

15 January 2023

Public Wireless Supply Chain Innovation (PWSCI) Fund Implementation

Federal Register Docket No. 221202-0260 posted 12/13/2022

Comments by the Resilient Navigation and Timing Foundation

Summary

We strongly recommend the PWSCI Fund include a project to establish a comprehensive and resilient national timing architecture and services based on Universal Coordinated Time (UTC). Ideally, it should also enable wireless location determination.

The architecture should be guided by and conform to the principles of the National Security Space Office’s “National Positioning, Navigation, and Timing Architecture Study Final Report”¹ and the joint Department of Defense/Department of Transportation “National Positioning, Navigation, and Timing Architecture Implementation Plan.”²

The Department of Transportation’s 2021 report “Complementary PNT and GPS Backup Technologies Demonstration Report”³ also provides helpful information about the diverse types of technologies that should be included.

Timing is foundational to telecom software, hardware, and cybersecurity. For example, it is needed for server virtualization, antenna synchronization, and frequency discipline for RAN and ORAN transmitters and receivers. Disaggregation in ORAN makes reliance on clock holdover with high stability oscillators less attractive⁴.

Standards for timing and transport are among the significant issues being addressed by the international ORAN Alliance. Its Work Group 9 has already developed a third version of its “Synchronization Architecture and Solution Specification.”⁵

A recent release from the International Telecommunications Union reiterated the importance of precise timing for 5G. It also stated precise timing will be even more important to future generations of telecom technology.⁶

¹ <https://rosap.ntl.bts.gov/view/dot/34816> accessed 12 Jan 2023

² <https://rosap.ntl.bts.gov/view/dot/18293> accessed 12 Jan 2023

³ <https://www.transportation.gov/administrations/assistant-secretary-research-and-technology/complementary-pnt-and-gps-backup> accessed 12 Jan 2023

⁴ <https://www.5gtechnologyworld.com/meet-timing-requirements-in-5g-networks/> accessed 6 January 2023

⁵ <https://orandownloadsweb.azurewebsites.net/specifications> accessed 6 Jan 2023

⁶ “Synchronization Technologies Evolving for 5G and Beyond” <https://www.itu.int/hub/2022/12/synchronization-technologies-evolving-for-5g-and-beyond/> accessed 5 Jan 2023

A distinguished panel of telecom CEOs and senior executives acting as the National Security Telecommunications Advisory Committee (NSTAC) have also documented the importance of timing to telecom. And, in their May 2021 report to President Biden, they advocated for a resilient national timing architecture, supported in part by federal funding:⁷

“...the Administration should consider developing a strategy for National Timing Architecture similar to that reflected in the Resilient Navigation and Timing Foundation’s paper entitled “A Resilient National Timing Architecture.”⁸ Further, to enhance the ability of commercial entities to afford leveraging this architecture, the Administration should appropriate sufficient funds to lay the foundation for creating this timing architecture, with the Federal Government being the first customer for what will ultimately become a resilient, interconnected network for PNT delivery.”

Location is also critical to 5G deployment and further development. Emerging applications use location data for improved spectrum efficiency. Location, combined with map-based propagation modeling enables simultaneous use of a frequency by devices physically shielded from each other. Precise location is becoming increasingly important as 5G is leveraged for vehicle autonomy(e.g. C-V2X), supply chain management, Internet of Things, and other applications, some as yet unanticipated.

Since timing is foundational to wireless location services, a robust national timing architecture can enhance location determination. Incorporating location capabilities in such an architecture would be a relatively minor add-on or expansion since the 5G waveforms provide requisite capabilities.

Establishment of a deterministic, secure, and distributed US national timing architecture will enable faster and more efficient implementation of 5G and subsequent telecom interactions, spur and support innovation, and greatly improve resilience against a host of threats.

Characteristics of the Architecture

In 2008 the federal government documented the characteristics of a national positioning, navigation, and timing architecture.⁹

It articulated a vision of “US leadership in Global PNT,” and a strategy to “best achieve efficiency and effectiveness through a greater common denominator approach.” The final

⁷ “NSTAC Report to the President on Communications Resiliency” page 22 https://www.cisa.gov/sites/default/files/publications/NSTAC%20Report%20to%20the%20President%20on%20Co mmunications%20Resiliency_0.pdf accessed 5 Jan 2023

⁸ “A Resilient National Timing Architecture” <https://rntfnd.org/wp-content/uploads/Resilient-National-Timing-Architecture-16-Oct-2020.pdf> accessed 5 Jan 2023

⁹ “National Positioning, Navigation, and Timing (PNT) Architecture” <https://www.transportation.gov/pnt/national-positioning-navigation-and-timing-pnt-architecture> accessed 6 Jan 2023

report and associated documents, while they might need minor updating, outline many of the principles of and characteristics needed in a national PNT or timing architecture.

With our white papers “A Resilient National Timing Architecture”¹⁰ and “A Resilient National Timing Architecture – Now for an RFP!”¹¹ we acknowledge the government’s work and provide additional suggestions. These include:

- That the architecture should have a widely available, easily accessed “basic utility” level of service provided to users without charge to support national and economic security.
- Provision for commercial fee-based services serving more sophisticated users with higher or more specialized requirements.
- All non-GPS services be provided by commercial entities instead of being government owned and operated.

Resilience for National & Economic Security

“From an economics viewpoint, timing attacks represent one of the worse holes in our private, public critical infrastructures, because they can be widely broadcast impacting many at once. They are relatively insidious and hard to detect until much IT damage is done. They can be launched by surreptitious means (until new remedies are deployed) and thus leave all open even if the actual attack is relatively concentrated.” – Telecom CEO

Telecom timing in the United States is derived wirelessly from GPS signals and by fiber. Often, the fiber signals can be ultimately traced back to GPS, or GPS-disciplined atomic clocks.

Weak signals from GPS and other GNSS are easy to deny (jam), or worse, imitate (spoof). This poses a significant threat to telecom operations and supply chains.¹²

While more difficult to interfere with, time over fiber is also vulnerable to hacking. A recent presentation by a researcher from Marist college determined at least five vulnerabilities currently exist in the network-based Precision Time Protocol (PTP), also known as IEEE 1588, widely in use today.¹³

¹⁰ “A Resilient National Timing Architecture” <https://rntfnd.org/wp-content/uploads/Resilient-National-Timing-Architecture-16-Oct-2020.pdf> accessed 6 Jan 2023

¹¹ “A Resilient National Timing Architecture – Now for an RFP!” <https://rntfnd.org/wp-content/uploads/A-Resilient-National-Timing-Architecture-Now-for-an-RFP.pdf> accessed 6 Jan 2023

¹² “Risks in the Information and Communications Technology Supply Chain” RNT Foundation Response to Request for Public Comment Oct 2021 <https://rntfnd.org/wp-content/uploads/RNTF-Supply-Chain-Comments-Info-and-Comms-Technology.pdf> accessed 6 Jan 2023

¹³ “Covert Message Channels and Clock Spoof DoS Attacks on IEEE Precision Time Protocol (PTPv2) with Timemaster” <https://wsts.atis.org/presentation/covert-message-channels-and-master-spoof-dos-attacks-on-ieee-precision-time-protocol-ptpv2-with-timemaster/> accessed 6 Jan 2023

A resilient national timing architecture would provide multiple and diverse methods for delivery of authoritative and authenticatable precise time. An October 2020 proposal published by the RNT Foundation includes as its foundational layer fiber time sourced to USNO and/or NIST, suites of existing atomic clocks at national laboratories, GPS signals, and terrestrial low frequency broadcast.¹⁴

The Department of Transportation also presented a similar combination of time dissemination systems needed for national security and resilience in a January 2021 report to Congress:¹⁵

“To achieve the parallel objective of resilience, as described in Executive Order (EO) 13905, that path should involve a plurality of diverse PNT technologies... Based on this demonstration, those technologies are LF and UHF terrestrial and L-band satellite broadcasts for PNT functions with supporting fiber optic time services to transmitters/control segments.”

While no single approach can provide absolute protection, a properly integrated and diverse architecture of timing sources is the best way to ensure our critical timing services.

Innovation, Competitiveness & Leadership

Establishment of a resilient national timing architecture will spur innovation by making multi-source, reliable precise time and synchronization more available and accessible. Entrepreneurs and innovators will no longer need atomic clocks for hold-over. Neither will they have to establish “local” time standards to coordinate system components. The extant national time scale delivered by multiple diverse paths will fill those roles.

Easily accessed national timing at an acceptable level of precision will be required if America is going to foster innovation and keep finding efficiencies to improve the way we operate.

Over 150 years ago the railroads realized they needed a common time reference so they could operate nationwide, efficiently, and avoid conflict. In 1883 they created the U.S. time zones to synchronize operations across the industry.

We must do the same for our telecoms and other technology. US innovation and competitiveness will depend upon our systems being able to operate together, nationwide, efficiently, avoid conflict, and synchronize operations. To do this we need to democratize precise timing.

¹⁴ “A Resilient National Timing Architecture” <https://rntfnd.org/wp-content/uploads/Resilient-National-Timing-Architecture-16-Oct-2020.pdf> accessed 6 Jan 2023

¹⁵ Complementary PNT and GPS Backup Technologies Demonstration Report https://www.transportation.gov/sites/dot.gov/files/2021-01/FY%2718%20NDAA%20Section%201606%20DOT%20Report%20to%20Congress_Combinedv2_January%202021.pdf Page 195, accessed 6 Jan 2023

Creating such an architecture will also help the U.S. recover global leadership in this field in which other nations have taken the lead. The United Kingdom, for example, has an aggressive project underway to augment its use of GNSS and terrestrial eLoran-based time with distributed suites of atomic clocks linked by fiber.

China is undoubtedly the most advanced in ensuring provision of highly precise and resilient time and location.¹⁶ The nation provides these services from satellites at GEO, MEO, and LEO, via a precisely measured fiber network, and nation-wide eLoran. We understand that as it implements 5G, the network will also be leveraged to provide hyper-precise time and location. This could support autonomy corridors and a wealth of other applications within the 5G coverage areas.



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About Us

The Resilient Navigation and Timing Foundation is a 501(c)3 scientific and educational charity incorporated in Virginia. We advocate for policies and systems to protect GPS/GNSS satellites, signals, and users.

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¹⁶ <https://www.gpsworld.com/china-leads-world-with-plan-for-comprehensive-pnt/> accessed 15 Jan 2023