

Whitespace Communications and The Adaptive Sharing of TV Channels in the USA

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Outline

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- Why sharing is important
- TV whitespace origin and technical issues
- Wireless mic issue
- FCC decision and remaining issues

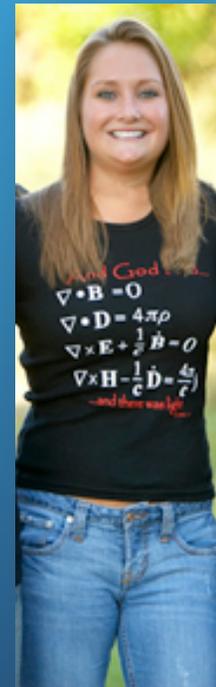
Engineer's viewpoint

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- Around the world - for better or for worse - wireless is more regulated than most other technologies



In wireless, regulations are just as real
 ← as Maxwell's equations! →



Why Sharing is Important

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- Like “beach front property”, spectrum is finite
- While there is unused spectrum above 95 GHz, spectrum below 30 GHz with attractive propagation qualities is generally licensed/assigned
 - Although *not* necessarily used heavily in time and location!
- Wireless communications is a key driver to both economic growth **and** public safety programs in **both** industrialized countries and developing countries
- Spectrum is a key resource for wireless systems and must be “recycled” as much as possible

Recycling Spectrum

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- Tensions/Conflicts
 - Exclusive licensing has many benefits:
 - Sole user with authority and financial incentives to innovate in many cases
 - Interference resolution straightforward
 - ***But*** exclusive license holders incentive are *not always* the same as public's:
 - May wish to minimize competition and crosselastic services
 - No direct benefit from spectrum sharing and associated risk of interference –whether real or imagined
 - “Receiver problem”

Genesis of TV Whitespace Issue

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- Began as part of 2003 Spectrum Policy Task Force Study to use cognitive radio technology to recycle spectrum idle in practice
- TV spectrum viewed as “low lying fruit” since:
 - Transmitters on usually 24/7 in fixed locations
 - Lots of “whitespace”
 - High transmit antennas
 - Well defined 6 MHz ATSC signal with lots of structure and high frequency and time stability
- Cyclostationary detectors appeared feasible for detecting ATSC signals

Cyclostationary Detectors

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- The issue for a cognitive radio is not to receive the primary signal, but to detect the primary signal
 - ATSC DTV signals have 18 Mbps in 6 MHz
- Detector does hypothesis testing on whether a signal with the specified format is present or not
 - Does not need to demodulate 18,000,000 bps, rather can take a long integration time to make 1 decision
 - US DTV receivers have a sensitivity of about -85 dBm
 - Cyclostationary detectors were shown in FCC testing to be reliable at -120 dBm for detecting ATSC signals

US Wireless Mic Problem - 1

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- FCC for decades allowed broadcasters and film producers to use TV white space for “Broadcast Auxiliary”/Part 74 uses
 - Only there “eligibles” were permitted to use this spectrum on a secondary basis as it was assumed they could manually coordinate with each other on details
 - With falling electronics costs a few manufacturers entered illicit/illegal wireless mic business for theatres, conference centers, event DJs, etc. rather than try to change FCC rules
 - Record murky on whether FCC knew this or if low level FCC managers condoned illicit use with “benign neglect”

US Wireless Mic Problem - 2

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- Cyclostationary detectors impractical for wireless mic detection
 - Difficult near/far geometry possible in worst case
 - Mics generally use wideband FM
 - In contrast to ATSC, modulation parameters and frequency stability not well defined
- Including wireless mic problem made cyclostationary detector solution impossible for TV whitespace
 - Beacon solution had technical appeal but no user interest
 - Irony is that continuing wireless mic long term use in white space may be impractical for various reasons and alternative long term solution will probably be necessary!



“Final” FCC Rules

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- Adopted in 2010
- Use geolocation approach that was in original proposals but attracted little interest at first.
 - Solved wireless mic issue
 - But lead to new problems since much of wireless mic use is dynamic in time and space (e.g. concerts)
 - Not clear if a practical system can be implemented to handle all wireless mic registration in database
- Dec. 2011 – First database approval and first equipment approval

Next?

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- Several mainstream manufacturers have urged FCC to loosen out-of-band-emission (OOBE) limits
 - May be trying to recycle Wi-Fi chip design in new band
 - But Wi-Fi has no sensitive neighbors so OOBE limits are loose
 - Adaptrum has demonstrated compliance with OOBE limits at reasonable power output
- FCC has little interest in changing present WS rules until there is practical experience
 - Chicken or egg problem?
- Incentive auction proposal may change VHF/UHF ecology and have domino effect on WS and wireless mics

Conclusions

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- Spectrum policy is not a spectator sport!
 - If you don't like what is happening – ***Get Involved!***
- Long delays by FCC, along with missing publicly announced schedules, may send a chilling message to VCs considering investing in wireless technologies needing nonroutine approvals
 - Raises question about whether FCC, as presently structured, has decision making throughput adequate for the current spectrum industry
 - “Governments move at government speed, technology moves at Internet speed”