# FreeDV 700D and 2020

- What is FreeDV?
- Why FreeDV?
- People Involved
- FreeDV over KiwiSDRs
- Lessons learned with 700D
- 2020 mode – Neural Net Vocoder
- Samples

# FreeDV

- Open Source Digital Voice for HF Radio
- Voice Codec, Modem, FEC
- GUI application
- FreeDV API, integrate into SDRs
- SM1000 FreeDV Adaptor
- International Team

# Why FreeDV?

# Why FreeDV

- Leading edge of Ham Radio
- Low SNR performance competitive with SSB
- No HF background noise
- A voice mode designed by Hams for Hams
- Not locked down by commercial companies
- Open Source – especially codec and modem
- Freedom to experiment – no legal barriers
- Low cost of entry

# Developers

- Steve K5OKC
- Richard KF5OIM
- Mooneer K6AQ
- Don W7DMR
- Brad AC0ZJ
- Mark VK5QI
- Bill VK5DSP
- Jeroen
- JimT
- Plus many others ....

# FreeDV over KiwiSDRs

- Used by UK, South America, Australia
- Assist in propagation/urban noise issues
- Jose LU5DKI/Peter VK3RV
- Using a variety of SDRs
- Common "meeting point" is Auckland NZ
- 3,000/10,000 km path
- FreeDV 700C due to polar path
- 40W/delta loop
- Daily rag chew QSOs between Argentina an VK3
- Virtual cables to route audio

# Road Map

- 2009 Codec 2
- 2012/13 FreeDV 1600 (DQPSK)
- 2015 SM1000 FreeDV Hardware
- 2017 FreeDV 700C (QPSK)
- 2018 FreeDV 700D low SNR > SSB
- 2019 FreeDV 2020 8kHz audio
- 2019 SM1000 700D port

# FreeDV 700C & 700D

- Same 700 bits/s codec
- Different modem/FEC approach
- Low to moderate voice quality
- Takes some getting used to (so does SSB)
- On air experience
- 700C works better on fast fading channels
- 700D works better on slow fading/low SNR
- Why?  Experimental radio
- Learning lessons to help push technology forward

# Towards a New Mode

- 700D optimised for low SNR
- Multipath is much harder to deal with than SNR
- So deal with multipath first, low SNR second
- Small frame sizes are better for sync
- Also lower latency
- Modems are much easier to develop than speech codecs
- Speech quality needs to improve .. but this is tough at low bit rates
- NN/better quantisation approaches but many hundreds of hours of R&D

# LPCNet

- Break through in speech synthesis
- Pioneered by Google
- Machine Learning and Deep Learning
- Applied to Speech Coding in 2018
- However closed source, and required a GPU card to run
- Jean-Marc Valin, Canadian open source dev
- Invented LPCNet – open source and efficient
- Its now running on high end x86 CPUs
- I've been applying it to FreeDV

# FreeDV 2020

- LPCNet codec quantised to 1700 bits/s
- Powerful forward error correction from Bill, VK5DSP
- Same modem as FreeDV 700D, works well on HF channels (Steve K5OKC)
- 8 kHz, high quality audio (Thanks Brad AC0ZJ)
- 1600 Hz of RF bandwidth
- Available in FreeDV 1.4 now
- First Neural Net vocoder on air?
- Nothing like it in commercial or closed source world

# FreeDV 2020 Demo

- Original
- SSB at 10dB SNR
- FreeDV 2020 (LPCNet at 1700 bits/s)
- Quite experimental
- Not as robust as 700D
- Works on about 90% of voices OK

# FreeDV 700D Demo

- Walter KW5H
- QSO with W4BCX in August 2020
- Low SNR/Poor condition capabilities
- "If it wasn't for FreeDV – there would have been no QSO"

# Why Not FreeDV

- Who can I talk too?
- Difficulty in set up (2 sound cards)
- Too experimental (this is not DRM)
- Constantly evolving
- Lack of polish
- Little commercial support (except Flex)
- Speech quality
- Development Linux >> Windows

# Technologies

- Low bit rate speech codec
- Coherent OFDM/QPSK HF modems
- Ideal performance FSK modem
- Powerful LDPC forward error correction
- Neural Network speech coding
- Cross platform Linux/Windows/OSX/BSD/uC/Pi
- GitHub/Travis
- 100 automated tests for x86/OSX/stm32
- Docker/Fedora to build Windows
- Open source

# What I'm working on

- Homebrew the physical layer
- Open and pushing physics
- Open IP over VHF/UHF (RPi + RTLSDR)
- Open modems for HF data for Winlink
- 4FSK modem/LDPC FEC waveforms
- FreeDV maintenance
- Improving PAPR
- Planning new FreeDV modes

# Summary

- FreeDV is open source Digital Voice
- 700D – outperforming SSB at low SNR!
- 2020 – 8kHz audio in 1600Hz of RF
- http://freedv.org
- http://rowetel.org