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MEMORANDUM FOR U.S. OWNERS AND OPERATORS USING GPS TO OBTAIN UTC TIME

Upcoming Global Positioning System Week Number Rollover Event

This paper is intended to provide an understanding of the possible effects of the April 6, 2019 GPS Week Number Rollover on Coordinated Universal Time derived from GPS devices.

Sponsored by the Department of Homeland Security's National Cybersecurity and Communications Integration Center in coordination with the Department of Homeland Security's Science and Technology Directorate, the Department of Homeland Security's National Protection and Programs Directorate Office of Infrastructure Protection, and the National Coordination Office for Space-Based Positioning, Navigation and Timing. This product is intended to assist federal, state, local, and private sector organizations with preparations for the April 6, 2019 GPS Week Number Rollover event.

SUMMARY: Critical Infrastructure (CI) owners and operators and other users who obtain Coordinated Universal Time (UTC) from Global Positioning System (GPS) devices should be aware of the GPS Week Number (WN) rollover events and the possible effect a GPS WN rollover event may have on the reliability of the reported UTC. The legacy GPS navigation message has a ten (10) bit parameter that represents WN. Thus, the WN parameter in the GPS navigation message "rolls over" to zero every 1024 weeks starting from 0000Z January 6, 1980. The next WN rollover will occur April 6, 2019. The IS-GPS-200H interface specification identifies both the ten bit WN parameter and the WN rollover events. A GPS device that conforms to the latest IS-GPS-200 and provides UTC should not be adversely affected. However, tests of some GPS devices revealed that not all manufacturer implementations correctly handle the April 6, 2019 WN rollover. Additionally, some manufacturer implementations interpret the WN parameter relative to a date other than January 5, 1980. These devices should not be affected by the WN rollover on April 6, 2019 but may experience a similar rollover event at a future date. For example, a particular GPS device may interpret the WN parameter relative to a firmware creation date and would experience a similar rollover event 1024 weeks after that firmware creation date.

RECOMMENDATIONS: Critical Infrastructure and other owners and operators are strongly encouraged:
1. to investigate and understand their possible dependencies on GPS for obtaining UTC,
2. to contact the GPS manufacturers of devices they use to obtain UTC
   a. to understand the manufacturers' preparedness for the April 6, 2019 WN rollover,
   b. to understand actions required by CI and other owners and operators to ensure proper operation through the April 6, 2019 WN rollover, and
3. to ensure that the firmware of such devices is up-to-date.

BACKGROUND: The GPS Internal Navigation Time Scale "GPS Time" is based on the weighted average of GPS satellites and ground station clocks. GPS Time is used for user navigation solutions. A nanosecond error in GPS Time can equate to one foot of position (ranging) error. The WN parameter is provided via a ten (10) bit parameter – or "counter." The valid range of values for the WN parameter is 0 to 1023 (or 1024 total values). The WN parameter is incremented by one each week. At the end of the 1024th week, the counter experiences a rollover (resets) to 0. Each WN rollover event defines a new GPS Time Epoch. The WN value is referenced to the start of the current GPS Time Epoch. The last WN rollover was August 21, 1999. GPS Time is currently in the second Epoch. The next WN rollover is April 6, 2019.

GPS Time is adjusted by the U.S. Air Force GPS Directorate to maintain alignment with UTC as provided by the U.S. Naval Observatory. A GPS device that provides UTC time does so by converting GPS Time to UTC using multiple parameters – including WN – conveyed in page 18 of GPS sub-frame 4. GPS devices with a poorly implemented GPS Time-to-UTC conversion algorithm may provide incorrect UTC following a WN rollover. Additionally, some GPS devices that calculate the WN value from a device-specific date rather than the start of the current GPS Time Epoch may provide incorrect UTC at some other device-specific date.

REFERENCES:
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