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Impacts of the LightSquared Network on Federal Science Activities

Chairman Hall, Ranking Member Johnson, and Members of the Committee, I am deeply honored for this opportunity to appear before you today. Like the Internet, Global Positioning System (GPS) is an essential element of the global information infrastructure. The free, open, and dependable nature of GPS has led to the development of thousands of applications affecting every aspect of modern life and new applications are developed daily. GPS technology is now in everything from cell phones and wristwatches to bulldozers and shipping containers. When you swipe your card at an Automatic Teller Machine (ATM) or your credit card at a gas pump, you are using GPS. GPS boosts productivity across a wide swath of the economy, to include farming, construction, mining, surveying, package delivery, and logistical supply chain management. Major communications networks, banking systems, financial markets, and power grids depend heavily on GPS for precise time synchronization. Some wireless services cannot operate without it.

GPS saves lives by preventing transportation accidents, aiding search and rescue efforts, assisting law enforcement and speeding the delivery of emergency services and disaster relief. GPS is vital to the Next Generation Air Transportation System (NextGen) that will enhance flight safety while increasing airspace capacity. GPS also

advances scientific aims such as weather forecasting, earthquake monitoring, and environmental protection.

The Role of the Space-Based Positioning, Navigation and Timing Executive Committee

On September 1, 1983, a Korean civilian airliner took off from Alaska and ended up straying way off course into Soviet airspace. The airliner was shot down as it attempted to leave the airspace and all 269 passengers were killed. As part of the response to that tragedy, President Reagan announced the United States would make its GPS signals available to the world to avoid any navigation errors of that type. That announcement marked the beginning of a multi-use policy approach to GPS and each successive administration has strengthened that concept. In 2004, President Bush issued a National Space-Based Positioning, Navigation and Timing (PNT) Policy establishing a Deputy Secretary level Executive Committee to advise and coordinate on policies, programs, requirements, schedules, architectures and budgets to sustain and modernize GPS, systems that augment or enhance GPS, and any backup systems. The Policy includes an explicit instruction to continue to operate and modernize GPS to meet growing scientific and commercial demands. Last year, President Obama signed out his comprehensive National Space Policy which left the existing PNT policy in place, but added emphasis and additional guidance in four key areas related to GPS. One of these new emphasis areas dealt specifically with the issue of harmful interference. We are also responsible in this policy to identify impacts to government space systems prior to any reallocation of spectrum for commercial, federal, or shared use.

To execute the staff functions of the Executive Committee, and to assist them in ensuring implementation of the President's policy objectives, a National Coordination Office (NCO) was established. The NCO is staffed with representatives from every department or agency with major equities in GPS. I am speaking to you today in my capacity as the Director of that office.

The National Space-Based Positioning, Navigation and Timing Systems Engineering Forum (NPEF)

The NPEF is an interagency working group that supports the Executive Committee on major technical issues that cross agency boundaries. Their reports help form the basis for recommendations made to the Executive Committee. The NPEF is co-chaired by the Air Force's Chief Engineer from the GPS Program Office and the FAA's Ground Segment Lead for Global Navigation Satellite Systems and Space-Based Augmentation Systems. They are assisted by technical representatives and other staff from across the interagency.

On the January 26 this year, the Federal Communications Commission (FCC) approved a Conditional Waiver for LightSquared's high power broadband network the Executive Committee had warned might cause significant interference to government-wide GPS applications. With the permission of the Executive Committee's Steering Group, the NPEF was tasked to evaluate the LightSquared proposal, assess impacts and look at potential mitigation of any harmful effects. I've included the NPEF Task Statement as part of this testimony.

Their test methodology involved modeling, simulation, analysis, bench testing, radiated testing inside an anechoic chamber, and what we call "live sky" testing where

they set up a tower outdoors and broadcast a signal as close as they could to what they expected the actual configuration to be. Each of these methods has advantages and limitations and using multiple methods enhances confidence in the results. LightSquared actively supported these efforts. They provided their actual hardware including a custom filter on their transmitters, technical specifications and answered numerous questions from NPEF engineers, and sent personnel to government test sites to review and comment on the test set-up. I would like to take this opportunity to publicly thank LightSquared for their cooperation. It greatly enhanced the fidelity of the results.

I do want to identify some limitations of our testing effort. The most significant is that there was only one LightSquared transmit antenna. Since interference effects can be additive, this is a serious limitation in a planned environment where the LightSquared base stations are densely enough packed that a given user will likely see effects from multiple towers simultaneously. This also greatly complicates some of the potential mitigation options. A second limiting factor was there were no LightSquared handsets available to test. The handsets operate at a different frequency than their base stations and are much less powerful. However, the NPEF anticipates they will be much more numerous and since they are mobile they could be anywhere, and may even be frequently co-located with GPS receivers. Several technical experts on the team consider this to be a very significant problem, but they were not able to explicitly address this issue. A third limiting factor is the inability to fully represent the diversity of the GPS user community. There are more GPS applications than we can count, and at the NCO we learn of new applications at the rate of about three per week. Each

application is different. Some require extreme position accuracy; others do not use position at all, but need very precise timing. Some applications require less precision, but need extremely high integrity—in other words they need high confidence the signal they receive is accurate. Still others do not even read the signal's message content; they only care about the phase relationship between the military and civil GPS signals. It was therefore difficult to construct tests that covered all of our diverse users in the time we had to work with. And a final limiting factor was the extremely compressed time frame.

But despite these limitations, the NPEF completed the job they were asked to do. They were able to look at a wide range of representative receivers against all three phases of LightSquared's proposed deployment plan. In all, 24 different organizations participated in testing more than 75 different receivers in over 50 separate test events. The answer is definitive: LightSquared's proposed system would create harmful interference throughout all three phases of its planned deployment. I have attached an Executive Summary of the publicly releasable results to this Testimony. The tests showed no evidence of out-of-band emissions. In other words, the NPEF was able to confirm LightSquared's claim they correctly filter their transmission so it is not leaking into the GPS band. However, the tests also confirm the presence of other serious and harmful interference effects. Although not every individual receiver failed to perform, there were unacceptable levels of harmful interference in every class of receiver tested and at significant distances.

In the NPEF task statement, the engineering team was asked to consider possible mitigations to any problems they discovered. They were asked to investigate not only

things that we might reasonably ask LightSquared to do, but also to look at changes the GPS community could do that would mitigate harmful interference and still allow LightSquared to execute their business plan. The NPEF spent many hours considering the full range of options such as: reducing power on LightSquared's transmission, increasing GPS's transmitted power, building better GPS filters, or asking for exclusion zones around certain sensitive installations that use GPS. Unfortunately the NPEF could not identify any feasible option that would mitigate harmful interference for all or even most GPS users, and still allow LightSquared to meet their system requirements. The only suggested option that might work would be moving LightSquared to a different part of the spectrum, and that involves a host of other issues outside the PNT community. I've included an Executive Summary of the results of the NPEF testing, including a discussion of the potential mitigation options, as part of this testimony.

LightSquared's Technical Working Group (TWG)

When the FCC granted the Conditional Waiver, one of the conditions was for the company to fund testing efforts to resolve the interference concerns the Executive Committee and GPS Industry had raised. The FCC Order further directed the creation of a LightSquared-led working group and highly encouraged participation from the U.S. Government and representation from across the diverse GPS industry. Altogether the TWG contained 39 full-time members and 61 part-time technical advisors, split between GPS Industry, LightSquared, and the Government. Like the NPEF, the TWG used an assortment of different techniques culminating in two weeks of "Live-Sky" testing in Las

Vegas. There was healthy crossflow of expertise and data sharing between the NPEF and TWG.

LightSquared chose to break the effort into seven separate sub-groups based on GPS application type. The results were completely consistent with what the NPEF found. All seven sub-groups reported significant harmful interference with respect to all three phases of LightSquared's planned deployment. There was no consensus on feasible mitigation options although most of the subgroups did advocate for moving LightSquared's service to a different frequency band.

LightSquared's New Plan

On June 29, 2011 LightSquared submitted their TWG report acknowledging the harmful interference their proposed system would create. Simultaneously they submitted a report outlining a proposed potential solution. This solution was completely separate from the TWG and not evaluated by them. LightSquared's new "Recommendation Paper" suggests three distinct changes. 1) A re-phasing of their plan where the first of their two transmissions is the one lower in their frequency band and therefore further from GPS; 2) A reduction in authorized power to the level they told us they originally planned to operate at; and 3) a "standstill" on transmitting their 2nd channel (closer to the GPS band) for some undefined period of time.

The FCC is currently evaluating this recommendation as well as considering all the comments received in the public comment period. The Government testing did not consider the configuration LightSquared is now proposing, although NPEF testing was done at the power level they indicate. The TWG did not plan to test this configuration

either, but in the final days of their testing did collect some data. The TWG report is inconclusive as to whether this lower channel transmission does or does not cause harmful interference to most GPS receivers. The limited data collected is highly disputed and all seven of LightSquared's sub-groups recommended further study of this planned change to the phasing. The federal departments and agencies are recommending retesting once the FCC defines the final configuration.

High-Precision Receivers

However all parties concur the class considered "High-Precision" would still be impacted even under the first phase of LightSquared's new proposal. LightSquared's TWG report indicates 31 of 33 receivers tested in this sub-group failed in an environment where LightSquared was not transmitting in the upper half of their band. This class of receivers involves many of those used in advanced scientific and research applications. For example, the receivers used in EarthScope's Plate Boundary Observatory can measure movements due to tidal forces less than a one millimeter. Receivers like these would fit into the "High-Precision" category and will eventually be in every county in the country. This National Science Foundation project is critical to our understanding of the interior of the Earth and supports research on earthquakes, tsunamis and global climate change.

Another example of a service which may be affected would be the National Institute of Standards and Technology (NIST) Time and Frequency Measurement and Analysis Service (TMAS) and (FMAS). LightSquared implementation, even under their new configuration, may impact NIST's ability to provide high-precision calibration services to

national laboratories and private sector customers nationwide. Even non-GPS related research may depend on accurate time and frequency calibration received from NIST.

High-Precision GPS is also used by the Environmental Protection Agency for numerous research applications and is an integral part of their FIeld EnvironmentaL Decision Support system, or FIELDS. This impacts areas such as hazard waste site clean-up, response to oil spills, emergency preparedness, revitalization and development. Another NSF-funded environmental research project involves spatial variability in plant nitrogen and forage quality related to grassland fires. This directly affects grazing habits of herbivores.

A final example would be potential impacts to efficient power distribution. The future "Smart Grid" incorporates geographically diverse Phasor Measurement Units (PMUs) to ensure alternating current is phase synchronized across the network. There are numerous economic and environmental benefits to this including reduced overall energy consumption, increased efficiency in demand response/load management programs, better utilization of equipment, reduction in carbon emissions, and the ability to more easily substitute renewable forms of energy. With the aid of precise GPS timing, the Department of Energy will be able to decrease the likelihood and the severity of major blackouts.

None of these systems I've mentioned above were directly tested by either the NPEF or the TWG, so we do not know if they would be impacted. But both sets of tests did indicate increased susceptibility to interference for those higher end, more sophisticated systems. Both the NPEF and the TWG sub-groups recommended further

testing, especially on the 10 MHz low configuration and on any proposed measures to mitigate harmful effects.

Summary

The extensive and comprehensive testing done by LightSquared, the NPEF, and the GPS Industry conclusively demonstrates harmful interference from LightSquared's intended deployment of their high power terrestrial broadband system and should not be allowed to commence commercial operations until the identified problems are resolved.

> The Administration believes that we must protect existing GPS users from disruption of the services they depend on today and ensure that innovative new GPS applications can be developed in the future. At the same time, recognizing the President's instruction to identify 500 MHz of new spectrum for innovative new mobile broadband services, we will continue our efforts at more efficient use of spectrum. Therefore, in the short run, we will participate in the further testing required to establish whether there are any mitigation strategies that can enable LSQ operation in the lower 10MHz of the band. We also encourage commercial entities with interests to work with Lightsquared toward a possible resolution, though any proposed mitigation must be subjected to full testing. The challenge of meeting the President's goal also depends on long-term actions by Federal agencies in the area of research and development, procurement practices that encourage spectrally-efficient applications, and new policy development.

Further study is needed on alternative concepts, including the most recent LightSquared proposal. The National Coordination Office will assist as directed by the Space-Based PNT Executive Committee in any follow-on efforts. I thank you for this opportunity to speak on an issue with a very significant impact to federal science activities and to over a billion world-wide users. I look forward to your questions.

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