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

NOV 25 2013

Mr. Julius P. Knapp
Chief, Office of Engineering and Technology
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

RE: Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz bands (GN Docket No. 13-185)

Dear Mr. Knapp:

The National Telecommunications and Information Administration (NTIA) appreciates that the Federal Communications Commission (FCC) has commenced the above-referenced rulemaking proceeding to repurpose the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz bands for additional Advanced Wireless Services (AWS-3).[1] This rulemaking represents a critical step to meet U.S. spectrum needs for wireless broadband while ensuring that federal agencies can continue to perform their essential missions. In this letter, NTIA responds to the *AWS-3 NPRM* for purposes of: (1) supplementing the information NTIA submitted to the FCC in July and April 2013 prior to adoption of the *NPRM*;[2] (2) proposing specific changes to the U.S. Table of Frequency Allocations for the 2025-2110 MHz band that are necessary to implement the alternative proposal of the Department of Defense (DoD) to relocate key operations from the 1755-1780 MHz band;[3] and (3) addressing other important issues raised in the *NPRM*.

First, NTIA transmits for inclusion in the record of the AWS-3 proceeding the enclosed reports that have been approved by NTIA's Commerce Spectrum Management Advisory Committee (CSMAC) pertaining to the 1695-1710 MHz and 1755-1850 MHz bands.[4] NTIA endorses the recommendations contained in these reports. The dialog and

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[1] *See* Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands, *Notice of Proposed Rulemaking* in GN Docket No. 13-185, 28 FCC Rcd 11479 (Jul. 23, 2013) (*AWS-3 NPRM*), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-13-102A1_Rcd.pdf.

[2] *See* Letter from Karl B. Nebbia, Associate Administrator, Office of Spectrum Management, to Julius P. Knapp, Chief, Office of Engineering and Technology (July 22, 2013) (*NTIA July 2013 Letter*), *available at* http://apps.fcc.gov/ecfs/document/view?id=7520933143; Letter from Lawrence E. Strickling, Assistant Secretary for Communications and Information, U.S. Dept. of Commerce, to Julius Genachowski, Chairman, FCC (Apr. 19, 2013) (*NTIA April 2013 Letter*), *available at* http://go.usa.gov/WcEz.

[3] *See NTIA July 2013 Letter* at Enclosure 1, Letter from Teresa M. Takai, Chief Information Officer, DoD, to Lawrence E. Strickling, Assistant Secretary for Communications and Information, U.S. Dept. of Commerce (Jul. 17, 2013).

[4] NTIA previously transmitted to the FCC two CSMAC reports with the *NTIA April 2013 Letter*, including recommendations developed in CSMAC Working Groups 1 and 2. On July 24, 2013, the CSMAC approved a revised version of the Working Group 1 report, which is enclosed. *See* CSMAC, "1695-1710 MHz

information exchanges conducted within the CSMAC's five working groups serve as an excellent example of government/industry collaboration that NTIA plans to formalize and draw upon in the future. In a recent executive memorandum, President Obama stated that these discussions between agencies and non-federal entities have "produced an unprecedented level of information-sharing and collaboration to identify opportunities for agencies to relinquish or share spectrum."[5] These discussions also led directly to the industry roadmap and alternative DoD proposal referenced in the *AWS-3 NPRM*. NTIA continues to encourage and facilitate further collaboration between federal and industry stakeholders, which NTIA believes will lead to further improvement in the analysis in support of greater wireless broadband access and reliable relocation and sharing approaches.

Second, NTIA fully supports DoD's proposal for the 1755-1780 MHz band transmitted to the FCC in July. As NTIA noted then, the proposal would reduce estimated costs and eliminate the need to displace any non-federal incumbents. Implementation of this proposed approach requires a change to the U.S. Table of Frequency Allocations for the 2025-2110 MHz band.[6] Specifically, NTIA proposes in Enclosure (1) that the FCC and NTIA: (a) add primary FIXED and MOBILE allocations in this band to the Federal Table of Frequency Allocations in column 4, 47 C.F.R. §2.106; (b) include two new footnotes limiting federal operations to the military and specifying coordination requirements[7] for new military operations, providing protection and priority to non-federal operations specified in the proposed US footnote; and (c) delete current footnote US393 from the table. Under these changes, DoD would use this spectrum efficiently, taking into account national security requirements and the need to have the flexibility to share with non-federal fixed and mobile operators in the Television Broadcast Auxiliary Service, the Cable Television Relay Service, or the Local Television Transmission Service. These changes would provide DoD additional spectrum access to a band with comparable technical characteristics to restore essential military capabilities that will be lost as a result of relocating systems out of 1755-1780 MHz, a statutory requirement under the Secretary of Commerce's, DoD's, and the Chairman of the Joint Chiefs of Staff's joint certification to Congress under the National Defense Authorization Act for Fiscal Year 2000.[8]

Meteorological-Satellite," Final Report of Working Group 1, Rev. 1 (July 23, 2013), *available at* http://go.usa.gov/DffR. This report includes, in Table 2 in Appendix 1.1, a revised list of federal sites that require protection.

[5] Memorandum for Heads of Executive Departments and Agencies, *Expanding America's Leadership in Wireless Innovation* (June 14, 2013), 78 Fed. Reg. 37431, 37433 at § 2(a) (June 20, 2013), *available at* http://www.gpo.gov/fdsys/pkg/FR-2013-06-20/pdf/2013-14971.pdf.

[6] *See AWS-3 NPRM* at ¶¶ 82, 175. In addition to seeking comment on any changes to the Table of Frequency Allocations that would be necessary to effectuate DoD's proposal for increased federal access to the 2025-2110 MHz band, the *AWS-3 NPRM* sought comment on a study conducted by the National Aeronautics and Space Administration (NASA) that assessed potential harmful interference from potential new commercial transmitters in the 2025-2110 MHz band to federal non-geostationary satellite stations. *See id.* at ¶ 21. Enclosed please find for inclusion in the record of GN Docket No. 13-185 NASA's response to comments from three parties that addressed the NASA study.

[7] As stated in the proposed US footnote, coordination should occur via a memorandum of understanding between the federal and non-federal fixed and mobile operators in the Television Broadcast Auxiliary Service, the Cable Television Relay Service, or the Local Television Transmission Service. A disclosure process similar to 47 C.F.R. § 27.1134 (e)(2) (agreements between AWS-4 operators and federal entities) would be appropriate and should be incorporated into the FCC rules.

[8] *See AWS-3 NPRM* at ¶ 178 (*citing* Sec. 1062(b) of Public Law No. 106–65).

As stated in the proposed US footnote, all new fixed and mobile military operations would protect the Television Broadcast Auxiliary Service, the Cable Television Relay Service, and the Local Television Transmission Service and would not constrain the activities of these non-federal services. Non-federal operations in the band would make all reasonable efforts to accommodate military mobile and fixed operations in the band. The proposed coordination requirements may result in improved processes over those currently employed pursuant to footnote US393, which would be deleted. Operations authorized under the current footnote US393 will need to be accounted for under the new fixed and mobile allocation. The proposed G footnote would require, to the extent practicable, new fixed and mobile military stations to employ frequency agile technologies and techniques, including the capability to tune to other frequency bands.[9] This overall approach will increase spectrum efficiency and utilization while freeing up valuable frequencies in the 1755-1780 MHz band.[10] In addition, the proposal would remove from future consideration the 5150-5250 MHz band as a comparable destination band for DoD aeronautical mobile telemetry systems,[11] which should allow greater flexibility in FCC decisions with respect to improving access to the 5 GHz band for unlicensed broadband devices.

Third, NTIA appreciates the FCC seeking comment on options for preserving federal users' access to the AWS-3 bands on federal lands and military training ranges in unpopulated areas that are generally unserved by commercial wireless networks.[12] NTIA agrees that expanding opportunities for federal access to this spectrum, including bands not specifically allocated for federal use (*e.g.*, 2155-2180 MHz), may allow federal agencies greater flexibility to meet tactical, training, and other requirements.[13] Federal agency domestic spectrum needs, particularly DoD's, sometimes require intermittent or geographically limited tactical and training operations that may not hinder the nationwide implementation of wireless broadband services.

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[9] For example, a modular retrofit band capability could facilitate non-military or other use of similar equipment in other allocated bands.

[10] Although the federal systems in question are relocating from 25 megahertz of spectrum into 85 megahertz of spectrum, the conditions described in the footnote are intended solely to ensure that DoD can maintain comparable capability of current activities utilizing the 1755-1780 MHz band following relocation. Providing federal systems access to the wider swath of spectrum in the 2025-2110 MHz band follows from the fact that in the band, unlike the 1755 MHz band, the federal systems will share with non-federal systems. Thus, the federal systems will have the flexibility they need to operate without limiting the existing non-federal users.

[11] *See NTIA July 2013 Letter* at Enclosure 1. *See also NTIA April 2013 Letter* at 3; Letter from Lawrence E. Strickling, Assistant Secretary for Communications and Information, U.S. Dept. of Commerce, to Julius Genachowski, Chairman, FCC, in ET Docket No. 13-49 (Feb. 19, 2013) at 3-4, *available at* http://apps.fcc.gov/ecfs/document/view?id=7022126657; FCC, Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band, *Notice of Proposed Rulemaking* in ET Docket No. 13-49, 28 FCC Rcd 1769, 1781 n.45 (2013), *available at* *http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-13-22A1_Rcd.pdf*.

[12] *See AWS-3 NPRM* at ¶ 81.

[13] The NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management already authorizes access to a wide range of non-federal bands for military tactical and training operations, including the 2155-2180 MHz band. *See, e.g., NTIA Manual* at § 7.15.3.5.d, *available at* http://www.ntia.doc.gov/files/ntia/publications/redbook/2013/7_13.pdf.

NTIA looks forward to our further collaborative efforts in this important proceeding. If you have any questions, please contact me or Byron Barker, Chief, Strategic Planning Division, Office of Spectrum Management at bbarker@ntia.doc.gov or (202) 482-5526.

Sincerely,

Karl B. Nebbia
Associate Administrator
Office of Spectrum Management

Enclosures (6)

Enclosure 1: Allocation Proposal for 2025-2110 MHz Band

International Table			United States Table		FCC Rule Part(s)
Region 1 Table	Region 2 Table	Region 3 Table	Federal Table	Non-Federal Table	
2025-2110 SPACE OPERATION (Earth-to-space) (space-to-space) EARTH EXPLORATION-SATELLITE (Earth-to-space) (space-to-space) FIXED MOBILE 5.391 SPACE RESEARCH (Earth-to-space) (space-to-space) 5.392			2025-2110 SPACE OPERATION (Earth-to-space) (space-to-space) EARTH EXPLORATION-SATELLITE (Earth-to-space) (space-to-space) SPACE RESEARCH (Earth-to-space) (space-to-space) [FIXED] [MOBILE] 5.391 5.392 US90 US222 US346 US347 ~~US393~~ [USXXX GXXX]	2025-2110 FIXED NG118 MOBILE 5.391 5.392 US90 US222 US346 US347 ~~US393~~ [USXXX]	TV Auxiliary Broadcasting (74F) Cable TV Relay (78) Local TV Transmission (101J)

ADD:

FIXED and MOBILE allocations in column 4.

USXXX Federal fixed and mobile operations in the band 2025-2110 MHz are co-primary and limited to the military services operating in accordance with the Frequency Allocation Table. To facilitate compatible operations, coordination is required in accordance with a Memorandum of Understanding between Federal and non-federal fixed and mobile operations in the Television Broadcast Auxiliary Service, the Cable Television Relay Service, or the Local Television Transmission Service. Fixed and mobile military stations in the band shall not cause harmful interference to nor constrain the deployment and use of the band by these non-federal Services. These non-federal operations in the band shall make all reasonable efforts to accommodate military mobile and fixed operations in the band, but the non-federal operations will have priority over such military operations.

GXXX Military stations operating in the fixed and mobile services in the band 2025-2110 MHz should, to the extent practicable, employ frequency agile technologies and techniques, including the capability to tune to other frequencies, including modular retrofit capabilities, to facilitate sharing of this band with incumbent federal and non-federal operations.

DELETE:

US393 In the band 2025-2110 MHz, the military services may operate stations in the fixed and mobile except aeronautical mobile services on a secondary and coordinated basis at the following sites:

Site	Coordinates	Radius of Operation (km)
Nellis AFB, NV……..……	36° 14' N 115° 02' W	80
China Lake, CA.…….	35° 41' N 117° 41' W	50
Ft. Irwin, CA……...	35° 16' N 116° 41' W	50
Pacific Missile Test Range/Pt. Mugu, CA…..	34° 07' N 119° 30' W	80
Yuma, AZ……...……	32° 32' N 113° 58' W	80
White Sands Missile Range, NM……..….	33° 00' N 106° 30' W	80

ENCLOSURES 2-5

Reports approved by NTIA's Commerce Spectrum Management Advisory Committee (CSMAC) pertaining to the 1695-1710 MHz and 1755-1850 MHz bands.

Enclosure 2: CSMAC, "1695-1710 MHz Meteorological-Satellite," Final Report of Working Group 1, Rev. 1 (July 23, 2013), *available at* http://www.ntia.doc.gov/files/ntia/publications/wg1_report_07232013.pdf.

Enclosure 3: CSMAC, "1755-1850 MHz Satellite Control and Electronic Warfare," Final Report of Working Group 3 (July 19, 2013), *available at* http://www.ntia.doc.gov/files/ntia/Working_Group_3_Final.pdf.

Enclosure 4: CSMAC, "1755-1850 MHz Point-to-Point Microwave, Tactical Radio Relay (TRR), Joint Tactical Radio System/Software Defined Radio (JTRS/SDR)," Final Report of Working Group 4 (July 23, 2013), *available at* http://www.ntia.doc.gov/files/ntia/publications/wg4_final_report_072413.pdf.

Enclosure 5: CSMAC, "1755-1850 MHz Airborne Operations (Air Combat Training System, Small Unmanned Aircraft Systems, Precision Guided Munitions, Aeronautical Mobile Telemetry)," Final Report of Working Group 5 (Sept. 16, 2013) *available at* http://www.ntia.doc.gov/files/ntia/publications/wg5_1755-1850_final_reportl-09-16-2013.pdf.

NASA's REPLY TO COMMENTS FILED WITH THE FCC IN RESPONSE TO ITS AWS-3 NPRM REGARDING NASA'S FEASIBILITY ASSESSMENT FOR ACCOMMODATION OF MOBILE BROADBAND LONG TERM EVOLUTION (LTE) SYSTEMS IN THE 2025-2110 MHz BAND[1]

I. INTRODUCTION AND SUMMARY

The FCC's AWS-3 NPRM, among other issues, seeks comments on NASA's "Feasibility Assessment For Accommodation of Mobile Broadband Long Term Evolution (LTE) Systems in the 2025-2110 MHz Band" ("*NASA Study*").[2] In their comments, three LTE proponents assert that the *NASA Study* is flawed because it relies on worst case assumptions or mischaracterizes LTE systems that are contemplated for the 2025-2110 MHz band. Two of these parties further claim that if the *NASA Study* were correct, NASA's Tracking and Data Relay Satellite System (TDRSS) would be experiencing interference today at 2109.49 MHz. One of these parties further contends that the *NASA Study* is incorrect because it is inconsistent with results of a Commerce Spectrum Management Advisory Committee (CSMAC) study of LTE sharing with Earth-to-space transmission systems operating in the 1755-1850 MHz band.

Contrary to the LTE proponent's comments, the conclusions of the *NASA Study* are not based on worst-case assumptions. In fact, NASA varied LTE system parameters and interfering signal propagation conditions to address a broad range of best-case and worst-case frequency sharing situations. Further, the *NASA Study* used the LTE parameters from the then most recent available studies conducted in CSMAC and the International Telecommunication Union Radiocommunication Sector (ITU-R) and provided an extrapolation methodology for addressing alternate assumptions. This notwithstanding, ITU-R experts recently provided a new definitive set of LTE system parameters for use in frequency sharing studies. Accordingly, NASA used these updated LTE parameters and assumptions, which are similar to those raised by the LTE proponent's in their comments, in an *Updated Study*.[3] The *Updated Study* also concludes that sharing between LTE systems and TDRSS in the 2025-2110 MHz band is not feasible. We also

[1] Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands, Notice of Proposed Rulemaking and Order on Reconsideration, FCC 13-102 (July 23, 2013) ("NPRM").

[2] *See* NPRM ¶21 and Letter from Karl B. Nebbia to Julius P. Knapp (July 22, 2013)(GN Docket No. 09-51), which presents the *NASA Study* as Enclosure 2.

[3] *See* United States of America: Proposed updates to Preliminary draft new Report ITU-R SA. [2 025 – 2 290 MHz], ITU-R Document 4-5-6-7/337-E (October 10, 2013) ("*Updated Study*"). This document consolidates and updates separate studies of LTE sharing with data relay satellite systems in the 2025-2110 MHz and 2200-2290 MHz bands. The definitive LTE parameters used in the *Updated Study* are presented in the attachment to ITU-R Doc. 4-5-6-7/236, Working Party 5D Liaison Statement to Joint Task Group 4-5-6-7, "Sharing Parameters for WRC-15 Agenda Item 1.1" (July 18, 2013).

note that none of the commenters provide their own independent analyses nor did they apply their alternative parameter assumptions in NASA's extrapolation methodology.

Commenters provided no rationale for their assertions that the *NASA Study* is incorrect because it would predict that TDRSS should be experiencing adjacent band interference today or because it is inconsistent with a CSMAC study of a different sharing situation. The *NASA Study* does not address adjacent band sharing between TDRSS operations below 2109.49 MHz and commercial broadband systems operating in the AWS-1 band above 2110 MHz. Adjacent band interference is not occurring today as a result of the frequency separation of TDRSS signals and AWS-1 broadband transmissions and the attendant frequency dependent rejection of unwanted signals. CSMAC Working Group 3 studied LTE sharing with high-power Earth-to-space transmission systems in the 1755-1850 MHz band, whereas the *NASA Study* addresses LTE sharing with low-power TDRSS space-to-space transmissions in the 2025-2110 MHz band. The space systems and LTE deployments considered in these studies differ substantially, and so, no consistency should be expected between the results.

We also note that none of the LTE proponents responded to the Commission's questions regarding the existing international prohibition of high density mobile systems in the 2025-2110 MHz band and the underlying need to protect foreign data relay satellite systems.[4]

II. THE *NASA STUDY* ADDRESSES VARIOUS BEST-CASE AND WORST-CASE SHARING ASSUMPTIONS THAT YIELD A RANGE OF REALISTIC RESULTS

CTIA states that the *NASA Study* appears to rely on worst-case, conservative assumptions.[5] This is not the case. The *NASA Study* explicitly addresses hypothetical best-case parameter values as well as alternate, worst-case-oriented parameter values, which yield results that would encompass the actual interference situation. The best-case assumptions for the analysis of transmitting LTE base stations included: a 4 Watt base station transmitter power level; actual base station antennas that have higher discrimination than the ITU-R standard reference antenna pattern; and complete blockage of base station signals at elevation angles of 45° or less. Even in the worst-case analyses, which use smaller elevation angles, the complete blockage assumption is retained, so these analyses are still not fully worst-case. The 4 Watt base station power level assumed for all base stations in the best-case is only one-tenth of the assumed base station peak power. It is unrealistically optimistic to assume that all base stations would be operating near a 4 Watt power level because it corresponds with very light traffic loading in all cells. An actual base station antenna pattern that has higher discrimination towards space than

[4] "Parties that advocate licensing 2095-2110 for wireless broadband should explain how such use can be reconciled with the footnote 5.391, including the underlying need to protect U.S. and foreign space systems, and describe in detail the technical, operational, and licensing rules that we should apply." *AWS-3 NPRM*, ¶39.

[5] Comments of CTIA – The Wireless Association, GN Docket 13-185, September 18, 2013, ("CTIA Comments"), at 17. CTIA's comments focus on LTE downlink (base station transmitter) use of the 2095-2110 MHz band.

the ITU-R reference antenna radiation pattern was assumed in the best-case since it would be possible to mandate this higher antenna performance. The assumption that all base station transmissions would be completely blocked at elevation angles of 45° or less is a simplified, over-optimistic way to evaluate the effects of interfering signal attenuation due to clutter, buildings and terrain. These path features cause signal attenuation to occur in some cases at low elevation angles, but the attenuation is nowhere near as severe as the assumed complete-signal-blockage (i.e., infinite attenuation); otherwise, cell phone and smartphone service would not be possible in many areas where clutter, buildings or terrain intercede on the signal path. Thus, actual LTE interfering signal levels would exceed the hypothetical best-case levels as LTE area coverage expands over time, well before reaching the overall U.S. and foreign coverage assumed in the *NASA Study*. Yet even using the best-case interference scenario the *NASA Study* concludes that the TDRSS protection criteria will be exceeded. This discussion also pertains to the *Updated Study*, which also uses a best-case interference scenario and concludes that the TDRS protection criteria will be exceeded.

III. ITU-R UPDATED PARAMETERS FOR LTE SYSTEMS ARE CONSISTENT WITH COMMENTS BUT DO NOT YIELD COMPATIBILITY WITH TDRSS

A. Geographic Deployment of Base Stations

CTIA asserts that the *NASA Study* assumes a far greater number of base stations than would be present in the real-world deployment and that actual base stations would be less equally distributed.[6] T-Mobile states that the largest existing network in the U.S. has approximately 60,000 cells, whereas the *NASA Study* assumes that there would be 210,015 cells in the U.S. if rural cells are neglected and it fails to use the inter-site distance agreed by CSMAC's Working Groups.[7] Ericsson states that inter-site distances are more diverse than the distances assumed in the *NASA Study*.[8] The fact is, the *NASA Study* applied the inter-site distances specified by CSMAC Working Group 1 and considered coverage areas in and around each city that were one-fourth the size of the coverage areas specified by CSMAC Working Group 1.[9] The smaller coverage areas used in the *NASA Study* reduced the assumed number of base stations per city compared to the number of base stations assumed by CSMAC Working Group 1, and so, this assumption improved the LTE sharing prospects. Moreover, the 210,015 cells considered in the *NASA Study* includes 126 rural-coverage cells at the outskirts of each of

[6] *Id.*, at 17.

[7] Comments of T-Mobile USA, Inc., GN Docket 13-185, September 18, 2013, at 22-23.

[8] Comments of Ericsson, GN Docket 13-185, September 18, 2013, at 14-15.

[9] *See* Commerce Spectrum Management Advisory Committee, Final Report, Working Group 1 – 1695-1710 MHz Meteorological-Satellite, (January 22, 2013), Appendix 3, "Baseline LTE Uplink Characteristics." The overall LTE coverage area assumed therein extends out to 100 km from the center of a city, whereas the *NASA Study* assumes coverage extending to only 50 km from the center of a city.

the 249 U.S. cities that were considered (a nationwide total of 31,374 rural cells).[10] This notwithstanding, reducing the assumed number of LTE base stations as suggested by the commenters is tantamount to reducing the amount of area or number of cities that are covered. If, for the sake of discussion, LTE systems were to cover only one-fourth the coverage area assumed in the *NASA Study* (i.e., 249/4 or 62 U.S. cities, using 52,503 base stations), the aggregate total interfering signal power would be lowered by a factor of about 6 dB. In the best case analysis, this reduced level of aggregate LTE base station interfering signal power would still substantially exceed the protection criteria for TDRSS.

The *Updated Study* reduces the assumed numbers of covered world and U.S. cities from 349 to 160 and from 249 to 55, respectively. However, this did not yield a significant reduction in the number of LTE base stations because the *Updated Study* applies the inter-site spacing distances specified by ITU-R Working Party 5D, which are much smaller than those assumed by CSMAC and the *NASA Study*.

B. LTE Base Station Transmitter Power Levels

Ericsson states that the *NASA Study* assumed a uniform 40 Watt power level for all LTE base stations and that power levels would be more diverse in the real-world.[11] T-Mobile asserts that the aggregate base station transmitter power per city is unrealistically and extraordinarily large.[12] The *NASA Study* addressed a range of base station traffic loading and power levels by treating the 40 Watt power level as a "peak power value" (corresponding with 100% traffic loading) and by varying loading and transmitter power levels.[13] The assumed average base station power level was 4 Watts in the hypothetical best-case, which corresponds with very light nationwide use of 2025-2110 MHz networks. Base station power levels were similarly varied in the *Updated Study*, and the assumed average base station power level is 8 Watts. The best-case results from both studies showed that the TDRSS protection criteria would be substantially exceeded.

C. LTE Base Station Antenna Down Tilt Angles

Ericsson notes that the *NASA Study* assumed 3° down tilt angles for all base station antennas and advises that the 3° value is typical for rural areas but that down tilt angles in urban and suburban areas are normally in the range of 6° to 10°.[14] This is consistent with the down tilt

[10] *NASA Study*, Appendix 2. CSMAC Working Group 1 did not specify how many U.S. cities might be covered by LTE systems at some point in the future.

[11] Comments of Ericsson, at 14-15.

[12] Comments of T-Mobile, at 23.

[13] See *NASA Study*, Table 2 and n1.

[14] Comments of Ericsson, at 15.

specifications that were provided by ITU-R Working Party 5D. Accordingly, the *Updated Study* applies these down tilt angles for base station antennas located in urban, suburban and rural areas, respectively.

D. LTE Base Station Azimuth Orientation

Ericsson states that "…use of a single virtual antenna modeled as a point source for each city is acceptable assuming the average effect of orientation of base station antennas towards the horizon is modeled randomly …" and that "[d]oing so will lower the total transmitted power by a factor of around 4.8 dB for a typical three-sector deployment."[15] This is exactly the approach NASA applied in the both the *NASA Study* and the *Updated Study*.

E. Interfering Signal Propagation

T-Mobile asserts that the *NASA Study* fails to use the propagation model and clutter factor that were agreed upon by CSMAC's Working Groups.[16] Ericsson states that clutter losses would be significant.[17] CSMAC Working Group 3 addressed propagation on LTE interfering signals on Earth-to-space paths, which are the same interfering signals paths addressed in the *NASA Study* and *Updated Study*. Working Group 3 did not include clutter factors in its propagation model; instead, it applied free space loss with an insignificant amount of atmospheric (gaseous) loss.[18] The *NASA Study* and *Updated Study* also applied free space loss, but included additional propagation losses modeled as complete signal blockage on interfering signal paths having elevation angles of 0°, 20° and 45° or lower. The *Updated Study* also assumes that building penetration losses amount to complete signal blockage, such that no indoor LTE emissions radiate into space, and includes clutter losses on un-blocked signal paths from outdoor LTE transmitters. Consequently, the best case analyses in the *NASA Study* and *Updated Study* apply substantially higher propagation losses to LTE interfering signals than the CSMAC Working Group 3 analyses.

F. Aggregate User Equipment Power Per City

T-Mobile asserts that the *NASA Study* assumes unrealistically large numbers of transmitting handsets and aggregate per-city handset transmitter power levels.[19] The *NASA Study*

[15] Comments of Ericsson, at 15

[16] Comments of T-Mobile, at 22.

[17] Comments of Ericsson, at 15.

[18] *See* Commerce Spectrum Management Advisory Committee (CSMAC) Working Group 3 (WG 3) Report on 1755-1850 MHz Satellite Control and Electronic Warfare, July 24, 2013 ("*CSMAC Report*"), at 155.

[19] Comments of T-Mobile, at 23.

assumed the handset transmitter power levels and the number of handsets per base station that were specified by CSMAC Working Group 1. The *Updated Study* assumes the handset transmitter power levels and the number of handsets per base station that were specified by the ITU-R experts. Additionally, the *NASA Study* and *Updated Study* both assume a smaller coverage area and fewer transmitting handsets per city than CSMAC Working Group 1. Thus, the aggregate per-city handset power levels in the *NASA Study* were lower than those assumed by CSMAC Working Group 1.

IV. SIMILAR RESULTS SHOULD NOT BE EXPECTED FROM THE NASA AND CSMAC STUDIES OF DIFFERENT FREQUENCY SHARING SITUATIONS

T-Mobile asserts that the *NASA Study* is inconsistent with the *CSMAC Report (provided by its Working Group 3),* which considered a "…similar interference scenario…" and "…concluded that there was minimal potential for interference from transmitting LTE handsets to orbiting satellite receivers."[20] To the contrary, the interference scenarios analyzed in the *NASA Study* and CSMAC Report address substantially different victim satellite systems and LTE deployments; thus, there is no reason to expect similar results.

The *CSMAC Report* Earth-to-space transmissions originate from earth stations radiating EIRPs of 72 dBW to 84 dBW, and, in sharp contrast, TDRSS satellite forward link transmitters radiate EIRPs of 55 dBW (less than one-hundredth the power). Therefore, the *CSMAC Report* links are much more robust than the TDRSS links, so the former are also much less sensitive to interfering signals.

Moreover, the *CSMAC Report* calculates potential interference from LTE systems that are assumed to cover one hundred (100) U.S. cities, whereas the *NASA Study* calculates potential interference from LTE systems that are assumed to cover three-hundred-and-forty nine (349) cities including one-hundred (100) foreign cities. The *CSMAC Report* recognizes that the 100-city LTE deployment it assumed may understate the actual aggregate interfering signal levels that will occur and recommends that the Commission periodically review licensee compatibility analyses and LTE deployment plans in order to ensure that the protection criteria for satellite control uplinks will not be exceeded:[21]

V. THE NASA STUDY DOES NOT INDICATE THAT AWS-1 BASE STATIONS ABOVE 2110 MHz WOULD BE INTERFERING WITH TDRSS TODAY

CTIA and Ericsson speculate that if the *NASA Study* were correct, AWS-1 base stations operating above 2110 MHz would be causing observable interference to the TDRSS today at 2109.49 MHz.[22] To the contrary, the *NASA Study* does not provide any insights about existing

[20] Comments of T-Mobile, at 22.

[21] *See CSMAC Report*, at 4-5.

[22] Comments of CTIA, at 17, and comments of Ericsson, at 17.

adjacent band interference that might be caused by AWS-1 base stations because it models and analyzes a totally different frequency sharing situation. The interfering signals considered in the *NASA Study* emanate from AWS-3 and foreign LTE systems that would operate in the 2025-2110 MHz band, whereas the AWS-1 base stations operating today in the 2110-2155 MHz band have different parameters. Moreover, the *NASA Study* analyzes the co-frequency sharing that would occur if LTE systems were to operate in the 2025-2110 MHz band and does not consider the substantial TDRSS user-satellite receiver rejection of signals from transmitters operating above 2110 MHz. The 2109.49 MHz TDRSS frequency cited by commenters is the upper edge of a TDRSS forward link channel centered at 2106.41 MHz, and so, the guard band and frequency separation from AWS-1 base station transmitters operating above 2110 MHz enables TDRSS user-satellite receiver filters to suppress signals occupying the 2110-2155 MHz band. Furthermore, the 3GPP LTE standard expressly requires guard bands whose size depends on the channeling scheme.[23]

[23] *See* ETSI TS 136 104 v11.2.0 (2012-11).