Digital Mobile Radio

DMR 101
Before We Begin…..

- Amateur Radio is Experimental
- Amateur Radio is Learning and Fun!
- Amateur Radio is pushing the boundaries in technology
- Amateur Radio is Amateur Radio and Fun!
- DMR is not the replacement of Analog, DStar, IRLP, Echolink, Packet Radio, HF Radio, Moonbounce, Scatter, Contesting, Electronics, the universe…..
What is Digital Mobile Radio

- Commonly Known as “DMR”
- A Standard for Digital Voice Communications
- Published by the European Telecommunications Standards Institute (ETSI) in 2005 (Tier 1 & Tier 2) | 2015
- The goal of the standards to create a digital systems are:
  - Low Cost
  - Low Complexity
  - Interoperable Between Vendors
DMR Association

- A Global Organization Focused on Growing the DMR Market
- Provides
  - Interoperability Testing
  - Certification
  - DMR Education, Promotion and Encourages Discussion
DMR Association Members
The DMR Standard

- Specifies the Air Interface Between Radios
- 2-Slot Time Domain Multiple Access (TDMA)
- 12.5 kHz Channel Width
- Digital Modulation (4FSK)
- Frequencies Between 30MHz - 1 GHz
- DMR Association Members Have Agreed to Use the AMBE +2 Vocoder
Benefits of Using DMR

- Allows 2 Simultaneous Voice Conversations using a Single Repeater
- Improved Audio Performance Over Analog
- More Efficient Use of Radio Spectrum vs Analog
- Longer Battery Life vs. Analog
- Lowest Total Cost of Ownership for Clubs - Compared to Other Ham Digital Modes
- +12 DMR Radio Manufactures = Lower Radio Prices
- Capable of Being Linked to Over 1,800 Repeaters Worldwide
## Features of HAM DMR Network

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Talk Groups</td>
<td>Allows users to access groups of other users by geography or language by simply keying their radios. No node numbers to dial or remember.</td>
</tr>
<tr>
<td>Dual Timeslots</td>
<td>Allows 2 simultaneous conversations using a single repeater. Like having 2 repeaters on one frequency.</td>
</tr>
<tr>
<td>Text Messaging</td>
<td>A quick and convenient way to send messages to a group or a single person.</td>
</tr>
<tr>
<td>Roaming</td>
<td>Allows DMR radios to switch between repeaters automatically, common TG</td>
</tr>
<tr>
<td>Remotely IP Programmable</td>
<td>Allows the repeater sponsors to make changes remotely.</td>
</tr>
<tr>
<td>Repeaters</td>
<td></td>
</tr>
<tr>
<td>APRS</td>
<td>Radios beacon location (radios with GPS Built in) Brandmeister Network Only</td>
</tr>
</tbody>
</table>
DMR vs Analog

DMR Repeater

30ms  30ms  30ms  30ms  30ms  30ms
Slot 1  Slot 2  Slot 1  Slot 2  Slot 1  Slot 2

2 Voice Channel

Analog Repeater

1 Voice Channel
Improved Voice Performance

- No Hiss, Popping or Static
- Better RF Range than older digital technologies
- Forward Error Correction and Cyclic Redundancy Check Coders
Improved Voice Performance

Digital Mode

Analog Mode

Digital signal is still clearly heard at the fringes of the coverage footprint.

Analog signal becomes harder to hear through noise at the edge of the communication range.
Efficient Use of Radio Spectrum

DMR Provides $4x$ as Many Voice Conversations Using the Same Spectrum as One FM Repeater @ 25 KHz.

<table>
<thead>
<tr>
<th>1 x 25 kHz Channel</th>
<th>1 FM Repeater</th>
<th>1 Voice Conversation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 DMR Repeaters</td>
<td>4 Voice Conversations</td>
<td></td>
</tr>
</tbody>
</table>
Two Repeaters in One

Two Channel Analog or Digital FDMA System

- Repeater 1
- Repeater 2

Combining Equipment

- Frequency 1
- Frequency 2

1 Call Per Repeater and Channel

Two Channel Digital TDMA System

- Repeater

Frequency 1

2 Calls per Repeater and Channel
Longer Battery Life

- Up to 40 percent in talk time compared to analog radios.
- Radio is transmitting half the time due to TDMA.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talkgroup</td>
<td>A Virtual Radio Channel, Typically assigned by geography or language.</td>
</tr>
<tr>
<td>Timeslot</td>
<td>A brief interval to which a DMR radio, especially a repeater, accepts data from another radio. For DMR there are two (2) 30ms time slots.</td>
</tr>
<tr>
<td>Color Code</td>
<td>A number that is analogous to the PL or CTCSS tone used during analog FM Analog Operation.</td>
</tr>
<tr>
<td>C-Bridge</td>
<td>A Server that bridges together regional DMR Networks. Or Brandmeister</td>
</tr>
<tr>
<td>User ID</td>
<td>A unique number assigned to each radio on the DMR Network. Also known as “Subscriber ID” or a “Radio ID”</td>
</tr>
<tr>
<td>CPS</td>
<td>Short for Customer Programming Software, which is the software used to program a DMR Radio.</td>
</tr>
<tr>
<td>vocoder</td>
<td>A Synthesizer in DMR Radio that converts analog voice to digital data.</td>
</tr>
<tr>
<td>Master</td>
<td>A DMR Repeater that connects to a c-Bridge on a ham DMR Network. All other DMR repeaters that connect to the network through the master are called peers.</td>
</tr>
</tbody>
</table>
# Digital Voice Systems

<table>
<thead>
<tr>
<th>Format Feature</th>
<th>P25 Phase II</th>
<th>DMR</th>
<th>DSTAR</th>
<th>FUSION</th>
<th>NXDN/IDAS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating Band</strong></td>
<td>VHF, UHF, 700/800</td>
<td>70cm, 2m, 33cm</td>
<td>2m, 70cm, 33cm</td>
<td>2m, 70cm</td>
<td>70cm, 2m, 33mc</td>
</tr>
<tr>
<td><strong>Dual Band</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Battery Life</strong></td>
<td>40% Longer</td>
<td>40% Longer</td>
<td>Normal</td>
<td>Normal</td>
<td>20% Longer</td>
</tr>
<tr>
<td><strong>Dual Time Slot</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>20-25% over wideband analog</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Manufacture Specific</strong></td>
<td>No</td>
<td>No</td>
<td>Yes, Icom</td>
<td>Yes, Yaesu</td>
<td>Yew, Kenwood, Ritron/Icom</td>
</tr>
<tr>
<td><strong># of Manufactures</strong></td>
<td>&gt;6</td>
<td>25+</td>
<td>1</td>
<td>1</td>
<td>2/1</td>
</tr>
</tbody>
</table>
## Digital Voice Systems

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<th>DSTAR</th>
<th>FUSION</th>
<th>NXDN/IDAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>TDMA</td>
<td>TDMA/4FSK</td>
<td>GMSK</td>
<td>FDMA/C4FM</td>
<td>FDMA</td>
</tr>
<tr>
<td>Vocoder</td>
<td>AMBE+2</td>
<td>AMBE+2</td>
<td>AMBE</td>
<td>AMBE+2</td>
<td>AMBE+2</td>
</tr>
<tr>
<td>Forward Error Correction</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes/Yes</td>
</tr>
<tr>
<td>Spatial Efficiency</td>
<td>12.5kHz dual 6.25kHz</td>
<td>12.5kHz dual 6.25kHz</td>
<td>6.25kHz</td>
<td>12.5kHz</td>
<td>6.25kHz/12.5Khz</td>
</tr>
<tr>
<td>Adopted Worldwide Standard</td>
<td>Yes, Public Safety</td>
<td>Yes, Commercial &amp; Amateur</td>
<td>Yes, Amateur Radio Only</td>
<td>No, Amateur Radio Only</td>
<td>No</td>
</tr>
<tr>
<td># Repeaters in US</td>
<td>170</td>
<td>908</td>
<td>1100</td>
<td>219</td>
<td>52</td>
</tr>
</tbody>
</table>
DMR Standards

• Tier 1
  ○ FDMA
  ○ dPMR - 446 MHz European Unlicensed Service

• Tier 2
  ○ 2 Slot TDMA
  ○ IP Site Connect (Vendor Specific)

• Tier 3
  ○ 2 Slot TDMA
  ○ Trunking
Amateur Radio DMR Networks

- Over 2,100 Repeaters Worldwide
- Over 34,000 Registered Radios Worldwide
- Over 14,700 US Registered Radios
- Networks Divided by Infrastructure
  - CBridge, SmartPTT - Mototrbo (Motorola Solutions)
    - Primarily US/UK
  - Brandmeister - Hytera, Mototrbo, Homebrew, MMDVM, DV4Mini, DVMega
    - Worldwide Growth - Newest System
  - DMR +
    - Original Hytera Network
    - Growth slowing and decreasing in use
Amateur Radio DMR Networks - Nevada

**Repeaters**
- 29 Repeaters Statewide
  - 5 Reno/Tahoe
  - 2 Elko
  - 22 Southern (LV, Henderson)

**Users**
- 364 Registered Radios / IDs
  - 160 Southern Nevada
  - 204 Northern Nevada
  - 164 Reno / Tahoe Area
Low Cost of Ownership

Example: A Ham Radio Club of 20 Members

<table>
<thead>
<tr>
<th></th>
<th>Quantity</th>
<th>FUSION</th>
<th>DSTAR</th>
<th>DMR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Repeater</td>
<td>1</td>
<td>$620$¹</td>
<td>$1,548$⁶</td>
<td>$1,800$²</td>
</tr>
<tr>
<td>Programming Cable &amp; Software</td>
<td>1</td>
<td>$0</td>
<td>$0</td>
<td>$375</td>
</tr>
<tr>
<td>Digital Portables</td>
<td>20</td>
<td>$6,000$³</td>
<td>$6,000$⁵</td>
<td>$3,980$⁴</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$6,620</td>
<td>$7,548</td>
<td>$6,155</td>
</tr>
</tbody>
</table>

1. Yaesu club price - $500.00, Wires-X $120.00
2. Motorola XPR 8400 Ham Friendly Dealer
3. Yaesu FT1DR-HD @ $300.00 Each
4. Connect Systems CS750 - 170.00 (Group Order)
5. ICOM IC-ID31A @ $300.00 Each
6. Icom Club Price ID-RP4000V @$700.00 ID-RP2C @$848.00
Mototrbo Repeaters

XPR 8400

SLR 5700
Portable Radios

- Connect Systems CS750: $239.00
- TYT MD380: $120.00
- Motorola XPR6550: $450.00
- Motorola XPR7550: $700.00
- Vertex/Standard EVX-539: $350.00
- Hytera PD-782: $585.00
Mobile Radios

- **Vertex/Standard EVX-5400**
  - Price: $400.00

- **Connect Systems CS800**
  - Price: $280.00

- **Hytera MD782**
  - Price: $565.00

- **Motorola XPR5550**
  - Price: $600.00

- **Motorola XPR4550**
  - Price: $450.00
Network - How it Works

IP Site Connect

CBridge Hardware (server)
Network - How it Works

Brandmeister
Hardware (server)
Common Courtesy

- All Radios Must Register for a 7-Digit DMR ID - [http://dmr-marc.net](http://dmr-marc.net)
- **ID** - You Must ID the same as you would on Analog - Per FCC Rules
- Remember you might be keying up 100+ repeaters
- **Test** - If you want to test go to Echo Test (Parrot) and ID
- **Pause** - pause between your communications to allow others to join
Common Courtesy

- What to do when keying up talk group
  - Give your Call and the Talk Group you are on
  - You can simply say “W7XM on SNARS Listening”
  - or “W7XM on SNARS”
  - or “W7XM on SNARS Looking for QSO”
  - Do whatever you feel comfortable
**Timeslots and Talkgroups**

A Virtual Radio Channel, Typically assigned by geography or language.

**Sample Talkgroups on the SNARS Systems**

<table>
<thead>
<tr>
<th>Talkgroup</th>
<th>Time Slot</th>
<th>Name</th>
<th>Connection</th>
<th>Timers</th>
</tr>
</thead>
<tbody>
<tr>
<td>6968</td>
<td>1</td>
<td>SNARS</td>
<td>Always Active</td>
<td></td>
</tr>
<tr>
<td>3132</td>
<td>2</td>
<td>Nevada</td>
<td>Always Active</td>
<td>Hold Off 5 Mins</td>
</tr>
<tr>
<td>3107</td>
<td>2</td>
<td>California</td>
<td>Always Active</td>
<td>Hold Off 5 Mins</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>World</td>
<td>User Activated</td>
<td>5 Min Activity</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>North America</td>
<td>User Activated</td>
<td>5 Min Activity</td>
</tr>
</tbody>
</table>
Getting Started as a DMR User

1. Check that you’re within the coverage area of a DMR Repeater
2. Request a User ID
3. Obtain a DMR Radio, programming hardware and software
4. Program your DMR Radio
5. Code Plugs available on websites, groups
Setting up a DMR Repeater

1. Obtain a Motorola MOTOTRBO DMR Repeater
2. Obtain a coordinated repeater frequency
3. Secure Location with Internet Access (500 kpbs minimum)
4. Register for a Repeater ID
5. Apply to join a DMR Network, such as DMR-MARC or Mountainwest
Other ways to Access DMR

- **DV Mega**
  - Raspberry PI
  - Dv-Mega DualBand
  - DMVega Raspberry PI Radio
  - $260 Gigaparts Dual Band Raspberry PI

- **DV4 Mini**
  - UHF
  - $129

- **MMDVM**
  - $70
  - Board & DUE

- **OpenSPOT**
  - UHF
  - Release in May
  - $??
Other ways to Access DMR

Brandmeister Network
http://hose.brandmeister.network

- Scanning (5 Talk Groups)
- Archive of Audio (30 Days)
- Audio Meters
- Save Scan List via URL
  - /scan/TG1,TG2, etc
Questions

http://snars.org/dmr
http://dmr-marc.net
http://mountainwestdmr.org
http://norcaldmr.org
http://papasys.com/dmr
http://brandmeister.network
http://hose.brandmeister.network
http://utah-dmr.net
http://www.trbo.net