Progress in Opening Access to Spectrum above 100 GHz

Michael J. Marcus

While the International Telecommunication Union (ITU) Table of International Allocations and most national allocations tables have listed spectrum allocations up to 275 GHz, in reality specific policies for technologies above 100 GHz have been very rare until recently. Both Conference of European Postal & Telecommunications (CEPT)/ERC, the group of European spectrum regulators, and the Japanese regulator MIC have had some specific provisions for this spectrum region. On March 15, 2019 the U.S. spectrum regulator FCC made a decision for this spectrum that opens a variety of new opportunities for use of this spectrum.[1]

In 2015 MIC allocated[2] 116-134 GHz for "Commercial Telecommunications Service" subject to the provision that "all practicable steps shall be taken to protect the radio astronomy service from harmful interference" in parts of the band.[3] CEPT/ERC's 2018 recommendation on "Short Range Devices," sometimes called "unlicensed devices," includes provisions for such devices at 122.0–122.25 GHz and 244–246 GHz. Unlike the Japanese provisions, power limits are given, and they are quite modest at 20 dBm effective isotropic radiated power (EIRP).[4]

The FCC decision followed from more general proposals it issued in February 2018.[5] FCC indicated that the new decision only addressed some of the issues in the original proposals and that subsequent decisions would address the areas that have not yet been addressed including provision for licensed spectrum above 95 GHz. The two issues addressed in the decision were the creation of four new unlicensed bands with a total bandwidth of 21.2 GHz and creating a new variant of experimental license that allows interim use of nominally any spectrum above 95 GHz — including sale of equipment — on any noninterference basis to other users.

The new unlicensed bands are 116–123 GHz, 174.8–182 GHz, 185–190 GHz, and 244–246 GHz. The largest of these bands has a bandwidth of 7.2 GHz, making it much wider than the CEPT bands mentioned above, but it is also much smaller than the Japanese 18 GHz wide band. However, the power permitted for these bands is quite generous and dwarfs the CEPT provisions. Power limits are based on EIRP. Average power is limited to 40 dBm and peak power is limited to 43 dBm. For fixed point-to-point transmitters located outdoors, the average is limited to 82 dBm, reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. Peak power is then limited to 85 dBm reduced in the same way for antennas with gains less than 51 dBi. The apparent reason for this gain reduction algorithm is to encourage the use of high gain, narrow beam antennas that will permit denser use of this spectrum when small antennas can easily have large gains.

The FCC decision explains why these four bands were selected. Spectrum above 100 GHz, unlike lower regions, has many aerosol molecular resonance frequencies in it that are key for both radio astronomy and satellite-based passive sensing of both climate and pollutants. Many of these resonant frequencies are thus given special protection. While this also happens at lower bands, the density and total bandwidth of protected bands is higher above 100 GHz than in lower bands.

Although several of the new FCC unlicensed bands here contain allocations for passive environmental satellites, none of these allocations are contained in ITU Radio Regulation 5.340, which prohibits "all emissions" in its enumerated bands. Two of the bands include frequencies long identified for industrial, scientific, and medical (ISM) use for which there is no stated power limit for terrestrial emissions.

These new unlicensed bands will now allow commercial use and marketing of new technologies with only routine regulatory approvals needed. Of course, the functionality of these applications will be limited by the limited bandwidths available in the four new bands.

The new experimental license provisions, called "Spectrum Horizons License" in the decision, offer a potential relief to the limited bandwidth access of the unlicensed bands. They allow potential access to any frequency between 95 GHz and 3 THz — often viewed as the transition point from radio technology to infrared technology. These new licenses do not have an a priori limit on power, but the application for such licenses must contain a statement that

> "sufficiently explain(s) the proposed new technology/potential new service and incorporate(s) an interference analysis that explains how the proposed experiment would not cause harmful interference to other services."[6]

Presumably the term "other services" here refers to two passive radio services: Radio Astronomy Service/RAS and Earth Exploration-Satellite Service/EESS. In practice RAS use above 100 GHz is generally in high arid mountain locations, so sharing with communications uses is generally feasible, but EESS antennas are downward pointing in satellites, and EESS sharing issues are much more complex. Thus, it remains to be seen whether the impact of the new FCC Spectrum Horizons Licenses will be significant, or degenerate into complex and contentious interservice sharing disputes.

Left unresolved in the FCC decisions are several issues. One is the question of any licensed spectrum above 95 GHz. Traditionally, cellular carriers have been very insistent

[1] https://docs.fcc.gov/public/attachments/FCC-19-19A1.pdf

[2] https://www.tele.soumu.go.jp/resource/e/search/share/pdf/t3.pdf

[3] Japan Allocation Table Footnote J36, https://www.tele.soumu.go.jp/resource/e/search/share/pdf/fj.pdf

[4] CEPT/ERC ERC Recommendation70-03, October 5, 2018 https://www.ecodocdb.dk/download/25c41779-cd6e/Rec7003.pdf

[5] https://docs.fcc.gov/public/attachments/FCC-18-17A1_Rcd.pdf

[6] 47 C.F.R. § 5.702

that only spectrum with areas licenses and with a single licensee in a given area was practical for commercial mobile services, and only licensed fixed service spectrum was practical for wireless backhaul. In comments to FCC, the main U.S. cellular trade association commented on the Spectrum Horizons Licenses that it was pleased that "Spectrum Horizons Licenses "will not impede future licensed services in the band."[7]

Another issue is RF safety standards. When FCC's RF safety regime was adopted in 1986, 100+ GHz seemed far away in implementation, and the rules only had numeric exposure limits below 100 GHz. Canada and the European Union now have limits up to 300 GHz, but FCC has yet to even propose a limit above 100 GHz. While lack of regulations is sometimes helpful for new technology, the lack of an explicit safety limit here may create litigation risks for manufacturers and operators of equipment above 100 GHz with respect to exposures of people in the United States.

This FCC action was a unilateral one consistent with ITU allocations but not in coordination with other national regulators. FCC has taken similar unilateral action in the past in creating the three unlicensed ISM bands that are now home to the ubiquitous Wi-Fi and Bluetooth and in creating the 60 GHz unlicensed band. This approach is different than that of most other national spectrum regulators who eschew this approach in favor of time consuming ITU consensus building before taking such regulatory actions. While it has worked out well for the FCC approach in these examples, this may become a good test case for the pros and cons of the two contrasting approaches.

[7] https://ecfsapi.fcc.gov/file/103080354705994/190308%20CTIA%20Ex%20Parte%20on%20Spectrum%20Horizons%20First%20Report%20and%20Order.pdf

Biography

Michael J. Marcus [S '66, M '72, SM '01, F '04] (mjmarcus@marcus-spectrum.com) is director of Marcus Spectrum Solutions, Cabin John, Maryland, and an adjunct professor at Virginia Tech's Bradley Department of Electrical and Computer Engineering. He retired from the Federal Communications Commission in 2004 after nearly 25 years in senior spectrum policy positions. While at FCC, he proposed and directed the policy developments that resulted in the bands used by Wi-Fi, Bluetooth, and licensed and unlicensed millimeter wave systems above 59 GHz. He was an exchange visitor from FCC to the Japanese spectrum regulator (now MIC) and has been a consultant to the European Commission and the Singapore regulator (now IMDA). During 2012–2013 he was Chair of the IEEE-USA Committee on Communication Policy and is now its Vice Chair for Spectrum Policy. In 2013, he was awarded the IEEE ComSoc Award for Public Service in the Field of Telecommunications "for pioneering spectrum policy initiatives that created modern unlicensed spectrum bands for applications that have changed our world." He received S.B. and Sc.D. degrees in electrical engineering from MIT.