

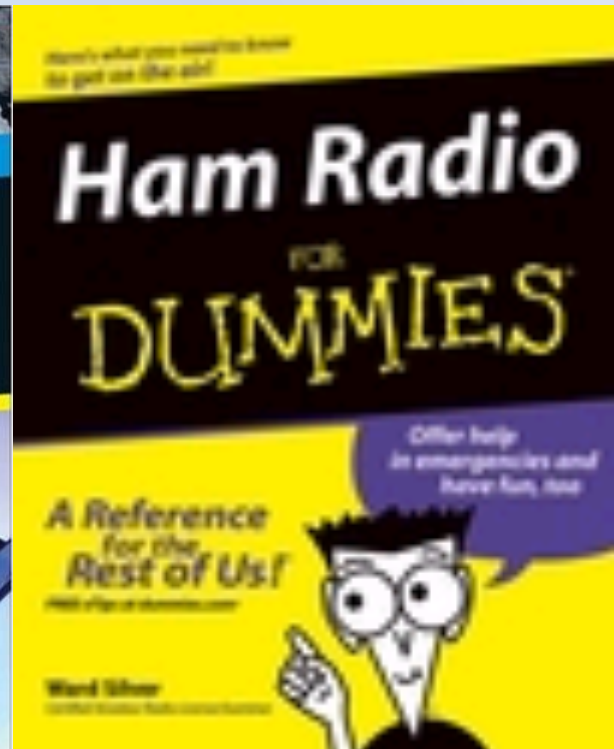
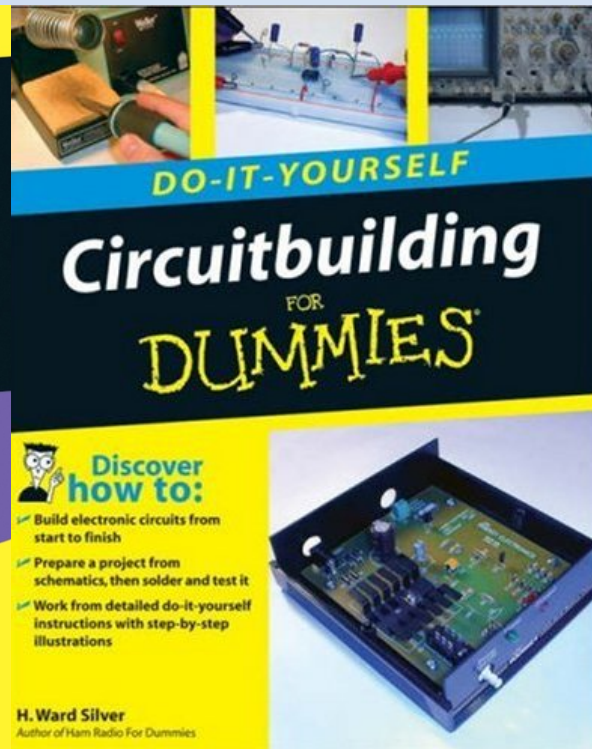
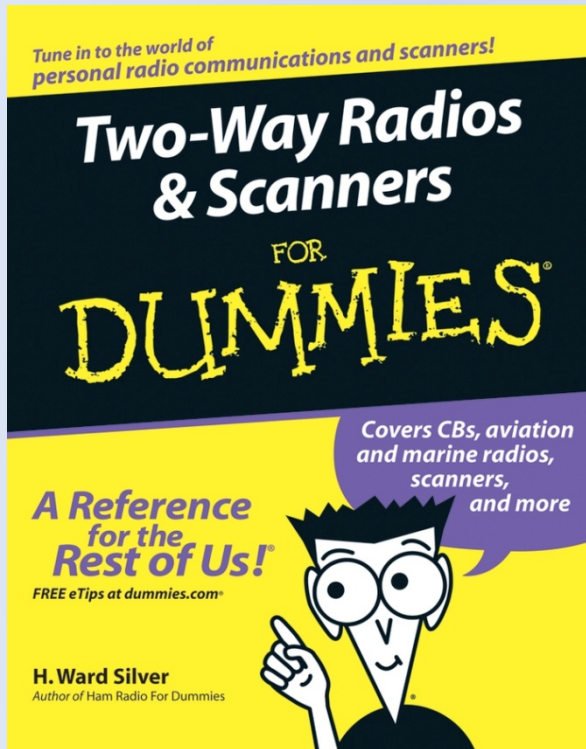


Dealing With the Mode Explosion

Ward Silver, NØAX

Microhams Conference – Sep 2010

No Subliminal Material!



No Subliminal Material!

Current Modes

- Per 2010 Handbook, Chap 16 by N7SS/W7AY
- **Unstructured** – limited error checking, coded
- **Fuzzy** – machine-generated, human-read
- **Structured** – packetized data & error-checking
- **Networking** – adds a session/connection

Unstructured Modes

- “Keyboard to Keyboard”
- **RTTY** (Baudot code, FSK)
- **PSK31/63/125** (FSK, varicode dibits)
- **MFSK** variants (multi-tone, one at a time)
- **DominoEX** (MSFK plus IFK by nibbles)
- **THROB** (tone pairs)
- **MT63** (64-tone with error detection)
- **Olivia** (MFSK-based, ASCII code, FEC)

Fuzzy Modes

- **Facsimile** (classic analog tone-encoding)
- **Slow-Scan TV** (analog version)
- **Hellschreiber/Feld-Hell** (pixel-based)

Structured Modes

- **FSK441** (FSK, 441-baud, rx-tx synchronization)
- **JT6M** (44-tone FSK, one tone per character)
- **JT65** (message codes, robust error correction)
- **WSPR** (beacon-style)
- HF Digital Voice
 - **AOR**, **WinDRM** (licensing issues), **FMMDV**
 - New **Codec2** by VK5DGR
- **ALE** (8-tone FSK, auto-link protocol)

Networking Modes

- *Connected vs Connectionless*
 - TCP/IP vs UDP
 - Session-level concepts for routing and status
 - Connectionless: each packet is standalone
- **PACTORs** and **WINMOR** (FSK and DPSK)
- **G-TOR** and **CLOVERs**
- **AX.25** (Packet Radio)
- **D-STAR** (DV and DD modes)

Messaging Systems

- Packet **BBS**
- **APRS** (more recent messaging features)
- **Winlink 2000** (SMTP email-based)
- D-STAR applications (**D-RATS**, **d*Chat**)

Regulatory Issues

- Definition of “**mode**” or “**emission**”
 - Linked to information carried
 - Some “modes” carry multiple data streams
 - FCC Part 97.3(c) and Part 2.201
- Speed of innovation
 - FCC Part 97.309(a)(4)
 - Allows any data emission “whose technical characteristics have been documented publically.”

Why Segmentation?

- Interference Control
 - Phone (AM) vs CW
 - CW vs Digital
 - Digital vs Digital
- Easy to enforce and **verify**
 - Identify signal and frequency
 - Compare to rules
- Verification is *crucial* to regulation

Segmentation Problems

- Blurring of modes
 - Digital mode explosion
 - Digital vs analog voice
- Doesn't address inter-mode interference
- Machine-controlled vs human-controlled
- Expansion of digital is inevitable
- Regulation needs to be flexible and dynamic

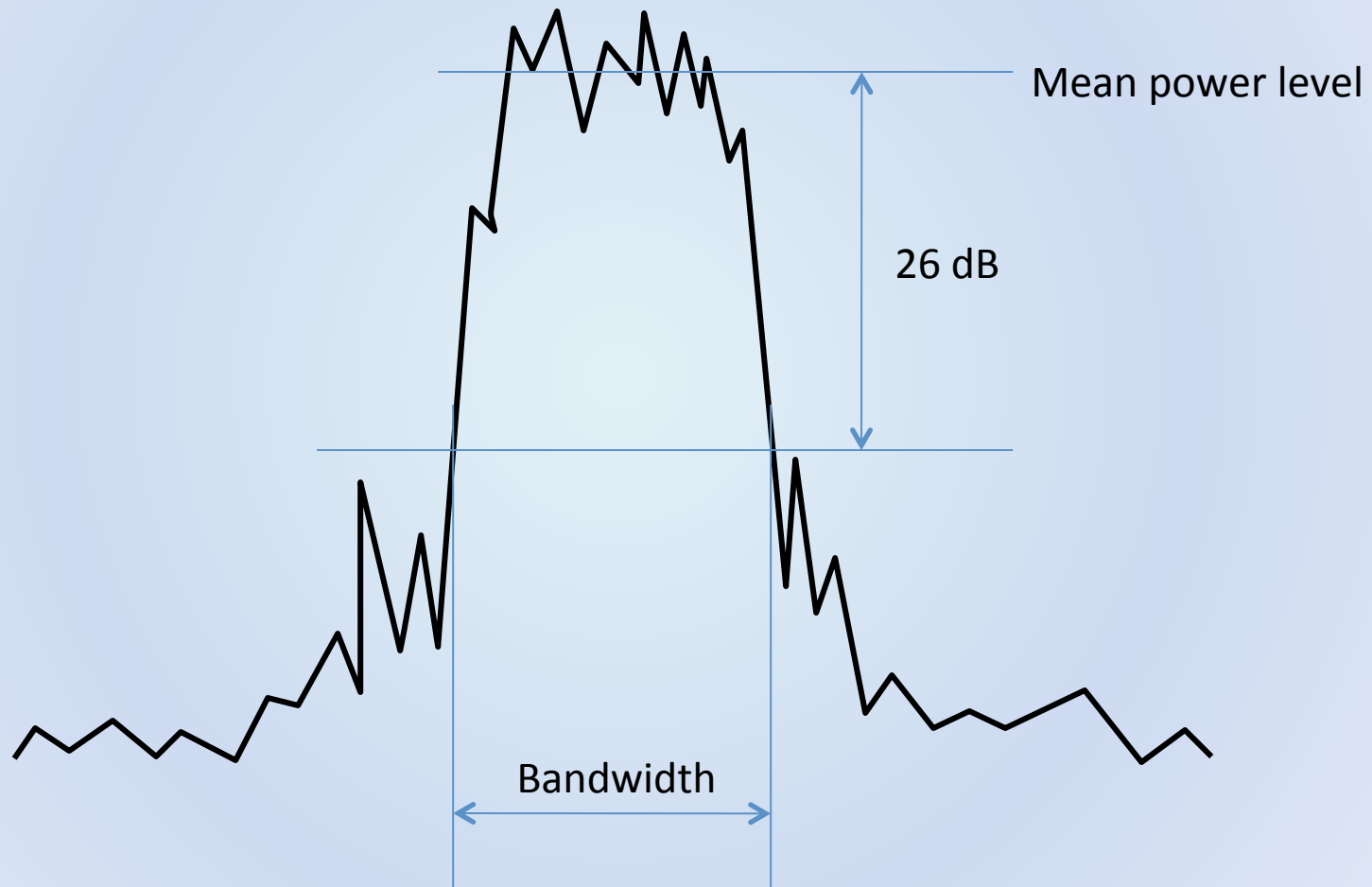
Regulation by Bandwidth

- Eliminates complex emission definitions
- Still verifiable because it's defined...

FCC Definition of Bandwidth

- May not be YOUR definition!
- **Part 97.3(a)(8)** - The width of a frequency band outside of which the mean power of the transmitted signal is attenuated at least 26 dB below the mean power of the transmitted signal with the band.
- No out-of-band component of the signal may have more than $1/400^{\text{th}}$ of the mean power.

FCC Definition of Bandwidth



Canadian Regulation

Frequency (MHz) Lower edge	Frequency (MHz) Upper edge	Maximum Bandwidth
1.8	2.0	6 kHz
3.5	4.0	6 kHz
7.0	7.3	6 kHz
10.1	10.15	1 kHz
14.0	14.350	6 kHz
18.068	18.168	6 kHz
21.0	21.450	6 kHz
24.890	24.990	6 kHz
28.0	29.7	20 kHz
50.0	54.0	30 kHz
144	148	30 kHz
220	225	100 kHz
430	450	12 MHz
902	928	12 MHz

Source - <http://www.rac.ca/en/rac/services/bandplans/allband.php>

Regulation by Bandwidth

- Initial ARRL proposal to FCC failed (2004)
 - A bit premature
 - Not ready within the ham community politically
 - Withdrawn in 2007
- Why did it fail?
 - Did not adequately address interference issues
 - Specifically, structured vs unstructured and CW
 - “Robot station invasion!”

Intermode Interference

- Not new
 - CW vs RTTY
 - HF packet vs CW
 - D-STAR vs FM or FM vs AM modes on VHF+
- Not technical
 - SSB receivers can hear CW fine and vice versa
- The “green light” problem
 - Automated signal detection is very limited
 - Limited human intervention
 - “Not detected” is not the same as “Not present”

Possible Solutions

- More sophisticated “*busy detector*”
- **RSID/TXID** Protocol
 - Reed-Solomon Identification by F6CTE
 - Precedes each packet in any modulation
- Intelligent channel management
 - Detect signal presence
 - Noise, communications, or spurious signals?

Possible Solutions

- More sophisticated “*busy detector*”
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 - Detect signal presence
 - Noise, communications, or spurious signals?
- We could try actually listening 😊

Regulation by Bandwidth

- Why not band plans?
 - Can't keep up
 - Too fragmented
 - Not flexible
 - Conveys the notion of “frequency ownership”
 - Calling frequencies are OK, though

Bandwidth or Behavior?

- Real issue is *machine-* or *human-controlled*
- Often incompatible behavior
 - Machines don't get frustrated, but people do!
 - Telling “**should**” from “**can**” is hard for machines
- Create protected and “open range” regions
 - Sort by control, not modulation or information
 - Treat as “**best practices**”
 - Continue to prohibit “**willful interference**”

Behavioral Example

- 14.000 - 14.050 Human-copy, < 1 kHz bandwidth
- 14.075 - 14.100 Mixed-copy, narrow bandwidth
- 14.100 - 14.150 Machine-copy, any bandwidth
 - As long as less than maximum bandwidth
- 14.150 - 14.225 Mixed-copy, wide bandwidth
- 14.225 - 14.350 Human-copy, wide bandwidth

Regulation by Behavior

- Recognizes and addresses the “**root cause**”
- Limits conflict through **protected zones**
- Bandwidth rules remain in place and verifiable
- How to tell machine from human?
 - Use automated ID mechanisms (RSID or other)
 - Creates a “**Turing Test**” for ham radio
- Still won't solve “**hidden transmitters**”

Summary

- **Accept** limits of existing definitions and rules
- **Avoid** throttling innovation
- **Remain** verifiable and objective
- **Recognize** breadth of technology in use
- **Address** root cause issues
- **Maintain** amateur radio for amateurs to experiment, use, and enjoy

