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Sam Pullen é pesquisador sênior no laboratório de GNSS da Universidade Stanford, EUA, onde concluiu em 1996 o seu doutorado em Aeronáutica e Astronáutica. Ele têm apoiado a FAA e outros provedores de serviços no desenvolvimento de sistemas para GBAS, SBAS e outras aplicações com GNSS, incluindo requisitos técnicos, algoritmos de integridade e modelos de desempenho. Sam Pullen também atua como consultor em projetos de sistemas GNSS, no desenvolvimento de aplicativos, avaliação de riscos e em suporte jurídico. Em 1999 foi premiado com o ION Early Achievement Award e tornou-se ION Fellow em 2017.

Título da Palestra: ”LESSONS LEARNED FROM THE DEVELOPMENT OF IONOSPHERIC MONITORING FOR GROUND-BASED AND SATELLITE-BASED AUGMENTATION OF GNSS”

Palestrante Convidado da Sessão Especial INCT GNSS NavAer Integrando Clima Espacial, Geodésia e Navegação Aérea: Sexta-feira, 29 de maio de 2020, das 08:30 às 09:10

Resumo: Ground-based and Satellite-based Augmentation Systems (GBAS and SBAS) provide differential corrections and integrity information that allow GNSS satellite range measurements to be used for aviation applications with demanding accuracy and safety-of-life requirements, such as not having unsafe and undetected errors occur more than once per ten million flight operations. Unusual variations in ionospheric delays that affect GNSS range measurements are one of the most challenging error sources that must be monitored by these systems. In mid-latitude regions where most GBAS and SBAS users reside, the ionosphere is almost always well-behaved spatially and temporally; thus almost all of the ionospheric delay is removed by applying differential corrections. The limited ionospheric data available in the late 1990's made it appear that anomalous ionospheric conditions driven by ionospheric storms or solar CMEs would create larger but manageable errors. However, early results from SBAS and CORS ground networks in the early 2000's discovered spatial gradients exceeding 300 mm/km during ionospheric anomalies caused by a powerful CME in October 2003. Gradients of this magnitude severely violated the "smoothness" assumptions of SBAS ionospheric fitting and created the potential for unsafe errors even for GBAS corrections generated a few kilometers from users. As a result, both systems had to be significantly modified to include real-time monitoring of ionospheric behavior and methods to calculate and verify bounds on anomalous ionospheric residual errors (after corrections and monitoring) that satisfy the integrity requirements mentioned above.

This presentation describes how these GBAS and SBAS ionospheric monitors and error bounds were developed and the performance and availability that they provide in the Conterminous United States (CONUS). The focus is on "lessons learned" from this process regarding (1) creating data-driven models representing anomalous ionospheric behavior; (2) adapting to constraints on what can be observed in real time; and (3) managing the development of safety-critical systems when surprising new threats are discovered. The implications of these lessons on newer systems that are affected by ionospheric behavior and safety-critical systems in general are also discussed.