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Key Spectrum Policy Issues for the Technical Community

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Topics

I. US Spectrum Policy Reform
- Based on IEEE-USA recommendations https://ieeeusa.org/wp-content/uploads/2018/10/SpectrumPolicy1018.pdf

II. Spectrum sharing with public safety & military

III. The problem of spectrum use/sharing >100 GHz

I. US Spectrum Policy Reform

IEEE★USA
POSITION STATEMENT

IMPROVING U.S. SPECTRUM POLICY DELIBERATIONS
Adopted by the IEEE-USA Board of Directors
(3 Oct. 2018)

- While IEEE is a multinational organization, IEEE-USA acts on behalf of its US members on policy issues
- US spectrum policy is of interest to both US members and others due to large size of US market and historical impact of US policies elsewhere
- These recommendations were intended to be nonpartisan & industry neutral since IEEE membership is very diverse
  - Also intended not to require new legislation but may require some new spending
    - US spectrum legislation passage has been problematic

I. US Spectrum Policy Reform:

Backgrounds of Key Officials and their Staff

- For complex reasons FCC commissioners and head of NTIA have been generally drawn from congressional staffs for the past 25 years
  - FCC has a broad jurisdiction beyond spectrum but key officials rarely have *any* background, technical or not, in ICT issues
- Suggest some future appointments should include individuals with actual experience in spectrum technology or in operations using spectrum
  - Even FCC commissioners' key "wireless advisors" have little previous background in spectrum

I. US Spectrum Policy Reform:

Joint FCC/NTIA Spectrum Advisory Committee

- Covid crisis has highlighted how other federal regulators, such as FDA, give a key role to panels of independent experts in complex technical policy deliberations
- While FCC and NTIA have technical advisory committees (TAC & CSMAC), they can not be involved in key decisions because of how they are structured
  - Almost all members have conflicts
- IEEE-USA urges a truly independent committee of experts to advise FCC and/or NTIA on key issues such as feasibility of spectrum sharing and adjacent band interference issues that drag on endlessly
  - *e.g.* 24 GHz/5G , GPS/Ligado, and >100 GHz sharing with passive satellites

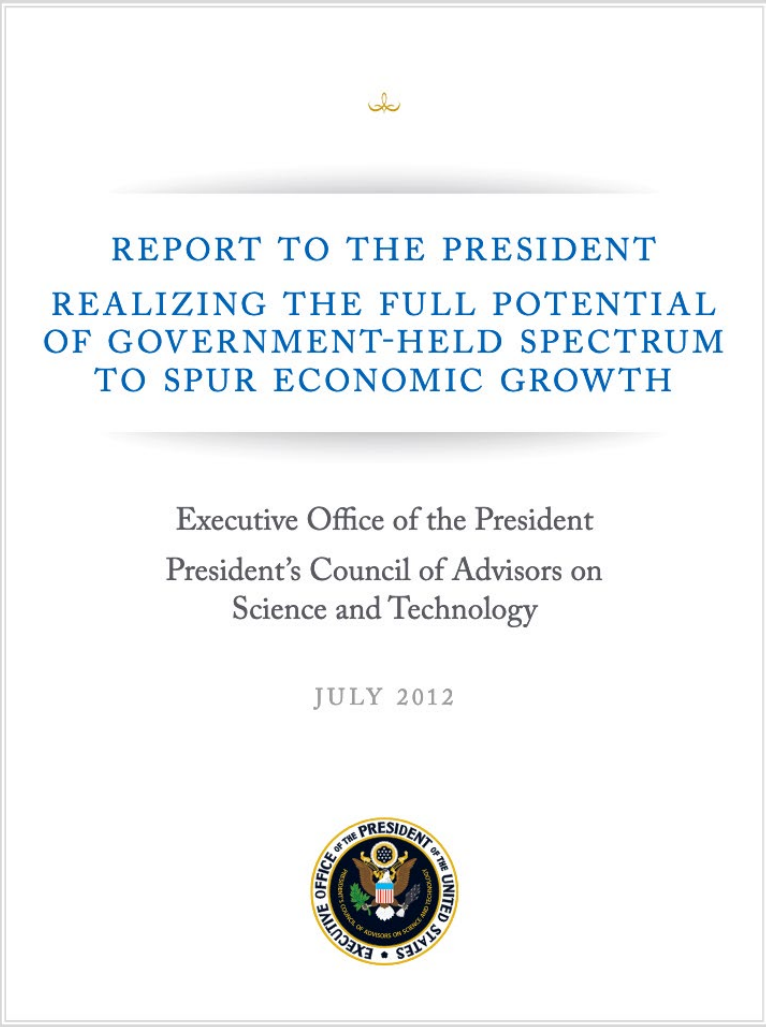
II. Spectrum sharing with public safety & military:

Basic Issues

- Even in urban areas of high spectrum demand, spectrum occupancy measurements usually show apparently vacant spectrum
  - Note there is no consensus method for quantifying spectrum utilization
- Much of this results from military and public safety spectrum uses which have:
  - High societal value
  - High peak to average spectrum use ratio
  - Spatial distribution generally different than other uses
  - Spectrum allocation usually independent of economic forces
  - Impractical to share spectrum with traditional technology
  - Legitimate need for secrecy about many unit locations & movements

II. Spectrum sharing with public safety & military:

Concepts from 2012 PCAST Report

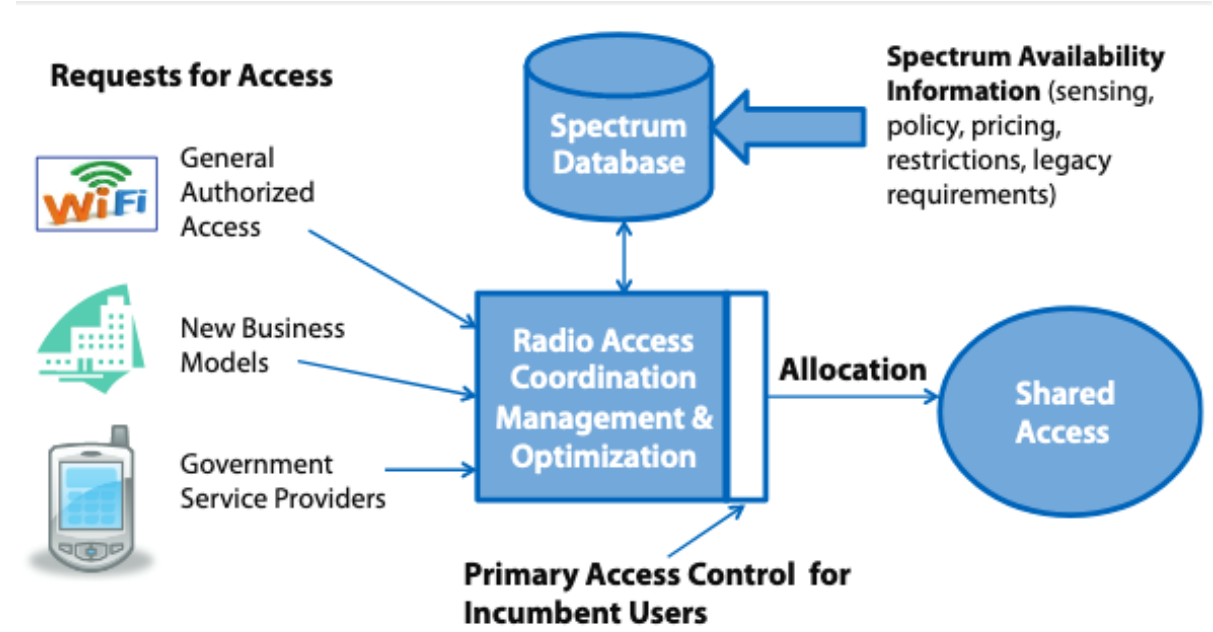


- "It is the policy of the U.S. government to share underutilized spectrum to the maximum extent consistent with the Federal mission"
- "In the coming years, access to spectrum will be an increasingly important foundation for America's economic growth and technological leadership"
- "Spectrum should be managed … by specifying large frequency bands that can accommodate a wide variety of compatible uses and new technologies that are more efficient with larger blocks of spectrum"

https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf

II. Spectrum sharing with public safety & military:

"Spectrum Access System" Concept



- Envisions a real time data base with information on current & planned spectrum use as well as policies
- Accepts requests from, possibly, multiple priority user classes and assigns spectrum *if* noninterference is feasible at location & time requested

https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf

II. Spectrum sharing with public safety & military:

FCC 2015 CBRS Decision


REPORT TO THE PRESIDENT

REALIZING THE FULL POTENTIAL OF GOVERNMENT-HELD SPECTRUM TO SPUR ECONOMIC GROWTH

Executive Office of the President

President's Council of Advisors on Science and Technology

JULY 2012

- Initial US implementation of SAS concept was in 3.5 GHz "Citizens Broadband Radio Service"/CBRS (3550-3700 MHz)
  - https://www.law.cornell.edu/cfr/text/47/part-96
  - https://www.fcc.gov/edocs/search-results?t=quick&dockets=12-354
- This band is used by radars on a few US Navy ships which are *sometimes* close enough to coast to creating sharing problems:
  - Interference to radars from civil users
  - Radar interference to civil users
  - Potential interference areas large to enough to preclude use in most major urban areas *if* sharing was static

II. Spectrum sharing with public safety & military:

FCC 2015 CBRS Decision

- Major issue: Source of real time information on ship locations
  - Legitimate security concerns and lack of benefit to Navy complicated options
- Final decision: Environmental Sensing Capability (ESC)
  https://www.law.cornell.edu/cfr/text/47/96.67
  - Privately operated spectrum monitoring system with geolocation capability
    - Can not store information and can not have communication with military
  - Provides SAS with real time location information but limits sharing potential:
    - Passive measurements from a distance always have greater error than GPS position
    - Sharing analysis for frequency use must be based on worst case assumptions for ship's position and other variables such as path loss
    - At best gives current position not any indication of future

See speaker's paper on SAS-like sharing in 12/20 issue of *IEEE Wireless Communications*

II. Spectrum sharing with public safety & military:

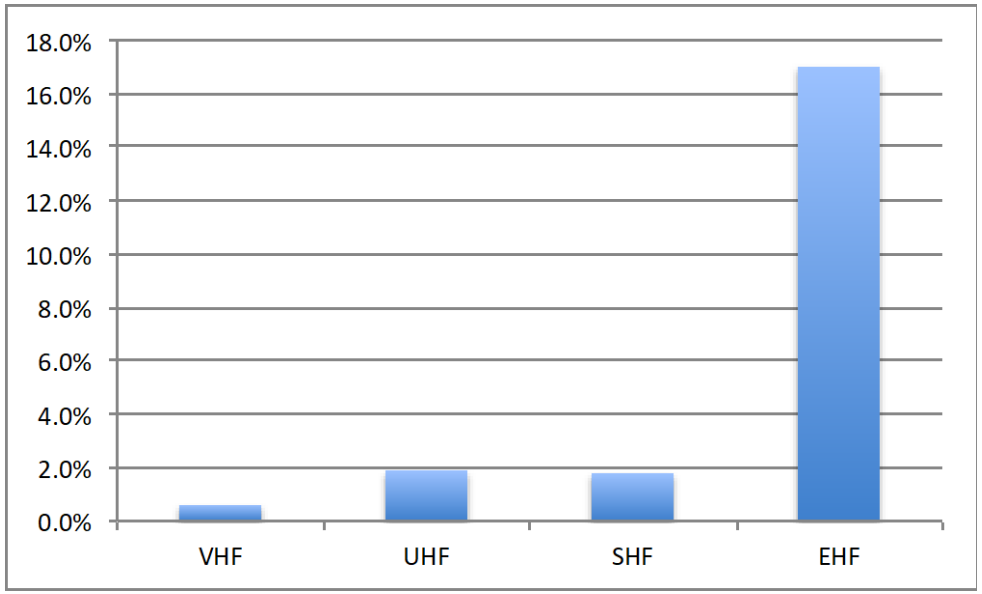
Future Alternatives for SAS-like Sharing

- Base stations & end users do **not** need details about military user location or spectrum use
  - Only need to know what spectrum can be used at a base station w/power limit
- Explore replacing ESC with a trusted intermediary with access to both **actual** military user position and plans
  - Trusted intermediary computes allowed spectrum and powers for base stations
  - To enhance security inserts a few intentional errors to prevent hostile analysis of position – erring on the side of preventing interference to primary user
  - Uses information on pending movement and spectrum use to make sharing more effective
    - Note in US design, assembly, and maintenance of nuclear weapons is done by quasigovernmental national labs and trusted contractors – **not** federal employees/military

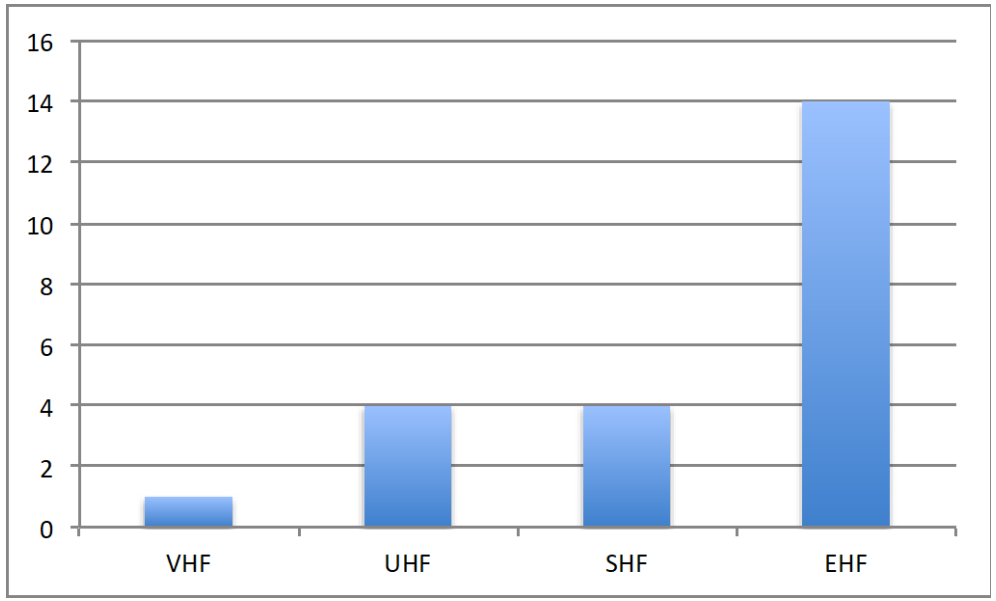
III. The problem of spectrum use/sharing >100 GHz

Impact of Passive "Forbidden Bands" on mmW/THz use

Size of forbidden bands



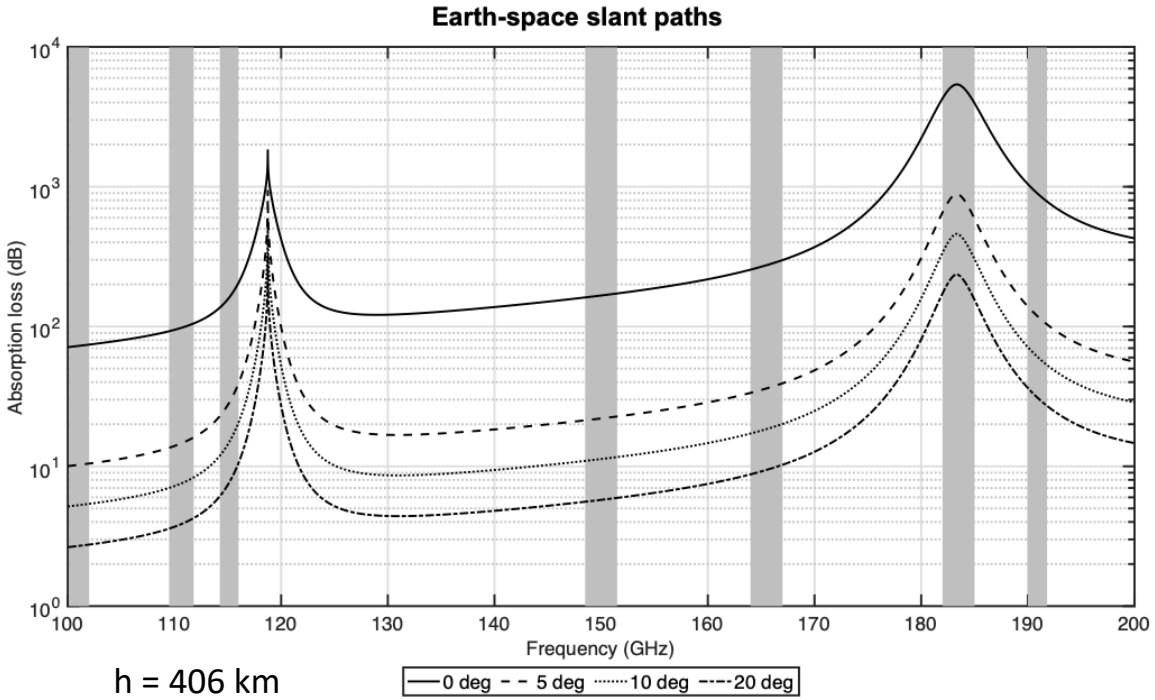
Number of forbidden bands



- Spectrum >100 GHz likely needed for 6G wideband uses
- While passive spectrum use <100 GHz is a minor factor, >100 GHz it is a major roadblock to new technology
- ITU RR5.340 & US246 total prohibitions of band use based on physics of lower bands – Date from WRC-2000 & <u>intended to be temporary</u>

Physics of >100 GHz Makes *Careful* Interference-free Sharing w/ Passive Users Possible

- While bands used for radio astronomy, real issue is NGSO passive satellites for weather and environmental monitoring
  - In these bands RA is very rare in populated areas



h = 406 km

- Propagation dominated by frequency and altitude dependent atmospheric absorption
  - High angle paths have HUGE path loss
- Passive satellite protection in these bands requires good sidelobe suppression
  - Facilitated by small λ which enables technologies less attractive in lower bands
- Sharing feasibility understood at WRC-2000 when most passive allocations were made – now "forgotten"

Physics of >100 GHz Makes *Careful* Interference-free Sharing w/ Passive Users Possible

- Even consideration of such sharing is facing major barriers in both FCC/NTIA forums and in ITU-R
  - WRC Res. 731, dating to WRC-2000 & renewed at WRC-19, directs ITU-R to do sharing feasibility studies
    - NASA firmly opposed to even studies!
  - Combination of 6G indecision and EU/Japan industrial policy decisions favoring R&D above 275 GHz may be decreasing pressure on spectrum regulators to address >100 GHz sharing feasibility
- Technical community should get more involved!

h = 406 km

Conclusions

- Spectrum policy is too important to be left to lawyers
  - It doesn't have to be a "spectator sport'
- It is just as important as Maxwell's Equations:

- 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!**