U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON TECHNOLOGY AND INNOVATION

HEARING CHARTER

Avoiding the Spectrum Crunch: Growing the Wireless Economy through Innovation

Wednesday, April 18, 2012
2:00 p.m. – 4:00 p.m.
2318 Rayburn House Office Building

I. Purpose

On Wednesday, April 18, 2012, the Committee on Science, Space, and Technology Subcommittee on Technology and Innovation will hold a hearing to review efforts supporting the flexible and innovative utilization of spectrum, while ensuring the continued growth of the wireless economy.

II. Witnesses

Dr. James Olthoff, Deputy Director, Physical Measurement Laboratory, National Institute of Standards and Technology

Mr. Richard Bennett, Senior Research Fellow, Information Technology and Innovation Foundation

Mr. Christopher Guttman-McCabe, Vice President, Regulatory Affairs, CTIA–The Wireless Association

Ms. Mary Brown, Director, Technology and Spectrum Policy, Cisco Systems, Inc.

Dr. Rangam Subramanian, Chief Wireless and Technology Strategist, Idaho National Laboratory

III. Background

Spectrum is a range of frequencies, divided into blocks or bands of frequencies that are "allocated" for particular services. Spectrum supports a wide variety of radio services, including public safety, defense, navigation, broadcasting, as well as both commercial and private wireless communications. These services are vital to our economy and to jobs–virtually every industry and business depends on spectrum for efficiency and competitiveness. As Thomas Power of the

National Telecommunications and Information Administration states, spectrum is "fast becoming a pillar of America's digital infrastructure."[1]

Maximizing the yield from this essential 21st century resource will create jobs, drive economic growth, and encourage innovation, and investment.[2] Since spectrum is a finite resource, the purpose of spectrum policy, law, and regulation is continuing to accommodate new services without disrupting services while providing the maximum possible benefit to the public.[3]

Spectrum is best described as a natural resource that exhibits some of the properties of what economists call an unusual "common good,"[4] because it is not destroyed by use—instead when one user stops using a portion, it can be readily used by another. However, spectrum use is limited by its scarcity because, at any given time and place, use of one portion precludes another user from using that same portion.[5] As a result of this characteristic, the use of spectrum must be regulated—with controlled access and rules for use—because unchecked use raises the possibilities of uncoordinated use and resulting interference.[6]

The use of the electromagnetic spectrum in the United States is managed using a dual organizational structure. Understanding the Federal Government's use of spectrum requires an understanding of the interplay between Federal and non-Federal use of the same spectrum. The Federal Communications Commission (FCC) manages all commercial, and state and local government spectrum use.[7] The National Telecommunications and Information Administration (NTIA) manages the Federal Government's use.[8] All spectrum allocations stem from agreements between NTIA and the FCC. In other words, there are no statutory "Federal" or "non-Federal" bands.

Federal Communications Commission (FCC)

The Federal Communications Commission (FCC) is an independent federal regulatory agency responsible directly to Congress. Established by the Communications Act of 1934, it is charged with regulating interstate and international communications by radio, television, wire, satellite, and cable. The FCC oversees the spectrum bands that facilitate the use of wireless communications by commercial interests, as well as state and local governments. The agency's spectrum goals include ensuring that all wireless operations co-exist; that public safety communications are effective; that innovative and modern services are provided to the public; and that access to spectrum results from open and transparent processes. The FCC regulates the

[1] Thomas Power, National Telecommunications and Information Administration, Remarks at the 12th Annual International Symposium on Advanced Ratio Technologies (July 28, 2011), *available at* http://www.ntia.doc.gov/speechtestimony/2011/remarks-ntia-chief-staff-thomas-power-12th-annual-isart-conference.
[2] Federal Communications Commission, Our Work, http://www.fcc.gov/our-work (last visited on April 13, 2012).
[3] CHARLES MATHIAS, SPECTRUM STRATEGY 6 (2011), *available at* www.gcatt.org/news/Mathias_Spectrum%20Strategy.pdf; LINDA K. MOORE, CONGRESSIONAL RESEARCH SERVICE, SPECTRUM POLICY IN THE AGE OF BROADBAND: ISSUES FOR CONGRESS 4 (2012).
[4] A common good meaning "[o]ther than the cost of designing, building, and operating radio stations, its use is free. Each user has no incentive to individually use the spectrum efficiently since there is no savings; and is, in fact, motivated to secure for his own use the maximum amount of spectrum. However, uncoordinated, wasteful use can easily result in everyone suffering interference, that prevents satisfactory operation, and denies access to new users." National Telecommunications and Information Administration, Basic Elements of Spectrum Management: Regulating the Use of the Spectrum, http://www.ntia.doc.gov/legacy/osmhome/roosa3.html (last visited on April 13, 2012).
[5] National Telecommunications and Information Administration, Basic Elements of Spectrum Management: Regulating the Use of the Spectrum, http://www.ntia.doc.gov/legacy/osmhome/roosa3.html (last visited on April 13, 2012).
[6] *Ibid.*.
[7] *See* 47 U.S.C. §151.
[8] *See* 47 U.S.C. §902.

use of radio frequency bands of the electromagnetic spectrum by a spectrum management process called frequency allocation. The FCC is also responsible for administering spectrum auctions, the funds from which are paid to the U.S. Treasury.

National Telecommunications and Information Administration (NTIA)

The National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce was established in 1978. The NTIA is the President's principal advisor on telecommunications and information policy issues, and in this role frequently works with other Executive Branch agencies to develop and present the Administration's position on telecommunications and information policy issues. In addition to representing the Executive Branch in both domestic and international telecommunications and information policy activities, NTIA also manages the Federal Government use of spectrum; performs cutting-edge telecommunications research and engineering, including resolving technical telecommunications issues for the Federal Government and private sector; and administers infrastructure and public telecommunications facilities grants.[9]

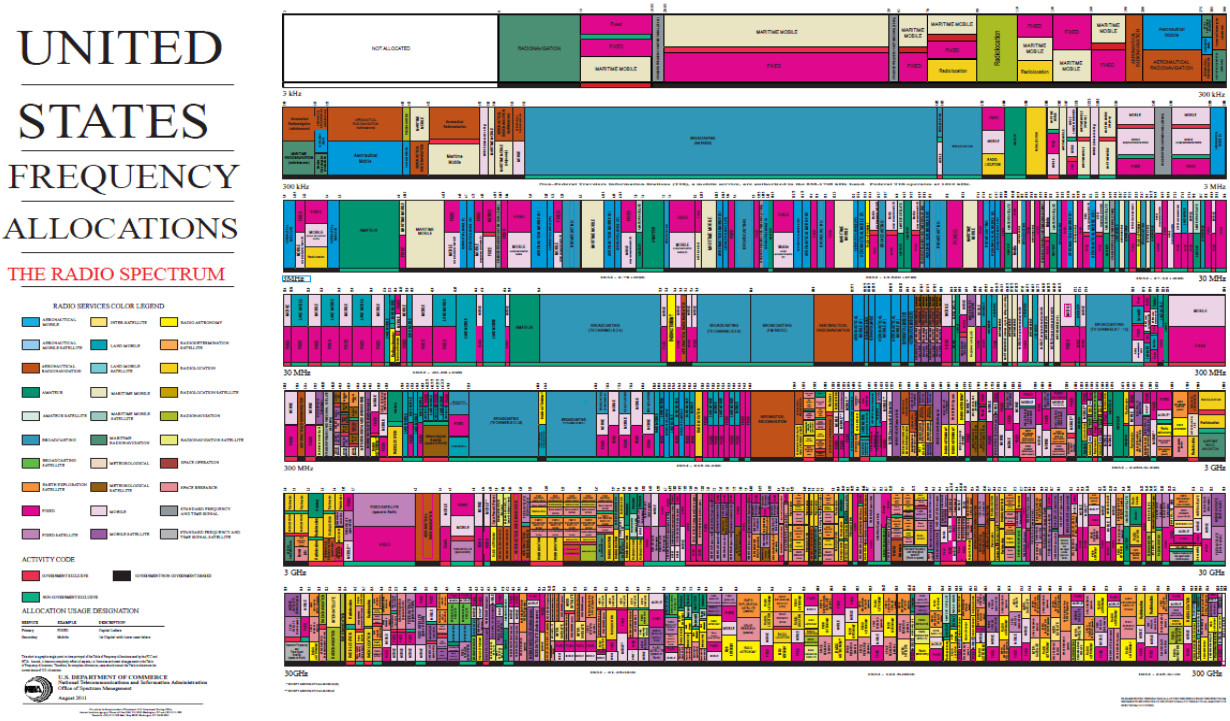

Figure 1. **The United States Frequency Allocation Chart**.
http://www.ntia.doc.gov/files/ntia/publications/spectrum_wall_chart_aug2011.pdf

Government Spectrum Usage

The Federal Government uses spectrum to provide critical public services, and seeks to deploy the most efficient technology consistent with available resources. The Department of Defense (DOD) uses a significant portion of the Federal Government spectrum for national security

[9] *See* National Telecommunications and Information Administration, About NTIA, http://www.ntia.doc.gov/about (last visited April 16, 2011).

purposes. The law enforcement agencies (e.g., Department of Homeland Security, Justice, Treasury, and Interior Departments) use spectrum for command and control of their forces, just as state and local police and fire departments do, with the exception that they must be able to operate throughout the United States. The Federal Aviation Administration uses it for safety services such as aeronautical radio navigation, precision landing systems for all weather operations, surveillance, and air/ground communications. The Department of Energy uses it to transmit power control data and commands for their dams and power grids. The National Aeronautics and Space Administration uses Federal spectrum during satellite launches for communications with satellites to collect data and command them.

In understanding the Federal Government's use of the spectrum, one must appreciate the interplay between Federal government and non-Federal government use of the same spectrum. In addition to the shared use of the same sections of spectrum for unrelated purposes, there is a substantial interface between government and non-government radio operations. Government radio facilities provide private sector ships and aircraft communications, navigation, and surveillance service; Federal law enforcement agencies have intercommunication with their state and local government counterparts; Federal electrical power systems interconnect with non-Federal power systems, both domestic and international; Civil Air Patrol stations communicate with the military, and so forth.

Public Safety

Prior to September 11, 2001, states and municipalities were largely responsible for first responders' emergency communications and providing effective response. However, long before 9/11, as radio technologies evolved, the awareness for better coordination and communications interoperability heightened.[10] Assigning spectrum for public safety wireless communications is a responsibility of the FCC; however, the ultimate decision regarding how spectrum access is to be divided has yet to be made. Some municipalities and states could develop commercial partnerships providing access to public safety spectrum in return for various resources, such as access to infrastructure or lease payments. Alternatively, the monetary value of spectrum access may be derived from commercial license auctions. Some proposals, including legislation introduced in the 112th Congress,[11] designate all or part of spectrum auction proceeds to funding public safety communications investments and operating costs. Proceeds would be deposited in a special fund, allowing grant administrators to borrow against anticipated future revenue so that grants could be provided immediately. Twice, Congress has created specials funds to receive and distribute revenue from spectrum auctions for specific purposes,[12] which departs from existing law requiring that auction proceeds be credited directly to the Treasury as income.[13]

The end of analog television broadcasting freed up some spectrum for public safety use. Public safety agencies have announced the intention to combine portions of spectrum already assigned

[10] *See* FROST & SULLIVAN, INTEROPERABLE COMMUNICATIONS FOR FIRST RESPONDERS 2 ("The challenge of interoperable communications for first responders was first addressed in 1970 when the FIRESCOPE Incident Command System was developed in Southern California as a result of a catastrophic wild fire.").
[11] S. 28 (Rockefeller), S. 1040 (Lieberman), S. 911, as amended (Rockefeller), and H.R. 607 (King).
[12] The Deficit Reduction Act of 2005 (P.L. 109-171, Title III) established the Digital Television Transition and Public Safety Fund to receive this auction revenue and use some of the proceeds for the transition to digital television, public safety communications, and other programs. The Commercial Spectrum Enhancement Act (P.L. 108-494, Title II) established a Spectrum Relocation Fund to hold the proceeds of certain spectrum auctions for the specific purpose of reimbursing federal entities for the costs of moving to new frequency assignments.
[13] 47 U.S.C. 309 (j) (8) (A)

for public safety use, known as the Public Safety Broadband License, to build a nationwide broadband network(s). The Public Safety Spectrum Trust (PSST), a not-for-profit corporation, originally granted the FCC the spectrum access that became the Public Safety Broadband License.[14]

The Middle Class Tax Relief and Job Creation Act of 2012 (P.L. 112-96) gave NTIA the new responsibility of creating and supporting a First Responder Network Authority, responsible for planning, building, and managing a new, nationwide broadband network for public safety communications. Together NTIA and the First Responder Network Authority must establish the grant program requirements for a State and Local Implementation Fund, while NTIA will determine the grant amounts for states participating in the network.

As part of this effort, the National Institute of Standards and Technology **(**NIST) will work with NTIA, the First Responder Network Authority, private industry, and public safety organizations to conduct research and develop new standards, technologies, and applications to advance public safety communications. Core components of this program will include documenting public safety requirements and driving the adoption of those requirements into the appropriate standards; developing the capability for communications between currently deployed public safety narrow band systems and the future nationwide broadband network; and establishing a roadmap that seeks to capture and address public safety's needs beyond what can be provided by the current generation of broadband technology and driving technological progress in that direction. The Middle Class Tax Relief and Job Creation Act allocates up to $300 million to NIST, dependent on the funds received from future spectrum auctions, to be spent through FY 2022.

Commercial Spectrum Usage and the "Spectrum Crunch"

There has been extreme growth in the number of active frequency authorizations at both NTIA and the FCC; at both agencies, there are twice as many assignments now as there were in 1980. As spectrum becomes more crowded, efforts to ensure that spectrum is used as efficiently as possible to maximize its availability and use by all become more urgent. Until recently, advanced technology has always kept slightly ahead of the demand for spectrum. As demand for spectrum increased, technology has developed that can perform the same function at higher unused frequencies or increase spectrum efficiency and re-use of existing frequencies. Now, as demand for spectrum is growing more rapidly, the technical advances needed to meet that demand may be "pushing the envelope" of practicality, at least in the short term.

Mobile data traffic has increased at an exponential rate over the last several years as the use of Wi-Fi networks and smart phones has proliferated. According to the Cisco Visual Networking Index Global Mobile Data Traffic Forecast, the amount of mobile data traffic more than doubled for the fourth year in a row in 2011.[15] In fact, global mobile data traffic in 2011 was more than eight times larger than *total* Internet data traffic (both mobile and non-mobile) in 2000.[16] Much

[14] *See* Public Safety Spectrum Trust, http://www.psst.org/about.jsp (last visited April 13, 2012).
[15] CISCO, Cisco Visual Networking Index (VNI) Global Mobile Data Traffic Forecast Update, 2011-2016 4 Feb. 14, 2012, *available at* http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.pdf.
[16] *Ibid*.

of this massive data growth is due to the increase of video data traffic, which accounted for over 50 percent of data traffic in 2011 for the first time.[17]

Cisco projects global mobile data traffic to grow to 10.8 exabytes per month in 2015, which would be 18 times the amount of usage in 2011.[18] Similarly, according to Cisco projections, North American mobile data traffic would increase 16.5 times from 119 petabytes per month in 2011 to 2.0 exabytes per month in 2016.

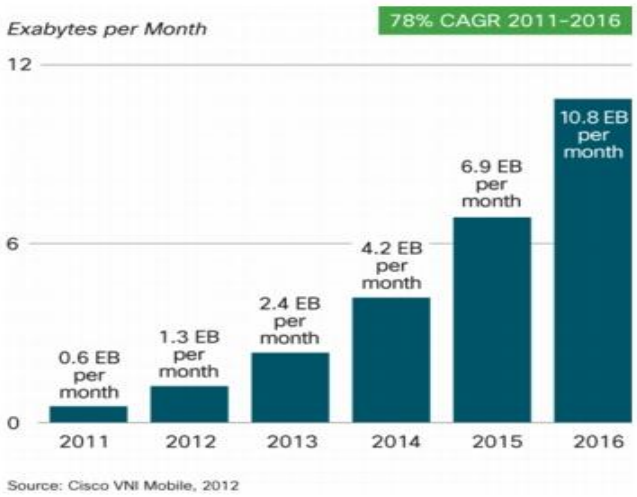

Figure 2. **Global Mobile Data Traffic, 2011 to 2016**. Image excerpted from the *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2011–2016*.
http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html

The FCC currently allocates a limited amount of spectrum for mobile broadband usage. A 2010 FCC paper projected that there would be a broadband spectrum deficit of 300 megahertz by 2014, based on an analysis of current and projected data usage.[19] This projected shortage has implications for service quality, cost, and innovation. As a result, the FCC's National Broadband Plan recommended that 500 megahertz be made available for mobile, fixed and unlicensed broadband over the next 10 years to meet projected growth in demand.[20]

[17] *Ibid*.
[18] *Ibid*.
[19] Federal Communications Commission OBI Technical Paper Series, *Mobile Broadband: The Benefits of Additional Spectrum*. October 2010.
http://transition.fcc.gov/Daily_Releases/Daily_Business/2010/db1021/DOC-302324A1.pdf.
[20] Federal Communications Commission, *National Broadband Plan, Connecting America*.
http://www.broadband.gov/plan/5-spectrum/#r5-8.

IV. Issues for Examination

Policy Challenges

Given continued growth projections and spectrum's finite nature, additional allocations of spectrum will only address the "spectrum crunch" for an indefinite period of time. Smartphone sales have eclipsed PC sales, and mobile broadband is being adopted faster than any computing platform in history. A smartphone places 24 times as much demand on spectrum as an old feature phone. A tablet device places 120 times as much demand on spectrum. According to the FCC, multiple experts agree that mobile demand for spectrum will increase more than 35 times in the next few years (3,500%).

The amount of additional spectrum needed due to the increased demand created by mobile broadband could be difficult to achieve through the auction process unless large amounts of new radio frequencies can be identified and released for that purpose. Without abandoning competitive auctions, spectrum policy could benefit from including additional ways to assign or manage spectrum that might better serve the deployment of wireless broadband and the implementation of a national broadband policy. Policies to provide additional spectrum for fixed or mobile broadband services are generally viewed as drivers that would stimulate technological innovation and economic growth. A policy that prioritizes providing spectrum to spur innovation, for example, could create new markets, new models for competition, and new competitors.

As industry leaders and policy makers seek ways to more effectively utilize spectrum, they will need to be cognizant of potential challenges as spectrum use becomes more crowded. This crowding may affect applications and services on neighboring blocks of spectrum. It may also affect the growth of unlicensed, localized spectrum use such as household Wi-Fi networks and wireless health applications. Research and development will be necessary to find ways to minimize interference among both neighboring blocks of spectrum and shared spectrum.

Research and Development

Although radio frequency spectrum is abundant, usable spectrum is currently limited by the constraints of technology. Developments in technology will be necessary to provide more lasting solutions to the spectrum crunch. At any given location or time, much of the spectrum is "unused". Research into dynamic spectrum access, or "opportunistic use," has the potential to organize wireless communications to achieve the same kinds of benefits that have been seen to accrue with the transition from proprietary data networks to the Internet. Adaptive technologies could allow communications to switch instantly among network frequencies that are not in use to maximize network performance.

In June 2010, the President issued a memorandum titled: *Unleashing the Wireless Broadband Revolution.*[21] The memorandum called upon the Secretary of Commerce to "create and implement a plan to facilitate research, development, experimentation, and testing by researchers

[21] Presidential Memorandum: Unleashing the Wireless Broadband Revolution (June 10, 2010), *available at* http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution.

to explore innovative spectrum-sharing technologies…." The National Information Technology Research and Development (NITRD) Wireless Spectrum R&D (WSRD) Senior Steering Group (SSG) was formed in response to this charge, to coordinate spectrum-related research and development activities across the Federal Government. The purpose of the WSRD SSG is two-fold: to help coordinate and inform ongoing activities across Federal agencies; and to facilitate the identification of shortcomings in the Government's R&D portfolio with respect to technologies that allow a more efficient use of spectrum.

The WSRD SSG has identified spectrum R&D activities at the following Federal agencies: the Department of Commerce, the Department of Defense (includes each military department's R&D activities, and DARPA), the Department of Energy, the Department of Homeland Security, the Department of Justice, the Federal Aviation Administration, the FCC, the NTIA, the National Aeronautics and Space Administration, and the National Science Foundation. Research focus areas include dynamic mechanisms to share spectrum; wireless test beds; simulation tools relevant to spectrum efficiency, access, and sharing; systems and models to transition from legacy architectures to new spectrum sharing architectures; hardware, protocols, and policy; and research into the security of spectrum-sharing technologies.

The WSRD SSG has highlighted the importance of coordinating Federal spectrum R&D with private industry, and works with academia and the private sector to help develop priorities, encourage private investment, and develop public/private partnerships when appropriate.