What Effect Will Galileo Have on the MRTFB Infrastructure?

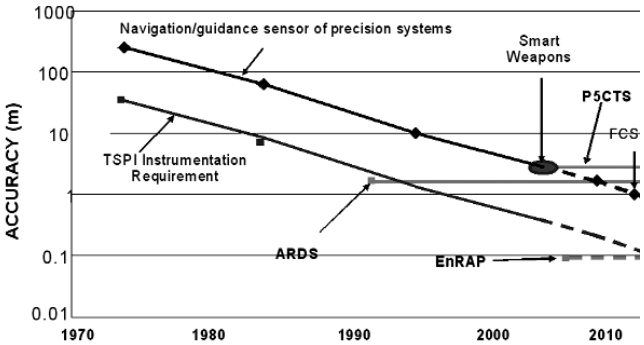
By G. Derrick Hinton

Since making its debut in the early 1990s, the Global Positioning System (GPS) has proven to be a cost-effective source for worldwide navigation, surveillance and tracking. GPS provides a source for computing highly accurate three-dimensional position, velocity and universal time. As such, GPS is widely employed on Department of Defense (DoD) smart weapons for navigation and guidance.

It is universally accepted that test equipment must provide a "factor of 10" better Time, Space, Position Information (TSPI) performance than the system under test. Until now, the test and evaluation (T&E) community has achieved the required level of performance by employing "differential" and, more recently, "kinematic" positioning, which requires a network of ground-based reference receivers. To date, warplanners have not proposed deploying such a network in an operational context, but this may change. The graph *(top right)* shows the trend in weapon system accuracy and the attendant performance of TSPI instrumentation.

The European Union (EU) is currently developing its own satellite navigation system, called Galileo. In 2004, the United States and the EU signed a cooperative agreement to "harmonize" GPS and Galileo. Galileo will comprise a constellation of 30 satellites in three orbital planes at an altitude of ~23,600 km. Galileo will broadcast 10 navigation signals in the L-band on three carrier frequencies with six of the navigation signals available to the civilian community. The Galileo signal parameters are very similar to the Modernized GPS satellites, which are organized in six orbital planes at an altitude of ~24,000 km. Modernized GPS will broadcast eight navigation signals in the L-band on three carrier frequencies, with four navigation signals available to the civilian community. Galileo does employ several key design features that offer performance advantages over GPS. These include the use of a hydrogen maser clock (versus rubidium) to enhance on-orbit accuracy and the coherent transmission of four signals with an effective bandwidth of 90 MHz (versus 20 MHz for GPS). 90 MHz has the potential to provided millimeter-level position accuracy.

The planned development of Galileo alongside GPS and its various augmentation services extends the number of satellite-based position and timing services. It is expected that both Modernized GPS (Block IIR and Block IIF with IOC 2010) and Galileo (IOC 2010) will be appropriately exploited by warfighters to achieve greater navigation and guidance accuracy while having better anti-jam performance. The T&E community must, in turn, enhance today's instrumentation to meet the test requirements of these higher-accuracy weapons. It is envisioned that an integrated GPS/Galileo instrumentation set must be developed as a baseline to achieve the TSPI accuracy required for future T&E. In addition, it is imperative for the T&E community to actively participate in the next-generation GPS III (FOC ~2030) constellation design/development phases, to support future T&E needs and performance requirements.



The Galileo spectrum was carefully chosen to facilitate system compatibility (non-interference when the two systems operate separately) while ensuring system interoperability (the combined use of the two systems). Compatibility/interoperability will allow the development of an integrated, low-cost GPS/Galileo-based TSPI set, which will significantly enhance the capabilities of a GPS-only TSPI set.

The integrated set would have access to more than 50 satellites. This added number of satellites would provide greater signal coverage and availability in urban and GPS-denied environments. More importantly, the added number of satellites would also enhance the achievable TSPI accuracy when both GPS and Galileo signals are available in the following way: The highest level of GPS-based positioning accuracy is provided by using the phase of the carrier signal (as opposed to the code signal). This carrier-based phase method, used in kinematic positioning, has been shown to provide cm-level accuracy. However, this method must first determine "carrier phase ambiguities." This process is very sensitive to environmental error sources and the number of simultaneous signals that are available for processing. An integrated GPS/Galileo set would increase TSPI performance by increasing the efficiency and reliability of the ambiguity resolution process. Because, for the reason stated above, a tactical weapon could not practically employ kinematic positioning; the resultant accuracy of the integrated set potentially can provide the "factor-of-10" accuracy advantage required for the GPS/Galileo-equipped tactical weapon.

But will it? Time will tell… Galileo is still under development, and GPS has not finished its system enhancements. But one thing is certain: The T&E community must explore integrated GPS/Galileo technology and be ready to exploit the increased accuracies offered by these systems, both in combination and standing alone. ❑

G. Derrick Hinton *is program manager, Central Test and Evaluation Investment Program, for the Joint Investment Programs and Policy deputate under the Defense Test Resource Management Center. He is also chairman of the ITEA Technology Committee* ***(itea@itea.org, Attn: G. Derrick Hinton, Chairman).***