ICOM

For the love of ham radio.

D-STAR

From the Beginning

- Late 90's development
  - Mobile Data Solutions
  - ISDN data rates
  - Voice communications
- Implementation Success!!
- JARL developed for Amateur Radio Use
  - CAI Standard is open source
    - On going debate

- Concept Introduced @ 2001 Tokyo Hamfair
  - Original Spec's
    - Frequency : 1.2 GHz band
    - Wave Type : FM (Analog voice), 0.5 GMSK (Digital voice/data)
    - Communication Speed : **8kbps (Voice)/**128kbps (Data)
    - Vocoder : **G723.1**
    - Data Interface : IEEE802.3 (10Base-T)
- http://www.arrl.org/files/file/Technology/tis/info/pdf/dstar.pdf

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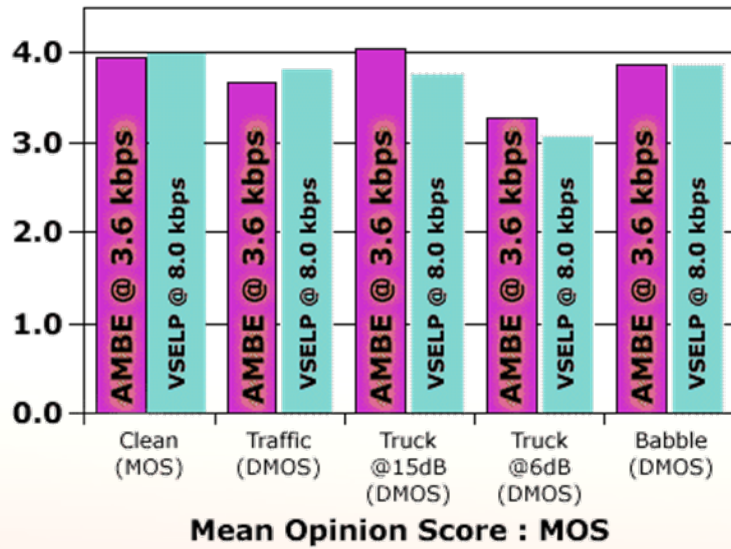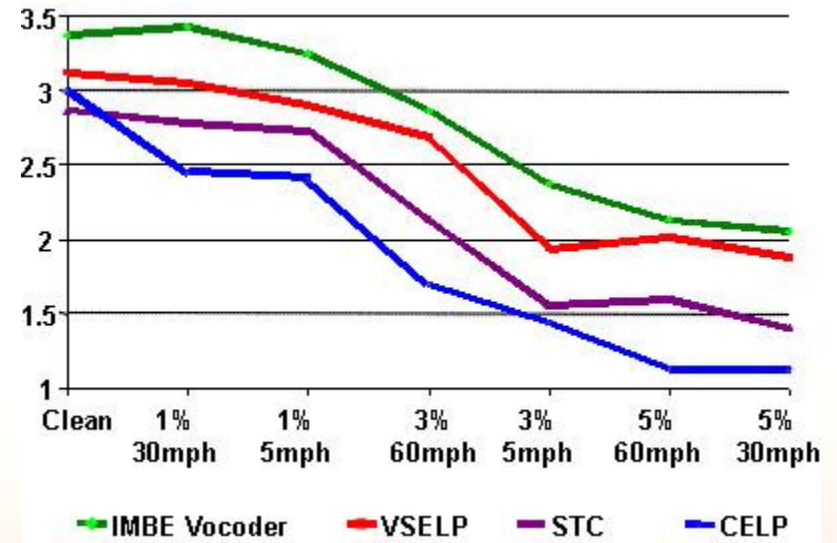
HAMS ONLY!

- D-STAR Concept Articles
  - QEX 2003
    - July – August
    - September – October
    - November – December
  - Article outlines
    - Part 1, New Mode introduction
    - Part 2, Design Considerations
    - Part 3, Implementation

- Codec comparisons
  - VSELP (Vector Sum Exited Linear Prediction)
    - Cellular Telephony standards (GSM, iDEN)
    - Limited ability to code non-speech sounds
  - RELP (Residual Excited Linear Prediction)
    - Cellular Telephony standards (GSM)
    - Performance limited by the tonal noise of the system
  - IMBE (Improved Multi-Band Excitation)
    - DVSI chipset, Developed in the early '80s at MIT
    - P25 devices, Inmarsat, OPTUS services
  - **AMBE (Advanced Multi-Band Excitation)**
    - DVSI Chipset
    - D-STAR, Phase II P25, DV Dongles, DVAP

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Inmarsat Voice Quality Test

APCO Voice Quality Test

http://www.dvsinc.com/papers/iambe.htm
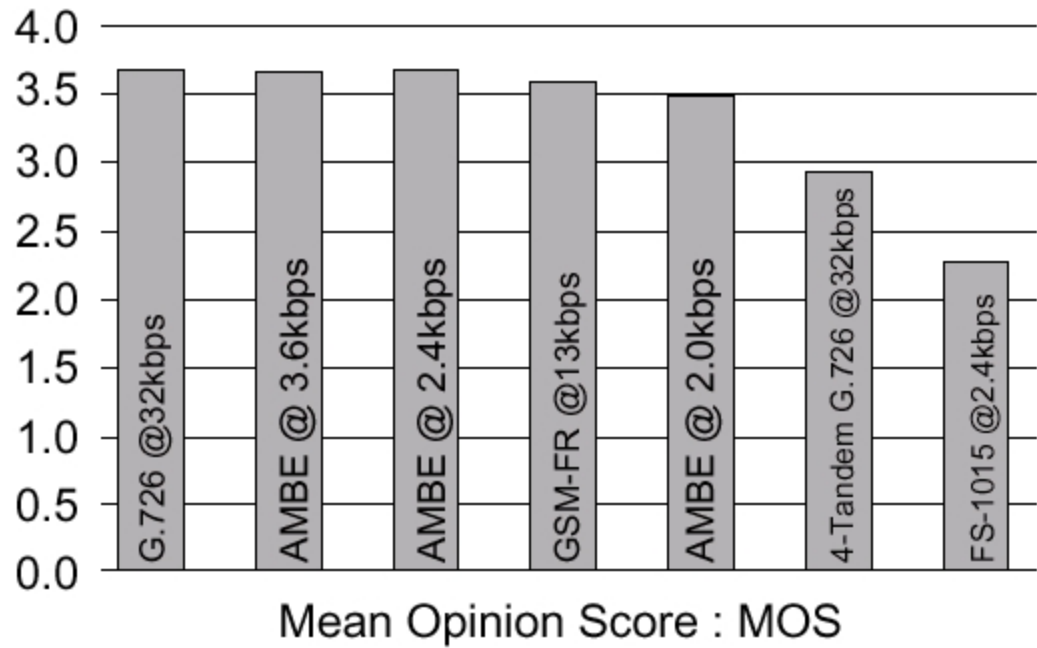
DIGITAL VOICE SYSTEMS, INC.
The Speech Compression Specialists

- Discriminate each voice segment for frequency band.
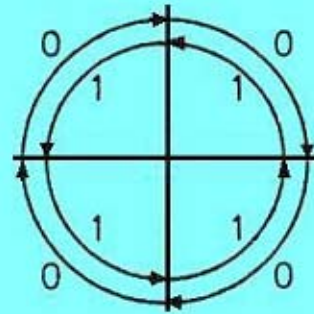- Decide voice/non-voice for each frequency band.
- Mix voice and noise of excitation signal versus specified voice

Bar chart — Mean Opinion Score : MOS

Codec	MOS
G.726 @32kbps	~3.65
AMBE @ 3.6kbps	~3.65
AMBE @ 2.4kbps	~3.65
GSM-FR @13kbps	~3.55
AMBE @ 2.0kbps	~3.45
4-Tandem G.726 @32kbps	~2.9
FS-1015 @2.4kbps	~2.3
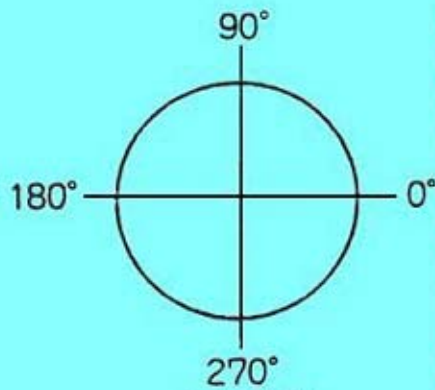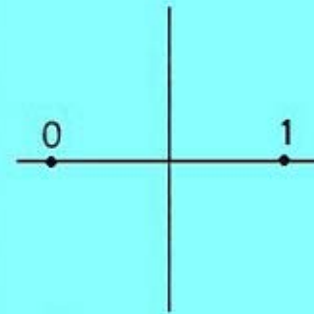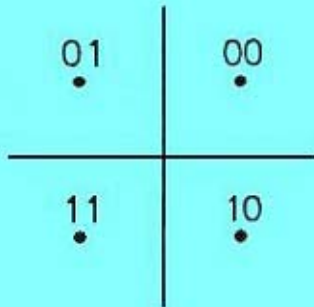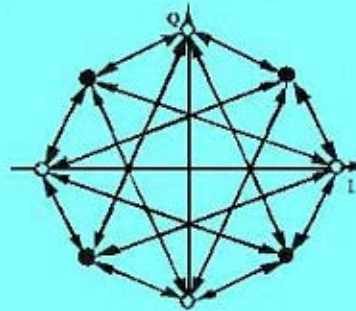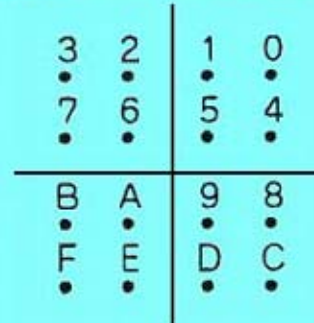
- Trade off
  - Simplicity/Bandwidth
    - Simplistic design, decrease the spectral efficiency
    - Increase spectrally efficient, Increase the complication the design

- Factors
  - Available bandwidth
  - Permissible power
  - Inherent noise levels

Modulation Format	Theoretical Bandwidth efficiency limits
MSK	1 bit/second/Hz
BPSK	1 bit/second/Hz
QPSK	2 bit/second/Hz
8PSK	3 bit/second/Hz
16QAM	4 bit/second/Hz
32QAM	5 bit/second/Hz
64 QAM	6 bit/second/Hz
256QAM	8 bit/second/Hz

- ## Ideal modulation
    - Spectrally Efficient
    - Good BER performance
    - Adjacent signal rejection
    - Self-synchronizing
    - Maximum data rate
        - Spectral efficient (6.25kHz Goal)
    - Constant envelope carrier
        - No amplitude variations
        - More efficient amplifiers
        - Reduces power consumption

- ## Class C amplifiers
    - Most efficient
    - Reduces weight
    - Reduces size
    - Increases talk time
    - Increases reliability

More in-depth comparison in Part 2, Design Considerations

Sep 06	108
Oct 06	150
Nov 06	198
Dec 06	226
Jan 07	286
Feb 07	338
Mar 07	413
Apr 07	474
May 07	580
Jun 07	645
Jul 07	703
Aug 07	784
Sep 07	1022
Oct 07	1152
Nov 07	1447
Dec 07	1656

D-STAR User Growth

12/2007

Dayton 2007

Dayton Backorder Shipments

Introduction Dayton 2006 VHF/UHF infrastructure

2
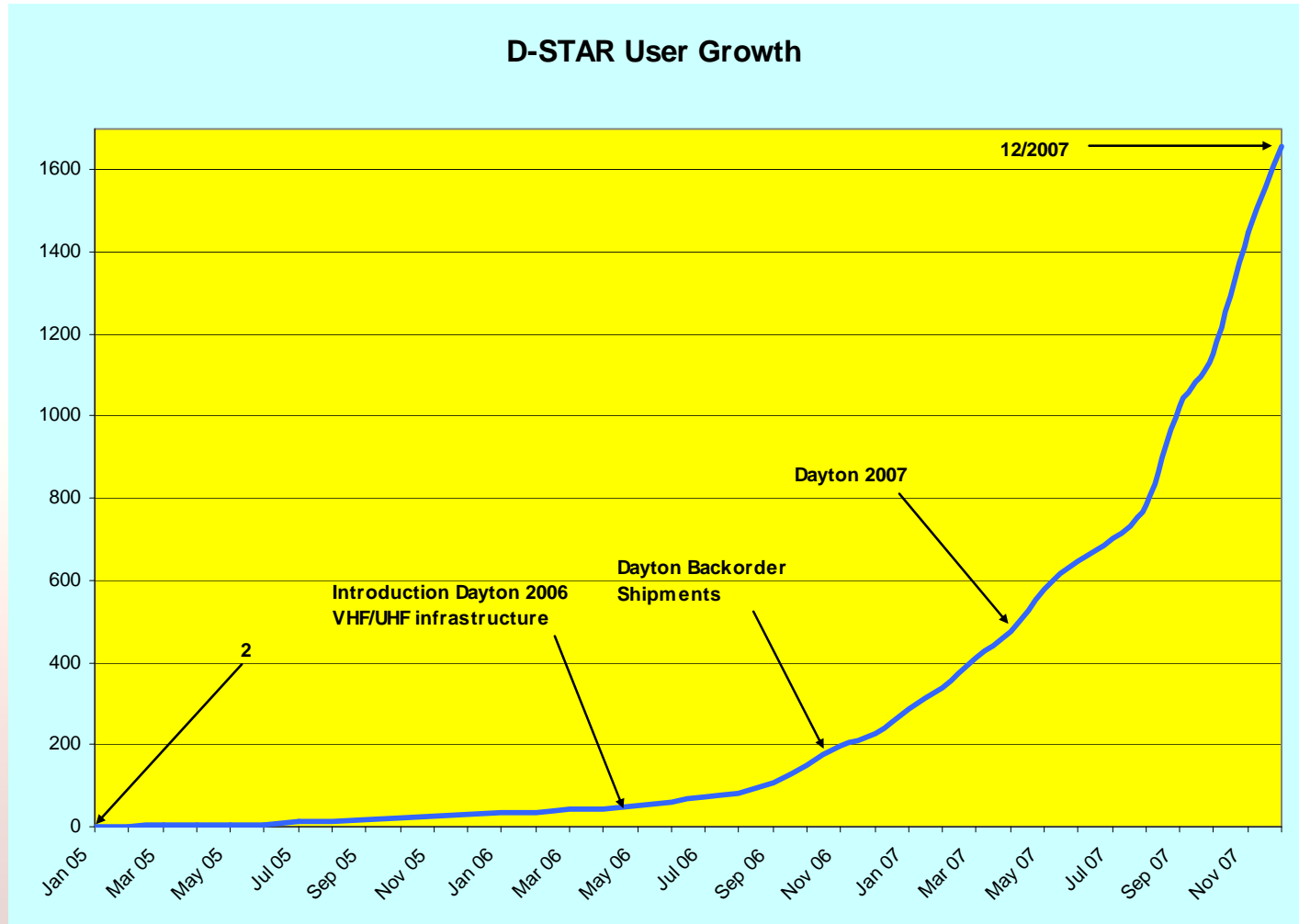
- Frack happens!!!!
  - A fictional expletive from the American TV series *Battlestar Galactica*
  - D-STAR = Fragmentation
    - Several groups/individuals developed their own gateway software.
  - ICOM Gateway Solution
    - G2
  - G4ULF
    - http://g4ulf.blogspot.com/
  - ircDDB
    - http://www.ircddb.net/

- December 2007
  - 1656 registered users on USRoot

- Current stats
  - 20,500 registered users on USRoot
  - 1,022 total Gateway Repeaters
    - 848 G2 gateway repeaters on USRoot
    - 256 gateway repeaters on ircDDB
    - Does not include D-STAR systems not on either system
      - Several states have private EmComm Networks
        - » FL (5), AL (4), OR (unknown)

- Why use Digital Voice
  - Spectral efficiency
    - Same reason as cellular service providers
    - Digital voice has a 6 kHz bandwidth
    - FM voice is 15-20 kHz bandwidth
    - TWICE as many repeaters in the same spectrum!
  - Shares spectrum with data
    - Callsigns, DPRS position data and messages can transmit WITH voice signal, unlike APRS
  - Voice QSOs are "routable"
    - Voice can be directed to another radio, repeater or gateway

- What does this mean to me?
  - Call *Anyone*
    - Radio knows your callsign
    - Your callsign appears on other radios when receiving
    - Can enter other callsign for "callsign squelch"
  - Call *Anywhere*
    - Voice can be sent through repeater or routed through a gateway via RF or the Internet
    - DSTAR users are registered with local repeaters for cellular-like service
  - Call *Anytime*
    - New ICOM Radios include an "answering system"

- ## How does D-STAR work?
  - Callsigns are the key
  - Mycall
  - RPT1
  - RPT2
  - URCALL

Header of Wireless Data									DATA					
			ID								MAC Header			
Bit Sync	Frame Sync	Flag	Destination Repeater	Departure Repeater	Destination Station Callsign	Departure Station Callsign		PFCS	ELAN	SA	DA	Type	Data Frame	FCS

- What about Analog?
  - D-STAR radios are backward compatible
  - Infrastructure Dual Mode?
    - DV mode only
      - Analog issues
        - » Spectrally inefficient
   - » Noisey
        - » Callsigns

- Why not IRLP?
  - No "callsign squelch"
  - Cannot call individual user – only links repeaters
  - Call routing is not automatic
  - Node names are numeric rather than callsigns
  - Requires activation via DTMF code sequence
    - DSTAR call information can be stored in memory
  - Cannot send callsign/messages/position or other data to remote users
  - DSTAR offers some level of secure transmission

- Why D-STAR Data?
  - DPRS position reports and messages like APRS
  - Transfer any type of data (text, photos, email, spreadsheets, etc)
  - Interface as COM port (low speed) or Ethernet port (high speed)
  - Routable to other radio anywhere in the system or gateway to Internet
  - 128K baud at 1.2GHz and 10M baud at 10GHz!
  - Plug and play – no extra TNC or radio cabling

- Why not Packet or Winlink?
    - Packet is a routing nightmare
        - Roaming IP is available for packet but not used
    - Packet protocols are unique to ham radio
        - DSTAR is either a COM port (low speed) or TCP/IP network (high speed)
    - Winlink is only Email (with small attachments)
    - Winlink is supported over DSTAR
        - D-RATS
    - Off the shelf, single-box solutions for 1200 baud and 128K baud!

- ## D-STAR killer app
  - Instant-message chat
  - Automatic beacon messages
  - File transfers with error detection
  - Structured forms
  - GPS position reports
  - And much more!
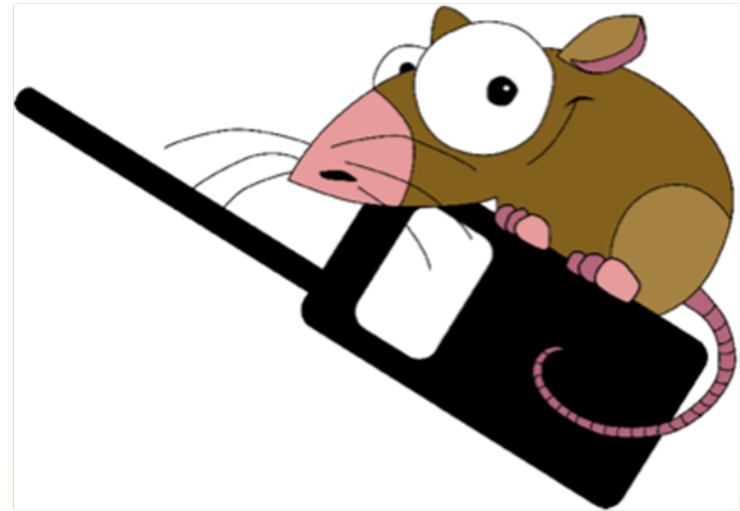
- **Multiple Interfaces**
  - D-STAR Radio
  - Internet Reflector
  - KISS-Mode TNC
    - AX25
  - DV Dongle
  - WinLink 2000

- **Traffic Routing**
  - Manual
  - Automatic

- Full line of radios and infrastructure from ICOM
  - 2m HT – V82 with UT-118
  - 70cm HT – U82 with UT-118
  - 70cm HT – ID-31A
  - Dual band HT with Dual VFOs – IC-92AD
  - 2m Mobile – IC-2200 with UT-118
  - Dual band mobile – ID-880H, IC-2820 with UT-123
  - 1.2Ghz mobile – ID-1 (supports high speed data)
  - VHF, UHF and SHF repeaters and controllers

- Costs
  - Product cost range from
    - Portables (31/80/92): $379.95/$439.95/$579.95
    - Mobiles (880/2820/ID1): $499.95/$919.95/$999.95
  - Comparison
    - Portable (UHF/DB): $159.95/$359.95
    - Mobile (DB Twin/Dual): $329.95/$429.95
    - TNC: range $124.95 - $409.95
      - Plus interface cables

- Locate a repeater!
  - ARRL Repeater Directory
    - Not really
  - www.dstarinfo.com
    - Repeater Maps
    - Repeater Listing
    - Memory downloads
  - www.dstarusers.org
    - Last heard
    - Repeater Directory
  - iPhone App
    - D-STAR repeater directory

- Locate a repeater! (31A)
  - Turn on radio
  - Turn on GPS
  - Enter DR mode
  - Select "Near Repeater"
    - Automatically programs
      - Frequency
      - Callsigns
  - Enter mycall
  - Select yourcall function

- "Embrace and Extend" Internet Technologies
  - The Internet is NOT killing ham radio
  - The Internet is ENABLING ham radio
- Most media is now digital
  - Documents, spreadsheets, databases, pictures, etc.
- "Interoperability" is the new buzz word
  - Digital information makes interoperability possible
- Served agencies will demand more than voice
  - They expect email, live video, web interfaces, etc.

www.icomamerica.com