The Genesis Mission and its Prospects for Time and Frequency Transfer over Trans-Continental Baselines

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GENESIS is an ESA-approved mission dedicated to GNSS Science conducted by the ESA Navigation Directorate. Its primary objective is the contribution to the improvement of the International Terrestrial Reference Frame (ITRF) accuracy (1mm) and long-term stability (0.1mm/year). Secondary objectives include the contribution to a high number of other scientific disciplines (geodesy, geodynamics, earth rotation, geophysics, earth gravity field, atmosphere and ionosphere sciences, metrology, relativity…) [1].

The GENESIS Space Segment includes a single spacecraft in MEO (6000km altitude, 95° inclination) co-locating for the first time in space the four geodetic instruments used for the realisation of ITRF: a GNSS receiver, an SLR reflector, a VLBI transmitter and a DORIS receiver. The Ground Segment is composed of a Mission Control Centre (including Ground Station) and will make use of the existing ground infrastructure: GNSS sensor stations network, SLR stations, VLBI antennas and DORIS beacons. The mission data will be processed, archived, and distributed by ESA, in close collaboration with the scientific community.

On the industrial side, the company OHB Italia has been contracted by ESA as prime for the development, qualification, launch and 2 years operation of the mission, with a launch date in 2028 [2]. Antwerp Space (B), as the major sub-contractor of OHB-I, oversees the payload and geodetic instruments. Industrial activities have been successfully kicked-off in April 2024 and work is on-going towards a System Requirements Review in Q3 2024.

In parallel, on the scientific side, after a successful GENESIS Workshop held in February 2024 [3], a GENESIS Science Team is being set-up and members appointed. This structure includes representatives of ESA, a lead Scientific Coordinator and Co-Coordinator, as well as five Working Groups covering the four geodetic techniques and their combination. This structure supports both the mission development (in particular consolidation of requirements) and its future exploitation.

Of particular interest to the ACES and time and frequency communities is the implementation, for the first time, of a one-way ranging mode on the multi-frequency VLBI transmitter that will allow a new type of time and frequency transfer over trans-continental baselines. With such a function, the high altitude of the Genesis spacecraft will allow common-view ground clock comparisons over baselines in excess of 6000km.

The paper will provide a detailed description of the scientific objectives, mission, and system overview, and a programmatic status of the GENESIS Mission, together with the principle and implementation of this new time and frequency transfer method.

[1]: Delva et al. Earth, Planets and Space 75, 5 (2023)

[2]: https://www.esa.int/Applications/Satellite_navigation/ESA_kicks_off_two_new_navigation_missions

[3]: https://www.esa.int/Applications/Satellite_navigation/The_geodetic_community_meets_Genesis