Introduction to Digital Voice Modes

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Charlotte Digital Radio Group

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Topics

- Who is Charlotte Digital Radio Group?
  – Some group history
  – Organization
  – Our repeaters
- How digital voice differs from FM
- Networking
- Currently available radios
- Access points (Hotspots)
- Bridges

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What we do

- We are digital voice enthusiasts
- We promote and support digital voice modes
  - 12 digital voice repeaters
  - 5 sites
  - 5 digital voice modes
- We try to educate hams about digital voice modes
- We have a forum where we can answer your questions

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The Beginning – D-STAR

- Nov. 2006, KA4YMY and KC4YOZ experimented with a Kenwood TKR-850 repeater interfaced with a Satoshi homebrew modem board to make the area's first D-STAR repeater.

- Nov. 2007, SERA began coordinating 12.5 kHz splinter channels for D-STAR. We were the first to get a pair assigned.

- ICOM D-STAR repeaters were added over the years to several sites – Spencer Mt, Crowders Mt, Wingate and Dallas.
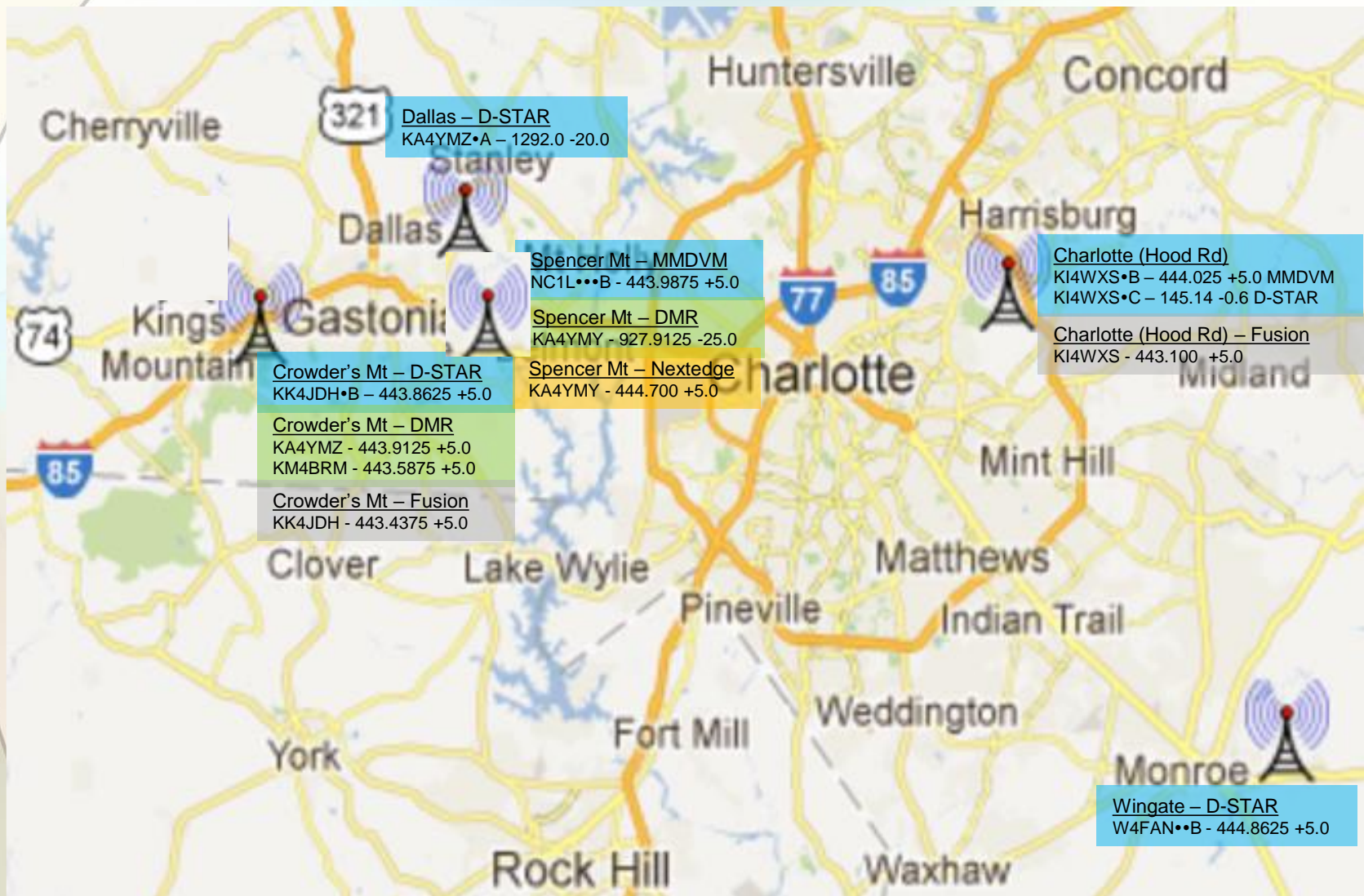
Next addition – DMR & Fusion

- In early 2014, we installed a DMR repeater at Crowders Mt networked to a DMR master controller owned by Ralph, W4ZO, located in NE Charlotte. 4 repeaters were networked.

- Later the network was replaced with a c-bridge controller and later by a software controller to allow expansion to form the NCPRN DMR network today.

- In Dec. 2014, we installed a System Fusion repeater at Crowders Mt. A second Fusion repeater came a year later at Hood Rd.

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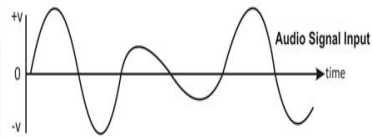
How we are organized

- We are not a club.
- We have always been a loose knit group.
- There are no elected officers.
- Users come and go.
- We have no membership nor dues.
- We pay our bills from private donations.
- Volunteers maintain our repeaters.
- We occasionally need professional tower climbers to repair/replace antennas.
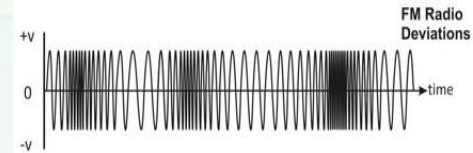
Charlotte Area Digital Voice Repeaters

Dallas – D-STAR
KA4YMZ•A – 1292.0 -20.0

Spencer Mt – MMDVM
NC1L•••B - 443.9875 +5.0

Spencer Mt – DMR
KA4YMY - 927.9125 -25.0

Spencer Mt – Nextedge
KA4YMY - 444.700 +5.0

Charlotte (Hood Rd)
KI4WXS•B – 444.025 +5.0 MMDVM
KI4WXS•C – 145.14 -0.6 D-STAR

Charlotte (Hood Rd) – Fusion
KI4WXS - 443.100 +5.0

Crowder's Mt – D-STAR
KK4JDH•B – 443.8625 +5.0

Crowder's Mt – DMR
KA4YMZ - 443.9125 +5.0
KM4BRM - 443.5875 +5.0

Crowder's Mt – Fusion
KK4JDH - 443.4375 +5.0

Wingate – D-STAR
W4FAN••B - 444.8625 +5.0

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What is Digital Voice?

Analog FM

MIC

Audio Signal Input

Modulator

FM Radio Deviations

What is Digital Voice?

Analog FM

MIC → Audio Signal Input → **Modulator** → FM Radio Deviations

Digital Voice

MIC → Audio Signal Input → **Vocoder** → 1 1 1 0 1 0 1 1 1 0 1 0 0 → **Modulator**

AMBE by Digital Voice Systems, Inc.

D-STAR – GMSK
DMR – 4FSK
Fusion – C4FM

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Digital Voice Packet Structure

	Radio Header											Data						
						ID												
Bit Syn	Frame Syn.	Flag 1	Flag 2	Flag 3	Destina-tion Repeater Callsign	Depar-ture Repeater Callsign	Compa-nion Callsign	Own Callsign 1	Own Callsig 2	P_FCS	Voice Frame	Data Frame	Voice Frame	Data Frame		Voice Frame	Data Frame
64bit	15bit	1	1 byte	1	8byte	8byte	8byte	8byte	4byte	2byte	72byte	24byte	72byte	24byte		72byte	24byte

|← error correction   660bit →|

	30 ms			330 ms													30 ms	
Data	Data	Data	Voice	Voice	Voice	Voice	Voice	Voice	Voice	Voice	Voice	Voice	Voice	Voice			Voice	Voice

Data SYNC   Data SYNC   Voice SYNC   Voice SYNC   Voice SYNC   Voice SYNC

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	M17
Vocoder	AMBE+	AMBE+2	AMBE+2	Codec 2
Modulation	GMSK	4FSK	C4FM	4FSK
Multiplex Method	FDMA	TDMA	FDMA	FDMA
Transmission Rate	4.8 kbps	4.8 kbps x 2	9.6 kbps	9.6 kbps
Bandwidth	6.25 kHz	12.5 kHz	12.5 kHz	9 kHz
Channels supported	1	2	1	1
Standard Developer	JARL	ETSI	Yaesu	M17 Team

AMBE = Advanced Multi-Band Excitation (patented Digital Voice Systems, Inc.)
Codec 2 = Codec 2 developed by David Rowe, VK5DGR, (LGPL license)
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

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Why Network?

- Repeaters are very quiet without users.

- Internet connectivity brings more users to the repeater and increases the coverage area.

- Reflectors provide multiple repeater connectivity.

- Wide area nets are possible.

- User network control gives the user choices, but some repeater owners prefer to limit control.

- Access Points (hotspots) give the user full control.

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Reflector – What is it?

- Software running on a PC with robust internet connection.
- It receives an incoming data stream and sends it back out to every connected repeater – i.e. it reflects the data.
- Terminology:
  - D-STAR calls them Reflectors
  - DMR calls them Talk Groups, but Europe calls them Reflectors
  - WIRES-X – Yaesu calls them Rooms
- There are many different reflector networking systems:
  - D-STAR – REF, XRF, DCS, XLX
  - DMR – IPSC (Motorola), IPMSC (Hytera), PCS, BrandMeister (DMR+), TGIF (DMR+)
  - Fusion – WIRES-X Rooms, YSF reflectors, FCS reflectors

Current D-STAR Radios

- Base – ICOM IC-9700 $1,700 VHF/UHF/1.2G
- Field – ICOM IC-705 $1,350 HF/VHF/UHF
- Mobile – ICOM ID-4100A $320 VHF/UHF
- Mobile – ICOM ID-5100A $400 VHF/UHF
- Mobile – ICOM IC-7100 $730 HF/VHF/UHF
- HT – ICOM ID-52A $650 VHF/UHF

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Current System Fusion Radios

- Base – Yaesu FT-991A $1,230 HF/VHF/UHF

- Mobile – Yaesu FTM-200DR $400 VHF/UHF

- Mobile – Yaesu FTM-300DR $460 VHF/UHF

- Mobile – Yaesu FTM-400XDR $590 VHF/UHF

- HT – Yaesu FT-70DR $175 VHF/UHF

- HT – Yaesu FT-5DR $450 VHF/UHF

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Current DMR Radios

- Mobile – Anytone D578UV Pro $400 VHF/UHF

- Mobile – TYT MD-9600 $269 VHF/UHF

- HT – Anytone D878UV $220 VHF/UHF

- HT – Wouxun KGUVN1 $140 VHF/UHF

- HT – TYT MD-2017 $169 VHF/UHF

- HT – TYT MD-UV380 $110 VHF/UHF

- HT – TYT MD-380 $100 UHF

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Access Points (Hotspots)

- Commercial
  - OpenSPOT 3 $447
  - DVMEGA Cast $400
  - TGIFSPOT $318

- Do-It-Yourself (components)
  - ZumSpot Elite $250
  - ZumSpot Kit $160 – also need Raspberry Pi
  - Thumb DV $120 – also need PC
  - DVMEGA $120 – also need Raspberry Pi
  - DV Stick 30 $110 – also need PC

Hotspot Software

Hostname: pi-stars
Pi-Star:4.1.0 / Dashboard: 20200528

Pi-Star Digital Voice Dashboard for W9HPX

Dashboard | Admin | Configuration

Modes Enabled

D-Star	DMR
YSF	P25
YSF XMode	NXDN
DMR XMode	POCSAG

Network Status

D-Star Net	DMR Net
YSF Net	P25 Net
YSF2DMR	NXDN Net
YSF2NXDN	YSF2P25
DMR2NXDN	DMR2YSF

Radio Info

Trx	Listening
Tx	430.100000 MHz
Rx	430.100000 MHz
FW	ZUMspot:v1.4.17
TCXO	14.7456 MHz

D-Star Repeater

RPT1	W9HPX B
RPT2	W9HPX G

D-Star Network

APRS	rotate.aprs2.net
IRC	rr.openquad.net

Linked to **REF054 C**
(DPlus Outgoing)

Gateway Activity

Time (EDT)	Mode	Callsign	Target	Src	Dur(s)	Loss	BER
10:42:24 Jun 3rd	D-Star	KA4VUK/MIKE	CQCQCQ	Net	1.0	0%	0.0%
09:32:35 Jun 3rd	D-Star	KF8PM/ALAN	CQCQCQ	Net	3.1	0%	0.0%
09:32:30 Jun 3rd	D-Star	W9HPX/9700	CQCQCQ	RF	26.6	0%	0.0%
09:23:04 Jun 3rd	D-Star	W9HPX/51AD	CQCQCQ	RF	13.4	0%	0.0%
09:19:41 Jun 3rd	D-Star	W9HPX/INFO	CQCQCQ	Net	7.2	0%	0.0%
09:18:14 Jun 3rd	YSF	N2RON	*****EAYgj	Net	28.2	0%	0.0%
09:17:40 Jun 3rd	YSF	K9VMY	ALL	Net	17.5	0%	0.0%
09:14:29 Jun 3rd	YSF	KO4LJ	ALL	Net	0.5	0%	0.0%
07:22:35 Jun 3rd	YSF	W4OLE	ALL	Net	0.5	0%	0.0%
06:26:40 Jun 3rd	YSF	WB4FCU	ALL	Net	19.2	0%	0.0%
06:26:17 Jun 3rd	YSF	KB4BCY	ALL	Net	66.2	0%	0.0%
21:43:30 Jun 2nd	D-Star	ND4L/ID51	CQCQCQ via REF054 C	Net	6.8	0%	0.0%
21:43:27 Jun 2nd	D-Star	KI4UDZ/ID51	CQCQCQ	Net	6.0	0%	0.0%
21:40:47 Jun 2nd	D-Star	N2RON/AMBE	CQCQCQ	Net	15.5	37%	0.3%
21:38:14 Jun 2nd	D-Star	KC8YQL/AMBE	CQCQCQ	Net	45.0	0%	0.0%
21:36:10 Jun 2nd	D-Star	W9HPX/9700	CQCQCQ	Net	132.0	0%	0.0%
21:32:49 Jun 2nd	D-Star	K4MVM/9700	CQCQCQ	Net	49.4	0%	0.0%
21:30:59 Jun 2nd	D-Star	KD8AGO H/JOHN	CQCQCQ	Net	69.9	0%	0.0%
21:24:26 Jun 2nd	D-Star	KF4BY/5100	CQCQCQ	Net	61.2	7%	0.0%
21:22:58 Jun 2nd	D-Star	K4FPP/RICH	CQCQCQ	Net	106.7	0%	0.0%

Local RF Activity

| Time (EDT)	Mode	Callsign	Target	Src	Dur(s)	BER	RSSI
09:32:30 Jun 3rd	D-Star	W9HPX/9700	CQCQCQ	RF	26.6	0.0%	S9+46dB (-47 dBm)
09:23:04 Jun 3rd	D-Star	W9HPX/51AD	CQCQCQ	RF	13.4	0.0%	S9+46dB (-47 dBm)

Pi-Star / Pi-Star Dashboard, © Andy Taylor (MW0MWZ) 2014-2020.
ircDDBGateway Dashboard by Hans-J. Barthen (DL5DI),
MMDVMDash developed by Kim Huebel (DG9VH),
Need help? Click here for the Facebook Group
or Click here to join the Support Forum
Get your copy of Pi-Star from here.
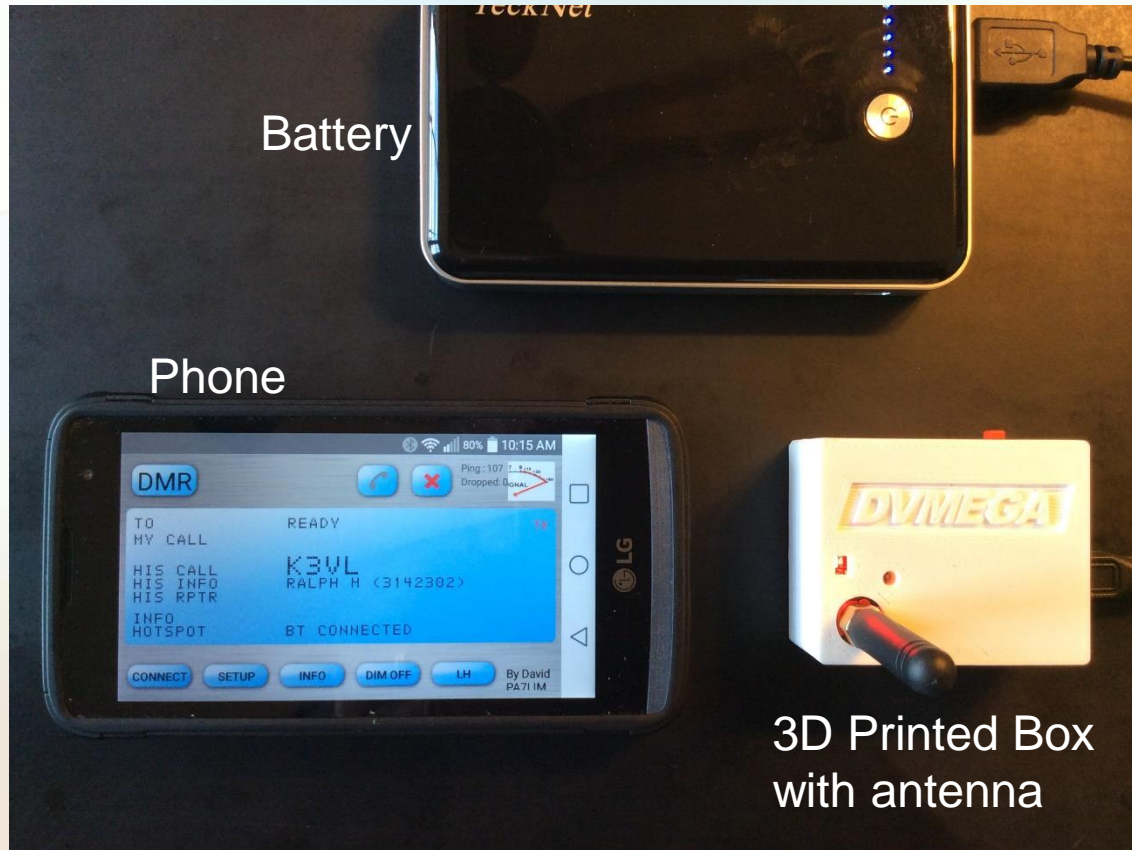
Free download at: http://www.pistar.uk/

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BlueDV software by David PA7LIM

- Least expensive way to get started – no radio to buy
- Buy an AMBE USB stick from several sources such as Northwest Digital Radio or DVMEGA
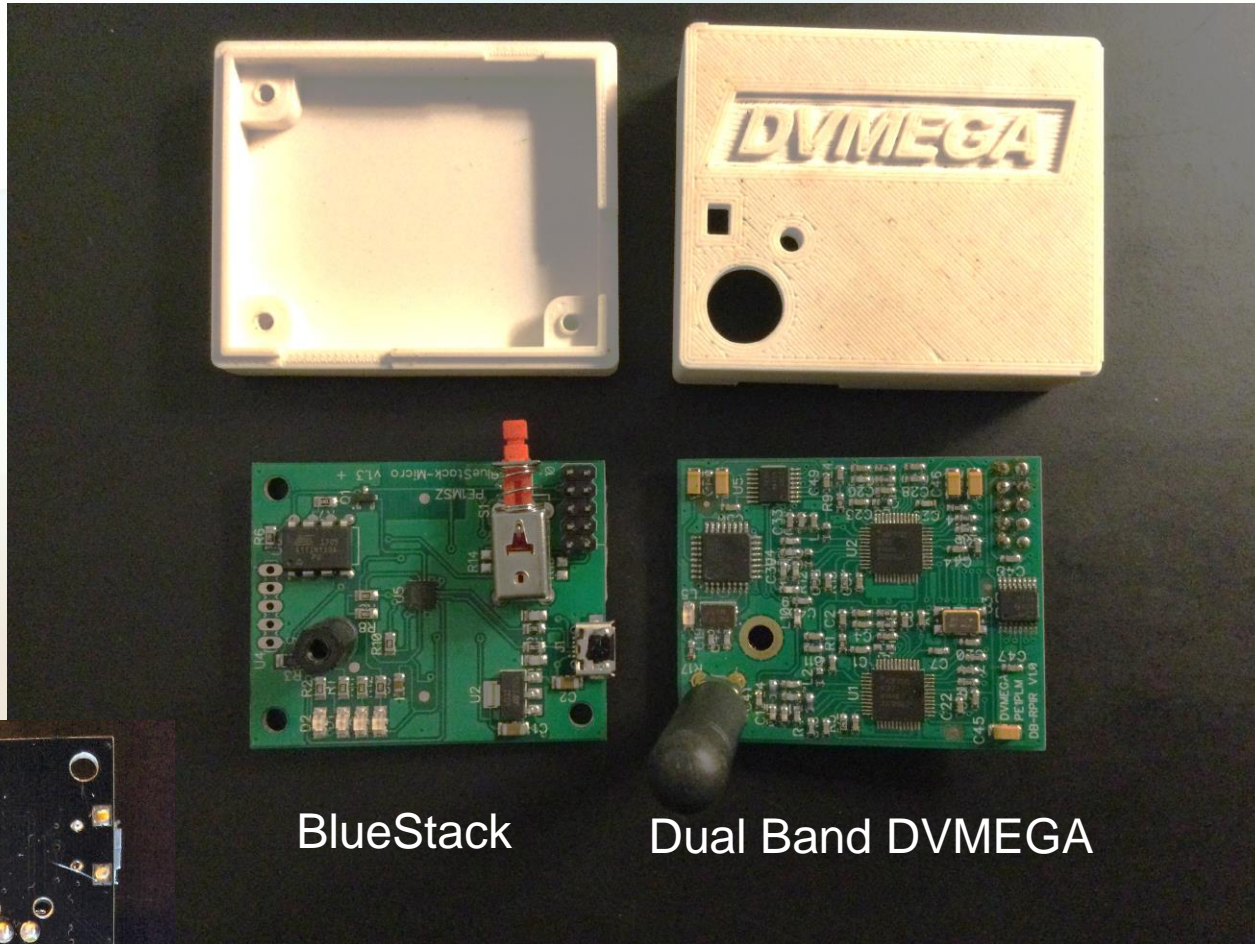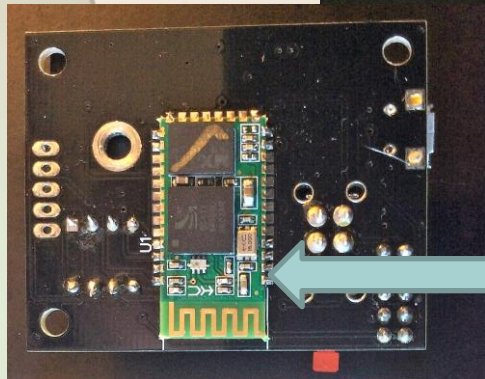- Free software download from www.pa7lim.nl
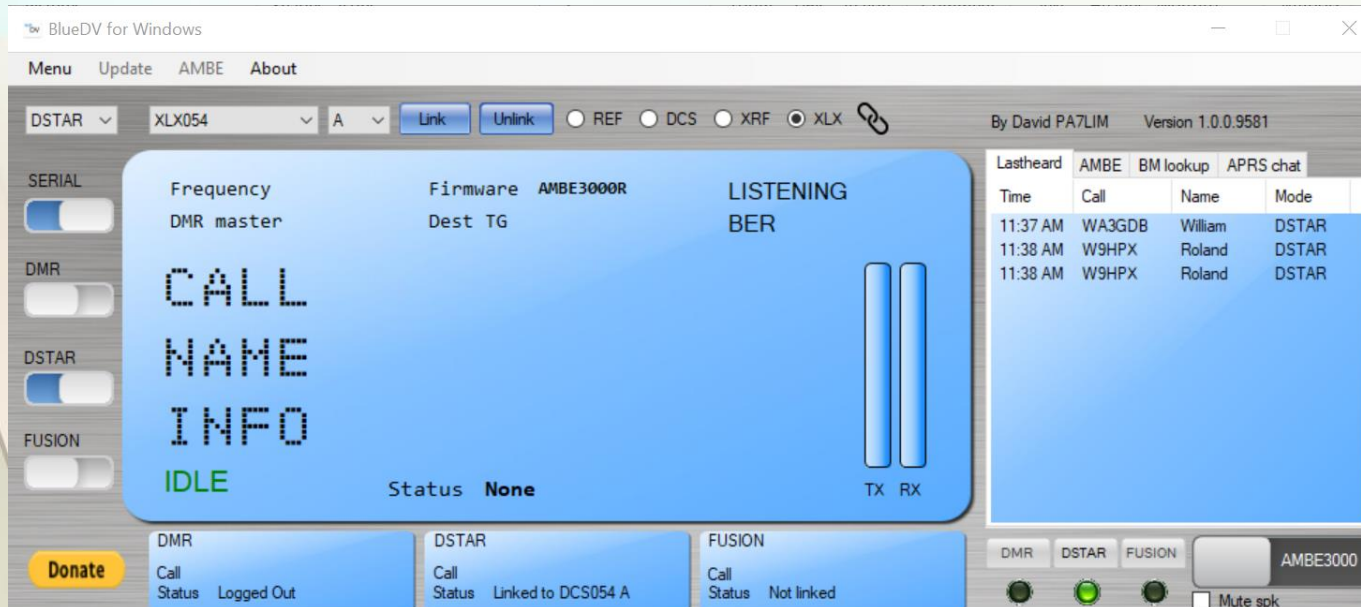
My Mobile Hotspot

DVMEGA on BlueStack Board paired via Bluetooth
to an Android phone running BlueDV software
D-STAR, DMR, YSF

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What's in the Box?

BlueStack   Dual Band DVMEGA

Bluetooth Module
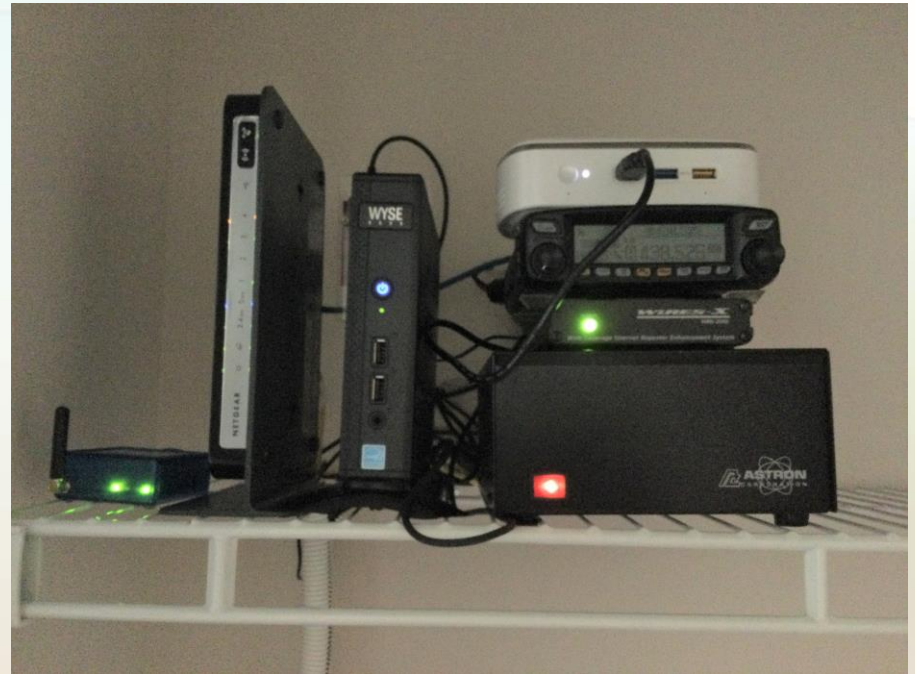
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Bridging DV Modes

- Why bridge?

  – Need to own fewer radios

  – Talk to hams that use a different DV mode

  – Expand beyond proprietary networks

- What is needed to create a bridge?

  – PC(s)

  – Software

  – Internet

  – Transcoder

  – Radios (only if an RF link is needed)

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Carolina Link Bridge

- Originally started by Steve, K4SQI (SK)

- Interconnects:

  - D-STAR DCS054A
  - WIRES-X Room 43008
  - YSF Reflector 79602
  - DMR TGIF TG 31374

- Dashboards:

  - http://xrf054.metro-uhf.org/index.php
  - http://ysf.metro-uhf.org/

Additional Information Sources

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- http://www.charlottedstar.org/ – This is our web site.
  https://groups.io/g/CharlotteDigitalRadio – This is our group. Please join to keep up with what we are doing. Post a message or a question.

- http://www.charlottedstar.org/D-STAR DR Mode.pdf – How to use DR mode.

- www.dstarinfo.com – download current repeater data (.cvs file) to import into your compatible D-STAR radio.

- www.dstarusers.org – Official D-STAR repeater directory.

- www.ncprn.net – Web site for our area DMR repeaters.

- https://radioid.net/register#! – Register your call sign here for DMR.

- www.trbo.org/docs/Amateur_Radio_Guide_to_DMR.pdf – Basic DMR guide.

- https://wp.hamoperator.com/ – learn about System Fusion and WIRES-X. Look for the WIRES-X bible under Fusion Help.

- https://m17project.org/ - website for M17 development.

Manufacturer's web sites have the most relevant specific radio information.

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THANKS FOR LISTENING

QUESTIONS?