

# A Comparison of Amateur Radio Digital Voice Systems



presented by

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# Topics

- Digital voice description
- Technical comparison
- Operational features
- Programmability
- Radio choices
- Charlotte DV repeaters
- Information sources
- Q & A

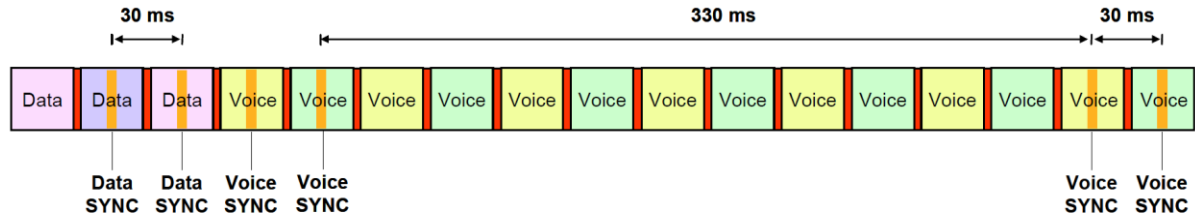
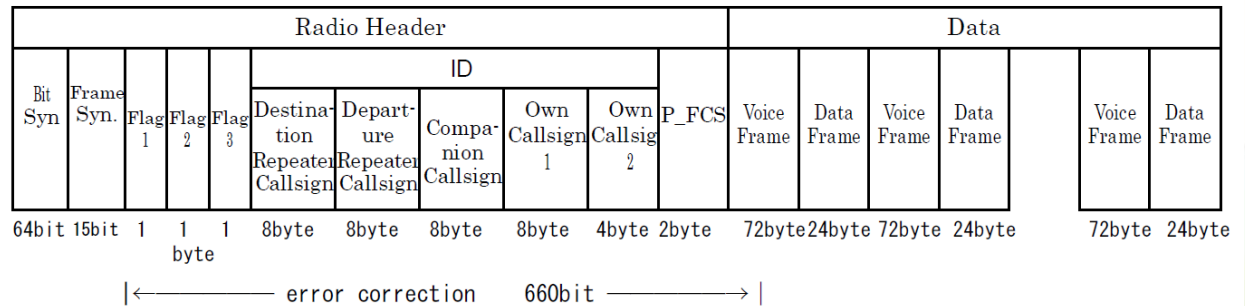


See p30 April 2015 QST

# What is Digital Voice?

- Digital data modulating an RF carrier
- The data is digitized audio from an A/D converter
- It is processed through a vocoder to compress the data and add forward error correction
- The data is sent serially in uniform length packets
- Header data is pre-pended to provide sync bits, routing instructions and user identity
- Other data is often interleaved or substituted for the voice to send text, pictures or other files

# Pictorial view



FS	FICH	DCH (0)	VCH (0)	VeCH (0)	DCH (1)	VCH (1)	VeCH (1)	DCH (2)	VCH (2)	VeCH (2)	DCH (3)	VCH (3)	VeCH (3)	DCH (4)	VCH (4)	VeCH (4)	Number of bits
40	200	40	72	32	40	72	32	40	72	32	40	72	32	40	72	32	Total 960 bit

# Tech Spec Comparison

	D-STAR	DMR	Fusion
Vocoder (see note)	AMBE+	AMBE+2	AMBE+2
Forward Error Corr.	Voice Only	Voice Only	Voice Only
Modulation	GMSK	4FSK	C4FM
Multiplex Method	FDMA	TDMA	FDMA
Transmission Rate	4.8 kbps	4.8 kbps x 2	9.6 kbps
Bandwidth	6.25 kHz	12.5 kHz	12.5 kHz
Channels supported	1	2	1
Standard Developer	JARL	ETSI	Yaesu

GMSK = Gaussian Minimum Shift Keying

4FSK = 4-level Frequency Shift Keying

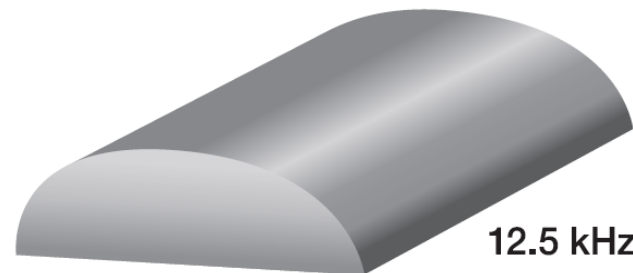
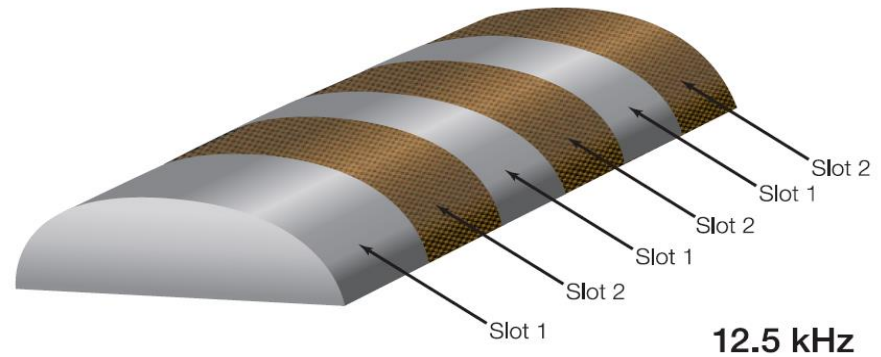
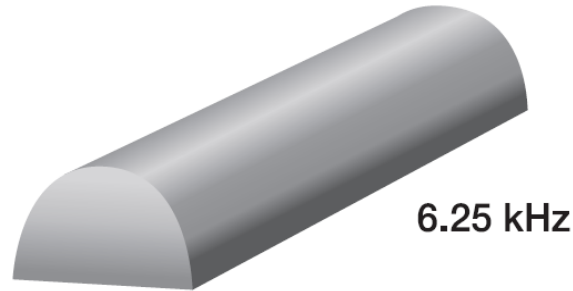
C4FM = Continuous 4-level Frequency Modulation

FDMA = Frequency Division Multiple Access

TDMA = Time Division Multiple Access

Note: Newer radios implement the vocoder in the DSP chip

# Bandwidth Comparison



# User Identification

	D-STAR	DMR	Fusion
Registration required?	Yes	Yes	No
User identity	Call sign	Subscriber ID	Call sign
ID displayed on radio's display	Call sign	Subscriber ID*	Call sign
Other text display options	4 characters 20 characters	No	No
Adequate for FCC ID?	Yes†	No	Yes†

\* Call sign displayed if the receiving station's subscriber ID is in the radio's contact list; otherwise subscriber ID appears.

† IDing by voice is still a good idea for the benefit of everyone listening.

# Repeater Connectivity

	D-STAR	DMR	Fusion
Talk locally	Yes	Yes	Yes
Link to another repeater	Yes	No	No
Multi-repeater connection	Reflectors	Talk Groups	WIRES-X Rooms
Selection method	UR entry	Channel Dial	Room name
Route to another ham	Yes	No	No
Echo test	Yes	Yes	No
Request link status	Yes	No	No



# Radio Operating Features

	D-STAR	DMR	Fusion
Memory selection	Dial or GPS search	Key Press	Dial
Repeater connection selection	Dial	Dial	Key press
Mode selection method	Key press	Fixed in memory	Key press *
Radio programming complexity	Difficult/Easy ◇	Difficult	Easy
Newbie learning curve	Steep	Fairly easy	Fairly easy
User manual pages - older HT	131 (IC-91)	65 (CS-700)	247 (FT-1DR)
User manual pages - newer HT	425 (ID-51)		340 (FT-2DR)

\* Fusion radios have AMS (automatic mode select)

◇ Older D-STAR radios are more difficult to program. Newer ones are pre-programmed, but must be updated as repeaters change.

# Signal Readability

	FM	D-STAR	DMR	Fusion *
Voice naturalness	Good	Good	Good	Narrow - good Wide - very good
Signal noise	Varies	None	None	None
Sync robustness	N/A	Fair	Good	Good
Sync recoverability	N/A	Poor	Best	Best

\* Fusion has two bandwidth voice modes. Wide sounds slightly better than narrow.

Sync robustness is the tendency to fall out of sync  
Sync recoverability is the ability to recover sync quickly

The opinions shown here are highly subjective. Your opinion may differ.

# Networking Characteristics

- D-STAR
  - User control capability - substantial
  - Networking options - G2, D-Plus, ircDDB
  - Innovation ability - many efforts and accomplishments
- DMR
  - Centrally controlled structure - inflexible
  - Networking options - c-bridge, hytera
  - Innovation ability - limited, but not impossible
- Fusion
  - Yaesu controlled servers - inflexible
  - Networking options - WIRES-X
  - Innovation ability - limited, but Hams are just getting started

# D-STAR HT's



## ID-31A

- Single band (70cm)
- 5W
- uSD card record
- 500 memories
- Internal GPS
- Repeater geo search
- \$295 new



## ID-51A Plus

- Dual band
- 5W
- uSD card record
- 1300 memories
- Internal GPS
- Repeater geo search
- \$450 new



# D-STAR Mobile's



## Older - ID-880H

- Dual band
- 50W
- 1050 memories
- \$420 new



## Newer - ID-5100A

- Dual band Touch Screen
- 50W
- 1000 + 1500 DR memories
- Internal GPS & DPRS
- SD card recording
- Repeater geo search
- \$600 new



# DMR HT's



## MotoTrbo - XPR-7550

- 440 MHz band
- 4W
- Color screen
- 1000 channels
- \$ 700 new



## Hytera PD782G-U1

- 440 MHz band
- 4W
- Color screen
- 1024 channels
- \$ 545 new



# DMR HT's (cont.)



## Connect Systems - CS700

- 440 MHz band
- 4W
- 1000 memories
- Chinese copy of XPR6550
- \$ 200 new



# DMR Mobile's



## MotoTrbo - XPR-5550

- 440 MHz band
- 40W
- 1000 channels
- Color screen
- \$ 600 new



## Hytera - MD782G-U1

- 440 MHz band
- 45W
- 1024 channels
- Color screen
- \$ 530 new





# System Fusion HT's



## Yaesu - FT-1DR

- Dual band
- 5W
- Automatic Mode Select
- 900 memories
- GPS & APRS
- \$300 new



## Yaesu - FT-2DR (new)

- Dual band
- 5W
- Automatic Mode Select
- 1245 memories
- GPS & APRS
- Touch screen
- \$550 new



# System Fusion Mobile



## Yaesu - FT-400DR

- Dual band
- 50W
- Automatic Mode Select
- 1000 memories
- GPS & APRS
- Color Touch screen
- \$500 new



## Yaesu - FT-100DR (new)

- Dual band
- 50W
- Automatic Mode Select
- 1000 memories
- GPS & APRS
- \$400 new



# Base Stations

ICOM - IC-7100



- HF + 6M - 100W
- 2M - 50W + 70 cm - 35W
- 1600 memories
- GPS
- Touch screen
- \$1,100 new



Yaesu - FT-991



- HF + 6M - 100W
- 2 & 70 cm - 50W
- Color TFT display
- Automatic antenna tuner
- Automatic Mode Select
- 1000 memories
- GPS & APRS
- \$1,600 new



# Other Digital Voice Suppliers

## DV Dongle

- Internet Labs
- D-STAR on your PC
- \$200 new



## Thumb DV



- Northwest Digital Radio
- D-STAR on your PC
- Uses AMBE 3000
- Other modes?
- \$120 new



# Other Digital Voice Devices

## DV Access Point

- Internet Labs
- Hotspot repeater
- Single band
- 2M \$240 new  
70 cm \$260 new



## DV Mega

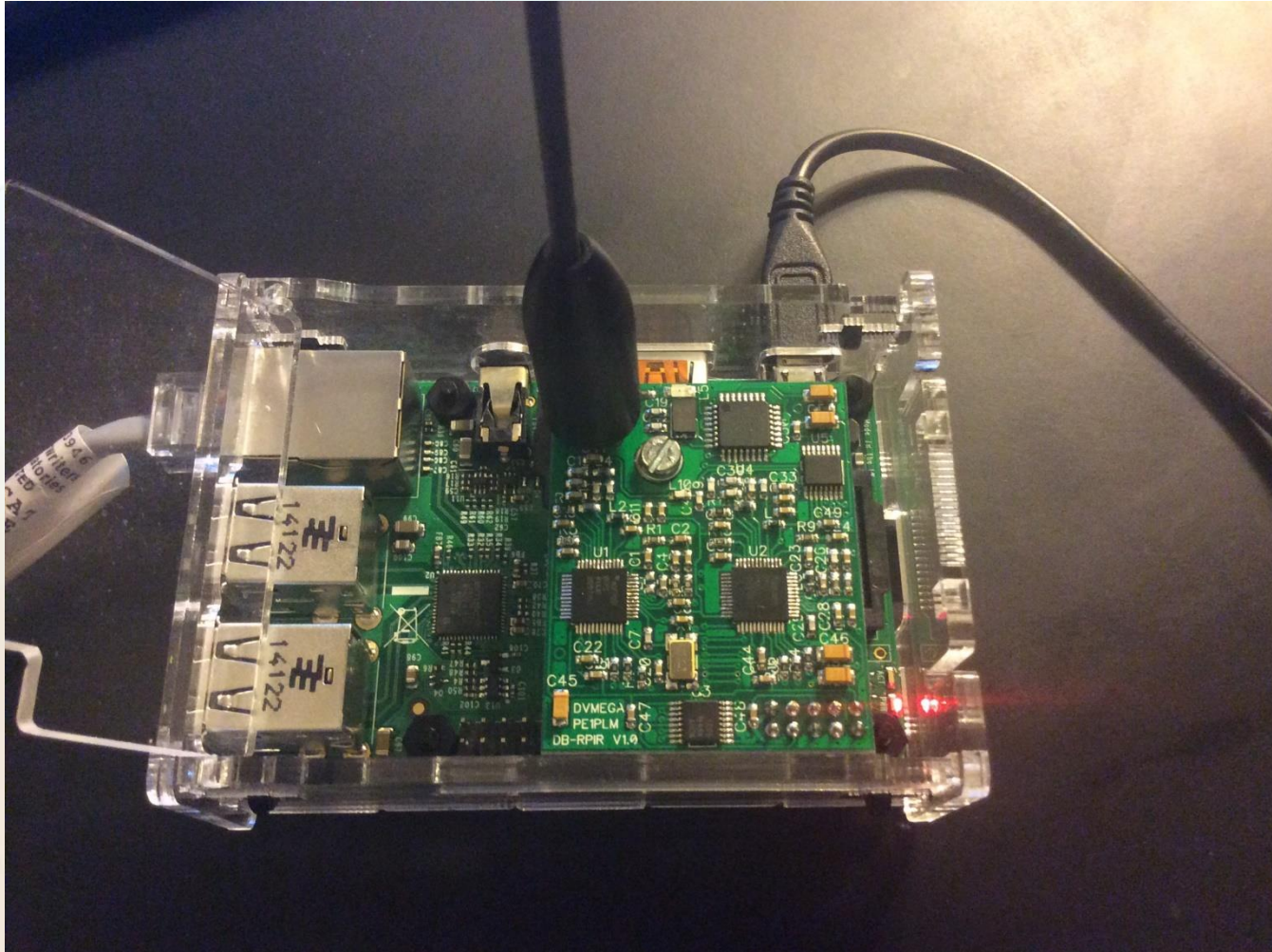
- Guus van Dooren PE1PLM
- Hotspot repeater
- Dual band
- \$180 new



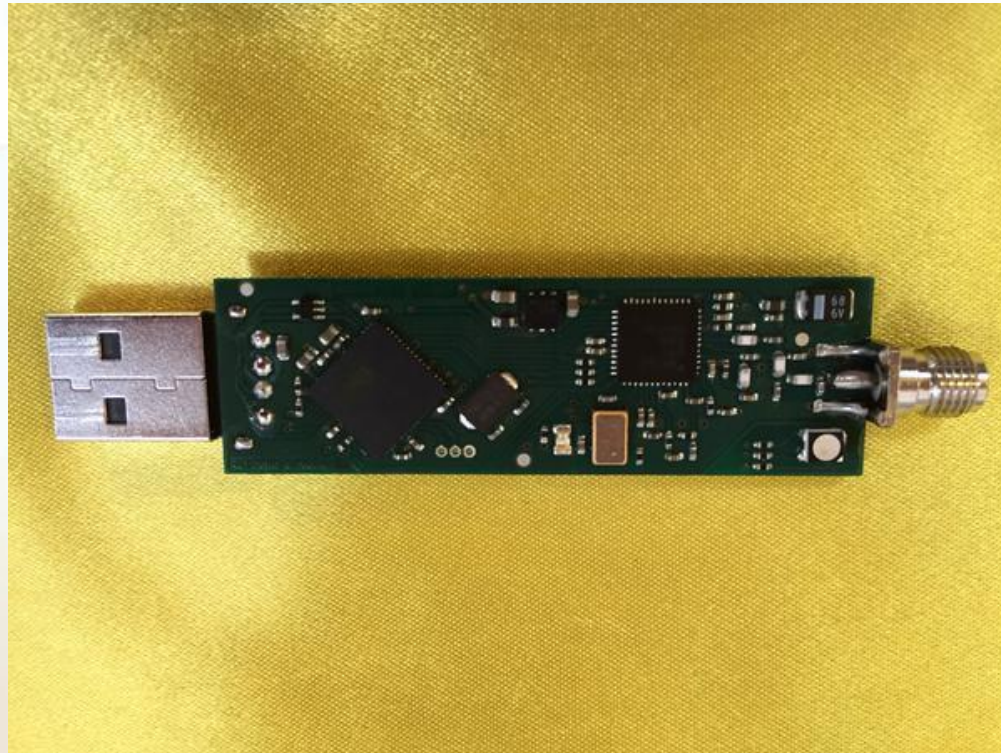
# Not near a D-STAR Repeater? Make your own - with this...



Or this...



# Or something not yet available...



DV4mini for DMR and D-STAR – 100 euro, available August



# Raspberry Pi G4KLX GUI

The screenshot displays the Raspberry Pi desktop environment with the G4KLX GUI. The desktop background is a blue starry theme with the text "Configs by KC4YOZ" and "Western D-Star". The taskbar at the bottom shows the following windows: "Timer Control - 20150213", "ircDDB Gateway - 20150213", "D-Star Repeater (DVMEGA) - modem1 - 20150213", and "D-Star Repeater (DVMEGA) - modem2 - 20150213".

**Timer Control - 20150213**

Day	Time	Type	Reflector	Sunday
Sunday	21:00	60 min...	REF002 A	00 : 00
Sunday	22:00	Never	REF054 C	None A

**ircDDB Gateway - 20150213**

Status: Connected D-PRS: Inactive

Links:

- Repeater 1: W9HPX C Not linked
- Repeater 2: W9HPX B Not linked
- Repeater 3:
- Repeater 4:

Dongles:

Log:

```
M: 2015-02-16 00:53:19: USER: DVMMET Z M0KSP C M0KSP G 92.13.44.205
M: 2015-02-16 00:53:19: GATEWAY: LASXFA G 195.0.204.150
M: 2015-02-16 00:53:24: USER: ZW0KMU NOT FOUND
M: 2015-02-16 00:53:46: USER: VE2GF VE2GF B VE2GF G 104.229.88.92
M: 2015-02-16 00:53:48: USER: ZW0KMU NOT FOUND
M: 2015-02-16 00:54:25: GATEWAY: N3EER G 70.88.145.166
M: 2015-02-16 00:54:29: USER: WBSRF WBSRF B WBSRF G 73.6.4.9
```

**D-Star Repeater (DVMEGA) - modem1 - 20150213**

Status: RX State: Listening Rpt State: Listening TX: Off

Header:

UR: RPT1: RPT2:

MY: Flags: 00 00 00 Loss/BER: 0.0%

Timers:

Timeout: 0/226 Beacon: 0/0 Announce: 0/0

Gateway:

Ack Text: Status 1: Status 2:

Status 3: Status 4: Status 5:

Log:

```
I: 2015-02-15 13:00:02: Output 1 = 0, output 2 = 0, output 3 = 0, output 4 = 0
I: 2015-02-15 13:00:02: Control: enabled: 1, RPT1: MY, RPT2: COMMAND, shutdown: STOP, startup: START, status1:
I: 2015-02-15 13:00:02: Frame logging set to 0, in /root
```

**D-Star Repeater (DVMEGA) - modem2 - 20150213**

Status: RX State: Listening Rpt State: Listening TX: Off

Header:

UR: RPT1: RPT2:

MY: Flags: 00 00 00 Loss/BER: 0.0%

Timers:

Timeout: 0/225 Beacon: 0/600 Announce: 0/0

Gateway:

Ack Text: Status 1: Status 2:

Status 3: Status 4: Status 5:

Log:

```
I: 2015-02-15 13:00:02: Output 1 = 0, output 2 = 0, output 3 = 0, output 4 = 0
I: 2015-02-15 13:00:02: Control: enabled: 0, RPT1: ., RPT2: ., shutdown: ., startup: ., status1: ., status2: ., status3: ., status4: ., status5: .
I: 2015-02-15 13:00:02: Frame logging set to 0, in /root
```

The desktop also features several icons on the left: "Other Icons", "Read-Me's", "LXTerminal", "WiFi Config", "Shutdown", "Midori", and "WDS Widget". The bottom of the screen displays the text "The Universal Operating System" and the "debian" logo.

# D-RATS

The screenshot displays the D-RATS software interface. The window title is "D-RATS: W9HPX". The interface includes a menu bar (File, View, Help) and a toolbar with options like "Add Filter", "Remove Filter", "Join Channel", and "Open Private Chat". The main chat area shows a list of messages from various stations, including AC7DS, N3TSZ, WX1DER, M0RCY, AE5RX, G7MNP, AK7AZ, IK5FKA, WA7MXZ, AK7AR, N4FNB, KG4CSQ, WB5UGC, KD5UBL, VR2XNG, and a QST message from K2TJW-1. A "Stations (27)" list on the right shows a scrollable list of call signs and their status (e.g., WB5UGC (1m), AK7AZ (1m), IK5FKA (1m), WB4LHD (1m), WA7MXZ (1m), AK7AR (1m), N4FNB (1m), KG4CSQ (1m), IW4EGP (1m), KF5VLK (1m), N4AAA (1m), WB8NUT (1m), SD6GB (1m), N1PTB (1m), AC7DS (1m), N3TSZ (1m), WX1DER (1m), M0RCY (1m)). A "My Status" panel at the bottom right shows the user's status as "Unattended" and "Online (D-RATS)". The status bar at the bottom indicates the sniffer is "DB0ZAV-H->CQCQCQ (chat: [QST] [See Station Details Visit] http://qrz.com/db/DB0ZAV)" and the current station is "W9HPX".

File View Help

Messages Chat Files Event Log

Add Filter Remove Filter Join Channel Open Private Chat

[21:13:03] AC7DS: Now Unattended: Dave, Tucson, AZ - DM42oc (Port RA I)  
[21:13:03] N3TSZ: Now Online: Patrick in Cheltenham, PA (Port RAT)  
[21:13:03] WX1DER: Now Online: Online (D-RATS) (Port RAT)  
[21:13:03] M0RCY: Now Online: Online (D-RATS) (Port RAT)  
[21:13:03] AE5RX: Now Online: Online (D-RATS) (Port RAT)  
[21:13:03] G7MNP: Now Online: Glen G7MNP: Warrington England Io83QJ (Port RAT)  
[21:13:04] AK7AZ: Now Online: 24HoP Net Control (Port RAT)  
[21:13:04] IK5FKA: Now Unattended: Online (D-RATS) (Port RAT)  
[21:13:04] WA7MXZ: Now Unattended: Online (D-RATS) (Port RAT)  
[21:13:04] AK7AR: Now Online: Owen in 12-Toes Arizona (Port RAT)  
[21:13:04] N4FNB: Now Online: Online (D-RATS) (Port RAT)  
[21:13:04] KG4CSQ: Now Online: Ralph, EM66hn09vs Clarksville TN (Port RAT)  
[21:13:05] WB5UGC: Now Online: Online (D-RATS) (Port RAT)  
[21:13:06] KD5UBL: Now Online: Online (D-RATS) (Port RAT)  
[21:13:06] VR2XNG: Now Online: Online (D-RATS)vr2ung (Port RAT)  
[21:14:10] [RAT] K2TJW-1: [QST]  
K2TJW-1

Main @WB4QOC

RAT

Send

Quick Messages  
QSTs

Stations (27)

WB5UGC (1m)  
AK7AZ (1m)  
IK5FKA (1m)  
WB4LHD (1m)  
WA7MXZ (1m)  
AK7AR (1m)  
N4FNB (1m)  
KG4CSQ (1m)  
IW4EGP (1m)  
KF5VLK (1m)  
N4AAA (1m)  
WB8NUT (1m)  
SD6GB (1m)  
N1PTB (1m)  
AC7DS (1m)  
N3TSZ (1m)  
WX1DER (1m)  
M0RCY (1m)

My Status

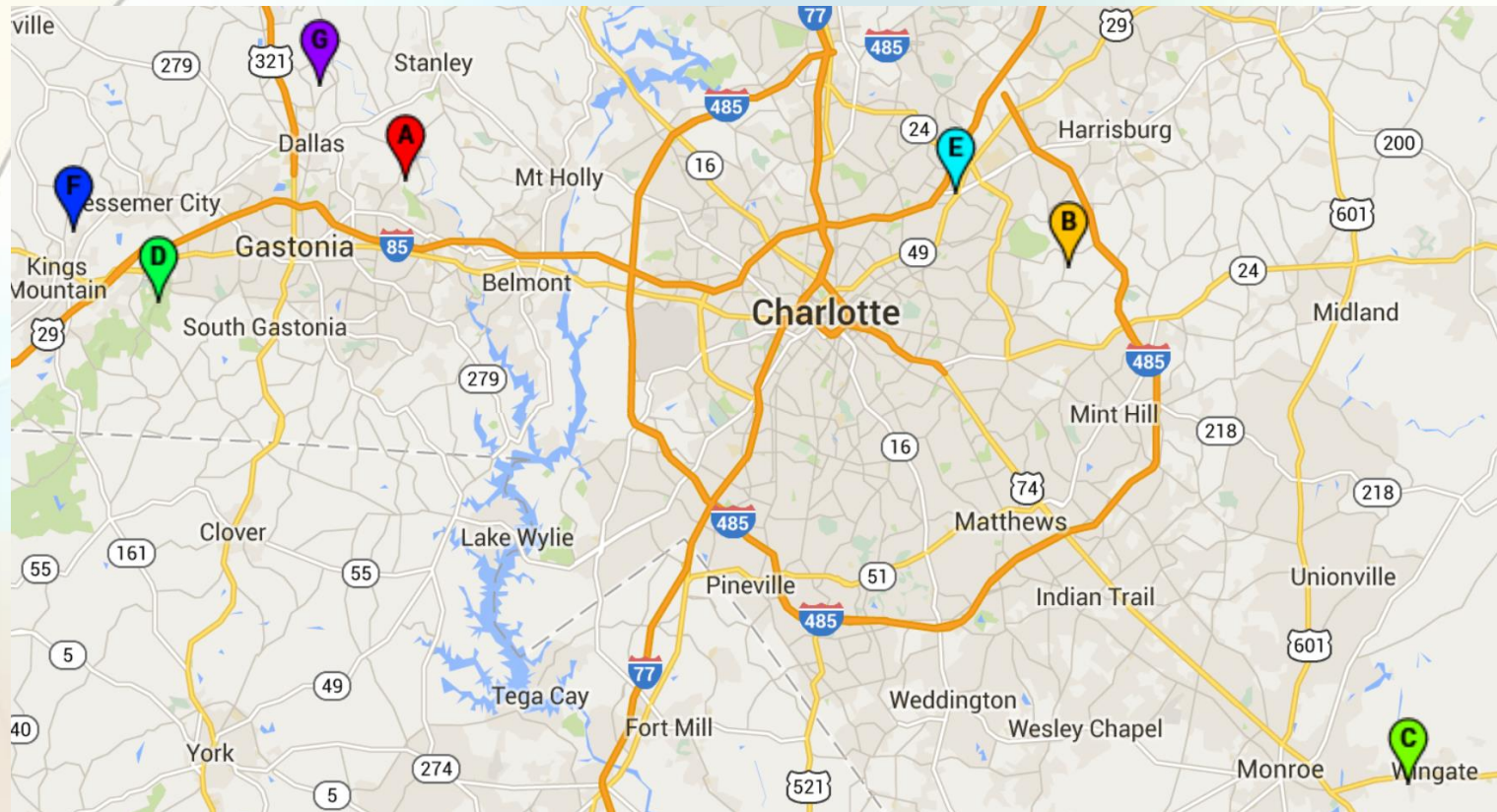
Unattended  
Online (D-RATS)

Sniffer: DB0ZAV-H->CQCQCQ (chat: [QST] [See Station Details Visit] http://qrz.com/db/DB0ZAV) W9HPX

# For More Information

- [www.charlottedstar.org](http://www.charlottedstar.org) - This is our web site. Register for D-STAR here.
- [groups.yahoo.com/neo/groups/clt-dstar/info](http://groups.yahoo.com/neo/groups/clt-dstar/info)  
This is our Yahoo group, but search for other Yahoo groups of interest such as D-STAR, Fusion, DMR, Connect Systems, etc. There's many.
- [www.dstar101.com](http://www.dstar101.com)
- [www.dstarinfo.com](http://www.dstarinfo.com)
- [www.dstarusers.org](http://www.dstarusers.org)
- [www.maryland-dstar.org](http://www.maryland-dstar.org) - for Raspberry Pi enthusiasts
- [www.ncprn.net](http://www.ncprn.net) - Web site for our area DMR repeaters & code plugs.
- [www.dmr-marc.net](http://www.dmr-marc.net)
- [www.trbo.org](http://www.trbo.org)
- [www.trinityos.com/HAM/Yaesu-System-Fusion/Yaesu-fusion-and-c4fm-v7.pdf](http://www.trinityos.com/HAM/Yaesu-System-Fusion/Yaesu-fusion-and-c4fm-v7.pdf) - Talk given by David Ranch KI6ZHD at 2015 Bay-Net meeting.
- [arvideonews.com/hrn/](http://arvideonews.com/hrn/) - Ham Radio Now – watch episodes 161 & 195
- <https://www.youtube.com/watch?v=eOYio06rsuo> – John Hays K7VE

# Charlotte Area Digital Voice Repeater Locations



- A – Spencer Mt. – D-STAR (70cm), DMR (70cm Hytera)
- B – Hood Rd. – D-STAR (2M & 70cm & 23cm), Fusion (70cm)
- C – Wingate – D-STAR (70cm), DMR (70cm)
- D – Crowder's Mt. – D-STAR (23cm), DMR (70cm), NexEdge (70cm)
- E – Charlotte – DMR (70cm)
- F – Shelby – D-STAR (2m & 70cm)
- G – Charlotte (Dallas) DMR (33cm)

# Questions?

Roland, W9HPX  
first licensed 1959  
w9hpx@arrl.net



Art, W9HPX (SK)  
first licensed 1933  
my Elmer