U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON ENERGY AND COMMERCE

November 13, 2017

TO: Members, Subcommittee on Communications and Technology

FROM: Committee Majority Staff

RE: Hearing entitled "The Race to 5G and its Potential to Revolutionize American Competitiveness"

I. INTRODUCTION

The Subcommittee on Communications and Technology will hold a hearing on Thursday, November 16, 2017, at 10:00 a.m. in 2123 Rayburn House Office Building. The hearing is entitled "The Race to 5G and its Potential to Revolutionize American Competitiveness."

II. WITNESSES

- The Honorable Jonathan Adelstein, President and CEO, Wireless Infrastructure Association;
- Dr. Coleman Bazelon, Principal, Brattle Group;
- Mr. Chris Pearson, President, 5G Americas;
- Mr. David Broeker, Founding CEO, Indiana Biosciences Research Institute; and
- Ms. Shireen Santosham, Chief Innovation Officer, City of San José

III. BACKGROUND

Information is power, and the ability to communicate and process information faster provides a competitive advantage. History shows countries with the best communications have the highest economic growth. A recent report concluded that doubling mobile data use leads to a 0.5 percent increase in per capita Gross Domestic Product (GDP) growth rates, and a 10 percent expansion of mobile penetration increases productivity by 4.2 percent.[1]

Roughly every ten years, mobile cellular communications networks make a generational shift from older to newer technology, standards, and protocols. Each successive generation brings an increase in network and spectral efficiency, as well as increases in applications and

[1] Deloitte, GSM Association, and Cisco, "What is the Impact of Mobile Telephony on Economic Growth?" (November 2012), pp 2, https://www.gsma.com/publicpolicy/wp-content/uploads/2012/11/gsma-deloitte-impact-mobile-telephony-economic-growth.pdf.

services available to household consumers, small businesses, and large enterprises. The last generational shift took place in the late 2000s, and we are on the verge of the next one – the shift to fifth generation (5G) mobile broadband cellular technology. The advancement of 5G holds promise to revolutionize American competitiveness across virtually every sector of the economy. However, U.S. leadership in 5G may be overtaken by international competitors if federal, state, and local policies constrict development and deployment of this technology.

Lastly, while the promise of 5G cannot be overstated, it must also be placed in context. 5G is one part of a tapestry of communications technology that includes fourth generation wireless networks, unlicensed spectrum, as well as coaxial cable, fiber optics, fixed wireless, and satellites. These technologies play a role in connectivity and ensuring continued American competitiveness.

A. Historical context

Cellular technology was developed with efficient use in mind because it allows many users to share a limited number of frequencies within a small geographic area without interference. Cellular technology spreads a multitude of low-powered antennas over a wide area in a honeycomb of hexagonal zones – or "cells" – with its own range of frequencies. Each cell has a base station to send and receive signals from mobile devices within the cell. In general, more users on a cellular network requires operators to deploy smaller cells and densify their networks.

As far back as 1947, Bell Labs had described in theory the operation of cellular communications.[2] Both domestically and internationally, the race to deploy cellular technology was fiercely competitive. In 1973, the first handheld mobile phone was demonstrated by Martin Cooper of Motorola – the call he made was to Joel Engle, his chief rival at Bell Labs in the race to perfect cellular technology.[3] As impressive as this first generation of cellular technology was for its day, it was based on analog signals, and it could only provide voice service.

The second generation (2G) of cellular technology emerged in 1991 as operators switched from analog to digital transmissions.[4] Analog transmissions require a continuous signal, but digital information (1s and 0s) can be compressed and packed together more efficiently. This allows more digital phone calls to occupy the same space as a single analog call.[5] Additionally, digital transmissions introduced mobile data services, such as text messaging and email.

By 2001, growth in consumer demand for mobile devices, as well as the services and applications available on them, required an evolution that could provide basic Internet service.[6] Thus, third generation (3G) systems evolved that allowed for a 70 percent increase in capacity.

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[2] James Martin, *Telecommunications and the Comptuer, 3rd ed.*, Simon & Schuster (1976, 1990), pp 629.
[3] http://www.foxnews.com/tech/2013/04/03/first-mobile-phone-call-was-placed-40-years-ago-today.html
[4] Lawrence Harte, Richard Levine, and Roman Kikta, *3G Wireless Demystified*, McGraw-Hill (2002), pp xix.
[5] https://electronics.howstuffworks.com/cell-phone5.htm
[6] Lawrence Harte, Richard Levine, and Roman Kikta, *3G Wireless Demystified*, McGraw-Hill (2002), pp xix.

3G networks were designed to use Internet Protocol that opened applications for web browsing, albeit at a basic level, at speeds of up to 2 Mbps. 3G also heralded the creation of the third generation partnership program (3GPP), an international standards setting body to create the specifications that defined 3G.[7] 3GPP still exists today as a standards setting body for subsequent generations of cellular technology.[8]

By March 2008, standards for fourth generation (4G) broadband cellular networks were devised. However, some of the standards proved unrealistic, and 4G technologies quickly converged on a new family of standards that became known as Long Term Evolution (LTE). LTE allowed carriers to advertise next-generation connectivity without necessarily having to reach the strictly defined 4G standards.[9]

LTE technology was and remains a significant improvement over previous 3G. LTE's combination with innovations in the competitive device marketplace illustrated the true value of mobile broadband for household consumers, businesses, and governments. LTE-based networks will likely remain a cornerstone of wireless connectivity even as 5G is deployed.

B. 5G's Potential to Revolutionize American Competitiveness

Spectrum can be divided into roughly three ranges of bands. First, low-band spectrum, generally up to 3 GHz, has very good propagation for coverage over large areas, but the nature of the wavelengths means it has limited capacity. Second, mid-band spectrum, generally between 3 GHz – 6 GHz, has increased capacity, but less range compared to low-band. Lastly, high-band spectrum, generally above 6 GHz, has very high capacity millimeter wavelengths, but also has very limited range.

The promise of 5G revolves around the enormously faster speeds it can provide through utilization of high-band, millimeter wave spectrum. Due to the short ranges of this spectrum, 5G will require dense networks of very small antennas, and will be able to provide enhanced mobile broadband with estimated speeds anywhere from 10 to 100 times faster than existing LTE, ultra-reliable and low-latency communication necessary to unleash benefits of vehicle-to-vehicle and vehicle-to-infrastructure communications, and massive machine-to-machine communications associated with Internet-connected devices (referred to as the "Internet of Things," or IoT).[10]

The development and deployment of 5G technology will impact virtually every industry, and the efficiencies to be gained will, in many cases, be disruptive to established practices in manufacturing, healthcare, transportation, finance, law enforcement and public safety, power generation and utilities, entertainment, and city management. A recent report noted the broader

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[7] *Ibid*, pp xx-xxi.
[8] http://www.3gpp.org/about-3gpp.
[9] https://www.digitaltrends.com/mobile/4g-vs-lte/
[10] 5G Americas, "5G Spectrum Recommendations," (April 2017), pp 2, http://www.5gamericas.org/files/9114/9324/1786/5GA_5G_Spectrum_Recommendations_2017_FINAL.pdf.

economic benefits of 5G across the economy may include 2.2 million jobs and roughly $420 billion in annual GDP.[11]

IV. ISSUES

The potential of 5G is clear, but there are challenges that must be overcome if ubiquitous deployment is to be realized. There is no limit to the capacity of our nation's telecommunications when one considers the advantages of 5G in conjunction with, and as a complement to, other technologies such as 4G LTE, coaxial cable, fiber optics, and satellites. But the challenges to the success of 5G may be generally categorized in three areas: leadership in efforts to harmonize international standards for 5G; availability of spectrum; and siting of small cell infrastructure.

First, America must lead the effort to harmonize international standards for what constitutes 5G. The United Nation's International Telecommunications Union Radiocommunication Sector (ITU-R) plays a role in the global management of radio-frequency spectrum to avoid cross-border interference and help harmonize standards necessary for international performance.[12] ITU-R organizes the World Radiocommunication Conferences (WRCs) every 3 to 4 years to review and revise the international Radio Regulations. The next WRC meeting (WRC-19) will consider spectrum bands to be identified for 5G, and is scheduled to commence on October 28, 2019.[13] [14] The Federal Communications Commission (FCC) and the Department of Commerce's National Telecommunications and Information Administration, the two federal agencies that regulate spectrum domestically, engage with the U.S. State Department through an interagency process to communicate U.S. views and proposals to the ITU. Additionally, 3GPP, a collaboration among standards-setting organization established in 1998, unites multiple standard development organizations to devise technical specifications and liaises closely with, and contributes to ITU proceedings.[15] The race to 5G is on between the U.S. and competitors in Europe and Asia. Leadership in the race to 5G presents benefits from patented technologies for American companies as much as the deployment of the technology itself for other sectors of the American economy.

Second, spectrum availability is critical to the success of 5G. Low-band, mid-band, and unlicensed spectrum will continue to be important to LTE, but high-band spectrum is crucial to realizing the benefits of 5G. At the FCC's Open Meeting held November 16, 2017, the Commission will consider a second Report and Order in its ongoing Spectrum Frontiers proceeding that would make 1.7 GHz of additional high-frequency spectrum available for

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[11] Accenture Strategy Report, "Smart Cities: How 5G Can Help Municipalities Become Vibrant Smart Cities," (2017), pp 4, https://www.accenture.com/t20170222T202102Z__w__/us-en/_acnmedia/PDF-43/Accenture-5G-Municipalities-Become-Smart-Cities.pdf.
[12] https://www.itu.int/en/ITU-R/information/Pages/mission-statement.aspx
[13] https://www.ntia.doc.gov/category/wrc-19
[14] http://www.itu.int/en/ITU-R/conferences/wrc/2019/Pages/default.aspx.
[15] http://www.3gpp.org/about-3gpp/about-3gpp.

flexible terrestrial use, as well as provide 4 GHz for core satellite use and adopt a number of service rules to promote deployment in these bands.

Lastly, analysis indicates that U.S. wireless providers are prepared to invest $275 billion over the next seven years to deploy the next-generation small cells that will make 5G a reality. This investment may be stymied by piecemeal state and local regulations spread across 3,000 counties and 20,000 incorporated places – all of which may require different regulations.[16] Telecommunications is characterized by major economies of scale, and it will be difficult to deploy small cells efficiently at scale without consistent and reasonable standards in relation to state and local siting fees, applications, and access to public rights-of-way, as well as reform to provide more flexibility to requirements under the federal National Environmental Policy Act and the National Historic Preservation Act.

V. STAFF CONTACTS

If you have any questions regarding this hearing, please contact Robin Colwell or Sean Farrell of the Committee staff at (202) 225-2927.

[16] American Consumer Institute Center for Citizen Research, "The Economimc & Consumer Benefits from 5G," pp 4, http://thelosteconomy.com/wp-content/uploads/2017/07/ACI-5G-Report-11117-2.pdf.