GNSS-based clock synchronisation: a performance assessment

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Abstract:

In bistatic and multistatic space radar systems the transmitter and the receiver are spatially separated, which is typically associated with reduced development costs, risks, and enhanced performance. In particular, multistatic constellations allow for lower revisit times and better reconfigurability and scalability. In these systems, however, different oscillators are used for modulation and demodulation the low-frequency phase errors of the oscillator are not canceled as in monostatic systems. This residual phase may cause defocusing, position and phase errors in the computed images, which may compromise the use of the systems for interferometric and tomographic applications. As an example, the generation of high-resolution digital elevation models (DEM) requires the knowledge of relative phases within a few degrees in order to avoid low-frequency modulation of the DEM in azimuth. In the TanDEM-X mission, synchronisation with this level of accuracy was achieved by exchanging radar pulses between the satellites through a direct microwave link, which required dedicated transmit and receive hardware and a total of six dedicated antennas covering the full solid angle. Besides the need for additional hardware, the incorporation of such direct links may be problematic due to differences in the development schedules of elements of the constellation, as is the case of companion SAR missions. We analyse in this paper a different approach, in which the same oscillator is shared by the radar hardware and the GNSS receiver. In this way, we can use GNSS data and results from the precise orbit determination to infer the phase noise component in the radar signal. We present simulation results and a performance assessment for the case of a Sentinel-1 companion mission.

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