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Entitled

PERFORMANCE ASSESSMENT OF A MULTI-GNSS LEO-BASED NAVIGATION AUGMENTATION SYSTEM FOR RAPID POSITIONING ACCURACY

by

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Date & Venue

11:00

Thursday 13/4/2023

F1 - 2010

Abstract

This thesis is concerned with Low Earth Orbit (LEO) Global Navigation Satellite Systems (GNSS) constellations and signals, and how can they provide rapid Positioning, Navigation, and Timing (PNT) services for the emerging technologies. The first objective of this thesis is to perform a simulation of a new mini-LEO GNSS constellation at 1000 km and assess its performance in different scenarios. The second objective is to design a signal simulator for two signals that are propriety of the Global Navigation Satellite Augmentation Systems (GNSSaS), which are the BOC(2,2) and ATLBOC(7.5, BOC(2,2)) modulation schemes. To simulate the mini-LEO GNSS constellation, two software were used: System Tool Kit to design the orbits of the constellation, and Skydel GNSS simulator to test the orbital scenarios as a functional GNSS constellation. To generate the GNSSaS signals, Gnu Radio which a specialized Software Defined Radio (SDR) software was used. The optimized mini-constellation consisted of four planes separated by 30°, each plane had three satellites with a true anomaly difference of 15°. The optimized constellation showed a 3D accuracy of 14-18 meters, and Time to First Fix (TTFF) of more than 200 seconds. The LEO GNSS constellation performance was not expected for LEO GNSS due to the fact that the U-blox EVK-M8T GNSS receiver was not designed to receive LEO GNSS signals. This is because of the higher dynamics of the LEO satellite compared to MEO, whereby the computed radial velocity and acceleration at 1000 km are 5380.485 m/s and 2.463 g respectively. The spectrum of both BOC(2,2) and ALTBOC(7.5, BOC(2,2)) signals were accurate and as expected, except for spectral lines presented in the ALTBOC(7.5, BOC(2,2)). The simulated GNSSaS signals are consistent with the theoretical and mathematical predictions. The research paves the way for further LEO GNSS development, by designing, optimizing and simulating LEO GNSS constellation, finding the lack of receiver technologies for LEO purposes, and generating first of its kind ALTBOC modulation for the GNSSaS satellite program.

Keywords: Low earth orbit, global navigation satellite system, binary offset carrier, alternate binary offset carrier, digital signal processing