

CREATING OPPORTUNITIES THROUGH IMPROVED GOVERNMENT SPECTRUM EFFICIENCY

HEARING BEFORE THE SUBCOMMITTEE ON COMMUNICATIONS AND TECHNOLOGY OF THE COMMITTEE ON ENERGY AND COMMERCE HOUSE OF REPRESENTATIVES ONE HUNDRED TWELFTH CONGRESS

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CREATING OPPORTUNITIES THROUGH IMPROVED GOVERNMENT SPECTRUM EFFICIENCY

THURSDAY, SEPTEMBER 12, 2012

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON COMMUNICATIONS AND TECHNOLOGY,
COMMITTEE ON ENERGY AND COMMERCE,
Washington, DC.

The subcommittee met, pursuant to call, at 10:16 a.m., in room 2123 of the Rayburn House Office Building, Hon. Greg Walden (chairman of the subcommittee) presiding.

Members present: Representatives Walden, Terry, Stearns, Shimkus, Bono Mack, Blackburn, Bilbray, Bass, Gingrey, Scalise, Latta, Guthrie, Kinzinger, Barton, Eshoo, Markey, Matsui, Barrow, Christensen, DeGette, and Waxman (ex officio).

Staff present: Gary Andres, Staff Director; Ray Baum, Senior Policy Advisor/Director of Coalitions; Andy Duberstein, Deputy Press Secretary; Neil Fried, Chief Counsel, Communications and Technology; Debbie Keller, Press Secretary; Alexa Marrero, Deputy Staff Director; David Redl, Counsel, Communications and Technology; Charlotte Savercool, Executive Assistant; Lyn Walker, Coordinator, Admin/Human Resources; Shawn Chang, Democratic Senior Counsel; Margaret McCarthy, Democratic Professional Staff Member; Roger Sherman, Democratic Chief Counsel; David Strickland, Democratic FCC Detailee; and Kara Van Stralen, Democratic Special Assistant.

OPENING STATEMENT OF HON. GREG WALDEN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OREGON

Mr. WALDEN. If everybody would please take their seats, we will get started here.

Good morning, and welcome to our hearing on creating opportunities to increase government spectrum efficiency. I welcome our witnesses and appreciate their counsel as we examine ways to increase government spectrum efficiency and satisfy American consumers' growing demand for wireless broadband services. I am convinced we can create new jobs from our work and bring innovation and efficiency to the Federal Government.

In the months since the Congress passed the Middle Class Tax Relief and Job Creation Act, including the spectrum incentive auction provisions this subcommittee brought to the table, we have turned our attention to Federal Government usage of spectrum. In coordination with Representative Eshoo, I appointed a working

group led by Brett Guthrie and Doris Matsui, and asked them to examine in depth how the government uses its spectrum. Our goal is to create more jobs by freeing up spectrum to meet demand and spur innovation in America. It is also our goal to bring innovation and spectrum efficiency to the government users.

One way we can create additional spectrum opportunities is through use of the Commercial Spectrum Enhancement Act. As you know, under the CSEA, commercial providers bear the cost of moving Federal incumbents to clear spectrum. Given the budgetary pressures facing the country, and the potential for sequestration to pose significant challenges, especially to our defense agencies, we have an opportunity to work together to optimize the value of underutilized spectrum and upgrade equipment and services used by our Federal agencies.

The best example of this process is the 2006 AWS-1 auction, which made 90 megahertz of spectrum available for wireless broadband and raised more than \$13.7 billion for the Treasury.

The President's Council of Advisors on Science and Technology, affectionately known as PCAST, has provided us with one view of how to create spectrum opportunities in Federal bands. Rather than look to ways to increase the efficiency of the government users, however, the recently released PCAST report assumes that it would cost too much and take too long to move most Federal systems. Instead, the report recommends that commercial providers operate around government systems and share spectrum. The concept of sharing is not new, and is certainly worth continued exploration. Sharing technologies and the underlying business models, however, are not sufficiently developed to make it the entire focus of our spectrum strategy nor to supplant clearing.

Spectrum sharing may hold potential in the future for some spectrum bands where clearing is impossible or we have certainty that the cost of relocation exceeds the value of that spectrum. I am not ready to accept the opinion that "the norm for spectrum use should be sharing" today. That is simply not good enough.

I am also concerned about the conclusion which appears based, at least in part, on a recent NTIA report concluding that it would cost \$18 billion and take 10 years to clear the Federal Government from the 1.7 gigahertz band. The NTIA has admitted, however, that it did not conduct an independent analysis to reach those estimates. Instead, the NTIA compiled estimates from the Federal users. As the GAO's written testimony for today's hearing indicates, we need more rigorous analysis before giving up on clearing spectrum and working to maximize efficiency in how the government uses that spectrum.

I appreciate our witnesses' testimony today. You are all very talented individuals who really help us in our work, and we appreciate what you are bringing to the table. I am particularly pleased to see Major General Wheeler with us today, as NTIA's preliminary responses to a letter from our government spectrum working group indicate that the Department of Defense is the largest government user of spectrum, with just under 90 percent of the ground-based assignments and over 99 percent of the airborne use of government spectrum below 3.1 gigahertz. Government systems can and should be comprised of the most efficient and technologically advanced

products available. We appreciate the work you have given to our working group, and to this committee.

Working together, I think we must increase efficiency, upgrade government systems, and make spectrum available to meet our country's wireless broadband demand.

[The prepared statement of Mr. Walden follows:]

Opening Statement of the Honorable Greg Walden
Subcommittee on Communications and Technology
Hearing on "Creating Opportunities through Improved
Government Spectrum Efficiency"
September 13, 2012
(As Prepared for Delivery)

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Working together we must increase efficiency, upgrade government systems, and make spectrum available to meet our country's wireless broadband demand.

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Mr. WALDEN. And with that, I would yield the balance of my time to the vice chairman of the subcommittee, Mr. Terry, for additional comments.

OPENING STATEMENT OF HON. LEE TERRY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEBRASKA

Mr. TERRY. Thank you, Mr. Chairman. I just want to thank you for holding this hearing and this series on how we are able to more efficiently use our spectrum. This time, the issue is spectrum efficiency and discussions about Department of Defense spectrum, and whether it is best used in a variety of different ways by allowing access to it by either having full power over it or shared to the private sector, and as consumers continue to demand more spectrum or access to spectrum.

Now, I also—just in my balance, General Wheeler, I represent Stratcom, a big user of the communication system and the spectrum, and so I probably have more of a nuanced position in making sure that we protect those assets for our military, at the same time, making sure that we do use the spectrum most efficiently.

And I yield back.

Mr. WALDEN. Gentleman yields back the balance of his time. I now recognize my friend from California, Ms. Eshoo, for her opening statement, and thank her for her work on the working group.

OPENING STATEMENT OF HON. ANNA G. ESHOO, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Ms. ESHOO. Thank you, Mr. Chairman, and good morning to all of the witnesses. We thank you for being here. This is a very distinguished panel. To Major General Wheeler, I think that this may be a first. I don't ever recall in my service on this subcommittee where we had the DoD testifying relative to telecommunications and spectrum. So this is an important hearing, and I think we are all going to draw a great deal from your testimony.

To advance a 21st century spectrum policy, I think we have to think outside of the box. With data traffic on mobile service provider networks expected to increase 18 times from 2011 to 2016, we have to, I think, also move quickly, while we, of course, consider both clearing and sharing to most efficiently use this scarce resource. I don't see this as an either/or situation. I think that they are complimentary.

Through the passage of legislation authorizing voluntary incentive spectrum auctions, our subcommittee took an important step toward achieving the President's goal of freeing up 500 megahertz of spectrum for expanded wireless broadband service. But our work is not complete, as evidenced by NTIA's report on the 1755 megahertz band, as well as the recently adopted report by the President's Council of Advisors on Science and Technology, as the chairman said we affectionately call PCAST.

Today, I would like to offer three observations that I believe are necessary to achieve our vision of a 21st century spectrum policy.

First, there is a simple reality that Federal agencies do not have the same financial incentive as commercial wireless providers to efficiently use the spectrum they hold. The PCAST report wisely pro-

poses the concept of spectrum currency, because it does have enormous currency—it is gold—an accounting, an allocation, and an incentive system that would encourage Federal agencies to relinquish or share more of their spectrum.

Second, we need greater investment in R&D. The use of database technology as well as automatic wifi switches, small cell technology, and cognitive radio can be part of the solution, making more efficient use of spectrum and even increasing the usability of spectrum above 2 gigahertz.

Finally, increased communication between the Federal Government and commercial wireless providers will promote greater collaboration and a mutual understanding of each other's needs. I don't think that has really taken place. I am encouraged by recent industry testing that explores the feasibility of sharing spectrum between Federal and commercial users in the 1755–1780 megahertz band. Embracing these concepts will support a growing base of mobile users with the bandwidth needed to drive the next generation of mobile applications and services.

I think that this is an opportunity for us to plan our spectrum future, and to keep America number one in this, and I think that is the goal for all of the members of the entire subcommittee.

I now would like to yield the balance of my time to Congresswoman Matsui, who has done, I think—really made wonderful contributions to the working group with Mr. Guthrie, and also has offered legislation with Mr. Stearns on this very subject matter.

OPENING STATEMENT OF HON. DORIS O. MATSUI, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Ms. MATSUI. Thank you very much, Ranking Member Eshoo, for yielding me time, and I want to thank the chairman for holding this hearing today. I want to join in welcoming our witnesses here today.

You know, over the last several months the spectrum working group has conducted a series of productive meeting with government and industry stakeholders, and I do believe that DOD, NTIA, and the FCC understand the urgency that they must reevaluate underutilized government spectrum holdings. There could be viable opportunities for both spectrum clearing and sharing to meet the short-term and long-term demands for a digital economy, all while protecting our national security interests.

It is my hope that today's panel will provide clear answers on which spectrum bands can be cleared below 3 gigahertz, and as a practical manner, which bands or areas would be ideal for sharing above 3 gigahertz. In addition, I am also interested in hearing from our panelists about how we can move forward in the short-term on repurposing the 1755 to 1850 bands, especially the lower megahertz between the 1755 and 1780 bands. I am also interested in hearing new ideas on incentivizing government agencies to relocate, including PCAST recommendations on spectrum currency.

The CSMAC process should have the full involvement of all sides. The government needs to talk to industry and vice versa. The process must not be a one-way street. The industry testing ef-

fort by T-Mobile, Verizon, and AT&T will also provide valuable insight and hopefully answer some important questions.

I do look forward to working with my colleagues and all stakeholders moving forward. I yield back the balance of my time.

Mr. WALDEN. The gentlelady yields back the balance of her time. The Chair now recognizes the former chairman of this subcommittee, Mr. Stearns, for his comments.

OPENING STATEMENT OF HON. CLIFF STEARNS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA

Mr. STEARNS. Thank you, Mr. Chairman. In February, I think all of us realized after a year of hearings and discussions which affected all the stakeholders, we passed important legislation that will result in a new—in a number of new spectrum auctions. Obviously, however, our work is not done. We must ensure that all spectrum users are using their spectrum as efficiently as possible, including the Federal Government. Examining spectrum that could be reallocated from government agencies and commercially auctioned could open money-raising opportunities to offset the upcoming sequestration.

As my colleague, Congresswoman Matsui, has indicated, I encourage my colleagues to take a serious look at the bill that she and I introduced, which is H.R. 4817, earlier this year. I believe spectrum sharing should be explored as part of a long-term solution. We simply, my colleagues, do not have the technology for such sharing available today is my understanding, and it is unclear what business models would sustain them if we used it. So I believe that sharing should not be considered simply as a substitution for clearing. I appreciate, Mr. Chairman, this subcommittee's continuing focus on spectrum. It is extremely important for innovation, productivity, and the future of this country.

And so I look forward to hearing from our witnesses today.

Mr. WALDEN. Thank the gentleman for his testimony. I now recognize the gentlelady from California who has been a real leader on our telecom issues, Ms. Bono Mack.

OPENING STATEMENT OF HON. MARY BONO MACK, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mrs. BONO MACK. Thank you, Mr. Chairman. Yesterday in my own subcommittee, the Subcommittee on Commerce, Manufacturing, and Trade, we took a hard look at growth in the app economy. Mr. Chairman, the sector is booming. Today, an estimated 90 million U.S. consumers spend about 60 minutes each day accessing the Internet with smartphones, while another 24 million people spend 75 minutes a day using the Internet on their tablets. If you haven't heard business leaders talk about the importance of mobile to their future, then you haven't been listening very closely. But what drives all of this growth? You guessed it, spectrum, and we need more of it.

Today we are examining Federal uses of spectrum. Unfortunately, the administration seems willing to settle only for spectrum sharing, and in my opinion, has based that strategy on an incom-

plete analysis. Spectrum sharing is an important piece of the puzzle, but by no means the only solution.

So I look forward to hearing from all of our witnesses today. I especially welcome Dr. Marshall, who is a fellow Trojan, working at USC, and I know we might not agree on all the issues, but we do agree that we are hoping for a big year out of Matt Barkley and the USC Trojans, and sorry, Mr. Chairman——

Mr. WALDEN. The gentlelady yields back her time.

Mrs. BONO MACK [continuing]. Your Ducks, you know——

Mr. WALDEN. We have done all right.

Mrs. BONO MACK. Yes.

Mr. WALDEN. We have done all right. Rose Bowl, yes.

Ms. Blackburn, we recognize you now.

OPENING STATEMENT OF HON. MARSHA BLACKBURN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF TENNESSEE

Mrs. BLACKBURN. I thank you, and I want to welcome our witnesses. We do appreciate that you are here, because we all agree that we are going to face a spectrum shortage or a spectrum crisis. Chairman Bono Mack referenced the hearing that we did yesterday that dealt with the app economy. We know what is coming toward us, what innovators are bringing to the marketplace very soon.

Now, one of the things we will want to explore today is the PCAST report, and then the GAO report, and the differences in these two. I think we can all agree that these two reports were not compatible when it comes to meeting consumer expectations of what is going to be there for their use and available spectrum.

So welcome to all, and I yield back my time.

Mr. WALDEN. Gentlelady yields back. Anyone else on our side who wants to make a comment? If not, we will return the balance of the time and I now recognize the chairman emeritus, Mr. Waxman, for an opening statement.

OPENING STATEMENT OF HON. HENRY A. WAXMAN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. WAXMAN. Thank you very much, Chairman Walden, for holding this timely hearing on the role of the Federal Government and how we can play a part in easing our Nation's anticipated spectrum crunch.

Since April, members of the bipartisan Federal spectrum working group led by Representatives Matsui and Guthrie have met with Federal agencies and industry stakeholders to explore opportunities for maximizing Federal spectrum efficiency. Today's hearing provides an opportunity for the entire subcommittee to discuss these issues.

I believe the administration is appropriately pursuing an all of the above approach to make more spectrum available for commercial mobile services. In 2010, the President called for 500 megahertz of spectrum to be made available for mobile broadband. Since then, the administration has already identified and begun freeing up over 400 megahertz of spectrum currently occupied by Federal users.

With the administration's support, this committee has taken action as well to increase available spectrum. Working on a bipartisan basis, we passed legislation that authorizes the first ever incentive auctions. Experts believe the new auction mechanism could clear up to 120 megahertz of underutilized broadcast television spectrum for commercial broadband services.

In preparation for this hearing, our staff spoke with several companies in the wireless industry to discuss options for utilizing Federal spectrum better. I am pleased to hear that these companies report that there has been an unprecedented level of cooperation between Federal and commercial stakeholders. In fact, one company told our staff that Federal agencies have shared more information in the last 2 months than in the previous 10 years. This collaborative process must continue if we are to meet our shared goal for greater spectrum availability.

Many individual have contributed to the progress we are making, and I want to commend Mr. Nebbia, Major General Wheeler, Mr. Sharkey, and the other members of the Commercial Spectrum Management Advisory Committee for their coordinated efforts to make more spectrum available, to fuel wireless innovation, and economic growth. I also want to commend efforts by members of the President's Council of Advisors on Science and Technology in authoring a forward thinking report focused on spectrum sharing as a way to improve the use of underutilized Federal spectrum. Given the looming spectrum crunch, I agree that we cannot afford to take any options off the table. Spectrum sharing is an innovative concept that should be part of a multi-prong strategy going forward, and I look forward to hearing from Dr. Marshall on the work of PCAST.

When Congress passed the Middle Class Tax Relief and Job Creation Act of 2012, they made significant changes to the Federal relocation process that created new incentives to encourage agencies to participate in the clearing or sharing of spectrum. Today, we should explore whether there may be additional incentives that would encourage Federal users to relinquish more underutilized spectrum. This could be a winning proposition for both the commercial and public sectors. Properly crafted incentives can give Federal users better tools to help fulfill their missions and ensure our Nation's long-term spectrum needs are met.

Mr. Chairman, I thank you for this time and I want to yield the balance of time that's been allocated to me to Mr. Barrow.

OPENING STATEMENT OF HON. JOHN BARROW, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF GEORGIA

Mr. BARROW. I thank the gentleman for yielding.

Mr. Chairman, today we tackle the important issue of how to use government spectrum more efficiently and how to create new opportunities that serve our national interest through improved efficiency.

As technology advances, broadband spectrum becomes more and more essential to everything we do in our daily lives. Given that our spectrum resources are limited, it is essential that we identify areas where spectrum isn't being used so well and make it available to those who can put it to higher and better use. For the past

4 months, I have had the privilege of working with the bipartisan Federal spectrum working group on a constructed examination of how we can use the Nation's airwaves better. I look forward to hearing our panelists' perspectives on spectrum clearing and spectrum sharing, and working on a common sense strategy to free up spectrum to meet demand before we reach a spectrum crisis.

I thank Mr. Waxman for the time, and I yield back.

Mr. WALDEN. Gentleman yields back the balance of his time. I think we have had our opening statements from both sides, so we will now proceed with the hearing and our witnesses. We thank you again for your work in preparing your statements and assisting our committee in its work.

We will start with Mr. Mark Goldstein—I am sorry, Mr. Karl Nebbia. We will start at that end. Associate Administrator, Office of Spectrum Management, National Telecommunications and Information Administration. So Mr. Nebbia, we appreciate your being here today. Pull that microphone close and turn it on, and you are on.

STATEMENTS OF KARL NEBBIA, ASSOCIATE ADMINISTRATOR, OFFICE OF SPECTRUM MANAGEMENT, NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION, DEPARTMENT OF COMMERCE; MAJOR GENERAL ROBERT E. WHEELER, USAF, DEPUTY CHIEF INFORMATION OFFICER FOR COMMAND, CONTROL, COMMUNICATIONS, AND COMPUTERS (C4) AND INFORMATION INFRASTRUCTURE, DEPARTMENT OF DEFENSE; MARK L. GOLDSTEIN, DIRECTOR, PHYSICAL INFRASTRUCTURE ISSUES, GOVERNMENT ACCOUNTABILITY OFFICE; DOUGLAS C. SMITH, PRESIDENT AND CHIEF EXECUTIVE OFFICER, OCEUS NETWORKS; PRESTON MARSHALL, DEPUTY DIRECTOR, INFORMATION SCIENCES INSTITUTE, VITERBI SCHOOL OF ENGINEERING, UNIVERSITY OF SOUTHERN CALIFORNIA; MARK RACEK, DIRECTOR, GLOBAL SPECTRUM POLICY, ERICSSON, INC.; AND STEVE B. SHARKEY, DIRECTOR, CHIEF ENGINEERING AND TECHNOLOGY POLICY, T-MOBILE USA, INC.

STATEMENT OF KARL NEBBIA

Mr. NEBBIA. Chairman Walden, Ranking Member Eshoo, and members of the subcommittee, thank you for the opportunity to testify on behalf of NTIA, the President's principle advisor on telecommunications and information policy, and manager of Federal use of the radio spectrum. As Associate Administrator for NTIA's Office of Spectrum Management, I oversee frequency assignment, engineering, planning, and policy activities. It has been my privilege to work along side NTIA's staff, Federal spectrum managers, our FCC counterparts, industry representatives, and your staff.

Spectrum—it cannot be overstated the importance of spectrum to our Nation. Increasing commercial use of broadband is transforming business, healthcare, government, and public safety. PCAST estimated that increasing spectrum for wireless broadband could yield benefits of over \$1 trillion, and create millions of American jobs.

Spectrum also supports vital agency missions. Federal radio systems have supported the war on terror, including helping to elimi-

nate Osama bin Laden. Weather satellites project hurricane paths, helping Americans prepare. Air traffic systems ensure that the American public fly safely. These safety and security systems provide the underlying framework that allows our society to thrive. Federal systems also put Neil Armstrong on the Moon, and more recently set curiosity to work on Mars.

In June, 2010, the President directed that an additional 500 megahertz be made available for wireless broadband by 2020. NTIA and other Federal agencies working in collaboration with the FCC, OMB, and OSTP have explored options and priorities. By November, 2010, NTIA recommended relocating, reallocating 115 megahertz of the 1695 to 1710 and 3550 to 3650 bands. NTIA and the other agencies then pressed forward to evaluate the 1755–1850 band. Federal uses include military tactical radio, law enforcement surveillance, drone control, air combat training systems, air nautical telemetry, and satellite control, among others. They all share that spectrum. Spectrum to which to relocate these systems is dwindling, as many operations actually require characteristics best suited for the spectrum beach front.

In March, 2012, NTIA reported that the full 95 megahertz could be repurposed once certain challenges are overcome, and based on estimates from 20 agencies with over 3,100 frequency assignments in the band, the report projected that clearing users would take at least 10 years and cost approximately \$18 billion. While the cost and time estimates are preliminary, relocating every system will be costly and take a long time.

Therefore, NTIA is pursuing a new path to make this band available faster and at lower cost than under a relocation-only process. Such an approach relies on relocating Federal users where feasible and affordable, and sharing spectrum where practical.

A critical component of this approach is to bring industry and government together to work collaboratively. In using our Spectrum Management Advisory Committee, NTIA organized groups of industry and government experts and by accounting for each Federal system, along with innovation and commercial technology, these groups can tailor and determine the best approach. In many cases, we expect recommendations for traditional relocation or geographic sharing. In others, we would expect that they approach a third option, that is, the possibility that commercial and Federal users can share frequencies through spectrum availability and technical flexibility. Sharing this spectrum could allow for more efficient use, matching intermittent or localized government use with other uses, and may reduce the uncertainties and disruptions that result from the constant threat of relocating in the future. We expect the findings of these groups in early 2013.

In support of this effort, NTIA and Federal agencies are working with Mr. Sharkey at T-Mobile and other carriers to perform measurements, while Verizon has committed \$5 million to test sharing approaches. NTIA is also evaluating 195 megahertz in the 5 gigahertz range for unlicensed wifi devices that enable service providers to offload traffic. In October, NTIA will complete a study identifying the risks as required by the Middle Class Tax Relief Act. Further collaborative work with industry will be required to

understand what technology approach will yield the best results, and safeguard Federal missions.

I want to thank the subcommittee for your efforts and support to improve the Commercial Spectrum Enhancement Act, allowing agencies to recover costs for planning, sharing, equipment upgrades, and moving to non-spectrum technology or commercial services where possible. Other provisions support the transparency and effectiveness of the auction preparation process and band transition, and NTIA has begun to implement these provisions. NTIA and the Federal agencies have made substantial progress and are currently close to meeting the President's goal. Our work on the Federal side has already recommended or is currently working on as much as 405 total megahertz, while safeguarding Federal operations, minimizing the cost and making spectrum available quickly.

We look forward to the successful incentive auctions by the FCC, and other initiatives to improve access to nonfederal spectrum. I welcome your questions.

[The prepared statement of Mr. Nebbia follows:]

**Testimony of
Mr. Karl Nebbia
Associate Administrator, Office of Spectrum Management
National Telecommunications and Information Administration
U.S. Department of Commerce**

**Before the
Subcommittee on Communications and Technology
Committee on Energy and Commerce
United States House of Representatives**

**Hearing on
“Creating Opportunities through Improved Government Spectrum Efficiency”
September 13, 2012**

I. Introduction

Chairman Walden, Ranking Member Eshoo, and Members of the Subcommittee, thank you for the opportunity to testify on behalf of the National Telecommunications and Information Administration (NTIA) regarding federal agencies’ use of spectrum. NTIA, an agency within the Department of Commerce, is the President’s principal advisor on telecommunications and information policy matters and manages the federal agencies’ use of radio spectrum.

As Associate Administrator for NTIA’s Office of Spectrum Management, I oversee NTIA’s federal spectrum management operations, including all frequency assignment, engineering, and spectrum planning and policy functions. It is a privilege to serve in this capacity and I am pleased to appear today to discuss federal use of the radio spectrum and NTIA’s substantial and multi-pronged efforts to identify spectrum for wireless broadband use while ensuring the ability of federal agencies to fulfill their challenging missions.

II. Moving Forward to Make Additional Spectrum Available for Commercial Broadband Use

It is hard to overstate the importance of radio frequency spectrum to our nation's economy and its impact on virtually every aspect of our society. Increasing commercial use of wireless spectrum for broadband is transforming multiple areas of the U.S. economy, including small businesses creation, productivity, employment, consumer welfare, health care, government services, and public safety. Research studies suggest that increased investment in new wireless broadband networks will boost national income,¹ significantly expand GDP growth,² and create hundreds of thousands of new jobs.³ A study commissioned by CTIA (the wireless industry trade association) estimated that the productivity gains from wireless broadband adoption result in nearly \$100 billion in annual cost savings in the United States.⁴ Recently, an expert working group of the President's Council of Advisors on Science and Technology (PCAST) – ably represented here today by Dr. Marshall – estimated that increasing the availability of spectrum for wireless broadband could yield social benefits of over \$1 trillion and create millions of American jobs over many years.⁵

¹ See, e.g., Pearce, Alan and Pagano, Michael, *Accelerated Wireless Broadband Infrastructure Deployment: The Impact on GDP and Employment*, Media Law and Policy, (2009), available at: http://www.nyls.edu/user_files/1/3/4/30/84/187/245/Pearce%20&%20Pagano.%20SPRING%202009%20&%20Pagano.%2018%20MEDIA%20L.%20&%20POL%E2%80%99Y.pdf.

² Deloitte Development, LLC, *The impact of 4G technology on commercial interactions, economic growth, and U.S. competitiveness* (Aug. 2011), available at: http://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/TMT_us_tmt/us_tmt_impactof4g_edited060612.pdf.

³ See, e.g., Crandall, R. and Singer, H., *The Economic Impact of Broadband Investment*, (Feb. 23, 2010), released by the Broadband for America coalition, available at: <http://www.ncta.com/DocumentBinary.aspx?id=880>; See also, Sosa, D. and M. Van Audenrode, *Private Sector Investment and Employment Impacts of Reassigning Spectrum to Mobile Broadband in the United States*, Analysis Group, Inc. (Aug. 2011).

⁴ Entner, Roger, *The Increasingly Important Impact of Wireless Broadband Technology and Services on the U.S. Economy* (2008), available at: http://files.ctia.org/pdf/Final_OvumEconomicImpact_Report_5_21_08.pdf.

⁵ "Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth," Report to the President by the President's Council of Advisors on Science and Technology (July 2012), at http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf.

Spectrum is vital to enabling federal agencies to perform their essential missions, as it supports national security, critical defense operations, law enforcement, homeland security, transportation safety, scientific research, environmental monitoring, power marketing and weather prediction. As set forth more fully in General Wheeler's testimony, federal radio and radar systems have been indispensable to fighting the war on terror, eliminating Osama Bin Laden and preparing for future threats and military conflicts. Weather radar and satellite communications systems are critical to our ability to accurately project and monitor hurricanes and to help our citizens to prepare for weather emergencies. Air traffic control radar and radio systems are vital to ensuring that the American public flies safely, supporting an ever-improving flight safety record in the face of an increasing number of flights. Federal radio communications helped put Neil Armstrong on the moon and, more recently, set Curiosity to work on Mars.

Recognizing the importance of jumpstarting additional investment in wireless broadband, the President has taken decisive action to ensure that American businesses and entrepreneurs could continue to meet the skyrocketing demand. In June 2010, the President directed the Department of Commerce, working through NTIA, to collaborate with the Federal Communications Commission (FCC) to make available an additional 500 megahertz of spectrum for commercial wireless broadband use by 2020.⁶ Since then, NTIA and other federal agencies have had our noses to the grindstone, determined to find the spectrum necessary to make these economic, technological and societal benefits a reality. In particular, we have been working closely with federal and non-federal stakeholders to explore all options for making additional spectrum available to commercial providers, licensed and unlicensed uses, clearing bands

⁶ Memorandum for the Heads of Executive Departments and Agencies, *Unleashing the Wireless Broadband Revolution* (Jun. 28, 2010), available at: <http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution>.

currently used by federal agencies, and sharing spectrum where technology and other factors permit.

In November 2010, soon after receiving the President's assignment, NTIA identified 2,200 megahertz of spectrum for evaluation. We have since added another 195 megahertz in the 5 GHz range to this list of candidate bands. Also in 2010, NTIA led an interagency "fast track" evaluation of certain bands that could be reallocated without requiring relocation of federal systems and recommended reallocating 115 megahertz in the 1695-1710 MHz and 3550-3650 MHz bands for wireless broadband use on a shared basis.⁷

As the FCC undertook its responsibility of determining how and when to make that 115 megahertz available, NTIA and the other agencies pressed forward to take on the substantial challenge of evaluating the 95 megahertz in the 1755-1850 MHz band, recognizing that the lower 25 megahertz is the most appealing to commercial carriers. With current federal uses in that band ranging from point-to-point microwave to covert law enforcement surveillance, drone control, and air combat training systems – where radio antennae are literally conformed to the skin of the aircraft – the critical and complex missions performed by federal agencies in the 1755-1850 MHz band have required systems of greater and greater sophistication and have increased the agencies' own needs for spectrum. The opportunities to find spectrum in which to relocate federal operations are dwindling rapidly as many of these missions, especially airborne systems, require high mobility, small size and, in some cases, the ability to access the spectrum internationally.

⁷ National Telecommunications and Information Administration, *Plan and Timetable to Make Available 500 MHz of Spectrum for Wireless Broadband* (Nov. 15, 2010), available at: http://www.ntia.doc.gov/reports/2010/TenYearPlan_11152010.pdf.

In a report to the President in March 2012, NTIA determined that the full 95 megahertz of this prime spectrum band could be repurposed for wireless broadband use once certain critical challenges are overcome.⁸ Based on preliminary estimates from the 20 agencies that have more than 3,100 individual frequency assignments in this band, this report projected that completely clearing all of these federal users would take at least ten years and cost approximately \$18 billion. Together with our agency partners, we concluded that the best and most fiscally responsible, long-term approach to this band is to evaluate the entire 95 megahertz of the band, and not some smaller portion, because many federal systems require access across the entire band to carry out their missions. Furthermore, reaching the goal of 500 megahertz will require larger steps. The extraordinary cost and time estimates identified in the report, while preliminary, compel us to explore a broader, more innovative, more aggressive approach to making the band, or some substantial portion thereof, available for commercial broadband use.

III. Spectrum Sharing, Combined with Traditional Relocation, Will Help Address Spectrum Needs

In light of the significant challenges in repurposing the 1755-1850 MHz band, NTIA is pursuing, with our industry and federal agency stakeholders, a new and innovative path forward that could allow us to make this band available faster and at a lower cost than would be possible under a traditional, relocation-only process, while still protecting critical federal missions. Such an approach relies on a combination of relocating federal users where feasible and affordable, and sharing spectrum between federal agencies and commercial users where possible and practical. By accounting for the unique requirements of each federal mission, along with recent

⁸ National Telecommunications and Information Administration, *An Assessment of the Viability of Accommodating Wireless Broadband in the 1755 – 1850 MHz Band* (March 27, 2012), available at: http://www.ntia.doc.gov/files/ntia/publications/ntia_1755_1850_mhz_report_march2012.pdf.

innovation in commercial technology, a tailored approach that employs a combination of relocation and sharing may provide the best way to achieve: (1) faster entry by commercial services; (2) substantially lower costs for the taxpayer; (3) more available spectrum due to efficiencies; and (4) greater innovation in the wireless marketplace.

Today, NTIA is fully engaged to make this happen. NTIA's Commerce Spectrum Management Advisory Committee (CSMAC) has organized several working groups, made up of experts from industry and government – an example of the public/private cooperation this Administration has favored – to evaluate all the different federal uses and the prospective commercial technology and to determine the fastest, most cost-effective way forward to allow commercial broadband access. In many cases, we expect that traditional relocation will be the CSMAC's recommendation. Systems such as point-to-point microwave circuits, for example, are relatively straightforward to move. Within this band, these are among the least costly systems to relocate, as both the necessary equipment and alternative spectrum is available. In other cases, such as federal satellite earth stations, the working groups are evaluating how to better define geographic protection and coordination zones as a way of allowing commercial access in large parts of the country. It is not possible to relocate these critical satellite control links to new bands in the near future because they support satellites already launched.

In addition to the relocation and geographic sharing options, the CSMAC working groups are considering a third option – the possibility that commercial users and the federal agencies can have access to the same frequencies in the same geographic areas through greater spectrum availability and the use of today's new commercial technologies, which possess flexibility, agility and growing acceptance by international standards development organizations such as the 3rd Generation Partnership Project (3GPP). While significant technical and policy challenges lie ahead, sharing would allow for more efficient use of this spectrum, could match intermittent

government use with other valuable uses, and may reduce the uncertainties and disruptions to agency missions that result from the constant threat of relocating again in the future. The CSMAC working groups are currently hard at work analyzing the available information, and we expect to receive these findings in early 2013. We very much appreciate the working group members' service and active participation.

Another example of the collaboration among federal and non-federal entities to find win-win solutions for the nation's spectrum needs can be seen in NTIA and the Defense Department's (DOD) support of the wireless industry's monitoring, analysis and testing efforts. T-Mobile USA, on behalf of the wireless industry, recently received experimental authorization from the FCC to engage in a pilot program to test sharing approaches to determine the feasibility of sharing the 1755-1850 MHz band with select categories of DoD systems. Additionally, Verizon has committed \$5 million to further testing of spectrum sharing approaches. NTIA strongly supports these types of collaborative efforts between federal agencies, the wireless industry and other wireless technology innovators. They are critical to driving this process forward, as quickly as we can, toward successful outcomes for all stakeholders.

The combined efforts of NTIA, federal agencies and industry to pursue spectrum clearing and sharing, along with the critical efforts of the FCC to conduct incentive auctions, will result in tremendous progress towards the goals we all share of maximizing the availability of commercial spectrum for wireless broadband uses.

IV. Unlicensed Devices in the 5 GHz Band

Pursuant to Section 6406(b) of the Middle Class Tax Relief and Job Creation Act of 2012 (Tax Relief Act), NTIA and the federal agencies have begun to evaluate known and proposed spectrum-sharing technologies and the risks to federal users if Unlicensed-National Information

Infrastructure (U-NII) devices are allowed to operate in the 5350-5470 MHz band and in the 5850-5925 MHz band. This additional 195 megahertz of spectrum holds the potential to expand significantly the bandwidth available for unlicensed broadband devices, which often provide a link to the Internet while enabling service providers to offload traffic from their licensed wireless networks, thus easing network congestion. We have held discussions with device manufacturers regarding these potential expansion bands as well as technical and regulatory options for addressing ongoing interference issues in other parts of the 5 GHz band.

In October, NTIA will complete a study of the 5350-5470 MHz and 5850-5925 MHz bands in accordance with the Tax Relief Act. Based on this study and further quantitative analyses, NTIA, the FCC and the federal agencies will need to work cooperatively with industry representatives to fully assess the conditions under which sharing is or is not possible in those bands and to mitigate the identified risks to authorized systems. As the Tax Relief Act requires, the FCC and NTIA must determine that licensed users will be protected by technical solutions and that the critical missions of federal spectrum users will not be compromised by unlicensed use in these bands. In addition, NTIA will also need to collaborate with the Department of State to address the international dimensions and ramifications of these issues.

V. Spectrum Sharing Research and Testing

The Administration has also moved forward to facilitate research, development, experimentation, and testing of innovative spectrum-sharing technologies. The Wireless Spectrum R&D Senior Steering Group (SSG) held three workshops between 2011 and July 2012 with the goal of identifying promising projects whose implementation will significantly advance progress in this area. The Senior Steering Group has also identified the federal research programs developing new sharing technologies and providing critical test capabilities. The most

recent workshop held this summer in Boulder, Colorado, provided the opportunity for participants to review proposals for projects that would address the challenges identified by Congress, the FCC, NTIA, and the WSRD to make spectrum sharing technologies more available to all sectors of the wireless community.

VI. Incentives for the Relocation of and Sharing with Federal Users

The recent enactment of the Tax Relief Act will also play an important role in providing the incentives and means for federal agencies to relocate from or share their existing spectrum bands. I want to thank the members of this Subcommittee and their staff for their substantial efforts and support to include key spectrum management reforms. The improvements made by Congress to the Commercial Spectrum Enhancement Act (CSEA) will allow agencies to recover costs for, among other activities, planning for the reallocation and/or sharing of spectrum, and implementing reallocation and/or spectrum sharing arrangements. They also open the door to agencies' upgrading their systems with state of the art technology and other technology or commercial platforms. Other improvements in the new law are aimed at facilitating better transparency, coordination, and predictability for bidders in FCC spectrum auctions and the ultimate winners of those auctions through, for example, a new requirement that NTIA publish agencies' spectrum transition plans on its website at least 120 days before the commencement of the corresponding FCC auction, with the exception of classified and sensitive information.

NTIA has been working with the Office of Management and Budget, the FCC and other federal agencies to implement these provisions well before the FCC announces the next auction of reallocated federal spectrum bands. NTIA's objectives in this effort are to ensure the accuracy and sufficiency of agency transition plans, assure sufficient and timely funding to pay for and implement such plans, reduce risk and uncertainty in the auction and transition process,

and avoid interruption or adverse impact to federal agencies' operations. New NTIA guidelines and regulations develop a common format for agency transition plans, establish a mechanism to review the sufficiency of such plans by an expert Technical Panel, and create a fair and efficient dispute resolution process for addressing disagreements that may arise over the execution, timing, or cost of transition plans.

VII. Conclusion

NTIA and the federal agencies have made substantial progress toward fulfilling the President's goal of doubling the amount of commercial wireless spectrum available this decade, and are excited by the strong momentum that today is driving our efforts. Indeed, our success is critical to enable businesses to grow faster and create more jobs, improve education and job training, enhance public safety, and encourage innovation and economic growth. To date, NTIA has put on the table 210 megahertz of additional federal spectrum to reallocate for commercial use. Together with similar efforts by the FCC, collaboration with industry, and the authority that Congress provided to the Commission to conduct incentive auctions, we are well on our way to achieving this success.

I appreciate the opportunity to testify before you today and welcome your questions.

Mr. WALDEN. I thank you for your testimony. We will now go to—Major General Robert Wheeler is next, the Deputy Chief Information Officer for Command, Control, Communications, and Computers, C4, and Information Infrastructure at the U.S. Department of Defense. Major General Wheeler, first, thank you for your service to the country. We are all indebted to you and the men and women who wear our Nation's uniform and have worn it in the past, and we are especially indebted to you for your work with us on this topic, so please, go ahead.

STATEMENT OF ROBERT E. WHEELER

Mr. WHEELER. Thank you, sir, I appreciate that. Good morning, Chairman Walden, Ranking Member Eshoo, and distinguished subcommittee members. Thank you for the opportunity to testify before this subcommittee regarding the vital importance of scarce radio frequency spectrum to U.S. national defense capabilities, the economy, and consumers. My name is Major General Robert E. Wheeler, and as we discussed, I am the Deputy Chief Information Officer for Command, Control, Communications, and Computers, and Information Infrastructure Capabilities.

Military spectrum requirements are diverse and complex given the variety of different missions the Department must support around the world. For example, the Air Combat Training System uses the 1755–1850 megahertz band to support combat readiness pilot certification for U.S. aircrews, as well as for crews from allied countries. The system is used at training ranges and bases across the U.S. with over 10,000 training flights per month. I have personally used this system several hundred times.

Spectrum is the critical enabler that ensures information is dependably available to train our forces and ensure safe and successful mission accomplishment. The Department's use of unmanned aerial systems to support its overseas operations requires spectrum to process volumes of critical intelligence, surveillance and reconnaissance data. Our inventory of UAS platforms has increased from 167 in 2002 to nearly 7,500 in 2010, and created an associated increase in demand for spectrum to satisfy those particular missions, and I believe it is going to increase even further.

Within the DoD, we understand that the strength of our Nation is rooted in the strength of our economy. We are dependent on industry for innovative products that can be used for national security. In that regard, we remain fully committed in support of our national economic and security goals of the President's 500 megahertz initiative. The implementation of more effective and efficient use of this finite radio spectrum and the development of solutions to meet these goals is equally important to both national security and the economic goals.

The Department continues to work with NTIA, other administration partners, and industry to develop the information required to ensure balanced spectrum repurposing decisions that are technically sound and operationally viable from a mission perspective.

The reallocation feasibility assessment of the 1755–1850 megahertz band shows that while there are challenges to overcome, it is possible to repurpose all 95 megahertz of that particular spectrum, based upon the conditions outlined in the NTIA report. DoD

is fully engaged in addressing these challenges, by closely working with industry to evaluate sharing possibilities.

The Department estimated it would cost almost \$13 billion to vacate or relocate out of the 1755 to 1850 megahertz band. This estimate was led and overseen by the Department's independent Cost Assessment and Program Evaluation, CAPE organization, to ensure consistency in methodologies and assumptions. The cost to modify or replace the existing systems to use the identified comparable spectrum were also included in the DoD's analysis.

Let me briefly address the issue of the lower 25 megahertz or the 1755 to 1780 megahertz band. As we worked within NTIA's established process to identify the 500 megahertz directed by the President, the Federal agencies, including DoD, were instructed to study reallocation of the entire 95 megahertz, as 25 megahertz would not reflect significant progress toward the overall end goal. This was due in part to the fact that many of the systems, including critical DoD systems, operate in this frequency band, operating across the entire 95 megahertz band. Thus, a detailed study of vacating solely the lower 25 megahertz has not been conducted, and the results of the full 95 megahertz band study cannot be extrapolated to a solution for just the lower 25 megahertz.

The Department has and continues to work with NTIA and the Federal Communications Commission to determine ways to share spectrum with commercial users when possible. A recent success is the FCC's new rules for Medical Body Area Network sensor devices in the 2360 to 2390 megahertz band. DoD is also cooperatively working with three major wireless providers to evaluate sharing the 1755 to 18 megahertz band, including spectrum monitoring at selected DoD sites.

DoD recognizes the need to move forward. We are developing a spectrum strategy focused on investing in technologies and capabilities aimed at more effective and efficient use and management of spectrum, and that begins at the acquisition cycle.

The ability to operate spectrum-dependent national security capabilities without causing and receiving harmful interference while understanding the critical needs of our Nation's economy remains absolutely paramount to this Department. The Federal Government and our industry partners have built an impressive team that is working toward solving the technical and policy issues so we can move ahead. Together, we will develop long-term solutions to achieving a balance between national security spectrum requirements and meeting the expanding demand of commercial broadband services.

I thank you for listening, and the time.

[The prepared statement of Mr. Wheeler follows:]

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SUBCOMMITTEE ON COMMUNICATIONS AND TECHNOLOGY

**STATEMENT OF
MAJOR GENERAL ROBERT E. WHEELER
DEPARTMENT OF DEFENSE DEPUTY
CHIEF INFORMATION OFFICER FOR
COMMAND, CONTROL, COMMUNICATIONS AND
COMPUTERS (C4) AND INFORMATION INFRASTRUCTURE
(DCIO FOR C4IIC)**

BEFORE

**THE HOUSE COMMITTEE ON ENERGY AND COMMERCE
SUBCOMMITTEE ON COMMUNICATIONS AND
TECHNOLOGY**

***Creating Opportunities through Improved Government Spectrum
Efficiency***

SEPTEMBER 13, 2012

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SUBCOMMITTEE ON COMMUNICATIONS AND TECHNOLOGY

Introduction

Good morning Mr. Chairmen and distinguished Subcommittee members. Thank you for the opportunity to testify before the Subcommittee regarding the vital importance of scarce radio frequency spectrum to U.S. national defense capabilities, the economy, and consumers. My name is Major General Robert Wheeler and I am the Deputy Chief Information Officer for Command, Control, Communications and Computers (C4) and Information Infrastructure Capabilities. My testimony today will focus on the importance of spectrum to the Department of Defense (DoD) in ensuring that our warfighters and mission partners have the critical capabilities they need to prepare for and execute the missions assigned to them by the Commander in Chief as safely and effectively as possible.

Importance of Spectrum to DoD

Military spectrum requirements are diverse and complex given the variety of different missions the Department must support around the world. DoD uses federally allocated and regulated spectrum assignments for command and control operations, communications, intelligence, surveillance and target acquisition, on land, at sea, in the air and in space. In the United States, our systems utilize spectrum in order to properly train as we must fight.

For example, the Air Combat Training System (ACTS) uses the 1755-1850 MHz band to support combat readiness pilot certification through robust United States aircrew training along with crews from allied countries. The system is used at training ranges and bases across the United States with over 10,000 training flights per month. ACTS is also used for 10-12 large Carrier Strike Group exercises annually, where it is used 24 by 7 for up to six weeks in duration.

In short, spectrum is the critical enabler that ensures information is dependably available to train our forces and ensure safe and successful mission accomplishment.

The Department, like the rest of the country and world, also has growing requirements resulting from our increasing reliance on spectrum-dependent technologies. An example is the Department's use of unmanned aerial systems (UAS) requires spectrum to process volumes of critical intelligence, surveillance and reconnaissance data in support of our missions in military areas of operation. Our inventory of UAS platforms has increased from 167 in 2002 to nearly 7,500 in 2010. This has resulted in a dramatic increase in UAS use and training requirements, and consequently an increase in demand for spectrum to adequately satisfy those missions.

While the Department critically depends on wireless and information technology that require spectrum, DoD is cognizant of the scarcity of this resource and its importance to the economic well-being of our nation. When referencing the United States Frequency Allocation chart, and using the strict interpretation of the allocations, one will find in spectrum bands 225 and 3700 MHz 18% government exclusive use, 33% non-government exclusive use, and 49% for government/non-government shared use. When you apply real-world factors for how spectrum is actually used within the United States, these numbers will vary, but they do illustrate the fact that there is not a significant gap between the amount of spectrum allocated to government and non-government users. Even within the exclusive federal bands, the majority of this spectrum is shared between DoD and all of the federal agencies, across a wide array of systems, performing a multitude of varied missions, often with very different technologies.

As noted above, the Department recognizes the importance of the growing needs for spectrum for economic development, technology innovation and consumer services. Within the DoD, we understand that the strength of our nation is rooted in the strength of our economy. We are dependent on industry for innovative products that can be used for national security. In that regard, we remain fully committed in support of the national economic and security goals of the President's 500 MHz initiative. The implementation of more effective and efficient use of this finite radio-frequency spectrum and the

development of solutions to meet these goals is equally important to both national security and economic goals.

The Department continues to work with the National Telecommunications and Information Administration (NTIA), other Administration partners, and industry to develop the information required to ensure balanced spectrum repurposing decisions that are technically sound and operationally viable from a mission perspective. The results so far have been promising. For instance, in support of the President's 500 MHz initiative, the initial frequency band assessment, commonly referred to as the "fast track study," resulted in arrangements to geographically share the 1695-1710 and 3550-3650 MHz bands.

Furthermore, the reallocation feasibility assessment of the 1755-1850 MHz band also marks another important step. While there are significant challenges yet to overcome, it is possible to repurpose all 95 MHz of spectrum, based on the conditions outlined in the NTIA report. DoD is fully engaged in addressing these challenges, by closely working with industry to evaluate sharing possibilities.

In general, in order to avoid critical mission impacts, there are three things the DoD requires if we are to relocate our systems out of spectrum to be repurposed for wireless broadband; cost reimbursement, sufficient time, and comparable spectrum (summarized at attachment 1).

Existing statutes provide for relocation costs to be reimbursed through the Spectrum Relocation Fund, using auction revenue. Auction revenues by law must meet 110% of the estimated federal relocation costs for the auction to go forward. During the Department's study of the 1755 – 1850 MHz band, the Service Cost Agencies led the development of cost estimates for their respective systems, while the entire process was led and overseen by the Department's independent Cost Assessment and Program Evaluation (CAPE) organization to ensure consistency in methodologies and assumptions. The costs to modify or replace existing systems to use the identified

comparable spectrum were included in the analysis. Any affected systems planned to be retired or already programmed to be replaced within the ten-year transition period (e.g., Air Force Precision Guided Munitions and Army Explosive Ordinance Disposal robots) were excluded. The Service Cost Agencies interviewed technical experts associated with each of the major systems to understand what components needed modification, made site visits to major test and training ranges to view the actual equipment, and gathered cost data for similar modifications and new components where available. The cost estimates were peer-reviewed through the respective Service Cost Agencies and reviewed again by CAPE and the DoD Chief Information Officer.

Sufficient time to relocate is dependent upon the schedule of developing and deploying alternative capabilities, and can vary from a few years for simple systems with readily available alternatives, up to 10 years for more complex systems, and upwards of 30 years for space systems, where modification is not an option. The last requirement is comparable spectrum to relocate systems into; this spectrum must have the physical properties to support the mission currently being performed. With the finite nature of spectrum, and growing requirements, this has become a tough requirement to meet.

Let me also address the issue of the lower 25 MHz or the 1755 – 1780 MHz band. We fully understand the desire to bring this 25 MHz to market rapidly, particularly with a potential pairing band called out for auction within three years in the Middle Class Tax Relief and Job Creation Act, but the Department has some significant reservations. As we worked within NTIA's established process to identify the 500 MHz directed by the President, the federal agencies, including DoD, were instructed to study reallocation of the entire 95 MHz band, as 25 MHz would not reflect significant progress toward the end goal. Thus, a detailed study of vacating solely the lower 25 MHz has not been conducted, and the results of the full 95 MHz band study cannot be extrapolated to a solution for just the lower 25 MHz. Further, it is important that DoD understand the long

term status of the full band as part of any decision on the lower 25 MHz, in order to fully understand the impacts on DoD warfighting missions and cost implications of any relocation. Further details are provided at attachment 2. In order to make balanced decisions about relocating from or sharing spectrum, the Department requires adequate time to conduct operational, technical, cost and schedule-feasibility analysis to ensure national security and other federal capabilities are preserved, while supporting the economic benefits spectrum use affords the nation. These studies are critical to preserving the warfighting advantages our weapons systems provide so that our soldiers, sailors, airman and marines can perform their missions with the greatest possible advantage over our adversaries, and return home to their loved ones safely.

Recognizing the relocation challenges, focus is shifting to spectrum sharing as a potential option for repurposing spectrum bands for commercial wireless broadband use.

The Department has and is continuing to work with NTIA and the Federal Communications Commission (FCC) to determine ways to share spectrum with commercial users when possible. A recent success is the FCC's new rules for Medical Body Area Network (MBAN) sensor devices in the 2360-2390 MHz band. This band is critical to our aeronautical mobile telemetry testing, yet collectively DoD and the medical community were able to establish the rules to permit this new use to enter the band without risk of harmful interference.

While moving from an exclusive right spectrum management regime to one focused on large-scale spectrum sharing presents new challenges, DoD is committed to working with government and industry partners to develop equitable spectrum sharing solutions. DoD is actively supporting efforts through NTIA-established working groups under its Commerce Spectrum Management Advisory Committee (CSMAC) to further the 1755-1850 MHz band assessment, working with interagency partners, NTIA, FCC and industry. The main focus of the evaluation is to determine the feasibility of sharing the

1755-1850 MHz band versus relocation. DoD is also cooperatively working with three major wireless providers to evaluate sharing the 1755-1850 MHz band including spectrum monitoring at selected DoD sites as well as modeling, simulation and analysis to develop an understanding of the sharing environment in the band. Results will inform the NTIA CSMAC working groups.

DoD recognizes the need to look forward. We are developing a spectrum strategy focused on investing in technologies and capabilities aimed at more effective and efficient use and management of spectrum.

Summary

The ability to operate spectrum-dependent national security capabilities without causing and receiving harmful interference while understanding the critical needs of our Nation's economy remains paramount to the Department. The federal government and our industry partners have built an impressive team that is working toward solving the technical and policy issues so we can move ahead. Together, we will develop long-term solutions to achieving a balance between national security spectrum requirements and meeting the expanding demand of commercial broadband services.

I want to thank you for your interest in hearing the importance of spectrum to DoD.

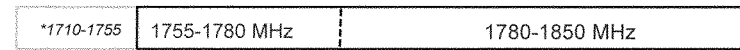


- **Comparable Spectrum:** Limited places to relocate DoD without loss of capability
 - Favorable, technically viable spectrum bands are already congested
 - The function/capability requirements drive the spectrum band options

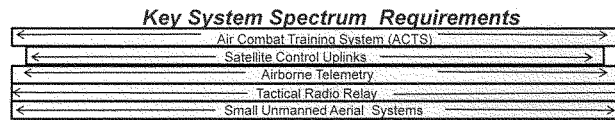
Note: Public Law 106-65 mandates that DoD obtain alternate spectrum with comparable technical characteristics before relinquishing any spectrum for commercial use
- **Cost:** Potentially high cost (e.g., DoD 1755-1850 relocation cost is estimated \$12.9B)
- **Timelines:** Realities of DoD/Federal relocations don't match commercial schedules
 - Systems reengineering, acquisition, and procurement drive DoD timelines
 - Funding to modify systems not provided until after auction
 - Protection zones are needed until transitions are complete (exacerbates the problem)

UNCLASSIFIED

Example - 1755-1780 MHz Reallocation



***DoD completed relocation in 2011** Can't Truncate into 1780-1850 MHz w/o Operational Impacts



• DoD would require additional study of the 1755-1780 MHz scenario to assess:

- Technical Feasibility: Assess technical feasibility for multiple scenarios centered on:
 - (1) relocating to a new band, or
 - (2) sharing within the band

Note: Availability of Comparable spectrum as required by PL 106-65 is a critical factor
- Operational Impacts: Assess nearly 100 distinct, operational systems in the band for both scenarios (relocation or sharing)
- Costs: Multiple scenarios based on technical/operational determinations; costs may be high
- Timelines: Programmatic requirements will require more than 5 years to complete

Mr. WALDEN. We appreciate your testimony.

We will now go to Mr. Mark Goldstein, Director, Physical Infrastructure Issues for the Government Accountability Office. Mr. Goldstein, thanks for your work. We look forward to your testimony.

STATEMENT OF MARK L. GOLDSTEIN

Mr. GOLDSTEIN. Good morning, Mr. Chairman, members of the subcommittee. Thank you for the invitation to testify today on issues related to the management of Federal spectrum and spectrum sharing.

Demand for spectrum is increasing rapidly with the widespread use of wireless broadband devices and services. However, nearly all usable spectrum has been allocated either by NTIA for Federal use or the FCC for commercial and nonfederal use. Federal initiatives are underway to identify Federal spectrum that could be repurposed or possibly shared by Federal users, or wireless broadband providers and other nonfederal users. Our statement today discusses how NTIA manages spectrum to address government-wide spectrum needs, the steps NTIA has taken to repurpose spectrum for broadband, and as part of an ongoing review, the statement also discusses preliminary information from the factors that prevent spectrum sharing and actions that can encourage sharing efficient spectrum use.

The following is what GAO has found in the two reports that we are talking about today.

First, while NTIA is responsible for government-wide Federal spectrum management, GAO reported in 2011 that its efforts in this area had been limited. Almost 10 years ago, the President directed NTIA to develop plans identifying Federal and nonfederal spectrum needs, and in 2008, NTIA issued the Federal plan. We found that this plan did not identify government-wide spectrum needs and did not contain key elements and conform to best practices for strategic planning. Generally, NTIA's primary spectrum management operations do not focus on government-wide needs. Instead, NTIA depends on agency self-evaluation of spectrum needs, and focuses on mitigating interference among spectrum users with limited emphasis on overall spectrum management.

Additionally, NTIA's data management system is antiquated and lacks internal controls to ensure the accuracy of agency-reported data, making it unclear if reliable data informed decisions about Federal spectrum use. NTIA is developing a new management system, but its implementation is years away.

Despite these limitations, NTIA has taken steps to identify spectrum that could potentially be made available for broadband use. For example, in 2010, NTIA evaluated various spectrum bands and identified 115 megahertz of spectrum that could be repurposed within the next 5 years. For each of the identified bands, NTIA reviewed the number of Federal frequency assignments within the band, the types of Federal operations and functions that the assignments support, and the geographic location of Federal users. However, the private sector has indicated that most of the frequencies located in these bands are not the most useful for expanding commercial broadband activities.

Second, in addition to efforts to repurpose spectrum, some stakeholders have also suggested that sharing spectrum between Federal and nonfederal users be considered to help make spectrum available for broadband. However, ongoing work has identified several significant barriers that limit sharing. Primarily, many Federal users may lack incentives to share inside a spectrum. Typically, paying the market price for a good or service helps to inform users of the value of the good and provides an incentive for efficient use. Yet Federal agencies pay only a small fee to NTIA for spectrum assignments and may, in some contexts, have little incentive to conserve or to share it. And accurate information about which areas might be best shared is inadequate. Federal agencies may also have limited budgets to upgrade to more spectrally efficient equipment that would better enable sharing. Nonfederal users also are reluctant to share with Federal users, due to a variety of regulatory hurdles, and are also wary of sharing with others in the private sector due to competition concerns.

Finally, GAO's ongoing work suggests that some actions might provide greater incentives and more opportunities for more efficient spectrum use in sharing. These actions could include studying spectrum usage fees to provide economic incentive for more efficient use in sharing, expanding the availability of unlicensed spectrum, and increasing the Federal focus on research and development of technologies that can enable spectrum sharing as well.

That concludes my statement, Mr. Chairman. I would be happy to answer any questions that the committee may have.

[The prepared statement of Mr. Goldstein follows:]

United States Government Accountability Office

GAO

Testimony
Before the Subcommittee on
Communications and Technology,
Committee on Energy and Commerce,
House of Representatives

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SPECTRUM MANAGEMENT

Federal Government's Use of Spectrum and Preliminary Information on Spectrum Sharing

Statement of Mark L. Goldstein, Director
Physical Infrastructure Issues



GAO-12-1018T



Highlights of GAO-12-1018T, a testimony before the Subcommittee on Communications and Technology, Committee on Energy and Commerce, House of Representatives

Why GAO Did This Study

Demand for spectrum is increasing rapidly with the widespread use of wireless broadband devices and services. However, nearly all usable spectrum has been allocated either by NTIA for federal use or by the Federal Communications Commission (FCC) for commercial and nonfederal use. Federal initiatives are under way to identify federal spectrum that could be repurposed or possibly shared by federal users or wireless broadband providers and other nonfederal users. This statement discusses how NTIA manages spectrum to address governmentwide spectrum needs and the steps NTIA has taken to repurpose spectrum for broadband. As part of an ongoing review, the statement also discusses preliminary information on the factors that prevent spectrum sharing and actions that can encourage sharing and efficient spectrum use. This testimony is based on GAO's prior work on federal spectrum management and ongoing work on spectrum sharing. GAO analyzed NTIA processes, policies and procedures, and interviewed relevant government officials, experts, and industry stakeholders.

What GAO Recommends

In April 2011, GAO recommended that NTIA (1) evaluate its current approach for validating agency-reported data and (2) establish internal controls for its data management systems. NTIA concurred with the recommendations and has proposed approaches to implement new measures to better ensure the accuracy of agency-reported data, and is taking steps to implement internal controls in a cost-efficient manner. GAO provided a draft of this statement to FCC and NTIA.

View GAO-12-1018T. For more information, contact Mark L. Goldstein at (202) 512-2834 or goldsteinm@gao.gov.

September 13, 2012

SPECTRUM MANAGEMENT

Federal Government's Use of Spectrum and Preliminary Information on Spectrum Sharing

What GAO Found

The National Telecommunications and Information Administration (NTIA) is responsible for governmentwide federal spectrum management, but GAO reported in 2011 that NTIA's efforts in this area had been limited. In 2003, the President directed NTIA to develop plans identifying federal and nonfederal spectrum needs, and in 2008, NTIA issued the federal plan. GAO found it did not identify governmentwide spectrum needs and did not contain key elements and conform to best practices for strategic planning. Furthermore, NTIA's primary spectrum management operations do not focus on governmentwide needs. Instead, NTIA depends on agency self-evaluation of spectrum needs and focuses on mitigating interference among spectrum users, with limited emphasis on overall spectrum management. Additionally, NTIA's data management system is antiquated and lacks internal controls to ensure the accuracy of agency-reported data, making it unclear if reliable data inform decisions about federal spectrum use. NTIA is developing a new data management system, but implementation is years away.

Despite these limitations, NTIA has taken steps to identify spectrum that could potentially be made available for broadband use. For example, in 2010 NTIA evaluated various spectrum bands and identified 115 megahertz of spectrum that could be repurposed within the next 5 years. In doing so, NTIA worked with a special steering group consisting of the Assistant Secretaries with spectrum management oversight in agencies that were the major stakeholders in the spectrum bands under consideration. For each of the identified bands, NTIA reviewed the number of federal frequency assignments within the band, the types of federal operations and functions that the assignments support, and the geographic location of federal use.

In addition to efforts to repurpose spectrum, industry stakeholders have also suggested that sharing spectrum between federal and nonfederal users be considered to help make spectrum available for broadband. Our ongoing work has identified several barriers that limit sharing. Primarily, many users may lack incentives to share assigned spectrum. Typically, paying the market price for a good or service helps to inform users of the value of the good and provides an incentive for efficient use. But federal agencies pay only a small fee to NTIA for spectrum assignments, and may, in some contexts, have little incentive to conserve or share it. Federal agencies may also have limited budgets to upgrade to more spectrally-efficient equipment that would better enable sharing. Nonfederal users are also reluctant to share spectrum. For instance, license holders may be reluctant because of concerns that spectrum sharing could encourage competition. A lack of information on federal spectrum use may limit users' ability to easily identify spectrum suitable for sharing.

GAO's ongoing work suggests that some actions might provide greater incentives and opportunities for more efficient spectrum use and sharing. These actions could include assessing spectrum usage fees to provide economic incentive for more efficient use and sharing, expanding the availability of unlicensed spectrum, and increasing the federal focus on research and development of technologies that can enable spectrum sharing and improve spectral efficiency. However, all of these actions also involve challenges and may require further study.

United States Government Accountability Office

Chairman Walden, Ranking Member Eshoo, and Members of the Subcommittee:

Thank you for the opportunity to testify today on issues related to spectrum management and spectrum sharing practices in the United States. Radio frequency spectrum enables wireless communications services critical to the U.S. economy and a variety of government functions, such as scientific research and national defense. Spectrum capacity is necessary to deliver wireless broadband to consumers and businesses and broadband deployment stimulates economic growth and boosts the nation's capabilities in areas such as education and health care. As the U.S. experiences significant growth in commercial wireless broadband services, the demand for spectrum has increased and additional capacity will be needed. However, nearly all usable spectrum has been allocated either by the National Telecommunications and Information Administration (NTIA) for federal government use or by the Federal Communications Commission (FCC) for commercial and other nonfederal use. Virtually no "green fields" of spectrum are currently available to allocate to new uses or technologies.

Currently, federal government initiatives are under way to identify spectrum that can be made available to meet the nation's increased demand for commercial wireless broadband services. In particular, the *National Broadband Plan* recommended that 500 megahertz (MHz) of spectrum be made newly available for broadband use within the next 10 years,¹ and in June 2010, the President issued a memorandum directing NTIA to begin identifying federal spectrum that can be made available for wireless broadband.² Solutions geared toward greater sharing of spectrum among users—federal and nonfederal—have become attractive because of the potential access to more spectrum and opportunities to use spectrum more efficiently than sharing presents. The President's Council of Advisors on Science and Technology (PCAST) recommended

¹In 2010, an FCC task force issued the *National Broadband Plan*. Federal Communications Commission, *Connecting America: The National Broadband Plan*, p. 84, Recommendation 5.8, (Mar. 16, 2010).

²See, *Unleashing the Wireless Broadband Revolution*, 75 Fed. Reg. 38387 (2010).

that 1,000 MHz of spectrum previously occupied only by federal users be shared with nonfederal users.³

Based on our April 2011 report, my testimony today discusses NTIA's spectrum management to address governmentwide spectrum needs and the steps NTIA has taken to repurpose spectrum for broadband.⁴ Based on an ongoing review, I will also discuss our preliminary information on the factors that prevent spectrum sharing and actions that might be taken to encourage sharing and efficient spectrum use. We plan to issue a report on these issues in fall 2012. In conducting our work, we reviewed NTIA documents, including its *Manual of Regulations and Procedures for the Federal Radio Frequency Management* (commonly referred to as the Redbook); an assessment of spectrum bands that could possibly be repurposed for wireless broadband (referred to as the Fast Track Evaluation); and other documentation of NTIA's current processes, policies, and procedures. We interviewed officials from NTIA's Office of Spectrum Management about their spectrum management policies and procedures and interviewed stakeholders with knowledge of spectrum issues including industry and academic experts, and representatives of an industry association and telecommunications companies. We selected the experts and industry stakeholders based on prior published literature, stakeholders' recognition and affiliation with the spectrum management industry, and NTIA and other stakeholders' recommendations. We also reviewed federal legislation, regulations, and processes regarding spectrum sharing, including various FCC plans, notices, orders and other publications. We conducted interviews with officials from FCC, NTIA, and various advisory committees, including the Commerce Spectrum Management Advisory Committee (CSMAC).⁵ We also interviewed several agencies on the Interdepartment Radio Advisory Committee

³President's Council of Advisors on Science and Technology, *Report to the President: Realizing the Full Potential of Government-held Spectrum to Spur Economic Growth* (Washington, D.C.: July 2012).

⁴GAO, *Spectrum Management: NTIA Planning and Processes Need Strengthening to Promote the Efficient Use of Spectrum by Federal Agencies*, GAO-11-352 (Washington, D.C.: April 12, 2011).

⁵CSMAC is a federal advisory committee that provides advice and recommendations to NTIA. It is organized through NTIA's Office of Policy Analysis and Development and consists of approximately 25 spectrum policy experts from the private sector.

(IRAC).⁶ Additional information on our scope and methodology is provided in our 2011 report. We conducted our work related to federal management and use of spectrum from May 2010 to April 2011 and our work related to spectrum sharing from September 2011 to September 2012. All of our work was conducted in accordance with generally accepted government auditing standards. We provided a draft of this statement related to spectrum sharing to FCC and NTIA officials to obtain their comments. FCC and NTIA provided technical corrections, which we incorporated where appropriate.

Background

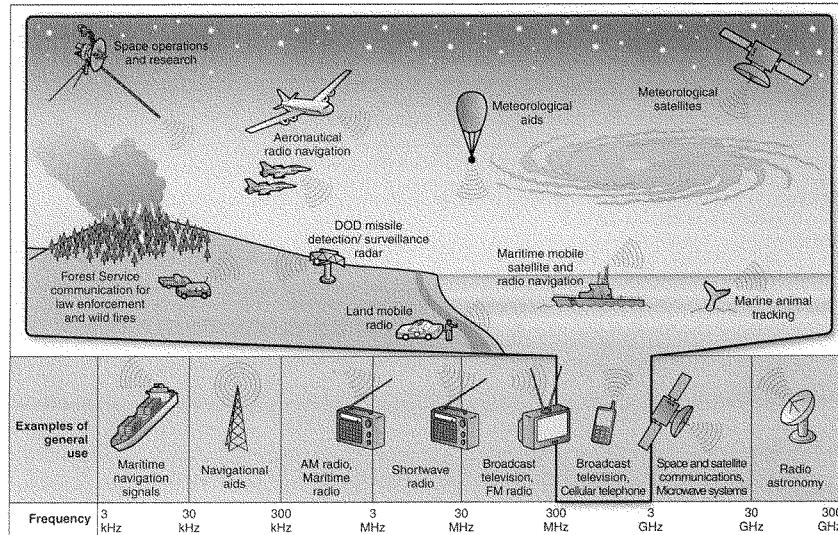
The radio frequency spectrum is the part of the natural spectrum of electromagnetic radiation lying between the frequency limits of 3 kilohertz (kHz) and 300 gigahertz (GHz). Not all spectrum has equal value. The spectrum most highly valued generally consists of frequencies between 225 MHz and 3700 MHz, as these frequencies have properties well suited to many important wireless technologies, such as mobile phones, radio, and television broadcasting. According to NTIA, as of September 2012, federal agencies had exclusive access to about 18 percent of these high-value frequencies, and nonfederal users had exclusive licenses to about 33 percent. The remainder of this spectrum is allocated to shared use. However, in many cases in these shared bands, federal or nonfederal uses may dominate and actual sharing is nominal. NTIA has concluded that overall, approximately 43 percent of these high-value frequencies are predominantly used by federal operations.

Federal agencies use spectrum to help meet a variety of missions, including emergency communications, national defense, land management, and law enforcement. Over 60 federal agencies and departments combined have over 240,000 frequency assignments. Agencies and departments within the Department of Defense have the most assignments, followed by the Federal Aviation Administration, the Department of Justice, the Department of Homeland Security, the Department of the Interior, the Department of Agriculture, U.S. Coast Guard, the Department of Energy, and the Department of Commerce, respectively. These federal agencies and departments hold 94 percent of

⁶IRAC is an interagency advisory committee that was established in 1922 to coordinate federal use of spectrum and provide policy advice on spectrum issues. It is comprised of representatives from 19 federal agencies that use spectrum. Those agencies hold over 90 percent of federally assigned spectrum.

all federally assigned spectrum. Nonfederal entities (which include commercial companies and state and local governments) also use spectrum to provide a variety of services. For example, state and local police departments, fire departments, and other emergency services agencies use spectrum to transmit and receive critical voice and data communications, while commercial entities use spectrum to provide wireless services, including mobile voice and data, paging, broadcast radio and television, and satellite services (see fig. 1).

Figure 1: Examples of Allocated Spectrum Uses, and Federal Spectrum Use in the High-Value Range

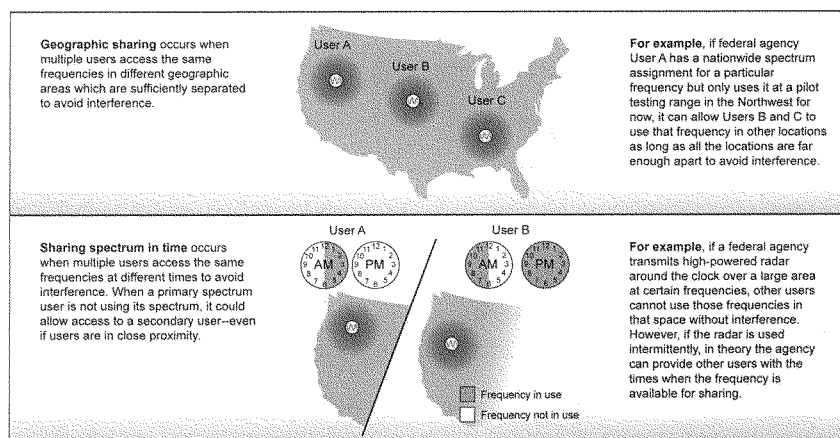


In the United States, responsibility for spectrum management is divided between NTIA and FCC. NTIA and FCC jointly determine the amount of spectrum allocated for federal, nonfederal, and shared use. After this allocation occurs, in order to use spectrum, nonfederal users must follow

rules and obtain authorizations from FCC to use specific spectrum frequencies, and federal users must follow rules and obtain frequency assignments from NTIA. In order for nonfederal users to share federal spectrum, NTIA and FCC are jointly involved in the process. The nonfederal party petitions FCC, and FCC in turn coordinates rulemakings and licenses with NTIA through IRAC. NTIA manages sharing between federal users on a day-to-day basis. If federal users are requesting frequency assignments in exclusive nonfederal or shared bands, that request is coordinated through IRAC with FCC. If sharing is solely between nonfederal users in exclusive nonfederal bands, sharing is generally governed by FCC rules and does not go through NTIA, unless there could be out-of-band interference. In addition to its spectrum allocation and authorization duties, NTIA serves as the President's principal advisor on telecommunications and information policy and manages federally assigned spectrum, including preparing for, participating in, and implementing the results of international radio conferences, as well as conducting extensive research and technical studies through its research and engineering laboratory, the Institute for Telecommunication Sciences. NTIA has authority to issue rules and regulations as may be necessary to ensure the effective, efficient, and equitable use of spectrum both nationally and internationally. It also has authority to develop long-range spectrum plans to meet future spectrum requirements for the federal government.

Spectrum sharing can be defined as the cooperative use of common spectrum. In this way, multiple users agree to access the same spectrum at different times or locations, as well as negotiate other technical parameters, to avoid adversely interfering with one another. For sharing to occur, users and regulators must negotiate and resolve where (geographic sharing), when (sharing in time), and how (technical parameters) spectrum will be used (see fig. 2).

Figure 2: Illustration and Examples of Spectrum Sharing



Sources: GAO and Map Resources.

Spectrum sharing also occurs with unlicensed use of spectrum, since it is accessible to anyone using wireless equipment certified by FCC for those frequencies. Equipment such as wireless microphones, baby monitors, and garage door openers typically share spectrum with other services on a non-interference basis using low power levels to avoid interference with higher priority uses. In contrast with most licensed spectrum use, unlicensed spectrum users have no regulatory protection against interference from other licensed or unlicensed users in the band. However, unlicensed use is regulated to ensure that unlicensed devices do not cause undue interference to operations with a higher priority. For example, in the 5 GHz band, wireless fidelity (Wi-Fi) devices share a band with military radar subject to the condition that the Wi-Fi devices are capable of spectrum sensing and dynamic frequency selection; if radar is detected, the unlicensed user must immediately vacate the channel.

NTIA's Processes for Managing Federal Spectrum Lack Governmentwide Focus and Accountability

NTIA's Spectrum Management Efforts

As the federal agency authorized to develop national spectrum policy, NTIA has been directed to conduct several projects focused on reforming governmentwide federal spectrum management and promoting efficiency among federal users of spectrum; however, we reported in 2011 that its efforts in this area had resulted in limited progress toward improved spectrum management. NTIA has authority to, among other things, establish policies concerning assigning spectrum to federal agencies, coordinate spectrum use across federal agencies, and promote efficient use of spectrum by federal agencies in a manner which encourages the most beneficial public use. As such, NTIA has a role in ensuring that federally allocated spectrum is used efficiently. According to NTIA's Redbook and agency officials, efficient use includes ensuring that federal agencies' decisions to use spectrum to support government missions have been adequately justified and that all viable tradeoffs and options have been explored before making the decision to use spectrum-dependent technology, and ensuring that these tradeoffs are continuously reviewed to determine if the need for spectrum has changed over time. NTIA's primary guidance to federal agencies is technical guidance provided through NTIA's Redbook concerning how to manage assigned spectrum.

In 2003, the Bush Administration directed NTIA to develop strategic plans, and in March 2008, NTIA issued its report on federal spectrum use entitled the *Federal Strategic Spectrum Plan*.⁷ While the intent of the *Federal Strategic Spectrum Plan* was to identify the current and projected spectrum requirements and long-range planning processes for the federal government, we reported in 2011 that the final plan is limited in these

⁷Department of Commerce, National Telecommunications and Information Administration, *Spectrum Policy for the 21st Century – The President's Spectrum Policy Initiative: The Federal Strategic Spectrum Plan* (March 2008).

	<p>areas. For example, the plan does not identify or include quantitative governmentwide data on federal spectrum needs. Instead, NTIA's plan primarily consists of a compilation of the plans submitted by 15 of the more than 60 agencies that use federal spectrum. Additionally, due to the fact that they contained limited information regarding future requirements and technology needs, NTIA concluded that its "long-range assumptions are necessarily also limited." Furthermore, NTIA's plan did not contain key elements and best practices of strategic planning.</p>
NTIA Focuses on Interference Mitigation Rather than on Best Use of Spectrum across Government	<p>NTIA's primary spectrum management operations include authorizing federal frequency assignments and certifying spectrum-dependent equipment for federal users; however, these processes are primarily focused on interference mitigation as determined by IRAC and do not focus on ensuring the best use of spectrum across the federal government. In 2011, we found that the process as established by federal regulations for review and approval of frequency assignment and system certification was technical in nature, focusing on ensuring that the new frequency or system that an agency wants to use would not interfere with another agency's operations. According to NTIA officials, this focus on day-to-day spectrum activities, such as interference mitigation, is due to the agency's limited resources. This focus, while important, makes limited consideration about the overall best use of federally allocated spectrum. Therefore, NTIA's current processes provide limited assurance that federal spectrum use is evaluated from a governmentwide perspective to ensure that decisions will meet the current and future needs of the agencies, as well as the federal government as a whole.</p>
NTIA's Current Data Management System Is of Limited Usefulness	<p>NTIA's data management system is antiquated and lacks transparency and internal controls. In 2011, we reported that NTIA collects all federal spectrum data in the Government Master File (GMF), which according to NTIA officials is an outdated legacy system that was developed primarily to store descriptive data. These data are not detailed enough to support the current analytical needs of NTIA or other federal users, as the system was not designed to conduct such analyses. NTIA does not generate any data, but maintains agency-reported spectrum data in the GMF, which are collected during the frequency assignment and review processes.</p> <p>NTIA's processes for collecting and verifying GMF data lack key internal controls, including those focused on data accuracy, integrity, and completeness. Control activities such as data verification and reconciliation are essential for ensuring accountability for government</p>

resources and achieving effective and efficient program results. In 2011, we reported that NTIA's data collection processes lack accuracy controls and do not provide assurance that data are being accurately reported by agencies. Rather, NTIA expects federal agencies to supply accurate and up-to-date data submissions, but it does not provide agencies with specific requirements on how to justify that the agencies' spectrum assignments will fulfill their mission needs.

NTIA is developing a new data management system—the Federal Spectrum Management System (FSMS)—to replace the GMF. According to NTIA officials, the new system will modernize and improve spectrum management processes by applying modern information technology to provide more rapid access to spectrum and make the spectrum management process more effective and efficient. NTIA projects that FSMS will improve existing GMF data quality, but not until 2018. According to NTIA's FSMS transition plan, at that time data accuracy will improve by over 50 percent. However, in the meantime it is unclear whether important decisions regarding current and future spectrum needs are based on reliable data.

NTIA Has Taken Steps to Identify Spectrum for Future Wireless Broadband Use

NTIA Efforts to Identify Spectrum for Broadband

In response to the government initiatives to make a total of 500 MHz of spectrum available for wireless broadband, in 2010 NTIA (1) identified 115 MHz of federally allocated spectrum to be made available for wireless broadband use within the next 5 years, referred to as the Fast Track Evaluation, and (2) developed an initial plan and timetable for repurposing additional spectrum for broadband, referred to as the 10-Year Plan.

Fast Track Evaluation. NTIA and the Policy and Plans Steering Group (PPSG)⁸ identified and recommended portions of two frequency bands,

⁸The PPSG consists of the Assistant Secretaries, or equivalent, with spectrum management oversight in agencies that are major stakeholders in the spectrum issues under consideration.

totaling 115 MHz of spectrum within the ranges of 1695–1710 MHz and 3550–3650 MHz to be made available for wireless broadband use.⁹ For each of these bands, NTIA reviewed the number of federal frequency assignments within the band, the types of federal operations and functions that the assignments support, and the geographic location of federal use. Since clearing these bands of federal users and relocating incumbent federal users to new bands was not an option in the given time frame, the bands that NTIA recommended be made available will be opened to geographic sharing by incumbent federal users and commercial broadband.

10-Year Plan. By a presidential memorandum, NTIA was directed to collaborate with FCC to make available 500 MHz of spectrum over the next 10 years, suitable for both mobile and fixed wireless broadband use, and complete by October 1, 2010, a specific plan and timetable for identifying and making available the 500 MHz for broadband use.¹⁰ NTIA publicly released this report in November 2010.¹¹ In total, NTIA and the National Broadband Plan identified 2,264 MHz of spectrum to analyze for possible repurposing, of which 639 MHz is exclusively used by the federal government and will be analyzed by NTIA. Additionally, NTIA will collaborate with FCC to analyze 835 MHz of spectrum that is currently located in bands that are shared by federal and nonfederal users. Furthermore, NTIA has stated that it plans to seek advice and assistance from CSMAC, its federal advisory committee comprised of industry representatives and experts, as it conducts analyses under the 10-Year Plan.

In January 2011, NTIA announced that it had selected the 1755–1850 MHz band as the first priority for detailed evaluation under the 10-Year Plan. According to NTIA, this band was given top priority for evaluation by NTIA and the federal agencies, based on a variety of factors, including industry interest and the band's potential for commercial use within 10 years. This is not the first time NTIA has studied this band. This band was

⁹In November 2010, NTIA publicly released its results. In its final report, NTIA summarized its analysis of four frequency bands: 1675–1710 MHz, 1755–1780 MHz, 3500–3650 MHz, and 4200–4400 MHz.

¹⁰ *Unleashing the Wireless Broadband Revolution*, 75 Fed. Reg. 38387.

¹¹ NTIA, *10 Year Plan and Timetable to Make Available 500 MHz of Spectrum for Wireless Broadband* (2010).

previously evaluated for reallocation, and in 2001, we reported that at the time adequate information was not currently available to fully identify and address the uncertainties and risks of reallocation.¹²

Industry Concerns with the Usefulness of the Identified Spectrum

Industry stakeholders, including wireless service providers, representatives of an industry association, and a think tank representative we contacted in 2011 expressed concerns over the usefulness of the spectrum identified by NTIA in the Fast Track Evaluation, since most of the spectrum identified (100 of the 115 MHz) is outside the range considered to have the best propagation characteristics for mobile broadband. Overall, there has been limited interest in the bands above 3 GHz for mobile broadband use because, according to industry stakeholders, there has been minimal development of mobile broadband in bands above 3 GHz and no foreseeable advances in this area at this time.

According to industry representatives, the 1755–1780 MHz band that NTIA considered as part of the Fast Track Evaluation has the best characteristics for mobile broadband use, and it is internationally harmonized for this use. NTIA did not select this band to be made available in the 5-year time frame due to the large number of federal users currently operating there. However, NTIA identified it as the first band to be analyzed under the 10-Year Plan to determine if it can be made available for commercial broadband use. An industry stakeholder has stated that the 1695–1710 MHz band identified by NTIA in the Fast Track Evaluation is the second-best alternative for wireless broadband if the 1755–1780 MHz band were not made available; however, the 1695–1710 MHz band is not currently used internationally for wireless broadband, which may reduce device manufacturers' incentive for developing technology that can be used in these frequencies.

¹²GAO, *Defense Spectrum Management: More Analysis Needed to Support Spectrum Use Decisions for the 1755-1850 MHz Band*, GAO-01-795 (Washington, D.C.: Aug. 21, 2001).

**Some Users Lack
Incentives and Face
Several Barriers to
Sharing Spectrum,
and Cannot Easily
Identify Available
Spectrum to Share**

**Some Users Lack
Economic Incentives to
Share Spectrum**

While federal spectrum users often share spectrum among themselves, they may have little economic incentive to otherwise use spectrum efficiently, including sharing it with nonfederal users. From an economic perspective, when a consumer pays the market price for a good or service and thus cannot get more of it without this expense, the consumer has an incentive to get the most value and efficiency out of the good as possible. If no price is attached to a good—which is essentially the case with federal agencies' use of spectrum¹³—the normal market incentive to use the good efficiently may be muted. In the case of federal spectrum users, obtaining new spectrum assignments may be difficult, so an agency may have an incentive to conserve and use the spectrum it currently has assigned to it or currently shares efficiently, but the extent of that incentive is likely weaker than if the agency had had to pay a market price for the all of their spectrum needs. As such, federal spectrum users do not fully face a market incentive to conserve on their use of spectrum or use it in an efficient manner. The full market value of the spectrum assigned to federal agencies has not been assessed, but, according to one expert, would most likely be valued in the tens of billions of dollars. Similarly, many nonfederal users, such as television broadcasters and public safety entities, did not pay for spectrum when it was assigned to them and do not pay the full market price for their continuing use of spectrum so, like federal agencies, they may not fully have market-based incentives to use spectrum efficiently.

While licensed, commercial users who purchased spectrum at auction generally have market incentives to use their spectrum holdings

¹³Agencies pay only a small, annual fee for their spectrum which is not comparable to its full market value. According to NTIA, federal agencies pay \$122 for each frequency assignment, totaling about \$30 million paid by 47 agencies to NTIA for fiscal year 2012.

efficiently, these users also have incentives that work against sharing spectrum, except in those instances where the incumbent licensee is unlikely to build out its network or offer services to a particular area, such as in certain remote, sparsely populated areas. FCC officials and industry stakeholders and experts told us that these users may prefer not to share their unused spectrum because they are concerned about the potential for interference to degrade service quality to their customers. Also, they may prefer to not give potential competitors access to spectrum. Industry stakeholders and experts also said that companies seeking spectrum may prefer obtaining exclusive spectrum licenses over sharing spectrum that is licensed to another company or federal user, given uncertainties about regulatory approvals, interference, and enforcement if interference occurs.

Several Barriers Can Deter Users from Sharing Spectrum

There are several barriers that can deter sharing. One such barrier is that federal agencies will not risk mission failure, particularly when there are security and public safety implications. According to the agency officials we contacted, federal agencies will typically not agree to share spectrum if it puts achieving their missions at risk. The officials stressed that when missions have security and safety implications, sharing may pose unacceptable risks. For example, the military tests aircraft and trains pilots over test ranges that can stretch hundreds of miles, maintaining constant wireless contact. The ranges, according to officials, cannot share the communication frequencies because even accidental interference in communications with an aircraft could result in catastrophic mission failure. Further, sharing information about such flights could expose particular pilots and aircraft, or the military's larger mission, to increased risk.

According to FCC officials, concerns about risk can drive conservative technical standards that can make sharing impractical. In general, the technical analyses and resulting standards are based on worst-case scenarios, and not on assessments of the most likely scenario or a range of scenarios. Moreover, in contrast to FCC's open rulemaking process, there is little opportunity for public input to the standards setting process. Stakeholders may meet or have discussions with NTIA and the relevant federal agencies, but this occurs without any formal public process. Nor do stakeholders have any effective means to appeal other than by asking FCC to reject NTIA's analysis or standards.

Another barrier is that spectrum sharing can be costly. Stakeholders told us that sharing federal spectrum can be costly for both the nonfederal and federal users seeking to share for the following reasons:

- Mitigation of potential interference can be costly in terms of equipment design and operation.
- Users applying to share federal frequencies may find that those frequencies are being used by more than one federal agency or program. As a result of needing to mitigate interference for multiple users, costs to share spectrum in that band could increase.
- Federal users often use and rely on proven older technology that was designed to use spectrum to meet a specific mission and typically is not conducive to operating as efficiently or flexibly as the state-of-the-art technologies might now allow. Limited budgets may prevent them from being able to invest in newer technology which can facilitate easier sharing.

Additionally, we found that spectrum sharing approval and enforcement processes can be lengthy and unpredictable. FCC and NTIA processes can cause two main problems when nonfederal users seek to share federal spectrum, or when nonfederal users share with one another, according to stakeholders:

- The spectrum-sharing approval process between FCC and NTIA can be lengthy and unpredictable, and the risk associated with it can be costly for new entrants. FCC officials told us that its internal processes can potentially last years if requiring a rulemaking to accommodate shared use of spectrum.¹⁴ In addition to that time, NTIA officials said that IRAC's evaluation of potential harmful interference could take months. In one example, the Department of Defense, along with other federal agencies and nonfederal entities, currently shares a spectrum band between 413–457 MHz with a nonprofit medical devices provider for use in implant products for veterans. It took approximately 2 years

¹⁴The time it takes to complete rules may vary because of the unique nature of each rulemaking. Certain factors, such as the technical complexity of the issue being addressed and the priority of the rulemaking in comparison to other issues, can also affect rulemaking time frames. FCC's rulemaking process includes multiple steps as outlined by law with opportunities for the public to participate, and FCC is generally not required by statute to complete rules within limited time frames.

(from 2009 to 2011) for FCC and NTIA to facilitate this arrangement, as FCC required a rulemaking and NTIA required a lengthy evaluation of potential interference. This nonprofit is funded by an endowment and was not dependent on income from the device to sustain itself during this process, but such delays, and the potential for a denial, could discourage for-profit companies from developing and investing in business plans that rely on sharing federal spectrum.

- Stakeholders we interviewed told us that when federal or nonfederal users share spectrum, both parties have concern that harmful interference may affect their missions or operations if the other party overreaches or does not follow the agreement. They also fear that the enforcement actions that are taken by FCC will happen too slowly to protect their interests or that enforcement outcomes can be unpredictable.

Users May Be Unable to Easily Identify Spectrum Suitable for Sharing

Besides lacking incentives and overcoming other barriers, users may also have difficulty identifying spectrum suitable for sharing because data on available spectrum is incomplete or inaccurate, and information on some federal spectrum usage is not publicly available. According to NTIA officials, coordinating spectrum sharing requires accurate data on users, frequencies, locations, times, power levels, and equipment, among other things. We recently reported that both FCC's and NTIA's spectrum databases may contain incomplete and inaccurate data.¹⁵ Further, federal agency spectrum managers told us that agencies have not been asked to regularly update their strategic spectrum plans, in which they were required to include an accounting of spectrum use.¹⁶

As mentioned, NTIA is developing a new data system that officials believe will provide more robust data that will enable more accurate analysis of spectrum usage and potential interference, which may in turn identify

¹⁵In November 2011, we reported on FCC's Universal Licensing System, Consolidated Database System, International Bureau Filing System, and Experimental Licensing System. See GAO, *Commercial Spectrum: Plans and Actions to Meet Future Needs, Including Continued Use of Auctions*, GAO-12-118 (Washington, D.C.: November 23, 2011). In April 2011, we reported on NTIA's Government Master File database. See GAO-11-352.

¹⁶The Bush Administration directed federal agencies to submit spectrum plans to NTIA and provide updates every 2 years. Since 2008, NTIA has ceased requesting those updates, and has put its strategic planning initiatives on hold due to limited resources.

more sharing opportunities. In addition, recently proposed legislation would require in part that FCC, in consultation with NTIA and the White House Office of Science and Technology Policy, prepare a report for Congress that includes an inventory of each radio spectrum band they manage.¹⁷ The inventory is also to include data on the number of transmitters and receiver terminals in use, if available, as well as other technical parameters—coverage area, receiver performance, location of transmitters, percentage and time of use, a list of unlicensed devices authorized to operate in the band and description of use—that allow for more specific evaluation of how spectrum can be shared. However, experts and federal officials we contacted told us that there may be some limitations to creating such an inventory. For instance, measuring spectrum usage can be difficult because it can only be accomplished on a small scale and technologies to measure or map widespread spectrum usage are not yet available.¹⁸ Additionally, FCC and NTIA officials told us that information on some federal spectrum bands may never be made publicly available because of the sensitive and classified nature of some federal spectrum use.

Incentives and Opportunities to Share Could Be Expanded

We have previously reported that to improve spectrum efficiency among federal agencies, Congress may wish to consider evaluating what mechanisms could be adopted to provide incentives and opportunities for agencies to move toward more efficient use of spectrum, which could free up some spectrum allocated for federal use to be made available for sharing or other purposes.¹⁹ Federal advisors and experts we talked to identified several options that could provide incentives and opportunities for more efficient spectrum use and spectrum sharing by federal and nonfederal users, which include, among others: (1) assessing spectrum usage fees; (2) expanding the availability of spectrum for unlicensed uses; and (3) increasing the federal focus on research and development of technologies that can enable spectrum sharing and improve spectral efficiency.

¹⁷S. 455, § 3, 112th Cong. (2011).

¹⁸The Department of Defense's Defense Advanced Research Projects Agency is working on frequency mapping.

¹⁹GAO, 2012 *Annual Report: Opportunities to Reduce Duplication, Overlap and Fragmentation, Achieve Savings, and Enhance Revenue*, GAO-12-342SP (Washington, D.C.: February 28, 2012).

Assessing spectrum usage fees. Several advisory groups and spectrum industry experts, including those we interviewed, have recommended that spectrum fees be assessed based on spectrum usage. As previously mentioned, with the exception of administrative fees for frequency assignments, federal users incur no costs for using spectrum. As such, federal users may have little incentive to share spectrum assigned to them with nonfederal users or identify opportunities to use spectrum more efficiently—except to the extent that sharing or more efficient use helps them achieve their mission requirements. In 2011, the CSMAC Incentives Subcommittee recommended that NTIA and FCC study the implementation of spectrum fees to drive greater efficiency and solicit input from both federal and nonfederal users who might be subject to fees.²⁰ The *National Broadband Plan* has also recommended that Congress consider granting FCC and NTIA authority to impose spectrum fees on unauctioned spectrum license holders—such as TV broadcasters and public safety entities—as well as government users. Fees may help to free spectrum for new uses, since licensees who use spectrum inefficiently may reduce their holdings or pursue sharing opportunities once they bear the opportunity cost of letting it remain fallow or underused. Further, FCC officials told us that they have proposed spectrum usage fees at various times, including in FCC's most recent congressional budget submission, and requested the legislative authorities to implement such a program.²¹

While noting the benefits, the CSMAC Incentives Subcommittee report mentions specific concerns about the impact of spectrum fees on government users. For instance, some CSMAC members expressed concern that fees do not fit into the federal annual appropriations process and new appropriations to cover fees are neither realistic nor warranted in the current budget environment. Other members suggested that fees will have no effect because agencies will be assured additional funds for their spectrum needs. Similarly, the *National Broadband Plan* notes that a different approach to setting fees may be appropriate for different spectrum users, and that a fee system must also avoid disrupting public

²⁰CSMAC Incentives Subcommittee Final Report (Washington, D.C.: January 11, 2011).

²¹Federal Communications Commission, *Fiscal Year 2013 Budget Estimates Submitted to Congress* (Washington, D.C.: February 2012).

safety, national defense, and other essential government services that protect human life, safety, and property.²²

To address some of the concerns regarding agency budgets, the recent PCAST report recommended the use of a "spectrum currency" process to promote spectrum efficiency. Rather than using funds to pay for spectrum, federal agencies would each be given an allocation of synthetic currency that they could use to "buy" their spectrum usage rights. Usage fees would be set based on valuations of comparable private sector uses for which the market has already set a price. Agencies would then have incentive to use their assignments more efficiently or share spectrum. In the PCAST proposal, agencies would also be rewarded for making spectrum available to others for sharing, by being reimbursed for their investments in improving spectrum sharing from a proposed Spectrum Efficiency Fund.²³

Expanding the availability of spectrum for unlicensed use. Unlicensed spectrum use is inherently shared spectrum access, and according to spectrum experts we interviewed and other stakeholders, unlicensed use of spectrum is a valuable complement to licensed spectrum and more spectrum could be made available for unlicensed use. Spectrum for unlicensed use can be used efficiently and for high value applications, like Wi-Fi, for example.²⁴ Increasing the amount of spectrum for unlicensed use may allow more users to share without going through lengthy negotiations and interference mitigations, and also allow for more experimentation and innovation.

²² *The National Broadband Plan*, p. 83, Recommendation 5.6, (Mar. 16, 2010).

²³ The PCAST recommended that the existing Spectrum Relocation Fund be redefined as a revolving Spectrum Efficiency Fund that reimburses federal agencies for investments in spectrum sharing and efficiency.

²⁴ The Industrial (900-928 MHz), Scientific (2.4 – 2.485 GHz) and Medical (5.7 – 5.825 GHz) are examples of the unlicensed spectrum bands. Wi-Fi networks can permit multiple computing devices in each discrete location to share a single wired connection to the Internet, thus efficiently sharing spectrum. Wi-Fi technologies are also being used to relieve network congestion. One report suggests that major wireless carriers, even with their large portfolios of exclusive-use, licensed spectrum, often rely on Wi-Fi infrastructure to offload traffic from their networks in congested areas, as much as 21 percent by some accounts.

More recently, FCC has provided unlicensed access to additional spectrum, known as TV “white spaces,” to help address spectrum demands.²⁵ The white spaces refer to the buffer zones that FCC assigned the television broadcasters to mitigate unwanted interference between adjacent stations. With the more efficient TV transmission capabilities that resulted from the digital television transition, the buffer zones are no longer needed and FCC approved the previously unused spectrum for unlicensed use. To identify available white space spectrum, devices must access a database which responds with a list of the frequencies that are available for use at the device’s location.²⁶ As an example, one local official explained that his city uses TV white space spectrum to provide a network of public Wi-Fi access and public safety surveillance functions.

Increasing the federal focus on research and development of technologies. Several technological advances promise to make sharing easier, but are still at early stages of development and testing. For example, various spectrum users and experts we contacted mentioned the potential of dynamic spectrum access technology. If made fully operational, dynamic spectrum access technology will be able to sense available frequencies in an area and jump between frequencies to seamlessly continue communication as the user moves geographically and through the spectrum. According to experts and researchers we contacted, progress has been made but there is no indication of how long it will be before this technology is fully deployable. Such new technologies can obviate or lessen the need for extensive regulatory procedures to enable sharing and can open up new market opportunities for wireless service providers. If a secondary user or sharing entity employs these technologies, the incumbent user or primary user would theoretically not experience harmful interference, and agreements and rulemakings that are currently needed may be streamlined or unnecessary to enable sharing.

Although industry participants indicated that extensive testing under realistic conditions is critical to conducting basic research on spectrum

²⁵In *Matter of Unlicensed Operation in the TV Broadcast Bands*, 27 FCC Rcd. 3,692 (April 5, 2012).

²⁶To date, FCC has designated two administrators to locate available white space spectrum for users of unlicensed devices, Spectrum Bridge and Telecordia Technologies. Devices must operate only on those channels designated by the administrator.

efficient technologies, we found that only a few companies are involved in such research and may experience challenges in the testing process. Companies tend to focus technology development on current business objectives as opposed to conducting basic research that may not show an immediate business return. For example, NTIA officials told us that one company that indicated it would participate in NTIA's dynamic spectrum access testing project removed its technologist from the testing effort to a project more closely related to its internal business objectives. Furthermore, some products are too early in the development stage to even be fully tested. For example, NTIA officials also said six companies responded to NTIA's invitation to participate in the previously mentioned dynamic spectrum access testing project. However, only two working devices were received for the testing, and a third device received did not work as intended. Other companies that responded told NTIA that they only had a concept and were not ready to test an actual prototype.

Recent federal advisory committee recommendations emphasize the importance of funding and providing incentives for research and development endeavors. For example, to promote research in efficient technologies, PCAST recommended that (1) the Research and Development Wireless Innovation Fund²⁷ release funds for this purpose and (2) the current Spectrum Relocation Fund be redefined as the Spectrum Efficiency Fund. As discussed, this adjustment would allow for federal agencies to be reimbursed for general investments in improving spectrum sharing. Similarly, CSMAC recommended the creation of a Spectrum Innovation Fund. Unlike the Spectrum Relocation Fund, which is strictly limited to the actual costs incurred in relocating federal systems from auctioned spectrum bands, the Spectrum Innovation Fund could also be used for spectrum sharing and other opportunities to enhance spectrum efficiency.²⁸

²⁷The Wireless Innovation Fund is a part of the 2012 payroll tax agreement for spectrum research and development. It will initially be a \$100 million fund at the National Institute of Standards and Technology. The fund will receive an additional \$200 million after approved auction income has been secured.

²⁸CSMAC Incentives Subcommittee Final Report.

Conclusions and Recommendations

Radio frequency spectrum is a scarce national resource that enables wireless communications services vital to the U.S. economy and to a variety of government functions, yet NTIA has not developed a strategic, governmentwide vision for managing federal use of this valuable resource. NTIA's spectrum management authority is broad in scope, but NTIA's focus is on the narrow technical aspects of spectrum management, such as ensuring new frequency assignments will not cause interference to spectrum-dependent devices already in use, rather than on whether new assignments should be approved based on a comprehensive evaluation of federal spectrum use from a governmentwide perspective. Lacking an overall strategic vision, NTIA cannot ensure that spectrum is being used efficiently by federal agencies. Furthermore, agencies are not required to submit justifications for their spectrum use and NTIA does not have a mechanism in place to validate and verify the accuracy of spectrum-related data submitted by the federal agencies. This has led to decreased accountability and transparency in how federal spectrum is being used and whether the spectrum-dependent systems the agencies have in place are necessary. Without meaningful data validation requirements, NTIA has limited assurance that the agency-reported data it collects are accurate and complete.

In our April 2011 report, we recommended that NTIA (1) develop an updated plan that includes key elements of a strategic plan, as well as information on how spectrum is being used across the federal government, opportunities to increase efficient use of federally allocated spectrum and infrastructure, an assessment of future spectrum needs, and plans to incorporate these needs in the frequency assignment, equipment certification, and review processes; (2) examine the assignment review processes and consider best practices to determine if the current approach for collecting and validating data from federal agencies can be streamlined or improved; and (3) establish internal controls for management oversight of the accuracy and completeness of currently reported agency data.²⁹ With respect to our first recommendation, NTIA has not developed an updated strategic plan and previously noted that the Presidential Memorandum of June 28, 2010, and the Wireless Innovation Initiative provide significant strategic direction for NTIA and the other federal agencies. In September 2012, NTIA officials told us that NTIA intends to update its strategic plan by October

²⁹GAO-11-352

2013. NTIA concurred with our other two recommendations and is taking action to address them. For example, NTIA has proposed approaches to implement new measures to better ensure the accuracy of agency-reported data, and is taking steps to implement internal controls for its data management system in a cost efficient manner.

With respect to spectrum sharing, there are currently insufficient incentives to encourage more sharing, and even if incentives were created, several barriers to sharing will continue. Options to address these issues in turn create new challenges, and may require further study.

Chairman Walden, Ranking Member Eshoo, and Members of the Subcommittee, this concludes my prepared statement. I will be happy to respond to any questions you may have at this time.

GAO Contact and Staff Acknowledgments

For further information on this testimony, please contact me at (202) 512-2834, or by e-mail at goldsteinm@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement. Individuals making key contributions to this testimony include Sally Moino and Andrew Von Ah, Assistant Directors; Amy Abramowitz; Colin Fallon; Bert Japikse; Elke Kolodinski; Maria Mercado; Erica Milles; and Hai Tran.

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Mr. WALDEN. Mr. Goldstein, thanks for the work you and your people do at GAO. We appreciate it.

We will now go to Mr. Doug Smith, President and CEO of Oceus Networks. Thank you for being here. We look forward to your comments, sir.

STATEMENT OF DOUGLAS C. SMITH

Mr. SMITH. Good morning, Chairman Walden, Ranking Member Eshoo, and distinguished members of the subcommittee. Thank you for inviting me to talk with you about how commercial wireless broadband technologies can provide opportunities to make government spectrum use more efficient and effective.

I am here today to discuss the importance of commercial wireless broadband technology, specifically, 4G LTE as a part of the tool set to meet growing broadband communications requirements for military and other Federal users.

Oceus Networks provides mobile broadband communication services and tactical military solutions for delivering high speed voice, video, and data communications. We are headquartered in Reston, Virginia, with a major R&D center in Plano, Texas. Our 4G LTE solution, Xiphos, provides mission-critical apps for Federal users, including the Department of Defense, for situational awareness, video streaming, voice over IP applications, among other lifesaving apps. Our solution provides the functionality of a full cellular network in a single unit to address warfighter broadband requirements on the move, without traditional cellular architectures.

Our mobile LTE networks can be placed aboard ships, installed in tactical warfighter vehicles, mounted on unmanned aerial systems, and/or be soldier backpacked. We provide these capabilities to standard headsets or switching algorithms. This allows the full cost savings of commercial economies of scale to flow to government users.

The mobile broadband revolution that is transforming consumers' daily lives has profound implications for government users, presenting both opportunities and challenges. DoD has a level of spectrum requirements that is unprecedented, driven by increasing data needs and increased reliance on advanced technology capabilities. Congress recognized the prevalence of LTE as the worldwide commercial standard for wireless broadband when adopting it as the standard for the nationwide public safety network. Such policies reflect an even larger reality. The expanded apps, continually evolving devices, and improved network performance of commercial mobile networks are embraced by most of our Nation's young men and women who are entering the military service. They grew up with wireless broadband devices, ranging from smartphones to tablets. They ask how the same advanced capabilities with stronger security features and military-appropriate apps could be made available when in training and in battle.

How are these technologies being used by the military today? One example is a Navy pilot in which Oceus Networks is participating to provide communication systems using our Xiphos solution, which marks the first operational deployment of 4G LTE for the Department of Defense. This 4G tactical network, using Android devices, will support communications, including classified

communications, for up to 3,500 Marines and sailors deployed with the Kearsarge Amphibious Ready Group. The project designates 4G as a mission-critical requirement for the Counter-Piracy Task Force, which mostly operates off the Horn of Africa.

Oceus Networks is also using its 4G LTE-based solution to support the FCC's consideration of the role of high altitude platforms in the national public safety network. In a trial this fall, we will demonstrate the role of 4G LTE in a rapidly deployable aerial communications architecture that can provide broadband communications to disaster areas shortly after the occurrence of a major natural disaster or terrorist attack.

As directed by the Middle Class Tax Relief Act, the FirstNet network will provide much-needed nationwide broadband reach for first responders, including deployment milestones for substantial rural coverage. Our mobile LTE solution cost effectively extends the LTE broadband footprint to public safety users in remote and rural communities.

Looking forward, policymakers are increasingly interested in sharing as a potential option to both enhance the effective and efficient spectrum use of government operations, and provide capacity for commercial broadband use. For new policies based on sharing to remain viable as a true win/win solution for commercial and government spectrum users, sharing must be viewed as a two-way street. To obtain improved economies of scale by adopting commercial technologies such as LTE, Federal users need access to commercial bands. As one aspect in a larger spectrum supportability tool set, this is an important option for government users, for whom modifying commercial technology to work effectively in government bands is expensive, time consuming, and off the commercial roadmap.

The timing of today's hearing comes as we remember the tragedy of September the 11th. It underscores the importance of giving our soldiers and first responders interoperable communications as they defend our Nation. Also this week, Apple has announced the release of LTE-based iPhone 5, which demonstrates widespread adoption of the technology and U.S. leadership in key technologies.

I want to thank the committee for asking the important question and raising awareness of how to advance commercial and military interests, and provide these critical advanced communications capabilities for our economy and our Nation's security.

Thank you for the opportunity to testify at today's hearing, and I look forward to answering any questions you may have.

[The prepared statement of Mr. Smith follows:]

Testimony of
Douglas C. Smith
President and CEO
Oceus Networks

Before the
House Energy and Commerce Committee
Subcommittee on Communications and Technology

Hearing on
Creating Opportunities through Improved Government Spectrum Efficiency
September 13, 2012 10:15 a.m.
Rayburn House Office Building 2123

Summary

Federal spectrum users require advanced commercial wireless technology to support bandwidth-intensive – and increasingly mobile – data communications to meet their mission. Commercial off-the-shelf technologies are an important part of the solution for how these needs are met.

DoD has a level of spectrum requirements that is unprecedented, driven by growing video and other data needs and increased reliance on advanced technology capabilities. Via state-of-the-art tactical use of LTE, Ocus Networks is committed to providing DoD and other Federal users the same technological capabilities for wireless broadband to which commercial consumers are now accustomed. With our portable 4G LTE broadband solution, *Xiphos*, we are demonstrating the capabilities of this technology to meet warfighter needs for many missions across the Services, including the first operational deployment of 4G LTE for DoD in the Navy. We are also using this solution to support the FCC's consideration of the potential role of High Altitude Platforms in the national public safety network.

As the globally accepted mobile broadband standard of choice, 4G LTE “evens the technology playing field” for government users. 4G LTE provides a clear way forward for many of DoD's advanced communications requirements by providing a technology roadmap with the same economies of scale, rapid technology life-cycles and low cost factors from which commercial users now benefit. Bringing the advantages of a commercial technology roadmap to Federal user requirements is impactful because:

1. Standardized commercial technologies such as LTE leverage the extensive ecosystem of commercial R&D investment and greatly reduce time from development to deployment.
2. Use of commercial wireless broadband technologies, when appropriate to meet mission needs, can allow military and other Federal government operations to use spectrum efficiently and cost-effectively.
3. Systems that rely on the same wireless broadband standard embraced in the commercial world (i.e., LTE) facilitate interoperability and sharing between government and private sector users.

Federal policymakers are increasingly looking to sharing as a potential option to both enhance the effective and efficient spectrum use of government operations and provide capacity for commercial broadband uses. Given the increasingly congested nature of the portions of spectrum most attractive for mobile broadband, the terms and conditions of how to apply a sharing framework to accommodate commercial operations in Federal spectrum are now being studied. For new policies based on sharing to remain viable as true “win-win” solutions, sharing should be viewed as a “two-way street.” Government and commercial use of standard technologies such as LTE facilitates the challenges associated with sharing over the long-term. Sharing is easier between “like” systems, recognizing that it is imperative that individual user requirements (i.e., national security needs) be protected.

Testimony

Good morning Chairman Walden, ranking member Eshoo and distinguished members of the Subcommittee. Thank you for inviting me to talk with you about how commercial wireless broadband technologies can provide opportunities to make government spectrum use more efficient and effective.

I. INTRODUCTION

Oceus Networks provides mobile broadband communications services and tactical military solutions for delivering high-speed voice, video and data communications. We are headquartered in Reston, Virginia, with a major R&D center in Plano, Texas.

The topic of today's hearing, "Creating Opportunities Through Improved Government Spectrum Efficiency," is very timely. A related, but critical, issue is the need that Federal spectrum users have for advanced commercial wireless technology to support bandwidth-intensive – and increasingly mobile – data communications to meet their mission. Commercial off-the-shelf technologies (COTS) are an important part of the solution set for how these needs will be met.

Need for 'Future-Proofed' Solutions: Few technology and policy challenges are more important for national security and economic growth. Fortunately, sound decisions can lead to "future-proofed" solutions, for both commercial wireless ecosystem development and the advanced, high-speed tactical and enterprise wireless communications required by military users on bases.

Across the Federal government, spectrum is a critical enabler. The mobile broadband revolution that is transforming consumers' daily lives has profound implications for government users, presenting both opportunities and challenges. DoD has described a level of spectrum

requirements that is unprecedented, driven by increased data needs and increased reliance on advanced technology capabilities.¹ Shrinking budgetary resources and a growing reliance on unmanned operations that require mobile, portable high-bandwidth solutions are other key drivers. In addition, the U.S. Armed Forces must maintain a high tempo of training, focused on expeditionary warfare capabilities, but with 80 percent of forces at home.² Warfighters are trained to fight through U.S.-based operations but must be ready to deploy with little or no notice. This means that for training and testing purposes, our soldiers, sailors and airmen and women require spectrum access on bases.

Through state-of-the-art tactical use of Fourth Generation Long Term Evolution technology, commonly known as 4G LTE, Oceus Networks is deeply committed to providing Federal users the same advanced technological capabilities for wireless broadband to which consumers have access. With our portable 4G LTE broadband solution, called *Xiphos*, we are today demonstrating the capabilities of this technology to meet warfighter needs for many missions across the Services, including the first operational deployment of 4G LTE for DoD in the Navy.³

The rapid evolution in modern communications technology is well-documented, with CTIA's semi-annual survey indicating that wireless data traffic grew 123 percent from 2010 to

¹ Statement by Teresa M. Takai, DoD Chief Information Office, Before the House Armed Services Committee, Subcommittee on Emerging Threats and Capabilities, on Fiscal Year 2013 Budget Request for Information Technology and Cyber Operations Programs, March 20, 2012, available at http://armedservices.house.gov/index.cfm/files/serve?File_id=d6d557bc-a941-49e0-996a-d29cf376fb0d.

² *CHIPS Magazine*, December, 2009, Interview with Commanding General, Network Enterprise Technology Command/9th Signal Command Maj. Gen. Susan Lawrence, available at www.doncio.navy.mil/chips/ArticleDetails.aspx?ID=2610.

³ Oceus Networks Press Release, "First U.S. DoD Operational Deployment of 4G LTE with Navy Pilot of Oceus Networks' Xiphos Solution," March 29, 2012, available at <http://oceusnetworks.com/news/oceus-news/first-us-dod-operational-deployment-4g-lte-navy-pilot-oceus-networks-xiphos™-solution>.

2011.⁴ However, this success story should not be limited to mass-market consumer devices. These capabilities meet mission needs today for Federal users who also need high-speed, mobile voice, video and data communications.

Parallel ‘Spectrum Crunches’: Oceus Networks appreciates the work that the Federal Spectrum Working Group has undertaken to examine more efficient ways for the Federal government to use spectrum. These challenges are neither new nor easy to resolve. Both commercial and government users face parallel trendlines of a “spectrum crunch” to meet growing bandwidth needs. Cisco estimates that video traffic will comprise 55 percent of all consumer Internet traffic in 2016, up from 51 percent in 2011, and that mobile data traffic will increase 18-fold between 2011 and 2016.⁵ With regard to mobile data services, I can personally vouch for these growing commercial requirements. I was an early employee at Ericsson in the United States and now have spent more than 20 years in the private sector working on broadband communications, including in support of carrier needs for wireless high-speed data.

At the same time, for DoD, there are parallel needs for bandwidth and apps for mission and enterprise use. As is the case in the private sector, these increased bandwidth requirements are driven, in part, by video, which has been a contributor to increased spectrum requirements. One case in point is the stunning increase in the number of Unmanned Aerial Systems (UASs), which rely on Federal spectrum, to process critical intelligence, surveillance and reconnaissance data, including through video transmission capabilities. For DoD, the number of UASs rose from

⁴ CTIA Press Release, CTIA-The Wireless Association® Semi-Annual Survey Shows Significant Demand by Americans for Wireless Broadband, April 13, 2012, available at <http://www.ctia.org/media/press/body.cfm/prid/2171>.

⁵ Cisco Visual Networking Index, The Zettabyte Era, May 30, 2012, available at http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/VNI_Hyperconnectivity_WP.html.

167 in 2002 to more than 7,500 in 2010.⁶ In the face of such increased demands, we laud the efforts that DoD is undertaking to use spectrum effectively to meet growing mission requirements for broadband. As DoD CIO Teri Takai recently noted: “We must ... recognize the growing spectrum demands resulting from [DOD’s] increasing reliance on spectrum-dependent technologies.”⁷

II. OVERVIEW

You may be asking why a player from a relatively new, but fast-growing, wireless technology firm is testifying today on this topic? I am here today to discuss the importance of commercial wireless broadband technology – specifically 4G LTE – as part of a toolset to meet the current and ever-emerging broadband communications requirements for military and other Federal users.

Oceus Networks recognizes that open, standards-based communications infrastructures, including those relying on 4G LTE, are not a one-size-fits all approach for all Federal spectrum user needs. Given the diversity of government spectrum requirements – for both communications and non-communications capabilities – no single technology could be. At the same time, it is a matter of long-standing DoD policy to rely on COTS technology, when technologically feasible to meet military requirements.⁸ As the Defense Science Board pointed out in a 2009 report: “Defense-funded research and development once drove commercial technology, but commercial technology now leads DOD in many key areas.”⁹ LTE is a prime

⁶ DOD News Article, “Defense CIO: Wireless Spectrum a Critical Enabler,” by Claudette Roulo, American Forces Press Service, July 20, 2012 available at <http://www.defense.gov/news/newsarticle.aspx?id=117210>.

⁷ Id.

⁸ 10 U.S. Code § 2501, “National security objectives concerning national technology and industrial base.”

⁹ Report of the Defense Science Board Task Force on Integrating Commercial Systems into the DOD,

example of this commercial-driven technology trend and the opportunity it presents for DoD and other Federal government users to leverage private industry R&D investments and have greater capabilities sooner and often at a lower cost than largely custom-built communications solutions.

4G LTE as Complement: DoD has a broad range of complex and often unique spectrum user requirements, for which the Department may need to rely on programs of record tailored to more specific mission requirements. Commercial technologies, including 4G LTE, are a strong complement to certain existing programs. LTE is the globally accepted mobile broadband standard of choice.¹⁰ As such, 4G LTE “evens the technology playing field” for government users. 4G LTE provides a clear way forward for many of DoD’s communications requirements by offering a technology roadmap with the same economies of scale, rapid technology life-cycles and low cost factors from which commercial users now benefit.

At the same time, these broadband communications requirements, based on LTE, are not often otherwise supported by commercial carriers on the bases and training ranges where warfighters require access, including remote parts of the country. As the FCC’s National Broadband Plan pointed out, increased spectrum demands are “primarily an urban phenomenon.”¹¹ Rather than waiting indefinitely for wireless broadband services to be made available as part of commercially deployed networks, portable LTE solutions such as ours are bringing this capability directly to our armed forces, where and when they need it.

“Effectively and Efficiently Buying Commercial: *Gaining the Cost/Schedule Benefits for Defense Systems*,” February 2009, Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, available at <http://www.acq.osd.mil/dsb/reports/ADA494760.pdf>.

¹⁰ “The Benefits of Using LTE Digital Dividend Spectrum,” 4G Americas, November 2011: “LTE is the global standard developed by the 3rd Generation Partnership Project (3GPP) for next-generation mobile broadband networks supported by all major players in the industry.” Available at www.4gamericas.org/documents/Benefits%20of%20LTE%20in%20Digital%20Dividend_11.08.11.pdf.

¹¹ FCC National Broadband Plan, Chapter 5, Spectrum, available at <http://www.broadband.gov/plan/>.

While the topic of security is outside of the scope of this hearing, Oceus Networks appreciates that this is an important issue for national security users. We are working with the Federal government to secure the 4G LTE waveform and user devices.

Federal Policy Drivers: Federal policy is increasingly recognizing the opportunities presented by powerful mobile broadband platforms, including LTE. Congress in its wisdom earlier this year recognized the prevalence of LTE as the worldwide commercial standard for wireless broadband when adopting it in the Middle Class Tax Relief and Job Creation Act as the standard for the nationwide public safety network for interoperability.¹² The White House issued a Digital Government Strategy earlier this year that included goals such as developing models for the delivery of commercial mobile applications into the federal environment.¹³ DoD released a ground-breaking Mobility Device Strategy in June.¹⁴

These important policy initiatives also reflect a larger reality. The expanded apps, continually evolving devices and improved network performance of commercial mobile networks are already embraced by most of our nation's young men and women who are entering military service. They grew up with wireless broadband devices ranging from smartphones to tablets. As a result, they ask how the same advanced capabilities, coupled with stronger security features and military-appropriate apps, could be made available on mobile devices when training and in the battlefield?

¹² PL 112-96, Section 6203.

¹³ "Building a 21st Century Digital Government," May 23, 2012, available at <http://www.whitehouse.gov/sites/default/files/omb/egov/digital-government/digital-government-strategy.pdf>.

¹⁴ DoD Mobility Device Strategy, June 8, 2012, available at www.defense.gov/news/dodmobilitystrategy.pdf.

III. COMMERCIAL TECHNOLOGY PATH FORWARD

As the Federal Spectrum Working Group has recognized, finding more efficient ways for government users to utilize spectrum “without compromising critical objectives” will produce valuable dividends for agencies and help foster economic growth in the private sector.¹⁵ To this end, DoD’s ability to harness commercial technological capabilities has several long-term benefits for our nation’s warfighters, both within the Continental United States (CONUS) and outside of it (OCONUS). Both scenarios are critical to members of the Armed Forces who need assured access to spectrum and modern technologies to “train as we fight.”

Bringing the advantages of a commercial technology roadmap to Federal user requirements is impactful because:

1. Standardized commercial technologies such as LTE leverage the extensive ecosystem of commercial R&D investment and reduce the time from development to deployment by years, and even decades. This is important for the ability to leverage today’s commercial innovations but even more important as it provides the ability for government users to more easily remain current going forward as emerging standards-based advanced capabilities are developed.
2. Use of commercial wireless broadband technologies, when appropriate to meet mission needs, can allow military and other Federal government operations to use spectrum even more efficiently and cost-effectively.
3. Deploying systems that rely on the same wireless broadband standard that is embraced in the commercial world (i.e., LTE) facilitates interoperability between government and private sector users.

¹⁵ House Energy and Commerce Committee press release, “Federal Spectrum Working Group Seeks Update on Government Spectrum Use,” July 10, 2012, available at <http://energycommerce.house.gov/press-release/federal-spectrum-working-group-seeks-update-government-spectrum-use>.

4. There is a technology gap between the technology development life-cycles of commercial cellular systems and specific DoD programs of record that can be measured in orders of magnitude. Relying on COTS, when it meets the mission, can help bridge this gap.

LTE offers technological capabilities that facilitate sharing between government, public safety and commercial users, including the ability to more easily coordinate operations in adjacent geographic areas. In addition, where security issues permit, it offers the ability for military users to roam onto a commercial network when leaving a base or installation. To help meet rising demands for mobile broadband data, Oceus Networks has been working with an array of Federal government and private sector users to ensure that 4G LTE technology solutions are part of comprehensive, forward-looking strategies for using commercial mobile broadband platforms.

Specifically, Oceus Networks delivers end-to-end cellular network solutions of varying sizes. These solutions range from full power macro solutions supporting multiple sectors to reduced size, backpack solutions. These deployable cellular solutions can be networked together to satisfy the needs of users over a large area. In contrast to traditional cellular networks, our highly survivable architecture establishes a core network in each radio node. Further, Oceus Networks offers a “network of networks” capability providing solutions for administration, maintenance, security, and provisioning. These features are accomplished via open interfaces facilitating expansion and integration with other systems. Nodes can be fixed, portable, mobile, airborne, marine, or ground. All nodes integrate into a network of networks, providing a seamless mobile experience for user and operator. All “networks of networks” interoperate with traditional mobile network architecture through open standard interfaces. The networks interoperate either as independent networks or as an integral part of a traditional carrier network.

Oceus Networks provides these capabilities securely and reliably, without changes to standard handsets or switching algorithms. This allows the full cost savings of commercial economies of scale to flow to Federal government users.

IV. MEETING WARFIGHTER REQUIREMENTS

Our 4G LTE solution *Xiphos* ensures that specific military user needs are addressed, through meeting specific encryption requirements and ruggedizing equipment as needed. We provide mission-critical apps for the warfighter, for situational awareness, video streaming and VoIP. Our mobile 4G LTE solution provides the functionality of a full cellular network in a single unit to address warfighter broadband requirements “on the move,” which would not be possible with fixed switching equipment. This means our mobile LTE networks can be placed aboard ships, installed in tactical warfighter vehicles, mounted on UASs and other aerial vehicles, and/or be soldier back-packed.

In addition, it is worth noting that it is no accident that for the first time in the history of the cellular wireless world, technology developers have converged on a single global standard technology of choice, which is LTE. What we are working on is strengthening our own product. However, we are also mindful that it would be a missed opportunity for Federal users to not incorporate LTE as part of their mobile data use profiles, to reflect the current commercial technology roadmap.

How are these technologies being used by the military today? One example is a Navy trial in which Oceus Networks is participating to provide communications systems using its 4G LTE-based *Xiphos* solution, which marks the first operational deployment of 4G LTE for the U.S. DoD. This technology allows the Navy to leverage the global mobile phone industry’s R&D investment. This 4G tactical network, using Android devices, will support communications,

including classified, for up to 3,500 marines and sailors deployed with the Kearsarge Amphibious Ready Group. The 4G solution that the Navy is currently testing here is an example of how Federal users are relying on commercial wireless broadband technology to use spectrum more efficiently and effectively. The data needs that the project supports free up limited bandwidth on intraship communications for other mission-critical needs. The project designates 4G as a “mission critical requirement” for the Counter-Piracy Task Force, which mostly operates off the Horn of Africa.¹⁶

V. REQUIREMENTS OF OTHER FEDERAL USERS

Oceus Networks is also using its 4G LTE-based solution to support the Federal Communications Commission’s consideration of the potential role of High Altitude Platforms in the national public safety network.¹⁷ In a Notice of Inquiry launched in May 2012, the FCC is considering how Deployable Aerial Communications Architecture (DACA) can restore the communications capabilities of first responders shortly after the occurrence of a major natural disaster or terrorist attack. DACA technologies are aerial technologies, ranging from UASs to weather balloons, which could provide emergency communications in the period immediately following a major disaster, when terrestrial communications infrastructures typically are damaged or disrupted. In a trial scheduled to begin this fall, we will demonstrate the role of 4G LTE in a rapidly deployable aerial communications architecture that can provide immediate broadband

¹⁶ Fast Company, “The 4G System That Powers The Navy’s Pirate Fights,” April 20, 2012, available at <http://www.fastcompany.com/1834739/4g-system-powers-navys-pirate-fights>.

¹⁷ FCC Notice of Inquiry, Utilizing Rapidly Deployable Aerial Communications Architecture in Response to an Emergency, adopted May 24, 2012, PS Docket No. 11-15.

communications to such disaster areas.¹⁸

Extending Reach with 4G LTE: Because the 4G LTE network based on *Xiphos* is an entire network of capability in each node, our robust, compact technology solution can be built to extend the reach of wireless broadband into remote or rural areas. These areas are not always a priority of coverage for large network operators, due to the cost-benefit trade-offs of deploying fixed networks to less densely populated areas. But for our *Xiphos* technology solution, this provides an excellent example of how advanced commercial wireless technology can enable more efficient and effective spectrum use in geographic areas that might not otherwise have access to the advanced communications capabilities provided with 4G LTE.

In the Middle Class Tax Relief Act, Congress envisioned the much-needed new public safety broadband network as providing nationwide reach to meet the broadband requirements of first responders, including deployment milestones for substantial rural coverage.¹⁹ To this end, our proven mobile 4G LTE solution can provide a cost-effective means to extend the national public safety network's LTE broadband footprint, both rapidly and cost-effectively, to reach public safety users in remote and rural communities. Given limits of time and funding, it is not otherwise reasonable to expect that a fixed cellular infrastructure could be feasibly built to completely fill out the required terrestrial footprint of the FirstNet network. But the portable 4G LTE solution developed by Oceus Networks could be deployed cost-effectively and quickly, including as part of vehicle-mounted solutions, to provide broadband connectivity to first responders as part of the FirstNet network. Multiple solutions will be required to extend the LTE

¹⁸ Oceus Networks Press Release, "Oceus Networks to Demonstrate Rapidly Deployable Networks for Public Safety," May 24, 2012, available at <http://oceusnetworks.com/news/oceus-news/oceus-networks-demonstrate-rapidly-deployable-networks-public-safety>.

¹⁹ PL 112-96, Section 6206.

footprint of the larger FirstNet network. The cost and time advantages of our solution are important given the need to stretch the finite FirstNet network funding as far as possible.

VI. SHARING AS A TWO-WAY STREET

Federal policymakers are increasingly interested in sharing as a potential option to both enhance the effective and efficient spectrum use of government operations and provide capacity for commercial broadband uses. Spectrum sharing based on time and geography is not a case of first impression, and in fact dates back to the creation of the Radio Act of 1912. But given the increasingly congested nature of the portions of spectrum most attractive for mobile broadband deployment, the terms and conditions of how to apply a sharing framework to accommodate commercial operations in Federal spectrum are now being studied. For new policies based on sharing to remain viable over the long-term as a true “win-win” solution for commercial and government spectrum users, sharing must be viewed as a “two-way street.” To obtain improved economies of scale by adopting commercial technologies such as LTE, Federal users need potential access to commercial spectrum bands. As one aspect in a larger spectrum supportability tool set, this is an important option for government users, for whom modifying commercial technology to work effectively in government bands is expensive, time consuming and off the commercial roadmap.

Need for Balance: The implications of finding solutions that get this balance right are far-reaching. Both Federal government and commercial wireless broadband users are integral to U.S. global leadership in mobile broadband technology. As the President’s Digital Government Strategy released earlier this year noted, the amazing mix of smarter mobile devices, cloud computing and collaboration tools is not only changing consumers’ experience but is “bleeding into government as both an opportunity and a challenge.”

Government and commercial use of standard technologies, such as LTE, facilitates the challenges associated with sharing over the long-term. Sharing is easier between “like” systems, although it is imperative that individual user requirements (i.e., national security needs) be protected. We are also studying the more dynamic-based sharing ideas raised in the recent recommendations to the President made by the President’s Council of Advisors on Science and Technology (PCAST). At the same time, we recognize that Dynamic Spectrum Access (DSA)-focused sharing may be more feasible in the longer-term, rather than currently available geography- and time-based alternatives.

VII. CONCLUSION

In sum, assured access to the kinds of modern advanced communications capabilities provided by technology solutions such as 4G LTE is essential for warfighters to maintain information dominance on the battlefield and for efficient and effective use as part of enterprise solutions.

Helping Federal users to harness the full advantages of 4G LTE is important for improving access to wireless broadband communications. To this end, Federal users need access to this technology in the bands identified by worldwide standards bodies for LTE deployment. As Congress has already recognized, this is a critical aspect of the buildout plans for the nationwide network for first responder interoperability that will unfold under FirstNet, which will rely on LTE technology in the 700 MHz band. In other areas, balanced policy approaches are also needed that view sharing as mutually beneficial to commercial and government users. Just as commercial users require access to current Federal spectrum bands for future deployments of 4G LTE, government users will need the flexibility to access bands that are globally harmonized for this technology, as well.

The stakes are high for getting the policy part of this equation right, including the terms of access for Federal users involved in first response. Ensuring a wireless broadband future for Federal government users that is on par with that of U.S. consumers is a key contributor to economic growth, technological competitiveness and national security.

Thank you for the opportunity to testify at today's hearing and I look forward to answering any questions you may have.

Mr. WALDEN. Mr. Smith, thank you. We appreciate your testimony and good work.

Now we will turn to Dr. Preston Marshall, Deputy Director, Information Sciences Institute, University of Southern California, who is an advisor to the President's Council of Advisors on Science and Technology.

Dr. Marshall, good to see you again. Thank you for being here. We look forward to your comments.

STATEMENT OF PRESTON MARSHALL

Mr. MARSHALL. Thank you, Chairman Walden and Ranking Member Eshoo. I appreciate this opportunity to continue the dialogue we had with many of the members and staff of the spectrum working group. My name is Preston Marshall. I am, as you said, Deputy Director of Information Sciences Institutes, author of several books in the field, and I was the program manager for 7 years at DARPA developing some of the wireless technology now being deployed in DoD, and have participated as an advisor.

Mr. Chairman, as you have noted, spectrum sharing is not new. There is nothing the PCAST report has that hasn't been done for decades. LTE shares with LTE, cellular shares with other commercial users, DoD shares with DoD, DoD shares with other Federal agencies, Federal agencies share with civil. What makes PCAST report unique is that it proposes to take sharing out of one-on-one relationships that are unpredictable and put it into a framework where every American can see what spectrum is available for new innovation and new business opportunities. It proposes to take it out of one-on-one relationships between a cellular provider and a Federal agency, and that Federal agencies document all the sharing opportunities they can provide, publish them, and make them available for innovators. Someone wishing to innovate in spectrum doesn't have to worry that they get into the death spiral or light-squared saw or M to Z, or some of these other conflicts. This is a fundamentally different approach to sharing. It is not technologically new, but it makes sharing the norm. It says we are going to share spectrum, we are going to document what it does. It addresses many of the issues the GAO brought up. It provides a way for Federal agencies to monitorize the value of the spectrum by having a secondary market but a right to share Federal spectrum. You can measure its goal.

We have always had a problem that Federal agencies can get acquisition money from Congress but not operational money. This is a way to bring an operational cash stream in to fund for the kind of offload for military systems to civil systems. It is appropriate. It provided a new framework at the White House for the spectrum management team to recognize that spectrum policy is fundamentally a policy decision, not just an engineering one, and to elevate and create and understand the tensions between economic opportunity and national security, and other Federal emissions.

We have been criticized—the report has been criticized for essentially concurring in the NTIA report, and that is certainly true. It concurred in the general framework that sharing—clearing spectrum has become increasingly difficult. We essentially created a—certainly you don't have it in California, but if you grew up in New

England, as a plow pushes against the snow, it starts out very soft and it becomes and turns into hard ice. Well in some cases, our Federal spectrum has turned into hard ice. We pushed and pushed, we compressed Federal users. It becomes exponentially more difficult to relocate them. Where it can be done, my reading of the PCAST report is that it was quiet. If there are ways to clear 25 megahertz or 50 megahertz for cellular, it in no way proposes to stand in the way. What it does say is that our goal should not be 50 or 100 megahertz, it should be support massive innovation throughout the spectrum on an order of a gigahertz a spectrum. And the only way to do that is to share what is there. We are not going to relocate a gigahertz of Federal users.

We are enabled in this by the fact that new low power technologies are much more sharable. When you look at the report from NTIA and you look at the restrictions on the use of, say the 3.6 gig band, you see that it is essentially useless for civil if you put high power LTE, but massively useful if you put low power devices. There is a convergence between where technology is going and where spectrum sharing can do. More power, more local communications is the way we are going to meet wireless needs, and spectrum sharing is particularly appropriate to that.

For those who read the report and say my gosh, it is all different, we will have to do different things, imagine if you had gone to the wireless industry 10 years ago, perhaps when Mr. Sharkey was at QUALCOMM, and said we want you to take your—50 percent of your wireless business, put it over congested, open to everyone, shared with every device in the country, \$100 devices, only 80 megahertz, and all of you have to share it, they would have laughed at you, and yet today, over half of our smartphone traffic runs across wifi. These are the opportunities for innovation. We are the first to meet this. We are the first to come up against this spectrum crunch. This is not bad, this is an opportunity to own the beach front innovation, and the key to that is sharing spectrum, not to walk away from licensed and exclusive use. I am a communications engineer. I know I would rather have a clear channel. I don't want to deal with sharing, but if the alternative is no spectrum at all, then this is a desirable path. This is an opportunity to do all of the above, continue the path on unlicensed and exclusive licensing, but open up this new opportunity for this third way which goes right down the middle. It draws the best from licensed use and it draws the best from unlicensed.

Thank you very much.

[The prepared statement of Mr. Marshall follows:]

**Prepared Remarks by Dr. Preston Marshall for the House Energy and Commerce
Subcommittee on Communications and Technology hearing:**

"Creating Opportunities through Improved Government Spectrum Efficiency."

Thursday, September 13th

Summary of Points to be made:

1. Spectrum Sharing is not new, and we know how to do it. The PCAST advance is to propose it become transparent and systematic so it can support innovation and new services without the disruption and cost of relocating Federal or Commercial users.
2. Industry has invested and innovated in shared spectrum, such as WiFi for enhanced cellular carrier offload, despite its shared and less predictable nature. The recommendations PCAST made will create enormously more opportunities for innovation and investment in technologies that would not be viable, given the delay, risk, and cost of long-term, licensed spectrum.
3. Lower power technologies, such as femtocells make sharing spectrum with Federal users more viable, and can exploit spectrum that is unsuitable for higher power uses.
4. Spectrum policy should consider that we do not know what the next big innovation will be. Flexible spectrum policy is likely to be critical to the viability of many innovations, and America's ability to lead in innovation.
5. PCAST report is not dependent on any new technology. Its technology assumptions are highly conservative, and available now.
6. While the NTIA report may not be "perfect", it is unlikely to be fundamentally incorrect in its premise that it is increasingly difficult, expensive, and disruptive to relocate Federal users. Some new mechanism is required to make use of this unused spectrum.
7. In summary, the PCAST recommendations do not remove any current access from either Federal or commercial users, and provide the opportunity for at least doubling the spectrum available for innovation throughout our economy.

**Prepared Remarks by Dr. Preston Marshall for the House Energy and Commerce
Subcommittee on Communications and Technology hearing:
“Creating Opportunities through Improved Government Spectrum Efficiency.”
Thursday, September 13th**

Thank you Chairman Walden, and Ranking member Eshoo. I appreciate the opportunity the Committee has provided to comment on spectrum policy, and some of the technology implications. I welcome this opportunity to continue the informal dialog we had with many of the members and staff of this committee.

My Name is Preston Marshall, and I am Deputy Director of the Information Sciences Institute at University of Southern California's Viterbi School of Engineering. I am also a Research Professor in the Ming Hsieh Department of Electrical Engineering. I am the author of two books on the subject of wireless networks, the latest of which is due to be released by Cambridge University Press in the fall. I was Program Manager for seven years of the Defense Advanced Research Projects Agency managing projects in wireless and networking, including the dynamic spectrum access program. I also participated as a technical advisor to the President's Council of Advisors on Science and Technology (PCAST) study titled "Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth." However, the opinions expressed here are my own, and not that of PCAST.

Spectrum sharing is not new. Cell towers share with cell towers, Federal users share with other Federal users, and often Federal users share with specific civil users, as well. Just recently, the FCC approved a Special Temporary authorization for T-Mobile to experiment with sharing one of the most contentious bands, 1755 MHZ. What makes the PCAST recommendation new and exciting is that it makes Federal spectrum sharing systematic and transparent. This will be based on a fundamental principle that underutilized Federal

spectrum should be shared to the greatest possible extent. Sharing opportunities would be visible to all potential users. No special connections or knowledge of Federal agencies or regulators would be required for potential innovators, or current spectrum users to determine the availability of sharable spectrum. A marketplace for sharing spectrum rights would operate to monetize these opportunities for the Federal Government, and to ensure protection for investors and innovators in these bands.

I have heard it said that industry would not invest in shared spectrum. Clearly this is not correct. Industry finds shared spectrum quite acceptable for investment, as we see more and more investment in large scale WiFi networks in unlicensed, shared spectrum. It is true that these investments have a very different cost and obsolescence structure than the large cellular towers, but this is exactly the innovation that is needed to bridge the gap between these two extreme models of wireless, and meet the need for exponential, not linear, growth in wireless capacity. In my opinion, the PCAST report recommendations will lead to any number of technology and service opportunities that can leverage the unique opportunities provided by different characteristics of spectrum, licensing, and exclusive operation.

The success of WiFi has another lesson for us. One of the major carriers has stated that it has shifted over half of its smartphone traffic to WiFi offload. The WiFi 2.4 GHz spectrum is significantly less than that exclusively licensed by that carrier. Just their usage of WiFi (a small fraction of all WiFi usage) is providing more capacity per MHz than the dedicated cellular spectrum.

I am not arguing for WiFi, but this does demonstrate that low power, localized communications is the solution to the bandwidth needs in our dense usage areas. Whether supplied by carrier, or private, femtocells, microcells or WiFi, the fact is that these low power systems essentially replicate their bandwidth hundreds of times in the same area that a tower has only one unit of capacity. This is the only way to meet bandwidth demands. Even if Federal usage was reduced to zero, the additional spectrum would only double the available spectrum, clearly not enough to meet demands for 50 or more times user bandwidth!

The use of smaller and smaller, low power cell sites is central to the ability to leverage Federal spectrum by commercial wireless. While sharing Federal spectrum with high power towers might have severe challenges, sharing with these emerging, low power, often indoor technologies provides a practical and effective application of spectrum that otherwise would serve no one. For example, the NTIA report shows that exclusion zones for the 3600 MHz band would essentially preclude access to most of the US population when sharing with high power LTE, but could be highly useful when used for lower power applications, such as femtocells.

It is true that the proposed sharing regime is not the same as the current exclusive regimes. Different does not mean inferior. The introduction of unlicensed spectrum was different, but it led to the explosion of unlicensed innovation, and an industry largely dominated by US Corporations. I believe the PCAST proposal provides for many more such opportunities for US firms to innovate and develop new products for the home market, and be in a position to dominate this technology as these principles are adopted worldwide. And, this opportunity does not require reallocating spectrum from any existing or future application,

just sharing the spectrum currently allocated to, and needed by, Federal users, and therefore not available for reallocation.

We should not assume that spectrum policy must consider only cellular. Innovation had been rampant when we have made spectrum available. Again, WiFi is a good example for this. However, it is hard to see that the current spectrum policy alternatives, which are completely shared, or auctioned and exclusively licensed, can support the emergence of new technologies. The National Broadband Plan shows the average delay from spectrum being identified to being used is over eight years. Issues with incumbent users, and band clearing can add years to this, as well as risk to the investment, as we all saw in the LightSquared issues. This is a poor environment to foster the innovation needed in this highly dynamic space. It fails to support the innovation cycle that has been so successful in creating domination in Internet, applications, devices, and Smartphones, as examples. For US companies to dominate these future environments, we must have a spectrum policy that enables them to predictably, rapidly, and affordably obtain access to spectrum to develop and promote these applications.

Some have commented that the PCAST report depends on high-risk technologies. If anything the opposite is true. There are exciting technologies that could have been included in the recommendations. An example of this is the Dynamic Spectrum Access technology I worked on at DARPA. However, the recommendations initiate spectrum sharing using very conservative and available technology that extends the current analytic approach to spectrum sharing. It builds on systems that have already been approved by the FCC for the TV Whitespaces. It is a pragmatic solution using today's technology.

I believe the PCAST report was correct in not challenging the fundamental conclusions of the NTIA report. While it is possible that specific Federal usages, relocation costs, or required timelines could be challenged, such system-by-system adjustments would not be likely to change the overall dynamic. Relocation of Federal users will be increasingly more expensive, technically challenging, operationally disruptive, and costly. A metaphor for this might be that when a plow first pushes against snow, it moves easily, but with increased movement, the snow compresses and becomes an intractable block of ice. With each reallocation, Federal users are, and will become more compressed into the remaining Federal spectrum, and reallocation will be increasingly difficult.

Further, the report recognizes that Federal usage is no more static than civil, and faces the same growth in information access seen in civil users. The PCAST report approach enables Federal usage to evolve, and avoids locking Federal users into a new, but equally rigid and inflexible set of spectrum assignments.

Another comment I have heard is that the PCAST recommendations abandon the successful model of exclusive licensing. I did not read that anywhere in the report! Spectrum that can be freed up through mechanisms such as incentive auctions, clearing, or other repurposing could still be provided for exclusive use auctions. What it does say is that the current toolkit to deploy spectrum for use by the civil community is inadequate, and can not make best use of spectrum that would otherwise lie fallow. Would industry prefer to let this spectrum remain unusable, rather than be provided for use under potentially restrictive terms. If so, the marketplace will respond that way. However, our experience shows otherwise. The investment by industry in WiFi and carrier offload into the non-exclusive,

and massively congested unlicensed bands is proof that exclusive control is not a prerequisite for investment.

Spectrum sharing is not in opposition to license or auction processes. Instead, it is an alternative to letting spectrum lay fallow due to allocation policies that are not flexible enough to accommodate a wide range of applications and usage. Additionally, spectrum sharing offers the opportunity for revenue from spectrum that would otherwise not be eligible for auction. It eliminates the delay for clearing and auction, we enable a much wider range of bidders. I read the PCAST report as clearly embracing market solutions, and applying them to a whole new class of spectrum.

Lastly, I believe the PCAST recommendations are very friendly to, and enabling for innovation: Current spectrum allocation processes take ten years through the clearing and auction process, have high levels of uncertainty due to the political and regulatory process, and carry risk due to unknown impact on incumbent users. This is hardly conducive to the investment ecosystem that has spawned US domination in many areas of technology.

In summary, why should anyone oppose this approach? It takes nothing off the plate for commercial spectrum users. If bands can be cleared and auctioned with exclusive licensing, and I believe the PCAST recommendations in no way preclude that. If Federal spectrum is as underutilized as some say, then that spectrum will be almost immediately available for use. If federal users could more effectively utilize commercial services, then there is a model for that spectrum to be placed into a secondary sharing rights market, generate revenue, and have that revenue defray the costs of the commercial services, and provide revenue.

Yes, the PCAST recommendations represent change, but it is change that takes nothing from current users; either commercial or Federal, and provides both category of participant the flexibility to fully exploit the full extent of the national spectrum resource.

What more desirable accomplishment could any recommendation provide?

Thank you very much for your time and attention.

Mr. WALDEN. Thank you, Dr. Marshall. We appreciate your comments and your good work on the PCAST report, and for briefing our committee before.

We will now go to Mr. Mark Racek, Director, Spectrum Policy of Ericsson. So we appreciate your being here and look forward to your testimony. Go ahead.

STATEMENT OF MARK RACEK

Mr. RACEK. Thank you, Mr. Chairman, and good morning to all the members of the committee. My name is Mark Racek and I help lead the development of Ericsson's global legislative, regulatory, and industry positions with regard to spectrum. As communication changes the way we live and work, Ericsson is playing a key role in this evolution. Using innovation to empower people, business, and society, we are working towards a networked society in which everything that can benefit from a connection will have one.

For our part, Ericsson is responsible for more than 40 percent of the world's mobile traffic which passes through our networks every day serving roughly 2.5 billion subscribers, and we have been at this game a long time. When our company was founded 136 years ago, Ulysses S. Grant occupied the White House. With time has come experience, knowledge, and we believe, credibility.

The lifeblood of the networked society is a network that is built on a robust mobile broadband ecosystem made possible by access to sufficient licensed spectrum, something that is in short supply and high demand.

A market data report Ericsson released last month cited a doubling of global mobile data traffic from 2011 to 2012 with a growth forecast of 15 times that amount by 2017. Ericsson invests more than \$5 billion annually in research and development, employs 22,000 R&D engineers, and holds 30,000 patents, all in an effort to improve the capability of networks and increase the efficient use of spectrum. But technology alone won't cure the demand for capacity.

Mr. Chairman, you and your colleagues deserve a great deal of praise for passing voluntary incentive auction legislation. While this key achievement was an important step, the question still remains, where can more spectrum be found?

Federal spectrum holdings prove to be the next logical possibility given that Federal Government is the largest user of spectrum below 3 gigahertz. And the new spectrum law is encouraging efficiency through collaboration with industry, and the Federal spectrum holders. As opportunities are identified within the Federal Government, a determination must be made as to which approach will serve the solution best, spectrum clearing or spectrum sharing?

Being a global leader in building networks that can operate in numerous spectrum ecosystems, we believe there are two key points to keep in mind as we answer that question.

The first is that clearing spectrum for licensed use is still the best option available today. The engineering is ready and there is a well-established and commercial business model for providers to rely upon to profitably build and operate such systems.

Second, while there is a lot of interest in the concept of spectrum sharing, I would caution policymakers from being too optimistic

about its potential. There are a host of challenges to building and operating shared spectrum networks and there is no evidence yet that business models exist to sustain them. The examples of challenges come in at least four different areas. The first is economic potential. The value of spectrum is directly dependent upon the extent to which services can be guaranteed. There has not been sufficient testing of technology or economic modeling to prove that the types of services can be met by a system predicated on sharing. Without these certainties, there will be little incentive for large scale investment.

Number two is the technical and commercial viability. Existing commercial mobile technologies have been optimized based upon a well-understood licensed spectrum, which has fueled innovation and investment. The technical requirements for a shared environment, on the other hand, are undefined and will require significant time for researching and for testing.

Number three, the operational complexity. For sharing to work, carriers will need clear answers to many questions about operational constraints. For example, what kinds of services can be supported in a shared environment, or can the spectrum be used nationwide?

And finally, number four, the regulatory structures. Sharing raises a number of regulatory challenges which will take years to test and model. Will shared spectrum users have to meet public interest requirements such as CALEA and E-911? Can this spectrum be auctioned? What are the interference protections for incumbent users?

Taken together, I believe that an analysis including these four factors leads us to the conclusion that while spectrum sharing solutions in the right circumstances may be able to support licensed operation and should be further assessed, sharing should not be considered as a substitute for cleared, licensed, spectrum to meet our Nation's needs. And when met, those needs will yield great returns for the economy.

The work ahead will be challenging, but our mission is clear: to ensure that everything that can benefit from being connected is connected. This will transform lives, it will revolutionize businesses, but more important than that, it will have a profound impact on our entire society. Our industry needs spectrum to deliver on that promise.

Thank you, Mr. Chairman, for the invitation to be here today, and I look forward to answering any questions that this subcommittee has.

[The prepared statement of Mr. Racek follows:]

Before the
Subcommittee on Communications and Technology
United States House of Representatives

Hearing on
"Creating Opportunities through Improved Government Spectrum Efficiency"

Statement of Mark Racek
Director, Global Spectrum Policy
Ericsson Inc.

September 13, 2012

Mark Racek, Ericsson Inc.

September 13, 2012

Summary of Key Points

- Using innovation to empower people, business and society, we are working towards the networked society, in which everything that can benefit from a connection will have one.
- High-performing, cost-efficient, mobile networks depend on continued development of 4G/LTE technology and advanced network architectures, and will only exist with a robust mobile broadband ecosystem made possible by access to sufficient spectrum.
- Technology alone won't cure the demand for more spectrum. The allocation of additional licensed spectrum is the best way to relieve congestion and promote prosperity, jobs, and innovation.
- While spectrum legislation signed into law earlier this year was a key achievement, the question still remains – where can more spectrum be found?
- Federal spectrum holdings prove to be the next logical possibility given that the federal government is the largest user of spectrum below 3GHz.
- Spectrum sharing comes with a number of key challenges:
 - #1 Economic Potential - The value of spectrum is directly dependent upon the extent to which services can be guaranteed.
 - #2 Technical and Commercial Viability - The technical requirements for a shared environment are undefined and will require significant time for research and testing.
 - #3 Operational Complexity - For sharing to work, carriers will need clear answers to many questions about operational constraints.
 - #4 Regulatory Structures - Sharing raises a number of regulatory challenges all of which will take years to test and model.
- In conclusion, while spectrum sharing solutions can, in the right circumstances, support licensed operation and should be further assessed, sharing should not be considered a substitute for cleared, licensed spectrum to meet our nation's needs.

Mark Racek, Ericsson Inc.

September 13, 2012

Written Testimony of Mark Racek, Ericsson Inc.

Thank you Mr. Chairman and good morning to all the members of the Committee.

My name is Mark Racek and I serve as Director of Spectrum Policy for Ericsson. In that capacity, I help lead the development of Ericsson's global legislative, regulatory, and industry positions with regard to spectrum. As communication changes the way we live and work, Ericsson is playing a key role in this evolution. Using innovation to empower people, business and society, we are working towards the networked society, in which everything that can benefit from a connection will have one.

For our part, Ericsson is responsible for more than 40 percent of the world's mobile traffic which passes through our networks every day serving roughly 2.5 billion subscribers. We are the fifth largest software company in the world. And we've been at this game a long time – when our company was founded 136 years ago, Ulysses S. Grant occupied the White House. With time has come experience, knowledge, and we believe, credibility.

The lifeblood of the networked society is a network that delivers what users want – wherever they are. This high-performing, cost-efficient, mobile network which in turn depends on continued development of 4G/LTE technology and advanced network architectures, will only exist with a robust mobile broadband ecosystem made possible by access to sufficient spectrum.

Mark Racek, Ericsson Inc.

September 13, 2012

This subcommittee knows too well the severe spectrum shortfall our country faces due to sharp increases in spectrum demand. A market data report Ericsson released last month cited a doubling of global mobile data traffic from 2011-2012 with a growth forecast of 15 times that amount by 2017. Ericsson invests more than five billion dollars annually in research and development, employs 22,000 R&D engineers, and holds 30,000 patents in support of our effort to improve the capability of networks and increase the efficient use of spectrum. But technology alone won't cure the demand for capacity. The allocation of additional licensed spectrum is the best way to relieve congestion and promote prosperity, jobs, and innovation.

Mr. Chairman, you and your colleagues deserve a great deal of praise for passing voluntary incentive auction legislation contained in the 'Middle Class Tax Relief and Job Creation Act.' While this key achievement was an important step, less than a quarter of the 500 MHz needed by 2020 and outlined in the Administration's National Broadband Plan will likely be made available. Our industry is investing billions to drive spectral efficiency and performance in existing bands, but we know it won't be enough. So the question still remains – where can more spectrum be found?

Federal spectrum holdings prove to be the next logical possibility given that the federal government is the largest user of spectrum below 3GHz. And the new spectrum law is encouraging efficiency through collaboration with industry. For example, in the area of public safety, FirstNet's adoption of standards-driven LTE is a model that can be used by federal agencies to benefit from commercial technology

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and increase spectral efficiency. In addition, federal agencies could also utilize commercial services wherever possible instead of relying on dedicated spectrum and dedicated systems. As similar opportunities are identified within the federal government, a determination must be made as to which approach will serve the solution best – spectrum clearing or spectrum sharing?

As a global leader in building networks that can operate in numerous spectrum ecosystems, I believe there are two key points to keep in mind as we answer that question:

First, clearing spectrum for licensed use is the best option available today. The engineering is ready and there is a well-established and commercial business model for providers to rely upon to profitably build and operate such systems.

Second, while there is a lot of interest in the concept of spectrum sharing, I would caution policymakers from being too optimistic about its potential. There are a host of technical and engineering challenges to building and operating networks that will rely upon shared spectrum and there is no evidence yet that business models exist to sustain them. The examples of challenges come in at least four areas:

#1 Economic Potential

The value of spectrum is directly dependent upon the extent to which services can be guaranteed. There has not been sufficient testing of technology or economic modeling to prove that the types of services consumers demand can be met by a

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system predicated on sharing. Without these certainties, there will be little incentive for large scale investment.

#2 Technical

Existing commercial mobile technologies have been optimized based on well-understood licensed spectrum, which has fueled innovation and investment. The technical requirements for a shared environment, on the other hand, are undefined and will require significant time for research and testing. In addition, every sharing situation is unique. So even if one branch of government's spectrum is freed via sharing, there is no guarantee that another branch's spectrum can be utilized in the same way. In addition, many popular sharing technologies such as cognitive radio simply aren't commercially viable today.

#3 Operational

For sharing to work, carriers will need clear answers to many questions about operational constraints. For example, what kinds of services can be supported in a shared environment? Can the spectrum be used nationwide? What incentives will be in place to encourage collaboration between licensees?

And finally,

#4 Regulatory

Sharing raises a number of regulatory challenges all of which will take years to test and model. Will the users of shared spectrum have to meet public interest requirements such as CALEA and E-911? Can this spectrum be auctioned? What

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about interference protections for incumbent users? Who will enforce issues that arise from interference or infringement? Who will develop the tests necessary to determine whether devices interfere? What legal rights will users and networks have with regards to federal spectrum?

These questions must be answered in advance to provide assurances for any potential operation to develop a business model for a shared environment.

Taken together, I believe that an analysis including these four factors leads us to the conclusion that while spectrum sharing solutions can, in the right circumstances, support licensed operation and should be further assessed, sharing should not be considered a substitute for cleared, licensed, spectrum to meet our nation's needs. And when met, those needs will yield great returns for the economy.

In the future, we see a world where everything that can benefit from being connected, is connected. This will transform lives. It will revolutionize businesses. But more than that, it will have a profound impact on our entire society. Our industry needs spectrum to deliver on that promise. We at Ericsson stand ready to support Congress, the Administration, and our industry colleagues in meeting that goal.

Thank you, Mr. Chairman, for the kind invitation to be a part of this important discussion today and I look forward to answering any questions that you, or any other members of the committee, may have.

Mr. WALDEN. Mr. Racek, thank you for your testimony and your work on this topic.

And now to our final witness on today's panel, Mr. Steve Sharkey, who is the Director, Federal Regulatory Affairs, and Chief Engineering and Technology Policy for T-Mobile USA, Inc. Mr. Sharkey, thank you for being here. We look forward to your testimony.

STATEMENT OF STEVE B. SHARKEY

Mr. SHARKEY. Thank you. Good morning, Chairman Walden and Ranking Member Eshoo, and members of the subcommittee. My name is Steve Sharkey and I am the Director, Chief Engineering and Technology Policy for T-Mobile, USA. Thank you for inviting me to testify today.

Mobile broadband is a significant economic driver, providing millions of jobs, economic opportunities for Americans, and billions of dollars in productivity improvements that help America compete in a global economy. The demand for mobile broadband data continues to grow at an unprecedented rate, and the need for additional spectrum to meet this demand is well-documented. The wireless industry is investing billions of dollars in new technologies to solve this problem by improving spectrum efficiency, adding cell sites, and improving network management practices, but it will not be enough. Additional spectrum must still be made available to meet exploding demand.

Among bands under consideration for reallocation, the 1755 to 1780 megahertz band stands out as uniquely suited for commercial use. This spectrum is immediately adjacent to spectrum that we use today for mobile broadband, and could be readily integrated with existing networks to expand services. The band is identified internationally and already used around the world for mobile broadband. Harmonized use of spectrum will facilitate rapid equipment development and service deployment, and produce economies of scale and scope that reduce the cost of deploying services.

There is also broad support in the wireless industry for pairing the 1755 to 1780 band with spectrum currently available for licensing at 2155 to 2180 megahertz, which Congress required to be licensed by February of 2015. Pairing 1755 to 1780 with 2155 to 2180 aligns with existing services and will facilitate faster deployment and maximize efficient use of the spectrum.

These benefits are reflected in how the spectrum is valued. One study found that auctioning the 2155 to 2180 megahertz band by itself would yield \$3.6 billion, but auctioned together with 1755 to 1780, the band would generate \$12 billion, over three times as much. Auctioning these bands on a paired basis will ensure the best economic return for taxpayers and provide the most efficient use for broadband services.

NTIA released a report earlier this year describing the considerable challenges to making the 1755 to 1780 megahertz band available for commercial use, given current Federal operations. T-Mobile believes, however, that the assessment of these challenges and their costs are overly pessimistic. T-Mobile's experience in relocating Federal users from the AWS-1 band, which was also reallocated from Federal to commercial use, demonstrates that the chal-

Challenges of relocation and sharing during a transition can be significantly overcome with dialogue and cooperation between Federal users and industry.

Fortunately, several steps have now been taken that T-Mobile believes will provide a path forward to transition the 1755 to 1780 megahertz band from Federal to commercial use. First, the FCC, working with NTIA, has granted T-Mobile special temporary authority to explore the prospects for limited sharing of the band. As part of an industry effort, we have already begun to work with the Department of Defense to identify the locations at which we will monitor the use of the band, and are pleased with the spirit of cooperation that has characterized our work with the Department of Defense and others so far. We anticipate that preliminary results for monitoring and simulations will be available before the end of the year and will provide a foundation for field testing.

Second, T-Mobile is participating in working groups created under NTIA's Commerce Spectrum Management Advisory Committee, or CSMAC. These working groups are a forum for exchanging technical and operational information between Federal entities and industry regarding their respective systems and the potential for sharing or facilitating relocation out of the band.

Third, important changes to the Commercial Spectrum Enhancement Act, or CSEA, provide resources for government agencies to study relocation options and to update equipment to facilitate clearing or shared use of the spectrum. We are hopeful that these efforts, taken together, will provide a path forward for making the 1755 to 1780 megahertz band available on a primary basis for commercial broadband use, while fully protecting Federal operations.

Where sharing is necessary, either through a transition period or indefinitely, it is important that the conditions for shared use are well understood and are clearly defined, and that substantial access for commercial operations is provided.

Certainty regarding the extent of access to the spectrum is necessary to provide the incentive for carriers to make the very substantial investments needed to deliver world-leading, high quality mobile broadband services to American consumers.

Thank you again for the opportunity to appear before you today. T-Mobile looks forward to continuing to work with you on these important and timely issues. I would be pleased to answer any questions you have.

[The prepared statement of Mr. Sharkey follows:]

**TESTIMONY OF STEVE B. SHARKEY
DIRECTOR, CHIEF ENGINEERING AND TECHNOLOGY POLICY,
T-MOBILE USA, INC.**

on

**CREATING OPPORTUNITIES THROUGH IMPROVED GOVERNMENT SPECTRUM
EFFICIENCY**

before the

**SUBCOMMITTEE ON COMMUNICATIONS AND TECHNOLOGY
HOUSE COMMITTEE ON ENERGY AND COMMERCE**

September 13, 2012

TESTIMONY OF STEVE B. SHARKEY**DIRECTOR, CHIEF ENGINEERING AND TECHNOLOGY POLICY,
T-MOBILE USA, INC.****Introduction**

Good morning Chairman Walden, Ranking Member Eshoo, and Members of the Subcommittee. My name is Steve Sharkey, and I am Director, Chief Engineering and Technology Policy for T-Mobile USA, Inc. T-Mobile, headquartered in Bellevue, Washington, offers nationwide wireless voice and data services to individual, business and government customers. It is the fourth largest wireless carrier in the United States and serves approximately 33 million subscribers. I have overall responsibility for T-Mobile's technical policy agenda before government. Thank you for inviting me today to testify regarding efforts to create opportunities to make additional spectrum available for commercial broadband services through improved government spectrum efficiency.

The Need for More Spectrum

The need for additional spectrum for commercial mobile broadband services is well documented. As FCC Chairman Genachowski has noted, spectrum is the "oxygen" of the wireless industry, and "if we don't free up more spectrum, we're going to run into a wall that will stifle mobile innovation, hurting consumers and slowing economic growth." T-Mobile wholeheartedly concurs. We have repeatedly stated that more spectrum is essential for carriers to accommodate the changing wireless market and to meet increasing demands from consumers.

According to a 2012 report by Recon Analytics, the Nation's mobile communications industry is a significant economic engine, directly or indirectly supporting 3.8 million jobs, or 2.6 percent of all U.S. employment, contributing \$195.5 billion to the U.S. gross domestic

product and driving \$33 billion in productivity improvements in 2011. The industry is expected to expand as businesses and consumers increasingly rely on wireless technologies, including bandwidth-intensive smartphones, tablets, and other hand-held devices as well as machine-to-machine communications. A recent report issued by Cisco, for instance, predicts that global mobile data traffic will increase 18-fold between 2011 and 2016 at a compound annual growth rate of 78 percent.

To help meet this demand, wireless carriers continually implement new and more efficient technologies and techniques to maximize the capacity of our limited spectrum. In fact, T-Mobile, which initially implemented technology evolutions every seven to eight years, now updates its technology almost annually to provide leading edge services that make the most of the spectrum we have. For instance, our predecessor Voicestream Wireless began providing service in 1994 using GSM technology. In 2002, T-Mobile launched the U.S.'s first Blackberry device using one of the first General Packet Radio Service, or GPRS networks. In 2006, we deployed EDGE technology in the network and also purchased additional spectrum for approximately \$4.3 billion at auction. Service using that new spectrum was launched in 2008 with a UMTS 3G deployment that was quickly upgraded to HSPA technology. In 2009, T-Mobile was the first carrier to launch an HSPA+ network, and in 2011 was the first carrier to launch an HSPA+ dual carrier network. Finally, in 2012, we announced our plan to launch LTE, or Long-Term Evolution, service in 2013.

In addition to using the newest technology, commercial wireless networks typically offload traffic to Wi-Fi systems where available to reduce the demand on commercial broadband spectrum, thereby reducing the overall need for additional spectrum. However, these and similar

industry efforts to use our spectrum more efficiently are simply not enough. To meet the ever-increasing demand for mobile broadband, more spectrum must be made available.

There are two potential sources for additional spectrum – reallocating spectrum used either for existing non-government operations or by Federal users. On the non-government side, Congress earlier this year passed legislation authorizing the FCC to reallocate television broadcast spectrum through the use of voluntary incentive auctions. Previous efforts relocated private users of valuable fixed microwave spectrum that could be used for mobile services. While the wireless industry continues to look for opportunities to use private sector spectrum more efficiently and for the services that are most highly valued, these efforts will be insufficient to meet the growing demand. We must therefore also look to spectrum used by government agencies to ensure that it is used as efficiently as possible and to seek opportunities to make some of the government spectrum available for commercial use.

T-Mobile recognizes the essential role spectrum plays for government users, just as it does for commercial entities. However, according to a 2011 GAO study, the Federal government operates in approximately 70 percent of the spectrum below 3 GHz – 18 percent on an exclusive basis and 52 percent on a shared basis with non-government users. Just as it is appropriate to ensure that spectrum available to the private sector is being used efficiently and for the most highly valued services, we must evaluate the Federal government's use of its spectrum and when it can be made available for commercial operations, it should be. The President recognized the need to provide additional spectrum for broadband services and to look at Federal spectrum as part of this effort when he issued a Memorandum in June 2010 directing NTIA to review Federal spectrum use and provide a plan to make 500 megahertz available.

The 1755-1780 MHz Band Is Uniquely Suited for Commercial Mobile Broadband

The 1755-1780 MHz band is particularly appropriate for commercial use and T-Mobile is actively working with other carriers, manufacturers and industry associations to demonstrate how it can be allocated for commercial use. In the United States, the 1755-1780 MHz band is currently used by DoD and other Federal agencies. However, the band is identified internationally for commercial mobile services and is used for that purpose throughout most of the world. The configuration would therefore harmonize U.S. allocation of spectrum with international use. The 1755-1780 MHz band is also immediately adjacent to existing domestic wireless spectrum and would therefore fit seamlessly into the current mobile broadband spectrum portfolio allowing for more immediate equipment development and deployment. Manufacturers could easily migrate existing and developing technologies to these bands. Creating a domestic allocation that is consistent with international use will produce economies of scale and scope, making for a more robust equipment market for the band, lowering costs and speeding implementation. International harmonization of this spectrum will also facilitate consumers' use of their wireless devices while traveling to other countries by alleviating compatibility problems. T-Mobile and other wireless carriers therefore believe this band can and should be reallocated for commercial operations.

There is also broad support in the wireless industry for pairing the 1755-1780 MHz band with spectrum currently available for licensing at 2155-2180 MHz. The Middle Class Tax Relief and Job Creation Act, or Jobs Act, requires that band to be licensed by February 2015. The 1755-1780 MHz band should be available in the same time frame so that the two bands can be made available together. The benefits of pairing 1755-1780 MHz with 2155-2180 MHz, which will permit alignment with existing services, facilitate faster deployment of services, and

maximize efficient use of the spectrum, are also reflected in how the spectrum is valued. One study found that auctioning the 2155-2180 MHz band by itself would yield \$3.6 billion – but auctioned together with 1755-1780 MHz band, the pair would generate \$12 billion. Auctioning these bands on a paired basis would therefore ensure the best economic return for taxpayers, as well as the most efficient use for broadband services. The value and benefits of reallocating the 1755-1780 MHz band consistent with this pairing are recognized by H.R. 4817, introduced by Representatives Stearns and Matsui, which would require reallocation of the band on the same timeframe as the reallocation and auction of spectrum mandated by the Jobs Act.

A Cooperative Process Can Facilitate Transition of the Spectrum

Reallocation of the 1755-1780 MHz band for commercial use is consistent with efforts that date back to the 2000 World Radiocommunication Conference. NTIA issued studies and reports in 2001, 2002, and 2010 that addressed use of the band for commercial services and the spectrum was also identified in the *National Broadband Plan* as potentially available for reallocation.

NTIA's most recent report, released March 2012, focuses in part on the 1755-1780 MHz band and makes clear that, given the Federal operations in the band, there are considerable challenges to making the band available for commercial use. However, studies of the potential to reallocate the band have largely been undertaken with little input from the private sector and, T-Mobile believes, have resulted in overly pessimistic results. Our own experience in relocating Federal users from the 1710-1755 MHz, or AWS-1 band, showed that, while relocation is challenging by nature, it is feasible when all of the parties involved act cooperatively. In relocating Federal users from the AWS-1 band, we found that fundamental misunderstandings of how our respective systems operate led to unnecessarily pessimistic predictions of potential

interference. As a result of more detailed technical discussions between T-Mobile and Federal users that took place as part of the relocation process, we were able to build a deeper understanding of how the systems would interact. These discussions resulted in T-Mobile being able to deploy services years earlier than originally anticipated, allowing consumers to benefit from early access to broadband services prior to completing the full transition of the band from Federal to commercial use. The experience that T-Mobile gained in relocating Federal users from the AWS-1 band should inform the potential relocation of Federal users from the 1755-1780 MHz band and points to the importance of a cooperative dialogue that takes into consideration the realistic operations of both the government and commercial operations.

Fortunately, several steps have now been taken that, T-Mobile is optimistic, will lead to the conclusion that use of the 1755-1780 MHz band is possible for commercial use.

T-Mobile Has Obtained Special Temporary Authorization to Explore the Prospects for Limited Sharing of the 1755-1780 MHz Band

First, T-Mobile has begun to work cooperatively with appropriate Federal entities to examine the impact of commercial use in the 1755-1780 MHz band and to assess whether there may need to be temporary or permanent exclusion zones for certain Federal operations, or whether sharing can be facilitated through coordination procedures. We are pleased to report that on August 14, the FCC, working with the NTIA, granted our request for special temporary authority, or STA, to test the suitability of mobile broadband services in the 1755-1780 MHz band. As part of this effort, we are implementing a program, working with other carriers and DoD, to monitor operation of and gather accurate information about several of the systems identified in NTIA's 2012 report that appear to be the most difficult, costly or time consuming to relocate.

As a first step, we have begun to work with the DoD to identify the locations at which we will monitor the use of the 1755-1780 MHz band and are pleased with the spirit of cooperation that has characterized our work with DoD and others so far. Once the site selection process is finalized, we will establish our monitoring facilities in coordination with DoD. We are also working with NTIA's lab in Boulder, Colorado to conduct additional focused monitoring and to perform interference modeling and simulations. We anticipate that both of these steps will be largely completed before the end of this year, which will enable us to conduct field testing after that. We are mindful, as we hope our government partners are, that we need to keep the process moving productively forward to ensure an outcome that makes the best sense for this spectrum, especially considering the deadline to auction the companion 2155-2180 MHz band.

Commerce Spectrum Management Advisory Committee ("CSMAC")

Second, we are participating in Working Groups created under the auspices of NTIA's CSMAC. Working Groups have been created to study each of the Federal systems operating in the 1755-1850 MHz band. These groups provide a forum for an exchange of technical information between Federal entities and industry regarding their respective systems and to discuss and explore potential solutions for relocation of Federal operations or for sharing. T-Mobile is hopeful that the information exchanged in these discussions will provide a path forward for making this spectrum available for commercial broadband operations.

New and Existing Laws

Third, new and existing laws will fully protect DoD and other Federal users in the 1755-1780 MHz band and provide the potential for modernizing Federal equipment. In the Jobs Act, Congress made important changes to the Commercial Spectrum Enhancement Act, or CSEA, which provides resources for government agencies to study relocation options and to update

equipment to facilitate clearing or shared use of spectrum. In particular, the Jobs Act allows NTIA to provide Federal agencies with compensation from the Spectrum Relocation Fund for “relocation or sharing costs” associated with the reallocation and auction of spectrum from Federal to non-Federal or shared use prior to auction. Those funds can be used for planning, equipment upgrades, spectrum sharing costs, and pre-auction planning costs associated with relocation or sharing. These changes to the CSEA provide the resources necessary to study and implement relocation or modernization of Federal systems.

These new protections are in addition to other important provisions, which ensure that Federal operations are not harmed as a result of a reallocation of spectrum. *First*, relocation costs, now including “the acquisition of state-of-the-art replacement systems,” are covered by the Spectrum Relocation Fund, would be funded through the proceeds of the auction of the band to commercial licensees. *Second*, the Secretaries of Defense and Commerce and the Chairman of the Joint Chiefs of Staff would have to certify that relocation spectrum identified by NTIA and the FCC “provides comparable technical characteristics to restore essential military capability,” as required by the National Defense Authorization Act for Fiscal Year 2000. *Finally*, Federal agencies would also have the procedural protections of the CSEA, as recently amended, which requires NTIA review and approval of Federal spectrum users’ relocation plans.

Given the extent of protections for Federal operations, particularly provisions for auction proceeds to cover relocation costs, it is imperative that estimates of relocation costs be as accurate as possible. Overstating these costs could lead to a false conclusion that the spectrum should not be reallocated, producing a missed opportunity to deliver the benefits of broadband to all Americans.

NTIA's March 2012 report examining the feasibility of using the 1755-1850 MHz band for commercial operations provides little information about how it determined the nature and extent of the use of the band by Federal users. There is no data, for example, on the cost of equipment or other expenses that Federal users would incur in relocating. Based on the AWS-1 relocation process, NTIA's economic and engineering impacts may be overstated. The NTIA's Fifth Annual Report on the progress of relocation from the AWS-1 band shows that relocating outdated analog surveillance systems from the AWS-1 spectrum to more efficient digital systems has cost approximately \$691 million. However, in its March 2012 report on the entire 1755-1850 MHz band, NTIA estimates that relocating these systems will cost over \$3 billion dollars. Thus, according to NTIA, it would cost more than four times more to clear users from approximately 40 percent of the spectrum. NTIA's March report also examined the entire 1755-1850 MHz band. NTIA did not provide estimates for relocation of just the 1755-1780 MHz band. While reallocation of the entire band may ultimately be desirable, the immediate focus should be on 1755-1780 MHz.

NTIA's estimates, even for the entire band, seem inconsistent with past estimates. We note in particular that NTIA's estimated costs for relocating systems from the entire 1755-1850 MHz band would be \$18 billion, but DoD earlier estimated that it would cost only \$4.6 billion to clear the entire band. We respectfully urge this Subcommittee and the Spectrum Task Force to seek a more refined review of the costs for reallocating Federal users from these 25 megahertz of spectrum.

Limitation on Sharing

While the wireless industry is fully engaged in evaluating all solutions to spectrum shortages, we continue to believe that in order to most effectively use the 1755-1780 MHz band

and other spectrum now employed by the Federal government, the bands should be reallocated for commercial use on an exclusive, or near-exclusive, basis. In most cases, carriers need exclusive use of spectrum to provide service to the public. Sharing can be a tool to facilitate the transition of government spectrum to commercial use, but the ultimate goal should be reallocation to the extent possible. Except for limited cases shared spectrum is an inadequate resource because it is available only some of the time in particular places. Such a resource can help supplement a provider's exclusive spectrum, but it cannot replace it, nor does it provide the incentives or certainty necessary for carriers to make the very substantial investments needed to deliver world-leading, high quality mobile broadband services to American consumers.

That said, T-Mobile recognizes that there are instances where sharing may be necessary and feasible and where advances in technology offer new techniques for implementing sharing. First, there are instances where sharing spectrum may mean that it is not available for non-Federal use only in limited rural areas where there is an identified Federal installation or where Federal use is limited in time. In those cases, carriers can plan around the identified geographic or temporal exclusion zones and still offer a commercially acceptable service.

Second, sharing may be appropriate as a transition mechanism while spectrum is being cleared by Federal users. In that case, Federal users and commercial providers can plan where and when spectrum will be available, allowing entities like T-Mobile to begin to implement systems using the newly available spectrum while protecting Federal users as they transition to alternative communications solutions.

T-Mobile supports continued study of technologies that can facilitate greater and more dynamic spectrum sharing, but the technologies for such sharing are not available today, have not yet been proven effective, and will not yield the capacity required to satisfy the growing

demand for broadband capacity. Sweeping conclusions that shared use is the only future are simply inappropriate. It is one of many available tools, and as technology advances it may provide additional opportunities for maximizing efficient use of the spectrum. The appropriate approach, whether shared use, reallocation for exclusive commercial use, or some mixture of the two, must be considered on a case-by-case basis.

Applied to the 1755-1780 MHz band, this means that relocation of Federal operations should be the first option. In some cases, however, Federal systems in the band will take too long, be too expensive, or prove too difficult to relocate. It is this subset of operations where coexistence and sharing should be further explored – either to facilitate commercial use during an extended transition period or in a very limited number of cases where sharing is limited to rural areas or where Federal use is infrequent and it may be feasible to share indefinitely. Sharing is therefore merely one tool, and for now a limited tool, that is available for use in making spectrum available for broadband. The focus should remain on clearing as a first priority where feasible.

Conclusion

T-Mobile believes that the cooperative efforts I have described will serve as the foundation for demonstrating that the 1755-1780 MHz band can be allocated for commercial use, paired with the 2155-2180 MHz band, and auctioned without a requirement that all government facilities be cleared completely from the spectrum before commencement of commercial operations, while fully protecting government operations. Spectrum sharing for at least an interim period will allow much earlier deployment of broadband services in the spectrum than otherwise would be possible and will help facilitate competition in the nationwide deployment of wireless broadband services, ultimately benefitting millions of U.S. wireless consumers.

T-Mobile appreciates this Subcommittee's continued focus on this important issue and it applauds the formation of the Spectrum Working Group task force. Interest by Congress and the Administration in making more Federal government spectrum available for commercial use is an important driver that provides the focus, resources and tools necessary to implement the processes I've described.

* * *

Thank you again for the opportunity to appear before you today. T-Mobile looks forward to continuing to work with you on these important and timely issues.

Mr. WALDEN. Mr. Sharkey, thank you very much for your testimony. We appreciate that of all our panelists today. It is most helpful in our effort.

I am going to start out with questions, and then of course we will go back and forth here on the dais.

Mr. Goldstein, I want to start with you. You have testified about fundamental flaws in the way the NTIA manages Federal spectrum, namely, the NTIA does no independent analysis of the information Federal spectrum users provide or of whether those users need all the spectrum they have, is my understanding of your work. Did the NTIA fix those flaws before issuing their most recent estimates relied upon by PCAST in their report that clearing the 1755 to 1850 megahertz band would take more than \$18 billion and 10 years?

Mr. GOLDSTEIN. I don't believe they have fixed those flaws yet, Mr. Chairman. The system I am talking about, which is called the Government Master File, which NTIA used to record the information that agencies send them on spectrum, is still being used today and won't be replaced for at least 6 years.

Mr. WALDEN. All right, thank you.

Mr. Sharkey, Mr. Racek, Mr. Goldstein's written testimony points out that Federal users will have a low tolerance for even the possibility of interference, which seems logical. Private sector, however, will be reluctant to invest significant capital in spectrum network equipment or devices if it doesn't have greater assurances that it will be able to use the spectrum it pays for when and how it needs to, that certainty piece that you were speaking of. Isn't this precisely why we should continue to emphasize clearing over sharing as our main strategy, not our singular strategy, but our main strategy if we are going to meet the spiraling demand for wireless broadband? Mr. Sharkey, Mr. Racek?

Mr. SHARKEY. Thank you, yes. You know, I think it is important to stay focused on relocation and clearing as much as possible, and there are a variety of different uses in the 1755 to 1780 megahertz band, and the NTIA report makes it clear that a number of those can be cleared in a more accelerated time, within five years. There are a number of systems where it is likely to take longer or be more costly to move those, and that is where we are focusing our efforts to try and look at sharing options that would be limited geographically or by time.

Mr. WALDEN. All right. Mr. Racek?

Mr. RACEK. Thank you, Mr. Chairman. The exclusive and dedicated globally allocated spectrum below 3 gigahertz is what we feel is necessary to be able to provide the regulatory certainty that is needed to be able to continue the investment and the innovation that has been done within the industry. So what we would like to see is a continuation of that. There is—part of the problem is with unlicensed type of spectrum that you get a level of uncertainty. It is ad hoc. It is definitely viewed as something that could be seen as a complement to licensed type of spectrum, but based upon its regulatory uncertainty it will not be the preferred methodology.

Mr. WALDEN. All right, thank you, Mr. Racek.

Major General Wheeler, Mr. Goldstein notes in his written testimony that the Federal users "often use and rely on older tech-

nology that is not conducive to operate as efficiently or flexibly as state-of-the-art technologies may allow.” The Commercial Spectrum Enhancement Act, or CSEA, which we made even better in the spectrum legislation as noted by my friend, Mr. Waxman, provides a mechanism to upgrade Federal facilities with private sector funding during the relocation process. Don’t we have an opportunity here to help agencies better meet their missions in a fiscally challenged climate while simultaneously freeing spectrum for commercial broadband?

Mr. WHEELER. I think there are some opportunities there in this particular area, sir, but I also understand that if you take a look at, for example, the satellite systems that are already up there in space right now with a single receiver or transmitter, the opportunity to change those out without significant costs and time, if you will, to put up a new satellite system, for example, is an example of where that area won’t work very well, and just the mass numbers of specific systems that we have. For example, if you were going to use the ACT system we talked about, which is the combat training system we discussed, that particular technology, there is no commercial variant of that particular one available, and that is in all of our airplanes, to include, for example, now internally to all of our Stealth airplanes, the F-35 and the F-22.

So there are examples of where that can work very well, and there are examples of where that doesn’t have an applicability to that specific system.

Mr. WALDEN. All right, thank you.

Mr. Racek, Mr. Sharkey, in the past 5 years we have seen two other significant attempts at sharing. The 700 megahertz D block failed to garner a winning bid because commercial providers were reluctant to pay for a spectrum they would need to share with public safety officials, the way that one was structured. Nearly 4 years after the FCC white spaces order, there are very few takers willing to or able to build a business around unlicensed devices in the TV broadcast band. Is there any reason to believe commercial providers would be more willing to spend money under the PCAST approach? You are representing the commercial side, what do you think?

Mr. SHARKEY. I think both of those examples are good examples of the need to have substantial access for commercial services in cleared spectrum and certainty about what is available. The problem with both of them was that 700 megahertz, there was no certainty about what would be available for commercial use at the end of the day and what that use would cost, so you were asked to pay a high cost up front with no certainty on the back end about what you were getting.

Mr. WALDEN. All right.

Mr. SHARKEY. And on the TV white space, there was availability in very rural areas, but the top markets had little to no spectrum available.

Mr. WALDEN. All right, Mr. Racek, very quickly if you can?

Mr. RACEK. Yes, the—I think the difficulty is that sometimes the answer comes actually before the definition of the problem in sort of the TV white spaces that the trying to be able to utilize that to be able to provide the type of services that you see that are being

used by the tablets and the iPhones and those sort of type of things needs a certain type of service level, some guaranteed type of service level. Unfortunately, some of the solutions that you are talking about actually haven't considered that. There are some—especially like when it comes to TV white spaces, the ability to gain access to spectrum is going to be limited, mostly to rural types of environments, but where you actually need the capacity is going to be in the urban type of environment. So it is sort of providing a solution, but not addressing sort of the needs of the commercial industry.

Mr. WALDEN. All right, thank you very much. My time is more than expired.

I will turn now to the ranking member of the subcommittee, Ms. Eshoo, for questions.

Ms. ESHOO. Thank you, Mr. Chairman, and first I would like to ask unanimous consent that the letter to the committee from the Competitive Carriers Association be made part of the record.

Mr. WALDEN. Without objection.

[The information follows:]



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September 12, 2012

The Honorable Greg Walden, Chairman
 The Honorable Anna Eshoo, Ranking Member
 U.S. House of Representatives Committee on Energy and Commerce
 Subcommittee on Communications and Technology
 2125 Rayburn House Office Building
 Washington, DC 20515

Dear Chairman Walden and Ranking Member Eshoo:

The Competitive Carriers Association (CCA) respectfully submits this letter for the record regarding the upcoming hearing on "Creating Opportunities Through Improved Government Spectrum Efficiency" before the House Committee on Energy and Commerce Subcommittee on Communications and Technology.

CCA commends the Committee, the Subcommittee, and its Members for your leadership on spectrum policy and for convening this important hearing. Through your work to free spectrum for mobile broadband services, CCA asks that the Committee consider reallocating spectrum for competitive carriers to further innovation and restore competition. Accordingly, CCA urges the Committee to: (1) work to restore interoperability in spectrum bands currently allocated for mobile broadband use and ensure interoperability in future bands; (2) emphasize clearing and reallocating spectrum above untested and uncertain sharing solutions; and (3) focus on spectrum bands and frequencies already within mobile broadband ecosystems or otherwise aptly-suited for mobile broadband services.

CCA represents over 100 competitive mobile providers, who provide new and innovative services, products, and price-plans. Competitive carriers require access to additional, useable spectrum. To provide additional frequencies for mobile broadband, spectrum – a limited, finite, taxpayer-owned resource – must be reallocated from other private licensees or federal users. Supported by the Committee's efforts, Congress provided the Federal Communications Commission (FCC) authority to reallocate licenses held by private companies through incentive auctions in the Middle Class Tax Relief and Job Creation Act of 2012 and reaffirmed FCC authority to adopt rules of general applicability to support competition. While incentive auction authority is an important step, it has yet to provide additional spectrum for mobile broadband, and all spectrum sources must be considered, including federal spectrum. Competitive carriers desperately need access to usable spectrum. CCA praises the work of the bipartisan Federal Spectrum Working Group and the Committee for focusing on the Federal Government, the single largest user of spectrum, and investigating whether certain frequencies may better benefit taxpayers through commercial allocation.

Restore Interoperability in Current and Ensure Interoperability in Future Spectrum Bands Allocated for Mobile Broadband

Dating back to the birth of cellular communications, interoperability has been a fundamental principle for wireless competition. As you scrutinize every hertz of taxpayer owned spectrum, interoperability is required to ensure efficient and full use by both commercial and federal users, and is particularly critical for efficient use for mobile broadband. Balkanizing spectrum into multiple, carrier-specific sub-bands decreases its utility overall and undermines and negatively impact its value at auction.

Interoperable bands, on the other hand, promote certainty in the industry, lead to confidence in auctions, and support expanded services and competition. Steps need to be taken now to restore interoperability to the Lower

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700 MHz Band and ensure that any future bands reallocated for mobile use, through incentive auction or reallocation from federal users, are interoperable.

Emphasize Clearing and Reallocating Spectrum Above Experimental Sharing Solutions

Clearing spectrum and reallocating from federal to mobile broadband use also provides the certainty needed to spur investment. Together with interoperability, these concepts provide industry with the confidence needed to take part in a spectrum auction. Removing interoperability and access to cleared spectrum upends the successful spectrum auction model, whereas reinforcing both wherever possible maximizes the taxpayer return on our nation's spectrum resources. Such certainty is especially important when predicted auction values impact whether spectrum is made available for mobile broadband or deemed an acceptable replacement for potential looming federal budget cuts.

Due to inherent limitations in spectrum sharing, CCA supports reallocating cleared spectrum wherever possible. CCA appreciates the need to continue to explore and study new technologies and techniques to advance spectrum sharing, but these methods are not a replacement for cleared spectrum at this time. In the event that clearing spectrum is not possible, the FCC, National Telecommunications & Information Administration (NTIA) and other federal stakeholders should study sharing spectrum on a case-by-case basis.

In frequencies where spectrum sharing is considered, the FCC and NTIA should first consider sharing between and among federal users. Federal spectrum sharing will increase the efficiency of federal users in ways similar to how the commercial sector has become increasingly efficient in its use of spectrum in interoperable bands. Additionally, this will ultimately aid in identifying spectrum that can be cleared and reallocated for commercial use. To facilitate this process, NTIA should continue to investigate federal spectrum use along the parameters outlined by the Federal Spectrum Working Group's July 10, 2012 letter to produce a final report by a date certain. Frequencies not included in the final report should be deemed no longer necessary for federal use, and NTIA should begin the process to reallocate for commercial use.

Another appropriate spectrum sharing policy in the near term is to share spectrum to facilitate a transition from federal allocation to commercial. Statutory flexibility for sharing over a transition period encourages cooperation and could reduce the overall transition time and costs to reach clear bands.

By no means should the premise of sharing spectrum erect a barrier to competition in the mobile industry by technologically blocking interoperability or roaming. For carriers to provide nationwide access to networks demanded by consumers, wireless networks have been and must remain accessible where technologically possible. Advances in technology should focus on expanding such technological possibilities, not limiting them. Implementation of any spectrum sharing policies must consider the impact on network access not only between and among Federal user(s) and specific carrier(s) but also on all carriers and consumers utilizing technology within a given mobile broadband ecosystem.

Focus First on Spectrum Bands that are Mobile Broadband Ready

Additionally, efforts to reallocate spectrum currently used by the Federal government for mobile broadband should focus primarily on bands and frequencies within latest generation mobile broadband technology ecosystems, which could quickly be used to deploy services. These efforts allow carriers to leverage economies of scale and promote international harmonization and limit roaming issues while helping maximize revenue from a future, competitively structured spectrum auction. A prime example of spectrum that is ready for near-term deployment is the 1755 – 1780 MHz band, when paired with the 2155 – 2180 MHz band currently slated for commercial auction. CCA applauds the efforts of T-Mobile and other CCA members who are working with the

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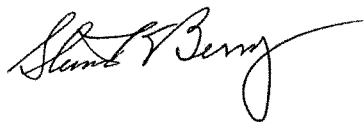
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Federal Government to explore the feasibility of commercial operations in this band. CCA supports H.R. 4817, the "Efficient Use of Government Spectrum Act of 2012" and the work of Congressman Stearns and Congresswoman Matsui to encourage commercial auction of this spectrum. A competitive auction of this spectrum allows competitive carriers to access LTE-ready frequencies in the near term to expand mobile broadband access while increasing competition in the industry.

In closing, CCA supports all efforts to make cleared spectrum available to foster competition and innovation in the mobile broadband industry. The incentives of the largest carriers to warehouse useable spectrum are increased without a clear path for future spectrum availability. Policymakers must scrutinize all spectrum holdings, federal and commercial, and adopt a policy framework that supports competition to efficiently use and maximize the value of finite spectrum resources.

CCA appreciates the opportunity to contribute to the record for today's hearing. We look forward to continuing to work with the Committee, Subcommittee, its Members, and the Federal Spectrum Working Group on these important issues and to restore and expand competition in the industry. Please do not hesitate to contact me with any questions.

Best Regards,

A handwritten signature in black ink, appearing to read "Steven K. Berry". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Steven K. Berry
President & CEO
Competitive Carriers Association

Ms. ESHOO. Thank you, Mr. Chairman.

First of all, thank you to each one of you. I think that this has been an exciting panel, and you all come at this from different ways, which is not a surprise, but it is instructive to us.

I would like to start with Dr. Marshall. The Majority has concerns that the PCAST approach is “too speculative” to be the focus of the committee’s spectrum strategy. Do you agree with this assertion? And I also have another question, and that is the PCAST report places a particular emphasis on spectrum bands over 2 gigahertz. Are there ways in which these higher bands of spectrum could be used by wireless carriers to fill in gaps in coverage or provide additional capacity in dense urban areas? You just heard Mr. Racek and Mr. Sharkey speak about certainty and that the service or the outcomes would apply to areas that—where we won’t be able to optimize what we are looking for. So if you could just give the briefest and the best answer, OK? Thank you.

Mr. MARSHALL. I think Mr. Chairman himself noted the TV white space has been out there for 3 years. It is a particularly unattractive spectrum option, but it did develop a technology base that the PCAST builds on. It does not build on the cognitive radio, many of the innovative and new ideas that are flowing. Those will make it better, but its basic deployment is the 3-year-old TV white space that otherwise has not had a lot of commercial uptake.

I would certainly look at the spectrum that is made free not as filling gaps in coverage, but filling gaps in capacity. What we face is not a coverage shortfall—if I can go and get those little maps that cellular providers give and they are all colored whatever color is supposed to be good. The issue we have is capacity, and for that higher frequency, short range, low power, like the wifi offload, is in fact what the carriers need to meet 50 times more capacity.

So I think we have to look at two strategies in wireless. One is coverage, and very clearly the licensed spectrum has allowed that to happen. When we talk about dense areas and urban, we get the opposite effect of the previous witness. Instead of—whereas TV is built where people are, much of the military is where people aren’t or where they don’t want them. And so here we have the opportunity to have the reverse to the TV white space experience. He can keep all the spectrum he wants in the Mojave Desert, and we take it in New York. He keeps his peak allocation, which is what he needs to do his job, and we can provide lots of offload capacity, much better than wifi. And very clearly, industry is willing to invest in that because you can’t go 2 weeks without seeing a press release of one major provider of Internet saying we are rolling out lots of wifi. And there is no spectrum less predictable and less desirable than wifi. And even so, it is attracting incredible investments. Think what a gigahertz could do.

Ms. ESHOO. Thank you very, very much.

I am interested—and I don’t know what witness wants to speak to this, but what is the global picture on this? Do we use—do our Federal agencies use more spectrum than other countries? I mean, we are larger and far more sophisticated, I believe, but are there any lessons that we can learn from others in what they are doing? I just don’t know what the answer to that is. Does anyone? Mr. Racek?

Mr. RACEK. Thank you, Chairwoman Eshoo.

Ms. ESHOO. Thank you for calling me Chairman. That is very nice. I will remember that.

Mr. RACEK. Congresswoman Eshoo.

Ms. ESHOO. You are my new best friend.

Mr. RACEK. I could take a little bit of a stab at that, and that is that the—Ericsson is very involved in standardization type of activities with respect to 3G PP, which is the Third Generation Partnership Program, and in that standardization development activity is where technologies like LTE that you have heard talked about are being developed. And one of the ways that they sort of develop the technology is by identifying bands, and then identifying the technology around that band.

Ms. ESHOO. And you are doing this globally?

Mr. RACEK. Yes, this is a global standards development organization, and the difficulty, though, is that the bands that are—sometimes that are identified seem to have more difficulty in actually being identified in the U.S. versus other countries.

Ms. ESHOO. I see.

Mr. RACEK. So it makes that in the U.S., oftentimes we end out having sort of unique solutions, and we try to work with the incumbents, work with the various regulators in each one of the countries to come up with as unified a position as we possibly can. And this is particularly for the 1755 to 1780. Originally in 3G PP, the band that is now called AWS-1 actually extended all the way up to 1780 megahertz. This is one of the reasons why 1755 is—to 1780 is so important is because it extends the band that we would have in the U.S. to be more in line with what the other regions may actually be able to allocate. So it has some alignment, at least regionally.

Ms. ESHOO. General Wheeler, would you like to comment? Thank you, Mr. Chairman.

Mr. WHEELER. Ranking Member Eshoo, the one thing I would add is from a—let us say, a Department of Defense perspective. They are watching how other militaries in the world—they come to us because they can't get spectrum in their country. So for example, doing the training they do, our allies come to us before they deploy forward. When they are going to be our partners in Afghanistan, they come to the U.S., for example, and go out to that Mojave Desert area that we just discussed and we actually do the training out there because the frequency is available there and they can get that "best training in the world," not just for spectrum, but because of the air space out there as well. So that becomes a big part of why they are so partnered with us, because we have the tools available to make them better and keep them safe in combat. And that is one of the areas, and that area that we are talking about, the 1755 to 1850 is where in other countries they use it for other purposes out there.

The other part is we are the only country with a large number of UAS's. The unmanned aerial vehicles, we have a ton of those particular types of things, and it has grown astronomically—

Ms. ESHOO. It has.

Mr. WHEELER [continuing]. In the last 10 years, and that is an area where—that we, again, fall into that particular spectrum.

Ms. ESHOO. Thank you. Thank you, Mr. Chairman.

Mr. TERRY [presiding]. Sure, thank you.

Sticking a little bit with General Wheeler and Mr. Goldstein, some commenters—we have actually had some people that have come to our office and presented the sharing option with the carrot approach, i.e., Department of Defense can share some of their spectrum with private sector companies and would be able to lease that spectrum, therefore, being a source of revenue for the Department of Defense or a particular agency government. Does that type of carrot approach resolve some of the issues with sharing? Have you looked into that type of a proposal?

Mr. GOLDSTEIN. We haven't specifically at that, Congressman, we have looked more broadly at sharing. A couple things that I think respond, well, that may be possible. One of the things we have found in our review in talking to really dozens of industry stakeholders is that there is not simply a lot of sharing going on between the public and the private sector. Most of the people we talked to couldn't really name more than one or two, and they are very well-known examples, and it is because the business model essentially does not work because of the uncertainty involved and frankly, the faith in technology—the leap of faith that is still required in many ways to get us there.

So it is something that can happen, I think, at the margins, but I think many of the challenges that were talked about in our testimony are going to exist for some time to come.

Mr. TERRY. All right. General Wheeler, what is your thoughts on the Department of Defense's thoughts on sharing, but you control—in essence, you become the lessor under certain conditions. Is that something that is appetizing?

Mr. WHEELER. It is an interesting concept, sir. What I would argue here is we are interested in sharing because we think that is a quicker way to vacate areas that you need, if you will. So in other words, to share would be an area to get availability of a set amount of spectrum, so we are looking at that from that perspective. The incentivizing, you know, I have a whole teams that works this and I put, actually, a lot of extra people on that. In fact, I pretty much dried up all the spectrum knowledgeable people within DoD to work on these particular parts, and the incentive for them is they believe that the economy is paramount so they really do force and work towards this. When you talk about a leasing aspect, we don't physically own the spectrum—

Mr. TERRY. Right.

Mr. WHEELER [continuing]. So we don't have that ownership of the said spectrum. So while I think an incentivizing model would be useful to DoD to move things out of there from a monetary perspective, I don't think it will make it move any faster from the perspective because our folks are working very hard and fast to try to find solutions to it to make sure that we can do that to make sure that we are following through on the President's desire for the 500 megahertz.

Mr. TERRY. If sharing is possible, more through some of the regulatory aspects that have been raised here by your testimony, I wonder, though, are there any security implications? Is there ways to protect secret classified information if you are sharing the same spectrum?

Mr. WHEELER. That is a good question, sir. I think I am going to go back to what Ranking Member Eshoo started in her opening statement where she talked about it is not just the sharing or the vacating, but I think it is going to be—in some cases, it is going to be actually vacating or relocating to a different location. I think there is also going to be sharing in some aspects, especially if you want to do this in a shorter period of time. I also think there are going to be some technologies out there that will make us use our areas more efficiently within the area that we are given. In other words, it is going to be that basket, if you will, of ways of approaching this to get us moving in the right direction quicker. But there are methodologies to protect the security in most aspects, and where we can't, we will vacate and move forward and have to go with those particular types of approaches. But we have that thought through pretty well.

Mr. TERRY. General Wheeler seems more optimistic on the abilities to do this than you did, Mr. Racek. What do you think?

Mr. RACEK. Thank you. The—I think if we look at the 3550 to 3650 band—and this was one of the bands that was identified earlier by Mr. Karl Nebbia, NTIA, and this is one of the bands that could possibly be made used for commercial types of services. And as we have heard before, though, is that there was a recognition that this spectrum could not be used for LTE high-powered types of systems. Well, this is typical where you actually sort of identify well yes, this spectrum could be shared but with sort of further identification, you understand well, there are going to be substantial limitations to its availability, and therefore, you start to question whether that spectrum could actually be used for the purposes that you had in mind.

Mr. TERRY. Thank you. My time has ceased.

Ms. Matsui, you are recognized for your 5 minutes. Thank you.

Ms. MATSUI. Thank you very much, Mr. Chairman.

I have a question for Mr. Sharkey. We know that the FCC has less than 3 years to auction and license the 2155 to 2180 band, and we know that the 1755 to 1780 band is an ideal pairing opportunity. How important is it to move forward and find a solution in a timely manner to get this spectrum out there?

Mr. SHARKEY. We think it is very important to move forward quickly and make it available, and we think that it is doable. We have a very good process in place now between the CSMAC working groups and the work that we are doing with DoD to really get the right people in the room that can dig down into the technologies and figure out the complexities around sharing.

Ms. MATSUI. OK, and how long do you anticipate the industry testing will last, and given we need to pair it with the 2155 to 2180 band in a timely manner?

Mr. SHARKEY. The—as I said in my earlier testimony, we expect to have some preliminary information from monitoring and some simulation work before the end of the year. That will lay the foundation for additional testing. We hope to have a good picture of what we can do moving forward early into next year, and then that can be refined as the overall regulatory process moves forward.

Ms. MATSUI. OK, thank you.

Mr. Nebbia, given that the FCC has less than 3 years to pair the AWS-3 band, do you believe the industry and the agencies are working cooperatively to ensure the 1755 to 1780 band will be made available for pairing with AWS-3 in the next 3 years?

Mr. NEBBIA. Certainly we have been encouraged by the cooperation that is going on between government and industry. As was said earlier, I believe, by Congressman Waxman the amount of information that is being passed back and forth is unprecedented and I believe we can, in fact, conclude on this range of spectrum in a timely manner. So we are very hopeful. We see a lot of great work going on.

Ms. MATSUI. OK, so that is great.

Mr. Racek and Dr. Marshall, as we explore each band for potential repurposing, which specific bands will be ideal to clear below 3 gigahertz and which specific bands or areas will be better suited for sharing above 3 gigahertz? I really would like you to be specific. Mr. Racek?

Mr. RACEK. Thank you. We would like to actually come back with you and provide some additional information. I do have some examples to give. We don't have with me sort of an all-inclusive list of all of the bands that we think would be applicable for clearing below 3 gigahertz. If I can give you an example, the one is that we have talked about substantially and that is the 1755 to 1850. The other one happens to be the 2.7 to 2.9 gigahertz band. This is the band that was also identified in the PCAST report, but it was a band that was identified by NTIA some time ago in one of its analyses as a possible band that could be reviewed—could be analyzed for the purpose of commercial usage. We are very supportive of that band; we have been for quite a while. We operate in this International Telecommunications Union, and in that process, you know, we have talked to other regulators in other countries and found that this spectrum would be available in other countries, and feel like this could be something useful for the U.S.

Now, for sharing above the 3 gigahertz, I think one of the things that probably would be useful to identify is that in the sharing opportunity, it isn't just about sort of unlicensed. For our view, unlicensed definitely has its benefits. It has already been talked about sort of an offloading perspective, but it does bring uncertainty and we are very interested in sort of achieving economies of scale. And so our approach is as more of a licensed shared access, either on a co-primary or a secondary type of basis.

Ms. MATSUI. OK.

Mr. RACEK. And we see that sort of being above 3 gigahertz. And the work that is being done within the 5 gigahertz, the 195 megahertz is the right step, but sort of a licensed approach is the step we would support.

Ms. MATSUI. OK. Dr. Marshall, do you have the specific bands that are ideal below 3 gigahertz, and specific bands above—I mean, for sharing above?

Mr. MARSHALL. OK. I think the industry—most over 1755. That was an incomplete action from—it was a political compromise from AWS-1, and like all compromises, it gets revisited. I think I am really enthused about the opportunity in 3.6, not just because it is spectrum that is available, but it does fit this new class of license

that PCAST proposes, which is to provide certainty of access to the industry partners, lets them acquire it, doesn't take it away from DoD, and labels them to meet their emission but still gives them the certainty of access and premise of access for a certain—a large amount of that spectrum. Very clearly we are putting a lot of traffic off onto wifi. Wifi is very inadequate compared to spectrum with certainty, so I think here is an opportunity to provide industry what it wants, which is certainty of access, along with sharing of Federal bands and not damaging the Federal emission.

Ms. MATSUI. OK, thank you very much. I see I have been over my time.

Mr. TERRY. Gentleman from Florida, Mr. Stearns, is recognized for your 5 minutes.

Mr. STEARNS. Thank you, Mr. Chairman.

Mr. Nebbia, when Federal users were relocated from the AWS-1 band so that those bands could be auctioned for commercial use, CBO estimated that DoD's relocation costs would exceed \$4 billion. By the time the auction occurred, the OMB approved relocation cost for DoD dropped to less than \$400 million. Given that track record, shouldn't we consider NTIA's \$18 billion estimated for relocating Federal users from the 1755 to 1850 bands as merely a starting point for serious discussions about relocation costs?

Mr. NEBBIA. Well certainly we have used that as a starting place, and it has, in fact, helped us to begin the communications and discussions regarding that particular band. The 1710 to 1755 band doesn't act as a terrific example in all cases, but for instance, the agencies first supplied estimates of about \$2.1 billion, and in that case later was adjusted to around \$900 million, and now we are back up to about \$1.5 billion. So we do realize there is some fluid activity, and certainly as we look at what systems we do not have to move out of the band, obviously that will have an impact on the cost.

Mr. STEARNS. Mr. Sharkey, based upon T-Mobile's experience with the AWS-1 relocation, would you care to comment?

Mr. SHARKEY. I think it is an excellent question that, you know, the costs came down significantly from initial estimates, and it is important to go back and—

Mr. STEARNS. Four billion to four hundred million?

Mr. SHARKEY. So it is very important to go back and make sure that the costs are as accurate as possible. You know, I think like Karl noted, some of the work that we are doing now to look at sharing and transition issues and how to facilitate transition out of a band, I think will significantly impact any relocation costs for moving out of the band.

Mr. STEARNS. OK. Mr. Marshall, you state in your testimony that "if bands can be cleared and auctioned with exclusive licensing," you "believe the PCAST recommendations in no way preclude that." Does this mean that you agree with the statement of Genachowski, the chairman, and many commercial entities that while spectrum sharing should be explored, it should not come at the expense of clearing?

Mr. MARSHALL. I think the argument in PCAST is you are going to have difficulty clearing. To the extent that argument doesn't hold out, then certainly clearing is a desirable option. No electrical

engineer could possibly get up and say they wouldn't want cleared spectrum over shared spectrum, so it is an absolute truth.

The question is the pragmatic issues that get in the way of it, not the theoretic.

Mr. STEARNS. OK. Mr. Sharkey, getting back to you. As you know, I have worked with Congresswoman Matsui to specifically reallocate and auction the 1755 to 1780 megahertz band for commercial use. Can you explain why this band is of particular value to the industry, and why NTIA should look at this band individually instead of the entire 1755 to 1850 megahertz band?

Mr. SHARKEY. The 1755 to 1780 is really unique in that it is used around the world for mobile services, so use would be harmonized with other commercial services. It is immediately adjacent to our AWS-1 band, so we can add on to what we are already using, expand services very quickly. So it is—and we have got spectrum that is paired with it—can be paired with it, 2155 to 2180. That spectrum is available now. It has been available for a long time, and now has a clock ticking of February, 2015, where that must be auctioned.

So this really is a unique opportunity that we need to move on very quickly, and I think, you know, one of the—one thing to keep in mind, too, with having it licensed by 2015, that doesn't mean that government users would have to be off the band by 2015, but that there is a transition process that has been identified.

Mr. STEARNS. Good point. General Wheeler, with the assumption that relocation involving the bands between 1755 and 1850 megahertz is coming, what percentage of current Federal operations could be delivered or accomplished in bands above the 3 gigahertz?

Mr. WHEELER. Before I answer that, sir, if I may clarify the last part, that might help illuminate a little bit there in a discussion about the costs in the 1710 to the 1755. That particular study was done for a larger area of spectrum, and then when there was an agreement to only do the last 45 megahertz there, that price came down significantly in that aspect there. For DoD perspective, we ended up retuning, basically, many of our systems out of the 1710 to 1755 megahertz into the 1755 to 1850. So we just finished that this year, in fact, and we moved some of our systems out of there into this other band that we are now looking at. So that is the reason why the cost came down, from a DoD perspective, because it was a smaller area than was originally looked at, so we didn't have to vacate and we were able to tune many of those systems just into the adjacent band, which happened to be the 1755 to 1850 and. So that is what created some of those specific issues that made the differences in the cost.

Mr. STEARNS. Thank you, Mr. Chairman.

Mr. TERRY. Thank you, Mr. Stearns.

Gentlelady from Colorado, the list that I was provided had you next. Gentlelady from Colorado is now recognized for 5 minutes.

Ms. DEGETTE. Thank you very much, Mr. Chairman.

First of all, I want to thank the chairman and Ms. Eshoo for appointing me to the Federal spectrum working group. I have really enjoyed the entire process and learned a lot.

I just want to ask a couple of questions. I want to start with you, Dr. Marshall. I want you to comment about whether there is a standard to measure efficiency in spectrum use?

Mr. MARSHALL. There is a very engineering one of bits per hertz that gets misapplied horribly that becomes the Holy Grail to people. The PCAST report proposes that we should really measure spectrum reuse, not spectrum use.

Ms. DEGETTE. You need to speak into the microphone from this angle over here. I can't hear everything.

Mr. MARSHALL. The PCAST report proposes that we should really be measuring spectrum reuse. If I use a lot of spectrum but 100 people can use it over and over again, then that is much more valuable than one person using it once, and that that should become the objective of Federal systems, not so much to optimize the signal, but to optimize how many signals sit in the spectrum.

Ms. DEGETTE. But there is no—what you are saying is that there is no agreed upon standard that is used right now, just the standard that is proposed?

Mr. MARSHALL. Only what someone wants to prove.

Ms. DEGETTE. How can concepts of efficiency be used to distinguish a measure of actual spectrum use between commercial and Federal users? Does PCAST talk about that?

Mr. MARSHALL. PCAST proposed that the SMT propose a set of metrics that probably look a little different than what NTIA would do. For example, we might want to measure Federal spectrum usage as a function of POP, so we don't charge a lot of federal bucks when they use it in Mojave, but we charge them a lot when they use it in New York. And so we clearly want to measure the opportunity costs associated with Federal spectrum use, not the use itself. And that, I think, was the key to that appendix.

What is the opportunity that Federal spectrum usage is taking away from the civil sector and being able to either share the spectrum or lease it?

Ms. DEGETTE. And let me talk about that a little bit, because I think that is one of the questions. Everybody makes allegations that both commercial and Federal users are sitting on spectrum, but there is no agreed upon way to monitor how we build it out, how we deploy it in daily use, who is using it, and we talk a lot in particular about the Federal spectrum about how it is just sitting there. I want to know, after listening to this panel testify today, what incentives actually exist for a commercial site to use spectrum effectively?

Mr. MARSHALL. Well, I think you have to ask—

Mr. SHARKEY. So I can answer—

Ms. DEGETTE. Feel free.

Mr. SHARKEY. I think there is tremendous incentives to use spectrum efficiently on the commercial side, and we do invest billions of dollars to use it efficiently.

Ms. DEGETTE. So what are those incentives?

Mr. SHARKEY. They are—as the FCC has moved to auctioning spectrum, there are financial incentives through auctions that cost us a lot of money to obtain new spectrum. Obviously, the more customers we can serve and the more information we can provide

them or data we can provide, the more money we can make by serving a larger base of customers.

Dr. Marshall's comment about measuring reuse and the ability to reuse frequencies as part of the efficiency, we—the technologies that we are implementing today reuse the same frequency everywhere. So where previous technologies would only reuse it—a particular slice of frequency every so often, new technologies use this entire spectrum we have available every place.

Ms. DEGETTE. OK. Mr. Goldstein, I wanted to ask you, some people have said that the GAO should take a greater role in investigating the Federal agency's spectrum use. Does the GAO have the resources and expertise to conduct this type of analysis?

Mr. GOLDSTEIN. We were talking about this the other day. We think maybe the best way to do this is getting the postal service to do it. They pass every house and every building in America. GAO would not have—

Ms. DEGETTE. Assuming the postal service is still around.

Mr. GOLDSTEIN. Exactly.

Ms. DEGETTE. So seriously, does the GAO have the resources to conduct these types of analyses?

Mr. GOLDSTEIN. I think it would be a tall order to ask almost anyone to be able to inventory Federal spectrum usage at this point in time.

Ms. DEGETTE. So your answer is no?

Mr. GOLDSTEIN. That is correct.

Ms. DEGETTE. Is there anybody who could do it at all?

Mr. GOLDSTEIN. I don't know. We have not looked at that. I can certainly talk with staff and get back to you—

Ms. DEGETTE. It would seem to me—

Mr. GOLDSTEIN [continuing]. And see whether we have any suggestions for you.

Ms. DEGETTE. If we are trying to figure out where the spectrum is, it might be helpful to have that.

Mr. GOLDSTEIN. Of course.

Ms. DEGETTE. Thank you very much, Mr. Chairman.

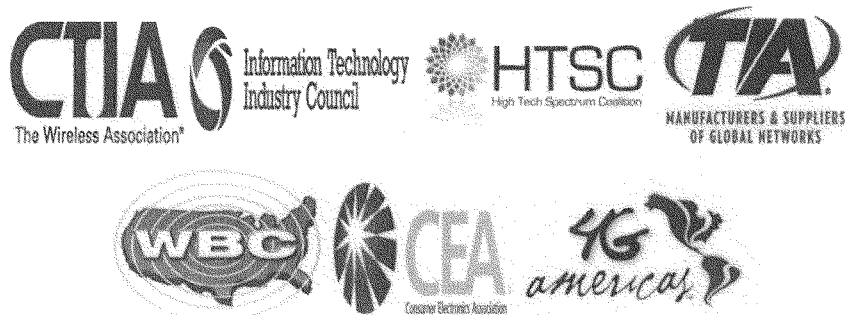
Mr. TERRY. Thank you. The gentleman from Illinois is recognized for his 5 minutes.

Mr. SHIMKUS. Thank you, Mr. Chairman. It is great to have you all here. It is great testimony. It is a great debate, and timely and needed.

Mr. Chairman, first I want to seek unanimous consent to enter into the record a letter from CTIA, the Wireless Association, Information Technology Industry, High Tech Spectrum Coalition, TIA, the Wireless Broadband Coalition, the Consumer Electronics Association, 4G America, urging the government to make more licensed, paired spectrum available. And I do this because then I go to—

Mr. TERRY. Without objection.

[The information follows:]



September 12, 2012

The Honorable Fred Upton
Chairman
Committee on Energy & Commerce
2125 Rayburn House Office Building
Washington, D.C. 20515

The Honorable Henry Waxman
Ranking Member
Committee on Energy & Commerce
2322A Rayburn House Office Building
Washington, D.C. 20515

The Honorable Greg Walden
Chairman, Subcommittee on
Communications & Technology
2182 Rayburn House Office Building
Washington, D.C. 20515

The Honorable Anna Eshoo
Ranking Member, Subcommittee on
Communications & Technology
205 Cannon House Office Building
Washington, D.C. 20515

Dear Chairmen Upton and Walden and Ranking Members Waxman and Eshoo:

We support the 10-year 500 MHz spectrum allocation goal outlined in the Federal Communications Commission's (FCC) March 2010 National Broadband Plan (NBP). The Administration, the FCC, and Congress deserve credit for taking the first concrete step toward implementing that goal by adopting the incentive auction provisions contained in the Middle Class Tax Relief Act.

Spectrum allocation policies that enjoy bipartisan support in Congress have helped make the wireless industry a bright spot in a sluggish U.S. economy. Recon Analytics reports that wireless added \$146.2 billion to U.S. GDP from mid-2010 to mid-2011, created an entirely new business sector—applications—that expanded to \$8.2 billion in 4 years, and was responsible for 3.8 million direct and indirect jobs in 2011, including 200,000 new jobs created since 2005.

Without near-term access to additional licensed spectrum allocations below 3 GHz, that growth and America's global leadership in mobile technology will be threatened by an inability to keep pace with dramatic increases in mobile broadband traffic. Over the past 2 years, actual traffic on licensed mobile networks has exceeded all the forecasts used by the FCC in developing the NBP spectrum allocation recommendations. Between Q1 2011 and Q1 2012, traffic on licensed mobile networks almost doubled. Cisco's U.S. mobile data forecast projects that mobile data traffic will increase 18 times from 2011 to 2016. Ericsson predicts that, over the next 5 years, mobile data traffic will grow 15 times.

The wireless industry is investing billions of dollars in new technologies to solve this problem by improving spectrum efficiency, deploying LTE networks, adding cell sites, and improving network management practices and technologies, but it will not be enough. The evidence is overwhelming. More cleared, paired, internationally-harmonized spectrum allocations below 3 GHz are needed and needed soon. America's economy and its global leadership in mobile broadband depend on it.

Sincerely,



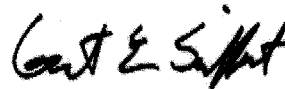
Steve Largent
President and Chief Executive Officer
CTIA – The Wireless Association



Dean Garfield
President
Information Technology Industry Council



Rhod Shaw
Executive Director
High-Tech Spectrum Coalition



Grant Seiffert
President
Telecommunications Industry Association



David F. Taylor
Executive Director
Wireless Broadband Coalition



Gary Shapiro
President and Chief Executive Officer
Consumer Electronics Association



Chris Pearson
President
4G Americas

Mr. SHIMKUS. Mr. Racek, do you think shifting emphasis toward the PCAST approach is more or less likely than clearing to help make such spectrum available? What does your crystal ball say?

Mr. SHARKEY. I think that there are still a lot of opportunities that exist to clear spectrum and make it more fully available. Certainly we are open to sharing and the conditions around sharing will depend on, you know, the specifics. It is not an easy process, and it is, you know, it really is a process where the parties need to sit down and understand and make sure that you are not going to interfere with the other user, which is the process that we are going through in 1755 right now. A broader sharing that is, I think, at least out of the PCAST report, has been largely portrayed of a database that allows free use, I think, you know, doesn't provide the kind of certainty that we need to provide a commercial service. You know, there does need to be substantial access to spectrum to be able to provide a reliable commercial service.

Mr. SHIMKUS. Mr. Racek?

Mr. RACEK. Could you go ahead and repeat the question?

Mr. SHIMKUS. The point I was making was do you think shifting emphasis towards the PCAST approach is more or less likely than clearing—to clearing spectrum to help make such spectrum available?

Mr. RACEK. I think that the type of services that the licensed spectrum provide is real time type of services. These are services that are statutorily mandated by the FCC. These are CALEA, this is e-911, you know, these are—there is a quality of service that is guaranteed on this spectrum. Those are the type of services that are currently in use. The types of services that we see for a licensed shared environment or a spectrum sharing environment, those are sort of like complementary to providing support for licensed type of operation. So you could see that as more of a best effort type of services, very good for sort of offloading, but it is an offloading of a licensed type of network.

Mr. SHIMKUS. And I appreciate Dr. Marshall's comment. Obviously being with PCAST, but as an engineer, you know that having it is better than sharing it. And for the private sector, their real testimony is they don't want to blow and lose capital, and they have got to have consumers and they want to maximize the potential of that spectrum use. I mean, it is a great capitalist debate of how to best get the max use out of a spectrum is give it to the private sector and see if they can turn a profit by maximizing use in that area.

But we have a history—I mean, we have history of sharing, or at least what happens to the economics of it, and the D block does talk about any takers. We also—and so the other question I have is—and sometimes we do this. I don't like to compare United States with what Europe is doing and what other folks are doing, because we are so big and all that stuff. But can anyone tell me of any other country that is in the high tech arena, like maybe in Asia, Japan, Korea, South Korea, Europe? Has anyone talked about shared spectrum and the like, and does the PCAST report—you look like you are interested in answering this.

Mr. MARSHALL. Yes, in the EU Spectrum Management Conference, which the community just had, they actually got up and

said if they don't get ahead of America, they will be in the dust. I think we have started a race to see who develops the technology that uses shared spectrum, because it is the next big sweet spot. There is some spectrum probably left over as Steve describes, but we are going to move to an era where this is the next—just like you moved out of the suburbs into further land, and after you did the plains you went to a little bit rockier soil because that was the only land available to farm. This is the place to farm for innovation, and I think the EU sees that opportunity as one they want to get ahead of us on.

Mr. SHIMKUS. In my last second, what examples do we have of spectrum sharing right now by Federal agencies, and the difficulties or challenges that have been faced?

Mr. NEBBIA. There is a great deal of sharing that already goes on among the Federal agencies, day in and day out. Few Federal assignments are exclusive types of assignments, but at the same time, we also share with a number of nonfederal uses. We share with wifi, we share with a system called Low Jack that we use to find stolen cars, we share with medical telemetry, public safety, land mobile satellite systems operated by the nonfederal side, amateurs. Almost every weekend, Federal spectrum is used by the broadcasting community to transmit signals related to sporting events that you are watching on TV. Weekend activities are a nice way to share. So that goes on all the time. The government has actually been operating in the TV white spaces for years, doing DoD training in those gaps between the broadcasters.

Mr. SHIMKUS. Thank you, Mr. Chairman. Thank you.

Mr. WALDEN. Thank you. Now I turn to Dr. Christensen for 5 minutes for questions.

Mrs. CHRISTENSEN. Thank you, Mr. Chairman, and thank you for this hearing. It has been very informative.

I want to go back so I understand about the costs and the time frames. That March, 2012, NTIA report on the potential for clearing and reallocation of the 1755 to 1850 megahertz band indicates that the—indicated that the full relocation would take up to 10 years and cost maybe \$18 billion, and those projections, as we discussed already, were provided by Federal spectrum users. As the government and the commercial providers are like endeavors to find a solution to access this spectrum, are we still—in light of the response, and I believe it was in response to the question by Chairman Stearns and some comments by General Wheeler, are we continuing to rely on that data?

Mr. NEBBIA. Congresswoman, that data is our starting point for the discussions we have been having. Certainly as we find ways to share the spectrum and we find opportunities where maybe some of those systems do not have to be moved, we will certainly see some of those numbers change. As we get closer to any auction process, there will be another review of that under the CSEA.

Mrs. CHRISTENSEN. And I believe GAO recommended that NTIA reevaluate your approach to validating the agency-reported data. How do agencies get—derive that data? What are you doing to assess and scrutinize them to getting a more accurate assessment, and to gain a better understanding of the costs to reallocate Federal spectrum users and to tighten the timeframes for vacating?

Mr. NEBBIA. Well first of all, I think it is important to recognize that, for instance, in the cell phone community, the people that are organizing that spectrum space have base stations, they have handsets, and they have backhaul. In the government, we have got satellite systems, we have got sensing systems, we have got military tactical systems, and with the great number of different operations that we have, we simply have to rely on the experts in those systems to look at their uses and needs and to project the kind of costs that they will have to relocate and the time to relocate. That simply can't be determined by our spectrum staff.

Mrs. CHRISTENSEN. OK, thank you.

Mr. Sharkey, Mr. Marshall has testified that wifi offloading is "providing more capacity per megahertz than a dedicated cellular spectrum." Is offloading broadband traffic on wifi an acceptable alternative to commercial wireless providers?

Mr. SHARKEY. It is not an acceptable alternative, but we do offload a lot of traffic onto wifi systems, and I think all the carriers now do that. Our devices can be set so that they prefer to be on a wifi network as a way to move traffic off of the broadband mobile network. However, you know, the projections that we see about growth of data on the broadband network are on the broadband network. When we report numbers about how much data our devices use, they don't include the data that has been offloaded onto wifi networks, so the growth that we see continues to impact the broader mobile network which provides highly reliable services wherever people are. And we, you know, we need dedicated spectrum that will continue to meet that demand and that growth, and at the same time, we are always interested and always moving to implement new technologies and techniques to minimize the impact of that growth.

Mrs. CHRISTENSEN. Thank you. I wanted to get that question in, and maybe I would go back to Mr. Goldstein to go back to my first question and your recommendation that NTIA reevaluate how they validate the agency's assessment of costs, and if you wanted to add anything to what Mr. Nebbia said about the difficulty in doing that and meeting that recommendation?

Mr. GOLDSTEIN. Ma'am, it is a very critical part of what has to happen, because whether we are talking about clearing space or whether we are talking about sharing spectrum, it is impossible to really figure out how to do this effectively if we don't know who is using what space, what spectrum. And in our analysis of use last year, we did a survey of all the Iraq members, and we found that many of them told us that they made many errors in assignments when they went back and looked, and for those agencies that actually did sample surveys or site visits to help them determine the accuracy of the information that they were providing to NTIA, much of the information that they provided they recognized was in error.

Mrs. CHRISTENSEN. OK. Thank you, Mr. Chairman. I think I will just yield back.

Mr. WALDEN. Thank you, Dr. Christensen.

We will now go to the gentlewoman from California, Ms. Bono Mack, for questions.

Mrs. BONO MACK. Thank you, Mr. Chairman, and I thank our panelists for very interesting and enlightening discussion.

Mr. Sharkey, my first question is to you. Mr. Marshall says that the people who say industry won't share spectrum are wrong because industry shares the wifi band, but as I understand it, commercial mobile providers do not use the wifi band as the primary means of enabling consumers to access mobile services. Instead, commercial mobile providers used—they use cleared spectrum for which they have exclusive rights. Isn't that correct?

Mr. SHARKEY. That is correct, and as I mentioned, the projections of growth are growth on that cleared spectrum, that dedicated spectrum, and having that enables us to—we are on a cycle of updating technology almost annually now for our network and implementing new techniques and technologies, and having that cleared assured access to spectrum gives us incentives to continue that innovation and growth so that we can provide greater data and serve more customers.

Mrs. BONO MACK. Thank you, and also, Mr. Sharkey, haven't preliminary conversations in the Commercial Spectrum Management Advisory Committee indicated that the Federal agencies had some fundamental misunderstandings about the technical specifications underlying the commercial sector's proposed use of the spectrum, and don't these types of misunderstandings underscore the need for independent verification of agency costs and time estimates?

Mr. SHARKEY. I certainly support verification of costs of relocating systems, and I think the, you know, some of the fundamental misunderstandings go to even our ability to share either through a transition period or indefinitely. In our AWS-1 clearing, we were—we had to work with DoD to get access to spectrum earlier than originally anticipated, and we found that once—well, initially it looked like we would not get access to it. Once the engineers were able to sit down and explain that how our systems operate and how they limit the potential for interference and noise into where the government systems would operate, we were able to access and deploy that spectrum years earlier than originally anticipated.

Mrs. BONO MACK. Thank you.

Dr. Marshall, in defending PCAST recommended sharing model, you assert that sharing will be based on the fundamental principle that underutilized Federal spectrum should be shared to the greatest possible extent. If that Federal spectrum is being underutilized, why shouldn't Federal users be consolidated into fewer bands, rather than require commercial providers to share spectrum with inefficient and underutilized government systems?

Mr. MARSHALL. Thank you for the question. So the premise of the PCAST report was that there is fundamental different usage between the kind of spectrum represented by the commercial world and much of the Federal agencies. Federal agency spectrum is largely driven by contingency and very geographically specific. So in the western test ranges, it is very hard to find any open frequencies because there is so much test training activity out there, whereas that spectrum in New York may be very underutilized. The fact that it is underutilized in New York or is it used 7 percent

across America—and I don't want to quote the number—doesn't mean that you can reduce it by 14. They need the peak out in the western test range, but they can make available that spectrum in New York. If you do reallocation, you essentially have to say I am going to squeeze them everywhere. If you do spectrum sharing, you open the opportunity to say we are going to commit 90 percent spectrum availability in New York, minus a 9/11-like event, but we are going to let you still test and train with a full complement of spectrum for all your systems. So it lets you not have to make a one size fits all, one size goes everywhere in the United States solution. So there is no tension at all behind saying that Federal spectrum is underutilized in many places, in fact, where people are, while at the same time saying you can't reduce those allocations. That is the conundrum you faced every time people have come to you to say reallocate, reallocate. The PCAST report says there is a different solution. Leave it like it is, learn to share. It is inconvenient, it is new. We don't know how to do it. We shouldn't be afraid of that. Let the Federal Government keep what it needs for its contingency. Now whether that contingency number is right or wrong is another question, but let it keep what it needs for contingency while you made the underused portion of that, the temporally and geographically underused portion available to people like Steve. It is a compromise that meets both side's needs without having to do grievous injury to either.

Mrs. BONO MACK. Thank you. Mr. Chairman, I will yield back my time.

Mr. WALDEN. Gentlelady yields back. Now gentleman from Massachusetts, Mr. Markey, is recognized.

Mr. MARKEY. Thank you, Mr. Chairman, very much.

Back in 1993 when I was chairman of this subcommittee, we held hearings on reclaiming spectrum from the military from other government agencies, and it was necessity. We only had two cell phone companies. They were both analog and they were both charging 50 cents a minute. And so we have the hearings here, and we moved over 200 megahertz of spectrum. General, your predecessor on the job was sitting there, raising national security concerns, which we appreciated. But we moved over the 200 megahertz and created a third, fourth, fifth, and sixth cell phone license in each market in the United States by the year 1996, and the four new companies in each market went digital, dropped the price to under 10 cents a minute, and that is the year you all bought a cell phone. I am pretty sure you didn't have brick you were carrying around in a bag. There might have been a few people, but not many. So we needed that revolution.

And so now we reach, you know, this modern era here where the surging growth and data-intensive devices and applications is leaving our mobile industries gasping for air or spectrum. So it is important for us to find ways of efficiently, in these 20 years later—it is only actually like 15 years. Everyone thinks they have had a cell phone in their pocket their whole life, much less an iPhone, and they haven't. It is just a very brief period of time that this whole era has existed, but this committee had to move over the spectrum and kind of balance the interests of the military and

other government agencies with the need to continue to provide that extra spectrum.

So when I—Mr. Goldstein, when I talked to Commissioner Knapp last year here in the subcommittee hearing, he told me that it would be possible that we could increase the efficiency of the spectrum we have from 10 to 50 percent. Do you agree with that?

Mr. GOLDSTEIN. We haven't looked at that, sir. I would be happy to talk to staff about doing it, but we have not done work specifically examining that.

Mr. MARKEY. OK. General Wheeler, what do you think?

Mr. WHEELER. I don't have a specific number out there, but I don't think that is unreasonable. I think that we can increase efficiencies across the board, given the new technologies that are going out there.

If I could clarify about a comment back on that vacating of the frequency, I was not here for the DoD guy that was nervous, I can tell you that. I was a young captain.

Mr. MARKEY. I am sure you understand this.

Mr. WHEELER. I do, because I was a B2 guy, a stealth bomber guy, and part of the area you vacated was the area for my radar, and so in that particular area that we had in there, we actually had to physically turn off in the weather on certain cases. And so we were at a 10-year area where we actually had to replace the radar for \$1.1 billion and weren't sure we could do it in the timeline we did, but we did find a way to do it. It did turn out to work. It did cost us money. It caused us some safety issues for a while, but we worked through those.

Mr. MARKEY. You know what? Here is the deal. Every Democrat and Republican on this committee would support whatever money you need in order to do that, because honestly, by 1996 everybody had a cell phone in their pocket and as a result of that, the devices got so inexpensive and it was digital that it went to every village in the world.

Mr. WHEELER. It started to balance.

Mr. MARKEY. So that is quite a revolution, you know, that all happened because the military understood that that might actually be a good thing to spread this communications technology, but we have to lead it here. So my hope is that—you are not opposed to this sharing of the spectrum?

Mr. WHEELER. No, sir, not at all. I think one of the points that I think is good to understand is that there is also geographics here, and I think that is where we are driving to over here, because there are areas where it is more difficult to move things from a cost perspective and those areas may—for example, a satellite control station, very difficult to change a satellite's receiver in orbit, obviously. So instead of doing that, you don't use that frequency in that particular area. Go ahead, sir.

Mr. MARKEY. If I may, according to the President's Council of Advisors on Science and Technology, the Federal Government's use of domestic spectrum is rising in part because of the increasing drone usage here at home. According to this report, the number of drones operating by the Department of Defense has drastically increased from 167 to nearly 7,500 from 2002 to 2010, and the systems are carrying larger payloads and collecting increased volumes of intel-

ligence, surveillance, and reconnaissance data, and that has resulted in a much larger increase in the number of domestic training requirements.

Dr. Marshall, in developing this report, what can you tell us about the types of information that the Pentagon collects when it flies drones over American soil, and what the Department does with that information?

Mr. MARSHALL. We certainly didn't audit what the government does with the information from the drones. Really, it wasn't our—I don't think the PCAST's job to audit the Federal usage. It was enough to see that there were these very large Federal systems like air traffic controller radar—

Mr. MARKEY. I guess what I am asking is do they have policies to delete information about innocent Americans that they are collecting, the military? Do they have a policy in place to delete it?

Mr. MARSHALL. I hope they have a policy not to collect it.

Mr. MARKEY. You hope they do. Do you have a policy to delete—

Mr. WHEELER. May I clarify? Yes, sir, we have—there is a whole legal piece in there and they do that.

Mr. MARKEY. Can you provide to the committee the Pentagon policy on eradicating all information that is gathered by 7,500, you know, drones flying over the United States of private American citizens—

Mr. WHEELER. Can I clarify a little bit on that particular—

Mr. WALDEN. The gentleman will need to move on.

Mr. WHEELER. I think it is important to understand that what happens in Iraq and Afghanistan today, those pilots in those UAVs, in many cases, are actually in the United States. The airplane may very well not be flying over the United States, but the spectrum and the uplink going to the satellite, that individual could be, for example, at Nellis Air Force Base and he is actually flying the airplane over Iraq and Afghanistan. No video taken over the United States, but in fact actually using that uplink from Nellis—

Mr. MARKEY. No, I appreciate that, and I have been—but what I would ask is if, you know, anything that is gathered here domestically, in training missions, anything—

Mr. WHEELER. Absolutely.

Mr. MARKEY [continuing]. What happens to that? And there is a policy, is that—

Mr. WHEELER. There is policy there, there is data not allowed to be used. There is no—they are very cautious of that particular Federal Government—and we will provide those rules to you so you can have those.

Mr. MARKEY. I think both sides would love to know what those rules are. Thank you, Mr. Chairman.

Mr. WALDEN. Thank you. We will now go to Mr. Scalise for 5 minutes for questions.

Mr. SCALISE. Thank you, Mr. Chairman. I appreciate you having this hearing. I know as we have done this work on the task force over the last few months, I think we all recognize that if you look at the economy, one of the growth sectors has been the technology industry, and probably one of the few, but one of the greatest growing—and you know, as we all use more technology, new technology,

you know, 3G networks are now 4G networks, the demand continues to increase for spectrum. And then, of course, as that demand is met it allows for more innovation, for more great new products that make everybody's life easier, but also creates thousands of new high-paying jobs. You know, the jobs in this industry are tremendously high-paying, really important to our economy, and also helps us as we try to increase exports to lead the world, it is one of the areas where we continue to be a dominant force. So figuring how to free up more spectrum is critical, not only for the industry and the growth of jobs, but also for America's economy to grow.

I appreciate the Federal agencies that we have met with over these last few months, and the conversations we have had because clearly, there is a lot of spectrum held by the Federal Government, and some, I think everybody acknowledges, of which can be freed up. How do we best go about that? I think where we start, how do we best get an inventory of that available spectrum, and I think that has been probably one of the hardest things to get a grip on. I think the GAO report brought this up and I want to ask Mr. Goldstein about this, because one thing it seems like is, you know, to get the inventory we have today it was almost like, you know, they went to everybody and said how much money do you have available in your savings account that you don't want to use? And you know, so when you are asking everybody how much spectrum do you have that you don't need, I don't know if that is the most objective way to get an inventory of spectrum.

So if you, Mr. Goldstein, can comment on the inventory that we have, and is there a better way to get an impartial, true inventory of what the Federal agencies hold that they really don't need, or could use more efficiently, especially if more was freed up where you generate money that could help build out a more efficient system for them so that more can be cleared and reallocated?

Mr. GOLDSTEIN. Congressman, I think because there is a lack of economic incentive on the part of agencies, we found that many of them simply don't do the work to figure out how best to use the spectrum they have. And we also found in a report last year when we surveyed all of the members, you know, in Iraq that 15 of the 18 Iraq members expect that they will have significant new needs for spectrum. I know that is probably not popular in this room right now. We have been talking about commercial needs, but almost all of them expressed the need for additional—significant additional spectrum themselves.

Now certainly you could argue they ought to better use the spectrum they have, and there needs to be ways in which they should do that. One of the recommendations we made to NTIA, working with Iraq, was to figure out how better to do that, and they agreed with that recommendation. What I don't know is how far along they have gotten on that recommendation since that report last April.

Mr. SCALISE. And I mean, those are fair points to bring up because if you look at, you know, a number of Federal agencies, we all acknowledge that some have spectrum that they are using and you can identify those areas, but there are also areas that they are not using today that they say they will need in the future, you

know, and in some cases you have got to dig in and see is that really something that is realistic? Is that something that they are going to truly be using? In some cases the answer is yes, and in some cases the answer is probably no, but in the case where the answer is yes—and I really want to ask General Wheeler this question, because we see in so many constraints with the threats of sequestration, the threats to the Department of Defense, you know, one of our main constitutional duties is to provide for our national defense. I think everybody here strongly supports that and wants to make sure that you have the tools you need to meet your mission, but while at the same time if there have been constraints that have held you back from making the most efficient use of the spectrum you have, and even the spectrum you are holding that you are not using that you might want to use later, if this concept of having some kind of incentive, which is a very important concept to bring to the table, because of billions of dollars will be generated to the Federal Government to make this available in the private sector to create those jobs and innovation, some of that money can be set on the side to help incentivize the agencies that have spectrum today to make better use of it, where in some cases you know you can make better use, you just don't have the money to do it. And some of that money could be made available to give you better use of your spectrum, which also frees up spectrum that can then go and generate even more money, billions of dollars to the Federal Treasury to go out to the private market. So if you can share with us what you have looked at in terms of the things that you could do if you had some money that was freed up from the sale of some of that spectrum that you can actually use to help make a more efficient use of what you have today?

Mr. WHEELER. From the DoD perspective, that is the basis of the NDA language that says that we have to have comparable spectrum. That is going to take us time, and then we are going to have to have money to actually move those systems. Where sometimes that difficulty comes in is that happens after the auction occurs, and while you are trying to do some of the planning up front, we basically front the money, per se, and we don't have real good avenues to receive that money within DoD from that side of the ballpark. The expectation is when we vacate something out of there is that we will have to get comparable spectrum time and money per the NDA language that actually addresses that specific issue.

As far as other monetary incentive schemes, we would be happy to study those. I don't have any direct answers to them, depending upon what the exact language, but I would also go back to one of my other comments that I made, that for the most part we are trying to vacate those areas and share, if you will, and find those efficient methodologies, because we also see from our perspective, economy is the strength of our Nation. So we are moving those forward, so we are putting a lot of assets against that. We actually move those specific areas that we are looking at, specifically we talk about the 1755 to the 1850. The other side of it is also from the DoD perspective is a long-term strategy, a long-term strategy for all of our spectrum, so we know what to expect and what we are going to move, and how to better purchase equipment, if you will, that has flexibility in the future. We can't put a satellite up—

we are thinking we have to move that particular frequency with a single receiver or single transmitter, because it is very difficult, obviously, to move that particular piece. And that is where that thinking ahead acquisition type cycles are very important. And many of the weapons systems that we are bringing online today were envisioned, built, engineered 10, 15 years ago, in many cases where this was not an issue. So that is what we are running into right now is we are having to change the way we think from that perspective.

So we are looking forward to building a long-term strategy for our spectrum, from a DoD perspective, to make sure that we are using it the most efficient way so that we can predict where to put our future systems so we don't run into the issue that we recently ran into where we moved from 1710 to 1755 into the 1755 to 1850 and now we are looking to move again quickly. So we are trying to find smart ways of doing this.

Mr. SCALISE. Thank you, Mr. Chairman. I yield back the balance of my time.

Mr. WALDEN. Thank you. We will now move on to Mr. Latta from Ohio. We welcome your questions.

Mr. LATTI. Well thank you, Mr. Chairman, for the very informational hearing that we are having today, and I want to thank all of our panelists that are here today for not only their testimony, but for their reasoned answers to a lot of questions.

Mr. Racek, if I could turn to your testimony. I found it rather interesting because you have a lot of questions that you pose, and I would like to see what kind of answers you might be able to get.

You know, in starting with it, you state that your premise that pretty much on spectrum clearing or spectrum sharing, which way to go, and you said the best way to look at this and be the cleanest would be that we should have spectrum clearing over the other option of spectrum sharing. If I could just ask you a few questions on what you stated, let us get on the technical side because, you know, in your testimony a little earlier, you said that—you cited a doubling of the global mobile data traffic from 2011 to 2012 with a global forecast of that going up 15 times by 2017. Do we have the technology out there in that—this next 5 years to be able to do that, you know, keep up with this if we are looking at global sharing versus global clearing?

Mr. RACEK. Thank you, Congressman. That was sort of the point of the testimony is that the preference for the or the need for dedicated license spectrum is based upon looking at the data traffic study, predicting the growth and the ability to—for technologies to be able to address that growth. There are a lot of developments—as I said in the testimony, Ericsson is spending \$5 billion in R&D every single year to be able to increase the spectrum efficiency of the technology to be able to address these sort of data traffic demands. But it is not going to be enough. The only way to be able to do that is going to be through licensed spectrum.

Now, licensed spectrum provides the certainty needed for the investment and the performance and will be able to provide the types of services, but the recognition is that, you know, licensed spectrum, it may not always be possible. Obviously if the band is identified by 3G PP, we would not want to see that band be identified

for spectrum sharing, but spectrum sharing may be the only option for some bands that are identified by 3G PP, but not available in the U.S. So we would still like to sort of pursue that as an option, but it is not going to replace the need for 500 megahertz as identified by the National Broadband Plan.

Mr. LATTA. Let me ask—let me go on with that, then, because in one of your other points, especially on the regulatory side, you say it is going to take—you say sharing raises a number of regulatory challenges, all of which will take years to test and model. How many years do you think it will take to test and model?

Mr. RACEK. I think that is a difficult question to answer, because not all of the questions have been identified yet. I think that is part of the activity that we are involved in, especially if we look for—look towards CSMAC and the investigation that is being conducted within the working groups, as well as looking towards international types of activities that are starting to maybe look at this type of activity, even within PCAST. These sort of things are looking at what are the questions and what are the answers to those questions. I think that that—we are still in sort of the infancy of that process, and there are questions that are out there that are yet to be asked, and obviously not answered.

Mr. LATTA. Let me just—one last question. Sorry that I am picking on you here, but overall, what would you say would be the best way to conduct a spectrum auction? What would be the best way to conduct an auction, a spectrum auction?

Mr. RACEK. And you are considering spectrum sharing?

Mr. LATTA. On your end, what would you see as how we should do something like that when you are looking at, you know, instead of on the sharing side but saying that we should go ahead and have some kind of an auction. What would you—how would you foresee that and how should we do it?

Mr. RACEK. Well, I think if we are looking—for instance, there has been a discussion about the 3550 to 3650 megahertz band, and that because of the radar operation in the band, it is likely that you would not be able to sort of utilize that in the same way with the same type of technologies that you use in sort of lower bands that are exclusive use types of bands. But there may still be an opportunity to provide some regulatory certainty for that spectrum through a licensed shared approach. The licensing provides you the protection that you need to be able to operate without the fear for being interfered with so you can provide a good quality of service to your customers, and also, it provides you with the ability, therefore, to have an understanding of what the terms and conditions of operations are up front, and that, in effect, would provide more value for the spectrum so that there is the possibility to auction that type of spectrum.

Mr. LATTA. Thank you. Mr. Chairman, I yield back.

Mr. WALDEN. Gentleman yields back. Chair now recognizes the gentleman from Kentucky, Mr. Guthrie, who co-led our working group on this topic. Thank you.

Mr. GUTHRIE. Thank you, Mr. Chairman, and I appreciate you appointing the working group and bringing that together. I really enjoy working with Congresswoman Matsui and a lot of you that participated that are here today. We appreciate that very much,

and no, not every military installation is where people don't want to be. Matter of fact, I would suggest coming to Fort Knox, Kentucky. It is a very beautiful place, and we are next to Louisville. I mean, Fort Knox is within 10 miles, probably, of definitely—not the heart of Louisville, but suburban Louisville, and so there are San Diego and Jacksonville and areas like that that we have to be mindful of in sharing. I have been to the Mojave Desert and I agree that I probably wouldn't want to go back to the national training center, but California has some other beautiful places that the military is located, so you have got to be mindful of that.

One thing—I think I heard Mr. Goldstein said it and I wrote down, leap of faith in technology for sharing. I guess my question is, if we got all this decided today and tomorrow we could turn over either full sharing or licensed—clearing license and all—we could snap our fingers and it happened, is the technology, I guess, Dr. Marshall, in place today to take advantage of that, or is this—we will build it and put it out there and have to innovate ourselves to make this work?

Mr. MARSHALL. So very clearly the technology exists for clear spectrum, although we have shown it takes, even with the technology in place, 8 years, if you look at the national broadband plan, between identification and occupancy. So it is not exactly a rapid process.

On the shared side, the PCAST report is remarkably conservative. We have been attacked for being too aggressive, but there are equal attacks for being unaggressive. The database technology is not the best way to do this, but it is available and it is certain, and it would provide certainty to Federal users that they could protect their equities while more fancy technologies came into play. So it is technologically unstressing.

What it does do is it continues the evolution towards much more flexibility in the provider's side, and so it will require the providers to make use of newer technologies, tunable filters and all.

Mr. GUTHRIE. New technology on the horizon, or new technology I will just have to completely—you are imagining technologies that don't exist?

Mr. MARSHALL. To fully exploit this, they will have to make adjustments and initially, like 3.6 gig, one could imagine that that band, they could start to use in a sharing fashion very, very rapidly. Putting many, many frequencies in a handset probably is going to evolve technologies and filters, hopefully led by the United States. But LTE already has 27 different frequencies, 42 different—so they are heading that way anyway.

So the PCAST is really a fast, low tech way to go there, and then you are going to build the technology in behind it. But you will get a lot out of it initially, and then you are going to make it better over 5 years.

Mr. GUTHRIE. And then the second question, I guess, Congressman Latta as he talked to Mr. Racek on the regulatory scheme that would have to come into play, and do you agree that is a barrier to the type sharing that—I was asking Dr. Marshall that—from the PCAST report. Did you all address that? I mean, I know you talked about it, but—

Mr. MARSHALL. We need to do a regulatory regime that is focused on sharing. Today we treat sharing as a special case. Steve is negotiating it with Karl, making their private deals. We have no framework for it. I think part of the PCAST report is just let us admit that that is going to become more and more fundamental to our approach to spectrum, and let us not treat it as a stepchild. Let us make it transparent. Let us make everyone able to make the same deal Steve does with Karl, and make that competitive, and in fact, let us auction the right to make that deal in a full and open marketplace. So I think it is different regulation. I think it is a fundamental commitment to a policy there. If we just do it—you don't need PCAST if you just want to go do it. We are doing it anyway. The PCAST recommendation is to move it forward, put it in front, and really think about the policies for financial remuneration, like how do I design an auction for shared spectrum? How do I deal with the e-911 and all those issues.

Mr. GUTHRIE. It is difficult to address, but the uncertainty for the users would be—and I am just kind of thinking out loud—is that we just said that we are going to create a system that nobody—you have to innovate to get there, and then people in Washington are going to have come up with a regulatory regime to try and manage that and a regulatory process is not as flexible as people innovate.

Mr. MARSHALL. So we put a new generation of wifi out every year. That is incredible. We put a new generation of cell phone out every 10 years. If we leave people alone, they will innovate the technology. PCAST proposes 3 years to implement it, and that was two and three quarters of them in Washington, and maybe 3 months for the engineers to start rolling things out. It will require a different kind of regulation. It requires a different thinking about what spectrum rights mean. It doesn't replace what we have now, but it extends it, and that is an important dialogue. And frankly, it is a dialogue you are not having now if we do spectrum sharing as a bunch of one off deals. It is to put it in the framework, put it up front, make it a norm, make it so someone who is building a venture capital proposal understands what the rules are if they go and invest in something that takes spectrum. Imagine doing that now where it is 8 years from seeing spectrum going up for auction to when you get into it, or do it when you are worried about light squarage and you have got to find out what a whole pile of forces are. I mean, it is to make this thing transparent and predictable, rather than private.

Mr. GUTHRIE. Thanks. Thank you, I yield back.

Mr. BASS [presiding]. Gentleman yields back. Chair recognizes himself for 5 minutes for questions. I want to apologize in advance because I have been in and out of this hearing.

Mr. Sharkey, your comments focus on the 1755 to 1780 megahertz sub-band. Does NTIA's reported costs of reallocating the current government systems from the entire 1755 to 1850, \$18 billion, fit with your own internal estimates and your experiences with the cost of reallocating government systems in the AWS-1 band, and if not, are there any estimates that specifically look at costs and potential revenues in the 1755 to 80 sub-band?

Mr. SHARKEY. Well first, if I can just make it clear that there are no private agreements between myself and Karl Nebbia. The process we are doing is an open—

Mr. BASS. Correction, so noted.

Mr. SHARKEY. I think the costs—and I think we do need to take a careful look at the costs of relocating systems. The costs varied significantly from initial estimates of clearing AWS-1 to what were the final costs of clearing that spectrum. In a 2001 report, NTIA estimated that clearing the entire band up to 1780 would be about \$4.6 billion, so now we have got an estimate that is \$18 billion, and you know, there may be a lot that has changed and it is difficult for us to know what the—you know, what underlies that estimate. So I think it is an important one to look at, and you know, one of the important issues about getting that estimate right is that under the CSEA, the costs of the monies raised in an auction to have to cover the cost of reallocating, relocating government users. So it is important that the estimate is accurate enough so that we have—so that an auction can actually go forward to cover the costs.

Mr. BASS. Second for, I suppose, Mr. Racek, you could address this as well. The PCAST study asserts that “Today’s apparent shortage of spectrum is, in fact, an illusion brought about because of the way spectrum is managed.” We have spent quite a while talking about this, actually. Do you agree with that statement? Do you think that carriers are not managing spectrum efficiently, or are there design issues associated with it?

Mr. RACEK. I think they were probably talking about different services other than commercial mobile type of services. Maybe they were pointing to other type of activities that we see ongoing right now, maybe with respect to incentive and voluntary incentive auctions, but I don’t think they were talking about our industry.

Mr. BASS. Anybody else want to comment on that? All right.

Mr. SMITH. NTIA’s report lists a number of video surveillance bands that are used by various Federal agencies. Is there any reason law enforcement video systems couldn’t use LTE to shrink their footprint and share resources?

Mr. SMITH. That is a great question, and certainly, law enforcement can and does use cellular technology today for certain video streams, and LTE being a video and high definition video technology certainly enables that quite substantially.

While I have the mic for just a second, if I could comment, there has been a number of questions around clearing versus sharing, and I just wanted to make—offer up the thought that geographic sharing—

Mr. BASS. Mr. Smith, you said they have it, but are they using it?

Mr. SMITH. Yes. Well, I don’t know how much is being used.

Mr. BASS. All right.

Mr. SMITH. In particular, LTE is just being largely rolled out the last year or two, but I don’t know how much today.

But if I could just finish one quick thought and take a moment. Geographic sharing is being—you know, has been done in the industry, in the cellular industry from the start. You know, it is not a technological issue. So if, you know, DoD bases today are 24 million acres out of 2.3 billion acres in the United States, roughly 1

percent, mostly where people are not, and you know, the notion of considering—policymakers considering having geographic sharing exclusions on bands for LTE use by DoD on bases is something that is in the realm of the doable today.

Mr. BASS. Thank you. I have no further questions. I would like to recognize the ranking member of the committee for a statement.

Ms. ESHOO. Thank you, Mr. Chairman, and first to all of our witnesses, you—each one of you is absolutely superb. You really engaged the members and our thinking. You have given us even more to work with, answered a lot of, you know, the tough questions, and we are very grateful to you. And sitting here as a member of the committee, I can't help but think collectively this is why our country is so great and has such enormous potential. You all represent that, and we are grateful to you.

Mr. Stearns is not here, and—but I wanted to make a—say a few words about his service, both as a chairman of this subcommittee. He has been a member of this subcommittee for well over a decade, and has taken the issues very, very seriously, has moved the needle on so many things, and I just want to say on behalf of my colleagues on this side of the aisle, that we wish him all of our best. We wish him all of our best and that he will be missed here, and today may very well have been the last—his last Telecom Subcommittee hearing. So we wish him Godspeed. We thank him for working so hard to make important investments for the future of our country. And with that, I will yield back.

Mr. BASS. The Chair thanks the ranking member for her comments and would like to associate himself with those remarks as well, as I am sure all of the other members of this subcommittee and full committee as well.

There being no other members wishing to ask questions, members are reminded that the record will remain open for 10 days to submit questions for the record. There being no other business to come before the subcommittee, the subcommittee stands adjourned.

[Whereupon, at 12:39 p.m., the subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]



UNITED STATES DEPARTMENT OF COMMERCE
National Telecommunications and
Information Administration
 Washington, D.C. 20230

MAR 11 2013

The Honorable Greg Walden
 Chairman
 Subcommittee on Communications and Technology
 Committee on Energy and Commerce
 House of Representatives
 Washington, DC 20515

Dear Chairman Walden:

Thank you for the opportunity to testify on September 13, 2012 before the Subcommittee on Communications and Technology at the hearing entitled "Creating Opportunities through Improved Government Spectrum Efficiency." I am enclosing my responses to the additional questions for the record you forwarded to me on January 25, 2013. If you or your staff have any additional questions, please do not hesitate to contact me or James Wasilewski, NTIA's Director of Congressional Affairs, at (202) 482-1840.

Sincerely,

Karl Nebbia
 Associate Administrator
 Office of Spectrum Management

cc: The Honorable Anna G. Eshoo, Ranking Member
 Subcommittee on Communications and Technology

Enclosure

Responses to Questions from the Honorable Anna Eshoo

1. What steps can both government and industry take to increase R&D investment in technologies that promote spectrum efficiency?

The Administration has several initiatives underway to support continued research and development (R&D) in the area of improving spectrum efficiency. The Wireless Spectrum Research and Development Senior Steering Group (WSRD SSG) of the National Information Technology Research and Development (NITRD) program, co-chaired by representatives from the National Telecommunications and Information Administration (NTIA) and the National Science Foundation (NSF), was established pursuant to the President's June 2010 memorandum, which called upon the Secretary of Commerce to "create and implement a plan to facilitate research, development, experimentation, and testing by researchers to explore innovative spectrum-sharing technologies...."¹ Since its formation in November 2010, the WSRD SSG has been engaged in outreach to private industry and academia to identify additional national-level R&D activities in spectrum sharing technologies that could result in improved spectrum efficiency. NITRD has developed an extensive database of over 600 ongoing or planned federal R&D projects and activities as well as a database of federal wireless testing facilities to share among federal, academic, and industry stakeholders.² The group will develop recommendations for federal research and development investments, including opportunities for technology transfer within the federal sector and to the private sector.

In 2008, NTIA established a spectrum sharing innovation test bed pilot program to analyze the sharing possibilities and efficiency gains of new spectrum technologies.³ This program is evaluating the ability of dynamic spectrum access devices employing spectrum sensing and geo-location techniques to share spectrum with land mobile radio systems in the 410-420 MHz federal band and the 470-512 MHz non-federal band. NTIA has actively promoted the publication of research surrounding spectrally-efficient technologies by sponsoring the International Symposium on Advanced Radio Technologies, an annual technical conference that brings together government, academia, and industry leaders to promote the development and

¹ Memorandum for the Heads of Executive Departments and Agencies, *Unleashing the Wireless Broadband Revolution* (rel. June 28, 2010), published at 75 Fed. Reg. 38387 (July 1, 2010), available at <http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution> (Presidential Memorandum).

² See Wireless Spectrum Research and Development, available at [http://www.nitrd.gov/nitrdgroups/index.php?title=Wireless_Spectrum_Research_and_Development_\(WSRD\)](http://www.nitrd.gov/nitrdgroups/index.php?title=Wireless_Spectrum_Research_and_Development_(WSRD)).

³ See NTIA, *The President's Spectrum Policy Initiative – Spectrum Sharing Innovation Test-Bed*, Notice of Inquiry, Docket No. 060602142-6142-01, 71 Fed. Reg. 33282 (June 8, 2006); see also NTIA, *Spectrum Sharing Innovation Test-Bed Pilot Program Fiscal Year 2011 Progress Report* (December 2011), available at <http://www.ntia.doc.gov/report/2012/spectrum-sharing-innovation-test-bed-pilot-program-fiscal-year-2011-progress-report>.

application of advanced radio communications technologies.⁴ In 2012, the conference focused on developing forward-thinking rules and processes for real-time federal spectrum sharing.

Beginning in 2012, NSF began a research grant program on the topic of “Enhancing Access to the Radio Spectrum” (EARS) which funds research with a goal toward enhancing spectrum efficiency and/or improving access to the radio spectrum by traditionally underserved populations. The priority research areas for funding under the EARS program are informed in part by the ongoing collaboration between NTIA and NSF through the NITRD WSRD SSG.

2. As each of you know, the PCAST report proposes the concept of “spectrum currency” as a way to incentivize federal agencies to relinquish or share more of their spectrum. While this idea has not been fully fleshed out, I’m interested in what factors would best motivate agency participation, particularly with respect to relinquishing the 1755 and 1780 megahertz band?

The PCAST report found that requiring federal agencies to “purchase spectrum rights through a market mechanism would go a long way toward achieving transparency, accountability, and efficiency in Federal spectrum use.”⁵ Such a mechanism would, according to the report, enable federal users to accurately internalize the opportunity cost of federal spectrum by allowing agencies to participate in a spectrum market within the federal government. This “synthetic currency” would be an alternative to spectrum fees and provide a positive incentive for agencies to adapt their systems to operate within large spectrum allocations through dynamic sharing with other federal and commercial systems. The PCAST report did not tie implementation of the spectrum currency concept to any particular spectrum bands.

In considering additional incentives for federal agencies such as the “spectrum currency” concept, NTIA recognizes that preserving, protecting, and enhancing the agencies’ ability to achieve their missions remains their primary objective.⁶ It is also important to acknowledge some of the constraints under which agencies operate their mission-critical, spectrum-dependent systems. For example, NTIA assigns each agency the frequencies required for its particular needs, but agencies currently have no defined or marketable rights to the spectrum subject to

⁴ See International Symposium on Advanced Radio Technologies, available at <http://www.its.bldrdoc.gov/isart/isart-home.aspx>.

⁵ “Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth,” Report to the President by the President’s Council of Advisors on Science and Technology (July 2012) at 55-56, available at http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf.

⁶ See, e.g., Testimony of Major General Robert Wheeler, USAF, Deputy Chief Information Officer for Command, Control, Communications and Computers (C4) and Information Infrastructure, U.S. Department of Defense, Before the Subcommittee on Communications and Technology, Committee on Energy and Commerce, United States House of Representatives, Hearing on “Creating Opportunities through Improved Government Spectrum Efficiency,” (September 13, 2012), available at <http://energycommerce.house.gov/sites/republicans.energycommerce.house.gov/files/Hearings/CT/20120913/HHRG-112-IF16-WState-WheelerR-20120913.pdf>.

each assignment. Rather, each assignment is typically limited to the technical characteristics of the specific system, its geographic location, and other conditions that may not be easily reflected in a pricing mechanism. In some limited cases, an agency may have an assignment that covers the United States and possessions, but its uses are also constrained by the authorized, often unique, application. Furthermore, such broadly defined assignments seldom, if ever, provide exclusive access. Accordingly, to implement the PCAST recommendation, three key factors would involve: (1) addressing the spectrum needs and missions of federal agencies; (2) how their rights are defined and valued, especially in the absence of a market for comparable uses; and (3) the ability of agencies to authorize access to spectrum.

Responses to Questions from the Honorable Henry Waxman

1. Some have suggested that the cost estimates for relocating from the 1710-1755 MHz band were initially around \$4 billion and later were found to be closer to \$1 billion. Is that correct? Does the 1710-1755 MHz band relocation experience serve as a helpful guide to the 1755-1850 MHz band relocation effort?

The actual costs of relocating federal operations from the 1710-1755 MHz band were, in fact, close to the agencies' estimated costs. The \$4 billion figure cited at the hearing may have come from a 2003 Congressional Budget Office estimate for relocating federal users from the *1710-1850 MHz band* or other options considered in NTIA's 2001 report that studied repurposing scenarios for these frequencies.⁷ Importantly, NTIA also reported in 2001 that the agencies' estimates to move their systems out of the 1710-1755 MHz segment was approximately \$2.1 billion,⁸ only 30 percent (\$550 million) higher than the final costs, which were approximately \$1.5 billion.

Although the government and industry gained valuable experience during the transition of federal operations from the 1710-1755 MHz band, the relocating systems from the 1755-1850 MHz band presents significantly greater challenges and thus would require much more significant actions and costs. During the 1710-1755 MHz band relocation effort, many federal agencies reduced the number or size of their frequency channels and moved their operations above 1755 MHz. The variety of federal operations and large number of systems in the 1755-1850 MHz band, as well as the length of the transition of those operations to other spectrum, would present greater coordination complexity and require commercial providers to operate in the presence of continuing and transitioning federal operations. Over 20 agencies utilize more than 3,100 individual frequency assignments in this band.⁶ Moreover, few bands and facilities are available to which these operations can move in order to achieve comparable capability of systems. Furthermore, relocating to other parts of the radio frequency spectrum means that many of the systems require redesign.

Despite the challenges, promising advances in commercial wireless technology may provide opportunities for the wireless industry to deploy networks that are more tolerant of interference without having to displace some federal systems. These technology advances and the industry's needs for additional spectrum capacity, especially in major metropolitan areas, have led to the exploration by government and industry stakeholders of early entry opportunities through spectrum sharing with certain incumbent federal systems. This collaborative effort seeks to optimize transition paths and reduce costs by leaving some federal systems in place where feasible. However, sharing during the transition period and thereafter would require clear

⁷ See Committee on Energy and Commerce, "Commercial Spectrum Enhancement Act" (H.R. 1320), H.R. Rep. No. 108-137 at 14 (June 3, 2003), available at <http://www.gpo.gov/fdsys/pkg/CRPT-108hrpt137/pdf/CRPT-108hrpt137.pdf>; NTIA, "The Potential for Accommodating Third Generation Mobile Systems in the 1710-1850 MHz Band: Federal Operations, Relocation Costs, and Operational Impacts - Final Report," NTIA Special Publication 01-46 at xix and 5-5 (March 2001), available at <http://www.ntia.doc.gov/files/ntia/publications/3g33001.pdf>.

⁸ See *id.* at xix and 5-13.

regulatory mechanisms prior to any auction to ensure appropriate protection of federal operations and clear expectations by prospective bidders of their status with respect to potential interference to and from federal operations.

2. How did the specific processes used by NTIA to collect information from agencies regarding the costs and timeframes associated with relocating federal systems from 1755-1850 MHz differ from NTIA's typical spectrum data collection efforts?

In the context of **identifying and recommending for reallocation** bands of frequencies from federal government use to non-federal use, NTIA's process to collect data on the estimated costs and timetables have evolved over the years in accordance with applicable statutory mandates and Presidential proclamations. On the other hand, the applicable procedures and assessments of these estimates during **the post-allocation transition phases** have been and will be governed by the Commercial Spectrum Enhancement Act (CSEA) modified by the Middle Class Tax Relief and Job Creation Act of 2012.⁹

The 1710-1755 MHz reallocation and transition processes were guided by title VI of the Omnibus Budget Reconciliation Act of 1993, title III of the Balanced Budget Act of 1997, and other statutory provisions.¹⁰ These included, for example, band selection criteria that included the general cost considerations and operational impact factors that NTIA addressed in its reallocation reports.¹¹

Regarding cost data that NTIA and the Office of Management and Budget (OMB) collected as part of the post-reallocation transition process for the 1710-1755 MHz band, NTIA and OMB followed the requirements set forth in the CSEA enacted in December 2004.¹² Specifically, soon after enactment of the CSEA, NTIA requested that the federal agencies with systems in the 1710-1755 MHz band submit their detailed relocation costs and timelines. In October 2005, NTIA provided this information to OMB for review pursuant to the CSEA, and then notified the FCC, Congress, and the Government Accountability Office of the total estimated costs. In February 2007, OMB, in consultation with NTIA, submitted a report to Congress detailing a transfer of

⁹ Pub. L. No. 112-96, Title VI, Subtitle G, 126 Stat. 245 (Feb. 22, 2012).

¹⁰ See, Pub. L. No. 103-66, Title VI, § 6001(a)(3), 107 Stat. 379 (codified respectively at 47 U.S.C. § 923(a)(4), (c)(1)(C)(i)-(ii) and (a)(4)).

¹¹ See, e.g., NTIA, *Spectrum Reallocation Final Report, Response to Title VI - Omnibus Budget Reconciliation Act of 1993*, NTIA Special Publication 95-32 at Sec. 3 (February 1995), available at <http://www.ntia.doc.gov/legacy/osmhome/EPS/openness/costs.html>.

¹² Pub. L. No. 108-494, Title II, § 202, 118 Stat. 3991 (Dec. 23, 2004). Before Congress established the Spectrum Relocation Fund with enactment of the CSEA, each agency's anticipated relocation costs would have been reported to NTIA, FCC and OMB pursuant to the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999, Pub. L. No. 105-261, Div. A, Title X, Subtitle G, § 1064, 112 Stat. 2132 (1998). This legislation mandated compensation payments from non-federal entities directly to federal entities when they relocate or modify their frequency use to accommodate the non-federal users of the reallocated spectrum.

\$1.008 billion from the Spectrum Relocation Fund to the federal agencies to relocate from the 1710-1755 MHz band. OMB transferred this amount to the agencies in March of 2007. NTIA and OMB have continued to monitor the actual costs of relocation in this band since it was auctioned in 2006 and have submitted annual reports to Congress with this data.

NTIA initiated its recent assessment of the potential reallocation of the 1755-1850 MHz band pursuant to President Obama's directive in his June 2010 memorandum, directing the Department of Commerce, in coordination with the FCC, to identify and make available 500 megahertz of spectrum over the next ten years for expanded wireless broadband use.¹³ In its Ten-Year Plan, NTIA provided guidance to the agencies regarding costs to be considered in evaluating bands.¹⁴ NTIA indicated specific costs to be included, such as engineering and operational analyses, research and development, equipment/system design (modifications or new designs), hardware integration, software development and integration, testing, operational and training costs, installation and maintenance. NTIA further specified that the cost data should support comparative analyses across systems, across repurposing options, and across candidate bands. Upon initiation of the 1755-1850 MHz band studies, NTIA provided further guidance to the agencies. For example, NTIA requested each agency to assume that all of the current systems would be relocated from the entire band within five to ten years and that the then-applicable definitions and provisions from the 2004 CSEA would be applicable to covered relocation costs.

NTIA and the federal agencies are currently at a juncture in the reallocation process for the 1755-1850 MHz band that is most analogous to the point in March 2001, evaluating several options for reallocating the 1710-1755 MHz band (and other bands), assessing different relocation and sharing scenarios, and relying on the agencies for their preliminary cost estimates based on applicable statutory provisions then in effect. NTIA's report last year on the 1755-1850 MHz band summarized the agencies' analysis and inputs on projected timelines, estimated costs, and prerequisites that would need to be satisfied to accommodate reallocation.¹⁵ As NTIA pointed out in that report, the estimated costs to relocate all federal operations from the band were "preliminary" assessments provided by each affected federal agency.

Looking ahead and in light of these preliminary estimates, other reallocation approaches in the 1755-1850 MHz band, such as sharing, which federal and industry stakeholders are currently discussing, may obviate the need for the relocation of some costly systems, resulting in lower costs. In addition, the new and amended provisions of the CSEA indicate that agencies have access to planning funds related to relocation and sharing scenarios. The law also requires that the agencies must have approved transition plans by the technical panel to be able to request

¹³ Presidential Memorandum at § 1(a).

¹⁴ See NTIA, *Plan and Timetable to Make Available 500 Megahertz of Spectrum for Wireless Broadband* (October 2010), available at http://www.ntia.doc.gov/files/ntia/publications/tenyearplan_11152010.pdf (Ten-Year Plan); Presidential Memorandum at § 1(d).

¹⁵ See National Telecommunications and Information Administration, U.S. Department of Commerce, "An Assessment of the Viability of Accommodating Wireless Broadband in the 1755-1850 MHz Band," at x-xi (March 2012), available at http://www.ntia.doc.gov/files/ntia/publications/ntia_1755_1850_mhz_report_march2012.pdf.

planning funds. Their estimated relocation and sharing costs will be set forth in detailed transition plans and reviewed by a three-member technical panel made up of representatives from NTIA, OMB, and the FCC.

As a result of NTIA's experiences with the 1710-1755 MHz band, NTIA will implement new planning tools in connection with future transitions. The planning tools should facilitate accounting for better planning assumptions, which help close the gap between the initial cost estimate and the final cost.

3. Last month NTIA submitted to members of this subcommittee a detailed inventory of federal frequency assignments, especially those assigned to what is known as the beachfront property for mobile broadband services. Could you discuss how much spectrum is actually assigned to federal users and whether they are using the spectrum on an exclusive or shared basis?

Of the 3,475 megahertz between 225 MHz and 3.7 GHz, approximately 18 percent has been allocated exclusively for federal use, 33 percent has been allocated for exclusive non-federal use, and 49 percent has been allocated on a shared basis.¹⁶ Quantifying spectrum in terms of *assignments* is much more difficult. There is not currently a precise way to quantify the amount of total spectrum assigned to federal users because each federal assignment is based on unique technical factors such as the authorized frequencies, bandwidth, and power. Each assignment also is bounded by different geographic, temporal, and environmental aspects of the system and application in use. The data NTIA submitted to the subcommittee represents the number of individual assignments to each of the agencies multiplied by the bandwidth associated with each assignment. Therefore, the data counts the same spectrum multiple times due to the fact that agencies have overlapping operations all over the United States and its possessions.

¹⁶ An **Allocation (of a frequency band)** is an entry in the International or U.S. Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more radiocommunication services or the radio astronomy service under specified conditions. An **Assignment (of a radio frequency or radio frequency channel)** is an authorization (e.g., license) for a radio station to use a radio frequency or radio frequency channel under specified conditions.

Hearing Date: September 13, 2012
House Energy and Commerce Committee
Subcommittee on Communications and Telecommunications
Member: Congressman Eshoo
Witness: Major General Robert Wheeler
Question: #1

Question: What steps can both government and industry take to increase R&D investment in technologies that promote spectrum efficiency?

Answer: DoD believes that the key step to promote spectrum efficiency is to forge a national level spectrum strategy, including R&D plans, through open and collaborative dialogue between government and industry to address challenges related to spectrum use by all the stakeholders. This plan must take into account the growing spectrum requirements of both federal and commercial users. In that regard, it is encouraging that the United States is moving to a new paradigm for spectrum sharing through technology where true real time sharing of spectrum is the end goal.

DoD is actively engaged in R&D investments to improve spectrum efficiency and effectiveness and supports increased investment to continue to advance flexible, agile and affordable technology solutions. The Department recognizes the substantive contributions that U.S. technology developers are making toward wireless broadband services, applications and systems, which provide important opportunities to advance DoD mission requirements while promoting economic development and U.S. technological competitiveness. DoD is also increasingly focused on incorporating into its policies elements to ensure that research, planning and acquisition efforts enable more efficient and effective use of the spectrum.

As part of implementing these goals, the Department is working with the Administration and the FCC to develop a sustainable mechanism for national level collaborative efforts between government and industry in order to advance flexible and agile technological solutions for improved spectrum efficiency while ensuring mission effectiveness. This effort will facilitate and optimize evaluation of spectrum sharing proposals between federal and commercial users. The effort will also expedite and optimize testing of spectrum dependent systems. This collaborative engagement will further the objective of co-existence and expand large-scale federal-commercial sharing opportunities in the long-term in any piece of the spectrum.

Continued funding to these important areas of spectrum innovation will help the nation continue to improve its efficient use of spectrum.

Hearing Date: September 13, 2012
House Energy and Commerce Committee
Subcommittee on Communications and Telecommunications
Member: Congressman Eshoo
Witness: Major General Robert Wheeler
Question: #2

Question: As each of you know, the PCAST report proposes the concept of “spectrum currency” as a way to incentivize federal agencies to relinquish or share more of their spectrum. While this idea has not been fully fleshed out, I’m interested in what factors would best motivate agency participation, particularly with respect to relinquishing the 1755 and 1780 megahertz band?

Answer: As the question notes, implementation details remain unclear regarding the PCAST “spectrum currency” concept, which implies that each federal agency would be given an allocation of a “synthetic currency” to “buy” their spectrum usage rights. Use of a monetary incentive mechanism based on the economic value of spectrum is challenging to implement because the economic value of spectrum from a commercial industry perspective is driven by a revenue-focused business model rather than the critical mission requirements that drive the value from a federal spectrum use perspective. Federal agencies do not “buy” spectrum usage rights or “own” spectrum, but are granted access by NTIA to spectrum based on mission requirements and availability of the spectrum.

Thus, from a DoD perspective, the fundamental motivator is the ability to have assured access to spectrum in order to meet its current and future global mission requirements, consistent with overarching Administration goals. The Department remains fully committed in support of the national economic and security goals of President Obama’s 500 MHz initiative to make spectrum available to meet increasing spectrum requirement for commercial broadband use while ensuring national security and other federal capabilities are preserved. Through NTIA established deliberate processes to methodically evaluate spectrum bands, the DoD is already proactively working with NTIA, other Administration partners, and industry to ensure balanced spectrum repurposing decisions that are technically sound and operationally viable from a mission perspective.

These efforts include working through highly complex technical issues to assess and recommend practical frameworks for the development of relocation, transition, and sharing arrangements and plans for the 1755-1850 MHz bands. While these efforts are considering the feasibility of early commercial access to the 1755-1780 MHz band, their focus is on finding a solution for the entire 95 MHz, consistent with NTIA’s assessment of the band. A deliberate plan for the entire 95 MHz is the best approach. DoD and other federal agencies would need to conduct new analysis to assess the operational and cost impact of an independent relocation or sharing of just the 25 MHz between 1755-1780 MHz, to ensure no adverse impacts to military training, operations, and combat readiness.

Hearing Date: September 13, 2012
House Energy and Commerce Committee
Subcommittee on Communications and Telecommunications
Member: Congressman Waxman
Witness: Major General Robert Wheeler
Question: #1

Question: Please describe the process by which you reached your cost estimates for relocating your systems from the 1755-1850 MHz band. How did you verify the accuracy of these estimates?

Answer: The development of the cost estimates to relocate DoD systems from the 1755-1850 MHz band was led by the Office of the Secretary of Defense Cost Assessment and Program Evaluation (CAPE) in concert with the Army, Navy and Air Force service cost centers. The process used to estimate the costs followed standard processes used by the Department for estimating the costs to develop and procure weapons systems. The key differences in the development of this cost estimate and a cost estimate to support a milestone decision to begin development or procurement for a major defense acquisition program include: (1) the purpose of the estimate; (2) the program planning and documentation; and (3) the time and resources available to develop the estimate.

First, per guidance from the National Telecommunications and Information Administration (NTIA), the purpose of the cost estimates to support the 1755-1850 MHz feasibility study was only intended to determine the relative magnitude of the cost to relocate federal systems. Experience with the previous 2000 IMT study assessing feasibility of relocation from 1710-1850 MHz, published in February 2001, also informed the preparation of this estimate. Similar to the initial estimates in the 2001 study, the Department developed this initial cost estimate based on key assumptions provided by NTIA and the information currently available. Detailed cost estimates are not typically done until the relocation decision has been made based on specific conditions. The initial cost estimate informs that decision, but would require refinement to the cost based on the specific conditions in lieu of the assumptions used to develop the initial cost estimate. For example, the 2001 cost estimates were revised and re-submitted only after the decision was made to auction the 1710-1755 MHz band and significant relocation planning for the affected DoD systems operating in that band was completed.

Second, any cost estimate is only as accurate as the assumptions upon which it is based. The key assumptions supporting the cost estimates for the 1755-1850 MHz feasibility study are well documented in the report; however, these assumptions are subject to change as a consequence of future decisions or as new information become available. In contrast to this study, detailed program planning precedes the development of an independent cost estimate for a major defense acquisition program (MDAP) approaching a milestone decision. MDAPs have an entire program office to plan the acquisition and sustainment of a weapon system and spend two to five years or more planning and preparing for a decision to begin engineering, manufacturing and development. These programs undergo several reviews at the service level and at the OSD level. Our estimates rely on this program documentation, and when a key assumption changes, we can often quantify how the cost estimate will change as a result. Since the cost estimates for the

feasibility study aren't built on the same level of pedigreed program documentation, we can be sure that assumptions are likely to change in any follow-on planning process which could have a significant effect on the cost estimates.

Third, the manpower and time available to develop the cost estimates for multiple and diverse systems associated with this feasibility study was much less than that is typically available to estimate the costs for a single major defense acquisition program.

Initially, the CAPE and service cost centers met regularly to develop a set of ground rules and assumptions to be applied consistently across all programs. These included the use of inflation indices, the timeline when relocation funding would become available to initiate relocation activities (planning, research and development, procurement, etc.), and most significantly, the definition of what is an applicable cost for relocation. The service cost centers then developed templates and questions, which were shared and reviewed as a group to ensure consistency across the services, and then distributed to program managers and field agencies. The cost estimators collected data and technical descriptions, and traveled to various operating locations to gain understanding of how each system was used and to interview engineers on the design of the system to understand what components needed to be modified or redesigned to operate in the new band(s) identified in the early phase of the study.

Then, as individual cost estimates were developed, each was reviewed by the respective service cost center's management using their standard procedures to validate the methodologies used. The estimates then received a subsequent review by CAPE and updates were briefed periodically to the Director. In addition, a senior review group led by the DoD CIO was established to support the overall feasibility study which received detailed program briefings on all of the key systems and periodic updates on the cost estimates. Finally, the CAPE developed a crosswalk to the 2000 IMT study and demonstrated that the cost estimates associated with the Spectrum Reallocation Feasibility Study for the 1755-1850 MHz Band were consistent with the previous study's cost estimates after accounting for the effect of inflation and changes in the quantities and types of systems within the band.

Hearing Date: September 13, 2012
House Energy and Commerce Committee
Subcommittee on Communications and Telecommunications
Member: Congressman Waxman
Witness: Major General Robert Wheeler
Question: #2

Question: What risks, if any, does relocation pose to federal operations? What risks are posed by sharing?

Answer: From a DoD perspective, both sharing and relocation decisions pose potential risks. While no decision to repurpose spectrum is “risk free,” the risks can and must be managed. Any repurposing decisions made without proper technical, operational and cost impact assessment could preempt critical requirements, causing adverse impact to military training, operations, and readiness. These risks are further complicated for DoD due to the magnitude, complexity and diversity of its operations.

Successful relocation of defense operations is dependent upon the ability to conduct adequate analysis to determine cost and operational feasibility; availability of alternate spectrum to relocate systems to; adequate implementation funding; and adequate time to execute the relocation. If any of these conditions is not met, then the ability to relocate defense and military operations is at risk.

Specific to sharing, a move from an exclusive usage rights spectrum management regime to a large-scale spectrum sharing between federal and commercial systems represents a major shift in the way spectrum is managed at the national level today and presents many challenges and risks, including technical, operational, and security. The advanced technologies (e.g., dynamic spectrum allocation, whitespace database) that are expected to facilitate sharing have not been previously deployed in the envisioned large-scale and complex federal-commercial sharing schema. Thus, the maturity of the technologies and effectiveness of such president setting approach is untested in real-world operations and is still extremely uncertain. Also often overlooked is the security framework necessary to ensure effective exchange of information using spectrum sharing technologies.

Additionally, neither federal operations nor commercial broadband operations will remain static as technologies and user requirements evolve. One risk in that regard is whether the spectrum regulatory and governance framework for sharing, including enforcement measures to protect against harmful interference, can be updated seamlessly to keep pace with the changes in the operating environment. Another risk is how the future growth in requirements for both commercial and government operations can be accommodated as bandwidth requirements grow.

Hearing Date: September 13, 2012
House Energy and Commerce Committee
Subcommittee on Communications and Telecommunications
Member: Congresswoman Matsui
Witness: Major General Robert Wheeler
Question: #1

Question: Can you provide information on when the last time that an evaluation was done to look at upgrading the technology? For instance, there have been press reports of the DoD's intent to use LTE technology. Would such a shift present new repurposing opportunities?

Answer: The complex spectrum environment and evolving threats that warfighters face compel DoD to constantly evaluate a broad array of technology improvements to meet mission requirements. While in general the licensed wireless industry has one major broadband technology at a time it must assess for improvements (e.g., LTE), DoD must undertake such analyses across numerous diverse spectrum-dependent systems, including both non-communications and communications technologies, with the same focus of mobility.

DoD released a Mobile Device Strategy in 2012 to identify information technology goals to capitalize on the full potential of mobile devices. The objectives include expanding DoD's infrastructure to support wireless capabilities. The strategy clearly recognizes that this evolution must "leverage industry infrastructure, emerging technologies and commercial off the shelf products in accordance with policy and standards." One area highlighted in the strategy is the need for DoD to continue to expand its wireless network presence in areas critical for mobile device access via the use of industry standards such as 3GPP LTE-based 4G systems where feasible. While the transition to such important technologies is important, it is also not a one-size-fits-all approach, especially when it comes to ensuring that stringent security requirements are met from a DoD perspective. In that regard, the Strategy notes that "although the use of commercial devices is more cost-effective than developing customized devices, most do not come equipped out-of-the-box with the security controls, access protocols, and necessary security features required by DoD."

Although use of commercial-off-the-shelf products, when and where appropriate, is nothing new to the department as long as mission needs can be met, that in and of itself does not open new spectrum repurposing opportunities. That is because in many of the federally allocated spectrum bands, extensive sharing between federal government systems, and in some cases with commercial systems, is already occurring. Therefore, repurposing decisions cannot be based on just one or a few systems without a holistic solution to accommodate all capabilities requiring the bands in order to prevent adverse operational impact, including to national security.

For example, DoD Military Services and Agencies operate over 100 distinct systems in the 1755-1850 MHz band. Capabilities include satellite launch and on-orbit control operations, electronic warfare systems, air combat training systems, air mobile telemetry for test and evaluation of aerial weapon systems, tactical communications, small unmanned aerial systems/vehicles, and precision guided munitions. Any repurposing solution regarding this band must address all of these

capabilities in order to achieve the necessary balance between national security spectrum requirements and meeting the expanding demand of commercial broadband services.



United States Government Accountability Office
Washington, DC 20548

February 8, 2013

The Honorable Greg Walden
Chairman
Subcommittee on Communications and Technology
Committee on Energy and Commerce
House of Representatives

Subject: *"Creating Opportunities through Improved Government Spectrum Efficiency"—Response to Questions for the Record*

Dear Mr. Chairman:

We appreciate the opportunity to testify before the Subcommittee on September 13, 2012, about the opportunities to improve government spectrum efficiency. On January 25, 2013, we received the Subcommittee's questions for the record. The enclosure is our response to the Subcommittee's questions. If you or members of your staff have any questions about our response, please contact me at (202) 512-2834 or goldsteinm@gao.gov.

Sincerely yours,

Mark L. Goldstein
Director, Physical Infrastructure Issues

Enclosure

cc: The Honorable Henry A. Waxman, Ranking Member, Committee on Energy and Commerce
The Honorable Anna Eshoo, Ranking Member, Subcommittee on Communications and Technology

Enclosure

Subcommittee on Communications and Technology
 "Creating Opportunities through Improved Government Spectrum Efficiency"
 September 13, 2012
 Additional Questions for the Record

The Honorable Anna Eshoo**1. What steps can both government and industry take to increase R&D investment in technologies that promote spectrum efficiency?**

As we have reported, government plays a key role in performing or encouraging research that private industry would not do on its own.¹ In our review of spectrum sharing, we found that, although industry participants indicated that extensive testing under realistic conditions is critical to conducting basic research on spectrum efficient technologies, only a few companies are involved in such research and that instead, companies tend to focus on current business objectives as opposed to conducting basic research that may not show an immediate business return.² Government agencies have already taken some steps to create opportunities for research and development in the private sector. For example, in January 2013, FCC adopted rules to add three new types of experimental licenses to allow universities, research labs, medical institutions, and other organizations to conduct research experiments and to test an array of devices without having to obtain a specific license for each trial. NTIA also has a pilot test bed program to evaluate dynamic spectrum access and technology for spectrum sharing in land mobile radio bands.

We have also emphasized the importance of the government's providing financial incentives or funding for research and development endeavors. The President's Council of Advisors on Science and Technology (PCAST)³ and the Commerce Spectrum Management Advisory Committee (CSMAC)⁴ have both made recommendations to create funds that can provide financial incentives for development of more spectrum efficient technologies. The PCAST recommended creation of a Spectrum Efficiency Fund, which would allow federal agencies to be reimbursed for general investments in improving spectrum sharing and efficiency and the CSMAC recommended the creation of a Spectrum Innovation Fund to be used for spectrum sharing and other opportunities to enhance spectrum efficiency.

¹GAO, *Research and Development: Lessons Learned from Previous Research Could Benefit FreedomCAR Initiative*, GAO-02-810T (Washington, D.C.: June 6, 2002).

²GAO, *Spectrum Management: Incentives, Opportunities, and Testing Needed to Enhance Spectrum Sharing*, GAO-13-7 (Washington, D.C.: Nov. 14, 2012).

³President's Council of Advisors on Science and Technology, *Report to the President: Realizing the Full Potential of Government-held Spectrum to Spur Economic Growth* (Washington, D.C.: July 2012).

⁴Commerce Spectrum Management Advisory Committee, *Incentives Subcommittee Final Report* (Washington, D.C.: Jan. 11, 2011).

Looking internationally, the Canadian government has instituted tax credits for research and development efforts by Canadian wireless companies, and required wireless companies to commit 2 percent of all revenues toward research and development activities related to spectrum.

2. As each of you know, the PCAST report proposes the concept of “spectrum currency” as a way to incentivize federal agencies to relinquish or share more of their spectrum. While this idea has not been fully fleshed out, I’m interested in what factors would best motivate agency participation, particularly with respect to relinquishing the 1755 and 1780 megahertz band?

In our recent spectrum sharing report, we found that federal agencies are reluctant to share spectrum for several reasons.⁵ First, while federal spectrum users often share spectrum among themselves, they may have little economic incentive to otherwise use spectrum efficiently, including sharing it with nonfederal users. Furthermore, obtaining new spectrum assignments may be difficult for federal users, so an agency may have an incentive to conserve and use the spectrum it currently has assigned to it or currently shares efficiently, but the extent of that incentive is likely weaker than if the agency had to pay the market price for all of its spectrum needs. Second, federal users are not willing to risk mission failure and sharing or relinquishing spectrum may pose unacceptable risks in some bands. Third, sharing spectrum can be costly for both the nonfederal and federal users seeking to use the spectrum because of the cost of interference mitigation for federal users, and budget limitations that prevent users from investing in more spectrally efficient technologies.

Our report identified several actions that could be taken to overcome these disincentives and promote more sharing and efficient use of spectrum by federal agencies. Such actions include requiring agencies to give more consideration to spectrum sharing and efficiency when designing or upgrading systems, doing more to identify spectrum used by federal agencies that is more likely to be feasible to share, and expanding opportunities for unlicensed use of spectrum. We also identified the need to evaluate whether spectrum fees or currencies can provide appropriate financial incentives to agencies. While we agree that spectrum usage fees or spectrum currency should be given further consideration, designing a fee or currency system is fraught with numerous obstacles and challenges, such as how such fees should be incorporated into agency budgets and the appropriations process in order to create the right incentives. A full evaluation of the potential benefits and impacts of implementing a fee structure would be a potential step in identifying the most prudent and effective approach. Although we did not make a specific recommendation in our recent spectrum sharing report regarding a spectrum currency process, we recommended that FCC and NTIA jointly report their agencies’ views and conclusions regarding spectrum usage fees to relevant congressional committees.

⁵GAO-13-7.

The Honorable Henry Waxman**1. Your testimony expresses concern about whether NTIA has reliable data on which to base spectrum policy decisions. Are there particular instances that you can point to where inadequate data has hindered decision making?**

As we reported in 2011, it is unclear whether important decisions regarding current and future spectrum needs are based on reliable data.⁶ NTIA's processes for collecting and verifying federal agency data lack key internal controls, including those focused on data accuracy, integrity, and completeness. Internal control activities, such as data verification and reconciliation, are essential for ensuring accountability for government resources and achieving effective and efficient program results. Lacking such controls, NTIA cannot ensure that agencies are accurately reporting data, and during our review, we found instances of inaccurate agency data. For example, officials from two federal agencies told us that they uncovered significant inaccuracies in their spectrum assignment records while completing in-depth reviews. In particular, officials from one agency told us that in a review of a sample of spectrum assignments in the Detroit, Michigan, metropolitan area, they uncovered that approximately half of the agency's assignment records were inaccurate. A spectrum manager from another agency told us that a review of spectrum assignments revealed that 25 percent of the assignments in one department were no longer being used, and the spectrum assignments were returned. As another example, according to a winning bidder in the 2006 Advanced Wireless Services spectrum auction,⁷ during the relocation of federal users, some agencies submitted inaccurate inventory data to NTIA and OMB causing delays in the transition time from federal to commercial use. As we noted in our 2011 report, these data weaknesses lead agencies to overestimate their need for spectrum frequency assignments, and better information would facilitate the more efficient use of spectrum because frequency assignments could be located closer together.

⁶GAO, *Spectrum Management: NTIA Planning and Processes Need Strengthening to Promote the Efficient Use of Spectrum by Federal Agencies*, GAO-11-352 (Washington, D.C.: Apr. 12, 2011).

⁷Spectrum auctions are a market-based mechanism in which FCC assigns a license to the entity that submits the highest bid for specific bands of spectrum.



**Responses To Additional Questions For the Record
For “Creating Opportunities through Improved Government Spectrum Efficiency”**

By Douglas Smith, CEO, Oceus Networks
February 8, 2013

The Honorable Anna Eshoo

1. What steps can both government and industry take to increase R&D investment in technologies that promote spectrum efficiency?

Oceus Networks believes that government use of commercial technologies, such as 4G LTE, for a wide-range of high-speed, high-bandwidth applications, promotes efficient spectrum use and leverages the huge investments in R&D by industry. In the current budgetary environment, government spending on custom-built technologies should be limited to those applications that industry cannot offer to meet the mission requirements of military and other government users. A continued focus on leveraging industry investment in commercial technologies will increase government’s efficient use of spectrum and provide greater capabilities for certain high-bandwidth communication applications for less cost.

Oceus Networks has adapted commercial 4G LTE technology for military and public safety high-bandwidth wireless applications. Extensive work was performed with DoD and other government users to ensure that these solutions would meet the unique requirements of these users, including for secure communications, without veering from the commercial roadmap.

For example, the U.S. Department of Navy’s Naval Air Systems Command (NAVAIR) is using our portable 4G LTE-in-a-box solution, *Xiphos*, in a pilot to provide real-time high-definition video, voice, and data to sailors on the U.S.S. Kearsarge for both shipboard communications and in support of tactical missions. Oceus Networks worked with the National Security Agency on developing a security framework that was approved for SECRET level communications across the network. Oceus Networks also worked with the Navy to ensure that the LTE signal would not interfere with existing on-board spectrum dependent systems.

The NAVAIR trial represents the first operational deployment of 4G LTE for DoD. Oceus Networks is discussing, and in some cases demonstrating, the use of its technologies in other branches of the military and different federal government agencies.

For non-communication spectrum-dependent government systems, Oceus Networks does not have the expertise to offer meaningful feedback about ways to spur R&D investment. However, Oceus Networks is committed to leveraging commercial investment in high-bandwidth wireless technologies and making investments to modify them for government

Oceus Network's Response
 February 8, 2013
 Page 2 of 2

use. By doing so, there is great opportunity for making government use of spectrum more efficient and, more importantly, providing government users with the necessary capability to meet their 21st century missions.

2. As each of you know, the PCAST report proposes the concept of “spectrum currency” as a way to incentivize federal agencies to relinquish or share more of their spectrum. While this idea has not been fully fleshed out, I’m interested in what factors would best motivate agency participation, particularly with respect to relinquishing the 1755 and 1780 megahertz band?

Oceus Networks does not have enough information to provide a viewpoint about how the “spectrum currency” idea proposed in the PCAST report could be implemented. However, on the issue of which factors would “best motivate agency participation, particularly with respect to relinquishing the 1755 and 1780 megahertz band,” we would recommend focusing on policy outcomes that balance both economic security and national security requirements.

Sharing on an equitable basis would be a valuable incentive to encourage Federal agency participation in efforts to make the 1755-1780 MHz band available for commercial wireless broadband (e.g., LTE). Extensive work on potential sharing of this band between incumbent government operations and LTE systems is already under way in the Commerce Spectrum Management Advisory Committee (CSMAC) working groups. In our view, developing sharing arrangements as a “two-way street” for Federal users would further expedite efforts to free this band, which is globally harmonized for LTE, for commercial 4G systems.

Government users also face growing requirements for wireless broadband capabilities. As a result, for enterprise and some tactical communications, Federal agencies require access to the same bands in which commercial LTE networks are deploying, in order to gain the same cost benefits and advanced capabilities. As I mentioned in my testimony last fall, sharing is also easier between “like” systems, as long as other critical mission needs are protected (e.g., security requirements.) Future sharing arrangements for LTE spectrum should not only promote commercial broadband deployments but also foster shared agency access to commercial bands, on a geographically limited basis, as needed.

Response to the Subcommittee on Communications and technology Hearing
 "Creating Opportunities through Improved Government Spectrum Efficiency"
 Additional Questions for the Record

Dr. Preston Marshall, University of Southern California

The Honorable Anna Eshoo

Q: What steps can both Government and industry take to increase R&D investment in technologies that promote spectrum efficiency?

A: We must promote spectrum policies that are as dynamic as the innovation process is. For example, the current clearing and auction process takes an average of eight years to make spectrum available, and the NTIA Report indicates that future relocations will be even more difficult and lengthy. There is little opportunity to innovate when there is this much delay from committing to such a significant investment, and deploying a service. That view is supported by the incredible innovation we see in the unlicensed bands, where spectrum availability is not such a challenge to innovative offerings. By contrast, the telecommunications industry infrastructure process operates on decades-scale, and has much less US leadership in the technology base. The delays and uncertainty in the current spectrum process make spectrum-dependent innovation a much less attractive investment.

The PCAST report proposes to use the sharing of Federal spectrum as a vehicle to enable innovative concepts to advance rapidly from concept to application. It is true that sharing spectrum may be less attractive to the current spectrum users; however this is the very challenge that will spur innovation in these bands. Leadership in this innovation will position the US to lead this technology worldwide as every other country in the world will face the same challenges of doing more with the fixed spectrum.

Q: As each of you know, the PCAST report proposed the concept of a "spectrum currency" as a way to incentivize federal agencies to relinquish or share more of their spectrum. While this idea has not been fully fleshed out, I'm interested in what factors would best motivate agency participation, particularly with respect to relinquishing the 1755 and 1780 megahertz band?

A: The current spectrum relocation trust fund only subsidizes agencies from completely moving out of a band, and having it auctioned. It provides no benefit to agencies from reducing their usage in the band, arranging methods to share it, or even to make modification to their equipment or operation that would enable it to be used by the civil sector. Nor does the Government receive any revenue from non-auction spectrum usage. The PCAST recommendation provides incentives to agencies to reduce spectrum usage, even if the band is not completely cleared for auction. The middle tier of spectrum access produces a funding stream for both the treasury, and for agencies, based on the ability to share this spectrum. This

process taps spectrum that otherwise is not used by the Federal Government at all times, and at all places, and makes it available for civil use, and produces income.

Instead of having to decide "who needs the band most", civil users and Federal agencies can both use it, shortening the time to make it available from the current years to decades, to months and, ultimately, seconds.

The PCAST notion of a spectrum currency enables the Federal Government to assess, track, and eventually reduce the spectrum footprint. It can provide a mechanism to investigate the marginal cost of improvements, or changes in Federal spectrum usage, and the value of that spectrum to the civil sector, as measured by the market value of the right to share this spectrum, on a locality by locality basis.

The 1755 sharing process now underway shows that industry and Government can work together to free spectrum that high value to the civil sector, and assure continued operation of Federal missions. The PCAST recommendations institutionalize this same process, but make it also accessible to innovators in all industries in a transparent process so that new and innovative, as well as existing applications can benefit from these opportunities.

The Honorable Henry Waxman

Q: During the hearing, Major general Wheeler raised the concern that the dynamics of mobile broadband present significant design challenges for using a database approach. Yet in your own testimony, you stated that the PCAST report is grounded in available technology which builds on systems that have already been approved by the FCC. Could you respond to Mr. Wheelers assertion that the technology discussed in the PCAST report for sharing has not been fully validated and that the effectiveness of such an approach remains uncertain?

A; I do not believe these two position are actually in conflict. There are a wide range of operating characteristics and technologies in use by Federal systems. MG Wheeler very correctly points out that some of them will be difficult to dynamically accommodate in a database system. Others, are static, and have very well known characteristics. The PCAST proposal was to begin with the systems that are most amenable to database approach, much as the FCC is currently moving to permit in the 3.5 GHz band. The power of the database approach is that if the understanding of how to share spectrum is not available at any point in time, that spectrum can be marked as unshareable. Industry and the Government should work together to determine the best targets of opportunity to increase Federal spectrum sharing, but only as this understanding develops. This is not a technology challenge, but one of engineering. We share spectrum between Federal and civil systems continually. The PCAST report proposes to extend this to a much larger scale, but does not propose any new sharing technology. As I noted in my testimony, the remaining challenge is to make the sharing information available to users, and the FCC certification of devices is a demonstration that this is readily achieved, and can be certified by Federal agency processes.

Q: How do you respond to the assertion by some during the hearing that there is no evidence yet that business models exist to sustain building and operating networks that will rely on shared spectrum?

A: I find that assertion from several witnesses obviously untrue. the same companies that demand exclusive rights for spectrum are building out extensive networks in unlicensed spectrum today to offload their wireless traffic. In fact, when the bits per Hertz of their networks is estimated, it is likely that major carriers are moving more user content over wireless bandwidth than over their dedicated spectrum; even when they are a small segment of the users of this spectrum! And this investment continues to be made, even as the unlicensed spectrum becomes more congested.

Perhaps what the testimony might have meant is that the industry would be hesitant to invest large amounts in a single macro cell without assured access. But we all know that the future of wireless broadband is not more macrocells, but is instead smaller, more localized devices, such as micro and femtocell devices. These can be much more agile in frequency and configuration, and are cost per unit similar to the WiFi devices now being deployed in great quantities.

Also, it is true that there is no current carrier equipment in shared spectrum because there is no suitable spectrum available today! What we do know from experience is that innovation finds ways to make value out of any spectrum that is not encumbered by over-regulation. Also, it is worth noting the carrier enthusiasm for sharing even portions of the 1755 MHz band!

The Honorable Doris Matsui

Q: As we explore each band for potential repurposing, which specific bands would be ideal to clear below 3 GHz, and which specific bands or areas could be better suited for sharing above 3 GHz. Please provide specifics.

A: I am hesitant to testify about specifics on existing Federal bands, as there is such an extensive quantity of inventory and analysis for the Federal sector, primarily through the NTIA reports. Some obvious candidates, such as portions of 1755 and 3.55 are already under consideration. Satellite downlink spectrum, where the usage is very local, and the stations are not mobile is obviously a candidate for sharing. Military test and training activities are generally concentrated geographically, and generally far from the dense civil population and thus bandwidth demand.

I do not believe we have a good handle on this issue, in any case. The question generally asked is which bands can be reallocated? There could be very good reasons to not relocate or reallocate a band, and still have that band provide significant value to the civil sector. This is fundamentally a different question than was posed in the National Broadband Plan.

In reality, all Federal spectrum can be shared to some extent. Ultra Wideband devices share this spectrum (except for GPS), as an example. The Government should document the

constraints on the sharing, and industry should be able to challenge these constraints. It is likely that most Federal spectrum will be sharable with some technology and business model, even if neither the model, or technology exist today.

Q: For spectrum above 3 GHz, what do we mean by sharing (i.e. are we talking about technology, exclusion zones)? And would it be licensed or unlicensed? Would there be spectrum rights?

A: The sharing proposed by PCAST will initially be primarily exclusion zones. These exclusion zones are not fixed, but would be determined based on the signal characteristics of the sharing devices. A low power device might be able to operate in close proximity to Federal users, while a higher power device would have to be separated by more distance. For example, in the NTIA report, a significant exclusion zone was depicted for sharing in the 3.5 GHz band, based on the sharing devices being high-power LTE macrocells. However, in the FCC's proceeding targeting femtocells, the exclusion zone was much smaller. PCAST did not recommend any exclusion zone to protect the sharing device, and left this protection to the device itself, and as an area for future innovation.

As for its licensing status, I would suggest that we think about licensing very differently than we do today. Technologies, markets, user needs and economics all change over time. Perpetual licensing does not facilitate that change, it impedes it! I believe it is reasonable that investors would desire that their investment be protected over its economic life, but licensing should not preclude the successor investment and market.

The PCAST report proposed that protected rights in shared spectrum should be a part of the policy, but that the terms and extent of these be much shorter (on the order of three years). New entrants could compete for this spectrum, presumably refreshing the technology and service model. Such a framework would also reduce the barriers to entry, since the short term licenses would be less of an investment than the effectively perpetual licenses of today.

A license in the context of the PCAST report also has a subtle difference. A license protects the operation of receivers, but does not preclude other from use of the spectrum, so long as a receiver was not interfered with. Instead of build out rules, spectrum that was not used (populated by receivers) could be used by others, until receivers were actually deployed, at which point they would be protected. Broadly spread signals could coexist with other uses, and poorly performing receivers would have to effectively purchase rights to adjoining spectrum if they desired protection; whereas today these burdens are forced on new entrants in adjacent bands. By focusing on the protecting receivers, massive inefficiencies in the current management of spectrum will be overcome.

FRED UPTON, MICHIGAN
CHAIRMAN

HENRY A. WAXMAN, CALIFORNIA
RANKING MEMBER

ONE HUNDRED THIRTEENTH CONGRESS
Congress of the United States
House of Representatives
COMMITTEE ON ENERGY AND COMMERCE
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January 25, 2013

Mr. Mark Racek
Director, Spectrum Policy
Ericsson Inc.
1634 I Street, N.W., Suite 600
Washington, D.C. 20006-4083

Dear Mr. Racek:

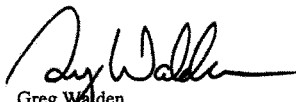
Thank you for appearing at the Subcommittee on Communications and Technology hearing entitled "Creating Opportunities through Improved Government Spectrum Efficiency" on September 13, 2012.

Pursuant to the Rules of the Committee on Energy and Commerce, the hearing record remains open for 10 business days to permit Members to submit additional questions to witnesses, which are attached. The format of your responses to these questions should be as follows: (1) the name of the Member whose question you are addressing, (2) the complete text of the question you are addressing in bold, and (3) your answer to that question in plain text.

To facilitate the printing of the hearing record, please e-mail your responses, in Word or PDF format, to Charlotte.Savercool@mail.house.gov by the close of business on Friday, February 8, 2013.

Thank you again for your time and effort preparing and delivering testimony before the Subcommittee.

Sincerely,



Greg Walden
Chairman
Subcommittee on Communications and Technology

cc: The Honorable Anna Eshoo, Ranking Member,
Subcommittee on Communications and Technology

Attachment

The Honorable Anna Eshoo

1. What steps can both government and industry take to increase R&D investment in technologies that promote spectrum efficiency?

There is no lack of investment and innovation being performed by the commercial mobile broadband industry. In fact the market is successfully driving the direction and scope of R&D in areas like modulation, compression, antennas, diversity, etc. The challenge, however, is overcoming the barriers to deployment like site acquisition or lack of suitable spectrum in sufficient amounts.

2. As each of you know, the PCAST report proposes the concept of “spectrum currency” as a way to incentivize federal agencies to relinquish or share more of their spectrum. While this idea has not been fully fleshed out, I’m interested in what factors would best motivate agency participation, particularly with respect to relinquishing the 1755 and 1780 megahertz band?

Although Ericsson does not have experience in this area, there is recognition that significant benefits can be attained in utilizing federal spectrum for broadband where that spectrum is unused or underutilized. As the PCAST report identifies, federal users have little incentive to improve their efficient use of spectrum. Instead they are concentrating on the mission that must be accomplished, and therefore spectrum utilization is not their main focus. Some factors that could be considered include leveraging commercial technology similarly to the way that the Public Safety Broadband Network is based on the commercial technology Long Term Evolution (“LTE”). Additional partnerships and interaction between the private and public interests could also incent federal agencies as these parties’ knowledge of the others’ technologies and operations grow.

The Honorable Henry Waxman

1. In clearing the 1755-1850 MHz band, what is your recommendation for where the vacating federal systems could be relocated?

Some federal services in the 1755-1850 MHz band can be transitioned to existing federally allocated spectrum. For instance, impacted agencies with fixed point-to-point line-of-sight communications have selected either the 4400-4490 MHz band or the 7125-8500 MHz band for relocation. Further analysis is needed of the remaining federal systems to determine 1) are there existing federally allocated bands suitable for relocation or sharing, 2) if commercial services can be utilized as a substitute, and 3) whether improvements in the spectral efficiency of these

Subcommittee on Communications and Technology
 “Creating Opportunities through Improved Government Spectrum Efficiency”
 September 13, 2012
 Additional Questions for the Record
 Ericsson Inc.

federal systems would mean they require less spectrum and thereby allow for commercial services in the vacated band.

The Honorable Doris Matsui

1. **As we explore each band [beyond 1755-1850 MHz] for potential repurposing, which specific [federal] bands would be ideal to clear below 3 GHz and which specific bands or ‘areas’ could be better suited for sharing above 3 GHz? Please provide specifics.**

- Repurpose. 1675-1710 MHz paired with 2075-2110 MHz (70 MHz). This allocation has the same duplex spacing as AWS-1 and is also adjacent to AWS-1 and therefore would benefit from the existing device eco-system in AWS-1. The 2075-2110 MHz band is currently allocated to Broadcast Auxiliary Systems. The 1675-1710 MHz band is currently allocated on a co-primary basis for Federal and non-Federal use for the meteorological aids service and the meteorological-satellite service (space-to-Earth). A portion of this band 1695-1710 MHz has been identified by NTIA in its *Fast Track Report* for possible spectrum sharing.
- Repurpose. The 2700–2900 MHz (200 MHz) band is globally harmonized and has radio wave propagation properties that make it an excellent band to consider for providing mobile broadband. Given the proximity of the 2700–2900 MHz band to the Broadband Radio Service (“BRS”) at 2.5 GHz and the internationally standardized 3GPP Band 7 (2500–2570 MHz uplink paired with 2620–2690 MHz downlink), this band warrants particular consideration.
- Repurpose. 1300-1390 MHz (90 MHz). The band 1300-1350 MHz is allocated for Aviation service by Federal and Non-Federal uses. It is specifically allocated to aeronautical radionavigation service where it is restricted to ground-based radars and associated airborne transponders which transmit exclusively in these bands and only in response to radars operating in the same bands. The band 1350-1390 MHz is allocated for exclusive Federal Government use. Its primary allocation is fixed satellite service (space-to-Earth) and mobile satellite service (space-to-Earth) for the relay of nuclear burst data. This band was identified for potential commercial allocation in 1997 Balanced Budget Act.
- Sharing. 5350-5470 MHz and the 5850-5925 MHz band (195 MHz). NTIA has initiated studies on the potential use of up to 195 MHz in the 5350-5470 MHz and the 5850-5925 MHz band.

FRED UPTON, MICHIGAN
CHAIRMAN

HENRY A. WAXMAN, CALIFORNIA
RANKING MEMBER

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January 25, 2013

Mr. Steve Sharkey
Chief Engineering and Technology Policy, Federal Regulatory
T-Mobile USA
601 Pennsylvania Avenue, N.W.
North Building, Suite 800
Washington, D.C. 20004

Dear Mr. Sharkey:

Thank you for appearing at the Subcommittee on Communications and Technology hearing entitled "Creating Opportunities through Improved Government Spectrum Efficiency" on September 13, 2012.

Pursuant to the Rules of the Committee on Energy and Commerce, the hearing record remains open for 10 business days to permit Members to submit additional questions to witnesses, which are attached. The format of your responses to these questions should be as follows: (1) the name of the Member whose question you are addressing, (2) the complete text of the question you are addressing in bold, and (3) your answer to that question in plain text.

To facilitate the printing of the hearing record, please e-mail your responses, in Word or PDF format, to Charlotte.Savercool@mail.house.gov by the close of business on Friday, February 8, 2013.

Thank you again for your time and effort preparing and delivering testimony before the Subcommittee.

Sincerely,



Greg Walden
Chairman

Subcommittee on Communications and Technology

cc: The Honorable Anna Eshoo, Ranking Member,
Subcommittee on Communications and Technology

Attachment

T-Mobile

601 Pennsylvania Ave. NW
North Building, Suite 800
Washington, DC 20004

Honorable Greg Walden
Chairman, Subcommittee on Communications and Technology
Committee on Energy and Commerce, House of Representatives
2125 Rayburn House Office Building
Washington, DC 20515

Dear Chairman Walden,

Thank you for the opportunity of appearing at the Subcommittee on Communications and Technology's hearing entitled "Creating Opportunities through Improved Government Spectrum Efficiency" on September 13, 2012. My responses to the questions contained in your letter of January 25, 2013 are below.

The Honorable Anna Eshoo

1. What steps can both government and industry take to increase R&D investment in technologies that promote spectrum efficiency?

A fruitful mechanism to promote R&D that advances technologies that promote sharing would be to create real opportunities to access spectrum on based on sharing of government spectrum by non-government users. T-Mobile continues to believe that carriers can best make use of spectrum that is allocated to them on an exclusive basis and that they have the right economic incentives to use that spectrum as efficiently as possible. However, as I said during my testimony, there are circumstances where spectrum sharing can be a useful tool that, when combined with traditional spectrum management mechanisms and economic incentives, can provide an overall approach for maximizing the efficient use of spectrum and create opportunities in cases where relocation is not feasible.

Government users and the private sector are already seeking to utilize sharing as part of the broader effort to repurpose government spectrum for commercial use where possible. The current effort in which industry and the Department of Defense are examining the use of the 1755-1780 MHz band is a good example of industry and government working together and one that is likely to yield technology advances related to sharing. Complex technical challenges can be solved if the technical staffs of industry and federal agencies work together to develop solutions that would for both parties. For example, in the 5 GHz band, government and industry worked together to develop a sharing approach that resulted in technology advances to allow unlicensed devices to "sense" when a government radar is using the spectrum and protocols for the unlicensed device to move to another channel to avoid interfering with the government operation.

Adequate funding for federal agencies to study spectrum relocation and sharing options would advance this collaborative research and development effort. Changes to the Commercial Spectrum Enhancement Act (CSEA), or further guidance from the Office of Management and Budget to provide funds necessary for federal agencies to study the feasibility and approaches to

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sharing or reallocation prior to a decision to reallocate the spectrum and a transition plan has been approved would provide a vehicle for funding. Recent guidance from OMB limits agencies to only getting planning funds following acceptance of a transition plan. This results in a lack of resources to conduct the detailed studies necessary to make an informed decision regarding relocation and sharing. More funding should be available for studying sharing outside of the current spectrum-specific approach.

Finally, requiring federal agencies to consider sharing mechanisms or technologies during the procurement process for a new system could have significant long-term impacts for sharing. Many federal systems have a long life span and are difficult or costly to make changes to after the system has been deployed. Requiring consideration of sharing mechanisms and the impact to other systems as part of the procurement process could make facilities opportunities in the future. This could include, among others, use of minimum channel bandwidths, provisions for technology updates and inclusion of signaling methods that could interact with other systems to facilitate temporal sharing.

2. As each of you know, the PCAST report proposes the concept of "spectrum currency" as a way to incentivize federal agencies to relinquish or share more of their spectrum. While this idea has not been fully fleshed out, I'm interested in what factors would best motivate agency participation, particularly with respect to relinquishing the 1755 and 1780 megahertz band?

Providing positive incentives for federal users to use spectrum as efficiently as possible has the potential to free up spectrum resources and be more effective than trying to mandate that users be more efficient. Commercial spectrum users are already strongly motivated by economic drivers. They generally buy spectrum at auction and are subject to a competitive business environment which promotes efficient spectrum use. Commercial providers also continually invest in technology and infrastructure to increase the utility of spectrum. It is much more complicated to apply those same incentives to federal users.

Having a technique that allows federal users to assign value to spectrum based on the frequency, bandwidth, affected geography, and duration of use would be a significant improvement to enhancing spectrum efficiency. For such an idea to be effective it would be necessary for NTIA to assign the spectrum currency to all federal systems with input from federal and commercial stakeholders. As the PCAST report noted, this should be distinguished from a usage fee because assigning value would involve no further appropriation or expenditures for the federal spectrum users. Rather, it would be used as a metric intended to help agencies and the NTIA to better consider spectrum efficacy. However, from the PCAST report it is unclear what actual benefit agencies would derive from the spectrum currency and it may be useful to request further consideration of this issue from PCAST.

While there are many issues that the PCAST report leaves undeveloped, it ties spectrum currency to a Spectrum Efficiency Fund that would provide real dollars to agencies to pay for changes that facilitate sharing or lead to more efficient use of the spectrum – thereby potentially

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freeing up spectrum for other purposes. This is a significant recommendation that should be explored further. It would provide the resources necessary for federal agencies to research, study and implement technologies and actions that can significantly advance access to additional spectrum.

The Honorable Henry Waxman

1. In clearing the 1755-1850 MHz band, what is your recommendation for where the vacating federal systems could be relocated?

The primary focus of industry has been on accessing the 1755-1780 MHz portion of the 1755-1850 MHz band. That portion of the band offers significant benefits for providing competitive broadband services because it can be readily paired with available spectrum at 2155-2180 MHz. It would also extend the existing AWS band and align with international use. These factors would maximize the value and benefits of both the 1755-1780 MHz and 2155-2180 MHz bands – not only by maximizing the potential for broadband services, but also by maximizing the potential auction revenue. The Middle Class Tax Relief Act of 2012 requires the FCC to auction and license the 2155-2180 MHz band by February 2015, which places additional pressure on efforts to make the 1755-1780 MHz band available as quickly as possible. Accordingly, while it is important to consider how existing users will be accommodated, availability of the 1755-1780 MHz portion of the band should not be delayed by consideration of a longer term transition of the entire 1755-1850 MHz band.

There is no single answer as to where the federal systems operating at 1755-1850 MHz should be relocated because each system is very different, both in the mission performed and the system operation. The best approach to making the 1755-1780 MHz band available is likely to be a combination of relocating systems out of the 1755-1850 MHz band, sharing within the band and restricting operations to the 1780-1850 MHz portion of the band.

NTIA's March 2012 report *An Assessment of the Viability of Accommodating Wireless Broadband in the 1755-1850 MHz band* provides a high level inventory of comparable bands and an overview of operations within those bands. In addition, the report provides an assessment, by agency, of the potential for systems to be accommodated in comparable bands. Based on the analysis in the report, "NTIA concludes that it is possible to repurpose all 95 megahertz of the band." However, because the report is based on a complete clearing of the band, there are several significant challenges, including the availability of relocation spectrum, the cost of relocation and the timing of relocation, which must be overcome.

As described in the NTIA report, numerous comparable bands are available for relocation - the majority of which are used primarily by federal agencies and currently available. However, the report focuses on the 2025-2110 MHz band as a high priority relocation band for almost every DoD system currently operating in the 1755-1850 MHz band. Such an approach is not optimal. While there are some federal operations currently in the 2025-2110 MHz band, the majority of use is for commercial operations and the band has significant commercial potential



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value for future commercial services, including for broadband services. Any move of Government systems into this band should only be done following consideration of the potential for sharing between government and commercial operations and the future potential use of the band for primarily commercial users .

While the NTIA report identifies comparable relocation bands, it does not provide sufficient information to fully understand or evaluate the conclusions of the report or the underlying analysis. It also looks primarily only at clearing of the entire 1755-1850 MHz band, rather than evaluating the possibility of clearing just some of the systems out of the entire band and retuning remaining systems to operate about 1780 MHz as a way to clear 1755-1780 MHz. Nor does it fully evaluate the costs of relocation specific to the lower band. While some sharing of the band may remain necessary, this information is critical to a fully informed evaluation of relocation of government systems from the lower band. Additional analysis to evaluate relocation of government systems from the lower band should proceed and should include third party oversight and involvement.

Significant work is being done as part of the Commerce Spectrum Management Advisory Committee to analyze the potential for sharing in the 1755-1850 MHz band between commercial and federal operations. However, there has been no work in that committee to review relocation options or cost estimates. Rather the working groups have been specifically directed to not do work in these areas. Such efforts should be initiated and proceed in parallel with sharing studies in order to provide a full understanding of the options available.

2. Given that WiFi offloading significantly reduces cellular network congestion today (especially in high density urban areas), what is your view on the feasibility and potential benefits of further advances in unlicensed spectrum?

T-Mobile has a long and proud history of using unlicensed spectrum. From the launch of a nationwide Wi-Fi Hotspot network, to the early incorporation of Wi-Fi into handsets, to being the only major carrier to provide Wi-Fi based calling, unlicensed spectrum is an important tool in the T-Mobile spectrum toolkit. However, unlicensed spectrum is just that – a tool in a toolkit that includes licensed spectrum and a host of other network technologies that maximize our network's capacity. Unlicensed spectrum is not a replacement for licensed spectrum and is not suitable for the wide-area mobile broadband that consumers demand and which significantly advances America's global competitiveness. Reliable wide area service requires tens of billions of dollars of investment to deploy and manage infrastructure and WiFi is not well-suited to such an approach.

We believe the focus should be on freeing up more licensed spectrum that enhances competition while making unlicensed spectrum available as possible. For example, the FCC has launched an effort to expand the amount of unlicensed spectrum in the 5 GHz band. We support this effort. The 5 GHz band would not be suitable for a wide area mobile service given the propagation characteristics of the band and restrictions on power and use necessary to share with

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incumbent federal operations. However, provided suitable sharing arrangements can be developed to protect federal incumbents, the band holds promise for expanding unlicensed spectrum capacity.

The Honorable Doris Matsui

1. As the we explore each band for potential repurposing, which specific bands would be ideal to clear below 3GHz; and which specific bands or 'areas' could be better suited for sharing above 3GHz? Please provide specifics.

Both the FCC in its Broadband Report and the NTIA in its October 2010 report, "Plan and Timetable to Make Available 500 Megahertz of Spectrum for Wireless Broadband," identify a significant number of suitable spectrum bands that should be evaluated for accommodation of commercial broadband services. In addition to the bands identified in the NTIA report, the 2025-2110 MHz band should also be evaluated as a potential band for commercial broadband services.

The evaluation of these other bands should not divert the focus on making spectrum available in the 1755-1780 MHz band and reallocating TV Broadcast spectrum though incentive auctions. The 1755-1780 MHz band, when paired with 2155-2180 MHz would provide 50 megahertz of spectrum that is immediately adjacent to the existing AWS spectrum and is used for commercial mobiles services around the world. Significant progress has already been done to study this band and bringing these efforts to a successful conclusion should be a high priority. Similarly, reallocating TV broadcast spectrum pursuant to incentive auctions has the potential to make significant amounts of spectrum with excellent coverage and propagation characteristics available.

In addition to those two bands, significant work has been done to develop a framework for sharing the 1695-1710 MHz band between federal and commercial operations. This is highly desirable spectrum that is also adjacent to the existing AWS band. To maximize the potential of the band for broadband services, the FCC must identify additional spectrum with which it could be paired. Given the requirement imposed by the Middle Class Tax Relief Act of 2012 to auction and license the 1695-1710 MHz band by February 2015, the effort to identify a paired band should begin immediately. A strong candidate for pairing would be the 2095-2110 MHz band. Pairing these two spectrum blocks would create a downward extension of the AWS spectrum and holds significant potential to expand broadband capacity.

2. Please comment on how the use of LTE can impact repurposing opportunities?

Long Term Evolution (LTE) technology can play an important role in repurposing federal spectrum.

For instance, LTE can provide a lower cost, off-the-shelf technology solution for the highly efficient delivery of broadband data and video. Upgrading federal systems that transmit data and video using this technology could reduce overall federal spectrum requirements



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compared to technologies currently used, which, in some cases continue to use technology that is decades old. This would not only improve spectrum efficiency but also enhance the capabilities of these particular systems and allow use by a larger number of devices. While not every federal system could use LTE technology, there are systems that could make better use of existing commercial technologies and increasing the spectral efficiency of operations should be a critical part of any spectrum review.

LTE can also facilitate spectrum sharing where that approach is appropriate. LTE provides a robust power control and spectrum selectivity capability that allows commercial carriers to power down transmissions or avoid certain portions of a band altogether where legacy federal systems are operating. The ability to tightly control the emissions and channels used by LTE devices can provide new opportunities to work around government operations, although the ability to do so must be evaluated on a case-by-case basis with close coordination between commercial and federal users. The attached document provides a further description of LTE technology and features that can facilities shared use.

Should you have any further questions please do not hesitate to contact me.

Respectfully,

A handwritten signature in black ink, appearing to read 'Steve B. Sharkey'.

Steve B. Sharkey
Chief of Engineering & Technology Policy
Federal Regulatory
T-Mobile USA, Inc.

Cc: The Honorable Anna Eshoo, Ranking Member
Subcommittee on Communications and Technology

Attachment

Overview of LTE Technology¹

I. Introduction and Summary

Commercial mobile wireless systems have undergone significant changes over the past 30 years, beginning with simple analog technology that was defined to support voice traffic, to more complex digital systems with rudimentary data capabilities. The purpose of this document is to provide an overview of the most prevalent of the current wireless standards driven by the 3rd Generation Partnership Project (“3GPP”). 3GPP has developed the standards surrounding the GSM family of technologies, including GSM, EDGE, UMTS, HSPA, HSPA+, and LTE. For purposes of this overview, this paper will focus on Long Term Evolution (“LTE”) and its capabilities. LTE is already deployed by many wireless providers in the United States, and is the most plausible technology choice for uplink operation in the 1755-1850 MHz band, once it is made available for commercial wireless services. As is described herein, LTE has a number of inherent advantages and improvements that make it capable of using spectrum resources efficiently, while also facilitating limited sharing between Federal and commercial services.

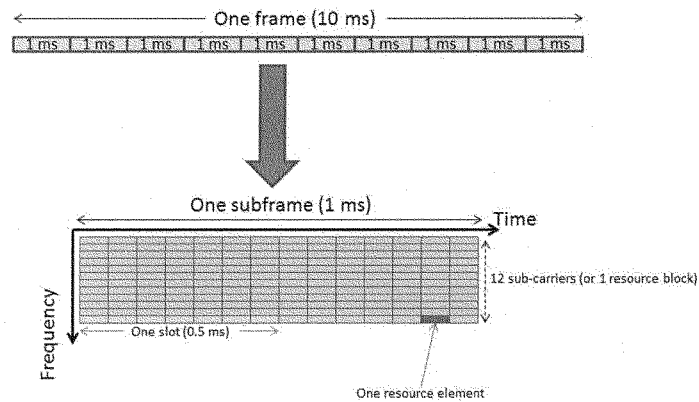
II. LTE Radio Access Features

LTE radio access differs in the downlink and uplink. The downlink uses orthogonal frequency division multiple access (“OFDMA”) to enable the high peak data rates desired for receiving data downloads from the Internet. The uplink path utilizes Single Carrier-Frequency Division multiple access (“SC-FDMA”) to mitigate the effects of the high peak to average ratios present if only OFDMA were used. High peak to average ratios compromise power efficiency which is a special concern for mobile units (that operate on the uplink side). Additionally, uplink system throughput and improved coverage and cell-edge performance is provided by use of SC-FDMA for the uplink.

In OFDMA, both time and/or frequency resources are used to separate the multiple user signals. Typically, a burst in an OFDMA system consists of several OFDM symbols. The subcarriers and the OFDM symbol period are the finest allocation units in the frequency and time domain, respectively. Multiple users are therefore allocated different slots in the time and frequency domain – different groups of subcarriers and/or OFDM symbols are used for transmitting the signals to/from multiple users.

¹ This overview is a relatively basic overview. For a more thorough description of all features and capabilities of LTE, see e.g., http://www.amazon.com/4G-LTE-LTE-Advanced-Mobile-Broadband/dp/012385489X/ref=pd_sim_b_1; <http://www.amazon.com/LTE-UMTS-Evolution-Theory-Practice/dp/0470660252>; 4G Mobile Broadband Evolution: Release 10, Release 11 and Beyond - HSPA, SAE/LTE and LTE-Advanced <http://www.4gamericas.org/documents/4G%20Mobile%20Broadband%20Evolution-Rel%2010%20Rel%2011%20and%20Beyond%20October%202012.pdf>, and Mobile Broadband Explosion: The 3GPP Wireless Evolution <http://www.4gamericas.org/documents/4G%20Americas%20Mobile%20Broadband%20Explosion%20August%2020121.pdf>

For LTE, the time domain structure has a 10 millisecond frame consisting of 10 sub-frames of 1 millisecond. Each sub-frame consists of two slots of 0.5 milliseconds. Each slot consists of seven OFDM symbols. The figure below describes the LTE physical resources:



A resource block is the key fundamental building block which is made up of 12 sub-carriers per 0.5 millisecond slot. Because LTE enables the use of sub-carriers in this fashion, any bandwidth can potentially be supported. However, the 3GPP has adopted these specific channel bandwidths:

Channel Bandwidth (MHz)	1.4	3	5	10	15	20
Transmission Bandwidth (numbers of resource blocks)	6	15	25	50	75	100

The number of resource blocks, as defined above, is limited to multiples of 2, 3 or 5 to reduce complexity of device operations. Channel bandwidths of 1.4 and 3 MHz are designed for ease of upgrading spectrum from existing networks and greater efficiencies are derived from deploying 5 to 20 MHz channel bandwidths. Further, LTE allows for the resource blocks to be deployed dynamically – in response to interference issues or otherwise to limit the number of mobile units deployed per sector to best manage the spectrum resource. Within a sector, downlink capacity is allocated to UEs via time and frequency division multiplexing in time increments of 1 millisecond and bandwidth increments of 15 kHz. Within a sector, uplink capacity is allocated to UEs by the network via time and frequency division multiplexing in time increments of 1 millisecond and bandwidth increments of 180 kHz.

The basic synchronization and broadcast control structure of an LTE signal is designed around the 6 resource blocks around the carrier frequency. This control channel structure is bandwidth invariant.

III. LTE Features That Enable Spectrum Sharing

As described briefly above, and in more detail below, LTE has a number of features that potentially facilitate the sharing of spectrum. Features that could allow coexistence include power control, traffic shifting, channel scaling and base station control over handset operations. Each of these features enable LTE to provide wireless operators the flexibility to respond to the particular interference environment and allows for specific deployments to accommodate the requirements necessary to share with incumbent Federal systems.

a. Power Control

Strict power control over handsets is critical to ensure that a system is properly deployed without harmful self-interference. Additionally, maintenance of power control allows LTE to provide the best data rates to consumers possible, by providing physical resources to match the data demands within the network. Strict power control also enables the most capacity to be provided throughout the network. Absent tight power control of the LTE system, a wireless provider would not be able to control and manage the interference environment and would have a deleterious effect on the overall efficiency and capacity of the network.

Power control for LTE is managed through an open loop power control algorithm. The open loop power control algorithm is configured to a fixed power level received by the base station for a resource block; this should be understood as a configuration of the received power spectral density for each UE transmission. This power spectral density is typically chosen to be at a level that provides a certain desired C/I (or received signal power over the sum of interference and noise). Modern cellular systems use fractional power control to bias the desired C/I of a user terminal downward when the user is at the edge of coverage. This in turn tends to lower the extent to which transmit power levels rise as the user gets closer to the edge of the cell. The effect of fractional power control is to lower the amount of interference

cell edge users cause to other cells, thereby lowering the overall amount of noise rise due to interference in the system.

The effect of this tight power control is to greatly limit the mobile station (or user equipment or “UE”) effective power in an LTE deployment. UE conducted power levels span a range from -36 dBm to 23 dBm for LTE. The use of the peak power level of 23 dBm will typically happen when the UE is at the edge of coverage and has no available power headroom in the power control procedures; the occurrence of the peak is rare in a well engineered system. Indeed, the cumulative distribution function provided by the industry (and agreed to as a fair representation by the Federal users) shows very low probabilities for the maximum power for UEs being utilized. Typical handheld mobile terminals have EIRP levels that are lower than the conducted peak due to the embedded antenna designs, and effects such as internal losses and body loss due to proximity with the user. EIRP levels are typically assumed to be around 20 dBm at peak transmit levels. Moreover, as described in more detail below, UE power control is managed closely by the base station and could potentially be controlled when in some proximity to protected Federal sites.

In sum, the power control features of LTE: (1) minimize the amount of power used by UEs and (2) can be managed, if necessary, to enable sharing between commercial LTE systems and incumbent Federal operations.

b. Traffic Shifting

Wireless providers have spectrum in a variety of bands, including: (1) the 700 MHz band; (2) the 800 MHz cellular and SMR bands, (3) the Advanced Wireless Service 1.7/2.1 GHz band; (4) the Personal Communications Service 1.9 GHz band and (5) the 2.5 GHz Broadband Radio Service band. In general, a single wireless provider has a license to use spectrum several of these spectrum bands and therefore has a diversity of available spectrum with which customers can be served. This spectrum diversity can allow providers to shift consumers, seamlessly, between spectrum resources in cases of capacity constraints or interference issues. In addition, UE devices have a variety of spectrum bands available within them to match up with the requirements of wireless providers. Indeed, so-called “multi-band” devices are widespread, that have five or more spectrum bands available within the device and even more if the ability to seamlessly interoperate between systems that use GSM/EDGE, WCDMA/HSPA and LTE is considered.

Similarly, wireless providers that are licensed in the 1755-1850 MHz spectrum will have the potential to dynamically shift end users from this spectrum to other licensed spectrum in areas where needed to protect Federal users. Such traffic shifting can be dynamic in response to certain inputs or triggers, such as interference levels, or dynamic load control, or fixed if there are certain areas that could never be utilized without presenting harmful interference to incumbent Federal systems.

c. Channel Scaling

The LTE standard provides a wireless operator extensive flexibility in deploying physical resources dependent upon spectrum licensed as well as the interference environment. Because LTE breaks down communications into small sub-carriers, operators are able to dynamically scale the use of the spectrum to meet network realities. Moreover, both the uplink and downlink traffic channels are fully scheduled since they are dynamically shared channels. This means that the physical downlink control channel (“PDCCH”) must indicate which users should decode the shared downlink traffic channel in each sub-frame and which users are allowed to transmit on the shared uplink traffic channel in each sub-frame.

Additionally, the scalability of LTE allows for use of a variety of bandwidths for an LTE deployment, ranging from 1.4 MHz to 20 MHz. This variability would allow a wireless provider to initiate commercial services during a transition period with smaller amounts of spectrum, with the expectation that potentially over time more spectrum could be made available for a more robust network. This mechanism could be used when a Federal incumbent has an expectation that it will relocate, but on a timetable that is longer than the commercial provider can wait deployment. Thus, a commercial operator could initiate an LTE system with 1.4 MHz channel bandwidth immediately, with the potential for increasing the amount of spectrum as it is made available from the Federal incumbent that is relocating.

d. Base Station Control

A final key feature of LTE is that control of the UE is managed by the base station. LTE base stations manage the control channels, which dictates how the traffic channels are allocated (and the physical resource blocks to each UE) as well as the power utilized by the UEs. Moreover, a mobile unit may not power on (or power up) without a command from the base station to do so.

This capability to manage handsets by the base station can be utilized to facilitate sharing. As described above, the base station can manage the power of the UEs and can force a shift in spectrum altogether. Moreover, base station control of mobiles could allow feedback into the network needed to enable sharing that is dynamic and based upon the actual operating environment. As an example, the base station network can monitor the interference environment and based on Federal station operations, migrate LTE UEs to spectrum that is less utilized, whether in the 1755-1850 MHz band or another band. Moreover, the base station can also manage the power used by UEs – increasing or decreasing the power based on the needs of the network and ensuring protection to the Federal incumbents.

IV. Conclusion

The LTE standard contains features and characteristics that could be practically implemented, if needed, to facilitate temporal sharing, protection of government systems while simultaneously allowing wireless providers to serve customers with minimal impact.

The exact extent of sharing will depend greatly on the parameters of the government operations.

