

Combined processing and orbit determination of Galileo and GPS satellites using phase clocks

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As a first step we introduced Galileo observables in the Bernese GPS software to study the combined processing of Galileo and GPS measurements based on the estimation of phase clocks for both GNSS systems.

We then simulated measurements for both, the Galileo and the GPS constellation and estimated all relevant IGS parameters like Galileo/GPS orbits, high-rate Galileo/GPS satellite clocks, Earth orientation parameters (EOPs), station coordinates, troposphere zenith delays, etc. In this contribution we show how Galileo helps to de-correlate troposphere zenith delay, receiver clock and horizontal station coordinates from the station height and improves the overall IGS processing performance and precise point positioning quality. We study ambiguity resolution strategies for such a combination of navigation satellite systems and discuss the improvements that the Galileo system might bring.

The method of phase clocks was originally developed for the orbit determination of LEO satellites and is based on the estimation of GNSS satellite clocks and ground receiver clocks using only zero-difference phase measurements from about 30 ground IGS stations. In this way, any influence coming from the noisy pseudo-range measurements or systematic code effects like inter-channel code biases or large code multipath is avoided. Phase clocks found very nice application in precise point positioning and frequency transfer. By making differences between the receiver clocks estimated in such way, one can immediately obtain information on the frequency comparison between them. Therefore, we will show how phase clocks can be used for the highly accurate frequency comparisons between H-masers within the IGS network. The method of phase clocks can also be used to handle the clock bias between Galileo and GPS satellite systems that make use of different frequencies and of onboard atomic standards of different quality. However, the clock of a combined GPS/GALILEO receiver to be estimated may be different for both GNSS systems. As long as this difference stays constant over time it can be absorbed by the phase ambiguities.

We also plan to present data processing and orbit determination for the first Galileo satellite using the new Galileo frequencies and SLR measurements and to make comparisons with the existing GPS system.