Scarcity to Abundance: Strategies to Fuel the 5G Wireless Ecosystem

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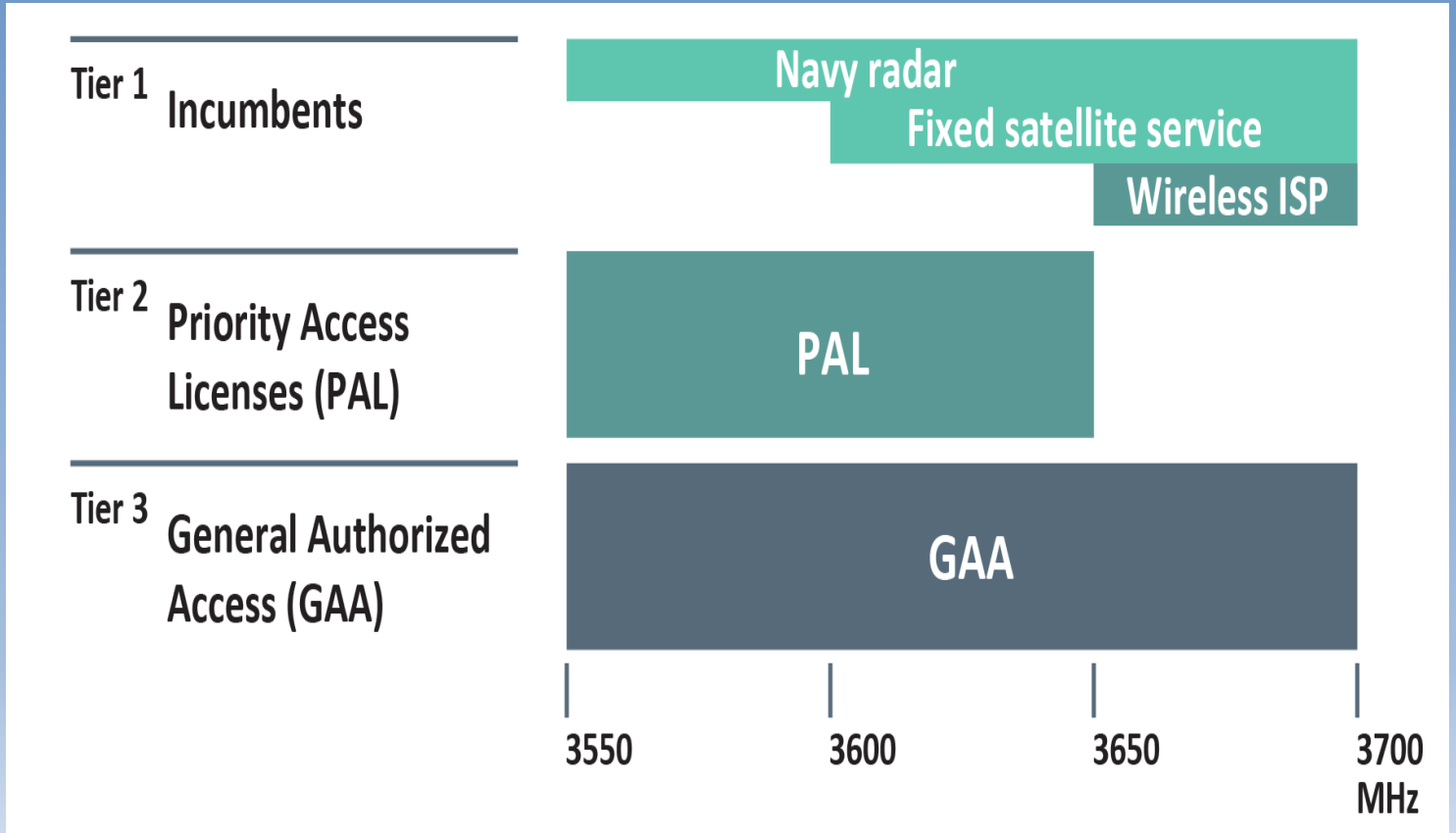
Spectrum Sharing: Critical Fuel for the 5G Wireless Ecosystem

- **A robust 5G ecosystem must extend far beyond mobile carrier networks**
  - Like today's 4G ecosystem, ubiquitous & affordable '5G' will depend on complementary, high-capacity, customized networks deployed by individual business firms and households
  - Licensed & Unlicensed, Fixed & Mobile, Coverage & Capacity, Indoors & Outdoors . . .
  - All wireless technologies must be part of the solution
- **Local network investments by households, enterprise and institutions** will require vastly more spectrum access
- **Dynamic sharing unlocks spectrum capacity**
  - Sharing techniques must be applied to more and more underutilized bands
  - This enables spectrum access for a wider variety of licensed, unlicensed, and lightly licensed (licensed by rule) operations – boosting connectivity & IoT at lower costs

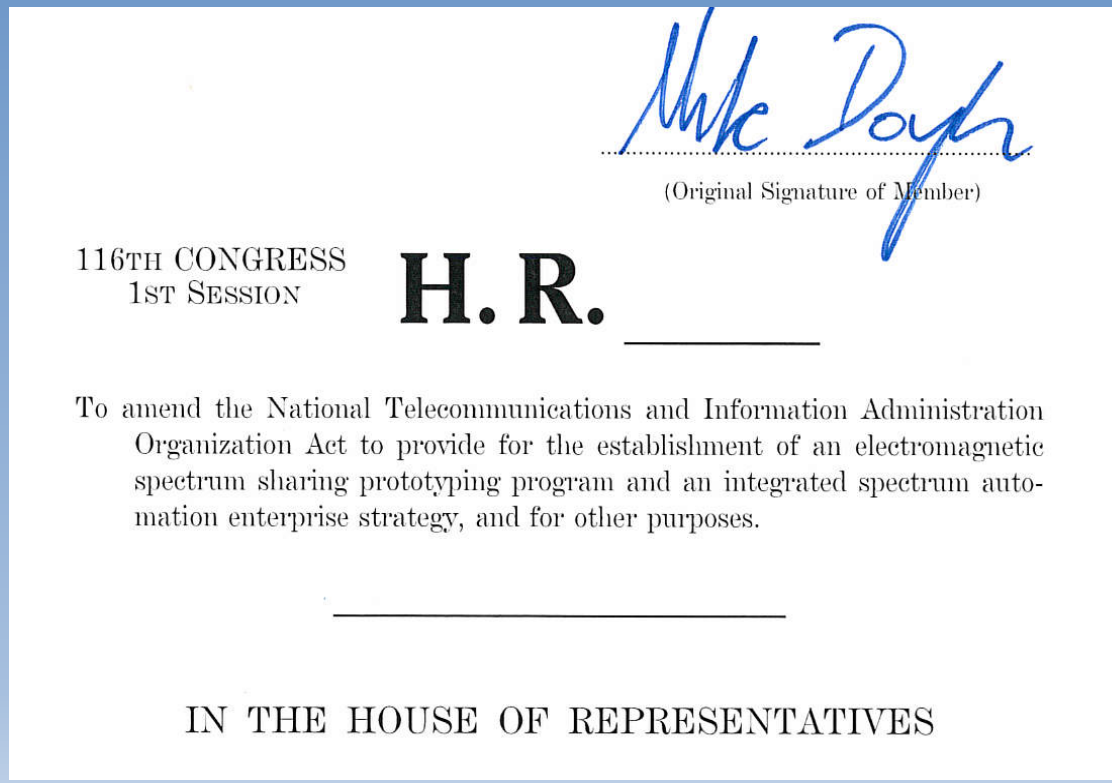
The Success of CBRS Can Accelerate Sharing

Three Key Strategies must be pushed faster forward – and become "the new normal":

1. **Automated Frequency Coordination (AFCs)**
1. **'Use it or Share it' rules**
1. **Property Owner Spectrum Rights (CAF)**



Bipartisan SHARE Act Adopted by House Commerce Nov. 19 Applies CBRS Sharing Techniques to lower 3 GHz, 7 GHz



(Original Signature of Member)

116TH CONGRESS
1ST SESSION

H. R. _____

To amend the National Telecommunications and Information Administration Organization Act to provide for the establishment of an electromagnetic spectrum sharing prototyping program and an integrated spectrum automation enterprise strategy, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

SEC. 3. FCC AND NTIA REPORT ON EXPANDING SPECTRUM SHARING TECHNIQUES AND SHARING STRATEGIES.

(a) FCC and NTIA shall submit a report that "provides **recommendations for expanding and improving spectrum sharing techniques developed for use in the 3.5 GHz band** . . . that includes" . . .

(4) The applicability of such sharing techniques or such other sharing strategies to frequencies between 3100 megahertz and 3550 megahertz, inclusive, and frequencies between 7125 megahertz and 8400 megahertz, inclusive, to the extent any portion of such frequencies cannot be cleared in a reasonable amount of time.

AUTOMATED FREQUENCY COORDINATION

An Established Tool for Modern Spectrum Management

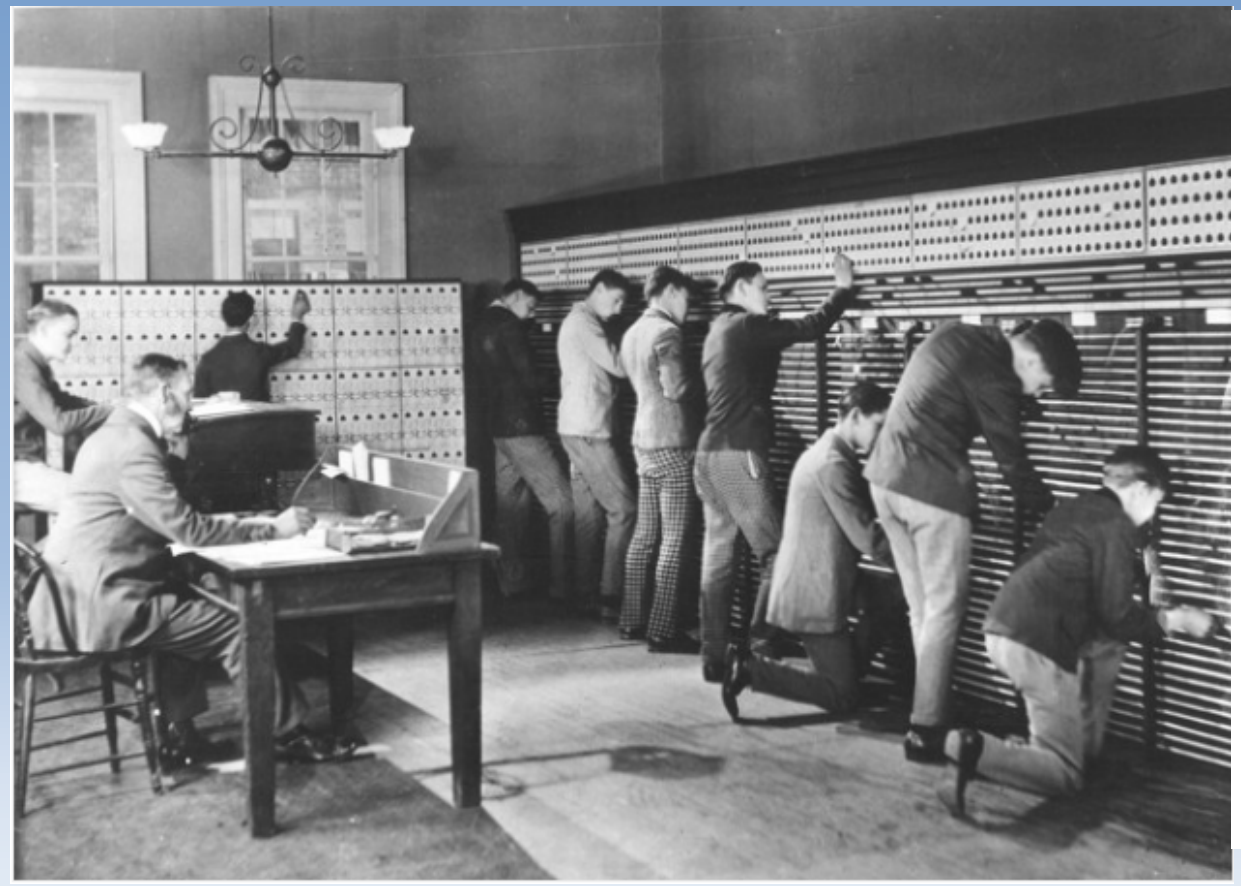
MARCH 2019

DSA

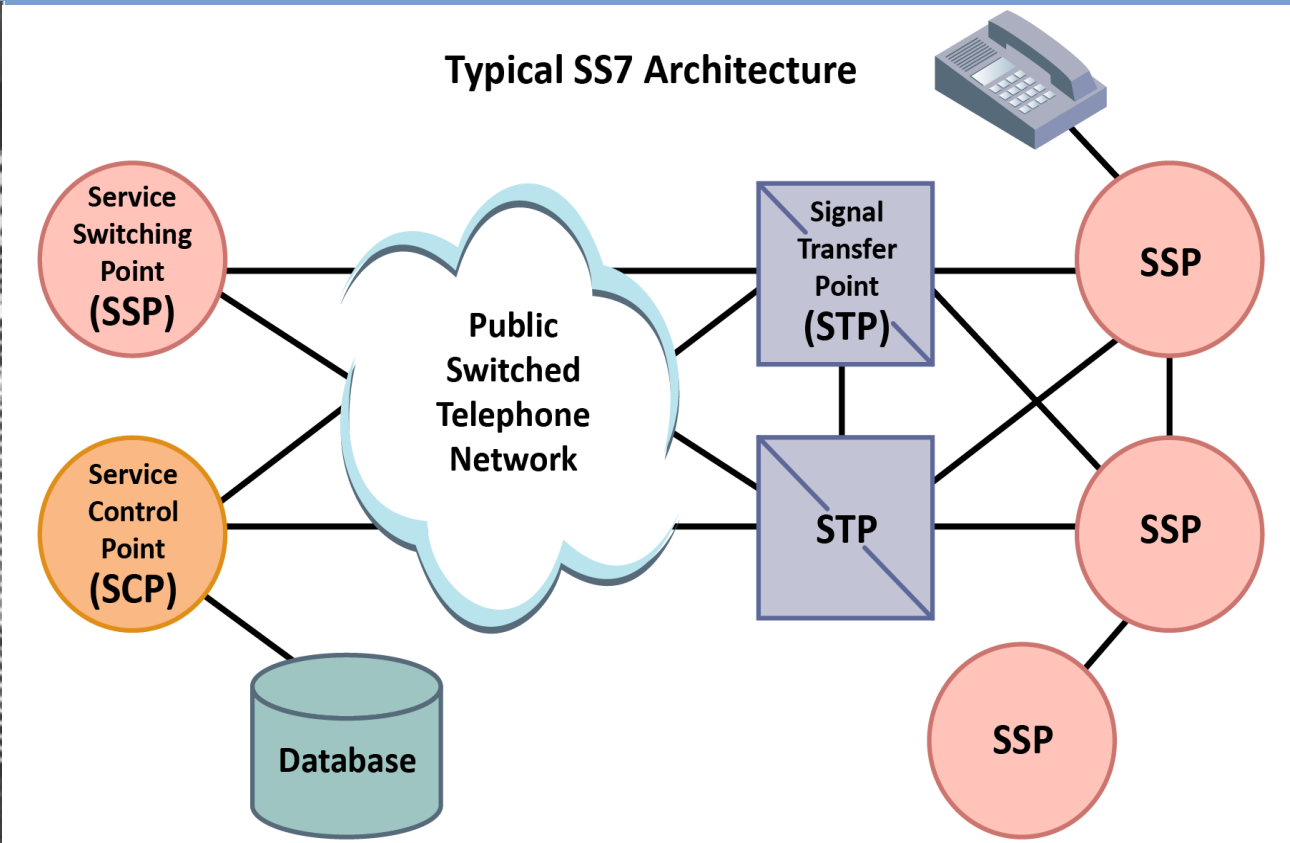
DYNAMIC • SPECTRUM • ALLIANCE

Telecom Database Management is Nothing New . . .
From SS7 Call Routing to Internet DNS Routing

Manual switchboard operators (circa 1877)



SS7 call-related signaling networks relied on automated databases. (The ITU adopted SS7 as international standard in 1988)



Dynamic Spectrum Databases – Getting Beyond the Myths

- Use of databases to coordinate and automate spectrum sharing is likewise ***nothing new*** – the steps are the same as in a manual coordination process
- ***What is new . . .***
  - **Surging demand** and the need to intensively share underutilized bands
  - The **technical ability** to automate the process, lower the costs, protect incumbents with greater certainty, and coordinate users and devices in near real-time
- AFC **databases enable a "third way"** that transcends the traditional (static) choice between exclusively licensed and unlicensed bands
- Spectrum DB management has ***evolved*** from manual, to automated, to dynamic – adding automation & propagation modeling to static licensing data
- ***Far greater efficiencies are possible*** as more granular real-world GIS data (terrain, clutter, etc.) is incorporated

Benefits to Regulators

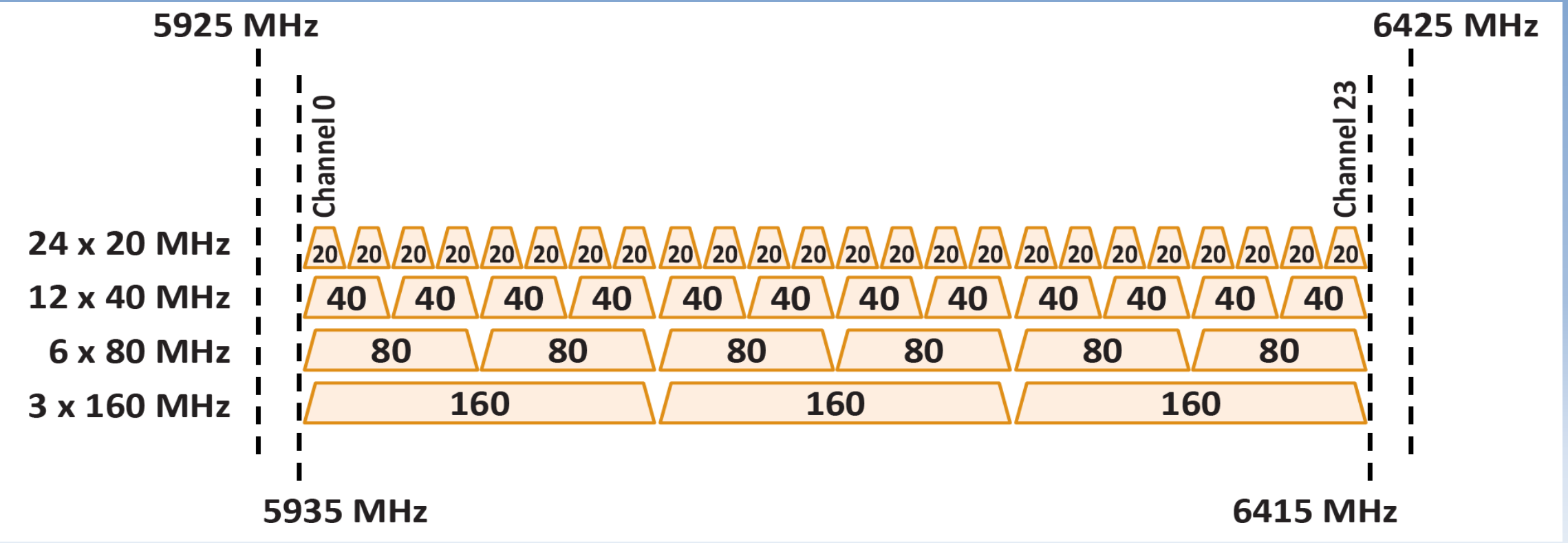
- **Automated Enforcement Tool**
  - Ensures consistent protection of incumbent licensees (including “kill switch” functionality)
  - AFCs can monitor spectrum use & help enforce rules re equipment certifications, licensing, operational, and/or fee requirements
- **Band coordination can be delegated while NRA retains authority**
  - DB operators authorized subject to specific obligations, reserving ultimate authority to NRA
  - Adapting model technical rules can speed time-to-market (e.g., DSA’s Model Rules for TV White Space)
- **Gives regulators more control over band sharing, including:**

  Flexibility to . . .
  - Change allocations or prioritizations without making equipment or infrastructure obsolete
  - Initially set and later update sharing parameters
  - Decide if DB is agency run *or* instead contracted to single/multiple providers
- **Cost recovery**
  - DB administrators can collect ‘fee for service’ revenue and/or NRA regulatory fees (see *ECC Report 236)*

Now that CBRS is Launched . . . Additional Bands Under Consideration for Dynamic Database Sharing

6 GHz: Expanding Unlicensed and Gigabit Wi-Fi

- Pending FCC rulemaking proposes to rely on AFC to open 1,200 MHz for Unlicensed Sharing (5925 – 7125 MHz)
- Europe (EU/CEPT) is similarly considering unlicensed sharing on 5925 – 6425 MHz. Wide channels enable next generation, gigabit-fast Wi-Fi 6

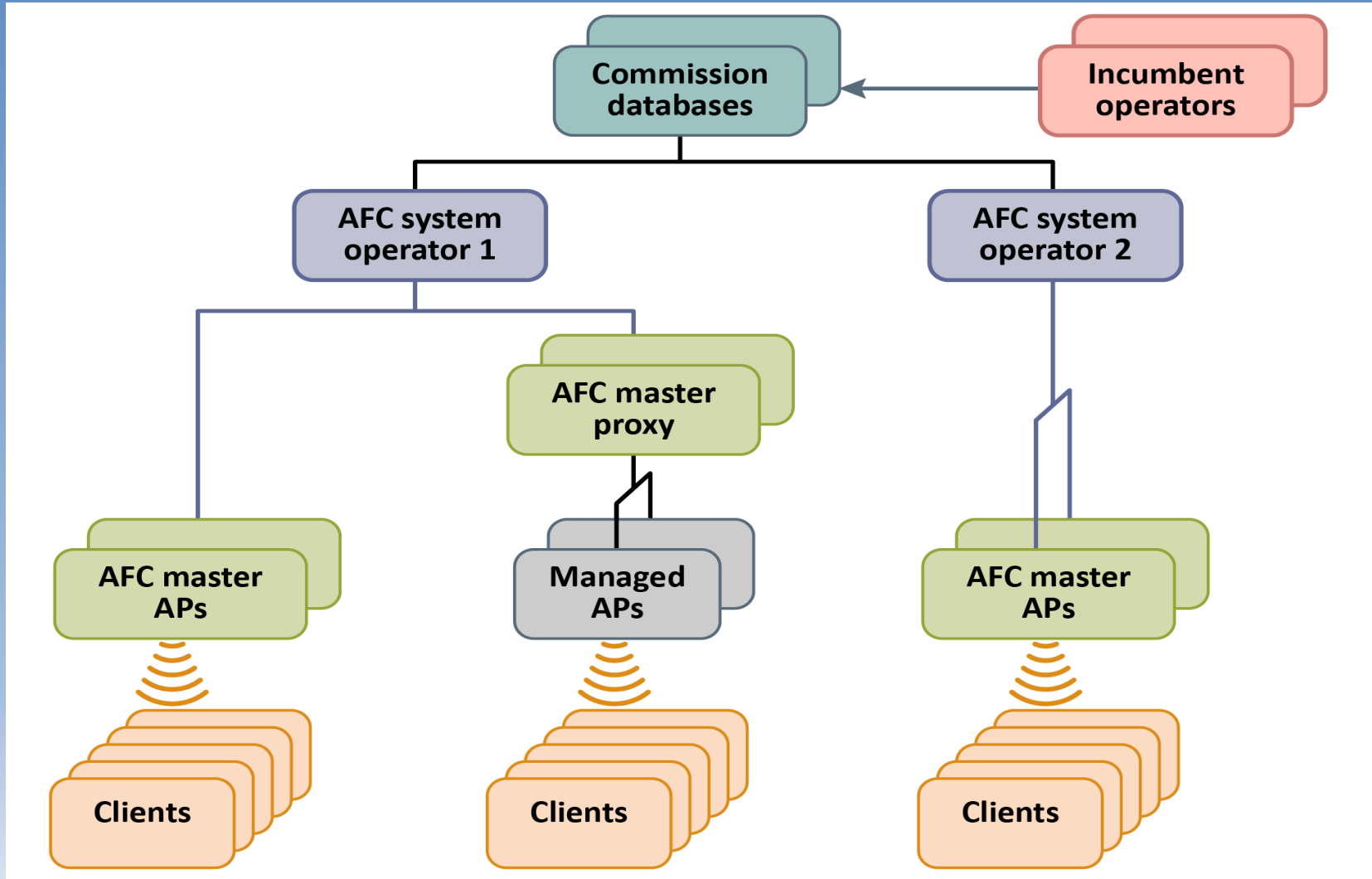


6 GHz: In U.S., Database Coordination Allows Wi-Fi Outdoors and at Higher Power

- **U-NII-5/7 sub-bands:** outdoor and indoor, controlled by Automated Frequency Coordination database (sharing with PtP links and FSS uplink)
- **U-NII-6/8 sub-bands:** lower-power, indoor-only but no database coordination required (sharing with non-fixed broadcast auxiliary, etc.)

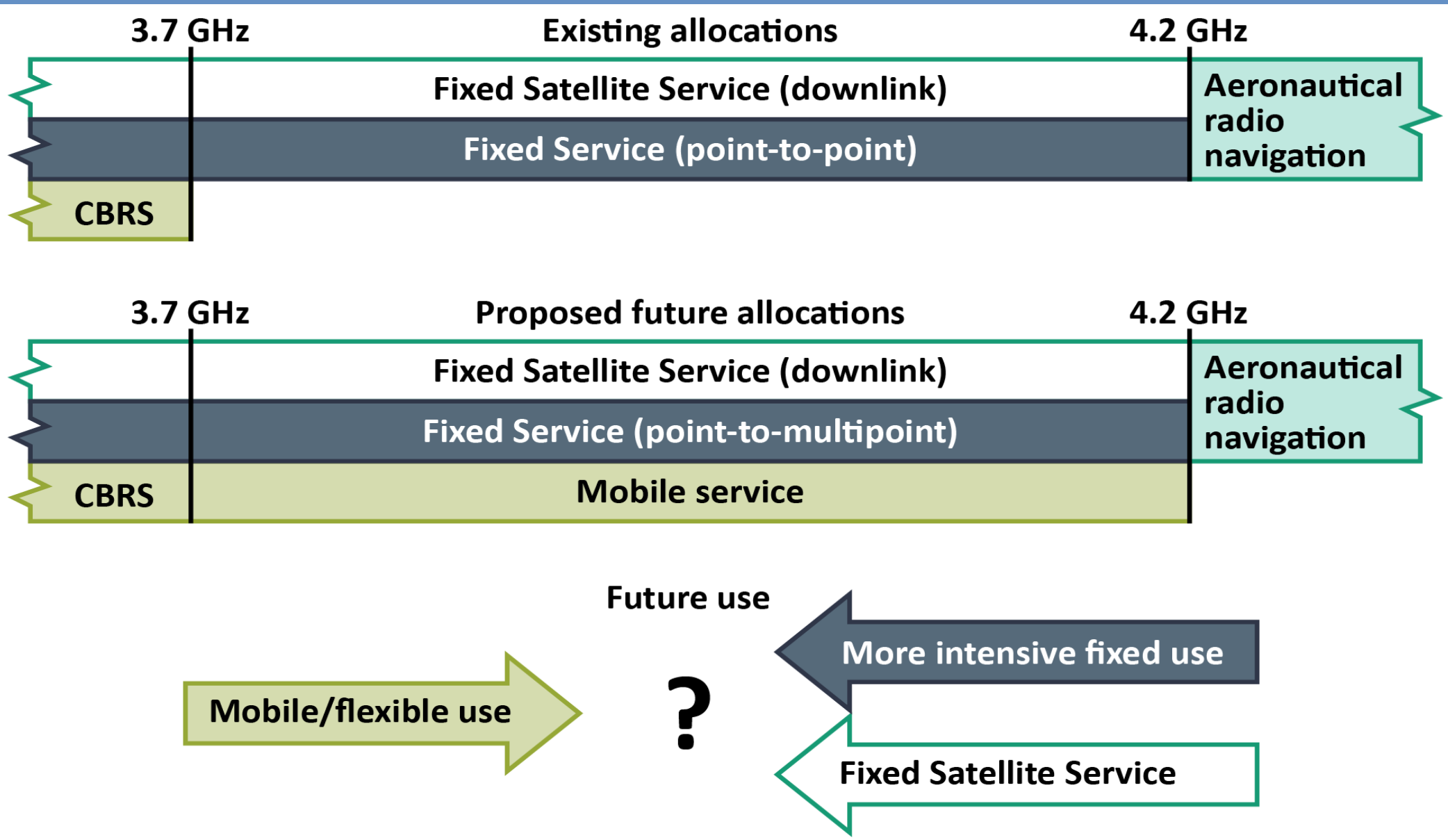
Band (MHz)	Primary Allocations	Reference in NPRM	Devices
5925-6425	Fixed Service FSS	U-NII-5	Standard-Power Access Point (subject to AFC)
6425-6525	Mobile Service FSS	U-NII-6	Low-Power Access Point (indoor only)
6525-6875	Fixed Service FSS	U-NII-7	Standard-Power Access Point (subject to AFC)
6875-7125	Fixed Service Mobile Service FSS	U-NII-8	Low-Power Access Point (indoor only)

AFC System Architecture for 6 GHz: Simpler and Potentially more Distributed than SAS

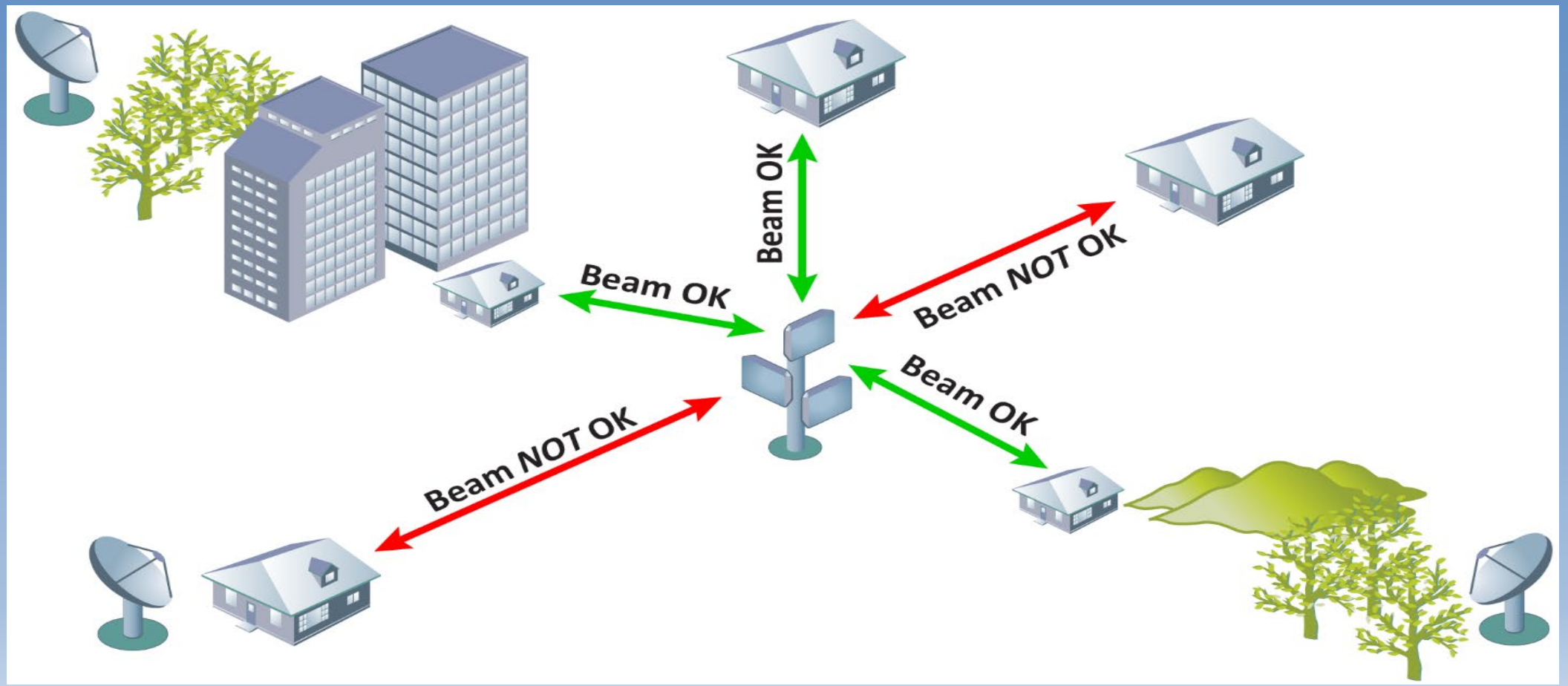


Simplified architecture for Automated Frequency Coordination in 6 GHz band.

C-Band (3.7-4.2 GHz): Coordinated Sharing Among Fixed Wireless (PtMP) & Fixed Satellite Service (FSS)



C-Band (3700-4200 MHz): AFCs can Coordinate PtMP and Earth Stations



A simplified AFC system can automate local coordination of PtMP with earth stations. Unlike mobile use, fixed PtMP is inherently directional and can be sectorized to coexist with FSS.

Shared Access Licenses (SALs): 37–37.6 GHz mmW Band Sharing (US)

Challenge: Accommodating Future Expansion of Federal Agency Use

- NASA & DoD only current users – but want flexibility to expand operations in future
- FCC in 2016 authorized shared commercial access, based on “Shared Access Licenses” (SALs)
- Operability requirement across 37-39 GHz band
- SAL rules and database TBD.

(source: Starry, Inc.)

The Innovative Future of Dynamic Spectrum Database Management

- Spectrum efficiency, interference protection, diverse use cases and QOS will be greatly enhanced in the future as AFC systems . . .
  - **Incorporate real-world propagation modeling & GIS data**
    - Terrain, clutter (trees, buildings – including heights and materials)
    - Antennas (e.g. polarization, radiation pattern, directivity)
    - Use of probabilistic propagation models – rather than static and worst case
  - **Real-time spectrum sensing data**
    - Fixed sensing networks (CBRS) or crowd-sourced (reporting by devices, base stations)
  - **Database Operators innovate value-added services**
    - Example: Optimize available bandwidth and QOS by incorporating more detailed GIS data
  - **The potential to combine blockchain technology with AFC coordination**
    - Example: Facilitate and streamline private secondary-market agreements

Use it or Share it

Key Precedents for Use-or-Share

FCC

- **CBRS:** The SAS manages opportunistic use of unused PAL spectrum (GAA basis) until licensees actually build out and commence service in that local area.
- **Post-Auction 600 MHz Band:** The TVWS Databases manages continued unlicensed use of locally-vacant 600 MHz until mobile carrier licensees (T-Mobile, et al.) actually deploy and commence service.
- **Note:** FCC has so far authorized use-or-share only under database control.

Ofcom

- ***Framework for Spectrum Sharing*** **(2015):** "Geolocation databases are making it easier for devices to identify spectrum available for sharing while protecting the operation of existing services."
- **Statement:** ***Enabling Wireless Innovation through Local Licensing*** **(July 25, 2019):** Adopts new "Shared Access" licensing framework allows non-national ISPs and individual enterprises to access unused 3.8-4.2 GHz FSS spectrum on a local, "first-come, first-served, Ofcom-coordinated basis."
- **Note:** Ofcom requires manual coordination ("mother may I") for Shared Access.

Closest thing to a 'Spectrum Free Lunch'? Key Benefits of a Use-or-Share Rule

- Remember . . . FCC **licenses are for *use, not non-use***
- ***Benefits***
  - Empowers WISPs, enterprise & others to use fallow spectrum on a local basis
  - Creates an incentive for licensees to build out more quickly, lease or partition – and to take account of the opportunity cost of non-use/warehousing
  - Demand discovery and lower transaction costs for leasing/partitioning
  - AFC protects incumbents & can give FCC/NRA real-time visibility into use/non-use
- **Secondary Markets are inadequate (e.g., partitioning, leasing):**
  - aversion to enabling competition
  - high transaction costs, cumbersome FCC procedures
  - Preference to maintain option value of unused spectrum
- ***Example: C-band*** –> OTI/BAC proposal to share all 500 mhz immediately for fixed PtMP, the lower 300 mhz opportunistically and AFC controlled

Property Owner Spectrum Rights (Contained Access Facilities)

Spectrum Property Rights: Why Limit Non-Interfering Low-Power Use in CAFs?

- **Question:** Why should a "flexible use" (e.g., PAL) licensee have exclusive rights to use *any* band inside my building on non-interfering basis?
- **Put differently:** If facility owners have exclusive control of building access & power – and can ensure no harmful 'leakage' outdoors – why not first-person spectrum property rights?
- **Contained Access Facility:** In shaping CBRS, the FCC considered authorizing CAFs to use the entire 150 mhz – under SAS control – if emissions to outdoors stayed below a 'harm threshold'
- **Example:** Amazon fulfillment centers are giant Faraday Cages – tens of thousands of robots & workers navigating via Wi-Fi & Bluetooth (but limited to unlicensed bands).
- Why not CBRS or any spectrum?

Thank You!