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Via Email
Helen Jackson (helen.jackson@hq.dhs.gov)
NSTAC Designated Federal Official
Department of Homeland Security
NPPD/CS&C/SECIR Division

Re: Recommended Updates to Telecom Vulnerability to Loss of GPS Signals Documentation

Dear Ms. Jackson:

The Alliance for Telecommunications Industry Solutions (ATIS), on behalf of its Copper/Optical Access, Synchronization and Transport (COAST), wishes to provide the attached document containing recommendations to the Department of Homeland Security to update and verify the information contained in *National Security Telecommunications Advisory Committee (NSTAC) Report to the President on Commercial Communications Reliance on the Global Positioning System (GPS) (2008 NSTAC Report).*

ATIS is a leading technology and solutions development organization. Through ATIS forums, 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. COAST Synchronization (SYNC) Subcommittee is responsible for validating the network interface standards developed within COAST, to ensure successful synchronization between carriers.

Wireline and wireless networks have dramatically changed since the publication of the *2008 NSTAC Report*. The progression of new infrastructure and technologies significantly impact synchronization of network interfaces. These changes have resulted in the exposure of commercial communications systems to the loss of GPS signal. LTE and LTE-Advanced systems are particularly sensitive to this loss of signal, and the risk of such loss has increased. Therefore, COAST SYNC believes there is value in validating the assumptions made in the *2008 NSTAC Report*.

In the attached document, COAST SYNC identifies the specific report assumptions that should be verified against a recommended series of contemporary technology considerations. COAST SYNC also proposes a study be launched to consider the vulnerability of current communications systems and threat scenarios.

If you would like additional information or if you have any questions, please do not hesitate to contact the undersigned.

Sincerely,

Thomas Goode
ATIS General Counsel

cc: Ken Biholar, ATIS COAST Chair
Bill Szeto, ATIS COAST Vice Chair
Lee Cosart, ATIS COAST SYNC Chair
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Jackie Voss, ATIS Manager, Global Standards Development
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Recommended Updates to Telecom Vulnerability to Loss of GPS Signals Documentation

A number of communications systems and requirements have changed since the publication of the February 28, 2008, *National Security Telecommunications Advisory Committee (NSTAC) Report to the President on Commercial Communications Reliance on the Global Positioning System (GPS) (2008 NSTAC Report)*. The following concerns have been identified by the Alliance for Telecommunications Industry Solutions (ATIS) Copper/Optical Access, Synchronization and Transport Committee (COAST) based on the *2008 NSTAC Report* relating to the exposure of commercial communications systems to a loss of the GPS signal:

- There are new requirements for more accurate synchronization. Universal Coordinated Time (UTC) traceable time and relative phase alignment between non-collocated elements are required and are more difficult to achieve without GPS. These transitioning wireless technologies require expensive backup systems to holdover at 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 nanosecond (ns) accuracy to UTC at the air interface for most macro cell towers. With the LORAN systems decommissioned, GPS is currently the only 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, there is a stringent GPS UTC requirement at base stations.
- There is an industry migration from time-division multiplexing (TDM), 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.

Based on the changing environment and technological advances since the publication of the *2008 NSTAC Report*, ATIS COAST SYNC recommends the following:

- The assumption that GPS outages would be localized and of a short duration should be revisited.
- The assumption regarding spoofing should also be revisited. At the time of the report, spoofing was not considered a significant concern because GPS spoofing technology was in its infancy, immature and not widely known.
- The "30 day" assumption for wireline networks should be revisited. This assumption was based on Rubidium clocks maintaining stable frequency outputs to TDM systems and SONET elements for up to 30 days in holdover.
- The "24 hour" assumption for wireless networks should be revisited. This assumption was based upon impact of GPS loss to the +/- 16 ppb frequency stability needed to insure +/- 50 ppb accuracy of the RF carrier at the air interface. During loss of GPS, the oven controlled crystal oscillators (OCXO) deployed in many base stations may not maintain a phase alignment for 24 hours at 1.5 µs.
- The evaluation of the phase performance of crystal-based oscillators used in LTE base stations in the presence of temperature fluctuations. This is important because the phase performance of crystal-based oscillators varies widely with temperature fluctuations. This was not considered in the *2008 NSTAC Report*.

- The use of accurate UTC time, called "Time of Day," and the use of differential phase accuracy should be considered. At the time of the *2008 NSTAC Report*, neither was part of the timing architecture and therefore was not considered.

The operation of critical infrastructures relies on communications networks, which in turn depend on GPS availability. Consequently, it is necessary to verify and validate each of the above assumptions taking account of the following:

- New and more broadly available technologies exist that can cause GPS outages of long duration and across vast areas.
- GPS spoofing is now a demonstrated threat.
- Some legacy wireless technologies require only frequency synchronization (*i.e.*, GSM) while other legacy wireless technologies (*i.e.*, CDMA) require phase accuracy (10 µs). Current wireless technology (*e.g.*, LTE-TDD and LTE-Advanced) requires more precise phase (1.5 µs) synchronization.
- Rubidium and OCXO cannot maintain accurate phase for any significant duration.
- Outage durations of short, medium, and long term and the geographic scope of outages need to be defined.

Additionally, COAST SYNC notes that there may be other issues associated with the loss of GPS that may impact wireless services. We acknowledge that it is not possible for COAST to assess such issues without additional input. This is 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.

Based on the above, COAST SYNC urges that a careful study be performed on the vulnerability of current communication systems and threat scenarios. This study should:

1. Evaluate phase performance requirements for current technology, particularly with a loss of the GPS signal over a localized region.
2. Engage wireless service providers and equipment vendors to evaluate how GPS outages will impact wireless services.
3. Engage wireless equipment vendors to study the holdover capability of crystal-based oscillators (*e.g.*, OCXOs) used in mobile base stations in dynamic environmental conditions (*e.g.*, temperature variations).

ATIS COAST SYNC looks forward to participating in this proposed study and welcomes the opportunity to assess the vulnerability of, and recommend corrective measures for, this critical infrastructure.