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The timing system of the European GNSS Galileo

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Galileo is Europe's contribution to the Global Navigation Satellite System (GNSS). The project is currently in preparation of the In-Orbit-Validation (IOV) phase, scheduled for 2008/2009. At that time 4 Galileo satellites will be in orbit and the ground infrastructure necessary to verify the system will be installed.

The timing system is at the heart of any GNSS. It comprises the on-board-clocks and the infrastructure on ground. Galileo's time reference, Galileo System Time (GST), will be realized in a Precise Timing Facility (PTF), and, actually, two of them shall be available already at IOV. Physikalisch-Technische Bundesanstalt (PTB) is involved in developing one PTF, under contract of Kayser-Threde, Munich. The PTF will provide GST as a physical signal with properties defined so that the navigation function of Galileo can be fulfilled.

Each GNSS is also a time distribution system. GST should thus have metrological quality and be close to UTC or TAI, representing the international timing reference. The Galileo Time Service Provider (GTSP) will ensure that GST is steered towards UTC with the help of an intermediate time scale produced as the composite of about 30 atomic clocks operated in European timing institutes. GTSP is currently developed under project management of Helios Technology (UK) by various European National Metrology Institutes and industrial partners in contract awarded by Galileo Joint Undertaking, Bruxelles.

The cooperation of the various elements in the Galileo Ground Segment involved requires state-of-the art time transfer between the elements to be performed. Two-way Satellite Time and Frequency Transfer (TWSTFT) through a geostationary telecommunications satellite has been defined as the primary method. It is PTB's task to manage TWSTFT operations and organize the calibration of all links involved in GTSP activities during IOV. I will thus discuss function and performance of this technique.

Another important issue in the context of the Galileo timing system is the interoperability of Galileo and GPS. The GPS-Galileo time difference is determined at the PTF and will later be broadcast as part of the navigation messages of both systems. So in the long term both satellite navigation systems can indeed be used in all applications simultaneously which improves reliability and availability compared to the situation when only one system alone is available.