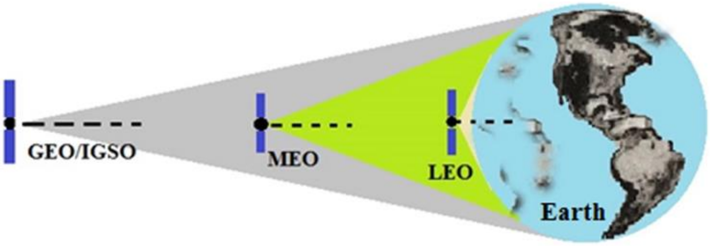
Master of Science Project

Geoscience and Remote Sensing

Theme: GNSS

# LEO-enhanced GNSS positioning




Li et al. (2018)

## Background information

Over the past years, we have seen a substantial grow in number of Medium Earth Orbit (MEO) satellites for the different Global Navigation Satellite Systems (GNSSs). The adoption of a multi-GNSS constellation is known to be beneficial at the user level, especially in support to precise positioning applications that need 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. However, 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 types of navigation signals. This is expected to have a large impact on the relative geometry change, while also further improving user real-time IAR capabilities and positioning performances on a global scale.

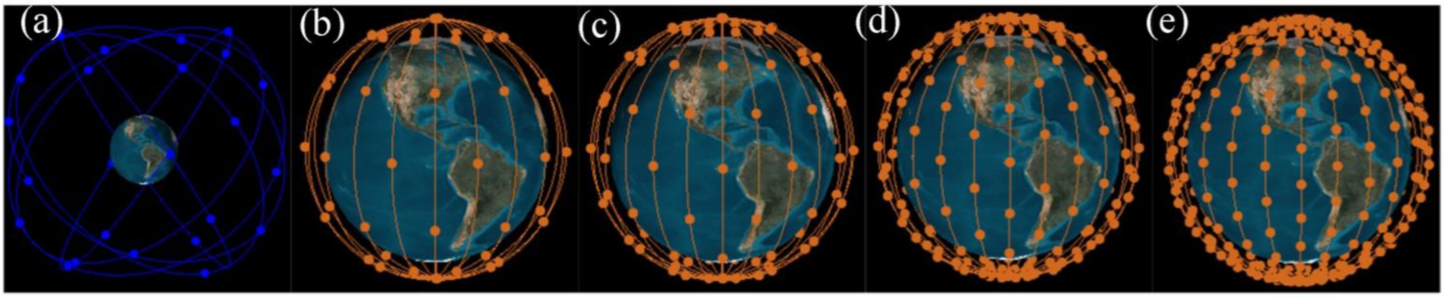
## Description of tasks

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

As main research goal, the candidate shall identify how to approach the future combination of MEO and LEO phase measurements in the IAR process, for example by considering only LEO ambiguities and later processing MEO ones. Several alternatives are possible, depending on the selected scenarios. A brief 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 be evaluated with a formal analysis, however the candidate shall be able to successfully identify the future limitations in the practical adoption of this LEO enhanced GNSS (LeGNSS) architecture.

## Requirements

The candidate shall have good programming skills (MATLAB or Python), and sufficient knowledge of fundamental principles for the 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. DOI: 10.3390/rs11030228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