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Entitled

Design and Assessment of a LEO GNSS mini-constellation for Positioning, Navigation, and Timing (PNT)

by

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Abstract: Recently, there has been a resurgent demand in the UAE for more accurate positioning, navigation, and timing signals, especially for some targeted applications such as autonomous vehicles and flying taxis. The existing GNSS provides real-time positioning accuracy for up to several meters, while the targeted applications require fast convergence of centimeter-level positioning accuracy. Recent studies have shown that transmitting GNSS signals from LEO instead of MEO would enhance positioning accuracy. The main objective of this thesis is to design and simulate an optimum scenario of a mini-LEO constellation transmitting GNSS signals in LEO and assess its performance using a GNSS simulator tool. The second objective is to assess the performance of a ground-based GNSS receiver receiving GNSS signals from LEO in terms of the receiver's time to lock, locking period, continuity, PDOP and 3D positioning accuracy. The final objective is to compare the performance of the simulated mini-LEO GNSS constellation with the existing MEO GPS and Galileo. Skydel GNSS simulator tool, single frequency L1/E1 ublox receiver, Systems Tool Kit (STK), and u-center software were used to conduct this research. The best simulated LEO scenario had a design consisting of 35 satellites at 800 km altitude, distributed into 5 planes, with 7 satellites in each plane, the planes were 45° apart and the satellites were 30° in each plane. The results showed a range of PDOP values from 2.1 to 3.3, 3D positioning accuracy of 5.86 m, the time the receiver took to lock was about 1 minute with a maximum locking period of 3 minutes and with no continuity. The results obtained from the simulated LEO constellation assessed using the ublox receiver were no better than to those of the simulated MEO GPS and Galileo. The main reason that contributed to the obtained results is the fact that the current GNSS receivers are not designed to cope with the higher dynamics of the satellites in LEO.

Keywords: Low Earth orbit, Medium Earth Orbit, Global navigation Satellite System, Skydel, STK