Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C 20554

In the Matter of	)	
	)	
Promoting the Development of Positioning,	)	WT Docket No. 25-110
Navigation, and Timing Technologies and	)	
Solutions	)	

COMMENTS OF THE

NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

As the President's principal adviser on information and communications policies, the National Telecommunications and Information Administration (NTIA) respectfully submits these comments on behalf of the Executive Branch.[1] In opening this inquiry, the Federal Communications Commission (Commission or FCC) grapples with vulnerabilities in a bedrock United States Government-provided technology, the Global Positioning System (GPS). The Executive Branch has previously recognized the crucial role of GPS for national and economic security.[2] Moreover, as the Commission notes, Federal agencies have key roles in operating and/or transforming the GPS system.[3]

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[1] NTIA is the Executive Branch agency principally responsible for the development of communications policies pertaining to the Nation's economic and technological advancement and to the regulation of the communications industry, for the coordination of the communications activities of the Executive Branch, and for the effective presentation of the views of the Executive Branch to the Commission. *See* 47 U.S.C. § 902 (b)(2).

[2] Exec. Order 13905, "Strengthening National Resilience Though Responsible Use of Positioning, Navigation and Timing Services," 85 Fed. Reg. 9359 (Feb. 12, 2020)(Executive Order 13905); White House, National Space Policy of the United States of America (Dec. 9, 2020) (National Space Policy) *available at* https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/12/National-Space-Policy.pdf

[3] FCC Notice of Inquiry, Promoting the Development of Positioning, Navigation, and Timing Technologies and Solutions, WT Docket No. 25-110, FCC 25-20 (Mar. 28, 2025) (PNT NOI) at ¶¶ 6, 14-15.

The Commission's "whole of government" approach aligns with Executive Branch operations, authorities and initiatives.[4] In these comments, NTIA highlights the key roles Federal agencies play in sustaining and improving Positioning, Navigation and Timing (PNT) services.

The Commission's "system of systems" approach seeks to ensure that the information gathered in this proceeding is comprehensive, among other benefits.[5] At the same time, the Commission flags a number of challenges. The record amassed in this proceeding promises to help to clarify and potentially prioritize policies for PNT.

NTIA agrees with the Commission's emphasis on incentivizing complements or augmentations to GPS.[6] NTIA will work with Federal agencies and the Commission on how best to accomplish this. Following more extensive interagency coordination, NTIA intends to supplement these comments.

Background

Role of the Executive Branch

~ Operation and Maintenance

The United States Government operates the current GPS system. The military originally designed the system for its own use. However, from the outset, the system has also served civil applications.[7] The Department of Defense (DOD) maintains, operates and secures the satellites,

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[4] *Id*. ¶¶4, 14-15.
[5] *Id.* ¶ 16.
[6] *Id*.
[7] 10 U.S.C. § 2281 requires DOD to make the service free of charge. This dates from the time of President Reagan's 1983 declaration after the downing of Korean Airlines Flight 007. Availability of GPS for civilian use was established before GPS even became operational. *Cf* "Statement by Deputy Press Secretary Speakes on the Soviet Attack on a Korean Civilian Airliner" (Sept.16, 1983) *available at* https://www.reaganlibrary.gov/archives/speech/statement-deputy-press-secretary-speakes-soviet-attack-korean-

payloads and associated parts that comprise the GPS system. GPS primarily operates in middle earth orbit satellites at 1-2 GHz.[8]

Satellite PNT services like GPS fundamentally depend on five systems: (1) Timing, (2) Earth Orientation Parameters (EOP), (3) Earth Gravitational Models (EGM), (4) World Magnetic Model (WMM), and (5) Terrestrial Reference Frame (TRF) and Celestial Reference Frame (CRF) standards and models.[9] The United States Naval Observatory (USNO) serves as the DOD authoritative source for the positions and motion of celestial bodies, motions of the Earth, and precise time. USNO is the source of PNT information for all DOD systems. It also serves as the time standard for many civilian applications, as well. Cellular networks, banking, financial markets, emergency services, all modes of transportation, agriculture and the U.S. power grid require time synchronization.

To ensure synchronized time across all government functions, USNO operates and maintains the Master Clock, providing Universal Coordinated Time (UTC)[10] to customers. NIST also provides UTC time to many customers in the energy, financial, and transportation sectors - primarily for U.S. civilian critical infrastructure and other public uses.

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civilian-airliner-1; Space Policy Directive 7 (Jan. 15, 2021), *available at* https://www.transportation.gov/sites/dot.gov/files/2023-11/Memorandum%20on%20Space%20Policy%20Directive%207.pdf ("SPD-7") (President Trump's directive, *inter alia,* that US policy for space-based GPS be free of charge).

[8] NovAtel, "GNSS Frequencies and Signals," *available at* https://novatel.com/support/known-solutions/gnss-frequencies-and-signals?utm_source=chatgpt.com.

[9] Terrestrial Reference Frame, provides the standard for measuring the position of objects on the ground and in space. NASA Jet Propulsion Laboratory, "What is Terrestrial Reference Frame?" *available at* https://www.jpl.nasa.gov/site/jsgt/jtrf/about/; The International Celestial Reference Frame System is the fundamental celestial reference system adopted by the International Astronomical Union (IAU) for high-precision positional astronomy. United States Naval Observatory, Astronomical Applications Department, *available at* https://aa.usno.navy.mil/faq/ICRS_doc.

[10] Coordinated Universal Time (UTC) is the global standard for time, based on atomic clocks maintained in national laboratories around the world. ITU, "Coordinated Universal Time: An Overview" *available at* https://www.itu.int/hub/2023/07/coordinated-universal-time-an-overview/.

Earth Orientation, the TRF (WGS-84) and the CRF (ICRF1) rely on availability of radio frequency spectrum.[11] NASA's Very Long Baseline Interferometry (VLBI)[12] Global Observing System (VGOS)[13] and the Very Long Baseline Array (VLBA)[14] operated by the National Science Foundation's (NSF's) National Radio Astronomy Observatory provide critical contributions to TRF, CRF and Earth Orientation Parameters (EOP). USNO uses VGOS and VLBA broadband radio spectrum data to calculate the position of the Earth every day.[15]

~ Recent Initiatives

In 2020, President Trump announced the National Space Policy, providing guidance for all space-based activities, including GPS.[16] He also signed Executive Order 13905, calling Federal agencies into action to strengthen national resilience through responsible use of PNT services.[17] The Administration followed with Space Policy Directive 7.[18] This reaffirmed the previously established National Space-Based Positioning, Navigation, and Timing Executive

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[11] These models are constructed utilizing observations of many distant galaxies to provide a reference for the Earth as it spins, wobbles and moves in its orbit around the Sun. World Geodetic System 1984 (WGS 84) is a 3-dimensional coordinate reference frame for establishing latitude, longitude and heights for navigation, positioning and targeting for the DoD, IC, NATO, International Hydrographic Office and the International Civil Aviation Organization. National Geospatial-Intelligence Agency, Office of Geomatics, "World Geodetic System 1984 WGS 84) *available at* https://earth-info.nga.mil/index.php?dir=wgs84&action=wgs84. ICRF1 refers to the International Celestial Reference Frame Standard adopted by the IAU in 1998. Science Direct, "Establishment of the ICRF" *available at* https://www.sciencedirect.com/science/article/abs/pii/S0273117702002831.

[12] Very Long Baseline Interferometry (VLBI) is an interferometric technique for greatly enhancing spatial resolution of astronomical observations by the use of two or more individual observing sites spaced at great distances. More information is *available at* https://www.cfa.harvard.edu/research/topic/very-long-baseline-interferometry.

[13] The VLBI Global Observing System (VGOS) is a VLBI observing network focused on the astronomical subfield of Space Geodesy/Geodetic observing (which applies the radio astronomical VLBI method using cosmic extragalactic radio sources as celestial reference points to monitor the orientation of the Earth and to determine terrestrial reference points). More information is *available at* https://earth.gsfc.nasa.gov/geo/instruments/vlbi-global-observing-system-vgos.

[14] The Very Long Baseline Array (VLBA) is an interferometric network of 10 stations located throughout the continental United States, U.S. Virgin Islands, and Hawaii. More information is *available at* https://science.nrao.edu/facilities/vlba/introduction-to-vlba.

[15] *See generally* USNO, Celestial Reference Frame Department, *available at* https://crf.usno.navy.mil/.

[16] National Space Policy, *supra* note 2.

[17] Executive Order 13905, *supra* note 2.

[18] "Memorandum on Space Policy: Directive 7" (Jan. 15, 2021) *available at* https://trumpwhitehouse.archives.gov/presidential-actions/memorandum-space-policy-directive-7/.

Committee (PNT EXCOM).[19] The PNT EXCOM reports to the White House as the interagency body guiding and preserving whole-of-government interests in the provision of space-based PNT services, augmentations, and space-based alternatives. The Deputy Secretaries of Defense and Transportation co-chair this committee.[20]

In 2021, the White House released a national plan for research and development of PNT, as required under President Trump's Executive Order 13905.[21] The Department of Transportation (DOT) has published a PNT Strategic Plan and a Complementary PNT Action Plan.[22] Congress directed DOT to develop complementary terrestrial PNT systems.[23] DOT is facilitating adoption of commercial complementary PNT (CPNT) systems.[24] In evaluating the demonstration results, DOT found that "the best strategy for achieving resilient PNT service is to pursue multiple technologies to promote diversity in the PNT functions that support transportation and other critical infrastructure sectors."[25] DOT awarded nine vendor contracts in 2024 and is currently evaluating proposals for Complementary PNT Rapid Phase II to increase the diversity of CPNT technologies under consideration.[26]

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[19] National Security Presidential Directive 39, Fact Sheet (2004)(NSPD-39), *available at* https://irp.fas.org/offdocs/nspd/nspd-39.htm.
[20] The PNT ExCom NCO supports the meetings and functions of the ExCom and its Executive Steering Group. *Id.*
[21] National Science and Technology Council, National Research and Development Plan for Positioning, Navigation, and Timing Resilience (2021) at i, *available at* https://bidenwhitehouse.archives.gov/wp-content/uploads/2021/08/Position_Navigation_Timing_RD_Plan-August-2021-1.pdf.
[22] U.S. Department of Transportation, Positioning, Navigation, and Timing Strategic Plan, *available at* https://www.transportation.gov/pnt; U.S. Department of Transportation, Complementary PNT Action Plan at 2-3 (2024)(Complementary PNT Action Plan), *available at* https://www.transportation.gov/sites/dot.gov/files/2024-03/DOT%20Complementary%20PNT%20Action%20Plan_Final_Updated_March%202024.pdf.
[23] Complementary PNT Action Plan, *supra* note 22.
[24] U.S. Department of Transportation, *National Timing Resilience and Security Act Roadmap to Implementation, Report to Congress* (Jan. 2021), *available at* https://www.transportation.gov/sites/dot.gov/files/2021-01/NTRSA%20Report%20to%20Congress_Final_January%202021.pdf=.
[25] U.S. Department of Transportation, *Complementary PNT and GPS Backup Technologies Demonstration Report* (Jan. 2021) (GPS Backup Report), at xxxviii, *available at* https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/complementary-pnt-and-gps-backup.
[26] US Department of Transportation, "Department of Transportation Awards $7 million for Complementary Positioning, Navigation and Timing Technologies" (July 3, 2024) *available at*

The National Institute of Standards and Technology (NIST) has responded to Executive Order 13905 in many ways. NIST has developed independent calibration services for Global Navigation Satellite System (GNSS)[27] that can allow customers to synchronize to UTC to within a few nanoseconds. These services deliver timing signals over optical fiber and two-way satellite time and frequency transfer via satellites in geostationary.[28] NIST has also provided access to its local realization of UTC to industry in order to document the performance of several commercial-based CPNT technologies.

The Executive Branch welcomes the Commission's PNT initiative. NTIA plans to participate in this "whole of government" effort.

I. The Commission's "System of Systems" Approach Will Produce a Comprehensive Record and Enable a Trenchant Inquiry

NTIA supports, as does the Commission, the "development of PNT solutions that can serve as a complement or alternative to GPS."[29] Adopting a "system of systems" approach to this inquiry will ensure that the Commission can examine a diversity of technologies, each of which may differ in positive and negative attributes. As DOT found after testing numerous technologies:

> "The demonstration indicates that there are suitable, mature and commercially available technologies to backup or complement the timing services provided by GPS. However, the demonstration also

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https://www.transportation.gov/briefing-room/department-transportation-awards-7-million-complementary-positioning-navigation-and. DOT has issued a follow-up presentation for operationally-ready vendors. U.S. Department of Transportation, "Complementary Positioning, Navigation, and Timing (CPNT) Services Rapid Phase II," *available at* https://www.transportation.gov/pnt/complementary-positioning-navigation-and-timing-cpnt-services-rapid-phase-ii.

[27] Global Navigation Satellite System is the generic term for any satellite constellation that provides PNT services on a global or regional basis.

[28] NIST Store, "Time Over Fiber Subscription Service, *available at* https://shop.nist.gov/ccrz__ProductDetails?sku=78200C&cclcl=en_US; NIST Store, "Time Over Satellite Special Test" *available at* https://shop.nist.gov/ccrz__ProductDetails?sku=78500S&cclcl=en_US.

[29] PNT NOI, *supra* note 3, ¶ 16.

> indicates that none of the systems can universally backup the positioning and navigations capabilities provided by GPS and its augmentations. The critical infrastructure positioning and navigation requirements are so varied that function, application, and end-user specific positioning and navigation solutions are needed. This necessitates a diverse universe of positioning and navigation technologies."[30]

Such diversity could help achieve an overall resiliency while meeting end user needs. The Commission's comprehensive approach will allow it to address any potential pitfalls before they arise.

II. The Commission Should Seek Information on Potential Challenges for Interoperability, Standards Adoption, and Graceful Technology Transitions

A diversity of systems allows for redundancy and greater customization to user needs. However, such diversity has the potential to cause interoperability issues. The Commission should ask what elements of a new technology must interoperate with existing systems, and whether these new technologies must be able to interoperate with each other. NTIA urges the Commission to incentivize new CPNT systems to harmonize with existing PNT systems and with each other.

This raises a related issue: whether standards-setting bodies, or the Commission, can or should develop protocols applicable to CPNT diversity. The Commission, in collaboration with the relevant Federal agencies, should explore whether PNT standards must use the same (quantifiable, testable) basis for timing and positioning so that different equipment makes or models of complementary PNT technologies can perform together in the same industry ecosystem and remain in sync. The Commission, coordinating with the relevant Federal partners, should consider whether existing standards could do this, or if standards bodies must

[30] DOT GPS Backup Report, *supra,* note 25, at 194.

fill gaps. If a proposed technology requires new standards, would that new standard be, or have to be, backward-compatible?

To maintain resiliency, a proposed CPNT solution might need to transition to a different provider if its service somehow faded or became untrustworthy. The Commission should ask how a given proposed technology could make this change, and whether such a transition requires a certain level of compatibility between technologies.

III. Safeguarding PNT Means Protecting the Radio Frequencies That Support It

The current GPS system relies on radio frequencies. The Commission accurately notes the potential for manipulation and disruption of space-based PNT.[31]

In addition, three (TRF, CRF, and EOP models) of the five systems foundational to PNT described above rely on regular observations of distant galaxies at consistent radiofrequency bands.[32] However, radiofrequency noise is increasing where the telescopes conducting these observations are located. The S (centered at 2.3 GHz) and X (centered at 8.4 GHz) radio frequency bands have enabled these observations for decades. However, S band interference has risen. Wider band models for VGOS (2 – 14 GHz) and for VLBA (8 – 40 GHz), of necessity, are being pursued.

The Government preferentially constructed the geodetic telescopes for these observations in remote locations away from populations. However, radiofrequency emissions, especially from some satellites, have risen. This challenges the assumption that remote location can offer sufficient interference protection. New advanced techniques, such as Operational Data Sharing,

[31] PNT NOI, ¶¶ 10-11.
[32] *See* text at note 9*, supra*.

may be useful to mitigate impact to these critical observations.[33] Geodetic observations contributing to the TRF, CRF, and EOP models are a critical part of the data supply chain necessary for accurate PNT.

Striving for more resilient PNT and CPNT, the NSF and the USNO are studying possible revitalization of the U.S. VLBI infrastructure, including building new antennas and receivers at locations less susceptible to radiofrequency interference. Needed spectrum protections at the geographic locations of VLBA, VGOS or new sites discussed above will require a whole-of-Government effort. Such an effort will produce a stronger underpinning for PNT and CPNT using the TRF, CRF, and EOP models. This in turn benefits both federal and commercial sectors. Thus, NTIA urges the Commission to consider spectrum protections for the existing GPS system, including its foundational technologies.

IV. New CPNT Systems May Need More Spectrum to Sustain Foundational PNT Models as Well as Their Own CPNT Systems

Increased external radio frequency use requires additional interference protections and mitigations to safeguard the underlying models for PNT and CPNT. Also, as the number of CPNT systems relying on these models increases, the Commission will have to understand whether these additional systems will need more enhanced geodetic observations. Such an increase may demand additional spectrum.

The Commission established the National Radio Quiet Zone (NRQZ) in 1958. The Commission should explore whether the NRQZ and other appropriate geographic areas, including around VLBA stations, could be used to enhance critical radio astronomy observations

[33] Operational data sharing enables dynamic spectrum sharing with satellite networks. NSF, National Radio Astronomy Laboratory, "Operational Data Sharing" *available at* https://obs.vla.nrao.edu/ods/.

for the fundamental underlying models to PNT, especially TRF, CRF, and EOP. The Commission should also explore encouraging dynamic coordination techniques that could enhance these critical observations while meeting the spectrum needs of other commercial wireless stakeholders, including CPNT providers.

Finally, the Commission must take account of the spectrum resources that new CPNT providers will require apart from these foundational models, as well as possible impacts for other spectrum users, especially for the existing incumbents supporting national security missions. The Commission should factor in whether the technology will use licensed or unlicensed spectrum, whether the spectrum needs of a provider will likely grow over time, and whether the new CPNT service will give rise to congestion in the long run. The Commission should consider whether the proposed PNT technology is capable of spectrum sharing and whether it is resilient to out-of-band emissions from other sources. The Commission should also consider whether it needs to formulate new performance metrics for these new technologies.

The Commission should also take into account the emergence of non-spectrum-based alternative or complementary PNT technologies. These have the potential to lessen the demand for spectrum resources both for existing PNT systems and their foundational technologies, as well as to minimize or even obviate the need for more spectrum for new systems. Magnetic navigation systems, which use scalar magnetometers to extract positioning and navigation data, are one example.[34]

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[34] Schweber, Bill, "Magnetic-Field Navigation as an "Alternative" GPS?" *Electronic Design* (November 20, 2020), https://www.electronicdesign.com/markets/automation/article/21145842/electronic-design-magnetic-field-navigation-as-an-alternative-gps.

V. The Commission Should Use All of Its Tools to Stimulate CPNT Investment and Adoption

End-User Adoption

GPS has always been free of direct service fees to consumers. The Commission must consider whether a new civil CPNT service will cost end users or continue to be free. If the former, a critical question is whether the new PNT service can motivate end users to pay.

The Commission should explore approaches that can generate consumer adoption. The Commission should consider how a new PNT technology might appeal to a broad customer base, or a large first-adopter user group, such as agriculture, government, or public safety.

Public/Private Partnerships

The Commission asks about the opportunities for public-private partnerships in advancing PNT technologies.[35] DOT has encouraged partnerships between PNT technology vendors and critical infrastructure owners and operators to facilitate adoption and use of CPNT technologies.[36] NTIA encourages the Commission to foster partnerships, which would increase end-user adoption.

Test Beds

The Commission asks whether it should foster testbeds to help develop new technologies.[37] If the Commission moves forward with this concept, it should consider if different types of testbeds, varying by purpose, should be created. For example, should there be specific testbeds to demonstrate performance and feasibility, to prove out interoperability, to

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[35] PNT NOI, ¶ 59.
[36] Inside GNSS, "DOT Issues Follow-Up Solicitation for Complementary PNT Testing and Evaluation" (Feb. 14, 2024) *available at* https://insidegnss.com/dot-issues-follow-up-solicitation-for-complementary-pnt-testing-and-evaluation/.
[37] PNT NOI, ¶ 60.

award certification, to assure compatibility and protection from radio frequency interference, or to validate[38]. In addition, the Commission should explore how different CPNT proposals perform in a contested environment against vulnerabilities common to a particular technology, such as against cable cuts for a wired system, equipment theft or vandalism for a terrestrial system, or jamming for a radio-frequency-based system.

CONCLUSION

NTIA applauds the Commission for moving forward on these crucial positioning, navigation and timing issues. The questions raised are full of interdependencies and ramifications. NTIA plans to delve deeper into them after further coordination within the Executive Branch and may provide supplemental information for the record of this proceeding.

Respectfully submitted,

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[38] The DOT Complementary PNT Action Plan, *supra* note 22, identifies three models of CPNT test beds: federal, critical infrastructure, and commercial. DOT is utilizing these testbed models in executing its Complementary PNT Rapid Phase testing.