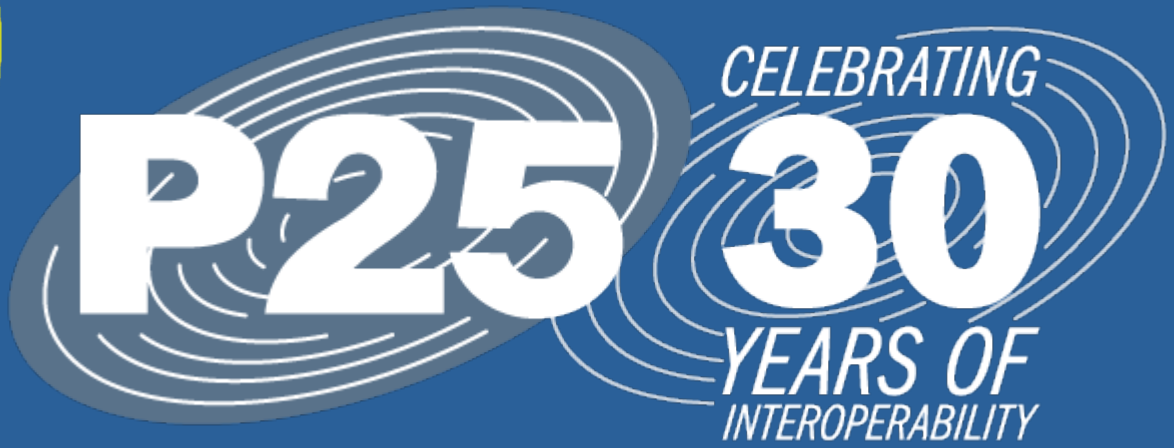
INTRO TO P25 RADIO

Presented by:

Nate Russell, N9BBM



INTRO TO P25 RADIO

Areas covered:

- Brief History
- Benefits of P25
- Technical Requirements
- Equipment

P25: HISTORY

- Over 25 year history in public service
- Established in 1989 by APCO, NASTD, NCS, NITA, and NSA
- These organizations created APCO-NASTD-FED Project 25
- Know as Project 25 or P25 now

P25: BENEFITS

- Multi-Vendor Sourcing
- Migration from Legacy Equipment
- Multiple Frequency Bands
- Conventional & Trunked Operation
- Secure Communication
- Global Standard with Worldwide Adoption
- Coverage Flexibility

P25: BENEFITS

- Voice and Data
- Established
- Public Safety Driven
- Spectral Efficiency
- Evolving
- Enabling Interoperability

P25: WHAT IS IT?

- Common Air Interface (CAI), specifies the type and content of signals transmitted by compliant radios
- Subscriber Data Peripheral Interface
- Fixed Stations Interface
- Console Subsystem Interface
- Network Management Interface
- Data Network Interface

P25: WHAT IS IT?

- Telephone Interconnect Interface
- Inter-RF Subsystem Interface

P25: OSI MODEL

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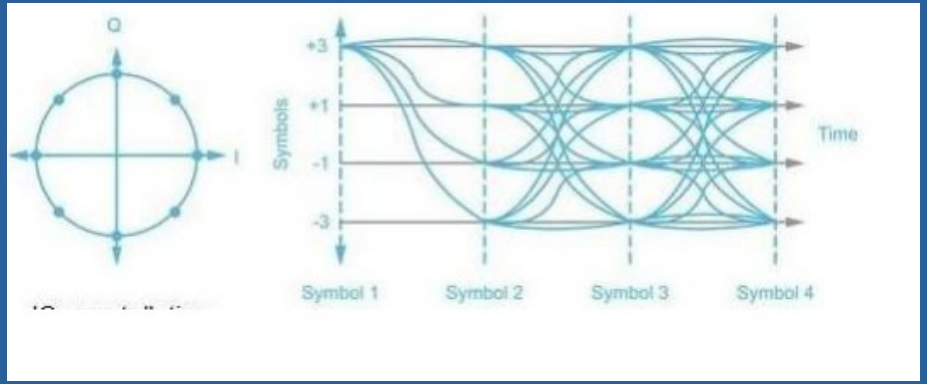
P25: LAYER 1 PHYSICAL

- Phase 1: Modulation is a form of π/4 differential QPSK • 4800 symbols (‘dibits’)/sec * 2 bits/symbol = 9600 bits/sec
- C4FM: Continuous 4-level FM Constant Amplitude Carrier



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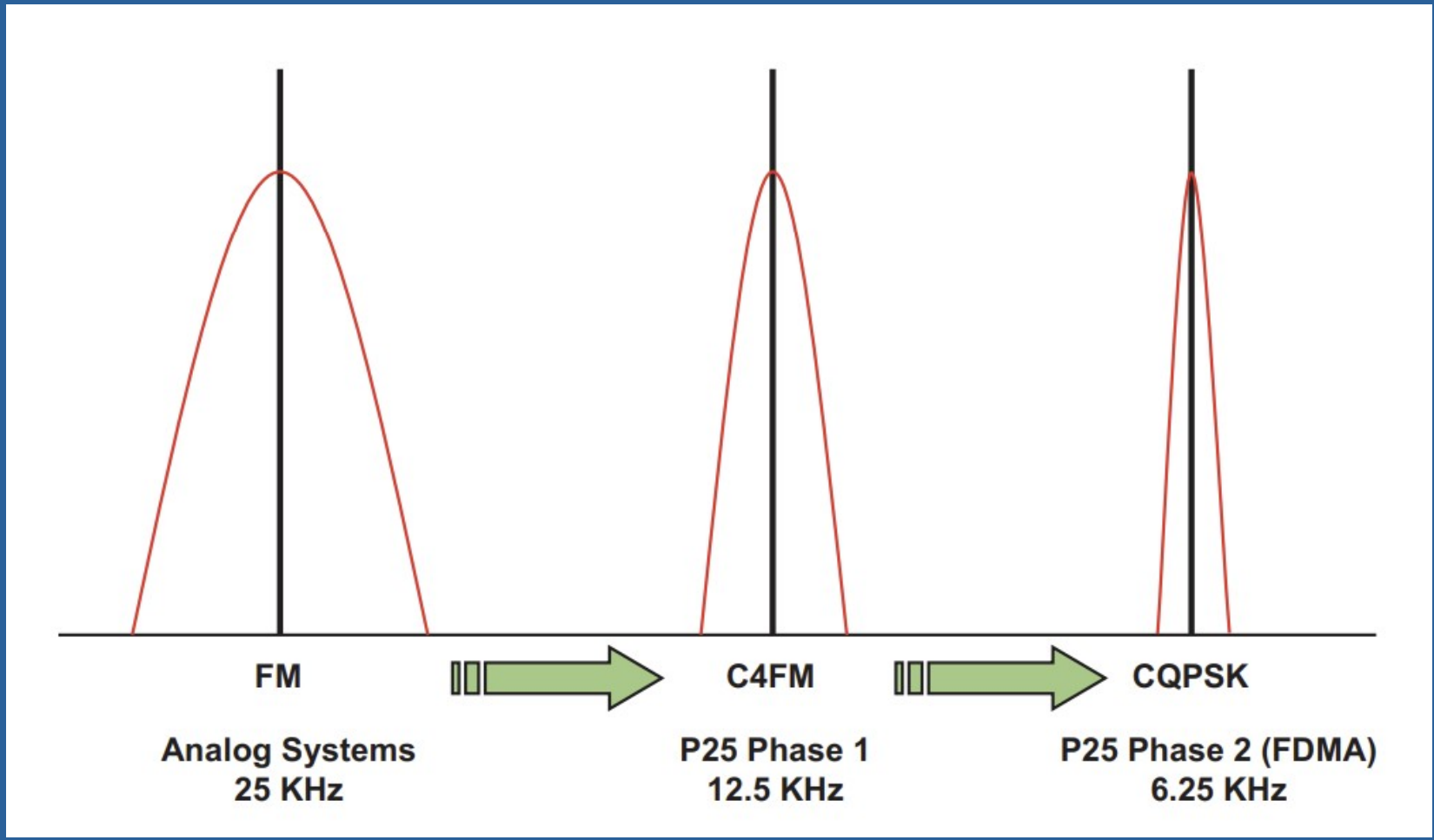
P25: LAYER 1 PHYSICAL



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P25: LAYER 1 PHYSICAL

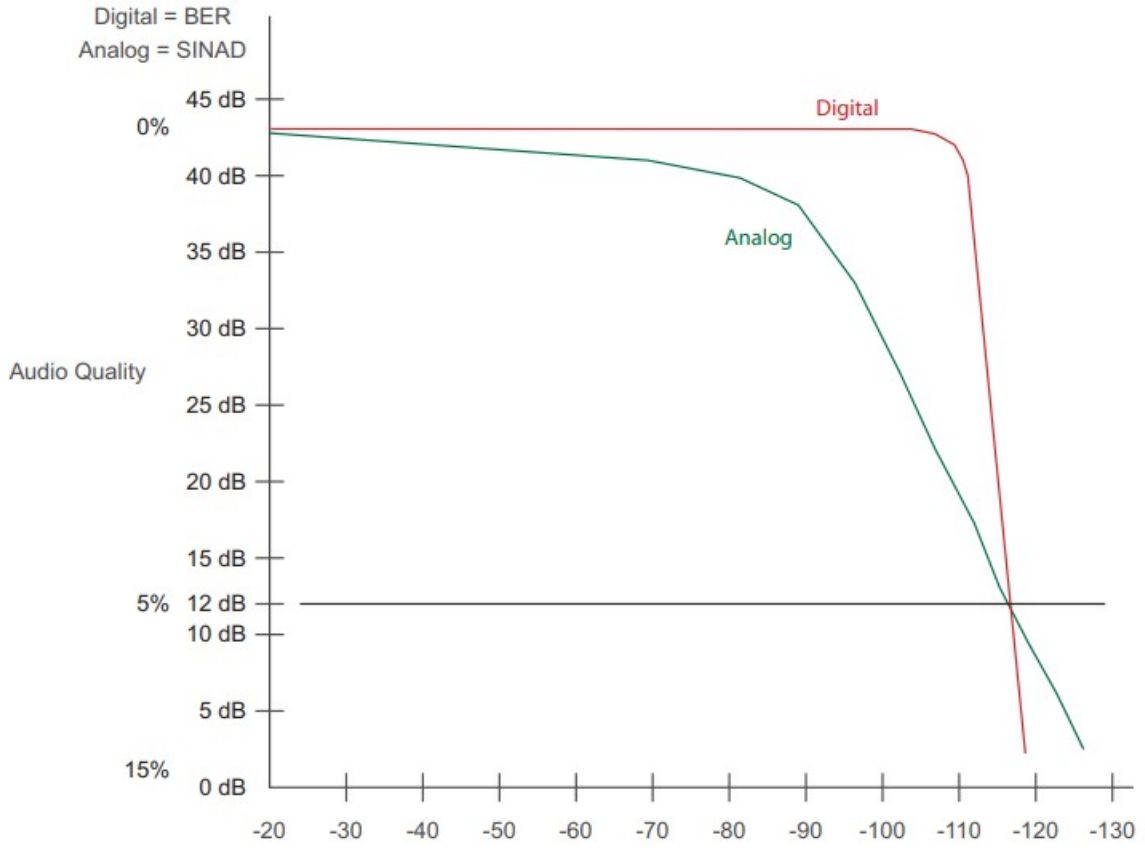

Figure 3-1: Analog vs. Digital Audio Quality

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P25: LAYER 1 PHYSICAL

- Phase 2: 2-slot FDMA in 12.5 kHz channel
- Provides two 6.25 kHz-equivalent channels
- 30 ms slots
- H-DQPSK modulation (Harmonized – Differential QPSK) outbound
- Essentially π/4 DQPSK with different filtering
- H-CPN (Harmonized – Continuous Phase Modulation) inbound

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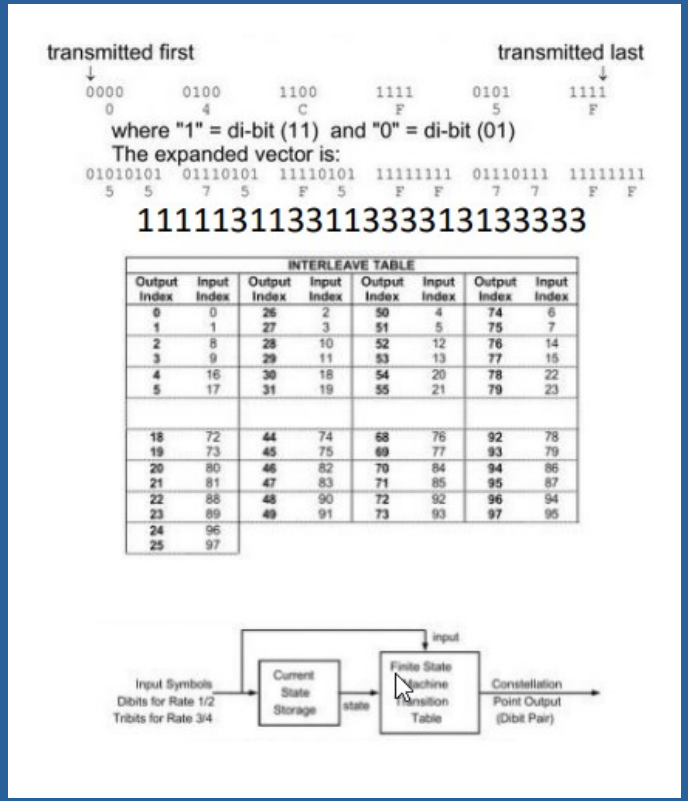
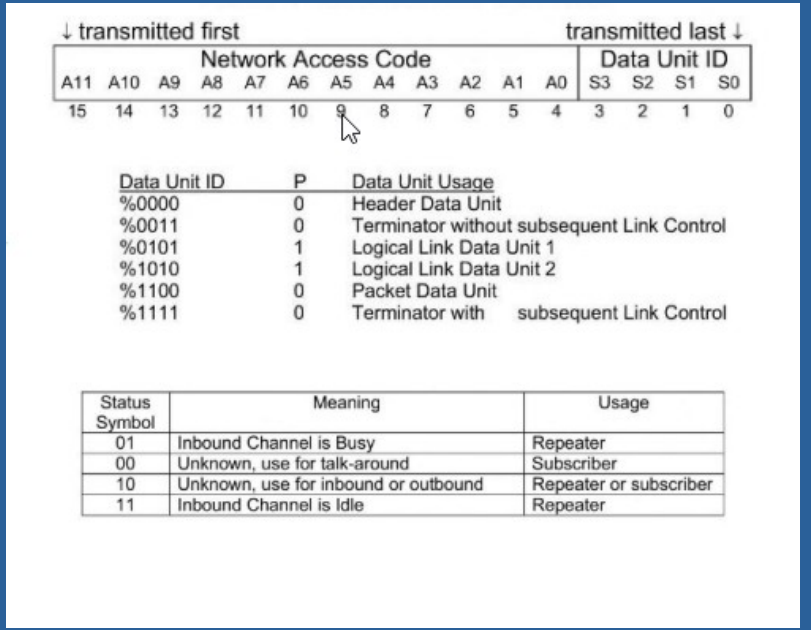
P25: LAYER 1 PHYSICAL

- 24-dibit frame synchronization
- Dibits are interleaved in data blocks to spread burst errors across the block
- Trellis encoding for error correction
  - Rate ½ code: 48 dibits in, 98 dibits out
    - Unconfirmed data blocks, including TSDUs
    - Rate ¾ code: 48 tribits in, 98 dibits out
      - • Confirmed data blocks



P25: LAYER 2 MEDIA ACCESS

- Voice and data messages are sent over the air as data units
- Voice-related data units
  - HDU – Header Data Unit
  - LDU1/LDU2 – Logical Link Data Unit
  - TDU – Terminator Data Unit
  - TDULC – Terminator Data Unit with Link Control



↓ transmitted first — transmitted last ↓

Network Access Code												Data Unit ID			
A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	S3	S2	S1	S0
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Data Unit ID	P	Data Unit Usage
%0000	0	Header Data Unit
%0011	0	Terminator without subsequent Link Control
%0101	1	Logical Link Data Unit 1
%1010	1	Logical Link Data Unit 2
%1100	0	Packet Data Unit
%1111	0	Terminator with subsequent Link Control

Status Symbol	Meaning	Usage
01	Inbound Channel is Busy	Repeater
00	Unknown, use for talk-around	Subscriber
10	Unknown, use for inbound or outbound	Repeater or subscriber
11	Inbound Channel is Idle	Repeater

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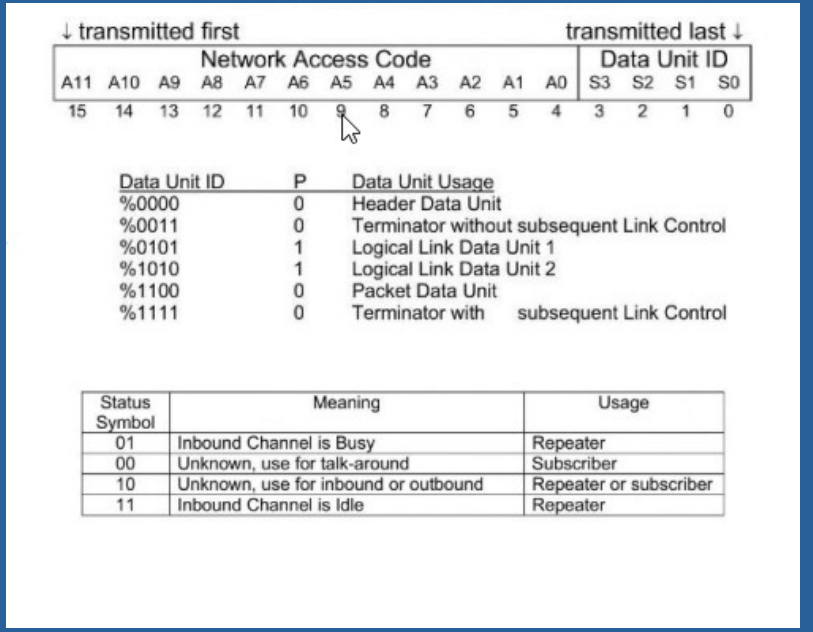
P25: LAYER 2 MEDIA ACCESS

- Data-related data units
  - PDU – Packet Data Unit (variable length data unit)
  - TSDU (a.k.a. TSBK) – Trunked Signalling Data Unit (Block)
    - Not part of CAI
    - Heavy use of error correction and detection codes



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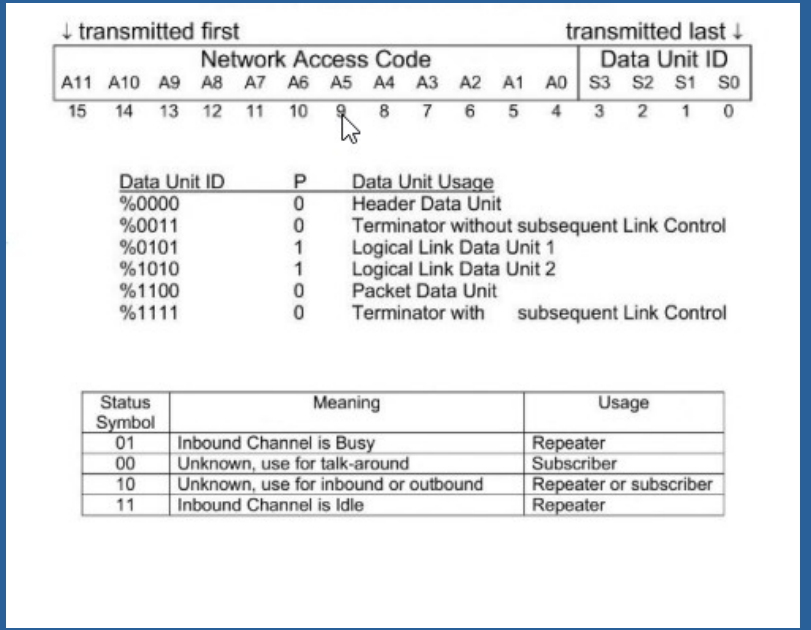
P25: LAYER 2 MEDIA ACCESS

- Data units begins with frame sync and network identification (NID)
  - NAC: Uniquely describes the system
  - DUID: Indicates the type of data unit to follow
- Status symbols
  - Injected periodically within data units to indicate status of channel
- Data packets include protection flag for encrypted payloads



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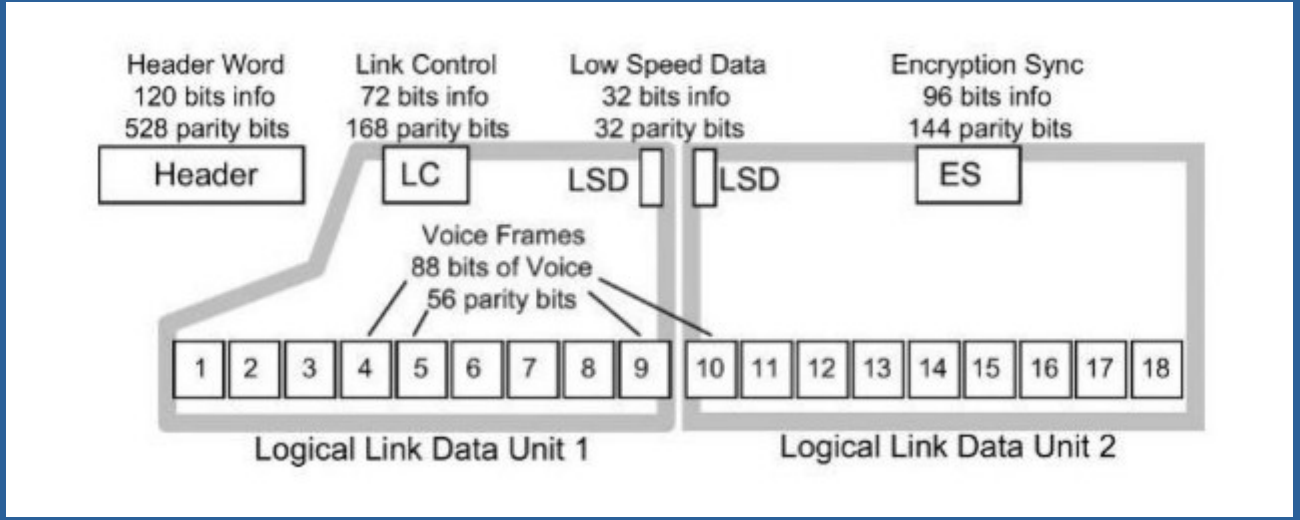
P25: VOICE TRAFFIC

- Voice traffic encoded as Improved Multi-Band Excitation (IMBE)
  - IMBE frames encode 20 ms of speech into 88 bits of information
    - This includes: pitch, voicing, gain for each audio band
      - Continuous average of 4.4 kbps



P25: VOICE TRAFFIC

- IMBE frame contents
  - Quantized pitch (8 bits)
  - Voicing vector information (3-12 bits, one bit per band
  - Quantized average frame gain level (6 bits)
  - Quantized gain vector and DCT coefficients (remainder
  - Sync (1 bit)
  - IMBE is a patented VOCODER from Digital Voice Systems, Inc. (DVSI)

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P25: EQUIPMENT

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NX-5200/5300/5400

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IC-F9011S

IC-F9011B

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P25: EQUIPMENT

P25: CONCLUSION

- Remember this is a terrific hobby!
- If you need help, please ask! There are plenty of experts willing to help.
- Be thankful for the digital repeaters on the air.
- Repeaters, servers, and networks require maintenance and funding.
- Get involved in your local radio club and help others around you.

https://www.repeater-builder.com/tech-info/pdfs/p25-training-guide.pdf

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P25: Questions & Comments