

February 12, 2025

VIA ECFS

Marlene H. Dortch
Secretary
Federal Communications Commission
45 L Street NE
Washington, DC 20554

Re: *Wireless Telecommunications Bureau and Office of Engineering and Technology Seek
Comment on NextNav Petition for Rulemaking, WT Docket No. 24-240, RM-11989*

Dear Ms. Dortch:

The Resilient Navigation and Timing Foundation (hereafter RNTF) is a public benefit 501(c)(3) scientific and educational charity. We advocate for policies and systems to protect, toughen, and augment America's positioning, navigation, and timing (PNT), especially the Global Positioning System (GPS). Our organizational role is to also educate government, industry, and end-users on the increasing role of GPS and PNT in critical infrastructure and the implications for national, homeland, and economic security.

As a 501(c)(3), RNTF is prohibited from supporting our members' commercial interests and makes every effort to provide the government and public with advice that is as impartial and objective as possible. Our RNTF individual and corporate members have broad expertise in space-based and terrestrial PNT (T-PNT). This experience gives us a unique and comprehensive perspective on PNT technology, as well as gives us insight on government/private sector coordination related to national PNT policy and systems.

The RNTF Board of Directors reflects the organization's civil and military PNT experience. The chairman of the RNTF board of directors is a former Assistant Secretary of Transportation, the Honorable Greg Winfree. Our president, Dana Goward, is a retired senior Coast Guard officer, former member of the federal Senior Executive Service, and served as the maritime navigation authority for the United States. Another board member is General William Shelton, U.S. Air Force (ret.), and former Commander of U.S. Air Force Space Command. All three are also members of the President's National Space-based Positioning, Navigation, and Timing Advisory Board (PNTAB). The PNTAB is the principle expert group that informs both defense and civil agency leads for GPS and other PNT issues. This extends to future generation PNT, international PNT, spectrum allocation, and coordination among our international counterparts. The PNTAB regularly provides recommendations to government and periodically formalizes them in reports.

The attached white paper supplements the comments we filed in WT Docket No. 24-240 on the 3rd of September 2024 in response to NextNav's petition for rulemaking, which sought to reconfigure the Lower 900 MHz band (902-928 MHz) to support T-PNT as well as a high-power terrestrial service. This brief was developed by RNTF staff in consultation with some of our members experienced in both PNT and telecommunications to respond to NextNav's PNT propositions.

While the country's need to supplement GPS is real and pressing—NextNav's FCC petition is less than candid and inappropriate.

It is less than candid in its discussion of the maturity and capability of its technology and the potential for NextNav's agreements with telecommunications providers who already have the capability to develop and implement PNT capability without their help.

It is inappropriate as it demands large amounts of spectrum it openly admits are not required to develop and implement its technology.

Also inappropriate is NextNav's request for the FCC to act in a way that is anti-competitive by granting them a multi-billion-dollar windfall without considering the number of alternative technologies and offerors in the T-PNT space. Over twenty other companies offer terrestrial technologies that provide backup and alternative sources of timing and/or positioning and navigation. To our knowledge, none require or are requesting additional spectrum to subsidize their efforts.

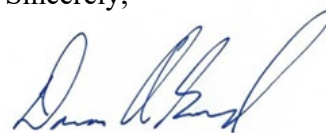
Our paper:

- Explains the false assertion that one system could adequately complement and backup GPS across all use cases and environments, given our nation's diverse maritime, aviation, terrestrial, and cyber PNT demands.
- Addresses the patently false assertions by NextNav that its system is the only T-PNT "solution" capable of providing comprehensive GPS backup.
- Demonstrates that the national interest is best served by implementing T-PNT systems without modifying spectrum allocations. Leading T-PNT systems available today do not require such modification, reallocation, or place burdens on incumbent operations by vacating those to support NextNav's spectrum windfall proposal absent justification.
- Explains why granting NextNav's subsidy request is harmful to GPS resilience, public policy, and outside the scope of FCC authority since PNT is primarily the responsibility of the executive branch.
- Explains how a grant of a windfall spectrum license—which if auctioned would be worth billions of dollars—opens the FCC to charges that it is anti-competitive as well as charges that it is using its authority to dispense spectrum inconsistent with the public interest, especially given the unproven claims at issue here. NextNav provides the FCC no credible evidence showing that it has or could deploy backup GPS. Its claims are unproven unlike the NIST-test solutions that are already currently in operation such as BPS and eLoran.

In short, approving NextNav's application will unjustifiably enrich its shareholders while doing nothing to make our nation safer.

Please contact me if you have any questions.

Sincerely,



Dana A. Goward

President, RNT Foundation

Attached: *Granting the NextNav FCC Proposal Will Not Solve the Country's GPS Challenge*



GRANTING THE NEXTNAV FCC PROPOSAL WILL NOT SOLVE THE COUNTRY'S GPS CHALLENGE

A White Paper on Positioning, Navigation, and Timing (PNT) Alternatives to NextNav
Prepared by the Resilient Navigation and Timing Foundation

February 12, 2025

Disclaimer: The Resilient Navigation and Timing Foundation (RNTF) is a 501(c)(3) public benefit, scientific, and educational charity. We advocate for policies and systems to protect GPS satellites, signals, and users. This report is based on the best information available to our board of directors and does not necessarily reflect the views or interests of our individual or commercial members.

Table of Contents

I. Introduction..... 3

II. The United States Must Supplement GPS to Address Security Concerns. 3

III.No Single System Is Enough to Protect America. 5

IV. There Are Many Alternatives That Are Better Suited to Address the Country’s PNT Challenge Without the Cost and Dislocation That Would Be Imposed by NextNav’s FCC Petition..... 7

A. Other Solutions Will Address the Nation’s PNT Challenge Without Requiring a Spectrum Subsidy from the FCC. 7

V. NextNav’s Proposed Solution Falls Short of Other Terrestrial PNT Systems..... 8

VI. The Nation Needs a Whole-of-Government Solution. 9

VII. Conclusion 10

I. Introduction

The Federal Communications Commission (FCC) is considering a Petition for Rulemaking from NextNav, Inc. (NextNav) to substantially change its rules for the 902-928 MHz band. Comments filed by a wide range of parties show this proposal will undermine valuable existing operations across the country related to transportation systems, industrial operations, and many other industries. Given the great costs associated with NextNav's proposal, it would have to deliver enormous benefits for the FCC to consider it.

NextNav makes an extraordinary claim about that benefit by asserting that granting the petition is necessary for the country to develop an alternative and complementary positioning, navigation, and timing (PNT) system for GPS. The Resilient Navigation and Timing Foundation (RNTF) is well positioned to assess this claim, as our membership represents broad expertise in PNT systems and deep experience with the applications of these technologies to our Nation's security.

Our conclusion is that (1) the United States must develop alternatives to GPS and strengthen its PNT capabilities but (2) granting the NextNav petition is costly in terms of spectrum, not necessary to achieve this goal and likely would not even deliver a real-world improvement in the country's PNT capabilities.

This white paper (1) discusses why the U.S. must supplement GPS to address security concerns, (2) provides that, in doing so, the U.S. should not rely on any one solution, and (3) explains that there are many alternatives to NextNav that do not require the FCC to undermine other economically important spectrum users and do not suffer from the fundamental flaws found in NextNav's approach.

II. The United States Must Supplement GPS to Address Security Concerns.

The United States is highly reliant on PNT signals from GPS satellites to support critical infrastructure and nearly every facet of modern life. This dependence has grown over the years to the point where a member of the National Security Council described GPS as a "single point of failure" for the nation.¹

While the GPS system itself has had vanishingly few outages or malfunctions over the last 30 years, its signals are so weak that they can easily be disrupted or blocked by readily available—though illegal to use—handheld devices and other equipment. Of perhaps greater concern is that GPS signal specifications are publicly available. Hacker tutorials and the advent of relatively inexpensive software-defined radios have made the ability to imitate GPS signals and provide false location information to users available to reasonably proficient hobbyists.²

¹ Dana Goward, *NSC Director: GPS 'Still a Single Point of Failure'*, GPS WORLD (Jan. 4, 2022), <https://www.gpsworld.com/nsc-director-gps-still-a-single-point-of-failure/>.

² Parmy Olson, *Hacking a Phone's GPS May Have Just Got Easier*, FORBES (Aug. 7, 2015), <https://www.forbes.com/sites/parmyolson/2015/08/07/gps-spoofing-hackers-defcon/>.

This has enabled attacks from a wide range of bad actors from organized crime hijacking cargo³ to nation states' attacks.⁴

As our dependence on GPS signals has greatly increased, so too have the threats and disruptions to GPS signals around the globe. In 2021, Russia shot down one of its defunct satellites and threatened to destroy all 32 GPS satellites “and blind NATO” if the U.S. or the alliance interfered with its invasion of Ukraine.⁵ Media reports have indicated that Russia plans to place a nuclear weapon in space to threaten satellites, and that both Russia and China have or will likely soon have the ability to interfere with GPS signals from space—impacting huge areas, if not the entire globe.⁶

Both China and Russia have terrestrial PNT (T-PNT) systems that make them much more resilient to interference with their satellite navigation systems. This navigation warfare asymmetry provides both nations, and especially China, huge hard and soft power advantages over the U.S. This is well documented in the National Security Space Association's paper “America's Asymmetric Vulnerability to Navigation Warfare: Leadership and Strategic Direction Needed to Mitigate Significant Threats.”⁷

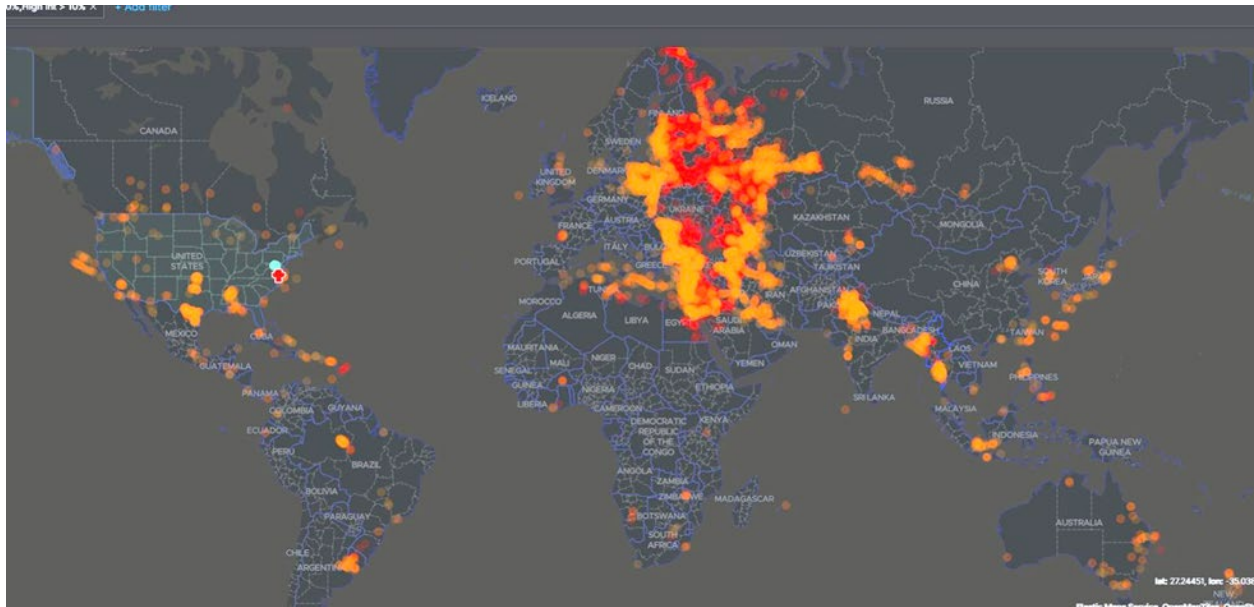
³ See, e.g., Nicolás Lucas-Bartolo, *Ley Anti-Jammer, que Prohíbe los Bloqueadores de Video, Voz y Datos, Entra en Vigor este Sábado*, El Economista (Jan.24, 2020), <https://www.eleconomista.com.mx/empresas/Ley-anti-jammer-que-prohibe-los-bloqueadores-de-video-voz-y-datos-entra-en-vigor-este-sabado-20200124-0053.html>; *GPS Spoofing Helps in \$1,000,000 Theft of Celebrity Tequila*, RNTF (Nov. 26, 2024), <https://rntfnd.org/2024/11/26/gps-spoofing-helps-in-1000000-theft-of-celebrity-tequila/>.

⁴ OPSGROUP Team, *GPS Spoofing: Final Report Published by WorkGroup*, OPSGROUP (Sept. 6, 2024), <https://ops.group/blog/gps-spoofing-final-report/>.

⁵ Tracy Cozzens, *Russia Issues Threat to GPS Satellites*, GPS WORLD (Nov. 29, 2021), <https://www.gpsworld.com/russia-issues-threat-to-gps-satellites/>.

⁶ Dana A. Goward, *America is at Risk of High Impact GPS Jamming and Spoofing from Space*, SPACENEWS (Oct. 24, 2024), <https://spacenews.com/america-risk-high-impact-gps-jamming-spoofing-from-space/>.

⁷ Marc J. Berkowitz, Nat'l Sec. Space Ass'n, *America's Asymmetric Vulnerability to Navigation Warfare: Leadership and Strategic Direction Needed to Mitigate Significant Threats* (2018), rntfnd.org/wp-content/uploads/NAVWAR-FINAL.pdf.



30 Days of GPS Disruption Incidents (Source: US DoT & DOD)

China’s PNT-capability lead over the U.S. was graphically documented in an enclosure to a July 19, 2024 memo from the chair of the National Space-based Positioning, Navigation, and Timing Advisory Board (PNTAB) to the deputy secretaries of Defense and Transportation.⁸

The United States government has recognized and validated the nation’s overdependence on GPS in several ways, including 2020’s Executive Order 13905, “Strengthening National Resilience Through Responsible Use of Positioning, Navigation, and Timing Services.”⁹

III. No Single System Is Enough to Protect America.

NextNav’s economic justification for its FCC petition is based on the assertion that just one system can solve the country’s PNT challenge—its own system. This is simply not the case. No single system for backing up GPS can be sufficient to establish the comprehensive and resilient national PNT architecture U.S. economic and national security demands. And, as discussed below, NextNav’s system is particularly unsuited to this task. Protecting the nation with resilient PNT *requires a system-of-systems approach*.

The need for a system-of-systems PNT approach was first documented in the government’s National Security Space office’s 2008 “National Positioning, Navigation, and Timing Architecture Study Final Report.”¹⁰ It describes the need for multiple systems with diverse sources and methods of delivery to protect the nation.

⁸ Memorandum from Thad Allen, Admiral (USCG, Ret), Chair, PNTAB (July, 19, 2024), <https://www.gps.gov/governance/advisory/recommendations/2024-07-PNTAB-chair-memo.pdf>.

⁹ Strengthening National Resilience Through Responsible Use of Position, Navigation, and Timing Services, 85 Fed. Reg. 9359 (Feb. 12, 2020).

¹⁰ U.S. Nat’l Sec. Space Off., *National Positioning, Navigation, and Timing Architecture Study Final Report*, ROSAP (Sept. 1, 2008), <https://rosap.ntl.bts.gov/view/dot/34816>.

In our keystone October 2020 paper, “A Resilient National Timing Architecture,”¹¹ RNTF took a more specific and pragmatic approach. We identified what some have called “the resilience triad” for national timing and overall PNT—a diverse, continuously cross-checked, independently operating set of time reference signals delivered from space, fiber, and terrestrial broadcast to critical infrastructure, government, and military nodes.

A January 2021 report from the U.S. Department of Transportation validated RNTF’s approach saying that, based on its multi-year tech demonstration program, the nation needed signals from space and terrestrial broadcast synchronized with fiber. Most recently, the Department of Transportation reinforced this finding in its December 2024 “Positioning, Navigation, and Timing Strategic Plan.”¹²

This approach has also been validated and adopted by other nations seeking to protect their critical infrastructures. The United Kingdom, South Korea, China, and others are at various stages of implementing national PNT architectures that meld sources delivered from space, terrestrial broadcast, and fiber.

The need for multiple systems is also supported by the Open PNT Alliance, an organization co-founded by NextNav, and of which it remains a member. In the Alliance’s own words from their FAQ page (emphasis added):

“A heterogeneous backup to GPS/GNSS is in the best public interest. Thankfully, **there are existing, mature PNT systems** developed in the commercial sector that are available today and currently being used by critical infrastructure providers for a variety of applications as secure and robust GPS/GNSS backup solutions.”¹³

“Using a **combination of alternative systems** will meet a range of performance specifications and operational characteristics as well as ensure the most resilient backup to GPS/GNSS.”¹⁴

Accordingly, private and public sectors alike—including NextNav’s own Alliance—recognize the need for multiple systems to provide a cohesive complement to GPS.

¹¹ Marc Weiss et al., RNTF, *A Resilient National Timing Architecture* (2020), <https://rntfnd.org/wp-content/uploads/Resilient-National-Timing-Architecture-16-Oct-2020.pdf>.

¹² U.S. Dep’t of Transp., *Positioning, Navigation, and Timing Strategic Plan* (2024), https://www.transportation.gov/sites/dot.gov/files/2025-01/Positioning%20Navigation%20and%20Timing%20Strategic%20Plan_v%20FINAL.pdf.

¹³ *FAQ*, OPENPNT, <https://openpnt.org/faq/> (last visited Feb. 7, 2025).

¹⁴ *Id.*

IV. There Are Many Alternatives That Are Better Suited to Address the Country's PNT Challenge Without the Cost and Dislocation That Would Be Imposed by NextNav's FCC Petition.

A. Other Solutions Will Address the Nation's PNT Challenge Without Requiring a Spectrum Subsidy from the FCC.

Contrary to NextNav's assertions, numerous technologies and companies are positioned to provide T-PNT to complement and backup GPS. These companies have not asked the FCC for additional spectrum to implement their solutions.

Other vendors and technologies include:

Locata and PhasorLab. Locata and PhasorLab, like NextNav, use short-range beacon-based solutions for bases or facility-based infrastructures within a city or smaller area. These require a substantial number of beacons to cover a service area. Both companies use unlicensed Wi-Fi spectrum, and neither requires changes to the current spectrum allocation and mandate. Locata systems are deployed in a variety of localities around the world including as the reference PNT system for the USAF at White Sands Missile Range. These systems provide centimeter, and sometimes millimeter positioning accuracy to container ports and other customers to augment as well as back up GPS/GNSS.¹⁵

Broadcast Network Solutions. The National Association of Broadcasters (NAB) has successfully demonstrated the Broadcast Positioning System (BPS) to the National Institute of Standards and Technology (NIST).¹⁶ This system is based on digital ATSC 3.0 digital television broadcasts and uses existing tower infrastructure. It also uses existing emergency broadcast spectrum and does not interfere with ATSC 3.0 signals. BPS is currently being demonstrated by NAB.¹⁷

eLoran. eLoran represents an advanced and modernized, globally standardized low frequency technology that is built on 80 years of successful Loran-based PNT. Effective transmission range extends to approximately 1,000 miles over water and 800 miles over land. Receiving one transmission station provides timing, while three or more station reception provides PNT. It uses 90 kHz to 110 kHz, which is reserved internationally for radionavigation. National Loran/eLoran systems currently serve China, Russia, South Korea, Saudi Arabia, and the United Kingdom with additional eLoran development in other countries. China has expanded its eLoran system to serve their entire nation. The U.K. has set a goal for its modernized national eLoran system to be at Initial Operational

¹⁵ *Locata: Time Flies . . . Breakthrough Timing, Over the Air*, INSIDE GNSS (Jan. 27, 2025), <https://insidengss.com/locata-time-fliesbreakthrough-timing-over-the-air/>.

¹⁶ *Abstract: Time Transfer Performance of the Broadcast Positioning System™ (BPS™)*, ION <https://www.ion.org/itm/abstracts.cfm?paperID=15154> (last visited Feb. 7, 2025); *Webinars and Podcasts*, BTS IEEE BROAD. TECH. SOC'Y, <https://bts.ieee.org/educational-programs/webinars-and-podcasts.html> (last visited Feb. 7, 2025).

¹⁷ NAB, *Protecting Critical Infrastructure: Augmenting GPS with the Broadcast Positioning System™ (BPS)*, https://www.nab.org/bps/BPS_Protecting-Critical-Infrastructure.pdf.

Capability by January 2027 and is in the process of acquiring a mobile eLoran for its armed forces. One other European country is also pursuing a mobile eLoran solution. Today in the United States, at least three eLoran transmission sites support customers for continued T-PNT LF research.¹⁸

NITRO. The National Guard’s National Integration of Timing Resilience for Operations (NITRO) project takes advantage of numerous space-based and T-PNT sources, authenticates, and integrates them to deliver via terrestrial means validated time and timing signals. One of NITRO’s goals is to expand from just timing to full PNT. NITRO has deployed terrestrial timing backup in eight states. If desired, the Commission may obtain more information directly from the National Guard.

In addition to the above examples of T-PNT solutions, there are systems that provide timing-only (e.g., fiber-linked clocks from Microchip and others) or positioning-and-navigation-only (e.g., Astranav’s magnetic flux navigation). Some of these are appropriate for both indoor and wide-area use. In addition to addressing specific needs and use cases, these systems could be combined to provide T-PNT solutions. None requires spectrum reallocation.

Also, the Open PNT Alliance identifies at least 18 of their members, in addition to NextNav, that offer either T-PNT solutions or a system that could be combined with another to provide a T-PNT service. Again, these solutions do not require spectrum reallocation.

V. NextNav’s Proposed Solution Falls Short of Other Terrestrial PNT Systems.

NextNav has not provided adequate detail on its PNT approach to fully assess its potential. But what it has disclosed suggests that NextNav’s solution falls short when compared to other T-PNT systems as a real-world answer to the country’s needs.

A system based on NextNav’s short-range beacons alone would require an enormous amount of infrastructure to be practical as a wide-enough area GPS backup to meet the country’s needs. It would have to deploy radios, power, backhaul connections, and access towers on a scale similar to what took the cellular industry decades to accomplish. The difficulty of companies like DISH in replicating the infrastructure builds of these cellular companies is well known, and NextNav would have to do what no other company has done. This approach to providing a GPS backup compares very poorly, for example, with systems like BPS and eLoran that can deliver wide-area coverage. Both systems are able to leverage much existing infrastructure and use already allocated frequencies.

NextNav purports to overcome its need for large amounts of infrastructure by a planned partnership with 5G providers. But to do this in a way that covers the country would require it to successfully negotiate not only with the large cellular companies, but with every mid-sized and small cellular company in the country or leave rural America behind. And access to the infrastructure of all of these companies would still leave large holes in NextNav’s coverage because it would be far too costly to serve remote, mountainous, and wilderness areas, nor most of America’s maritime Exclusive Economic Zone.

¹⁸ *Systems*, URSANAV, <https://ursanav.com/systems/> (last visited Feb. 7, 2025).

In addition, today NextNav does not have any of these agreements, and—even if the petition is granted—cellular companies will have inadequate incentives to undertake this enormous and expensive infrastructure project with NextNav. Even if the Commission were to mandate cellular companies to provide T-PNT services, they would have little reason to partner with NextNav as they already have the ability to do so using their own resources.¹⁹

NextNav’s system also does not seem to compare well to criteria listed in the DoT’s PNT Strategic Plan.²⁰ For instance, if the NextNav PNT system differs from GPS, there are no other PNT reference systems to determine which system is at fault. The resilient triad system, however, can cross-calibrate across multiple systems. In addition, as a wireless relay node-to-node dissemination system, the NextNav system is just as vulnerable to attack as GPS. A table developed by Greenwood Telecommunications Consultants, LLC at the end of the brief fully illustrates the shortcomings of the NextNav system.

For much of the last decade NextNav has urged the executive branch to not “select a winner” as companies innovated in a free market to develop PNT alternatives. But now it asks the Commission to do just that by subsidizing their company and technology over others. NextNav’s change of position and attempt to win a spectrum subsidy from the FCC may stem from concern that its technology and business plan are not competitive with others in the field. Should the Commission grant NextNav’s petition, this would certainly be viewed as anti-competitive and draw significant and strident protests.

If the federal government is to address the need for one or more national T-PNT systems, the public would be better served by a competitive contractual process open to all potential providers. A competitive process would better identify the most economical and effective systems and legally bind the winning contractor to perform.

VI. The Nation Needs a Whole-of-Government Solution.

GPS’s “single point of failure” is, indeed, a major national, homeland, and economic security issue. We completely understand if the Commission is concerned and wishes to be part of the solution. Yet, effective solutions must come from concerted and coordinated efforts across all branches of government.

We have seen many “solutions” fail in the absence of such a whole-of-government approach.

- In 2008, the National Space-based Executive Committee, co-chaired by the deputy secretaries of Defense and Transportation, resolved to meet President Bush’s mandate for a backup system for GPS by upgrading the legacy Loran-C system to eLoran.²¹ Yet administration-wide consensus was not achieved on that approach and, rather than transferring the small amount of funding needed from one agency to another as planned,

¹⁹ See, e.g., Tracy Cozzens, *GMV, FortierSI, Ericsson and Optus Prove 5G-Based High-Accuracy Positioning*, GPS WORLD (Sept. 25, 2022), <https://www.gpsworld.com/gmv-frontiersi-ericsson-and-optus-prove-5g-based-high-accuracy-positioning/>.

²⁰ U.S. Dep’t of Transp., *supra* note 12.

²¹ Statement from DHS Press Secretary Laura Keehner on the Adoption of National Backup System to GPS, (Feb. 7, 2008), <https://rntfnd.org/wp-content/uploads/DHS-Press-Release-GPS-Backup-2008.pdf>.

budget officials eliminated the funding from the President’s 2010 budget request terminating the effort.²²

- Responding to congressional concerns in 2015,²³ the Obama administration made what seemed to be commitments to address the need for a GPS backup capability by first implementing a timing system, while examining navigation systems.²⁴ Yet no subsequent action was taken.
- In 2018, the Cruz-Markey National Timing Resilience and Security Act mandated the Department of Transportation ensure creation of a terrestrial timing capability to serve as a backup for GPS.²⁵ Subsequent administrations have continued a long line of studies admiring the problem but have taken little action to ensure solutions.

Responsibility for ensuring national resilient PNT lies primarily with the executive branch, which has been struggling with the issue for over twenty years. In its July 2024 report, the PNTAB observed that the fundamental reason for this was from an outmoded governance structure and failure to appropriately prioritize the issue. The board observed that effective solutions will require legislation and cooperation between the administration and Congress.

Rather than embarking on such an effort on its own by approving NextNav’s petition, we urge the Commission to engage with the new administration and new Congress on this issue. The Commission’s expertise and gravitas will bring new energy and interest to the table. Such efforts could well be the catalyst for changes essential to protecting our nation. RNTF will be proud and pleased to assist in the Commission’s efforts in any way we are able.

VII. Conclusion

In all, we urge the Commission to not move forward with NextNav’s petition for rulemaking. NextNav’s proposal contains false assertions regarding its PNT capabilities and will ultimately *not* result in the establishment of a T-PNT service that is a viable backup for GPS in the United States. Instead, we urge the Commission to engage with the new administration and the new Congress on T-PNT to further advance the issue of backup GPS.

²² Department of Homeland Security Appropriations Act, 2010, Pub. L. No. 111-83, 123 Stat. 2142 (2009).

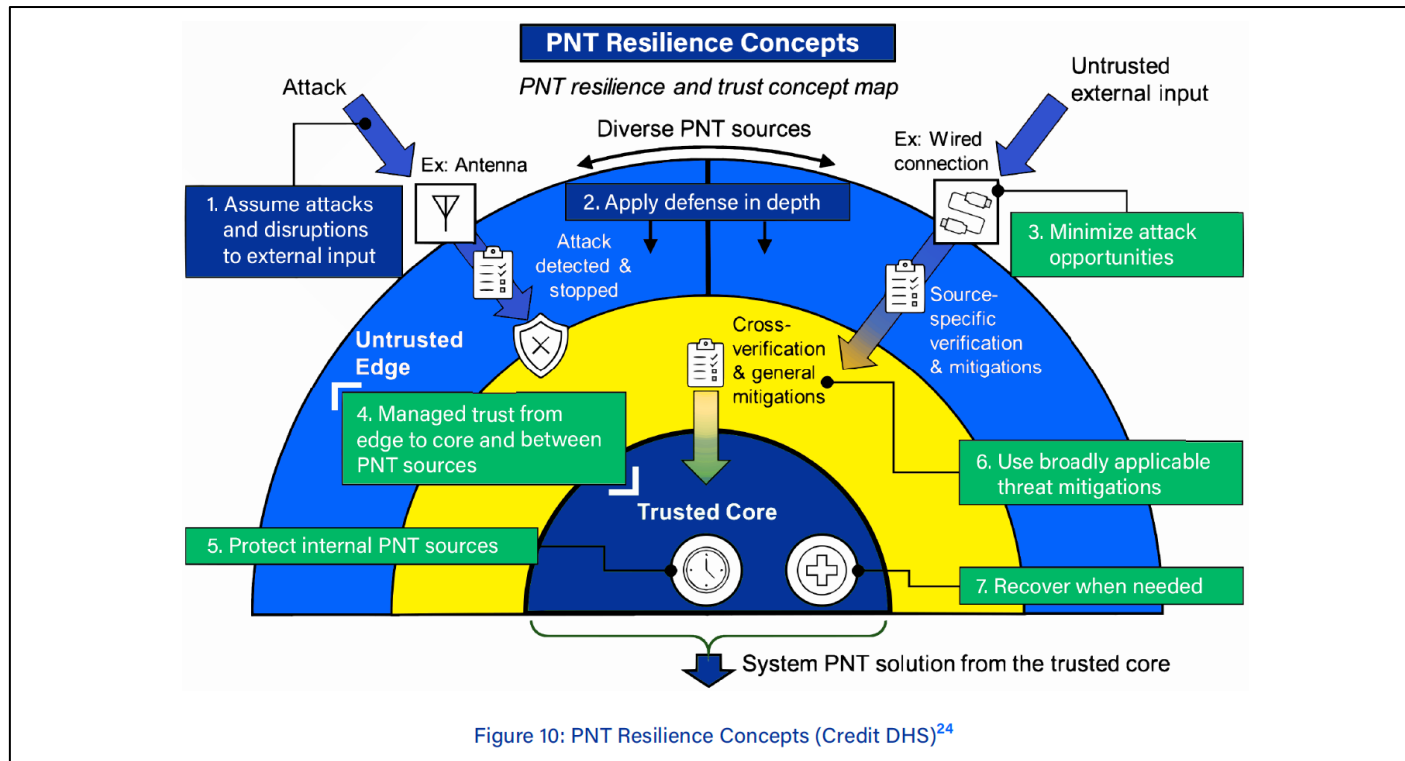
²³ Letter from John Garamendi, CA-03, et al., to Honorable Robert O. Work, Deputy Sec’y of Def. and Honorable Victor Mendez, Deputy Sec’y of Transp., Co-Chairs, Nat’l Exec. Comm. for Space-based PNT (Aug. 31, 2015), <https://rntfnd.org/wp-content/uploads/Congressional-Letter-to-PNT-Executive-Committee.pdf>.

²⁴ Letter from Victor M. Mendez, Deputy Sec’y of Transp. and Robert O. Work, Deputy Sec’y of Def., Co-Chairs, Nat’l Exec. Comm. for Space-based PNT to Honorable John Garamendi, U.S. House of Representatives (Dec. 8, 2015), <https://rntfnd.org/wp-content/uploads/DSD-and-Dep-DOT-reply-to-Mr.-Garamendi.pdf>.

²⁵ Dana Goward, *GPS to Get Terrestrial Backup System*, GPS WORLD (Dec. 5, 2018), <https://www.gpsworld.com/gps-to-get-terrestrial-backup-system/>.

Comparison of NextNav (NN) System Features to Desirable PNT System Criteria Listed in DoT “Positioning, Navigation, and Timing Strategic Plan” December 2024

Greenwood Telecommunications Consultants, LLC



Graphic from US Department of Transportation “Positioning, Navigation, and Timing Strategic Plan” December 2024

DoT Defined Resilience to Attack & Response Dec 2024 PNT Strategic Plan	RNTF Defined Resilient Triad System	Comments Regarding Petitioner’s Declared and/or Claimed Capability
1. Attacks External Signal	<ul style="list-style-type: none"> Vigilant defense, non-GPS timing sources constantly cross calibrated. 	<ul style="list-style-type: none"> NN lacks fiber delivery and does not allow diverse alternatives, including Galileo, which are commercially proven.
2. Apply Defense in Depth	<ul style="list-style-type: none"> A change in Triad cross-calibration triggers response to majority vote the time reference, core notified and adopts majority, promptly alerts USG directed security center. 	<ul style="list-style-type: none"> No majority (i.e., 2 of 3 sources’ measured time agreement) arises since NN believes it is the only source needed for backup. If NN departs from GPS, it cannot automatically exclude that fault lies within the NN time delivery process. Therefore, a hostile jammer could be remotely aimed at the NN or GPS wireless signals with similar levels of interference power.
3. Minimize Attack Opportunities	<ul style="list-style-type: none"> Diverse solution, designed to eliminate a single point of failure with the minimum, but necessarily minimum number of diverse timing sources. To maintain time in P5G, CI will later add GPS/GNSS assistance to add jamming, spoofing resistance, to GPS and GAL signals over a diversity of reception sites, azimuths, elevation entry angles. 	<ul style="list-style-type: none"> Jamming NN is as easy as the same hostile intent to jam un-assisted GPS. Assisted GPS/GNSS is substantially more resilient than its unassisted counterpart, and uses existing network core and edge connectivity. NN doesn’t seem to provide greater time or positioning performance than exists within the 5G networks it purports to shield against GPS outage.
4. Managed Trust for Edge to Core and Between PNT Sources	<ul style="list-style-type: none"> Triad and GPS/GAL Assistance measures and manages trust to maintain GPS/GAL time. If one system is under attack, it has substantial fallback depth adding fiber, terrestrial wireless, or both. Proven delivery and proven GPS assistance methods to core/edge networks. 	<ul style="list-style-type: none"> NN requires extraordinarily close proximity to edge nodes based on the same DoT prototype demonstrations it referenced in its petition.
5. Protect Internal PNT Sources	<ul style="list-style-type: none"> Triad and GPS/GAL Assistance provides cross-calibration thus a multi-surface shield against all known attack vectors. 	<ul style="list-style-type: none"> NN provides no detail on how it protects internal PNT other than making broad claims about the prospect of GPS outage, while not presenting how it adds protection over eLoran, NAB/BPS, Fiber/OTT Timing, Assistance and upcoming P5G/xG Cooperative Array processing.
6. Use Broadly Applicable Threat Mitigations	<ul style="list-style-type: none"> In addition to the Triad in above discussion, for both timing and positioning, CRPA (applicable to stationary, surface and airborne vehicle), and for fixed and certain 	<ul style="list-style-type: none"> NN presents itself as a wireless relay node-to-node dissemination system thus is as similarly vulnerable to attack by malicious attacker as would be GPS or another cellular based as a timing node at the edge of network –

	vehicular cases, use of GPS/GAL assistance all further shield GPS/GAL from hostile ground-based and certain airborne attacks.	without assistance or a diverse source such as UHF BPS, eLoran and/or fiber timing solutions.
7. Recover When Needed	<ul style="list-style-type: none"> The Triad and Assistance methods offer cross-check and virtually instant (within a few seconds) recovery. Assistance provides a continuous check on precision, trust of the satellite signal components, & elevates performance for indoor cases, thus removes obvious outdoor attack cases (e.g., rooftop antennas). 	<ul style="list-style-type: none"> Unclear what NN provides during attack-recovery phases of time-security operation, since it has no verification or trust-based solution present in the petition.