**Before the**
**DEPARTMENT OF TRANSPORTATION**
**Washington, DC 20591**

| | | |
|---|---|---|
| In the Matter of | ) | |
| | ) | |
| Complementary Positioning, Navigation, And Timing Capability | ) | Docket No. DOT-OST-2015-0053 |
| | ) | |
| | ) | |

Attention: Office of the Assistant Secretary
for Research and Technology

## COMMENTS OF THE GPS INNOVATION ALLIANCE

The GPS Innovation Alliance ("GPSIA") hereby files these comments in response to the Department of Transportation's ("DOT's") inquiry regarding the United States Government's potential plans to implement an enhanced Long Range Navigation ("eLoran") position, navigation, and timing ("PNT") system as a supplement to the existing Global Positioning System ("GPS").[1] National planning for resilient PNT solutions that supplement and complement GPS represents sound public policy. GPSIA therefore supports exploration and development of an eLoran system that could provide redundancy for certain PNT functions. At the same time, it is important for policy makers to understand the PNT functions that eLoran can and cannot support based on the capabilities of the technology and its usability in different applications.

## I. INTRODUCTION

The GPSIA was formed in February 2013 to protect, promote, and enhance the use of GPS and Global Navigation Satellite System ("GNSS") technologies. GPS and GNSS systems, as well as augmentations to GNSS systems, operate in frequency bands allocated to radio

[1] Department of Transportation, Complementary Position, Navigation, and Timing Capability, N*otice; Request for Public Comment*, Docket No. DOT-OST-2015-0053, 80 Fed. Reg. 15286 (Mar. 23, 2015) (the "Notice").

navigation satellite services ("RNSS"). Members and affiliates of the GPSIA are drawn from a wide variety of fields and businesses reliant on GPS, including manufacturing, aviation, agriculture, construction, transportation, first responders, surveying, and mapping. The GPSIA also includes organizations representing consumers who depend on GPS for boating and other outdoor activities, and in their automobiles, smart phones, and tablets.

Given its strong interest in PNT issues, GPSIA applauds DOT for commencing a public discussion of plans for an eLoran system that could provide a terrestrial supplement to the nation's satellite-based PNT resources. As described more fully below, PNT functions demand a high degree of accuracy and resiliency, and GPS user equipment manufacturers have continually invested to develop new features that maximize these characteristics. eLoran may be able to offer a complementary source of PNT data to users to maintain accuracy in specific applications, and resiliency for some PNT functions during periods when GPS signals may be unavailable. Of course, as in the past, commercial feasibility of adding capability, such as eLoran, to GNSS equipment will ultimately be decided by the demands and requirements of current and future customers and end users. The government's role should consist of making the system available and specifying its use in the safety of life applications where navigation capabilities are now otherwise specified and the use of eLoran is appropriate. In other contexts, the marketplace should determine its acceptance and implementation.

eLoran may involve considerable investment over time to ensure that it reaches its maximum potential as a PNT complement to GPS. However, it should be recognized that eLoran is limited in significant ways that will make it inappropriate to support many high-precision, aviation, and other GPS-dependent functions on an ongoing, regular basis. For these reasons, eLoran should not be considered a substitute for GPS, and the U.S. Government's investments in eLoran should not divert resources from preserving and improving the existing GPS system.

## II. GPSIA SUPPORTS DEVELOPMENT OF ELORAN AS A POTENTIAL COMPLEMENT TO GPS FOR SOME PNT FUNCTIONS.

The public interest would be served by the development of systems that may act as a supplement and complement to the important PNT functions supported by GPS. PNT functions are crucial to a wide range of aviation, maritime, communications (*i.e.*, timing), agricultural, public safety and other functions. The increasing accuracy of GPS and the expansion of GPS functions have led American industry, governmental agencies, and the public to rely on GPS-enabled devices and applications more than ever to provide reliable PNT data.

The GPS marketplace has a long history of innovations that increase the reliability of PNT data. GPS users demand applications that are resilient – both redundant and complementary – and that ensure high-quality PNT data. In response to these demands, GPS manufacturers already include resilient characteristics such as the ability to access multiple GNSS systems. They also have adopted GPS augmentation systems and technologies, including satellite-based augmentation systems like the Federal Aviation Administration's Wide Area Augmentation System ("WAAS") and ground based augmentation systems like the U.S. Nationwide Differential GPS System ("NDGPS"). Many GPS-enabled devices also employ high-stability clock oscillators that preserve the timing function of devices during periods when GPS signals may be unavailable. And, GPS manufacturers include resilient features like inertial navigation and map-matching algorithms to ensure that the position and navigation information provided by their devices is sufficiently accurate to support a full range of functions.

However, like any navigation system, GPS is susceptible to both natural and man-made threats. Therefore, if eLoran can provide a reliable terrestrial back-up to specific PNT functions, the nation's PNT system will necessarily become more robust.

In that regard, eLoran offers several potential benefits. Its high-power, low frequency signal should lead to widespread reception where terrain is not a significant factor and may provide usable data to indoor locations. Moreover, in the unlikely event that GPS is temporarily compromised by a natural or man-made incident, eLoran signal characteristics are sufficiently distinct from GPS to make it unlikely that it would be disrupted by the same occurrence. eLoran requires more testing to ensure that it will function as intended, but may be capable of acting as an alternative source of PNT data for select applications during a short-term GPS disruption.

The governments of the U.K., South Korea, and Russia, among others, have begun to explore introduction of eLoran as a supplemental PNT system. eLoran therefore also provides the U.S. Government with an opportunity to maintain world leadership in the development of resilient PNT systems and solutions. Nevertheless, market confidence to adopt and invest in resilient PNT solutions will depend on stable and transparent public policy commitments on signal availability and access conditions.

## III. ANY CONSIDERATION OF ELORAN SHOULD TAKE INTO ACCOUNT THE TECHNICAL CAPABILITIES OF THE SYSTEM.

While GPSIA supports exploration and development of eLoran, it is important to recognize its specific capabilities and limitations as a PNT resource under certain conditions and the cost of making eLoran a meaningful complement to GPS.

1) <u>Lack of Comparable Performance.</u> eLoran cannot provide the same level of PNT performance as GPS.

2) Substantial Costs Will Be Incurred to Develop Databases. While the costs of restoring and upgrading the existing LORAN system may be relatively modest (estimates of $50 million), there will be substantial costs associated with developing the necessary databases for correction of the eLoran signal, maintenance of the system, and outfitting GPS-dependent equipment and devices with eLoran-capable receivers.

3) Necessary ASF Databases Have Not Yet Been Developed. Positional and navigational applications increasingly rely on the very precise data provided by modern systems that utilize GPS. eLoran is not capable of providing the degree of precision that GPS allows for several reasons. The first structural limitation to eLoran is that to obtain optimal positioning performance, the system must rely on an Additional Secondary Factor ("ASF") database that corrects for the particular ground wave propagation delays typical in a small geographic region, such as a harbor area or airport. The ASF database must be constructed based on local ground surveys using specialized equipment, then uploaded to the eLoran receiver. Without the ASF database information, eLoran position data will not be accurate.[2] ASF databases currently do not exist in the vast majority of areas in the United States, and a very large effort would be required to create ASF databases for a significant portion of the United States. While most discussions to date have focused on the cost to deploy the eLoran transmitter sites and maintenance costs to

---

[2] Each eLoran reference station also transmits differential corrections on its own ranging signal. These transmissions are used to correct for short term propagation delay errors introduced by such factors as the ionosphere, rain, snow, seasonal variation in ASF information and other factors. These differential corrections also are essential to optimizing eLoran performance.

run the eLoran network, such cost and resource estimates also should account for the effort required to create, distribute and maintain the necessary ASF databases.[3]

4) eLoran Does Not Provide the Same Level of Navigational Precision. Even with the use of an ASF database and differential corrections, eLoran does not provide navigation or position data with the level of accuracy needed for many PNT functions. Studies suggest that eLoran can achieve positional accuracy within 10 meters (with 95% confidence) at sites that are well surveyed and have good signal coverage.[4] While this level of accuracy can support many applications, such as Maritime Harbor Entrance and Approach ("HEA"), it does not support GPS applications that require more precise positional location data. High precision agriculture, surveying, automotive navigation, public safety/law enforcement, and intelligent transportation systems are just a few of the many PNT applications that could not function reliably using eLoran positional data alone.[5]

5) eLoran Does Not Provide Vertical Positioning. In addition, due to its limitations as a terrestrial system, eLoran cannot provide positioning in the vertical dimension. That

---

[3] G.W. Johnson, *et. al.*, *An Evaluation of eLoran as a Backup to GPS*, published in the proceedings of the 2007 IEEE Conference on Technologies for Homeland Security, *available at* http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=4227790&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D4227790.

[4] A. Helwig, *et. al.*, *eLoran System Definition and Signal Specification Tutorial*, UrsaNav presentation to the International Loran Association (ILA-40), November 2011, *available at* http://www.ursanav.com/sites/default/files/pdfs/news/UrsaNav%20ILA-40%20eLoran%20System%20Definition%20%26%20Signal%20Specification%20Tutorial.pdf.

[5] Some applications, including (but not limited to) high precision agriculture, surveying, and earthquake fault monitoring have come to rely on position and navigation data that achieves centimeter-level accuracy tracking the GPS signal carrier phase. eLoran would not be capable of matching this level of precision.

limitation does not impede its utility for maritime applications where elevation is constant. In other applications, an independent source of elevation such as a barometric-altimeter must be used to provide accurate enough positional data to support navigation. The most obvious examples of applications that rely on vertical positioning data include those associated with aviation, which rely heavily on vertical position data for precision runway approach functions.

6) An Aviation Standard for eLoran Has Not Been Developed. Another challenge to integrating eLoran into aircraft will be the process for FAA approval of new avionics standards and equipment. While the Radio Technical Commission for Maritime Services, through RTCM SC-127, is actively working on an eLoran standard for maritime applications, there is no parallel effort underway to create an aviation standard. To the contrary, the existing Loran-C equipment Technical Standard Order ("TSO")[6] and the related installation guidance Advisory Circular ("AC")[7] have been cancelled. Further, due to signal modifications with respect to Loran-C and the need to support NextGen applications,[8] any new eLoran standards (TSO and AC) will have to be reviewed for their acceptability in terms of accuracy, integrity, availability and continuity—a multi-year,

---

[6] *See* TSO-C60b, "Airborne Area Navigation Equipment Using Loran C Inputs," May 11, 1988, *cancelled by* http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/0/5C3F6393325E7DDE86256DC0006A1BE0?OpenDocument.

[7] AC 20-121A, "Airworthiness Approval of Loran-C Navigation Systems for use in the U.S. National & Airspace System (NAS) and Alaska," August 24, 1988, *cancelled by* http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/22128.

[8] Alternate PNT such as eLoran would need to support NextGen features such as Required Navigation Performance non-precision approaches and Automatic Dependent Surveillance-Broadcast ("ADS-B").

iterative process. For these reasons, the FAA reportedly has no current plan to adopt eLoran as an alternative means of navigation.

7) Integration of eLoran is a Challenge for Many Devices. Finally, receive antennas typically associated with eLoran will limit adoption of the terrestrial system by many GPS users. Due to the long wavelength of the eLoran signals (3 km), they rely on relatively large E-field and H-field antennas. E-field antennas have proven susceptible to precipitation static ("p-static") in aircraft installations. H-field antennas are susceptible to magnetic fields in many installation scenarios, and may require magnetic field mapping or precision calibration of vehicles – a difficult feat for large ships and aircraft. Moreover, both E-field and H-field antennas are currently not feasible for inclusion in handheld and portable devices. While researchers continue to pursue smaller antennas for integration into portable devices, present day tradeoffs between signal-to-noise ratio and size/weight, as well as cost, make integration of eLoran into small devices an additional challenge that would need to be overcome in the coming years.[9]

[9] De Lorenzo, *et. al.*, *A Miniaturized Loran H-field Antenna for Handheld Devices*, *available at* http://waas.stanford.edu/papers/DeLorenzo_ILA_2009.pdf.

## IV. CONCLUSION

GPSIA looks forward to working with DOT and other government agencies in evaluating the suitability of eLoran as a potential supplement to the current GPS system. As with GPS, commercial adoption of eLoran should be user-driven rather than government-mandated except as otherwise consistent with current required safety of life applications. While the adoption, implementation, and widespread deployment of eLoran solutions face the issues noted in these comments, there is value in beginning this discussion now. eLoran does have the potential to make the nation's PNT resources more diverse and dependable, especially in maritime and other coarse positioning applications, and GPSIA fully supports exploring those possibilities.

Respectfully submitted,

GPS INNOVATION ALLIANCE

By: /s/
James A. Kirkland
President

May 22, 2015