Digital Voice Progress - 2016

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Amateur Radio experimentation is alive and well in Digital Voice

Notetaking Optional

- These slides are available for download at our web site www.charlottedstar.org 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 – Link*

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Discussion Topics

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

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What are the Digital Voice Modes?

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

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* ARRL asked the FCC to clarify the legality of DMR for hams. RM-11625 is still pending after 5 years.

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 – Link
- 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 – Link

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 – Link

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The Creation of D-Plus

- Robin Cutshaw, AA4RC, developed a system to link multiple D-STAR repeaters to a reflector conference bridge – Video
- 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

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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 – Link
- Tom Early, AC2IE, has saved Scott's work – Link

Development of ircDDB

- Hans Barthen, DL5DI, Michael Dirska, DL1BFF, and Jann Traschewski, DG8NGN created a network to exchange D-STAR routing information – Link
- 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 – Link and Link
- The DV-AP allows a ham too far from a D-STAR repeater to get on D-STAR with only his HT – Link

More D-STAR Hardware Development

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

and the

DV3000U --->

- Another is StarDV from Matrix Circuits – Link --->

- All do the same thing as the DV Dongle

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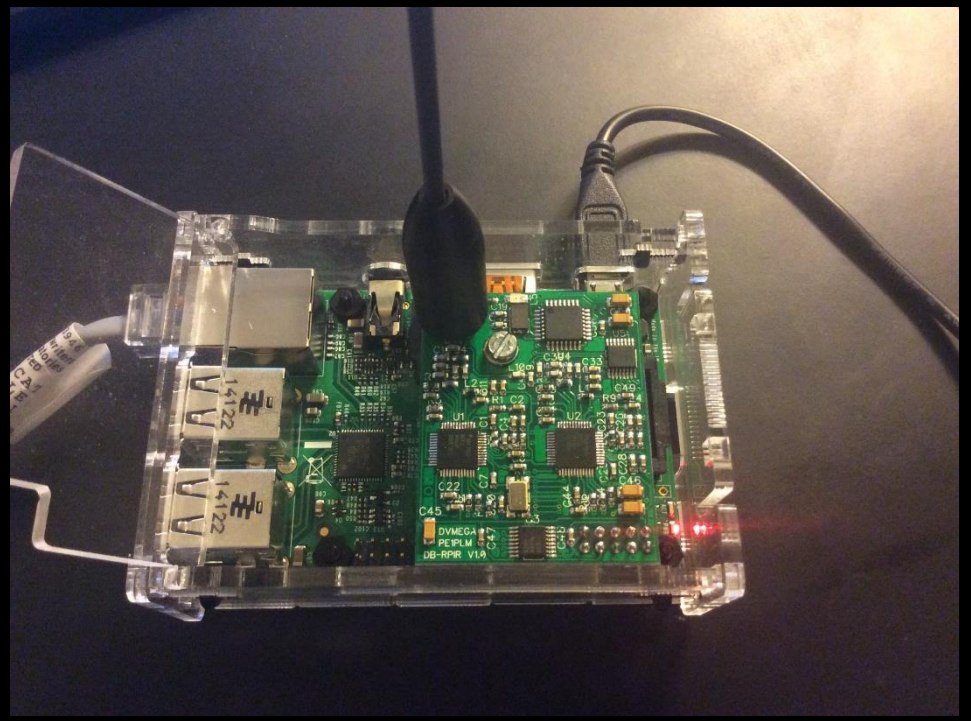
Still More D-STAR Hardware Development

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



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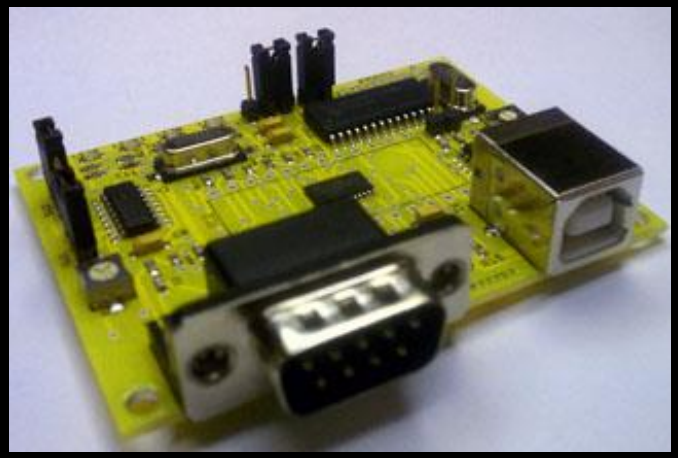
Can I do D-STAR with my FM radio?

- 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 – Link

- The Matrix Circuits Starboard is another GMSK modem with excellent support from Jim Moen, K6JM at MoenComm– Link



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

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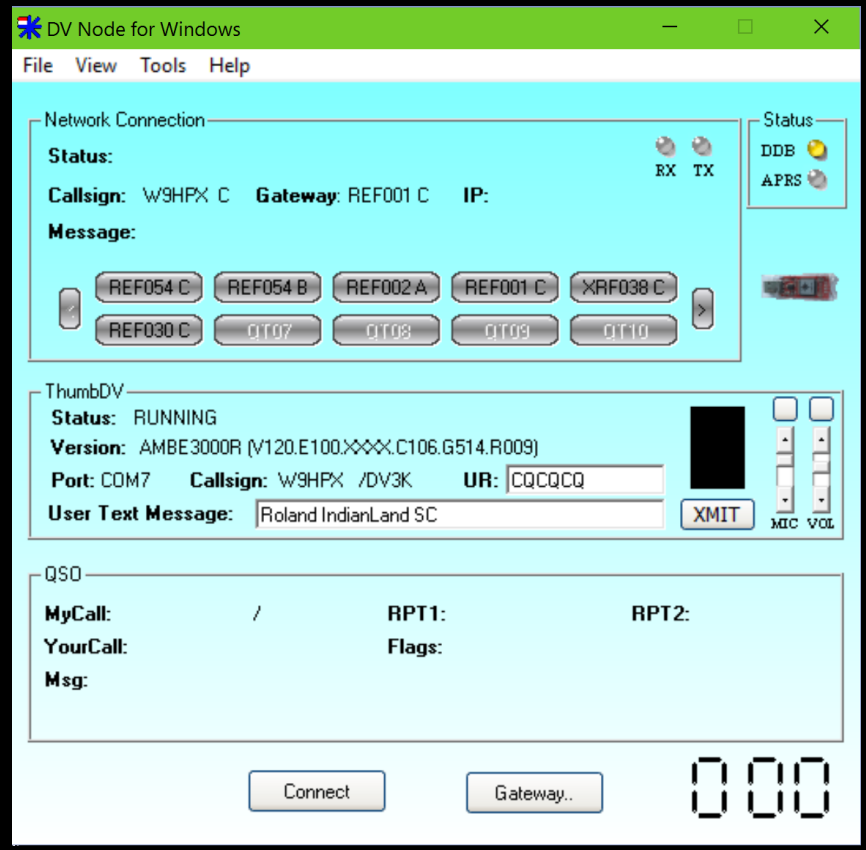
Does this Hardware Need Software?

- Robin provides DVTool for use with his DV Dongles – Download
- Robin provides DVAPTool for use with his DV-AP – Download
- Fred van Kempen, PA4YBR, wrote a very nice piece of software called WinDV for Windows – Link
  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 – Link
- 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 – Link*
  - PC Repeater Controller – Link*
- Images for various platforms are available from several sources. Here are some of the most popular:
  - Western D-STAR – Link
  - Maryland D-STAR – Link
  - D-STAR Commander – Link

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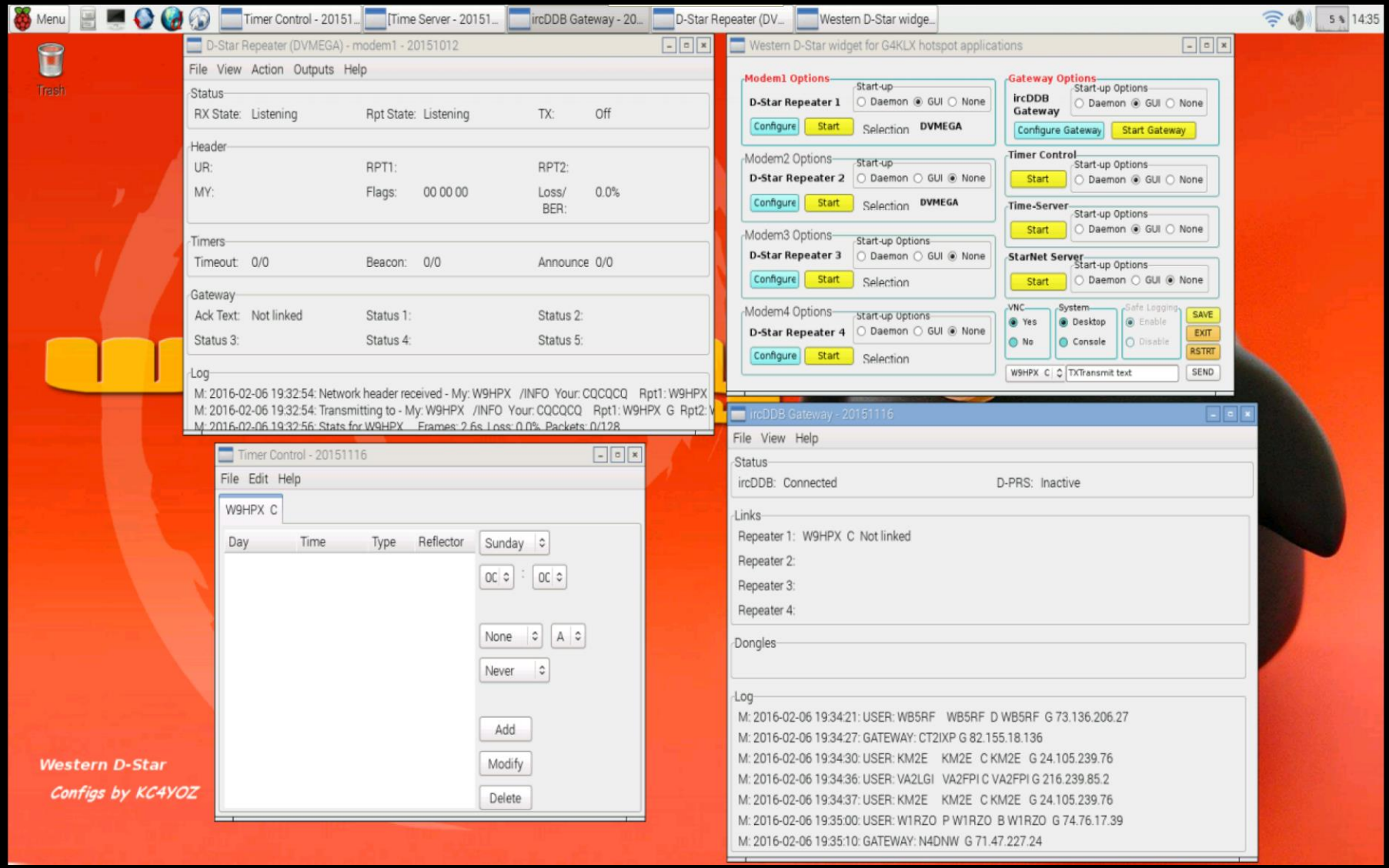
* Must be a member of the Yahoo group to access

G4KLX software on a Raspberry Pi GUI



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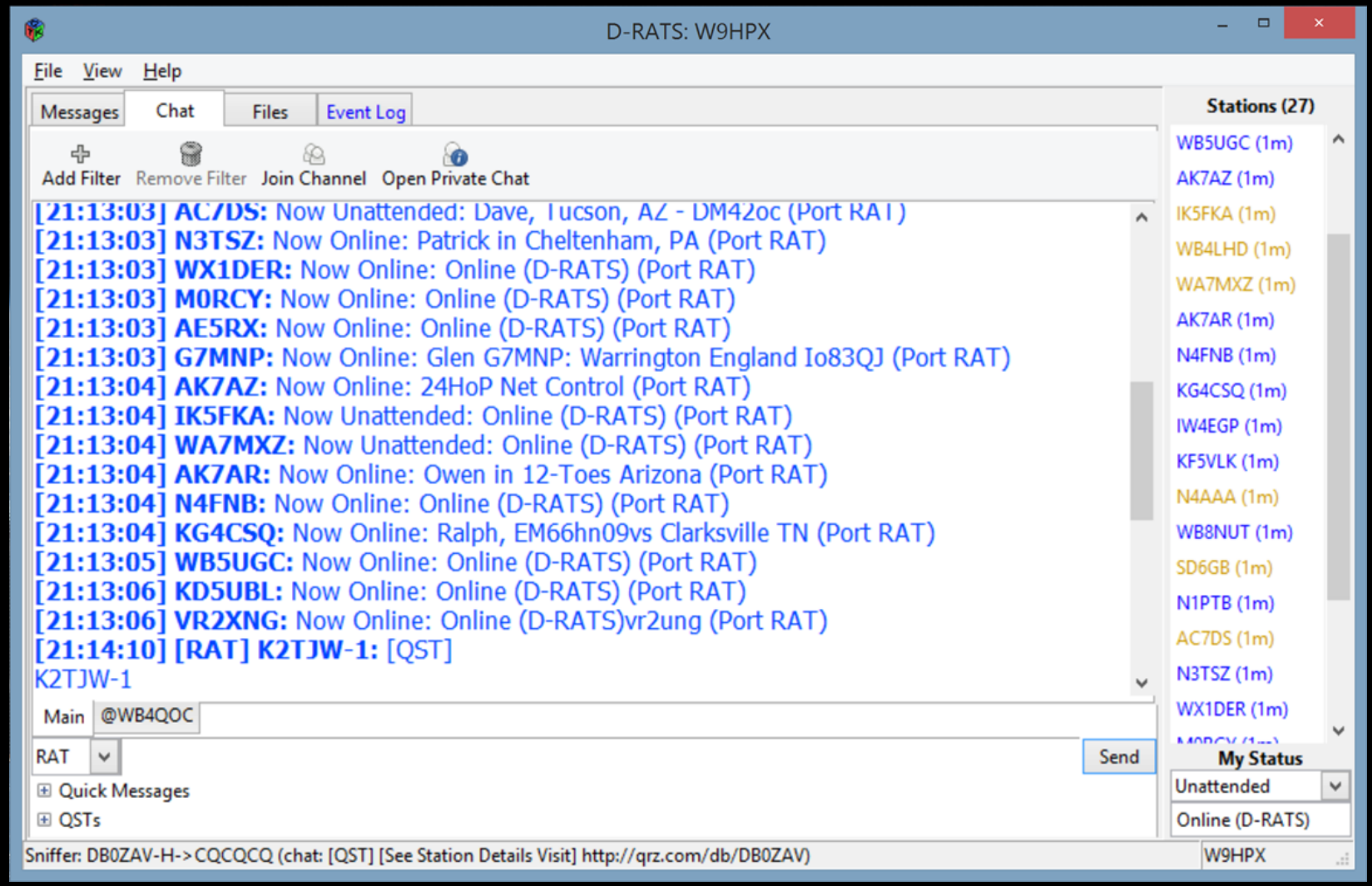
D-RATS

- 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 – Link
- Training manual for D-RATS – PDF

D-RATS



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DMR Network

- Two commercial DMR network protocols – Link
  - IP Site Connect (Motorola)
  - IP Multi-site Connect (Hytera)
- There are also regional networks such as PRN – Link
- 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 – PDF

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DMR Network Developmental Work

- The Raycom c-Bridge is used by hams to connect MotoTrbo repeaters into a much larger network – Link
- 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 – Link
- 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– Link
- 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 – Link

- 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

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System Fusion's Networking – WIRES-X

- The WIRES-X interface (HRI-200) connects a Fusion radio or a Fusion repeater to the internet – Link
- 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 – Video
- 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

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DV4Mini Stick

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

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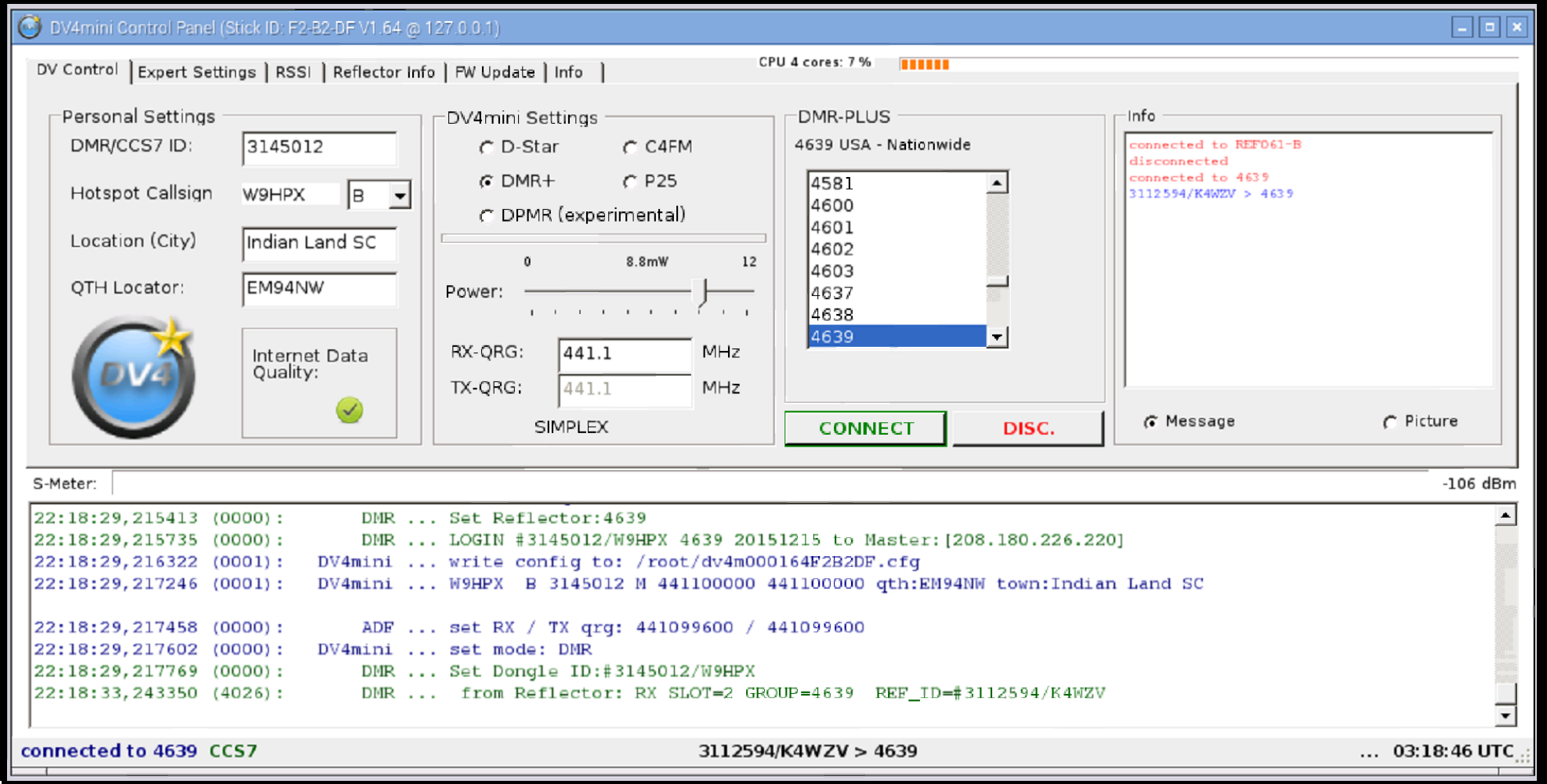
DV4mini Control Panel on my RasPi



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NANO-DV Digital Radio Hotspot

Micro-Node International – Link

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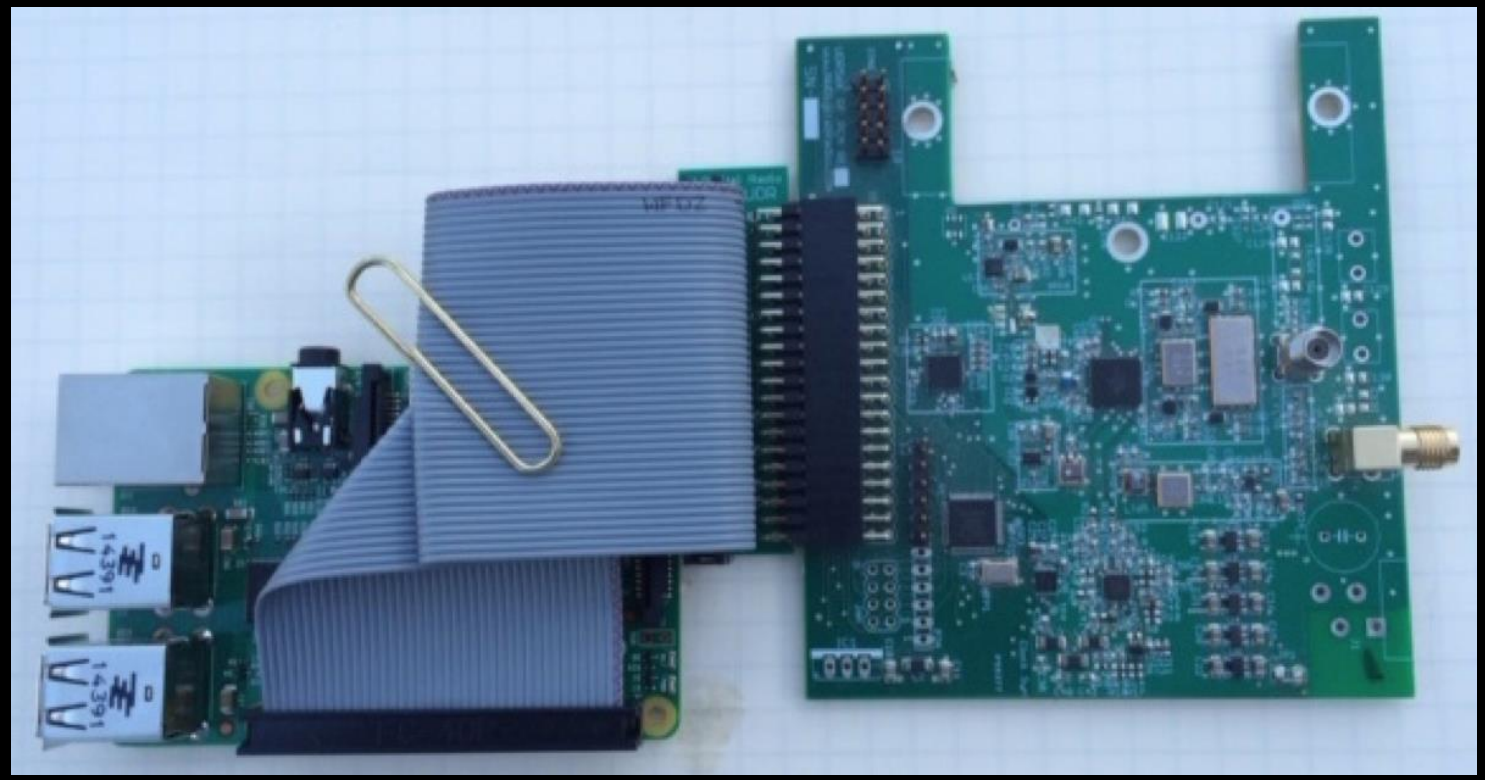
UDRX-440 by Northwest Digital Radio

- 25W, 70cm multi-mode software defined digital radio – Link
- 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+

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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 – Link*

* Must be a member of the Yahoo group to access

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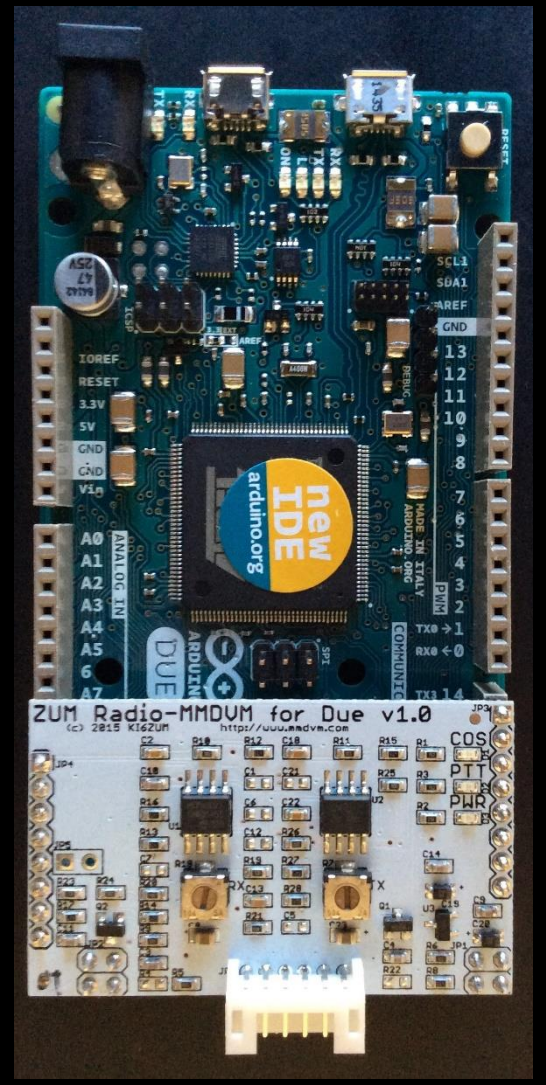
MMDVM – Multi-Mode Digital Voice Modem

- 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



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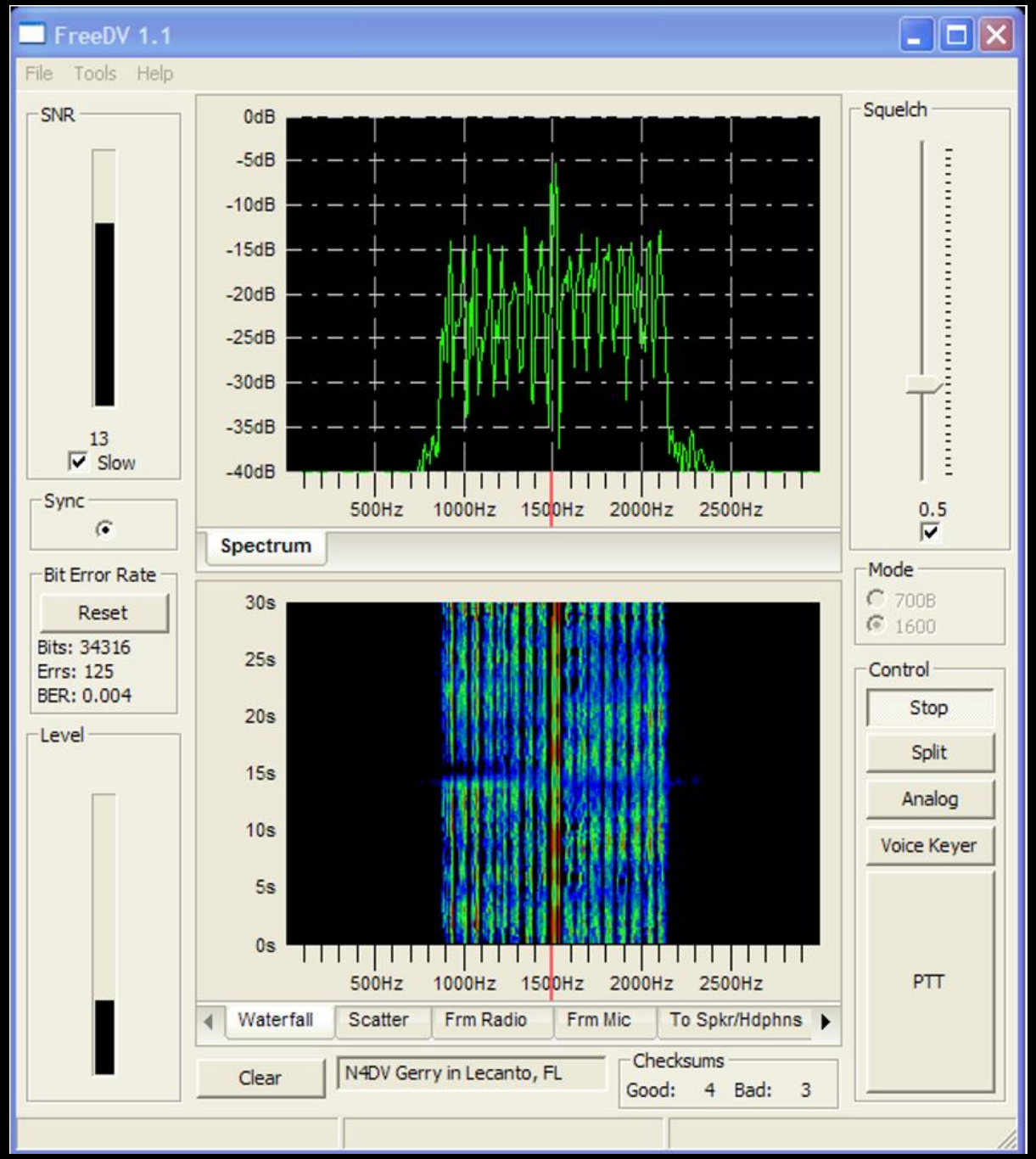
Free DV and Codec2

- Bruce Perens, K6BP, wanted to create an open source codec. (Bruce is an open source evangelist – PDF)
- 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 – Link
- 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



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SM1000 FreeDV Adapter from Rowetel

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

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Other Information Sources

- Yahoo groups – Link – 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 – Link
  - Pascal Villeneuve, VA2PV, does short videos about System Fusion, DV4mini and DMR – Link
    - Blog page – Link
    - Web site – Link
  - Many others

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What will the creative ham community build next?

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