Satellite clock steering based on a Kalman filter approach

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Due to mechanical and launch constraints, the size of space instruments is limited. A viable solution to circumvent these limitations is the distribution of instruments across a swarm of satellites. This concept of distributed instrument already exists on the ground, as demonstrated by the radio telescope network LOFAR and EHT.

To ensure that a swarm of satellites can contribute to a common measurement, each unitary measure needs to be performed in a common timescale. The synchronization performance between the clocks can become particularly crucial, depending on the specific application. Recognizing this, CNES has developed a dedicated test bed to assess the performance of various clocks, identified as prospective candidates for future swarm missions.

Furthermore, this test bed serves as a platform for evaluating different clock steering methodologies. This study presents the outcomes of our investigation into a comparison between the classical steering approach and a Kalman filter-based approach, both through simulation and experimental assessments.

The outcomes reveal distinct advantages and limitations of each approach: the classical method offers simplicity and ease of implementation, while the Kalman filter-based approach provides enhanced adaptability to the dynamic space environment, especially in the context of swarms of satellites, where continuous and direct communication between satellites is not guaranteed.

The comparative analysis underscores the potential of the Kalman filter-based method as a more robust solution for clock synchronization in satellite swarms.