United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

JUL - 7 2011

MEMORANDUM FOR: Karl Nebbia, Associate Administrator
National Telecommunications and Information Administration

FROM: Deanna Archuleta, Senior Advisor to the Secretary
Department of the Interior

SUBJECT: Impacts of LightSquared Interference on GPS to the Department of the Interior

The Department of the Interior is pleased to respond to the request for information from the Executive Committee for Space-Based Positioning, Navigation and Timing. The Department remains committed to preventing disruptions of GPS operations, which have become so critical to the Department and the Nation.

The GPS is vitally important in acquiring virtually every type of spatially referenced data in use today. If there is a piece of data that is collected using modern equipment, GPS is in the background providing the positioning. This includes aerial and satellite imagery, seismic networks, land surveys, engineering and scientific observations of all kinds. It has become so pervasive— it is taken for granted. Without it, our Nation would be set back.

1. **Summarize and quantify current and future benefits provided by use of GPS-based applications and any cost-benefit analyses that are available.**

In 2010, the Department of the Interior (DOI) issued a GPS Report based on upon an extensive internal survey. The report identified 56 different GPS-based application areas. Thus, there are many diverse benefits of GPS technology within DOI.

Strategically there are many benefits to using GPS technology. Below is a comment from a DOI GPS user describing the value of GPS as used in a Florida everglades project:

New, state-of-the-art "On-The-Fly" differential GPS technology was developed and used by US Geological Survey (USGS) for a pilot project in the Florida Everglades in the mid-1990s to demonstrate and quantify the vertical accuracy achievable in a wetland environment. The purpose of the project was to demonstrate that a regional topographic survey with a vertical accuracy specification of 15 centimeters was feasible. The pilot project was successful, and led to the multi-year project "High Accuracy Elevation Data Collection Project", under the auspices of the USGS Priority Ecosystem Studies Program, that was funded by multiple Federal and State agencies. A key component of the project was the development of a helicopter-based surveying instrument known as the "Airborne Height Finder" based on GPS.

Vertical geodetic control points, as well as vertical reference marks for water level gages, were also surveyed using GPS technology. The project was completed in 2007, culminating in the most accurate Digital Elevation Model of the Everglades ever produced. These data are critical input to hydrologic and ecosystem restoration models being developed for the Comprehensive Everglades Restoration Plan. These successful results would not have been possible without GPS!

Unfortunately, projects like this have not been the subject of a cost benefit analysis with regard to GPS.

The Department is aware of a number studies addressing cost benefit that have been conducted related to geospatial data in general. For example, the National Geodetic Survey issued this study: "Socio-Economic Benefits Study: Scoping the Value of CORS and GRAV-D." In general, it is reasonable to believe that this report typifies the magnitude and type of benefits that can be expected from GPS applications.

The DOI GPS Report estimates the Department has invested between $100 to $200 million in GPS technology. Estimating a tenfold return on this GPS investment, as put forwarded by at least some investigators, this suggests the Department has realized about $1-2 billion in benefits from GPS. In addition, the Department continues to invest in GPS at the rate of about $12-$24 million annually; again assuming a factor of 10 for these benefits, there is an estimated annual return of $120-$240 million.

The GPS Report clearly indicates that the use of GPS technology is growing within the Department. This implies that future benefits to the Department will grow too (particularly as GPS modernization capabilities are implemented). In short, GPS technology is a proven high value asset widely used throughout the Department.

2. **Summarize and quantify total sunk costs in GPS-based infrastructure (prior years to date) and planned investments going forward.**

As mentioned in question one, the 2010 GPS Report estimates the Department has invested in the range of $100 to $200 million in GPS technology. It further estimates the Department invests in GPS at the rate of about $12-$24 million annually. It is important to note that, there is no coordinated plan for GPS investments in DOI. Each bureau, agency or office manages its own GPS investments. Thus, it's difficult to know with certainty what investments are being planned and made.

3. **To the extent possible, qualify, quantify, and describe risks to your agency's GPS-based mission capability, including "lost benefits" if GPS performance were degraded (or lost) due to LightSquared's signals including the costs to modify (or replace) GPS receiver infrastructure and the time frame required to replace that infrastructure.**

Because of the widespread use of GPS within the Department of the Interior (DOI), it is not possible to provide a comprehensive view of the impacts to Interior from the planned LightSquared signals. It is clear the impacts are significant and include safety of life applications.

Several points are highlighted. First, DOI receivers were tested and found to be adversely impacted. The impact of LightedSquared signals to several application domains is explained; these domains include general uses of GPS, natural resources, wildfire, law enforcement, geospatial programs, and hazards. Lastly, the cost to replace or modify existing GPS equipment is discussed.

TESTING OF DOI RECEIVERS

The DOI, through the Bureau of Land Management, arranged to have a number of GPS mapping and survey receivers collect data during the open sky testing at Holloman Air Force Base. This equipment represents a cross section of mapping and surveying receivers currently in use within DOI. In general, all of the Department's tested receivers encountered problems, with some exceptions. The LightSquared signals, as tested, severely limit the Department's use of GPS.

GENERAL

The 2010 GPS report assessed the impact of a GPS outage. The LightSquared signals, in the worst case, would cause a permanent outage of GPS (L1 signal). The Report indicates 84 % of GPS users see permanent loss as high impact. Furthermore, this high impact would be exacerbated because a majority of DOI GPS users do not have back-up plans. Even where back up plans exist, they would result in a more cumbersome work flow for employees and lower accuracy products. For example the report quotes a GPS field user:

> *"... the back-up plan, if GPS were to go out during planned field reconnaissance, would be to rely on making marks on topographic or bathymetric charts. We use to manually plot our routes and mark locations prior to use of GPS. Could do that again. Transferring that information to GIS [Geographic Information System] would result in a less accurate product, but doable. Field reconnaissance is currently planned with the assumption that GPS will be available."*

NATURAL RESOURCES

The leading use of GPS technology in DOI is for natural resource applications. It is a major field data collection tool used by all resource management applications within the Department. If the LightSquared implementation plan goes forward as proposed, it will have a severe negative impact on the Department's ability to efficiently and effectively collect data used to manage our Nation's resources. The Department would be forced to go back to alternative data collection methods, like total station surveys, which would add costs for both operations and personnel. In addition, the LightSquared plan could result in the Continually Operating Reference Station network being impeded thus limiting access to the National Spatial Reference System (NSRS). This will hamper the Department's ability to accurately reference its geospatial data.

WILDFIRE (and Disaster Response)

The Department (in cooperation with the US Forest Service) trains and uses GPS for fire management as well as in the Incident Command System. GPS is used to locate wildfire perimeters, locate spot fires, monitor and fight wildfire, track crew and safety zones, and for other tactical and safety issues. These uses rely upon a robust GPS signal. Without GPS, these efforts would continue, but would rely on map interpretation and aerial sketch mapping, involve more manpower, reduce effectiveness, and consume more days to get a fire incident under control. The result is it will be harder to mange and contain wildfires.

Other disaster responses such as hurricanes and floods rely on the Incident Command System. It is the most efficient management tool to oversee disaster response, using GPS to monitor, track, and make tactical decisions that are identical to fighting wildfires.

LAW ENFORCEMENT

Law enforcement groups within the Department routinely use commercial GPS systems. The GPS uses and impacts cited from the United States Park Police are also widespread among all DOI law enforcement bureaus.

The United States Park Police uses a simulcast radio system that relies on GPS timing to ensure appropriate synchronization of radio transmissions between sites. Disruptions to the GPS signal could have significant adverse affect on these radio systems.

The United States Park Police intends to integrate GPS and Automatic Vehicle Location into cruisers in order to facilitate location data into police reports, precise location marking is critical.

Within the next two years, land mobile radio providers will begin to routinely embed GPS chips into radios. Use of GPS for officer down or non-responsive officers requires precise location marking as a critical life-safety issue.

Within the next two years, the United States Park Police will begin to deploy in-car video units. Manufacturers of these units are also now including GPS technologies for determination of location of recording. Discrepancies in GPS location may result in the exclusion of video as a forensic tool or as evidence in court.

The United States Park Police uses GPS technologies in covert investigations – as well as for vehicle and cell phone tracking. Again, the precise location can be a critical life-safety issue.

GPS is now integrated into E-911 systems. While the United States Park Police is not a primary public safety answering point (PSAP), and does not have an integrated 911 systems, they receive transfer calls from the various PSAPs in the National Capital Region. As these dispatch centers utilize enhanced 911 systems (E-911) or move to next generation 911 systems, the accuracy of GPS will be a critical life-safety issue.

The National Park Service maintains PSAPs in Yosemite, Yellowstone, and Grand Canyon. Large parks rely on E-911 for location-based 911 calls. These PSAPs receive calls from OnStar and other similar vendors that provide emergency response services to the motor vehicle market. Park visitors' lives have been saved based on the reliability of the GPS location-based services included in their vehicles.

Use of GPS based tracking devices is spreading rapidly throughout the DOI landscape. Interior employees and their supervisors are relying on them daily for critical life safety applications.

In the marine environment, GPS is used to pinpoint security zone perimeters, for issuing violation notices, and for coordinates in any boating accident investigation. Most importantly, GPS can determine the location of a vessel in distress when they give coordinates of their location. GPS is used to assist in coordinated and logical grid search and rescue missions for missing vessels. GPS can plot courses when traveling between destinations. GPS will also document precise locations related to death investigations (drowning).

Many of DOI's 3000 boats now include GPS for guidance. Boat operators rely on the accuracy of GPS navigation at night and in adverse weather. Without accurate marine navigation systems, lives will be at risk.

In Aviation, GPS is used in the airborne moving map system and in the aviation flight following systems. It helps employees coordinate and conduct logical grid search and rescue missions. It is used to located and conduct rescue missions or law enforcement support missions for incidents in wild land/back country areas. GPS is utilized to mark potential threat areas or issues in support of Presidential protection duties of the aviation unit.

Law Enforcement Impacts of Compromised GPS Accuracy:

- It would have detrimental impact on life safety of employees and public. As many cellular and personal or vehicle/vessel location devices and systems (such as OnStar) now provide GPS location data, inaccuracies in that data may prohibit a timely response to locating the person or vehicle/vessel in distress. In many instances, seconds and minutes in response time may truly make a life or death difference.
- It would cause issues in responding to unfamiliar locations outside of routine patrol areas for all DOI Law Enforcement Bureaus (responding to wild land/back country areas). This becomes a life safety issue when a GPS location is significantly off or unavailable and a rescue mission cannot be conducted in a timely manner because the precise location is not reliable.
- It could cause critical infrastructure such as police radio systems to fail, removing ability to communicate quickly and effectively with police units.
- It could inhibit effective integration of GPS into law enforcement reports. This brings potential for loss of prosecution because of location discrepancies and removes location as an effective forensic tool in investigation. Additionally, geo-location of incidents (mandated by the White House and Government Accountability Office as part of Incident Management

Analysis and Reporting System) is the basis of predictive policing models and other systems used to determine need for re-engineering of infrastructure. For example, geo-location of motor vehicle crashes is used heavily by the Federal Highway Administration to determine where roadways or traffic signage changes or improvements need to be made. Imprecise locations could result in skewed analysis to address criminal or motor vehicle traffic patterns and behaviors.

- It would impact enforcement of marine security zones. The United States Park Police is responsible for maintaining security zone buoys and making sure their locations are accurate. Potential impact could be loss of ability to prosecute cases successfully.
- It would significantly affect the ability to track airborne assets. Should there be an airborne incident/accident; proper location for emergency response may not be obtainable.

DOI Law Enforcement Summary: With law enforcement programs in 7 bureaus and 4000 officers throughout the United States, disruption to commercial GPS systems could have realistic critical impact to life-safety emergency response and rescue operations. Furthermore, disruption resulting in inaccurate locations could provide legitimate cause for doubt in criminal investigation and prosecution. Finally, inaccurate locations removes effectiveness of predictive modeling tools to address criminal and traffic issues and behaviors, which would adversely affect proactive efforts to reduce crime and enhance traffic safety efforts.

HAZARDS

The Department uses GPS technology in its hazards program. In particular, earthquake and volcano monitoring systems rely upon GPS technology for measuring small movements in the Earth's crust. Very precise records of daily GPS station positions, some going back 20 years, provide irreplaceable information about the deformation associated with volcanoes, earthquakes, and active faulting. These GPS networks are beneficial for understanding earth processes but also for warning of dangerous conditions. Upgrades to real-time processing, currently in progress, will enhance the usefulness of GPS in volcano monitoring, earthquake response, and possibly Earthquake Early Warning. In addition, seismic instruments use GPS for stable, precise timing --also important for understanding and warning of dangerous earthquake events. The long-term inability to use GPS and potential degradation of the GPS L1 signals would have a major detrimental impact in our Nation's ability to understand volcanic and earthquake processes but also pose a threat to the public by not being able to monitor and thus warn of hazardous conditions.

In 2010, the Earthquake and Volcano Hazards Programs collaborated to procure new state-of-the-art GPS equipment using almost $2 million of ARRA (American Recovery and Reinvestment Act) funds. A 5-year task order is in effect, allowing Hazards Programs to use another $2 million of non-ARRA funds, should funding become available for further purchases.

Seismic monitoring: supporting earthquake alerting and tsunami warning

- Global Seismographic Network
- Advanced National Seismic System

Deformation monitoring: regional GPS networks funded by the Department for regional deformation monitoring. (Southern California, San Francisco Bay area, Pacific Northwest, Utah (Wasatch fault), central U.S. /New Madrid Seismic Zone)

Volcano monitoring: seismic, GPS and other geophysical and geochemical monitoring systems. Six volcano observatory sites: Hawaii, California, Oregon/Washington, Alaska, Yellowstone, Marianas

Landslide monitoring: monitoring approximately a dozen research sites in the western United States.

The above rely on GPS timing, although some systems use Network Time Protocol. These systems support Departmental responsibilities under the Stafford act to provide hazard warnings and notifications.

GEOSPATIAL PROGRAMS

Interior's National Geospatial Program (NGP) reports that the degradation of GPS would have devastating impacts on everyone who collects geospatial information. Nearly 100% of the NGP data collection involves the use of GPS. For example, all modern airborne and satellite-based acquisition systems for imagery and other types of remotely sensed geospatial data are dependent on GPS for navigation and positioning. This includes ortho-imagery and elevation data that are part of *The National Map*.

The National Map is a set of basic geospatial information provided as a variety of map products and services. These products and services are used widely by public and private sector agencies in applications such as scientific investigations, emergency response, natural resource management, planning, and recreation.

If GPS were not available, the impact on the NGP and its many partners and contractors in the geospatial community, would be extremely significant. The accurate, current geospatial information users have come to expect to be readily available would be extremely expensive to collect and would likely become quickly out of date. The importance of preserving the quality of the GPS signal is critical to the continued success of the NGP.

COST TO REPLACE/MODIFY CURRENT SYSTEMS

The effects from GPS signal denial would clearly be expensive. It is difficult to speculate on the impact of replacing the Department's GPS receivers. However, the Department estimates that it has over $100 million invested in this technology. The replacement costs are thought to be in the $250-$500 million range.

To some degree, the Department, through its bureaus, agencies or offices, is continually updating and improving its equipment. With the GPS constellation of satellites modernization, the Department will need to upgrade its equipment to take advantage of new GPS signals. In addition, other Global Navigation Satellite Systems (GNSS) are emerging in addition to GPS. The Department will also need to improve upon our current GPS equipment to be GNSS compatible and interoperable.

A short-term requirement for a Department-wide replacement or modification would be chaotic, expensive and negatively influence the Department's GPS applications. Many of these applications are critical to our mission effectiveness and our resource efficiency. With adequate funding, a gradual upgrade or modification to receivers over time (a few years) would be reasonable and would need to be done in a deliberate, well-planned manner.

CONTACTS:

Milo Robinson, Department of the Interior, Senior Advisor, National Coordination Office for Space-Based Positioning, Navigation and Timing (703-648-5162 or 202-482-0019, mrobinson@usgs.gov or Milo.Robinson@pnt.gov).

Chris Lewis, Department of the Interior, Interoperability Program Manager, National Radio and Spectrum Program Management Office (703- 648-5550 or 202-320-3731 Cell, Christopher_Lewis@ios.doi.gov).