1200 G Street, NW
Suite 500
Washington, DC 20005

P: +1 202-628-6380
W: www.atis.org

May 20, 2015

Via Email
Karen L. Van Dyke (karen.vandyke@dot.gov)
Director, Positioning, Navigation, and Timing and Spectrum Management
Office of the Assistant Secretary for Research and Technology Administration
United States Department of Transportation

RE: Docket No. DOT-OST-2015-0053

Dear Ms. Van Dyke:

In response to the Department of Transportation's request for comments in the above-referenced docket, the Alliance for Telecommunications Industry Solutions' (ATIS) Copper/Optical Access, Synchronization and Transport Committee (COAST) would like to provide information on the committee's view regarding the timing needs of the communications industry as it relates to wired and wireless services.

Background

ATIS is a leading technology and solutions development organization. Through ATIS, nearly 200 companies address priorities such as cloud services, device solutions, emergency services, cyber security, network evolution, and quality of service. COAST, one of ATIS' 15 industry forums, develops standards and technical reports related to telecommunications network technology pertaining to network synchronization interfaces over copper and optical mediums, and hierarchical structures for U.S. telecommunications networks. The COAST Synchronization Subcommittee (COAST SYNC) is responsible for validating the network interface standards developed within COAST, to ensure successful synchronization between carriers. Experts on synchronization have been working together within COAST SYNC for more than 30 years through many changes in technologies with new synchronization requirements.

As you may know, the communications industry historically was a large user of LORAN-C for time and frequency synchronization. While GPS, in conjunction with other technologies, has replaced LORAN-C for both time and frequency synchronization, COAST SYNC recently began to study GPS vulnerability to jamming and spoofing, mitigation of jamming and spoofing, as well as proposals to back up GPS as a timing source for the telecommunications sector. The use of eLORAN is one of the backup technologies being considered.

The Application: the communications industry's need for time and frequency synchronization

Access to a primary frequency source for time and frequency synchronization is essential for the operation of wireline and wireless telecommunications service networks. The need for time in telecommunication networks comes mainly from wireless applications, while the need for frequency traceability comes from both wireless and wired equipment.[1]

The newest wireless technologies including LTE and LTE-A require Universal Coordinated Time (UTC) traceable time and relative phase alignment between elements in different locations. These requirements are difficult to achieve without GPS. These deployed wireless technologies require expensive backup systems to continue to operate optimally during a temporary loss of the GPS signal. For example, LTE and LTE-Advanced frequency and phase requirements are +/- 50 parts per billion (ppb) and 1.5 microsecond (µs), respectively, at the air interface. It is a significant challenge and expense to meet these requirements during a GPS outage.

The evolving Federal Communications Commission enhanced 911 (E911) location requirements lead to a significant synchronization requirement of approximately +/- 100 nanoseconds (ns) accuracy to UTC at the air interface for most macrocell towers. With the LORAN systems decommissioned, GPS is currently the only radio-navigation technology that can meet synchronization requirements for E911 as there is no other widely available access to UTC time-of-day in the United States. As a result, the requirement for UTC at base stations places a stringent dependence on GPS.

The telecommunications industry is migrating from time-division multiplexing (TDM) and synchronous optical network (SONET) based infrastructure toward an all-IP network. This will result in the removal of portions of SONET as the base transport, and the implementation of native IP networks (i.e., those with no synchronization support). The native IP networks themselves cannot provide frequency, phase, and time; therefore, GPS is required for synchronization applications. Thus, there is an increased vulnerability to the loss of GPS.

ATIS COAST notes that there may be other issues associated with the loss of GPS that may impact wireless services. It is not possible for COAST to assess such issues because techniques for timing and synchronization in wireless services are based on non-public, vendor-specific, or proprietary implementations. It is likely that different wireless equipment vendors have different methods for timing and synchronization, and the impact of a loss of GPS will vary depending on the equipment used.

The positioning, navigation, and/or timing performance required for a complementary positioning, navigation and timing (PNT) capability to support operations during a disruption of GPS that could last for longer than a day

Based on limited public results from eLORAN tests from various vendors, ATIS COAST expects that eLORAN can meet all the above requirements for an extended period of time without GPS. In this case, eLORAN would be considered for use in the telecommunications network and would be able to cover a GPS outage without seeing any service impacts even if the outage was extended.

---

[1] The telecommunications application for timing uses stationary receivers that are mounted on buildings that house equipment, or are located in the field with smaller groups of equipment in a small enclosure. The GPS antenna is usually mounted on the roof to get a good view of the sky. As the telecommunications industry uses stationary receivers, it makes the receivers more susceptible to sustained interference (both accidental and intentional).

Moreover, because eLORAN uses the same underlying signals as LORAN-C, it is anticipated that many of LORAN-C's advantages over GPS would extend to eLORAN.[2] These advantages include resilience against unintentional and intentional jamming and the ability to work in urban canyons. Due to LORAN-C's low frequency, high power, and geographically diverse signals, it is virtually un-jammable. In addition, LORAN-C's ability to use indoor antennas also eliminates problems associated with ice/snow accumulation and lightning strikes on external antennas.

Furthermore, eLORAN could also address new requirements associated with the current widespread use of wireless technologies that were not present when the telecommunications industry was using LORAN-C. Wireless requirements need the time transfer and higher accuracy provided by the eLORAN data channel which includes the Additional Secondary Factors for accuracy and time transfer information.

Availability and coverage area required for a complementary PNT capability:

The proposed eLORAN service would be needed throughout the United States.

Current and planned availability of eLORAN capable user equipment:

Due to the past use of LORAN-C, the telecommunications industry would consider using eLORAN if available and able to meet the above requirements and if eLORAN signals were widely available throughout the United States for the lifetime of new equipment (which may be longer than 15 years).

Other currently available or planned non-eLORAN PNT technologies or operational procedures that could be used during a disruption of GPS for longer than a day:

While frequency requirements typically can be met using higher-performance oscillators (such as rubidium and OCXO oscillators), these have limited use for phase stability when GPS is unavailable. A radio-navigation or network-based approach can reduce the need for more expensive oscillators and provide better phase stability.

Many network operators are considering the use of packet timing to transfer time from a master clock to another location, when frequency and time are required. This approach can be used to minimize the effect of local timing outages when used in conjunction with GPS or to replace a local GPS receiver depending on the application. Packet timing uses upgraded network elements to send IEEE 1588[3] (Precision Timing Protocol) packets over IP or Ethernet networks to align a master and slave in both frequency and time. The industry has completed much work in this area over the last few years and IEEE 1588 based network equipment is widely available and deployed. The accuracy of the time transfer is dependent on the network architecture and equipment used in a service provider network, but can in some cases meet the phase/time requirements outlined earlier in this document. The packet timing master in IEEE 1588 is still dependent on an external timing source (for example GPS) and is not an independent source of timing.

---

[2] Any benefit would depend on the number of transmission stations used versus the older LORAN-C system

[3] IEEE Standard for Precision Clock Synchronization Protocol for Networked Measurement and Control Systems (IEEE 1588-2008).

Additional proposals that have been discussed within COAST-SYNC for mitigation of GPS vulnerability to jamming and spoofing are:

1. Navigational Message Authentication on L2C;
2. Sync over fiber; and
3. Sync distribution via other RF spectrum.

More study is needed for these proposals before they could be widely used in the telecommunication industry to mitigate GPS vulnerabilities. The first proposal adds additional security to the GPS signal to protect against a subset of GPS disruptions. The last two proposals are separate from GPS and could be used during a GPS outage. More information about these approaches is found in Appendix A.

Conclusion

For the telecommunications industry, eLORAN provides some advantages over these other proposed solutions because it would be widely available and is predicted to meet requirements for frequency and time accuracy. While there are other proposals that provide frequency and time when GPS signals may be impaired, eLORAN has distinct advantages due to its independence from the existing GPS infrastructure. If eLORAN can meet the accuracy requirements summarized above and has stable funding, the telecommunications industry may consider using a mix of eLORAN and GPS receivers throughout the network.

If you have any questions regarding this matter, please feel free to contact the undersigned.

Sincerely,

Thomas Goode
ATIS General Counsel

cc: Ken Biholar, ATIS COAST Chair, ken.biholar@alcatel-lucent.com
William Szeto, ATIS COAST Vice Chair, william.szeto@xtera.com
Lee Cosart, ATIS COAST SYNC Chair, lee.cosart@microsemi.com
David Overdorf, ATIS COAST SYNC Vice Chair, do3863@att.com
Steve Barclay, ATIS Director, Global Standards Development, sbarclay@atis.org
Jackie Voss, ATIS Manager, Global Standards Development, jvoss@atis.org
Emily Hoefer, ATIS Committee Administrator, ehoefer@atis.org

Appendix A

This appendix describes the three additional proposals for mitigation of GPS Vulnerability: (1) Navigational Message Authentication on L2C; (2) Sync over fiber; (3) Sync distribution via RF spectrum.

1. Navigational Message Authentication (NMA) on L2C

This proposal would add Navigational Message Authentication (NMA) to GPS L2C signals as a means to mitigate spoofing attacks on GPS devices using L2C. COAST SYNC has spent a considerable amount of time discussing the merits of NMA, and points out that the telecom sector is presently using only L1 GPS receivers for timing and synchronization. Telecom sector use of NMA on L2C would require the deployment of additional receivers, or replacement of existing L1 receivers with a dual mode version supporting both L1 and L2C operation. COAST SYNC further notes that NMA does not provide any mitigation of a jamming attack, nor does it address the issue of poor penetration of GPS signals into buildings. While NMA on L2C would not be immediately usable by current telecom receivers, the long-term application of NMA on GPS civilian signals may become an important defense against a spoofing attack.

2. Sync over fiber

Private sector companies and NIST are conducting a proof of concept trial of transporting very high precision time and phase synchronization over fiber using IEEE-1588v2 Precision Time Protocol (PTP). COAST SYNC finds the results to date of this trial encouraging, but additional study and work are needed to determine if this method will be viable. PTP packetizes time and phase information, for delivery over a packet based network such as Ethernet which is in turn transported over fiber. PTP is susceptible to impairments due to packet delay variation and asymmetry in the forward versus reverse transmission paths. Further, there is a need to determine if PTP can be used to transport very high precision time and phase sync over the vast distances required to cover the continental United States.

COAST SYNC notes that there is a second proposal for sync over fiber that may develop in the future. ITU-T standard J.211 describes a two way protocol transported over the physical layer that includes a mechanism to correct for transport delay and asymmetry. It is not packet based and thus is not impaired by delay variation. COAST SYNC has been advised that this technology could be adapted to fiber transport using telecom industry standard Wave Division Multiplexing (WDM) technology.

3. Sync distribution via other RF spectrum

COAST SYNC notes that it is technologically feasible to develop a very high precision timing reference similar to WWVB that would operate in RF-spectrum. Such a solution has been discussed in COAST SYNC. Sub-1 GHz RF spectrum signals penetrate buildings very well, and a timing source in that spectrum could be a viable back up to GPS for timing references. This proposal would require development to determine how best to provide the accuracies required for telecom needs. Another RF spectrum solution that could be considered is the use of terrestrial beacons.

Notes

NMA on L2C (proposal 1) would provide mitigation against spoofing of the L2C signal only.

Like eLORAN, sync over fiber and sync distribution via RF spectrum (proposals 2 and 3 respectively) are methods for transporting time and phase synchronization that are technologically diverse from GPS; these proposals could continue to deliver time and phase sync even if there were a total failure of the GPS system.