The FCC's Auction Authority, the 3.1–3.45 GHz Conundrum, and NTIA's Spectrum Strategy

Monisha Ghosh

Spectrum regulation and policy have been the recent focus of many discussions at the Congress, Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA). This column will provide a brief overview of three recent developments that promise to have an impact on future spectrum policy.

The FCC's Auction Authority

It is easy to forget that allocating spectrum for specific uses via auctions was not the norm even 30 years ago. The FCC was given auction authority through the Omnibus Budget Reconciliation Act of 1993, with the first spectrum auction being conducted in 1994 [1]. There have been several long-term extensions of this authority since then, the most recent one being an extension of 10 years granted in 2012 which expired on September 30, 2022. Since the expiration last year, there have been several bills to extend the auction authority, but they have not passed, with the result that for the first time since the authority was granted, as of March 9, 2023, the FCC cannot auction any spectrum, unless the authority is reinstated. Among other issues related to spectrum and wireless, the FCC's auction authority was discussed at a Congressional hearing on the Future of Spectrum Management on March 10, 2023 [2].

Over the past 30 years the FCC has successfully used its authority to conduct over a hundred auctions in various bands for services, such as cellular, satellite, and paging. These auctions have raised more than $200 billion in direct revenues, in addition to the billions of dollars in revenue generated by the many innovative uses of the spectrum itself by increasing access to mobile broadband connectivity. Prior to 1993, spectrum was allocated via inefficient methods, such as lotteries and "comparative hearings" where the FCC determined which allocations would provide the maximum utility. The specific auction framework used today was devised by Robert Wilson and Paul Milgrom who were awarded the Nobel Prize for Economics in 2020 for their work: auctions have now become a mainstay of spectrum allocation methodology around the world.

How did it come to pass then that the FCC's auction authority was not extended? While the exact reasons for the stalemate are unknown, at the core of the controversy is the desire for commercial wireless service providers , mainly Mobile Network Operators (MNOs) to have access to spectrum that is currently allocated for federal services, which includes spectrum used by the Department of Defense (DoD) for various radar operations. In particular, the 3 GHz band is one that is coveted for 5G due to the propagation characteristics being more favorable than the mmWave range (> 24 GHz), and the availability of reasonable amounts of contiguous bandwidth (> 100 MHz). Since 2020, the FCC has conducted a number of auctions in 3 GHz making available several bands for commercial use: C-band, 3.7–3.98 GHz [3], Citizens Broadband Radio Service (CBRS), 3.55–3.7 GHz [4], and the 3.45–3.55 GHz band [5]. The latter two were primarily DoD bands and different mechanisms were adopted to allow use by commercial wireless services while protecting the DoD incumbent usage in the band. The CBRS band, though auctioned, is shared with Navy radars being the primary incumbent, and the 3.45–3.55 GHz band has certain restrictions in a handful of locations around the country where usage by commercial wireless needs to be coordinated with DoD uses, with some incumbents being relocated to the 2.9–3.0 GHz bands. These encumbrances are reflected in the price of spectrum: the unencumbered C-band auction raised $81B for 280 MHz of spectrum, the lightly encumbered 3.45–3.55 GHz band raised $22.5B for 100 MHz of spectrum, and the shared CBRS band raised only $4.5B for 150 MHz of spectrum, with a provision for users without licenses to also use the band albeit at the lowest priority level, termed General Authorized Access (GAA). Shared spectrum usually entails lower transmit power for the secondary user: C-band and 3.45–3.55 GHz allow a maximum Effective Isotropic Radiated Power (EIRP) of 62 dBm/MHz (1640 W/MHz) in urban areas whereas CBRS users can only transmit a maximum EIRP of 47 dBm/ 10 MHz. While the lower power limits in CBRS may seem like a hindrance, in fact, there are many emerging use cases which do not necessarily require the higher transmit power of a wide-range mobile broadband network, such as community networks, factory, warehouse control, etc. Moreover, the lower-power is more amenable to sharing with incumbents.

The 3.1–3.45 GHz Conundrum

The 3.1–3.45 GHz band has similar incumbents as in CBRS, primarily various types of radar used by the DoD, including airborne radars, such as those used in Airborne Warning and Control System (AWACS) aircraft. The Partnering to Advance Trusted and Holistic Spectrum Solutions (PATHSS) task group within the National Spectrum Consortium (NSC) is deliberating on ways this band could be made available for commercial use, while not affecting incumbent federal operations. All options are being considered and technical evaluations are underway to determine how the spectrum utility of this band could be maximized. In order to auction the band with no encumbrances, the existing incumbents would need to be relocated to other bands or operations consolidated into a part of the band with the rest being cleared for auction. This would allow high-powered use by cellular operators for 5G today and by future cellular generations, at the expense of some impact on current federal operations in the band. The other alternative is to use sharing mechanisms similar to the Spectrum Access System (SAS) approach used in CBRS. However, there are limitations to sharing using the CBRS approach, which were detailed recently in a white paper written by the FCC's Technological Advisory Council (TAC) Working Group on spectrum sharing [6]. The SAS relies on receiving information about incumbent usage from a network of sensors, called the Environmental Sensing Capability (ESC), deployed along the coasts to detect Navy radars. However, these sensors themselves need "whisper zones" i.e., areas where no CBRS transmissions are permitted so that low-level of incumbent signals can be detected. This leads to inefficient spectrum use: the sensors themselves need protection zones in addition to that required for the incumbent. Hence, an alternative method, called ""Incumbent Informing Capability" or IIC [7] is being considered for sharing in this band: this would require the DoD to approve sharing information of current and future spectrum use with a trusted third-party who would only inform the new entrant whether a certain band is available or not.

There are other alternatives, which should be considered as well for sharing. The 6 GHz unlicensed rules, for example, allow low-power indoor (LPI) devices to operate in a shared band with high-power outdoor incumbents on a shared but unlicensed basis. It is challenging to determine whether devices are indoors or outdoors, but machine learning methods can be utilized to robustly identify device environment as shown in [8]. This sharing model could be extended to licensed spectrum as well: it is well accepted that 70–80% of mobile data is generated indoors [9], and much of the high-powered 5G outdoor deployments are being used by cellular operators to reach customers indoors as demonstrated by the recent "5G at home" wireless broadband services offered by many carriers. This begs the question: is this a "green" approach to designing future cellular networks? Nationwide, a high-powered cellular footprint is required for ubiquitous connectivity, but even after more than a decade of high-power 4G deployments in the low (< 1 GHz) and mid (1–2 GHz) bands, there are vast, mostly rural, areas that remain unconnected. These areas are not likely to be served by high-power 5G deployments in 3 GHz either since the higher frequency will require denser deployments than today. Hence, the most promising approach for the 3.1–3.45 GHz seems to be a low-power, small-cell, shared approach, similar to CBRS that will allow communities to access spectrum at low/no cost while protecting federal incumbents.

NTIA's Spectrum Strategy

Looking forward, in addition to the 3.1–3.45 GHz band, the range of frequencies between 7–24 GHz have been called out as well for potential sharing [10]. Most current allocations in these bands are for federal and scientific uses and hence FCC and NTIA need to collaborate along with industry, scientific agencies and academia to create a long-term spectrum strategy on optimum use of these bands. To that end, the NTIA has announced a Request For Comments (RFC) as they develop a national spectrum roadmap [11]. In advance of the reallocations in the 3 GHz band, the NTIA conducted several detailed quantitative assessments of spectrum usage in the band [12]: in order to determine how the 7 – 24 GHz band could be reallocated or shared, such assessments are essential. Academic researchers should be engaged in the process of developing the national mid-band spectrum strategy.

References

[1] FCC Auction Summary, https://www.fcc.gov/auctions-summary.

[2] Communications and Technology Subcommittee Hearing, Defending America's Wireless Leadership, https://energycommerce.house.gov/events/communications-and-technology-subcommittee-hearing-defending-america-s-wireless-leadership.

[3] Auction 107, 3.7 GHz Service, https://www.fcc.gov/auction/107.

[4] Auction 105, 3.5 GHz Service, https://www.fcc.gov/auction/105.

[5] Auction 110, 3.45 GHz Service, https://www.fcc.gov/auction/110.

[6] Recommendations to the Federal Communication Commission based on lessons learnt from CBRS, https://www.fcc.gov/sites/default/files/recommendations_to_the_federal_communications_commission_based_on_lessons_learned_from_cbrs.pdf.

[7] Incumbent Informing Capability (IIC) for Time-Based Spectrum Sharing, https://ntia.gov/sites/default/files/publications/iic_for_time-based_spectrum_sharing_0.pdf.

[8] A. Ramamurthy *et al.*, "ML-Based Classification of Device Environment Using Wi-Fi and Cellular Signal Measurements," *IEEE Access*, vol. 10, 2022, pp. 29,461–72, DOI: 10.1109/ACCESS.2022.3158056.

[9] Planning In-Building Coverage for 5G: From Rules of Thumb to Statistics and AI, https://www.ericsson.com/en/reports-and-papers/mobility-report/articles/indoor-outdoor.

[10] Chairwoman Rosenworcel's Remarks at the 2022 NTIA Spectrum Policy Symposium, https://docs.fcc.gov/public/attachments/DOC-387346A1.pdf.

[11] NTIA, Developing a National Spectrum Strategy, https://www.ntia.doc.gov/issues/national-spectrum-strategy.

[12] Quantitative Assessments of Spectrum Usage, 2016, https://www.ntia.doc.gov/report/2016/quantitative-assessments-spectrum-usage.

Biography

Monisha Ghosh (mghosh3@nd.edu) is a Professor of Electrical Engineering at the University of Notre Dame and a member of the Notre Dame Wireless Institute. She is also the Policy Outreach Director for SpectrumX (https://www.spectrumx.org/), the first NSF Center for Spectrum Innovation, and was the co-chair of the FCC's Technological Advisory Council (TAC) Working Group on Advanced Spectrum Sharing. Her research interests are in the development of next generation wireless systems: cellular, Wi-Fi and IoT, with an emphasis on spectrum sharing in 2022, coexistence, and applications of machine learning to improve network performance. Prior to joining the University of Notre Dame in 2022, she was the chief technology officer at the Federal Communications Commission, a Program Director at the National Science Foundation, Research Professor at the University of Chicago; and spent 24 years in industry research at Bell Labs, Philips Research and Interdigital working on a wide variety of wireless systems: HDTV, Wi-Fi, TV white spaces, and cellular. She obtained her B.Tech from IIT Kharagpur in 1986 and Ph.D. from USC in 1991.