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Real-world ionospheric events in a Spirent Simulator

Spirent Communications plc produces multi-frequency multi-constellation Global Navigation Satellite Simulators for R&D and performance testing of GNSS receivers. The simulator replicates all aspects of the GNSS operating environment providing the ability to introduce or reproduce real-world incidents, testing the operation and reliability of a receiver in a laboratory environment. Vulnerabilities including jamming, spoofing and environmental incidents such as ionospheric variability are part of the current capability.

Spirent has an on-going development and improvement program called the Robust Position Navigation and Timing Framework. Within this program they are currently addressing the need to upgrade the capability of the ionospheric simulation.

This paper introduces two new approaches to develop the ionospheric capability.

The first uses historical data to generate amplitude and phase scintillation across a grid of latitude and local time for a given location. The scintillation profiles used within the framework are extracted from historical 50 Hz raw data. Data collected between 2004 and 2013 from two scintillation-rich sites at low and high latitudes (Cape Verde, off the coast of Africa (15N, 23W) and Tromso, Norway, (70N,19E) respectively) are analyzed to obtain a series of profiles corresponding to different strengths of amplitude and phase scintillation. Extraction of scintillation signatures from raw data is achieved using established methods described in past literature: Amplitude perturbations are derived by normalizing the scintillating signal intensity by the mean received intensity; while phase scintillation is extracted from the received carrier phase by de-trending the signal using a 6th order high-pass Butterworth filter.

The second area of development is in the ionospheric electron density modelling. The existing capability does not include simulations of extreme ionospheric events. A modeling capability is being developed at the University of Bath to produce realistic extreme ionospheric storm scenarios using the MIDAS software suite. The results will be integrated into the Spirent simulator to allow extreme space weather events to be realized and tested.

The ability to replay real, observed phenomena and extreme event simulations as proposed in this paper is expected to present the best opportunity for developers, integrators and users of

GNSS systems to build up a picture of their systems' resilience to ionospheric scintillation, and is likely to result in a much more effective risk assessment tool.