Before the
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Washington, D.C.

Office of Science and Technology Policy: Request for Information	)	FR Doc. 2014-03413

RESPONSE OF THE CONSUMER ELECTRONICS ASSOCIATION

The Consumer Electronics Association ("CEA")[1] respectfully submits this response to the Request for Information ("RFI") issued by the White House Office of Science and Technology Policy ("OSTP") on February 14, 2014.[2]

I. INTRODUCTION AND SUMMARY

CEA appreciates this opportunity to comment on the report by the Science and Technology Policy Institute ("STPI Report").[3] The STPI Report represents a crucial step toward developing incentives that encourage federal agencies to relinquish or share crucial spectrum resources with commercial wireless service providers, as required by the President's June 2013 Memorandum "Expanding America's Leadership in Wireless Innovation."[4] The need for additional spectrum to meet the ever-growing consumer and business demands for broadband services and applications is undisputable. Making federal spectrum available for commercial use

[1] CEA is the principal U.S. trade association of the consumer electronics and information technologies industries. CEA's more than 2,000 member companies lead the consumer electronics industry in the development, manufacturing and distribution of audio, video, mobile electronics, communications, information technology, multimedia, and accessory products, as well as related services, that are sold through consumer channels. Ranging from giant multi-national corporations to specialty niche companies, CEA members cumulatively generate more than $208 billion in annual factory sales and employ tens of thousands of people in the United States.

[2] Office of Science and Technology Policy, *Notice of Request for Information*, 79 Fed. Reg. 9288 (Feb. 18, 2014).

[3] *See* IDA Science & Technology Policy Institute, *A Review of Approaches to Sharing or Relinquishing Agency-Assigned Spectrum*, IDA Paper P-5102 (Jan. 2014), *available at* https://www.ida.org/upload/stpi/pdfs/p5102final.pdf.

[4] Presidential Memorandum, *Expanding America's Leadership in Wireless Innovation*, 78 Fed. Reg. 37431, 37434 § 6 (June 20, 2013) ("Presidential Memorandum").

is a critical element in addressing this need. To meet this objective, Government must develop incentive mechanisms that encourage federal agencies to relinquish spectrum and assure them that they can continue to meet their mission-critical communications needs.

There is a clear preference for relinquishment in the Middle Class Tax Relief and Job Creation Act of 2012,[5] and efforts should be made to encourage relinquishment. Further, all incentive mechanisms, whether focused on relocation and repurposing or on sharing, should be structured so that agencies not only recover the costs associated with relocation or sharing, but also receive additional financial and/or operational benefits. Cost recovery, alone, is not an adequate incentive for federal agencies to relinquish or share spectrum. Additional financial incentives, that are not otherwise offset in the budgeting process, and/or operational benefits such as updated technology and capabilities are necessary components of an incentive mechanism.

Finally, spectrum sharing should be considered in appropriate circumstances as provided in the 2012 Spectrum Act. Implementation of advanced spectrum sharing mechanisms will require coordination among government and commercial user groups, interference modeling, and testing. Transmitter operating parameters are one way to address interference. In some cases, receiver performance in particular shared use scenarios may be relevant to the analysis of the feasibility of these arrangements. To the extent sharing arrangements are explored, the emphasis should be on providing equipment designers with information on a pre-established received signal strength profile that, if exceeded, allows a claim for harmful interference to be made (*e.g.,* "harm claim threshold") as opposed to mandated receiver standards.

[5] Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96 § 6701, 126 Stat. 156, 245-52 (2012), codified at 47 U.S.C. § 923 (the "2012 Spectrum Act").

II. REPURPOSING FEDERAL SPECTRUM TO COMMERCIAL USE IS KEY TO HELP ALLEVIATE SPECTRUM CONSTRAINTS

It is clearly evident that spectrum resources should be devoted to commercial use so that industry may respond to the continuing growth in mobile wireless use by consumers and businesses. U.S. consumers increasingly integrate their smartphones and tablets into their daily lives. At least 66 percent of online U.S. consumers indicate they own a smartphone,[6] and 44 percent own a tablet, with 70 percent of consumers expecting to purchase a tablet sometime in the future.[7] The number of smartphones shipped is expected to increase approximately 10 percent this year as compared to 2013.[8] Unit sales of tablets also are projected to rise this year, with an increase of more than 15 percent over the number of units sold in 2013.[9]

Further, the combined total minutes that smartphone users spend on activities requiring data connectivity now far surpasses telephony use. In 2013, smartphone owners spent an average of 54 minutes a day texting, emailing, and visiting webpages, but only 23 minutes a day talking on the phone.[10] Almost a third of consumers view video content on smartphones (32 percent) and tablets (31 percent),[11] and more than half of smartphone owners (52 percent) have

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[6] Press Release, CEA, Combined Smartphone Data-Based Activities Far Outpace Talking, CEA Study Finds (Sept. 17, 2013) (referencing CEA Market Research Report, *Smartphones: Consumer Behavioral Trends* (Sept. 2013)) ("*Smartphones: Consumer Behavioral Trends*").

[7] Press Release, CEA, *Tablet Ownership Rate Reaches New High of 44 Percent, According to CEA's Tablet Report* (Jan. 27, 2014) (referencing CEA Market Research Report, *Consumer Outlook on Tablets: Adoption, Sentiment and Social Media Conversation* (Jan. 2014)).

[8] Press Release, CEA, CE Industry Revenues to Reach Record High of $208 Billion in 2014, According to CEA Sales and Forecast Report (Jan. 7, 2014) (referencing CEA Market Research Report, *The U.S. Consumer Electronics Sales and Forecast 2009-2014* (Jan. 2014)).

[9] *Id.*

[10] *See* Smartphones: Consumer Behavioral Trends, *supra* note 6.

[11] Press Release, CEA, *Digital Video Content Is a Supplement, Not Replacement for TV Programming, Finds New CEA Study* (Feb. 27, 2014) (referencing CEA Market Research Report, *Video Content Discovery and Purchasing Trends* (2014)).

used their devices to shop online.[12] Mobile commerce sales in the U.S. increased from approximately $25 billion in 2012 to approximately $42 billion in 2013, and are expected to represent $131 billion by 2018 – more than three times the total for last year.[13] This wireless growth is not merely an American phenomenon; globally, penetration of mobile Internet services will surpass fixed broadband by 2016.[14] And, there is no end in sight – global mobile data traffic will increase nearly 11-fold between 2013 and 2018.[15]

It is equally evident that repurposing federal spectrum to commercial use is a critical element for addressing these looming spectrum constraints. To this end, Congress and the Executive Branch have taken numerous actions to facilitate repurposing federal spectrum to commercial use. In the 2012 Spectrum Act, Congress sought to expedite the availability of spectrum for commercial mobile broadband use through, among other things, the reallocation of spectrum, the requirement for the Federal Communications Commission ("FCC") to auction and license 65 MHz of additional spectrum for commercial use by February 2015, and changes in procedures for repurposing spectrum used by the federal government.[16] Congress also amended the Commercial Spectrum Enhancement Act ("CSEA") to further expand the circumstances in which federal agencies can recover the costs associated with making spectrum available for exclusive or shared commercial.[17] The Office of Management and Budget ("OMB") now requires federal agencies to consider the economic value of the spectrum being used in their

[12] *See* Smartphones: Consumer Behavioral Trends, *supra* note 6.

[13] Goldman Sachs Equity Research, *eCommerce expected to accelerate globally in 2014* at 15-16 (Mar. 5, 2014).

[14] PricewaterhouseCoopers, Outlook Insights: Global Entertainment and Media Outlook: 2013-2017 Regarding Internet Access (Sept. 2013) (Chart entitled *Global fixed broadband and mobile Internet penetration 2008-2017*), http://www.pwc.com/gx/en/global-entertainment-media-outlook/segment-insights/internet-access.jhtml.

[15] Cisco, Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013-2018, at 3 (Feb. 2014), http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html.

[16] 2012 Spectrum Act, §§ 6401(b) and 6701.

[17] *See* 47 U.S.C. § 928.

budget justifications for procurement of major systems, to evaluate whether spectrum sharing is possible, and to certify that commercial alternatives and non-spectrum dependent alternatives were considered.[18] The National Telecommunications Information Administration ("NTIA"), in coordination with the FCC, has made strides in identifying spectrum bands for evaluation for potential reallocation to commercial use.[19] The Presidential Memorandum included several additional directives to NTIA, OMB and other governmental bodies aimed at the careful evaluation of federal spectrum use, the consideration of spectrum bands for relocation or sharing, and improving the efficiency of federal spectrum use.[20] Those directives should be implemented, agencies should be accountable for their spectrum use, and their spectrum efficiency should be a central factor in the procurement and budget processes as contemplated by the Presidential Memorandum.

Despite these laudable efforts, more can and should be done to make federal spectrum resources available to serve consumers. To date, federal agencies have been disinclined to relinquish or share their spectrum holdings because of a lack of effective incentives and the need to maintain mission-critical communications systems. Without mechanisms that enable agencies to maintain necessary communications capabilities and provide financial and/or operational benefit to the agencies, they will continue to have little incentive to share or relinquish spectrum. The STPI Report represents an important step toward resolving this conundrum by evaluating "market-based or other approaches that could give agencies greater incentive to share or

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[18] *See* Office of Management and Budget, *Preparation, Submission, and Execution of the Budget*, Circular No. A-11, §§ 31.12, 51.18 (Aug. 2012), *available at* http://www.whitehouse.gov/sites/default/files/omb/assets/a11_current_year/a_11_2012.pdf.

[19] *See generally* 2012 Spectrum Act, § 6401; Rebecca Blank and Lawrence E. Strickling, Dep't of Commerce, *Identification of 15 Megahertz of Spectrum Between 1675 and 1710 MHz for Reallocation from Federal Use to Non-Federal Use Pursuant to Section 6401(a) of [the 2012 Spectrum Act]*, Report to the President (Feb, 2013), http://www.ntia.doc.gov/files/ntia/publications/1675-1710_mhz_report_to_president_02192013.pdf.

[20] Presidential Memorandum, 78 Fed. Reg. at 37432-34 §§ 3, 4.

relinquish spectrum, while protecting the mission capabilities of existing and future systems that rely on spectrum use."[21]

III. DEVELOPING APPROPRIATE INCENTIVES IS CRITICAL TO PROVIDE COMMERCIAL ACCESS TO FEDERAL SPECTRUM

The Government should target its efforts toward incentive mechanisms that promote relinquishment of spectrum for exclusive commercial use. In addition, incentive mechanisms must: (i) allow agencies to recover all costs related to planning, research and development, testing, and implementation for relocating their operations or otherwise making spectrum available for sharing (where sharing scenarios are pursued); and (ii) provide agencies financial and/or operational benefits above and beyond cost recovery.

A. Repurposing Federal Spectrum for Exclusive Commercial Use Must Be Given Priority

NTIA is required by the 2012 Spectrum Act to give priority to reallocation options that assign spectrum for exclusive, non-federal uses through competitive bidding, and to proceed with sharing arrangements only where relocation is technically or economically infeasible.[22] Moreover, NTIA is required to demonstrate to Congressional Committees the "specific technical or cost constraints" that warrant spectrum sharing rather than relocation. This statutory preference for relinquishment should flow through to the priorities assigned to various incentive mechanisms being developed.

B. Incentive Mechanisms Must Go Beyond Simple Cost Recovery

To be effective, any incentive mechanism must as a matter of course reimburse agencies for all costs reasonably incurred in relinquishing or sharing spectrum. This proposition is largely

[21] *Id.* at 37434, § 6.

[22] In evaluating of a band for possible reallocation, NTIA should "give priority to options involving reallocation of the band for exclusive non-Federal use and shall choose options involving shared use only when it determines, in consultation with the Director of the [OMB], that relocation of a Federal entity from the band is not feasible because of technical or cost constraints." 2012 Spectrum Act, § 6701(j)(1).

enshrined in existing law – specifically the CSEA, which allows agencies to recover relocation and sharing costs from a fund that is financed with revenues from the auction of that spectrum.[23] Existing law, however, does not account for cost recovery associated with relinquishing or sharing spectrum that is not auctioned. That remaining gap in the CSEA should be closed – agencies that relinquish or share spectrum should be entitled to recover their costs regardless of the licensing mechanism the FCC employs to ultimately assign the spectrum.

Further, reimbursing agencies for their relocation and/or sharing costs alone will not effectively incentivize agencies to relinquish or share spectrum. Additional financial and/or operational benefits are necessary. Financial benefits could include direct payments to agencies that relinquish or share spectrum. Payments to agencies that relocate should be higher than payments to agencies that agree to share spectrum. One interesting proposal is the Federal Spectrum Incentive Fund that would be created under H.R. 3674, which remains pending in the U.S. House of Representatives. Under that bill, agencies that relinquish spectrum could receive a percentage of the proceeds from the sale of that spectrum. The additional financial resources could be used to purchase updated technology or systems, including commercial systems, to meet their communications needs.

Operational incentives can include assistance in testing and implementing new technologies and capabilities into agency systems, enabling them to improve their capabilities, better perform their mission, and use spectrum more efficiently. In this way, agencies could ensure that their communications systems are upgraded and maintained on an ongoing basis to ensure greater efficiencies, allow their wireless communications technologies to keep pace with

[23] *See* 47 U.S.C. §§ 923, 928.

innovation, and to meet their budgetary obligations to consider commercial alternatives to meeting their mission/operational requirements.[24]

IV. SHARING MAY BE APPROPRIATE WHERE RELOCATION AND REPURPOSING IS NOT FEASIBLE

Although repurposing federal spectrum must be the priority, there will be instances in which it is not technically or economically feasible for agencies to relocate entirely. Spectrum sharing is appropriate in those circumstances. Indeed, sharing technologies already are in use in the 600 MHz and 5 GHz bands, and the FCC is considering a proposal to open to the 3.5 GHz band to commercial users while leaving the band's federal incumbents in place. As sharing technologies including database-enabled spectrum access continue to improve, additional opportunities may arise.

Implementation of advanced spectrum sharing arrangements will require additional research, coordination among government and commercial user groups regarding the anticipated nature of operations of systems in particular circumstances, interference modeling based on the anticipated operations, and testing. Operating parameters must be developed on a case-by-case basis to ensure that federal incumbent users are protected from interference so that they can continue to carry out their missions, while also providing meaningful access to the spectrum for both licensed and unlicensed use by commercial operators. While the focus for minimizing interference has often appropriately focused on setting power limits on devices that transmit wireless signals in order to avoid interfering with other authorized users, in some scenarios receivers may also play a role.

The design and performance of both government-operated and commercial receivers – in particular, how well they handle interference from other authorized transmitters in the band –

[24] OMB Circular No. A-11, § 51.18.

affects spectrum efficiency and should be considered in the design of spectrum sharing solutions. While it is impossible to set operating parameters outside the context of consideration of a particular band, a general approach on receiver performance issues can and should be followed throughout. Specifically, to the extent sharing arrangements are explored, the emphasis should be on providing equipment designers with information on appropriate harm claim thresholds as opposed to mandated receiver standards. Indeed, recently the FCC's Technological Advisory Council ("TAC") released an initial white paper and a subsequent paper serving as an introduction to the harm claim threshold concept, both of which address the role of receivers in the efficient use of spectrum.[25]

The TAC White Paper proposed, among other things, the use of harm claim thresholds to improve receiver performance to achieve more efficient use of spectrum. In essence, harm claim thresholds describe the environment in which a receiver must operate without specifying how the receiver must perform in that environment.[26] The harm claim threshold relies on a pre-established "received signal strength profile that, if exceeded at a specific percentage of locations and times within a measurement area, allows a claim for harmful interference to be made; or conversely, the interference below which an assignee has no enforcement recourse at the FCC."[27] That is, an operator experiencing interference above the harm claim threshold could claim harm

[25] FCC Technical Advisory Council, *Interference Limits Policy: The Use of Harm Claim Thresholds to Improve the Interference Tolerance of Wireless Systems* (Feb. 6, 2013) ("TAC White Paper"), *available at* http://transition.fcc.gov/bureaus/oet/tac/tacdocs/WhitePaperTACInterferenceLimitsv1.0.pdf; *see also*, FCC Technical Advisory Council, *Interference Limits Policy and Harm Claim Thresholds: An Introduction* (Mar. 5, 2014), *available at* http://transition.fcc.gov/oet/tac/tacdocs/reports/TACInterferenceLimitsIntrov1.0.pdf.

[26] TAC White Paper at 8.

[27] *Id.*

from other systems[28] and, below this threshold, receivers would be responsible for handling interfering signals.[29]

CEA, in comments submitted to the FCC regarding the TAC White Paper, strongly supported the use of claim harm thresholds and detailed their many benefits.[30] As CEA described, harm claim thresholds can give equipment manufacturers and service providers much needed predictability regarding the spectral environment they can expect when designing products and services. Such predictability is particularly important in emerging technology markets because it enables new entrants to attract investment and drive innovation. Harm claim thresholds also preserve device manufacturers' and service providers' ability to evaluate receiver design trade-offs based upon market forces and technological considerations and can provide incentives to improve receiver performance. Finally, harm claim thresholds benefit the consumer by allowing manufacturers to offer products that perform in a predictable and reliable fashion, without paying additional cost for a product that must be capable of and subject to ongoing attempts to increase robustness as the RF environment changes.

Harm claim thresholds and signal strength profiles must be driven by consensus, technological concerns, and industry expertise. There is no single set of general interference limits that would be appropriate to apply across all bands, all applications, and all standards. Harm claim thresholds and the underlying signal strength profiles can only be established on a band-by-band basis, making input of the affected industry stakeholders critical.

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[28] *Id.* at 8-9.

[29] *Id.*

[30] *See Office of Engineering and Technology Invites Comments on Technological Advisory Council (TAC) White Paper and Recommendations for Improving Receiver Performance*, ET Docket No. 13-101, Comments of CEA (filed Jul. 22, 2013).

V. CONCLUSION

The STPI Report is a strong step in the evaluation and development of effective federal incentive mechanisms. Existing incentive programs, alone, have not been effective in encouraging agencies to identify potential spectrum bands for relocation or sharing. CEA stands ready to join with and support this Administration's efforts to better encourage federal agencies to make more spectrum available for wireless broadband applications.

Respectfully submitted,

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Before the
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
Washington D.C. 20504

Request for Information:
Agency Incentives – Spectrum

COMMENTS OF VERIZON

Verizon submits these Comments in response to the Office of Science and Technology Policy's ("OSTP") Request for Information[1] on the Science and Technology Policy Institute ("STPI") Report[2] that catalogues current proposals that would provide greater incentives for federal agencies to relinquish or share spectrum. The RFI will gather input to inform the Spectrum Policy Team's ("SPT") recommendations to the President. Verizon is committed to continuing to work side-by-side with federal agencies and all stakeholders to find ways to repurpose spectrum for commercial use while maintaining the federal mission. We welcome this opportunity to engage the Administration on an issue – spectrum – that is critical to the mobile communications sector, American consumers, the national economy, and the global marketplace.

As an initial matter, Verizon applauds the federal government for its significant efforts to make more spectrum available for wireless broadband. It was just four years ago that the President issued his first Presidential Memorandum on spectrum,[3] fully embracing the goal to

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[1] Office of Science and Technology Policy, Spectrum Policy, *Notice of Request for Information*, 79 Fed. Reg. 9288 (Feb. 18, 2014) ("RFI").

[2] IDA Science and Technology Policy Institute, *A Review of Approaches to Sharing or Relinquishing Agency-Assigned Spectrum* (Jan. 2014) (the "Report").

[3] Presidential Memorandum, *Unleashing the Wireless Broadband Revolution*, (June 28, 2010), http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution ("June 2010 Presidential Memorandum").

allocate by 2020 an additional 500 MHz of spectrum for commercial broadband use. The June 2010 Presidential Memorandum emphasized that "America's future competitiveness and global technology leadership depend, in part, upon the availability of additional spectrum,"[4] and it tasked the National Telecommunications and Information Administration ("NTIA") to work with the FCC to identify spectrum for commercial use.

In the intervening years, the Administration, Congress, and the FCC have all demonstrated tremendous focus on the need to free more spectrum for commercial use. Congress adopted the legislation necessary to conduct incentive auctions[5] and continues to look for novel ways to free federal spectrum for commercial use.[6] The Administration is working with the Department of Defense and other agencies to clear 65 MHz of spectrum for commercial use.[7] The FCC will auction that spectrum this coming fall in the AWS-3 auction, and spectrum cleared through the first broadcast incentive auction by mid-2015.[8]

In the four years since the release of the June 2010 Presidential Memorandum, however, the growth in demand for wireless broadband has not abated. Indeed, it has accelerated to the point where today's mobile traffic is 24 times what it was in 2010 when the Administration first projected the need for an additional 500 MHz of spectrum.[9] The government actions described

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[4] *Id*.

[5] Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. 112-96, §§ 6402, 6403, 126 Stat. 156 (2012) ("2012 Spectrum Act").

[6] *See e.g.,* H.R. 3674, The Federal Spectrum Incentive Act of 2013

[7] Letter from Karl Nebbia, NTIA, to Julius Knapp, FCC, July 22, 2013 ("Nebbia letter").

[8] *See Amendment of the Commission's Rules with Regard to Commercial Operations in the 1605-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Notice of Proposed Rulemaking and Order on Reconsideration, 28 FCC Rcd 11479 (2013) and *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions,* Notice of Proposed Rulemaking, Docket No. 12-268, 27 FCC Rcd 12357 (2012).

[9] *See* Cisco, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2009-2014," 12 (2010), http://tmfassociates.com/blog/wp-content/uploads/2013/02/Cisco-

above are important first steps, but will not meet the future consumer demand for more wireless broadband.

The second Presidential Memorandum released in June 2013 charts important additional steps toward finding more ways to repurpose spectrum for commercial broadband.[10] In particular, it found that "[e]xpanding the availability of spectrum for innovative and flexible commercial uses, including for broadband services, will further promote our Nation's economic development by providing citizens and businesses with greater speed and availability of coverage, encourage further development of cutting-edge wireless technologies, applications, and services, and help reduce usage charges for households and businesses."[11]

To this end, the June 2013 Presidential Memorandum explored ways of bringing much needed wireless spectrum to the consumer marketplace both through federal government-spectrum users being more efficient with their assigned spectrum, as well as government and commercial entities sharing spectrum. It set out a number of tasks and deliverables to improve both our understanding of how the federal government uses its assigned spectrum as well as ways commercial entities can gain access to this spectrum without undermining fundamental federal missions. It created and Executive Branch Spectrum Policy Team and charged it with examining incentives for federal users to use spectrum efficiently and to take into account spectrum efficiency in future spectrum-dependent procurement. The SPT must recommend

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mobile-VNI-Feb-2010.pdf; Cisco, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013–2018," 34 (Feb. 4, 2014), http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.pdf.

[10] Presidential Memorandum, *Expanding America's Leadership in Wireless Innovation*, (June 14, 2013), http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio ("June 2013 Presidential Memorandum").

[11] *Id.*

market-based or other approaches to give agencies greater incentive to share or relinquish spectrum, while protecting agencies' mission capabilities.

OSTP's release of the STPI Report for comment is an important step in implementing the Presidential Memorandum. The STPI Report compiles the major "publicly available analyses and proposal regarding incentives for agencies to share or relinquish spectrum,"[12] which, on its own, is a valuable undertaking. In addition to providing a vehicle for further comment and eventual recommendation on next steps, we believe that the STPI Report is an important launching pad for new work in this area.

Verizon still believes that the best approaches are those that encourage more efficient use and result in clearing spectrum for flexible, exclusive-use licensing. This continues to be an important national policy goal.

As a nation, however, we are embracing multiple options for finding new spectrum resources, including new sharing paradigms. FCC Chairman Tom Wheeler made that point a few weeks ago at the Mobile World Congress when he said, "[o]f course, identifying new 'clean' spectrum will continue to be important, but we are living in a new era of sharing with respect to licensed spectrum uses."[13] Reallocation is an increasing challenge, and in some cases the best solution involves some form of geographic or temporal sharing.

Verizon is fully committed to working with the federal government to find ways for commercial and federal users to share spectrum. In 2012 Verizon Chairman and CEO Lowell McAdam spoke at a Defense Information Systems Agency conference and pledged Verizon

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[12] RFI, 79 Fed. Reg. at 9289.

[13] Prepared Remarks of FCC Chairman Tom Wheeler, GSMA Mobile World Congress, Barcelona, Spain (Feb. 24, 2014), http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0224/DOC-325751A1.pdf.

manpower and $5 million to explore workable methods of sharing spectrum with certain Federal users. As he said then, "[g]overnment and industry must work together to find ways to use spectrum more efficiently so that we are all truly connected, especially in times of need," [14]

Over the past two years, Verizon Wireless has invested considerable resources in the work of the Commerce Spectrum Management Advisory Committee (CSMAC), as well as other efforts to study how sharing in certain bands of spectrum might take place. Verizon has been working closely with government and other stakeholders to examine sharing and ways to repurpose the 1755-1850 MHz and 1695-1710 MHz bands.[15] In particular, we worked closely with DoD on its "roadmap" for making 1755-1850 MHz available for commercial broadband use.[16] We are committed to this ongoing work with the Administration, Congress and other stakeholders in the wireless market.

As the Report observes, the Administration already has certain tools it can use to encourage more efficient use of spectrum that could ultimately lead to more available spectrum. For example, OMB Circular No. A-11, revised pursuant to the Spectrum Act of 2012, requires agencies to consider the economic value of the spectrum being used in their procurement budget

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[14] "Verizon's McAdam, in Keynote Address, Advocates for Shared Spectrum by Public and Private Sectors,"(2012) http://newscenter2.verizon.com/press-releases/verizon/2012/verizons-mcadam-in-keynote.html.

[15] In addition, Verizon recently supported economic work that explores the impact of sharing on the economic value of spectrum and also posits basing a fee on the "commercial value of spectrum would require that federal users at least acknowledge this opportunity cost of the spectrum use and publically argue that the value of their use of the spectrum exceeds this opportunity cost." *See* Coleman Bazelon and Giulia McHenry, *Spectrum Sharing: Taxonomy and Economics*, p. v (Feb. 6, 2014), http://www.brattle.com/system/news/pdf2s/000/000/617/original/Spectrum_Sharing_-_Taxonomy_and_Economics_Full_Report.pdf?1391695199.

[16] Nebbia Letter, Enclosure 1.

justifications.[17] The potential outcome of implementing OMB Circular No. A-11 is that spectrum would be treated like any other resource. This, in combination with DoD's goal to "exploit technology advances to access less-used spectrum and seek to use commercial services and technologies to meet DoD requirements where possible"[18] could prove a powerful way to free up more spectrum for commercial uses.

We commend the Administration for laying out a path that will help bring more spectrum to consumers of wireless services, where it will allow the U.S. to maintain its global leadership position in wireless innovation. We look forward to continuing to work with the Administration on this important issue.

Respectfully submitted,

By: /s/ Charla M. Rath

VERIZON

March 20, 2014

[17] *See* Office of Management and Budget, Circular No. A-11: Preparation, Submission, and Execution of the Budget, § 31-12 (Aug. 2012) ("OMB Circular No. A-11").

[18] Department of Defense, *Electromagnetic Spectrum Strategy 2013: A Call to Action* (2013), http://www.defense.gov/news/dodspectrumstrategy.pdf.

Spectrum Sharing

Taxonomy and Economics

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THE Brattle GROUP

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Executive Summary

As demand for more complex wireless technologies increases, so does the demand for spectrum suitable for wireless broadband services. This is true for both government and commercial users. On the commercial side, Cisco famously predicted that U.S. mobile data traffic will grow 9-fold between 2012 and 2017. On the federal side, users have over 240,000 frequency assignments and their needs are increasing. Sharing between federal and commercial users will be a key component of the strategy to meet growing demands for spectrum.

Allocating shared spectrum "efficiently," however, requires balancing competing demands to assign the spectrum use rights to the user(s) who value(s) them most. In principle, when managing the trade-offs from competing demands, efficient spectrum management policy should seek to maximize total social and economic value of spectrum, subject to the priorities set by policymakers. When applied to spectrum sharing proposals, these principles of efficient spectrum allocation lead to two findings. First, spectrum sharing should only be implemented if the foregone value to the primary user from sharing is less than the added value to the secondary user(s). Second, spectrum sharing is efficient when the cumulative value to all users is higher than the potential value to a single user.

The economic value of spectrum today is simply the present value of the cumulative future profits that can be earned using the resource. When spectrum is shared amongst multiple users, this cumulative profit includes the total profits for all services deployed on the spectrum (including the value created by public uses.) The profits from a band of spectrum are the net revenues, or revenues less investment and operating costs, of deploying the spectrum band. For each user, the derived value of spectrum is based on the additional value, or net profit for commercial users, that spectrum adds to a particular spectrum based service. The value of a band of spectrum, then, is related to the value created by all users.

Since the value of spectrum is defined by the profitability of the spectrum based services deployed, any factor that impacts the residual profits of using a band of spectrum will impact the value of that band. This includes restrictions to use rights that reduce potential ***revenues*** from service, increase the ***costs*** of deployment, or create added ***uncertainty*** about the potential for realizing future profits. The effect from sharing on each of these factors is likely to diminish the profitability, and hence value, of a band a band of spectrum.

There are several different types of spectrum sharing currently proposed or in use.

- Under ***geographic sharing***, a given spectrum user's transmissions are limited to a predefined service area. Several proposals are already being considered for geographic sharing arrangements between federal and commercial users in the 1695-1710 MHz band and the 1755-1850 MHz band.

- Another commonly considered type of sharing is ***temporal sharing***. In this case, two or more users would share access to the same band of spectrum in the same geographic area, but at different times. Such arrangements can be divided into two major categories: predictable and random. Under a ***predictable temporal sharing*** regime, one user agrees not to transmit during particular pre-defined times to accommodate the other user's services. The impact of predictable sharing on the value to a given user depends, in part, on the timing, frequency and certainty of when interruptions might occur. ***Unpredictable or random temporal sharing*** occurs when the secondary user may have to stop using the specific spectrum on short notice or without warning. This type of sharing was initially proposed for the 700 MHz D Block. Typically, the greater the sharing obligations and the less predictable they are, the greater the diminution in value for the user(s) that have to accommodate or yield in their use to allow the sharing.

- ***Coordinated sharing*** refers to sharing arrangements where two or more users are using the same band of spectrum in the same geographic area at the same time. To prevent harmful interference, users' devices must detect what other devices are operating in the same geographic area and on the same frequencies, and then respond accordingly. The two potential mechanisms for coordination are databases and cognitive radios. Cognitive radio networks or devices automatically detect devices in its vicinity and coordinate usage in response. Alternatively, spectrum databases register their location and devices, and then identify which spectrum is available for use. This is the approach already in use for unlicensed devices operating in the television bands.

- ***Uncoordinated Rule-Based sharing*** refers to situations where rules of use are designed to prevent harmful interference. Uncoordinated sharing typically occurs over unlicensed spectrum in which devices that meet a particular set of criteria are allowed to transmit over the spectrum. This approach is typically employed for low power devices, such as baby monitors and wireless microphones, WiFi, and radio astronomy.

We numerically illustrate the impact of sharing on spectrum value through a series of examples, both hypothetical and grounded in CSMAC recommendations. For example, geographic exclusion areas would reduce the potential value of a band. We show that for the 1695 MHz – 1710 MHz band, excluding 12% of the population in the currently proposed exclusion zones could reduce the value of the band by 16%, but relocating some of the exclusion zones from urban to rural areas would only reduce the value of the band by 7%. This option increases total value so long as the cost of relocating the exclusion zones is less than the value created. As an alternative to exclusion zones, it may be possible to use additional filters on base stations. We illustrate this impact of increased cost on spectrum value by modeling a 20% capital cost increase for 15% of the network impacted by exclusion zones. In this case, that added cost reduces the value of the spectrum by 11%, an option that preserves more value than the 16% loss associated with the currently proposed exclusion zones, but potentially less (depending on the relocation costs) than the 7% loss when the exclusion zones are relocated to less populated areas. In a separate, illustrative, analysis we show how increased uncertainty in the form of a 1% increase in the firm's cost of capital can reduce the value of a band of spectrum by 29%.

It is widely accepted that until Federal users internalize the costs associated with their spectrum use, they have little incentive to use spectrum more efficiently or support proposals to share their spectrum. If federal users paid for spectrums use, they would internalize the cost associated with holding spectrum assignments that prevent other productive uses of the frequencies. Recognizing the costs of spectrum through a federal fee would incentivize federal users to adjust their usage to reduce costs. While there are limitations to a fee-based approach, it would require government users to incur some cost for spectrum usage. By imposing a spectrum based fee, the cost of spectrum based services for federal users will reflect the use of this scarce resource. The question is: *what should the fee be tied to?* Consistent with the principle that government spectrum users should consider the forgone economic value of spectrum deployed for their services, we suggest that a federal user fee should be based on the commercial value of spectrum. By tying the fee for federal spectrum to spectrum's commercial price, federal users would be incurring the foregone economic value or opportunity cost of the spectrum in deploying these federal services. A fee based on the commercial value of spectrum would require that federal users at least acknowledge this opportunity cost of the spectrum use and publically argue that the value of their use of the spectrum exceeds this opportunity cost.

I. Introduction

As demand for more complex wireless technologies increases, so does the demand for spectrum suitable for wireless broadband and WiFi services. This is true for both government and commercial users. In 2013, Cisco predicted that U.S. mobile data traffic will grow 9-fold between 2012 and 2017.[1] Consumers are using their mobile devices more than ever. According to a recent study, in 2013, the average American spent 2 hours and 21 minutes per day on mobile devices using non-voice mobile activities, up from only 24 minutes in 2010.[2] This demand is likely to continue rising.

Demand for Federal allocations continues to expand as well. As of September 2012, federal users had over 240,000 frequency assignments[3] and their needs are increasing.[4] Superstorm Sandy and the Mid-Atlantic Derecho only reinforced the need for accurate satellite weather tracking and hardened wireless infrastructure that can sustain the force of brutal storms. Even before the

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1 *See*, Cisco, "VNI Mobile Forecast Highlights, 2012 – 2017: United States – 2017 Forecast Highlights," at: http://www.cisco.com/web/solutions/sp/vni/vni_mobile_forecast_highlight/index.html#~Country (last visited 6 Aug. 2013).

2 Of this time in 2013, 47.5% was spent on a smartphone, 44.8% was spent on a tablet, and 7.7% was spent on a feature phone. In 2010, 41.5% of the time was spent on a smartphone, 4.3% was spent on a tablet, and 54.3% was spent on a feature phone. *See*, "Digital Set to Surpass TV in Time Spent with US Media," *eMarketer*, 1 Aug. 2013, available at: http://www.emarketer.com/Article/Digital-Set-Surpass-TV-Time-Spent-with-US-Media/1010096 (last visited 12 Aug. 2013). *See also*, Alex Colon, "Pretty soon we'll all be watching tablets instead of televisions," *Gigaom*, 2 Aug. 2013, available at: http://gigaom.com/2013/08/02/pretty-soon-well-all-be-watching-tablets-instead-of-televisions/ (last visited 12 Aug. 2013).

3 *See*, GAO, "Spectrum Management, Incentives, Opportunities, and Testing Needed to Enhance Spectrum Sharing," *GAO-13-7*, November 2012, (herein, "GAO 13-7 Spectrum Sharing), at page 5.

4 *See*, 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 "Equipping Carriers and Agencies in the Wireless Era," 27 June 2013, (herein, "Nebbia, 2013"), available at: http://www.ntia.doc.gov/speechtestimony/2013/testimony-associate-administrator-nebbia-hearing-equipping-carriers-and-agencie (last visited 12 Aug. 2013).

nationwide interoperable public safety network is built, local public safety groups foresee a growing need for video surveillance and mobile wireless video support for rapid response.[5]

Spectrum sharing between federal and commercial users will be a key component of the strategy to meet these growing demands. All else equal, any spectrum user would prefer exclusive use of spectrum. However, as the value of spectrum increases, creating or keeping a band of spectrum dedicated to a single user is increasingly costly. Consequently, both incumbent users who want to maintain their existing assignments and new users looking for available frequencies will, by necessity, need to seriously consider sharing an allocation of spectrum.

In considering spectrum sharing opportunities, however, it is important to assess if a given sharing proposal improves the overall management of radio spectrum. That is, if the value sacrificed by a single user is worth the benefits of allowing multiple users access to the spectrum. Some sharing proposals will leave all users worse off and such proposals should be rejected. Between commercial users, where sharing would be valuable, we generally expect the parties to make efficient agreements. With respect to sharing between commercial and federal users, however, they have divergent incentives. In such cases, spectrum managers must decide the appropriate allocation.

This paper focuses on how to evaluate efficient sharing between federal and non-federal users. We recognize, however, that the issue of sharing—and the analytic framework developed herein—is broader than federal and non-federal users. We set out an analytic framework for evaluating when spectrum sharing proposals improve welfare, and when they do not. We illustrate our proposed approach by evaluating the potential impact on value from the spectrum sharing recommendations made by the Commerce Spectrum Management Advisory Committee ("CSMAC") for the 1690 MHz – 1710 MHz and 1755 MHz – 1850 MHz bands.

To motivate the efficient use of federal spectrum, policymakers are now calling for incentives for federal users. One proposal has been a fee based assignment for federal users. The question is: *what should the fee be tied to?* We suggest that the fee should be based on the value of spectrum for commercial users. This approach ensures that government spectrum users consider the

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[5] *See*, Michael Catalano, Spectrum Supply and Demand, Washington Post Live, 18 June 2013, remarks, webcast available at http://www.washingtonpost.com/postlive/conferences/spectrum (last visited 2 Sept. 2013).

forgone economic value of spectrum deployed for their services. As part of a fee based approach, however, federal users must be assured that they will be able to acquire spectrum assignments when they have a justifiable need. Otherwise, they may not have an incentive to relinquish unused spectrum, regardless of spectrum based fees.

II. Economic Factors Critical to Spectrum Sharing

To understand the effect of sharing on spectrum value, we start by looking at the economic factors critical to spectrum sharing. The spectrum sharing arrangement determines how a band of spectrum can be deployed by two or more users. Such division of use rights only improves the efficiency of spectrum use overall if the total value from sharing exceeds the value from an exclusive user.

A. Spectrum Sharing Policies

Now, more than ever, spectrum is a truly scarce national resource that must be allocated, or reallocated, as efficiently as possible to further our national interests. Some of these interests include growing the national economy, improving access to educational resources, supporting local public safety, and strengthening national security and defense.[6] However, achieving this myriad of goals is particularly challenging when it requires balancing a number of conflicting interests. Several spectrum blocks have been identified as lynchpins in the National Broadband Plan's (NBP's) goal of repurposing 500 MHz of spectrum to commercial use, including:[7]

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[6] *See*, The White House Office of the Press Secretary, *Presidential Memorandum – Expanding America's Leadership in Wireless Innovation*, 14 June 2013, (herein, "Presidential Memorandum, 2013"), available at: http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio (last visited 11 Aug. 2013). *See also*, Nebbia, 2013, at section 2.

[7] These bands have been identified in the Job Creation Act, in the NBP, by NTIA, and in various FCC regulatory proceedings. *See*, H.R. 3630, "Middle Class Tax Relief and Job Creation Act," 22 Feb. 2012, Section VI, Subtitle D; National Broadband Plan, Chapter 5, available at http://www.broadband.gov/plan/5-spectrum/ (last visited 2 Sept. 2013). *See also,* FCC Notice of Proposed Rulemaking and Order, GN Docket 12-354, 12 Dec. 2012 (herein, "NPRM 3.5 GHz"); FCC Notice of Proposed Rulemaking, ET Docket 13-49, 20 Feb. 2013 (herein, "NPRM 5 GHz"); FCC Notice of Proposed Rulemaking and Order on Reconsideration, GN Docket 13-185, 23 July 2013 (herein, "NPRM 1.7 GHz").

- 1695-1710 MHz band;
- 1755-1850 MHz band;
- 3550-3650 MHz band; and
- 5350-5470 MHz and 5850-5925 MHz bands.

At the same time, existing federal users have ongoing—and sometimes expanding—needs for wireless services as well as costs associated with moving to alternative bands. In many cases, federal users who relinquish spectrum must continue providing the same missions, either through alternative technology or new assignments. Moving federal assignments, however, may be costly and time consuming. A 2012 NTIA report found that moving Federal users out of the 1755-1850 MHz band would cost approximately $18 billion and take 10 years.[8] Similarly, the NTIA Fast Track Report found that the 1695-1710 MHz band could be largely cleared, with the exception of exclusion zones around NOAA weather satellite receiver base stations.[9] Where clearing spectrum outright is not feasible, policymakers are looking to sharing as a solution.

Spectrum sharing, which can be defined as the "cooperative use of common spectrum" for disparate uses, is not a new concept.[10] Until recently, however, spectrum sharing was generally confined to private license holders, federal or other governmental users, or unlicensed users, rather than across these types of users. Cooperative sharing among a group of (usually similar) users is generally easier to achieve through existing mechanisms. For instance, sharing between commercial or other private licensed users is either built into the allocation by the FCC—say, through geographic sharing that results from different licensees being assigned different sub-national licenses—or negotiated on a contractual basis between parties. Federal spectrum assignments are acquired through an application and review process. Spectrum sharing between federal assignment holders is then based on mission, need, and ability to coexist. Sharing between different types of users, however, creates a more complicated cooperation problem,

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8 *See,* NTIA, "An Assessment of the Viability of Accommodating Wireless Broadband in the 1755–1850 MHz Band," March 2012, page iii.

9 *See,* 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," October 2010, (herein, "NTIA Fast Track Report").

10 *See*, GAO 13-7 Spectrum Sharing, at page 7. Some scholars—such as Thomas Hazlett—note that even exclusively licensed spectrum is shared with the users of the network. However, for the purposes of this paper, we distinguish between sharing between users and sharing between spectrum assignees and/or licensees.

because the actual uses of the spectrum are likely to be different. This creates more potential scenarios for users to interfere with each other, as the parties' incentives are not unified.

B. Challenges of Spectrum Sharing

In light of the demands and the challenges of relocating existing users, commercial/Federal spectrum sharing was initially proposed as a compromise to open bands to commercial users without uprooting federal users. The July 2012 President's Council of Advisors on Science and Technology ("PCAST") Report presented sharing as a superhighway of diverse users cooperatively using the same radio waves.[11] To begin work on implementation, CSMAC was tasked with evaluating the potential for sharing in these targeted bands between commercial and Federal users.

It is important to recognize, however, that spectrum sharing between different types of users creates several unique hurdles. First, spectrum sharing limits the value of spectrum to individual users and, thereby, has the potential to reduce the cumulative value of spectrum to all users. Second, divergent motivations, lack of unifying incentives to share, and security concerns are likely to make negotiating between Federal and commercial uses time consuming and difficult.[12]

Sharing necessarily limits how users can use spectrum, and thereby limits the value of spectrum for individual users. Spectrum use rights can be defined in many dimensions—geography, time, direction, etc.[13]—but the specific definition or rights is not key here. Rather, for sharing, what is important is that such use rights can be disaggregated. The economic value of a spectrum license for a license holder is equal to the NPV of future profits from deploying spectrum based services.[14] This value depends critically on what a user can do with a license or assignment. Limiting uses restricts what an individual user can do with the spectrum. By separating what

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11 *See*, PCAST, "Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth," Report to the President, July 2012, Executive Summary page vii.

12 *See*, for example, the concerns raised in CSMAC Meetings, and Separate Statements of Working Group Members, Harold Furtchgott Roth, and Janice Obuchowski, each released 19 August 2013, available at: http://www.ntia.doc.gov/category/csmac (last visited 2 Sept. 2013).

13 *See,* for example, Robert Matheson and Adele C. Morris, "The technical basis for spectrum rights: Policies to enhance market efficiency," Brookings Institution, March 3, 2011, page 8.

14 *See*, Coleman Bazelon and Giulia McHenry, "Spectrum Value," *Journal of Telecommunications Policy*, forthcoming, (herein, "Bazelon and McHenry (2013)").

users can do, or when they can do it, spectrum sharing limits the potential use and economic value for the commercial license holder or welfare created by a non-commercial user.

Successful spectrum sharing depends critically on assigning the use rights for each user to ensure that they can use the spectrum effectively to provide a valuable service. Moreover, depending on how the use rights are allocated, spectrum sharing may reduce the cumulative value of the spectrum for all users.

C. Framework for Spectrum Sharing Decisions

Allocating shared spectrum "efficiently" requires balancing competing demands to assign the spectrum use rights to the user(s) who value(s) them most. Spectrum managers must take into account all of the legitimate demands for spectrum from government, commercial, and other non-commercial users. These include public safety, military protection, promoting education and scientific research, and spurring economic growth and prosperity in the private sector.

In principle, when managing the trade-offs from competing demands, efficient spectrum management policy should seek to maximize total social and economic value of spectrum, subject to the priorities set by policymakers. There are at least two types of value that may be created by spectrum based services for policymakers to consider: economic value driven by the potential profits from deploying the spectrum, and social value created by the non-commercial spectrum based applications. Both of these types of value should be considered when making spectrum allocation decisions.

Nevertheless, there is often an inherent tradeoff between economic efficiency and other public policy objectives. Economic efficiency maximizes the contribution of spectrum to creating economic value and consumer welfare from commercial services. As described below, the economic value of spectrum is derived from the expected profits of services deployed on that spectrum. Maximizing the economic value of spectrum is essentially equivalent to maximizing the potential profits derived from the spectrum. To align with public policy objectives, policy makers must impose binding constraints on commercial users, thereby reducing the economic value of spectrum. However, restrictions on the use of spectrum limit the potential profits available to a given user. At the extreme, exclusive use of a spectrum band for government uses implies that no private economic value will be directly derived from that band. Below that extreme, any restrictions that limit the use of spectrum are liable to diminish its value.

The social welfare from non-economic public policy goals is also difficult to quantify in economic terms. We know what a tank costs, but it is difficult to articulate the monetary value a tank contributes to our national defense. In the absence of a useful metric for quantifying social welfare from policy goals, an alternative approach is to assess the forgone economic value from deviating from the economic value maximizing spectrum allocation. A policy that deviates from the economically efficient spectrum allocation is only worth pursuing if the benefits are expected to outweigh the foregone value. While this does not strictly maximize the return on social policies, it does ensure that such policies are only undertaken when they are believed to be at least as valuable as efficient commercial allocations.

This also implies that policymakers should endeavor to maximize economic efficiency, because it creates the most economic value. This efficiency should only be sacrificed for explicit policy objectives that are considered more socially valuable than the forgone value of using the spectrum efficiently. Based on these principles, it is crucial to know the costs and forgone opportunity associated with any allocation policy when trying to achieve efficient spectrum management, or evaluate proposed departures from efficient uses of spectrum.

These principles of efficient spectrum allocation should apply when evaluating spectrum sharing proposals, because any specific proposal inevitably balances the value and requirements between two or more competing users. First, spectrum sharing should only be implemented if the foregone value to the primary user from sharing is less than the added value to the secondary user(s). Second, spectrum sharing is efficient when the cumulative value to all users is higher than the potential value to a single user. In a commercial world, economists believe that the price mechanism generally achieves efficient allocations, even in the context of sharing. A commercial license holder is only willing to sell the partial rights to the spectrum license if she values that portion of the spectrum less than what another user is willing to pay for those rights. With respect to non-commercial allocations, even if we cannot value the benefit of a particular non-commercial use of spectrum, policy makers should consider and evaluate the foregone commercial value from its use.

III. Taxonomy of Spectrum Sharing

There are several different types of spectrum sharing currently proposed or in use. Below we categorize four broad types of sharing, and offer some current or proposed examples of each type.

The four categories of spectrum sharing are: geographic, temporal, coordinated, and uncoordinated rule-based. In addition to the types of sharing, the extent of sharing and compatibility of users is also key to evaluating the impact of a specific sharing arrangement on spectrum value.

A. Geographic Sharing

Under geographic sharing, a given spectrum user's transmissions are limited to a predefined service area. As discussed below, several proposals are already being considered for such an arrangement between federal and commercial users in the 1695-1710 MHz band and the 1755-1780 MHz band.[15] In fact, geographic sharing is already commonly used in the commercial and federal spectrum bands. FCC licenses are mostly divided regionally, resulting in individual users having transmission rights in different geographic areas of the U.S. In these cases, the FCC has concluded that the loss in value from not issuing a single national license is worth the added flexibility in allowing regional differences in license holders.

B. Temporal Sharing, Predictable and Random

Another commonly considered type of sharing is temporal sharing. In this case, two users would share access to the same band of spectrum in the same geographic area, but at different times. There are several ways in which a temporal sharing arrangement might be constructed.[16] Such arrangements can be divided into two major categories: predictable and random. Under a predictable temporal sharing regime, one user agrees not to transmit during particular pre-defined times to accommodate the other user's services. Such sharing might vary by frequency and regularity.

The impact of predictable sharing on the value to a given user depends, in part, on the timing, frequency and certainty of when interruptions might occur. For instance, AM radio spectrum is shared between daytime and dominant 24-hour broadcasters. Many of the daytime broadcasters are required to reduce or turn off their service at night, allowing the dominant 24-hour station to

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15 *See*, NPRM 1.7 GHz, paragraphs 53 through 76.

16 For instance, one user may be considered a priority user who essentially dictates when they plan to use the spectrum, there may be a preset contract stipulating usage, users may negotiate a time allocation, or users may set up a mechanism to pay for time.

broadcast to a larger footprint as its nighttime propagation widened its footprint.[17] Alternatively, a general user might have access to a band of spectrum, except when it is needed during rocket launches. To the extent that the timing of predictable sharing can also be negotiated, to occur at times that are acceptable to both parties, the value lost may be even lower.

Unpredictable or random sharing occurs when the secondary user may have to stop using the specific spectrum on short notice or without warning. This type of sharing was initially proposed for the 700 MHz D Block. Typically, the greater the duration and less predictable the sharing obligations, the greater the diminution in value for the secondary user(s).

C. Coordinated Sharing

Coordinated sharing refers to sharing arrangements where two or more users are using the same band of spectrum in the same geographic area at the same time. To prevent harmful interference, coordinated sharing requires that users detect what devices are operating in the same geographic area and on the same frequencies, and then respond accordingly. The two potential mechanisms for coordination are databases and cognitive radios.

Coordinated sharing prevents harmful interference through the use of intelligent radio networks or devices. Depending on the technology, cognitive networks or handsets are designed to detect the presence of other potentially interfering devices and decide whether or not it can operate. These devices may also be able to search for alternative frequencies that would be available for transmission. These technologies are still developing, however, and are not widely available for commercial deployments. An alternative is a spectrum database in which users register their location and devices, and can then identify which spectrum is available for use. This is the approach developed to share the television bands with unlicensed devices.

D. Uncoordinated Rule-Based Sharing

Uncoordinated Rule-Based sharing refers to situations where rules of use are designed to prevent harmful interference. Uncoordinated sharing typically occurs over unlicensed spectrum in

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[17] *See*, http://www.fcc.gov/encyclopedia/why-am-radio-stations-must-reduce-power-change-operations-or-cease-broadcasting-night (last visited 17 December 2013).

which devices that meet a particular set of criteria are allowed to transmit over the spectrum.[18] Since this type of sharing is rule-based, as long as all users follow the rules for the band, unlike in the case of cognitive sharing, there is no further need for coordination among the users. Examples of this type of sharing include low power devices, such as baby monitors and wireless microphones, WiFi, and even radio astronomy.

IV. Drivers of Spectrum's Economic Value

In order to understand the inherent tradeoffs and forgone economic value for a public policy goal, it is necessary to understand what drives the economic value of spectrum. Spectrum is not a store of value; rather, it is an input into the production of valued services. A clear understanding of these principles will illuminate how particular sharing arrangements are likely to impact spectrum value.

A. Value of Spectrum is the Cumulative Value of Services Deployed

Similar to all scarce resources, the value of spectrum is determined by the economic value generated by its deployment. For assets that are in limited supply, this concept is typically understood as economic rent, or net profitability attributable to the scarce asset. Since spectrum is in fixed supply, it is a limiting factor in the production of wireless services. That is, less spectrum results in less, or higher cost, wireless service; more spectrum results in more, or lower cost, services. Since spectrum availability limits the availability of wireless services, much of the value created from the wireless services is attributed to the spectrum itself. This effect is similar to how a coffee shop on a busy corner gets more business than if it was on a side street, but will also pay for these extra sales in higher rents. The additional sales are due to the location, which then justifies higher rents. Likewise, differences in the potential profits of various spectrum bands imply differences in the value of those bands. When rules on the use of spectrum alter the potential profitability from its use, the value of the spectrum will change accordingly.

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[18] Unlicensed refers to the type of allocation, whereas the low power limits and other rules are how the unlicensed bands mitigate harmful interference. Similar mitigation techniques, however, can also be deployed on licensed bands. *See*, Thomas Hazlett and Coleman Bazelon, "Market Allocation of Radio Spectrum," ITU Workshop on Market Mechanisms for Spectrum Management, Geneva, January 2007.

The economic value of spectrum today is simply the present value of the cumulative future profits that can be earned using the resource. When spectrum is shared amongst multiple users, this cumulative profit includes the total profits for all services deployed on the spectrum. For each user, the derived value of spectrum is based on the additional value, or net profit, that spectrum adds to a particular spectrum based service. The value of a band of spectrum, then, is related to the profits that can be made from using it.

These profits are derived from the net revenues, or revenues less investment and operating costs, of deploying the spectrum band. Deploying a band of spectrum for any service requires both permission to use the spectrum and capital expenditures for the infrastructure necessary to transmit services. What a network operator can pay to secure the spectrum rights to licensed spectrum is determined by the profits from service, net of the capital and operating costs of the specific spectrum band. Each operator cannot pay more than the value of those profits (or the operator would lose money on the venture). However, the operator is also unlikely to pay much less for licensed spectrum, otherwise a competing operator would be willing to pay more for access to the same spectrum rights. Similarly, the operator will forgo the spectrum if it can identify a more profitable, or less costly, alternative way to provide the same service without the spectrum asset. For instance, a wireless broadband provider might invest in additional capital to re-farm its existing spectrum holdings rather than acquire access to new frequencies. Therefore, the value of a given spectrum license is limited by the profits that can be made with its use, which are, in turn, limited by the profits from alternative ways to provide the same service.

Since offering spectrum based services typically requires substantial upfront investments in infrastructure and compatible technology, the time dimension is important. Consequently, the value of a spectrum license must be based on the net present value (NPV) of future profits. This value is driven by more than the profits earned in the next year or two. As with any capital investment, the net return of investing in a band of spectrum will be realized over time. The value of the investment and expected stream of profits depends critically on the timing of this stream of returns. The NPV of a capital investment represents the cash value today of the expected stream of net returns (revenues minus costs) that an investment is expected to yield over its lifetime. The NPV accounts for the interest that investment would have otherwise accrued over the investment period, and the future uncertainty of a particular use. The present value of any investment by user i is equal to the sum of the present value of each annual net return or cash flow, $\left(R_t - C_t\right)$, discounted by the rate of return (r_t) for that year:

$$NPV_i = \sum_{t=0}^{\infty} \frac{R_{it} - C_{it}}{(1+r_t)^t} \quad (1)$$

With respect to shared spectrum, the cumulative economic value of the band is equal to the sum of all future expected net profits for all users:

$$NPV = \sum_{i=1}^{n} \sum_{t=0}^{\infty} \frac{R_{it} - C_{it}}{(1+r_t)^t} \quad (2)$$

B. Changes in Residual Profit Drive Changes in Spectrum Value

Since the value of spectrum is defined by the profitability of the spectrum based services deployed, any factor that impacts the residual profits of using a band of spectrum will impact the value of that band. This includes restrictions to use rights that reduce potential revenues from service, increase the costs of deployment, or create added uncertainty about the potential for realizing future profits. Each of these factors is likely to diminish the profitability of a band.

To the extent that the profitability of spectrum based services vary, so too will the value of spectrum that make those services possible. Geographic areas with dense populations where spectrum services are heavily used are more valuable than less populated areas where demand for services is lower. Although more difficult to observe, temporal differences in value are driven by the peak or off-peak hours of use.

V. The Impact of Sharing on Spectrum Value

In this section we apply the taxonomy in Section III and principles from Section IV to discuss how sharing will likely impact the value of spectrum to a single user and the cumulative value to all users. Below we review the potential types of sharing, and describe the key impacts on value for each.

A. When Sharing Restricts How One User Would Otherwise Use a Band of Spectrum it Reduces the Profits for that User

In essence, spectrum sharing necessarily creates costs and restricts revenues, compared to exclusive use of the same band. Sharing may restrict what, when or where services,

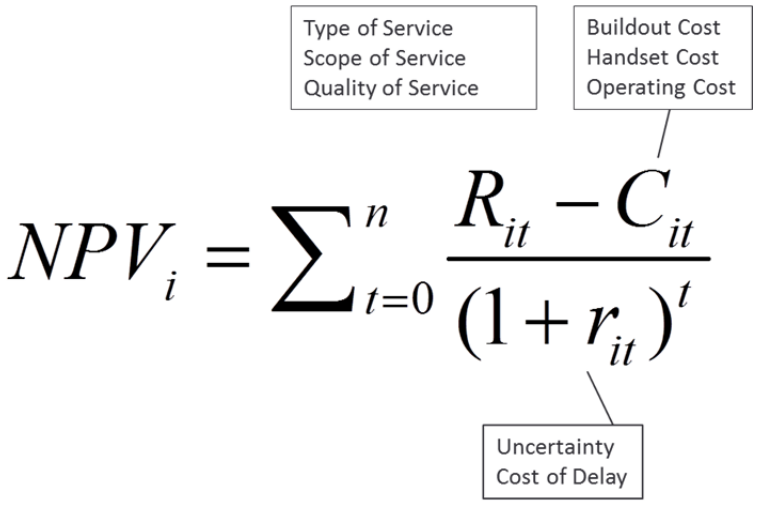
infrastructure, or capital are deployed. For instance, if spectrum sharing requires more complex technology, such as cognitive radios, the added cost and uncertainty of developing and deploying those technologies will limit profitability compared to using a band that did not require such added costs. To the extent that sharing limits the type or quality of allowable services—for instance by intermittently interrupting service—it curbs the potential revenues from services.

Sharing involves trade-offs. Allowing a new user into a band will likely diminish what the existing user can do. Consequently, the lost value to an individual user should be part of the consideration for evaluating whether sharing spectrum is efficient. Never the less, sharing may still be less costly or more socially and economically valuable than moving existing users. This depends on whether the gains to those who benefit by the partial use of the spectrum are greater than the losses to those who would otherwise have exclusive access to the band.

To understand the impact of sharing on spectrum value, consider equation (1) above. The profitability of a spectrum band depends on the revenues, costs, and discount rate associated with that spectrum.[19] Figure 1 summarizes the types of factors that are likely to affect each of these components of spectrum value. For instance, revenues typically depend on the factors related to the wireless service provided, including the type of service, its quality and scope. Sharing, in turn, may alter any one of these factors, thereby reducing the total profitability of the service. Similarly, sharing may increase the cost of deployment, or uncertainty. Below we explore each of these sets of factors in more detail.

[19] Note that increases and decreases in value are not simply about costs. Restrictions that affect revenues (or the missions for public sector users) also impact value. Assessing the forgone revenue of sharing is essential to understanding the costs and benefits of a shared band.

Figure 1. Components of Spectrum Value



1. Sharing may decrease revenues by restricting use

Since revenues flow directly from the potential services deployed, revenues from shared spectrum will decrease with a change in the types of deployable services. The extent to which sharing might alter revenues depends on whether allowable services are impacted. At one extreme, sharing a band may require a license holder to change the type of service they provide. For instance, while it may be possible to deploy an exclusive use band for wireless broadband services, sharing that same band may reduce the potential services to intermittent unlicensed devices only. One example of this would be the TV Broadcast spectrum band, which could be repurposed for exclusive wireless broadband use. As a secondary user to TV Broadcasters, however, deploying broadband is limited to white spaces, which in the current environment implies relatively limited spectrum availability and lower revenue expectations as a result.

Even if sharing does not alter the type of wireless service, it is likely to reduce the expected revenues from service and resulting value of the band. Moreover, this reduction in value is likely to be *increasing* relative to the extent of sharing; more sharing results in even greater discounts to the value relative to the proportion of spectrum shared. Setting aside the impact on the type of service discussed above, spectrum sharing is likely to have two effects on revenue even when the same type of service is deployed. First, a smaller *scope* of services will reduce revenues in proportion to the diminution in service. Second, any decreased *quality* of services will further

reduce revenue. While the first factor should decrease revenues relative to forgone service, the second factor decreases revenues for the remaining services network-wide.

All else equal, when sharing restricts the scope of services deployed, it reduces the value associated with the use right that has been carved out. This reduction in revenue is generally proportional to the value of the restricted service. For instance, if sharing limits services in an area that comprises 30% of the revenues from a nationwide license, revenues will be lost for 30% of the market. A similar effect would occur if sharing limited service hours, or capacity. The reduction in revenues is proportional to the value driven by that portion of the market forgone. This suggests that limiting daytime service in top markets will have a greater impact on revenue than restricting service in the middle of the night or remote locations.

In addition to restricting scope of service, sharing can reduce the *quality* of spectrum based services, resulting in diminished revenues and profit margins for the services deployed. This reduction in quality is a critical component of the loss in value from shared spectrum. For example, temporary interruptions in service caused by temporal sharing are likely to reduce the quality of wireless broadband services. Likewise, if geographic exclusion zones result in limited access to services in certain areas, this would reduce the quality of service. In fact, empirical evidence from auction receipts and academic research suggests that there is a premium for larger contiguous spectrum holdings.[20]

Once these two factors are combined, the impact on the value of the band is likely to be proportionally greater than the value captured by the excluded area. Tables 1 and 2 present

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[20] For instance, De Vries and Chan (2010) found that the price of spectrum in an auction is proportional to (the license population)^1.1. Moreover, they found an aggregation premium of about 13% between regional economic area ("REA") licenses and the substantially smaller economic area ("EA") licenses. (See, J. Pierre de Vries and Cheng-Yu Chan, "Edge License Discounts in Cellular Auctions," Presented at The 38th Research Conference on Communication, Information and Internet Policy (TPRC 2010), 1-3 Oct. 2010, available at http://ssrn.com/abstract=1988429, pages 17-18.) The FCC applied a nationwide spectrum premium of 5% in Nextel spectrum swap. (*See*, FCC, Report and Order, Fifth Report and Order, Fourth Memorandum Opinion and Order, and Order, FCC 04-168, Released 6 Aug. 2004, para. 297.)

Holding a single aggregated license area can be less costly to build, and more reliable roaming network than would be feasible by aggregating a network from disaggregated spectrum holdings.

illustrative examples of the value reduction from geographic and temporal sharing assuming the total value of an exclusive nationwide 10 MHz spectrum block is $3.12 billion.[21]

Geographic. By creating geographic exclusion zones, sharing results in reduced revenues from a smaller coverage area and a discount to the overall revenues because it cannot be a nationwide network. Table 1 illustrates the effect of a geographic exclusion zone that represents 15% of the nationwide coverage on a value weighted basis.[22] Even before a reduction in quality, the value of this band would be 15% lower based on the revised footprint and resulting reduced scope of services. For illustrative purposes, we assume a premium for nationwide coverage of 5%, although it may well be higher.[23] With this assumption, the value to the user of the shared band would be further reduced to $2.5 billion. In total, sharing 15% of the value weighted area, results in a 19% reduction in the value of the band.

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[21] For the ease of our illustrative example, we suppose the value of this band is $1.00 per MHz-Pop and the total population is 312 million. The unit price or value of flexible use or wireless broadband spectrum is typically represented in terms of "MHz-pops," which is equal to the product of the MHz of the spectrum band and the total population covered. The total value is then equal to $1*312 million pops*10 MHz. This price is not based on our assessment of the any spectrum bands.

[22] As discussed above, spectrum value varies regionally and temporally. For instance, the value of spectrum is higher in New York City than most rural areas on both a total value and a MHz-pop basis. For more explanation of value weights and methods for deriving weights, see Bazelon and McHenry (2013).

[23] See footnote 20.

Table 1. Illustrative Example of Geographic Sharing

[A]	MHz		10
[B]	Population		312,000,000
[C]	Spectrum Price	$	1.00
[D]	Nationwide Value	$	3,120,000,000
[E]	Value Weighted Exclusion		15%
[F]	Value Excluded	$	468,000,000
[G]	Value with Nationwide Premium	$	2,652,000,000
[H]	Nationwide Premium		5%
[I]	Shared Spectrum Value	$	2,525,714,286
[J]	Total Discount to Shared Spectrum		19%

Notes and Sources:
The Brattle Group Analysis.
[D]: [A] x [B] x [C].
[F]: [D] x [E].
[G]: [D] - [F].
[I]: [G] / (1 + [H]).
[J]: 1 - ([I] / [D]).

Temporal. With respect to temporal restrictions, there may be even more severe penalties from unpredictable interruptions. While there is less empirical evidence about the effect of temporal interruptions, the experience of the 700 MHz D-Block from FCC Auction 73 suggests that the risk of unpredictable temporal interruptions drastically reduces the value of spectrum.[24] It is very difficult to operate a reliable voice network when it is unclear when the service will work. In such a case, unpredictable service interruptions are likely to drastically limit the potential services and revenues of a band. As the severity of service interruptions and diminished footprints increases, the quality discount is likely to increase.

Table 2 presents an illustrative example of temporal sharing. Suppose temporal sharing requires a one hour, unpredictable service interruption every day. As a result, the band may only be usable for non-voice data services, as opposed to voice and data broadband service. If ARPU for

[24] For more information on the 700 MHz D-Block, see Coleman Bazelon, "Too many goals: Problems with the 700 MHz auction," Information Economics and Policy 21 (2009), pages 115–127.

tablet data-only services is half that of voice and data services,[25] then the potential for service interruptions cuts the value of the band in half, from $3.12 billion to $1.56 billion. We assume the exclusion of an hour of time at midnight is an approximately 2% loss, and the exclusion of an hour of time at noon is a little over a 5% loss.[26] These value weighted exclusion times have the effect of reducing the total value of the interrupted spectrum to 51% and 53% of its original value, respectively. To the extent that losing service at midnight for an hour effects the quality of the service less, the total discount to the shared spectrum value may be lower.

Generally, the extent to which temporal sharing is limited to infrequent, off-peak, predictable interruptions, it is likely to reduce the scope of value-weighted services affected, and allow for higher quality services. Less intrusions results in higher expected revenues for the same level of capacity and, as a consequence, greater value. The more frequent, unpredictable, or inconvenient the interruptions are the greater reduction in spectrum value.

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[25] Analyst reports suggest that data revenue per user is a little less than half of postpaid ARPU. *See*, for example, Bank of America Merrill Lynch, Wireline & Wireless Telecom Services, 16 May 2011, pages 24-25.

[26] Based on the level of data traffic in North America at noon and midnight as estimated by MIT SENSEable City Lab. See P Cruz and C. Ratto, "How the world uses its phone," Wired UK, 2013, pages 34-35.

Table 2. Illustrative Example of Temporal Sharing

[A]	Exclusive Spectrum Value	$	3,120,000,000
[B]	Voice and Data ARPU	$	50
[C]	Data Only ARPU	$	25
[D]	Data Only Service Discount		50%
[E]	Interruptible Service Spectrum Value	$	1,560,000,000
	One Hour Exclusion - Midnight		
[F]	Value Weighted Time of Exclusion		2%
[G]	Value Excluded	$	31,096,345.51
[H]	Interrupted Spectrum Value	$	1,528,903,654
[I]	Total Discount to Shared Spectrum		51%
	One Hour Exclusion - Noon		
[J]	Value Weighted Time of Exclusion		5%
[K]	Value Excluded		$82,923,588
[L]	Interrupted Spectrum Value	$	1,477,076,412
[M]	Total Discount to Shared Spectrum		53%

Notes and Sources:
The Brattle Group Analysis.
[D]: 1 - ([C] / [B]).
[E]: [A] x (1 - [D]).
[F]&[J]: Based on MIT, SENSEable City Lab, 'How the world uses its phone,' 2013.
[G]: [E] x [F].
[H]: [E] - [G].
[I]: 1 - ([H]/[A]).
[K]: [E] x [J].
[L]: [E] - [K].
[M]: 1 - ([L]/[A]).

2. Sharing may increase costs of avoiding interference with other users

Referring back to Figure 1, the value of spectrum will decrease with added operating costs and capital expenditures. Whether *coordinated sharing* or *uncoordinated rule based sharing*, users may have to make additional investments to mitigate interference.[27] With a greater chance for interference, spectrum sharing may necessitate additional filters and more costly base stations or handsets, reduced power levels and more cell sites, and connections to a spectrum management

[27] *Geographic sharing* and *temporal sharing* can also lead to additional costs, with effects similar to those described in this section.

database. In addition, if sharing arrangements necessitate using additional bands of spectrum for deployment, there may be additional fixed costs. These added costs begin even before deployment, requiring more intensive development and research efforts. When sharing requires lower power levels, it increases the number of cell sites and resulting cost of deployment. Complex cognitive sensing arrangements, where a secondary user must automatically detect when to shut off, will take substantial capital and investment, as will connectivity to databases or servers that facilitate sharing.

Consequently, depending on the arrangement, sharing is likely to increase both the upfront cost of deployment and the ongoing cost of operations. As costs increase, cash flows and expected profits diminish, and the resulting spectrum license value will decrease. However, unlike revenues, it is not clear that the discount to value is necessarily increasing relative to the severity of the restriction.

Table 3 offers an illustrative example of how the added costs are likely to reduce cash flows and profitability of spectrum based services. Suppose the sharing arrangement requires additional filters on base stations. Based on the cost of development and installation, suppose these added costs increase the capital investment by 10%, and require an additional 5% in operating expenditures related to base station equipment. The increased capital costs are represented as an increase in the amortized capital expenditures, whereas increased operating costs are represented as an increase in service costs. Based on a review of public financial statements from wireless carriers,[28] suppose net cash flow for a wireless carrier is 15%, while amortized capital costs are 15% of revenues, the cost of equipment is 15% of revenues, and the cost of service is 25% of revenues. As shown in Table 3, based on these assumptions, a 10% increase in capital costs and 5% increase in service costs reduces net cash flows by 18% to 12% of revenues, reducing spectrum value by a similar amount.

[28] This assumption is generally based on the cash flows observed in the public financial filings of U.S. wireless carriers.

Table 3. Illustrative Example of Added Sharing Costs

	Basic Wireless Network Cash Flow Assumptions	Factor
[A]	Cost, amortized capital (% of initial revenue)	15%
[B]	Cost, service (% of initial revenue)	25%
[C]	Cost, equipment (% of initial revenue)	15%
[D]	Cost, SGA (% of initial revenue)	30%
[E]	Total Cost (% of initial revenue)	85%
[F]	Net Cash Flow (% of initial revenue)	15%
	Financial Adjustment	
[G]	Change in Cost, amortized capital	10%
[H]	Change in Cost, service	5%
	Implied Adjusted Network Cash Flow	
[I]	Cost, amortized capital (% of initial revenue)	17%
[J]	Cost, service (% of initial revenue)	26%
[K]	Cost, equipment (% of initial revenue)	15%
[L]	Cost, SGA (% of initial revenue)	30%
[M]	Total Cost (% of initial revenue)	88%
[N]	Net Cash Flow (% of initial revenue)	12%
[O]	Discount to Net Cash Flow	18%

Notes and Sources:
The Brattle Group Analysis.
[A]-[D]: Based off of 2011 Income Statements of Verizon, Sprint, and AT&T.
[E]: Sum of [A]-[D].
[F]: 1 - [E].
[G]-[H]: Changes in cost as a share of revenue.
[I]: (1 + [G]) x [A].
[J]: (1 + [H]) x [B].
[K]: [C].
[L]: [D].
[M]: Sum of [I]-[L].
[N]: 1 - [M].
[O]: ([F] - [N]) / [F].

3. Sharing may increase uncertainty of the profitability of a project

As discussed above, the NPV of a spectrum service is driven by the cash flows, the timing of those cash flow, and the cost of investment. To the extent that sharing introduces delays or adds time for development when compared to using exclusive spectrum, sharing reduces the NPV of any given spectrum deployment.[29] All types of spectrum sharing require several steps that are not otherwise required to deploy an exclusive band. First, users have to investigate the potential interference issues and negotiate cooperative terms of use. Next, users must develop technologies, including filters, cognitive radios and handsets that operate within the parameters of the sharing arrangement. These negotiations and development efforts could be both costly and lengthy. In addition, sharing potentially creates new uncertainties, for instance, when spectrum will be available and whether prohibitive interference will arise. These will also reduce the NPV from spectrum based services and, in turn, reduce the value of the spectrum assignment. Table 4 presents an illustration of the reduction in value from a delay in deployment and increase in uncertainty. Combining a one year delay in deployment and a one percentage point increase in the cost of capital, results in a 29% discount to the NPV and spectrum value.

[29] It is worth noting that sharing has the potential to speed reallocations compared to waiting to redeploy incumbent users.

Table 4. Illustrative Example of Increased Capital Cost and Delay

	Basic Wireless Network Cash Flow Assumptions	Factor
[A]	Cost, amortized capital (% of initial revenue)	15%
[B]	Cost, service (% of initial revenue)	25%
[C]	Cost, equipment (% of initial revenue)	15%
[D]	Cost, SGA (% of initial revenue)	30%
[E]	Total Cost (% of initial revenue)	85%
[F]	Net Cash Flow (% of initial revenue)	15%
	NPV Assumptions	
[G]	Cost of Capital (%)	7%
[H]	Year Cumulative NPV of Cash Flow Turns Positive	7
[I]	Steady State Growth (%)	3%
[J]	NPV as a Multiple of Year 5 Cash Flow	16.5
	Adjusted NPV Assumptions	
[K]	Cost of Capital (%)	8%
[L]	Year Cumulative NPV of Cash Flow Turns Positive	8
[M]	Steady State Growth (%)	3%
[N]	NPV as a Multiple of Year 5 Cash Flow	11.8
[O]	**Total Discount to NPV**	**29%**

Notes and Sources:
The Brattle Group Analysis.
[A]-[D]: Based off of 2011 Income Statements of Verizon, Sprint, and AT&T.
[E]: Sum of [A]-[D].
[F]: 1 - [E].
[G]: Based on Telecommunications, Services sector cost of capital, http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/wacc.htm, accessed 10/30/13.
[H]: Build Out - Annual Cash Flow, Base WACC Scenario.
[I]: Brattle assumptions.
[J]: (1 + [I])^([H] - 5) / (([G] - [I]) x (1 + [G])^[H]).
[K]: Assumed higher WACC.
[L]: One year delay from [H].
[M]: Assumed revenue growth rate.
[N]: (1 + [M])^([L] - 5) / (([K] - [M]) x (1 + [K])^[L]).
[O]: ([J] - [N]) / [J].

In practice, changes in the three components of spectrum value are not mutually exclusive. To some extent, there are potential tradeoffs between increasing costs, reducing revenues and increasing uncertainty. When facing a geographic interference zone, carriers may either try to maintain service by installing costly filters, or forgo revenues in those areas. Moreover, shared spectrum may result in a combination of increased revenues, costs and uncertainty. Figure 2

provides a brief description of the different types of services which might be impacted by sharing.

Figure 2. Potential Impacts from Spectrum Sharing

Type of Sharing	Reduced Baseline Profitability	Reduced Revenue	Increased Costs	Added Uncertainty
Geographic	Services may be limited.	Reduced scope of service; no nationwide premium.	Increased costs due to interference; lower demand increases per unit cost.	
Temporal: Predictable	Services may be limited.	Reduced scope of service; reduced quality of service.	Increased costs due to interference.	
Temporal: Random	Services likely limited by unpredictability.	Reduced scope of service; further reductions in service quality.	Added network cost to accommodate randome interruption.	Lack of service predictability increases uncertainty.
Coordinated	Potential uses limited.	Revenues limited by service.	Substantial ecosystem development costs; added infrastructure and device costs.	Unpredictable service availability; ecosystem uncertainty; historically mixed results.
Uncoordinated Rule-Based	Restricted to low power uses; limited potential for service-based revenue.			

Source: The Brattle Group Analysis.

B. EFFICIENCY OF SHARING

As explained above, the total value of a band of spectrum is the sum of the values for each use. If the reduction in value to each shared use is such that the sum of these uses is less than the total value from a single exclusive use, then sharing is inefficient. Put differently, if the value lost to the highest value user is greater than the value gained by all other users, spectrum sharing is inefficient. In the context of sharing between federal and commercial users, the value lost to the highest valued commercial use, or combination of commercial shared users, is essentially the foregone value or cost to freeing (or keeping) that spectrum for a federal use. If this cost is greater than the social value of the federal service, or if there is a more cost effective way to provide the same public service, then sharing would be inefficient.

Conversely, if the cumulative value from shared uses is greater than the highest value to a single user, then sharing is efficient. Further, if value lost from commercial uses is less than the social value of the federal service, and there is no more cost-effective way to provide the service, then sharing between federal and commercial users is efficient.

VI. Illustrative Examples: Impact of Sharing on Spectrum Value

This section uses illustrative examples based on the CSMAC Working Groups 1 (WG-1) and 3 (WG-3) findings to demonstrate how various sharing proposals are likely to impact the value of spectrum. The purpose of each example is to illustrate how both the type and extent of sharing impacts the value of spectrum in that arrangement. Moreover, as described above, different types of sharing are likely to impact the value through different components of the NPV equation. These examples illustrate how the relationship between each component of profit impacts value.

A. CSMAC WG-1: Geographic Sharing in the 1695–1710 MHz Band

This section uses illustrative examples based on CSMAC WG-1 to demonstrate how sharing is likely to impact the value of spectrum, and how several mitigation techniques could increase the value of the band. As this illustration shows, both the type and extent of sharing impacts the value of spectrum in that arrangement.

Background. After NTIA released its Fast Track Report, WG-1 was tasked with evaluating the potential for harmful interference between meteorological satellite ground stations and future commercial wireless broadband operations, particularly Long-Term Evolution (LTE) technology. NOAA operates orbital satellites in the 1695-1710 MHz band and geostationary weather satellites in the adjacent 1675-1695 MHz band. These two constellations utilize at least 27 earth station locations that would require protection from harmful interference if commercial LTE base stations operated in the 1695-1710 MHz band.[30]

Based on its evaluation, WG-1 recommends geographic protection zones around each of these 27 satellite earth stations. According to WG-1, these protection zones comprise approximately 10% of the 2010 U.S. population, including nine top 100 mobile wireless markets representing approximately 8% of the U.S. population.[31] This proposal was a refinement to the NTIA Fast Track Report proposal to entirely exclude commercial service from 18 zones representing 13% of

[30] *See*, CSMAC, Final Report: Working Group 1 – 1695-1710 MHz Meteorological-Satellite, (herein "WG-1 Final Report"), 23 July 2013, Appendix 1.1.

[31] *See*, CSMAC, Working Group 1 (herein "WG-1 Report (6/2013)"), 18 June 2013, page 4. *See,* also, *Id.* As discussed below, our analysis found that these zones comprise approximately 9% of the 2010 U.S. population, and 8% in top 100 markets. For our analysis, we use these values.

the population.[32] As proposed, these protection zones would be areas in which commercial wireless services would not be permitted, unless the commercial licensee could coordinate with NTIA and FCC to ensure that there would be no harmful interference. Clearing the technical and regulatory hurdles to coordinate LTE operations is still uncertain and potentially costly, but likely feasible.

WG-1 also identifies several potential opportunities to further mitigate the impact of these protection zones, which they recommended for further analysis. First, to eliminate the need for sharing in the most valuable markets, it may be possible to move certain earth stations to lessen the population affected and impact on commercial value.[33] Second, coordinating operations with the geostationary satellites in 1675-1695 MHz may be possible by improving receiver filtering of adjacent band interference.[34] Third, depending on the location, type of satellite operation and specifics of the receiver, there may be potential for temporal sharing between orbital satellites and commercial LTE operations in these zones.[35] It is still not clear whether sharing operations would be possible predictably or randomly. While all three mitigation options may increase the potential revenue from operating the wireless broadband spectrum, they also increase the cost of deploying the spectrum. Below we evaluate the forgone value of the exclusions zones, and potential value from the WG-1 proposals for mitigating the interference issues.

Analysis. As discussed above, the size, location and timing of geographic sharing affects the value of spectrum. To illustrate, we will first compare the value of the spectrum as if it were a complete nationwide band to the value of the remaining spectrum outside the protection zones. For purposes of illustrating the effect of sharing, we adopt a value of spectrum for these bands of $1/MHz-pop.[36] While the protected area represents approximately 9%[37] of the population, not all population is equally valuable. Given the areas in top 100 markets, the reduction in value of the commercial spectrum if normal LTE operations are allowed in the protection zones

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[32] *See*, *Ibid.*, page 5.

[33] *See*, WG-1 Final Report, pages 5 – 6.

[34] *See*, *Ibid.* Appendix 5-1.

[35] *See*, *Ibid.* Appendix 5-1 and 5-2.

[36] The spectrum value adopted herein is a reasonable approximation, but not intended to be a precise estimate of value.

[37] WG-1 reports that the protected areas cover 10% of national population, but our analysis of their data indicate that only 9% of the population is covered. We use our analysis of population throughout.

represents closer to 12% of the value. Next, we consider the potential value regained from relocating satellite base stations out of top 100 markets. Finally, we consider the mitigation strategy of adding filters to base stations or mobile receivers and using part of the protected zones around geostationary satellite earth stations.

1. Exclusion zones

Strict exclusion from operating in these protection zones is likely to have two negative effects on the spectrum value. While the protected area represents approximately 9% of the population, given the areas in top 100 markets, the reduction in commercial spectrum value if all LTE operations are prohibited in the protection zones 12%. Moreover, depending on the nationwide premium, since the band is no longer nationwide, the value of the spectrum decreases by 5% or more.

Table 5 below illustrates the potential reduction in value of wireless broadband spectrum that results from excluding these areas from service. Based on the assumptions above, excluding these areas would result in 16% lower spectrum value than if it were dedicated to exclusive use by wireless broadband users. If, for example, the value were $4.7 billion for a nationwide exclusive band, the lost value would be $750 million or 16%, leaving $3.9 billion of value for the shared spectrum.

Table 5. Illustrative Example of 1695-1710 MHz Value with Exclusion Zones

		Effect on Value
	No Exclusions	
[1]	Population	312,400,577
[2]	MHz-Pop	4,686,008,655
[3]	Value including Nationwide Premium	$4,686,008,655
	Loss from Exclusions	
[4]	Excluded Population	27,946,166
[5]	MHz-Pop Excluded	419,192,490
[6]	Premium for Relative Value of Locations	32%
[7]	Total Value Lost from Excluded Population	$553,631,024
[8]	% Total Value Lost from Excluded Population	12%
[9]	Additional Loss of Nationwide Premium	$196,779,887
[10]	Total Value Lost	$750,410,911
[11]	% Total Value Lost	16%

Notes and Sources:
The Brattle Group Analysis.
[1]: Total US population, from 2010 Census data, by county.
[2]: [1] x 15 MHz of spectrum.
[3]: [2] x estimated national average $/MHz-Pop ($1.00).
[4]: Exclusion zones from CSMAC Working Group 1 (WG-1) Report, 18 June 2013, 1695-1710 MHz, Meteorological-Satellite, p. 4. Excluded population is the population of census blocks included in protection radius.
[5]: [4] x 15 MHz of spectrum.
[6]: Relative value of excluded population to national average. Based on CMA licenses in Auctions 66 and 73.
[7]: [5] x (1 + [6]) x estimated national average $/MHz-Pop ($1.00).
[8]: [7] / [3].
[9]: ([3] - [7]) x price x (1 - (1 / (1 + nationwide premium))), assuming an average price of $1.00 and a nationwide premium of 5%.
[10]: [7] + [9].
[11]: [10] / [3].

2. Move exclusion zones to less populated areas

WG-1 also identifies several potential opportunities to further mitigate the impact of these protection zones, which they recommend for further analysis.[38] One of these proposals is to eliminate the need for sharing in the most valuable markets by relocating certain earth stations

[38] *See*, WG-1 Final Report, Appendix 5.

to less populated areas. The 9 protection zones in top 100 markets represent approximately 7%[39] of the U.S. population. Table 6 below illustrates the change in value to the band if these sites were moved to areas within the same or neighboring state.[40] Rather than estimate an exact location for the relocated site, we assume that the population density excluded around the site is equal to the average population density for that state.[41] If these sites could be moved to relatively rural areas, the affected population would be even lower.

As illustrated in Table 6, the total population excluded after relocation would 56% less. This would have several effects on value. First, fewer pops are excluded, increasing the MHz-pops and value of the usable spectrum. Second, by replacing some high-valued urban areas with low-valued rural areas, the relative value of the restricted areas could be approximately 27% lower than the national average spectrum value. By comparison, the relative value of the spectrum in the existing areas is 32% higher than the national average. As a result, the total value lost to the nationwide spectrum value if the nationwide premium is lost is 7%, or $351 million based on our assumptions above. If the excluded population after relocation is sufficiently small to permit the nationwide premium to remain, the lost value would be only 3%, or $133 million based on our assumptions above. This mitigation would make sense if the relocation costs were less than the value gained from the relocations.

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39 While our analysis found that 7% of the exclusion zone population was in top 100 markets, WG-1 found that 8% of the nationwide population was in top 100 markets. We continue to use our analysis.

40 All sites are assumed to remain in the same state except for the Suitland MD site, which we assumed this could move to Virginia.

41 To estimate the population of the excluded area, we calculated: protection area based on maximum protection distance x average state population per square km.

Table 6. Illustrative Example of 1695-1710 MHz Value Relocating Sites in Top 100 Market

		Effect on Value
	No Exclusions	
[1]	Population	312,400,577
[2]	MHz-Pop	4,686,008,655
[3]	Value including Nationwide Premium	$4,686,008,655
	Original Exclusion Zones	
[4]	Total Value Lost	$750,410,911
[5]	% Total Value Lost	16%
	Moving Zones in Top 100 Markets to State Average Locations	
[6]	Excluded Population	12,172,298
[7]	MHz-Pop Excluded	182,584,475
[8]	Premium for Relative Value of Locations	-27%
[9]	Total Value Lost from Excluded Population	$133,779,126
[10]	% Total Value Lost from Excluded Population	3%
[11]	Additional Loss of Nationwide Premium	$216,772,835
[12]	Total Value Lost	$350,551,960
[13]	% Total Value Lost	7%

Notes and Sources:
The Brattle Group Analysis.
[1]: Total US population, from 2010 Census data, by county.
[2]: [1] x 15 MHz of spectrum.
[3]: [2] x estimated national average $/MHz-Pop ($1.00).
[4]: See Table 5, [10].
[5]: [4] / [3].
[6]: Exclusion zones from CSMAC Working Group 1 (WG-1) Report, 18 June 2013, 1695-1710 MHz, Meteorological-Satellite, p. 4. Sites at Suitland, MD (VA); Miami, FL; Hickam AFB, HI; Cincinnati, OH; St. Louis, MO; Omaha, NE; Sacramento, CA; Kansas City, MO; Knoxville, TN are replaced with implied covered pops based on average state population density and exclusion area size.
[7]: [6] x 15 MHz of spectrum.
[8]: Relative value of excluded population to national average. Based on CMA licenses in Auctions 66 and 73.
[9]: [7] x (1 + [8]) x estimated national average $/MHz-Pop ($1.00).
[10]: [9] / [3].
[11]: ([3] - [9]) x price x (1 - (1 / (1 + nationwide premium))), assuming an average price of $1.00 and a nationwide premium of 5%.
[12]: [9] + [11].
[13]: [12] / [3].

3. Partial use in protected zones with filters

Finally, it may be possible to operate in some protection zones by improving adjacent band receiver filtering on LTE base stations. While this would increase the scope of service, it would also increase the cost of deployment in these areas. To illustrate the effect of this type of cost, we assume that OOBE filtering would increase the cost of cell sites and network operating costs by 20%, which would apply to the approximately 15% of the network that is inside the exclusion zone.[42] As shown in Table 7, below, based on these illustrative added costs, the profitability of the commercial spectrum, and resulting value, would be approximately 11% lower than if it were an exclusive band. This suggests that filtering would be more valuable than losing access to the spectrum entirely, which would reduce the spectrum value by 16%.

[42] Given the relative value of the excluded areas, we assume that roughly 15% of the nationwide network would be built in these protection zones. If filtering were to add an additional 20% to the capital expenditure and operating costs in exclusion areas, this would imply a 3% increase in total capital and operating expenditures: 1 + 0.15 x 0.20 = 1.03.

Table 7. Illustrative Example of 1695-1710 MHz Value with Filter Costs

	Basic Wireless Network Cash Flow Assumptions	Factor
[A]	Cost, amortized capital (% of initial revenue)	15%
[B]	Cost, service (% of initial revenue)	25%
[C]	Cost, equipment (% of initial revenue)	15%
[D]	Cost, SGA (% of initial revenue)	30%
[E]	Total Cost (% of initial revenue)	85%
[F]	Net Cash Flow (% of initial revenue)	15%
[G]	NPV as a Multiple of Cash Flow	16.5
	Financial Adjustment	
[H]	Change in Cost, amortized capital and service	3%
	Implied Adjusted Network Cash Flow	
[I]	Cost, amortized capital (% of initial revenue)	15%
[J]	Cost, service (% of initial revenue)	26%
[K]	Cost, equipment (% of initial revenue)	15%
[L]	Cost, SGA (% of initial revenue)	30%
[M]	Total Cost (% of initial revenue)	86%
[N]	Net Cash Flow (% of initial revenue)	14%
[O]	Discount to Net Cash Flow	8%
[P]	NPV as a Multiple of Cash Flow	15.9
[Q]	Discount to NPV Multiple	4%
[R]	Total Discount to NPV	11%
[S]	Initial Total Value	$4,686,008,655
[T]	**Value Lost from Increased Costs**	**$536,044,354.55**

Notes and Sources:
The Brattle Group Analysis.
[A]-[D]: Based off of 2011 Income Statements of Verizon, Sprint, and AT&T.
[E]: Sum of [A]-[D].
[F]: 1 - [E].
[G]: (1 + growth rate)^(year cumulative cash flow turns positve - 5) / ((WACC - growth rate) x (1 + WACC)^year cumulative cash flow turns positve), with a growth rate of 3%, year cumulative cash flow turns positive of 7, and WACC of 7%.
[I]: [A] x (1 + [H]).
[J]: [B] x (1 + [H]).
[K]: [C].
[L]: [D].
[M]: Sum of [I]-[L].
[N]: 1 - [M].
[O]: ([F] - [N]) / [F].
[P]: (1 + growth rate)^(year cumulative cash flow turns positve - 5) / ((WACC - growth rate) x (1 + WACC)^year cumulative cash flow turns positve), with a growth rate of 3%, year cumulative cash flow turns positive of 8, and WACC of 7%.
[Q]: ([G] - [P]) / [G].
[R]: 1 - (1-[O]) x (1-[Q]).
[S]: See Table 5, [3].
[T]: [R] x [S].

B. CSMAC WG-3: Temporal and Geographic Sharing in 1755–1780 MHz

This section uses illustrative examples based on CSMAC WG-3 to demonstrate how its sharing proposal is likely to impact the value of spectrum, and how both the type and extent of sharing impacts the value of spectrum in that arrangement. In addition to the issues with geographic sharing illustrated in the WG-1 analysis, above, the bands analyzed by WG-3 introduce *temporal sharing*.

Background. WG-3 was tasked with evaluating the potential for commercial access to the entire 1755-1850 MHz band, but focusing particularly on the lowest 25 MHz at 1755-1850 MHz.[43] This work primarily involved evaluating the potential for interference with the DOD satellite control systems (SATOPS) and electronic warfare deployments that are dispersed through the 1755-1850 MHz band. First, WG-3 found that LTE base stations can coexist with electronic warfare (EW) systems, such as training missions and tests that involved 1755-1850 MHz spectrum. EW operations include the research and development, testing, and training with systems that are meant to defend against electronic attacks in the 1755-1850 MHz band. DOD needs the ability to test and train with devices that operate in the band. For this type of sharing to work, however, there needs to be a framework in place for coordinated temporal sharing around certain DOD training facilities.[44]

WG-3 found that there is potential for interference is from earth stations for SATOPS into commercial receivers on mobile wireless cell sites that are in the vicinity of those earth stations.[45] A number of potential mitigation techniques were also identified for this band. These mitigation techniques ranged from simple solutions, such as optimizing cell tower antenna configurations and building landscape barriers between the LTE base stations and SATOPS, to complex solutions such as dynamic spectrum access (DSA), as well as time and frequency sharing. Alternative solutions included base station filters that can be installed in commercial base

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[43] Accessing this lowest 25 MHz has been identified as a priority by industry, because it could be used as an extension to the existing AWS-1 allocation. *See,* CSMAC, Working Group 3 (WG 3) Report on 1755-1850 MHz Satellite Control and Electronic Warfare (herein "WG-3 Report"), released July 2013, page 2.

[44] *See*, WG-3 Report, pages 9 and 10.

[45] They also examined the potential for LTE transmissions to interrupt satellite operations, but found that risk minimal. *See,* WG-3 Report, pages 7 and 8.

stations in the vicinity of satellite earth stations to mitigate the interference. To the extent that harmful interference remains, additional options are to set up geographic zones in which commercial service is either excluded or interruptible, depending on the arc of the satellite.[46]

In its recommendations, WG-3 made it clear that any strategies for sharing in the band must be sufficiently flexible to allow federal spectrum needs to vary over time. It will be some time before SATOPS could transition from the band and, in that time, the need for specific earth stations to communicate with a satellite are likely to change. Moreover, the EW operations at 1850 MHz are particularly valuable for DOD operations, and it is unlikely to vacate the spectrum in the foreseeable future.

1. Electronic warfare

The extent to which EW operations would affect the value of the spectrum is likely to depend on where and when these missions are being carried out and how often the spectrum is being used. Temporary, localized EW operations may require that LTE operations cease in the area for a specific time, and duration. Provided that these operations are limited to DOD facilities, and anticipated well in advance, the likely impact on value would not be substantial. On the one hand, if commercial operators and DOD could negotiate on a time that was acceptable to both parties—for instance, at off-peak overnight hours—the impact on value could be low. On the other hand, if commercial operators do not have warning prior to an interruption, the economic value of the spectrum will decrease. Since CSMAC's WG-3 did not release the specific locations of these training missions, we cannot estimate the specific impact to each facility.

2. SATOPS

WG-3 identifies 23 satellite tracking stations within the 50 United States.[47] WG-3 concludes that when a satellite spacecraft is communicating with a satellite earth station, there would be harmful interference to LTE base stations within the vicinity of the SATOPS facilities.[48]

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[46] *See,* WG-3 Report, pages 135 – 152, and 176 – 189.

[47] The WG-3 Report identifies 28 satellite tracking stations, but 5 are outside of the 50 United States. The excluded sites are in England, Diego Garcia, Greenland and Guam. Although Guam is a U.S. territory, it does not have excess demand for spectrum and is assumed to not be worth the costs of sharing spectrum.

[48] *See,* WG-3 Report, sections 4.2.3 and 4.2.4.

Depending on the orbit of a satellite, the duration of interference from a single pass is typically around 10 to 15 minutes and typically uses 2-4 MHz.[49] However, a single SATOPS usually communicates with multiple spacecraft several times a day and on multiple channels.[50] Table 8 shows the cumulative radiation time by SATOPS and spectrum use over a given year. These results suggest that LTE operations would be limited to some extent in areas for some amount of time. However, the specific interference is conditional on a variety of factors, including the orbit of the satellite, configuration of the SATOPS and LTE base stations, and the terrain.

[49] *See,* WG-3 Report, Figures 4.2.2-2 and 4.2.2-4.

[50] *See,* WG-3 Report, Table 4.2.1-3, Figures 4.2.1-5, 4.2.2-2 and 4.2.2-4.

Table 8. Summary of SATOPS Spectrum Use, 1755-1850 MHz

SATOP Locations	CMA	2010 Population (Count)	Radiation Time (Percent)	Instantaneous Spectrum Use (MHz)	Channel Excluded (MHz)
Annapolis, Maryland	14	2,662,691	4%	2	5
Buckley AFB, Colorado	19	2,733,780	18%	2	5
Blossom Point, Maryland	8	4,814,094	45%	5	5
Cape GA, CCAFB, Florida	137	543,376	46%	2	5
Camp Parks, California	7	4,335,391	0%**	0	0
Colorado Tracking Station, Schriever AFB, Colorado	117	645,613	30%	4	5
Eastern Vehicle Checkout Facility, Cape Canaveral AFS, Florida (Launch support only)	137	543,376	1%	4	5
Fairbanks (NOAA), Alaska	315	145,928	11%	2	5
Ft Bragg, NC	149	319,431	2%	1	5
Fort Belvoir, Virginia	8	4,814,094	20%	4	5
Ft Hood, TX	160	385,623	2%	1	5
Huntington Beach , CA	2	17,053,688	2%	1	5
Hawaii Tracking Station, Kaena Point, Oahu, Hawaii	50	953,207	70%	5	5
Joint Base Lewis-McChord, WA	82	795,225	2%	1	5
Kirtland AFB, New Mexico	86	794,125	1%	2	5
JIATF-S, Key West, FL	370	73,090	2%	1	5
Laguna Peak, California (Navy)	73	823,318	9%	3	5
Monterey, California	126	415,057	4%	2	5
New Hampshire Tracking Station, New Boston AFS, New Hampshire	133	400,721	60%	6	10
Prospect Harbor, Maine (Navy)	466	87,274	3%	3	5
Patuxent River NAS, MD	468	542,006	2%	1	5
Sacramento, CA	35	1,968,069	2%	1	5
Vandenberg Tracking Station, Vandenberg AFB, California	124	423,895	65%	6	10

Notes and Sources:
The Brattle Group Analysis and CSMAC Working Group 3 Final Report (pages 14 - 16).
Note: Excludes SATOP sites in England, Diego Garcia, Greenland and Guam.
** Camp Parks, California is not currently in operation.

To illustrate the forgone economic value from SATOPS operations, we examine several scenarios for sharing between SATOPS and commercial LTE in the entire 1755-1850 MHz band. First, we analyze the impact of excluding all LTE operations in the vicinity of these 23 domestic satellite tracking stations.[51] Next, we estimate the impact on commercial value of allowing LTE operations in the exclusion zones that can be interrupted, either unpredictably or predictably, by the intermittent satellite tracking operations. Depending on the satellites being tracked by each

[51] WG-3 does not conclude what size any exclusion zone would have to be. For the purpose of our illustrative examples, we assumed SATOPS would impact LTE operations in the CMA of the facility.

station, such operations vary in how much spectrum they use and how often they use it. Unless a system is put in place for dynamic spectrum sharing, even if a satellite only uses 2 MHz, the entire affected LTE channel would have to cease operations in that time. As a final step, we consider the value of implementing a DSA system, in which LTE operations can reassign handsets depending on spectrum availability.

a. Scenario 1: SATOPS exclusive use

Based on our analysis, the area surrounding each of the 23 SATOPS facilities represents approximately 41 million people, or 13% of the U.S. population.[52] Similar to WG-1, the value of the spectrum in the areas around these facilities is 30% higher than the national average spectrum value, implying that the excluded area represents 17% of the value of a nationwide spectrum band.[53] In particular, the high value locations include several of the sites in California and Maryland. Excluding the entire 95 MHz of spectrum from commercial use in these areas would preclude approximately 3.9 billion MHz-pops. Factoring both the reduced scope (17%) and the loss in value due to the nationwide premium, the shared band would be 21% less valuable than if it were licensed as exclusive, commercial spectrum. See Table 9 below.

[52] *See,* WG-3 Report, pages 9 and 10. For our analysis, we assume the area in the CMA surrounding the facility is excluded.

[53] 13% x (1 + 30%) = 17%.

Table 9. Illustrative Example of 1755-1780 MHz Spectrum Value with Exclusion Zones

		Effect on Value
	No Exclusions	
[1]	Population	312,400,577
[2]	MHz-Pop	29,678,054,815
[3]	Value including Nationwide Premium	$29,678,054,815
	Loss from Exclusions	
[4]	Excluded Population	40,915,602
[5]	MHz-Pop	3,886,982,190
[6]	Premium for Relative Value of Locations	30%
[7]	Total Value Lost from Excluded Population	$5,052,012,956
[8]	% Total Value Lost from Excluded Population	17%
[9]	Additional Loss of Nationwide Premium	$1,172,668,660
[10]	Total Value Lost	$6,224,681,616
[11]	% Total Value Lost	21%

Notes and Sources:
The Brattle Group Analysis.
[1]: Total US population, from 2010 Census data, by county.
[2]: [1] x 95 MHz of spectrum.
[3]: [2] x estimated national average $/MHz-Pop ($1.00).
[4]: 2010 population of estimated CMAs covered by excluded zones in CSMAC Working Group 3 Final Report, pages 14 - 16.
[5]: [4] x 95 MHz of spectrum.
[6]: Relative value of excluded population to national average. Based on CMA licenses in Auctions 66 and 73.
[7]: [5] x (1 + [6]) x estimated national average $/MHz-Pop ($1.00).
[8]: [7] / [3].
[9]: ([3] - [7]) x price x (1 - (1 / (1 + nationwide premium))), assuming an average price of $1.00 and a nationwide premium of 5%.
[10]: [7] + [9].
[11]: [10] / [3].

b. Scenarios 2 and 3: Temporal sharing

Given the relatively low radiation time and instantaneous spectrum use of some of these SATOPS facilities, LTE operations may be feasible on an interruptible basis in their vicinity.[54] The key determinant of the impact of these disruptions on the commercial value of using these frequencies is whether or not the commercial users have any warning about when the spectrum will be preempted. WG-3 expresses concern about security issues related to sharing operational schedules of classified operations, suggesting it is not possible to coordinate.[55] So long as the information is not made public it seems plausible that wireless network operators with proper security procedures could use the information to plan network operations without compromising national security. Nevertheless, as this is an unresolved question, we model the impacts of temporal sharing on a predictable and unpredictable basis.

Based on the annual radiation time and simultaneous spectrum use for each SATOPS, the interrupted service represents the equivalent of 32 million MHz-pops over a year, or 0.11% of the spectrum.[56] Due to the nature of the SATOPS sites with the highest use, the relative value weight of the spectrum used would be 80% higher than the average value of nationwide spectrum. So long as the interruptions are predictable and do not represent a substantial portion of the band, there are two negative impacts on spectrum value. These are outlined in Table 10. The economic value is lost due to the reduced scope of services. This results in a 0.19% reduction in value. Given that so little of the spectrum is being used, such an exclusion is unlikely to effect the premium for nationwide spectrum.

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54 According to the WG-3 Report, "at any given moment, about 95% of the spectrum in the 1755-1850 MHz band will be free from SATOPS signal power, thus LTE base stations could theoretically schedule operations to minimize the impact of SATOPS interference." *See*, WG-3 Report, page 147.

55 *See*, WG-3 Report, page 136.

56 Radiation time x interrupted MHz x interrupted pops. With current LTE technology, SATOPS would interrupt operations for an entire LTE channel, so the interrupted MHz is the total channel size. We assume each channel is 5 MHz. On 23 July 2013, the FCC proposed uplink blocks of 5 MHz for 1755-1780 MHz in its Notice of Proposed Rulemaking and Order on Reconsideration for the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands (GN Docket 13-185), paragraph 47.

Table 10. Illustrative Example of 1755-1780 MHz Spectrum Value with Predictable Sharing

		Effect on Value
	No Exclusions	
[1]	Population	312,400,577
[2]	MHz-Pop	29,678,054,815
[3]	Value including Nationwide Premium	$29,678,054,815
	Loss from Exclusions	
[4]	Excluded Equivalent MHz-Pops	32,064,360
[5]	Premium for Relative Value of Locations	80%
[6]	Total Value Lost from Excluded Population	$57,816,671
[7]	% Total Value Lost from Excluded Population	0.19%

Notes and Sources:
The Brattle Group Analysis.
[1]: Total US population, from 2010 Census data, by county.
[2]: [1] x 95 MHz of spectrum.
[3]: [2] x estimated national average $/MHz-Pop ($1.00).
[4]: CSMAC Working Group 3 Final Report, pages 14 - 16. Excluded MHz-Pops calculated as population of excluded CMA, % of radiation time, and the MHz of the channel that would be excluded during radiation time.
[5]: Relative value of excluded population to national average. Based on CMA licenses in Auctions 66 and 73. The large value is driven primarily by the locations in Blossom Point, MD and Fort Belvoir, VA, which are within the Washington, DC CMA.
[6]: [4] x (1 + [5]) x estimated national average $/MHz-Pop ($1.00).
[7]: [6] / [3].

An alternative scenario occurs, however, if the interruptions are unpredictable. In this case, a carrier would likely have to change its business plan to account for the lower quality services due to such interruptions. In the extreme, if there is no predictability about when the interruptions will occur, the geographic areas bands with interruptions will be essentially valueless, because the quality of service will be severely limited. Similar to the analysis in Scenario 1 as reported in Table 9, above, this could amount to essentially a 21% discount to the spectrum value.

c. Scenario 4: Frequency sharing

As the analysis of value presented above indicates, the ability to coordinate temporal sharing will impact the value of the spectrum. Much of this reduction in value is due to the entire loss of LTE service during an interruption. As shown in Table 8 above, however, SATOPS occupy a relatively small amount of spectrum. While current LTE systems cannot schedule operations to

use only select frequencies within a channel, WG-3 concluded that future LTE systems could have this capability.[57] If it were possible for LTE base stations to schedule which frequencies it used at specific time intervals, it may be possible to continue service with lower capacity, rather than ceasing operations on a channel altogether.

There are several economic factors to consider in this case. First, assuming that the only frequencies lost are those that are actually being used by the SATOPS when they are communicating with spacecraft, the specific frequencies interrupted would total the equivalent of a little over 24 million MHz-pop. See Table 11. Second, since commercial carriers could continue operations, they would not be subject to the loss in nationwide service premium or degradation of service. Developing these technologies, however, will be costly. WG-3 estimates that the total cost would be "low to moderate" for LTE operators to implement at each SATOPS facility.[58] For the purposes of our analysis, we assume that the cost is roughly $1 million per SATOPS facility, or $23 million for all 23 SATOPS within the 50 states. As illustrated in Table 11, compared to the alternative of excluding this spectrum entirely, this amounts to a total savings of approximately $6.2 billion.

[57] *See*, WG-3 Report, page 147.

[58] *See*, WG-3 Report pages 181 and 184. According to the WG-3 Report, low cost solutions are less than $1 million per facility and moderate cost solutions are $1 - $10 million per facility.

Table 11. Illustrative Example of 1755-1780 MHz Frequency Sharing

		Effect on Value
	No Exclusions	
[1]	Population	312,400,577
[2]	MHz-Pop	29,678,054,815
[3]	Value including Nationwide Premium	$29,678,054,815
	Loss from Exclusions	
[4]	Total Value Lost, excluding zones	$6,224,681,616
[5]	% Total Value Lost, excluding zones	21%
	Loss Using DSA	
[6]	Upfront Investment	$23,000,000
[7]	Excluded MHz-Pops	24,336,281
[8]	Premium for Relative Value of Locations	102%
[9]	Total Value Lost	$72,213,557
[10]	% Total Value Lost	0.2%
	Savings from Using DSA	
[11]	Savings from Using DSA versus excluding zones	$6,152,468,059
[12]	Savings from DSA versus excluding zones as % of Initial Value	21%

Notes and Sources:
The Brattle Group Analysis.
[1]: Total US population, from 2010 Census data, by county.
[2]: [1] x 95 MHz of spectrum.
[3]: [2] x estimated national average $/MHz-Pop ($1.00).
[4]: See Table 9, [10].
[5]: [4] / [3].
[6]: $1 million x 23 sites.
[7]: CSMAC Working Group 3 Final Report, pages 14 - 16. Excluded MHz-Pops calculated as population of excluded CMA, % of radiation time, and the MHz that would be excluded during radiation time.
[8]: Relative value of excluded population to national average. Based on CMA licenses in Auctions 66 and 73. The large value is driven primarily by the locations in Blossom Point, MD and Fort Belvoir, VA, which are within the Washington, DC CMA.
[9]: [6] + [7] x (1 + [8]) x estimated national average $/MHz-Pop ($1.00).
[10]: [9] / [3].
[11]: [4] - [9].
[12]: [11] / [3].

VII. Facilitating Sharing: Incentivizing Federal Users

It is widely accepted that until Federal users internalize the costs associated with their spectrum use, Federal users have no incentive for using spectrum more efficiently or maximizing spectrum's total social value. Quantifying that foregone value along the lines described above is one way for policymakers to weigh the tradeoffs of conflicting demands and make efficiency enhancing choices about spectrum allocations and assignments, including when spectrum bands should be shared among different classes of users. But knowledge of the right solution is not always sufficient to affect good policy. There remain at least two long term challenges for efficient spectrum sharing.

First, just as commercial users' spectrum demands evolve, government spectrum users' needs are likely to vary over time. As constraints on spectrum get tighter, spectrum will be more heavily used—both temporally and between frequencies. This is the impetus for spectrum sharing. For it to work, however, policymakers need a mechanism for government users to adjust their spectrum usage—and even assignments—according to current needs and cost-effectiveness. Rather than holding spectrum assignments for some future objective or utilizing more spectrum in lieu of potentially more spectrum efficient alternatives, agencies should have a reason to relinquish assignments they are no longer using, or adjust usage to increase the overall efficiency of spectrum, including through increased sharing. An important component of this, however, is that federal users must be assured that they will be able to acquire spectrum assignments when they have a justifiable need. Otherwise, they will still not have an incentive to relinquish spectrum they are not using.

Second, to weigh the true costs and benefits of a wireless communication service, government users need a way to internalize the cost of the spectrum they use. Spectrum is a highly valued, scarce resource. However, once they receive an assignment, federal users do not incur costs to holding on to the asset. This valuable asset is essentially free to them. Federal users typically incur costs associated with utilizing many other valuable assets. For instance, the Government Services Administration charges federal users rent for office space. DOD pays for artillery and machinery. If federal users paid for its use, they would internalize the cost associated with holding spectrum assignments that prevent other productive uses of the frequencies. Recognizing the costs of spectrum would incentivize federal users to adjust their usage to reduce costs. For instance, they may choose to adjust the timing of their spectrum related missions, invest in higher quality filters to limit their spectrum needs, lease capacity from commercial

carriers rather than deploy their own services, or more readily accommodate sharing with other users.

Such an approach is consistent with general Presidential directives and Office of Management and Budget (OMB) guidance. A Presidential memorandum released in June 2013 called for an evaluation of spectrum efficiency in procurements and market-based incentives for the efficient use of federal spectrum.[59] The 2013 OMB guidance instructs federal agencies to consider the economic value of spectrum in weighing alternative proposals for deploying spectrum based services.[60] This guidance is intended to ensure "proper stewardship of the spectrum resource."[61] However, government spectrum users still have no consistent basis or incentive to quantify the economic value of spectrum. Federal users need an incentive to adjust their spectrum usage to their need, either in real time, or over time.

Several critical stakeholders have already endorsed a fee based approach.[62] FCC Commissioner Rosenworcel voiced similar sentiments in late 2012.[63] Other countries, notably the UK, have

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59 *See,* Presidential Memorandum, 2013, sections 4 and 6.

60 *See*, Office of Management and Budget, Preparation, Submission, and Execution of the Budget, Circular No. A-11, July 2013, section 31.12, available at: http://www.whitehouse.gov/omb/circulars_a11_current_year_a11_toc (last visited 11 Aug. 2013). According to this guidance:

> The value of radio spectrum required for telecommunications, radars, and related systems should be considered, to the extent practical, in economic analyses of alternative systems/solutions. In some cases, greater investments in systems could enhance Federal spectrum efficiency (e.g., purchase of more expensive radios that use less bandwidth); in other cases, the desired service could be met through other forms of supply (e.g., private wireless services or use of land lines). Therefore, to identify solutions that have the highest net benefits, agencies should consider greater investment to increase spectrum efficiency along with cost minimizing strategies. To this end, section 6411 of the Middle Class Tax Relief and Job Creation Act directed that A–11 be updated with sections (a) and (c). Subsection (b) provides a methodology for determining a baseline to evaluate improvements in spectrum efficiency.

61 *Ibid.*

62 *See,* GAO*,* Federal Government's Use of Spectrum and Preliminary Information on Spectrum Sharing, Testimony Before the Subcommittee on Communications and Technology, Committee on Energy and Commerce, House of Representatives, GAO-12-1018T, 13 September 2012.

63 *See*, Remarks of Commissioner Jessica Rosenworcel at Silicon Flatirons: The Next Ten Years of Spectrum Policy, 13 November 2012.

adopted significant fees for spectrum usage.[64] While there are limitations to a fee-based approach,[65] it would require government users to incur some cost for spectrum usage. Furthermore, accurately set fees would make the costs of federal spectrum usage more transparent. By imposing a spectrum based fee, the cost of spectrum based services for federal users will reflect the use of this scarce resource. The question is: *what should the fee be tied to?*

Consistent with the principle that government spectrum users should consider the forgone economic value of spectrum deployed for their services, we suggest that a federal user fee should be based on the commercial value of spectrum. It may be difficult to calculate the precise economic value of a band of spectrum to a federal user, but this should generally be equivalent to the economic value of the spectrum used—either when shared or used exclusively. While the theoretical economic value of a band of spectrum is difficult to determine, the commercial price of spectrum realized at auction or in secondary trades is one observed estimate of this value. By tying the fee for federal spectrum to spectrum's commercial price, federal users would be incurring the foregone economic value or opportunity cost of the spectrum in deploying these federal services. A fee based on commercial spectrum value would require that federal users at least acknowledge the opportunity cost of the spectrum and defend their use based on this cost.

Calculating the fee would be a two-step process. In the first step, commercially attractive swaths of spectrum currently occupied by federal users would be identified and valued. This may be a 50 MHz or 100 MHz band, the exact size depending on several factors including the currently preferred size of commercial deployments. The commercial value of the band, if it were not shared with federal users, can be calculated using standard spectrum valuation techniques.[66] The lump sum value of the spectrum could be translated into an annual payment through the application of the appropriate discount rate. This value represents the opportunity cost of the band remaining exclusively under federal control.

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64 *See*, for example, Ofcom, "Annual License Fees for 900 MHz and 1800 MHz Spectrum Consultation," 10 October 2013. Available at: http://stakeholders.ofcom.org.uk/consultations/900-1800-mhz-fees/?utm_source=updates&utm_medium=email&utm_campaign=alf-consultation (last visited 22 December 2013).

65 Since agencies are still dependent on Congress to set its budget, any reduced costs would essentially mean a reduced budget from Congress, rather than a reallocation of resources to other important missions of that agency.

66 *See*, Bazelon & McHenry (2013).

The second step of the fee calculation would then be to allocate the value of the band to the individual federal users. This allocation exercise would consider the relative value of all of the users in the band. Agencies that thought they were allocated too large a share of the band's costs would be well incentivized to produce analysis correcting the record. Note that under this scheme, if a federal user chose to stop using a specific band of spectrum, the opportunity cost associated with that band (from step one) would not change and that cost would now be allocated to a smaller group of users. Such an approach would also incentivize spectrum sharing because introducing commercial users in a band would reduce the share of opportunity costs that would need to be covered by the federal users.

This process can be illustrated with a hypothetical example. Suppose a 100 MHz swath of spectrum is allocated to federal users. Further assume the commercial value of this band of spectrum is $1/MHz-pop, suggesting the total commercial value of the band is $31.2 billion.[67] Using a 10% discount rate, the annual cost of using this spectrum would be $3.1 billion.[68] Suppose there are 10 federal agencies that have national assignments of 10 MHz each. One allocation of the fees among the federal users would be to allocate one-tenth, or an annual fee of $310 million, to each agency. If one or more of the federal agencies believed that the value of their spectrum use was less than one-tenth of the value of all federal users in the band, then that agency would be well incentivized to provide supporting evidence of the relative value of the various federal users in the band. Suppose, purely hypothetically, that one of the 10 federal users was the Forest Service and the other nine were law enforcement agencies. In such a case, the Forest Service might submit analysis suggesting that its use is relatively less valuable than law enforcement and, therefore, it should be assigned less than one-tenth of costs of using the band. Such incentives would lead to the expectation that the fees would accurately reflect the relative value of federal users within the band.

The incentive benefits of such a fee would motivate efficient spectrum sharing. If the federal users were to share the band with commercial users, a share of the value of the band would then be paid by commercial users, rather than included in the spectrum fees. For example, if commercial use of the spectrum created $10 billion in value, then $10 billion would be deducted from the total value of the band in calculating the federal fees. In that case, the total value

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[67] $1/MHz-pop x 312 million pops x 100 MHz.

[68] $3.1 billion per year discounted at 10% per year in perpetuity has a present value of $31 billion.

allocated to federal use would drop to $21 billion and the total of the annual fee paid by the 10 federal users would now be $210 million. Note that this creates the incentive for federal users to share with commercial users so long as the value foregone to the federal users is less than the value created by the commercial users.

No federal spectrum user fee scheme will ever create perfect incentives for federal users to use their spectrum assignments efficiently. Beyond the usual principal agent issues that arise with public sector provision of goods and services, the budgetary incentives will never reflect underlying valuations. Congress cannot credibly commit to letting a federal agency keep the value gained by more efficiently using spectrum because they cannot commit to multiyear budgets for agencies. But the spectrum fee proposed here should create some incentives for efficient spectrum use, if for no other reason than shining a light on the costs of spectrum use by federal users. Additionally, the fee setting process proposed here should generate good, accurate information about the value of federal spectrum use—information policymakers can utilize in more direct spectrum management decisions.

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THE Brattle GROUP

Attention: Mr. Tom Power,
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Executive Office Building,
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Washington, DC 20504.
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Thomas_C_Power@ostp.eop.gov

Subject: Agency Incentives - Spectrum

Spectrum Bridge is pleased to provide the following response to OSTP's request for information regarding "approaches to providing incentives to Federal agencies to share or relinquish spectrum, representing a variety of paths to satisfying the increasing demands for spectrum capacity from both government and commercial users." and provide input regarding "other Incentive based measures that could promote spectrum sharing or relinquishment."

Spectrum Bridge has significant experience in spectrum sharing and the development of spectrum management solutions. In this role we have witnessed a growing and critical need for broadband spectrum to further enable efficient wireless applications within many industries. This need goes far beyond what large carriers enabling traditional broadband cellular data services are willing or able to to provide. The same industries, who for many years have made efficient use of the 12/25/50 kHz industrial, scientific and private/commercial land mobile (PLMR/CLMR) radio spectrum now need access to much broader channels to support modern broadband applications. The challenge to these industries is that their business models are not designed to generate revenue directly from a wireless subscriber base which creates different cost models. Furthermore, many applications that could benefit from additional spectrum would be categorized within the antiquated Private Land Mobile Radio spectrum plan which has little spectrum to offer for modern wireless services.

In this pursuit, we have found it particularly challenging to support industries other than those in the business of directly offering telecom services to end customers that rely on wireless communications. We are generally stymied by [artificial] spectrum scarcity. Although there are many instances in which spectrum scarcity is a real challenge, especially in large markets (e.g. NY, LA, Chicago), spectrum is generally allocated in equal amounts in all geographies. It is therefore obvious that much of the spectrum in rural areas lies fallow. Ironically, these are areas in which there are many industries that could benefit most from wireless communications (farming, forestry, mining, fishing, energy resource and production, transportation). Yet the

existing rules and policies make it difficult, if not impossible to quickly and efficiently repurpose spectrum to meet these needs. Spectrum Bridge has spent significant time and resources attempting to fulfil this vision, but been met with significant resistance by incumbent spectrum holders and policies that are well intended, but do not allow practical fulfillment of their intended purpose – an efficient supply/demand driven, secondary spectrum market.

A primary reason is that traditional wireless communications carrier business models (and the consumers they typically serve) are very different from the needs of other industries that rely on wireless communications to more efficiently execute internal business operations. To this end, the spectrum auction and licensing process is designed and optimized around the former. As a result, it is often not possible to serve industrial broadband needs because the cost and burden of executing a transaction in the secondary market, far exceeds the economic value of the spectrum needed – even if it can be found. Another challenge is that the true economic value of fallow broadband spectrum is not fully understood, as the vast majority of spectrum is held by an oligopoly.

The process of spectrum license disaggregation, partitioning, leasing and sub-leasing require significant legal expertise and financial expense on the part of an industry that desires efficient access to broadband spectrum. So in considering market based approaches to more efficient spectrum access and sharing we emphasize the following:

- There exists a large underserved industrial segment that has needs that are quite different than the needs wireless carriers traditionally serve. In general, many industrial users require temporal access to spectrum in localized areas that are not typically defined by census tracts or other economic partitioning used for wireless carrier applications. In many cases, sufficient access can even be non-exclusive. However, a form of limited/controlled access through coordination would be ideal.

- The auction process is not an ideal mechanism to allocate spectrum to all industry or business users. Many industries do not have the same business planning cycles or an extended view of spectrum use that the wireless carriers benefit from. In addition, wireless carriers actually benefit from situations where competitors lack access to spectrum. In the end, an open market, based on true supply and demand, would be ideal for industrial wireless applications and users.

- Genuine spectrum scarcity exists only in the largest urban markets and areas (top 10 or so). *Artificial* spectrum scarcity is becoming acute everywhere.

Our recommendations are as follows:

- Simplify the licensing mechanisms and processes, especially as they pertain to industries that rely on broadband spectrum for internal business use. When spectrum licenses are defined for relatively small or targeted areas, they may have a fair market value of several thousand(s) of dollars. Therefore the fees and costs associated with acquiring or borrowing those licenses should be commensurate with those values. An open market designed to serve a wider segment of industry is needed, however, the secondary market mechanisms in place

today are not compatible with the diversity of spectrum use cases and users that exist today. The current secondary market caters to a system of long term licensing, enables hoarding and is inherently too complex a system for efficient market transactions and spectrum fungibility.

- Discourage warehousing of spectrum through more comprehensive buildout requirements and provisions for closed loop auditing. Very little has been accomplished to validate self-declared license buildout and construction requirements or to verify actual usage of licensed spectrum. Furthermore, it has become a trivial task to reprogram existing multiband, frequency agile base station equipment to make a claim that a compelling service has been *provisioned*, even when subscriber or customer access is not deployed or possible. Construction requirements must be modernized to be commensurate with technology. Taxing spectrum holding would also be an effective means for encouraging more efficient spectrum use. Spectrum "buyers" can build the cost of this tax into the initial bid price, negating the claim of additional costs.

- Reinvent the PLMR service for broadband applications. Use the open market to identify a fair system for fees for a parallel system of business/industrial broadband applications.

- Spectrum Bridge's comments regarding FCC proceeding 12-354 In the Matter of Amendment to the Commission's Rules with Regard to Commercial Operations In the 3550-3650 MHz Band also suggests a number of potential solutions that are conducive to more efficient spectrum use.

Should you have any questions or desire additional information please do not hesitate to contact us.

Respectfully,

Peter Stanforth
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Via Electronic Mail

March 20, 2014

Tom Power
Deputy Chief Technology Officer, Telecommunications
Office of Science and Technology Policy
Eisenhower Executive Office Building
1650 Pennsylvania Ave., NW
Washington, DC 20504

Re: Office of Science and Technology Policy Notice of Request for Information on Spectrum Policy

Dear Mr. Power:

CTIA – The Wireless Association® ("CTIA") submits this letter in response to the Notice of Request for Information ("*NRI*") issued by the Office of Science and Technology Policy ("OSTP") on the Science and Technology Policy Institute ("STPI") report identifying approaches to providing incentives to federal agencies to share or relinquish spectrum.[1/] CTIA applauds OSTP's steps to implement the President's June 2013 memorandum, which recognizes the need to make more spectrum available for commercial broadband systems.[2/] OSTP and other stakeholders must not let these first steps also be the last. Congress, the Office of Management and Budget ("OMB"), the National Telecommunications and Information Administration ("NTIA"), and others should adopt affirmative measures that will enable federal agencies to take advantage of incentives to free up the additional spectrum that will continue to drive the growth of the wireless industry and our Nation's economy.

Spectrum Should Be Made Available for Exclusive Commercial Use.

In considering incentives for federal agencies to make additional spectrum available, OSTP and others should focus in particular on spectrum that can be reallocated for exclusive non-federal use. As CTIA has explained, there is no substitute for licensed, exclusive-use spectrum.[3/]

1/ *See Spectrum Policy*, Notice of Request for Information, Docket No. OSTP-2014-0002-0001, 79 Fed. Reg. 9288 (Feb. 18, 2014) ("*NRI*"); Science and Technology Policy Institute, *A Review of Approaches to Sharing or Relinquishing Agency-Assigned Spectrum* (Jan. 2014) ("*STPI Report*"), *available at* https://www.ida.org/upload/stpi/pdfs/p5102final.pdf.

2/ *See Expanding America's Leadership in Wireless Innovation*, 78 Fed. Reg. 37431 (June 20, 2013) ("*2013 Presidential Memorandum*").

3/ *See, e.g.*, Comments of CTIA–The Wireless Association®, GN Docket No. 12-354, at 6-10 (filed Feb. 20, 2013) ("CTIA 3.5 GHz Band Comments"); Letter from CTIA, 4G Americas, Consumer Electronics Association, High-Tech Spectrum Coalition, Information Technology Industry Council, Telecommunications Industry Association, and Wireless Broadband Coalition to Chairmen Upton and Walden and Ranking Members Waxman and Eshoo, Committee on Energy & Commerce, at 2 (Sept. 12, 2012), *available at* http://www.4gamericas.org/documents/120912%20Mulit%20Assoc%20Call%20for%20More%20Licensed%20Spe

Exclusive licensing creates the certainty necessary for commercial entities to invest and innovate in spectrum bands.

Congress, President Obama, and the Commission have all recognized the importance of cleared federal spectrum. For example, through the Middle Class Tax Relief and Job Creation Act of 2012 ("Spectrum Act"), Congress expressed its preference for reallocating federal spectrum for exclusive, non-federal use by directing NTIA, when evaluating frequency bands, to "give priority to options involving reallocation of the band for exclusive non-Federal use and [to] choose options involving shared use only when it determines . . . that relocation of a Federal entity from the band is not feasible because of technical or other cost constraints."[4/] Similarly, President Obama has repeatedly underscored the importance of freeing up spectrum that is suitable for mobile broadband, *i.e.*, licensed, exclusive-use spectrum. In his *2010 Presidential Memorandum*, for instance, President Obama directed NTIA to "collaborate with the [FCC] to make available a total of 500 megahertz of Federal and non-Federal spectrum over the next ten years, suitable for both mobile and fixed wireless broadband use."[5/] The Commission has likewise expressed its preference "to clear and allocate spectrum . . . for exclusive commercial use to the maximum extent feasible."[6/]

Pursuant to the *2013 Presidential Memorandum*, STPI considered the spectrum proposals in the July 2012 report prepared by the President's Council of Advisors on Science and Technology ("PCAST"), which concluded that shared use should be the preferred model going forward since "clearing and reallocation of Federal spectrum is not a sustainable basis for spectrum policy."[7/] While CTIA agrees that investigating creative approaches for making federal government spectrum commercially available is important, OSTP should recognize, as CTIA has previously pointed out, that "[t]he preference for clearing and an exclusive-use approach has fostered the U.S. wireless industry's world-leading deployment of mobile broadband networks and provided tremendous economic benefits for U.S. consumers and businesses."[8/] The sharing approaches proposed by STPI – shared access to federal spectrum through short-term leases,[9/] prioritized

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ctruml.pdf ("More cleared, paired, internationally-harmonized spectrum allocations below 3 GHz are needed and needed soon.").

4/ Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, 126 Stat. 156, § 6701(a)(3) (2012) (codified at 47 U.S.C. 923(j)).

5/ *Unleashing the Wireless Broadband Revolution*, 75 Fed. Reg. 38385, 38388 (July 1, 2010) ("*2010 Presidential Memorandum*").

6/ *Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands, et al.*, Notice of Proposed Rulemaking and Order on Reconsideration, 28 FCC Rcd 11479, ¶¶ 1, 27 (2013) ("We reiterate the priority in the Spectrum Act for relocation over sharing, and our goal remains to clear and allocate spectrum for exclusive commercial use.").

7/ PCAST, *Report to the President: Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth*, at vi (July 2012) ("*PCAST Report*"), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf; *see also NRI* at 9289.

8/ CTIA 3.5 GHz Band Comments at 11; *see also* CTIA, *CTIA Statement on PCAST Government Spectrum Report* (July 20, 2012), *available at* http://blog.ctia.org/2012/07/20/pcast-report/.

9/ *See STPI Report* at 32-36.

shared access to spectrum,[10/] and PCAST's spectrum "superhighways" proposal – are particularly problematic. They raise complex challenges that are unlikely to ensure the efficient use of spectrum by federal users and will not produce spectrum that can be used by commercial wireless broadband providers on an exclusive basis.

Funding for Research and Development Activities Should Be More Broadly Available.

CTIA agrees with STPI that funding is needed to cover all costs, including research and development expenses, related to spectrum relocation, efficiency and sharing.[11/] As STPI points out,[12/] federal entities can currently recover costs incurred from vacating or sharing spectrum from the Spectrum Relocation Fund ("SRF") established by the Commercial Spectrum Enhancement Act of 2004 ("CSEA"), as amended by the Spectrum Act.[13/] The Spectrum Act recently expanded the types of costs that federal entities can receive from the SRF to include the costs of certain research, engineering studies, and economic analyses.[14/]

CTIA supports an expansive interpretation of the CSEA so that federal agencies may receive reimbursement for a range of expenses. In addition, Congress should consider modification of the CSEA so that funds remaining in the SRF after agencies complete post-auction reconfiguration are available for research and development. Today, funds that remain in the SRF for greater than eight years after they have been deposited must be provided to the Treasury for deficit reduction.[15/] Instead, Congress should allow those funds to be used by agencies that provide a detailed plan of research and development efforts that will result in more efficient spectrum use and the ultimate relinquishment of spectrum.

The SRF remains limited to requests related to auctioned spectrum.[16/] Funding should also be available to federal agencies for research and development activities unrelated to spectrum that they are required to relinquish or share. Instead, agencies should be able to engage in research and development regarding more efficient use of spectrum for which there are no immediate reallocation or sharing plans. Funding for long-term research will provide the precise incentives

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10/ *See id.* at 36-40.

11/ *See id.* at 25.

12/ *See id.* at 5.

13/ *See* Commercial Spectrum Enhancement Act, Pub. L. No. 108-494, Title II, 118 Stat. 3986 (2004) (codified in various sections of Title 47 of the U.S. Code).

14/ *See* 47 U.S.C. § 923(g)(3)(A)(iii); OMB, *Memorandum for the Heads of Executive Departments and Agencies: Guidance for Agencies on Transfers from the Spectrum Relocation Fund for Certain Pre-Auction Costs*, at 1 (Nov. 20, 2012) ("OMB Guidance Memorandum"), *available at* http://www.whitehouse.gov/sites/default/files/omb/memoranda/2013/m-13-01.pdf (noting that the changes made by the Spectrum Act "will permit agencies to receive funds for costs associated with planning for FCC auctions and relocations, spectrum sharing, the use of alternative technologies, the replacement of existing government-owned equipment with state-of-the-art systems, and the research, engineering studies and economic analyses conducted in connection with spectrum sharing arrangements, including coordination with auction winners").

15/ *See* 47 U.S.C. § 928(d)(4).

16/ *See id.* § 928(c) (stating that funds "from auctions of eligible frequencies are authorized to be used to pay relocation or sharing costs . . . with respect to relocation from or sharing of *those frequencies*")(*emphasis added*).

for federal agencies to investigate the use of more spectrum-efficient or state-of-the-art technologies and will cause them to naturally migrate to those new technologies. When that occurs, spectrum no longer necessary to support outdated technologies can be made available for commercial operations – a result that will produce several positive outcomes: better technology for federal agencies, more commercial spectrum to promote economic development, and funding from auctioning that spectrum. Funding for research and development unrelated to spectrum targeted for auction will also be consistent with federal agencies' own goals. The Department of Defense ("DoD"), for example, recently reported that it is seeking to increase the agility of its spectrum operations.[17/] Providing DoD with funding for these efforts would help expedite the process.

Of course, federal agencies' ability to access money from a research and development fund – regardless of whether it is created from excess SRF deposits or separate funding – should not be unrestricted. Agencies should be required to demonstrate how the funds can result in more efficient spectrum use. They should also be required to specify a timeframe by which their research and development efforts can reasonably be expected to lead to spectrum becoming available for commercial wireless broadband systems.

Federal Agencies Should Be Provided with Financial Incentives to Use Spectrum More Efficiently.

OSTP notes that legislation has been introduced in the House of Representatives that would expand the allowable usage of auction proceeds for agencies that voluntarily relinquish spectrum to include appropriation accounts reduced by sequestration, up to the level induced by sequestration.[18/] CTIA applauds the sponsors of that legislation, Reps. Brett Guthrie and Doris Matsui, for their forward-thinking proposal. Sequestration funds are a good beginning for ways to provide incentives to federal agencies to relinquish spectrum. These efforts are consistent with the paradigm suggested by Federal Communications Commission Commissioner Rosenworcel. As she observed:

> [W]e need a new approach that provides incentives that reward federal users for efficiency with our airwaves. . . . That is why I believe it is time for federal government users to share in the benefit from repurposing their spectrum. We need to develop a series of incentives to serve as the catalyst for freeing more federal spectrum for commercial use. We need to find ways to reward federal authorities for efficient use of their spectrum so that they see benefit in commercial reallocation and not just loss.[19/]

Congress should further investigate other ways by which agencies' budgets can be increased if they make spectrum available for commercial wireless broadband systems. While the CSEA

[17/] *See* DoD, *Electromagnetic Spectrum Strategy 2013: A Call to Action*, at 7 (2013), *available at* http://www.defense.gov/news/dodspectrumstrategy.pdf.

[18/] *See NRI* at 9290; Federal Spectrum Incentive Act of 2013, H.R. 3674, 113th Cong. (2013).

[19/] *See* Prepared Remarks of FCC Commissioner Jessica Rosenworcel, CTIA 2013 Las Vegas, Nevada, at 4-5 (May 22, 2013) ("Rosenworcel Remarks"), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-321155A1.pdf.

provides federal agencies with reimbursement for costs they incur as a result of spectrum relocation, agencies do not otherwise recognize any revenue from auction of their spectrum. Congress may wish to consider amending the CSEA and the NTIA Organization Act so that some percentage of auction revenues of spectrum voluntarily relinquished may be returned to the agencies.[20/] Agencies that agree to relinquish exclusive use spectrum should enjoy a higher percentage of auction revenues than agencies that relinquish shared spectrum. Any incentive payments provided to agencies would be *in addition* to payments that they would otherwise receive for relocation or sharing under the CSEA (unless they merely relinquish spectrum and do not relocate to other frequency bands). Similarly, agency budgets should not be reduced by the amount of payments they receive from auction proceeds; auction proceeds under those circumstances should truly be incentive payments.

Procurement Guidelines Should Be Changed to Provide Spectrum Efficiency Incentives.

Federal procurement guidelines provide agencies with incentives for a variety of purposes. For instance, Congress amended the Small Business Act to include measures that promote contracting and subcontracting with "small businesses" by federal agencies.[21/] Pursuant to this directive, 23 percent of federal contracts must be awarded to small businesses; 5 percent of federal contracts and sub-contracts must be awarded to women-owned small businesses; and 3 percent of federal contracts and sub-contracts must be awarded to service-disabled veteran-owned small businesses; among others.[22/] Agencies that fail to meet these goals must provide a justification for doing so. OMB can use similar procurement guidelines to award preferences to vendors that supply equipment or systems that feature spectrum efficient technology.

In addition, when an agency requests funding for a spectrum-based communications system, it should be required to demonstrate that the equipment and the technology it proposes to acquire represents the most spectrum efficient alternative available and that there are no off-the-shelf alternatives.

The NTIA Process for Assigning Frequencies Must Be Reformed.

Federal agencies are assigned spectrum by NTIA. However, there is no direct cost to agencies to obtain particular frequency assignments from NTIA. Moreover, the costs associated with agency use of spectrum do not vary based on the characteristics of the frequency assignment they use. Instead, NTIA charges each agency a share of a portion of its operating budget based on the

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20/ *See* 47 U.S.C. §§ 923, 928.

21/ *See* An Act to Amend the Small Business Act and the Small Business Investment Act of 1958, Pub. L. No. 95-507, § 221, 92 Stat. 1771 (1978) (codified at 15 U.S.C. § 644(g)(2)); Business Opportunity Development Reform Act, Pub. L. No. 100-656, § 502, 102 Stat. 3853, 3881 (Nov. 15, 1988) (codified, as amended, at 15 U.S.C. § 644(g)(1)); Kate M. Manuel and Erika K. Lunder, *Federal Contracting and Subcontracting with Small Businesses: Issues in the 112th Congress*, Congressional Research Service # R42390, at 1, 5 (Jan. 24, 2013).

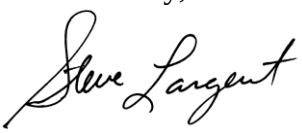
22/ *See* U.S. Small Business Administration, Statutory Goals Established by Federal Executive Agencies (last visited March 19, 2013), http://www.sba.gov/content/statutory-guidelines-0.

number of frequency assignments the agency holds.[23/] That share is unrelated to how efficiently an agency uses spectrum. Indeed, as NTIA points out, "[t]his small annual amount is unlikely to have a significant influence over agency decisions affecting spectrum use or efficiency."[24/] Frequency assignments are not distinguished by bandwidth or geography. So, an agency that uses spectrum efficiently supports NTIA at the same per-frequency level as an agency that uses spectrum inefficiently. However, all frequency assignments are not created equal. CTIA has noted that spectrum below 3 GHz, for example, is better suited for mobile broadband services.[25/] Congress should evaluate the current NTIA support mechanism so that agencies that use spectrum more efficiently – narrower bandwidth applications, for example – are not treated the same as agencies that have not taken measures to improve spectrum efficiencies.

* * *

The proposals in the *NRI* and *STPI Report* are a good beginning to providing federal agencies with incentives to use spectrum more efficiently – a result that can lead to additional spectrum becoming available for the commercial wireless broadband providers who are helping to grow our Nation's economy. Congress, OMB, NTIA, and others should now adopt plans to allow federal agencies to take advantage of these incentives. CTIA looks forward to working with OSTP and relevant stakeholders to implement these important proposals.

Sincerely,



Steve Largent

23/ *See* NTIA Responses to Senators' Questions at 9, *attached to*, Letter from Lawrence E. Strickling, Assistant Secretary for Communications and Information, NTIA, U.S. Dept. of Commerce, to The Honorable Marco Rubio, U.S. Senator (Oct. 28, 2013).

24/ *Id.* at 9.

25/ *See* CTIA 3.5 GHz Band Comments at 6-10.

Response to RFI: Agency Incentives to Share or Relinquish Spectrum

It is undisputed that the US leads the world on a number of important mobile and wireless measures, including the number of mobile broadband subscriptions, diversification of mobile technologies, the number of 4G/LTE smartphones sold, and the proliferation of mobile applications. CTIA the Wireless Association observes that key achievements have been made even in just the last five years, including growing from zero to some 50 million 4G/LTE subscriptions. Smartphone subscriptions have increased from 41 million to more than 150 million. The iPad didn't exist in 2009, but 220 million have been sold since then. Meanwhile the number of apps has increased from 150,000 to 4 million. Mobile penetration increased from the already high 89 percent to 110 percent. SMS and MMS have doubled. This short list of accomplishments doesn't begin to describe the advancements being launched in entirely new industries of m-health, m-education, and m-transportation.

But leadership in wireless rests on the effective optimization of one asset above all: spectrum.

The US has taken advantage of technologies to improve the utilization of spectrum, but relying on efficiency enhancement alone is not enough. The supply of spectrum is fixed, and it needs to be allocated and utilized more efficiently.

A suboptimal approach to spectrum management may "satisfice" for the moment, but it is not strategic for the long term. The US faces an exploding demand for mobile data, cellular telephony on licensed spectrum, and a range of devices needing unlicensed spectrum. This situation of squandered spectrum is a great concern to the nation and a threat to future economic growth and global competitiveness. Citing the National Telecommunications and Information Administration's Office of Spectrum Management, the President's Council on Advisors for Science and Technology explains the situation.

> *Federal agencies have exclusive use of 18.1% (629 MHz) of the frequencies between 225 and 3700 MHz (traditionally referred to as the "beachfront frequencies"), while non-Federal users have exclusive licenses to 30.4% (1058 MHz). The remaining 51.5% is shared, with Federal use primary and private sector use secondary. Approximately 80% of the shared allocation—or 40% of the total—have a "dominant" Federal use (e.g., radar, aeronautical telemetry) that under the current coordination regime effectively precludes substantial commercial use of those bands. In other words, nearly 60% of the beachfront frequencies are predominantly allocated to Federal uses.*[1]

[1] President's Council on Advisors for Science and Technology, "Realizing the Full Potential of Government-held Spectrum to Spur Economic Growth," July 2012. http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf; Karl Nebbia, Director, NTIA Office of Spectrum Management, presentation to the Commerce Spectrum Management Advisory Committee (CSMAC), Dec. 9, 2009.

President Obama has taken a number of actions on this issue. He deserves commendation for his important and forward-looking leadership in 2010 to require that a combined 500 MHz of of federal and non-federal spectrum be shared or relinquished by 2020. His Wireless Innovation and Infrastructure Initiative[2] described freeing spectrum through incentive auctions. The President has wisely recognized that there isn't a simple solution to spectrum management, and auctions and sharing are only two tools in the toolkit. It is a testament to his leadership that he would make such an effort, the political rewards of which will come after his presidency.

In 2012 the President's Council on Advisors for Science and Technology issued a report suggesting that relinquishing spectrum was not feasible for the high cost, lengthy transition time, and disruption to federal agencies' mission. The report suggested that sharing and better management of existing spectrum could ultimately recover 1000 MHz, twice the amount initially proposed. As a result, President Obama issued a follow up memo[3] to accelerate the sharing of spectrum, expediting commercial access to additional spectrum bands, and eliminating restrictions to commercial carrier's ability to negotiate sharing agreements with agencies.

While sharing has a role in spectrum policy, the US should certainly not give up the valuable efforts to auction relinquished spectrum for licensed use. Indeed the United Kingdom realizes 84 percent of its spectrum being traded,[4] and where necessary, the government has seized spectrum from uncooperative government agencies.

A number of economists and engineers have observed the downsides of spectrum sharing. Faulhaber and Farber estimate that sharing can reduce the value of a spectrum by 60 percent.[5] Cooper suggests that a sharing requirement made the 700 MHz band D block spectrum so unattractive that no commercial actor would take it up.[6] Moreover, in a seminal analysis of spectrum auctions in 25 countries, Hazlett and Munoz conclude that auctions overwhelmingly support consumer welfare, greater than other methods of spectrum allocation, including sharing. They estimate a lost opportunity of $67 billion in consumer welfare over 6 years for the failure to include an additional 30 MHz in the C block auction in 1996.[7]

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[2] White House Press Office, Presidential Memorandum, "President Obama Details Plan to Win the Future through Expanded Wireless Access", Feb 10, 2011. http://www.whitehouse.gov/the-press-office/2011/02/10/president-obama-details-plan-win-future-through-expanded-wireless-access

[3] White House Press Office, Presidential Memorandum , "Expanding America's Leadership in Wireless Innovation" http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio

[4] Ofcom, "Spectrum Management Strategy: Ofcom's approach to and priorities for spectrum management over the next ten years", 2013 http://stakeholders.ofcom.org.uk/binaries/consultations/spectrum-management-strategy/summary/spectrum_management_strategy.pdf

[5] Faulhaber, Gerard R and David J. Farber. "The Open Internet: A Customer-Centric Framework". International Journal of Communication 4 (2010). http://ijoc.org/index.php/ijoc/article/viewFile/727/411

[6] Cooper, Seth L. "Sharing Licensed Spectrum with Government Lessens Prospects for Wireless Broadband", The Free State Foundation, March 4, 2013, Vol. 8, No.7. http://www.freestatefoundation.org/images/Sharing_Licensed_Spectrum_with_Government_Lessens_Prospects_for_Wireless_Broadband_030413.pdf

[7] Hazlett, Thomas W. and Roberto E. Munoz. "A welfare analysis of spectrum allocation policies", RAND Journal of Economics Vol. 40, No. 3, Autumn 2009 http://mason.gmu.edu/~thazlett/pubs/Hazlett.Munoz.RandJournalofEconomics.pdf

Both sharing and relinquishing spectrum to market mechanisms are two important paths that the US needs to pursue. Sharing is seen as a solution to working with reluctant agencies that won't relinquish spectrum. However other countries, particularly the UK, New Zealand, and Australia, all with similar legal traditions to the US, have developed national markets with relinquished spectrum. The recovered spectrum is auctioned, traded, and leased. Compared to the US where some 60 percent of prime spectrum is held by government agencies unavailable to private users, in the UK over 75 percent of spectrum is available to all comers. Of this, 46 percent is occupied by private users and 29 percent is shared by private and public users.[8] Public actors occupy just 25 percent. There is no reason why the US cannot and should not develop this toolkit of capabilities. No agency should be able to handcuff the wireless future and supersede the American citizens it serves.

The Office of Science and Technology Policy (OSTP) also deserves commendation for its request for information on behalf of the White House Spectrum Policy Team to solicit ways to provide greater incentives for agencies to share or relinquish spectrum.

Federal spectrum holdings are assigned to some 60 federal agencies which don't necessarily have the information or incentives to steward their use of the resource. Given the importance of spectrum to the nation's economic health and security, a rational spectrum policy to recover unused and underutilized spectrum is in order. A Consumer Electronics Association study suggests there is a $1 trillion business opportunity in converting some $62 billion worth of spectrum. Mobile telephony is just one of many areas where high value use can be substituted for low value use, bringing greater efficiency and economic welfare.

The key theoretical notion underpinning the relinquishing of spectrum is that federal agencies procure their other resources through the market and competitive processes. There is no justification that spectrum, one of the most valuable inputs, should not be part of that process. The academic theory introduced by Herzel, formalized by Coase, and demonstrated successively with auctions, is that those who value spectrum most will pay the most for it and thereby put it to the most productive use.

Federal agencies use the General Services Administration (GSA) to procure their inputs of land and capital. They go to labor markets to hire employees. Thus agencies already have experience using markets, and this suggests that a GSA-like agency could also manage the allocation of spectrum. As government agencies do in the UK and Australia, American agencies can pay fees for spectrum, like any other inputs. An additional benefit of this process and the establishment of such a GSA-like entity would be to create transparency with a centralized database of all spectrum.

While the economics and politics to share and relinquish spectrum are important, policymakers should not forget the engineering. An excellent paper on the "Technical Principles of Spectrum Allocation"[9] offers valuable guidance on this front.

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[8] Ibid

[9] Bennet, Richard. "Technical Principles of Spectrum Allocation", TPRC 41: The 41st Research Conference on Communication, Information and Internet Policy 2013 http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2240625

Following are comments to the questions regarding spectrum fees, a spectrum fund, property rights, command and control approaches, and coordination of agencies.

Questions to Inform Development of Spectrum Policy

(A)With respect to spectrum user fees, what are the lessons learned from the United Kingdom's experience as well as any comparable efforts in other countries? To the extent that Federal agencies seek spectrum assignments based on mission-based needs, how would the imposition of user fees affect agency demand for spectrum? How would a system of spectrum user fees operate in the context of the traditional Federal appropriations process?

Lessons from the UK, New Zealand, and Australia suggest that spectrum fees can work. Though new regimes take time to develop and require audit and revision, these countries, within 2-3 years of launch, were able to realize national markets for spectrum with both public and private actors participating.

The move to national markets for spectrum began in New Zealand in 1989, followed by Australia, and the UK. User fees have been in place in the UK market for not only commercial mobile and fixed wireless services, but defense, maritime, public safety, satellite, and telemetry. In 2014 an auction for LTE spectrum in the UK using reclaimed spectrum from the military will take place.

The UK's Revised Framework for Spectrum Pricing[10] by Ofcom, the UK telecom regulator, rests on the following principles:

- The radio spectrum is a valuable resource and shortages are likely.
- Decisions by users are more likely to secure optimal use (As a general rule, better outcomes are more likely to be achieved if detailed decisions on how spectrum is used are left to those directly engaged in its use rather than dictated centrally by a regulator.).
- Most licensed spectrum users pay annual fees.
- Administrative Incentive Pricing (AIP) is used as a complement to other regulatory instruments including spectrum auctions, trading, and liberalization.

AIP was an instrument launched in 1998 to transition spectrum by application to a fee-based model. In the instances where the government is the only spectrum user, an auction is not necessarily practical. So a price needs to be established.

The notion was that spectrum should be priced to maximize the total welfare or surplus. Originally the Smith-NERA method was used to estimate marginal opportunity cost. This resulted in prices being set too low for a 2x1 MHz national channel; the price was 3 percent too low for the 900 MHz and 107 percent too low for the 1800 MHz.[11]The AIP was updated in 2002 using dynamic opportunity cost

[10] http://stakeholders.ofcom.org.uk/consultations/srsp/summary

[11] Marks, Phillipa et al. An Economic Study to Review Spectrum Policy. Indepen, Aegis Systems, and Warwick Business School, February 2004. http://www.ictregulationtoolkit.org/Documents/Document/Document/2452

pricing (though incorporating the basics of Smith-NERA) to show relative opportunity costs between multiple uses.

It was soon realized that spectrum trading and AIP can exist in the same spectrum bands and that each have advantages. With trading, there is no need to set an AIP price, but AIP can work when trading is not possible. Both methods can lead to the same outcomes.

It was noted that international services (NATO bands etc) are not suitable for AIP[12]. One of the architects of the spectrum policy, Phillipa Marks, observed, "As one of the purposes of administered incentive pricing is to ensure that supply and demand for spectrum are balanced, the operation of AIP ought to mimic what would emerge spontaneously through market interactions."[13] As such, fees are audited periodically to ensure that they match market rates that might be achieved through other means.

(B) With respect to a spectrum fund, what are alternative means to fund agency planning, research, and development? If the funding is to come from subsequent auctions of the spectrum band in question, how would agencies assess the potential risk of not being reimbursed for planning costs given that the plans may not be approved or implemented as expected? Likewise, how would such a fund be financially supported and used to promote relinquishment or sharing of bands that could be put to innovative and productive commercial uses without auctioning (e.g. unlicensed uses)? What are ways that a spectrum fund can provide a true incentive to agencies, and not simply reimburse them for costs incurred? Likewise, what is the best way to ensure that disbursements to an agency from a spectrum fund are not simply offset a corresponding deduction from the agency's budget for the following fiscal year, thus negating the incentive?

Unencumbered incentive auctions are the clear solution to this problem. The FCC defines an incentive auction as a voluntary, market-based means of repurposing much-needed spectrum for flexible use, including mobile services.[14]

This effort for incentive auctions should be applauded, but the original good idea has been marred in a few recent occasions. It is not possible to have a pure, bona fide incentive auction if arbitrary and capricious conditions are added to the auction (not allowing certain players to bid, restricting participating etc). Such practices distort the information and incentives of the agencies that are foregoing the spectrum. Without having a true reflection of the market value or the buyers interested in the spectrum, agencies can't get a clear sense of the value they are relinquishing and what returns they can expect in future. The spectrum auction has to be held in good faith and with transparency in order to work.

In this regard H.R. 3674[15], legislation currently pending in the U.S. House of Representatives, could prove helpful.

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[12] Ibid.
[13] Ibid.
[14] http://www.fcc.gov/incentiveauctions
[15] http://beta.congress.gov/bill/113th/house-bill/3674

(C) With respect to spectrum property rights, how would the introduction of such an approach affect mission capabilities? To the extent that a property right approach provides an incentive to share or relinquish spectrum already acquired, what corresponding conditions, if any, should be imposed on the acquisition of spectrum rights by one or more agencies? What are the practical or legal limitations that would affect the likely benefits of this approach related to spectrum efficiency, operational flexibility, or financial incentives? What are the potential unintended consequences (e.g., hoarding) of granting such rights and how could they be curtailed without impeding an agency's flexibility?

Overlay licenses are a possible solution to some of these challenges. An overlay license is a flexible-use license which encourages the new service provider and incumbent to find voluntary settlements to the shared spectrum. The license is awarded in an auction where the new entrant wins primary rights with the incumbent holding secondary rights. There is generally a deadline in which the incumbent needs to vacate the band. For further discussion see "Reclaiming Federal Spectrum: Proposals and Recommendations."[16]

(D) With respect to a command-and-control approach, how would efficiency gains be measured and what additional resources, if any, would be required? What kind of additional authority and resources would NTIA or OMB need to effectively implement this approach?

The command and control approach has the advantage of removing political pressure and temptation for any political actor to influence the process to relinquish spectrum. There are times when the President needs to take swift, unimpeded action. The Base Realignment and Closure (BRAC) project facilitated the difficult process of closing bases in phases following the Cold War. The US needs to take the same approach with spectrum, also known as BRAC the spectrum. A helpful discussion of this is available in "Getting Away from Gosplan: A BRAC like effort is need to repurpose federal spectrum."[17]

Spectrum is a scarce, valuable resource which should not be free. It should be reclaimed quickly with a minimum of fuss and priced in the market. The drawn out process of engaging with agency stakeholders is not productive. Dr. Marks, key architect of the UK and New Zealand policy, has observed that the US has been too lenient with agencies and "too incremental" in its approach to spectrum[18]. Other countries have used executive power to force the parties to give up the spectrum.

Sometimes a hegemon is needed to bring order for the greater good. The Federal government works this way to organize the 50 states, and a similar discipline can be applied to Federal agencies.

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[16] Skorup, Brent. "Reclaiming Federal Spectrum: Proposals and Recommendations". Mercatus Center, George Mason University, May 2013. http://mercatus.org/sites/default/files/Skorup_FederalSpectrum_v1%5B1%5D.pdf

[17] Skorup, Brent. "Getting Away from Gosplan: A BRAC like effort is need to repurpose federal spectrum" Regulation, Winter 2013-2014. http://object.cato.org/sites/cato.org/files/serials/files/regulation/2014/1/regulation-v36n4-7.pdf

[18] Presentation of Phillipa Marks, RadComms Conference, Australian Communications & Media Authority 2011. http://www.youtube.com/watch?v=VfErJk3Qhko Scroll to 27 minutes

(E) With respect to any approach, what are the means to ensure effective coordination among agencies, such that their collective efforts are brought to bear most productively, especially in the specific bands valued by the private sector? What approaches are most conducive to or dependent on spectrum sharing? What technological and logistical challenges need to be overcome and how significant are those challenges?

The President may need to do more to support the process than to make a decree. He may need to enlist the support of lawmakers and facilitate coordination and support across government, including political leaders and key institutions, not just the agencies themselves.

In the UK case, the Ministry of Finance was part of the spectrum discussion. There was a realization that "money is needed to get people to move"[19], so that in order to clear certain bands, some parties were compensated.

Another lesson is that policy makers should be weary of thinking that their design will be perfect. Indeed there is not perfect competition anywhere it the world, and it's unrealistic even to attempt it. There will always be unintended consequences. The upside is that consumers and businesses, if left to their own devices, can generally solve problems. Policy makers can also rely on competition law to address issues of consumer harm, should they arise.

In any case, it is imperative that the US move quickly in getting agencies to share and relinquish spectrum. National spectrum markets have been ongoing for more than two decades in other countries, and the US can move toward this goal. With each year passing of poor spectrum policy, the American people suffer. Squandering one of America's most important resources for lack of coordination is no longer tenable.

[19] Ibid

COMMENTS OF HANCE HANEY
SENIOR FELLOW
DISCOVERY INSTITUTE

IN RESPONSE TO
NOTICE OF REQUEST FOR INFORMATION
AGENCY INCENTIVES—SPECTRUM

The Office of Science and Technology Policy released a Request for Information that seeks comment on incentive-based measures that could promote spectrum sharing or relinquishment by Federal agencies.[1] Question (B) asks:

> … What are ways that a spectrum fund can provide a true incentive to agencies, and not simply reimburse them for costs incurred? Likewise, what is the best way to ensure that disbursements to an agency from a spectrum fund are not simply offset by a corresponding deduction from the agency's budget for the following fiscal year, thus negating the incentive?

Whether allocated for public or private use, the current process for reallocating spectrum to accommodate the explosive demand for mobile broadband services is too slow and cumbersome. The report of the President's Council of Advisors on Science and Technology, *Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth,* issued in July 2012, concludes that

> Clearing and reallocation of Federal spectrum for exclusive use is not a sustainable basis for spectrum policy due to the high cost, lengthy time to implement, and disruption to the Federal mission. Sharing of Federal spectrum, however, would provide the basis for economic and social benefits for the Nation.[2]

Subject to the caveat that secondary sharing may not be optimal for vital civilian communications in all cases, the conclusion is not unreasonable as a result of technology innovation that is making spectrum sharing an increasingly practical-looking alternative to exclusive use. The goal of multiplying the effective capacity of spectrum by a factor of 1,000 through spectrum sharing should be pursued.

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[1] 79 FR 9288 (Feb. 18, 2014) *available at* https://federalregister.gov/a/2014-03413.
[2] "Report to the President: Realizing the Full Potential of Government-Held Spectrum To Spur Economic Growth" (July, 2012) *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf (Finding 1.2).

Unfortunately, bureaucratic self-interest stands as an obstacle to this goal. According to the report,

> Federal users currently have no incentives to improve the efficiency with which they use their own spectrum allocation, nor does the Federal system as a whole have incentives to improve its overall efficiency.[3]

It's a rather breathtaking indictment of government to suggest that it won't act except in its own self-interest. Wireless innovation promises enormous benefits for the nation. Federal, state, and local governments already realize vast direct benefits, and officials should be under no illusion that the mobile communications industry can pay unlimited sums for financing the growth of government. Federal agencies are merely being asked to share unused and underutilized frequencies with the private sector. The government should limit its expectation to cost recovery and find other ways to motivate recalcitrant bureaucracies.

I. REVENUES

Spectrum auctions have raised more than $50 billion in revenue for the U.S. Treasury[4], a fact that tends to obscure other salient details and considerations. The report appropriately recommends that spectrum policies should be "based primarily on their effects on innovation and growth in wireless devices, services, and associated markets; direct revenue considerations should be treated as secondary."[5]

First, the report observes that due to significant costs associated with relocating current Federal users to other areas of spectrum, auctioning Federal spectrum for exclusive use will likely generate only "modest sums."[6] Although spectrum-sharing licenses will "also provide a way to collect an ongoing stream of revenue, if that is desired,"[7] there could also be significant costs as Federal agencies update their systems to accommodate sharing or for making more efficient use of spectrum. No one is suggesting that the agencies will be expected to absorb these costs—even though the agencies may wind up with technologically improved systems that are more useful in the process—because that would be impractical.

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[3] *Report, supra note 2,* at ix.
[4] *See, e.g.,* Julius Genachowski, "Remarks on Spectrum – As Prepared for Delivery; The White House, Washington, D.C." (Apr. 6, 2011) *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-305593A1.pdf.
[5] *Report, supra note 2,* (Recommendation 4.1).
[6] *Id.,* at ix
[7] *Id.*

The report also cites research suggesting that wireless technologies could contribute $4.5 trillion to the global economy through the expansion of existing business and the creation of new opportunities.[8] This economic growth and innovation will yield new tax revenue for Federal, state and local governments. Not counting payments for spectrum licenses, the wireless industry already generates significant tax revenue on an annual basis. Analyst Roger Entner estimates that the industry and its direct and indirect employees paid $88.6 billion in taxes in 2011—including federal, state and local fees and taxes.[9] Entner also estimates that for every 10 megahertz of additional spectrum, government tax revenues increase by $468 million.

Mobile communications also have the potential to reduce costs and improve outcomes in both the public and private sectors. In health care, for example, Darrell M. West of the Brookings Institution notes that mobile technology is "poised to alter how health care is delivered, the quality of the patient experience, and the cost of health care."[10] According to Robin Cook and Eric Topol,

> Today, all the physiological data monitored in a hospital intensive-care unit—including ECG, blood pressure, pulse, oxygenation, sugar level, breathing rate and body temperature—can be recorded and analyzed continuously in real time on a smartphone. A small piece of hardware, either the size of a cellphone, or one integrated with a cellphone, held against your body, functions as an ultrasound device. It can deliver information instantly to you or anyone you designate, and the information rivals that collected in a physician's office or hospital setting. It can do so when you are experiencing specific symptoms—no appointment necessary—and at virtually no additional cost.[11]

Robert Litan of the Brookings Institution has estimated that remote monitoring technologies could save as much as $197 billion over over a 25 year period in the U.S.[12]

In sum, government at all levels enjoys enormous direct revenue from mobile communication, and stands to gain both more revenue and enormous projected cost savings from mobile innovation, in government programs such as healthcare. The government must remember, however, that the more it taxes mobile communications services, the more it will limit usage and blunt the industry's growth.

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[8] *Id.,* at 1
[9] Roger Entner, "The Wireless Industry: The Essential Engine of U.S. Economic Growth," *Recon Analytics* (May 2012) *available at* http://reconanalytics.com/wp-content/uploads/2012/04/Wireless-The-Ubiquitous-Engine-by-Recon-Analytics-1.pdf
[10] Darrell M. West, "How Mobile Devices are Transforming Healthcare," *Brookings Institution* (May 22, 2012) *available at* http://www.brookings.edu/research/papers/2012/05/22-mobile-health-west.
[11] "How Digital Medicine Will Soon Save Your Life," by Robin Cook and Eric Topol, *Wall Street Journal* (Feb. 21, 2014) *available at* http://online.wsj.com/news/articles/SB10001424052702303973704579351080028045594.
[12] *How Mobile Devices are Transforming Healthcare, supra note 9,* at 3.

One of the key advantages of spectrum sharing is that auctions won't be necessary. Spectrum auctions do a better job of allocating spectrum for its highest and best use as compared to adjudicatory assignments or lotteries. However, auctions themselves are an imperfect relic from another era. When the current auction framework was adopted in 1993, mobile phones were relatively expensive luxury items. Since firms generally recover their cost of doing business, wireless auction proceeds affect the price of wireless services. To the extent that auction proceeds exceed the cost of the services provided by the government, spectrum auctions operate like a tax that is inefficient and regressive. As Jerry Hausman explained in a 1999 paper, "the taxation of wireless imposes high efficiency costs on the U.S. economy" due to the fact that the elasticity of demand for wireless service is "relatively high."[13] Therefore, taxes decrease the consumption of mobile communications. The opposite is also true: Lower taxes could increase usage. Tax policy ought to encourage the consumption of mobile services.

II. COMPETITION EFFECTS

Spectrum sharing should also promote competition, another important government policy objective. As the report notes, there is a limited number of business entities that have the means to participate in auctions for nationwide, long term spectrum licenses; therefore, opportunities for business entities to rent or lease spectrum "should foster the promotion and validation of highly innovative ideas through short term, low cost access to spectrum," and could increase the number of participants in the market.[14]

Increasing the number of market participants is the goal of competition policy, which currently takes some highly undesirable forms. Spectrum aggregation limits, for example, are a crude form of rationing that could seriously disrupt competition by starving some firms of the additional spectrum they need for relieving network congestion. Transforming spectrum scarcity into abundance through spectrum sharing should obviate the so-called need for ham-handed intervention by regulators to promote competition by subsidizing new entrants or less-efficient firms in one form or another. The absence of such intervention will promote economic efficiency and American competitiveness.

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[13] Jerry Hausman, "Efficiency Effects on the U.S. Economy from Wireless Taxation," *National Bureau of Economic Research* (Aug. 1999) *available at* http://www.nber.org/papers/w7281.
[14] *Report, supra note 2,* at 39

CONCLUSION

When viewed strictly from the perspective of what the government gets from mobile innovation, the answer is the government already gets quite a lot and stands to gain more if it doesn't become too greedy. If, on the other hand, the government tries to tax the industry for every penny it can get, it risks diminishing the contribution that mobile innovation can make to the nation and the world. Asking the mobile communications industry to make incentive payments above and beyond the cost of relocating Federal users to other areas of spectrum, updating their systems to accommodate sharing or making more efficient use of spectrum—and implying that it can't or won't happen otherwise—seems like an abdication of leadership.

Respectfully submitted,

/s/

Hance Haney
Senior Fellow
Discovery Institute

The views expressed herein are my own and do not necessarily reflect the views of the Discovery Institute.

Before the
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
Washington, DC 20504

In the Matter of	)	
Spectrum Policy	)	Docket No. OSTP-2014-0002-0001

COMMENTS OF T-MOBILE USA, INC.

T-Mobile USA, Inc. ("T-Mobile")[1/] submits this response to the Notice of Request for Information ("*NRI*") issued by the Office of Science and Technology Policy ("OSTP") in the above-referenced proceeding,[2/] which seeks comment on various approaches to providing federal agencies incentives to share or relinquish spectrum. T-Mobile applauds OSTP's efforts, which may lead to additional spectrum becoming available to meet the rapidly expanding demand for commercial broadband wireless capacity. T-Mobile encourages OSTP to take the next steps by working with affected stakeholders to implement these approaches and outlines, in particular, two potential mechanisms – spectrum user fees and a spectrum fund for research and development activities – that may be particularly effective to encourage efficient spectrum use, while ensuring that federal agencies have the necessary resources to meet their needs.

I. INTRODUCTION AND BACKGROUND

As the fourth largest wireless carrier in the United States, T-Mobile, including the MetroPCS brand, offers nationwide wireless voice, text, and data services to approximately 46.7 million subscribers and provides products and services through over 70,000 points of distribution.[3/] T-Mobile's 4G Long-Term Evolution network is now the fastest in the country

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1/ T-Mobile USA, Inc. is a wholly-owned subsidiary of T-Mobile US, Inc., a publicly traded company.

2/ *See Spectrum Policy*, Notice of Request for Information, Docket No. OSTP-2014-0002-0001, 79 Fed. Reg. 9288 (Feb. 18, 2014) ("*NRI*").

3/ *See* T-Mobile News Release, *T-Mobile US Reports Fourth Quarter and Full Year 2013 Results and Third Consecutive Quarter of Over One Million Net Customer Additions* (Feb. 25, 2014) ("T-Mobile

and extends to 273 metropolitan areas covering 209 million people.[4/] In the fourth quarter of 2013, we added 1.645 million net customers, including 869,000 branded post-paid net additions and 112,000 branded pre-paid net additions.[5/] As of the end of 2013, T-Mobile added more than 4.4 million total customers, and we expect to add between two to three million in post-paid subscribers in 2014.[6/]

As the President recognized in his June 14, 2013, memorandum, there is a growing need for spectrum for commercial services so carriers like T-Mobile can continue to bring innovative products and services to consumers.[7/] Accordingly, the *2013 Presidential Memorandum* established a Spectrum Policy Team and directed it to provide recommendations "regarding market-based or other approaches that could give agencies greater incentive to share or relinquish spectrum."[8/] Toward this end, the Spectrum Policy Team asked the Science and Technology Policy Institute ("STPI") to review publicly available analyses and proposals regarding incentives for agencies to share or relinquish spectrum. STPI prepared a report identifying nine major approaches to providing incentives to federal agencies,[9/] and OSTP, on behalf of the White House Spectrum Policy Team, now seeks comment on these approaches,

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Q4 Press Release"), *available at* http://newsroom.t-mobile.com/phoenix.zhtml?c=251624&p=irol-newsArticle&ID=1903058&highlight=.

4/ *See* T-Mobile News Release, *Customer Data Proves T-Mobile Network Now Fastest 4G LTE in the U.S.* (Jan. 8, 2014), *available at* http://newsroom.t-mobile.com/phoenix.zhtml?c=251624&p=irol-newsArticle&ID=1889173&highlight=; T-Mobile Q4 Press Release.

5/ *See* T-Mobile Q4 Press Release.

6/ *See id*.

7/ *See Expanding America's Leadership in Wireless Innovation*, 78 Fed. Reg. 37431, 37431 (June 20, 2013) ("*2013 Presidential Memorandum*") ("We must continue to make additional spectrum available as promptly as possible for the benefit of consumers and businesses.").

8/ *Id.* at 37434.

9/ *See* Science and Technology Policy Institute, *A Review of Approaches to Sharing or Relinquishing Agency-Assigned Spectrum* (Jan. 2014) ("*STPI Report*"), *available at* https://www.ida.org/upload/stpi/pdfs/p5102final.pdf.

grouped into four categories – spectrum user fees, a spectrum fund, spectrum property rights, and command-and-control.[10/]

T-Mobile strongly supports the goals of the *2013 Presidential Memorandum* and OSTP's efforts to implement the memorandum. T-Mobile encourages other stakeholders covered by the memorandum, like the National Telecommunications and Information Administration ("NTIA"), to act on those directives in order to increase access to federal spectrum and make more capacity available for commercial broadband systems. In particular, T-Mobile recommends the implementation of two critical processes by which federal agencies can be incentivized to maintain access only to the spectrum they need, making excess capacity available for commercial wireless broadband operations: (1) requiring agencies to pay a more realistic fee for spectrum use; and (2) allowing agencies to access research and development funds outside of the auction context.

II. COMMENTS

A. Spectrum User Fees Must Incentivize Federal Agencies to Use Spectrum Efficiently.

T-Mobile agrees with STPI that spectrum fees could potentially incentivize agencies to use spectrum more efficiently.[11/] T-Mobile proposes that one way to create proper incentives is to ensure that fees equate to the value of spectrum.

1. The Current System is Ineffective.

Federal agencies currently pay a uniform fee per spectrum assignment, which is nearly always less than what the spectrum is worth. In particular, NTIA is permitted to receive 20 percent of its operating funds on an annual basis through appropriations and 80 percent through

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10/ *See NRI* at 9289.

11/ *See STPI Report* at 18.

fees that it charges to federal agencies for spectrum management services.[12/] NTIA charges each agency a portion of the amount it is permitted to collect, based the number of frequency assignments held by each agency. For 2013, NTIA was authorized to collect a total of $26,629,916 from 46 agencies, resulting in a $108 fee per frequency assignment for all agencies.[13/] The fee structure is calculated by dividing the fixed amount each agency pays NTIA by the number of assignments each agency has assigned. As NTIA recognizes, this spectrum use fee is a "small" amount that "is unlikely to have a significant influence over agency decisions affecting spectrum use or efficiency."[14/]

The current fee process provides no incentives for federal agencies to use their spectrum more efficiently for several reasons. *First*, because agencies pay NTIA a fixed amount yearly, the more assignments a federal agency obtains, the lower the actual cost per assignment. So, instead of paying more for increased use of spectrum, agencies actually pay less per assignment. This outcome turns the incentive to make efficient use of spectrum on its head. By way of example, the Government Accountability Office has noted that the Department of Defense ("DoD") "has dramatically increased its use of unmanned aerial systems [("UAS")] in support of overseas missions" which has led to an increase in DoD's demand for spectrum assignments associated with UAS.[15/] At the same time DoD's use is *increasing*, however, its cost for each

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12/ *See* NTIA Responses to Senators' Questions at 9, *attached to*, Letter from Lawrence E. Strickling, Assistant Secretary for Communications and Information, NTIA, U.S. Dep't. of Commerce, to The Honorable Marco Rubio, U.S. Senator (Oct. 28, 2013).

13/ *See id.*

14/ *Id*.

15/ U.S. Government Accountability Office, Testimony Before the Subcommittee on Strategic Forces, Committee on Armed Services, U.S. Senate, *Spectrum Management: Preliminary Findings on Federal Relocation Costs and Auction Revenues*, GAO 13-563T, at 17 (April 24, 2013) (Statement of Mark L. Goldstein, Director, Physical Infrastructure Issues), *available at* http://www.gao.gov/assets/660/654116.pdf.

additional time and location at which it uses the assignment *decreases* – creating an institutional process at odds with promoting spectrum efficiencies.

Second, because agencies pay a flat fee to use a frequency assignment, that fee is the same amount regardless of the value of spectrum – agencies pay the same fee whether spectrum is located above or below 1 GHz, whether the assignment is 50 kilohertz or 50 megahertz, and whether the spectrum is located in rural or urban areas. This process has allowed federal agencies to access large swaths of spectrum at minimal costs, wherever they wish, with no incentive to use the minimum amount of spectrum required. For example, as T-Mobile previously pointed out, federal agencies such as DoD currently utilize 275 megahertz of spectrum across three bands of "beachfront" frequencies – 1435-1525 MHz, 1755-1850 MHz, and 2200-2290 MHz – to support Aeronautical Mobile Telemetry ("AMT").[16/] While T-Mobile recognizes the critical nature of AMT for safety in-flight testing, there is no incentive for DoD to use anything less than all 275 megahertz of spectrum. However, with more rationale spectrum use incentives, AMT systems may be able to operate with less than 275 megahertz of spectrum, particularly in light of recent technology improvements.[17/]

2. Spectrum User Fees Should Account for Differences in Spectrum Values.

It is well established that spectrum assignments have different values based on their spectral location, bandwidth, and population coverage, among other factors. As T-Mobile has explained, differences in propagation characteristics, for example, make low-frequency spectrum more valuable than high-frequency spectrum for mobile service providers.[18/] The Department

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16/ *See* Comments of T-Mobile USA, Inc., IB Docket No. 04-286, at 7 (filed Feb. 18, 2014).

17/ *See id.* at 8.

18/ *See, e.g.*, Comments of T-Mobile US, Inc., WT Docket No. 13-135, at 18-20 (filed June 17, 2013); Reply Comments of T-Mobile US, Inc., WT Docket No. 13-135, at 12-16 (filed July 25, 2013); *see also* Comments of T-Mobile USA, Inc., WT Docket No. 12-269 (filed Nov. 28, 2012); Reply

of Justice has similarly noted that "low-frequency spectrum . . . has superior propagation characteristics, permitting better coverage in both rural areas and buildings."[19/] The National Broadband Plan ("*NBP*") has likewise acknowledged the importance of low-frequency spectrum by specifically targeting the frequencies between 225 MHz and 3.7 GHz for mobile broadband services.[20/] Even DoD has acknowledged the difference, pointing out that while higher frequencies are required for accurate target location, lower frequencies are necessary for mobile communications.[21/]

In addition to spectral location, bandwidth is a critical factor in determining spectral value. Greater bandwidth allows transmission of more information, the transmission of data at

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Comments of T-Mobile USA, Inc., WT Docket No. 12-269 (filed Jan. 7, 2013); Letter from Thomas J. Sugrue, Senior Vice President, Government Affairs, T-Mobile, to Julius Genachowski, Chairman, FCC, *et al.*, WT Docket No. 12-269 (filed May 7, 2013). Commercial users recognize this difference by paying more for low-band spectrum at auction. For instance, while the recently concluded H Block auction resulted in DISH paying an average of $.50 MHz/POP for spectrum in the 1915-1920 MHz and 1995-2000 MHz bands, the auction of 700 MHz spectrum resulted in bidders paying an average of $1.11 to $1.28 per MHz/POP. *See* FCC Auctions: Auction 96 (last visited March 19, 2014), http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=96; *Auction of H Block Licenses in the 1915-1920 MHz and 1995-2000 MHz Bands Scheduled for January 14, 2014; Notice and Filing Requirements, Reserve Price, Minimum Opening Bids, Upfront Payments, and Other Procedures for Auction 96*, Public Notice, 28 FCC Rcd 13019, ¶ 172 (2013) ("*H Block Public Notice*"); J.P. Morgan, *Telecom Services & Towers: Spectrum Overview & Valuation Matrix – Carrier by Carrier Spectrum Value Across the Wireless Industry* (Dec. 5, 2012), *attached to* Letter from Trey Hanbury, Hogan Lovells US LLP, Counsel to T-Mobile USA, Inc., to Marlene H. Dortch, Secretary, FCC, WT Docket No. 12-269 (filed Aug. 15, 2013).

19/ *Ex Parte* Submission of the United States Department of Justice, WT Docket No. 12-269, at 12 (filed April 11, 2013); *see also* U.K. Department for Culture, Media and Sport, *The UK Spectrum Strategy: Delivering the Best Value from Spectrum for the UK*, at 11 (March 10, 2014), *available at* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287994/UK_Spectrum_Strategy_FINAL.pdf (noting that "[d]ifferent frequencies have different physical characteristics that make them more suitable for one type of application over another" and that "lower frequencies tend to travel further, be less susceptible to rain attenuation and penetrate buildings better compared to higher frequencies").

20/ *Connecting America: The National Broadband Plan*, at 84 (2010) ("*NBP*"), *available at* http://www.broadband.gov/plan/.

21/ *See* DoD, *Electromagnetic Spectrum Strategy 2013: A Call to Action* (2013) ("*DoD Strategy*"), *available at* http://www.defense.gov/news/dodspectrumstrategy.pdf.

greater speeds, or both.[22/] Finally, population coverage also affects spectrum value. Spectrum authorizations covering urban and more populous areas are more valuable than those covering less dense rural areas. As demonstrated in almost every spectrum auction, bidders are willing to pay significantly higher fees for spectrum licenses covering major cities such as New York, Los Angeles, and Chicago than other areas of the U.S.[23/]

Spectrum fees paid by federal entities should therefore account for these differences. More realistic fees will drive federal agencies to use spectrum more efficiently. They will also promote technological development by favoring vendors who can offer equipment solutions that use more efficient spectrum technologies.

3. Various Models Exist for Calculating Spectrum User Fees.

As STPI notes, several agencies have examined spectrum values and the feasibility of spectrum user fees.[24/] For instance, the Office of Management and Budget ("OMB") has suggested that a weighted MHz/POP metric could be a baseline for capturing the value of spectrum.[25/] Similarly, NTIA's Commerce Spectrum Management Advisory Committee has

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22/ *See, e.g.*, *Expanding Access to Broadband and Encouraging Innovation Through Establishment of an Air-Ground Mobile Broadband Secondary Service for Passengers Aboard Aircraft in the 14.0-14.5 GHz Band*, Notice of Proposed Rulemaking, 28 FCC Rcd 6765, ¶¶ 18, 58 (2013) (suggesting that "500 megahertz of spectrum at 14.0-14.5 GHz can sustain data rates of 300 gigabits per second [("Gbps")]" whereas 250 megahertz of spectrum would halve the throughput to 150 Gbps); *see also* QUALCOMM Incorporated Petition for Rulemaking, RM-11640, at 14 (filed July 7, 2011).

23/ *See, e.g.*, FCC Integrated Spectrum Auction System, Auction 96 (last visited March 19, 2014), https://auctionsignon.fcc.gov/signon/index.htm; FCC Integrated Spectrum Auction System, Auction 73 (last visited March 19, 2014), https://auctionsignon.fcc.gov/signon/index.htm; FCC, *FCC Advanced Wireless Services Auction No. 66, Final* (2006), *available* at http://wireless.fcc.gov/auctions/66/charts/66press_1.pdf; FCC, *FCC Broadband PCS Auction No. 58, Final* (2005), *available* at http://wireless.fcc.gov/auctions/58/charts/58press1.pdf.

24/ *See STPI Report* at 8-9, 13-14.

25/ *See id.* at 8-9; OMB, *Circular No. A-11: Preparation, Submission, and Execution of the Budget*, at Section 31.12 (July 2013), *available at* http://www.whitehouse.gov/sites/default/files/omb/assets/a11_current_year/a11_2013.pdf.

recommended that spectrum fees could be structured as a flat rate per MHz/POP.[26/] Contrary to STPI's suggestion,[27/] there is no reason the same metrics should not be applied to federal spectrum. The FCC routinely makes judgments regarding the value of spectrum prior to auctions when it sets reserve prices, which are also based on a MHz/POP value,[28/] and NTIA or OMB can take the same approach with respect to use of spectrum by federal agencies.

As STPI recognizes,[29/] the U.K.'s Administered Incentive Pricing ("AIP") program established by its spectrum regulatory authority – the Office of Communications ("Ofcom") – imposes value-based spectrum fees. In particular, AIP involves charging spectrum use fees to reflect the opportunity cost of spectrum denied to other uses and users, rather than just the costs of managing the radio spectrum.[30/] Ofcom has adopted eight principles and four methodologies for determining whether an AIP fee should be applied and at what level the AIP fee should be set.[31/] Pursuant to these methodologies, Ofcom will, in setting AIP fees, (1) assess current and future congestion in a spectrum band; (2) use reference rates based on the estimated opportunity cost of spectrum use, which will be informed by the market value of spectrum where appropriate; (3) convert the reference rates to fees, the calculation of which will generally be based on frequency, geographic location, bandwidth, geographical coverage, and other metrics; and (4)

26/ *See STPI Report* at 15.

27/ *See id.* at 9 (stating that OMB's methodology for calculating spectrum value in terms of weighted MHz/POP "may better capture the value of commercial communications than many government uses").

28/ *See generally H Block Public Notice*.

29/ *See STPI Report* at 16-17.

30/ *See* Ofcom, *Policy Evaluation Report: AIP*, at 1 (July 3, 2009), *available at* http://stakeholders.ofcom.org.uk/binaries/research/spectrum-research/evaluation_report_AIP.pdf.

31/ *See* Ofcom, *SRSP: The Revised Framework for Spectrum Pricing*, at 2 (Dec. 17, 2010), *available at* http://stakeholders.ofcom.org.uk/binaries/consultations/srsp/statement/srsp-statement.pdf. It also established three pricing review principles to address how and when AIP fees will be reviewed and to evaluate the success of these fees.

undertake impact assessments on the fee proposals.[32/] These principles could likewise be applied in the U.S.

STPI asserts that adopting the U.K. model may not be effective unless the adopted plan, like the AIP program, "include[s] a commitment to a timeline for raising fees to the level of opportunity costs."[33/] T-Mobile agrees and suggests that a schedule of fees should be made available so that agencies can calculate how much to allocate in their budgets for spectrum – as they do for any other asset. Congress would also be required to understand that it should not merely expand appropriations to cover increased spectrum fee costs, as doing so would defeat the desired incentive. Instead, agencies would be required to justify the spectrum use fees that they proposed to incur.

4. Performance Requirements are Necessary.

Market or value-based spectrum use fees are not the only tool that NTIA and OMB should use to ensure that agencies are actually using spectrum. In order to ensure spectrum does not lie fallow once it is authorized for federal use, agencies should be subject to an annual review to demonstrate that they are using and will continue to need their spectrum. In the commercial context, the FCC has established performance requirements to encourage spectrum use and efficiency. For instance, AWS licensees are required to make a showing of "substantial service" in their license area by the end of their license term.[34/] H Block licensees are similarly required to meet certain population-based build-out requirements during the middle and end of their

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32/ *See id.* at 4-5.

33/ *STPI Report* at 17.

34/ *See* 47 C.F.R. §§ 27.13, 27.14.

license terms.[35/] Federal entities should be held accountable for their use of spectrum with a performance showing or risk having their spectrum recaptured.

B. Eligible Costs From a Spectrum Fund Should Be Construed Broadly.

In addition to spectrum user fees, STPI correctly concludes that some form of fund is needed for costs related to planning, research and development, testing, and upgrading equipment.[36/] T-Mobile suggests that funds be made available unrelated to spectrum auctions that will enable federal agencies to engage in a variety of research and development activities. As the President's Council of Advisors on Science and Technology ("PCAST") has observed, "[e]nhancing agency budgets for the purpose of upgrading to state-of-the-art equipment could prove to be a strong incentive, since it would provide agencies with budget dollars above and beyond their normal appropriation."[37/]

Today, funding is principally available through a Spectrum Relocation Fund ("SRF") created by the Commercial Spectrum Enhancement Act of 2004 ("CSEA"), as amended by the Middle Class Tax Relief and Job Creation Act of 2012.[38/] The CSEA ties funding from the SRF to spectrum auctions, providing that funds "from auctions of eligible frequencies are authorized to be used to pay relocation or sharing costs . . . with respect to relocation from or sharing of *those frequencies*."[39/] However, the Administration should seek and Congress should approve

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35/ *See id.* § 27.14.

36/ *See STPI Report* at 25.

37/ PCAST, *Report to the President: Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth*, at 57 (July 2012) ("*PCAST Report*"), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf.

38/ *See* Commercial Spectrum Enhancement Act, Pub. L. No. 108-494, Title II, 118 Stat. 3986, (2004) (codified in various sections of Title 47 of the U.S. Code); Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, 126 Stat. 156 (2012) (codified in various sections of Title 47 of the U.S. Code).

39/ 47 U.S.C. § 928(c) (*emphasis added*).

the establishment of a fund from which agencies could draw that is unrelated to spectrum auctions.

The availability of such funding would serve the public interest for several reasons. Agencies could explore the use of equipment that would better meet their operational requirements. For example, DoD has stated that it would be useful to move to equipment that will permit it to increase the agility of its operations.[40/] Research and development funding can also produce a "virtuous cycle" of reducing agencies' spectrum costs. Agencies will be able to develop and evaluate new technologies to reduce their spectrum consumption, thereby driving down their overall funding needs, creating even more federal funds for research and development.

The fund can be created from a portion of spectrum auction revenues already available; there is currently approximately $5.3 billion in the SRF, which will be available through at least December 31, 2014.[41/] As noted above, since the use of funds from the SRF is tied to the auction of spectrum, Congress would need to amend the CSEA to allow broader use of these funds. If funding is not available from the SRF through auction revenues, Congress should establish a separate research and development spectrum fund with separate appropriations. While T-Mobile recognizes that short-term appropriations may be required to create the fund (if funding is not available through the SRF), making those resources available will produce two important long-term revenue generating benefits – more spectrum that can be auctioned for commercial use and less money spent by agencies in the future on spectrum.

40/ *See DoD Strategy* at 7 ("DoD's spectrum use will become more agile.").

41/ *See* OMB, *Fiscal Year 2014, Appendix, Budget of the U.S. Government*, at 1126-1127 (2013), *available at* http://www.whitehouse.govisitesidefault/files/omb/budgetify2014/assets/appendix.pdf.

T-Mobile appreciates the approach that the Federal Spectrum Incentive Act, introduced by Representatives Guthrie and Matsui, takes by offering federal agencies auction proceeds for relinquishing spectrum and allowing them to use such funding to offset sequestration cuts.[42/] While this could, as an initial step, create a strong incentive, as STPI notes, for federal agencies to relocate,[43/] the broader steps suggested here – requiring agencies to pay a fair price for spectrum and ensuring that they have funding for research and development to move to less spectrum use – will result in longer-term benefits to taxpayers, commercial providers, and federal agencies.

C. Spectrum Property Rights Need Not Be Afforded to Federal Agencies.

STPI suggests that spectrum property rights could provide a market-based alternative for traditional spectrum management.[44/] It also provides detail on similar approaches, including allowing shared access to federal spectrum through short-term leases;[45/] utilizing flexible license regimes and prioritizing shared access to spectrum;[46/] and establishing spectrum "superhighways" coupled with "Spectrum Currency" and "Spectrum Efficiency Fund."[47/]

Spectrum property rights, however, should not be granted to federal agencies. As STPI recognizes, granting agencies spectrum property rights could present a number of challenges. For instance, granting spectrum property rights could lead to market fragmentation, making it

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42/ *See* Federal Spectrum Incentive Act of 2013, H.R. 3674, 113th Cong. (2013).

43/ *See STPI Report* at 23.

44/ *See id.* at 25.

45/ *See id.* at 32-36.

46/ *See id.* at 36-40.

47/ *See id.* at 40-46.

difficult for a single entity to obtain a contiguous block of spectrum.[48/] Moreover, spectrum property rights may not incentivize federal agencies to use spectrum more efficiently, especially if the agency's budget is not directly affected by the use or non-use of spectrum. If the agency believes any proceeds it receives from the sale of spectrum will be offset by future budget reductions, spectrum property rights will have no impact on spectrum use.[49/] Spectrum property rights may also hinder spectrum sharing and create interference concerns.[50/]

Similarly, adopting dynamic federal spectrum sharing in secondary markets,[51/] implementing flexible access rights, and establishing spectrum superhighways are complicated approaches that are unnecessary and not consistent with ensuring the most efficient use of spectrum by federal agencies. STPI, for example, observes that all three approaches raise complex challenges, including how to allocate and manage spectrum use and to avoid interference.[52/] More broadly, these approaches may not be the most effective means to satisfy either federal or commercial users because they focus on sharing; both federal and commercial users generally require exclusive licensing.

While "property rights" such as the ability to lease, partition, and disaggregate spectrum are appropriate for commercial users, they are not for government agencies. These rights enable commercial entities to maximize revenues. Federal agencies, on the other hand, should be

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48/ *See id.* at 30 (citing the Commission of Communications Regulation of Ireland); *see also PCAST Report* at vii (asserting that spectrum should not be managed "by fragmenting it into ever more finely divided exclusive frequency assignments").

49/ *See STPI Report* at 29-30 (citing the Digital Age Communications Act Report from the Working Group on New Spectrum Policy).

50/ *See id.* at 30-31.

51/ While relying on federal users to implement secondary market mechanisms is unlikely to yield results given the lack of incentives for federal users to enter into agreements, it may be feasible for federal agencies to enter into secondary market agreements to use non-federal resources.

52/ *See STPI Report* at 35-36, 40, 44-46.

focused on fulfilling their critical mission objectives using the most efficient means possible. OSTP's spectrum policies should therefore encourage federal agencies to make their spectrum use more targeted and efficient through the incentives and funding mechanisms discussed above.

D. A Command-and-Control Approach is More Appropriate.

Rather than provide federal agencies with greater rights to their spectrum authorizations, federal spectrum management should remain under a centralized authority – specifically NTIA. The NTIA Organization Act ("NTIA Act") granted to NTIA the authority to assign frequencies to federal agencies and to modify or revoke such assignments.[53/] Agencies, as STPI recognizes, do not "own" their spectrum.[54/] In addition, as the *STPI Report* and *NBP* point out, a centralized owner of federal spectrum holdings is necessary for the administration of spectrum user fees.[55/] Consistent with the NTIA Act and *NBP*, NTIA, not the individual agencies, should remain the steward of federal spectrum holdings and decide how spectrum is used.

T-Mobile also supports further review of other similar approaches addressed in the *STPI Report*, such as processes modeled on the Defense Base Closure and Realignment Commission ("BRAC") or zero-based budgeting,[56/] the use of an OMB spectrum auditor,[57/] and the implementation of administrative relocation with a mechanism allowing the overlay license holder to negotiate relocation terms with federal entities.[58/] These proposals recognize the importance of a holistic approach with an independent manager to oversee and encourage efficient federal spectrum use. T-Mobile, however, recognizes that each of these approaches

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53/ *See* 47 U.S.C. § 902(b)(2)(A).

54/ *See STPI Report* at 25.

55/ *See id.* at 15; *NBP* at 82-83.

56/ *See STPI Report* at 46-49.

57/ *See id.* at 49-52.

58/ *See id.* at 52-55.

raise their own unique challenges.[59/] Thus, the better approach would be for NTIA to continue to leverage its expertise and maintain its proactive oversight over federal spectrum.

III. CONCLUSION

The *2013 Presidential Memorandum* directed OSTP to develop incentives for federal agencies to share or relinquish spectrum. T-Mobile appreciates the work performed by OSTP and STPI thus far to fulfill this important objective. It continues to support clearing federal spectrum for commercial use and encourages providing incentives to federal agencies to use their spectrum more efficiently to help achieve this goal. T-Mobile therefore suggests that OSTP, in developing its spectrum policies, adopt proposals that will ensure agencies pay a meaningful fee for their spectrum use and have access to sufficient funds for research and development activities.

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59/ *See, e.g.*, *id.* at 48-49 (discussing the challenges facing the BRAC approach); *id.* at 51-52 (discussing the challenges raised by the OMB spectrum auditor proposal); *id.* at 54-55 (discussing the challenges with administrative relocation with overlay license negotiation).

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Re: OSTP Request for Information on Agency Incentives – Spectrum Policy

The Edison Electric Institute ("EEI") on behalf of its member electric utilities submits these comments in response to the Office of Science and Technology Policy's ("OSTP") Notice of Request for Information ("Notice") published on February 18, 2014. In its Notice OSTP seeks public input to inform the development of recommendations "regarding market-based or other approaches that could give departments and agencies greater incentive to share or relinquish spectrum, while protecting the mission capabilities of existing and future systems that rely on spectrum use."[1] EEI urges OSTP as it examines these issues to be mindful of the importance of spectrum to electric utilities, as critical infrastructure ("CII") entities, and to proceed carefully and recognize that facilitating sharing arrangements among Federal agencies and CII entities for mission critical communications will in some cases represent the highest and best use of this spectrum, and will support a variety of Federal goals and policies.

[1] Spectrum Policy, Notice of Request for Information, Office of Science and Technology Policy, 79 Fed. Reg. 9288-9289 (February 18, 2014).

DISCUSSION

I. Introduction and Utility Spectrum Needs

EEI is an association of United States investor-owned electric utilities and industry associates worldwide. Its U.S. members serve almost 95 percent of all customers served by the shareholder-owned segment of the U.S. industry, about 70 percent of all electricity customers, and generate about 70 percent of the electricity delivered in the U.S. EEI frequently represents its U.S. members before Federal agencies, courts and Congress in matters of common concern, and has filed comments in various proceedings affecting the interests of its members.

EEI's members make extensive use of communications as providers of CII services, both as owners and operators of private communications systems, and as end-users of commercial communications networks. Electric utilities utilize both licenses and unlicensed spectrum. They are in fact among this nation's largest users of communications networks and services and, over the years, have invested and continue to invest billions of dollars in communications plant as this nation's electric grid is modernized. In fact this investment has grown exponentially over the last five years. Electric utilities make particular use of communications in their vital Supervisory Control And Data Acquisition ("SCADA"), distributed automation and field operations systems. Many utilities have found that they cannot rely on commercial networks for critical communications because their requirements for latency and reliability, particularly during emergencies, cannot be met.

As was recognized in the National Broadband Plan, electric utilities have a growing need for spectrum in order to carry out their core mission of safely and reliably delivering electric service to most, if not all, of the nation's residential and business consumers. This need has become even more critical as demonstrated by severe weather events such as Hurricane Sandy,

when private utility networks remained in service and available to CII emergency response crews even after commercial networks went down. The heightened cybersecurity risk faced by utilities has also increased the need for utility access to secure spectrum.

II. OSTP Should Support and Encourage Prioritized, Dynamic Spectrum Sharing Between Federal Agencies and CII Entities

As described in the Notice, the fundamental purpose of OSTP's overall inquiry is to evaluate market-based and other 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. EEI urges the Administration to eschew an approach based purely on direct revenue considerations and instead look at broader issues such as effects on innovation and facilitating the achievement of national priorities such as grid modernization and cybersecurity. This approach would align with the recommendation from the President's Council of Advisors on Science and Technology ("PCAST") that "policies enabling commercial access to Federal spectrum be based primarily on their effects on innovation…direct revenue considerations should be treated as secondary."[2]

Some commercial entities use spectrum with an eye toward public purpose as well as innovation. CII entities such as electric utilities are classic examples of this. While for the most part private entities, as noted above, utilities provide vital public services relied on by most, if not all, of the nation's government agencies, military bases, public safety and emergency health care services, as well as business and residential users. Moreover, utility crews often act in close support of first responders. Electric utilities rely on spectrum in this regard for purposes of

[2] Recommendation 4.1, *Report to the President Realizing the full Potential of Govern-Held Spectrum to spur Economic Growth.* Executive Office of the President President's Council of Advisors on Science and Technology, xiii (July 2012).

emergency response – to ensure the safety and protection of consumers and electric utility service personnel, as well as for purposes of service restoration – to facilitate the natural recovery of infrastructure and to more effectively dispatch field crews. Moreover, ensuring the reliability and resiliency of this nation's electric grid and protecting it from cyber-attack have become major national goals.[3] Electric utilities also increasingly use communications in new and innovative ways to facilitate grid modernization.

In addition, expanded deployment of variable generation, such as wind and solar power, on the bulk power system, and new intelligent load devices and appliances on the consumption side necessitate novel approaches to how electric power is managed and delivered. Innovative use of communications technologies and spectrum by electric utilities is a key component in this effort, further underscoring the importance of dynamic spectrum sharing. The expected continuing evolution of the electric power system through penetration of small-scale photo-voltaic systems and growing interest in net-zero buildings and building-to-grid integration are among the issues that have serious consequences for future grid operations and value creation and realization. Of particular concern is that significant growth of variable generation resources has already made it increasingly difficult to use the traditional load-following system.[4] At the same time, increased use of distributed energy resources and the electrification of transportation[5] has increased electric power system complexity and introduced new challenges. This evolution of the electric system may lead to more distributed control of the grid especially at the

[3] Executive Order 13636, *Improving Critical Infrastructure* (February 12, 2013).

[4] Historically, the electric power system was operated as load-following system in which loads were variable but predictable, generation was dispatchable, and there was no significant amount of bulk energy storage in the power system. In this environment, generation resources were operated through periodic dispatches that roughly aligned supply with demand and allowed automatic closed-loop controls to adjust generation to precisely match load.

[5] For example, electric vehicles present the possibility of increased peak loads if large groups of electric vehicle owners opt to charge their vehicles in the evening when they come home from work.

distribution level, with much faster operation, and more automated control which, with human supervision, can be coordinated to span multiple levels of grid hierarchy. A key issue, then, is how electric utilities will transition from traditional controls to this advanced control framework. Moreover, as the grid evolves new sensors, actuators, distributed and centralized control elements must be deployed. In this context, devices and systems employed by utilities must support information gathering and automation in a manner that is much more flexible than has been needed for operating the traditional grid. This entails multiple levels of control that differ greatly from what exists today because it will require end-to-end communications, with interoperability between systems. Utilities' ability to share spectrum on a prioritized basis with Federal agencies is essential to facilitate these innovative forms of communications.

Utility communications have become vital as billions of dollars are invested in modernizing the electric grid in order to meet national goals of grid reliability, resiliency and security. While electric utilities rely on commercial carriers where possible, they must rely on their own private networks for certain critical Supervisory Control And Data Acquisition ("SCADA") systems and other communications. As a result, the unmet spectrum needs of electric utilities have grown considerably – a phenomenon acknowledged by the FCC in the National Broadband Plan when that agency recommended utilities "be empowered to construct and operate their own mission-critical broadband networks."[6] Unfortunately, all attempts by electric utility to effectuate the FCC's recommendation have been rejected.

This Notice presents a meaningful opportunity to address at some level the unmet spectrum needs of electric utilities and other CII entities. Many Federal agencies now find

[6] National Broadband Plan at 251

themselves in a position similar to electric utilities in that they have mission-critical needs that limit their ability to rely on commercial carrier networks. Consequently, in many instances Federal agencies and CII entities may make ideal partners for sharing spectrum based on negotiated arrangements that address fundamental issues such as prioritization. The Department of Defense ("DoD") pointed to such arrangements in its recent "Electromagnetic Spectrum Strategy—A Call to Action" paper ("EMS Paper").[7] There, DoD acknowledged the growth in its spectrum requirements and expressed willingness to "identify and evaluate incentives for spectrum sharing while developing spectrum policy…to share spectrum through agreements and on an on-demand basis with an understanding of potential risks spectrum sharing entails."[8]

Specifically, EEI sees value in an approach that focuses on prioritized dynamic access to spectrum, with licensed primary access by Federal agencies and exclusive shared licensed access by CII entities based upon a long-term arrangements agreed to by the parties. This approach will allow licensed CII users access to unused or underused spectrum. EEI believes that this model holds great potential for facilitating shared use of spectrum, maximizing access to and efficient use of spectrum, and keeping costs low.

Given the critical nature of much of the Federal and CII communications which might be involved, both shared use and prioritization thereof requires a flexible approach and should be negotiated between or among the parties. It is worth noting that there likely will be sufficient bandwidth to permit sharing among CII and Federal agencies, if proper technology is used and the network is appropriately managed. Such technology could manage the co-existence of

[7] Department of Defense, Electromagnetic Spectrum Strategy – A Call to Action (Sept. 2013), available here: http://www.defense.gov/news/dodspectrumstrategy.pdf.

[8] EMS paper at 1, 7.

parties seeking to share network spectrum and infrastructure, and make it easier to coordinate shared usage of spectrum. For example, in some instances Long Term Evolution ("LTE") technology may have the ability to provide allocation capability as well as a convergence of voice, data and video over a shared infrastructure. This technology could regulate usage and over-subscription of capacity, and may provide a shared usage schema that eliminates the need to consider the question of shared usage.

As an initial matter, not all traffic from utilities would need to be classified as "critical." Utilities operate both critical and non-critical services, and require priority shared access only for critical services with public safety impacts. What constitutes a critical utility service may vary between regions and, therefore, any prioritization guidelines for shared use should be flexible to permit utilities and Federal agencies to work together in determining how best to manage prioritization.

Generally, however, there are four primary utility application groups that likely would involve critical communications: (1) voice, such as push-to-talk dispatch for field crews, is an essential service during restoration and service switching operations; (2) mobility, similar to voice, is essential to support service restoration and field service dispatch; (3) SCADA telemetry; and (4) distribution automation, which enables automatic and remote switching of lines, and allows utilities to identify and isolate faults and to monitor grid health and emergency restoration efforts in real-time. Distribution automation improves reliability through real-time monitoring and intelligent control in normal and emergency operations, and enables faster service restoration. Automated line switching capabilities allow important service restoration efforts to occur without endangering utility crews who otherwise must manually operate distribution switches. As a result, distribution automation serves an important public safety function for field

crews and the public at large. EEI notes that use cases beyond these four could also involve critical communications (*e.g.*, video surveillance of electric system events; electric system physical security; data collection points for disparate utility communications systems; fixed voice in remote areas, etc.). Therefore, flexibility is essential to allow utilities to rely on non-preemptible prioritized shared access such that they can manage their operations based on varying circumstances.

CONCLUSION

In sum, OSTP should endorse an approach that supports and encourages dynamic spectrum sharing between Federal agencies and CII entities, including utilities, and that recognizes the value of such shared use. It should develop a proposal that encourages sharing arrangements between government and CII entities, and does not hinder these entities' ability to make the most efficient use of spectrum through opportunities for sharing. In this manner, shared use of spectrum will improve efficiencies, making networks more cost-effective and affordable, and will further support the critical communications needs of electric utilities and other CII entities.

Respectfully submitted,

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Re: Agency Incentives—Spectrum

These comments are in response to the Office of Science and Technology's Notice of Request for Information of February 14, 2014. OSTP is requesting input "regarding market-based or other approaches that could give departments and agencies greater incentive to share or relinquish spectrum, while protecting the mission capabilities of existing and future systems that rely on spectrum use."

These comments are drawn from our earlier Technology Policy Institute paper on options for increasing spectrum for broadband.[1] Although major elements of our proposal have been summarized in the Institute for Defense Analysis's Science and Technology Policy Institute review commissioned by OSTP,[2] it seems useful to supplement that review with a more complete discussion as presented in our paper.

These comments are primarily responsive to Question A:

> (A) With respect to spectrum user fees, what are the lessons learned from the United Kingdom's experience as well as any comparable efforts in other countries? To the extent that Federal agencies seek spectrum assignments based on mission-based needs, how would the imposition of user fees affect agency demand for spectrum? How would a system of spectrum user fees operate in the context of the traditional Federal appropriations process?

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[1] Thomas M. Lenard, Lawrence J. White, and James L. Riso, "Increasing Spectrum for Broadband: What are the Options," February 2010, available at http://www.techpolicyinstitute.org/files/increasing_spectrum_for_broadband1.pdf. Lenard and White are the authors of these submitted comments.

[2] https://www.ida.org/upload/stpi/pdfs/p5102final.pdf.

The essence of our proposal consists of two elements:

1. The establishment of a Government Spectrum Ownership Corporation (GSOC) that would own government-used spectrum and lease it to agencies at market-based rates, much in the same way as the General Services Administration (GSA) does with real estate.
2. Making spectrum allocation decisions a more integral part of the annual Office of Management and Budget (OMB) budgeting process.

These proposals are discussed in more detail below.

The Problem: Government Spectrum Use and Opportunity Costs

There is a widespread consensus that spectrum in government hands is likely not being used efficiently and that some—perhaps a significant amount—could be reallocated to more efficient private uses.[3] However, efforts to determine the extent of this "surplus" and then to devise a method of freeing it from government hands confront a dilemma: the absence of a market mechanism, or even a budgetary mechanism, that could encourage this reallocation.

First, government agencies do not operate in a market context, and profit maximization is not their goal. Consequently, the "opportunity cost" paradigm that naturally applies in a market-oriented context is often neglected within government agencies.

Second, unlike most of the inputs that are used by a government agency—e.g., personnel, materials, vehicles and equipment, rental real estate—which are subject to annual budgetary allocations, the spectrum that is under a government agency's control was received from the Department of Commerce and now is effectively "owned" by the government agency. From the agency's perspective (i.e., the perspective of the agency's senior management), the spectrum is a free resource, for which it pays no rent or upkeep costs. The perceived opportunity costs of spectrum are small at best, since there is no market for this spectrum.

Further, even if there were an active market for government-held spectrum (and hence readily apparent opportunity costs), and even if a government agency were interested in increasing the resources that are at its disposal, the agency could nevertheless be largely indifferent to those opportunity costs for the following reason: If an agency were to sell its spectrum, the agency's net

[3] This is implied by the broadly popular Radio Spectrum Inventory Act, which is premised on the ability to "promote the efficient use" of spectrum. Bykowsky and Marcus (2002) note that some observers believe that the public sector employs too much spectrum to meet its ends; e.g., in 1996 former Senator Larry Pressler recommended that the federal government reallocate 25% of its holdings below 5 GHz (see https://www.policyarchive.org/bitstream/handle/10207/8335/bg-1085.pdf, p. 8). In addition, Cave and Morris (2005), and Carter and Marcus (2009) illustrate why the nature of government users leads to the expectation that they will not use spectrum efficiently.

gain might be far smaller than the selling price—or even zero. That result could occur due to budget reallocations that would net out the agency's gain. From an agency's perspective, a better strategy might well be to make some use of the spectrum under its control (even if that use is of low value, as judged by opportunity costs), or even to let the resource lie idle and wait for some future use, since doing so is costless.

As an analogy, one might think of real estate that, at some time in the past, had somehow come under a government agency's ownership and control. If that real estate has little or no upkeep costs, then from the agency's perspective it is a free resource. The opportunity costs of the real estate may be of little interest to the agency, for the budgetary recoupment reasons mentioned above. The agency may put the real estate to low-value uses, or even keep it idle. When challenged by higher governmental authority, an agency's narrow interests will be best served by claiming that the real estate is vital to the agency's current and future functions.

There are limits, of course, to the real estate analogy. As compared with spectrum, the opportunity costs of an agency's real estate holdings are likely to be much clearer. Physical inspection of the property to determine whether the agency is making reasonable use of it (in light of its opportunity costs) is surely easier as well.

Accordingly, the task of determining the extent of surplus spectrum in government hands and "liberating" it for reallocation to wireless broadband use will be even more difficult than if the resource being considered were real estate. Further, implicit in this discussion is the inability to bring the power of the profit motive as a force for assisting in the reallocation.

As a consequence, the effectiveness of market or quasi-market mechanisms in identifying and freeing up government spectrum might be limited—at least in the short run. The experiences of other countries support this pessimism. Although many governments give some lip service to improving their allocation of spectrum, only the United Kingdom appears actually to have instituted a system of "administered incentive pricing" (AIP), which has provided direct pricing incentives for some government agencies to use spectrum more efficiently. But the United Kingdom began developing its AIP policies over a decade ago, and AIP appears to have induced only marginal results during that time.[4]

This general skepticism of the ability of market-based efforts to identify and free up existing spectrum that is in government hands does not extend to the use of market-based methods when agencies seek additional spectrum. In such instances, agencies should be required to pay the opportunity costs for their spectrum use. Consistent with this approach, agencies should also be

[4] See, for example, Cave and Morris (2005); HM Treasury (2005); Ofcom (2006, 2007); Cave et al. (2007); UK Spectrum Strategy Committee (2009); and Carter and Marcus (2009).

encouraged to purchase *communications services* rather than the spectrum itself, since such purchases would likely mean greater economizing on the use of the spectrum.

Short-Run Recommendations

Administrative mechanisms hold the greatest promise, at least for the short run:

1. NTIA should prepare an annual report that presents data on the government's spectrum inventory, the opportunity costs of the various bands, and the likely sources of surplus spectrum. The data on surplus positions should take into account changes in usage and technology.
2. OMB, as part of its annual budget process, should require any U.S. government agency that has a spectrum allocation to provide an annual accounting of that agency's use of that spectrum. OMB should have a heightened awareness of spectrum as a scarce resource (the NTIA estimations of opportunity costs would help in this awareness) and should routinely search for under-utilized spectrum that could be auctioned by the FCC.[5] In essence, OMB should become a skeptical auditor of government-held spectrum, its use, and its opportunity costs.
3. OMB should encourage (and provide the funding for) agencies to create employee incentive plans that would provide rewards (including cash awards) to agency employees for devising ways for their agency to economize on its use of spectrum. The spirit of these awards would be consistent with other government awards that encourage employees to take special efforts to utilize resources efficiently and to provide outstanding performance.

Long-Run Recommendation: A Government Spectrum Ownership Corporation

Pricing mechanisms for allocating existing government-held spectrum are likely to be ineffective for the short run, but the federal government should pursue AIP mechanisms over the longer run.

One simple model for exploration in this direction is based on the market-oriented rental rates that agencies are charged when they lease space in buildings that are owned (or leased) by the GSA. The GSA's Federal Buildings Fund (FBF) provides recognition of the opportunity costs of those buildings.[6] The government agencies make rental payments to GSA, which can use the money to acquire additional property if necessary. These rental payments provide an incentive for government agencies to economize on space.

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[5] OMB should also be encouraging agencies to share the use of under-utilized spectrum, again encouraging greater efficiency.

[6] As another analogy, government agencies pay postal rates to the U.S. Postal Service (USPS) when the agencies make hard-copy mailings through the USPS.

Suppose, then, that all U.S. government-used spectrum were "owned" by a central government agency and leased to government users. In this case, the idea that the spectrum-using agencies should pay rental fees to —and that those rental fees should represent something approximating the opportunity costs of the spectrum holdings—would not be much different from the practice that government agencies pay rent for their use of the GSA's buildings.

Accordingly, the federal government should create a "Government Spectrum Ownership Corporation," or GSOC. The GSOC would take possession of all government-held spectrum, with the existing user agencies granted annual leases (that are perpetually renewable at the option of the agency) at annual rental rates that are determined by the GSOC, based on its estimates of the relevant opportunity costs. The GSOC would forward its net proceeds to the Treasury. In the first year OMB would add to each using agency's budget a sum that is just equal to the rental payment, so the first year's financial transactions would be a "wash" for all agencies (and for the Treasury).

In subsequent years the agencies' budgets would start from the base that included the initial allocations and rental charges; but the GSOC would change the rental rates in light of updated information about opportunity costs. The agencies and OMB would then negotiate (as they do now) over resource usage and budget allocations; but, although the agency's budget would take into account its spectrum rental costs, there need not (and should not) be a one-to-one adjustment in an agency's budget allocation in relation to any changes in its spectrum rental costs. Instead, the agency's budget allocation should reflect its overall resource needs in light of its overall mission and operations. Thus, this "normal" budgetary negotiation process would recognize the opportunity costs of spectrum in the same ways that the opportunity costs of an agency's use of other resources are recognized.

The goal would be that such a system would (like the GSA framework) provide sensible incentives for agencies to economize on spectrum use. The GSOC might then have a surplus of spectrum that it could sell or lease to the private sector (or turn over to the FCC for auctions). The GSOC could also accumulate a fund (again, similar to GSA) that could be used to purchase additional spectrum if needed for leasing to government agencies.

Respectfully Submitted,

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Before the
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
EXECUTIVE OFFICE OF THE PRESIDENT
THE WHITE HOUSE
Washington, D.C.

In the Matter of	)	
	)	
Spectrum Policy	)	FR Doc. 2014-03413
Notice of Request for Information	)	
	)	

RESPONSE OF LOCKHEED MARTIN CORPORATION

With the continuing revolution in communications technology, improvements in the use of spectrum by both the government and the private sector are ever more critical for both our national and economic security. Simply put, the spectrum needs of both Federal agencies and the private sector are expanding quickly and dramatically. To ensure greater efficiency in the use of spectrum, it is important to identify technology solutions that will enable Federal and non-federal users to share spectrum. In so doing, "protecting the mission capabilities of existing and future [government] systems that rely on spectrum use"[1] must be a priority.

There is a broad consensus that the commercial sector needs access to additional spectrum to meet the demand for broadband services; there is also a broad consensus that meeting this demand is an important national priority. At the same time, there is a broad consensus that Federal agency missions are increasingly enabled by platforms, systems and solutions that are spectrum-dependent, resulting in spectrum resources being increasingly critical

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[1] Presidential Memorandum, *Expanding America's Leadership in Wireless Innovation* (June 14, 2013) ("*Presidential Memorandum*"), § 6, available at http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio.

to our military, to our homeland security, to our national air space, and to other important national priorities that equally serve the citizens of the United States.

Given that Federal agencies face ever-greater requirements for access to spectrum resources, they face pressure to cooperate among themselves to improve their ability to share spectrum intra-governmentally. When combined with the pressure of the commercial mobile broadband industry to access spectrum currently supporting Federal agencies, it is logical that Federal agencies can see the merits of finding a means for sharing spectrum. This means that our spectrum policy should encourage Federal agencies to invest in technologies that will facilitate spectrum sharing, as that will ensure that agencies can meet both their current and their future mission-critical needs.

To be effective, any system providing incentives for agencies to share spectrum must give agencies the confidence that they will have the funding needed to develop and implement new technology solutions and/or to upgrade their systems to improve spectral efficiency. The best way to accomplish this is to ensure that agencies have the ability to access auction proceeds both to fund targeted R&D in spectrum sharing technologies, and to procure and deploy those technologies. The Federal agencies are uniquely positioned to conduct such R&D programs, given their inherent understanding of the mission and capabilities requirements.

I. Incentives to Share Spectrum Must Promote the Deployment of Innovative New Technologies by Federal Agencies.

Lockheed Martin fully supports the effort of the Spectrum Policy Team to advance the dual goals set forth in the *Presidential Memorandum* of "mak[ing] additional spectrum available as promptly as possible for the benefit of consumers and businesses" while "ensur[ing] that Federal, State, local, tribal, and territorial governments are able to maintain mission critical

capabilities that depend on spectrum today, as well as effectively and efficiently meet future requirements."[2] These goals are achievable, but only if Federal agencies have the ability to develop and acquire the most effective and efficient spectrum-dependent platforms, systems, and solutions.

As President Obama stated in 2010, "We can also unlock the value of otherwise underutilized spectrum and open new avenues for spectrum users to derive value through the development of advanced, situation-aware spectrum-sharing technologies."[3] These words apply equally to the use of Federal and non-federal spectrum. Fulfillment of these goals requires that agencies be certain they will have the means by which to increase their efficiency in use of spectrum.[4] The Spectrum Policy Team's recommendations should favor mechanisms that will promote increased spectrum efficiency, and must make it as easy as possible for agencies to take advantage of these mechanisms.

As Assistant Secretary of Commerce Larry Strickling said recently, the Obama Administration's commitment to solving the challenges faced in achieving the more efficient use of spectrum "is centered on developing the necessary technology innovations and policy initiatives to support a new and more collaborative way of doing business for federal spectrum."[5]

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2 *Presidential Memorandum*, at p. 1.

3 Presidential Memorandum, *Unleashing the Wireless Broadband Revolution* (June 28, 2010), available at http://www.whitehouse.gov/the-press-office/presidential-memorandum-unleashing-wireless-broadband-revolution.

4 The Department of Defense has made increasing the efficiency with which it uses spectrum a key element of its recently-announced "Spectrum Strategy," stating that "DoD must become more efficient, flexible, adaptable, and agile in its spectrum use in order to have the spectrum access required when and where needed to achieve mission success, particularly in the face of competition for access." Department of Defense, Electromagnetic Spectrum Strategy 2013: A Call to Action, dated Sept. 11, 2013 (rel. Feb. 20, 2014), at p. 6, available at http://www.defense.gov/news/dodspectrumstrategy.pdf.

5 Remarks by Lawrence E. Strickling, Assistant Secretary of Commerce for Communications and Information, "The Spectrum Sharing Paradigm," NTIA/NIST Innovative Spectrum Sharing Technology Day, Washington,

To be sure, enhancing the spectral efficiency of any spectrum-dependent system, platform or solution requires an ability to continually innovate. This is especially critical for Federal agencies, which must not be constrained in their ability to procure new technologies that enhance their use of any given spectrum band. Furthermore, as history has shown, the innovations produced by Federal government R&D and other programs have had transformative economic and social benefits for the consumer, the business sector, and the public safety community, from the development of cellular phone technology, to the Global Positioning System, to the Internet.

The Spectrum Policy Team, therefore, should focus its recommendations on measures that will facilitate federal agencies' ability to innovate, whether through the development of new sharing technologies or through upgrades to mission-critical Federal systems. In addition, the recommendations should enable Federal agencies to extend any spectrum sharing capabilities to non-federal spectrum. As spectrum sharing protocols are devised and proven, Federal and commercial users each will develop confidence in their ability to share spectrum effectively, and thus will increase their motivation to do so.

There have, unfortunately, been a number of instances in the past where Federal agencies have agreed to share spectrum, expecting to have continued use of those frequencies – only to have had those expectations dashed. The adage, "once burned, twice shy", applies to agencies as well as people. Therefore, any incentive system also should include clear, unambiguous processes and timelines to resolve harmful interference or address failures of technologies to perform as set forth in FCC rules. Without the knowledge that spectrum sharing regimes will

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DC (Nov. 5, 2013), available at http://www.ntia.doc.gov/speechtestimony/2013/remarks-assistant-secretary-strickling-innovative-spectrum-sharing-technology-d.

include adequate safeguards to ensure their ongoing ability to support federal missions, it would be irresponsible for federal agencies to agree to share spectrum.

As discussed below, a "Federal Spectrum Innovation Fund" created to provide a source of "off-budget" funding which agencies can use for research, development, and deployment of new and innovative technologies to enable spectrum sharing may offer the right incentives. However, the imposition of spectrum user fees would do little if anything to provide useful incentives to accomplish the goals of the *Presidential Memorandum*. And while some may suggest that affording agencies greater property rights in their allocated spectrum may possibly offer some incentives, the meaning of property rights in this context is inherently unclear – and could never provide agencies sufficient certainty to encourage sound decision-making.

II. A Spectrum Innovation Fund Is A Positive Incentive To Further Spectrum Sharing.

As noted above, Federal agencies will be motivated to share spectrum if they can be sure that doing so will enable them to deploy new sharing technologies or to upgrade their systems to become more spectrally efficient (while maintaining mission capabilities). The reimbursement of agency relocation costs under the currently-existing statutory regimes provides insufficient incentives, and other ideas (such as the Spectrum Efficiency Fund/Spectrum Currency concept offered by the President's Council of Advisors on Science and Technology ("PCAST")), involve complications that would jeopardize their successful implementation.[6] Like the Commerce Department's Spectrum Management Advisory Committee ("CSMAC"), Lockheed Martin favors the creation of a Federal Spectrum Innovation Fund ("Fund") that would encourage

[6] For example, the Spectrum Efficiency Fund/Spectrum Currency concept envisioned by PCAST might involve an OMB-conducted competitive auction involving multiple agencies, which would introduce significant uncertainties.

Federal agencies to invest in increasing their spectrum efficiency by providing dedicated funding to pay for feasibility studies, R&D, planning, and upgraded equipment.[7]

The concept of a Federal Spectrum Incentive Fund (Fund), which would make available to Federal agencies a portion of the proceeds of auctions involving spectrum to be shared, would appear to be a step in the right direction;[8] however, any such fund needs to be administered in a clear, concise manner – the greater the ambiguity or uncertainty, the less incentive provided. Such a fund could offer agencies a dedicated source of funding for the necessary research and development of sharing technologies and/or upgrades to their systems to enhance their ability to share confidently – whether by enabling greater sharing among multiple agencies' diverse platforms, systems and solutions, or by enhancing the ability to share with non-federal systems.

However, any such fund must be independent of, and cannot be in lieu of, the cost recovery provided Federal agencies under the Commercial Spectrum Enhancement Act (CSEA),[9] as expanded by the 2012 Spectrum Act.[10] To assure accomplishment of the goal of encouraging more efficient Federal spectrum use, any new Fund should require that agencies use the fund for purchases directly relating to achieving this objective. The Fund also could be used to fund reimbursement of other costs associated with such upgrades.

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7 *See* Final Report of the Incentive Subcommittee, Commerce Spectrum Management Advisory Committee, adopted Jan. 11, 2011, at pp. 15-19 ("*CSMAC Incentives Committee Report*"), available at http://www.ntia.doc.gov/report/2011/final-report-incentives-subcommittee.

8 A "Federal Spectrum Incentive Fund" would be created under pending bi-partisan legislation (H.R. 3674), which was approved by the House Energy and Commerce Committee on December 22, 2013.

9 Commercial Spectrum Enhancement Act of 2004 (CSEA), Title II of H.R. 5419, Pub. L. No. 108-494, 118 Stat. 3986 (2004).

10 *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, 126 Stat. 156 (2012) ("Spectrum Act"), §6701. Section 6701 of the Spectrum Act extended the CSEA cost reimbursement mechanism for Federal incumbents to include sharing as well as relocation costs, and to facilitate Federal incumbents sharing of spectrum with commercial users by expanding the types of expenditures that can be funded or reimbursed from the Spectrum Relocation Fund.

Establishment of the Fund would create a virtuous cycle in which the incentives created for Federal agencies – to use spectrum more efficiently and acquire new technology to do it – will likely trigger increased private sector investment in research and development, thereby serving to boost America's economy by creating additional high-paying jobs.

III. Imposing Spectrum User Fees on Federal Agencies Will Not Provide Useful Incentives and Indeed Could Have Harmful Effects.

Some economists have theorized that imposing spectrum fees on Federal agencies will give those agencies a greater incentive to use their assigned spectrum more efficiently. As the report of the Science & Technology Policy Institute ("STPI") acknowledges, however, the issues surrounding the implementation of any spectrum fee regime "remain a significant challenge to the approach's feasibility."[11] Lockheed Martin agrees with this conclusion, and in fact believes that a spectrum fee regime cannot work as an incentive for Federal agencies because it ignores real-world considerations.[12]

First and foremost, the market theory on which spectrum fees is based simply does not apply in the government context. The underlying rationale for fees is that, when faced with a cost that rises proportionately with the amount of spectrum used, a spectrum user will naturally seek to limit its use. While this rationale makes sense in a commercial context, Federal agencies and their spectrum managers are motivated not by market forces but instead by their obligation to provide the necessary spectrum to support their agencies' missions. Agencies subjected to

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[11] *See* IDA Paper P-5102, *A Review of Approaches to Sharing or Relinquishing Agency-Assigned Spectrum*, IDA Science & Technology Policy Institute, January 2014 ("STPI Report"), at p. 18, available at https://www.ida.org/upload/stpi/pdfs/p5102final.pdf.

[12] PCAST also has concluded that a system of spectrum fees is "likely to run into practical difficulties that would render it ineffective." *See* President's Council of Advisors on Science and Technology, *Report to the President: Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth* (July 2012), at p. 55, available at http://www.whitehouse.gov/administration/eop/ostp/pcast/docsreports.

spectrum fees simply will incorporate the fees into their budgeting processes. There is no direct line – and maybe no line at all – between an agency paying spectrum fees and an agency sharing spectrum. In addition, were spectrum fees applied, and were they to force agencies to relinquish spectrum without new technologies in place, current mission critical functions would be jeopardized.

Second, the imposition of spectrum fees domestically would open the way for administrations elsewhere in the world to follow this policy lead and impose fees on U.S. government operations within their own borders.[13] As the CSMAC Incentive Subcommittee noted, this "opens substantial risk to the Federal budget for existing and future global operations and to industry, which would have to incorporate this expense in the cost of service."[14]

Third, imposing spectrum fees would unduly punish agencies whose missions require access to larger bandwidths, whether for detection avoidance or other purposes, and would not take account of whether the allocated spectrum was already being used in an efficient manner.

Finally, the blunt instrument of spectrum fees does not take into account the true societal value (*e.g.*, in national security, law enforcement, air safety, etc.) of Federal agencies' use of spectrum. Rather than providing an incentive to agencies, spectrum fees instead will be viewed punitively. The Spectrum Policy Team should remain focused on productive and not punitive recommendations that will accomplish the twin goals of making spectrum available for commercial uses and ensuring maintenance of mission critical federal capabilities.

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[13] In an analogous commercial context, Congress barred the use of auctions for licenses to provide international or global satellite communications service, primarily because of fears that other countries would follow suit, creating an insurmountable financial burden for commercial satellite operators.

[14] *CSMAC Incentives Committee Report*, at p. 11.

IV. Conclusion

For Federal agencies to meet their mission critical capabilities and share more spectrum with the private sector, development of viable sharing technologies must be a priority. This can happen only if Federal agencies are provided with the means to undertake the necessary research and development for new and innovative spectrum technologies, and are encouraged to take advantage of opportunities to share commercial spectrum. Imposing spectrum fees would not provide those means; rather it would create conflicts among agency programs, threatening the ability of agencies to meet their respective mission critical needs. The Spectrum Policy Team therefore should reject the use of spectrum fees.

In contrast, a properly constructed Federal Spectrum Innovation Fund is not only an incentive likely to be proven meaningful for agencies to invest in achieving greater spectrum efficiency; it is also the only means through which they can act on that incentive. The Spectrum Policy Team should therefore pursue the development of such a Fund.

Respectfully submitted,

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March 20, 2014

Before the
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
EXECUTIVE OFFICE OF THE PRESIDENT
Washington D.C.

Request for Information:	)	FR Doc. 2014-03413
Agency Incentives – Spectrum	)	

COMMENTS OF MOBILE FUTURE

Mobile Future[1] submits these Comments in response to the Office of Science and Technology Policy's ("OSTP") Request for Information[2] inviting comment on the Science and Technology Policy Institute ("STPI") Report[3] that may inform the Spectrum Policy Team's ("Spectrum Team") recommendations to the President on mechanisms to incentivize Federal agencies to relinquish or share crucial spectrum resources. Mobile Future commends OSTP for soliciting input regarding Federal incentive mechanisms. Collaborative efforts by Government and the public will promote the development of effective incentive programs.

The Administration, Congress and Federal agencies have made some strides in encouraging efficient spectrum use, but more work is necessary to meet booming consumer demand. It is apparent from a review of Federal spectrum management over the past 30 years that current policies do not create incentives for efficient Government use, nor do they bring any market forces to bear on Federal users.

New incentive mechanisms should be structured so that agencies not only recover the costs associated with the relinquishment or sharing of Federal spectrum, but also receive

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[1] Mobile Future is an association of wireless technology businesses and non-profit organizations dedicated to advocating for an environment in which innovations in wireless technology and services are enabled and encouraged. Mobile Future About Us, http://mobilefuture.org/about/ (last visited Mar. 19, 2014).
[2] Office of Science and Technology Policy, Spectrum Policy, *Notice of Request for Information*, 79 Fed. Reg. 9288 (Feb. 18, 2014).
[3] IDA Science and Technology Policy Institute, *A Review of Approaches to Sharing or Relinquishing Agency-Assigned Spectrum* (Jan. 2014) (the "Report").

additional financial and/or operational benefit from such efforts. In addition, the focus should be primarily on incentive mechanisms that promote relinquishment of Federal spectrum for exclusive commercial use, as there is a clear preference for relinquishment in the Middle Class Tax Relief and Job Creation Act of 2012,[4] and exclusive use spectrum is most likely to generate revenues that can fund agency incentive mechanisms and relocation efforts. Finally, the Office of Management and Budget ("OMB") and the National Telecommunications and Information Administration ("NTIA") should take additional measures, including instituting an annual review of Federal agency spectrum holdings and their use, to encourage efficient spectrum use through the budget and procurement processes.

I. ADDITIONAL SPECTRUM RESOURCES ARE NEEDED TO ADDRESS EXPLODING CONSUMER DEMAND

More spectrum resources are needed to address the continually increasing consumer demand for mobility, connectivity, speed, and functionality. Worldwide, mobile data traffic increased 81 percent last year, due in part to the addition of over half a billion mobile connections and devices – 77 percent of which were smartphones – in 2013.[5] In the U.S., recent studies indicate that mobile data traffic will grow eightfold in the next four years, at a compounded annual growth rate of 50 percent.[6] Estimates show the U.S. continuing to lead all

[4] Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. 112-96, 126 Stat. 156, 245-52 (2012) ("2012 Spectrum Act").
[5] Cisco, *Cisco Visual Network Index: Global Mobile Data Traffic Forecast Update, 2013-2018*, at 1 (Feb. 5, 2014) ("Cisco White Paper"), *available at* http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.pdf.
[6] Amy Schatz, *Wireless Data Demand in U.S. Isn't Slowing, Cisco Says,* re/code (Feb. 5, 2014), http://recode net/2014/02/05/wireless-data-demand-in-u-s-isnt-slowing-cisco-says/.

countries in share of total worldwide 4G LTE connections,[7] despite having just 5 percent of overall global wireless subscribers today.[8]

Driving this growth are smartphone and tablet usage as well as machine-to-machine devices – the "Internet of Things" ("IoT") phenomenon – the latter of which will represent 40.2 percent of U.S. mobile devices in four years.[9] The mobile app industry will continue its explosive growth – 268 billion downloads by 2017,[10] and IoT connections will grow from 10 billion+ wireless connected devices today to more than 30 billion devices by 2020.[11]

In light of this exploding consumer demand, Government and industry must work together to find effective ways to make additional spectrum resources available to serve consumers while protecting important agency missions.

II. GOVERNMENT MUST FULLY IMPLEMENT, MAKE TRANSPARENT, AND ENFORCE EXISTING MEASURES TO MAKE FEDERAL SPECTRUM AVAILABLE FOR COMMERCIAL USE

The Government is making progress encouraging more efficient use of Federal spectrum, with significant developments occurring in the past two years. Each of these reforms requires continued vigilance and oversight. It is critical that systems be put in place to implement the reforms, that they are transparent and enforced, and that agencies are held accountable for their spectrum use.

For example, the 2012 Spectrum Act established a preference for agencies relinquishing Federal spectrum for exclusive commercial use, encouraging the pursuit of sharing arrangements

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[7] Cisco White Paper at 10.
[8] Testimony of Randal Milch, Verizon Communications Inc., Before the Subcommittee on Antitrust, Competition Policy, and Consumer Rights, Committee on the Judiciary, U.S. Senate, *An Examination of Competition in the Wireless Market*, at 1 (Feb. 26, 2014), http://www.judiciary.senate.gov/pdf/02-26-14MilchTestimony.pdf.
[9] *Supra* note 6.
[10] Tony Danova, *Gartner: Mobile Apps Will Have Generated $77 Billion In Revenue By 2017*, Business Insider (Jan. 23, 2014), http://www.businessinsider.com/gartner-mobile-apps-will-generate-77-billion-in-revenue-by-2017-2014-1.
[11] Natasha Lomas, *10BN+ Wirelessly Connected Devices Today, 30 BN+ In 2020's 'Internet of Everything', Says ABI Research*, Tech Crunch (May 9, 2013), http://techcrunch.com/2013/05/09/internet-of-everything/.

only where relocation is not technically or financially feasible,[12] and revised the Commercial Spectrum Enhancement Act ("CSEA") to expand the scope of costs that agencies may recover in connection with making spectrum available on an exclusive or shared basis.[13] A process should be established to provide for NTIA consultation with the OMB Director regarding the relinquishment or sharing of specific Federal spectrum bands. Any decision by NTIA that a particular band should be made available on a shared basis must, as required by the 2012 Spectrum Act, demonstrate the specific basis for the conclusion that relocation from a particular band is not technically or financially feasible. These decisions should be available to the public, and subject to review.

In addition, consistent with the Commercial Spectrum Management Advisory Committee's ("CSMAC") recommendation, OMB revised its Circular No. A-11 pursuant to the 2012 Spectrum Act[14] to add directives requiring agencies: to consider the economic value of the spectrum being used in their budget justifications for procurement of major telecom, broadcast, radar and similar systems; to indicate whether the system procured was the most spectrum "efficient" among those that met the agency's operational requirements; to indicate whether the system will or could operate on shared spectrum; and to certify that commercial alternatives and non-spectrum-dependent alternatives were considered.[15] In light of this revision, OMB should require agencies to demonstrate: why the proposed system is the most efficient of the alternatives considered; why any system not operating on shared spectrum cannot be operated on shared spectrum; and why commercial off the shelf systems and equipment, including broadband networks, could not be used to meet the agency's needs.

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[12] 47 U.S.C. § 923(j).
[13] 2012 Spectrum Act § 6701(a)(1), 126 Stat. at 245.
[14] *See* Office of Management and Budget, Circular No. A-11: Preparation, Submission, and Execution of the Budget (Aug. 2012).
[15] *Id*. at Sections 31.12 and 51.18.

Further, President Obama's June 2013 Memorandum "Expanding America's Leadership in Wireless Innovation,"[16] directed NTIA to implement a number of measures. For example, it instructed NTIA, by December 2013, to require agencies seeking procurements in the 400 MHz – 6 GHz range to verify that they are unable to meet their spectrum needs through means other than procuring spectrum in those bands, cannot satisfy its requirements through other means, and will use the minimal amount of spectrum necessary.[17] It is unclear whether these directives have been implemented and are being enforced. To the extent these practices are not already in place, NTIA should complete that process in an expedited timeframe.

NTIA also was required to issue a plan directing agencies to assess their spectrum use in certain bands, require agencies to file those assessments within 12 months of that plan's release, and then release a summary of those assessments along with recommendations regarding the availability of spectrum in those bands for commercial use.[18] The deadlines associated with these deliverables should be monitored closely to ensure that agencies submit assessments when required and that NTIA makes the summary available to the public in a timely fashion.

III. NEW MECHANISMS THAT INCENTIVIZE RELINQUISHMENT OF FEDERAL SPECTRUM FOR EXCLUSIVE COMMERCIAL USE MUST BE THE PRIMARY FOCUS

As required by statute, the Government should focus first and primarily on those incentive mechanisms that encourage and facilitate relinquishing and repurposing Federal spectrum for exclusive commercial use. The 2012 Spectrum Act expresses a clear priority for reallocation of Federal spectrum for exclusive commercial use, requiring that NTIA's evaluation of a band for possible reallocation "give priority to options involving reallocation of the band for

[16] Presidential Memorandum, *Expanding America's Leadership in Wireless Innovation*, (June 14, 2013) ("June 2013 Presidential Memorandum"), http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio.
[17] *Id*. at Section 3(e).
[18] *Id*. at Sections 3(a) and (b).

exclusive non-Federal use" and that NTIA "shall choose options involving shared use only when it determines, in consultation with the Director of the Office of Management and Budget, that relocation of a Federal entity from the band is not feasible because of technical or cost constraints."[19] If NTIA reaches that conclusion, it must then notify the Senate Committee on Commerce, Science, and Transportation and the House of Representatives Committee on Energy and Commerce, and identify the "specific technical or cost constraints" that form the basis of NTIA's determination.[20] In addition to this statutory preference for relinquishment, making spectrum available for exclusive use better promotes Federal incentives programs. Exclusive use spectrum is valued more highly by commercial operators trying to meet consumer demand, and is likely to generate greater proceeds in a Federal Communications Commission competitive bidding process. Those proceeds may then be used to fund the incentives programs.

Also, incentives offered to agencies should be greater when they are relocating from spectrum so that it can be reallocated for exclusive non-Federal use. For example, while agencies should recover costs incurred in connection with either relocation or sharing, the additional financial incentives provided to agencies should be higher for spectrum that an agency is relinquishing for exclusive use, as opposed to sharing. Exclusive-use spectrum has the highest utility in providing service to consumers, and should be afforded a priority in the incentives programs.

Finally, notwithstanding the priority expressed for relocation, in appropriate circumstances – *e.g.*, where it is not technically feasible for agencies to relocate entirely from a band – agencies should be encouraged to make spectrum available on a shared basis. In the first instance, agencies should be encouraged to share spectrum with other agencies in order to

[19] 47 U.S.C. § 923(j)(1).
[20] *Id*. § 923(j)(2).

increase spectrum efficiency and to potentially clear a portion of Federal spectrum to make it available to commercial operators on an exclusive basis. Encouragement of agency sharing should be unified across government, and should be made a part of Federal spectrum management policies, for example by NTIA and OMB in the budget and procurement processes. Where inter-agency sharing is not feasible, Federal and non-Federal sharing opportunities should be pursued. These types of sharing arrangements should be targeted to spectrum in higher bands such as the 3.5 GHz band that is currently being examined.

IV. NEW INCENTIVES MUST INCLUDE COST RECOVERY AS WELL AS FINANCIAL AND OPERATIONAL BENEFITS TO BE SUCCESSFUL

Appropriately structured incentive mechanisms are crucial to enabling agencies to take the steps necessary to relinquish or share spectrum. At a minimum, any incentive mechanism must reimburse agencies for costs incurred in connection with the relinquishment or sharing efforts – including costs related to the identification of candidate spectrum, research and development, planning, testing, and implementation.

Existing statutes address almost all of those costs. The CSEA established the Spectrum Relocation Fund ("SRF"),[21] from which agencies may recover costs incurred with relocation from eligible frequencies – *i.e.*, frequencies explicitly identified in legislation, or any other band reallocated from Federal to non-Federal use that is auctioned.[22] Proceeds from those auctions fund the SRF. The 2012 Spectrum Act amended the CSEA by allowing the SRF to cover costs associated with the shared use of Federal spectrum;[23] the acquisition of state-of-the-art replacement systems to meet comparable operational requirements;[24] and costs associated with

[21] *Id*. § 928.
[22] Commercial Spectrum Enhancement Act (CSEA), Pub. L. No. 108-494, 118 Stat. 3986, 3991 § 202 (2004); *see also* 47 U.S.C. § 928.
[23] 47 U.S.C. § 923(g).
[24] *Id*. § 923(g)(3)(b)(ii).

the planning of spectrum relocation or sharing.[25] Existing laws do not, however, allow the use of SRF funds to cover costs associated with relinquishment or sharing of spectrum that is not auctioned. As a result, the costs associated with agency efforts to make spectrum available on a shared basis, where that spectrum is licensed other than through auction, would not be covered by the SRF. The CSMAC Incentives Subcommittee identified this issue in 2011, and correctly observed that those costs associated with the availability of spectrum on a shared basis – including agency costs associated with testing the feasibility of sharing, implementing sharing arrangements, and the development of the technologies and advanced databases essential to those sharing arrangements, should be recoverable.[26]

Cost recovery, alone, however, does not provide an incentive to agencies to relinquish or share spectrum. In addition to cost recovery, incentive mechanisms must provide a financial and/or operational benefit (such as updated technology, additional functionality) to the agency. The amount of the additional financial incentives should be higher for spectrum that has greater utility in serving consumer demands. Thus, as suggested above, spectrum made available for exclusive commercial use should garner a higher incentive. Similarly, agencies relinquishing spectrum below 3 GHz, which is most highly valued for the provision of mobile broadband, should receive higher financial incentives for that spectrum. Importantly, any additional financial or operational benefits must not be offset in the budgeting process. An agency's budget should not be reduced by the amount of the financial benefit received, or by the savings associated with the use of updated technologies and systems.

[25] *Id*. § 923(g)(3)(A)(iii).
[26] Commerce Spectrum Management Advisory Committee, Incentives Subcommittee, *Incentives Subcommittee Report*, at 17 (Jan. 11, 2011).

V. THE GOVERNMENT SHOULD ENCOURAGE EFFICIENT SPECTRUM USE, INCLUDING THROUGH THE BUDGET AND PROCUREMENT PROCESSES

The incentive approaches identified in the Report have the potential to incentivize agencies to look more closely at their spectrum holdings and use, and to possibly make additional resources available to commercial operators. The Government should establish test beds to evaluate the various incentive models to enable it to proceed with their development and implementation.

In addition to implementation of one or more of the market-based incentive mechanisms described, the Government should use additional tools to facilitate a more consistent evaluation of Federal spectrum use and promote efficient spectrum use across the board. NTIA and OMB should play significant roles in encouraging spectrum efficiency in the procurement and budgeting processes. For example, NTIA should develop and implement spectrum efficiency guidelines in the budget and procurement processes for all agencies, as required by the June 2013 Presidential Memorandum.[27] Implementation of this Presidential directive will systemize the regular review of spectrum efficiency regardless of whether an agency is in the process of seeking additional spectrum procurements. It also would facilitate review of both new and existing spectrum assignments and encourage overall efficiency.

OMB should be given authority to use its influence in agency appropriations to steer agencies toward more efficient spectrum management – *e.g.,* through implementation of the three complementary proposals described in the Report.[28] First, OMB should revise Circular No. 11-A to not only consider the costs of spectrum in an agency's capital planning process, but also to consider spectrum efficiency, spectrum sharing and trade-offs in spectrum use, as suggested

[27] June 2013 Presidential Memorandum at Section 4.
[28] Report at 50-51.

by CSMAC. OMB should ask agencies to choose the spectrum-efficient option when picking between procurement options that meet the agency's operational requirements. Second, OMB should review agency spectrum holdings annually, and require agencies to justify their spectrum needs and identify spectrum to be made available for sharing, lease or auction. Third, OMB should refer to research and recommendations from the National Academy of Sciences ("NAS"), the proposed Government Spectrum Reform Task Force ("GSRTF"), and NTIA to encourage agencies to relinquish or share underutilized spectrum. As described in the Report: NAS would prepare a study detailing current Federal spectrum allocation, opportunities for reallocation and the opportunity costs of Federal use; GSRTF would make recommendations for spectrum bands that should be relinquished; and NTIA annual reports would detail current inventory and opportunity cost information and identify future likely sources of surplus spectrum. In addition to these steps, OMB also should require agencies to file annual "report cards" demonstrating progress made on making additional Federal spectrum resources available for commercial use.

The Government also can promote efficiency independent of the budget and procurement processes. In particular, it should consider using revenue from spectrum auctions to establish and fund an efficiency endowment that would cover the costs of agency experiments in new technologies or systems that would enable agencies to relinquish Federal spectrum. Without such funds, and often lacking targeted budgets for these initiatives, agencies have little incentive to incur the costs and risks associated with upgrading systems or processes to promote spectrum efficiency that would enable them to relinquish spectrum.

VI. CONCLUSION

The OSTP Request for Information is an important step toward the development of meaningful Federal incentives programs that could result in access to additional spectrum

resources to serve consumers. Successful incentive mechanisms should enable Federal users to recover their costs and should provide financial and/or operational incentives that promote relocation from Federal spectrum. Further, the incentive mechanisms should be part of a larger more holistic approach to encouraging efficient spectrum use, including through the procurement and budget processes, as described herein.

Respectfully submitted,

By: __/s/ Jonathan Spalter_____

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March 20, 2014

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March 20, 2014

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Dear Mr. Power:

The Utilities Telecom Council (UTC) is pleased to provide the following comments in response to the Office of Science and Technology Policy's Notice of Request for Information (RFI) regarding agency incentives to share or relinquish spectrum.[1]

Created in 1948, UTC is an international trade association for the telecommunications and information technology interests of utilities and other critical infrastructure industries. UTC's members include investor-owned utilities, cooperatively organized utilities and municipal utilities, as well as pipeline companies. All of UTC's members own, manage or control extensive private internal communications networks, including wireless communications networks. Therefore, UTC is pleased to respond to the RFI as it affects the interests of utilities in access to suitable spectrum to meet their communications needs.

At the outset, UTC states that electric, gas and water utilities need access to spectrum to support the safe, secure and effective delivery of essential services to the public at large. Utilities increasingly rely on their own private internal communications networks that they use for voice and data. These networks include both wireline and wireless systems. Wireless is a critical component of utility communications networks, because they provide cost-effective wide-area communications for fixed applications and they enable mobile communications, such as voice dispatch and emergency response with service crews in the field. However, utilities need additional spectrum in order to provide sufficient capacity and coverage to meet their increasing communications requirements for fixed and mobile communications. Access to government spectrum on a dedicated or shared basis with priority access would help to support utilities' wireless communications requirements. UTC submits that these utilities perform a critical public service, and that the Federal government should promote spectrum access for utilities in recognition of the importance of protecting these critical infrastructure networks. Therefore, UTC supports the RFI in order to promote opportunities for utility access to Federal spectrum.

In response to the RFI, UTC supports certain approaches that were suggested by the Science and Technology Policy Institute (STPI) in its report commissioned by the Spectrum Policy Team, which carries out certain directives regarding "incentives for agencies" that are part of the June 14, 2013 White

[1] Notice of Request for Information, 79 Fed. Reg. 03413-14. *See also* "Request for Information: Agency Incentives to Share or Relinquish Spectrum" at http://www.whitehouse.gov/blog/2014/02/14/request-information-agency-incentives-share-or-relinquish-spectrum.

House memorandum on spectrum policy.[2] Specifically, UTC supports approaches that create positive incentives for agencies to share or relinquish spectrum that they currently use. UTC believes that there is significant potential for agencies to share spectrum with non-federal entities, such as utilities, and that providing agencies with positive incentives to do so will eliminate barriers that currently discourage them from doing so. UTC provides further detailed comments on the STPI report below.

UTC also responds to Questions to Inform Development of Spectrum Policy, as described in detail below. Generally, UTC supports positive incentives that encourage agencies to share spectrum with non-federal entities. For example, UTC supports the creation of a spectrum fund that agencies could draw from to plan and execute spectrum relocation and sharing strategies. UTC believes that funding planning is an important component to promote spectrum sharing and spectrum access in general. This point is relevant to the RFI's question regarding H.R. 3674, the Federal Spectrum Incentive Act of 2013. This legislation would allow agencies to keep a percentage of the proceeds from the auction of spectrum that they relinquish. As more fully described below, UTC supports this form of incentive, but suggests that the legislation could be improved if agencies had access to funding for planning to share or relinquish spectrum, such as a spectrum fund as contemplated in the RFI. Such funding for agencies would provide positive incentives that could encourage agencies to share and relinquish spectrum.

Comments on the STPI Report

The STPI report suggests nine approaches, including spectrum use fees; a Generalized Spectrum Relocation Fund; spectrum property rights; dynamic federal spectrum secondary markets; flexible access rights; a PCAST Shared-Use Spectrum Superhighways, Spectrum Currency, and Spectrum Efficiency Fund; relinquishing spectrum through a BRAC approach; using an OMB spectrum auditor; and finally administrative relocation with overlay license negotiations. As the STPI explains, the first six approaches are market-based approaches, while the last three are directed reallocation and sharing approaches.[3] Finally, the STPI concludes that the nine approaches described in this paper represent a variety of paths to satisfying the increasing demands for spectrum capacity and that no single approach is likely to be the final answer.[4]

UTC agrees that no one approach may solve all of the spectrum needs of government and non-federal entities, but UTC suggests that the government should start by implementing market-based approaches rather than directives for reallocation and sharing. In addition, those market-based approaches should create positive incentives to encourage agencies to share or relinquish spectrum. In that regard, UTC supports approaches like the Generalized Spectrum Relocation Fund and a spectrum property rights approach, which would provide funding for agencies and allow them to keep those funds in exchange for their property right in the spectrum. By contrast, UTC agrees with the STPI that negative incentives, such as spectrum use fees, raise issues with regard to their implementation, as well as doubts about their

[2] A Review of Approaches to Sharing or Relinquishing Agency-Assigned Spectrum, Science and Technology Policy Institute (Jan. 2014) at https://www.ida.org/upload/stpi/pdfs/p5102final.pdf (hereinafter STPI Report); *See also* Presidential Memorandum, "Expanding America's Leadership in Wireless Innovation," (June 14, 2013) at http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio

[3] STPI Report at iv.

[4] *Id*. at v-vi.

effectiveness in terms of making spectrum available.[5] Similarly, a directed reallocation or sharing approach, such as a BRAC approach or an OMB spectrum auditor, could create resistance from agencies to relinquish or share spectrum. As such, UTC supports the use of market-based approaches that create positive incentives for agencies to share or relinquish spectrum, which should accelerate access to government spectrum by non-federal entities, such as utilities.

Comments on Questions to Inform Development of Spectrum Policy

The RFI poses six questions on possible spectrum policies, including spectrum user fees; a spectrum fund to pay for relocation, sharing and spectrum planning; the impact these policies would have on government missions as well as other consequences both intended and unintended; the implications of a command and control approach, including additional authority necessary for NTIA or OMB to carry such an approach out; and how to ensure effective coordination between agencies. The RFI also requests comment on H.R. 3674, the Federal Spectrum Incentive Act of 2013, which would create incentives for agencies by allowing them to keep one percent of the auction proceeds from spectrum they relinquished.

Spectrum user fees. In response to the question of spectrum user fees, UTC reiterates that spectrum user fees could prove to be ineffective at encouraging agencies to relinquish or share spectrum. Moreover, UTC agrees with SPTI that spectrum fees would be difficult to implement under the current appropriations process. UTC believes that spectrum fees would also be difficult to set, and that those fees would likely be passed onto taxpayers with no net effect on agencies in terms of giving up spectrum. Therefore, UTC suggests using positive incentives for agencies to relinquish or share spectrum, rather than spectrum fees that would be difficult to implement and would likely delay access to spectrum by non-federal entities.

Spectrum fund. In response to the question of a fund to pay for spectrum relocation, sharing and planning, UTC reiterates its support for such an approach. UTC does not see any obvious alternative means to fund agency planning, research, and development. Unless funds are simply set aside for agencies to plan and conduct research and development around spectrum sharing, it is very likely that there won't be any spectrum relinquished or shared. At the very least, there will be less spectrum that would be made available without upfront funding for planning and research and development.

Agencies will be disinclined to incur costs for spectrum planning, particularly if it appears that the spectrum would be difficult to share or relinquish – leaving them with no way of recouping their costs through auctions or lease fees. Similarly, agencies would be skeptical about technologies such as dynamic frequency allocation (DFA) to make more efficient use of spectrum, unless they could conduct research and development that would be paid for out of a fund that was set aside. It is effectively a chicken or egg situation; agencies won't release spectrum because they can't plan or conduct research and development – and they can't plan or conduct research, because they haven't released spectrum that could raise funds for planning and research and development. Also as the RFI implies, there would be no incentive for agencies to relinquish spectrum that couldn't be auctioned or leased (i.e. unlicensed spectrum). As such, UTC does not see any reasonable alternatives to providing upfront funding for spectrum planning and research and development.

There must be sufficient incentives for agencies to want to share spectrum. As explained more fully below, agencies should be able to keep more of the proceeds from the auctioning or leasing of spectrum that they relinquish or share. By the same token, if such revenues are treated simply as pass throughs to

[5] *Id.* at 16-17 (describing as "unclear" the effectiveness of spectrum fees in terms of the roster of government bands actually vacated in the United Kingdom and highlighting the challenges of the appropriations process in terms of the implementation of spectrum fees here in the United States.)

the U.S. Treasury, there would be little if any incentive for agencies to want to relinquish or share spectrum. There again, agencies should be able to benefit from relinquishing or sharing spectrum, which could occur if the agency held a property right in the spectrum.

Spectrum property rights. In response to the question about spectrum property rights, UTC believes that such an approach could be implemented without impacting mission capabilities. Agencies would keep the spectrum that they needed and would relinquish or lease the spectrum that wouldn't impact their mission capabilities. As the RFI implies, there are likely multiple agencies that share a given band, and UTC believes that a property rights approach would enable them to divide the proceeds from an auction or lease between the agencies. Hoarding of spectrum is a possibility, if agencies were provided a property right in spectrum. However, NTIA could be assigned the responsibility of policing such activities.

Command and control approach. In response to the question on the efficiency gains and enforcement costs of a command and control approach, UTC believes that the likely gains would be slow and limited, and its enforcement would be difficult and arbitrary. Agencies without incentives to relinquish or share spectrum would likely hold onto spectrum and it would be difficult to make them give it up, just as it is currently the case. If such an approach were taken, NTIA and OMB would need much greater investigative and enforcement authority than they currently have. They would also need considerably more resources to command and control spectrum use to a greater extent.

Coordinating effectively. In response to the question on how to effectively coordinate efforts among agencies, UTC believes that NTIA could assist in this capacity. To the extent that there was greater transparency regarding federal use of spectrum, non-federal entities could also assist with coordination of spectrum access efforts by agencies. For example, a spectrum access database could be created for non-classified uses of Federal spectrum. That is only one example, but UTC believes that there could be other mechanisms established whereby spectrum access could be coordinated, even in real-time using a spectrum access database.

H.R. 3674, the Federal Spectrum Incentive Act. In response to the question on possible modifications to legislation providing incentives for agencies to share or relinquish spectrum for non-federal entities, UTC supports such incentives with some modifications. Specifically, agencies should be able to retain more than one percent of the proceeds from a spectrum auction. In addition, the legislation should provide funding for spectrum planning, as well as for spectrum that is actually relinquished or shared. As described above, funding for planning and research and development could open up additional opportunities for spectrum access from federal agencies. Therefore, UTC supports the bi-partisan legislative incentives and believes the legislation could be improved by providing greater incentives for agencies to relinquish and share spectrum with non-federal entities, such as utilities and other critical infrastructure industries.

Conclusion

While UTC supports market-based approaches that create positive incentives, it agrees with the PCAST that "policies enabling commercial access to Federal spectrum be based primarily on their effects on innovation…direct revenue considerations should be treated as secondary."[6] Utility access to spectrum will promote innovation by utilities in the form of network modernization technologies that promise to improve the reliability, safety and security of the nation's critical energy and water infrastructure. The socio-economic benefits of these technologies that would be enabled through spectrum access would

[6] Recommendation 4.1, *Report to the President Realizing the full Potential of Govern-Held Spectrum to spur Economic Growth.* Executive Office of the President President's Council of Advisors on Science and Technology, xiii (July 2012).

justify utility access to the spectrum made available by federal agencies. In addition, there are integral benefits to national security that would inure from utility access to spectrum, because federal government and public safety effectiveness is dependent in many ways upon reliable, safe and secure energy and water services.

Moreover, UTC believes that utilities would make ideal partners for sharing spectrum with federal government users, some of whom (e.g. Tennessee Valley Authority and Bonneville Power Authority) are utilities themselves. They share similar missions and use communications in support of those missions, requiring highly reliable communications. As such, prioritization for utility communications on shared spectrum would be essential. Otherwise, federal spectrum access would not be suitable for many utility mission critical applications, such as SCADA and synchrophasors, which need low latency communication to protect the safety, integrity and security of utility infrastructure systems. UTC believes that such sharing could be accomplished dynamically, so that traffic requirements of federal and non-federal utilities could be accommodated.

For all of these reasons, UTC supports the efforts of the Federal government to make spectrum available for non-federal use by utilities and other critical infrastructure industries. UTC believes that the incentives described in the STPI report and pending legislation would encourage federal agencies to relinquish and share spectrum with utilities. Moreover, UTC submits that there is a critical need for access to spectrum by utilities and that they would make ideal partners for spectrum sharing with federal government agencies, due to their similar communications needs and missions.

If there are any questions concerning this matter, please let me know.

Respectfully,

Brett Kilbourne

Competitive Carriers Association
Rural • Regional • Nationwide®

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March 20, 2014

Via E-Mail

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Re: Agency Initiatives – Spectrum (STPI Report RFI Response; 79 Fed. Reg. 9288)

Mr. Power,

Competitive Carriers Association ("CCA") hereby submits this response to the Request for Information issued by the Office of Science and Technology Policy ("OSTP").[1] CCA represents the interests of more than 100 competitive wireless carriers, including rural and regional carriers as well as national providers. CCA's members are keenly interested in greater availability of spectrum for commercial wireless broadband uses. As explained more fully below, CCA supports assessing Federal agencies spectrum use fees related to the market value of their allocated spectrum as the most effective mechanism for incentivizing efficient use of spectrum and potential repurposing for commercial use. In addition, aspects of a spectrum relocation fund and command-and-control mechanisms merit consideration. However, CCA does not support an approach that assigns spectrum property rights to agencies, as granting complete discretion for spectrum relocation decisions to Federal agencies is unlikely to spur voluntary relinquishment of spectrum.

INTRODUCTION

It is well recognized that greater availability of spectrum for wireless broadband services is necessary to ensure that all consumers have access to educational and employment opportunities, health care, and other basic needs, through wireless connectivity.[2] And, as demand for mobile broadband

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[1] Spectrum Policy, Notice of Request for Information, 79 Fed. Reg. 9288 (Feb. 18, 2014) ("Notice").

[2] *See, e.g.,* The White House, Office of the Press Secretary, *Presidential Memorandum: Unleashing the Wireless Broadband Revolution* (June 28, 2010) ("Expanded wireless broadband access will trigger the creation of innovative new businesses, provide cost-effective connections in rural areas, increase productivity, improve public safety, and allow for the development of mobile telemedicine, telework, distance learning, and other new applications that will transform Americans' lives."); *see also Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Notice of Proposed Rulemaking, FCC 12-118 ¶¶ 1, 3 (rel. Oct. 2, 2012) ("Our country faces a major challenge to ensure that the speed, capacity, and accessibility of our wireless networks keeps pace with these

services across the United States has continued to surge in recent years, commercial wireless service providers face ever increasing spectrum constraints. The Federal Communications Commission ("FCC"), the expert agency on spectrum, has recognized the critical importance of addressing spectrum scarcity for wireless services in the face of the looming spectrum crunch.[3] As FCC Chairman Tom Wheeler has emphasized, ensuring access to the opportunities made possible by wireless broadband technologies requires "removing unnecessary barriers to mobile infrastructure investment and buildout,"[4] which will require all stakeholders "to think creatively to meet the world's spectrum needs."[5]

Allocation of additional spectrum for commercial use is particularly important to competitive carriers that seek to become stronger rivals to AT&T and Verizon, because spectrum is a critical input and a precondition to the provision of mobile wireless services.[6] The need to efficiently allocate spectrum resources grows more urgent as the two largest carriers continue to dominate the secondary market for spectrum and aggregate the lion's share of critical low-band spectrum. Greater availability of commercial spectrum, together with common-sense aggregation rules, will enhance competition among wireless carriers, which ultimately will benefit consumers through better service and lower prices that will flow from having a choice of carriers. This is why CCA has taken a proactive role in brokering solutions and advocating for policies that promote the availability and efficient use of spectrum resources.[7]

For the same reasons, CCA supports the efforts of OSTP, and the Obama Administration more generally, to take action aimed at promoting efficient spectrum use by all users, including Federal government agencies, and welcomes the opportunity to provide its perspectives on the IDA Science and Technology Policy Institute's ("STPI") proposals to achieve these goals.[8]

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demands in the years ahead, so the networks can support the critical economic, public safety, health care, and other activities that increasingly rely on them.").

[3] *See* Federal Communications Commission, Omnibus Broadband Initiative, *Connecting America: The National Broadband Plan*, at 77 (2010) (issuing warnings of dire consequences "if government does not make spectrum available to enable [wireless broadband] network expansion and technology upgrades"); *see also* Tom Wheeler, Chairman, FCC, Prepared Remarks at the Computer History Museum, Mountain View, California, at 3 (Jan. 9, 2014), *available at* http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0117/DOC-325054A1.pdf (citing the "need to bring more spectrum capacity to market … and fast").

[4] The Hon. Tom Wheeler, Chairman, FCC, Prepared Remarks at the GSMA Mobile World Congress, Barcelona, Spain, at 1-2 (Feb. 24, 2014), *available at* http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0224/DOC-325751A1.pdf.

[5] *Id.* at 4.

[6] *Policies Regarding Mobile Spectrum Holdings*, Notice of Proposed Rulemaking, WT Docket No. 12-269, FCC 12-119 ¶¶ 2, 4 (rel. Sept. 28, 2012).

[7] *See, e.g., Promoting Interoperability in the 700 MHz Commercial Spectrum, Requests for Waiver and Extension of Lower 700 MHz Band Interim Construction Benchmark Deadlines*, Report and Order and Order of Proposed Modification, 28 FCC Rcd 15122 (2013). In this proceeding before the FCC, CCA played a leading role in working with the FCC and other stakeholders to achieve a transformative industry compromise to promote device interoperability in the Lower 700 MHz band.

[8] *See* IDA Science & Technology Policy Institute, *A Review of Approaches to Sharing or Relinquishing Agency-Assigned Spectrum* (Jan. 2014) ("STPI Report").

DISCUSSION

The STPI Report proposes a number of approaches to providing incentives for Federal agencies to relinquish or share spectrum. In general, CCA favors proposals that encourage and incentivize agencies to relinquish spectrum that can be put to more efficient and socially beneficial uses. Freeing up unencumbered spectrum will provide commercial users with maximum flexibility to employ the most efficient and effective technologies suitable for the desired wireless service. However, spectrum sharing with incumbent Federal users should be considered where clearing of government spectrum is infeasible, or as an interim measure while government users are being relocated. Although spectrum sharing potentially adds cost to the provision of service and may limit the suitability of the spectrum for certain uses, emerging spectrum-sharing technologies may offer a reliable solution to enable the provision of certain types of wireless broadband services.

The Notice categorizes the approaches identified in the STPI Report into four types of mechanisms: (i) spectrum user fees; (ii) a spectrum relocation fund; (iii) command-and-control; and (iv) spectrum property rights. CCA strongly supports an approach that imposes spectrum usage fees on Federal agencies in connection with their use of spectrum resources to promote efficiency and deter waste. However, as identified in the STPI Report, CCA agrees that the complex issues involved will not be resolved by any single approach.[9] Thus, there are aspects of approaches that employ a spectrum relocation fund or a command-and-control mechanism that warrant further exploration. In contrast, CCA opposes any mechanism that provides agencies with complete discretion and predominant decision-making authority for identifying and relinquishing their currently allocated spectrum.

Spectrum Use Fees. Among the approaches identified in the STIP Report, spectrum user fees, payable by agencies based on a market-based valuation of their spectrum assignments, appear to provide the best balance between the needs and priorities of Federal agencies and commercial carriers while maintaining a centralized authority to identify and coordinate the relinquishment of spectrum most suitable for commercial uses. Under this approach, Federal government spectrum users would pay an annual amount for their spectrum use, based on a fee that approximates the opportunity cost of their spectrum holding. As others have pointed out, "government agencies buy most inputs . . . at approximately the market price. Not so with spectrum, and it distorts federal usage of the resource."[10] Agencies are in the best position to prioritize their use of spectrum, and the budgetary impact associated with the use of such spectrum would provide an appropriate incentive for agencies to regularly review their spectrum needs and encourage procurement of spectrally efficient products and services based on today's technological solutions and mission requirements. Therefore, this approach constitutes a suitable combination of "carrots" and "sticks" that would incentivize agencies to identify spectrum that can be relinquished and to implement more efficient technologies, while holding them accountable for the spectrum that they will continue to use. In addition, spectrum use fees allow involvement and oversight by a central authority to identify the market-based value of Federal spectrum and to determine the proper level of expense to charge agencies for the use of spectrum. This approach has been met with "relative success" in the United Kingdom. In 2014, the UK's Ministry of Defence reportedly will sell for the first time spectrum to commercial users for 4G mobile services as a result of spectrum use fees.[11]

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[9] *See id.* at vi.

[10] *See, e.g.*, Brent Skorup, *Reclaiming Federal Spectrum: Proposals and Recommendations* 15 (Mercatus Center, George Mason University, Working Paper No. 13-10, May 2013) (*available at* http://iep.gmu.edu/wp-content/uploads/2013/06/Reclaiming-Federal-Spectrum-Proposals-and-Recommendations.pdf) ("Mercatus Study").

[11] Mercatus Study at 24.

Spectrum Relocation Funds. While CCA favors spectrum use fees, other "hybrid" approaches that allow for joint decision-making between the agency and the central authority also merit consideration. More specifically, a spectrum relocation fund that agencies could draw from to plan and execute spectrum relocation and sharing strategies would also achieve the goal of freeing Federal spectrum for commercial use. While the complexity of managing and maintaining a spectrum relocation fund may be a drawback, this kind of fund could be an effective means of maximizing participation by agencies while allowing flexibility to determine their own spectrum needs to meet critically important mission functions. To provide meaningful incentives for agencies to vacate unused spectrum, and not merely the provision of reimbursement for the expenses of relocation, CCA supports the legislation pending before the U.S. House of Representatives that would provide additional funding beyond the costs of relocation to agencies for relinquishing spectrum.[12] Similarly, Commissioner Rosenworcel has repeatedly called for incentives for federal users to relinquish their spectrum.[13] Allowing an agency to share in revenues generated by a spectrum auction to offset sequester budget cuts would provide further incentives for agencies to identify and relinquish their unused and underutilized spectrum.

Command-and-Control. CCA also supports further consideration and development of a "Base Closure and Realignment" ("BRAC") type mechanism. Under the BRAC approach, a central authority, such as the National Telecommunications and Information Administration and/or the Office of Management and Budget, would require Federal agencies to identify spectrum to be vacated and auctioned for commercial use. Although this approach would remove substantial control from the Federal agencies for their own spectrum use decisions, a command-and-control approach that places greater decision-making authority with a central authority could offer an effective means of making more spectrum available to meet consumer demand for wireless broadband. Oversight and involvement by a central authority also would ensure that standards for efficient use of spectrum are applied consistently across the Federal government.

Spectrum Property Rights. However, CCA opposes mechanisms that provide agencies with complete discretion or predominant decision-making authority for relocation decisions. CCA agrees with the assessment described in the STPI Report that such approaches tend to allow agencies to "hoard" spectrum.[14] Because Federal agencies are not currently motivated by market-based incentives to sell or lease their unused or underutilized spectrum, the drawbacks to this approach are significant. Maintaining the status quo for Federal agency use of spectrum would promote continued inefficient use. Moreover, without usage fees or a central authority to devise and implement a cohesive plan for identifying unused or underused spectrum that would be better allocated for commercial use, relying on unilateral action by individual agencies would result in inefficiency and delays in making the spectrum available. Therefore, OSTP should not consider this proposal.

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CCA supports measures that prioritize Federal agency relinquishment of spectrum over spectrum sharing proposals. Further, CCA is in favor of approaches that allow for agency input into

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12 H.R. 3674, 113th Cong. (2013).

13 *See, e.g.*, Jessica Rosenworcel, Commissioner, FCC, Remarks at CTIA 2013—The Mobile Marketplace at 4-5 (May 22, 2013) ("I believe it is time for federal government users to share in the benefit from repurposing their spectrum."); Juliana Gruenwald, *Rosenworcel: Give Agencies Financial Incentives for Their Spectrum*, National Journal (Nov. 13, 2012).

14 STPI Report at 29.

spectrum use decisions and that provide appropriate incentives to encourage voluntary relocation of Federal users. Overall, the complexities in balancing mission-critical spectrum uses by Federal agencies with the President's directives aimed at relieving the spectrum crunch warrant review of a range of approaches presented by the STPI Report.

Respectfully submitted,

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March 20, 2014

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Eisenhower Executive Office Building
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Washington, DC 20504

RE: **Response to Request for Information Regarding STPI Report on Incentives to Increase the Efficient Use, Relinquishment or Sharing of Federal Spectrum.**

Dear Mr. Power:

AT&T applauds the efforts of the Office of Science and Technology Policy, and the Spectrum Policy Team in particular, to explore ways to ensure that the nation's airwaves are used more efficiently. The report of the IDA Science and Technology Policy Institute reviews a number of potential approaches to accomplish this important goal, and AT&T appreciates the opportunity to provide these comments in response to your Notice of Request for Information.[1]

The IDA report provides an excellent summary of many approaches that have been proposed to incent governmental spectrum users to consider whether to relinquish or share spectrum to make additional spectrum available for commercial applications. These include positive incentives like granting agencies spectrum "property rights," under which they would have the right to engage in secondary market transactions to sell or lease portions of their allocations; negative incentives such as spectrum usage fees, which would incent agencies to part with any underutilized spectrum to control costs; and directed reallocation approaches, under which a central planning authority such as OMB, NTIA or an independent commission might direct the reallocation of federal spectrum. Most of the proposals in the report suggest that financial incentives, designed to motivate agencies to act more like market participants, should be adopted to achieve more efficient allocations. While such proposals deserve further consideration, AT&T believes that ultimately, decisions about how to allocate spectrum among various federal and commercial uses will require some degree of central direction. Agencies do not operate in the same way as commercial entities, nor should they. Accordingly, market incentives by themselves, cannot be expected to wholly resolve questions about the efficient allocation of spectrum resources between public and private uses.

Moreover, to the extent that the goal is to use market incentives to guide decisions about the most efficient spectrum allocation, it also should be noted that the incentives discussed in the report operate entirely on the "sell" side of the equation. AT&T believes that equal attention must be paid to the "demand" side, i.e., potential non-government users, to ensure that spectrum is efficiently allocated between public and private uses to achieve the maximum benefits for the American people.

[1] *See,* Notice of Request for Information, Office of Science and Technology Policy, 79 Fed. Reg. 9289, Feb. 18, 2014.

Of the incentives reviewed in the Report, the approaches that AT&T believes hold the greatest promises are those that would provide for a general Spectrum Relocation Fund. These proposals would incentivize agencies to identify spectrum for relinquishment by providing them with funds – up front and independent of any particular auction -- to allow them to engage in planning, research and development, to identify alternative frequencies suitable to their operations, to develop and test upgraded, more spectrum efficient equipment, or commercial, off-the-shelf (COTS) solutions. Current law provides for a Spectrum Relocation Fund (SRF) taken from the proceeds of spectrum auctions, but agencies may draw on the fund only to cover the cost of relocation from the spectrum auctioned, and funding is only available after the auction has ended. An agency may be reluctant to incur the potentially significant up-front costs of evaluating whether current operations could be relocated, or whether more advanced, spectrum efficient equipment may be developed, if to do so would require them to draw funds from their annual appropriations, potentially impacting the agency's fundamental mission.

AT&T agrees with recommendations made by CSMAC's Incentive Subcommittee and in the National Broadband Plan to broaden the uses to which spectrum relocation funding, like the SRF may be applied. Moreover, AT&T recommends that the SRF be made a general fund. The auction revenues from the 2006 AWS spectrum auction, for example, greatly exceeded the eventual relocation costs. Under current law, these funds will eventually disappear from the SRF. AT&T recommends that Congress consider making the SRF a general fund, with any remaining auction revenues in the SRF available for agencies to explore whether other spectrum bands could be made available for commercial use. NTIA, in consultation with the FCC, could identify and prioritize federal spectrum allocations for possible reallocation to commercial use, and the affected agencies would be able to apply to NTIA for funding from the general SRF to cover the up-front R&D costs necessary to evaluate alternative spectrum, equipment or COTS solutions. And any funds received in this manner would be in addition to, not in lieu of, funds needed later to defray relocation costs.

AT&T also supports exploring the approach proposed in the Federal Spectrum Incentive Act proposed by Doris Matsui (D-CA) and Brett Guthrie (R-KY). Under the proposed legislation, agencies would be incentivized to relinquish or share federal spectrum by allowing them to share in the proceeds of the auction, offering them one percent of the revenues generated from the auction of the reallocated spectrum. Under the bill, the revenue would not be duplicative of any funds drawn from the SRF—any funds received from the SRF would be subtracted from the agency's share of auction revenues. AT&T believes that this approach would provide an appropriate incentive to federal agencies as well. Indeed, higher percentages should be shared with agencies who relinquish, rather than share, their federal spectrum allocations. In addition, revenue received by an agency from the auction should be protected from being "zeroed out" in the budget process via funding cuts concerning other agency matters.

While AT&T applauds the OSTP for searching for ways to incent federal agencies to consider relinquishing or sharing federal spectrum allocations, it is important to note that incentives that operate only on the "seller" side of a market are not likely, in and of themselves, to be completely effective. The spectrum bands agencies ultimately determine to offer may not be suited to the commercial uses that would most benefit the public interest. For example, many of the spectrum bands identified by the NTIA's "Fast

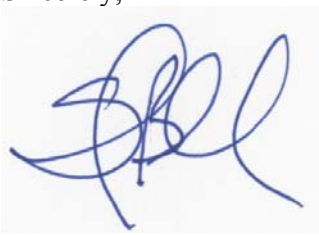
Track" report[2] were not ideally suited to address the needs for commercial mobile spectrum identified in the National Broadband Report. These bands may, however, provide a good place for government systems to relocate to from bands better suited for commercial use.

Moreover, agencies do not operate in accordance with a profit motive. Nor should they—each has a public policy mission to accomplish. They do not serve shareholders, but the public. Accordingly, incentives like the spectrum property rights proposal may be unlikely to result in striking a proper balance in allocating spectrum bands between federal and commercial users. In addition, relying on individual agencies to determine which frequencies should be made available to commercial users is likely to result in band fragmentation, which would limit both the utility and value of any spectrum ultimately offered to commercial users.

For these reasons, it likely will be necessary to also explore and include some directed reallocation approaches to ensure that the needs of the public for commercial services that require spectrum use can be met while ensuring that the missions of the agencies are not compromised. The FCC is well-positioned to identify the bands best suited to serve commercial needs and to consider band plans and service rules that will guard against fragmentation or unwieldy sharing proposals that would impair the utility of reallocated spectrum. To ensure that cost/benefit decisions take into consideration all factors, including the need for commercial spectrum and the importance of spectrum allocations to the accomplishment of important federal goals, free (to the extent possible) of political pressures, it also may be useful to consider whether an independent commission, perhaps like the Defense Base Closure and Realignment Commission, might be best suited to consider how best to resolve the competing demands for spectrum between public and private sectors in a way that is both fair and fiscally responsible.

AT&T appreciates the opportunity to review and comment on the IDA Report. We applaud the OSTP for this effort, and look forward to the opportunity to work with the OSTP toward achieving the President's goal of repurposing 500 MHz of spectrum for commercial broadband use by 2020.

Sincerely,



Stacey G. Black

[2] http://www.ntia.doc.gov/report/2010/assessment-near-term-viability-accommodating-wireless-broadband-systems-1675-1710-mhz-17

Before the
WHITE HOUSE
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
Washington, DC 20500

In the Matter of	)	
	)	
Spectrum Policy	)	FR Doc. No. 2014-03413

COMMENTS OF THE TELECOMMUNICATIONS INDUSTRY ASSOCIATION

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March 20, 2014

Before the Office of Science and Technology Policy
Comments of the Telecommunications Industry Association

I. Introduction

The Telecommunications Industry Association ("TIA")[1] hereby submits its comments in response to the February 18, 2014 Notice of Request for Information ("RFI") issued by the White House Office of Science and Technology Policy ("OSTP") regarding spectrum policy.[2] TIA applauds OSTP for seeking input regarding market-based or other approaches that could give departments and agencies greater incentive to share or relinquish spectrum. White House-driven leadership is critical to interagency engagement and success on this important issue.

TIA is the leading trade association for the information and communications technology ("ICT") manufacturer, vendor, and supplier community. TIA members manufacture a wide range of products for both the commercial and government wireless markets, including Wi-Fi, LTE, emerging small cell technologies, non-radio products such as routers and switches, and many other ICT products.

II. Four Principles for a National Spectrum Policy

Radio spectrum has never before been more important. In commercial communications networks, mobile data use is exploding as consumers embrace smartphones, tablets and other

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[1] TIA is a Washington, DC-based trade association representing hundreds of ICT manufacturers, vendors, and suppliers across all technology platforms. Members' products and services empower communications in every industry and market, including healthcare, education, security, public safety, transportation, government, the military, the environment and entertainment.

TIA is also an American National Standards Institute ("ANSI")-accredited standards development organization for the telecommunications field. For more information, please see TIA's 2013 Policy Playbook, which provides an overview of the ICT market, technologies and policies that drive innovation and investment. *See* http://www.tiaonline.org/policy/tia-2013-playbook.

[2] Notice of Request for Information, *Spectrum Policy*, Federal Register Doc. No. 2014-03413.

devices. Wireless connectivity is becoming the way in which consumers access the Internet from technologies such as LTE, Wi-Fi and satellite.

In addition to commercial uses, the Federal Government has a significant dependency on spectrum for both communications and non-communications purposes. These include GPS, radars, satellite, sensing capabilities, and other civil and military uses across a wide variety of agencies to achieve a diverse set of missions unique to government. Moreover, radio technologies themselves are changing, placing new demands on spectrum allocations, and raising new operational and regulatory challenges. As a result of these dynamic changes, spectrum allocations and uses that met the country's needs during the 20th century are increasingly under stress.

However, U.S. policymakers are no longer writing spectrum policy on a blank sheet of paper, and virtually all spectrum has been allocated. For that reason, TIA believes that a national spectrum policy must reflect the following principles to allow the nation's use of radio spectrum to evolve to meet changing demand and innovation:

- *Predictability.* To drive investment by commercial and government users alike, spectrum allocations need to be predictable. Identifying demand and changes in demand, understanding the pace of radio technology development by platform, and long-term planning are all essential parts of a spectrum policy that can provide predictability for both commercial and government users.
- *Flexibility.* For commercial allocations, flexible use policies consistent with baseline technical rules that are technology-neutral have proven to be the best approach.
- *Efficiency.* Policies should encourage more efficient use of spectrum where technically and economically feasible.

- *Priority.* In cases where band sharing is technically and economically possible, policies must advance good engineering practice to best support an environment that protects those with superior spectrum rights from harmful interference.

TIA has long-advocated for realizing the broadly-expressed national policy goal of making more spectrum available for commercial use. This will create hundreds of thousands of jobs for Americans while improving U.S. technological competitiveness. It will enable the mobile industry to meet the demand for high-speed wireless applications, and will help drive the U.S. economy, both near-term and long-term.

III. Improving Federal Spectrum Management

This Administration has shown great initiative in improving the federal government's use of spectrum. To begin with, TIA appreciates the Department of Defense ("DoD")'s recently-announced Electromagnetic Spectrum Strategy.[3] This strategy clearly and publicly articulates to the DoD spectrum community the need for increased efficiency, creativity and flexibility in spectrum use. In doing so, DoD specifically called out various mechanisms that it believes may be useful in circumstances where spectrum sharing is possible. Critically, DoD also recognized that wise use of spectrum is a matter of national economic security as well as national security, and that appropriate balancing of these interests is required.

A number of additional steps can be taken towards improving federal spectrum management. Some of the actions discussed below may require the participation of other stakeholders such as Congress or independent agencies like the FCC, but some can be taken through executive-branch administrative action.

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[3] Department of Defense, *Electromagnetic Spectrum Strategy*, Release No. NR-091-14 (rel. Feb. 20, 2014), *available at* http://www.defense.gov/news/dodspectrumstrategy.pdf

Better Tracking is Needed. A better spectrum use tracking and management process will undoubtedly encourage more efficient uses of spectrum by all users. However, achieving this objective will require more frequent and sustained engagement between government and private-sector users at a technical level. In cases of spectrum sharing, federal policy should support forums for all stakeholders to periodically exchange information to better ensure that the sharing environment is and remains workable.

Stronger Central Coordination May Be Useful. NTIA – an agency in the Department of Commerce – is currently tasked with coordinating spectrum use for the federal government. However, as various spectrum-related efforts in recent years have demonstrated, a stronger level of coordination or management for federal spectrum usage may be required. Indeed, in some cases NTIA has occasionally had difficulties even obtaining current information from other departments, making it difficult for the agency to effectively respond to Administration and Congressional requests for more detailed information regarding federal use. It may be valuable to have NTIA be staffed to engage more closely with other spectrum management offices to ensure that there is greater currency to government records of use, providing greater transparency for management purposes.

Agency Incentives Are Required. Spectrum plays an essential role in fulfilling government missions, and this will continue despite any transition or sharing of particular bands for commercial use. For this reason, although White House-driven leadership to ensure more efficient federal use is necessary – and this Administration's engagement is very encouraging – agency-level incentives are also necessary to ensure that federal spectrum uses (and users) are responsive to constraints of efficiency, predictability, flexibility, etc. in a similar manner to those faced by commercial users. Forward-looking management of radio spectrum is essential to the

goal of expanding telecommunications services and ensuring that the public derives maximum benefit from the use of spectrum – whether by its government or wireless operators.

The proposed Federal Spectrum Incentive Act (H.R. 3674, introduced by Reps. Guthrie and Matsui) represents potentially important legislative progress towards this goal. This bi-partisan legislation is designed to provide agencies with voluntary budgetary incentives to transition spectrum to commercial uses, by simply allowing agencies to keep a portion of the proceeds of any auctioned spectrum for their own use.[4] However, even while supporting this effort, the Administration should also explore ways to provide incentives for more efficient spectrum use deeper within the agency budgeting process, *i.e.*, at a more granular level than simply an agency's top-line retention of a portion of auction proceeds.

Spectrum "Ownership" is Outdated in an IP World. TIA does not support moving towards a model of agency "ownership" of spectrum. To begin with, moving towards an agency ownership model would diminish the prospects for centralized control and (certainly) for transparency.

Moreover, at least for communications-based functions, the notion of spectrum ownership by agencies was an idea promulgated in an era where networks and the data flowing over them were tightly linked, *i.e.*, pre-dating the transition to IP networks. In today's world, spectrum ownership would make it more difficult to transition agencies towards a more flexible approach for meeting their communications needs. For those communications capabilities that can be provided equally well by commercial providers, agencies should be considering commercial options in lieu of using their own legacy systems – options that may be more cost-

[4] Spectrum auction legislation is usually considered to be a net "plus" for federal revenues, which has typically been a significant factor towards its advancement in Congress. TIA encourages the Administration to work with the sponsors of H.R. 3674 and others in Congress to enact federal incentive legislation that will similarly be seen as budgetary "win-win."

effective while providing much greater flexibility in serving an agency's mission. Indeed, any legacy uses of agency spectrum for communications purposes may need to be re-evaluated in favor of a more flexible approach that will ultimately benefit the agencies themselves.[5]

Spectrum Fees Could Create Market and Technology Distortions. Spectrum fees are not a helpful tool to drive efficiency. To begin with, the implementation of any such fees would almost certainly not be universal, and would therefore create myriad opportunities for "market distortions" including administrative and/or legislative intervention over time. (To use an analogy, the existing problems of a massively complex tax code should not be imported into spectrum policy.) Moreover, this would result in a marketplace that may not be technology-neutral, *i.e.*, in which the government is picking technological winners and losers. Finally, experience shows that fees are unnecessary – the commercial spectrum market already reflects intense market-based competition and strong pressure to use spectrum as efficiently as possible, all without spectrum fees.

The Administration Should Push For Legislative Action. While some actions above can be taken administratively, some require legislative action. The Administration can and should work with Congress to support greater effectiveness in the management of Federal spectrum (including proper inventories of usage, valuations, and transparency), long term planning, and to provide incentives (carrots, rather than sticks) for agencies to maximize the use of scarce spectrum resources to support their own increasing requirements and those of other users..

[5] The outcomes of such re-evaluations may be different for each agency, particularly when considering certain non-"communications" uses of spectrum (radar, telemetry, etc.).

IV. Facilitating Spectrum Transitions

Spectrum transitions must be managed by agencies to ensure prompt and predictable outcomes that follow a transparent process.

Cleared Spectrum is Important to Commercial Users. TIA supports the clearing of re-purposed spectrum bands to the maximum extent feasible. Where possible, cleared, exclusively licensed spectrum bands allow for the most efficient and dependable use of spectrum suitable for mobile broadband deployment, and maximize network investment, marketability, availability and consumer use. However when incumbent uses make clearing infeasible, TIA supports greater spectrum efficiency through sharing. Indeed, TIA has recognized that for low-power technology such as Wi-Fi, shared spectrum use such as at 5 GHZ, is a good option. Meanwhile, TIA has been encouraged by DoD's recent work to facilitate opening the 1755-1780 MHz band for commercial use.

Flexible-Use Funding is Required. The use of commercial auction proceeds has traditionally been an important and effective tool to migrate and upgrade federal systems to make way for commercial uses, and to support cost impacts on existing programs/contracts when changes are made. As future spectrum transitions are contemplated, the Administration should ensure that any spectrum transition funds can be used in a manner flexible enough to cover a wide range of costs. Indeed, such flexibility may also help overcome any agency resistance to "unknowns" associated with any particular transition of spectrum.

The FCC Must Play a Central Role. TIA cautions against any agencies other than the FCC allocating spectrum rights for commercial use. The FCC has developed a strong track record in transitioning spectrum to commercial use and for its administration, and future spectrum transitions should leverage this expertise.

V. Spectrum Sharing Research and Development

The Administration must continue to play a strong role in encouraging spectrum sharing research and development. In December 2013, TIA released its Spectrum Sharing Research and Development white paper.[6] This paper was developed with input from stakeholders across the ICT industry, and includes recommendations for actions by policymakers in Congress, the Administration, and at specific funding agencies.[7] OSTP can play a significant role in facilitating or encouraging progress on several of these recommendations, including:

- Urging Congress to update NITRD's reporting requirements to ensure a more accurate picture of federal funding for network and information technology research;
- Updating the statutory basis of the NITRD program to encompass and prioritize areas such as spectrum sharing research; and
- Continuing to seek opportunities to administratively target research funding towards spectrum sharing research and development.

Connecting Transitions to R&D Funding. As the Administration looks for further ways to improve federal spectrum management and facilitate transitions to commercial use, it should continue to advocate (administratively and legislatively) for re-investment of a portion of spectrum funds in spectrum research and development efforts. Spectrum R&D is the "seed corn" that has enabled more efficient uses of spectrum by federal and commercial users alike, resulting in macroeconomic benefits to the U.S. economy as well as direct benefits to the Treasury when more spectrum is made available for auction.

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[6] Telecommunications Industry Association, *Spectrum Sharing Research and Development* (rel. Dec. 11, 2013), *available at* https://www.tiaonline.org/policy/spectrum-sharing-research-development-white-paper

[7] TIA presented the white paper at a regular meeting of the NITRD-led interagency Wireless Spectrum Research and Development Senior Steering Group (WSRD SSG) held on February 6, 2014.

The Administration previously proposed a Wireless Innovation Fund ("WIN"), but funding for this initiative was unfortunately not included in the 2012 spectrum law.[8] These and other proposals should be revived as part of any legislative initiative to transfer or open federal spectrum for commercial use.

VI. Conclusion

TIA thanks OSTP for seeking comment regarding improvements in federal spectrum policy and management. We urge OSTP to consider the positions of the ICT manufacturer and vendor community as it proceeds in its efforts.

Respectfully submitted,

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March 20, 2014

[8] Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96.