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February 14, 2022

National Spectrum Policy: Interference Issues in the 5G Context

Radio Spectrum as a National Resource

Most wireless technologies, including mobile communications, radionavigation systems (e.g., the Global Positioning System, GPS), radar systems, satellites, and radio and television broadcasting, rely on a range of frequencies of electromagnetic radiation to transmit signals and data. Radio spectrum is the continuum of frequencies allocated for various radiocommunication services.

Spectrum is an invisible, vital, and limited resource for the nation's economic well-being, security, science, and safety. The Code of Federal Regulations specifies frequency allocations between 8.3 kilohertz (kHz) and 275 gigahertz (GHz). This portion of the spectrum is divided into about 800 bands (or groups of frequencies) for over 30 types of communication services, based on frequency characteristics. Some frequencies can travel long distances and penetrate seawater, making them useful for land-to-submarine communications. Other frequencies can travel a few miles and penetrate obstacles (e.g., buildings), making them useful for mobile communications.

Radio communication involves the transmission and reception of signals by a radio system. Intended signals may be interfered with by signals transmitted on the same frequency at the same time as well as by spill-over from signals transmitted on adjacent frequencies. Spectrum use is regulated and coordinated to minimize interference and maximize its efficient and productive use.

Regulatory Framework for Spectrum

For cross-border radio operations and frequency allocations, the International Telecommunication Union (ITU), an agency of the United Nations, issues a collection of Radio Regulations (RR), an international agreement reached by member nations, including the United States. Nations present and discuss spectrum allocation and use positions at international meetings, including the ITU's World Radiocommunication Conference that revises and adopts the RR. Nations also align their domestic regulations with ITU regulations, but may adopt different policies that align with their national interests and priorities.

In the United States, the Communications Act of 1934, as amended, assigned joint jurisdiction over spectrum regulation to the Federal Communications Commission (FCC) and the President. The FCC regulates nonfederal spectrum use. Commercial entities and state and local governments generally obtain a license from the agency to transmit on an allocated frequency. During the licensing process, the FCC's primary consideration is "whether the public interest, convenience, and necessity will be served."

The President has the authority to assign frequencies for federal use. Since 1978, this power has been delegated to the National Telecommunications and Information Administration (NTIA), an agency in the Department of Commerce. Federal users must obtain frequency assignments and comply with NTIA regulations and guidance. Its policy priority is to ensure a balance between vital federal operations and commercial use.

NTIA has the statutory responsibility to present to the FCC the views of the executive branch on telecommunications. It chairs and receives advice from the Interdepartment Radio Advisory Committee, which consists of representatives of 20 departments and agencies that use spectrum.

Coordination of Spectrum Policy

The FCC and NTIA coordinate spectrum allocations, which are not perpetual and may be reassigned. By statute (47 U.S.C. §922), the agencies must meet regularly to conduct joint spectrum planning. They maintain a memorandum of understanding (MOU) setting terms of coordination. Moreover, a frequency allocated primarily for federal use may be used for nonfederal purposes on a mixed-use basis (subject to conditions). Over 90% of U.S. radio spectrum is shared between federal and nonfederal users. The FCC and NTIA coordinate this sharing to avoid harmful interference and resolve technical, procedural, and policy differences.

Spectrum Repurposing

According to a 2011 Government Accountability Office report, over 60 federal users hold about 240,000 frequency assignments for a variety of purposes, including air navigation and traffic control communications, national defense, land management, and law enforcement. To address the growing demand for spectrum for wireless broadband technologies, including fifth-generation (5G) telecommunications, Congress has directed NTIA to identify federal frequencies that can be reallocated to the FCC for nonfederal or shared use. As of 2020, NTIA and the FCC had made a total of 1,131 megahertz of mid-band (1-10 GHz) spectrum available for commercial 5G services.

Interference Issues

An emission that falls outside its intended frequency and spills over into adjacent frequencies is an out-of-band emission (OOBE) and a major source of interference. Common methods to mitigate OOBE interference are to create a guard band of unused frequencies between the intended and adjacent frequencies and to reduce the power level of transmitters in adjacent frequencies.

The FCC and NTIA use the term "harmful interference" as defined in the ITU's RR. The term indicates interference at a level that "endangers the functioning of a radionavigation

service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service." A challenge addressing potential harmful interference is that users do not always agree on mitigation methods and power levels. This issue has drawn congressional attention as the FCC has issued licenses for reallocated spectrum, in some instances despite objections by NTIA and affected agencies. Several cases highlighted their competing or even conflicting positions on spectrum.

Weather Satellite Interference

In May 2019, the FCC auctioned licenses for commercial 5G deployment. The auction made 2,909 licenses available in the 24 GHz band and raised more than $2 billion. Throughout the proceeding, the National Oceanic and Atmospheric Administration and the National Aeronautics and Space Administration raised concerns that 5G services could cause harmful interference to the passive sensors onboard satellites that the agencies operate in the adjacent 23.8 GHz band for weather forecasting and earth science research. Based on technical studies by the agencies, NTIA advocated for more stringent OOBE limits than those adopted by the FCC. The ITU later updated its standard with more stringent OOBE limits in the 24 GHz band, which the FCC subsequently was considering to adopt. For more information of the issue, see CRS Report R46416, *Forecasting Tropical Cyclones: Overview and Issues for Congress*, by Eva Lipiec.

GPS Interference

In April 2020, the FCC authorized Ligado Networks LLC to deploy a terrestrial wireless network operating in a segment of the L-band (i.e., 1.5-1.6 GHz). The national security community and GPS equipment makers raised concerns that Ligado's operations would interfere with GPS signals in the 1559-1610 MHz band. Based on technical analysis by its engineers, the FCC concluded that the conditions in place (e.g., power levels, guard band, and coordination requirements) would protect against interference, promote efficient use of spectrum, and support 5G deployment, and therefore the authorization was "in the public interest." See CRS In Focus IF11558, *Spectrum Interference Issues: Ligado, the L-Band, and GPS*, by Jill C. Gallagher, Alyssa K. King, and Clare Y. Cho and CRS Insight IN11400, *DOD Concerns About the FCC-Approved Ligado Network*, by Kelley M. Sayler and John R. Hoehn.

NTIA argued that Ligado's network would interfere with critical national security and public safety GPS use and that the FCC failed to adequately weigh agency concerns. NTIA disagreed with the FCC's interference evaluation methods, and countered that the FCC should use Department of Transportation (DOT) methods, which found a level of interference high enough to endanger the reliability of GPS devices. Pursuant to P.L. 116-283, the Department of Defense contracted with the National Academies of Sciences, Engineering, and Medicine (NASEM) to conduct an independent technical review to compare FCC and DOT methods and recommend which most effectively evaluates interference risks to GPS devices. NASEM started the review process in September 2021 and projected the duration of the review to be 15 months.

Aviation Altimeter Interference

Radio altimeters are critical aircraft instruments that provide precise height-above-terrain/water information. Low altitude operations and flight guidance systems rely on radio altimeter inputs. Globally, governments and civil aviation use the 4.2-4.4 GHz band exclusively for radio altimeters. The Federal Aviation Administration (FAA) raised concerns in 2015 that 5G signals transmitted on nearby frequencies could potentially interfere with radio altimeters, particularly if high-powered 5G base stations were placed close to airport runways. In October 2020, RTCA, an aviation technical advisory group, cautioned of likely interference to current generation altimeters from 5G signals in the 3.7-3.98 GHz band. See CRS In Focus IF12028, *Aviation Concerns Regarding the Rollout of 5G Wireless Telecommunications Networks*, by Bart Elias.

In February 2020, the FCC found the OOBE limits it set and the 220 megahertz separation between 5G services in the 3.7-3.98 GHz band and radio altimeter operations in the 4.2-4.4 GHz band should mitigate any significant interference. It concluded a spectrum auction in February 2021, making 5,684 licenses available and raising over $81 billion. The FCC asserted the auction was critical for implementing its 5G FAST Plan, which emphases quick mid-band 5G buildout, and fulfilled its mandate under the MOBILE NOW Act (P.L. 115-141, Division P, Title VI) to identify 100 megahertz below 6 GHz for 5G use. In January 2022, 5G carriers agreed to establish buffer zones near airports identified by FAA, where wireless carriers would turn off transmitters for six months while FAA assesses altimeter performance in the 5G environment.

Improving Interagency Coordination

The aforementioned interference disputes have relied on technical studies submitted by interested parties and agencies, which the FCC analyzed before making decisions. Affected agencies contend that the FCC has dismissed their technical findings and their interference concerns.

Congress may consider whether the current interagency process is adequate for identifying potential harmful interference and resolving differences. It may also consider whether the process is effective to balance public and private sector interests in accelerating 5G deployment with protection of critical national functions. Several bills have been introduced addressing spectrum coordination between the FCC and NTIA. For example, S. 1472, the Improving Spectrum Coordination Act of 2021, would require the agencies to update their MOU periodically and report to Congress annually on joint spectrum planning activities. The update would (1) outline processes for addressing differences in frequency allocation; (2) clarify NTIA's role in managing federal spectrum use; (3) take into account scientific analyses and implications of spectrum policy in decisionmaking; and (4) ensure the efficient use of frequencies assigned to the federal government and the reallocation of those frequencies not required for federal use to nonfederal users. Another bill, H.R. 2501, the Spectrum Coordination Act, would also require the FCC and NTIA to update the MOU to "improve the process for resolving frequency allocation disputes in shared or adjacent bands ... expeditiously and efficiently."

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