Response to Written Questions Submitted by Hon.
John Thune
Written Questions for the Record to
Mr. Dean Brenner

Question 1. You mentioned that Qualcomm is developing versions of 5G that will use new spectrum sharing techniques better than possible today in any unlicensed band. Can you explain what that will look like?

Response. As I explained at the hearing, Qualcomm is developing two versions of 5G that will be optimized for deployment in shared spectrum bands. The first version is a 5G-based evolution of the spectrum sharing techniques used in 4G known as Licensed Assisted Access or LAA. 4G-based LAA has been deployed in the US and around the world, and it is significantly improving 4G mobile broadband for consumers.

The second version uses revolutionary new spectrum sharing techniques that will in fact substantially improve the user experience in shared spectrum over what is possible today. Let me explain this. LAA, Wi-Fi and other existing technologies all enable spectrum sharing based on time. Under this existing technique, each user on a shared channel uses a shared channel for its proportionate share of the time, but each user must be silent when awaiting its turn to use the channel. So, if there are ten users on a shared channel, each user uses the spectrum for one-tenth of the time and is silent for nine-tenths of the time.

The new 5G spectrum sharing techniques that Qualcomm is developing are spatial-based—spectrum is shared by enabling users to use a shared channel in different directions so that each user can use the shared channel simultaneously. 5G uses a very fast new radio, and each 5G base station and device has many antennas that transmit and receive in very narrow, highly directional beams. The new spectrum sharing technique takes advantage of these attributes. So, under this new technique that Qualcomm is developing, if there are ten users on a shared channel all using this new technique, each user can use the spectrum for 100 percent of the time and will not interfere with one another by transmitting in different directions, instead of being able to use the channel for only one-tenth of the time as is the case today. This technique substantially increases the overall capacity of a shared channel for all users, increases the efficiency and utilization of spectrum, and enables a vastly better mobile broadband experience for each user.

More information about our work on this new spectrum sharing technique is available on this website: https://www.qualcomm.com/invention/5g/spectrum-sharing.

Question 2. A July 1, 2018, Politico article, "Telcogeopolitics: West vs. China in 5G Race," reported that "Over the last two years, Huawei, ZTE and other Chinese players have increased their share of patents underpinning the global standards — the higher the amount of intellectual property a company holds in the overall global telecoms rulebook, the greater control it can exert on how the mobile technology will be used." The article also stated that "Qualcomm alone accounts for more than 15 percent of current 5G patents," while Nokia -- a Finish company --

accounts for 11 percent and Ericsson -- a Swedish company -- holds roughly 8 percent of 5G patents. Is that report accurate? Can you describe how Qualcomm is engaging in the 5G standards-setting process and what the U.S. needs to do to maintain our leadership in the race to develop and commercialize 5G technology?

Response. Qualcomm is exercising leadership in the development and standardization of 5G, just as it has for prior generations of wireless technology. Here is some additional information on the 5G standards process and Qualcomm's role.

5G, which is formally known as 5G New Radio or 5G NR, is being developed in a global industry standardization group called 3GPP. Cellular communications are based on standards. Therefore, many of the innovations in cellular technology go through a standardization process in 3GPP. Virtually all companies involved in cellular communications around the world participate in 3GPP. This includes US companies such as Qualcomm, all of the US cellular carriers, and other US tech companies, and it also includes participants from diverse areas such as automotive, public safety and first responders, broadcasting and more. As noted, 3GPP is truly a global group with participants from all over the world. Several Chinese companies are also active members of 3GPP, a reflection of the growing penetration of smartphones and of cellular communication in China.

Qualcomm has been part of 3GPP from its inception and has been a very active participant for quite a long time. Qualcomm is a major contributor to 3GPP's work, and a large number of the advancements in cellular communications over the years standardized in 3GPP originate from Qualcomm. The same has been true during the 5G standardization process. A significant number of Qualcomm's innovations in key aspects of 5G technology, including air interface design, protocol design, security and system architecture, have successfully gone through the 3GPP standardization process and have eventually been incorporated into the 5G standard. Thus, the 5G standard already includes many important innovations developed by Qualcomm.

Moreover, Qualcomm's technical work in developing additional important aspects of 5G —such as the technologies referred to in my answer to Question 1 above—and our leadership in standardizing them in 3GPP is ongoing.