



# ➤ DMR: Introduction to a New D/V Mode for AMATEUR Radio

HamSCI 2018-02  
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# Presentation Summary

## Summary

- DMR Requirements
- DMR Tiering and ETSI DMR Standard Parts
- DMR Technology Overview
- DMR Tier II Features
- Benefits of DMR



# Digital Mobile Radio

- An ETSI published global standard
- Many manufacturers
- Longer battery life
- Supports multiple talk groups
- Supports DATA applications (IoT)

# DMR Association

## Equipment Mfg Members

**aselsan**

 **AVTEC**

consoles you can count on

 **BFDX**®  **emc**  
www.emc-spa.com

**FYLDE  
MIKRO**

**HARRIS**  **HQT**

**Hytera**™  
Respond & Achieve

 **ICOM**

**JVC** **KENWOOD**

**IRISUN**

 **LARIMART**

 **MOTOROLA**

 Omsk Manufacturing Association  
named after A.S. Popov  
www.mta.ru

**Radio Activity**  
∞ Solutions

**RADIODATA**

 **Selex ES**  
A Finmeccanica Company

**sepura**

**taii**  
communications

 **simoco**

 **Vertex Standard**

**ZETRON**®

# Intellectual Property Licensing



## MOTOROLA DMR LICENSEES

(as of 01 September 2017)

- 3M Innovative Properties Company
- ASELSAN Elektronik Sanayi ve Ticaret A.Ş.
- Excera Technology Co., Ltd.
- Fujian Baofeng Electronics Co, Ltd.
- Fujian Beifeng Telecom Technology Co., Ltd.
- Guangzhou Victel Technology Co., Ltd.
- Hytera Communications Corporation Limited
- JUSTON Electronic Equipment Co., Ltd.
- JVCKENWOOD Corporation
- Kirisun Communications Co., Ltd.
- Leonardo S.p.A.
- Lisheng (Fujian) Communications Co., Ltd.
- Qixiang Electron Science & Technology Co., Ltd.
- Quansheng Electronics Co., Ltd.
- Quanshun Communication Technology Co., Ltd.
- Quanzhou City New Century Communication Electronics Co., Ltd.
- Quanzhou Feijie Electron Co., Ltd.
- Quanzhou Risen Electronics Co., Ltd.
- Quanzhou SFE Electronic Technology Co., Ltd.
- Quanzhou Tietong Electronic Equipment Co., Ltd.
- Radio Activity S.r.l.
- Shenzhen COVALUE Communications Co., Ltd.
- Shenzhen Samhoo Science & Technology Co., Ltd.
- Tait Electronics, Ltd.
- TTG Global Ltd.
- TYT Electronics Co., Ltd.
- Uniden America Corporation
- Xiamen Puxing Electronics Science & Technology Co., Ltd.
- ZTE Trunking Technology Corporation

# DMR Standards

## ETSI DMR Standard Parts

### DMR Tier I: Unlicensed

- Products for license-free use in the 446 MHz band.

### DMR Tier II: Conventional

- Licensed conventional radio systems operating in LMR frequency bands 30 to 1000 MHz. Targeted at users who need spectral efficiency, advanced voice features and integrated IP data services in licensed bands.

### DMR Tier III: Trunked

- Trunking operation in frequency bands 30 to 1000 MHz. The ETSI Tier III standard supports voice and short messaging handling similar to MPT1327.





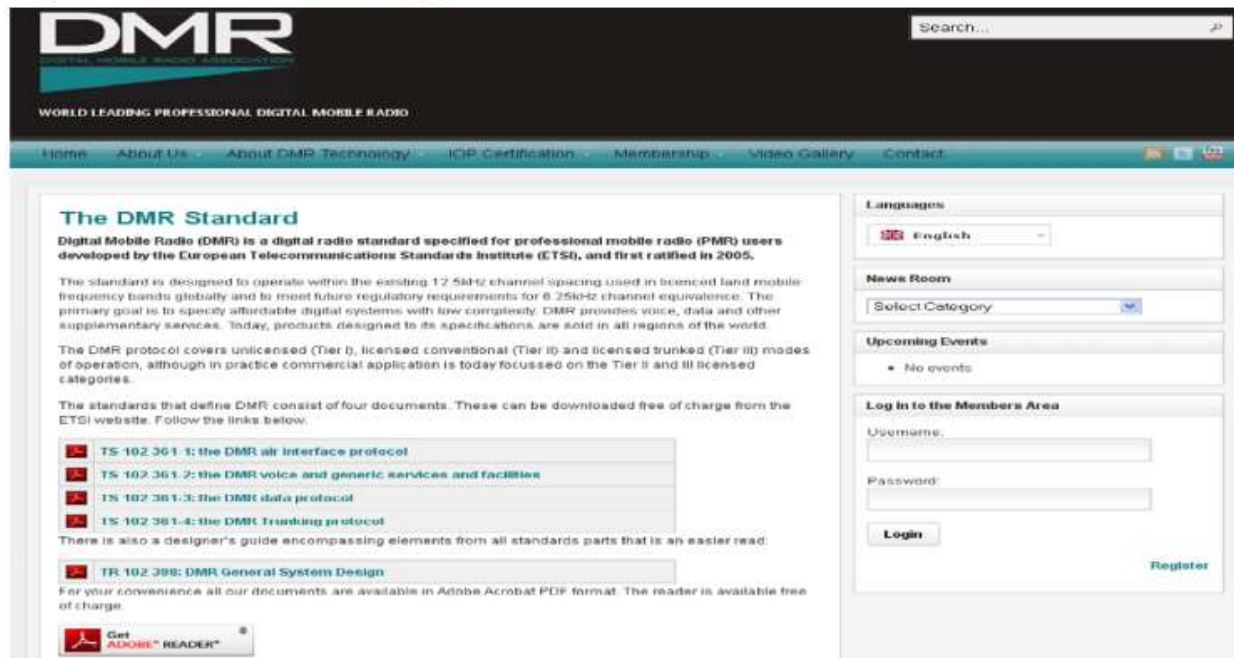
# DMR Standard

- DMR Tier II: Conventional
  - Licensed conventional radio systems, mobiles and hand portables operating in PMR frequency bands 30 to 1000 MHz
  - Targeted at users who need in licensed bands:
    - Spectral efficiency;
    - Advanced voice features;
    - Integrated IP data services.
- Tier II Supports Tier I, not converse!

# DMR Standards Public Access

## DMR Tiering and ETSI DMR Standard Parts

All DMR standards are available on the DMR Associations website  
<http://dmrassociation.org/>



The screenshot displays the DMR Association website. The header features the DMR logo and the tagline 'WORLD LEADING PROFESSIONAL DIGITAL MOBILE RADIO'. A navigation bar includes links for Home, About Us, About DMR Technology, IOP Certification, Membership, Video Gallery, and Contact. A search bar is located in the top right corner.

The main content area is titled 'The DMR Standard' and provides information about the Digital Mobile Radio (DMR) standard, developed by the European Telecommunications Standards Institute (ETSI) in 2005. It describes the standard's design for 12.5kHz channel spacing and its application in various modes of operation.

Below the text, there is a list of downloadable documents:

- TS 102 361-1: the DMR air interface protocol
- TS 102 361-2: the DMR voice and generic services and facilities
- TS 102 361-3: the DMR data protocol
- TS 102 361-4: the DMR trunking protocol

A note mentions that there is also a designer's guide encompassing elements from all standards parts that is an easier read.

At the bottom, it states that for convenience, all documents are available in Adobe Acrobat PDF format, and a link to the Adobe Reader is provided.

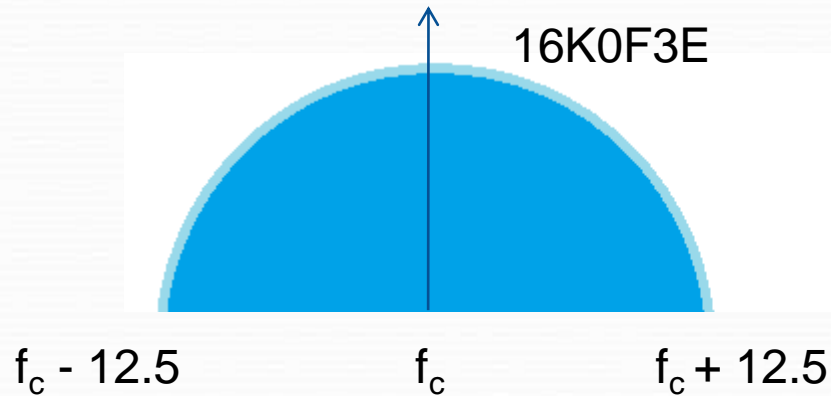
The right sidebar contains a 'Languages' section with a dropdown menu set to 'English', a 'News Room' section with a 'Select Category' dropdown, an 'Upcoming Events' section showing 'No events', and a 'Log in to the Members Area' section with fields for 'Username', 'Password', and a 'Login' button, along with a 'Register' link.



# DMR Main Characteristics

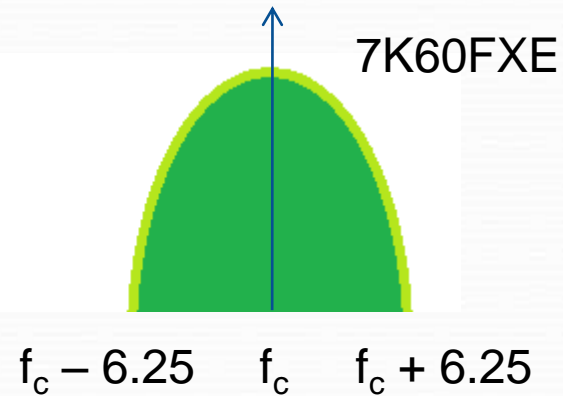
- 12,5 kHz channel
- 9,6 kbps gross bit rate
- 4-FSK modulation (constant envelope)
- 2-slot TDMA channel
  - Built around a 30 ms slot structure
  - 50% duty cycle slot structure
    - Forward and reverse transmission on a time division basis
- Voice, data or generic signaling
- Designed for frequency bands from 30 to 1000 MHz

# Half the Channel Bandwidth



Traditional Analog  
25 kHz  
Channel Bandwidth

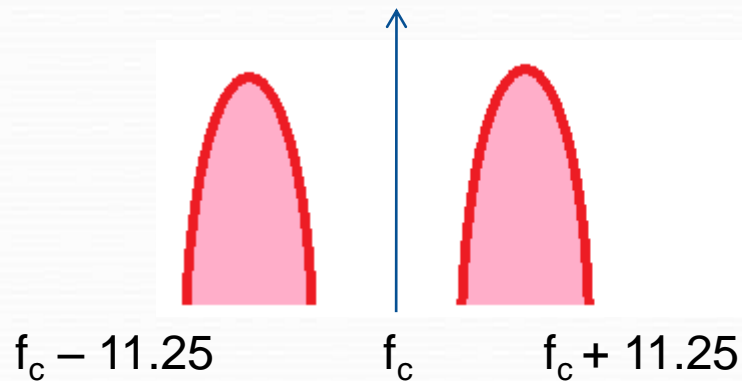
1 Channel  
1 Repeater



DMR  
**12.5 kHz**  
Channel Bandwidth

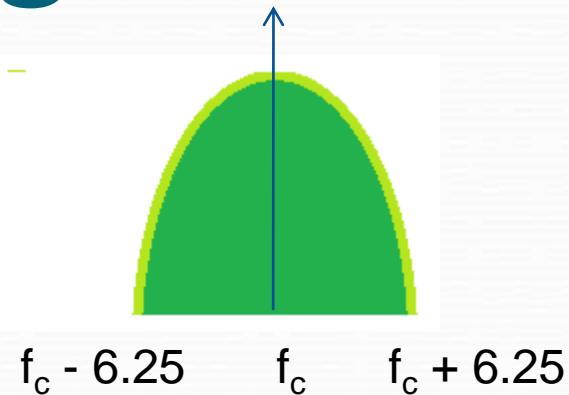
**2 Channels**  
1 Repeater

# More Spectrum Efficient than Older Digital Modes



Guard Band  
as large as 10 kHz  
between channels

**Total BW= 22.5 kHz**



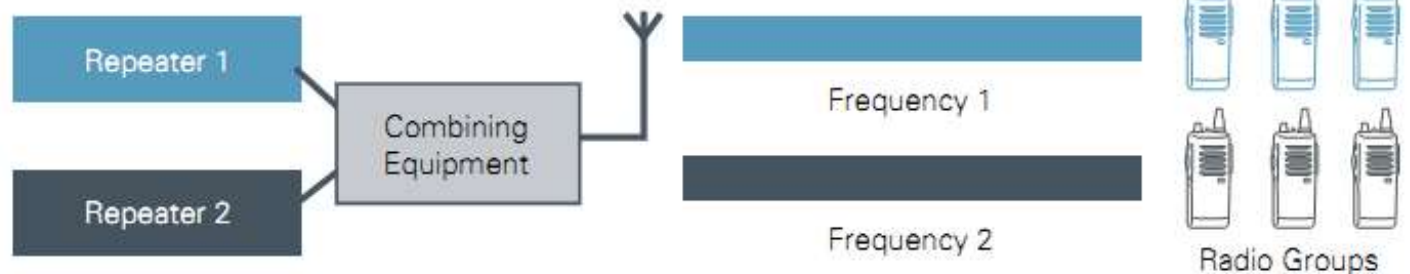
No Guard Band  
between 2  
channels

**Total BW= 12.5 kHz**

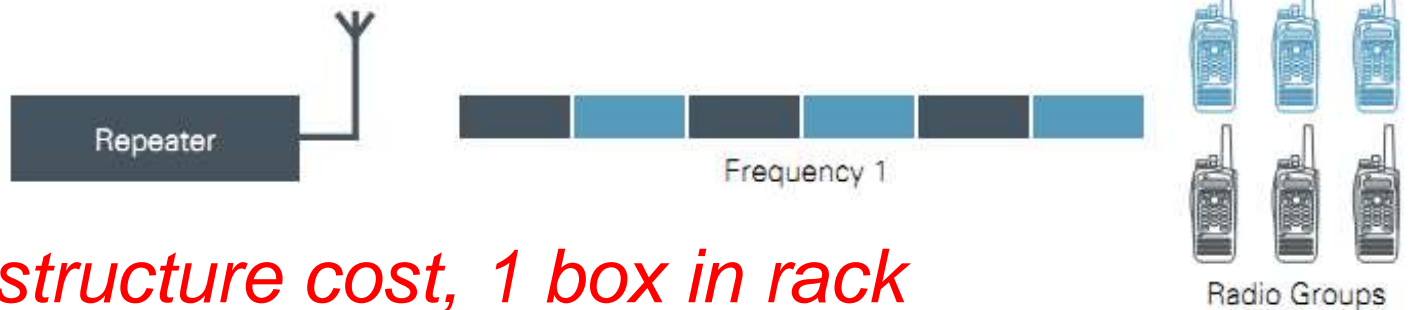
# TWO Repeaters in One!

TDMA saves licensing and equipment costs by enabling the equivalent of two 6.25 kHz channels within a single licensed 12.5 kHz channel.

Two-channel Analog or Digital FDMA System



Two-channel Digital TDMA System



*Lower infrastructure cost, 1 box in rack  
TWO voice/data channels from one repeater*

# Digital Voice CODECs

- D-STAR (Icom)
  - GMSK/AMBE Vocoder
- P25 Phase 1 (Multi-Vendor)
  - FDMA/IMBE Vocoder
- System Fusion (Yaesu)
  - FDMA/C4FM/AMBE+2 Vocoder
- DMR (Multi-Vendor)
  - 2-slot TDMA/AMBE+2 Vocoder
- Digital Voice CODEC Not Specified
  - Flexibility for EXPERIMENTATION

# Longer Battery Life



Older Digital Modes  
(FDMA)



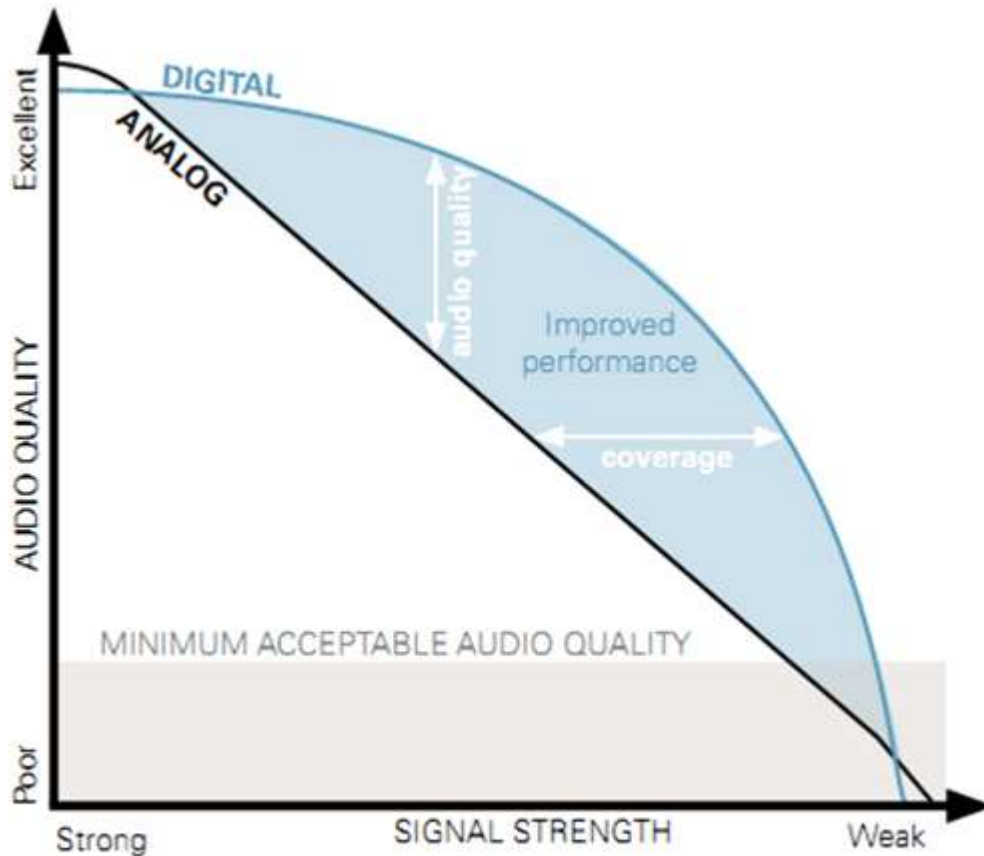
DMR  
(TDMA)

“For each hour of usage the TDMA radios show between 19% and 34% less battery capacity is required than for the FDMA models.”

“40 percent improvement in talk time in comparison with analog radios “



# Better Speech Clarity



Digital voice retains better quality than analog as signal strength decreases.

- No hiss/pop/static
- Forward Error Correction (FEC), Cyclic Redundancy Check (CRC) encoding
- Better RF range due to processing gain

# S unit, dBm, milliWatt

<u>S</u>	<u>dBm</u>	<u>mW</u>	<u>mV at 50 ohms</u>
S0	-127	0.00000000000000199526	0.00009988149
S1	-121	0.00000000000000794328	0.00019928977
S2	-115	0.00000000000003162278	0.00039763536
S3	-109	0.0000000000012589254	0.00079338686
S4	-103	0.0000000000050118723	0.00158301490
S5	-97	0.000000000199526231	0.00315852997
S6	-91	0.000000000794328235	0.00630209582
S7	-85	0.000000003162277660	0.01257433430
S8	-79	0.000000012589254118	0.02508909536
S9	-73	0.000000050118723363	0.05005932649

# Better Audio Quality

- Listen for yourself. DMR does sound better than older digital technologies.



# Better Performance

- DMR radios share basic processing, resulting in
  - Better sensitivity/selectivity;
  - Better spurious/intermodulation rejection;
  - Better blocking;
  - Better adjacent channel power;
  - Better adjacent transient channel power.
- More rugged
  - IP54/IP65/IP67 (dust tight/splash to immersion)
- Polite Access
  - Blocks TX into existing QSO, override available

# Substandard Terminals

- No FCC Certification
  - Searchable on FCC Database?
- Support Tier I (Only)
  - Radio-to-radio?
- Simultaneous Double Time Slot
  - No sync, interferes with repeater
- Works with hotspot only
  - Questionable Performance
- Bargain Price

# Simultaneous Data/Voice



Slot 1 Voice



Slot 2 GPS Location

(or second channel voice when not sending GPS data)



Give your location WHILE talking!



# Dynamic Mixed Mode

Analog



OR



Slot 1 TDMA



Slot 2 TDMA

Analog



Slot 1 TDMA



Slot 2 TDMA

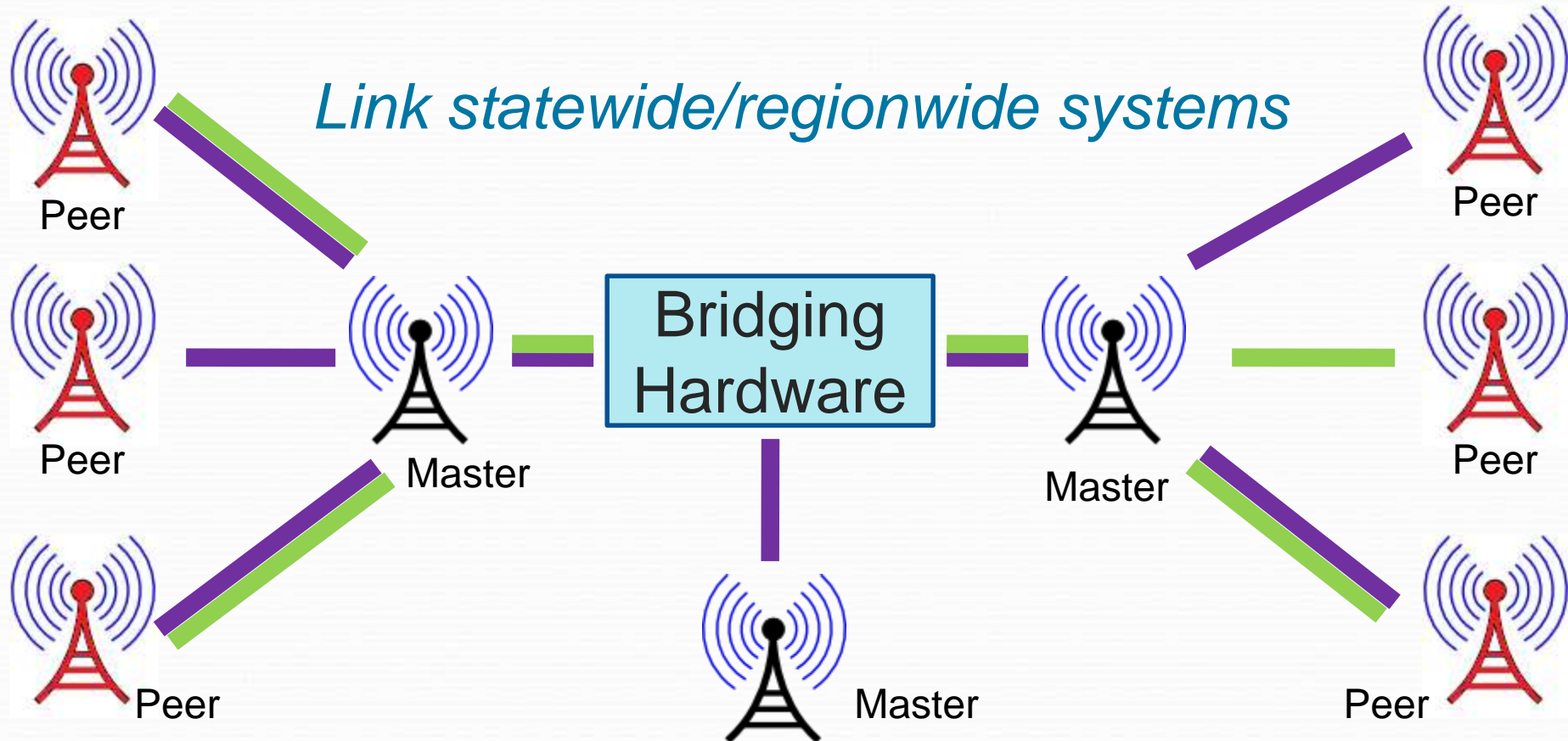
*Repeater dynamically detects the type of input  
IP site connect is supported on digital modes*

*This is an option for a phased migration from  
analog to networked DMR repeaters.*

# IP Site Connect

## 1 or 2 slots (channels)

*Link statewide/regionwide systems*



# IP Site Connect

- A peer can participate with one or both time-slots
- Peers register with the Master
- Master keeps peers informed about other peers
- Master/Peers function as a fully meshed network for voice and data traffic
- If the Master fails, the fully mesh network continues to operate, but new peers can not join nor are changes announced
- A third-party bridge is used to interconnect IP Site Connect networks

# Text Messaging



Send to one person, or a group of people.

- Weather Alerts
- Club Meetings
- Announcements



- 3100 Site network in 48 US States, 63 Countries
  - ND(6) and SD(12) not [yet] deployed
- Also bridged to other Motorola Repeater-Based DMR networks
- 100% Pure Digital
- 82,000+ registered user IDs
- To register or learn more
  - <http://dmr-marc.net>

# DMR-Plus Network

- <100 Site network in the US and Europe
- Bridged to other Hytera repeater-based DMR networks
- 100% Pure Digital
- Allows interface to Motorola Repeaters (via R-pi & app)
- Allows data dongle into network -  
[http://www.dj0abr.de/english/technik/dstar/dv4/dv4\\_roadmap.htm](http://www.dj0abr.de/english/technik/dstar/dv4/dv4_roadmap.htm)
- Shares user and repeater registration with DMR-MARC
- To register or learn more <http://ham-dmr.de>



# BrandMeister Network

- Rival to DMR-MARC
- Bridged to other non-Motorola DMR networks
- 100% Pure Digital
- Allows and supports Multi-Vendor DMR repeaters
- Allows APRS, texting, dongles, homebrew into network - [http://www.dj0abr.de/english/technik/dstar/dv4/dv4\\_roadmap.htm](http://www.dj0abr.de/english/technik/dstar/dv4/dv4_roadmap.htm)
- Scanner-like monitoring via PC and Internet link
- Shares user and repeater registration with DMR-MARC
- This is the network to watch!
- To learn more <https://brandmeister.network>

# WW Networked Repeaters



# BrandMeister Home Page

## User Dashboard



Repeater in  
RX



Repeater in  
TX



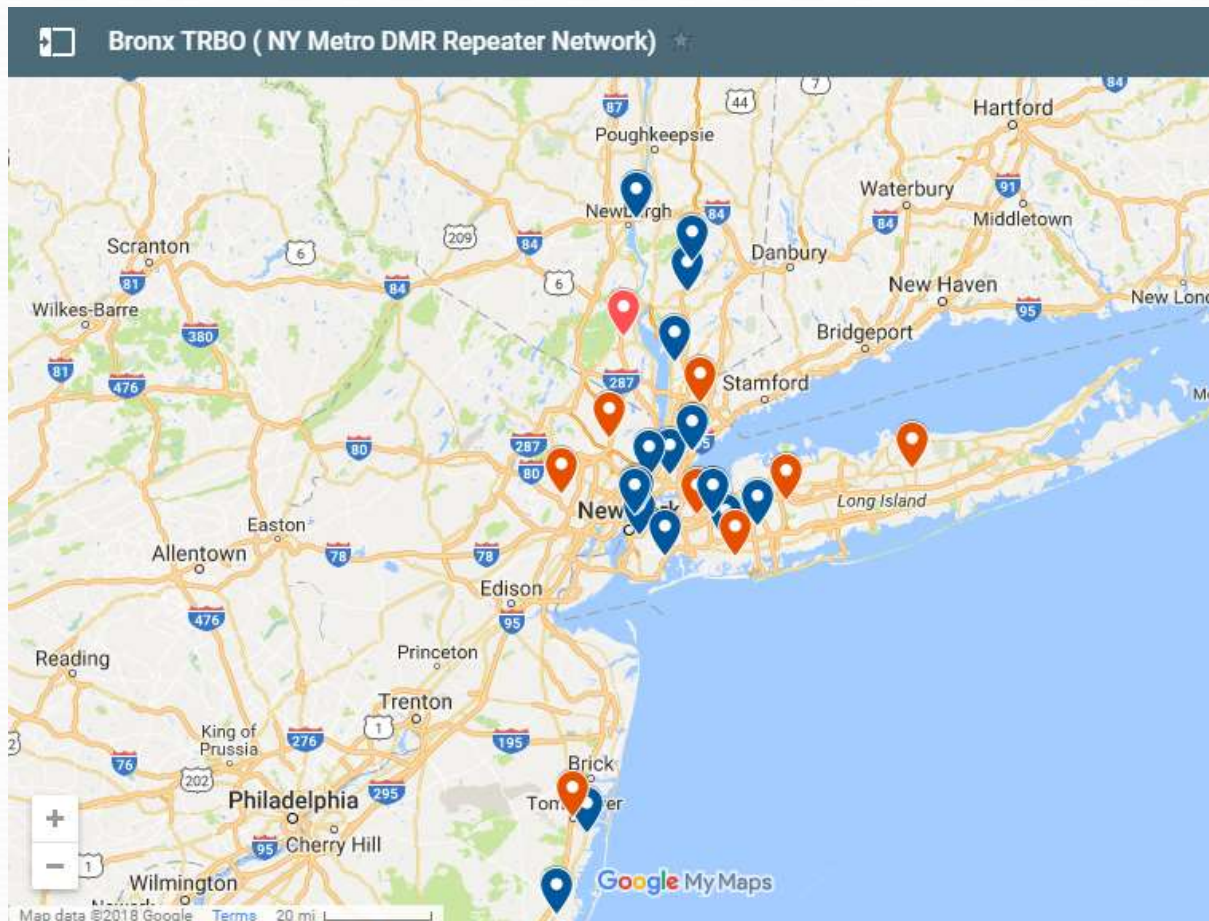
External calls



Map

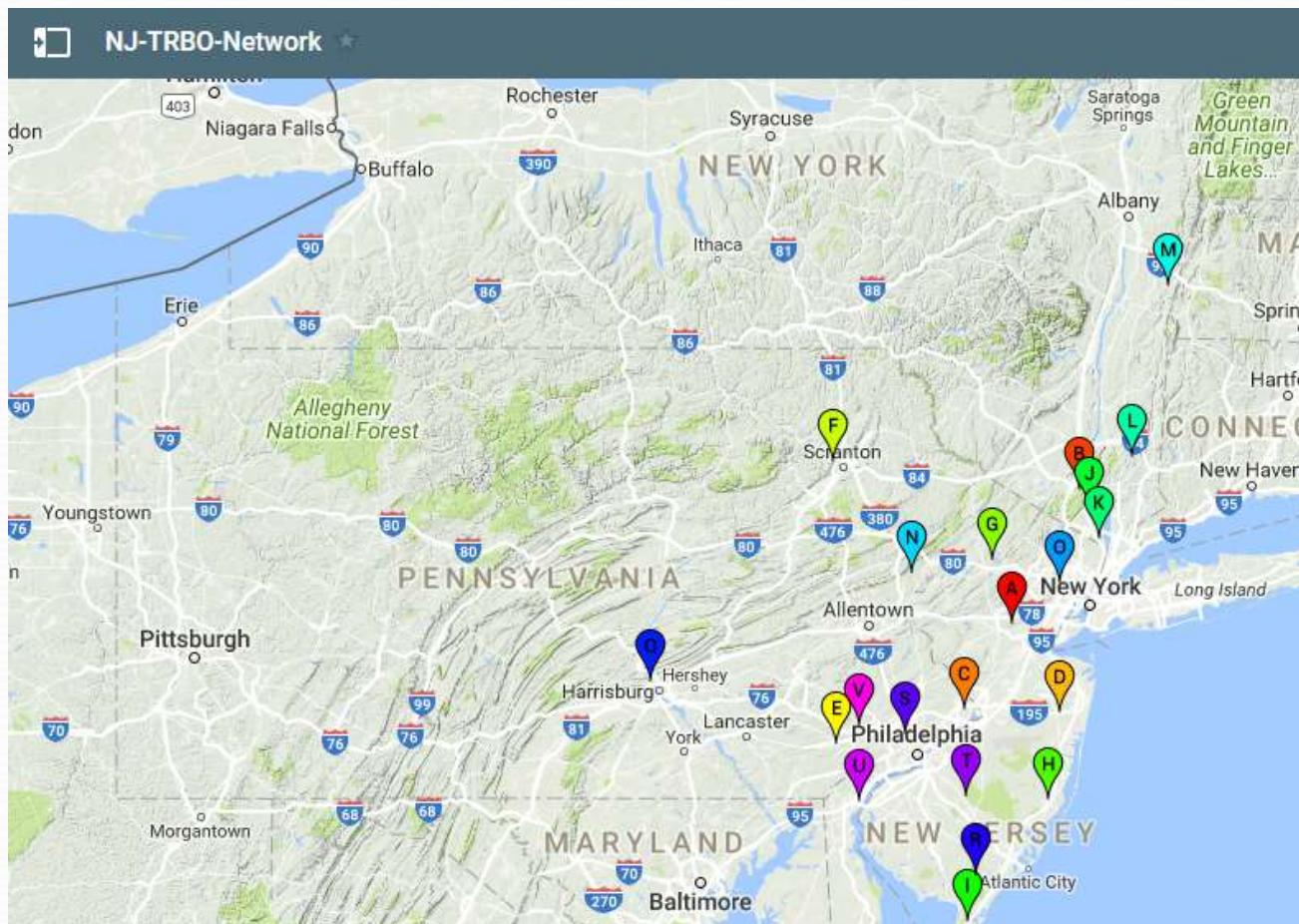


# Bronx TRBO Repeater Map

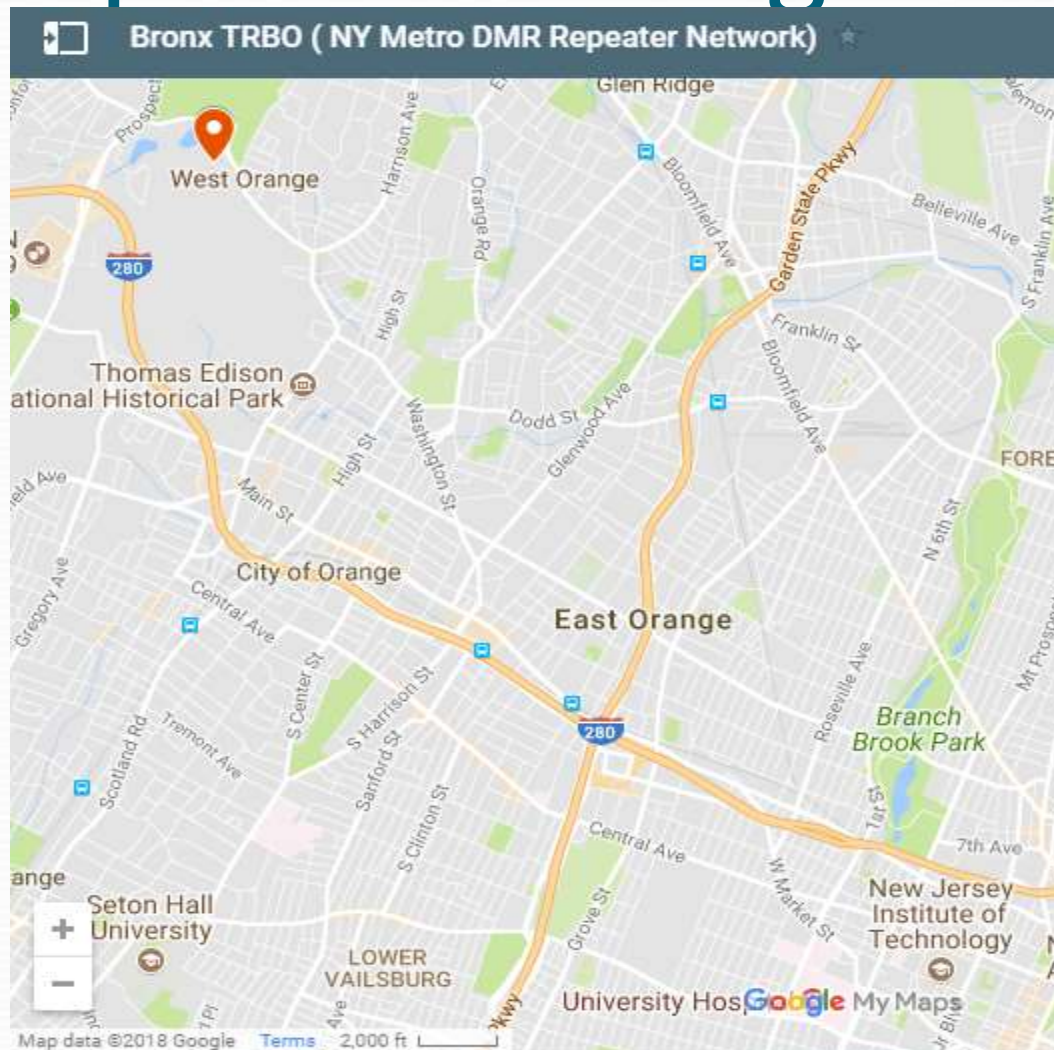




# NJ TRBO Repeater Map



# Repeater Listing



← West Orange, NJ

name

West Orange, NJ

description

West Orange, NJ KC2NFB 446.225 -5 MHz  
Color Code 1

Time Slot

#1 - Group Call TG 444 Bronx Trbo System  
Wide - FT  
#2 - member only private Talk Groups

coverage: <http://www.k2hr.com/W%20Orange.html>



# Talkgroup Support DMR-MARC

 KB2RF Howell, NJ 

description  
KB2RF Howell, NJ

name  
440.3000 +5 MHz Color Code 1  
(Bridge Partner of DMR-MARC)

TS #2 - TG 2 = Tri-State (ON)  
TS #1 - TG 3 = N. America (PTT)  
TS #1 - TG 9 = Local Repeater (PTT)  
TS #1 - TG 1 = World Wide (PTT)  
TS #1 - TG 13 = WW English (PTT)  
TS #1 - TG 95 = TAC I 95 (PTT)  
TS #1 - TG 3172 = Northeast Reg. (PTT)  
TS #1 - TG 310 = TAC 310 (PTT)  
TS #1 - TG 311 = TAC 311 (PTT)  
TS #1 - TG 8951 = TAC 1 (PTT)  
TS #1 - TG 8952 = TAC 2 (PTT)  
TS #1 - TG 8953 = TAC 3 (PTT)  
TS #1 - TG 3134 = NJ State (PTT)  
TS #1 - TG 3136 = NY State (PTT)  
TS #1 - TG 3142 = PA State (PTT)  
TS #1 - TG 3125 = MA State (PTT)  
TS #1 - TG 31121 = First - Coast - FL  
(PTT)

# BM Repeater Info 1

## Repeater N2DMJ

User Dashboard > Repeaters > N2DMJ

### Repeater Info

Number	313442
City	Newark, New Jersey
Country	US
Website	<a href="#">Click here</a>
Sysops	<a href="#">N2US8</a>
Hardware	MMDVM (Repeater)
Firmware	20180222_Pi-Star
Power (EIRP)	10 Watt
Status	Slot 1 & 2 linked
Master	BM3108

### N2DMJ

[Last Heard](#)

	Time	Master	My call	Destination	Options	RSSI
	87 Seconds	3108	N2DMJ [Daniel] (3134893)	Skynet (37030)	<b>TS1</b> <b>DMR</b>	
	18 Minutes	3108	N2DMJ [Daniel] (3134893)	Skynet (37030)	<b>TS1</b> <b>DMR</b>	
	21 Minutes	3108	N2DMJ [Daniel] (3134893)	Skynet (37030)	<b>TS1</b> <b>DMR</b>	
	21 Minutes	3108	N2DMJ [Daniel] (3134893)	Skynet (37030)	<b>TS1</b> <b>DMR</b>	
	30 Minutes	3108	N2DMJ [Daniel] (3134893)	Skynet (37030)	<b>TS1</b> <b>DMR</b>	

Showing 1 to 5 of 5 entries

# BM Repeater Info 2

## Frequency Details

**TX** 443.0900 MHz

**RX** 448.0900 MHz

**Shift** 5.000 MHz

**CC** 1

## Slot details

**Timeslot** 370

**1** 37030

**Timeslot**

**2**

**Reflector** Disconnected

## Antenna Details

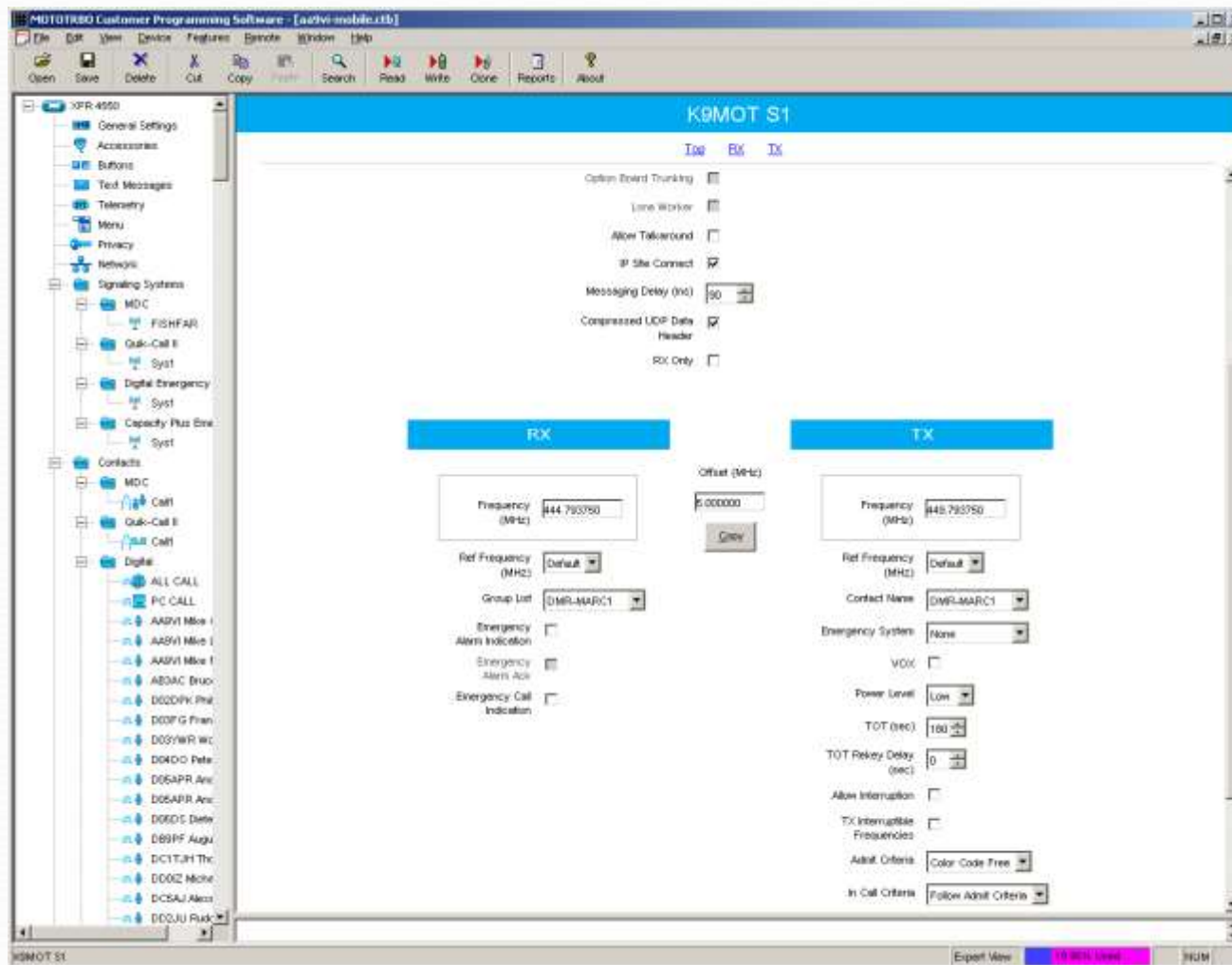
**Antenna Height** 60 m  
(AGL in m)

**Antenna Height** 196.8  
(AGL in ft) ft

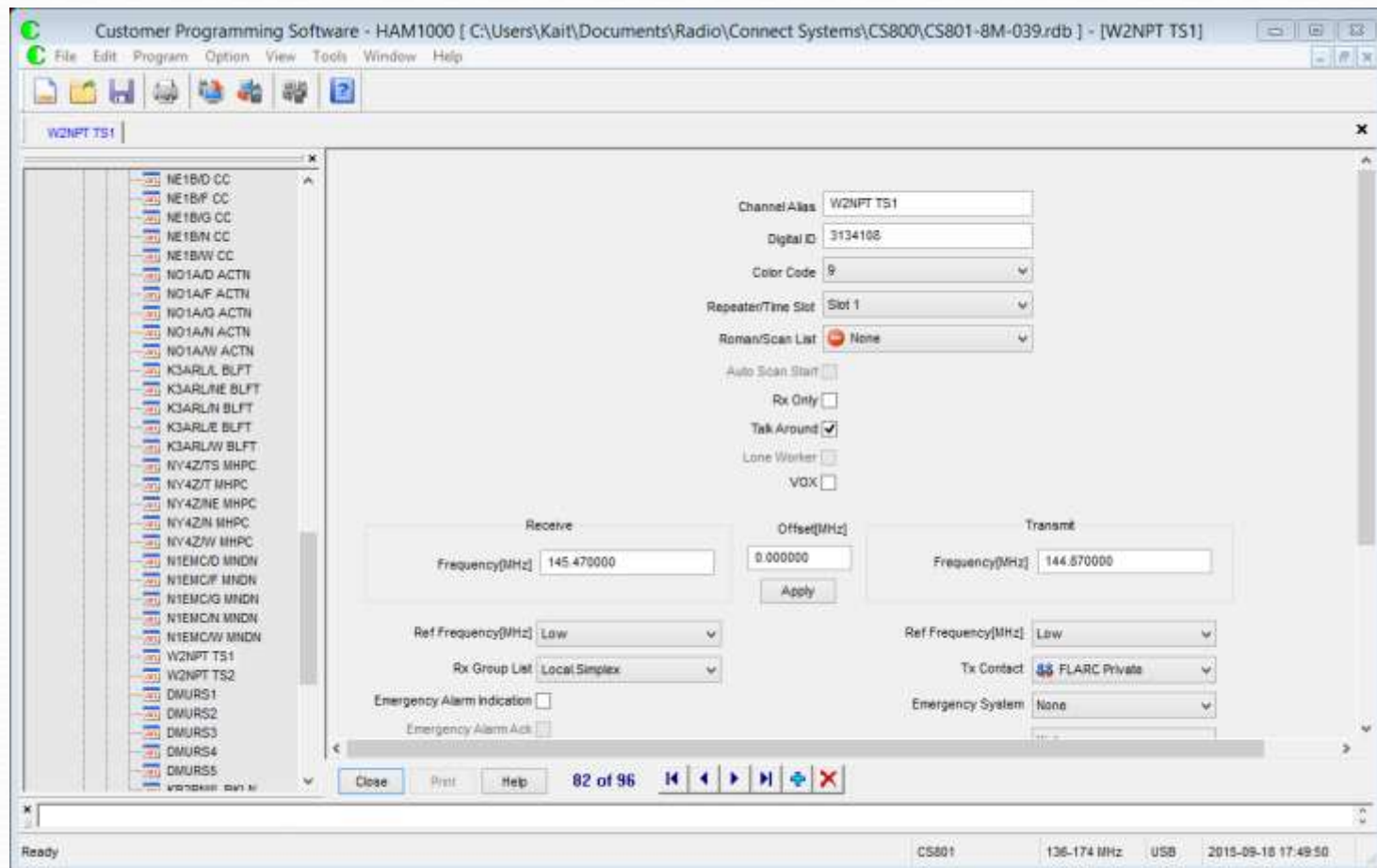
## Location



# Motorola CPS

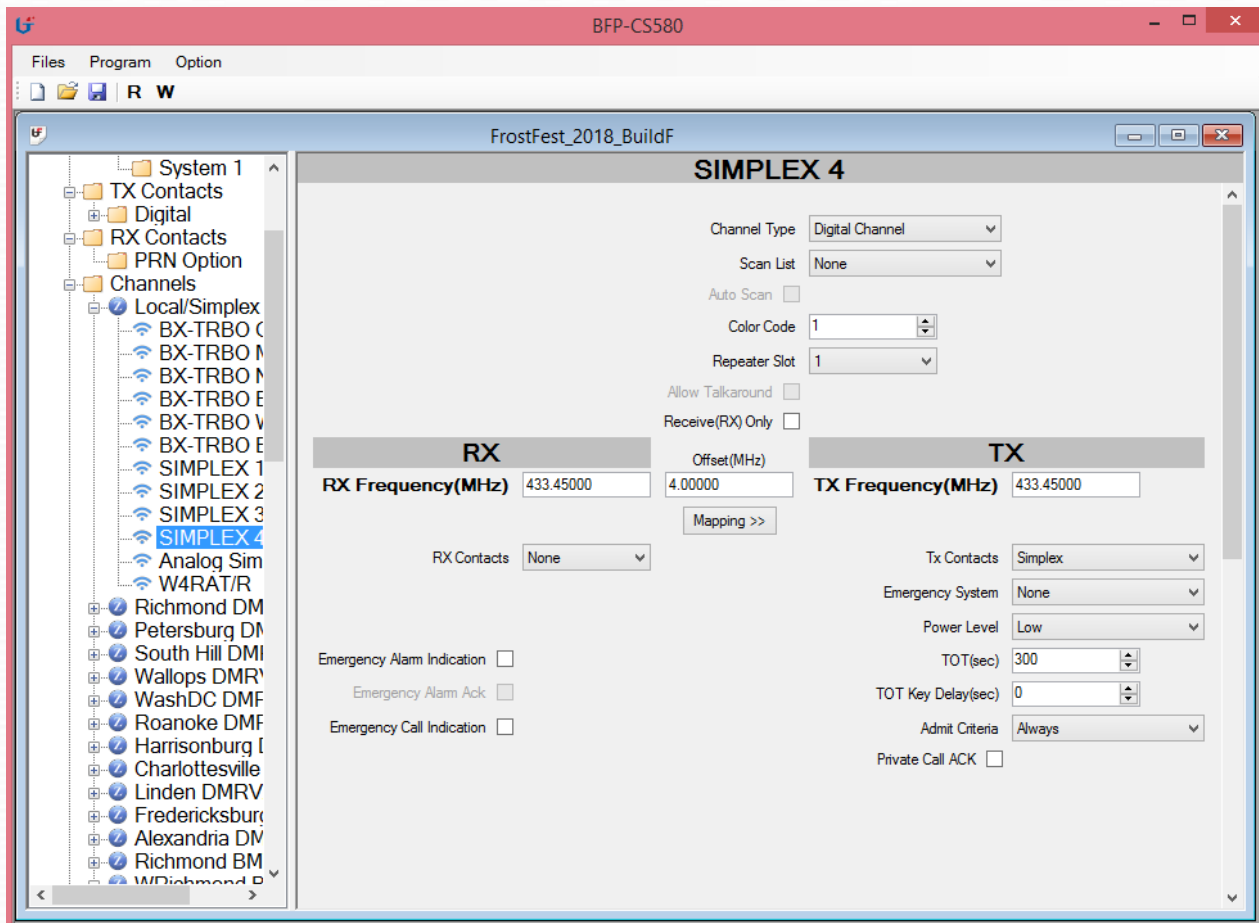


# Connect Systems CPS

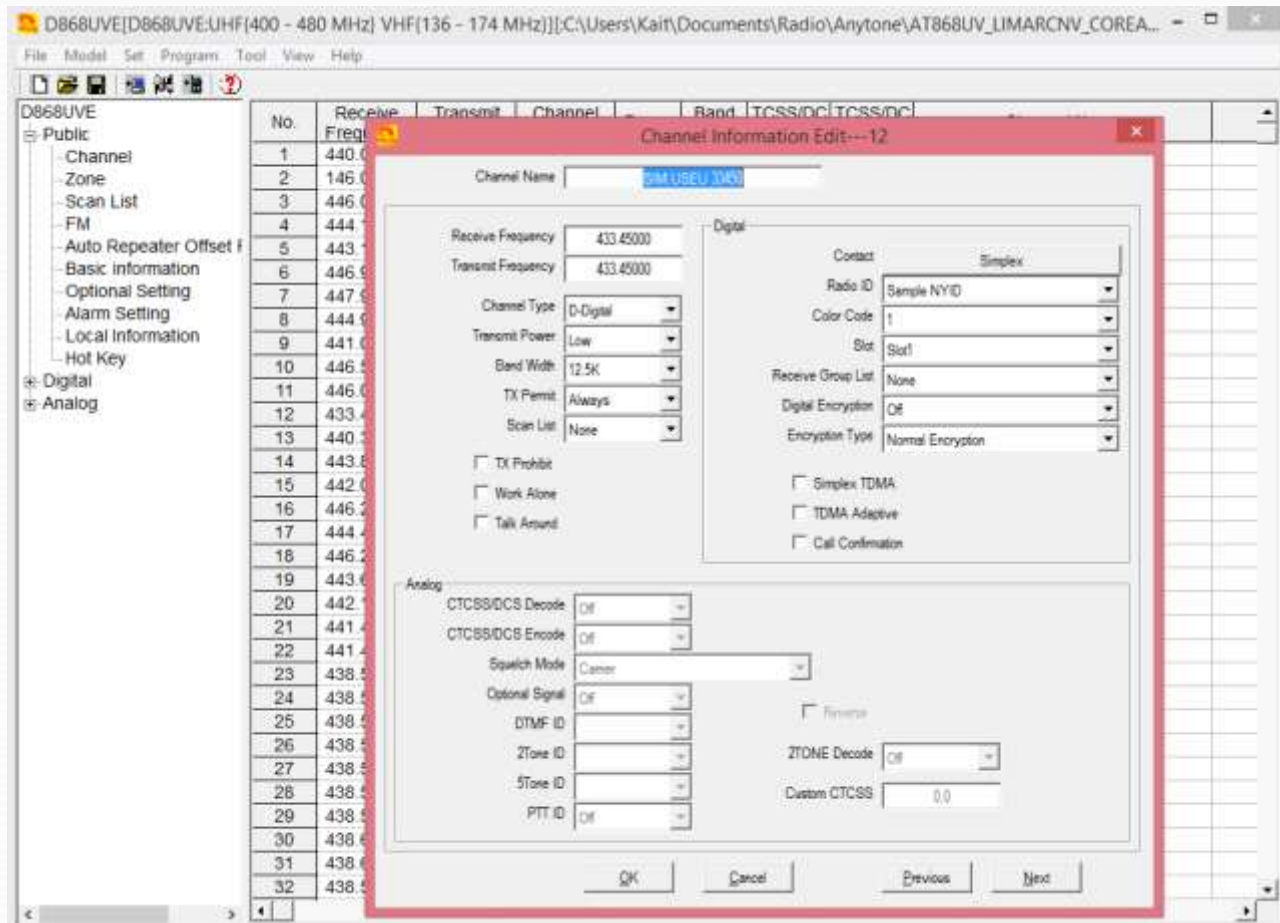




# BFDX CPS



# Anytone CPS





# DMR Commercial Radios



# DMR Amateur HTs



# DMR Amateur Mobile





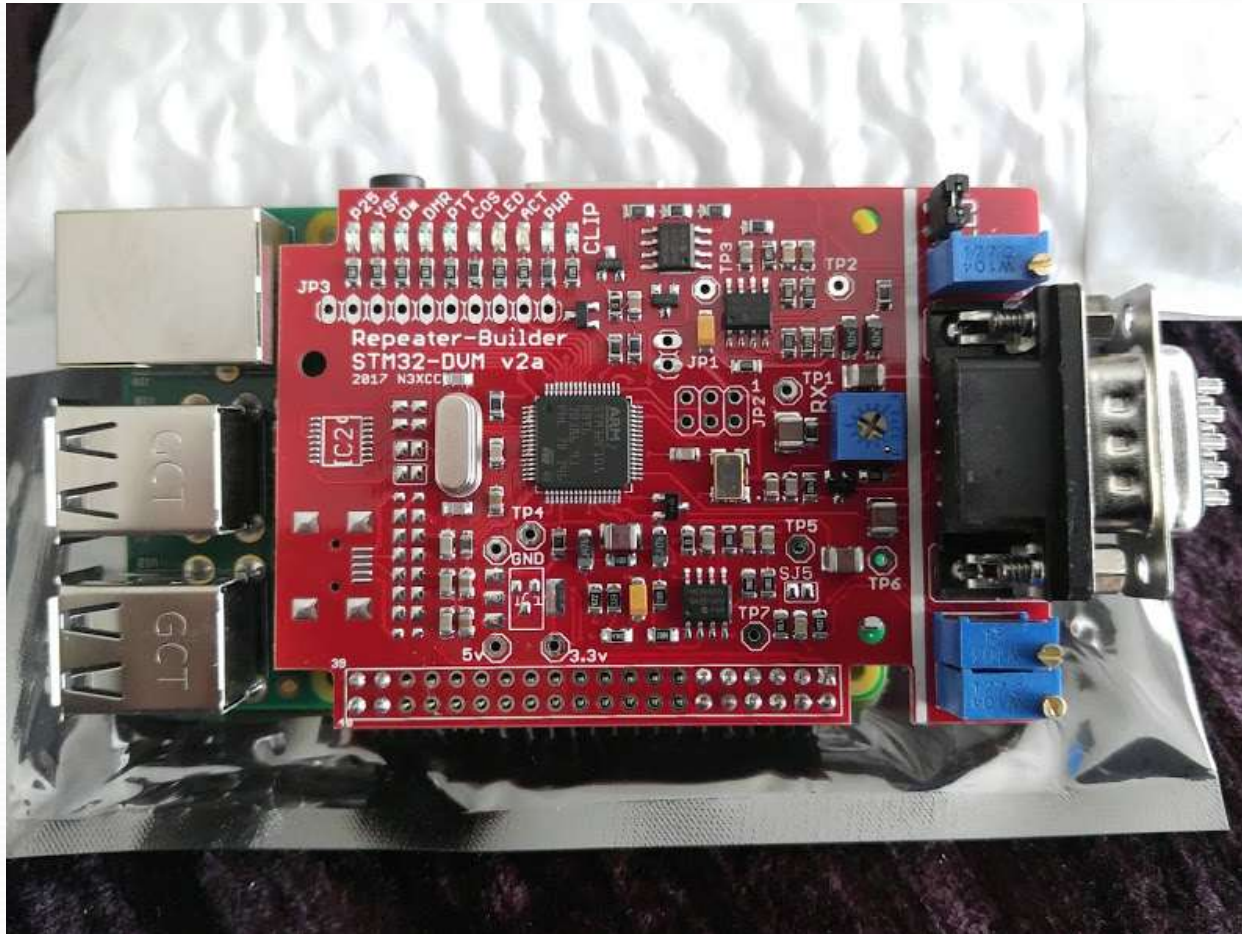
### K1MOT Hudson Site

145 and 447 MHz MotoTRBO

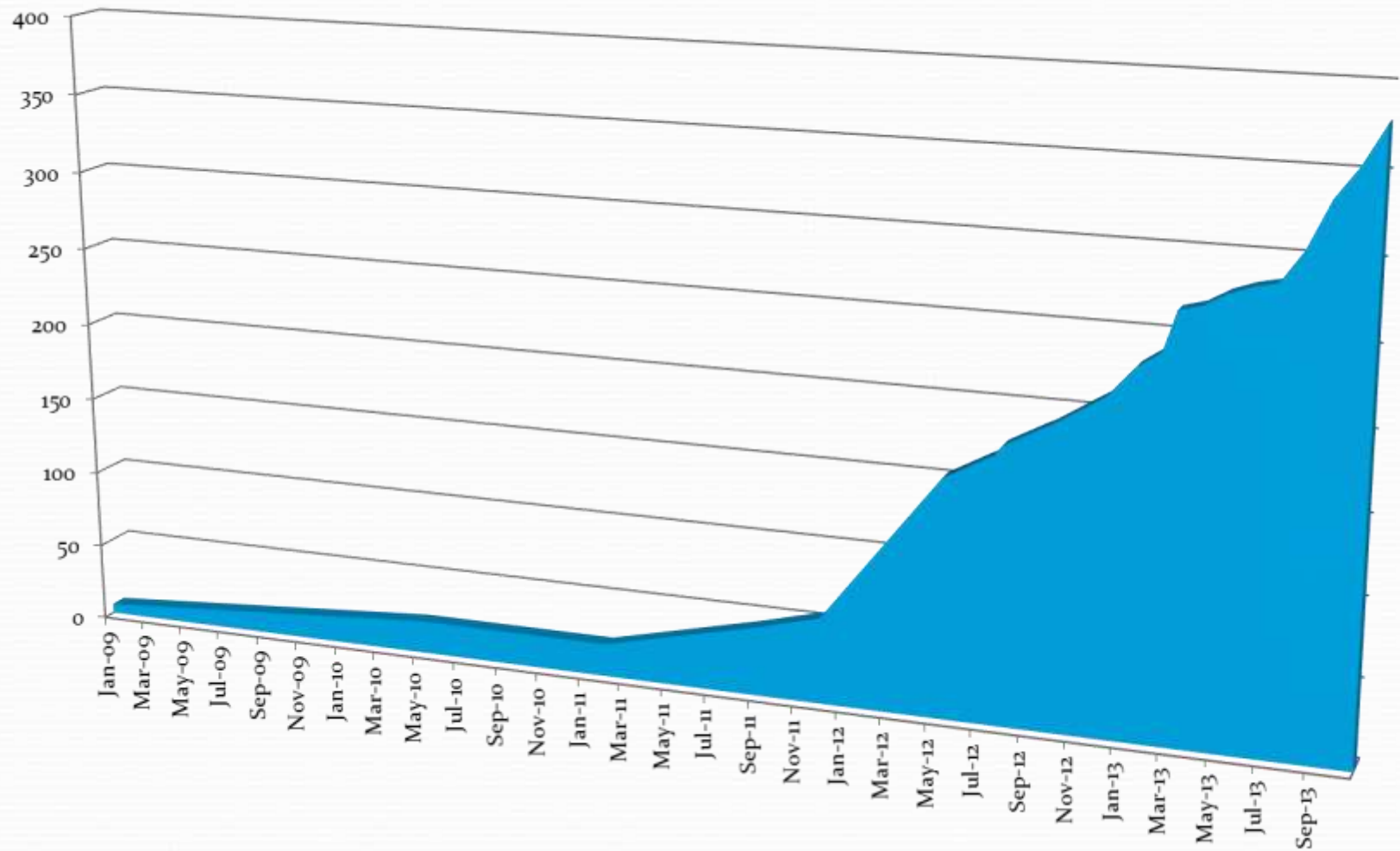
- 50 watt Repeaters on
- 1400 VA UPS
- Kohler 14 KW Auto-start Generator



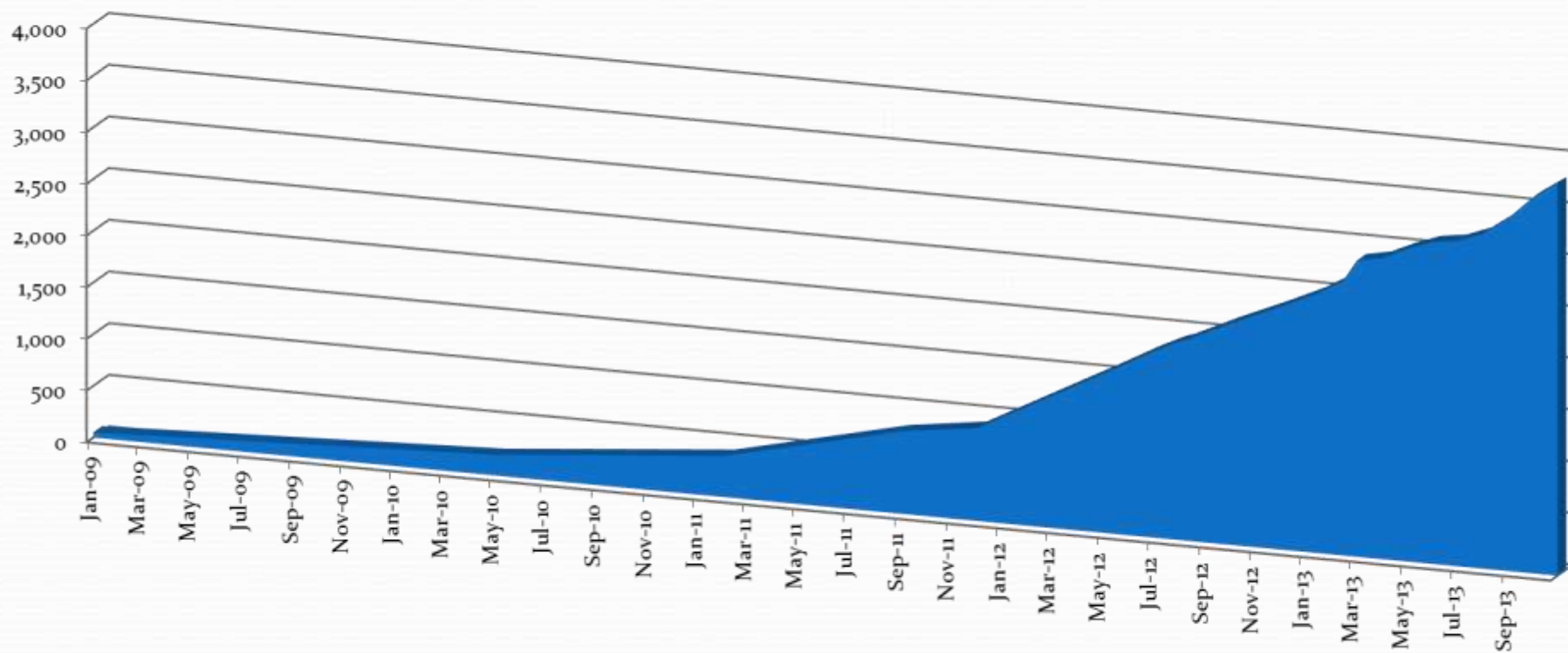
# MMDVM Amateur Repeater Controller



## Amateur DMR Growth by # Repeaters



## Amateur DMR Growth by # Radio IDs





# Some DMR Web Sites

(check out the links at these web sites)

- <http://www.dmr-marc.net/> (great general info)
- <http://groups.yahoo.com/group/MOTOTRBO/> (need to join the group to access some links)
- <http://brandmeister.network> (Brandmeister)
- <http://trbo.org> (Independent Digital Network)
- <http://hose.brandmeister.network> (Listen In)

# DMR: A NEW MODE FOR AMATEUR DIGITAL RADIO

- Spectrum Efficient!
- Supported by multiple manufacturers!
- Longer Battery Life!
- Resilient Networks (no internet needed)
- To learn more <http://dmr-marc.net>

# Questions?

- Contact Kai Chen, [k2trw@arrl.net](mailto:k2trw@arrl.net)
- Registration <http://dmr-marc.net/contact.html>
  - Reserve your DMR Identification Number
  - For your next DMR radio
    - KB Cubed LLC [sales@kbcubed.com](mailto:sales@kbcubed.com)
    - Authorized Connect Systems Value Added Reseller
    - Barbara KD2JCK 201-660-5051

# Acknowledgement

- Thanks to Bill NE1B for key slides
- Thanks to DMR-MARC for starting network
- Thanks to NJ-TRBO Bob KC2CWT
- Thanks to the many amateur radio infrastructure operators whom have put in much of their time, money and effort into making DMR possible for radio (terminal) users
- THANK YOU FOR YOUR TIME AND ATTENTION