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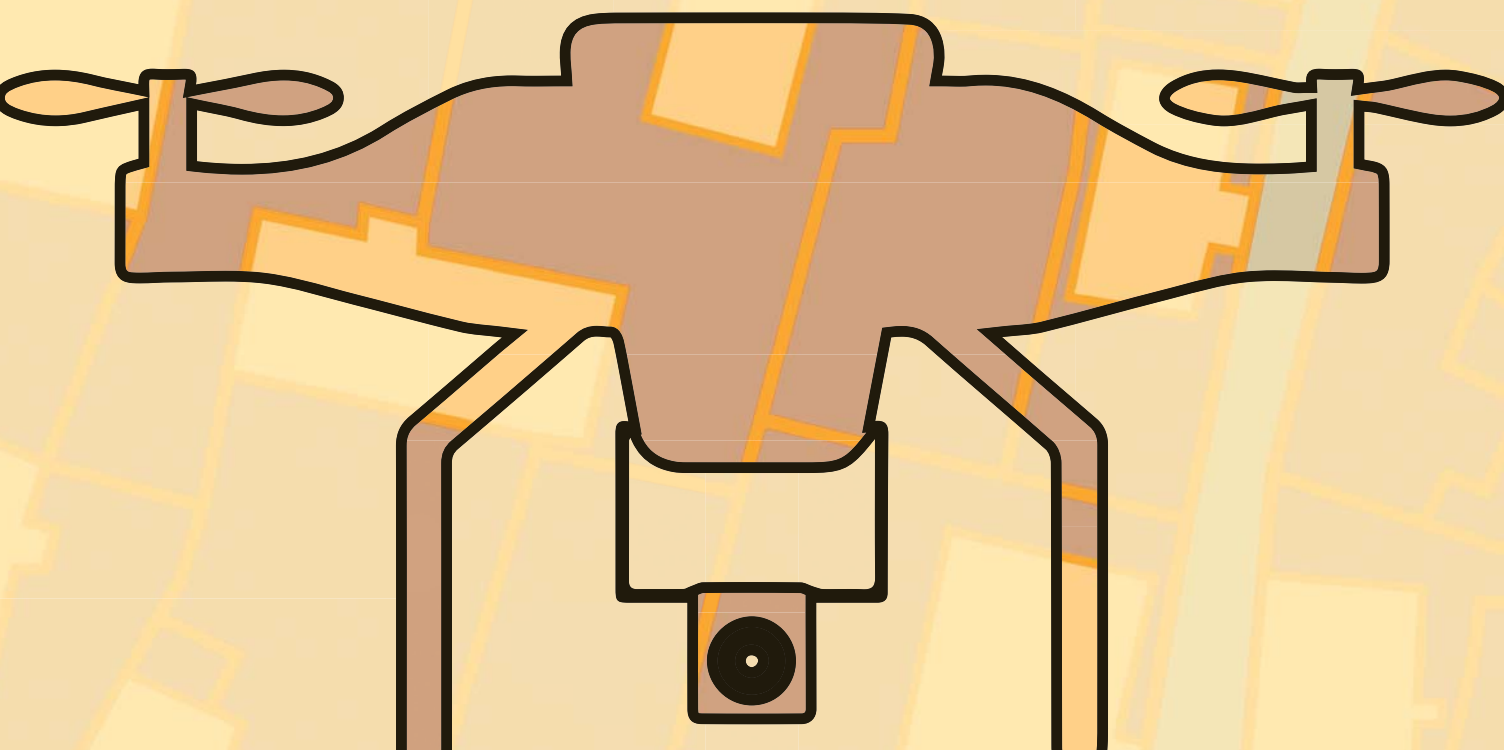
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Coordinates

Volume XII, Issue 05, May 2016

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND



Systematic cadastral registration using UAV

Also

- Beyond Limits – For a dynamic future cadastre
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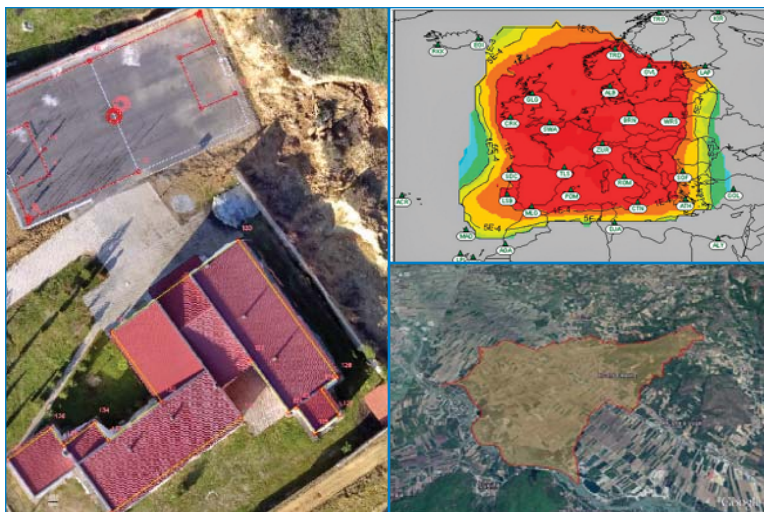
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In this issue

Coordinates Volume 12, Issue 05, May 2016

Articles

Beyond Limits – For a Dynamic Future Cadastre DANIEL STEUDLER 8 **SBAS CAT-I available in Europe**
PEDRO PINTOR, TEODORO SEOANE, RIDHA CHAGGARA AND ROBERTO ROLDAN 12 **Spatial map policies** N K AGRAWAL 21 **Systematic
cadastral registration using UAV technology** MURAT MEHA, KATHRINE KELM, MUZAFER ÇAKA, QAZIM SINANI AND KORAB
AHMETAJ 31 **The Geospatial Information Regulation Bill, 2016 (Draft)** 39

Columns

My Coordinates EDITORIAL 6 **Conference** MUNICH SATELLITE NAVIGATION SUMMIT 2016 20 **News** GALILEO UPDATE 22 GIS 22
IMAGING 45 LBS 45 GNSS 46 UAV 47 INDUSTRY 48 **Mark your calendar** MAY 2016 TO DECEMBER 2016 50

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The Government of India

Intends to regulate 'Geospatial Information',

And rightly so,

Hence, draft "The Geospatial Information Regulation Bill, 2016" (read page no.)

In public domain for discussions and deliberations.

The draft that envisages

Severe monetary penalties and imprisonment

In case of possession or publication of incorrect maps...etc.

Appears to anticipate that these 'provisions' would enable

A more regulated 'geospatial information scenario'.

Let us discuss and debate,

The points and the 'finer points'.

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Beyond Limits – For a Dynamic Future Cadastre

This article is based on the publication "Beyond Limits" by the Swiss "Dimension Cadastre" think tank. The intention of "Beyond Limits" is not to predict the future, but to identify and discuss trends that are felt within society and within the professional community



Daniel Steudler
on behalf of Think
Tank "Dimension
Cadastre", Switzerland

New information and communication technologies, along with the economic, financial and political globalisation, the increasing mobility of people and the cultural and social exchange, all helped to shape the way in which we perceive geographic information systems, including cadastres, today. The Swiss Think Tank "Dimension Cadastre" identified trends that are felt within society and within the professional community that potentially may affect the future development of cadastral systems.

Changing World

Examining the evolution of the cadastre, of surveying and its various aspects means above all tracing the development of methods and technologies from drawing board and pencil to computer, from 2D to 3D, from terrestrial measurement to global navigation satellite system, from terrestrial surveying to photogrammetry, from databases to knowledge bases, and from analogue to digital technology. Boundaries between the private and the public sphere are disappearing.

Technology

Today's devices no longer are passive terminals linked to central systems. They are computers in their own right, equipped with diverse sensors and countless apps; they even can show us the way around due to the built-in global navigation satellite systems. This allows for a contextual presence, in situ. These devices also can take photos and create video footage instantly – a far cry from Polaroid technology – since digital images can be modified, transmitted and stored "on the

spot". This is a key factor for the coming decade. Our societies are moving away from the written word towards imagery, forming new semantics, new languages and a new framework of understanding.

Data

Massive data collections are being generated also with help of those devices. The use of data mining, an approach to analyze and search such large databases can make use – or misuse – of those data collections. This development also caused considerable anger and concern throughout the world following the revelations by Edward Snowden. In that same context, the issue of open data is gaining ground, especially within public administrations, based on the concept of the openness of the Internet and open source software.

Social networks

The rapid rise of social networks brings about the biggest change in social behaviour in decades. People are enabled to "socialise" freely with others at low cost, with varying degrees of commitment and for an indefinite duration in a new kind of "common interest club". This represents a complete restructuring of social relationships. It is not driven by religious movements or cliques, and even less by political circles or unions. Decisions are taken by each individual citizen. This empowerment is the very essence of the ongoing social revolution.

Surveying and Positioning

We are witnessing the end of surveying in the conventional sense, mainly because positioning might soon be just as accurate

The growing importance of "legitimate" versus "legal", which can be interpreted as a confrontation between a priori and a posteriori legislation

and more or less obtainable in real time by the above mentioned devices. The contributions from – traditional – surveyors will decrease, which also can mean the end of the surveying profession as we knew it up to now. But what does that mean for the future of the surveying profession? There are indications that surveyors in the future will have a role to play in the transition process, i.e. as professionals in charge of changing and adapting representations of properties, and the management of land and augmented reality.

One thing that seems certain is that official cadastral surveying provides authentic and certified data that are essential for a country's economic development through guarantee of the required geometrical and attributive accuracy. And this official guarantee needs to be retained, as numerous political and social decisions depend directly on official cadastral data.

What may change, however, is the method of data collection. Global navigation satellite systems in combination with smart devices may provide data, collected by citizens, through visual recognition. It is by pointing the smart device at a building, a land parcel, or even a landscape that recognition in its entirety will work. The territory will signal our position to us with absolute accuracy. In a manner of speaking, the land will become the map encompassing all maps.

The theoretical and practical consequences will certainly concern the legal recognition of such methods, or more precisely of the algorithms behind. Up to now we set out to define databases of objects, cadastral layers, etc. But in the future, in addition to all the existing or new databases, we will also be storing and archiving algorithms. These will require official certification because they will form the basis of the reconstitution of datasets and data.

The Objects of the Cadastres

The legal mandate has been an essential factor for the traditional cadastres, based on surveying and land registration. But increasingly, and in the wake of digital technology and

the political call for professional land management, new categories of legal land objects are evolving and thus give rise to new levels of representation.

While technological and political pressures led to the rapid development of the cadastre over the last two decades, particularly following the advent of the Internet some 20 years ago, we have to anticipate that social changes – increased involvement of the public (access to open data, apps and open source software) and social networks (e.g. participation in activities such as Wikipedia, eBirds, Youtube) – will give rise to radical new approaches, namely a society driven more by a legitimate than a legal impetus.

If the legal basis was a constitutional element in democracies, especially in the West, the situation seems to become somewhat different today. In fact it now appears that an action deemed “legitimate” can prevail over a national legal system. An example can be seen in Switzerland in connection with the blacklist of countries regarded by the OECD as “tax havens”. Although Switzerland's position was based on a sovereign and legal foundation, the “legitimate” pressure exerted by some of the major OECD member states sufficed to cause Switzerland to quickly bend one of its most essential principles, namely the rule of law.

The differentiation between a position based on a legal foundation and one based on “legitimate” actions is a constituting element of societies today, and especially of global governance. As more and more people become involved in social networks, they will continue to exert pressure in this sense, and if we consider the development of public opinion, transparency and “political correctness” in society in the course of the last few decades, there can no longer be much doubt about this process of societal change.

Cadastral Dimensions

When representation was planar, we were dealing with a world in which objects were described in two dimensions; maps and plans were sufficient. The representation of pipes and conduits beneath the ground, and

of the height of buildings, slope of roofs, etc., led to the creation of what we now call 3D within geographic information systems.

But modifications, and above all their preservation together with their still legible notes on old plans and maps despite the fact that they had been partly erased, gave rise to the illusion of historical development. Today, with the aid of digital storage of data it is – and will remain – easier to obtain a history of modifications of the cadastral system and thus of the recorded objects. In areas such as tourism and land-use planning, as well as regional economic development, there are also calls for data to be attached or linked historically to buildings and land. Temporal (4D) data of this type are not currently regarded as an integral part of the cadastral system, but they should be incorporated in the future, also at the legislative level.

The Internet of Things

Smart devices act as intelligent systems equipped with functions for geo-localisation, visualisation, simulation and anticipation. They will act with algorithms and huge databases that are fed and accessed via cloud-services on the Internet, basically anytime anywhere.

What is lacking is an understanding of the implications for the cadastral system. Let us imagine how it may look like in twenty years' time from now: we can assume that, in addition to surface, line and point objects, there will also be virtual and algorithmic objects. Together these will form the basis of a new cadastral system. Each of these objects will belong to a new nomenclature recordable in URI format so that it can be directly accessed via the Internet. This will resemble a huge virtual library in which each object will have an identifier just as each book has its own form of identification (ISBN). Initially, all cadastral objects will be provided with a uniform resource identifier (URI), in order to be addressed; later they will be given physical (IP) addresses to make it possible to connect smart systems associated with the objects.

As far as the objects forming the present-day cadastre are concerned, it can already

be predicted that in the future they will mainly be linked with each other via the Internet platform. This is only possible when an infinite number of IP addresses is available, which will be very useful for urban development, construction of new roads, etc. It will be possible to provisionally deposit measurement instruments in order to simulate situations such as rainfall, landslides or exposure to sunlight.

Surveyors in the future will ideally be the architects of this transformation and acting as brokers of the transition process. They will thus have to evolve towards a transformational profession.

Augmented Citizen

In the previous chapters concerning the major changes taking place today, we have noted that there has been an increase in the role played by citizens (grouped into social networks) in the value-added chain. Thanks primarily to the Internet and so-called smart systems and devices, people now find themselves in a situation in which they can directly intervene in information and production systems. Blogs, feedback, applications like Mash-up, etc., enable them to contribute to databases, including geographic information systems, to such an extent that these have come to rely heavily on their input. Consider, for example, feedback on restaurants, hotels, travel, visits to museums, etc., in the tourism sector, or reviews of music and books, or comments on numerous other products. Everything, or almost everything, can now be reviewed, commented on or ranked by anyone. The information about such items is significantly modified because it has acquired a subjective and more or less emotional dimension. This kind of contribution is unexpected for specialists working with “cold” objects like maps and cadastres! The way forward has been mapped out, and we are moving in the direction of integrated information systems: the objective and the subjective, the legal and legitimate, the real and the virtual. Through this integration we describe the core of our vision for which we have enhanced the dimensions, the objects and the involved players (or stakeholders).

One of the major challenges to be faced in the future concerns the integration of the public as stakeholders in the cadastral system. The solution will neither be obvious, nor easy. Initially the answer will be to prompt people to submit comments regarding, for example, footpaths by asking them to intervene prospectively to report identified dangers and problems and to give warnings so that their contribution can be clearly beneficial to others.

The new “Common Property” and Stakeholders

A new notion is emerging between private and public property, namely one that could be referred to as “common property” or “common asset”, which to a certain extent takes the form of shared knowledge, or public and open know-how. To better illustrate, we may look at examples from various newspaper articles initiating a web-based platform for reporting of information that permits people to describe an aspect of specific locations in for example 100 characters.

Combining data and knowledge, such initiatives can create a common asset. Other examples are knowledge about footpaths, Google Street View, City Wikis, as well as dedicated web sites such as Craigslist (San Francisco), eBird.org for birds, virtual visits to tourist destinations, but also knowledge of the past or present development of a particular city, district or street. At the same time, these private and open knowledge collections can be link or combined with public and authoritative data of different levels defined by geomatics, cadastre, geography, or geology.

For surveying, cadastre and land register professionals, the concept of “common property” as neither private nor public, but somewhere in between, certainly raises questions. It may mean that the professional communities may have to rethink their approach to these issues.

Concluding remarks

In a kind of metaphorical reversal, it is the land that has taken today the upper

hand and determines our activities; the land is becoming the map, so to speak. By looking at the landscape with the aid of mobile and intelligent devices such as smart phones, tablets, or drones, we are able to obtain images of augmented reality.

The virtual world has for many years been used mainly for special effects on big screens and will increasingly be used in the future, whether for activities via webcams or via applications for smart devices. There are three key elements that play a role in this: first, the Internet provides a common platform and simplifies the communication between systems that were previously incompatible; second, the introduction of geo-localisation via global navigation satellite systems means that any location can be viewed and accessed in real time and at any time; and third, visual recognition makes it possible to remotely identify, for example, the names of mountains, sites and monuments. The combination of these key elements makes it possible to bring more or less complex datasets and images onto the screen.

Future discussions will mainly revolve around issues relating to open data and open source software. Initially public administrations and politicians had good intentions by establishing and using large databases, mainly for providing security and public safety. However, the debate has taken a drastic new turn with the capacities of data mining and certain algorithms, and above all the use to which they have been put to, in particular in the USA by the National Security Agency to spy on people and organisations. Doubts regarding the non-private use of personal data will remain until a technical or legal solution is found to assure better privacy protection.

Another aspect of the ongoing discussion concerns the question of how to open up “big data” to the public, and not only to companies. The idea based on the model of Wikipedia is to offer virtual communities (social networks) the possibility of accessing these data without restriction and free of charge. The introduction of the Internet allowed for the concept of free of charge information access, which often led to radical modification of business models and activities.

So how can we incorporate the opening up process without harming the privacy at the same time (a question that is illustrated by the discussions around Facebook)?

And how can we retain the concept of free of charge information access without harming the business sector? These are social issues that the current debate is only now beginning to address.

As far as the future of the cadastre is concerned, there are several key issues to be discussed:

First, the growing importance of “legitimate” versus “legal”, which can be interpreted as a confrontation between a priori and a posteriori legislation. To a certain extent, there is a shift happening between the European continental (a priori) civil code and the Anglo-Saxon (a posteriori) common law jurisdiction systems that could be observed for the last two decades.

Second, there is the question of the relevance of introducing new objects into cadastral systems. Following

the introduction of 3D, we are now witnessing the emergence of 4D with the history of modifications.

Third, there is the question of the public as stakeholder, as consumer, player, and co-creator of future information systems. Crowdsourcing appears to be invading the Internet and it is conceivable that it can affect matters, which were reserved for public administrations so far. It might therefore be essential to prepare for this development, even if the debate has barely commenced.

And finally, there is the central question of ownership, the private/public aspect and the new concept of the “common asset”. This is still in its infancy to the extent to which, in our society, it initially concerns the issue of transparency. But if we can see the names of the owners of all plots of land throughout the country on our smart phone, it is difficult to imagine how the question of protection of the private sphere can be addressed. The question of transparency and privacy has not yet been resolved at the social and political levels.

In this discussion paper we have considered some of the issues which will be discussed in the future and will concern society as a whole. But we are well aware that, for the involved professionals, another matter appears to be just as urgent, namely the redistribution of tasks. In other words, who will be responsible for what in the future at the different administrative levels, in the private and public sectors, and in the professional and private domains.

Our conclusion can perhaps be summed up by reversing Alfred Korzybski’s aphorism “The map is not the territory”, BUT **“The territory is the map”**.

This article is a shortened and summarized version of the report “Beyond Limits” by the Swiss “Dimension Cadastre” think tank (more information at www.cadastre.ch/vision). The intention of that report was not to predict the future, but to identify and discuss trends that are felt within society and within the professional community. ▴

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In the first semester of 2015, ESSP, the EGNOS service provider, deployed EGNOS System Release (ESR) v2.4.1M. This was a major achievement. ESR v2.4.1M SiS was broadcast on the 30th June for the first time in a seamless manner from an EGNOS user point of view. This new ESR was the last step before declaration of EGNOS SoL LPV200 service level on the 22nd September 2015 which was officially announced on the EGNOS Workshop in Copenhagen on the 29th September. For the first time, CAT-I service level based on SBAS in Europe is achieved.

LPV200 service brings improvement in the existing Air Navigation capacities and infrastructure in Europe enabling the implementation of the PBN concept in Europe within the Single European Sky and the ICAO Global Air Navigation Plan. The use of the LPV200 service based approach procedures allows performing the final descent from FAF to DA/H in the same manner as for current LPV with the only exception, as indicated, that the DH can be as low as 200 ft. above the runway threshold.

It is to be underlined the promulgation of RNP APCH down to LPV minima as low as 200 ft. does not represent any change in the way these approach procedures are currently flown or implemented. Aircrafts already equipped with EGNOS need neither to upgrade

avionics nor to approve for additional airworthiness unless otherwise specified in the Aircraft Flight Manual. Crews do not require additional training or license to perform LPV200 operations.

Besides increasing safety in RNP APCH, LPV200 service reduces the environmental impact thanks to time and fuel savings and improves significantly the ATM flexibility and capacity. Savings in maintenance costs associated with ground-based conventional navigation aids are also noticeable.

LPV200 service level is described in the EGNOS SoL Service Definition Document [1] includes the availability and continuity commitment maps which represent the minimum level of performances the user can expect under specific conditions. ESSP elaborates SDD availability and continuity commitment maps based on ICAO requirements (Table 1) for RNP approaches to LPV minima equal to 200ft., as defined in [2] for SBAS.

LPV200 Horizontal Alert Limit (HAL) is 40m and Vertical Alert Limit (VAL) is 35m. LPV200 requirements relative to the maximum VNSE probability are novel with respect to APV-I and whenever the instantaneous VNSE exceeds the 10m threshold in nominal conditions it is said that an Accuracy Major Event (AME) happens.

The inclusion of new LPV200 requirements for the accuracy tails in [2] requests a new statistical characterization of VNSE accuracy distribution tails in line with AME occurrences. Monitoring of AME and the corresponding VNSE accuracy tails requires the development of a new methodology and new tools for performance assessment.

This paper presents the LPV200 availability and continuity commitment area, ESSP new tool for accuracy tail characterization

Table 1: LPV200 ICAO requirements

Parameter	Detail	Requirement
LPV200 Availability	Availability	0.99 to 0.99999
LPV200 Continuity	Continuity	1 - 8×10^{-6} per 15 s
LPV200 Integrity	Integrity Time To Alert	1 - 2×10^{-7} in any 150s 6s
LPV200 Accuracy	HNSE (95%) VNSE (95%) Probability (VNSE > 10m) Probability (VNSE > 15m)	16.0 m 4.0 m < $10^{-7}/150s$ in nominal conditions < $10^{-5}/150s$ in degraded conditions

and first EGNOS performance results since service declaration.

LPV200 committed coverage

The EGNOS SoL SDD [1] is published by European GNSS Agency (GSA) and presents the minimum performance characteristics of the EGNOS SoL Service offered by the version of EGNOS currently in operation. Three service levels are described in [1]: NPA, APV-I and LPV200.

ESSP is in charge of the elaboration of [1] availability and continuity commitment maps. Availability commitment maps show the percentage of time EGNOS protection levels are bounded by the alarm limits for the different operations (HPL<40m and VPL<50m for APV-I and HPL<40m and VPL<35m for LPV200). Continuity commitment maps show the probability of EGNOS protection levels remaining below the corresponding alarm limits for APV-I and LPV200 during the approach. These maps represent the minimum level of performances the user can expect under specific conditions.

These conditions refer to both the internal status of the system, essentially EGNOS RIMS and GEO satellites, and external conditions such as number of GPS satellites in the constellation or environmental conditions which might include severe ionospheric activity. Under such high ionospheric activity or geomagnetic storm periods caused

by sudden eruptions of the Sun, SBAS systems (including ground ranging stations and processing facilities) can experience residual ionospheric effects owing to increased ionospheric variability impossible to be effectively modelled and corrected, which can reduce navigation performance at the user level.

APV-I and LPV200 commitment maps [1] are elaborated following the same methodology based on results obtained during several months of observation of EGNOS performances. Computation of LPV200 availability and continuity commitment maps accounts for two extra requirements. Firstly, the probability that the VNSE exceeds 10m in nominal system operation conditions shall be less than 10^{-7} /per approach. Secondly, the probability that the VNSE exceeds 15m in degraded system operation conditions shall be less than 10^{-5} /per approach. Areas compliant to availability and continuity requirements but not meeting the two extra requirements on accuracy tail distribution are excluded from the commitment area.

LPV200 performance results

Following results correspond to the LPV200 performance from the **22nd of September 2015**, date of LPV200 service level declaration, **to the 31st of March 2016**. During this period, EGNOS broadcast the operational SIS through GEOs PRN120 and PRN136, using 39 RIMS for monitoring around

30 GPS satellites. Detailed information such as LPV200 Availability and Continuity, LPV200 User domain Integrity, LPV200 Horizontal and Vertical Accuracy (95%) and LPV200 Vertical Accuracy tails can be found in the EGNOS User Support Website [3].

LPV200 Availability and Continuity

ESSP monitoring of LPV200 availability and continuity results uses fault-free techniques, what make them independent of the data obtained in a receiver and therefore unaffected by local effects such as multipath and receiver noise and failures. This characteristic enables the computation of results in a grid of 1x1 degrees at any location of the EGNOS service area using consolidated data, including remote or even oceanic areas in which no receivers are available and locations in which a detailed monitoring is needed, i.e. airports with SBAS procedures approved or under validation.

Maps in Figure 1 provide the LPV200 Availability and the LPV200 Continuity Risk from the 22nd of September 2015 to the 31st of March 2016:

The maps represent the availability and continuity of LPV200 service (HPL<40m and VPL<35m). The 99% area shows a very good coverage in most of the ECAC. The availability and continuity for the period meet the commitment maps of LPV200 certifying very good EGNOS performance.

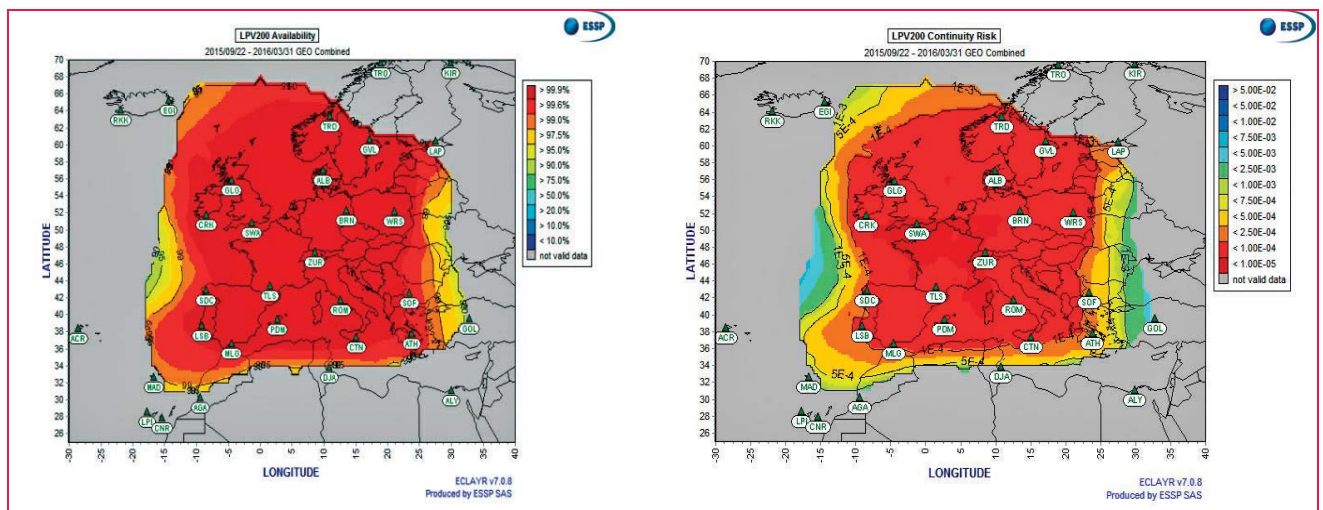


Figure 1: LPV200 Availability and Continuity map. 22nd September 2015–31st March 2016

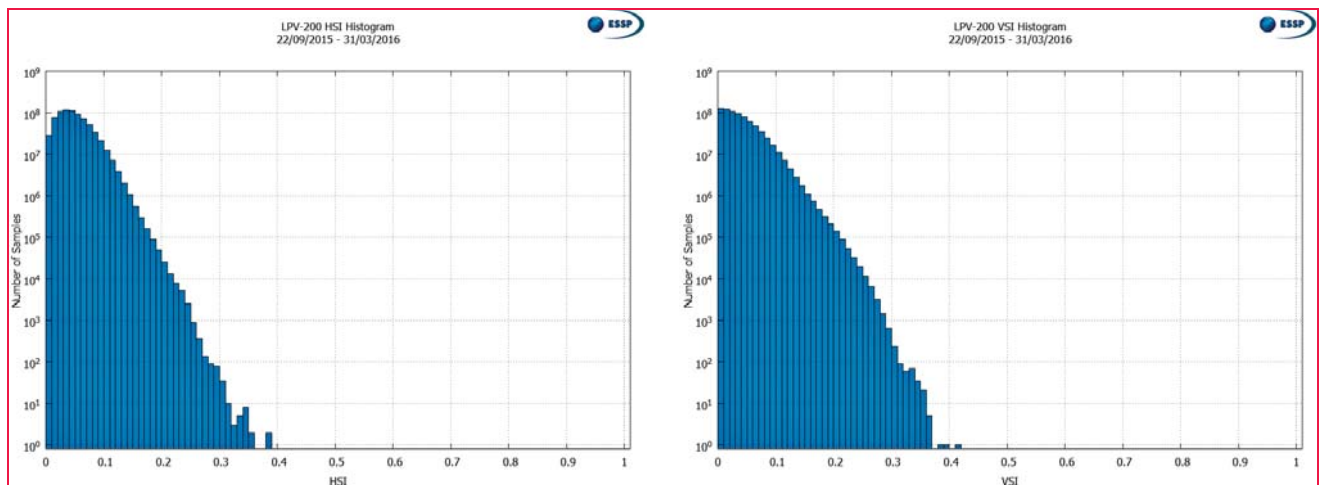


Figure 2: Example of LPV200 HSI and VSI histograms accumulated in RIMS and independent receivers

Table 2: LPV200 maximum HSI and VSI

RIMS	Max HSI	Max VSI	RIMS	Max HSI	Max VSI	RIMS/Rx	Max HSI	Max VSI
Aalborg	0.21	0.31	Swanwick	0.29	0.31	Trondheim	0.24	0.31
Berlin	0.20	0.26	Athens	0.21	0.27	P. de Mallorca	0.37	0.50
Catania	0.21	0.23	Málaga	0.34	0.33	Zürich	0.21	0.25
Cork	0.19	0.25	Rome	0.22	0.26	Toulouse (Rx)	0.23	0.42
Warsaw	0.21	0.26	S. Compostela	0.23	0.22	Burum (Rx)	0.23	0.42
Djerba	0.36	0.21	Sofia	0.39	0.37	Bergen (Rx)	0.25	0.36
Glasgow	0.20	0.28	Gävle	0.22	0.29	Grasse (Rx)	0.24	0.19
Lisbon	0.31	0.37	Toulouse	0.21	0.22			

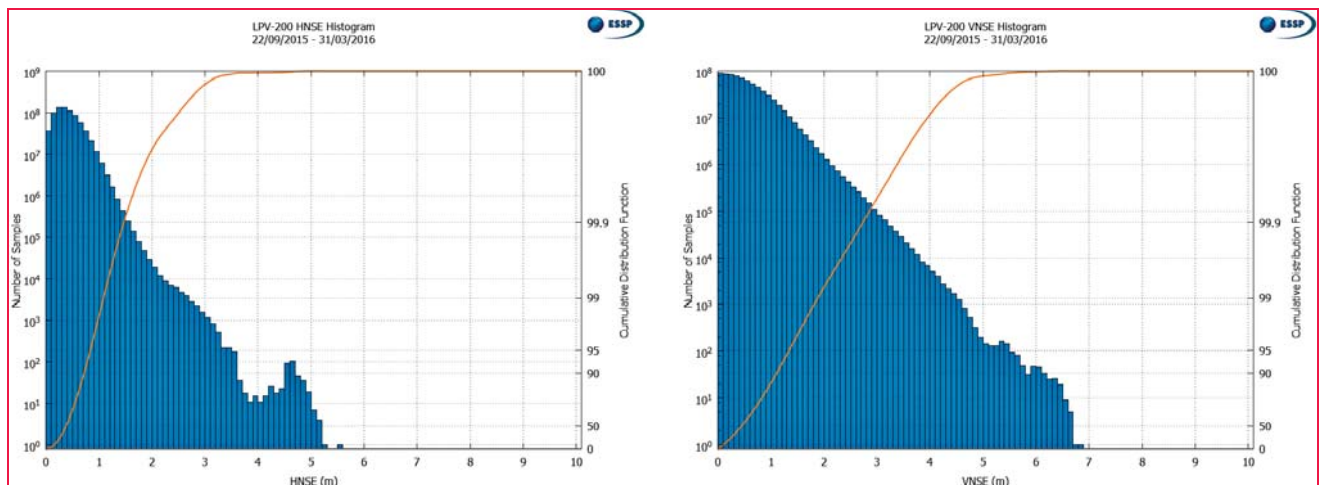


Figure 3. Example of LPV200 NSE histograms (blue) and CDF (orange) accumulated in RIMS & independent receivers

LPV200 User domain Integrity

Figure 2 provides the histogram for Horizontal Safety Index (HSI) and Vertical Safety Index (VSI) when accumulating measurements from the 19 RIMS and 4 receivers within the LPV200 commitment area over the period. These histograms were calculated considering the samples in which LPV200 was available:

The maximum safety index at the RIMS sites and independent receivers (Rx), over the whole period, is included in Table 2, both horizontal and vertical; note the maximum value is 0.50, which means a large integrity margin.

LPV200 Horizontal and Vertical Accuracy 95%

The VNSE histograms and

Cumulative Density Function (CDF) for 19 RIMS and 4 receivers within the LPV200 commitment area are presented in Figure 3:

The LPV200 Accuracy 95% values at the RIMS sites, when the LPV200 service is available (HPL<40m and VPL<35m), are included in Table 3. For every station the obtained performance is well below the corresponding

Table 3: LPV200 Accuracy 95%

RIMS	HNSE 95%	VNSE 95%	RIMS	HNSE 95%	VNSE 95%	RIMS/Rx	HNSE 95%	VNSE 95%
Aalborg	0.7 m	1.4 m	Swanwick	1.1 m	1.8 m	Trondheim	0.8 m	1.5 m
Berlin	0.8 m	1.2 m	Athens	0.7 m	1.3 m	P. de Mallorca	0.7 m	1.1 m
Catania	0.7 m	1.2 m	Málaga	0.9 m	1.2 m	Zürich	0.8 m	1.2 m
Cork	0.9 m	1.3 m	Rome	0.7 m	1.2 m	Toulouse (Rx)	0.9 m	1.2 m
Warsaw	0.9 m	1.4 m	S. Compostela	0.9 m	1.1 m	Burum (Rx)	0.9 m	1.4 m
Djerba	0.8 m	1.3 m	Sofia	1.1 m	2.1 m	Bergen (Rx)	0.9 m	1.6 m
Glasgow	0.8 m	1.4 m	Gävle	0.7 m	1.5 m	Grasse (Rx)	1.0 m	1.0 m
Lisbon	1.0 m	1.6 m	Toulouse	0.8 m	1.1 m			

requirement (16m for the horizontal case and 4m for the vertical one).

Values show EGNOS compliance to HNSE 95% and VNSE 95% requirements with a very comfortable margin during the period of analysis.

Computation of the accuracy tails: the LACTA tool

ESR 2.4.1M deployment and qualification for LPV200 allowed declaration of the LPV200 service level the 22nd September 2015. For the first time, EGNOS faces LPV200 stringent requirements on the accuracy distribution tail of the user vertical position error (VNSE). Performance monitoring of this requirement is challenging since it would need more than several decades of data per receiver to get a value at the requested confidence levels. It is, then, necessary to explore alternative verification approaches.

ESA and Industry designed and implemented EGNOS V2.4.1M and subsequently tested and qualified it for LPV200. Extensive work was performed to address the accuracy distribution tail in the different V2.4.1 project phases. An overview of the LPV200 accuracy distribution tail methodology for EGNOS LPV200 accuracy distribution tail qualification was presented to the GNSS community in [4]. Based on a Gaussian extrapolation assuming that the nominal error model pseudorange error is characterized by a non-biased Gaussian distribution, this methodology includes four functions: data filtering, distribution characterization, over-bounding sigma computation and VNSE extrapolation.

Based on [4] methodology, ESSP developed and validated a tool called LACTA (Lpv200 ACcuracy Tails) to analyze the tails of the accuracy distributions. LACTA uses real data from EGNOS receivers (i.e. RIMS) for a given period (typically several months) to estimate the probability of having vertical

errors higher than 10 meters. For a specific receiver, LACTA users select a period of time for which the overbounding distribution is to be calculated for a single GEO or several GEOs combined. Then, LACTA cumulates daily VNSE data for the period. Using the cumulated VNSE distribution, LACTA calculates the overbounding distribution (σ_{bound}) and the VNSE_{bound} extrapolated to the 10⁻⁷/150s. LACTA output is shown in Figure 4.

Figure 4 plots the accumulated VNSE histogram in dark blue and referenced to the vertical axis on the left, the Complementary Cumulative Density Function (CCDF) of the accuracy distribution in orange referenced to the vertical axis on the right, the CCDF of the overbounding Gaussian distribution (σ_{bound}) in pink referenced to the vertical axis on the right and the value in meters of the VNSE_{bound} extrapolated to the 10⁻⁷/150s located on the right-top corner and indicated with a red vertical line.

LPV200 Vertical accuracy tails

LACTA was run for the period of analysis from the 22nd September 2015 to the 31st March 2016 for all 19 RIMS and 4 independent receivers within the LPV200 commitment map. According to [4], VNSE values are filtered to remove data affected by quality issues such as local effects or receiver malfunctioning. This requires a huge daily storage capacity for processed data only for accuracy. This need is independent from legal recording.

LACTA was run for the period of analysis from the 22nd September 2015 to the 31st March 2016 for all 19 RIMS and 4 independent receivers within the LPV200 commitment map. According to [4], VNSE values are filtered to remove data affected by quality issues such as local effects or receiver malfunctioning. Extrapolated VNSE is calculated to the 10⁻⁷/150s probability even though LPV200 accuracy tail requirement is twofold (nominal operational conditions and degraded conditions) because data classification into one of these categories is not straightforward.

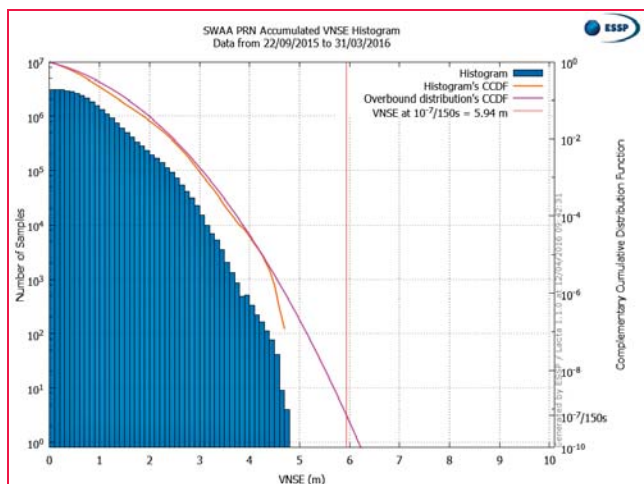


Figure 4: Example of LACTA output

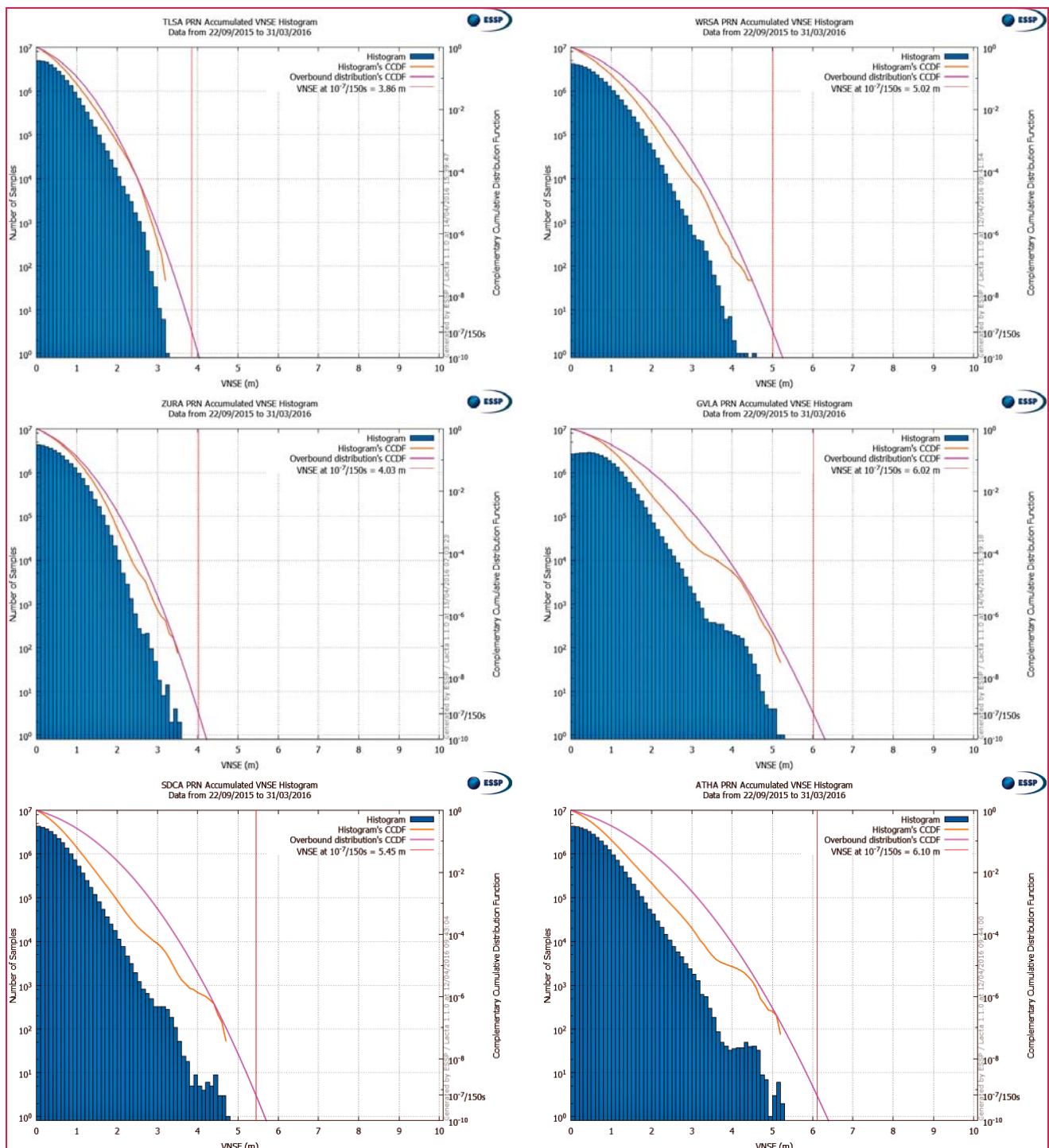


Figure 5: EGNOS VNSE(m) histogram for the period of analysis (blue), CCDF (orange) and overbounding Gaussian CCDF (magenta) for Toulouse, Warsaw, Zürich, Gävle, Santiago de Compostela and Athens RIMS receivers. The vertical red line is the extrapolated VNSE value to $10^{-7}/150s$.

The analysis performed assumes all the data in the period is subjected to the more stringent requirement which is the $\Pr(VNSE < 10m) < 10^{-7}/150s$ for nominal operational conditions. It is only in case the extrapolated VNSE to the $10^{-7}/150s$ exceeds the 10m nominal conditions requirement when a specific assessment determines

if the samples leading to the non-compliance result could be considered within degraded conditions.

Figure 5 and Figure 6 present the Complementary Cumulative Density Function (CCDF) of the extrapolated EGNOS vertical accuracy (VNSE) to the $10^{-7}/150s$ in RIMS using

LACTA. Results are the combination of both operational EGNOS GEOs (PRN 120 and PRN 136).

ESSP performs a thorough analysis of receivers to identify and characterize EGNOS performance in these sites. Extensive work is daily performed by RIMS and

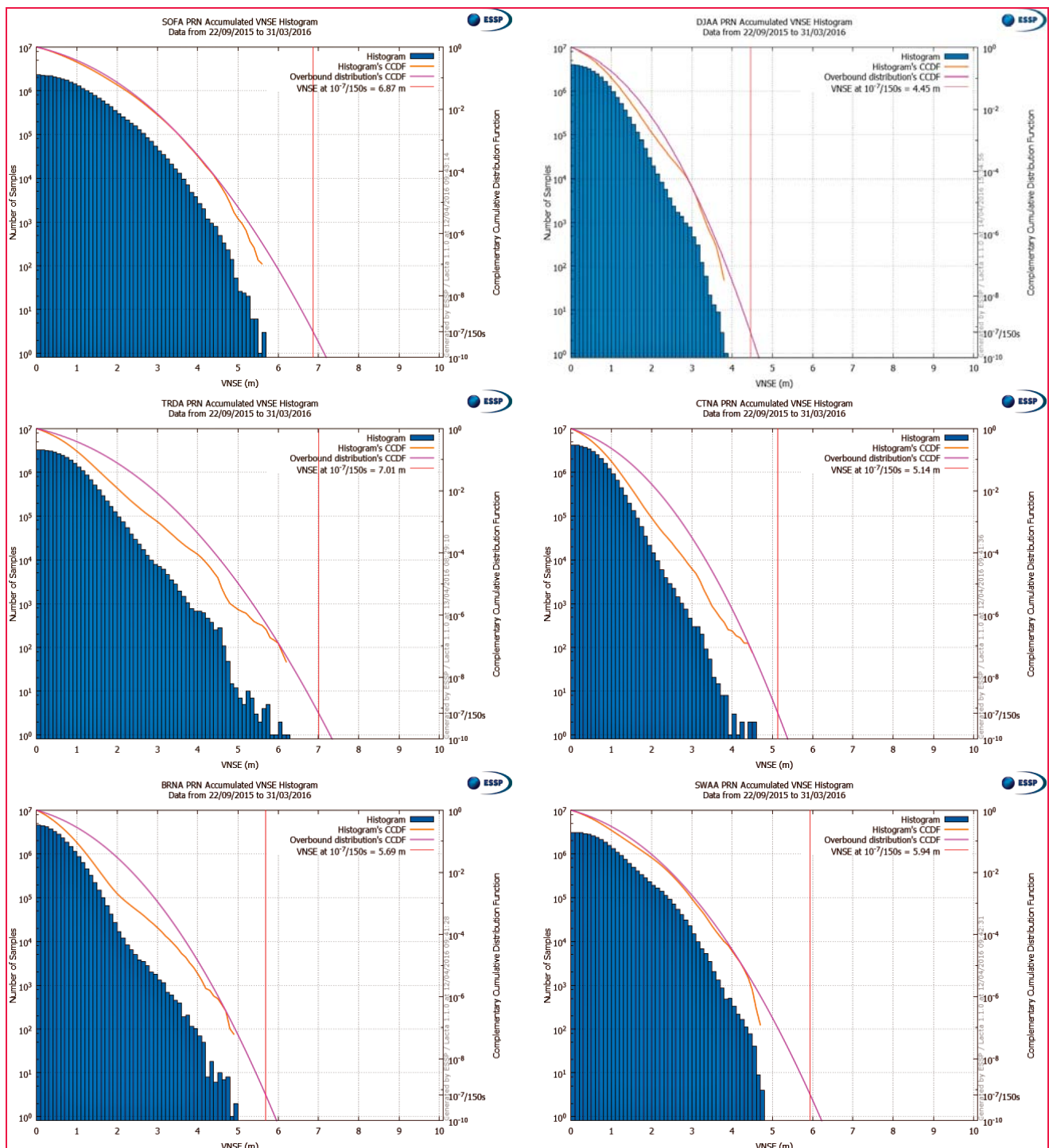


Figure 6: EGNOS VNSE(m) histogram for the period of analysis (blue), CCDF (orange) and overbounding Gaussian CCDF (magenta) for Sofia, Djerba, Trondheim, Catania, Berlin and Swanwick RIMS receivers. The vertical red line is the extrapolated VNSE value to $10^{-7}/150s$.

performance experts to detect possible local causes of degradations like local L1 interferences, multipath, issues in the GPS constellation and high ionospheric activity.

All VNSE extrapolated values in the RIMS meet the $10^{-7}/150s$ requirement with a very wide margin. RIMS

located in center of ECAC tend to provide better values whereas those in the north normally present higher values traced to ionospheric activity.

In order to crosscheck results, extrapolated VNSE is calculated in four independent receivers with similar results (Figure 7):

Summary of Vertical accuracy tails results

Figure 8 shows RIMS and independent receiver locations. Size and color of circles indicate the extrapolated VNSE calculated. All of them are below 10m and therefore meeting the $10^{-7}/150s$ requirement.

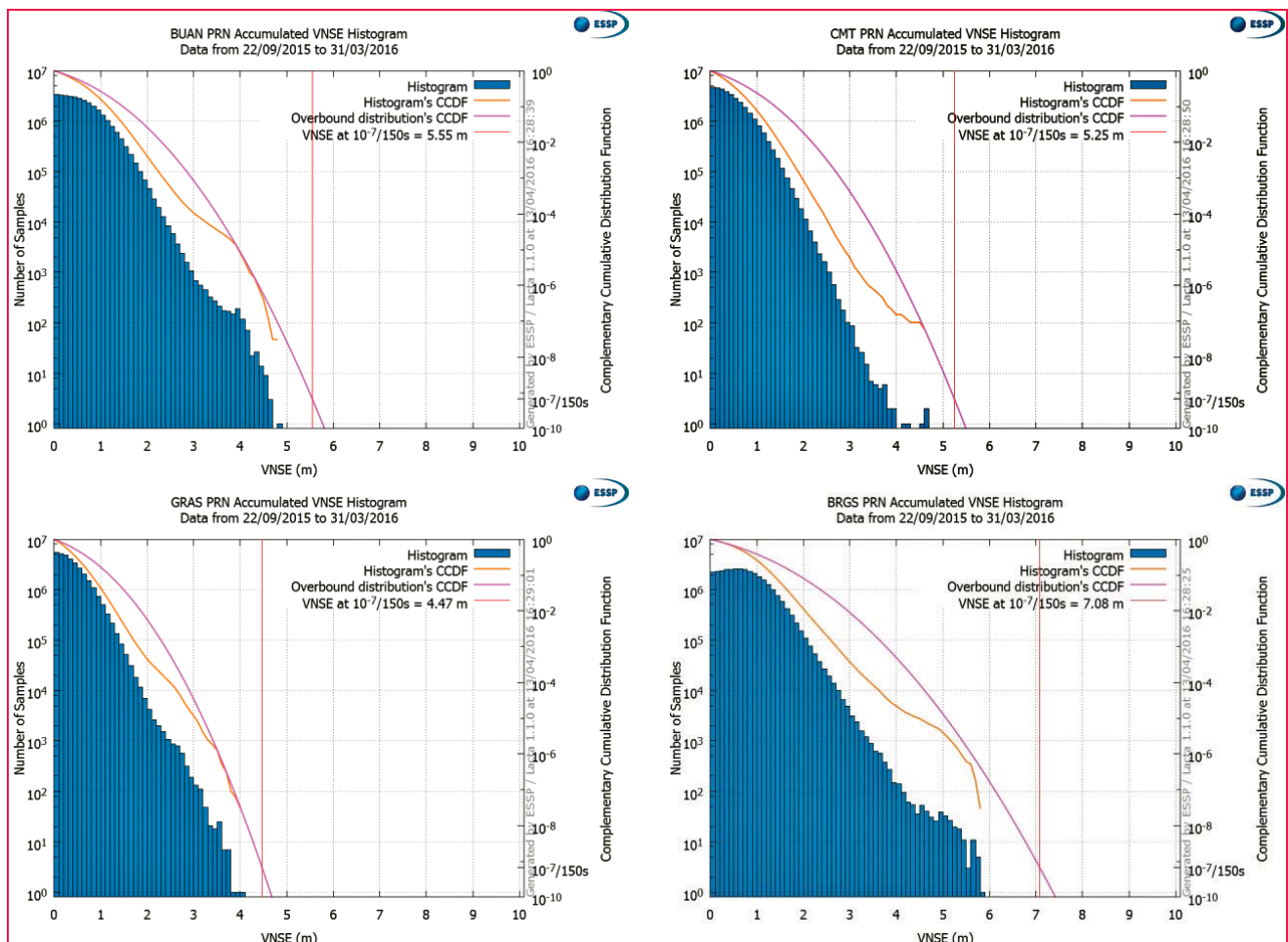


Figure 7: EGNOS VNSE(m) histogram for the period of analysis (blue), CCDF (orange) and overbounding Gaussian CCDF (magenta) for Burum, Toulouse, Grasse and Bergen independent receivers. The vertical red line is the extrapolated VNSE value to $10^{-7}/150s$.

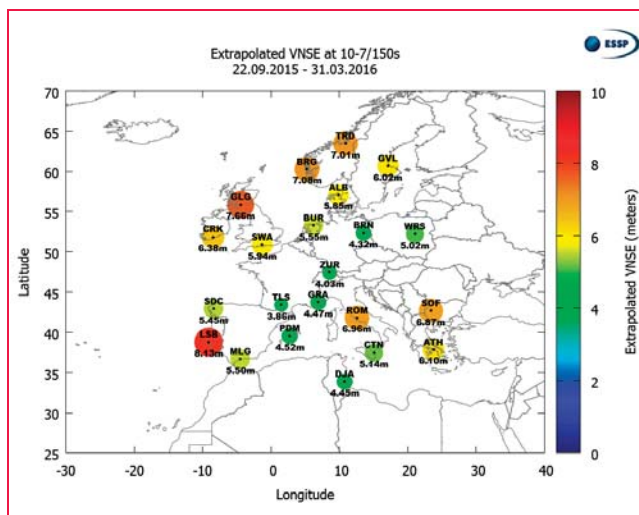


Figure 8: Extrapolated VNSE(m) for RIMS receivers & independent receivers

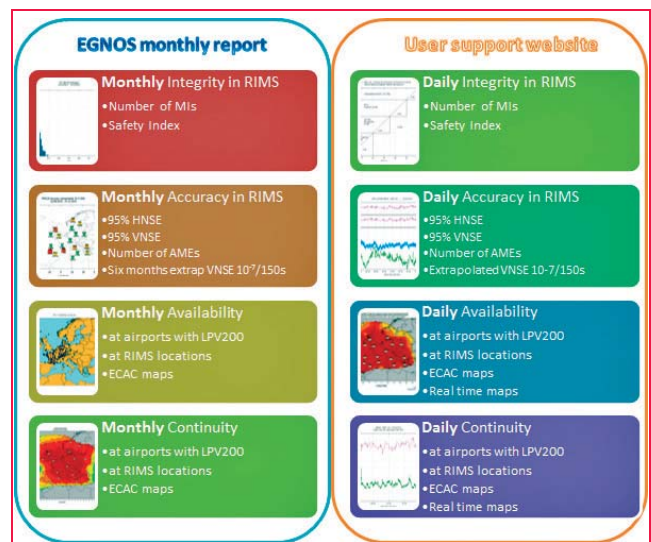


Figure 9: Summary of LPV200 monitoring parameters

The extrapolated VNSE to $10^{-7}/150s$ is reported every six months (January and July) in the EGNOS Monthly report for each RIMS stations within the LPV200 commitment area.

LPV200 performance available to the users

ESSP is committed to a full reporting of LPV200 service level available through

the EGNOS user support website [3] and the Monthly Performance Report [5]. Figure 9 provides a summary of the information available, the period of reporting and where can be found:

This information is available in the EGNOS User Support Website [3] and Monthly Performance reports [5]. Besides EGNOS Helpdesk is available 24/7 to answer queries from EGNOS users.

Conclusions

In the first semester 2015, the EGNOS service provider, ESSP, deployed EGNOS System Release (ESR) v2.4.1M. This new ESR was the last step before declaration of EGNOS SoL LPV200 service level on the 22nd September 2015. For the first time, an equivalent CAT-I service based on SBAS in Europe is achieved. LPV200 service brings improvement in the existing Air Navigation capacities and infrastructure in Europe enabling the implementation of the PBN concept in Europe within the Single European Sky and the ICAO Global Air Navigation Plan.

LPV200 service level is described in the EGNOS SoL Service Definition Document [1] and includes the availability and continuity commitment maps

which represent the minimum level of performances the user can expect under specific conditions. ESSP elaborates SDD availability and continuity commitment maps based on ICAO requirements for RNP approaches to LPV minima equal to 200ft.

This paper has presented EGNOS performance from the 22nd of September 2015 to the 31st of March 2016. The period showed excellent coverage of availability and continuity in most of the ECAC. LPV200 integrity enjoyed large margins through the period, 95% horizontal and vertical accuracy is well within the requirements for both RIMS and independent receivers.

The inclusion of new LPV200 requirements for the accuracy tails in [2] requested a new statistical characterization of VNSE accuracy distribution tails. Therefore, ESSP developed and validated a tool called LACTA. Results for the period showed extrapolated VNSE maximum values at around 8m well within the requirement. The analysis performed assumes all the data in the period is subjected to the more stringent requirement

which is the $\Pr(VNSE < 10m) < 10^{-7}/150s$ for nominal operational conditions.

Results are available at the EGNOS User Support Website [3] and Monthly Performance reports [5].

References

- [1] European GNSS Agency, "EGNOS Safety of Life (SoL) Service Definition Document", Rev. 3.0. in <http://egnos-portal.gsa.europa.eu> . September 2015.
- [2] RTCA Special Committee 159. "Minimum Operational Performance Standards for GPS/WAAS airborne equipment," RTCA Inc, December 2006.
- [3] ESSP SAS. "EGNOS User Support Website," in <http://egnos-user-support.essp-sas.eu>.
- [4] F.Bauer, E. Tapias and C. Lopez de Echazarreta, "Challenging EGNOS on the LPV200 Vertical Accuracy Tail Requirements," ION 2014 proceedings, September 2014.
- [5] ESSP, "Monthly Performance Report January 2016", in <http://www.essp-sas.eu/>, January 2016. ▴

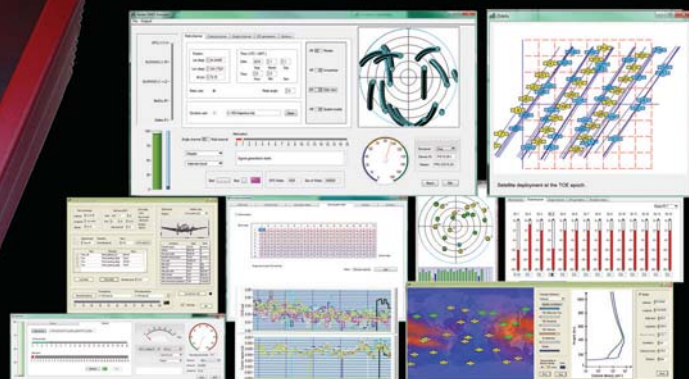


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Satellite Navigation turns the world into a global village

This year's Munich Satellite Navigation Summit was held on March 1 - 3, 2016 under the motto: "GNSS - Creating a global village". About 80 speakers from government, industry and science were invited by the organizing Institute of Space Technology and Space Applications (ISTA) of the Universität der Bundeswehr München to talk about the impact of satellite navigation on global developments and different areas of life.

GNSS connects the world

The 13th edition of the annual conference was kicked off on March 1 in the historical Court Church of All Saints with a ceremonial opening and discussions amongst high-level representatives from various European ministries and entities as well as from the USA and China. About 350 participants from 22 nations were welcomed by the Deputy Bavarian Minister-President and Bavarian State Minister for Economic Affairs and the Media, Energy and Technology, Ilse Aigner, as well as the Parliamentary State Secretary at the German Federal Ministry of Transport and Digital Infrastructure, Dorothee Bär, and Prof. Dr. Bernd Eissfeller, chairman of the conference. Ilse Aigner underlined that the aviation and space industry is a key sector in Bavaria. According to Ilse Aigner the dynamic of the new developments and the value added chain is perfectly used in the State of Bavaria, where 150 companies produce a sales volume of 350 Million and 90 more business start-ups are expected for the upcoming years.

The topic of the panel discussion was "GNSS - An element of a global digital infrastructure". It became clear that GNSS is a perfect tool to build up a global digital infrastructure. Pierre Delsaux, Deputy Director General, DG Internal Market, Industry, Entrepreneurship and SMEs at the European Commission, pointed out that EGNOS is already working very

well and that it could be very useful for countries in the Southern Hemisphere, where negotiations with Africa are ongoing. Jean-Yves Le Gall, President of CNES, underlined that CNES fully supports the activities of the European Commission and that GNSS can help countries like Africa to skip one step in their development. Prof. Dr. Jan Woerner, Director General at ESA, highlighted that space activities are able to bridge the strongest problems on earth. The planned "moon village" will enable sustainable operations on the surface of the moon and shall open the exploration area for all states on the globe, in order to create a better world. Harold Martin, Director of the National Coordination Office for Space-Based Positioning, Navigation, and Timing in Washington, said that due to all the excellent systems the availability of information is at its best level and that impoverished nations can "cheaply take advantage of billions of dollars of investment by Northern Hemisphere countries", for example by using a Smartphone.

The conference program continued on the following two days with a broad overview on different up-to-date topics and applications as well as several user segments. While the focus was on the regions and countries of the main service providers in the last years, it was the aim of this year to include the view of countries from the Southern Hemisphere like Africa, South America and South East Asia.

Besides the traditional first session on the global satellite navigation systems, the panel on regional and augmentation

satellite navigation systems included for the first time representatives from the Southern Hemisphere. Julien Lapie from the Agency for Air Navigation Safety in Africa and Madagascar (ASECNA) informed about the development of a programme for the deployment of EGNOS in Africa. Dr. John A. Momoh from the Nigerian National Space Research and Development Agency described the test results for the satellite NigComSat-IR, which is fully operational. According to Dr. Momoh it showed a signal in space that is compatible with GNSS and could be the main part of an African SBAS. The panel discussion "GNSS in the Southern Hemisphere and Equatorial Regions", chaired by Prof. Vidal Ashkenazi from Nottingham Scientific Ltd, focused on the perspective of countries like Australia, Brasil, Egypt, Japan and South Africa on current and future applications in Satellite Navigation. In the further course of the program topics like the Galileo PRS, the role of GNSS in Telematics Systems for the Autonomous Vehicle, the GNSS Authentication Services as well as Precise Positioning Technology in Agriculture and Forestry were discussed. The conference program was completed by an exhibition, at which several companies and institutions presented their business and products.

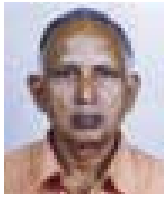
- Kristina Kudlich, kristina.kudlich@munich-satellite-navigation-summit.org △



Opening Panel members (L to R): Carlo des Dorides, Pierre Delsaux, Prof Dr Jan Woerner, Jean-Yves Le Gall, Harold Martin, Jun Shen, Prof Dr Hansjörg Dittus

Spatial map policies

Problems and solutions



N K Agrawal

Former Director, Indian Institute of Surveying and Mapping (ITI), Hyderabad, India

We have come across many policies and programs for the last many years with thousands of crores being spent with unsatisfactory outcome. We hardly see any concrete results. Look at the policies and programs mentioned below:

Computerisation of Land Records, Digitisation of Land Records and Other Maps, Resurvey of Land Holdings (Cadastral Survey), National Map Policy-2005, National Resources Data Management System (NRDMS), National Spatial Data Infrastructure (NSDI), 1:10,000 Scale Mapping Under Ppp, Survey Of India Revamping or Restructuring, National Geospatial Policy (NGP), National GIS (NGIS), National Data Registry (NDR), National Data Platform (NDP), National Product Development Mission (NPM), National Remote Sensing Policy -2011, National Data Sharing And Accessibility Policy-2012 (NDSAP), Bhuvan, Indian Regionalsatellite Navigation System (Irnss), GPS Aided Geo Augmentation System (Gagan), National Centre of Geoinformatics, etc.

We can discuss and say that a lot has been done and will continue to be done. We, however, see that maps and data are not available. Umpteen number of conferences and meetings have taken place and will continue. Any concrete solution has been suggested? What are the reasons for failure?

We have to go to the root of the problem and suggest solutions :

1. Survey of India is not capable of mapping and providing updated maps of the whole country even on 1:50,000 scale. Talk of 1:10,000 scale mapping is going on for many years?

2. Similar is the case with Cadastral survey in states. Records are in poor condition are even not available. Most require resurvey. Many programs initiated and experiments done with poor results. Courts are full of litigations.
3. First and foremost is that we have to concede that Survey of India or one single agency that can not do the job for the country. India has so many states with governments in place in a federal structure. Many states are larger than Sri Lanka, Bangladesh or Nepal.. So why cant we take lessons from our neighbours and give responsibility of all types of survey and mapping to states in their area of jurisdiction including topographical survey from 1:10,000 to 1:50,000 scale, Cadastral survey, irrigation survey , road survey, forest survey etc. All states should have survey departments as large as in Sri Lanka, Nepal, Malawi or any other developed /developing country.
4. Responsibility of Survey of India may be:
 - a. Survey and mapping of external borders of India.
 - b. Zero order Geodetic control points all over India, 50 km apart in WGS84/Indian Geodetic System.
 - c. Coordination and cooperation with states.
 - d.Help in establishing Survey Training Institutes in all states similar to IISM of Survey of India in all states.
5. Responsibility of states may be:
 - a. Geodetic control points with permanent monuments, 1st order 20 km apart, 2nd order 10 km apart, 3rd order 5 km apart and 4th order 2 km apart.
 - b. Survey and mapping including 1:10,000 to 1:50,000 scale topographical mapping, 1:2000 to 1:5000 scale Cadastral mapping and for all development in the state. All land holding corners to be coordinated by adopting a rectangular grid for the state. ▷

India launches IRNSS-1G

The Polar Satellite Launch Vehicle, in its thirty-fifth flight (PSLV-C33), launches IRNSS-1G, the seventh satellite of the Indian Regional Navigation Satellite System (IRNSS) into a Sub-Geosynchronous Transfer Orbit (Sub-GTO). The launch took place from the First Launch Pad (FLP) of Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota on April 28, 2016. As in the previous six launches of IRNSS satellites, PSLV-C33 uses 'XL' version of PSLV equipped with six strap-ons, each carrying 12 tons of propellant.

The 'XL' configuration of PSLV is used for the thirteenth time. Besides launching six IRNSS satellites, PSLV-XL has also launched many other spacecraft including India's Mars Orbiter spacecraft, the multi-wavelength observatory ASTROSAT, Radar Imaging satellite RISAT-1 and the Communication satellite GSAT-12. This apart, PSLV-XL has successfully placed five satellites from United Kingdom into orbit in a single commercial mission.

This is the thirty-fourth consecutively successful mission of PSLV, repeatedly proving its reliability and versatility. Like its other IRNSS predecessors, IRNSS-1G also carries two types of payloads – navigation payload and ranging payload. The navigation payload of IRNSS-1G will transmit navigation service signals to the users. This payload will be operating in L5-band and S-band. A highly accurate Rubidium atomic clock is part of the navigation payload of the satellite. The ranging payload of IRNSS-1G consists of a C-band transponder, which facilitates accurate determination of the range of the satellite. www.isro.gov.in



Galileo update

△ NEWS – GIS

SuperGIS Desktop 3.3

Supergeo has recently released the latest version of SuperGIS Desktop 3.3! In this latest version, several new capabilities to enhance the user experience has been added. First, manipulation of layers has become easier. Users now can use keyboard shortcuts to select multiple layers and then remove or group them in great speed. Second, this latest version also strengthens the capability of “Select by Attributes”. The new quick query allows entering the attribute and finds the corresponded attribute immediately. www.supergeotek.com

National Hydrology Project gets cabinet clearance in India

The cabinet has cleared the Rs. 3, 679 - crore National Hydrology Project (NHP) that aims to collect hydro-metrological data across India and use it for efficient water management in the country. The scheme will help address the water crisis in the country. The project will inform the public about how much water is available and assist farmers in planning their crops and other farm-related activities.

Data would be collected using various information systems and technologies, including remote sensing. Briefing reporters on the cabinet decision, telecom minister Ravi Shankar Prasad said the decision was taken to collect and store national hydro-metrological data on real time and digitize it for proper forecasting of water availability. The project has been approved keeping long-term prospects in mind, the minister said. It will integrate water resource management by adopting a river basin approach through collation and management of hydro-meteorological data. The government plans to use the data to increase the lead time in flood forecasting from one to at least three days, map flood inundation areas and assess surface and ground water resources in a river basin for better planning and allocation for Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and other government schemes. www.livemint.com △

Awarding Galileo Enabled Applications

From 1 April to 30 June 2016, the European Satellite Navigation Competition (ESNC) - the largest international competition for the commercial use of satellite navigation - will once again be looking for outstanding ideas and business models.

This year's winners will take home prizes worth a total of EUR 1 million and be welcomed into the ESNC's leading innovation network for global satellite navigation systems. Along with cash, the various prize categories on offer primarily include technical, business-related, and legal support in realising the winning business models. A jury of international experts from the realms of research and industry will also evaluate the winners of all the categories to select an overall winner, who will be revealed at the festive Awards Ceremony.

Those who enter the ESNC also stand to benefit greatly from the opportunity to work closely with leading institutions and regional partners. The ESNC is geared towards individuals and teams from companies, research facilities, and universities around the world.

In ESNC 2016, prizes are to be sponsored by the following partner regions and institutions: the European Space Agency (ESA), the German Aerospace Center (DLR), the German Federal Ministry of Transport and Digital Infrastructure (BMVI), and the Horizon 2020 project BELS. Prototypes

can also be entered into the GNSS Living Lab Challenge. The University Challenge, meanwhile, is explicitly designed for students and university research assistants. This year's confirmed partner regions are: Asia, Austria, Baden-Württemberg, Bavaria, the Czech Republic, Flanders, France, Galicia, Hesse, Ireland, Israel, Lithuania, Madrid, the Netherlands, Norway, Poland, Romania, Sweden, Switzerland, the United Kingdom, and Valencia. More to follow soon. www.esnc.eu

Ground-based Galileo satellite joins post-launch dress rehearsal

The navigation satellite set to become the 16th in the Galileo constellation has been taken through a Europe-wide rehearsal for its launch and early operations in space.

A joint team from ESA and France's CNES space agency oversee Galileo's Launch and Early Operations Phase (LEOP) – the initial switching on and checking and configuration of satellite systems. LEOP is run from either ESOC or CNES Toulouse, on an alternating basis.

ESOC will host the LEOP team for the next launch of two Galileo satellites by Soyuz from French Guiana in May. Then the team will switch to Toulouse for the first launch of four Galileo satellites by Ariane 5, scheduled for this autumn. △





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Surveyors

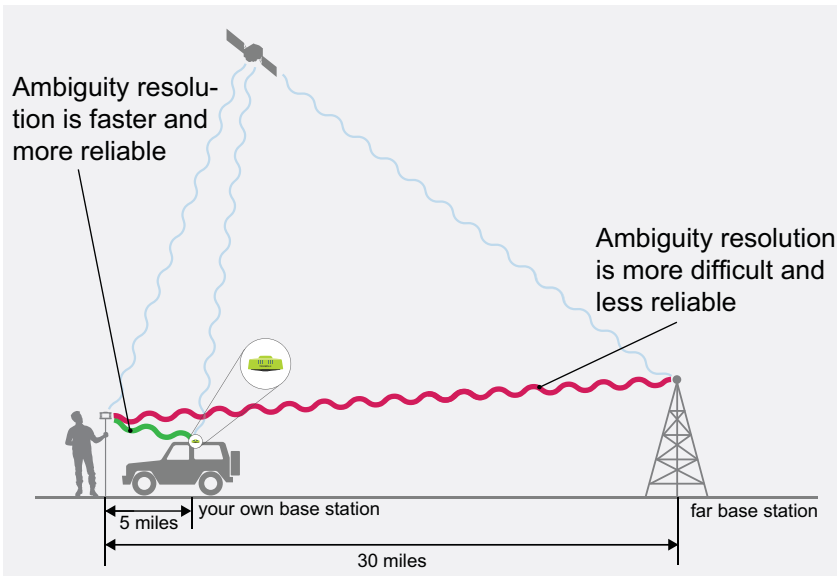
Shawn Billings, PLS

Matt Johnson, PE



... so surveyors do more of this!

Advantages of your own base station and short baselines



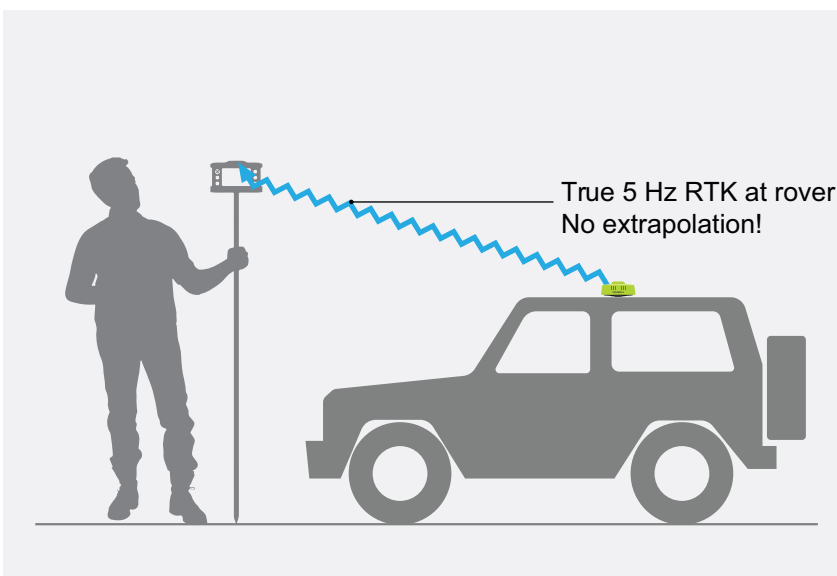
1. Shorter baselines provide significantly better **reliability** because the ambiguities are much easier to resolve and the correct ambiguity solution has an obvious contrast.

2. Shorter baseline has better **accuracy** because most of errors (like atmospheric and tropospheric effects) are common and cancel.

3. Shorter baseline ambiguities are resolved much **faster**. In longer baselines, incorrect ambiguities may pose as being correct in the statistical evaluations and it takes longer to isolate incorrect ambiguities.

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2 Park your car, Start Base

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Rover Setup screen makes it easy to configure the base and rover with the same parameters.

Use “**Auto**” for the base coordinate. “Auto” will use an autonomous solution as the base coordinates which may be off by several meters (this will be corrected later). Then click **Start Base**.

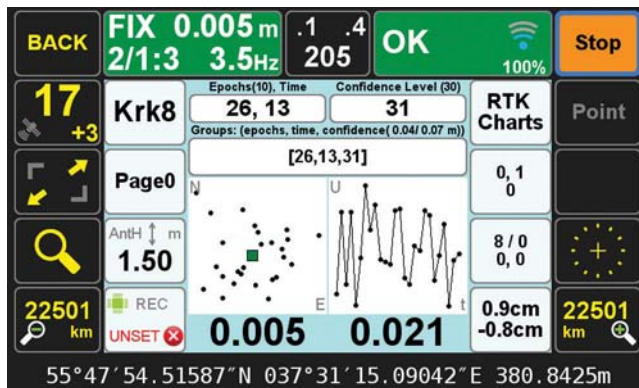
Proposed Base Position		Autonomous Position
From List	Enter	From Auto
[Base] Ref41 55°47'55.34736"N 037°31'15.53083"E 363.0468m WGS84(ITRF2008) @2005.0000		55°47'55.26300"N 037°31'15.51039"E 360.6257m WGS84(ITRF2008) @2005.0000 2D Delta: 2.63 m
Broadcasting Ref. Frame WGS84(ITRF2008)		
Antenna Height:		
Vertical	Height 0.0 m	Offset 0.0 m
Esc		OK

[Base] Base3	
55°47'55.32196"N 037°31'15.54498"E 363.5364m WGS84(ITRF2008)	
Do you want to Start Base?	
Stored Point Name	Base3
Code	Page0
Description	
Yes, Store Point and Start Base	
Esc	

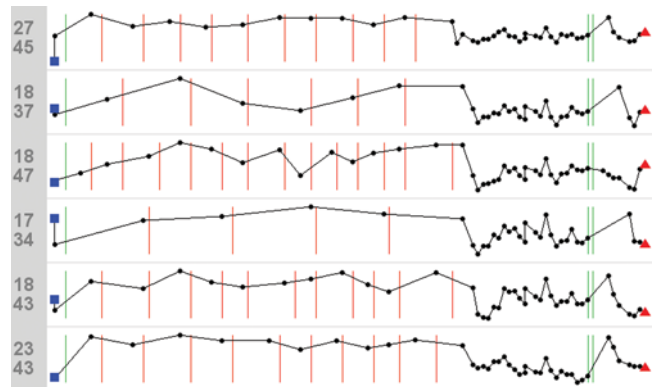
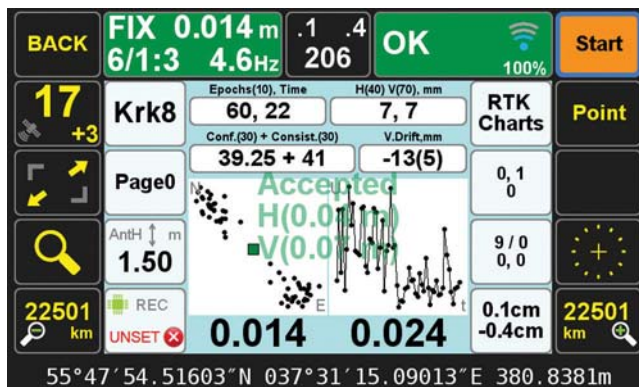
Disconnect		Start Base	
5 Receiving OK		Rover: Triumph-LS 9DT_00281 Base: JAVAD GNSS 35006	
Uhf5hznew Base ID: 0 Ref. Frame: WGS84(ITRF2008) Format: RTCM 3.0 Min Period: 0.2 Sec Frequency: 461.02500 MHz Mod. Band.: D16QAM, 25.0 KHz FEC, Scrm: On, On Out. Power: 30/15 mW/dBm		[Base] Ref42 55°47'55.30679"N 037°31'15.48313"E 361.0235m WGS84(ITRF2008) @2005.0000 2D Delta: 0.66 m Δ H: -0.45 m Azimuth: --- Ant. Type: JAVTRIUMPH_1MR NONE Ant. Height: 0.0 m Vertical	
From Base	To Base	Recall	Copy As Done

3 RTK Survey

Use your rover to perform your tasks. We have combined UHF and Spread Spectrum Frequency Hopping (FHSS) in the same module in TRIUMPH-LS as an option. The automatic “**Verify**” feature (Phase-1 and Phase-2) ensures that you will never get a wrong solution.



Since your RTK baselines are short, you benefit from all advantages that we discussed earlier BUT all your rover shots are shifted by the offset error of the autonomous base coordinates (up to several meters). “DPOS-It” or “Reverse-Shift-It” to correct for the error from the autonomous position.



4 DPOS-it, Reverse-Shift-it, CORS Process it, AUTOMATICALLY with Hybrid RTK.



Hybrid RTK

Triple-Check your RTK results and ...

It triple checks the accuracy of RTK solutions by post-processing and CORS processing. In addition, if RTK can't get a fix (because of bad environment or bad communication with Base) Hybrid RTK comes to your rescue... automatically.

Nine Automatic Steps of Hybrid RTK

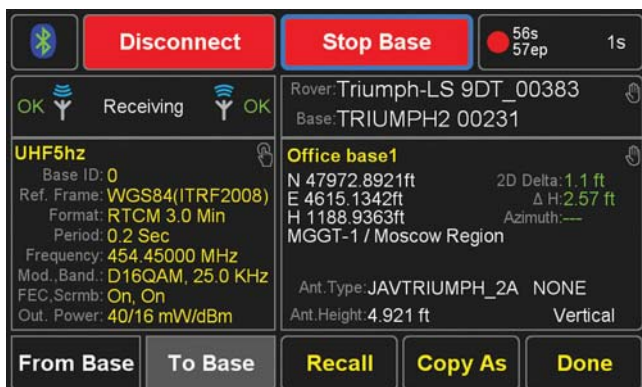
Confidence and Speed... Unlimited!

You do this ▾

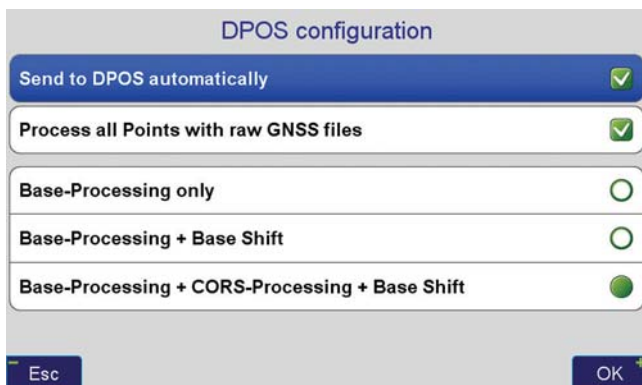
1

Downloading base data.

When your RTK job is finished, go to your base and in Base/Rover screen click **"Stop Base"**. Base data will be downloaded to TRIUMPH-LS via fast Bluetooth automatically. All of the following steps will be performed automatically too when WiFi/Internet connection is established.



DPOS options



Automated steps ▾

2

Base data downloaded.

3

Awaiting DPOS server connection.

4

Rover points and base data sent to DPOS. Awaiting DPOS to process base-rover.

5

Rover points processed with base (relative).

6

Base data sent to DPOS to be processed with CORS data. Awaiting CORS data.

7

Base processed with CORS and corrections applied. (Absolute)

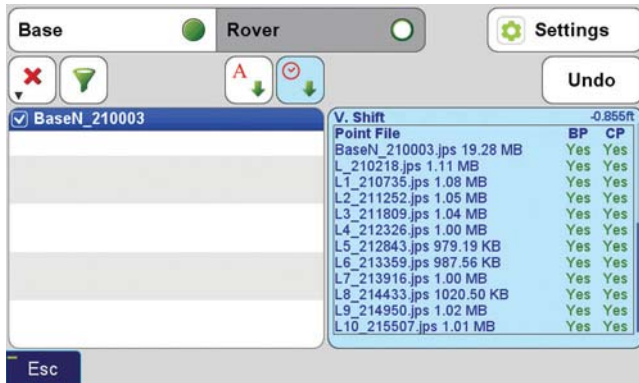
8

Base and rover points sent for CORS processing.

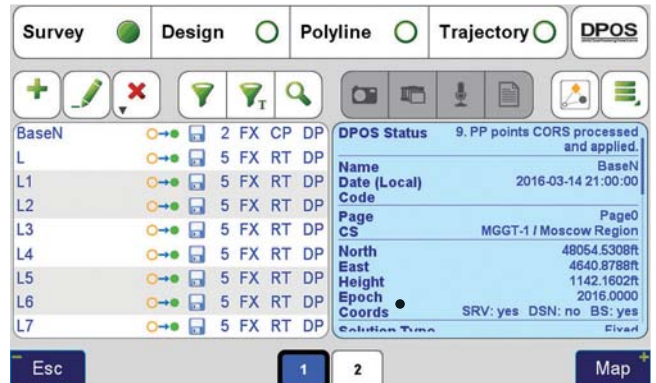
9

Rover points individually processed with CORS data.

Post-process and CORS process missed points... Automatically!



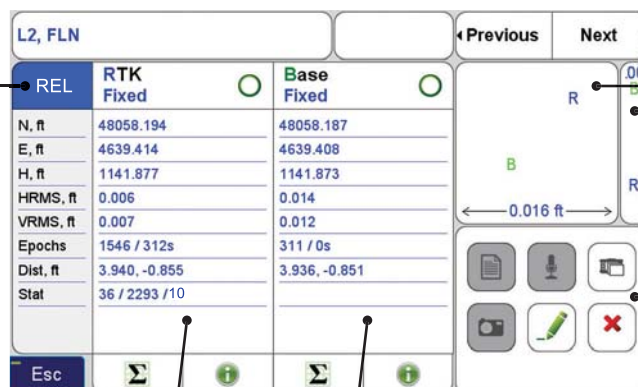
Status of DPOS and Hybrid RTK processing for this session.



Status of each point and indication that base was DPOsed and corrections were applied.

Switch between REL (Relative) and ABS (Absolute) screens.

RTK and post-processed rover solutions based on autonomous (standalone) position of the base (Relative).



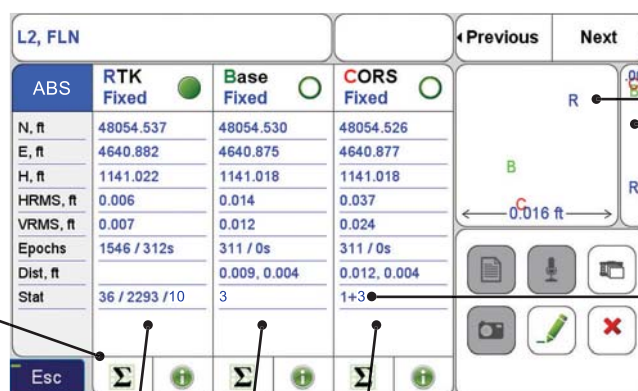
Horizontal and vertical graph of Relative solutions.

Access notes, audio, photos and screen shots that are attached to this point.

RTK solution (relative to autonomous position of the base).

Post-processed solution (relative to the autonomous position of the base).

Three types of Absolute rover solutions after autonomous position of the base is corrected with CORS data.



Horizontal and vertical graph of Absolute solutions.

Number of CORS stations used.

Statistical details.

Corrected RTK solution.

Corrected post-processed solution.

Solution post-processed directly with base and with CORS data.

Your thick trees and Our six RTK engines...

"This thing
is bad ass!"

"I used 'Beast Mode' on a small project yesterday and all I can say is WOW!!!! Did Javad and Red Bull team up to enhance RTK or did my system drink hypercaffeinated coffee when I wasn't looking? Amazing accomplishment/development Javad. I can't imagine using any other GPS equipment."

"the data collection will make your whole body stiff, and quiver from head to toe. It is flat awesome."

"We are considering a third system (these things are awesome)"

"got some shots that he could not get with our gr5's"

"The LS has increased our productivity 2:1."

"Btw, pardon my French, but holy shit. I got some ridiculous 'fixes' today in some horrible situations. Reset receiver, moved around, etc. Tried to get a bad fix but had a hard time doing it."

"On a side bar, the highway contractor had a guy using a Trimble for his as-built shots. My Javad ate his lunch on fixes and the verify routines. He had never seen anything like it. His was stop, drop, and go."

"I've been using BEAST MODE RTK and it works very fine even in heavy canopy. Tremendous application."

"The only bitching now is for the crew that has to take out the Hyper V."

"I often get 2 days of work done, in a day."

"This thing
is bad ass!"



...making friends!

HOW DEEP IS YOUR LOVE

for science?

for technology?

for survey?

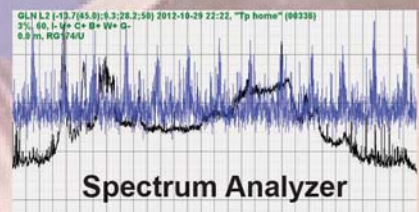
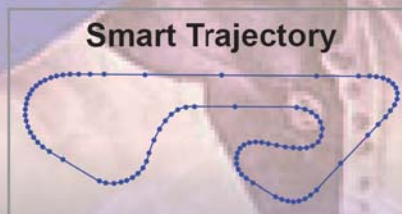
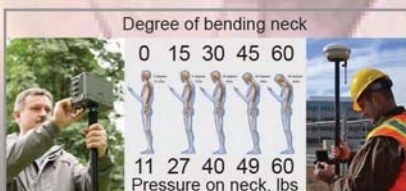
for money?

and for

Hybrid RTK

A u t o m a t i c

and much more...



RAMS

Remote Assistance & Monitoring Services



REVERSE SHIFT<<it



BEAST^{MODE} RTK

Real 5-Hz Base Station Transmission



>>>
Wolfman Jack

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Systematic cadastral registration using UAV technology

The paper presents the results of scaling up the use of UAV technology for registration of property rights in the Republic of Kosovo, while showing practical challenges faced and lessons learned



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CEO, Kosovo Cadastral Agency, a University Professor and Head of the state Border Demarcation Commission, Kosovo



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Senior Land Administration Specialist, World Bank



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Kosovo Cadastral Agency, Republic of Kosovo

Activities for land administration, cadastral mapping and registration of real property rights in the Republic of Kosovo are priority components for the country's economic development strategy. In this context, the development of the national spatial data infrastructure (NSDI) is also an integral approach because cadastral data are a core spatial data set. The purpose is to update cadastral data, using new technology and highlight transparency.

With the support of the World Bank-financed Real Estate Cadastre and Registration Project (RECAP) progress on systematic updating of cadastral data is underway through cadastre reconstruction which has updated thousands of properties in more than 100 cadastral zones of 16 municipalities. Even though much progress has been made, many properties remain at a legal standstill due to issues such as inheritance. The legal and technical issues have been analysed and lessons learned discussed, with the conclusion that it is appropriate to test a new mapping and property rights registration toolkit for faster, cheaper, citizen-centric cadastral mapping and recording of land rights.

In 2013 and 2014 the World Bank team successfully piloted the use of unmanned aerial vehicles (UAVs or "drones") as a way to produce faster, fit-for-purpose spatial data (aerial photographs, orthophoto maps, and 3-D models). Typically, project costs for aerial surveys are hundreds of thousands or millions of dollars and can use up to 25% of the project budget. The maps using the conventional method take months to be produced, by which time the situation has already changed. The team's tests in 2014 demonstrated

how UAVs allow local map production with very high accuracy (4-8 cm) in a matter of days. In addition to maps, the technology can produce 3-D models that can be used for multiple purposes.

In 2015 the World Bank's Innovation Labs purchased a fixed-wing UAV to support operations and in December the team, together with the Kosovo Cadastral Agency (KCA), mobilized the UAV to support the national cadastral reconstruction program. This work is the first phase of a broader task to combine UAV technology with the use of free, customizable open source registration software (OSS) that is easily deployable in the field on tablets for data collection. Combining the UAV and OSS will put the Kosovo Cadastre Agency at the forefront of developing and testing an innovative mapping/registration tool kit and methodology in a national-level government project. It is believed that the combination of new technology can revolutionize the way the Bank and its clients design, implement, and monitor projects by making these processes more accurate and more cost effective. It also allows improvements to the way governments and/or local communities map and record property rights. Ultimately the combination will be assessed for suitability in diverse scenarios: Post-conflict/Post-Disaster response (quickly mobilizing fast and cheap technology to record the facts on the ground and collect information from survivors), community based mapping and recording rights (indigenous and vulnerable communities), and mainstream registration.

This paper will present the results of scaling up the use of UAV technology

to the production level as well as some of the practical challenges faced and lessons learned.

Using UAV technology for cadastre reconstruction

The UAV was used in three diverse settings:

- *Rural Setting:* In 1999, a lot of men and boys of the Krusha e Madhe village in southern Kosovo were massacred in the Balkan conflicts. The women of Krusha have been slowly rebuilding their community and have organized several agricultural cooperatives. However, the ownership of their land/houses remains unregistered or registered in the names of the deceased men thereby increasing tenure insecurity and preventing the land from being used as an effective economic asset. The time, cost and complexity of conventional cadastral surveying and registration is one of the key constraints for the women. Thus, about 1200 hectare (ha.) village was selected for the UAV work. The work is ongoing to update the cadastral information and this zone will be the first area where the new OSS will be used for field data collection of ownership information as part of the Phase II activity, which started in April 2016.
- *Urban Setting:* Over the past two decades many cities in Kosovo have experienced rapid, unplanned urban expansion resulting in informal settlements, illegal constructions and chaotic development. The Government of Kosovo has introduced a program for land owners to legalize their property rights and municipalities are working to integrate the new developments and provide services to citizens. In order to facilitate decision making, improve planning and prioritize investments, the team chose part of the city of Ferizaj for the UAV work. Work is ongoing to update and complete the cadastral and ownership data according to the actual situation on the ground. The information will also be used to assess its relevance and suitability for the legalization program, and the 3D

models will be assessed for suitability for urban planning, infrastructure development, taxation etc. as part of the Kosovo Cadastral Agency's role in developing and promoting the NSDI.

- *Road Corridor:* Although the initial focus of the work was to integrate UAVs into the cadastral mapping process, the team responded to a spontaneous request for assistance on construction of the R6 national highway. While flying in the urban zone near the new highway, a municipal representative noted that the road crew had recently found an archaeological site. The available aerial imagery and maps provided no evidence of the site. With the UAV the team was able to plan, fly and process a very high resolution 3D map at and around the area in less than 24 hours. This provides fresh and accurate information for rerouting the road, cultural heritage preservation and other important decision making.

Process of implementation and processing of the data

The objective of the pilot project in the selected areas, Krusha e Madhe, Ferizaj and highway Prishtina- Skopje, which is under construction, is to test whether we can use the UAVs (Unmanned Aerial Vehicles) in future cadastre reconstruction projects to be implemented by the Kosovo Cadastral Agency. Therefore the project's aim is to test the required level of accuracy for cadastral surveying according to the standards in Kosovo. Overall the advantage of UAV systems lies in their high flexibility and efficiency in capturing the surface of an area from a low flight altitude. In

addition, further information such as ortho images, elevation models and 3D objects can easily be gained from UAV images. Altogether, this project endorses the benefit of using UAVs in cadastral applications as well as new opportunities they provide for future cadastre reconstruction projects in Kosovo.

Preparation phase

The preparation phase started in November 2015, when the flight approvals were obtained from the Civil Aviation Authority of Kosovo and KFOR/NATO. Additionally, the officials of Municipal Cadastral Offices in Rahovec (for cadastral zone Krusha e Madhe) and Ferizaj were informed with the details of the pilot project. In the beginning of December 2015 the World Bank team together with the Kosovo Cadastral Agency (KCA) (The World Bank team includes Kathrine Kelm, Dr. Bruno Sanchez-Andrade Nuno, Eric Sundheim, geodetic surveyor from Geomatikk Norway; Ana Jesenicnik cadastral engineer from Sensefly Switzerland; and Qazim Sinani and Korab Ahmetaj, cadastral surveyors from the Kosovo Cadastral Agency), mobilized the UAV to test the use of this technology for cadastre reconstruction projects in the abovementioned locations.

Krusha e Madhe was selected among the rural zones, whereas a part of the cadastral zone of the municipality of Ferizaj was selected among the urban zones. Part of the new highway Prishtina-Skopje that is under construction was also selected, along with archaeological sites which were discovered during the excavation of the new highway.

Before being able to fully employ the UAV technology, the team was initially required



Figure 1: Selected areas of the project (Cadastral Zone Krusha e Madhe and Cadastral Zone Ferizaj)



Figure 2: Cadastral zone Krusha e Madhe – Flight planning and GCP

to mark in the field Ground Control Points (GCP). The importance of these points is for the post processing phase of the images in order to geo reference the blocks. For good coverage, of one block of size 0.5 km by 0.5 km at least 5 GCP were planned.

The blocks of flight were planned to last approximately 30 minutes per flight. Flight planning is made according to the division of the zone: the urban constructed part, the rural zone with agricultural parcels, and the zones with height differences for the photographing effects with various resolutions depending on the flight altitude.

The cadastral zone Krusha e Madhe was divided into 14 flight blocks with 41 GCPs marked in the field. In this case the border points between blocks were also used for the neighbouring block. The urban part of cadastral zone Ferizaj, was divided only in one block, with 16 GCPs marked in the field.

Field work activities

The field work started after the preparatory phase, which included planning of the blocks of flight as well as the planning of the marking the of GCP in the selected zones for this project. The selection criteria for finding a suitable location for marking the GCP in the planned zones were: having an accessible point, no obstacles in front, proper visibility, and a sustainable ground. The cemented parts, such as sidewalks, the edge of roads in the asphalt, were preferred, provided that they were not located in the space where the traffic

transited, because the color could be damaged due to the circulation of the vehicles, as well as due to the risk that the marking could be covered at the time of flight. In order to mark the GCP with color, a template in the form of a cross, with wing dimensions of 25 cm by 10 cm was designed.

The points in the field were numbered with ordinal number for easier identification in the picture. Hereafter, these points were measured with GNSS rover by using KOPOS-Kosovo Positioning System. Each point was measured three times aiming to calculate the average for the accuracy of measurements such as standard deviation.

After marking the GCP for a block, preparations were made to survey the block with the eBee drone. This is done through the software eMotion2, where initially the planned block was inserted, and then the space was defined through eMotion2 software. Beside this, other parameters were set as well, such as: altitude, resolution, coverage



Figure 3: Part of cadastral zone Ferizaj – Flight planning and GCP

between the images, wind speed, the launching point of the drone, and the landing point, at which point this plan was stored with a new name.

After making all the preparations, the drone was prepared for the flight with the camera in place. The Cannon 4.2 and Sony 3.2 cameras were used. Before launching the drone for the flight, the flight plan that was created earlier was inserted and the list of all parameters about the state of the drone, state of camera, the battery as well as the wing direction were checked.

When all conditions were fulfilled according to the control check list, the drone was ready for flight.

After successful launching, the drone flew in a spiral form until it reached the altitude that was previously determined. Once it reached the certain height the photographing started in accordance with the flight plan. Upon completion of the block the drone returned and landed to the previously determined point.



Figure 4: Marking and the measurements of GCP in the field



Figure 5: Preparation and monitoring of the flight plan

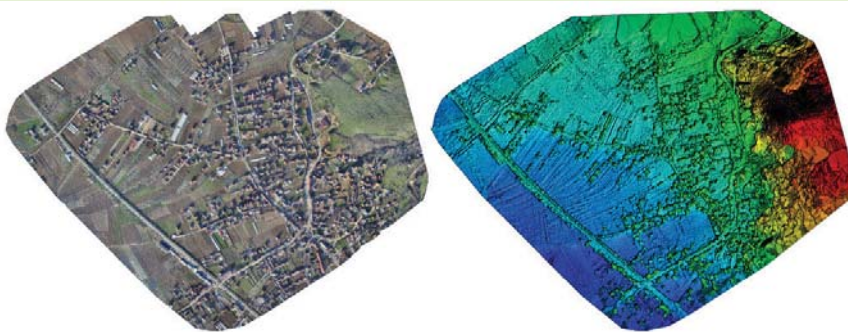
Summary		
Project	4dec-1-2	
Processed	2015-12-07 08:25:55	
Average Ground Sampling Distance (GSD)	3.91 cm/1.54 in	
Area Covered	1.576 km ² /157.604 ha/0.6088 sq. mi./389.65 acres	
Quality Check		
🔍 Images	median of 62435 keypoint per image	✔
🔍 Dataset	640 out of 643 images calibrated (99%), all image enabled	✔
🔍 Camera Optimization	1.81% relative difference between initial and optimized internal camera parameters	✔
🔍 Matching	median of 11011.4 matches per calibrated image	✔
🔍 Georeferencing	yes, 8 GCPs (8 3D), mean RMS error = 0.032 m	✔
Preview		
		

Figure 6: Ortho-mosaic and the corresponding sparse Digital Surface Model (DSM) before densification

Image processing

Image processing was done automatically through the Post flight Terra 3D version 4.0.89 software. After the processing, along with the products, the software generated a quality report with some examples as explained in figure 6.

Ground Control Points

Localisation accuracy per GCP and mean errors in the three coordinates directions. The last column in Table 1 counts the number of calibrated images where the GCP has been automatically verified vs. manually marked.

Absolute Geo location Variance

Min Error and Max Error represent geolocation error intervals between -1.5 and 1.5 times, the maximum accuracy of all the images. Columns X, Y, Z in table 2 show the percentage of images with geolocation errors within the predefined error intervals. The geolocation error is the difference between the initial and computed image positions. Note that the image geolocation errors do not correspond to the accuracy of the observed 3D points.

Results of the project

The field recording with UAV technology was a new and special experience for experts and management of the Kosovo Cadastral Agency. This was done with concrete support from the World Bank to the Kosovo Cadastral Agency in

Table 1: Ground Control Points

GCP Name	Accuracy XY/Z [m]	Error X[m]	Error Y[m]	Error Z[m]	Projection Error [pixel]	Verified/Marked
km11 (3D)	0.020/0.020	-0.006	0.010	0.019	0.574	8/8
km12 (3D)	0.020/0.020	0.003	0.008	0.001	0.971	7/7
km3 (3D)	0.020/0.020	0.089	-0.042	0.015	0.811	7/7
km4 (3D)	0.020/0.020	-0.037	0.060	0.003	0.966	17/17
km5 (3D)	0.020/0.020	-0.016	-0.032	-0.009	1.123	22/22
km6 (3D)	0.020/0.020	0.005	-0.065	0.001	1.185	19/19
km7 (3D)	0.020/0.020	0.067	0.012	0.010	1.159	8/8
km8 (3D)	0.020/0.020	-0.076	0.046	0.015	0.469	6/6
Mean [m]		0.003586	-0.000134	0.006772		
Sigma [m]		0.049651	0.040238	0.008862		
RMS Error [m]		0.040238	0.040238	0.011153		

Table 2: Absolute Geolocation Variance

Min Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-5.32	0.00	0.00	0.00
-5.32	-4.26	0.00	0.00	0.00
-4.26	-3.19	0.16	0.00	0.00
-3.19	-2.13	0.00	0.31	0.00
-2.13	-1.06	3.75	4.38	10.31
-1.06	0.00	48.91	44.53	44.53
0.00	1.06	42.50	45.16	35.47
1.06	2.13	4.69	5.47	7.50
2.13	3.19	0.00	0.16	1.56
3.19	4.26	0.00	0.00	0.16
4.26	5.32	0.00	0.00	0.47
5.32	-	0.00	0.00	0.00
Mean [m]		0.323378	1.340779	-51.620312
Sigma [m]		0.643864	0.685550	0.893175
RMS Error [m]		0.720510	1.505877	51.628039

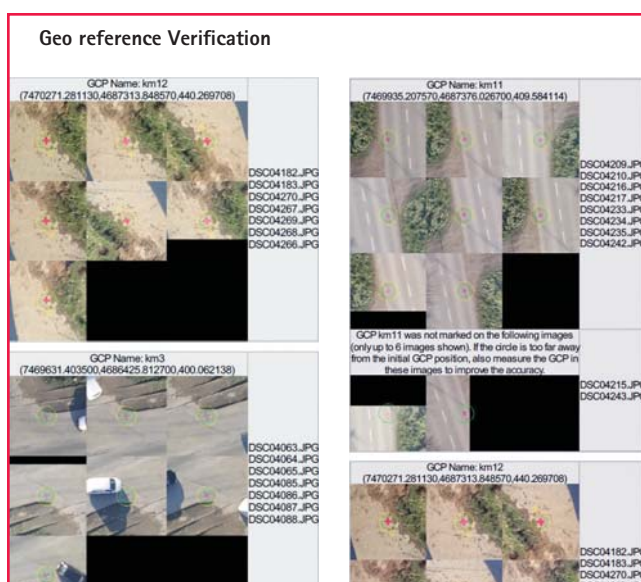


Figure 7: GCP – Geo-reference verification

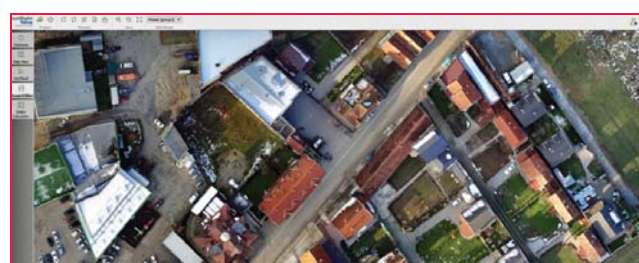


Figure 8: Orthophoto (3 cm image Resolution, 1 cm accuracy)

order to test the innovative approaches for the cadastre development in the Republic of Kosovo and beyond.

During the first phase in December 2015, after finalizing the processing of data, orthophotos were created with a resolution of 3 to 6 cm and with an accuracy of up to 1 cm. Whereas during the second phase, in April 2016 in Cadastral Zone of Krusha e Madhe where created new orthophoto by using the Drone without GPS/RTK and for same area was used Drone with GPS/RTK. Also it was used the thermal camera to create orthophotos for agricultural needs. The produced orthophotos from 2016 will be used in the second phase of

the digitization of cadastral units based on these orthophotos as well as their decoding, door to door along with the owners and members' of the community input. A pilot for a block of parcels using both decoding and OSS-an application produced by Cadasta (Cadasta Foundation is dedicated to the support, continued development and growth of the Cadasta Platform – an innovative, open source suite of tools for the collection and management of ownership, occupancy, and spatial data that meets the unique challenges of this process in much of the world.) which is for data collection based on the filed form that is being used during Cadastre reconstruction, shall be implemented.

the pilot project which consists in the reconstruction of the cadastral information on the part of cadastral zone Krusha e Madhe and Ferizaj. This process will continue with

Another result is the DSM (Digital Surface Model). This product enables the creation of the 3D orthophotos. The UAV method allows for the derivation of much more information. Based on the image orientation, a digital elevation model of different grid and area sizes can be calculated. In addition, 3D models of objects such as buildings can be generated based on the captured UAV data.

The final textured model can be exported as VRML (Virtual Reality Modelling Language) for general 3D viewers or as a KMZ file for display in Google Earth.

As part of this pilot project 1,581 ha were recorded in four different zones including: urban, rural and archaeological zone as well as in a part of a highway that is under construction.

Sixty-nine GCPs were previously marked in all these zones, whereby the largest part is in Krusha e Madhe, which also includes the largest surface for which surface images were taken.



Figure 9: Examples from transparent mosaics: a) rural area, b) archaeological site, c) new road and d) urban area

The resolution of the images was determined depending on the part where the drone flight took place, starting from 1.9 cm for the archaeological part and up to 4 to 6 cm for the rural part in the cadastral zone Krusha e Madhe. The total number of images taken after completion of all flights of all planned zones is 11,315 images.

The analysis of the produced data to be used for the cadaster purposes

The use of the UAV technology and Open Source Software in this pilot project was initiated in order to analyse whether these products (orthophotos) offer accuracy according to the tolerances determined by

Table 3: Statistics for surveyed zones in the project from December 2015

Site	Area (ha)	Area (km ²)	Size	#GCP	resolution	#images
Archaeology site	20	0.2	0.5km of road	5	1.9cm	283
New Road	83	0.8	0.55*1.5km dist.	7	2cm	640
Ferizaj (urban)	293	2.9	2.2km long(N-S)	16	3cm	1260
Krusha e madhe (rural)	1185	11.9	(ca5.5*2.5km)	41	4-6cm	9132
Total sum:	1581	15.8		69		11315

the Law and Administrative Instruction for use in the cadastre in Kosovo.

The selection of the cases was conducted for analyses from orthophotos from two locations: Ferizaj and Krusha e Madhe. In these cases the elements such as: the boundaries of the parcels, fences, walls, pavements, white lines on the road, houses etc., were manually digitized in orthophotos. Furthermore the selected cases and the digitized ones were measured in the field with GPS/GNNS, whereas the houses were measured with Total Station.

On location 1 (Ferizaj) are measured 176 points as shown above. As can be seen from the sketches there are measured houses, walls, fences, sidewalks, electrical poles, pits.

The measurements in the field are compared to the similar points digitized in orthophotos.

in the field are compared to the similar points digitized in orthophotos.

On the walls, fences, white lines the difference is between 2cm and 10cm. On the buildings the minimum difference is 20cm.

Based on the "Framework No. KCA 2013/02 on the Standardisation of Measurements and Cadastral Surveys" "article 6, "Standard deviation of measurements and cadastral surveys"

Standard deviation (σ) is the unit for assigning the accuracy of the geodetic measurements which is also applied in the measurements as well as in the cadastral surveys. The coordinate accuracy for the first order point and for the permanent station of KOPOS reference has been specified in the standard deviation (σ) on the field categories as mentioned in table 4.



Figure 10: Example from Ferizaj



Figure 11: Images from Krusha e Madhe

On the walls, fences, sidewalks, poles the difference is between 1 cm and 5cm, on the buildings the difference is 7cm.

On location 2 (Krusha e Madhe) there are measured 181 points. As seen in the sketches above there are houses, walls, train rails, white lines on the road and stadiums. The measurements

The preliminary results do not fully comply with the Framework No. KCA 2013/02, therefore, at the beginning of April, a new flight took place with another model of drone equipped with GPS/RTK. The products/orthophotos gained with this new methodology, are used for the second phase of the project which is: Reconstruction of Cadastral Information with UAV and Open Source Software technology that is aiming to identify properties based on the orthophoto-products gained through this technology.

Lessons learned

There were several lessons learned at various stages of the implementation of this project:

Table 4: The coordinate accuracy for the first order point and for the permanent station of KOPOS reference has been specified in the standard deviation (s) on the field categories

Category	Standard deviation (σ) on the horizontal level	Description
1	Coordinates are treated "no errors"	First order referent point and permanent station of KOPOS reference
2	$\sigma \leq 15$ mm	Second order referent point
3	$\sigma \leq 20$ mm	Third order referent point
4	$\sigma \leq 25$ mm	Additional stabilized point for further detailed measurements.
5	$\sigma \leq 30$ mm	Detailed point for the cadastral unit in urban area
6	$\sigma \leq 50$ mm	Detailed point for the cadastral unit in rural area
7	$\sigma \leq 100$ mm	Detailed point for the cadastral unit in mountain area

Preparation stages:

a. Acquiring permission for flights: it was important to determine the authorities from whom the team needed permission for the flights to take place. Additionally, it was helpful to know the timelines by which such permissions were given in order to begin communication with the local population as well as necessary officials in the zones before

and during flying for permission to use land such as airports, etc.

b. Work Flow: it is necessary to set up Ground Control Points (GCPs) 1 to 2 days before flying. It is also important to have flight planning considerations (such as climate, etc.) as well as the ideal team members participating.

c. Data Processing: there must minimum "Big Data" processing and storage

requirements that need to be planned for and met. For example, in the team's case the initial KCA computer that was set up was too small and slow. There need to be considerations for processing times as well as setting up the workflow by thinking about what is done automatically by the program and what needs manual input.

External factors

In order to use an UAV in the Cadastre, it is important to select the period of the year when the vegetation is at a minimum. The most suitable time is in the early spring or autumn. On the other hand, in these periods of time the atmospheric conditions may not be stable, as was the case with the pilot Project in Krushe e Madhe. In that case due to the fog, the team had some daily delays and was not able to perform the flight on the given days.

"Marking the boundary of parcels"

To have the best benefits from UAV for Cadastre it is better to have an Awareness

LINERTEC

LGP-300 Series
WinCE Reflectorless
Total Station

LTS-200 Series
Reflectorless
Total Station

LTH-02/05
Electronic
Theodolite

LGN-200 GNSS

A-100 Series
Automatic
Level

**Cutting-Edge Technology
at an Affordable Price**

TI Asahi Co., Ltd.

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Contact in India: Premier Optical Pvt. Ltd. - poplpremier@gmail.com

Campaign for several weeks, with owners/users of parcels. The Awareness Campaign would be used as a tool to inform and request from owners/users to mark and color the boundary points of parcels. After marking the boundaries, the flight could take place and from the orthophoto gained the boundaries will be easily identify by the owners/users.

Findings and conclusions

Time and cost savings - The advantage of UAV systems is the ability to quickly observe the surface of areas at low flying altitude while still meeting the accuracy requirements and standards of the Cadastre in Kosovo. For example the ortho image with high accuracy was produced for a part of the cadastral zone of Ferizaj within 24 hours. About 293 hectare are surveyed and processed up to the final product. Usually when surveying with the conventional methods using GNSS technology for the same size area, would have taken up to 10 working days, assuming the atmospheric conditions permitted.

Additionally even though the team's initial work was focused on integrating UAVs into the cadastral mapping process, they received a spontaneous request for assistance by the highway authorities. A municipal representative informed them that a road crew had recently found an archaeological site near a highway under construction. The available aerial imagery at the time provided no evidence of the site. The team quickly mobilized the drone to produce a high resolution 3D map of the area in less than 24 hours. This provided fresh and accurate information for rerouting the road, additional land acquisition needs, cultural heritage preservation and other important decision making issues.

UAVs are rapidly becoming an effective tool for mapping in many diverse scenarios and the work in Kosovo demonstrates only a few examples of their potential. Therefore, by using the UAV technology these projects will be accomplished by spending less time and with more quality within the tolerances set by the law on cadaster and administrative instructions for the Reconstruction of the Cadastral Information.

Local Capacity and Production:

Moreover, the Kosovo Cadastral experts have been introduced for the first time to a new technology for the needs of cadaster. They are also trained to use this new technology starting from planning, surveying and processing of data offered by this technology.

“Fit for Purpose mapping”- A new way to envision national mapping and systematic registration programs:

The UAV technology is an easy procedure which is easily transferable to local experts and the processing and production of final orthophotos can be handled locally as well. The beneficiary organizations can, in a straightforward manner, update the information for smaller areas with local capacities, instead of using big international contracts, which are used mainly for national level aerial photography.

“On demand” services for multiple sectors: UAV technology is flexible and has the potential for multiple uses across diverse sectors. This can be seen in an example in this very project where the team was able to mobilize quickly to account for the archeological site discovered during the high infrastructure project. Additionally, UAVs produce richer data: DEM and 3D models, which will help build up KCA's NSDI for both public and private sector benefit.

Beyond the Kosovo Cadastral Agency's use of this technology, the UAV measurements can present a great benefit to other users of cadastral data, such as private licensed surveyors, real estate agencies, insurance companies etc. In areas where access can be difficult, UAVs can offer a valuable alternative to conventional measurement equipment such as the total stations and Kosovo Positioning System (KOPOS). In the future, UAVs will be used where a need for high accuracy is required and fast data capturing is needed. Therefore, the use of UAVs is an opportunity for cadastral surveying in the future.

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The Geospatial Information Regulation Bill, 2016 (Draft)

The Government of India has prepared the draft of "The Geospatial Information Regulation Bill, 2016". Please share your views on this at talktous@mycoordinates.org

A Bill to regulate the acquisition, dissemination, publication and distribution of geospatial information of India which is likely to affect the security, sovereignty and integrity of India and for matters connected therewith or incidental thereto;

Be it enacted by the Parliament in the Sixty-Seventh Year of the Republic of India as follows:-

Chapter I: Preliminary

1. Short title, extent, commencement and application.

- (1) This Act may be called the Geospatial Information Regulation Act, 2016.
- (2) It shall extend to the whole of India and it applies also to-
 - (a) citizens of India outside India;
 - (b) persons in the service of the Government, wherever they may be; and
 - (c) persons on ships and aircrafts, registered in India, wherever they may be.
- (3) Every person shall be liable to punishment under this Act for every act or omission contrary to the provisions thereof, of which he is held guilty in India.
- (4) Any person, who commits an offence beyond India, which is punishable under this Act, shall be dealt with according to the provisions of this Act in the same manner as if such act had been committed in India.
- (5) It shall come into force on such date as the Central Government may, by notification, appoint and different dates may be appointed for different provisions of this Act and

any reference in any such provision to the commencement of this Act shall be construed as a reference to the commencement of that provision.

2. Definitions

- (1) In this Act, unless the context otherwise requires,-
 - (a) "*Apex Committee*" means a Committee constituted by the Central Government under sub-section (1) of section 7;
 - (b) "*Appellate Authority*" means an Authority constituted by the Central Government under sub-section (1) of section 23;
 - (c) "*Computer resource*" the term 'computer resource' shall have the meaning assigned to it in clause (k) of sub-section (1) of section 2 of the Information Technology Act, 2000;
 - (d) "*Enforcement Authority*" means an Authority constituted by the Central Government under sub-section (1) of section 17;
 - (e) "*Geospatial Information*" means geospatial imagery or data acquired through space or aerial platforms such as satellite, aircrafts, airships, balloons, unmanned aerial vehicles including value addition; or graphical or digital data depicting natural or man-made physical features, phenomenon or boundaries of the earth or any information related thereto including surveys, charts, maps, terrestrial photos referenced to a co-ordinate system and having attributes;
 - (f) "*Guidelines*" means the guidelines framed under this Act and the rules or regulations thereunder for licensing of geospatial information of India;
 - (g) "*Licence*" means a licence granted to a person under the provisions of this Act
 - (h) "*Licensee*" means a person who obtains a licence under the provisions of this Act;
 - (i) "*National Policies*" means the prevailing policies of the Government such as Remote Sensing Data policy, Map Policy and such other policies related to the objective of this Act;
 - (j) "*Person*" includes;-
 - i. an individual,
 - ii. a company,
 - iii. a firm,
 - iv. a trust,
 - v. an association of persons or a body of individuals, whether incorporated or not
 - vi. every artificial juridical person, not falling within any of the preceding sub-clauses, and
 - vii. any agency, office or branch owned or controlled by any of the above persons mentioned in the preceding sub-clauses
 - (k) "*Prescribed*" means prescribed under the rules or regulations framed under this Act;
 - (l) "*Rules*" means the rules framed under this Act;
 - (m) "*Regulations*" means the regulations framed under this Act and the rules thereunder;
 - (n) "*Security Vetting Authority*" means an Authority constituted by the Central Government under sub-section (1) of section 8;
 - (o) "*Security Vetting of Geospatial Information*" means a process followed by the Vetting Authority, which inter-alia includes i) conducting sensitivity checks

with respect to the technical & information contents and the target area in consonance with the provisions of the prevailing National Policies and ii) screening of the credentials of the end-users and end-use applications, with the sole objective of protecting national security, sovereignty, safety and integrity

- (2) Any reference in this Act to any enactment or any provision thereof shall, in relation to an area in which such enactment or such provision is not in force, be construed as a reference to the corresponding law or the relevant provision of the corresponding law, if any, in force in that area.

Chapter II: Regulation of geospatial information of India

3. Acquisition of Geospatial Information of India

- (1) Save as otherwise provided in this Act, rules or regulations made thereunder, or with the general or special permission of the Security Vetting Authority, no person shall acquire geospatial imagery or data including value addition of any part of India either through any space or aerial platforms such as satellite, aircrafts, airships, balloons, unmanned aerial vehicles or terrestrial vehicles, or any other means whatsoever.
- (2) Every person who has already acquired any geospatial imagery or data of any part of India either through space or aerial platforms such as satellite, aircrafts, airships, balloons, unmanned aerial vehicles or terrestrial vehicles or any other manner including value addition prior to coming of this Act into effect, shall within one year from the commencement of this Act, make an application along with requisite fees to the Security Vetting Authority for retaining such geospatial information and grant of licence thereof.
- (3) The Security Vetting Authority shall, within three months from the date of receipt of an application made under sub-section (2), either grant a licence with such conditions as may be specified thereon or reject

the application as the case may be after examining the application in terms of the guidelines:

Provided that no application shall be rejected under this section unless the applicant has been given a reasonable opportunity of presenting his case.

- (4) No person shall continue possession of geospatial information of India, after rejection of the application by the Security Vetting Authority under sub-section (3) above or after dismissal of appeal, if any, by the Appellate Authority or the High Court or the Supreme Court, as the case may be, whichever is later

4. Dissemination, Publication or Distribution of the Geospatial Information of India

Save as otherwise provided in this Act, rules or regulations made thereunder, and with the general or special permission of the Security Vetting Authority, no person shall disseminate or allow visualization of any geospatial information of India either through internet platforms or online services, or publish or distribute any geospatial information of India in any electronic or physical form.

5. Use of Geospatial Information of India outside India

Save as otherwise provided in any international convention, treaty or agreement of which India is signatory or as provided in this Act, rules or regulations made thereunder, or with the general or special permission of the Security Vetting Authority, no person shall, in any manner, make use of, disseminate, publish or distribute any geospatial information of India, outside India, without prior permission from the Security Vetting Authority.

6. Wrong depiction of map of India etc.

No person shall depict, disseminate, publish or distribute any wrong or false topographic information of India including international boundaries through internet platforms or online services or in any electronic or physical form.

Chapter III: Apex Committee

7. Apex Committee

- (1) The Central Government shall, by notification in Official Gazette, constitute an Apex Committee under the Ministry of Home Affairs to oversee and administer the implementation of this Act in accordance with the prevailing National Policies.
- (2) The Apex Committee shall do all such acts and deeds that may be necessary or otherwise desirable to achieve the objectives of the Act, including the following functions:
 - (a) To oversee and administer the implementation of this Act in accordance with the prevailing National Policies.
 - (b) To make Regulations for implementation, surveillance and monitoring and enforcement of the provisions of this Act and Rules framed thereunder, as required from time to time.
 - (c) To prescribe such fees, levies or charges and guidelines for licensing of geospatial information of India
- (3) The Apex Committee may, by general or special order in writing, delegate to any constituent member of the Apex Committee or any other subordinate committee or officer subject to such conditions, as may be specified in the order, such of its powers and functions under this Act as it may deem necessary, except the power to make regulations.
- (4) In the discharge of its functions, the Apex Committee shall be guided by such directions in matters of policy involving national security as well as public interest as the Central Government may give to it in writing.

Chapter IV: Licensing and Security Vetting

8. Security Vetting Authority

- (1) The Central Government shall, by notification in the Official Gazette, constitute a Security Vetting Authority to carry out security vetting of the Geospatial Information of India in a time bound

manner and as per the regulations framed by the Apex Committee.

- (2) The Security Vetting Authority shall consist of an officer of the rank of Joint Secretary to the Government of India or above as Chairman and two members, one, a technical expert and the other, a national security expert.
- (3) The Security Vetting Authority may, by general or special order in writing, delegate to any constituent member of the Security Vetting Authority or any other subordinate committee or officer subject to such conditions, as may be specified in the order, such of its powers and functions under this Act as it may deem necessary, except the power to determine whether a licence under the provisions of this Act, is to be granted or not.
- (4) In the discharge of its functions, the Security Vetting Authority shall be guided by such directions in matters of policy involving national security as well as public interest as the Central Government or the Apex Committee may give to it in writing.

9. Licence to acquire, disseminate, publish or distribute any Geospatial Information of India

- (1) Any person who wants to acquire, disseminate, publish or distribute any geospatial information of India, may make an application along with requisite fees to the Security Vetting Authority for security vetting of such geospatial information and licence thereof to acquire, disseminate, publish or distribute such Geospatial Information in any electronic or physical form.
- (2) The Security Vetting Authority, on receipt of an application made under sub- section (1) above and after examining the application in terms of the guidelines, shall either grant the licence or reject the application as the case may be: Provided that no application shall be rejected under this section unless the applicant has been given a reasonable opportunity of presenting his case.
- (3) A licence granted under sub-section (2) shall be subject to such terms and conditions as may be specified in the licence.

10. Suspension or revocation of licence

- (1) In case a licensee fails to comply with the terms and conditions subject to which the licence was granted or contravenes any provisions of this Act, rule, regulation or guidelines or order made thereunder, the Enforcement Authority may, after making such inquiry as may be thought fit, revoke the licence granted to such licensee: Provided that no licence shall be revoked unless the licensee has been given a reasonable opportunity of showing cause against the proposed revocation.
- (2) The Enforcement Authority, having reasonable cause to believe that there are grounds for revoking a licence under sub-section (1), may by order suspend such licence, pending the completion of any inquiry ordered by him: Provided that no licence shall be suspended for a period exceeding ten days unless the licensee has been given a reasonable opportunity of showing cause against the proposed suspension.

11. Obligations of Licensee

- (1) Licensee shall be supplied with the security- vetted Geospatial Information, by the Security Vetting Authority, within a period mutually agreed upon, based on the quantum and nature of the subject matter to be vetted, on best effort basis.
- (2) Licensee shall not acquire, publish, disseminate or distribute any geospatial information of India through any media or by any means, unless such geospatial information are security-vetted by the Security Vetting Authority.
- (3) Licensee shall display the insignia of the clearance of the Security Vetting Authority on the security-vetted geospatial information by appropriate means such as water-marking or licence as relevant, while disseminating or distributing of such geospatial information
- (4) Licensee shall indemnify the Security Vetting Authority for any consequential loss or damages whatsoever that might be caused to any person or agency in India or abroad, due to the use or supply of security vetted geospatial information.

Chapter V: Offences and Penalties

12. Penalty for illegal acquisition of geospatial information of India

Whoever acquires any geospatial information of India in contravention of section 3, shall be punished with a fine ranging from Rupees one crore to Rupees one hundred crore and/or imprisonment for a period up to seven years.

13. Penalty for illegal dissemination, publication or distribution of geospatial information of India

Whoever disseminates, publishes or distributes any geospatial information of India in contravention of section 4, shall be punished with a fine ranging from Rupees ten lac to Rupees one hundred crore and/or imprisonment for a period up to seven years.

14. Penalty for use of geospatial information of India outside India

Whoever uses any geospatial information of India in contravention of section 5, shall be punished with a fine ranging from Rupees one crore to Rupees one hundred crore and/or imprisonment for a period up to seven years.

15. Penalty for wrong depiction of map of India etc.

Whoever depicts, disseminates, publishes or distributes any wrong or false topographic information of India including international boundaries in contravention of section 6, shall be punished with a fine ranging from Rupees ten lac to Rupees one hundred crore and/or imprisonment for a period upto seven years.

16. Penalty for violation of terms and conditions of a licence

If a licensee violates the terms and conditions mentioned thereof, he shall be punished with a fine ranging from Rupees ten lac to Rupees one hundred crore and/or suspension or revocation of the licence and/or imprisonment for a period upto seven years.

Chapter Vi: Enforcement Mechanism

17. Enforcement Authority

- (1) The Central Government shall, by notification in Official Gazette, constitute an Enforcement Authority for enforcement of the provisions of this Act.
- (2) The Enforcement Authority shall consist of an officer of the rank of Joint Secretary to the Government of India or above as Chairman and two members, one as technical expert and other as national security expert.
- (3) The Enforcement Authority shall do surveillance and monitoring, as may be required to enforce the provisions of this Act and the rules and regulations framed thereunder.
- (4) The Enforcement Authority shall monitor compliance of the terms and conditions of the licences granted under this Act.
- (5) The Enforcement Authority may, by general or special order in writing, delegate to any constituent member of the Enforcement Authority or any other sub-ordinate Committee or officer subject to such conditions, as may be specified in the order, such of its powers and functions under this Act as it may deem necessary, except the power to determine whether a case is to be tried before a Court of Sessions or to determine the amount of financial penalty to be imposed by it on the violators of the provisions of this Act.
- (6) In the discharge of its functions, the Enforcement Authority shall be guided by such directions in matters of policy involving national security as well as public interest as the Central Government or the Apex Committee may give to it in writing.

18. Power to inquire contraventions

- (1) The Enforcement Authority shall make inquiry about any contravention of the provisions of this Act, rules or regulations made thereunder or terms and conditions of a licence granted under this Act.
- (2) The Enforcement Authority shall, if he has reasonable cause to suspect that any contravention of the provisions

of this Act, rules or regulations made thereunder has been committed, shall have access to any computer resource, any apparatus, data or any other material connected with such system, for the purpose of searching or causing a search to be made for obtaining any information or data contained in or available to such computer system.

- (3) For the purposes of sub-section (2), the Enforcement Authority, by order, direct any person in charge of, or otherwise concerned with the operation of, the computer system, data apparatus or material, to provide him with such reasonable technical and other assistance as he may consider necessary.

19. Power to adjudicate

- (1) The Enforcement Authority shall prima-facie assess the information gathered during surveillance and monitoring by it or received as a complaint from anyone and determine whether, having regard to the gravity of the offence and other relevant factors, it is a fit case which may attract the imposition of penalty of imprisonment also as prescribed in the Act or rules or regulations made thereunder. If so, the Enforcement Authority shall make a complaint to Police to investigate and prosecute the person before a Court of Sessions. If not, the Enforcement Authority shall adjudicate the case itself.
- (2) In respect of cases to be adjudicated by the Enforcement Authority, the Enforcement Authority after giving the defaulter a reasonable opportunity for making representation in the matter and if, on such inquiry, is satisfied that the person has committed the contravention, it may,
 - (a) confiscate all the computers resources and publications used for violation of the provisions of this Act; and/or
 - (b) impose such financial penalty as it thinks fit in accordance with the provisions of this Act and rules and regulations framed thereunder; and/or
 - (c) suspend or revoke licence as the case may be.
- (3) The Enforcement Authority shall have the powers of a civil court for the purposes of sections 345 and 346

of the Code of Criminal Procedure, 1973 and all proceedings before it shall be deemed to be judicial proceedings within the meaning of sections 193 and 228 of the Indian Penal Code;

20. Power of Enforcement Authority to give directions

- (1) The Enforcement Authority may, by order, direct a person to take such measures or cease carrying on such activities as specified in the order if those are necessary to ensure compliance with the provisions of this Act, rules or any regulations made thereunder.
- (2) Any person who fails to comply with any order under sub-section (1) shall be guilty of an offence and shall be liable on conviction to imprisonment for a term not exceeding three years or to a fine not exceeding rupees one crore or to both.

21. Compounding of contraventions

- (1) Any contravention under this Act may, either before or after the institution of Inquiry proceedings, be compounded by the Enforcement Authority subject to such conditions as the Enforcement Authority may specify: Provided that such sum shall not, in any case, exceed the maximum amount of the penalty which may be imposed under this Act for the contravention so compounded.
- (2) Nothing in sub-section (1) shall apply to a person who commits the same or similar contravention within a period of one year from the date on which the first contravention, committed by him, was compounded.
Explanation — For the purposes of this sub-section, any second or subsequent contravention committed after the expiry of a period of one year from the date on which the contravention was previously compounded shall be deemed to be a first contravention.
- (3) Where any contravention has been compounded under sub-section (1), no proceeding or further proceeding, as the case may be, shall be taken against the person guilty of such contravention in respect of the contravention so compounded.

22. Recovery of penalty

A penalty imposed under this Act, if fail in lieu of penalty, shall be recovered as an arrear of land revenue and the licence shall be suspended till the penalty is paid.

Chapter VII: Appellate Mechanism

23. Appellate Authority

- (1) The Central Government shall, by notification in Official Gazette, constitute an Appellate Authority to adjudicate the appeals against the decisions of the Security Vetting Authority or the Enforcement Authority as the case may be.
- (2) The authority shall consist of a retired Supreme Court/High Court Judge as Chairmen and two members, one as technical expert and other as national security expert.
Or
Nominate any existing judicial authority, such as National Company Law Appellate Tribunal (NCLAT), to be the appellate authority.

24. Appeal to Appellate Authority

- (1) Save as provided in sub-section (2), any person aggrieved by an order made by the Security Vetting Authority or by the Enforcement Authority under this Act may prefer an appeal before the Appellate Authority.
- (2) Every appeal under sub-section (1) shall be filed within a period of forty-five days from the date on which a copy of the order made by the Security Vetting Authority or by the Enforcement Authority is received by the aggrieved person and it shall be in such form and be accompanied by such fee as may be prescribed: Provided that the Appellate Authority may entertain an appeal after the expiry of the said period of forty-five days if it is satisfied that there was sufficient cause for not filing it within that period.
- (3) On receipt of an appeal under sub-section (1), the Appellate Authority may, after giving the parties to the appeal, an opportunity of being heard,

pass such orders thereon as it thinks fit, confirming, modifying or setting aside the order appealed against.

- (4) The appeal filed before the Appellate Authority under sub-section (1) shall be dealt with by it as expeditiously as possible and endeavor shall be made by it to dispose of the appeal finally within six months from the date of receipt of the appeal.

25. Procedure and powers of the Appellate Authority

- (1) The Appellate Authority shall not be bound by the procedure laid down by the Code of Civil Procedure, 1908 but shall be guided by the principles of natural justice and, subject to the other provisions of this Act and of any rules made thereunder. The Appellate Authority shall have the powers to regulate its own procedure including the place at which it shall have its sittings.
- (2) The Appellate Authority shall have, for the purposes of discharging its functions under this Act, the same powers as are vested in a civil court under the Code of Civil Procedure, 1908, while trying a suit, in respect of the following matters, namely:—
 - (a) summoning and enforcing the attendance of any person and examining him on oath;
 - (b) requiring the discovery and production of documents or other electronic records;
 - (c) receiving evidence on affidavits;
 - (d) issuing commissions for the examination of witnesses or documents;
 - (e) reviewing its decisions;
 - (f) dismissing an application for default or deciding it *ex parte*;
 - (g) any other matter which may be prescribed.
- (3) Every proceeding before the Appellate Authority shall be deemed to be a judicial proceeding within the meaning of sections 193, 196 and 228 of the Indian Penal Code and the Appellate Authority shall be deemed to be a civil court for the purposes of section 195 and Chapter XXVI of the Code of Criminal Procedure, 1973.

26. Court not to have jurisdiction

No court shall have jurisdiction to entertain any suit or proceeding in respect of any matter which an Appellate Authority constituted under this Act is empowered by or under this Act to determine and no injunction shall be granted by any court or other authority in respect of any action taken or to be taken in pursuance of any power conferred by or under this Act.

27. Appeal to High Court

Any person aggrieved by any decision or order of the Appellate Authority may file an appeal to the High Court within sixty days from the date of communication of the decision or order of the Appellate Authority to him on any question of fact or law arising out of such order:

Provided that the High Court may, if it is satisfied that the appellant was prevented by sufficient cause from filing the appeal within the said period, allow it to be filed within a further period not exceeding sixty days.

28. Prompt disposal of Appeals

Appeal filed, if any, before any of the Appellate bodies namely the Appellate Authority, the High Court or the Supreme Court shall be dealt with as expeditiously as possible and the endeavor shall be to dispose of the appeal within six months from the date of receipt of the appeal at each stage, viewing the security concerns of India.

Chapter VIII: Miscellaneous

29. Cognizance of offences by Court

No court shall take cognizance of an offence under this Act unless upon a complaint made by the order of the Enforcement Authority as defined in the clause (d) of sub-section (1) of section 2.

30. Offences by companies

- (1) Where a person committing a contravention of any of the provisions of this Act or of any rule, direction or

order made thereunder is a company, every person who, at the time the contravention was committed, was in charge of, and was responsible to, the company for the conduct of business of the company as well as the company, shall be guilty of the contravention and shall be liable to be proceeded against and punished accordingly: Provided that nothing contained in this sub-section shall render any such person liable to punishment if he proves that the contravention took place without his knowledge or that he exercised all due diligence to prevent such contravention.

- (2) Notwithstanding anything contained in sub-section (1), where a contravention of any of the provisions of this Act or of any rule, direction or order made thereunder has been committed by a company and it is proved that the contravention has taken place with the consent or connivance of, or is attributable to any neglect on the part of, any director, manager, secretary or other officer of the company, such director, manager, secretary or other officer shall also be deemed to be guilty of the contravention and shall be liable to be proceeded against and punished accordingly.

Explanation.—For the purposes of this section,—

- (i) "Company" means anybody corporate and includes a firm or other association of individuals; and
- (ii) "Director", in relation to a firm, means a partner in the firm.

31. Power to make rules

- (1) The Central Government may, by notification, make rules to carry out the provisions of the Act.
- (2) In particular, but without prejudice to the generality of the provision of sub-section (1) above, such rules may provide for all or any of the following matters, namely:—
- (a) The criteria and procedure for constitution of the Apex Committee, Security Vetting Authority, Enforcement Authority and Appellate Authority;
 - (b) the manner and procedure in which the function is to be discharged

by the members, officers and other employees of the Apex Committee, Security Vetting Authority, Enforcement Authority and Appellate Authority;

- (c) the term of office, salary, allowances and other terms and conditions of service of the Chairman and the Members of the Appellate Authority.

32. Rules and regulations to be laid before Parliament

- (1) Every rule made by the Central Government and every regulation made by the Apex Committee under this Act shall be laid, as soon as may be after it is made, before each house of Parliament, while it is in session, for a total period of thirty days which may be comprised in one session or in two or more successive sessions, and if, before the expiry of the session immediately following the session or the successive sessions aforesaid, both houses agree in making any modification in the rule or the regulation or both houses agree that the rule should not be made, the rule shall thereafter have effect only in such modified form or be of no effect, as the case may be; so however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule/regulation.
- (2) Nothing in this Act shall affect the activities of the Central Government in the discharge of its functions relating to the security or the defence of India.
- (3) No suit, prosecution or other legal proceeding shall lie against the Central Government or Apex Committee or Security Vetting Authority or Enforcement Authority, on whom powers have been conferred pursuant to this Act, for anything which is done or purported to be done in good faith in pursuance of this Act or for any rule or regulation made under this Act.

33. Act to have overriding effect

The provisions of this Act shall have effect notwithstanding anything inconsistent therewith contained in any other law for the time being in force.

34. Chairman, Members and Employees of the Apex Committee, Security Vetting Authority, Enforcement Authority and Appellate Authority to be public servants

Chairman, Members, and Employees of the Apex Committee, Security Vetting Authority, Enforcement Authority and Appellate Authority shall be deemed to be public servants within the meaning of section 21 of the Indian Penal Code.


35. Protection of action taken in good faith

No suit, prosecution or other legal proceeding shall lie against the Central Government, the Apex Committee, the Security Vetting Authority, the Enforcement Authority or the Appellate Authority or any person acting on behalf of them, for anything which is in good faith done or intended to be done in pursuance of this Act or any rule, regulation or order made thereunder.

36. Removal of difficulties

- (1) If any difficulty arises in giving effect to the provisions of this Act, the Central Government may, by order published in the Official Gazette, make such provisions not inconsistent with the provisions of this Act as appear to it to be necessary or expedient for removing the difficulty: Provided that no order shall be made under this section after the expiry of a period of two years from the commencement of this Act.
- (2) Every order made under this section shall be laid, as soon as may be after it is made, before each House of Parliament.

37. Act not to apply to Indian Governmental Bodies

The Central Government may, by notification in Official Gazette, exempt the Ministries, Departments, Public Sector Enterprises or any other attached or subordinate offices of the Central Government or State Governments from the provisions of this Act to the extent it deems fit. 

Sentinel-1B on its way to complete Europe's "RadarVision"

Airbus Defence and Space built C-Band radars will monitor the environment around the clock in all weathers Europe's Earth Observation satellite Sentinel-1B, built by Thales Alenia Space as prime contractor and carrying an Airbus Defence and Space built radar instrument, is on its way to complete the Copernicus radar constellation. Once activated, it will operate jointly with its twin, Sentinel-1A (launched in April 2014) and form the Sentinel-1 polar orbiting constellation, which will significantly improve revisit and response times to provide continuous all-weather round the clock imagery for marine, land monitoring and emergency services. www.airbusdefenceandspace.com

MicroCarb to map CO₂ levels

CNES, the French Space Agency, has awarded Airbus Defence and Space, a contract to design and build the optical instrument for MicroCarb, a microsatellite to map global carbon dioxide levels. After launch in 2020, the satellite will study carbon dioxide sources (which produce CO₂) and sinks (which absorb it) to understand how this greenhouse gas is affecting climate change. MicroCarb will be the first European mission dedicated solely to measuring CO₂ levels using a spectrometer scanning at visible and near infra-red wavelengths.

Brock Gold Medal for Prof. Wolfgang Förstner

The International Society for Photogrammetry and Remote Sensing (ISPRS) has announced that Prof. Wolfgang Förstner of Bonn University, Germany, will be presented with the 2016 Brock Gold Medal Award for his outstanding scientific achievements in the fields of photogrammetry and computer vision. Professor Förstner is an internationally leading expert in photogrammetry, computer vision, pattern recognition and machine learning. Throughout his exemplary career of nearly 40 years as a researcher, inventor, innovator and educator, he has made exceptionally significant

scientific contributions in many areas of *Information from Imagery* and mentored generations of mapping scientists and engineers. Examples of his work include blunder detection for aerial triangulation, image matching, object recognition and statistical projective geometry.

MDS univ. to carry out digital mapping

The Ministry of Human Resource Development has chosen the department of remote sensing, Maharishi Dayanand Saraswati University in Ajmer to carry out a detailed digital mapping of two cities—Jodhpur and Kota recently. The department of remote sensing established in 2002 is the only one in the state running UG and PG programmes. <http://timesofindia.indiatimes.com>

Philippines deploys DIWATA-1

The Japan Aerospace Exploration Agency (JAXA), Tohoku University, Hokkaido University, the Department of Science and Technology (DOST) of the Republic of the Philippines, and the University of the Philippines Diliman have successfully deployed DIWATA-1 satellite in the space - first microsatellite of Philippines. JAXA also deployed a 50 kg-class microsatellite from the ISS Japanese Experiment Module "Kibo". This was also the first success for JAXA to deploy a 50 kg-class microsatellite from the ISS Japanese Experiment Module "Kibo".

DigitalGlobe delivers first phase of continent-scale mapping for PSMA

DigitalGlobe has completed the first phase of a continent-scale mapping initiative that will enable Geoscape, a new information product from PSMA Australia, to support Australia's digital economy. Under the second phase, DigitalGlobe will leverage a range of geospatial technologies to map the locations and characterize the physical attributes of more than 15 million structures spread across the entire continent of Australia. When completed, Geoscape will provide a comprehensive view into the location, distribution, and characteristics of structures around the entire continent with unprecedented fidelity. DigitalGlobe.com

Imaginary mobile devices to deceive location-based apps

Researchers from the University of California, Santa Barbara have uncovered a hacking technique that could allow bad actors to sabotage location-based mobile apps — including the maps and navigation app Waze — by simulating large number of mobile devices that don't actually exist.

According to a new report, hackers can use malicious "Sybil" scripts, which appear to application servers as "virtual mobile devices," to overload mobile services with fake traffic, in what is for all intents and purposes a distributed denial of service (DDoS) attack. Furthermore, by generating fake traffic, adversaries can also supply false data to location-based apps that rely on crowdsourced data from its active user base. In the case of Waze, the researchers were actually able to create imaginary traffic jams and road congestion on various highways, which theoretically could have caused the app to reroute genuine users on unwanted detours. (Researchers conducted these tests in the middle of the night and halted operations whenever a genuine user was within 10 miles of an affected area.)

Chinese driverless cars tests begin, aim to beat Google car

Two driverless cars produced by a Chinese automobile company began a 2,000-kilometre test drive in a bid to steal a march over US giant Google, which hopes to release its self-driving cars to the public by 2020. Li Yusheng, engineer-in-chief of Chang'an Automobile Engineering & Research Institute, said the drive will help test their functions in diverse conditions. "We want to improve the vehicles' sensors and processing technology, and then to prepare models for mass production," Tan Benhong, deputy director of the institute was quoted as saying by the state-run Xinhua news agency.

Chang'an aims to put its driverless cars into commercial use in 2018. They are expected to pose a competition to Google's self-driving cars currently under development. Google's cars have

already travelled over 1 million miles without anyone at the wheel. The internet search company hopes the vehicles will be released to the public in 2020. <http://timesofindia.indiatimes.com>

Google Maps gets live traffic alerts in India

The navigation mode of Google Maps has turned the free app into an invaluable tool for hundreds of millions of drivers worldwide. Now, drivers on India's notoriously congested roads can use Google Maps to steer away from the worst jams, in real time. When users enter a destination, the app warns them about any segments with heavy traffic on route. Based on the explanation, users are able to pick alternate routes that are longer, but may actually be more convenient. www.androidauthority.com

Malaysia introduces professional title "Geospatialist"

The Institution of Geospatial and Remote Sensing Malaysia (IGRSM) has recently introduced the Geospatialist (Gs) title to its members. The title is part of an initiative by IGRSM to increase recognition of the role of geospatial practitioners in both public and private sectors. According to IGRSM's constitution, the minimum requirements for a Malaysian geospatial practitioner to be eligible to use the title Gs is minimum qualification of degree in Geospatial or related fields; and at least 3 years of professional experience or equivalent in the field of Geospatial.

Pune, India starts GIS-enabled tree census

The Pune Municipal Corporation (PMC) started a high-tech tree census to track the location, type and other details of every tree in the city. PMC will use GIS to effectively map and enumerate the trees. The census data will be available to citizens at a click of the mouse. Citizens will also be able to send suggestions and objections regarding the data and the administration make changes based on these, if needed. <http://timesofindia.indiatimes.com>

India unlikely to budge on GPS diktat for mobile phones

Telecom minister of India Ravi Shankar Prasad has reiterated that all new mobile phones will have a panic button starting January 2017 and in-built GPS from January 2018, but added that the telecom department will discuss all issues with the industry to allay any apprehensions.

The statement comes after handset makers raised concerns that GPS installations in featurephones will lead to a significant increase in costs. Handset makers though have backed the implementation of panic buttons in all new phones from January 2017 onwards that is much needed for ensuring women safety. Starting January, all smartphones will have a panic button while the department has identified numeric keys 5 and 9 as push buttons for an emergency in feature phones. <http://articles.economictimes.indiatimes.com>

Russia opens 4th Monitoring Station in Brazil

The ground stations are used to trace signals from the GLONASS constellation as well as those of similar networks – GPS, Galileo and Compass. The input is then processed and transmitted to the global analytic center for high-precision information. <http://sputniknews.com/science>

Russian Aerospace University release new GPS Easy Suite

Kai Borre, now a professor and senior researcher at Russia's Samara State Aerospace University, has released a new version of Easy Suite, a collection of Matlab-based scripts and explanatory text that illustrated a variety of common GPS issues.

Borre, a geodesist who founded and directed the Danish GPS Center for many years, based the first collection of Easy Suite files on RINEX version 2.10. Over the years he received many requests for a code that starts from RINEX version 3.03. In the intervening time, Matlab had also changed and now includes new

relevant commands. So, Borre decided to update the files with a code based on Matlab version 8.5 (R2015a). Samara State Aerospace University supported Borre's efforts, which were undertaken from last August to February of this year.

GPS/GLONASS development kit with patch antenna evaluation board

Available from RS Components, the L86 evaluation board offers an effective and complete interface of the Quectel L86 GNSS module with a patch antenna and a computer. The module has an embedded patch antenna (18.4mm × 18.4mm × 4mm) and LNA brings high performance of MTK positioning engine to industrial applications. It is able to achieve the industry's highest level of sensitivity, accuracy and TTFF with the lowest power consumption in a small-footprint lead-free package. The embedded flash memory provides capacity for users to store some useful navigation data and allows for future updates. www.electropages.com/

EU approves new rule on personal data protection, including Geolocation

The European Parliament has approved new rules on personal data — including geolocation — that create a high, uniform level of data protection across the European Union. The measure also sets minimum standards on use of data for policing and judicial purposes. The reform will replace the current data protection directive, dating back to 1995. The new rules include provisions that require "clear and affirmative consent" to the processing of private data by the person concerned, ensure that privacy policies are explained in clear and understandable language, and enact stronger enforcement and fines up to four percent of company's total worldwide annual turnover, as a deterrent to breaking the rules. The data protection package also includes a directive on data transfers for policing and judicial purposes. It will apply to data transfers across borders within the EU as well as, for the first time, setting minimum standards for data processing for policing purposes within each member state.

SpaceX wins its first national security launch contract

SpaceX has won an \$82.7 million contract to launch a GPS-3 navigational satellite into orbit for the U.S. Air Force, marking the first national security mission for the California-based company. The award was virtually in the bag for SpaceX because United Launch Alliance, the only other company certified to launch national security payloads, dropped out of the competition last November. www.geekwire.com

S Korea tells U.N. about North Korea GPS jamming threats

North Korea has been jamming GPS signals in South Korea since March 31, threatening the safety of civilian aircraft and vessels and violating international agreements, Seoul told the UN Security Council.

South Korean U.N. Ambassador Oh Joon said the electronic jamming signals have come from five North Korean regions - Haeju, Yonan, Pyongyang, Kumgang and Kaesong - and "dangerously affect" the Global Positioning System. "The GPS jamming by DPRK (North Korea) is an act of provocation that poses a threat to the security of the Republic of Korea and undermines the safety of civil transportation, including aircraft and vessels," Oh wrote in the April 5 letter. www.reuters.com

China Launches BeiDou IGSO Spacecraft

China has launched another second-generation BeiDou Navigation Satellite System (BDS) satellite, the 22nd in the nation's GNSS program. The satellite launched from the Xichang Satellite Launch Center in the southwestern province of Sichuan on March 29 local time on board a Long March-3A carrier rocket.

This is the second BDS launch this year, following one on February 1 that placed a middle-Earth-orbit (MEO) into the constellation.

SOYUZ-2.1B • GLONASS-M

Next Glonass-M Satellite launch scheduled in 2016 from Plesetsk Cosmodrome. It will be very similar launch to this from February 7, 2016 – Soyuz-2.1B again will be equipped in Fregat-M upper stage. Glonass-M is made by NPO Prikladnoi Mekhaniki (present name is Reshetnev Information Satellite Systems) and is equipped with L band transponder and cesium clocks and powered by two deployable solar arrays. It will be positioned on orbit of 19100 km × 19100 km with inclination at 64.8° and remain in space for at least 7 years. Glonass-M series is designed to replace Glonass-K1 and Glonass-K2 satellite. www.military-technologies.net

Roscosmos establishes GLONASS development department

The leadership of the Roscosmos State Corporation has established the department of navigation space systems to coordinate the resolution of all tasks connected with the development and use of the GLONASS, the Izvestia daily reported citing the Roscosmos press service. <http://tass.ru/en>

Satellites to keep Japanese connected when disaster strikes

Japan plans to build a satellite-based communications network that would fill in when a natural disaster knocks out regular systems. Several GPS satellites would transmit text data between survivors, municipalities and other parties.

The government intends to employ a set of satellites that go by the name Michibiki. The first of these is already in orbit. Three more Michibikis are to be launched by the first half of fiscal 2017 -- the year through March 2018 -- followed by another trio by fiscal 2023. This fleet will give Japan its own accurate GPS system. But the satellites can also function as relay stations. The government will use this feature to connect disaster victims' smartphones with data terminals at the Japan Meteorological Agency, municipal offices, fire stations, hospitals and other organizations, bypassing ground-based communications infrastructure. 

DJI creates M600 for professional aerial photography and industrial use

DJI has released its latest professional aerial photography product Matrice 600. The new drone is specially designed for professional aerial photography and industrial applications. The drone is a dust proof propulsion system that ensures easy maintenance. With actively cooled motors, the M600 operates for longer durations of time. Moreover, the new drone supports all Zenmuse cameras and gimbals including the Z15 series and the Zenmuse X series cameras, which are unmatched in providing stabilized aerial imagery. It could also fly the Ronin-MX, DJI's newest handheld and aerial three-axis gimbal, and a variety of cameras from Micro Four Third systems to the RED Epic with the help its capacity of managing a maximum payload of 6 kg. <http://nhv.us>

Iconem help to restore Palmyra monuments

The ancient Semitic city of Palmyra, which thousands of years ago was a hub for commerce and trade and which in more recent times has been known for its impressive ruins and stunning ancient colonnades, temples, and arches, has been at the center of many recent news stories. An effort is being conducted by French startup Iconem, which specializes in 3D scanning technologies and has dedicated itself to digitally preserving archaeological remains that are in danger of destruction or disappearance since its founding in 2013. The company, which is working in collaboration with Syria's Directorate-General of Antiquities & Museums, has been deployed to the recently recaptured city of Palmyra in order to 3D scan and digitally restore five monuments that were badly damaged by ISIS forces: the temple of Bêl, the temple of Baalshamin, the monumental arch, the valley of tombs, and the Palmyra museum. <http://www.3ders.org>

Aerial Photography, Inspection Top List of FAA-Approved Business Uses for UAS

The Association for Unmanned Vehicle Systems International (AUVSI) has

released an interactive analysis that finds 38 types of business operations have been approved by the Federal Aviation Administration (FAA) to fly unmanned aircraft systems commercially in the National Airspace System (NAS). According to the report that analyzed more than 3,000 FAA exemptions, aerial photography received the most, followed by real estate and aerial inspection. The report also finds that exemptions have been approved in all 50 states and Puerto Rico. In Sept. 2014, the FAA started granting exemptions for certain low-risk commercial UAS applications under Section 333 of the FAA Modernization and Reform Act of 2012. Since then, the agency has received more than 15,000 and approved more than 4,600 petitions. www.auvsi.org/exemptions

Indian Industry Group presses for UAS Operating Rules

Recognizing the need for a regulatory framework for operating civilian unmanned aerial systems (UASs), the Federation of Indian Chambers of Commerce and Industry (FICCI) has provided India's Ministry of Civil Aviation initial guidelines that it hopes will form the basis of legislation. The final policy is expected to be released by year-end, Rajiv Nayan Choubey, India's secretary for the Ministry of Civil Aviation, confirmed to AIN recently.

Currently, the Directorate General of Civil Aviation permits only government agencies to fly UASs in India. The Indian Space Research Organization has made a start to open operations to others by filing a request for proposal (RFP) for exploratory studies using UASs for remote sensing. An unidentified U.S. company is believed to have received a separate RFP from the Gas Authority of India for using UASs to inspect a 60-mile stretch of gas pipelines in the Indian state of Bengal. www.ainonline.com

FAA approves Tremco's SkyBEAM UAV drone operation

The US Federal Aviation Administration (FAA) has approved Tremco Roofing &

Building Maintenance's Building Envelope Aerial Mapping (SkyBEAM) unmanned aerial vehicles (UAVs) for conducting night-time commercial drone operations in the US. www.aerospace-technology.com

FAA committee allows micro UAVs to fly over cities and crowds

A committee set by FAA on how small drones should be regulated in city area, submitted its report. As per new guidelines, FAA has allowed micro UAVs to fly over cities and crowds. The committee report has opened a path for commercial drone flight over US cities. The report argues that drones weigh less than 250 grams should be allowed to fly with no restrictions, as they don't pose a serious risk. Drones that weigh four to five pounds, would be allowed to fly over populated areas and even over crowds, but would have to maintain a greater distance from people, staying at least twenty feet above or 10 feet away. The report further suggests of creating several classes of drones, and allowing them to fly over people, if they meet certain safety thresholds.

SimActive revamps Correlator3D

SimActive has announced the latest version of its Correlator3D that comes with a completely redesigned aerial triangulation (AT) module. To enhance it further, the company has added tie point extraction and a bundle of algorithms to address problematic input data. The release features an industry-first alignment tool which automatically registers new projects to older mosaics and DEMs. It removes the need for recollecting ground control points.

Hemisphere GNSS strategic partnership with CPAC Systems AB

Hemisphere GNSS has announced a significant expansion of their strategic partnership with CPAC Systems, Gothenburg, Sweden (CPAC), owned by the Volvo Group. After signing a large contract, Hemisphere will now be the sole source of GNSS positioning and heading systems to CPAC Systems. www.HGNSS.com. ▴

Surphaser 75 Ultra Short Range 3D scanner

Basis Software Inc has launched Surphaser Ultra Short Range 3D scanner model 75 (USR)). It is sharing the form factor with recently released Surphaser 10 joining the family of smallest and lightest of Surphaser scanners to date. Unique combination of small-sized hemispherical scanner, low noise, and close range allows users to scan with high precision in close proximity and in tight spaces. Highly versatile, it can be used in many applications. www.surphaser.com

Trimble Partners with the University of Cambridge

Trimble has partnered with the University of Cambridge to collaborate on research to advance technology development in the engineering and construction industry. Trimble will work closely with the Laing O'Rourke Centre's Construction Information Technology Laboratory (CIT). CIT is a state-of-the-art research facility with a mission to solve complex engineering problems and automate difficult construction tasks through decision support tools. www.trimble.com

Trimble Unity 3.0

Trimble Unity is a cloud-based, (GIS) centric software-as-a-service (SaaS) solution for smart water management. Version 3.0 includes new features and workflows and also offers an App Builder and new integration capabilities to simplify connecting mobile workers with maps and data from back office enterprise systems. It offers a unified cloud-based and mobile collaboration platform for smart water mapping and work management to water, wastewater, storm water and environmental water industry customers. www.trimble.com

MobileMapper 300 now driven by DigiTerra Explorer v7

The MobileMapper 300 smart antenna and DigiTerra Explorer v7, one of Europe's leading GIS software solutions for mobile mapping, now interface

seamlessly. This enables the DigiTerra Explorer to drive the MobileMapper 300 directly. The MobileMapper 300 is a professional-grade GNSS receiver with advanced accuracy options that are scalable from mapping grade to full RTK accuracy, including RangePoint RTX over IP support. It is designed for use in combination with a wide variety of mobile devices, including smart phones, tablets, and notebook computers.

DigiTerra Explorer offers mobile mapping, GIS data collection and maintenance as well as field-to-office workflow solutions. The software enjoys a significant share of the GIS forestry and agriculture markets in Europe, and it is rapidly expanding into a wide variety of vertical markets and into North America. www.spectraprecision.com

Septentrio offers PolaRx5 CORS

Septentrio Americas has announced the availability of its new PolaRx5 Continuously Operating Reference Station (CORS) platforms optimized for state DOTs and other RTK network operators. It is powered by Septentrio's AsteRx4 next-generation multi-frequency engine. It offers 544 hardware channels and supports all major satellite signals. www.septentrio.com

Teledyne to acquire CARIS

Teledyne Technologies Incorporated and CARIS have jointly announced that the CARIS business and its international affiliates have agreed to be acquired by a wholly-owned subsidiary of Teledyne. CARIS, headquartered in Fredericton, New Brunswick, is the leading developer of geospatial software designed for the hydrographic and marine community.

CARIS Bathymetric DataBASE™ 4.2.

CARIS has released CARIS Bathymetric DataBASE™ 4.2. As part of the CARIS Ping-to-Chart™ solution, it is a powerful system for the management and analysis of bathymetric surfaces and point clouds. This update provides a more powerful and user friendly environment for interacting with large volumes of point

data from multibeam, laser scanner and LiDAR sensors. www.caris.com

Multi-sensor IOT board hosts EVA-7M GPS/GNSS receiver

EVA-7M GPS/GNSS receiver module has been embedded in the miniature IoT development board LoRaONE by Sodaq, now running a campaign on Kickstarter. The product is a 32-bit Arduino compatible board equipped with Low-Power WAN connectivity that enables development of any kind of IoT solution, anywhere.

The matchbox-sized product (40 x 25 mm) is packed with sensors. The u-blox EVA-7M on the board enables a quick positioning fix. www.u-blox.com

Topcon and RDO GNSS Network Service Grows

Topcon Positioning Group and RDO Integrated Controls have expanded the TopNETlive GNSS network service across Montana, Wyoming, North Dakota, South Dakota and Minnesota in the USA. The increased availability is the result of a cooperative effort between Topcon and RDO Integrated Controls.

Small Precise GNSS Receiver

The company, eGPS Solutions, offers direct sale or rental of technology to the surveying and mapping industries. eGPS also owns a statewide Real Time Network (RTN) blanketing Georgia and extending 5 miles off the coastline. The eGPS RTN was the first in the state and has been operational for more than 10 years. It is comprised of multiple reference stations providing a continuous collection and broadcast of both GPS and Glonass satellite signals.

Antenova M2M expands design and support facilities in Taipei

Antenova Ltd, manufacturer of antennas and RF antenna modules for M2M, has expanded its design and development facility in Taipei's technology quarter Nei Hu District, Taiwan. This is in direct response to the increasing demand from

customers for antennas for M2M and IoT applications. Antenova's engineering resources cover the USA, Europe and Asia, with a specialist RF team in Taipei leading the company's antenna design and development operations. As well as designing the company's antennas, the same RF engineers also provide support to Antenova's customers, assisting by providing antenna integration and matching services throughout the entire design process.

New UltraCam Condor for nationwide mapping by Vexcel Imaging

Vexcel Imaging has introduced a new camera model, the UltraCam Condor. Designed for high-altitude mapping, its frame combines a high-resolution RGB image at 37,800 x 5,200 pixel with a lower resolution PAN data capture for automated DSMOrtho and DTMOrtho image generation that is consistently sharp, geometrically accurate and of superior radiometry. Its expansive footprint, along with the camera's fast frame rate, allows capture of large regions – even continents – in record-time. This all-in-one system is complemented by a NIR channel, making the UltraCam Condor an ideal solution for agriculture, forestry and land management applications.

Surface Navigator and True North Finding System by iMAR has selected STIM300

The STIM300 provides high accuracy inertial data for the iMAR iNAT-M200 Inertial Navigation System and for the iATTHEMO-C High Precision Heading, Attitude, Position & Velocity Reference. The multiband GNSS systems have been through extensive testing and qualifications and are now in regular production already in use with several international customers. The robust, compact and lightweight system at 750 grams provides high accuracy real-time data with a data update rate of up to 500 Hz. With focus on cost, weight and lifetime reliability the iATTHEMO-C is an excellent option to provide Attitude, Heading and Motion measurements for many surface, airborne, naval and

automotive applications (best condition heading accuracy $< 0.05^\circ$ rms).

STIM300 is a small, lightweight and low power, ITAR free high performance Inertial Measurement Unit (IMU) with 3 gyros, 3 accelerometers and 3 inclinometers. The STIM300 IMU is closing the performance gap to FOG (fiber optic gyro) and it is a powerful alternative to current solutions in the market. STIM300 is today implemented in applications like UAVs, satellites, man and vehicle portable target acquisition systems, land navigations systems, turret stabilization, missile stability and navigation, and mortar aiming systems just to mention a few.


Leica News

New Reference Servers, Monitoring Receiver

The Leica GR30 and GR50 reference servers and GM30 monitoring receiver are primed for the constantly changing requirements of GNSS technology. Now equipped with 555 channels, the new solutions support all global GNSS constellations including GPS, GLONASS, Galileo and BeiDou, as well as regional systems such as QZSS and SBAS. The multitude of signals has been incorporated with the aim to help users obtain high-quality data and uninterrupted accuracy.

Smart Antenna launched

The Leica GMX910 smart antenna can also enable dynamic monitoring with up to 10-Hz data streaming and advanced multi-frequency, multi-constellation tracking.

Starting with the basic GPS single frequency receiver and adding multiple upgradable options, this antenna fits the needs of diverse monitoring projects. It supports multiple GNSS satellite systems and signals. Tracking up to 555 channels, this antenna anticipates the future and is ready for ongoing changes in GNSS technology. 

MARK YOUR CALENDAR

May 2016

European Navigation Conference

30 May - 02 June
Helsinki, Finland
www.enc2015.eu

June 2016

2016 Baltic Geodetic Congress (Geomatics)

2 - 4 June
Gdansk, Poland
<http://www.bkg.geomatyka.eu>

HxGN LIVE

13 - 16 June
Anaheim, USA
<http://hxgnlive.com/anaheim>

6th International Conference on Cartography & GIS

13-17 June
Albena, Bulgaria
www.iccgis2016.cartography-gis.com

WGDC2016

15-16 June
Beijing
<http://wgdc2016.3snews.net/en.html>

2016 Esri International User Conference

27 June to 1 July
San Diego, USA
www.esri.com

July 2016

6th Digital Earth Summit

7- 8 July
Beijing China
www.isde2016summit.org

ISPRS – PRAGUE 2016

12 - 19 July
Prague, Czech Republic
<http://www.isprs2016-prague.com/>

ESA – International Summer School on Global Satellite Navigation Systems

18 - 29 July
Joint Research Centre (JRC)/CCR Ispra, Italy
www.munich-satellite-navigation-summer-school.org

September 2016

The Commercial UAV Show Asia

1-2 September
Singapore
www.terrapinn.com/exhibition/commercial-uav-asia/index.stm

Interdrone 2016

7-9 September
Las Vegas, USA
www.interdrone.com

ION GNSS+ 2016

12 - 16 September
Portland, Oregon USA
www.ion.org

EUROGEO 2016

29 - 30 September
University of Malaga, Spain
www.eurogeography.eu/conference-2016-malaga/

October 2016

INTERGEO 2016

11 - 13 October
Hamburg, Germany
www.intergeo.de

37th Asian Conference on Remote Sensing (ACRS)

17 - 21 October
Colombo, Sri Lanka
www.acrs2016.org

3D Athens Conference

18-21 October
Athens, Greece
<http://3dathens2016.gr/site/>

3rd Commercial UAV Show

19-20 October
ExCel, London, UK
<http://www.terrapinn.com/exhibition/the-commercial-uav-show/>

Commercial UAV Expo 2016

31 October - 2 November
Las Vegas, USA
www.expouav.com

November 2016

Trimble Dimension 2016

7-9 November
Las Vegas, USA
<http://www.trimbledimensions.com/>

INC 2016: RIN International Navigation Conference

8 - 10 November
Glasgow, Scotland
<http://www.rin.org.uk/Events/4131/INC16>

13th International Conference on Location Based Services

14-16 November
Vienna, Austria
<http://lbs2016.org>

International technical symposium on navigation and timing

15-16 Nov
Toulouse, France
<http://itsnt.recherche.enac.fr/index.php>

GSDI 2015 World Conference

28 November - 2 December
Taipei, Taiwan
<http://gsdiassociation.org/index.php/homepage/gsd-15-world-conference.html>

December 2016

ISGNSS 2016

5 - 7 Dec
Tainan, Taiwan
<http://isgnss2016.ncku.edu.tw/>

PENTAX

Scanning System S-3180V

3D laser measurement system



- + Integrated HDR camera allows combination of brilliant colours with high-resolution scan data
- + The fastest laser-scanner over 1 million points/second
- + Eyesafe laser class 1
- + IP53 dust & water resistance

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