New England Section of the Institute of Navigation
Announcement of the 34th Meeting
Wednesday May 5, 2004 at the MIT Haystack Observatory, Westford, MA

Presentations by Patricia Doherty and Jon Parmet

On Wednesday May 5, 2004 we will hold our thirty-fourth meeting at the MIT Haystack Observatory, Westford, MA. Two short presentations will be given. Patricia Doherty of Boston College will first present "Space Weather Effects on WAAS: A Performance and Status Report." Jon Parmet of the Volpe National Transportation Systems Center will follow with "Development Of Global Positioning System Prediction Tools To Support Flight Planning." Please refer to the abstracts and speaker biographies at the end of this announcement.

Faculty and graduate students from the Department of Geodesy and Geomatics Engineering at the University of New Brunswick will join the meeting via a video teleconference hook-up in Fredericton, New Brunswick.

The meeting will begin at 6:45 PM with an optional dinner at 6:00 PM for $15.00 (payable at the dinner). If you plan to attend, please reply to George Koehler via e-mail (gkoehler@drc.com) or telephone (1-978-683-2087). Haystack needs a list of attendees. If you plan to attend dinner, please so indicate and have your response in by 4:00pm April 28. The dinner includes: tossed garden salad, fancy rolls with butter, chicken piccata and marinated steak tips, rice pilaf, vegetable du jour, assorted miniature desserts, assorted beverages.. For our section records, please indicate whether or not you are an ION member. Since the Section's goals include increasing its knowledge base and forming communications networks, attendance is not restricted to ION members.

For directions to MIT Haystack, please see http://www.haystack.mit.edu/directions.html. The MIT Haystack Observatory is located off Route 40, on the border of Groton, Westford, and Tyngsboro. One way to get to Route 40 is to go north on Route 3 from I-495. The MIT access road off Route 40 is about 5 miles west of Route 3 and is clearly marked. Haystack is at the very end of the road (1.5 miles up the road). Since our last meeting at Haystack, a security gate has been installed along the road to the facility. **THIS UNATTTENDED GATE CLOSES PROMPTLY AT 7:00 p.m.** Access to the meeting after this time can be obtained only by calling the guard (781-981-5612) from a phone box at the gate and waiting for him to drive to the gate to let you in.

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SPACE WEATHER EFFECTS ON WAAS: A PERFORMANCE AND STATUS REPORT

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The Wide Area Augmentation System (WAAS) is a GPS-based system designed as a primary means of navigation for en route, non-precision and precision approach phases of flight in the National Airspace System (NAS). It functions by improving the accuracy and ensuring the integrity of the GPS message. These functions are implemented by providing corrections for the GPS satellite clock errors, ephemeris errors, and ionospheric errors.

WAAS was commissioned for use in July 2003. On this date, aviation users were able to use WAAS for en-route and Lateral Navigation/Vertical Navigation (LNAV/VNAV) capability. That means that pilots could safely descend to 350 ft above the runway threshold with the vertical guidance provided by WAAS. In September 2003 the first of the near precision approaches, Localizer Approach with Vertical Guidance (LPV), were provided where pilots could safely descend to a 250 ft decision height.

WAAS ionospheric corrections include differential range delays and the associated error bounds for a virtual grid of constant latitude and longitude at the height of the ionosphere. Variations in ionospheric conditions, such as those that occur during magnetic storm activity, affect WAAS performance. WAAS detects storm activity at early stages by monitoring spatial and temporal irregularities in real-time ionospheric measurements. When a storm is detected, the more dynamic variations result in increased error bounds at the affected grid points. In October and November 2003, WAAS was challenged by some of the most severe ionospheric storm conditions of this solar cycle. During these storms, LNAV/VNAV and LPV service were significantly affected. Non-precision approach services, however, were available throughout the storm periods. Although availability of the near-precision approach services was degraded, the WAAS system storm detection techniques were successful. They detected the onset of the storm activity, increased the error bounds on the affected grid points and increased the user protections levels, which bounded the navigation errors in the WAAS coverage areas.

In this presentation, we will provide a performance analysis of WAAS during the October and November storm periods and compare it to performance during nominal conditions. We will augment the presentation with updates on WAAS plans for improvement and for the global implementation of Space Based Augmentation Systems (SBAS).

Author Biography

Patricia Doherty is a Senior Scientist at Boston College. Her prime research activities include ionospheric modeling and characterization using both ground-based and satellite techniques. She has worked on ionospheric characterization for WAAS and continues these efforts in support of world-wide expansion of satellite based navigation systems. She also works to support ionospheric modeling and predictions for Air Force Space Weather programs.

She was a co-recipient of the 1996 ION Burka Award and the 2001 Air Force Merewether Award. Recently, she has been named as the Western Region Chair of the Beacon Satellite Studies Group. She is an active member of ION, the American Geophysical Union and the International Union of Radio Scientists.

DEVELOPMENT OF GLOBAL POSITIONING SYSTEM PREDICTION TOOLS TO SUPPORT FLIGHT PLANNING

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Satellite navigation systems such as the GPS have generated a challenge to predicting availability of service for air navigation. GPS differs from traditional ground-based navigation systems due to the fact that the satellites and areas of degraded coverage are in constant motion. If a satellite fails or is taken out of service for maintenance, it is not intuitively known which areas, if any, may lose coverage. Also, since GPS was not designed to meet the stringent requirements of aviation, service outages can occur even when all GPS satellites are healthy. The status of the components of GPS augmentation systems such as the Wide Area and Local Area Augmentation Systems (WAAS and LAAS) also must be taken into account to determine availability of service.

A predictive model of GPS, the augmentation systems, and algorithms used by the onboard receiver equipment are required to determine service availability and areas that expect to experience outages where these systems are used. The objective of the prediction capability is to provide a method to disseminate performance-based outage information to pilots during pre-flight planning, as well as to air traffic control. The predictive model must then be integrated with a system that can provide advance outage information reliably to pilots and air traffic control.

Author Biography

Jon Parmet is a member of the Volpe Center team which deployed GPS outage reporting systems for the U.S Air Force, FAA, Deutsche Flugsicherung and AirServices Australia. Mr. Parmet received his BS in Computer Science from the University of Rhode Island.