MultiMode Digital Voice
The Exciting New Trend in DV

Jim McLaughlin – KI6ZUM
Jim Moen – K6JM
Don Jacob – WB5EKU

Pacificon
Oct 21, 2017
Agenda

• Brief Introduction: Why Digital Voice and what is MultiMode?
  - Jim Moen, K6JM

• Keynote: MultiMode Digital Modem
  - Jim McLaughlin, KI6ZUM

• MultiMode Options, Uses and Demo
  - Jim, K6JM; Don Jacob, WB5EKU
DV Radios
Simplified Block Diagram

Mic

Analog to Digital

Compress (AMBE chip)

Generate tones (modem function)

FM Modulator

FM Radio

Speaker

Digital to Analog

Decompress (AMBE chip)

Convert tones to digital data

FM Discriminator
Why Digital Voice

• Bandwidth
  – FCC is moving other services to narrow band
  – DV modes use no more than 12.5 KHz, some 6.25

• Clear, quiet Audio
  – Digital audio does not include hiss or noise, even as signals weaken (though it can suffer multipath)
  – Digital just drops out entirely when signal too weak

• Digital Extras
  – Radio can display Callsigns, Text Messages, more

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What Else?

• Robust Networking
  – Ability to link repeaters together using Conference Bridges (Talkgroups, Reflectors, Rooms etc.)
  – Ability to link bridges to bridges

• VeryActive 3rd Party Development

• Examples of good DV modes:
  – D-STAR, DMR, C4FM/Fusion, P25

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What is MultiMode?

- Hardware & Software that support more than one DV mode
- So one repeater can support DMR QSOs, D-Star QSOs, Fusion QSOs etc.
- One mode at a time – other mode radios will not hear, but will see a busy repeater
- Or a Homebrew Hotspot can do the same

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Ways to get into a DV Network

• A Digital Voice Repeater that’s been configured to access gateways on the internet.

• Your own Hotspot (similar to a D-Star DVAP, but for your preferred DV mode) that has a radio, a modem and a computer with internet access. We’ll be talking a lot about Hotspots.

• A computer with appropriate software and a dongle with AMBE compression software.

First two use a radio, the third uses PC spkr/mike

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Next Up
Jim McLaughlin, KI6ZUM

• Jim is one of the Movers & Shakers in the MultiMode field
• Jim has been developing and releasing open source hardware and software for over 30 years
• When not experimenting with digital radio, he spends his time planning and running ARISS events to allow students to talk to astronauts on the ISS, mentoring SDSU students building a Cubesat and coaching FTC.
MultiMode Digital Voice Modem (MMDVM)

Jim McLaughlin KI6ZUM
October 21, 2017
Open Source

“Generally, open source refers to a computer program in which the source code is available to the general public for use and/or modification from its original design. Open-source code is typically a collaborative effort where programmers improve upon the source code and share the changes within the community so that other members can help improve it further.”[1]

- Open source usually means free, but not always
- Software copyright licenses – eg. GPL, MIT, Debian etc.
- Hardware copyright licenses – eg. Creative Commons, TAPR Open Hardware License
- Patents – usually developer promises not to assert IP rights, but that doesn’t mean other entities can’t assert IP rights
- Trademarks – held by an entity but can be licensed broadly under specific Terms & Conditions
- Copyright – rights are retained by the original author who can release under other licenses too

Early projects

GMSK for Arduino

ADF7021 for Raspberry Pi
Project conceived (Spring 2015) and developed by Jonathan G4KLX and Jim KI6ZUM

- all of the software, much of the firmware developed by Jonathan
- hardware, much of the firmware developed by Jim
- later firmware developed by Andy CD6JAU
MMDVM Status (October 2015)

• D-STAR firmware and dstarrepeater working
• DMR firmware almost done, software hopefully soon
• Fusion in progress, P25 and analog are in planning stages
MMDVM Status (October 2017)

• D-STAR, DMR, Fusion & P25 firmware, mmdvmhost and repeaters operational
• Yahoo group has nearly 3000 members
• Thriving community of hams around the world developing hardware and software
MMDVM Arduino/Pi

- Original uses Arduino Due
- Next gen is a Pi HAT
- Latest analog filter design
ZUMspot Pi

- Pi Zero size mounts on any recent Raspberry Pi or on a Bluetooth board
- 2m/220/440/900 versions
- D-STAR/DMR/YSF/P25
ZUMspot USB

• Same basic hardware as Pi version
• USB (now A connector)
• Dstar/DMR/YSF/P25
Bluetooth/Wi-Fi

• ZUMspot and MMDVM Pi boards
  – Bluetooth connection for both Android and iOS
  – Wi-Fi connection
Local repeaters

- Oat Mt. K6PUW
- 447.200 -5MHz
- All 4 mode

- Vista Peak KJ6FCH
- 447.300 -5MHz
- All 4 mode

- Soon to include Mt. Palomar and Toro Pk.
MMDVM availability

• All software available on Github:
  – https://github.com/g4klx/MMDVM
  – https://github.com/juribeparada/MMDVM_HS

• ZUMspot Pi and MMDVM Pi boards currently available via http://www.mmdvm.com

• ZUMspot USB boards ???

• Bluetooth??? Wi-Fi???
Licensing

Creative Commons BY-NC-SA+

- **Attribution** — You must give appropriate credit
- **NonCommercial** — You may not use the material for commercial purposes
- **ShareAlike** — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original
- **Plus** — another separate and independent agreement granting more permissions

Please consider purchasing your MMDVM products from vendors honoring the licenses.
Other MultiMode Options

Jim Moen – K6JM

Pacificon 2017
San Ramon, CA
October 21, 2017
Why Am I Interested In DV MultiMode?

• My two main hobbies are Ham Radio and Dogs

• Dogshows are fun, but I need my technology fix too

• This is my 8\textsuperscript{th} Pacificon talk about Digital Voice, though previous were mostly about D-STAR

• MultiMode is rapidly becoming popular

• But at Dayton, I found no talks just on MultiMode

• I decided we should talk about MM at Pacificon

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Most-Used Ham DV Modes

• **D-STAR**
  - Developed late 1990s by JARL, open RF standard, multi-vendor
  - Designed for Amateur Radio, ID is Callsign, 6.25 khz

• **DMR**
  - Commercial Land/Mobile, open standard 2005, ID is 7-digit #
  - 2 channels, 12.5 khz bandwidth
  - Originally predominately Motorola, now many vendors
  - Very competitive pricing, especially entry level ($89)

• **Yaesu System Fusion**
  - 2013, designed for Amateur Radio, ID is Callsign
  - 12.5 khz bandwidth, config options (data, high-Q audio)

• **P25**
  - Public Safety, government, developed 1990s, 6.25 khz bandwidth
  - Expensive radios now, but beginning to see affordable used radios

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Multimode Topics

• Dueling Modes or Emerging Unity?
• Why MultiMode?
• Popular MultiMode Hardware & Software
• The K6PUW MultiMode Repeater in SoCal
• XRF002 and its “Constellation of Reflectors”
• Cross-mode 4K Transcoding – Don, WB5EKU
Dueling Modes or Emerging Unity?

- Fans of each mode can now share proven hardware and software.
- New bridges can transcode, allowing different mode radios to talk to each other.
- Rather than abandoning their first DV mode, more and more Hams are getting into new modes and using all of them. So MultiMode is helping to reduce mode factions.
- D-STAR & DMR have seen some network factions within each mode (different reflectors, different DMR networks) but software like MMDVMHost & DMRGateway allow access to multiple Networks and help bring network factions together.

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Why MultiMode??

• With limited coordinations on VHF and even UHF, one repeater can support several modes

• MultiMode Hotspots at home or travelling give us more flexibility, now and in the future

• Two kinds of MultiMode users:
  – Those preferring a single mode, using proven H/W & S/W, with flexibility to try a new mode
  – Those who like several modes, have several radios, and use all of them

Some users even have several Hotspots, one for each mode

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Popular Multi-Mode Products

• **MMDVM** — Jim KI6ZUM just gave you details. Open Source and Creative Commons. Various board versions available; most popular are the ZUM board and ZUMspot. Sold by Bruce Given VE2GZI: mmdvm.blogspot.com

• **DVMEGA** Dutch hotspot RF boards, works with G4KLX software, so similar experience to MMDVM products

• **BlueDV** Software supports AMBE3000 devices like the Northwest Digital Radio’s ThumbDV

• **DV4mini** German designers, created DSP modem DVRPTR. USB stick is low power hotspot that supports multiple modes

• **SharkRF openSPOT** Stand-alone device, separate computer like Pi not needed. Local transcoding DMR-Fusion.

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G4KLX MMDVM Software

• Even a year ago, I recommended MMDVM mostly for experimenters

• Now, with 2 excellent Pi images available, MMDVM is available to all of us – Linux is configured & ready to go, G4KLX S/W installed

• My preferred images:
  • KB5RAB – you log onto the Pi using a VNC client for a Windows-like control to configure your callsign, etc.
  • Pi-Star – provides a web browser interface to the Pi for configuration and management – the Cat’s Meow

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Behind the scenes...

- MMDVMHost manages the modem
- It also manages network connections
- MMDVM.ini is used to configure 1, up to 4, networks
  - D-Star with REF/XRF/DCS linking including XLX Reflectors
  - DMR – can choose your favorite Master (BrandMeister, DMR Plus, XLX etc.) – but just one
  - YSF Reflectors (rooms)
  - P25 Reflectors
- Or turn on DMRGateway and you can configure multiple DMR networks using TalkGroup Rewriting
- You can have your cake and eat it too!
- This is really, really (cool/hot/neat)

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My Own Favorite MultiMode Solutions

There are lots more great ways to do this – these are what I have/use

- For a higher-power Hotspot
  - Get a MMDVM modem for your 1 or 2 analog radios and use G4KLX MMDVMHost and related software

- For a short-range Hotspot
  - Get a ZUMspot (MMDVM board with radio on a PiZeroW) running either KB5RAB image or Pi-Star image
  - Or a DVMega Pi board connected to a Pi running either image above
  - Or a DVMega Pi board and a BlueStack, and use BlueDV software
Example – DVMega & BlueStack

BlueDV software manages the radio and internet connections

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More Info

- MMDVM - [wmmdvm.blogspot.com/](wmmdvm.blogspot.com/)
- DVMega - [www.dvmega.auria.nl/](www.dvmega.auria.nl/)
- BlueStack & MMDVM - [www.combitronics.nl/](www.combitronics.nl/)
- BlueDV - [www.pa7lim.nl/bluedv/](www.pa7lim.nl/bluedv/)
- DV4 family - [www.wirelesshold.com/](www.wirelesshold.com/)
- SharkRF - [https://www.sharkrf.com/products/openspot/](https://www.sharkrf.com/products/openspot/)
- K6PUW – [www.k6puw.com](www.k6puw.com)
- My slides will be available at [www.k6jm.com/dv](www.k6jm.com/dv)
Next Up
Don Jacob, WB5EKU

• Don is retired from the TV industry, having been involved in many roles in the production of TV programs over the years.
• His favorite activity was helping direct live TV programs, often national sports events. He remains active in his video and editing work for various clients, as well as his many Ham Radio activities.
• In the MMDVM world, Don is the owner and Trustee of K6PUW, California’s first Wide area coverage MMDVM Digital Voice Multimode Repeater
• Don will talk about the K6PUW MultiMode repeater in Los Angeles & High Quality Transcoding services now available

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MultiMode 4K Transcoding

Don Jacob – WB5EKU

Pacificon 2017
October 21, 2017
K6PUW
MMDVM Multi-Mode Repeater
K6PUW B    XRF002 A
447.200 -5MHz
DStar, DMR, C4FM (Fusion) & P25
Los Angeles, Ventura and Parts of Orange Counties
Affiliated with the Kings of Digital
www.k6puuw.com
repeater.k6puuw@gmail.com
TRANSCODING
What is Transcoding?
What is Transcoding?

The process of converting one Digital file from one format To another.
TRANSCODING

DStar
TRANSCODING

DStar  ➡️  ➡️  DMR
TRANSCODING

DStar  DMR

XRF002 A
4K TRANSCODING

DStar  ➔  DMR

XRF002 A  ➔  XLX313 A

To TG4001
4K TRANSCODING

DStar  DMR

XRF002 A  XLX313 A

((Constellation of Reflectors)
XRF313 A
XRF555 A
XRF626 C
+
All of the Repeaters, Gateway
And Hotspots connected.

To TG4001
4K TRANSCODING

DStar  ➔  ➔  DMR

XRF002 A  ➔  XLX313 A

To TG4001
4K TRANSCODING

DStar  ➤  ➤  DMR

12 Channels of Transcoding, 6 per Mode
4K TRANSCODING

DStar  ➔  ➔  DMR

12 Channels of Transcoding, 6 per Mode
4K TRANSCODING

DStar  ➤  DMR

6 DStar Channels
XLX313 A
XLX313 B
XLX313 C
XLX313 D
XLX313 E
XLX313 F

6 DMR Channels
4K TRANSCODING

DStar  ➔  DMR

Address of XLX313 →

[XLX Network 1]
Enabled=1
Address=dmr.openstd.net
# Address=xlx950.epf.lu
Port=62030
Local=62031
# Options=
Slot=2
TG=6
Base=64000
Startup=4001
Relink=0
Password=password
Debug=0
### XLX Multiprotocol Gateway Reflector

#### XLX313 v2.0.0 - Dashboard v2.3.7 / Service uptime: 38 days 02:24:14

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4K TRANSCODING

DStar ↔ ↔ DMR

Software Written by the XLX Reflector Creators;
LX1IQ Luc and LX3JL Jean-Luc
4K TRANSCODING

DStar ➔ ➔ DMR

Software Enhancements, XLX reflectors and AMBEd
Server Operated & Maintained by W6KD and K6KD
Welcome to 4K TRANSCODING
THANK YOU

73