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A REVIEW OF ISSUES ASSOCIATED WITH PROTECTING AND IMPROVING OUR NATION'S AVIATION SATELLITE-BASED GLOBAL POSITIONING SYSTEM INFRASTRUCTURE

(112–71)

HEARING

BEFORE THE

SUBCOMMITTEE ON
AVIATION

OF THE

COMMITTEE ON
TRANSPORTATION AND
INFRASTRUCTURE
HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

SECOND SESSION

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February 6, 2012

MEMORANDUM

TO: Members, Subcommittee on Aviation

FROM: The Honorable Thomas E. Petri, Chairman, Subcommittee on Aviation

SUBJECT: A Review of Issues Associated with Protecting and Improving our Nation's Aviation Satellite-based Global Positioning System Infrastructure

PURPOSE

The Subcommittee on Aviation will receive testimony from federal government and industry witnesses regarding the importance of the Global Positioning System (GPS) as a critical part of transportation infrastructure. The subcommittee will also receive testimony on the public policy ramifications of protecting that infrastructure to ensure transportation safety and efficiencies provided by GPS technologies and innovations.

BACKGROUND

The Global Positioning System (GPS) is the global navigation satellite system (GNSS) developed in the United States that provides position and timing information at any place on the globe with a high degree of accuracy. GPS is composed of three different segments: satellites, a ground control system, and receivers. The United States Air Force maintains a constellation of at least 24 satellites that orbit 12,500 miles above the surface of the earth in six orbital planes so that at least four satellites are in view of any point in the world at any given moment.[1] The satellites transmit an encrypted military signal and an unencrypted civilian signal to military and commercial receivers, respectively. These two signals are monitored by the ground control system segment, which ensures the accuracy of the signals by sending periodic updates to the

[1] "The Global Positioning System for Military Users: Current Modernization Plans and Alternatives", The Congressional Budget Office, October 2011, p.2.

satellites.[2] After travelling 12,500 miles from space to the receivers, the GPS's 25-watt signal is weak when it reaches the ground.[3] For GPS to work properly, there must be at least 24 satellites operational. Currently, the Air Force flies 31 operational satellites, and another three satellites fly dormant and stand ready to be reactivated, as needed.[4]

First developed by the military during the Cold War, GPS was made available for civilian use by President Ronald Reagan after Korean Air Lines flight 007 was shot down in 1983 for straying into Soviet airspace due to imprecise navigation.[5] All 269 people aboard the aircraft were killed, including then-sitting U.S. Congressman Lawrence McDonald. Subject to President Reagan's order, the Department of Defense (DoD) began to repurpose GPS for civilian use. GPS was ordered to be made available for civilian use at its intended accuracy level, free of charge by Presidential Decision Directive NSTC-6 in 1996.[6] Selective availability, or the intentional degradation of the GPS signal to reduce accuracy available to commercial receivers, was turned off permanently in 2000.[7] Since then, GPS has evolved into an important part of everyday life as new capabilities have developed. GPS functionality can be found in just about everything with an "on-off" switch, including cell phones, cars, Automated Teller Machines (ATM), farming equipment, and of course, aviation surveillance and navigation equipment.

The use of GPS in transportation, and aviation in particular, benefits safety and efficiency by providing highly reliable, and more accurate position information when compared to the legacy surveillance systems. In aviation, GPS will soon replace radar as the primary surveillance method. The Department of Transportation (DOT) and the Federal Aviation Administration (FAA) already utilize GPS technology in a broad variety of surveillance, navigation, safety, and efficiency applications.[8]

Billions of dollars of federal and private-sector investment as well as millions of U.S. jobs are tied to the future of GPS infrastructure. According to press accounts, the DoD investments into GPS have topped $35 billion since its introduction and continue at roughly $1 billion annually.[9] In addition, the FAA has invested $3.1 billion in GPS to date. FAA investments include:

- $1.7 billion in the Wide-Area Augmentation System, which will enhance the accuracy of GPS and permit aircraft to perform precision approaches in poor-visibility conditions;
- $1.1 billion in automatic dependent surveillance-broadcast (ADS-B), a GPS-based system for air traffic control that will ultimately replace controllers' use of radar to track aircraft in flight;

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[2] CBO, October 2011, p. 3.
[3] Ibid., p. 4.
[4] http://www.gps.gov/systems/gps/space/
[5] The Washington Post: "Now we know where we stand, and it's about time", Curt Suplee, November 3, 2009.
[6] Presidential Decision Directive NSTC-6, The White House, March 28, 1996.
[7] Testimony of The Honorable Roy W. Kienitz, Under Secretary for Policy, U.S. Department of Transportation before the Subcommittees on Aviation and Coast Guard and Maritime Transportation, U.S. House of Representatives, June 23, 2011.
[8] GAO Report: Global Positioning System: Challenges in Sustaining and Upgrading Capabilities Persist, September 2010 (GAO-10-636).
[9] "LightSquared Plans Hinge on Outcome of GPS Interference Debate" by Peter B. de Selding, Space News International, March 4, 2011.

- $100 million toward the implementation of performance-based navigation procedures, which allow aircraft to fly fuel-efficient routes and flight profiles, saving time, expense, and greenhouse gas emissions; and
- $200 million in the Ground-Based Augmentation System, which allows for more precise navigation after takeoff and on approach.

Additionally, the FAA's Capital Investment Plan calls for $2.2 billion of further investment in GPS-related NextGen systems until fiscal year 2013.[10] The FAA estimates by 2013, in addition to DoD spending, up to $10 billion of public and private sector investments will have been made in civilian GPS uses. According to the FAA, over 360,000 civil aircraft are currently equipped with GPS-enabled avionics.[11]

Under the direction of the United States Air Force, the DoD is managing a GPS modernization program. In maintaining and modernizing the GPS system with new encryption systems, the DoD has $22.3 billion in planned upgrades to, and replacement of, the current constellation by 2030.[12] Among the satellites that will be replaced are ten, classified by the Air Force as the Block IIA satellites, that have flown for over twenty years, tripling their expected service life.[13]

Importance of GPS to the Economy

The importance of GPS cannot be overstated. According to the DOT, sales of GPS navigation devices exceed $20 billion worldwide each year. Tens of millions of cars across the United States are equipped with GPS navigation receivers. An estimated $3 trillion in economic activity relies on GPS for tracking, timing, and navigation. According to the Deputy Secretary of Transportation, Roy Kienitz, regardless of the quantification of benefits, "the decision to provide GPS as a free service constitutes one of America's greatest economic gifts to the world since the Marshall Plan."[14] According to a recent study, the GPS industry supports over 3.3 million U.S. jobs annually. The direct economic benefits of GPS technologies to commercial GPS users are estimated to be over $67.6 billion per year in the U.S.[15] The ubiquitous use of GPS in transportation safety and navigation has made it a critical element of transportation infrastructure in the United States, and around the world.

In 2004, the DOT was appointed to be the lead federal agency guiding government policy for all federal civilian uses of radio spectrum, including GPS. In that capacity, the Department

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[10] Fed. Aviation Admin., *National Airspace System Capital Investment Plan, FY 2012-2016* (May 2011), *available at* http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/operations/sysengsaf/cip/files/FY12-16/FY12-16_CIP_Complete_May_2011.pdf.

[11] According to the FAA, this figure includes 5,800 Passenger, Cargo, and Regional carriers, 2,800 International carriers, and 352,000 General Aviation and Air Taxi operators.

[12] "The Global Positioning System for Military Users: Current Modernization Plans and Alternatives", The Congressional Budget Office, October 2011, p.9.

[13] http://www.gps.gov/systems/gps/space/

[14] Testimony of The Honorable Roy W. Kienitz, Under Secretary for Policy, U.S. Department of Transportation before the Subcommittees on Aviation and Coast Guard and Maritime Transportation, U.S. House of Representatives, June 23, 2011.

[15] "The Economic Benefits of Commercial GPS Use in the U.S. and the Costs of Potential Disruption" by ndp consulting. Author is Nam D. Pham, Ph.D. June 2011. According to the report, 3.3 million jobs rely on GPS technology. 130,000 in GPS manufacturing and 3.2 million in downstream commercial GPS intensive industries.

has also come to represent a host of non-transportation related uses of spectrum. According to the DOT, "GPS is essential for the operations of first responders, search and rescue, resource management, weather tracking, energy independence, critical infrastructure such as dams and power plants, financial transactions and banking, surveying and mapping, and industries such as precision agriculture, where the ability to water and fertilize plants with centimetric accuracy increases conservation, reduces waste run-off, and saves American farmers up to $5 billion, annually."[16]

GPS is an American invention, available for use around the world. U.S. leadership in satellite-based navigation technology, and the endless opportunity for innovation in its potential uses, has enabled job growth in the U.S.-based technology sector.[17]

GPS Reliability At Risk

Military receivers are equipped with classified anti-jamming capabilities, but the question of equipping commercial receivers with this capability raises concerns over weakening the military's strategic advantage over adversaries around the world. Commercial availability of anti-jamming capabilities could potentially put the weapons of war the U.S. has developed over the last few decades into the hands of its adversaries. Because of the relatively weak signal strength, the unencrypted commercial signal is susceptible to interference, whether intentional or not.

For instance, in the spring of 2010, the Federal Communications Commission's (FCC) New York Office of the Bureau of Enforcement received complaints about GPS failures at the Newark Liberty Airport. A GPS-based landing system was experiencing intermittent failures. Upon investigation, it was discovered that the driver of a truck was using a personal jamming device to disable the GPS locator on his company's truck. In this case, the driver was unintentionally disabling the airport devices as he drove past the airport on the New Jersey Turnpike.[18] The Communications Act of 1934 prohibits the use of jammers, and FCC rules prohibit the manufacture, importation, marketing, sale or operation of jamming devices within the United States.[19] However, such devices are available and risk both intentional and unintentional consequences of GPS operations.

More recently, the reliability of the GPS signal, a critical element of transportation safety infrastructure, has been under threat from a commercial interest, LightSquared Subsidiary, LLC (LightSquared). The company is seeking to stake a claim to spectrum near the GPS allocation to establish a terrestrial telecom network despite the FCC's conditions to resolve GPS interference concerns. The FCC did not pursue enforcement action against LightSquared under the applicable statute and rules because LightSquared has not yet begun operations. However, it is conceivable that the agency could theoretically pursue an enforcement action against

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[16] Testimony of The Honorable Roy W. Kienitz, Under Secretary for Policy, U.S. Department of Transportation before the Subcommittees on Aviation and Coast Guard and Maritime Transportation, U.S. House of Representatives, June 23, 2011.

[17] Ibid.

[18] Notice of Unlicensed Operation served to Anoy Wrat of Carteret, New Jersey by Enforcement Bureau Northeast Region, Federal Communications Commission. Case Number EB-10-NY-0062, Document Number W201032380068. May 18, 2010.

[19] Title 47 U.S.C. § 301, §302(b), §333, §503, and §510; Title 47 C.F.R. § 2.803

LightSquared based on previous enforcement actions taken if its network, once turned on, interferes with the GPS signal.[20]

In any event, the FCC has repeatedly exercised a policy of protecting the spectrum used by GPS for compatible purposes. The L-Band frequency has been historically reserved for low power communications between satellites and mobile earth stations.[21] According to the DoD, the frequency band 1525-1559 MHz was originally allocated exclusively for Mobile Satellite Service (MSS) Space-to-Earth signals (for example: Inmarsat and Iridium) and terrestrial systems were not permitted. Beginning in 2003, the FCC authorized terrestrial transmissions in the MSS band as Ancillary Terrestrial Component (ATC) transmissions, which were intended to fill in gaps in the coverage of satellite signals. The initial FCC MSS ATC service rules were designed to ensure that terrestrial parts of the networks remained truly ancillary and as mitigation for potential interference to other systems such as Inmarsat and GPS.[22] The FCC has, in every order since 2003, maintained that ATC transmissions must remain ancillary to satellite transmissions, and more recently, that any attempt to establish a full terrestrial network would only be allowed if GPS interference issues are resolved. For more details regarding the history of authorizations in the L-Band, and the manner in which the FCC has protected against interference, see the subcommittee's briefing memo for the June 23, 2011 hearing entitled, "GPS Reliability: A Review of Aviation Industry Performance, Safety Issues, and Avoiding Potential New and Costly Government Burdens".

Radio spectrum is a finite resource, and its allocation is managed by the FCC. Spectrum that is currently allocated for use by broadband networks is highly valuable, given the market opportunity for the licensees of that spectrum. There are sectors of the telecommunications community that warn of a spectrum shortage crisis in order to advance an agenda of repurposing cheap spectrum held by some into broadband network spectrum.

Consequences of GPS Interference

For the past year, there was a proposal to repurpose spectrum located near the spectrum used by GPS, and stakeholders across the economy cited grave concerns.

i. GPS Reliability Issues Faced by the Department of Transportation (DOT):

As discussed earlier, navigation and the operation of transportation systems today are heavily dependent on GPS. In the aviation sector, GPS also provides more accurate position information than legacy surveillance systems (including radar). With the higher degree of accuracy and precision offered by GPS for aeronautical surveillance and navigation, the safety of the national airspace system has been greatly improved. Furthermore, GPS usage within the aviation industry is widespread, with over 360,000 civil aircraft currently equipped with GPS-enabled avionics.

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[20] Notice of Unlicensed Operation served to Anoy Wrat of Carteret, New Jersey by Enforcement Bureau Northeast Region, Federal Communications Commission. Case Number EB-10-NY-0062, Document Number W201032380068. May 18, 2010.

[21] "L-Band" broadly refers to the frequency range from one to two gigahertz, a portion of which is allocated for MSS operations. Specifically, 1525-1559 MHz is domestically and internationally allocated for transmission from satellites to mobile earth stations and 1610-1660.5 MHz for transmission from mobile earth stations to satellites.

[22] GPS Interference Information Paper, Office of the Secretary of Defense, March 11, 2011.

In addition to concerns regarding the effect of GPS reliability and interference on current operations, the DOT must also weigh potential negative impacts on the FAA's air traffic control modernization program. For the past several decades, the FAA has been implementing the planned modernization of the national airspace system, known as NextGen. NextGen will include a transition from radar-based aircraft surveillance and management to a satellite-based system to achieve both safety and efficiency benefits. Billions of taxpayer and industry dollars have already been invested in the NextGen program. A chief concern at the DOT is that GPS interference problems might cause delays in much-needed NextGen benefits, or jeopardize the NextGen effort altogether. [23]

According to airline industry experts, the U.S. airline industry has lost 160,000 jobs over the last ten years. Implementation of NextGen will create nearly the same amount of jobs nationwide over the next four years. If U.S. airlines were required to install filters and or replace GPS receivers on approximately 7,000 commercial aircraft to accommodate the repurposing of MSS spectrum, NextGen implementation would be delayed by up to ten years, thereby prohibiting this job growth.[24]

The United States is also a signatory member of the United Nations' International Civil Aviation Organization (ICAO), an important institution which ensures international harmonization in aviation standards and regulations. The President and Secretary General of ICAO cosigned a letter to the FCC Chairman expressing concerns about the potential impact of GPS interference to current aviation operations, as well as modernization efforts underway in the United States and Europe.[25]

ii. GPS Reliability Issues Faced by the DoD:

As the custodian of the GPS services, the DoD's primary concern is the continued availability and reliability of the GPS signal to Federal, commercial, and personal users. Specifically, the DoD is concerned about any ground-based system that would transmit a high-powered signal preventing GPS receivers from successfully receiving the GPS signal. According to the DoD, the increased signal via a ground network for commercial mobile voice and Internet service would effectively operate as a GPS jammer and potentially degrade accuracy or cause a GPS receiver to completely lose its connection to the GPS signal. Potential harmful interference to GPS receivers from a prolonged interruption of GPS could come in many forms, for example: loss of service due to GPS receiver front end saturation due to insufficient filtering of ATC signals, or loss of accuracy as a result of loss of GPS signals.[26]

[23] According to the FAA, NextGen Programs at risk include ADS-B, RNP/RNAV, WAAS, LAAS, Cockpit Display of Traffic Information (CDTI), and Ground-Based Augmentation System (GBAS).
[24] Testimony of Mr. Tom Hendricks on behalf of The Air Transport Association of America, Inc. before the Subcommittee on Aviation and Subcommittee on Coast Guard and Maritime Transportation, June 23, 2011, P.3.
[25] ICAO President and Secretary General letter to FCC Chairman Julius Genachowski, June 13, 2011.
[26] GPS Interference Information Paper, Office of the Secretary of Defense, March 11, 2011.

Moving Forward: Potential Mitigation Strategies

Currently, there are prohibitions in place for personal jammers used by unauthorized personnel. The FCC is authorized to take enforcement action against those who use unauthorized transmitters to maliciously interfere with other radio signals, including GPS.

Over the last year or so, much has gone into the evaluation of the prolonged interference posed by LightSquared's proposed network, and what to do about it. On January 13, 2012, the Deputy Secretaries of the Departments of Transportation and the Defense issued a joint assessment, carried out in accordance with testing protocols issued by the National Telecommunications and Information Administration, of the proposed repurposing of the neighboring spectrum, and the impacts on the reliability of the GPS signal. After working with LightSquared for a year, their findings were as follows:

> "It is the unanimous conclusion of the test findings by the National Space-Based PNT EXCOM Agencies that both LightSquared's original and modified plans for its proposed mobile network would cause harmful interference to many GPS receivers. Additionally, an analysis by the Federal Aviation Administration (FAA) has concluded that the LightSquared proposals are not compatible with several GPS-dependent aircraft safety-of-flight systems. Based upon this testing and analysis, there appear to be no practical solutions or mitigations that would permit the LightSquared broadband service, as proposed, to operate in the next few months or years without significantly interfering with GPS. As a result, no additional testing is warranted at this time."[27]

While LightSquared disputes these findings, the company's efforts to repurpose MSS radio spectrum for terrestrial use, and the resulting GSP interference, have raised important public policy questions for the transportation community. Among the issues that will be explored at the hearing are: 1) whether the benefits of GPS warrant protection of the signal for military and commercial users, 2) whether the GPS signal, as a critical element of transportation infrastructure, should be protected from interference as a matter of written policy or law, and 3) what ideas for mechanisms the government can utilize to protect the GPS signal from future interference.

[27] Deputy Secretary of Defense Ashton B. Carter and Deputy Secretary of Transportation John D. Porcari to Assistant Secretary for Communications and Information Lawrence E. Strickling, U.S. Department of Commerce, January 13, 2012.

Witnesses:

Panel I

The Honorable John Porcari
Deputy Secretary
U.S. Department of Transportation

Mr. Vincent Galotti
Deputy Director
Air Navigation Bureau
International Civil Aviation Organization (ICAO) of the United Nations

Panel II

Mr. Thomas L. Hendricks
Senior Vice President of Safety, Security and Operations
Air Transport Association

Captain Sean Cassidy
First Vice President
Air Line Pilots Association

Mr. Craig Fuller
President and CEO
Aircraft Owners and Pilots Association

Mr. John M. Foley
Director, Aviation GNSS Technology
Garmin AT, Inc.

Dr. Scott Pace
Director, Space Policy Institute
Elliott School of International Affairs
The George Washington University

A REVIEW OF ISSUES ASSOCIATED WITH PROTECTING AND IMPROVING OUR NATION'S AVIATION SATELLITE-BASED GLOBAL POSITIONING SYSTEM INFRASTRUCTURE

WEDNESDAY, FEBRUARY 8, 2012

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON AVIATION,
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE,
Washington, DC.

The subcommittee met, pursuant to notice, at 11:00 a.m. in Room 2167, Rayburn House Office Building, Hon. Thomas E. Petri (Chairman of the subcommittee) presiding.

Mr. PETRI. The subcommittee will come to order. We meet today to discuss a critical part of transportation infrastructure, the Global Positioning System, commonly referred to as GPS.

So, I thank the witnesses for their participation in today's hearing, and would like to say a special welcome to Deputy Secretary, Mr. Porcari, and Mr. Galotti, our witnesses from the United Nations International Civil Aviation Organization, a very important framework for our global aviation industry. Your participation in today's hearing speaks to the importance of this issue, not only here, but around the globe.

For this committee, for this subcommittee, aviation safety is the top priority. According to the Department of Transportation, the Global Positioning System has served as a critical component of aviation safety improvements that the aviation community has embraced. Moreover, GPS is critical to the safety and efficiency improvements planned as part of NextGen, that we are in the process of rolling out here in this country and other countries as well.

Our aviation infrastructure and efforts to update it with the Department of Transportation's NextGen program are a platform for growth in the U.S. economy. NextGen is also a catalyst for job creation within the aviation industry.

It is important for Government to avoid constraining that growth by limiting the efficiency gains and job creation achieved by NextGen, which is reliant on GPS. As important as GPS is to transportation safety and efficiency, its signal strength is very weak. Therefore, GPS is susceptible to interference by other transmissions, even if those other transmissions are constrained within their own spectrum allocation.

Over the past year or so, the subcommittee has watched with interest the developments of issues related to radio spectrum within the L band. As the Federal Communications Commission deliberates the issues before it, we recognize the potential impacts on the transportation community, and hence, today's hearing.

However, out of fairness to the parties involved in the FCC proceedings, I would ask the witnesses to focus their comments today on the question at hand regarding the importance of GPS as an element of transportation infrastructure, and the public policy considerations of the transportation community to protect that infrastructure.

Today's hearings serve as an opportunity to hear ideas for the best way forward, given what we have learned about GPS. Where there are good engineers, there may be a variety of solutions. And it would be helpful for technologies to co-exist because, given the spectrum demand, the problem of interference between competing uses on various points along the spectrum is not going away.

So, I would encourage the agencies and industry to find a way to safely co-exist, if possible. I believe that we can and must find a way for us to continue to encourage innovation in both the broadband and GPS industries.

Finally, before I recognize Mr. Costello for his opening statement, and other Members, I would ask unanimous consent that all Members have 5 legislative days to revise and extend their remarks and include extraneous material for the record of this hearing.

[No response.]

Mr. PETRI. Without objection, so ordered. And now I will recognize Mr. Costello.

Mr. COSTELLO. Mr. Chairman, thank you. And I want to thank you for calling the hearing today. I will submit my statement for the record.

I welcome our witnesses and look forward to hearing their testimony. And with that, Mr. Chairman, I yield back.

Mr. PETRI. Mr. Cravaack, did you——

Mr. CRAVAACK. Thank you, Mr. Chairman. I would like to thank Chairman Petri and Ranking Member Costello for holding these important hearings on the critical importance of GPS to our Nation's transportation infrastructure.

I would like to welcome today's witnesses, and I look forward to hearing your testimony on the importance of the issue regarding the future of GPS. GPS is the cornerstone, as you well know, of aviation system that is in our country, and any threat to GPS needs to be handled with the utmost care, and ensure that our skies are safe.

One of my key concerns has been the LightSquared project, and how it affects GPS devices. I am very concerned that the reliability of GPS might be put at risk. I will be interested to hear any opinions or any solutions to the situation, because we need to solve all concerns before they become a problem and put lives at risk.

I look forward to hearing from the witnesses, their thoughts on the GPS and its role in our aviation system. Thank you again, and I look forward to hearing from your testimony.

And I yield back.

Mr. PETRI. Thank you. Now we turn to our first panel, which consists of the Honorable John Porcari, deputy secretary of the United States Department of Transportation, and Mr. Vincent Galotti, who is the deputy director, air navigation bureau, International Civil Aviation Organization, or ICAO, of the United Nations.

Gentlemen, thank you very much for coming. Thank you for your prepared statements. And we would invite you to summarize them, if possible, in about 5 minutes, and then we will have some questions, I suspect.

Thank you very much, and we will begin with Mr. Porcari.

TESTIMONY OF HON. JOHN D. PORCARI, DEPUTY SECRETARY, U.S. DEPARTMENT OF TRANSPORTATION; AND VINCENT GALOTTI, DEPUTY DIRECTOR, AIR NAVIGATION BUREAU, INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) OF THE UNITED NATIONS

Mr. PORCARI. Thank you, Chairman Petri and Ranking Member Costello. Thanks to the members of the subcommittee. I appreciate the opportunity to appear before you today.

The simple fact is the Global Positioning System (GPS) applications are vital to transportation safety and efficiency. Tens of millions of drivers across America use GPS to navigate every day. In the Department of Transportation's Federal Aviation Administration, we estimate that by 2013, 60,000 aircraft will be equipped with GPS to navigate the skies over America. This is what we refer to collectively as NextGen.

On the ground, Positive Train Control, which is an improved safety application for rail transportation, relies on GPS, as well. The Intelligent Transportation Systems will depend on GPS as a key technology for vehicle collision warning and crash avoidance systems.

What's more, GPS is essential for the operations of first responders, search and rescue, resource management, weather tracking and prediction, earthquake monitoring, and other critical national security functions. From there, the list goes on and on.

Now, as you know, the LightSquared Corporation has proposed to create a wireless broadband network. In the Obama administration, we believe deeply in what LightSquared is attempting to do, which is to make the Internet more accessible to more people all across the country. This is an urgent national priority. But after comprehensive testing, we have concluded that the current plan to provide such services adversely affect GPS signals. And I will be happy to delve into the details during our conversation, as I have in my written testimony.

In short, both LightSquared's original and revised plans generate considerable harmful interference with GPS. Our researchers could find no obvious practical mitigations to solve the interference issues.

I would also point out that substantial Federal resources, including over $2 million from the FAA, has been diverted from other programs in testing and analyzing LightSquared's proposals.

Even if these interference issues were somehow resolved, LightSquared would still have to design fixes for known interference with high-precision GPS receivers that are vital for agriculture, science, and surveying. And LightSquared's operating plan still leaves open the possibility of broadcasting on both bands. Its

FCC filings propose only a "standstill" on broadband use of the upper 10 MHz band.

Considering all these factors, the Executive Committee (EXCOM) of the National Space-Based Positioning, Navigation, and Timing group have now unanimously concluded that LightSquared's proposal is fundamentally incompatible with GPS use, and that no additional testing or analysis is warranted at this time.

Going forward, the EXCOM agencies continue to strongly support President Obama's directive to make available a total of over 500 MHz of spectrum over the next 10 years suitable for broadband use.

We recognize that we all have to do our part in spectrum use, making it as efficient as possible. We propose to work with the National Telecommunications and Information Administration in the Department of Commerce to draft new GPS spectrum interference standards.

These standards, which would inform future potential commercial operators, would let them know in advance which uses in adjacent bands would or would not be compatible with GPS, and will ensure that this national policy protection for GPS evolves through clear communications with stakeholders, and that it is implemented without affecting existing and emerging uses of space-based positioning, navigation, and timing services that are vital to economic, public safety, scientific, and national security needs.

In summary, our GPS system is one of the more vital, if less visible, parts of our national infrastructure. With that, I will be happy to answer any questions. And again, thank you for permitting me to testify.

Mr. PETRI. Thank you.

Mr. Galotti?

Mr. GALOTTI. Thank you, and good morning, Mr. Chairman, Ranking Member, and subcommittee members. It is an honor to be able to testify before this subcommittee, and I would like to thank you for the opportunity. My testimony today will focus on the importance of what we call the global navigation satellite systems to international civil aviation.

And there are a few other global systems. Russia has its GLONASS, which has had some reliability and maintenance problems over the years, although that government is now committed to a Next General system. There is the European Galileo, not yet operational, and of course China is in the process of launching its Compass system.

Because of the reliability and continued upgrading of the GPS and the commitment of the United States Government, GPS has evolved into the most fundamental and important piece of supporting infrastructure for the global aviation system.

And just at the beginning I would like to mention that the United States is one of the primary contributors to ICAO in terms of technical expertise and knowledge, and in support of consensus-building and excellence in international standards and policy development, for which we are grateful. Most of the technical work that we do is accomplished by groups of experts nominated by the member States. The FAA has been the major contributor to ICAO in this respect, and I believe it has served the U.S. interests extremely well.

ICAO's close involvement with satellite navigation systems goes back to the work of the ICAO Committee on Future Air Navigation Systems, more commonly known as the FANS Committee. The U.S. was a major contributor and participant of that committee. In adopting the outcomes of the FANS Committee at the 10th Air Navigation Conference in 1991, a conclusion was reached that the exploitation of satellite technology appears to be the only valuable solution to overcoming the shortcomings of the present system, and also fulfill the global needs and requirements of the foreseeable future, and that satellite-based systems will be the key to worldwide improvements.

In recognition of this turning point and acknowledgment by the world community of the importance of GNSS, which was highly dependent—and is—on the U.S. GPS, President Clinton formally offered the GPS standard positioning service, SPS, to the global aviation community through ICAO to support international civil aviation. This commitment was reaffirmed in 2007 under President Bush, as follows: "The U.S. Government maintains its commitment to provide GPS SPS signals on a continuous worldwide basis, free of direct user fees, enabling worldwide civil space-based navigation services, and to provide open, free access to information necessary to develop and build equipment to use these services."

Even before the work of the FANS Committee and the offers of both Presidents Clinton and Bush, the availability of GPS to civil aviation first came about, as I am sure you are aware of, when President Reagan authorized its use for international civil aviation after the shootdown of Korean 007.

Following the initial U.S. offer, ICAO developed international standards to satellite navigation systems. With the availability of the GPS system, it became globally recognized by the international civil aviation community as the central element of GNSS. ICAO and the entire international civil aviation community are now completely reliant on the longstanding U.S. Government policy and its commitment as a key enabler to international aviation.

And I just want to go over a few of the important ways that GPS supports international aviation. There are many areas in the world where the conventional terrestrial navigation and infrastructure is inadequate. And GNSS is often the only reliable source of navigation information.

Before GNSS, navigation in high-seas airspace was crude and inaccurate. Separate distance between aircraft used by air traffic control were as much as 100 miles laterally and 15 to 20 minutes. The superior accuracy of GNSS, especially when integrated with sophisticated flight management systems, has enabled a number of substantial navigation improvements, which are the foundation of the concept of performance-based navigation, or PBN.

In PBN, airspace separation between aircraft is significantly reduced, thereby increasing capacity while bringing safety, efficiency, and environmental benefits. The United States provides air traffic control services over vast expanses of high-seas airspace.

In the North Atlantic there are over 2,000 crossings a day. The transpacific passenger traffic is expected to grow by 4.2 percent between 2009 and 2030. Intra-Asia-Pacific traffic during that period is expected to grow by 5.1 percent. And right now there are approximately 8,000 flights per year that operate on cross-polar routes, and they are totally reliant on GPS.

Until very recently, all final approaches to land at major airports were accomplished by means of instrument landing systems. This is OK in States that are able to maintain these, and that have the infrastructure to support that. In many parts of the world, maintaining such systems is prohibitive because of the cost and expertise. Using PBN approach procedures based on GPS, more and more approaches to land are accomplished by means of the equipment in the aircraft only, with little or no reliance on ground equipment, bringing enormous safety benefits. And airports that previously had no instrument approaches now have PBN.

Today, when U.S. airlines fly into Lagos, Nigeria; Almaty, Kazakhstan; Ulan Bator, Mongolia; Dakar, Senegal; Quito, Ecuador; and Georgetown, Guyana, to name but a few out of hundreds, they are more assured of safe operations because of GPS.

GNSS is important for Next Generation aircraft surveillance, and I am sure you are all aware of automatic dependent surveillance broadcast. But over oceanic airspace, automatic dependent surveillance contracts allows air traffic control to have surveillance, where this was impossible.

And finally, two of the most significant near-term air traffic management improvements that have recently become available are continuous descent operations and continuous climb operations. This is a major initiative at ICAO, and GPS allows this extremely efficient flight routing to be enabled.

And now, just a few words about the spectrum major issue that has as much to do with the importance of GPS as anything else. I am referring to the problem of frequency spectrum.

Available radio frequency spectrum is the lifeblood of aviation, and the protection of spectrum used by aviation radio systems is absolutely essential for safety. ICAO has been vehemently supporting the protection of GNSS spectrum for decades, in all international fora, especially the world radio conferences—and there is one going on in Geneva right now.

Against that background I would urge you to consider that any decision by the United States that affects frequency spectrum, which impacts on GNSS, will have a critical impact on the safety record, the investments made in GNSS, the international standards, and the recertification of equipment.

In summary, Mr. Chairman, I would like to appeal to you and the committee that ICAO and international civil aviation continue to benefit from U.S. leadership and cooperation in many ways, including invaluable support through the sharing of technical information and expertise, support of consensus-building and excellence in international standard and policy development, and concrete projects to assist countries in need of strengthening their aviation programs.

GPS is among the most important ways that the U.S. provides technological, humanitarian, and political leadership. ICAO looks forward to deepening this relationship and working together.

Thank you for this opportunity to share ICAO's views with this important subcommittee.

Mr. PETRI. Thank you. Thank you both. At previous hearings this subcommittee has been informed that as we gain momentum in deploying the NextGen technology, it will have enormous return on the American Government's investment in it, reduce fuel use for the industry by some 20 or 30 percent, expand the capacity of the system without having to build additional runways and so on, improve the safety of the system, shorten the time of flights, and it goes on and on and on. To reduce the sound footprint, as planes are able to glide down more for many of the airports where that has been a problem. A lot of benefits from this new—for using this technology in the aviation industry, as other industries have found.

I do have a couple of questions. First, Mr. Porcari, you mentioned that you proposed the Department of Transportation work with the National Telecommunications and Information Administration to draft new GPS spectrum interference standards to strengthen existing national policy protection of adjacent band spectrum. Could you elaborate on what that all means?

Mr. PORCARI. I would be happy to, Mr. Chairman. One thing that recent events has shown us is that GPS is not only a national infrastructure asset, but that protecting that asset, we are going to have to be much more sophisticated in the future on how we do that.

In layman's terms, on both sides of the existing GPS frequency there were mobile satellite-type applications that were also quiet, as it were, that did not interfere with GPS's ability to hear what is a very weak signal from space, basically 50 watts, 22,000 miles up.

The spectrum interference standards—and we would take a whole-of-government approach to this, working through our Positioning, Navigation, and Timing Executive Committee—the idea would be to identify before anyone puts capital at risk or major project at risk, what are compatible uses to GPS.

In general terms, the more precise the GPS receiver—for example, the avionics in an aircraft—the more precise they are, the more that they are likely to have a wideband receiver that, in fact, needs to be able to listen beyond the GPS frequency. Acknowledging that, and building a policy around that, would be, we think, a very good use of staff time and, from a policy perspective, critical to protecting GPS as an asset.

Mr. PETRI. Proposing to set interference standards—how is the proposal to set interference standards different from setting receiver standards?

Mr. PORCARI. There are currently no receiver standards. The idea of spectrum interference standards would be to give everyone involved, the industry and others, confidence in the long term that, as they build more and more precise GPS devices—and I know our focus is on aviation, where GPS is absolutely critical to operations today, but will be even more so in the future—but other applications: precision farming, construction, and others. Spectrum interference standards would be clear guidelines for all users, both within the GPS spectrum and adjacent spectrums.

We think, if we can build the kind of consistency and predictability for both the GPS users and adjacent spectrum users, that that will serve everyone's interests well.

Mr. PETRI. Yes, I understand there is some sort of a curfunkle about the adjacent—who is interfering on whose turf in this particular area, and that, in fact, it was allowed for a little broader use of spectrum, because it didn't interfere with adjacent use. And then, when the type of use was changed somewhat at the staff level, that has created a problem. Is that what you are trying to avoid?

Mr. PORCARI. Yes, Mr. Chairman. That is exactly it. GPS, by its very nature, is a very weak space-based signal that is very faint when it is received by GPS receivers in the atmosphere, or in terrestrial applications.

I think of it in zoning terms, because that is probably the way to think about compatibility of uses. GPS was—the spectrum was originally put in a quiet neighborhood, because it needed a quiet neighborhood with quiet neighbors to be able to have accuracy in receivers. The adjacent pieces of spectrum were for mobile satellite service, which was another quiet use.

What has happened with this specific proposal is essentially you went from a mobile satellite service proposal with limited ground augmentation to a ground-based service with limited satellite augmentation. And that really changed the fundamental nature of signals, and how they would be received. But it is, I think, really important to point out that GPS was put in a quiet piece of the spectrum on purpose because, fundamentally, it has to have quiet neighbors.

Mr. PETRI. So this was well known at the technical level at the time this strategy was put in place?

Mr. PORCARI. Yes, I believe that the physics and the technical parts of it have been well-known all along.

I would also point out that, as Mr. Galotti had, from an international perspective, harmonizing that use of the frequency internationally was important as well, so that the same kind of safety of flight avionics that we are using today, and as we build a larger NextGen system of systems, can be used around the world.

Mr. PETRI. Mr. Galotti, in your testimony you referred to the GPS spectrum use being under some threat, and it being discussed at past world radio conferences and I think some current or upcoming conferences as well. Could you elaborate on that, and what role you, as representing the global aviation industry, play in those conferences, and how you have been able to work out resolutions in the past?

Mr. GALOTTI. The international telecommunication holds a world radio conference every 3 years. And it is a huge event, it lasts for 4 weeks. The States go with very powerful representation. And also industry goes with incredible force. Telecommunication providers are—as you can imagine, have the most to gain, and they put a lot of pressure, and they work around the clock, virtually, on—getting emails from my people at 2:00 and 3:00 in the morning.

ICAO is an observer. But during the 3 years in between we meet with all of our member States and we develop—we prepare an ICAO position that at least the member States agree to, so we get just about unanimous decision on the ICAO position for radio frequency spectrum. It doesn't always pan out that way at the event itself because, again, there is a lot of lobbying, there is a lot of pressure, a lot of jobs at stake. But as observers there, we do have a lot of close contacts with the States and with friends in the aviation industry. And we have been very successful in working with the member States. And the United States has been a strong supporter of protecting the GPS spectrum from other uses. Thank you.

Mr. PETRI. Thank you. Mr. Costello?

Mr. COSTELLO. Mr. Chairman, thank you. To Deputy Secretary Porcari, to follow up on the chairman's question, he asked the same question that, actually, I was going to ask. But I would like to have you clarify a point.

My understanding is that you are proposing that DOT work with other agencies to develop a policy. Does that mean for radio transmission standards in the spectrum? Is the interference now between the agencies—are we talking about transmission standards? Or what are we talking about?

Mr. PORCARI. What we are really talking about is, more generically and more broadly, spectrum interference standards, where we could establish, by consensus and with input from everyone who has an equity in this, industry, interested observers and others, the kind of standards that would protect the GPS spectrum, both today and in the future.

If you look at the evolution of GPS, just in the last 10 or 15 years, for example, the GPS uses, especially in aviation, have gotten more and more precise, and they are now safety of flight issues, which requires spectrum interference protection.

Mr. COSTELLO. We are talking primarily about transmission standards.

Mr. PORCARI. We are talking about primarily the requirement for precise navigation devices that use GPS to be able to utilize as broad a band as possible, which they have been to date, and which was acknowledged in the original approval of mobile satellite services on either end of that spectrum.

So, I say this because, in fairness to all the potential users outside of the GPS band, establishing those standards would give them a good sense of what kind of uses would be compatible, and which would not.

Mr. COSTELLO. You also mention in your testimony that the Obama administration—that their goal is to free up federally owned spectrum and make it available for mobile broadband, especially providing access to underserved rural communities. I certainly support that goal, and I think many members of the committee would, as well, especially for underserved communities for wireless service, and where consumers would benefit from competition between service providers.

Let me ask. If the mobile satellite service band is not compatible with the high-speed wireless transmissions, then what can the administration do to provide greater access to high-speed service?

Mr. PORCARI. The administration, the Department of Transportation and every part of the administration, is again committed to identifying those 500 MHz of additional spectrum over the next 10 years.

We strongly support what you have underlined, which is the need for rural broadband and broadband competition. There are some features of the recent proposal that are very valuable, from that perspective. But we think that working across the Government with our Positioning, Navigation, and Timing Executive Committee, with NTIA, will ultimately be helpful.

Obviously, we would not presume to know what actions the Federal Communications Commission, an independent agency, would take.

Mr. COSTELLO. Thank you, Mr. Chairman.

Mr. PETRI. Mr. Coble.

Mr. COBLE. Thank you, Mr. Chairman. Gentlemen, thank you for your testimony.

Mr. Porcari, are there immunity standards for military GPS receivers that protect them from transmissions from outside the GPS band?

Mr. PORCARI. Congressman, my understanding—and I believe General Shelton testified before the House Armed Services Committee—is that there are not. And I do know that, at least in some cases, the Department of Defense aircraft are using commercial, off-the-shelf avionics that are FAA-certified for commercial use, as opposed to military.

Mr. COBLE. Thank you, sir. Well, let me ask you another question, Mr. Porcari. What standards are currently in place to make sure that the receivers and equipment purchased pick up only signals used in the GPS frequency band?

Mr. PORCARI. There are no current standards in place. That is part of the reason for the discussion. Again, we think, going forward, having the consistency and predictability of spectrum interference standards will help all parties involved.

Mr. COBLE. Thank you, sir. Mr. Galotti—I will put this question to each of you.

What impact might protections for GPS have on the marketplace for radio spectrum, A? And then, B, how does this bear on the question as to whether or not GPS warrants protections?

[No response.]

Mr. COBLE. Either of you is fine. Mr. Galotti? Want to start with you?

Mr. GALOTTI. Thank you, Congressman. I guess there are various figures that exist as to the number of jobs, and the value of spectrum. And, as I have said earlier, there is tremendous pressure from the telecommunication providers who have significant figures on jobs.

But on the other hand, aviation globally, I believe the number that is out there is worth about $3 trillion to the global economy a year, when you consider the economics, the tourism, the aviation industry itself, the business, carriage of goods and other things.

So, probably a good case could be made that, economically, aviation is critical. But there will be more and more pressure from particularly the telecommunication providers. Thank you.

Mr. COBLE. Particularly from who?

Mr. GALOTTI. The telecommunication providers. Sorry, sir.

Mr. COBLE. Right. I didn't hear you.

Mr. GALOTTI. Thank you, sir.

Mr. COBLE. Mr. Porcari, you want to weigh in?

Mr. PORCARI. Yes, Congressman. I don't know the values of the spectrum in itself.

I would point out that the national investment we have made in GPS, first from a military-only perspective and now from a combined military-civil perspective, has been enormous. It is one of the more precious and important pieces of national infrastructure we have, even if you can't see it and feel it. It is also a U.S. national leadership issue.

I would point out in the aviation context, I would argue that one of the single best safety advances we have made in the last 20 years, which is the terrain avoidance warning system—20 years ago, controlled flight into terrain, for both commercial and recreational aircraft, was a leading cause of accidents. The terrain avoidance warning systems that are GPS-enabled have taken controlled flight into terrain from a leading cause of accidents into something that is way down on the list.

Another example is, as of today, part of our NextGen system, ADSB, is operational in the Gulf of Mexico, where we have had no radar coverage. And we have thousands of flight operations a day, for example, serving offshore petroleum rigs via helicopter that had no radar coverage before that, are now served by ADSB.

So, it is important to make sure that we understand the value on both sides of the equation, including the enormous national investment that has been made in GPS, which has gone far beyond military uses, has gone far beyond aviation uses, and for precision farming, construction, safety of our train systems, those are not possible today without GPS.

Mr. COBLE. Thank you, sir. Mr. Chairman, my red light is about to illuminate, so I will yield back.

Mr. PETRI. Thank you. Mr. Duncan?

Mr. DUNCAN. Well, thank you, Mr. Chairman. And this is my first real involvement with this, so there is much of it that I don't really understand.

But, Mr. Secretary, I have read this statement from this assessment. It says by the deputy secretaries of the Department of Transportation and the Department of Defense, and I assume that is from you?

Mr. PORCARI. Yes.

Mr. DUNCAN. And it is a very strong statement that you put out about 3½ weeks ago. And you say there that—you mention that LightSquared had an original proposal and then they modified it. Can you explain to me, in layman's terms, how much of a change they made in their original plan?

And it also tells us in our briefing papers that they are disputing your findings, or your assessment.

Mr. PORCARI. I will be happy to, Congressman.

Mr. DUNCAN. OK.

Mr. PORCARI. And layman's terms is all I am capable of here.

Mr. DUNCAN. OK.

Mr. PORCARI. So I will try to do it in that sense. The original LightSquared proposal of roughly a year ago, January of 2011, proposed up to 40,000 ground-based transmitters that would effectively blank out the GPS signal in large stretches of the U.S. and in some very critical areas. There was some early testing done, both by the Department of Defense and the FAA. It was clear from that testing that there was an interference issue.

The forum for this is a relatively obscure group, the Positioning, Navigation, and Timing Executive Committee, which the Deputy Secretary of Defense and I co-chair, Deputy Secretary Carter representing the military users, and myself representing all the civil users. Through that committee, which includes all the executive-branch agencies, which includes others, including the Federal Communications Commission, as an observer, it was clear that additional testing of a different proposal was in order.

We worked with LightSquared. They were part of developing the testing protocols. They were part of the testing itself. And the results, I think, are very clear-cut. I would point out that the testing results from both the NPEF work and separate Federal Aviation Administration work are currently with NTIA and will be transmitted to FCC shortly.

But those results were independently verified by both the Idaho National Engineering Laboratories and then the Lincoln Laboratories at MIT. And from my layman's perspective, the result, especially with the precision safety of flight avionics that we use in aircraft, the results were unacceptable.

Mr. DUNCAN. Well, let me ask you this. I said it was a very strong assessment. And what I am talking about, it says, "Based upon this testing and analysis, there appears to be no practical solutions or mitigations that will permit the LightSquared broadband service, as proposed, to operate in the next few months or years without significantly interfering with GPS."

I understand the dangers or the concerns or the problems. But it is a fascinating thing to me that you could say that there is nothing that they could even do within the next few years. It does tell us—and I have no connection whatsoever with LightSquared, I have never even talked to these people. But it says they dispute these findings. How do they dispute them, do you know? Or could you tell us something?

Mr. PORCARI. First, I believe the LightSquared representatives can and should better explain how they dispute the findings. I would point out that the statement, Congressman, is strong. I believe it is warranted, given the circumstances.

When we talk about in the next few months or years, remember there is a very large installed base of GPS receivers. Just focusing on aviation for a moment, there is about 60,000 GPS receivers out there that are used for safety of flight things like terrain avoidance warning systems. Each of those is about $40,000. If you look at the life cycle of aircraft and avionics, they serve for decades.

And the reason for that part of the statement is to point out that there is no easy retrofit or filter or any other kind of retrofit that would, from a safety of flight perspective, make the proposal, as currently proposed by LightSquared, compatible with aviation.

Mr. DUNCAN. Well, I am not saying it wasn't warranted. I just was saying it is a fascinating thing that there would be a statement that nothing could be done even in the next few years, when technology advances as fast as it does. So it was kind of an interesting thing. Thank you very much.

Mr. PETRI. Thank you. Mr. LoBiondo? You—Mr. Cravaack?

Mr. CRAVAACK. Thank you, Mr. Chairman. And thank you for your testimony today. I can truly tell you, as a pilot, there was a palpable difference in the cockpit when you have terrain avoidance systems using GPS. When you are flying that approach coming in from the east going in to Salt Lake City, and you know you are skirting the top of those mountains, it was really a comforting feeling to have that GPS in the cockpit.

But LightSquared is—has agreed to a standstill, as I understand it, on the use of the upper portion of the spectrum, and it is the portion that is actually closest to the GPS signal. And LightSquared has stated that it would like to work with the GPS community to develop "mitigating strategies," as they put it, in order to initiate commercial operations in the upper spectrum within 2 and 3 years.

Is—in your opinion—I understand in your testimony you said there is no mitigating conclusion here, and that—do you really think 2 or 3 years to be able to find some type of strategy is in that window?

And two, from what we know, even though we really can't identify a mitigating strategy, the cost to general aviation to implement that strategy, as well? So——

Mr. PORCARI. Thank you, Congressman. First I would point out I am not sure what a standstill means on the upper 10 MHz. There are no time limits to that, and no technical triggers, that I am aware of, on that.

There is a fundamental incompatibility between the LightSquared proposal, as proposed, and the continued use of GPS as a precision air navigation use. And again, I would point out that this has been built over decades now, where more and more we are dependent on GPS for a much higher standard of safety than we are able to achieve with the old instrument landing systems, without the terrain avoidance warning systems, without wide area augmentation systems. All of those are very significant safety advances.

I can't speculate on the cost, because I am not sure anyone can quantify the cost, even if it could be done, of retrofits, if they were technically viable, to existing avionics uses.

Mr. CRAVAACK. So, just to be clear then, there is no plans at this time to retrofit or reconfigure any systems to work LightSquared into this bracket, is that correct?

Mr. PORCARI. That is correct, Congressman. I would say, in contrast, mobile satellite service uses on the adjacent frequencies, which is what they were originally zoned for, if you will, have been and will be compatible.

Mr. CRAVAACK. Super. Thank you very much, and I yield back.

Mr. PETRI. Thank you. Mr. Fleischmann? Mr. Ribble? Mr. Farenthold?

Mr. FARENTHOLD. Thank you very much. And I am troubled that a terrestrial base system like LightSquared has the potential for interfering with GPS. I am afraid it points out the actual delicate nature of the GPS system, and its potential vulnerability to be—for nothing else, an attack. You hear reports of a truck driver with a jamming device degrading the system near Newark Airport. Suppose someone not friendly to this country were to intentionally put up some high-powered jamming stuff. We would be in trouble.

Historically, LORAN has been considered a backup to GPS. But that is currently being dismantled. I am concerned that we have all of this reliance on GPS from everything from my car to my cell phone to landing a 777 aircraft in the future. It seems to me that we are creating a vulnerable system with no backups. Can you all comment on that?

Mr. PORCARI. Yes, Congressman. First, you have brought up a very important point. There are—by its very nature, there are vulnerabilities for the GPS. You pointed out one specific incident where a commercially bought, over-the-Internet $99 jammer caused real issues at one of our major airports in the country.

One of the things that we have done is a national positioning, navigation, and timing architecture study of the overall system architecture. Following on that, the Federal Aviation Administration has committed to an alternate PNT research program where, just as today, with our terrestrial radar-based air navigation system we have vulnerabilities, and you basically build defense in depth with backup systems, we know, as we move with the implementation of NextGen, as we move forward with that, it will be more and more important to have backups to the GPS-based system.

They will only be short-term backup systems. And it is important to point out that we are moving aggressively——

Mr. FARENTHOLD. Could you define "short-term backup"? I don't——

Mr. PORCARI. Well, I mean for short duration. In other words, if we were denied the use of GPS systems for air navigation today for an extended period of time, it would have severe impacts on the national airspace system. If it were for 10 minutes, it would be a little bit different.

Mr. FARENTHOLD. OK.

Mr. PORCARI. But——

Mr. FARENTHOLD. So minutes, as opposed to days.

Mr. PORCARI. Minutes, as opposed to days. But again, you have put your finger on a vulnerability in the system that——

Mr. FARENTHOLD. And it seems a vulnerability easy to exploit.

Mr. PORCARI. Well, it can be. Part of this is the architecture and design going forward of how we design the system of systems that is NextGen. We are very focused on this. Also, I would point out there is an important enforcement side. There is no legitimate commercial use for a GPS jammer.

Mr. FARENTHOLD. All right. And just for my information, I have seen press reports about other countries developing their own GPS satellite arrays. Do we know where that is going?

Mr. GALOTTI. Thank you, Congressman. The Russian Federation had established their system in the 1990s. And when the Soviet Union disintegrated, it was not maintained. But I understand as of December of 2011, now they have a full constellation and they have committed to GLONASS–K, which is similar to GPS III, and they hope to have that in place by 2014.

The Europeans have Galileo, which—two satellites are up. And I think the total constellation is, I believe, 18.

And China is putting in place what they call Compass. They have 2 satellites in place, and they plan to launch 6 in 2012, and the full complement by 2020. And that will initially be for East Asia and China, parts of the——

Mr. FARENTHOLD. And if you will allow me just to geek out for a second, we have got a massive array of radio transmitters in the form of our cell tower network that can contain longitude and latitude information in the cell tower. Is any research going into tapping into those to create some sort of system as a fallback to GPS?

Mr. PORCARI. I don't know. What I would be happy to do is actually research that and get back to the committee.

Mr. FARENTHOLD. Yes, just curious. It seems like there is——

Mr. PORCARI. It is a good question.

Mr. FARENTHOLD [continuing]. An infrastructure in place. You might be able to develop a fallback system.

Mr. PORCARI. I appreciate the question, and I will find out for you.

Mr. FARENTHOLD. OK. And my time has expired. Thank you.

Mr. PETRI. Well, I am sure we all have a lot of other questions, but I will leave it there for the purpose of this hearing at this point. Thank you very much. It has been very, very informative.

Mr. PORCARI. Thank you, Mr. Chairman.

Mr. GALOTTI. Thank you.

Mr. PORCARI. Thank you, Members.

Mr. PETRI. The second panel consists of Mr. Thomas L. Hendricks, who is senior vice president of safety, security and operations, Airlines for America; Captain Sean Cassidy, first vice president, Air Line Pilots Association, International; Craig Fuller, president of the Aircraft Owners and Pilots Association; John M. Foley, director, aviation GNSS technology, of Garmin International, Inc., and Dr. Scott Pace, who is the director of the Space Policy Institute, Elliott School of International Affairs, The George Washington University.

I thank you for making—all of you—for making the time to be with us today on this very—somewhat technical but very important subject for sectors of our economy and our safety and competitiveness, as a country. And we will begin with Captain Cassidy, waiting for Mr. Hendricks.

TESTIMONY OF CAPTAIN SEAN P. CASSIDY, FIRST VICE PRESIDENT, AIR LINE PILOTS ASSOCIATION, INTERNATIONAL; THOMAS L. HENDRICKS, SENIOR VICE PRESIDENT OF SAFETY, SECURITY AND OPERATIONS, AIRLINES FOR AMERICA; CRAIG FULLER, PRESIDENT, AIRCRAFT OWNERS AND PILOTS ASSOCIATION; JOHN M. FOLEY, DIRECTOR, AVIATION GNSS TECHNOLOGY, GARMIN INTERNATIONAL, INC.; AND SCOTT PACE, PH.D., DIRECTOR, SPACE POLICY INSTITUTE, ELLIOTT SCHOOL OF INTERNATIONAL AFFAIRS, THE GEORGE WASHINGTON UNIVERSITY

Captain CASSIDY. Good morning, Mr. Chairman and the members of the subcommittee. I am Captain Sean Cassidy, first vice president of the Air Line Pilots Association International, and I represent more than 53,000 professional pilots based in the United States and Canada. It is an honor to appear before the subcommittee to underscore the tremendous contribution that the satellite-based navigation system makes to ensuring efficient and safe operations in the United States and around the globe.

Given the vital importance of the Global Positioning System as a key component of this country's transportation infrastructure, it is appropriate, and indeed essential, for the House Transportation and Infrastructure Committee and this Aviation Subcommittee to be fully engaged in protecting that system.

As the members of the subcommittee know, over more than two decades the invaluable navigation information available through GPS has enabled air transportation to make tremendous gains in safety and efficiency.

Since 1983, when GPS became available to the public at no cost, the system has evolved to become a vital tool for aircraft navigation, all-weather approaches and landings, surveillance, maintaining required separation between aircraft, and pilot situational awareness.

GPS allows pilots to fly aircraft using the safest and most efficient routes, which benefits every flight operation, but particularly those over the Atlantic and Pacific, or on transport on long-range routes, where diversion options are very limited. The enhanced accuracy of GPS also allows aircraft on parallel runways to operate independently, safely increasing arrival rates.

In major metropolitan areas that are served by several airports, GPS allows us to analyze the entire airspace and operate flights based on a regional strategy, rather than airport-by-airport. These opportunities to improve flight operations, possible only through GPS, reduce fuel burn, decrease noise, and cut CO2 and other greenhouse gas emissions, while making our industry safer, more efficient, and better positioned to meet future demand.

Let me give you one example from my own flying experience. The airport at Juneau, Alaska, the State capital, is situated on a base surrounded by high terrain. Before GPS, we pilots only had two choices for approaching landing at Juneau, and they are both very challenging. The approach from the east and the one from the west both required fairly high cloud ceilings and a tight turn at low altitude to line up for landing. Without GPS, the terrain and weather conditions forced many flight cancellations.

In 1996, Alaska Airlines pioneered a GPS-based instrument approach to Juneau, Alaska. The pinpoint accuracy of the GPS approach allows me to fly directly over the center of the Gastineau Channel, as depicted in the photo up on the screen, and stay clear of the high terrain surrounding the channel and the airport. The result enhances safety and reduces delays and cancellations.

Since then, the Alaska Airlines has expanded the GPS-based approach to other airports in the country. In 2011, the airport completed more than 1,500 flights that would likely have been canceled or diverted, and the net result was $19 million worth of saved revenue, and over 210,000 gallons worth of fuel that was not burned.

Across the United States the FAA has published more than 11,000 GPS approaches to thousands of airports, including our own backyard here at Reagan National, where highly accurate GPS-based approaches reduce flight delays, diversions, and cancellations.

GPS signals are low power by design to allow them to be based on satellites. However, this low-energy environment also makes them susceptible to interference from other radio transmissions. For this reason, only low-powered satellite-based signals have historically been permitted in the radio frequencies that are closest to the GPS bandwidth.

One recent proposal to deploy 40,000 high-powered ground-based transmitters and the radio frequency spectrum that is directly adjacent to GPS bandwidth raised alarm as a result of the risk it posed to the safety of air transportation, as well as to emergency services such as first responders.

Rigorous industry and Government testing demonstrated that if LightSquared's proposal had been allowed to go forward, GPS would be inaccessible over large regions of the U.S. at normal operational altitudes for airliners. Were this proposal or anything like it to be allowed to proceed, pilots will lose a tremendous navigational tool that is especially important in mountainous terrain, remote areas, and bad weather, and that supports a safe and efficient air transportation system that helps drive the U.S. economy and secure tens of thousands of jobs.

Looking to the future, GPS is critical to our efforts to modernize the U.S. air traffic control system through NextGen. ALPA is a staunch advocate for Next Gen, because of its enormous potential to enhance safety, increase capacity and efficiency, and protect the environment. As part of the NextGen initiative, the FAA has already invested more than $1 billion in GPS-based technology that is designed to replace radar-based surveillance of aircraft. As NextGen continues to mature, GPS will become more important.

The pilots of ALPA commend the U.S. Aviation Subcommittee for holding this hearing, and allow us to underscore the unmatched benefit that GPS provides to air transportation, both now and in the future. Thank you very much.

Mr. PETRI. Thank you.

Mr. Hendricks?

Mr. HENDRICKS. Chairman Petri, Ranking Member Costello, and members of the subcommittee, thank you for inviting us to appear at this timely and important hearing. And I do apologize for my slight delay in my pushback for my testimony this morning. It is good to speak with you again.

The continued integrity of the Global Positioning System is critically important to the millions of customers who we fly every day, as well as to the tens of millions of other people in our country who rely on it. GPS will be the backbone of air navigation, both domestically and internationally, in the coming years. Interference with this accessibility and reliability would be catastrophic for civil aviation and the communities that depend on air transportation. We deeply appreciate the subcommittee's recognition in the FAA reauthorization bill of the importance of this technology, and particularly your support for the continued advancement of NextGen.

With respect to the LightSquared proposal, the incontestable fact is that it will create widespread GPS interference, which will have ruinous effects on aviation. Experts have repeatedly reached that conclusion. LightSquared's proposal, therefore, should be withdrawn. This matter needs to be put to rest, once and for all.

To be clear, we do not oppose the expansion of wireless broadband services. But any expansion cannot be permitted to interfere with existing or anticipated aviation GPS use, many of which will significantly enhance safety. We are dependent on that technology; there is no substitute for it.

One obvious lesson of the convoluted experience with the LightSquared application is the need for a governmentwide policy that protects the aviation GPS spectrum. Without such an authoritative policy, spectrum encroachment will remain a threat.

As the subcommittee knows all too well, we have historically relied on a ground-based air navigation system. It is a system that has become increasingly defined by its limitations. Users of the system have, for the most part, had to fly from one ground navigation aid to the next, often resulting in circuitous routings. This inefficiency wastes time and fuel. It also restricts the number of routings that aircraft can use, which in turn constricts capacity growth.

GPS is at the heart of the ongoing multibillion-dollar NextGen program that will shift air navigation from that outmoded terrestrial system to a modern satellite-based system. This is a transformational change. All who are involved in it—Congress, the Federal Aviation Administration, airlines, general aviation, and the Department of Defense—recognize the need for that transformation. This massive effort will result in more precise navigation, safer operations, far more direct aircraft routings, better airspace utilization and airspace capacity growth. Because of these operational improvements, there will be substantial reductions in greenhouse gas emissions.

One existing application of GPS has produced a breakthrough in the safety of airline operations. It has been referred to earlier here: the elimination of controlled flight into terrain accidents for large jet aircraft in the United States. Enhanced ground proximity warning systems aboard aircraft combine GPS information with onboard terrain databases to provide flight deck crews with look-ahead warnings of dangerous terrain. This has made air travel far safer than it was only recently, and illustrates the remarkable benefits that leveraging GPS with other technologies can achieve.

The introduction in the coming decades of NextGen capabilities will be the real game-changer. Its integration of GPS with other technological innovations will create the satellite-based system of air traffic management that we all realize is necessary. GPS is the indispensable element of this long-needed overhaul.

Given the essential role of GPS, the Federal Government must develop comprehensive safeguards for aviation's use of it. The stakes are too high for the passengers and shippers that rely on air transportation, the communities and businesses that depend on air service, and the airlines and their employees, to leave to chance our continued ability to utilize GPS to the greatest advantage. Consequently, we need a governmentwide policy that guides Federal agencies' responses when potential interference issues emerge. That policy must make clear that interference in the aviation spectrum is prohibited, and that other users cannot be permitted to encroach into the aviation spectrum.

Domestically, the most obvious place to begin to strengthen governmental policy against GPS interference is the National Executive Committee for Space-Based Positioning, Navigation, and Timing, the PNT. The PNT is a Government organization established by Presidential directive to advise and coordinate Federal departments and agencies on matters concerning GPS.

The PNT is chaired jointly by the Secretaries of Defense and Transportation, and includes equivalent-level officials from the Departments of Homeland Security, State, Interior, Agriculture, and Commerce. The Federal Communications Commission chairman participates in the PNT as a liaison. At the very least, the FCC should be required to consult with the PNT before taking action on any application to operate a terrestrial-based communications network that may affect the L-band spectrum, which is the band that GPS uses.

On the international front, U.S. Government positions expressed at international conferences at which spectrum issues are considered, such as the world radio communications conference that is currently being held in Geneva, must reflect the importance of protecting the GPS spectrum throughout the world.

We appreciate the subcommittee's interest in this vital issue. We are prepared to assist you in any way we can. And I would be happy to take any questions you might have.

Mr. PETRI. Thank you.

Mr. Fuller?

Mr. FULLER. Good morning, Mr. Chairman, Ranking Member Costello. Craig Fuller, president and CEO of the Aircraft Owners and Pilots Association. It is always a pleasure to be before the committee.

I am going to start with a statement I don't always get to make, and that is that we are in absolute full agreement with the Obama administration on the question before you today. I thought the statements by the deputy secretary of transportation were right to the point. We agree with every point that was made there.

Indeed, the other members of the administration, other departments and agencies that have looked at this, are of the same view. There is only one somewhat reluctant regulator out there that seems not to have gotten this message. But perhaps today's hearing will help, although I know that is a topic maybe for another day.

I have a statement I have filed for the record. It makes many of the points that have been made. I thought I would give just a couple of comments—a little different perspective.

You know we all say GPS is extremely important. We certainly believe that. But in a way, GPS is pretty simple. I took off yesterday from Frederick, Maryland, in an aircraft. As soon as it was airborne—in fact, even before it was airborne—a small box in the plane received multiple signals from GPS transmitters in space. All that box did initially was identify those signals and determine precisely where it was. That is GPS.

The genius of GPS is what it enables. The fact that GPS has been around for a long time as a technology that can determine precisely where something is in space doesn't mean that this is somehow old and not exciting, because the excitement in GPS is what it enables. The fact that that box, as I traveled, kept determining exactly where that airplane was in space—you now have two points—the box calculated my air speed. The box calculated my heading. The box calculated that there are towers on hills near Frederick, Maryland, that I was within 500 feet of. If I had an emergency of some kind, the box would tell me exactly where the nearest airport was, what the route was to it, and how long it would take me to get there, simply because it could receive this very small signal from space, from the GPS transmitter.

I guess I would submit that while some may say, well, it is time to look to new technology for greater benefits, we have just begun to tap this genius of GPS and what it can enable. As you have heard today, it is absolutely at the center of NextGen technology. We have 5,200 public-use airports in this country. We couldn't possibly afford to put instrument landing systems in all those airports with equipment on the ground. And yet every one of those airports can have a precision approach to every runway on the field, using GPS capabilities. That is what it enables. And it enables emergency helicopters to go precisely to the scene of a crime, to a mountain climber that needs to be rescued, and know exactly what the closest landing site is for the helicopter. All these things are enabled by this GPS signal.

So, I guess, from where we sit, my 400,000 members who are flying general aviation airplanes see this as absolutely essential. By the way, you have heard from two very respected members of the industry who fly large airplanes. The airplane I was in was a two-seater Aviat *Husky*, and it has this same GPS capability that airliners have.

I think when we talked about this issue before I said it is—there is nothing wrong with a Government agency looking forward and seeing an opportunity and letting it be explored. And indeed, the Food and Drug Administration does that all the time with miracle cures in medicines. But sometimes they don't work. And I think what the agencies of the Federal Government have said is, "We embrace the concept that is being considered, but the approach simply doesn't work," and it puts at risk all that GPS enables, which is not only what we have experienced for the last 20 years we have been using it, but the promise that it holds for the future.

So, we very much appreciate the committee's interest in this. We certainly embrace, as I said, the statements made by the administration. We strongly urge that the Federal Communications Commission rescind waivers that keep this cloud over us on this important topic until further research can be done.

Thank you, Mr. Chairman.

Mr. PETRI. Thank you.

Mr. Foley?

Mr. FOLEY. I am grateful for the opportunity to participate in this important hearing. I am John Foley, director of aviation GNSS technology at Garmin. The 9,200 people at Garmin are devoted to designing and building GPS devices for millions of users worldwide, improving their lives and safety.

The GPS industry in this country alone accounts for over 130,000 direct jobs. What was once a government-only technology is now fully woven into the fabric of our infrastructure. That did not happen overnight. It has taken two decades of hard work to mature it from a fledgling technology into a reliable force for safety and efficiency. Yet, unbelievably, what we have built together is now threatened.

Today, virtually all types of aircraft utilize GPS for navigation and approaches. Loss of even a fraction of GPS reliability would pose significant danger to aviation safety. Four areas are particularly worrisome: loss of GPS while on approach would unsafely increase pilot workload during a critical phase of flight; loss of GPS would deny coverage at hundreds of airports and heliports lacking ground-based navigation aids; without GPS, the terrain awareness and warning system, or TAWS, would not work; loss of GPS means a loss of situational awareness for cockpit displays of traffic and weather information, including on the ground, to prevent runway incursions. Last, but not least, reliable GPS is essential for the FAA's proposed NextGen system.

We can sum up the last year in four words: grant first, test later. Grant first, test later seems to stand the process of public decision-making on its head. This approach placed a severe burden on everyone's time, attention, and resources, a burden that should have been placed on those seeking something from the FCC. Everyone concerned about GPS reliability had to devote 6 months last spring and millions of dollars to testing the effects of constantly changing proposals. The tests revealed extensive interference. Anyone aware of the tremendous difference in signal strength between GPS and a high-powered terrestrial network could have predicted this result.

Yet, despite all this, another round of extensive Government testing occurred last fall. The PNT EXCOM again concluded in a recent letter to the NTIA that various plans for a high-powered terrestrial broadband network would cause harmful interference to many GPS receivers. The letter noted that the FAA's separate analysis similarly concluded that such proposals are not compatible with several GPS-dependent aircraft safety systems, and that no practical solutions exist to prevent significant interference to GPS. The EXCOM stated that no further testing was necessary.

Garmin has found many developments over the last year to be troubling. Why did the FCC make a far-reaching decision without conducting its own tests or spending time to evaluate Garmin's first test results? Shouldn't an applicant have the burden of demonstrating market readiness?

Why were objections from the Departments of Transportation and Defense ignored?

We hope you are asking these same questions, too.

Well, where do we go now? We believe that the PNT has the right structure, the right stakeholders, including a liaison role for the FCC, and on paper should be effective. However, future coordination must be improved. The FCC should obtain PNT EXCOM sign-off when proposals before it potentially interfere with GPS reliability, the level of reliability that our customers have come to expect.

Going forward, if the PNT believes that the creation of a post—of something akin to a national chief GPS officer would help ensure that coordination, we could support that. We think such an officer should alternately come from the Departments of Defense and Transportation.

In their recent letter to NTIA, the EXCOM said that they proposed to draft new GPS spectrum interference standards. In response, we simply note that in the last year parts of our Government seemed unaware that, at least for certified aviation GPS devices, the FAA and Department of Defense standards already address interference. Any analysis in the future should recognize and build upon that work.

In short, Garmin and other manufacturers have had their businesses greatly disrupted by the failure of Government to effectively coordinate. It has cost us millions of dollars and thousands of person hours that could have been better spent improving GPS products. If anything, for businesses, consumers, and the Nation, this year has in essence been a trial run. We have learned a lot, but the threat is still there, and we need your continued vigilance to help.

Thank you, and I look forward to answering your questions.

Mr. PETRI. Thank you.

Dr. Pace?

Mr. PACE. Thank you, Mr. Chairman. And thank you to this committee for an opportunity to discuss this topic. As you have heard, GPS is a global utility that is critically important to all modes of our Nation's transportation infrastructure.

What I would like to do is provide a little historical or policy perspective, because some of these issues of threats to GPS are actually not new. There have been and continue to be many policy and legal risks for GPS, from funding constraints, the transition to modernized signals, international trade barriers, and domestic regulations. The most serious threats, however, are not to the GPS itself, but to the spectrum environment upon which it depends. If you will, the foundation on which all these applications reside.

Every type of threat, from band sharing, segmentation, out of band emissions, noise floor increases, and reallocation of adjacent bands, have been attempted over the past 15 years. To date, all such threats have been removed or mitigated through government-industry cooperation and through bipartisan support from multiple Congresses and administrations who sought to protect the spectrum in which GPS operates.

Four Presidents, two Republican, two Democratic, have issued policy statements regarding GPS. These statements have recognized the dual-use nature of GPS as more than a military system, crucial to a broad range of U.S. interests. Similarly, Congress has passed numerous bills related to the protection of GPS, and Federal statutes can be found under both Title 10, Armed Services, and Title 51, National and Commercial Space Programs.

Regulatory processes for rulemaking are well-defined in the Administrative Procedures Act. I would say that the United States has sufficient law and policy on the books to protect GPS. What has been missing at times has been a willingness to enforce those laws and procedures, and follow the basics of good Government. Given the high stakes involved in preventing risk to GPS, it is attempting to look for a special policy fence that would automatically prevent problems from arising. Given the FCC is an independent regulatory commission, however, that does not report to the President, any special policy for GPS will require congressional action in a very complex area.

Receiver standards have been mentioned as a possible way of allowing higher power emissions in bands adjacent to the GPS spectrum, or at least creating a more predictable regulatory environment for new entrants. I do not believe this will be a useful approach, and would suggest instead focusing on defining GPS spectrum protection criteria. It is a subtle difference, but an important one.

The creation of government-driven design standards outside of those necessary for national security and public safety can stifle innovation. Receiver standards can also be a subtle regulatory means of sacrificing some categories of users and their applications in rapidly evolving markets. On the other hand, transparent protection for the GPS spectrum environment can provide better predictability for new entrants, while not constraining GPS applications.

Finally, I would like to mention two areas of risk not related to spectrum. In today's fiscal environment, it may be tempting to slow or cancel the acquisition of GPS III satellites, or hope to rely on foreign systems to fill the gaps. This is a very dangerous idea, given our Nation's reliance on GPS and the lack of demonstrated reliability of foreign systems.

A second risk area would be disruptions to existing GPS users as an unintended result of modernization. There is a need to explicitly confirm that changes to GPS are backwards compatible with the installed base. If not, there needs to be a transition plan developed with the relevant stakeholders in Government, industry, and even nongovernment organizations, such as advisory committees and scientific societies. We have a precious resource in that installed base that needs to be protected.

Finally, the spectrum neighborhood in which GPS resides should be preserved, as you have heard from other witnesses. As GPS modernization proceeds, the U.S. Government should ensure that the installed base suffers no disruptions, as new GPS capabilities come online. And for the aviation community, it is not an overstatement to say that eternal vigilance is, in fact, the price of safety.

I thank you for your time, and I would be happy to answer any questions you might have.

Mr. PETRI. We thank you, and we thank the entire panel for your contribution.

Craig Fuller talked about this simple technology with 1,000 and more, many more, permutations and advantages—I was thinking in my own area we have a boat manufacturer now that has a boat hook, it is a GPS. You push a button and the boat will stay perfectly still without an anchor in the ocean.

And of course, John Deere and these people now can do—apply fertilizers to fields based on the characteristics at that spot on the field, and it has a huge return for the additional investment—make agricultural more productive, less wasteful, and all the rest. And it is all GPS. And this is only the beginning of how we can refine the application of technology for changes in circumstances on practically a 6- by 6-inch basis across our country.

You have heard the testimony of the previous panel. And I really wonder if, in particular, Mr. Foley and Mr. Pace would care to comment on it. You have in your prepared remarks—but we found ourselves in a rather peculiar situation in that I—I am sure good-meaning people who see a business opportunity spent some billions of dollars to help achieve a national objective, which is a good one, of making broadband more available, high-speed broadband across our country, and yet we had a GPS system set up and elaborate for a number of years, that needed to be in a quiet area, as was testified before. And it was well known, evidently, the price of that spectrum reflected that to some extent.

And yet, that spectrum was acquired and the previous purpose was broadened at the staff level at the FCC, evidently leading people to think they could do something. And it is going to ruin a lot of savings of people who have invested in all this technology.

So is this a staff failure? Or are people leading someone down the primrose path, or—I mean how—or do we need clearer fences here, explain to people why this—evidently the spectrum price reflected some knowledge at the investor level, as to what was going on.

But was it a failure of the technical advisors of these investors to—or do you have any—I guess it is speculation, but maybe looking forward, how can we avoid this waste of resources in the future, or rescue the situation that we find ourselves in?

Either of you have any ideas?

Mr. FOLEY. Well, thank you. I think the main thing—and I think we have all kind of highlighted on that—is that we need to make sure that we protect the spectrum that we have. And looking kind of backwards, I think, at least from my perspective as a GPS receiver manufacturer, there are some standards for interference that have been in place for quite some time, back to 1996, I believe. So it was a bit of a surprise for us to see that when this new proposed system came up, it was actually putting out signals far in excess of those receiver—or interference protection limits.

So, any future plans would want to—we would want to build on those existing limits. And I think that is what the PNT has said, and DOT has said. So, to the extent that we do that, I think that is the best way to move forward.

And, just more generally, as I stated in my testimony, improved coordination between the PNT and the FCC and the rest of Government, to make sure that all the stakeholders get represented when new policy decisions are made.

Mr. PACE. I think, Mr. Chairman—I think looking back at it, I think the fundamental error was in not really applying the intent or the past practices of the Administrative Procedures Act, and notices of proposed rulemakings that involve reallocation of spectrum.

The argument was made that this was not a reallocation from mobile satellite services to a high-powered broadband terrestrial mobile service, that this was, in fact, simply a relaxation of some—maybe some outdated constraints and some waivers could be applied, and maybe some new efficiencies could be found.

I think, in retrospect, that was too clever by half, that it was a reallocation, that a notice of proposed rulemaking should have been done, the notice of proposed rulemaking would have generated the technical data necessary to understand what was involved, and that one would have fairly quickly seen that this was a non-starter.

When this originally started back in about 2003, the idea of an ancillary terrestrial component to mobile satellite service was considered a kind of a fill-in, a gap-filler, a relatively low-power system. No one was talking about 40,000 high-powered cell towers blanketing the country. Nobody was talking about having an independent terrestrial service separate from the satellite services. The FCC was very clear over the years that they would not allow a separate, standalone service, that, in fact, it always had to be tied to the satellite service, and no interference with the satellite service would occur.

Terrestrial broadband systems would not interfere with mobile satellite services in their own band, what they call co-channel interference, which is a really big sin.

So, I think that the position of people at the time was to try to find some way to make these ancillary systems work. I think there was good faith technical effort. There was really no technical data available then. And then people gradually, gradually got into trying to change it into something else, a reallocation. And they did not do a notice of proposed rulemaking. And hence, I think people were surprised when they found out that when they actually got data, that it was a much different situation than what they had intended.

So, I don't know how you prevent people from making bad decisions. I don't know if that is really possible. I do think we have rules and procedures that, if followed, would have protected us.

Mr. PETRI. Any other comments?

Mr. FULLER. Mr. Chairman, I just have a quick comment. One of the reasons, seriously, for my enthusiasm about the clarity of the Obama administration statement today is that it should send a very clear signal to any agency, even an independent agency. And we really don't have to speculate. There are plenty of people who have issued press releases. There are plenty of representatives making cases. But no one has done the hard work of testing that has come to any other conclusion than this won't work.

And so, I would hope that the administration, who had to clear the testimony today at OMB at the Executive Office of the President, I would hope the administration would provide an equally clear message to its appointees and an independent agency to say, "If you have some special knowledge that none of us have been able to uncover, then bring it forward. Bring it to the Congress. Bring it to the industry."

So far, literally—we have had press releases, but we have had not nearly the kind of certainty that experts, technical experts in this field, have. And I think the process that led to the testimony today is sound and solid and represents the best clear thinking in this administration that the project should not go forward as proposed.

Mr. PETRI. Mr. Cravaack?

Mr. CRAVAACK. Thank you, Mr. Chairman. Thank you for the great testimony. There is so much information that you have just given us, I really appreciate it.

One of the things you have said, Mr. Fuller—I don't want to—I want to make sure that the committee understands it. With the GPS system, there needs to be no terrestrial navigational systems at an airport. So you could be flying, and if you have an emergency, just as you alluded to, you could create an approach to go into an airport to fly into it that would not have any other navigational devices to it.

So, if you could expand upon that, that would be very helpful. And also talk about the minimums that you could bring this aircraft down to if you needed to.

Mr. FULLER. Getting into dangerous ground, because I can talk about flying all afternoon.

The interesting thing is that—and they will speak for themselves, but I think this is a topic on which we are in absolute agreement throughout the aviation community. The general aviation community has equipped with GPS avionics for years. The commercial aircraft industry has equipped with this technology for years, and is equipping more with the prospect of the NextGen technology being more fully utilized. All of it gives the ability, whether I am in the two-seater Aviat *Husky* or the *Citation* jet, or these gentlemen flying a commercial airline, that we have the technology to take us from the altitude—our en route altitude down to a couple of hundred feet above the center line of the runway using nothing but the satellite-based technology above the earth, and the GPS box and the related computers in the aircraft.

Furthermore, it allows them to know where I am at and me to know where they are at, so it provides separation of aircraft. That is going to be an increasingly important feature with this technology. It makes it possible to do this whether you are flying to your destination airport that you go to all the time, or you have an emergency and you have to suddenly find a suitable runway nearby.

So, as I said, this basic principle of being able to define precisely where you are in space continuously over time provides all kinds of enhancements.

Mr. Chairman, I also have a sailboat, and, believe it or not, it also helps us. In case the anchor is slipping, an alarm goes off because it shows the boat is moving. So there are all kinds of possibilities.

Mr. CRAVAACK. Thank you. And Captain Cassidy, as a pilot, can you tell me in regards to NextGen and what—some of the interference—what is your nightmare scenario? What do you see that the effects of you flying your commercial aircraft with LightSquared that could affect you, as a pilot, navigating down that gulf there?

Captain CASSIDY. Well, I suppose the nightmare scenario would be that I anticipated that I was putting myself back up in Juneau, flying down the Gastineau Channel, that I had a very highly reliable, highly effective navigation system, and suddenly somebody flipped the switch on it and then I had to go back to the old procedures. It would make me much more concerned about the safe conduct of flight, because now I would be—have a lot less of ability to have a very good estimate at what my arrival fuel would need to be at my missed approach point in order to get to my divert.

And that kind of tails on to what Mr. Fuller just said. I think that one of the big safety aspects of GPS technology is it allows you to be more proactive and anticipate contingency situations further down the road. In this case, I would—based upon what the arrival weather would be, I would estimate what a safe arrival fuel would be that would allow me then to divert and go to an alternate, and also have the coordinates of that alternate, and also, on top of that, have the approaches built into that alternate in my flight management system so it is all there and I have a one-stop-shop. And that is an incredible safety benefit that is clearly purely the benefit of satellite-based navigation.

Mr. CRAVAACK. Thank you, Captain. Mr. Chairman, can I have indulgence, just a little more time? Thank you.

Mr. Foley, in regards to LightSquared, obviously they are trying to get in the lower end of the spectrum. That is their initial business plan. They are going to try to get into—I see them trying to start working into the higher end of the spectrum, as well.

Is their current proposal any different than past proposal? And if they do try to get into the higher spectrum, what does that mean to you, as your business model?

Mr. FOLEY. Well, let me say I think the LightSquared proposals have changed numerous times over the past year or so. But primarily, operating on that upper 10 MHz frequency closest to GPS, all of the testing that has been done so far, all of the analysis has shown that would be just catastrophic. You will have widespread outages of GPS. The majority of the receivers that we tested just did not work at those types of power levels that close.

Moving to the lower 10 helps somewhat, but all of the analysis we have done so far says that doesn't get a clean bill of health, either. There are still significant problems with that proposal, as well, you know, specifically, the terrain awareness and warning systems. We talked about ADSB operations at low altitude. It poses a lot of problems for aviation.

Mr. CRAVAACK. Thank you, sir. And with that, I will yield back. Thanks for your chair's indulgence.

Mr. PETRI. Thank you, gentlemen. Thank you all for the effort that went into your prepared testimony, and for your being here, and your enlightening testimony today.

And this hearing is adjourned.

[Whereupon, at 12:30 p.m., the subcommittee was adjourned.]

STATEMENT OF
THE HONORABLE JERRY F. COSTELLO
SUBCOMMITTEE ON AVIATION HEARING ON
"A REVIEW OF ISSUES ASSOCIATED WITH PROTECTING AND IMPROVING OUR NATION'S AVIATION AND SATELLITE-BASED GLOBAL POSITIONING SYSTEM INFRASTRUCTURE"
FEBRUARY 8, 2012

- I want to thank Chairman Petri for calling today's hearing to review issues associated with protecting and improving our Nation's aviation and satellite-based Global Positioning System infrastructure.

- We all know that the ongoing effort to implement NextGen, which will transform our airspace, will require a transition from ground-based to satellite-based capabilities. The FAA and some airlines have already made substantial investments in GPS-based technologies that are enhancing safety and efficiency today. Moreover, the FAA estimates that by 2013, up to $10 billion in public and private sector aviation investment will be made in GPS-based technologies.

- Mr. Chairman, it is in the Nation's vital economic, security and safety interests to have a fully functioning global positioning system, and we must protect both the public and private sector investment in GPS-based technology. I would like to hear from our witnesses whether they believe that new spectrum management policies or procedures could better safeguard GPS and its many uses.

- Thank you, Chairman Petri and I look forward to hearing from our witnesses.

STATEMENT OF

THE HONORABLE JOHN D. PORCARI
DEPUTY SECRETARY
U.S. DEPARTMENT OF TRANSPORTATION

BEFORE THE

SUBCOMMITTEE ON AVIATION
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
U.S. HOUSE OF REPRESENTATIVES

HEARING ON

A Review of Issues Associated with Protecting and Improving Our Nation's Aviation Satellite-Based Global Positioning System Infrastructure

February 8, 2012

Chairman Petri, Ranking Member Costello and Members of the Subcommittee:

Thank you for the opportunity to appear before you today to discuss this important topic.

Global Positioning System (GPS) applications are vital to transportation safety and efficiency. Tens of millions of drivers across America use GPS to navigate. The Department's Federal Aviation Administration (FAA) estimates that by 2013, 60,000 aircraft will be equipped with GPS to navigate the skies over America. Positive Train Control, which is an improved safety application for rail transportation, will increasingly rely on GPS. The Intelligent Transportation System (ITS) program will depend on GPS as a key technology for vehicle collision-warning and crash-avoidance systems.

The Department of Transportation has committed to deploying the Next Generation Air Transportation System (NextGen) to modernize America's air traffic control system. NextGen will transform America's air traffic control system from the aging ground-based system of today to a satellite-based system of the future. NextGen employs GPS technology to shorten routes, save time and fuel, reduce traffic delays, increase capacity, and permit controllers to monitor and manage aircraft with greater safety margins.

The FAA and industry have invested as much as $8 billion into NextGen. The FAA conservatively estimates that the benefits of NextGen will total $23 billion by 2018, and over $120 billion by 2030.

In addition to the transportation applications I mentioned, GPS is essential for the operations of first responders, search and rescue, resource management, weather tracking and prediction, earthquake monitoring, national security, and critical infrastructure such as dams and power plants, financial transactions, surveying and mapping, and industries such as precision agriculture, where the ability to fertilize plants with centimeter-level accuracy increases conservation, reduces waste run-off, and saves American farmers up to $14-30 billion, annually.

As a testament to its success, the GPS program was the 2011 winner of the 60th Anniversary Award from the International Astronautical Federation for having "provided the greatest human benefit over the history of the space age".

In June, 2010 President Obama announced an administration goal to free up 500 MHz of federally-owned spectrum and make it available for mobile broadband, in support of a goal to provide at least 98% of Americans with access to 4G high-speed wireless service, and to especially provide access to underserved rural communities. The President asked this be done in such a way as to "...ensure no loss of critical existing and planned Federal, State, Local and Tribal Government capabilities".

LightSquared proposed that the Federal Communications Commission (FCC) allow the company to broadcast broadband signals in the Mobile Satellite Service (MSS) band. LightSquared's concept is to develop the first wholesale-only wireless 4G-LTE broadband network, reaching over 260 million people by the end of 2015. In January, 2011, the FCC approved this concept, contingent on LightSquared conducting tests with the GPS industry and affected federal agencies to identify and resolve any interference to GPS.

Since 2004, the Department of Transportation has served as the lead federal agency for all federal civilian uses of GPS. I, along with the Deputy Secretary of Defense, co-chair the National Executive Committee for Space-Based Positioning, Navigation, and Timing (PNT), which includes representatives from seven cabinet agencies, the National Aeronautics and Space Administration (NASA), and the Joint Chiefs of Staff.

Over the past year, at the request of the FCC and the National Telecommunications and Information Administration (NTIA), the agencies comprising the National Space-Based PNT Executive Committee (EXCOM) have worked closely with LightSquared to evaluate its original deployment plan, and subsequent modifications, to address GPS interference concerns. LightSquared's cooperation in the testing and analysis has been exemplary. The company shared proprietary business plans, as well as technical data and equipment.

The test results showed that LightSquared's design and filters effectively prevented "out-of-band" emissions; in other words, their powerful broadband signal was not 'leaking' into the adjacent GPS band.

However, the powerful broadband signal operating in the upper and lower 10 MHz of the MSS band (5 billion times the signal of GPS even ½ a mile from a LightSquared transmitter) overwhelmed filters and effectively blocked GPS signals in most of the devices tested in what is referred to as "overload interference". Also, interference caused by LightSquared's design of a dual carrier signal (upper and lower 10 MHz channels combined) resulted in an inter-modulation product in the adjacent GPS frequency band.

The most modern and accurate GPS devices, picking up the widest range of signals, tended to be affected the most. Less accurate "narrow band" GPS receivers, such as those commonly built into cell phones, were less affected.

Test results on LightSquared's original operating plan to operate in the upper and lower 10 MHz of the MSS band conducted by the National Space-Based PNT Systems Engineering Forum (NPEF) and the LightSquared-led Technical Working Group (TWG) were submitted to the NTIA and the FCC respectively in June 2011.

In addition, the FAA commissioned RTCA, Inc. to study the impact of LightSquared's proposed operations in the upper and lower 10 MHz of the MSS band on certified aviation receivers. This report also was completed in June 2011. All three test and analysis efforts concluded that LightSquared's planned operation would cause significant interference to GPS.

On June 30, 2011, LightSquared submitted a Recommendation Paper to the FCC proposing to initially broadcast only on the lower 10 MHz portion of the MSS band and "standstill" on the upper 10 MHz for an unspecified period of time in an attempt to avoid many of the interference issues with GPS receivers. In this paper, LightSquared recognized that even if transmissions were limited to only the "lower 10", they would still interfere with many GPS high precision receivers largely used for science and surveying, and in agriculture, mining and construction.

LightSquared committed to develop filters and mitigations for affected high precision receivers, while the FCC and NTIA asked the EXCOM agencies to analyze and test

LightSquared's revised plan for interference with general navigation devices. The FAA separately analyzed the plan's impact on certified aviation GPS devices.

If and when any interference concerns with certified aviation and general navigation devices are resolved, the involved federal agencies would then work with LightSquared to test its proposed solutions to interference with high precision receivers.

On September 9, 2011, the NTIA Administrator requested that NPEF and LightSquared jointly test this modified LightSquared proposal with general/personal navigation and cell-phone GPS, in strict adherence to NTIA standards and methods. NTIA requested that tests enable conclusive and final recommendations about general/personal navigation and cellular GPS devices.

Participants in the second round of testing included representatives from the Departments of Defense, Transportation, Homeland Security, Commerce, Interior, Agriculture, and State, as well as LightSquared, Broadcom, Garmin, Hemisphere GPS, John Deere, OnStar, and Trimble. This testing was completed in November 2011.

Analysis of the data was based on criteria provided by the NTIA for determining harmful interference. Based on this criteria, the NPEF testing showed that 75% of the tested general navigation devices experienced harmful interference from the LightSquared lower 10 MHz signal, experiencing a degradation in receiver carrier to noise density ratio of 1 dB or greater at an equivalent distance of greater than 100 meters from the LightSquared simulated tower. This impact is based on LightSquared's proposed transmit power level and a standard propagation model chosen by NTIA.

The NPEF test results were independently reviewed by Idaho National Laboratory and MIT Lincoln Laboratory, neither of which are affiliated with GPS industry. Both independent labs not only confirmed the NPEF findings, but felt that the NPEF may even have underestimated the magnitude of the harmful effects on the set of receivers tested.

In addition, FAA has been working with LightSquared since August 2011 on an analysis of the impact to certified aviation receivers of LightSquared's planned operation at the lower 10 MHz channel only. Since certified aviation receivers are necessarily designed and built to strict, internationally harmonized standards, analysis instead of testing is quite effective and LightSquared concurred with this approach.

Based on this analysis, the FAA concluded that LightSquared's proposed terrestrial network is not compatible with FAA requirements for low-altitude operations in the vicinity of LightSquared transmitters. This incompatibility is primarily focused on lower-altitude aviation operations, including use of GPS for terrain awareness and warning systems (TAWS), navigation operations to include GPS-based approaches, departures and some low-altitude enroute flight, and automatic dependent surveillance-broadcast (ADS-B).

TAWS is used by the fixed-wing and helicopter communities to reduce the risk of controlled flight into terrain. This technology uses GPS position in conjunction with a database of terrain to alert the flight crew of potentially unsafe trajectories and was mandated for commercially-operated turbine aircraft with 6 seats or more after a 1995 accident in Cali, Colombia which took 160 lives.

The mandatory installation of TAWS into U.S. commercial aircraft is considered by many to have made the single greatest impact to improving U.S. commercial aviation safety in the last 20 years. This technology also has been voluntarily adopted in general aviation as part of GPS-based navigation systems. With improvements in obstacle databases, the technology has proved particularly useful for helicopter operations at low altitudes and outside of FAA-established routes.

LightSquared has proposed to address this interference issue through a combination of site-by-site tailoring of their network density and operating parameters plus neutral third-party verification. Prior to initiating any attempt to implement such a solution, site-by-site analyses to account for differences in signal blockage and reflections would be required and the remaining technical issues on the specific propagation models would need to be resolved.

Even if these conditions could be accomplished, maintaining the in-air power level limit presents a severe challenge, as the surrounding environment, LightSquared's network, and aviation operations are all dynamic and continue to change. For example, helicopter MediVac or search-and-rescue need to be able to operate anywhere and if an adjacent building is constructed, it could create a new signal reflection.

In sum, LightSquared's proposal would require constant, individual monitoring and adjustments to over 40,000 broadcasting sites nationwide, to ensure that they could be, and would remain, consistent with air safety requirements. This is simply not practical. Therefore, based upon all of the testing and analysis that has been performed, there appears to be no practical solutions or mitigations that would permit the LightSquared broadband service, as proposed, to operate in the next few months or years without significantly interfering with GPS.

It is the unanimous conclusion of the test findings by the EXCOM agencies that both LightSquared's original and modified plans for its proposed mobile network would cause harmful interference to many GPS receivers. As a result, we believe no additional testing or analysis is warranted at this time.

Substantial federal resources, including over $2 million from the FAA, have been expended and diverted from other programs in testing and analyzing LightSquared's proposals.

This level of investment in assisting a commercial applicant to achieve the successful approval of its government application is quite unusual. However, due to the Administration's commitment to increased access to broadband, the investment was merited, but given the results we reviewed, further investment cannot be justified at this time.

The EXCOM agencies continue to strongly support the President's June 28, 2010 Memorandum to make available a total of 500 MHz of spectrum over the next 10 years, suitable for broadband use.
We propose to work with NTIA to draft new GPS spectrum interference standards that will help inform future proposals for non-space, commercial uses in the bands adjacent to the GPS signals, to strengthen existing national policy protection of adjacent band spectrum.

We will ensure that any such proposals are clearly communicated with stakeholders and are implemented without affecting existing and evolving uses of space-based PNT services vital to economic, public safety, scientific, and national security needs.

Thank you and I look forward to answering your questions.

# # #

International Civil Aviation Organization (ICAO)

Vincent Galotti
Deputy Director, Air Navigation Bureau

Statement to the United States House of Representatives Subcommittee on Aviation

Hearing on "A Review of Issues Associated with Protecting and Improving our Nation's Aviation Satellite-based Global Positioning System Infrastructure"

8 February 2012

Good morning Mr. Chairman, Ranking Member and Subcommittee members. It is an honour to be able to testify before this subcommittee and I would like to thank you for this opportunity. My name is Vincent Galotti and I am Deputy Director of the Air Navigation Bureau at the International Civil Aviation Organization (ICAO), which is a United Nations Specialized Agency. My testimony today will focus on the importance of the Global Navigation Satellite System or GNSS. The term GNSS is what we use to refer to the entire global satellite system and there are a few other systems.

Russia has its GLONASS which has had some reliability and maintenance problems over the years although that government has now committed to a next generation system. Europe has its Galileo which is not yet operational and China is in the process of launching its Compass system. Because of the reliability and continued upgrading of the GPS and the commitment of the

United States government, GPS is the most fundamental and important piece of supporting infrastructure of the global system.

By way of background, ICAO was established by the 1944 Convention on International Civil Aviation, also known as the Chicago Convention, and is a specialized agency of the United Nations. As the global forum for cooperation among its 192 Member States and with the world aviation community, ICAO sets standards for the safe and orderly development of international civil aviation. In fulfilling its mission, ICAO has established three Strategic Objectives:

1. Enhance global civil aviation safety;
2. Enhance global civil aviation security; and
3. Foster harmonized and economically viable development of international civil aviation that does not unduly harm the environment.

There are several hundred thousand commercial flights that take place around the globe each and every day in support of the world's social and economic infrastructure. The international standards established through ICAO as well as the global infrastructure put in place through the ICAO processes, enables those flights to operate seamlessly across international boundaries.

I would like to mention that the United States is one of the primary contributors to ICAO in terms of technical expertise and knowledge and in support of consensus-building and excellence in international standards and policy development, for which we are grateful. Most of the technical work that we do is accomplished through groups of experts nominated by Member States. The Federal Aviation Administration has been a major contributor to ICAO in this respect and I believe this has served U.S. interests extremely well.

ICAO's close involvement with satellite navigation systems goes back to the work of the ICAO Committee on Future Air Navigation Systems, more commonly known as the FANS Committee. The United States was a major contributor and participant to that committee. In adopting the outcomes of the FANS Committee at the Tenth Air Navigation Conference in 1991, a conclusion was reached that "the exploitation of satellite technology appears to be the only viable solution to overcome the shortcomings of the present system and also fulfil the global needs and requirements of the foreseeable future... and that satellite based systems will be the key to worldwide improvements".

In recognition of this turning point and acknowledgement by the world community of the importance of global satellite navigation systems, which was highly dependent on the U.S. GPS, President Clinton formally offered the GPS standard positioning service or SPS, to the global aviation community, through ICAO, to support the needs of international civil aviation. The U.S. commitment was formally reaffirmed in 2007 under President Bush as follows: "The U.S. Government maintains its commitment to provide GPS SPS signals on a continuous worldwide basis, free of direct user fees, enabling worldwide civil space-based navigation services and to provide open, free access to information necessary to develop and build equipment to use these services."

For the record, I should point out that even before the work of the FANS Committee and the offers of both Presidents Clinton and Bush, the availability of GPS to civil aviation first came about, as I am sure you are aware, when President Reagan authorized its use for international civil aviation after Korean Air 007 was shot down in 1983 for straying into Soviet airspace because of a navigation error. So it is safe to say that every sitting President since Ronald Reagan has either formally affirmed or re-affirmed the use of the U.S. GPS system in support of a global satellite navigation system.

Following the initial U.S. offer, ICAO developed international Standards on a more generic approach to satellite navigation systems, under the GNSS programme. With the availability of ICAO Standards, the GPS system became globally recognized by the international civil aviation community as the central element of GNSS. ICAO and the entire international civil aviation community are now completely reliant on the long-standing U.S. government policy and its international commitment to GNSS, as a key enabler of ICAO's strategic objectives. GNSS, and specifically GPS, has become the backbone of the global aviation infrastructure.

Today, the importance of GNSS to international civil aviation cannot be overstated as it has grown into the most critical piece of the global infrastructure in support of a seamless and interoperable global system. I will give a few practical examples.

- In areas of the world where the conventional terrestrial navigation aid infrastructure is inadequate, GNSS may well be the only reliable source of navigation information for international air transport. In other words, GNSS may be even more critical to safety of U.S. citizens when flying outside the U.S. than within;

- Before GNSS, navigation in high seas airspace was crude and inaccurate. Separation distances between aircraft used by air traffic control were as much as 100 miles laterally and 15 to 20 minutes in trail. The superior accuracy of GNSS, especially when integrated with sophisticated flight management systems, has enabled a number of substantial navigation improvements, which are the foundation of the ICAO concept of performance based navigation or PBN. In PBN airspace, separation between aircraft is significantly reduced thereby increasing capacity while bringing safety, efficiency and environmental benefits. The United States provides air traffic control services over vast expanses of high seas airspace. In the North Atlantic alone, there are over 2000 crossings a day. The trans-Pacific passenger traffic is expected to grow by 4.2 per cent between 2009 and 2030. The intra Asia/Pacific traffic during that period is expected to grow by 5.1 per cent and at present, approximately 8,000 flights per year operate on trans- or cross-polar routes as they allow shorter, more direct long-haul routes, which save fuel and minimise environmental impact and are more convenient for passengers.

- Until very recently, all final approaches to land at major airports were accomplished by means of instrument landing systems. Such systems, while proven and reliable, are expensive to implement and maintain. In the U.S. and in other high density traffic countries, this may not be a critical issue. However, in many parts of the world, maintaining such systems is prohibitive because of cost and expertise. Using GNSS as the basis for PBN approach procedures, more and more approaches to land are accomplished by means of the equipment in the aircraft only, with little or no reliance on ground equipment, bringing enormous safety benefits at many airports. And airports that previously had no instrument approaches now have PBN approaches. Today, when U.S. airlines fly approaches into Lagos (Nigeria), Almaty (Kazakhstan), Ulan Bator (Mongolia), Dakar (Senegal), Quito (Ecuador) and Georgetown (Guyana) to name but a few out of hundreds, they are more assured of safe operations because of GNSS-based PBN;

- In more developed areas of the world, gradual decommissioning of conventional navigational aids is underway in favour of a GNSS-based navigation system. This will enable significant cost savings while enhancing safety;

- Globally, GNSS is the enabling technology for a host of performance and safety enhancements;

- GNSS is important for next generation aircraft surveillance and here I am referring to automatic dependent surveillance–broadcast or ADS-B. ADS-B is being introduced in many countries as a replacement of or in lieu of traditional and expensive radar systems. ADS systems use GNSS positioning information, which is relayed to the ground for air traffic control purposes. And ADS – Contract or ADS-C, also based on GNSS, is being used in high seas airspace for surveillance, where prior to this, surveillance was not possible;

- And finally, two of the most significant near term air traffic management improvements that have recently become available, and that GNSS supports, are continuous descent operations and continuous climb operations. Each of these have the benefit of, as the titles suggest, allowing aircraft to continuously descend or continuously climb when operating in and out of airports, avoiding the inefficient practice of air traffic control of levelling aircraft off several times during arrival and departure. Again, safety, efficiency and environmental benefits.

Finally, after highlighting the importance of GNSS, and in this case GPS, internationally, I would like to touch on a major issue that has as much, if not more, of an impact globally than domestically. I am referring to the protection of aviation frequency spectrum. Available radiofrequency spectrum is the lifeblood of aviation and the protection of spectrum used by aviation radio systems is absolutely essential for flight safety. In the case of GNSS systems where power of the received signal is extremely weak, spectrum protection is particularly important.

ICAO has been vehemently supporting the protection of GNSS spectrum for decades in all international fora, such as the World Radio Conferences held every three years as part of the International Telecommunication Union or ITU framework. To give you just a few historical examples, in 1997 and again in 2000, two ITU Conferences discussed proposals to allocate spectrum within the current GNSS L1 bands to different radio services. This of course was seen as a major threat of interference to GNSS signals. ICAO strongly opposed the proposal and we believe that our opposition had an important role in developing a broad international consensus that the proposal was unacceptable.

Against that background, I would urge you to consider that any decision by the United States that affects frequency spectrum which impacts on GNSS, will have a critical impact on, to name a few:

- The excellent aviation safety record;
- The GNSS investment by the entire international fleet of every airline;
- The international standards that I spoke about earlier; and
- New-equipment and/or re-certification of existing equipment which is a lengthy and expensive process.

I cannot overstate the serious concerns of ICAO with respect to any decisions that may negatively impact on the availability and protection of GNSS, and the U.S. GPS on the Global Navigation Satellite System upon which the international civil aviation community has placed such importance. This has a lot to do with the full faith of the U.S. government that the global aviation community has come to expect.

In summary Mr. Chairman, I would like to appeal to you and the Committee that ICAO and international civil aviation continue to benefit from U.S. leadership and cooperation in many ways including invaluable support through the sharing of technical information and expertise; support of consensus-building and excellence in international standard and policy development; and concrete projects to assist countries in need of strengthening their aviation programmes. GPS is among the most important ways that the U.S. provides technological, humanitarian and political leadership.

ICAO looks forward to further deepening and strengthening this important and timely relationship.

Thank you for this opportunity to share ICAO's views with this important Subcommittee.

STATEMENT OF

CAPTAIN SEAN P. CASSIDY

FIRST VICE PRESIDENT

AIR LINE PILOTS ASSOCIATION, INTERNATIONAL

BEFORE THE

SUBCOMMITTEE ON AVIATION

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

UNITED STATES HOUSE OF REPRESENTATIVES

WASHINGTON, DC

FEBRUARY 8, 2012

"A Review of Issues Associated With Protecting And Improving Our Nation's Aviation Satellite-Based Global Positioning System (GPS) Infrastructure"

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**STATEMENT OF
CAPTAIN SEAN P. CASSIDY
FIRST VICE PRESIDENT
AIR LINE PILOTS ASSOCIATION, INTERNATIONAL
BEFORE THE
SUBCOMMITTEE ON AVIATION
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
UNITED STATES HOUSE OF REPRESENTATIVES
ON
A REVIEW OF ISSUES ASSOCIATED WITH PROTECTING AND
IMPROVING OUR NATION'S AVIATION SATELLITE-BASED
GLOBAL POSITIONING SYSTEM (GPS) INFRASTRUCTURE
FEBRUARY 8, 2012**

Good morning, Mr. Chairman and members of the Subcommittee. I am Captain Sean Cassidy, First Vice President and National Safety Coordinator of the Air Line Pilots Association, International (ALPA). ALPA represents over 53,000 pilots who fly for 37 passenger and all-cargo airlines in the United States and Canada. On behalf of our members, I want to thank you for the opportunity to provide our perspectives on the role of the Global Positioning System (GPS) in the aviation infrastructure. We applaud the Subcommittee for bringing attention to the need for protecting this critically important national safety and security resource.

For the past 15 years, GPS has been an integral component of the aviation infrastructure. GPS was originally developed by the Department of Defense (DOD) in the 1970's as an advanced navigation system for the delivery of high-precision weapons. Following the shoot-down of Korean Air Lines Flight 007 in 1983, which was due to a positioning error that allowed the airliner to stray into then-Soviet airspace, President Ronald Reagan issued a directive making the system available to the public at no cost.

GPS has evolved from a simple aid to navigation worldwide on land, sea, and air, to become a critical technology that has led to significant safety improvements in a wide range of activities. In aviation, GPS is now used to ensure pin point navigation. It is an essential component of the system that has provided the safest form of transportation in human history - and it is critical in safely operating around areas such as our nation's capital. Its broad uses include map-making, land surveying, product manufacturing, agriculture, commercial shipping and recreational boating, and construction. GPS also provides a precise time reference used in many applications including scientific study of earthquakes and synchronization of telecommunications networks for banking. The 911 system is critically dependent on GPS signals from cell phones and transponders so that first responders can more quickly respond to emergencies.

Early Government/Industry GPS Activities

Although GPS had originally been developed for use on military aircraft, the civilian aviation community quickly recognized the potential for GPS applications to that sector. The FAA requested that RTCA, Inc. develop standards for civil GPS equipment to ensure commonality across platforms and therefore commercial viability. RTCA is a private, not-for-profit corporation that develops standards and provides recommendations to the Federal Aviation Administration (FAA) on communications, navigation, surveillance, and air traffic management (CNS/ATM) system issues. RTCA functions as a Federal Advisory Committee with the participation of government and industry.

Two RTCA groups involved in GPS issues are noteworthy: RTCA Special Committee 159 (SC-159) and RTCA Task Force 1. Since SC-159's first meeting in March 1985, there have been 87 meetings of the committee and hundreds more of its working groups. Industry and government subject matter experts have literally contributed hundreds of thousands of hours in this effort, and the countless working papers, studies, and evaluations of these experts have yielded 16 comprehensive standards documents from 1988 to the present. Less than one year ago, Working Group 6 of SC-159 published an assessment of LightSquared's proposed use of spectrum adjacent to the GPS frequency spectrum for terrestrial communications. The assessment, which found that the LightSquared proposal would compromise the integrity of GPS signals, served as the aviation community's input to the Federal Communications Commission's (FCC) requirement for a joint LightSquared/industry Technical Working Group.

RTCA Task Force 1 published a report in 1992 on the transition and implementation of GPS. The Task Force concluded that as there were no institutional issues that would preclude implementation of GPS, it should be adopted in an expeditious manner. The report also emphasized the transition should be user driven and evolutionary.

Summary:

- Civil aviation community has been involved with developing GPS equipment standards since 1985
- Civil aviation community has achieved commonality across platforms and commercial viability
- There were no institutional issues to preclude a user–driven, evolutionary, and expeditious implementation of GPS.

GPS Evolves into the Cornerstone of Aviation Infrastructure

I would like to provide four examples of how GPS has become a cornerstone of the aviation infrastructure. These examples cover various areas of flight and include oceanic routes, operations into remote areas, major metropolitan airport complexes, and parallel approaches into busy airports.

GPS equipment has been installed on commercial air carrier aircraft since 1994. Long-range aircraft operating over oceanic routes used GPS as an aid for improving navigation and shortening routes. Before the introduction of GPS for oceanic navigation, aircraft were required to be separated by 20 minutes or approximately 160 nautical miles (NMs) in trail. The oceanic routes were at least 120 NMs apart. These separation standards limited the number of aircraft that could fly the routes at any given time. In addition, the lack of radar and communications capabilities in oceanic areas often meant that aircraft had to fly at less-than-optimum altitudes to avoid conflicting with each other's paths.

Areas like the North Atlantic routes between Europe and North America, and the Pacific routes between North America and Australia/New Zealand were the first areas to use GPS. The use of GPS, combined with satellite communications and automatic position reporting equipment developed for use on the aircraft, allowed air traffic control to have a more accurate position on each aircraft and, therefore, reduce separation on oceanic routes and thus increasing capacity on those routes.

The use of GPS for reducing aircraft separation began in the largest controlled airspace in the world. Together the U.S., Australia, and New Zealand provide air traffic control services to over 23 million square miles of airspace in the Pacific. In 2005, air traffic control providers used this technology to safely reduce the separation between GPS-equipped aircraft to 30 NM in-trail separation and 30 NM separation between routes. The new separation standard now only requires the controller to "protect" – meaning they ensure that no other aircraft encroach on any given aircraft's protected space—only 6% of the airspace previously protected. The net result is safely increased airspace capacity and route flexibility which in turn leads to more efficient routes, substantially decreased fuel burn per flight, and decreased CO2 emissions.

Summary:

- In oceanic routes, precise GPS navigation equipment allows aircraft to fly more efficient routes at optimum altitudes
- GPS has increased capacity of oceanic routes in Atlantic and Pacific
- GPS provides for a safer operation that allows aircraft to fly more efficient routes, substantially decreases fuel burn per flight, and decreases CO2 emissions.

GPS Use in Remote Areas

GPS has also been beneficial to communities in remote areas like Alaska. Very few of the towns and villages in Alaska currently have roads between themselves, much less to the outside world. Consequently, boats or dogsleds were the only way to provide supplies to these communities before air travel. Since the birth of aviation, airplanes have quite literally become the lifeline to these communities.

At over 4 times the land area of California, not only is Alaska massively big, but its desolate terrain and hostile weather have meant that aircraft operations there are subject to significantly more hazards than those in the rest of the United States. At most airports, ground-based navigational aids have either been limited or unavailable due to terrain, and they are often extremely expensive to maintain. This meant that many of the air carrier flights often had to be cancelled for weather or due to ground equipment being out of service. In that region, air carrier flights are not simply a convenient form of transportation; due to the fact that they are often the only means of connecting a population center with critical services, cancellations of flights have a major impact on public safety.

One of the first airports in Alaska, and in fact the world, with a GPS-based instrument approach was the capital of Alaska, Juneau. Before the advent of GPS, the limited accuracy of conventional navigational aids available combined with very closely situated mountainous terrain dictated that the arrival procedures needed to have high weather minima, meaning that even with instrument flight systems in place, relatively high ceilings and visibility were still necessary to fly there safely. This operating environment, compounded by notoriously dramatic weather swings, limited the number of days the airport could operate. Consequently, a large percentage of flights were cancelled into the state capital-- a city where the longest road only spans 40 miles.

In 1996, ALPA pilots flying for Alaska Airlines pioneered GPS-based procedures, using a concept called Required Navigation Performance or RNP approaches, into Juneau. RNP technology provides computer-generated landing paths with pinpoint accuracy by using a combination of onboard navigation technology and the GPS satellite network. The RNP arrival route for runway 26 descends below the level of surrounding mountains as it takes the airplane down the narrow Gastineau Channel. The precision nature of the RNP approach allows the aircraft to remain over the center of the channel and away from the high terrain nearby. Due to GPS-based RNP technology, the pilot is able to gradually descend and place the aircraft in a position to be safely aligned with the runway. In the case of a missed approach or go-around, the flight crew is still able to safely maneuver the aircraft clear of the terrain- again using RNP guidance. The net result is that it allows aircraft to fly safer, more reliable approaches, and reduces reliance on ground-based navigation aids.

Since the initial RNP operations at Juneau, Alaska Airlines has expanded the use of RNP for operations into other airports in Alaska, Hawaii and the Continental U.S. They have developed and received operational approval from the FAA for over 80 different RNP procedures. In terms of measurable results, in 2011 alone, out of the over 6,300 flights Alaska Airlines operated , more than 1,500 of those flights would have likely resulted in a cancellation or divert but for the benefits of RNP technology. The resulting savings for the company was over $19 million in revenue and 210,000 fewer gallons of fuel burned.

These are significant savings for just one airline for just one year, but that is only one part of the story. Due to GPS technology, many communities now have services that simply would not been possible without those capabilities. ALPA has had a front row seat on the development of these procedures and a unique appreciation for the potential of this technology since our pilots flying for Alaska Airlines fly into those communities daily using this technology, and have witnessed the benefits firsthand.

Although the previous example of GPS benefits is a compelling one, to suggest that Alaska Airlines and the State of Alaska are the only beneficiaries would be a mistake. Here are two notable examples of benefits in the Lower 48: Palm Springs, CA and Reagan National Airport. Like many of the Alaskan airports, Palm Springs is in an area with very challenging terrain. RNP procedures now allow aircraft to maneuver well clear of the high terrain which is located very close to the airport. At Reagan National, RNP-guided approaches reduce the number of flights delayed, diverted or canceled due to poor weather conditions. The technology also supports noise abatement efforts by allowing more aircraft to fly the preferred approach directly above the Potomac River instead of above nearby residential neighborhoods. And very importantly, RNP provides the ability to overfly extremely precise navigation points - a critical safety and security need for operating so closely to restricted airspace surrounding the nation's capital.

Our FAA partners have been working to develop and expand GPS-based approaches, departures and arrivals around the country. As of the end of 2011, the FAA has published 11,541 GPS-based instrument approach procedures. This is in addition to the 6,675 ground-based conventional approaches. Many of these GPS-based approaches are for airports without conventional approaches to runway ends. This provides a means for airliners to access airports with a far greater level of safety than previously available.

Summary:

- GPS provides computer-generated landing paths with pinpoint accuracy by using a combination of onboard navigation technology and the GPS satellite network
- It allows aircraft to fly safer, more reliable landings, and reduces reliance on ground-based navigation aids
- Results in significant annual savings in operational costs
- Majority of instrument procedures being developed and published are now GPS-based

Metroplex

In 2010, following the recommendations of the aviation community to RTCA, the FAA created an initiative called the Optimization of the Airspace and Procedures in the Metroplex (OAPM).

A metroplex is a geographic area covering several airports, serving major metropolitan areas and a diversity of aviation stakeholders. Congestion, airport activity in close geographical proximity, and other limiting factors such as environmental constraints combine to reduce efficiency in busy metroplexes. A total of 29 metroplexes, situated around the FAA's Core 30 airports, were selected as candidates. Core 30 airports are those with significant activity serving major metropolitan areas and also serve as hubs for airline operations. Whenever possible, closely associated metroplexes were combined. In addition, metroplexes with on-going airspace redesigns like Chicago and New York were eliminated. The result was a final group of 21 metroplexes that were chosen for the OAPM process.

OAPM is an optimization of the airspace through analysis and provides solutions to these issues on a regional scale, rather than focusing on a single airport or set of procedures. It takes into account all airports and airspace that support metropolitan area operations, including connectivity with other metroplexes. The process considers a myriad of factors including safety, efficiency, capacity, access, and environmental considerations.

Based on feedback from major industry stakeholders, it was decided that a collaborative government/ industry approach for optimization using Performance Based Navigation (PBN), e.g., GPS-based procedures, combined with airspace redesign, would deliver the most efficient operation and benefits to the selected metroplex. Their primary task involves analyzing operational challenges in their regions, assessing planned and potential new solutions and making recommendations for advancement by the design and implementation teams. This collaborative approach has been successful in aligning airline and air traffic control priorities and requirements. The airlines have also contributed pilots and flight simulation resources to ensure that the proposed procedures are operationally flyable and to help derive the benefits from the proposed procedures.

Arrivals and departures into and out of metroplexes extend for hundreds of miles outside of the metroplex airspace and allow air traffic control to coordinate the flow of aircraft from many directions into areas that frequently have multiple large, busy airports. Currently, conventional arrivals and departures are often limited to a single line of aircraft. Weather, slower aircraft, and traffic flow restrictions then compound the challenge for air traffic control to meet the capacity of the airport. In addition, conventional arrivals and departures were designed based only on the major arrival airport and did not consider the dynamic relationship of other airports or metroplexes. The result was that other airports in the metroplex, e.g., Dallas-Ft Worth, Houston, Atlanta, and Charlotte often had conflicting arrival and departure traffic patterns.

GPS is extremely beneficial in JFK just as it is in Juneau. One of the major tools for OAPM is the use of GPS-based arrivals and departures, because these GPS aided procedures have several advantages over the existing conventional ground-based arrivals and departures. Using historical radar data from previous years, the arrival and departure routes can be designed to follow the historical flight tracks. When required, dual flight tracks can be used to funnel multiple streams of aircraft into or out of the metroplex. These dual tracks often allow flight tracks to be shortened thus reducing fuel burn, noise, and CO2 emissions. Whenever possible, descents are based on idle thrust with a minimum of level-offs. This results in a smoother flow and reduced workload for both pilots and controllers.

The OAPM process is moving rapidly. Currently, OAPM has completed several study and design reports for Washington, D.C., North Texas (Dallas-Ft Worth), Charlotte, Northern California, Southern California, and Houston. A Study and Design Team is currently completing reports at Atlanta. Design and Implementation teams are now underway at Washington DC, North Texas, and Houston.

Let me highlight some additional information about the Houston OAPM to illustrate the advantages. Houston is of significant interest to our members since it is a major hub for several airlines.

The Design and Implementation portion of the Houston OAPM has drawn the attention of the White House and is one of the 14 national infrastructure projects tracked on the President's Federal Infrastructure Dashboard. Based on studies already performed for Houston OAPM, this initiative will translate to an estimated annual savings of up to 6.9 million gallons of jet fuel, equivalent to nearly 21 million dollars at the current fuel cost. Carbon emissions are expected to be reduced by up to 71,000 metric tons-a significant reduction in greenhouse gas emissions by any measure. Additional savings in delay hours and other benefits will continue to be calculated based on the results of the project as more data comes in

All revised arrival and departure procedures must still comply with existing FAA standards, criteria and requirements, and with requirements for environmental reviews. New arrival and departure procedures must also comply with internal FAA approvals as well as review under the National Environmental Policy Act (NEPA). FAA is using an Environmental Management System (EMS) approach to tightly integrate the NEPA reviews into FAA's internal approval process, which will expedite this project. Studying the impacts of the new procedures also will lead to NextGen procedural improvement on future projects. FAA also has developed a NextGen NEPA Plan to help ensure timely, effective, and efficient environmental reviews of proposed NextGen improvements. As part of this plan, the FAA will use a focused Environmental Assessment (EA) approach to yield more concise and timely environmental reviews for proposed FAA actions. All these measures will demonstrate responsible yet streamlined environmental processing for future NextGen procedural improvements.

A typical OAPM project undergoes a development life-cycle of about 3 years from study to implementation. As part of an initiative to expedite reviews of new NextGen enabled procedures, the FAA will further hasten implementation of new, more efficient routes for airports in the Houston area. This new, accelerated process can bring benefits to the Houston metroplex in about 24 months. If this expedited process can be used at the other metroplexes, the result will obviously be expedited savings. Without GPS, these savings will not be possible.

Summary:

- Metroplexes are geographic areas covering several airports, serving major metropolitan areas and a diversity of aviation stakeholders
- Core 30 airports are those with significant activity serving major metropolitan areas and also serve as hubs for airline operations
- OAPM - Optimization of the airspace through analysis and provides solutions to these issues on a regional scale, rather than focusing on a single airport or set of procedures

- OAPM allows dual flight tracks to funnel multiple streams of aircraft into or out of the metroplex
- OAPM allows flight tracks to be shortened, thus reducing fuel burn, noise, and CO2 emissions.
- Descents are based on idle thrust with a minimum of level-offs resulting in a smoother flow and reduced workload for both pilots and controllers
- Houston OAPM is one of the 14 national infrastructure projects tracked on the President's Federal Infrastructure Dashboard
- Houston OAPM uses an expedited environmental assessment process to reduce implementation time from about 36 months to 24 months

Parallel Approaches into Airports

On January 18, 2012, the FAA began allowing the simultaneous use of GPS-based approaches on parallel runways. Without the use of these more accurate technology enhanced procedures, aircraft on parallel paths flying traditional ground based Instrument Landing System or ILS approaches had to be 'staggered' to account for the possibility that the aircraft with the less-accurate navigation capability might stray into the other's protected airspace. With the added accuracy of GPS, aircraft will not have to be sequenced in such a manner, thus increasing the arrival rate. Additionally, aircraft will no longer be restricted from simultaneous operations when an instrument landing system is unavailable on a parallel runway.

Although FAA policy has been slow to change, this policy is a major step forward because it recognizes the well-established benefits of this technology. The simple fact is that GPS-based approaches have long had the capability to allow suitably equipped aircraft to operate safely in proximity to ILS equipped aircraft.

This policy is especially important in light of the announcement of the FAA's Notice of Proposed Policy, published in the Federal Register December 15, 2011. The Proposed Policy, titled "Proposed Provision of Navigation Services for the Next Generation Air Transportation System (NextGen) Transition to Performance-Based Navigation (PBN)" details the FAA's plans to transition from defining airways, routes and procedures using VHF Omni-directional Range (VOR) and other legacy navigation aids towards a NAS that is based on more accurate navigation capability enabled largely by the Global Positioning System (GPS) and further refined by the Wide Area Augmentation System (WAAS). The FAA plans to retain an optimized network of Distance Measuring Equipment (DME) stations and a minimum operational network (MON) of VOR stations to ensure safety and continuous operations for high- and low-altitude en route airspace over the contiguous U.S. (CONUS) and terminal operations at the Core 30 airports. The FAA is also conducting research on Alternate Positioning, Navigation and Timing (APNT) solutions that would enable further reduction of VORs below the MON.

Since VORs do not support or enable more modern GPS-oriented navigation capability, including the emerging Automatic Dependent Surveillance-Broadcast (ADS-B) operations, the FAA plans to reduce costs by drawing down the number of FAA-provided VORs. Currently, over 80% of the 967 VORs in the NAS inventory are past their economic service life and cost the FAA more than $110M per year to operate. Likewise, replacement parts are becoming increasingly difficult to obtain. The replacement of all of the VORs would cost over $1.0 billion. Therefore, the FAA is planning a gradual discontinuance (i.e., removal from service) of VOR facilities in the continental U.S. down to the MON.

The MON would enable non-GPS equipped aircraft anywhere in the CONUS to proceed safely to a destination with a GPS-independent approach within 100 nm. MON coverage is planned to be provided at altitudes above 5,000 feet above ground level (AGL). The FAA would also retain VORs to support international arrival airways from the Atlantic, Pacific, Caribbean, and at the Core 30 airports. The existing U.S. legacy navigation aids outside the continental U.S. will be retained until a longer-term solution can be coordinated with users. The drawdown of VORs to a MON would be completed no later than January 1, 2020. Existing ILSs would provide an alternative approach and landing capability in support of recovery and dispatch of aircraft during GPS outages. ILSs would provide the precision approach and landing segment for APNT.

As the number of VORs is decreased to the level of the MON, more routes will be developed that are based solely on GPS. Known as Q-Routes, several of these routes are already in use in the Western U.S. as well as in the Gulf of Mexico. Aircraft can now fly from central Florida to Louisiana and Texas, navigating accurately beyond the range of land-based navigation aids and avoiding the military warning areas in the Gulf. Before Q-routes, most aircraft were required to fly overland, resulting in increases in miles traveled, fuel, and time.

Summary:

- With the added accuracy of GPS, aircraft on parallel runways may operate independently from each other, increasing the arrival rate
- New FAA policy is a major step forward and will result in increased capacity.
- FAA is proposing a reduction in ground-based navigational aids infrastructure
- As the ground-based navigational aids infrastructure is decreased, more routes will be developed based solely on GPS

GPS and the Future

GPS-based navigation applications are not the only aviation use for GPS. Within the next 10 years, GPS will also be used for surveillance applications – both air-air and air-ground. Surveillance is the term generally used to mean the air traffic controllers' ability to "see" and therefore accurately control, aircraft in the air or even on the ground. The FAA is fielding an Automatic Dependent Surveillance– Broadcast (ADS-B) ground-system as a supplement for radar surveillance. GPS alone—that is, without supplemental means to augment its accuracy—is capable of providing the accuracy and integrity required by the FAA's ADS-B Out regulations that have a compliance date of January 1, 2020. The FAA is looking at ADS-B as the eventual replacement for most radar surveillance in the U.S.

The tentative approval by the Federal Communications Commission (FCC) for LightSquared to use frequencies adjacent to the GPS band for terrestrial communications was a wake-up call for the GPS community. The results of testing by government agencies and industry concluded that the LightSquared proposal would significantly interfere with GPS operations and signals.

On December 20, 2011, LightSquared filed a request for a Declaratory Ruling to "resolve the regulatory status" of commercial GPS receivers. LightSquared requests specific declarations designed to establish that commercial GPS devices are not entitled to interference protection from LightSquared's operations, so long as LightSquared operates within the technical parameters prescribed by rule and Commission Order. The FCC has requested comments from the public on the petition. The FCC stated that the Interference-Resolution Process, contained FCC's Conditional Waiver Order, IB Docket No.11-109, has not been completed and is still the most appropriate forum for considering LightSquared petition

On December 23, 2011, Congress enacted the 2012 general Government Appropriations Act. The Act prohibits the FCC from using any funds made available by the Act "to remove the conditions imposed on commercial terrestrial operations in the Order and Authorization adopted by the Commission on January 26, 2011 (DA 11-133) [i.e., the Conditional Waiver Order], or otherwise permit such operations, until the Commission has resolved concerns of potential widespread harmful interference by such commercial terrestrial operations to commercially available Global Positioning System devices."

On January 13, 2012 the National Executive Committee (EXCOM) for Space-based Positioning, Navigation, and Timing sent a memo to Assistant Secretary for Communications and Information, Department of Commerce, Lawrence Strickling. The EXCOM Co-chairs, Deputy Secretary of Defense Ashton Carter and Deputy Secretary of Transportation John Porcari stated:

> "It is the unanimous conclusion of the test findings by the National Space-Based PNT EXCOM Agencies that both LightSquared's original and modified plans for its proposed mobile network would cause harmful interference to many GPS receivers. Additionally, an analysis by the Federal Aviation Administration (FAA) has concluded that the LightSquared proposals are not compatible with several GPS-dependent aircraft safety-of-flight systems. Based upon this testing and analysis, there appear to be no practical solutions or mitigations that would permit the LightSquared broadband service, as proposed, to operate in the next few months or years without significantly interfering with GPS."

ALPA believes that the LightSquared's request for a Declaratory Ruling should be denied based on the results of the vast number of tests conducted by the government and industry confirming the potential negative impact to established GPS operations. LightSquared has been either a participant or observer in the testing. As we discussed earlier, the civil aviation community has been developing equipment standards since 1985. These standards have been evaluated and adopted worldwide and long preceded the FCC's rules and LightSquared's request.

Even if LightSquared's proposal is ultimately disallowed, the issue of interference is still significant. The FAA plans to purchase portable interference monitoring-detection systems to help officials in its spectrum engineering services directorate track down and shut down illegal GPS jammer activity. Personal privacy devices, more commonly referred to as GPS jammers, being used on a highway near the Newark International airport, derailed the rollout of a GPS-based instrument landing system at the airport in late 2009. Continental Airlines at the time had equipped a portion of its fleet with avionics to use ground-based augmentation system (GBAS) approaches. After several years of analysis and radio frequency interference (RFI) upgrades to the Honeywell-built ground equipment, United-Continental and the FAA are once again preparing to begin testing GBAS both at Newark and the Houston Intercontinental airport.

Regardless of whether signal interference is intentional or not, it is important that government and industry continue to monitor and protect the GPS infrastructure.

Summary:

- GPS is vital for expanded uses of GPS such as ADS-B
- ADS-B is envisioned as the eventual replacement for most radar surveillance in the U.S.
- Proposal by LightSquared to use spectrum adjacent to GPS spectrum would interfere with civil and military GPS aviation operations
- Although interference or jamming may not be intentional, it is important that government and industry continue to monitor and protect the GPS signal

Conclusion

As you can see, GPS, and GPS-based procedures, have transformed aviation from a ground-based navigation system to a space-based navigation system. In the future, as GPS-enabled surveillance systems evolve, GPS will become an even more integral part of an increasingly safe and efficient aviation infrastructure. By contrast not only do ground based navigation systems have well defined limitations, but the cost of maintaining them is very high. Simply put, when we look at the vastly improved navigational accuracy provided by GPS we see a win-win outcome on safety and operational grounds. If we expect to maintain the world-leading safety record that we point to with pride, the vital component that is GPS must be vigorously protected. The protection must include defenses against electronic interference and provision of sufficient redundancy to ensure continuous operation.

Today, our members safely and efficiently fly 100's of millions of passengers and millions of tons of cargo around the globe using some of the most advanced GPS-equipped aircraft in the world. GPS is a winning technology with well-established benefits and an even brighter future. Please help us continue to preserve, protect and develop this vital national resource.

Summary:

- GPS has transformed aviation from a ground-based navigation system to a space-based navigation system
- As GPS-enabled surveillance systems evolve, GPS will become an even more integral part of the aviation infrastructure
- Cost of maintaining a redundant ground-based navigation system is high
- GPS provides a critical safety benefit to the nation's aviation infrastructure
- GPS' importance must be recognized, supported by funding and other resources, and it certainly must be protected
- GPS protection must include defenses against electronic interference and provision of sufficient redundancy to ensure continuous operation

Thank you for your attention to these remarks. I would be pleased to take any questions that you may have.

Airlines for America
We Connect the World

Testimony

A Review of Issues Associated with Protecting and Improving Our Nation's Aviation Satellite-Based Global Positioning System Infrastructure

Statement of
Thomas L. Hendricks
Senior Vice President
Safety, Security And Operations
Airlines for America (A4A)
before the
Subcommittee on Aviation
of the
House Transportation and Infrastructure Committee

February 8, 2012

Chairman Petri, Ranking Member Costello and Members of the Subcommittee, thank you for inviting us to appear at this timely and important hearing.

The continued integrity of the Global Positioning System is critically important to the millions of customers who we fly every day, as well as to the tens of millions of other people in our country who rely on it. GPS will be the backbone of air navigation both domestically and internationally in the coming years. Interference with its accessibility or reliability would be catastrophic for civil aviation and the communities that depend on air transportation.

We deeply appreciate the Subcommittee's recognition in the FAA reauthorization bill of the importance of this technology and, particularly, your support for the continued advancement of NextGen.

With respect to the LightSquared proposal, the incontestable fact is that it will create widespread GPS interference, which will have ruinous effects on aviation. Experts have repeatedly reached that conclusion. LightSquared's proposal therefore should be withdrawn. This matter needs to be put to rest once and for all.

To be clear, we do not oppose the expansion of wireless broadband services but any expansion cannot be permitted to interfere with existing or anticipated aviation GPS use, many of which will significantly enhance safety. We are dependent on that technology; there is no substitute for it.

One obvious lesson of the convoluted experience with the LightSquared application is the need for a governmentwide policy that protects the aviation GPS spectrum. Without such an authoritative policy, spectrum encroachment will remain a threat.

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THE IMPORTANCE OF GPS TO AVIATION

As the Subcommittee knows all too well, we have historically relied on a ground-based air navigation system. It is a system that has become increasingly defined by its limitations. Users of the system have, for the most part, had to fly from one ground navigation aid to the next, often resulting in circuitous routings. This inefficiency wastes time and fuel. It also restricts the number of routings that aircraft can use, which in turn constricts capacity growth.

GPS is at the heart of the ongoing, multi-billion dollar NextGen program that will shift air navigation from that outmoded terrestrial system to a modern satellite-based system. This is a transformational change.

All who are involved in it – Congress, the Federal Aviation Administration, airlines, general aviation and the Department of Defense – recognize the need for that transformation. This massive effort will result in more precise navigation, safer operations, far more direct aircraft routings, better airspace utilization and airspace capacity growth. Because of these operational improvements, there will be substantial reductions in greenhouse gas emissions.

One existing application of GPS has produced a breakthrough in the safety of airline operations: the elimination of controlled flight into terrain (CFIT) accidents for large jet aircraft in the United States. Enhanced Ground Proximity Warning Systems aboard aircraft combine GPS information with onboard terrain databases to provide flight-deck crews with look-ahead warnings of dangerous terrain. This has made air travel far safer than it was only recently and illustrates the remarkable benefits that leveraging GPS with other technologies can achieve.

The introduction in the coming decades of NextGen capabilities will be the real game-changer. Its integration of GPS with other technological innovations will create the satellite-based system of air traffic management that we all realize is so necessary. GPS is the indispensable element of this long-needed overhaul.

PROTECTING GPS FROM INTERFERENCE

Given the essential role of GPS, the federal government must develop comprehensive safeguards for aviation's use of it. The stakes are too high for the passengers and shippers that rely on air transportation, the communities and businesses that depend on air service, and airlines and their employees to leave to chance our continued ability to utilize GPS to the greatest advantage.

Consequently, we need a governmentwide policy that guides federal agencies' responses when potential interference issues emerge. That policy must make clear that interference in the aviation spectrum is prohibited and that other users cannot be permitted to encroach into the aviation spectrum.

Domestically, the most obvious place to begin to strengthen governmental policy against GPS interference is the National Executive Committee for Space-Based Positioning, Navigation and Timing (PNT). PNT is a government organization established by presidential directive to advise and coordinate federal departments and agencies on matters concerning GPS. The PNT is

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chaired jointly by the Secretaries of Defense and Transportation, and includes equivalent-level officials from the Departments of Homeland Security, State, Interior, Agriculture and Commerce.

The Federal Communications Commission (FCC) chairman participates in the PNT as a liaison. At the very least, the FCC should be required to consult with the PNT before taking action on any application to operate a terrestrial-based communications network that may affect the L-band spectrum, which is the band that GPS uses.

On the international front, U.S. government positions expressed at international conferences at which spectrum issues are considered – such as the World Radiocommunications Conference that is currently being held in Geneva – must reflect the importance of protecting the GPS spectrum throughout the world.

CONCLUSION

We appreciate the Subcommittee's interest in this vital issue. We are prepared to assist you in any way that we can.

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Statement of Craig Fuller, President

Aircraft Owners and Pilots Association

Before the

Committee on Transportation and Infrastructure

Subcommittee on Aviation

U.S. House of Representatives

Concerning

A Review of Issues Associated with Protecting and Improving our Nation's Aviation Satellite-based Global Positioning System Infrastructure

February 8, 2012

Statement Highlights:

1. GPS is critical to safety of flight for thousands of general aviation pilots and aircraft operating in the United States each day and has become a vital part of our national transportation infrastructure.
2. No viable backup system has been designated in the event that GPS becomes inaccessible to general aviation.
3. Current policy supports the protection of access to GPS for civilian use.
4. PNT's clear and to the point findings on the LightSquared proposals are instructive on the importance of avoiding harmful interference to GPS receivers and GPS-dependent aircraft safety-of-flight systems. Additional

> protections are needed to ensure that similar proposals do not advance to the stage that they receive conditional approvals or waivers. The development of such protections will require the collaboration of numerous agencies whose policies and decisions affect the GPS system.

The Aircraft Owners and Pilots Association (AOPA) is a not-for-profit individual membership organization representing approximately 400,000 members. AOPA's mission is to effectively represent the interests of its members as aircraft owners and pilots concerning the economy, safety, utility, and popularity of flight in general aviation (GA) aircraft.

As pilots flying in the United States, we experience firsthand the safest and most efficient air transportation system in the world. This aviation network of 5,200 public use airports, complemented by more than 13,000 privately owned landing facilities, is a unique national resource. Each year, 170 million passengers fly using personal aviation, the equivalent of one of the nation's major airlines. General aviation contributes more than $150 billion to U.S. economic output, directly or indirectly, and employs nearly 1.3 million people whose collective annual earnings exceed $53 billion.

Use of GPS by General Aviation

General aviation pilots rely on GPS in all phases of flight. From takeoff through landing, GPS provides navigation information that allows for the safe and efficient operation of general aviation aircraft for business and personal transportation as well as medical, firefighting, law enforcement, humanitarian, and agricultural operations. Approximately 70 percent of AOPA's members rely on GPS as their primary means of navigation while many of the remainder use it as a backup form of navigation.

Overall, approximately 50 percent of the general aviation fleet is equipped with some form of GPS. We can expect that percentage to rise as manufacturers like Cessna make GPS standard equipment on all new aircraft.

In addition, thousands of GPS-based instrument approaches are in use at airports nationwide, with more such approaches being added each year. For general aviation, the availability of GPS and Wide Area Augmentation System (WAAS) precision instrument approaches has allowed all-weather access into more than 2,000 airports nationwide at a fraction of the cost of traditional ground-based approaches. WAAS represents the world's only satellite-based augmentation system certified for 24-hour per day operations. This system has been embraced by the general aviation community, with more than 74,000 WAAS units sold to date.

As of January 2012, there were 11,541 approaches that rely on GPS operating in the United States, compared to only 6,675 ground-based instrument approaches. Without reliable access to GPS in all areas and at all altitudes, thousands of airports would no longer be accessible in low weather conditions, critically diminishing the utility and safety of general aviation flying.

In addition, the FAA continues to establish GPS-based airways, known as T-routes, that provide more efficient and economical routing while reducing pilot and controller workload in busy terminal areas. T-routes can overcome the limitation of ground-based navigational aids, such as line-of-site requirements and signal reception. And, because of the accuracy of GPS signals, T-routes can offer lower minimum altitudes giving pilots more options for avoiding icing conditions, a major safety consideration for general aviation.

In the decades since GPS was first made available for civilian use, it has become a critical part of our national transportation infrastructure. Just as surface highways provide for commercial and personal transportation around the nation, so GPS "highways" in the sky allow for the efficient movement of people and goods via general aviation aircraft. And just as the integrity and access to our surface infrastructure must be protected, so must the reliability and accessibility of our airborne infrastructure.

GPS is also a foundational technology in the FAA's ongoing efforts to modernize the air traffic system, an effort known as NextGen. As the FAA continues to move away from a ground-based system and toward a satellite-based system, pilot and air traffic controller reliance on GPS will necessarily continue to increase.

Vulnerability of GPS

The general aviation community depends upon the federal government to ensure civilian access to the GPS system is stable and protected.

While thousands of flights in U.S. airspace rely on GPS daily, there is currently no designated alternative to GPS in the event the system becomes inaccessible for any reason. In March 2007, the Department of Homeland Security (DHS) designated eLORAN as the official backup for the GPS system. However, beginning in 2009, DHS began dismantling that system. While many of the towers required for eLORAN transmissions have since been destroyed, no replacement backup system has been designated.

While recognizing that the FAA is studying the possible alternate options for position, navigation, and timing, with no formal backup in place at present GPS users are vulnerable in the event of a system shutdown or interference. The designation of an official backup would allow equipment manufacturers to begin creating products that incorporate whatever technology might be needed to access that backup. It is important to note, however, that sufficient lead time will be required to develop and implement any necessary equipment changes to accommodate a backup system.

Access to the GPS system is also vulnerable to interference from changing uses of the broadcast spectrum. As recent events showed, powerful ground-based transmitters using spectrum adjacent to that designated for GPS are one potential source of interference. But as the demand for bandwidth continues to grow and new technologies are developed, the potential for interference will also continue to expand. Because it is impossible to determine how yet-to-be-designed technologies may operate, it is essential to protect the GPS system not only from existing threats but from potential new ones as well.

Recognition of GPS as a Critical Safety Technology

Current policy and practice recognize the importance of reliable access to the GPS system for general aviation and other users.

As far back as 2004, the White House established a national policy that set guidance and implementation actions for space-based positioning, navigation, and timing programs, augmentations, and activities for U.S. national and homeland security, civil, scientific, and commercial purposes.

This policy made it clear that the government is to "provide uninterrupted availability of positioning, navigation, and timing services" to domestic users. New to the policy was the coordination of multiple agencies to protect the domestic GPS signal from accidental or intentional jamming.

In the years since this policy was first established, GPS has become exponentially more central to the safety and efficiency of general aviation operations, suggesting that any new guidance should expand existing protections for GPS.

Establishing New Protections for GPS

While the concerns and protections set forth in the 2004 policy remain valid, new concerns continue to arise with changing technology and the expanded use of GPS. Because of the increasingly heavy reliance on the GPS system, new protections are needed to ensure the long-term availability of the system. These protections must take into account not only existing threats to the GPS system but also address anticipated future threats.

Given the importance of GPS, a clear statement of the need and intent to protect the system from a wide range of harmful actions would be an effective starting point. In addition, the creation and enforcement of new protections will require extensive cross-agency and user collaboration, to include input from FAA, FCC, DOD, DHS, the Department of Agriculture, and others whose policies and decisions impact the viability of the GPS system. For example, to avoid a repetition of the very substantial risks to GPS that were posed by the LightSquared proposals, Congress could require the FCC to obtain concurrence from both DOT and DOD before approving any similar applications, regardless of the entity making the proposal.

Conclusion

On behalf of the 400,000 members of AOPA, thank you for your leadership in protecting the integrity of the GPS system that forms a critical safety component of the national air transportation system. GPS is a vital part of our national transportation infrastructure that must be protected with the same vigor as other forms of infrastructure. By acting now to preserve GPS from both present and future threats, you can help ensure the continued safety and efficacy of general aviation.

Written Testimony of John M. Foley
Director, Aviation GNSS Technology
Garmin International, Inc.

Before the Committee on Transportation and Infrastructure
Subcommittee on Aviation
U.S. House of Representatives

"A Review of Issues Associated with Protecting and Improving Our Nation's Aviation Satellite-Based Global Positioning System Infrastructure"

February 8, 2012

My name is John M. Foley, and I am Director, Aviation GNSS Technology, for Garmin International, Inc. ("Garmin"). Garmin is extremely appreciative of the opportunity that you have given us to address the issue of protecting and improving our nation's Global Positioning System ("GPS"). Not only does GPS represent the very core of our business, it is a valuable national treasure, and we are heartened that the Subcommittee has scheduled today's session so we can explore and discuss how to protect it.

This hearing is very timely after the year we have just experienced. Over the last twelve months and continuing today, we have seen one part of our government come close to authorizing a new high powered terrestrial broadband service that would have posed an extreme threat to the existence of GPS. We think it is very prudent today to review what we learned from that experience as well as the extensive GPS benefits that we might have lost, so history does not repeat itself.

Before I begin, I would like to emphasize, as my colleague Phil Straub did when he appeared before this Subcommittee last June, that Garmin is not opposed to the rollout of improved broadband service. Improved broadband is essential for our economy to prosper and our businesses to remain globally competitive. We just believe that such advancement, and the implementation of other new services and technologies, should not be done in a way that would cripple GPS service.

I. Garmin Is a World Leader in the Design and Manufacture of Reliable GPS-Enabled Aviation Products

Garmin is the leading manufacturer of GPS products for the General Aviation ("GA") industry in the United States. It also is a leading supplier of general location/navigation GPS devices to consumers around the world. Garmin has been manufacturing GPS-enabled navigation devices since 1991.

Over the past two decades, Garmin's aviation business has grown, and today Garmin has a larger installed user base of GPS equipment than all other aviation manufacturers combined. Garmin provides a full suite of avionics for GA aircraft, helicopters, and Part 25 business aircraft. When Phil Straub testified before you, he provided a lengthy list of our aviation products, and I attach that list to this testimony as Appendix A. Since Mr. Straub testified, we have introduced two new products for the GPS aviation market:

- *The GTX™ 23 ES remote transponder, a new remote-mounted Mode-S extended squitter transponder for experimental and light sport aircraft.* Using GPS's referenced positioning information, the extended squitter technology in this device positions it for ADS-B compliance and enables it to automatically transmit more accurate, and more reliable, traffic surveillance data – including aircraft flight identification, position, altitude, velocity, climb/descent, and heading information. Traditional Mode S and Mode C transponders can only broadcast altitude, and thus require ground-based radar to correlate and identify the aircraft position. The GTX 23 E offers much more.

- *The aera® 796 and aera 795, a new series of portable aviation navigation devices.* These products similarly improve the information available to pilots. The aera 796 features 3D Vision, a unique 3D view of database-generated terrain. 3D Vision uses GPS position and a terrain-alerting database to recreate a behind-the-aircraft perspective view of the topographic landscape. The resulting virtual reality display offers pilots a supplemental 3D depiction of land and water features, including terrain, obstacles, runways, and airport signposts, all shown in relative proximity to the aircraft. With the flick of a finger, the 3D view can be rotated around the aircraft to easily view the terrain surrounding the aircraft.

II. Our Customers As Well As Documented Studies Consistently Remind Us of the Life-Saving Improvements That GPS Makes to Aviation Safety

The introduction and use of GPS-enabled devices, like Garmin's, have brought significant advances in aviation safety, particularly for the GA market. GPS has become ubiquitous and indispensable in the years since Garmin introduced its first aviation GPS receiver. Virtually all types of aircraft utilize GPS for navigation and approaches. For the majority of these aircraft, GPS is the primary means of navigation.

When Phil Straub testified last summer, he did an excellent job articulating how GPS-dependent features on our devices assist pilots day-in and day-out and describing the features that improve aviation safety. Again, I would like to make sure his very clear explanations are a part of this record, so I attach them as Appendix B.

Perhaps the best way for interested parties who are not themselves pilots to experience how these systems work is to view them from a pilot's perspective. I commend to you the following two videos that Garmin has prepared that put the viewer in the cockpit of both fixed-wing aircraft and helicopters:

- "Garmin G1000 retrofit avionics impresses King Air owners and operators," *available at* http://youtube.com/watch?v=Y9_Wo7e0XOMZ; and

- "Garmin Helicopter Solutions," *available at* http://www.youtube.com/watch?v=GtLUIcNBhuU.

Both videos show what it is like to experience the operational features GPS provides, including improved traffic awareness and terrain awareness.

Almost from the launch of our first products in 1991, our customers quickly began to make us aware of how our products bring life-saving benefits to aviation. Over the years, we have received hundreds of reports from customers who have written to tell us how our products saved their lives or the lives of their colleagues, friends, and loved ones. These often harrowing, but ultimately positive, tales are replete in our records and on our customer blogs. Stories like the following show how various devices throughout our GPS avionics product line have saved lives in many different ways:

- A couple of years ago, one Florida pilot gained instant regional notoriety when he used his Garmin GPSMAP® 696 to help him land his small plane on a dark Tallahassee-area road after he had experienced engine roughness and could not make it to the nearest airport.
- A number of pilots involved in organ transplant flights have told us that their aviation GPS devices have ensured that they fly the most efficient route between two destinations when time is critical for preservation of their life-saving cargo. (For one pilot's story, *see* http://www.youtube.com/watch?v=ds0HoBn7GAQ.)
- For search and rescue missions, first responders have reported that GPS helps them deploy teams in search grids and then provides a standard for communicating the exact position once a search subject is found and emergency air evacuation is critical to the subject's survival.
- One military pilot in the Iraqi war wrote to tell us that, when a complete electrical failure caused his plane to lose use of all navigation and communications radios, his own portable GPS device allowed him to program in his return route back to Kuwait, saving both his multimillion dollar aircraft and his life.
- A helicopter pilot assigned to Iraq similarly reported that not only he, but every one of his pilots in his unit had "either a Garmin 196 or 296 that we fly with and they have saved our lives many times."
- Another pilot flying from Austin, Texas to Gulfport, Mississippi related that, when the alternator in his new plane unexpectedly began to fail, his GPS III Pilot helped guide him along a highway to a safe landing at a nearby airport despite hazy visibility, a lack of landmarks, a dead battery, and no radio.
- Finally, a new pilot with under 100 hours flying experience told us that his Garmin GPSMAP 295 saved his life and that of a friend when he lost visibility off the Florida coast because of a sudden freak storm and had to rely on his Garmin device to guide him to the nearest airport.

As use of GPS-enabled aviation devices has become more prevalent, studies have begun to emerge documenting and quantifying the life-saving benefits that our own customers have anecdotally reported to us. Among the conclusions and statistics included in these studies are the following:

- Just last month, it was reported that, due to FAA implementation of a recommendation from the US Commercial Aviation Safety Team ("CAST") that airlines install terrain avoidance systems, terrain accidents have been greatly curtailed, if not eliminated. From 1982 to 1992, bad weather or dark conditions contributed to 12 airline crashes that killed 420 people. No such U.S. airline accidents have occurred since 2005, when the FAA mandated that airlines install such GPs-enabled warning devices on turbine aircraft. ("How U.S. Airlines Got a Whole Lot Safer, "*Bloomberg Businessweek,* Jan. 26, 2012, available at http://www.businessweek.com/magazine/how-us-airlines-got-a-whole-lot-safer-01262012.html.) This same article reported that, in the last five years, the odds of a U.S. airliner going down and killing someone have become 1 in 49 million, a 93 percent decline from 1994 to 1998, when they were 1 in 3.7 million. Accident rates are also down in Canada, Europe, Australia and Japan. (*Id.*)

- The availability of GPS has made a huge difference in preventing runway collisions. A recent analysis by the U.S. Department of Transportation's Volpe National Transportation Systems Center showed that use of a surface moving map with own-ship position, features only available through GPS, could prevent approximately one-third of all runway incursions based on FY2007 and FY2008 data. The benefit doubled with the addition of *all* surface traffic (air cargo and surface vehicles) to the moving map displays. (S. Chase, *et. al.,* "Mitigating Runway Incursions: A Safety Benefits Assessment of Airplane Surface Moving Map Displays," November 2010, *available at* http://www.volpe.dot.gov/coi/hfrsa/docs/chaseeonyeh2010.pdf.)

- According to the FAA, from 2006 to 2011, fatal controlled-flight-into-terrain ("CFIT") accidents in GA and non-scheduled air carrier operations decreased 44 percent from the preceding five years; fatal approach-and-landing accidents and all fatal accidents at night decreased by 30 percent. Glass cockpits became standard equipment in GA aircraft beginning about 2003, and the FAA reports that glass cockpits and GPS are a primary explanation for these improvements and that they will likely continue for several more years as GPS-based equipment continues to penetrate the GA market. ("LightSquared Impact to Aviation Operations Input Provided by Federal Aviation Administration," at A-3, Appendix A to Letter from Joel Szabat, Deputy Assistant Secretary for Transportation Policy to Mr. Karl B. Nebbia, Associate Administrator, National Telecommunications and Information Administration, July 21, 2011.)

- The FAA has quantified that the safety impact of a 10-year loss of GPS functionality would result in the loss of approximately 800 lives. The figure includes fatality estimates for both air carrier and GA operators. The FAA noted that the figures for each component were conservative and that its study did not even take into account assumptions concerning serious injury, minor injury, and property loss. (*Id.* at A-4.)

- The Capstone project in Alaska, a precursor to nationwide roll-out of the new NextGen system, produced even more evidence that GPS-enabled devices improve aviation safety:

- -- The Bethel/Yukon Delta area of Alaska served as the initial test bed since it is served by approximately 25 percent of the commercial aircraft in Alaska and has a proportional number of accidents. A 2004 study by The MITRE Corporation and the University of Alaska at Anchorage found that, from 2000 to 2004, the rate of accidents for Capstone-equipped (ADS-B equipment) aircraft was reduced by 47 percent. (FAA, "Surveillance and Broadcast Services, Western Service Area (WSA)," *available at* http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/enroute/surveillance_broadcast/wsa/.)

- -- According to the FAA Alaska Region's Administrator, in the early 1990s, Alaska was averaging 180 aviation accidents per year, and it averaged one aviation fatality every nine days. At the end of FY2010, the state recorded 93 accidents, a 50 percent decline. (S. Day, "Alaska aviation safety continues improvements," *Juneau Empire*, Oct. 13, 2011, *available at* http://juneauempire.com/local/2011-10-14/alaska-aviation-safety-continues-improvements.)

- -- In 2003, there were 20 accidents per 100,000 flying hours in Alaska, while, in the Lower 48, the number was 6 accidents. As of October 2011, Alaska had half as many accidents as in 2003. (*Id.*)

- -- The Capstone program also reduced the number of aviation midair collisions in cruise flight. Prior to Capstone's initiation, cruise flight accounted for the largest number of accidents. By 2011, about 15 percent of aviation accidents were in cruise flight, 44 percent were during landings, and 27 percent were in takeoff or initial climb. (*Id.*)

With any loss or impairment of GPS, these documented benefits and positive trends would be immediately reversed. The opportunity for longer-term benefits would also be sacrificed. For GA in particular, its losses, unlike those related to air carriers, would not be offset by Instrument Landing Systems ("ILS") and air traffic control because some of the GA fleet would not be equipped with ILS, not all GA airports have ILS equipment, and GA aircraft may not be under air traffic control. Without GPS or with compromised GPS, the safety impacts and costs to GA would be felt in full and would be severe.

III. Garmin's Experience Over the Last 12 Months Has Firmly Convinced It That There Needs To Be More and Better Coordination Over GPS Policy at the Federal Level

Garmin, like many parties in business and government, was surprised when the proponent of a new high-powered broadband terrestrial network filed a letter with the Federal Communications Commission ("FCC") on November 18, 2010, informing the agency that it had developed a new business plan that involved offering Ancillary Terrestrial Component service on a wholesale basis to retail wireless providers. The proposed network involved 40,000 terrestrial transmitters located nationwide. Most importantly, the proponent would no longer commit to satisfying the FCC's "Integrated Service Rule" by offering service only for use with "dual mode" handsets. Instead, it contended that it would be offering an "integrated service" merely because it would continue to offer Mobile Satellite Service ("MSS") in the rural and sparsely populated areas where its ATC service would be unavailable.

Without the provision of "dual mode" handsets, the proponent would no longer need to avoid self-interference, a crucial requirement basic to the GPS industry's willingness on several prior occasions to work with MSS applicants to ensure their Ancillary Terrestrial Component service did not result in harmful interference and remained truly "ancillary." The November 2010 filing transformed the proposed service into an offering that would severely degrade GPS service for the millions of individuals, businesses, and government agencies that rely upon it.

Garmin recognized the serious implications, and its engineers, as quickly as possible, began to conduct their own tests of the proposal, which revealed extensive interference. Given its preliminary testing, Garmin was again surprised when NTIA, despite its awareness of concerns from the Departments of Defense, Transportation, and Homeland Security, did not seek to delay or oppose a decision on the proposal, but instead sent a letter to the FCC Chairman stating that, if the FCC intended to grant the proposal as modified in the November 2010 filing, the agency should establish a process for analyzing the scope of the potential interference and possible solutions before allowing the network to commence service. Garmin completed its testing and prepared a report on the potential interference, which was filed with the FCC on January 20, 2011. Less than a week later, on January 26, 2011, the FCC's International Bureau granted the proponent's application, subject to the condition that it engage in a process with interested parties to identify the scope of anticipated interference and propose solutions for mitigating it.[1]

For almost six months, Garmin and many other private and governmental parties devoted millions of dollars to testing the effect of varying proposals for operation of the network upon a wide range of GPS devices. The test results revealed extensive problems with interference to the GPS signal just as Garmin had demonstrated at the beginning of the year and as anyone cognizant of the tremendous disparity in signal strength between GPS signals and the proposal could have predicted.

Despite all this work, another round of extensive testing occurred in the fall -- this time limited to cellular and general location/navigation GPS devices -- but still involving millions of dollars, numerous devices, and private and public parties. Again, as the Co-Chairs of the Space-Based Positioning Navigation and Timing National Executive Committee ("EXCOM") concluded in a letter to NTIA on January 13, 2012, the proponent's original and modified plans for its network would cause harmful interference to many GPS receivers. It noted that a separate analysis by the FAA similarly concluded that the proposals are not compatible with several GPS-dependent aircraft safety-of-flight systems. Based on the testing and analysis, the EXCOM Co-Chairs wrote that there appeared to be no practical solutions or mitigations that would prevent significant interference to GPS. According to the letter, no further testing was required.

As an interested observer and participant in much of the testing and as a company that in the past was focused on developing, manufacturing, and selling products rather than on government interaction, Garmin has found a number of developments over the last year to be

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1 *Order and Authorization*, 26 FCC Rcd 566, 586-87, ¶¶ 41-43 (IB Bur. 2011).

troubling. First was the rapidity with which the FCC reached a decision, seemingly without conducting any of its own tests, spending time to evaluate Garmin's test results, calling for the proponent to address the testing or other concerns, or placing on the proponent the burden of demonstrating that its technical proposals were market-ready. Second was what appeared to be the FCC's failure to evaluate fully the objections of Cabinet-level departments with expertise on the matter at issue. Third was what seemed the FCC's strong willingness to allow a major change in policy and exception to its rules to occur in an application context rather than through traditional, statutorily prescribed notice and comment proceedings. The "grant first and test later" standard seemed anomalous, to say the least.

In trying to devise a means for preventing a repetition of the past year's experience, Garmin is loathe to prescribe more federal regulation or "red tape" for fear it would disrupt the well-functioning market-driven development of GPS products. Congress and the President have already established a U.S. space-based PNT organizational structure that includes the relevant stakeholders and provides a liaison role for the FCC. On paper, the structure appears logical and likely to be effective.

Given the events of the past year, however, Garmin would urge that future coordination be improved through some type of mechanism that requires the FCC to obtain PNT EXCOM sign-off or approval when proceedings before the FCC include documented or substantiated claims of potential interference to GPS. Garmin believes that officials involved in the PNT are those best qualified to decide how this increased coordination and approval should be structured. Garmin also believes the EXCOM Co-Chairs are very capable of making any determination that GPS would be impaired by proposed new technologies or services. If the Co-Chairs, however, feel that creation of the post of something akin to a national "Chief GPS Officer," with the individual drawn alternately from the Departments of Transportation and Defense, would help ensure coordination and better protect GPS, Garmin could support that idea.

In their January 13, 2012 letter to NTIA, the EXCOM Co-Chairs stated that they proposed to draft "new GPS Spectrum interference standards." In response, Garmin would simply note that another area of its surprise over the last year's events involved the seeming lack of acknowledgment at the FCC and in some other parts of the government that, at least for certified GPS aviation devices, industry and government regulators are already guided by numerous existing standards. The FAA and the Department of Defense mandated these aviation GPS receiver standards developed via a government-industry voluntary consensus process. For instance, the interference mask used by these standards predated the FCC's January 2011 decision.

In short, Garmin and other manufacturers like it have had their businesses greatly disrupted by the failure of constituent parts of the government to coordinate effectively among themselves. Fortunately for businesses, consumers, and the nation, this year has in essence been a "trial run." No system was actually launched or significant threat unleashed that wiped out or began to shut down GPS. With the advent, however, of devices at the consumer level that have the potential to jam GPS and the pressing need that some perceive to free up more spectrum, Garmin encourages government decision makers to take the lessons of this "trial run" to heart, so that we put in place enforcement and coordination mechanisms to ensure that the unthinkable does not occur in the future.

Appendix A

Garmin Aviation Devices That Improve Aviation Safety

- Fully integrated "Flight Decks," like the popular G1000®, which provide pilots with instrumentation, navigation, weather, terrain, traffic, and engine data on large-format, high-resolution displays;
- GPS navigation/communication devices, like the GNS™ 400 and 500 product lines that have been the General Aviation standard since 1998 (over 115,000 sold) and their successors, the recently certified GTN™ 650 and 750. These aid pilots with high-resolution terrain mapping, graphical flight planning, geo-referenced charting, traffic display, and satellite weather;
- Mode S transponders which feature the extended squitter broadcast that enables the transponders to automatically transmit more accurate, and more useful, traffic surveillance data to support Automatic Dependent Surveillance-Broadcast, including aircraft flight identification, position, altitude, velocity, climb/descent, and heading information; and
- Many other GPS devices that assist pilots in monitoring every element of their flight conditions.

Appendix B

How GPS-Enabled Devices Assist Pilots and Help Ensure Aviation Safety

The position information computed by GPS receivers provides pilots with a reliable and accurate navigation source. When it is integrated with other systems in the cockpit, GPS enables a multitude of capabilities that enhance safety and improve operating efficiency. As the Aviation Subcommittee knows, GPS is the foundation for the Federal Aviation Administration's ("FAA's") new NextGen System. The existing uses of GPS that are described below have made critical differences in the ability of pilots to ensure safety of life in the skies; proposed improvements in future devices will only enhance these benefits.

GPS provides pilots with the ability to fly point-to-point instead of following ground-based radio navigation aids that require longer flight paths between airports. GPS also gives pilots the ability to immediately orient where an aircraft is located relative to terrain or obstacle features when the GPS position is paired with map details. This combination provides "instant" orientation without the mental gymnastics that were necessary before GPS was introduced into the cockpit. This is a significant safety enhancement because it frees the pilot to concentrate on flying the airplane instead of working to stay oriented. During in-flight emergencies, GPS systems can provide immediate navigation to the closest airport, even in areas where there are no ground-based navigation aids.

GPS-based instrument approach procedures, both standalone and those enhanced by the Wide Area Augmentation System ("WAAS") or Ground-Based Augmentation System ("GBAS"), allow aircraft to land safely at airports throughout the country. GPS approaches require substantially less ground infrastructure than those approaches utilizing ground-based navigation aids such as the Instrument Landing System ("ILS"). GPS/WAAS-based Lateral Navigation ("LNAV")/Vertical Navigation ("VNAV"), Localizer Performance with Vertical guidance ("LPV"), and GBAS approaches provide both horizontal and vertical guidance that improve aviation safety by allowing the pilot to fly a stabilized approach to a safe landing. There are, in fact, now more LPV approaches in the United States that require GPS/WAAS rather than ILS approaches. All told, the FAA has published over 10,000 approach procedures that use GPS,[1] at roughly 3,000 airports and heliports across the 50 states and U.S. territories. Over 900 of these airports and heliports have only GPS-based approaches; in other words, instrument approaches are not possible at these airports without GPS. GPS navigation also enables the use of repeatable curved approach and departure paths to and from airports which shortens flight paths, requires less fuel burn, results in lower costs to operate, and creates a smaller carbon footprint. In summary, GPS navigation improves airport capacity, access, and efficiency.

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[1] *See* http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/approaches/index.cfm, update effective June 2, 2011.

Availability, integrity, and accuracy are all necessary for GPS to function as a primary means of navigation and to ensure aviation safety. When weather is poor and a pilot cannot see outside the aircraft beyond the tips of the wings, he or she must rely on the plane's navigation system to keep the aircraft in safe airspace. During an approach, the pilot works hard to follow the FAA-prescribed flight path to the runway and must be able to rely on the GPS and have confidence in the system. Improperly executed instrument approach accidents are consistently among the most common causes of lethal descent and approach accidents.[2] The loss of the GPS signal during this critical time is clearly a hazard to safety. Without it, pilots have to scramble to stay ahead of the airplane by tuning to the frequencies of alternate navigation equipment and shifting their mindset to alternate navigation methods instead of relying on GPS.

Automatic Dependent Surveillance-Broadcast ("ADS-B") equipment broadcasts GPS-derived position reports to other aircraft in the vicinity and to Air Traffic Control centers on the ground. ADS-B will enable increased safety, precision, capacity, and capability for Air Traffic Control with a reduced cost of operation since it is not dependent on ground-based radar systems.

GPS is also used as an input to many traffic awareness systems, particularly those derived from ADS-B. These systems can enhance safety by providing pilots with timely alerts of potential collisions with other aircraft so that they can be avoided. Additionally, GPS supplies position, altitude, and velocity information to many terrain awareness systems. Such systems greatly reduce the likelihood of controlled-flight-into-terrain incidents by providing the pilot with audible alerts of potential terrain and obstacle conflicts along the flight path and a picture of the aircraft's position relative to the surrounding terrain and obstacles. GPS also enables synthetic vision systems to display external topography from the perspective of the flight deck, enhancing situational awareness when pilots are flying in instrument conditions.

Many aircraft are equipped with electronic multi-function displays that depict the aircraft's location on a map. GPS is a primary source of position data for these displays, which reduce pilot workload by improving situational awareness through pictures that show an aircraft's position on a map that can be overlaid with weather radar and traffic information while airborne. Other GPS-enabled map displays, such as Garmin's SafeTaxi®, provide the flight crew with a detailed picture of the runway and taxiway environment while on the ground to prevent runway incursions. When visibility is poor, it is difficult to remain oriented when taxiing. SafeTaxi®'s moving map display makes it easy.

In General Aviation aircraft, GPS is also used in conjunction with low cost inertial sensors to provide reliable, inexpensive, and lightweight attitude and heading systems. These devices replace spinning-mass gyroscopic instruments that have notoriously poor reliability and that otherwise would provide a pilot's primary means for determining attitude and heading during instrument flight.

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2 Aircraft Owners and Pilots Association Air Safety Institute, *2010 Nall Report: The Joseph T. Nall Report of Accident Trends and Factors*, at 24, 26, http://www.aopa.org/asf/publications/nall.html.

Finally, GPS is a crucial technology for airborne search and rescue operators. GPS allows search and rescue aircraft to fly precise, predetermined search patterns at any location, day or night, under all weather conditions. Accurate GPS position reports allow rescue personnel to quickly reach the correct location once the victim is found.

GARMIN.

March 8, 2012

The Honorable Eddie Bernice Johnson
2468 Rayburn Building
Washington, DC 20515-4330

Dear Congresswoman Johnson:

Thank you for providing Garmin with the opportunity to answer your questions regarding my recent testimony before the House Transportation and Infrastructure Subcommittee on Aviation. Garmin very much appreciates the attention that you and the other members of the Committee have given to the very important issue of ensuring Global Positioning System ("GPS") service remains available to the hundreds of millions of Americans who rely on GPS on a daily basis.

Question 1(a): Was the interference protection to GPS that the FCC provided at the request of both NTIA and the GPS community in fact inadequate?

To date, the FCC has not allowed LightSquared to proceed with deploying its proposed nationwide terrestrial broadband network. As you are probably aware, on February 15, 2012, the FCC stated that LightSquared has not successfully demonstrated that the GPS interference problem is resolved and accordingly proposed to vacate its January 26, 2011 waiver of the "integrated service rule" and revoke LightSquared's Ancillary Terrestrial Component ("ATC") authority. These conclusions were based on the extensive independent testing that definitively demonstrated that LightSquared's proposed network would cause widespread interference to GPS.

Garmin is concerned about what it perceives as misconceptions in your letter concerning the nature of LightSquared's ATC authority. The January 2011 decision by the FCC to waive the "integrated service rule" for LightSquared's ATC operations was much more than a decision addressing the types of handsets that LightSquared could sell. This waiver removed a key restriction that would have ensured that LightSquared's ATC service would, in fact, have remained ancillary to primary satellite services. Put simply, it meant that LightSquared could deploy a stand-alone terrestrial network that would have interfered with the reception of its own and others' satellite services.

Prior to the waiver, LightSquared's authority to operate terrestrially was limited to secondary "in-fill" transmitters that augmented the satellite network in areas where satellite reception was poor. These same restrictions also protected the reception of GPS signals, which operate at power levels similar to those broadcast from LightSquared's satellites.

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The January 2011 waiver effectively repurposed LightSquared's spectrum so that the previously ancillary terrestrial service would become the primary service. Under LightSquared's proposed deployment plan, its satellite service would have been jammed everywhere its terrestrial service was available. GPS would also have been jammed, as has been demonstrated multiple times by independent tests over the past year. This drastic change to spectrum allocation was accomplished without a formal notice-and-comment rulemaking process, and it was done despite the serious concerns of both the Departments of Defense and Transportation and the GPS community. Garmin itself conducted tests that were submitted to the FCC by the US GPS Industry Council on January 20, 2012, prior to the waiver grant; these tests showed the potential for widespread GPS interference.

Rather than delay or reject LightSquared's waiver request, the FCC went ahead and granted it on the condition that commercial operation of LightSquared's proposed terrestrial network not begin until it was shown that it would not cause interference to GPS. The FCC further required that LightSquared work with the GPS community to determine the impact on GPS. The FCC provided roughly a five-month schedule for accomplishing the first round of testing. This initial round showed extensive interference to all classes of GPS receivers and prompted LightSquared to contemplate changes to its deployment plan.

In order to evaluate LightSquared's revised proposal, another round of government-run testing was conducted last fall. This second round produced a similar result - extensive interference to GPS from LightSquared's network. Both rounds of tests were expensive and very disruptive to those involved. This pain could have been avoided altogether had the FCC not rushed to grant LightSquared's waiver in the first place. I stand by my summary of the situation as "Grant first, test later."

Question 1(b): Given the potential impact on aviation, why did Garmin wait this long to raise its current concerns?

Garmin did not perceive a problem until LightSquared requested a waiver of the "integrated service rule" that protected GPS signal reception by ensuring that LightSquared's ATC service would not interfere with the primary satellite service. Faced with the prospect of a widely deployed, high powered terrestrial network in the adjacent spectrum, Garmin acted quickly and began to conduct its own tests, which, as noted above, were submitted to the FCC. Prior to LightSquared's request for a waiver, Garmin believed that GPS reception would be protected by any parties offering service in compliance with the "integrated service rule".

Question 1(c): Did Garmin take the base station operations permitted by the 2005 FCC decision into account in designing its GPS receivers over the past seven years? If not, why not?

Garmin develops its certified aviation receivers to comply with the Federal Aviation Administration's performance standards for interference rejection, which are specified in RTCA/DO-229 and are consistent with International Civil Aviation Organization and International Telecommunications Union standards.

As I have indicated in my preceding answers, the FCC's "integrated service rule" prevents ATC licensees from operating their terrestrial networks in a way that would interfere with primary satellite services. This restriction also protects GPS. The "integrated service rule" was in place when the FCC updated its ATC rules in 2005. Garmin has developed its receivers with the understanding that ATC operators in the adjacent spectrum would not jam their own satellite service. This understanding was consistent with FCC rules until LightSquared was granted a waiver of the "integrated service rule" in January 2011.

Question 2(a): Do you agree with the conclusion of the June RTCA report cited by Deputy Secretary Porcari that the RTCA, in its 2006 review of the radiofrequency environment for GPS, overlooked the potential [for] aviation receivers to overload in the vicinity of FCC authorized operations in the adjacent band?

It is true that RTCA/DO-235B does not evaluate the potential for GPS receiver overload with respect to MSS/ATC operations. The analysis in that document is focused primarily on the effects of out-of-band emissions from ATC base stations that would fall within the GPS L1 band. Given that the protections afforded by the ATC integrated service rule were in place when RTCA conducted its review of the radiofrequency environment for GPS, this was not an oversight on the part of RTCA.

Question 2(b): Does Garmin participate in those RTCA activities?

Garmin regularly participates in a variety of RTCA activities, and its representatives were a part of Special Committee 159 when the RTCA/DO-235B report on radio frequency interference was published. However, Garmin was not actively involved in the working group that produced that document and was not involved in SC-159's assessment of MSS/ATC operations. While Garmin was not actively involved, GPS interests were represented.

Question 2(c): How do you explain the failure of the RTCA and Garmin to account for those FCC decisions?

The FCC decisions that you have referenced consistently maintain that terrestrial operations in the MSS band must be secondary to primary satellite services. At no point has LightSquared been authorized to provide a terrestrial service that interferes with GPS. Section 25.255 of the FCC rules includes the following unambiguous requirement:

> [I]f harmful interference is caused to other services by ancillary MSS ATC operations, either from ATC base stations or mobile terminals, the MSS ATC operator must resolve any such

> interference. If the MSS ATC operator claims to have resolved the interference and other operators claim that interference has not been resolved, then the parties to the dispute may petition the Commission for a resolution of their claims.

The only party that has failed to account for the FCC decisions regarding ATC is LightSquared. It has proposed to deploy a terrestrial broadband network that has repeatedly been demonstrated to interfere with GPS and consequently violate FCC rules.

Thank you again for providing me the opportunity to answer your questions.

Very truly yours,

John M. Foley

Hearing of the Subcommittee on Aviation
Transportation and Infrastructure Committee
U.S. House of Representatives

"A Review of Issues Associated with Improving our Nation's Aviation Satellite-based Global Positioning System Infrastructure"

Wednesday, February 8, 2012 - 11:00 AM – RHOB 2167

Testimony of Dr. Scott Pace, Director, Space Policy Institute, Elliott School of International Affairs, The George Washington University

Thank you, Mr. Chairman, and thanks to this Committee, for providing an opportunity to discuss this important topic. The subject of today's hearing is a complex one that involves not just aviation infrastructure, but national security, public safety, foreign policy, and the health of economic sectors from agriculture to information technology.

The United States launched the first atomic clocks into space in 1974 on board a Navigation Technology Satellite. The first NAVSTAR satellites that would become the GPS constellation were launched in 1978. In 1983, after the Soviet downing of a civilian Korean airliner, President Reagan offered the use of GPS to the international aviation community free of charge as it became operational. In 1991, GPS came to wider public attention as a result of its extensive and successful use in Operation Desert Storm. GPS has been in development and use for decades, but realization of its significance continues to evolve as new applications continue to be found for precision timing, positioning, and navigation.

I have been involved with GPS issues for over twenty years, beginning with work at the U.S. Department of Commerce around the time of the first Gulf War. While at the RAND Corporation, I supported the Office of Science and Technology Policy during the creation of the first Presidential Decision Directive on GPS in 1996. I have also been involved in domestic and international conflicts over radio frequency spectrum used by GPS for almost as long, including negotiations at the International Telecommunications Union and proceedings before the Federal Communications Commission. I am currently the Director of the Space Policy Institute at George Washington University and am speaking today purely in a personal capacity. My comments do not necessarily represent the views of any agency, organization or company.

Other witnesses have ably described the importance of GPS signals to the transportation needs of their agencies and organizations. These users tend to be very demanding, seeking the most precision, integrity, and accuracy possible. This in turn requires taking in the most information possible not only from GPS signals but also using accuracy augmentation signals that are carried on nearby Mobile Satellite Service (MSS) systems. In the future, it is likely that other Global Navigation Satellite Systems (GNSS) such as the European Galileo system will also be used in conjunction with GPS.

In addition to Federal agencies and industry, state and local governments use high precision GPS for mapping, surveying, and infrastructure maintenance. High precision data is used in Geographic Information Systems (GIS) for asset management, emergency preparedness, disaster response and E911 mapping, public sector water, wastewater and electric utilities, public works, environmental management, dam and structure monitoring, environmental health, insurance rating districts, flood zones, tax appraisals, the provision of geodetic control networks, and a host of other functions.

GPS Operations Require Secure Spectrum

The most commonly used GPS signal, L1, is located in the spectrum band 1559-1610 MHz. This band is specifically "zoned" internationally for Radionavigation Satellite Service (RNSS) systems like GPS, the Russian GLONASS system, and the European Galileo system. On either side of the band, are MSS bands at 1525-1559 MHz, below GPS, and at 1610-1660.5 MHz, above GPS. The key point is that the entire "neighborhood" is oriented to satellite services and such services require "quiet" spectrum as the powers of signals transmitted from space are many orders of magnitude weaker than those transmitted by typical terrestrial stations. Major power differences exist between satellite services as well. The power of an MSS signal is much greater than that of a signal coming from a GPS satellite. Thus MSS and GPS signals operate in adjacent bands where their functions are compatible with each other but they do not operate in the same band since MSS signals would easily drown out the GPS signal.

The bandwidth of the highest precision GPS receivers are designed to receive not only the full range of RNSS signals, including GPS, but also MSS signals in the adjacent band that carry wide-area differential GPS corrections from commercial providers such as Starfire using commercial MSS systems such as Inmarsat. Thus, when talking about receiver bandwidths, it is not enough to receive just the GPS signal, but all the services used for precision positioning, navigation, and timing. The evolution of high precision capabilities has been possible because of carefully considered past spectrum management decisions to use this particular neighborhood for satellite services, not terrestrial ones.

There have been and continue to be many policy and legal risks for GPS, from funding constraints and the transition to modernized signals to international trade barriers and domestic regulations. The most serious threats, however, may not be to GPS itself but to the spectrum environment upon which it depends. Over the past two decades, there have been a number of serious threats to this spectrum. Some of these threats were international and some were domestic, but all involved attempts to undermine or change the protections that had enabled the successful development and evolution of GPS applications. To date, all such threats have been removed or mitigated through strong government-industry cooperation and bipartisan support from multiple Congresses and Administrations.

Sometimes called the "three ways to die" chart, Figure 1 below shows the many ways that the spectrum in which GPS is located can be harmed. The RNSS band is also used for aeronautical radio navigation services (ARNS) that are considered a compatible use.

If incompatible services are allowed to "share" the band, then systems in the RNSS band subject to overlay can be harmed. If the band is "segmented" to allow for a new, incompatible service to have its own band, then this can limit the evolution of RNSS services, such as the addition of new signals to existing systems, the placement of augmentation signals, or the creation of new systems by other countries. If radio energy from services in adjacent bands is allowed to spill over into the RNSS band, these "out of band emissions" (OOBE) can interfere with existing signals such as those from GPS or GLONASS. If even very low power emissions are allowed to flood across the restricted RNSS band, these can raise what is called the "noise floor" in the band. Like trying to hear a single conversation in a crowded room, increases to the noise floor make hearing the low-power GPS signal increasingly difficult.

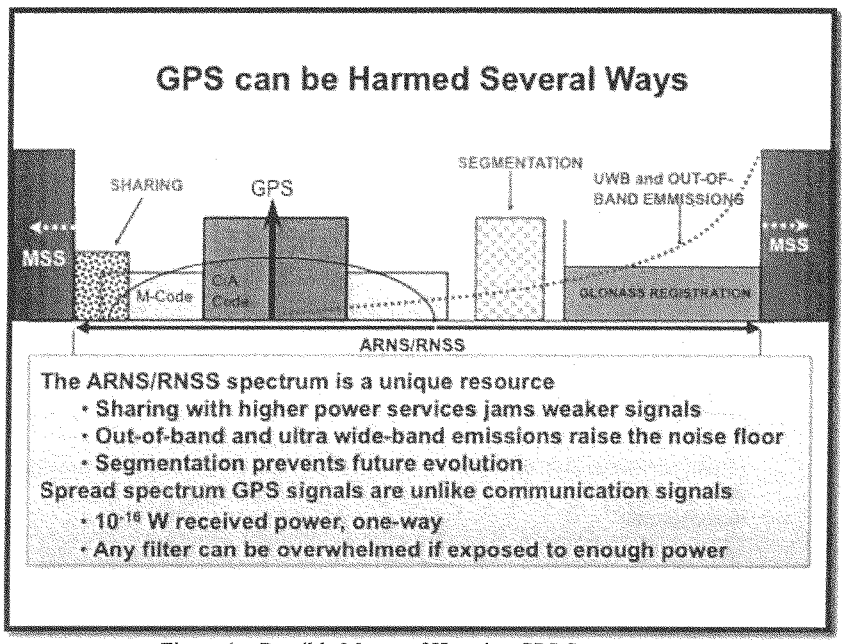

Figure 1 – Possible Means of Harming GPS Spectrum

A fourth way to harm the spectrum would be if the adjacent bands were reallocated from MSS to an incompatible service, such as high-powered, terrestrial mobile services. Even if the out-of-band emissions are kept under tolerable limits, the high energy created in adjacent band can "deafen" the sensitive receivers designed to pick up the low power GPS signals. Filters can reduce the interference, but they can also degrade the performance of the GPS receiver. As with the analogy of trying to pick up a single, soft conversation in a noisy room, wearing ear plugs blocks the noise but also your own ability to hear accurately.

This last point is sometimes hard to understand, even for communications engineers, as GPS is not a communications service. It is not "telling" a receiver what its location is but is using ranging information between the receiver and multiple GPS satellites in view. Location information is derived from measuring the arrival times of transitions in the code message that is modulated onto the GPS carrier frequency and the arrival times of the carrier waves. That is, GPS receivers need to measure the precise times and positions of a known coded sequence. Filtering blurs the ability to measure accurately.

In one of the many filings to the FCC on the LightSquared proceeding, Mr. Glenn Borkenhagen of Cody, Wyoming offered this description that I cannot improve on:

> "Synchronized atomic clocks on each of the satellites tell us when the signals leave the satellites, and when the GPS receiver is tracing four or more satellites the receiver can measure with atomic-clock accuracy when the clean signals arrive at the receiver's antenna. To oversimplify a bit, the important factor about a clean code-message signal is that it has a good sharp and square edge when the digital signal modulated onto the carrier frequency changes from a digital 0 to a digital 1 or vice-versa. We know the signal traveled at the speed of light from the satellite to the receiver's antenna and when we know how long it took to make the trip we know how far the receiver's antenna is from each satellite and can determine the position of the receiver's antenna.
>
> Accurate edge/transition-time detection is necessary to determine when the signals arrive at the receiver's antenna. When heavy filtering is applied to remove strong near-band interference, the signal edge transitions get rounded, blurred, and even time-displaced so determining an accurate arrival time becomes much more difficult if not impossible. It is easy in comparison to filter simple 0s and 1s to transmit a video file, for example – much more difficult to filter code and carrier without destroying the essential ranging information. GPS is essentially determining position using a "measuring stick" that is moving at 3 x 10**8 meter/second."[1]

All receivers take in energy from adjacent bands to varying degrees and any filter can eventually be overpowered. The power of MSS signals adjacent to (but not on top of) the RNSS band is not a problem. GPS receivers can and do filter unwanted MSS signals without harm to their performance. The power of a dense, terrestrial broadband network adjacent to the RNSS band is a problem, even if the OOBE limits are the same. One cannot imagine a more incompatible pairing than placing a high-powered terrestrial communications service next to a low-power, space-based navigation service. This is why such a pairing has not been done to date in the United States or internationally.

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[1] Glenn Borkenhagen, Letter to the Federal Communications Commission, IB Docket 11-109, 30 July 2011.

Proper placement of compatible services in the radiofrequency spectrum is in fact the essence of responsible spectrum planning and management.

Historical Spectrum Conflicts

Threats to GPS spectrum have come from both international and domestic sources. In 1997, Europe attempted to allow sharing 4 MHz of the RNSS band with MSS to support a mobile satellite service proposal by Inmarsat. The proposal was deferred for study at the 1997 World Radiocommunications Conference (WRC). Subsequent studies showed the idea was infeasible and the proposal was rejected at the 2000 WRC.

In 2000, the FCC released a Notice of Proposed Rule-Making on allowing "ultra wideband" or UWB devices to operate as Part 15 unlicensed devices across 1-6 GHz, included the restricted aviation and RNSS bands. Subsequent testing resulted in a 2002 rule that restricted UWB communications to above 3.1 GHz and excluded the RNSS band with specific protection criteria to protect the noise floor in that band.

Later in 2002, there was a proposal by an MSS operator to create an "ancillary terrestrial component" or ATC within the MSS band. This led to technical negotiations with the U.S. GPS industry and an agreement that was adopted by the FCC. This agreement was premised on the MSS band remaining a relatively quiet satellite band, limited the out of band emissions into the adjacent RNSS band, assured non-interference between the ATC and MSS signals of other MSS service providers, and was conditioned on the retention of an integrated satellite service. In 2010, LightSquared petitioned the FCC to waive the "satellite gating" requirement and permit stand-alone terrestrial services. The FCC conditionally granted that request in January 2011, and that decision led to the controversy of the past year.

Sharing, segmentation, out-of-band emissions, noise floor increases, and reallocation of adjacent bands have all been attempted over the past fifteen years. The pressure has primarily come from commercial interests both within the United States and abroad. These examples represent an on-going conflict over the many public and private sector interests contending for the same spectrum where GPS has operated since 1978.

Presidential Policies

To date, four Presidents, two Republican and two Democratic, have issued policy statements regarding GPS. These statements have recognized the dual-use nature of GPS as more than a military system and crucial to a broad range of U.S. interests. In 1983, the White House announced "President (Reagan) has determined that the United States is prepared to make available to civilian aircraft the facilities of its Global Positioning System when it becomes operational in 1988."[2] This opened up GPS to be accepted for international civil aviation.

[2] The White House, "Statement by the Principal Deputy Press Secretary to the President," Office of the Press Secretary, September 16, 1983.

In 1996, President Clinton issued the first comprehensive presidential policy on GPS.[3] In particular, he stated that: "We will continue to provide the GPS Standard Positioning Service for peaceful civil, commercial and scientific use on a continuous, worldwide basis, free of direct user fees...We will cooperate with other governments and international organizations to ensure an appropriate balance between the requirements of international civil, commercial and scientific users and international security interests...(and) We will advocate the acceptance of GPS and U.S. Government augmentations as standards for international use." These commitments accelerated the acceptance of GPS not only for international aviation use but also for many other applications.

In 2004, President Bush updated the 1996 GPS policy to a broader one dealing with "positioning, navigation, and timing" or PNT generally. The 1996 policy did not specifically mention spectrum protection, and the international conflicts at the International Telecommunications Union led to an explicit statement in the 2004 policy that "the Secretary of Commerce shall:

- In coordination with the Secretaries of State, Defense, and Transportation and the National Aeronautics and Space Administration, seek to protect the radio frequency spectrum used by the Global Positioning System and its augmentations through appropriate domestic and international spectrum management and regulatory practices;
- In coordination with the Secretaries of Defense and Transportation, and the Administrator of the National Aeronautics and Space Administration, facilitate cooperation between the United States Government and U.S. industry as appropriate to identify mutually acceptable solutions that will preserve existing and evolving uses of space-based positioning, navigation, and timing services, while allowing for the development of other technologies and services that depend on use of the radio frequency spectrum;"

This direction is made more significant by the fact that the agency responsible for federal spectrum use, the National Telecommunications and Information Agency (NTIA), reports to the Secretary of Commerce.

In 2010, President Obama released a National Space Policy that continued the major themes for GPS established by Presidents Clinton and Bush. The policy referred to GPS as a form of space-based positioning, navigation, and timing and the President said, "The United States must maintain its leadership in the service, provision, and use of global navigation satellite systems." More specifically, this required the "Protection of radionavigation spectrum from disruption and interference."[4]

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[3] The White House, "U.S. Global Positioning System Policy," Office of Science and Technology Policy, National Security Council, March 29, 1996.

[4] The White House, "National Space Policy," Office of the Press Secretary, June 28, 2010.

Competition for spectrum had become more intense, not only around GPS, but for all U.S. government space systems. To address this issue, the current National Space Policy has an explicit section on "Radiofrequency Spectrum and Interference Protection" in which "the U.S Government shall:

- Seek to protect U.S. global access to, and operation in, the radiofrequency spectrum and related orbital assignments required to support the use of space by the United States Government, its allies, and U.S. commercial users;...
- Seek to ensure the necessary national and international regulatory frameworks will remain in place over the lifetime of the system;
- Identify impacts to government space systems prior to reallocating spectrum for commercial, federal, or shared use;
- Enhance capabilities and techniques, in cooperation with civil, commercial, and foreign partners, to identify, locate, and attribute sources of radio frequency interference, and take necessary measures to sustain the radiofrequency environment in which critical U.S. space systems operate;"

These statements made clear that impacts to government space systems needed to be understood prior to any reallocation decisions and that U.S. requirements for space spectrum needed to consider technical and regulatory aspects on a global basis. These are the same considerations that can and should be applied to an aviation infrastructure that is increasingly reliant on GPS.

On the same day as the National Space Policy release, the Obama Administration also released an executive memorandum aimed at expanding spectrum for wireless broadband use. The Memorandum from the President called for collaboration between the FCC and the NTIA to "make available a total of 500 MHz of Federal and nonfederal spectrum over the next 10 years, suitable for both mobile and fixed wireless broadband use." However, the Memorandum cautioned that agencies were to "take into account the need to ensure no loss of critical existing and planned Federal, State, local, and tribal government capabilities...."[5] While not including an explicit mention of GPS, one can certainly read into this statement an intent to understand the impact to government systems prior to making any changes. It would be an understatement to say that GPS is a critical existing capability.

Legislation

Congress has passed numerous bills related to the protection of GPS and its contributions. As of today, federal statutes related to GPS can be found in two areas, Title 10 (Armed Forces) and Title 51 (National and Commercial Space Programs). In addition, the Nationwide Differential GPS (NDGPS) augmentation system is addressed in Title 49 (Transportation).[6] Rather than address all of these provisions, I would like to draw

[5] The White House, "Unleashing the Wireless Broadband Revolution," Office of the Press Secretary, June 28, 2010.

[6] The web site, http://www.gps.gov has a convenient summary of GPS provisions in the U.S. Code.

attention to the ones that are most relevant to protecting GPS for civil applications like air transportation.

10 U.S.C. § 2281 "Global Positioning System" was created by Section 1074 of the National Defense Authorization Act for Fiscal Year 1998. It assigns the Secretary of Defense statutory authority to sustain and operate GPS for military and civil purposes; and directs the Secretary of Defense to: provide civil GPS service on a continuous, worldwide basis, free of direct user fees; coordinate with the Secretary of Transportation on GPS requirements and GPS augmentation systems, and coordinate with the Secretary of Commerce and others to facilitate civil and commercial GPS uses. Finally, the statute directs the Secretary of Defense to develop measures for preventing hostile use of GPS in a particular area without hindering peaceful civil use of the system elsewhere.

51 U.S.C. § 50112 "Promotion of United States Global Positioning System standards" incorporates Section 104 of the Commercial Space Act of 1998. It encourages the continuous, worldwide operation of GPS free of direct user fees, international promotion of GPS as an international standard, and protection of the radio spectrum used by GPS. The statute goes on to say: "In order to support and sustain the Global Positioning System in a manner that will most effectively contribute to the national security, public safety, scientific, and economic interests of the United States, Congress encourages the President to:

(1) Ensure the operation of the Global Positioning System on a continuous worldwide basis free of direct user fees;

(2) Enter into international agreements that promote cooperation with foreign governments and international organizations to
(A) Establish the Global Positioning System and its augmentations as an acceptable international standard; and
(B) Eliminate any foreign barriers to applications of the Global Positioning System worldwide; and

(3) Provide clear direction and adequate resources to the Assistant Secretary of Commerce for Communications and Information so that on an international basis the Assistant Secretary can
(A) Achieve and sustain efficient management of the electromagnetic spectrum used by the Global Positioning System; and
(B) Protect that spectrum from disruption and interference."

Legislation for GPS protection tends to be general and not directed toward specific issues, but the LightSquared controversy has been an exception. The recently signed Consolidated Appropriations Act for fiscal year 2012 included funded for the FCC. Section 628 of Division C bars the FCC from using these funds to remove the conditions of the LightSquared's January 2011 authorization, or to otherwise permit commercial LightSquared operations, until the FCC has resolved GPS interference concerns.

International Agreements

Consistent with Presidential policy and Congressional legislation, the United States has entered into a number of international cooperative agreements, most notably being the ones with Japan and Europe. The 1998 US-Japan Joint Statement with respect to the Global Positioning System was the first international agreement made after the 1996 GPS Policy of President Clinton. In the joint statement, the United States and Japan agreed to:

- Promote compatibility of operating standards for GPS technologies, equipment, and services;
- Help develop effective approaches toward providing adequate radio frequency allocations for GPS and other radionavigation systems;
- Identify potential barriers to the growth of commercial applications of GPS and appropriate preventative measures;
- Encourage trade and investment in GPS equipment and services as a means of enhancing the information infrastructure of the Asia-Pacific region; and
- Facilitate exchange of information on GPS-related matters of interest to both countries, such as enhancement of global positioning, navigation, and timing technologies and capabilities.[7]

As with domestic legislation, a central purpose of this joint statement is to promote the use of GPS and protect the radio frequency spectrum that GPS and its users rely on. As GPS modernizes, the statement is intended to promote the exchange of information so as to retain the trust of Japanese users in GPS, and by extension other users in the Asia-Pacific region.

The 2004 Agreement between the United States and the member states of the European Community was a more complex one as Europe was planning to build its own independent GNSS system, Galileo. The "Agreement on the Promotion, Provision and Use of Galileo and GPS Satellite-based Navigation Systems and Related Applications" contained many articles on how the United States and Europe would ensure GPS and Galileo would not interfere with each other ("compatibility") while striving for the ability to use each other's satellites seamlessly ("interoperability"). Both parties recognized that they had a common interest in spectrum protection and Article 11 states:

> "The Parties shall work together to promote adequate frequency allocations for satellite-based navigation and timing signals, to ensure radio frequency compatibility in spectrum use between each other's signals, to make all practicable efforts to protect each other's signals from interference by the radio frequency emissions of other systems, and to promote harmonised use of spectrum on a global basis, notably at the ITU. The Parties shall cooperate with

[7] The White House, "Joint Statement by the Government of the United States of America and the Government of Japan on Cooperation in the Use of the Global Positioning System," Office of the Press Secretary (New York, New York), September 22, 1998.

> respect to identifying sources of interference and taking appropriate follow-on actions."[8]

Thus even in a situation where their satellite-based navigation systems were potentially in competition, the United States and Europe found common ground in protecting the spectrum both relied upon and in finding and removing potential sources of interference. This was done with caveats with regard to other potential uses of the spectrum but with recognition of the singular importance of GPS and GPS-like capabilities to their respective national interests.

Risks to GPS in Global Infrastructure

GPS applications are more pervasive and well known today compared to when it first emerged to public awareness during the first Gulf War. GPS devices gone from being separate pieces of equipment to being embedded chips in mobile phones and all manner of platforms and information networks. Several countries are seeking to build their own versions of GPS, leading to greater international agreement to protect the international radio spectrum upon which the systems all depend. In addition to regulatory protection of existing allocations, there is increasing interest in detecting and suppressing sources of accidental or intentional interference to GPS from commercial devices – such as small illegal jammers that can be purchased from overseas manufactures.

Areas of regulatory risk to GPS today come primarily from commercial pressures to use L-band spectrum in and around GPS for non-compatible purposes. The forms of incompatibility can be quite varied as described earlier, but the overall effect results in limiting the ability to use GPS signals for some applications. Regulations to date have been successful in preserving the "noise floor" in the GPS band and in maintaining a compatible "neighborhood" in the adjacent bands, but threats to change this situation have been continual over the past 15 years and can be expected to continue. Protecting the spectrum environment for GPS is key to retaining the national strategic advantage the United States has enjoyed to date. Failure to do so would be rapidly noticed worldwide as like it or not, U.S. actions with respect to GPS are closely and continually observed.

Given the strong policy interest in broadband spectrum, it is important to understand that there is as yet no viable or verifiable technological solution that would allow a ground-based broadband communications network to operate in close proximity to GPS signals. This is in part why the band has, for decades, been internationally allocated for space services. Even if some new, as yet unforeseen, technology did appear, the industrial, commercial, and public sector users of GPS equipment routinely take up to 15 years to complete a normal replacement cycle. Equipment installed on aircraft, vessels, agricultural, construction and mining machinery, commercial vehicles, or high cost professional instruments used today are not thrown away after a few years of use; their lifetimes are measured in decades.

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[8] The White House, "Fact Sheet: U.S.-EU Summit: Agreement on GPS-Galileo Cooperation," Office of the Press Secretary, June 26, 2004.

At the same time, there is a desire to provide a more predictable environment for making regulatory decisions about new spectrum uses that may potentially impact GPS. In a January letter to the NTIA regarding LightSquared interference testing, the Deputy Secretaries of Defense and Transportation said:

> "We propose to draft new GPS Spectrum interference standards that will help inform future proposals for non-space, commercial uses in the bands adjacent to the GPS signals and ensure that any such proposals are implemented without affecting existing and evolving uses of space-based PNT services vital to economic, public safety, scientific, and national security needs." [9]

While a reasonable sounding statement, I would have preferred to avoid the word "standards" and talk instead about GPS spectrum protection criteria. The latter is more likely to be useful in practice. However, it is notable that the National PNT Executive Committee is willing to take on this task. In doing so, I would urge that they use the proven successful model of relying on the National PNT Engineering Forum (NPEF) and an extensive, open consultation with industry. This effort should proceed carefully and cautiously, however, to ensure protection of "existing and evolving uses" of GPS as no one agency has complete knowledge of the field. The NPEF should be careful to avoid creating "standards" that would stifle innovation in GPS applications as that would only benefit foreign systems and shift resources and expertise overseas.

The primary risk in this effort is that there will be proposals impose regulatory standards limiting the capabilities or protections afforded to GPS receivers. In general, FCC regulations place limits on radio emissions, not radio reception. There are plenty of industry standards for electronic equipment, international radio regulations for RNSS operation, and specialized performance standards exist for national security and public safety purposes (e.g., aviation). It is difficult to imagine any justification for imposing receiver design or performance standards on commercial GPS receivers as the open market already provides its own discipline on manufactures.

To be fair, the January letter to NTIA does not call for receiver standards, but that is a risk to watch out for. It is a risk because such standards can provide a "safe haven" from competitive forces. Military and aviation receivers that are built to strict, justifiable standards do not show the same rate of innovation as commercial receivers built for the survey, construction, and agricultural markets. Receiver standards can also be a subtle regulatory means of sacrificing some categories of users and their applications. For example, there could be a standard that says that high precision scientific receivers will not be afforded the same protection as a GPS receiver in a mobile phone. Receiver standards can thus be a form of industrial policy that enables regulators to pick "winners and losers" in rapidly, evolving markets. On the other hand, transparent protection for

[9] National Executive Committee for Space-based Positioning, Navigation, and Time, Letter to Larry Strickling, Assistant Secretary for Communications and Information, NTIA, January 13, 2012.

the GPS spectrum environment can provide better predictability for new entrants while not constraining GPS applications.

Given the high stakes involved in preventing risks to GPS, it is tempting to look for a special "policy fence" that would automatically prevent problems from arising. The key problem with this idea is not the "fence" but the "policy" aspect. Should the FCC treat RNSS allocations and systems like GPS as a special case? If so, what would be the legal basis? Should the FCC be required to treat aviation performance standards for GPS as inviolate in their proceedings? Should the National Coordination Office or the co-chairs for the PNT Executive Committee be given a veto over any service that impacts the GPS bands? How would this be different from the authorities already held by the Administration in dealing with an independent regulatory commission like the FCC? What should we do internationally at the ITU? Should the boundary lines for RNSS be moved and some existing MSS allocations transferred to being exclusively RNSS/ARNS?

Given the FCC is an independent regulatory commission that does not report to the President, any special policy fence for GPS will require Congressional action in a very complex area. The spectrum threats in recent years from receiver overload and increases to the noise floor arose in the context of the regulatory rights and responsibilities of users in adjacent spectrum bands. This is one of the most difficult areas of spectrum regulation, both domestically and internationally. For example, there was an issue of adjacent band interference between Iridium and Inmarsat at the ITU that involved over ten years of technical study. The regulatory experts studying the issue in the ITU were unable to agree on a solution, determined that the matter could not be resolved, and further study was halted as a result. The central problem is that regulatory rights in terms of interference protection (e.g., Primary versus Secondary services) are only defined for services operating in the same band, with only a few exceptions such as the protection of passive services and radio astronomy. Attempting to define rights and responsibilities for services operating in adjacent bands would be an enormously complicated endeavor that would set precedents affecting all users of the radio spectrum. As a result, spectrum regulatory agencies worldwide try to avoid such questions.

Non-spectrum Risks

My testimony has focused on the domestic and international spectrum risks to GPS, as those tend to occur outside the direct control of the GPS program or the Administration. However, it is important to remember there is the potential for major "self-inflicted wounds" in the funding and modernization of the GPS constellation. In today's increasingly tough fiscal environment, it may be tempting to slow or cancel the acquisition of GPS III satellites and hope to rely on foreign systems to fill the gaps. This is very dangerous given our nation's reliance on GPS and the lack of demonstrated operational reliability of foreign systems. It is also dangerous as it reduces U.S. influence in international discussions of performance standards, spectrum allocations, and trade barriers as well as reducing confidence in U.S. national security space capabilities. A reduction in international confidence in GPS would inevitably impact international acceptance of satellite-based air traffic management improvements desired by the United States.

A second area of non-spectrum risk would be in any disruptions of service to the existing global installed base of user through modernization. The Air Force is undertaking complex upgrades to the operational control segment (OCX) that manages the GPS constellation. These upgrades are necessary to enable use of modernized signals such as L5 and L1C that are of interest to aviation and civil users. There is and will continue to be a need to explicitly confirm that changes to GPS are backwards compatible with the installed base. If not, then there should be a transition plan that is developed with the relevant stakeholders in government, industry, and even non-government organizations (e.g., advisory committees, scientific societies). The GPS Directorate holds periodic public meetings to discuss updates to GPS interface control documents actively take input from non-government experts and industry. This is a very useful mechanism to ensure the government and commercial GPS manufactures are not surprised and thus crucial to maintaining user trust in GPS as more foreign systems become operational.

Conclusion

GPS is a critical global utility that is particularly important to the safe modernization of the international air transportation management system. Presidential policies supporting and protecting GPS as a dual-use system have been consistent for decades across multiple Administrations. Congressional legislation and existing statues have been similarly consistent and clear. Regulatory processes for rulemaking are well defined in the Administrative Procedures Act. The United States has sufficient law and policy on the books to protect GPS. What has been missing at times is a willingness to enforce those laws and procedures and follow the basics of good government.

Verifiable data should be on hand before making a change that can impact the national security, safety, commercial, or scientific uses of GPS. When characterizing interference, it is important to use multiple approaches. Paper and pencil calculations of potential interference should be compared with testing in controlled environments (e.g., anechoic chambers), and finally with realistic operational scenarios for specific applications. Measurements of "live sky" field tests should be done on qualified test ranges, either government-controlled or independent. These steps reflect current best practices for interference studies when national security or public safety applications are at risk – no one approach is to be trusted but all are used to see if consistent results are achieved.

It is sometimes argued that accommodations by legacy systems need to be made to enable new uses of spectrum and that doing so enables more efficient use of a scarce, natural resource. When it comes to spectrum efficiency, GPS is arguably the most efficient use of spectrum the world has ever seen; almost a billion people are currently benefitting from the 20 MHz GPS signal that is available today. In fact, the entire global population could use GPS without *any* additional spectrum being used. This use represents a massive installed base and source of advantage for the United States, of which international scientific cooperation is but one part. Most importantly, it represents a high degree of trust and confidence in the United States and its stewardship of GPS.

The spectrum neighborhood in which GPS resides consists of compatible services today. That neighborhood should be preserved. As GPS modernization proceeds, the U.S. government should be in consistent, open communication with its agencies, industry stakeholders, international partners, and GPS users to ensure the installed base suffers no disruptions as new GPS capabilities come on line. For the aviation community, it is not an overstatement to say that eternal vigilance is the price of safety.

Thank you for your attention. I would be happy to answer any questions you might have.

Scott Pace

Dr. Scott Pace is the Director of the Space Policy Institute and a Professor of Practice in International Affairs at George Washington University's Elliott School of International Affairs. His research interests include civil, commercial, and national security space policy, and the management of technical innovation. From 2005-2008, he served as the Associate Administrator for Program Analysis and Evaluation at NASA.

Prior to NASA, Dr. Pace was the Assistant Director for Space and Aeronautics in the White House Office of Science and Technology Policy (OSTP). From 1993-2000, Dr. Pace worked for the RAND Corporation's Science and Technology Policy Institute (STPI). From 1990 to 1993, Dr. Pace served as the Deputy Director and Acting Director of the Office of Space Commerce, in the Office of the Deputy Secretary of the Department of Commerce. He received a Bachelor of Science degree in Physics from Harvey Mudd College in 1980; Masters degrees in Aeronautics & Astronautics and Technology & Policy from the Massachusetts Institute of Technology in 1982; and a Doctorate in Policy Analysis from the RAND Graduate School in 1989.

Dr. Pace received the NASA Outstanding Leadership Medal in 2008, the U.S. Department of State's Group Superior Honor Award, *GPS Interagency Team*, in 2005, and the NASA Group Achievement Award, *Columbia Accident Rapid Reaction Team*, in 2004. He has been a member of the U.S. Delegation to the World Radiocommunication Conferences in 1997, 2000, 2003, and 2007. He was also a member of the U.S. Delegation to the Asia-Pacific Economic Cooperation Telecommunications Working Group, 1997-2000. He is a past member of the Earth Studies Committee, Space Studies Board, National Research Council and the Commercial Activities Subcommittee, NASA Advisory Council. Dr. Pace is a currently a member of the Board of Trustees, Universities Space Research Association, a Corresponding Member of the International Academy of Astronautics, and a member of the Board of Governors of the National Space Society.

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LightSquared

February 8, 2011

Honorable Thomas Petri
Chairman, Aviation Subcommittee
House Transportation & Infrastructure Committee
2251 Rayburn House Office Building
Washington, DC 20515

Re: **2/8/12 Hearing on Protecting GPS Reliability**

Dear Chairman Petri:

On February 8, 2012, your Subcommittee will hold a hearing on protecting GPS from interference. Although we were assured by staff that the hearing was not about LightSquared, the briefing memorandum for the hearing makes numerous references to LightSquared. We assume, then, that any commentary on protecting GPS from out-of-band interference – which we agree is an important issue – will also include the same mischaracterizations of the history of LightSquared and GPS as were inserted into the briefing memorandum. As LightSquared was not invited to the hearing to provide rebuttal, we instead provide the following comments, which are material to the Subcommittee's consideration of this issue.

Although LightSquared is compelled to correct the record of this proceeding, we also want to make clear that we are committed to working with the FCC, FAA, NTIA, DoD and other federal agencies to ensure that we can build our network while maintaining a fully robust GPS system.

We also want to make clear that in no way does LightSquared dispute the importance of GPS to the aviation industry or to safety-of-life services. LightSquared has taken significant steps to protect GPS by committing to operate in spectrum distant from it, at reduced power levels. On February 7, LightSquared requested that the FCC open a proceeding to develop standards that would make GPS receivers better able to handle licensed services in bands nearby to GPS, while protecting GPS capabilities.

The Briefing Memorandum Does Not Correctly Portray How the Interference Issue Arose
I have attached hereto responses to points raised in the briefing memorandum. Remarkably, despite the existence of hundreds of pages of test data showing that GPS receivers have been designed to receive frequencies licensed by LightSquared, the briefing memorandum appears to absolve GPS manufacturers from any responsibility whatsoever for their faulty designs. LightSquared has been authorized to use its frequencies for a terrestrial system since 2005, and has never been under any specific requirement to rely primarily on its satellite for routing traffic. Yet the briefing memorandum ignores this well-established history in repeating arguments that GPS manufacturers have made for the last year in a self-interested attempt to avoid any responsibility for creating the interference issue.

LightSquared Has Been Authorized to Build a Ground Network for Years

As I testified before the Transportation & Infrastructure Committee in 2011, FCC rules first allowed ground networks in LightSquared's band in 2003. LightSquared received specific authorization from the FCC to build a ground network in 2004, and was authorized to use ground transmissions of up to 1.6 kw in 2005. This is the maximum power level that LightSquared will use in its deployment today. At each stage of this process, the Department of Transportation (DoD) and Federal Aviation Administration (FAA) reviewed and approved the FCC actions through the Interdepartment Radio Advisory Committee (IRAC) process administered by NTIA.

Contrary to the assertions of the briefing memorandum, the waiver issued by the FCC in January, 2011 did not change the power of LightSquared's ground network or the number of base stations it was authorized to build. It only allowed LightSquared to add ground-only devices to a network that will *continue* to also feature integrated devices linking to both the satellite and ground networks. Indeed, LightSquared must observe specific regulatory conditions to continue to provide an integrated service. The January waiver thus did not impact the interference issue in any way whatsoever – LightSquared could have built exactly the same network in 2005 as it is building today. The overload issue would be the same whether LightSquared was deploying 1, 1,000, or 40,000 base stations. None of the testimony before the Subcommittee specifically explains how the waiver changed an already existent interference issue – one that the GPS manufacturers should have raised six years ago.

GPS manufacturers have, however, repeatedly argued that this issue was somehow created in January 2011. They have done so in order to distract policymakers from the fact that while they were aware of the fact that a ground network had been authorized in 2005 that could overload GPS receivers, they did nothing to change the design of those receivers or otherwise prepare for stronger signals in LightSquared's band. Indeed, it is reasonable to expect they will continue to blame everyone else for the consequences of their receiver design at today's hearing, and instead call for the costs of protecting GPS to be placed on everyone b ut the manufacturers of the devices.

GPS Can Best Be Protected Through a Combination of LightSquared's Commitments and Receiver Standards

As I have also testified, LightSquared has made a series of commitments to restrict its operations in order to protect GPS. When cooperative testing showed that we could not use the spectrum closest to GPS without requiring replacement of millions of devices, including aviation devices, we committed to operate in spectrum 23 MHz away from GPS, providing GPS with a guard band several times wider than any previous regulatory requirement. We also committed to operate at substantially reduced power in order to protect particularly sensitive devices. Finally, we committed to the DoT and FAA to operate our network in a way that would protect all of the technical parameters provided to us regarding navigation and terrain avoidance technology.

These commitments show LightSquared's good faith in making commitments to protect GPS, *notwithstanding the fact that the interference is caused by GPS devices designed to look into our spectrum.*

Going forward, however, LightSquared believes it is additionally crucial for the FCC to examine whether specific receiver reliability standards should be applied to GPS devices. I have attached hereto our filing made with the FCC on February 7 on this issue. The FCC's rules make clear that when unlicensed receivers look outside of their spectrum and into other bands, they are not entitled to protection. This principle works in most cases – receiver manufacturers will not normally want to take the risk that licensed services will interfere, and so will design their receivers in a responsible way. If they don't, they bear the risk. Unfortunately, this paradigm has broken down in the case of GPS. With 450 million receivers in the U.S. market, GPS manufacturers have instead argued for the last year that they are entitled to extra-legal protection that does not exist. Given this massive market failure, the FCC should take steps, well within its jurisdiction, to apply receiver reliability standards to GPS receivers and so ensure that they can be used safely in the future.

Notably, this is very similar to calls made within the GPS industry over a period of some years to improve the resilience of receivers. Indeed, as recently as November 2010 the PNT Advisory Board, which advises the U.S. government on questions of GPS policy and technology, stated:

> Government should foster and help to stimulate Manufacturers to speed up the development and offering of interference resistant GPS receivers, especially for safety-of-life applications such as commercial air and maritime.[1]

Our request to the FCC is in line with this reasonable policy – if GPS *users* are to be protected, then it is reasonable to hold GPS *manufacturers* to some reasonable minimum set of standards, particularly when their technology is used in aviation and similar safety-of-life environments.

Conclusion

While we applaud the Subcommittee's interest in looking in to how best to protect GPS users, we have a reasonable concern that the measures discussed by some of the witnesses at the hearing will actually focus on how to protect GPS manufacturers:

- Protect them from the consequences of their poor design choices
- Protect them from liability for looking at spectrum they are not supposed to use and

[1] http://www.pnt.gov/advisory/recommendations/2010-11-jammingwhitepaper.pdf

- Protect them from reasonable steps that can and should be taken to protect crucial GPS uses, and that have in fact been discussed broadly within the GPS community for years.

We hope that the Subcommittee accepts input on a variety of measures that can be used to protect GPS. Thank you for your attention to this matter, and do not hesitate to contact us if we can be of any help to the Subcommittee, its Members or staff.

Sincerely,

/s/Jeffrey Carlisle
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ATTACHMENT 1

RESPONSE TO BRIEFING MEMORANDUM

LightSquared's Response to the Committee on Transportation and Infrastructure's Aviation Subcommittee Staff Briefing Memo

- LightSquared is not "seeking to stake a claim to spectrum" as the briefing memo asserts. LightSquared has been a licensee in this neighboring spectrum band since 1988 and has been authorized to provide terrestrial services in this band since 2005.

- The memo goes on to assert that "the FCC did not pursue enforcement action against LightSquared." Obviously, there was never any basis for FCC enforcement against LightSquared as an authorized licensee in its spectrum band. All of LightSquared's intended transmissions are within the levels authorized in its license; most at levels well below the maximums authorized by the FCC

- The memo states that the FCC has a policy of "protecting the spectrum used by GPS for compatible purposes." LightSquared does not disagree with this and notes that it does not operate in the GPS spectrum band. LightSquared agreed to stringent out of band emission limits with the GPS industry and interested federal agencies in 2002 in order to ensure its terrestrial transmissions do not send any energy into the GPS band.

- The FCC has a detailed definition of "Ancillary Terrestrial Component" with which LightSquared's proposed operation fully complies. The GPS industry has chosen to recast the FCC's ATC definition on its own in a way that is markedly different than what is actually in the FCC's rules.

- The memo also states that the FCC mandated that "any attempt to establish a full terrestrial network would only be allowed if GPS interference issues are resolved." This is incorrect; the FCC actually mandated that LightSquared build a full terrestrial network in its March 2010 order approving the acquisition of LightSquared. The resolution of GPS issues was a provision attached to a waiver request conditionally approved by the FCC that would allow LightSquared to offer some devices for sale that would only have access to the terrestrial component of its network.

- LightSquared made its original proposal to provide terrestrial services in 2001; with an extensive FCC rulemaking and licensing process which followed. LightSquared was authorized by the FCC in 2005 to provide terrestrial services on its licensed spectrum. LightSquared's proposed transmissions are actually now at levels well below those authorized in 2005.

- LightSquared has worked closely with the FAA throughout much of 2011 in order to understand any potential conflicts between its operations and existing FAA GPS standards. LightSquared has proposed mitigation measures that fully address all concerns identified by the FAA, but the FAA refused to evaluate these measures and instead based its assessment on an outdated deployment proposal.

- LightSquared's mitigation plan would place all burdens on LightSquared and would not require any aircraft retrofit or any relaxation of safety standards. No specific conflict between LightSquared's operations and next-gen ATC has ever been identified by the FAA.

- The DoD did not actually test whether LightSquared's signal would "jam" or degrade GPS operation. The tests conducted by DoD only measured for slight increases in the GPS "noise floor" which GPS devices are designed to tolerate as this is part of their normal operating environment. Tests conducted by the Technical Working Group demonstrated that the levels used by the DoD did not correlate to any change in GPS device functionality from the end-user perspective.

- To be clear, LightSquared's intended operation are entirely within its own band and in complete compliance with FCC rules. It has revised its operating parameters so that they are much lower than the maximum levels currently authorized. The TWG confirmed that LightSquared's operation will not send any energy into the GPS band. The issue lies entirely with the design of some GPS devices which make them susceptible to LightSquared's licensed operations outside of the GPS band.

- The PNT EXCOMM conclusions were drawn based on biased testing that occurred with the cooperation of GPS interests; concerns raised by LightSquared about the testing process were ignored by PNT EXCOMM. It is unfortunate that PNT EXCOMM did not conduct a scientifically valid and transparent testing program. If it had, it would not doubt have shown, as other testing has conclusively, that there is no conflict between LightSquared's licensed transmissions and the performance of almost all unlicensed GPS devices.

ATTACHMENT 2

REQUEST FOR INITIATION OF PROCEEDING

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
The Development of Rules Establishing	)	Docket No. ________
Reliability Standards for Commercial	)	
Radionavigation-Satellite Service	)	
Receivers	)	

REQUEST FOR INITIATION OF PROCEEDING

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February 7, 2012

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Before the
FEDERAL COMMUNICATIONS COMMISSION
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In the Matter of	)	
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The Development of Rules Establishing	)	Docket No. ________
Reliability Standards for Commercial	)	
Radionavigation-Satellite Service	)	
Receivers	)	

REQUEST FOR INITIATION OF PROCEEDING

In accordance with Sections 1.41, 1.401, and 1.430 of the Commission's rules,[1] LightSquared Inc. and its affiliates (collectively, "LightSquared") respectfully request that the Commission initiate a proceeding to develop rules that establish reliability standards for unlicensed commercial devices that receive signals in the 1559-1610 MHz band from satellite systems operating in the Radionavigation-Satellite Service (RNSS). LightSquared has an interest in establishing these standards in order to ensure that RNSS receivers perform as intended, taking into account licensed operations in adjacent spectrum bands—including the 1525-1559 MHz and 1626.6-1660.5 MHz bands in which LightSquared is authorized to operate. To the extent that the Commission has the data it needs to proceed with a Notice of Proposed Rulemaking, LightSquared respectfully requests the prompt initiation of such a proceeding.[2] If the Commission needs to develop more facts, LightSquared requests that the Commission instead issue a Notice of Inquiry.

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1 *See* 47 C.F.R. §§ 1.41, 1.401, 1.430.

2 *See Interference Immunity Performance Specifications for Radio Receivers*, 22 FCC Rcd 8941, ¶ 2 (2007) ("*2007 Receiver Order*") (concluding an inquiry into receiver standards, and noting that "to the extent receiver interference immunity performance specifications are desirable, they may be addressed in proceedings that are frequency band or service specific").

I. INTRODUCTION AND SUMMARY

As the Commission is well aware, the issue of RNSS receiver performance has received significant focus over the past year.[3] It has become apparent that the commercial RNSS industry has failed to design receivers that communicate with the U.S. GPS system in a manner that is compatible with the authorized use of adjacent spectrum bands. This failure has inhibited the deployment of licensed services in adjacent bands that would provide significant public interest benefits, such as increased competition. In fact, over time, it appears that some members of the commercial RNSS industry actually have *exacerbated* the incompatibility of RNSS receivers by employing wider bandwidth front ends with slow rolloffs, which consequently are less tolerant of adjacent band spectrum occupancy than previous generation RNSS receivers. Alluding to these design choices, the Commission recently recognized that it may be necessary to adopt RNSS receiver standards in order to achieve efficient use of the limited spectrum resource.[4]

While the Commission often defers to market forces rather than directly regulating receiver performance, regulation of RNSS receivers is needed because the market has failed to provide a sufficient incentive for all manufacturers of commercial RNSS receivers to ensure that their devices operate reliably in the vicinity of authorized transmitters in adjacent

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3 *See, e.g.*, IB Docket No. 11-109; IBFS File No. SAT-MOD-20101118-00239.

4 *Fixed and Mobile Services in the Mobile Satellite Service Bands at 1525-1559 MHz and 1626.5-1660.5 MHz, 1610-1626.5 MHz and 2483.5-2500 MHz, and 2000-2020 MHz and 2180-2200 MHz*, 26 FCC Rcd 5710, ¶ 28 (2011) ("We emphasize that responsibility for protecting services rests not only on new entrants but also on incumbent users themselves, who must use receivers that reasonably discriminate against reception of signals outside their allocated spectrum. In the case of GPS, we note that extensive terrestrial operations have been anticipated in the L-band for at least 8 years. We are, of course, committed to preventing harmful interference to GPS and *we will look closely at additional measures that may be required to achieve efficient use of the spectrum, including the possibility of establishing receiver standards relative to the ability to reject interference from signals outside their allocated spectrum.*") (emphasis added).

bands. Reliability standards are particularly warranted because RNSS receivers are becoming more widely imbedded in mobile devices used by consumers and are increasingly relied upon for public safety purposes such as Enhanced 911. Moreover, as the Commission previously recognized when it adopted mandatory receiver standards for differential GPS, the continued deployment of spectrally inefficient RNSS receiver designs inhibits the introduction of valuable new services in adjacent frequencies. For these reasons, it is appropriate to adopt RNSS receiver reliability standards that adequately protect consumers and also advance the larger public interest. Accordingly, LightSquared respectfully requests that the Commission promptly initiate a proceeding to develop reliability standards for commercial RNSS receivers, as well as procedures for ensuring that all commercial RNSS receivers manufactured, marketed, and/or sold in the United States meet such standards.

LightSquared recommends that the Commission's development of commercial RNSS receiver reliability standards balance the following considerations:

- Compliance should ensure the reliability of commercial RNSS receivers in known radiofrequency operating environments.
- Where possible, compliance should improve the performance of commercial RNSS receivers.
- Compliance should allow licensees in bands adjacent to RNSS to fully enjoy the benefits of their licenses.
- The standards should be achievable through state-of-the-art technology (including expected future technical progress and innovation).
- Where possible, compliance should not appreciably increase the cost of the devices in which RNSS receivers are contained.
- Public interest determinations must be made before accommodating the use of non-U.S.-licensed RNSS systems to serve the United States, taking into account technical compatibility determinations and trade-related considerations.

A reliability standard that defines the adjacent band signal-power levels that an RNSS receiver should be designed to tolerate is preferable to one that might specify minimum receiver performance characteristics, such as radio frequency selectivity or other front-end receiver performance. Specifying the adjacent band signal-power levels that must be taken into account allows the receiver manufacturer to determine how tolerance for adjacent band signal-power levels should be achieved.

As further detailed below, evidence already exists that RNSS receiver manufacturers can readily design and manufacture devices that tolerate adjacent band signal-power levels from licensed services (including LightSquared's ATC services) while still performing as intended. A wide variety of solutions are available today, and more will be developed in the near term. The adoption of reliability standards for commercial RNSS receivers (indeed, even the proposed adoption of such standards) will undoubtedly drive technological innovation and the state of the art even further than it has come in the past year.

II. REGULATION OF COMMERCIAL RNSS RECEIVERS IS NECESSARY

As detailed below, the initiation of a proceeding to adopt RNSS receiver reliability standards is necessary to: (i) correct market failures; (ii) protect consumers from the continued proliferation of RNSS devices that are not compatible with licensed operations in adjacent spectrum bands; and (iii) promote the efficient use of limited spectrum resources.

A. Market Forces Have Proven Insufficient to Ensure the Reliability and Spectral Efficiency of Commercial RNSS Receivers

Today, most RNSS receivers that operate with the U.S. GPS system fail to incorporate adequate front-end frequency selectivity.[5] As a result, (i) those RNSS receivers do

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[5] *See generally* Javad Ashjaee, A Technical Story of a Bad Filter and a Good Filter Which Turned Political (Dec. 23, 2011), *available at* http://javad.com/downloads/javadgnss/publications/20112312.pdf (last visited Feb. 7, 2012).

not minimize reception of licensed signals in adjacent bands that could cause RNSS receiver overload; and (ii) even where "overload" is not a concern, those RNSS receivers do not minimize the net additive power of the signal at the analog to digital converter (such power includes the cumulative contribution of white noise and low level signals in the entire passband of the receiver), thereby making maximal use of the dynamic range of the analog to digital converter. It also appears that many RNSS receivers fail to meet the few design guidelines that do exist.[6] Consequently, there can be no assurance that these devices will operate reliably in the vicinity of licensed transmitters in adjacent frequency bands—including the wireless 4G LTE network that LightSquared will deploy—and thus that these RNSS receivers will continue to function as intended over their expected lifecycles. Remarkably, even RNSS receiver manufacturers themselves have acknowledged that existing GPS receivers are incompatible with long-planned operations in adjacent bands that are licensed and are entirely consistent with the U.S. Table of Allocations.[7]

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6 Comments of Information Technology and Innovation Foundation, IB Docket No. 11-109, at 6 (Aug. 15, 2011) (stating that high-precision GPS receivers that amplify rather than filter L-band signals employ a "very bad design" that "violates design guidelines issued by the DoD[]"); Jules McNeff, Overlook Systems Technologies, Inc., GPS Civil/Commercial Receivers Compliance & Certification, at 3 (Nov. 9, 2011), *available at* http://www.pnt.gov/advisory/2011/11/mcneff.pdf (explaining that manufacturers have not complied with GPS receiver interface specifications).

7 *See, e.g.*, Letter to FCC from Garmin International, Inc., IBFS File No. SAT-MOD-20101118-00239, Attachment: Written Testimony of Philip Straub, Vice President, Aviation Engineering, Garmin International, Inc., at 6 (June 27, 2011) ("GPS receivers of all types are not designed to exclude such strong signals [operating on nearby frequencies]."); Letter to FCC from Deere & Company, IBFS File No. SAT-MOD-20101118-00239, Attachment: LightSquared Interference to GPS and StarFire, at 8 (May 31, 2011) (demonstrating that "modern" high precision RNSS receivers are tuned to receive more of the adjacent L-band MSS signals than "older" high precision RNSS receivers).

To date, the market for RNSS receivers has been characterized by "moral hazard"[8]: manufacturers have not been required to internalize the full costs of their receiver design decisions.[9] Instead, the industry has deployed receivers that are susceptible to interference from licensed operations in nearby spectrum, while attempting to shift the costs and burdens resulting from this decision onto licensees in adjacent spectrum bands.[10]

Manufacturers of RNSS receivers also have little incentive to design their devices to be spectrally efficient because the RNSS receivers used in the U.S. today rely chiefly on signals transmitted by U.S. Government-owned and operated GPS satellites, and the satellite operator does not control the quality of the receivers.[11] Moreover, the RNSS receiver

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8 In economic theory, "moral hazard" refers to a situation in which one party makes a decision and realizes the benefit of that decision, but leaves *another* party to bear the adverse consequence and/or costs of that decision. Because the party avoiding the risk is not forced to take responsibility for its own actions, it naturally has a tendency to act less responsibly than it otherwise would. As a result, the market may not produce results that benefit the public as a whole. *See, e.g.*, Jonathan R. Macey & James P. Holdcroft, Jr., *Failure is an Option: An Ersatz-Antitrust Approach to Financial Regulation*, 120 YALE L.J. 1368, 1370 (2011) (discussing how an expectation of a government "bailout" leads to moral hazard because the potential recipients make decisions expecting that they will not be forced to bear the costs associated with adverse outcomes).

9 *Spectrum Policy Task Force Report of the Spectrum Efficiency Working Group*, ET Docket No. 02-135, at 35 (Nov. 15, 2002) ("The Commission should consider setting receiver performance standards whenever the marketplace isn't adequate in promoting a reasonable level of interference tolerance (e.g., when receivers are not owned and controlled by the licensee).").

10 *See, e.g.*, Letter to FCC from U.S. GPS Industry Council, IB Docket No. 11-109, at 5 (Nov. 9, 2011) (suggesting that LightSquared "pay all of the costs associated with retrofitting existing GPS receivers"); Letter to FCC from Trimble Navigation Limited, IB Docket No. 11-109, at 19 (Oct. 6, 2011) (same). LightSquared has asked the Commission to confirm that RNSS manufacturers are in fact responsible for the costs of ensuring that their devices are compatible with adjacent band operations. LightSquared Petition for Declaratory Ruling, IB Docket No. 11-109, ET Docket No. 10-142 (Jan. 30, 2012).

11 *See Spectrum Policy Task Force Report of the Interference Protection Working Group*, ET Docket No. 02-135, at 25 (Nov. 15, 2002) ("[U]nless the characteristics of the receiver can [b]e dictated by the service provider . . . , the provider has no control over

manufacturers benefit from these satellites without compensating the U.S. Government or the public for the use of these signals. In contrast, most satellite operators, who typically invest many hundreds of millions of dollars to design and implement their satellites and the associated ground network, have powerful incentives to make efficient use of available spectrum resources and thus minimize opportunity costs.[12] As the Commission's Spectrum Policy Task Force has recognized, regulatory intervention in the form of receiver standards is appropriate in circumstances where receiver deployment is not controlled by the system operator and little incentive exists to design receivers that are compatible with neighboring spectrum uses.[13]

B. Commercial RNSS Receiver Reliability Standards Would Protect Consumers

The need for reliability standards increases as RNSS receivers are incorporated into an ever-growing list of consumer devices. The importance of reliability standards for both consumer protection and public safety will become paramount as more commercial RNSS receivers are integrated into personal wireless devices (*e.g.*, smartphones) to satisfy new

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the quality of the receiver . . . ."); *Review of Part 15 and Other Parts of the Commission's Rules*, 17 FCC Rcd 14063, ¶ 11 (2002) (imposing emission limits on radar detectors in part because the source of interference was not under the control of the affected satellite operator and could not be remedied by the satellite operator); *see also Spectrum Policy Task Force Report of the Spectrum Efficiency Working Group*, ET Docket No. 02-135, at 23 (Nov. 15, 2002) (inefficiency is more likely to occur among spectrum users who have not been forced to incur the requisite opportunity costs). Although the U.S. Government has provided specifications that RNSS receivers utilizing the U.S. GPS system should employ, those specifications are not enforced and apparently are not currently followed by many manufacturers of commercial RNSS receivers. *See supra* note 6.

12 *Cf. SkyTerra Subsidiary LLC, Application for Modification Authority for an Ancillary Terrestrial Component*, 25 FCC Rcd 3043, ¶¶ 13-32 (2010) (giving effect to a coordination agreement between two satellite operators, LightSquared's predecessor SkyTerra and Inmarsat, in order to "facilitate continued improvement in the efficiency of spectrum use in the L-Band").

13 *Spectrum Policy Task Force Report of the Spectrum Efficiency Working Group*, ET Docket No. 02-135, at 35 (Nov. 15, 2002).

Enhanced 911 standards that require GPS location-positioning capabilities.[14] Receiver standards would ensure that RNSS receivers in those types of devices are sufficiently robust to facilitate such capabilities.

The Commission's Spectrum Policy Task Force has endorsed the adoption of receiver standards in cases such as this involving ubiquitous use by consumers.[15] Standards are particularly helpful in the case of consumer products, which are difficult to retrofit once they are distributed.[16] Commercial RNSS receivers are ubiquitously deployed and yet remain largely unregulated. Moreover, manufacturers of consumer receivers have had little motivation to design robust receivers because their objective is to design the most economical product that will work in the radiofrequency environment that exists at the time of sale. To date, they have had little incentive to design receivers that will work in future radiofrequency environments, even when the future nature of those environments was well-known years in advance. This failure is a problem not only because of its impact on the consumers who purchase defective receivers, but also because of the constraints it places on the deployment of new wireless broadband services, and the achievement of the goals articulated in the Commission's National Broadband Plan.

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14 *Wireless E911 Location Accuracy Requirements*, 26 FCC Rcd 10074, ¶ 19 (2011) (requiring all wireless carriers to meet handset-based location accuracy standards by January 19, 2019); *cf. Interference Immunity Performance Specifications for Radio Receivers*, 18 FCC Rcd 6039, ¶ 25 (2003) ("*Receiver NOI*") ("[T]he operating requirements of public safety communications systems would seem to warrant or even necessitate the use of receiver immunity performance guidelines/ standards that are tighter than those for general communication services.").

15 *See, e.g., Spectrum Policy Task Force Report of the Interference Protection Working Group*, ET Docket No. 02-135, at 24 (Nov. 15, 2002) (encouraging the use of receiver standards where the spectrum environment consists of widely deployed mobile devices).

16 *See, e.g., Amendment of Part 15 to Redefine and Clarify the Rules Governing Restricted Radiation Devices and Low Power Communication Devices*, 79 FCC 2d 28, ¶ 20 (1979).

Because of the complexity of the technical issues involved, most consumers in the mass market are unable to evaluate the adequacy of RNSS receivers, identify their deficiencies, and understand the implications of those deficiencies in light of the evolving interference environment. Because consumers cannot do so, they cannot exert adequate pressure on manufacturers through the market to ensure that such deficiencies are addressed. RNSS receiver standards are needed to ensure that these devices are sufficiently robust to reliably provide the navigational and public safety services which RNSS receiver manufacturers market their devices as being capable of providing to consumers.

C. Commercial RNSS Receiver Reliability Standards Would Encourage Spectral Efficiency and Facilitate the Introduction of New Services

The proposed standards for commercial RNSS receivers would promote the efficient use of spectrum and benefit the public interest. The Commission "expect[s] receiver manufacturers to design receivers reflecting the state of the art" and considers "the installation of suitable receiver filters" an appropriate remedy "[w]here design inadequacies in various situations result in interference being received."[17] In similar circumstances, the Commission even has imposed technical standards based on expected future technical progress and innovation.[18]

Adoption of RNSS receiver standards would avoid the need to employ wasteful spectrum guard bands, and thereby facilitate more efficient use of limited spectrum resources. As the Commission's Spectrum Policy Task Force has observed, failure to employ receiver

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17 *Policy to Govern the Change of FM Channels to Avoid Interference to Television Reception*, Public Notice, 2 FCC 2d 462 (1966).

18 *UHF Television Receiver Noise Figures*, 70 FCC 2d 1176, ¶ 19 (1978); *UHF Television Receiver Noise Figures*, 69 FCC 2d 1866, ¶ 34 (1978).

standards could force new services to make use of lower power and/or inefficient guard bands to protect established services operating in adjacent spectrum bands.[19]

Significantly, the adoption of RNSS receiver standards is not new to the Commission. Almost a decade ago, the Commission established receiver standards to ensure that differential GPS receivers could function properly without continuing to preclude the introduction of new FM radio services.[20] The same policy considerations that warranted that action warrant the regulation of commercial RNSS receivers more generally.

The Commission has acknowledged that "minimally performing receivers" have an adverse impact on consumers and a preemptive effect on the development of innovative communications services. For this reason, the Commission has found that "mandatory standards for certain classes of receivers," including the "expected performance characteristics" of those receivers, may be warranted in order to ensure that they can "better tolerate the introduction of newer services on the same or proximate frequencies."[21] Nowhere is this truer than in the RNSS context, where voluminous evidence demonstrates that manufacturers of RNSS receivers have

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19 *See Spectrum Policy Task Force Report of the Spectrum Efficiency Working Group*, ET Docket No. 02-135, at 24 (Nov. 15, 2002).

20 *See Review of Part 87 of the Commission's Rules Concerning the Aviation Radio Service*, 18 FCC Rcd 21432, ¶¶ 53, 55 (2003). *See also Jesse Willard Shirley*, 36 FCC 2d 127, ¶ 7 (1972) (concluding that television receivers with a poor design and susceptible to interference should not preclude the allocation of new FM stations); *Case Western Reserve University*, 44 RR2d 45, ¶¶ 4-6 (1978) (same); *Potential Interference to Television Reception from the Operation of FM Broadcast Stations on Certain Frequencies*, Information Bulletin, FCC 65-130 (rel. Feb. 19, 1965) ("This type of [desensitization] interference cannot be cured at the FM station and should not be blamed on the FM station licensee. It is basically a TV receiver design problem, since the receiver does not have sufficient selectivity to reject an FM signal which is far removed from the TV signal frequency.").

21 *Receiver NOI*, ¶ 2; *see also 2007 Receiver Order*, ¶ 2.

failed to account for the long-planned deployment of Mobile Satellite Service ("MSS") Ancillary Terrestrial Component ("ATC") services in the 1525-1559 MHz band in particular.[22]

III. EQUIPMENT CERTIFICATION WOULD ENSURE THAT RNSS RECEIVERS SATISFY THE NEW STANDARDS

To ensure compliance with the new reliability standards, RNSS receivers should be certified pursuant to Part 2 of the Commission's rules. Applying the existing equipment certification procedures to RNSS receivers would protect both consumers and users of adjacent frequencies. Certification is appropriate because of: (i) the demonstrated incompatibility of RNSS receivers with adjacent uses of spectrum; (ii) the wide distribution of RNSS receivers to consumers; (iii) the failure of manufacturers to take into account known and licensed high-powered transmitters in adjacent bands;[23] and (iv) the failure of manufacturers to otherwise comply with the design guidelines that already exist.

The demonstrated incompatibility of many RNSS receivers with authorized adjacent services warrants the use of certification to ensure compatibility of such devices going forward. Manufacturers of RNSS receivers have admitted—even insisted—that their devices are designed in a manner that is incompatible with the use of terrestrial transmitters in neighboring spectrum. Many existing commercial RNSS receivers have wide-open front ends extending to

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22 *See, e.g.*, LightSquared Petition for Declaratory Ruling, IB Docket No. 11-109, ET Docket No. 10-142 (Jan. 30, 2012); *see generally* IB Docket No. 11-109; IBFS File No. SAT-MOD-20101118-00239.

23 *See* 47 C.F.R. § 15.17 ("Parties responsible for equipment compliance are advised to consider the proximity and the high power of non-Government licensed radio stations . . . and of U.S. Government radio stations . . . when choosing operating frequencies during the design of their equipment so as to reduce the susceptibility for receiving harmful interference.").

several hundred megahertz.[24] Therefore, they receive signals emitted over wide swaths of adjacent frequencies and have to deal with excessive amounts of internal thermal noise. This results in sensitivity to overload and generally poor receiver dynamic range.

Certification of RNSS receivers would allow the Commission (or telecommunications certification bodies) to ensure that those devices comply with the new technical standards before the devices are distributed in mass quantities to consumers. Millions of commercial RNSS receivers currently are in use in the United States. As discussed above, the number of commercial RNSS receivers on the market will only continue to increase as they are integrated into a growing number of mobile devices. Compliance testing of each receiver type prior to distribution would prevent extremely expensive and logistically difficult recalls of noncompliant devices.

Certification is especially appropriate because the alternative—manufacturer's "self-approval"—is unlikely to be adequate due to the high risk of non-compliance,[25] and the absence of any industry standards that account for the known radiofrequency environment that RNSS receivers are legally required to accommodate.[26] Certification would provide assurance that the RNSS community uniformly adheres to the newly established receiver performance standards, despite its past history.

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24 *See supra* note 7.

25 *See 1998 Biennial Regulatory Review*, 13 FCC Rcd 24687, ¶ 12 (1998); *see also Review of Part 15 and Other Parts of the Commission's Rules*, 17 FCC Rcd 14063, ¶ 16 (2002); *Amendment of Part 15 to Redefine and Clarify the Rules Governing Restricted Radiation Devices and Low Power Communication Devices*, 79 FCC 2d 28, ¶ 31 (1979).

26 *See generally* LightSquared Petition for Declaratory Ruling, IB Docket No. 11-109, ET Docket No. 10-142 (Jan. 30, 2012).

IV. A PROPOSED FRAMEWORK FOR COMMERCIAL RNSS RECEIVER RELIABILITY STANDARDS

The development of any receiver standard involves a variety of policy tradeoffs. LightSquared recommends that the Commission's development of commercial RNSS receiver reliability standards take into account the following considerations:

- Compliance should ensure the reliability of commercial RNSS receivers in known radiofrequency operating environments.
- Where possible, compliance should improve the performance of commercial RNSS receivers.
- Compliance should allow licensees in bands adjacent to RNSS to fully enjoy the benefits of their licenses.
- The standards should be achievable through state-of-the-art technology (including expected future technical progress and innovation).
- Where possible, compliance should not appreciably increase the cost of the devices in which RNSS receivers are contained.
- Public interest determinations must be made before accommodating the use of non-U.S.-licensed RNSS systems to serve the United States, taking into account technical compatibility determinations and trade-related considerations.[27]

Each of these factors should be balanced in assessing the appropriateness of any potential standard.

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27 *See Public Notice: National Telecommunications and Information Administration Provides Information Concerning Executive Branch Recommendations for Waiver of Part 25 Rules Concerning Licensing of Receive-Only Earth Stations Operating with Non-U.S. Radionavigation Satellites*, DA 11-498 (Mar. 15, 2011); *id.* Attachment: Letter to FCC from NTIA (Mar. 2, 2011) (reception of signals from non-U.S.-licensed RNSS systems must be authorized; authorization will depend on whether a variety of technical and policy considerations are satisfied); *see also Telesat Canada, Petition for Declaratory Ruling for Inclusion of Anik F2 on the Permitted Space Station List, Petition for Declaratory Ruling to Serve the U.S. Market Using Ka-band Capacity on Anik F2*, 17 FCC Rcd 25287, ¶ 6 (2002) (describing the public interest analysis applicable to the evaluation of applications to use non-U.S. licensed space stations to provide satellite service, which requires consideration of a number of factors, such as competition in the United States, spectrum availability, eligibility requirements, technical requirements, national security, law enforcement, foreign policy, and trade concerns).

In developing a reliability standard, an approach that defines the adjacent band signal-power levels that an RNSS receiver should be designed to tolerate is preferable to one that might specify minimum receiver performance characteristics, such as radio frequency selectivity or other front-end receiver performance. Specifying the adjacent band signal-power levels that must be taken into account allows the receiver manufacturer to determine how tolerance for adjacent band signal-power levels should be achieved. In this respect, it bears emphasis that a variety of means are available to the receiver designer, which could be used singularly or in combination, including: improved low noise amplifiers (LNAs), improved bandpass filters, optimizing the distribution of LNAs and bandpass filters in a multistage front end, improved IF filtering, higher resolution A/D converters, and improved digital signal processing. Different combinations of these solutions might be appropriate for different types of RNSS devices. For example, owing to different space constraints, high-precision RNSS receivers may be able to employ filters and antennas that might not be feasible to use with personal wireless devices. Many personal wireless devices already are able to tolerate significant levels of adjacent band signal power, and may simply need the addition of a small filter or the improvement of existing filters that would add about a nickel to the cost of the device.[28] The "insertion loss" associated with any such additional filtering may be accommodated without adversely affecting the operational reliability of the device.[29]

In order to define the level of adjacent band signal-power levels that an RNSS receiver should be required to tolerate, LightSquared believes that a good starting point already exists. RTCA has a adopted a mask that defines, as a function of frequency offset from the edge

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28 *See* Technical Working Group Final Report, IBFS File No. SAT-MOD-20101118-00239, at 55 (June 30, 2011) ("TWG Final Report"); *id.* App. C.5, at 7-8.

29 *See, e.g., infra.* pp. 15-17.

of a defined band, the out-of-band signal-power levels that an aviation-certified RNSS receiver must be designed to tolerate.[30] While this mask is understood and proven in the industry, it was not based on the "state of the art" in receiver design, and originally was designed to accommodate only those MSS operations that actually then existed in the adjacent band. Because the RTCA mask does not account for the ATC operations that were first authorized in 2003, it would need to be suitably modified to accommodate licensed ATC operations in the adjacent MSS bands. Modifying such a mask to account for signal-power levels that appropriately account for licensed operations in the adjacent band would provide a suitable starting point for RNSS reliability standards.

By using one or more of the receiver design options described above, RNSS receiver manufacturers can readily design and manufacture devices that tolerate adjacent band signal-power levels from licensed services (including LightSquared's ATC services). Evidence already exists that this result is achievable. For example, Avago Technologies has demonstrated that film bulk acoustic resonator (FBAR) technology exists today to manufacture filters that offer at least 40 dB rejection in the stopbands 1525–1555 MHz and 1626.5–1660.5 MHz, with minimal insertion loss and performance that is stable across a wide range of temperatures.[31] Qualcomm has indicated that it should not add more than about 5 cents to the current

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30 RTCA, Inc., Minimum Operational Performance Standards for Global Positioning System / Wide Area Augmentation System Airborne Equipment, at Appendix C, DO-229 (2006).

31 TWG Final Report App. C.2, at 9 ("Present Avago FBAR manufacturing technology can support a filter with <1.5 dB insertion loss across narrow GPS + GLONASS (1574-1606 MHZ) that provides 40 dB of rejection in the [adjacent] bands. This performance can be maintained across manufacturing variation and a temperature range of -30 to +85 C.").

manufacturing cost of such a filter to provide this type of increased performance.[32] Moreover, Maxtena currently produces a highly frequency-selective antenna that has at least 40 dB of selectivity at frequencies below 1547 MHz and above 1622 MHz. This antenna is advertised by its manufacturer as suitable for a wide variety of applications, including precision navigation and timing.[33] In short, a wide variety of solutions are available today, and more will be developed in the near term.[34] The proposal, and ultimately the adoption, of reliability standards for commercial RNSS receivers will undoubtedly drive technological innovation even further than it has come in the past year.

Consideration also should be given to assessing the amount of noise figure increase that an RNSS receiver may reasonably be expected to tolerate in order to operate reliably in the vicinity of adjacent band signals. Any such assessment should be based on the operational (*i.e.*, user perceptible) impact of the noise figure degradation, not on an unsubstantiated metric. Factors that drive the operational impact include the following:

- The net link margin with which the device normally operates and the relative magnitude of the noise figure degradation (*e.g.*, 1 dB) relative to the net link margin (*e.g.*, 10 dB).[35]

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32 TWG Final Report App. C.5, at 7-8 ("The cost impact could be on the order of 5 cents, depending on volume.").

33 *See* http://www.ion.org/meetings/exhibitorProfile/gnss2011/files/491_m1227hct-a-sma.pdf (last visited Feb. 7, 2012).

34 *See* TWG Final Report, at 55 (For LightSquared operations in the lower 10 MHz of the L Band, "additional immunity to adjacent L Band signals are within grasp using existing, known filter technologies," and for the upper 10 MHz of the L Band, "filtering technology may be available to reduce susceptibility to adjacent band signals into the GPS receivers of future cellular devices.").

35 The RNSS industry has advocated using a 1 dB reduction in C/N_0 as the threshold for measuring RNSS receiver performance in other contexts. *See, e.g.*, U.S. GPS Industry Counsel Comments, IB Docket No. 11-109, at 22-25 (Aug. 1, 2011). LightSquared's

- Whether any given class of RNSS device (such as unassisted ground based GPS) is more likely to be affected, operationally, by factors such as variable blockage conditions than by a small increase in noise figure, and what operational impact (if any) that increase in noise will have given the existing operational challenges that the device already faces.[36]

* * * *

For the foregoing reasons, LightSquared respectfully requests that the Commission promptly initiate a proceeding to develop reliability standards for commercial RNSS receivers. Adoption of suitable standards would correct market failures, protect consumers from the continued proliferation of devices that are not designed to operate in the vicinity of licensed transmitters in adjacent bands, and promote the efficient use of limited spectrum resources. Moreover, certification of RNSS receivers manufactured, marketed, or sold in the United States would protect the end users that ultimately purchase and rely on these products. To the extent that the Commission has the data it needs to proceed with a Notice of Proposed Rulemaking, LightSquared respectfully requests the prompt initiation of such a

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reference to this value should not be construed as its agreement about what impact on RNSS receiver performance from transmitters in adjacent bands should be acceptable, particularly given the unprotected status of commercial RNSS receivers under FCC rules and precedent. *See generally* LightSquared Petition for Declaratory Ruling, IB Docket No. 11-109, ET Docket No. 10-142 (Jan. 30, 2012).

36 The Commission's ATC decisions expressly contemplate that non-ATC devices will need to accommodate certain increases in noise to improve spectral efficiency, and that the theoretical impact of ATC must be balanced against the operational environment in which the other devices actually operate (*e.g.*, expected signal blockage). *See, e.g.*, *SkyTerra Subsidiary LLC Application for Modification of Authority for an Ancillary Terrestrial Component*, 25 FCC Rcd 3043, ¶ 28 & n.75 (2010) (citing *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L Band, and the 1.6/2.4 GHz Bands*, 18 FCC Rcd 1962, ¶ 153 (2003)).

proceeding. If the Commission needs to develop more facts, LightSquared requests that the Commission instead issue a Notice of Inquiry.

Respectfully submitted,

Jeffrey J. Carlisle
Executive Vice President
Regulatory Affairs and Public Policy
LIGHTSQUARED INC.
10802 Parkridge Boulevard
Reston, VA 20191
703-390-2001

February 7, 2012

Attachment 1 to State letter LE 4/49.1 - 94/89

U.S. Department of Transportation
Federal Aviation Administration

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

OCT 14 1994

Dr. Assad Kotaite
President of the Council
International Civil Aviation Organization
1000 Sherbrooke Street West
Montreal, Quebec, Canada H3A 2R2

Dear Dr. Kotaite:

This letter supersedes my letter of April 14, 1994.

I would like to commend, on behalf of the United States, the Committees on Future Air Navigation Systems (FANS) of the International Civil Aviation Organization (ICA0) for pioneering progress in the development of global statellite navigation for civil aviation. I note in this regard that the ICAO Council, on December 11, 1991, requested the Secretary General of ICAO to initiate an agreement between ICAO and Global Navigation Satellite System (GNSS) provider states concerning the duration and quality of the future GNSS.

I would like to take this opportunity to reiterate my Government's offer of the Standard Positioning Service (SPS) of the United States Global Positioning System (GPS) for use by the international community. As the United States made clear at the ICAO Tenth Air Navigation Conference and the 29th ICAO Assembly, the United States intends, subject to the availability of funds as required by United States law, to make GPS-SPS available for the foreseeable future, on a continuous, worldwide basis and free of direct user fees. This offer satisfies ICAO requirements for minimum duration of service (10 years) and freedom from direct charges. This service, which will be available as provided in the United States Government's technical sections of the Federal Radio Navigation Plan on a nondiscriminatory basis to all users of civil aviation, will provide horizontal accuracies of 100 meters (95 percent probability) and 300 meters (99.99 percent probability). The United States shall take all necessary measures to maintain the integrity and reliability of the service and expects that it will be able to provide at least 6 years notice prior to termination of GPS operations or elimination of the GPS-SPS.

The GPS/SPS is a candidate component of the future GNSS as envisioned by FANS. The United States believes that making the GPS available to the international community will enable states to develop a more complete understanding of this valuable technology as a component of the GNSS. The availability of GPS-SPS, of course, is not intended in any way to limit the rights of any state to control the operations of aircraft and enforce safety regulations within its sovereign airspace.

In the coming years, the international community must decide how to implement an international civil global navigation system based on satellite technology. The United States pledges its full cooperation in that endeavor and in working with ICAO to establish appropriate standards and recommended practices (SARP) in accordance with Article 37 of the Convention on International Civil Aviation (Chicago Convention). Consistent with this goal, the United States expects that SARP's developed by ICAO will be compatible with GPS operations and vice versa and that states will be free to augment GPS-SPS in accordance with appropriate SARP's. The United States will also undertake a continuing exchange of information with ICAO regarding the operation of the GPS to assist the ICAO Council in carrying out its responsibilities under the Chicago Convention.

I would be grateful if you could confirm that International Civil Aviation Organization is satisfied with the foregoing, which I submit in lieu of an agreement. In that event this letter and your reply will comprise mutual understandings regarding the Global Positioning System between the Government of the United States of America and the International Civil Aviation Organization.

Sincerely,

David R. Hinson
Administrator

U.S. Department
of Transportation

**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

SEP 1 0 2007

Mr. Roberto Kobeh
President of the Council
International Civil Aviation Organization
999 University Street
Montreal, Quebec, Canada H3C 5J9

Dear Mr. Kobeh:

This letter reaffirms the United States Government's commitment to provide the Global Positioning System (GPS) Standard Positioning Service (SPS) for aviation throughout the world. Further, the United States commits to provide the Wide-Area Augmentation System (WAAS) service within its prescribed service volume.

More than ten years ago, the United States began providing the GPS SPS. Since 1994, GPS has grown into a global utility whose multi-use services have become essential elements of the worldwide infrastructure. In 2003, the United States commissioned the WAAS Satellite-Based Augmentation System to provide improved space-based positioning, navigation and timing (PNT) service. In 2004, the U.S. Government's GPS management structure was improved by national policy directive to accommodate a more comprehensive approach to planning, resource allocation, and system development. This policy strengthens civil participation in managing GPS and supports state aircraft access to airspace using other GPS signals, such as Precise Positioning Service (PPS) where the capability is equivalent.[1]

The U.S. Government maintains its commitment to provide GPS SPS signals on a continuous worldwide basis, free of direct user fees, enabling worldwide civil space-based PNT services (to include GPS SPS augmentations), and to provide open, free access to information necessary to develop and build equipment to use these services.

The U.S. Government commits to providing single frequency WAAS signals on a nondiscriminatory basis, free of direct user fees, throughout the area of coverage of WAAS satellites within its prescribed service volume and to provide open, free access to information necessary to develop and build equipment to use these services. WAAS provides new and improved aviation capabilities for satellite-based vertical-guidance procedures, consistent with International Civil Aviation Organization (ICAO) initiatives. The U.S. Government has concluded arrangements with Canada and Mexico that extend the WAAS service in

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[1] 35th ICAO Assembly WP/274 "Use of GPS PPS in Domestic and International Airspace," September 30, 2004

North America and is supporting testing and development of WAAS capabilities for the Western Hemisphere.

The U.S. Government plans to take all necessary measures for the foreseeable future to maintain the integrity, reliability, and availability of the GPS SPS and WAAS service and expects to provide at least six years' notice prior to any termination of such operations or elimination of such services.

All of the above commitments are subject to the availability of funds as required by United States law.

The availability of GPS and WAAS signals is not intended in any way to limit the right of any State to control the operations of aircraft and enforce safety regulations within its sovereign airspace. Furthermore, the United States expects that standards and recommended practices (SARPS) developed by the ICAO will continue to be compatible with GPS operations and vice versa, and that States will be free to augment GPS in accordance with appropriate SARPS.

I would greatly appreciate your confirmation that the ICAO is satisfied with the foregoing political commitments, which I submit in lieu of an agreement. In that event, this letter and your reply will comprise the continued mutual understanding between the Government of the United States and the ICAO regarding the provision and use of space-based navigation services.

Sincerely,

Marion Blakey

Marion C. Blakey
Administrator

cc: Ambassador Donald T. Bliss
U.S. Representative to the Council of ICAO