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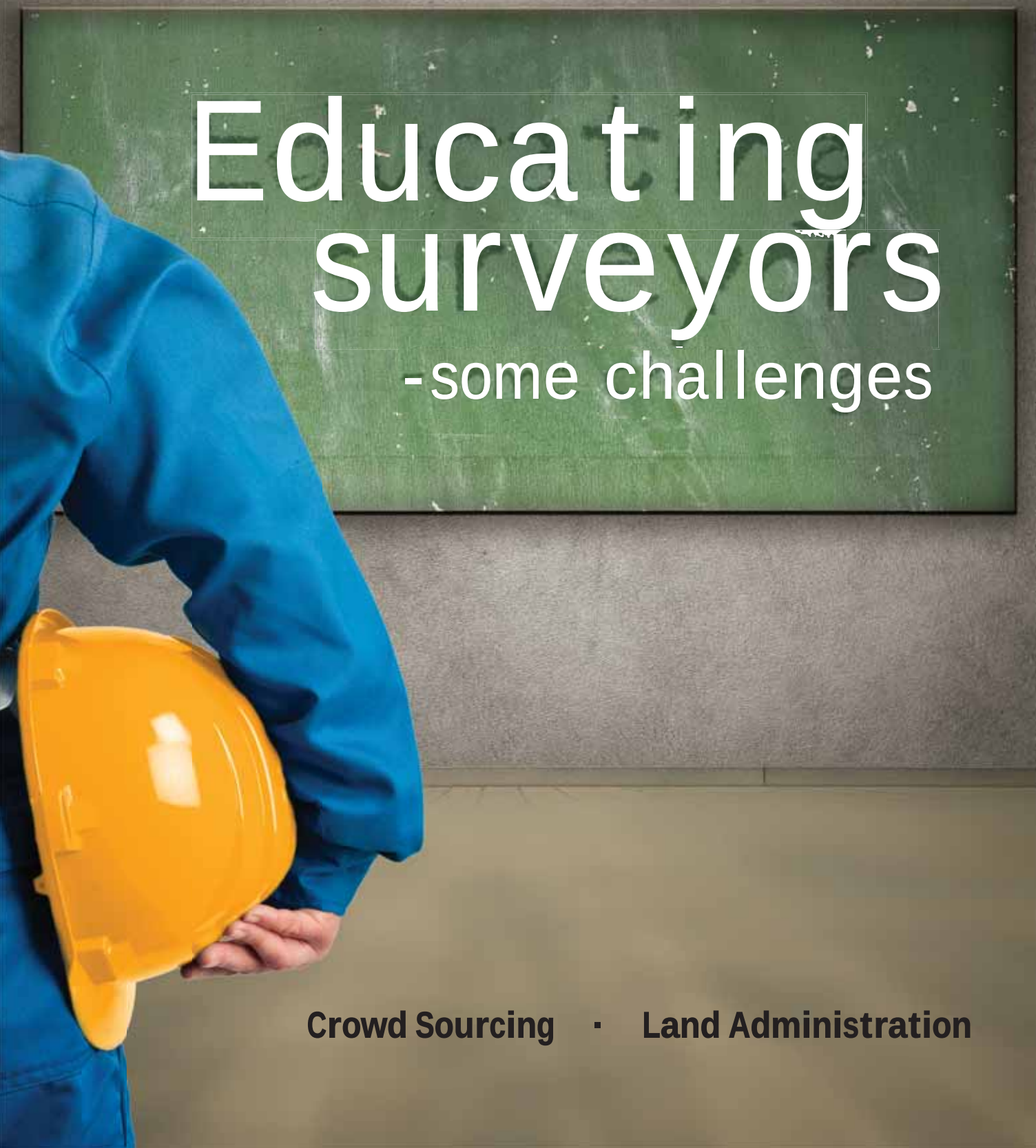

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## Articles



## Columns



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**Bal Krishna, Editor**
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# Playing in the OEM world means strong and efficient technical support!

An interview with Olivier Casabianca, Portfolio Manager, Integrated Technologies at Ashtech, a Trimble Company about ABX series GNSS sensors and newly launched OEM Boards

## How do you ensure the quality of your products that makes them reliable?

Ashtech has been designing advanced devices for more than 25 years with numerous patents in GNSS technology. For OEMs, quality and reliability is key and is the number one selection criteria from our customers. Everybody in the company is working to maintain high quality products… and even to improve!

## What are the key differentiating features of the Z-blade technology?

Z-Blade has been designed to escape from GPS reliance. Indeed, most of the GNSS (RTK) engines have been designed under the GPS-only era. They have been adapted later on in order to absorb other constellations, but always with GPS as a prerequisite, i.e., 'no GPS, no position'!

Thus in difficult environments, a GNSS receiver may not provide a (RTK) solution just because it does not track enough GPS satellites even if GLONASS is there.

Z-Blade allows receivers to use equally any satellite available. You do not need 4 GPS satellites to maintain a RTK fixed position. You just need 4 satellites which can be 2 GPS + 2 GLONASS.

This is what we call a GNSS-centric engine, in opposition to a GPS-centric one. This approach allows us to provide any kind of constellation-only position, i.e., GLONASS- only solution, from standalone to RTK, which is available from our OEM receivers. Tomorrow, it could be GALILEO only, COMPASS only or full GNSS.

## The ABX100 is pegged as a 'smart, simple and rugged sensor'. What more goes into the making of this device?

ABX Series are state-of-the-art GNSS sensors intended for general-purpose, real-time, high-accuracy, absolute positioning applications with additionally accurate heading measurements and relative positioning for some of the available models.

All receivers from the ABX series share the same weatherproof, lightweight, small size and rugged enclosure capable of accommodating either one GNSS MB100 board (ABX100), one GNSS MB800 board (ABX800) or two GNSS MB800 boards (ABX802).

Designed for seamless integration, the ABX Series allows OEM and system integrators to rapidly integrate centimeter-level positioning into their application. Each receiver from the ABX Series is fitted with a built-in power supply extending the input voltage range to between 9 and 36 V DC while maintaining a low power consumption regardless of the power input voltage.

Built in a weatherproof, rugged and small-size unit, the ABX receivers can be operated in harsh environments while requiring a minimum of space for their installation. As lightweight high-end units, all ABX receivers are also compatible with airborne applications for which weight considerations are critical.

Additionally, industry standard and independent I/O connectors simplify cabling for system integrators. Smart mounting bracket design allows seamless integration on board a machine or a vehicle for land, air or sea operations. Being a 'plug and play' system, it is ideally suited for mobile positioning and navigation onboard-solutions for which precision and flexibility are equally important.

The latest state-of-the art XDL Micro UHF Transceiver (TRx) from Pacific Crest are also available with ABX800 and ABX802 models.


**ABX802:** Rugged, Compact & High-End GNSS Sensors

## How does the HDS800 compete with other competitive positioning devices in the field of bathymetry and other marine applications?

HDS800 is the most advanced GNSS System ever produced by Ashtech. This is a unique high-end RTK+Heading+Pitch/Roll System which is highly rugged and flexible. HDS800 provide Hot-Standby RTK feature which automatically selects the best available position when receiving two sets of corrections. It also provides dependable Heading + Pitch/Roll measurements with baseline auto-calibration. The configuration is a snap using the embedded web server!

The innovative design integrates all the communication components (GSM/GPRS and/or UHF radios) offering an all-in-one robust solution to the user. The weatherproof, high-impact resistant molded aluminum housing, the floating power input, the earth terminal and the optical isolation from internal circuitry of all available signals, ensures your investment is safe in all conditions. In addition to the unique set of built-in communication features, the HDS800 features internal and removable battery which acts as an Uninterruptible Power Supply (UPS) for a power source outage and internal memory expandable through USB key.

The HDS800 boosts levels of performance ahead of the most sophisticated equipment available today. Thanks to this unique design, it can also be easily carried from site to site, vessel to vessel.

## Please highlight the application segments of your products?

Ashtech OEM products are intended to help OEM, VAR and Integrators to quickly and easily integrate high-end GNSS positioning and/or heading/attitude determination into their own application. We do not address specifics vertical markets, our customers do!

**HDS800:** Flexible, Rugged, High-Performance GNSS RTK+HeaDing System


Our technology is flexible enough to be used in many applications such as Survey (land and Marine), Offshore, Machine guidance and control, Precision Agriculture, UAV/drones, Avionics.

## How do you ensure efficient customer support system?

Playing in the OEM world means strong and efficient technical support. OEM integration means long-term relationship, trust and support. Our customers rely on us to provide support during the integration process and during the whole life product cycle which is more important to OEMs. We have Field Application Engineers in US, Europe and Asia covering WW support to our customers and helping them in each stage of their development.

## What are the various operations that the MB100 supports?

The MB100 OEM board is extremely important in the Ashtech OEM Portfolio since it is intended to replace the legendary DG14. However, the MB100 is offering much more! This is a L1 GPS, L1 GPS+GLONASS, L1/L2 GPS board (SBAS, of course) covering the whole range of positioning, from standalone (meter accuracy) to RTK (centimeter accuracy). The MB100 features two antenna input connectors, with automatic switching between the two antennas for specific applications such as handheld and tablet PC integration.

Finally, the MB100 can also use these 2 antennas connector simultaneously to be the ideal low-cost GNSS compass solution, providing dependable Heading + Pitch/Roll determination in addition to SBAS or DGPS or even L1 (Flying) RTK position.

## How do you see the growth of positioning and navigation technologies in future in general and products and solutions offered by Ashtech in particular?

The trend is clearly towards the convergence/integration with additional sensors (IMU) to increase (always) availability. Communications is also extremely important. In terms of vertical markets, the UAV/drone is showing high potential.

Being part of Trimble Integrated Technology division – which is also doing Trimble OEM – boosts us to focus on our strengths and differentiators which are Heading / Attitude Solutions for specific niche markets, GLONASS and GNSS (RTK) expertize and Avionics – Ashtech OEM has FAA-certifiable boards for Flight Management System integration for long time now.


**MB100:** Compact, Low-Power, GPS/GLONASS, RTK OEM Receiver Module

# Educating surveyors: Some of the challenges

Maintaining a strong financial foundation, raising the academic entry levels, building research capability, maintaining an appropriate curriculum,...

**John Hannah**
Emeritus Professor
University of Otago,
Dunedin, New Zealand

Over my nineteen years of employment in the School of Surveying at the University of Otago, I have had the opportunity of participating in three (formal) school curriculum reviews and three departmental reviews. I have watched the university change from its relatively quiet, conservative academic roots, to a more business-focused organisation and thence into an academic/research intensive organization, focussed on maintaining its status as New Zealand's top ranked university as measured by research quality.

During these same years, the surveying profession in New Zealand has also undergone substantial change. In 2001, the New Zealand Institute of Surveyors (NZIS) lost its statutory protection and become a voluntary organization able to make and police its own rules. New criteria for professional entry into the NZIS were developed, a new Cadastral Surveyors Licensing Board (with new professional examination criteria) replaced the old Survey Board of New Zealand, and a system introduced whereby members of the NZIS are required to demonstrate ongoing professional competency. Through all of these changes, there have been some fundamental challenges that seem to me to be an ongoing part of academic life in any professional school. They are challenges that seem to confront many university surveying programs in the world. These and the solutions that we have adopted are the subject of this article.

## Establishing financial foundations

Maintaining a strong financial foundation is essential. By far the largest part of the School's funding (over 90%) is driven by the number of its Equivalent Full Time Students (EFTS). The School is a stand-alone entity within the Division of Sciences which itself is one of four academic divisions within the university. Although the base funding is not in a strict linear relationship to EFTS (the Division of Sciences "smooths" funding on a year-to-year basis), typically the more EFTS enrolled in papers taught within the School, the larger the base budget. In this type of funding regime, and because of the efficiencies able to be achieved, large undergraduate student classes provide the base cash flow upon which to build a financially successful department. This is one of the reasons why the School has chosen to make it a priority to attract high school students into its first year papers. The marketing momentum built up over a substantial number of years has been such that the School now typically attracts 100 or more students into these papers. This group of students then forms the competitive pool from which 60 are selected for entry into the second year of the degree. Over the last decade or more, the School has usually had 100 or more students in the first year of their surveying degree and 60 in each of the three subsequent years. Within the broader constraints due to the government-imposed changes on tertiary institutions, this has resulted in a very stable funding environment.

## Raising the academic entry levels

The second challenge has been one of progressively moving the overall academic quality of the School's undergraduate students to higher levels. As implied above, once students have completed their first

year at university during which time they are required to successfully complete four specified papers (one of which is Introductory Surveying), plus three elective papers, they then apply for admission into the surveying degree program. Numbers at 100- level are unrestricted. Thus, the greater the number of 100-level students, the greater the competition for the 60 places available in the second year of the BSurv degree program. Over the last decade, the highest number of applicants for admission to the BSurv degree in any one year has been in excess of 120. That particular year, the average grade required for entry into the second year of the BSurv degree was between a B and B+, a level comparable to Otago's very competitive LLB program. In order to achieve competitive entry, the School has worked consistently and diligently on marketing a career in surveying to high schools throughout New Zealand. In this regard, it has been greatly assisted both by Otago University's high school's liaison officers and by the NZIS. One of my primary goals as Head of Department (HoD) was to ensure, firstly, that the School had excellent relationships with the liaison officers; secondly, that at least two pieces of new marketing information crossed the desk of every high schools career advisor each year and thirdly, that I would visit at least 5 –10 high schools each year, typically to take a senior mathematics class. The results speak for themselves – we know of no other surveying degree program in Australasia, the UK or North America that has the level of competitive entry found at Otago.

The School also offers a three-year BSc degree majoring in Land Planning and Development, as well as a four-year BAppSc degree in GIS. These degrees have no entry restrictions. A significant number of students not admitted to the four-year BSurv degree will move across to these degrees and either reapply for the BSurv degree a year later or move down a slightly different career path.

## Building research capability

The third challenge has been that of building a high quality research capability whilst still maintaining a strong professional emphasis to the academic program. This challenge manifests itself in two different ways. In the first instance, it results in tension for staff members in the allocation of their time and in the second instance in the recruitment of staff.

The time allocation issue arises from the university's expectation of high quality research outputs from all academic staff. In the School's case, this is more heavily emphasised by virtue of the fact that the Division of Sciences is by far the most research intensive of the four academic divisions within the university, attracting the greatest number of research grants and generating the most high quality academic publications/staff member. Research expectations are high. Those periods of time outside the teaching semester when there is little or no student contact are prized. However, in order to meet professional expectations, Otago's BSurv degree program has a three-week field camp prior to the beginning of the 2nd year, a one-week camp at the end of the 2nd year and a three-four

week camp at the end of the 3rd year. Thus at a time when most other university staff are focused on their research, the surveying staff traditionally had to run field camps. The School has substantially overcome this problem by employing a small number of full-time Professional Practise Fellows for whom there is no research expectation. Over the last decade, it has been these, plus the School's technical staff which put in the hard work required to organise and successfully run the field camps.

The issue of staff recruitment relates largely to expectations from both the students and the profession. The ideal staff member in the School of Surveying at Otago will have a PhD degree, a capacity to develop and sustain a strong research program, good (real world) professional surveying experience and the ability to teach undergraduate and postgraduate students fluently and well. Such personnel are not easy to find! In order to help overcome this problem, the School has had some success in recruiting staff with Masters degree and then, as an expectation of employment, provided the necessary support for them to complete their PhD degrees. Having said this, the reality remains that professional schools have additional staff recruitment criteria that are not normally found in a pure academic department. The drive to have faculty who produce leading edge research to the detriment of almost every other criteria, seems to me as damaging and short-sighted, certainly from a professional point of view. I can think of instances (not in my own department, fortunately) where a staff member's research has been absolutely outstanding but where their ability to teach students has been dismal by any and every measure. In my view, this is unacceptable. It is here that strong representations from the surveying profession can make a difference. Otago has always taken the view that its flagship BSurv degree and the well-being of the School itself, are really a partnership between the university and the surveying profession.

Having recruited the appropriate staff and substantially resolved the time allocation issues, the subsequent challenge becomes one of attracting research capable postgraduate students. High quality research students are the lifeblood of university research programs. In the School's experience, the development of good postgraduate research program is a function of attracting high quality academic staff, helping them to develop an international research profile, good funding, marketing and easy to follow admission procedures. In many regards, the funding issue is perhaps the most crucial and it is here that a great deal of energy has been focused. In recent years, Otago University has introduced a large number of fully funded scholarships for students studying towards research based Masters or PhD degrees. The School has had considerable success in seeing its students win these scholarships. This has been a significant element in building research momentum. This momentum is a crucial early step in enabling staff to build their research profiles and thus attract their own research grants.

## Maintaining an appropriate curriculum

In order to ensure that the curriculum remains up-to-date, the School undertakes periodic (formal) curriculum reviews. This has been done in conjunction with the surveying profession. In addition, it has a Board of Studies that meets at least annually and is comprised of both university staff and members of the profession. The Board will periodically review aspects of the course. Within these overarching processes, the school staff has the freedom to make informal curriculum adjustments on a semester-to-semester or year-to-year basis.

A second curriculum issue relates to the breadth of Otago's BSurv curriculum. The professional surveyor in New Zealand is a specialist in measurement science, land development (including subdivisional planning and engineering design) and cadastral studies. He/she will also require a good working knowledge of GIS systems and technology. Over time, various questionnaires have revealed clearly that there continues to be a strong demand for the high-quality 'general practice' type graduate Otago typically produces. In many ways, and from a global perspective, this is one of the distinctive features of an Otago graduate.

This breadth of curriculum presents real challenges when it comes to designing course papers and fitting them into the standardised paper/degree system used at the University of Otago. Most papers are now expected to entail180 hours of total learning and be delivered in one semester. Because surveying students are funded by government for a four-year, full-time academic program, the length of the degree course is constrained. The School constantly looks for ways of engaging its students in practical, thought provoking learning exercises that link across papers and curriculum modules.

## Concluding thoughts

In seeking to overcome the above challenges and create a thriving academic and professional program that is of a high standard of excellence, the School has sought to be cognizant of the thoughts of Hilborn and Howes (2004) ("Why many undergraduate physics programs are good but few are great", Physics Today, Sept. 2004). In their analysis of what makes the difference between a good undergraduate physics program in the United States, versus a great program (of which they found very few), they noted three primary characteristics. Firstly, a great program is challenging, supportive and encouraging and includes well-developed advising and mentoring systems, an undergraduate research program, plenty of informal staff-student interaction and a strong sense of community. Secondly, there is a widespread sense amongst the staff that it is their collective responsibility to maintain and improve the program. This brings with it continuous evaluation and experimentation. Such a department initiates reform efforts in areas of change that it sees as being of importance. Finally, such a program has a clear sense of mission and enjoys strong and sustained leadership.

These are all the characteristics that the School of Surveying at Otago University would aspire towards achieving both in the present and in the future.

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# Key demands for sustainable land administration

Spatially enabled, fit for purpose, and supporting the global agenda

**Stig Enemark**
Department of Development and Planning
Aalborg University, Denmark, Honorary President,
International Federation of Surveyors, FIG

Imagine a country without any basic administration of land – their key asset. Imagine that tenure to land and property cannot be secured, and that mortgage loans cannot be established as a basis for property improvement. Imagine that the use and development of land is not controlled through overall planning policies and regulations.

Land administration systems (LAS) are about addressing these problems by providing a basic infrastructure for implementing land related policies to ensure social equity, economic growth and environmental protection. Until 2008, the developed world often took land administration for granted. But the global economic collapse has sharply focused on mortgage policies and on the need for adequate and timely information. Simply, information about land from effective LAS plays a critical role in all economies.

The recent book "Land Administration for Sustainable Development" (Williamson, Enemark, Wallace, Rajabifard, 2010) explores the capacity of the systems that administer the way people relate to land. An LAS provides a country with the infrastructure to implement land policies and land management strategies. An overall theme in the book is about developing land administration capacity to manage change. For many countries, meeting the challenges of poverty alleviation, economic development, environmental sustainability, and management of rapidly growing cities, are immediate concerns. For more developed countries, immediate concerns involve updating and integrating agencies in relatively successful LAS, and putting land information to work for emergency management, environmental protection, economic decision making, etc.

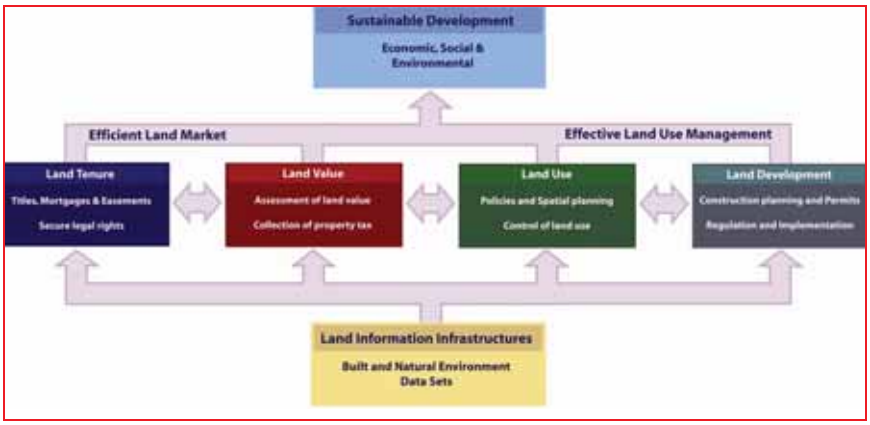


**Figure 1: A global land administration perspective (Williamson, Enemark, Wallace, Rajabifard, 2010).**

## Land administration systems

A land administration system (LAS) provides a country with the infrastructure to implement land-related policies and management strategies. It is not a new discipline but has evolved out of the cadastre and land registration areas with specific focus on security of land rights. The need to address land management issues systematically pushes the design of LAS towards an enabling infrastructure for implementing land policies. Such a global land administration perspective is presented in figure 1.

The four land administration functions are different in their professional focus. Even if land administration is traditionally centred on cadastral activities, modern LAS deliver an essential infrastructure and encourage integration of the processes related to *land tenure* (securing and transferring land rights); *land value* (valuation and taxation of land); *land use* (planning and control

| | |
|---|---|
| LAS | LAS provides the infrastructure for implementation of land polices and landmanagement strategies in support of sustainable development. |
| Land management paradigm | The land management paradigm provides a conceptual framework for understanding and innovation in land administration systems. |
| People and institutions | LAS is all about engagement of people within the unique social and institutional fabric of each country. |
| Rights, restrictions and responsibilities | LAS are the basis for conceptualising rights, restrictions and responsibilities (RRR) related to policies, places and people. |
| Cadastre | The cadastre is at the core of any LAS providing spatial integrity and unique identification of every land parcel. |
| LAS are dynamic | LAS are dynamic and reflect the people to land relationship over time . |
| Processes | LAS include a set of processes that manage change in relation to land tenures, land values, and land uses |
| Technology | Technology offers opportunities for improved efficiency of LAS and spatial enablement of land issues. |
| Spatial data infrastructure | Efficient and effective land administration systems that support sustainable development require a spatial data infrastructure to operate. |
| Measure for success | Successful LAS are measured by their ability to manage and administer land efficiently, effectively and at low cost. |

**Figure 2: Ten land administration principles (Williamson, Enemark, Wallace, Rajabifard, 2010,)**

of the use of land); and *land development* (implementing utilities, infrastructure and construction planning). The four functions interact to deliver overall policy objectives, and they are facilitated by appropriate land information infrastructures that include cadastral and topographic datasets linking the built and natural environment.

Ultimately, the design of adequate systems of land tenure and value should support efficient land markets capable of supporting trading in simple and complex commodities. The design of adequate systems to deliver land-use control and land development should lead to effective land-use management. The combination of efficient land markets and effective land-use management should support economic, social, and environmental sustainable development.

From this global perspective, LAS act within adopted land policies that define the legal regulatory pattern for dealing with land issues. Benefits that arise through LAS include guarantee of ownership, security of tenure and credit; facilitating efficient land transfers; supporting management of assets; and providing basic information and efficient administrative processes in valuation, land use planning, development and environmental protection.

## Ten land administration principles

Despite the uniqueness of local systems, the range of cognitive frameworks about land, and difficulties in transferring institutions, design of robust and successful LAS is possible. The ten land administration statements in figure 2 set boundaries for designers, builders and managers of LAS to help them design and refine their local system. The statements reflect a holistic approach for any LAS, and focus on sustainable development as the overriding policy for any national system, irrespective of whether a country implements property institutions, communal land arrangements, or socializes its land.

## Three key demands

In more general terms, sustainable land governance must respond to three key demands:

- Government/society should be *spatially enabled*.
  If we can understand more about the nature of "place" where things happen, and the impact on people and assets there, we can plan better, manage risk better, and use our resources better (Communities and Local Government, 2008). Spatially enabled government is achieved when "place" is used as the key means of organising activities, and when location and spatial information are available to citizens and businesses to encourage creativity.
- The spatial framework should be *fit for purpose*.
  The spatial framework is the basic large scale mapping showing the way land is divided into parcels and plots for specific use. The spatial framework underpins all four functions of LAS. However, in many developing countries the cadastral coverage is less than one third of the country. The nationwide spatial framework is merely at a stage of entry and should be designed using a more flexible "fit for purpose" approach to accuracy and identification..
- Land Governance should *support global agenda*.
  The global agenda is threefold and has changed over recent decades. In the 1990s, the focus was on sustainable development; in the 2000s the MDGs appeared as the overarching agenda; and in the 2010s there is increasingly focus on climate change and rapid urbanisation. The land management perspective and the operational component of integrated and spatially enabled land administration systems therefore need high-level political support and recognition.

These three demands are further explored in the sections below.

## Spatially enabled

The term 'spatially enabled society' describes the emerging cultural and governance revolution offered by pervasive spatial IT and spatially equipped citizens. Spatially enabled societies make possible sustainable cities, early warning systems, smarter delivery of housing, improved risk management, and better macroeconomic decision making. Importantly, the concept

is not about managing spatial information - it is about managing information, or governing society, spatially.

The term emerged in the mid 2000s as new spatial technologies began pervading mainstream user groups: in-car navigation systems, GPS enabled mobile devices, and various digital globes (e.g. Google Earth) gained popularity. New distribution concepts such as Google Earth provide user friendly information in an accessible way. We should consider the option where spatial data from such concepts are merged with built and natural environment data. This unleashes the power of both technologies in relation to emergency response, taxation assessment, environmental monitoring and conservation, economic planning and assessment, infrastructure planning, etc.

Creating awareness of the benefits of developing a shared platform for integrated land information management takes time. National Mapping/Cadastral Agencies have a key role to play by coordinating the interests and potential of various stakeholders. Thus, spatial information is an enabling technology to facilitate decision making. This will be achieved by creating an environment so that we can locate, connect and deliver as illustrated in Figure 3.

With this in mind, many countries are developing Spatial Data Infrastructures (SDIs) as a way to facilitate data management and sharing and utilise their spatial data assets as this information is one of the most critical elements underpinning decision making for many disciplines. The unique cadastral capacity is to identify a parcel of land both on the ground and in the system in terms that all stakeholders can relate to.

Advanced economies have continued to exploit the convergence of geospatial and ICT for public administration as well as commercial and private businesses. On the other hand, developing countries, with international aid support, have been more focused on investing in the basic systems for land and property rights and planning, which over time should evolve into more sophisticated systems including SDIs (Bell, 2011).

## Fit for purpose

LAS require a large scale spatial framework to operate. This framework should identify the spatial units such as land parcels as a basis for dealing with the land administration functions. In many developed countries, this countrywide highly accurate spatial framework has been developed over centuries as large scale cadastral mapping and maintained through property boundary surveys. Technology development now provides opportunities of further improving the accuracy of cadastral surveys and thereby providing full consistency between cadastral, topographic, and other land related information.

In contrast, most developing countries have a cadastral coverage of less than 30 per cent of the country.

Conventional LAS are based on the 'parcel approach'. A more flexible system is needed for identifying the various kinds of land tenure in informal settlements. A solution to this problem is suggested by the so called Social Tenure Domain Model (STDM) as initiated by UN-HABITAT, the Global Land Tool Network and developed in cooperation with FIG, ITC and WB (FIG/GLTN, 2010). The STDM is a pro poor land information management system which can be used to support the land systems of the poor in urban and rural areas, but which can also be linked to the formal cadastral system so that all information can be held on one system (Augustinus, 2010).


**Figure 3: Locate, connect and deliver spatial information (Rajabifard, 2010).**

The discussion above underpins the need for a flexible approach to building the spatial framework in terms of technology and investment choices. Building such a spatial framework is more about adequate identification and representation of spatial parcels. The required scale of the framework depends on topography and density of development and may vary from large scale mapping in dense urban areas to minor scale images in rural areas and remote regions. In any case, the framework should be linked to the national grid through a positioning infrastructure based on the Global Navigation Satellite Systems (GNSS) so that maintenance, updating, and upgrading can take place whenever needed.

In short – the spatial framework should be developed using a flexible and *fit-for purpose* approach rather than being guided by costly field survey procedures. When considering the resources and capacities required to build such spatial frameworks in developing countries, the western concepts may well be seen as the end target but not as the point of entry. When assessing the technology and investment choices the focus should be on building a fit-for-purpose framework that will meet the needs of society today and that can be incrementally improved over time.

## Supporting the global agenda

The key challenges of the new millennium are clearly listed already. They relate to climate change; food shortage; urban growth; environmental degradation; and natural disasters. These challenges of are to a large extent caused by the overarching challenge of climate change, while the rapid urbanisation is a general trend in itself. Measures for adaptation to climate change must be integrated into strategies for poverty reduction to ensure sustainable development and for meeting the MDGs (FIG/WB, 2010).

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### Climate change and natural disasters

Adaptation to and mitigation of climate change challenge governments and professionals to incorporate climate change issues into their land policies, land policy instruments and facilitating land tools. Adaptation to climate change can be achieved to a large extent through building sustainable and spatially enabled LAS. The systems should identify all prone areas subject to sea-level rise, drought, flooding, fires, etc., as well as measures and regulations to prevent the impact of predicted climate change.

Key policy issues to be addressed should relate to protecting the citizens by avoiding concentration of population in vulnerable areas and improving resilience of ecosystems. Integrated LAS should include additional information that is required about environmental rating of buildings, energy use, and current and potential land use related to carbon stock potential and greenhouse gases emissions. LAS should thereby serve a key means for climate change adaption.

### Millennium Development Goals

The eight MDGs form a blueprint agreed to by all the world's countries and the world's leading development institutions. The first seven are mutually reinforcing and are directed at reducing poverty in all its forms. The last goal - global partnership for development - is about the means to achieve the first seven. To track the progress in achieving the MDGs a framework of targets and indicators is developed. Land professionals have a key role to play driving LAS s in support of efficient land markets and land-use management.

The MDGs represent a vision for the future, where the contribution of the global surveying community is vital. In a global perspective, the areas of surveying and land administration are basically about *people*, *politics*, and *places*. It is about *people* in terms human rights, engagement and dignity; it is about *politics* in terms of land policies and good government; and it is about *places* in terms of shelter, land and natural resources.

**Figure 4: Lagos is one the fastest growing cities in the world with huge slum areas expanding into the waters (Photo: Enemark, 2009).**

### Rapid urbanisation

Urbanisation is another major change that is taking place globally. The urban global tipping point was reached in 2007 when over half of the world's population was living in urban areas. This rapid growth of megacities causes severe ecological, economic and social problems. It is recognised that over 70% of the growth currently happens outside of the formal planning process and that one billion people, 30% of the world´s urban population, live in slums or informal settlements, see figure 4.

Rapid urbanisation is also having a significant impact on climate. It is setting the greatest test for land professionals. The challenge is to deal with the social, economic and environment consequences of this development through more effective and comprehensive spatial and urban planning and administration.

## Final remarks

LAS, in principle, reflect the social relationship between people and land recognized by any particular jurisdiction or state. However, LAS are not an end in itself. Instead, the systems facilitate implementation of land policies within the context of a wider national land management framework. Sustainable LAS provide clear identification of the individual land rights attached to these parcels. This information is crucial for accommodating the new vision of spatially enabled society. This information also plays a key role in facing the global agenda through adaptation to climate change, management of natural disasters, alleviation of poverty, and management of rapid urban growth.

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# Improving cadastral survey procedures using crowd sourcing techniques

The scope of the paper is to present the first practical experiments which were carried out in Greece in an effort to engage VGI to Cadastre. The researchers' aim is to clarify the strengths and the weaknesses of a real involvement of volunteers in Cadastre

**Sofia Basiouka**
Surveyor Engineer, NTUA, Ph.D. student, National Technical University of Athens School of Rural & Surveying Engineering, Greece

**Chryssy Potsiou**
Assistant Professor, National Technical University of Athens School of Rural & Surveying Engineering, Greece

Volunteered Geographic Information (VGI) was first introduced as a term by Goodchild (2007), who presented the Volunteered Geographic Information as an individual effort of amateurs who act voluntarily in GIS collection, editing and manipulation and their results may or may not be accurate. The main goal of the new phenomenon is the participation of the citizens. Everyone can be involved by collecting and uploading data or by editing entries and monitoring the results. Different terms are interlinked to it; User Generated Content, Crowdsourcing and Neogeography are only a few of them share the main philosophy. It is clear that a new era has risen in geographic information science by the citizens' involvement.

VGI techniques were first used for navigation purposes and leisurely activities due to the high cost of conventional maps and the restrictions towards their use. However, the phenomenon was quickly extended in crisis management. Haiti earthquake and Hurricane Katrina are two representative examples of VGI mapping, which meant that supplies in medicine and food were provided in short time. Pultar et al., (2009) were among the first who noticed that dynamic GIS is an ideal tool for storing, analyzing and visualizing natural disasters such as hurricanes, wildfires and earthquakes. Slum mapping and mapping of virgin areas was also developed with the aid of VGI. World Bank supported South Sudan mapping and numerous other applications which are carried out worldwide.

Land administration consists the basic tool for a proper land management; guarantee of ownership and security of tenure, fair taxation, security for credit, development of land markets, protection of land recourses, facilitation of State-owned land, reduction of land disputes, facilitation of rural land reform and improvement of urban planning (UNECE, 2005). It is remarkable that the number of megacities has risen from two in 1950 to 20 in 2005, while 17 of them are located in the world's less developed regions (Doytsher et al., 2010). More than 1.1 billion people live in slums which are located to unregistered parcels (McLaren, 2011). It is clear that the procedures should quicken and the cost should be in low levels with the involvement of individuals. As Adlington (2011) has underlined in East Central Asia region, the World Bank Land Administration and Management projects have succeeded the greatest land reform the world has ever seen because they have been guided by surveyors who were open to help without being stuck to traditional methods and high levels of accuracy, and they were willing to be practical and meet the needs of the society. Social media & crowdsourced technology may provide transparent land administration in places where corruption & inefficiency is endemic, if used with an understanding of errors, accuracies & usefulness of various forms of spatial information.

It is clear that society's needs for easy editable and inexpensive maps which can be produced in short time have

involved VGI in various fields. Is land management, which mainly applies land information to land resources (UNECE, 2005) between the fields that can flourish with the aid of VGI? Can legal principles and strict regulations be bypassed? Can sensitive personal information be trusted to volunteers? Is accuracy the most important part of a cadastre and how it can be achieved? The research community has to identify VGI's opportunities and limits.

## The hellenic cadastre

### Progress and Statistics

The Hellenic Cadastre started its operation in 1995. Although the project is in progress for 17 years, the results in some regions are quite disappointing concerning progress and efficiency. It affects an area of 132,000 km$^2$ and 37,200,000 property rights of 11,000,000 people approximately. However, only 6.4% of the total area has been completed until now, which means that 8,400 km$^2$ and 6,800,000 property rights (which in percentage is 17%) have been officially recorded. The total cost of the project has reached 340 M€. Nowadays, 3,100 km$^2$ of the total area and 7,500,000 property rights approximately are under compilation. The cost of the new cadastral survey is estimated to 212 M€, not including VAT, and the amount of the new registered rights approaches 42 M€. The remaining 120,500 km$^2$ and 22,900,000 rights, concerning mainly rural areas, are still unregistered.

### Processes

The process of a cadastral record is summarized in the following steps. At first, the declarations of the property owners are submitted to the Cadastral Survey Offices and the registration of the declared rights is introduced in a digital database. Owners are also expected to recognize their properties on orthophotos, although the process is not characterized as successful in rural areas. Secondly, the interim cadastral tables and diagrams are formed based on the data that has been collected from the submitted declarations which means that an objection period starts by the suspension of the interim cadastral data at the Cadastral Survey Offices for a two-month period. Meanwhile, dispatch of extracts is sent to the right holders for their information and acceptance. The objections or applications for correction of a cadastral registration are submitted and forwarded to independent administrative committees, depending on the case, by whoever has a legal right. Then, the cadastral data is reformed and the final cadastral tables and diagrams are revised. These registrations are called Initial Registrations and they constitute the first registration in the Hellenic cadastre (Hellenic Cadastre, 2011).

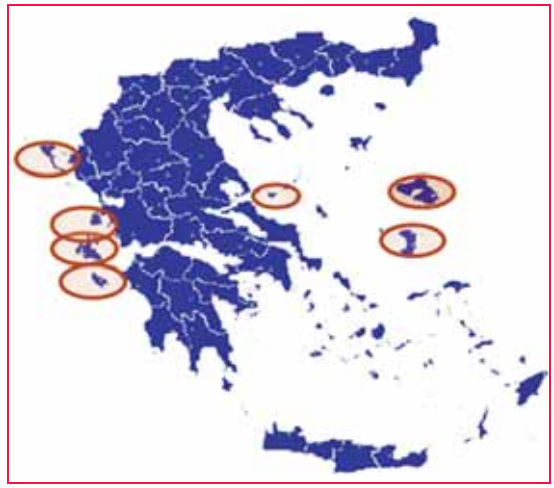

**Figure 1: Areas with gross errors during cadastral survey**

### Identified errors – Three representative examples

Identified errors concerning *the location*, *the shape* and *the boundaries* of land parcels have been recorded in various areas of the first pilot project where cadastral survey has been completed. Errors are also noticed at the *records of the cadastral tables* where properties are recorded to belong to "*unknown owners*". According to KT the most important areas with identified errors are Lefkada, Corfu, Lesvos, Chios, Alonissos, Kefalonia and Zakinthos islands (Figure 1).

More precisely, there are four categories of errors which affect the areas mentioned below:

1. Land parcels whose shape or boundaries need correction
2. Land parcels which although they were declared by the owners within the declaration period, they were not recorded by the contractor in the interim cadastral plans. Hence, these were not recorded at all.
3. Land parcels which were registered into the interim cadastral plans in wrong cadastral units
4. Land parcels which are located in adjacent cadastral units and are affected geometrically due to the correction of the boundaries of the unit and are under re-survey

#### Lesvos Island

Lesvos is among the areas where gross errors have been recorded during the objection period. Near 42,205 land parcels have been registered until now and is still unknown how many land parcels have been recorded wrongly as the cadastral survey is still under the editing process. More than 2,500 objections have been submitted until now. It is estimated that if the percentage reaches 30% (aprox. 12,000 land parcels) the cadastral surveys will be repeated.

#### Chios Island

Chios is in a similar situation to Lesvos. Almost 113,400 land parcels have been recorded until now, while 1,970 errors have been mentioned. The policy is the same; if the recorded errors are more than 34,020 the procedure should be repeated.

#### Lefkada Island

Lefkada was affected in two different cadastral areas mainly; Tsoukalades and Haniotes village which are both mountainous and are located to the hinterland of the island. Tsoukalades was selected by the research team as the ideal area where the first practical experiment took place (Basiouka & Potsiou, 2012). The research team came in contact with the local authorities of the village and asked for their participation. In their turn, local authorities asked among the property owners for volunteers. The process and

the results were analyzed in the next chapter. It is estimated that 43,440 land parcels were recorded in total, while 790 errors have been found till now.

The exact cost and time for the process to be repeated is not known yet as the objection period has not come to an end and the number of gross errors has not been identified in detail. However, the new cadastral survey is expected to last a year for the declaration collection and two years for the processing based on past experience.

## VGI methodology – A rough estimation for an alternative process

A rough estimation of the VGI methodology as an alternative way to correct the gross errors indicated that the time and cost can be minimized. According to the assumptions of the estimation, 10 volunteers should participate and record 15 parcels per day. This estimation is based on the results derived by the first practical experiment which was carried out by the research team in Lefkada Island. The results showed that the scattered areas in Chios can be resurveyed in nine months and data editing can be concluded in four months. The whole process does not exceed 13 months in total in an island which seems to confront the greater problem. The errors in Lesvos can be corrected with the same process within five months. The cadastral surveys may be held with the aid of undergraduate technical university students as team leaders. Similar role may be also kept by the local authorities who may provide the volunteers with the needed equipment and support on technical issues. It is clear that the whole process is based on what Goodchild (2008) mentioned in his research; "Residents of a neighborhood are inherently experts in the local area." The results are summarized in Table 1.

The main idea of the VGI methodology was adopted by OpenStreetMap which is the first free, editable and not restricted by copyrights map whose success is based on volunteers who collect and edit the data. It's operation is simplified in five main steps which can be carried out by the volunteers; gathering and uploading data, editing maps and data, rendering maps.

The first step of the process should be done on the field with the aid of orthophotos as draft maps and a handheld GPS. A hierarchical pyramid of volunteers which will be constituted by students, local authorities and the local residents can take action. The experience indicated that the identification of the parcels on orthophotos by the owners at the cadastral office was unsuccessful at rural areas. Alternatively, this process may be done simultaneously with the data collection by the volunteers at the field.

The second step includes data uploading by volunteers and the third includes map editing. The local residents supported by the young team leaders will be able to edit the collected nodes and create polygons by using open source systems.

The attribute data which will accompany the geographical data will be registered by the volunteers at the forth step of the procedure and the result will be shown at the last step.

**Table 1: VGI methodology – time needed**

| Island | Number of Volunteers | Data Collection | Data Editing | Total Time |
|---|---|---|---|---|
| Lesvos | 10 | 3 months | 2 months | 5 months |
| Chios | 10 | 9 months | 4 months | 13 months |
| Lefkada | 10 | 3 months | 2 months | 5 months |

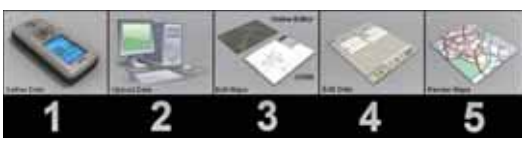


**Figure 2: OpenStreetMap process** (source: OpenStreetMap, 2010)

## The practical experiments – crowd sourcing in cadastre

The two practical experiments were carried out in different time periods and areas covering different methodologies of VGI. The aim of the experiments was to simplify the processes needed for a cadastral survey, and to reduce time and cost. Although the concept behind the two experiments was the same, the process was different. The first experiment was carried out in a rural area at Lefkada Island and the second in an urban area in the city of Athens. The results of the first practical experiment were presented at the FIG Commission 3 Workshop and were published (Basiouka & Potsiou, 2012).

### The test areas

The first experiment was carried out in Lefkada Island, an island of the Ionian Sea. It lies between the islands of Corfu and Kefalonia. It is very close to the shores of the western mainland of Greece covering an area of 302.5 km$^2$ and is fourth in size in the Ioanian islands complex, with a population of 23,000 people. The community of Tsoukalades is one among seven communities part of the municipality of Lefkada. Tsoukalades village is located 220 m above sea level in the north-west part of the island and it has 430 habitants according to the last census.

The second experiment was carried out in the city of Athens at the area of Kallithea, which is expanded between Athens and Faliro Bay. Municipality of Kallithea is an urban area at the south east part of Athens and it has more than 200,000 habitants.

The first area was under cadastral survey for more than 12 years due to the errors and the specific cadastral unit which has been resurveyed four times. The cadastral survey at the second area of interest which is an urban area with well defined boundaries has not yet been finished.

### The experiments

#### Rural area – Lefkada Island

The first experiment took place at Lefkada Island during a summer weekend of 2011. Fifteen volunteers participated and 19 land parcels were traced with the aid of three experts and a handheld GPS. The area of interest is a rural one with olive trees and cultivated areas. The parcels were chosen randomly so that the sample will be representative and the land owners

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**Figure 3: The test areas; Lefkada island (left) and Kallithea (right).**

volunteered to collect the tracks of their boundaries with the aid of a handheld GPS (figure 4). The data editing was done later at the laboratory by the research team.

The results indicated that the location and shape of all land parcels compared to the last official cadastral survey are correctly defined and the majority of the land parcels' area size is sufficiently defined and within the AAA requirements posed by the KTIMATOLOGIO SA. Only eight of the hundred measured nodes have coordinate deviations greater than 5m, while the area size of seven out of the nineteen land parcels (37%) differentiated from the correct size more than the required accuracy.

The main weaknesses of the process were focused on the minor obstacles of GPS signal due to the trees and the difficulties that some elderly volunteers faced with the use of the GPS. The main strengths were focused on the great participation of volunteers, the lack of disputes and their easiness to identify their properties in the field and to answer sensitive personal questions.

### Urban area – Kallithea

The second test took place at Kallithea Municipality, close to the centre of Athens, in a one day application during the winter 2012. Nine volunteers participated, seven land parcels were traced, one handheld GPS and iPad were used. The results using the handheld GPS were disappointing compared to the technical specifications required by the official mapping agent. Due to signal obstacles, the accuracy was not satisfactory so a different approach was applied. The land parcels were drawn online on orthophotos provided by KTIMATOLOGIO with the aid of iPad (figure 6). The volunteers used the online web system which is supported by the official mapping agent (KTIMATOLOGIO SA) and created the interim cadastral map extract of their building on orthophotos (figure 5). The orthophotos which are provided by the system were received between 2007 and 2009, and their accuracy approaches 20 cm in urban areas and 50 cm in rural areas. Each extract was accompanied by the parcel's coordinates and total area which could be used comparatively in a further step of the process as a control. The whole process was straightforward and offered the opportunity to local residents to conclude the process from data editing to map rendering. The results were in high levels of accuracy.

### The volunteers

The sample of volunteers varied a lot between the two experiments. In the first experiment elderly people with no special educational background took part. In the second, young students under 25, familiar to new technologies participated (figure 6). All were local residents and property owners in both areas of interest based on the perception that no one knows the area better than the residents.

Their motivations were summarized in four main categories: speed up the procedures; eliminate the costs; unblock the market in the areas with errors in cadastral survey; participate as active cells of the society. As Laarakker (2011) first mentioned, their motivations are not altruistic. They are motivated by their need for an updated transparent land administrative system which will guarantee their ownership.

## Conclusions

The applied methodology, offered satisfactory results in both cases and within the technical specifications required by KTIMATOLOGIO. The participation was enormous and time was eliminated dramatically without taking into account the cost. The volunteers were willing to participate, answer the questions and get involved in the experiment. The involvement of local authorities in the first experiment and undergraduate students in the second one guaranteed the process

**Figure 4: The Volunteers at the Rural Area**

Figure 5: The interim cadastral map derived online

and help to overcome technical issues.

It is clear that the process is not regulated yet, but the very first steps have already been done towards this direction. Handheld GPS will soon be replaced by smartphones and new applications will be created to serve these needs. It is obvious that, the volunteers will be get involved in the next step of VGI, such as uploading and editing of data so that the final map will be produced by them. Authors believe that VGI methods may be integrated in the cadastral survey process in order to increase owners' participation, speed up the creation of draft cadastral maps, eliminate the total costs and minimize the gross errors in future. The aim is not to replace the traditional procedure by using VGI, but to improve it with innovative, quick and cost efficient methods. This paper is a first approach towards this direction and it is coordinated with the activities of FIG Com. 3 W.G. 3.2.

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**Figure 6: The volunteers at the urban area**

and to S. Soile, Surveyor Engineer at the Laboratory of Photogrammetry of NTUA for her technical support and K. Apostolopoulos, undergraduate student of NTUA who helped in the implementation of the second experiment.

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## Online resources

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# GIS makes geography alive

"Geography is our platform for understanding the world," said Esri president Jack Dangermond in his opening remarks at the 2012 Esri International User Conference, held July 23–27 in San Diego, California, "and GIS makes geography come alive by condensing down data and knowledge into a kind of language that we can easily understand."

Dangermond went on to talk about Geography as a Platform (GaaP), a GIS-based environment he envisions that will deliver enabling technology to anyone, anywhere, on any type of device. He indicated that ArcGIS Online, Esri's cloud service, is a fundamental component of the GaaP concept because it promotes platform interoperability.

Keynote speaker Julia Marton-Lefèvre, director-general of the International Union for Conservation of Nature (IUCN), addressed the problem of species loss and talked about the IUCN Red List of Threatened Species map portal that accesses a vast dataset of 40,000 georeferenced species. Another plenary speaker, Peter Carlisle, mayor of Honolulu, Hawaii, discussed how his city used ArcGIS and Esri CityEngine to look at the impact of population growth on Honolulu's public transport network. Bruce Wong, manager of network analytics at General Motors, shared how successful location analytics helped transform the company.

During the technology workshops, Esri's technical support team demonstrated new tools, workflows, and applications available in ArcGIS 10.1. A key benefit is the creation of an interactive common operating picture, which incorporates web applications created on ArcGIS for Server, and Software/Data as a Service provided by ArcGIS Online.

The more than 15,500 attendees had a number of opportunities to share their work, including the User Software Applications Fair, Map Gallery, Lightning Talks, and moderated paper sessions. At the GIS Solutions EXPO, many users joined the Hands-on Learning Lab and watched product and application demonstrations.


The annual awards presentation is an eagerly anticipated part of the conference. This year, the Lifetime Achievement Award was presented to renowned landscape architect Stephen Ervin, while the President's Award acknowledged the work of the US Environmental Protection Agency. Two Making a Difference Awards were presented this year: one to the Trust for Public Land and the other to Mayor Carlisle. The US Geological Survey was given a special mention for its 40-year-old Landsat program and thanked for making this data available for free. In addition, Esri celebrated the outstanding work of more than 160 businesses, governments, and organizations around the world at the Special Achievement in GIS Awards ceremony. During the closing session, awards for selected maps exhibited in the Map Gallery were presented.

Esri staged five concurrent conventions this year in conjunction with its User Conference: the Esri Business Summit, Survey Summit (jointly with the American Congress on Surveying and Mapping Annual Conference), Esri Homeland Security Summit, Global Marketing and Sales Summit, and Esri Education GIS Conference.

Juliana Rotich, cofounder and executive director of Ushahidi, spoke on crowd mapping, citizen science, and participatory learning during a special presentation at the education conference. Based in Nairobi, Kenya, Ushahidi—which means "testimony" in Swahili—supports map-based, crowdsourced data collection for the democratization of information. Esri is a longtime supporter of Ushahidi and recently released the ArcGIS Add-in for Ushahidi.

While the User Conference is now concluded, it is still possible to learn about the latest trends and GIS technologies that were discussed. The conference website, esri.com/uc, is a valuable resource for viewing the plenary talks, listening to technical session podcasts, and reading conference proceedings such as user presentations.

The 2013 Esri International User Conference will be held at the San Diego Convention Center July 8–12.

**Jim Baumann, Esri Writer**

# J-Shield


You can either hope that interferences will never happen; or get a GNSS receiver that has protection against interferences.

You can either hope that special interest groups, and Coalitions, who cannot build a good filter, will always be successful in lobbying to offer mediocre technology, keep the precious bands near GNSS wasted and prevent systems like LightSquared authorization, or get a GNSS receiver that has protection against such systems while offering better performance too.

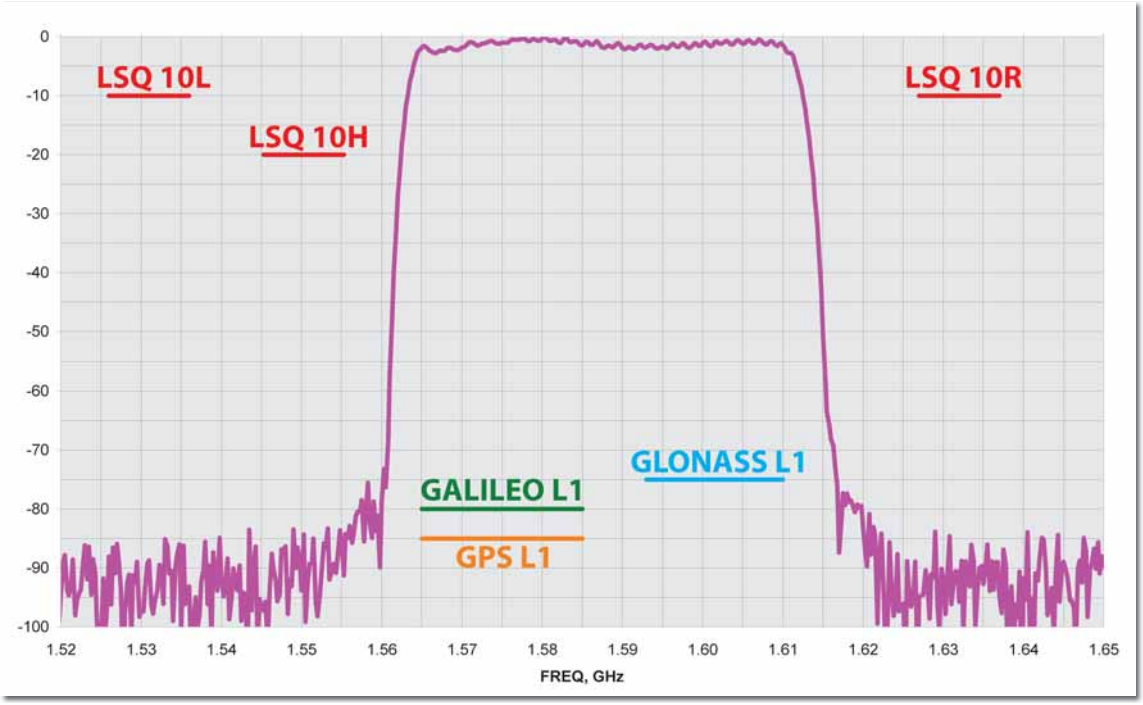
The United States of America is currently ranked 16th on broadband wireless connectivity. We are proud that our technology not only protects and improves the performance of the GNSS system, but also helps to support proper usage of the precious bands to improve broadband wireless communication and reduce user costs to 1/3 of what is today.

You can either trap yourself by owning defective GNSS receivers which forces you to support coalitions preventing progress of wireless broadband in the United States, or you can own a GNSS receiver that performs better, has protection against such interferences and frees you from such political games.

Our team has been bringing you the latest GNSS technology for the past 30 years. We were working on defending against in-band and out-of-band interferences ten years before the LightSquared issue surfaced.

You can either listen to some folks who do not have sufficient knowledge about GNSS technology, but give advice and testimony to Congress, or analyze the technical details that we present in the next few pages which are backed by our GNSS receivers in mass production today.

# J-Shield ....




A good GNSS receiver should bring in ALL of wideband GNSS signals and reject all other unwanted signals. We announced the existence of this technology months ago for the L1 band. Now we have improved this filter and added similar protection for all other GNSS bands.

The figure above shows the frequency response of our filter for L1. As shown in this figure, it allows complete, undisturbed L1 signals in and defends against any other signals outside this band. In particular it defends against LightSquared signals of 10L, 10H, and 10R (Handsets). The filter drops down quickly, at the rate of 12 dB/MHz outside the GNSS band.

Figure on the right shows the frequency response of our filter for other GNSS bands. Although there are no requests for other systems near these GNSS bands yet, our filters have protection if this happens in future.

Interference is not limited to wideband wireless systems. Harmonics of other transmitters can occur anywhere and we see it as an essential requirement to protect all GNSS bands in our receivers against all interferences as much as possible. Our technology allows us to do a better job today.

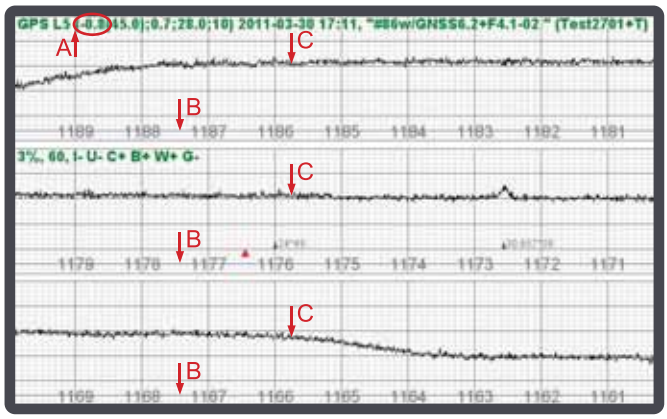
Our effort in protecting the GNSS bands did not end with designing appropriate filters. We needed to a) prove that these filters work, b) prove that these filters not only do not degrade the performance of GNSS receivers but improve performance, c) devise features that any person can use to test our receivers, and d) devise features where users can readily see the effect of interferences that may fall within the GNSS bands in some areas or see the effect of intentional jammers that are marketed these days with prices as low as $400.

So, how to recognize interferences and how to quantify their effects?

# Interference Analyzer ...

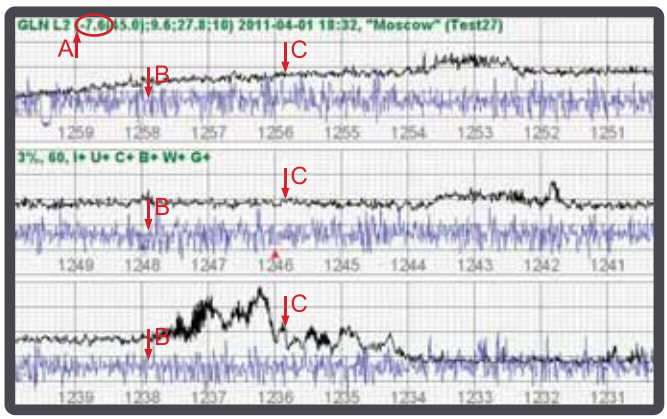

Click the “Spectrum” icon on the Home page to see the vast amount of information on interferences. See www.javad.com for details of screens which follows.

Next to the “Spectrum” icon is the “Cycle Slip” icon which is discussed later.



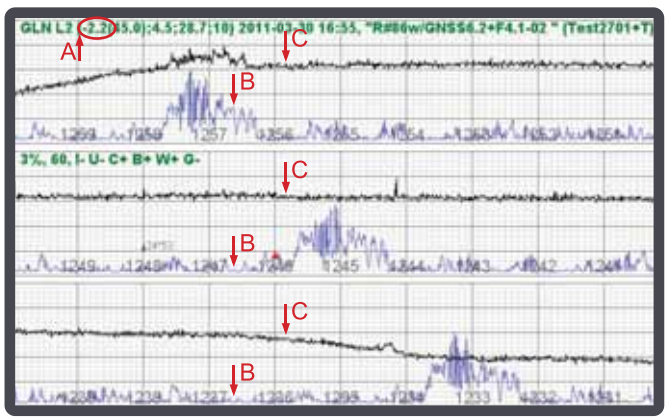

Numbers marked “A” on top left of the spectrum screens show the power of interference. The interference may be in-band or out-of band or a very wide “white noise”.

The shape of the spectrum (marked “C”) shows the location of in-band interference.




We have assigned 60 of our 216 GNSS channels to monitor the 6 GNSS bands and report interferences in four different ways. You can check interferences in your environment before starting your job to ensure your environment is clean.

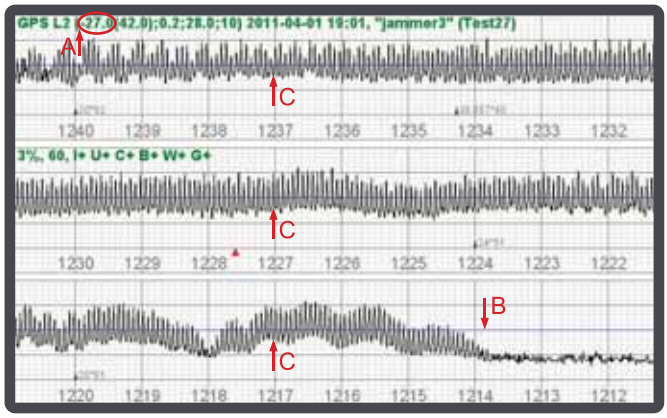
The blue line (marked “B”) is the control voltage and fluctuations there shows the presence of unwanted signals with some visual quantification.



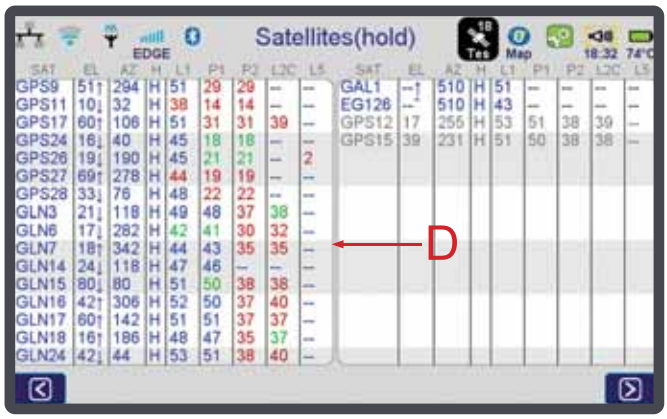

First screen shows no interference and the two figures below it show some interference as shown by A, B and C designations.

# ... Monitoring/quantifying Interferences

In this figure the band has been completely jammed by a $400 jammer.

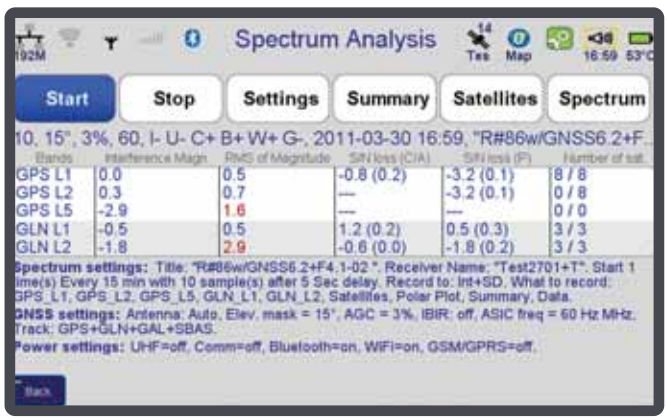



This figure shows color coded satellite signal strength after signal processing. Blue: Perfect, green: 3dB less, red: at least 6 dB less.




This figure shows the same color coded information in polar coordinates of satellites. This helps to verify if satellites have been blocked by obstruction(s).


This figure shows the summary of the spectrum analysis before and after the signal processing. See details in a 22-minute video at www.javad.com in “video lesson” section.



# Real-Time Cycle Slip Detection...


Tracking and measuring carrier phases of satellites are the foundation for all GNSS precision applications. This is why high precision GNSS receivers are much more complicated and more expensive than low precision receivers which only measure code phases. Any internal deficiency in design and/or manufacturing of high precision GNSS receivers; or the effect of any external phenomena (like interference and multipath) can cause carrier phase tracking to jump from one cycle of carrier to another. This is called carrier "Cycle Slip". You may call it missing a "heartbeat".

Unlike "loss of lock" which is obvious to detect, carrier cycle slips may have no apparent effect on satellite signal tracking and producing navigation solutions. They can be discovered and repaired in post processing software or in RTK engines after enough data is processed. Erroneous results in high precision solutions (post processed or RTK) are the result of undetected cycle slips.

If the ultimate objective of any high precision receiver is to track carrier phases of satellites correctly, it is highly desirable that any test that is intended to monitor the effect of interferences of other signals on GNSS, should also focus on monitoring and quantifying cycle slips. It is much like monitoring the "heartbeat" of a GNSS receiver in real-time.

We are proud to announce that we have been able to provide this feature in our GNSS receivers and monitor cycle slips in real-time as the ultimate way to determine the quality of a GNSS receiver and the effect of interferences.

Part of our confidence in the excellent performance of our J-Shield filters is based on monitoring the heart beat and observing that J-Shield does not cause even one cycle slip after 24 hours of tracking. Not even missing one "heartbeat" in 24 hours!

An interesting feature of our innovation is that it is available in our GNSS receivers and users by a simple click can access screens and features that we are going to explain next.

# ... Monitoring the "Heartbeat"

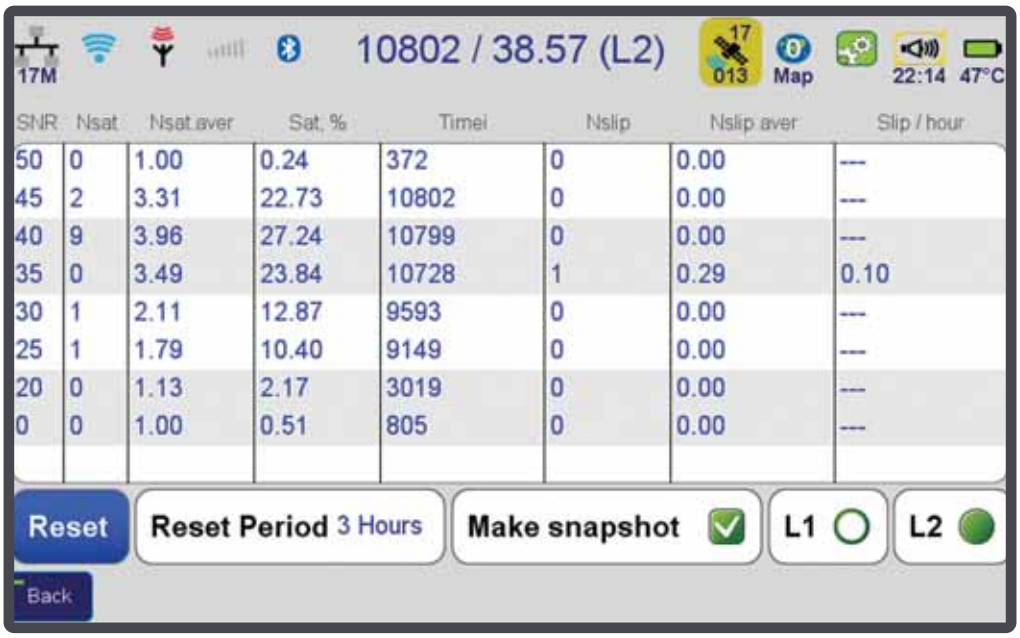



Figure above shows the cycle slip screen which is updated every second and records the number of satellite cycle slips grouped according to their signal strengths.

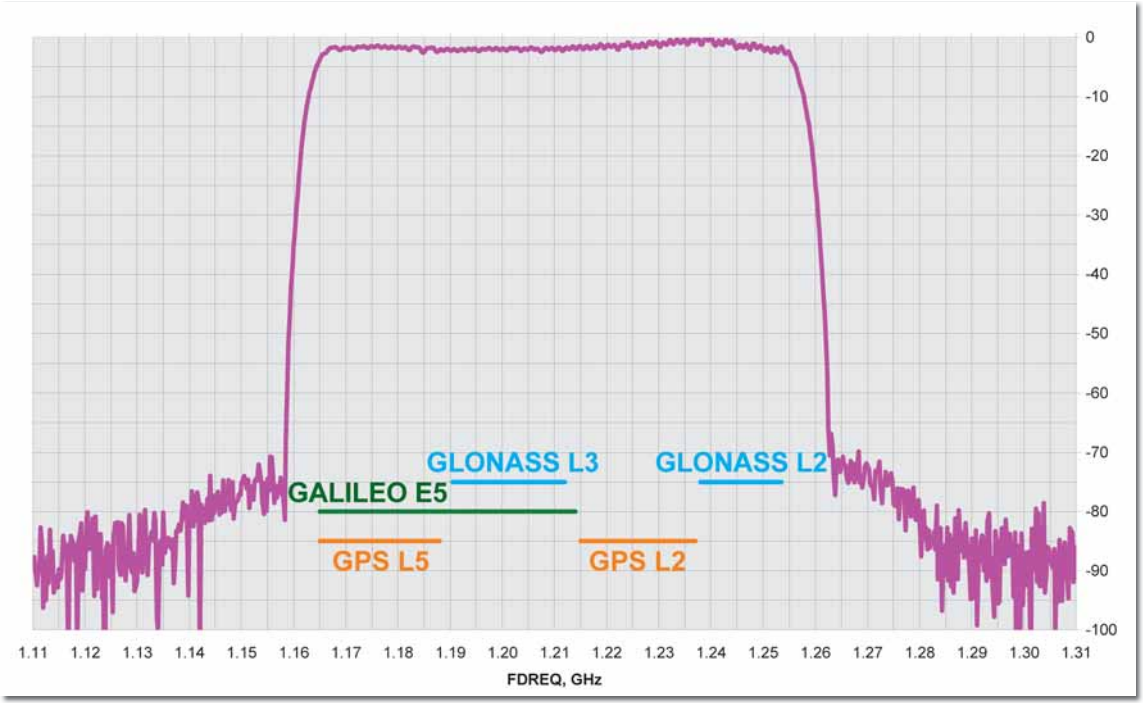
Col 1 (SNR) is the signal strength of satellites grouped from 0 to above 50 dB/Hz. Col 2 (Nsat) is the current number of satellites with strength in each bin. Col 3 (Nsat aver) is the average number of satellites with strength in each bin since test started or reset. Col 4 (Sat %) is the percentage of satellite signals in each bin during test period. Col 5 (Timei) is accumulative time that any satellite has strength in that bin. Col 6 (Nslip) is the total number of cycle slips form all satellites during the test period. Col 7 (Nslip aver) is the average number of cycle slips per satellites during the test prior. Col 8 (Slip/hour) is the average number of cycle slip per satellite per hour during the test period (N/A is shown during the first 30 minutes).The number on the top left (10800) is the elapsed time since test started. The number on the top next to it (47.65) is the average of all satellite signal strengths during the test period. Reset button restarts the test; Reset Period selection option restarts test automatically after this elapsed test time; and Make snapshot checkbox records this screen after each test period (if checked). L1 and L2 buttons select screens for L1 and L2 signals.

Figure on the right side shows similar items for the L2 band. Note that the average signal strength of the L2 band is about 9 dB less than the L1 band (47.65 - 38.57). This is because the GPS L2 signals are encrypted.

With comprehensive test features that we have embedded in our receivers users can monitor the environment and gain detailed information about possible interferences and their spectral characteristic. They can also look at the heartbeat of a receiver by looking at the cycle slip screen.

All such tests are being performed in the background without any interruption to the normal operation of the receiver in performing survey and RTK tasks.

# ... For All GNSS Bands




Without proper equipment and knowledge any technical issue can turn political and lobbyists, politicians, bloggers and editors will take over and stars of generals and titles of people will eclipse the scientific facts.

To study the effect of interferences in some official tests, they had to use very expensive equipment in highly sophisticated laboratories, employ experts, and then wait for several weeks to get the test results. These results were not conclusive and therefore were open to interpretation.

It is our claim that these new innovative test features that we have embedded in our GNSS receivers a) are much more comprehensive than those done in laboratories with a roomful of equipment, b) can be used by any novice user in the field, and c) provide instantaneous results.

The embedded features perform five different highly sophisticated tests and show the results automatically in a user friendly and easy way. A push of a button activates all these tests in the background while user can perform their normal survey or other positioning tasks.

For each GNSS band we have embedded features to **A)** quantify interferences by AGS numbers, and its variations, **B)** visualize interferences by the AGC control voltage graph, **C)** visualize and quantify in-band-interferences by the spectrum graphs deep inside the signal processing section, **D)** show deviations of C/N0 from standard numbers, **E)** measure and show any missing 'heartbeat' inside the carrier phase tracking system with our new sophisticated and comprehensive real-time cycle slip indicator.

The next four pages (inside) are dedicated to brief explanations of these subjects.

# How to report Interferences?

**GNSS receivers in reference stations should have Interference monitoring and reporting features.**

**Via Wi-Fi to Victor-VS**

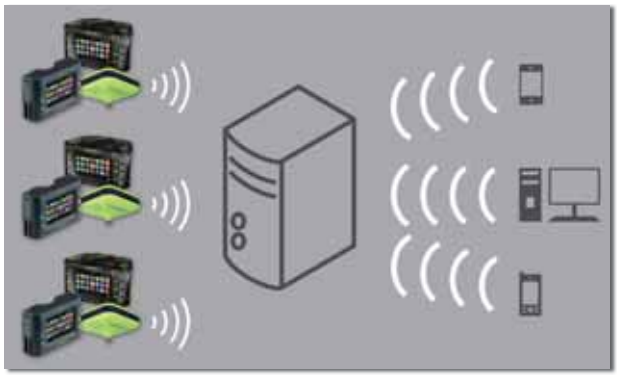
Victor-VS can connect to TRIUMPH-1 or TRIUMPH-VS anywhere in the world and get direct report about interferences.

**Via Wi-Fi to NetView**

NetWiew, running on any PC, can connect to TRIUMPH-1 or TRIUMPH-VS anywhere in the world and get direct report about interferences.

**Via Wi-Fi to NetHub**

NetHub, running on any PC, can connect to several TRIUMPH-1's or TRIUMPH-VS's anywhere in the world and get direct report about interferences.



**Via Wi-Fi to FTP or E-mail**

TRIUMPH-VS and Victor-VS can send interference reports to FTP sites and authorized persons can view them via browsers (computers, iPhones, etc). It can also e-mail reports to intended people.

**Monitor interference in any area before performing task; like pilots check the weather before take off.**

# Continuity of the Pasaia Tide Gauge measurements

In this work, the stations description, the first results obtained with four years of tide gauge measurements, the evaluation of the altimetry link campaigns and the comparison of the levels of different measurements are detailed. The statistical analysis of four years of records is provided as well

**Miguel J Sevilla**
Astronomy and Geodesy.
Faculty of Mathematics.
University Complutense
of Madrid, Spain

**Joaquín Zurutuza**
ARANZADI

**Adriana M Martín**
Astronomy and Geodesy.
Faculty of Mathematics.
University Complutense
of Madrid, Spain

As of February 2007, a Tide Gauge (TG) was set up in the Pasaia Harbour, in northern Spain (Figure 1). The main reason for such location was the existence of a Permanent GNSS Station and the access to the Internet and electricity in the AZTI facilities 15 m away.

The aim of the TG is the study of sea level and its variation in time. On the other hand, one of the major goals of the GNSS station is the determination of possible vertical crustal movements in the area of study and the connection of the reference of the tide gauge (TGBM). The TGBM is referred to a local reference system and to the global geocentric reference system (ITRF), so the GNSS data will allow to correct the long sea level records obtained with the TG, to isolate sea level variations of the crustal deformations and to obtain the absolute sea level (Zurutuza and Sevilla 2006).


**Figure 1: TG and GNSS station situation**

Both the tide gauge and the GNSS antenna are linked to four additional benchmarks (TGBM) that provide information about possible local deformations and are, therefore, used as a support to monitor if any of the TGBMs has disappeared or has been destroyed. (Figure 2). These connections are made through GNSS observations and precision levelling. The link of the GNSS antenna, which is on a building's roof, with the tide gauge TGBM, is done by reciprocal and simultaneous trigonometric precise levelling to ensure millimeter accuracy. Both the levelling networks between TGBMs as well as the link with the GNSS antenna are observed annually for control. Also, additional weather equipment provides continuous pressure, temperature and humidity data and are gathered in RINEX format. Gravity measurements are also available in the area. All these data allow for instrumental corrections and calibration of instruments and are therefore used to either study possible seasonal variations or to smooth the frequent storms in the Cantabrian Sea effects.

## The tide gauge

A pressure PARONCIENTIFIC tide gauge for measuring water level by immersion with a Digiquartz © 8DP070-GV digital quartz sensor with intelligent electronics model 735 was set up. The data storage is run in a Campbell Datalogger R800. Daily files are produced with a sampling interval of one sample data every minute.

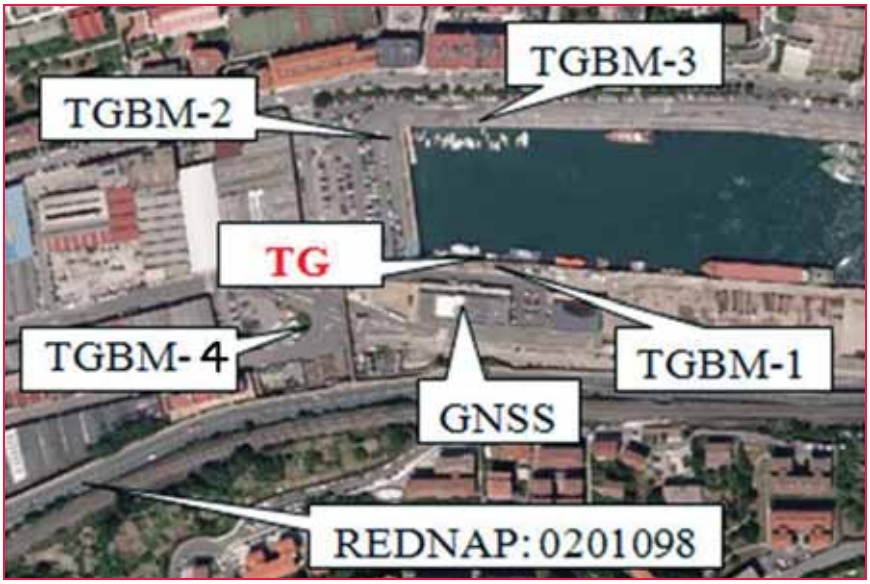



**Figure 2: Situation of TGBMs in Pasaia**


**Figure 3. Building of AZTI and GPS Antenna**

## Permanent GNSS station

The GNSS receiver is a dual-frequency Leica GR10 receiver (14 GPS + 12 GLONASS). The antenna is mounted on a stable mast on the roof of the AZTI building (Figure 3), at about 15 m from the tide gauge TGBM. It has clear horizon and is free of radio interference. The antenna is a LEIAR25.R4. Absolute Phase Center Variations (PCV) for this antenna are retrieved from the IGS absolute Phase Center Variations ANTEX files IGS05.atx and IGS08.ATX, which contain the latest versions. The approximate coordinates (ETRS89) are: $\varphi = 43^{o}19'18".373$ $\lambda = -1^{o}55'52".059$.

The daily precise data processing (only GPS data) is performed with the Bernese 5.0 (Dach et al., 2007) software, whereas the rapid daily solutions to check inconsistencies is carried out with our processing software routines: AutoGNSS (Zurutuza et al., 2007), which is based in the PAGE-NT. The main parameters considered are (Zurutuza and Sevilla, 2007, 2009): Sampling interval 30 seconds, elevation mask 10°, Niell tropospheric model estimated every three hours and piece-wise interpolated. Ionosphere almost eliminated with the frequency 'iono-free' IGS precise ephemeris. Earth tides and DD correlations are used. The fixed IGS stations are BRUS, EBRE, VILL and YEBE. The GNSS station belongs to the GNSS network of Gipuzkoa.

The control network of the permanent GNSS station has four additional stations nearby. They are used to identify possible local deformations (mainly of the building of AZTI) that could influence the determined coordinates of the station (Sevilla et al., 2010, Sevilla and Romero 1991, Garcia and Sevilla 2006). The maximum distance from the GNSS antenna to the control TGBM stations is of about 400 m.

The linking of the GNSS antenna with the sea level and the Spanish Precise Levelling Network (REDNAP) in Pasaia is a rather delicate operation due to the configuration of the route that runs from the terrace where the GNSS antenna is located, to the pier in the port where the tide gauge is located. This link is repeated every year. The major difficulty that arises is to connect with millimetre accuracy two stations separated at a distance of 31.5 m, with a height difference of about 14.6 m and with no direct visibility. For the altimetry control, the TGBM is also linked with a benchmark of the REDNAP.

The instrumentation used is a WILD T2 theodolite, NPT NITRIVAL sighting system (Figure 4) and a PENTAX ATS 101 total station, with a precision over distances of 2 mm + 2 ppm, which includes automatic weather corrections for pressure and temperature. The constants are calibrated on the basis of three pillars of the laboratory of the Faculty of Mathematics of Madrid. For the spirit levelling, a SOKKIA SDL30 digital automatic level is used with millimetre fibreglass staff with bar codes.

Levelling campaigns have been carried out during the months of July of 2008, 2009, 2010 and 2011. They are scheduled at the same epoch every year in order to have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• Small and compact design for handheld
• Windows Mobile OS
• 3.5'' Sunlight readable QVGA touch screen display
• GSM module for seamless connection with control center
• High capacity battery lasting for whole day work
• Waterproof and dustproof to IP65
• 3M auto focus camera
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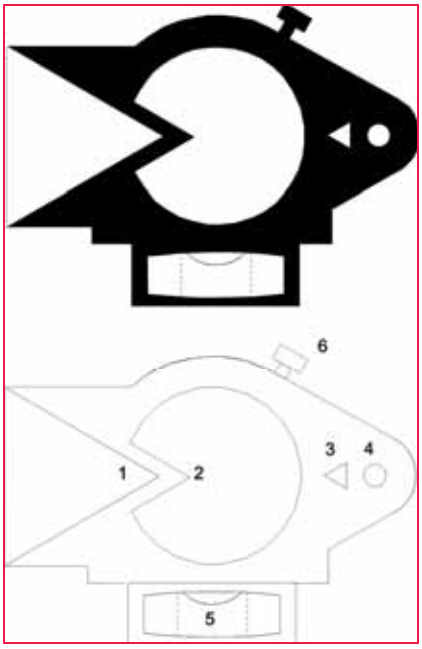


**Figure 4. NITRIVAL NPT Targets**

similar weather conditions. As outlined before, the spirit and trigonometric levelling are used to achieve the required accuracies. Simultaneous and reciprocal trigonometric levelling is chosen to link the GNSS station with the tide gauge, while the spirit levelling is used to obtain the altitudes of all the TGBM. Considering the mean of the observed elevations the closing errors rarely exceed 1.5 mm (Valbuena et al., 1966).

After every campaign, all the observed height differences are computed. To get the differences in trigonometric altitudes the direct independent calculation method is used. The points are clearly marked on the ground with standard marks or solid references are as follows (Figure 5): the tide gauge tube (1), TGBM 1, 2 and 3 (2), TGBM4 (3), IGN 201098 levelling mark (4) and GPS antenna (5).

Table 1 shows the differences in altitude and the altitudes obtained from the observed reference points in the four years. The 0 (zero) is the tide gauge tube, the TGBM1 is 6 m away from the tide gauge in the pier, the TGBM2 is in the northwest corner of the pier at about 170 m from the TGBM1, and the TGBM3 is at about 170 m from the TGBM2 to the east and the TGBM4 in the external round to the enclosure of ACTI (Figure 2). The TGBM1 was taken as the reference of the tide gauge and the sea level is referred to this point. In the table, the following naming is used:

| | Name |
|---|---|
| **0** | Tide Gauge |
| **1000** | TGBM1 |
| **2000** | TGBM2 |
| **3000** | TGBM3 |
| **999** | GNSS Antenna |
| **1999** | Mark near the antenna |
| **66** | TGBM4 |
| **10** | REDNAP 201098 |

In the 2010 campaign, (Sevilla et al., 2011) it became evident that it was completely necessary to set a permanent mark on the terrace of AZTI. Such a new mark had to be linked, by the aforementioned trigonometric precise levelling to TGBM1, to take advantage of its precise spirit levelled height. The computation sequence follows this way:

- TG – TGBM1: spirit levelling,
- TGBM1 – Auxiliar Station: direct measurement (zenital straight angle),
- Auxiliar Station - Auxiliar Station (terrace): precise trigonometric levelling, Auxiliar Station (terrace) – Auxiliar terrace mark: direct measurement (zenital straight angle).

This way, if for some reason, the antenna is replaced it would only be necessary to repeat the link of the antenna with the mark. This new mark was installed at the northeast corner of the terrace in June and was assigned the number 1999. The observation of 2011 was made to this new mark so that the difference in altitude between the 1000 mark and the 999 antenna has two sections, the trigonometric link from 1000 to 1999 and the geometric link from 1999 to 999.

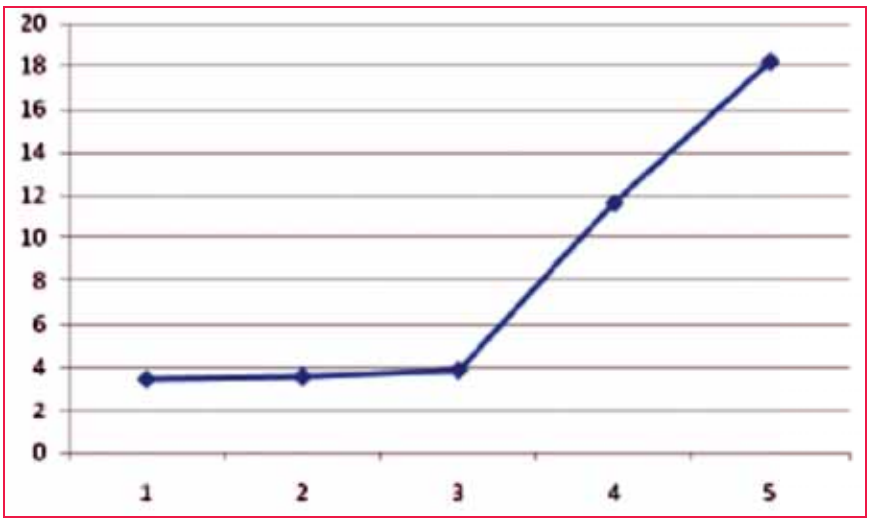


**Figure 5. Profile of the spirit levelling**

## Analysis of the mean sea level

In the following lines, the measurements of 2007, 2008, 2009, 2010 and 2011 are outlined. The TG started to work from March 28, 2007 and produced valid data since May 1, 2007. The tide gauge stopped working on February 7, 2009 due to problems with the data storage system. We call this interval the 1st cycle. The sampling rate was one each minute, but five minutes-interval data was used to compute the solutions. Eventually, a new data storage system was set up (data logger) that became operational on July 10, 2009 and is still working as of April 2012. This is the 2nd cycle. Table 2 shows the statistics of filtered data from the two cycles.

It can be seen that the total average is 3.511 and the standard deviation is 0.107. The daily averages range from a minimum value of 3.224 to a maximum value of 3.925, in a range of 0.701. The observed values ranged from a minimum value of 0.842 and a maximum of 6.523, i.e. between the low tide and the high tide recorded, in the observation period, the difference is 5.681 m. Standard deviations of the observed values range from a low of 0.374 and 1.711. Figure 6 shows a graph of data per day.

**Table 1. Results for campaigns 2008 to 2011**

| **Summary of results** (altitudes in meters, differences in millimeters) | **2008** | **2009** | **2010** | **2011** | **8-9** | **8-10** | **8-11** | **9-10** | **9-11** | **10-11** |
|---|---|---|---|---|---|---|---|---|---|---|
| GPS AZTI minus TGBM1 (999-1000) | 14,7368 | 14,7373 | 14,7369 | 14,7370 | -0,500 | -0,100 | -0,202 | 0,400 | 0,298 | -0,102 |
| TGBM4 minus TGBM1 (66-1000) | 0,2981 | 0,2969 | 0,2955 | 0,2946 | 1,200 | 2,650 | 3,550 | 1,450 | 2,350 | 0,900 |
| REDNAP mark minus TGBM4 (10-66) | 7,7509 | 7,7511 | 7,7527 | | -0,150 | -1,800 | | -1,650 | | |
| REDNAP mark minus TGBM1 (10-1000) | 8,0490 | 8,0480 | 8,0482 | | 1,050 | 0,850 | | -0,200 | | |
| TGBM4 minus TGBM2 (66-2000) | | | -0,6976 | -0,6964 | | | | | | -1,250 |
| TGBM2 minus TGBM3 (2000-3000) | | | -0,0469 | -0,0473 | | | | | | 0,350 |
| TGBM1 minus Tide gauge tube (1000-0) | 0,1140 | 0,1143 | 0,1146 | 0,1149 | -0,250 | -0,550 | -0,900 | -0,300 | -0,650 | -0,350 |
| Tide gauge zero minus Tide gauge (Fix) | 6,940 | 6,940 | 6,940 | 6,940 | | | | | | |
| Mean sea level from Tide gauge zero | 3,4786 | 3,4786 | 3,4786 | 3,4786 | | | | | | |
| **Altitudes above MSL of Pasaia** | **2008** | **2009** | **2010** | **2011** | **8-9** | **8-10** | **8-11** | **9-10** | **9-11** | **10-11** |
| H of the tide gauge tube | 3,4614 | 3,4614 | 3,4614 | 3,4614 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| H of the TGBM1 | 3,5754 | 3,5757 | 3,5760 | 3,5763 | -0,250 | -0,550 | -0,900 | -0,300 | -0,650 | -0,350 |
| H of the TGBM4 | 3,8735 | 3,8726 | 3,8714 | 3,8709 | 0,950 | 2,100 | 2,650 | 1,150 | 1,700 | 0,550 |
| H of the TGBM2 | | | 3,1738 | 3,1745 | | | | | | -0,700 |
| H of the TGBM3 | | | 3,1269 | 3,1273 | | | | | | -0,350 |
| H of the REDNAP 201098 mark | 11,6244 | 11,6236 | 11,6241 | | 0,800 | 0,300 | | -0,500 | | |
| H GPS Azti (4644909.4163, -156645.5982, 4353622.6602) | 18,3122 | 18,3130 | 18,3129 | 18,3133 | -0,750 | -0,650 | -1,102 | 0,100 | -0,352 | -0,452 |
| **Altitudes above the TGBM1 of Pasaia** | **2008** | **2009** | **2010** | **2011** | **8-9** | **8-10** | **8-11** | **9-10** | **9-11** | **10-11** |
| H of the tide gauge tube | -0,1140 | -0,1143 | -0,1146 | -0,1149 | 0,250 | 0,550 | 0,900 | 0,300 | 0,650 | 0,350 |
| H of the TGBM1 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| H of the TGBM4 | 0,2981 | 0,2969 | 0,2955 | 0,2946 | 1,200 | 2,650 | 3,550 | 1,450 | 2,350 | 0,900 |
| H of the TGBM2 | | | -0,4022 | -0,4018 | | | | | | -0,350 |
| H of the TGBM3 | | | -0,4491 | -0,4491 | | | | | | 0,000 |
| H of the REDNAP 201098 mark | 8,0490 | 8,0480 | 8,0482 | | 1,050 | 0,850 | | -0,200 | | |
| H GPS Azti (4644909.4163, -156645.5982, 4353622.6602) | 14,7368 | 14,7373 | 14,7369 | 14,7370 | -0,500 | -0,100 | -0,202 | 0,400 | 0,298 | -0,102 |
| Mean sea level | -3,5754 | -3,5757 | -3,5760 | -3,5763 | 0,250 | 0,550 | 0,900 | 0,300 | 0,650 | 0,350 |

**Table 2. Statistics for all the reviewed data**

| | | | | | | |
|---|---|---|---|---|---|---|
| Sum | 5143,617 | | | | | 5741 |
| Average | 3,511 | | | | | |
| DT | 0,107 | | | | | |
| Minimum | 3,224 | 0,374 | 0,842 | 6,523 | 5,681 | |
| Maximum | 3,925 | 1,711 | | | | |
| Rank | 0,701 | | | | | |
| No Data | 82 | | | | | |

Table 3 shows the following results:
Average = Monthly average of one value every 5 minutes (288*30 = 8640 elements)
Average A = Total accumulated average of one value every 5 minutes (8640*N elements)
Total average (average of the monthly averages) = **3.5091**
Total average A (accumulated average of all data up to this month) = **3.5106**

From Table 4, it can be seen that all means are equal to the order of one millimeter, so the mean sea level (without any corrections) from May 2007 to December 2011, with respect to the tide gauge zero, is of **3.510** m.

The monthly averages show an anomaly produced in the months from November 2009 to February 2010. In these months, residuals of 149, 147, 49 and 120 mm with respect to the mean value of 3,509 m are obtained. There have been a review of the circumstances of the records, the operation of the tide gauge, the meteorological parameters of that time,

Table 3. Monthly and total averages of data every 5 minutes

| Year | Month | Average | Residuals | Total data | Average A | Residuals |
|---|---|---|---|---|---|---|
| 2007 | 5 | 3,493 | -0,017 | 6628 | 3,493 | -0,018 |
| | 6 | 3,514 | 0,005 | 13216 | 3,503 | -0,007 |
| | 7 | 3,496 | -0,013 | 18669 | 3,501 | -0,009 |
| | 8 | 3,499 | -0,010 | 27597 | 3,501 | -0,010 |
| | 9 | 3,412 | -0,097 | 34944 | 3,482 | -0,028 |
| | 10 | 3,472 | -0,037 | 43561 | 3,480 | -0,030 |
| | 11 | 3,420 | -0,089 | 49874 | 3,473 | -0,038 |
| | 12 | 3,427 | -0,082 | 57585 | 3,466 | -0,044 |
| 2008 | 1 | 3,439 | -0,070 | 65272 | 3,463 | -0,047 |
| | 2 | 3,428 | -0,081 | 73285 | 3,459 | -0,051 |
| | 3 | 3,471 | -0,038 | 82213 | 3,461 | -0,050 |
| | 4 | 3,508 | -0,001 | 90770 | 3,465 | -0,045 |
| | 5 | 3,503 | -0,006 | 98000 | 3,468 | -0,043 |
| | 6 | 3,457 | -0,052 | 106622 | 3,467 | -0,044 |
| | 7 | 3,474 | -0,035 | 113946 | 3,468 | -0,043 |
| | 8 | 3,481 | -0,028 | 122874 | 3,469 | -0,042 |
| | 9 | 3,521 | 0,012 | 130827 | 3,472 | -0,039 |
| | 10 | 3,486 | -0,023 | 139712 | 3,473 | -0,038 |
| | 11 | 3,536 | 0,027 | 148352 | 3,476 | -0,034 |
| | 12 | 3,476 | -0,033 | 157280 | 3,476 | -0,034 |
| 2009 | 1 | 3,518 | 0,009 | 166054 | 3,479 | -0,032 |
| | 7 | 3,503 | -0,006 | 172371 | 3,479 | -0,031 |
| | 8 | 3,486 | -0,023 | 181299 | 3,480 | -0,031 |
| | 9 | 3,490 | -0,019 | 189939 | 3,480 | -0,030 |
| | 10 | 3,520 | 0,011 | 198742 | 3,482 | -0,029 |
| | 11 | 3,658 | 0,149 | 207379 | 3,489 | -0,021 |
| | 12 | 3,656 | 0,147 | 216307 | 3,496 | -0,014 |
| 2010 | 1 | 3,558 | 0,049 | 225235 | 3,499 | -0,012 |
| | 2 | 3,629 | 0,120 | 233299 | 3,503 | -0,007 |
| | 3 | 3,502 | -0,007 | 242227 | 3,503 | -0,007 |
| | 4 | 3,467 | -0,042 | 250867 | 3,502 | -0,009 |
| | 5 | 3,490 | -0,019 | 259795 | 3,502 | -0,009 |
| | 6 | 3,525 | 0,016 | 268435 | 3,502 | -0,008 |
| | 7 | 3,471 | -0,038 | 277363 | 3,501 | -0,009 |
| | 8 | 3,495 | -0,014 | 286291 | 3,501 | -0,010 |
| | 9 | 3,540 | 0,031 | 294931 | 3,502 | -0,008 |
| | 10 | 3,618 | 0,109 | 303859 | 3,506 | -0,005 |
| | 11 | 3,673 | 0,164 | 312499 | 3,510 | 0,000 |
| | 12 | 3,601 | 0,092 | 321427 | 3,513 | 0,002 |
| 2011 | 1 | 3,494 | -0,016 | 330355 | 3,512 | 0,002 |
| | 2 | 3,478 | -0,031 | 338419 | 3,511 | 0,001 |
| | 3 | 3,442 | -0,067 | 347347 | 3,510 | -0,001 |
| | 4 | 3,478 | -0,031 | 355987 | 3,509 | -0,002 |
| | 5 | 3,457 | -0,052 | 364915 | 3,508 | -0,003 |
| | 6 | 3,496 | -0,013 | 373555 | 3,507 | -0,003 |
| | 7 | 3,517 | 0,008 | 382483 | 3,508 | -0,003 |
| | 8 | 3,529 | 0,020 | 391411 | 3,508 | -0,003 |
| | 9 | 3,528 | 0,019 | 400051 | 3,508 | -0,002 |
| | 10 | 3,530 | 0,021 | 408979 | 3,509 | -0,002 |
| | 11 | 3,590 | 0,081 | 417619 | 3,511 | 0,000 |
| | 12 | 3,510 | 0,001 | 426547 | 3,511 | |
| Total average | | 3,509 | | | | |

variations of the astronomical tide, the water input, etc., but the cause of these anomalies have not been found. What we have seen in the consulted bibliography (Sveet et al., 2009) is that this event is not unique in our tide gauge (Pasaia), similar anomalies have occurred in other places on Earth and on other dates also without a plausible explanation.

This phenomena is repeated in the months of October, November and December 2010 and November 2011, with differences of 109, 164, 92 and 81 mm respectively, compared with the average of 3.509 m. This anomaly is clearly seen in Figure 7. Figure 8 shows the accumulated sea level.

## Conclusions

The Pasaia Tide Gauge, together with the Permanent GNSS Station has been described in this paper, as well as the obtained results of more than four years of continuous GNSS and TG sea level data analysis. The links for precision levelling between the TGBMs network, the zero of the tide gauge and the GNSS antenna have been analyzed as well. The statistics of the results and corresponding graphs have also been included. These results show that the GNSS/TG station is fully operational and final results can be obtained when sufficient years of observational data are available.

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# www.bhuvan.nrsc.gov.in

## Features

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- Societal applications
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Table 4. Summary of averages

| Average type | Values |
|---|---|
| Average of daily mean values, raw data | **3.5104** |
| Average of daily mean values, adjusted data (less than 36 days) | **3.5110** |
| Average of monthly averages | **3.5096** |
| Accumulated mean value, monthly data | **3.5104** |
| Average of mean values every 5M | **3,5091** |
| Accumulated mean value of data every 5M | **3,5106** |

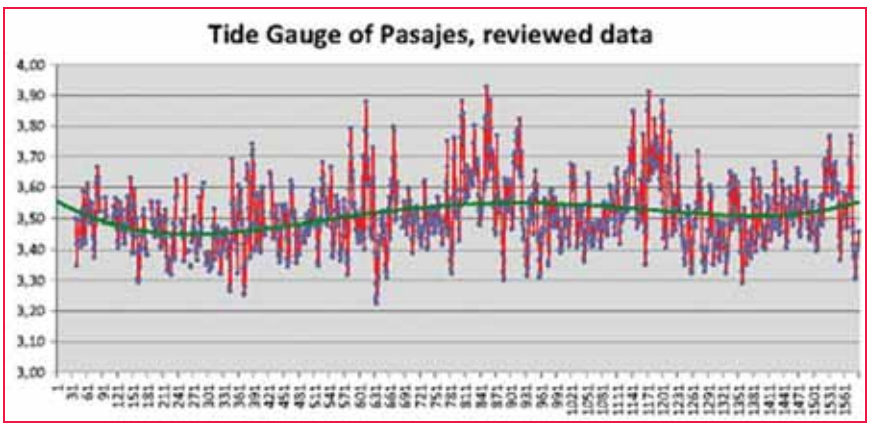


Figure 6. Pasaia Tide Gauge Data.

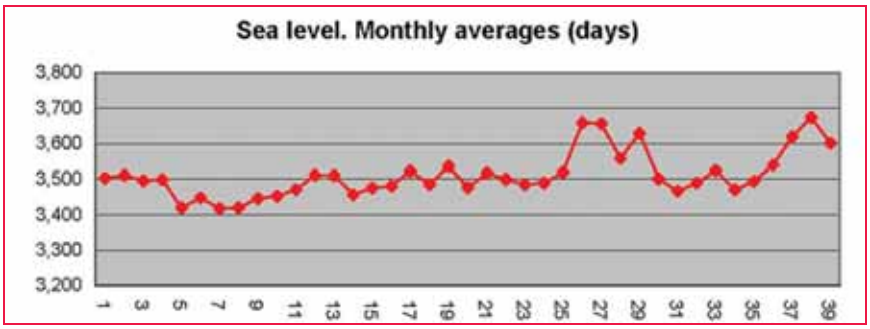


Figure 7. Monthly averages

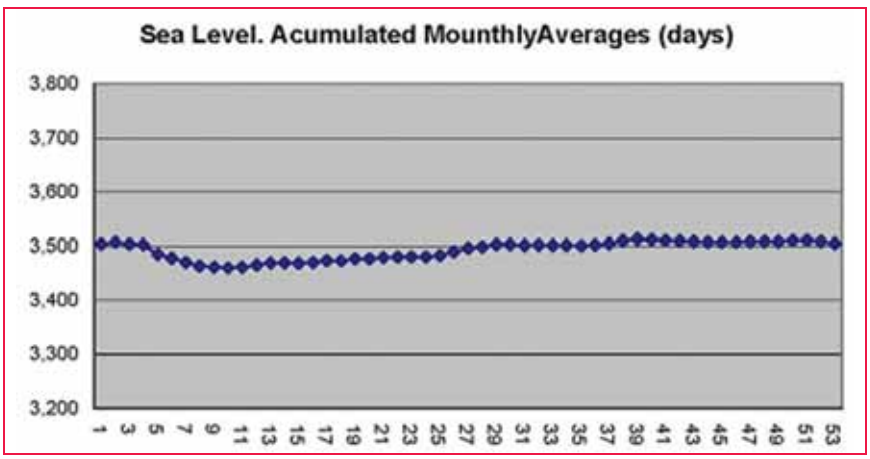


Figure 8. Accumulated average


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# Low cost optimized GNSS application

The benefit of low cost GNSS applications is brilliantly described and taken in focus in the targets and working groups of UNOOSA

**Dr Ivo Milev**
Managing Director
technet-rail 2010
GmbH; Germany

Today global navigation systems have become a part of our everyday life. It is part of many useful things and assisted people in many ways. It is part of the marine, aircraft and traffic issues - from private user up to logistic cooperation. Also it is used in agricultural companies for precise farming as well as for information systems in all kind of tasks like geology, archeology, hydrology and a lot more. In the sector of engineering, it supports and guides the construction machines. Diverse scientific experiments and duties utilize GPS as part of their time measuring systems. In the field of survey, the exploit broadness is also widely spread.

## Motivation

The main motivation is to provide a solution for engineering professionals but with a mass market-based Android application platform. So, combining simplicity in handling with object orientated databases - where targets can be addressed and edited. It can be used by people without special surveyor education but produces outcomes that can further be used in high end solutions. A qualified post processing is possible any time.

A large part of the world doesn`t have the infrastructure for bi-directional online services for high precision GNSS and also lack of money for cost intensive two frequency devices. In conclusion, we try to use the possibilities that are available at the time to raise the precision of low cost GNSS devices. The fields of use are the rail and road maintenance (infrastructure and building sites) as well as the power supply infrastructure.

At the time, we combine tablet PC's that have the application and already have an internal GPS chip (in some cases an AGPS) or for higher precision OEM GPS receiver via Bluetooth (see figure 2).

So GPS and GLONASS satellites are used in combination and additionally the SBAS service from the geostationary satellites. In conjunction, the signals can suffice to raise the precision up to 1.5m accuracy and lower.

This is an adequate resolution for supervising in the field and detecting data.

**Figure 1: Tablet-PC with App, showing a nature protection area**

## Fundamentals

GNSS is the term for a global navigation satellite system that consists of several satellites (~ 30) which transmit their position and time. With the combination

of the signals (min. 4 satellites), a receiver could identify its own position through intersection methods. There are some GNSS in use and they partly transmit on the same frequency (see figure 3).

There are GPS (USA), GLONASS (Russia), Compass (BeiDou) and Galileo (Europe - under construction). Each global navigation satellite system consists of 24 to 34 satellites in altitudes of 19,000 km till 25,000 km. The European system - Galileo, the only system that`s not under military control, is still under construction and competes with china`s system - Compass for the same frequency channels. The channels were configured for thin bandwidth, so that important military channels are not overlaid.

SBAS is an additional system that makes use of geostationary satellites which have a transponder on board that broadcast on the same frequency channel as GPS correction signals for improving the positioning. The additional SBAS system with geostationary satellites for Europe is called EGNOS. There are several SBAS systems in use and intended, which are dispersed over the world and continents (see figure 4). There is the WAAS (Wide Area Augmentation System) from the United States, the MSAS (Multi-functional Satellite Augmentation System) from Japan, the proposed GAGAN (GPS-aided geo augmented navigation) from India, the proposed SDCM (System for Differential Correction and Monitoring) from Russia as well as some commercial solutions.

The differential navigation system EGNOS (for Europe) transmits the corrections of the GPS signals via 3 geostationary satellites (120,124,126) at the time. In near future, it should be amplified with two additional satellites. The data are used for safety in aviation. When the position accuracy exceeds a marginal value of about 20 m horizontal/40 m vertical radius, a warning signal is transmitted after 6 seconds. So the user knows that there is a problem with the signals and the data are too inexact for using GPS alone. The gratis correction data are not so dense like the paid ones. Also there are several proposals with costs from the regional government authorities. For Germany, it is SAPOS where correction data for high accuracy is sent via radio or internet (also mobile communication). The adequate service for central and eastern Europe is called EUPOS. This is a special kind of Ground Based Augmentation System (GBAS) with more than 1,000 permanent stations between 6° east and the Ural Mountain (www.eupos.org). So the correction data could be processed in real-time or retrospectively. The IGS (International GNSS Service) has stations and service centers around the world that provides correction data for the time specifications and maps of the ionosphere. GIGOS service available correction data from IGS:

- The satellite ephemerides for GPS and GLONASS,
- earth rotation parameters

Figure 2: GNSS OEM based device

Figure 3: GNSS – GPS/GLONASS/SBAS

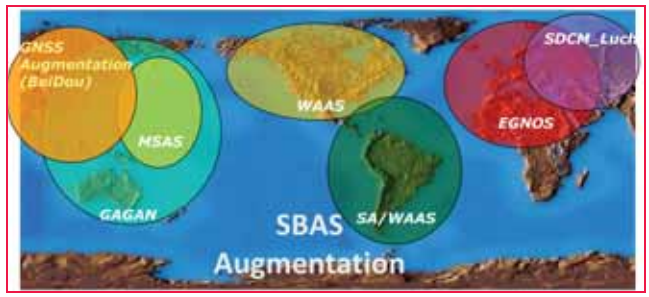


Figure 4: SBASystems that are in use or intended

Figure 5: Tablet with user defined layers for maintenance predefined cycles

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Figure 6: Tablet with Position Marker related to the track infrastructure

Figure 7: German Railway – High precision corridors

- IGS tracking station coordinates and speed measurements
- GPS and IGS monitoring stations and their time information
- The tropospheric zenith path delay
- Global ionospheric maps (www.igs.org/components/prods.html)

The IGS centers generate and provide accurate GPS and GLONASS products and facilitate support. The IGS service portal is called GGOS. GGOS integrates different geodetic techniques, different models and different approaches in order to ensure a long-term, precise monitoring of the geodetic observables.

Figure 8: Navigation function for stations coordinates or track and chainage offline SD card based

Figure 9: Example of a combined vector data on SD card and Google Earth online service

The benefit of low cost GNSS applications is brilliantly described and taken in focus in the targets and working groups of UNOOSA. The United Nations Office for Outer Space Affairs (UNOOSA) is the United Nation's office responsible for promoting international cooperation in the peaceful use of outer space. UNOOSA serves as the secretariat for the General Assembly's only committee dealing exclusively with international cooperation in the peaceful use of outer space (www.UNOOOSA unvienna.org). UNOOSA is the current secretariat of the International Committee on Global Navigation Satellite Systems (ICG). The current and future development planned GNSS and SBAS systems are described in one of the main ICG publications.

## Tablet-PC with GNSS-Application

The application could be downloaded from the technet-rail server for the German Railway. There is an online and an offline version. The installation is carried out on the SD card of the device. Track geometry data and points of interest and infrastructure facilities are stored on the SD card too.

Subsequently, the data can be read out and committed to other computers for further editing or for documentation. It's also possible to synchronize data via Internet or transferred to experts. The app is working on the android system (minimum version 3 – "Honeycomb"). The SD card space should be minimum 32 GB. When the app starts, the dataset is loaded and the internal GPS is on reception. Over the Bluetooth connection, an external GPS receiver can be connected. This has a tremendous influence in raising the accuracy of the positioning without using any mobile GPRS /3G /4G or internet services.

## Features

The tablet shows your position in an information system background, so you can retrieve information and determine points of engineering maintenance interest (rail or electric wire faults). The system has a layered structure on which several datasets can be imported. Data of objects like bridges, tunnel, crossings, rail switches or nature protection areas are available as well as information about the whole rail net like the track numbers and the chainage.

Despite this, there is always the coordinates shown in UTM and as geographic coordinates. There can be hand out PDFs at any time to present and transfer an issue to colleagues. The elements (bridges, tunnel...) are implemented as editable objects and can be additionally fitted with comments or technical data. Just as well, there can be exported geotiffs or tiffs. In the background, there is diverse map material (scalable) achievable for the different user tasks. The infrastructure plans from the German Deutsche Bahn AG (ivl plan) shows the rail environment and counts as special maps, but there were also open source data implemented like WMS (web map

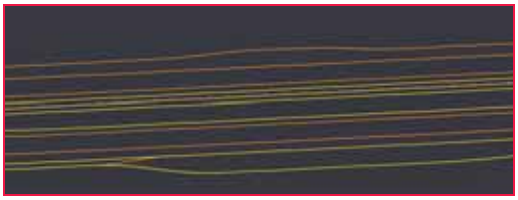

**Figure 10: Example of the vector data from SD card visualized in the German rail-network, showing track rails (yellow), the stationary rails (orange) and the routing (pink points) – always with the information of the explicit track number, chainage and coordinates**

**Figure 11: Presentation of background tracks information, special map and chainage. Combination on- and offline**

**Figure 12: Position marker with information for the track and the station**

service), TMS (tile map service) or some free digital orthophotos (DOP40) from the German bureau of cartography and geodesy. They cover the state "Nordrhein-Westfalen" in 40 cm ground resolution. In principle, every user can load or buy map material for their issues from several services and call them up via internet. The interface for implementing the data is already there.

The position of the user is shown in the middle of the monitor as standard. In the upper menu console the coordinates are shown as well as information to the track the user is on. So there is shown the nearest track number and the chainage at this position. It also classified the rails in main or stationary rails and additionally could replay directional if there were nature protection areas to estimate.

The tracked data can be exported to just save or use it for documentation purposes or for further processing.

The High precision corridors are a combination of raster and vector data of the tracks and the track vicinity infrastructure. All this are stored on the SD card. The navigation tool allows the precise navigation based on geo position, track number and railway station ID.

If the online use is not possible, the background for the geo position is the raster data of the railway cadaster. Additional markers can be loaded for representing clearance restrictions.

### Feature resume

- Diverse basis layer
- IVL drawings (infrastructure maps of the Deutsche Bahn AG)
- Information of main and rail station tracks
- Information of chainage
- Search function to navigate to stations, tracks with chainage or coordinates
- Display position with marker
- Display clearance restrictions
- Display environment protected areas
- Set points of interest

### Components

The Android unit with application and internal GNNS chip. Diverse information layer are also offline accessible because they are stored on the SD Card. An OEM GNSS (GPS/GLONASS L1) sensor plugged on via Bluetooth.

## Conclusion

The app is useful as a low cost GNSS solution for investigation, capturing measurements in real time and simple for field evaluation. Further analyzing subsequently on high end software is feasible. The app can be modified for other duties so it could be convenient for diverse disciplines. At the time, it is on the stadium of a pilot project and has to extend in its features.

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ICG_ebook.pdf - Current and Planned Global and Regional Navigation Satellite Systems and Satellite-based Augmentations Systems

## Japanese Cabinet outlines plans for procurement of QZSS Ground Segment

The Japanese Cabinet Office issued an official announcement recently approving plans to procure and finance construction of the ground control system and the operation of the next phase of the Quasi-Zenith Satellite System (QZSS). Procurement is going to be carried out using PFI (private finance initiative) scheme. The construction of the space segment itself is excluded from the operational control segment PFI, but a description of the overall QZSS system design and current implementation schedule is included in a requirements and standards document that accompanied the announcement. The requirements document specifies that check-out of the on-orbit QZSS SVs and the ground system must be finished by March 2018.

## India's heaviest satellite GSAT-10 launched

India's advanced communication satellite GSAT-10 was successfully launched early Saturday on board Ariane-5 rocket from Europe's spaceport in French Guiana. GSAT-10, with a design life of 15 years is expected to be operational by November and will augment telecommunication, Direct-To-Home and radio navigation services. At 3,400 kg at lift-off, GSAT-10 is the heaviest built by Bangalore-headquartered Indian Space Research Organisation. It was ISRO's 101st space mission. GSAT-10 is fitted with 30 transponders (12 Ku-band, 12 C-band and six Extended C-Band), which will provide vital augmentation to INSAT/GSAT transponder capacity.

It also has a navigation payload — GAGAN (GPS aided Geo Augmented Navigation) — that would provide improved accuracy of GPS signals (of better than seven metres) to be used by Airports Authority of India for civil aviation requirements. This is the second satellite in INSAT/GSAT constellation with GAGAN payload after GSAT-8, launched in May 2011. *http://www.thehindu.com/news/*

## Geomatics Engineering Department links Saudi Arabia to Global Satellites Network

Department of Geomatics Engineering of Yanbu Industrial College has linked Yanbu and Saudi Arabia to the Multi-Global Navigation Satellites System Network (MGM-Net) of the Japan Aerospace Exploration Agency. (JAXA). The Agency has accepted the application of the Yanbu Industrial College to host one of the !4 Multi-Global Navigation Satellite Receivers in the world. The site can be a key station for the MGM-Net. The establishment of MGM-Net by JAXA is under international collaboration as part of "Multi-GNSS Demonstration Campaign". The installation of the Multi-GNSS Monitoring receiver in Yanbu, will enhance the applications of GNSS within the region.

## GPS devices help check illegal waste dumping in Abu Dhabi

Increased awareness and installing GPS devices in waste collection trucks to track them have minimized number of illegal waste dumping in the emirate, according to the Centre of Waste Management – Abu Dhabi. Out of more than 4,300 waste collection trucks in the emirate 4,200 have been installed with GPS device. *http://gulfnews.com*

## US, Canadian GPS differences lead to pipe break

Authorities say differences between GPS systems in the U.S. and Canada were behind the international bridge construction error this summer that severed a wastewater discharge pipe. A spokeswoman for the New Brunswick Department of Transportation tells the Bangor Daily News ( http://bit.ly/Spyivw) the GPS coordinate system upon which surveys typically are based is different in the U.S. than in Canada. *http://www.boston.com/news/*

## FAA responds to users on future navigation system

As the FAA begins to detail plans to take the National Airspace System from ground-based navigation systems to satellite technology, the agency has committed to creating an advisory group urged by AOPA and others to help set key guidelines for the transition.

The FAA said it had accepted the recommendation to set up the advisory group in published responses to stakeholder comments on its proposed provision of navigation services.
In December 2011 the FAA invited comments on its plans to transition from ground-based navaids to satellite-based navigationin particular the details of its planned technological departure from VOR and other legacy navigation aids. *http://www.aviationpros.com/news/*

## Mumbai airport to get satellite-based navigation system

Aircraft coming into Mumbai will soon be able to use a satellite-based navigation aid for landing. The Airports Authority of India (AAI) is planning to introduce a satellite-based landing procedure across the country in a phased manner. Currently, aircraft land with the help of ground-based navigation systems. *http://articles.timesofindia.indiatimes.com/*

## In-Store navigation is finally here

The retail drug store Walgreen's in USA has been working with a company called aisle411 to develop an in-store navigation system customers can use on their smart phones. The app, which will work on all smart phones, will provide a more convenient shopping experience for customers. Essentially, customers will be able to use their smart phones to see a type of birds-eye view of the store and the aisles to see where they are and easily zoom in and find what they're looking for. *http://www.business2community.com/*

## China launches another 2 navigation system satellites

China successfully launched another two satellites into space for its indigenous global navigation and positioning network. They were the 14th and 15th satellites for the Beidou, or Compass, system. *http://news.xinhuanet.com/english/*

## JAVAD GNSS improves GNSS filter designs, components

In a recently issued a letter to the FCC and NTIA, JAVAD GNSS informed them of the current status of technical possibilities in GNSS filter designs and components, in the hope that the information presented be used to establish the performance guidelines and requirements for all GNSS receivers used in critical applications.

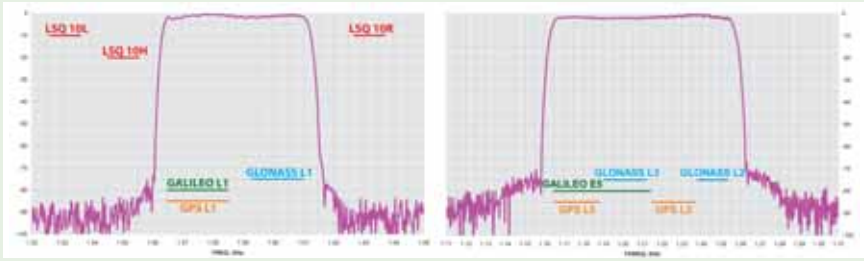
In the letter, JAVAD mentioned the improvements made to their previous L1 filter and the changes made to the design to include all commercial GNSS bands.

Figure 1 depicts the filter that protects GPS L1 and GLONASS L1 bands, and brings in only the useful signals with the slope of 12 dB/Mhz. Similarly, Figure 1 is the filter designed to protect GPS L2, GPS L5, GLONASS L2 and Galileo L5 and has slope of about 9 dB/Mhz.

These filters, extensively tested with five different innovative tests, are mass-produced today and every user can test their receivers in all environments. Even a novice can test these filters by clicking the right buttons.

The filters allow better usage of these precious bands, in particular for broadband wireless communication. The letter states, "These filters not only protect GNSS signals against all LightSquared signals (10L, 10H and 10R handsets) but also from all similar signals that may appear near all commercial GNSS bands in the future."

The filters apply to wideband high precision GNSS receivers and are cheaper than earlier conventional filters. "The low precision receivers (L1 C/A code only) require filter slopes 10 times less steep than those presented here and do not necessitate additional costs," the letter adds.




## India could lease satellite-based system to neighbours

With India moving ahead to implement satellite-based navigation system from next year, an industry expert has suggested this futuristic facility could be leased to neighboring countries to help them navigate their air traffic.

GAGAN – a joint project by Airports Authority of India and ISRO conducted the Final Acceptance Test in July, paving the way for its scheduled commissioning in mid-2013.

"The technology can be leased by India to neighbouring countries to manage their air traffic as well as overflights. Leasing will generate substantial funds for India," William Blair, President, Raytheon India, said.

In July'12, a team of AAI, ISRO and Raytheon completed the Final System Acceptance Test of GAGAN in Bangalore. The certification by the Director General of Civil Aviation (DGCA) is scheduled soon after completion of the Operational Testing performed by AAI in 2013.

"GAGAN will be the world's most advanced air navigation system and further reinforces India's leadership in the forefront of air navigation," Raytheon Network Centric Systems Vice President Andy Zogg said in a statement. *http://zeenews.india.com/news/*

## Apple Maps: On a road to nowhere

Mapping and navigation is at the heart of how we use smartphones today. By extension, the Apple Maps app is at the heart of iOS 6. And so Apple's decision to swap Google Maps for Apple Maps in its new operating system was bound to attract some attention. Unfortunately, imperfection is unavoidable and inherent in any map, indeed in any geographic data. Imperfection begins with the map data. In Apple's case, the underlying map data are supplied by TomTom.

Using a process called map matching, today's navigation systems can reliably identify which road a vehicle is driving on and which intersection comes next (high topological accuracy). This is even the case when the coordinate positions encoded in the underlying map data and generated by GPS contain quite substantial errors (low positional accuracy). Another facet of imperfection is the currency of map data. In a constantly changing world (new roads, new buildings, moving businesses, renamed stadiums) map data needs to be maintained. So imperfections are unavoidable in our maps, our map data, and the procedures we rely on to organise and search that data. Merely making maps digital does not make them correct. *http://theconversation.edu.au/*

## GNSS threat mitigation technologies by Septentrio

With threats to GNSS increasing daily, Septentrio has responded with a whole suite of defensive technologies which enable reliable positioning when Septentrio receivers encounter interference. These counter-measures include adaptive notch filtering, pulse blanking and GLONASS L2 band remapping. Working in concert, these and other analog and digital countermeasures, form Septentrio's AIM+ (Advanced Interference Mitigation) technology.

## Spirent solution to reveal differences in performance of leading smartphones

Spirent 8100 Location Technology solution was used by Signals Research Group (SRG) in the industry's first independent benchmark study of the performance of location technologies in chipset platforms and leading smartphone models. The SRG report reveals significant performance differences in the Assisted GPS (A-GPS) receive sensitivity of leading smartphones. The report also highlights the incremental benefits of a multi-GNSS (Global Navigation Satellite System) approach, using signals from the Russian GLONASS satellite system in conjunction with A-GPS, when obtaining a location fix. *http://www.heraldonline.com/*

## Apple wants to sync iPhone and in-car GPS

Apple filed a patent related to syncing an iPhone with a car with the US Patent and Trademark Office in May 2012. The patent refers to sharing location information between the car and iPhone so that features like turn-by-turn navigation can be utilised. It includes the option of tracking your location using the vehicle's GPS. *www.macworld.com.au*

## Google maps adds navigation, live traffic updates

Google recently announced the availability of two new features for Google Maps in India: turn-by-turn voice-guided driving directions through Google Maps Navigation (Beta) and live traffic information for several major cities. *http://ibnlive.in.com/news/*

## Bharti Airtel launches navigation application

Bharti Airtel in India has launched a navigation application - SmartDrive - that enables users to view their location on a map and plan the route from one place to another. "SmartDrive is assisted by a voice based turn by turn navigation that gives real time information updates on traffic situation on roads around," the company said in a statement. *http://india.nydailynews.com/business/*

## Directions and navigation for Android brought to MENA

Google is announcing the next step for Google Maps for mobile in the Middle East and North Africa- the availability of Google Maps with Navigation (Beta) for phones running Android 4.0 in nine countries across MENA. It is an Internet-connected GPS navigation or 'satnav' system that provides turn-by-turn voice driving directions as a feature of Google Maps for mobile. *http://www.ameinfo.com/*

## Belarusian Railways working on electronic navigation in locomotives

The R&D center of Belarusian Railways is working on a pilot project to install electronic navigation equipment in locomotives. At present Belarusian Railways is busy installing satellite navigation means with an operator's electronic key at 15 passenger electric locomotives operated by the Minsk Office. The rolling stock is used on the territory of Belarus and Russia. *http://news.belta.by/en/news/*

## Pole Star deploys over 6.5 million square feet at the Paris-CDG Airport

Pole Star in partnership with the Wi-Fi operator, Hub Telecom, has extended coverage of the NAO Campus solution to all of terminals of Paris-Charles de Gaulle Airport. The CDG Airport is the first venue in the world to offer indoor location service over such a large area and in such a complex environment. The Pole Star indoor location solution enables users to locate their position with an average accuracy of 5 meters and even up to 1.5 meters depending on the zone, while guaranteeing seamless indoor/outdoor and level transitions.

## Yandex to power iPhone map services in Russia

Russian search giant Yandex will power the mapping services for Apple users in the country when the latest version of Apple's mobile operating system goes live, according to a report published in the Wall Street Journal. Anyone using Apple's mapping service on an iOS6 powered device inside Russia will receive information provided by Yandex, according to the report. In addition, anyone using mapping services about Russia but located outside the country will be fed information by Yandex. *http://blogs.wsj.com/tech-europe/*

## Family locator services to reach 70 million active users in Europe and N America

According Berg Insight report, the number of active users of family locator services in Europe and North America is forecasted to grow from 16 million in 2011 at a compound annual growth rate (CAGR) of 34 percent to reach 70 million in 2016. In terms of number of users, family locator services is the largest segment for people monitoring and safety solutions based on either GPS-enabled smartphones or dedicated cellular/GPS location devices. *www.berginsight.com*

## Global LBS Market 2011-2015

TechNavio's analysts forecast the Global LBS market to grow at a CAGR of 48 percent over the period 2011-2015. One of the key factors contributing to this market growth is the increasing adoption of GPS-enabled smartphones and tablets. The Global LBS market has also been witnessing the increasing adoption of LBS across industries. However, the lack of wireless network coverage and bandwidth could pose a challenge to the growth of this market. *http://www.heraldonline.com/*

## Tahoe RF Licenses latest GNSS technology from Stanford University

Tahoe RF Semiconductor has licensed the latest GNSS technology from Stanford University for the development of their next generation low-power, low-cost universal GNSS IC. The technology employs unique RF subsampling techniques that enable the receiver to support all the GNSS bands and be implemented on a single RF CMOS IC Technology *http://www.itnewsonline.com/*

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## British Geological Survey Maps the World with 3D Laser Mapping

The British Geological Survey is to use a state of the art laser scanner to map volcanoes, glaciers and other natural phenomena. The RIEGL VZ-1000 purchased from 3D Laser Mapping will be used around the world to collect data that will be used to create photorealistic fly-throughs, 3D height models and highly accurate area and volume calculations. *www.3dlasermapping.com*

## Melbourne selects CARIS for bathymetrical database system

CARIS has recently completed a successful project for the provision of a bathymetrical database system for the Port of Melbourne Corporation (PoMC). PoMC conducts regular bathymetric surveys as part of its statutory obligation to provide safe and effective transit of vessels through Port Waters. The project involved the integration of CARIS Bathy DataBASE and the Engineering Analysis Module into existing PoMC workflows. *www.caris.com*

## OGC adopts netCDF enhanced data model extension standard

The Open Geospatial Consortium (OGC) membership has approved the enhanced data model extension to the OGC Network Common Data Form (netCDF) core encoding standard. The enhanced data model extension, along with the core encoding standard, the netCDF binary encoding extension standard - netCDF classic, and the 64-bit offset format are available for free download at *http://www.opengeospatial.org/standards/netcdf*

## Sri Lanka, UN to improve disaster management through Open Data

The Survey Department of Sri Lanka and the United Nations Office for the Coordination of Humanitarian Affairs signed an agreement for digital data dissemination, which will allow organisations to freely use Government geographic data for disaster management purposes. The initiative stemmed from the need to address challenges posed by the lack of access to essential information needed to make well-informed decisions during critical situations. *http://www.futuregov.asia*

## US Army to establish standard for geospatial data storage

The US Army in collaboration with the National Geospatial-Intelligence Agency and US Marine Corps is working to establish the Ground-Warfighter Geospatial Data Model as the ground-warfighter National System for Geospatial-Intelligence standard. The purpose of the effort is to reduce stovepipes, lower costs, simplify acquisition and accelerate transition of technology as part of a standard and shareable geospatial foundation. *http://defensesystems.com/*

## Lagos land information system to go online soon

The Lagos State GIS and digital mapping would go online before the end of 2012 to speed up land documentation. The present land documentation system is slow due to physical submission and retrieval of land information for processing land titles, particularly Certificate of Occupancy.

## Indonesia to map quake-prone areas

The Volcanology and Disaster Mitigation Agency and the Energy and Mineral Resources Ministry have been working together to map areas in Indonesia that are prone to earthquakes. The agency's head, Surono, said that the map would be provincial in scale and would be completed in 2014.

## MIT develops automatic building mapping system

Researchers from Massachusetts Institute of Technology (MIT) have developed a wearable sensor system that automatically creates a digital map of the environment through which the wearer is moving. The prototype system is envisioned as a tool to help emergency responders coordinate disaster response. *http://web.mit.edu/newsoffice/*

## Bentley acquires Ivara Corporation

Bentley Systems, acquired Canada-based Ivara Corporation, a leading provider of asset performance management (APM) software solutions. *www.bentley.com*

## OpenSignal raises USD 1.3 mn

OpenSignal has raised USD 1.3 million seed round from Qualcomm Ventures, O'Reilly AlphaTech Ventures and Passion Capital, which it will use to build up its database of mobile network performance metrics. OpenSignal has an Android app that allows one to track the towers their phone connects to and measure their signal strength. *http://gigaom.com/*

## Bahrain saves BHD 31 mn

The plan to integrate all services of the Kingdom of Bahrain into the Central Informatics and Telecommunication hub saved the government BHD (Bahrain Dinar) 31 million, said Dr Khalid Abdul Rahman Al Haidan, Director, GIS *http://www.bna.bh/portal/en/news/*

## Content-based geographic map search tool unveiled

A new digital map-search tool, LandEx, has been unveiled by University of Cincinnati Professor Tomasz Stepinski. It is a GeoWeb-based tool for exploration of patterns in raster maps. Stepinski describes LandEx as a new, content-based geographic map search tool. The tool is currently available online to allow researchers and educators to explore its capabilities. *http://www.uc.edu/news/*

## Blue Marble releases Desktop 2.5

Blue Marble Geographics released Blue Marble Desktop v2.5. It has new powerful geodetic tools, new time dependent transformations and file formats. Its geospatial data manipulation and conversion solutions are used worldwide by thousands of GIS analysts at software, oil and gas , mining, civil engineering, surveying, technology companies, governmental and university organizations. *www.bluemarblegeo.com*

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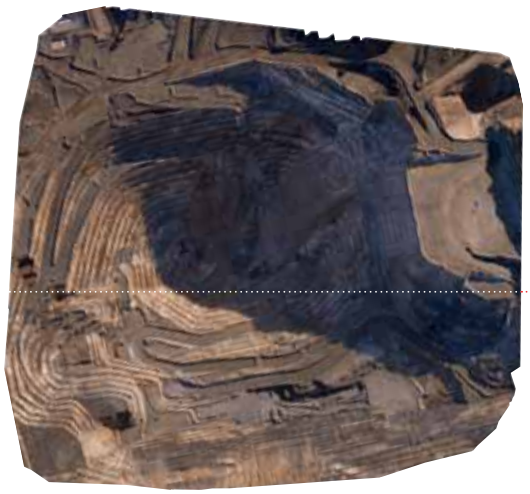

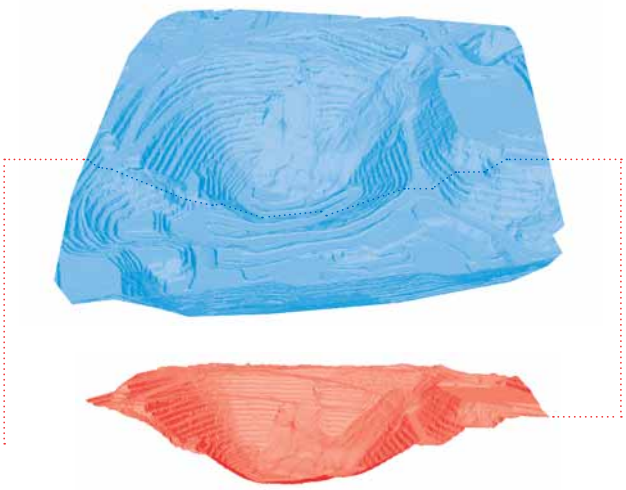

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## China to promote drones for marine surveillance

China will promote the use of drones, or unmanned aerial vehicles (UAVs), to strengthen the nation's marine surveillance, the State Oceanic Administration (SOA) said. The SOA verified and accepted a pilot program of using drones to undertake remote-sensing marine surveillance in Lianyungang, a costal city in eastern Jiangsu Province. With the experience learned from the pilot program, the SOA would try to form a managerial system and technical regulations in a bid to set up UAV surveillance and monitoring bases in provinces along China's coastline by 2015. *http://news.xinhuanet.com/english/china/*

## PSLV orbits commercial remote sensing satellite

An Indian launcher lifted off and placed France's Spot 6 commercial Earth imaging satellite and a Japanese secondary payload into orbit 400 miles high on September 9, 2012. The Polar Satellite Launch Vehicle lifted off at 0423 GMT (12:23 a.m. EDT) from the Satish Dhawan Space Center on Sriharikota Island, India's primary launch site on the country's east coast about 50 miles north of Chennai. The rocket also orbited the student-built Proiteres microsatellite for the Osaka Institute of Technology in Japan. The 1,569-pound Spot 6 satellite will collect high-resolution imagery, resolving objects as small as 1.5 meters, or about 4.9 feet. The launch marked India's 100th space mission, including indigenous rockets and Indian-built satellites.

## First Images from SPOT 6 Satellite

Astrium Services has posted the first images from the SPOT 6 satellite, just 3 days after its launch on 9 September. These first images present very varied landscapes, highlighting SPOT 6's potential for applications like urban and natural resource mapping or agricultural and environmental monitoring.

## US Dept of Justice seeks detail of DigitalGlobe merger

DigitalGlobe said that the Department of Justice, US, is seeking further information about its planned acquisition of GeoEye.

The Department of Justice has sent two requests to DigitalGlobe for information about the deal, which the company says are a standard part of the regulatory process. Their requests extend the waiting period under certain antitrust laws that prohibit the deal from closing until the information is provided by the company, or until the federal government lifts the waiting period.

## NASA ER-2 aircraft helping to test new science instruments

NASA will be using an ER-2 high altitude research aircraft to fly test models of two future satellite instruments. The aircraft will be used to take models of these instruments at altitudes greater than 60,000 feet to gather information researchers will use to develop ways to handle data that future space born versions will collect. The aircraft will be carrying the Cloud-Aerosol Transport System (CATS) and the Multiple Altimeter Beam Experiment Lidar (MABEL) up to high altitudes for tests. CATS is a high spectral resolution lidar that uses a laser to help scientists have a better understanding of clouds and aerosols. MABEL is a laser altimeter built to simulate the primary instrument on ICESat-2, which will study land, sea ice and vegetation. *http://www.redorbit.com/news/*

## New VG4D-SmartLiDARRoadXtract from Virtual Geomatics

Virtual Geomatics SmartLiDAR RoadXtract™ software is specially developed to cater to the needs of today's transportation industry. It is a stand-alone, feature rich software solution, designed to provide the Departments of Transportation & Roadway Engineering contractors an easy path to incorporating LiDAR data for their road design and analysis. It can directly import data from variety of popular mobile, terrestrial and airborne lidar sensors to generate outputs compatible with industry standard Autodesk and Bentley packages. *http://www.itnewsonline.com/*

## RaLi – mobile lidar for rail

Surveying Solutions RaLi is a purpose-built vehicle that can travel along railway lines, on the tracks, and provide mobile laser scanning. It's what's known as a "hi-rail" vehicle, which means it can travel on both normal roadways and train tracks (it's a modified Ford F-350, actually), and the company has equipped it with a specially manufactured frame that allows the company to quickly and easily attach the same Riegl VMX-250-based mobile scanning solution it uses for normal roadway scanning. *http://www.sparpointgroup.com/News/*

## LiDAR survey uncovers Skokholm island settlements

The Royal Commission on the Ancient and Historical Monuments of Wales, UK said a new laser survey from the air uncovered new clues to the history of a Pembrokeshire island. LiDAR (light detection and ranging) technique was used to draw a detailed model of the island's surface. The new discoveries include the remains of enclosures and fields underlying the field pattern of the island's 19th Century farm. Some of the discoveries show similar but less complex activity to that on the neighbouring island of Skomer.

## Charter offers 'Universal Access' to satellite data

The international space organisation that makes timely satellite data available to rescue authorities is now offering 'Universal Access' to the data for emergency response purposes, strengthening its contribution to disaster management worldwide.

Founded by ESA and the French and Canadian space agencies, the Charter is an international collaboration between the owners and operators of Earth observation missions. It provides rapid access to satellite data to help disaster management authorities in the event of a natural or man-made disaster. *www.esa.int*

# Galileo update

## EC ensures funding for Galileo, EGNOS till 2020

Industry Committee Members of the European Parliament (MEPs) approved new legislation to ensure that Europe's two satellite navigation systems — Galileo, the European GPS system, and the EGNOS programmes for improving GPS signal quality — can be funded and operated from 2014 to 2020.

The European Commission has earmarked EUR 7.9 billion to complete the EU's satellite navigation infrastructure over the seven-year period. MEPs call in amendments to the draft legislation for more of the new services to be offered free of charge. The Public Regulated Service, which will ensure, from 2014, that key services such as police and ambulance services continue to operate in times of crisis, must be free, they say. So must the Safety of Life Service, a European Geostationary Navigation Overlay Service (EGNOS) program, which will be fully available later and will make air navigation safer.

Two other Galileo services will be available from 2014: the Open Service, which will be accessible free of charge and will provide positioning, velocity and timing information, useful for example, in mapping, and the Search-and-Rescue Service, for use in emergencies such as the loss of a sailor at sea. The Commercial Service, allowing commercial applications of the technology, will be available later. *http://marinelog.com*

## Galileo Agency inaugurates new Seat, to endorse new responsibilities

The European GNSS Agency (GSA) officially opened its new headquarters in Prague last week after its staff relocated from Brussels during the summer. This new location is symbolically expressing its growing operational responsibilities.

As a direct consequence the staff of the GSA is expected to grow from 60 people today to more than 180 in 2020. *http://www.gpsbusinessnews.com/*

## Outback MAX with ConnX by Hemisphere GPS

The new Outback MAX integrated display terminal from Hemisphere GPS offers section and variable rate control, GPS and GLONASS guidance, video support for up to four cameras, plus wireless data transfer capabilities to automatically import and export prescription application maps, as-applied files and other critical precision agriculture data. The optional Outback ConnX data management system provides seamless data transfer between the Outback MAX terminal, the farm office and service providers using AgJunction, AgVerdict, NutriScription HD, OptiGro and Precision.Ag data platforms. *www.OutbackMAX.com.*

## CHC Navigation opens Canadian service center

CHC Navigation extends its Customer Service portfolio by opening its Canadian Service Center. Located in Trois-Rivieres (Quebec), the Service Center is fully equipped to meet the needs of Canadian partners and customers that require fast, flexible and reliable training and repair services. *www.chcnav.com*

## Trimble introduces new compact OEM GNSS receiver module

Trimble has introduced the Trimble® BD920-W3G receiver and communication module. As part of Trimble's GNSS OEM portfolio, the new compact module features centimeter-level, Real-Time Kinematic (RTK) positioning capabilities coupled with Wi-Fi, Bluetooth and cellular that deliver flexible communication options for precise, mobile positioning. Its connectivity and configuration ease allow system integrators and OEMs to easily add GNSS centimeter-level positioning to specialized or custom hardware solutions. The Trimble BD920-W3G module has been designed for applications requiring centimeter accuracy in a compact package. By integrating wireless communications on the same module, the task of receiving and transmitting data such as RTK corrections is greatly simplified. *www.trimble.com*

## IQ Wide Format Scanner Series, MFP Solutions by Contex

Contex A/S, recently announced several new wide format scanning solutions: the all-new IQ scanner series, MFP2GO, and MFP Repro. The IQ scanner series is the most advanced in CIS technology and boasts a number of features that produce exquisite image quality for 24- and 44-inch wide technical documents, maps, and drawings. Enhancing the users' scanning workflow, Contex's new MFP2GO lets customers turn their HP or Canon wide format printer into a copier, without the need for a PC.

## New Leica Zeno GG03

The Leica Zeno GG03 is an upgradable GNSS SmartAntenna for organizations that require a compact and lightweight device for accurate and reliable positioning. It is upgradable to centimeter accuracy and connects to all Leica Zeno GIS handhelds and tablet devices including the new Leica Zeno 5. This allows field workers to select the most suitable solution for a wide range of applications, delivering unmatched flexibility in asset collection jobs with the desired accuracy. *http://www.leica-geosystems.com/Zeno*

## New OEM Version of NovAtel's Pinwheel™ GNSS Antenna

NovAtel Inc has unveiled the Pinwheel OEM ION . It is a GNSS antenna module that can be easily integrated into end-user GNSS positioning products. With a small form factor of only 143 mm x 30 mm, the antenna module receives GPS L1/L2, GLONASS L1/L2 and L-Band signals for enhanced positioning reliability and availability. It provides increased multi-path rejection and excellent phase centre stability.

It has also announced the addition of SPAN GNSS/Inertial Navigation System (INS) technology to its OEM6 GNSS receiver platform. NovAtel's SPAN technology tightly couples precision GNSS receivers with robust Inertial Measurement Units (IMUs) to provide reliable, continuously available, position, velocity and attitude (roll, pitch, yaw), even during short periods of time when satellite signals are blocked or unavailable. The release of SPAN on OEM6 provides SPAN OEM customers with new features and functionality previously unavailable on NovAtel's OEMV based SPAN platform. positioning. *www.novatel.com*

## Rockwell Collins MicroGRAM to provide secure GPS capability

AeroVironment has selected Rockwell Collins to provide its MicroGRAM GPS receiver for the Wasp™ AE small unmanned aircraft system, bringing secure, jam-resistant GPS capability to a micro UAV for the first time. MicroGRAM's unique security features are the result of designing a rugged product that leverages Rockwell Collins's strong legacy in providing Selective Availability Anti-Spoofing Module (SAASM) GPS capabilities to warfighters. *www.rockwellcollins.com*

## Gexcel Srl releases Vehicle Mounted Fully Automated Scanning

An advanced capability version of Gexcel Srl's popular JRC 3D Reconstructor® software is now available with a comprehensive Stop & Go scanner control and acquisition package for most commercially available terrestrial 3D lidar scanners. This new system allows the installation of a laser scanner onto a vehicle to gather multiple scans which are automatically georeferenced and prepared for further automated post processing applications packages such as JRC 3D Reconstructor® Mining/Tunnelling, Construction, Heritage/Architectural etc. *www.gexcel.it*

## Northrop Grumman provides navigation for Embraer KC-390

Northrop Grumman Corp won a contract to supply the hybrid GPS and inertial reference system for Embraer Defense and Security's KC-390 medium-lift military transport aircraft. Engineers at Northrop Grumman LITEF, the German navigation systems subsidiary of the prime contractor, will provide the fiber-optic,


## Introducing our new easier-to-hide OEM6.

The new OEM615 GNSS receiver from NovAtel provides the industry's leading GPS+GLONASS dual frequency RTK positioning performance – in our smallest form factor – so you get all of NovAtel's reliability but in a more discreet, easy-to-integrate card. For more info, visit novatel.com/oem6 or call you-know-who. **Integrate success into your [redacted].**

NovAtel

gyro-compass LCR-100 Attitude and Heading Reference System for use on Embraer's fly-by-wire KC-390 aircraft, scheduled for flight in 2014. *http://www.avionics-intelligence.com/*

## CBx5 Touch-Screen Control Box from Carlson Machine Control

Carlson Software's Machine Control Division introduces the CBx5 Control Box Console, the next generation, ruggedized, touch-screen control box. It's designed for use in heavy equipment utilized in mining, landfills, dredging, blast drilling and for other 3D machine control applications. Its communication ports ensure that future sensors and application features will be supported and the unit has a scalable option for integrated GPS+GLONASS.

## Upgraded forest inventory solution by F4

F4 Tech released SilvAssist version 3.0. It reduces the steps required to setup, manage, report, and analyze forest inventory. It is an extension to ArcGIS by Esri. It complements F4 Tech's Real-Time Inventory (RTI) by providing faster, more thorough GIS tools for managing forest inventory cruises.

## Google Search integrated into SatGuide V10

SatNav Technologies has integrated Google Search into its turn-by-turn GPS navigation software. The app, which provides navigation for Android, iPhone, Windows and tablets across all of India, has enhanced the navigation experience with a plethora of new state-of-the-art features.

## Altus Positioning Systems to supply GNSS Survey receivers

Altus Positioning Systems has been selected by the National Courts Administration of Norway, Land Consolidation Court Division, to provide APS-3G series GNSS survey receivers.

## MARK YOUR CALENDAR

### October 2012

**Esri Malaysia User Conference 2012**
23 & 24 0CTOBER 2012
PUTRAJAYA, Malaysia
**http://www.esrimalaysia.com.my**

**19th ITS World Congress**
22 – 26 October
Vienna, Austria
**http://2012.itsworldcongress.com/content/congress**

**19th United Nations Regional Cartographic Conference for Asia and the Pacific**
29 October - 1 November
Bangkok, Thailand
**http://unstats.un.org/unsd/geoinfo/RCC/unrccap19.html**

**The International symposium on GPS/GNSS 2012**
31 October - 2 November
Xi'an, China
**www.gpsgnss2012.com**

### November 2012

**Trimble Dimensions User Conference**
November 5-7
Las Vegas, USA
**http://www.trimbledimensions.com/**

**ICG-7: Seventh Meeting of the International Committee on GNSS**
5 - 9 November
Beijing, China
**http://www.icg2012.cn**

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

**spatial@gov® Conference and Exhibition 2012**
20 – 22 November
Canberra, Australia
**www.cebit.com.au/spatial**

**8th Fig Regional Conference**
26 - 29 November
Montevideo, Uruguay
**www.fig.net/uruguay**

**The 33rd Asian Conference on Remote Sensing**
26 - 30, November
Pattaya, Thailand
**http://acrs2012.gistda.or.th**

### December 2012

**European Space Solutions Conference and Space Expo**
3 - 5 December
London, United Kingdom
**www.space-solutions.eu**

**European LiDAR Mapping Forum**
4 - 5 December
Salzburg, Austria
**www.lidarmap.org**

**Esri India User Conference**
5 - 6 December
Noida, NCR, India
**http://esriindia.com/Events/UC_2012**

**NAVITEC 2012**
5 - 7 December
Noordwijk, Netherlands
**www.congrexprojects.com/12c13/introduction**

**4th Asia Oceania Regional Workshop on GNSS**
9-10 December
Kuala Lumpur, Malaysia
**www.multignss.asia**

**NAVCOM 2012**
20 - 21 December
Hyderabad, India
**ads_nertu@yahoo.co.in**

### January 2013

**ION International Technical Meeting**
27 – 29 January
San Diego, California, United States
**http://ion.org/meetings/**

### February 2013

**Second High Level Forum on Global Geospatial Information Management**
4-6 February
Doha, Qatar
**http://ggim.un.org/**

**The International LiDAR Mapping Forum**
11-13 February
Colorado, USA
**www.lidarmap.org**

**The Munich Satellite Navigation Summit 2013**
26 – 28 February
Munich Germany
**www.munich-satellite-navigation-summit.org**

### April 2013

**Pacific PNT**
22-25 April 2013
Honolulu, Hawaii
**www.ion.org**

**35th International Symposium on Remote Sensing of Environment**
22 - 26 April
Beijing, China
**http://www.isrse35.org**

### May 2012

**CSNC 2013: China Satellite Navigation Conference**
15 - 17 May
Wuhan, China
**www.beidou.org/english/paper/**

### June 2013

**TransNav 2013**
19 - 21 June
Gdynia, Poland
**http://transnav2013.am.gdynia.pl**

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### India Headoffice

**SOUTH PRECISION INSTRUMENT PVT.LTD.**
Add: 1108-09-10-11, 11th Floor, RG Trade Tower,Plot No-B-7,
Netaji Subhash Place, Pitam Pura, New Delhi-110034
Tel: +91-11-49995999, 9999999255 Fax: +91-11-45605999
Http://www.southinstrument.com Http://www.southprecision.in

### Customer Support Center

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ABX receivers are smart GNSS receivers built around the GPS/GLONASS/SBAS, single- or dual-frequency MB100 or MB800 board recently introduced in the market. Embedded Z-Blade™ technology in the board ensures powerful performance and a patented way to use multiple GNSS constellations for high-accuracy positioning solutions:

- Fast initialization and accuracy at long-range,
- Patented multi-constellation signal processing,
- Dependable Heading + Pitch/ Roll measurements ,
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Built in a weatherproof, rugged and small-size unit, the ABX receivers can be operated in harsh environments while requiring a minimum of space for their installation.

## HDS800: RUGGED AND COMPACT GNSS SYSTEM

The HDS800 is a rugged dual board GNSS system that delivers state-of-the-art RTK accuracy, including heading and relative positioning. Designed for seamless onboard system integration, it is available in a variety of configurations. Embedded Z-Blade™ technology ensures powerful RTK performance and a patented way to use multiple GNSS constellations for high-accuracy positioning and surveying solutions. See the full scope of Ashtech's GNSS sensors at www.ashtech-oem.com

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www.sxbluegps.com
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