IGS

Session 8: Global Navigation Satellite Systems II

Session Description

Chairs: J. Slater, R. Langley

This session will focus on developments, applications and issues related to the actual and potential exploitation of multiple global navigation satellite systems. It will address current uses of GPS and GLONASS, and future uses of Galileo. Topics will include receiver technology, time transfer, reference frame definition, and IGS efforts to combine GPS and GLONASS in network operations, orbit computations and standard products.

Session Summary

J. Slater

The second GNSS session consisted of five oral presentations and three poster papers. Subjects included terrestrial reference frame issues, receiver antenna design and measurement biases, time transfer, the integration of GLONASS into IGS operations, and geodetic positioning applications. Claude Boucher began the session with a discussion of "*The ITRF/Galileo Interface*", citing the requirement that the Galileo terrestrial reference frame be an independent realization of the ITRS and that it be maintained in close alignment with the ITRS. Galileo System Time will be a continuous time scale steered toward TAI. Specific plans are needed to define the initial reference frame based on a network of sensor stations temporarily or permanently collocated with other GNSS stations. It was recommended that the IAG/IGS Working Group on GNSS should work with the Galileo system management and establish an implementation plan for incorporating Galileo into the ITRF. A final issue was the need to ensure long-term availability and reliability of the ITRF from a liability perspective, possibly by making it the responsibility of an inter-governmental organization, rather than a non-governmental organization (IERS).

New satellite systems and new signals place new demands on receiver antennas. Dmitry Tatarnikov addressed the issue of antenna ground plane design for multipath reduction in his paper on "*GPS/GLONASS Antennas and Ground Planes: Size and Weight Reduction Perspectives*." There is a tradeoff between antenna gain level for low elevation signals and multipath protection given by the ground plane for higher elevations. After giving an overview of conventional ground plane theory, the development of small-size vertical structure antennas was discussed as applied to combined GPS/GLONASS operation. It was shown that a prototype 9-centimeter diameter antenna structure performs about the same as a conventional antenna on a flat ground plane of about 18 to 20-centimeter (1-wavelength) diameter.

The Royal Observatory of Belgium has been testing the Topcon Legacy-E and Septentrio PolaRx2 geodetic receivers in comparison with its current Ashtech Z-XII3T receiver for precise time and frequency transfer. In her presentation on "*Time and Frequency Transfer Using GNSS*", Pascale Defraigne described the results of tests being performed and possible improvements in time transfer applications that could be obtained by adding the GLONASS P-codes and the future Galileo signals. Two Common View techniques were employed – one based on GPS pseudoranges and the other based on combined code-carrier phase analysis in conjunction with the Bernese software. Preliminary results were good for both the Topcon and Septentrio receivers compared to the Ashtech. Time transfer using GLONASS P-code proved to be less successful due to the difficulty in calibrating the different hardware delays in the receiver corresponding to the different broadcast frequencies of the GLONASS satellites. As a result, this approach was not pursued. Simulations of combined Galileo and GPS time transfer were carried out. The results showed about a factor of 2 improvement in the Allan Deviations of the Common View with the combined systems compared to those currently obtained with GPS alone.

During the past year, the IGS integrated its GLONASS pilot service more directly into the standard IGS operations. James Slater's presentation on "*The IGLOS Pilot Project – Transitioning an Experiment into an Operational Service*" traced the development of IGS's GLONASS tracking network, orbit processing and data products from an experimental campaign in 1998 to the present operation. Currently, the 10 active GLONASS satellites combined with the GPS constellation enable some sites to see as many as 16 satellites for part of the day. Forty-seven IGS tracking sites are equipped with Javad or Ashtech combined GPS/GLONASS receivers, but there is an over-concentration of stations in Europe and sparse coverage on other continents. The infrastructure developed by IGS over many years for GPS operations was critical to the success of the IGLOS project. Data formats, tracking station specifications, communications protocols and data management were adapted to handle GLONASS data. Four analysis groups support GLONASS data processing. GPS orbit software was modified to allow for GLONASS observations. BKG, CODE and ESA generate precise orbits and other products within a week of the observations. The Russian Mission Control Center (MCC) generates orbits based solely on laser ranging data from the three satellites for which data are available. A combined orbit is also generated. Overall orbit accuracy is about 10 cm.

The IGS Analysis Center at the University of Berne has produced the most fully integrated GNSS orbit determination process as described by Stefan Schaer in his paper on "*GNSS Analysis at CODE*." A new version of the Bernese orbit software was developed specifically for the GNSS processing. Rapid, ultra-rapid and final orbits are produced for GLONASS and GPS satellites in one simultaneous solution. Weekly SINEX files include station coordinate solutions for many of the combined GPS/GLONASS stations, and Earth rotation parameters are now GNSS-based. Troposphere zenith path delay estimates are also being generated for a significant number of the combined GPS/GLONASS stations. In addition, CODE has begun estimating satellite antenna phase center patterns for GPS and GLONASS satellites. Precise GLONASS satellite clock offset values are not yet computed.

In their poster paper "*GLONASS Analysis for IGS*", Habrich et al. provided a summary of the BKG GLONASS precise orbit determination process. BKG needs the IGS precise GPS orbits prior to processing the GLONASS observations. The recent incorporation of the IGS rapid GPS orbits in place of the IGS final orbits in its GLONASS data processing has enabled BKG to compute the GLONASS orbits on a more timely basis. Van der Marel et al. investigated the anticipated advantages of additional satellites from Galileo in their poster paper on the "*Impact of Galileo on Geodetic Positioning Applications*." Height precision is improved as well as the precision of tropospheric parameters. This applies especially to the case of moving receivers. The increased number of satellites and new signals from GPS will also result in improved ambiguity resolution. In the last poster paper, "*C/A Code Biases in High-end Receivers*," Simsky et al. described systematic biases in C/A-code pseudoranges that can occur in high-end GPS receivers when multipath-mitigating code tracking is employed. These are satellite-dependent biases, but when they are know and understood, they can be compensated for in the receiver or in post-processing.