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Injecting the Free Market into Spectrum Use for Space Applications

AUTHOR
Clayton Swope

A Report of the CSIS Aerospace Security Project

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Center for Strategic & International Studies
1616 Rhode Island Avenue, NW
Washington, DC 20036
202-887-0200 | www.csis.org

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Contents

Foreword

This paper was originally intended to focus on equivalent power flux density (EPFD) rules, providing background on their purpose and development along with an analysis of proposed changes. This analysis would have examined whether–and if so, how–reforms to EPFD rules could improve the productive potential of spectrum resources. At an early stage of research, however, it became clear that such a narrow focus would miss the forest for the trees; in fact, the entire spectrum governance structure needed to be reassessed. EPFD rules are a product of the spectrum management system in which they were created; they are constrained within it, and changing the rules without changing the system will generate marginal improvements at best. To truly optimize the productivity and efficient use of spectrum resources, the entire status quo spectrum governance framework needs to be reevaluated.

To get at this new vision, it is necessary to start at first principles. The use of any limited natural resource should be governed in a way that encourages efficiency and productivity. Could a system based on private property rights better optimize productivity than the current system of administratively directed decisions that determine who gets to use a resource and for what purpose? A right to private property, as opposed to state control and ownership, is a foundational characteristic of liberal democracies worldwide. Yet the United States (and nearly every other country) takes a curious approach when it comes to spectrum, relying on governmental processes to decide who gets to use spectrum and how that spectrum is used. The foundations of the system are based on government control rather than property rights. This paper lays out the case for property rights for spectrum use, anchoring the arguments for doing so around how such a change would benefit the space economy, which wholly depends on spectrum.

While it is fair to ask whether it is worth fixing a system that is not obviously broken, an equally good question is whether repeatedly modifying a spectrum management structure whose cornerstone was laid before the advent of any modern communications technologies is better than designing a new approach from the ground up with the future in mind. There may be too many entrenched interests that strenuously resist efforts to hit the reset button, but is it worth considering what an all-new framework—aligned toward optimizing the productivity of spectrum—could look like. At the very least, envisioning a new approach to spectrum management and governance would cast light on the deficiencies in the current approach, possibly making more modest changes and improvement easier to swallow. But the main reason to consider such drastic changes now is that, with the anticipated increase in the number of satellites in orbit over the coming years, the current approach to spectrum use governance will buckle under the weight of such explosive growth. Cracks will appear in the system when it tries to operate at this scale, holding back the space economy, discouraging innovation, and serving as a barrier to new entrants and startups needing spectrum to test their ideas in space.

Introduction

In the 1890s, Guglielmo Marconi invented a device that used radio waves–the lowest frequencies on the electromagnetic spectrum–to transmit information wirelessly between two locations. His innovation revolutionized communications, instantly transforming spectrum into a limited natural resource with incredible economic potential. Over the next few decades, governments around the world began to implement a spectrum governance structure that placed governmental entities in charge of deciding who can use spectrum and for what purposes, along with when and where entities can transmit radio signals. This approach is essentially the same governance model used today. It is also fundamentally different from how the possession and use of other limited natural resources are governed.

In market-based economies, property rights underpin the system by which people exchange and use resources, services, and other goods. Regulation (i.e., sacrificing individual rights for the common good) is generally used sparingly, and the perceived benefits of property rights are that they incentivize economic growth and encourage investment. Property rights entail certain distinct but complementary elements. For example, a landowner can choose how to use their land, legally prevent someone else from using it, and sell or transfer the land to another party. For spectrum, however, decisions such as these are often made by a government agency, akin to how a nation with a state-directed economy manages resource apportionment and use. Why is spectrum use universally governed in this manner? The answer is simple: It is the way things have always been done. For various reasons, very few have tried to use a different approach, and many believe it cannot be done any other way. But there are reasons to consider changes–big ones, but also small ones–for how spectrum is licensed for nonfederal space applications.

The United States, many other countries, and the International Telecommunication Union (ITU) use the concept of interference, which has two essential levels—harmful and permissible—as the basis for establishing operational parameters for radio networks.[1] Interference is the result of the interactions between more than one radio transmission at a receiver; it is not something that can be specified for a transmitted signal alone. This means that what a licensed user can or cannot do with spectrum is constrained by the actions of other licensees. To complicate matters, for spectrum used in space, certain users end up with priority protections from interference, with longtime users often granted protections from newcomers. Although reforms adopted by the Federal Communications Commission (FCC) in July 2026 to space licensing processes incorporate more performance-based criteria, the United States has heretofore mainly used an inflexible command-and-control approach for licensing spectrum for private sector space activities.[2] These factors have created a bias against innovation and new entrants and have done little to encourage incumbents to use spectrum more productively or efficiently.

Aligning spectrum use governance to a property-rights model would address these issues. The regulatory concept of harmful interference would be retired, as it cannot be defined in terms of a right held by only one entity. Instead, it would be replaced by rights that are defined according to transmitter-only criteria and legally enforceable, using harm claim thresholds, through administrative actions or, if necessary, in a court, like any other property right. Making this change would also remove the need for rules based on harmful interference, such as interference protections that prioritize one user over another (e.g., EPFD rules) and rules for allocating spectrum bands for specific services. Using a property-rights model would therefore remove the constraints on how licensees can use spectrum. It should be noted that establishing property rights for spectrum use is not synonymous with holding spectrum auctions, as an auction is just one possible way of initially assigning spectrum rights. Also, property rights would not favor entities with deep pockets wishing to use spectrum any more than property rights for other resources favor entities with more money over those with less. There are measures that can be taken to minimize spectrum warehousing.

Refactoring spectrum governance, so that its foundations are built on legally strong property rights, would be a giant shift and transcend any individual FCC rulemaking—but such a change should be considered if maximizing the efficient and productive use of spectrum resources and ensuring the United States maintains its lead of the global space economy are important goals. It is worth noting that policymakers can make small modifications that improve the chances that spectrum is used more productively without such fundamental changes: For example, the updates to EPFD rules adopted by the FCC during its meeting on April 30, 2026, will improve the efficiency of spectrum used by both geostationary orbit (GSO) and non-geostationary orbit (NGSO) systems.[3] These changes represent a meaningfully positive step toward increasing the efficiency of spectrum use for space applications today and tomorrow. The new rules adopted by the FCC in July 2026 to modernize space licensing processes, aimed at creating a more flexible and predictable framework and reducing approval times for applications meeting certain requirements, are also positive steps that will improve the productivity of spectrum use.[4] But policymakers should not shy away from drastic change—and they should understand the benefits that would be derived from such a change.

The prevailing reason to rethink widely held assumptions about the usability of a property rights approach is to increase the productivity and efficiency of spectrum use in light of the incredible growth demand. Thanks to technological advancements, spectrum is a critical enabler of just about every facet of daily life. Spectrum is particularly important for space–and as more and more satellites are placed in orbit, demands on spectrum will continue to rise. There is likely not one satellite in orbit that does not use spectrum. Thus, any efforts to make the use of spectrum more efficient and productive will yield benefits to all users, but particularly those operating systems in space. Several characteristics of how the United States manages private sector spectrum use in space create inefficiencies that could be reduced with a governance model that includes property rights.

Why Consider Changing Spectrum Governance Now?

Now is the time to consider monumental changes in how spectrum use is governed, particularly the use of spectrum in space. The business of space is booming and set to grow exponentially in the coming years, and the inefficiencies of a government-directed resource assignment approach will hamper that growth. One space consultancy predicts that over 43,000 satellites will be launched by 2034.[5] Goldman Sachs says that number could be closer to 70,000 by 2030.[6] A report from the National Telecommunications and Information Administration (NTIA) published in 2021 described the importance of spectrum to space: All satellites will need spectrum, and they will compete with other users of spectrum, such as terrestrial mobile operators, which have demonstrated an insatiable appetite for even more spectrum.[7] The current approach for spectrum resource assignment, in which a government agency decides who gets to use spectrum and for what purpose, will not be able to keep up with this demand and ensure that spectrum is paired with the most economically productive use.

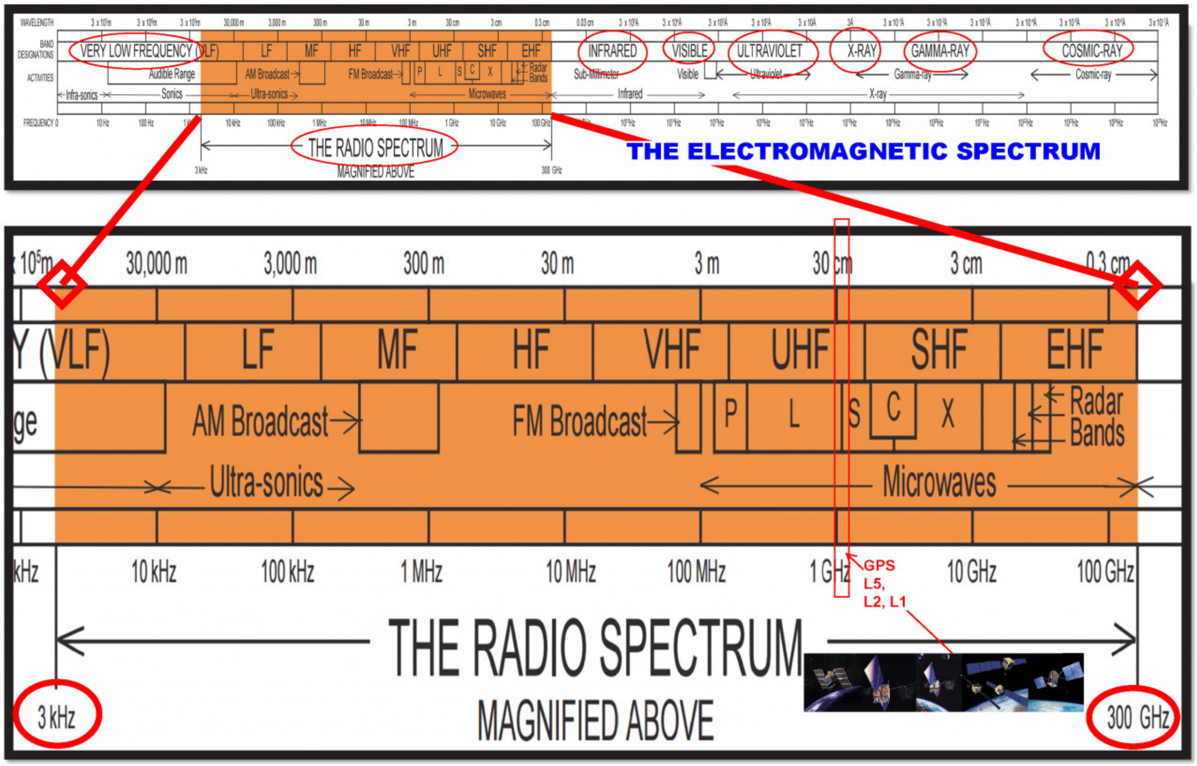
Spectrum resource assignments and uses are managed by government-directed processes primarily based on the assumption that this is the best, maybe only, way to prevent harmful interference—but other approaches have never been comprehensively tested and vetted. As this paper explains in later sections, strong legal protections and civil, administrative, and, when appropriate, criminal mechanisms would work to safeguard the rights of spectrum users in any new system based on property rights. Already, the current government-directed approach to spectrum governance is having a hard time keeping up with improvements to technology and the resulting demand for more services using spectrum. The FCC was clear in its docket for the April 2026 meeting: Outdated EPFD rules are inefficient and limit the number of households with access to space-based broadband connectivity.[8] Though the FCC decision to update EPFD rules will improve the efficiency of spectrum use, the overall framework remains oriented around protecting incumbents at the expense of new entrants–a structural tendency in tension with market forces and one that can stifle innovation and new ideas.[9] For example, the processing round framework for granting NGSO broadband systems licenses grants term-limited interference protections to operators holding the oldest licenses, essentially the incumbent operators.[10] As a recent example, in an April 2026 decision, the FCC did not allow new entrants access to certain Mobile Satellite Service spectrum bands, currently used by incumbent operators.[11]

What Is Spectrum?

The electromagnetic spectrum is made up of different types of electromagnetic radiation—such as radio waves, infrared, visible light, ultraviolet, X-rays, and gamma rays—which are typically organized by frequency, visualized with the lowest-frequency sources of electromagnetic radiation on the left and highest-frequency sources on the right.[12] At the low end, radio waves typically include spectrum up to 300 GHz. These can occur naturally: Lightning and astronomical bodies, like stars, galaxies, and nebulas, produce naturally occurring radio waves. Since the late nineteenth century, however, artificially produced radio waves generated by a transmitter have been used for communications. Today, applications using radio waves include mobile phone networks, radio and television broadcasting, satellite communications, wireless computer networks, and satellite-based navigation systems, among many other important functions.

The use of radio waves within the frequency spectrum involves three dimensions: frequency, time, and space. Radio waves are transmitted at specific frequencies and occupy a certain amount of bandwidth. They are transmitted at a certain time (although some transmitters, such as GPS, are always radiating signals). Finally, they are transmitted through physical space, with the power level of that radiating signal varying at each discrete point within that space. Interference, which occurs at the receiver of the signal, can only happen when more than one transmission simultaneously occupies all three dimensions. Two transmitters broadcasting at the same time and space will not cause interference if they are using different frequencies (transmissions on adjacent frequencies, however, can cause interference in certain circumstances). Similarly, two signals transmitting at the same time and on the same frequency will not interfere with each other if they are radiating energy in separate, nonoverlapping locations.

Figure 1: Visualizing the Electromagnetic Spectrum



Source: "What is Radio Spectrum?," U.S. Department of Transportation, updated September 21, 2017, https://www.transportation.gov/pnt/what-radio-spectrum.

Spectrum is often referred to as a natural resource, even though it is not consumed by use, as is the case with other natural resources such as coal or oil.[13] Theoretically, the electromagnetic spectrum is infinite, but the portion of spectrum usable for transmitting radio signals is limited. Technological advancements, however, routinely increase the amount of spectrum usable for wireless communications and other applications. Like with other natural resources, the value of spectrum comes from its use in various commercial and governmental applications, which–in the case of spectrum–involve the wireless transmission or derivation of information. Spectrum use requires technology in a similar way that technologies are used to harness and exploit other national resources, often for creating economic value.

The Origins of Spectrum Regulation

By the turn of the twentieth century, as nations grasped the transformative power of wireless radio and its implications to their national security, the leaders of the great powers sought to apply the same type of governmental regulation on spectrum use that they had previously applied to wired telegraphy through multilateral agreements. Great Britain and the United States took an early lead on commercializing and proliferating radio technology, relying on private enterprise to develop, build, and operate wireless systems much as they had for telegraphy. Fearful that Britain would come to dominate and control the new field of wireless communications, Germany organized the world's first conference in 1903 to discuss international radio communications issues. The origins of international spectrum governance frameworks, however, are rooted in earlier efforts to develop similar frameworks for wired telegraphy.

International Rules

The governance of spectrum use has a relatively short history, dating back to the mid-nineteenth century. The earliest electric telegraphy systems were invented in the early 1800s, with telegraphs entering commercial use in the 1830s. By the 1850s, all major countries were operating telegraphic systems, often installed in post offices. The world's first undersea cable was installed in 1850 and connected France to Great Britain, though only a few messages were exchanged before a fisherman accidentally severed the cable.[14] Telegraphy—a technology that enables near instantaneous long-distance communications—was recognized as a source of economic, geostrategic, and military power. To some, telegraphy was even dangerous: Russian Czar Nicolas I called the telegraph "subversive" and feared its widespread use in Russia.[15]

Before long, nations sought to control telegraphy by harnessing its power for themselves, while also trying to deny their geopolitical competitors any advantage gained from the emerging technology. Great Britain, whose telegraphic networks were mostly operated by companies, quickly became the leader in undersea cable installation and operation, building networks around the globe to connect the disparate parts of the British Empire. Great Britain's main continental rivals at the time—France, Germany, Russia, and the Hapsburg Empire—operated government-run systems that terminated at their nations' borders, usually co-located with post offices.

Beginning in the 1840s, countries across Europe began to enact bilateral and regional agreements to govern the operation of international telegraphy connections, similar to the system used for cross-border postal service.[16] In 1865, France convened a conference, inviting representatives from 20 countries, to develop a multilateral agreement covering telegraphy across Europe. Great Britain was not invited to the conference because its telegraph networks at that time were operated by private companies rather than the state.[17] The conference produced the International Telegraph Convention (ITC), which, among other things, established the ITU, specified the use of Morse code for international communications, and set fees for cross-border communications.

Britain joined the convention after the next conference in 1868, because the ITC would now cover private telegraph network operators (a moot point, as Britain decided to nationalize its telegraphic systems in 1868). The ITC was revised in 1868 to establish a permanent secretariat in Switzerland.[18] Participants at the third conference, convened in 1871, decided to allow companies to participate but not vote in future proceedings.[19] The United States participated for the first time in the fourth conference, held in St. Petersburg in 1875. Both the United States and Great Britain supported a convention provision assuring the privacy of telegraphic messages. However, Russia and Germany succeeded in adding language that placed limits on that provision, allowing a nation to violate the privacy of international telegraphic communications to protect "state security, public order, and public morality."[20] Calling this provision censorship, the United States refused to sign the convention. Although administrative conferences were held every few years after 1875, the next plenipotentiary conference was not called until 1932. In the meantime, governments turned their attention to the emerging technology of wireless communications, aiming to apply the same types of controls on it that they had applied to wired telegraphy.[21]

The possibilities of wireless communications had been known for some time, as the scientific foundations of wireless technologies date to the discovery and transmission of electromagnetic waves in the early 1800s. But it was nearly 100 years later, in 1895, that Guglielmo Marconi invented the world's first radio communications system.[22] He subsequently designed a long-distance radio transmission system, for which he received a British patent in 1897. That same year, Marconi established the Wireless Telegraph and Signal Company in London and soon began incorporating subsidiaries around the world, starting with the Marconi Wireless Telegraph Company of America in 1899. By the end of the nineteenth century, government owned and operated coastal radio stations built for communicating with radio-equipped warships at sea worked alongside commercial stations—the latter of which were predominantly run by Marconi's company, based in London. As it did with electric telegraphy, Great Britain—home to the world's preeminent radio company—soon rose to dominate wireless communications.

Marconi's growing dominance of wireless communications drew attention and ire from several European capitals, most notably Berlin. As with the telegraph, statesmen on the continent wanted to wrest control over another new technology from the British. In 1903, the German government organized the first multilateral discussions on wireless communications in Berlin, with the unambiguously stated aim of breaking the Marconi hold on wireless communications.[23] In spite of opposition from Great Britain and Italy—countries in which Marconi and his firms had significant interests—conference participants developed a protocol that, among other things, required all radio operators to receive messages regardless of the type of radio equipment used.[24] This provision was a direct response to Marconi's prohibition on the use of his radios to receive messages from radios made by other companies. The next multilateral conference, which met in Berlin in 1906 and included 30 participating nations, finalized the 1903 protocol. The resulting Berlin Protocol of 1906 included the world's first frequency allocations, which specified wavelengths for public maritime correspondence, coastal station communications, and military communications.[25] The 1906 conference is now recognized as the first International Radiotelegraph Conference.[26]

In spite of resistance and occasional opposition to certain elements of both the ITC and International Radiotelegraph Convention, the United States and Great Britain supported a multilateral approach to regulating and coordinating international communications. In 1932, during a plenipotentiary meeting of the International Telegraph Conference and International Radiotelegraph Conference in Madrid, the membership of each agreed to merge the two entities into a single organization—the ITU—charged with promulgating international rules and standards for telegraphy, telephony, and radio.[27] The ITU took on the traditions of its constituent organizations, hosting plenipotentiary meetings to address a broad range of issues under its mandate and world radiocommunication conferences to update radio regulations to enable new uses, promote harmonization, and protect against cross-border interference.

U.S. Regulations

As Europe was hosting the first radio conferences, the United States was pursuing its own domestic measures to regulate radio. In 1910, Congress passed the first U.S. legislation addressing radio communications. The Wireless Ship Act of 1910 required certain ocean-going vessels to carry radio equipment and trained operators.[28] The act also required operators to exchange messages with other operators regardless of the equipment used. By this time, the United States had participated in both Berlin conferences but objected to their proposed tariff system, and still had not ratified the Berlin Protocol. Eventually, in 1912, the United States ratified the agreement when the conveners of the third conference, planned for London later that year, threatened to exclude the United States if it did not do so.[29]

Table 1: International Conferences Related to the Development of the ITC and ITU

Year	Name	Type	Location
1865	International Telegraph Conference	Plenipotentiary Conference	Paris
1868	International Telegraph Conference	Plenipotentiary Conference	Vienna
1871	International Telegraph Conference	Plenipotentiary Conference	Rome
1875	International Telegraph Conference	Plenipotentiary Conference	St. Petersburg
1903	Preliminary Conference on Wireless Telegraphy	Radio Conference	Berlin
1906	International Radiotelegraph Conference	Radio Conference	Berlin
1912	International Radiotelegraph Conference	Radio Conference	London
1927	International Radiotelegraph Conference	Radio Conference	Washington
1932	International Radiotelegraph Conference	Radio Conference	Madrid
1932	International Telegraph Conference	Plenipotentiary Conference	Madrid

Source: "List of ITU Conferences, Assemblies and Events," ITU, https://www.itu.int/en/history/Pages/ListOfITUConferencesAssembliesAndEvents.aspx.

From that point on, the United States was required to ensure that provisions of the Berlin Protocol were reflected in U.S. domestic regulations, necessitating the passage of the Radio Act of 1912, which codified the Berlin Protocol in U.S. law.[30] The Radio Act authorized the U.S. government to allocate frequencies for various uses, license users of radio frequencies, and require the prioritization of distress calls, establishing the first comprehensive set of regulations governing radio communications in the United States.[31]

While the Radio Act of 1912 allocated ranges of spectrum for certain uses (i.e., government, commercial, and amateur), it was silent on the assignment of spectrum to specific users. For example, the law did not establish which entities had the right to use frequency bandwidth for commercial purposes within the portion of spectrum allocated for commercial use. An equivalent situation for use of land, or physical real estate, would be the creation of a zoning code without establishing ownership or use rights of specific parcels of land. This proved to be the fatal flaw of the Radio Act of 1912. In response to legal challenges, U.S. courts overturned the law's key provisions, necessitating the passage of a new law–the Radio Act of 1927–giving the federal government sweeping powers to not only regulate but also allocate and assign spectrum within the United States.[32]

The Radio Act of 1927 enumerated the government's right to "regulate all forms of interstate and foreign radio transmissions and communications within the United States" and decreed that, in order to receive a license, radio broadcasters had to demonstrate that their programming served "the public interest, convenience, or necessity."[33] Concerns about interference had skyrocketed during the 1920s due to the advent of public radio and the proliferation of multiple broadcasters attempting to use the same frequencies to deliver programming. Instead of affecting small numbers of commercial users who used radio for long-distance communications, interference now affected thousands of households listening to receive-only consumer radios. To oversee the regulatory provisions on radio broadcasting, the Radio Act of 1927 created the Federal Radio Commission (FRC).[34] In 1928, the FRC enacted orders that sought to reduce the congestion of broadcast frequencies with the goal of reducing interference and improving the reception quality of radio broadcasts. The FRC, however, was short-lived, soon becoming a part of the FCC.

The FCC was created by Congress through the passage of the Communications Act of 1934 in response to a recommendation from President Franklin D. Roosevelt about establishing one federal agency responsible for regulating communications.[35] Granted the authority to regulate "interstate and foreign commerce in communication by wire and radio," the FCC was created by merging the FRC and the wireline telecommunications regulatory authorities of the Interstate Commerce Commission.[36] Like the FRC, the FCC was authorized to issue regulations in a manner "consistent with the public interest, convenience, and necessity" that would govern the "interference potential" of devices emitting radio signals and establish standards for consumer technologies to reduce their susceptibility to interference.[37] The Communications Act of 1934 also gave the president authority to assign frequencies to federal radio users–authority which, as delegated by the president, currently rests with the NTIA. The FCC has retained authority to regulate all nonfederal uses of spectrum.[38]

Table 2: Development of Early U.S. Laws on Radio Communications

Year	**Law**
1910	Wireless Ship Act of 1910
1912	Radio Act of 1912
1927	Radio Act of 1927
1934	Communications Act of 1934

Source: John O. Robinson, *Spectrum Management Policy in the United States: A Historical Account* (Washington, DC: FCC, April 1985), https://transition.fcc.gov/Bureaus/OPP/working_papers/oppwp15.pdf.

The State of Spectrum Use Governance Today

According to the preamble of its constitution, the purpose of the ITU is to facilitate "peaceful relations, international cooperation among peoples and economic and social development by means of efficient telecommunication services."[39] For spectrum use, this mandate includes efforts aimed at preventing harmful interference. According to the ITU Radio Regulations (RR1.166-RR1.169), interference is defined as the "effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radiocommunication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy."[40] Harmful interference is meanwhile defined as "interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations."[41]

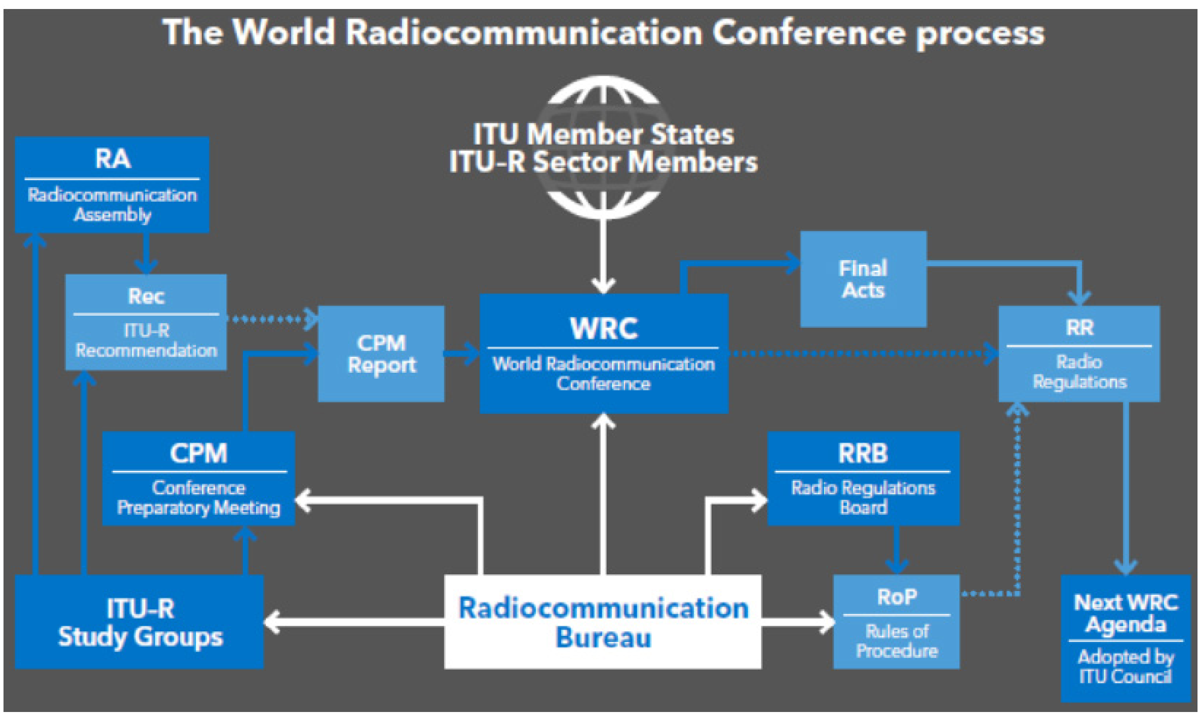
For spectrum use in space, the ITU constitution goes further, noting that orbits and frequencies are "limited, natural resources" that should be used "rationally, efficiently and economically" and stating that countries must have equitable access to "orbits and frequencies."[42] Among other activities, the ITU develops and coordinates technical standards and rules on how spectrum is used to meet these goals. At the national level, countries who are ITU members typically implement rules and technical requirements adopted through ITU processes. However, as the ITU constitution recognizes "the sovereign right of each State to regulate its telecommunication," regulations and licensing decisions are decided at the national level by agencies, such as the FCC in the United States.[43]

According to U.S. law, the FCC's mission is to "make available . . . a rapid, efficient, nation-wide, and worldwide wire and radio communication service . . . at reasonable charges" in a manner that ensures national defense and promotes safety of human life and property.[44] Moreover, the Communications Act of 1934 states that it is U.S. policy to "encourage the provision of new technologies and services to the public," noting that anyone opposing a new technology has the burden to prove such technologies are "inconsistent with the public interest."[45] This same law prohibits the private ownership of spectrum.

Role of the ITU in Spectrum Use Management

The ITU originated as a mechanism for nations to control the use of telegraphy, then later radio technologies, with a focus on coordination among nations. Beyond standards, protocols, and fee schedules, the ITU also took charge of international efforts to prevent cross-border radio signal interference. Since its creation in 1932 and incorporation into the UN system as a specialized UN agency in 1949, the ITU has grown to include over 190 countries and around 1,000 nonstate members, including companies, academic institutions, and international and regional organizations.[46] The ITU plays a central role in setting rules, policies, and standards for information and communications technologies that are, in many cases, implemented in national laws and regulations and adopted by equipment operators and developers around the globe.

Figure 2: The World Radiocommunication Conference Process



Source: Joanne Wilson, "ITU and ITU-R: Basics and Facts" (presented at the 29th World Radiocommunication Seminar, December 7–11, 2020), ITU Radiocommunication Bureau, https://www.itu.int/bestofwrs/wp-content/uploads/sites/15/2021/12/P1.-ITU-and-ITU-R-Basics-and-Facts.pdf.

The ITU convenes members–who make decisions by consensus–for two separate conferences, each with a different purpose: plenipotentiary conferences and world radiocommunication conferences. The former, held every four years, are used to determine ITU policies and budgets and address the full range of information and communications technology issues covered by the ITU. The latter, held every three to four years, specifically focus on spectrum management and can make changes to the Radio Regulations treaty, which establishes global rules for spectrum use. The Radio Regulations treaty recognizes over 40 different radio services, each of which is a distinct application of spectrum use: for example, fixed, mobile, broadcasting, amateur, radio location, fixed-satellite, mobile-satellite, and earth-sensing services. During world radio conferences, new services can be added and frequency allocations changed or created as technology enables the exploitation of higher frequencies.

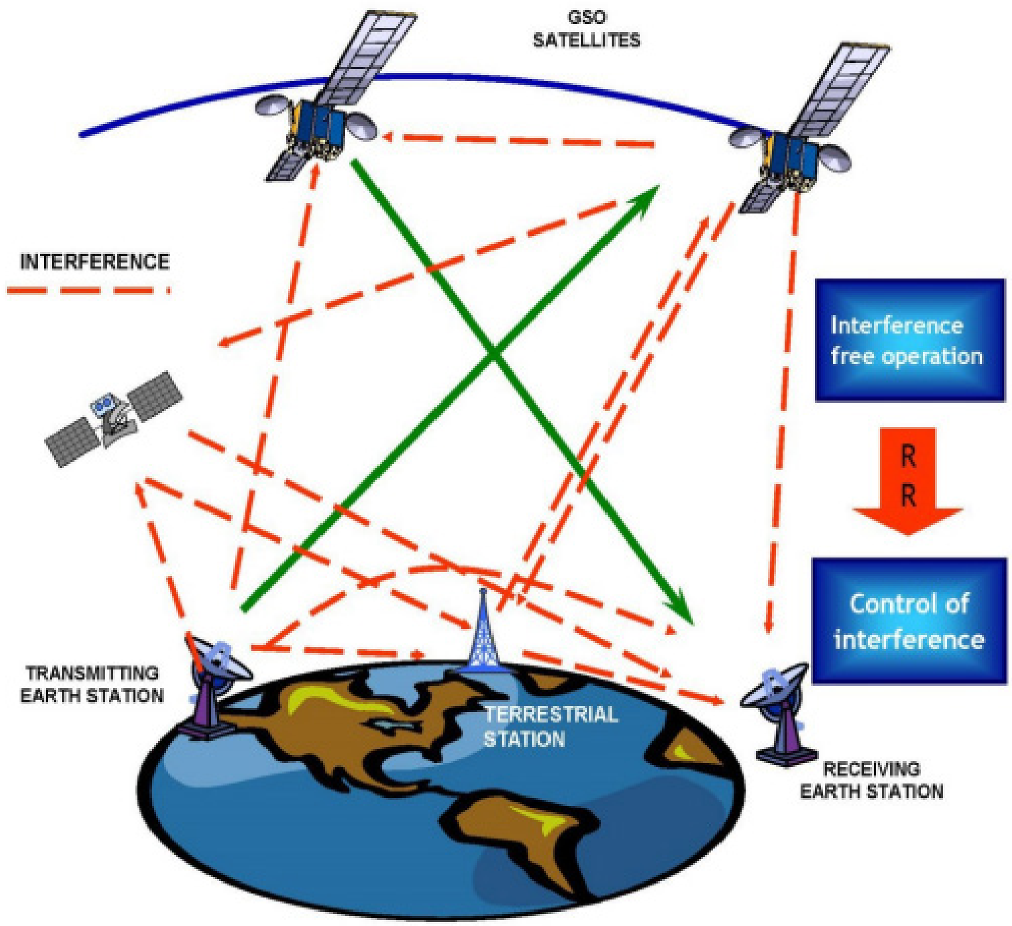
Space services recognized by the ITU with dedicated or shared-use frequency allocations include

- fixed-satellite service (FSS) (e.g., telephone and internet between fixed points on Earth);
- broadcasting-satellite service (BSS) (e.g., direct-to-home television and radio);
- mobile satellite service (MSS) (e.g., telephone and internet for mobile users);
- navigation satellite service (e.g., global and regional navigation satellite systems);
- inter-satellite service (e.g., spacecraft-to-spacecraft communications); and
- space applications, including
    - Earth exploration-satellite service (e.g., remote sensing missions);
    - meteorological-satellite service (e.g., weather satellites);
    - space operation service (e.g., spacecraft telemetry, tracking, and command); and
    - space research service (e.g., space science missions).

ITU guidelines for radio services result in harmonized frequency allocations around the world. Frequency bands can be allocated for specific services or shared by more than one service, including in some instances a mix of both terrestrial and space services in the same band. Space services, such as FSS, BSS, and MSS, have both dedicated and shared-use frequency bands. In cases of shared use, one service is often designated as primary and another secondary, but two services can also be designated as co-primary. Secondary users receive no interference protections from primary users and must not cause harmful interference for primary users. Some nations, including the United States, also have bands for unlicensed use; within certain rules, these bands can be used by anyone without getting a license. Bluetooth and Wi-Fi technologies operate according to these rules in unlicensed frequency bands.

In addition to its role in the spectrum allocation processes, the ITU plays a role in registering spectrum use. This is separate from assigning, which is done by national governments. Specifically, the Radio Regulations treaty contains a requirement for "notification and recording of frequency assignments" by national authorities to the ITU so that they can be recorded in the Master International Frequency Register if they meet one of several specified criteria, including spectrum use by an entity in one nation that could cause interference in another jurisdiction.[47] The criteria apply to frequency registrations for spacecraft and satellites, as well as for their associated ground components, such as ground stations and user terminals.

Figure 3: Various Modes of Interference



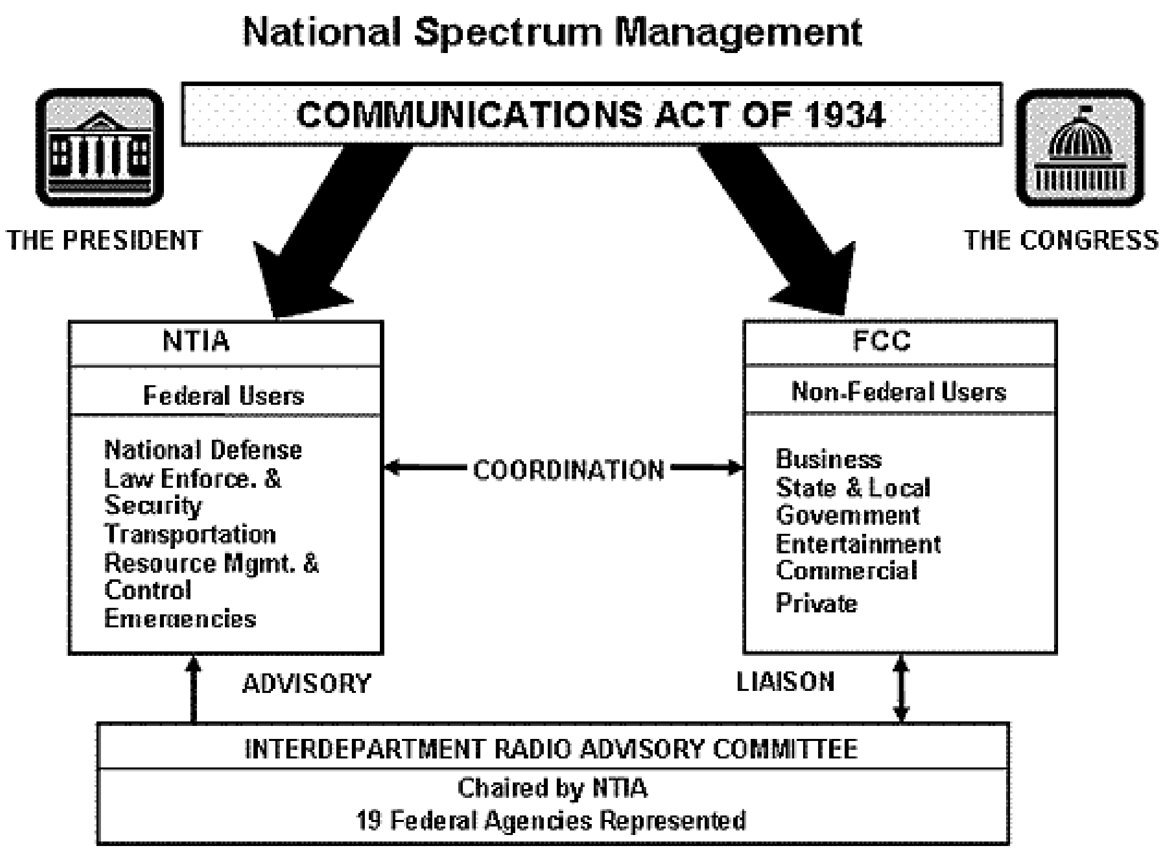
Source: Joanne Wilson, "ITU and ITU-R: Basics and Facts" (presented at the 29th World Radiocommunication Seminar, December 7–11, 2020), ITU Radiocommunication Bureau, https://www.itu.int/bestofwrs/wp-content/uploads/sites/15/2021/12/P1.-ITU-and-ITU-R-Basics-and-Facts.pdf.

Additionally, separate from the Master International Frequency Register process, satellites are required to submit detailed technical information to the ITU as part of a coordination process that can in some cases stretch up to nine years.[48] However, any operator can proceed at its own risk without following any or all of the coordination requirements, subject to national regulations. This process operates using a "first come, first served" (FCFS) model.[49] For certain applications to use spectrum in space, FCFS determines the order by which applications are considered as part of a coordination process. The ITU Radio Regulations also specify how NGSO systems should protect GSO systems from unacceptable interference.[50] These rules place limits on EPFD for NGSO systems.

How the United States Regulates Spectrum Use

In the United States, the FCC is responsible for allocating, assigning, and regulating the use of spectrum for the private sector and nonfederal public sector users, with the NTIA playing a similar role for federal users. Other nations have organizations akin to the FCC and NTIA–often combined into one agency–that manage and regulate domestic spectrum use. An FCC license authorizes the use of radio signals according to the terms of the license, which specify, for example, the length of time or conditions during which the licensee can use the specified spectrum, and possibly conditions by which the licensee can renew or extend its term. It many cases, it delineates how and where a licensee may use spectrum and includes detailed specifics related to transmitted power levels, frequencies, signal polarization, and many other operational parameters. The licensing process does not transfer any type of property rights to the licensed user.

Figure 4: Who Regulates Spectrum in the United States?



Source: "Who Regulates the Spectrum," NTIA, https://www.ntia.gov/book-page/who-regulates-spectrum.

How the FCC prioritizes applications for licenses to use spectrum has changed over time. Beginning with the passage of the Radio Act of 1912, the Department of Commerce registered spectrum for use by specific users based on an FCFS basis. During the early years of public radio broadcasting and concurrent rise in incidents of radio interference caused by competing public broadcasters, two court cases–*Hoover v. Intercity Radio Co.* (1923) and *United States v. Zenith Radio Corp*. (1926)–

successfully challenged the authority of the government to assign any type of rights to specific users over certain frequency bandwidths. The Radio Act of 1927 subsequently clarified the authority of the government over spectrum, establishing the "public interest" standard for issuing licenses.

Instead of assigning licenses on an FCFS basis, the FRC (and subsequently the FCC) held proceedings called comparative hearings to rank applicants, awarding licenses to the highest ranked. Despite charges of political bias, use of the comparative hearing process continued for decades. In 1981, Congress authorized the FCC to assign some types of non-broadcast licenses through lotteries whereby winners of licenses were selected at random. The lottery process—essentially a non-market-based method to distribute spectrum—did nothing to help allocate spectrum to its most productive use. In fact, it did quite the opposite, in many cases placing valuable spectrum in the hands of entities who did not have the resources to use it.[51]

In order to help align the spectrum licensing process with a market-based approach, in 1993, Congress authorized the use of a competitive bidding process for FCC licenses.[52] As of March 2026, the FCC has conducted over 100 spectrum auctions through this authority. Though these have mostly covered terrestrial services, there have been two auctions for spectrum used for BSS, both in 1996. Two of the highest grossing FCC spectrum auctions—the 3.45 gigahertz (GHz) auction for rights to use 100 megahertz (MHz) of continuous spectrum and a C-band auction for the rights to use 280 MHz of spectrum—happened in 2021 and together brought in over $100 billion.[53]

Licenses acquired from spectrum auctions have some unique attributes, such as flexibility in how the winners can use spectrum. In many cases, auctioned spectrum can be used for either fixed radio services or mobile technologies, such as 5G and 6G networks. Auctioned spectrum can be transferred (e.g., bought and sold), with the new owner having similar flexibility to use the spectrum in different ways. The federal government has made clear that it does not consider any FCC license, including ones issued through auctions, to confer property rights.[54]

Other than the two aforementioned spectrum auctions for BSS, the FCC has not used an auction model for licensing spectrum used by satellites and other space systems. Satellite operators, as well as policymakers, have generally opposed the use of auctions for assigning spectrum for cross-border services.[55] The ORBIT Act of 2000 (U.S. Code Title 47, Section 765f) specifically bans the use of competitive bidding by the FCC to assign spectrum or orbital locations for "international or global" satellite communications.[56] The BSS auctions by the FCC did not run afoul of this law because the associated services were focused on the United States only.

Historically, the FCC has licensed space services using a command-and-control regulatory framework: Applicants are required to provide detailed information about system operations and technical parameters, from which they cannot deviate without permission from the FCC once a license is granted. However, in July 2026, the FCC adopted significant reforms to its space licensing processes, moving away from prescriptive rules and toward an approach for certain systems that increases the use of performance-based criteria. These reforms aim to accelerate the issuance of licenses and improve the predictability of processes, among other objectives.[57]

The FCC, as well as the ITU, distinguishes between space systems in GSO and NGSO; since 2003, a FCFS process has been used for licensing GSO satellites, while yet another model, based on processing rounds, is used for NGSO satellites. Under the processing round model, the FCC has designated specific frequency bands, such as Ku-/Ka-band and V-band, and accepted applications during a specified time period from prospective NGSO operators who want to use those frequencies. The FCC conducted the first NGSO processing round in 2016, with OneWeb submitting the lead application and companies including SpaceX and Telesat additionally submitting applications. The FCC conducted later NGSO processing rounds in 2017, 2020, and 2021.[58] The FCC has processed licenses for NGSO Earth exploration-satellite service systems outside of processing rounds because such systems are generally less complicated and pose less interference risks than FSS and MSS NGSO systems.[59]

Table 3: NGSO FSS Interference Protection Priority Groups in Ka-band

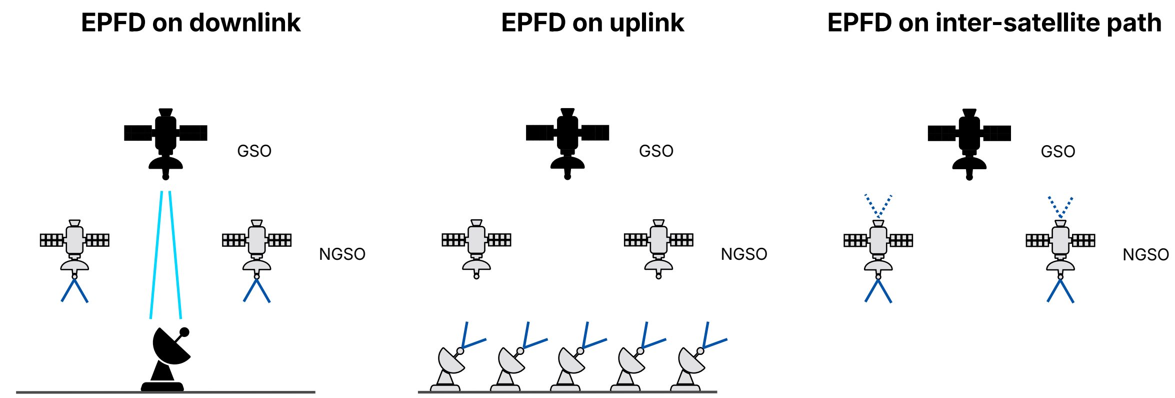
System Name	**Interference Protection Priority**
OneWeb	1st
Space Norway	1st
Telesat	1st
SpaceX Generation 1	1st
O3b	1st
Theia Holding	1st
Viasat MEO Constellation	1st
Kuiper (Amazon Leo)	2nd
OneWeb Phase 2	2nd
SpaceX Generation 2	2nd
New Spectrum Satellite	2nd
Kepler	2nd
O3b	2nd
Telesat Phase 2	2nd
Viasat LEO Constellation	2nd
Mangata	2nd

Source: Argyris Kriezis, “NGSO Fixed Satellite Service Spectrum Priority in the US: Payload Research,” Payload, December 18, 2024, https://payloadspace.com/status-of-ngso-fixed-satellite-service-spectrum-priority-in-the-us-payload-research/; and Christian Frhr. Von der Ropp, “New FCC processing round prompts license requests for 81,195 NGSO satellites,” LinkedIn Pulse, May 27, 2020, https://www.linkedin.com/pulse/new-fcc-processing-round-prompts-license-requests-frhr-von-der-ropp/.

For NGSO systems, license holders with an earlier license date typically receive interference protections, which sunset over time, from more recent licensees. NGSO systems approved in later rounds are required to demonstrate they will protect or coordinate with earlier round systems.[60] Between 2016 and 2021, the FCC conducted NGSO processing rounds that covered spectrum in the Ku-band, Ka-band, and V-band—for each band, applicants have been grouped into interference protection priority groups.[61] Although the FCC has yet to grant authorizations to all applicants to its 2020 Ku-band and Ka-band processing round and initiated new processing rounds for these bands in June 2026, the interference protection priority groups for Ka-band first- and second-round applicants are shown in Table 3. As of May 2026, the FCC is considering changes to many of its rules for licensing space systems, including changes to the processing round framework.[62]

NGSO operators are required to protect GSO operations using EPFD rules, which place limits on the power levels of transmissions from NGSO networks. EPFD is an amalgamation of possible interference coming from three different sources of transmissions from NGSO networks: downlink, uplink, and inter-satellite signals. The rules are intended to keep the signal power received from NGSO transmissions by a GSO satellite below a proscribed power level. However, by limiting power, these rules constrain the number of customers that can be served by NGSO systems. Both SpaceX and Amazon argue that EPFD limits can be changed without creating harmful interference for GSO operators.[63] Conversely, GSO operators argue that the current limits are beneficial and that modifications would generate more interference for GSO satellite networks.[64]

Figure 5: Downlink, Uplink, and Inter-Satellite EPFD Considerations



Source: ITU, "ITU World Radiocommunication Seminar 2018," PowerPoint, ITU HQ Geneva, December 6, 2018.

Focusing on Efficiency and Productivity

If the goal of the ITU and individual member nations, including the United States, is to maximize the productive use of spectrum, there is room for improvement. This is particularly true with respect to spectrum use in space. The FCC recognizes this and is already working to update its spectrum rules for space systems, but there is only so much change possible within the existing government-directed approach to spectrum allocation and assignment. Optimizing a system based entirely on government control, with the aim to maximize the productivity of a limited natural resource—in this case, spectrum—is a challenge. Optimization will require a significant restructuring of how spectrum is assigned, used, transferred, and regulated. This report posits that the governance structures of other limited resources—specifically, property rights—can be applied to spectrum.

Contrasting Rights with Regulations

The first 10 amendments of the U.S. Constitution—also known as the Bill of Rights—describe and guarantee personal freedoms, as well as other natural and legal rights, including the right to life, liberty, and property. The Universal Declaration of Human Rights, approved by the UN General Assembly in 1948, outlines similar principles and rights, placing limits on the power of governments over their people. The right to property is an important right described in both documents, encompassing a bundle of rights held by individuals and entities over tangible assets, such as land and equipment, as well as intangible assets, such as intellectual property. Among property rights are (1) the right of control, to use the property however the right holder deems fit, (2) the right of exclusion, to prevent others from trespassing, and (3) the right of disposal, which includes the right to transfer, lease, or outright sell the property to someone else.[65] Property rights encourage productivity and market exchanges because they provide a secure and stable framework for the use of a resource.[66] Holders of property rights have judicial, legal, and contractual avenues to enforce their rights and, if an infringement of a right happens, to impose punitive measures on the violator. Property rights are often associated with "ownership" of an interest or asset but can also come from a leasehold arrangement.[67]

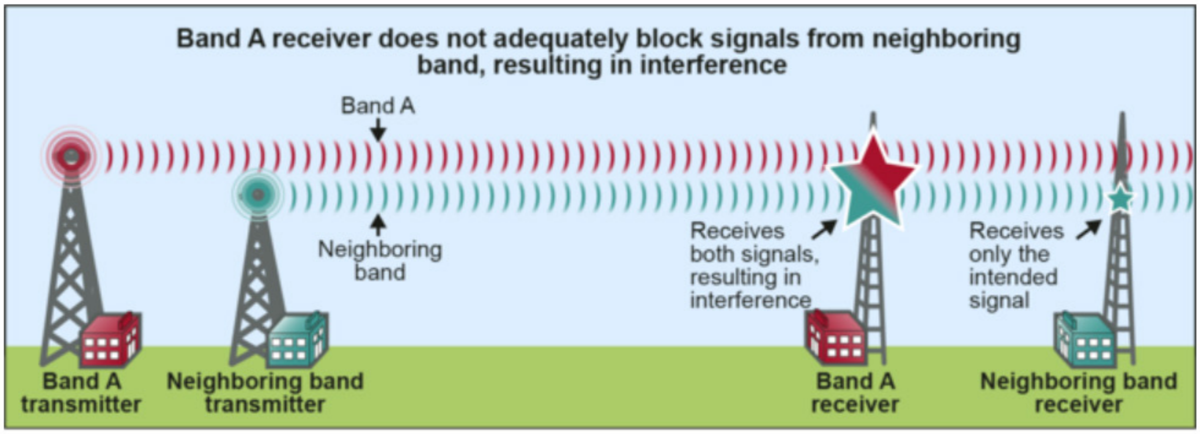
On the other side of the coin, governments constrain the freedoms of individuals or groups for the benefit of others—such as for the public good and general welfare of society—through regulation.

What Are Regulations?

Regulations are governmental rules aimed at achieving certain outcomes that can be grouped into one of two categories: economic or social. Economic regulations aim to control market entry and pricing, such as through licensing processes; rules that encourage competition and discourage the creation of monopolies; and price controls, particularly for sectors—such as utilities or telecommunications—where there is an expectation of limited competition. Social regulations focus on achieving outcomes not directly related to the market, such as environmental, health, and safety objectives, and they can apply both to businesses and to individuals. Regulations are generally evaluated on their net benefits to society, The net benefit weighs the total societal benefits and costs—including nonmonetary costs—of a new regulation or alternation of an existing one.

Interference happens when a receiver gets an unwanted signal. The level of interference experienced by a receiver is a function of the signal environment, which depends on externalities beyond the control of the receiver, as well as on the ability of the receiver to identify and make sense of the signal which it wants to receive. This latter factor is dependent on the receiver itself, including how well the receiver is able to isolate the desired signal and filter out other unwanted signals. This means that the transmitter of the unwanted signal (i.e., the interferer) and operator of the receiver experiencing the interference share responsibility for minimizing the impact of interference on the performance of a radio network. Interference may or may not significantly interfere with the performance of a radio network. By definition, "harmful" interference results in significant degradations of radio network performance.

Figure 6: Example of a Receiver Unable to Reject Unwanted Signals



Source: U.S. Government Accountability Office, Spectrum Management: *Key Practices Could Help Address Challenges to Improving Receiver Performance*, GAO-24-106325 (Washington, DC: GAO, July 2024), https://www.gao.gov/products/gao-24-106325.

In the current governance approach, the responsibility to prevent harmful interference—which directly translates to a financial cost—falls entirely on the transmitter of the unwanted signal, without incentivizing the party reporting the interference to take any measures to improve or optimize its own network. For example, as a cost-saving measure, the operator of a radio system could employ a receiver that does a poor job of rejecting and filtering out unwanted signals—leaving the network especially susceptible to service degradation from interference and yet imposing a financial burden on whoever may have transmitted said signals. Additionally, modulation and coding schemes can be optimized to adjust for interference, though such optimization impacts the data rate or information throughput of a signal and can add costs to operators. According to the current schema, operators have no responsibility to take on these costs.

This regulatory arrangement not only tolerates but embeds inefficiency in how spectrum is used for space applications. Networks that have protections against harmful interference have no regulatory incentive to improve the interference tolerance of their own systems, and over time, as technology improves, they end up using their assigned spectrum less efficiently than they could be. Conversely, networks required to prevent their transmissions from causing harmful interference are essentially regulatorily prohibited from using the spectrum assigned to them as efficiently as possible. From an efficiency standpoint, this is a lose-lose for both parties.

The continued growth of the space economy, which directly impacts U.S. economic growth and job creation, will be in jeopardy without finding a more economical and productive way to use spectrum resources.

Certainly, EPFD rules and other regulatory requirements designed to minimize harmful interference have yielded positive results. These rules facilitate interference-free operations between radio networks, including between GSO and NGSO networks—but this benefit comes at a high cost to efficiency and productivity. Particularly in space, with rapid increases in the number of satellites in orbit, which are all transmitting and receiving radio signals, it is becoming harder to justify this model if there are other approaches that could produce the same results with less inefficiencies. The continued growth of the space economy, which directly impacts U.S. economic growth and job creation, will be in jeopardy without a more economical and productive way to use spectrum resources.

Renewing the Case for Spectrum Property Rights

Property rights incentivize investment, stimulate economic growth, encourage companies to spend money on innovation and new ideas, and create wealth.[68] Property rights, lubricated by a market-based pricing model of exchange, help allocate limited natural resources, such as land, to their most productive uses.[69]

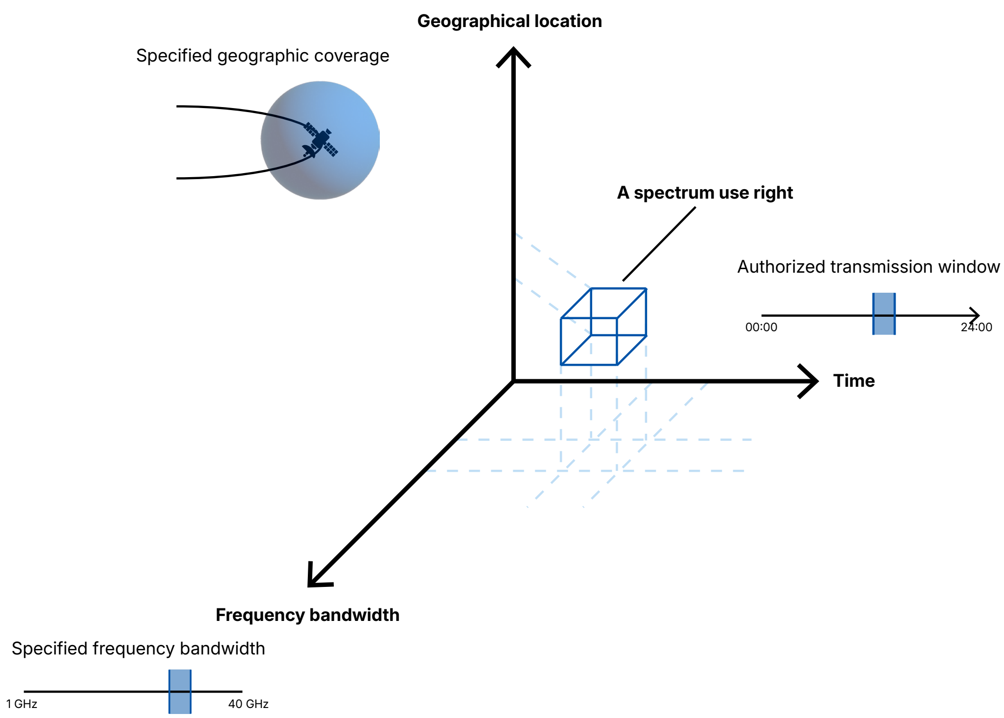
Licensing terms for spectrum awarded through a spectrum auction should not be confused with property rights. Though spectrum auctions aim to better represent market considerations in the spectrum assignment process, the U.S. government has argued that no spectrum license conveys property rights. In 2006, a U.S. federal appeals court also made clear in a ruling to a case brought against the FCC by a company called Mobile Relay Associates, who lost access to spectrum acquired from an auction when the FCC updated frequency allocations, that a license does not convey property rights.[70]

What would property rights for spectrum use look like? First and foremost, they would apply to the signal transmitter alone, rather than being tied to other radio networks, as is the case today with regulations on interference. Such rights would clarify precisely what a transmitter is legally allowed to transmit and what it is not, removing the need for a metric based also on receiver performance. A transmitter-only right incentivizes networks that are possibly susceptible to interference—protected under the current model—to improve the efficiencies of their own networks and provides legal clarity to transmitters so that they can use their licensed spectrum most efficiently.

The case for a transmitter-only right for spectrum use is hardly new, having already been made by economist Ronald Coase in 1959.[71] As proposed by Coase, property rights for spectrum would be defined in terms of the three dimensions occupied by an electromagnetic transmission: (1) frequency bandwidth, (2) time, and (3) geographical location, specifically the signal power level measured at a given location. A paper led by economist Arthur S. de Vany and published in 1969 provided a technical framework for a property rights system for assigning and using spectrum.[72] The spectrum use right would carry the right to transmit and the right to exclude others from transmitting within the designated three dimensions. Such a right would also include the right to transfer, by buying and selling, all or part of a right to other users. As with property rights, a legal framework would establish mechanisms allowing one party to seek redress for violations of its spectrum use right through administrative and legal processes and contractual mechanisms. The right need not convey ownership, but it could be a temporary conveyance of rights through an arrangement such as a leasehold for land. This would ensure compatibility with current U.S. law, which prohibits private ownership of spectrum. A leasehold-like arrangement could convey the bundle of rights associated with property rights, such as the right to use, transfer, subdivide, and prevent unauthorized use and trespass. Ideally, the leasehold approach would include predictable, straightforward criteria for renewal by the holder of the spectrum use right.

Two nations have gone further than others in implementing Coase-style reforms: Guatemala and El Salvador. In 1996 and 1997, respectively, Guatemala and El Salvador changed their spectrum assignment rules, creating a system that granted usufructuary rights (i.e., legal rights to an asset without owning it) for spectrum. In Guatemala, the national government conveys the right to use spectrum through *"títulos de usufructo de frecuencias,"* or usufructuary frequency titles, which grant broad flexibility to holders in how they can use their spectrum.[73] Holders can also transfer, sell, and subdivide their titles. These rights are referred to as radio spectrum frequency concessions in El Salvador.[74] According to a 2006 study led by Thomas Hazlett, former chief economist of the FCC, this approach has "expanded spectrum use and competition in mobile markets" and "led to reduced retail prices" in both countries.[75] The study also found that transaction costs—the costs associated with establishing, enforcing, and transferring property rights—are low and explained how the identification and prevention of illegal transmissions are possible under these systems. Guatemala uses administrative mechanisms to address allegations of signal interference.

Figure 7: Three-Dimensional Representation of a Spectrum Use Right



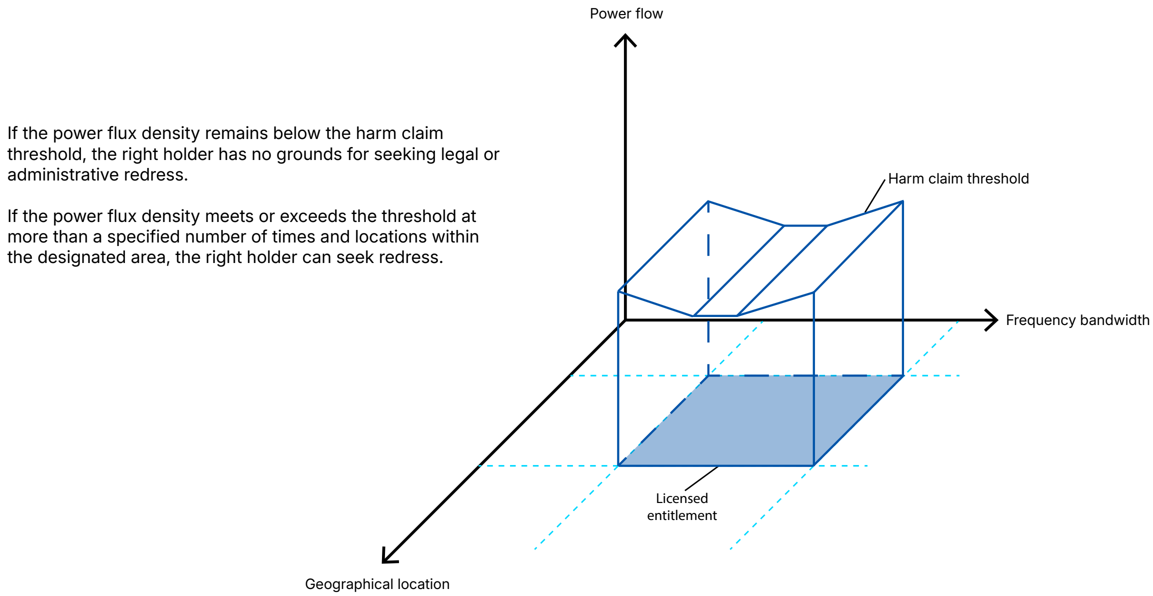
Source: CSIS.

This concept can be applied to space services. Consider again the main elements of a spectrum use right: (1) frequency bandwidth, (2) time, and (3) geographical location. Spectrum field strength is a measure of electromagnetic signal power density at a certain frequency and location; thus, spectrum field strength, along with a time component, is another way to define a specific spectrum use right. For most satellite communications networks, the time element would be always, giving the user the right to transmit continuously. For other satellite applications—such as remote sensing satellite downlinks, telemetry, tracking, and command communications—and for satellite servicing applications, the time element would be scheduled. A rights-based approach to shared spectrum could be modeled after a condominium timeshare, in which all users who want to use a portion of frequency bandwidth jointly hold the right to its use and negotiate among themselves an agreement on how the spectrum is shared.

A rights-based approach to shared spectrum could . . . be modeled after a condominium timeshare, in which all users who want to use a portion of frequency bandwidth jointly hold the right to its use and negotiate among themselves an agreement on how the spectrum is shared.

In addition to the right to transmit, the right holder would be able to prohibit anyone else from sending a transmission on the same frequency bandwidth, at the same specified time, and at an equal or greater power level measured at that specific location. Although the aim of preventing interference is the same, the right to prohibit transmission would differ from the contemporary regulatory concept of harmful interference because the right would be defined independently of the performance of the receiver experiencing interference. In the case of the right to prohibit a transmission, such a right could be modeled after the concept of a harm claim threshold, which would define signal level thresholds according to the three dimensions mentioned above. Signal power flow, frequency bandwidth, and geographical location combined is a power flux density (defined in the U.S. Code of Federal Regulations, Chapter 47, Section 25.20) and, coincidentally, the basic metric used in EPFD rules. Should these thresholds be exceeded at more than a specified number of times and locations within the designated area, the holder of the right to prohibit a transmission could have justification to seek administrative or other legal redress. The concept of a harm claim threshold is illustrated in Figure 8, consistent with the definition used in the white paper titled "Interference Limits Policy," published by the FCC Technological Advisory Council in February 2013.[76]

Figure 8: Parameters of a Spectrum Use Right Using Harm Claim Thresholds



Source: CSIS; and "Interference Limits Policy," FCC Technological Advisory Council, February 2013, https://transition.fcc.gov/bureaus/oet/tac/tacdocs/WhitePaperTACInterferenceLimitsv1.0.pdf.

At the moment, although spectrum licensed for space services can be transferred, such as through mergers and acquisitions of companies and their associated satellite systems, the spectrum must be used according to the original license application. For example, if one company purchases a GSO satellite from another operator, the new owner can continue operating the GSO satellites, but it must adhere precisely to the original operator's license, providing no flexibility to use the spectrum in a different way without an FCC waiver. Essentially, the new owner is buying the operations of the existing network, rather than the ability to reuse that spectrum in a different, perhaps more productive, manner. In contrast, a transmitter-only right for spectrum use, which would include harm claim threshold, would allow for flexibility in use of the spectrum that could transfer between rights holders.

Additionally, there would be no technical reason to group similar services into certain designated frequency bands; currently, space applications are divided into over 10 distinct services for which certain parts of the spectrum are allocated, yet fixed and mobile terrestrial services can coexist in the same bands. New frequency allocations are usually created as new technologies are able to exploit and use increasingly higher frequencies. Spectrum is therefore often mapped to the service that made the most sense when technologies opened up that portion of spectrum for use, rather than the use it is most suitable for. The benefit of doing away with frequency allocations for specific services is that it opens the door for spectrum to be used in its most productive way in space as it already is with terrestrial spectrum.

More important than the way the right is initially conveyed is that the right be established and then assigned. Once rights are assigned, because the rights could be bought and sold—they have economic value—entities using spectrum would want to maximize and economize their ability to generate wealth. In some cases, that would mean holders of rights would sell their rights to other entities, just as property is bought and sold. Technology that makes the use of spectrum for one purpose more efficient may cause a company to subdivide and sell a portion of its rights because it no longer needs as much spectrum as it once did. Additionally, because technology will make more spectrum available for use at higher frequencies—rights over new spectrum can be sold or freely dispersed by the FCC—the overall spectrum market and amount of frequency bandwidth available for use will always be increasing.

A fair question would be how to transition from the current approach of spectrum management and licensing in the United States (or in any other country) to one based on property rights. The transition would be more straightforward for spectrum that has never been used. How to transition incumbent licensees may appear to pose a particular challenge. Must the government "sell" a spectrum use right, using a competitive bidding process or some other similar mechanism by which the government attempts to place a market value on spectrum, which is then charged to the initial holder of the spectrum use right? Not necessarily. The FCC could simply award use rights to incumbent users of spectrum. Auctions could play a role in the initial assignment of spectrum use rights, but they are not the only way to do so.

It should be noted that auctioned spectrum can already be used for space services, but such uses have been limited (e.g., the aforementioned BSS auctions) or have required FCC waivers. In November 2025, SpaceX agreed to pay Echostar $2.6 billion in exchange for spectrum licenses.[77] As this spectrum was originally licensed for terrestrial use, and SpaceX wants to use the spectrum for MSS (e.g., direct-to-device services), SpaceX requires an FCC waiver. No such waiver is required for terrestrial uses; for example, AT&T spent $23 billion to acquire 50 MHz of spectrum from Echostar in August 2025, but as this was already licensed for terrestrial use it can be used for mobile or fixed use without a waiver from the FCC.[78] But this is not to say that auctions are the best way to assign spectrum use rights for space services—or any other radio services for that matter.

It is worth emphasizing that the long-term benefits of a property-rights based approach come from the rights assignation itself. Flexibility in use and the ability to transfer a spectrum use right creates the right conditions for market forces to ensure that a spectrum use right eventually finds its way into the hands of an entity that can make the most productive use of the spectrum. If the holder of a spectrum use right can derive more value from selling all or part of the right than from using it, they will probably seek do so.

Historically, experts have raised concerns about spectrum warehousing: the idea that entities would acquire spectrum that they had no intent to use.[79] Spectrum warehousing could be used, for example, for anticompetitive purposes, with one entity acquiring spectrum to deny its use by a business competitor.[80] For auctioned spectrum, a specific concern was speculation, whereby an entity acquires and holds on to spectrum without an intent to use it but rather to resell it at a presumably higher price than the purchase amount or consolidate spectrum in the hands of only a few entities. The FCC has occasionally alleged and investigated concerns about warehousing, but there are no indications in public records that the FCC has issued a formal determination that any company was actually warehousing spectrum. In fact, there is evidence to the contrary. The FCC has noted that auctioned spectrum has been changing hands in secondary markets, suggesting that market-based forces are diversifying the number of entities with access to auctioned spectrum.[81]

If the notion of property rights for spectrum use instigates new concerns about warehousing, there are new possible regulatory measures that could be taken to address those concerns. One possible option would be something modeled after a vacancy tax, which can be used to lower the number of vacant residential or commercial real estate properties.[82] For spectrum use, this type of regulation could translate into a tax or penalty on nonuse of spectrum. Such a penalty need not be levied immediately, but could come into play after a period of time. Holding property rights for spectrum use—whether the spectrum is used or not used—has no financial costs, unlike for other types of property, which require paying for storage or maintenance, for instance. A nonuse penalty essentially attaches a similar financial cost to spectrum. This would work similarly to the build-out requirements in use today for terrestrial networks using spectrum acquired from auctions. Another condition might be that the spectrum is used within a certain period, like infrastructure build-out requirements on U.S. licensees for terrestrial spectrum and satellite networks.[83]

Another issue with the current U.S. approach to spectrum management results from the requirement for private users to coordinate with government in cases when there is a perception that the private use of spectrum could interfere with the government use case. Federal government spectrum users could also be granted rights to the spectrum they use now. Both private sector and federal government users of spectrum would have specified rights, just the same as private sector and federal government users of land have rights over the land they own or lease. A rights-based approach to spectrum use would streamline and reduce the uncertainties of the current coordination process between federal and nonfederal uses. The right of the federal government to acquire private property using eminent domain authorities could also be applied to spectrum. The use of eminent domain for acquiring spectrum use rights in private hands does open up the federal government to legal challenges based on the protections afforded by the Fifth Amendment of the U.S. Constitution, which is often referred to as the "takings clause."[84]

Enforcement of Spectrum Rights

When considering the potential enforcement of spectrum property rights, it is useful to consider enforcement mechanisms for other property rights, particularly those related to nonphysical things. Intellectual property, for example, is considered a private property right.

Intellectual Property Rights: An Overview

Intellectual property is a creation of the mind, such as an invention; a manuscript, musical, or other type of artistic work; a photograph or image; or a name used in commerce.[85] Legal protections for intellectual property, which include patents, copyrights, and trademarks, aim to encourage creativity and invention by protecting the interests of innovators, while also fostering benefits from the use of new ideas and innovations for the benefit of society. Legal protections for intellectual property do not last forever. Generally, a patent issued in the United States lasts between 15 and 20 years, but in some cases a patent holder is required to pay maintenance fees to the U.S. Patent and Trade Office to keep a patent active.[86] The term length and other conditions, such as maintenance fees, are designed to balance the rights of the innovator with the needs of the general public.

The holder of the right is generally responsible for enforcing it when it is violated, with governmental rules and infrastructure providing the mechanisms through which enforcement occurs. Intellectual property rights are granted at the national level, in the same way that spectrum licenses today—and potentially spectrum use rights in the future—are issued. International treaties—such as the Agreement on Trade-Related Aspects of Intellectual Property Rights, a World Trade Organization treaty—establish standards for intellectual property regulation. Additionally, the World Intellectual Property Organization works to harmonize laws on intellectual property and streamline patent and trademark applications for multiple countries.

Since enforcement occurs at the national level, intellectual property rights disputes are handled differently country by country. In the United States, rights are enforced through civil litigation in federal courts, through administrative processes carried out by federal agencies, and, in certain cases, through criminal prosecution by the Department of Justice.

The enforcement of intellectual property rights can be inconsistent across countries, however. In particular, enforcement of intellectual property rights for U.S. entities in China and Russia, among other countries, is increasingly difficult given ongoing geopolitical tensions. While China has developed a robust set of protections for intellectual property, these rules are applied inconsistently to U.S. intellectual property, influenced by the broader trade dynamic with the United States. China's framework for enforcement of intellectual property rules is generally consistent, however, with its obligations under international treaties.[87] On the other hand, Russia is increasingly outright opposed to the protection of intellectual property rights held in Western countries, with a specific focus on the United States.[88] Domestic laws in Russia contradict international obligations under treaties signed by Russia, with state-directed uncompensated use of foreign intellectual property.

On the whole, a system of enforcement for spectrum use property rights could look similar to the one used for intellectual property. Such a system would of course come with the same problems—namely, that enforcement rests mainly with the rights holder and that rules are enforced inconsistently from nation to nation even if international frameworks exist. But enforcement of any property right typically rests with the right holder, whether that right be for intellectual property or some physical item. Property rights for spectrum use, and enforcement mechanisms that primarily depend on actions of the rights holder, merely aligns spectrum use with how the use of other resources is governed—normalizing spectrum whereas now it is a unique outlier. In the case of Guatemala, holders of usufructuary frequency licenses use an administrative avenue through the national spectrum authority—equivalent to the FCC in the United States—to address concerns about rights violations. Through this mechanism, the right holder and alleged trespasser are required to submit technical reports on which the spectrum authority decides on the validity of the complaint. Fines can be levied when complaints are deemed valid.

The Role of International Coordination and Harmonization

A system through which the FCC assigns property rights for spectrum use through a licensing process to private entities operating in the United States is not wholly incompatible with the ITU and international spectrum management system. But adapting the ITU and international spectrum coordination and harmonization processes to a system based on property rights would require change. One of the biggest changes would be the deprecation of frequency allocations for specific radio services.

Frequency allocations are intended to reduce interference among services, allowing for the reliable use of spectrum resources. Certainly, allocations are an important element of the current government-directed spectrum use governance process. But secure, well-defined legal entitlements for spectrum use, with robust mechanisms for holders of property rights to seek redress for violations of their rights, achieve the same goal, with no need for allocations. The current governance framework already has a way to ensure the *reliable* use of spectrum resources, but property rights generally facilitate the most *productiv*e use of a resource. For spectrum specifically, establishing property rights and moving away from the need for frequency allocations allows specific frequencies to be used for their most productive purposes, rather than only for the services earmarked for certain bands. A potential new role for the ITU would involve harmonization and coordination of the legal frameworks in each member nation underpinning property rights for spectrum use. As is true for the enforcement of intellectual property rights, enforcement of property rights for spectrum use would benefit from international coordination. This coordination could aim to share best practices and facilitate the standardization of national-level laws and rules on enforcement.

In addition to interference reduction, another argument in favor of frequency allocations is that they theoretically provide space network operators and equipment manufacturers with clarity on which frequencies they can use for specific space services worldwide. But the market can efficiently perform this function, and already does so in a variety of similar instances. For example, in the United States, California state emissions rules for passenger vehicles are typically implemented by automobile manufacturers across all cars and trucks sold in the United States due to the dominant position of the California market. Rhode Island, on the other hand, does not have similar leverage and likely could not compel an automobile manufacturer to produce a car specific to Rhode Island emissions standards. Rhode Island can either take it or leave it—an automobile manufacturer would find it more economical to simply not sell cars in Rhode Island should the state reject the California-inspired model. No doubt that Togo and Fiji appreciate that their views on spectrum allocations carry the same weight as those of the United States at the ITU. But this makes little sense from a market-based standpoint, giving smaller actors significant influence over decisions with global impact.

The same effects would manifest in space services, such as satellite broadband without any government-directed international coordination or harmonization. This would mean that the biggest space markets—their California—would set de facto standards for frequencies and other performance characteristics. This approach would benefit nations who innovate and drive economic growth, as well as nations with large markets for space services. Even with frequency allocations adopted widely around the globe, national authorities are today the ultimate decisionmakers on how and by whom spectrum is used. National authorities also decide whether to even adopt (or adopt with modifications) frequency allocations agreed on through ITU processes. Nations would certainly retain the same sovereign right to make decisions about how spectrum is used within their jurisdiction under a property rights approach. A remodeled ITU—one that would perform a function similar to what the World Intellectual Property Organization does for intellectual property—would work to harmonize rules around the world for spectrum use property rights. But in many instances, with a model using property rights for spectrum use, nations would be confronted with choices determined by market forces rather than ones shaped mostly by government-directed processes.

With a model using property rights for spectrum use, nations would be confronted with choices determined by market forces rather than ones shaped mostly by government-directed processes.

For example, if Starlink has rights to certain frequencies that it uses to serve its largest market—likely the United States—it will justifiably want to use those same frequencies to provide service in other countries. On a nation-by-nation basis, countries can decide whether they want to allow Starlink services in their jurisdiction under those conditions. If no other user already has rights to those frequencies, the decision is arguably straightforward. A spectrum use property right could be given away by the government or sold, with the price set arbitrarily or through a competitive bidding process. Understandably, a satellite operator who intends to provide services in dozens of countries does not want to have to pay for spectrum, using an auction or any other mechanism, over and over again. But when the pricing (i.e., value) of spectrum use rights is based on market forces, the cost for acquiring a right will widely vary, in the same way that the cost of land is not uniform across the United States. The cost of a spectrum right is directly proportional to its economic utility. Once acquired, it also would have value and can be resold. A satellite operator acquiring rights in various countries not only acquires a resource that it needs for its business to work but also a resource, like land, that has its own intrinsic value on a corporate balance sheet.

Conclusion

The United States as a Catalyst for Change

History is full of examples of the status quo resisting the adoption and operationalization of new ideas at scale, and innovation comes with significant risks. New ideas can lead to spectacular business success and the incubation of future commercial juggernauts. They can also lead to a slow slide toward irrelevance and insolvency for businesses who cannot adapt. Disrupting the status quo can lead to many unpleasant ramifications–companies going out of business, job losses, customer equipment obsolescence, and ripple effects across supply chains. Changing how spectrum use is managed, whether through wholesale changes in the governance structure to make it more market-based or minor changes in regulation, will upset the status quo. But change is part of the process of creative destruction, whereby old ideas and business are eventually swept away by new ones, which too will eventually be superseded by even newer ideas.

The success of U.S. companies in retaining and growing their share of the global space market will shape overall U.S. economic and military space power.

In most cases, the market is responsible for the process of creative destruction. But when it comes to spectrum use, the government has placed itself in that the role of kingmaker, deciding who has access to a valuable resource and how use of that resource is regulated. The U.S. government should want to facilitate the process of creative destruction and ensure the disruption of the status quo; it should modernize regulations, do away with the concept of interference as a licensing criterion, and even consider a property rights approach for spectrum use. The April 2026 updates to EPFD rules and overhaul of its space licensing processes adopted in July 2026 will create positive and meaningful impacts, but more profound changes should be considered. The payoff from these changes would be worth it, as they would pave the way for economic growth and innovation in the space economy. The success of U.S. companies in retaining and growing their share of the global space market will shape overall U.S. economic and national power. That success hinges on improving the way spectrum use for space applications is governed and regulated.

About the Author

Clayton Swope is the deputy director of the Aerospace Security Project and a senior fellow in the Defense and Security Department at the Center for Strategic and International Studies (CSIS). Before joining CSIS, Swope led national security and cybersecurity public policy for Amazon's Project Kuiper, an initiative to increase global broadband access through a constellation of satellites in low Earth orbit. While at Amazon, he also worked on cloud policy issues. Prior to his time at Amazon, Swope served as a senior adviser on national security, space, foreign affairs, and technology policy issues for a member of the U.S. House of Representatives. He also worked for more than 14 years at the Central Intelligence Agency, serving largely in the Directorate of Science and Technology. He holds a bachelor of science in mechanical engineering from the University of Notre Dame.

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