

SHARING THE 4.4 GHZ BAND

EXTENDING AMERICAN LEADERSHIP IN SPECTRUM ACCESS

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1. Executive Summary

Spectrum is a finite American resource with extremely high demand by our government, commercial enterprises, and American consumers more generally. In a short span, broadband connectivity has evolved from a "nice to have" across our homes, businesses, and schools into a critical "must have" to keep pace with an increasingly fast-paced digital world. Wireless connectivity powered by spectrum has been – and continues to be – a key component of this dynamic broadband connectivity.

AI's rapid rise is now driving another major societal and technological transformation. While the exact shape and form of AI's development and deployment remains uncertain, its rapid adoption and accelerating diffusion across the economy substantially raise the stakes and critical importance of broadband connectivity in our country. Spectrum will play a central role in that AI connectivity, and spectrum policy decisions must prioritize allocating spectrum to its highest and most efficient use, benefitting as many providers and users as possible.

Over the past six years of full commercial CBRS operation, spectrum sharing has emerged and grown into a successful method of putting spectrum to use quickly and efficiently, accommodating multiple new users and uses while fully protecting incumbent operations such as critical military systems. As we cross the threshold to a new era of innovation – one centered on AI, robotics, and advanced enterprise connectivity – opportunities for spectrum sharing should be front and center as policymakers examine how to get more spectrum into the marketplace.

The *Working Families Tax Cut Act*¹ (WFTCA) and the December 2025 presidential memorandum "Winning the 6G Race"² both identified the 4400-4940 MHz band ("the 4.4 GHz band") as a band to study for potential use for commercial broadband, whether on an exclusive basis, a

¹ Public Law 119-21, [Working Families Tax Cut Act](#) (formerly known as the *One Big Beautiful Bill Act*) (July 4, 2025).

² Presidential Memorandum, ["Winning the 6G Race"](#) (Dec. 19, 2025).

shared federal/non-federal basis, or a combination of the two. The band is today allocated primarily to critical federal operations — fixed and mobile links, “ship shore ship” and “air ground air” communications, transportable stations, and radio astronomy — in service of agriculture, defense, homeland security, law enforcement, and scientific research. The National Telecommunications and Information Administration’s (NTIA’s) interagency study of the band is expected to begin no earlier than fall 2026.

This paper examines the opportunity for shared use of the 4.4 GHz band in the context of existing federal uses, while fully protecting those uses. The sharing mechanisms we describe could make bandwidth available to commercial users quickly and efficiently — helping the United States meet its national objectives by making spectrum available for AI and enabling the US to win the race to 6G — while avoiding unnecessary delay and undue impact to current and future federal operations. Our analysis is independent of, and complementary to, any reallocation of a portion of the band for high-power exclusive licensing, which would in any case lag well behind the shared-use mechanisms described here. Policymakers should question the assumption that “clear and auction” is the most appropriate — much less the only — path to commercial access in this band.

Shared spectrum maximizes the potential of the 4.4 GHz band. A sharing approach — in which commercial users coexist with federal incumbents under a coordination framework — is not merely a pragmatic compromise; it is the architecture best suited to the band’s technical characteristics, the nation’s economic interests, and the imperatives of national security. Sharing would bring more commercial spectrum online faster, allow more efficient use of scarce spectrum bandwidth, provide the type of spectrum necessary for the development, deployment, and use of AI, strengthen America’s private-networking ecosystem, and allow critical federal missions to adapt to what the future may bring.

More usable spectrum, sooner. Clearing federal incumbents requires relocating mission-critical systems — historically a process taking a decade or more and costing billions of dollars, with significant friction from existing users and timelines that routinely slip. Sharing requires no such

relocation: commercial deployment can begin once a coordination system is operational, and federal systems remain in place. Because sharing carves out no exclusive block, the full breadth of the band is available wherever and whenever incumbents are not using it — often far more bandwidth, in the dense urban and suburban markets where demand is greatest, than any realistic clearing scenario would yield.

National security preserved, with a dual-use dividend. Clearing is a one-way door: once incumbents vacate and exclusive licenses are granted, reclaiming that spectrum as missions evolve becomes practically impossible. Sharing preserves federal access as a permanent, adaptable feature of the band. It also yields a dual-use dividend — the public and private networks that shared spectrum enables run on the same commercial technology base that already supports defense deployments at installations such as MCLB Albany and NAS Whidbey Island and can provide a resilient communications fabric in a crisis.

Efficient deployment and a connected AI ecosystem. The band's propagation characteristics favor precisely the dense, small-cell, and indoor architectures that a sharing framework's power and coordination constraints naturally encourage, maximizing spectral reuse and total capacity per square kilometer. Those same characteristics make the band well suited to private networks, an area in which the United States already leads due to the availability of the 3.5 GHz CBRS band. Lightly licensed and shared-access tiers put dedicated spectrum within reach of manufacturers, ports, utilities, and healthcare and research institutions — the industrial innovators driving smart manufacturing, automated logistics, and AI-enabled robotics — without the prohibitive cost of large-area exclusive licenses. While the verdict is out on whether AI will generate new load on wide area macrocell networks – or possibly reduce the load – early experience suggests that robust private networks will be essential to establishing a national advantage in robotics, enterprise logistics, and other high-value AI use cases. Shared spectrum is tailor made for unlocking exactly these kinds of opportunities.

The 4.4 GHz band today. As discussed below, publicly available sources show that federal use of the 4.4 GHz band is extensive and widespread. It is one of the most highly utilized bands ever

considered for repurposing. Based on assignment data, uses of the band include fixed point-to-point links — on the order of a few thousand, with the largest portions operated by the Department of Agriculture for forestry programs and the Department of Energy for supervisory control and other purposes. The Navy’s “ship shore ship” operations, including the Cooperative Engagement Capability, are the next most prevalent and are used in and near coasts and ports. The remainder comprises aeronautical telemetry and “air ground air” links (predominantly downlink, concentrated on military bases and test ranges), largely military mobile systems, a small number of non-federal satellite earth stations, radio astronomy at 4825–4835 MHz across 17 remote sites, and military research and testing. The federal band study starting in fall 2026 should refine this picture, but nearly every incumbent operation shares a characteristic — a fixed location, a coastal footprint, a base boundary, or a known site — that makes it well suited to interference protection in a shared spectrum environment.

A hybrid coordination framework. We propose, as a strawman for further analysis, a hybrid framework assembled from coordination systems already proven at scale. Fixed point-to-point links would be protected by an Automated Frequency Coordination (AFC) system of the kind already managing roughly 70,000 commercial links in the 6 GHz band. Because federal system details are not public, a federally operated AFC can return obfuscated frequency availability that reveals nothing about sensitive incumbent operations. A single federally operated AFC could further account for aggregate interference across all secondary devices, going beyond current 6 GHz practice. Ship shore ship, aeronautical, radio astronomy, and mobile operations would be protected by Dynamic Protection Areas such as those successfully in use today. Fixed-satellite earth stations would be protected by coordination zones similar to those used to protect fixed-satellite operations today in the extended C band.

The economics of spectrum sharing compare favorably to a “clear and auction” approach.

Comparing implementation cost, time to market, marginal value, and net revenue, a medium-power shared framework compares favorably with clearing. Sharing avoids relocation costs that could reach tens of billions of dollars; it makes spectrum commercially usable far sooner; and it directs marginal capacity to where spectrum scarcity is most stark — the industrial, enterprise,

and private-network users who cannot justify large-area exclusive licenses — rather than to a mobile market that is effectively saturated.³ Even considering auction proceeds, the appropriate comparison is net rather than gross revenue: a shared, auctioned license tier carries little clearing cost and generates proceeds far earlier, so its net return to the Treasury can rival or exceed that of a cleared exclusive auction. Sharing is naturally conducive to the widest range of spectrum users and uses, resulting in more robust auction participation. These advantages serve core national objectives: a broader base for innovation and competition, a foundation for AI deployment, stronger industrial competitiveness at a moment when China is organizing its manufacturing strategy around dedicated industrial spectrum,⁴ and preservation of the defense and critical-infrastructure systems already in the band, rather than a forced choice between economic gain and national security.

In summary. Sharing in the 4.4 GHz band is not only highly feasible, it compares favorably against the alternatives. It is therefore worthy of serious study as the interagency process proceeds, and the framework outlined here is offered as a basic model to build upon. While a small amount of spectrum in the band could be cleared for exclusive licensing, it makes sense to study how much can be shared so that we can best meet national objectives.

2. Shared Spectrum Maximizes the Potential of the 4.4 GHz Band

The 4.4 GHz band represents one of the most significant opportunities to expand mid-band spectrum access in the United States. However, the path to realizing that opportunity depends critically on the framework chosen to govern its use. A shared spectrum approach, in which commercial users coexist with incumbent federal operations under a coordination framework, is not merely a pragmatic compromise; it is the policy architecture best suited to the band's technical characteristics, the nation's economic interests, and the imperatives of national security. Sharing will bring more spectrum online faster, encourage more spectrally efficient

³ Webb, W., and Roberson, D., [The End of Telecoms History](#), 2nd edition (August 2025).

⁴ Hundman, Eric, [China's Management of Electromagnetic Spectrum Resources](#), report prepared for the U.S.-China Economic and Security Review Commission (March 2026).

network architectures, supercharge America’s private networking ecosystem, and allow important federal missions to adapt to what the future may bring.

2.1. Sharing Delivers More Usable Spectrum, Sooner

A sharing framework can deliver commercial access to the 4.4 GHz band faster, at lower cost, and across more bandwidth than any clearing-based alternative.

The United States has led the world by building the institutional and technical infrastructure for spectrum sharing. Of course, spectrum sharing is as old as the very first uses of radio—spectrum licensing is just an early twentieth-century technology for accommodating multiple spectrum users.⁵ But the United States has demonstrated in recent years that more advanced approaches can unlock new value in the spectrum. The CBRS framework in the 3.5 GHz band established the Spectrum Access System as a proven, operational platform for dynamic coordination between federal incumbents and commercial users, and the Automated Frequency Coordination system developed for the 6 GHz band extended this model further. These are not experimental prototypes — they are standards-based, certification-tested, FCC-approved and fielded systems managing real-world coexistence at scale today. Over 440,000 base stations are currently operating in the CBRS band today⁶ without causing harmful interference to incumbent military radars. A sharing regime in the 4.4 GHz band can build directly on these or similar platforms, adapting existing coordination engines, databases, and operational procedures rather than designing them from scratch. At the same time a new band presents opportunities to augment these systems by leveraging new AI and 6G capabilities. The result would be a dramatically compressed path from rulemaking to commercial deployment, while setting the stage for expanded spectrum access over time.

Speed matters because the alternative is extraordinarily expensive — not only in direct outlays but in opportunities foregone. Clearing federal incumbents from any portion of the 4.4 GHz

⁵ See Leibovitz, J., and Milkman, R., [Taking Stock of Spectrum Sharing](#), Social Science Research Network (October 6, 2021).

⁶ OnGo Alliance, [CBRS Map](#) (data as of August 11, 2026).

band requires relocating mission-critical systems to new frequencies or new architectures, a costly process (in both money and time) that entails equipment redesign, testing, certification, and revalidation across multiple agencies. Historical clearing efforts have consumed a decade or more and billions of dollars in transition costs, with timelines that routinely slip significantly as unforeseen technical and institutional complications emerge.⁷ These direct costs are compounded by the opportunity cost of delay: every year that the band remains inaccessible to commercial use is a year of foregone capacity, foregone investment, and foregone innovation. A sharing framework avoids this trap entirely, enabling high-value commercial deployments to proceed while incumbent systems remain in place and fully operational. Moreover, costs imposed on federal systems go well beyond the immediate costs associated with the redesign and redeployment of equipment and infrastructure. With the clear and auction approach, there are costs and implications for the future ability of federal agencies to be able to fully carry out and adapt their own missions to the needs of an AI era. Given the potential efficiencies and cost savings possible, policy makers need to scope out and fully consider a spectrum sharing option in the 4.4 GHz band before any final decision is made.

Perhaps most importantly, sharing can potentially make more of the band available in more high-value places than a blunt repack-and-auction approach. Clearing for high-powered use necessarily concentrates on carving out a contiguous block of spectrum that can be licensed exclusively — which in practice means that federal operations must be compressed into a reduced allocation, and the cleared portion is all that commercial users ever access. Sharing faces no such constraint. Because commercial deployments coexist with federal systems under dynamic coordination, the entire breadth of the band is potentially available wherever and whenever incumbents are not actively using it. In many locations — particularly the dense urban and suburban areas where commercial demand is greatest and federal operations may be sparse or intermittent — this means access to significantly more bandwidth than any realistic clearing scenario would yield. Sharing does not divide the band between federal and

⁷ E.g. [2024 Commercial Spectrum Enhancement Act \(CSEA\) Report](#), U.S. Department of Commerce (Dec. 1, 2025).

commercial use; it allows both to draw from the full resource, maximizing total utilization across all users. In the end, sharing has the potential to deliver the highest value to the American public, the designated beneficiaries of the country's spectrum resources.

2.2. Sharing Preserves National Security While Enabling Dual-Use Technology

Federal operations in the 4.4 GHz band serve missions of direct consequence to national security. Any reallocation framework must be evaluated not only by how much commercial capacity it enables but by how well it preserves the government's ability to execute current missions and adapt to future ones. On this criterion, shared spectrum holds a decisive advantage over clearing.

Clearing is a one-way door. Once federal systems vacate a band and commercial licenses are granted on an exclusive basis, reclaiming that spectrum for government use becomes politically, legally, and practically difficult — regardless of how national security requirements may evolve. Sharing, by contrast, preserves federal access as a structural feature of the band plan. Incumbent systems continue to operate, and the coordination framework can be updated over time to accommodate new federal missions, emerging threat environments, or shifts in concepts of operations. This retained flexibility is a concrete strategic asset in an era when electromagnetic spectrum is increasingly contested and the nature of federal spectrum demand is changing rapidly.

A shared 4.4 GHz band also offers an additional national security dividend through the private networks it enables. Private wireless infrastructure deployed across American manufacturing facilities, logistics hubs, energy systems, and transportation networks constitutes a foundational dual-use technology. In a steady state, these networks drive commercial productivity. In crisis — whether a natural disaster, a supply chain disruption, or a national security contingency — they provide a distributed, resilient communications fabric that can be leveraged to support federal missions. This dividend cuts both ways: As evidenced by deployments at MCLB Albany, NAS Whidbey Island, and other military installations, DoD and other national security agencies can deploy their own private networks on the same spectrum

bands and commercial technology base, benefiting from commercial-scale investment while their requirements help drive new use cases and security standards for the broader ecosystem. Private networks operating on shared spectrum can be designed with interoperability standards that facilitate rapid integration with government systems when circumstances demand it.

This dual-use potential transforms the calculus of spectrum allocation. Rather than viewing commercial access and federal mission assurance as competing objectives that must be traded off against one another, a sharing framework in the 4.4 GHz band allows them to be pursued in concert. The same policy that accelerates commercial deployment also seeds the nation's critical infrastructure sectors with advanced wireless capabilities that strengthen overall resilience. Shared spectrum does not ask the nation to sacrifice security for economic gain — it offers a path to both.

2.3. 4 GHz Propagation Characteristics Promote Spectrally Efficient High-Density Deployment

The propagation characteristics of the 4.4 GHz band occupy a distinct position in the mid-band landscape. Compared to lower bands, signals at 4.4 GHz experience greater path loss over distance⁸ and more significant attenuation through building materials and foliage.⁹ While these characteristics pose challenges for macrocell network deployments, they also constitute advantages for small cell networks that a well-designed sharing framework can effectively leverage.

Shared spectrum regimes typically impose power and geographic constraints on commercial users to protect incumbents. At 4.4 GHz, these constraints align naturally with the band's physics. Lower power limits and coordination boundaries encourage the deployment of smaller, denser cell architectures — exactly the topology that maximizes spectral reuse across a given

⁸ [Free space loss](#) increases with the square of the frequency. Under line-of-sight conditions, therefore, the loss at 4.4 GHz is more than 25 times (14 dB) greater than the loss in low-band spectrum at 850 MHz.

⁹ International Telecommunication Union, [Recommendation ITU-R P.2108, Prediction of Clutter Loss](#) (Sep. 2021). See Fig. 1, showing approximately 6 and 3 dB more clutter loss at 4 GHz compared to 1 and 2 GHz, respectively.

geographic area. Where a high-power macro deployment would serve a wide area with a single frequency assignment, a dense small-cell deployment can reuse the same frequencies many times over within that same footprint, dramatically increasing aggregate throughput per square kilometer. The result is more network deployments, more competition, and better performance for end users. With the emergence of AI and the role of wireless networks in supporting substantially increased demand for connectivity, especially for high-velocity applications at the network edge, densification through a larger number of localized networks – in lieu of the traditional high-power macrocellular approach – will be the necessary solution.

The band's building penetration characteristics further reinforce this dynamic. Indoor deployments — enterprise networks within factories, warehouses, hospitals, and office buildings — benefit from the natural isolation that walls and floors provide.¹⁰ Each indoor installation becomes, in effect, its own interference-contained cell, enabling aggressive frequency reuse with minimal coordination burden, while avoiding the trap of traditional high-power outdoor macro cell deployments where 95% or more of the signal energy is lost going into or leaving the building.¹¹ The result is a virtuous alignment: the sharing framework's constraints push deployment patterns toward the architectures that extract the greatest total capacity from the band. Shared spectrum at 4.4 GHz does not merely accommodate dense and indoor deployment — it incentivizes it, producing higher overall spectral efficiency than an exclusive-license regime optimized for wide-area macro coverage at lower frequencies would likely achieve. As AI demand skyrockets and its output is delivered indoors to our factories, businesses, homes, schools and beyond, this type of spectral efficiency is vital if we want to ensure that every megahertz of spectrum is put to its highest and best use.

¹⁰ For an analysis of these characteristics in the 3.5 GHz CBRS band, see Ghosh, M., et. al., [Neutral-Hosts in the Shared Mid-Bands: Addressing Indoor Cellular Performance](#) (May 23, 2025).

¹¹ For example, a building entry loss of 15 dB is assumed in the CBRS band. This represents the loss of nearly 97% of the radio energy coming or going from the building. See Wireless Innovation Forum, Technical Specification TS-0112, [Requirements for Commercial Operation in the U.S. 3550-3700 MHz Citizens Broadband Radio Service Band](#), v. 1.9.2, p. 11, requirement R2-SGN-03 (March 29, 2024).

2.4. Shared Spectrum Fuels American Innovation Through Private Networks

The economic case for shared spectrum in the 4.4 GHz band extends well beyond conventional mobile broadband. The U.S. leads the world in the deployment of private cellular networks due to the availability of the CBRS band, but more spectrum for these types of networks will be needed as American businesses and industry continue to deploy.¹² The 4.4 GHz band's characteristics and the access models enabled by sharing make it exceptionally well suited to private network deployment — and private networks are rapidly becoming an essential ingredient in the industrial transformation of the American economy.

AI-driven robotics, smart manufacturing, automated logistics, and precision agriculture all depend on wireless connectivity that enterprise operators can tailor to their own requirements: deterministic latency, guaranteed availability, local data sovereignty, and seamless integration with operational technology systems. These are not capabilities that general-purpose public networks are designed for. Private networks, built and managed by the enterprises they serve, fill this gap — but only if spectrum is accessible on terms that make private deployment economically viable.

A sharing framework in the 4.4 GHz band enables private network deployment in ways that exclusive licensing cannot. Lightly licensed or authorized shared access tiers offer enterprises a path to localized dedicated spectrum without the capital outlay of acquiring nationwide exclusive licenses at auction — costs that are prohibitive for all but the largest carriers. This democratization of spectrum access opens the door to a broad base of industrial innovators: manufacturers deploying autonomous AI-driven mobile robots on factory floors, port operators coordinating container movements in real time, energy companies managing distributed generation assets, and healthcare systems monitoring patient care across campus networks. Each of these use cases represents not only a productivity gain for the deploying enterprise but a market opportunity for the American equipment vendors, software developers, and systems integrators who build the enabling technology. A shared spectrum framework in the 4.4 GHz

¹² Global mobile Suppliers Association (GSA), [Private Mobile Networks](#) (June 2026).

band would cultivate an innovation ecosystem that is diverse, competitive, and rooted in domestic industry. And, it should be noted, when sharing incorporates a priority tier with appropriately small license areas, it can enable all of these uses to coexist with broader-coverage carrier networks as has been the case in the CBRS band.

3. The 4.4 GHz Band Today

The 4.4 GHz band is today heavily used by the federal government for many mission-critical operations. As discussed below, point-to-point links are the predominant use, but the Navy also uses the band extensively for training and battlefield coordination among ships, aircraft, and other assets. Drone operations in the band are extensive and growing given the increasing importance of drones in modern warfare. The White House issued an executive order addressing the importance of drone dominance,¹³ and subsequently the FCC released a public notice which, among other topics, sought input on the need for spectrum for drone testing and operations.¹⁴ Shared use of the 4.4 GHz band represents an opportunity to meet some of those demands without relocating existing services. Clearing any portion of the band would be an expensive, complex, disruptive, and time-consuming endeavor. Leaving federal systems in place and implementing a shared spectrum framework in which secondary users fully protect existing government operations is clearly a better strategy both to enable the continued use of the band by the federal government while adding substantial capacity to the nation's broadband stockpile.

This section describes the federal government's use of the 4.4 GHz band today. It also includes a description of the current non-federal use, which is a relatively minor use of the band. The next section examines these uses in the context of how the band could be shared given our understanding of the nature of the operations that currently exist. As detailed below, our analysis is based on a review of publicly available sources and therefore may be incomplete.

¹³ The White House, Executive Order 14307, [Unleashing American Drone Dominance](#) (June 6, 2025).

¹⁴ Federal Communications Commission, Public Notice DA 26-314, [FCC Seeks Comment on Unleashing American Drone Dominance](#) (April 1, 2026)

This discussion and proposal for sharing is not intended to be definitive or the only option for sharing in the 4.4 GHz band, but instead a proposal to be considered as a starting point for discussions. As this band is slated for study by NTIA and other federal agencies, we anticipate that more information may become publicly available that could inform a future update to this report and its sharing proposals.

We start with allocations. The 4.4 GHz band is allocated on a primary basis to federal fixed and mobile services. A portion of the band is also allocated on a co-primary basis to the non-federal fixed-satellite service (FSS) in the space-to-Earth direction, limited to international inter-continental systems. A 10 MHz segment of the band is identified for use by the radio astronomy service but that use is not granted an allocation status in the band.

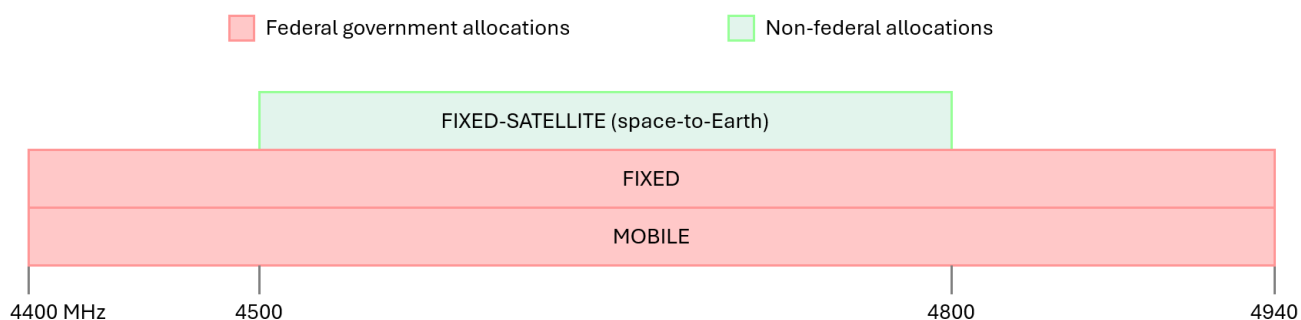


Figure 3.1: U.S. allocations in the 4.4 GHz band.

Frequency assignments for federal government stations are contained in the Government Master File (GMF), a non-public database. Some characteristics of GMF assignments, such as those that are nationwide without listing specific locations,¹⁵ create barriers to discerning the actual distribution of deployed systems in a federal band even if the GMF data were available. There are few incentives for federal agencies to maintain accurate and current registrations. Therefore, many legacy GMF assignments remain, and new deployments are not necessarily

¹⁵ These assignments, also known as United States and Possessions (US&P) assignments, are broad, geographical authorizations permitting federal agencies to operate mobile, transportable, or emergency radio systems anywhere within U.S. and territories, international airspace, and international waters without being locked to a single fixed location.

represented by the GMF data. The NTIA's own spectrum use reports are handicapped in this respect.

The true extent of federal use of the 4.4 GHz band is not discernible without substantial input and analysis by the individual federal agencies that use the band. The WFTCA and the President's memo on "Winning the 6G Race" mandate that NTIA commence a study of the 4.4 GHz band. Current plans call for the study to commence near the end of September 2026.¹⁶ This analysis will yield more data and specifics on federal use of the 4.4 GHz band, although there is no indication whether the results of the analysis will be made public.

Multiple publicly available sources have been used to discern the federal government's specific uses in the 4.4 GHz band.¹⁷ Based on the existing data, a breakdown of the number of frequency assignments by operation type is shown in Figure 3.2.

A summary of the current use of the 4.4 GHz band is provided below categorized by general type of operation (fixed, aeronautical, etc.). Note that the specific use cases and the actual extent of use may evolve as the government releases information from its 4.4 GHz band study, but the general nature of the band's use is governed by the allocation table and is unlikely to change -- the general types of systems that operate in the band are likely well represented by the available information, even if their numbers and geographic distribution are less certain.

¹⁶ National Telecommunications and Information Administration press release, *Administration Clears Plan for 4.4 GHz Study in Major Milestone for 6G Leadership* (July 31, 2026) (agencies' funds available 60 days after plan clearance).

¹⁷ Including [Federal government spectrum use reports](#); [NTIA Redbook](#); public statements and presentations by NTIA; system documentation; published standards; [spectrumwiki.com](#); and other sources.

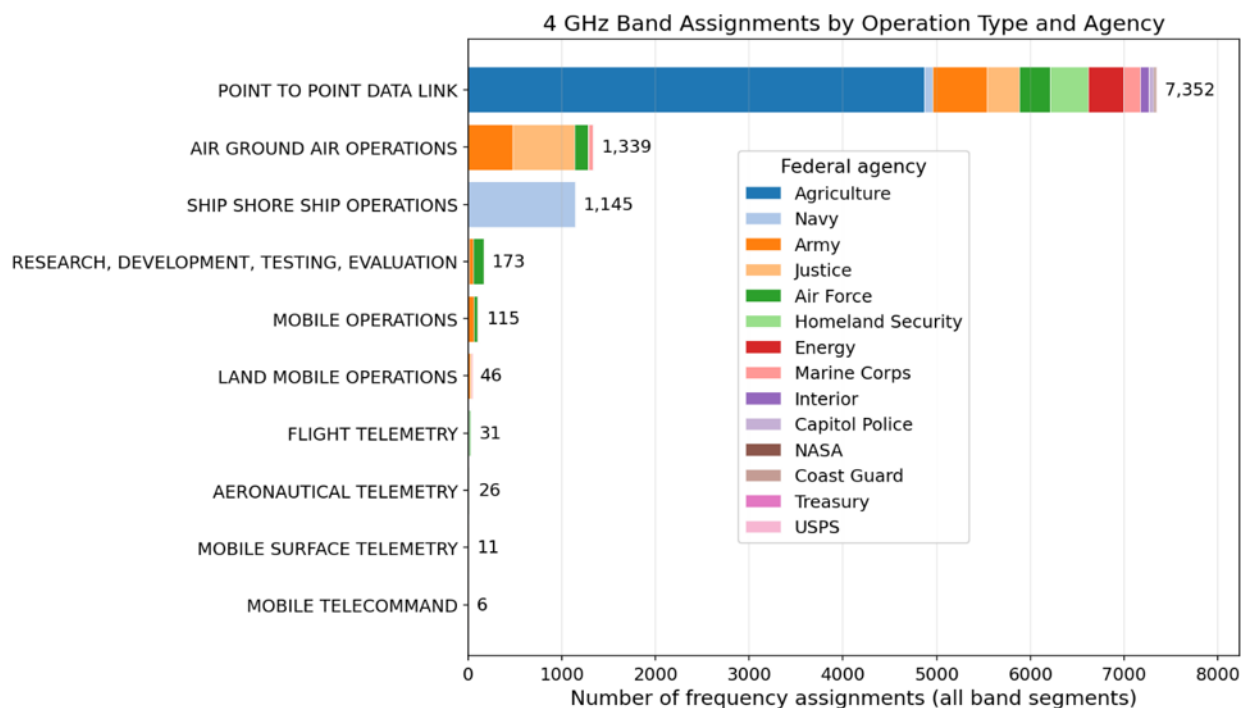


Figure 3.2: Number of GMF assignments by operation type and agency.

3.1. Fixed

By assignments, the predominant federal use of the 4.4 GHz band is for fixed point-to-point (P2P) systems (see Fig. 3.2). According to discussions with NTIA, “a few thousand” point-to-point links operate in the band. According to the Federal Government Spectrum Use Reports, there are over 7300 P2P frequency assignments in the 4.4 GHz band,¹⁸ which is more than the sum of assignments for all other uses. Some fixed uses of the band include point-to-multipoint (P2MP) systems. It is not clear if the assignments are for the ends of each link (i.e., two or more assignments per link), or one assignment that covers all ends of a P2P or P2MP system. In public presentations¹⁹ the NTIA has indicated that there are ~3,000 links in the band, so we believe that there may be assignments for each end of the links and that there are approximately

¹⁸ NTIA Spectrum Compendium dataset, [225-5000-composite-inventory 2015-12-16 0.xlsx](#) (latest available version, Dec 16, 2015).

¹⁹ For example, presentation by LaSorte, N., [The Fix is In: Understanding the 4.4 GHz Band](#), National Spectrum Management Association conference (May 13, 2026).

$\sim 7300/2 = 3650$ links, but that would need to be confirmed by the band studies being conducted by NTIA. According to NTIA,²⁰ most (~75%) of the P2P systems in the band use Frequency Division Duplex (FDD).

Several federal agencies use P2P systems in the band, including (in order of the number of P2P assignments) Agriculture; Departments of Defense, Homeland Security, Energy, Justice, and Interior; U.S. Capitol Police; NASA; Treasury; and the USPS. The links support a wide variety of operations including forestry programs, data relay, system monitoring, border patrol, law enforcement, and national security. The largest user is Agriculture, as evidenced from Figure 3.2. NTIA indicates that Agriculture's use of fixed links is in support of data and video transmissions related to forest programs,²¹ including monitoring for wildfires, tracking invasive species, protecting natural resources, and conducting law enforcement operations.

The Department of Energy uses some of its 372 P2P assignments to support the Nuclear Emergency Support Team (NEST), which contends with "radiological and nuclear challenges."²² Activities include "preventive nuclear and radiological detection and threat-based nuclear search; public health and safety missions, including radiological consequence management; and responses to U.S. nuclear weapon accidents and incidents. Additionally, NEST maintains operational capabilities that enable nuclear forensic analysis of nuclear material used in an improvised nuclear device or interdicted outside of regulatory control."

The Department of Defense P2P uses include both line-of-sight (LOS) (i.e., the traditional microwave dishes), and non-LOS (i.e., troposcatter communications links). In the latter category, the Raytheon AN/TRC-244(V)1 system uses troposcatter²³ to support beyond-the-

²⁰ LaSorte, N., *op. cit.*

²¹ NTIA Spectrum Compendium, [4800-4940 MHz](#), p. 6 (undated; circa 2016).

²² U.S. Department of Energy, [Nuclear Emergency Support Team \(NEST\)](#) (visited August 13, 2026).

²³ Troposcatter is the scattering of radio signals off index of refraction variations in the atmosphere caused by winds, turbulence, temperature gradients, and other normal and persistent weather effects.

horizon relay of battlefield information.²⁴ Active duty, reserve, and national guard troops train on the transportable AN/TRC-244(V)1 system in the U.S.

3.2. Aeronautical

The federal government uses airborne systems in the band for a variety of purposes. Assignment data list operations as air ground air, aeronautical telemetry, and flight telemetry.

By number of assignments, the predominant airborne use of the band is for air ground air operations, which are used to support Unmanned Aerial Vehicles (UAVs) and law enforcement systems to relay data, video and information from onboard sensors to the ground control stations.

Aeronautical telemetry (DoD and NASA) and Flight Telemetry (DoD, DHS, and DOE) are used for transmission of flight telemetry data during missile testing, video target scoring on aircraft armaments, drone control, target drone control, and acquisition of lightning data.

Data such as radar scans are also transmitted from balloons (“aerostats”) located near the Mexican border and in the Caribbean, in part to detect low-flying aircraft for drug interdiction. Note that this use is under the fixed service allocation since the aerostats are tethered and therefore considered fixed.

The NTIA band compendium reports indicate that airborne use is predominantly air-to-ground, supporting data telemetry and video streaming.

3.3. Maritime

The Navy uses the band for ship-to-shore and ship-to-ship links, which are identified in Fig. 3.2 as Ship Shore Ship Operations (SSSO). The links provide network connectivity for ships in and near ports and are also used for data fusion among multiple vessels off the coast. The Navy’s

²⁴ Cf. Spectrum Wiki, [Military Troposcatter Systems](#) (visited August 13, 2026).

use of the band for SSSO is the second largest number of assignments in the 4.4 GHz band after fixed point-to-point.

Under SSSO, the Navy operates the Cooperative Engagement Capability (CEC) in the 4.4 GHz band.²⁵ The CEC system distributes data between sensor and weapons assets to create a single, distributed, integrated air picture that supports and enables Integrated Fire Control. Each ship and aircraft transmits its own sensor data to every other ship and aircraft within line of sight. In turn, each ship and aircraft receive sensor data from every other ship and aircraft, and CEC then combines that data with its own data to form a composite picture.^{26, 27}

Further study of the CEC is needed to fully characterize the operational characteristics and interference susceptibility; however, its use is concentrated in coastal areas and four inland training ranges as noted in the Cooperative Engagement Capability Operating Area Descriptions in DA 98-162, which is similar to the distribution of incumbent activity in the CBRS band.

3.4. Mobile

The 2015 NTIA spectrum use reports note the use of the band for mobile communications, including internetworking at Navy bases and to provide radiocommunications for data, voice and video, and support many range systems during tactical training exercises. The 2023 revision of the Redbook asserts that “currently, land mobile radio assignments are not deployed in the 4400-4940 MHz band.” Nonetheless, NTIA data show over 115 mobile assignments for DoD and

²⁵ When the FCC decided to auction the 4660-4685 MHz band for the General Wireless Communications Service (GWCS), they issued a Public Notice that described the CEC and provided technical data to help interested parties evaluate the band. The PN indicates that the CEC operates in the bands above and below the 4635-4685 MHz band. See *Comment Sought on Reserve Prices or Minimum Opening Bids for the General Wireless Communications Service (GWCS) in the 4660-4685 MHz Band*, 63 FCC Rcd 6181 ([via Federal Register](#)) (Feb. 6, 1998) (“DA 98-162”).

²⁶ See Johns Hopkins Applied Physics Laboratory, [The Cooperative Engagement Capability](#), Johns Hopkins APL Technical Digest, Volume 16, Number 4, p. 377 (1995)

²⁷ Hurt, G. F., Cerezo, E. A., and Slye, W.R., [Assessment of Electromagnetic Spectrum Reallocation: Response to Title X of the National Defense Authorization Act for Fiscal Year 2000](#), Special Publication NTIA SP 01-44, U.S. Department of Commerce, National Telecommunications and Information Administration, Institute for Telecommunication Sciences, p. 3 (Jan. 2001).

DOE, 46 land mobile assignments for DoD and Interior, 11 assignments for “mobile surface telemetry” for DoD and DOE, and 6 assignments for “mobile telecommand” for the Air Force.

3.5. Non-Federal Satellite Earth Stations

The non-federal fixed-satellite service (FSS) uses the 4500-4800 MHz portion of the band for reception of downlink (space-to-Earth) transmissions from international inter-continental satellites to fixed points on the ground. This band is typically paired with the 6.7 GHz band (6725-7025 MHz) for Earth-to-space (uplink) operations, a band that is shared with tens of thousands of point-to-point links, as well as unlicensed devices.

FCC data shows fewer than a dozen FSS licensees in the 4.4 GHz band. Typical uses are for both fixed and temporary fixed transportable earth stations. The FCC licensing data do not indicate a substantial number of earth stations.²⁸

3.6. Research, Development, Testing, and Experimentation

The federal government operates experimental radio communications in the band for basic research or for the evaluation or testing of electronic equipment or systems that have been developed for operational use. NTIA data indicates all 173 assignments in this service are for DoD.

3.7. Radio Astronomy

Radio astronomy is defined as “astronomy based on the reception of radio waves of cosmic origin.”²⁹ It is a passive (non-transmitting, receive-only) service.

Although there is no formal allocation to the radio astronomy service in the 4.4 GHz band, radio astronomers use the 4825-4835 MHz segment for observations of the formaldehyde spectral line in space. Because this particular frequency in the 4.4 GHz band is based upon the rest

²⁸ The FCC’s International Communications Filing System (ICFS) data indicate that many of the licenses have terminated, and many operating frequencies appear to be incorrect. Additional study of the ICFS data is required to more fully characterize use. However, it appears that non-federal FSS use is not substantial.

²⁹ 47 CFR 2.1 “[Radio Astronomy](#)”

frequency of a formaldehyde spectral line, radio astronomy systems cannot be relocated to other frequencies, as they must use this particular frequency range due to physics. This use is noted in footnotes to the allocation table,³⁰ indicating that the observations are conducted at a total of 17 radio astronomy observatories around the U.S. and possessions. The footnotes call for efforts to be made to avoid assigning frequencies to federal systems in this band, as well as otherwise avoiding interference to the radio astronomy observatories, particularly from airborne and space-based transmissions. The footnotes protect both federal and non-federal radio astronomy operations in the band.

3.8. Other Services

Other services operating in the 4.4 GHz band include Mobile Surface Telemetry and Mobile Telecommand, both of which have relatively few assignments (17 total). Telecommanding signals are used to initiate or modify the function of drones and various systems on military test ranges. Land telecommand signals are transmitted from stationary platforms on the ground and mobile telecommand signals can be moving platforms.

3.9. Summary of 4.4 GHz Uses Today

Figure 3.3 summarizes the use of the 4.4 GHz band today. To the extent that publicly available band plans exist for specific uses, those are indicated in the chart.

³⁰ See U.S. Table of Frequency Allocations, footnotes [US113](#) and [US342](#) (via Spectrum Wiki).

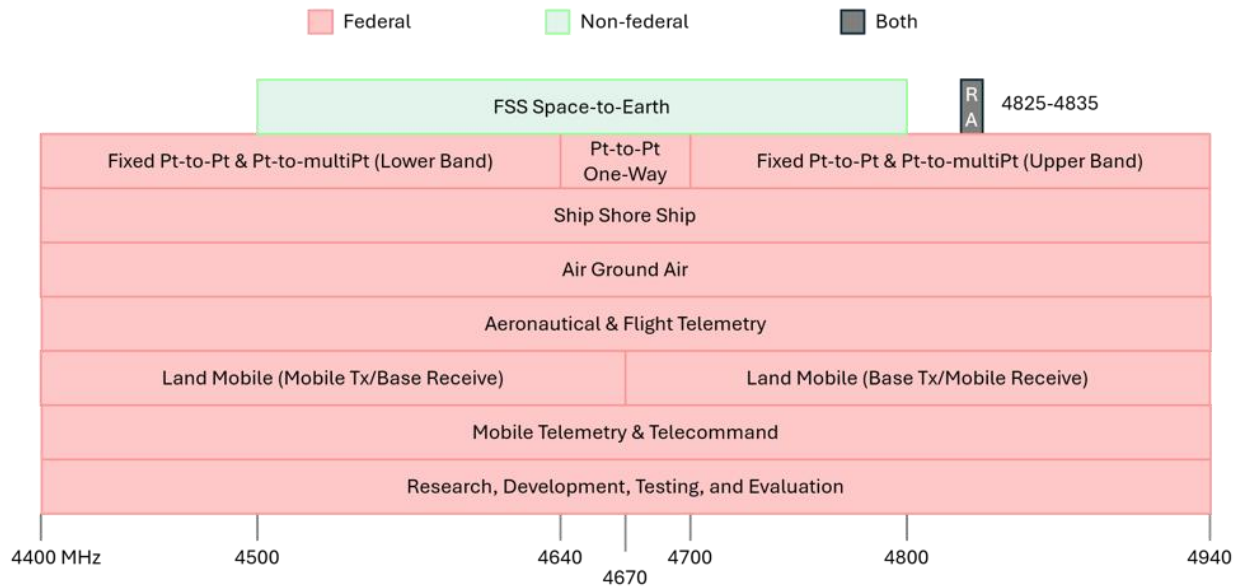


Figure 3.3: Summary of 4.4 GHz band uses.

3.10. Adjacent Band Considerations

The bands immediately below 4400 MHz and immediately above 4940 MHz band merit a brief discussion because they may impact operations in the band and could impact an analysis as to whether the 4.4 GHz band itself should be put under a shared spectrum or high powered exclusively licensed regime. On first review, potential interference concerns in the adjacent bands suggest that a shared licensed approach is favorable to mitigate any issues as more commercial operations are introduced into the 4.4 GHz band, particularly high-power operations.

Below 4400 MHz: The 4200-4400 MHz band is allocated to the aeronautical radionavigation service on a primary basis and is used mainly for radio altimeters on aircraft.

In consideration of the FCC allowing high-power commercial use of the 3.98-4.14 GHz band (“Upper C Band”),³¹ the FAA issued an Order to address new requirements for radio altimeter

³¹ See Federal Communications Commission, [FCC Adopts Plan for C-Band Auction in July 2027](#), (July 1, 2026).

systems to facilitate coexistence with such high-power commercial mobile systems.³² The FAA rules provide an interference tolerance mask (ITM) for radio altimeters that establishes the specific minimum interference rejection capabilities for an entire radio altimeter system above and below its operating band as shown in Figure 3.4. This ITM extends up to 4470 MHz and could have an impact on commercial systems operating between 4400-4470 MHz, particularly high-power systems. Radio altimeters must accept signals at levels of -82 dBW/m²/MHz at 4400 MHz, increasing up to +9.5 dBW/m²/MHz at and above 4470 MHz. This reflects the use of filters in the radio altimeters whose rejection of interfering signals improves with frequency separation from the radio altimeter band edge.

For reference, calculations show that the required separation distance to meet the ITM requirements at the band edge (4400 MHz) would be approximately 14 km for a high-powered commercial base station, 0.8 km for a Category B CBRS-like device, and 20 m for an indoor Category A CBRS-like device.³³

³² Federal Aviation Administration, FAA-2025-5666, [Requirements for Interference-Tolerant Radio Altimeter Systems](#), 91 FR 48656 (Jul. 31, 2026).

³³ This calculation assumes free space loss; EIRP of 1640 W/MHz for the full-power commercial base station, 5 W/MHz for Category B-like devices, 0.003 W/MHz for the indoor Category A-like device; and a 20 dB combined (base station + radio altimeter) antenna pattern discrimination.

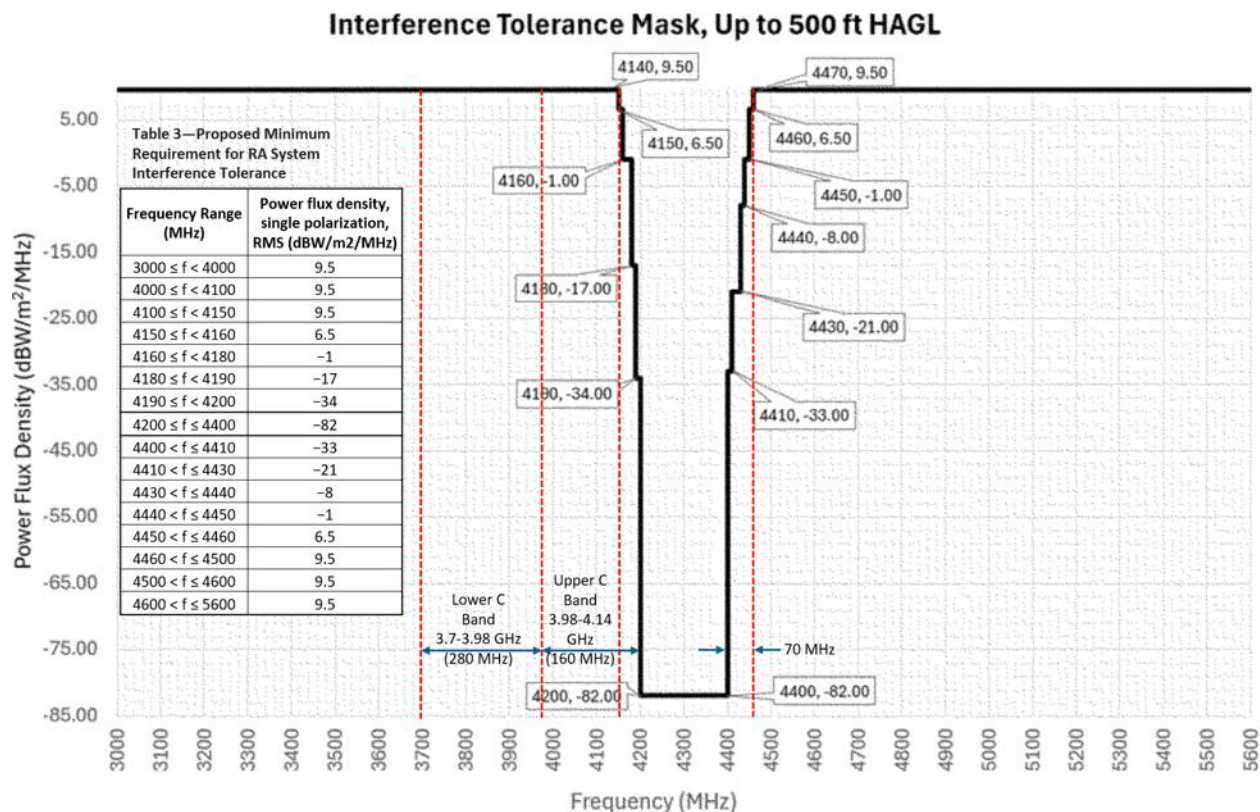


Figure 3.4: FAA minimum radio altimeter system Interference Tolerance Mask (ITM).

Above 4940 MHz: The 4940–4990 MHz band (“4.9 GHz band”) is governed under Part 90 Subpart Y of the FCC rules.³⁴ Eligibility is limited to state and local public safety agencies. Permitted use includes mobile, fixed, point-to-point, and point to multi-point operation within a specific geographic area encompassing the legal jurisdiction of the licensee. Licenses are for 1 to 5 MHz channels and the max EIRP is 85 dBm for point-to-point and point-to-multipoint systems, and 37 dBm for base, mobile, and temporary fixed operations.³⁵

The regulatory status of the band is complicated. The FCC has issued an 8th Report & Order and a 9th Further Notice of Proposed Rulemaking.³⁶ These rulemakings have been issued to address

³⁴ [47 CFR Part 90, Subpart Y.](#)

³⁵ [47 CFR 90.1215.](#)

³⁶ Federal Communications Commission, Amendment of Part 90 of the Commission's Rules, WP Docket No. 07-100, [Eighth Report and Order](#), 39 FCC Rcd 12032 (13), Oct 22, 2024 and [Seventh Report and Order and Ninth Further](#)

issues such as nationwide overlay license, spectrum sharing agreement with FirstNet, a band manager, non-Public Safety use of the band, frequency coordination, etc.³⁷ The band has been frozen since Sep 8, 2020, for new or modified license applications with some exceptions. The ULS shows over 9100 active licenses, the majority of which (over 5700) are for point-to-point or point-to-multipoint operation.

Future use of the bands below 4940 MHz may require consideration of the 4.9 GHz band regarding the possibility of adjacent channel protections for public safety operations.

4. Sharing and Compatibility

Here we discuss the potential for commercial wireless services to share part or all of the 4.4 GHz band with federal incumbents on a secondary non-interference basis, based on the incumbent operations identified in section 3. Commercial wireless services can include any broadband technology (including 3GPP 5G/6G or proprietary air interfaces) across both mobile and fixed wireless access. While power levels are not specified, the localized signals inherent to low- and medium-power systems make them better suited to sharing with federal incumbents than high-powered systems. Further, as noted in Appendix A, indoor systems are even more conducive to sharing because their signals are better isolated from incumbent operations due to building penetration losses.

We categorize the incumbent systems by coexistence characteristics and provide considerations for how sharing might be accommodated, with an objective of mitigating or eliminating any impacts to the incumbent systems or their operation. We conclude that for the most prevalent services in the band, sharing is likely to be readily accommodated using sharing concepts that have already been proven commercially at scale in other bands. Other services

[Notice of Proposed Rulemaking](#), 38 FCC Rcd 704 (2023) (Seventh Report and Order or Ninth Further Notice), 38 FCC Rcd 704 (1), (Jan 18, 2023).

³⁷ We also note that the DC Circuit recently affirmed the FCC's 2024 Order to establish a nationwide band manager, which would coordinate operations in the 4.9 GHz band and expand efficient public safety use through a sharing agreement with FirstNet.

require additional study pending release of more details of their deployments based on the 4.4 GHz band study being conducted by NTIA.

4.1. Coexistence with Fixed Point-to-Point Systems

As noted in Section 3, by far the predominant use of the 4.4 GHz band by the federal government is for fixed line-of-sight (LOS) point-to-point communications. These links support a variety of important government operations, but all or virtually all share common characteristics:

- Fixed transmitter and receiver locations
- Fixed antenna pointing directions
- Highly directional antennas
- Unobstructed path (no terrain or clutter)

From a coexistence perspective these characteristics are ideal for supporting spectrum sharing because predicting and avoiding interference is as straightforward as possible. Given the location of an incumbent's receive antenna, its pointing direction, and its gain pattern, it is straightforward to estimate and mitigate the amount of interference from a secondary user into the receiver, assuming all of the corresponding characteristics of the secondary transmitter are known as well.

In fact, the ability to share between secondary systems and primary point-to-point links has already been demonstrated at scale in the non-federal 6 GHz band, where unlicensed devices with powers as much as 36 dBm (4 W) EIRP are authorized by the FCC to operate among more than 70,000 primary non-federal point-to-point links with over 100,000 associated receive sites.

The key to sharing in the 6 GHz band is that each unlicensed device must check, on a daily basis, with an Automated Frequency Coordination (AFC) system, which computes potential interference from the secondary unlicensed device into any fixed links in the area based on the FCC's public database of point-to-point systems in the band. The AFC provides frequencies and power levels at which the unlicensed device can operate without causing harmful interference

to the fixed links. The unlicensed devices must check with the AFC at least once per day in the event that a new link is constructed in its vicinity or the characteristics of existing links change. To our knowledge, there have been no significant claims of unresolved harmful interference in the band caused by this new unlicensed use.

Achieving coexistence between mass-market 6 GHz unlicensed devices (almost entirely Wi-Fi devices)³⁸ and over 70,000 point-to-point links (i.e., about 20 times as many as in the 4.4 GHz band) affirms that sharing with 4.4 GHz federal links is entirely feasible. Unlike in 6 GHz, there is no public database of the federal systems in the band, so that any AFC-like coordination system would require federal involvement.

The system could be as simple as the yellow/green light coordination system used in the 70/80/90 GHz coordination framework, in which the characteristics of proposed secondary systems are submitted to an NTIA-maintained API, coexistence calculations are run by NTIA against the non-public database of federal systems (the GMF), and an indication is given whether the proposed secondary operation is OK (green light) or needs further coordination (yellow light).³⁹ A secondary or unlicensed device could check in with the coordination system on a regular basis (daily, weekly, etc.) to assess whether conditions have changed. No details of federal systems are publicly revealed in the process.

For over 20 years, this stoplight system has worked very well for 70/80/90 GHz coordination and there is reason to believe it could work equally well in the 4.4 GHz band. Operational security can be maintained by limiting access to the API to FCC-approved frequency coordinators (as is done in 70/80/90 GHz), and rate-limiting the API to ensure that a rogue operator could not overwhelm the system with coordination requests to “smoke out” the detailed characteristics of any federal systems in the band.

³⁸ Wi-Fi Now, [Massive market adoption: 5000+ Wi-Fi devices now support 6 GHz, 1200+ support Wi-Fi 7, Intel says](#) (April 22, 2025).

³⁹ Federal Communications Commission, [Millimeter Wave 70/80/90 GHz Service](#) (visited August 13, 2026).

Due to the success of 70/80/90 GHz coordination, a similar coordination process has been established by the FCC for the lower 37 GHz band (37.0-37.6 GHz), which is shared with several federal users including NASA and DoD.⁴⁰ The FCC will require site-based registration of point to-point links and base stations prior to operation.

In addition to allowing for active management of secondary operations in the 6 GHz band through the use of an AFC, the FCC has determined that low power indoor (LPI) use of unlicensed devices can be accommodated without risk of interference to any P2P links in the band and therefore can be deployed with no further analysis. LPI access points are physically constructed to ensure that they operate indoors only and within the allowed EIRP constraints of no more than 30 dBm total, and 5 dBm in any 1 MHz bandwidth.⁴¹

The FCC has further determined that the use of Very Low Power (VLP) devices anywhere (indoors or out) is not an interference risk to any point-to-point links if they conform to prescribed EIRP limits of 14 dBm total, and -5 dBm in any 1 MHz.⁴²

Given the successful coexistence in the 6 GHz band between tens of thousands of commercial P2P links with potentially millions of secondary devices operating under AFC, LPI, and VLP rules, it is virtually certain that the same sharing scenarios could readily be established in the 4.4 GHz band, which contains only ~1/20th as many incumbent P2P links.

The NTIA band studies indicate that line-of-sight point-to-multipoint systems (P2MP) also exist in the band. Such systems can simply be considered a collection of P2P systems with a common central node. For example, a P2MP system might consist of a central node communicating with two remote nodes. This can be considered two P2P links: central node to remote node 1, and central node to remote node 2. For this reason, coexistence with such systems can be readily

⁴⁰ Federal Communications Commission, [In the Matter of Lower 37 GHz Band, Use of Spectrum Bands Above 24 GHz for Mobile Radio Services](#), R&O, 6th R&O, and FNPRM, WT Docket No. 24-243 at ¶163 (April 29, 2025).

⁴¹ [47 CFR 15.407\(a\)\(5\)](#)

⁴² [47 CFR 15.407\(a\)\(9\)](#)

coordinated in the same manner as P2P systems, and the techniques described in the section above can also be applied to P2MP systems.

4.2. Coexistence with Ship Shore Ship Systems

According to assignment data, the second most prevalent use of the 4.4 GHz band is by the Navy for ship shore ship operations (SSSO). The military uses ship-to-shore and ship-to-ship links in the 4.4 GHz band to provide network connectivity and backhaul, and for data fusion among multiple ships and other assets.

While this use of the band by the Navy is apparently extensive, it shares a common characteristic that makes interference protection straightforward: the use is geographically constrained to ports and coastal areas, plus a small number of inland ranges. Such use is substantially similar to the protection of Navy radars in the CBRS band that is successfully handled through implementation of Dynamic Protection Areas (DPAs), which are defined geographic areas in which incumbents may be operating. The signal level from secondary users as received anywhere in the DPA is managed so as not to cause harmful interference to the incumbents. SSSO in the 4.4 GHz band can be protected in a similar fashion, although the use of a scheduling utility such as TARDyS3 (Telecommunications Advanced Research and Dynamic Spectrum Sharing System) rather than a sensing system such as the Environmental Sensing Capability (ESC) used in CBRS would probably be necessary.⁴³ There are a variety of reasons for this. For example, in the case of CBRS ESC, the radars that are being detected are high power and point their beams in all directions, meaning that sensors located at discrete points along the coast can readily detect their presence over tens to hundreds of kilometers. The 4.4 GHz SSSO, on the other hand, is lower in power and doesn't point in all directions and therefore would require an exceedingly large number of sensors to be sure that at least one sensor is in or near the beam of a link.

⁴³ See Federal Communications Commission, DA-23-733, [WTB/OET Announce Deployment of a New Federal Portal and a Revision to the List of Protected Facilities in the 3.5 GHz Band](#), 38 FCC Rcd 7626 (9), (Aug. 21, 2023).

Instead of using an ESC-like centralized sensing system, secondary devices operating in the 4.4 GHz band could conceivably use a sensing capability or portal-informed AFC system to automatically adjust their operations to avoid interference with a ship-to-shore link. According to NTIA information, ship-to-shore links often involve ships that are docked, establishing a broadband connection to the ship by communicating with another fixed point on the base. In this sense, the ship-to-shore link could be treated like a fixed point-to-point link (because neither end of the link is in motion) and could be coordinated using the AFC process as described above.

4.3. Coexistence with Aeronautical and Flight Telemetry Systems

Based on available information, federal airborne use in the 4.4 GHz band appears to be predominantly downlink (air-to-ground direction) to support telemetry, video, and other streaming downlink signals.

A significant amount of air-to-ground activity occurs on military bases. The Range Commanders Council (RCC), dedicated to serving the technical and operational needs of U.S. test, training, and operational ranges, publishes telemetry standards that provide additional insight into the use of the 4.4 GHz band.⁴⁴ The RCC standards note the suggested use of the upper end of the band (4880-4940 MHz) for bidirectional operation, presumably recommending leaving the majority of the band (4400-4880 MHz) for downlink only.

According to RCC, the ground stations use antennas with significant apertures, ranging from 1.2 to 30 m in diameter, with 5 m being typical. As a result, their antenna beams are narrow, and therefore good at rejecting interference coming from off-axis directions.

From an interference perspective, air-to-ground systems are easier to coexist with than ground-to-air. Propagation loss from a terrestrial interference source to a ground receiver station is

⁴⁴ Range Commanders Council (RCC) Telemetry Group, Publication 106, [Telemetry Standards](#) (Jan. 2025).

mitigated by terrain, buildings, foliage, and other considerations, compared to airborne receivers that may have unobstructed paths over a wide area.

Coexistence with the predominant federal aeronautical operations therefore comes down to protecting ground station receivers. There are existing tools for such protections that have been proven to work at scale, notably in the CBRS band. In CBRS, certain military facilities operate ground-based radars in this band, which must be protected from harmful interference caused by the secondary commercial broadband users of the band (CBRS). The facilities are declared Dynamic Protection Areas (DPAs), with defined geographic borders and a maximum allowed aggregate interference level anywhere within those borders. Interference management is enforced by a Spectrum Access System (SAS), which is a centralized system that is used to grant spectrum access to commercial CBRS devices (CBSDs) before they are allowed to transmit.

Inland DPA protections are enforced either statically (“always-on DPAs”), or dynamically. In the dynamic case, use of specific channels within the CBRS band by the primary military incumbent is notified to the SAS through a secure online scheduling utility (e.g., TARDyS3) which is monitored by the SAS, which then implements interference protections where and when needed.

The use of DPAs for incumbent protections has been highly successful in the CBRS band. There has never been a reported instance of harmful interference to federal incumbents in the band in over six years of CBRS operation. The DPA construct is band- and system-agnostic. It can be extended to other bands, such as the 4.4 GHz band, and implemented using a commercial or federal SAS-like system.

4.4. Coexistence with Aeronautical Air Ground Air Systems

The frequency assignment data indicate that the Department of Justice and the Army hold a significant number of assignments categorized as “air ground air.” While specific assignments

are not detailed, NTIA band reports indicate that air ground air operations cover the following activities:

- UAV/UAS command, control and data relay
- Video/data downlinks from onboard sensors to ground control stations
- Law enforcement air-to-ground video/data (DOE helicopters)
- High resolution data downlinks from aircraft (NASA)

As in the telemetry uses described above, these operations appear to be predominantly downlink in nature. Given significant use by DOJ, the operations are likely not constrained to defined military bases, and the ground stations could be itinerant in nature. Additional information about where and when the ground stations are operated would help advance an effective interference protection framework. Further information is also needed regarding the use of airborne receivers (if any) as part of the air ground air operations.

In the discussion of mobile systems in the band, the band reports note DoD telecommanding applications to initiate or modify functions of drones, weapons and range systems from the ground. This implies that there are airborne receivers to receive such data and commands, but the extent of this use, and whether the airborne receivers operate in the 4.4 GHz band or the uplink is in a different band, is not clear.

4.5. Coexistence with Non-Line-of-Sight Point-to-Point Systems

Non-Line-of-Sight (NLOS) P2P systems are used for over-the-horizon communications using forward scattering off the lower portion of the Earth's atmosphere, referred to as troposcatter. Troposcatter links are typically transportable units used by the military, such as the Raytheon AN/TRC-244(V)1 system. The fraction of energy that is scattered by the atmosphere is relatively small, so troposcatter systems must use relatively high transmit power and high gain (therefore, narrow beam) antennas. Furthermore, each end of the link must be pointed at a relatively small common volume of atmosphere based on the geometry between the two nodes

and the current characteristics of the atmosphere so that high-gain (small beamwidth) antennas, pointed above the horizon, must be used on both ends of the link.

The amount of scattering is highly dependent on the scattering angle, so the radio signal strength off-axis to the intended path is exceedingly weak. This is a desirable characteristic of troposcatter links used by the military because the ability for an adversary to intercept the communications is greatly suppressed. Due to the reciprocal nature of radio propagation, this also makes the links highly resistant to interference coming from points other than the intended nodes of the links. Interference would have to be extremely high power, tightly focused on the common scattering volume by a high-gain antenna, and generally located along the same path line as the desired nodes. A source close to one end of the link could also cause interference arriving in the sidelobe of the troposcatter antenna. Given that the nodes are generally located on military bases or in areas otherwise controlled by the operator of the troposcatter link, such interference would likely be mitigated or eliminated altogether by the physical access restrictions that exist at such facilities.

4.6. Coexistence with Mobile Systems

Mobile operations in the band are primarily military focused:

- Limited mobile operations providing radiocommunications for data, voice and video
- Supports DoD range systems (e.g., video on moving targets transmitted to fixed locations)
- Supports Navy coastal administrative systems such as wireless pier networks
- DoD land mobile activities providing radio communications

Given that the predominant use is for DoD and therefore likely to be geographically constrained to military bases (only 11 of the 178 mobile assignments (6%) are for non-DoD operations), protection of mobile operations could be accomplished through the DPA framework described above. In fact, the same restrictions implemented to protect ground stations in the aeronautical

telemetry operations would also protect any ground-based mobile operations at the same bases.

4.7. Coexistence with Research, Development, Testing, and Evaluation Systems

There are 173 assignments in the NTIA data file under the category of Research, Development, Testing, and Evaluation. By its nature, such uses are difficult to assess in terms of coexistence, because presumably it covers many different types of operations. Many of these operations will be forefront-type systems, which, as the category name implies, are still in the R&D and testing/evaluation phase. Without further information, it's not possible to make meaningful recommendations on potential sharing frameworks. However, it is noted that all the RDT&E assignments are held by military agencies, so that to the extent such operations are limited to military bases, a DPA-like construct could be used to protect them.

More information on encumbrances caused by RDT&E operations is necessary and presumably will be made available once NTIA and the agencies have concluded their 4.4 GHz band study.

4.8. Coexistence with Fixed-Satellite Service Earth Stations

As noted in Section 3, there are non-federal operators in the fixed-satellite service using the 4500-4800 MHz portion of this band. By FCC rule, FSS use is limited to receive-only earth stations that are receiving signals from international intercontinental satellites. This is virtually identical to the restrictions on receive-only FSS earth stations in the extended C-band (3600-3700 MHz). That band segment is shared with, and protected from, CBRS operations, with aggregate interference protections implemented by the SAS. There has never been a reported case of harmful interference from CBRS to any FSS earth station, so the protection methodology appears to be working. In essence, the aggregate interference at the FSS receiver location is calculated from all co-channel CBRS devices within 150 km of the receiver site, and such interference is kept below an FCC-mandated threshold. FCC rules also consider blocking interference into non-co-channel extended C-band earth stations, and blocking and out-of-band emissions into some earth stations above 3700 MHz, caused by CBRS devices within 40 km.

Protection of any FSS earth stations operating in the 4.4 GHz band can be implemented similar to the FSS earth stations protections successfully established for CBRS. The FCC requires FSS earth station licensees requesting protection to register with the FCC annually, no later than 30 days before the end of the preceding calendar year, or upon making changes to any of the operational parameters.⁴⁵ A similar (or even the same) registration system can be used for 4.4 GHz earth stations.⁴⁶

Some FSS use in the band appears to be for transportable systems that support major events such as professional major league sports. These events are scheduled months in advance (if not more than a year), and the corresponding transportable FSS operations are scheduled well in advance, with the earth station operator completing frequency coordination typically months ahead of time. There would be no problem protecting transportable operations using the same coordination techniques as for permanent earth stations for the duration of their temporary operations (typically one week or less).

4.9. Coexistence with Radio Astronomy

Both federal and non-federal receive-only radio astronomy observations in the 4825-4835 MHz band segment are noted in footnotes to the U.S. table of frequency allocations. While the radio astronomy service does not have a formal allocation status in the band, the footnotes indicate that efforts should be taken to protect radio astronomy observations in this band segment.

The protections are limited to a total of 17 radio astronomy sites listed in footnote US113 to the Table of Frequency Allocations.⁴⁷ Radio astronomy sites tend to be located in remote areas to protect their observations (at all frequencies) from interference due to terrestrial wireless signals. The protection criteria for the radio astronomy service are established in ITU-R

⁴⁵ [47 CFR 96.17\(d\)](#).

⁴⁶ See Federal Communications Commission, [3.5 GHz Band - Protected Fixed Satellite Service \(FSS\) Earth Stations](#) (Oct 9, 2018).

⁴⁷ See U.S. Table of Frequency Allocations, footnote [US113](#).

Recommendation RA.769.⁴⁸ While the criteria are quite strict due to the very sensitive receivers used by radio telescopes, the remoteness of the observatories allow the criteria to be met, given coordination and potentially a suitable keep-out zone for co-channel wireless devices, and potentially for adjacent channel devices as well. The keep-out zone would be larger for higher-power devices than for lower-power devices.

Examples of successes in sharing of radio astronomy bands already exist, such as Wireless Medical Telemetry Service (WMTS) devices coexisting with radio astronomy in the 608-614 MHz band in which the radio astronomy service has a primary allocation.

An additional dimension to radio astronomy protections is time. A typical radio astronomy observatory is not observing in every radio astronomy band at all times. Typically, observations are scheduled based on the target source (i.e., it must be above the horizon in its diurnal motion across the sky) and scientific objectives that dictate the band or bands being used. Therefore, dynamic coordination can be employed, protecting the observatory only when and if necessary. Data from the National Radio Astronomy Observatory's Green Bank Telescope in West Virginia, the largest fully-steerable radio telescope in the world, show that over a seven-year period, the average amount of time spent observing in the 4825-4835 MHz range is less than 1%.⁴⁹

Because of the dynamic nature of radio astronomy observations, Dynamic Protection Areas (DPAs) could be used to protect their operations. Because radio astronomy is passive (non-transmitting), the schedule of the radio observatories would need to be published through a TARDyS3-like portal. This exact arrangement has been successfully implemented in CBRS to protect dynamic operations at some inland military sites, including those whose research involves passive systems.

⁴⁸ International Telecommunication Union (ITU) Radiocommunication Sector (ITU-R) Recommendation RA.769-2, [*Protection Criteria Used for Radio Astronomical Measurements*](#) (May 2003).

⁴⁹ Clegg, A., [*Spectrum Management and Radio Astronomy: The Future*](#), presentation to the IUCAF 4th School on Spectrum Management for Radio Astronomy, Santiago, Chile, p. 10 (April 2014).

4.10. Summary

We conclude that for the most prevalent services in the band, sharing is likely to be readily accommodated using sharing concepts that have already been proven commercially at scale in other bands.

5. Strawman Proposal: A Hybrid Coordination Framework

We propose here a hybrid coordination system based on proven success of AFC in the 6 GHz band and SAS in the CBRS band, and adapted for protecting the federal incumbent systems operating in the 4.4 GHz band. This proposal is intended as a starting point for further analysis and for elaboration based on findings from the forthcoming band study.

We note that what's proposed here are notional examples. When more information is available about specific deployments in the band, these proposed sharing frameworks can be refined, and others proposed. In the end, there may be a variety of techniques that can be used to effectively protect critical incumbent systems while still providing opportunities to quickly and efficiently grow the nation's supply of broadband spectrum for next-generation wireless networks.

5.1. Point-to-Point Protections

Based on large-scale experience with the 6 GHz band, secondary systems could readily coexist with federal fixed P2P and P2MP incumbents in the 4.4 GHz band using a hybrid system similar to a combination of 6 GHz AFC and 70/80/90 GHz stoplight coordination. Lower-power devices could coexist without active management by using the 6 GHz LPI and/or VLP frameworks adopted by the FCC. Dynamic Frequency Selection may also be effective. In either scenario, coordination can be accomplished much more quickly and with far less risk to existing critical federal operations than a clear and auction approach, and therefore a close look at sharing is warranted.

5.2. Ship Shore Ship

Multiple mechanisms could be considered to protect the Navy's ship-to-shore links in the 4.4 GHz band. Because such operations are constrained to ports and coastal areas, a DPA-like construct could be employed. Much of the ship-to-shore links are P2P-like in nature, so an AFC and/or stoplight type of mechanism could also be used. Sharing the 4.4 GHz band would be faster and much less disruptive to ship shore ship operations than the impact of clearing and auctioning the frequencies on which they operate.

5.3. Aeronautical & Flight Telemetry

Because the federal aeronautical telemetry operations appear to be primarily air-to-ground, coexistence comes down to targeted protection of ground stations, as opposed to wide-area protections for airborne receivers. Protection of military bases, where a significant amount of activity occurs, could be implemented similar to the DPA construct successfully used in CBRs.

5.4. Aeronautical Air Ground Air Operations

Further information about air ground air operations is needed to fully assess the methods by which sharing could be accommodated. To the extent that such operations are air-to-ground, ground stations can be protected through the use of DPAs and coordination zones. To the extent that the operations are ground-to-air, if they are limited to specific areas (for example military bases and test ranges), they can be protected through DPAs, similar to the manner in which China Lake airborne operations are protected in the CBRs band.

5.5. Non-Line-of-Sight Point-to-Point Systems

Troposcatter links are highly immune to interference (and communications interception) from paths and locations that are not the intended ends of the link. It is unlikely that protection of troposcatter links represents a significant coexistence barrier for sharing the 4.4 GHz band. The DoD and other agencies have made considerable investments in troposcatter systems and have been using these systems for decades. Clearing this band for the purpose of auctioning the spectrum would require substantially retooling the transmitters, receivers, and antennas to

operate in a different band, which would require a substantial amount of time and likely be disruptive to ongoing troposcatter operations across multiple military departments. Any interference to troposcatter links would likely come from very strong emitters in the immediate vicinity of military bases in which troposcatter systems are in operation and could therefore be protected through the use of DPAs.

5.6. Mobile Systems

Mobile activity is DoD-focused and therefore likely geographically constrained to military bases. In this case, a DPA framework could be implemented to effectively protect mobile operations from interference.

5.7. Research, Development, Testing, and Evaluation Systems

Only military agencies conduct RDT&E in the 4.4 GHz band based on assignment data. If such activity is limited to military bases, DPAs could be used to ensure protection from harmful interference. However, more details are needed on the nature of RDT&E operations to fully assess spectrum coexistence factors.

5.8. Fixed-Satellite Protections

Due to the proven success in protecting FSS earth stations in the CBRS band, the same protection methodologies could be used to protect similar earth stations in the 4.4 GHz band. Transportable FSS operations covering major scheduled events could be protected on a similar basis for the pendency of their temporary operation, which is typically one week or less, and known months in advance.

5.9. Radio Astronomy Protections

Given the remote, but known, locations of radio astronomy observatories requiring protection, ITU-established radio astronomy interference protection criteria, and existing examples of spectrum sharing with the radio astronomy service, sharing the 4825-4835 MHz band with a secondary commercial service would be straightforward, particularly if the service does not use extremely high power. A DPA construct is the most likely implementation.

5.10. Further Considerations

The hybrid system described is capable of protecting the substantial majority of federal operations in the 4.4 GHz band based on the available information. Protection of the remaining minority use of the band will depend on the details of that use which should be forthcoming from the band study being conducted as mandated by the WFTCA.

5.11. Summary

The following table summarizes the mechanisms that could be used to facilitate spectrum sharing in the 4.4 GHz band. The proposed mechanisms are subject to change based upon further details of federal operations in the 4.4 GHz band becoming available.

Table 5.1: Notional spectrum sharing mechanisms in the 4.4 GHz band.

Operation Type	Mode	SHARING METHODOLOGIES							
		Federal AFC	Stoplight	Portal	Coastal DPA	Inland DPA	Coord. Zone	Natural Interference Suppression	Additional Data Needed
Fixed P2P	Static	✓	✓						
Ship Shore Ship	Dynamic	✓	✓	✓	✓				
Aeronautical & Flight Telemetry	Dynamic			✓		✓			
Air Ground Air	Dynamic								✓
Non-LOS P2P	Dynamic							✓	
Mobile	Dynamic					✓			
RDT&E	Dynamic				✓	✓			✓
FSS	Static						✓		
Radio Astronomy	Dynamic			✓		✓			

6. A Shared 4.4 GHz Band Compares Favorably to a Clear and Auction Approach

Taken in combination, a range of factors discussed above and technical factors discussed below suggest that a spectrum sharing framework would maximize the value of the 4.4 GHz band by

using spectrum efficiently, putting spectrum in the hands of more providers and enhancing competition, all while minimizing implementation and transition costs for the wide range of existing government users that rely on the 4.4 GHz band to fulfill their mission. Policymakers should carefully question the assumption that “clear and auction” is the most appropriate or sole option for commercial service in this band. In the final analysis, sharing could generate more marginal economic benefit, in less time, and at lower cost. All of this translates into policy outcomes that meet the urgent need for wireless policy that makes America more innovative, more globally competitive, and more secure, especially in the age of AI.

6.1. Medium power spectrum sharing maximizes marginal economic benefit

The relative merits of exclusive licensing and spectrum sharing can be evaluated along several practical dimensions in addition to technical feasibility. These include the cost of implementation, the time required to make spectrum available for commercial use, the marginal economic and social value of the resulting spectrum access, and the net fiscal return to the government. Across each of these criteria, a medium-power shared framework compares favorably with an approach that first clears incumbent federal operations. The following sections examine these considerations in turn.

Implementation cost. The principal cost of repurposing the 4.4 GHz band is not the conduct of an auction but the relocation of incumbent operations. The band currently supports numerous federal systems, many of which were not designed to be relocated and cannot be moved without substantial re-engineering, re-fielding, and re-validation of mission-critical functions—and, in certain cases, without comparable spectrum to which they could be transitioned. These costs are a function of incumbent system complexity rather than of the commercial value of the spectrum, and for systems of this character they are considerable. A medium-power sharing framework substantially mitigates these costs. Rather than displacing incumbents, it accommodates new commercial entrants alongside them: medium-power operation within a managed coordination framework permits substantial commercial use of the band while federal systems continue to operate without disruption. The implementation burden is thereby reduced from a multi-year relocation program of significant fiscal magnitude to the

considerably more limited cost of establishing the coordination infrastructure that governs shared access.⁵⁰

Time to market. Because a sharing framework requires no incumbent relocation, it imposes no transition period that must elapse before the spectrum becomes commercially usable. Clearing, by contrast, is inherently sequential: no commercial licensee may operate until incumbent systems have been relocated, with the result that the timeline is determined by the most complex incumbent in the band. For a band as densely occupied by federal users as the 4.4 GHz band, that process can reasonably be expected to require several years, during which the spectrum remains economically unproductive. A sharing framework decouples commercial entry from incumbent departure, permitting authorized use to commence as soon as the coordination mechanism is operational. The economic value of spectrum is closely tied to the timing of access; spectrum made available in the near term is materially more valuable than equivalent spectrum made available only after a multi-year clearing process. A sharing approach realizes that value promptly rather than deferring it across an extended and uncertain transition.

Marginal social value. The appropriate allocation question is where an additional increment of capacity yields the greatest economic and social return, which in turn depends on where capacity is most constrained. Making a substantial quantity of 4.4 GHz spectrum available on a medium-power shared basis would meaningfully expand the national supply of such spectrum, which remains limited relative to demand. That supply is the binding constraint for a growing set of applications for which localized, mid-band, medium-power access is essential, including industrial and enterprise networks, robotics and automation, private wireless systems, fixed wireless access, and sensing. In particular, these localized, medium-power networks are tailor-made for the latency and throughput demands of edge AI applications, enabling real-time processing and decision-making directly at the facility level. Users in these categories are

⁵⁰ We note that four years after the auction of the 3.45 GHz Band, licensees have reported an inability to coordinate their high-powered systems with military radar and other operations in certain markets. By contrast, CBRS has demonstrated a working and highly scalable automated system for coordinating with naval radars.

generally unable to obtain, or to justify the cost of, exclusive nationwide or even large-area licenses; for them, shared spectrum is not a secondary alternative but the enabling input, and the marginal value of additional supply is correspondingly high. Expanding access to a broader, more diverse ecosystem of users and providers also injects vital competition into the marketplace, stimulating downstream innovation and preventing spectrum concentration. The allocation of the same spectrum to exclusive mobile licenses would, by contrast, augment capacity in a mature and well-provisioned market. Mobile penetration in the United States is effectively saturated, prevailing service already delivers speeds of several hundred megabits per second, and demand growth has substantially moderated;⁵¹ incremental exclusive capacity would therefore yield only marginal improvements in speed and network headroom. Directing a constrained resource to its highest-value application is a central objective of sound spectrum policy, and on that criterion the next increment of capacity is most productively allocated to the emerging shared-use sector.

Auction revenue. A comparison of the two approaches on revenue grounds should be conducted on a net rather than a gross basis. The headline proceeds of a cleared auction are gross figures, against which the full cost of incumbent relocation must be offset—costs that may reach tens of billions of dollars and that, under existing statutory requirements, auction proceeds must exceed by a prescribed margin for the auction to proceed. A shared, auctioned tier structured along the lines of the CBRS Priority Access License model would entail little or no comparable clearing cost and would generate meaningful revenue substantially earlier in time. Moreover, sharing is naturally conducive to smaller-footprint geographical licenses that are economically attractive to a wide range of bidders. The combination of materially lower transition costs, accelerated time to market, and broadened auction participation means that the net proceeds to the government from a shared licensing tier may exceed those of a cleared exclusive auction, notwithstanding a higher gross figure in the latter case. Because net rather

⁵¹ Webb, W., and Roberson, D., *op. cit.*

than gross revenue is the appropriate basis for decision, the shared approach warrants serious consideration on fiscal grounds alone.^{52,53}

6.2. Sharing serves core national objectives

These principled advantages—lower implementation cost, near-immediate availability, and higher value at the margin—are not ends in themselves. They translate into at least three concrete returns for U.S. policy: a broader base for innovation, a stronger position in industrial competitiveness, and the preservation of critical government systems that underpin national security.

National security. Critically, these economic gains can be realized without displacing current and future mission-critical federal systems. The 4.4 GHz band supports important military and civil infrastructure functions, and a clearing approach would require relocating those systems—at substantial cost, over a period of several years, and with attendant operational risk to missions that depend on continuity. A medium-power sharing framework avoids that disruption by design: incumbents remain in place and continue to operate, while commercial use is coordinated around them. This allows the United States to capture the full economic and innovation value of the band while preserving the defense and critical-infrastructure capabilities that reside there, rather than trading one national priority against another. In this respect, sharing is not merely the more economical path; it is the approach that simultaneously strengthens the commercial technology base and reinforces national security, advancing both objectives where clearing would force a choice between them. Moreover, AI is not only reshaping the civilian sector; it is also reshaping important government national security and other missions. Only a shared approach the 4.4 GHz band will provide critical optionality for the deployment of AI-based technologies that will undergird American security and supremacy in the future.

⁵² Bazelon, C., Sanyal, P., and Paek, Y., [Principles of Spectrum Sharing: Understanding the Value of Shared Spectrum](#) (Sep. 18, 2023).

⁵³ Ostrovsky, M., [Dual-Track Auction for Market-Based Determination of Spectrum Clearing](#) (Aug. 30, 2024).

Innovation and Market Competition. A shared, medium-power framework widens the set of entities that can obtain spectrum, and that breadth of access is itself a driver of innovation and market competition. Exclusive licensing concentrates a band in the hands of a small number of national operators whose business models and deployment priorities are well established; shared access, by contrast, extends usable spectrum to manufacturers, logistics operators, ports, utilities, research institutions, and the technology firms building on top of them. These are precisely the participants developing the next generation of automated, AI-enabled systems—industrial robotics, autonomous material handling, machine vision, and real-time control—and a base layer of reliable enterprise wireless connectivity sits at the foundation of that technology stack. Connectivity is the layer on which the higher tiers of the stack depend: without pervasive, dependable wireless access, the automation, sensing, and AI capabilities built above it cannot operate at scale. By lowering the barrier to spectrum access, a sharing regime allows that foundational layer to be deployed across many firms and use cases simultaneously, rather than waiting on the roadmap of a few incumbents—enabling experimentation and development throughout the technology stack. The result is a larger and more diverse innovation pipeline anchored in the 4.4 GHz band.

Productivity and global competitiveness. The applications that shared spectrum enables are concentrated in the sectors most central to national economic strength: advanced manufacturing, industrial automation, and logistics. Enterprise wireless connectivity is the connective tissue of the modern "smart factory," linking sensors, robotics, and control systems into integrated, automated production environments; expanding the supply of spectrum suited to these deployments directly supports gains in productivity, manufacturing output, and industrial resilience. This consideration carries particular weight in light of international developments. China has made the fusion of advanced wireless connectivity with industrial capability an explicit element of national strategy, allocating dedicated industrial spectrum for private enterprise networks—beginning with its first corporate private-network license in 2022—and more recently directing its operators and provincial authorities to help large enterprises and strategic industries obtain spectrum for private network deployment. It has tied

these measures to an industrial-internet sector valued in the hundreds of billions of dollars and positioned them as instruments of manufacturing competitiveness. A U.S. decision to expand medium-power shared spectrum at 4.4 GHz would advance a comparable objective through means consistent with the American regulatory tradition—open, market-based access rather than state direction—and would help ensure that the United States does not cede leadership in the industrial applications that will define the next phase of global economic competition. Moreover, this policy would support an important recommendation of the U.S.-China Economic and Security Review Commission, to “[i]ncrease funding for foundational research on advanced technologies such as cognitive radio and radar, dynamic approaches to spectrum allocation, and spectrum sharing.”⁵⁴

7. Conclusion

Our analysis supports the central conclusions that sharing in the 4.4 GHz band is highly feasible and compares favorably against the alternatives.

- The band's incumbents can be protected through coordination mechanisms already proven at scale;
- Sharing brings more spectrum into commercial use sooner and at lower cost, while preserving the federal operations on which critical missions depend; and
- Measured against a clear-and-auction approach on implementation cost, time to market, marginal value, and net revenue, it is superior.

A shared approach is therefore worthy of serious further study as the interagency review of the band proceeds. To that end, we have set out a strawman framework—a hybrid coordination model combining automated frequency coordination, dynamic protection areas, and coordination zones—as a concrete starting point, to be tested and refined against the fuller data that study will produce.

⁵⁴ Hundman, E., *op. cit.*

We do not contend that sharing is the only answer. A combination of exclusive and shared access may ultimately prove the arrangement that best maximizes national policy objectives, satisfies the legislative mandates, and preserves the government's ability to perform critical missions well into the future. What our analysis makes clear is that shared use deserves full and equal consideration within that process.

Appendix A: Advantages of Medium Power Sharing

An important consideration when analyzing sharing opportunities is the transmit power of the secondary user. The higher the transmit power, the greater the distance and area over which it can cause interference.

This section evaluates how transmit power dictates a signal's interference footprint. While higher-power transmitters deliver broader coverage, they also project harmful interference over larger distances, which is a major drawback when coexisting with incumbent systems. Conversely, lower-power devices provide targeted coverage over localized areas without risking long-range interference.

The comparative impacts of three different power classes will be assessed:

- Indoor device (consistent with indoor CBRS Category A device)
 - 30 dBm EIRP per 10 MHz
 - 15 dB of building loss
 - Net EIRP: 15 dBm (0.032 W) per 10 MHz
- Outdoor device (consistent with CBRS Category B device)
 - 47 dBm (50 W) EIRP per 10 MHz
- High-power commercial macro cell (consistent with Part 27 rules)
 - 72.1 dBm (16,400 W) EIRP per 10 MHz

A simple power-law propagation model will be used:⁵⁵

$$P_r \propto \frac{P_t}{d^n}$$

⁵⁵ Cf. Goldsmith, A., Stanford University EE 359 Lecture Notes, [Signal Propagation and Path Loss Models](#), section 6 (2020).

where P_r is received power, P_t is transmit power, d is distance, and n is the power law exponent. For a given received interference power level, the distance scales as $d \propto P_t^{1/n}$. The interference area $A = \pi d^2$ scales as the square of the interference distance, so $A \propto P_t^{2/n}$.

Commonly used values for n are:

- $n = 2$
 - Free space loss, line of sight, no clutter
 - Suitable for airborne with unobstructed path
- $n = 3$
 - Moderate clutter, suitable for suburban environment
- $n = 4$
 - Heavy clutter, suitable for urban environment

The following tables summarize the relative interference distance and area for each of the three power classes.

Table A.1: Comparative interference distance and area for line of sight ($n=2$).

Power Class	Interference Distance Relative to 1 W Indoor	Interference Area Relative to 1 W Indoor
1 W indoor	1	1
50 W outdoor	39.8	1,581
16,400 W outdoor macro	720	518,614

Table A.2: Comparative interference distance and area for suburban environment ($n=3$).

Power Class	Interference Distance Relative to 1 W Indoor	Interference Area Relative to 1 W Indoor
1 W indoor	1	1
50 W outdoor	11.6	136
16,400 W outdoor macro	80.3	6,455

Table A.3: Comparative interference distance and area for dense urban environment ($n=4$).

Power Class	Interference Distance Relative to 1 W Indoor	Interference Area Relative to 1 W Indoor
1 W indoor	1	1
50 W outdoor	6.3	39.8
16,400 W outdoor macro	26.7	720

As evidenced from this simple analysis, the interference distance for a macro cell can be ~30 (dense urban) to ~700 (free space loss) times greater than for a 1 W indoor device, and the interference area (square of distance) can be ~700 (dense urban) to some ~500,000 (free space loss) times greater. Comparing the macro cell interference distance and area to the 50 W outdoor device yields corresponding multipliers of ~4 to 20 in distance and ~18 to ~300 in area.

In reality, the interference area differences may be even more extreme than highlighted here. For example, low-power cells may be more likely to exist within the clutter layer (n is between 3 and 4), while the high power macrocells are on tall towers above much of the clutter (n is between 2 and 3). In that case, the propagation loss from the tall high-power macrocells would be disproportionately less than the loss from the lower-power cells, and the interference distance/area disproportionately greater.

This calculation underscores the extreme challenges with sharing with high-power macro cells compared to sharing with lower-power devices.

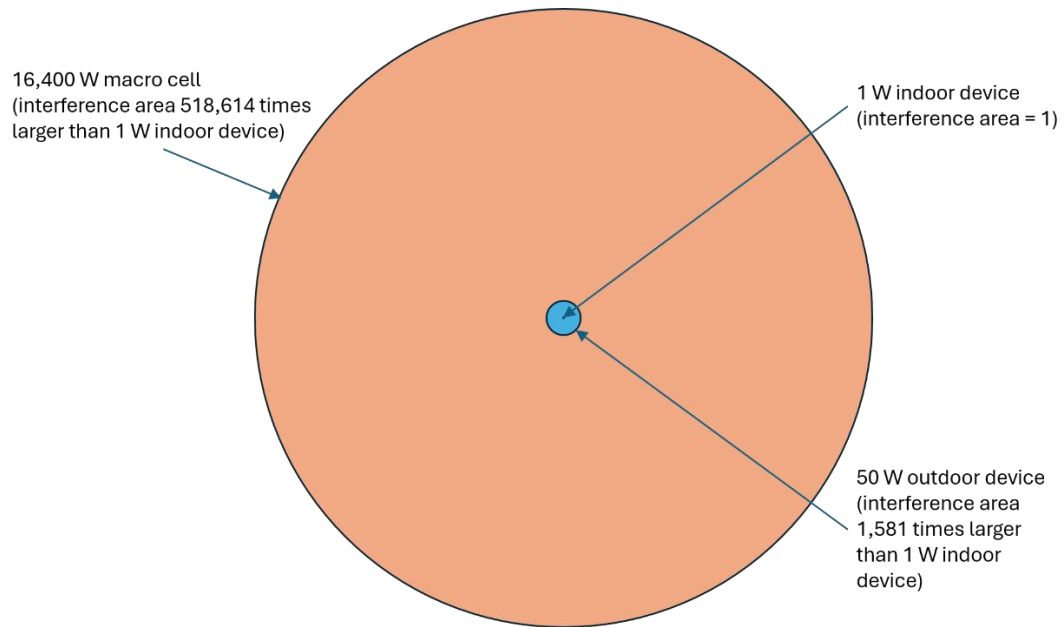


Figure A.1: Comparative area over which three different cells of three different power levels would cause interference in a line-of-sight environment ($n=2$).

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