Before the
U.S. DEPARTMENT OF COMMERCE
NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
Washington, DC 20230

In the Matter of	)	
	)	
Developing a Sustainable Spectrum Strategy for America's Future	)	Docket No. 181130999-8999-01
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COMMENTS OF
THE BOEING COMPANY

The Boeing Company ("Boeing") provides these comments in response to the inquiry of the National Telecommunications and Information Administration ("NTIA") regarding the development of a sustainable spectrum strategy to support the communications and operational needs of government and nongovernment interests.

As a global leader in the design and manufacture of aircraft, defense, and aerospace systems, Boeing employs a very wide range of wireless systems, including for research and development, worker safety and automated manufacturing, aircraft flight testing, and incorporation within the operational systems of each aircraft, defense system, and space vehicle manufactured by Boeing. Because of this critical dependency on spectrum resources, Boeing routinely holds more experimental licenses issued by the Federal Communications Commission ("FCC")—many of them granted following FCC coordination with NTIA's Spectrum Management Office—than any other entity. Boeing conducts many company led testing activities for products which may one day be part of a US Government contract. These activities require licenses from the FCC with approval from NTIA, and operate in US Government spectrum. Boeing also carries out major contracts with U.S. federal government agencies that require the use of spectrum assignments

issued by NTIA to those agencies for the development and testing of government aircraft, defense and aerospace systems and other devices that employ RF resources for monitoring and communications.

Boeing actively participates in United States working groups and advisory communities tasked with developing U.S. and regional positions within the International Telecommunication Union ("ITU") World Radiocommunication Conference process. Boeing also frequently provides comment to the FCC and the regulatory agencies in other countries on rulemakings and consultations intended to improve national regulatory requirements and optimize the management of scarce spectrum resources. As an aerospace leader, Boeing's innovation, research and development facilitates growth of new licensed and unlicensed communications services, while ensuring the safe and reliable operation of existing spectrum uses supporting public safety, disaster relief, aircraft navigation and landing systems, flight testing, radar, precision location, and satellite broadband and video distribution, to name a few. With this background, Boeing welcomes NTIA's invitation to provide recommendations toward the development of a sustainable spectrum strategy that will support major U.S. industry, transportation systems and other critical infrastructure, while concurrently optimizing the use of scarce spectrum resources to provide wireless communications services to consumers.

Boeing responds herein to each of the substantive questions raised by NTIA in its public notice. In doing so, Boeing addresses a number of specific substantive concerns of relevance to NTIA, particularly protecting and expanding access to spectrum for aircraft flight test operations (Section V below), protecting the global navigation satellite service ("GNSS") (also Section V), protecting aeronautical radio altimeter systems (also Section V), developing operational rules for spectrum allocated to unmanned aircraft systems (also Section V), ensuring access for broadband

satellite systems in millimeter wave ("mmW") spectrum (Section VII), and identifying significant additional spectrum for unlicensed operations in mmW frequencies (also Section VII).

I. IN WHAT WAYS COULD THE PREDICTABILITY OF SPECTRUM ACCESS FOR ALL USERS BE IMPROVED?

Predictability in spectrum access could be greatly improved if NTIA provided better access to reliable and up-to-date database information regarding the specific spectrum uses of the federal government within the United States at identified geographic locations. When a private interest such as Boeing identifies the need for spectrum resources to support a new invention, service, or initiative, the first step in the process is usually an investigation into what spectrum resources may be available (either on an exclusive or shared basis) in the geographic locations where the new spectrum use could be located. Although such investigations are never easy, they are greatly assisted by the FCC's Universal Licensing System ("ULS"), International Bureau Filing System ("IBFS"), Experimental Licensing System ("ELS") and other FCC-managed databases, each of which permit interested parties to search by specific frequencies and often in specific locations, such as by county, geographic coordinates, or a radius around a latitude and longitude.

The FCC databases also reveal additional information about the types of uses in specific locations, including power levels, antenna heights, and whether they are fixed or mobile. The FCC databases additionally include contact information for the individuals responsible for each spectrum use, enabling specific inquiries where appropriate. In addition, the FCC's Equipment Authorization System ("EAS") provides even greater detail regarding the types of equipment that may be used at licensed spectrum locations, including the frequency modulation and signal propagation characteristics of such devices. All of this information is invaluable to companies and individuals seeking to propose a new spectrum uses either on an exclusive or shared basis in various frequency bands.

In contrast, very little information is publicly available regarding the U.S. federal government's use of frequency resources within the United States. NTIA did publish a summary of federal spectrum activities in 2010,[1] but the summary is too general to enable private parties to determine whether new shared spectrum use may be feasible and, with the passage of time, is somewhat out of date. NTIA subsequently published its Federal Government Spectrum Compendium, but that summary is also generalized in nature, it only covers frequency uses between 225 MHz and 7.125 GHz, and most of the summary has not been updated since December 2015.[2] Finally, NTIA regularly publishes its Manual of Regulations and Procedures for Federal Radio Frequency Management (known as the Red Book), but that document includes only brief summaries of federal spectrum uses within the United States.[3]

The absence of specific, searchable database information regarding federal spectrum use often leads to an unproductive process in which proponents of new spectrum uses are forced to engage NTIA staff directly (or through the FCC's experimental licensing inter-agency coordination process) to ascertain whether a proposed spectrum use may be compatible with federal activities. Such discussions and coordination efforts often resemble a game of "20 questions," eliciting yes/no responses and often failing to reveal sufficient information about

[1] Federal Spectrum Use Summary, 30 MHz – 3000 GHz, National Telecommunications and Information Administration, Office of Spectrum Management (Jun. 21, 2010) (available at https://www.ntia.doc.gov/files/ntia/Spectrum_Use_Summary_Master-06212010.pdf).

[2] Federal Government Spectrum Compendium, 225 MHz – 7.125 GHz, National Telecommunications and Information Administration, Office of Spectrum Management (Aug. 21, 2017) (available at https://www.ntia.doc.gov/other-publication/2017/federal-government-spectrum-compendium).

[3] Manual of Regulations and Procedures for Federal Radio Frequency Management ("Red Book), Sept. 2017 Revision of the May 2013 Edition, National Telecommunications and Information Administration, Office of Spectrum Management (Sept. 2017) (available at https://www.ntia.doc.gov/files/ntia/publications/ntia_manual_september_2017_revision.pdf).

federal activities to indicate whether spectrum sharing may be possible and whether certain technical or operational adjustments to the proposed spectrum use could facilitate such sharing.

The availability of a public database of federal frequency assignment information would greatly facilitate the activities of prospective spectrum users in ascertaining whether newly proposed spectrum uses could operate without conflicting or interfering with federal activities. Such a database would also permit equipment manufacturers to investigate and potentially complete coordination and deconfliction arrangements with federal users operating in a given geographic region. Although other federal agencies, such as the FAA, have their own dedicated pre-coordination database for aeronautical spectrum, the NTIA does not have anything similar. A single database supporting frequency coordination across all federal government agencies would better enable industry to plan testing and acquire licensing to support innovation.

The development of a public database would also facilitate the development by U.S. manufacturers of equipment and services that could be purchased and used by federal agencies, such as direct commercial sales of military products and services. For example, companies engaged in federal government contracting should be given access to the NTIA spectrum certification process outside the scope of a Department of Defense ("DoD") or other US government contract. Such access would allow industry to develop new spectrum dependent military hardware and test and certify such equipment before it is marketed or sold to the defense community.

The development of a public database would also facilitate the development by U.S. manufacturers of equipment, particularly military equipment and services that could be purchased and used by federal agencies and foreign governments. For example, direct commercial sales of military products and services to a foreign government do not have a DoD contract. This contract

number seems to be the critical component for access to spectrum controlled by NTIA. This creates significant difficulties for industry because the final product will ultimately utilize the same spectrum as that used by DoD. For example, Boeing sells its F-16 aircraft to the United States government and allied foreign governments. This aircraft might be sold under a "direct commercial sale" contract which means there isn't a DoD sponsor or DoD contract to reference when applying for access to DoD spectrum. As a result, companies need access to the NTIA spectrum certification process outside scope of a Department of Defense or other U.S. government agencies' contracts. Such access would allow industry to develop new spectrum dependent military hardware and test and certify such equipment before it is marketed or sold to the U.S. or allied government community.

The NTIA had previously considered implementing an industry portal, but as of now it appears the previous plan was not implemented. Development of a strategy in which industry can test new transmission equipment in advance of marketing and selling would make the purchasing process for such federal agencies as the DoD more cost effective, agile, and efficient.

Additionally, NTIA could to sanction some of the well-recognized outside laboratories to perform certification testing of radio frequency devices for the federal government, much in the same way as the FCC has done for private industry. NTIA could leverage the FCC's list of approved laboratories to implement this new process. Defense contractors could then make arrangements with an NTIA-sanctioned laboratory to conduct testing for the device certification. Once the lab tests are completed, the NTIA could approve the certification based on the sanctioned lab's test report and recommendation. This would benefit not only large aerospace government contractors such as Boeing, but also small businesses across the nation that are developing innovative new applications for government use. It would also take the government out of the

tedious process of conducting equipment certification reviews and would allow NTIA to require a device manufacturer to obtain device certification prior to any sale to the government.

Obviously, in some cases, the specific purposes of federal spectrum uses and classified transmission characteristics need to be excluded from public databases to protect classified or sensitive activities. The FCC has developed effective measures that permit licensees and applicants for equipment certifications to exclude or keep confidential certain information where necessary. In all cases, however, the FCC's public records list the type of spectrum use or equipment involved (i.e., fixed, mobile, point-to-point, or wide area), its modulation and frequency propagation characteristics, and the specific geographic location in question. Of equal importance, the FCC's public records also identify the telephone number and other contact information for an individual that can respond to questions about specific spectrum uses, possibly after the inquiring party as demonstrated their legitimate purpose in receiving such information.

NTIA should therefore create one or more public databases that include detailed, accurate and reliable information regarding federal spectrum assignments. Such access could be developed in a secure manner without compromising sensitive or classified information regarding government spectrum uses within the United States. Further, such access would greatly enhance the predictability of spectrum access in the United States, directly promoting research and development of new communications services and equipment on behalf of U.S. and federal government consumers.

II. TO WHAT EXTENT WOULD THE INTRODUCTION OF AUTOMATION FACILITATE ASSESSMENTS OF SPECTRUM USE AND EXPEDITE THE COORDINATION OF SHARED ACCESS, ESPECIALLY AMONG FEDERAL AND NON-FEDERAL SPECTRUM STAKEHOLDERS?

As explained above, the NTIA should develop one or more publicly-accessible databases that could facilitate spectrum access. These databases could also facilitate the automation of

certain processes used to assess whether proposed spectrum uses can operate with existing federal operations on an adjacent or shared basis.

Automation technologies can play an important role in enabling significant improvements in spectrum utilization and efficiency. Numerous technological advancements that will enable new forms of spectrum sharing, making more opportunistic use scenarios possible, and enabling more efficient use of scarce spectrum resources. These technologies include cognitive radios, sense and avoid technologies, dynamic beam forming antenna technologies that create "nulls" in the direction of interference sources, and automated clearinghouse systems built upon dynamic spectrum databases. These spectrum sharing opportunities are enabled by the emergence of innovative and automated technologies that make possible new forms of spectrum sharing.

Automated systems that rely on such technologies could permit secondary spectrum users to query a neutral clearinghouse about spectrum re-use availability, providing a simple and objective response that could enable the prospective spectrum user to either move forward with the proposed activity, or modify the proposal if necessary and appropriate to ensure compatible spectrum use. Further, such automated spectrum management systems could be operated by independent third parties under contract with NTIA, ensuring that confidential and sensitive information can be protected, while enabling access to information necessary to facilitate prompt assessment of proposed spectrum uses and real time coordination with existing federal spectrum users.

III. WHAT IS THE PRACTICAL EXTENT OF APPLYING STANDARDS, INCENTIVES, AND ENFORCEMENT MECHANISMS TO PROMOTE EFFICIENT AND EFFECTIVE SPECTRUM USE?

It would be very difficult to develop enforcement mechanisms that could be employed in an objective and reliable manner to promote efficient and effective spectrum use. Instead, the

U.S. federal government, primarily through the FCC, should continue to adopt technical guidelines that, where appropriate, govern efficiency requirements for spectrum use. To the extent possible, these guidelines should be based on industry-developed standards covering such issues as bandwidth, frequency tolerance, frequency agility, and limits on out of band emissions. Such guidelines, however, should not attempt to address such issues as channel loading or frequency reuse requirements, since such capabilities different dramatically depending on the type of spectrum use involved and the tolerance of that use for periodic interruptions. As an obvious example, the acceptable error rate for consumer cellular services can be far greater than for air traffic control communications. Further, such guidelines should not include receiver performance and tolerance requirements because, here too, the capabilities of RF receivers differ widely depending on the intended use. For example, receivers used for the reception of satellite or signals from the global positioning system ("GPS") are necessarily much more sensitive to interference than receivers used for relatively short range cellular communications.

NTIA should consider the use spectrum fees (as the FCC already does) to create incentives for the efficient and effective use of non-auctioned spectrum resources. Some fees within the federal government would likely constitute a budgetary obligation and transfer of funds between agencies to create internalized "costs" for federal agencies for the right to use spectrum resources.

The use of modest spectrum fees are sufficient to ensure that licensees limit their licensed spectrum holdings to only those resources that they are actually using and return those licenses that are no longer needed. For example, Boeing engages in a continuous process of auditing and consolidating its radio communications systems, surrendering those FCC licenses that are no longer actively utilized. Boeing anticipates that other enterprise users of large amounts of radio spectrum engage in similar auditing activities.

IV. HOW MIGHT INVESTMENT IN RDT&E IMPROVE SPECTRUM-UTILIZATION METHODS, AND SPECTRUM-SHARING TOOLS AND TECHNIQUES?

It is beyond question that numerous private interests are actively engaged in research and development efforts focused on improving spectrum utilization methods and developing spectrum sharing tools and techniques that enable additional sharing of scarce spectrum resources. The economic incentives for these private initiatives are potentially enormous, as evidenced by the development and commercial implementation of new radio communications technologies.

Given these significant and rapid advances, however, it does not appear necessary for the U.S. federal government to subsidize or otherwise fund research and development efforts in radio technology in excess of current levels. Instead, the economic incentives for private interests in this space are sufficient to ensure that developments continue in this area.

This said, NTIA could assist in private initiatives by engaging in further efforts to facilitate the identification of available spectrum for services and to expedite the review and approval of applications for experimental licenses that are coordinated between the FCC and NTIA. With respect to the former, as discussed above, the NTIA should develop up-to-date and detailed databases of federal spectrum uses that are accessible to developers of new spectrum-related products and services.

With respect to the latter, NTIA should expedite the coordination process for experimental licenses by avoiding as much as possible the current practice of "tabling" many experimental license applications that are submitted by the FCC to NTIA for coordination and also by limiting its imposition of restrictions and conditions on experimental licenses to only those that are clearly necessary to protect sensitive governmental communications systems and activities. In all other instances, concerns about spectrum sharing with government systems could be addressed by

allowing experimental licensees to discuss more directly with potentially impacted federal agencies in order to accelerate the NTIA review and approval process.

V. WHAT ARE THE RISKS, IF ANY, TO THE GLOBAL COMPETITIVENESS OF U.S. INDUSTRIES ASSOCIATED WITH SPECTRUM MANAGEMENT AND POLICY ACTIONS?

The spectrum management and policy actions of the U.S. federal government carry a substantial risk (and corresponding potential benefit) to the global competitiveness of U.S. industries. This said, the spectrum management challenge is far more complicated than the view expressed by those who claim the U.S. is in a race with other countries over which country allocates the most spectrum as rapidly as possible to still-aspirational 5G wireless services. Instead, countless U.S. industries and public interests depend on access to spectrum resources to develop, test and operate industrial, transportation, and aerospace systems that contribute greatly to U.S. foreign trade and the quality of life for U.S. citizens. Therefore, the spectrum management policies of the United States must entail a careful balancing of the needs of different spectrum uses, ensuring that no particular interest is permitted to employ unproven and potentially inflated estimates of economic benefits at the expense of access to sufficient spectrum resources used for industry, transportation, science, government, public safety, and other important uses.

Several specific examples are provided herein in these comments. First, NTIA needs to continue to engage proactively to protect and expand access to spectrum for commercial and government aircraft flight testing. As NTIA is aware, the spectrum requirements for flight test telemetry continue to increase in terms of bandwidth capacity, noise floor limitations and geographic reach. Flight testing is a critical component in determining the safety of an aircraft. While fundamental, it also takes a significant amount of time. Access to spectrum is critical and enables the U.S. aerospace industry to bring billions of dollars of aerospace products to market in

an efficient manner. As a result of flight testing's impact on safe air transportation and our nation's economy, NTIA should strengthen its efforts to protect and expand spectrum availability for flight test operations.

For example, NTIA should support flight test operations in the 5091-5150 MHz band. In raising this issue, Boeing understands there are potentially competing users for access to the 5091-5150 MHz band. Boeing fully supports protecting aviation safety systems, but aircraft manufacturers also must have access to this frequency band for critical flight testing purposes. Therefore, in order to accomplish both of these objectives, the NTIA should consider efforts to find ways sharing can be accomplished between FAA AeroMacs system and flight testing. If a reasonable method for sharing the same spectrum cannot be found, then segregating usage of the spectrum within the frequency band should be considered, particularly given the fact that priority is not exclusivity.

As a second example, the NTIA must continue to protect the global navigation satellite service ("GNSS"), including the global positioning system ("GPS"), from harmful interference, especially GNSS receivers used on commercial and government aircraft. Efforts to convert nearly adjacent spectrum bands to more intensive terrestrial use continue and their potential impact on GNSS must remain a central focus for NTIA.

As a third example, the NTIA must take the lead on behalf of the federal government in ensuring that the identification of new high-density spectrum uses in the 3.7-4.2 GHz band does not endanger the flying public due to harmful interference to critical aircraft systems, namely the radio altimeters that operate in the 4.2-4.4 GHz band. As ITU studies have documented, aircraft radio altimeter systems are very sensitive to interference, including interference from adjacent frequency bands. For this reason, it would be entirely inappropriate to permit the operation of

high density communications systems in spectrum immediately adjacent to spectrum used for aircraft radio altimeter operations. It is therefore imperative that NTIA fulfill its public safety mandate by ensuring the adequate protection of these safety-of-life aircraft systems.

As a fourth example, the NTIA should promote the identification and use of both federal and non-federal spectrum for the control and operation of unmanned aircraft systems ("UAS") to support both government and commercial operations provided that the reliability of the communications can be demonstrated to aviation regulators. The growth and development of UAS in the United States—both for use by commercial and governmental interests—would greatly benefit from access to radio frequency spectrum that has been allocated to a safety service and therefore ensures reliability for uninterrupted use. In its efforts to make more robust use of spectrum, NTIA should also support permitting mobile radio frequency band allocations to be utilized for command and control of UAS once appropriate signal reliability can be demonstrated possibly through the development of standards and recommended practices, minimum operational performance standards and/or minimum aviation system performance standards.

With more UAS filling the skies today than ever before, standardization of UAS operations is crucial for public safety and security purposes. For example, according to one study, the number of public safety agencies using drones has more than doubled since 2016.[4] As a step toward creating uniformity in UAS operations, the NTIA could also encourage the adoption of operational rules for UAS flights in the 5030-5091 MHz frequency band.

The lack of operational rules for UAS operations has also negatively impacted the U.S. economy and the United States' status as a leader in the field of emerging technology. Without

[4] *See Law Enforcement Agencies Turning to Drones to Fight Crime*, The Washington Post, at 6 (May 29, 2018) (citing to study by the Bard College, New York, Center for the Study of the Drone).

operational rules, UAS manufacturers such as Boeing have been inhibited from realizing the full potential of their UAS development and integration efforts. According to the White House Office of Science and Technology Policy, the forecasted benefits of increased UAS development and deployment in the United States include "tens of billions of dollars" in economic impact and "tens of thousands of new jobs."[5] In fact, while the lack of certainty regarding operational rules in the United States has caused UAS innovation and development to slow, the regulations in other countries have allowed the UAS industry to expand. As a result, some U.S. manufacturers and developers have taken their UAS programs overseas.[6] To ensure the global leadership of the United States in UAS development and integration, NTIA should encourage the FCC to act quickly to promulgate licensing and operational rules for the 5030-5091 MHz band.[7]

The NTIA should recognize that the above discussion provides just a few examples of the numerous areas where the spectrum management policies of the U.S. federal government have a substantial impact on the global competitiveness of U.S. industries. The U.S. government must continue to ensure its spectrum management policies accurately reflect the numerous important and often conflicting needs for access to existing and future spectrum resources, without favoring

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[5] *Integrating Unmanned Aircraft Systems into the National Airspace*, Office of Science and Technology Policy (Oct. 25, 2017), *available at* https://www.whitehouse.gov/articles/integrating-unmanned-aircraft-systems-national-airspace/ (*last visited* May 21, 2018).

[6] *See id.*

[7] *See Unmanned Aircraft Systems Integration Pilot Program*, Presidential Memorandum for the Secretary of Transportation, The White House, Sect. 1 (Oct. 25, 2017), *available at* https://www.whitehouse.gov/presidential-actions/presidential-memorandum-secretary-transportation (*last visited* May 21, 2018) (declaring it to be the policy of the United States to promote the safe operation of UAS and enable the development of UAS technologies for a variety of uses).

any single type of use through excessive spectrum allocations that may not be based on an accurate assessment of existing productive use.

VI. HOW COULD A SPECTRUM MANAGEMENT PARADIGM BE STRUCTURED SUCH THAT IT SATISFIES THE NEEDS OF COMMERCIAL INTERESTS WHILE PRESERVING THE SPECTRUM ACCESS NECESSARY TO SATISFY THE MISSION REQUIREMENTS AND OPERATIONS OF FEDERAL ENTITIES?

Currently, the U.S. federal government's use of radio spectrum is governed by NTIA's Manual of Regulations and Procedures for Federal Radio Frequency Management (often referred to as the Red Book).[8] The Red Book is maintained and updated periodically by NTIA without any public input or comment. Nevertheless, the Red Book constitutes binding and enforceable federal regulation with its contents specifically incorporated by reference in Section 300.1 of Title 47 of the Code of Federal Regulations ("CFR"). The absence of any public input in the preparation of the Red Book is rationalized by a statement in the CFR that it "applies only to Federal agencies and does not impact the rights or obligations of the public."[9]

In reality, however, the substance of the Red Book and its periodic changes have a substantial impact on the public and other non-government interests, particularly with respect to commercial, industrial and enterprise users of spectrum resources that often must share with or otherwise protect or accept interference from government communications in shared frequency bands. In addition, companies that support federal missions through government contracts or other means consistently require access to federal government spectrum to develop and test

[8] Manual of Regulations and Procedures for Federal Radio Frequency Management ("Red Book), Sept. 2017 Revision of the May 2013 Edition, National Telecommunications and Information Administration, Office of Spectrum Management (Sept. 2017) (available at https://www.ntia.doc.gov/files/ntia/publications/ntia_manual_september_2017_revision.pdf).

[9] *See* 47 C.F.R. § 300.1.

communications systems that are being manufactured for federal agencies and to operate such systems if required by government contract. In addition, many commercial satellite systems operate on federal radio frequencies to support federal communications systems. Also, major defense contractors such as Boeing routinely construct aircraft, aerospace, and other systems on behalf of U.S.-allied foreign governments that are designed to operate on U.S. federal frequencies and therefore must be tested in the United States using those federal frequencies prior to export.

Given the significant interrelationship between federal spectrum usage and regulation and the public's need to have access to and utilize this spectrum, it would be constructive for NTIA to request public comments on possible changes to the Red Book (both those under consideration by NTIA and any additional changes recommended by the public) prior to updating and releasing each new addition. The use of such a notice and comment process would have the positive impact of providing NTIA information regarding how proposed changes would impact all users and how the US government and the public can benefit as a result of spectrum sharing opportunities.

As just one example discussed above in these comments, Boeing is closely aligned with U.S. federal government interests in protecting and expanding access to interference free spectrum for use to conduct aircraft flight testing. Boeing and countless U.S. businesses and private interests are also aligned with NTIA in preserving the integrity and reliability of GNSS. If the NTIA were to routinely seek public comment on its proposed changes and additions to the NTIA Red Book, a public comment process would enable NTIA to rely on additional evidence and support provided through public comment to support its advocacy within the federal government and before Congress and the White House on the need to preserve frequency allocations used on a shared basis with private interests to support critically important spectrum uses.

VII. WHAT ARE THE LIKELY FUTURE NEEDS OF SPECTRUM USERS, BOTH TERRESTRIALLY AND FOR SPACE-BASED APPLICATIONS, WITHIN THE NEXT 15 YEARS? IN PARTICULAR, ARE PRESENT ALLOCATIONS OF SPECTRUM SUFFICIENT TO PROVIDE NEXT GENERATION SERVICES LIKE FIFTH GENERATION (5G) CELLULAR SERVICES AND EMERGING SPACE-BASED APPLICATIONS? FOR COMMENTERS WHO ASSERT THAT EXISTING ALLOCATIONS ARE INSUFFICIENT, NTIA IS INTERESTED IN UNDERSTANDING BETTER THE AMOUNT OF SPECTRUM PRESENTLY AVAILABLE TO PROVIDE PARTICULAR SERVICES (OR SIMILAR SERVICES) AND ESTIMATES OF THE AMOUNT OF ADDITIONAL SPECTRUM IN EACH FREQUENCY BAND THAT THE COMMENTER BELIEVES IS NEEDED.

A major concern for Boeing is the preservation of continued access to existing allocations of spectrum, including both allocations below 1 GHz (many of which are used to support aviation, public safety, and business and industrial communications) and mid-band spectrum (including spectrum used for GNSS, flight testing, satellite communications, and certain unlicensed activities, such as Wi-Fi). Although commercial wireless interests routinely express the need for access to spectrum resources (almost always on an exclusive basis), the fact remains that commercial wireless interests continue to warehouse substantial quantities of spectrum.

In addition, a pressing need exists for increased access to high band millimeter wave ("mmW") spectrum to support broadband satellite and unlicensed wireless communications systems. While terrestrial wireless systems are still largely on the drawing board with respect to their use of mmW spectrum resources for broadband services, satellite communications systems have long since engaged in extensive use of mmW spectrum in the Ka-band to provide broadband services to individual and enterprise customers, regardless of their location. Broadband satellite systems operating in mmW spectrum are already helping to resolve the digital divide by providing high speed connected services to all locations, particularly remote regions of the planet, across oceans, and to aircraft in flight.

Unfortunately, the spectrum allocations available for satellite systems in the Ka-band have already become saturated and these spectrum resources are insufficient to support the broadband needs of larger populations. Therefore, new broadband satellite systems currently under development must have access to additional mmW spectrum resources in higher frequency bands, including exclusive access to at least two gigahertz of paired spectrum in the V-band (likely the 40-42 GHz band (space-to-Earth) paired with the 48.2-50.2 GHz band (Earth-to-Earth) for the operation of ubiquitously deployed end user terminals, along with shared access to at least two gigahertz of additional paired spectrum resources in the V-band (likely in the 37.5-40 GHz (space-to-Earth) paired with the 47.2-50.2 GHz and the 50.4-52.4 Hz (Earth-to-space) for the operation of gateway earth stations at coordinated locations. Further, future satellite systems that are likely to be developed that will require access to even higher mmW spectrum resources in the 71-76 and 81-86 GHz bands, potentially on a shared basis with terrestrial fixed service systems.

Boeing and other industrial enterprises also require much greater access to unlicensed spectrum resources in higher frequency bands. U.S. spectrum policy has long since demonstrated that the unfettered availability of unlicensed spectrum resources greatly encourages innovation and development of new types of communications systems and services that commercial wireless operators often lack sufficient incentive to deploy. Unfortunately, these significant opportunities are also saturating the available unlicensed bands.

For example, in some locations, Boeing's current unlicensed operations to support industrial activities effectively use the entire available unlicensed spectrum. This problem is most critical at Boeing's Everett, Washington location, which is the largest manufacturing building in the world, accommodating thousands of aerospace employees to support aircraft fabrication, production and assembly, product development, aviation safety and security and airplane

certifications for the 747, 767, 777, and the 787 airplanes. Each of these tasks employs machines and data systems that require reliable access to unlicensed spectrum. Today, however, existing operations have exhausted the available unlicensed spectrum at the Everett site. Boeing is therefore exploring the use of unlicensed data communications systems in mmW frequency bands in order to provide increased capacity and transmission speed.

Boeing is also exploring the use of mmW spectrum for very short range communications links involving large amounts of data onboard aircraft. The passenger cabin of large commercial aircraft is quickly becoming the most congested wireless operational environment in the world, with hundreds of seated passengers using personal wireless devices to simultaneously access video and internet content using the same inflight wireless network. Passengers on commercial aircraft are demanding more services requiring unlicensed wireless spectrum. With each new aircraft model that Boeing develops, communications and data requirements for passengers' increases significantly.

Consistent with these critical needs and developments, NTIA should actively support spectrum management initiatives that identify additional spectrum for unlicensed use by non-government entities in additional frequency bands, including mmW bands that could successfully be employed on a shared basis with the passive services that are allocated in this spectrum.[10]

VIII. CONCLUSION

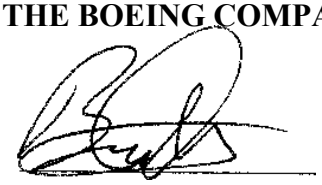
Boeing appreciates NTIA's initiative in requesting public comment on its development of a sustainable spectrum management strategy to promote economic development and social benefits in the United States. As discussed in these comments, the U.S. government's strategy must be

[10] *See id.*, ¶ 57.

carefully balanced and multi-dimensional, reflecting the numerous existing and future needs of users for reliable access to spectrum resources to support private enterprise, major industries, transportation and communications systems, government operations, and public safety. Boeing looks forward to a continued dialogue with NTIA has it works to advance these important public policy requirements.

Respectfully submitted,

THE BOEING COMPANY

By: 

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