

Digital Voice Progress - 2016 Roland Kraatz - W9HPX Charlotte Digital Radio Group Charlotte Hamfest - 3/12/2016

Amateur Radio experimentation is alive and well in Digital Voice



Notetaking Optional

- These slides are available for download at our web site <u>www.charlottedstar.org</u> as a PDF file.
- There are many embedded internet links that will take you to many useful Digital Voice web sites.
- Note all the links worked, but web pages sometimes disappear or move and the links fail.
- In that case join our clt-dstar Yahoo group and post your question or comment to the group – <u>Link</u>*

Discussion Topics

- Technical comparison of Digital Voice systems
- Amateur enhancements to the original designs
- Current amateur developmental work
- The future
- Questions



What are the Digital Voice Modes?

- P-25 Implemented by Public Safety agencies in 90's, administered by Telecommunications Industry Assn – <u>Link</u>
- D-STAR Japan ARL spec. published 2001 <u>Link</u> implemented by ICOM
- DMR* ETSI spec. published 2007 in 3 parts <u>Link</u> implemented by Motorola and Hytera
- NXDN– Kenwood/ICOM spec. published 2012 <u>Link</u>
- System Fusion Yaesu spec. published 2013 <u>PDF</u>
- Free DV open source spec. <u>Link</u>

What makes it Digital Voice (DV)?

- A DV transmission is digital data assembled into packets sent in a continuous stream modulating an RF carrier*
- Each Packet contains a header, sync bits and payload data
- Sync bits permit the receiver to identify when the data begins
- Header provides identity, routing, type of payload, etc.
- The voice payload is data to represent the elements of voice such as frequency, attack, volume, etc.
- The payload can also contain text or other types of data either interleaved with the voice data or replacing the voice data



* Even though DV is a stream of data bits, FCC regulates it based on its content (i.e. phone)

What is the voice payload?

- An objective of Digital Voice is to reduce signal bandwidth
- A vocoder compresses the digital audio to half the incoming bit rate – 8 kHz to 4 kHz
- Most all DV systems use the proprietary Digital Voice Systems, Inc. AMBE family of vocoders – <u>Link</u>
- AMBE compresses by coding voice characteristics and adds forward error correction for use over a lossy channel
- Is there a non-proprietary vocoder? Yes, David Rowe, VK5DGR, created Codec2 but it is used mostly on HF – <u>Link</u>



Major DV Mode Spec Differences

	Vocoder	Channels	Bandwidth	Multiplex	Modulation
P25 – Phase 1*	IMBE	1	12.5 kHz	FDM	C4FM
D-STAR	AMBE+	1	6.25 kHz	FDM	GMSK
DMR	AMBE+2	2	12.5 kHz	TDM	4FSK
NXDN	AMBE+2	1	6.25/12.5 kHz	FDM	C4FM
System Fusion	AMBE+2	1	12.5 kHz	FDM	C4FM
Free DV (HF)	Codec 2	1	1.25 kHz	FDM	QPSK

*P25 phase 2 is excluded because it is still under development



D-STAR Network Features

- Originally D-STAR could only operate:
 - Locally to anyone listening on the repeater
 - Via internet to a user's call sign (call sign routing)
 - Via internet to anyone listening on a different repeater
- It was not possible to tie together many D-STAR repeaters in conference mode the way you can with IRLP or Echolink
- Resource: D-STAR 101 web site <u>Link</u>



The Creation of D-Plus

- Robin Cutshaw, AA4RC, developed a system to link multiple D-STAR repeaters to a reflector conference bridge – <u>Video</u>
- D-Plus software runs on the repeater's gateway computer
- Software for the reflector runs at a computer data center
- D-Plus permits a user via the UR command to:
 - Link the repeater to a reflector
 - Unlink the repeater
 - Request the link status
 - Echo test the audio
 - Connect DV Dongles to the D-STAR network



The Other D-STAR Reflectors

- Robin maintains and manages D-Plus installations
- Scott Lawson, KI4LKF, wrote DExtra, a D-Plus open source replacement with its own Multi-trust network of servers and X-reflectors
- Now, anyone can download DExtra and operate their own X-reflector
- Scott ended his work, but you can read about it <u>Link</u>
- Tom Early, AC2IE, has saved Scott's work <u>Link</u>



Development of ircDDB

- Hans Barthen, DL5DI, Michael Dirska, DL1BFF, and Jann Traschewski, DG8NGN created a network to exchange D-STAR routing information – <u>Link</u>
- Michael and Scott collaborated to write g2_ircddb used at D-STAR repeaters to take advantage of the ircDDB network
- It sends last heard data in near-real time



Early D-STAR Hardware Development

- ICOM was first with D-STAR hardware
- Robin, AA4RC, and Moe Wheatley, AE4JY, developed the DV Dongle, the DV-AP and the DV3K
- The DV Dongle and DV3K dongle allow a ham to access the D-STAR network without a D-STAR radio – <u>Link</u> and <u>Link</u>
- The DV-AP allows a ham too far from a D-STAR repeater to get on D-STAR with only his HT – <u>Link</u>





More D-STAR Hardware Development

- Brian Hoyer, K7UDR, and John Hays, K7VE, formed NW Digital Radio to produce the UDRX-440 digital radio – <u>Link</u>
- They developed the DV3000 ----->

and the DV3000U ----





Another is StarDV from Matrix Circuits – <u>Link</u> --->



• All do the same thing as the DV Dongle



Still More D-STAR Hardware Development

- Guus van Dooren, PE1PLM, has created several D-STAR radio products for the Raspberry Pi and Arduino – <u>Link</u>
- Dual band DVMega for Raspberry Pi
- Does the same thing as the DV-AP, except 2 bands
- Support forum for DVMega products – <u>Link</u>





Can I do D-STAR with my FM radio?

- The DVRPTR is a GMSK modem that will connect to your FM radio packet port or to an FM repeater to send/receive D-STAR digital – <u>Link</u>
- The Matrix Circuits Starboard is another GMSK modem with excellent support from Jim Moen, K6JM at MoenComm– Link

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 They can also be connected to an HF radio's packet port and a DV Dongle to do D-STAR on HF

Does this Hardware Need Software?

- Robin provides DVTool for use with his DV Dongles <u>Download</u>
- Robin provides DVAPTool for use with his DV-AP <u>Download</u>
- Fred van Kempen, PA4YBR, wrote a very nice piece of software called WinDV for Windows – <u>Link</u> It supports:
 - DV Dongle
 - DV-AP
 - DV3000U
 - DVRPTR modem
 - DVMega
 - StarDV

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What About Hotspot Software?

- Ramesh Dhami, VA3UV, developed Freestar (open source) and also provides an image download for the Raspberry Pi – <u>Link</u>
- Jonathan Naylor, G4KLX, developed programs (open source) that are probably the most used hotspot software today. They can be installed on a Windows PC from Yahoo Groups
 - ircDDBGateway <u>Link</u>*
 - PC Repeater Controller <u>Link</u>*
- Images for various platforms are available from several sources. Here are some of the most popular:
 - Western D-STAR <u>Link</u>
 - Maryland D-STAR <u>Link</u>

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Radio Group Digital Voice Communications • D-STAR Commander – <u>Link</u>

* Must be a member of the Yahoo group to access

G4KLX software on a Raspberry Pi GUI

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D-RATS

- Originally developed by Dan Smith, KK4DS, for D-STAR
- Features chat, email, file transfer and fillable forms functions using D-STAR radios or over the internet
- Popular with EMCOMM users
- Downloadable Windows version <u>Link</u>
- Training manual for D-RATS <u>PDF</u>



D-RATS

Ø D-RATS: W9HPX	- 🗆 ×			
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I QSTs				
Sniffer: DB0ZAV-H->CQCQCQ (chat: [QST] [See Station Details Visit] http://qrz.com/db/DB0ZAV)				

DMR Network

- Two commercial DMR network protocols <u>Link</u>
 - IP Site Connect (Motorola)
 - IP Multi-site Connect (Hytera)
- There are also regional networks such as PRN <u>Link</u>
- DMR uses talkgroups to create the channels hams use
- Repeater owners decide what network to join, and must conform to that network's structure
- Users program their radios to utilize the talkgroups
- Resource document: "Amateur Radio Guide to DMR" by John Burningham, W2XAB – <u>PDF</u>



DMR Network Developmental Work

- The Raycom c-Bridge is used by hams to connect MotoTrbo repeaters into a much larger network – <u>Link</u>
- In 2013, Hans Barthen, DL5DI, and Torsten Schultze, DG1HT, created the DMRplus network and reflectors that work with the Hytera network and are now part of the DV4mini project
- Hans and Torsten also wrote DMR+Mbridge to bridge the MotoTrbo and Hytera networks – <u>Link</u>
- BrandMeister is a system that enables linking between different networks such as DMR to Hytera and is rapidly replacing the DMR+ reflectors – Link

P25 and NXDN Networks

- Like DMR, these Public Safety systems have been repurposed to ham radio use
- Also like DMR they use talkgroups to define the channels
- Robert Thoelen, N1XDN, makes available NXCore Manager open source software which implements an Amateur Radio NXDN network– <u>Link</u>
- He periodically releases software updates on his website and provides implementation instructions
- NXDN in Amateur Radio is still small, but growing
- Both Kenwood and ICOM sell NXDN radios



Yaesu System Fusion – <u>Link</u>

- Yaesu joined the amateur digital voice community in 2012
- They have aggressively marketed System Fusion bringing out 2-HT's, 2-mobiles, an HF/VHF/UHF base station, and a repeater
- All their System Fusion radios have Automatic Mode Select
- Yaesu has heavily discounted their DR-1X repeater



System Fusion's Networking - WIRES-X

- The WIRES-X interface (HRI-200) connects a Fusion radio or a Fusion repeater to the internet – <u>Link</u>
- The WIRES-X network is proprietary to Yaesu
- Hams can set up the network by creating their own node with an HRI-200 connected to an FTM-100 or an FTM-400 Fusion radio
- You need to buy 2 Fusion radios; one for the node and one to use it



System Fusion's Feature Set

- Yaesu puts lots of features into their Fusion radios:
 - Automatic mode select
 - GPS
 - APRS
 - WIRES-X
 - Group Monitor
- Complexity creates more opportunity for things to not work
- Yaesu is still improving / de-bugging WIRES-X and their radios
- To many hams, progress has been slow and frustrating



Can't we make these modes work together?

- "DV modes are 95% the same and 100% incompatible" – John Hays, K7VE – <u>Video</u>
- There is opportunity here!
- A number of interesting projects are being worked on:
 - DV4Mini stick
 - UDRX-440
 - BrandMeister (BrandMaster)
 - XLX reflectors
 - MMDVM
 - Codec2 and SM1000



DV4Mini Stick

- Developed by DG8FAC, DG1HT, DJ0ABR
- Hotspot for D-STAR, DMR+, P25, Fusion
- You need a radio for each mode
- U.S. distributer <u>Link</u>
- Control Panel software <u>Link</u> and <u>Link</u>
- RaspberryPi image <u>PDF with link to image</u>
- Reflectors used on DMR and Fusion are different than Hytera's and Fusion's rooms





DV4mini Control Panel on my RasPi



NANO-DV Digital Radio Hotspot



Micro-Node International – <u>Link</u>



UDRX-440 by Northwest Digital Radio

- 25W, 70cm multi-mode software defined digital radio <u>Link</u>
- Announced 2012
- Now in beta
- On sale this year?
- Some software to be developed by others
- Open source





BrandMeister

- An open source master server to integrate Digital Voice networks worldwide
- Designed to integrate these networks:
 - Hytera Multi-Site Connect
 - Motorola IP Site Connect
 - MMDVM Host
 - c-Bridge CC-CC Link
 - DV4Mini
 - D-STAR
- Quickly taking the place of DMR+



XLX Reflector System

- XLX is a multi-protocol D-STAR reflector system
- Supports D-Plus, DExtra, DCS
- Being developed by Luc Engelmann, LX1IQ and Jean-Luc Boevange, LX3JL
- Still in beta but progressing quickly
- XLX Yahoo group <u>Link</u>*

* Must be a member of the Yahoo group to access



MMDVM - Multi-Mode Digital Voice Modem

- A Jonathan Naylor, G4KLX, project to build a system to operate D-STAR, DMR, and Fusion through an FM radio or repeater Link*
- The interface board developed by Jim McLaughlin, KI6ZUM, and Bruce Givens, VE2GZI mates with an Arduino Due can be ordered from Bruce at: ve2gzi@gmail.com - \$50 shipped
- Currently in early beta testing with more work to be done





Free DV and Codec2

- Bruce Perens, K6BP, wanted to create an open source codec. (Bruce is an open source evangelist – <u>PDF</u>)
- Bruce convinced David Rowe, VK5DGR, to write the open source Codec2. It is based on his 1997 Ph.D. thesis.
- With selectable bit rates between 700 to 3200 bps, Codec 2 outperforms AMBE in less bandwidth
- Codec2 is being used in the HF bands at half the bandwith of SSB using the FreeDV software – <u>Link</u>
- They are now looking to apply Codec2 to VHF/UHF bands



Free DV Control Panel

- Need an HF SSB transceiver
- Need a USB connection or an interface such as a Signal Link



SM1000 FreeDV Adapter from Rowetel

- David Rowe designed the SM1000 adapter - <u>Link</u>
- It runs FreeDV without a computer
- Just plug into your HF rig microphone jack
- Digital voice at 900 Hz bandwidth
- Buy from AliExpress <u>Link</u>





Other Information Sources

- Yahoo groups <u>Link</u> just search for D-STAR, DMR, P25, System Fusion, etc. and join the ones you want
- YouTube videos search for what you want
 - Ham Radio Now Gary Pearce, KN4AQ does a lot of DV videos including D-STAR university <u>Link</u>
 - Pascal Villeneuve, VA2PV, does short videos about System Fusion, DV4mini and DMR – <u>Link</u>
 - Blog page <u>Link</u>
 - Web site <u>Link</u>
 - Many others



What will the creative ham community build next?

