

Introduction to Digital Voice over HF



WinDRM

**FDM
DV**



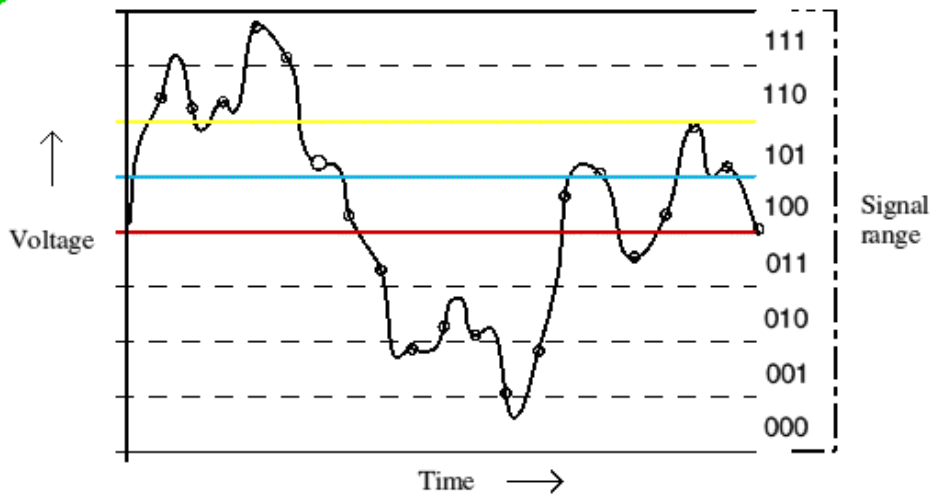
HF Digital Voice

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

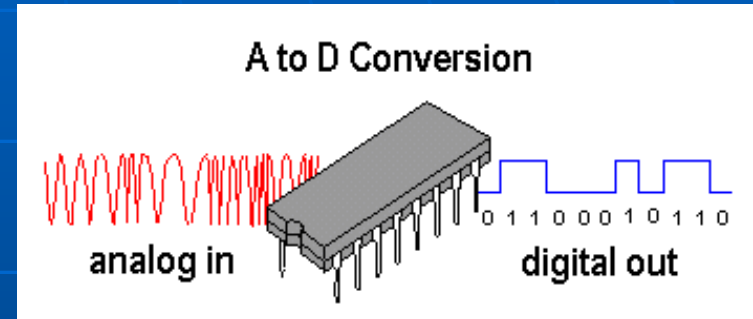
Why digital ?

- 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...



110110110111111101100011001010010001001100101011100101101100..



(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.

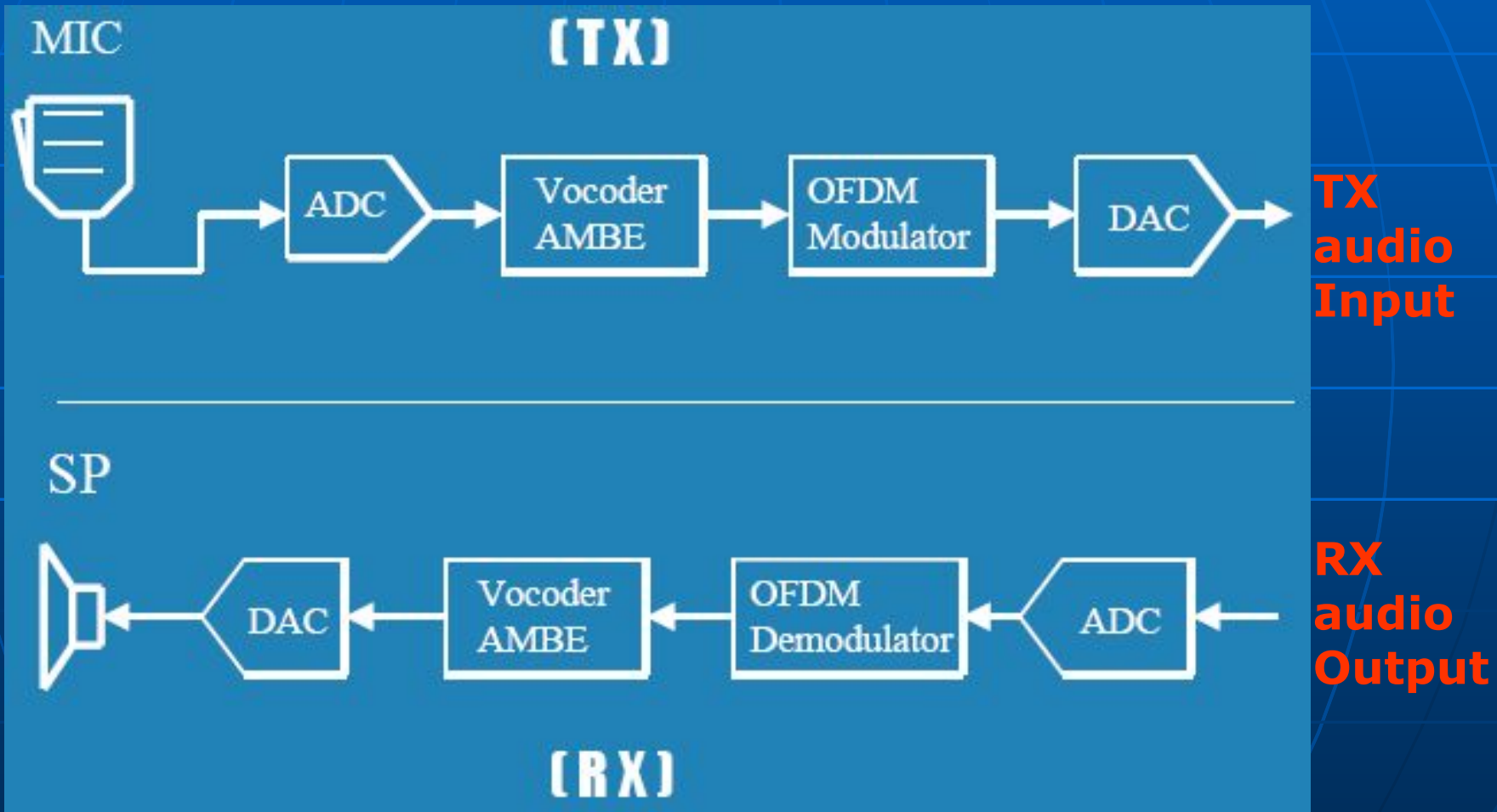
DV Basics... Voice Coding

- **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



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

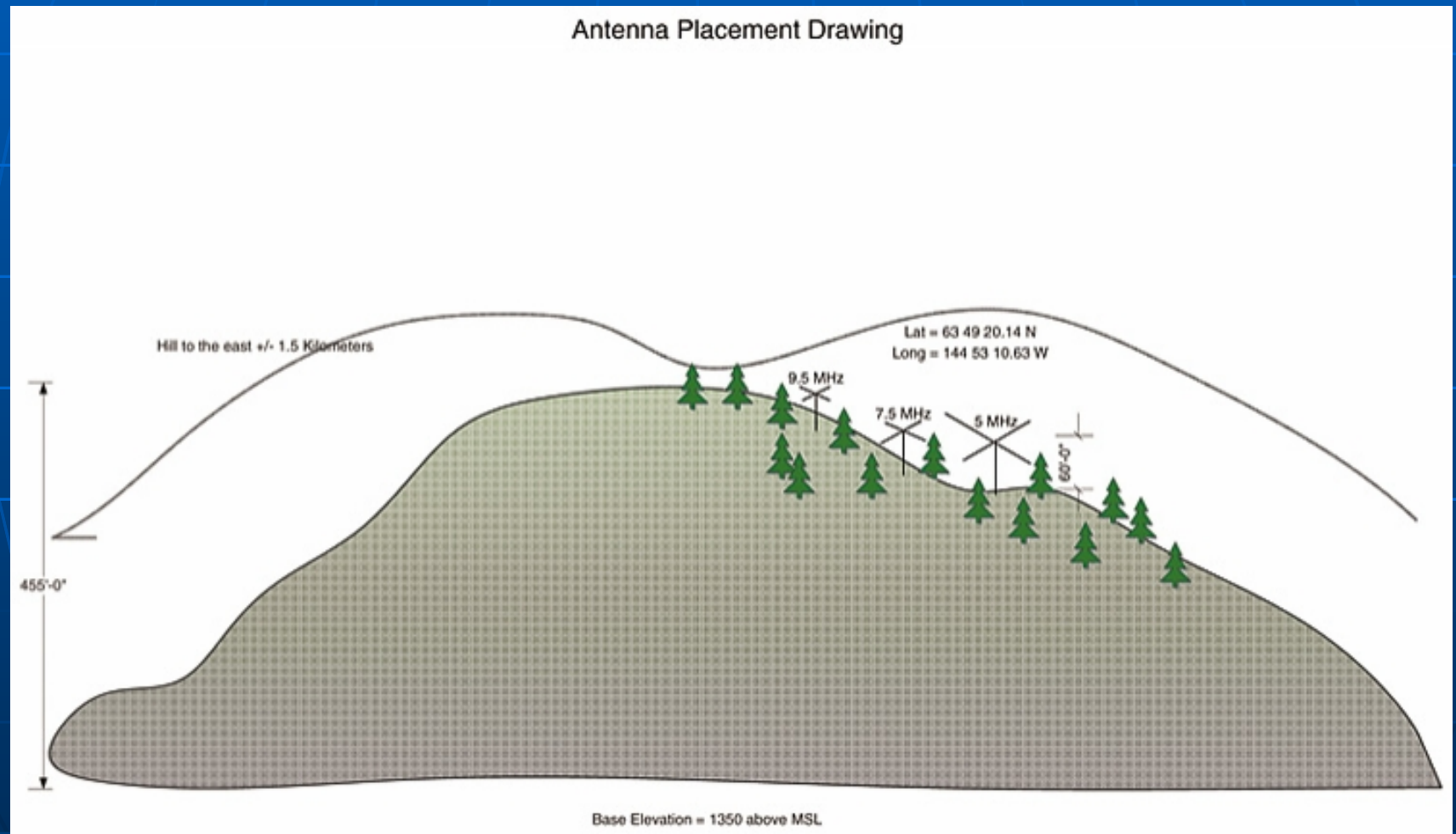
Digital Radio Mondiale

Digital replacement for AM

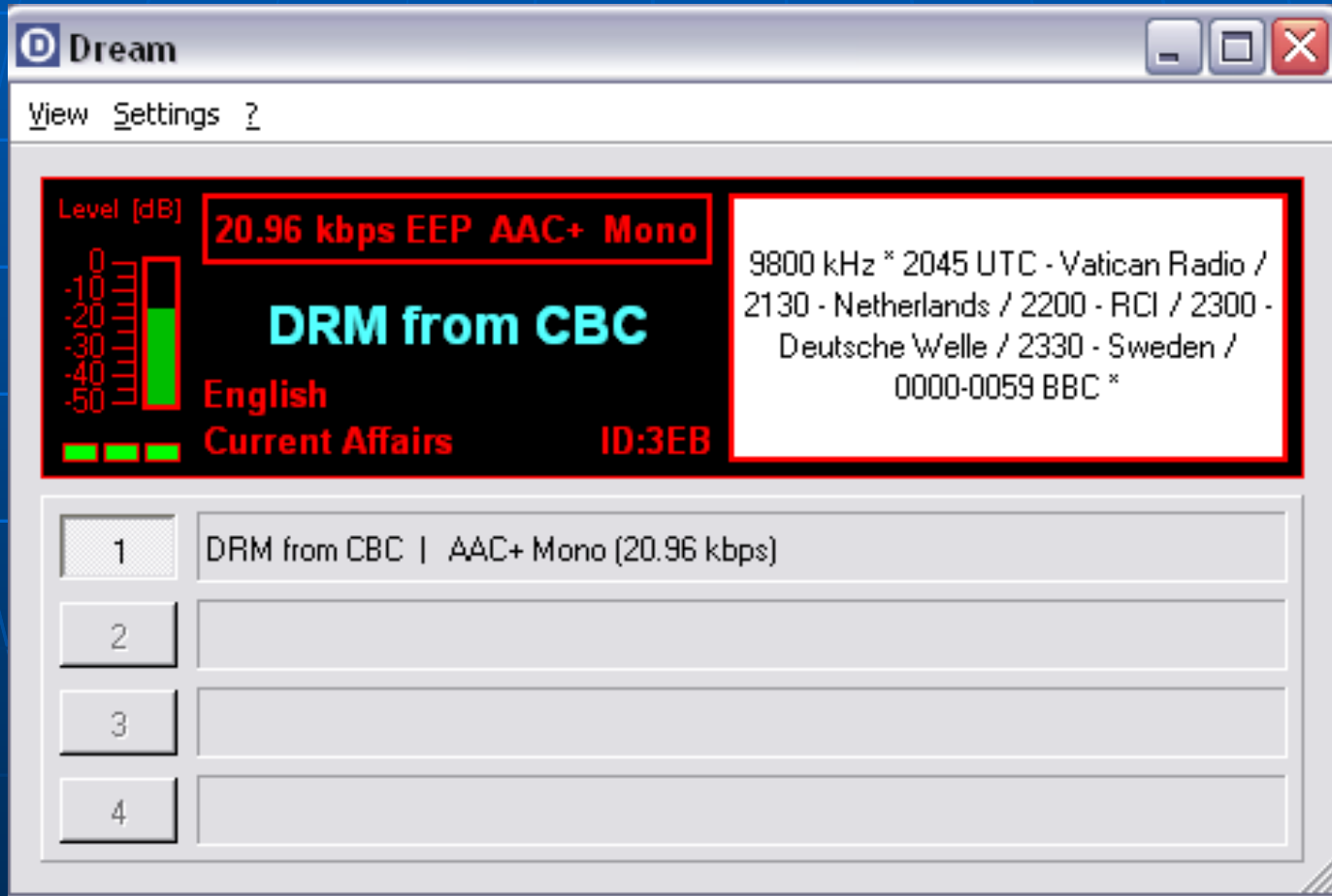


- DRM is a global open (free) digital radio standard capable of providing near-FM quality sound for SW, MW and LW.
- Driven by an international consortium of broadcasters, manufacturers, regulators and educators with about a 100 members.
- DRM is found world wide with most stations in Europe, Asia, and 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



The screenshot shows the Dream receiver software interface. At the top, there is a title bar with the text "Dream" and standard window control buttons. Below the title bar is a menu bar with "View", "Settings", and a question mark. The main content area is divided into several sections. On the left, there is a speaker icon and a volume level indicator labeled "Level [dB]" with a scale from 0 to -50. The volume bar is green and shows a level of approximately -25 dB. To the right of the volume indicator, there is a red-bordered box containing the text "20.96 kbps EEP AAC+ Mono". Below this, the text "DRM from CBC" is displayed in large, cyan letters. Underneath, "English" is written in red, and "Current Affairs" is written in red with a small green bar to its left. To the right of "Current Affairs", the text "ID:3EB" is displayed. Further to the right, there is a white-bordered box containing the text "9800 kHz * 2045 UTC - Vatican Radio / 2130 - Netherlands / 2200 - RCI / 2300 - Deutsche Welle / 2330 - Sweden / 0000-0059 BBC *". At the bottom of the interface, there is a list of four items, each with a button labeled with a number (1, 2, 3, 4) and a text field. The first item is "1 | DRM from CBC | AAC+ Mono (20.96 kbps)".

DRM Multi-Media Services



DRM digital Shortwave 49-19mtr



Dream

View Settings ?

Level [dB] 20.46 kbps UEP (12.1 %) AAC+ Mono

Radio Australia

English Australia ID:1

Varied

dream

View Settings ?

Level [dB] 11.64 kbps EEP aac Mono

MOI KUWAIT

Arabic Information

Dream

View Settings ?

Level [dB] 17.08 kbps EEP AAC+ Mono

RNZI

English New Zealand ID:36

Varied

NEWS HEADLINES

Dream

View Settings ?

Level [dB] 18.08 kbps UEP (43.6 %) AAC+ P-Stereo

CVC

Portuguese

Informes a ondacorta@cvclavoz.cl

ID:E1C303

Dream

View Settings ?

Level [dB] 18.08 kbps EEP AAC+ P-Stereo

Deutsche Welle

Current Affairs Germany ID:445700

Court rules Politkovskaya trial open to the public

1	Deutsche Welle AAC+ P-Stereo (18.08 kbps) + AFS
2	DW Journaline Data: Journaline (0.36 kbps)
3	
4	

dream

View Settings ?

Level [dB] 17.12 kbps EEP AAC+ Mono

IBB / HCJB

English Varied ID:A0A100

You are listening to the IBB / HCJB digital test transmission. ibbhcb@gmail.com

1	IBB / HCJB AAC+ Mono (17.12 kbps)
2	Pictures Data: MOT Slideshow (3.84 kbps)
3	
4	

25Sep10

DCC - Portland

DRM – how does it work?



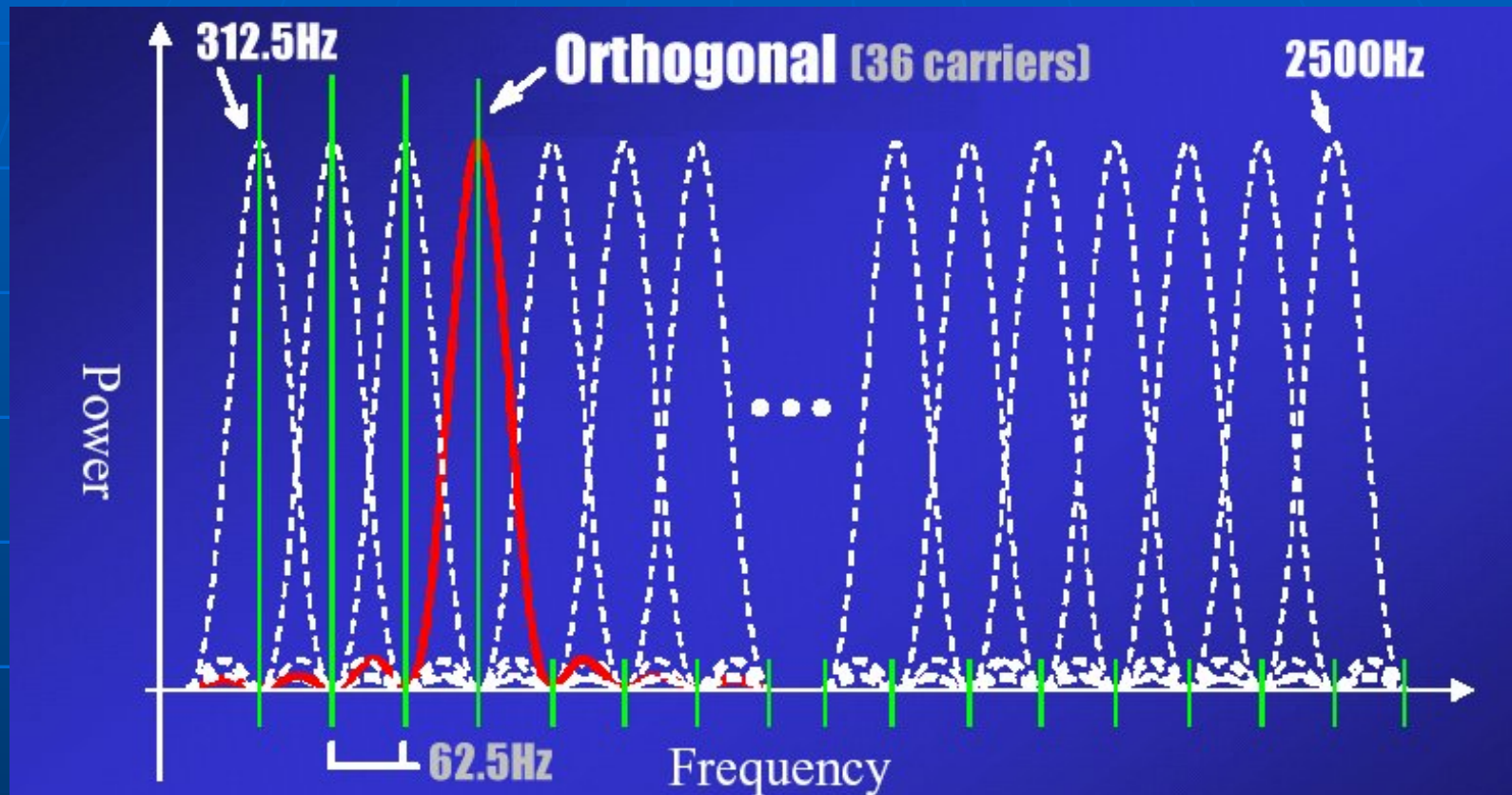
- Coded OFDM multiple-carriers with QAM16/QAM64.
- MPEG4 AAC, CELP and HVXC CODECS.*
- SW 10kHz channel spacing/Up to 25+ Kbps data.
- Integrates images, html pages, schedules.
- Robustness modes match propagation conditions.

* AAC=Advanced Audio Coding + Spectral Band Rep +
Parametric-Stereo

CELP=Coded Excited Linear Prediction (robust speech)

HVXC=Harmonic Vector Excitation (low bit speech coder)

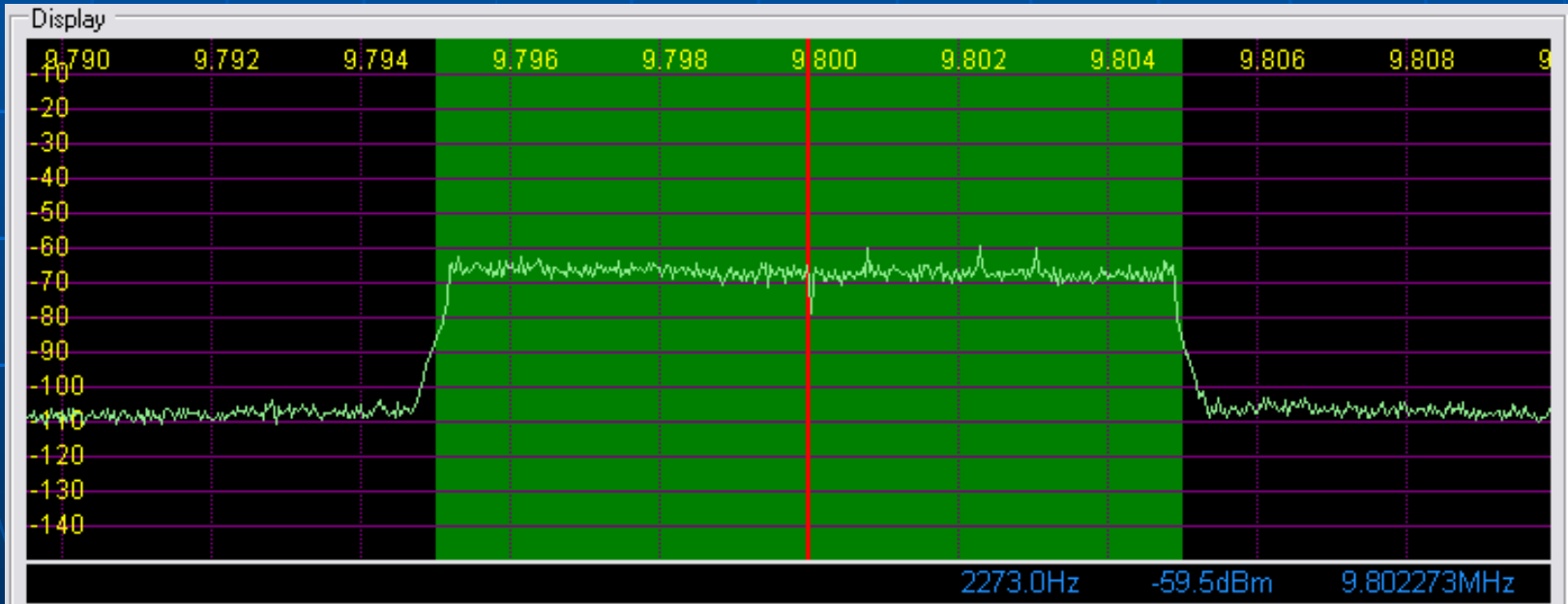
Example of OFDM carriers



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

Dream
Volker Fischer, Alexander Kurpiers
Darmstadt University of Technology
Institute for Communication Technology

Channel Parameters

Robustness Mode: A B C D

Bandwidth: 4,5 kHz 9 kHz 18 kHz
 5 kHz 10 kHz 20 kHz

MSC Constellation Scheme: SM 64-QAM MSC Protection Level: 1

SDC Constellation Scheme: 16-QAM MSC Interleaver Mode: 2 s (Long Interleaving)

Output

IF: 12000.00 Hz Real val. I/Q (pos) I/Q (neg) E/P

Indicators

Audio Level [dB]: -50 -40 -30 -20 -10 0

arch_closeup.jpg: 74%

Enable

Label: KOPFX

Service ID: EM48

Language: English

Audio

Enable

Program Type: No programme type

Text Message

Enable

1

Dream DRM Transmitter
This is a test transmission

Clear All Add / Modify

Data (SlideShow Application)

Enable

File Name	Size [KB]	Full Path
arch_closeup.jpg	8.90	C:/Documents and Settings

Clear All Add

Service 1 Service 2 Service 3 Service 4

Stop Close

First ham DRM application Hamdream

HAMDREAM_V3_5

View Settings ?

dream

Volker Fischer, Alexander Kurpiers
Darmstadt University of Technology
Institute for Communication Technology

Modified for HAM Radio by HB9TLK

N1SU - Jason - Boxboro,
MA FN42fl
2.5kHz - LPC codec -
16QAM - 2s interleave

Input Level [dB]

0
-10
-20
-30
-40
-50

Status

LPC(8 kHz)

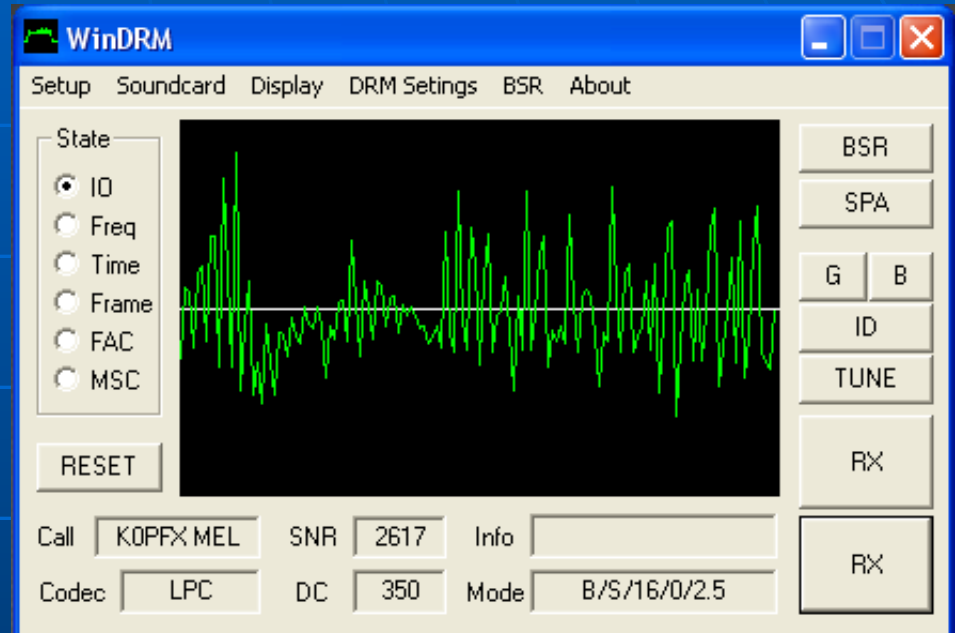
N1SU

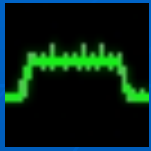
Bit Rate: 2.60 kbps

1	N1SU LPC(8 kHz)
2	
3	
4	

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

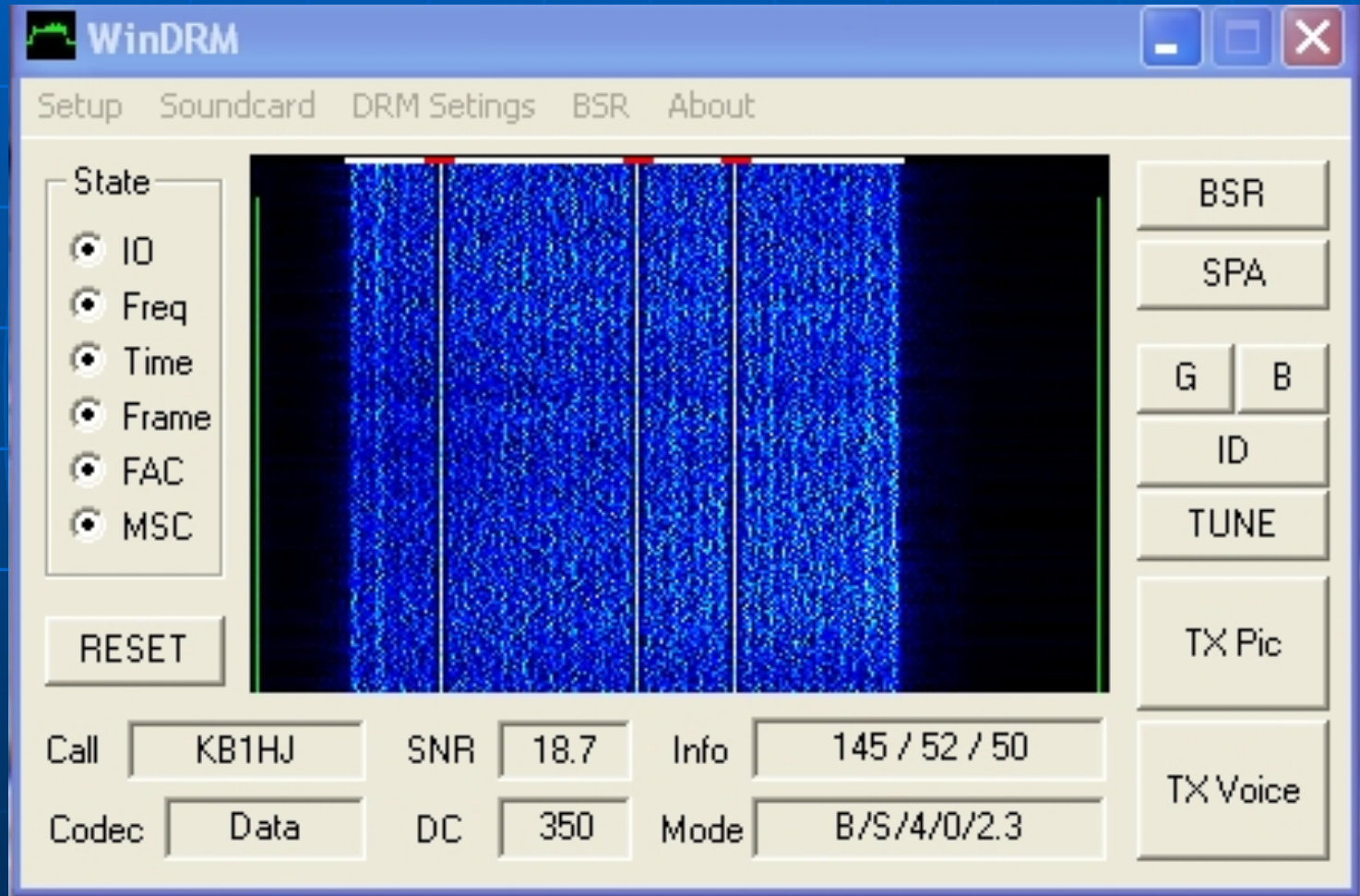




WinDRM

- 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

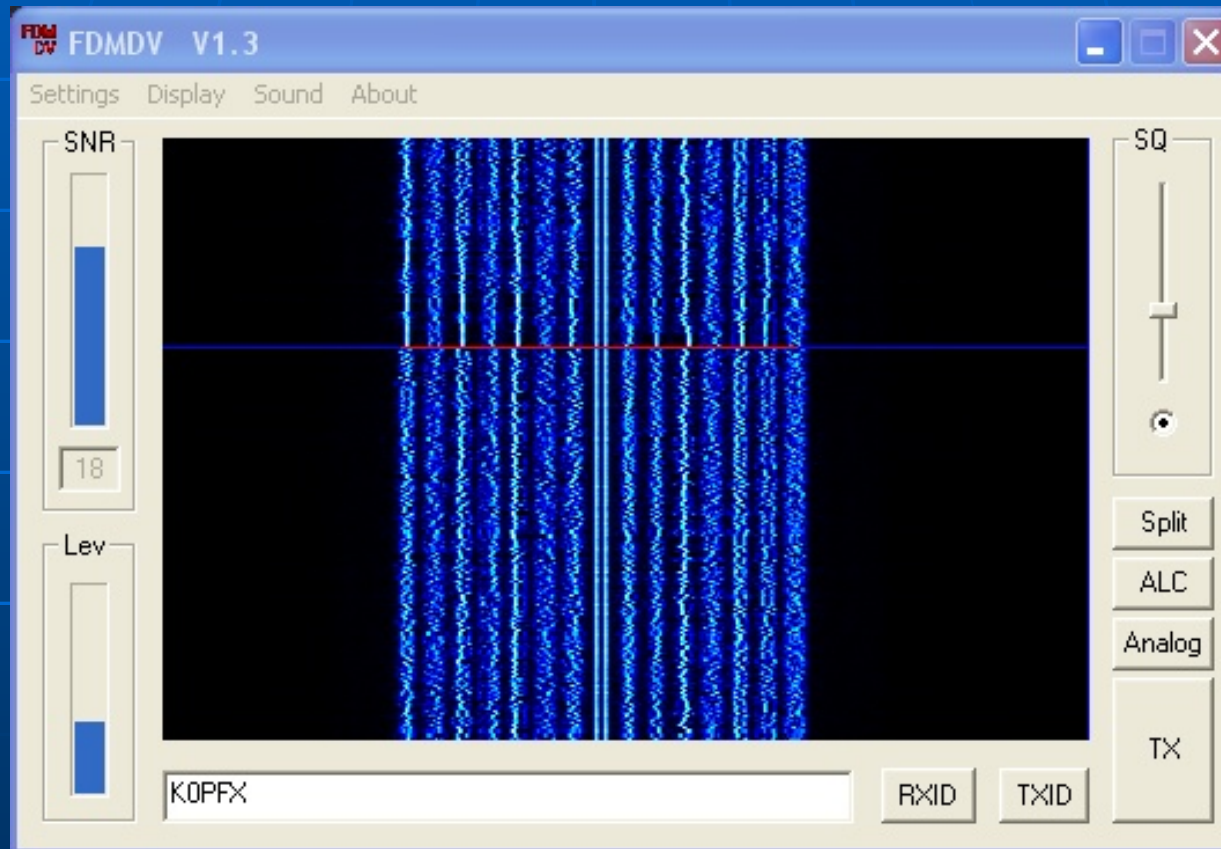


FDMDV

Frequency Division Multiplex

HF Digital Voice

HB9TLK's Frequency Division Multiplex Digital Voice



FDMDV

Description

- 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 $<4\text{dB}$ 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



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

Some FDMDV specs...

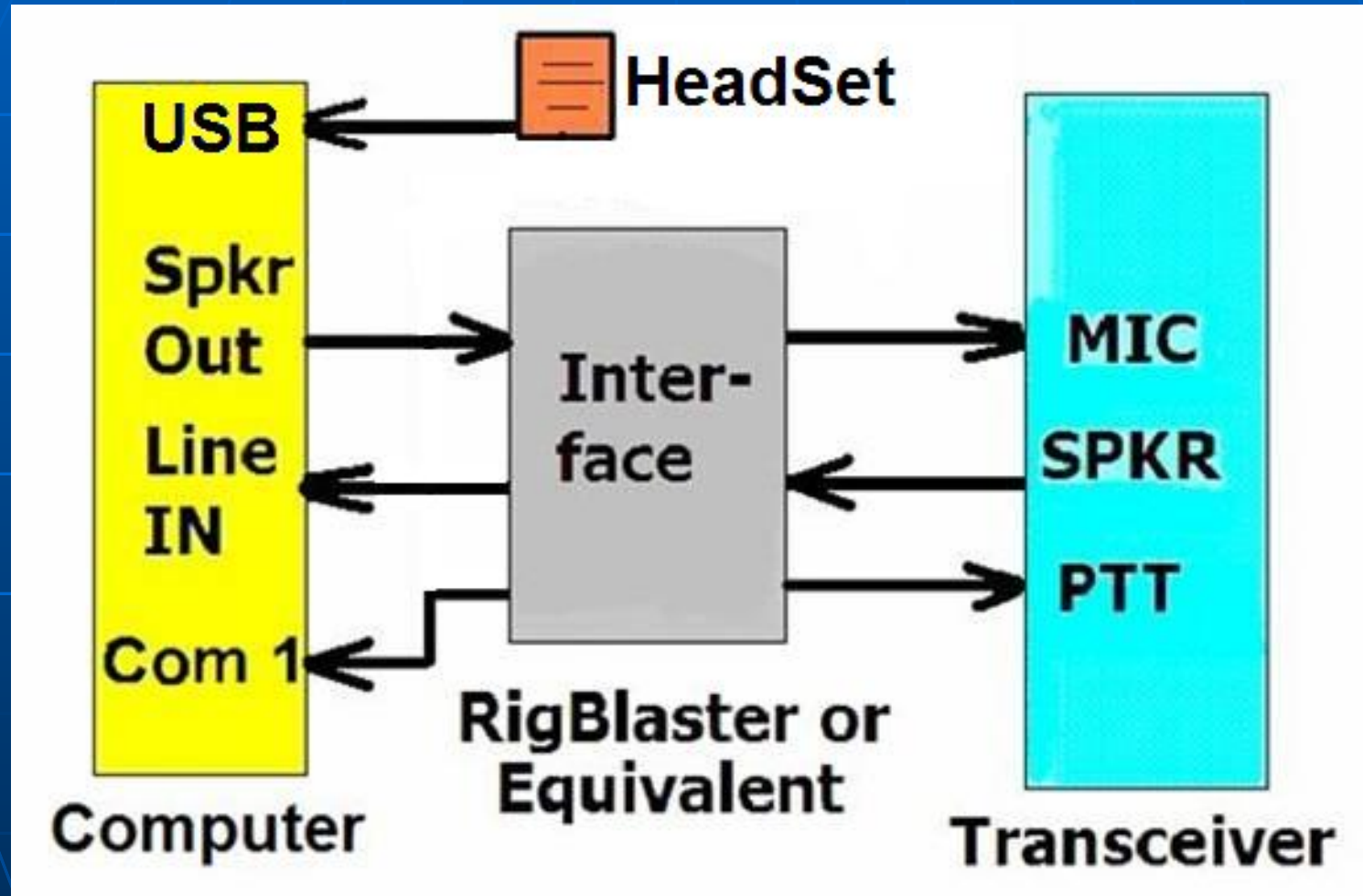
FDM
DV

- 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!

- 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



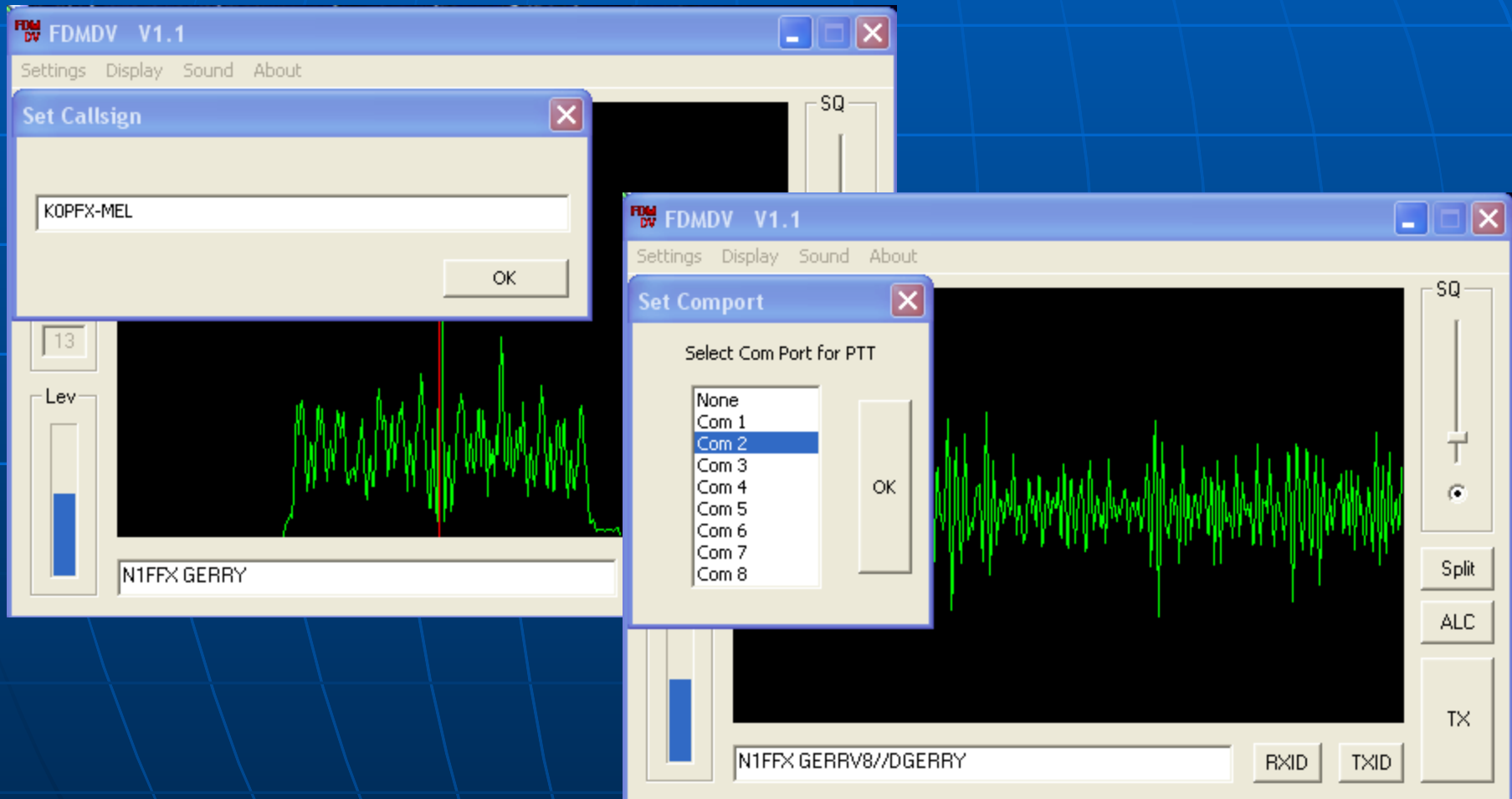
USB Sound Adapter
from Geeks.com
\$7.50



file folder...

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

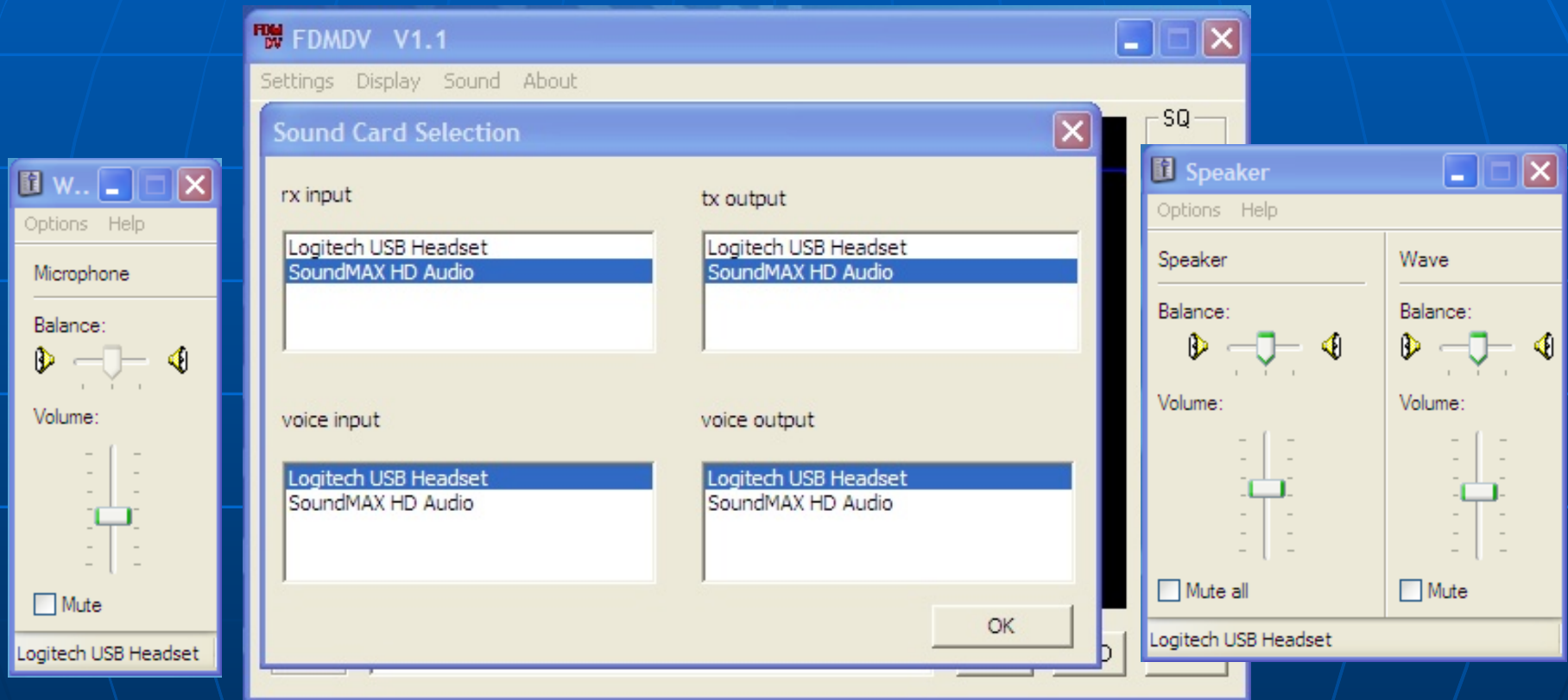
Set up screens...



Soundcard for transceiver I/O

USB Headset for voice I/O

FDM
DV





Cesco, HB9TLK, author of WinDRM and FDMDV

New Open Source “Codec2”

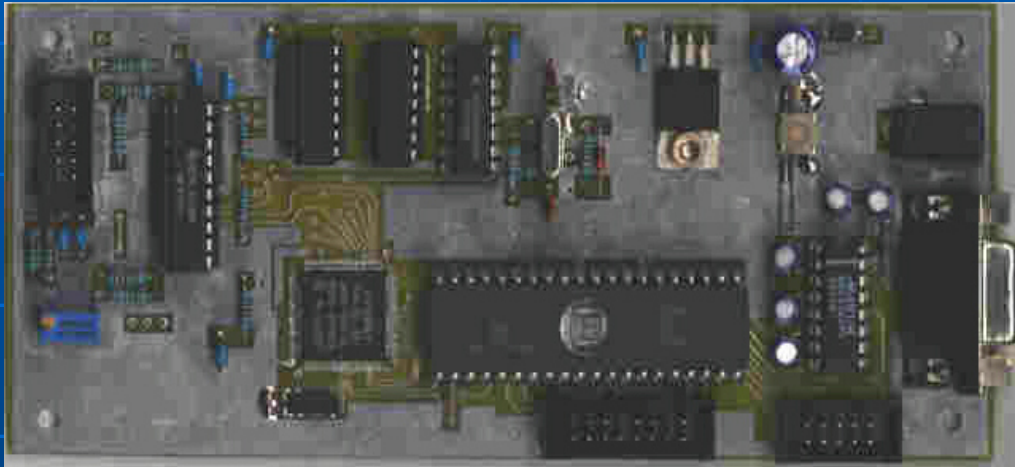
- The best voice quality low bit rate codec suitable for HF is protected by patents.
- David, VK5DGR is developing an open source 2400 k/bits codec that will be available for the ham radio community.
- The voice quality of the codec is expected to be close to MELP.
- At 3:15 today Bruce, K6BP will present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

