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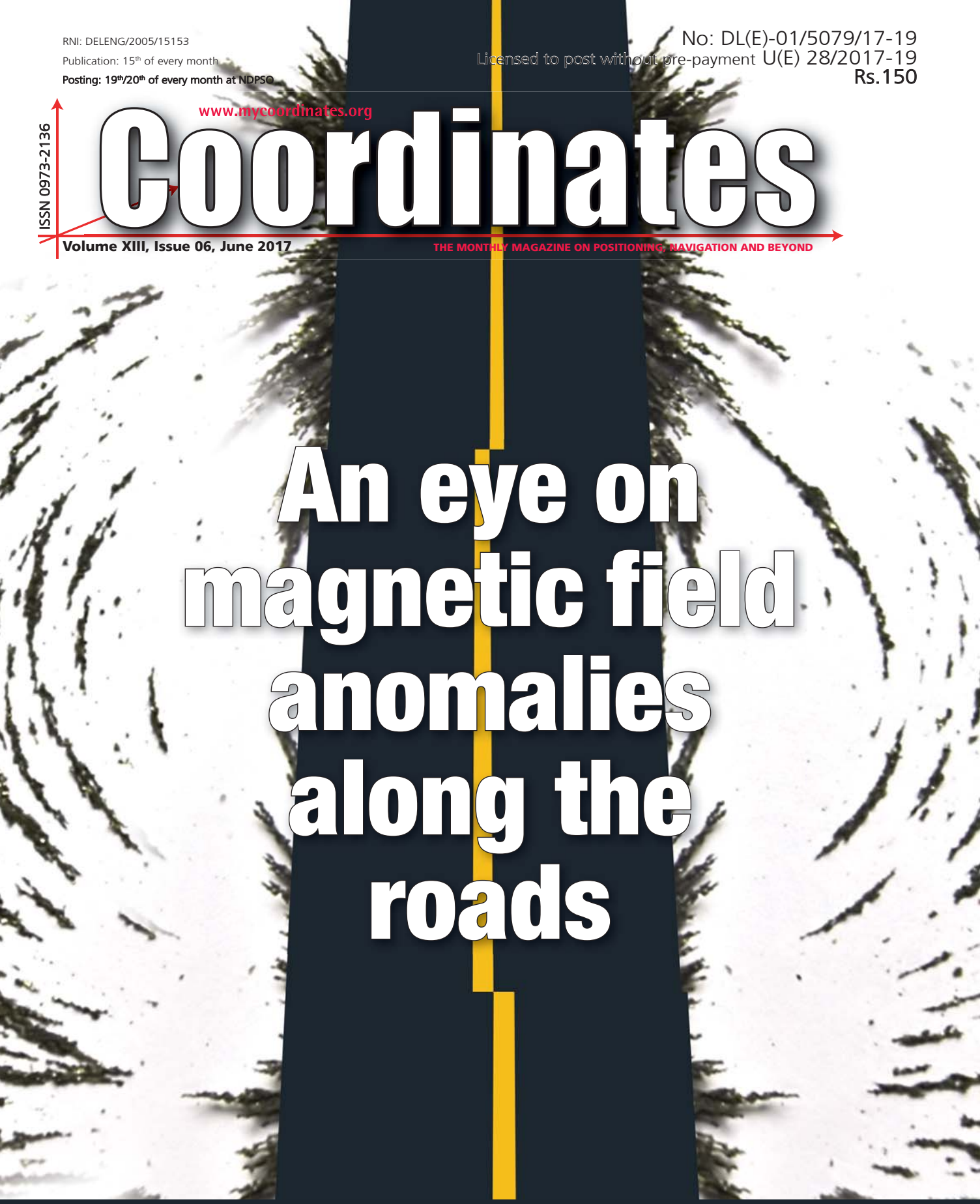
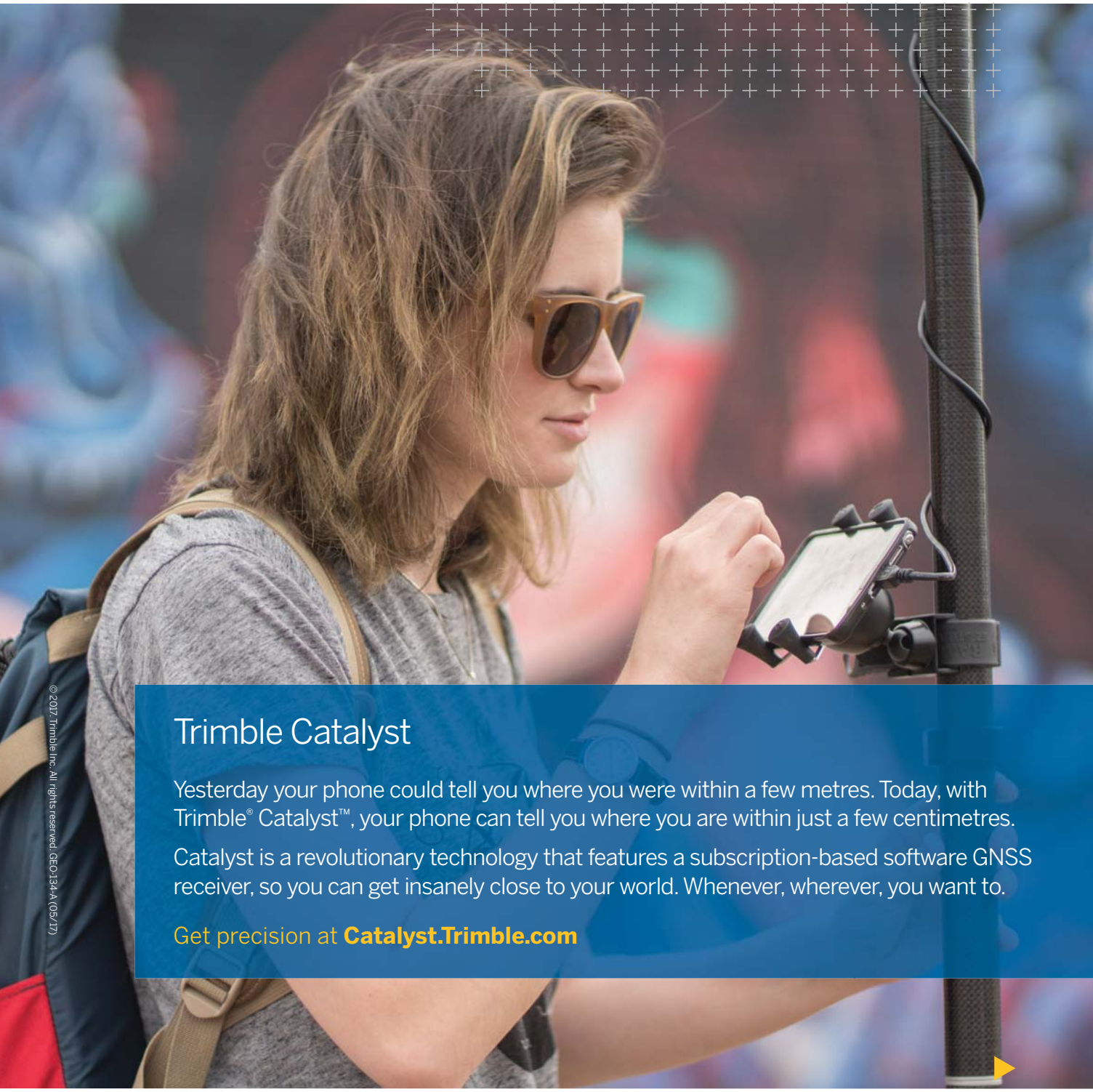


An eye on magnetic field anomalies along the roads

Instruments of land mobilisation



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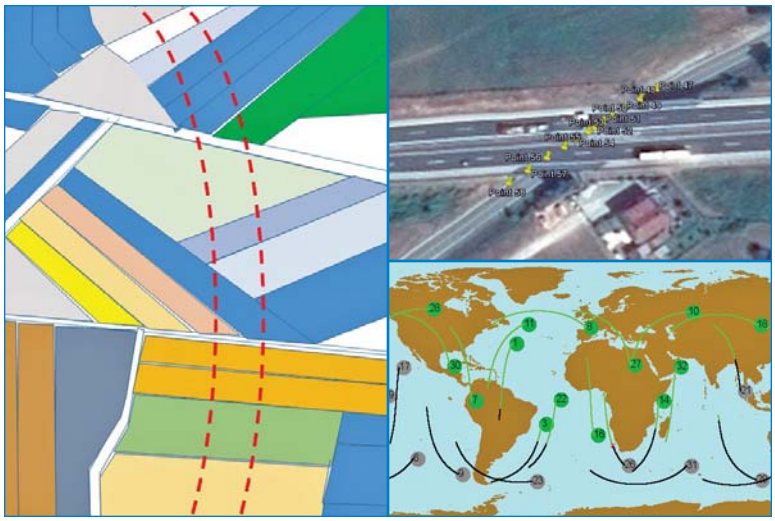

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Coordinates Volume 13, Issue 06, June 2017

Articles

Columns

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Aleksander Grm, Alina Hriscu, Matej Bažec, Franc Dimc, Pedro Pintor, Roberto Roldán, Manuel Lopez-Martinez, Norzailawati Mohd Noor, Nur Aulia Rosni, Rick Ma and Walter Timo de Vries and; HiTarget, IP Solutions, Javad, NT Labs, Pentax, Riegl, SBG System, Trace Me, Trimble and many others.

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

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

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Editor Bal Krishna
Owner Coordinates Media Pvt Ltd (CMPL)
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This issue of Coordinates is of 52 pages, including cover.

A Giant leap

Last month, it was GSAT-9,

South Asia Satellite.

And now a giant leap

With the successful developmental flight of

India's heaviest Geosynchronous Satellite Launch Vehicle,

the GSLV Mark-III,

Indian Space Research Organization (ISRO)

Has placed India with the elite few

Who have excelled in cryogenic technology.

The successfully placing

Of a satellite weighing over 3.1 tonnes

in geostationary orbit is demonstration of

India's self reliance in launching heavier satellites.

This will not only bring down

the cost substantially but also

boost the nation's economy.

Bal Krishna, Editor
bal@mycoordinates.org

Mobile Mapping System in Reconstruction and Expansion of Highways in India

Rick Ma
Laser Scanner
Product Manager
Hi-Target Surveying
Instrument Co.,Ltd

India is at an infrastructure crossroads. As demand for infrastructure development has grown, the country's tireless growth has raced ahead of its ability to develop and deliver the necessary number infrastructure projects.

In developing countries, an essential requirement for economic growth and sustainable development is the provision of efficient, reliable and affordable infrastructure services. A good road and highways network is a critical infrastructure requirement for economic development of a country.

The requirement of India's highway expansion with an accuracy of less than 2cm, only the high-precision equipment HiScan-S mobile mapping system by Hi-Target can meet the need.

In this case study, we choose a highway in the east of Delhi having rugged road surface. Under the requirement of converting four lanes into six lanes, it is necessary to use the point cloud collected by HiScan-S to provide the cross section and the feature points and lines.

HiScan-S high accuracy mobile mapping system configs single Z+F 9012 scanner which scanning frequency up to 1,01 million points/s make the point cloud data high density. Seamlessly intergrated high performance IMU/GNSS make position high accuracy can reach 1-2cm that is enough to meet the needs of India highway reconstruction and expansion.

Before the data collection, we need to collect some control points. Every 600m interval a control point which measurement plane accuracy requirements of 3cm and elevation accuracy requirements of 2cm. The control points are used for correcting the elevation error and verify the accuracy.

We also use the prepared map data to do field survey, confirm the collection of road traffic conditions, the relationship between the collection line, and mark on the map, so that it will be a reasonable planning. Plan the base station position, POS alignment position, travel route in advance and try to ensure along the GNSS signal good area.

Please set the base station at the open area to ensure HiScan-S acquisition accuracy, The distance between HiScan-S and base station is less than 20km.

The steps of data collection are as following:

(1) Heading angle convergence
The vehicle need to be accelerated, decelerated, turns (turns in multiple directions) and so on until the heading angle converges to 0.1 °.

(2) POS data collection
After the acquisition of POS data, before the project data collection, according to the acquisition requirements to do the parameter settings, including the scanner parameters, camera trigger mode, camera exposure parameters.

(3) Project collection
After the POS alignment is completed and the parameters are appropriate, then start and complete the data acquisition. Then copy the data from HiScan-S to the laptop.

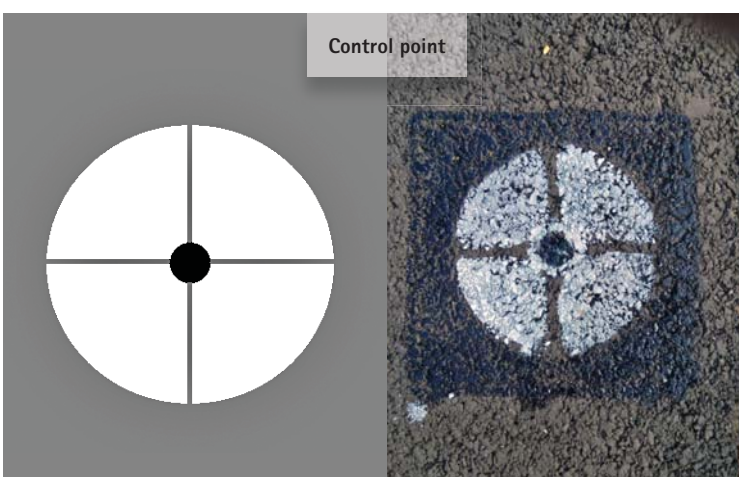
For HiScan-S mobile mapping solution, the data post-processing is very important and the steps are as following:

Raw Data Processing

The raw data collected by HiScan must be processed and can be used by other applications. The preprocessing of raw data includes POS solution and fusion solution.

POS Calculation

POS solution is mainly based on base station data and POS data combination



ACCURACY VERIFICATION REPORT									
Number	Verified Points			Control Points			Residual		
	pX(m)	pY(m)	pZ(m)	cX(m)	cY(m)	cZ(m)	dX(m)	dY(m)	dZ(m)
5	682414.118	3405399.989	398.479	682414.131	3405399.974	398.463	0.013	-0.015	-0.016
6	682517.363	3205944.554	419.36	682517.37	3405944.553	419.363	0.007	-0.001	0.003
7	682560.521	3406154.44	430.131	682560.53	3406154.448	430.118	0.009	0.008	-0.013
8	682708.797	3406523.519	438.343	682708.82	3406523.546	438.34	0.023	0.027	-0.003
1	682979.019	3407163.778	456.013	682979.029	3407163.791	455.999	0.01	0.013	-0.014
2	683115.78	3407440.852	464.23	683115.78	3407440.828	464.224	0	-0.024	-0.006
3	683245.726	3407714.738	473.116	683245.723	3407714.74	473.122	-0.003	0.002	0.006
4	683280.812	3407970.502	480.611	683280.82	3407970.498	480.602	0.008	-0.004	-0.009
						Mean	0.008	0.001	-0.007
						Std	0.007	0.015	0.008

of computing, and output fusion software necessary high-precision position data.

In the POS solution, mainly including the base station data preprocessing and IE solution. The base station data preprocessing is to convert the original data of the base station into the corresponding format, and then the base station data and HiScan data are combined to obtain the high precision position data.

Fusion Calculation

When the mobile mapping system records the measurement data of each sensor, it is necessary to register and combine the data according to the measurement model so that we can restore the 3D geometric spatial coordinates and attributes of the measured object. Fusion calculation is process the raw data which collected by HiScan-S and generate point cloud data for other series of software for follow-up processing.

Accuracy Verification

After obtaining the point cloud data, it is necessary to verify the accuracy of the point. Select corresponding control points coordinates in the point cloud, and the accuracy verification report is obtained by comparing with the coordinates of the control point. For places where the accuracy does not meet the requirements of the place with the control point for POS correction.

POS Data Correction

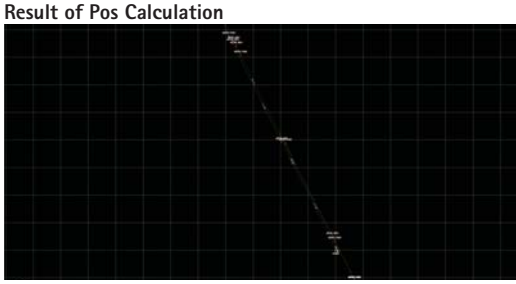
Set the known control points on the motion trajectory of the HiScan-S to adjust the coordinates of the other scanning points to improve the accuracy of mobile mapping system. In the subsequent data processing, the coordinates of these control points into the point cloud coordinate calculation of the adjustment process, in order to enhance the mobile mapping system accuracy, so that it can fully meet the requirements of the highway expansion of measurement accuracy.

After ensuring the point cloud data meet the accuracy requirements,use customized software for the road expansion to extract the basic data of highway expansion automaticly or semi-automaticly, including road cross, vertical section extraction and feature points and lines.

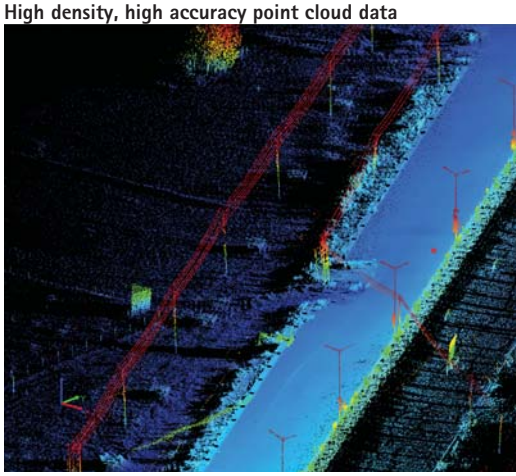
Customers give a high rating in our operating software, post-data processing and data accuracy, because our operate software is easy to implement, data post-processing quickly and accurately, get the point cloud accuracy of less than 2cm which meet the requirements of highway expansion.

Installation of the HiScan-S in progress

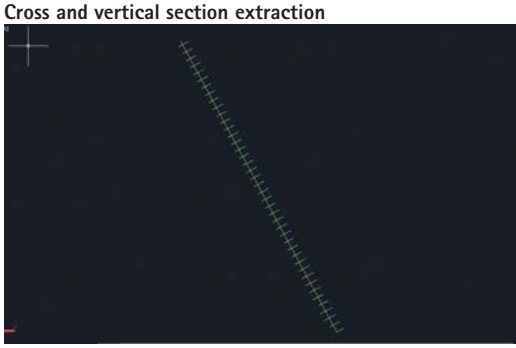
Result of Pos Calculation



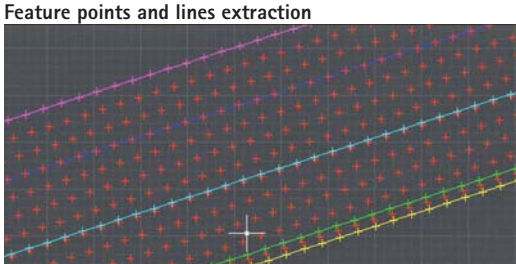
High density, high accuracy point cloud data



Cross and vertical section extraction



Feature points and lines extraction



An eye on magnetic field anomalies along the roads

The paper supports the attempts of the group from University of Ljubljana to enhance the estimations of the longitudinal position of the vehicle with adding the information on regular distortions of the magnetic field densities

Matej Bažec
University of Ljubljana, Faculty of Maritime and Transport Studies, Portorož, Slovenia

Aleksander Grm
University of Ljubljana, Faculty of Maritime and Transport Studies, Portorož, Slovenia

Franc Dimc
University of Ljubljana, Faculty of Maritime and Transport Studies, Portorož, Slovenia

Contemporary navigation systems heavily rely on the satellite based systems, mostly still on GPS. The systems proved robust and accurate enough for the vast majority of its today uses. However, there are situations where the reliability and the accuracy of such systems do not meet the expected criteria. In the first instance, there are potential applications that would need not just a better accuracy but also a greater integrity like the GNSS based *pay as you drive* highway tolling collection technologies, with its independence on the road infrastructure [1] and the advancing drivers support solutions to avoid road disasters in harsh conditions [2]. Second, the increased control and traceability of the vehicles by employing the satellite based applications also increased the occurrence of jammers and spoofers of the GNSS signals. And obviously, urban canyon conditions as an example of environment that prevent the reliable reception of the satellite signal due to the geographical constraints urges for another reliable source of Earth data information [4], [5].

The problems addressed above led to alternative approaches for the position determination with the measurement of the magnetic anomalies among them [6]. The latter is mainly based on the fact that massive ferromagnetic objects close to the road modify the magnetic field densities around them. And so do the electrical transmission lines when powering large consumers.

For this purpose an analysis was performed in the vicinity of Črnotiče, a village in southwest Slovenia. The location was selected due to the low traffic, abundant presence of ferromagnetic objects (fences and bridges) and the crossing of the road over an electrified railway line. Such a destination allowed for an experiment in a controlled environment. On the other hand, some realistic survey measurements were performed on some local roads as well as highways in the southern Primorska region in Slovenia. No emitters of electromagnetic interferences were present on-board during these magnetic mapping tests.

The tests were performed with the vehicle axes aligned MEMS-based Attitude and Heading Reference System MTi-G from Xsens (AHRS) on one side and the cheap three-axis magnetic sensor found in many smart

Along the road mapping and creating the world model automatically still remains a challenge, but according to the data processed so far, a good correlation between the peaks and presence of ferromagnetic structures obviously exists

Figure 1: Two frames from the collected video ground truth captured at the times of peaks of magnetic anomalies get by post-processing of the recorded data.

phone devices on the other. For the latter an HTC One X was used with the Androsensor application used for the capture and logging. An additional smart phone recorded a video file which served as a ground truth source.

Data Analysis

In the first set of the experiments, the focus of the data analysis was focused on the isolation and identification of any eventual magnetic anomaly. However, due to the weak declination of the magnetic field attributed to the presence of the large ferromagnetic objects, the signal was obfuscated in a high (with respect to the signal) noise environment. This made the anomalies identification quite a challenge. The aim of the analysis was to perform a standard procedure on acquired date in order to build a geographical database of ferromagnetic objects.

Since both the sensors used measure the magnetic field in all the three dimensions, the first step was to calculate the magnitude of the magnetic field. Next a filter was applied in order to reduce the noise. The collected points were smoothed by calculating an average over a window of fixed width (S). This way a running average was achieved.

Since the non-investigated magnetic coupling of the car body and any driven-by ferromagnetic objects also influences the behavior, for any large acquisition attempt an automatic calibration approach has to be proposed. A potential contributor to the database should collect the geo-referenced magnetic field data with at least 10Hz sampling frequency.

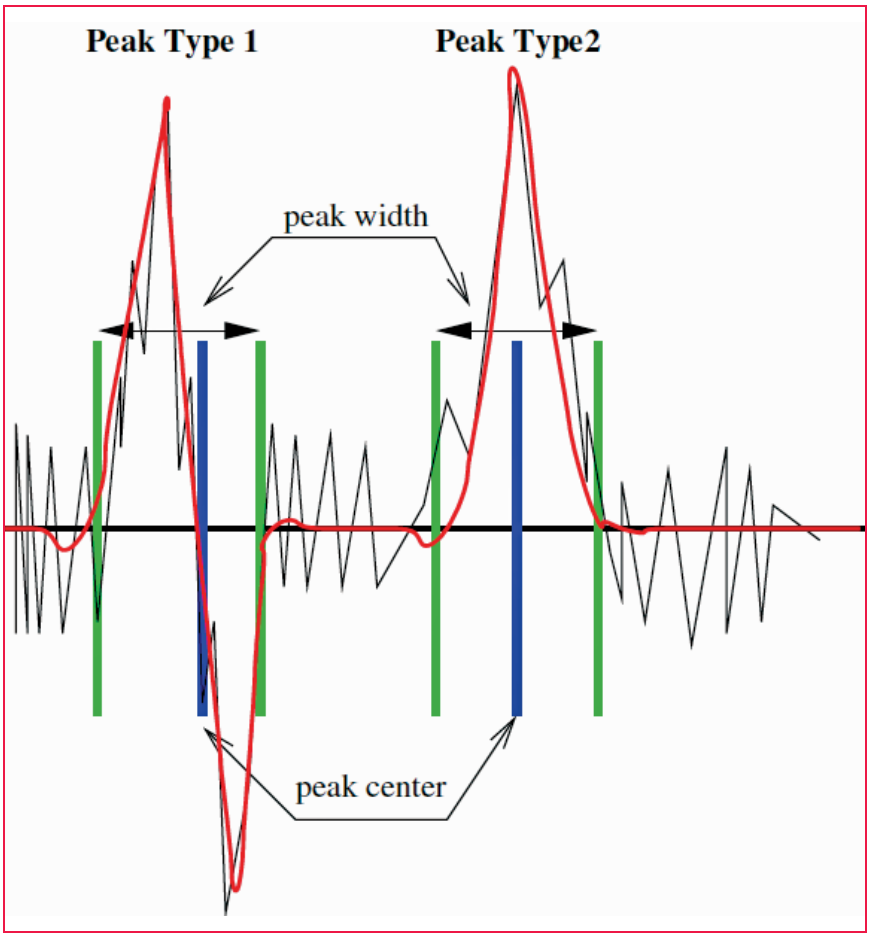


Figure 2: Typical shapes of the acquired peaks. The black line represents raw data, the red line shows the filtered data, blue the center of the peak and the green lines its width.

The smoothed data was subtracted with the time average of width *W* (local mean). Then the standard deviation was calculated in the same window. The deviations were then averaged once again over *Q* samples. This was defined to be the local mean deviation. A peak acquisition was triggered if the deviation was greater than the local mean deviation [6].

The last decision was to define the shape, amplitude, center and the width of the peak. As can be seen in the figure 2, the shape of the peaks was mainly of the two types. The amplitude and the width were not taken into account for the moment. The center was used to set the position coordinates of the anomalies. The center was set on zero crossing for the peak of the type 1 and its maximum for the type 2.

When the peaks were close to one another, so that it was meaningful to attribute them to the same source, they were merged into single event.

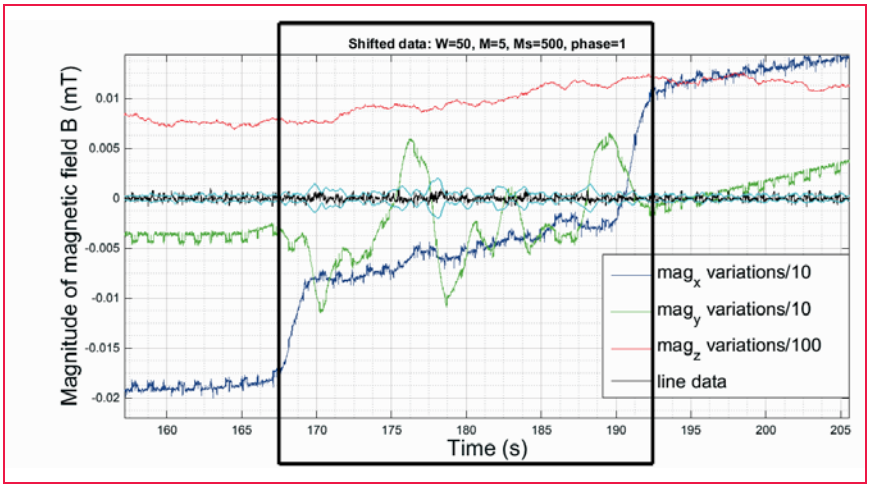


Figure 3: Transition of the train under the bridge. The black rectangle shows the time the train crossing as it was acquired from the recorded video.

Results

This section provides a summary of the results obtained after the previously explained analysis for the different anomaly causing objects considered.

Crossing the railway power lines

The effect of the passage of the train under a bridge near Črnotiče was measured. The results were expected to be interesting particularly due to the fact that the Slovenian railways use DC power lines to feed the trains' electric motors. The DC current running through these lines should thus provide a static and almost constant magnetic field in the direction perpendicular to the lines. The question was whether this contribution to the magnetic field could be measured.

As it can be seen in the figure 3 the effect of the train passing under is of order of magnitude of 0.1 mT. Using the Ampere's law an estimate of the electrical current needed to produce such a magnetic field can be calculated:

$$I = \frac{2\pi RB}{\mu_0}$$

This gives the current in the order of magnitude of few kA which is perfectly sensible for a locomotive of 6MW fed with a 3kV power line. Furthermore, according to the recorded video the change of the magnitude completely coincides with the train passage. It should be noted that due to the high inclination of the railway in question the train compositions have at least two locomotives, one

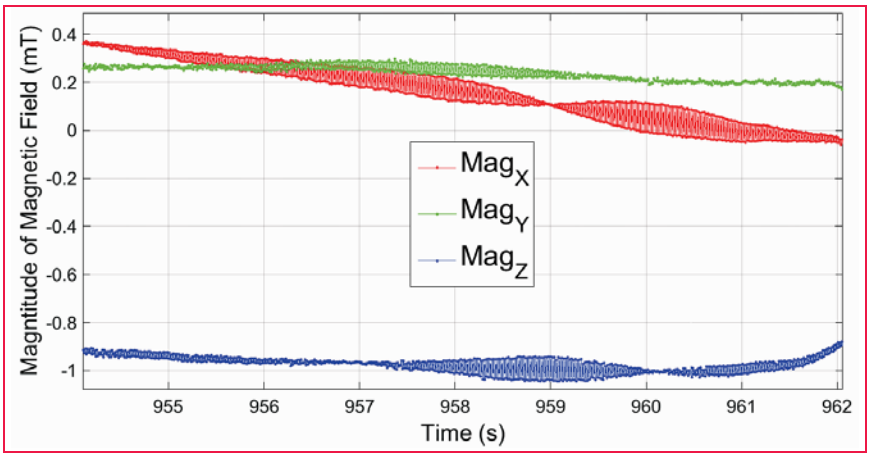


Figure 4: Car driving under an electrical power distribution line. The velocity was approximately 40 km/h.

Figure 5: The selected nearly perfect NW-SE orientated bridge over the railway (source: Google).

on the front and one at the tail. This leads to a conclusion that the change in the magnetic field should necessary be the consequence of the electrical current feeding the trains' motors.

The small trend of almost linear increasing of the magnetic field could be attributed to the change of the terrain slope and the train needs to draw more current. At the same time no sensible explanation was found for the variations in the perpendicular directions. An early proposition was to attribute the variation to a possible magnetic properties of the transported ore. However, this would make a contribution in a random direction that would be isotropically distributed along the train composition. There are also some small variations on the order of magnitude of 1s in both directions that neither could be explained well.

Energy distribution lines

A similar effect was observed when driving under power distribution lines in the vicinity of Hruševje. The difference from the railway power lines is that the electrical power distribution in Slovenia has a frequency of 50~Hz. This is just on the Nyquist limit of our sampling rate (100~Hz).

In the figure 4 an oscillation of the magnetic field can be observed that has an amplitude on the order of magnitude of ~0.1mT and frequency 50~Hz. Using the same reasoning as above, those effects can be easily contributed to the AC currents in the power line of the order of magnitude of few kA.

From the velocity sensors it can be seen that the car was driving at approximately

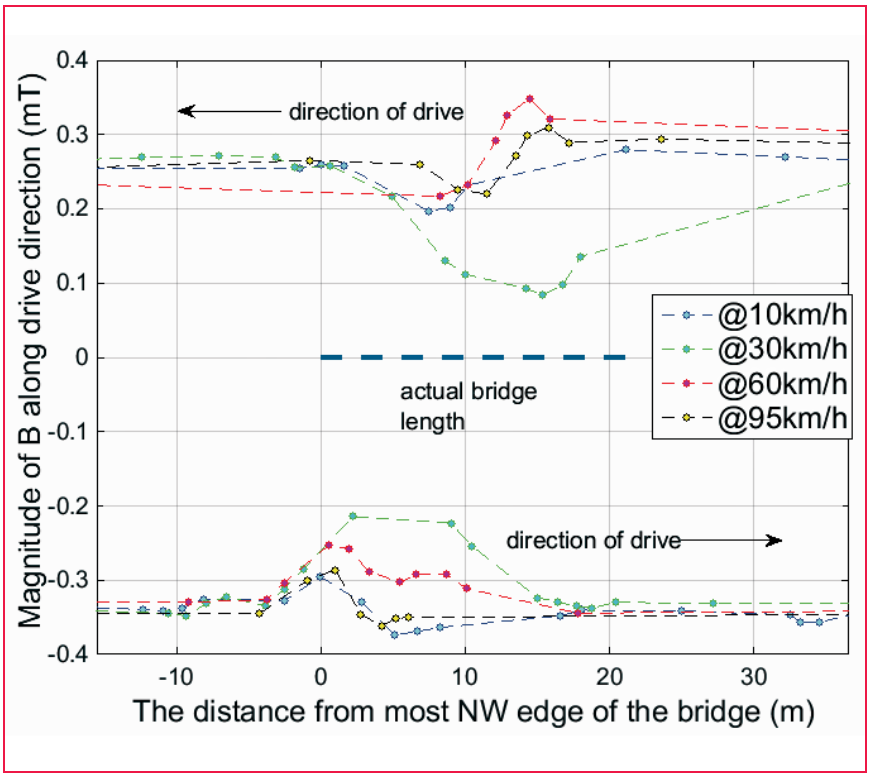


Figure 6: Magnitudes of the magnetic field density component as logged at the points of peaks at different speeds.

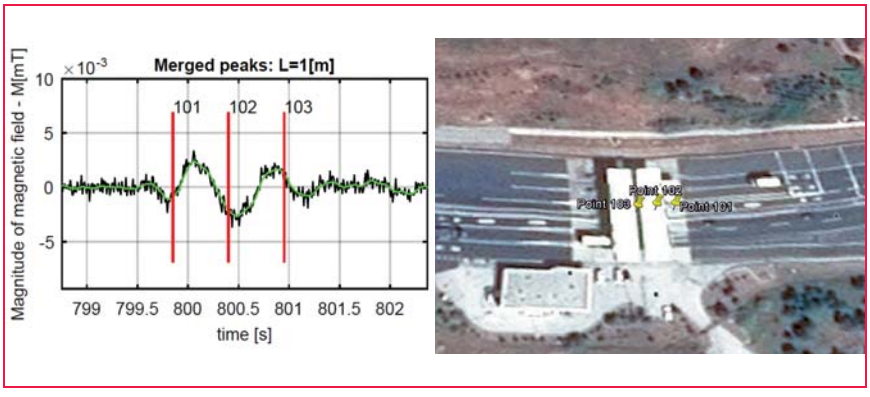


Figure 7: (left) The derived peaks of magnetic anomalies at the toll station gantry. (right) The peaks' positions according to the simultaneously collected GNSS data.

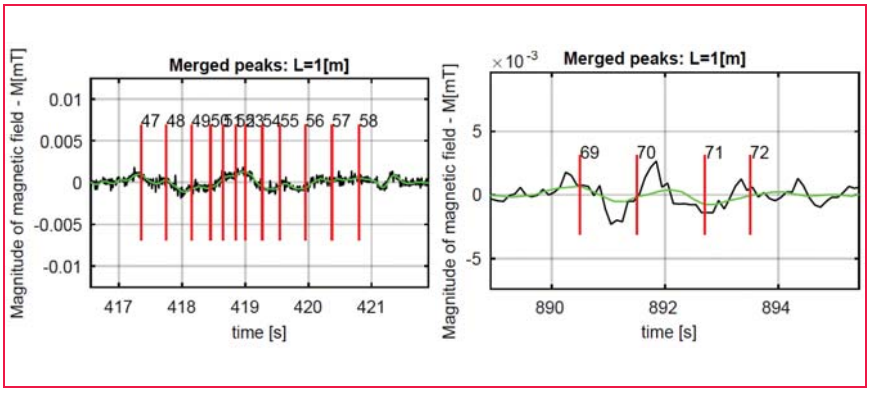


Figure 8: Comparison the observed peaks within 4 seconds acquired during the drive under the highway bridge by the non-synchronized AHRS (left) and smartphone (right).

40 km/h. The variations of the envelope of the oscillations can be attributed to the high curvature at the location of transition or could be attributed to the under-sampling rather than the effect of different sources (each from a wire of a different phase); the latter would imply that the wires should be at least 20 m apart. A repeated experiment is needed by either increasing the sampling rate or driving at a slower velocity.

The bridge: Observed along drive magnetic magnitudes at peaks

The filtering algorithm was tested in the specific magnetic environment of bridge over railway, as shows the figure 5. Several tests at different speeds were performed to justify the admissible parameter set. When passing the bridge from each direction a significant behavior of transients i.e. the shapes and mean levels occurs at different speeds, as shows the figure 6. A very well magnetically defined most NW edge occurs, regardless of the speed.

Data collection on the roads

Inertial and magnetic field data were collected on the roads in the Littoral Region of Slovenia. The set of selected 400km of roads brings a set of different types of roads (local, regional and highway). Interestingly, very rare portal pillars were signed with magnetic signature, while most bridge structures and fences left at least their edges fingerprints.

As an example of still typical infrastructure object on Slovenian highways, a toll gantry is presented. A graph on the figure 7 shows regular fingerprint as get at the speed of 20km/h.

AHRS vs. smartphones data collection

In order to floor the crowdsourcing, a comparison of the AHRS and the smart phones built-in sensors was involved. For this purpose the measurements of the influence a highway bridge structure was used. As one can see comparing the figures 8 and 9, for its higher sampling

Figure 9: Positions of the peaks from the Figure B geo-located by the internal GNSS receivers of AHRS (left) and the smart phone (right).

rate (100Hz vs. 10Hz) the acquisition from AHRS unveils more details of the bridge, while the shape of the transient is quite similar and it also marks both edges of the bridge. The coordinates of the peaks as referenced by the smart phone shows the lower accuracy of its GNSS receiver.

We should emphasize that the repetition of the measurement gave similar results, regardless of the driving direction. This seems very promising and could potentially lead to a map of magnetic anomalies. A consideration on how to adapt the sensor to a vehicle is well investigated [5]. However, the demands for a person who takes part in crowd-sourcing to appropriately record the magnetic deviation curve of the vehicle before starting the data collection - is not very reliable. The significance of the uncalibrated data is poor for mapping [5], even in the case that they are well georeferenced and the influence of the local geomagnetic field is known for example from the INTERMAGNET exchange.

Conclusions

Along the road mapping and creating the world model automatically [3], [5] still remains a challenge, but according to the data processed so far, a good correlation between the peaks and presence of ferromagnetic structures obviously exists.

Since the non-investigated magnetic coupling of the car body and any driven-by ferromagnetic objects also influences the behavior, for any large acquisition attempt an automatic calibration approach has to be proposed. A potential contributor to the database should collect the geo-referenced magnetic field data with at least 10Hz sampling frequency.

After establishing the confirmed physical distances between the peaks by appropriate processing, a certain Braille's script of the road is expected. And only a skilled 'finger' is needed to read it.

Acknowledgements

COST action TU1302 Satellite Positioning Performance Assessment for Road Transport (SaPPART) is gratefully acknowledged for the motivation on strengthening the navigation solutions.

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EGNOS multimodal performance

This paper addresses the level of performance reached by EGNOS in SoL Service in aviation and, for the first time, results on preliminary SoL Service in maritime and Open Service in agriculture and mapping during 2016

Pedro Pintor
Service Provision Unit,
ESSP SAS, Madrid, Spain

Roberto Roldán
Service Provision Unit,
ESSP SAS, Madrid, Spain

Manuel Lopez-Martinez
Market Development,
GSA, Prague,
Czech Republic

Alina Hriscu
Market Development,
GSA, Prague,
Czech Republic

The European Geostationary Navigation Overlay Service (EGNOS) provides an augmentation of the open public service offered by the GPS. EGNOS makes GPS suitable for safety critical applications such as civil aviation. As the European satellite-based augmentation system (SBAS), EGNOS provides (free of charge) both corrections and integrity information about the GPS system, delivering opportunities for sub-metre level positioning for improving existing applications or developing a wide range of new ones. EGNOS offers three services: Open Service, Safety-of-life Service and EDAS.

- The EGNOS Open Service (OS), improving the accuracy down to sub-metre level of the GPS signals, targets mass market/general purpose applications by augmenting the GPS standalone performances. This positioning accuracy improvement is achievable thanks to the correction of the error sources affecting the GPS signals related to satellite clocks, satellite payload induced signal distortions, satellite position uncertainties and ionospheric effects. The EGNOS OS is accessible in Europe and some areas beyond to any user equipped with an appropriate SBAS compatible receiver for which no specific receiver certification is required. The EGNOS OS has been qualified by defining the minimum compliance area where the user is able to calculate its position with a specified level of accuracy defined in the EGNOS OS Service Definition Document (SDD) [1].
- The EGNOS Safety of Life Service (SoL), firstly conceived for aviation, consists of signals for timing and positioning intended for most transport applications in different domains where lives could be endangered if the performance of the navigation system is degraded below specific accuracy limits without giving notice in the specified time to alert. This requires that the relevant authority of the particular transport domain determines specific requirements for the navigation service based on the needs of that domain, as well as certification procedures if necessary. The EGNOS SoL Service Definition Document (SDD) [3] is published by the European GNSS Agency (GSA) and presents the minimum performance characteristics of Service. The EGNOS SoL Service is based on differential corrections and integrity data provided through all Messages Types transmitted by EGNOS [2].
- The EGNOS Data Access Service (EDAS) is the ground-based access (through the Internet) to real-time and historical EGNOS data which collects all data generated by the EGNOS infrastructure.

This paper is organized in four different user's domains: aviation, maritime, agriculture and mapping. Each section shows the level of performance reached by EGNOS during 2016. The performance parameters for aviation, mapping and agriculture are well known by the user community. For maritime, it is included a definition of the identified performance parameters specifically tailored to meet maritime user needs.

Aviation

EGNOS SoL service is compliant with operational requirements set by International Civil Aviation Organization for NPA (Non Precision Approach), APV-1 (Approach with Vertical Guidance) and LPV200 requirements, except for specific deviations [3]. This paper assesses the performance with respect the requirement of the two most stringent operations APV-1 and LPV200 (Table 1 and Table 2).

Following results present the LPV200 and APV-1 performance from the 1st January to the 31st of December 2016. During this period, EGNOS broadcast the operational SIS through GEOs PRN120 and PRN136, using 39 RIMS for monitoring around 30 GPS satellites.

Availability and Continuity

ESSP monitoring of APV-1 and LPV200 availability and continuity results uses fault-free techniques [5], what make them independent of the data obtained in a receiver and therefore unaffected by local effects such as multipath, receiver noise and failures. This characteristic enables the computation of results over 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 (Figure 1).

Computation of LPV200 performance accounts for two extra requirements with respect to APV-1. 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. 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 can experience residual ionospheric effects owing to increased ionospheric variability impossible to be effectively modelled and corrected.Areas compliant to availability and continuity requirements but not meeting the two extra requirements on accuracy tail distribution are excluded from maps and plotted in grey (Figure 2).

Availability and continuity of APV-1 and LPV200 service for 2016 shows a very good coverage in most of the ECAC. The 2016 availability meets the APV-1 and LPV200 commitment area defined in the SoL Service Definition Document [3] in 98.4% and 99.0% respectively.

User domain integrity

The Safety Index, defined as the ratio between the Position error and the Protection Level (xPE/xPL) provides a clear indicator of the integrity margin obtained using EGNOS corrections. This indicator should always remain below 1, what ensures that no loss-of-integrity events take place.

The maximum Horizontal and Vertical Safety Index (HSI and VSI) at RIMS sites located within the APV-1 commitment area [3] over the period is included in the Table 3. LPV200 results are not presented for RIMS outside the LPV200 commitment area which is smaller than APV-1 commitment.

Note the maximum value is 0.60, which means an integrity margin of 40%.

Table 1: APV-1 ICAO requirements

Parameter	ICAO requirement	
	Detail	Value
APV-1 Availability	Availability	0.99 to 0.99999
APV-1 Continuity	Continuity	1-8 × 10-6 per 15 s
APV-1 Integrity	Integrity Time To Alert HAL VAL	1-2 × 10-7 in any 150s 6s 40m 50m
APV-1 Accuracy	HNSE (95%) VNSE (95%)	16.0 m 20.0 m

Table 2: LPV200 icao requirements

Parameter	ICAO requirement	
	Detail	Value
LPV200 Availability	Availability	0.99 to 0.99999
LPV200 Continuity	Continuity	1 - 8 × 10-6 per 15 s
LPV200 Integrity	Integrity Time To Alert HAL VAL	1 - 2 × 10-7 in any 150s 6s 40m 35m
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

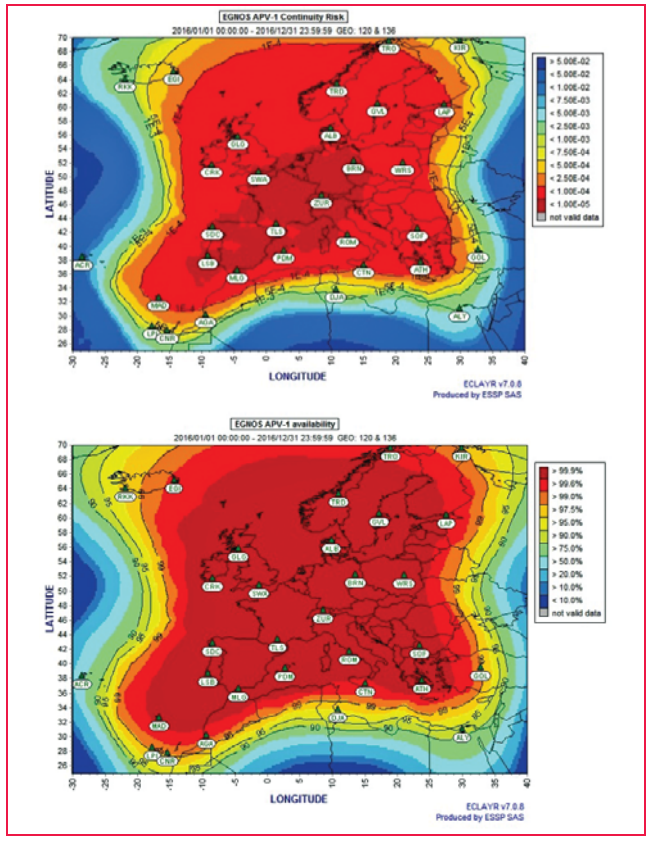

Figure 1: EGNOS APV-1 Availability (top) and Continuity (bottom) maps. 1st January-31st December 2016

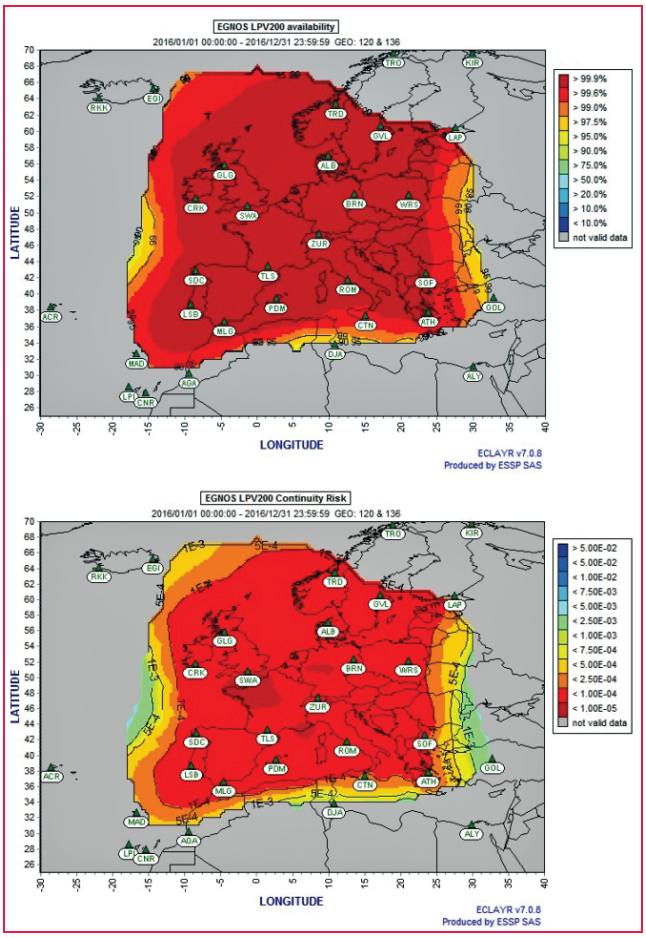

Figure 2: EGNOS LPV200 Availability (top) and Continuity (bottom) maps. 1st January–31st December 2016

Table 3: Safety index

RIMS	Safety Index			
	LPV200		APV-1	
	Max HSI	Max VSI	Max HSI	Max VSI
Aalborg	0.23	0.24	0.25	0.31
Athens	0.27	0.23	0.31	0.33
Berlin	0.22	0.26	0.28	0.26
Cork	0.19	0.29	0.37	0.34
Catania	0.24	0.22	0.24	0.22
Djerba	0.21	0.24	0.24	0.26
Egilsstadir	*	*	0.37	0.37
Glasgow	0.20	0.27	0.33	0.28
Golbasi	*	*	0.24	0.27
Gavle	0.23	0.24	0.59	0.50
Kirkenes	*	*	0.57	0.32
Laperantaa	*	*	0.31	0.28
Lisbon	0.24	0.26	0.25	0.28
Madeira	*	*	0.31	0.26
Malaga	0.21	0.22	0.22	0.22
P. Mallorca	0.32	0.34	0.32	0.35
Reikjavik	*	*	0.60	0.51
Rome	0.19	0.22	0.36	0.35
S. Compostela	0.22	0.23	0.37	0.38
Sofia	0.32	0.43	0.39	0.43
Swanwick	0.27	0.26	0.28	0.33
Toulouse	0.19	0.20	0.38	0.33
Trondheim	0.33	0.39	0.33	0.48
Tromso	*	*	0.31	0.40
Warsaw	0.23	0.23	0.46	0.37
Zurich	0.22	0.29	0.23	0.29

Horizontal and Vertical Accuracy 95%

The LPV200 and APV-1 Accuracy 95% values at the RIMS sites, when the LPV200 and APV-1 service is available, are included in Table 4. The Horizontal and Vertical Navigation System Error (HNSE and VNSE) for every station is well below the corresponding requirement.

LPV200 Vertical accuracy tails

LPV200 accuracy tail requirement is twofold (nominal operational conditions and degraded conditions) but data classification into one of these categories is not straightforward. Thus, the analysis performed assumes all data in the period is subjected to the more stringent requirement; $Pr(VNSE<10m)<10^{-7}/150s$ 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. Size and color of circles in Figure 3 indicate the extrapolated VNSE calculated.

All of them are below 10m and therefore meeting the $10^{-7}/150s$ requirement.

Maritime

EGNOS can complement the existing maritime radionavigation systems (e.g. DGNSS) in the European region for enhanced accuracy and integrity information where there is no back-up infrastructure or in poorly covered environments. Since 2014 the European GNSS Agency (GSA) and the EGNOS service provider (ESSP SAS) are working together to foster the use of EGNOS among merchant vessels and shape up a potential EGNOS Safety of Life service adapted to the maritime needs and using the current EGNOS V2 Signal in Space (SiS). This service will meet the International Maritime Organization (IMO) performance requirements detailed on IMO Res. A.1046 (27) for systems to be recognized as components of the worldwide radionavigation systems (WWRNS) in terms of Ocean Waters and Harbour entrances, Harbour approaches and Coastal waters.

The development of a new EGNOS Safety of Life service for maritime implies two key tasks at service performance level. The first one is the identification and definition of a set of performance parameters required for a complete characterization of the new service taking into account IMO Res. A.1046 (27) [6] and also the particularities of EGNOS and the second task comprises a preliminary performance assessment to grasp an initial idea of the level of service

Table 4: Accuracy 95%

RIMS	Accuracy 95% (m)			
	LPV200		APV-1	
	HNSE	VNSE	HNSE	VNSE
Aalborg	0.9	1.4	0.8	1.4
Athens	0.7	1.2	0.8	1.3
Berlin	0.9	1.2	0.8	1.2
Cork	0.9	1.2	0.9	1.3
Catania	0.6	1.1	0.7	1.2
Djerba	0.8	1.1	0.8	1.2
Egilsstadir	*	*	0.8	1.7
Glasgow	0.9	1.4	0.8	1.4
Golbasi	*	*	1.0	1.5
Gavle	0.7	1.6	0.7	1.6
Kirkenes	*	*	1.0	1.9
Laperantaa	*	*	0.8	1.7
Lisbon	0.9	1.4	0.9	0.9
Madeira	*	*	0.9	0.9
Malaga	0.8	1.1	0.8	0.8
P. Mallorca	0.6	1.0	0.7	1.1
Reikjavik	*	*	0.9	1.7
Rome	0.7	1.1	0.7	1.1
S. Compostela	0.9	1.0	0.9	1.1
Sofia	1.1	2.2	1.1	2.3
Swanwick	1.1	1.5	1.1	1.6
Toulouse	0.7	1.0	0.7	1.1
Trondheim	0.7	1.6	0.7	1.6
Tromso	*	*	1.1	2.2
Warsaw	0.9	1.4	0.9	1.4
Zurich	0.8	1.1	0.8	1.2

reached by the new service. For the sake of clarity, the EGNOS Safety of Life service for maritime based on IMO Res. A.1046 (27) is called EGNOS 1046.

IMO performance requirements in Table V come with no detailed definition. Thus, an additional task consists on defining the parameters to account for the specific characteristics of EGNOS as a maritime radionavigation aid when compared to, for example, others such as DGNSS. Reference [7] defines how to calculate the performance parameters for DGNSS. This approach has been used to understand parameters in Table 5 and propose the following definitions for IMO performance parameters. Note that, for EGNOS, one additional parameter (Service Availability) is included.

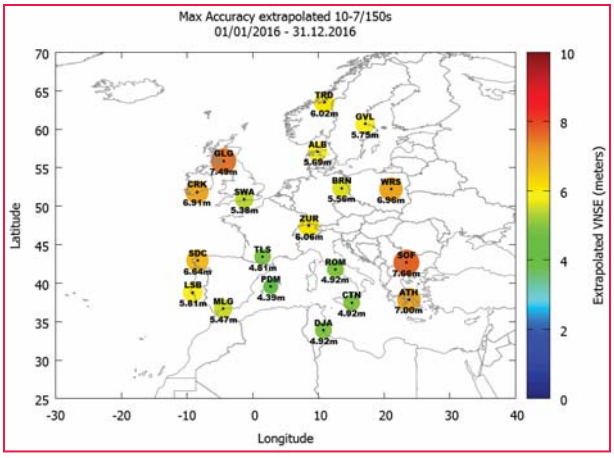

Figure 3: EGNOS LPV200 Availability (top) and Continuity (bottom) maps. 1st January–31st December 2016

Signal Availability

Signal availability is given if the radio reception of the signal is ensured in the specified system coverage and if the signal is provided according to its specification. EGNOS 1046 Signal Availability assesses the percentage of time the EGNOS SiS is providing messages [2] that can be processed by SBAS type-approved receivers.

EGNOS broadcasts through two operational GEO satellites PRN120 & PRN 136 during 2016. This redundancy will benefit EGNOS 1046 receivers capable of instantaneous GEO switching and therefore, signal availability has to be calculated as the combined signal availability of both operational EGNOS GEOs. EGNOS 1046 signal availability reaches the same value in the intersection area of both EGNOS GEOs footprint (Figure 4).

From May 2016 to March 2017, Signal Availability reached 100% meeting the IMO requirement of 99.8% for the intersection area of both EGNOS GEOs footprint.

Horizontal Accuracy 95%

Horizontal Accuracy is the 95% percentile of the Horizontal Position Error (HPE) distribution. HPE is the 2D radial error of the instantaneous measured position respect to the true instantaneous position.

Table 6 shows the Horizontal Accuracy 95% values in meters in EGNOS RIMS (Table 6).

All RIMS stations meet the IMO requirements of 10m 95% for harbour entrances, harbour approaches and coastal waters surrounding Europe and IMO requirements of 100m 95% for ocean waters.

Service Availability

Performance parameters in Table 5 come from IMO Res. A.1046 (27) which is a set of requirements that shall be met by radionavigation aids to be recognized as components of IMO WWRNS. As a radionavigation aid, EGNOS has a particularity: EGNOS GEO satellites broadcast messages over the GEOs footprint (Figure 4) but EGNOS performance is not the same in the whole EGNOS GEO footprint. For example, in some areas where EGNOS SiS is received, EGNOS 1046 receivers will not be able

Table 5: WWRNS IMO requirements

Parameter	Maritime requirements based on IMO A.1046 (27)	
	Ocean Waters	Harbour entrances, harbour approaches and coastal waters
Horizontal Accuracy 95%	100m	10m
Signal Availability	99.8%	99.8%
Service continuity (over 15min)	-	99.97%
Position update rate	2s	2s
Time to Alarm[1]	MSI as soon as practicable	10s
System coverage	Adequate[2]	Adequate[2]
[1]Generation of integrity warnings in cases of system malfunctions, non-availability or discontinuities.		
[2]Taking into account the radio frequency environment, the coverage of the system should be adequate to provide position-fixing throughout this phase of navigation.		

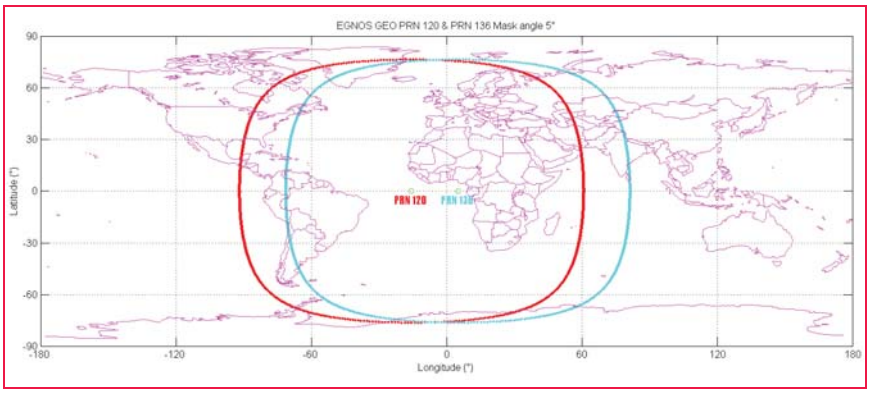

Figure 4: Operational EGNOS GEOs footprint during 2016

Table 6: Horizontal accuracy

RIMS	Horiz Acc 95% (m)	RIMS	Horiz Acc 95% (m)
Aalborg	0.8	Madeira	0.9
Athens	0.8	Malaga	0.8
Berlin	0.9	P. Mallorca	0.7
Cork	0.9	Reikjavik	1.0
Catania	0.7	Rome	0.7
Djerba	0.9	S.Compostela	0.9
Egilsstadir	0.8	Sofia	1.1
Glasgow	0.8	Swanwick	1.1
Golbasi	1.0	Toulouse	0.7
Gavle	0.7	Trondheim	0.7
Kirkenes	1.0	Tromso	1.0
Laperantaa	0.8	Warsaw	0.9
Lisbon	0.9	Zurich	0.8
Agadir	1.0	Longyearbyen	2.3
Canary Isl.	1.2	Abu Simbel	3.1
La Palma	1.1	Alexandria	1.3
Azores	2.8	Jan Mayen	1.2

to compute a navigation solution based on EGNOS. This happens because EGNOS messages include ionospheric corrections only for a region around Europe (Figure 5) and, for a specific epoch, only for a subset of GPS satellites. This subset of satellites is the specific subset in view from Europe and the surrounding area (Figure 6):

Figure 5 represents in blue the monitored IGPs for a specific epoch. A monitored IGP means the ionospheric differential corrections and integrity information is available and can be used by EGNOS users. Figure 5 represents in red the not monitored IGPs.

A similar issue happens for each GPS satellite. For example, Figure 6 presents in green GPS satellites monitored by EGNOS during a period of two hours.

A GPS satellite is monitored if EGNOS differential corrections and integrity information is available for that GPS satellite and then it can be used for the navigation solution. In grey GPS satellites which were not monitored during that period of time. As a result, users in Europe and the surrounding area can use EGNOS differential corrections and integrity information to improve their positioning. On the other hand, some users within the footprint but located far away from Europe landmasses will not be able to calculate a navigation solution based on EGNOS 1046 service although they receive EGNOS SiS. For example, users located in Africa's sub-Saharan region receive EGNOS SiS but, as only a few of the satellites in view by them are monitored and none of IGPs are monitored, sub-Saharan users are not capable to calculate an EGNOS 1046 navigation solution. In order to differ service performance for users that are able to calculate a navigation solution for a particular epoch from those users also within the footprint that are not, a parameter must be defined. This performance parameter is the EGNOS Service Availability and it is the percentage of time a position calculated using EGNOS 1046 is available in a specific location. EGNOS 1046 Service Availability shall be calculated considering receivers are able to do instantaneous GEO switching. For Service Availability, which is not an IMO requirement, it is proposed a target value of 99.8% that will ensure very high quality service. Note that the lack of Signal Availability is one of the events affecting the Service Availability. Figure 7 shows the Service Availability from May 2016 to March 2017.

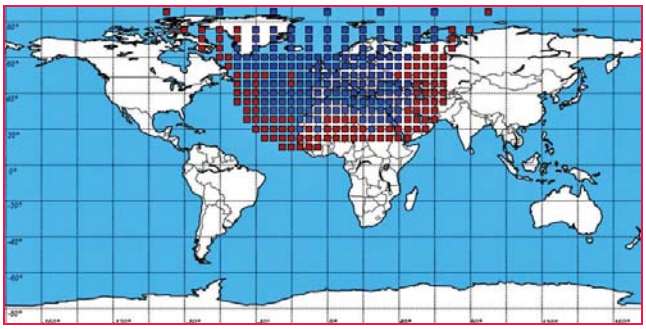

Figure 5: Squares represent the grid of EGNOS ionospheric grid points (IGP) during a specific epoch for ionospheric differential corrections and integrity information

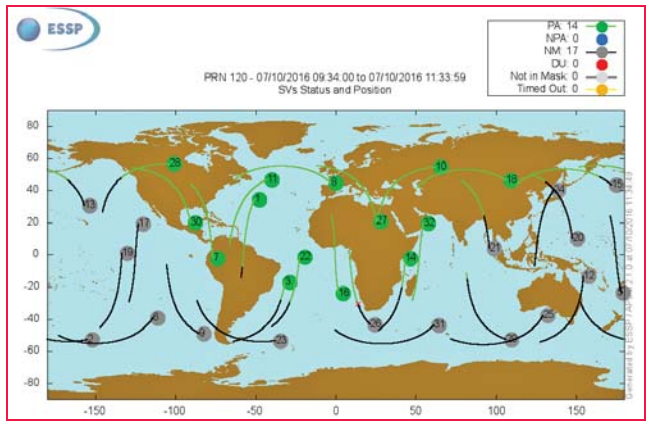

Figure 6: GPS satellites monitored by EGNOS (in green) during a period of two hours

Service Continuity

The Service continuity is the probability that a lack of navigation solution will start during the Continuity Time Interval (CTI), which is defined to be 15 min [7]. EGNOS 1046 Service Continuity is closely linked to Service Availability. Every transition from a service available to unavailable is a service continuity event. Service Continuity is calculated using combined GEOs. Equation (1) shows how EGNOS 1046 Service Continuity is calculated [7]:

$$\text{Service Continuity} = 1 - \text{CTI}/\text{MTBF} \quad (1)$$

Where CTI is 15 min and MTBF is the "Mean Time Between Failures", as measured by the service provider [7], e.g.over a period of two years.

EGNOS SiS monitoring from May 2016 to March 2017, reports the following percentages of Service Continuity for harbour entrances, harbour approaches and coastal waters surrounding Europe. Note there is no IMO continuity requirement for ocean waters.

The reduced area meeting the Service Continuity IMO requirement (99.97% over 15min) over some areas is due to events that affected EGNOS position solution on limited over the period; in particular, in August and September several of them (e.g. 01/08, 04/08, 17/08, 15/09, 25/09, 26/09) impacted the coverage in the North. These events reduced drastically the Service Continuity area reaching the 99.97% over 15 min.

Time To Alarm

The requirement in IMO Resolution A.1046 (27) is 10 seconds for harbour entrances, harbour approaches and coastal waters. EGNOS design ensures timely integrity alarms to GPS satellites for pseudorange and ionospheric corrections in 6 seconds.

Since operational, EGNOS has successfully responded to GPS anomalies sending timely alerts for SoL users within the Time to Alert (TTA). EGNOS TTA response to GPS events is monitored at pseudorange level by ESSP.

Position update rate

EGNOS 1046 receivers must be designed to meet the 2 seconds update rate required by IMO Resolution A.1046(27).

Service Coverage

The service coverage is a designated geographical area where EGNOS provides adequate performance throughout a phase of navigation. By "adequate" it is understood that for a specific location EGNOS 1046 meets for Ocean Waters: the Horizontal Accuracy 95%, Signal Availability and Service Availability and for Harbour entrances, Harbour approaches and coastal waters the Horizontal Accuracy 95%, Signal Availability, Service Availability, Service Continuity and Time to Alarm.

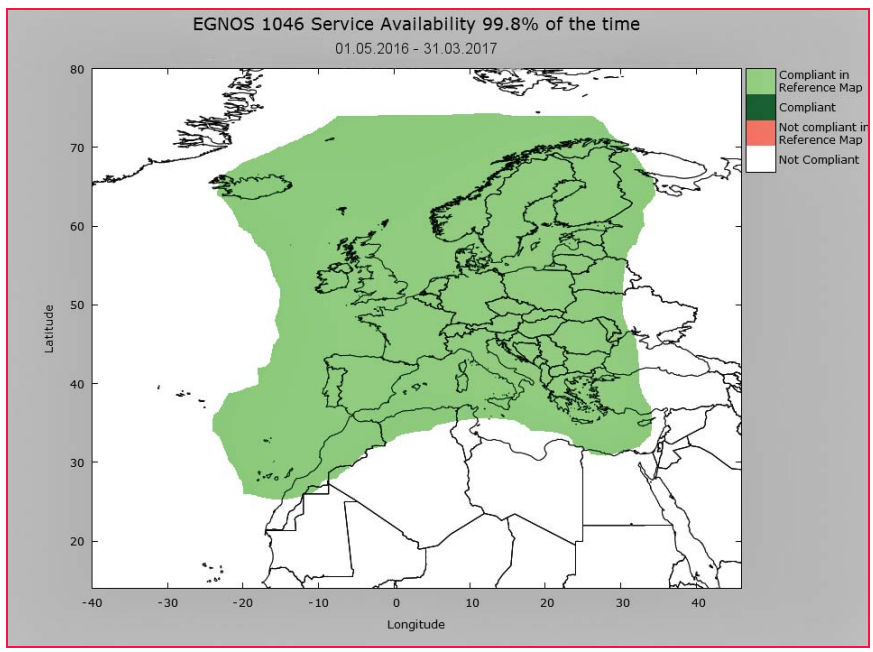

Figure 7: EGNOS 1046 Service Availability from May 2016–March 2017

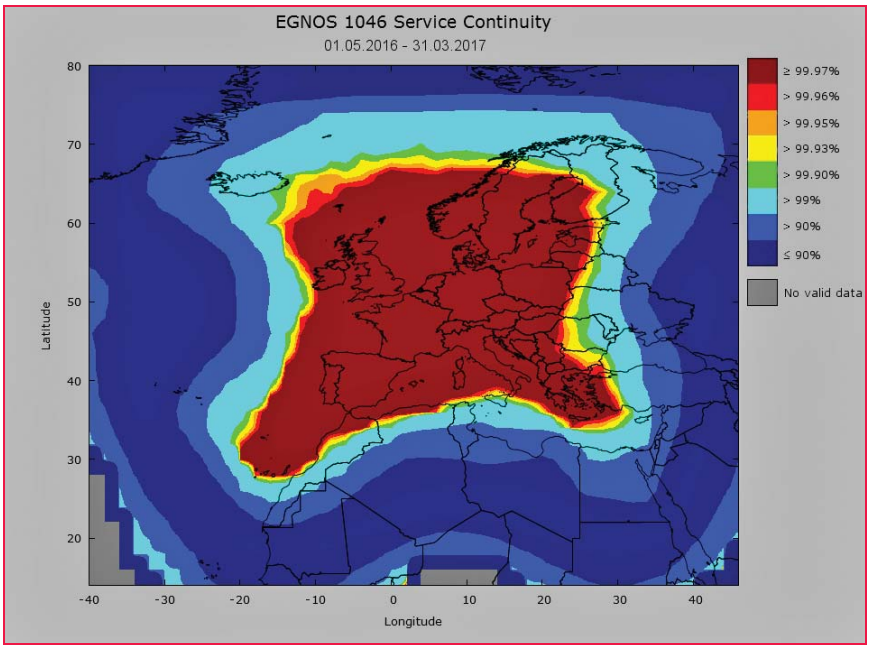

Figure 8: EGNOS 1046 Service Continuity from May 2016–March 2017

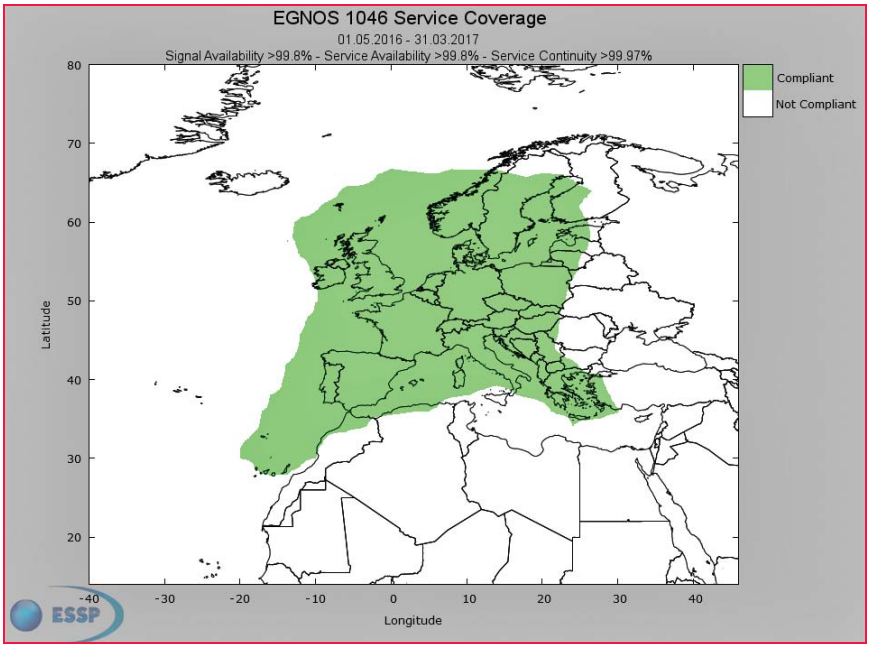

Figure 9: EGNOS 1046 Service Coverage for harbour entrances, harbour approaches and coastal waters from May 2016–March 2017

Figure 9. Identifies Service Coverage which is the geographical area where EGNOS met IMO requirements for Harbour entrances, Harbour approaches and coastal water.

Green area (>99.8% service availability) in Figure 7 delimits the service coverage area for the case of navigation in ocean waters, since there is no requirement for continuity.

Agriculture

According to [10], more 200 000 tractors were equipped with GNSS in Europe in 2013. However, GPS standalone accuracy is not enough for agriculture applications and the level of accuracy required is linked with the type of crop and the needed task to be carried to cultivate such crop. The most commonly required technologies are those providing position with pass-to-pass accuracy covering the range of 20-30 cm level. EGNOS benefits agriculture through a minimal investment obtaining optimization of yields, increment of labour productivity and profit margins, extension of equipment life, reduction of driver fatigue and reducing over-application of fertilizers and herbicides.

Pass to Pass accuracy is the term used by farmers to describe their user needs in relation with accuracy and also the term used by GNSS manufacturers to describe the accuracy the equipment can provide. Pass-to-pass accuracy is defined as the accuracy which can be achieved over a 15 minute window, being 15min the approximate time to make a pass in a typical field. Figure 10. explains graphically the concept.

Once a tractor has done a pass in the field, upon return the driver attempts to place the tractor at the same starting position. However, according to the GNSS equipment, the tractor is not exactly in the same place: there is a bias. This bias is the so called pass-to-pass accuracy. Reference [8] describes in detail how to compute this accuracy.

Two displacement directions have been selected to assess the value of the pass-to-pass accuracy (North-South and East-West). It is important to note that values in column "Pass-to-pass Accuracy" represent the maximum pass-to-pass accuracy error that would be found by agriculture machinery moving in one of the selected directions (direction N-S or E-W). Although, these two directions are taken as a reference for calculations, any other movement direction selected by the agriculture user would find the same level of pass-to-pass accuracy. This performance assessment (Table 7) shows the values of the worst daily pass-to-pass accuracy using EGNOS in several RIMS locations in Europe during 2016.

Data have been assessed to remove potential local issues. Values calculated in these stations are also valid as a reference for agriculture users within the whole EGNOS OS commitment area [1] and not only for users in the very vicinity of the selected stations.

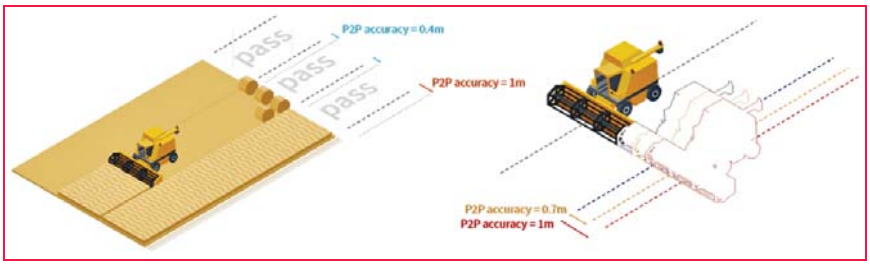

Figure 10: Pass to pass accuracy [4]

Table 7: Pass to pass accuracy

RIMS	Pass to pass Accuracy (m)	RIMS	Pass to pass Accuracy (m)
Aalborg	0.18	Madeira	0.28
Athens	0.25	Malaga	0.20
Berlin	0.22	P. Mallorca	0.19
Cork	0.17	Reikjavik	0.45
Catania	0.25	Rome	0.23
Djerba	0.31	S. Compostela	0.18
Egilsstadir	0.30	Sofia	0.30
Glasgow	0.23	Swanwick	0.25
Golbasi	0.35	Toulouse	0.20
Gavle	0.21	Trondheim	0.24
Kirkenes	0.35	Tromso	0.36
Laperantaa	0.22	Warsaw	0.24
Lisbon	0.24	Zurich	0.22

Mapping

Nowadays the usage of maps has become ubiquitous. From ordinary citizens to professionals performing their duties, it is becoming essential to have visual representation of georeferenced objects: to manage natural resources, to view inventories or stocks, to locate interesting places, to organize logistics and so on. Underlying all those applications there is a common need: objects need to be positioned. EGNOS is a suitable solution when it is needed to locate great amount of points with sub-meter accuracy in an easy, affordable and flexible way and in real time. EGNOS can boost the data capture, usually the most time consuming process in the development of a mapping (road signaling, forestry inventories, on-the-spot checks of area based subsidies, etc...) or GIS application.

In the particular case of mapping, the positioning accuracy is defined mainly for horizontal coordinates (although EGNOS provides also augmented*

Table 8: Error ellipse and 2drms

RIMS	Error ellipse		2DRMS (m)
	Axis (m)		
	Semimajor	Semiminor	
Aalborg	0.56	0.41	0.57
Athens	0.59	0.46	0.61
Berlin	0.61	0.45	0.62
Cork	0.53	0.41	0.55
Catania	0.81	0.44	0.78
Egilsstadir	0.91	0.46	0.86
Glasgow	0.60	0.45	0.62
Golbasi	0.95	0.66	0.98
Gavle	0.60	0.44	0.62
Kirkenes	1.30	0.57	1.45
Laperantaa	0.71	0.47	0.71
Lisbon	0.77	0.63	0.81
Madeira	0.77	0.50	0.75
Malaga	0.62	0.44	0.62
P. Mallorca	0.59	0.41	0.59
Reikjavik	2.15	0.62	1.88
Rome	0.68	0.48	0.68
S. Compostela	0.61	0.46	0.62
Sofia	1.39	0.78	1.32
Swanwick	1.07	0.57	1.03
Toulouse	0.63	0.42	0.62
Trondheim	1.15	0.52	1.07
Tromso	1.14	0.68	1.10
Warsaw	0.67	0.51	0.69
Zurich	0.63	0.46	0.64

vertical position). The following parameters are key performance indicators for mapping users:

- 95% Error Ellipse is an approximate graphical representation of the standard deviation in two directions (lowest and highest precision directions).
- The 2DRMS represents the twice the distance root mean square of the two dimensions instantaneous horizontal error.

Accuracy for mapping is reported in twenty-five RIMS stations. These stations are referenced at centimeter-level and the error is assessed every second. Table 8 presents the average daily EGNOS 95% error ellipse and the 2DRMS in specific locations for 2016:

Values calculated in these stations are also valid as a reference for mapping users within the whole EGNOS OS commitment area [1] and not only for users in the vicinity of the selected stations.

Reporting EGNOS performance

One of the main roles of the ESSP consists on the continuous monitoring of the performance of EGNOS with the objective of ensuring that the quality of the services provided to the EGNOS users is in line with the level of performance specified in the Safety of Life (SoL) [3] and Open Service (OS) [1] SDDs.

This information is accessible to the EGNOS users through the different reporting means such as the EGNOS Monthly Performance Report, the EGNOS User Support Website and EGNOS User Helpdesk. [4]

Conclusions

The paper presents a summary of EGNOS performance during 2016 in aviation, maritime, agriculture and mapping. For aviation, availability, integrity, continuity and accuracy present excellent values both for APV-1 and LPV200. For maritime, the paper defined a preliminary set of parameters to characterize a future EGNOS SoL service for maritime based on IMO Res. A1046(27) and presented a 9-month performance analysis. For agriculture and mapping, the paper shows that values for 2016 were well within the range of values required by the end users. The pass to pass accuracy, the 2DRMS and error ellipse also showed excellent EGNOS performance.

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[5] R. Roldan R., P. Pintor, J. Gomez, C. De la Casa and R. Fidalgo. "The EGNOS Performance monitoring activities performed by the ESSP," ENC 2014 proceedings, April 2014.

[6] International Maritime Organization, "Worldwide Radionavigation System, Resolution A.1046(27)". December 2016.

[7] IALA "IALA Guideline No. 1112 On Peformance and Monitoring of DGNSS Services in the Frequency Band 283.5-325KHz. Edition 1". May 2015.

[8] International Organization for Standardization, "ISO 12188-1 Tractors and machinery for agriculture and forestry-Test procedures for positioning and guidance systems in agriculture-Part1: Dynamic testing of satellite-based positioning devices", 2010.

[9] European GNSS Agency, "GNSS Market Report", Issue 4. in www.gsa.europa.eu. March 2015.

TRIUMPH-LS and J-Field

Hands free operation

RAMS

Remote Assistance & Monitoring Services (RAMS) allows you to connect to your Triumph-LS from anywhere in the world when both your computer and Triumph-LS have access to the Internet. Every function of J-Field that is available to the operator of the Triumph-LS that's in the field, is available to the remote viewer!

There's nothing else on the surveying market like RAMS, that I'm aware of. What an extremely handy tool that works really well and is perfectly integrated into the field software!

Over the past year I've kept the LS system mostly to myself, learning as much as I could about it and getting comfortable with it before I started training any of my crew leaders to use it. Recently I've started training one of my guys to use it, the most experienced of my field team and an extremely bright guy.

This morning, while on a project 40 miles away, I was re-walking him through setup/ground projections and I was logged on to RAMS watching/helping his setup process. ***It's an amazing thing to be able to step in and help out a crew from the office!*** *It's been incredibly helpful the countless times I've called @Adam for help.*

I have to say, this is excellent work by the Javad team!!

Here's a cool screen grab of him staking to his base point to make sure everything was jiving.

Wes Cole
Asheville, NC

J-Field • J-Tip • J-Pod • J-Pack • J-Shield

Front

“Why Javad? Because it works where nothing else will and it has abilities and features that nothing else does.”

“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.”

“Truely amazing with a 4” grape vine directly overhead and the tree cover.”

“This thing is bad ass!”

“Using licensed professionals for development has been a brilliant idea. Tip of the hat to the programmers and designers that put the original box together it appears to me that they knew where they were going with this years ago.”

“I had 100% confidence this RTK was good. As soon as I stored the shot I inversed to my design point at that location and got 0.06’. No second PPK necessary! Then for the cherry on top, I processed the PPK at the office at it was 0.05’ from the RTK I stored. **Just an amazing Surveying machine!**”

“The LS has increased our productivity 2:1”

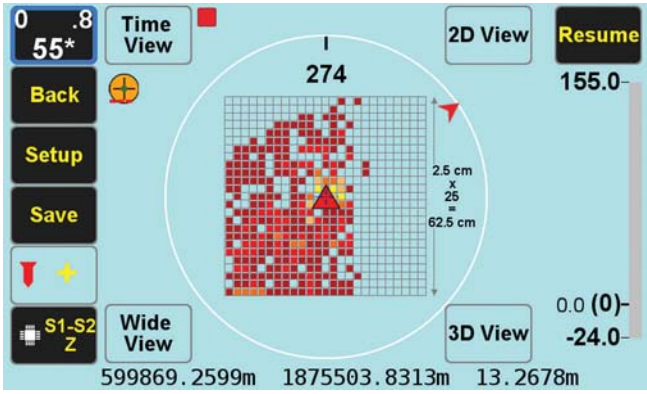
FL

J-Tip

Integrated Magnetic Locator

$850

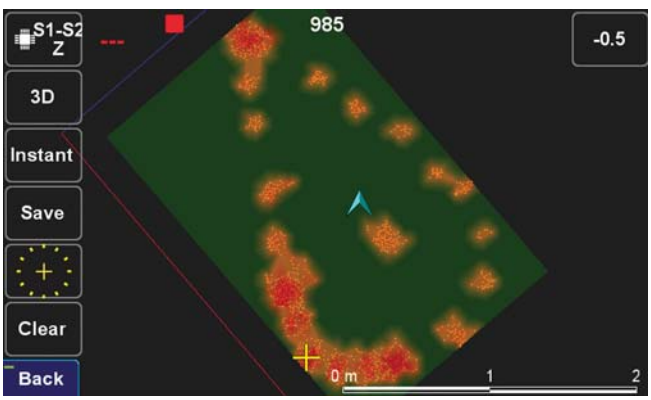
TRIUMPH-LS tags coordinates with magnetic values, It also guides you to top of the item to survey it.

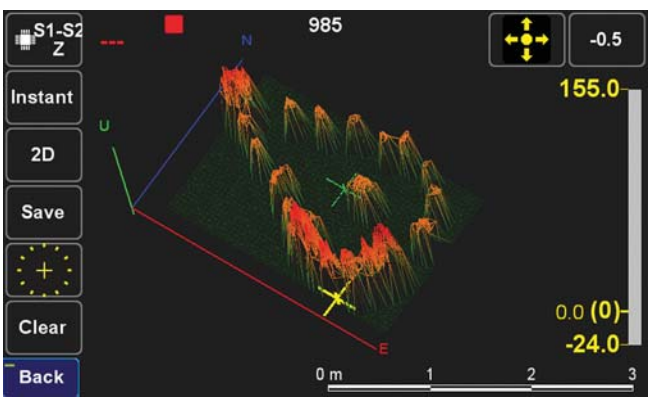


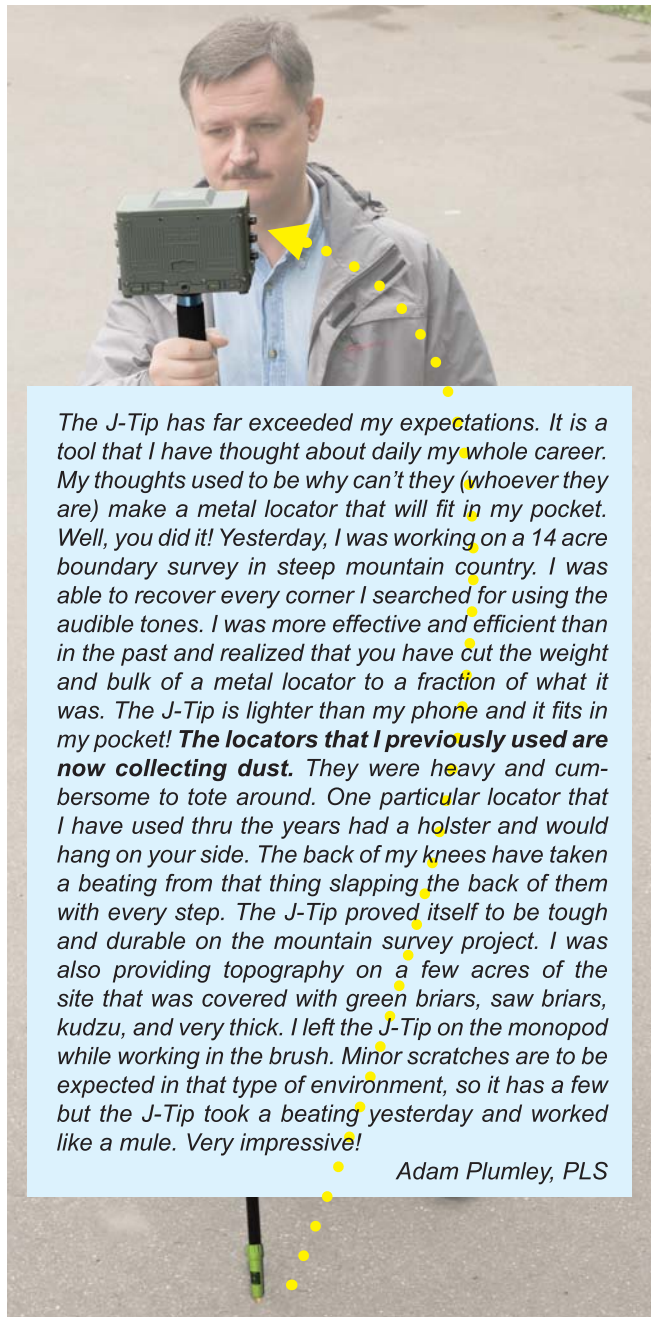
The Mag View focuses only on the mag object with the highest mag value.

The audio and graphical bar on the right side show the magnitude of the magnetic object.

In “Setup” you can select the cell size and the size of the field you want to scan.







The J-Tip has far exceeded my expectations. It is a tool that I have thought about daily my whole career. My thoughts used to be why can’t they (whoever they are) make a metal locator that will fit in my pocket. Well, you did it! Yesterday, I was working on a 14 acre boundary survey in steep mountain country. I was able to recover every corner I searched for using the audible tones. I was more effective and efficient than in the past and realized that you have cut the weight and bulk of a metal locator to a fraction of what it was. The J-Tip is lighter than my phone and it fits in my pocket! ***The locators that I previously used are now collecting dust.*** *They were heavy and cumbersome to tote around. One particular locator that I have used thru the years had a holster and would hang on your side. The back of my knees have taken a beating from that thing slapping the back of them with every step. The J-Tip proved itself to be tough and durable on the mountain survey project. I was also providing topography on a few acres of the site that was covered with green briars, saw briars, kudzu, and very thick. I left the J-Tip on the monopod while working in the brush. Minor scratches are to be expected in that type of environment, so it has a few but the J-Tip took a beating yesterday and worked like a mule. Very impressive!*

Adam Plumley, PLS

2D and 3D views of the field show the magnetic objects that have been scanned.

Zooming the 2D and 3D screens can show the shape of the magnetic objects under the ground.

For many sophisticated features of the J-Tip see its Users Manual in www.javad.com

J-Pod $850

A rugged Transformer-Pod

J-Pack $290

Convenient survey bag

Javad.....Bravo!!!!

The J-Pack is nicest bag I have ever seen for surveying. I especially like the pocket in the back and all of the places to tie down equipment and stuff.

Adam Plumley, PLS

Landing Pads

J-Pod Inside bag.

Monopod >>> to + Bipod >>> to + Tripod…
On demand.

The best surveying machine that's ever been made!

Hasn't been much to chat about lately and it's been a while since I posted so....

While nothing earth shattering has been added to the LS since probably the PPK ability back around six to eight months ago, there have been many minor subtle changes that continue to improve ***the best surveying machine that's ever been made!*** *Upsampling, the ability and programming to work with the J-Tip and several changes and improvements in DPOS (most notably the ability to DPOS from a second rover) have all been used and noticed by us. Several others, I'm sure, I've not even noticed or found yet.*

That being said, what continues to amaze me is the small amount of problems, we the users have with these changes. Sure, there's an occasional little "bug" here and there, but ***the overall performance, durability and dependability of this amazing little box is unreal!!***

When there is an issue, as Nate had yesterday with the dist to last white box, it is addressed and taken care of almost immediately.

With almost 30 years of working with all different types and brands of equipment ***I've never seen or used anything close to what the Javad products deliver!*** *All the designers, engineers and 5PLS crew should be proud of what you're doing and it's a pleasure to be a small part of it myself.*

Darren Clemons
Central Kentucky

Just a note complimenting on the service you provided setting up a transverse Mercator county coordinate datum for my Javad LS. I can now duplicate county coordinates on any published DOT or NGS station in that tilted plane zone in our county in Minnesota within millimeters.

Recently, I purchased a used [redacted] Geo XH 6000 series submeter unit but found the TM county zone was not loaded. In conversations with a [redacted] dealer, I was told they do not support the datum. They did try to create the coordinate system using the NGS parameters but when I proofed it, the coordinates may have just as well been on the moon. Leica has the coordinates on their units and Nadcon/ Connad83 publish the TM zone coordinates... but not [redacted].

I emailed [redacted] back today complimenting JAVAD on their professional quick turnaround on my problem. Doug Carter had the field savvy to finesse the problem and get it into Vladimar's hands where it was quickly dealt with. The Javad process took about ten days back and forth with field checking and all. ***It was a VERY pleasant experience dealing with the professional geodetic JAVAD engineers.***

As county surveyor, I will continue to reject any plats brought forward done in that zone trying to use another county coordinate system. Our Minnesota statute requires plat be done within 0.02' accuracy so I believe I have firm ground upon which to stand.

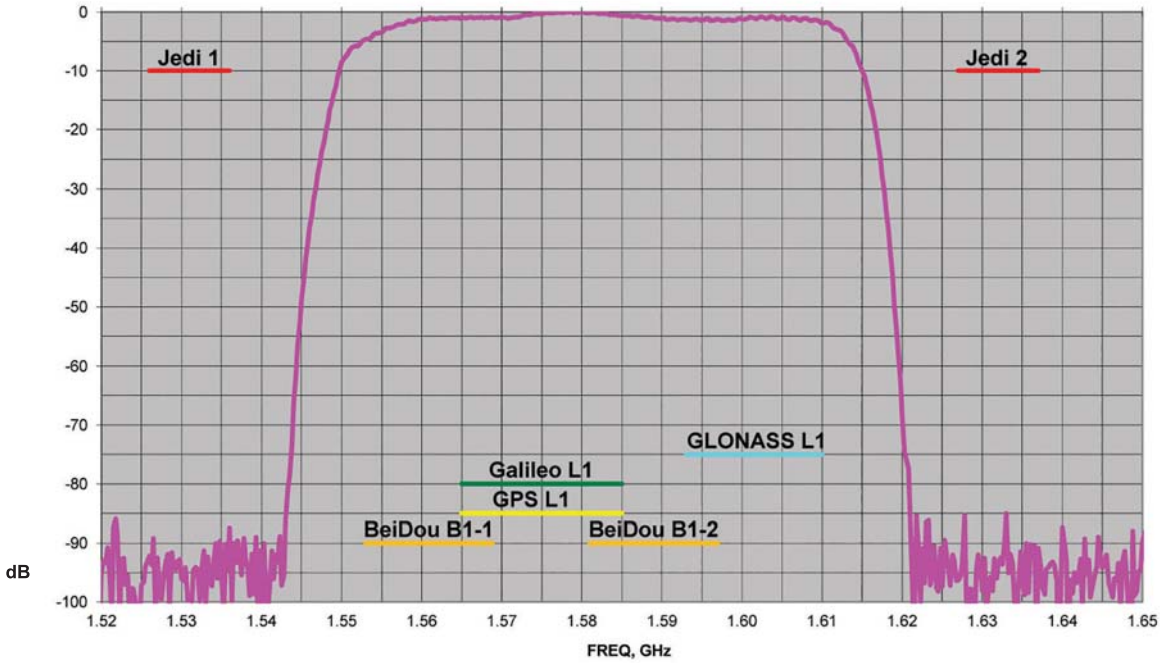
In fairness, I await [redacted] resolution of the process. I explained the JAVAD methodology and results. Hopefully, sometime soon, they will support the NGS published datum and upgrade their units for their clients.

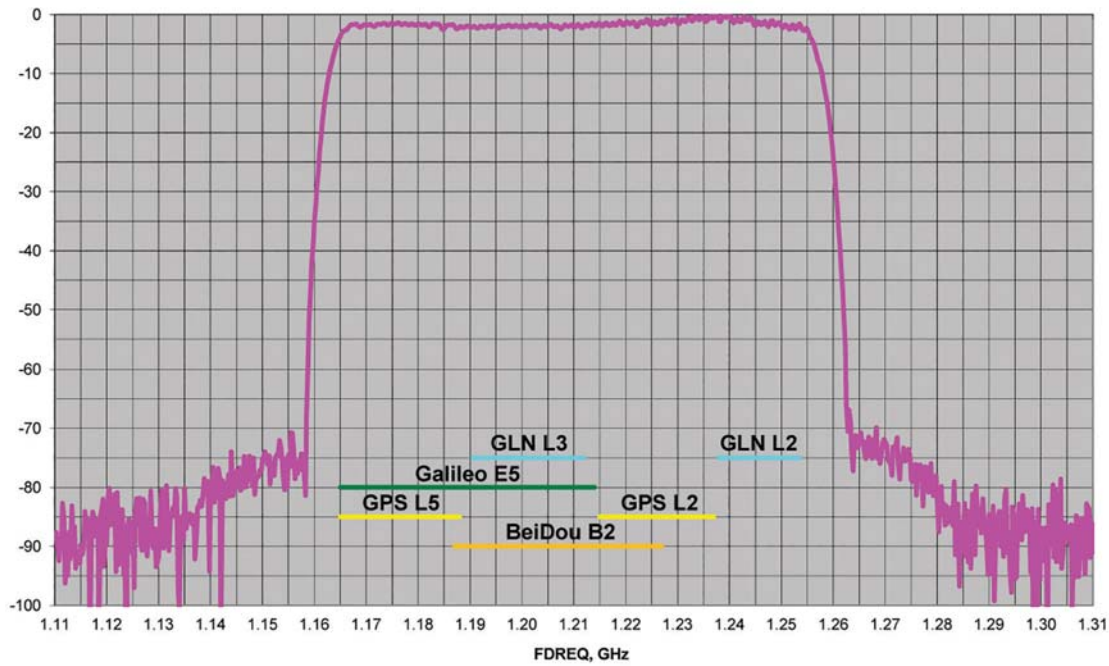
Wayne Hensche

J-Shield

In case the **Jedi** returns

$450





J-Shield of TRIUMPH-LS
protecting all GNSS Bands.

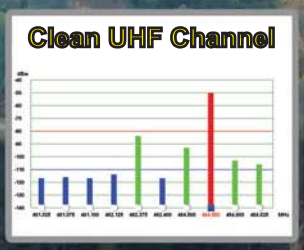
J-Field
Software Features

"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 hyper-caffeinated coffee when I wasn't looking? Amazing accomplishment/development Javad.
I can't imagine using any other GPS equipment."

"I surveyed 20 acres today and never used the total station."

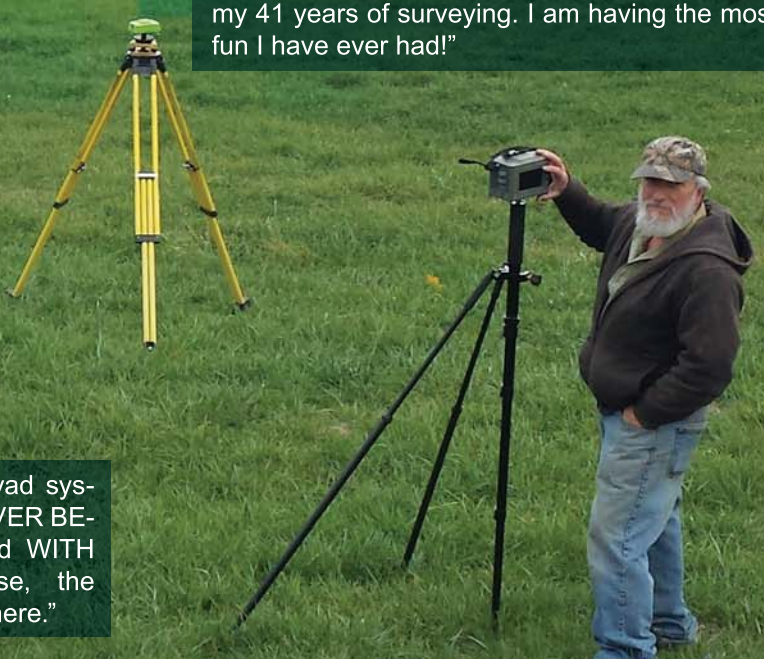
"The only bitching now is for the crew that has to take out the Hyper V."

DPOSit
Data Processing Online Service



REVERSE SHIFT<<it

"Thank you for the most awesome set of equipment I have had the pleasure of running in my 41 years of surveying. I am having the most fun I have ever had!"



"Since I got the Javad system, I go places NEVER BEFORE possible, and WITH confidence, because, the quality checks are there."

FR

TRIUMPH-1M

864 channel chip, equipped with the internal 4G/ LTE/3G card, easy accessible microSD and microSIM cards, includes “Lift & Tilt” technology.

TRIUMPH-2

Total 216 channels: all-in-view (GPS L1/L2, GLONASS L1/L2, SBAS L1) integrated receiver.

The one and the only Digital Radio Transceiver in the world!

Unique adaptive digital signal processing, which has benefits: the full UHF frequency range and all channel bandwidths worldwide • the best sensitivity, dynamic range, and the highest radio link data throughput • embedded interference scanner and analyzer • compatibility with another protocols. Cable free Bluetooth connectivity with GNSS receivers and Internet RTN/VRS access via embedded LAN, Wi-Fi, and 3.5G

And all this with competitive prices!

HPT435BT/HPT135BT/HPT225BT*

$2,710

35 W UHF/VHF Transceiver

HPT404BT/HPT104BT/HPT204BT*

$1,640

4 W UHF/VHF Transceiver

HPT401BT/HPT101BT/HPT201BT*

$2,040

1 W UHF/VHF with internal battery

L-Band/Beacon*

$1,550

Receivers for multiple applications

JLink 3G LTE BAT*

$2,735

Web-interface Wi-Fi, Ethernet, 3.5 G, UHF/VHF/FH915, internal battery

OEM Solutions

$840

902-928, 360-470, 225-255, 138-174 MHz

*Power, data cables and antenna are included.

Instruments of Land Mobilisation – concepts and examples

This paper discusses characteristics of land mobilisation and conceptualises it as a type of a land management intervention

Walter Timo de Vries
Technical University of Munich

The land mobilisation is more than just a spatial legal conversion of land. In all phases of a land interventions – preparation, execution and finalisation – changes in governance, legal, social, economic relations, perceptions and behaviour occur.

The construction of infrastructure requires land on which the infrastructure is planned. If the constructor does not have any formal rights to that land, land use conversion needs to takes place such that the land can be legally acquired by the construction company or the construction authority. Such a process can be referred to as land 'mobilisation', a process supporting the formal conversion and transfer of land in order to enable the process of construction. Mobilisation of land does however not come without problems. There are numerous examples of where the original land owners or users resist, either because of opposing the anticipated infrastructure, or because of fearing losing their land without any compensation. Hence, the process of land mobilisation is not a very generic term related to legal land acquisition or conversion only. It involves a number of additional conversion processes which need to be executed simultaneously and in parallel. So, how generic or context- specific are the problems of land mobilisation? This question needs to be better understood in order to make future land mobilisation more effective and/or successful.

This paper first discusses characteristics of land mobilisation, and conceptualises it as a type of a land management intervention. Then, 5 examples of land mobilisation instances are compared based on the key descriptive and relational aspects of land management interventions. Finally, a number of conclusions and recommendations are given.

Conceptualising land mobilisation

There are three main aspects of land mobilisation. First, in addition to activity of land acquisition, land mobilisation is usually associated with a public purpose or a public service. Land mobilisation is often also associated with a change of land use relevant for this public use. This in itself requires a formal, democratic, process of justifying the need for this public service and debating the need with both stakeholders. Only if the public need is approved the acquisition can occur.

Secondly, the conversion of land use occurs in multiple ways. A change from agricultural use to roads requires such a physical change of the land itself such that the road can be constructed. In addition, the legal change will need to be enforced by a public land use planning decision with legal force. Essentially a conversion is a change of the physical, biological, economic and legal land use. One can differentiate between a functional conversion of land use (e.g. from agricultural to industrial or residential), a legal conversion (from public land to private land, or vice versa), economic conversion (from agricultural manufacturing to infrastructure combined with service industry) and a physical conversion (from vegetation to a change of topsoil, soil compaction, stabilization, road/ building construction). This conversion is only possible, allowable, steerable, and controllable through land use planning.

Thirdly, there is the aspect of compensation. If land is acquired for a public purpose, than there has to be some sort of compensation, either in the form of money or in the form of alternative land or alternative services. If people need to be moved from one location to another than land mobilisation also refers to the (temporary and structural) allocation of land for (trans)migrants, storage of resources or materials.

In sum, land mobilisation refers to processes of conversion of land rights, land interests, land values, land sizes, land claims prior, during and after a large infrastructural projects or projects of public use, public value, public means. It occurs in the form of evaluation, planning, valuing, acquiring and compensation of land.

If we combine these different characteristics then one can explain land mobilisation as a type and instance of land management 'interventions'. de Vries and Chigbu (2017) argue that Land management is both the science and the practice related to the conceptualisation, design, implementation and evaluation of socio-spatial 'interventions', with the purpose to improve the quality of life and the resilience of livelihoods in a responsible, effective, efficient, consensual and smart manner. One can describe the intervention of land mobilisation as an instance of a land management intervention ΔLM, resulting in and relating to a combination of 6 types of changes and adaptations:

1. Governance -> ΔG
2. Land, property, real estate, land use Law -> ΔL
3. Social-spatial relations -> ΔS
4. Economic opportunities and dependencies -> ΔE
5. Perceptions/beliefs/values) -> ΔP
6. Behavior -> ΔB

In short form, any instance of land mobilisation can be described as a function of a number of changes which either occur or need to occur:

ΔLM (Land Mobilisation) = f (ΔG, ΔL, ΔS, ΔE, ΔP, ΔB)

This generic relation can be used to describe and review a number of examples of land mobilisation.

Examples of land mobilisation

In order to explain how each of the changes occur during a land mobilisation intervention five types of archetypical land mobilisation projects are described and further reviewed.

Construction, improvement or expansion of a new major road

If a major road or highway is (re-) constructed it directly affects both the users and owners of the plots where the intervention is planned, and the residents and firms which are located in the vicinity (Figure 1).

Indirectly the construction affects an entire village or region, as transportation and mobility possibilities and associated behavioural patterns may change. The land mobilisation process stands or falls by the requirements to acquire the immediate plots affected, but it is typically also accompanied by a re-construction and exchange of parcels, i.e. a specific form of a land consolidation. Ultimately the decision behind the land consolidation also provides the government agency responsible for the decision the possibility to expropriate individual parcels if ultimately needed. For the case of Bavaria in Germany STMELF (Bayerisches Staatsministerium für Ernährung (2012) describe in detail how land mobilisation for the purpose of road construction typically relies on an extensive land consolidation and public participation process. Complementary, Šumrada et al. (2013) describe the detailed process of expropriation for a 'public benefit', such as a road construction, in Slovenia. It is usually a long administrative process in which various types of stakeholders

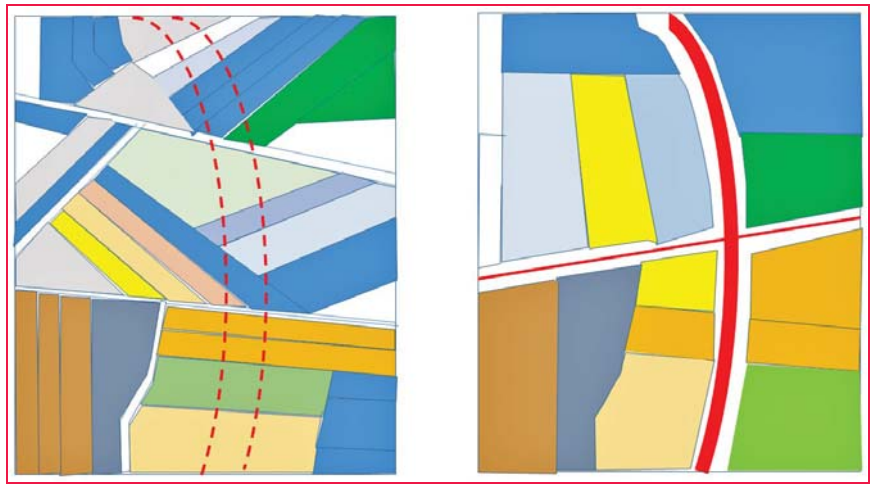


Figure 1: Affected parcels and re-constructed parcels before and after land mobilization

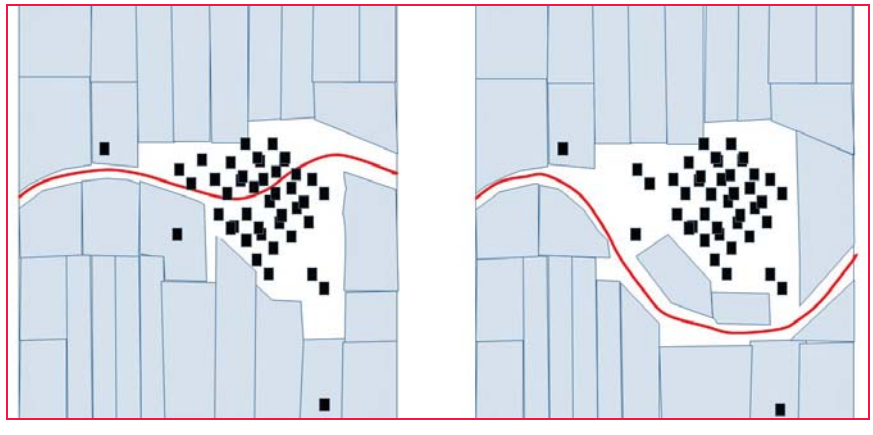


Figure 2: Replacement of a road from a town centre to outside a town

and government agencies are involved. Governments often like to avoid opting for compulsory expropriation given its complexity and duration even though ultimately the change of legal right to the affected land is transacted from individual owners to or via a government agency. If the original legal rights are not secured or are not registered at all, as in many developing countries, direct expropriation does not take place, but still people need to be evicted. Moreover, once evicted, the affected owners, tenants and users will need to be compensated. Especially this part is not a standard procedure in different countries.

Replacement of a road from a town center to outside a town

Instead of constructing a road anew, a road can also be reconverted and improved (Figure 2).

This occurs especially in and around villages where inner city roads are causing negative effects in the form of traffic jams and decreased accessibility of inner cities due to through traffic. In these cases there are not so much economic gains for the village from the re-construction. Instead the re-construction reduces noise levels, inner city pollution, and improves inner city mobility. At the same time, land needs to be acquired and re-allocated outside of the main settlement areas. This outer city road construction is typically accompanied with creating additional access points and access roads for firms adjacent to the outer city road. Figure 3 shows an example of these parallel road structures alongside the new main through road.

Figure 3: Main road and adjacent secondary access roads after land mobilisation project in Schwaben, Germany

Reconstruction of a riverside or waterway

When a waterway is expanded in size or complemented with either boulevards or flood protection structures additional space and land is necessary. International renowned waterfront development projects include that of Shanghai's Bund or London's St. Katherin's Docks. Alongside inner city development, land mobilisation is required, which usually reduces the size of the land of the adjacent plots of the waterway. If land belongs to the State, such as in China, both the acquisition and redevelopment is State-led. Yet, the re-construction also tends to directly benefit the affected land and building owners, users or developers in terms of better access, improved facilities and, ultimately, increased value for their property.

In the preparation process it must be clear however which stakeholders are affected in which way. Rukmana (2017) investigates the land mobilisation effects of an extension and improvement of an inner city waterway in East Jakarta in Indonesia (Figure 4).

The project itself could be initiated by 3 formal government regulations and decrees, backed-up by a land procurement act for public purposes. The extension and improvement of the riverbed over a length of almost 5 km affected 706 land parcels with a total area of 20207 m^2. Due to a significant amount of informal land tenure and occupation there was a lot of uncertainty of land right along the river. As a result, it became difficult to establish who the actual right holders were, so public land ownership was the default in case on uncertainty. This avoided direct expropriation but still led to eviction. Moreover, as long as uncertainty exists opportunistic behaviour from both government agencies and directly affected stakeholders can persist – mostly in the form of speculation through rapid and undocumented transactions.

Construction of ecological corridors

The construction of ecological corridors consists of connecting disconnected or fragmented nature conservation or habitat areas (Figure 5).

The connection allows exchange and movement of groups of animals which became isolated due to roads or built-up areas. One of the largest ecological structures is the European green belt in Eastern Europe (http://www.europeangreenbelt.org/route.html). This did not require a lot of land acquisition or land conversion however. In the more densely populated Netherlands, the 'Ecologische Hoofdstructuur' (ecological spatial structure), recently renamed the Natuurnetwerk Nederland (Nature network Netherlands), land conversion and acquisition has been inevitable. This required however a special fund to enable this acquisition process, largely

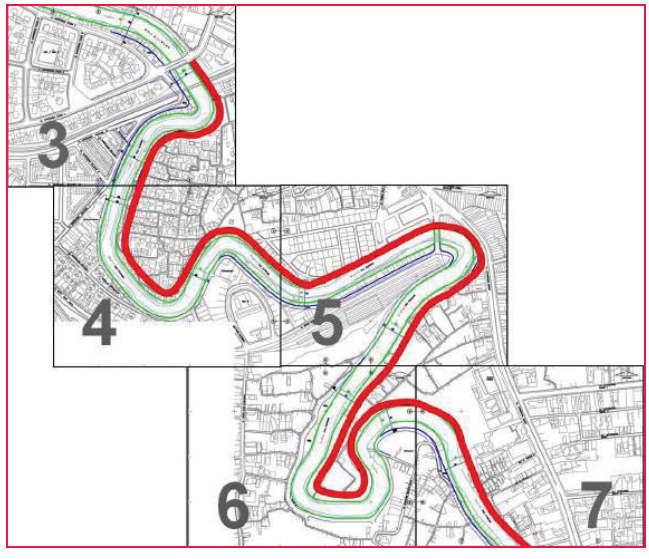


Figure 4: Land acquisition Kampung Melayu (source: (Rukmana 2017)

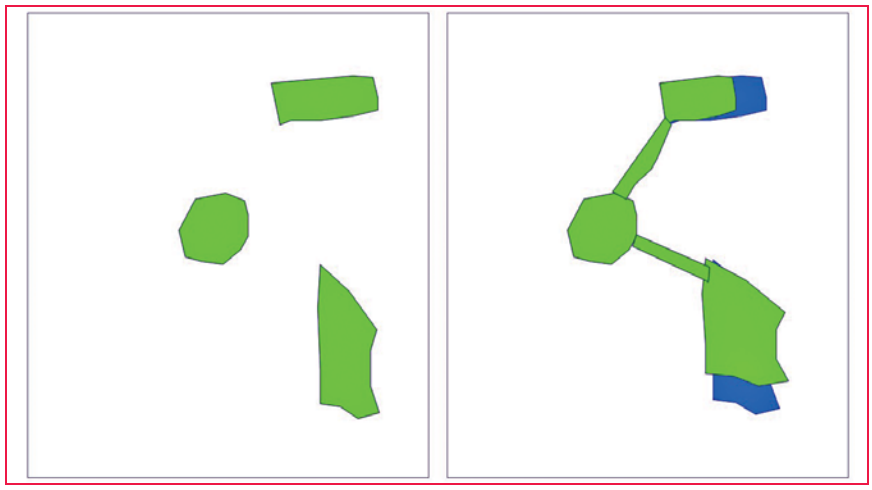


Figure 5: Construction of ecological corridors

undertaken by regional governments. The obligation to manage the land for ecological or nature purposes is connected to the subsidy. This may imply that a change in responsibility in converting the land use and maintaining the quality of land use of the area. Accredited or acknowledged nature organizations may take up that responsibility.

A major problem with creating ecological corridors may be a conflict of norms and perceptions towards the ecological value. A recent public TV documentary on a project in Germany revealed the failure of a 30–year long effort in participation and consensus building in order to reach a decision between the protection of local fauna versus the construction of a highway in a rural region (Bosse 2016). The rationality of the cost/benefits of road infrastructure was incompatible with ecological value systems, whilst changes in public or private ownership rights resulted in public resistance. Hence, land mobilisation decisions related to ecological corridors need to resolve incomparable public and private interests in land use at both national and local scales.

Replacement / extension of urban / city boundaries

The enormous urbanisation rate in especially countries in transition, such as China and Vietnam, often requires a redefinition and re-delineation of urban boundaries (Figure 6).

Long et al. (2013) compare various methods to compare anticipated or planned urban growth with de facto urban growth. They conclude that current models are not appropriate to manage and control urban growth resulting in ever growing urbanized areas. Land is needed for this rapid urban expansion which is accompanied by large-scale land conversion from agricultural or ecological lands to residential or industrial lands. This is not only accompanied by a formal land use conversion, but also by a change in responsibility to uphold the living or use quality certain areas (or simply put: a change in spatial governance) and a significant socio-spatial change (framers becoming urban residents). Thanh et al. (2016) clarify how these accompanying changes are shaping up, and observe that even with financial compensation of converted farmers the social implications are more drastic than anticipated. They not only lose their land, but also lose their livelihood and daily social network.

Discussion – aggregated changes due to land mobilisation intervention

Change in governance (ΔG)

All types of land mobilisation can only start with a formal decision of a government agency. Besides a land use planning decision or a re-definition of boundaries, the process also involves a land re-allocation or land consolidation process. In this process a committee may be established with stakeholders who may contribute to the preparation of the re-allotment plans and ultimately also decide on actual re-allotment. Most land mobilisation projects differ however from typical land consolidation projects for agricultural purposes in the sense that the compensation may not be in form of agricultural land, but in financial terms. Most land consolidation laws still do not foresee a compensation in terms of ecological value if part of the re-allocation deals with ecological improvement or exchange of plots with ecological value, making mobilisation for ecological purposes still different from most other forms. In this case the governance change primarily affects the stakeholder being responsible for the use of the (re-allocated) plot rather than the actual ownership.

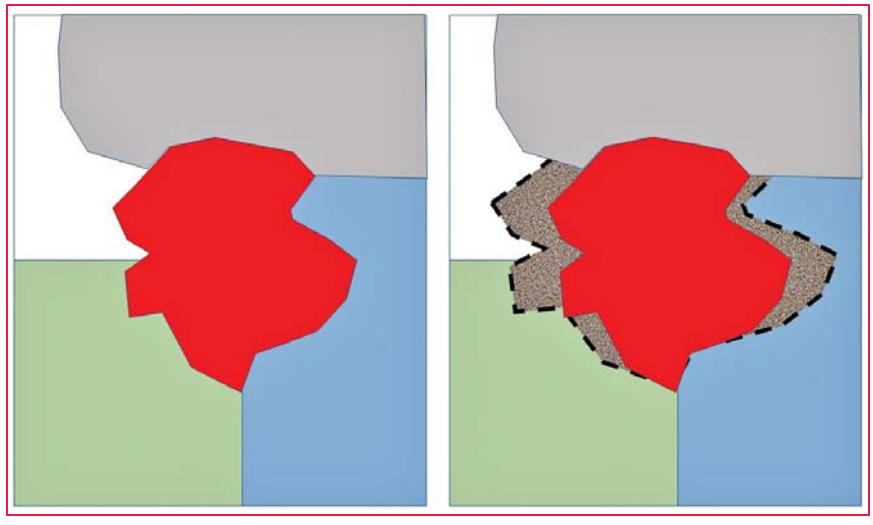


Figure 6: Conversion of land use due to extension of urban boundaries

Change in legal relations (ΔL)

There are various moments in time where land rights change. First, there is a form of expropriation, either voluntary or compulsory. Land rights are transferred from individuals to the State, or a facility – such as a land consolidation committee of stakeholders - supported by the State. Then rights are both reconverted to the private companies who execute the construction and the private or corporate parties who were affected by the project. All-in-all, it leads to a spatial re-allocation of rights.

Change in socio-spatial relations (ΔS)

Land mobilisation for road replacement or for urban expansion often changes agricultural land use to residential and industrial one. This process affects the social and economic daily life of those who were previously only relying on farming. In case of road replacement the process allows for new types of business with access to the new roads, or alongside the new roads. In case of urban expansion providing more housing and residential space within the city boundaries has both positive and negative socio-spatial side effects. Farmers do not just stop being farmers if they are absorbed by the cities. Their social and economic activities were often historically and culturally rooted in their spatial location. It is not so easy to change this at the same pace as the urbanisation rate. As a result, especially in countries in transition, many of them are still struggling to make ends meet and find a new avenues for daily activities. Compensation in money terms is then either not enough or sometimes even not appropriate.

Change in economic relations and dependencies (ΔE)

The economic changes involve both changes in economic opportunities due to the land mobilisation effects (e.g. new types of businesses along the new roads or improved waterways, or ecological tourism activities in the ecological corridors), a dramatic change in land value (given the change of access and mobility), as well as a shift in government expenses (given the cost for the acquisition and conversion of land). To which extent the acquisition processes are cost-effective and cost-efficient depends however to a large extent on how much administrative transaction costs can be kept to a minimum and the degree to which the anticipated benefits can be realised. Groetelaers et al. (2013) provide a normative framework to demonstrate that costs for land acquisition are often underestimated. This may be due to the delays, or due to underestimation of amount of parcels and diversity in (often undocumented) existing land tenancy and land use relation in a certain area.

Change in perceptions, beliefs and values (ΔP)

Land mobilisation is often built on different rationalities and norms and as a consequence different perceptions and values of what is considered appropriate. The conflicts in values systems become most apparent when land with economical value needs to be exchange or converted into land with ecological value, or vice versa. There is no universal value system available to make this exchange acceptable and appropriate to all stakeholders. Consequently, land mobilisation projects tend to prioritize one rationality over another. The examples discussed above show that usually the economic rationality prevails, even in the land mobilisation for ecological corridors (where still emphasis is placed economic means for managing the corridors).

Change in behaviour (ΔB)

Land mobilisation may inflict several behavioural effects. Land speculation may emerge once people or firms become informed of a land mobilisation project, knowing that it usually results in properties with more value. In addition, compensation demands of affected parties may increase, knowing that without their plots the entire project may be delayed. So, the project creates new dependency relations on the basis of which opportunistic behaviour may arise.

Conclusion

The example indicate that land mobilisation is more than just a spatial legal conversion of land. In all phases of a land interventions – preparation, execution and finalisation – changes in governance, legal, social, economic relations, perceptions and behaviour occur.

Further comparative research is recommended to which extent countries effectively and efficiently employing their legal instruments for land mobilisation and under which conditions and by which factors perceptions and behaviour change before, during and after a land mobilisation process. This is important to understand how to manage the socio-economic dynamics which develops in conjunction with the land mobilization.

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The evolution of UAVs applications in urban planning

This paper attempts to review on the evolution of UAVs application from the urban planning perspectives

Norzailawati Mohd Noor
Department of Urban and Regional Planning, Kulliyah of Architecture and Environmental Design, International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur, Malaysia

Nur Aulia Rosni
Department of Urban and Regional Planning, Kulliyah of Architecture and Environmental Design, International Islamic University Malaysia, Jalan Gombak, Kuala Lumpur, Malaysia

UAVs/drones can be simply defined as robotics planes. It is also known as Unmanned Aerial Vehicles (UAV), unmanned aircraft systems (UAS) and remotely piloted aircraft (RPAs) Ivosevic et.al. (2015). Malaysia Department of Civil Aviation (2008) defined UAVs/drones like an airplane which is designed to function without a human pilot on board. UAVs/drones have evolved and rapidly developed over past decades mainly for military and civilian purposes. After a few decades passes, UAVs/drones are used for non-military purposes such as for atmospheric research, earth and weather observations as well as remote sensing applications (Kellington et al., 2015). Recently, its low-cost monitoring and low-impact solutions encourage the usage of UAVs/drones in a broader context such as mapping tools for environmental monitoring.

The United States made it as a necessity to integrate Unmanned Aircraft Systems into the National Airspace System, which includes all aircraft, manned or unmanned to abide by the regulations provided by Federal Aviation Administration (Rango & Laliberte, 2010). In Malaysia, Department of Civil Aviation (DCA), Malaysian Communication and Multimedia Commission (MCMC), Jabatan Ukur dan Pemetaan Malaysia (JUPEM) and Selangor Town and Country Planning Department are among the responsible government agencies in monitoring UAVs/drones activities in Malaysia. The rules and regulations designed for UAVs/drones highlights on a few aspects that control its usage such as, the surrounding conditions, types, and size of UAVs/drones, categories of users as well as safety, privacy and security.

However, the use of robotic planes or UAVs/drones in urban planning is still in the infancy stage of development, especially in Malaysia. Recently, many research groups around the world have worked to improve the remote sensing UAVs/drones application to monitor inaccessible areas and mapping it. If remote sensing UAVs/drones were to apply vastly in various aspect especially in urban planning, there is a need to regulate laws and zones for the UAVs/drones users to comply. UAVs/drones technology used in urban areas raises important questions and concerns about public safety, privacy, and the potential implications of public and private utility and use. The regulations act as a way UAVs/drones can be utilised without violating the privacy and safety of the public as well as the natural environment and ecosystem.

Theoretical of UAVs/drones usage in urban area

The rapidly evolved technology of UAV or drones, provide potential uses in many aspects of urban life, including in the urban planning fields. Remote sensing UAVs/drone's applications provide a superior low cost, adaptable and accurate data gathering tool for planners (Alexander & Jenkins, 2015; Colomina & Molina, 2014).

Recent Issues Relating to UAVs/drones Usage in Urban Area

Although UAVs/drones may present excellent options for accuracy assessment by providing a real-time, and high-resolution imagery of remote areas without threat to human life or the environment, they are not always ideal solutions for

every situation (Kelly & Kelly, 2014). There are many issues arise from UAVs/ Drones usage, especially in the urban area.

Safety and Security

In this paper, the issues on Safety and Security do not only focus on the people living in the urban area or any parties affected by UAVs/Drones usage but also includes the safety and security aspect of drone users, the equipment, licensing, training and maintenance. The aspect of UAVs/Drones usage sometimes being neglected by users probably due to the cost and lack of awareness and this community is facing a global problem and should strive towards attaining a global solution (Kelly et. al.,2014). The most important part is to create awareness of the community with efforts by all global stakeholders in UAV/Drones applications. International synchronization of rules and regulations about the use of drones in the urban airspace to ensure the aspect of safety and security can only be achieved if there is continued contact, co-ordination and co-operation between all the stakeholders involved.

Privacy

Recently, many types of UAVs/drones became widely available due to affordable prices and stable flight performance. UAVs/drones can capture the scene from different points of view, and can get close to targets which as a result, they can collect private personal data. This situation alerts a new dimension to issues around privacy and calls for appropriate privacy protection solutions (Bonetto et al 2015). Moreover, the domestic use of UAVs/ drones by law enforcement has become a popular topic in the U.S leading to the establishment of FAA Modernisation and Reform Act of 2012. The act fixed that the FAA must integrate the unmanned aircraft systems which include UAVs/ drones into the national airspace by September of 2015. Due to this matter, some organisations have expressed concern over the possibility that thousands of UAVs/drones will be crowding the skies, and the risk of improper safeguard on aerial surveillance (Mcneal, 2014).

The domestic use of UAVs/drones by law enforcement is likely to prompt privacy debate. It can be a valuable tool in certain kinds of operations by the law enforcer where they are liable to use UAVs/drones in tactical operations and to view public spaces clearly. Nonetheless, the Legal experts say they will have to obtain a warrant to spy on private homes. (Kohn, 2016) designs a city that is UAVs/drones-proof. He argues that a town that's impermeable to the newest instruments of war not be just a novelty, but it is a necessity. On the other hand, the potential for hijacking a UAVs/drones has already been realised among hobbyists and enthusiasts, and as UAVs/drones become commercially accepted. There will be a need for secure communications between the UAV and ground control. This security issue may require either, or both, a semiconductor and software solution. The issue should be addressed before the commercial market expands and the potential dangers arise (Hoy, 2015).

UAVs/Drones used in urban areas

Many remote sensing applications have benefited from the use of drones due to the cost of the mission, the need for quick response or even the fact that observations need to be carried out in an environment that may be dangerous or inaccessible to an individual. Many types of research have been done with the adoption of UAVs/drones with remote sensing techniques. The studies includes archaeology (Agapiou & Lysandrou, 2015), monitoring vegetating area (Salamí, Barrado, & Pastor, 2014), 3d modelling and tree species cataloguing in a park area (Gini et al 2012) and rangelands studies. Other studies include using this application for post-disaster management. In Japan, UAVs/Drones are used as part of farm equipment and for environmental conservation purposes like tree plantation and orang-utan habitat distribution (Chen, Shioi, Montesinos, & Koh, 2014).

In the urban area, Hermes 900 is one example of high-endurance UAVs/ drones with longer flying time that being use to patrol stadium for national events such as World Cup 2014 and in-coming Olympic Games 2016 (Pool, 2016). UAVs/drones modern machinery that can be selected for a broad range of applications to improve the way we work, play, and live. For example, UAVs/drones are used in Singapore today for diverse applications ranging from emergency operations, research, to urban planning and design (Authority, 2016). Bonetto et al., (2015) inventively studied the use of UAVs/drones for surveillance in the urban area, e.g. car park, and recreational park with the Crowdsourcing method. Crowdsourcing-based evaluation of privacy trade-off in video surveillance has shown good consistency with laboratory-based studies. The crowdsourcing methodology benefits from a large number of participants and can be performed efficiently and at a relatively low cost with drone applications. Nonetheless, there is some evidence that the use of UAVs/drones is gaining traction among law enforcement agencies responsible for public security. Some countries began using UAVs for surveillance, like law enforcer in Brazil used UAVs in special urban operations such as tracking a top drug kingpin (Pool, 2016

Context of urban planning

Urban planners and other city personnel are often tasked with the difficult job of renovating a section of the city. With aerial UAVs/drones photography, the photo and video of the block or area that is to be renovated can be precisely captures. In the urban planning context, the rapid response imaging using UAV/UAVs/ drones has received much attention as well which has been demonstrated by road accident simulations, Pedestrian Detection on TUD-crossing Image Sequence (Chen et al., 2014), traffic monitoring as well as zoning and land use planning (Alexander & Jenkins, 2015). The authors also listed some UAVs/drones applicability in urban area such as Window Cleaning UAVs/ drones, Fog Dissipation, Power Grid Monitoring, Site Inspector UAVs/drones, Fully automated paid parking system UAVs/drones, Autonomous Infrastructure Mapping and Evaluation Robot, Coupling of UAVs/drones with Public Buses, UAE

Falcon to allocate accidents, UAVs/drones used for organ transportation in emergency cases, Sky Net Delivery Catchment System, UAVs/drones for Planting 1 Billion Trees a Year, and lastly drones used to scan and probe lakes, rivers for emerging pollutants and threats.

Schroyer, (2014) in his journal listed several UAVs/drones applications such as in Agriculture for weed management, UAVs/drones assist in disaster management such as Fukushima Disaster in 2011 and post-hurricane mapping in the Philippines in 2014. Urban planning in Albania using UAVs/drones application for running the smart city in 2014, and demand for infrastructure as well as detecting illegal dumping site potential to affect the environment negatively. Some stated that a difficulty in gaining cloud-free scene at the region from satellite platforms. It can be solved by using aerial imagery as an effort for introducing an economical method of remote sensing data; which only requires UAV/Drones to be used with a digital camera to provide near-time data. The results indicated that the drones with a high-resolution digital camera could reduce the time and cost of images acquisition for LULC mapping.

The Singapore Urban Redevelopment Authority is currently exploring the use of aerial images captured by UAVs to create 3D digital models of heritage building and sites in the city areas. The process is done using a technique called photogrammetry, which is the science of making measurements from photographs (Authority, 2016).

Drones law

In the United States, the airspace above 700 feet is restricted under federal regulations, only the airspace 30 feet from the ground surface considered as part of individual property rights. Property owners can sell the airspace ownership through a transfer of development rights. According to Hoy, (2015), the U.S. Congress has ordered the Federal Aviation Administration (FAA) to put into effect a plan to allow commercial UAVs/drones in the U.S. airspace in 2015 while The European Union has a similar deadline set for 2018. However, a different situation is a practice in Malaysia where the land owner fully own both the airspace and the underground within the owned land as stated in Section 75B, National Land Code 1965. Due to this situation, the Legal consideration in the exercise of the powers on UAV/Drones operations in Malaysian Airspace stated that there are two categories of Unmanned Aerial Vehicles comprise of civil aircraft and state aircraft. As previously mentioned, UAVs/drones operating in Malaysia falls under "Malaysia Aircraft" which means it must fulfil the safety and operational standards as the manned aircraft.

Analysis Inter Countries

Among countries in Europe, France has the largest number of drone operators which is over 1,600 registered companies. Due to that, France has one of the most advanced laws on the use of civilian drones. Paris, the capital city of France, is zoned as a restricted area for flying. Any illegal use of a drone in this city will cause a maximum of five years' jail and €75,000 (USD 84,400) fine. The French law also prohibits small citizen drones from sensitive areas such as nuclear facilities, which are protected zone that extends at the 2.5km radius and a height of 1,000m (MLV Drone, 2015).

Transport Canada is the agency that controls the Canadian air space. The agency has set a clear line for UAVs/Drones between "commercial use" and "recreational use". The recreationally used aircraft which is under lighter regulations which require being less than 77.2 pounds in weight, must be individually owned and non-profit-seeking. Aircraft which do not meet this criterion are officially considered as "unmanned aerial vehicles for commercial use" and require Special Flight Operations certificates. The certification requires a very strict process that includes a detail list of specifications. For example, a UAV can meet the three model aircraft standards listed above, but if it is also attached to a small camera, then the UAV defined by the category of an "unmanned aerial vehicle" under the law.

Currently, in Mexico, no regulations are affecting UAVs/Drones users. The government also uses UAVs for various purposes from detecting drug-dealing activity to university research (Mexico Moves to Regulate Use of Drones, 2015). Brazil has become a leading player in UAVs/Drones usage for South America. On the national level, the country is spending intensely in UAVs/Drones usage to patrol its borders (Agencia Nacional de Aviacao Civil, 2015). In 2013, a company, XMobots, has been permitted to fly the first civil drone for the purpose of monitoring Jirau dam (Stochero, 2013).

However, in the United Kingdom, the UAVs/Drones laws are similar to the current policies of the United States of America. The laws are more like guidelines than a comprehensive set of regulations. Currently, CAP 722 claims jurisdiction over UAVs/Drones use in the United Kingdom. The legislation divides the use of UAVs/Drones into two groups which both groups require permits. The weight limit of the UAVs/Drones cannot surpass 20.7kg for it to be considered as a "small unmanned aircraft" (Castella, 2014).

Australia and New Zealand that share the same law, however; New Zealand does not require identification requirement. The Aviation Industry Association of New Zealand has planned legislation on UAVs/Drones, but the suggestion is apparently more of a non-restrictive manual for UAV use than anything. An "unmanned aircraft system" is Australian terminology for a UAV used for profit-seeking "air work," but such commercial use only requires some easily available identification. Otherwise, the UAV is a "model aircraft, flown for sport & recreation and education," according to the Civil Aviation Safety Authority. Model aircraft are completely hands-off in terms of regulation

Singapore Air Navigation Order requires permits to be attained for flying a drone within 5km of an airport or air base. The same requirement applies for flying a drone higher than 61m above the average sea level. An application to conduct aerial photography from a camera-mounted

drone must also be submitted to the Civil Aviation Authority of Singapore (CAAS) (Civil Aviation Authority of Singapore, 2015). The new regulation basis stipulates that users need a permit to fly a drone that weighs more than 7kg, as well as for commercial purposes. Specialised services like surveying, aerial advertising or the discharge of any substance from the drone will also require a permit. In addition, security-sensitive locations and special event areas - for instance, at the upcoming SEA Games - will be gazetted as "protected areas" and those without a permit will not be allowed to fly drones or take aerial photographs of these regions (Chan, 2015). A list of security-sensitive areas where such aircraft are not authorised to fly without a permit, like the Istana, will be published.

In Malaysia, it is the policy of Malaysia Department of Civil Aviation that Unmanned Aerial Vehicles must meet or surpass the operational and safety standards as the manned aircraft. Thus, Unmanned Aerial Vehicles operations must be safe as manned aircraft as to not cause or create any harm towards a persons or property in the air or on the ground (Department of Civil Aviation, 2008). The civil UAVs/drones which not exceed 20kg are prohibited in controlled airspace or within aerodrome traffic zone without permission of air traffic controller. Operators must receive authorisation from the Department of Civil Aviation before flying a UAV.

Aspect the drones law and regulations

Most countries imposed the laws and regulations on UAVs/Drones concerning a few important aspects which are safety, security and privacy. All of the mentioned aspects are applicable to all main components in UAV/Drones application which are; the users, the UAVs/Drones and the air space. The type of users defines on what kind of drones they are using and skill in handling the equipment. The types of users and equipment also justify user's ability to fly in different types of airspace without neglecting the safety requirement as to avoid causing disturbance to any parties. Some country has very specific area in term of regulation on air space where the drone are prohibited, restricted and allowed to fly. Some countries outline the zoning for the drone, which in this case, identify the type of land use and its activity varies crucial before the drone zone could be implemented. Some zones are fixed, such as buildings and gathering square. But there is a country that very detail in defining the airspace. The temporarily prohibited area, for example, are not fixed, it is based on events and occasions that held in that particular area in some certain timeframe. There are pros and cons come along with UAV technology, but with best-designed guidelines and zoning for its applications will give more positive impacts and open to new findings in urban planning in particular, and reduce the negative impacts and a grey area in legislation statutes.

Conclusion

Drones are a highly adaptable technology that is constantly changing in innovative ways to provide greater utility. This tool provides planners with a source of unique aerial data by which they can better inform the client and public. Drones are also relatively inexpensive, providing access to data and information which was previously cost prohibitive for many planning tasks; such as with satellite technologies. Therefore, due to both the adaptability of the technology and the low cost of drones compared with alternatives, the utilisation of drones in urban planning provides one of the most cost-efficient data collection and transport task utility tools of our time. If Malaysia is able to come out with a comprehensive drone zoning for urban planning purposes and progressively address the issues surrounding the remote sensing drones applications, then this technology can help to plan for, and monitor progress towards sustainable urban development.

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GIS mapping in smart city in Odisha, India

In wake of land encroachment in the heart of Odisha capital, the government has decided to use GIS to keep records of all the lands in the smart city. Odisha Space Application Centre (ORSAC) has been assigned for the GIS mapping of the land under Bhubaneswar Municipal Corporation (BMC).

The land records of 65 mouzas will be digitized. In first phase, a blueprint has been prepared for Bapuji Nagar mouza with the land records of different zones including yellow zone, green zone, red zone and environment sensitive zone. As the land record of the government land is not available for now due to land encroachment, problems occur for execution of various government projects in the land. Even, the government is not able to acquire land for any project. As per the decision, the land bank will be formed and all the details of those lands will be kept in the record by using the GIS. *http://odishasuntimes.com*

Satellite mapping of Kedarnath, India soon for boosting tourism

The state government Uttarakhand is set to conduct mapping of Kedarnath area, including the famed shrine town, using high-resolution satellite images to regulate tourism activities. This will be followed by preparation of the Kedarnath Master Plan that covers an area of more than 500 hectares.

The Uttarakhand Tourism Development Board (UTDB) invited bids from consultant firms for surveying and mapping of Kedarnath Development Area (KDA) located in Rudraprayag district using satellite imagery data and aerial photography. *www.hindustantimes.com*

Cadcorp launches Risk Modeller

Cadcorp has released a new application to help fire services determine aggregate risk. Risk Modeller provides analytical functionality for determining risk by combining the effects of spatial and attribute data from a range of different layers. *www.cadcorp.com*

GHGSat unveils Satellite Imagery of Greenhouse Gas

GHGSat Inc. has unveiled sample imagery from its demonstration satellite, Claire (or GHGSat-D), which has detected emissions of methane from a hydroelectric facility under construction in Africa. GHGSat's vision is to become the global reference for remote sensing of greenhouse gas (GHG) emissions from industrial sites, using satellite technology. Claire captures an array of over 200,000 atmospheric measurements around an industrial facility in a few seconds.

These measurements are processed to produce imagery showing a "heat map" of greenhouse gas concentrations from the facility. It is the world's first and only satellite designed to measure greenhouse gas emissions from sources on the scale of industrial facilities. GHGSat's sensor technology has also been miniaturized to fit on a low-cost nanosatellite, enabling the company to offer commercial greenhouse gas measurement and monitoring services to help industrial emitters measure, control and ultimately reduce their emissions. *www.ghgsat.com*

SpecTIR LLC awarded RS Contract

SpecTIR will provide National Grid advanced remote sensing data to support their environmental mapping, structural characterization, and for other potential uses. *www.spectir.com*

Space Flight Laboratory (SFL) signs contract with Dubai Space Centre

The Space Flight Laboratory (SFL) of Toronto has announced the signing of a new contract to provide Dubai-based Mohammed Bin Rashid Space Centre (MBRSC) with a microsatellite for aerosol and greenhouse gas monitoring. The DMSat-1 (also known as "AirWatch") satellite will leverage past developments at SFL for a rapidly developed mission that will incorporate two payloads. The primary payload is a multispectral polarimeter used to monitor aerosols – fine particles of liquid and solids in the upper atmosphere normally caused by man-made sources, but also correlating to natural phenomena such as dust storms. The secondary instrument is a pair of spectrometers that will enable MBRSC to detect greenhouse gases like carbon dioxide and methane over the UAE. *www.utias-sfl.net*

At least 15 Russian remote sensing satellites to operate by 2020

The number of operating Russian remote sensing satellites orbiting the Earth will reach 15 by 2020, Russian President Vladimir Putin has said. Currently, a group of eight Russian remote sensing satellites is in orbit around the planet.

He pointed out that the demand for services linked to the use of data obtained by remote sensing was significantly increasing.

"Russia is known to have incontestable competitive advantages in this sphere and we must use them as much as we can. First of all we should increase the orbital group ensuring the remote sensing," Putin said. *http://news.az/articles/world/121925*

DigitalGlobe to provide elevation data to rise broadband

DigitalGlobe, Inc. has announced an agreement to provide elevation data to Rise Broadband to enable faster and more efficient deployment of wireless internet services in the United States. It will provide Rise Broadband, the country's largest fixed wireless internet service provider (WISP), with Vricon's™ high-resolution Digital Surface Model (DSM) data, to rapidly verify fixed wireless broadband service availability to households and businesses in its market areas before sending installation teams into the field. *www.vricon.com*

Remote sensing data shows massive erosion of forests in Kerala, India

A new Indian Institute of Science (IISc), Bengaluru, study named 'Four decades of forest loss: Drought in Kerala' using remote sensing data pins the blame on eroding forest cover. Between 1973 and 2016, Kerala lost 906,440 hectares (9064.4 sq.km) of forest land, as per the study. Consequently, the forest cover as

ISRO successfully launches GSLV MK III-D1 rocket carrying the GSAT-19 satellite

The Indian Space Research Organisation launched the GSAT-19 satellite, one of the heaviest communication satellites, with the GSLV MK III-D1 rocket. The rocket became the heaviest to be launched by the Indian space agency ever with the heaviest single payload put in orbit as well. The rocket has the capability to carry a payload as heavy as 4,000 kg and put in into the Geosynchronous Transfer Orbit. It can also carry a 10,000 kg payload and put in into the Low Earth Orbit.

A jubilant Indian Space Research Organisation (ISRO) Chairman A S Kiran Kumar said it "is a historic day" and the the Geosynchronous Satellite Launch Vehicle Mark-III (MkIII D-1) has successfully demonstrated its capabilities with the injection of GSAT-19 into the desired orbit. "It is a great success in the first maiden attempt and GSLV MkIII has successfully put in orbit GSAT-19 which is a next generation satellite," Kumar said.

The launch marks another success for India's space agency that has made record-setting launches during the past year. ISRO has plans to use the rocket for manned missions in the future. The rocket is a three-stage launch vehicle which has two solid motor strap-ons, a liquid propellant core stage and a cryogenic stage. The rocket is 43.39 metre in height which is roughly the height of a 12-storey building. *http://indianexpress.com*

Galileo update

First Galileo open service performance report published

The European GNSS Agency (GSA) has published its first Galileo Open Service quarterly performance report. It covers the first three months of 2017, is available online in the GSC Electronic Library.

Following the Declaration of Initial Services in December 2016, the GSA will publish a new Galileo Initial Services Open Service report after each quarter. The quarterly reports aim to provide the public with the latest information on the Galileo Open Service's performance.

The document reports on such parameters as:

- Galileo Initial Open Service ranging performance
- Galileo Coordinated Universal Time (UTC) dissemination and Galileo to GPS time offset (GGTO) determination performance
- Galileo positioning performance
- Timely publication of Notice Advisory to Galileo Users

Each of these parameters is examined with respect to their minimum performance levels (MPLs), as declared in the European GNSS (Galileo) Open Service Definition Document (OS-SDD).

Highlights from Q1 2017

In the first quarterly reporting period after the Declaration of Galileo Initial Services, the measured Galileo Initial Open Service performance figures generally exceeded the MPL targets specified in the OS-SDD by significant margins.

Some highlights from the report:

- Availability of the Galileo ranging service at the worst user location, with monthly values of 100 percent, is significantly above expectations, where the MPL is 87 percent.
- The signal in space ranging accuracy shows a 95th percentile monthly accuracy better than 1.07 [m] for individual space vehicles.
- Availability of the Galileo UTC time determination service was achieved, with a monthly value of 100 percent, compared to the [OS-SDD] MPL target of 87 percent.
- Availability of GGTO determination (not declared as a service in this phase) was 100 percent in January and March. February showed a slightly lower figure of 96.44 percent, although still well above the [OS-SDD] MPL target of 80 percent.
- Excellent values were achieved for UTC time dissemination service accuracy. The measured Galileo Initial Open Service performance figures generally exceeded the MPL targets specified in the OS-SDD by significant margins.

a percentage of total land area has been reduced from 66.2% to 42.15%. In other words, Kerala has diverted more than 50% of its total forest area for other purposes since 1973 (from when the remote sensing data is available). But the drastic reduction in forest cover points towards the massive land use changes in the state, said Ramkrishnan Ramabhadran, who along with senior scientist T.V. Ramachandra, authored the IISc study. *www.livemint.com*

ESA to investigate 3D printing potential for space projects

ESA is establishing a 'one-stop shop' in partnership with the Manufacturing Technology Centre to cover 3D printing. The MTC research organization will manage the new ESA Additive Manufacturing Benchmarking Centre (AMBC), which will provide a simple and easy way for ESA projects and hi-tech companies to investigate the potential of 3D printing for their work. The move will see the ESA call on the expertise of the MTC, which offers access to the latest state-of-the-art 3D printing capabilities, allowing prototype parts to be produced and then assessed in terms of their suitability for specific applications.

NASA advances world's first spaceborne Sodium Lidar

It's used as a coolant in nuclear power plants and as a desiccant to remove humidity that otherwise would ruin moisture-sensitive products. Found in every cell in the human body, it transmits nerve impulses and regulates blood pressure. And as it turns out, sodium — the sixth most abundant element in Earth's crust — also is useful as a tracer for characterizing Earth's mesosphere, a poorly understood region of Earth's atmosphere that's sensitive to both the influences from the sun above and the atmospheric layers below. A team of scientists at NASA's Goddard Space Flight Center in Greenbelt, Md., now wants to develop the world's first spaceborne sodium lidar that would illuminate the complex relationship between the chemistry and dynamics of the mesosphere that lies 40-110 miles above Earth's surface — the region where Earth's atmosphere meets the vacuum of space. *www.nasa.gov*

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Icaros releases Version 5.0 of OneButton™

Icaros Inc. has released version 5.0 of OneButton™ Standard and Professional image processing software for UAVs. It has been developed for geospatial end users to easily and automatically generate precise, fully orthorectified 2D maps and 3D models from frame-based aerial imaging systems. Originally engineered for manned aircraft sensors, the software has been modified to accommodate the unique collection conditions of unmanned aerial systems (UAS). OneButton is application platform and sensor agnostic, and processes raster image data from small, medium, and large-format frame sensors capable of capturing visible RBG, multispectral, near-infrared, and thermal infrared data. *www.icaros.us*

New Mapping Software from Pix4D

Pix4D has released version 3.2 of Pix4Dmapper Desktop. The new version features upgrades in stability and usability. Uploading desktop projects to the cloud is now 10 times faster. Camera parameter correlations are displayed in the quality report for easier troubleshooting and assessment. Also, new key output: tiled level-of-detail mesh is available in osgb and Esri formats and the software is now available in Russian language. Similar to tiled maps or vectors, LoD mesh is stored in multiple hierarchies. This allows loading the mesh geometry and texture only within the visible extent and at different level of details based on zoom scales. Without this technique, users can load the entire file before taking any actions.

Court of Appeals strikes down FAA Drone Registration Rule

An appeals courtstruck down a Federal Aviation Administration (FAA) rule that required owners of drones used for recreation to register their aircraft. The FAA has released the following statement in response to the decision:

Brian Wynne, president and CEO of the Association for Unmanned Vehicle Systems International (AUVSI), has also issued a statement on the U.S. Court of Appeals decision:

"AUVSI is disappointed with the decision by the U.S. Court of Appeals to reject the FAA's rule for registering recreational unmanned aircraft systems (UAS). A UAS registration system is important to promote accountability and responsibility by users of the national airspace, and helps create a culture of safety that deters careless and reckless behavior. We plan to work with Congress on a legislative solution that will ensure continued accountability across the entire aviation community, both manned and unmanned."

UNSW develops autonomous 3D mapping drone

Researchers from the University of New South Wales (UNSW), Australia have created an autonomous 3D mapping drone that reduces map surveying times. The university's engineering researchers, together with Linke & Linke Surveys, developed the unmanned aerial vehicle (UAV) using spinning light detection and ranging (LiDAR) technology that produces accurate 3D maps of key areas.

It weighs approximately 12kg and can travel for up to 18 minutes over any terrain, able to deliver data in real time from 30,000 reference points per second. *www.australianmining.com.au*

Singapore joins global panel to regulate drone use

Singapore has joined a 15-member group set up by the United Nations' civil aviation arm to draw up global rules and regulations for the safe use of unmanned aircraft, including drones. The team, formed last year, comprises eight countries, including the United States, France and China, as well as industry bodies like the global pilots' association.

In December last year, the group came up with an online toolkit to provide the aviation authorities and regulators with information on unmanned aircraft and how they can be safely operated. The next step is to develop a more comprehensive global framework that will address concerns that pilots and other stakeholders might have.

The sooner this framework is agreed upon internationally, the sooner the industry will be able to align their developing UAS businesses within harmonised systems, according to ICAO. *www.straitstimes.com*

Dutch start-up launches next generation mapping drone Marlyn

Drone company Atmos UAV launches Marlyn, a lightweight drone which flies automatically, effortlessly and at high wind speeds. One of the first customers that signed up is Skeye, Europe's leading unmanned aircraft data provider.

This brand new technology allows industry professionals around the world to map the surface 10 times faster and guarantees no more drone crashes.

Drones comprehensive policy on the cards in Kartnaka, India

Karnataka will soon become the first state in the country to use drones in all its departments. The state government is planning to come up with a comprehensive policy on using Unmanned Aerial Vehicles (UAVs) in various government departments following Karnataka Jnana Ayoga (KJA) recommendations. Drones will be used in the state to gather information on drought, monitor crowds, tackle forest fire, survey encroachment and perform several other tasks.

KJA, headed by former ISRO chairman K Kasturirangan, is framing the draft policy and recommendations will be submitted to Chief Minister Siddaramaiah in June. *www.newindianexpress.com*

Naval Research Laboratory Moving Forward with Autonomous Solar UAV

Researchers at the U.S. Naval Research Laboratory, Vehicle Research

Section and Photovoltaic Section have investigated the presence of solar photovoltaics to the cooperative autonomous soaring techniques to enable long endurance flights of unmanned sailplanes that use solar power.

The Solar Photovoltaic and Autonomous Soaring Base Program and the U.S. Marine Corps' Expeditionary Energy Office have begun to improve UAV's so they can support a round-the-clock information, surveillance and reconnaissance mission, which would be able to benefit warfighters because it will reduce the amount of batteries or fuel needed to carry into battle and improve the availability of continuous coverage of ISR assets.

The UAV with solar arrays was able to fly for 10 hours and 50 minutes last October without using the entire charge on the battery. Another UAV took off in April and flew for 11 hours and two minutes while using significantly less battery power. *www.rdmag.com*

Brazil drone ops to be regulated by its National Civil Aviation Agency

The Brazilian National Civil Aviation Agency (ANAC) approved the text that regulates the operation of drones for commercial purposes throughout the Brazilian territory.

The regulation brings standards and procedures that guarantee legal and operational safety and will have a great impact on the market's sustainable growth.

According to the ANAC, the objective of the new regulations is to make viable Drones operations in Brazil, keeping in mind the safety the people.

Briefly, the regulations divide the equipment into three categories:

- Drones under 25 kilos
- Drones between 25 and 150 kilos
- Drones over 150 kilos

For drones over 25 kilos or for any flight over 120 meters high, the pilot must undergo training and be over 18 years of age. For equipment between 250 grams and 25 kilos, the user should only register on the Agency's. *www.anac.gov.br/*

Lockheed Martin introduces Indago 3 quadrotor

Lockheed Martin has introduced its newest variant of Indago quadrotor drone for sensitive intelligence, surveillance and reconnaissance missions. The new variant goes by the name, Indago 3, comes with Enhanced ISR capability, with the addition of TrellisWare Technologies MANET software. It has a minimal radio frequency footprint through the use of TrellisWare's TW-600 Ocelot module.

The Indago 3 system features improved propulsion technology for reduced noise signature, extended flight time, a military-grade encrypted and secure data link, mesh-capable video dissemination and long-range radio for long distance operation at low altitudes.

STMicroelectronics and Allystar partnership

STMicroelectronics is working with Allystar to develop and market GNSS solutions for automotive products and other applications. Allystar is a spin-off from CEC Huada Electronic Design Co. Ltd. and a Chinese GNSS chip designer. ST and Allystar are already co-marketing products for the automotive market and cost-competitive products for the consumer market.

Glonass delivered to Armenia

GLONASS has been delivered to Armenia, Armenia's Ministry of Transport, Communications and Information Technology said. Armenian specialists from the ministry of transport, communications and information technology, the Crisis Management Center of the Ministry of Emergency Situations, the Byurakan Observatory and Yerevan State University and Russian space agency Roskosmos will soon discuss the system's installation in Armenia. *http://asbarez.com*

Gatwick Airport now has 2,000 beacons for indoor navigation

The UK's second busiest airport, Gatwick, has opted to power an indoor navigation system it's launching as part of a wider, multi-year transformation program.

It's now finished kitting out its two terminals with around 2,000 battery-powered beacons so that digital map users will get a more accurate blue dot as they wander around. The beacon system will also be used to power an augmented reality wayfinding tool— so that mobile users will be able to be guided to specific locations within the terminals via on-screen arrows. The beacon system is slated as supporting positioning with +/-3m accuracy.

Gatwick is planning to integrate indoor positioning into some of its apps, and says it's in discussions with airlines to tap into it for their own apps and services — giving example of them being able to send push notifications to warn passengers if they're running late, or even make a decision on whether or not to wait or offload luggage so an aircraft can take off on time.

Retailers and other third parties will also be able to use the system for proximity detection of potential shoppers and push marketing messages and offers — at least to those who have opted in to receive them. *https://techcrunch.com*

China launches advanced satellite navigation positioning system

China has launched national satellite navigation and positioning system. It is the largest in the country and boasts the widest coverage. Li Weisen, deputy director of the National Administration of Surveying, Mapping and Geoinformation, said that the system consists of 2,700 base stations, a national database center and 30 provincial level database centers.

The system, featuring faster speed, higher accuracy and wider coverage, will be compatible with other satellite navigation systems, such as the BeiDou Navigation Satellite System and GPS. According to the administration, the system is able to provide positioning service to transportation, emergency medical rescue and city planning and management. *www.shanghaidaily.com*

Japan mulls seven-satellite QZSS system

The Japanese government is considering adding an additional three satellites to the country's domestic navigation system in order to ensure that it would work with or without the U.S.'s GPS system.

Japan's Quasi-Zenith Satellite System, or QZSS, currently calls for four satellites, of which only one is in orbit.

Colonel Shinichiro Tsui, a counsellor in Japan's Cabinet Office, said \ that the next three QZSS satellites are all scheduled to launch this year, followed by service activation in 2018. Those satellites, provided by manufacturer Mitsubishi Electric, would augment GPS signals, Tsui said, honing their positioning accuracy from sub-meter to centimeters.

Tsui said Japan's goal would be to have a seven-satellite system in orbit by 2023. *http://spacenews.com*

One satellite to be launched for GLONASS system by end 2017

At least one navigation satellite for the GLONASS system will be launched into orbit before the end of this year, Reshetnev Information Satellite Systems CEO Nikolay Testoyedov told TASS in an interview.

At present, there are 27 satellites in the GLONASS group, 24 of which are functioning for their intended purposes, one is being studied by the chief engineer, another is being held in reserve, while one other satellite is still in the flight testing phase. It should be noted that more than half of the operating satellites' warranty have past their deadline. *http://tass.com/science/946052*

The UK driving test will soon include a GPS navigation section

The UK is changing its driver's license testing, and the process is getting a technological update for the modern era. As part of the practical exams given to new drivers starting in December 2017, potential licensees will have to prove that they are capable of navigating by GPS.

According to the government announcement on the changes to the test, most would-be drivers will be required to follow directions from a satellite navigation device during their test. This "independent driving" portion of the test will last 20 minutes, about half the total amount of time of the exam. Not everyone will be subject to the GPS test, though; one out of every five students will be asked to navigate based on traffic signs instead. The new exam procedure will debut on December 4, 2017. *http://mentalfloss.com*

Leica Ready now offered on Liebherr dozers, excavators

Leica Ready machine control kits will now be offered on dozers and excavators by Liebherr, one of the world's largest manufacturers of construction machinery. Working with high precision GNSS, Leica Ready kits bring increased accuracy and improve efficiency up to 30 per cent. Enabling swift and fast installation of Leica Geosystems' Machine Control systems, such as Leica iCON iGD4^{SP} Dual GNSS and iGD3 3D for bulldozers and the Leica iCON iXE3 system for excavators, return on investment is easily realised.

"Being able to offer Leica Ready on Liebherr dozers and excavators will help construction operators increase productivity and improve efficiencies in their operations. Combined with our newly released MSS400 sensor series for excavators, construction professionals will have the very best available machine control at their fingertips," said Johan Arnberg, Leica Geosystems Machine Control Division president.

Global alliance agreement between Rockwell Collins and QinetiQ

Rockwell Collins and QinetiQ have signed a global alliance agreement to collaborate on the development of next-generation, multi-constellation open service and secure GNSS receivers. The effort will support the critical mission needs of military, government and critical national infrastructure. *www.rockwellcollins.com*

2G Robotics selected as official supplier to the Royal Norwegian Navy

2G Robotics has been selected to supply AUV-based laser scanning, stills imaging, and illumination solutions for HUGIN AUVs to be delivered to the Royal Norwegian Navy. As part of this relationship, 2G Robotics is looking forward to being involved in the upcoming, state-of-the-art mine countermeasure project and would like to congratulate Kongsberg Maritime and

Trimble SiteVision Prototype

SiteVision is designed to be used outdoors—presumably for certain construction design and mining applications—so it doesn't require the complex locating technologies used when access to positioning satellites is denied. Instead, it implements Trimble's Catalyst GNSS solution, which uses software and a powerful antenna to locate a mobile device to within a few centimeters. SiteVision combines Catalyst with a Lenovo Phab2 Pro. This phone is one of the first Google Tango-enabled mobile devices.

Real-Time Remote Diagnostic System for Euromaint Rail

Euromaint Rail has deployed the Trimble® R2M real-time remote diagnostic system to manage the maintenance of fleets running on Stockholm Commuter lines and Norrtåg regional rail lines. The deployment is part of Euromaint Rail's Remote Vehicle Monitoring (RVM) program to enhance its customer service by providing a modern and reliable condition-based maintenance strategy. The Trimble R2M real-time remote diagnostic system will be one of the key components in Euromaint Rail's RVM program to support its overall fleet reliability and availability objectives. *www.trimble.com*

the Norwegian Defence Materiel Agency (NDMA) on their latest agreement for the delivery of four complete HUGIN AUV systems. *www.2GRobotics.com*

Jamming robustness available in Septentrio's GNSS receivers

The AsteRx-m2 and AsteRx-m2 UAS OEM boards have been launched by Septentrio. The credit-card sized boards offer all-in-view multi-frequency, multi-constellation tracking and centimetre-level RTK position accuracy for the lowest power of any comparable receiver. Additionally, both can receive TerraStar satellite-based correction signals for PPP positioning. *www.septentrio.com*

Satlab announces SLX-1 Multi-application Receiver Mobile Upgrade

Satlab Geosolutions has released an upgrade to its multi-purpose, multi-frequency SLX-1 GNSS receiver. The SLX-1 was initially released as a CORS receiver but is now able to function as a mobile sensor suitable for any application where a rugged multi-application GNSS receiver is required. The receiver tracks GPS, GLONASS, BDS, Galileo, QZSS and SBAS constellations and can maximise the tracking to observe all visible GNSS satellite signals.

Mobile App for Understanding of the Ocean Anywhere, Anytime

Esri have announced its innovative Ecological Marine Units (EMU) app is now available for mobile devices. The app provides a valuable resource for scientists, educators, governments, and industries seeking easily accessible information and imagery about the ocean's long-term physical and nutrient properties. The EMU app puts data such as temperature, salinity, and dissolved oxygen from 52 million locations throughout the world's oceans at any user's fingertips.

This data informs how livable marine environments are for ocean-dwelling species as well as the overall health of the ecosystem. Organizations involved in fishery planning, for instance, can use the EMU mobile app to review proposed boundaries with a better understanding of which habitats will likely harbor certain species and manage fisheries more cost-effectively.

Swift Navigation enhances cm-accurate GNSS technology

Swift Navigation has announced the first major firmware upgrade to its flagship product Piksi® Multi GNSS Module. The upgrade is available at no cost to Piksi Multi users and expands on dynamic RTK application support, increasing functionality for users, expanding use case applications and allowing users to better leverage existing infrastructure and facilitate post-processing. *www.swiftnav.com*

Spirent to help civil aviation manage GNSS interference threats

Spirent Communications has announced GSS200D interference detector as part of Spirent's partnership with Nottingham Scientific - a solution that enables the civil aviation industry to evaluate the growing threat of GNSS interference, jamming and spoofing. Ground-Based Augmentation System (GBAS) and instrument approach procedures based on Satellite Based Augmentation Systems (SBAS), such as Localizer Performance with Vertical Guidance (LPV) and Required Navigation Performance (RNP), provide air traffic management with cost-effective alternatives while providing equivalent operational performance, according to the company.

GSS200D solution monitors the radio bands used by EGNOS, as well as other GNSS augmentation systems such as the Wide Area Augmentation System (WAAS) or the GPS Aided Geo Augmented Navigation (GAGAN) system, to ensure awareness of interference that could compromise positioning information. *www.satellitetoday.com*

Tersus releases Precis-BX316R GNSS PPK board

Tersus GNSS has released to the market its new GNSS PPK board, the Precis-BX316R, which is a GNSS Post-Processing Kinematic (PPK) board for accurate positioning. It supports raw measurement output from two antennas: GPS L1/L2, GLONASS G1/G2 and BDS B1/B2 from primary antenna and GPS L1/L2 from the second. *www.tersus-gnss.com/*

Ultra-slim, smart antenna GNSS location module by Telit

Telit has introduced a new, ultra-slim family of smart antenna GNSS receiver modules. These fully integrated SL876Q5-A modules

include a comprehensive feature set that eliminates the need for additional components, making them well suited for Internet of Things (IoT) projects with size, cost, and time constraints.

Hemisphere GNSS new OEM board

The new Vector Eclipse H328 is the latest offering in Hemisphere GNSS' line of low-power, high-precision, positioning and heading OEM boards. The multi-frequency, multi-GNSS H328 is an all signals receiver board that includes Hemisphere's new hardware platform and integrates Atlas GNSS Global Correction Service.

In addition to a new hardware platform, the overall cost, size, weight and power consumption of the H328 are reduced. It offers scalability with centimeter-level accuracy in either single- frequency mode or full performance multi-frequency, multi-GNSS, Atlas-capable mode that supports fast RTK initialization times over long distances. The H328 offers fast accuracy heading of better than 0.17 degrees at 0.5 meter antenna separation and aiding gyroscope and tilt sensors for temporary GNSS outages. The 60-millimeter-by-100-millimeter module with 24-pin and 16-pin headers is a drop in upgrade for existing designs using this industry standard form factor.

Oscilloquartz unveils Synchronization Solution

Oscilloquartz, an ADVA Optical Networking company, has launched the OSA 5405 SyncReach(TM), an integrated PTP grandmaster and GNSS receiver with a patent-pending dual antenna and receiver to enable the mass roll out of small cells. The new technology has been specifically engineered to provide accurate and affordable phase synchronization for the rapidly growing small cell market and meet the stringent timing requirements of 4.5G and 5G connectivity. *http://adva.li/osa5405-video*

Gexcel introduces mobile surveying and mapping system

An Italy-based LiDAR and imagery analysis software solution provider, Gexcel, has entered 3D mobile mapping market with its HERON system. It is developed for professional indoor/outdoor mapping and surveying. Developed for challenging mapping and surveying tasks, such as deep dark underground mines or tunnels or in a complex industrial area, HERON is suited both for surveying, localisation and model-comparison tasks.

Real-time maritime tracking service by exactEarth

exactEarth has launched exactView RT – the world's first global, persistent real-time Satellite AIS service. Powered by Harris, this revolutionary capability is expected to enable a wide variety of new service capabilities for the global maritime community and to contribute strongly over the next 20 years to the improvement of maritime safety, commerce, navigation,

environmental management, and security. It consists of a system of more than 60 maritime satellite payloads, designed, built and operated by Harris Corporation. These advanced maritime payloads cover the entire maritime VHF radio band and leverage the unique cross-linked architecture of the global Iridium NEXT satellite constellation to deliver AIS and other vessel-based VHF data services from any vessel, anywhere on the globe, relaying that data securely to customers in real-time.

Integrated aerial cameras for DJI drone platform by Phase One

Phase One Industrial introduces fully integrated iXU and iXU-RS aerial cameras for DJI's M600 and M600 Pro drones. This is the latest drone platform that is supported by Phase One. Both the UAV cameras are uniquely capable of addressing diverse aerial imaging applications — from photogrammetry to critical infrastructure monitoring projects.

Antenova launches Grandis

Antenova Ltd have announced a new antenna, Grandis, part number SR42I010. It is an SMD antenna that is physically smaller yet provides enhanced performance in the 863-870 MHz and 902-928MHz bands. It directly targets the growing number of M2M and IoT applications using the LPWAN protocols.

With Grandis, Antenova has reduced the footprint of the LPWAN antenna to 12.0 x 11.0 x 1.6mm, while also enhancing the antenna's performance. It a low-profile antenna which uses a ground plane to radiate, and is designed to be placed in the corner of the PCB. LPWAN is an increasingly popular choice for IoT and smart city applications because it uses less power, which means that the batteries within individual devices will have an extended life. Antenova's Grandis antenna covers the newer LPWAN standards for connected devices in IoT and smart cities: LoRa, SigFox and Weightless-P.

MARK YOUR CALENDAR

June 2017

37th EARSeL Symposium
27-30 June
Prague, Czech Republic
http://symposium.earsel.org/37th-symposium-Prague/

July 2017

IGS 2017: International GNSS Service Workshop
3 - 7 July
Paris, France
www.igs.org

IEEE Frequency Control Symposium and European Frequency and Time Forum
9 - 13 July
Besançon, France
www.eftf-ifcs2017.org

Esri User Conference
10 – 14 July
San Diego, USA
http://www.esri.com/events/user-conference/papers

Geo4Africa Summit 2017 Conference
11 - 14 July
Kampala, Uganda
http://geo4africa.com

United Nations/United States of America Workshop on the International Space Weather Initiative
31 July - 4 August
Boston College, Massachusetts, USA
www.unoosa.org

August 2017

SEASC 2017
15-17 August
Brunei Darussalam
www.seasc2017.org/

September 2017

INSPIRE 2017
4 - 5 September, Kehl Germany
6 - 8 September, Strasbourg France
http://inspire.ec.europa.eu/events/inspire-conference-2017

Interdrone 2017
6 - 8 September
Las Vegas, USA
www.interdrone.com

ESA-JRC Summer School on GNSS 2017
4 - 15 September
Svalbard-Spitsbergen, Norway
www.esa-jrc-summerschool.org

56th Photogrammetric Week '17
11-15 September
Stuttgart, Germany
www.ifp.uni-stuttgart.de/phowo

ION GNSS+ 2017
25 - 29 September
Portland, USA
www.ion.org

Intergeo 2017
26 - 28 September
Berlin, Germany
www.intergeo.de

October 2017

Year in Infrastructure Conference
10 -12 October
Singapore
https://www.bentley.com/en/yii/home

INGEO2017
18 – 20 October
Lisbon, Portugal
http://ingeo2017.lnec.pt/index.html

ACRS 2017
23 - 27 October
New Delhi, India
www.acrs2017.org

6th International Colloquium – Scientific and Fundamental Aspects of GNSS/Galileo
25 – 27 October
Valencia, Spain
http://esaconferencebureau.com/2017-events/17a08/introduction

3D Australia Conference 2017
26 - 27 October
Melbourne, Australia
http://3dgeoinfo2017.com

ITS World Congress 2017
29 October – 2 November 2
Palais des congrès de Montréal, Quebec
itsworldcongress2017.org

November 2017

International Technical Symposium on Navigation and Timing (ITSNT)
14 – 17 November
Toulouse, France
http://www.itsnt.fr

Commercial UAV Show and GeoConnect Show 2017
15 - 16 November
London, UK
http://www.terrapinn.com/template/live/add2diary.aspx?e=9214

INC 2017
27 - 30 November 2017
Brighton, UK
http://www.internationalnavigationconference.org.uk

December 2017

International Symposium on GNSS (ISGNSS 2017)
10-13 December
Hong Kong
www.lsgi.polyu.edu.hk

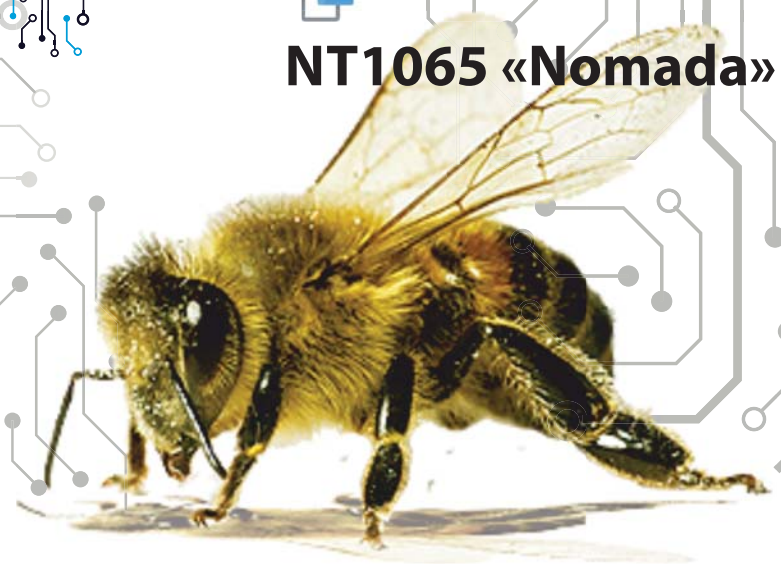
KCS TraceME

WORLDWIDE DISTRIBUTOR REQUESTS ARE WELCOME!

KCS always expands their distribution network worldwide. Please have a look at our company website for product details. We are only looking for financial strong distributors who understand our product line and programming scripts and can fully support their customers. Please feel free to send your distributor request. For KCS TraceME / LoRa Track & Trace product requests please fill in our web form.

www.Trace.ME

NT1065 «Nomada»



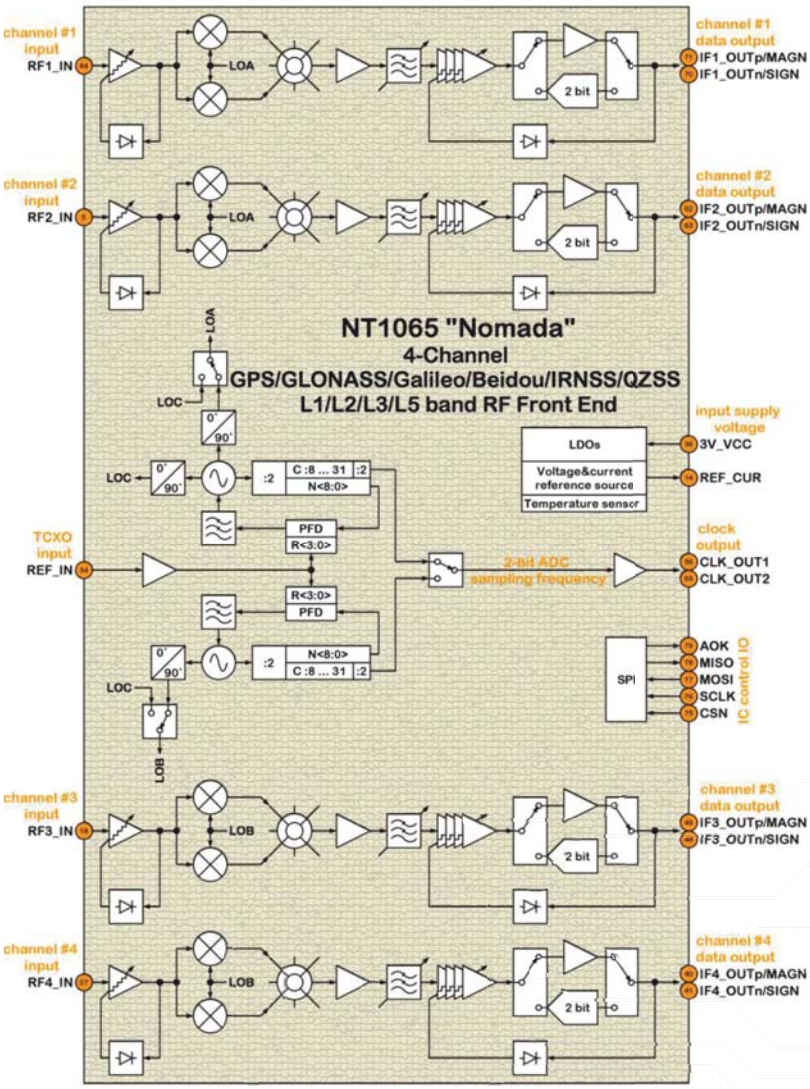
NT1065 "Nomada" is a 4-channel GNSS RF Front-End chip for professional navigation market: geodesy, driverless cars, drones and similar applications.

The feature list includes:

- **simultaneous reception of GPS/GLONASS/Galileo/BeiDou/ IRNSS/QZSS signals**
- **frequency bands: L1/L2/L3/L5/E1/E5a/E5b/E6/ B1-C/B1I(Q)/B1-2I(Q)/B2/B3**
- **full programmability of each of 4 channels (signal bandwidth, downconversion sideband, AGC options, analog/2-bit digitized output, etc.)**
- **simple and easy-to-use register map for chip configuration.**

NT1065 also could be used by GNSS researchers to create sophisticated front-ends for their receivers.
For such purposes, we offer wide selection of evaluation kits: with 4 and more channels, analog and digitized outputs, connectable to PC or FPGA platforms.

Precision is going to be simpler, cheaper, faster...



www.ntlab.com info@ntlab.com

NT1065 is already in mass production. Fabricated by amsAG, Austria.