Thinking Outside the GNSS Receiver Box and Antenna

With so many off-the-shelf GNSS solutions is there still room for innovation? Joël van Cranenbroeck thinks so. One such solution could be based on multiple antennas. But remember, the antenna is still the analogue part that drives the final quality.

After decades of research and improvement of GNSS receiver and antenna technology, we have to admit that today solutions are mostly available off the shelf and so you would not expect there to be much room left for innovation. Yet, surprisingly, there are still GNSS applications where there is scope for development.

Reliability for Monitoring

In geodetic deformation monitoring, for instance, there has been a long struggle to request from the industry more affordable solutions, but at the highest performance in terms of accuracy and reliability. The old-fashioned single frequency L1 GPS receiver is still a topic of research blended with wireless communication and low power consumption. And although it may seem that OEM boards and chipsets meet today's expectations, we would prefer double measuring boards to increase their reliability. There should also be some integrity checks (zero baseline test) especially when the receiver is deployed for mission-critical measurements or located in remote places where the costs associated with travelling to the site to exchange failed equipment are prohibitive. Despite the low cost of GPS L1 OEM boards we should not forget that to achieve high accuracy the antenna is still the analogue part that drives the final quality. Low cost microstrip antennas must be calibrated if we want to keep the solution effectively affordable. Connecting a low cost GPS L1 receiver to a geodetic grade antenna makes no sense.

For GPS deformation monitoring-based applications, the receiver and the antenna comprise a very sensitive part, but the whole system, including communications, power supply, cabinet and pillar, must also be reviewed. Security of the equipment is also a sensitive matter and there will be resistance from the project's owner if vandalism can impact installations that are deployed on public areas.

One Receiver, Several Antennas

The multi-switch antenna concept has been an attempt to decrease the cost of GPS technology used for deformation monitoring. The principle is to share multiple antennae with only one GPS receiver. The receiver connects sequentially with each connected antenna. The Chinese hydro power industry now considers this approach to be a de-facto standard, but in western countries, until recently we have simply ignored the idea, even though it could certainly fit with civilian client expectations regarding budget, without any concession regarding the performance needed by the equipment to provide effective results from unstable areas such as landslides, large subsidence areas and so on.

The concept of connecting multiple antennae to a single GPS or GNSS receiver can also bring an interesting possibility for handling the situation where it is impossible for physical reasons, or forbidden for security reasons, to set up an antenna. The case of high rise buildings and towers has raised interest for such a solution. Instead of trying to place an antenna right on the top of the structure, why not surround the structure with three or four antennae, all connected to a common GPS or GNSS receiver? Each antenna will track only the part of the satellite constellation that is visible at each location, but signals not observed at one antenna will be observed at one or more of the others to make a complete sky view. Combined into one GPS or GNSS receiver, the signals will be received through separate channels and, in case of multiple signals coming from one given satellite, the multipath rejection algorithm will identify the strongest signal. We may argue that the point solution will no longer be for a physical point, but a virtual station, however, such solutions have been introduced for GNSS Network RTK technology without many concerns.

Software Receivers

Software GNSS receivers have popped up, mainly from academics who wanted to get a better insight into the whole digital signal processing chain. Considered as a curiosity by the industry, the simple idea of placing the analogue to digital part of the processing chain on to the antenna, means that signals can be transmitted to the cloud and processed using GNSS software receivers in the cloud. We can imagine various adaptive processing strategies for this concept and certainly a breakthrough for GNSS network positioning infrastructure, especially when it is important to tune the electronics to cope with adverse environments to get the best of the signal quality. In that case, there will not be any box to think outside of!

Diverse Applications, Same Technology

Another paradox from the manufacturing industry is a great keenness to diversify the applications for its range of products into various

types of receivers all using the same hardware, which are all tuned for high dynamic tracking situations. This is certainly an advantage for surveyors, who need to track all satellites in view when they are working dynamically in an over-masked environment such as forests or urban conditions where satellites frequently come in and go out of view. However, for permanent installations the situation is different. GNSS antennae used for Network RTK infrastructure or deformation monitoring are static and operate in open field conditions. So, why not make use of these characteristics to tune the code and phase lock loops differently? Receivers tuned in such a way will not track suddenly any new satellite signal in view, or nearly in view, above a given cut-off angle and it will take a little more time to track satellite signals, but we can expect at least to improve observational accuracy, which is certainly what people involved in infrastructure and monitoring applications are searching for.

There is currently an emphasis on providing more channels onboard to track not only GPS and GLONASS constellations signals but also future signals coming from new constellations (Galileo and Compass / Beidou). It would also be interesting to consider tracking ground positioning system signals as well, such as Locata and eLoran (enhanced Loran). In this connection, there are voices expressing the need to back up vulnerable GNSS signals that may be jammed, interfered with or even made unavailable due to GNSS signals overlapping with wireless telecommunication, such as nearly happened with the LightSquared issue in the USA. Vulnerability is becoming a serious concern.

Positioning in Canyons

Meanwhile, Europe is still convinced that the Galileo constellation is a must-have, but being largely urbanised and having a new “made in Europe” constellation will not help fix the surveyor’s position in the middle of Paris or Milan. Having more satellites in the same “corridor” (urban canyon) will not contribute to improving the GDOP (Geometric Dilution of Precision), but research into developing signals transmitted from the ground would definitively place Europe in a leading position. Thinking outside the GPS (GNSS) box can lead the industry to extend its design by welcoming other signals or even to transmitting or replicating some of them.

Last but not least, the look and feel of most GPS receivers available in the marketplace are not really appealing. From all on the pole, then with a backpack and again on the pole, a visit to a large exhibition like Intergeo will reveal that there is not so much difference between the receivers’ performance beyond their colours. Creativity seems to have disappeared when it comes to the design of housings and shapes of GPS and GNSS receivers and antenna.

GPS Dancing

To conclude, let’s hope that challenging the actors in the GPS/GNSS industry to think outside the (GPS) box will bring us back the original excitement we had when the first GPS satellites rose over the horizon of geodesy. For sure the world is not yet flat enough and the next revolution will surely come from the Internet of Things (IoT) where the boxes will start to socialise with each other and share some features and capacity.

A good example of things to come is the GPS Dancer, a peer-to-peer process on the internet for precise geodetic analysis of GPS data. It is being developed as a voluntary project under the auspices of the International Association of Geodesy. A single Dancer peer is a computer program for analysing observation data from a geodetic GPS receiver. All by itself, the Dancer peer would never be able to compute global products such as satellite orbits, satellite clocks or Earth rotation parameters. However, if the Dancer peer connects to a couple of other peers on the internet, it is no longer alone. A global network of GPS Dancer peers forms a worldwide grid computer with all the functionalities of a global analysis centre, but with a much larger processing capacity. With Digital GNSS Antenna’s and software receivers, we can dream about a truly exciting future for geodesy. Imagine, for example, forecasting crustal deformation in the future just as the weather is forecast today.

This article was published in Geomatics World March/April 2014