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Coordinates

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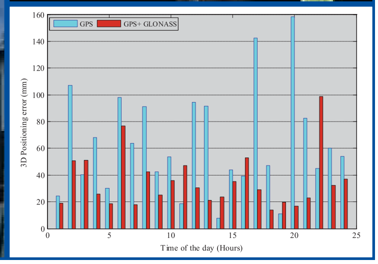
THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

GPS and LightSquared row: It cannot go on forever…

We have to find a solution!

LIDAR • Precision Viticulture • Positioning



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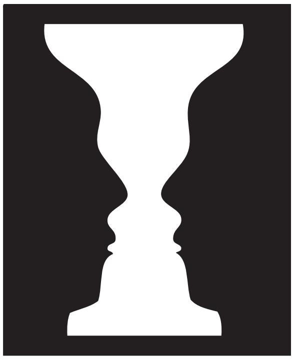


Perception and reality

If on the spot survey at European Navigation Conference 2011 held in London gives any indication

About GNSS community perception,

It suggests it will be led pre-dominantly by the North America.

Despite the recent launch of the two satellites,

Galileo is yet to enthuse the confidence in the community,

As most of the respondents believe that Galileo Operational Service would be ready to use only after 2020

And not only that

It is considered as the last one to reach the mass market after GPS, Glonass and Compass.

These are the perceptions.

But given the changing dynamics of the world,

The reality might be different.

Who knows!

Who had imagined five years before,

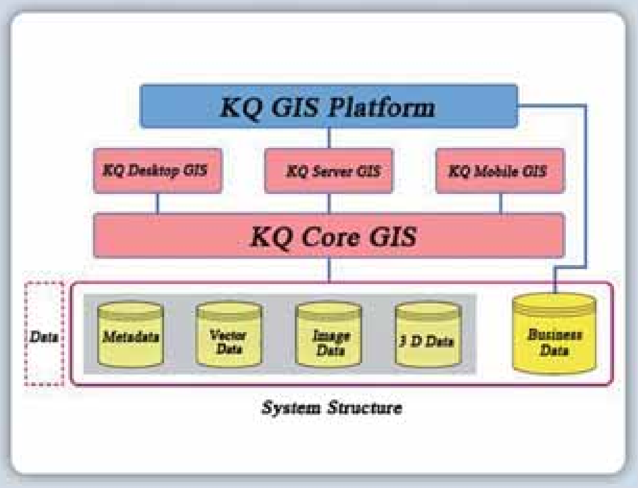
The resurgence of Glonass,

Fast pace of Compass,

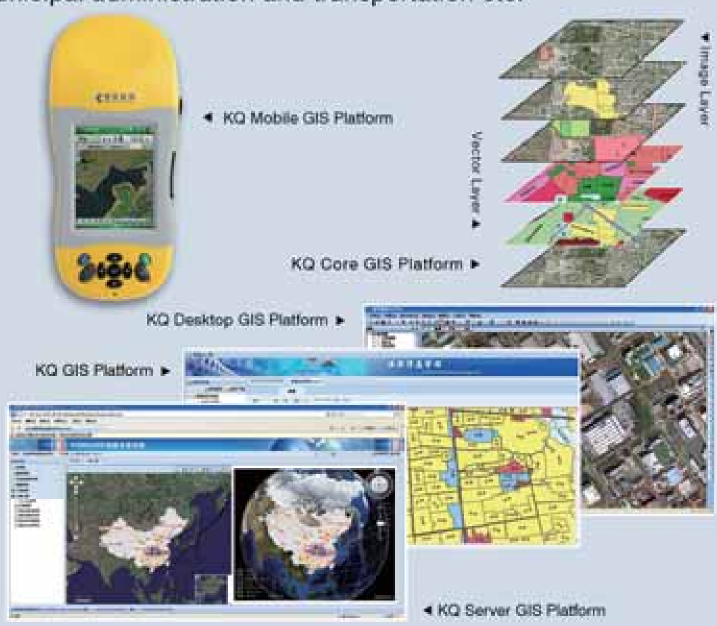
And the silence of IRNSS.

Bal Krishna, Editor
bal@mycoordinates.org

KQ's five platforms with independent intellectual property right serve a wide range of areas, such as land resources, water conservancy, forestry, agriculture, municipal administration and transportation etc.



System Structure



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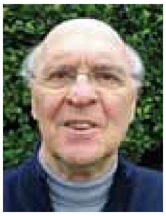
It cannot go on forever... We have to find a solution!

GPS might shrink their spectrum needs and the GPS industry/providers/users could start paying for the spectrum



Durk van Willigen
Delft University of Technology, em. Prof Dr
Reelektronika BV, CEO, The Netherlands

The discussions in the United States among LightSquared, the Federal Communications Commission (FCC), the Global Positioning System (GPS) industry, Department of Defence (DoD), Department of Transportation (DoT) and users about the division of spectrum in the L-band should not be seen as just an internal US affair. The strength of both the camps, Telecom providers and the GPS industry indicate that this battle may easily expand to other parts of the world. For many, this battle was a surprise, particularly for a peaceful world like navigation, where discussions are more gentlemen like and either focused on which GNSS systems is the best, or on the backup of GNSS which is so vulnerable and where society cannot function anymore without GNSS. All this changed abruptly when LightSquared published plans to install 40,000 transmitters in a band adjacent to L1 band used by GPS. This led to numerous protests in the GPS industry and among its users as what has been published in many magazines. It is for us to see whether it is telecom versus GPS, or is there a sensible cooperation in reach?

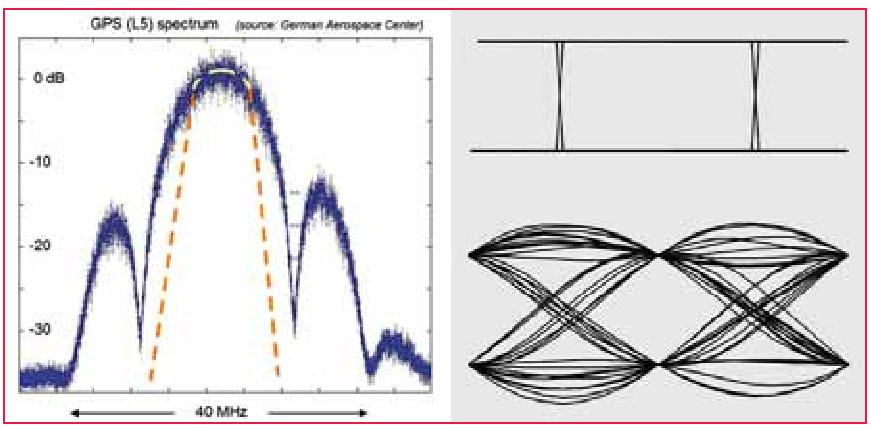


Fig. 1 – The L5 GPS spectrum (blue) as sent is approximately 40 MHz wide. If this code would be used for telecom applications, the spectrum could be reduced down to less than 20 MHz without introducing data errors. The upper eye pattern on the right show the steep slopes needed to achieve well-defined correlation peaks. The lower eye pattern is indicative for telecom data transmissions. Although the bandwidth is significantly reduced as shown by the orange line in the spectrum plot, the sloppy slopes do not endanger the data detection reliability.

Many may wonder whether these debates are really important and why this exploded so unexpectedly. A short look into radio navigation history may help to understand the underlying discomfort on both sides. Radio navigation started as terrestrial based systems, and later some 30 years ago space-based systems took over.

The first worldwide radio navigation system was Omega, which basically used four carrier wave signals in the 10-14 kHz band. For identification and wide-laning purposes, the four carriers were switched on and off in an accurately defined pattern. The radiated signals propagated quite easily in the layers between the earth surface and the ionosphere. The attenuation in those layers is moderate, so, the 10 kW ERP signals could be received worldwide. As the propagation models are complex and not accurately known, the attainable accuracy was in the range of some kilometres. As Very Low Frequency (VLF) signals can also be received under water, therefore, the navy's interest at that time was understandable. However, the overwhelming introduction of GPS made Omega disappear rapidly. However, it is important to remember that the on-off modulation pattern in Omega required a total spectrum bandwidth of approximately 160 Hz.

Loran-C, operating at 100 kHz, showed a much better accuracy. Although the system was originally specified to achieve absolute accuracy levels of

It is for us to see whether it is telecom versus GPS, or is there a sensible cooperation in reach?

better than one quarter mile i.e. 463 metres, in practice much better results were obtained. The main reason was a better understanding of the propagation phenomena, and the possibility to discriminate between groundwave and skywave signals. This was achieved by applying pulse-like amplitude modulation instead of using carrier waves only. As the skywave path was longer than that of the groundwave, the receiver could relatively easily select the groundwave for the position determination. This ground/sky wave discrimination works well up to distances of 1,000 km or more. The models of the groundwave propagation are much more accurately known than that of Omega which results in accuracy levels down to 50 metres. If differential Loran-C techniques are applied, absolute accuracies better than 10 metres are attainable. Loran-C, and its successor eLoran, is in use in many parts of the world like northwest Europe, Russia (called Chayka), South Korea, Japan, India and the Middle East. To overcome the high atmospheric noise levels in the 100 kHz band, high-power transmitters in the range of 100 kW to 2 MW were a necessity. For a long time these high energy levels were considered as an economic disadvantage, but today it is a blessing as jamming these strong signals over larger areas is very difficult. This makes eLoran a very capable and efficient backup for today's GNSS systems which are easily denied over rather large areas with simple low-power jammers. The Loran pulse modulation of the 100 kHz carrier implies a larger claim on the spectral bandwidth and amounts to 20 kHz.

DECCA is another LF system which also has been decommissioned after GPS became operational. This system used a number of carriers which were on-off modulated in well-defined rhythms' as identification of the station. The required total spectral bandwidth was about 120 Hz. Due to the carrier-wave type of signals, ground-waves cannot be separated from sky-waves which, depending on the ionosphere conditions, limited the working range down to a 100 km which made it a typical coastal navigation system. The accuracy was quite good and could be around 50 metres.

When the Russians launched the first Sputnik satellite, the Americans listened to the broadcast signals and observed a rather strong Doppler shift of the received signals. These Doppler shifts made computation of the satellite's orbit feasible. Then the US scientists developed the first space-based navigation system called Transit, while the Tsiklon in the former USSR, worked in an opposite manner. The orbits of the satellites are now accurately known and by measuring the Doppler shifts over some time, the users' position could be established. Accuracies were in the order of 10 – 50 metres, and the systems could be used worldwide. Transit broadcasts two carriers on 150 and 400 MHz, respectively. The Doppler peak-to-peak shift ranged from 4 kHz on 150 MHz to 10 kHz on 400 MHz. So, the total spectrum bandwidth was a mere 14 kHz.

The real major step in all aspects of radio navigation was done by GPS in the US and GLONASS in Russia. These systems apply CDMA code for ranging and data transfer and the signals are spread-spectrum modulated on the L1, L2, and L5 bands. Although the accuracy of these worldwide systems is an impressive 2 – 20 m, the spectrum requirements are also impressive being approximately 60 MHz. This bandwidth is primarily needed for ranges which is based on correlation of the received signals with the replica code of the selected satellite. The data transmissions need less than 1 kHz bandwidth.

The table 1 shows the enormous differences in spectrum needs for a number of well-known systems.

This leaves us with two burning questions whether these enormous spectrum claims by GNSS are really needed, and were at the start of designing GPS, alternative solutions considered that have more modest bandwidth claims without losing performance?

This makes eLoran a very capable and efficient backup for today's GNSS systems which are easily denied over rather large areas with simple low-power jammers.

CDMA offers many advantages in respect of accurate measuring the time of arrival of the signals, rejecting multipath, simple decoding of the received signals, and also that all satellites can broadcast in the same part of the spectrum. For the military it was important that that these signals could not be used when the code was not known. Further, the applied spread-spectrum technique makes it difficult to detect the unknown received signals which are some 20 dB below the galactic

Table 1: Systems and their spectral requirements

System		Spectral requirement
Terrestrial based	Omega	160 Hz in VLF-band
	DECCA	120 Hz LF-band
	Loran-C/eLoran/Chayka	20 kHz in LF-band
Space based	Transit	15 kHz in VHF-band
	GPS/GLONASS/Compass/Galileo	60 MHz in L-band

noise level. The disadvantage of CDMA, however, is that range measurements require a rather large bandwidth to obtain sharp correlation responses, a prerequisite for accurate ranging.

It is interesting to see how Omega was designed. All eight stations broadcast sequentially four different carriers in the VLF band. On basis of the way the frequency steps were formatted, the receiver could identify which station was broadcasting on one of the four frequencies. Although the accuracy was rather poor, the basic concept was quite ingenious as it offered worldwide a simple carrier tracking ranging technique with a total bandwidth of just a mere 160 Hz.

Although the GNSS signal concept cannot be changed anymore, it is still interesting to see whether a pure carrier-tracking technique could also lead to an accurate GNSS navigation system with a large reduction in spectral bandwidth. For example, assume that a satellite sends on L1, L2 and L5 a carrier, each with two sub-carriers. This would result in 9 carriers in total. Further, we assume that only carrier tracking is used for range measurements in order to keep the bandwidth limited. The largest unambiguous range should be about 30,000 km for Medium Earth Orbit (MEO) satellites. This can be achieved by using two carriers separated by 10 Hz. The phase difference between the two carriers which started at the same time in the SV is a measure of the distance between de SV and the receiver. We assume that this range measurement can be done with an accuracy of better than

> This leaves us with two burning questions whether these enormous spectrum claims by GNSS are really needed, and were at the start of designing GPS, alternative solutions considered that have more modest bandwidth claims without losing performance?

10 percent of unambiguous range, so a 3,000 km in this example. The next step is then to use two frequencies at 100 Hz apart, which would yield an unambiguous range of this 3,000 km and with an accuracy of 300 km. In practice, the precision on L-band frequencies is better than 10 percent, more around 1 percent of the wavelength. If we use the following set of nine carrier frequencies as mentioned in table 2, we would end up in carrier tracking without ambiguous range problems down to a precision at L1 of a few mm. By adding quadrature modulation on for example L1 and L2, orbital and time information of each SV can be received by the user.

Ionosphere data can be retrieved from the differences between de basic carriers on L1, L2 and L5. This relatively simple concept is modest in its spectrum needs. Although only carriers are used, Doppler effects will consume 30 kHz on L1, 24 kHz on L2 and 21 kHz on L5, totalling to 75 kHz. The data modulation is just a small fraction of the Doppler. Further, as all satellites would operate on a different frequency, no mutual interference would be experienced. So, for 100 SVs, the total spectrum needed is limited to 7.5 MHz. Two additional advantages of this concept are that although more satellites will consume more spectrum, this will not lead to an increased noise floor as is the case with the CDMA structure of GPS. Due to the applied carrier technique it would be more difficult to jam; the power density is much higher, and the receiver tracking bandwidth is rather small. Jamming over the entire spectral bandwidth would require significantly much more power than with CDMA techniques.

However, the above given idea is just an exercise as modifying the current GNSS structures is out of the question. But the present conflict between LightSquared and GPS would be easier to solve if we can have such a spectrum-efficient system.

The basic issue between LightSquared and the GPS spectrum is the so called comfort-zone, the separation between the GPS spectrum and that of LightSquared. GPS receivers cannot apply brick-stone type of bandpass filters in front of the LNA in the antenna without sacrificing its noise performance and still be able to show excessive attenuation for LightSquared signals. Although JAVAD had published that they have developed a useful solution, we have not yet seen the objective tests to confirm their claim. The large bandwidth need of GPS is easier to understand by looking at the eye-pattern of GPS and digital telecom signals. GPS receivers need very steep slopes of the eyes in order to make sharp correlation peaks feasible, while telecom receivers just need to discriminate between ‘ones’ or ‘zeroes’. The latter allows bandpass filters which are about as narrow as 50 percent of the span between the first two ‘nulls’. GPS receivers prefer filters that are 2 to 3 times wider than the distance between the two ‘nulls’. See Fig. 1.

Table 2: Frequencies, unambiguous range and precision

Frequency	Unambiguous range	Precision 1 % of wavelength
L1	0.2 m	2 mm
L1 + 10 Hz	30,000 km	300 km
L1 + 100 Hz	3,000 km	30 km
L2 + 1.5 kHz	200 km	2 km
L2 + 20 kHz	15 km	150 m
L5 + 300 kHz	1 km	10 m
L5 + 5 MHz	60 m	0.6 m
L1 – L2 => 350 MHz	0.86 m	8.6 mm
L2 – L5 => 50 MHz	6 m	60 mm

High-end GPS receivers can be upgraded according to JAVAD's approach. Unfortunately, this method is nearly impossible to implement in the millions of GPS receivers used in smart phones and car navigation systems. Should all existing GPS C/A type receivers simply be depreciated and destroyed? And who will pay for this enormous logistically challenging modification or retro-fitting process? We may expect an interesting series of law suits.

An underlying issue is the commercial spectrum business which is so different for GPS and for telecom. GPS and all other GNSS systems have free access to use 60 MHz wide spectrum while the telecom providers usually have to pay for this. For example, the G3 30 MHz wide spectrum in the UK has been sold by auction for 1.350 billion Euros/year which is 22 Euro/year/capita. An identical approach happened in the Netherlands where the Dutch pay about 9 Euro/year/capita. These auctions yield relatively easy incomes for governments as the tax mechanism is simple. If this should also be done with the use of the GNSS bands, how to collect these taxes, and which government would be allowed to collect this money? Should the GNSS providers be authorized for this, and would, for example, South American users want to pay for US, Russian, Chinese or European spectrum claims? Who owns the spectrum anyway? Can anybody sell something which he doesn't own? This lack of balance between the GPS community and the telecom providers might disturb the relations between the two large and powerful communities.

Conclusions

- Pressure on the GNSS spectrum will not just continue but will even increase in many parts of the world.
- GPS spectral claims are primarily based on current technology and on its enormous installed user base.
- Spectrum is becoming scarce, so the price will rise but the telecom industry shows that this does not block the business profitability.
- Balancing the 'spectrum rent' costs between GPS and telecom users might help to relax the discussions.

Solution

A solution shall be found as both, GPS and telecom networks are essential parts of today's economies. GPS might shrink their spectrum needs and the GPS industry/providers/users could start paying for the spectrum. Both solutions, at present, are most likely just wishful thinking. So, the only remaining solution is to improve GPS receivers so that they can withstand the new powerful neighbours. However, this may cause a costly operation and logistically nearly impossible to realize in a couple of years. But, JAVAD made the first step which is difficult to ignore! Who's next?

The compatibility between the EU system and other GNSS systems is our main concern

says Antonio Tajani, Vice President, European Commission in an interview with Coordinates

Congratulations for the successful launch of Galileo IOV Satellites. How satisfied you are with the progress of Galileo program?

Indeed, the successful launch of two Galileo satellites on 21 October 2011 from French Guyana was a key step for the programme. Galileo is now becoming a reality and I am really proud of it. The EU, with its partners, in particular the European Space Agency, has demonstrated its ability to manage such a large scale programme. We are reaping the fruits of our continuous efforts. The programme is under control both on programmatic and financial levels and it is now possible to accelerate the deployment of the constellation of satellites. That is why I have decided to buy additional satellites.

The priority for Galileo is now to achieve initial operational capability with at least 18 satellites in orbit by 2014. This will allow offering first services: the open service and the European participation in the international search and rescue service. First demonstrators for the public regulated service for government-authorised users will also be made possible at that time. Benefits to satellite navigation users around the globe will become tangible.

The Commission is fully backing the programme with its proposal for the period 2014-2020, released on 30 November. This proposal provides for a stable and long-term financing of 7 billions EUR and new governance arrangements. This will allow for the completion of the Galileo infrastructure and the management of the programme in its operational phase. The programme is definitely on the right track.

Recently in Munich Satellite Summit, the European Commission spoke about linking of space initiatives to the political identity. Would you like to elaborate on this?

Space policy is an instrument serving the Union's internal and external policies. We all use space based applications throughout our daily lives. Galileo, EGNOS and GMES are part of the EU Space Policy. The EU invests in space for the benefit of the citizens. It also supports the EU as a global economic power. Clearly, space is part of our identity. This is recognized by the recent Lisbon Treaty which confirmed the important role for the EU in space matters. It allows also the EU to intensify cooperation and partnerships with other space faring nations. Space should serve to cement the EU's position as a major player on the international stage.

What kind of challenges the EU space policy would like to respond?

With its space policy, the EU tries to address a combination of social, economic and strategic needs. Space applications provide us with the information and tools to improve our policies and their implementation. Space plays a role in many domains, such as environment, combating climate change, improving transport safety, or public security, emergency management, etc. The list is long. Many of these applications directly impact the well-being and security of our citizens. Space brings a potentially huge added value to the European economy. It is a powerful driver for innovation and contributes to competitiveness, growth and job creation. Last but not least, EU space policy contributes to the Union's economic and political independence.

Where do Galileo and GMES fit in EU space policy?

Galileo, EGNOS and GMES are the EU flagship space programmes. They are the first priorities of the EU space policy. This is constantly confirmed at EU political level since 2007. They form also an integral part of the *Europe 2020* strategy, which contains our strategic objectives for growth in this decade. These programmes will generate innovative downstream services, new business opportunities and jobs creation across various sectors of the European economy. For all these reasons the Commission remains fully committed to securing the timely completion and sustainable long-term exploitation of these flagship programmes.

How to address the conflict of interests of Galileo with other satellite navigational program?

Galileo shares resources with other global or regional satellite navigation programmes, be they GPS (United States), Glonass (Russia), Beidou (China) and others. The compatibility between the EU system and these systems is our main concern. To this end, the Commission consults regularly with its international partners, bilaterally as well as in multilateral fora. We have to live under one roof, which we achieve through consultation, including under the United Nations umbrella.

What are the challenges in international cooperation?

I see three challenges that can be best tackled through international cooperation: achieving compatibility among the global navigation satellites systems; providing satellite-based safety-of-life services for the civil aviation community, including through the extension of European services to Africa whenever possible; and enhancing the uptake of European GNSS technologies and services worldwide. The Commission is leading the European effort in that matter with the very active support of the European Space Agency, the European GNSS Agency, and the European External Action Service.

How the EU space policy proposes to serve European Union's security and defence interests?

As I already mentioned it, space systems can respond to the strategic needs of the EU, including the security and defence dimensions. Space can do a lot to improve security in Europe and to protect the lives and safety of European citizens. Security aspects are already included in our two flagship programmes. GMES, for example, is developing services aimed at humanitarian and crisis management operations, maritime surveillance and border control.

Galileo will provide a restricted and robust Public Regulated Service (PRS) for government-authorised users such as the police, military or security services. Therefore, the PRS can have important impacts on the EU's Common Foreign and Security Policy and on the European Security and Defence Policy.

The EU has recently agreed on the rules under which the EU Member States, EU institutions and bodies, third countries and international organisations may access the Galileo PRS. This paves the way for further development of the security and defence interests of the European Union.

Would you like to explain the key points of "Space Industrial Policy"?

The Commission attaches great importance to the competitiveness of the European space industry. We are actively involved together with ESA and EU Member States in the elaboration of actions to boost global competitive position. In its Communication on the EU space strategy adopted last April, the Commission described the key points of its future space industrial policy.

Its main objectives are to further develop a solid, efficient and balanced industrial base in Europe and support SME participation, to support the development of innovative technologies, cross-fertilisation, high-skilled manpower and provide policy support for increased market access, to develop markets for space applications and services and to ensure the technological non-dependence and an independent access to space. The Commission also examines whether the expansion of space activities raises legal issues which would need to be addressed at European level. On this the Commission may come forward with more concrete ideas on space industrial policy which I intend to propose in 2012.

Any focus on research, development and innovation in space segment?

Space is a major theme in the 7th European Research Framework programme. I see three main directions in research and innovation to support space-related activities, on which Europe should focus:

- Monitoring the eco-system of the Earth and providing of information and services from space-based system to the various users. The EU through FP7 has invested some EUR 300 millions in Earth Observation services in the land, marine, atmosphere and security domains as well as in supporting emergency response services with space data.
- Provide satellite-based navigation services for every citizen and a large number of economic fields like land, air and marine transport, communication and security.
- Last but not least is the objective to explore the origin and the future of our solar system and deepen our knowledge on the basic principles of the Universe.
- For all this Europe needs a sophisticated science, technology and innovation basis. A dedicated research and development effort is needed to make Europe non-dependent on technologies critical for space endeavours. Some 60% of electronic components needed for space still have to be imported from outside the EU.

A major challenge is to protect humans and our space infrastructures from threats from space weather; we do this in cooperation with US institutions including NASA, NOAA and other international partners. Another large project on mitigating threats posed by asteroids to our planet will start in the following months with participation of a large European consortium together with US and Russian scientists.

The growing amount of space debris is causing us more and more problems. We need technologies to mitigate collisions in orbit and to actively remove old satellites. With projects on rover and robotic technologies for space exploration the EU programme supports international efforts to explore our solar system.

To guarantee Europe's independent access to space and make launches more affordable, the Research Framework programme is contributing also to the development of new clean and efficient propulsion technologies.

In conclusion I would say that investments in space science and technology directly contribute to the attractiveness of European research establishments and the competitiveness of European industry. They create highly qualified jobs and support Europe's role as a global economic power for the future.

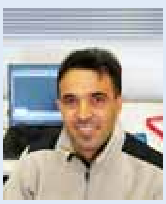
LIDAR for visualization of 3D geological models

This study has used the LIDAR technique in order to acquire geological data from an outcrop located in southern Brazil

Geological researches have increased the utilization of tridimensional models in the last years in order to make possible visualization, parametrization and interpretation of data. The LIDAR technique allows to acquire a huge amount of georeferrenced data using a Terrestrial Laser Scanner (TLS). Both fastness and accuracy are the main characteristics of this equipment. Its utilization in geological studies has started in the last decade (Bellian et al., 2002), but only in the last years the number of scientific articles has increased significantly. The TLS acquires georeferrenced point clouds that can be converted in digital models after processing, especially digital outcrop models (DOM).

Digital Outcrop Models obtained from TLS have been expanding worldwide in the last years. There are relatively few studies that used laser scanners for generating tridimensional outcrop models. Research using the LIDAR technique is still incipient and requires improvements, especially concerning processing, visualization, geological interpretation and integration with other databases. The integration with other available geotechnologies such as total station, GPS and high-resolution digital photographs allows creating models with high accuracy and visual quality, which enhance geological features and help to interpretate DOMs under a geological point of view. Recent applications in geology has yielded good results (Pringle *et al.,* 2004, Bellian *et al.,* 2005; Buckley et al., 2008; Fabuel-Perez *et al.,* 2009; Rotevatn *et al*. 2009; Ferrari et al., 2011).

TLS is capable of capturing hundreds of millions of points with three-dimensional coordinates. The equipment emits laser a pulse with the aid of a scanning mirror. This pulse hits the object and part of the energy return to the system. Thus, knowing the geodetic coordinate of the TLS station, the speed of the laser propagation and the time between the transmission and reception of the laser pulse is possible to determine the distance between the sensor and the object, calculate the geodetic position of each point and, consequently, reconstruct the surface of the object. New procedures and methods involving remote sensing techniques and DOMs are crucial for improving the quality of tridimensional geological models and, consequently, their interpretations. Nowadays, the huge volume of data, the lack of optimized processing resources and the inadequate dataset management became visualization and interpretation of DOMs a difficult task. Furthermore, it is necessary to develop a software with an efficient tridimensional visualization system with specific tools for geological interpretations. The main



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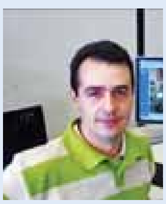

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goal of this study was to set up some key guidelines for generating 3D DOMs.

Materials and methods

Database

The study area is an outcrop of the Rio Bonito Formation, Lower Permian of the Paraná Basin, called Morro Papaleo and located at Mariana Pimentel, Rio Grande do Sul state, southern Brazil (Figure 1), between the geodetic coordinates, latitudes 30⁰18'10"S and 30⁰18'40"S and longitudes 51⁰28'20"W and 51⁰38'20"W in the datum WGS-84. The mentioned area is an abandoned quarry originally exploited for kaolin. It is a three-dimensional outcrop with a good exposure of rocks such as fossiliferous siltstone, carbonaceous siltstone, pebbly mudstone and sandstone.

The following equipment and softwares were used in this work, as follow:

- A Terrestrial Laser Scanner – ILRIS 3D – Optech (Figure 2A);
- A pair of receivers GPS-RTK 900 - Leica (Figure 2B);

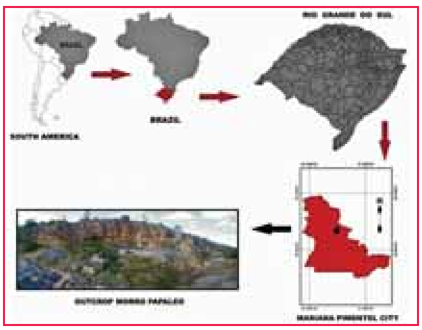

Figure 1. Location map of the study area. The black circle represents the position of the outcrop.

Figure 2. Equipments used for scanning the outcrop. (A) Terrestrial Laser Scanner – ILRIS 3D – Optech. (B) GPS-RTK 900 – Leica.

- Softwares Polyworks®, Point Cloud®, Parser® and Leica Geo Office®;

Methods

Fieldwork - Tracking the Geodetic Marker

The acquisition of field data with GPS was needed as the first step to determine the coordinates of a geodetic marker, tracked for 4 hours with a dual frequency GPS (L1, L2). The transport of the coordinates was performed from points of the Brazilian Network for Continuous Monitoring (RBMC) of the Brazilian Institute of Geography and Statistics (IBGE), located in Santa Maria (SMAR) and Porto Alegre (POAL).

Fieldwork - Scanning the outcrop with Terrestrial Laser Scanner 3D

The integrated utilization of a GPS-RTK together with the TLS in both the control points was necessary for guaranteeing the accuracy of the data. This technology allows the real-time correction based on radio frequency. The coordinates obtained from two different scanning stations were used for georeferrencing the point cloud acquired with the TLS. It was necessary to locate the equipment in two different stations in order to assure a minimum of 10% of overlap between the two shots. This procedure was previously recommended by Bellian et al. (2005) to avoid and/or minimize effects caused by shadows during scanning. It was adopted as a parameter for the scanning a spacing ranging from 1 mm to 3 cm between the dots, which generated a cloud with 151,395,728 points. The total time involved in this procedure lasted approximately eight hours. For a good acquisition it was necessary good illumination conditions, *i.e.*, few clouds, sun light directly on the outcrop and low amount of aerosols in order to ensure a better quality of the digital photographs, once that TLS has a digital camera integrated in the system. Good photographs are necessary to associate the RGB pattern of the digital photos with the point cloud, allowing the visualization of DOMs with good quality for geological purposes (Fig. 3). Image processing techniques were also used for improving the quality of digital photographs by the manipulation of properties as brightness, contrast and intensity.

Data processing

The data collected with the TLS were downloaded using the software Parser® whereas the processing of the point cloud was performed with the software Polyworks®. Four steps were necessary, as follow:

- Cleaning - in this procedure vegetation, boulders and other obstacles were eliminated of the cloud. This type of data increases the size of the files and consequently the total time of processing;
- Alignment - this procedure were performed to merge the two point clouds into a single file;
- Georeferencing - this step was performed during the alignment to georeference the point cloud using the data obtained with the GPS-RTK;
- Triangulation - this step reconstructed the surface of the outcrop using triangulation of the point cloud. It is also possible to add the RGB from the digital photograph in order to obtain a photorealistic model.

Results and discussions

Based on the digital outcrop model (Fig. 3), it was possible to obtain measurements such as height, length and thickness of strata with accuracy of 3 centimeters (Fig. 4) and identify other important geological features as bed geometry, lithology, sedimentary structures, fractures and faults. A fieldwork was performed in order to validate the interpretations obtained from the DOM (Fig. 5). Criteria for recognition of geological features from image analysis were established and this process confirmed its usefulness as a technique for analysis and interpretation of outcrops complementary to conventional fieldwork.

This study has shown that LIDAR/TLS is an efficient technique for geological purposes. DOMs are an efficient tool for helping in the planning a field activity as well as in high accuracy measurements of geological features such as thickness of beds, size of clasts and orientation of fractures. Moreover, a database formed by DOMs can help to preserve geological data, either in situations involving degradation by weathering, common in tropical areas, or antropic action, for example, mining and civil engineering activities.

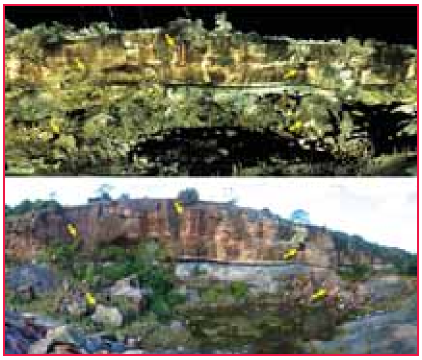

Figure 3. Tridimensional DOM (above) compared with its equivalent photomosaic (below). Note the deformation of the compound photographs. Yellow arrows show features in both images.

Figure 4. Photorealistic digital outcrop model. Note that the lower portion of the outcrop had obstacles removed during the processing (black areas). From the base to the top, it is possible to distinguish and measure pebbly mudstones (label 2), carbonaceous siltstones (the black layer above) and sandstones (labels 1, 4 and 8). Values are in meters.

Figure 5. Interpreted digital outcrop model. The red line represents the base of carbonaceous siltstone whereas the green lines (above) represent different sandbodies.

The geological interpretations are still limited due to utilization of a conventional CAD-based software for manipulation and processing of point clouds, in which is available only lines, polylines and polygons (Fig. 4). Moreover, the huge amount of data has been an additional problem due to limitations of the central processing unit (CPU) of desktop computers. Preliminary results approaching graphic processing unit (GPU) have shown improvements in handle a large amount of points with fastness and efficiency.

The development of computational routines both in hardware as in software is crucial to optimize the processing and interpretation of DOMs and must include enhanced processing and visualization techniques. As a new field of knowledge a lot of research is needed. A multidisciplinary research group involving Geology, Surveyor Engineering and Computer Graphic has been working for improving data acquisition and processing, 3D visualization techniques, interpretation of geological features and also integration of the interpreted DOM´s with different types of modeling software.

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PPP using combined GPS/ GLONASS measurements

This study investigates the effect of combining GPS and GLONASS dual-frequency measurements on the static PPP solution and its sensitivity to different processing strategies

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GPS was officially declared to have achieved full operational capability (FOC) on July 17, 1995, ensuring the availability of at least 24 operational, non-experimental, GPS satellites. To meet the future requirements, the GPS decision makers have studied several options to adequately modify the signal structure and system architecture of the future GPS constellation. The modernization program aims to, among other things, provide signal redundancy and improve positioning accuracy, signal availability, and system integrity (El-Rabbany 2006). Unfortunately, even with the modernized system, there exist situations where the GPS signal may be partially obstructed, e.g. in urban canyons, which in turn affect the availability and reliability of the PPP solution.

To improve the availability, positioning accuracy and reliability of the PPP solution, we propose to combine the GPS and GLONASS constellations. GLONASS has been gradually replenished since 2002 and has reached a total of 22 operational modernized satellites at present (Defraigne and Baire 2010; Springer and Dach 2010). In addition, Russia is planning to include eight different Code Division Multiple Access (CDMA) signals, along with its existing Frequency Division Multiple Access (FDMA) transmissions.

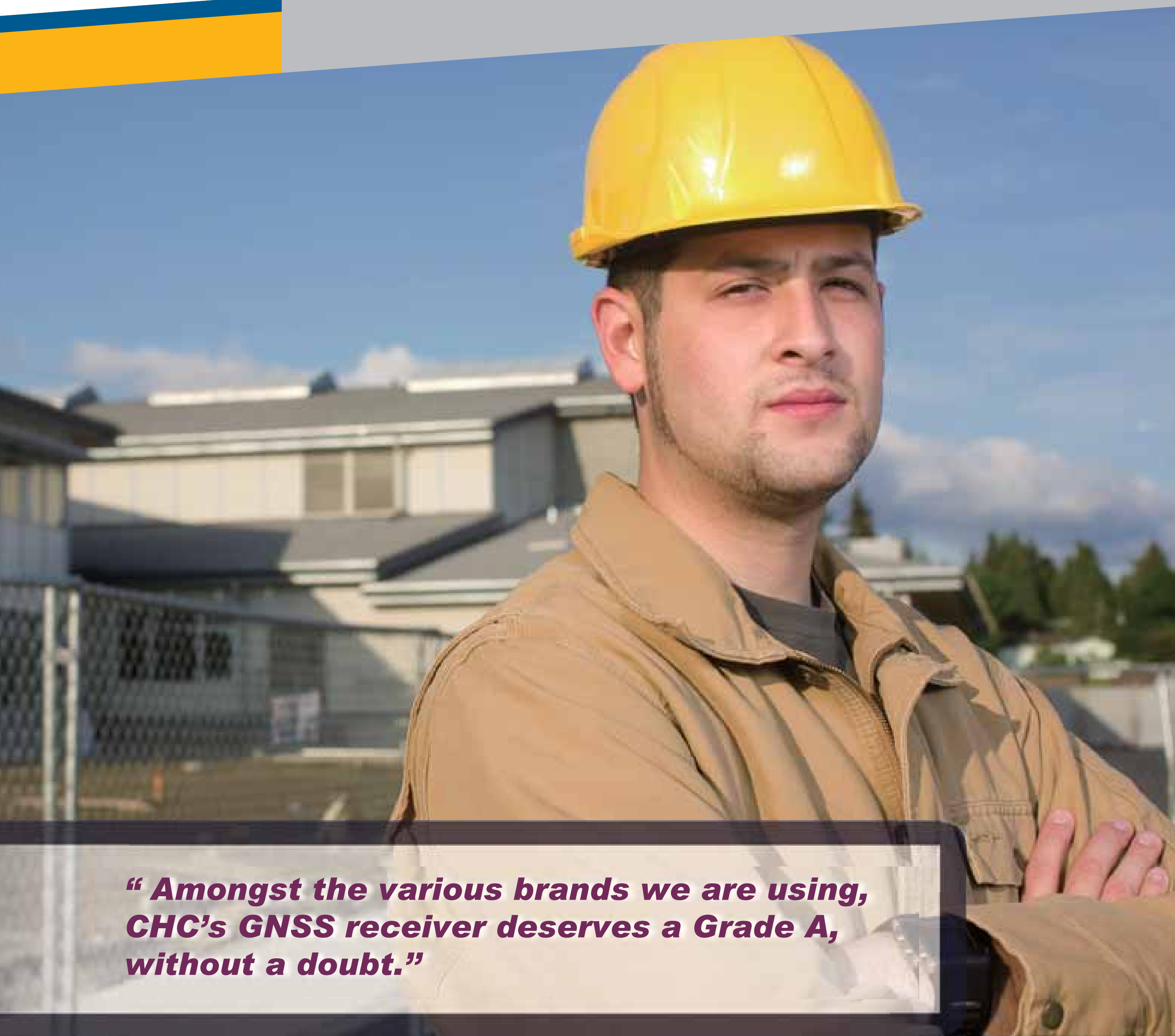
This study investigates the effect of combining GPS and GLONASS dual-frequency measurements on the static PPP solution and its sensitivity to different processing strategies. Many data sets from IGS tracking stations distributed across North America were processed using the Bernese GPS 5.0 software package. It is shown that the addition of GLONASS constellation improves the number of visible satellites and geometry (PDOP) by more than 60% and 30%, respectively. Statistical analysis of PPP results shows that the performance of the combined GPS/GLONASS solution is superior to that of GPS-only solution. However, the improvement in the final daily (i.e., with 24 hours of observations) solution is not significant.

System availability

To verify the improvement in the system's availability, we used the GSSF simulation software to generate the global coverage and PDOP maps for the GPS and the combined GPS/GLONASS constellations, respectively, on November 9, 2010. As can be seen through the satellite coverage map (Figure 1), the addition of GLONASS constellation improved the global coverage by more than 60%. In addition, it improved the satellite geometry by 30% to 60% and eliminated dead zones (Figure 2).

Modeling and processing of combined GPS/GLONASS PPP

To examine the feasibility of combining GPS and GLONASS observations for PPP, we used the Bernese 5.0 software package, developed at the Astronomical Institute at the University of Bern (AIUB), to process GNSS observations from both systems. Bernese Processing Engine (BPE) tool was used to modify an existing automated GPS data processing control file (PCF) and to build a new automated PCF for combined GPS/GLONASS observations (Habrich 1999; Dach, Hugentobler et al. 2007). Common errors and biased were taken into account, including the relativistic effect,



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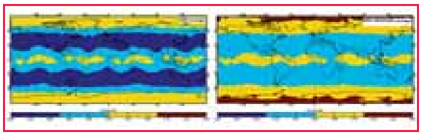

Figure 1. Satellite coverage map for November 9, 2010.

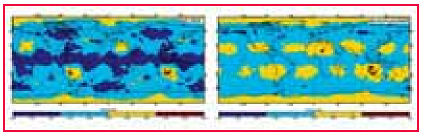

Figure 2. PDOP map for November 9, 2010.

Figure 3. Selected IGS stations

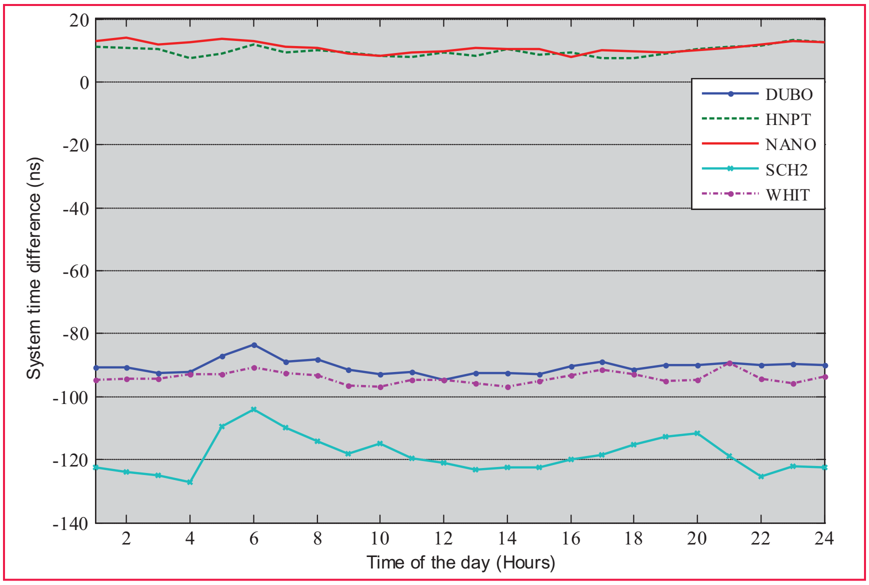

Figure 4. Hourly estimates of system time-difference, for November 9, 2010.

Table 1: Receiver/antenna types at selected stations

Station	NANO	HNPT	DUBO	WHIT	SCH2
Receiver	LEICA GRX1200GGPRO		TPS NETG3		
Antenna	LEIAT504GG	LEIAX1202GG	AOAD/M_T		ASH701945E_M

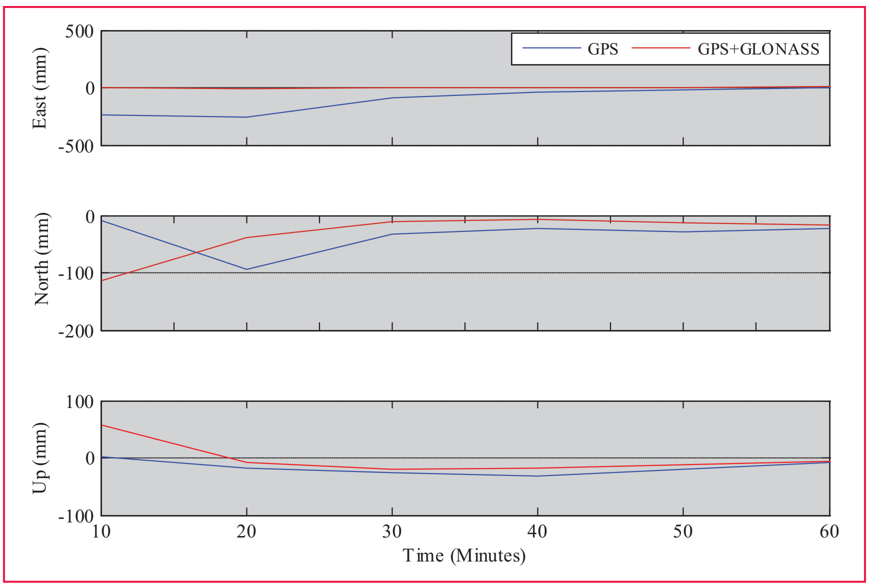

Figure 5. Positioning solution convergence for station NANO, first 60 minutes of the day under consideration.

phase center variation (PCV), solar radiation pressure for both GPS and GLONASS satellites (see Kouba 2009 for details).

Data sets from five International GNSS Service (IGS) tracking stations across North America (Figure 3) were acquired for November 9, 2010. Precise orbits and clocks corrections were obtained from the European Space Agency (ESA) to satisfy the compatibility conditions of orbit and clock corrections. Differential code bias (DCB) and ocean loading corrections were downloaded from the Center for Orbit Determination in Europe (CODE) and the Onsala Space Observatory (OSO) websites, respectively.

Combined GPS/ GLONASS PPP results

Estimation of system time difference

The estimation of system time-difference between GPS and GLONASS is an essential step for the combined GPS/ GLONASS standalone solution. Unfortunately, because there are no available calibrated values for the hardware delay of GLONASS receivers, the inter-system hardware delay will be included in the estimated time difference (Habrich 1999; Cai and Gao 2007). In the sequel, we will refer to the biased system time difference by TDGG.

To verify the short-time stability of TDGG estimation, the combined GPS/GLONASS processing control file was used to estimate TDGG values every hour, for the five selected stations, over the 24 hours under consideration. Figure 4 shows the hourly estimation of TDGG at the selected IGS stations over 24 hours. As can be seen, the estimated hourly values of TDGG agree to within 10 ns, except for station SCH2. For stations with same receiver/antenna brand (Table 1), the system time difference values agree to within 5 ns. However, discrepancies of up to 130 ns in the values of TDGG occurred between stations with different

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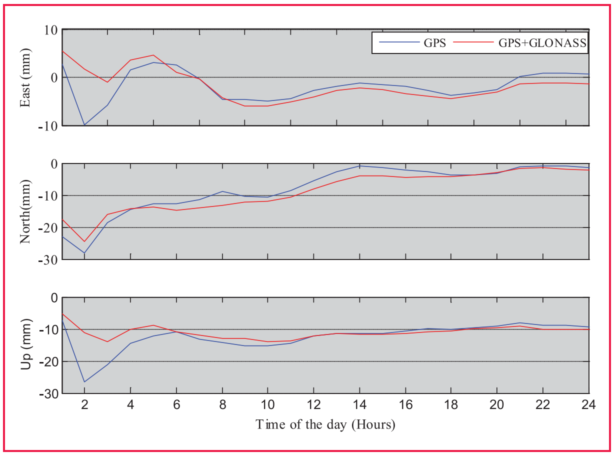

Figure 6. Positioning solution convergence for station NANO, 24 hours.

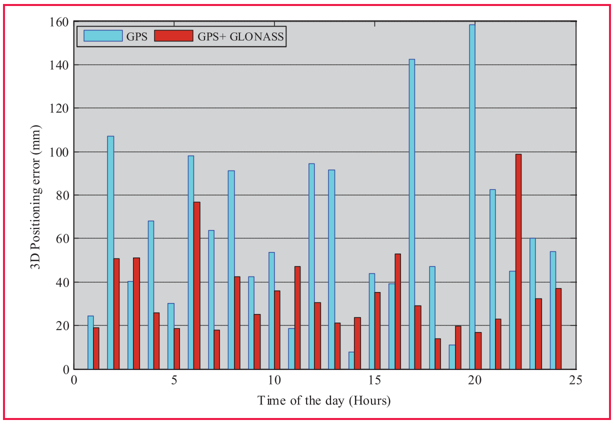

Figure 7. PPP solution repeatability for station NANO with 1 hour observations.

receiver/antenna configuration, which reflect the contribution of hardware delay.

PPP results and analysis

As indicated earlier, data sets from five IGS reference stations (Figure 3) were processed using the Bernese software. The obtained results show that there is a significant improvement in the convergence and repeatability of the combined solution, especially in the first observation hour. Figures 5 and 6 show the PPP solution convergence, final solution accuracy and repeatability results are presented for station NANO as an example. Similar results were obtained for the other stations.

As can be seen in Figures 5 and 6, positioning accuracy of 3 cm can be achieved with only 30 minutes of observations for the combined GPS/GLONASS solution, while it requires about 3 hours for the GPS-only solution to achieve the same accuracy level. However, the two solutions become comparable after 6 hours.

To examine the repeatability of the combined GPS/GLONASS solution, positioning errors were estimated every hour over the 24 hours under consideration. Figure 7 shows the hourly positioning error for both of GPS-only and combined GPS/GLONASS solutions. As can be seen, the combined solution has better repeatability in 75% of cases.

Conclusions

This study investigated the performance of dual-frequency GPS/GLONASS PPP solution. It has been shown that the addition of GLONASS constellation improved the satellite availability and geometry by more than 30%. This allows for precise surveying in urban areas or when the satellite signal is partially obstructed. In addition, the performance of the combined GPS/GLONASS PPP solution was found to be superior to that of GPS-only solution. While a few centimetre-level accuracy can be achieved within 30 minutes with combined GPS/GLONASS PPP solution, it requires about 3 hours with GPS-only solution.

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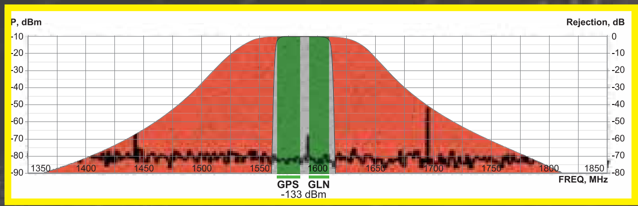
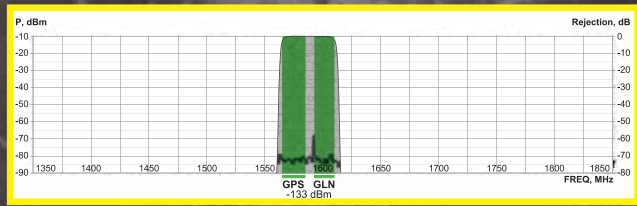
A technical story...

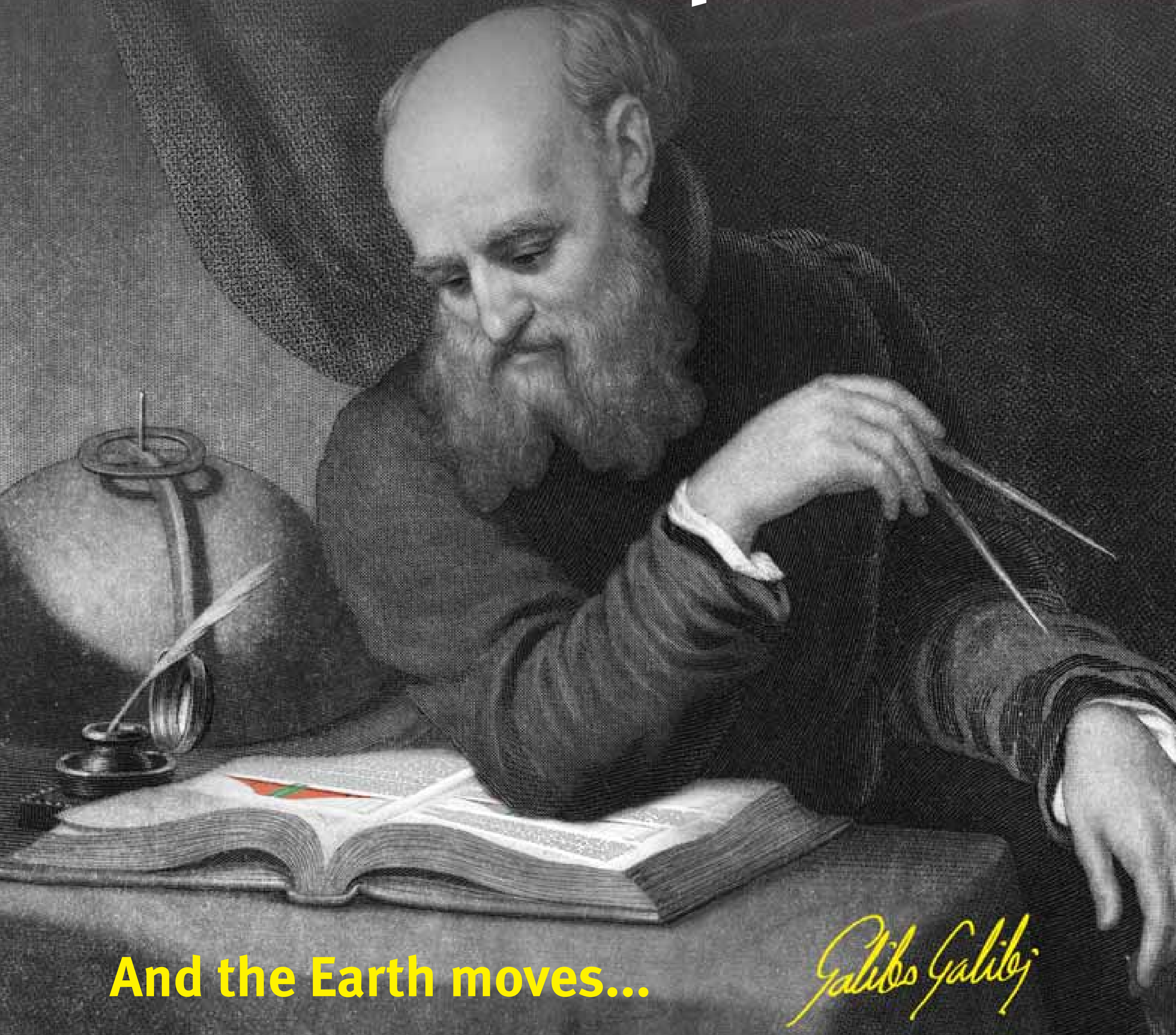
of a bad filter...



and a good filter...



which turned political!



And the Earth moves...

The Real Interference Issue: Political Noise

I have been reflecting on events related to the GPS interference issue and LightSquared. What I discovered revealed the root of this problem, and as I will describe in this paper, it is entirely caused by poor design of GPS receivers The problem can be solved easily and with existing technology. In fact, it already has been solved.

Unfortunately, the GPS interference issue is a perfect example of how Washington is allowing politics to influence a technical debate. Opponents of LightSquared are trying to deal with the GPS interference issue by employing armies of lawyers and lobbyists who either don't understand the scientific facts or are lying about them. Instead, it would be much better for those who are making much of the noise about LightSquared, to spend money on research and development to help solve the problem.

This political approach to a technical issue demonstrates why the United States is currently ranked seventh in the world for the most scientific and engineering researchers per capita, following Finland, Sweden, Japan, Singapore and Norway. Why would high-caliber talent want to go into technology-related jobs when our system appears to be placing low value on scientific facts and high value on political influence?

How I Came to Understand the Real Issue

Around December 2010, when I received initial reports and letters regarding LightSquared interference with GPS, I joined the Coalition to Save GPS and signed a letter to the chairman of the Federal Communications Commission thinking I was doing my part to protect GPS. I wrote similar commentary on my website, www.javad.com.

Then I was invited to participate in the 2011 ESRI[1] conference in San Diego and join a panel to discuss the LightSquared-GPS issues. In order to defend the GPS system and provide technical data, I started my own investigation of the problem. I soon realized that my own company had a fundamental problem in the first stage of our antenna system. It was allowing other radio energies into the receiver in addition to the Global Navigation Satellite System (GNSS) signals. I recognized that the flaw in our filter system would degrade the performance of our GNSS receivers whether LightSquared's system is deployed or not.

As an engineer, I always strive to innovate my products and took it upon myself to see if we could develop a device that filters out as much noise as possible from the adjacent band without affecting the integrity of the GNSS signals. Unfortunately, this was never a priority in our industry – we always used filters that offered little protection against interference.

I soon drew the conclusion that the standard operating procedure resulted in degraded performance. **Figure 1**, below, shows the theoretical spectrum of the United States' GPS satellite system and Russia's similar system, GLONASS, the so-called L1 bands. This figure shows GPS and GLONASS spectrum allocations and assumes that all of the adjacent spectrum is completely clean and free of any radio signals. At least that's the theory. In practice this is not the case.

[1]ESRI is a company based in Redlands, CA that creates Geographic Information Systems software and provides digital maps and other GIS data. They sponsor numerous conferences each year.

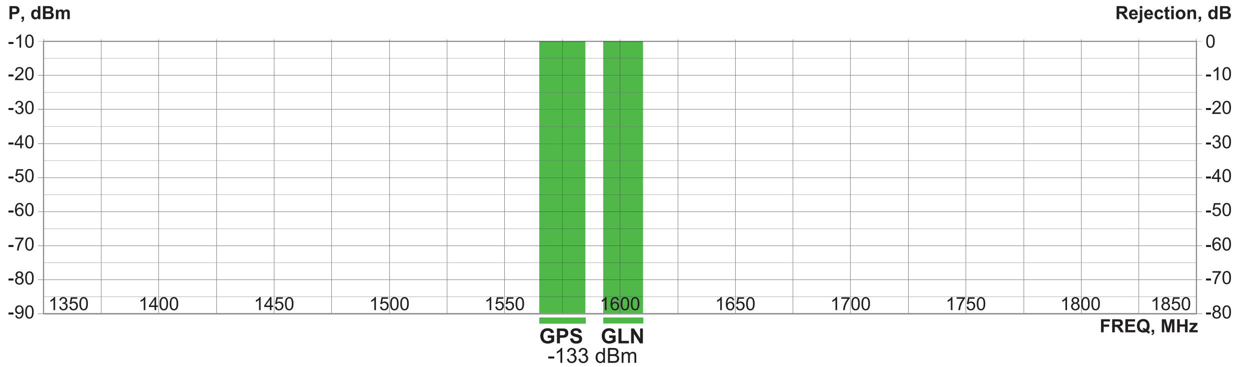


Figure 2, below, shows what the actual spectrum may look like. It has lots of “white noise” and harmonics of other existing transmitters. In the real world, the GPS system lives in a very noisy neighbourhood. The shape of interfering signals can change drastically as you drive around. To extract the best of GNSS signals, we should only allow these signals in and do not invite other outside noise.

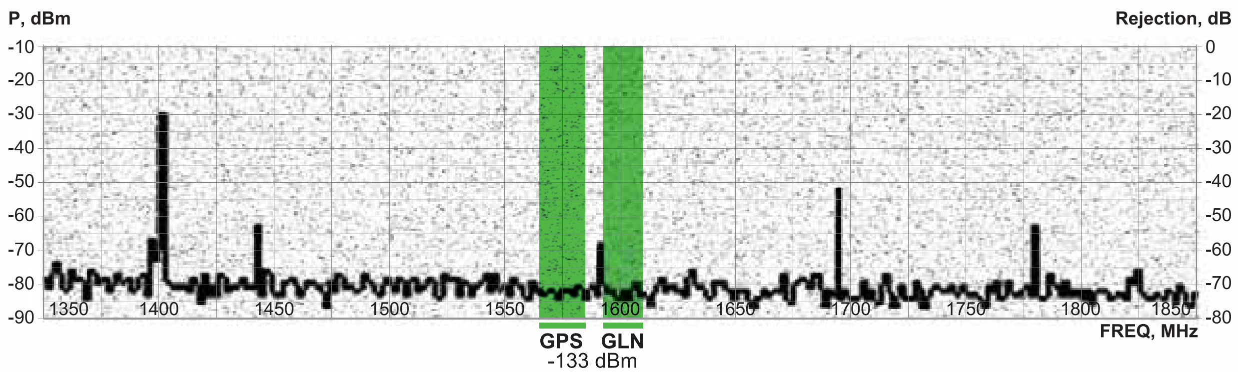
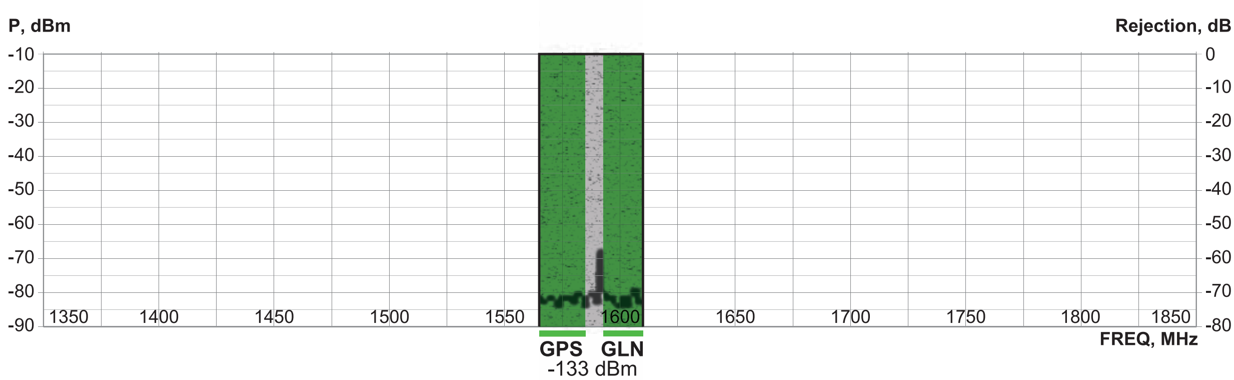
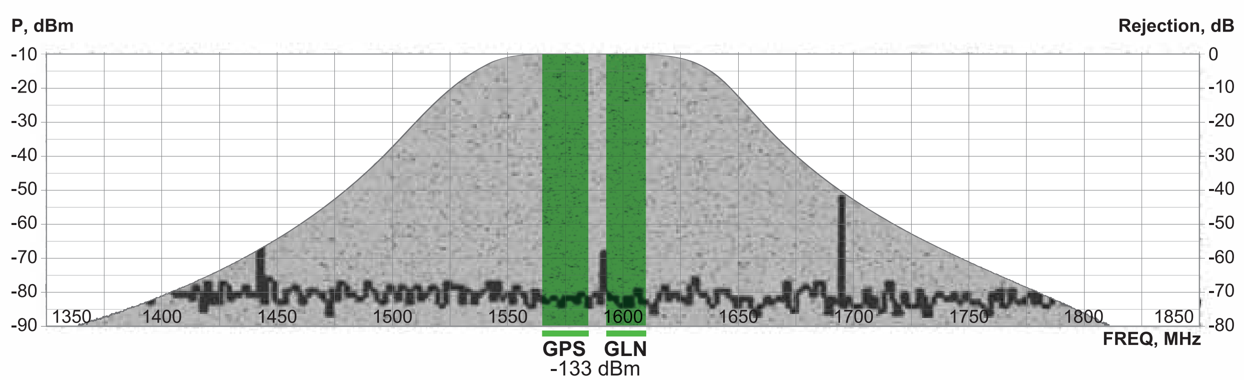


Figure 3, shows a perfect theoretical filter. It allows 100% of GNSS signals to pass from the antenna to the receiver, and it blocks 100% of all radio signals outside the spectrum allotted to GNSS. Such a filter would give us the best possible theoretical signal-to-noise ratio in a receiver and the best possible theoretical receiver performance. This theoretical filter would let in all signals in the GNSS spectrum pass, and completely blocks everything else.

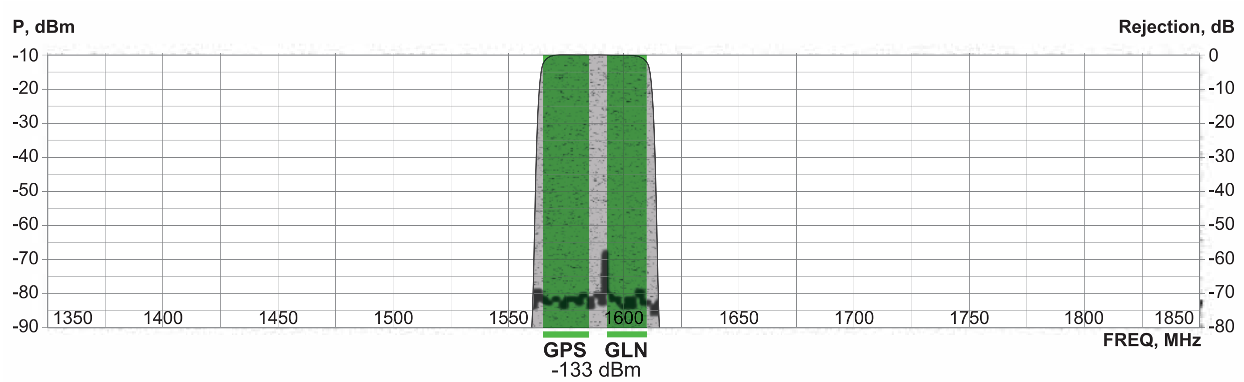


Unfortunately, it is not technically possible to build such a perfect filter. Our challenge is to build the best filter that keeps the GNSS signals intact and blocks unwanted signals as much as possible. In other words, make the side slopes, or skirts, of a filter as steep as possible. How difficult it is to build such a filter? How much would it cost?

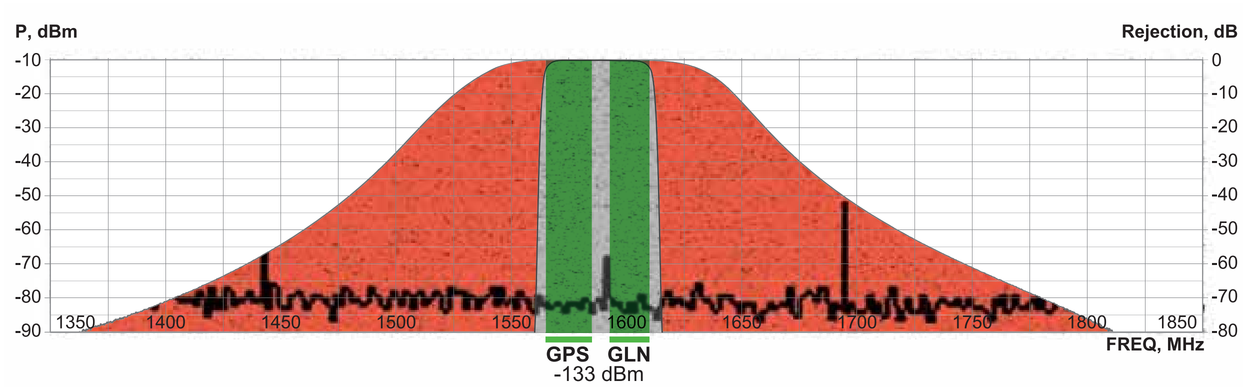
First let us look at the filter that we were using in my own company's GPS receiver products (see **Figure 4**). Those long, gently sloping skirts are not good. Filters with this shape allow a lot of white noise and strong signal spikes into the receiver that a GNSS device doesn't need, and doesn't want (the overall grey area). I knew we could do better, and this is why I set out to find a solution that filters out as much as possible.



As an innovator, I always want to improve our filter designs and enhance overall performance. **Figure 5** shows the performance curve and shape of a filter that we built and tested that met these criteria. And as you see below, the skirts on this filter are nearly vertical, indicating that we were able to block out almost all the noise. In technical terms, the slope of the filter on each side is about 10dB per MHz. In the future we may be able to do even better, but today, I think this the state-of-the-art design. To my delight, there is considerable benefit to this new filter because it is simpler, it performs better and it costs less than our old filter design.



The performance difference between the old filter of **Figure 4** and new filter of **Figure 5** is enormous. The red section in **Figure 6**, below, illustrates the extra noise and undesirable signals that our old filter was allowing to pass from the antenna into the receiver. All of that extra noise degrades the performance of GNSS receivers.



To think in laymen's terms about such performance degradation, consider having a conversation with a friend in a quiet room. Now consider trying to have the same conversation in a crowded restaurant with waiters shouting to each other (noise spikes) and all the restaurant customers talking loudly to overcome all the background noise. All that extra noise makes it a lot harder to understand what your friend is trying to say to you. The same is true for radio receivers: the more background noise they hear, the harder it is for them to detect and understand the signal that they are supposed to be listening to.

As **Figure 6** shows, we had a lot of extra noise coming into our GNSS receivers. Note again that we are not discussing LightSquared here. Our focus is to improve the performance of GNSS receivers by eliminating as much noise as possible from the red zone – whether coming from a LightSquared transmitter or any other source.

If you are out in the countryside in an electronically quiet environment, you may see only small amount of improvement with our new filter, but in cities, where there are lots of other transmitters, the improvement will be significant. With the new filter, you probably will be able to get a Real Time Kinematic[2] (RTK) solution faster and with greater accuracy. With the old, broad-skirted filter, you will need to stay longer in one position to get a position fix, and your solution may not be as accurate. Indeed, your receiver might stop functioning completely if there's too much radio noise. All practicing surveyors will say that there have been times when their receivers were not functioning properly. They usually blame it on foliage, rain, and other physical environmental conditions, when the real problem often is a noisy radio spectrum environment that does not allow enough margin for operation under foliage and where GNSS signal reception is weaker.

In scientific terms, the filter of **Figure 4** can allow enough noise to get into the receiver to create the equivalent of several dB of additional "noise figure"[3]. To put this in perspective, a good receiver has a noise figure of less than 2 dB. Most engineers would agree that an effective noise figure of more than 3 dB means poor receiver performance. Allowing extra noise into the receiver can make the effective noise figure much more than 3 dB.

It's important to distinguish between "noise figure" and "signal-to-noise" ratios that are determined at the end of the signal processing. Even 1 dB of additional "noise figure" will degrade performance, but several dB change in signal to noise ratio might not be noticeable at all in a GNSS receiver. Please note that the discussion so far has nothing to do with LightSquared. Everything I've outlined thus is meant to improve receiver design overall.

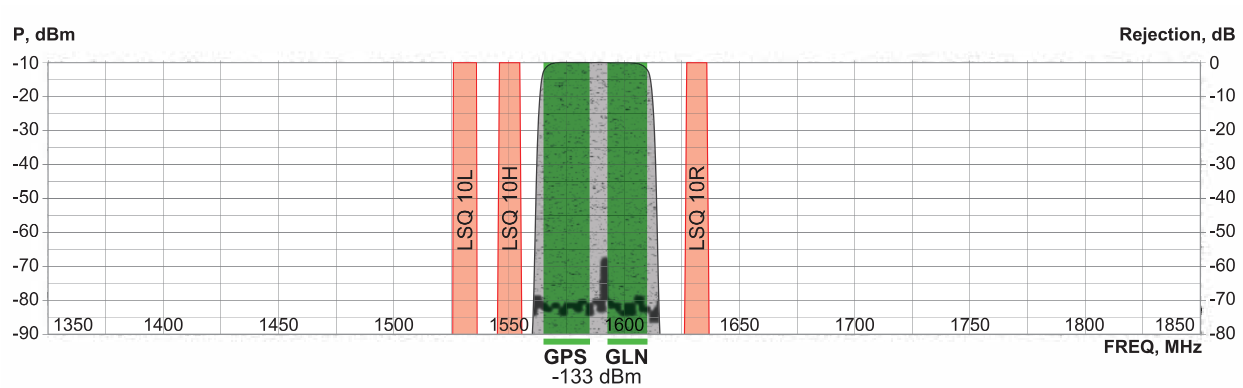
[2]RTK devices are high-precision receivers that use information from terrestrial transmitters to provide additional information, allowing more precise positional solutions.

[3]Noise figure is defined as the difference (in decibels) between a theoretically perfect receiver that does not generate any noise internally, and a real-world receiver.

Better Filters Provide Multiple Benefits

I think this discussion shows that other GNSS manufacturers are not showing a desire to innovate and improve their designs. Either they don't want to block out noise, or they don't have the technical competency to do so. The filter in **Figure 5** is much better than the one in **Figure 4** because it provides superior performance for GNSS receivers, with or without LightSquared. If they thought they couldn't build such filters without negative side effects, they were wrong – we have demonstrated that it can be done.

If we build better filters and better GNSS receivers, both general purpose users and high-precision users of GNSS will get improved results. In addition, the **Figure 5** filter will protect the receiver from hearing LightSquared signals. This is shown in **Figure 7**, below. The GPS and GLONASS signals are shown in green. Our new steep-skirt filter is shown in grey, and the LightSquared signals are pink. Note that this new filter completely blocks out the LightSquared signals without reducing the signal strength of GNSS signals.



This improved filter design should make it clear that LightSquared can coexist with GNSS. Once we understand that, we can also understand that high-precision GNSS receivers can benefit from LightSquared. We can use LightSquared for RTK communication (the land-based signals that augment signals from GPS satellites and provide more precise positional data). We desperately need better RTK communication, and LightSquared's network can provide it.

My desire to innovate filter design was evident in my presentation at the 2011 ESRI conference, where a representative from LightSquared spoke with me on a panel. He was intrigued by the challenge I wanted to tackle offered to support my efforts to build a new and improved filter.

The GPS Community's Response (or Non-Response) to Scientific Facts

Since the ESRI conference, the community's response has been a mix of good, bad, and even ugly. The good part is that our cooperation with LightSquared led to effective and cost-effective solutions to the technical problem. The bad part was that most of the GNSS receiver community stuck fingers in their ears and said, in effect: "I'm not listening! I can't hear you!" The ugly part came in the form of numerous hostile responses I received when I presented my solution at the 2011 PNT[4] meeting, published my findings, and partici-

[4]The National Executive Committee for Space-Based Positioning, Navigation, and Timing (PNT) is a U.S. Government organization established by Presidential directive to advise and coordinate federal departments and agencies on matters concerning the Global Positioning System (GPS) and related systems.

pated in the GPS World webinar.

Proving that it was possible to design and build a filter that would improve GNSS receiver performance, and do away with the possibility of interference from LightSquared, made me a villain to the status quo. But I ignored their hostility because my objective is to build better receivers, not please the establishment.

I soon took the designs out of the theoretical realm and successfully built a number of prototypes to test in the laboratory and in the field. The results were successful, and within just a few months from the point when I decided to tackle this problem, we were in full production – not only were my new devices more accurate because they filtered out unnecessary noise, they were cheaper to produce and they were compatible with LightSquared.

The PNT Advisory Board's letter to the FCC Chairman on August 3, 2011 blamed LightSquared for the interference and asserted that the only solution was to shut down the company. Rather than innovate and develop a technical solution to the interference problem, those on the PNT Advisory Board, several of whom represent the major GPS companies with a financial interest in the outcome of this debate, chose to use their political might.

The Sound of Silence

I chose to let the science inform my opinion. We developed a theoretical solution, created an experiment to test it, and proved that the theory was correct. The last step in the scientific process is that experimental results must be replicable. To assist others in replicating my findings, I took 40 units of the new system to the November PNT Advisory Board Meeting and offered our new filter design to those who wished to test them. Some people took up my offer, but nobody has come out in public and announced the results of their own tests. Did anyone conduct any tests? If so, what were the results?

All I heard was silence! I have to assume that any tests that were actually conducted in fact replicated our results. If the new filters didn't work, opponents of LightSquared would have been shouting their test results from the rooftops.

The reaction from many of my industry peers to my scientific analysis was decidedly unscientific. My pure technical findings were tagged as hostile, harsh, disrespectful, political, self-serving and betraying. I ask my critics: How in the world could I possibly want to cause harm to GNSS systems that I have worked so hard in the past 30 years to improve? If GNSS system receives any harm, my company and I are among the first to feel the damage!

I'm not a stranger to controversy, so I chose to ignore them. I received similar personal attacks for ten years when I was working on GLONASS. Déjà vu!

Despite my findings that proved the August 3rd letter technically wrong, the PNT did not correct the record, nor did they offer an apology to the FCC chairman for making false claims. In the scientific community, an organization that puts out such blatantly wrong information loses its credibility and goes silent for a while.

So recently, others inside the government created a new smoke screen: low precision (C/A code only) receivers. The government tests reported that 75% of low-precision receivers "failed" a compatibility test with LightSquared, but what they neglect to explain is that their definition of "failure" is 1-dB loss in signal-to-noise!

There are two points to note: First, most receivers have up to 20-dB of margin on signal-to-noise and users most likely will not even notice a 1-dB loss. Second, if you take any one of the so called "failed" receivers near many existing transmitting systems (like AM and FM radio and TV towers) you will see that they will lose some dB's of signal-to-noise or they may completely stop functioning. Should we force all such transmitters off the air? Or better yet, should we demand that GPS receivers that are being used in critical applications have protection against existing systems? I wrote a letter regarding this issue to the FCC Chairman recently outlining my point-of-view on this false rationale.

Next came the issue that LightSquared interferes with avionic systems that warn pilots about approaching terrain and mountains. This was tested in a laboratory. In addition to all I mentioned earlier, the test also ignored that LightSquared towers are aimed six degrees below the horizon and transmit 20-dB (100 times) less power in directions above the horizon. Those conducting the testing and analysis of the data clearly chose to ignore some facts.

It Would Be Funny If It Weren't So Tragic

The story does not end here. According to the official test results, 300 million inexpensive GPS receivers built into cellular telephones are not affected by LightSquared. However, the very expensive encrypted military GPS receivers that are supposed to be battle hardened are affected!

Why is no one asking the Pentagon why they procured equipment that's vulnerable to wireless signals of all things?

One may argue that the reason military receivers did worse than cell phones is that military receivers use wide band P-code. This is exactly my point; the military receivers which use wide band un-encrypted P-code for the main purpose of getting better protection against interferences, end up performing worse than even a cell phone in the presence of interference. This also applies to the FAA. Everyone in Washington ignores these facts!

This technical matter has a lot of lawyers, lobbyists and spin doctors involved, but it's the engineers who have the ability to solve this problem.

No matter what happens to LightSquared, I am determined to build a better filter system for our GNSS receivers and offer better products to surveyors worldwide, and if we can accomplish this while facilitating a better RTK network, all the more reason.

I would like to invite engineers who want to roll up their sleeves and find solutions and discuss technical details to join me and several of my peers on Tuesday, January 17, 2012 in my San Jose facility. Please RSVP to javad@javad.com.

Javad Ashjaee

Spatially Smart Wine

Spatially Smart Wine was a project initiated by an enthusiastic group of Sydney Young Surveyors, with the support of the Institute of Surveyors New South Wales and the School of Surveying and Spatial Information Systems and the University of New South Wales. Readers may recall that we published the first part of the paper in December 2011 issue. We present here the second part of the paper

Testing of geospatial technologies – discussion

Status of the vineyard

Jarrett's wines, the subject location of this study, had undertaken much of the above however it soon became apparent that data was poorly managed, with a mix of hard- and soft-copy data. The importance of spatial data management is rarely reported in the PV literature, and the ad hoc nature of spatial data acquisition and surveyor involvement limits the opportunities for an efficient spatial data management system to be implemented.

User defined needs and goals are critical to spatial planning, and on discussion with the vineyard owner the following needs were identified:

- **Short-term:** Interactive map of the farm, to include collated and digitised hardcopy data, to be updatable, portable and easy for all staff to use;
- **Long-term:** GNSS- and sensor-enabled machinery to facilitate variable application of mulch, irrigation and sprays;
- **Ongoing:** Develop knowledge of the vineyard, including vine mapping, identification of yield and foliage density etc. to inform pruning and harvesting.

GNSS equipment

A selection of GNSS-enabled equipment was tested on site to determine its suitability for operational use in a vineyard, including:

- Getac Toughbook (rugged tablet computer), with ESRI ArcPad (Provided by ESRI Australia)
- Leica Zeno (Provided by CR Kennedy) (handheld, differential GPS)
- Leica Viva (RTK with solutions up to 2cm) (Provided by NSW Land and Property Management Authority)

In order to achieve Differential GPS and RTK solutions, correction data from CORSnet-NSW, the New South Wales government funded Continuously Operating Reference Station (CORS) network, was utilised. The closest CORS was Orange (approximately 30km from site), although virtual base DGPS solutions, Virtual Reference Station (VRS) and Master Auxiliary Concept (MAC) solutions provided through the network were also tested.

The vineyard manager was present at testing, and provided valuable insight into the suitability and application of these technologies to the vineyard. We will examine each technology and its application in the vineyard in the following subsections.

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Getac Toughbook with ESRI ArcPad

Large amounts of data are associated with PV. Given the surveyor cannot remain on hand, vineyard managers need to be able to easily create, store and retrieve spatial data. Handheld computers are cost-effective and convenient for basic mapping and data collection tasks commonly performed for precision agriculture practices (Koostra et al, 2003).

The Getac Toughbook is both GIS- and GPS-enabled. Note that not all Toughbooks are GPS-enabled, but GPS add-ons are easily attainable. In this case study, the vineyard manager had recently purchased a Toughbook, deeming it necessary for day-to-day tasks within the vineyard including the onsite viewing of spatial data, tracking of tasks and identification of follow-up areas. For example, vineyard inspections to identify follow-up locations for pest and weed treatment, or localised incidents of vine disease.

For efficient and integrated use (i.e. across multiple computers and personnel) some form of mapping software is a requirement. ESRI's ArcPad was used in this field test, but it is by no means the only, or necessarily the best option. Advanced spatial users can easily develop mapping applications, mashups and queries to best inform vineyard decision making, using either ESRI, open source or other applications. This is identified as a significant market area for further development as no immediate, easy-to-use and off-the-shelf options are known to the authors. Wireless connectivity between hardware is a further option under consideration on the farm.

Problems observed in the field using the Toughbook include difficulties of use in bright sunlight, screen size and intuitiveness to users not accustomed to spatial data. There was a need for better accessories to ease its utility in the field (e.g. vehicle and personal holders and data entry tools). GPS and CORS were deemed critical enablers for in the field applications.

Leica Zeno handheld DGPS, ESRI ArcPad enabled

The Leica Zeno is marketed as the 'most rugged and versatile GNSS/GIS handheld in the market'(Leica Geosystems, 2009). The Zeno provides a differential correction to the GPS coordinates which would allow operators to easily determine the specific row and vine for follow up inspections.

The Leica Zeno used in the pilot project also had ESRI ArcPad installed on it. We found the Zeno to be more suited to users with a spatial background as it has functionalities (e.g. DGPS capabilities) that can be easily understood by a spatial-user and vice versa. The Toughbook on the other hand has limited high-accuracy surveying capabilities, thus making it easier to use and therefore suitable for non-spatial users.

Leica Viva RTK

RTK solutions were found to primarily support the implementation of machine guidance operations. For the efficient operation of auto-steered machinery, as discussed in the following section, key aspects (especially obstacles) of the vineyard would need to be mapped to a high level of accuracy. Auto-steer technologies would then use RTK position solutions, with operator alerts if the machinery began to run off-centre due to degradation of the RTK signal or other problem such as close proximity to buildings and trees due to multipath.

With all three technologies having useful application within the vineyard it is evident that an integrated data management system would be highly beneficial. A decision support system can be used and integrated with the process model to represent the use of information (Smith et al., 1998). With wireless connectivity available on all three devices this management system need not be provided by the vineyard but is possible through broader precision agriculture support services. It is in this area that significant research and development can still take place to value-add on the implementation of positioning and guidance technologies in the vineyard.

The Australian government announcement of a National Broadband Network is also expected to further this research area.

ESRI's ArcPad

ArcPad is ESRI's solution for database access, mapping, GIS, and GPS integration on handheld and mobile devices (ESRI 2002). The most salient feature of ArcPad for our purposes is the ability to customise by:

- Designing forms for more efficient data collection,
- Writing scripts for more efficient, user-friendly analysis, and
- Building applets that customise a collection of tools and scripts.

A chief concern with the use of ESRI's ArcPad is the licence cost and user training needs. The above features would need to be set up by a more experienced spatial professional. A number of alternative GIS and spatial data display/management systems exist, but testing these is beyond the scope of this paper (http://opensourcegis.org details many alternative options. Google Earth is a familiar option that many lay users would find easy to adopt).

LiDAR Technology

LiDAR (Light Detection And Ranging) is an optical remote sensing technology which is used to measure properties of scattered light to find range, elevation

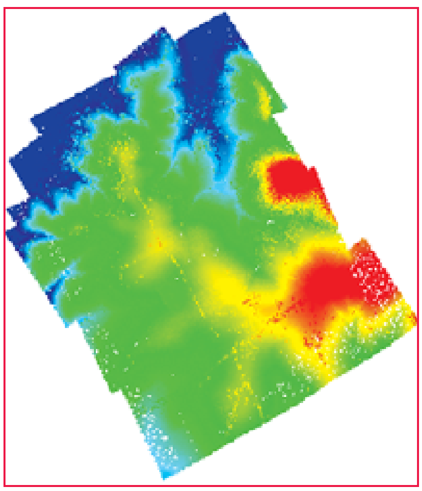

Figure 2: Point-cloud data of aerial-LiDAR over the Jarrett's Wines vineyard

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The importance of spatial data management is rarely reported in the PV literature, and the ad hoc nature of spatial data acquisition and surveyor involvement limits the opportunities for an efficient spatial data management system to be implemented.

and other information of a distant target. It records not only the multi-reflection laser pulses that return from the object but the intensity information for each returned laser pulse. The LiDAR system is widely used in geoinformatics, archaeology, geography, geology, geomorphology, seismology, remote sensing and atmospheric physics (Cracknell et al, 2007).

Aerial LiDAR data was gathered during a flight over the vineyard (LiDAR was flown over the area by the NSW Land and Property Management Authority for calibration purposes of their newly acquired aircraft) and Figure 2 shows the resulting aerial point cloud. Figure 3 shows a subset of the points overlaid on aerial imagery. The LiDAR imagery was obtained for a terrain map of the area of study. It was envisaged that LiDAR technology may improve understanding of vineyard processes and foliage density, which would help develop precision pruning and harvesting of future crops. The vineyard manager already had a time series of multispectral aerial imagery data (As a general indication, Bramley (2009) reports the cost of multispectral imagery at AUD$30/ha), and LiDAR imagery was deemed to further augment this. It is estimated that the cost of aerial-LiDAR to be around AU$3000 for the survey of the vineyard.

Data Specification/Description

Table 2: General specifications of aerial-LiDAR data (LPMA, 2010)

Horizontal Datum	GDA94
Vertical Datum (Orthometric)	AHD71
Vertical Datum (Ellipsoidal)	ITRF05
Projection	MGA Zone 55
Geoid	AUSGeoid09
Metadata	ANZLIC Metadata Profile Version 1.1

Table 3: Five classification levels of aerial-LiDAR data (LPMA, 2010)

Level	Description
0	Unidentified
1	Automated Classification
2	Ground Anomaly Removal
3	Manual Ground Correction
4	Full Classification

Note: The classified point cloud is also retained in its primary ellipsoid height format so as to allow for future improvements in the vertical datum and to enable accurate nesting of adjacent elevation data

LiDAR Analysis

The LiDAR was flown, analysed and processed by the Land, Property and Management Authority (LPMA) in Bathurst (see Table 2 for specifications). Data was predominantly processed using *TerraMatch* and *TerraScan* MicroStation plug-ins. In addition to that, the plug-in LP360 by QCoherent was also used to check data quality and to verify the processed (final) LAS files. *TerraMatch* was used to apply corrections and changes to the LAS files based on (1) heading, (2) roll, (3) pitch, (4) mirror scale and (5) z-shift (elevation) of the points captured based on the movement of the plane relative to the point-capture exercise.

The LiDAR datasets were classified according to the "spatial accuracy" of the data. Once a LiDAR survey is determined to be "spatially accurate", any remaining significant errors in the data are likely to be the result of incorrect classification. For example in wetland areas, due to the lack of actual ground strikes, dense vegetation is often classified as ground by the automated algorithms. A significant amount of manual effort is then required to correct the classification attributes (LPMA, 2010). Table 3 briefly outlines the five classification levels as defined by the LPMA. The levels are allocated by the various automated and manual processes. Successive level reflects increasing classification completeness and effort. For the purpose of this project, the aerial LiDAR data has been processed to Level 2 standards, where the anomalies found in the ground data were removed to create a ground surface suitable for ortho-rectification of imagery with minimum effort (LPMA, 2010).

LiDAR Accuracy

The following discussion on LiDAR accuracy is based on the LPMA standards for processing aerial-

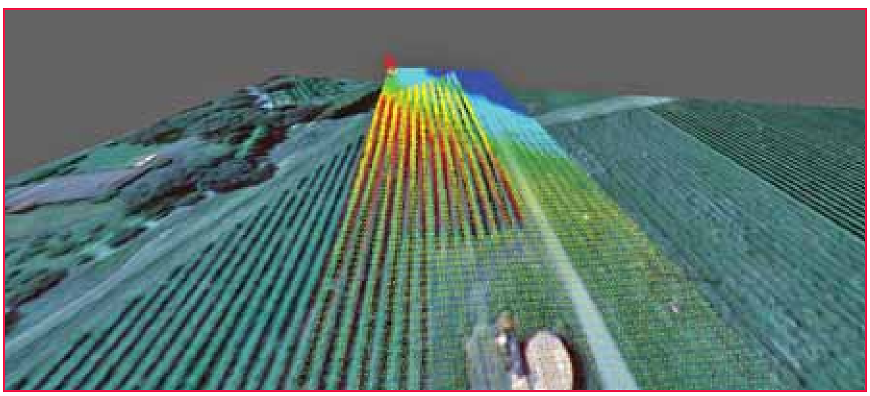

Figure 3: Aerial LiDAR overlaid on aerial photograph

LiDAR data (This section is an excerpt from the LPMA Standard LiDAR Product Specifications, Version 2.0, July 2010).

Vertical accuracy is assessed by comparing LiDAR point returns against survey check points on bare open ground. It is calculated at the 95% confidence level as a function of vertical RMSW (as per ICSM Guidelines for Digital Elevation Data 2008 (Retrieved online from the 'Intergovernmental Committee on Surveying & Mapping' (ICSM) website - http://www.icsm.gov.au/icsm/elevation/ICSM-GuidelinesDigitalElevationDataV1.pdf)). This is undertaken after the standard relative and absolute adjustment of the point cloud data has taken place (i.e. flight line matching and shift/transformation to local AHD).

Horizontal accuracy is checked by comparing the LiDAR intensity data viewed as a "TIN" surface against surveyed ground features such as existing photo point targets. To date our analysis of ground comparisons shows that although the vertical accuracy achieved on bare open ground is well within the requirements for Category 1 Digital Elevation Model (DEM) products as specified in the ICSM Guidelines for Digital Elevation Data, local geoid and height control anomalies may degrade the accuracy on large coastal projects.

Vertical accuracy	±30cm at 95% confidence (1.96 x RMSE)
Horizontal accuracy	±80cm at 95% confidence (1.73 x RMSE)

Advantages and Disadvantages of LiDAR Technology

Advantages of LiDAR include the high data accuracy, large area coverage and quick data turnaround. The cost is small compared with the acquisition of similar accuracy level data using a team of surveyors and total stations (Note the authors did not pay for the LiDAR data collection in this analysis. An estimated cost was provided by the LPMA, a government department, of around AU$3000 for the 300ha vineyard. As a general comparison, Bramley (2009) reports the cost of multispectral imagery at AUD$30/ha, however prices are decreasing at a rapid rate.).

Disadvantages include the weather-dependence of LiDAR, and the inability of LiDAR to penetrate dense canopies (such as vines during harvest season), thus preventing the creation of accurate DEMs. Canopy imaging does, however, present a further opportunity for LiDAR applications (see Table 1), however more research is required and it may be possible to derive the same benefits from terrestrial applications.

...to be concluded in next issue

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Mr Rajendra S Pawar addressing the conference

12th Esri India User Conference

7 – 8 December 2011, Noida, India

The 12th Annual Esri India User Conference was a big hit with Users and Partners from across all spectrums of GIS Users. Held at the Radisson Blu MBD Hotel at Noida on Dec. 7th & 8th, 2011. It was a resounding success for the organizers, NIIT GIS Limited (Esri India), with more than 1000 delegates (around 70% higher than the previous edition) attending the conference over the two days. The delegates were extremely happy with the content of the Conference and the associated Exhibition where not only solutions from Esri India were exhibited but also Partner solutions like from IBM. Trimble, GeoEye and Hemisphere GPS were shown along with that of Institutions providing GIS courses like NIIT University and Symbiosis Institute of Geoinformatics. Prominent Users like RGI and NATMO too had showcased the work they had done using GIS.

The Theme of the Conference this year was 'Understanding our World'. At the Inaugural Session, Mr S Sridhar, President & COO, NIIT GIS Limited, spoke on how Esri India has grown in the last 15 years and showcased some of the work done by their Users in the recent past. Mr Rajendra S Pawar, Chairman, NIIT Group, spoke on the theme of the Conference, highlighting the need for using GIS in reaching the benefits of large government aided programs and policies to the grass roots of society and the need for capacity building. Mr Jim Higgins, Regional Manager, Esri Inc., spoke on the Vision of Esri and how geospatial technology is now reaching out to every nook and comer of society. During the Technology Exposition the delegates were shown by the Technology & Solutions Team of Esri India the latest products and updates from Esri, Exelis VIS and Telvent, with a talk by Ms Victoria Kouyoumjian, IT Strategies Architect, Esri, on ArcGIS Online, Esri's cloud-based geospatial content management system for storing and managing maps, data, and other geospatial information.

The Panel Discussion held on the evening of the second day on the theme of the Conference 'Understanding our World' was well attended and the points made by the distinguished Panel consisting of Dr Shailesh Nayak, Secretary, MoES, Mr. S Subba Rao, Surveyor General of India, SOI, Dr Vandana Sharma, Dy Director General, NIC, Dr Devendra Pandey, Former DG, FSI and Mr Rajesh C Mathur, Vice Chairman, Esri India, were well received. The interaction with the audience during the Open House was also of a very high quality.

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New generation Glonass development to start from 2017

Russian satellite producer Reshetnev Information Satellite Systems plans to start developing a new generation satellites for the country's Global Navigation Satellite System (GLONASS) in 2017. The company plans to finish developing the projected satellites, called GLONASS-KM, in 2020. *Prime Business News*

Researcher predicts magnitude-9 earthquake in Kashmir

Roger Bilham of Colorado University predicted a magnitude-9 earthquake in Kashmir Valley. The US professor claimed that his observation is based-on the new GPS data readings which revealed gradual movement of rocks in the Zanskar mountains north of the valley. Bilham has, however, put no timeframe for his predictions. In its typical doomsday forecast, the study warned, "The zone would rupture when a quake eventually happens. The quake would be 200 kilometres wide as against 80 kilometres predicted earlier."

Commenting on Bilham's study, M.I. Bhat, a senior geologist in Srinagar, said, "Earlier we believed that the Kashmir Valley was vulnerable to destruction from quakes generated along the Pir Panchal mountain range. But with availability of the GPS data from the region, it is now evident that the northeastern side of the valley is more vulnerable to earthquake generation than the Pir Panchal range." *Deccan Herald*

Tests show LightSquared interference with 75 percent of GPS receivers

U.S. government tests conducted in November showed that 75 percent of GPS receivers examined were interfered with at a distance of 100 meters from a LightSquared base station. The report states that "No additional testing is required to confirm harmful interference exists," and "Immediate use of satellite service spectrum for terrestrial service not viable because of system engineering and integration challenges." The tests showing interference by the LightSquared Lower 10 terrestrial signal with an overwhelming majority of general-purpose GPS receivers. Data from LightSquared handsets was collected, and analysis is underway, but no results were presented on December 14. The presentation of findings was made to the National Executive Committee for Space-Based Positioning, Navigation, and Timing (PNT ExCom) by Lt Col Robert Erickson, U.S. Air Force, and Dean Bunce, Federal Aviation Administration, the two co-chairs of the National Space-Based PNT Systems Engineering Forum (NPEF).

Statement by Anthony Russo Director, National Coordination Office

On Behalf of the National Executive Committee for Space-Based Positioning, Navigation, and Timing, December 14, 2011

"Today (December 14), a government technical group reviewed the findings from last month's testing of LightSquared's proposal to provide new broadband service. The final test report will be sent to the National Telecommunications and Information Administration (NTIA), which advises the President on telecommunications policy, and represents federal agencies to the Federal Communications Commission (FCC). Preliminary analysis of the test findings found no significant interference with cellular phones. However, the testing did show that LightSquared signals caused harmful interference to the majority of other tested general purpose GPS receivers. Separate analysis by the Federal Aviation Administration also found interference with a flight safety system designed to warn pilots of approaching terrain. The findings were presented to the technical steering group which represents the nine federal agencies that make up the National Executive Committee for Space-Based Positioning, Navigation, and Timing. Over the next several weeks, the final analysis of the findings will be completed and a final report will be transmitted from NTIA to the FCC."

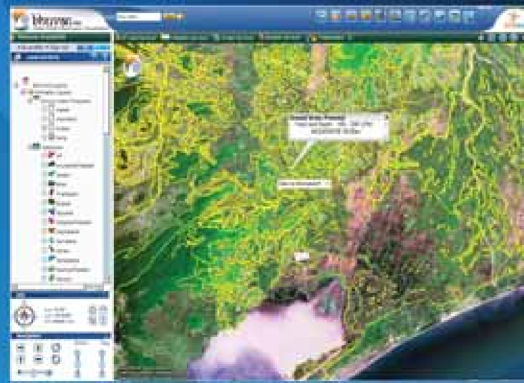
LightSquared petitions FCC to confirm company's rights to GPS Spectrum

LightSquared has asked the FCC to confirm the company's right to use spectrum licensed to it and that commercial GPS manufacturers have no right to interference protection from LightSquared's proposed wireless broadband network. The company asserts that commercial GPS manufacturers are responsible for having designed and sold unlicensed devices that use spectrum licensed to LightSquared and its predecessor companies.

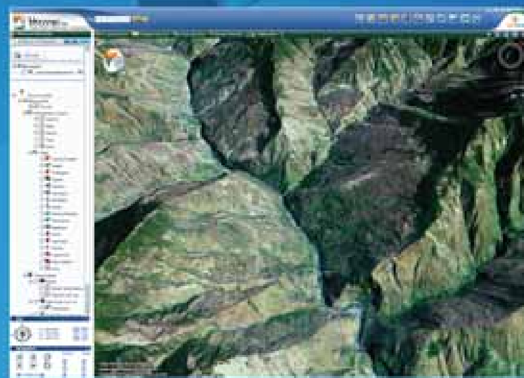
JAVAD urges FCC to establish guidelines for GPS receivers

In response to leaked claims that 75 percent of tested receivers failed the most recent round of testing against the LightSquared signal, Dr Javad Ashjaee, president and CEO of JAVAD GNSS, wrote a letter to FCC Chairman Julius Genachowski noting that any GPS receiver that failed the test against the LightSquared signal will also fail against many other existing transmitting systems. "The problem is in the design of the GPS receivers that were tested," he said. "Anyone can test this. Take any low-end GPS receiver similar to those they claim 'failed' the test and get close to some FM radio transmitting stations, for example." He urged the FCC to establish guidelines for GPS receivers. "The FCC should mandate that any receiver used for critical applications must show their signal-to-noise numbers, so every user can see degradations when they encounter interference," the letter said. "Had the FCC established and enforced receiver standards to begin with, we could have avoided this entire interference debate between LightSquared and the GPS industry."

Bhuvan : Gateway to Indian Earth Observation



Ground Water Prospects Map - Part of Orissa



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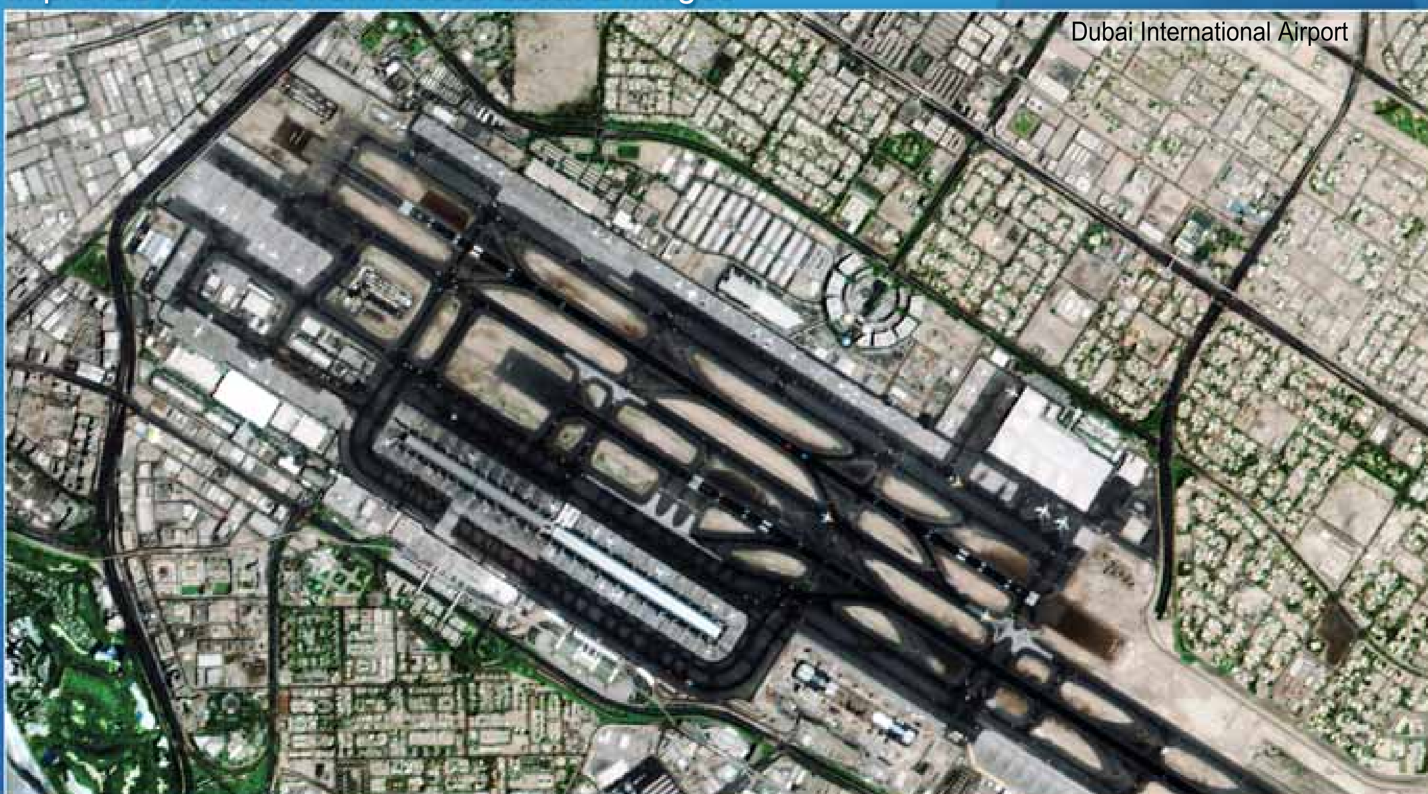


Dubai International Airport

Indian Defence inks deal with Russia on Glonass

An Indian defence team of scientists and defence brass inked an agreement with Russia for receiving precision signals from Glonass. These signals will allow missiles, including those fired from nuclear submarine Chakra, to strike within half a metre of distant targets. *www.thehindu.com*

NIS Glonass eyes Indian LBS market

According to NIS Glonass, it will start its India operation in the first quarter of 2012 with its head office in Mumbai and regional offices in Delhi and Chandigarh. The company is part of JSFC Sistema, the largest public diversified financial corporation in Russia and the CIS and manages a business portfolio of high-growth consumer service companies. So far, the company has done pilots with Glonis Solution and HBL Power Systems in the Indian market related to fleet management system. For embedded system, the company has signed up with Tata Elxsi. *www. voicendata.ciol.com*

European Commission rolls out free software for EGNOS Developers

The European Commission has introduced free, downloadable and ready-to-use software tools to help anyone develop enhanced location and timing applications that harness the power of Europe's European Geostationary Navigation Overlay Service (EGNOS). EGNOS, which began operations earlier this year, provides real-time satellite-based corrections and integrity monitoring for GPS satellite signals.

India to provide Glonass equipments

In a joint statement, Russian President Dmitry Medvedev and Indian Prime Minister Manmohan Singh said that Russia and India intend to cooperate in the production of satellite navigation equipments and to provide services to civilian users of the Glonass system. *http://en.rian.ru*

EGNOS extends its reach to the UK and Germany

EGNOS Safety-of-Life signal for aviation is set to extend from France and Switzerland to the UK and Germany, according to the European Space Agency (ESA). The system is the European equivalent of the 'Wide Area Augmentation System (WAAS)' overlay service in use across North America, which is today being used by more than 40 000 aircraft with more than 2000 landing procedures published. French airports Pau Pyrénées, Clemont-Ferrand and Le Bourget were the first to authorise use of EGNOS, joined last month by Les Eplatures Airport and St. Gallen-Altenrhein Airport in Switzerland, planning to use it as a low-cost backup to ILS in the event of bad weather. Germany's Federal Supervisory Authority for Air Navigation Services has given permission for EGNOS to be used across 38 German airports from 15 December onwards. *www.esa.int*

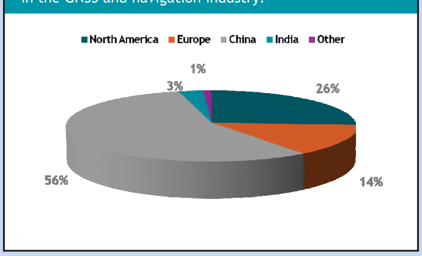
Iran controls US Drone with GPS spoofing

Using GPS spoofing technique, Iran guided the "lost" stealth US drone (RQ-170 Sentinel) to an intact landing inside hostile territory, according to an Iranian engineer now working on the captured drone's systems inside Iran. The engineer explained that Iran used the knowledge gleaned from previous downed US drones and a technique proudly claimed by Iranian commanders in September, the Iranian specialists then reconfigured the drone's GPS coordinates to make it land in Iran at what the drone thought was its actual home base in Afghanistan. The US military has reportedly been aware of vulnerabilities with pirating unencrypted drone data streams since the Bosnia campaign in the mid-1990s. *www.csmonitor.com*

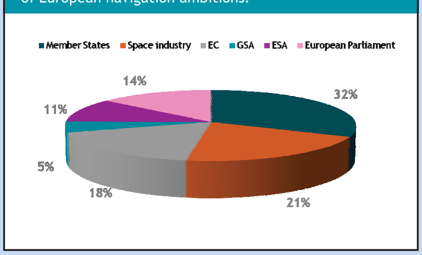
GPS would lead mass market in 2020

Around 45 percent survey respondents of European Navigation Conference 2011 felt that in year 2020 the order in which the GNSS systems reach the mass market would be GPS-GLONASS-Compass-Galileo. This option was supported by GNSS users (62 percent) and industry/service providers (55 percent) than those in the government/public sector (50 percent) and consultancy/academic (43 percent) categories. The survey was conducted by Helios during the European Navigation Conference 2011 on 30 November 2011 in London. Delegates were asked 8 questions with multiple choice answers. Using handheld keypads and live electronic voting, they were then asked to vote. The survey was participated by 140 delegates and some of the results were compared with a previous survey held in 2007. Around 56 percent of the participants felt that North America would lead in innovation in GNSS and navigation industry in year 2020. Despite the launch of Galileo satellites, 43 percent of the respondents were of the opinion that the Galileo Open Service would be ready only at 2020 or later. Around 50 percent of the respondent believed that the most widely adopted solution to GNSS vulnerability would be MEMS/INS integration.

In 2020, which region of the world will lead innovation in the GNSS and navigation industry?



Who will play the most important role in the realisation of European navigation ambitions?



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ICO expresses concerns over use of LBS data

The UK's Information Commissioner's Office (ICO) voiced concerns over the growing pervasiveness of LBS and the lack of end user awareness about how much data these systems transmit. According to Jonathan Bamford, Head of strategic liaison at the data protection watchdog, the speed of development in this sector leaves regulators struggling to ensure that the necessary safeguards are in place. "The sheer scale of technological change and the ingenuity with which people are using LBS data feeds means we are always playing catch-up," *www.V3.co.uk*

Garmin offers GTN 750 trainer app for iPad 2

Garmin has announced the release of a new GTN 750 trainer app for the iPad 2. This trainer, downloadable from the iTunes Store, simulates the behavior of the GTN 750 system interface and provides pilots with a safe, on-the-ground environment to learn the basic operation of the system. *www.itunes.com/appstore.*

Qualcomm announces support for GLONASS

Qualcomm Snapdragon S2 and S3 processors will now come equipped with compatibility with both Russian GLONASS and GPS satellites. The ability to connect to both sets of satellites means users will be provided with a better and more accurate location service.

Rs. 3 billion to be spent by Coal India for GPS based tracking system

World"s largest miner Coal India (CIL) plans to install GPS-based movement tracking system to increase output in its major mines. CIL plans to cover all major projects (mines) under the GPS-based movement tracking system at an estimated cost of Rs 300 crore. The project is being implemented by Wipro and Leica Geosystems. "The Coal Ministry is keen on Operator Independent Truck dispatch Systems. It will be expanded to 10-11 other major mines following a review of the same. Meanwhile, CIL requires Rs 1,000 crore to cover all mines under the GPS system," the official said. *http://news.in.msn.com*

O2 launches location-based Mobile Marketing Service in Ireland

O2 has become the first operator in Ireland to offer large-scale location-based mobile marketing services, enabling brands to deliver relevant promotional text and picture messages to consumers in a more targeted, engaging and effective way than ever before. *www.wirelessdevnet.com*

NexTraq expands functionality in its fleet tracking platform

NexTraq have expanded functionality within the NexTraq™ Fleet Tracking platform. It has added Driver ID and asset tracking functionality to its solution as well as fuel card integration based directly on customer feedback. *www.nextraq.com*

LBS market to grow by 16 pc

The LBS market is set to grow by 15 percent by 2016, but it must adopt new business models, move up the value chain, and forget about Western Europe to achieve this, according to ABI Research's new study, LBS Platforms. While GPS penetration grows rapidly outside of North America, it has still to reach the levels where carriers feel there will be a strong return on investment (ROI). *www. abiresearch.com*

LBS revenues to reach 435 million EUR by 2016

According to Berg Insight report, mobile LBS revenues in Europe will grow from 205 million EUR in 2010 at a CAGR of 13.4% to reach 435 million EUR in 2016. It estimates that 20% of all mobile subscribers on the Old Continent already use some kind of location-enhanced application on a regular basis like local search, social networking and navigation services. *www.intomobile.com*

GPS-enabled cars to drive real-time traffic information industry

By 2016, revenue for the real-time traffic information providers industry will increase at an average annualized rate of 38.9% to USD 1.6 billion. According to IBISWorld report, while the industry is forecast to continue growing at a phenomenal rate, revenue growth is expected to decelerate compared with the last five years. *www. sfgate.com*

PDS computerisation and GPS for mobile tax vans in Uttarakhand

Uttarakhand Cabinet in India has decided to computerize Public Distribution System (PDS) by introducing pension scheme for construction workers and equipped GPS with mobile tax vans. A budget of Rs 20 crore was sanctioned to computerize the department as well as the Fair Price Shops to bring transparency and improve efficiency in the department and to stem pilferage of food grains meant for the common man. *http://news.webindia123.com*

GPS to help curb corruption in Indian PDS

In India, the Madhya Pradesh state government decided to install GPS instruments on vehicles transporting food grains, sugar and kerosene under the public distribution system (PDS). The decision was taken by the state cabinet as a measure to check pilferage of food grains and other items being supplied through the PDS. *www.timesofindia.com*

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China, UK build geospatial research center

The Sino-British Geospatial Information Research Centre, jointly built by the China Academy of Surveying and Mapping and U.K. University of Nottingham, opened in Beijing on Dec. 13. This research centre will develop geospatial information research to solve the key scientific issues of the two countries. It will utilize China and Britain's advantages to promote services such as navigation and global positioning, photogrammetry and remote sensing, cartography and geographic information systems as well as geospatial information technologies.

Venezuela, Brazil to share geospatial tech expertise

Venezuelan President Hugo Chavez and his Brazilian counterpart Dilma Rousseff, signed 11 agreements to strengthen strategic partnership in various fields such as housing, banking, aviation, energy and oil, electricity, science and technology, and agriculture. A MoU between both the countries aims to facilitate exchange of expertise and training activities in the field of geomatics engineering, geoscience and space science. *www.correodelorinoco.gob.ve*

GIS-based census in Pakistan

The Census Commission in Pakistan geared up the process of carving fresh census blocks — which is likely to affect delimitation — on a district basis in Karachi using GPS and GIS technologies. Explaining the use of GPS and GIS technologies in the field, the census commissioner said that by the GPS, a machine would identify the latitude and longitude of a location and GIS would help prepare charts and graphs on the basis of GPS markings. *www.dawn.com*

Underwater mapping in Sri Lanka

Sri Lanka's marine researchers are considering using aerial and underwater unmanned vehicles with remote sensing technology to study the oceans around the country, according to Sri Lanka's National Aquatic Research Agency (NARA). The NARA wants to team up with the island's Air Force to use unmanned aerial vehicles (UAVs) for marine search. *www.lankabusinessonline.com*

GIS to ensure health services for HIV patients

Kimberly Brouwer, Ph.D., associate professor of medicine in the Division of Global Public Health at UC San Diego, and her team, are developing a GIS model to measure HIV/AIDS clustering and recommend better distribution of health services. With GIS model, she aims to explore social and environmental factors affecting disease transmission and risk behaviours. *www.lajollalight.com*

ICIMOD releases status report of snow cover in HKH region

International Centre for Integrated Mountain Development (ICIMOD) released the report, 'Climate change in the Hindu Kush-Himalayas: The state of current knowledge', during the United Nations climate summit in Durban, South Africa. The report is based-on a new survey of the Hindu Kush Himalayas (HKH) using satellite imagery. It established the extent of the glaciated area of the of the region and helps fill a crucial knowledge gap in the region, referred to as a 'white spot' in data in the Intergovernmental Panel on Climate Change (IPCC)'s 2007 report. *www.scidev.net*

Autodesk acquires BIM solutions provider

Autodesk has recently acquired Horizontal Systems, a provider of cloud-based building information modelling (BIM) collaboration solutions for the architecture, engineering and construction (AEC) industry. By providing diverse, distributed teams with more secure, easy-to-use and fast-to-deploy solutions, Autodesk 360 for BIM makes project data available across the project lifecycle, wherever and whenever it is needed. *Autodesk*

Google Maps accused of US national security breach

Flight Global, an aviation website, claimed that Google is compromising with US national security. According to the website, Google Maps allows aerial shots of secret military bases to be viewed by the general public in the name of better mapping technology. *www.timesofindia.com*

Indian Army blinded by controversial equipment

The Indian Army's imagery interpretation capabilities, critical to providing information on the locations of enemy troops and their military assets, have been compromised by flawed contracts placed with a company that has failed to provide critical software upgrades, an investigation by The Hindu has found.

Documents obtained by The Hindu from the Ministry of Defence show that the firm responsible for supplying and integrating software used in critical image intelligence analysis was relieved of its responsibility to provide free upgrades in 2008 — and is now on the verge of receiving a Rs.165-crore contract for the supply of software it may no longer have licensing rights for. *www.thehindu.com*

Maharashtra moving towards g-governance

Prithviraj Chavan, Chief Minister of Maharashtra, India, launched Geoportal of Maharashtra Remote Sensing and Application Centre (MRSAC). He said, "We are moving from e-governance to g-governance using data generated by scientific institutes like MRSAC. But sadly enough we have silly policies which do not allow high resolution maps and data generated by our own agencies to our own government departments and people in the name of security and defence. If someone was to use such data there are other ways to procure them from international agencies or through Google." *www.timesofindia.com*

Bhuvan announces thematic services

Bhuvan, ISRO's geoportal and gateway to Indian earth-observation data products and services, announced that now users can select, browse and query the thematic datasets from its website. Users can also use these thematic datasets and integrate them into their systems as OGC web services. At present, Land Use Land Cover (LULC) 50K : 2005-2006, datasets are available on the website. It can be accessed from the link provided at the Bhuvan home page (*www.bhuvan.nrsc.gov.in*) or accessed directly from *http://bhuvan-noeda.nrsc.gov.in/theme*

Taiwan schedules a series of RS satellite launch

The launch date for FORMOSAT-5, a remote-sensing satellite, is scheduled for 2014, while 12 meteorological satellites under the FORMOSAT-7 programme are scheduled to be launched in 2015 and 2017, according to Taiwan's National Space Organization (NSPO). *www.focustaiwan.tw*

EC proposes common border surveillance system

The European Commission (EC) proposed European Border Surveillance (EUROSUR) to enhance internal coordination between member states in the fight against illegal immigration and also to improve the combat other serious crimes such as trafficking in drugs and human trafficking. Under the proposed surveillance system, exchange of operational data and the use of modern surveillance technology which facilitates real time satellite imagery between national border surveillance authorities, is compulsory. *www.larazon.es*

China to launch satellite for geological mapping

China will launch Ziyuan III, its first-ever high-resolution geological mapping satellite for civil purposes, in January 2012, Xinhua reported. The Ziyuan III's surveying covers the entire area between 84 degrees north latitude and 84 degrees south latitude. The satellite will be used to conduct geological mapping, carry out surveys on land resources, help with natural disaster-reduction and prevention, and lend assistance to farming, water conservation, urban planning and other sectors. *Xinhua*

Satellite images reveal setback for Iranian missile programme

Satellite images have revealed what appears to be a major setback for the Iranian missile programme. A new image obtained by CBS News shows extensive damage from an explosion three weeks ago. *www.cbsnews.com*

China to develop system to count carbon emissions

China will develop its own system for monitoring and accurately calculating the country's greenhouse gas (GHG) emissions, according to Ding Zhongli, Vice President of the Chinese Academy of Sciences (CAS). In addition, China also plans to set up a system to monitor atmospheric CO_2 concentration through remote sensing satellite, aerial and ground monitoring, and atmospheric modelling, he told to a China daily. Zhongli explained that there is no comparable system in place currently and its creation will help the country find out exactly how much GHG it emits, knowledge which is an essential basis for China's carbon emission reduction efforts. *http://news.xinhuanet.com*

Malaysia curbs illegal logging using geospatial tech

Number of illegal logging cases nationwide declined as the Forestry Department extensively used remote sensing and GIS technology to trap illegal loggers, according to Peninsular Malaysia Forestry Department. There were 54 cases last year, and as of this October, only 17 cases were reported, including illegal felling in both forest reserves and government land. *www.nst.com.my*

DigitalGlobe completes enhanced view critical design review

DigitalGlobe has successfully completed the latest infrastructure enhancement critical design review (CDR) for the National Geospatial-Intelligence Agency (NGA). To date, DigitalGlobe passed every milestone for the EnhancedView programme on schedule. *www.digitalglobe.com*

CNES receives first imagery from Pleiades 1

The new French high-resolution Pleiades 1 earth-observation satellite sent down its first pictures. One of the shots released by the French space agency (CNES) is of central Paris, showing the Louvre and the Place De La Concorde - “naturellement”. The satellite was launched on December 16, 2011. The Pleiades project has been in development for the best part of a decade. It will produce pictures that have a resolution of 50cm after processing. The satellite will give Europe a high performance capability to rival that of the US. *www.bbc.co.uk*

Galileo update

Galileo transmits first navigation signal

Europe's Galileo system has passed its latest milestone, transmitting its very first test navigation signal back to Earth. According European Space Agency (ESA), the different Galileo signals are being activated and tested one by one. Soon after the payload power amplifiers were switched on and 'outgassed'– warmed up to release vapours that might otherwise interfere with operations – the first test signal was captured at Redu. The test signal was transmitted in the 'E1' band, which will be used for Galileo's Open Service once the system begins initial operations in 2014. The Open Service will be freely available to users all over the world. This signal is particularly important because it shares the 'L1' band of the US GPS navigation satellites. *ESA*

GFZ German Research Centre receives the Galileo signals

On 10 December, seven weeks after the start of the first two Galileo navigation satellites, scientists at the GFZ German Research Centre for Geosciences received the first signals from one of the two satellites (GSAT101). Four days later, the signals could be successfully recorded on a second frequency with a worldwide network of 18 ground stations of ESA. By analysing these first observational data, the GFZ scientists were able to determine the orbit of the satellites, which are flying at an altitude of 23222 km, for the first time to a few decimetres. Besides the calculations of the highly accurate atomic clocks on board, this is a significant factor for the overall performance of the system and the satellites. The independent examination of the satellite orbit parameters undertaken at the GFZ is used for the precise determination of the orbit. This is ultimately of great importance to the end user, e.g. motorists, since the orbit is the basis for the highly accurate location determination on the ground. Additionally, the possible linkage with the U.S. GPS would improve this positioning, because more satellites are available – an advantage for example in densely developed cities. *www.eurekalert.org*

GMV follows tracks in Space of Galileo IOV satellite

GMV has announced the tracking of both data and pilot channels of Galileo first satellite signal with its own line of GNSS receiver products. It has developed its own GNSS software receiver products: SRX-10 on GPS, which has been optimized for the urban environment, NUSAR for GPS L1 and Galileo E1 and its own L1 front end. This experience has been applied, even previously to the development of the receivers, to many studies on receiver performances under very diverse signal conditions and designs, namely by processing the GIOVE satellites signal. *www.satnews.com*

EC has proposed a new framework for Galileo financing

The European Commission proposes to earmark 7.0 billion euros to guarantee the completion of the EU satellite navigation infrastructure and to ensure the exploitation of the systems until 2020, such as the operations of the space and terrestrial infrastructures, the necessary replenishment/replacement activities, certification procedures, and notably the provision of services. The proposal also recalls that the Union remains the owner of the systems. *www.satnews.com*

SNIPPETS

At a Glance

- GeoEye-2 service to be available in 2013
- China to launch five foreign satellites in 2012
- Thales Avionics tracks L1 signal of first Galileo satellite
- NavtechGPS takes on Raven GPS related product distribution
- US Army builds intel capabilities in cloud
- Esri prepares spatial plan for Marine Park in Cook Islands
- Geographical Indications agreement between EU and Switzerland comes into force
- University of Sharjah Select SuperGIS Desktop
- Optech wins MAPPS 2011 Technology Innovation award
- 3D Laser Mapping expands to Australia
- Bentley receives Construction Computing Awards
- Thales Avionics Tracks L1 Signal of First Galileo Satellite
- Kochi , India to have automated transport system based on GPS
- Haryana state transport, India to have tracking device in its buses
- NAVTEQ map coverage now available on Esri ArcGIS
- Fast INSPIRE compliant service for the Netherlands
- DigitalGlobe's imagery available for broadcasters
- u-blox achieves sub-meter GPS accuracy with PPP
- China launches Yaogan XIII RS satellite

CHC introduces new X900 Series GNSS receiver

CHC has announced the availability of X900 GNSS receiver bringing extremely affordable and reliable GPS+GLONASS real-time centimeter level solution to surveyors without the conventional cost associated with GNSS solutions. The X900 GNSS combines field proven 72 channels GPS+GLONASS technology and state-of-the-art RTK solution for either traditional base + rover configuration and RTK networks thanks to its flexible GPRS and UHF communication systems. The X900 is available in various bundled packages to fit end users need with choice of various data collection software and handheld controllers.

Spirent launches data sets of world city environments

Spirent Communications has launched data set subscription service for its GSS6400 GNSS Record and Playback test System. The data sets comprise of live GNSS (GPS, GLONASS and QZSS) environmental capture data set samples, recorded at major locations worldwide, in challenging urban and suburban conditions. The data sets encompass a variety of recorded scenario's ranging from drive through multi-level roads, tunnels & car parks to drive through in downtown areas with high rise buildings. The real world effects such as atmospheric, environmental (multipath, interference, terrain obscuration) are all captured making use of data sets ideal for debugging issues, performance tuning and optimization of GNSS receivers. *www.spirent.com*

Trimble expands construction solutions

Trimble has agreed to acquire the StruCad and StruEngineer business from AceCad Software to expand its construction solutions. The StruCad and StruEngineering business will be reported as part of the Trimble's Engineering and Construction segment. The addition of the software products is expected to extend Tekla's industry leading Building Information Modeling (BIM) solutions for structural steel contractors to automate project estimating and management, modelling and detailing. *www.trimble.com*

Leica Builder measures with SEMA Timber Construction Software

SEMA has announced a survey module for the Leica Builder Series. Since its market introduction more than six years ago, the Leica Builder has been the perfect tool used by many construction professionals. It is an easy-to-use, self-explanatory and powerful instrument with a clearly structured model range meeting all requirements on a construction site - from simple tasks to daily use with special requirements. *www.leica-geosystems.com/builder*

New FARO Edge integrated in PolyWorks V12

FARO and Duwe-3d AG have announced the results of the integration tests of the FARO Edge measuring arm and the PolyWorks V12 software. On 30th September 2011, Duwe-3d AG made tests extensively examining the connection between the new FARO Edge measuring arm and the new version 12 of the PolyWorks software. The latter is the standardised solution for visual and tactile coordinate measuring technology and for the processing and evaluation of 3D data in industrial applications. The result of the test series confirmed the excellent integration. Thus, the PolyWorks software supports measuring and scanning.

Telit Wireless to acquire Navman Wireless OEM Solutions

Telit Wireless Solutions shall purchase Navman Wireless OEM Solutions, designer and manufacturer of GPS modules and solutions, for $3 million in cash.

Northrop Grumman awarded contract to support LN-251 Navigation Systems

Northrop Grumman Corporation has been awarded a follow-on contract by the U.S. Navy to provide integration and laboratory test support for the LN-251 embedded GPS/fiber-optic inertial navigation system (INS) on the new CH-53K Super Stallion helicopter. *Northrop Grumman Corp.*

Bergman Photographic upgrades to UltraCamXp

Bergman Photographic Services has contracted with Microsoft's UltraCam business unit and subsidiary, Vexcel Imaging GmbH, to upgrade its UltraCamLp digital aerial photogrammetric camera to an UltraCamXp system. *www.microsoft.com*

Rohde & Schwarz and u-blox validate GLONASS compatibility

u-blox and Rohde & Schwarz (R&S) have successfully concluded a simulation of the GLONASS satellite navigation system. The test, carried out with the R&S®SMBV100A vector signal generator and its GNSS simulation options, verified the u blox proof-of-concept and the compatibility of u-blox receiver technology with the GLONASS transmission protocol.

Esri Adds Community Analyst to Educational Site License Program

Students in colleges, universities, and K–12 schools throughout the United States now have access to Esri Community Analyst through the Esri educational site license program at no additional cost. Community Analyst includes demographic, health, economic, education, and business data variables for the entire United States, allowing students to study individual neighborhoods within their own communities or compare their communities to benchmarks such as national averages.

SatLab Geosolutions established in Czech Republic

SatLab Geosolutions have now established a regional office in Czech Republic. It will be able to give better delivery times and better after sales support in Eastern European Countries. Having headquarters in Sweden and regional office in Turkey, SatLab has been expanding its operational structure in order to make sure about giving its distribution the best possible support available.

Gatewing introduces Stretchout – UAV desktop processing solution

Gatewing®, manufacturer of the revolutionary X100 unmanned aerial system (UAS) for mapping and surveying, introduces Gatewing Stretchout™, a breakthrough image processing solution which automatically converts your X100 image data to accurate orthophotos and DSMs. "Stretchout™ begins the process by geotagging the images and then processes them using automatic aerial triangulation followed by a bundle block adjustment which calculates camera interior orientation as well as position and attitude of each camera station. One can easily integrate these products into the workflow, be it GIS, CAD or other mapping, design or visualization systems.

Blue Marble to develop Sea Level Rise Modeling Tool

Blue Marble Geographics has been selected by the New England Environmental Finance Center (NEEFC) from the Edmund Muskie School of Policy Research at the University of Southern Maine, USA to develop the software interface for a coastal climatic disruption modeling tool entitled COAST. The tool will be used to create a GIS model of cost avoidance strategies to protect against asset damage from sea level rise due to storm surge and coastal flooding.

DAT/EM Systems International donates to the University of Alaska

DAT/EM Systems International donated 16 licenses of their SUMMIT EVOLUTION Professional digital stereoplotter to the Geomatics Department in the University of Alaska Anchorage (UAA) School of Engineering, USA. Valued at over $300,000, this gift forms part of DAT/EM's on-going initiative to sponsor higher education through software, software support, student training and consultation to the faculty.

January 2012

ION International Technical Meeting
30 Jan-1 Feb
California, United States (USA)
http://ion.org/meetings

February 2012

RIEGL LiDAR 2012 International Airborne and Mobile User Conference
28 Feb-1 March
Orlando, USA
www.riegl.com

Mobile World Congress 2012
27 Feb-1 March
Barcelona, Spain
www.mobileworldcongress.com

March 2012

Munich Satellite Navigation Summit 2012
13-15 March
Munich, Germany
www.munich-satellite-navigation-summit.org

ASPRS Annual Conference
19-23 March
Sacramento, California, USA
www.asprs.org

April 2012

Europeon Navigation Conference 2012
23-25 April
Gdansk, Poland
www.enc2012.org

2012 European Frequency and Time Forum
23-26 April
Gothenburg, Sweden
www.eftf2012.org

Geo Siberia
25-27 April
Novosibirsk, Russia
www.biztradeshows.com

The Seventh National GIS Symposium in Saudi Arabia
29 April – 1 May
Eastern Province – Dammam, Saudi Arabia
www.saudigis.org

May 2012

FIG Working Week 2012
6-10 May
Rome, Italy
www.fig.net

2nd International conference and exhibition on mapping and spatial information (ICMSI2012)
8-10 May
Tehran, Iran
http://conf.ncc.org.ir

Global Geospatial Joint Conference 2012
14-17 May
Quebee City, Canada
www.gsdi.org/gsdiconf/gsdi13

Geospatial Intelligence Middle East
15 - 18, May
Abu Dhabi, United Arab Emirates
www.geospatialdefence.com

6th GNSS Vulnerabilities and Solutions Conference
21-24 May
Baska, Croatia
www.rin.org.uk

MundoGEO#Connect 2012
29-31 May Sao Paulo, Brazil
http://mundogeoconnect.com/2012/en/

The 3rd China Satellite Navigation Conference
May 2012
Goangzhou, China
www.beidou.org

June 2012

Hexagon
4-7 June
Las Vegas, USA
www.hexagonconference.com

20th International Conference on GeoInformatics
15-17 June
Hong Kong
http://old.nabble.com

July 2012

ESRI International User Conference 2012
23-27 July
San Diego, USA
www.esri.com

August 2012

The XXII Congress of the ISPRS
25 August-1 September
Melbourne, Australia
www.isprs.org

September 2012

ION GNSS 2012
September 17-21, 2012 (Tutorials & CGSIC: September 17-18)
Nashville Convention Centre, Nashville, Tennessee, USA
www.ion.org

October 2012

INTERGEO 2012
9-11 October
Hanover, Germany
www.intergeo.de/en

November 2012

2012 International Conference on Indoor Positioning and Indoor Navigation (IPIN)
13-15 November
Sydney, Australia
www.surveying.unsw.edu.au/ipin2012


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