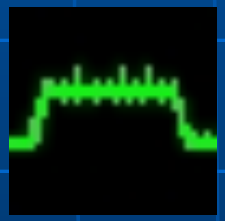
Introduction to Digital Voice over HF



WinDRM

FDM DV

AOR

Mel Whitten, KØPFX
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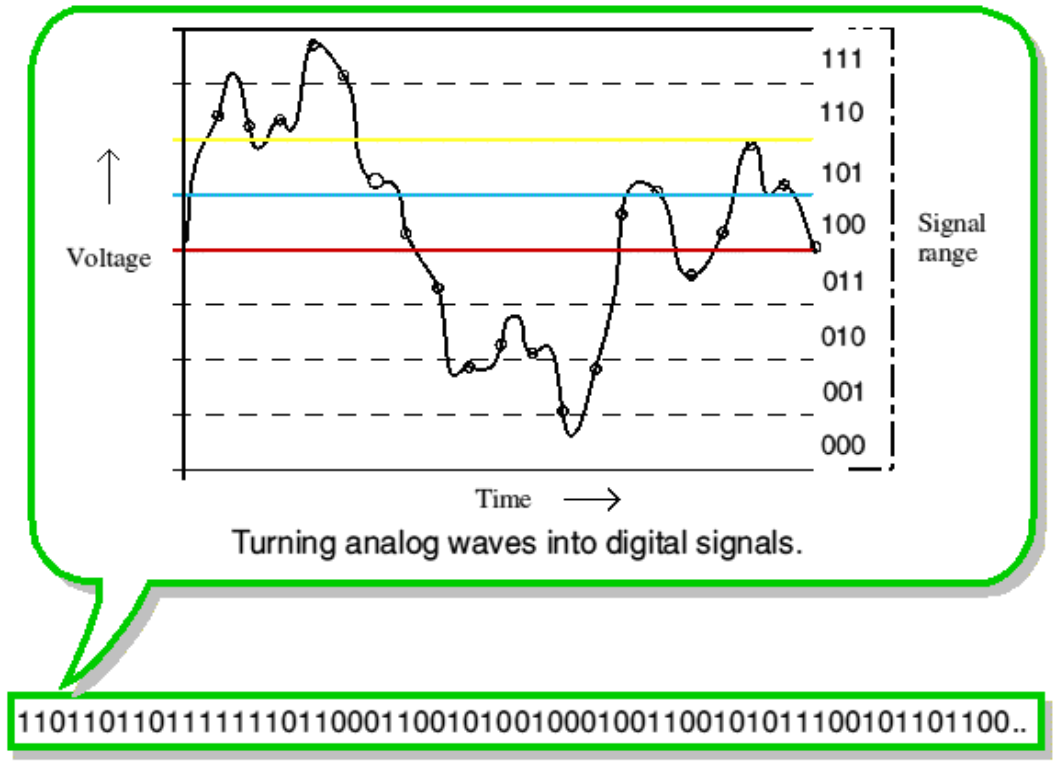
HF Digital Voice

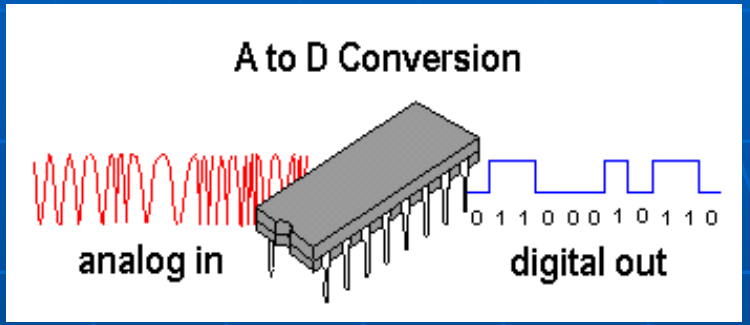
- Why digital?
- DV basics
- DV Evolution in Software
- The AOR hardware solution
- On-the-Air with DV

Why digital ?

- Binary decisions are easier to make than complex ones of varying voltages.
- Applying coding algorithms, digital errors are much easier to detect, correct and process than complex analog signals.
- "Noise" is effectively lost – it is not in the demodulation process as found in the analog world.
- The listener gets back the original signal.
- Multi-media features can be included.

DV Basics…





(Sound Card)

Sampling… The voice is sampled (measured) using an A-D converter. Each sample represents the wave's voltage level at that moment in time. Output of this converter then turns the voice into numerical values.

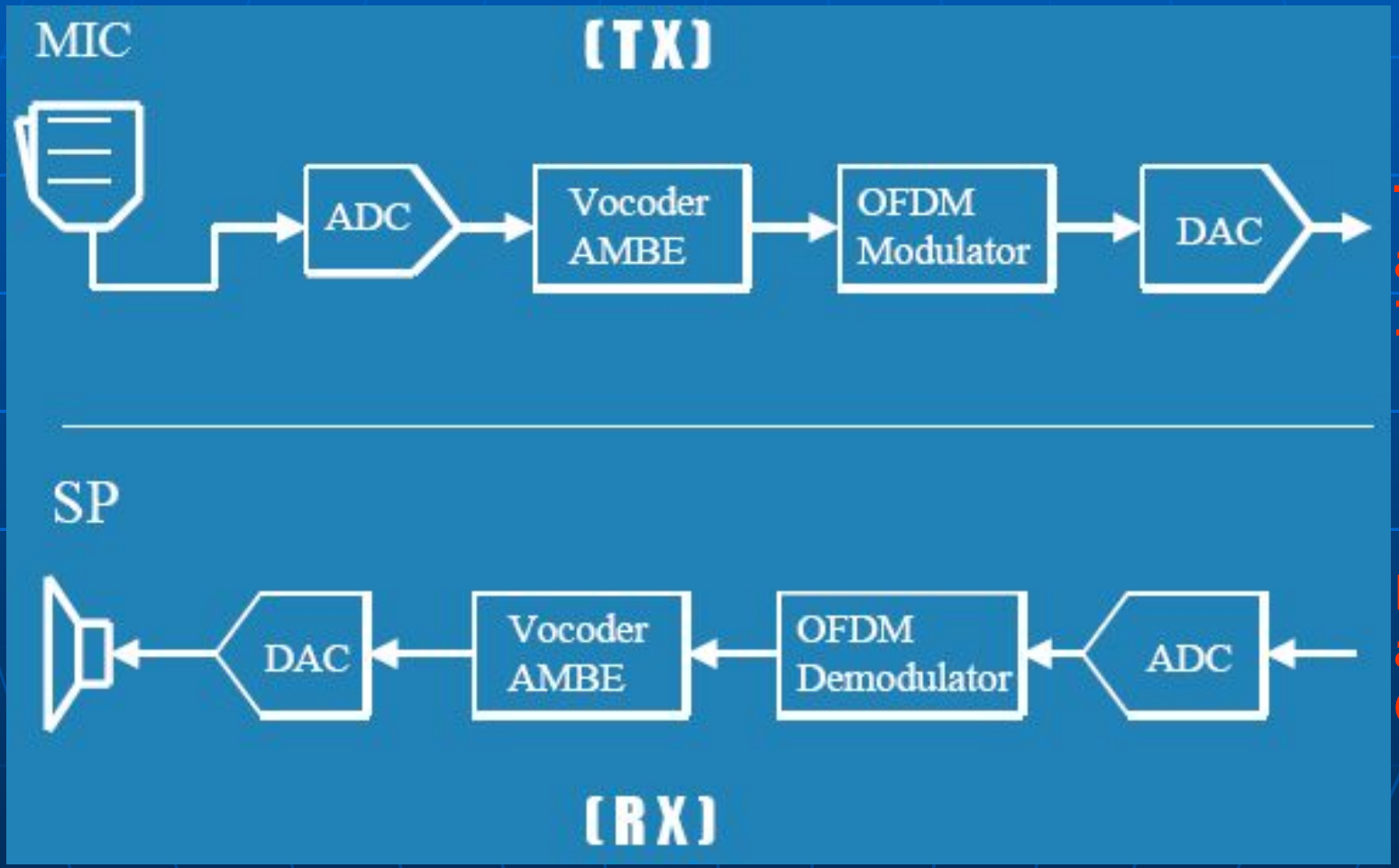
DV Basics… Voice Coding

- ***Encoding…*** The output of the A-D converter can then be efficiently compressed and encoded into a digital bit stream for transmission over a carrier.
- ***Decoding…*** A corresponding voice decoder then receives the data bit stream for processing.

HF Coder/decoders - CODECS

- Codecs model speech in small segments and then convert it into a synthesized speech signal which is perceptually close to the original.
- Parameters for pitch, level, freq response are extracted and then encoded into a bit stream.
- LPC-10, SPEEX, AMBE and coming soon..Codec2 are examples of Codecs that make HF voice possible with their lower data rates.

Typical Digital Voice Process



TX audio Input

RX audio Output

Applying the digital process to HF Voice then…

- QRN (noise) and QSB (fades) are eliminated in the decoded voice reducing listener fatigue.
- Spectral efficiency is realized narrowing bandwidth requirements.
- Other non-voice apps for data are also realized (call-signs, text, pictures, mode configuration, etc).

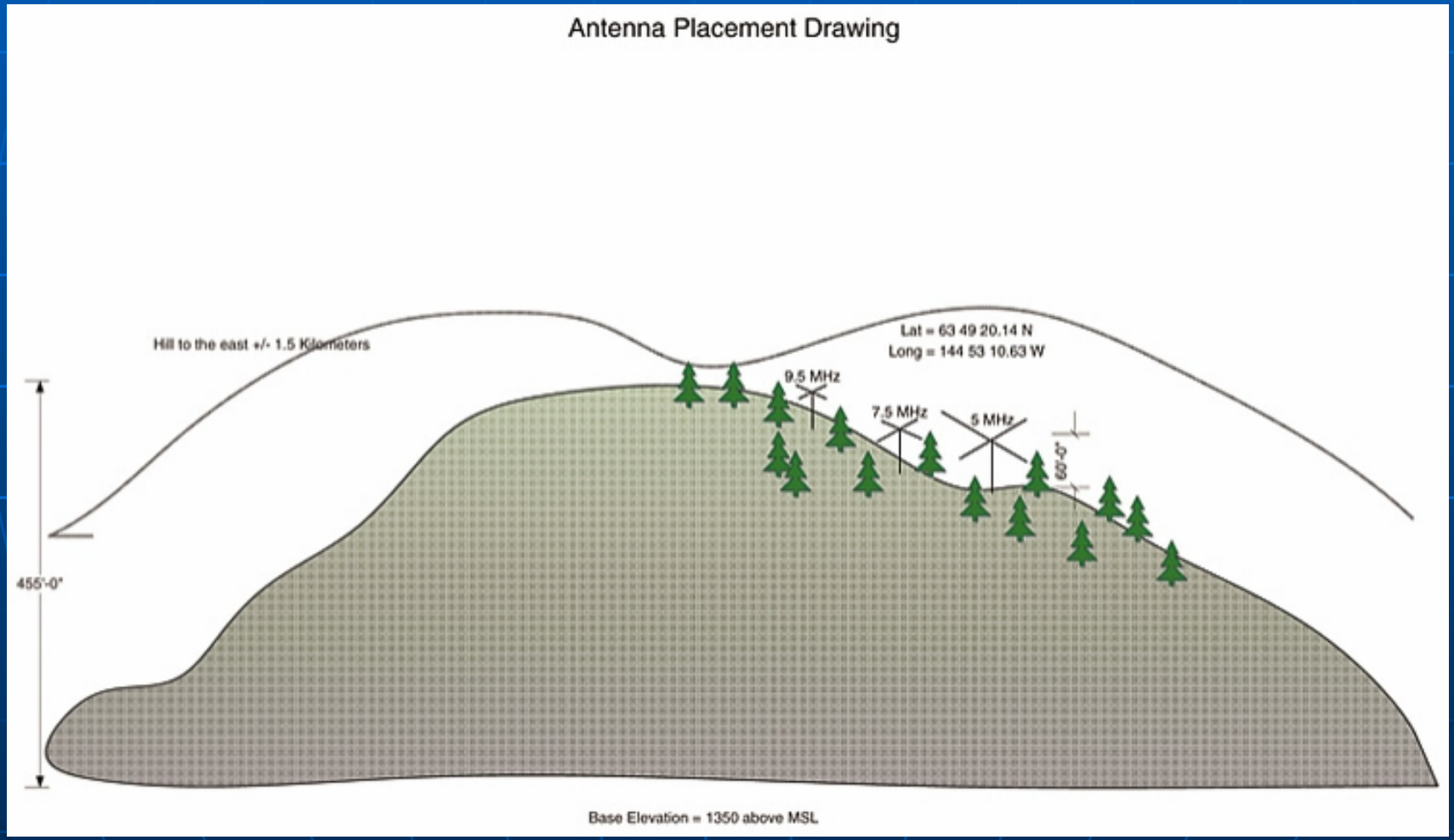
Software Evolution of HF DV

Digital Radio Mondiale – DRM

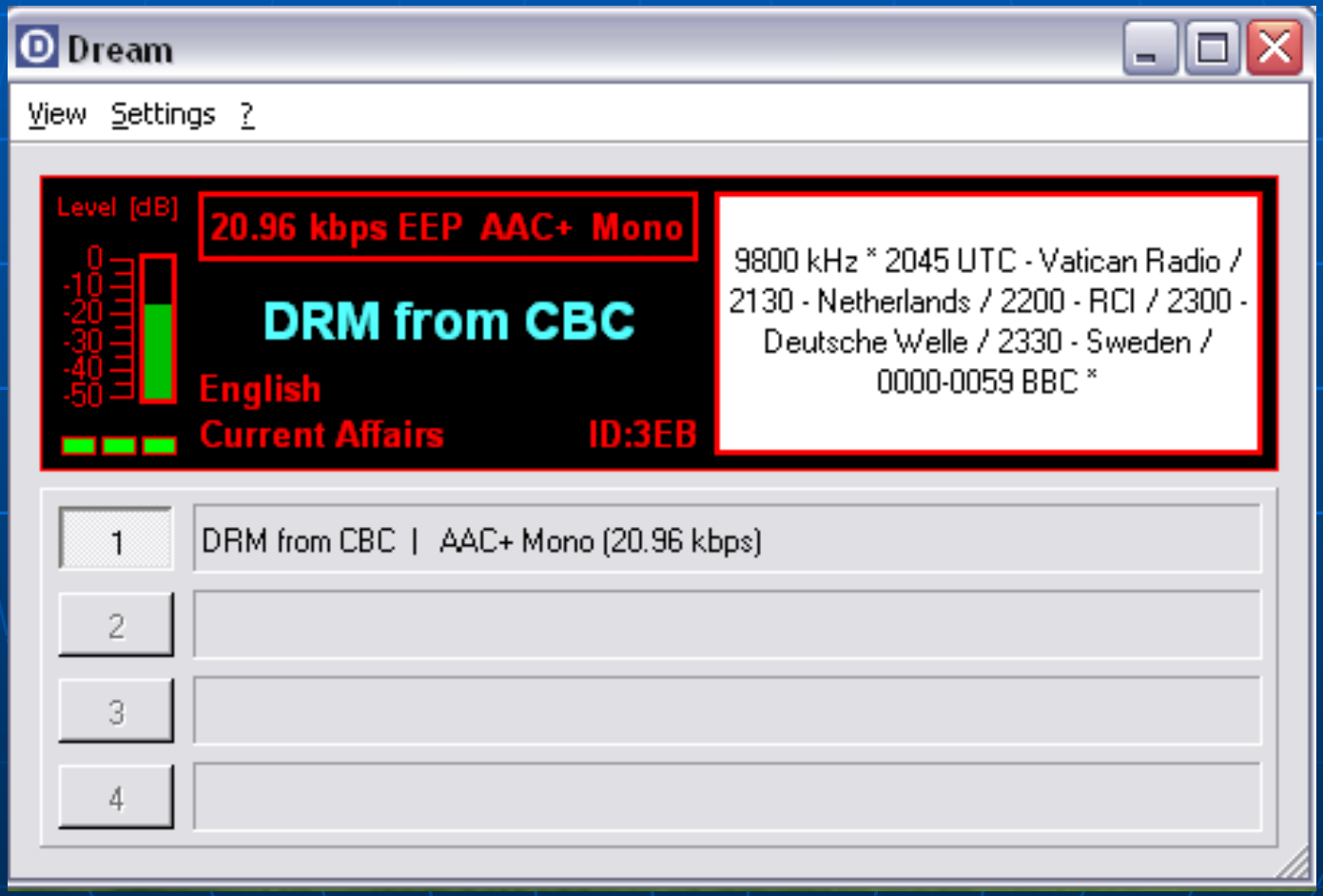
Digital Radio Mondiale
Digital replacement for AM

- DRM is a global open (free) digital radio standard capable of providing near-FM quality sound for SW, MW and LW.
- Driven by an international consortium of broadcasters, manufacturers, regulators and educators with about a 100 members.
- DRM is found world wide with most stations in Europe, Asia, and Pacific.
- In 2008 FCC granted Alaska Experimental DRM license WE2XRH for use with DART transmitters.

Alaska's DRM project using Digital Aurora Radio Tech (DART) Transmitters and new Cross Dipole Antennas on 5/7.5/9.5 mHz

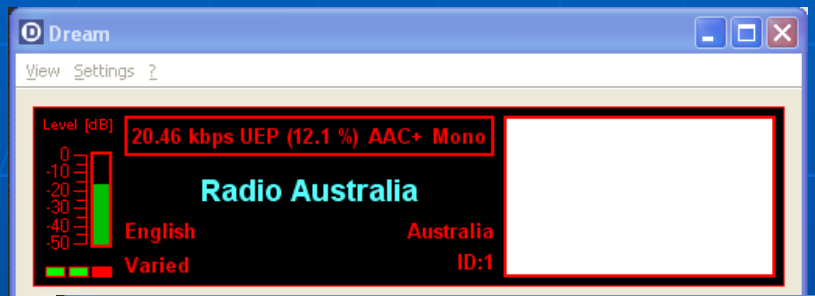


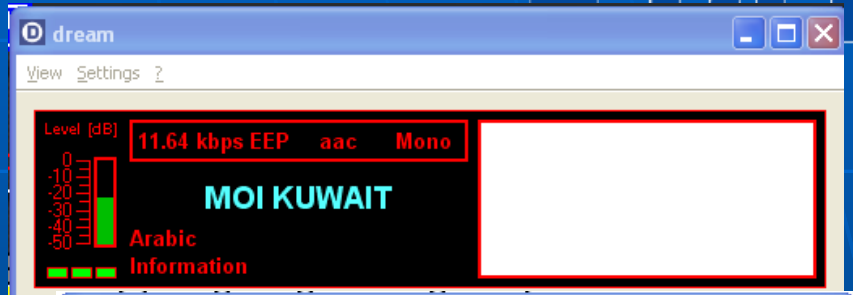
Open-Source DRM DREAM Receiver Software

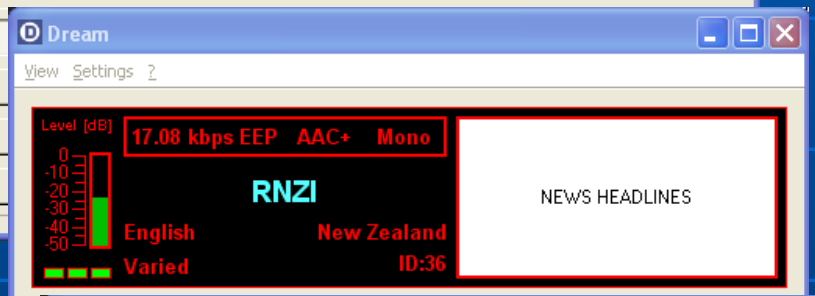


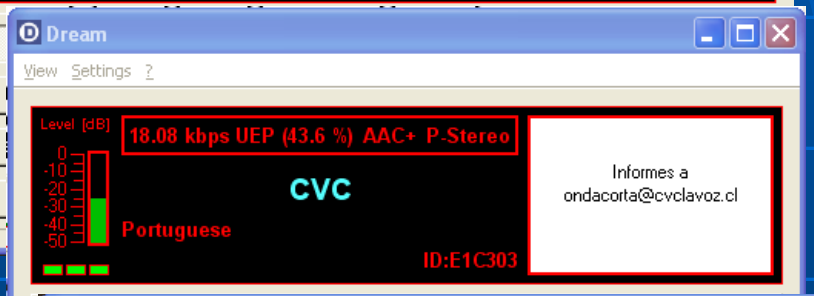
DRM Multi-Media Services

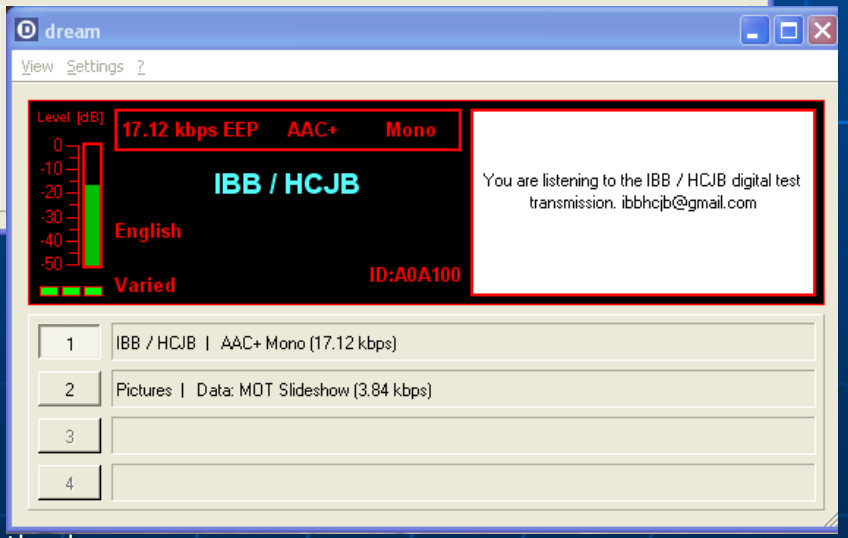
DRM digital Shortwave 49-19mtr









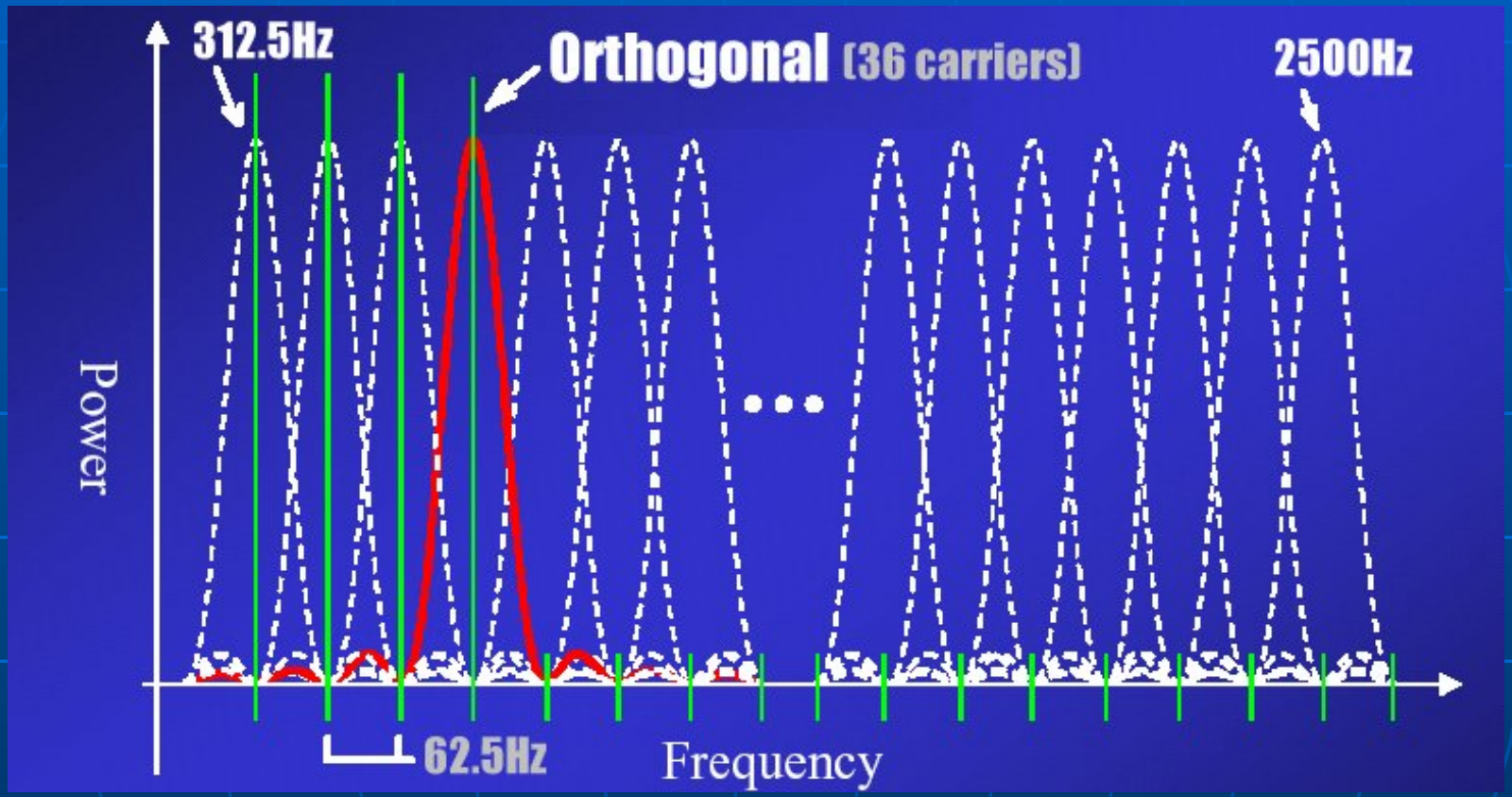


DRM – how does it work?

- Coded OFDM multiple-carriers with QAM16/QAM64.
- MPEG4 AAC, CELP and HVXC CODECS.*
- SW 10kHz channel spacing/Up to 25+ Kbps data.
- Integrates images, html pages, schedules.
- Robustness modes match propagation conditions.

* AAC=Advanced Audio Coding + Spectral Band Rep + Parametric-Stereo
CELP=Coded Excited Linear Prediction (robust speech)
HVXC=Harmonic Vector Excitation (low bit speech coder)

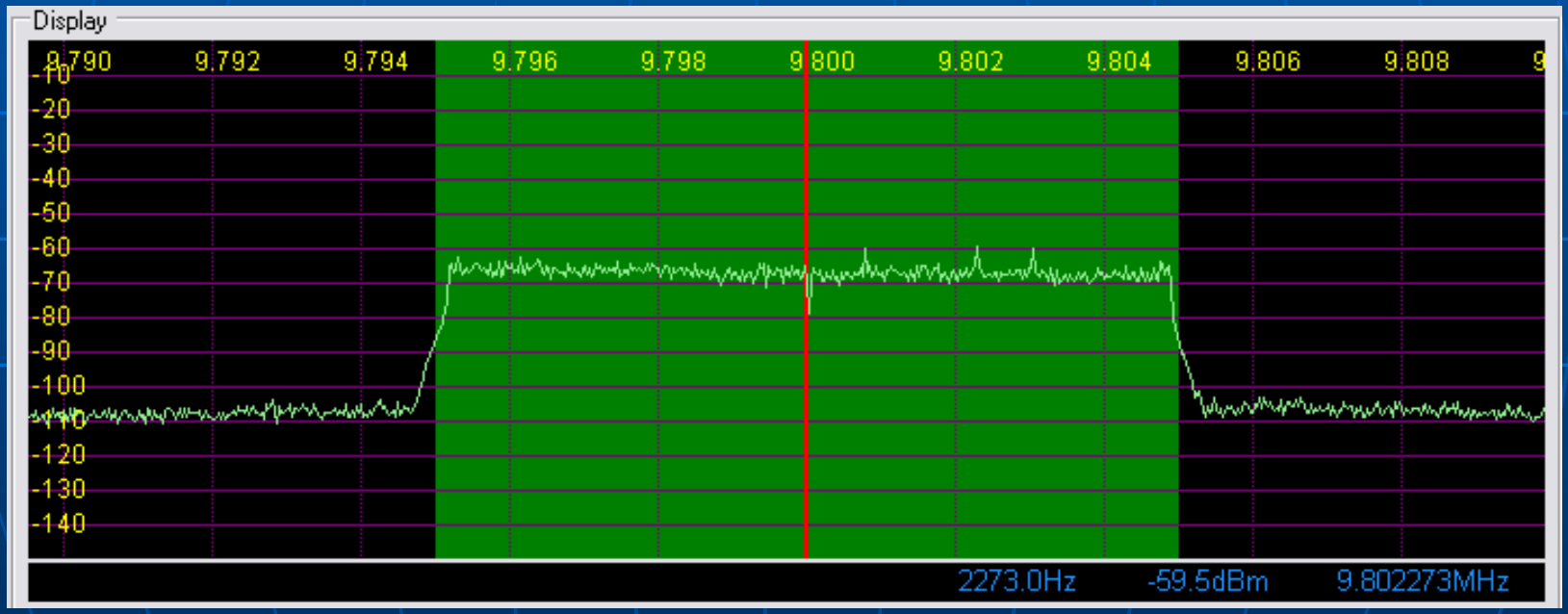
Example of OFDM carriers



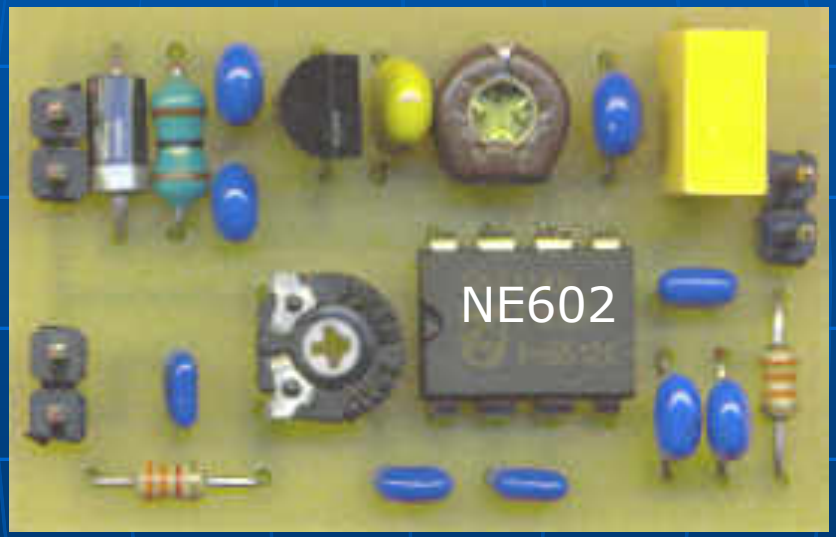
Data

All the data, including the digitally encoded audio, is shared out for transmission across equally spaced carriers. This unique spacing ensures the *orthogonality* of the carriers. Each transmits a small amount of the overall data stream.

Digital Radio Mondiale 10kHz BW



I5XWW 455 kHz to 12kHz Receiver IF Converter



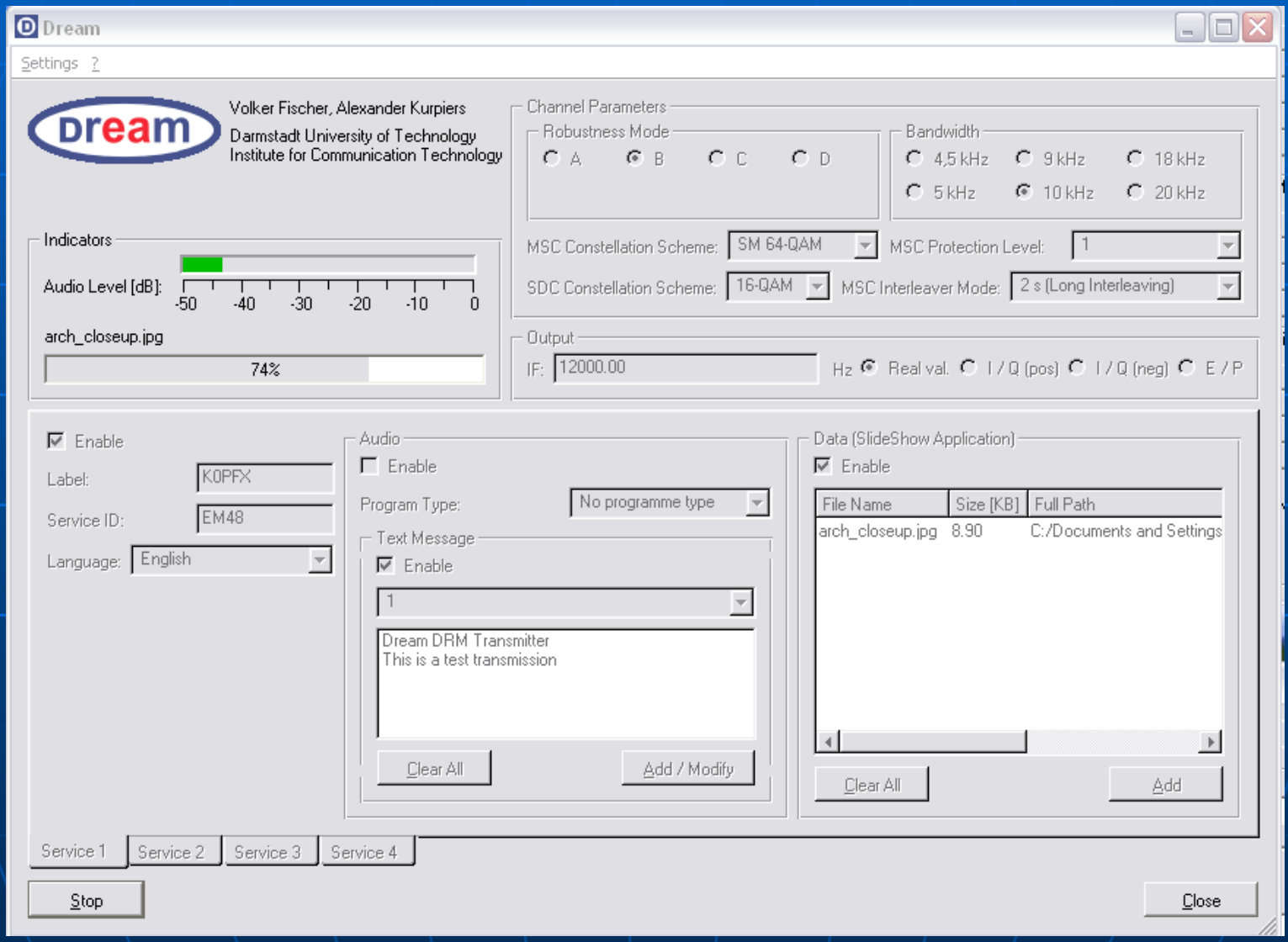
455kHz to 12kHz $28/

9.016mHz to 12kHz for ICOM Radios

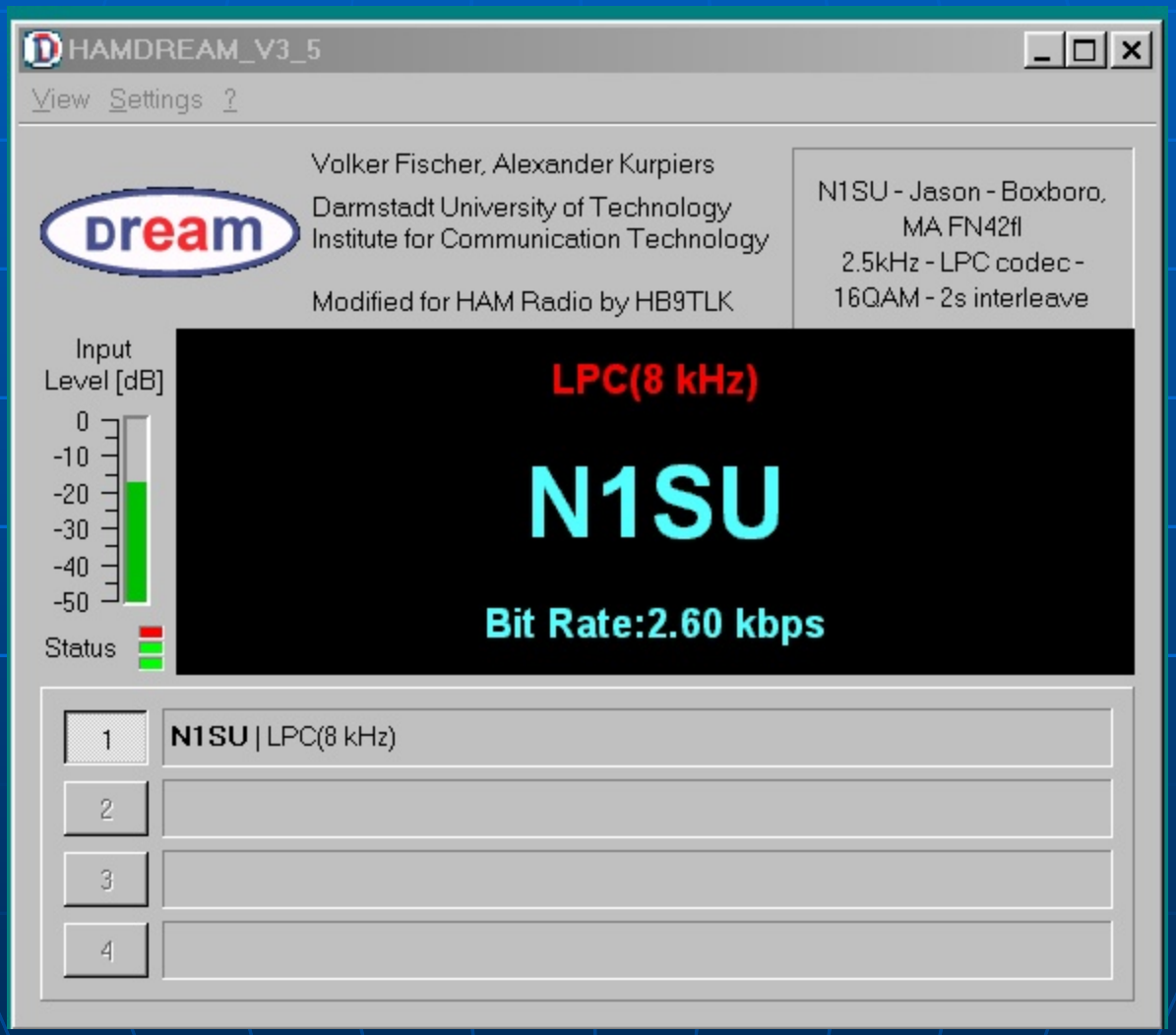
Hardware solution – New DRM Receiver

UniWave "Di-Wave 100" DRM Receiver

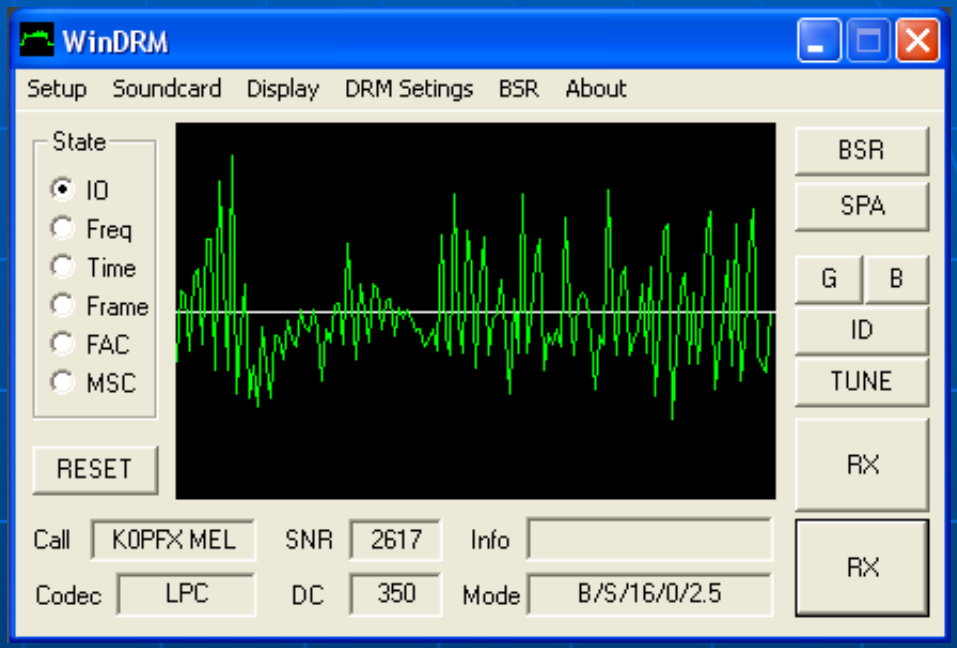
DRM TX Software



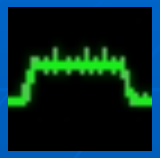
First ham DRM application Hamdream



WinDRM Digital Voice + Data



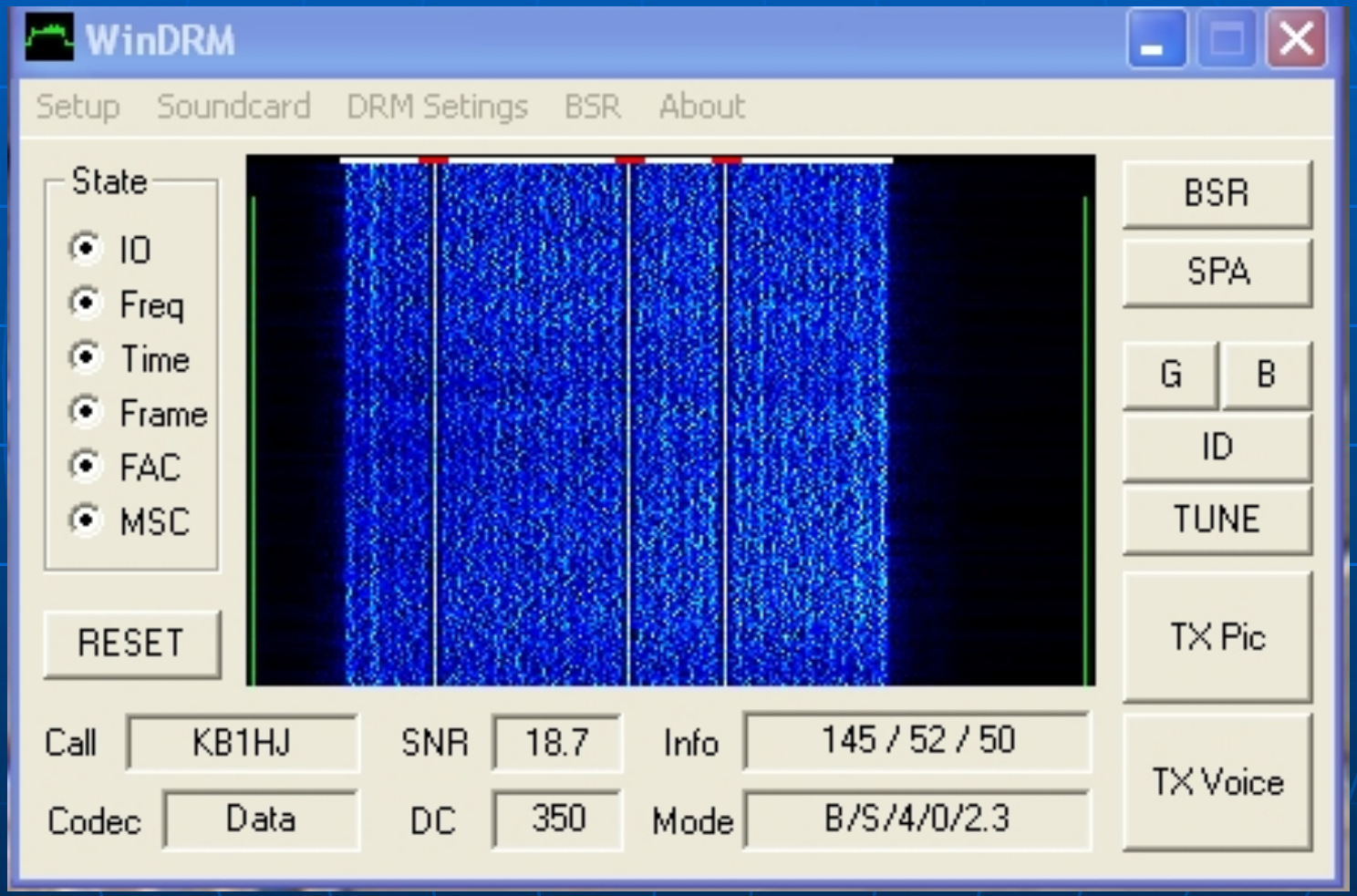
- Voice/Data/Images
- One GUI for both RX/TX
- 2.3-2.5Khz SSB BW
- OFDM 29-57 carriers
- 2400 bps open source SPEEX & LPC CODECS (~8dB SNR voice)
- MSC channel data rate 1 Kbps to 6.3 Kbps
- 4 to 64QAM Quadrature Amplitude Modulation
- Multiple TX/RX DRM modes to match propagation



WinDRM

- Developed for ham transceivers – no mods.
- **FAC** (Fast Access Channel) transmits call sign, modulation, interleaver, BW and sync pilots.
- **MSC** (Main Service Channel) transmits the voice/file data at 4-64QAM with FEC protection.
- Multiple displays for monitoring OFDM RX sigs.
- Complete User Docs available.

WinDRM Waterfall
Sync Reference Pilots



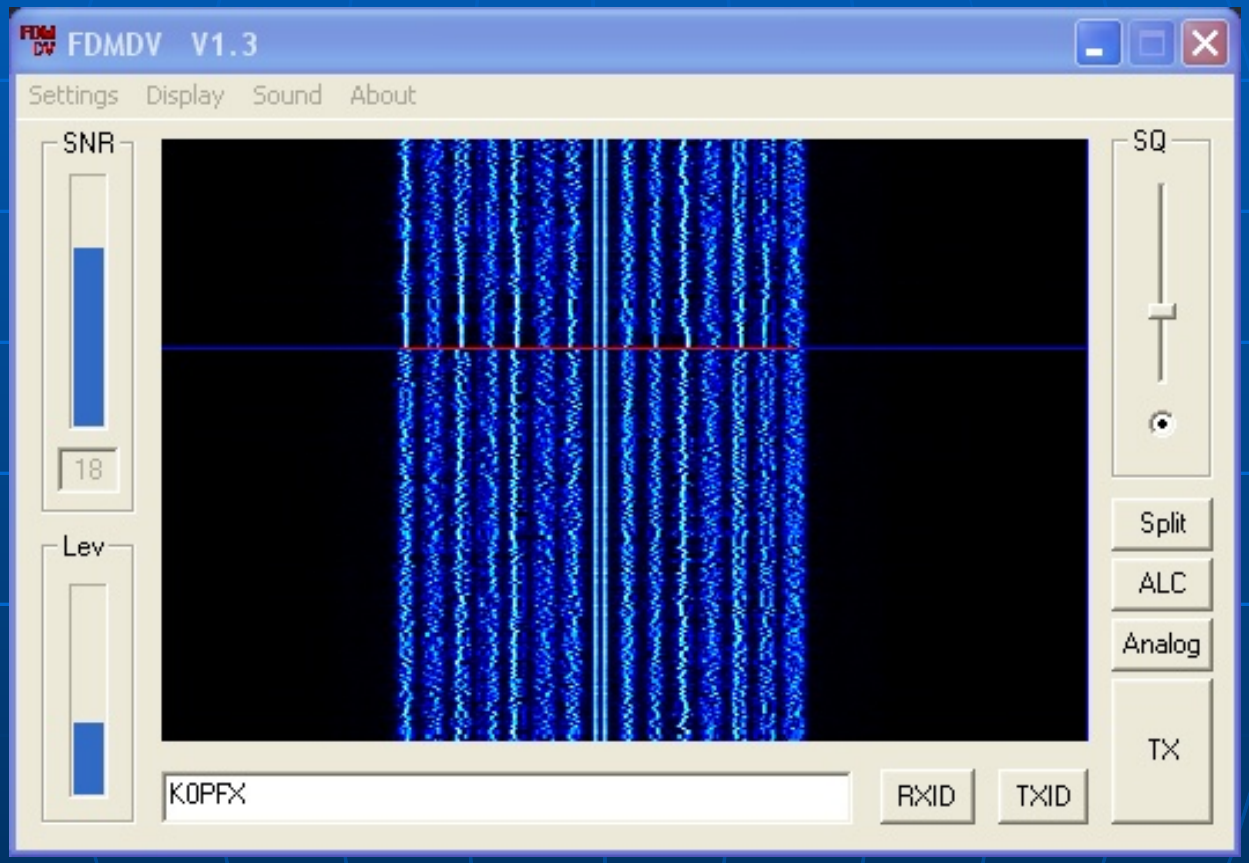
FDM
DV

FDMDV

Frequency Division Multiplex

HF Digital Voice

HB9TLK's Frequency Division Multiplex Digital Voice



FDMDV

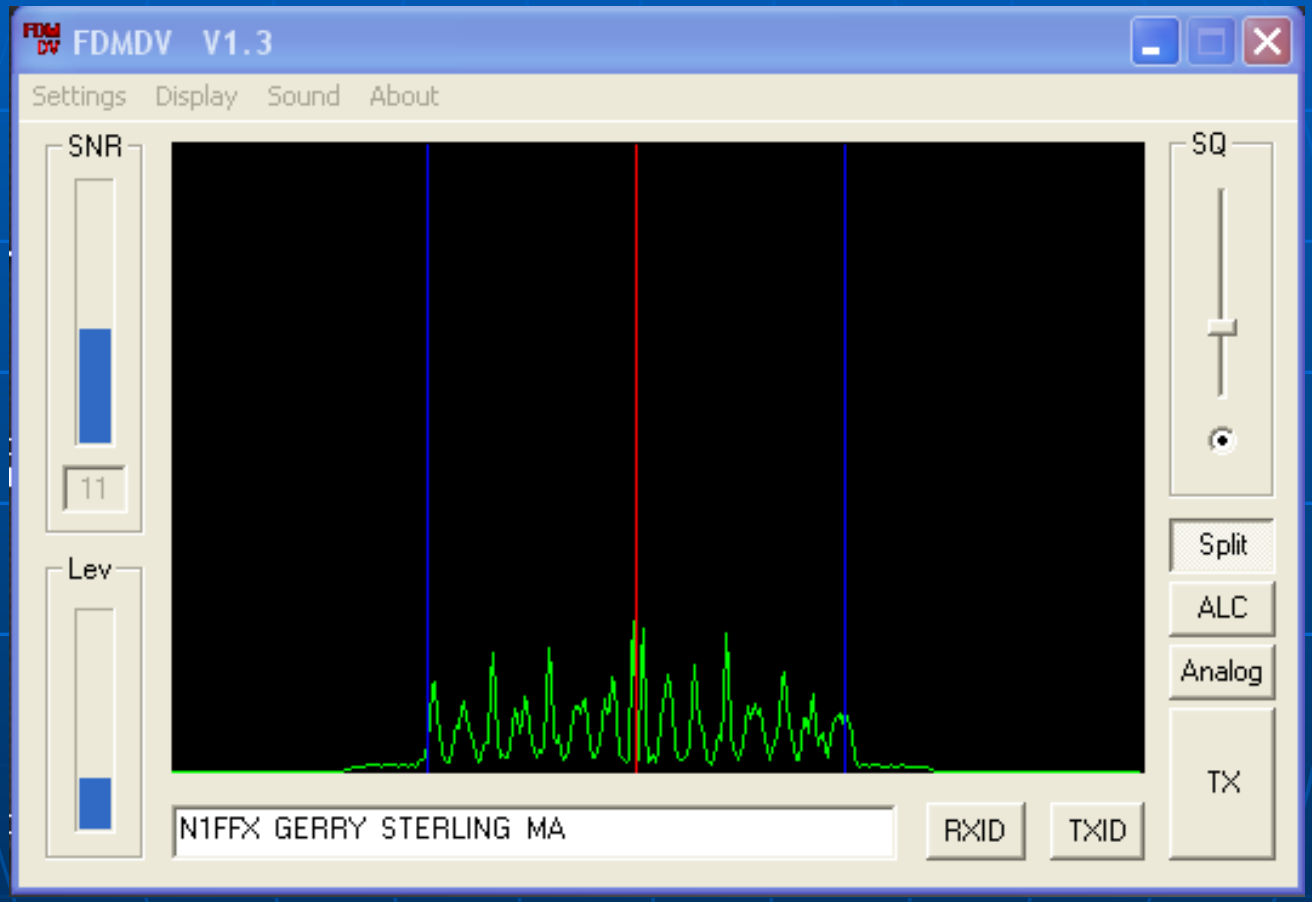
Description

FDM DV

- Latest DV development, Dec 2007 release
- Com voice quality in one-half BW of SSB
- Fast “instant” sync on the voice – no delays
- Robust in noise and QRM to <4dB SNR
- Auto ID/Tuning or mouse “click tuning”
- Multiple displays for signal analysis/tuning
- AFC keeps any TX drift in sync with receive
- No radio mods, compatible with SSB radios

Spectrum

FDM DV



Original idea of using FDM with no FEC based on work of Peter, G3PLX

Some FDMDV specs…

FDM DV

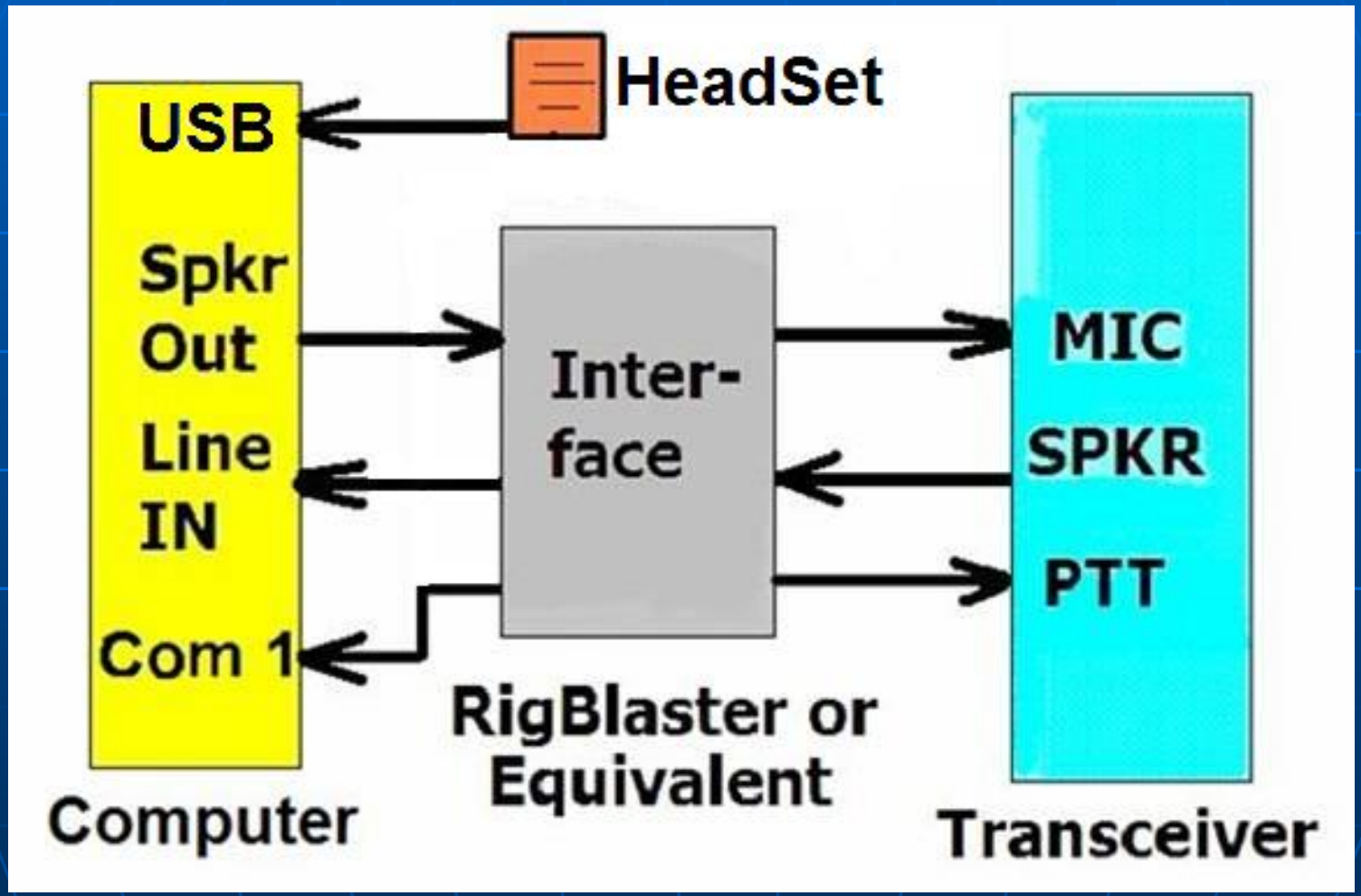
- 14 QPSK 50 baud carriers for voice data multiplexed for 1400 bps with no FEC
- 1 BPSK w/2x power for data synchronizing
- 50bps/80 character SMS (callsign/qth/etc)
- Narrow 1.125kHz occupied Bandwidth
- 1400 bps LPC CODEC
- F6CTE's RS-ID for mode ID/auto sync
- Transmit ALC to improve average power
- Detailed FCC spec published

Radio/PC easy set up!

FDM DV

- Uses same audio and PTT connections as other digital modes (just like PSK31)
- For voice I/O, just add a 2nd sound card or a USB headset such as a Logitech 250/350
- Execute software, set mixers, enter Com Port and call sign/location info
- Uses conventional SSB mode with no EQ
- Run 100w rigs at 25w max power output
- Quick start and detailed docs

Transceiver connections to Sound Card and USB Head Set



"2nd" Sound Card

Logitech 250
USB Head set
$20

OR

USB Sound Adapter
from Geeks.com
$7.50

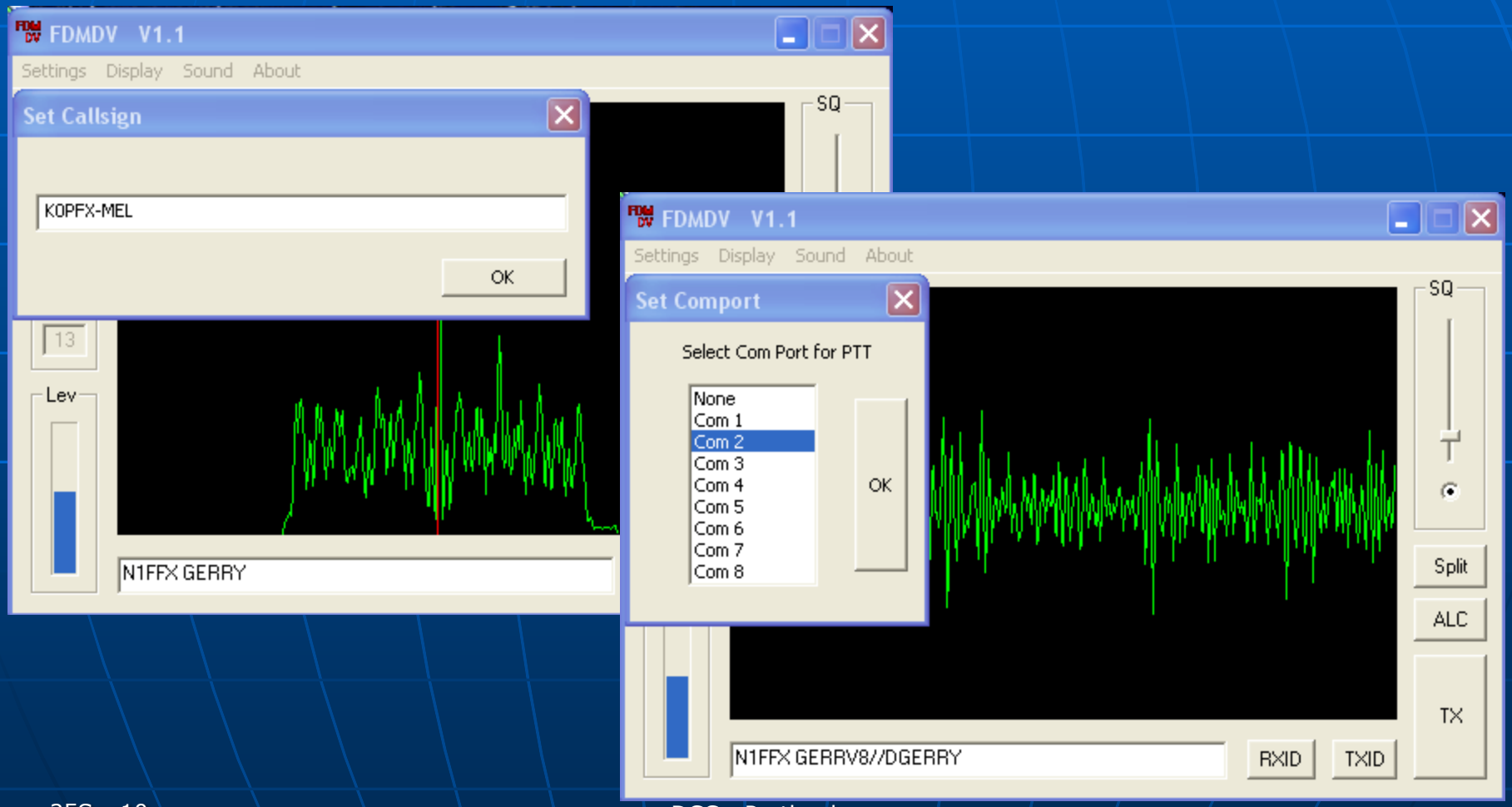
file folder…

FDM DV

Name	Size	Type	Date Modified
codec.dll	12 KB	Application Extension	7/20/2008 7:26 AM
cs.txt	1 KB	Text Document	8/25/2008 5:15 PM
fdmdv.exe	93 KB	Application	7/20/2008 6:04 AM
rsid.dll	24 KB	Application Extension	3/2/2008 4:24 AM
txport.bin	1 KB	BIN File	8/17/2008 4:06 PM
sc.txt	1 KB	Text Document	8/25/2008 5:15 PM

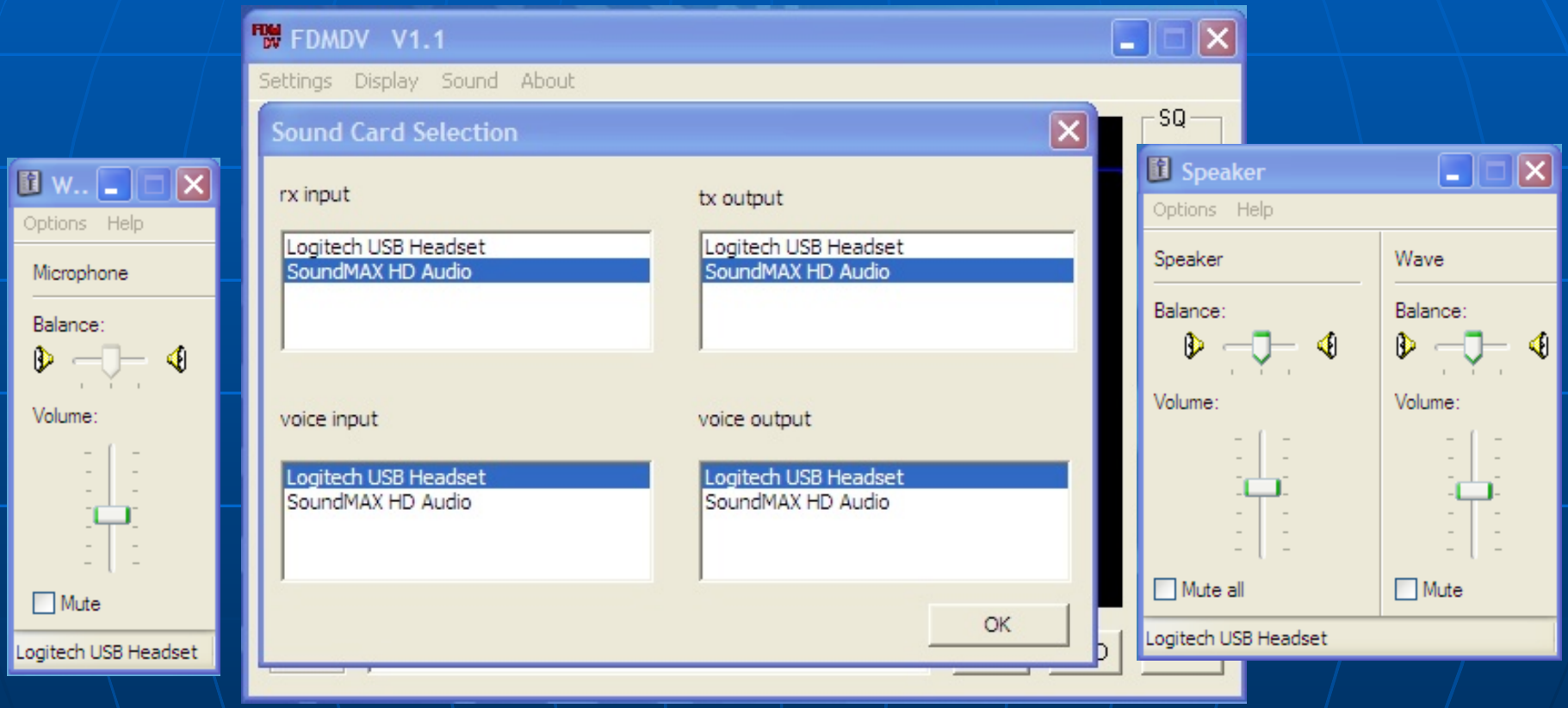
Set up screens…

FDM DV



Soundcard for transceiver I/O
USB Headset for voice I/O

FDM DV



Cesco, HB9TLK, author of WinDRM and FDMDV

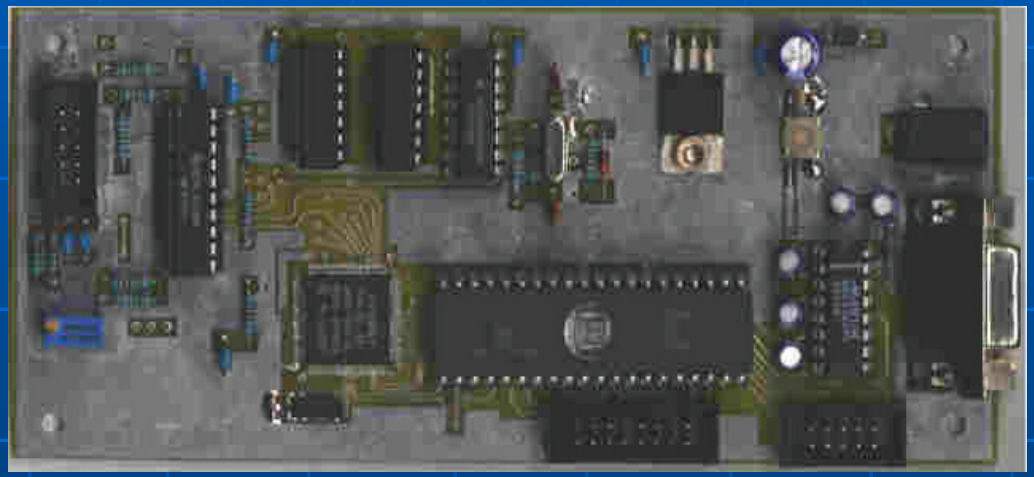
New Open Source “Codec2”

- The best voice quality low bit rate codec suitable for HF is protected by patents.
- David, VK5DGR is developing an open source 2400 k/bits codec that will be available for the ham radio community.
- The voice quality of the codec is expected to be close to MELP.
- At 3:15 today Bruce, K6BP will present this new Codec2.

A Hardware DV alternative

Authority On Radio

G4GUO DV Prototype (1999)



- Used early AMBE - Advanced Multiband Excitation Vocoder
- Open source software
- Predecessor of the AOR 9800

DV with D-SSTV option

2.4kHz occupied BW

OFDM 36 Carriers DQPSK

AMBE Vocoder chip

Excellent speech quality
PC command set
No DRM compatibility

ARD 9000 Mark 2

Lower cost

Compatible with 9800

Digital Voice only

Same AMBE Vocoder
Plug ‘n Play
No DRM compatibility

Resources…

SOFTWARE and Documentation

www.n1su.com www.drm.org www.sourceforge.net

SUPPORT

digitalvoice Google Group ARD9800 Yahoo Group

Digital Voice Website

www.hamradio-dv.org

Digital Voice Nets

Saturday/Sunday 18:00-20:00UTC 14.236 USB

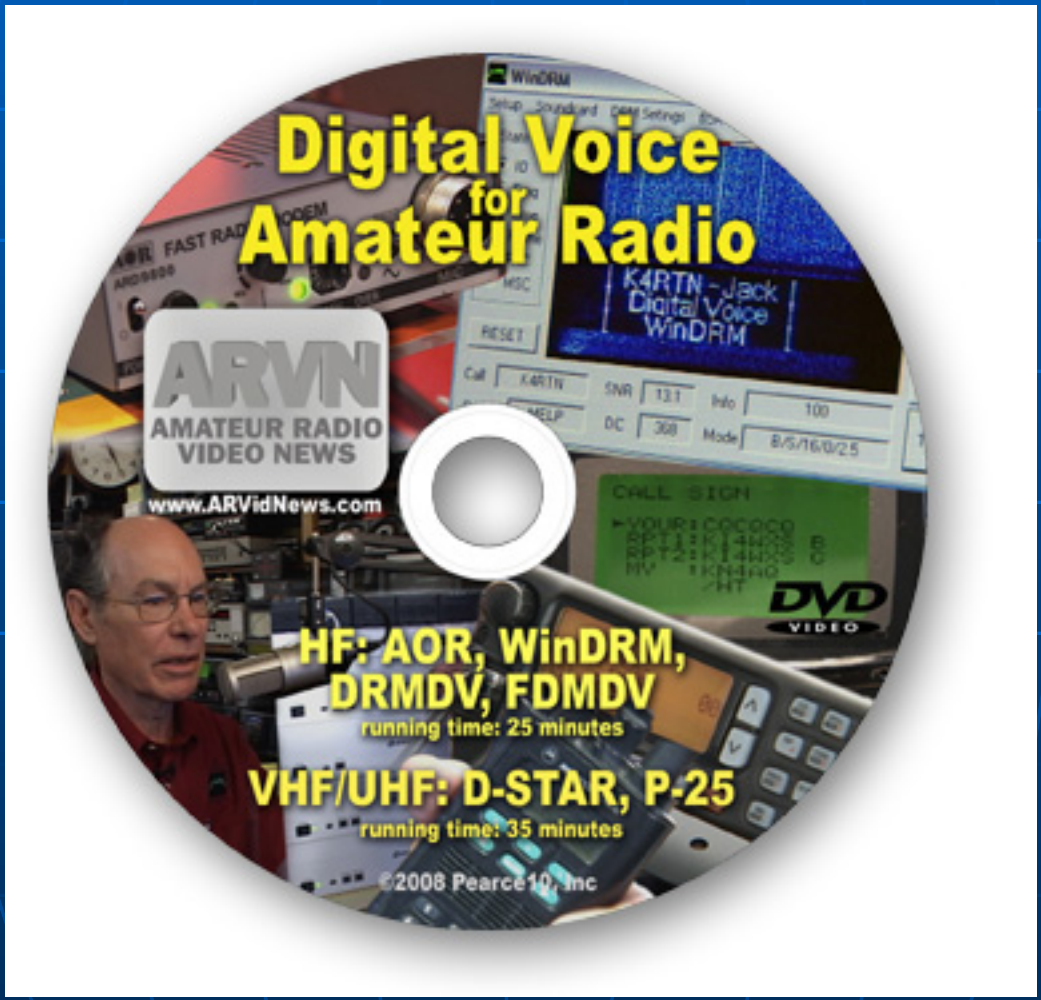
CODEC2:

https://sourceforge.net/lists/listinfofreetel-codec2

http://www.rowetel.com/blog/?page_id=452

..and more on DV here from ARVN – Amateur Radio Video News

www.ARVideoNews.com



GOTA
GET ON
THE AIR
With DV