

**Testimony of  
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**Before the**

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

**Hearing on  
“Equipping Carriers and Agencies in the Wireless Era”  
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## **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 and the Administration's ongoing efforts to make additional spectrum available for wireless broadband services. 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. This is my second appearance in less than a year before the Subcommittee to discuss federal spectrum matters, clearly underscoring the urgency with which the Subcommittee views these issues. I can assure you that NTIA shares this sense of urgency.

In my testimony today, I will discuss briefly the growing demand for spectrum by both consumers and government operations. I will also update you on NTIA's progress in repurposing federal spectrum for consumer uses in pursuit of the President's 500 megahertz goal, and summarize President Obama's recent executive memorandum to federal agencies, directing further improvements in spectrum access opportunities and efficiency to promote economic growth and expand America's leadership in wireless innovation.

## **II. The Ever-Increasing Demand For Spectrum**

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. Spectrum is also vital to enabling federal agencies to perform their essential missions, as it supports national security, critical defense operations, law enforcement and emergency response, homeland security, transportation safety, scientific research, environmental monitoring, power marketing, and weather prediction. While federal agencies make heavy use of commercial services and unlicensed devices where appropriate, their spectrum needs for mission-critical capabilities continue to increase.

Modern, mass-market, commercial wireless operations generally tend to be homogenous, centrally controlled by licensed carriers, and subject to market-based principles. The American people's desire for wireless broadband services enables service and technology providers to refresh their networks and devices regularly to get us next-generation features and functionality.

Federal agencies' wireless operations, on the other hand, support a diverse set of missions and a variety of technologies, including fixed and mobile communications, many types of radars, sensors, radio astronomy, ground-based, ship-borne, airborne, and satellite systems. These systems must be reliably available when and where they are needed. Another key difference between commercial and government systems is that government systems are developed and deployed with taxpayer funding, within congressionally-imposed budgetary constraints that necessitate plans for many systems to stay in service for up to 20 years or longer, with limited refresh opportunities.

The physics driving the demand for certain spectrum bands centers around the need for signal coverage, bandwidth capacity, and mobility. Lower frequencies provide better coverage, higher frequencies can produce more bandwidth and greater data rates, but the prime spectrum bands (between 300 and 3000 MHz) support greater mobility required by small handheld devices. This "beachfront spectrum" also allows pocket-sized cell phones, small GPS receivers to receive weak satellite signals, radar systems to detect objects at longer distances, and tactical radios to penetrate heavy foliage.

In light of the significant challenges in repurposing a diminishing amount of available spectrum, NTIA is pursuing, with our industry and federal agency stakeholders, an 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 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) lower costs for the taxpayer; (3) more available spectrum due to efficiencies; (4) greater innovation in the wireless marketplace; and (5) assured capabilities for federal departments and agencies.

### **III. Challenges to Repurposing Spectrum**

If it was easy to repurpose spectrum from long-term legacy uses to enable new consumer services and technologies, today's hearing would not be happening. In fact, our goal of making additional broadband spectrum available is extremely challenging – logistically, technically, and economically. NTIA is committed to overcoming these challenges in collaboration with federal agencies and our colleagues in the Federal Communications Commission (FCC) and industry stakeholders.

Information sharing between federal agencies and industry representatives has been one of the most significant challenges. While the level of cooperation and information exchange between industry and government working within NTIA's Commerce Spectrum Management Advisory Committee (CSMAC) working groups reviewing the 1755-1850 MHz band reallocation over the past year has been unprecedented, and continues to improve. DOD and industry representatives have made significant progress in recent days regarding industry access to sensitive information on certain military systems. The DOD and industry are discussing improving information sharing by working with a subset of working group members or "Trusted Agents," through whom sensitive information could be shared under non-disclosure agreements.

Transition planning and preparation for the auction of the 1695-1710 MHz and 1755-1780 MHz bands, in the face of uncertain clearing and sharing outcomes, is another issue we are addressing. In a March 20, 2013 letter, the FCC notified NTIA of its plans to auction these two bands "as early as September 2014."<sup>[1]</sup> NTIA supports the FCC's efforts to ensure adequate time to conduct the auction and complete the subsequent licensing process pursuant to the Tax Relief Act's February 2015 deadline.<sup>[2]</sup> At the same time, there are other key statutory milestones and issues that, together with the other federal agencies and industry stakeholders, we must achieve and address to ensure a successful auction and smooth transition.

In order for agencies to timely and adequately prepare sufficient transition plans, especially those for the 1755-1780 MHz band, the FCC and NTIA must confront several important issues as soon as possible, many of which must be raised in the FCC's upcoming rulemaking proceeding. These issues include the nearer-term pairing of the 1755-1780 MHz band with the 2155-2180 MHz band, a long-term plan for the upper 70 MHz in the 1780-

1850 MHz band, and the identification of alternative spectrum to which federal operations could be relocated, if necessary.[3]

First, NTIA recognizes that pairing and auctioning the 25 megahertz of spectrum in the 2155-2180 MHz band with the 1755-1780 MHz band is a priority for the FCC and the commercial mobile wireless industry. NTIA recognizes, however, the need to explore ways to accommodate a two-phased approach for the entire 95 MHz of spectrum in the 1755-1850 MHz band since most federal functions require and operate throughout the 1755-1850 MHz band to meet their missions. Specifically, the FCC will need to consider, whether as part of relocation or a sharing arrangement, the potential for a phased transition that facilitates commercial access to the 1755-1780 MHz band in a shorter timeframe, while preserving longer-term repurposing and transition opportunities for the entire 1755-1850 MHz band. NTIA and DOD are working with the FCC and industry representatives on a proposed roadmap to accommodate this two-phased approach.

Second, and equally important, agencies must have certainty that their mission-critical, spectrum-dependent operations will be maintained without interruption. Before agencies can plan to relocate any of their systems, the FCC and NTIA must identify and reallocate expeditiously spectrum to accommodate displaced federal operations, unless these agencies can maintain comparable capability of systems via sharing or utilizing alternative technology.

Each agency with operations in the 1755-1780 MHz band provided NTIA, in rank order, a prioritization of comparable replacement spectrum for their operations. For example, the Department of Defense (DOD) identified the 2025-2110 MHz band as its preferred option to relocate most of its operations.[4] Current law requires that before DOD can “surrender” frequencies that result in a loss of “essential military capability,” DOD and NTIA must jointly certify to Congress that alternative bands provide comparable technical characteristics to restore such capability or that capabilities are maintained through other means.[5]

Improvements to the Commercial Spectrum Enhancement Act (CSEA) enacted in the Middle Class Tax Relief and Job Creation Act of 2012 (Tax Relief Act) will play an essential role in facilitating federal agency relocation and sharing of spectrum the FCC plans to auction. For instance, agencies will be able to recover costs for planning for the reallocation and auctioning of spectrum, allowing agencies to more accurately plan how they will relocate from or share spectrum, and providing them with an important incentive to do so in a more timely and cost-effective manner. The CSEA also enables federal agencies to upgrade their systems with state of the art technology or commercial platforms, which is another important incentive to more quickly moving from or sharing spectrum. Other improvements in the law are aimed at facilitating better transparency, coordination, and predictability for bidders in FCC spectrum auctions and the ultimate winners of those auctions. For example, the 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, will aid in post-auction coordination by facilitating more timely and easy access to information by auction winners.

NTIA has been working with the Office of Management and Budget (OMB), the FCC and other federal agencies to implement these provisions. Our 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. However, the FCC’s February 2015 licensing deadline is quickly approaching and, in light of the potential for a September 2014 auction, agency transition plans could be due as early as January 2014 even though the FCC has not yet commenced a rulemaking for the 1695-1710 MHz and 1755-1780 MHz bands. This leaves federal agencies without information critical to the development of transition plans, with three of the ten months normally available having already passed.

## **IV. 2013 Presidential Memorandum**

The Executive Memorandum signed by President Obama on June 14<sup>th</sup> reflects the Administration’s recognition of, and commitment to overcome, the significant and complex challenges that both industry and federal agencies face in improving access to and more efficient use of spectrum.[6] Specifically, it establishes measures federal agencies must take to more aggressively consider spectrum efficiency. It also directs NTIA to

continue facilitating discussions and information sharing to expedite commercial entry into federal bands while maintaining and protecting the mission capabilities of federal systems. To this end, NTIA and the National Institute of Standards and Technology (NIST) have announced plans to establish a new Center for Advanced Communications in Boulder, Colorado, that will develop policies and best practices to promote and facilitate greater collaboration among agencies, the private sector, and academia with respect to research, development, testing, and evaluation of spectrum-sharing technologies.[7]

The memorandum also creates a Spectrum Policy Team within the Administration tasked with monitoring and supporting advances in spectrum sharing policies and technologies. Among the Spectrum Policy Team's short-term deliverables are recommendations to the President regarding approaches that could give agencies greater incentive to share or relinquish spectrum, while protecting the mission capabilities of existing and future systems that rely on spectrum use. The team will consider whether proposals made by the President's Council of Advisors on Science and Technology (PCAST) – including the establishment of so-called “spectrum currency” and a “spectrum efficiency fund” – would be effective.

The memorandum also aims to improve the nature of information gathered on usage of spectrum by federal entities. NTIA will develop an approach for improved quantification of spectrum use by federal systems. This effort could potentially quantify the bandwidth and population occupied by federal systems, as well as consider the time of use along with other metrics and parameters. This will help determine the extent to which spectrum assigned to the agencies could potentially be made available for sharing with or reallocation to commercial users, particularly in major metropolitan areas. Each assessment will address the nature of the agencies' missions and projected increases in spectrum usage and needs, identifying situations where access to non-federal spectrum could aid in fulfilling agency missions. In addition to these quantitative assessments, the President's memorandum and the Administration's FY 2014 budget proposes the design, development, and deployment of a new spectrum monitoring capability. The memorandum includes other approaches to ensure efficient use of spectrum. For example, an agency that requests a new spectrum assignment or that seeks to procure a spectrum-dependent system will have to document its consideration of alternative approaches and verify that it is pursuing the most spectrum-efficient method, in consideration of all relevant factors including cost and agency mission, particularly in the “beachfront spectrum.”

## **V. Delivering on the President's Initiative to Double the Amount of Spectrum Available for Wireless Broadband**

Since June 2010, when the President directed the Department of Commerce, working through NTIA, to collaborate with the FCC to make available an additional 500 megahertz of spectrum for wireless broadband use by 2020, NTIA and other federal agencies have pressed ahead to find the spectrum necessary to make these economic, technological, and societal benefits a reality.[8] Five hundred megahertz is a large amount of spectrum. NTIA has 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, exclusive use and shared use. Everything is on the table. This involves potentially repurposing bands currently used by federal agencies by relocating them to other bands or by sharing spectrum where technology and other factors permit. Thus far, NTIA has formally recommended or otherwise identified for potential reallocation up to 405 megahertz:

- 15 megahertz from the 1695-1710 MHz band;
- 100 megahertz from the 3550-3650 MHz band;
- 95 megahertz from the 1755-1850 MHz band; and
- 195 megahertz in the 5350-5470 MHz and 5850-5925 MHz bands.

None of these bands are easy to repurpose because they include major taxpayer-supported infrastructure investments by federal agencies, and similar infrastructure investments by the private sector. Federal operations are increasingly expensive and time-consuming to move, and few bands remain to which to move them. And before we can move federal systems, we must find ways to maintain capabilities, which could include identifying comparable spectrum bands, in order for agencies to maintain their operations and protect the federal missions they support. Private sector investments must also be protected by ensuring that

appropriate and reliable sharing technologies are applied to give incumbent private sector users assurance they will have spectrum access when needed. In addition, the conditions and plans under which spectrum the identified spectrum is repurposed affects the potential benefits to the economy. But the increasingly important benefits of broadband to consumers, to commerce, and to ongoing innovation warrant our doing everything we can to get this job done.

a. 1695-1710 MHz and 3550-3650 MHz Bands

In 2010, NTIA led an interagency “fast track” evaluation of spectrum that could be reallocated without requiring relocation of federal systems and ultimately recommended reallocating 115 megahertz in the 1695-1710 MHz and 3550-3650 MHz bands for wireless broadband use on a shared basis.<sup>[9]</sup>

Further, as directed by Congress in Section 6401(a)(3) of the Tax Relief Act, NTIA submitted a report to the President identifying the 1695-1710 MHz band for reallocation from federal to non-federal use.<sup>[10]</sup>

The FCC has notified NTIA that it plans to auction licenses in the 1695-1710 MHz band as early as September 2014, although it has not yet launched a rulemaking.<sup>[11]</sup> The CSMAC recommended a framework for sharing the 1695-1710 MHz band with incumbent federal operations that maximizes the opportunity for new commercial use while protecting federal meteorological earth stations from harmful interference.<sup>[12]</sup>

The FCC has commenced a rulemaking on the 3550-3650 MHz band, proposing the use of new and innovative spectrum sharing technologies including low-power, small-cell deployments controlled by geo-location databases to protect critical federal radar and satellite operations in the band.<sup>[13]</sup> NTIA is working with FCC and DOD to ensure that implementation of small cell technology ensures the protection of DOD radar operations.

b. 5 GHz Expansion Bands

Pursuant to Section 6406(b) of the Tax Relief Act, NTIA and the federal agencies have evaluated known and proposed spectrum-sharing technologies and the risks to federal users if the FCC allows Unlicensed-National Information Infrastructure (U-NII) devices to expand operations into the 5350-5470 MHz and 5850-5925 MHz bands. <sup>[14]</sup> 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. In February, the FCC commenced a rulemaking proceeding that proposes to modify its Part 15 rules to provide U-NII devices access to additional contiguous spectrum at 5 GHz with consistent technical requirements, allowing unlicensed devices to use wider bandwidth channels, leading to faster speeds.<sup>[15]</sup>

We welcome this proceeding but note that a number of federal radar systems operate in the 5350-5470 MHz band and must be protected. Some of these are airborne, resulting in a more challenging sharing environment. Furthermore, other countries operate or depend on satellite-based sensing radars in the band. NTIA, the FCC, the agencies, and industry are working cooperatively to fully assess the conditions under which sharing may be possible in this band. In the 5850-5925 MHz band, the vehicle and infrastructure industries, with the support of the Department of Transportation (DOT), have been developing connected vehicle and infrastructure technologies that have safety and mobility applications using dedicated short-range communications (DSRC) services for more than a decade. The transportation industry may benefit from the economies of scale resulting from working with WiFi technology developers if DSRC commonality with unlicensed devices is possible. While both systems use the basic IEEE 802.11 standard, they implement the standard in different ways that may not allow spectrum sharing. NTIA’s January 2013 Report to Congress identified some of the risks that need to be mitigated to support spectrum sharing in the 5850-5925 MHz band. We have encouraged the WiFi and transportation industries to work together to determine how best to address these risks. The transportation industry has engaged with the WiFi industry to determine if effective sharing techniques can be developed that protect the incumbent DSRC service. Furthermore, NTIA is engaged with DOT, FCC and other stakeholders in the public and private sectors to determine the potential effects of sharing in the 5850-5925 MHz band, with a view toward ensuring that critical public safety interests are protected.

c. 1755-1850 MHz Band

In January 2011, NTIA asked federal agencies with operations in the 95 megahertz of spectrum in the 1755-1850 MHz band to assess the feasibility of relocating in ten years and to determine whether their systems could transition out of the 1755-1780 MHz portion of the band in five years, the conditions under which relocation could be accomplished, and the associated costs. In March 2012, NTIA determined that the full 1755-1850 MHz band could be repurposed for wireless broadband use once certain critical challenges are overcome.<sup>[16]</sup>

The challenges of repurposing the 1755-1850 MHz band include the high costs and long timeline of the undertaking, preliminarily estimated to be approximately \$18 billion over ten years, and comparable spectrum requirements at 2025-2110 MHz and 5150-5250 MHz, assuming relocation of most existing federal users.<sup>[17]</sup> A May 2013 report of the Government Accountability Office (GAO) regarding the relocation costs associated with the 1710-1755 MHz band validated the agencies' approach to developing these cost estimates.<sup>[18]</sup> Although the government and industry gained valuable experience during the transition of federal operations from the 1710-1755 MHz band, relocating systems from the 1755-1850 MHz band presents significantly greater challenges and thus will require much more significant actions, costs and time. NTIA is therefore pursuing an approach that incorporates both relocation and sharing to make this band, and other bands, available more quickly and at less cost.

Accordingly, NTIA initiated, through the CSMAC, industry and government collaboration to identify potential solutions, including partial clearing scenarios. The CSMAC established several working groups, made up of experts from industry and government to evaluate each type of federal system and the prospective commercial technology solutions to determine the fastest, most cost-effective way forward to allow commercial broadband access in the 1755-1850 MHz band. The groups organized around particular federal operations that currently share the entire band throughout the country. In addition to relocation and geographic sharing options, some of the working groups considered the possibility that commercial users and federal agencies could access the same frequencies in the same geographic areas through greater spectrum availability and the use of new flexible and agile commercial technologies. 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.

In some cases, sharing is not feasible and the CSMAC is recommending the relocation of federal systems. For example, for law enforcement surveillance systems, the CSMAC recommended prioritizing market areas for clearing, first considering the 1755-1780 MHz sub-band and second, 1780-1850 MHz.<sup>[19]</sup> This recommended priority list will serve as input to affected federal agencies with video surveillance operations in the band as they develop their transition plans.

The working group addressing satellite links and electronic warfare systems completed its recommendations and presented them to the full CSMAC at last week's meeting. The group determined that commercial wireless networks are unlikely to impact the federal satellite operations in the 1755-1850 MHz band, but that the commercial wireless operators will likely have to bear some risk of interference within close proximity to the satellite earth stations sending signals into space. Electronic warfare preparedness operations will be coordinated under existing rules according to the working group's recommendations. We expect the full CSMAC to deliberate on these working group recommendations and approve final recommendations at its next meeting on July 24, 2013.

The CSMAC working group addressing federal fixed microwave and military tactical radio communications in the band is nearing completion of its work. Point-to-point microwave systems are relatively straightforward to move and comparable spectrum has been identified where these systems can be relocated. The working group will be identifying military sites where tactical radio relay systems are used for training exercises that will need to be protected, and technical analysis may help significantly reduce the size of the protection areas and coordination zones.

The CSMAC working group with the most difficult challenges is studying clearing and sharing options for military airborne operations. This group has initially identified the need for large protection areas based on

traditional spectrum analysis techniques. To address this issue, NTIA and DOD will need to explore more advanced mitigation techniques to facilitate sharing or relocate the operations.

The CSMAC working groups have suggested that their results could be improved, offering greater potential for increased commercial access to the spectrum and successful sharing, if sensitive information, which cannot be shared publicly, could be more readily shared between industry engineers and the federal agencies, particularly DOD. As I will discuss shortly, the President has taken action to improve this information sharing, including the handling of sensitive information. NTIA is committed to facilitating these communications to ensure that private and public stakeholders have the information they need to fully and adequately assess various options and hasten reallocation to the greatest extent possible.

## VI. Conclusion

NTIA, in collaboration with the FCC and the federal agencies, has made substantial progress toward fulfilling the President's goal of doubling the amount of commercial wireless spectrum available this decade. We are excited by the strong and renewed momentum that the CSMAC's progress and the new Presidential Memorandum bring. 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 while protecting critical federal missions.

We still have a lot of work to do. We will continue to work through the bands that NTIA has placed on the table. Under the President's new memorandum, we will continue to move forward to consider other bands used by the federal agencies while we explore a new set of tools to maximize use of our critical resource.

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

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[1] See, FCC March 20, 2013 letter to NTIA.

[2] This deadline is directly applicable to the 1695-1710 MHz band, and to the 2155-2180 MHz band that the FCC is proposing to pair with 1755-1780 MHz, but does not apply directly to the 1755-1780 MHz band.

[3] NTIA, Letter of Assistant Secretary Lawrence E. Strickling to FCC Chairman Julius Genachowski on the planned auction of licenses in the 1695-1710 MHz Band and the 1755-1780 MHz Band at 2 (April 19, 2013), available at <http://www.ntia.doc.gov/other-publication/2013/letter-assistant-secretary-strickling-fcc-chairman-genachowski-planned-auction> [5].

[4] See March 2012 Report at Table 3-2.

[5] National Defense Authorization Act, Pub. L. No. 106-65, Div A, Title X, Subtitle G, §1062(b)(1), 113 Stat. 768 (Oct. 5, 1999), codified at 47 U.S.C. §921 note (Surrender of Department of Defense spectrum).

[6] White House, Memorandum for the Heads of Executive Departments and Agencies, *Expanding America's Leadership in Wireless Innovation* (June 14, 2013), available at <http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovation>.

[7] See Press Release, *NIST and NTIA Announce Plans to Establish New Center for Advanced Communications* (June 14, 2013), available at <http://1.usa.gov/12QE9QI> [6].

[8] White House, Memorandum for the Heads of Executive Departments and Agencies, *Unleashing the Wireless Broadband Revolution* (June 2010), available at <http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution> [7].

[9] NTIA, *An Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz, 4380-4400 MHz Bands* (Oct. 2010), available at [http://www.ntia.doc.gov/files/ntia/publications/fasttrackevaluation\\_11152010.pdf](http://www.ntia.doc.gov/files/ntia/publications/fasttrackevaluation_11152010.pdf) [8].

[10] NTIA, Report to the President: *Identification of 15 MHz of Spectrum Between 1675 MHz and 1710 MHz for Reallocation* (Feb. 2013), available at [http://www.ntia.doc.gov/files/ntia/publications/1675-1710\\_mhz\\_report\\_to\\_president\\_02192013.pdf](http://www.ntia.doc.gov/files/ntia/publications/1675-1710_mhz_report_to_president_02192013.pdf) [9].

[11] FCC, Letter of FCC Chairman Julius Genachowski, to Lawrence E. Strickling, Assistant Secretary for Communications and Information (Mar. 20, 2013) (FCC March 20, 2013 letter to NTIA), available at [http://transition.fcc.gov/Daily\\_Releases/Daily\\_Business/2013/db0321/DOC-319708A1.pdf](http://transition.fcc.gov/Daily_Releases/Daily_Business/2013/db0321/DOC-319708A1.pdf).

[12] See CSMAC, *1695-1710 MHz Meteorological-Satellite, Final Report of Working Group 1* (Feb. 2013), available at [http://www.ntia.doc.gov/files/ntia/publications/wg-1\\_report\\_v2.pdf](http://www.ntia.doc.gov/files/ntia/publications/wg-1_report_v2.pdf).

[13] FCC, *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, Notice of Proposed Rulemaking and Order*, GN Docket No. 12-354 (Dec. 12, 2012), available at [http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/FCC-12-148A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-12-148A1.pdf).

[14] NTIA, *Evaluation of the 5350-5470 MHz and 5850-5925 MHz Bands Pursuant To Section 6406(b) of the Middle Class Tax Relief and Job Creation Act of 2012* (Jan. 2013), available at [http://www.ntia.doc.gov/files/ntia/publications/ntia\\_5\\_ghz\\_report\\_01-25-2013.pdf](http://www.ntia.doc.gov/files/ntia/publications/ntia_5_ghz_report_01-25-2013.pdf).

[15] FCC, *Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Infrastructure (U-NII) Devices in the 5 GHz Band, Notice of Proposed Rulemaking*, ET Docket No. 13-49 (Feb. 20, 2013), available at [http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/FCC-13-22A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-13-22A1.pdf).

[16] See NTIA, *An Assessment of the Viability of Accommodating Wireless Broadband in the 1755-1850 MHz Band*, (Mar. 2012) (March 2012 Report), available at [http://www.ntia.doc.gov/files/ntia/publications/ntia\\_1755\\_1850\\_mhz\\_report\\_march2012.pdf](http://www.ntia.doc.gov/files/ntia/publications/ntia_1755_1850_mhz_report_march2012.pdf) [10].

[17] See March 2012 Report at 3.

[18] GAO, *Federal Relocation Costs and Auction Revenues* (May 22, 2013), available at <http://www.gao.gov/products/GAO-13-472> [11].

[19] CSMAC, *1755-1850 MHz Law Enforcement Surveillance, Explosive Ordnance Disposal, and other short distance links*, Final Report of Working Group 2 (Jan. 2013), available at [http://www.ntia.doc.gov/files/ntia/publications/csmac\\_wg-2\\_final\\_report\\_jan-4-2012.pdf](http://www.ntia.doc.gov/files/ntia/publications/csmac_wg-2_final_report_jan-4-2012.pdf) [12].