# FCC Spectrum Activities: Fueling the Internet of Things

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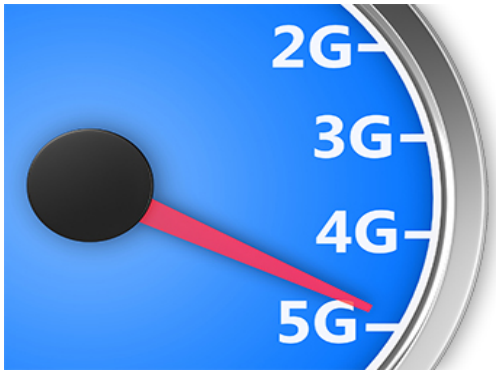
Note: The views expressed in this presentation are those of the author and may not necessarily represent the views of the Federal Communications Commission

# FCC 5G FAST Plan

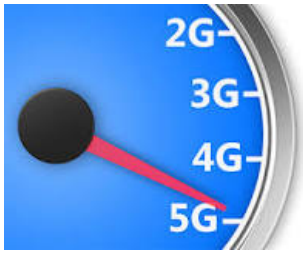
*"At the FCC, we call our strategy for U.S. leadership in fifth-generation wireless technology the 5G FAST plan. It consists of three central components: freeing up much more spectrum for the commercial marketplace, promoting wireless infrastructure deployment, and modernizing our regulations to promote more fiber deployment."* – Chairman Ajit Pai




https://www.fcc.gov/5G

# FCC 5G FAST Plan

Facilitate America's Superiority in 5G Technology




## Spectrum:

- ***High-band:*** Completed auctions of both the 28 GHz and 24 GHz bands - - a combined 1,550 megahertz of spectrum. Auction of the upper 37 GHz, 39 GHz, and 47 GHz band started on December 10, 2019 – a combined 3,400 megahertz of spectrum.

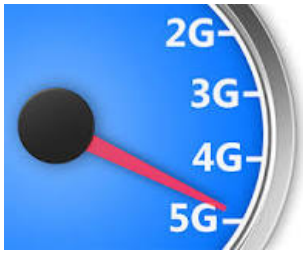
- ***Mid-band:*** Adopted flexible new rules for the 2.5 GHz band - intend to auction the unused portions of the band in 2020. Will auction 70 MHz of spectrum in the 3.5 GHz band in June of 2020. And working to free up additional airwaves for 5G in the 3.7-4.2 GHz band, commonly called the C-band.

- ***Low-band:*** Repurposing spectrum for mobile broadband in the 600 MHz band, which was long used for broadcast television.

- ***Unlicensed:*** Made over 21 gigahertz of spectrum available for use by unlicensed devices above 95 GHz; proposed 1,200 megahertz of potential spectrum for next-generation Wi-Fi at 6 GHz

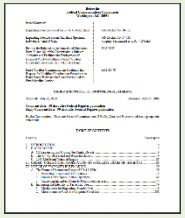
# FCC 5G FAST Plan

Facilitate America's Superiority in 5G Technology



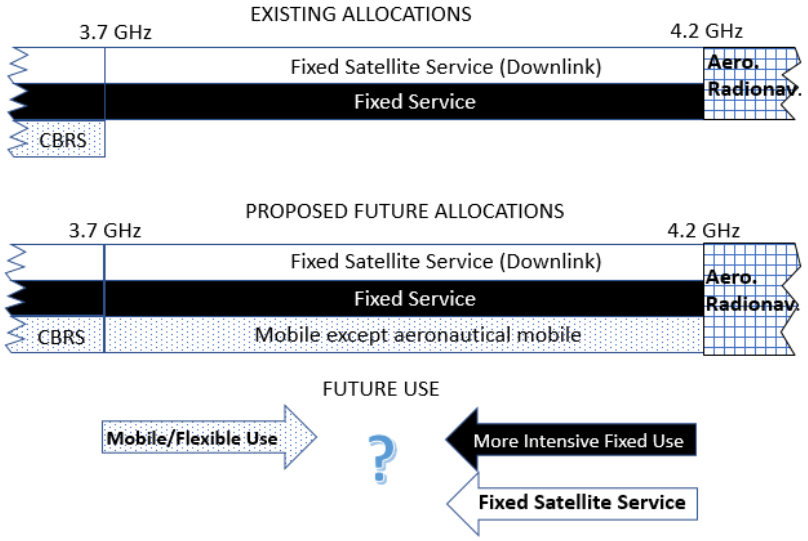

- **Infrastructure Policy:**
  - Speeding Up the Deployment of small cells
  - Speeding up State and Local Review of Small Cells
- **Modernizing Outdated Regulations:**
  - Restoring Internet Freedom
  - One-touch make ready
  - Speeding the IP Transition
  - Business Data Services
  - Supply Chain Integrity

# Proposal to Repurpose C-band Spectrum (3.7 – 4.2 GHz) For Wireless

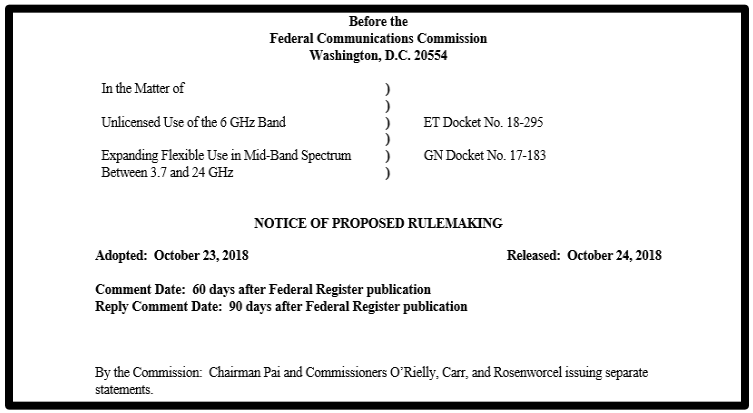


https://www.fcc.gov/document/fcc-expands-flexible-use-mid-band-spectrum

- Notice of Proposed Rule Making
- Considers of C-band DL for wireless
- C-Band Alliance proposal (transition via market transactions)
- Commenters suggest alternatives
- Complex policy, legal, economic and technical issues
- Action expected later this year



# Proposal for Unlicensed at 6 GHz Based on Sharing



Before the
Federal Communications Commission
Washington, D.C. 20554

| | | |
|---|---|---|
| In the Matter of | ) | |
| | ) | |
| Unlicensed Use of the 6 GHz Band | ) | ET Docket No. 18-295 |
| | ) | |
| Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz | ) | GN Docket No. 17-183 |
| | ) | |

NOTICE OF PROPOSED RULEMAKING

Adopted: October 23, 2018 Released: October 24, 2018

Comment Date: 60 days after Federal Register publication
Reply Comment Date: 90 days after Federal Register publication

By the Commission: Chairman Pai and Commissioners O'Rielly, Carr, and Rosenworcel issuing separate statements.

See https://www.fcc.gov/document/fcc-proposes-more-spectrum-unlicensed-use-0

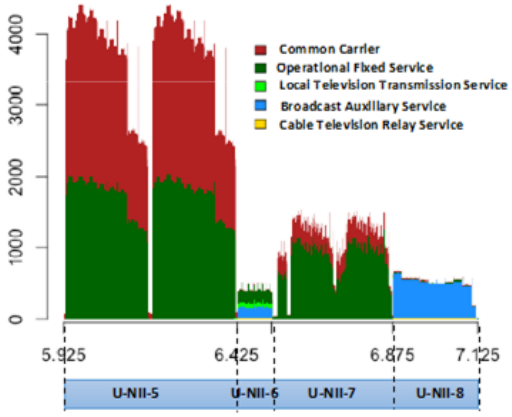



*Figure 1. Assignment Density*

| Band (GHz) | Primary Allocations | Reference used in this NPRM[63] | Devices |
|---|---|---|---|
| 5.925-6.425 | Fixed Service FSS | U-NII-5 | Standard-Power Access Point |
| 6.425-6.525 | Mobile Service FSS | U-NII-6 | Low-Power Access Point |
| 6.525-6.875 | Fixed Service FSS | U-NII-7 | Standard-Power Access Point |
| 6.875-7.125 | Fixed Service Mobile Service FSS[64] | U-NII-8 | Low-Power Access Point |

Proposed sharing with fixed service based on automated frequency coordination (for outdoor use)

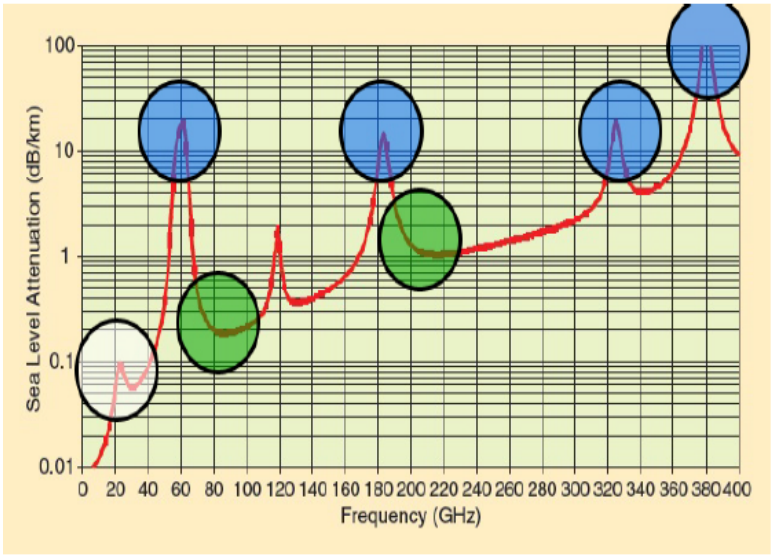
# US Table of Frequency Allocation

| Frequency Range | Allocations | FCC Service Rules |
|---|---|---|
| 9KHz – 95GHz | Various Allocations in Primary, Co-Primary, or Secondary | Various service rules for a given allocation |
| 95GHz - 275GHz | Every hertz is allocated in terrestrial, satellite, space and/or other services. Federal and non-Federal users share co-primary status.<br><br>US Allocation Table is almost identical to ITU Allocation Table. | No Service Rules |
| 275GHz - 3000GHz | No Allocation | No Service Rules |

# 2013 TAC Slide on Atmospheric Loss

NEW YORK UNIVERSITY

## Atmospheric Attenuation: mm-waves




- 0.012 dB over 200 m at 28 GHz
- 0.016 dB over 200m at 38 GHz

- White
  - Current cellular frequencies and low mm-wave
- Blue
  - Short-range indoor communications, whisper radios of the future
    - Higher attenuation
- Green
  - Future backhaul and cellular frequencies
    - Low atmospheric attenuation
    - Multi-GHz Bandwidth
    - Directional Antenna Arrays with Beamsteering
    - CMOS: cost-effective with high frequency limits
    - Atmospherics are challenging

T. S. Rappaport, J. N. Murdock, and F. Gutierrez, "State of the Art in 60-GHz Integrated Circuits and Systems for Wireless Communications," Proceedings of the IEEE, vol. 99, no. 8, pp. 1390–1436, August 2011.

Your mileage may vary:

Foliage loss at 80 GHz and 10m penetration = 23.5 dB (15dB higher than @ 3 GHz)

Heavy rain in 70/80/90 GHz band results in 10 dB/km fade

Source: Samsung

NYU·poly
POLYTECHNIC INSTITUTE OF NYU





Source: IEEE ICC Plenary Presentation by Prof. T. Rappaport, 6/2013

# Key Milestones of Spectrum Frontiers

- NOI on October 2014: Sought comment on bands above 24GHz
- NPRM on October 2015: Multiple bands were proposed
  - 24GHz, 28GHz, 31GHz, 37GHz, 39GHz, 42GHz, 48GHz, 50GHz, 60GHz, 70/80GHz
- 1st R&O on July 2016
  - 10.85GHz of Spectrum added for mobile
    - Licensed Bands (3.85GHz): 27.5-28.35 GHz; 37-38.6 GHz; 38.6-40 GHz;
    - Unlicensed Bands (7GHz): 64-71 GHz
- 2nd R&O on Nov 2017:
  - 1700MHz of spectrum added for flexible wireless use
    - 24.25-24.45 GHz; 24.75-25.25 GHz; 47.2-48.2 GHz
- 3rd R&O, MO&O, and 3rd FNPRM on June 2018
  - Operability requirement for the entire 24 GHz band, FSS sharing in a portion of 24 GHz band, a band plan for the Lower 37GHz band, and spectrum aggregation rules applicable to certain bands
  - Deny petitions for reconsideration asking for geographic area licensing in the Lower 37GHz band and asking to allocate the 42GHz band for satellite use
  - Seek comment on making 2.75 GHz of additional spectrum in the 26GHz band 42 GHz bands

# Spectrum Frontiers

## Spectrum Allocations

- 12.55 GHz of Spectrum added for mobile
  - **Licensed Bands (Total 5.55 GHz):** 24.25-24.45 GHz and 24.75-25.25 GHz; 47.2-48.2 GHz; 27.5-28.35 GHz; 37-38.6 GHz; 38.6-40 GHz;
  - **Unlicensed Bands (Total 7 GHz):** 64-71 GHz

## Service Rules

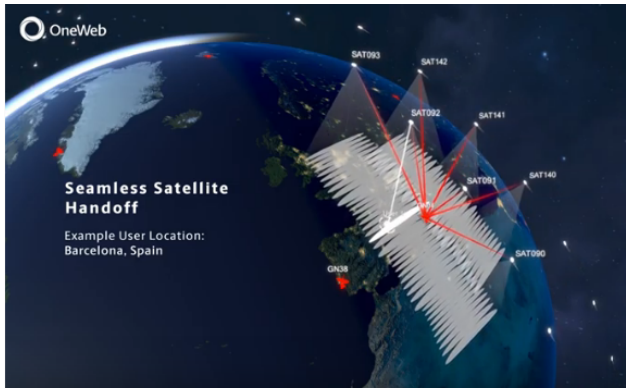
- Part 30: Upper Microwave Flexible Use Service (UMFUS)
- Geographic Area Licensing, Area Size, Band Plan, License Term, Overlay Auctions
- Technical rules
- Performance Requirements

Often Associated with “5G” – but 5G is not band specific

# Broadband Via Satellite

- FCC has licensed multiple LEO satellite systems - will offer broadband connectivity
- Satellites are anticipated to play a significant role in delivering 5G, IoT and other broadband services
- President Trump signed the Space Policy Directive-2 (SPD-2) on May 24, 2018 promoting spectrum support for commercial space sector

Example: SpaceX Starlink

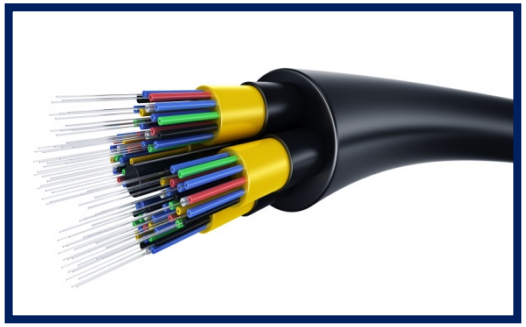



Example: OneWeb

# Expanding Access to Upper Reaches of the Spectrum

- **FCC Spectrum Horizons proceeding**
- **Expanded access above 95 GHz**
  - **Order adopted March 15, 2019**
  - **Total of 21.2 GHz for unlicensed use**
    - 116-123 GHz, 174.8-182 GHz, 185-190 GHz and 244-246 GHz, bands
    - Similar to 60 GHz rules
    - Selected high absorption bands
  - **New type of experimental licenses > 95 GHz**
    - Longer license terms
    - Ability to sell devices

Much of the spectrum above 95 GHz is allocated for passive services



Achieve Fiber Capacity

**Innovation**

See https://www.fcc.gov/document/fcc-opens-spectrum-horizons-new-services-technologies-0

# Special Presentation from Prof Rappaport 3/15/2019 Commission Meeting

NYU TANDON SCHOOL OF ENGINEERING

## mmWave & THz Applications

NYU WIRELESS

| mmWave & THz Applications—the potential for 6G [1] | |
|---|---|
| Wireless Cognition | Robotic Control [27, 28]<br>Drone Fleet Control [27] |
| Sensing | Air quality detection [5]<br>Personal health monitoring system [6]<br>Gesture detection and touchless smartphones [7]<br>Explosive detection and gas sensing [8] |
| Imaging | See in the dark (mmWave Camera) [9]<br>High-definition video resolution radar [10]<br>Terahertz security body scan [11] |
| Communication | Wireless fiber for backhaul [12]<br>Intra-device radio communication [13]<br>Connectivity in data centers [14]<br>Information shower (100 Gbps) [15] |
| Positioning | Centimeter-level Positioning [9,16] |

[1] T. S. Rappaport, Y. Xing, O. Kanhere, S. Ju, A. Alkhateeb, G. C. Trichopoulos, A. Madanayake, S. Mandal, "Wireless Communications and Applications Above 100 GHz: Opportunities and Challenges for 6G and Beyond (Invited)," IEEE ACCESS, submitted Feb. 2019.

# Update on Experimental Program License Program

- In April 2017 OET Implemented New Experimental License Program:
  - Recognizes that many R&D institutions control the space within which experiments occur - - Campuses, test ranges, etc.
  - Risk of interference is minimized within such controlled spaces
- Program License:
  - Grants general authority to conduct experiments in defined geographic area
  - Must describe experiment & post on FCC program license website
  - Website permits inspection by public and automatic notification by triggers on experiment characteristics to interested parties
  - If no objections received within 10 day period (15 federal frequencies), applicant is authorized to proceed
  - Report on experiment including any interference incidents must be posted on website within 30 days of experiment termination

**We have since granted more than 60 experimental program licenses**

# Innovation Zones

- On 9/18/19 FCC announced the first Innovation Zones for Program Experimental Licenses See https://docs.fcc.gov/public/attachments/DA-19-923A1.pdf
- New York City and Salt Lake City
- Process is in place to protect against harmful interference
- Platforms for Advanced Wireless Research (PAWR) - funded by the National Science Foundation sponsored and a consortium or 30 companies - - supports 5G R&D


See https://advancedwireless.org/

# Part 15 Waivers

- **A Radio frequency device that operates in accordance with the Part 15 unlicensed rules may not be marketed unless it has completed the appropriate equipment authorization process, certification in most cases.**

- **Certification will only be granted for a device that has demonstrated compliance with all applicable Commission Rules.**

- **If a specific rule cannot be complied with, the responsible party may submit a request for waiver.**

# Waiver Process

- **A request must demonstrate that there is good cause to waive the specific rule requirement.**

  - If the staff determines that the request warrants further consideration, it typically will release a public notice establishing a period for public comment.

- **The request will be granted or denied based upon review of the entire record.**

  - When appropriate, grants may include special conditions intended to ensure that underlying purpose of the waived rule continues to be satisfied.

- **Parties are expected to provide a copy of the granted waiver when submitting the application for certification.**

# Recent Waiver Grants and Filings

- **Information about waiver filings and decisional documents may be found on the Commission's website**

  - The OET website includes headline links related to all Office activities : **www.fcc.gov/engineering-technology**

  - Commission and staff- level decisions may be found in the EDOCS system: **www.fcc.gov/edocs**

  - Petitions and related comment may be found in the ECFS system: **www.fcc.gov/ecfs**

  - Decisions are references by FCC/DA #; Most proceedings may be found by Docket No.; Text/title search also available

- **Recent Waivers have reflected a variety of emerging technologies. Some examples include…**

# World Radio Conference 2019 (WRC-19)

- International Telecommunication Union (ITU)World Radio Conferences (WRCs) review and, if necessary, revise the international Radio Regulations (RR), the international treaty governing the use of the radio-frequency spectrum.

- WRC-19 concluded in November 2019 and the Final Acts will be implemented in coordination with NTIA

- There are several topics on mmW bands

- Will identify spectrum to be studied for the next WRC in mmW/THz bands

# FCC Technological Advisory Council

- 2019 WG Topics:
  - 5G and the Internet of Things
  - Antenna Technology
  - Communication Strategy for Drones
  - Artificial Intelligence
- 2020 TAC Session will begin in March

Thank You!