Mapping Matters

Your Questions Answered
The layman's perspective on technical theory and practical applications of mapping and GIS

By Qassim A. Abdullah, Ph.D., PLS, CP

Q: Would the Russian navigation satellite help the accuracy of a survey if its data was received and processed with GPS data?

Anonymous

Dr. Abdullah: The short and direct answer to this question is yes, utilizing more satellites in the sky will improve the accuracy, the integrity, and the reliability of the receiver geographic positioning capability at any part of the world. In the February issue of *GIM International*, a small piece published under the title "GLONASS Goes Civil," echoed Russian Defense Minister Sergei Ivanov's announcement to lift all precision restrictions on the Russian military-controlled Global Navigation Satellite System (GLONASS) for accurate and unlimited commercial use; this should start later this year. Similar action was taken by the United States on May 2000 when a presidential order mandated the Selective Availability (SA) feature on the nation's Global Positioning System (GPS) be removed. The SA removal resulted in a much improved L1 precision carrier signal for civilian users. While GPS accuracy for military use had always been within 1 meter, removal of the SA increased the direct civilian signal accuracy from a previous 100 meters to below 15 meters. The U.S. National Coordination Office for Space-based Positioning, Navigation, and Timing (PNT) reported that the achieved accuracy of the GPS far exceeded the design specifications. The RMS in the User Range Error (URE) for the GPS single frequency (L1) was found to be around 1.1 meter and well within the 6 meters design requirement of the system.

The removal of the SA presented the first building block in the "GPS modernization program" that the U.S. government announced during 1998. The program's second initiative is the addition of a new and more powerful Civil Signal (CS) to the GPS L2 carrier frequency that was originally created for military use. Known as L2C signal, this signal requires more sophisticated receivers for recovery of improved data. The strong L1 and L2C signals combined now provide more robust GPS measurement, resulting in better correction and a more reliable GPS observation for precise surveying work. The first satellite carrying the L2C capability was launched on December 16, 2005 followed by another satellite on September 25, 2006. In addition to the L2C signal capability, most manufacturers of commercial GPS receivers are adding the capability to capture and process signals from other systems including GLONASS and the European Galileo global satellite navigation systems as well. Funded by the European Commission (EC) and the European Space Agency (ESA), Galileo's first four satellites were launched in December 2005. The mini-constellation, which was completed in 2006, is undergoing stringent testing and in-orbit validation. Once completed in about 2008, the Galileo constellation will contain 30 satellites with anticipated 2-meter accuracy for civilian and commercial users from any location, including within tunnels and buildings. ESA expects that international users of Galileo will operate 3 billion receivers by the year 2010. Galileo is GPS-compatible and -interpretable, which will enable users to combine its data with GPS data for more robust GPS-based surveying and navigation. Galileo will offer five services including a free open service and a fee-based service.

For the next phase of the GPS modernization program, the United States plans to launch satellites that will transmit an entirely new civilian L5 frequency. This new block of satellites (block IIF) and its related civilian signal are being built by Boeing for launch in 2008.

The three giant global navigation systems— GPS, GLOSNASS, and Galileo—have become an integral part of the civil aircraft and airports guidance called the Global Navigation Satellite System (GNSS), regulated by the International Civil Aviation Organization (ICAO). Furthermore, the International GNSS Service (IGS) which is a network of over 350 GPS monitoring stations from 200 contributing organizations in 80 countries. Its mission is to provide the highest quality data and products as the standard for Global Navigation Satellite Systems (GNSS) in support of Earth science research, multidisciplinary applications, and education, as well as to facilitate other civilian applications. Approximately 100 IGS stations transmit their tracking data within one hour of collection.

Through its base stations network, the IGS is used globally to determine the geographic location of a user's receiver anywhere in world without the investment of maintaining local networks. The international community took advantage of the GNSS to control and guide its aircraft and airports through seamless satellite-based navigation coverage. The surveying and mapping community is the last to realize the advantage of such a system. Manufacturers of geodetic-grade receivers such as Trimble and Leica Geosystems are now producing systems that are GNSS-ready or -compatible. Users of these systems can take advantage of the satellite-based augmentation services of GPS, GLONASS, and eventually Galileo, without needing to separate the services of these three systems.

Continued advancement in space-based navigation technologies will greatly contribute to the performance of the Inertial Navigation System (INS) that is widely used now a days to determine the sensor position and orientation, through:

- substitution of missing satellite broadcast data when access is intermittent, difficult, or impossible due to obstruction;
- extended capabilities of traditional receivers in reducing the time required to "first fix," enabling a high sensitivity mode for enhanced operation in urban canyons and indoors; and,
- improved and more reliable ambiguity fixes and more efficient trajectory processing.

The latter improvements are resulting in a better performance of all collection sensors that rely on integrated GNSS/INS technologies such lidar, digital imagery, and other remote sensing technologies.

In a nut shell, the quality of position determination using satellite-based navigation techniques will soon reach a level of reliability and accuracy never before witnessed. The horizon over a receiver at any time and in any part of the world will contain a dense network of navigation satellites from GPS, GLONASS, and Galileo, all with new or enhanced signals. Modernized receivers can benefit from these multiple strong signals with a widened window of operation. This should effectively minimizie or eliminate any concerns about a

continued on page 608

continued from page 607

poor Positional Dilution of Precision (PDOP) number or intermittent reception. PDOP is a GPS accuracy indicator that is determined by a satellite's geometry or configuration in the horizon of a receiver.

Users of these navigation technologies are naturally concerned about the huge investments already made in old types of receivers. To make the transition as seamless and harmless as possible, users may be able to continue using old receivers with minimum upgrades or, it is possible that manufacturers will offer a fair trade-in plan for old equipment. Users shopping for new receivers are encouraged to buy GNSS-ready equipment for enhanced capability and improved accuracies.

Please send your question to Mapping_Matters@asprs.org and indicate whether you want your name to be blocked from publishing.

Answers for all questions that are not published in *PE&RS* can be found on line at www.asprs.org/Mapping Matters.

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