The Committee on Energy and Commerce

Memorandum

November 27, 2012

To: Members and Staff, Subcommittee on Communications and Technology

From: Majority Committee Staff

Subject: Hearing on "The Role of Receivers in a Spectrum Scarce World"

The Subcommittee on Communications and Technology will hold a hearing on Thursday, November 29, 2012, at 10:00 a.m. in 2322 Rayburn House Office Building. The title of the hearing is "The Role of Receivers in a Spectrum Scarce World."

I. Witnesses

One panel of witnesses will testify:

Brian Markwalter
Senior Vice President, Research and Standards
Consumer Electronics Association

Ron Repasi
Deputy Chief, Office of Engineering and Technology
Federal Communications Commission (FCC)

Pierre de Vries
Senior Adjunct Fellow, Silicon Flatirons Center
University of Colorado, Boulder

II. Overview

With Americans' thirst for wireless services increasing by leaps and bounds, and with particular broadband technologies and business models evolving at an accelerating clip, how can spectrum users inhabit increasingly close quarters without stepping on each other toes? Good fences make good neighbors, as the adage goes, but how do you know how high to build your fence or what materials to use if you don't know who your neighbors might be in the future or precisely what they will be doing on their lot? Can smart engineering and forward-looking spectrum strategies account for the possibility of unanticipated technologies and uses in adjacent spectrum bands and help prevent today's decisions from limiting flexibility in the future? How do we promote such flexibility without unreasonably increasing the cost of services and devices? These are the questions to be addressed at Thursday's hearing, with an emphasis on receiver design and performance.

III. Background

In the wireless world, the two main "fences" for protecting services from interfering with each other are guard bands and filters. Guard bands are bands of spectrum with restrictions on use to protect adjacent users from interference. Filters are components integrated into the transmitters and receivers of wireless devices to control the amount of energy they emit or receive, minimizing or eliminating the need for guard bands.

In the case of receivers, filters control what part of the electromagnetic spectrum the device can hear. This allows the device to listen for the signals it is looking for and ignore the "noise" coming from the many other uses of spectrum around it. Sunglasses present another analogy. The sun is a high-energy source of light. Using the lenses of sunglasses to filter out some of the energy makes it easier to see the relatively low-light energy reflecting off of all of the objects around us. As a result, we can drive on a sunny day with less distraction and still see the cars in front of us we want to pay attention to. By forcing the receivers in wireless devices to ignore frequencies that are outside the range the devices are listening for, filters help the devices make sense from signals in a crowded spectrum environment.

In the absence of filters capable of adequately screening out energy from adjacent bands, receivers experience "overload" that can prevent a device from operating properly. Because this can cause a device to fail, issues of potential receiver overload are starting to concern more than just spectrum engineers and are garnering the attention of policy makers and even the general public. Below are some recent cases in which receiver overload was at least one factor:

- **LightSquared and GPS:** In the most recent example of potential receiver overload, the GPS community objected to the terrestrial use of L-band satellite spectrum by LightSquared. Many GPS devices use receiver filters that extend beyond the GPS spectrum into LightSquared's licensed spectrum. When the L-band is used only for low-power satellite systems, the filters are adequate to permit proper GPS device operation. However, because the filters in GPS receivers are not limited to the GPS spectrum, higher-power terrestrial use by LightSquared could result in some GPS devices ceasing to function properly. Filters tuned specifically to the GPS spectrum may have ameliorated this problem. Compounding the matter is the lack of a direct, ongoing relationship between the GPS signal provider, the retail device manufacturer and the end user that is present with smartphones. As a result, tracking and resolving issues with retail devices becomes more difficult. This issue is pending at the FCC, but LightSquared is not permitted to operate as a terrestrial licensee unless this issue is resolved.

- **AWS-3 and M2Z Networks:** Seeking to use the spectrum at 2155-2180 MHz, M2Z Networks petitioned the FCC to permit time division duplexed operation (transmitting and receiving in the same channel, but at different times). Existing commercial wireless providers, however, had deployed devices in the immediately adjacent AWS-1 band with receiver filters designed to the international standard (2110-2180 MHz), not the U.S. allocation (2110-2155 MHz). As a result, had the Commission authorized M2Z, M2Z customers transmitting in 2155-2180 MHz could have disrupted operations for existing wireless customers by transmitting in a band designed for mobile receivers. Filters tuned to the U.S. allocation may have eliminated the interference concerns. The FCC denied M2Z's request (for a variety of reasons, not just interference concerns).

- **WCS and SDARS:** The Wireless Communications Service (WCS) and the Satellite Digital Audio Radio Service (SDARS, or satellite radio) share the 2.3 GHz band. As satellite radio began to gain commercial adoption, the relatively weak satellite signal had reception problems in some areas, particularly urban areas where skyscrapers prevented a line-of-sight connection to the satellites. To address this, the SDARS licensees (then XM and Sirius) deployed terrestrial repeaters (at higher power) to provide signals to satellite radio receivers. WCS licensees now had to contend with significantly higher power operations in adjacent spectrum. The FCC resolved this issue by placing conditions on the merger of XM and Sirius and changing the operating rules for WCS licensees.

- **Broadcast Television and White Space Devices:** In its proceeding to authorize the use of unlicensed wireless devices in the UHF television band, the Commission confronted the challenge of authorizing mobile or nomadic transmitters in a band that is used by fixed broadcasters and received by over-the-air television tuners. To protect the installed base of televisions in the United States relying on over-the-air signals, the FCC required the new users—white spaces devices—to use filters on the transmitter side to limit emissions.

IV. Discussion

How to tackle potential receiver interference issues has long been a topic of discussion between and among engineers and regulators. For example, the Commission has long used band-plan design to reduce the chances of interference between services and licensees. Guard bands, duplex gaps (the separation between the spectrum used to emit and receive signals in devices that use two separate channels to transmit to and listen for another device or network — called frequency division duplexing), and the placement of similar services near each other are all tools the Commission has used to reduce the chances of receiver overload. Band plan management tools do not work in every circumstance, however, and will fall short with growing frequency in an increasingly spectrum-constrained and technologically complex environment. Many also argue that using guard bands to mitigate interference is less efficient because they represent underutilized spectrum.

The FCC also tries to address potential interference by regulating the power levels at which devices may transmit and limiting their level of out-of-band emissions (OOBE). Because the FCC must inspect and authorize each device that emits radio energy, the Commission has traditionally used this type of regulation to control the spectrum environment. Many argue, however, that looking at transmitters but not receivers ignores half the equation when trying to maximize the use of scarce spectrum resources.

Traditionally, discussion of how to handle receiver overload has focused on whether to strictly regulate receivers in the same way the Commission currently regulates transmitters. More recent proposals, on the other hand, have examined whether defining receiver interference rights would better balance efficient spectrum use and innovation. Under this approach, the FCC would define the maximum level of interference that a device manufacturer should expect users to experience, but would not mandate specific receiver performance. Manufacturers would then be free to develop devices to operate within that environment without the burden of a technology

mandate, but with the understanding that they would not have any recourse at the FCC for interference below the FCC's maximum interference threshold.

Opponents of defining receiver performance levels argue that if the defined levels exceed those that exist in the real-world spectrum environment, manufacturers will be forced to over-engineer devices — raising the cost to manufacture the devices, and thus the cost to consumers. In essence, device manufacturers would be forced to design devices for the worst case, not the use case. Proponents argue that receivers are currently under-engineered to cope with a changing spectrum world and that establishing receiver performance levels will solve the receiver problem without a technology mandate or cumbersome FCC oversight of device manufacturing. Moreover, they argue that the certainty of knowing what level of interference a device will tolerate will make it easier for the FCC to reallocate spectrum for new and innovative technologies without fear of disrupting existing users.

Recently this topic has also been the discussion of multiple government convened advisory groups. The President's Council of Advisors on Science and Technology (PCAST) released a report on spectrum use in September 2012 that strongly recommended that the FCC and NTIA establish minimum technical standards for receivers. Additionally, the Commission, in order to examine how it can promote strategies and practices by wireless device makers to increase the resiliency of receivers, has convened its Technological Advisory Council (TAC) to work on recommendations for Commission action. Its recommendation is expected this December 2012.

If you need more information, please contact Neil Fried or David Redl at (202) 225-2927.