

A Comparison of Amateur Radio Digital Voice Systems



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These slides are on our web site – www.charlottedigitalradio.org

Topics

- Digital voice differences from FM
- Modes - technical comparison
- Operating features
- Radios
- Access point (hotspot) hardware including non-radio options
- Additional information sources

What is Digital Voice?

Analog FM

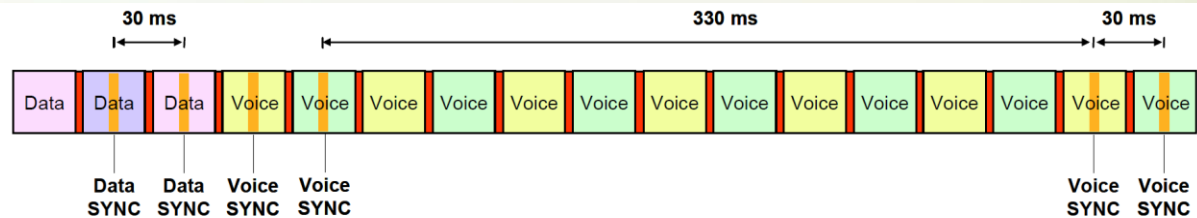
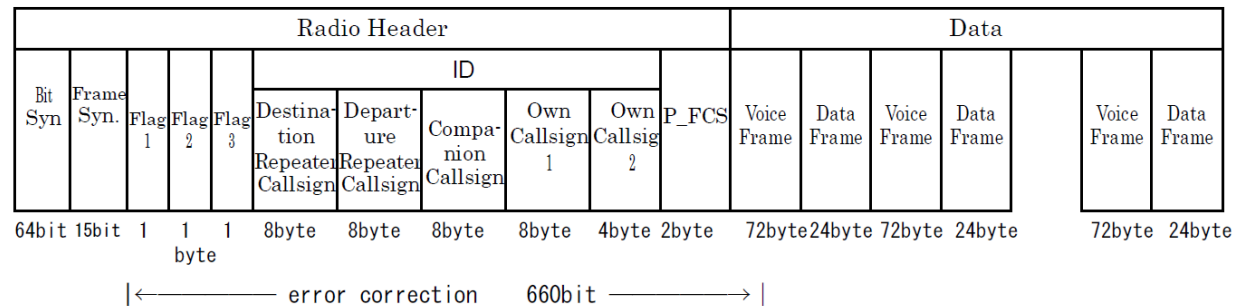


Digital Voice



AMBE by Digital
Voice Systems, Inc.

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



		DCH			DCH		VeCH	DCH		VeCH	DCH		VeCH	DCH		VeCH	Number of bits
FS	FICH	(0)	VCH (0)	VeCH (0)	(1)	VCH (1)	(1)	(2)	VCH (2)	(2)	(3)	VCH (3)	(3)	(4)	VCH (4)	(4)	
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	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

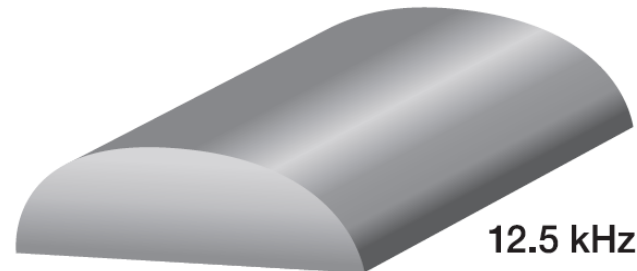
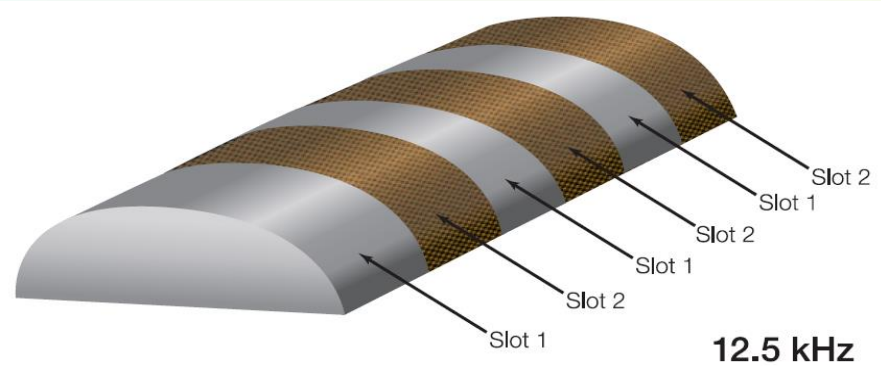
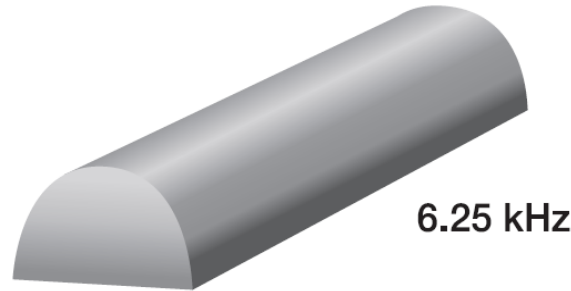
4FSK = 4-level Frequency Shift Keying

C4FM = Continuous 4-level Frequency Modulation

FDMA = Frequency Division Multiple Access

TDMA = Time Division Multiple Access

Bandwidth Pictorial



User ID specs

	D-STAR	DMR	Fusion
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. If the radio's firmware supports "Talker alias" the call sign is displayed.

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

Mode Audio Quality

	FM	D-STAR	DMR	Fusion
Voice naturalness*	Good	Fair	Good	Best
Noise on signal	Varies	None	None	None
Sync robustness	N/A	Fair	Good	Good
Sync recoverability	N/A	Poor	Best	Best

*Assumes properly set microphone gain – too much gain will cause clipping and poor audio

Sync robustness is the tendency to fall out of sync on weak signals

Sync recoverability is the ability to recover sync quickly

The opinions shown are the author's. Your opinion may vary.

Why Network?

- Repeaters are very quiet without users.
- Internet connectivity brings more users to the repeater.
- Reflectors provide multiple repeater connectivity.
- Increased coverage and wide area nets are possible.
- User network control gives the user choice, but some repeater owners prefer to retain control.
- Access Points (hotspots) give the user full control.

Reflector - What is it?

- It is software typically running at a location with robust internet.
- It receives an incoming data stream and sends it back out to every currently connected device - i.e. it reflects the data.
- Terminology:
 - D-STAR calls them Reflectors
 - DMR calls them Talk Groups and/or Reflectors (in Europe)
 - WIRES-X calls them Rooms
- There are many different reflector systems:
 - D-STAR - REF, XRF, DCS, XLX
 - DMR - IPSC (Motorola), IPMSC (Hytera), PCS, BrandMeister (DMR+)
 - WIRES-X - Yaesu rooms, YSF rooms (G4KLX), FCS
 - P25 - PCS

DCS, PCS and FCS developed by the DV4Mini group

D-STAR Radio



ICOM ID-51A Plus 2 HT

- Dual band
- 5W
- uSD card record
- 1300 memories
- Internal GPS
- Repeater geo search
- Terminal Mode
- Access Point mode
- \$350



Similar mobile ICOM IC-5100A - \$400

DMR Radio



AnyTone AT-D878UV HT

- Dual band
- 6W
- 4000 channels
- Front panel programmable*
- Color display
- GPS & APRS
- \$220

* FCC requires the keyboard be locked for US sales. Cable and instructions are included to unlock the keyboard for amateur use.



System Fusion Radio



Yaesu *FT-3DR* HT

- Dual band
- 5W
- Automatic Mode Select
- WIRES-X search & connect
- 1245 channels
- GPS & APRS
- Color Touch screen
- PDN mode with optional cable
- \$390



Similar mobile Yaesu FTM-300DR - \$500

Commercial Access Points

Stand alone hot spots - PC needed to configure, not to use

SharkRF *openSPOT3*

- UHF 20 mw
- Li-ion battery
- Internal antenna
- D-STAR, DMR, C4FM (YSF, FCS), NXDN, P25, POCSAG, APRS
- WiFi network connection IEEE 802b/g/n
- Web based setup / configuration
- Built-in transcoding
- www.sharkrf.com/products/openspot3/
- €249 = \$280



openSPOT and *openSPOT2* are discontinued, but available used.

Yaesu System Fusion WIRES-X Node

Your own YSF node and room!



Yaesu - *FTM-100DR*

- Dedicated transceiver running in HRI-200 mode
- Available used

Yaesu *HRI-200*

- Radio to PC interface
- Specialized sound card
- \$125

*You still need
another Fusion
Radio to use it.*

Windows PC running
WIRES-X software



- There are typically about 1,500 WIRES-X rooms active for use.

Multi-mode IP Radio

Is it a radio? It's not! It connects only to the internet.

DVMEGA Cast

- D-STAR, DMR, Fusion (YSF & FCS) but no radios needed
- AMBE+2 vocoder
- WiFi and cable internet connections
- 3-watt front facing speaker; microphone included
- Touch screen
- Configures from a web page
- \$430



Access Point Devices for Builders

- No repeater nearby?
- Build your own 10 mW simplex repeater (hotspot)
- Add a PC or Raspberry Pi and the appropriate software such as Pi-Star
- Radio is necessary for each mode you use
- Other devices available from China



Device	Manufacturer	Supports	Connect to	Price
ZumSpot	KI6ZUM	5 modes*	RaspPi GPIO	120
ZumSpot USB	KI5ZUM	5 modes*	USB port	110
DV MEGA -70 cm	Dooren Elect.	D-STAR+DMR+YSF	RaspPi GPIO	129
DV MEGA -2 band	Dooren Elect.	D-STAR+DMR+YSF	RaspPi GPIO	169

* 5 modes are D-STAR, YSF, DMR, NXDN, P25



Assembled Hotspots



Dual Band DVMega
on Raspberry Pi 2
D-STAR, DMR, YSF



ZumSpot on
Raspberry Pi 3B
D-STAR, DMR, YSF,
NXDN, P25



Duplex MMDVM
on Raspberry Pi 3B
DMR both slots

Software for Your Hotspot

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	K14UDZ/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)

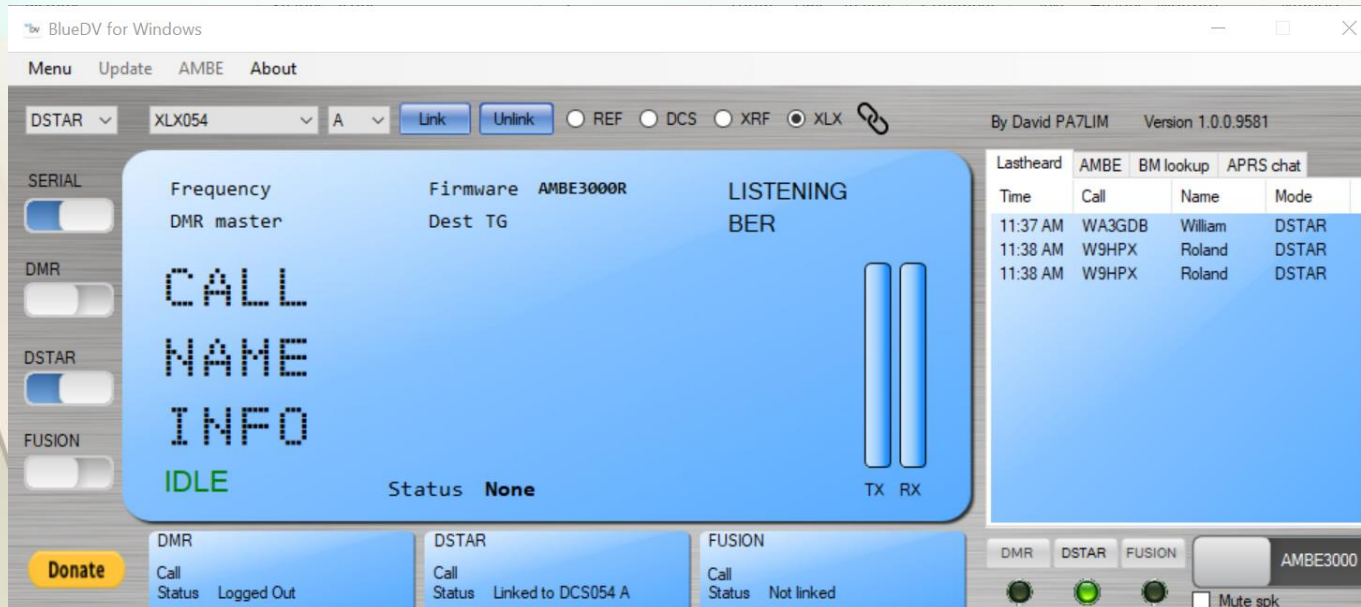
Pi-Star / Pi-Star Dashboard, © Andy Taylor (MW0MWZ) 2014-2020.
ircDDBGateway Dashboard by Hans-J. Barthen (DL5DI),
MMDVMDash developed by Kim Huebel (DG9VH),
Need help? Click here for the Facebook Group
or Click here to join the Support Forum
Get your copy of Pi-Star from here.

Get it at: <http://www.pistar.uk/>

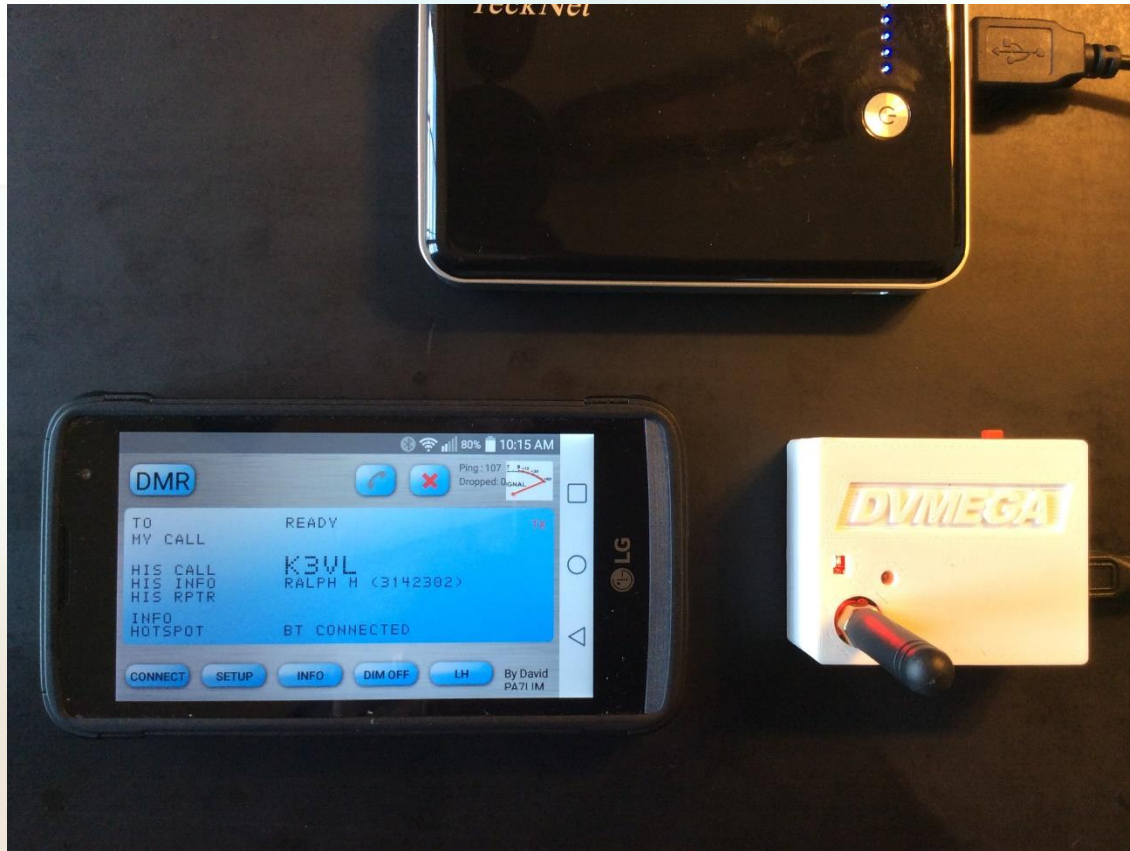
Charlotte Digital
Radio Group
Digital Voice Communications

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



Mobile Hotspot



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

Additional Information Sources

- <http://www.charlottedstar.org/> – This is our web site. Use Registration link at the bottom of the page to register your call sign for D-STAR.
 - <https://groups.io/g/CharlotteDigitalRadio> – This is our group. Please join to keep up with what we are doing. Post a message or question.
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- www.dstar101.com – good beginner's web site to learn about D-STAR.
 - <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.
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- 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://brandmeister.network/> - Home page for Brandmeister DMR network activity and info.
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- <https://wp.hamoperator.com/> – learn about System Fusion and WIRES-X. Look for the WIRES-X bible under Fusion Help.
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Manufacturer's web sites have the most relevant specific radio information.