The Experience of a Time Metrology Institute in the Galileo Navigation System: The Time Validation Facility

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The National Institute of Metrological Research (INRIM) in Italy has been deeply involved in the last 15 years in the development of the timing system of the European Satellite Navigation System Galileo, collaborating with the European metrological time laboratories, space industries, and the European Space Agency. In 2010-2013, INRIM designed, developed and operated the Time Validation Facility (TVF), a crucial timing element used for the In Orbit Validation (IOV) Galileo phase carried out with the first 4 satellites in 2013.

This paper shows TVF main results obtained in the IOV phase in the assessment of the Galileo timing system [1]. The main roles of the TVF are related to the validation of all the system clocks, both in space and on ground, showing that the performances are compliant with the requirements. Moreover, the TVF has the task to maintain the strict synchronization between the Galileo System Time (GST) versus the international reference time UTC. TVF estimates the frequency steering correction to be applied to GST in order to maintain its time and frequency offset within the system requirements. As reference for steering UTCapprox is taken, it is a real time mean of UTC(k) time scales involved into the project. The computed frequency correction is evaluated and communicated daily to the PTF on a regular base from more than one year, since February 2013. Figure 1 shows the behaviour of UTCapprox-GST from May 1st, 2013 to October 20th, 2013, as well as the measured differences UTC(k)-GST. It is visible that the requirements are fully satisfied during all the considered period [2].

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig1.png}
\caption{GST steering: The measured differences UTC(k)-GST and the estimated UTCapprox-GST (from May 1st to October 20th, 2013)}
\end{figure}

In addition, the UTC-GST offset is daily predicted and uploaded in the broadcast Galileo navigation message. This allowed to start the Galileo UTC dissemination service since April 2013.

The main timing results of one year of real-time steering of GST by TVF and the timing achievement in the frame of the Galileo In Orbit Validation obtained in 2013 are reported, pointing out the most important contribution of time metrology to a navigation system.
References:
