GNSS and Hydrography

A precise navigation system that has been fully operational only since 1995, yet has had such an impact on hydrography; it looks as if the future of these systems will make interesting reading.

GNSS stands for Global Navigation Satellite System and has been dominated by GPS. All hydrographic surveyors will know how this has improved their productivity in the last decade. Today GNSS includes GPS and, to a lesser extent, Glonass. In the future it may well include modernised GPS signals, further Glonass, the European-funded Galileo system, and other satellite-based augmentation services. Not only does this scenario mean more of the same™ but it would also provide the GNSS system with greater accuracy and robustness.

**Status**

A scan of GNSS systems is dominated by GPS, which has been giving solid service since going operational last decade. The intentional degradation of the GPS position, called Selective Availability, was removed in the year 2000, improving standalone accuracy to about 10m. Civil users are currently limited to one GPS signal (C/A on L1); they are also given only codeless or semi-codeless access to the P(Y) code on the L2 frequency. The GPS Satellite Vehicles (SVs) have progressed through various models and all Block II/IIA SVs have been launched. The Block IIR-M are in production, with six operational; Block IIF SVs are under development.

In terms of Glonass, there are today a limited number of operational SVs: seven, in fact. It has been difficult to predict the launch pattern of Glonass, the last launch having been in December 2002. Galileo is the European-funded satellite system presently in the planning stages. It is designed to be interoperable with GPS and therefore global, but with built-in regional and local enhancement capabilities. Since February 2003 there has been some debate between the various member countries concerning management and funding issues.

DGPS Navigation Beacons have been established by more than forty countries as an aid to marine navigation. The most reliable of these are those that comply with the IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities) standards. Navigation beacons are, during 2003, still being installed world-wide and are used by many hydrographic surveying users, as metre level accuracy is being achieved.

In the USA and Europe™ free to air™ Satellite-Based Augmentation Services (SBAS) such as the US-based WAAS and the European equivalent, EGNOS, are today being tested by civilian GPS receivers. SBAS transmit DGPS corrections only at this stage. They deliver code phase corrections and a level of integrity monitoring, the focus being on use for aviation. The footprint of these geostationary satellites typically covers continental land-masses, but users on inland waterways and in coastal regions can also receive these signals.

**GPS Modernisation**

Because the US Department of Transportation has clearly stated plans for GPS modernisation, this stands as one of the most definitive statements of all GNSS strategies. As of December 2002 the Department has stated a wish for:

- Stable, consistent GPS policy and service
- Expanding use of GPS in transport safety
- Second Civil signal (L2C), beginning with launches in 2004 of Block IIR-M SVs
- Third Civil signal (L5), beginning with launches in 2005 of Block IIF SVs

What does this mean for hydrographic users? The second civil frequency means a stronger signal, which will assist in cases of canopy problems (e.g. riverbank trees) and use that is less susceptible to unintentional interference. The third civil frequency should mean a considerably faster and more robust carrier phase integer ambiguity search, leading to improvements in real-time kinematic positioning (RTK - centimetre accuracy) such as longer range, rapid initialisation and possibly improved vertical accuracy.

**The Future**

GPS modernisation has already been mentioned in this article. The L2C signal will begin with SV launches in 2004 and projected full capability in 2012. The third civilian frequency, L5, will begin with launches in 2005 with projected full capability in 2015.

Glonass is harder to forecast. For example, the impact of the recent Colombia shuttle incident may mean that the Russian space agency will focus on support for the International Space Station rather than on Glonass launches. Future budgetary constraints on the part of the Russian Government are also hard to predict. However the published Glonass programme lists system upgrades with new Glonass-M SVs - their first launch in 2003. These SVs will introduce a second frequency for the civilian community. The programme also introduces Glonass-K SVs at a later stage, these having reduced mass and the ability to launch six to eight at a time from the Proton-M rocket.

With the Galileo project currently funded for further planning, its timetable has it operating in 2008, although recently
commentators say this projected date is slipping out towards 2012. The total design, in-orbit validation and full deployment of Galileo is costing 3.4 Billion euros. Satellite Based Augmentation Services (SBAS) are about to go operational. The USA WAAS is due to go into full operation capability in 2003. Civilian users are presently utilising the European EGNOS in test mode. This may well go into full operational status in April 2004. In the future, EGNOS may accommodate corrections from other systems, such as Galileo. The Japanese SBAS equivalent, MSAS, is planning to launch its first SV in 2003 after a launch failure in 1999 delayed such plans. There are also plans by Canada, China and India to operate SBAS services over their countries.

The Impact on Hydrography
The impact of all these plans for GNSS is good news for hydrography. GPS receiver manufacturers are studying the interoperability of these systems in new receiver designs. The future of the GNSS will result in a more robust solution for users. There will be more SVs in orbit, originating from more countries. The new signals will reduce vulnerability from unintentional interference as frequencies are added and spread over the spectrum. Since the signals will be stronger, GNSS will operate in more marginal areas where vegetation obstructs the antenna during waterway surveys. Standalone positional accuracy should improve from the 10m to the 2m level, assuming the use of a suitable receiver capable of utilising the new signals. Users will have greater access to reliable centimetre accuracy positioning, due initially to the second civilian frequency (L2C) and then to the third civilian frequency (L5). By processing this extra data, the GNSS receiver of the future should be able to operate from a base station in RTK mode over much extended ranges and initialise virtually immediately, as does DGPS presently. Other benefits, such as greater vertical accuracy, should result and this can be used for tide, draft and heave measurements.

The impact of national SBAS systems on hydrography may be significant in the future. Why is SBAS not in major use today in hydrography? Firstly, marine authorities were quick to see value in the installation of land-based navigation beacons (MSK) to counter the effects of Selective Availability, and many coastal waterways are well covered by this service. Secondly, SBAS coverage is optimised for continental landmasses and offshore coverage is therefore not ideal. However, future systems may better cover coastal and offshore regions and therefore be used to a greater extent in hydrographic surveying. GPS receiver manufacturers are aware of these future satellite-based navigation systems. The improvements are global in the true sense of the word. Hydrographers will be users of GNSS well into the future and will be keen to use receivers which operate in a seamless and global manner, with yet higher quality assurances.

References / Further Reading

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- Galileo: http://europa.eu.int/comm/dgs/energy_transport/galileo
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