The Politics of Spectrum Sharing

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Need for Spectrum Sharing

- spectrum usage has increased dramatically since 1980s
  - due largely to lower costs and greater demand for digital radio
    - due in turn to inexpensive DSP chips

- useful spectrum has not increased in proportion
  - newly available higher frequencies have short range, poor wall penetration
- result: most spectrum below 30 GHz is shared
  - effective sharing essential to modern civilization.

Priorities in Spectrum Sharing

- each user is designated as primary, secondary, or unlicensed
- primary:
  - need not protect other users (except co-primary) from harmful interference
  - need not accept harmful interference from other users
- secondary:
  - must protect primary (and co-secondary) users from harmful interference
  - must accept harmful interference from primary users
- unlicensed:
  - must protect primary and secondary users from harmful interference
  - must accept interference from all (including from other unlicensed).

“Harmful Interference” – 1

- relations among primary, secondary, unlicensed turn on meaning of “harmful interference”
- FCC defines harmful interference as:
  - “Interference which endangers the functioning of a radio navigation service or of other safety services or
  - “seriously degrades, obstructs, or repeatedly interrupts a [licensed] radiocommunication service …”

    47 C.F.R. § 2.1

“Harmful Interference” – 2

- three categories of protection:
  1. safety services (and radionavigation) have highest protection, against any “interference which endangers … functioning”
     - some such services have exclusive (unshared) allocations
     - near-zero chance of interference
  2. all other licensed services have lower protection
     - protected only against interference that “seriously degrades, obstructs, or repeatedly interrupts”
     - standard is open to range of interpretations
  3. unlicensed devices have no protection
     - despite growing importance of unlicensed use (sometimes in critical applications).

Factors in Spectrum Sharing

- FCC must assess harmful interference when adding new service
  - often concerns interference to incumbent non-safety service
- definition treats all non-safety services alike
  - wide variation in public interest
    - from truckers' CB chatter to pipeline control and 911 backhaul
  - wide variation in susceptibility to interference
- properly managed sharing must account for:
  1. likelihood of new service causing interference to incumbent
  2. practical harm if incumbent receives interference
  3. public interest in new service *vs.* incumbent
- *these factors are both technical and political.*

(pause for discussion)

Case Studies

Spread Spectrum (1985) – 1

- entrant: LAN/PAN data communication
- frequencies: 902-928, 2400-2483.5, 5725-5850 MHz
- incumbents: ISM, Amateur, military radar
- status: unlicensed at 4W EIRP
- likelihood of interference: medium to high

Spread Spectrum – 2

- universal response to initial proposal: “Not in my band!”
- FCC authorized spread spectrum in three ISM bands
  - reasoned that incumbents have no expectation of quiet spectrum
- public interest
  - in 1985: unknown
  - in 2021: high (Wi-Fi, Bluetooth, ZigBee, much more)
- comment: use of ISM bands was politically acceptable solution
  - one of the FCC’s most successful decisions.

Ultra-Wideband (2002) – 1

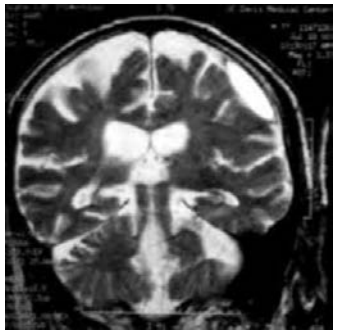
- entrant: novel technology for data communication, imaging
- frequencies: 960-10,600 MHz
- status: unlicensed at –41.3 dBm EIRP max, down to –85.3 dBm EIRP
- incumbents who opposed:

  aerospace manufacturers, aircraft manufacturers, airlines, amateur radio, Bluetooth, radio and TV broadcasters, CB users, cell phone companies, Dept. of Defense and individual military branches, emergency beacon manufacturers, FAA, GPS industry, hospitals, medical monitoring, model aircraft hobbyists, NASA, oil and gas pipelines, public safety users, radio astronomers, radar industry, radio astronomy, railroads, satellite-cable companies, satellite industry, satellite radio, space-launch industry, stolen-vehicle recovery, two-way radio, utilities, weather forecasters, Wi-Fi

  - GPS, FAA, NASA, military lobbied hard in opposition

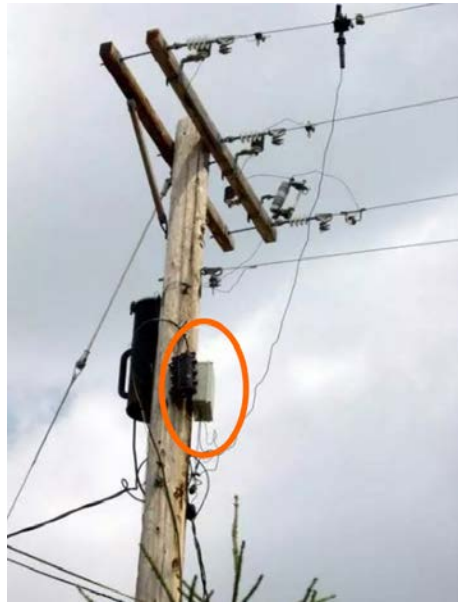
Ultra-Wideband (2002) – 2

- likelihood of interference: very low
- public interest
  - expanded use of fully occupied spectrum
    - promised: high-speed, short-range data transmission (“Bluetooth on steroids”); imaging
    - actual: ground penetrating radar, medical imaging, positioning, Apple AirTags
- comment:
  - FCC unpersuaded by opponents’ technical showings
- decision prioritized technical findings over strong political pressure



Broadband-over-Power-Line (2004) – 1

- entrant: broadband Internet delivery
- frequencies: 1.705-80 MHz
- status: unlicensed at (very low) default emission levels for unlicensed devices
- incumbents: mobile radio, Amateur, many others
  - Amateurs vehemently opposed
  - claimed interference from “city-sized antennas”
- likelihood of interference: moderate within a few meters of BPL pole, very low elsewhere
- public interest: “third wire” to compete with cable and telco ISPs



Broadband-over-Power-Line – 2

- FCC responded to interference concerns with strict mitigation
  - BPL providers must:
    - maintain publicly accessible database by zip code and frequencies
    - notch 25 dB (<30 MHz) or 10 dB (>30 MHz) if interference reported
    - turn off if interference persists (to fixed victim receivers)
- Amateurs sued (and lost) over interference to mobile receivers
- today BPL used only for internal utility communications.
  - could not compete with increasing cable and telco data speeds
- comment: FCC over-responded to Amateurs' exaggerated interference claims
  - but found solution BPL providers could work with.

Airport Body Scanner (2006) – 1

- entrant: security screening device
- frequencies 24.25-30 GHz (original version)
  - later expanded to 20-40 GHz
- status: unlicensed at –41.3 dBm
  - integrated over fast sweep, 0 dBm peak
- incumbents: fixed wireless at 24 & 28 GHz
  - licensed but few constructed
  - opposed original 24.25-30 GHz version

Airport Body Scanner – 2

- likelihood of interference: very low
  - opposition relied on unlikely interference scenarios
- public interest: detect non-metallic weapons, explosives
- comment: FCC decided improved security outweighed opponents' implausible interference claims
  - 2016 expansion to 20-40 GHz was unopposed.

(pause for discussion)

ReconRobotics (2010) – 1

- entrant: remote surveillance robot for police and firefighters
- frequencies: 430-448 MHz
- status: licensed (secondary) at 0.25 W, limited to public safety
- incumbents: military radar (primary), Amateur (secondary)
  - military perfunctorily opposed; could have blocked but did not
  - Amateurs strongly opposed, made unrealistic claims
    - *e.g.*, "blanketing interference" over hundreds of miles

ReconRobotics – 2

- likelihood of interference: very low
- public interest: safety of police and firefighting personnel, hostages, fire victims
  - police strongly supported
- comment: FCC gave surprising credence to technically baseless opposition, but eventually approved.

6 GHz Wi-Fi (2020) – 1

- entrant: expanded Wi-Fi operation
- frequencies: 5925-7125 MHz
- status: unlicensed
  - indoors/outdoors w/ Automated Frequency Coordination (AFC): 36 dBm EIRP
  - indoors without AFC: 30 dBm EIRP
  - outdoors without AFC: 14 dBm EIRP (proposed)
- incumbents:
  - fixed wireless – strongly opposed without AFC
    - includes multiple critical services
  - fixed satellite uplink
  - radio astronomy

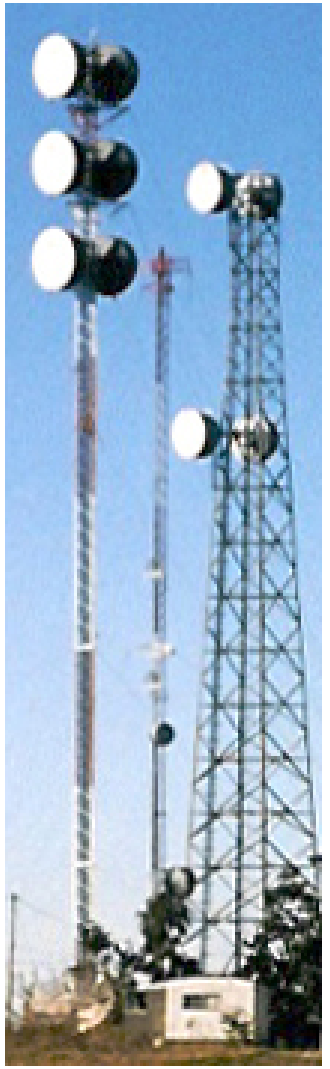


photo: George Kizer

6 GHz Wi-Fi – 2

- likelihood of interference: certain
- public interest: additional Wi-Fi options
- comment: FCC ignored–
  - balance of public interest: safety-critical systems *vs*. more Wi-Fi
  - low probability of interference *per device*, over a billion projected devices, predicts statistically certain interference overall
  - engineering analysis as to:
    - propagation model
    - duty cycle
    - adjacent channel issues
    - building entry loss
    - more

6 GHz Wi-Fi – 3

- comment (cont'd)
  - 6 GHz Wi-Fi proposal backed by Apple, Broadcom, Cisco, Facebook, Google, Hewlett Packard, Intel, Microsoft, Qualcomm, others
    - same request from small, unknown company would likely have failed: benefit not worth the risk
  - FCC appears to have adjusted its technical analysis to favor celebrity companies.

Conclusion

- FCC is a political body:
  - created by Congress
  - Commissioners nominated by President, confirmed by Senate
  - Congress authorizes funding, provides oversight
- but the FCC has technical responsibilities
  - propagation of radio waves unaffected by party in power
- previous presidential Administration often ignored scientific facts for political gain
  - FCC may have done the same at 6 GHz
- can hope 6 GHz was an aberration, that the FCC will resume its tradition of responsible, science-based decision-making.

Thank you!

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