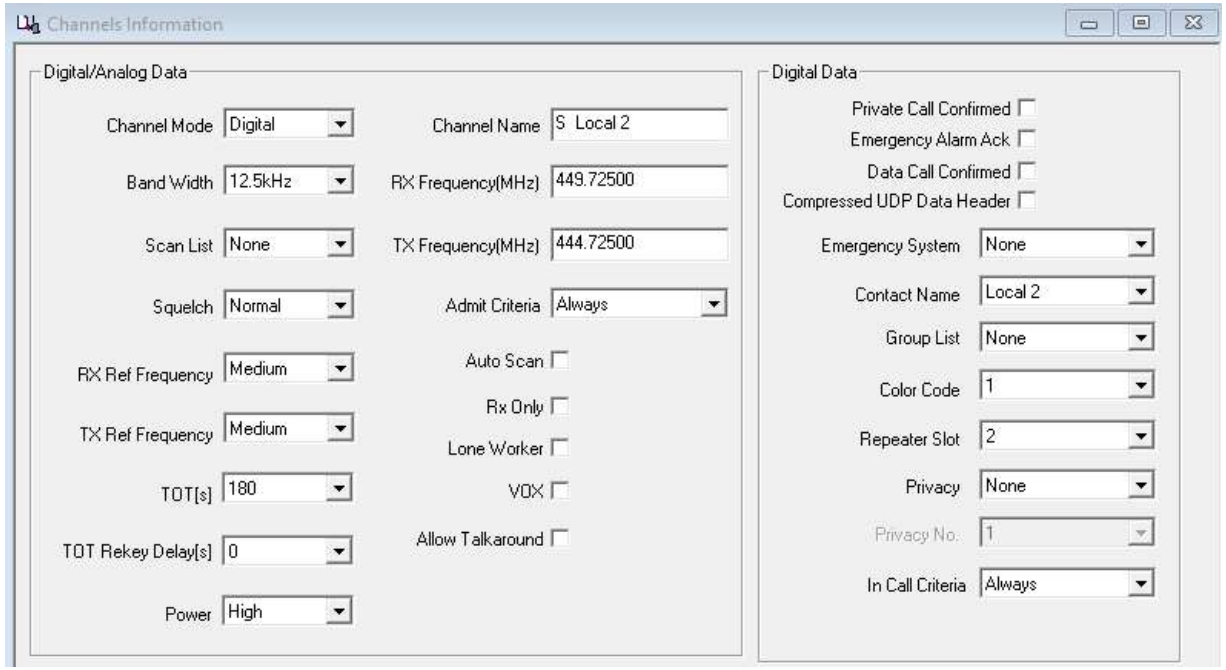
Code Plug – The Scan List

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

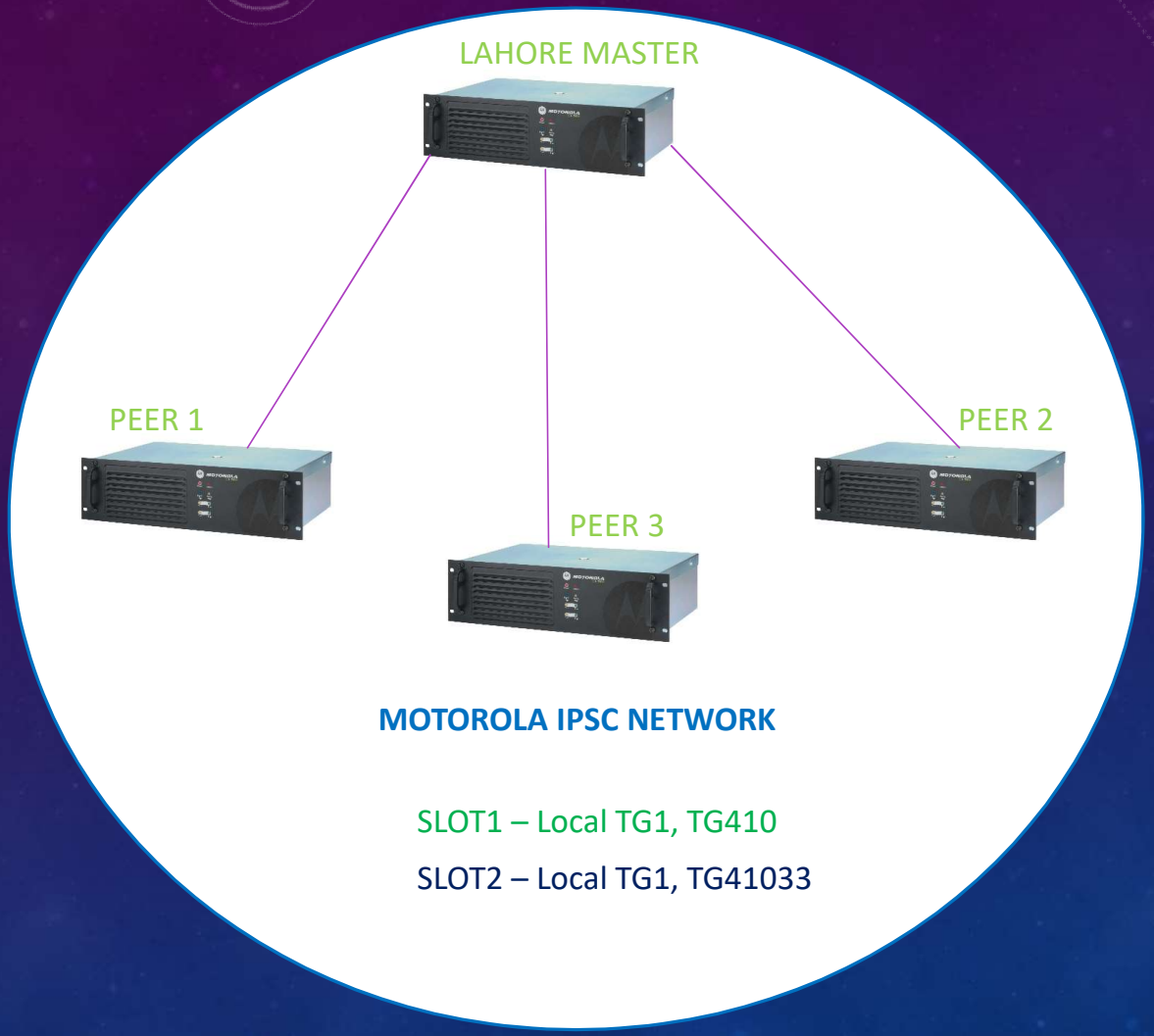
- First and foremost, never forget that this is a hobby.
  - Individuals have invested many hours and dollars in support of this network. Repeaters, servers and networks require maintenance. Support your local club whenever possible.
- If a network or online software develops a temporary issue, be patient.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

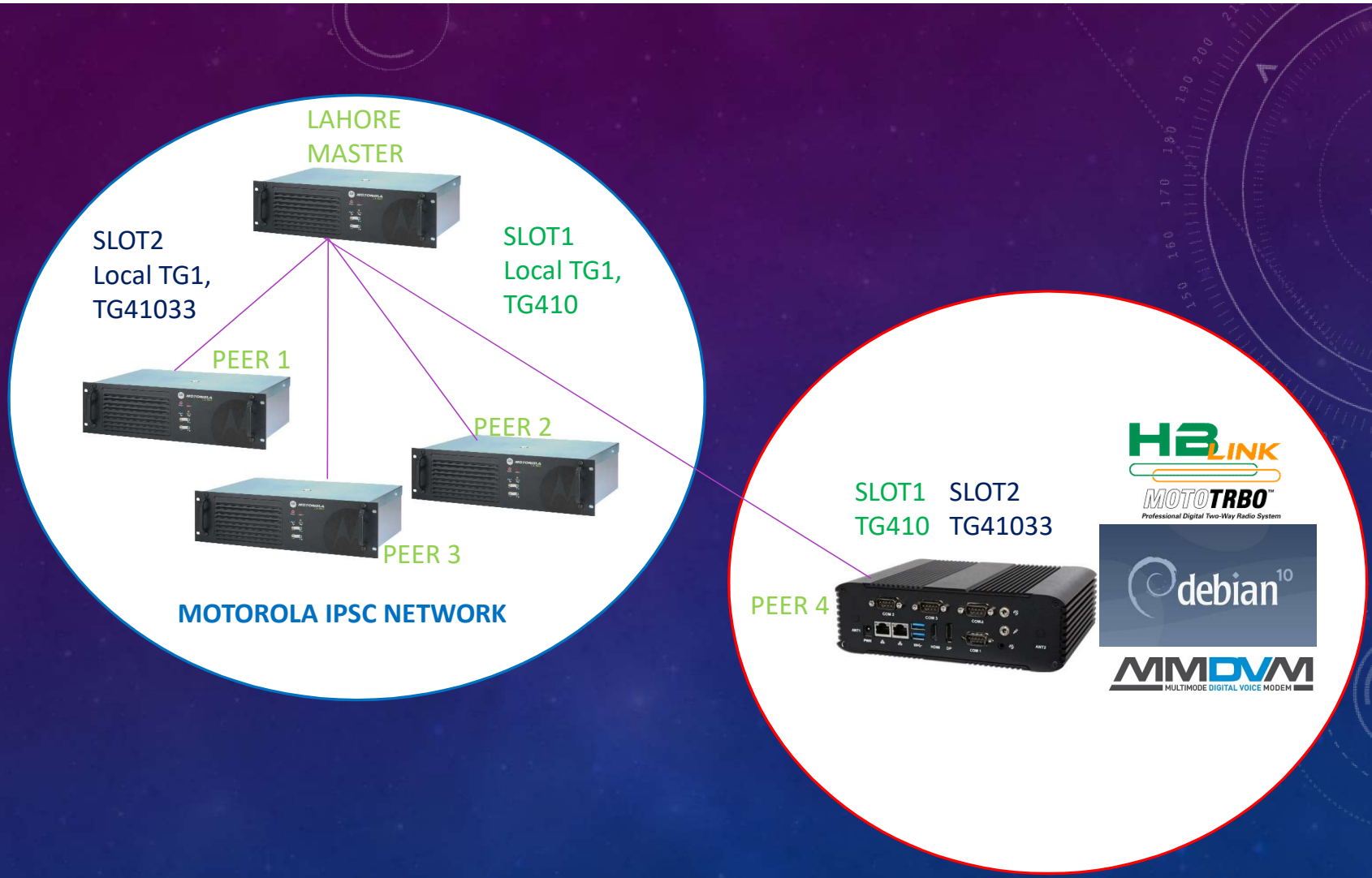
Conclusion

- 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.


THE TANGLED WEB !!


LAHORE MASTER
PEER 1
PEER 2
PEER 3
MOTOROLA IPSC NETWORK
SLOT1 – Local TG1, TG410
SLOT2 – Local TG1, TG41033


LAHORE
MASTER
SLOT2
Local TG1,
TG41033
SLOT1
Local TG1,
TG410
PEER 1
PEER 2
PEER 3
MOTOROLA IPSC NETWORK
SLOT1
TG410
SLOT2
TG41033
PEER 4
HBLINK
MOTOTRBO
Professional Digital Two-Way Radio System
debian 10
MMDVM
MULTIMODE DIGITAL VOICE MODEM

PEER 4

MOTOTRBO™
Professional Digital Two-Way Radio System

debian 10

MASTER
Server

HBLINK

SLOT1 TG410

SLOT2 TG41033

LAHORE
MASTER

SLOT2
Local TG1,
TG41033

SLOT1
Local TG1,
TG410

PEER 1

PEER 2

PEER 3

MOTOROLA IPSC NETWORK

PEER 4

MOTOTRBO
Professional Digital Two-Way Radio System

MMDVM
MULTIMODE DIGITAL VOICE MODEM

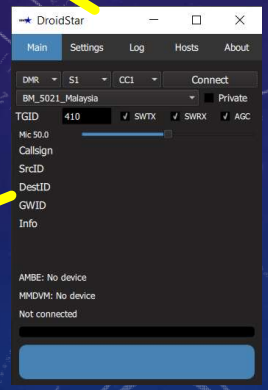
HBLINK

MASTER
Server

SLOT1 SLOT2
TG410 TG41033

DMR
BrandMeister

SLOT1 SLOT2
TG410 TG41033



LAHORE
MASTER

SLOT2
Local TG1,
TG41033

SLOT1
Local TG1,
TG410

PEER 1

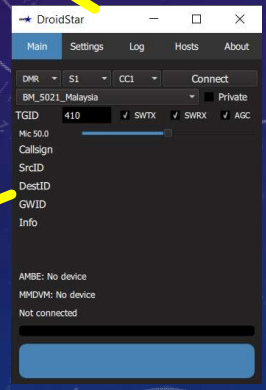
PEER 2

PEER 3

MOTOROLA IPSC NETWORK

DMR
BrandMeister

SLOT1 SLOT2
TG410 TG41033



PEER 4

MMDVM
MULTIMODE DIGITAL VOICE MODEM

HB LINK

MASTER
Server

SLOT1 SLOT2
TG410 TG41033

AP2ARS-R
Aug 2012

Analog
RF

AP2CJ-L

SLOT2
DMO

MMDVM
MULTIMODE DIGITAL VOICE MODEM

AllStar
Link

LAHORE
MASTER

SLOT2
Local TG1,
TG41033

SLOT1
Local TG1,
TG410

PEER 1

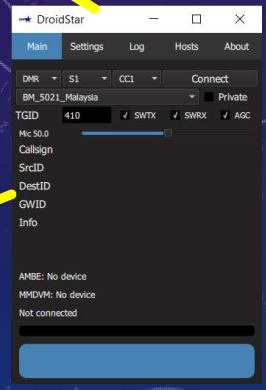
PEER 2

PEER 3

MOTOROLA IPSC NETWORK

DMR
BrandMeister

SLOT1 SLOT2
TG410 TG41033



PEER 4

MMDVM
MULTIMODE DIGITAL VOICE MODEM

HB LINK

MASTER
Server

SLOT1 SLOT2
TG410 TG41033

AP2ARS-R
Aug 2012

Analog
RF

AP2CJ-L

SLOT2
DMO

MMDVM
MULTIMODE DIGITAL VOICE MODEM

AllStar Link

E