SUBMISSION IN RESPONSE TO REQUEST FOR INFORMATION ABOUT PROFILE OF RESPONSIBLE USE OF POSITIONING, NAVIGATION, AND TIMING SERVICES

Dennis D. McCarthy
Retired Former Director of Time, U. S. Naval Observatory

Background

1. The existence of precise frequency and time capability serves as an enabler of many modern processes. For example, precise time/frequency is used in radiocommunications and telecommunication systems, in most navigation systems, in computer networks, in accounting and banking systems, in air and sea traffic control systems, in fault detection and efficiency monitoring of power grids, in environmental sensing, in plane collision avoidance and precision landing, and in truck fleet tracking. More than two billion quartz resonators are made per year and the number of atomic clocks in use is about a hundred thousand
2. However, maintenance of accurate Positioning, Navigation and Timing (PNT) services not only depends critically on precise timing but also on the maintenance of accurate astro-geodetic reference systems and frames, particularly geodetic reference frames. Maintenance of those geodetic frames requires ongoing observations and modeling of reference station motions. PNT services also rely on the ongoing observation and prediction of the Earth's orientation in an inertial reference frame to model and predict the orbits of navigational artificial satellites with the required accuracy. The accuracy of these components is directly translatable into the positional accuracy of global positioning and navigation services.
3. Current accuracy available from today's time and frequency devices can provide the precise timing suitable for most practical applications. However, the largest challenge in utilizing this precision is the lack of ability to transfer precise time/frequency over distance with accuracy equivalent to that provided by the most precise time and frequency devices.
4. Perhaps the most potentially dangerous situation with respect to users of accurate time information, however, remains the possible confusion surrounding the occasional breaks in the world standard Coordinated Universal Time (UTC) scale caused by the introduction of leap seconds. These one-second breaks in the normal counting of seconds have caused confusion in their implementation leading to breaks in communications and electronic data transfer. Originally designed as a means to maintain a relationship of the civil time scale with the rotation angle of the Earth within 0.9 time seconds, the process has been questioned by some members of the International Telecommunications Union, and their continued use is being considered currently. With the widespread electronic and printed availability of the accurate knowledge of the Earth's rotation angle, such a practice adds confusion to the non-expert user of PNT information for no apparent reason. This practice also has led to an ever-increasing separation of the UTC time scale from some satellite navigation system times. In the case of the U. S. Global Positioning System, the GPS System Time, the time scale internal to GPS operations, sometimes referred to as "GPS Time", is currently 18 seconds different from UTC. That situation obviously can cause confusion among non-expert users of precise time, not to mention the usual confusion on how to implement leap seconds in existing equipment that occurs each time a leap second is introduced.

Recommendations for use of non-research PNT services.

1. Provide ongoing support for continuous maintenance and improvement of reference frames and predictions of Earth orientation information.
2. Provide support for the development of improved secure time/frequency transfer techniques.
3. Support the elimination of leap seconds in the UTC time scale.