Which is the Best Voice Mode for VHF & UHF?

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Jack Gerbs, WB8SCT

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Who is Using Digital Voice on VHF/UHF?

- D-STAR
- Fusion
- DMR
- P25

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Presenter

Brief Bio:
- Been a ham for a long time
- Been playing with DMR for a long time
- Not an expert on DMR and all digital modes, but I do have some experience and lots of opinions…

Contact Info:
- Jack Gerbs, WB8SCT (good on QRZ)
- Email - jgerbs123@gmail.com

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Goal

Help you better understand the differences between the major digital modes and then let you decide which is best

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Target Audience and **Confession**

Because of the diversity of this group, we will be covering basics, and going into some technical details. The presentation primarily covers modes available for Hams on VHF and UHF

Confession/Credits: Not all the images and information presented is my original content. Some of the content has been shamelessly borrowed from the Internet and proper credit has not been given to those who deserve it.

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Quiz?

- Digital vs analog quiz?
  - Better audio quality?
  - Believes digital can better coverage?

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Answers?

- Better Coverage, Bogus Question!
  - For real-time voice communications analog goes a further distance
  - For digital data, with very high error correction digital can go further (FT8)

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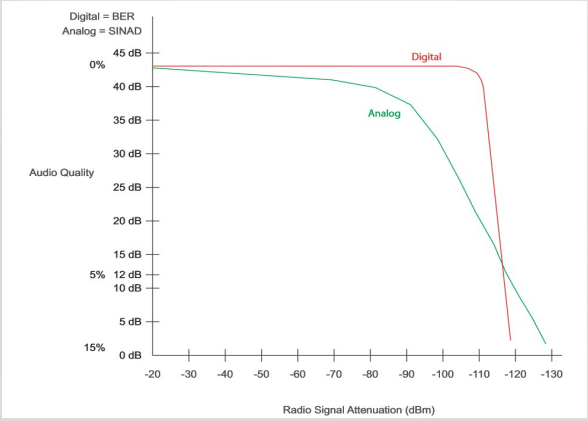
Digital vs Analog Audio Quality



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Channel Width vs. Bandwidth

- Channel width is the spacing between adjacent channels
- Bandwidth is the bandwidth used within the channel spacing. Typically, people refer to these as the same, but they are different.
- Example 2.4 – 2.5 GHz WIFI band has 14 channels with a bandwidth of **20 MHz/channel** all contained in a 100 MHz wide spectrum *(Math 14x20 = 280MHz)*
- ***How do you fit 280MHz into 100MHz?***

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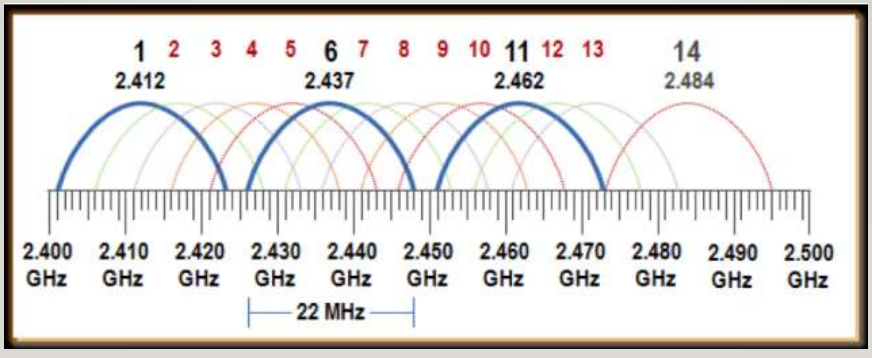
Channel Width vs. Bandwidth



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Digital Modes – How did we get here?

- FCC Mandate
  - By January 1, 2013, all public safety and industrial land mobile radio systems must operate within 12.5 KHz, or ***equivalent-efficiency***.
  - Equivalent-efficiency is defined as:
    - One voice path in a 12.5 KHz channel
    - Two voice paths in a 25 KHz channel
    - Data Operations on channels greater 12.5 KHz must employ data rates greater than 4.8 kbps per 6.25 KHz channel,
  - FCC's Ultimate rebanding goal is 6.25 KHz or equivalent-efficiency

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Digital Modes & a Vocoder (CoDec)

- DSTAR (JARL) 6.25 KHz AMBE 2020 - Single Data Stream (FDMA)
- DMR Tier 1 – FDMA 12.5 IMBE
- DMR Tier 2 - TDMA, 12.5 KHz AMBE+2
- Fusion FDMA 12.5 KHz AMBE+2 (similar to DMR Tier I)
- P25 Phase 1 FDMA 12.5 KHz AMMB+2
- P25 Phase 2 TDMA 12.5 KHz AMBE+2

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TDMA vs FDMA

- TDMA – Time Division Multiple Access
  - There are two time slots and and each time slot can handle a conversations (two simultaneous conversations on one frequency).
- FDMA – Frequency Division Multiple Access
  - The user takes the whole frequency and there are two carriers in the channel. Typically, one carrier is used for voice and the other for data.

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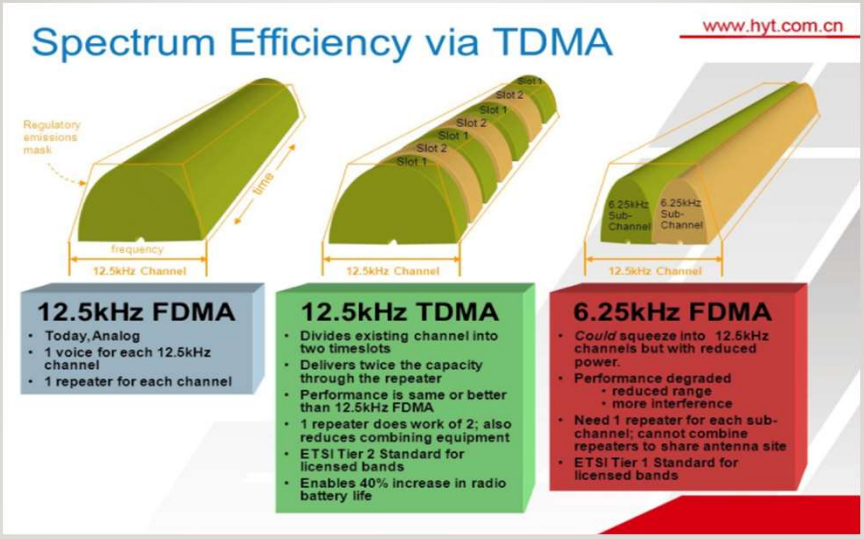
Analog vs TDMA vs FDMA



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Forward Error Correction (FEC)

FEC sends extra data because the time to request a resend of data is too costly or time sensitive

For the guys who understand network protocols: UDP vs TCP traffic

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DSTAR

Digital Smart Technology for Amateur Radio

6.25 KHz Bandwidth, 10 KHz Spacing. FDMA Single Data Stream and in the data stream there is voice and data packets

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D-STAR Digital Smart Technology for Amateur Radio

- Uses AMBE 2020 Chip Set
- Uses and Interleaver Convolutional Forward Error Correction technology, not very good for noisy traffic
- Has no quieting for lost Voice Data Packets, that is the reason for the R2D2 effect
- 2.4 Kbs voice data
- 1.2 Kbs data stream
- 1.2 Kbs for synchronization and some FEC

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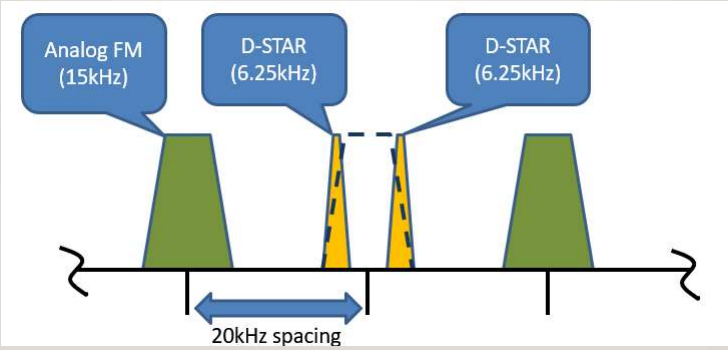
D-STAR Bandwidth



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D-STAR Advantages and Disadvantages

- Advantages
  - Call sign routing and squelching
- Disadvantages
  - Older Technology AMBE 2020 chipset
  - Poor error correction
  - Audio quality on the older equipment tends to be bass
  - Digital artifacting (R2D2 noise)

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DMR Tier II

- TDMA – Two Time Slots in a with 12.5KHz bandwidth
- Equivalent efficiency BW 6.25 KHz
- AMBE+2 Chip set
- FEC – Cyclic Redundancy Correction (CRC)
  - 25% of the data packet is used for error correction
  - Dropped packet quieting

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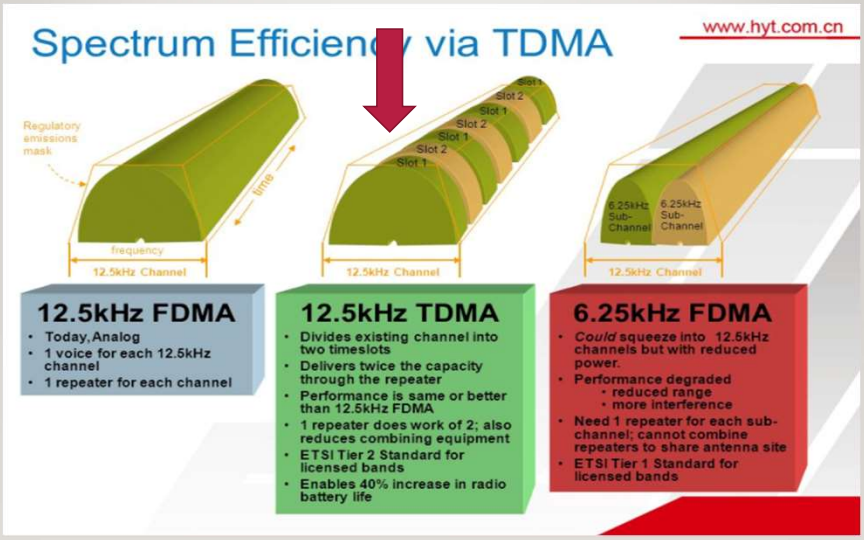

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DMR Internet Connectivity (1)

- Repeaters come with IP Site Connect (IPSC) built in
- Repeaters can be connected to each other via Ethernet or Internet connections
- Up to 15 repeaters can be tied together to build a Wide Area Network
  - One repeater needs to be selected as a master

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DMR Internet Connectivity (2)

- Local area and wide area connectivity can be achieved by:
  - CBridge
  - BrandMeister
    - Support for hot spots, etc.

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DMR Advantages

- TDMA allows two interleaved simultaneous data streams
- **Two simultaneous voice conversations on a single repeater**
- One voice stream and one data stream
- Two simultaneous data streams each at 9.6 Kbs

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DMR Advantages

- **Two Simultaneous Conversations on One Repeater!**
- **35% More Battery Operating Capacity Savings!**
- **Worldwide Network of Repeaters**

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DMR Disadvantage

- Higher data latency (relatively speaking)
- No call sign routing
- Too many cheap radios and hot spots are polluting the spectrum (Radio reports, tell the truth!)
- Very few amplifiers support TDMA for the remote site

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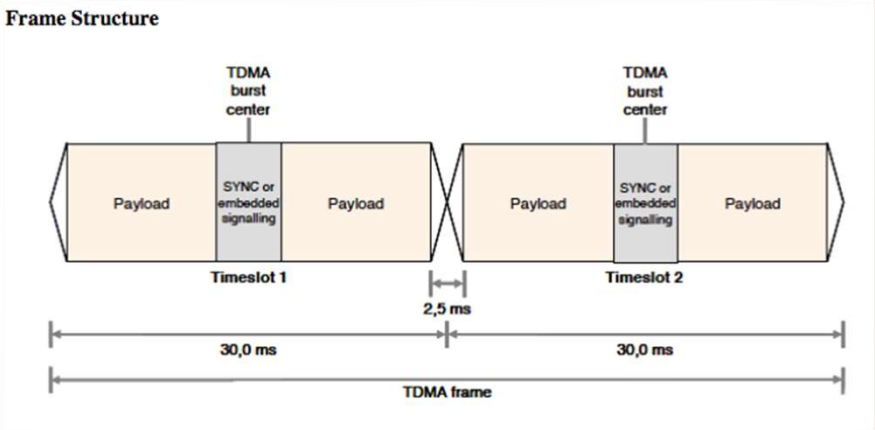
TDMA Timing (Radio)



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System Fusion (Yaesu)

YAESU System Fusion The radio

- FDMA – 12.5KHz bandwidth with two 6.25 KHz carriers
- Functional equivalent BW 6.25 KHz
- AMBE+2 Chipset

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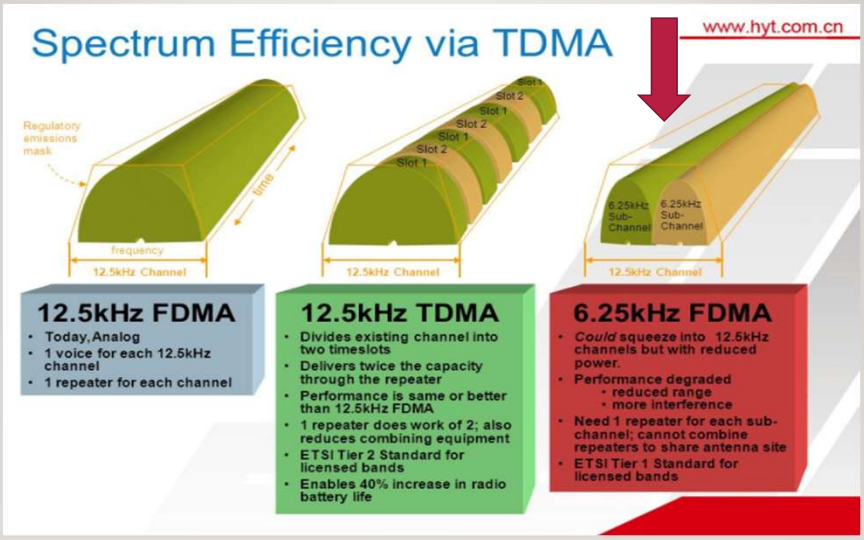
System Fusion



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System Fusion

- Can use each carrier for a combination of:
  - Voice and Data each frame is 9.6 Kbs
  - Voice Only: Best quality voice using 12.5 KHz
  - Data Only Highest throughput and low latency data rate 19.2 Kbs
- Radios are aware of analog FM or Fusion mode and switch automatically

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System Fusion Internet Connectivity

- Repeaters require a Wires X add-on
  - Very few System Fusion are networked together

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P25

- Phase 1, FDMA – 12.5KHz bandwidth
- Functional equivalent BW 6.25 KHz
- AMBE+2 chip set
- FEC – Trellis Code and Interleaving + Others Options

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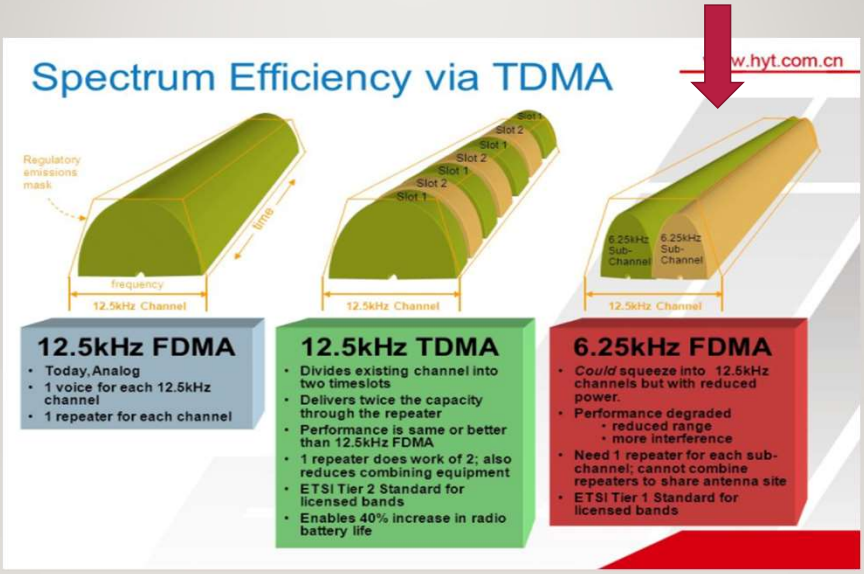
P25



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P25 Internet Connectivity (1)

- Short list of extra parts needed
  - V.24 Interface Board
  - Cisco Router
  - Cisco DCE Cable
  - Adapter Cable

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P25 Internet Connectivity (2)

- P25 technology is good for building local area networks and even wide area networks
- By design it is going to be very difficult to build out a World Wide Network like DMR.

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P25 Advantages and Disadvantages

- **Advantages**
  - FDMA –Excellent voice quality
  - Best error correction technology in use
- **Disadvantages**
  - Complex networking with other repeaters
  - Limited scalability for Amateur use

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QUESTIONS?

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