OPNT's Response to NIST RFI re EQ13905

13 July 2020

NIST is seeking the following information from PNT technology vendors, users of PNT services and other key stakeholders for the purpose of gathering information to foster the responsible use of PNT services:

1. **Describe any public or private sector need for and/or dependency on the use of positioning, navigation, and timing, or any combination of these, services.**

All sectors across all geographies are deeply dependent upon timing, the "T" in PNT. It is foundational, with "P" and "N" based directly on and dependent upon it.

The most fundamental aspect of timing for sector use is the ability to achieve and maintain synchronization. In addition, a large or larger challenge is knowing with adequate assurance that the required level of synchronization is maintained.

Many systems require time traceable to UTC. For these U.S. users, synchronization assurance needs to be maintained to UTC(NIST) or UTC(USNO). In some cases, time is required at remote locations, but only relative to a specific reference time that may not be UTC.

In conclusion, many users require the ability to ensure continuity of reliable and trustworthy deliverance of synchronization or a reference time.

2. **Identify and describe any impacts to public or private sector operations if PNT services are disrupted or manipulated.**

With focus on "T", for real time capabilities like voice and video communications that require on-going synchronization, end-to-end communications will fail. This can cause either loss of service, or, potentially worse, communications of wrong or misunderstood content.

For other IT based operations where the order of events is important, the resulting order will either be unknown or incorrect if synchronization is lost. The impacts of this can vary from minor to catastrophic.

As we say above, "T", or time, is generally the basis of position and navigation, the "P" and the "N" in PNT. Position and navigation are achieved based on the measurement of the time of arrival of a signal that has been time stamped at the reference clock. Disruption or manipulation of these signals can cause serious damage to property and loss of life. E911 calls that give the wrong or lack of position can cause rescue teams to arrive too late to save a life. Autonomous vehicles can careen out of control, causing serious accidents. Similarly, industrial automation is dependent on real-time positioning of robotic machines. Errors in time translate to damage to equipment or products, loss of property or serious harm to people or loss of life.

Simply the threat of intentional or unintentional interference prevents some systems from relying on important or needed PNT services. The electric power industry will not use phase measurement units (PMUs) for real-time control based solely on GPS or GNSS signals. Yet, many failures in power systems have been traced to a lack of synchronized measurements over large areas of the United States.

3**. Identify any standards, guidance, industry practices and sector specific requirements referenced in association with managing public or private sector cybersecurity risk to PNT services.**

4**. Identify and describe any processes or procedures employed by the public or private sector to manage cybersecurity risks to PNT services.**

To accomplish our nations' critical time delivery backbone, we believe the only realistic alternative to GPS or GNSS is through a *National Terrestrial Fiber-Based Time Network.* There are a number of excellent technologies that can deliver PNT. However, to be completely GPS and GNSS independent over wide areas they all need a method of receiving UTC independent of GNSS. There are few ways of doing this, and it appears clear to us that the only practical way to provide UTC delivered from NIST and/or USNO to many users across the U.S. is via *a National Terrestrial Fiber-Based Time Network.* Time and Frequency can be delivered through fiber with accuracies that far exceed the vast majority of requirements for all systems. However, using the existing fibers already in place requires a special engineering of these systems. A *Time Network* requires special design and maintenance separate from the way data networks operate.

Beyond the technical requirements, *affordability*, has been the main barrier that has kept industry from implementing alternatives to GPS. The largest cost of the National Fiber-Based Time Network will be the cost of using fiber. This can be ameliorated with a public-private agreement between the government and the companies who provide time. For government this could be federal, state or urban government participating in the cost. For private operators, OPNT has a design and the beginnings of a national network already, though collaboration with other companies is possible. Indeed, wide delivery of PNT from the National Time Network will require RF transmitters like those offered from a number of companies. In addition to the public-private partnership design, cost-sharing and even-revenue sharing between the TaaS operator and the fiber owners may further improve affordability.

OPNT's global Time as a Service (TaaS) solution redundantly delivers UTC from National Metrology Insitutes (NMIs) via fiber within countries and across country boundaries. It currently includes beta service from UTC(NIST) and UTC(VSL). Negotiations and planning are underway for implementation in other countries along with considerations for straightforward expansion within the U.S. to include both USNO sites plus addition of the second NIST site, currently not accessed in the TaaS.

With time traceable across the connected timing sources, accuracy to better than 1 microsecond is available using affordable technologies across the US. These technologies have levels of reliability and continuity at least comparable to GPS. The OPNT TaaS is also available at better than 1 nanosecond (ns) time transfer accuracy over 100's of miles and expected less than 5 ns for U.S. "coast-to-coast", though at somewhat higher prices.

Including at these higher performance levels, time can be broadcast using various RF technologies to provide positioning with more accuracy than GPS, and with much less chance of disruption or manipulation. Such RF technologies include existing beacon-based PNT options along with evolving initiatives such as OPNT's participation in the SuperGPS project in Delft University, targeted at centimeter-level positioning for autonomous vehicles and other highly demanding applications.

OPNT's solution also incorporates the ability to monitor and correct for the timing content of wireless signals, taking advantage of its precision timing base. For instance, the LTE signals from mobile network operator base stations can continuously be monitored and compared to OPNT's known-good-time, able to then automatically send continuous correction guidance to the base station if/as needed to maintain its required level of synchronization. This is anticipated to be a very-high value offering toward overcoming both cost and redundancy challenges associated with the providing assured timing to buildings and other "last mile" applications. Having precise control and delivery of "T" is critical for both the distribution of time and monitoring through such a "closed loop" return path.

Except for the advanced RF-based time transmission, each of the above was part of OPNT's demonstration within the DOT GPS Backup Demonstration program.

5**. Identify and describe any approaches or technologies employed by the public or private sector to detect disruption or manipulation of PNT services.**

By using OPNT TaaS, users have independent, differently routed methods of receiving UTC as sourced from multiple timing locations, versus limited to UTC from GPS. Within each of OPNT's internally redundant "timing PoPs" (timing Points of Presence), all available sources, including GPS where included, are continuously compared to each other on a picosecond (ps) basis. This provides strong real-time detection methods for disruption in any of the incoming time distribution channels. Coupled with OPNT's automatic, real-time ability to perform a near-glitchless switch to a backup from both hard and soft-fault conditions, continuous operation can be maintained.

As a result, it is significantly more difficult to disrupt or manipulate OPNT TaaS-based PNT than using GPS. Further, OPNT TaaS built-in checking on top of two-way plus loop-around communications techniques provides further assurance vs the one-way time delivery structure of GPS. This applies directly to the area of continuous traceability.

The result of the above is akin to the establishment of thousands of UTC sources across the country. In an extreme case, any one of these Master Clocks that have been synchronized to UTC can be configured during an emergency as the prime national timing source, with the redundant connectivity across the entire network being remotely reconfigurable to accommodate. An example of this being useful is the historical damage of Hurricane Sandy on the U.S. east coast. With proper advanced planning and configuration, one of these Master Clocks could have allowed electric power to have been either maintained in island modes throughout the storm or if not, power could have been recovered much sooner than the time it took to connect to the larger power network.

6. **Identify any processes or procedures employed in the public or private sector to manage the risk that disruption or manipulation to PNT services pose.**

By providing time through terrestrial fiber, completely independent of GPS, OPNT TaaS minimizes the risk of disruption or manipulation to PNT. It is much more difficult to disrupt or manipulate signals sent through the telecom fibers with strong signals, than those like GPS, sent through the air and with extremely low power. If combined with GPS, the user has two independently routed methods of getting time, which creates even lower risk.

7. **Identify and describe any approaches, practices, and/or technologies used by the public or private sector to recover or respond to PNT disruptions.**

8. **Any other comments or suggestions related to the responsible use of PNT services.**

The only realistic alternative to GPS or GNSS PNT requires *a U.S. National Terrestrial Fiber-Based Time Network.* This will disseminate UTC time from NMIs to accessible points throughout the U.S. from which PNT can be provided to users by RF providers along with direct delivery of time from OPNT's access points. The largest barrier to development of GNSS alternatives has been affordability. The National Time Network becomes especially affordable through public-private partnerships as well as cost sharing, and potentially revenue sharing, between the operator of the National Time Network and fiber owners.

OPNT has recognized the need for an operator of Terrestrial-Fiber Based Time Networks, and has taken this on as its mission. OPNT has developed designs and technology to support this, and has already started several Time Networks delivering UTC from NMIs.