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A Novel Method of Simulating Space Weather and Scintillation Effects on GPS within a Spirent GNSS Simulator

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ABSTRACT

The position, navigation and timing (PNT) market using Global Navigation Satellite Systems (GNSS) such as the Global Positioning System (GPS) is expected to grow in the future; particularly in the high precision, robust PNT sector. The ionosphere is the largest source of error for GNSS, which causes phase advance/group delay of the signals, resulting in tens to hundreds of meters in error. These errors can be enhanced when the ionosphere experiences a space weather-induced geomagnetic storm due to the significant increase in the ionospheric total electron content (TEC). In addition, small- and large-scale electron density structures formed during a storm can result in the rapid fluctuation of amplitude and phase of the signal, which is known as ionospheric scintillation.

Given the nature of robust PNT applications and the impact should such a system fail, it is crucial to test the systems under a simulated environment that is as realistic as possible. The Spirent GSS6700 is a multi-constellation GNSS simulator that models the effect of different errors on GNSS RF signals. The work presented here proposes a method to enhance Spirent's range of GNSS simulators by adding the capability to simulate space weather effects on the GPS L1 (1.575 GHz) signal; with a view to expand to other GNSS frequencies at a later stage. As its first phase, the method proposes to use historic GPS data of a space weather event to reconstruct the regional TEC by means of ionospheric tomography, which can then be used in the simulator to model path delays in the RF signal. Phase two will address scintillation effects caused by ionospheric structures, using recorded scintillation statistics in the region and calculating corresponding range and phase offsets in the RF signals for the satellites in view.

Key words: Space Weather, Ionosphere, GPS, Scintillation, Spirent Simulator

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