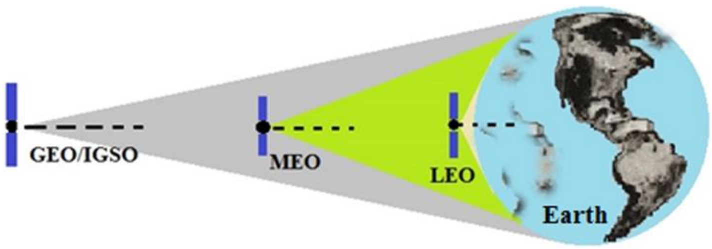
Master of Science Project

Geoscience and Remote Sensing

Theme: GNSS

LEO-enhanced GNSS positioning.



Background information

Over the past years, we have seen a substantial grow in number of Medium Earth Orbit (MEO) satellites for different Global Navigation Satellite Systems (GNSSs). Adoption of a multi-GNSS constellation is known to be beneficial at the user level, especially in support to precise point positioning (PPP) applications that require a short convergence time to achieve centimeter accuracy.

It follows the importance of integer ambiguity resolution (IAR) in order to fully exploit the millimeter level precision of carrier-phase measurements. Nonetheless, more recently, a LEO enhanced GNSS (LeGNSS) concept has been proposed by Ge et al. (2018), based on the addition of satellites in a Low Earth Orbit (LEO) that might actually transmit similar navigation signals. This is expected to largely impact on the geometry change, so also further improving user real-time IAR capability and positioning performance on a global scale.

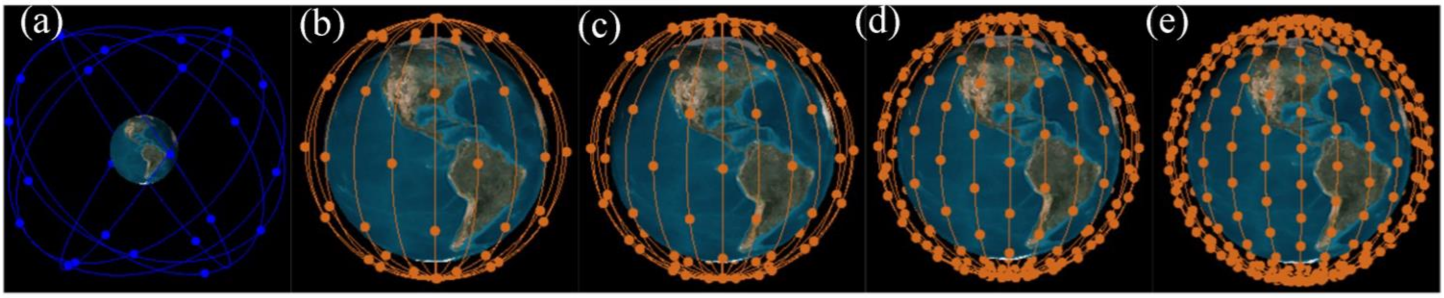
Description tasks

The candidate will firstly perform a literature review in order to identify relevant LEO/GNSS scenarios that will be analyzed, therefore considering a specific LEO-augmented configuration. A synthetic framework for simulating the LeGNSS constellation will be then implemented, without accounting for orbital dynamics perturbations. Working with a nominal constellation, i.e. Kepler motion, will allow focusing more on IAR strategies that should carefully consider the possibly different geometries involved.

As a research goal, the candidate shall identify how to better approach the combination of MEO and LEO carrier-phase measurements in the IAR process, for example by considering only LEO ambiguities and so conditioning the MEO ones. Several alternatives are possible, depending on the selected scenarios. A trade-off analysis for selecting a suitable LeAR scheme shall be presented and results will be validated by a numerical assessment onto user positioning performances. The performance of this LeAR strategy might also be evaluated by relying on a formal analysis, however the candidate shall be able to successfully identify some possible limitations in the practical adoption of such LEO enhanced GNSS (LeGNSS) architectures.

Requirements

The candidate shall have good programming skills (MATLAB or Python), and sufficient knowledge (e.g. CIE4522) of fundamental principles of GNSS data processing and user positioning.



Example of different LEO constellations (orange), compared with a MEO-based GPS constellation (blue). From left to right, each LEO constellation contains 60 (b), 96 (c), 192 (d) and 288(d) satellites in polar orbits at 1000 km altitude.

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