TESTIMONY OF MARY M. GLACKIN
DEPUTY UNDER SECRETARY FOR OPERATIONS
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
HEARING ON
LIGHTSQUARED INTERFERENCE TO THE GLOBAL POSITIONING SYSTEM
BEFORE THE
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

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Mr. Chairman, Ranking Member Johnson, and Members of the Committee, thank you for the opportunity to speak today on the importance of the Global Positioning System (GPS) to the National Oceanic and Atmospheric Administration (NOAA) and the operational impacts we could face as a result of GPS interference from the proposed LightSquared communications network.

My name is Mary Glackin and I am the Deputy Under Secretary for Operations at NOAA.

From daily weather forecasts, severe storm warnings, and climate monitoring to fisheries management, coastal restoration, and supporting marine commerce, NOAA's products and services support economic vitality and affect more than one-third of America's gross domestic product. GPS technology is a key enabler for all of these activities, integrated into our operational systems and functions across all of the line offices at NOAA.

For this reason, NOAA has been very interested and involved in the recent activities surrounding LightSquared Subsidiary LLC and its conditional authorization to broadcast in the 1525-1559 MHz band next to the GPS signal. NOAA contributed GPS equipment and experts to both of the major interference testing efforts that took place this spring – namely, the Technical Working Group led by LightSquared, and the government's National Space-Based Positioning, Navigation, and Timing Systems Engineering Forum.

Those testing efforts focused primarily on the original LightSquared broadcasting plan involving two channels, referred to as the upper 10 MHz and lower 10 MHz channels. But both groups also performed initial testing of LightSquared's modified spectrum plan involving only the lower 10 MHz channel. My testimony today will address potential effects of both the original and modified LightSquared spectrum plans, based on our analysis of the empirical test data collected to date.

<u>Potential NOAA Impacts of LightSquared's Original Spectrum Plan</u>

In response to tasking from the National Space-Based Positioning, Navigation, and Timing Executive Committee, we recently conducted an extensive review of GPS usage across NOAA, including the National Weather Service, the National Ocean Service, the Office of Oceanic and Atmospheric Research, the National Marine Fisheries Service, and the National Environmental Satellite, Data, and Information Service.

Our review concluded that interference to GPS under LightSquared's *original* spectrum plan would cause serious performance degradation or a total loss of mission for a wide range of our operational systems, resulting in the loss of critical services and potential loss of life and property. These include major satellite, airborne, sea-based, and terrestrial systems used for weather forecasting, climate observation, search and rescue, vessel navigation, nautical charting, emergency response, and geodesy.

Our entire fleet of meteorological satellites would be put at risk. All of the ground stations that control the current GOES (Geostationary Operational Environmental Satellite) and POES (Polar-orbiting Operational Environmental Satellite) spacecraft depend on GPS for accurate system timing. Without GPS, these ground systems would eventually fail to keep proper time, causing widespread errors that degrade the quality of satellite-based weather and climate measurements. The result would be less accurate warnings of tornadoes, hurricanes, and other severe weather directly affecting U.S. public safety, property, and businesses. Eventually, if the timing errors reach the order of a few microseconds, spacecraft could become unstable and we could completely lose the ability to command and control them.

Likewise, NOAA's satellite-based search and rescue system, SARSAT, uses multiple GPS receivers at its ground stations to determine and maintain precise time. Since 1982, SARSAT has contributed to over 28,000 worldwide rescues -- including last year's rescue of Abby Sunderland, the 16-year-old who capsized in the Indian Ocean while sailing around the world. SARSAT ground stations use GPS time maintain the clocks on the satellite instruments that relay distress alerts. Without precise GPS time, the accuracy and timeliness of distress alert position calculations are significantly impacted. This leads to larger search areas, increased rescue personnel and fuel costs, longer response times, and ultimately, greater risk to rescuers and persons in distress.

Our future satellites, including the NPOESS Preparatory Project (NPP) and GOES-R, will use on-board GPS receivers for timing and orbit determination. The testing to date has shown that LightSquared's original broadcast could cause interference to GPS equipment in low Earth orbit, where NPP will fly. Our own engineering analysis suggests that it could even affect GOES-R at geostationary orbit, since GPS reception is already weak at that long distance. NPP and GOES-R are essential to continuing our weather and climate observations; without reliable GPS, their data will become almost useless.

Aside from our satellites, NOAA has deployed over 23,000 environmental sensor platforms across the planet that depend critically on GPS for accurate geo-referencing and time stamping of data. All of the sensor data must be tightly bound to the same geospatial and time scales, or it cannot be combined and ingested into our weather and climate models. The sensor platforms also require GPS time to synchronize their radio transmitters, so they can share limited radio spectrum as they relay data via the GOES and POES Data Collection Systems. Prolonged, continuous GPS interference at sensor platforms would cause their radios to start transmitting at the wrong times, and eventually cease operation. This would cause data corruption and gaps, degrading our modeling, forecasting, and disaster warning capabilities. Redesigning the radio system and redeploying it to over 23,000 remote locations would require new technology whose cost cannot be estimated at this time.

Similarly, NOAA's network of NEXRAD weather radars and sea surface radar altimeters require GPS-based time synchronization to enable the sharing of radio frequencies among dozens of radars. The NEXRAD system is critical to issuing timely severe storm and flood warnings, and local weather forecasts. The oceanographic radar systems measure conditions at the ocean surface and ocean currents to improve weather and climate models, as well as models used to inform search and rescue operations at sea. NOAA used these radars to predict the growth of the Deepwater Horizon oil spill last year. Loss of GPS timing would require either greater use of spectrum, which is very unlikely, or loss of current NOAA capabilities.

NOAA's radiosondes and dropsondes – instruments we attach to weather balloons and drop from aircraft into hurricanes – are entirely dependent on GPS for accurate position and velocity measurements. These measurements provide wind speed data used for aviation forecasts and as input to global numerical weather prediction models. Widespread interference to GPS would force us to re-engineer these critical systems using alternative methods. These methods would be less accurate and take many years to develop and implement. Meanwhile, we would be left with major data gaps for numerical weather prediction models, support to air traffic, and hurricane forecasts.

NOAA's fleet of 19 ships employs a variety of GPS and differential GPS receivers for navigation and scientific use. These vessels support oceanographic, atmospheric, fisheries and coral reef research, nautical charting, environmental monitoring, and ocean exploration. In addition, NOAA has numerous fleets of smaller vessels used for research, education, damage assessment, law enforcement, environmental observation, and buoy maintenance. If GPS service becomes unavailable or unreliable along U.S. coasts and waterways, NOAA vessels will be unable to perform many operations and missions.

I have described just a few of the myriad NOAA systems that depend on GPS and that would be impacted by GPS interference under LightSquared's original spectrum plan.

<u>Potential NOAA Impacts from LightSquared's Modified Spectrum Plan</u>

LightSquared's proposed solution to the problem involves voluntary power limits and the postponement of one of its two planned broadcast channels -- the upper 10 MHz bordering the GPS signal.

Unfortunately, the existing data from the interference testing groups, including LightSquared's own report to the FCC, demonstrates that the *new* spectrum plan, involving the *lower 10 MHz channel*, still raises issues for high-precision GPS receivers that feature a wideband design. As I mentioned, NOAA participated in this testing. Specifically, we provided five different wideband receivers that are representative of the equipment in use at NOAA for high-precision positioning. During the tests, four out of the five models failed when subjected to only the lower 10 MHz LightSquared channel. Since many critical NOAA operations require high-precision, wideband GPS equipment, we support further testing of LightSquared's proposal and continued investigations into mitigation options for wideband applications.

We have identified at least five major NOAA systems or functions that require wideband GPS equipment. These include:

(1) the six-satellite COSMIC system that observes the Earth's atmosphere to improve global weather and climate models;

(2) the monitoring of sea level trends to protect natural and human communities;

(3) the Ground-Based GPS Meteorology (GPS-Met) project, which measures atmospheric moisture to improve short-term weather forecasts;

(4) the issuance of the U.S. Total Electron Content (US-TEC) product to inform surveyors and other customers about space weather conditions affecting GPS accuracy; and

(5) the maintenance of the National Spatial Reference System to ensure compatibility among U.S. maps, surveys, and other geospatial products.

Three of these five activities depend on NOAA's management of a nationwide network of Continuously Operating Reference Stations, or CORS, which collect and share precise data about GPS satellite orbits. CORS provides a consistent positioning technology, accurate to an inch, that is used by millions of people throughout the United States, from surveyors to farmers to the FAA. This network is critical to anchoring nautical charts, building roads and railways, surveying airports, and responding to natural disasters and other emergencies, such as Hurricane Katrina and the Deepwater Horizon oil spill. For example, it allows FEMA flood maps to be seamlessly overlaid with levee surveys from the Army Corps of Engineers.

Unlike consumer GPS devices used for basic positioning, high-precision GPS equipment costs thousands of dollars per unit, and the economic value it provides to society is similarly high. In the case of CORS alone, there are over 1,800 reference stations, many of which have multiple GPS receivers. This multi-million dollar investment has been made not only by NOAA, but over 190 stakeholder organizations, including states, local communities, universities and other Federal Agencies. They all have a shared interest in maintaining a common standard for geospatial positioning in the United States, so the construction and maintenance of roads, bridges, railways, inland waterways, and other projects that cross-jurisdictional boundaries all use the same coordinate system.

If testing confirms that high-precision GPS receivers are significantly degraded by LightSquared's lower channel, and a suitable mitigation is not developed, major portions of the CORS network could cease functioning. Depending on the geographic distribution of the remaining sites, the entire network could fail to serve its intended purpose, forcing NOAA to use less accurate, more labor-intensive, and more costly methods such as line-of-sight triangulation to define the National Spatial Reference System.

For example, the cost to update the International Great Lakes Datum – a water level reference system of enormous economic importance to the United States and Canada for maritime navigation and shipping – could increase from under $30 million using GPS to $160 million using older methods. In addition, the widespread socio-economic benefits of CORS use, estimated at $758 million annually, could be lost due to interference at CORS sites.[1]

Similarly, we must find a way to preserve the high-precision GPS receivers used to measure sea level rise, which are subject to the same interference risk as the CORS equipment. Monitoring of ecological observations within an accurate and consistent geospatial framework requires high-precision GPS. Losing the availability or reliability of this technology would have a profound effect on our ability to monitor the impacts of sea level changes and inundation from storms and coastal flooding on coastal communities and ecosystems. This would undermine the ability of communities to identify their risk to sea level change and episodic storm events.

Finally, we have concerns about the COSMIC satellite system that uses the "GPS radio occultation" technique to probe the Earth's atmosphere. We use COSMIC data operationally to significantly increase the accuracy of hurricane forecasts and other weather models. COSMIC flies in low Earth orbit and would have been impacted by LightSquared's original broadcast plan. The next round of testing needs to assess whether wideband receivers in low Earth orbit, including those on COSMIC, are affected by LightSquared's new plan involving only the lower channel with proposed maximum power levels. If they are affected, the mitigation options will be limited, as the COSMIC satellites are already in space and cannot be modified.

For the wideband GPS receivers that are on the ground, LightSquared has stated its belief that new radio signal filtering techniques and/or exclusion zones can mitigate the interference concern for GPS users. Our engineers are concerned that a filter capable of blocking out the powerful LightSquared signal at the lower channel may also prevent the receiver from detecting the GPS signal, rendering it useless. This is something that must be investigated thoroughly in the next round of testing, so that NOAA does not lose important operational capabilities. If a filter-based solution is identified, it must preserve the receiver's high-precision functionality and

[1] Leveson, Irving. 2009. Socio-Economic Benefits Study: Scoping the Value of CORS and GRAV-D. NOAA's National Geodetic Survey, Washington, D.C.

it must not impose an unreasonable cost burden on NOAA and its partners. Establishing exclusion zones to keep LightSquared base stations away from major GPS users such as CORS sites may be more feasible, although this creates its own set of problems.

Conclusion

Mr. Chairman, 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 recommend further testing in order to assess the GPS interference concerns in the lower 10MHz of the band and to establish whether there are any feasible mitigation strategies. 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 Administration appreciates LightSquared's offer to not transmit in the upper 10MHz of its band, right next to GPS, and strongly supports efforts to identify alternative means of achieving the intended purpose of the signal that was planned there. 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.

NOAA has communicated our concerns to the National Telecommunications and Information Administration (NTIA), the agency that is responsible for managing Federal agencies' use of spectrum, and with which the FCC has stated it will consult in determining whether the interference concerns raised by this matter have been resolved.

NTIA, on behalf of impacted Federal agencies, has previously informed the FCC, on two occasions, that the LightSquared proposal "raises significant interference concerns" with respect to GPS and GNSS receivers and has urged the FCC to ensure these concerns are resolved before permitting LightSquared to become operational.[2]

This concludes my prepared statement. I thank you for your attention and look forward to your questions.

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[2] Letter from Lawrence E. Strickling, Assistant Secretary for Communications and Information, U.S. Department of Commerce, to Julius Genachowski, Chairman, Federal Communications Commission, (January 12, 2011). *See also,* Letter from Lawrence E. Strickling, Assistant Secretary for Communications and Information, U.S. Department of Commerce, to Julius Genachowski, Chairman, Federal Communications Commission, (July 6, 2011).