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GPS Timing: Investigating Ionospheric Effects on Receiver Timing Accuracy

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ABSTRACT

The Global Positioning System (GPS) is used in a multitude of applications such as power grid synchronisation, telecommunications, and global financial trading and transactions. A GPS radio signal encounters different errors from different sources as it travels from the satellite to the receiver. For precise GPS timing, propagation impairments such as multipath, ionospheric effects, and spoofing, may cause receiver errors. Assessing propagation impairments on GPS receiver positioning and timing is possible through simulation. Lab emulation of such impairments provides a means by which to understand receiver behaviour towards amplitude fading and phase variation of L1 GPS signals (1575.42MHz).

The purpose of this study is to quantify ionospheric errors on GPS receiver timing accuracy. This is achieved by simulating ionospheric phase variations using MATLAB, and a Spirent GPS simulator. Results were obtained from a Septentrio PolaRxS receiver. The primary reference to the receiver timing accuracy in this study is the Time Dilution of Precision (TDOP), which is an internal measurement of receiver accuracy performance. The TDOP is also satellite geometry dependent; therefore the repeatability offered by the simulator setup for constellation configurations was an advantage of the method used. In addition, different phase variation profiles for a particular scenario were also analysed. This paper shows sample results that indicate GPS receiver timing accuracy is degraded as ionosphere-like phase variations are applied on GPS L1 signals. The results of this study are expected to raise awareness of the robustness of current GPS receivers, and enable improvements in those receivers accordingly.

Key words: GPS Timing, Propagation, TDOP, GNSS.

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