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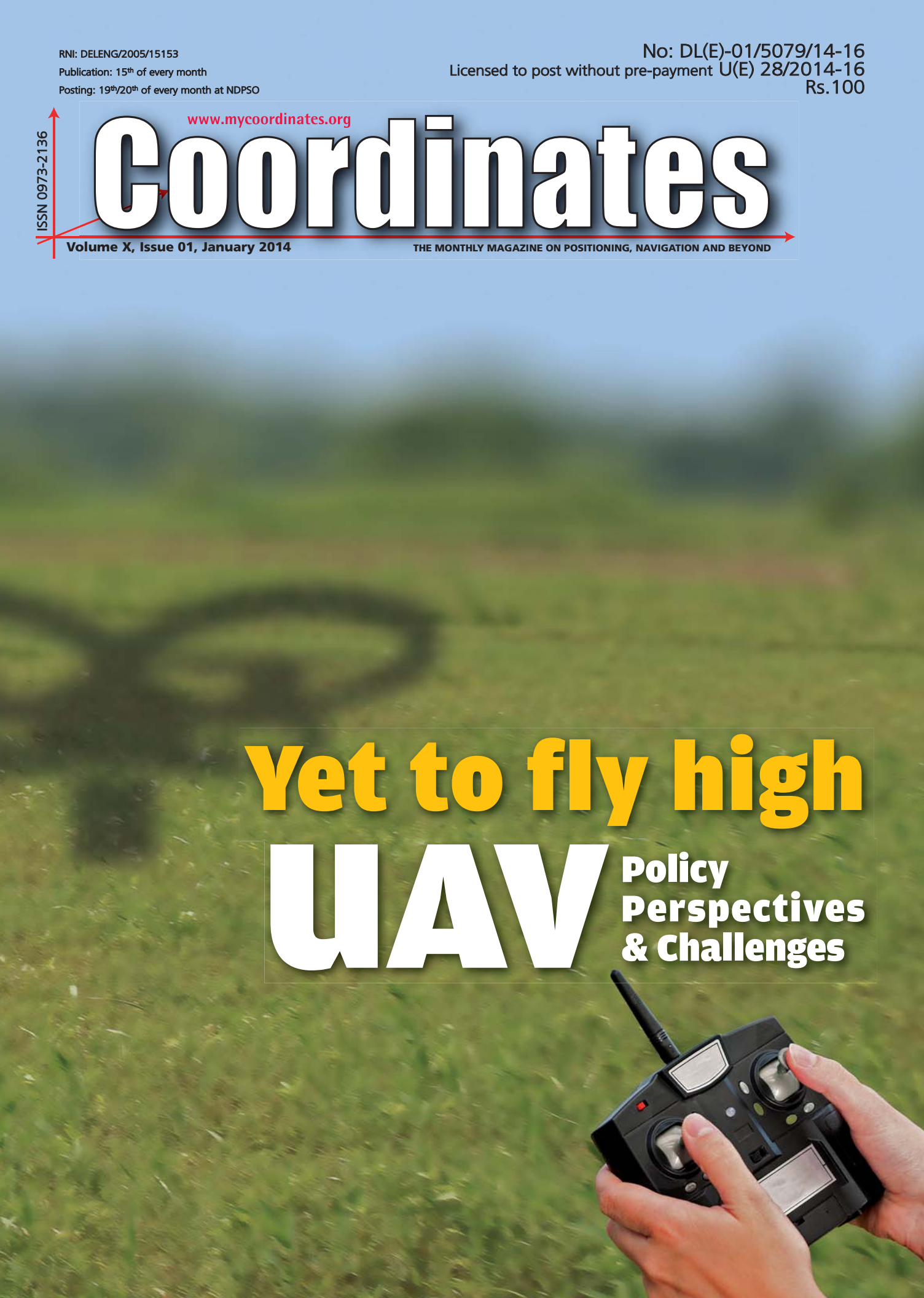
Volume X, Issue 01, January 2014

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND



Yet to fly high

UAV

Policy Perspectives & Challenges

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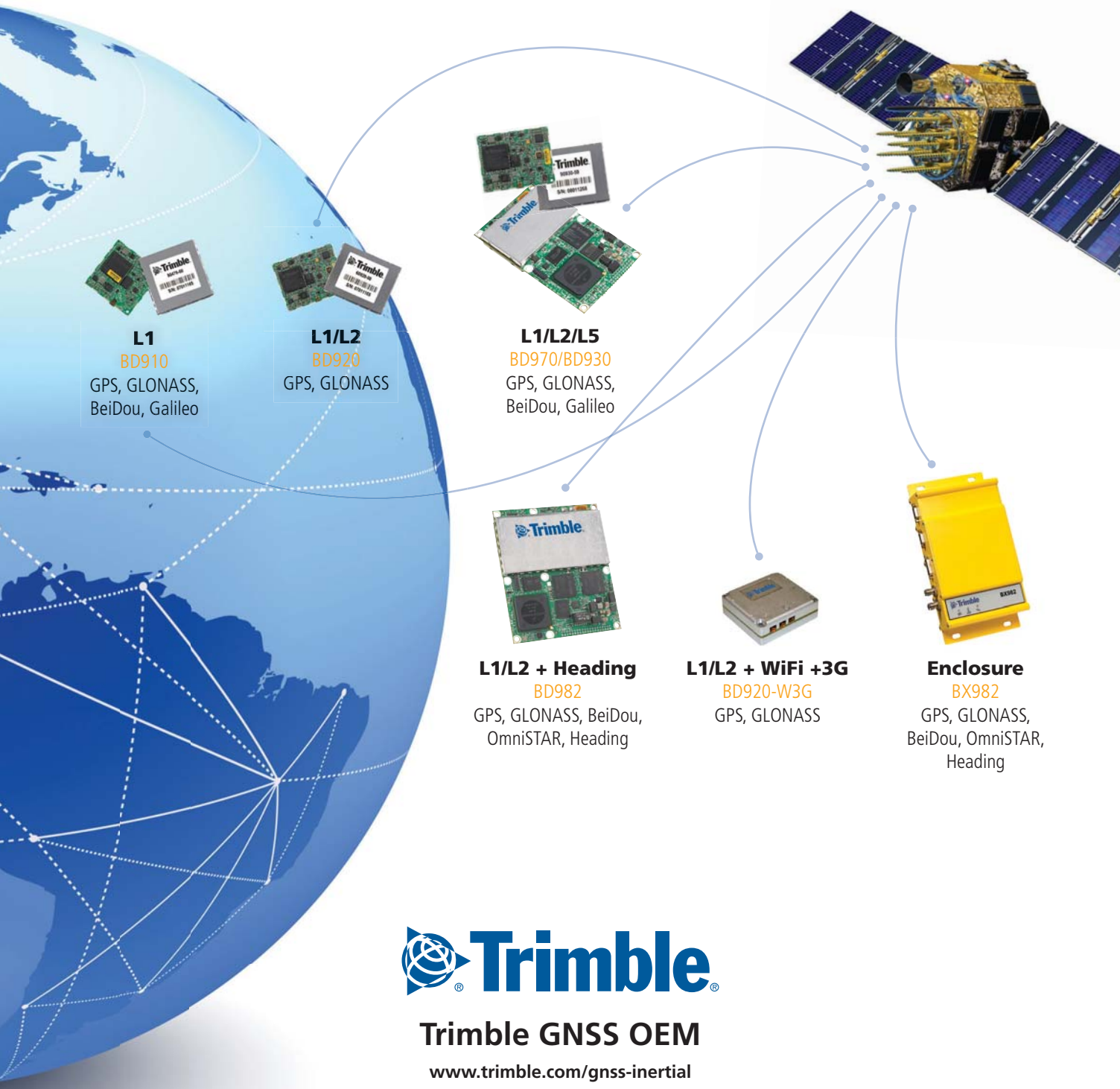

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BD910
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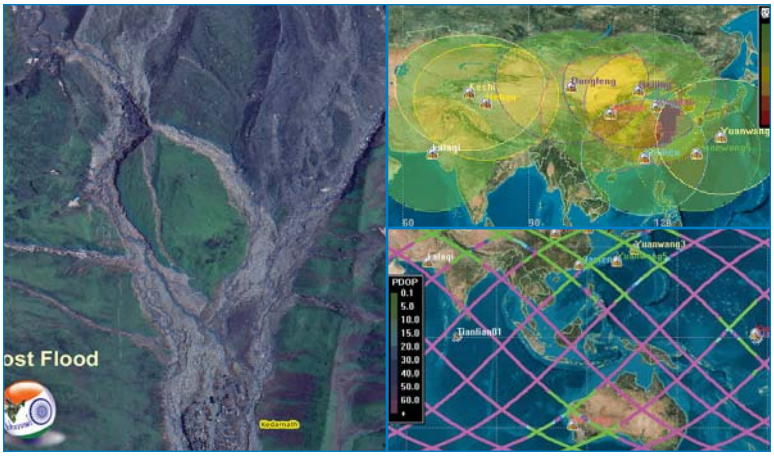

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Columns

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Mailing Address
A 002, Mansara Apartments
C 9, Vasundhara Enclave
Delhi 110 096, India.
Phones +91 11 22632607, 98102 33422, 98107 24567
Fax +91 11 22632607

Email
[information] talktous@mycoordinates.org
[editorial] bal@mycoordinates.org
[advertising] sam@mycoordinates.org
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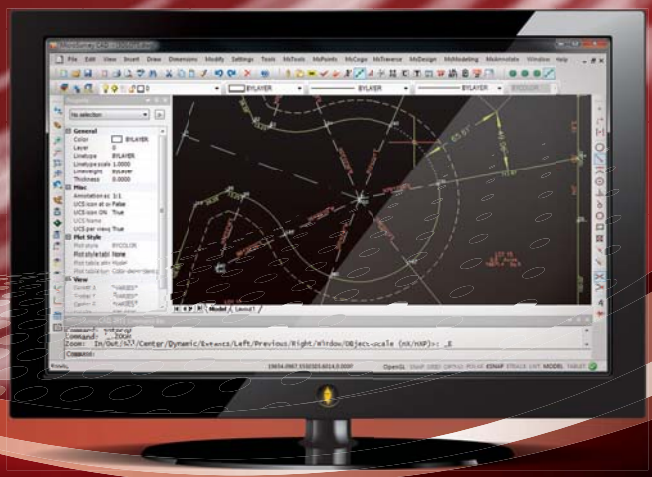

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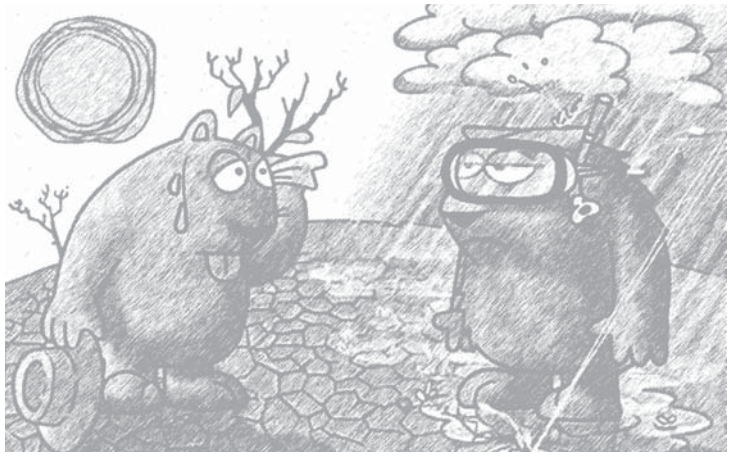

The vicious cycle

America freezes and Australia sweats.

With weather becoming more chaotic than erratic

The consequences of climate change

Appears to be getting worse

This, ironically, further reinforces the causes

With soaring energy demands

Required to adapt with weather extremities.

While mankind may have genuine reasons

To be narcissistic about the success of its development models,

Yet, there is a possibility that it may be blamed

For not only threatening its own survival

But also of fellow living beings for none of their faults.

Bal Krishna, Editor
bal@mycoordinates.org

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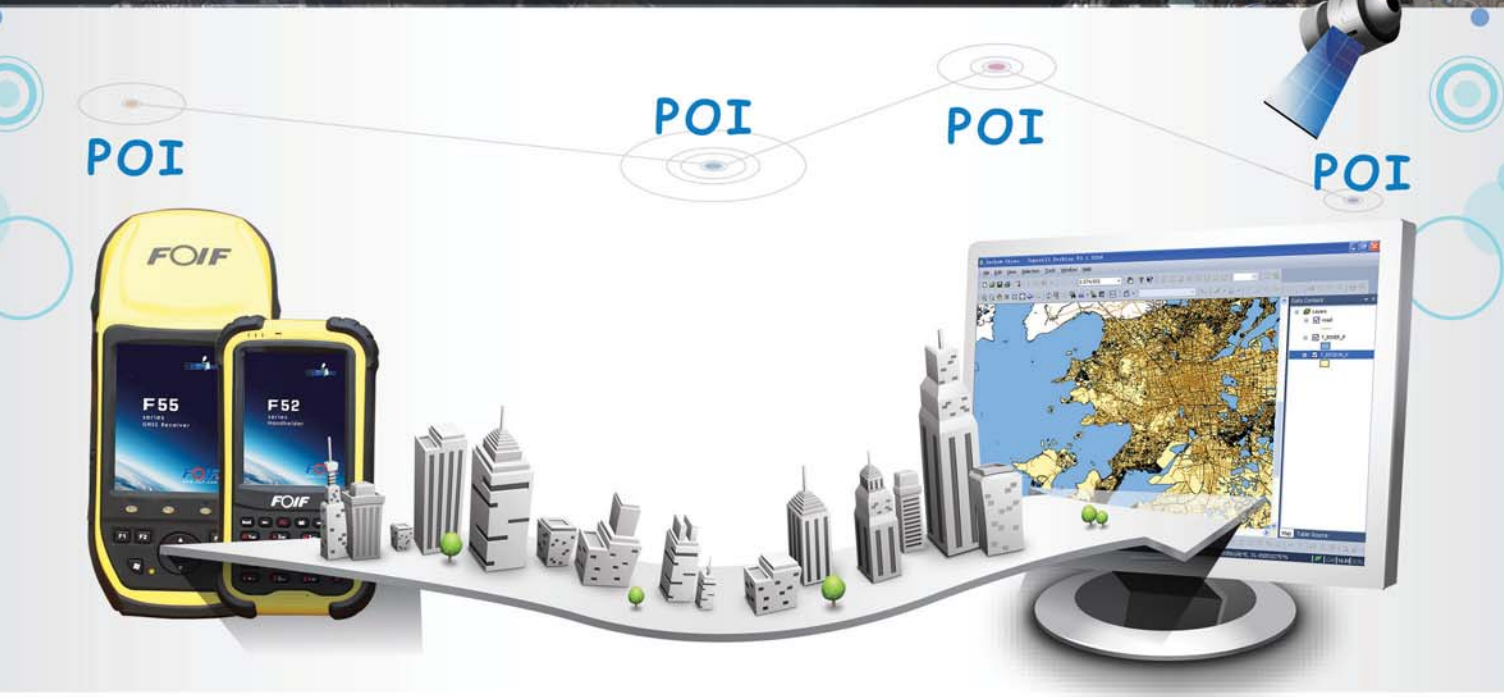

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JANAK

Ease of operations and low-cost of UAS will allow democratization of aerial imagery

say Philippe Simard, President and Louis Simard, CTO - SimActive Inc, in an interview with Coordinates

"SimActive is the pioneer of the new mapping era offering cutting-edge photogrammetry software". Please elaborate.

When SimActive started the development of its Correlator3D™ software back in 2003, the capability to rapidly gather vast amounts of imagery was quickly becoming the bottleneck in geospatial data production. Since then, the use of medium and large format aerial systems, satellite sensors and consumer grade cameras mounted on UAV platforms has exploded. Hence, there has been a growing requirement for photogrammetric software tools able to handle thousands of frames from any kind of imaging system.

SimActive has been the first company to introduce the use of graphics processing units (GPUs) to generate digital surface models (DSMs) and a new technology for producing ultra large orthomosaics with no limit to the number of images. The company is also the first and only provider to offer an aerial triangulation (AT) module based on GPUs, bringing the fastest commercial tool for that purpose.

Describe the features of latest version 5.0 of the Correlator3D™ software?

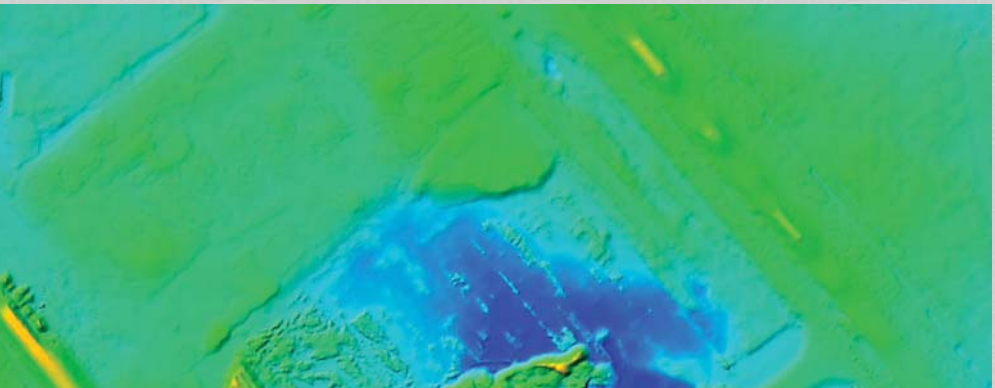
With the release of version 5.0, Correlator3D™ brings a unique approach for visualizing AT results. This allows for a quick assessment of quality, including the capability to see links between adjacent images after tie point extraction as well as bundle adjustment residuals. Although these concepts are quite abstract and hence difficult to visually represent, the software produces a view that allows quick and intuitive inspection of results. Furthermore, the software's digital terrain model (DTM) extraction module was completely redesigned, leading to better results and significantly faster processing times.

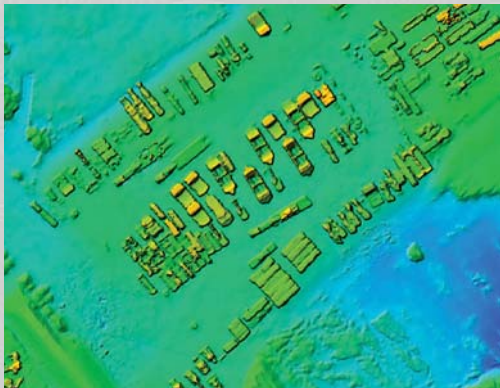
How is Correlator3D™ software better than other competitors in the market?

Correlator3D™ innovative design enables processing an unlimited number of images - multi terabyte data - empowering users to tackle any project with confidence. To process larger projects with ever increasing frame size, the intelligent use of GPUs and multi-core CPUs was introduced providing a significant boost to traditional CPU or ad-hoc GPU solutions. This allows even the highest density DSMs and DTMs to be produced for a full project within only a couple of days. The software also features a special structure developed for handling orthomosaics, called mosaic fragmentation. This innovative design not only makes it possible to process limitless number of images, but also allows for limitless users to simultaneously edit a mosaic without conflicts or duplication of any data.

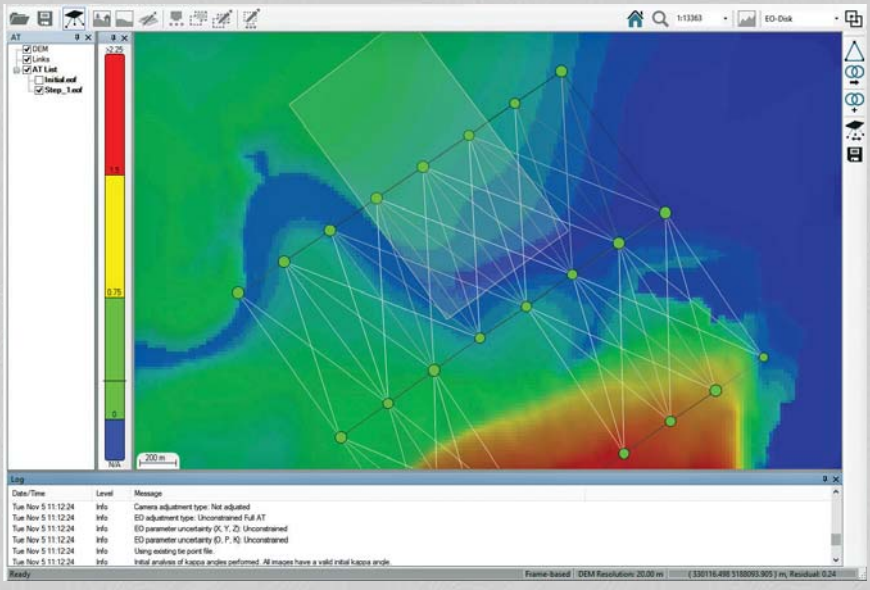
What are the different application areas Correlator3D™ software could become an ideal choice for your customer?

Correlator3D™ allows processing of data from traditional medium / large format aerial cameras, satellite sensors and any consumer grade camera such as those found on UAV platforms. This is a big advantage as the same photogrammetry tool can be used on any kind of data, in the exact same production workflow. Photogrammetry experts can produce high accuracy results and rapidly map





large areas using aerial cameras as well as satellite data. UAV users can also benefit from a simple-to-use software that allows to bring the precision of traditional photogrammetry to UAV mapping.



What are the main R&D considerations while developing the software?

Significant R&D efforts went into bringing intelligence into the software, alleviating the need for specialized photogrammetry knowledge. This means the software is accessible to all users regardless of their experience or knowledge level. This is especially useful when new personnel are coming on board or when a high turnaround of users is present, and ends up saving companies time and money. With simple self-explanatory windows and modules that naturally flow into one another, an intuitive workflow promotes a high level of automation and robustness by design. Thus, precise geospatial products are generated in an efficient and simple manner.

With the advent of UAV, how do you see the evolution of photogrammetry?

There are multiple operational advantages associated with UAVs, such as quick deployment and associated low costs. From their ability to fly at low altitudes, they usually also collect imagery at much higher resolutions (e.g. 1cm ground sample distance). However, the drawback is that they can cover only small areas and the quality of images is generally poorer than their large-format counterparts. Photogrammetry software solutions therefore need to be highly robust to be able to handle such data and still produce high quality results. Because of the drawbacks associated with UAVs, any large scale production project, such as that to map cities, counties or other large areas will still continue to require large-format cameras and satellite data.

What are the challenges associated with the imagery acquired using a UAV?

UAV imagery is typically collected within a couple of hours. Such a collection rate necessitates a need for quick image processing, with the expected time to be generally within the same day or week. This is quite a difference from traditional photogrammetry, where processing can be spread over a few months. Other challenges include the ability to cope with inconsistent overlap between images. Traditional survey systems ensure constant overlap between successive images, while UAVs produce widely varying data, complicating the photogrammetry problem. In conjunction with the varying overlap, the radiometry within a UAV project (color across different images) also varies significantly, making the mosaic creation process significantly more difficult.

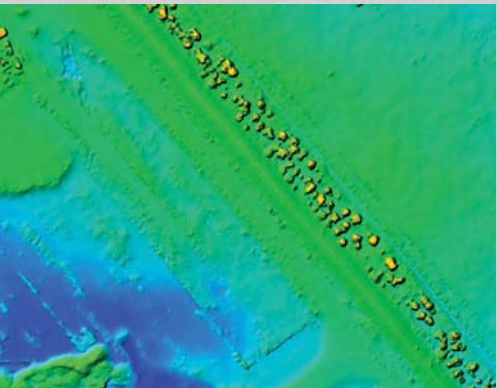
How do you see the growth potential of UAV/UAS market in the years to come?

The number of UAVs worldwide has exploded in the last couple of years and will keep growing rapidly. The operational advantages as well as low-cost of these systems will allow a democratization of aerial imagery and associated geospatial data. New applications are developing around UAV mapping, such as periodic monitoring of areas (e.g. mine pits), as they allow quick and cheap up-to-date data. Photogrammetry software will thus need to the pace and meet continually changing requirements.

Testimonial

"We were impressed with the software's capability and processing times. The results achieved were not only produced quickly, but with a high degree of accuracy"

- Mr. Mohamad El Kadi, Managing Director of Space Imaging Middle East



UAV: Yet to fly high

Recently FAA released Unmanned Aircraft Systems Integration Roadmap. Experts share their views on policy perspective and challenges

The U.S. Department of Transportation's Federal Aviation Administration (FAA) released on November 7, 2013 its first annual Roadmap outlining efforts needed to safely integrate unmanned aircraft systems (UAS) into the nation's airspace. The Roadmap addresses current and future policies, regulations, technologies and procedures that will be required as demand moves the country from today's limited accommodation of UAS operations to the extensive integration of UAS into the NextGen aviation system in the future. "Government and industry face significant challenges as unmanned aircraft move into the aviation mainstream," said U.S. Transportation Secretary Anthony Foxx. "This Roadmap is an important step forward that will help stakeholders understand the operational goals and safety issues we need to consider when planning for the future of our airspace."

The Roadmap outlines the FAA's approach to ensuring that widespread UAS use is safe, from the perspective of accommodation, integration, and evolution. The FAA's main goal for integration is to establish requirements that UAS operators will have to meet in order to increase access to airspace over the next five to 10 years. The Roadmap discusses items such as new or revised regulations, policies, procedures, guidance material, training and understanding of systems and operations to support routine UAS operations. "The FAA is committed to safe, efficient and timely integration of UAS into our airspace," said FAA Administrator Michael Huerta. "We are dedicated to moving this exciting new technology along as quickly and safely as possible."

The Roadmap also addresses the evolution of UAS operations once all requirements and standards are in place and are routinely updated to support UAS operations as the National Airspace System evolves over time. The document stresses that the UAS community must understand the system is not static, and that many improvements are planned for the airspace system over the next 15 years. The FAA plans to select six UAS test sites to begin work on safely integrating UAS into the airspace. These congressionally-mandated test sites will conduct critical research into how best to safely integrate UAS systems into the national airspace over the next several years and what certification and navigation requirements will need to be established.

The use of UAS, both at the designated test sites and in the national airspace generally, raises the issue of privacy and protection of civil liberties. In February, the FAA asked for public comments specifically on the draft privacy requirements for the six test sites. Today, the agency sent a final privacy policy to the Federal Register that requires test site operators to comply with federal, state, and other laws on individual privacy protection, to have a publicly available privacy plan and a written plan for data use and retention, and to conduct an annual review of privacy practices that allows for public comment. Information about the test site selection process and final test site privacy policy is available at: http://www.faa.gov/about/initiatives/uas/

For the next several years, the FAA will continue to use special mitigations and procedures to safely accommodate limited UAS access to the nation's airspace on a case-by-case basis. The Roadmap notes that this case-by-case accommodation will decline significantly as integration begins and expands, but will continue to be a practical way to allow flights by some UAS operators in certain circumstances. In addition to the FAA's Roadmap, as required in the 2012 FAA Reauthorization, the Joint Planning and Development Office (JPDO) has developed a comprehensive plan to safely accelerate the integration of civil UAS into the national airspace system. That plan details a multi-agency approach to safe and timely UAS integration and coordination with the NextGen shift to satellite-based technologies and new procedures.

The UAS Roadmap (PDF) and UAS Comprehensive Plan is available on our website. http://www.faa.gov/news/press_releases/news_story.cfm?newsid=15334

Creating regulatory structure is the biggest challenge

Here are the responses of the FAA to questions raised by Coordinates relating to UAS integration Roadmap

Please highlight few key features of UAS Integration Roadmap?

The Roadmap provides a "how to" for safe, efficient and timely integration of UAS into the busiest, most complex airspace in the world. The Roadmap lays out in one place the regulations, technologies, standards and policies the FAA needs to ensure are needed to accommodate a wide variety of UAS operations, and do so safely.

What are the main challenges before FAA?

Creating the regulatory structure is the biggest challenge for UAS integration. This structure has to address and accommodate the technological aspects of an evolving industry, as well as regulatory standards. The long term goal for UAS integration is for UAS to operate in the same airspace as manned aircraft. Current separation standards for manned aircraft are based on many criteria. UAS-related standards, rules and procedures are being developed to address detect-and-avoid, but much research remains to be done to determine if UAS will require new separation criteria.

Is there a need to regulate the flying of UAS?

UAS are inherently different from manned aircraft, so introducing them into the nation's

airspace is challenging for both the FAA and the aviation community. We are progressing as quickly as we can in crafting regulations and policies given the current state of technology and our core mission of ensuring safety for the flying public and for persons and property on the ground. The FAA has asked RTCA to work with industry and assist in the development of UAS standards. RTCA's technical group will address how UAS will handle communication, command and control and how UAS will detect and avoid other aircraft.

What are the plans of FAA of integrating UAS to the National Airspace System (NAS)?

The Roadmap lays out a clear path toward that goal. The 2012 FAA Reauthorization calls for "safe integration" of UAS by the 2015 date. The intent of the legislation is for the FAA to have a specific plan with milestones, and to show progress against these milestones. The small UAS proposed rule that we expect to publish in 2014 will help with integration and will address what we think is the largest area of pent-up UAS demand - commercial operations. In addition, the six UAS test sites, which we will select by the end of this year, will give us data that will help our integration efforts.

Is privacy an issue that needs attention in context of UAS?

We have already ensured individual privacy and civil liberties are protected as part of the test site selection process. The selected test site operators will be required to adhere to a test site privacy policy which includes obeying all federal, state, and local laws on individual privacy, and to take other measures to ensure accountability for data collected as a result of test site operations. The FAA's primary mission is safety. While we acknowledge that privacy and the protection of civil liberties are important issues affecting UAS integration, a whole-of-government approach will be needed to address the broader aspects of a privacy policy, beyond the test sites. The FAA is cooperating with other agency partners to advance this policy.

The FAA paves the way for UAS Integration

Michael Toscano
President & CEO of the Association for Unmanned Vehicles Systems International

The FAA took important steps in 2013 to advance integration and set 2014 as an exciting year for the UAS industry. After months of delays, the FAA finally released its integration roadmap and announced the six UAS test sites, which are significant initial steps on the path to integration.

The potential for the growth of the UAS industry needs no better evidence than the furor with which states pursued the six coveted FAA test site designations. State legislatures from Hawaii to Michigan passed resolutions in support of their states' bids. Elected officials in Nevada, North Dakota and Ohio announced plans for development parks in support of the industry.

In the end, the University of Alaska, State of Nevada, New York's Griffiss International Airport, North Dakota Department of Commerce, Texas A&M University - Corpus Christi, and Virginia Polytechnic Institute and State University (Virginia Tech) and their partners received FAA approval to operate test sites. No doubt more organizations will reapply for test sites as the integration process progresses.

In designating the UAS test sites in these states, the FAA has taken an important step toward recognizing the incredible economic and job creation potential this technology brings. AUVSI released an economic report in 2013 that found the industry would create 100,000 jobs and create more than $82 billion in economic impact in the first decade after integration.

There's a lot of excitement and enthusiasm for the civil and commercial uses of UAS. Amazon's plans to launch a 'Prime Air' delivery system demonstrate the promise of unmanned aircraft systems. It underscores how this innovative technology will transform the way industries operate. For instance, some farmers have already begun experimenting with the technology, which can help them detect crop disease or stress earlier and more efficiently manage their crops, increasing yields and saving money. Other industries, from oil and gas to real estate agents to firefighters are waiting in the wings to take advantage of this technology.

A recent poll by the Institute for Homeland Security Solutions found that 61 percent of respondents support using UAS for commercial applications. In addition to commercial applications, support for public safety applications is growing. A Monmouth University poll released in August 2013 found that an overwhelming majority of Americans – 83 percent – support the idea of using UAS to help with search and rescue missions.

The approach that the FAA has taken towards integration has reflected how seriously it takes the issues of safety and privacy. The integration roadmap affirms the robust legal framework that already protects Americans, starting with the Fourth Amendment and its interpretation through court decisions. It also requires test sites to have a written plan for data use and retention, which will help to increase transparency. These test sites will serve an important role for experimenting with policies to determine how to use UAS responsibly.

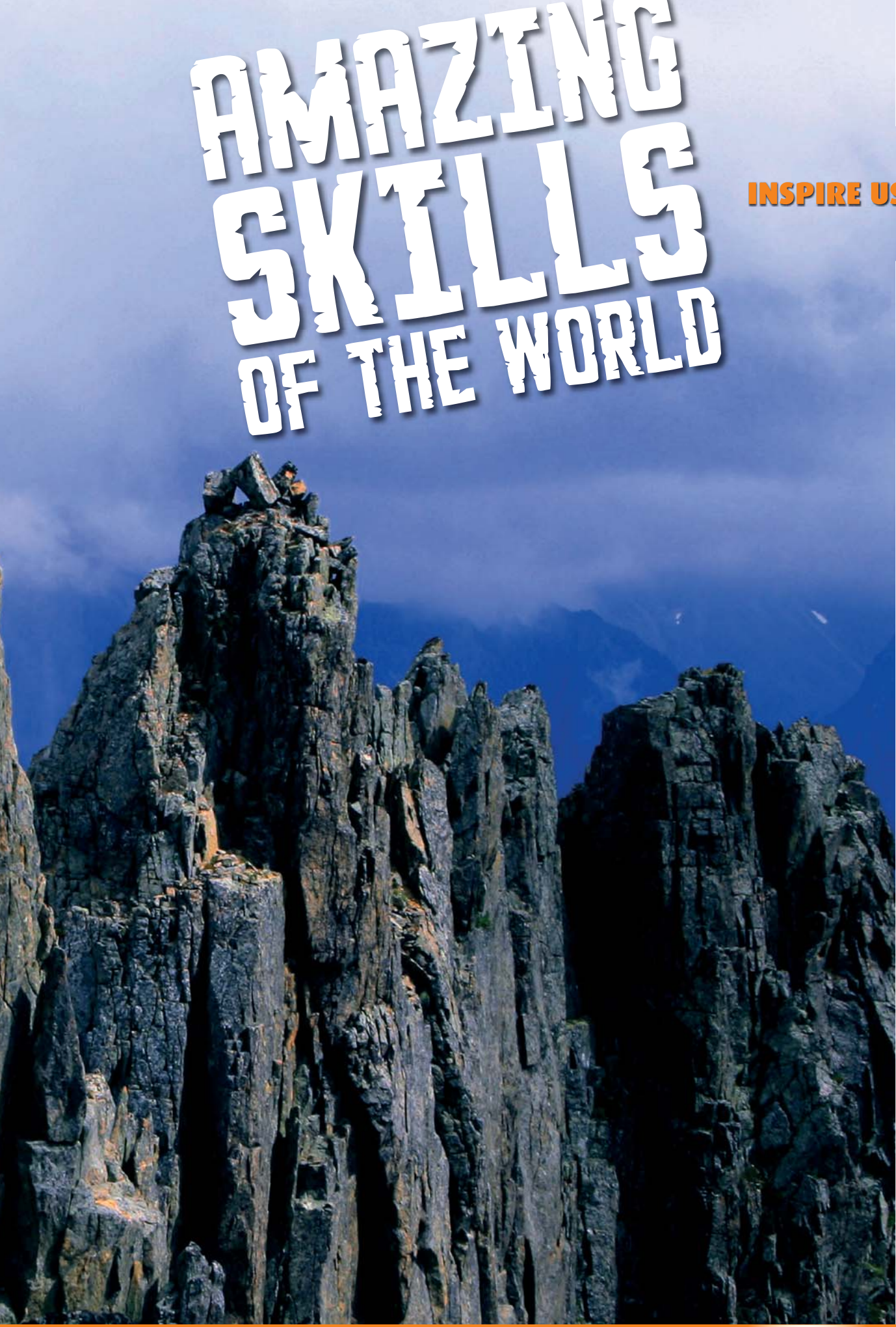
Now is an exciting time for the UAS industry as the FAA begins the work that will allow industries to use UAS to do everything from helping fight wildfires to searching for missing hikers to filming Hollywood blockbusters.

Photo: Hermod Halse

NORWEGIAN EXTREME ARTIST, ESKIL RONNINGSBAKKEN, DURING A ONE-HANDED HANDSTAND AT THE DISTINCTIVE NEEDLE PEAK, BLADET, NORWAY, 2010.

AMAZING SKILLS OF THE WORLD

INSPIRE US ...



The FAA Unmanned Aircraft Systems Roadmap

Patrick Egan
Editor, Americas Desk, sUAS News and host and Executive Producer of the sUAS News Podcast Series and Drone TV. He also serves as President of the Silicon Valley Chapter of AUVSI.

A short synopsis of what it means to the rest of us outside of Washington D.C. The technology has many names and more are sure to come, but by-in-large the most widely accepted name is Drone. Be on the look out for the ICAO definition of RPAS (Remotely Piloted Aircraft System). However, here in the U.S., we can't even really agree on a name that satisfies the different strata's of stakeholder much less anything that resembles viable regulations for the use of this potentially transformative technology. Not to say that people aren't already using the technology every day. Youtube, Vimeo and almost any other forum that has to do with a profession that can benefit from the addition of low altitude remote sensing (photography) are full of people successfully using drones.

The disruptive promise of Unmanned Aircraft is the ability to conduct low cost and self-guided remote sensing. Not just filming extreme sports, as tens of thousands of posted videos would suggest. Most of the application success stories come from existing businesses that can use this technology platform to enhance efficiency. Aerial photography has held benefit or appeal to many professions. However, that usually comes at a price in both wait time and money with no guaranty you'll even get the data you need or wanted. So, most don't bother and use more traditional very often slower means of gathering relevant data. True it is less efficient, but it is a sure bet on your schedule. This will be changing as low cost unmanned systems the miniaturization of sensors and the proliferation of software all mean that the end-user is able to gather their own data on their terms.

Here in the U.S., we have an FAA roadmap. Many believe it shows what it looks like when government representatives or civil employees who know little about technology try to regulate said technology. Nothing takes the wind out of the sails of innovation quite like bad regulation. Furthermore, over regulation usually hamstrings the benefits a new technology can bring. The U.S. is seen as a leader in the unmanned systems technology sector. While that is true for military use, some are beginning to have doubts about the civilian sector. Advancements are obstructed as the academic and business end-users suffer from a shortage of legal income streams and institutional investment. This can be traced directly back to a lack of common sense regulation. This work is done in private as people work in silos of secrecy not to have their research or business compromised by the government. No shortage of "moonshots" and monkeyshines here in the U.S. as there exists many people working on the same problem with a different perspective and sets of priorities. Woefully inefficient and counter productive to the promise offered by unmanned systems.

I hear different business models from a wide cross section of potential users who have no idea what the regulations will look like, or believe that the skies of the U.S. will open up to unmanned systems in September of 2015. Unfortunately, it is very likely that the mandated deadline will come and go without achieving the desired intent. So, most of the time I counsel these would be entrepreneurs that they should go off shore.

Promise for anyone throughout the global community -

What does this lack of U.S. regulatory action mean to the rest of the world? Well, our folly is everyone else's opportunity to gain. In South America, for example, some countries believe that certain agrarian applications for unmanned technologies will help them be more competitive with U.S. The opportunity to be the first to market with the process and applications for unmanned technology is still open to innovators and visionaries no matter their nationality or location. Those same innovators and visionaries have the means at their disposal to help feed a hungry world and to be better stewards of our finite private and public resources.

UAV in Japan: Needs improvement

Shunji Murai
Professor Emeritus, University of Tokyo, Japan

There are many problems about UAV in Japan.

- Electric frequency restriction blocks to use wireless system to transfer image data taken by UAV to ground control center.
- Security control is too severe to fly over the sky of urban areas which results in flying only less populated areas.
- Insurance is too costive as there were many crash accidents.
- Camera selection is not flexible concerning commercial UAVs.
- Fully self-reliant UAV system has not yet been developed. It means that we need specialist of manual operation of take-off and touch-down.
- Many accidents occurred by following the operation manual of computer control navigation system which was provided by the manufacturer.

My view will be "a lot of improvement should be undertaken for self-reliant UAV system", and "we need some sort of guarantee to allow flyingover populated areas such as urban areas".

Amazon testing drones for deliveries

Amazon, the world's largest online retailer, is testing unmanned drones to deliver goods to customers, Chief Executive Jeff Bezos says.

The drones, called Octocopters, could deliver packages weighing up to 2.3kg to customers within 30 minutes of them placing the order, he said.

However, he added that it could take up to five years for the service to start.

The US Federal Aviation Administration is yet to approve the use of unmanned drones for civilian purposes.

"I know this looks like science fiction, but it's not," Mr Bezos told CBS television's 60 Minutes programme.

"We can do half-hour delivery... and we can carry objects, we think, up to five pounds (2.3kg), which covers 86% of the items that we deliver."

Goa University students build QuadCopter

A team of gadget geeks from Goa University's electronics department have built their own version of an Unmanned Surveillance Vehicle (UAV) a 1.2 kg QuadCopter or four-rotor helicopter as their final year project. While QuadCopters are being constructed and researched extensively by the armed forces across the world, the GU team's device, named Aditya is unique because it was built from scratch on a budget of only 30,000.

The zippy little craft however is a work in progress and its creators, the team of eight final year MSc Electronics students, will push for a patent once they perfect their 'flight mechanism'.

'Aditya weighs 1.2kg and has a payload capacity of 200g. It has been successfully tested for vertical take-off and landing operations,' said Kevin D'Souza, 22, one of the students who developed the device. 'It can fly in a radius of 200m and fly to heights of 15-20m, for 20 minutes on a single battery charge,' he added.

Photo: Hermod Halse

The main challenges, besides technology, are societal acceptance and cultural acceptance by the aviation community, including the regulators

Filippo Tomasello
Rulemaking Officer
(Initial Airworthiness)
European Aviation
Safety Authority

You may like to highlight the growth potential of UAS technology and also the challenges before it.

Mankind experienced three industrial revolutions. First energy at factories and second energy "in motion". Development of transportation means, including aviation, is linked to the second revolution. Aviation is still there, mainly using energy to transport people or freight, while in other segments of social life we are already in the third revolution. UAS technology finally brings aviation into this third revolution: the information society. UAS are in fact not mainly intended to replace manned aviation, but to acquire any sort of data, which further processing may turn into information. This is the biggest opportunity. The second opportunity is that UAS will "colonise" volumes of airspace not significantly used by manned aviation (e.g. below 500 feet), so better exploiting this natural resource.

The main challenges, besides technology, are societal acceptance and cultural acceptance by the aviation community, including the regulators. The latter historically saw airworthiness in the first place and, only after, considered operations. For UAS we have to consider also operations from beginning, since safety can be achieved, when appropriate, through operational limitations (e.g. not overfly populated areas).

With the entry of many players from the private sector, academia and the government in UAV segment, what are the main challenges before (European Aviation Safety Authority) EASA?

In the USA the Federal Aviation Administration (FAA) is responsible to regulate access to their airspace by all public and private entities, for experimental, recreational, professional or commercial use. Consistency of approach is ensured by the unique responsibility conferred by the USA legislator to the FAA. The institutional situation in the European Union is much more complex, with Member States responsible to regulate experimental flights and civil UAS below 150 Kg. EASA is only responsible for UAS produced in industrial series for civil use and above such mass. Furthermore, the competent authority in the States for public flights is not always the CAA. Finally there are public Agencies, like EMSA and FRONTEX, which may execute "public" flights, but are not necessarily under the jurisdiction of the State where they are located, since they are EU Agencies. But we cannot divergent regulatory approaches. The challenge is hence to maintain a constant dialogue between EASA and all the other involved authorities, to possibly jointly progress in a harmonized way.

Do you think there is a need to regulate the flying of UAS especially to deal with issues of safety and security?

Yes. Safety and security first. But also privacy and data protection, as well as li ability and insurance.

If we do not regulate all these facets in a synchronized way, society would not accept wide use of UAS. This is the reason for which the EU "roadmap" *http://easa.europa.eu/rulemaking/Unmanned-Aircraft-Systems-(UAS)-and-Remotely-Piloted-Aircraft-Systems-(RPAS).php* comprises three pillars: safety led by EASA; research and development led by SESAR JU and other societal aspects (e.g. liability) led by the European Commission. Even in this case the main challenge for Europe is to maintain synchronization among different public entities with different mandates.

Do you think privacy is an issue that needs attention in context of UAS?

Definitely. And I, for safety, security, privacy, liability and insurance I see no solution, unless we clearly identify the legal responsibilities of the UAS "operator" (i.e. the company; not the remote pilot) and the associated privileges. According to amendment 43 to ICAO Annex 2, the RPAS operator need a certificate and continuous oversight by its competent aviation authority. In the draft requirements 'JARUS-ORG' we already have the concept that the operator is responsible to manage not only safety, but also security (e.g. properly storing the UAS overnight), privacy and liability (i.e. obligation to be insured).

Are you also working with other international counterparts to harmonize standards, policies, procedures, and regulatory requirements?

Yes. With my friend Jim Coyne (Australia) I co-chair the ICAO Study Group on the matter, where we have colleagues coming from all the continents, as well as from selected international organisations. So far we intend to propose ICAO standards only for UAS operations of global relevance: i.e. "beyond Visual Line-of-sight" (BVLOS). Reality of emerging civil operations is that the majority of them is today on the contrary in VLOS (i.e. below 500 ft and few hundred metres from the remote pilot on the ground). So, while we agree that ICAO standardization should only cover BVLOS, in Europe we think that, to safely open the internal market, we also need to harmonise rules for VLOS. This is what we are striving for in the group of Joint Authorities for Rulemaking on Unmanned Systems (JARUS).

The market needs to mature, both commercially and technically

Ron van de Leijgraaf
Senior Policy Advisor
Aviation Safety Unit,
Aviation Department
Directorate-General for
Mobility and Transport
Ministry of Infrastructure
and the Environment, the Netherlands

What are the growth potential of commercial UAS and the challenges before it?

Commercial UAS technology is growing at a very rapid pace, allowing a steady grow in the civil UAS market, both from a business perspective and from a technological perspective. The challenges this industry is facing are multiple. First the market needs to mature, both commercially and technically. We need mature, reliable systems to develop a stable and mature commercial market.

On the other hand, aviation authorities will have to adapt to this quickly growing industry and develop suitable and proportionate regulation to allow UAS to operate safely while not delaying the growth and development of the market. One of the major issues that the authorities are facing is that UAS operations are extremely diverse (e.g. delivering goods, inspecting windmills, photogrammetry of agricultural areas, surveilling fire areas) and in most cases incomparable to operations in manned aviation. This diversity in operations makes it very difficult to develop one set of regulations for all UAS operations. The biggest technology challenge at the moment is the development of a detect and avoid system, which will allow full integration of UAS in the airspace.

Is there a need to regulate the flying of UAS to deal with issues of safety and security?

UAS are operating in a well-organized and regulated aviation environment. For many UAS industries, this operational area is totally new. This means that the industry is exposed to aviation regulation and they have to fit into this currently existing system. Aviation regulators will have to get familiar with this new 'kid on the block' in the aviation community and find an appropriate and proportionate regulatory system to allow safe operations by UAS.

What do you think about privacy issue in context of UAS?

Privacy is definitely one of the major issues that the UAS market is facing. At a global level it is clear that the primary interest at a political level regarding UAS is focused on privacy. Although usually different organizations within a country are responsible for privacy, security and safety, the issue of privacy could be best addressed in close coordination with the safety and security regulation.

Delfly UAV is inspired by how small insects and birds fly

Guido de Croon
Assistant-professor,
Micro Air Vehicle
laboratory, Section
Control and Simulation,
Department Control
and Operations, Faculty
of Aerospace Engineering, Delft University
of Technology, the Netherlands

How is the Delfly UAV system unique from others?

The Delfly is different from most commercial UAVs because it is inspired by how small insects and birds fly. It is bio-inspired and so it is very different from rotor craft UAV systems. The Delfly Explorer is the first flapping wing micro air vehicle that can avoid obstacles by itself in an unknown environment. It carries a 4 g stereo vision system which enables to avoid obstacles. We think that this light-weight flapping wing system opens up many new possibilities. Since they are light weight, it is suitable for indoors. In comparison with small rotor craft, they are more efficient at smaller scales and in forward flight. It can fly slowly for ~10 minutes, but will fly much longer when flying forward. If it flies into an obstacle, it will not break anything because of the flapping wings: the system uses unsteady aerodynamics to fly, and the speeds of the wings are close to zero when they touch something. In contrast, in a rotor craft the rotor moves very fast, which gives it a tendency to suck itself into the ceiling or the walls; this does not happen as much with the flapping wings. The concrete examples of applications include flying in a greenhouse, detecting where there is fruit, determining when you can pluck it or where the plants need more water. Another example could be inspection of pipelines inside factories. Also, if you have a concert indoors then it could fly over the crowd and stream the images onto a screen.

What system do you use for navigation?

The main problem for navigation indoors is that you always have obstacles close by, and that we solve with the help of the stereo vision system and the onboard control algorithms. We also have a very small auto pilot of one gram. It does have gyros, pressure meter and the gear meter too. The pressure meter controls the height during the flight and before it takes off it measures the pressure. It uses the gyros to counteract the wind gusts, a draft from an air conditioner is a disturbance to the Delfly trajectory, so we use auto pilot to counteract it.

What about debates of safety issues and security policies?

The Delfly Explorer is a very lightweight flapping wing UAV. I think they can open up very new applications, since they are so very different from most current UAVs. They are so lightweight that they are inherently completely safe. The technology we work on to avoid obstacles with them will be very important to any application. If you can use the obstacle avoidance system for the small scale of the DelFly, you can also use it for the bigger ones and make them safe without reducing the payload capabilities.

Bhuvan - Support to Uttarakhand disaster

The efforts of providing near real time services on Bhuvan in disaster management support has been noteworthy, specially considering the series of disasters in 2013

Dr V K Dadhwal
Director, National Remote Sensing Centre (NRSC), Hyderabad, India

Bhuvan (www.bhuvan.nrsc.gov.in), a unique geoportal of NRSC that provide diversified geospatial services, is gaining popularity day by day and is much appreciated for its dynamic services. Initiated in 2009, Bhuvan has grown up rapidly and has made its impact on Indian user community. Expanding it's state-of-art facilities and a datacentre at Hyderabad, Bhuvan is now extending geographically with its distributed architecture. This expansion plan goes hand in hand with the increased usage. Developed , using open source software and OGC compliant services, it has now grown to cater to various facets of applications including planning and development. Bhuvan has played a critical role in providing near real time information on the recent disasters in the public domain. Specific updates carried out on Bhuvan during 2013 and also the role played by Bhuvan in multi-institution projects like 'Map the neighbourhood in Uttarakhand' (MANU) is also highlighted here.

Bhuvan geoportal with 2D and 3D display capabilities is organized as visualization, Services and Application portal of NRSC. The various recent updates in developments and facilities created under three broad areas are summarized here -

Bhuvan visualization

Understanding the basic information needs for diversified sections of Bhuvan users, Bhuvan has now included Map and Terrain backdrops in addition to satellite and hybrid view in its prime 2D viewer . This has expanded the use of Bhuvan for variety of applications because of its sheer usefulness.

Similarly, to widen the user base and to provide better user experience Bhuvan 2D interface has been redesigned. It is also optimized for reducing network load and larger viewer space for map display.

Bhuvan's prime focus is building applications towards societal benefit. In order to value add the images and maps, the ground level information is key requirement. With its national reach in carrying out projects in remote sensing area and making frequent ground surveys, the vast amount field information is gathered , this is being now disseminated through field photograph section as additional layers of information collating all field data. This field data is also strengthened with field data collected through crowd sourcing (Public and Controlled).

Further, high resolution datasets with 1 meter resolution are made available in 2D, 3D for 41 cities to meet the user demand.

Bhuvan services

The key area of Bhuvan is dissemination of diversified products and services. Bhuvan comes up with following update in services -

Ocean Services' is enabled for visualizing data received from Moored Buoys, Waverider Buoys & Agro Floats of INCOIS, Hyderabad apart from earlier available PFZ.

i. 'Disaster Services' has been strengthened and continuous support has been provided through Bhuvan for Uttarakhand disaster, Floods in other states due to heavy rainfall and inundated areas during Cyclones like Phailin, Leher.

Bhuvan's prime focus is building applications towards societal benefit

ii. Initiated Data support for international Disasters under ISRO DMSP program. Provided satellite data visualisation and download support under various International Disaster programmes (International Charter Space and Major Disasters to international Disaster events, Sentinel Asia Framework, UN-SPIDER and UNESCAP)
iii. Bhuvan NOEDA updated with temporal datasets of AWiFS and LISS III, improved 2nd version of CartoDEM and added download facility for IMS-1 (Hyper Spectral Imager) and NICES products (Model derived 26deg isotherm Model derived TCHP, Near real time TCHP, Near real time Ocean Heat Content etc).
iv. Thematic services are updated with multi-thematic contents: LULC-50K (2011-12), Geomorphology, Lineament, Land Use 10K from SIS-DP Project.

Bhuvan applications

A number of versatile applications encompassing variety of tools and OGC compliant web services have been launched:

- Municipal WebGIS for Ludhiana Municipal Corporation is released with detailed data on ward and plot level boundaries, visualisation and various location based services.
- Satellite based monitoring of irrigation projects (Accelerated Irrigation Benefit Program - AIBP) for Central Water Commisison : 103 Projects completed under AIBP Phase I & II are hosted as inventory of irrigation projects, while AIBP Phase III portal is developed for monitoring of ongoing irrigation infrastructure development by CWC officials, it is kind of virtual GIS laboratory.
- Himachal Pradesh Forest monitoring portal provides forest assets management enabling users to visualize up to beat level forest boundaries, Greening India Mission assets, Climate Vulnerability data with SMS alert facility on forest fire for forest officials up to beat level.
- Agriculture Pest/Disease Surveillance application allows users to share, access and upload the pests and disease related information in a near real time basis towards making the data available to experts for advisory while Plantations section gives the inventory of natural rubber plantation (commercial crop) and identifying potential wastelands for expanding area under rubber plantations.
- Collaborative Mapping (Students' collaboration from Vijayawada) enabled users to collect various users' interest information of Vijayawada using Mobile based application and visualise it on Bhuvan on various tourism interest.
- Urban Growth monitoring showcases the growth of the urban areas of Bangalore, Cochin, Mysore and Coimbatore over last decade or so.
- Tourism Application with new datasets of Hampi, Badami, Nalanda & Vijayawada and improved datasets of Amritsar providing tourist information with Bhuvan satellite data to overcome the limited details available in the traditional paper maps or difficulty in searching for a place of interest.
- Bhuvan - Panchayat : SISP DP status viewer is released with status of mapping done for roads, rail, drainage and landuse at 1:10k for various states towards e-governance
- Kumbh Mela application showcased the time series data of the Sangam area and facilitated the data download for various scientific and planning actitivties.
- Sports portal allowed users to visualise the stadiums of various sports i.e. Cricket, Hockey, Football, Badminton, Golf and related information as well having the facility to showcase the events. IPL-2013 and IBL-2013 related event details were active and attractive among the users during the events.
- Oceansat-2 Scatterometer (OSCAT) Virtual Reality is a plug-in free 3D viewer developed using open source solutions enabled the users to visualize Oceansat scatterometer global data. Time series visulaistion planned using OSCAT data will enable the new paradigm to understand various dynamics of the features.

The Mobile application developed by NRSC is used for reporting the damages in Char Dham area. The hill universities/ institutes have participated in field data collection and have executed the uphill task of assessing the physical situation in the field and uploaded vital information on Bhuvan portal

Bhuvan supports Crowd Sourcing; Major efforts in the recent times has been on enabling controlled crowd sourcing for registered users on Bhuvan platform (Add Content option for Point of Interest (POI) data collection; Web based Mapping for POI, Roads, Rails and polygon feature; Field Data/POI data – Point, Line, Polygon Collection through Android App for smart phones, having custom features to tweak to any specific sector and successfully made operational in Mahalanobis National Crop Forecast Centre, Mapping the Neighborhood in Uttarakhand-MANU, Vijayawada GIS etc). Bhuvan-Mapper is developed as a cross platform and browser independent web based mapping editor using open source solutions with rich graphical user interface and crowd sourcing tools for collecting data on point locations, Line and Polygon features with highly customized attribute fields. It opens the possibility of use of web based editor for a range of applications involving mapping/ tagging of the geographical data.

The efforts of providing near real time services on Bhuvan in disaster management support has been noteworthy, specially considering the series of disasters in 2013. A brief account of Uttarakhand disaster and the Mapping the Neighborhood in Uttarakhand program is provided here.

MANU : Initiative for Uttarakhand reconstruction

The Central Higher Himalayan region of Uttarakhand received extreme rainfall to the order of about 350 mm/ day during 15th - 17th June 2013 causing flooding, toe erosion, debris flows and landslides in upper the catchments of the rivers originating from this segment.

The extreme rainfall that started on the 15th of June and continued for three days causing sporadic flash-flood like events, probably due to the burst of accumulated water bodies by unstable glacial moraine. This phenomenon was observed near Kedarnath temple where the moraine material of the Chaurabari glacier caused temporary ponding upstream of the Kedarnath temple and which later breached causing severe damage to the Holy Shrine of Kedarnath, killing thousands of people and causing damage to the settlements downstream in the Mandakini valley.

This extreme rainfall caused severe damage in the area resulting in loss of precious lives, damage to roads, bridges and culverts, destruction of houses and agricultural areas and hydropower projects.

One of the prime reasons for the damage was the slope destabilization associated with the rainfall causing numerous landslides, toe-erosion and debris flow in the catchments of Alakananda, Bhagirathi, Mandakini and Yamuna. Rainfall being one of the prime triggering factors of the landslides in the Himalayan region, the high intensity rainfall events initiated new landslides and re-activated many old landslides. The downpour also caused huge amounts of debris from steep, upstream catchments to be removed, mixed with water forming debris flow which accentuates the damage on its course. NRSC carried out the inventory of landslides post this extreme rainfall event and mapped about 5000 landslides in the catchments of Alakananda, Bhagirathi and Mandakini.

Map the Neighbourhood in Uttarakhand (MANU); the multi-institutional programme has been initiated by the Department of Science and Technology

Figure 1: High resolution 1 m images generated using Cartosat 2 and LISS IV sensors, showing pre and post flood scenario around Kedarnath town. It shows the breaching of moraine at Chorabari lake, widening and creation of new channels for water and debris flow.

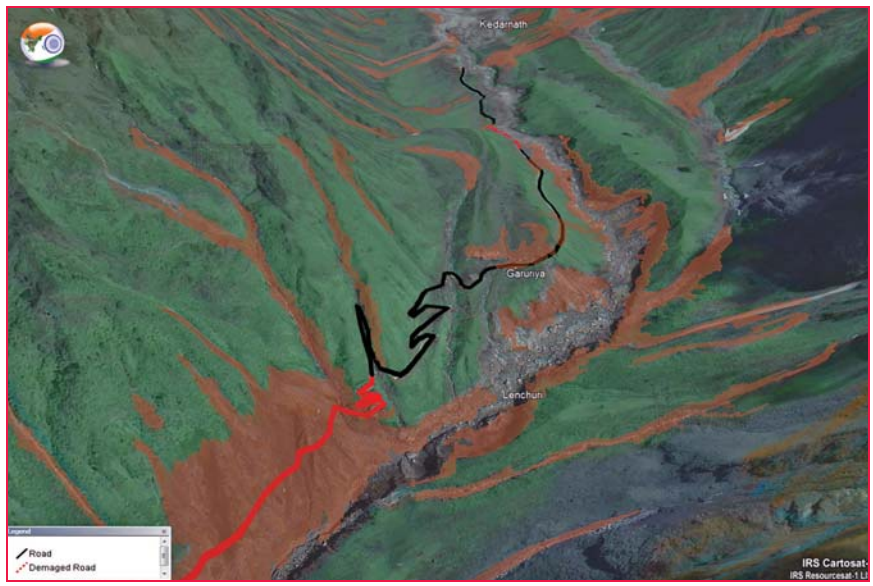


Figure 2: Post flood satellite Image showing the extent of damage caused to roads, brown color zones shows the landslides occurred during the event. Road, shown in red from Lenturi to Ghindurpani is completely damaged.

(DST), Govt. of India, primarily to map the extent of devastation and damage associated with this extreme rainfall event in Char-Dham (Gangotri, Yamunotri, Badrinath and Kedarnath) and Pinder Valley areas, covering about 8000 sq km. National Remote Sensing Centre (NRSC) has played a pioneer role under this program for enabling crowdsourcing /collaborative mapping through Bhuvan Portal and mobie mapping application. While Indian Institute of Remote Sensing (IIRS), Dehradun along with NRSC, Survey of India has been instrumental in capacity building the field teams.

The Mobile application developed by NRSC is used for reporting the damages in Char Dham area. The hill universities/ institutes have participated in field data

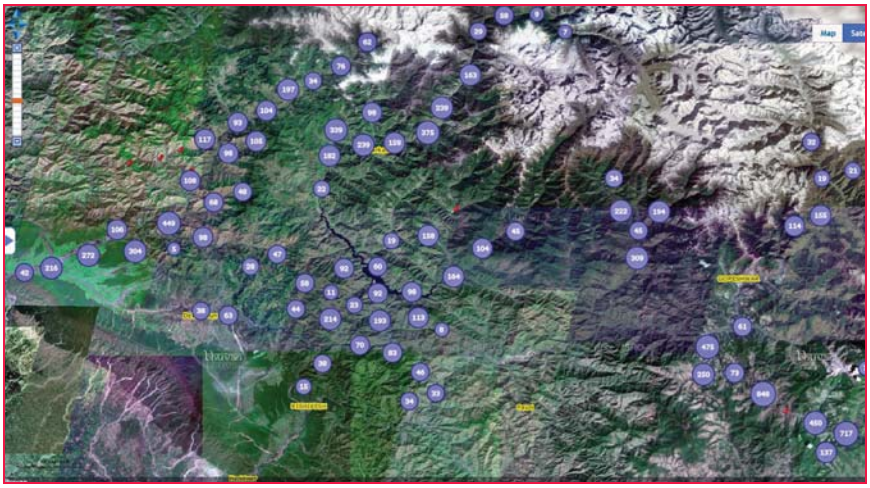


Figure 3: Bhuvan showing the field data collected by field teams in Char-Dham area

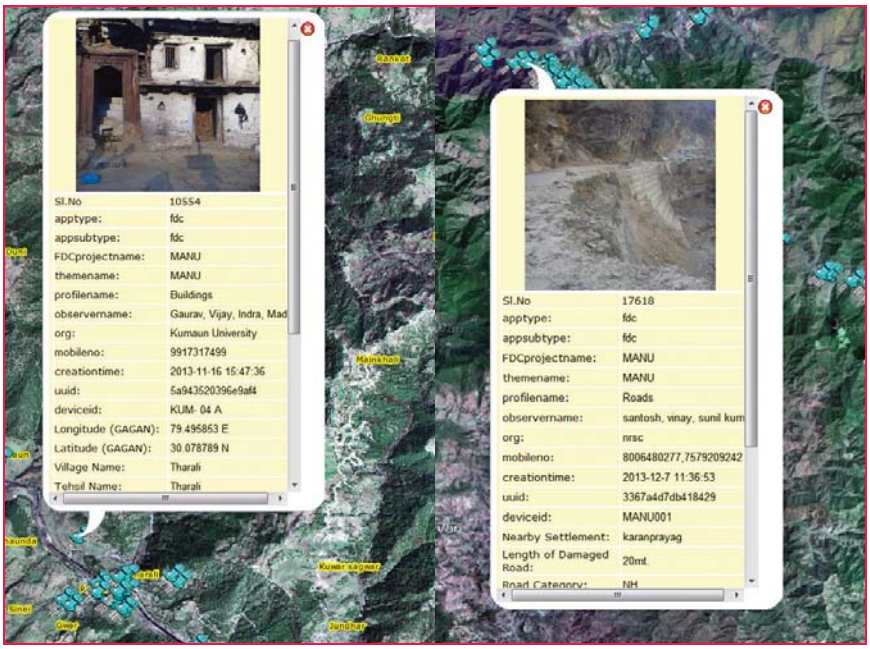


Figure 4: Images showing the damage caused to the buildings and roads as reported by field team

collection and have executed the uphill task of assessing the physical situation in the field and uploaded vital information on Bhuvan portal. Bhuvan-MANU collaboration portal which was developed for facilitating field data collection through Mobile devices and Bhuvan-Mapper web applications are widely used for this purpose. The online validation mechanism has been established on Bhuvan through experts who validate the data received through this crowd sourcing mechanism. The landslides' attributes like type of slide, the rock type and the damage caused are captured during the field campaign and are validated prior to posting on Bhuvan. The online 3D visualization of Char Dham area is created on Bhuvan for terrain understanding. For better communication among the teams, mentors and experts discussion forum has been specifically create for MANU team.

The training of MANU teams have aroused lot of interest amongst youth and younger generation . They have been trained for map reading, using mobile applications in the field, global positioning systems and improvement of location coordinates with GAGAN based positioning system, use of total station etc. ISRO (NRSC and IIRS) in association with Survey of India (SOI) has trained 130 students and 19 faculty/ scientists from Wadia Institute of Himalayan Geology (WIHG), HNB Garhwal University (HNBGU) and Kumaun University (KU). The training was conducted at IIRS in two batches during 27-29 September and 3-5 October, 2013.

The field parties from WIHG, HNBGU and KU are in the process of data collection in Char-Dham and Pinder Valley after a week of training programme. The teams have made remarkable progress in surveying various valleys and over 15000 locations have been surveyed (till 31st Dec, 2013) by the MANU teams. They have collected information on damages to buildings, infrastructure (roads, bridges/ culverts, and other infrastructure) and have also identified landslide and river bank erosion areas. This data is ingested into Bhuvan, directly from field, and are made available on Bhuvan portal along with the field photograph and description after due validation of incoming data by experts

Such online data are of significant use and will be of great help for the local government to plan the reconstruction and rehabilitation activities in Uttarakhand.

It is also to be noted that In the aftermath of the devastating floods and landslides in Uttarakhand in June 2013, ISRO provided all possible support to the state government. This included satellite communication support in the inaccessible area through mobile terminals, providing value-added satellite images of pre- and post-disaster, online information through NDEM on VPN network and training the concerned officials from police, defence and civil administration. Towards providing communication support, 12 numbers of INSAT-MSS Type-D Terminals (Satellite phones) were deployed at different places in inaccessible areas after training the police personnel; DMS hub and user nodes using C_{Ext} 1.8m VSAT antennas were installed at Police HQ, Dehradun, Guptkashi, Badrinath, Barkot and Pithoragarh. Pre- and post-disaster satellite imagery (Resourcesat LISS-IV & Cartosat PAN merged image with details on landslides, trekking route, potential landslide locations, and settlement locations) and 3-D terrain view draped with post-disaster satellite image were provided to Air Force officials for rescue & relief operations and also to District Magistrate of Rudraprayag district.

Coordinating GNSS growth in Europe

Even with a global recession, the installed base of GNSS devices has surpassed 2 billion and is predicted to rise to 7 billion by 2022, predicts European GNSS Agency (GSA) Market Report

On the 15th of October 2013 the European GNSS Agency (GSA) released the latest version of its GNSS Market Report. The Market Report brings an updated and enhanced view of the GNSS global market "as it is experimenting rapid developments". It encompasses a larger scope than before, features an assessment of the GNSS Rail market segment, and for the first time provides easy cross-comparison between market segments. The GSA intends to constantly develop and update the market report, publishing a new edition every eighteen months.

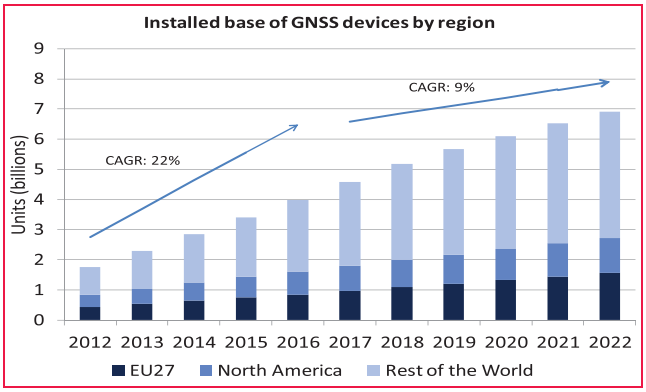
The European GNSS Agency (GSA) was established by the European Commission in 2004 as a Community Agency, under its former name, the GNSS Supervisory Authority. The GSA is an official European Union regulatory authority and manages public interests related to GNSS. Lead by Carlo des Dorides (Executive Director), the GSA mission is exploitation and market development of EGNOS and Galileo systems. This means development of the downstream services based on the European GNSS. The Market Report is developed and published by the Market Development department, headed by Gian Gherardo Calini. This department aims at maximising EGNOS and Galileo penetration among users and stakeholdrs in the whole value chain, including chipset and receiver manufacturers.

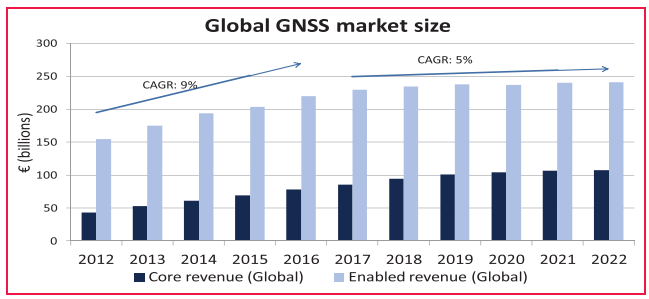
Mr. Calini confirms that the Market Report is "A reference for the European Community to foster the uptake of European GNSS, by allowing stakeholders to understand market opportunities, companies to invest in business development and innovation".

Currently, the Market Report divides the GNSS market into seven primary segments and identifies their individual predicted Cumulative Core Revenues as a share of the overall market for the period 2012-2020. The identified market segments are: Location Based Services (LBS) with 46.9% of the market, Road/Automotive (46.2%), Aviation (1.0%), Rail (0.1%), Maritime (0.3%), Agriculture (1.4%), and Surveying (4.1%). Each market segment covers several categories of devices or applications, with the numbers of devices and applications being modelled in order to predict future growth. The market report provides information on the annual revenue, annual shipments, and installed base (the number of devices currently in use) for all the devices and applications within each segment. Although the market is divided into segments, it is clear that effects can be cross-cutting, with growth in some segments directly influencing a recession in others. The various segments are monitored using a validated forecasting process.

The **Market Modelling and Forecasting Process** (MMFP) is a defined methodology used to predict the growth or decline of GNSS market applications. The tool uses advanced forecasting techniques, and detailed statistical analysis of the market, combined with a robust validation process that utilises industry expertise. These methods allow the tool to predict with reasonable confidence the future evolution of the GNSS market. The tool currently segregates the global market into three overall regions, Europe, North America, and the Rest of the World.

Across all markets segments, future growth is expected to be overwhelmingly positive. Even with a global recession, the installed base of GNSS devices has surpassed 2 billion and is predicted to rise to 7 billion by 2022; that is, almost one GNSS device per person worldwide. Factoring in the current





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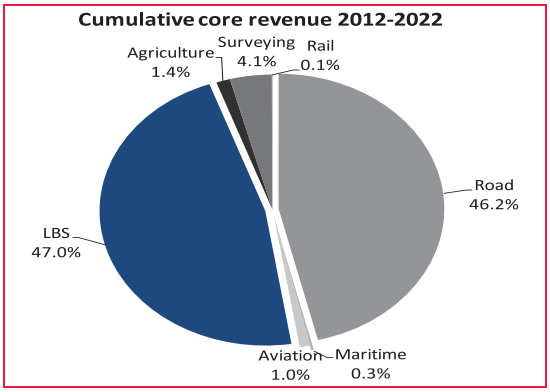
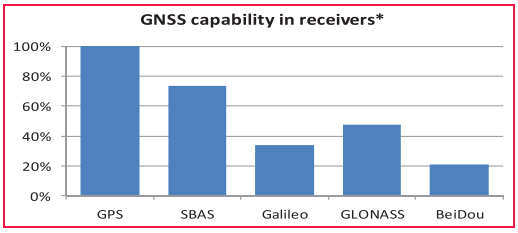




expansion within the recent past global economic recession, growth is expected to accelerate over the next few years, especially for new applications. Currently the largest market segment is LBS which is expected to grow in dominance in the future.

The **LBS Segment** encompasses Smartphones, Tablets, Digital Cameras, Portable Computers, Fitness Devices and People Tracking applications. Smartphones currently dominate the LBS market segment in revenue, sales, and installed base. This is predicted to remain so for the foreseeable future. The installed base of tablets is predicted to increase rapidly, but this is not mirrored with a significant growth in revenue.

The LBS market has shown significant growth since the 2nd edition of the Market Report. Although the predictions made in the previous edition, relevant to Smartphones, were accurate, they predicted fewer shipments and that mobile data costs would be higher. In reality, the shipments of Smartphones have greatly exceeded expectations and this has enabled mobile service providers to reduce the cost of mobile data. This is great news for both the manufacturers, as devices have outsold previous predictions, and end users, as the cost to them is greatly reduced. It is also significant to note that the capability of LBS chipsets is evolving rapidly, with 70% being capable of utilising Satellite Based Augmentation Systems (SBAS) – such as WAAS/EGNOS – and 30% being capable of using the new European Galileo system. Part of the growth seen in the LBS segment may be attributed to declines in other market segments as application migrate from application-specific platforms towards multi-purpose platforms such as smartphones and tablets – the Road/Automotive segment being the worst victim of this.

The **Road/Automotive Segment** encompasses devices and applications such as Advanced Driver Assistance Systems (ADAS), Personal Navigation Devices (PND), Pay-Per-Use Insurance (PPUI) platforms, Road User Charging (RUC) platforms, satellite road traffic monitoring, and emergency call management systems – eCall.

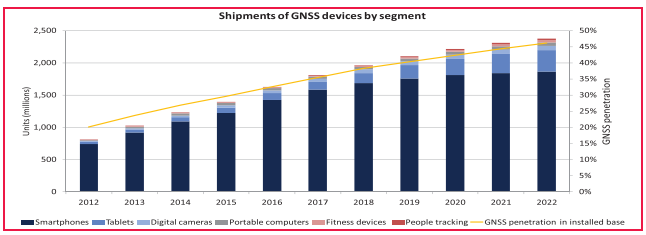
Until recently, PNDs – known colloquially by consumers as "SatNavs" – have been a key component in the Road/Automotive market in terms of installed base, shipments and, most importantly, revenues. With massive reductions in the cost of mobile data charges, smartphones are rapidly replacing PNDs in the road user environment as they can provide the same functionality for little or no added cost.

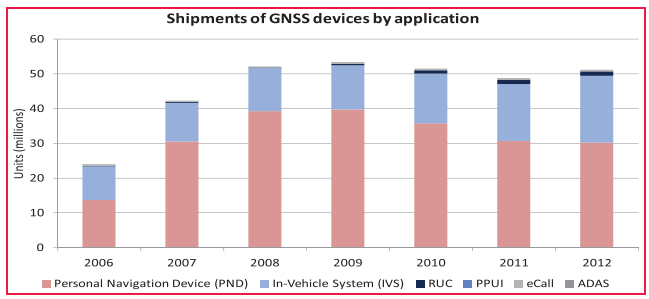
However, even with a large decline in PND sales, the outlook for growth in the Road market segment is positive. There is a number of applications that have extremely high growth potential. These new applications are likely to generate new growth for the GNSS market as a whole, as opposed to cannibalisation from other segments.

The In-Vehicle Systems market has maintained a Compound Annual Growth Rate (CAGR) of 13% over the previous four years, and with ever new inventive systems, is showing no signs of slowing.

A key driver for growth in the European road segment will be the mandatory installation of eCall within all new cars and light vehicles. eCall is designed to contact automatically emergency and rescue services, providing GNSS positional information, in the event of a crash. The system is usually activated when an airbag is deployed. The regulation is set to enter in force throughout Europe during 2015 and is expected to stimulate large revenue growth within the Road segment thereafter.

To summarise, the Road market segment has undergone significant changes recently due to the enhanced capabilities of smartphones. However, with innovations that are already being realised, such as PPUI, RUC, and ADAS, the future developments in the Road segment are likely to be exciting for both business and the end user. eCall could also be a game changer for the market if implemented. Whilst regulation is a novel concept for the Road/Automotive market segment other segments such as Aviation have been highly regulated for a long time, leading to far more stable and predictable market evolution.





The **Aviation Segment** is divided into four sub-segments. Three are heavily regulated; Commercial Air Transport (CAT), Regional Aviation, Business Aviation, and General Aviation/Instrument Flight Rules (GA/IFR). The other sub-segment, General Aviation/Visual Flight Rules (VFR) is less heavily-regulated, although it must conform to airworthiness requirements. IFR equipment is heavily regulated and relatively expensive. Most IFR instrumentation has an intended life of approximately fifteen years, usually based on a forward fit when the airframe is procured initially, with a retrofit halfway through an airframe lifecycle. In the future, it is estimated that IFR sales will be dominated by newly-built aircraft.

General Aviation/VFR is the largest sub-segment by both shipments and installed base. As pilots are operating using VFR, any GNSS device covered by this sub-segment is not considered to be safety critical, and is not regulated in operational terms. This sub-segment will account for around 90% of all shipments to 2022. The majority of current sales are within North America. However, Europe and the Rest of the World have rapidly growing sales, particularly within the BRIC countries.

GNSS penetration rates within the Aviation market segment are very high. Currently standing at 80%, it is predicted to rise to over 90% by 2022. The Aviation segment is projected to maintain steady revenues through to 2022 and beyond.

Considering SBAS systems such as WAAS and EGNOS, there are several initiatives that provide opportunities to increase the use of EGNOS within the aviation segment. EGNOS can be used to provide instrument approaches with vertical guidance (LPV200 and APV-I) for all airports within Europe. The system can provide increased capacity and improved operations in poor visual conditions, especially in small airports. As IFR applications are heavily regulated, change within this sub-segment tends to be slow over time. Similar slow evolution is expected in other well-regulated market segments such as the Maritime segment.

The **Maritime Segment** of the GSA Market Report has been greatly enhanced since the 2nd edition. It is divided into a number of sub-segments, each containing a number of applications. The sub-segments identified are: General Navigation, Traffic Management, Marine Engineering, Homeland Security, Search and Rescue, Ports, and Inland Waterways. Although the Maritime segment is significantly enhanced relative to previous editions of the Market Report, it only encompasses the regulated maritime market, and not the unregulated leisure market.

There have been a number of recent developments in the Maritime Segment that will drive growth in some sub-segments. The tracking of fishing vessels is becoming increasingly important and GNSS is being used evermore to do this. Also, the e-Navigation initiative of the International Maritime Organisation (IMO), which is designed to reduce the complexity of bridge/command systems on-board ships, is expected to be a driver for GNSS multi-constellation uptake.

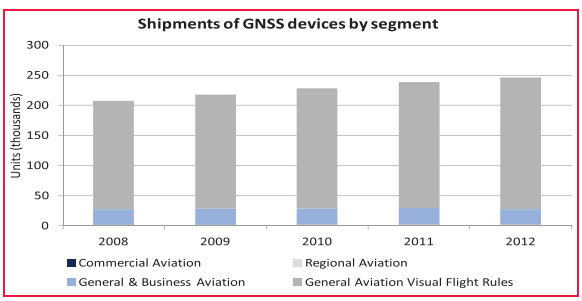
Current analysis indicates the device sales will be largely driven by search and rescue applications. Multiple search and rescue beacons are required to be installed on all vessels, including lifeboats. In addition, search and rescue beacons have a shorter lifecycle than other receivers, because of their safety critical nature, leading to a large number of device sales which drives overall revenues within the segment. Further growth in this sub-segment is likely to be driven by enhanced features delivered by Galileo. Galileo will introduce a return communications link within the system, notifying casualties that their call for help has been received and help is on the way.

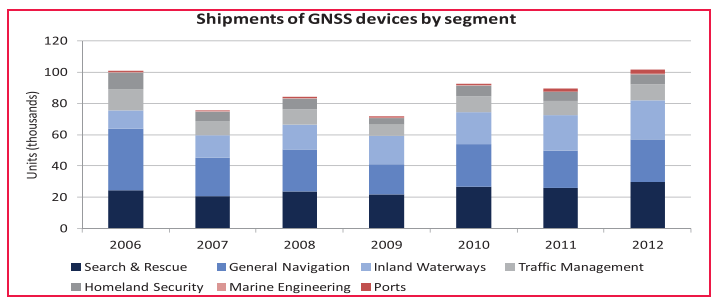
General Navigation and Inland Waterways account for a large proportion of the sales and revenue of the Maritime segment. Currently, only GPS and GLONASS are approved for use by the IMO. Approximately half of all devices used in the Maritime environment are multi-constellation (GPS/GLONASS) system and this fraction is likely to increase once Galileo and BeiDou have been approved for use by the IMO by accepting them into the World Wide Radio-Navigation System.

With increasing accuracy and continuity, more applications will become available to the Maritime market. With this increasing accuracy the Ports sub-segment is predicted to expand rapidly over the next ten years. Maritime surveying applications, which are included within the Surveying segment, are also expected to benefit from increased system navigation accuracy capabilities.

The **Surveying Segment** includes applications such as; Cadastral Surveying, Construction Surveying, Mapping, Mine Surveying, Hydrographic Surveys, and Offshore Surveys.

The Survey market segment is heavily dependent on the growth of general national economies and is correlates strongly with growth in the construction and mining sectors.





With the increasing accuracy of GNSS devices, and the added benefit that will be delivered by the GPS L1/L5 and Galileo E1/E5 signals, new applications are being developed by professional users. The Rest of the World area is set to outstrip Europe and North America for device sales and growth in revenues as the developing world grows at double-digit rates which drive domestic construction sectors.

An interesting growth area within the surveying segment is the use of GNSS for machine control with construction. In Canada road construction is being completed using real-time GNSS information to guide road laying equipment. This is similar to applications used in the Agriculture market where tractor guidance and control is ubiquitous in developed market sectors.

The combined use of surveying and earth observation techniques has allowed great improvements and new applications in the agriculture market. The **Agriculture Segment** for GNSS includes devices/ capabilities such as Tractor Guidance, Automatic Steering, Variable Rate Technology (VRT), and included in the 3rd edition of the Market Report for the first time, Asset Management.

The two Agricultural applications that are predicted to experience massive growth over the next ten years are VRT and automatic steering. VRT uses earth observation and other techniques to ensure the application of a locally-adapted supply of nutrients and fertilisers to best suit local conditions. The amounts applied can be varied across individual fields. Automatic Steering is the most advanced form of tractor guidance which allows the farm equipment to repeatedly manoeuvre on the same track, reducing wastage, and frees the operator/driver to concentrate solely on monitoring the overall situation.

The GSA is heavily involved in promoting GNSS within the Agriculture segment. The GSA awards a "Farming by Satellite" prize, which is targeted at universities, students, and young professionals interested in agriculture, with the aim of promoting GNSS benefits in agriculture. For more information please visit: *www.farmingbysatellite.eu*

The Agriculture segment is predicted to be one of the fastest growing segments covered by the Market Report. There is clearly scope for innovation and new business opportunities here! Another market segment that is expected to experience massive growth over the next ten years is the Rail segment as this highly-regulated marketplace begins to embrace GNSS technologies for train tracking, control and management.

The **Rail Segment** is featured for the first time in the 3rd edition of the Market Report. It includes applications such as Asset Management, Passenger Information systems, Low Density Line Command and Control Systems (CCS), and High Density Line CCS.

The railways provide a difficult operational environment for GNSS technologies. Tunnels, cuttings and urban canyons are all problematic factors, potentially causing blockage of GNSS signals thus degrading GNSS availability and integrity, which is why historically GNSS has not been used for safety-critical train systems. However, GNSS when combined with other systems, such as inertial measurement units (IMU), does have potential to provide high accuracy and integrity positioning for train control/rail management systems.

The primary growth in revenue in the Rail segment is expected to come from High Density Line CCS. The introduction of Positive Train Control (PTC) within North America will drastically change the size of revenues within the Rail Segment and the growth in the next decade is expected, primarily due to innovations in the CCS and other applications, such as train tracking/management, logistics support and passenger information provision. In summary, the GSA Market Report indicates that over the coming decade, 2012-2022, the installed base of GNSS devices will increase nearly four-fold, largely driven by market penetration in regions outside Europe and North America. It is believed that the gains and benefits in the European and North American economies derived from the application of GNSS technologies is many market sectors will be replicated throughout the Rest of the World as these regions embrace GNSS technologies.

Global technology trends indicate that new smartphone capabilities alongside integrated technologies are blurring the market segment breakdowns, as LBS devices increasingly support navigation and services in other application areas. The LBS segment is forecasted to be the largest market segment by revenue, overtaking the Road/Automotive segment, where the PND market continues to decline, being cannibalised by the use of smartphones in cars. LBS devices are also being increasingly used in the general aviation and maritime leisure markets.

Overall, the GNSS market is forecasted to grow strongly as new capabilities emerge, such as multi-constellation positioning and navigation using Galileo and BeiDou, and new applications begin to add benefits to the daily lives of all humans on the planet by the end of the next decade – by the end of the second decade of the 21st century GNSS will truly be the "fifth utility" element, alongside water, electricity, gas and telecommunications, on a global scale.

The European Union is involoving the industry and research community into creating the added value of the European GNSS by different tools. In December 2013 the Horizon 2020 programme for research and innovation was launched. It includes the Call for Applications in Satellite Navigation- Galileo, with the budget of €38m in the first year. The topics within the call are aimed at supporting the development of innovative applications that can have a substantial effect on strengthening the EU industry and its ability to compete. Looking at the GNSS market potential in the GSA's Market report, it is a good attitute to create synergies between research and market, building the EU added value in the most promising sectors.

The complete report can be download at *http://gsa.europa.eu/market/market-report*

Performance analysis of position estimation based on laser scanner and SLAM

In this paper, performance estimation of the position and attitude using the 2D laser scanner has been discussed

Jun-Hyuck Im
Electronic Engineering,
Konkuk University,
South Korea

Gyu-In Jee
Electronic Engineering,
Konkuk University,
South Korea

In areas such as the environment of the city, for reasons such as multipath and GPS signal blocking, accurate position estimation is difficult only GPS system. The study such as GPS/INS, GPS/DR has been performed. Location estimation technique that combines vehicle-mounted sensors, camera, laser scanners have been studied here. Especially in recent years, studies for improving the position and attitude estimation performance of the robot and the car with a laser scanner is performed[1-3]. More recently, studies using the Velodyne(3D laser scanner) is a new research [4].

In order to use laser scanner information, it is necessary to extract feature points surrounding environment. This applies equally to the case of using the image information. However, the laser scanner provides intuitive information as angle and distance to nearby landmarks different from the image information. And, as with the error range of a few cm, distance information of laser scanner is very accurate.

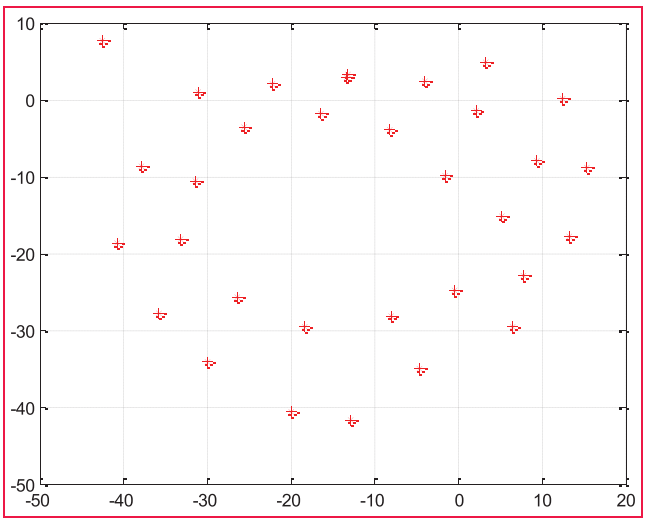


Figure 1: Experiment Environment

In this paper, we extract the position of the surrounding landmarks using a laser scanner and applying the SLAM (Simultaneous Localization and Mapping) technology to estimate the position and attitude of the vehicle.

Situation set of experiment

The experimental situation, in an environment where you placed the cylindrical obstacle of about 70cm diameter and obstruction of conical shape of about 30cm in diameter, was set up to run the dot of the specified path the vehicle. Figure 1 shows an arrangement of obstacles for the experiment.

In Figure 1, Red stars are obstacles, starting from (0,0), unmanned ground vehicle is traveling between the obstacles in a counter-clockwise direction.

Kalman filter

In this paper, we used the bicycle model. System equation using the bicycle model is as follows.

$$q_{k+1} = F_K q_k + G_k u_k \quad (1)$$

State variables is $q_k = (x_k, y_k, \theta_k)^T$. It represents east, north direction coordinate and the Heading angle, respectively. Input is $u_k = (V_k, \delta_k)^T$. It represents the goal speed and the steering angle, respectively. Transition matrix for this is as follows.

$$F_k = \begin{bmatrix} 1 & 0 & -\|V_k\| \cdot \Delta t \cdot \sin\left(\theta_k + \frac{\Delta\theta}{2}\right) \\ 0 & 1 & \|V_k\| \cdot \Delta t \cdot \cos\left(\theta_k + \frac{\Delta\theta}{2}\right) \\ 0 & 0 & 1 \end{bmatrix}$$

$$G_k = \begin{bmatrix} \Delta t \cdot \cos(\theta_k + \Delta\theta) & \frac{L \cdot \Delta\theta \left\{\cos(\theta_k + \Delta\theta) - \cos\left(\theta_k + \frac{\Delta\theta}{2}\right)\right\}}{\sin^2 \delta_k} \\ -\Delta t \cdot \sin(\theta_k + \Delta\theta) & \frac{-L \cdot \Delta\theta \left\{\sin(\theta_k + \Delta\theta) - \sin\left(\theta_k + \frac{\Delta\theta}{2}\right)\right\}}{\sin^2 \delta_k} \\ \frac{\tan \delta_k}{L} \cdot \Delta t & \frac{\|V_k\| \cdot \Delta t}{L \cdot \cos^2 \delta_k} \end{bmatrix} \quad (2)$$

Where, L represents the distance between the rear wheel axle and the front axle of the vehicle, $\Delta\theta$ represents the amount of change in heading angle of the vehicle and is calculated by the following relationship.

$$\Delta\theta = \frac{\|V_k\| \cdot \Delta t}{L} \cdot \tan \delta_k \quad (3)$$

Measurements obtained from the laser scanner is the information of the distance (r) and the angle (α). Measurement equation to obtain this is as follows.

$$r_k = \sqrt{(x_k - x)^2 + (y_k - y)^2}$$
$$\alpha_k = \tan^{-1}\left(\frac{y_k - y}{x_k - x}\right) - \theta \qquad k = 1, 2, \cdots \quad (4)$$

Where, n is the number of measurements and θ is a current heading angle of the vehicle. Observation matrix for this is as follows.

$$H_k = \begin{bmatrix} \frac{-(x_k - x)}{\sqrt{(x_k - x)^2 + (y_k - y)^2}} & \frac{-(y_k - y)}{\sqrt{(x_k - x)^2 + (y_k - y)^2}} & 0 \\ \frac{(y_k - y)}{(x_k - x)^2 + (y_k - y)^2} & \frac{-(x_k - x)}{(x_k - x)^2 + (y_k - y)^2} & -1 \end{bmatrix} \quad (k = 1, 2, \cdots) \quad (5)$$

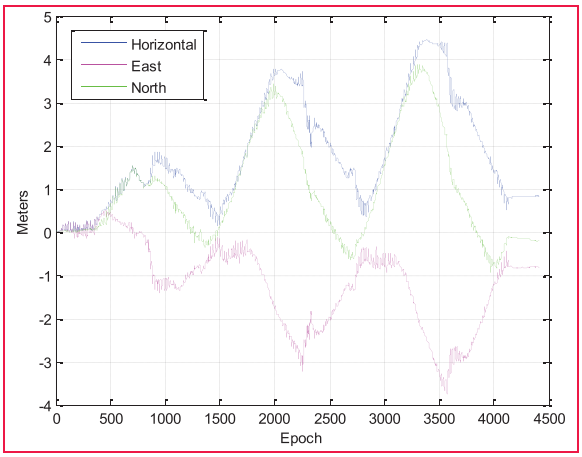


Figure 2. Position error

Experiment result

Standard deviation of the steering angle and speed input are 3 degrees and 0.3 m/s, respectively. Further, measurement (angle and distance) error was set at 3 degrees and 0.3m, respectively. Figure 2 shows the position errors between the real trajectory and the estimated trajectory. Figure 3 shows the attitude error. Figure 4 shows the driving trajectory. At the experiment result, position error was within 4.5m, attitude error was revealed in 7 degrees or less.

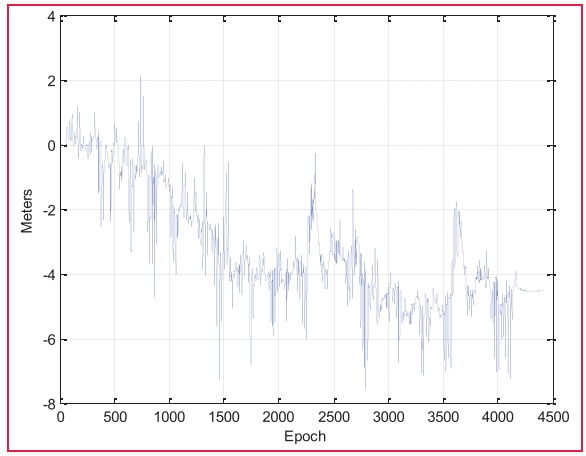


Figure 3. Heading error

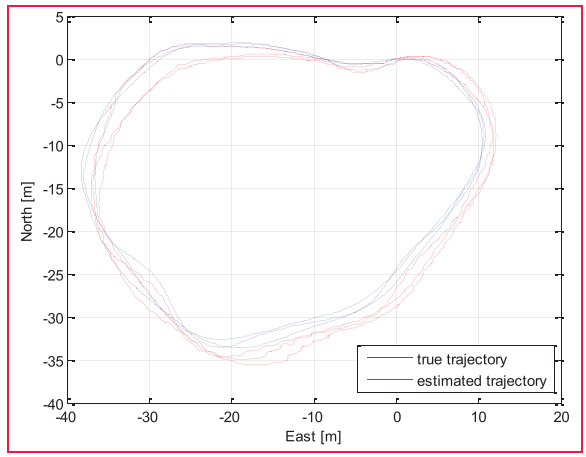


Figure 4. Driving trajectory

Conclusion

In this paper, we performed an experiment of position and attitude estimation of the vehicle with a laser scanner. At the experiment results, very reliable result was obtained in a short interval. In the future, Study about sensor fusion with GPS, IMU and Vehicle mounted sensors must be carried out for performance advance.

Acknowledgements

This work was supported by a grant from Korea Research Council of Fundamental Science & Technology funded by Ministry of Education, Science and Technology in 2013 [Project : A Study on Satellite based Position Tracking Technology for Calamity Prevention and Public Safety Improvement].

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Introducing

TRIUMPH-LS

The ultimate **L**and **S**urvey machine

2.5

25

8640

864

Complete RTK Unit

The most channels

Rugged ✓ Fully Integrated

The best performance and productivity

Interference protection and monitoring

Lightest weight in class ✓ Best battery life

An unbelievable price

Store and Stake like never before

Stakeout

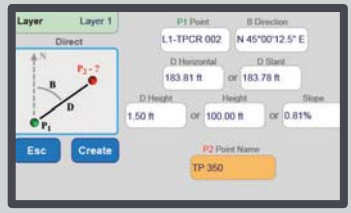
Survey

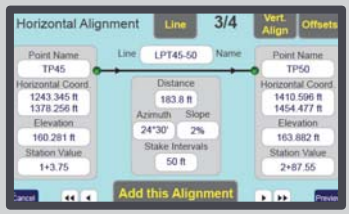
GIS

Introducing GUIDE data collection in the TRIUMPH-LS. Visual Stake-out, navigation, six parallel RTK engines, over 3,000 coordinate conversions, advanced CoGo features, rich attribute tagging on a high resolution, large, bright 800x480 pixel display.

Versatile attribute tagging, feature coding and automatic photo and voice documentation.

The TRIUMPH-LS automatically updates all firmware when connected to a Wi-Fi internet connection.





Productivity & Performance

864 Channels, All Satellite signals, 6-parallel RTK engines, Visual Stake out, innovative simple and accurate field line work.

channels

864

~~440~~

~~220~~

~~216~~

~~76~~

~~12~~

~~4~~

JAVAD has always been the channel count leader with 12, 76, and 216 channel receivers and now we introduce the TRIUMPH-LS with 864 channels combined with three powerful processors and program memory in a single chip which uses less power and makes the total system less expensive.

Some questioned the need for the 216 channels. They now realize the need for 440 channels. We assign multiple channels to each satellite for redundancy and reliability. We use over 100 channels to scan GNSS bands for interference (patent pending). 864 channels is the KEY to reliable performance.

Our satellite tracking technology, 6-parallel RTK engines, visual stakeout, revolutionary innovative simple and accurate field line work, visual stakeout, an unique interference monitoring and reporting feature, TRIUMPH-LS is the most advanced GNSS system ever built.

*GPS+GLONASS+Galileo+SBAS+BeiDou+QZSS

Battery Life: 25 Hours; System Weight: 2.5 Kg (5.5 lb)

hours

25

~~10~~

~~8~~

~~6~~

~~4~~

~~2~~

25 hour battery life in RTK rover mode with full screen brightness and UHF/GSM. Hot Swappable" and "removable batteries" are concepts of the past.

Two hours of charge = Two days of surveying

The internal batteries are field serviceable and can be easily replaced by the user when needed.

The TRIUMPH-LS, including batteries and pole is the lightest complete GNSS RTK receiver in its class. The total weight of the TRIUMPH-LS RTK system, including radio, controller, pole and 25 hours of internal battery is 2.5 Kg.

For comparison, the Trimble R10, TSC3 data collector and pole, with about 5 hours of battery life is 3.57 Kg (7.86 lb).

~~50 (110)~~

~~30 (66)~~

~~20 (44)~~

~~10 (22)~~

~~5 (11)~~

2.5 (5.5)

Kg (lb)

TRIUMPH-LS
Rugged, Tough, Versatile

Built on a tough magnesium alloy chassis, all connectors, SIM cards, Micro-SD cards are protected against the harshest environment.

You can collapse the pole and take the unit next to you in your car seat. There are no long poles and no separate controller and brackets to disassemble.

9 keys provide direct access to all functions. Six keys are user programmable.

The built in GNSS full tracking antenna has a large ground plane and the best centering and rotational performance on the market.

$ 8,640

complete RTK receiver system

Receiver+Antenna+Radio Modem+Controller+Pole

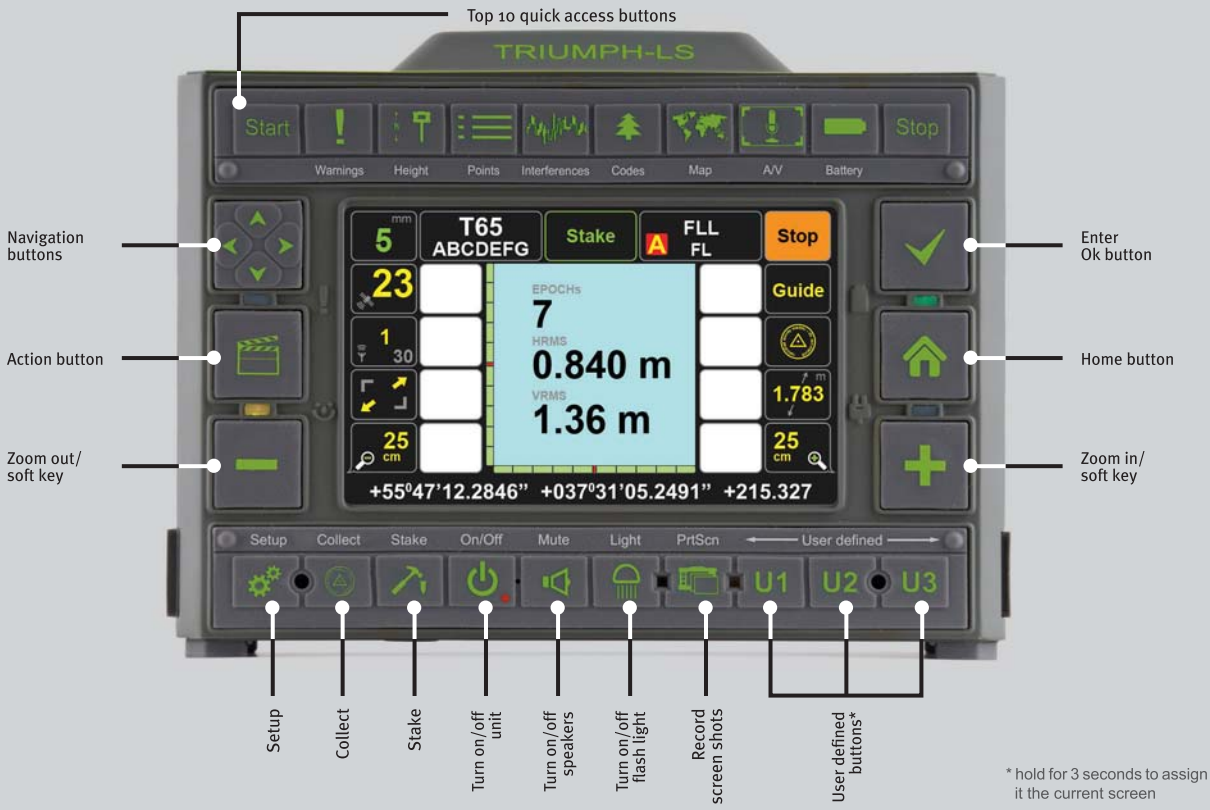
~~200,000~~
~~70,000~~
~~50,000~~
~~35,000~~
~~18,000~~

8,640

US $

- Base or Rover
- GSM Modem
- UHF Transmit & Receive
- Lifetime Firmware & Software Updates
- 3-Year Unlimited Warranty

U.S. Professional Land Surveyors (registered PLS) can test drive the TRIUMPH-LS for two weeks at no charge (includes 2 Day FedEx delivery and return).
See **www.javad.com** to reserve one (for U.S. Licensed PLS only).



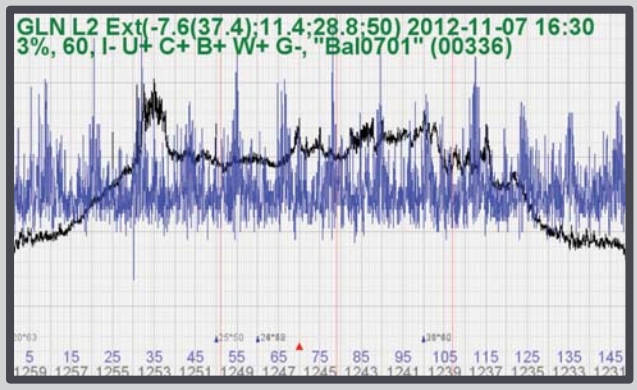
Interference Monitoring and Reporting

Radios
TV's
Radars
Harmonics
GSM
LTE
&
Jammers

Have you noticed in some places on some days that your receiver does not operate as it should? Intentional and unintentional interference appears almost everywhere. The Triumph-LS has the best available interference protection. It is the only receiver that monitors and reports interference graphically and numerically. Over 100 channels are dedicated to continuous interference monitoring.

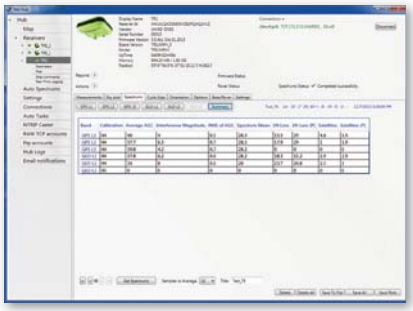
Interference awareness is a must when performing GNSS work. It allows safe GNSS operation in a city, airport and military environment.

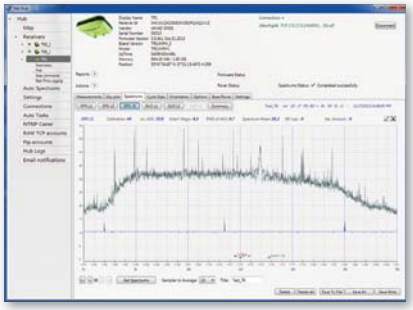
Some interference

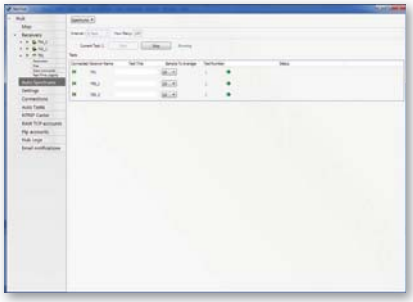


Big interference

A one man coalition to protect all GNSS bands!







We protect against out-of-band and near-band interferences with J-Shield.

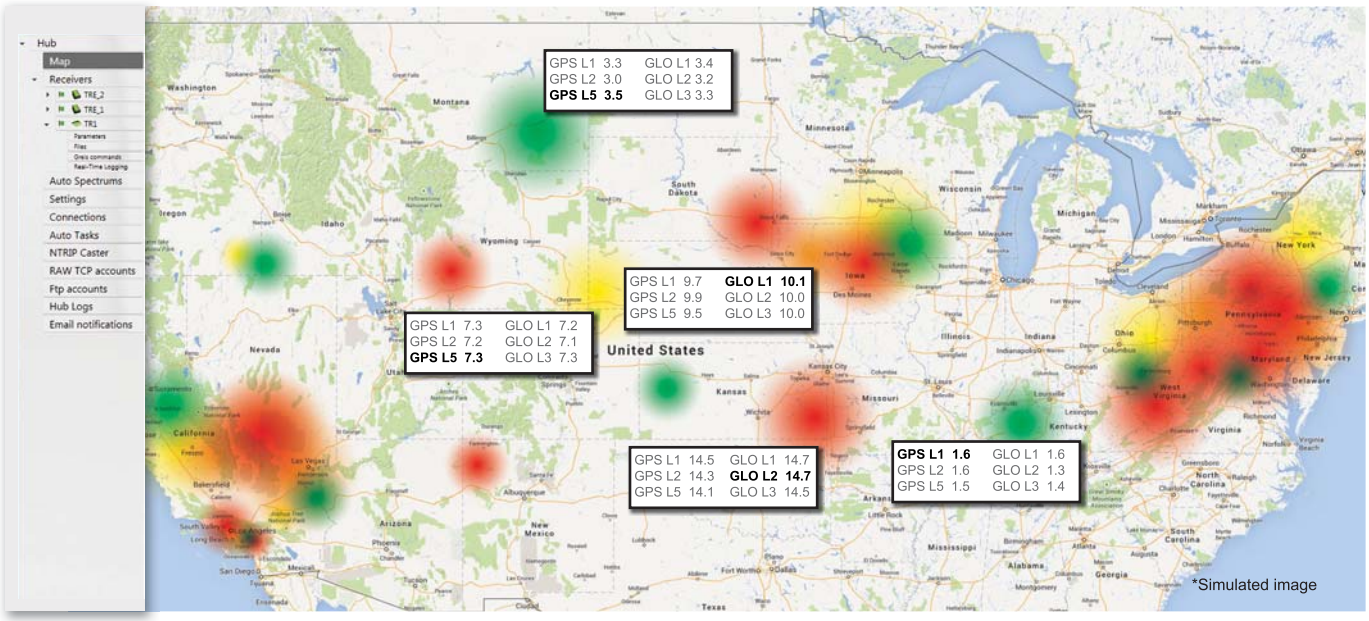
We protect against narrow in-band interferences with an 80’th order adaptive filter.

We monitor interferences in five different ways* in each receiver and report with Net-Hub.

This is true GNSS patriotism.

A one man coalition
to protect all GNSS bands!

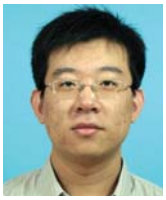
* 1) Spectrum Shape, 2) AGC values, 3) AGC variations,
4) Satellites C/No, 5) Satellites C/No variations



Efficiency and geometric precision of Chinese spaceflight TT&C network observing Tiangong-1

In this paper, the efficiency and geometric precision (PDOP) of Chinese spaceflight TT&C network observing Tiangong-1 were calculated and analyzed based on ground-based TT&C network and the new TT&C network included Tianlian-1 Tracking and Data Relay Satellite System respectively according to the Tiangong-1 task

Erhu WEI
Professor, Ph.D supervisor, School of Geodesy and Geomatics, the Key Laboratory of Geospace Environment and Geodesy, Ministry of Education, Wuhan University, Wuhan, China



Peng WANG
Assistant Engineer, Guangzhou Urban Planning Design & Survery Research Institute, Guangzhou, China

China has invested enormous effort in manned space engineering. The Tiangong-1 and Shenzhou-8 have been launched, twice rendezvouses have been accomplished successfully. In order to meet the requirements of the manned space engineering on the TT&C network, and prepare for our country's space station construction on TT&C in the future, two satellites of Tianlian-1 Tracking Data Relay Satellite System have been launched and are running together, and been used for the rendezvous task.

China's existing TT& C Network is composed by five control centers, number of Ground-based control stations/ships, and two tracking and data relay satellites. The TT&C system is the unified S-band system which is widely used in international, so we could use other country's TT&C stations on the task requirement to expand the range that can be observed.

This paper will analyze the coverage efficiency and geometric precision based on Ground-based TT&C Network and the new TT&C Network included Tianlian-1 Tracking and Data Relay Satellite System respectively according to the Tiangong-1 task.

The research present that the coverage efficiency of our country's new TT&C Network included Tianlian-1 Tracking and Data Relay Satellite System has met the manned space engineering requirement. The coverage efficiency has improved several times compared to the traditional Ground-based TT&C Network, and the Tiangong-1 can be totally controlled when located in our country and nearby. On the geometric precision, the PDOP of the new TT&C Network include Tianlian-1 system observe Tiangong-1 can be less than 50 in most time, and it's benefit for the rendezvous task and determining the orbit and operating status after the Tiangong-1 and Shenzhou-8 docked. Integrated USB ranging accuracy and PDOP values calculated results, consider of the orbit determination needs and only consider the impact of ranging accuracy the positioning accuracy of our country's TT&C Network observing Tiangong-1 can be better than 10m in most time, and can be better than 20m almost all the time.

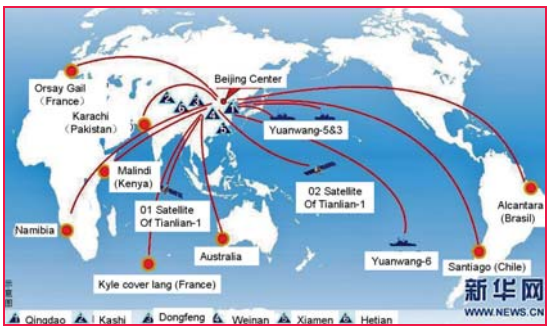


Figure 1: TT&C Network for Tiangong-1[1]

The TT&C network for Tiangong-1

It's the first time that the TT&C Network for Tiangong-1 used for manned spaceflight task after the Tianlian-1 system was completed. The TT&C Network must have high coverage efficiency, accuracy and reliable because of the rendezvous and docking, and another rendezvous and docking after separate. The TT&C Network for Tiangong-1 is composed of Beijing spaceflight control center, six domestic land-based stations, eight foreign

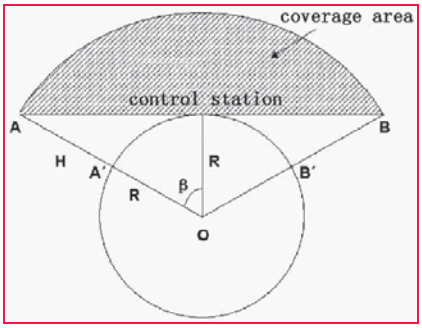


Figure 2: Coverage Area of Control Station

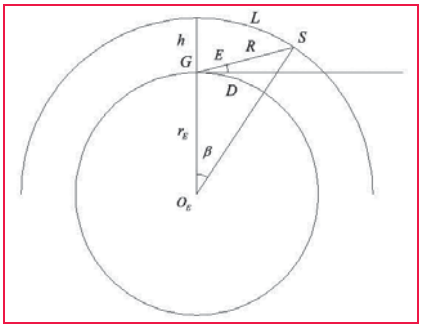


Figure 3: Maximum coverage area of control station

land-based stations, three Yuanwang measurement ships, and Tianliang-1 tracking and data relay satellite system, the measurement ships will maneuver according to mission requirements.

Coverage and PDOP calculate method

Coverage area of control station

The coverage area of a control station for the spacecraft with the orbit altitude H was the shadow area shown in figure 2. Projected onto the sphere is an arc area, and the control station is the center, the radius is the long from the control station to A′or B′[2].

In order to improve the data quality and reduce affections of atmospheric refraction of electromagnetic wave propagation, the minimum elevation angle must be set. For the observing of near-earth spacecraft, the spacecraft orbit can be seen round and the earth is stationary.

Figure 3 shows the coverage area when the spacecraft through control station zenith.

Coverage area of TDRS

The tracking and data relay satellite is a geosynchronous satellite, assume the satellite location is (λ_S, 0). The designed antenna angel is decided by the tracked spacecraft apogee altitude h_a, see equation (1).

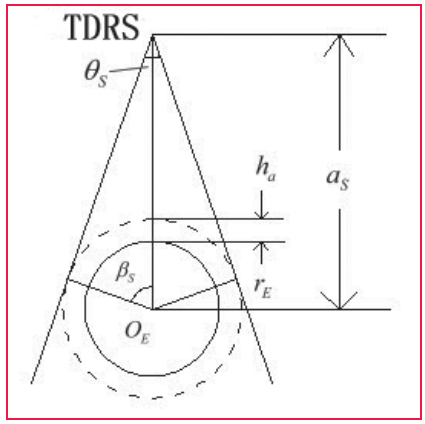
$$\theta_S = 2\arcsin\frac{r_E + h_a}{a_S} \tag{1}$$

a_S is the orbit radius of the tracking and data relay satellite, $a_S \approx$ 42164km.

The data relay satellite coverage projects for a circle on the earth, the center coordinate is $\lambda = \lambda_S$, $\varphi \approx 0$, the radius is $(r_E+h_a)\sin\beta_S$. It can be covered when the spacecraft orbit altitude $h \le h_S$, and the ground track is in the circle.

PDOP calculate method

Now the common measure systems used by our county's TT&C Network are



Figur 4: Antenna Angel of TDRS

single station RAE and multi stations ranging system, and we derivative the PDOP calculate method based on multi stations ranging system.

In order to briefly discuss, we only considered the ranging error, and didn't consider other affections of measurement errors. Assume the distance measurement values at the time t are R_i (i=1,2,3), $M(X,Y,Z)$, is the location of spacecraft at the time t in the geodetic coordinate system, three stations locations are $S_1(X_1,Y_1,Z_1)$, $S_2(X_2,Y_2,Z_2)$ and $S_3(X_3,Y_3,Z_3)$ in the geodetic coordinate system,

R_i^t (i = 1,2,3) are real distances between the stations and spacecraft at t, so

$$R_i = R_i^t + \varepsilon_i \tag{2}$$

$$R_i^t = \sqrt{(X-X_i)^2 + (Y-Y_i)^2 + (Z-Z_i)^2} \tag{3}$$

ε_i is measurement noise. So

$$R_i = \sqrt{(X-X_i)^2 + (Y-Y_i)^2 + (Z-Z_i)^2} + \varepsilon_i \tag{4}$$

Taylor expansive the equation (4) at the initial value $M(X^0,Y^0,Z^0)$ and column error equation is

$$\Delta R_i = -\frac{X^0 - X_i}{R_i^0}\Delta X - \frac{Y^0 - Y_i}{R_i^0}\Delta Y - \frac{Z^0 - Z_i}{R_i^0}\Delta Z - R_i + R_i^0 + \varepsilon_i \tag{5}$$

In the equation

$$R_i^0 = \sqrt{(X^0 - X_i)^2 + (Y^0 - Y_i)^2 + (Z^0 - Z_i)^2} \tag{6}$$

Equation (5) can be simplified to

$$\Delta R = B\Delta r - l \tag{7}$$

And

$$\Delta r = \begin{pmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{pmatrix} \tag{8}$$

$$l = \begin{pmatrix} R_1 - R_1^0 - \varepsilon_1 \\ R_2 - R_2^0 - \varepsilon_2 \\ R_3 - R_3^0 - \varepsilon_3 \end{pmatrix} \tag{9}$$

If the ranging accuracies of each control stations are the same, scilicet distance measurement values have the same weight, so

$$\Delta r = \left(B^T B\right)^{-1} B^T l \tag{10}$$

$Q = \left(B^T B\right)^{-1}$ is called weight coefficient matrix, the PDOP is defined as

$$\text{PDOP} = \sqrt{trQ} \tag{11}$$

So the location accuracy σ_M is

$$\sigma_M = \text{PDOP} \times \sigma_0 \tag{12}$$

σ_0 is the estimated value of ranging accuracy.

Coverage analysis

The orbit data of Tiangong-1 and Tianlian-1 used in this paper were two-line element set (TLE) data that published by North American Aerospace Defence Command (NORAD), the ephemeris data will be updated from time to time according to demand. The TLE data is a kind of general ephemeris data and founded by NORAD.

The orbit altitude of Tiangong-1 is nearby 330km, the coverage efficiency of the TT&C Network to the 330km high will be analyzed first, then the coverage efficiency of the TT&C Network to Tiangong-1 will be analyzed, at last the affection of Tianlian-1 to the TT&C Network will be analyzed.

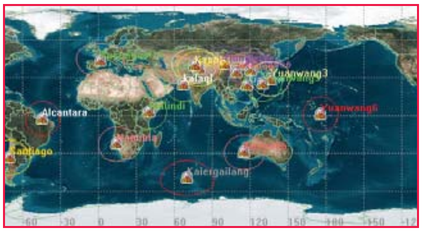


Figure 5: Coverage area of ground-based stations or ships

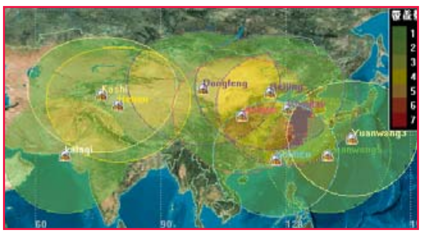


Figure 6: Number of stations

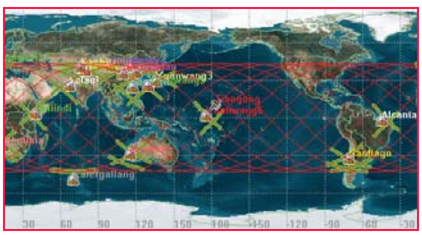


Figure 7: Arcs can be covered

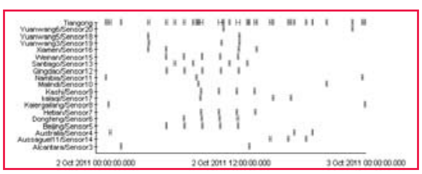


Figure 8: Periods of each stations and ships

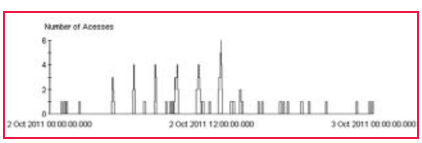


Figure 9: Number of available stations

One day ephemeris data of Tiangong-1 from 2011.10.2 00:00:00.00 to 2011.10.3 00:00:00.00 was choice to calculate when Tiangong-1 was in the test orbit, the ephemeris data of Tianlian-1 was also in that period. The minimum elevation angel was 5º, and the duration time of the station must be longer than 360s.

Coverage efficiency analysis of ground-based network

Figure 5 presents the area that can be covered by ground-based stations or ships, figure 6 presents the area that can be covered by multi ground-based stations or ships and the number of the stations or ships.

The area that can be covered by multi ground-based stations or ships is very small according to figure 6, only some areas in our country can be covered by multi ground-based stations, the max number of stations that can cover the same area is six. Through statistical, the area where can be covered is 17.9% the total.

Figure 7 presents the arcs that Tiangong-1 can be controlled, figure 8 presents the periods of each stations or ships when available, figure 9 presents the change of the number of available stations or ships from time to time. Table 1 and table 2 present the statistics result of the arcs can be controlled.

The arc period use single station is short. When only use ground-based TT&C Network, the total time observing Tiangong-1 is short and is only 18.77% a day.

Coverage efficiency of the new TT&C network

Figure 10 presents the areas where can be covered by the new TT&C Network, the pink is the area covered by Tianlian-1 01, the blue is the area covered by Tianlian-1 02. Figure 11 presents the areas can be covered by multi stations, ships and satellites, and the number of stations, ships and satellites.

Figure 11 presents the areas where can be covered by multi stations, ships and satellites have been improved, only some area in Pacific Ocean and South American, and east of North American can't be covered, the max number of stations that can cover the same area is eight. Through statistical, the area where can be covered is 88.21% the total.

Figure 12 presents the arcs that Tiangong-1 can be controlled, figure 13 presents the periods of each stations or ships when available, figure 14 presents the change of the number of available stations or ships from time to time. Table 3 and table 4 present the period when Tianlian-1 01 and Tianlian-1 02 can cover Tiangong-1.

From table 3 and table 4 we can conclude the effect of Tianlian-1 observing Tiangong-1, the total time that single satellite can observing Tiangong-1 account over 55% a day.

Table 1: Time of single station

	Station	Start	End	Period
Shortest	Beijing	06:12:03	06:18:07	362.881s
Longest	San Diego	06:56:44	07:04:29	465.240s

Table 2: Arcs can be control

	Start	End	Period
Shortest	19:09:54	19:16:21	385.795s
Longest	10:50:47	11:11:20	1233.014s
Total			16219.474s
Percent of a Day			18.77%

Jiang hu had analyzed relay performance of Tianlian-1 01 in the paper [3], he pointed out that the shortest period that Tianlian-1 01 can cover the satellite with 400km altitude and 400 inclination was 1357s, the longest period was 3510s, and the total

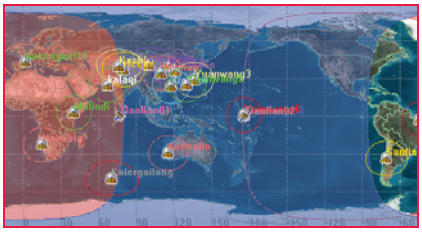


Figure 10: Coverage areas of new TT&C network

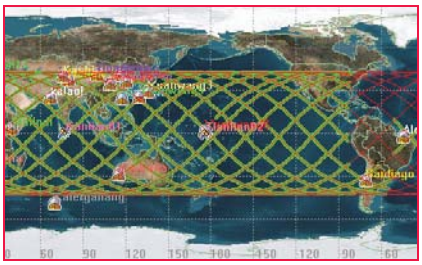


Figure 12: Arcs can be covered

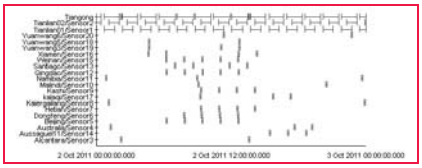


Figure 13: Periods of each stations or ships

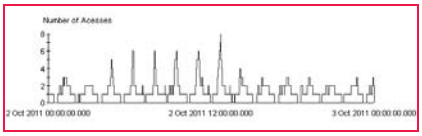


Figure 14: Number of available stations

Table 3: Tianlian-1 01

	Start	End	Period
Shortest	23:12:47	00:00:00	2053.123s
Longest	12:03:101	13:00:28	3437.335s
Total			48200.831s
Percent of a Day			55.79%

Table 4: Tianlian-1 02

	Start	End	Period
Shortest	23:53:28	00:00:00	391.861s
Longest	17:23:01	18:20:16	3434.812s
Total			48051.384s
Percent of a Day			55.62%

Table 5: Statistics result of the sustainable arcs

	Start	End	Period
Shortest	13:32:34	13:39:42	427.502s
Longest	05:34:09	07:04:29	5420.736s
Total			74621.225s
Percent of a Day			86.37%

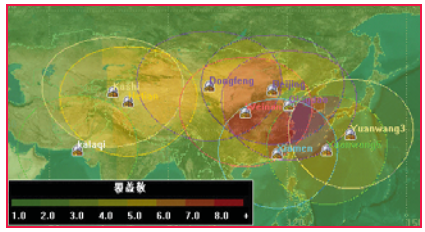


Figure 11: Number of stations

time account 56.5% a day. So this paper's result is in keeping with that.

Table 5 presents the statistics result of the sustainable arcs that the new TT&C Network can cover Tiangogn-1.

It can be concluded that the total time account to 86.37% a day, and more than 4 times than 18.77% which only use ground-based TT&C Network. The demanded coverage efficiency of the TT&C Network for manned spaceflight is: there must be more than 9min one loop evenly that the spacecraft can be controlled when it is in task orbit, and won't be more than one loop when control stations couldn't communicate with the spacecraft. It's 17.2min one loop evenly when only use ground-based TT&C Network, and control stations can communicate with the spacecraft all the loops; and 79.0min one loop evenly when only use the new TT&C Network, and control stations can communicate with the spacecraft all the loops. So using our country's new TT&C Network can improve the period when spacecraft can be covered effectively, and can guarantee Tiangong-1 task implement smoothly.

PDOP analysis

The geometric precision based on Ground-based TT&C Network and the new TT&C Network will be analyzed respectively in this part. According to the international TT&C standards, the spacecraft's measurement position accuracy should be better than 100m, now the ranging accuracy of our country's USB system is better than 2m, so the PDOP should be lower than 50.

The PDOP of the TT&C Network to the 330km high will be analyzed first, then the PDOP of the TT&C Network to Tiangong-1 will be analyzed, at last the position accuracy of the new TT&C Network observing Tiangong-1 will be concluded. One day ephemeris data of Tiangong-1 from 2011.10.31 00:00:00.00 to 2011.11.1 00:00:00.00 was choice to calculate when Tiangong-1 was in the rendezvous and docking state of readiness orbit, the ephemeris data of Tianlian-1 was also in that period. The located of the stations and ships were the same as they were in the coverage efficiency analysis, and the minimum elevation angel was 5°.

PDOP of Ground-Based TT&C Network

Figure 15 presents the PDOP of 330km altitude all over the world, the color in the area represent the change of PDOP. It can be concluded that the areas can be covered by multi stations and ships are small when only use ground-based TT&C Network, where are central and eastern areas, and some areas of Xinjiang and Tibet of China, and some areas in West Asia and Western Pacific in some areas, the total areas account to 2.26% all the world.

Figure 16 presents the result of observing Tiangogn-1, the pink is where PDOP is greater than 60 or unavailable, and figure 17 presents the change of PDOP from time to time a day when ground-based TT&C Network observing Tiangong-1. After statistics obtained, the time is 68min that there are at least 3 stations and ships can cover Tiangong-1 at the same time a day, and it account 4.74% a day, and the minimum PDOP is 1.98, the maximum is 105.68.

After statistics obtained, the longest period is 534.67s and the shortest period is 23.66s when Tiangong-1 can be covered by at least 3 stations and ships.

PDOP of the New TT&C Neteork

Figure 18 presents the PDOP of 330km altitude all over the world, the color in

Figure 15: PDOP all over the world

Figure 16: PDOP of ground-based TT&C network observing Tiangong-1

the area represent the change of PDOP. It can be concluded that the areas can be covered by at least 3 stations and ships are almost 4 times than that when only using ground-based TT&C Network, where are in addition to the northeast of Heilongjiang province in China a outside of almost all land areas and most parts of

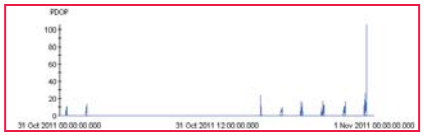


Figure 17: Change of PDOP using ground-based TT&C network

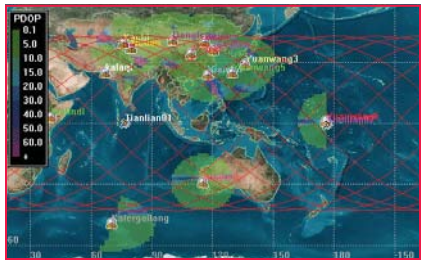


Figure 18: POPD of 330km altitude all over the world

Central and West Asia, and some areas in Western Australia and South Atlantic, continental and marine areas, the total area account to 8.31% all the world.

Figure 19 presents the result of observing Tiangogn-1, the pink is where PDOP is greater than 60 or unavailable, and figure 20 presents the change of PDOP from time to

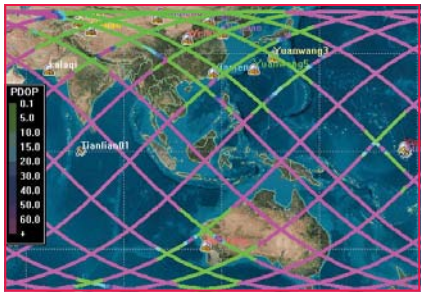


Figure 19: PDOP of the new TT&C network observing Tiangong-1

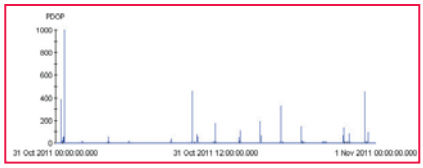


Figure 20: Change of PDOP using the new TT&C network

time a day when the hew TT&C Network observing Tiangong-1. After statistics obtained, the time is 176min that there are at least 3 stations and ships can cover Tiangong-1 at the same time a day, and it account 12.20% a day, and it is almost 3 times than that when only using ground-

Table 6: PDOP less than 50

Rang	Percent Worldwide	Percent Available
0-5	5.90%	71.00%
5-10	1.27%	15.28%
10-50	0.91%	10.93%
0-50	8.08%	97.21%

Table 7: Average PDOP of Single Arc

Range	Length	Arcs
-5	6714.70	13
5-10	2345.66	10
>10	435.87	2

based TT&C Network. The minimum PDOP is 1.32, the maximum is 1000.00.

In view of the situation that PDOP is great and the maxima is greater in few areas, we analyzed the position of Tiangong-1 and other situations and concluded that after Tianlian-1 added to the TT&C Network, when the spacecraft located in some positions, uneven distribution of stations on the perpendicular to the direction of the orbital plane, and this led to the PDOP larger. And some areas become available after Tianlian-1 added to the TT&C Network also led to the PDOP larger.

Position accuracy of the new TT&C network observing Tiangong-1

Doing statistics of PDOP less than 50 regional worldwide, the result is presented in table 6. It can be concluded that almost all areas PDOP is less than 50, and account 97.21% the area available, 8.08% all over the world.

After the statistics of the sub-arc of observation Tiangong-1, the maximum PDOP is 48.24, and the minimum is 1.32. The maximum average PDOP of a single arc is 13.80, and the minimum is 2.13. The average PDOP a day is 5.54.

Table 7 presents the average PDOP statistic result of each single arc. When using the new TT&C Network, there are 13 arcs that the average PDOP is less than 5, 10 arcs that the average PDOP is between 5 and 10, only 2 arcs that the average PDOP is great than 10.

According to our country USB system ranging accuracy and the simulation result of PDOP, it can be concluded that if only consider the ranging accuracy, the position accuracy of our country TT&C Network observing Tiangong-1 can be better than 10m in most time, and better than 20m in almost all the time.

Conclusion

The conclusion is obtained according to analyzing the coverage efficiency:

(1) When only using the ground-based TT&C Network, the shortest period is 362.881s of a single station, and the longest is 465.240s; the shortest length of the arc can be controlled is 385.795s, and the longest is 1233.014s; the total time is 16219.474s a day, and account 18.77% a day;

(2) After the entry of Tianlian-1, the shortest length of the arc can be controlled is 427.502s, and the longest is 5420.736s; the total time is 74621.225s a day, and account 86.37% a day;

The conclusion is obtained according to analyzing the PDOP of the TT&C Network observing Tiangong-1:

(1) When only using the ground-based TT&C Network, the areas where can be covered by multi stations and ships are small, account 2.26% worldwide. The time is 68min that there are at least 3 stations and ships can cover Tiangong-1 at the same time, and it account 4.74% a day, and the minimum PDOP is 1.98, the maximum is 105.68.

(2) When using the new TT&C Network, the areas can be covered by at least 3 stations and ships are almost 4 times than that when only using ground-based TT&C Network. The time is 176min that there are at least 3 stations and ships can cover Tiangong-1 at the same time a day, and it account 12.20% a day, and it is almost 3 times than that when only using ground-based TT&C Network. The minimum PDOP is 1.32, the maximum is 1000.00. According to our country USB system ranging accuracy and the simulation result of PDOP, it can be concluded that if only consider the ranging accuracy, the position accuracy of our country TT&C Network observing Tiangong-1 can be better than 10m in most time, and better than 20m in almost all the time.

Acknowledgments

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Can LADM contribute to a more fair large scale land acquisition?

The paper investigates up to which level the Land Administration Domain Model (LADM) can contribute to a fair approach in large scale land acquisition

João Paulo Hespanha
Adjunct Professor,
University of Aveiro,
Águeda, Portugal

Tarun Ghawana
GIS Consultant,
Integrated Spatial Analytics Consultants,
New Delhi, India

Dr Christiaan Lemmen
International Consultant,
Netherlands Cadastre,
Land Registry and Mapping Agency,
The Netherlands

Jaap Zevenbergen
Professor in Land Administration Systems,
University of Twente,
Faculty of Geo-Information Science and Earth Observation (ITC),
AE Enschede, The Netherlands

Potential conflicts between customary and / or informal systems of land tenure with the state supported formal systems of land registration are an issue in many developing regions. Africa presents a significant challenge because the traditional authorities (chiefs, clans, families etc.) have significant authority over land in most countries. Where it exists, formal land administration consists of the conventional approach based predominantly on deeds and title registration. However, the vast majority of the urban and rural population in African countries uses customary systems of land administration. Further due to the complex nature of the cadastre and property rights, colonial land administration laws and regulations remain entrenched in many countries (Burns, 2006; UN ECA, 2012).

In recent years, a new dimension has added to this situation and makes it more complex. Non-African governments concerned about stability of food supplies are promoting acquisition of farmland in foreign countries as an alternative to purchasing food from international markets. This fast-evolving context creates opportunities, challenges and risks. Increased investment may bring macro-level benefits and create opportunities for raising local living standards (Cotula et. al., 2009; Von Braun, and Meinzen-Dick, 2009).

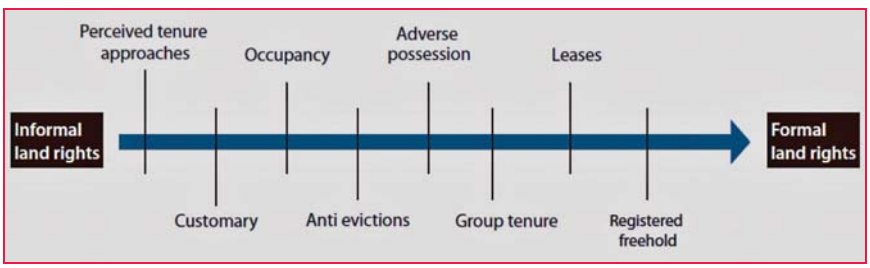

Figure 1 The continuum of land rights (from UN-HABITAT, 2008 There is an earlier version in UN-HABITAT, 2004).

On the other hand, land deals in Africa are framed by high levels of public concern over land rights and food security, both within countries and internationally. Commentators and insiders recognise the need to weigh the ambitions and potential of large-scale land-based developments against the concerns of host country citizens about sovereignty over local resources, as well as the vigorous criticism of some civil society organisations (Cotula et. al., 2009).

This study is largely based on previous studies done by international organisations and many of them refer to media reports as their basis. For this study, the authors have tried to present the situation in the context of the Land Administration Domain Model (LADM) framework.

The continuum of land rights

Already in the FIG Bogor Declaration (FIG, 1996) the different needs from different countries are underlined: a simple low cost manual cadastre recording only private ownership rights may be appropriate for one country, while a sophisticated and relatively expensive fully computerised cadastre recording a wide range of ownership and land use rights may be appropriate for another country. The infrastructure can support a vast array of legal, technical, administrative and institutional options in designing and establishing an appropriate cadastral system, providing a continuum of forms of cadastre ranging from the very simple to the very sophisticated. Such flexibility allows cadastres to record a continuum of land tenure arrangements (Section 4.5 of the Bogor Declaration) from private and individual land rights

through to communal land rights, as well as having the ability to accommodate traditional or customary land rights. In field operations there is a range of technologies from plane table to GPS. Work may commence with large scale images for adjudication purposes.

Larsson (1991) presents 'axis of variation' in the (so-called progressive, see Fourie and Van Gysen (1995)) development of cadastral/land information systems. One can start at different levels; types of simplification can be seen as variations along a number of axes – which together determine information content. Most important axes are according to Larsson:

- the *land – unit division axis.* For parcel based systems a division in land units is imperative. Variations can be found in size of the units – group (village), farm, parcel, etc,
- the *location – determination axis.* Location of land can be indexed without maps, as in the Doomsday Book and in most ancient tax recordation's. It can be also located by a point on an aerial photograph or map or as a co-ordinate. If the boundaries of the units have been recorded on the ground, they can be recorded in a map or co-ordinate record with a varying degree of accuracy. This depends partly on whether ground survey, photo interpretation or photogrammetric methods are being used. Variations in methods and results are possible,
- the *information – content axis.* To the primary land unit designation can be added various information. Such as area, land use, buildings, assessed value, owner, other rights, population, etc,
- the *information – quality axis.* In a land information system may vary considerably in quality,
- the *maintenance – axis.* Larsson says that the availability of up-to-date data is of strategic importance for land information systems. It may be included as a quality issue, and:
- the *spatial* – axis. This is about priority setting in order to determine which areas should be included.

Fourie (1998) pays a lot of attention to identification of objects. As a result a range of identifiers has been proposed based on some innovative new concepts, see also Fourie and Nino-Fluck (2000): points, lines, sketch maps, text, list of names, non geo-referenced parcels, unique numbers, geo-referenced parcels, etc.:

- points, geo-codes (sometimes known as dots on plots), and lines, in vector or raster format;
- polygons with fuzzy boundaries;
- text, including lists of names and unique numbers;
- parcels - poorly surveyed, non geo-referenced and geo-referenced; and:
- sketch maps, and photographs, in the absence of any better description.

In 1998 Fourie undertook a comprehensive review of the cadastre and land information in Africa for the United Nations Economic Commission for Africa. An overview is presented in that review as to what is required in terms of spatial units, identifiers, representation of varying accuracies, scales and qualities combined with persons and based on evidence (from the field) of how social tenures actually worked. The whole spectrum of tenure systems needs to be covered: formal, informal and customary systems, not neglecting land related disputes and conflicts. Focus in the design of systems should be on sustainable development – not on land transactions and mortgage. Design criteria for an information system are worked out in detail in this review – e.g. on the use of graphical reference frameworks; on the possible use of a range of instruments and data acquisition methods; on the contents of an information system where cadastre can be a linked system.

The importance of standards and national spatial frameworks was recognised, allowing decentral use of data for different purposes and for many different decision makers, combined with central use of data. Conventional LASs are parcel based. Fourie and Nino-Fluck (1999) propose ranges of technologies for data acquisition. Modelling: cadastral mapping using remotely sensed images, aerial photographs and GPS as source should be possible. According to them it should be possible to have flexible accuracy demands: it should accommodate, *'defined in Dale and McLaughlin (1988) terms',* graphical (pictorial) data, geometric (measurement based) data and topological data. Illegal and informal lands and customary lands should be possible to include. A continuum of land rights is proposed in UN-HABITAT (2008).

LASs are not yet supporting all these requirements. This continuum of land rights was already discussed in UN-HABITAT, 2003: 'there is a range of land rights in most countries which occupy a continuum, with a number of such rights occurring on the same site or plot'. And: 'there is a range of informal-formal (illegal-legal) types along a continuum, with some settlements being more illegal in comparison to others'. There is a reference to Payne (1997) who speaks about a useful strategy for policy makers '...every step along the continuum from complete illegality to formal tenure and property rights as a move in the right direction, to be made on an incremental basis'.

Simple approaches to formalise land market transactions (announcement of agreements at public meetings, providing facilities for written transactions, registration of contracts, and the witnessing of signatures. And: low cost survey and registration procedures. Further attention is paid to the recognition and integration of customary rights into the legislative framework and the extension of tenants rights.

UN-HABITAT (2008) views the various types of land right as existing along a continuum, with some settlements being more consistent with law than others. This view makes it possible to include the people with the weakest tenures in the idea of sufficient legal access, see Figure 1.

One more 'continuum' is at the subject side: FIG (1995) states that land units as parcels are defined by the formal or informal boundaries marking the extent of lands held for exclusive use by individuals and specific groups of individuals (e.g. families, corporations, and communal groups). Toulmin and Quan, 2000, speak about land shared by several groupings (e.g. wetlands, woodlands, grazing area's) and about fuzzy boundaries.

Today there is more and more discussion about complete global coverage, see for example (Bennet et al, 2010). There can be

support in the avoidance of land grabbing with an overview of the complete set of existing people to land relationships. Knowledge on areas which are included in land registry and area's which are not included has a special value in this context.

Enemark (2012) recognises cadastre as the core engine for spatially enabled land administration. According to him spatial enablement is not primarily about accuracy: it is about adequate identification, completeness and credibility. Systems should be built using a 'fit for purpose' approach while accuracy can be incrementally improved over time when justifying serving the needs of citizens and society. In relation to the concept of the continuum of land rights such a fit for purpose approach could then be referred to as a 'continuum of accuracy'.

In (Zevenbergen, 2013) the development of pro-poor land-recording systems is highlighted. It is stated that the Global Land Tool Network (GLTN) will document and analyse the institutional issues associated with local land-record management, before undertaking a pilot project. Work is also needed on organising data collection for local land records, such as customary land rights. It is important to find ways for the public sector – especially the courts and land agencies – to accept information from these nonconventional approaches, for example, to accept them as evidence in a court case, or to use them for land management. A next step would be to set up land information systems that cover larger areas and that rely on information from both conventional and non-conventional sources.

CheeHai Teo, (2012) sees a 'continuum of approaches', ranging from 'less rigorous' to more 'rigorous', a 'continuum of technology', ranging from 'less sophisticate' to 'more sophisticate' and a 'continuum of measurement' from 'more precise' to 'less precise'.

The Social Tenure Domain Model (STDM) (Augustinus et.al, 2006, FIG, 2010, UN HABITAT 2012), as a specialisation of the Land Administration Domain Model, brings all required functionality together. This functionality is also available in the LADM (ISO, 2012). LADM includes the so called Basic Adminsitrative Units, allowing grouping of spatial units. This functionality is not explicitly (but implicitly) available in STDM.

Transfers on land (use) rights and restrictions

Foreign governments and private enterprises are described as involved in dealings with national or sub-national governments and also with community representatives or individuals; see for example (Oxfam, 2011). However, different reports mentioned dominance of different parties in such types of dealings. Generally a private or joint equity company is engaged in acquiring land, but it can also be a foreign government. On the other side of the deal is a land provider, either a government or, much more rarely, a private land-owner (Cotula et al, 2009; Friis and Reenberg, 2010).

Each deal typically involves a wide range of parties through the multiple stages of preparing, negotiating, contracting and operationalising the project. First, multiple agencies within the host government are engaged. Even in countries where there is a central point of contact ('one-stop shop') for prospective investors, usually an investment promotion agency, this agency alone will not deal with all aspects of the land deal. At a minimum, the investor is likely to need to engage separately with government agencies at the local level. As per World Bank Study (Deininger et. al., 2011), contrary to the image of a neo-colonial foreign scramble for land that often emerges from media reports, acquisitions recorded by official inventories are dominated by local individuals or companies.

Specific restrictions on the acquisition of certain land rights by non-nationals may also exist. In some countries, non-nationals face restrictions on land ownership (e.g. in Ghana, under article 266 of the 1992 Constitution) and on resource use (for example, in Tanzania foreigners may acquire land rights only for the purpose of an investment project under the Tanzania Investment Act). But under certain circumstances incorporation of local subsidiaries may enable foreign investors to overcome these barriers. And in countries like Mali there is no formal legal differentiation of treatment between nationals and non-nationals though differences in practice may still exist. In Mozambique, foreign and domestic investors alike may acquire a renewable 50-year land use right, which for the first two years (five for nationals) is conditional upon the implementation of an agreed investment plan (articles 17 and 18 of the Land Act 1997).

In terms of legal analysis, the Sudan-Syria inter-governmental land deal, involves a renewable 50-year lease; the government of Sudan commits itself to delimiting the land and delivering it to the government of Syria "free from any right" other than ownership, which remains vested with the government of Sudan (article 3 of the agreement). The contract between Varun and 13 associations of local landowners involves a 50-year deal combining lease and contract farming arrangements, renewable for up to 99

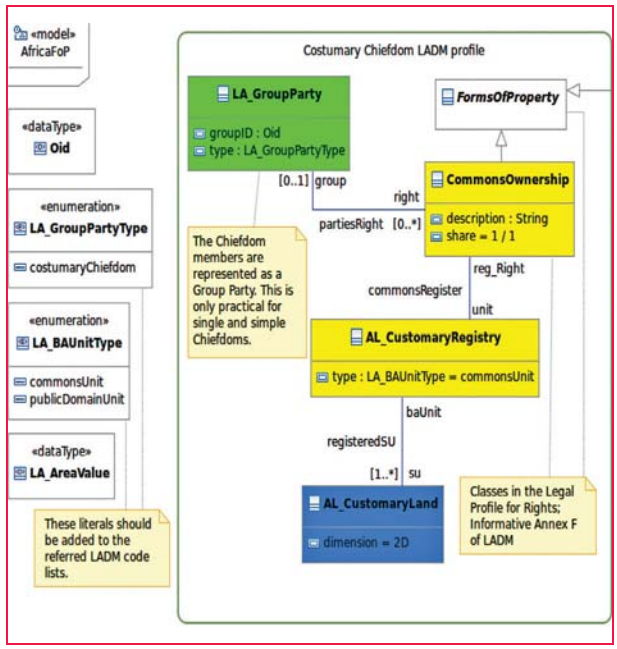

Figure 2: LADM Profile for a Customary Tenure

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years. Similarly, in Ethiopia, a contract from Benishangul Gumuz Regional State involved a 50-year lease (article 3). In Mali, land allocations to investors in the Office du Niger area also typically involve leases.

Some African countries have recently taken steps to strengthen the protection of local land rights, including customary rights – even where land is state owned or vested with the state in trust for the nation. Customary rights are for instance protected, to varying degrees, under Mali's Land Code 2000, Mozambique's Land Act 1997, Tanzania's Land Act and Village Land Act 1999 and Uganda's Land Act 1998 (Cotula et al, 2009).

Unlike Latin America and Eastern Europe, the land deals taking place in Africa predominantly involve government allocated land leases or land-use rights being distributed instead of land sales. The types of land agreement are ultimately determined by the status of land ownership within countries, which in Africa often involves collective ownership. In fact, an estimate from the World Bank (Deininger et.al., 2011) states that between only 2 and 10 percent of land across Africa is held under formal land tenure, which is normally just in urban settings.

Most of the international studies have quoted the various media reports as their references. This is due to the lack of transparency in making public the documents related to many such deals. However at one point FAO (see Cotula, et. al., 2009) states that most documented land leases are granted by the government. This includes 100% of documented cases in Ethiopia, Mali and Mozambique, and the vast majority of cases in Sudan. In other countries there is room for private transactions, however. In Ghana, for example, leases may be granted by the Land Commission, by customary chiefs or by families or individuals, depending on who holds the land. All the land leases documented by the Ghana inventory were granted by private right holders, particularly customary chiefs purporting to act on behalf of their communities. World Bank report 2011 (Deiniger et. al., 2011) cites the data officially available to in-country consultants for large land transfers during 2004-09 in 14 countries, complemented by analysis of media reports on large investments in 2008-09.

LADM framework

The Land Administration Domain Model (LADM) has been published as a International Standard (IS) by the International Organisation for Standardization (ISO, 2012; Lemmen et al, 2011), as ISO 19152. The IS covers basic information related to components of land administration (including water and elements above and below the earth surface). It includes agreements on data about administrative and spatial units, land rights in a broad sense and source documents (e.g. deeds or survey plans). The IS can be extended and adapted to local situations; in this way all *people land relationships* may be represented (Lemmen et al, 2011). The different 'continuum' approaches, as introduced in section 2 of this paper are supported (ISO, 2012). See also (FIG, 2010) for the STDM. The core of LADM is in four basic classes: LA_Party, LA_RRR, LA_BAUnit and LA_SpatialUnit. These are defined as follows:

Three typical forms of land tenure which can be abstracted from the reports from a number of countries in Africa (Burns, 2006; Cotula et.al, 2009; von Braun and Meinzen-Dick; 2009; Aryeetey and Lewis, 2010; Cuffaro and Hallam, 2011), coincide with the different forms of Property identified in the Rights Profile of ISO 19152 LADM proposal (ISO, 2012). Those three forms of tenure are: customary tenure, government land, and privately held land. Combined representations of those forms of tenure are presented below.

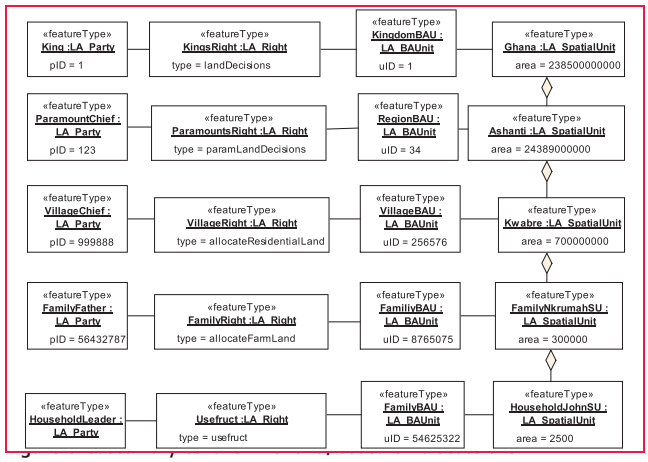
Customary tenure

One of these forms of tenure concerns the rights held in common by local communities, referred generally as customary tenure.

The diagram in Figure 2 depicts how this situation can be modelled by using LADM classes in UML, for the case of a single and simple Chiefdom (customary tenure), typically comprising a set of lands (as Spatial Units) around a village, governed by a single Chief. The group of members (Parties) holding property rights over the common land is represented by a Group Party (class LA_GroupParty in LADM) which collectively holds one or more (or none) Commons Ownership type of rights for a special type of Basic Administrative Unit (AL_CustomaryRegistry; check specialisations from LADM in Figure 7). It must be said that this kind of commonly held registries are not always registered in the existing Land Registry systems. So, a new kind of registry, or the integration into existing registry systems has to be considered to formalise such rights into each national property law.

Further, it is possible that each register for a Commons Ownership includes more than one, spatially separated Spatial Unit, including individual facilities or buildings included into private or state held property (the other two Forms of Property). A new type of Spatial Unit has been considered (AL_CustomaryLand as specialisation from LA_SpatialUnit).

An example of a real case of customary tenure is presented in the instance level here below in Figure 3. See Arko-Adjei (2006) and Arko-Adjei (2011).



with Arko-Adjei; see also ISO (2012), Annex C

Government land

Another major form of property for many countries in Africa (namely Mozambique), are the government held lands through nationalisation, which can cover the entire jurisdiction or just a part of it, like in Ghana.

The class diagram in Figure 4 shows how LADM can model lands which fall into the Public Domain, and therefore are owned by the State. The owner, represented by the basic LADM class of LA_Party, with some default values for the role and type attributes, can be a single non natural person representing the whole state. But it is also possible to consider particular state or federal agencies which have the role of administering Public Domains of some sort. Each one of these agencies can have more than one ownership (and administration) rights.

This is represented by the PublicDomainOwnership class and the "stateOwns" association. Typically, it can be assumed that only one ownership right holds for a given basic administration unit, to be registered in a special public registry of lands. This is represented by the AL_PublicLandRegistry class. These type of registers are usually separate from the classic Land Registries, namely in many Western European countries. For every registered Public Domain, there could be one or more individual Spatial Units, which must be considered apart from the customary and the private lands. And so, a specialised class (AL_PublicDomain) is considered. This should be represented by a Polygon with one or more holes, for any privately owned enclaves within the Public Domain. It should be allowed to constitute aggregates (as Multi-polygons), for the cases where the Public Domain Lands have non-contiguous parcels. The enumerations shown in the diagram correspond to code lists in LADM; however in this case, it was not needed to add any new literals to the existing ones.

Privately held Land

As can be abstracted by a number of references (Burns, 2006; Cotula, 2009; von Braun, 2009; Aryeetey, 2010; Cuffaro, 2011), there are few cases respecting land grabs, where the process is done primarily through private land acquisition. Involving thus the transfer of ownership from the previous owners (holding a freehold or property type of right), to the entity representing the foreign investors.

Rather, and as observed by (Aryeetey, 2010), the predominant form of foreign investment lies in long term land lease agreements, often contracted for more than 50 years, which are negotiated with the State.

This fact can be understood due to the recent historical evolution of the Land Administration in Africa, where in many countries subject to land grabs, land has been nationalised. Although many do recognise customary forms of tenure. The exceptions lie mostly in Commonwealth countries, formerly colonised by the British, which do have greater extent of their territories under private ownership domain, like Kenya. For instance, in (Burns, 2006) it is referred that in Namibia the majority of the land is under a common law based Freehold and is registered (through a deeds based registration system); and in South Africa, 80% to 90% is covered by registered rights and up-to-date cadastral data, although former homelands are often held under customary tenure. It must be said, however, that there are no reports of land grabs in either of these countries.

In spite of this fact, this form of acquisition can not be ignored, taking into consideration that not just the basic ownership right, but that other derived rights can be created in such large transnational land acquisitions, such as (possibly) Plantation or certain Use Rights. The class diagram for the private land acquisition in Figure 5 depicts the registered situation after a simple land transfer for a freehold property, whose ownership is ultimately detained by a non-natural person (a firm), representing the foreign investors. The most logical initial values where attributed to the LA_Party class: The LA_PartyType is a nonNaturalPerson, and the LA_PartyRoleType corresponds to "citizen". The spatial extent of the property right defines the boundaries of the Spatial Unit, coinciding with the LA_BAUnit register. This conforms with the most traditional view of the functions of a Land Registry. This is also the reason for this particular case being the one which uses mostly the LADM basic classes. Off course that for each particular country eventually adopting the Domain Model (LADM), specific attributes and code lists values should be considered for the different classes.

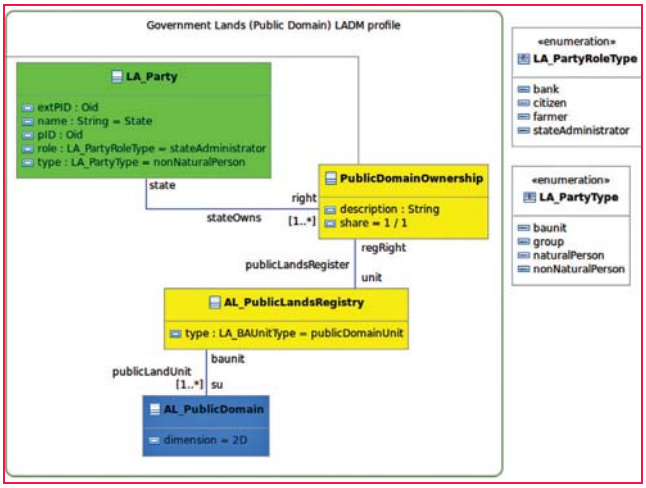


Figure 4: LADM Profile for Government Land

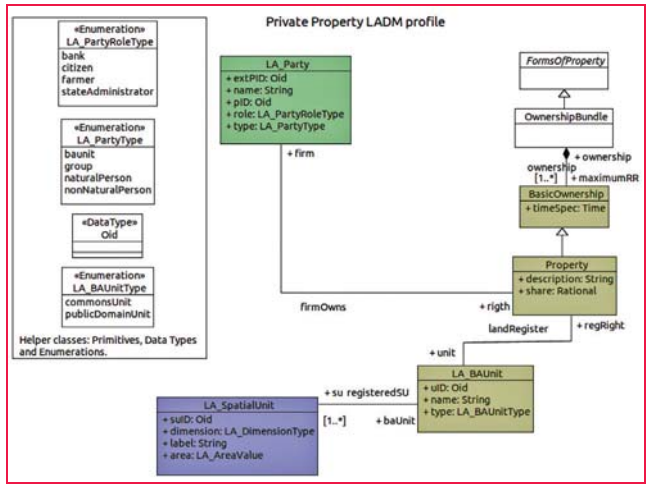


Figure 5: LADM profile for Private Land

The consideration of using or even upgrading existing Land Registration Systems in those countries, must be confronted with the fact that, and according to World Bank estimates, only between 2 and 10% of the land, mainly urban, is held under a formal land tenure (Cuffaro and Hallam, 2011).

These concerns, however, should be raised when planning for implementation, and this paper is more concerned with finding if the domain model in LADM is capable of depicting the Land Administration System aspects of different forms of land grabbing.

One aspect that has to be considered at the domain modelling stage, however, is the Land Administration support for an investment which assures Sustainable Development.

In LADM, this can be seen as a different level of Spatial Units, which are to be defined through Public Regulations which are valid upon all different forms of property (commonly held, public or private).

In the last case, these could assume the form of administrative servitudes, temporary use of land, or even expropriation. The specifics of each type of restriction or responsibility should be defined through a Land Policy Act, having the goals of Sustainable Development, creating infrastructure and employment, while at the same time securing local land rights, as demanded by (Cotula, 2009). To this fact, consider the following quote from (Cotula, 2009):

'Many countries do not have in place legal or procedural mechanisms to protect local rights and take account of local interests, livelihoods and welfare'.

Taking into consideration the above defined goals, a new diagram is created which depicts an hypothetical case of a beneficial large-scale land acquisition, as can be modelled through LADM by considering some specialisations from existing classes. This has been titled as "Sustainable large-scale land acquisition upon private land" and the corresponding class diagram is presented as Figure 6.

The diagram in figure 6 is of course an over-simplification of any hypothetical real case for a sustainable large-scale land acquisition. The purpose is to show how the basic LADM classes, together with classes from the Rights, Restrictions and Responsibilities profile in LADM (Annex F of ISO 2012), can support for the registration of such a case.

The diagram presents just the class names, for those depicted in the previous diagram, concerning private land. It adds however two specialised classes, one for a possible type of public based regulation (AL_InfrastructureReserve), using the parent classes from Annex F, and the other for a new type of Land Registration, where both the basic ownership rights and the publicly imposed restrictions are registered for each basic administrative unit.

As the note in the diagram clearly states, there should be more than one Spatial Unit for such cases, in order to quantify and locate the boundaries of the (public) regulation within the parcel. In this example, a portion of the land within the property should be reserved for a particular type of infrastructure, like rural irrigation.

To consider implementation of such a profile, known recommendations and best practices from documented cases should be studied in detail. It is expected that a number of Restrictions and Responsibilities of different types should be depicted for any given parcel, privately owned or under a long lease or concession over government or commonly held land.

Modelling of specialisations in ladm

This section shows what specialised classes had to be considered in the modelling of African Lands. We use in this paper the prefix AL to identify this, see figure 7. The use of prefixes in this way is very common in UML models in ISO standards.

As already mentioned in section 4.1 a new kind of registry, or the integration into existing registry systems has to

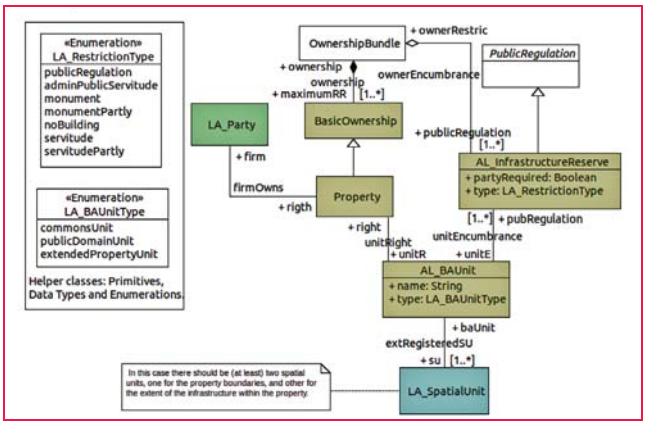


Figure 6: Sustainable large-scale land acquisition LADM profile

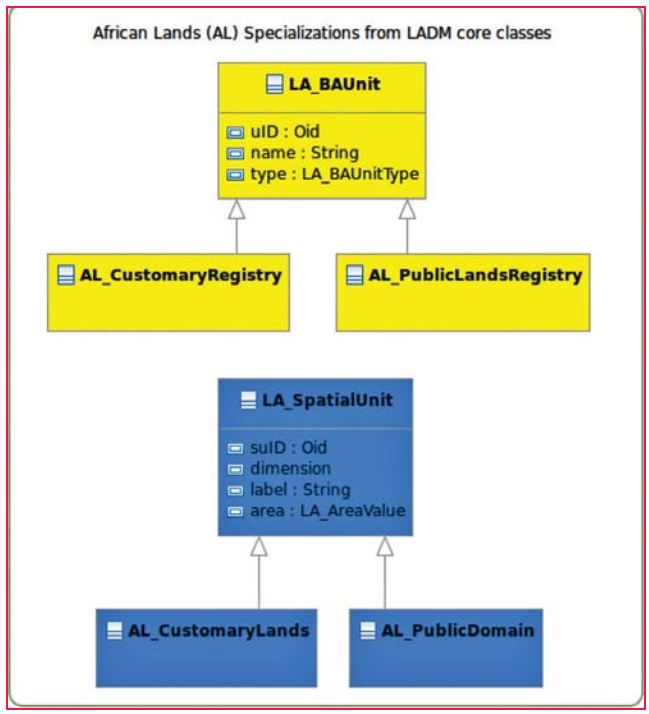


Figure 7: Specialised Classes from LADM basic Classes

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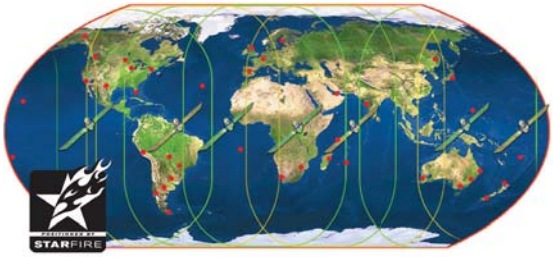

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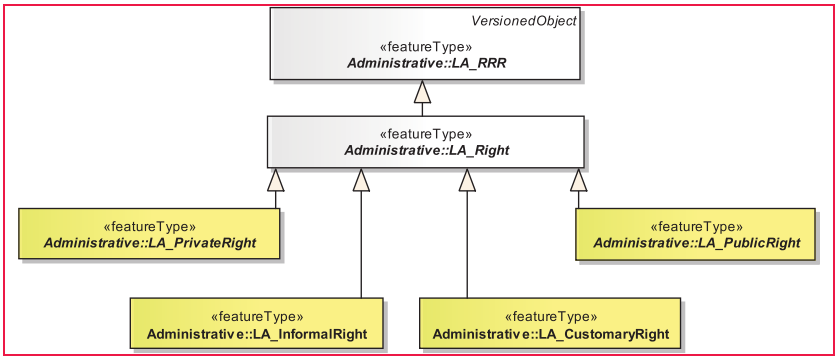

Figuur 8 Further alignment with LADM developments is needed

be considered to formalise such rights into each national property law. This is possible in LADM: registertype is an attribute of LA_Level. A level is a set of spatial units, with a geometric, and/or topological, and/or thematic coherence. For example: there can be one level of spatial units for an urban cadastre and another for spatial units for a rural cadastre. Or, another example: one level of spatial units to define basic administrative units associated with formal rights, a second level for spatial units to define basic administrative units associated with informal rights and a third level for spatial units to define basic administrative units associated with customary rights.

This paper shows what are the generalisation associations to the existing LADM basic Classes LA_ Party, LA_RRR, LA_BAUnit and LA_ SpatialUnit. LA_Level is associated to LA_SpatialUnit and can include the different registration types, see Figure 7. Even if they are specialised at this level of analysis, it is perfectly possible that there can be further specialisations for each African Country, taking into account their different cultural and historical background, and current legislation.

In the Spatial Unit component, each specialised class can be further associated with individual LA_Level classes, each with a particular spatial structure and its set of geometric and topology rules – which can be combined with different registry types. The LA_StructureType code list includes all the various spatial structure types, such as point or polygon, used in a specific land administration profile implementation.

Discussion

With its broad functionality LADM can support in the development of concepts for land administration systems which can be in support administration of multiple types of tenure. This is also valid for the Social Tenure Domain Model (STDM). Unconventional types of rights and spatial units can be included. Overlapping claims can be represented. This functionality allows a flexible approach in Land Administration and may result in fast availability of a cadastral map with a related registry of all (formal, informal, customary) in an area. This can then be used as a (more) solid base for large scale land acquisitions. In this way all claims can be brought to decision support. If this results in a more fair large scale land acquisitions depends on the way this application is organised: the functionality is there - it could be used in a proper way. A migration from STDM to LADM is possible without problems. LADM includes core class LA_BAUnit which is not available under STDM. A migration from STDM to LADM supports in building land administration infrastructure.

Further refinements are needed in this development. A more detailed alignment with the proposals as in Paasch et al (2013) is needed, this is very well possible on the basis of the contents of this paper, see Figure 8. The results of this alignment will be published in a next version of this paper.

The complete paper can be seen at www.mycoordinates.org

Indoor positioning solution for mobile devices by SPIRIT Navigation

SPIRIT DSP announced that SPIRIT Navigation and the EADS Russian Technology Office had successfully tested the prototype of the indoor positioning solution for mobile devices at both the EADS Russia offices and the Afimall Shopping Center in Moscow. The solution is unique in providing precise positioning inside buildings without the need to install dedicated beacons transmitting special signals. *www.broadwayworld.com*

LBS market thrives on the growth of GPS-enabled devices

The analysts forecast the global LBS market to grow at a CAGR of 35.25 percent over the period 2012-2016. Research and Markets, in its report mentioned that one of the main factors driving the market is the increasing adoption of GPS-enabled devices. The adoption of GPS-enabled devices such as smartphones, tablets, PNDs, handhelds devices, wrist-worn devices, two-way radios, sports devices, and portable LBS devices has increased significantly over the past few years. *www.ciol.com*

MEC India wins most Effective LBS/Campaign award in London

MEC India was awarded the 'Most Effective Location-based Service/ Campaign' at Effective Mobile Marketing Awards ceremony 2013 held in London. MEC achieved the award for one of its campaigns designed for Colgate at Kumbh Mela. MEC is the only Indian agency to win this prestigious award. *www.mediamughals.com*

Smartphones combat dengue in Pakistan

Punjab Information Technology Board (PITB), the ICT arm of Government of Punjab, Pakistan uses smartphones to successfully combat dengue across over 36 districts. The government deployed more than 1,200 smartphones to all city workers so they could upload and geotag photos on the go.

The data, plotted onto Google maps, allowed workers to visualise locations of ponding areas and dengue cases.

Data was transmitted real-time to a centralised server and the work of more than 25 departments could be viewed on a consolidated dashboard.

MapmyIndia introduces ReachMe app

MapmyIndia, has released a new app-ReachMe. This application allows users to share their location details with their friends and contacts. It has more of a social take to share location and also choose the best route. Apart from the app, it can also be accessed through the web browser. The app is available for free Android devices, for iOS devices and for Windows Phone devices. *www.themobileindian.com*

The NAUTIZ X1 is now shipping

Handheld Group has started shipping the Nautiz X1. It is the toughest enterprise smartphone in the world — it's waterproof, dustproof, shock-resistant and can handle extreme temperatures, yet it's also slim, lightweight and smartly designed for both work and play. *www.handheldgroup.com*

Deal signed for developing national geospatial platform for Nepal

A Memorandum of Understanding (MoU) to increase cooperation in establishing a national geospatial platform has been signed between the International Centre for Integrated Mountain Development (ICIMOD) and National Information Technology Center (NITC) of Government of Nepal. The MoU signals a commitment by the two institutions to assist in capacity building on geospatial information management. *ICIMOD*

Esri India partners with MapmyIndia

Esri India has entered into a strategic partnership with MapmyIndia. MapmyIndia maps will now be available through Esri's ArcGIS Online (AGOL), a cloud based GIS platform that can be readily adopted as the mapping platform of choice by organizations.

ESA's Gaia star surveying satellite launched

The European Space Agency launched its star-surveying satellite Gaia into space, hoping to produce the most accurate 3-D map of the Milky Way and to better understand the evolution of our galaxy.

Using its twin telescopes, Gaia will study the position, distance, movement, chemical composition and brightness of a billion stars in the galaxy, or roughly one per cent of the Milky Way's 100 billion stars. The data will help scientists determine the Milky Way's origin and evolution. The project is the successor to ESA's Hipparcos satellite, which was launched in 1989 and measured the position of 100,000 stars in the Milky Way. *www.cbc.ca/news/*

No foreign spy satellite detected in last five years: India

Government of India has said it has not found presence of any foreign spy satellite in the last five years. It also stated that it was difficult to distinguish between high-resolution remote sensing satellites for civilian purposes and spy satellites. *http://articles.economictimes.indiatimes.com/*

KhalifaSat set to be launched in 2017

KhalifaSat, the UAE's first locally-built satellite, is set to be launched in 2017. The KhalifaSat will be the third after DubaiSat1 and DubaiSat2, which have been built in Seoul, under a knowledge-sharing arrangement with the South Korean company Satrec. *http://gulfnews.com/*

China's earth observation satellite inducted into service

China's high definition earth observation satellite Gaofen-1 has been formally inducted into service. According to the State Administration of Science, Technology and Industry for National Defence (SASTIND), the satellite has undergone eight months of in-orbit tests since it blasted off April 26. It has met requirements and performed even better than expected by sending high quality photos, Xinhua reported. The satellite will help in geographic and resources surveys, environment and climate change monitoring, precision agriculture, disaster relief and city planning. *www.business-standard.com*

India's sulfur dioxide emissions increases - NASA Satellite

Power plant emissions of sulfur dioxide - an atmospheric pollutant with both health and climate impacts - have increased across India in recent years, according to a new analysis of data from a NASA satellite.

The analysis of data captured by an instrument on NASA's Aura satellite found that emissions of sulfur dioxide from Indian power plants have increased by more than 60 percent between 2005 and 2012, according to new research led by Zifeng

India surpassed the United States in 2010 to become the world's second largest emitter of sulfur dioxide, after China, according to emission estimates previously published by Lu and scientists from universities and the U.S. Environmental Protection Agency. That same research showed that about half of India's emissions come from the coal-fired power sector. *www.spacedaily.com*

Satellite-derived bathymetric and seafloor maps by Proteus

Proteus has delivered accurate bathymetric and seafloor classification maps for a joint UK-France amphibious military exercise on the Island of Corsica. In the pilot managed by the UK Hydrographic Office (UKHO), Proteus partnered with DigitalGlobe to derive accurate bathymetric measurements and identify four seabed types to a depth of 12 meters from multispectral satellite imagery without ground control. *www.proteusgeo.com*

Share in GLONASS for India

Russia is seriously considering building a broad international consortium for the development and implementation of the Russian GLONASS on a global scale.

"We have prioritized the countries -firstly the states where GLONASS may be required for geopolitical reasons," says Navigation Information Systems (NIS, formerly NIS GLONASS) Chief Executive Alexander Gurko says. "We could invite India, Kazakhstan, Brazil, South Korea and several other countries into the consortium."

These countries have traditionally been considered as the priority markets for the GLONASS technology, except perhaps South Korea. The idea of bringing India as a strategic partner for the development of GLONASS was discussed several times at the highest level. In 2007, then-Defence Minister Sergei Ivanov said that India was ready to participate in the development of GLONASS, providing rockets for launching satellites and helping to develop new spacecraft for the navigation system.

According Gurko in the early 2000s, India itself actively offered investments in GLONASS to the Russian government. "I met with the director of the Indian Space Agency at that time. He expressed bewilderment why Russia refused the idea of investment then, because it was obvious that this investment would offer many opportunities of opening a new and huge GLONASS market, and to build an appropriate technical regulation in the Indian market." *http://indrus.in/*

New Law All but Bars Russian GPS Sites in U.S.

Tucked into the mammoth defense budget bill that President Obama signed into law is a measure that virtually bars Russia from building about a half-dozen monitor stations on American soil that critics fear Moscow could use to spy on the United States or worse.

Russia first broached the idea of erecting the domed antenna structures here nearly two years ago, saying they would significantly improve the accuracy and reliability of GLONASS.

As the White House sought to reconcile the internal squabbling among government agencies, skeptical members of the intelligence and armed services committees in Congress intervened to deal a near-crippling blow to the prospect of Glonass stations in the United States.

Under the new law, unless the secretary of defense and the director of national intelligence certify to Congress that the monitor stations would not be used to spy on the United States or improve the effectiveness of Russian weaponry — or unless they waive that requirement altogether on national security grounds — the plan is dead. *www.nytimes.com*

GPS mandatory for Gurgaon cabs

Vehicles used by companies in Gurgaon in India to ferry employees will have to be equipped with GPS. The orders will come into force with immediate effect and shall remain in force till further orders. *www.mizonews.net*

Russian mobile operators to support Era-Glonass

The three major Russian mobile operators, MTS, Megafon and Beeline, will start providing Glonass, the operator of the emergency system Era-Glonass, with access to their radio sub-systems by the end of the year. Glonass will be able to access the networks as a MVNO. Beeline and MTS have already signed agreements with Glonass on the issue, and Megafon plans to sign an agreement before the end of the year. *www.telecompaper.com*

Warning for delays in launching GLONASS programs

Russian Deputy Prime Minister Dmitry Rogozin warned governors about delays in developing regional programs to launch the GLONASS. Those who can offer no sound excuse for delaying the launching of GLONASS programs will be summoned to Moscow and reprimanded, Rogozin warned at a session of the Military-Industrial Commission on civil use of the GLONASS system. *http://indrus.in/*

Rohde & Schwarz GNSS Simulator Now Supports Chinese BeiDou Standard

Rohde & Schwarz has added BeiDou functionality to its GNSS simulator integrated into the company's R&S SMBV100A vector signal generator. With the R&S SMBV-K107 option the GNSS simulator now covers the BeiDou standard as well as those for GPS, Galileo, and GLONASS.

Now available, the new option allows users to generate real-time scenarios with up to 24 BeiDou satellites. According to the company, the R&S SMBV-K107 supports all possible BeiDou orbits and can therefore even simulate satellites that are not yet in orbit. It also supports hybrid scenarios with GPS, Galileo, or GLONASS signals and satellites. A software update simplifies the BeiDou upgrade; no hardware modifications are required.

GPS for buses, vans and trucks in Thailand

The Transport Company will next year equip all of its franchise buses and vans with the (GPS) for safety, Transport Minister of Thailand, Chadchat Sittipunt wrote in his Facebook page. He sent the message after visiting the Land Transport Department's GPS centre. He said all of the 659 buses of the Transport Company and 2,263 trucks for transporting dangerous substances like chemicals, gas and oil have been equipped with GPS which enables officials to monitor the speed and behaviour of the driver of each vehicle all over the country. As a result, the number of accidents has been reduced and driver behaviour has improved. Next year the Transport Company has a plan to install GPS in 4,385 franchise buses and vans operating under its authority and 6,191 trucks transporting dangerous substances, Mr Chadchat wrote. *www.bangkokpost.com*

Beidou to cover world by 2020 with 30 satellites

China is planning to expand its homegrown Beidou navigation system by 2020 and make it accurate to within centimeters. Currently the system can reach an error margin as low as 5 meters in trials and can be further improved to within centimeters to compete with the dominant US GPS. *Xinhua News Agency*

Russia to secure Glonass against electronic warfare

The Russian Ministry of Defense has launched a project aiming to secure Glonass against enemy disruptions of signals. The ministry has handed a 350 million ruble (US $11 million) contract to two local entities, the Russian Scientific-Research Institute of Physical-technical and Radiotechnical Measurements (VNIIFTRI) and NAVIS navigation systems. The two contractors are to increase the system's immunity to electronic warfare. *www.defensenews.com*

New Land-Based Positioning System by Iranian Defense Ministry

The Iranian Defense Ministry has unveiled a home-made Land-Based Positioning System with applications in different military, aviation and navigation industries.

According to Defense Minister Brigadier General Hossein Dehqan , "Positioning is one of the principles of military operation in the air, on land and on the sea. Elaborating on the performance of the Land-Based Positioning System, he said, "Using this method, the positioning signals are transmitted through radio transmitting stations located on land and those interested will find their position with some levels of accuracy by receiving radio. *http://english.farsnews.com/*

GPS tracker to map illegal structures in India

A little known GPS device is helping civic officials in Thane to map illegal buildings. The tiny Trimble Juno SB scans interiors and external contours of a structure within minutes by just a hand-held tour of any edifice. The corporation has so far scanned and mapped 160 structures with the help from this device. Once the scanning is completed by the device, the data is uploaded onto a central server, which could be accessed by anyone at the ward level.

Since it launched a special drive earlier this year, the corporation has cracked down on 200 illegal structures. The mapping of illegal structures has helped immensely in speeding up the process. *http://articles.timesofindia.indiatimes.com/*

GPS/GNSS Devices Market to record 4.6% CAGR through 2023

The overall spending on GPS/GNSS devices and systems is likely to stay robust through upcoming decade. The worldwide market for GPS/GNSS devices is poised to register a 4.6% CAGR through the next ten years. The key growth stimulators include, among others, tremendous advancements in anti-jamming, increased expenditure on satellite navigation programs, as well as expanding applications for the GPS technology. *www.prweb.com*

NSA tracking cellphone locations worldwide, Snowden documents show

The National Security Agency is gathering nearly 5 billion records a day on the whereabouts of cellphones around the world, according to top-secret documents and interviews with U.S. intelligence officials, enabling the agency to track the movements of individuals — and map their relationships — in ways that would have been previously unimaginable.

The records feed a vast database that stores information about the locations of at least hundreds of millions of devices, according to the officials and the documents, which were provided by former NSA contractor Edward Snowden. New projects created to analyze that data have provided the intelligence community with what amounts to a mass surveillance tool. *www.washingtonpost.com*

At a Glance

- DigitalGlobe, Valtus form Aerial Imagery partnership
- Constant Contact releases enhanced cardstar app with new location-based services and local offers
- Kano, Nigeria earmarks N700m for Geographic Information System
- Singapore to develop 3D National Topographic Model
- Dubai municipality launches electronic map application
- Japan provides GIS tools to Nepal for forest preservation system
- US census bureau launches interactive mapping portal
- Korea chooses Boeing and Kaman as contractors for GPS-guided bombs
- Brazil and China schedule new satellite launch for 2014
- US Air Force increases GPS 3 satellite purchases from Lockheed Martin
- ESA"s Cryosat mission detects West Antarctic ice loss
- Azerbaijan to introduce European standards in land valuation
- Kenya partners with China for geo-mapping of minerals
- Esri Press Publishes The GIS Guide for Elected Officials
- Intergraph Launches Intergraph Geospatial 2014
- Charles Joseph named President and CEO and Member of the Board of Directors of Hemisphere GNSS
- The East View Geospatial target Ukraine and the Chinese Moon Atlas

Galileo update

Switzerland to take part in Galileo, EGNOS

The Swiss Federal Council has signed a cooperation agreement with the European Union for Switzerland to participate in the satellite programmes Galileo and EGNOS. Switzerland's participation would provide it with access to all satellite signals. It will contribute some EUR 27 million or CHF 34 million per year towards costs. *www.telecompaper.com*

Galileo Achieves First Airborne Tracking

The European Space Agency's Galileo satellites have achieved their first aerial fix of longitude, latitude and altitude, enabling the inflight tracking of a test aircraft. ESA's four Galileo satellites in orbit have supported months of positioning tests on the ground across Europe since the first fix in March.

Now the first aerial tracking using Galileo has taken place, marking the first time that Europe has been able to determine the position of an aircraft using only its own independent navigation system. The milestone took place on a Fairchild Metro-II above Gilze-Rijen Air Force Base in the Netherlands at 12:38 GMT on November 12. It was part of an aerial campaign overseen jointly by ESA and the National Aerospace Laboratory of the Netherlands, NLR, with the support of Eurocontrol, the European Organisation for the Safety of Air Navigation, and LVNL, the Dutch Air Navigation Service Provider.

A pair of Galileo test receivers was used aboard the aircraft, the same kind employed for Galileo testing in the field and in labs across Europe. They were connected to an aeronautical-certified triple-frequency Galileo-ready antenna mounted on top of the aircraft.

Tests were scheduled during periods when all four Galileo satellites were visible in the sky – four being the minimum needed for positioning fixes. The receivers fixed the plane's position and, as well as determining key variables such as the position, velocity and timing accuracy; time to first fix; signal-to-noise ratio; range error; and range–rate error.

Testing covered both Galileo's publicly available Open Service and the more precise, encrypted Public Regulated Service, whose availability is limited to governmental entities.

Flights covered all major phases: take off, straight and level flight with constant speed, orbit, straight and level flight with alternating speeds, turns with a maximum bank angle of 60º, pull-ups and push-overs, approaches and landings.

They also allowed positioning to be carried out during a wide variety of conditions, such as vibrations, speeds up to 456 km/h, accelerations up to 2 ghorizontal and 0.5–1.5 gvertical, and rapid jerks. The maximum altitude reached during the flights were 3000 m.

The definition and development of Galileo's in-orbit validation phase were carried out by ESA and co-funded by ESA and the EU.

Missing legislation for survey council and real estate in Ghana

The Ghana Institution of Surveyors (GhIS) has underscored the need for the passage of the pieces of legislation for Survey Council and Real Estate. Such legislation will give legal backing to operations in the land management industry and stem the incidence of multiple sale of land, with its attendant violence and protracted conflicts. It will also ensure that whatever gains are made in the Land Administration Project (LAP I and II) will be sustained. There will also be firm control over land management within the public and the customary sectors. *www.spyghana.com*

National GIS Organisation to be formed in India

The Union Government of India is planning to establish an Indian National GIS Organisation to collate, verify and maintain GIS data which could be accessed by stakeholders and the public, according to Union Secretary (Department of Science, govt of India) Mr. T Ramasami. He said the Government was taking up the project to create a national decision support system. A Cabinet note was put up last month and a decision may be expected soon. The Rs 3,000 crore project would be incubated by the Department of Science and Technology (DST) and it would be operated and maintained by the Department of Electronics and Information Technology (DEIT). "National GIS is a development aspiration of India and it will help fast and evidence based resource planning," he said. *www.thehindu.co.in*

National Map Corps Edits 25,000 Manmade Map Features

Civilian volunteers are making significant additions to the U.S. Geological Survey's ability to provide accurate mapping information to the public. Using crowd-sourcing techniques, the USGS' Volunteered Geographic Information (VGI) project known as The National Map Corps (TNMCorps) encourages citizen volunteers to collect manmade structures data in an effort to provide accurate and

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authoritative spatial map data for the National Geospatial Program's web-based The National Map. Structures being updated include schools, hospitals, post offices, police stations and other important public buildings. *www.infozine.com*

Azerbaijan conducted survey for new processing complex

Fugro Company jointly with British BP and French Total has recently conducted topographical surveys at the site 60 kilometres from Baku where a new Oil and Gas Processing and Petrochemical Complex (OGPC) will be located, according to SOCAR (the State Oil Company of Azerbaijan). In particular, aerial photography of the site was done. The data obtained in the survey is currently being processed by SOCAR Foster Wheeler LLC and upon approval will be used for the next stage of the project implementation. *http://en.trend.az/*

Govt of Korea cautious about Google Maps

The Korean government remains cautious about giving a license for mapping activities here to Google due to security concerns. Google has been working with Kim & Chang, the country's leading law firm, to get permission for its mapping here, but has failed to persuade Korean officials.

Google Chairman Eric Schmidt recently insisted that censorship around the world could end in a decade, and better use of encryption will help the public overcome government surveillance.

While Google is insisting its mapping activities were mostly aimed at providing creative value to people, there are still many issues that should be addressed and questions that Google needs to answer. *www.koreatimes.co.kr*

New Lands' data centre in Kenya

The Lands Ministry will set up a geospatial data centre to make national geographic information available to Kenyans. The open data initiative will help investors and other stakeholders get accurate and reliable information on location of land, ownership, administrative boundaries and features on and beneath the land. *www.the-star.co.ke/news/*

NAMRIA re–mapping shows forest cover in CAR increases

Amidst issues on illegal logging and a downward trend on the national scale, the Cordillera has marked an increase in its forest covers from 2003 to 2010, according to the research done by the National Mapping and Resource Information Authority (Namria), Philippines as reported by a regional environment official. The result was derived after they conducted a satellite re-mapping of the country's forest cover in 2010, compared to the mapping list in 2003. *http://baguiomidlandcourier.com.ph/*

SDI implementation in Sri Lanka

The Survey Department of Sri Lanka has recently received a Cabinet approval to build the National Spatial Data Infrastructure. According to senior deputy Surveyor General at the Department of Survey, they have recently established a steering committee composed of representatives from relevant government organisations tasked with the responsibility to draft the policies, procedures and data standards necessary to foster the efficient use, management and production of geospatial information. *www.futuregov.asia/*

Soc Trang province of Vietnam launches geospatial database

Officials from the Ministry of Agriculture and Rural Development, Vietnam and the German Society for International Cooperation (GIZ) handed over a geospatial database to the administration of Soc Trang province, as it joins four other provinces in the Mekong Delta in a climate change adaptation programme.

The climate change adaptation programme is national project which aims to help provinces in the Mekong Delta develop an effective strategy to adapt to climate change and ensure sustainable natural resource exploitation. The initiative is funded by the German Federal Ministry for Economic Development and Cooperation and implemented by GIZ.

"Unmappable" Great Barrier Reef mapped

These world-first digital maps are a critical step towards identifying, managing and essentially preserving and protecting what lies within the waters of this global icon.

Project partner, Dr Robin Beaman of James Cook University, says the product is different to anything else available, as until now, nearly half of the shallow water reef areas on the Great Barrier Reef were not mapped using modern digital surveys. Instead of relying on traditional surveying vessels or aircraft to map the many 'un-mappable' areas of the reef, EOMAP used space-borne satellites to overcome these hurdles. The result is the largest project of its kind ever conducted in Australia, and possibly the entire world. The 3D water depth maps have a 30m horizontal resolution over approximately 350,000 km2 of the Great Barrier Reef World Heritage Area and Torres Strait, providing not only more detailed individual reef data, but also a complete picture of Earth's largest coral reef ecosystem. *www.crcsi.com.au/*

Land record computerisation in Pakistan

People in Punjab, Pakistan would now be getting property deeds and other documents relating to their land holdings and plots in only 30 minutes as the Punjab chief minister inaugurated land record computerisation centre in Lahore Cantonment.

He said when this modern system becomes fully functional in all districts of the province, the culture of corruption, bribery and forgery in the matters relating to land would be eliminated and the people would get rid of the obsolete and exploitative system of Patwaris and Tehsildars. *www.nation.com.pk*

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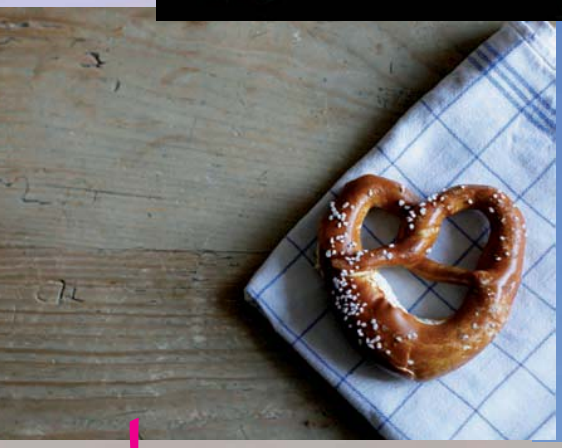

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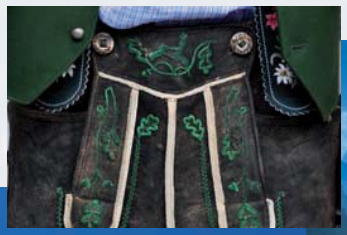


Quelle: thinkstockphotos.de/photocase.de

www.munich-satellite-navigation-summit.org

MUNICH SATELLITE NAVIGATION SUMMIT 2014

OnPOZ EZSurv is now compatible with Galileo and Beidou

New OnPOZ EZSurv® GNSS Post-processing Software (V2.93) by Effigis Geo-Solutions Inc. is now compatible with both the European Galileo and the Chinese BeiDou satellite constellations. With the integration of these two new satellite constellations, EZSurv® becomes one of the most powerful and easy to use tools on the Survey/GIS market to complement any RTK system. *www.effigis.com*

NavSpark-BD model

NavSpark-BD model has GPS/Beidou receiver onboard, enabling users to use the latest GPS/Beidou navigation technology just as large smartphone makers are beginning to adopt this new technology. Similarly, NavSpark-GL model has GPS/GLONASS receiver onboard. *www.skytraq.com.tw*

Topcon offers entry-level display modeled on X30

The X14 is Topcon's newest precision farming in-cab display and offers entry-level guidance with the look and feel of TPA's larger X30 touchscreen console. The 4.3 inch full-color 3D touchscreen offers moving map visualization and an on-screen, software-based virtual lightbar. For low-cost guidance, it can be paired with Topcon's SGR-1 GNSS receiver featuring TruPass technology. For high-accuracy autosteering, it can team up withTopcon's new AGI-4 GNSS receiver/steering controller.

Loctronix Ships ASR-2300

Loctronix Corporation has begun shipments of its new software-defined radio (SDR) module, the ASR-2300, for developing high-performance positioning, navigation and timing (PNT), and communication applications. Developers looking to create solutions for demanding military, scientific and industrial applications will realize greater functionality with the ASR-2300, thanks to its multiple sensor and multiple frequency capabilities.

CHC awarded 520 GNSS Receivers' Contract in Myanmar

CHC Navigation has announced the successful delivery completion of 520 units of X91+ GNSS receivers to the Settlement and Land Records Department (SLRD), a part of the Myanmar Ministry of Agriculture and Irrigation. Its activities encompass the collection of agricultural statistics, annual assessment of land revenue, land lease and tenure, and many other agricultural land administration tasks. CHC Navigation, in cooperation with its distributor, IGS Company Limited, has demonstrated the outstanding performances of the X91+ during stringent field technical assessments versus other major GNSS industry players. *www.chcnav.com*

New GNSS Location Chip by Broadcom

Broadcom Corporation has introduced the BCM47531, a GNSS chip that generates positioning data from five satellite constellations simultaneously (GPS, GLONASS, QZSS, SBAS and BeiDou). *www.broadcom.com.*

Qualcomm includes Beidou

Qualcomm has begun working with Beidou to enhance the positioning accuracy of smartphones and tablets in China. Its subsidiary Qualcomm Technologies collaborated with Samsung on its IZat positioning system, which increases the number of satellites that the devices run on Qualcomm processors can process. Samsung's Galaxy Note 3 that runs on Qualcomm's Snapdragon 800 processor MSM8974 can now respond to signals from US, Russian and Chinese satellites to provide accurate positioning information. *www.wantchinatimes.com*

Delivery of Navigation Information Platform to ERA-GLONASS by Luxoft

Luxoft LXFT has closed the full cycle commercial software development of the navigation and information platform for ERA-GLONASS, which is a national system of emergency response and deploys a combination of technologies such as telecom, information processing and satnav solutions. It is run by a non-commercial partnership GLONASS (NP

GIS – Transforming our World

14th Esri India User Conference, 11 – 12 December 2013, New Delhi, India

The word "transformation" has to do with change - changing physical circumstances and changing how we see things. The concept of GIS changing the world is not new. It's already happening. GIS is transforming geography, transforming health and public safety, transforming green buildings, transforming libraries, roadways, education, and national security. GIS is changing how we conceptualize and see the world. The theme of the 14th Esri India User Conference was 'GIS – Transforming our World'. With the participation of around 400, the conference was attended by various professionals from the industry, academia and government.

In the inaugural session Agendra Kumar, President, Esri India explained the purpose and importance of the User Conference. The plenary address was delivered by Dean Angelidas, Director, International Operations, Esri. He highlighted the importance of GIS technology in addressing several issues pertaining to mankind. Rajesh C Mathur, Vice Chairman, Esri India in his address elaborated the evolution of GIS from technology to its role in delivering various services. He presented several success stories of GIS applications in various projects in India. Many eminent speakers Dr S N Das, Director, Maharashtra Remote Sensing Application Centre and Sunil Pawar (IFS), DCF – Bidar, Karnataka Forest Department (KFD), Rakesh Verma MapmyIndia and Dr Vandana Sharma, DDG, National Informatics Centre also addressed the participants.

GLONASS). Luxoft was operating on a tight time line to develop a software for the navigation and information platform, a complex country-wide system required to interact with numerous external systems and to meet stringent reliability and availability requirements. *www.m2.com*

Navtech and DW International partnership

Navtech, Inc. has entered a partnership with DW International (DWI). The UK-based aviation consultancy will provide Navtech Flight Plan (NFP) customers with GNSS RAIM/RNP Prediction Services. This service, required to meet FAA Performance Based Navigation (PBN) guidelines and state requirements, fits into Navtech's current suite and provides GPS coverage information for routes and airports as part of the flight planning process.

Raytheon gets contract modification for GPS 3 ground segment

Raytheon Intelligence and Information Systems of Aurora, Colo., has been awarded a change order worth as much as $8.5 million to assure a new GPS military signal works with the satellite navigation constellation's next-generation ground segment. The work on the GPS Operational Control Segment (OCX) under the contract modification is specifically on the M-code implementation. M-code is the new highly secure, anti-jam signal designed for the GPS 3 constellation. The current GPS ground control system does not have M-code capability. *www.spacenews.com*

Imdaad to deploy FleetMan GPS in fleet

UAE-based Imdaad plans to install FleetMan, a GPS-based fleet tracking system for the vehicle management cycle of its fleet of vehicles from initial acquisition until its final disposal. FleetMan is a web-based system that will enable Imdaad to improve the efficiency of its fleet.It can be viewed and controlled from the computer and GPS tracking equipments fitted in the vehicles, facilitating them to monitor the whereabouts of their fleet in real-time. *www.tradearabia.com*

Aireon to receive $120 million investment

Aireon LLC has entered into a binding agreement with three major Air Navigation Service Providers (ANSPs) to make a $120 million investment in the revolutionary new service that it will provide. The new ANSP investors, ENAV (Italy), the Irish Aviation Authority, and Naviair (Denmark), are responsible for providing air traffic control service in some of the busiest airspace in Europe. With this agreement, combined with the previously announced $150 million commitment from NAV CANADA, Aireon is well positioned to build and launch the world's first space-based global air traffic surveillance system, extending Automatic Dependent Surveillance Broadcast (ADS-B) coverage and benefits to every flight path across the planet. *www.aireon.com.*

Sustainable farming software acquired by Trimble

Trimble Navigation has acquired the assets of C3 Consulting LLC, a privately held, crop science software firm promoting sustainable farming methods with tools to conserve natural resources, reduce chemical inputs and restore native fertility. Farmers can view C3's detailed soil analysis, which can be applied to all manufacturer equipment types, and recommendations from their advisor on its new Connected Farm online dashboard, which displays farm information such as weather forecasting, rainfall totals, irrigation rates, fertilizer rates, commodity prices, field operation maps, and fleet locations.

Hi-Target won 100 units Total Stations tender in Myanmar

Hi-Target Surveying Instrument Co., Ltd has won the bidding announced by Settlement and Land Record Department, Ministry of Agriculture in Myanmar. This 100 units of total station will make professional contribution to Myanmar Ministry of Agriculture in data collection statistics, land valuation and land management with excellent quality. According to the ministry official, excellent performance total station, strong business support and strong background of being a listed company were the key elements for Hi-Target to win this tender. *www.hi-target.com.cn/en/*

Quantum Spatial partners with Hawkeye Helicopter

Quantum Spatial, Inc. has recently entered into a Master Services Agreement with Hawkeye Helicopter, LLC to provide precision helicopter-mounted LiDAR solutions to both Quantum Spatial and Hawkeye clients. *www.quantumspatial.com*

Aibotix enters a partnership with Cooliris

Aibotix has announced a partnership with Cooliris to bring a brand new consumer sharing experience for drone photography. Using the Cooliris mobile app, consumer will be able to view and share drone photos and videos in real-time on their iPad and iPhone in a 3D Wall. Using Aibotix's multicopter, the Aibot X6, which has a built-in camera mount, and Cooliris Groups, consumers will be able to capture otherwise inaccessible aerial angles of landscapes, inspection of power lines, photovoltaic systems or bridge facilities, or mapping tasks, and share them with private groups as the moments unfold. *www.aibotix.com*

Leica GMX901plus

The Leica GMX901plus is an affordable and rugged GNSS receiver that delivers precise and reliable data about movements of sensitive structures such as mine walls, rock slopes, dams, and buildings. For time-critical applications that require high rate data and a higher accuracy the GMX901plus can be smoothly upgraded to a powerful L1/L2 GPS/GLONASS receiver with an update rate of 5 Hz. *www.leica-geosystems.com*

Blue Marble Releases GeoCalc 6.7

Blue Marble Geographics has released GeoCalc 6.7 software development kit (SDK). This release features enhanced speed and memory handling, making the GeoCalc SDK even more powerful for coordinate transformation. *www.bluemarblegeo.com*

Using GIS Web and iOS Travel Apps to Stimulate Tourism Industry

Supergeo helps Chiayi City Government, Taiwan develop a GIS website and iOS GIS apps to promote the local tourism industry. These GIS tools are served as excellent introductions to the local traditional culture. To achieve this, a GIS website and mobile apps were developed to record the data about human resource management, and construction of aesthetics for the living space and then formulate creative marketing campaigns to increase jobs and accelerate urban economic revitalization in the City.

The website established with SuperGIS Server includes front-end and back-end platforms. The back-end platform enables administrators to easily upload and manage data usage, as well as showing the audited data on the front-end platform for query.

Multi-Constellation Compact GPS Antennas by Tallysman Wireless

The TW4327 and TW4329 are the only low power GPS L1 + GLONASS G1 antennas on the market by Tallysman Wireless Inc.. They feature current consumption of 1.75mA typically and parametrically invariant performance over a supply range from 2.5V to 12V.

The TW4327 o_ers 21dB gain minimum and the TW4329 includes a narrow pre-_lter to prevent front end saturation by near out-of-band interfering signals. Both antennas are more tolerant to detuning e_ects caused by the operational environment thanks to a 40% thicker patch element that provides wider bandwidth than conventional antennas.

MARK YOUR CALENDAR

February 2014

International LiDAR Mapping Forum
17 – 19 February 2014
Denver, Colorado, USA
www.lidarmap.org/international

March 2014

Munich Satellite Navigation Summit 2014
25 – 27 March
Munich, Germany
www.munich-satellite-navigation-summit.org

ASPRS 2014 Annual Conference
23 - 28 March
Louisville, Kentucky USA
www.asprs.org

April 2014

ENC-GNSS 2014
14 – 17 April
Rotterdam, The Netherlands
www.enc-gnss2014.com

SPAR International
14-17 April 2014
Colorado Springs, CO, USA
http://www.sparpointgroup.com/international/

Interexpo GEO-Siberia 2014
16 - 18 April
Novosibirsk, Russia
http://expo-geo.ru/event/27_Interexpo-GEO-Siberia-2013

IGRSM 2014
21 - 22 April
Kuala Lumpur, Malaysia
http://www.igrsm.com/igrsm2014/

2014 International Satellite Navigation Forum
23 – 24 April
Moscow, Russia
http://eng.glonass-forum.ru

9th National GIS Symposium in Saudi Arabia
28 - 30 April 2014
Dammam, Saudi Arabia
http://www.saudigis.org/default.aspx

May 2014

China Satellite Navigation Conference
May 2014
Nanjing, China
http://www.beidou.org/english/index.asp

IEEE/ION Position Location and Navigation Symposium
5 – 8 May 2014
Monterey, CA
www.ion.org

Esri Africa User Conference
6 – 8, May 2014
Cape Town, South Africa
www.esri.com/events/auc

Annual Baska GNSS Conference
7 – 9 May 2014
Baska, Krk Island, Croatia
renato.filjar@rin.org.uk

MundoGEO Connect 2014
7 – 9 May
Sao Paulo, Brazil
http://mundogeoconnect.com/2014/en/

GNSS: Principles, Augmentations and Evolutions of EGNOS
12-23 May 2014
Toulouse, France
sandrine.castiglioni@enac.fr

GEO Business
28 – 29 May 2014
London, UK
www.geobusinessshow.com

June 2014

Hexagon Conference 2014
2 – 5 June
Las Vegas USA
http://hxgnlive.com/

ION Joint Navigation Conference 2014
16 – 19 June
Orlando, United States
www.ion.org/jnc

5th International Conference on Cartography and GIS
15 – 21 June 2014
Riviera, Bulgari
http://iccgis2014.cartography-gis.com/Home.html

XXV FIG Congress
16 – 21 June
Kuala Lumpur, Malaysia
www.fig.net

July 2014

GI Forum 2014
1 – 4 July 2014
Salzburg, Austria
www.gi-forum.org

Esri International User Conference
14 – 18 July 2014
San Diego, USA
www.esri.com

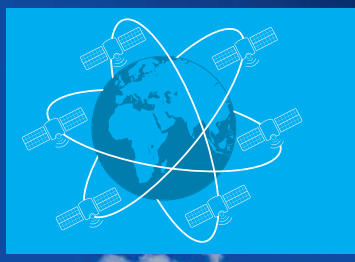
October 2014

ISGNSS2014
22 - 24 October
Jeju Island, Korea
www.isgnss2014.org

November 2014

Trimble Dimensions 2014
3 - 5, November
Las Vegas, USA
www.trimbledimensions.com

Gain perspective in real-world GNSS simulation



The GNSS simulator in the R&S®SMBV100A vector signal generator
Expensive, inflexible simulation of GNSS scenarios is a thing of the past. Now you can easily and cost-effectively test your satellite receivers under realistic conditions.

- Comes with a variety of predefined environment models such as "rural area", "urban canyon", "bridge" and "highway"
- Allows flexible configuration of realistic user environments including atmospheric modeling, obscuration, multipath, antenna characteristics and vehicle attitude

The R&S®SMBV100A generates all relevant communications and broadcasting standards such as LTE, HSPA+, WLAN, HD Radio™ and FM stereo.

To find out more, go to
www.rohde-schwarz.com/ad/smbv-gnss

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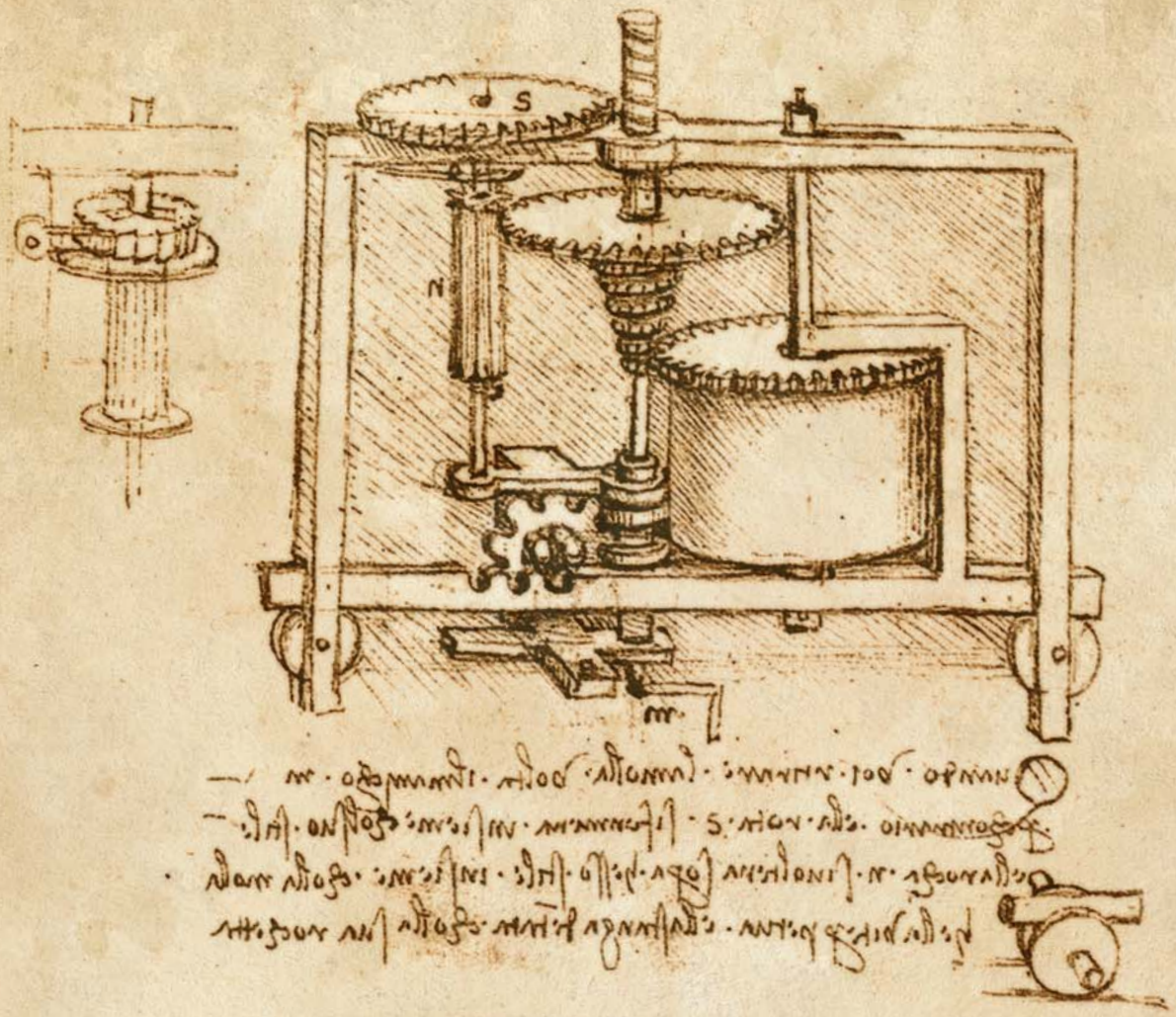

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Like great thinkers of the past, engineers are at the forefront of creating inventions that change our world. NovAtel's three new OEM6 high precision receivers – containing our most advanced positioning technology – will help you push the boundaries of possibility. The new OEM638 receiver card, ProPak6 enclosure and SMART6 integrated receiver/antenna provide the multi-constellation tracking, configurability and scalability for solutions you are working on today and for your inventions to come in the future. Visit **novatel.com/6** to learn more.

NovAtel

Integrate success into your [redacted].