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Sampling of Departments and Agencies Shows $245 Billion Potential LightSquared Impacts on GPS in Federal Government Uses Alone

Compilation offers insight into potential range of costs and disruption that negative impacts on GPS would cause, even without information for all significant federal departments and agencies

A compilation of the limited number of publicly available statements and estimates concerning the costs the federal government would face if LightSquared's planned broadband system is allowed to go forward shows that the impact could be in the range of $245 billion.

The documents show that the federal government has invested at least $47 billion in GPS infrastructure and devices; that an estimated $160 billion in public safety, efficiency and socio-economic benefits would be at risk if LightSquared is allowed to proceed; and that costs incurred for GPS device and infrastructure replacement, as well as increased costs because of efficiency losses, could be $38 billion.

A number of federal departments and agencies are not included in the compilation, including such heavy GPS users as the Departments of Homeland Security, Agriculture and Energy. And, this sketch of approximated costs does not include those that would be incurred by state and local governments – including fields such as public safety that are highly dependent on GPS – as well as businesses and individuals. A June 2011 economic study showed that LightSquared's plans threaten as many as 3.3 million U.S. jobs and costs of up to $96 billion to U.S. commercial GPS users and manufacturers. So, actual costs could greatly exceed the figures referenced in this document.

With no uniform manner established in which to report federal government investments in GPS or estimated replacement costs and benefits that would be lost, along with varying time frames for those estimates which are available, arriving at valid figures is difficult. Nonetheless, we believe this snapshot helps vividly illustrate how widespread and engrained the use of GPS, particularly high-precision GPS, is in the federal government, and lends insight into how disruptive any replacement or retrofitting process would be.

Many of the documents referenced below were submitted to the House Committee on Science, Space, and Technology, which had requested assessments from a wide range of federal department and agencies, and continues to seek further information. Additional information was provided in hearing transcripts and a news story. In some instances, the below excerpts are lightly edited for continuity. All boldfacing in the following pages has been added by the Coalition.

Department of Defense Impacts

While the Department of Defense has not released a formal impact assessment, it is clear from what is on the public record that GPS equipment replacement and retrofitting costs would be mammoth. The U.S. government, including practically every major federal department and agency, is the biggest single user of GPS equipment and services, and has invested many more billions of dollars in GPS-based equipment and systems. So, while the information available on DOD costs is far from complete, the below gives a strong indication of the scope of the potential financial cost.

In his written testimony for the September 15, 2011 House Subcommittee on Strategic Forces Armed Services Committee, Gen. William Shelton, head of the Air Force Space Command, stated, "**As a Nation, we have invested roughly $34 billion to field and operate the GPS constellation**. Clearly, it has become a global utility serving a worldwide user population."

Later, when General Shelton was questioned about what he thought the timing and cost of GPS equipment replacement and retrofitting would be, he said, "We have not estimated cost. However, I think it'd be **very safe to say that the cost would be in the b's – billions of dollars**. We believe that the timing would probably be **a decade or more** to accomplish all this. And the reason for that is that there are **probably a million GPS receivers out there in the military**, maybe even more than that."

In a June 23, 2011 hearing of the Committee on Transportation and Infrastructure Subcommittee on Aviation and the Subcommittee on Coast Guard and Maritime Transportation, Teresa M. Takai, DOD's Chief Information Officer, testified:

"To deliver GPS service to all DOD and civil and commercial users who rely upon it, **DOD maintains and continuously** upgrades a constant constellation of 24 satellites composed of a minimum of four satellites in each six planetary orbits at a **very cost-effective budget currently of $1.7 billion annually**."

Department of Transportation Impacts

DOT Aviation Impacts:

PLEASE NOTE: The Aviation Impacts section of the following DOT section of this document contains material from both the FAA PowerPoint and the DOT Impact document. Unless the

page citation specifically references the FAA, the page number cited is from the DOT Impact document.

- GPS currently provides at least **$200 million in efficiency benefits** for aviation each year. *[pg 1]*
- GPS safety enhancements are expected to prevent the loss of approximately 800 lives over the next 10 years, with an estimated public safety benefit of about **$5 billion**.*[pg 1]*
- 10 years needed to design, develop, certify and modify civil aviation fleet. Aviation would return to full dependency on antiquated ground-based navigational aids. GPS-enabled operational, economic and **public safety benefits lost** until aircraft are reequipped. *[pg 4 FAA]*
- Based upon existing information, LightSquared's operations at the lower channel would also **preclude the following critical capabilities** that rely on high precision and GPS timing:
    - Airfield and Flight Procedure surveys
    - Flight test tracking
    - Space Weather monitoring
    - GPS Timing for computing resources and numerous mission critical systems, including
        - Terminal, enroute and oceanic automation systems
        - Surveillance systems
        - Voice communications and recoding systems
        - Maintenance support systems *[pg 14 FAA]*
- GPS is also an essential building block in the ongoing deployment of the Next Generation Air Transportation System (NextGen), that builds upon current GPS-based capabilities. The FAA estimates the cumulative benefits of NextGen to be **$23 billion** through 2018; and by 2030, the cumulative benefits grow to **$123 billion** and reduce CO2 emissions by 64 million tons. *[pg 1]*
- FAA and aviation community **sunk costs** not Included in the estimate:
    - U.S. taxpayers have invested **$3 billion** in FAA implementation of GPS and NextGen through FY11
    - Aviation industry investment in GPS equipment estimated to be **$3 to $4 billion**
    - Estimate does not include equipage for thousands of DOD, Federal, State and Local government public utility aircraft
    - Total FAA and civil aviation community **investment loss of $6 to 7 billion** *[pg 12 FAA]*
- If LightSquared deploys as currently proposed, the NextGen investments would need to be replanned; most of its benefits would be delayed by approximately 10 years. Planned NextGen investments from 2012 through 2018 that would need to be replanned total **approximately $17 billion**. *[pg 2]*
- Based on input from RTCA as well as National Space-Based Position Navigation and Timing Systems Engineering Forum, proposed LightSquared deployment would result in

an estimated aviation community cost of at least **$72 billion over a 10 year replanning and aircraft retro-fit schedule,** stemming from:

- **$2 billion loss** of existing GPS efficiency benefits
- **$5 billion loss** of existing GPS safety benefits
- **$59 billion** due to delayed NextGen benefits
- **$6 billion** in aircraft retrofit costs *[pg 11 FAA]*

- These results **likely underestimate** the National **economic be**nefits of GPS aviation use to the overall U.S. economy, since **they do no**t include the productivity gains enabled by accelerated cargo delivery; nor the benefits provided to the operators of thousands of military and other public use aircraft used for homeland security, law enforcement, medical emergency and other applications. *[pg 1]*

DOT Rail Transportation Impacts:

- Freight railroads have begun to use the GPS data regarding train position and movement to enhance operational efficiency. Preliminary FRA estimates suggest that railroads could lose productivity gains (most of which accrue to society at large) of **up to $29 billion over 20 years**. *[pg 2]*
- Positive Train Control (PTC) systems serve to prevent train-to-train collisions, overspeed train derailments, incursions into roadway work zones, and accidents caused by railroad switches left in an incorrect position. *[pg 2]*
- All PTC systems require some form of transmission of PNT information. In 2009, the Federal Railroad Administration (FRA) estimated that the safety benefits alone of PTC system implementation could total **more than $673 million over 20 years**. *[pg 2]*
- The FRA estimates that the sunk cost in PTC systems that rely on GPS is **over one billion dollars**, and that railroads plan an **additional $4.3 billion** by December 31, 2015 in GPS-based PTC systems. FRA estimates that such railroads required to implement a transponder-based PTC system in lieu of a GPS-based system would face increased costs of up to **$25 billion over 20 years**. *[pg 2]* Further, FRA has spent **$65 million** on its **Automatic Track Inspection Program (A TIP). FRA owns** five A TIP vehicles, which us**e GPS to record the loc**ation of track perturbations, including violations, defects and anomalies. *[pg 2]*

DOT Maritime Transportation Impacts:

- A **conservative estimate** provided by MARAD for all GPS-related equipment that is **required to be on a vesse**l *greater* than 300 gross tons is **$100K per vessel**. Including the vessels in the RRF with the U.S. commercial and coastal fleet, **this approaches $500 million dollars** for currently installed GPS-related marine equipment. These costs are much higher if all inland commercial vessels that are less than 300 gross tons but still carry GPS receivers or other GPS related marine equipment were included. *[pg 3]*
- The **dollar value** on potential contributory ship groundings, collisions and allusions could **run into tens of billions of dollars** in hull, cargo and oil pollution costs not to mention injuries and loss of life as well as economic losses to ports and corporations negatively impacted by a related incident. *[pg 3]*

- The retrofit of GPS marine equipment with filters or other fixes is not practical from a deployment or an economic perspective. *[pg 3]*

DOT Highway Transportation Impacts:

- The Intelligent Transportation System (ITS) (JPO) has **invested several hundred million dollars** over the course of many years in safety-based research that requires GPS positioning to be effective. Therefore any loss of GPS would prevent the effectiveness of the solutions and jeopardize the considerable research investment made by both the federal government and the major automotive industry in connected vehicle safety research. *[pgs 3-4]*
- Going forward, DOT is planning to **invest approximately another $100 million** in the Vehicle-to-Vehicle and Vehicle-to-Infrastructure related research that utilizes GPS positioning. [*pgs 3-4]*

Other DOT Impacts:

- The DOT-funded (inland or terrestrial) National Differential GPS System represent **$71.8** million in direct DOT funding for GPS-based infrastructure (FY 1998 - FY 2011). *[pg 4]*
- An additional **$25 million** in funding has been provided state and local partners for specific site development for a total investment of approximately **$97 million.** *[pg 4]*

National Oceanic and Atmospheric Administration Impacts

Source: *Written testimony of Ms. Mary Glackin, Deputy Under Secretary, National Oceanic and Atmospheric Administration, before the Committee on Science, Space, and Technology Hearing on "Impacts of the LightSquared Network on Federal Science Activities," Sept. 8, 2011*
Full transcript available here.

- At least five major NOAA systems or functions require high precision wideband GPS equipment, including systems that:
    - observe the Earth's atmosphere to improve global weather and climate models;
    - monitor sea level trends, measure atmospheric moisture to improve short-term weather forecasts;
    - inform surveyors and other customers about space weather conditions affecting GPS accuracy; and,
    - ensure compatibility among U.S. maps, surveys, and other geospatial products. *[pg 4]*
- Three of these five activities depend on NOAA's nationwide network of Continuously Operating Reference Stations (CORS) which collect and share precise data about GPS satellite orbits. CORS provides a consistent positioning technology, accurate to an inch, **used by millions of people throughout the United States, from surveyors to farmers to the FAA**. *[pg 4]*
- This network is critical to anchoring nautical charts, building roads and railways, surveying airports, and responding to natural disasters and other emergencies, such as Hurricane Katrina and the Deepwater Horizon oil spill. *[pg 4]*

- In the case of CORS alone, there are over 1,800 reference stations, many of which have multiple GPS receivers. *[pg 4]*
- This multi-million dollar investment has been made not only by NOAA, but over 190 stakeholder organizations, including states, local communities, universities and other Federal Agencies. They all have a shared interest in maintaining a common standard for geospatial positioning in the United States, so the construction and maintenance of roads, bridges, railways, 5 inland waterways, and other projects that cross-jurisdictional boundaries all use the same coordinate system. *[pgs 4-5]*
- If testing confirms that high-precision GPS receivers are significantly degraded by LightSquared's lower channel, and a suitable mitigation is not developed, **major portions of the CORS network could cease functioning**. . . .[T]he entire network could fail to serve its intended purpose, forcing NOAA to use less accurate, more labor-intensive, and more costly methods.
    - For example, the **cost to update the International Great Lakes Datum** – a water level reference system of enormous economic importance to the United States and Canada for maritime navigation and shipping – could **increase from under $30 million using GPS to $160 million** using older methods.
    - In addition, the widespread **socio-economic benefits of CORS use, estimated at $758 million annually, could be lost** due to interference at CORS sites. *[pg 5]*

Department of Interior Impacts

Full document available here.

- The GPS is vitally important in acquiring virtually every type of spatially referenced date in use today. This includes aerial and satellite imagery, seismic networks, land surveys, engineering and scientific observation of all kinds. [*pg 1]*
- The DOl GPS Report estimates the Department has **invested between $100 to $200 million** in GPS technology. *[pg 2]*
- Estimating a tenfold return on this GPS investment, as put forward by some investigators, this suggests the Department has realized about **$1-2 billion in benefits** from GPS. *[pg 2]*
- The Department continues to invest at the rate of about **$12-24 million annually.** Again, assuming a factor of 10 for these benefits, there is an estimated annual return 0f **$120 million - $240 million.** *[pg 2]*
- **Replacement costs** for Department of Interior GPS equipment are thought to be in the **$250-$500 million range**. *[pg 7]*

U.S. Geological Survey Impacts

Source: *Written Testimony of Dr. David Applegate, Associate Director, Natural Hazards, U.S. Geological Survey before the Committee on Science, Space, and Technology Hearing on "Impacts of the LightSquared Network on Federal Science Activities," Sept. 8, 2011*
Full testimony available here.

- The Department estimates that it has **invested about $100 million in the technology and it could cost as much as $500 million to replace it.** Also, there could be a cost in lost situational awareness and on-going scientific research. *[pg 4]*

Flooding/Waterway Management

- GPS signals in mobile applications are used to accurately position flow-measuring equipment and obtain data needed to calibrate streamgages, which have radios that use the GPS timing signal to make near real-time transmission of data possible. *[pg 2]*
- There are about 9,000 of these radios in use and without them the quality of data from the streamgages would be diminished.
  - For example, it would reduce the accuracy of National Weather Service flood forecasts and would likely diminish the ability of flood-fighting agencies such as the Corps of Engineers to minimize flood damage.
  - The confidence and timeliness of water-management decisions made by states, the Bureau of Reclamation, and the Army Corps of Engineers could also be impacted. *[pg 2]*
- Since 2009, the USGS has **invested $11.5 million** in GPS-based satellite radios and 91 acoustic doppler current profilers. *[pg 2]*
- Without the GPS-driven streamgage satellite radios, the increase in costs will **approach $6.6 million per year** based on the expense of periodically resetting physical clocks at each streamgage. *[pg 2]*

Earthquake, Volcano and Landslide Monitoring, Prediction and Prevention

- Today, nearly all (mapping) data collected involves the use of GPS. All modern airborne or satellite-based systems are dependent on GPS for navigation, positioning and geolocation of the data. *[pg 2]*
- Ortho-rectified imagery needs GPS to reliably determine the location of each image. LiDAR technology, meanwhile, can determine elevation to within centimeters, but requires equally precise GPS positioning data to validate it. High-precision LiDAR data can reveal hidden faults, map out ancient landslides, and determine the shape of volcanoes in unprecedented detail. Since 2008, USGS has made between **$18 million and $20 million** in LiDAR acquisition purchases per year. The **2010 total was over $40 million.** *[pg2]*
- Our ability to monitor deformation of the Earth's crust requires the most precise, accurate, and reliable GPS signals. We and our university cooperators, along with the National Science Foundation and UNAVCO consortium, **maintain and use over 1,000 permanent continuously operating GPS stations** to track plate motions and monitor ground deformation due to earthquakes along **faults like the San** Andreas and hundreds of others nationwide. *[pg 3]*
- Dense networks of high data rate, high-precision GPS stations are **particularly important for earthquake monitoring for at-risk urban areas in southern California, the San Francisco Bay Area, and the Pacific Northwest.** *[pg 3]*

- The estimated **capital cost** of the USGS investment in these geodetic networks is **$26 million.** For the NSF Earthscope project alone, GPS network **capital costs are about $100 million** and current operation and **maintenance costs are $11 million yearly**. UNAVCO expert analysis shows that this NSF investment would be put in jeopardy if the LightSquared Network is given approval to proceed. *[pg3]*
- The USGS capital investment in GPS receivers currently used for volcano monitoring is **$3.5 million.** *[pg 3]*
- Given the wide use of such receivers and the uncertainty of technical fixes, **it is impossible to predict exactly how much it would cost** to replace these receivers.

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