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Performance Aspects of Future Gravity Mission Constellations

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Quick-look and full-scale simulations reveal that one or more pairs of satellites in low-low configuration look most promising for a future gravity mission. As for GRACE, the spacecraft will be equipped with satellite-to-satellite tracking metrology for distance variation measurement and inertial sensors for the determination of non-gravitational accelerations. However, to achieve the envisaged improvement of the gravity field recovery, several major mission design changes have to be taken into account.

First the satellite constellation will no longer be GRACE-like, but realized as some kind of pendulum, cartwheel or LISA/helix configuration where both satellites of each pair are placed on slightly different orbits to obtain cross-track and/or radial information in addition to the 'typical' along-track measurement. Together with the fact that the microwave link between the two satellites will be replaced by a laser link (realized as an interferometric or a pulsed system) for performance reasons, this leads to new important (or driving) aspects for the overall system performance.

Both payloads are integral parts of the control system and thus, payloads and control system cannot be treated independently. For example, the laser link system will not only be used to measure distance variations as science data, but also to keep up the link itself by providing accurate 2-axis information of the relative attitude. Concerning the inertial sensor, measured accelerations are science data as well as input to drag compensation loops allowing the sensors to operate in more sensitive resolution ranges.

While above mentioned would generally also hold for a inline (GRACE) configuration, the situation gets more crucial for the new types of constellation as they do no longer have a constant working point but require continuously varying angular motion of each satellite. Thus, special care has to be taken from a system point of view concerning the coupling of the spacecraft motion (DC and noise) with the displacement of the payload sensors with respect to the measurement reference point.

In this presentation we show how such a new constellation together with sensor positioning affects the science measurement and how errors could be mitigated. The proposed approaches are based on trades between control system aspect and positioning accuracy as well as on a different reference point selection for the science measurements.

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