

CBRS Refresh

WinnForum Webinar Series #30



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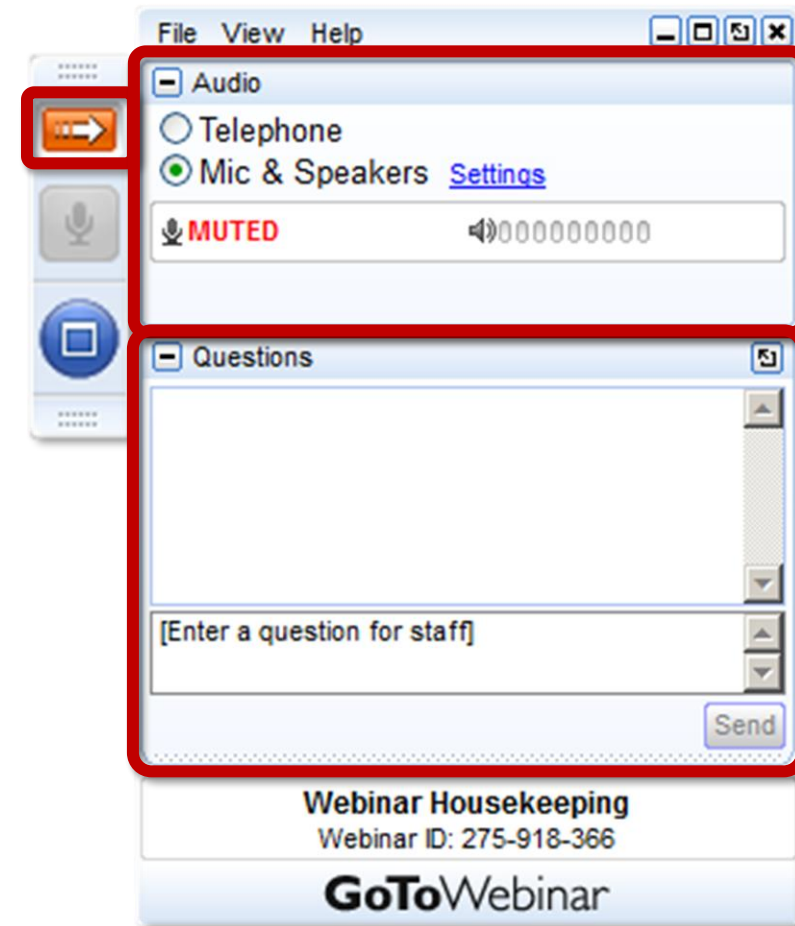
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Agenda

Introductions

- Lee Pucker, CEO, The Wireless Innovation Forum



CBRS Overview

- Richard Bernhardt, National Spectrum Advisor, WISPA



The Practicalities of Sharing CBRS Spectrum With Others

- Andrew Clegg, Spectrum Engineering Lead, Google



How CBRS has Developed Since Commercial Service Began

- Mark Gibson, CommScope



CBRS: AN UPDATED VERSION – REFRESHER SUMMARY



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Now...Let's have fun. 😊 Thanks!



Overview: Loads to Learn, Little Time Here – So Let's Get Started

1. **Why CBRS? Learning about CBRS and its Component Parts.**
2. **Incumbents in the CBRS Band: What does it mean to be an Incumbent?**
3. **Spectrum Access System (SASs) – Frequency & Power Assignment, Protection of Incumbents**
4. **ESCs and Perhaps...Coming Alternatives – Sensing Federal Incumbents**
5. **Shared Use Spectrum (Federal and Commercial Uses in the Same Band) – CBRS layout**
6. **CBRS Tiers of Use**
7. **Priority Access Licensees (PALs)**
8. **PAL and Opportunistic Use – Tier 2**
9. **Generally Authorized Access: GAA Use – Licensed by Rule – Tier 3**
10. **CBRS Equipment Ecosystem: CBSDs, EUDs, Antennas, Domain Proxies**
11. **Installation and Registration: CPIs, TPAs, Registering a Device with a SAS**
12. **Security, PKI, Certificates and Authentication in CBRS**
13. **Making Changes in Anything You do with a CBSD**
14. **Requesting Frequencies – Grants**
15. **Power Chart and Permissible Levels**
16. **Part 90-96 Transition**
17. **Category A and Category B Use**
18. **WinnForum Baseline CBRS Standards**
19. **WinnForum Release 2 CBRS: Enhanced Features, Functions and Capabilities (RI/NRI)**
20. **Markets and Vertical Market Uses for CBRS**
21. **Conclusion: Why CBRS?**

Ah yes, this is a lot, but its not everything. There is even more...



Why CBRS

CBRS is that is:

Flexible and Efficient – Shared Band: Uses 150 MHz of spectrum for a wide-variety of uses including sharing the band with incumbents.

Diverse and Tech Neutral: CBRS is regulated by Part 96 by the FCC and standardized by the Wireless Innovation Forum in its Baseline Standards. The band is technology neutral meaning no particular air-interface or set of technologies is required or determined.

Open for Different Uses and Markets: CBRS can be deployed by traditional means like fixed wireless as well as for mobile uses. Networks can be typical or private. Even neutral host possibilities are possible with CBRS. Many use cases and current deployments.

Best of all Worlds: CBRS provides both Priority Access Licensees (PAL) and Generally Authorized Access (GAA).



Tier 1: Incumbents: Those Protected

- **Incumbents**



- **Federal government – Such as US Navy Radar Systems**
 - Mainly shipborne radar operated in coastal areas
 - Some inland radar sites
 - Protected from aggregate interference due to CBRS
 - Radar activity is generally detected by Environmental Sensing Capability (ESC) networks; some are informed to SASs by the government through a portal



- **Fixed-satellite service (FSS) receive-only earth stations**
 - Approximately 20 extended C-band sites, mostly on east and west coasts
 - Most operate down to 3625 MHz, some down to 3610 MHz
 - Protected from aggregate interference and blocking interference due to CBRS



- **Grandfathered Wireless Protection Zones (GWPZ)**
 - Legacy FCC Part 90 operations in 3650-3700 MHz
 - Most GWPZs have expired starting October 17, 2020 (meaning almost gone...)
 - A few will remain as late as January 2023
 - Protected from aggregate interference caused by CBRS, until expiration
 - Many grandfathered operators are transitioning to CBRS (FCC Part 96)

Spectrum Access System (SAS): CBRS Central Control

If you will the SAS run by the SAS Administrator is the **guiding coordinator of the band**. It fulfills the function of monitoring the use of the band, providing grants and information that are consistent with protecting incumbent users. This allows the **safe shared use** of the band and efficiencies. The SAS is responsible for many things outlined in Part 96, but first it takes the registration of critical information from CPIs (see later) and CBSDs. It is the way you “onboard” onto the CBRS ecosystem. Rules for SASs in Part 96 can be found: *Part 96 at sections: 96.53-96.66*

Spectrum Access System or SAS Administrators coordinate the use of CBRS spectrum in the ecosystem. SASs are private entities. They must follow and **comply with FCC’s Part 96** and they are expected to cooperate in many areas with other SASs (SAS Administrators).

SASs compare notes in their databases during an event called CPAS where all of the SASs show their uses to each other so they can protect incumbents. All CBSDs must be registered with a SAS when active in the CBRS ecosystem and must comply with the SAS.

SASs are certified by the FCC based and based on extensive testing, provided the right to operate. Some SASs operate ESCs while others do not. SASs without ESC rights can only operate with clients into in DPA protection areas.



Protection of Incumbents and Other's Protected

Federal Systems: May be Naval Radar systems and other Federal uses. These uses operate in 3550-3650 MHz and must be protected whenever SASs are notified of their operation.

Fixed Satellite Systems (FSS) (see: FCC Part 96.17): Earth stations operating in: 3600-3700 MHz. These are protected by SASs and operators addressing a known database of FSS recorded use.

Grandfathered Wireless Broadband Licensees (see: FCC Part 96.21): Presently valid Part 90z NN licenses (some 25 MHz, some 50 MHz) that were recorded in the FCC's Universal Licensing System (ULS) at a specific time, are protected so long as they are validly licensed. This is in 3650-3700 MHz.

United States of America Borders (see: FCC Part 96.21): The Canadian and Mexican border of the United States must be protected according to international treaty controls.

Official Quiet Zones: There are official areas where the government proscribes any or specific RF use within a protected area. These "quiet zones" are protected from interference. Some may permit coordinated use.

Responses to Presidential Orders: If the President of the United States declares a specific need for use of the spectrum, SASs and operators/CBSDs must comply. This may mean going off the air in some or all areas or changing frequencies and/or power.

Environmental Sensing Capability (Sensors) – ESCs

What May be Coming with IIC or other Options

Environmental Sensing Capability (ESC): A system that detects and communicates the presence of a signal from an Incumbent User to an SAS to facilitate shared spectrum access consistent with [§§ 96.15](#) and [96.67](#).

ESCs alert SAS Administrators of the presence of the need for protection based on the use of Federal Radar Systems.

Most of the Protection Areas are along the coasts of the United States, but there are some inland protected areas.

Protection Areas for a DPA (Dynamic Protection Area) once activated is around 150-250 KM.

Dynamic Protection Areas (DPAs) may be enabled (notified by ESC) in more than one area. Some areas may be an obfuscation to maintain national security).

The US Department of Defense is considering a possible alternative system to ESCs called Incumbent Informing Capability (IIC) which may provide the need for less protection areas around ESCs and provide other features.

NOTE – After Activation – What Happens?: Within 300 seconds after an ESC communicates that it has detected a signal from a Federal system in a given area, or the SAS is otherwise notified of current federal incumbent use of the band, the SAS must either confirm suspension of the CBSDs operation or its relocation to another unoccupied frequency, if available.

CBRS (3550-3700 MHz) Layout: Shared Spectrum, A Grand Experiment Solution

3550-3700 MHz (Total of Band: 150 MHz). Two distinct portions:

- **3550-3650 MHz (100 MHz):** The lower 100 MHz. Occupied by Federal Incumbents, PAL holders, a few FSS uses, and GAA
- **3650-3700 MHz (50 MHz):** Upper 50 MHz. Occupied by Incumbent Fixed Satellite Service (FSS Ground Stations), Grandfathered Wireless licensees (Active Part 90z NN licenses) and GAA

CBRS is a “shared spectrum” meaning that a variety of incumbent operators/users/uses occupy the same spectrum that is shared with CBRS GAA and PAL operators.

There are two CBRS (Non-Incumbent) Tiers:

GAA: Generally Authorized Access (Licensed by Rule)

PAL: Priority Access Licensees



Tiers of CBRS: PALs and GAA: PALs First

See Part § 96.13 Frequency assignments; and Related Matters:

- **PALs (Priority Access Licensees) operate in the 3550-3650 MHz range.**
- **Each holder of a PAL can hold no more than 40 MHz total PAL spectrum in a PAL auctioned area (partitioned by counties). PALs may be aggregated.**
- **PALs are broken down by 10 MHz allocations of spectrum.**
- **There are no more than seven (7) CBRS PAL 10 MHz slots at any one time in a County.**
- **Auction of the PALs: The first competitively bid auction of CBRS PALs was FCC Auction 105.**
- **PALs may not interfere with Federal incumbents.**
- **10-year renewable (some performance conditions) license**
- **When using an area, must record a PAL Protection Area (PPA) with the SAS**

FCC Part 96: “A holder of one or more PALs. Priority Access Licensees shall be entitled to protection from General Authorized Access Users and other Priority Access Licensees within the defined temporal, geographic, and frequency limits of their PAL, consistent with the rules set forth in this part.”



Priority Access Licensees (PALs)

The area within the Priority Access Licensee's **default protection contour**, as calculated by the SAS in accordance with § 96.25 (or smaller, self-reported protection contour). This area will be protected from interference in accordance with §§ 96.25 and 96.41(d).

PALs: What's Protected? Opportunistic? What if Not Used?

Priority Access Licensees (PALs): Have priority access to frequencies requested of a SAS in the 3550-3650 MHz range. There are a maximum of seven (7) 10 MHz slots of frequency for PALs per county. No holder may hold more than 40 MHz. Must be an eligible user as defined by the FCC and have access to PAL use.

PALs operate within a wholly defined county areas. But a PAL operates as it deploys, not automatically within the entire permitted PAL area. Where not operating, **opportunistic use by GAA may occur**. See: 96.13(c)

Opportunistic use allows any unused portion of a PAL area to be used as GAA spectrum until or unless the PAL claims use by filing a PPA.

Now GAA: Generally Authorized Access (GAA) – Licensed by Rule

- **3650-3700 MHz is reserved for GAA** unless restricted by incumbent or other Rule.
- **3550-3650 MHz is available for GAA use unless occupied by a PAL or used/protected from an incumbent (Federal use, FSS, quiet zones, borders, etc.). If a PAL is not using spectrum which might be assigned as a PAL use if recorded as a PPA, then it may be opportunistically use a GAA.**
- **Seven (7) of the ten 10 MHz slots in 3550-3650 MHz are reserved for PAL use and the remainder are available for GAA use.**
- **GAA is available on a shared use basis.** This means that any operator can request use of GAA spectrum available, whether or not occupied. There is no First In or First Out rights.
- **GAA Operators are expected to “Play Nice in the Sandbox” per the Part 96.35 Rules:**

General Authorized Access Users operating Category B CBSDs must make every effort to cooperate in the selection and use of available frequencies provided by an SAS to minimize the potential for interference and make the most effective use of the authorized facilities. Such users shall coordinate with an SAS before seeking station authorization, and make every effort to ensure that their CBSDs operate at a location, and with technical parameters, that will minimize the potential to cause and receive interference among CBSDs. Operators of CBSDs suffering from or causing harmful interference are expected to cooperate and resolve interference problems through technological solutions or by other mutually satisfactory arrangements.

Using GAA (Licensed by Rule) – Can Anyone Use It? Yes, with Conditions

Per FCC Part 96 GAA Spectrum: General Authorized Access (GAA) Users may operate in the 3550-3700 MHz frequency band.

Open and Unused Spectrum: Any unused (and not requiring protection) CBRS frequency may be considered GAA. The statement, “Use it or share it” means that unused PAL or PAL frequencies not assigned may be used as GAA. If not used by PAL and not required to be protected, the spectrum in the entire CBRS band is open to GAA.

Licensed by Rule: No formal license is required, but GAA users must follow all FCC rules. GAA is Licensed by Rule.

Open to Anyone: All users of any size or network type may use GAA spectrum and request a grant. Grants are in 10 MHz increments. Not FIFO. All who wish to use may use.

Play Nice in the Sandbox/Cooperate: Part 96 requires users of GAA spectrum to “cooperate”. This means intentional interference is frowned upon. Make sure to cooperate in the band.

How Much Spectrum? How Available is the Spectrum? As much as 150 MHz...and yes, you may request it all. Not First In-First Out. May be crowded in dense areas. May require individual coordination or work with the SAS.



CBRS Equipment Ecosystem

CBSDs (Citizens Broadband Radio Service Device) – Category A and Category B: (These are Fixed Devices)

- The FCC has certified many types of CBSDs, which are available for commercial service.
- A complete list of certified CBSDs can be found on the FCC's Equipment Authorization System (EAS) search page
- Choose "CBSD-Citizens Band Category A and B Devices" in the equipment class to get a list of certified CBSDs
 - Category A: Indoor device (may not be deployed outdoors). Antennas may not exceed 6M above ground terrain. Maximum EIRP: 30 dBm (dBm/10 MHz) – This is around 1 Watt. CPI installs unless it can self-geolocate.
 - Category B: Higher power device with maximum EIRP 47 dBm (dBm/10 MHz) or around 50 Watts. Antennas can be higher than 6M.

Domain Proxy: An appropriate Domain Proxy may be used but must be tested in conjunction with an approved CBSD model

EUDs (End User Devices):

- Several dozen end user devices and modules have been certified by the FCC. May not exceed 23 dBm EIRP (approximately 200 mW).
- A complete list of certified CBSDs can be found on the FCC's Equipment Authorization System search page
 - Choose "CBE-Citizens Band End User Devices" in the equipment class to get a list of certified EUDs and modules
 - Examples of EUDs may be cell phones, tablets, small devices like IoT sensors, etc. They may not be "serving" devices like a CBSD. EUDs are low power and they do not register with the SAS.

Certified Professional Installers (CPIs) and Becoming One

A Certified Professional Installer (CPI) is defined by the Wireless Innovation Forum's Specifications and are in response to the need for required "professional installation" cited in Part 96 for most CBSD (any CBSD indoor which cannot geolocate, or which operates like a Category B device; and all Category B devices). Note...a CPI does not need to be the individual who actually deploys/installs the radio/CBSD. However, the CPI is responsible for the accuracy of information provided to the SAS about that installation.

A CPI must be trained and certified by a TPA. WinnForum sets for the specifications and protocols for CPIs who are trained by authorized Training Program Administrators (TPAs) who offer commercial courses and certification to become and maintain status as a CPI. [Quick humorous note: Another speaker on this Webinar is Dr. Andy Clegg...he was the first trained and certified CPI. He uses his bragging rights...☺*]**

CPIs once certified, hold their status for five (5) years (may be renewed by appropriate process) as long as they are in good standing. They must stay up-to-date.

All CPIs hold their status as individual, even if they work for another entity or employer. CPI status runs with the holder.

CPIs are responsible for the accurate entry of required data with the SAS for CBSD registration.



Resources Around Installation, CPI, and TPAs

So, what does a CPI do and what does someone need to know to become a CPI?

At the time of this taping (yes, I'm dating myself) there are over 4,000 trained and certified CPIs.

CPIs are trained by TPAs and the information about CPIs and TPAs can be found here:

<https://cbrs.wirelessinnovation.org/cpi-training-program> (CPI Training Program Information)

<https://cbrs.wirelessinnovation.org/release-1-standards-specifications> (CBRS Baseline Standards - look for -0247 Technical Specification)

What must be registered with a SAS before operating a CBSD:

- **See: 96.57 of Part 96 on Registration and Authentication by a SAS of CBSDs**
- **AND**
- **See: WinnForum Baseline Standards: Registering a CBSD with a SAS:**
- **WINNF-TS-0112**

Security, PKI, Certificates and Authentication

WinnForum Baseline Standards take into account security of the band. WINNF-TS-0065 and WINNF-TS-0071. <https://cbrs.wirelessinnovation.org/release-1-standards-specifications>

SASs, CBSDs, and CPIs must utilize according to the security specifications, PKI (Public Key Infrastructure) certification. These are used by the SAS to authenticate the CPI installing CBSDs and to cross-reference CBSDs to assure they are valid, not rogue systems. CPIs work with approved PKI vendors so that the keys can be issued and maintained. See WINNF-TS-0022. <https://cbrs.wirelessinnovation.org/release-1-standards-specifications>

Because incumbents have sometimes critical and vital functions, protection of incumbents requires an extra degree of assurance and authentication. Also, because the ecosystem carries uses which may be sensitive, protecting the ecosystem is also very important. The use of registration information, references to current databased, and such things as PKI certification are some means to protect the CBRS ecosystem.

Registering with a SAS

After acquiring CBSD(s), in order to operate on the CBRS band, the CBSD must be registered with the SAS of choice. Sometimes SASs are connected by agreement with manufacturers, others market themselves independently, but the choice of SAS is not governed by any specification or rule. It is the operator's choice.

Each SAS has a front-end to register CBSDs. This may differ from SAS to SAS, but each one has at least the requirements in the Baseline Standards (WinnForum) for registration requirements.

Registration requirements include things like (see: WINNF-TS-0112): Serial Number of the CBSD, FCC ID, make-model of the CBSD, user ID, air interface type, sensing capability, location information (including latitude, longitude, antenna height above ground level, CPI information and authentication (if CPI required), and optional information like vendor specific information, additional antenna information and more.

Requesting Frequencies/Grant and Power

Each CBSD can request information about available spectrum ranges. This is known as a spectrum inquiry.

Each CBSD, in order to operate, must request (offline from CBRS frequencies except as provided by Rule for CPE-CBSDs) a grant, which is a range of frequencies and a power level (equating to something either in Category A or Category B). The SAS then reviews the request and provide response codes which may deny the request or otherwise; or may provide a grant which allows the CBSD to come online in a specific frequency range at its current location at a given power.

Power Comparisons of CBSDs and EUDs

CBDS Type	Maximum EIRP (dBm/10 MHz)	Maximum EIRP (dBm/MHz)	Antenna Height (Meter)
Category A	30 dBm or 1 watt	20 dBm	< 6 meters
Category B	47 dBm or 50 Watt	37 dBm	> 6 meters
End User Device	23 dBm or 200 mili Watt	NA	NA

Citizens Broadband Radio Service Device (CBSD) Categories

Device	Max EIRP per 10 MHz	Indoor Operation	Outdoor Operation	Professional Installation Required?
Category A CBSD	1 W	Allowed	Allowed at or below 6 m HAAT, otherwise must be operated as Category B	If unable to geolocate to required accuracy (50 m horizontal x 3 m vertical)
Category B CBSD	50 W	Not allowed	Yes. No height limit.	Always
End User Device (EUD)	200 mW	Must be under control of a CBSD. SAS does not manage EUDs nor does it have any knowledge about EUDs.		

New Equipment v. Older Equipment (Can Older Equipment be Upgraded or Used in CBRS?)

Current equipment utilized for RF transmission and radio functions under Part 90 may or may not qualify for transition into the Part 96. This will primarily on the ability to comply with Part 96 rules; including such things as radio frequency operating range, power limitations, out-of-band emissions and the ability to connect to a SAS or a Domain Proxy among other considerations.

Most important is that any equipment operating under Part 96 must tested and certified for Part 96 operation. All operating equipment (with a few exceptions provided in the Rules) must be able to operate in all 150 MHz, be controlled by a SAS, and conform to the requirements of the CBRS Band.

As the 3650-3700 MHz band has been in use while different technologies have been in play, it is possible some equipment may be able to be tested, certified and transitioned, while others cannot. The manufacturer of the equipment should be able to provide guidance on whether the needed aspects for Part 96 operation can be provided by upgrade (such as software defined changes), firmware changes or other changes.

Policies governing the use of the 3650-3700 MHz band – Part 90z

§ 90.1319 Policies governing the use of the 3650-3700 MHz band. (What was and is going away)

- (a) Channels in this band are available on a **shared basis only** and will not be assigned for the exclusive use of any licensee.
- (b) Any base, fixed, or mobile station operating in the band **must employ a contention-based protocol**.
- (c) Equipment incorporating an unrestricted contention-based protocol (i.e. one capable of avoiding co-frequency interference with devices using all other types of contention-based protocols) may **operate throughout the 50 megahertz of this frequency band**. Equipment incorporating a restricted contention-based protocol (i.e. one that does not qualify as unrestricted) may operate in, and shall only tune over, the lower 25 megahertz of this frequency band.
- (d) **All applicants and licensees shall cooperate in the selection and use of frequencies in the 3650-3700 MHz band in order to minimize the potential for interference and make the most effective use of the authorized facilities.** A database identifying the locations of registered stations will be available at <http://wireless.fcc.gov/uls>. Licensees should examine this database before seeking station authorization, and make every effort to ensure that their fixed and base stations operate at a location, and with technical parameters, that will minimize the potential to cause and receive interference. Licensees of stations suffering or causing harmful interference are expected to cooperate and resolve this problem by mutually satisfactory arrangements.

Citizens Broadband Radio Service (CBRS) is Regulated by 47 USC Part 96

See Also WinnForum Specifications

CBRS is an FCC approved band under 47 USC Part 96. In order to use the band, all operators, equipment providers and users must comply with FCC Rules.

<https://www.ecfr.gov/current/title-47/chapter-I/subchapter-D/part-96>

CBRS Standards have been created by WinnForum. Both the WinnForum Baseline Standards (Release 1) and Additional Features, Functions and Capabilities (Release 2) can be found on the WinnForum Website:

<https://cbrs.wirelessinnovation.org/>

<https://cbrs.wirelessinnovation.org/release-1-standards-specifications>

Release 2 Enhancements: <https://cbrs.wirelessinnovation.org/enhancements-to-baseline-specifications>



Category A and Category B CBSD Devices

Category A CBSD. A lower power CBSD that meets the general requirements applicable to all CBSDs and the specific requirements for Category A CBSDs set forth in §§ 96.41 and 96.43.

Category B CBSD. A higher power CBSD that meets the general requirements applicable to all CBSDs and the specific requirements for Category B CBSDs set forth in §§ 96.41 and 96.45.

WinnForum Baseline Standards (Release 1)



WinnForum Release 2 – Enhanced Features, Functions and Capabilities

WinnForum provides for additional features, functions and capabilities to enhance and complement the CBRS ecosystem. These functions (mostly optional and at the choice of both the SAS and the CBSD) are additive to the WinnForum Baseline Standards and are sometimes referred to as Release 2.

Backwards Compatible. The functionality or capability must function both with the new capacity and the Baseline Standards (Release 1).

May be approached by WinnForum as: a) Non-Regulatory Impacting – something which does not affect the FCC Rules or incumbent protection; or b) Regulatory Impacting which likely requires approvals, perhaps testing, and some authority to enact.

Examples of Release 2 Features, Functions and Capabilities may include (some may be under consideration): a) Passive DAS with CBRS; b) Enhanced Antenna Patterns; c) Grouping, d) Flexible Grants...and more.

Specialized CBSDs: CPE-CBSDs

For CBSDs that are locating in areas (generally rural) where no other means exists to connect to the SAS to undergo authentication, registration, and gain a grant, certain devices may use a protocol which is designed to allow the CBSD to connect through an access point/eNodeB in a controlled manner to enter the CBRS ecosystem.

These devices are known as CPE-CBSDs and they must follow a specific Knowledge Database (KDB) of the FCC in order to be allowed to connect in this fashion. The requirements and methods can be found here, known as handshake procedures:
<https://apps.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?switch=P&id=229297>

What can CBRS be Used For? Markets and Deployments

Medical/Dental Office and Hospitals and Centers &	Airports and Campuses
Telemedicine	Oil and Gas
Education (K-12 and Higher Ed) & Remote Education	Energy
Industry and Commercial	Healthcare, Doctors Offices/Clinics and Telemedicine
Security and Surveillance	Power and Utilities Systems
Hospitality and Accommodations	Telecommunications
Venues, Stadiums, Public Places	Transportation
Retail Business and Offices	IoT and IIoT as well as use with AI
Multi-Family Residential	Entertainment
Multi-Tenant Enterprise (MTEs) and More.

Sample CBRS Deployments

Applications for CBRS Networks may include (indoor and outdoor):

Delivery of a Private Network limited to a specific group of credentialed users or interconnected with differing rights allowing roaming into other networks.

Delivery of Video Content: This might be in high-intensity security and surveillance uses where cameras are used with CBRS networks, or it might be for the delivery of entertainment and video/audio services and more.

Mobile Communication Networks: CBRS is used today in back-office deployments for networks designated for company employees; or, for use in much wider applications such as stadiums and large public forums. Mobile networks and extensions of fixed networks to mobile (e.g., nomadic).

Internet of Things (IoT/IIoT) and Sensor Based Controllers or Reporting: CBRS may be used in industrial applications for continuous or time-base measurement, device control, geofencing and a wide-array of industrial, research, and other applications.

Neutral Host Networks (NHN): CBRS offers a unique opportunity for independent sources to provide access to more than one provider. This opens the ability to centralize equipment, but diversity offerings and access.

New Specific Use Cases – Under WInnForum Release 2

WInnForum Release 2 Standards provides new and incremental options for creating new features that add to use choices and function in CBRS.

While Release 2 is just beginning, examples of uses/features which can be added are virtually endless. For example, a group can be created to define a specific need.

Example: Groups and Grouping: Single or Common Frequency Group/Use

If a network depends on operating on a common frequency, they may designate that need by defining a group which fits that need. In the case of common frequency group, for example, an operator may seek to have multiple client devices (CPE) on the same frequency as the base station (or eNodeB) or base stations. This permits the SAS to understand that such grouping is important, and if there is any move or transition needed, the SAS will consider the common frequency requirement in its grants or changes.

Specific Examples of CBRS Use Cases

Precision Agriculture, Agricultural Advancement, Dairy: Agricultural vendor using lots of continuous data to surveil and track country farming fields. Building out an LTE CBRS system for continuous monitoring and provision of connectivity in the fields. Use of CBRS in farming buildings and with farming equipment. Utilizing a back-up to the cloud. Utilizing IoT sensors in the fields as controllers of things like watering and other field activities and sensing (such as moisture, etc.). Geography: Central United States.

Fixed Wireless WISP: WISP (Wireless Internet Service Provider) providing rural Internet services to under-served and rural environments where there is currently no or little connectivity. Using low power small cells and keeping costs down but able to deliver to a broad area. Geography: California.

CBRS Takes the Place of Another Band: Focus on SAS providing a model for WISPs utilizing towers for green field deployments and applications. Replacing 2.5 GHz (licensed) deployments with CBRS. Providing service for IoT/IIoT hosted core solutions with advanced CBRS equipment. Providing full end-to-end support in CBRS. Geography: Unstated.

Passive DAS: Deploying in-building Passive DAS system with CBRS. Geography: Unstated Geography.

Smart City: Deploying a Smart City application for interactive use with utilities. Geography: Ohio

More Examples of Use Cases

Oil and Gas and Energy Sector: A hardware vendor in the fixed wireless access space. They deliver "large scale solutions". They operate in oil and gas and energy solutions and see CBRS OnGo in both fixed and mobile solutions for oil/gas/mining deployments. And, in IIoT and large-scale industrial uses. Geography: Nationwide.

Cable Options: Large provider is examining fixed wireless access solutions compatible with their cable deployments. They will get back with FWA about a range of solutions they see possible along their strands and in combination with cable deployments.

Mobility: Large providers of networked MSO services provides nationwide coverage using a diversity of spectrum bands. CBRS qualifies as a 5G mid-band. It can utilize the spectrum to deliver services on a primary or secondary basis adding access to more spectrum for consistent service.

Other examples are in transportation systems.

Conclusion: CBRS Provides New Options in a Diverse Band

CBRS utilizes standards from the Wireless Innovation Forum (WinnForum) to create a green field for development of networks which provide uses only defined by need.

Where a specific target is needed, Release 2 of the WinnForum Standards now allow for permitted Customization and enhancement of functions, features and uses of the Band for even greater deployment possibilities.

Release 2 is incremental and can be added to as demand is created in the CBRS ecosystem. This permits new uses or expanded uses to be created that fit many needs.

As evidenced during the Pandemic, providing more accessible broadband solutions equals more services, even at a distance including the promotion of commerce even in an emergency.

We want to hear about your use, technology integration, use of the WinnForum Standards, and how CBRS deployments are making a difference.



Questions and Contacts

Have questions? Now is the time to ask. Please use the chat function in this Webinar to ask questions you have about CBRS and its use.

Contacts:

Richard Bernhardt
National Spectrum Adviser
Wireless Internet Service Providers Association (WISPA)
Co-Chairman, Spectrum Sharing Committee (SSC)
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Sharing the CBRS Band

21 June 2022



CBRS is a Shared Band

- **CBRS is a shared band**
- **CBRS has lower priority than incumbent operators**
- **Some incumbents are dynamic, some are static**
- **Also:**
 - Within CBRS, GAA must protect PALs and PALs must protect each other
 - CBRS must respect certain protections granted by the FCC's general rules, such as quiet zones
- **In this presentation, we'll go through these various protection requirements that can impact CBRS operations**

- **Much more extensive information about incumbent operations is available in [WinnForum Technical Report TR-5003](https://winnf.memberclicks.net/assets/CBRS/WINNF-TR-5003.pdf), “**CBRS Incumbent Protections and Encumbrances Overview**”**
 - URL if the link above isn't active: <https://winnf.memberclicks.net/assets/CBRS/WINNF-TR-5003.pdf>

Incumbent DoD Radar

- **Military radars are the predominant incumbent in the band**
- **The most frequently operated radars are shipborne and therefore impact coastal areas, but:**
 - Some radars operate at inland sites
 - Some inland radar sites operate in the lower adjacent band and are protected from CBRS out-of-band interference
- **Shipborne radar operations occur in 3550-3650 MHz, but some inland sites operate in the entire CBRS band (or below, as noted above)**
- **Most radar operations are dynamic and therefore their impact on CBRS operations are too**

Incumbent Fixed-Satellite Service Earth Stations

- **Non-government fixed-satellite service (FSS) earth stations also occupy the CBRS band**
- **The earth stations are receive-only, and SASs must manage CBSDs so as to not cause interference to the earth stations**
 - Interference does not occur into CBRS from the earth stations because the earth stations transmit in the 6 GHz band, if they transmit at all
- **The earth stations that receive in the CBRS band are limited to those that listen to international satellites (Europe and Asia) and are therefore clustered along the east and west U.S. coasts**
- **Depending on earth station, FSS uses frequencies as low as 3600 MHz**
 - Some protections exist for a small number of adjacent-band earth stations above 3700 MHz but those protections have relatively small impact on CBRS and will likely be re-examined in light of the migration of FSS out of the 3700-3980 MHz band in the contiguous U.S.

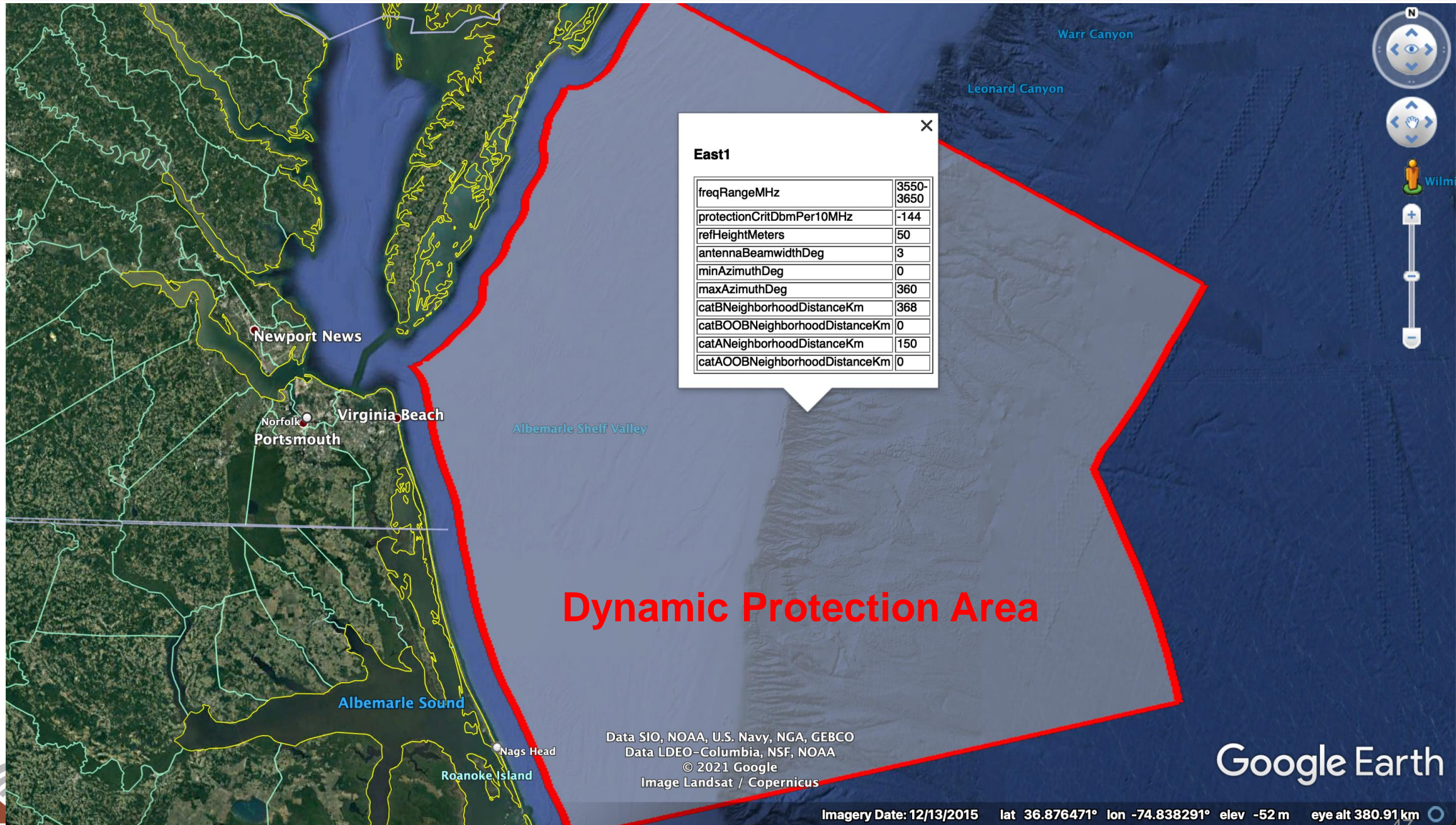
Quiet Zones and Coordination Zones

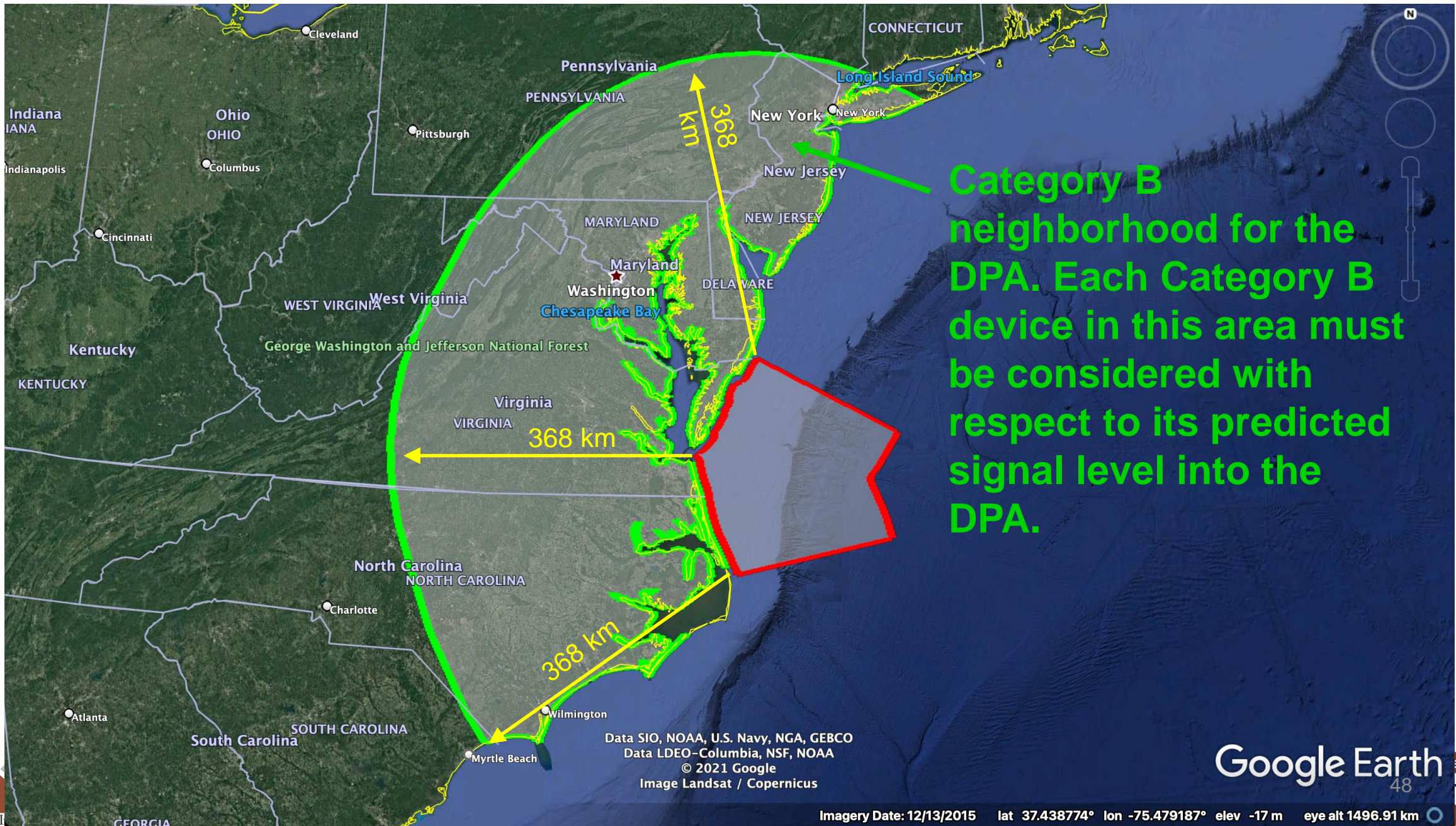
- **The FCC rules (47 CFR 1.924) require respecting certain coordination and quiet zones**
- **Generally speaking CBRS operations within these zones is possible with the proper advanced coordination and if the CBSDs do not exceed the required interference criteria**

Incumbent Legacy Broadband Operators

- **Some legacy broadband operators use the upper 50 MHz of the CBRS band (3650-3700 MHz)**
- **Such operations and protections are in the process of sunseting and will no longer be a factor after January 2023**
- **This presentation will not focus on protection of legacy broadband since it is going away in a short time**
 - See Section 5 of [TR-5003](#) for more information

DoD Protections





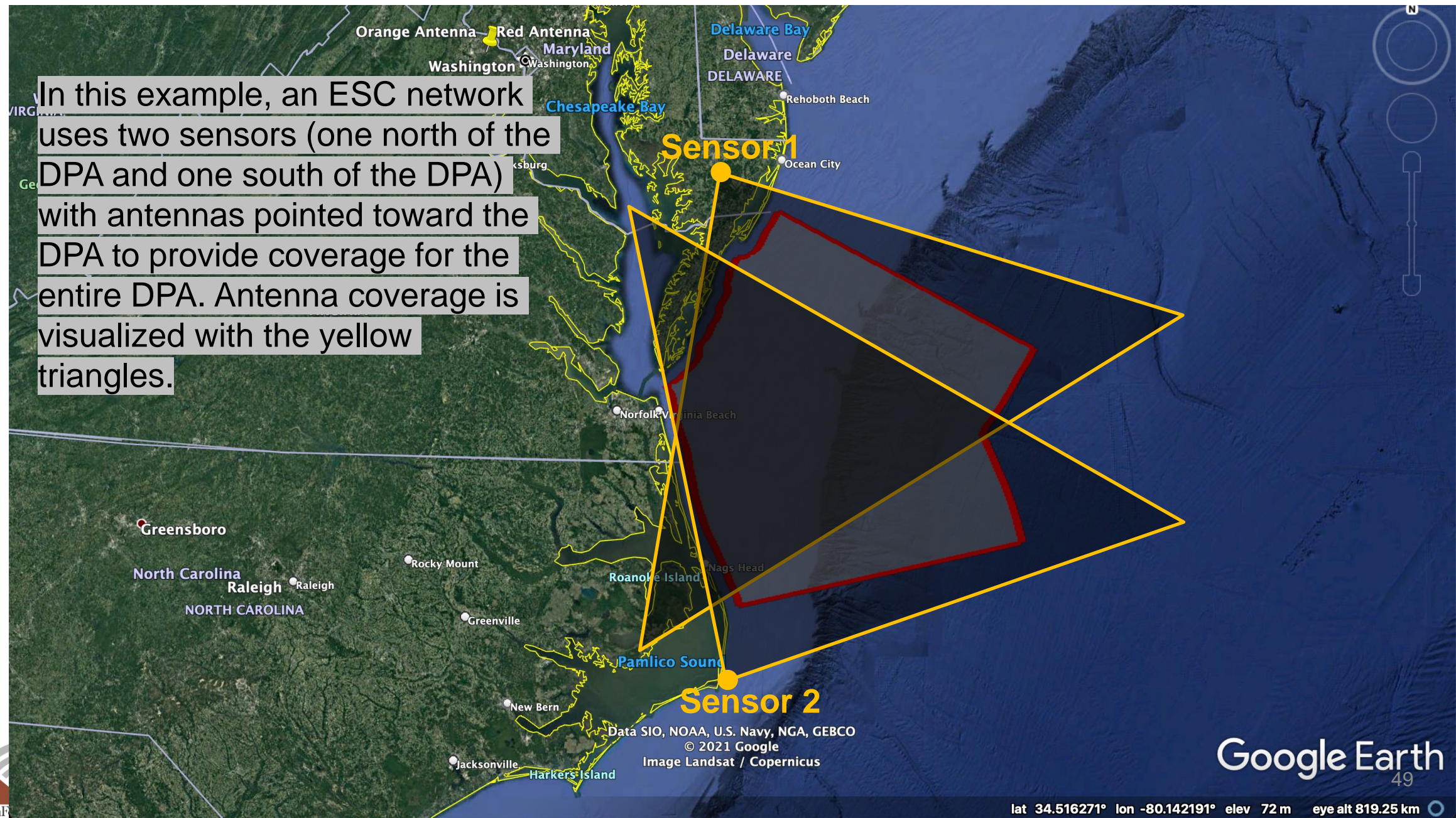
Category B neighborhood for the DPA. Each Category B device in this area must be considered with respect to its predicted signal level into the DPA.

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
© 2021 Google
Image Landsat / Copernicus

Google Earth

Imagery Date: 12/13/2015 lat 37.438774° lon -75.479187° elev -17 m eye alt 1496.91 km

In this example, an ESC network uses two sensors (one north of the DPA and one south of the DPA) with antennas pointed toward the DPA to provide coverage for the entire DPA. Antenna coverage is visualized with the yellow triangles.



**Coastal DPAs in the Contiguous U.S. (red)
and their Cat B Neighborhoods (green)
Note: Dynamically active**

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
US Dept of State Geographer
© 2021 Google
Image Landsat / Copernicus



Downsides of ESC

The need to protect ESC sensors from interference creates dead zones (“whisper zones”) around sensor sites where CBRS deployments must be prohibited or curtailed

- WInnForum has released a Technical Report describing the issue. See [TR-1015](#), “Potential Metrics for Assessing the Impact of ESC Sensors and Networks on CBRS Deployments”

Whisper zones cover 3550-3650 MHz and are always active

SSC WG1 ESC Sensor Impact Task Group
ESC Sensor Impact Metrics
WINNF-TR-1015-V1.0.0

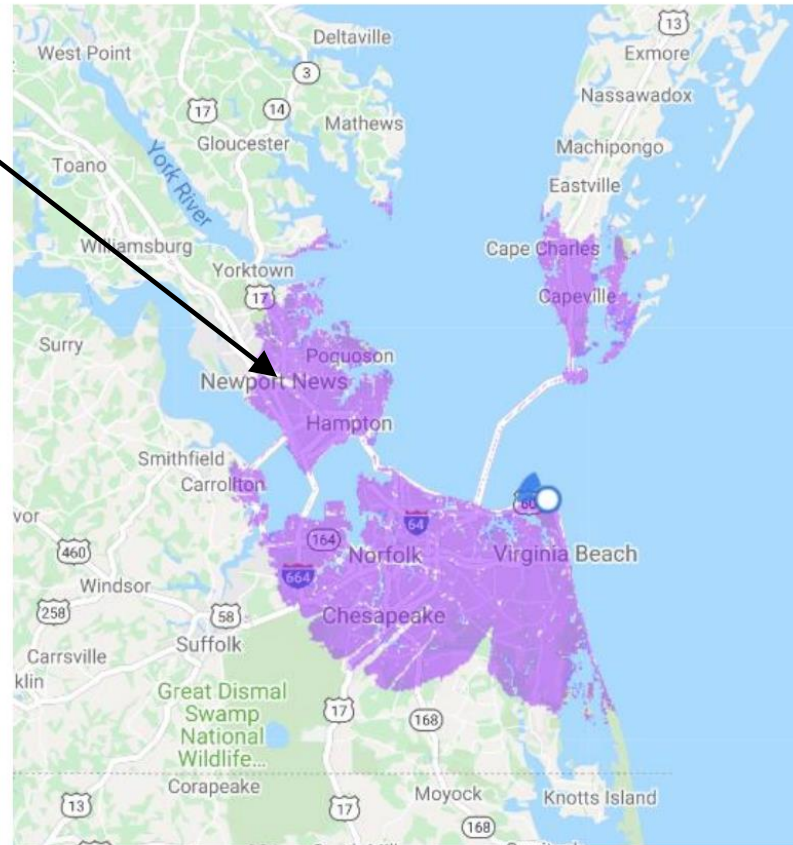


Figure 6: Impact (whisper zone) of the imaginary sensor atop the Cape Henry lighthouse.

Alternative to ESC: Portal-Managed DPAs/IIC

- **The use of a particular DPA at a particular frequency range can be notified through a calendar-like portal, instead of by sensing**
- **Avoids the need for whisper zones**
- **The incumbent controls the information flow**
- **Commonly referred to as Informing Incumbent Capability, or IIC**
- **Portal-managed DPAs/IIC are already being used in CBRS for a few sites through a lightweight framework based on Google Calendar**
- **DoD is moving toward a government-managed portal; not yet online**

Portal-Managed DPAs in the Contiguous U.S.

Not shown: Barking Sands HI and American Samoa

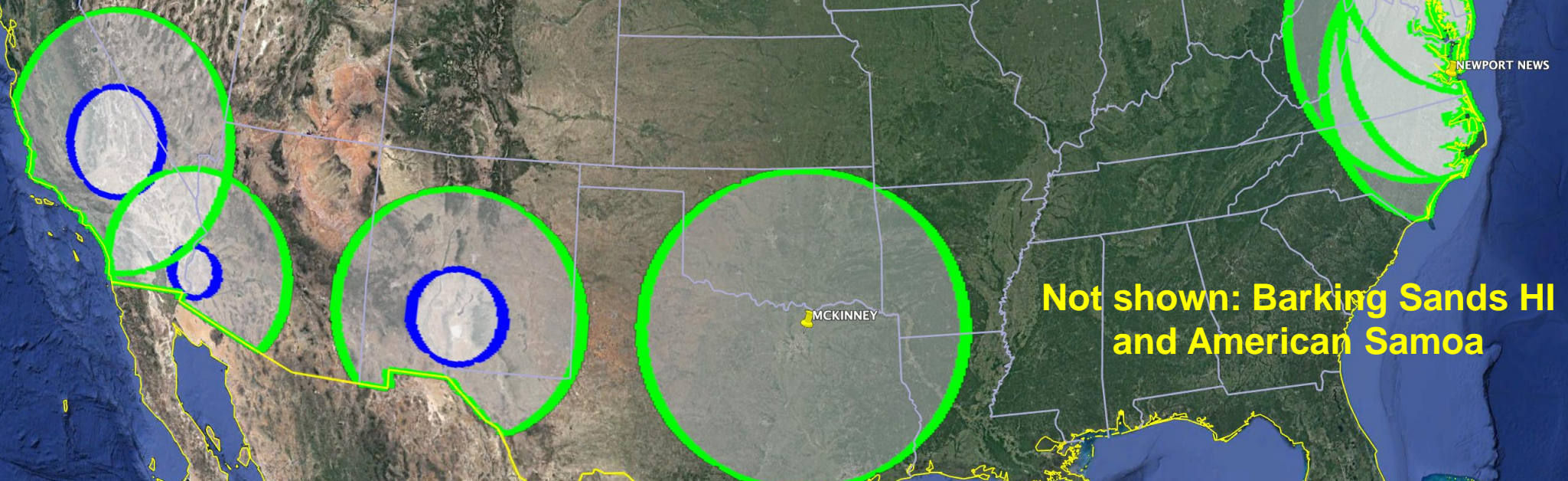
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Google Earth

lat 38.537066° lon -68.721096° elev -3684 m eye alt 3876.01 km



Portal-Managed DPA Neighborhoods (In-band Category B) in the Contiguous U.S. Note: Dynamically active



Not shown: Barking Sands HI
and American Samoa

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US Dept of State Geographer
Image Landsat / Copernicus

Google Earth

Imagery Date: 12/13/2015 lat 38.422203° lon -97.107900° elev 407 m eye alt 3876.01 km

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Portal DPAs

- **The portal DPAs require adjacent band protections below 3550 MHz when active below 3550 MHz**
- **The Category B OOB neighborhood is fixed at 25 km. There are no Category A neighborhoods**
- **This requirement is being revisited in light of the new 3.45 GHz Service high-power deployments in 3450-3550 MHz**

Ground-Based Radar 3 (“GB3”) Sites

- **A few sites around the country must be protected from CBRS OOB**E at all times
- **These sites use a radar referred to as Ground-Based Radar 3 (GB3) that operates below 3550 MHz**
- **Category B neighborhood distances around GB3 sites range from 2-13 km depending on site**
- **Category A neighborhood distance is 1 km for all GB3 sites**
- **OOBE protections for GB3 sites are also being reconciled with the new 3.45 GHz Service deployments**

GB3 Sites with Nominal 8 km Cat B Neighborhoods

Note: "Always-on" OOB/E protections



Wireless Innovation Forum

Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google Earth

Imagery Date: 12/13/2015 lat 36.398294° lon -94.229276° elev 380 m eye alt 3842.10 km

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Wireless Innovation Forum

DoD Exclusion Zones

- **A few DoD sites create exclusion zones for CBRS operations in portions of the CBRS band**
- **In the 3650-3700 segment, there are 80-km radius exclusion zones around three sites in Pascagoula MS, Pensacola FL, and St. Inigoes MD**
- **In the 3550-3650 MHz band, operations are forbidden at the Nevada Test and Training Range**

Always-on Exclusion Zones

3550-3650

3650-3700

3650-3700

Google Earth

Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2020 Google
US Dept of State Geographer



How often does DoD Radar Activity Impact CBRS?

- **Depends on location and frequency**
- **Recall that some protections are static (“always-on”), such as GB3 OOB protection and exclusion zones**
- **Coastal DPA activity depends on location and only impacts parts of the 3550-3650 MHz range**
 - In some areas, activations are infrequent (once a month or less)
 - In some areas (Norfolk, San Diego), 2-4 CBRS channels in 3550-3650 MHz may be taken out for a few hours a few times per week
 - DoD does not currently allow publication of activation statistics, but please refer to [ITS occupancy report](#) based on long-term monitoring
 - San Diego & Norfolk ~14%
 - Oregon & San Francisco <= 1%
 - Note that SASs apply a 2 hour additional activation time after last detection. We are working with DoD to shorten this period

Resources for DoD Radar Information

- The KML files showing ESC-monitored DPAs (e-dpas), portal-monitored DPAs (p-dpas), GB3 sites (gb-dpas), and exclusion zones (exz) are published on the [NTIA web site](https://www.ntia.doc.gov/fcc-filing/2015/ntia-letter-fcc-commercial-operations-3550-3650-mhz-band) (<https://www.ntia.doc.gov/fcc-filing/2015/ntia-letter-fcc-commercial-operations-3550-3650-mhz-band>)
- Also, please refer to [Technical Report TR-5003](https://winnf.memberclicks.net/assets/CBRS/WINNF-TR-5003.pdf), “**CBRS Incumbent Protections and Encumbrances Overview**”
 - (<https://winnf.memberclicks.net/assets/CBRS/WINNF-TR-5003.pdf>)

Fixed-Satellite Service Protections

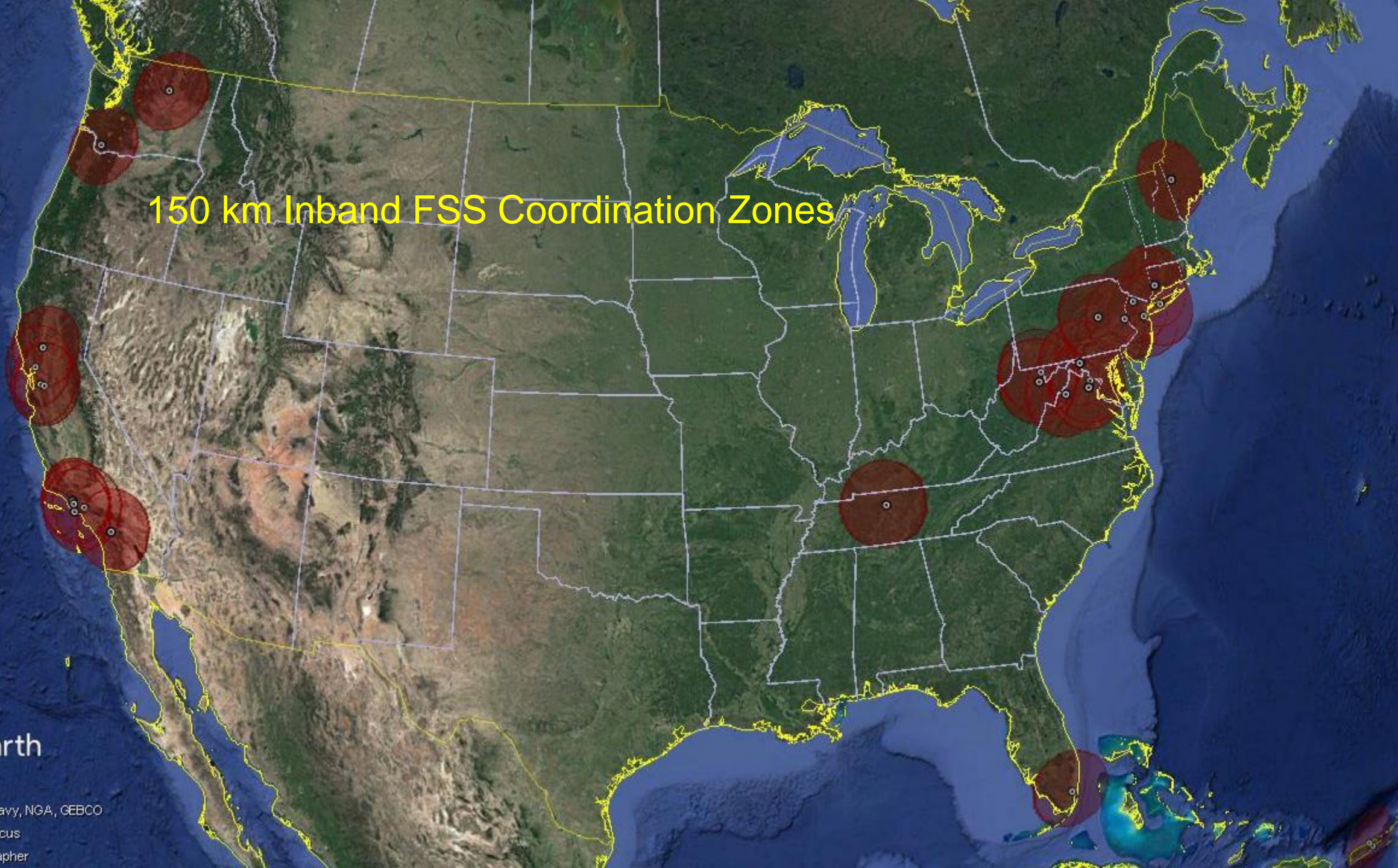
FSS Protections

- **Much simpler than DoD protections**
- **Effectively static**
- **FSS earth stations that operate below 3700 MHz are protected from co-channel aggregate interference and from blocking interference**
- **Earth stations are protected from co-channel interference in their registered band of operation, which may extend to as low as 3600 MHz**
- **FSS earth stations above 3700 MHz that are used for TT&C are protected from blocking and OOB interference**
 - All CBSDs within 40 km are taken into account
 - These protections are generally only a factor within a very short distance of the sites (~1 km or less) and potentially going away soon due to the reconfiguration of the 3700-3980 MHz band
- **All co-channel CBSDs within 150 km are included in aggregate interference calculations**
- **All CBSDs within 40 km are analyzed for blocking interference**

150 km Inband FSS Coordination Zones

Google Earth

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Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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JS Dept of State Geographer



40 km Adjacent Band FSS Coordination Zones

Google Earth

Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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US Dept of State Geographer

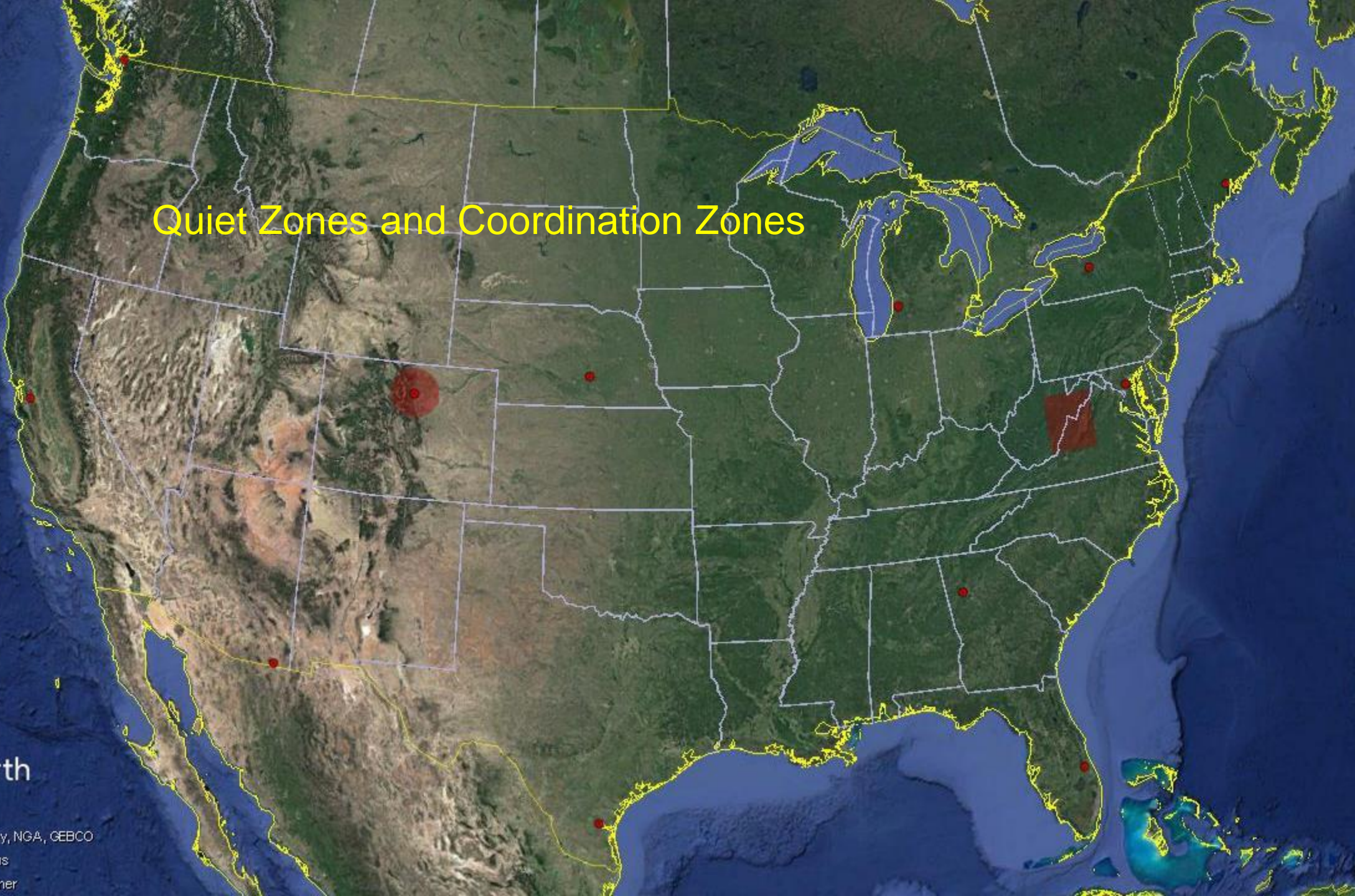


Quiet Zones and Coordination Zones

Quiet Zones and Coordination Zones

Google Earth

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JS Dept of State Geographer



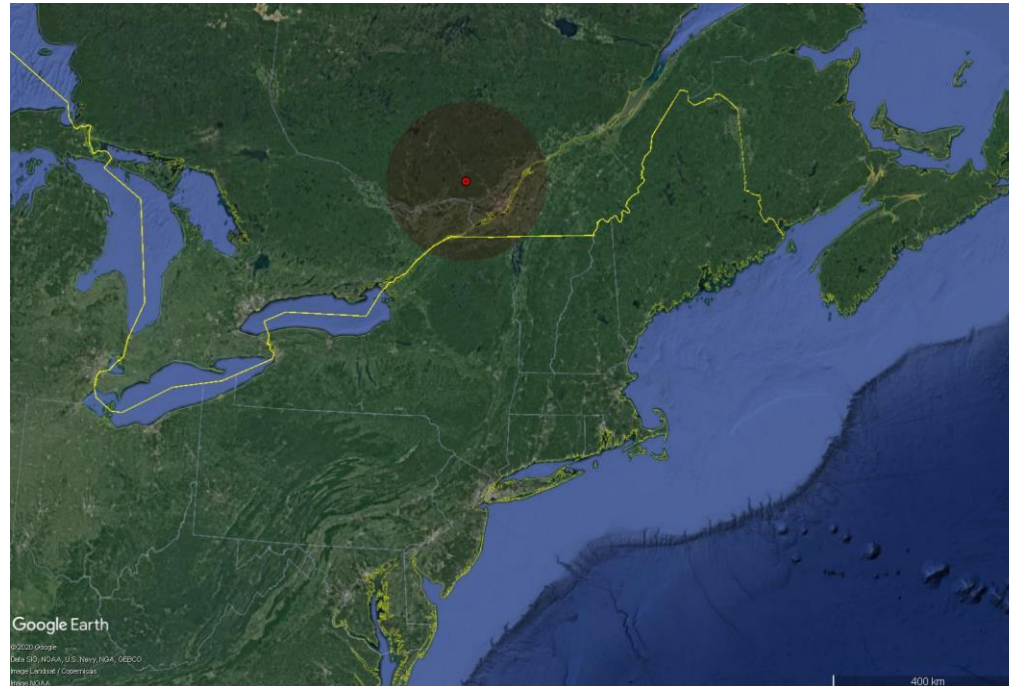
FSS Protections

- **National Radio Quiet Zone (NRQZ), West Virginia/Virginia/Maryland**
- **Table Mountain Coordination Zone, Boulder CO**
- **FCC field offices (various)**

Border Protections

Border Protections

- **SAS/CBSDs must respect terms of international agreements with Canada and Mexico**
- **Current agreement currently exists with Canada; none with Mexico**
- **Current Canadian agreement covers 3650-3700 MHz only**
 - 8 km (CBSD antenna pointing generally away from Canadian border)
 - 56 km (CBSD antenna pointing generally toward Canadian border)
- **Co-channel protection of an FSS site located in the province of Quebec that operates in the 3615-3620 MHz segment**



Slide 70

Conclusions

- Refer to [TR-5003](#) for lots more detail
- Talk to your SAS Administrator

Thank You!



CBRS SO FAR

HOW CBRS HAS DEVELOPED SINCE COMMERCIAL SERVICE BEGAN

June 21, 2022



Agenda

CBRS Update

Use Cases

CBRS UPDATE



PAL Licensing

- **Gross Proceeds: \$4,585,663,345**

Licenses won: 20,625 / 2,946 counties

Licenses not sold: 2,006 / 287 counties

- **\$/MHz-pop: ~ \$0.216921**

- **271 qualified bidders**

- **228 winning bidders**

- **17,703 licenses granted to date**

Top 20 Winning Bidders

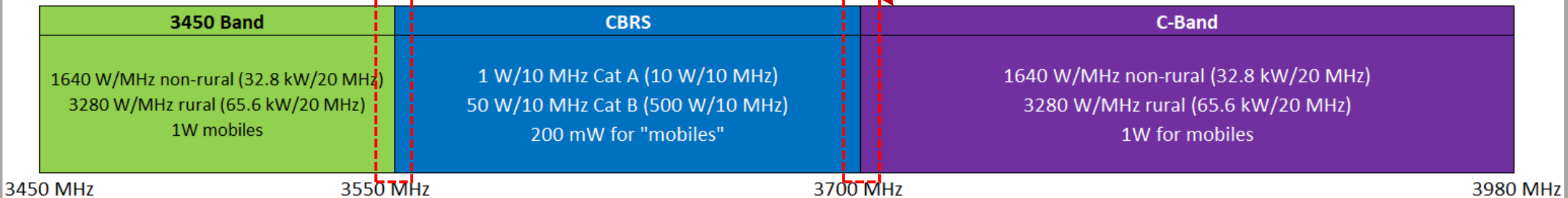
	Company	Bidding Entity	Number of Licenses Won	Net Payment
1	Verizon	Verizon Wireless Network Procurement	557	\$1,893,791,991
2	Dish Network	Wetterhorn Wireless	5,492	\$912,939,410
3	Charter	Spectrum Wireless Holdings	210	\$464,251,209
4	Comcast	XF Wireless Investment	830	\$458,725,900
5	Cox	Cox Communications	470	\$212,805,412
6	Southern California Edison	Southern California Edison Company	20	\$118,951,433
7	Windstream	Windstream Services	1,014	\$38,534,863
8	Mediacom	Mediacom	576	\$29,478,887
9	Nextlink Internet	AMG Technology Investment Group	1,072	\$28,489,750
10	JBG SMITH	SEAD	7	\$25,274,477
11	Sempra Energy	San Diego Gas and Electric Company	3	\$21,273,340
12	ATN International	SAL Spectrum	1,569	\$20,396,530
13	Claro Puerto Rico	Puerto Rico Telephone Company	231	\$18,887,528
14	Alabama Power	Alabama Power Company	271	\$18,878,280
15	Shentel	Shenandoah Cable Television	262	\$16,118,381
16	VTX1 Companies	VTX Communications	112	\$15,373,263
17	Viaero	NE Colorado Cellular	558	\$15,087,268
18	U.S. Cellular	United States Cellular Corporation	243	\$13,538,232
19	Watch Communications	W.A.T.C.H. TV Company	517	\$10,942,047
20	Cable One	Cable One	547	\$10,544,441



We Have New Neighbors

- TDD Frame Sync coordination
- RF coordination
- Coordination with CBRS ESC operators to protect "whisper zones"
 - [WINNF-RC-1016-v1.0.0](#)
- Coordination processes TBD

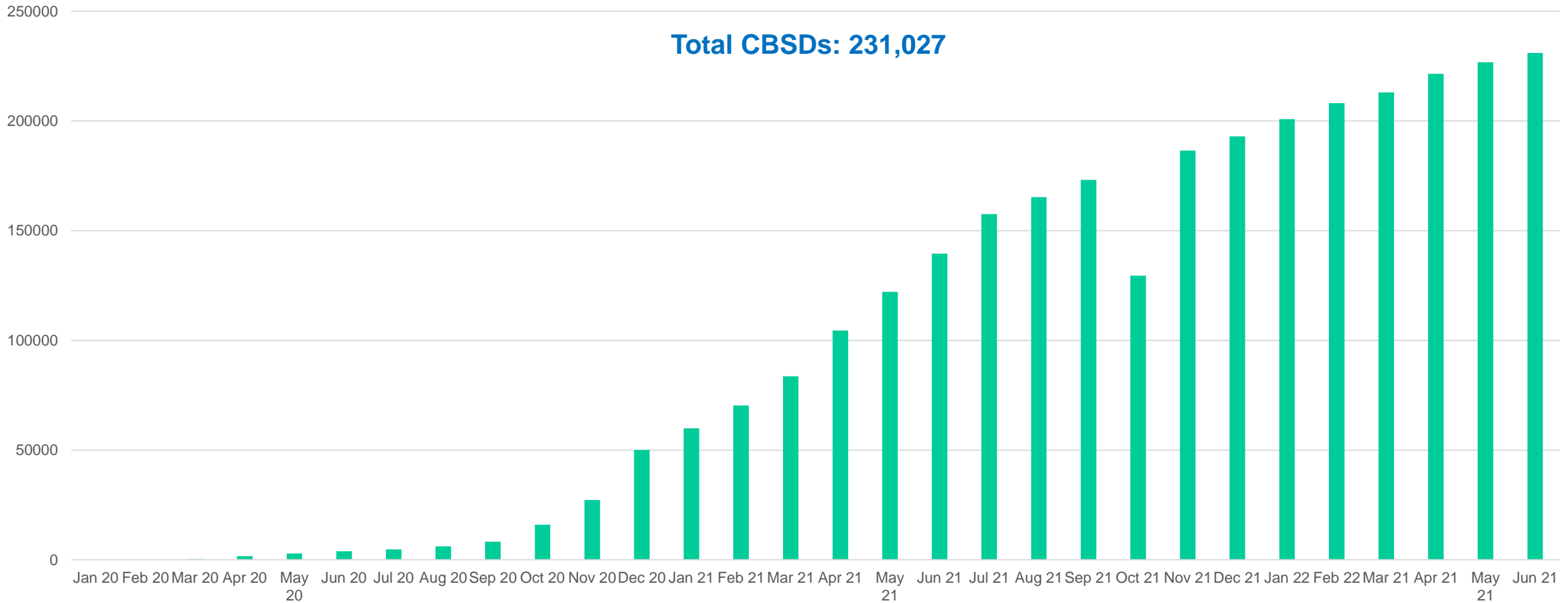
- 3.7 GHz Technical Working Group 4 [report](#)
- TDD Frame Sync coordination
- RF coordination
- Coordination process TBD



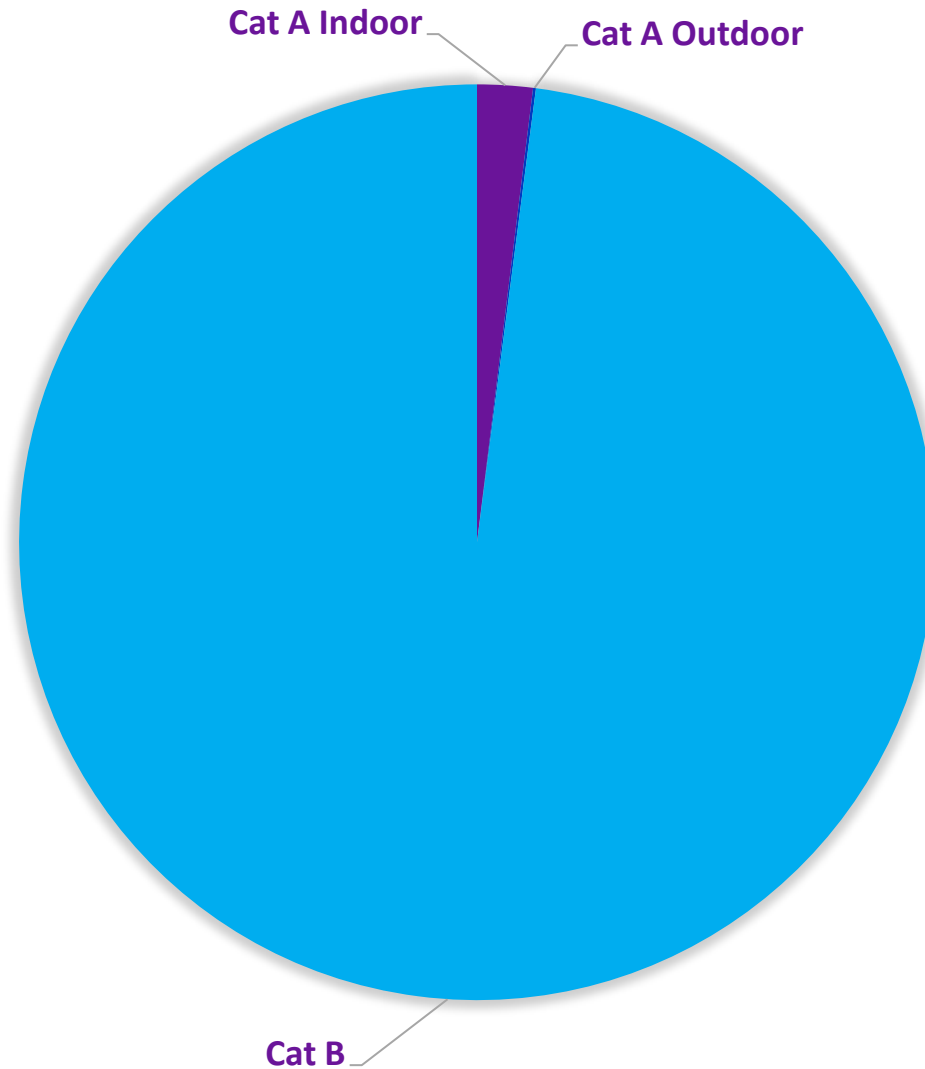
CBSD Deployment Growth Since Commercial Launch

Cumulative CBSD Deployments

Total CBSDs: 231,027



Category A vs Category B Deployments

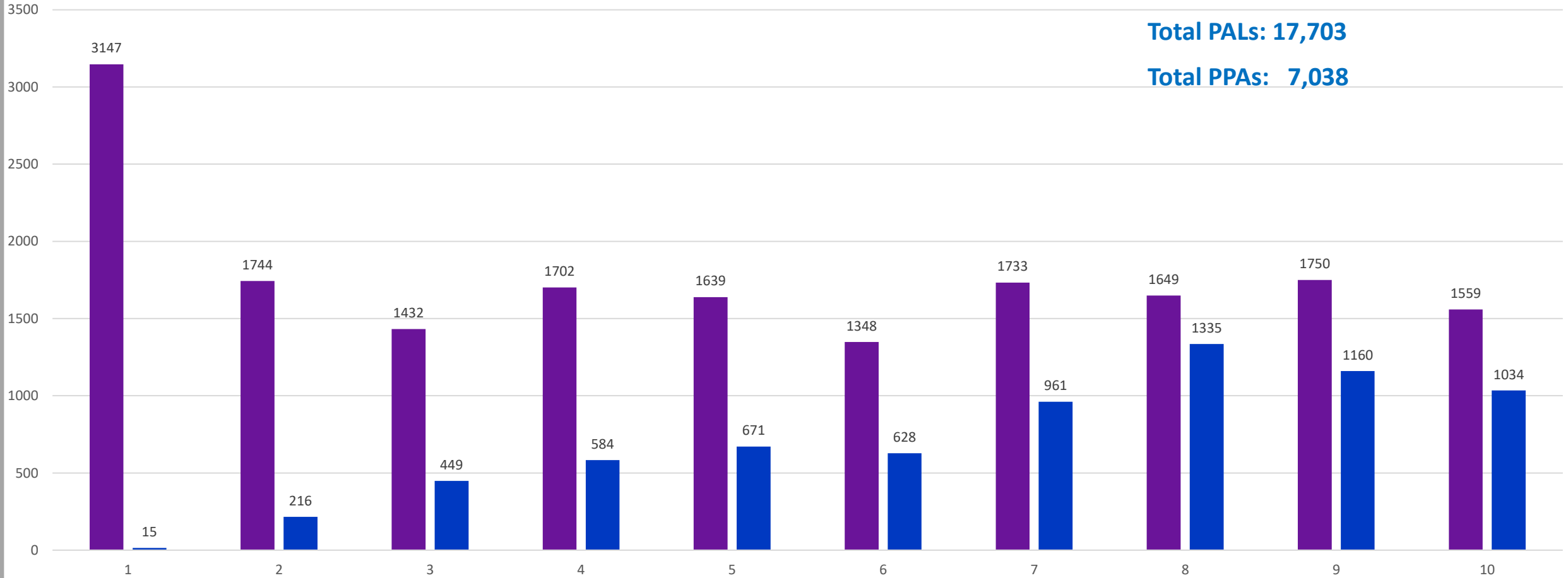


PAL Licensing

PAL Status

Total PALs: 17,703

Total PPAs: 7,038



■ # of PALs ■ # of PPAs

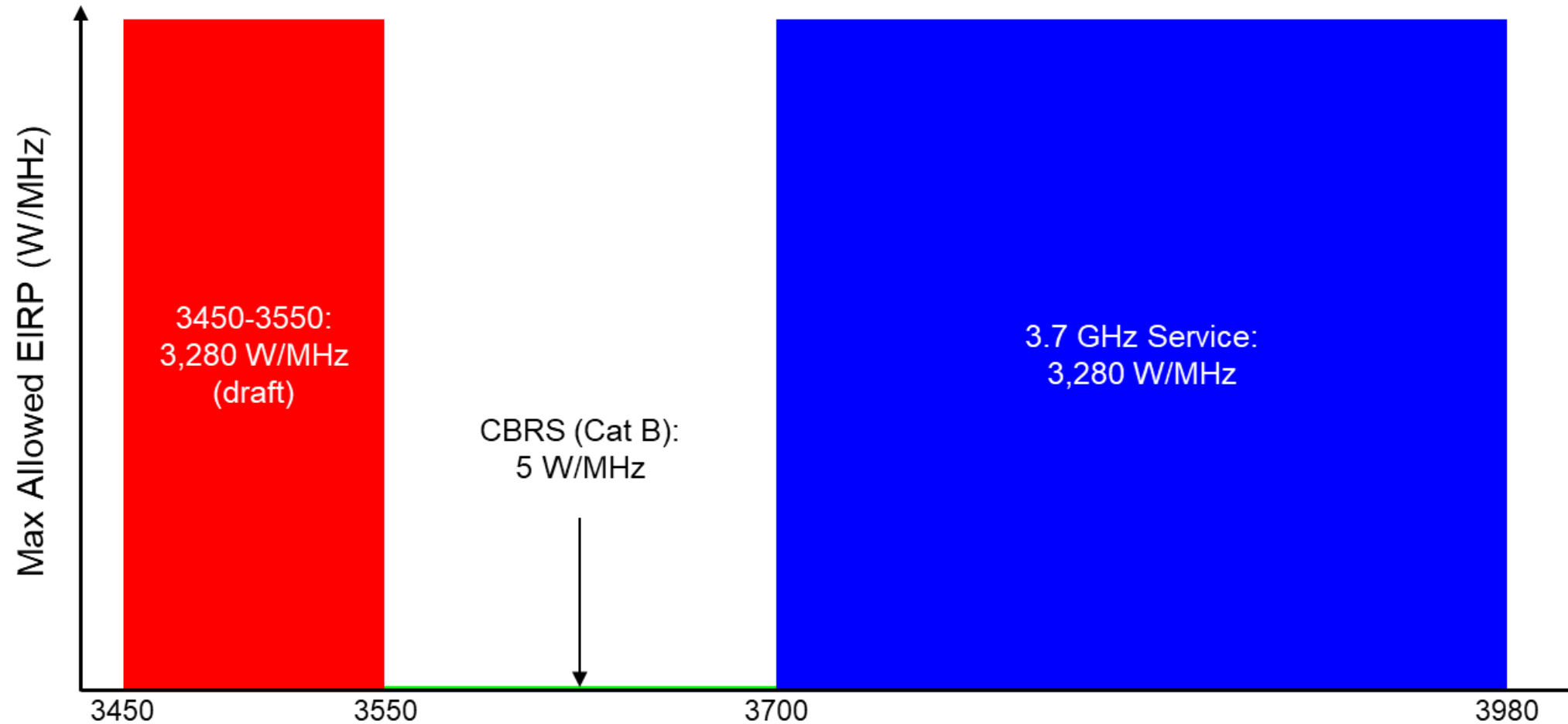


Key Activities / Issues / Updates

- **Part 90 to 96 transition winding down**
- **PAL Channel Assignment began in May 2021**
- **Secondary market s l o w l y developing**
- **Working on adjacent-band coordination**
- **Also working on ESC interference protection**

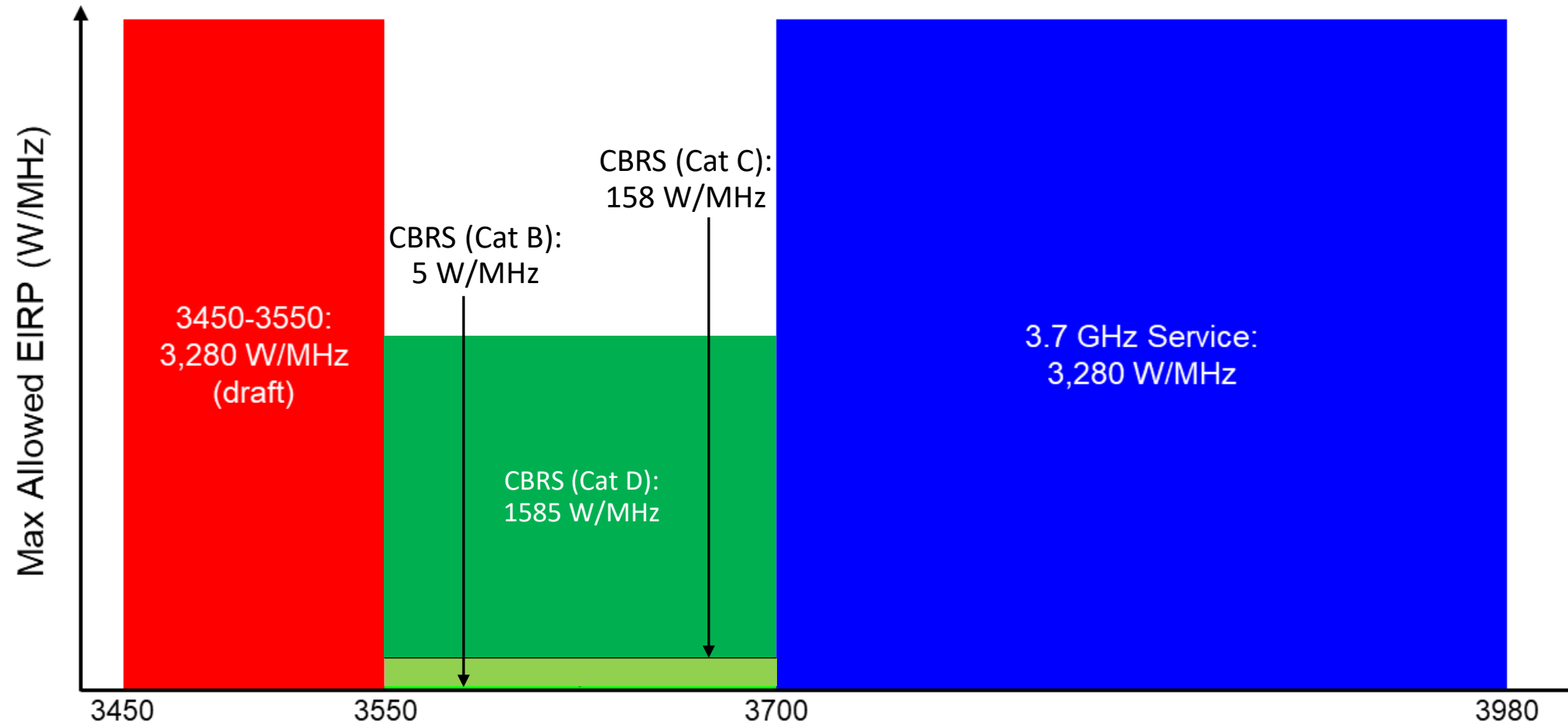
Higher Power Proposal

Current CBRS Max Power Compared to 3.45 GHz & 3.7 GHz



Higher Power Proposal

Proposed CBRS Max Power Compared to 3.45 GHz & 3.7 GHz



USE CASES

Private Markets

- **FWA early adopter**

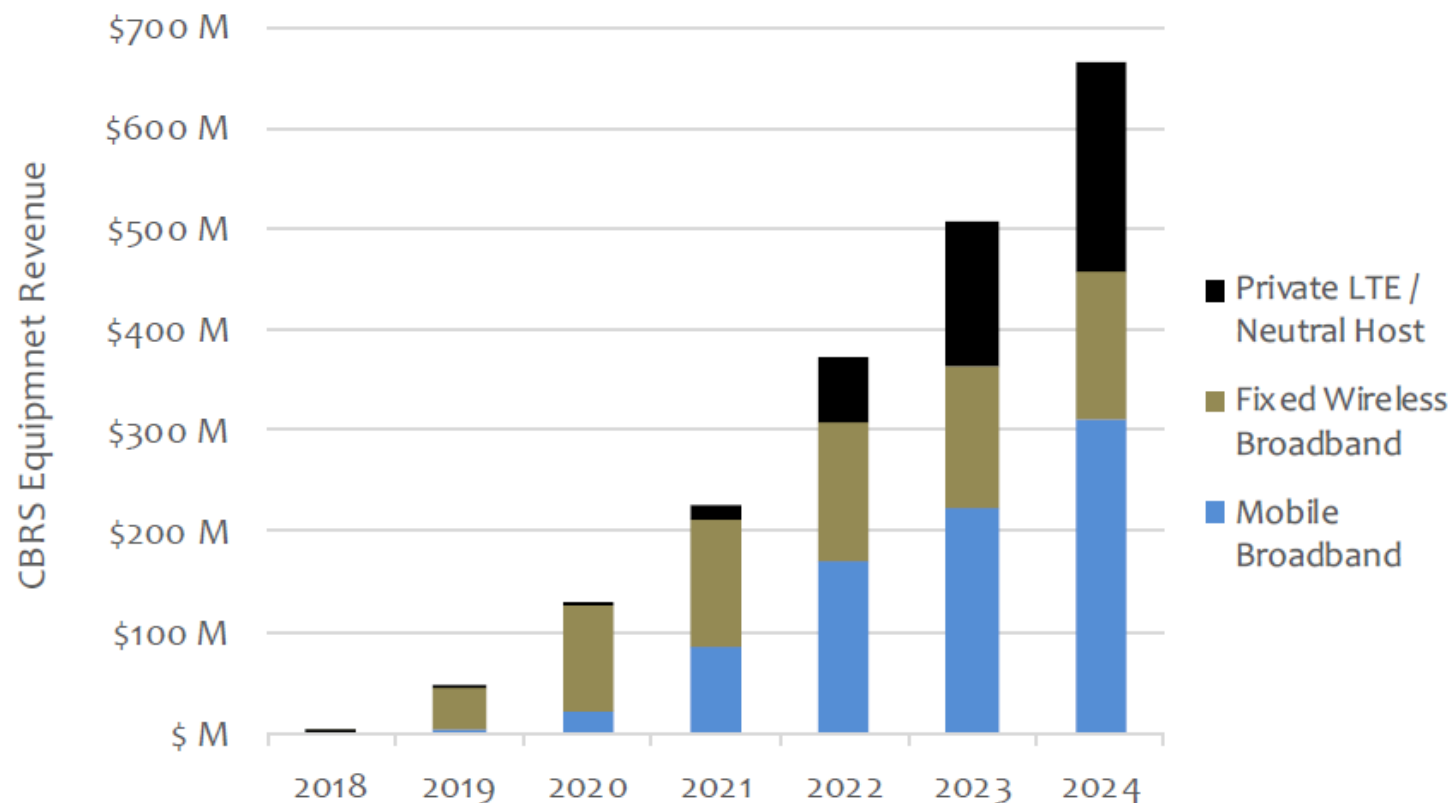
Part 90 conversion

Software Upgrade

GAA

- **Mobile gains momentum with PAL availability**

- **P-LTE opens opportunity for bundled service offerings**

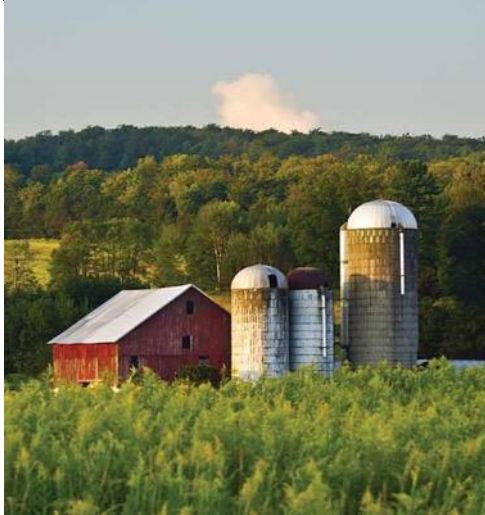


Source: Mobile Experts



CBRS Applications

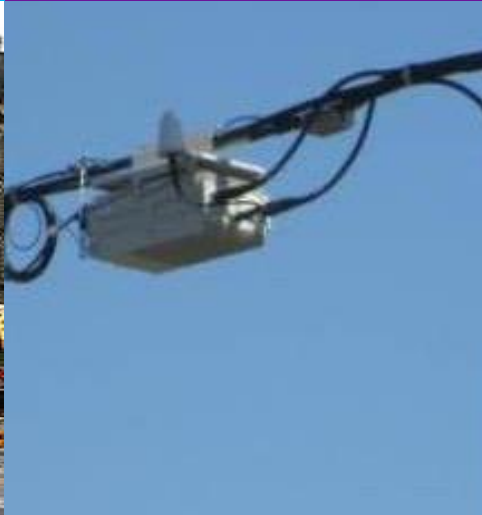
Fixed Wireless
Broadband



Mobile Capacity
Augmentation



Alternative Mobile
Footprint



Private LTE



In-Building
Cellular



- Operational use cases
- Network owner also controls the devices
- High-value use cases that can't be solved with Wi-Fi

Use Cases

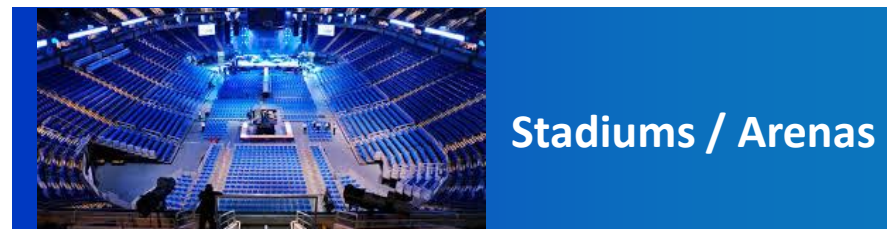
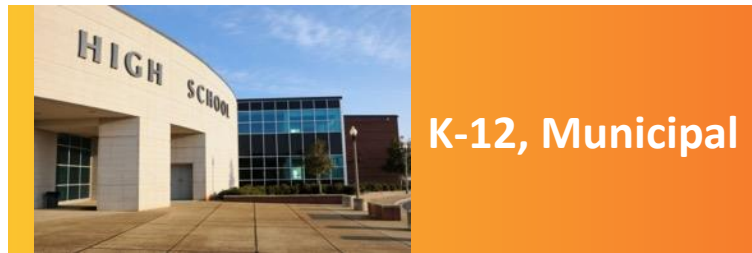
Critical enterprise connectivity needs that can be addressed with CBRS LTE

Cross-vertical opportunities:

- IP Video camera backhaul
- IoT Gateway
- Equipment / Asset Tracking
- Kiosks / Digital Signage
- PTT / Critical Communications
- Temporary broadband access

Industry-specific opportunities (representative):

- Mobile Point Of Sale
- Bar Code Scanners / Mobile Computers
- Nurse Call
- Remote operations
- Mining / Agriculture / Oil and Gas
- Police/Ambulance video upload
- Traffic control
- Wi-Fi on buses



Use Cases

CBRS for COVID-19 Triage Centers

- Initial deployments at Duke and Rush Medical Centers
- Delivers broadband to Triage tents
 - Easy to deploy
 - Uses existing devices
 - Secure, long-range connection
 - Plenty of capacity for critical use cases
- Using Cradlepoint and MiFi clients



Use Cases

CBRS for COVID-19 School Network Extension

- **Response to COVID-19 stay-at-home mandates**
- **Home broadband for Video Classroom and Homework**
 - Closes the Digital Divide
 - Pew Study: High percentage of low-income students live within 1 mile of school
 - All content, security and privacy filters of the school network are extended to the home network
 - Avoids school becoming ISP
- **Using Cradlepoint or ARRIS NVG558 at the home**



Thank You!

