Before the
U.S. DEPARTMENT OF TRANSPORTATION
Washington, DC 20590

In the Matter of	)	
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Demonstration of Backup and Complementary Positioning Navigation, and Timing (PNT) Capabilities of Global Positioning System and GPS	)	Docket No. DOT-OST-2019-0051

Attention: Office of the Secretary

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 its plan to conduct a field demonstration of technologies "that are capable of providing backup positioning, navigation, and/or timing ("PNT") services to critical infrastructure ("CI") in the event of a temporary disruption" to the Global Positioning System ("GPS").[1] Review and testing of resilient PNT solutions that may complement GPS represents sound public policy, and GPSIA has consistently supported exploration and development of systems that could provide redundancy for certain PNT functions.[2] While GPS continues to be the best technology to support a broad range of PNT requirements, the GPS industry supports the exploration of innovative complementary solutions provided they are fully evaluated to ensure that they offer equivalent capabilities and a level of performance on par with GPS technologies.

I. INTRODUCTION

The GPSIA was formed in February 2013 to protect, promote, and enhance the use of

[1] U.S. Department of Transportation, Demonstration of Backup and Complementary Positioning, Navigation, and Timing (PNT) Capabilities of Global Positioning System (GPS), *Request for Information*, Docket No. DOT-OST-2019-0051, 84 Fed. Reg. 19154 (May 3, 2019) (the "Request").

[2] *See*, *e.g.*, "Comments of the GPS Innovation Alliance," filed in Docket No. DOT-OST-2015-0053 (May 22, 2015).

GPS and other Global Navigation Satellite System ("GNSS") technologies. GNSS systems, as well as augmentations to such systems, operate in frequency bands allocated to radio navigation satellite services. 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 who utilize GPS in their automobiles, smart phones, and tablets.

Because GPS is the preeminent PNT technology, GPSIA applauds DOT for seeking comment on conducting the demonstration contemplated by recent legislation.[3] As described more fully below, PNT functions demand a high degree of accuracy and resiliency, and GPS equipment manufacturers are continually investing to develop new features that maximize these characteristics. In some instances, other technologies may be able to offer a complementary source of PNT data for a subset of users' requirements. In the end, the marketplace will decide whether the complementary capability of those other technologies merits users' investment.

Any complementary technologies will likely require considerable development over time to ensure that they reach their maximum potential as true PNT complements to GPS. As DOT conducts the proposed demonstration and takes follow-up actions, it should be alert to the costs required to develop these technologies and the limitations they may possess that restrict their utility for many high-precision, aviation, and other GPS-dependent functions on an ongoing, regular basis. For this reason, the federal government's resources should continue to be principally directed to maintaining and improving the existing GPS system.

[3] Section 1606, National Defense Authorization Act for Fiscal Year 2018, Pub. L. 115-91, 131 Stat. 1283.

II. GPSIA SUPPORTS DEVELOPMENT OF NEW TECHNOLOGIES AS POTENTIAL COMPLEMENTS TO GPS FOR SOME PNT FUNCTIONS

The public interest may be served by the development of systems that act as a supplement and complement to the important PNT functions GPS provides. PNT functions are critical to a wide array of aviation, maritime, communications, agricultural, public safety, and other systems and services. Improvements in the accuracy of GPS-equipped devices and the expansion of GPS functions have led American industry, governmental agencies, and consumers to increasingly rely on GPS-enabled devices and applications for reliable PNT data in many facets of their operations and lives.

The history of the GPS industry is replete with countless innovations that have increased the reliability and accuracy of PNT data. GPS users require applications that are resilient and that ensure high-quality PNT data. In response to these demands, GPS manufacturers already 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 devices also include resilient characteristics, such as the ability to access multiple GNSS systems. Other GNSS constellations, under the right conditions, may provide "expanding PNT capabilities" and may enable "cross-checking." For example, the European Union's Galileo system is expected to include signal authentication, a feature it can offer because its satellites, unlike GPS satellites, have built-in data communications capabilities. This development will provide multi-constellation devices with the ability to combat spoofing and to cross-check signals from other constellations. [4] GPS satellites also continue to improve their

[4] The regulatory and diplomatic environment facilitates these and other benefits for devices that access GNSS systems besides GPS. For instance, the waiver that the FCC recently granted for

capabilities, with new GPS III satellites that are expected to provide signals that enhance robustness. In particular, GPS III satellites will provide improved accuracy, reliability, and interoperability with the new L1C signal. Military users will benefit from increased jamming resistance with the full realization of M-code capability.[5]

In addition, many GPS-enabled devices already employ redundant technologies to improve performance and resilience. For example, GPS-disciplined timing devices employ high-stability oscillators to improve holdover performance—preserving the timing function of these devices in the unlikely event that GPS signals may be unavailable. Many GPS navigation devices also already include resilient features like inertial navigation and map-matching algorithms to ensure that the position and navigation information they provide is sufficiently accurate to support a full range of functions.

Like any satellite-based system, however, GPS is susceptible to both natural and man-made threats; new technologies and systems may be able to provide reliable back-up for specific PNT functions in those circumstances, potentially making the nation's PNT system even more

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GPS-devices to access Galileo signals ensures equal access and robustness for GPS devices' use of Galileo signals. Order, *Waiver of Part 25 Licensing Requirements for Receive-Only Earth Stations Operating with the Galileo Radionavigation-Satellite Service*, FCC IB Docket No. 17-16, FCC 18-158, released Nov. 16, 2018.

In addition, the US-EU bilateral agreement giving GPS-devices access to Galileo signals ensures that the two independent systems are compatible and interoperable, that there will not be discrimination in access, and that open markets will exist for trade in civil satellite navigation-related goods and services. "Agreement on the Promotion, Provision and Use of Galileo and GPS Satellite-Based Navigation Systems and Related Applications," (June 26, 2004), *available at* http://www.gps.gov/policy/cooperation/europe/2004/gps-galileo-agreement.pdf. As accessing additional GNSS signals becomes possible, the industry can expect that new laws and treaties will similarly ensure free utility and benefits that flow from the robustness of other nations' or regions' GNSS systems.

[5] "Benefits Coming from GPS III Constellation," *GPS World*, Apr. 1, 2019, *available at* https://www.gpsworld.com/benefits-coming-from-gps-iii-constellation; *see also* "GPS III: The Future of Global Positioning Systems," *available at* https://www.lockheedmartin.com/en-us/products/gps.html.

robust. Governments in other industrialized countries have begun to examine the introduction of supplements to GNSS systems. DOT's exploration of complementary technologies will provide the U.S. with an opportunity to maintain world leadership in the development of resilient PNT systems and solutions. Nevertheless, marketplace forces and not government mandates should be the primary drivers of demand for these complementary solutions.

III. TESTING AND CONSIDERATION OF COMPLEMENTARY TECHNOLOGIES SHOULD PROBE THE TECHNICAL CAPABILITIES OF THESE PROPOSALS

At a minimum, the proposed demonstration must test and ensure the accuracy of complementary technologies, and DOT must be alert to the level of accuracy that is being delivered – is it 10-*meter* accuracy or 3-*centimeter* accuracy? – and is the level of accuracy appropriate for the intended use case?

For instance, a widely discussed complementary technology – 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.[6] While this level of accuracy may support a number of applications, such as Maritime Harbor Entrance and Approach ("HEA"), it does not support the many GPS applications that require more precise positional location data. High precision agriculture, surveying, automotive navigation, and intelligent transportation systems are just a few of the many PNT applications that could not function reliably using eLoran position data alone.[7]

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[6] 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.

[7] Moreover, for eLoran to obtain optimal positioning performance, it must rely on an Additional Secondary Factor ("ASF") database that corrects for the particular ground wave propagation delays

Demonstrations and testing should also evaluate whether the complementary technology offers vertical positioning capability. For aviation applications, terrestrial systems, such as eLoran, can only back up GPS with respect to a few phases of flight, such as en route, terminal, and non-precision approaches. More accurate approach requirements, such as WAAS approaches, are not certified for eLoran backup. Relying only on eLoran would leave several thousand airports unable to offer precise approaches.

The evaluation of complementary technologies, however, should not focus on one core feature like accuracy. While accuracy is very important, for a back-up system to meet the needs of existing and future PNT users, it must deliver not only an accurate signal, but one that has integrity and is available and continuous. GPSIA has explained these core features in detail elsewhere, and they must be demonstrated for any complementary offering.[8]

The proposed demonstration must also focus on various other practical capabilities and limitations. First, the demonstration should evaluate whether the complementary technologies can be successfully integrated into current or future devices, particularly hand-held mobile and wearable devices that have extreme cost sensitivity due to high production volume, power constraints due to battery-life requirements, and space limitations due to their small size. A truly complementary technology must be accessible to the millions of individuals using such devices.

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typical in a small geographic region, such as a harbor or an airport. ASF databases currently do not exist in many areas of the United States, and an extensive effort would be required to create ASF databases for a significant portion of the country. Similar concerns should be taken into account when DOT evaluates other complementary back-up technologies.

[8] *See*, Written Ex Parte Presentation of F. Michael Swiek, GPSIA, FCC IB Dockets 12-340 *et. al.*, July 13, 2017, at 4-5. *Accuracy* is the difference between a GPS device's indicated position, velocity, and time ("PVT") and its actual PVT at any given moment. *Integrity* is the ability of GNSS systems to provide *timely* warning to users of problems in the system or equipment and shut itself down when it is unable to meet accuracy requirements. *Availability* describes how often a GNSS system is available for use when it satisfies accuracy and integrity requirements. The fourth attribute, *continuity*, evidences GPS's ability to provide the required level of service without unscheduled interruption.

Second, the demonstration should evaluate the geographic reach of the complementary technology; is it capable of delivering wide-spread (national or global) back-up, or is it merely regional or local in scope? Can the technology's reach be modified or expanded over time, and at what cost?

The proposed demonstration offers an opportunity to determine the attributes of possible back-up technologies, but the demonstration will only be valuable if it fully explores all relevant characteristics of PNT systems.

IV. THE MARKETPLACE SHOULD DETERMINE THE ULTIMATE "WINNERS AND LOSERS"

To merit consideration and make demonstration and testing meaningful, the proposals should be at a high level of technology readiness. The Request states that the proposals included in the demonstration must be of at least Technology Readiness Level ("TRL") 6 or higher.[9] As DOT has made clear in the past, "TRL 6" simply means a prototype of the new technology has been "demonstrated in [a] relevant environment."[10] Not until a new concept reaches "TRL 7" has a "prototype [been] demonstrated in an operational environment"; as DOT itself has stated, products at "TRL 6" and below have not faced "real-world conditions."[11]

Performance in "real world conditions" will be absolutely essential to evaluating whether a new technology can actually back up a service as critical as GPS. GPSIA encourages DOT to only test products at "TRL 7" or higher. Satisfactory "real world" performance will be essential for marketplace adoption, and, in light of constrained resources, DOT should not give recognition

[9] Request, 84 Fed. Reg. at 19154.

[10] U.S. Department of Transportation, Federal Highway Administration, "*Technology Readiness Level Guidebook*," 2015, at 7, *available at* https://www.fhwa.dot.gov/publications/research/ear/17047/17047.pdf.

[11] *Id*.

or opportunities to proposals that do not meet that threshold.

In the end, market-driven back-up technologies will sustain themselves on their own merits, without legislation requiring their utilization, if they provide true complements to what is not fully available from GPS capabilities and support. These new entrants will be required to provide capabilities unavailable from GPS in order to succeed.

V. CONCLUSION

GPSIA looks forward to working with DOT in evaluating other technologies as potential complements to GPS. DOT should ensure that the coming demonstration provides an opportunity to probe fully both the capabilities and limitations of these back-up technologies. DOT should be alert not only to their limitations but also to the costs of their implementation. As with GPS, commercial adoption should be user-driven rather than government-mandated, except as otherwise consistent with required safety of life applications. Back-up technologies have the potential to make the nation's PNT resources more diverse and dependable, and GPSIA fully supports exploring these possibilities.

Respectfully submitted,

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