

# INTRODUCTION TO DIGITAL VOICE MODES

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Jim Bates  
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# Who are these guys?

- Jay, KD4BPZ
  - Amateur since 1991
  - Diverse amateur interests: DX, digital HF modes, 6m SSB, weak signal, beacons, repeaters, digital voice
- Jim, K8OI
  - Amateur since 2010
  - Likes American Pale Ale and Dopplebock
  - Hates long walks on the beach and looking for sea shells
  - Enjoys 6m, VHF+, & non-FM activity

# Objectives

- Learners will be:
  - Able to describe basic characteristics of DSTAR, P25, and DMR
  - Able to understand basic differences between the systems
  - Able to understand local options for trying these systems
  - Create awareness of new and used gear that can be used
  - Be aware of common myths that relate to digital communications

# Why consider digital voice modes?

- “New” technology – but not really...
- Opportunities to experiment and pioneer
- Audio Quality
- Networking / linking capability

# Quick Overview

D-STAR - Digital Smart Technologies for Amateur Radio is an open standard digital communication protocol established by the Japan Amateur Radio League (JARL). This protocol was designed for the Amateur Radio Service and ICOM is currently the only major equipment manufacturer making D-STAR gear. See “D-STAR, Digital Voice for VHF/UHF,” CQ VHF magazine, Winter 2006.

APCO 25 - The Project 25 radio standard was developed by the Association of Public-Safety Communications Officials-International (APCO) primarily for the Public Safety Spectrum. A primary goal of this standard is to enable intercommunication between multiple public safety organizations (e.g., fire, police, medical). Uses both FMDA and TDMA in different parts of the standard (phase I vs phase II). Can be used trunked or non-trunked.

DMR - Digital Mobile Radio standard was developed by the European Telecommunications Standards Institute (ETSI). This standard uses TDMA to allow two communication links simultaneously on a single 12.5-kHz channel. See “TRBO Hits the Amateur Bands,” CQ VHF magazine, Spring 2012.

Overview comments are from CQ Amateur Radio - Mar-Apr-2014

# DSTAR - Richmond

- 3 Repeaters in the “Stack”
  - Each repeater is connected to the Gateway
  - The Gateway allows each repeater independent access to the D-Star Network
- Located in downtown Richmond
- W4FJ C is 2m, 147.255+
- W4FJ B is 70cm, 443.7125+
- W4FJ A is 23cm, 1,284 -20Mhz
- Internet Gateway is available for linking
- W4FJ C is automatically “linked” during the work week to REF025C (N. Va Repeaters)

# □ W4FJ D-Star Repeater Stack

- Controller
- 2m Module
- 70cm Module
- 23cm Module
- Gateway
- Power Supplies
- Duplexers
- Amplifiers



# DSTAR - Applications

## Application 1

### Digital voice (DV mode)

Analog audio is modulated to a digital signal and transmitted in the digital mode signal by the D-STAR radio.



## Internet connection\*

The Internet gateway allows linking of D-STAR repeater sites over the Internet. You can uplink to your local repeater and downlink from a remote repeater, even from a foreign country!

INTERNET

## Application 5

### IP camera (DD mode)

You can transmit live images in DD mode and watch real-time images from a remote location.



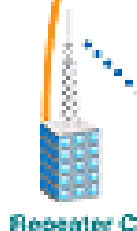
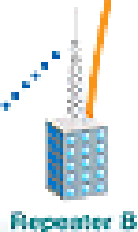
## Application 2

### Short data message (DV mode)

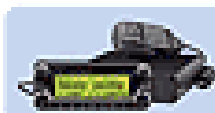
HELLO



Call sign identification and short data messages are available.



GPS satellite



## Application 3

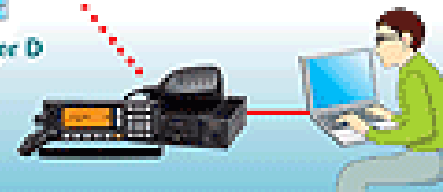
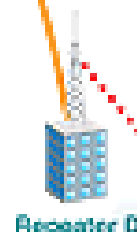
### GPS tracking (DV mode)

With a GPS receiver, you can send your current position information to another radio.

## Application 4

### Internet access (DD mode)\*

In DD mode operation, you can access to the Internet via a D-STAR Internet gateway. Connect a PC with the ID-1 and you can browse web sites or check e-mail.



- Internet
- DV mode (4.8kbps)
- DD mode (128kbps)



# D-STAR - Radios

**ICOM** **D-STAR Handheld** Radio Selection Chart  
 full-featured radios; Icom has the right radio for the right job

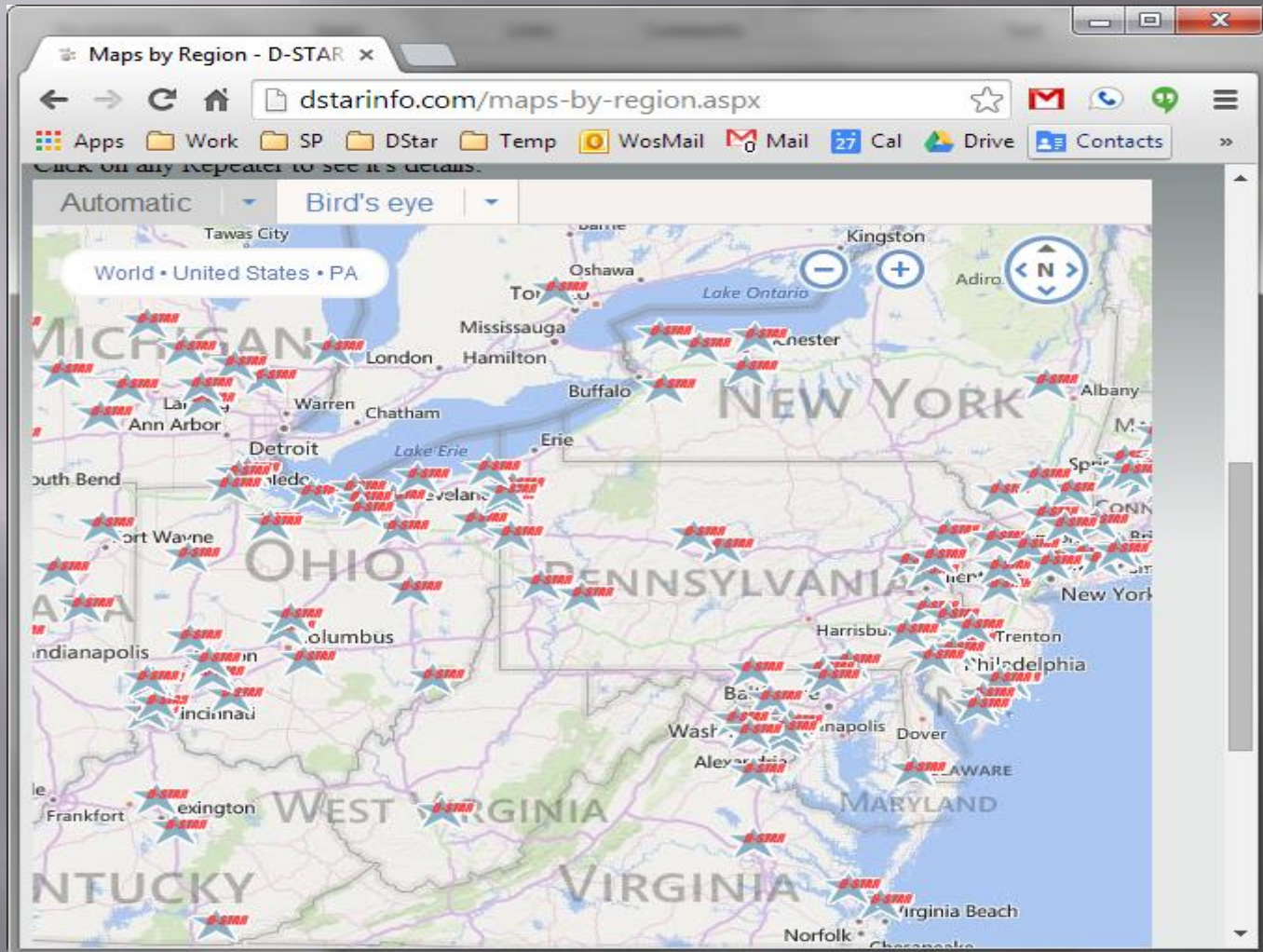
				
<b>RADIO/FEATURES</b>	<b>ID-51A</b>	<b>ID-31A</b>	<b>IC-80AD</b>	<b>IC-92AD</b>
<b>GENERAL</b>				

**ICOM** **D-STAR Mobile** Radio Selection Chart  
 full-featured radios; Icom has the right radio for the right job

			
<b>RADIO/FEATURES</b>	<b>ID-880H</b>	<b>IC-2820H</b>	<b>ID-1</b>
<b>GENERAL</b>			
Digital Functionality	D-STAR Upgradable	D-STAR Upgradable	D-STAR Compatible
DD Mode (Digital Data Mode)	N/A	N/A	Yes

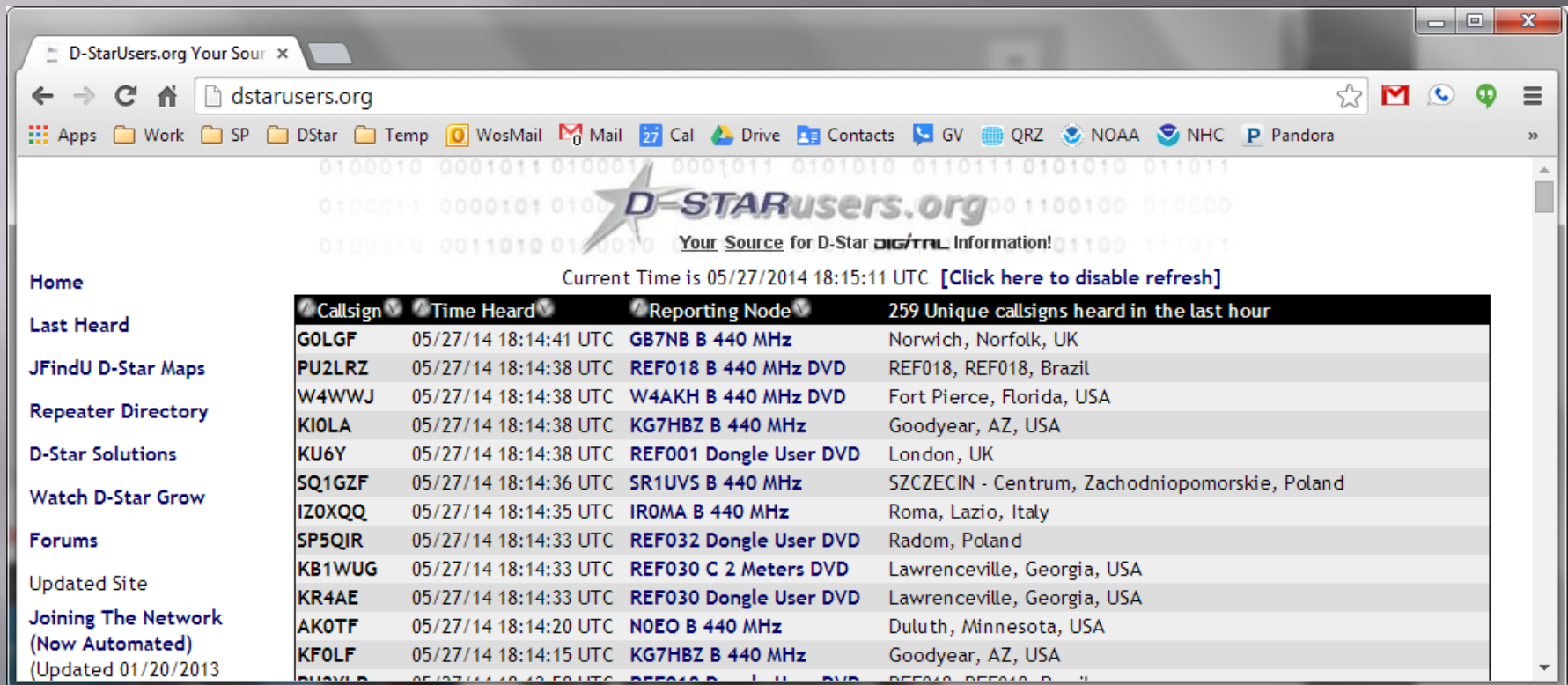
# DSTAR – Overview

[www.dstarinfo.com](http://www.dstarinfo.com)



# DSTAR – Overview

[www.dstarusers.org](http://www.dstarusers.org)



The screenshot shows a web browser window with the URL [dstarusers.org](http://dstarusers.org). The page features a navigation menu on the left and a main content area with a table of active callsigns. The table is titled "259 Unique callsigns heard in the last hour" and includes columns for Callsign, Time Heard, Reporting Node, and location. The current time is 05/27/2014 18:15:11 UTC.

Home  
Last Heard  
JFindU D-Star Maps  
Repeater Directory  
D-Star Solutions  
Watch D-Star Grow  
Forums  
Updated Site  
Joining The Network (Now Automated) (Updated 01/20/2013)

0100010 0001011 0100011 0001011 0101010 0110101 10101010 011011  
0100011 0000101 0100011 0001011 0101010 0110101 10101010 011011  
0100010 0011010 0100011 0001011 0101010 0110101 10101010 011011

**D-STARusers.org**  
Your Source for D-Star DIGITAL Information!

Current Time is 05/27/2014 18:15:11 UTC [\[Click here to disable refresh\]](#)

Callsign	Time Heard	Reporting Node	259 Unique callsigns heard in the last hour
G0LGF	05/27/14 18:14:41 UTC	GB7NB B 440 MHz	Norwich, Norfolk, UK
PU2LRZ	05/27/14 18:14:38 UTC	REF018 B 440 MHz DVD	REF018, REF018, Brazil
W4WWJ	05/27/14 18:14:38 UTC	W4AKH B 440 MHz DVD	Fort Pierce, Florida, USA
KI0LA	05/27/14 18:14:38 UTC	KG7HBZ B 440 MHz	Goodyear, AZ, USA
KU6Y	05/27/14 18:14:38 UTC	REF001 Dongle User DVD	London, UK
SQ1GZF	05/27/14 18:14:36 UTC	SR1UVS B 440 MHz	SZCZECIN - Centrum, Zachodniopomorskie, Poland
IZ0XQQ	05/27/14 18:14:35 UTC	IR0MA B 440 MHz	Roma, Lazio, Italy
SP5QIR	05/27/14 18:14:33 UTC	REF032 Dongle User DVD	Radom, Poland
KB1WUG	05/27/14 18:14:33 UTC	REF030 C 2 Meters DVD	Lawrenceville, Georgia, USA
KR4AE	05/27/14 18:14:33 UTC	REF030 Dongle User DVD	Lawrenceville, Georgia, USA
AK0TF	05/27/14 18:14:20 UTC	NOEO B 440 MHz	Duluth, Minnesota, USA
KF0LF	05/27/14 18:14:15 UTC	KG7HBZ B 440 MHz	Goodyear, AZ, USA
...	...	...	...

# DSTAR – Overview

## w4fj.dstargateway.org

The screenshot shows a web browser window with the address bar at [w4fj.dstargateway.org](http://w4fj.dstargateway.org). The page title is "DPLUS Dashboard | Gateway Status and Control". Below the title is a navigation bar with three items: "Registration", "W4FJ Repeater System", and "DPLUS version 2.2k".

### Linked Gateways / Reflectors

Module	Linked to
A	unlinked
B	unlinked
C	REF025 B
D	unlinked
E	unlinked

### Remote Users

Callsign	User Message	Last TX on	Type
WA3J	Allan is mobile	C	2014/05/27 14:01:37
WA4SSG	RICHMOND VA	A	2014/05/27 09:07:12

### Last Heard

Callsign	User Message	Last TX on	Time
WA3J	Allan is mobile	C	2014/05/27 14:01:37
WA4SSG	RICHMOND VA	A	2014/05/27 09:07:12

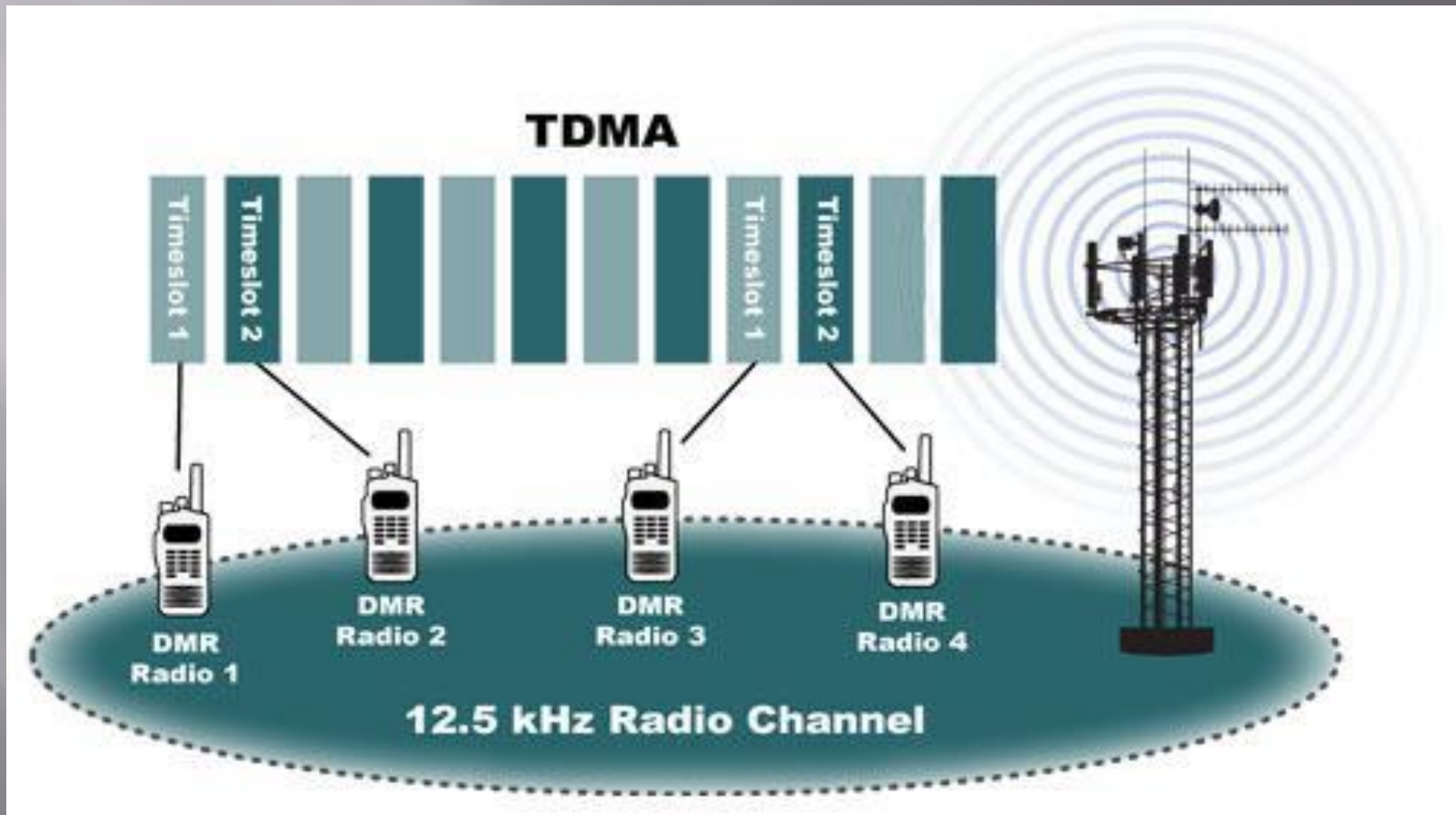
# DMR Overview and qualities

- Basic technology info
  - Open digital standard – adopted by numerous manufacturers
  - Designed to be spectrum efficient
  - Radios are generally backwards compatible with FM operation
  - Error correction protocols used in audio processing
  - Ongoing and flexible standards development

# DMR Overview and qualities

- Basic technology info
  - Allows 2 simultaneous voice conversations using a single repeater
    - 12.5 khz segment of spectrum can hold two simultaneous conversations
  - Multiple talk paths possible (talkgroups)
  - High quality audio performance
  - More efficient use of radio spectrum
  - Longer battery life

# Two time slot system



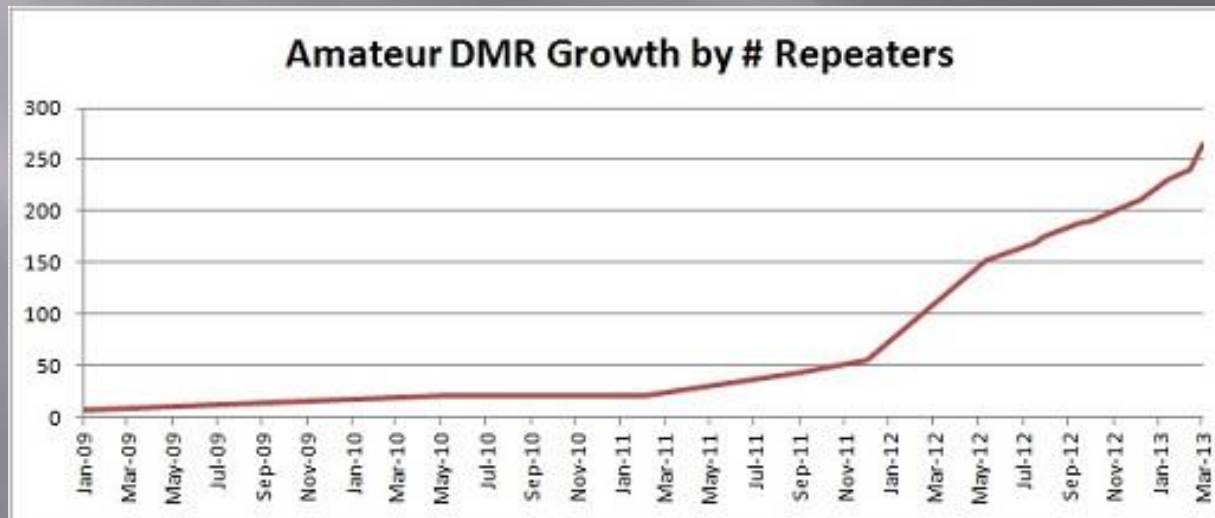
# DMR History

- Digital Mobile Radio
  - AKA MotoTRBO
  
- ESTI Standard
- 2005
- First marketed and intended for land mobile radio
- In USA, has expanded to some public safety utilization
  
- Three tiers
  - Tier I – intended for personal mobile radio (dPMR) – similar to FRS outside of the USA
    - Not widely implemented
  - Tier II – commonly implemented, repeater and simplex utilization
  - Tier III – trunking, messaging and data expansion on top of Tier II
  
- Amateur utilization – various networks throughout the world



# DMR History in the Amateur World

- Implementations almost immediately in large metro areas
- Several large national and international networks
  - DMR MARC, DCI, PRN, etc
- Virginia since 2010
  - W4YP, WA4FC
- New RATS system April 2014



# DMR Equipment Vendors



# Typical DMR Hardware



- Commercially available gear from several different manufacturers
- Most DMR infrastructure is built from Motorola hardware, some Hytera
- New and used gear available
- Pictured – Motorola XPR8300 repeater, XPR4550 mobile, XPR6550 portable

# Hytera



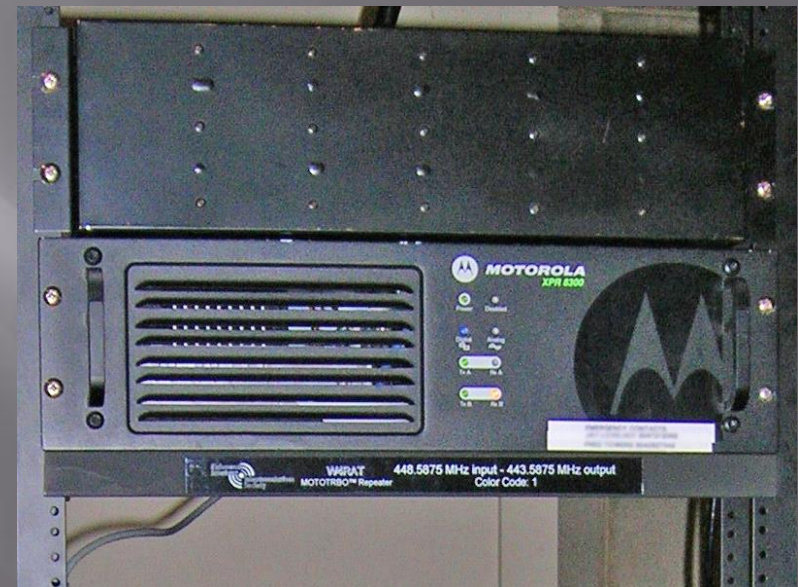
# Connect Systems CS700

- Entry level DMR radio – under \$200 new
- Software – free
- Programming cable – free
- Firmware – new radio
- Very popular in metro Richmond
- Analog and DMR formats
- No field programming



# Local DMR Repeater System

- New RATS system
  - 443.5875 MHz
  - Previously on air in Prince George
- Haymarket, Virginia
- Fancy Gap, Virginia
- Washington, DC
- Baltimore, MD
- Dayton, Ohio (3 repeaters)
- Large system across North Carolina
- Many urban areas across the USA



# DMR – National Overview

- DMR MARC Network
  - Cooperative effort between various segments of Motorola Amateur Radio Club and others
- Over 300 repeaters in 21 countries
- All digital (DMR) network
- Weekly nets
- Technical oriented users



# DMR Last Heard List

NC PRN

A Wide-Area Digital Amateur Radio Network

Home Getting Started Repeaters Talkgroups FAQ Downloads Advanced Contact Us News Forum Last Heard



## Control Center PRN Backup

10:54:55 June 01, 2014 EST

start time	duration	source peer alias	source radio alias	Bridge Group	RSSI (dBm)	Site name	Loss rate

start time	duration	source peer alias	source radio alias	Bridge Group	RSSI (dBm)	Site name	Loss rate
10:40:07.369 Jun 1	6.7	Charlotte - North Carolina - USA --W4ZO	WD4ASW Barry Baines Westborough Massachusetts United States - 3125039	PRN	-118.5	PRN-Network	7.1%
10:39:03.205 Jun 1	0.5	Charlotte - North Carolina - USA --W4ZO	WD4ASW Barry Baines Westborough Massachusetts United States - 3125039	Charlotte Local	-104.3	PRN-Network	0.0%
10:38:38.881 Jun 1	0.8	King - North Carolina - USA --W4SNA	K4NWJ Nathan Jackson Sophia North Carolina United States - 3137052	PRN	-111.7	PRN-Network	0.0%
10:28:56.868 Jun 1	0.5	Richmond - Virginia - USA --WA4FC	KD4BPZ Jay Lovelady Chester Virginia United States - 3151011	Richmond Local	-120.9	PRN-Network	0.0%
10:08:43.556 Jun 1	3.1	Gastonia - North Carolina - USA --KA4YMZ	KF4UVL James Garris Charlotte North Carolina United States - 3137053	PRN	-100.5	PRN-Network	0.0%
10:08:05.639 Jun 1	5.2	Gastonia - North Carolina - USA --KA4YMZ	KF4UVL James Garris Charlotte North Carolina United States - 3137053	PRN	-96.0	PRN-Network	2.2%
10:07:20.822 Jun 1	5.6	Gastonia - North Carolina - USA --KA4YMZ	KF4UVL James Garris Charlotte North Carolina United States - 3137053	PRN	-103.9	PRN-Network	1.0%
09:52:43.604 Jun 1	5.6	Gastonia - North Carolina - USA --KA4YMZ	KF4UVL James Garris Charlotte North Carolina United States - 3137053	Gastonia Local	-97.2	PRN-Network	0.0%
09:52:03.271 Jun 1	5.6	Gastonia - North Carolina - USA --KA4YMZ	KF4UVL James Garris Charlotte North Carolina United States - 3137053	Gastonia Local	-95.3	PRN-Network	0.0%
09:48:24.131 Jun 1	3.4	Fancy Gap - Virginia - USA --WX4F	WA4PBA Edward Midkiff Mount Airy North Carolina United States - 3137112	PRN	-87.0	PRN-Network	0.0%
09:47:53.288 Jun 1	28.3	Fancy Gap - Virginia - USA --WX4F	NC4BL Bill Lundy Mount Airy North Carolina United States - 3137185	PRN	-72.0	PRN-Network	0.0%
09:47:29.330 Jun 1	22.1	Fancy Gap - Virginia - USA --WX4F	WA4PBA Edward Midkiff Mount Airy North Carolina United States - 3137112	PRN	-86.5	PRN-Network	0.0%
09:47:18.340 Jun 1	8.5	Fancy Gap - Virginia - USA --WX4F	NC4BL Bill Lundy Mount Airy North Carolina United States - 3137185	PRN	-81.1	PRN-Network	0.0%



# Project 25 – It's different!

## “P25 is a set of standards”

- Project 25 (P25) is a set of standards produced through the joint efforts of the Association of Public Safety Communications Officials International (APCO), the National Association of State Telecommunications Directors (NASTD), selected federal agencies and the National Communications System (NCS), and standardized under the Telecommunications Industry Association (TIA)...
- The P25 suite of standards involves digital Land Mobile Radio (LMR) services for local, state/provincial and national (federal) public safety organizations and agencies...
- Although developed primarily for North American public safety services, P25 technology and products are not limited to public safety alone and have also been selected and deployed in other private system application, worldwide.

# Project 25 – Open Interfaces

- ❑ **Common Air Interface (CAI)** – standard specifies the type and content of signals transmitted by compliant radios. One radio using CAI should be able to communicate with any other CAI radio, regardless of manufacturer
- ❑ **Subscriber Data Peripheral Interface** – standard specifies the port through which mobiles and portables can connect to laptops or data networks
- ❑ **Fixed Station Interface** – standard specifies a set of mandatory messages supporting digital voice, data, encryption and telephone interconnect necessary for communication between a Fixed Station and P25 RF Subsystem
- ❑ **Console Subsystem Interface** – standard specifies the basic messaging to interface a console subsystem to a P25 RF Subsystem
- ❑ **Network Management Interface** – standard specifies a single network management scheme which will allow all network elements of the RF subsystem to be managed
- ❑ **Data Network Interface** – standard specifies the RF Subsystem's connections to computers, data networks, or external data sources
- ❑ **Telephone Interconnect Interface** – standard specifies the interface to Public Switched Telephone Network (PSTN) supporting both analog and ISDN telephone interfaces.
- ❑ **Inter RF Subsystem Interface (ISSI)** – standard specifies the interface between RF subsystems which will allow them to be connected into wide area networks

# Project 25 – HT's

Common Air Interface (CAI) – Allows ALL these to work seamlessly!



# Project 25 – Richmond

KG4MRA Repeater (Used to be W4SQT) 145.430 -  
Dual mode operation – Both FM & P25  
Covers the entire Richmond area



# Project 25 – Richmond

□ 927.050 MHz – Downtown



927.025 MHz - Midlo



# Common Myths about Digital Modes

- Will D-Star radios talk “D-Star” with DMR or P25 radios?
  - No
- Will DMR radios talk “DMR” to D-Star or P25 radios?
  - No
- Will P25 radios talk “P25” to D-Star or DMR Radios?
  - No
- Will all the radios talk “FM” to each other?
  - YES!
- Will the digital networks talk to each other?
  - Not natively – interop devices exist
- What about programming? Do I have to pay someone? Buy software?
  - It depends.
- Is it legal to use these modes on the ham bands?
  - DMR recently clarified

# Yahoo Groups

- [richmond-d-star@yahoo.com](mailto:richmond-d-star@yahoo.com)
- [richmond-900@yahoo.com](mailto:richmond-900@yahoo.com)
- [richmond-digital@yahoo.com](mailto:richmond-digital@yahoo.com)

# Demonstration and Questions

