NIST method improves reliability of GPS clocks

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The average user may not notice, but the Global Positioning System (GPS) is more reliable today than it was several years ago.

Widely used by the military, first responders, surveyors and even consumers, GPS is a navigation and positioning system consisting of ground-based monitors and a constellation of satellites that rely on atomic clocks. A statistical method, developed by the National Institute of Standards and Technology (NIST) and tested and implemented with the help of several collaborators, has made the job of analyzing the accuracy and reliability of these satellite-borne time signals significantly faster and easier. The method will help ensure that GPS clocks produce accurate location and distance measurements and remain closely synchronized with official world time.

The NIST method, described in a recent paper,* has been incorporated over the past few years into the GPS clock analysis software system managed by the Naval Research Laboratory (NRL). The satellite clocks--commercial devices based in part on research originally done at NIST--use the natural oscillations of rubidium atoms as "ticks," or frequency standards. The algorithm helps detect and correct GPS time and frequency anomalies. The algorithm also can be used to improve the control of other types of atomic clocks and has been incorporated into commercial software and instruments for various timing applications, according to NIST electronics engineer David Howe, lead author of the paper.

A GPS receiver pinpoints its location based on the distance to three or more GPS satellites at known locations in space. The distance is calculated from the time it takes for satellite radio signals to travel to the receiver. Thus, timing accuracy affects distance measurements. The NIST method makes a series of mathematical calculations to account for numerous measures of random "noise" fluctuations in clock operation simultaneously.

This makes it easier to estimate many sources of error and identify the onset of instabilities in the clocks in minutes or hours rather than days. Adjustments then can be made promptly. The technique also could accelerate the evaluation of clocks during the process of building GPS satellites, where test time is at a premium. "Ultimately, it should improve reliability, stability and accuracy for many people who use GPS for time and navigation,"said Howe.

Co-authors of the paper include scientists from NRL, the Jet Propulsion Laboratory at the California Institute of Technology, the Observatoire de Besancon in France, and Hamilton Technical Services in South Carolina.

* D.A. Howe, R.L. Beard, C.A. Greenhall, F. Vernotte, W.J. Riley, T.K. Peppler. Enhancements to GPS operations and clock evaluations using a "total" hadamard deviation. IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control. August 2005.

Source: NIST