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# Coordinates

Volume IX, Issue 5, May 2013

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

## Characterization of GNSS Jammers

## The challenges of good land governance

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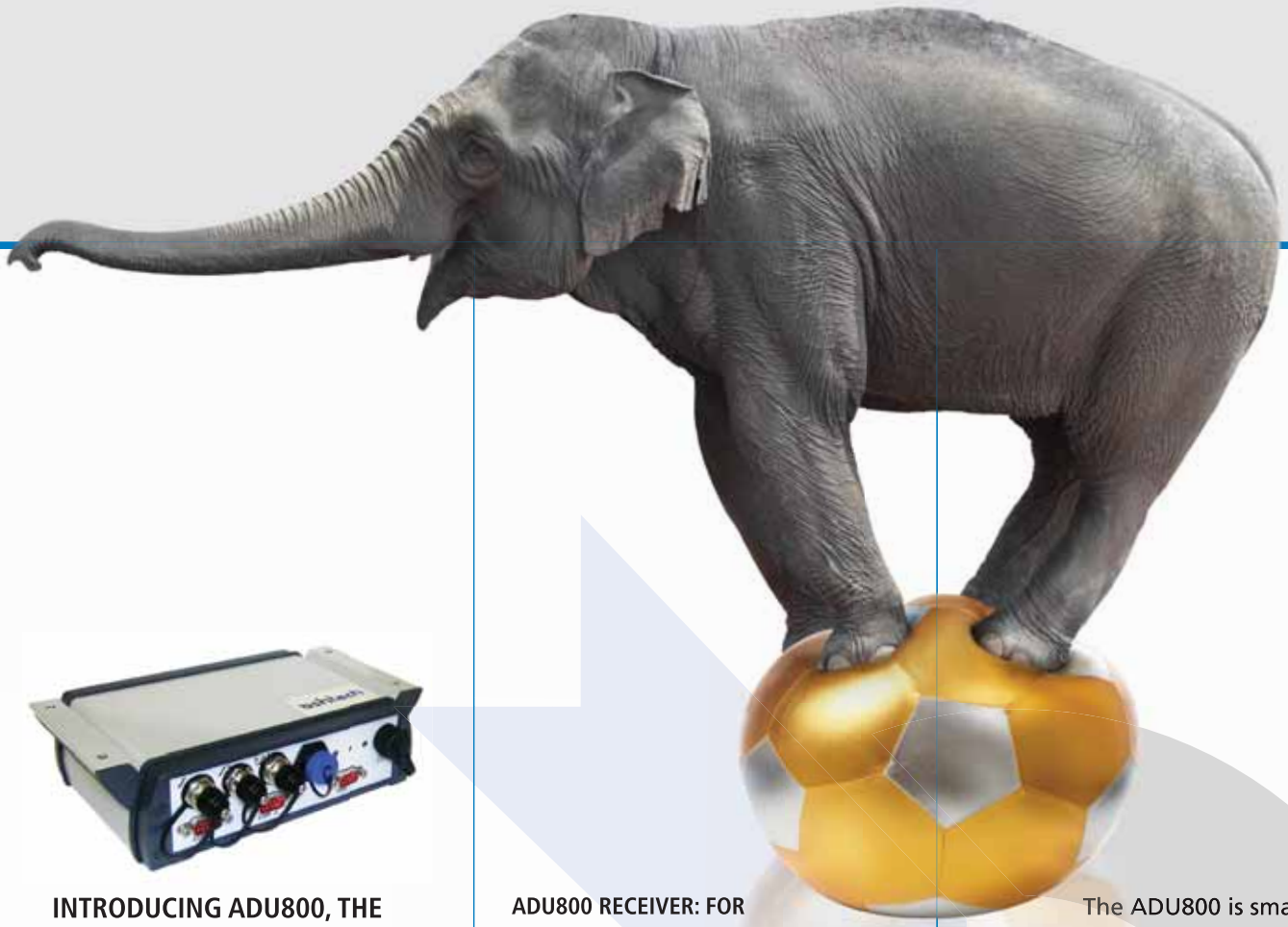



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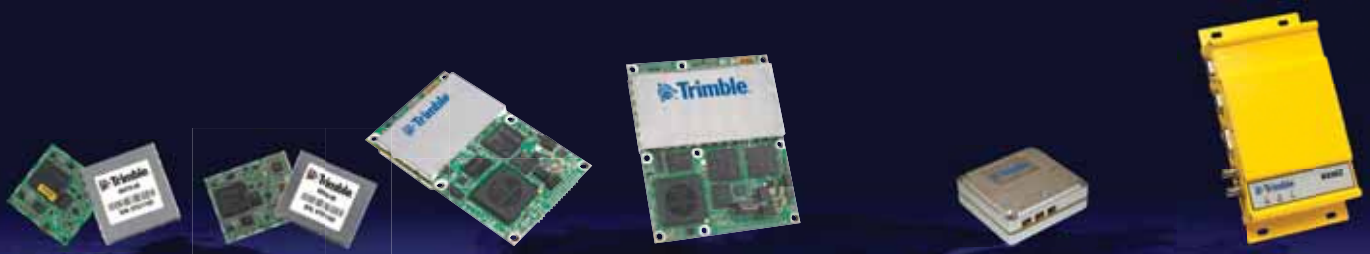


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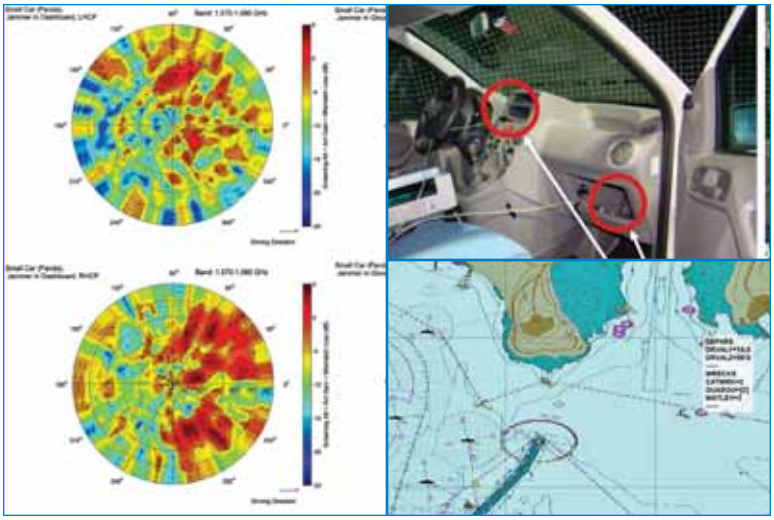

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## Articles



## Columns



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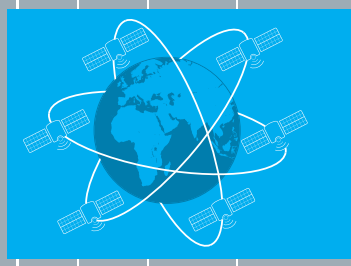

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# Jamming backups?

South Korea faces the heat.

Where GNSS signals are jammed more than often.

Even US Army would want to limit its dependence on GPS.

The vulnerability of GNSS is increasingly being felt

With increasing dependence on GNSS

Especially on application areas where consequences could be far reaching.

Though endeavors are being made

To make GNSS more robust

Still, the efforts for a few backups,

Must be encouraged

And the ones that existed

Could be revived.

**Bal Krishna, Editor**
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# Characterization of GNSS Jammers

The main focus of this paper is the spectral and spatial characterization of GNSS jammers with specific emphasis on multi-frequency wideband jammers which are able to simultaneously jam up to three frequencies. The paper extends previous analysis to jammers also operating in the L2 and L5 bands

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Global Navigation Satellite Systems (GNSSs) are able to provide precise location and timing information which find use in several applications. The usage of GNSSs is not limited to personal and car navigation but, for example, they can be employed for the tracking of goods and animals, to locate trains, navigate ships and for sport applications. In addition to this, precise synchronization can be achieved using relatively cheap Global Positioning System (GPS) clocks: telecommunication networks can be precisely synchronized using the common time scale provided by a GNSS.

In addition to this, new GNSS applications are currently under development or consolidation. For example, GPS boxes can be used by insurance companies to monitor the behaviour of a driver and adjust the insurance premium accordingly. GPS and GNSSs in general enable 'pay-as-you-drive' applications which also require the monitoring of the user behaviour. This type of application inevitably introduces privacy issues since GNSSs are used to collect information on GNSS users. This motivates the development and use of devices which can deny GNSS signal reception (Pullen and Gao, 2012).

GNSS jammers are small portable devices able to broadcast disruptive signals in the GNSS bands. A jammer can overpower the much weaker GNSS signals and disrupt GNSS-based services in a geographical area with a radius of several kilometres (Mitch et al., 2011). Despite the fact that the use of such devices is illegal in most countries, jammers can be easily purchased on the internet and their rapid diffusion is becoming a serious threat to satellite navigation.

Clear examples of the risks associated with the usage of GNSS were recently reported in the international press (The Economist, 2011). The case of a truck driver periodically passing close to the Newark Liberty International Airport is described by The Economist (2011). The driver was using a GNSS jammer (or so-called Personal Privacy Device (PPD)) to prevent his company from tracking his position. The jammer was however so powerful that problems were caused to the reception of Wide Area Augmentation System (WAAS) and GNSS signals. Eventually, after three months of investigation, the authorities were able to identify the problem, locate the jammer and fine the truck driver.

From this discussion, it emerges that GNSS jammers are expected to become a serious threat for GNSS operations and countermeasures should be developed to reduce the associated risks. A proper characterization of jamming signals has been recognized as the first step towards the development of appropriate jamming countermeasures (Mitch et al., 2011). Only accurate jamming signal models enable the design of effective detection, mitigation and location strategies.

The main focus of this paper is thus the spectral and spatial characterization of GNSS jammers with specific emphasis on multi-frequency wideband jammers which are able to simultaneously jam up to three frequencies. The paper extends previous analysis to jammers also operating in the L2 and L5 bands.

The characterization of the signals emitted by GNSS jammers was performed in terms of signal spectral features and spatial propagation. The signals transmitted by jammers are frequency modulated chirps which span one or more bands centred on the GNSS frequencies. For each jammer, parameters such as the sweep period, the maximum and minimum swept frequencies and the transmitted power were determined. The spatial characteristics of jammer signals have also been analysed. In particular, it is recognized that the majority of the GNSS denial events reported in the literature originated from in-car jammers. Thus, the effect of the vehicle in which the jammer is located should be taken into account. For this reason, the spatial distribution of the power transmitted by a jammer was analysed accounting for the vehicle presence. The analysis was repeated for two different vehicles: a small car (Fiat Panda) and a van (Fiat Ducato). From the analysis, it emerges that the structure of the vehicle favours specific propagation directions, usually corresponding to the windows. This type of analysis can be useful for the design of sophisticated jammer detection/location algorithms.

## Multi-frequency jammer characterization

In this section, the spectral characteristics of 7 GNSS jammers are described. The jammers used for the analysis were provided by Nottingham Scientific Ltd. (NSL), the coordinator of the FP7 project DETECTOR (*http://www.gnss-detector.eu/*) which focuses on the "detection, evaluation and characterization of threats to road applications". NSL kindly made the jammers available to the JRC for the tests reported on herein.

The jammers used for the analysis were labeled from 1 to 7 and can be classified as follows. Jammers 1 and 2 belong to group 2 (SMA-battery jammers) of the classification proposed by Mitch et al. (2011) whereas jammers from 4 to 7 are cigarette lighter jammers (group 1). Jammer 3 requires an external 12 Volt power supply and although it came without a dedicated connection for the cigarette lighter it can be powered in this way. All the jammers transmit a single saw-tooth chirp signal and thus belong to class 1 of the classification suggested by Kraus et al. (2011). The tests were conducted inside the JRC anechoic chamber where it is possible to transmit signals without interfering with other systems. The jammer under test was mounted on a tripod and used to transmit the jamming signal which was received by a calibrated double ridge horn antenna. The receiving antenna was connected to a Tektronix RSA6114a, a wideband real-time spectrum analyzer able to collect In-phase/Quadrature (I&Q) samples with a sampling frequency up to 150 MHz. Several short datasets of 1 ms duration were collected and used for the characterization of the jamming signals. A Rohde & Schwarz (RS) SMB100A RF and microwave signal generator was used to calibrate the transmission chain and determine the calibration factors used to measure the absolute power transmitted by each jammer.

The analysis of the jammers follows the approach employed by Mitch et al. (2011) and provides the sweep and power parameters of the signals emitted by the devices considered. The sweep parameters of the 7 jammers are provided in Table 1 which also considers signals transmitted in non-GNSS bands. A significant variability among the sweep parameters is observed: for example, the sweep period in the L1 band varies from about 5 to 37 µs. This variability is observable not only among jammers of different models but also among devices of the same type. This phenomenon is consistent with the results discussed by Mitch et al. (2011).

**Table 1. Sweep parameters measured for a set of seven GNSSS jammers. Signals transmitted in the non-GNSS bands are also considered.**

| Jammer | Centre Frequency | *fmin*, MHz | *fmax*, MHz | Sweep Range, MHz | Sweep Period, µs |
|---|---|---|---|---|---|
| 1 | GPS L1 | 20.8 | 28.4 | 49.2 | 5.34 |
| 1 | GPS L2 | 10.7 | 11.2 | 21.9 | 5.54 |
| 1 | GPS L5 | 11.8 | 12.2 | 24 | 5.54 |
| 2 | GPS L1 | 24.6 | 26.2 | 50.8 | 5.15 |
| 2 | GPS L2 | 8.5 | 8.6 | 17.1 | 5.24 |
| 2 | GPS L5 | 11.6 | 11.6 | 23.2 | 5.24 |
| 3 | GPS L1 | 27 | 29 | 56 | 6.83 |
| 3 | GPS L2 | 16.1 | 16.4 | 32.5 | 6.83 |
| 3 | 945 MHz | 21 | 21 | 42 | 41.9 |
| 3 | 846.5 MHz | 42.2 | 42.2 | 84.4 | 41.9 |
| 4 | GPS L1 | 7 | 4.5 | 11.5 | 9.47 |
| 5 | GPS L1 | 6.6 | 4 | 10.6 | 8.64 |
| 6 | GPS L1 | 6 | 5.5 | 11.5 | 9.09 |
| 7 | GPS L1 | 7.4 | 26.5 | 33.9 | 36.7 |

Non-cigarette lighter jammers (J01, J02 and J03) are able to jam very wide frequency ranges (about 50 MHz) in the L1 frequency. In this case, the military P(Y) and Galileo Public Regulated Service (PRS) signals will also be severely affected.

Multi-frequency jammers transmit signals characterized by the same sweep period in each frequency band. This indicates that a single local oscillator is used for the generation of all the signals. Consider for example, jammer J01: the sweep period for the L1 signals is about 5.34 µs whereas for the L2 and L5 components is 5.54 µs. The difference between the two periods is explained by the fact that two different datasets were used for the analysis. The jammer local clock is affected by biases and drifts which explain the variability between measurements taken at different times. Since the spectrum analyzer used for the analysis is able to capture an instantaneous bandwidth of about 150

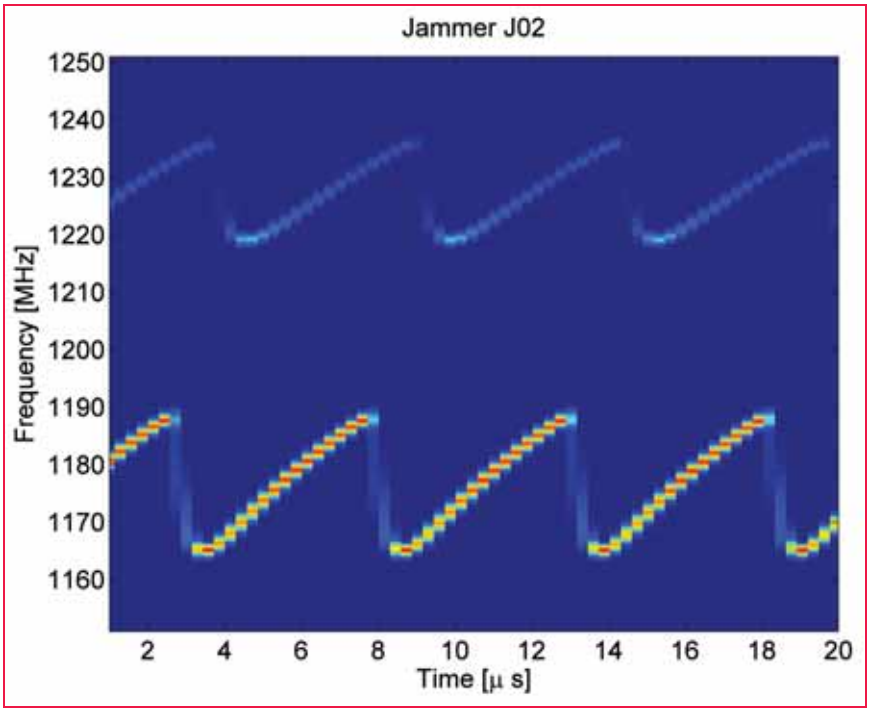


**Figure 1. Spectrogram of the signals transmitted by jammer J02 in the GNSS L2 and L5 bands.**

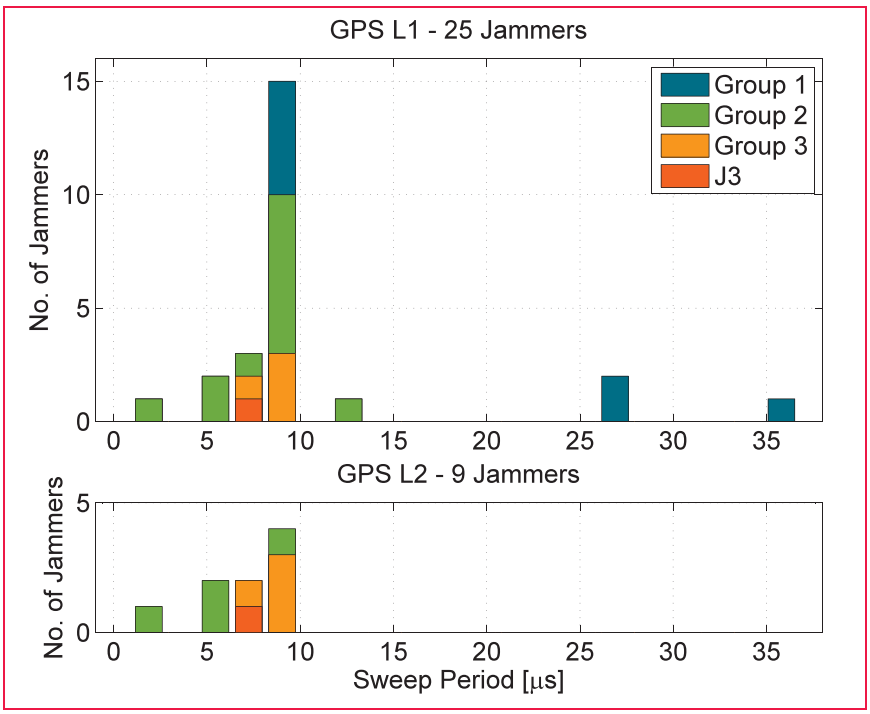


**Figure 2. Distribution of the sweep times obtained combining the results obtained with those from (Mitch et al., 2011). Group 1 refers to cigarette lighter jammers, Group 2 to SMA/battery jammers and Group 3 to non-SMA/battery jammers.**

MHz, it was possible to jointly collect signals in the L2 and L5 bands. The spectrogram of the signals transmitted by jammer J02 in L2 and L5 is shown in Figure 1. The L2 and L5 jamming signals have a similar pattern although the L5 component is more powerful and spans a larger frequency range. The two signals have the same sweep period even if there is a relatively small offset between the instants at which a frequency reset occurs. Signals transmitted in non-GNSS bands are characterized by much slower sweep periods. In particular, the signals transmitted in the GSM bands by jammer J03 are characterized by sweep periods about six times slower than those of the signals emitted in the GNSS frequencies.

The results obtained are combined with those of (Mitch et al., 2011) in Figure 2 which provides some indication of the distribution of the sweep periods of jammers available on the market. From the figure, it emerges that cigarette lighter jammers currently operate only in the L1 frequency. Moreover most of these jammers have a sweep period of about 9 μs even if significant deviations can be found. This is the case of jammer J07 which has a sweep period equal to 36.7 μs. When considering the totality of the jammers, it clearly emerges that 9 μs is the most common value for the sweep period. In Figure 2, jammer J03 is considered separately given its architecture and power consumption.

The power parameters measured for the 7 jammers are analyzed in Figure 3 along with the findings obtained by Mitch et al. (2011). The total transmitted power varies depending on the type of jammer and even among jammers of the same type. In general, cigarette lighter jammers are characterized by lower power levels than multi-frequency battery jammers. Moreover, extremely high powers are transmitted in the non-GNSS bands.

## Jammer spatial characterization

Most jammer events detected "in the wild" have arisen from low-cost in-vehicle jammers. For this reason, several tests were performed in the JRC anechoic chamber with the final goal of investigating the impact of the vehicle type and antenna location on the jamming signal.

Two types of tests were conducted:

- *Network analyzer based tests*: the JRC anechoic chamber is equipped with a Vector Network Analyzer (VNA) which allows one

to characterize an RF channel as a function of the azimuth and elevation of the receive antenna. In this case, the jammer is replaced by a signal source emitting signals with known properties, i.e. CW signals with known power. The measurements with the VNA were conducted using three monopole antennas (those that came with jammers 4, 5, and 6) and a 3-port electromechanical RF switch. At each receiver position (azimuth and elevation), the RF channel associated with each of the three monopole antennas was measured. The total measurement procedure over all azimuth and elevation angles took a total of just over 9 hours.

- *Spectrum analyzer based tests*: measurements with a real jammer placed inside a vehicle were conducted. In this case, the Tektronix spectrum analyzer mentioned above was connected to the probe antenna placed on one of the sleds of the anechoic chamber. The JRC anechoic chamber is equipped with two sleds allowing one to scan different elevation angles.

An example of a measurement setup using the network and spectrum analyzer is shown in Figure 4. In this case, a small car, a Fiat Panda, was placed inside the anechoic chamber and three different jammer locations were considered for the network analyzer case (left part of Figure 4). In the spectrum analyzer case, a single jammer position was considered.

The three positions considered for the network analyzer tests are:

- the *dashboard* of the vehicle. This position represents the case of a jammer inserted in the cigarette lighter plug.
- the *glove box* of the vehicle. This position corresponds to the case of a battery jammer left in the glove box.
- in the *boot* of the vehicle. Although this is a less realistic location, it was selected because it was expected to provide significantly different results with respect to the previous cases.

For the spectrum analyzer based tests, the following approach was used. At each position of the probe antenna two

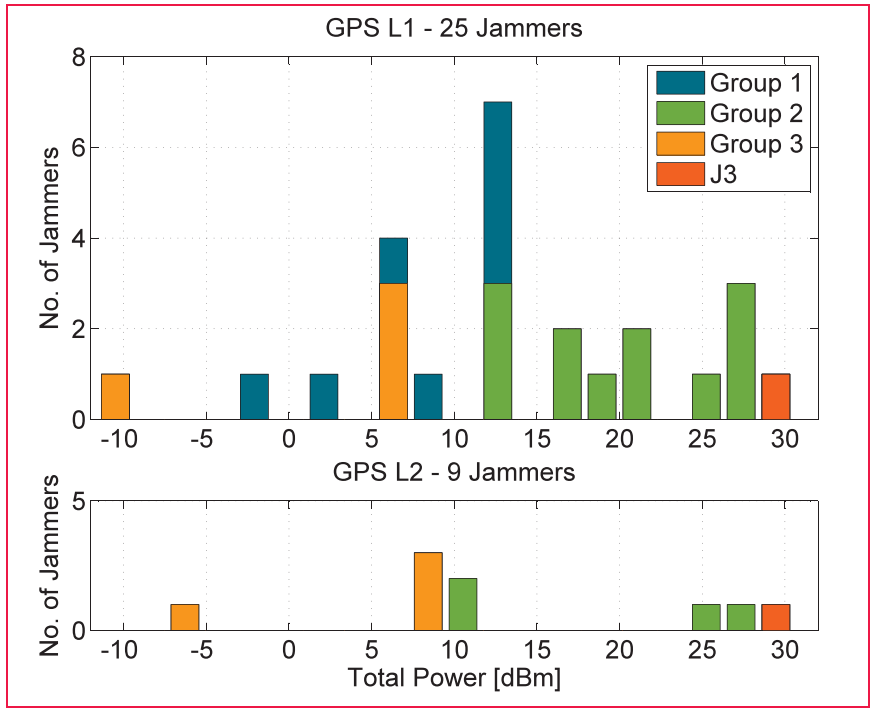


**Figure 3. Distribution of the total powers obtained combining the results obtained with those from (Mitch et al., 2011). Group 1 refers to cigarette lighter jammers, Group 2 to SMA/battery jammers and Group 3 to non-SMA/battery jammers.**

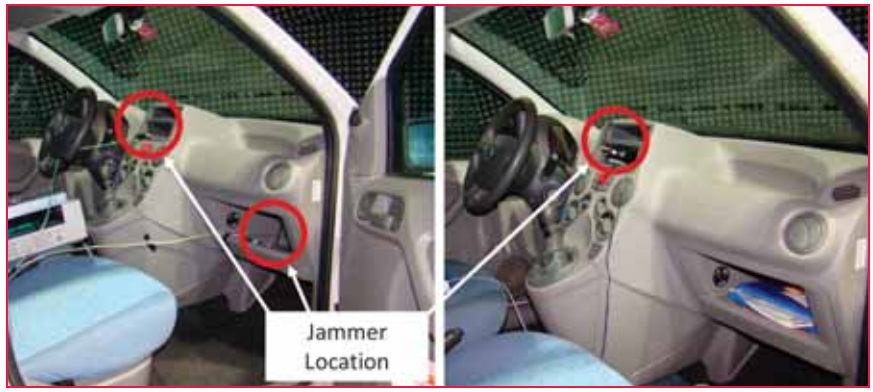


**Figure 4. Location of the jammer for the tests conducted on a small car. Left: network analyzer case. Right: Spectrum analyzer case.**

measurements were performed and I&Q samples were collected for both Right Hand Circular Polarization (RHCP) and Left Hand Circular Polarization (LHCP) polarizations. The length of each dataset collected was 1 ms, and a sampling frequency $f_s$ = 150 MHz was used.

## Results: Network Analyzer Tests

The calibrated transmission/reception chain of the JRC anechoic chamber was used to determine the composite loss,

$$L_c(\theta,\phi) = L_v(\theta,\phi) + G_{Tx}(\theta,\phi) + L_m, \quad (1)$$

given by the loss caused by the vehicle, $L_v$, the jammer antenna gain and other mismatch losses, $L_m$. Quantities in (1) are expressed in dB and the same sign convention is used for losses and gains. This implies that negative quantities in (1) imply a reduction of the signal power. Note that the quantities in (1) are a function of the elevation and azimuth of the receive antenna, $\theta$ and $\phi$, respectively. Mismatch losses account, for example, for polarization mismatches between the receive and transmit antennas.

The composite loss, $L_c$, allows one to determine the impact of a vehicle on

Photo: Sindre Lundvold

**NORWEGIAN EXTREME ARTIST, ESKIL RONNINGSBAKKEN, ON A UNICYCLE AT TROLLVEGGEN, THE TALLEST VERTICAL ROCK FACE IN EUROPE. NORWAY, 2010.**

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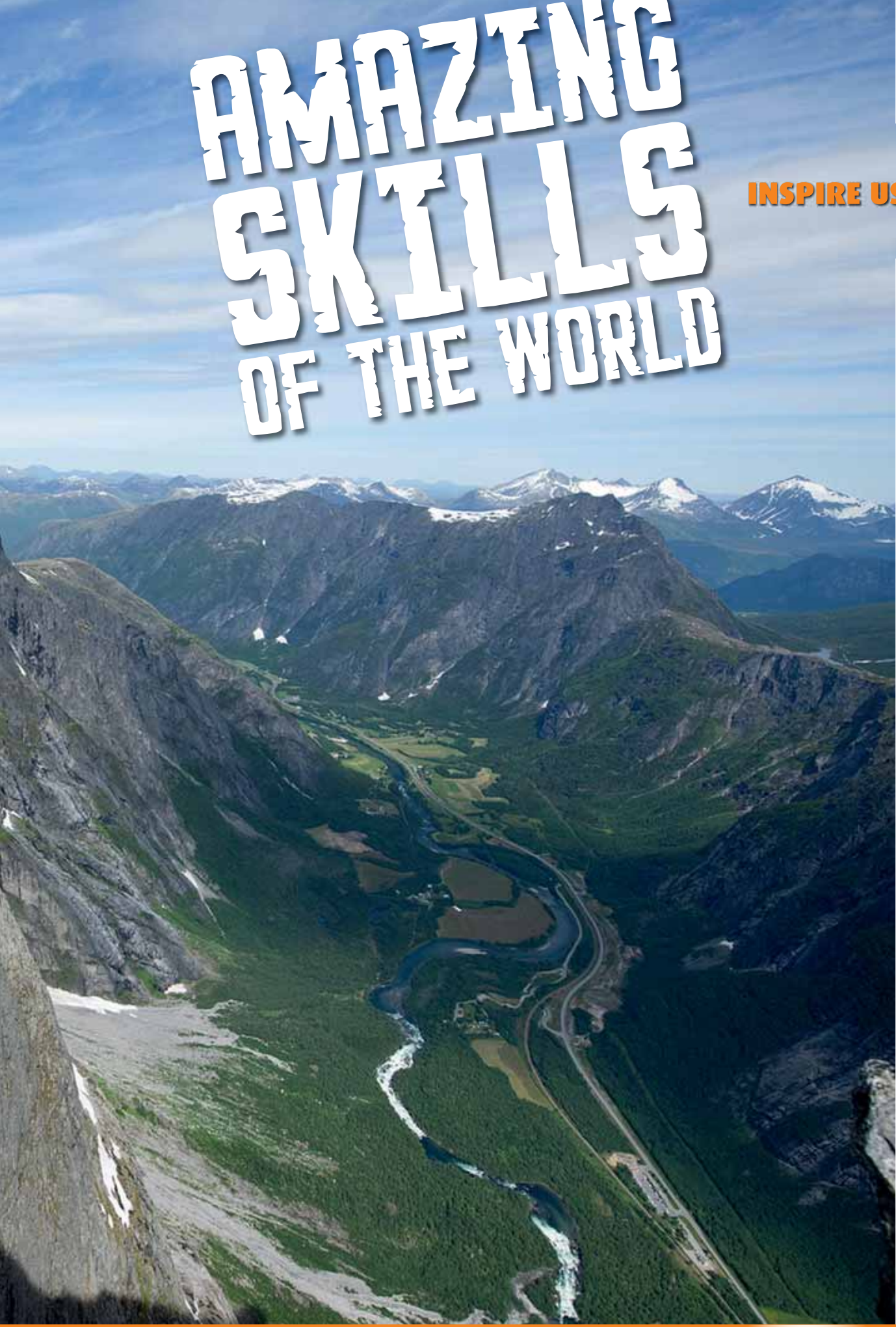

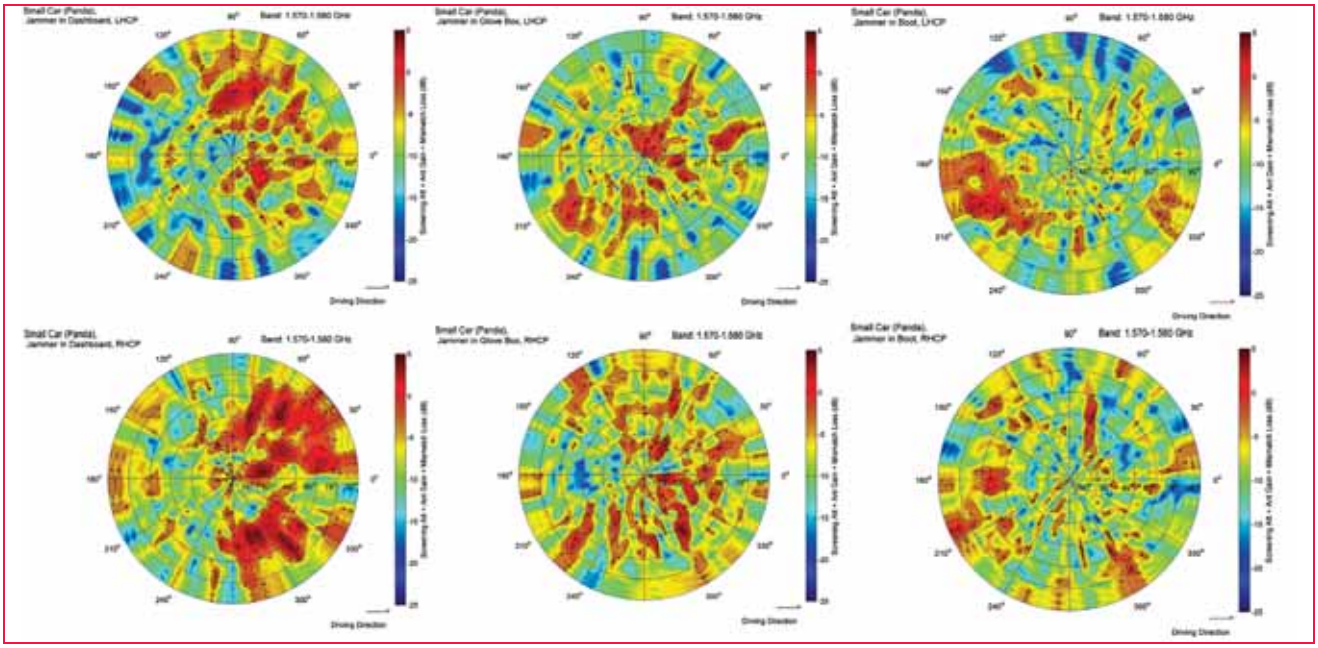

**Figure 5. Composite loss accounting for vehicle attenuation, jammer antenna gain and other mismatch losses in the case of a small car (Fiat Panda). The loss was obtained by averaging network analyzer measurements in the 1.570-1.580 GHz frequency range. Different jammer locations and antenna polarizations are considered.**

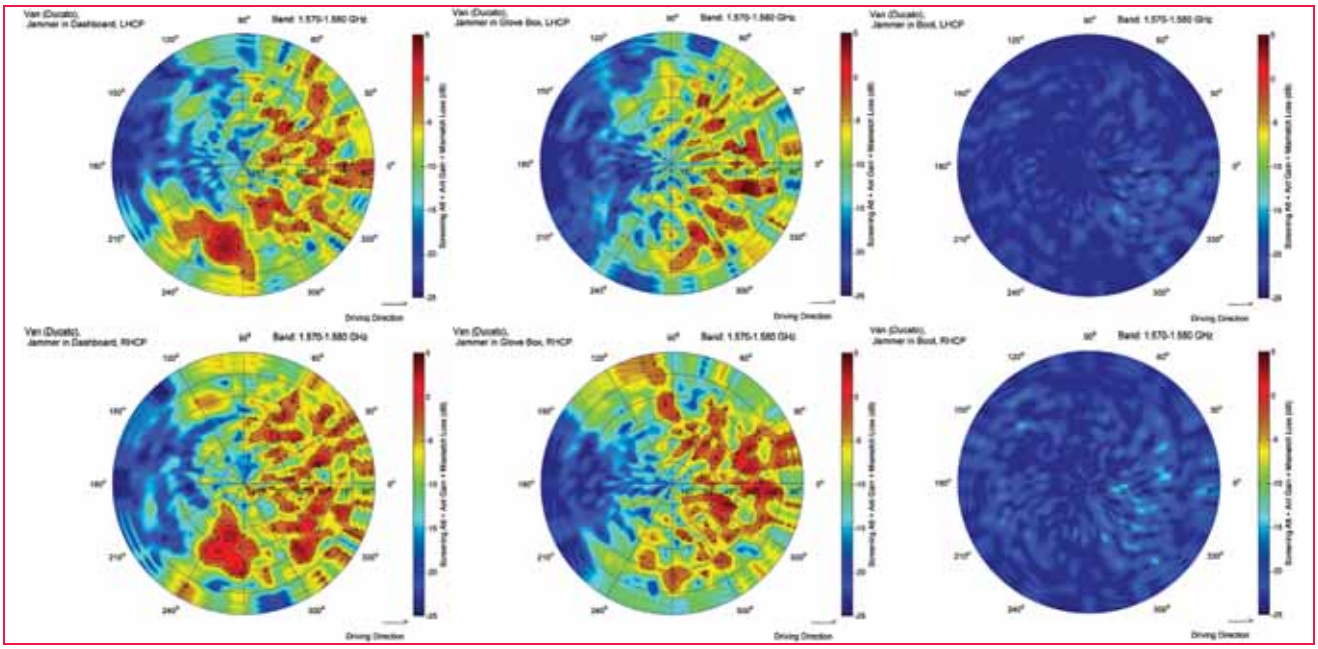

**Figure 6. Composite loss accounting for vehicle attenuation, jammer antenna gain and other mismatch losses in the case of a van (Fiat Ducato). The loss was obtained by averaging network analyzer measurements in the 1.570-1.580 GHz frequency range. Different jammer locations and antenna polarizations are considered.**

the signal transmitted by a jammer as a function of the jammer direction of arrival. In particular, the jammer power received at a distance $r$ can be computed as

$$P_{Rx}(\theta,\phi)\big|_{dBm} = P_{Tx}\big|_{dBm} + L_c(\theta,\phi) - 20\log_{10}\left(\frac{4\pi r}{\lambda}\right) \quad (2)$$

where $\lambda$ is wavelength associated to the received signal centre frequency.

Measurements were conducted considering a 5 degree resolution in both the azimuth and elevation domains. Moreover, $L_c$ was obtained by transmitting a CW at a specific frequency. During the tests, the [0.8-2.4] GHz frequency range was swept with a 1 MHz step. The results presented in the following were obtained by averaging the channel losses measured over the 1.570-1.580 GHz frequency range. This range is approximately centered around the GPS L1 centre frequency and has a width comparable to the bandwidths of commercial GNSS receivers.

The results obtained from the network analyzer tests are shown in Figure 5 and Figure 6. From the figures, it emerges that

the interaction between the jammer and the vehicle favours specific propagation directions. For example, when the jammer is placed in the dashboard, the transmitted signal is amplified when received from directions corresponding to the vehicle windscreen. The glass of the windscreen does not significantly attenuate the signal. On the contrary, directions corresponding to the rear of the car are less favoured. By comparing LHCP and RHCP plots, it emerges that there is not a favoured polarization. When considering the glove box position, no specific propagation direction seems to be favoured in the small car case. When the jammer antenna is placed in this position, the signal emitted interacts with the different elements of the car and several reflections occur. Moreover, the Fiat Panda has wide windows through which the jammer signal can easily propagate. This phenomenon does not occur for the van. The Fiat Ducato does not have rear windows and the jammer signal can propagate only through the front windows. This effect clearly appears in Figure 6: $L_c$ assumes higher values (in some cases amplification occurs) in correspondence with the front of the vehicle. When the jammer antenna is placed in the rear of the vehicle two situations occur. In the small car case, angles corresponding to the rear windows seem to favour signal propagation. This fact is particularly evident in right part of Figure 5 where $L_c$ assumes positive values in the [150-240] degree azimuth range. The asymmetry in the plot is due to the location of the jammer antenna.

The results obtained for the van are substantially different from those observed during the small car experiments. There are no windows in the rear of the van which essentially behaves as a metal cage. For this reason, the jammer signal is strongly attenuated and $L_c$ assumes values lower than - 15 dB. From these results, it emerges that vehicles equipped with GNSS jammers show clear RF signatures which may be used for identifying the vehicle type.

### Results: Spectrum Analyzer Tests

For the spectrum analyzer tests, only the case of a jammer placed in the cigarette lighter of the Fiat Panda was considered. The analysis was limited to one case due to the complexity of the setup and the time required for a single scan: the whole test lasted 7.4 hours.

The total received power is shown in Figure 7 as a function of the direction of arrival (azimuth and elevation angles). The received power is shown in order to provide an indication of the signal strength as seen by a receiver placed at a distance of about 9.5 m from a vehicle equipped with a jammer (the radius of the anechoic chamber is about 9.5 m). Note that the transmit power can be calculated for the received power using (2).The diagrams reported in Figure 7 are in agreement with the results reported for the network analyzer case. In particular, patterns similar to those observed in Figure 5 are found: the jammer power mainly propagates through the windscreen of the car whereas other propagation directions

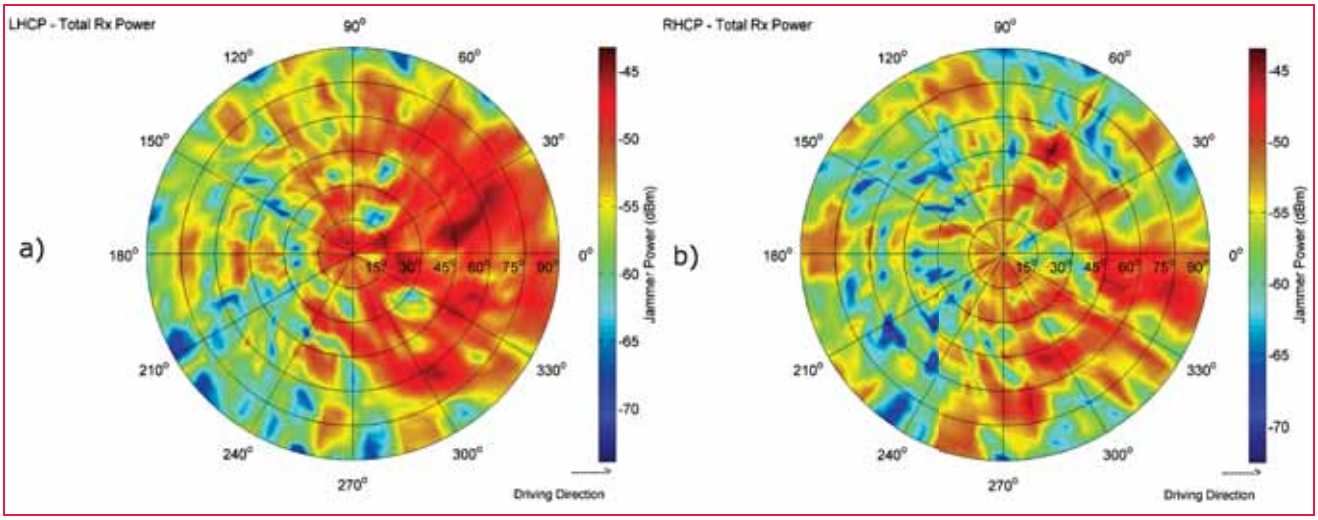


**Figure 7. Received power as a function of the direction of arrival measured using a wideband spectrum analyzer. Two different polarizations (LHCP and RHCP) were considered. Jammer J06, Fiat Panda**

are more attenuated. Differences between Figure 7 and Figure 5 are justified by the different way the received power was measured. The agreement should be however considered satisfactory since both tests clearly show that specific propagation directions, which reflect the structure of the vehicle, are favoured.

## Conclusions

In this paper, signals emitted by several GNSS jammers have been analyzed and spectral and spatial characterizations of jamming signals have been provided. From the signal characterization it emerges that jamming signals can sweep large frequency ranges in short time periods. In particular, it was found that the smallest frequency range covered by a jammer is about 10.5 MHz with a sweep period of about 9 µs. The transmitted power varies significantly depending on the jammer type. Combining results from the literature and experimental findings, it was shown that the transmitted power can vary from about -10 to more than 30 dBm. This variability is due to the availability of different jammer models. When battery jammers are considered the transmitted power is also impacted by the charge level. Despite the large variability, the power levels measured are extremely high compared to the strength of GNSS signals. For this reason, jammers can create serious problems for GNSS operations in large geographical areas.

A spatial characterization of the signals transmitted by jammers was also performed since it has been recognized that most of the jamming events reported in the literature originated from vehicles such as trucks and cars. Thus, the propagation of jamming signals is strongly impacted by the structure of the vehicle which hosts it. The jamming propagation channel was characterized considering the impact of different vehicles and jammer positions. Two vehicles, a small car and a van, were used for the measurements and the attenuation due to the jammer antenna gain pattern and the vehicle structure was determined for different reception angles. From the analysis, it emerges that the structure of the vehicle favours specific propagation directions which usually correspond to windows. Metal parts of the vehicle strongly attenuate the jamming signals. Each vehicle has a specific RF frequency signature which identifies the vehicle type and may be used to improve jammer detection and location.

## Acknowledgments

The authors would like to express their thanks to the partners of the FP7 project DETECTOR for the support provided in this measurement campaign, in particular for the loan of the jammer used for the tests. Special thanks for the support provided during the measurement campaign are also due to Messrs. Jean-Marc Chareau, Philippe Viaud and Marco Basso, all in Unit G06 of the Institute for the Protection and Security of the Citizen, EC Joint Research Centre.

## References

Kraus, T., Bauernfeind R. and Eissfeller B. (2011). Survey of in-car jammers - analysis and modeling of the RF signals and IF samples (suitable for active signal cancelation). *Proceedings. of the 24th International Technical Meeting of The Satellite Division of the Institute of Navigation ION/ GNSS*, pages 430-435, Portland, OR.

Mitch, R. H., Dougherty, R. C., Psiaki, M. L., Powell, S. P., O'Hanlon, B. W., Bhatti, B. W. and Humphreys T. E. (2011). Signal characteristics of civil GPS jammers. *Proceedings of the 24th International Technical Meeting of The Satellite Division of the Institute of Navigation (ION/GNSS)*, pages 1907-1919, Portland, OR.

Pullen, S. and Gao G. (2012). GNSS jamming in the name of privacy. *Inside GNSS*, pages 34-43

The Economist (2011). GPS jamming: No jamming tomorrow. *Technology Quartely*, March.

# The challenges of good land governance

Indonesia's political stability has created a window of opportunity to reform the land sector

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Fundamental to the challenges facing the reform of the Indonesian land sector is that it lacks a comprehensive land law. All land in Indonesia falls into one of two categories: (i) forest estate (*kawasan hutan*); and (ii) non-forest estate (*Areal Pengunan Lain,* APL). As such, land is administered under a dual system through two different government agencies, the Ministry of Forestry (MoFor) and the National Land Agency (Badan Pertanahan Nasional, BPN) responsible for forestry and non-forestry lands, respectively. It is further complicated by indeterminate entitlements to land; lack of recognition of customary *(adat)* rights to land; lack of processes allowing free, prior, and informed consent; excessive application of the State's power of eminent domain; and a policy for the allocation of land concessions that ignores or overrides the rights and interests of other rights holders. Add to this, government control over land, State land (*hak menguasi negara*). Land administration and land management are also built upon a range of complexities established in the colonial past. Taken together, the dual system, along with colonial legacies, have generated numerous challenges to good land governance in the country including the rights of individuals, communities, and the sustainable management of natural resources. Confronted with serious challenges, the government is currently working to clear hurdles with regard to existing land-related regulations that date back to the 1800s.

It is generally acknowledged that across Indonesia, land-tenure legislation struggles to be properly implemented, and most people gain access to land on the basis of local land-tenure systems and community-acknowledged traditions. These customary practices and systems, broadly described as *adat*, have been profoundly impacted by decades of colonial and post-independence government interventions and are continually burdened as a result of diverse factors such as cultural interactions, population growth, socio-economic changes, and political processes. *Adat* land systems are extremely diverse. This diversity is the result of a range of cultural, social, ecological, and economic factors in respective communities in the different regions of the country.

Indonesia's political stability has created a window of opportunity to reform the land sector.

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## Political economy

At the International Conference on *Regulatory Reform of Indonesian Land Laws for People's Welfare*, held in Jakarta on December 11, 2012, high-level government and civil society speakers identified lack of political will at the highest levels as the key obstacle to land reform in Indonesia. Initiatives to transform property rights seriously challenge existing structures that sustain deforestation. This means that any reform must challenge the power of the MoFor and local administration over forest lands. At stake with any such reform is the ongoing accumulation of vast profits from economic activities generated from

Understanding the underlying dynamics of the political economy of land that challenge the implementation of good land governance in Indonesia is fundamental to the achievement of land sector reform and providing donor support

unregulated and unsustainable forestry. Accordingly, any effort to implement good governance over forest land faces numerous challenges. In case of non-forest land areas, complex and overlaps laws, decrees and regulations prevent resolution of tenure claims and strengthening land administration. Further, lack of clarity on forest and non-forest land areas, due to absence of reliable maps and data, prevent progress in building tenure security.

In order to appreciate the challenges facing land-sector reforms in the country, it is also necessary to understand the political economy of land in Indonesia. Real prospects for reform have emerged only since the late 1990s. Indonesia's growing political stability has created a window of opportunity for the implementation of important reforms, including land reforms. The government recently made a strategic commitment to developing stronger, more robust policies and programs for addressing land-sector problems. The reforms are taking place through a dynamic series of top-down high-level initiatives and seem to be followed by a series of complementary bottom-up responses from civil society. Taken together, these are leading to changes in the formal and informal balance of power between central and regional government authorities such as in determining the allocation of land within provincial spatial plans. A pilot assessment of land governance, using the World Bank's land Governance Assessment Framework (LGAF) was undertaken in 2009. It is anticipated that a more comprehensive assessment will commence later in 2013. In addition, it is anticipated that there will be support for dissemination of the United Nations Voluntary Guidelines for Land Tenure.

## Key government land reforms: top-down initiatives

The government has initiated several measures at national and local levels to focus on and resolve overlaps and simplify complexities of the legal instruments, confirm tenure security, and strengthen institutional mechanisms for land governance. These initiatives include:

- In early 2010, a unified Presidential Task Force on Reduced Emissions from Deforestation and Forest Degradation (REDD+) was created. The Task Force is working on REDD+ related tasks to develop a set of strategies and plans for implementation. The REDD+ Task Force has 16 working groups to address specific issues. This Task Force has drafted a national strategy to unify all initiatives under REDD+, and set-up criteria and guidelines for funding mechanisms. The Task Force is also working on legal and enforcement issues. Central Kalimantan has been selected as the pilot province for these efforts. These efforts run parallel, and are complimented by current trends towards decentralization of government functions.
- In May 2011, the national government announced a 2-year moratorium on the award of new land use licenses on primary natural forests and peat land areas. The Presidential Task Force is monitoring the enforcement of this moratorium. The government has acknowledged several issues go well beyond REDD+ and forest carbon/climate mitigation issues.
- The House of Representatives approved a Land Acquisition and Compensation Law in December 2011, which covers land acquisition for public projects such as railways, ports, roads and dams. This law is seen as an instrument to clear existing blocks to executing infrastructure projects. This, and other new regulations have met with expected controversy and opinions are polarized on investor versus community/individual rights.
- The passage of the Geospatial Law in 2011, has endorsed Indonesia's National Spatial Data Infrastructure (NSDI), and mandated that Badan Informasi Geospasial (BIG, National Mapping Agency) is the lead agency. BIG will provide much needed leadership to unify information on land and natural resources in the country. The *OneMap* policy recognizes that Indonesia needs a standard reference set of basic mapping. It also recognizes that this must also include cadastral information - knowing where each land parcel is, its boundaries, who owns it, and the rights attached to the land. This is fundamental to good land governance and government decision making on land and natural resources. There are also other efforts to merge innovations and different technologies through a national data warehouse.
- Following the decision of the Constitutional Court in early 2012 on forest land areas, MoFor has revitalized the *Tenure Working Group on Forest Lands* in which representatives from civil society organizations (CSOs) also take part. This dialogue process was complemented by the CSOs drafting a *Roadmap for Tenure Reforms (of forest land areas)*.

Taken together, the top-down reforms are leading to changes to the formal and informal balance of power between central and regional government authorities in determining the allocation of land to forestry versus no-forestry purposes within provincial spatial plans.

## Civil society advocacy and bottom-up engagements

On the bottom-up side of the reforms, the following initiates are important to note:

- The judicial review petitions filed by the civil society groups on the authority

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and management of forest land areas and pending petition on Land Acquisition and Compensation Law, 2011 show that the support of local authorities and civil society groups for the big bang reforms is conditional.

- The *OneMap* approach is designed to generate bottom-up support through *community mapping* to help people negotiate rights among themselves. BIG and the REDD+ Task Force are also taking steps to combine community mapping with satellite imagery and other geospatial information in a geographic information system under *OneMap* that can assist in recording and enforcing the agreements reached through community negotiation.
- Together with *OneMap*, the government has introduced participatory land use planning in the forest areas. This is an initiative that MoFor has been keen to scale up from previous pilot efforts. This brings in both bottom up support/work and also endorsement from the top.
- Government is gradually opening up to endorsing some new tenure norms (e.g., community titling for Indigenous Peoples' based on community maps produced in the Ancestral Domain areas and pertinent registry). Government has also agreed to accept community maps produced for the Ancestral Domain areas where Indigenous Peoples' reside.
- The Memorandum of Understanding signed between Aliansi Masyarakat Adat Nusantara (AMAN, Indigenous Peoples' Alliance of the Archipelago) and BPN in September 2011, there is an additional effort on the part of civil society organizations. This additional effort concerns how to carry out reforms within the agrarian land sector (that includes forest land areas outside official governmental forest estate) such that the rights of Indigenous Peoples are recognized. As a result of this initiative, the land tenure reforms' appear as more comprehensive and respond to key issues confronted by the Indigenous Peoples.
- The NGOs working as part of the MoFor's *Tenure Working Group* have prepared a road-map to achieve tenurial justice for forest land areas and is working with the ministry in implementing the Forest Tenure Improvement Program.
- Through on-going dialogue, a concerted effort is being put in place strengthened tenure security over both Forestry and Non-Forestry Land. Not only will this significantly improve the lives of millions living in the official "forest estate" but given Indonesia's focal status in REDD+ agenda, these reforms have placed the potential to transform rural people's well being, forest condition as well as greenhouse gas emissions. In effect, the tenure working group provides the bottom-up approach to complement the top-down initiatives like REDD+ Task Force.

While the Indonesian government and political leaders struggle to reform land laws, local communities and local governments seem to have taken the lead in forging new relationships and patterns in land management creating new challenges for land governance

## Final remarks

Understanding the underlying dynamics of the political economy of land that challenge the implementation of good land governance in Indonesia is fundamental to the achievement of land sector reform and providing donor support. Changes within the Indonesian government and changing relationships between the government, civil society, and the private sector are opening up new spaces for negotiation and also new areas of conflict. The highly political nature of Agrarian Reforms, especially given statements by the President himself, has seen the subject return to the center stage of public debate. While the Indonesian government and political leaders struggle to reform land laws, local communities and local governments seem to have taken the lead in forging new relationships and patterns in land management creating new challenges for land governance.

The current World Bank's stock-taking of the Indonesian land sector, which will be delivered by September 2013, is expected to identify priorities for donor support to land-sector reform. Early indications suggest that support may be required in the areas of: (i) the proposed new Land Law and implementing regulations; (ii) Land Reform Plus (Agrarian Reform); (iii) procedures for recognition of participatory community land mapping; to be undertaken by civil society in support of the land rights of indigenous communities, especially in forest lands; (iv) enhancing National Spatial Data Infrastructure (NSDI) along with OneMap; (v) land governance, including the application of the Land Governance Assessment Framework (LGAF) and awareness raising of the Voluntary Guidelines for Land Governance; and (vi) a comprehensive study on the political economy of land.

## References

**Bell, K.C., Srinivas, M.S. and Martinez, J. (2013),** *Reforming Indonesia's Complex Legal Environment for Land Governance: Complementary Top-Down and Bottom-Up Approaches*, paper presented to the Annual World Bank Land and Poverty Conference, April 8-11, 2013, Washington D.C.

**FAO, 2012.** *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security,* Rome.

**World Bank, 2012.** *Land Governance Assessment Framework: Implementation Manual for Assessing Governance in the Land Sector,* World Bank, Washington D.C.

# Geospatial Data Infrastructure of the KSA Border Guard

The Border Guard of the Kingdom of Saudi Arabia is undergoing a major development program, under which a Border Security system will be installed along the border of the Kingdom

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The Kingdom of Saudi Arabia (KSA) Ministry of Interior (MOI) has initiated a major development program for its Border Guard (BG) to develop the BG's organization into a 21st century security force capable of delivering comprehensive border protection [KSA MOI 2007]. Such a sustainable approach requires a comprehensive modernization and integration of command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR), supporting telecommunications and information technologies, organizational development and training as well as air, land and sea assets and infrastructure to create an effective border security and protection system.

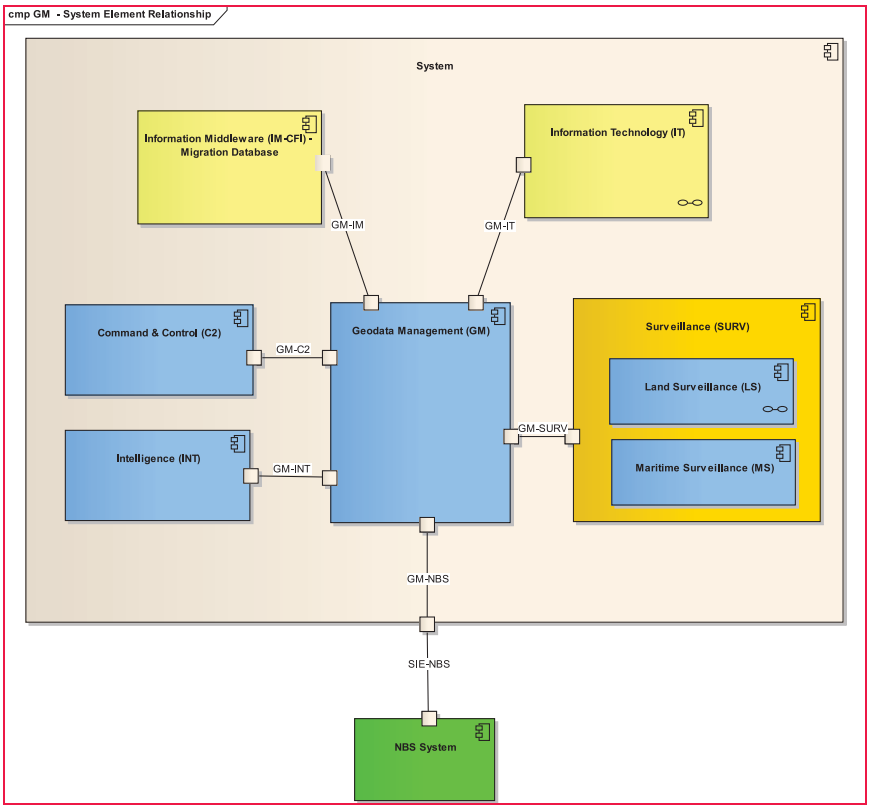


**Figure 1: Internal interfaces of the system element geospatial & environmental reference**

The main purpose of the target border security system is to [KSA MOI 2007]:

- Deny illegal entry of people and contraband into the Kingdom;
- Provide front-line staff the best possible environment to effectively deter, detect, identify, classify, respond to and resolve border security situations;
- And to balance the need for efficient border crossing processes to encourage economic growth while also ensuring that threats are countered before they impact the country, therefore protecting the citizens and legitimate residents of the Kingdom.

This overall development program was contracted in two parts. The first tranche is a pilot that aims for the protection of the northern part of the border of the Kingdom towards Iraq and is therefore called NBS (Northern Border Security). It covers only land sectors. The second tranche deals with the full scope of the border while having a supplemental requirement to provide for an integration of the NBS solution into the overall target system solution. It covers not only land sectors like NBS but also the shores of the Red Sea and the Arabian Gulf, thus land and maritime sectors. As this second tranche deals with the integration of several system elements into an overall system while encompassing as well the integration of NBS and interfaces to other KSA agencies and existing infrastructures, it was therefore called the Systems Integration Engineer (SIE) project.

Similarly to the NBS system, as part of the SIE system surveillance sensors will be installed along the border, and incidents detected on the basis of sensor observations are nowadays displayed in a graphically enabled application to provide the system

operators the full overview of the situation along the border, showing amongst others the detected incidents, own installations and forces together with geospatial and environmental data. Consequently such a system provides for what is typically termed a Common Operational Picture (COP).

One major part within a COP is geospatial and environmental data that is used on the one hand for visualization purpose and on the other hand to support the decision making process in the headquarters, for example by geospatial analysis of bounding conditions of a mission to be conducted. Besides this use geospatial data is also needed for processing and georeferencing the observations from the sensors. To enable that all levels of echelon have access to the same data based on the single source of information principle, a central management and provision of this data is required. Therefore the Geospatial & Environmental Reference System Element (G&ERSE) is a fundamental part of the system, which serves all other system elements on all levels of echelon with up-to-date geospatial and environmental data, irrespective of operational domains, environments and locations.

In the following the requirements for this G&ERSE are summarized for both data and technical aspects and an outline of its architecture including an overview of its interfaces is provided. This is followed by an introduction into two prototypes that have been developed to de-risk and prepare for the development of the target G&ERSE architecture.

## Requirements for the border guard's future geospatial data infrastructure

### Requirements for the technical geospatial infrastructure

Whereas the geospatial data for NBS was provided by the KSA MOI as a customer furnished item to be integrated by the contractor into the system, this is different for the SIE approach. The delivery of geospatial data is within the scope of the contract for the SIE system, and dedicated comprehensive requirements for both the GIS software infrastructure and the geospatial data are part of the request for proposal [KSA MOI 2007]. The main requirements that have been stipulated for the future geospatial data software infrastructure may be summarized as follows:

- A central geospatial database in the system, and provision of data to other system elements on the same and subordinated levels of echelon;
- Ability to easily update geospatial and environmental data within the system on all levels of echelon assuring data integrity and consistency;
- Capability of accessing Esri compatible data and ability to consider existing Border Guard Esri installations;
- Integration of the NBS geospatial installation;
- Interoperability with other KSA agencies, neighbours and allies, where applicable;
- exploit national, allied and coalition standards.

### Requirements for geospatial & environmental data

Geospatial data to be included in the system comprise:

- Maps: both raster and vector based on DIGEST standards;
- Satellite imagery with a ground sampling resolution of better than 1 m;
- Digital Terrain Elevation Data (DTED) Level 2;
- Air Charts and Maritime Charts.

Whereas it is straightforward to include georeferenced scanned raster maps into a GIS, for a comprehensive vector map it is clearly necessary to define the feature catalogue that shall be used for digitization. As there are as well requirements to be interoperable with neighbours and to adopt existing standards, the choice for the feature catalogue was to base the future Border Guard Feature Catalogue on the Defence Geospatial Information Working Group (DGIWG) Feature Data Dictionary (DFDD), i.e. to make a profile of DFDD and adding relevant Border Guard specific features and mapping as well the existing NBS feature catalogue to this new Border Guard Feature Catalogue. The DFDD is the successor of the well-known FACC, the Feature and Attribute Coding Catalogue [DGIWG 2000] to which the SIE shall also be compatible, and DGIWG recommends to use in the future the DFDD.

Note that the DFDD was used in the frame of the MGCP, the Multinational Geospatial Co-production Program, for which an overview is given in [Farkas 2009]. DFDD therefore has a high level of interoperability with potential allies.

DTED is standardized via [NIMA 2000] and [NATO2004]. State-of-the-art maritime / nautical charts are nowadays provided in digital format based on standards from the International Hydrographic Organization (IHO) and its bureau, the International Hydrographic Bureau (IHB). Not only the contents and the visualization styles of nautical charts are standardized for both analogue [IHO 2012a] and digital data [IHO 2000 Appendix A, IHO 2010] but especially the digital formats of nautical charts [IHO 2000 Appendix B; IHO 2012b]. Electronic Nautical Charts (ENC) were developed in the frame of the development of Electronic Chart Display and Information Systems (ECDIS, cf. e.g. [Hecht et al. 2011]) and the carriage requirements for ships from the International Maritime Organization (IMO). ENC are the only officially authorized data sets allowed to be used for an ECDIS. As the Border Guard will also have communication with Search & Rescue (SAR) units and shall be interoperable with other KSA agencies which potentially will use the available ENC in ECDIS, a requirement refined from the general requirement to integrate maritime charts is to use was well ENC data in the SIE system to enable communication by use of equal data sets, even when SIE is not an ECDIS as specified by [IEC 2008]. Nevertheless it is for example stated by IHO as well [IHO 2011] that ENC data should be part of (national) spatial data infrastructures as they describe maritime and navigational aspects of the environment and thus are important for a comprehensive future COP for the Border Guard.

Air Charts are described in general by [ICAO 2010] and it is currently under investigation which air charts will be integrated in the system, depending on commercial availability or availability as customer furnished item.

Besides the integration of geospatial data into the SIE system, it is clear that bounding environmental conditions have a strong impact on missions as well as on sensor coverage. Therefore environmental data has to be provided in the SIE system where current weather data is certainly one of the most important data to be mentioned as it provides bounding conditions of the situation in the field and also for the deployment of own forces to counter incidents. Environmental data to be included in the system comprises:

- Weather data: World Meteorological Organization (WMO) and International Civil Aviation Organization (ICAO) formats to be used such as but not limited to:
  - GRIB (GRIdded Binary for version 1 / General Regularly-distributed Information in Binary form for version 2);
  - BUFR (Binary Universal Form for the Representation of meteorological data);
  - TAF (Terminal Aerodrome Forecast);
  - METAR (Meteorological Aerodrome Report);
  - SIGMET (SIGnificant METeorological information for aviation);
  - synoptic and other meteorological data;
- Tide tables;
- Sunset/Sunrise/Sun Plot, Moonset/Moonrise/Moon Plot.

Additionally, prayers and a gazetteer with Arabic place names shall be provided within the system.

Weather data is standardized in general by the World Meteorological Organization (WMO) [WMO 2011a/b] and the aviation related aspects by the International Civil Aviation Organization (ICAO), cf. [ICAO 2011].

## Geospatial & environmental reference system element architecture

### Bounding conditions for the system element architecture

Integration of several system elements and interfaces into an overall system has to consider a multitude of bounding conditions. For the G&ERSE the main architecture drivers are in particular:

- The use of different geographic information system (GIS) software families within the SIE system elements, i.e. the solutions used for the mobile forces and the surveillance system elements are based on products from the Luciad company, and the existing main BG GIS infrastructure as well as the Command & Control (C2) headquarter component is based on Esri technology. The G&ERSE has to serve and support both families of GIS software products.
- The Mobile C2 forces will not have online access to geospatial data; hence they have to store data

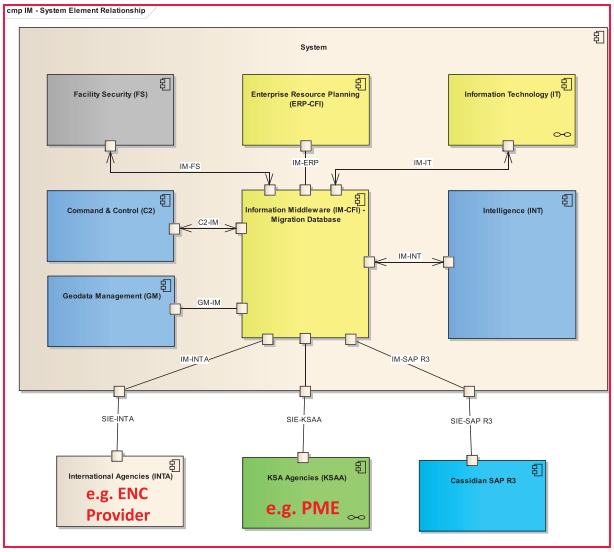


**Figure 2: Interfaces of the system element geospatial & environmental reference**

locally but being able of updating its repository when connected again.

- The refined requirement to include ENC in the system, and these ENC have to be visualized in all system elements in the general spirit of a COP, i.e. common data from one source and similar visualization in all system element's graphically enabled clients.
- The Esri GIS software family does not support the processing of commercial ENC data in its encrypted variant [cf. IHO 2012b], it only supports the un-encrypted data format of ENC [IHO 2000].

## Interfaces of the geospatial system element

The Figure 1 depicts the internal interfaces the G&ERSE has within the SIE system. It has to be distinguished between interfaces where services will be provided for enabling functionality in other system elements, like C2, Intelligence and Surveillance, and interfaces where services from other system elements are consumed.

The latter are general IT services, e.g. provision of storage for geospatial data in terms of file systems and databases (e.g. Oracle) and middleware services to provide the opportunity to connect the G&ERSE with the outer world by secure means.

Services provided from G&ERSE comprise the access to geospatial & environmental data as needed by the individual other system elements. In order to provide the requested interoperability, there will not only be proprietary interfaces such as Esri internal interfaces between Esri servers from G&ERSE and clients from G&ERSE and other system elements (and similarly between Luciad servers and Luciad based clients), but also interfaces based on open standards such as the standards from the Open Geospatial Consortium (OGC).

The most important interface to be mentioned is obviously the Web Map Service (WMS) interface, as specified by the OGC [OGC 2006] but also standardized as ISO 19128:2005. This will also enable to serve thin clients in the system, i.e. browser based clients, with geospatial and environmental data. It also supports provision of data where clients cannot read specific formats natively, or where clients shall have a common style of visualization in the spirit of a COP as data provided by a WMS is already visualized data rather than data where still a styling has to be applied to.

Figure 2 depicts the way how external data sources may be accessed. The core requirement from a geospatial perspective is here to provide the opportunity to update the geospatial & environmental reference on a regular basis.

The Information Middleware System Element provides therefore a gateway with a Demilitarized Zone (DMZ) to protect the SIE system from unauthorized access. Via this DMZ access is provided to external data providers. Whereas the update frequency for example for weather data is quite high ranging from 1 to 6 hours or even higher for weather satellite imagery, providers for ENC update their charts in accordance with the Notice To Mariner scheme (cf. International Convention for the Safety of Life at Sea, SOLAS, Chapter V – Safety of Navigation, Regulation 9 – Hydrographic Services). Typical update periods are two weeks, so that differential updates need to be received in a system using this data every fortnight, and after some update periods full new data sets are provided in order to avoid an administrative overhead with the updates.

For the provision of meteorological data the operational SIE system will have an online access to an external weather data provider to retrieve weather and meteorological data in accordance to the frequency in which this data is available. As the requested variety of weather data is typically not read by all GIS systems, it is planned in the architecture to have in parallel to the core geospatial database a meteorological database and application that pre-processes and stores the data and visualizes it so that it can be read easily in standard GIS clients via OGC interfaces. This is discussed below in more detail.

For oceanographic data which is necessary for example for Search & Rescue applications it is still under investigation which source could provide this data for the Arabian Gulf and the Red Sea to support respective missions.

## Overview of the current geospatial & environmental reference system element architecture

The Figure 3 provides the current stage of planning how the geospatial & environmental architecture will look like on the level of the National Headquarter (NHQ). On the top level the various different types of geodata are listed, and on the left are the applications that use this data via the technical infrastructure. For the processing and provision of vector map data it is planned to have a central Esri ArcGIS for Server. The ArcGIS for Server will also be used for metadata management in general, and the metadata shall also be used by the Luciad Fusion Server. For redundancy and security reasons a similar architecture is currently planned for the HQs of the next subordinated level, and data is

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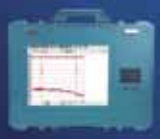

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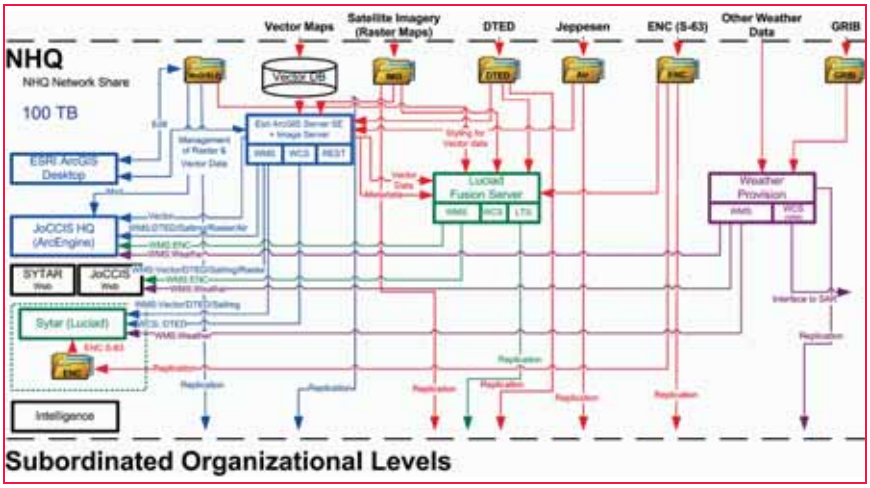


**Figure 3: Overview of the intended architecture of the system element geospatial & environmental reference at national headquarter level**

passed through via various replication mechanisms on a data need basis. On even lower organizational levels it is planned to have either local copies of geodata, e.g. a File Geodatabase, or to rely on the provision of geodata via respective services like OGC or REST services from the ArcGIS for Server. Web clients will have access to data via OGC services.

The C2 Mobile Clients (not depicted in the figure) have the peculiarity that they cannot update geodata when in the field due to bandwidth issues. They will update when they are directly connected to the network again. They will make use of the Luciad Tile Stream Service (LTS) which is basically a file cache, and the C2 Mobile will have an application to extract mission relevant parts of this geodata cache onto their harddrive when they are planning for their mission. DTED data is provided in visualized way via WMS, and a Web Coverage Service (WCS, e.g. [OGC 2010] or one of the predecessor versions) will provide access to elevation data files, for example for observation processing at the sensors or numerical terrain analysis like line of sight computations.

Besides these architecture parts related to core geospatial data, there will also be a weather data provision via WMS and a WCS for provision of GRIB data to applications in need of numerical rather than visualized weather data, like SAR applications. The weather data provision is discussed in more detail in the next section.

## Prototypes to prepare for development

With the deployment of the Northern Border Security system the Border Guard already has an outmost sophisticated C4ISR system in place that is at the leading edge of technology in the world. It is currently in the process of installation, rollout and acceptance, and some parts are already in operation. The reason to develop prototypes for certain aspects in the SIE system were to investigate in more detail the issues that are new in SIE in comparison to the NBS system as SIE will even enhance the outstanding functionality of NBS due to SIE's far more extended scope. For the G&ERSE there were in particular the new requirements concerning the provision of weather data as well as the new maritime sectors which have to be provided with appropriate maritime charts, i.e. ENC as described above. Another reason was to start to work on the realization of both national and international interfaces as from existing experience it was clear that this will take a considerable amount of time. It is also stated in literature (e.g. [Tomlinson 2011]) that prototypes or pilot projects as they are termed as well are useful in demonstrating planned capabilities to management and potential users, for evaluating performance and solving data problems.

### GIS prototype weather

For the GIS Prototype Weather the most important requirements are:

- Be capable of reading and processing the required weather data formats, as listed in Sec. 2.2 on a 24/7 basis;
- Retrieval of this weather data in the frequency as updates are available at the weather data provider, e.g. the Presidency of Meteorology and Environment (PME) in Jeddah;
- Expose visualized weather data via the OGC WMS, including the GetFeatureInfo interface to query individual stations or point-based observables;
- Store the weather data for a certain period of time, where there shall be a configurable default storage time and as well an extended time period for which weather data that is of particular interest can be stored;
- Provide an OGC Web Coverage Service (WCS) for provision of weather data via GRIB files for system elements who not only need visualized data but also numerical weather data, for example to feed the SAR software with environmental parameters to predict the drift way of objects at sea.

After a tender procedure involving several companies a renown company was selected that is already present with its products in KSA as it provides for example parts of the technical infrastructure of the PME. The selected product is a highly flexible and configurable installation that supports in particular provision of weather information via OGC services in a sophisticated way. For the provision of weather data an online access from the prototype to a weather data provider was realized. Figure 4 shows a sample screenshot from the prototype's Graphical User Interface (GUI) how access to meteorological data could be provided and here in particular how access to weather forecasts could look like. A particular feature is that a specific time slider was implemented that enables to visualize the weather forecast for different time slots using one WMS and involving the "TIME" parameter of the GetMap request (see Figure 4 upper right corner). Based on the GetFeatureInfo interface it is also possible to query the field of values to retrieve numerical values of phenomena (see Figure 4 lower left corner), or to query synoptic weather data from stations.

### GIS Prototype Maritime

A broad overview on the relevant standards on ENC has already been given. In detail the main requirements for the GIS Prototype Maritime are:

- The GIS Prototype Maritime shall provide Electronic Navigational Chart (ENC) data via an OGC Web Map Service interface [ISO 2005; OGC 2006].
- The ENC WMS shall provide the WMS GetFeatureInfo interface operation [cf. ISO 2005; OGC 2006] for retrieval of textual attribute information of ENC objects. Note: the GetFeatureInfo interface is not a mandatory operation for a WMS; therefore this interface operation is requested explicitly for the mentioned purpose.
- The GIS Prototype Maritime shall be capable of handling both un-encrypted and encrypted ENC data, i.e. S-57 [IHO 2000 Appendix B] and S-63 formats [IHO 2012b].
- The GIS Prototype Maritime shall be capable of handling updates for both un-encrypted and encrypted ENC data, i.e. S-57 [IHO 2000 Appendix B] and S-63 formats [IHO 2012b].
- The portrayal of ENC data shall be in the general spirit of S-52 [IHO 2010] with regard to symbolization of ENC content and the use of units on the display.
- The ENC WMS shall be configurable with regard to colour tables (daytime, night-time), display categories (Base, Standard, Additional), depth settings, display of chart cell boundaries, the indicators for availability of higher resolutions as well as indicators for overscale presentation, as described by S-52 [IHO 2010] and ECDIS Performance Specification [IEC 2008].

As there is the bounding constraint for the geospatial architecture to include a Luciad Fusion Server for the provision of geospatial data, it was decided for aspects of synergies that the Luciad Fusion Server shall also be used for the publication of the ENC WMS. Although this was at that time not a feature of the Fusion Server, a custom development based on the above mentioned requirements (and others more detailed ones) was conducted as a prototype.

Figure 5 shows a sample screenshot from the maritime prototype's GUI using the IHO Test Data Sets for ECDIS [IHO 2012c]. Additionally the screenshot shows the return of a GetFeatureInfo request. Please note that the service returns attributes not only for one feature but for all features that have been identified at the respective position. For the example a DEPth AREa (DEPARE) has been identified which has two Depth Range VALues (DRVAL1 and DRVAL2) indicating the depth ranges in this area, and a wreck (WRECKS) resides at this location, having attributes CATWRK (CATegory of WRecK) equal to 2 (dangerous wreck), QUASOU (QUAlity of SOUnding measurement) equal to 2 (depth unknown) as well as WATLEV (WATer LEVel effect) equal to 3 (always under water/submerged).

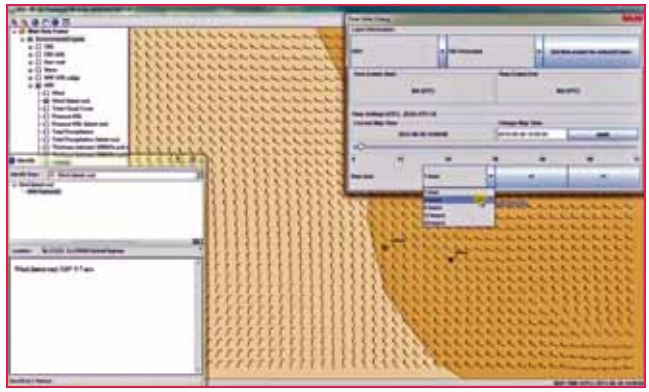

**Figure 4 – Example from the GIS Prototype Weather**

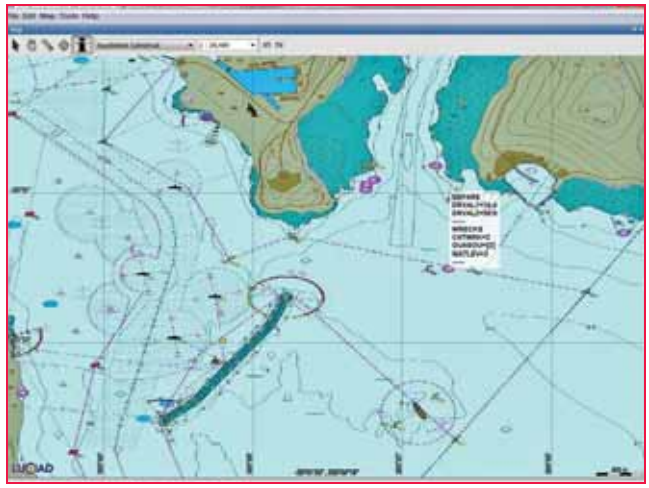

**Figure 5 – Example from the GIS Prototype Maritime using S-64 IHO Test Data Sets for ECDIS**

## Discussion

From an architectural and technical perspective it is a challenge to built a system that shall support all the different domains, i.e. land operations, maritime operations and to a certain extent air operation by including land mapping and maritime and air charts, as the different GIS software families on the market have different strengths and advantages driven by the backgrounds where the different products come from. There is no all-embracing data model and format available. The use of open standards supports in particular the set-up of such an integrated and centralized geospatial data infrastructure. It is advantageous to use open standards therefore not only for external interfaces but also for internal interfaces. From an integrators perspective, this eases and de-risks the development of a large system considerably as open and/or international standards not only are commonly implemented but also provide the opportunity to exchange a subcontractor or a client software without too much impact on the architecture, in case a subcontractor is for various reasons not available anymore or a client software has to be replaced. Additionally, it is much easier to specify interfaces as it is possible to reference to existing and accepted standards.

## Conclusions

With the introduction of a comprehensive Geospatial & Environmental Reference infrastructure the KSA Border Guard

geoinformation working group will be well prepared for its future challenge to support the geographically enabled applications in the future KSA Border Security system with up-to-date data in a consistent and reliable way. The geospatial architecture and data to be supplied inherently support a high level of interoperability as to an outmost extent open standards were adopted for the design of the architecture and the specification of data.

The GIS Prototypes that were run to de-risk development for the Geospatial & environmental Reference were a successful step to show on the one hand current technical limitations in commercial software and to start to work on them, including sizing investigations, on the other hand the prototypes revealed again that it is a challenge to implement online interfaces with both national and international agencies. In that sense they supported both the technical and the organizational and administrative set-up of the geospatial system element. Additionally it is an opportunity for the end-user of a system to familiarize at an early stage of development with the future system and by doing so and providing feedback to improve end-user satisfaction. It is also a means to familiarize as well at an early stage with all the relevant standards stemming from the different (geospatial) standardization organisation, like DGIWG, ICAO, IEC, IHO, ISO, NATO, OGC, WMO, etc. Consequently it can only be highly recommended to conduct such prototypes or pilot projects to prepare for the success of a system in general or for the case at hand a geospatially enabled system in particular.

## References


DGIWG, 2000: The Digital Geographic Information Exchange Standard (DIGEST) Part 4 Feature and Attribute Coding Catalogue (FACC). Edition 2.1 September 2000.

Farkas, I., 2009: Key points and the most significant documents in the production of the High Resolution Vector Data (HRVD) within the Multinational Geospatial Co-production Program (MGCP). Academic and Applied Research in Military Science (AARMS) Vol. 8, No. 1, 141–149.

Hecht, H., Berking B., Jonas M. & Alexander L. 2011: The Electronic Chart, Fundamentals, Functions, Data and other Essentials. Geomares Publishing; 3rd Edition (2011).

ICAO 2011: International Standards and Recommended Practices, Annex 3 to the Convention on International Civil Aviation – Meteorological Service for International Air Navigation. 17th Edition, ICAO, July 2010.

ICAO 2010: International Standards and Recommended Practices, Annex 4 to the Convention on International Civil Aviation – Aeronautical Charts. 11th Edition, ICAO, July 2009.

IEC 2008: Maritime navigation and radiocommunication equipment and systems – Electronic chart display and information system (ECDIS) – Operational and performance requirements, methods of testing and required test results (IEC 61174:2008).

IHO 2000: Publication S-57: IHO Transfer Standard for Digital Hydrographic Data. Edition 3.1 - IHB, November 2000.

IHO 2010: Publication S-52: IHO Specifications for Chart Content and Display Aspects of ECDIS. Edition 6.0, IHB, March 2010.

IHO 2011: Publication C-17: Spatial Data Infrastructures "The Marine Dimension". Edition 1.1.0, IHB, February 2011.

IHO 2012a: Publication S-4: Regulations of the IHO for International (INT) Charts and Chart Specifications of the IHO. Edition 4.3.0 – IHB, August 2012.

IHO 2012b: Publication S-63: IHO Data Protection Scheme. Edition 1.1.1 – IHB, April 2012.

IHO 2012c: Publication S-64: IHO Test Data Sets for ECDIS. Edition 2.0.0 – IHB, May 2012.

ISO 2005: Geoinformation – Web Map server interface (ISO 19128:2005).

KSA MOI 2007: General Directorate of Border Guard – Border Guard Development Program – System Integration Engineer (SIE) Request for Proposal (RfP). 15 July 2007.

NIMA 2000: Performance Specification Digital Terrain Elevation Data (DTED). NIMA (United States National Imagery and Mapping Agency, nowadays National Geospatial-Intelligence Agency NGA) MIL-PRF-89020B, 23 May 2000.

NATO 2004: STANAG 3809 IGEO (Edition 4) – Digital Terrain Elevation Data (DTED) Exchange Format.

OGC 2006: OpenGIS® Web Map Server Implementation Specification, v. 1.3, OGC Document Number OGC® 06-042.

OGC 2010: OGC® WCS 2.0 Interface Standard - Core, v. 2.0.0, OGC Document Number OGC® 09-110r3.

Tomlinson, R. 2011: Thinking about GIS – Geographic Information System Planning for Managers. 4th Edition, Esri Press, Redlands, California, USA.

WMO 2011a: WMO-No. 306 Manual on Codes - International Codes Volume I.1 Part A – Alphanumeric Codes.

WMO 2011b: WMO-No. 306 Manual on Codes - International Codes Volume I.2 Part B – Binary Codes.


## Internet Ressources


DFDD: DGIWG Feature Data Dictionary, URL: *https://www.dgiwg.org/FAD/overview.jsp* (last visited 20.01.2013)

DGIWG: Defence Geospatial Information Working Group, URL: *http://www.dgiwg.org/* (last visited 20.01.2013)

FACC: Feature and Attribute Coding Catalogue, URL: *http://www.dgiwg.org/digest/* (last visited 20.01.2013)

ICAO: International Civil Aviation Organization, URL: http://www.icao.int/ (last visited 20.01.2013)

IHO: International Hydrographic Organization, URL: http://www.iho.int/ (last visited 20.01.2013)

IMO: International Maritime Organization, URL: http://www.imo.int/ (last visited 20.01.2013)

OGC: Open Geospatial Consortium, URL: http://www.opengeospatial.org/ (last visited 20.01.2013)

SOLAS: International Convention for the Safety of Life at Sea, URL: *http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-%28SOLAS%29,-1974.aspx* (last visited 20.01.2013)

WMO: World Meterological Organization, URL: *http://www.wmo.int/* (last visited 20.01.2013)



*The paper was presented at The Eighth National GIS Symposium in Saudi Arabia during 15-17 April 2013.*

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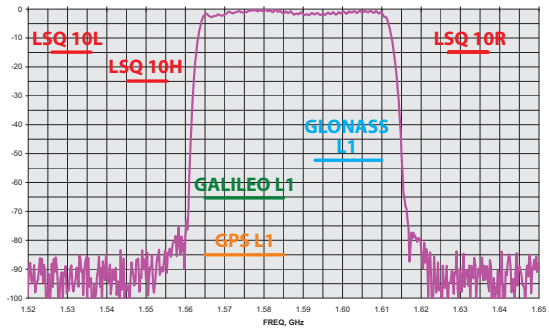


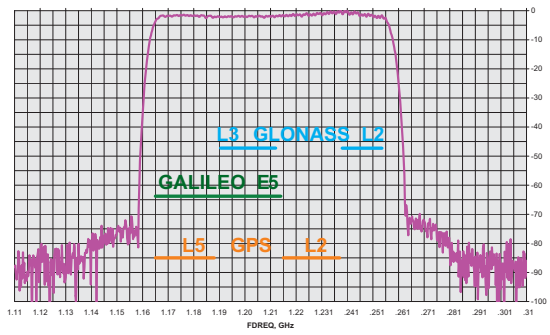


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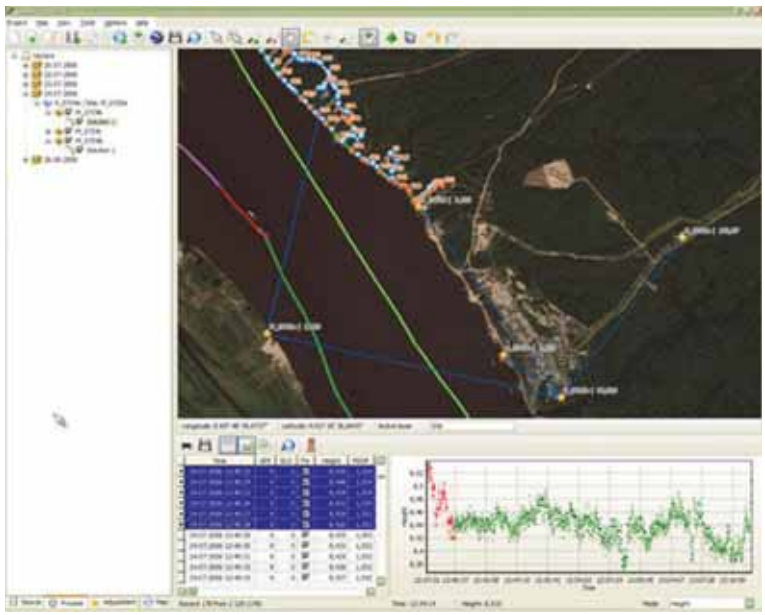

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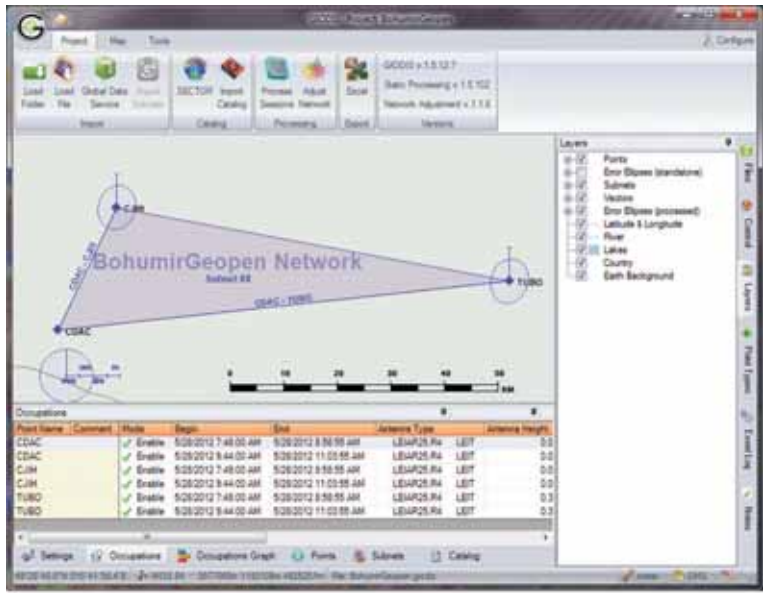


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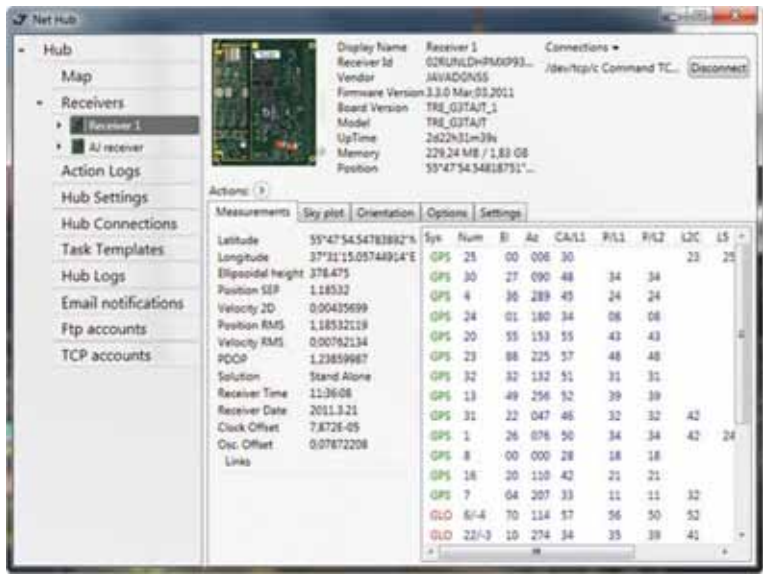


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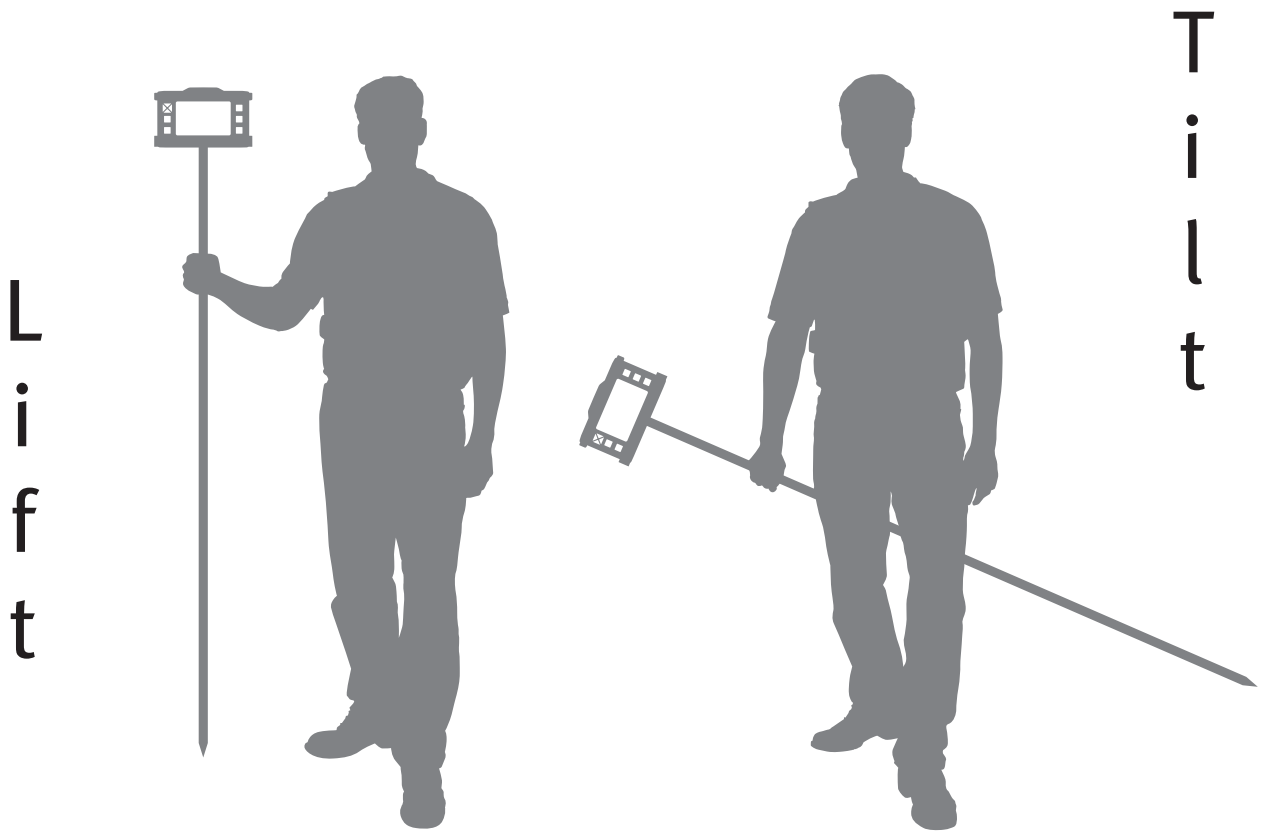


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# Study on the teaching method innovation of space geodesy

The state of the art and the teaching content of space geodesy are introduced in the paper

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Space geodesy is a complete set of theory and method which uses natural objects or artificial objects to accurately determine the position of the point to determine the earth's shape, size, external gravitational field and their changes over time [1]. Space geodetic techniques are changing quickly as many countries enhance emphasis on space exploration as well as the development of space science, computer, electronic communication and other modern science. The developments of society and human life in all areas have been profoundly affected by the achievements of space geodesy.

The principles, techniques and methods are systematically introduced in the course of space geodesy, which will help students to master relevant knowledge comprehensively and lay a solid foundation for the subsequent scientific research.

## Technology status of space geodesy

The primary missions of space geodesy consist of establishing and maintaining the earth or celestial reference frame and determining the high precision of Earth's gravity field [1]. The resolutions of these issues need to rely on the continuous development of space geodetic techniques.

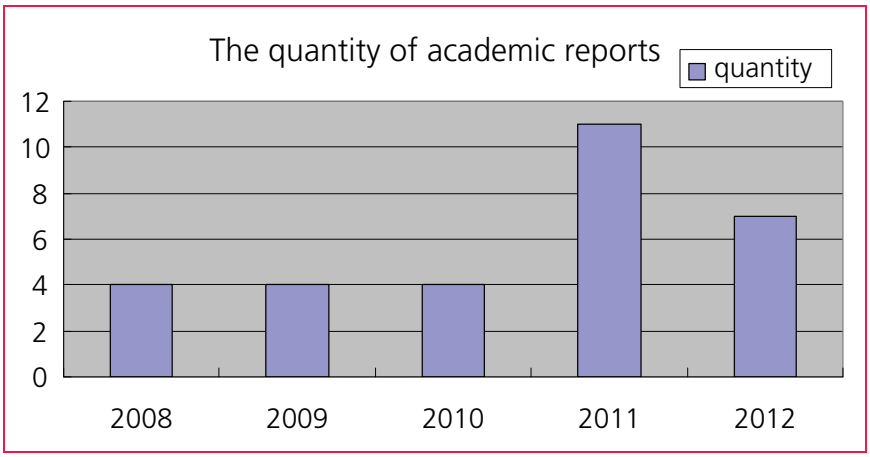


**Figure 1: The quantity of academic reports**

### Very Long Baseline Interferometry (VLBI)

VLBI measures the time differences τ and its rate dτ/dt in the arrival of microwave signals from extragalactic radio sources received at two or more radio observatories. Then, the baseline and the coordinate of the radio sources are determined.

VLBI can be used to interconnect the Celestial coordinate system and the Earth coordinate system. Therefore, it can help us to determine the polar motion (Xp, Yp), the earth-rotation variations UT1, the Precession and the Nutation parameters as well as providing scale reference for the ITRF.

In order to break through the resolution limitations by the earth radius, the Space VLBI (SVLBI) has been studied and implemented. In addition, the Real-time VLBI represents the development trend of this technique.

### Global Navigation Satellite System (GNSS)

On October 25, 2012, the successful launch of the 16th Beidou navigation satellite of China marks that the Compass can provide navigation service covering the Asia Pacific region. In addition, the GALILEO of Europe is under construction. And the GLONASS is gradually being restored by Russia. The modernization upgrade of the GPS has been implemented [2]. All of these make up the GNSS.

The function of satellite positioning technology will be expanded in space geodesy, with the gradual development and improvement of the GNSS.

### Satellite gravity survey

The first generation of satellite gravity technology takes advantage of the orbit perturbation of the satellite. Then, the satellite altimetry technology is used in the second. These have made great contributions to the establishment of the Earth's gravity field model and the refinement of quasi-geoid.

The third generation of satellite gravity technology, which consists of the CHAMP, GRACE and GOCE, has being implemented. It greatly promotes the model's resolution and precision of the Earth's gravity field and the refinement of quasi-geoid.

### Satellite Laser Ranging (SLR)

SLR has played an important role in determining the satellite orbit and orbital perturbation, as well as the establishment and maintenance of the ITRF. It will tap its huge potential in geodynamics along with the promotion of the observational accuracy, and the increase of the observation time and more reasonable of the station distribution.

### Satellite to Satellite Tracking (SST)

There are two different patterns SST used– one is HL-SST which uses the high-orbit satellite tracking low-orbit satellite, while the other uses the low-orbit satellite tracking low-orbit satellite. The former has been successfully employed to the inversion of gravity field of the earth by satellite CHAMP; moreover, it can also determine the satellite orbit. The GRACE uses the second pattern to achieve better precision of the earth's gravity field.

## The teaching material contents and plan

The teaching material keeps up with the latest technology and scientific research in the field of space geodesy. The basic concept, principle and technology are introduced to the students as much as possible in a way that is easy to be accepted.

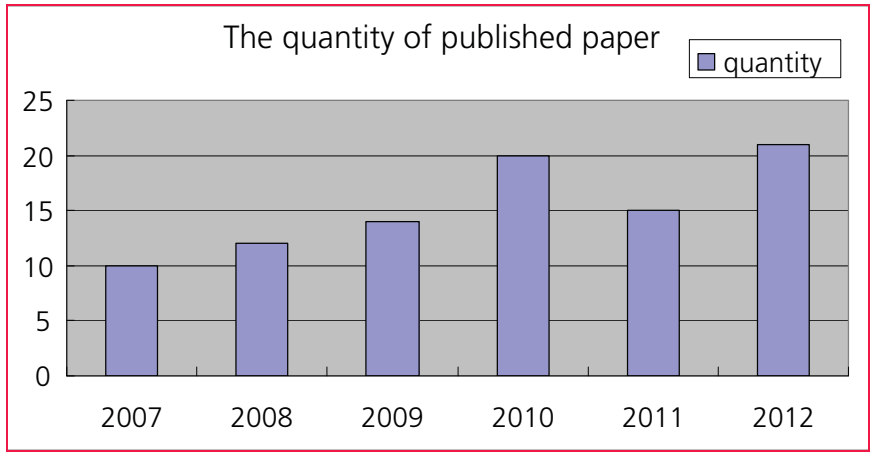


**Figure 2: The quantity of published paper**

The teaching material consists of eight chapters. In the introduction, beginning with the limitation of the traditional geodetic techniques, the necessity and feasibility of the space geodesy is elaborated. Then, the basic concept, task and technology are introduced briefly [3].

Time and space are the basic dimensions used to describe the physical movement and change of objects. Therefore, the establishment, conversion and connection of the time references and position references are the primary research task for space geodesy. These contents are introduced in the second and third chapters.

The theory and implementation of VLBI generally used in space exploration are introduced in the fourth chapter. Moreover, the high resolution and better precision are the strength of VLBI. The application and trends of this technology are given according to current scientific research.

SLR can achieve centimeter to millimeter accuracy, which has played an important role in determining the satellite orbit and earth rotation variations precisely [3]. The new round of lunar exploration is planned and implemented, in which the Lunar Laser Ranging (LLR) will play an increasingly important role because of its high accuracy in determining the reference frame on the moon. These are the contents of the fifth chapter.

Satellite altimetry and satellite gravimetry are successfully used in achieving high precision model of global gravity field and global geoid. The principle, data processing and development trend are introduced in the next two chapters. In addition, their increasing importance in oceanography, seismology and the global environment change and monitoring are also given.

The development, present situation and upgradation of satellite navigation and positioning system are introduced in the last chapter. Moreover, the principle and data processing of pulsars navigation and positioning technology which have great potential in space exploration are introduced, too.

## The improvement of teaching method and effect analysis

Based on the traditional teaching mode, the original teaching method mainly relies on depiction teaching, a certain amount of homework and discussions. This method needs further improvement in inspiring students' interest and initiative. In order to keep up with the development of space geodesy, some improvements should be researched. Based on our experience in teaching and scientific research, some effective methods are introduced in the following, along with the teaching achievements.

### Participatory teaching method

Participatory teaching method can fully take advantage of the initiative of teachers and students. It provides a communication platform which can be used in achieving thoughts and cognitive resonance [4].

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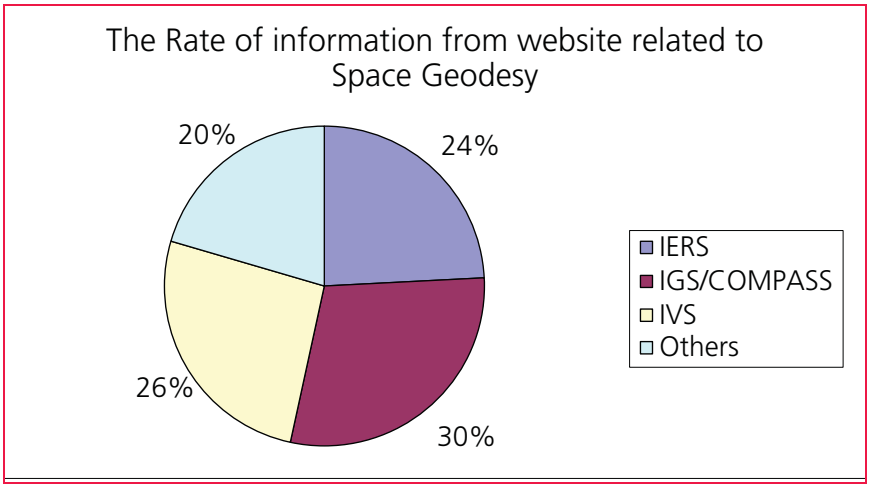


**Figure 3: The rate of information from website related to space geodesy**

Space geodesy is the forefront of geodesy, so it is difficult to master the knowledge because of its comprehensive content. Students can enhance the overall grasp of the course by making courseware, which can also help students to make full use of network to search the frontier. In addition, teachers can find some mistakes through the courseware. According to these, they can provide students with some advice. Moreover, the role reversal and discussions in class are also effective.

For example, the quantity of international academic communication reports given by students in our research group within the past five years is presented in Figure 1.

Figure 1 shows that the index has an apparent growth, which suggests that students' creation and communication ability have been improved.

### Research-centered teaching

Learning theory is aimed at application and research. Teachers should set up different research topics for each chapter according to the content of the course. Students should submit reports or papers after selective study. This method can not only help students to master knowledge profoundly, but also improve their comprehensive skills.

Research-centered teaching can help students in learning. Moreover, it plays an important role in helping students to distinguish the trend and mainstream as well as scientific literacy training, which, therefore, is necessary to be adopted.

For example, the quantity of published paper given by students in our research group within the past six years is presented in Figure 2.

Figure 2 shows that the quantity of published paper by students in our research group grows apparently, which suggests the effectivity of the Research-centered teaching method.

### Tracking the frontier

An up-to-date state is one of the characteristics of space geodesy. All kinds of new theory, technology and research plans have been emerging with the development of science. Keeping abreast of new knowledge plays a definite role in grasping the teaching focus and research trend correctly.

Students should be guided to browse websites (such as IERS, IVS, IGS etc) and periodical (such as Journal of Geodynamics, Planetary and Space science, Journal of Geodesy, Space Science Reviews etc) related to the subject. Some comments and advices should be given according to the report about the frontier submitted by students.

The statistics of the information from the websites related to space geodesy in our students' papers are given in Figure 3.

The combination of both the three charts suggests that it is helpful for students' science research by tracking the frontier of space geodesy.

### The combination of subjects

Space geodesy involves many subjects and technologies, such as space, computer, electronics and information technology etc. Therefore, making full use of achievements of all subjects is necessary and effective. For example, analysis of time series can play an important role in the analysis of Polar Motion. More conditions favorable to students to use this method should be created.

## Conclusion

Space geodesy is developing rapidly and the new space exploration movements are in the ascendant. All these indicate the bright prospects of Space Geodesy. Hoping all of these teaching method innovations from our research and teaching experiences can provide some good references.

## Acknowledgments

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## References

[1] Zhenghang LI, Erhu WEI, Zhengtao WANG et al. Space Geodesy [M], WUHAN: WUHAN UNIVERSITY PRESS, 2010.

[2] WEI Erhu,CHANG Liu,LI Zhenghang On Course Construction of GPS Surveying and Data Processing[J]. Journal of Geomatics. Jun. 2012, 37(3) 44-46;

[3] Erhu WEI, Qi ZHANG, Zhenghang LI, Fuhong WANG. On the Construction and Teaching Method of the Course of Space Geodesy[J]. Bulletin of Surveying and Mapping, 2011(12) : 83-85;

[4] Zhen Li. Study on Participatory Teaching Method[J]. Science Information, 2007(9):159

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# Elements, issues and challenges in implementation of NSDI

NSDI is also facing several challenges in the areas of accessibility, availability, institutional arrangements, lack of standards and experts

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Spatial Data Infrastructure (SDI) consists of Global Positioning System (GPS), Geographic Information System (GIS), Remote Sensing (RS), and the procedures and tools for creating, sharing, and integrating the SDI. The accessibility to SDI as input variables for many project plans and implementation reflects the effectiveness of using SDI. It is created throughout the world by several countries at all level (governments, private sectors, national, state, province and region) (Rajabifard et al, 2003). SDI is encompassed framework policies, standards, network accessibility (technologies), fundamental datasets and human resources (users and the datasets providers) (Feeney et al, 2002; Rajabifard et al, 2006). It is developed from local level to state/province level, then national and after that at global level. Building and implementation of SDI is not only concerned with technology but also concerned with policies and obtaining of new skills (Feeney et al, 2002; Foresman et al, 2004).The goal of these attempts, as mentioned by Masser et al, (2007) is to raise the economic development to create better government to support the environmental and business needs. National Spatial Data Infrastructure (NSDI) is the best solution to spatial data between different organizations (Pulusani, 2004; Williamson et al, 2007).

NSDI comes from technology, standards, criteria and the people that create access and share the spatial data throughout all levels (private sector, non-profit sector and government agencies). It represents the base structure of the relationship between those who use and deal with spatial datasets and data providers (users and data producers). NSDI represents new technology to share, access and use the spatial data. This is very useful for analyzing and processing, and then using the output to help in the process of decision-making (Clinton, 1994; Coleman et al 1998).

## NSDI elements

Many researchers and agencies have generated their own NSDI elements depending on their objectives, work vision, priorities and requirements at a national level. For example, the federal geographic data committee (FGDC) created its own NSDI with six basic elements. These elements are (clearinghouse, geospatial data, partnerships, geo-data metadata, standards and framework), as shown in figure (1) (FGDC, 2005; Masser, 2002). Tosta (1995) established its own NSDI model with four elements. They are geospatial data clearinghouse, standards of geospatial data, framework data and partnership. On the other hand, the Australia New Zealand land information council created its own NSDI with four elements, and these elements are - framework, standards, fundamental datasets and clearinghouse (Masser, 2002; Anzlic, 1998). The permanent committee on GIS infrastructure for Asia and the Pacific has considered the same elements as of the Australia New Zealand land information council NSDI (PCGIAP, 1998). It considers interaction between the human resources and the NSDI important as the human resources involve in the NSDI framework. Human resources are considered as a key in collecting, managing, controlling and analyzing the datasets of NSDI. Rajabifard et al,(2001) also suggested that the NSDI includes more than four elements that are described by Anzlic, therefore, we should add another component to NSDI elements. This element is human resources.

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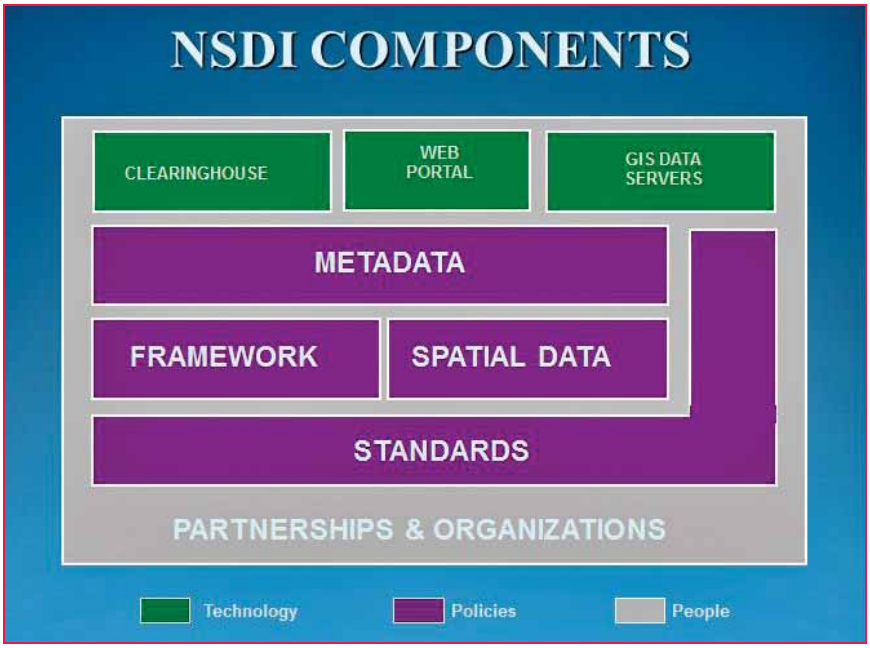


**Figure 1: NSDI Components** (Source: FGDC, 2005)

Crompvoets, (2006); Rajabifard et al, (2002) demonstrated these categories could be changed, for example, both data and human resources could be combined into one category related to the relationship between them. Technologies that consist of (clearinghouse, policy and standard) are considered as the second category. This category controls the first one.

## Metadata

The meaning of Metadata is a file that has a format (XML) document that describes the content, quality and type of the data. In other words, it is the information used to describe data and its services. The spatial data Metadata usually documents data related to the Geographic Information System (GIS), Geo-spatial datasets, satellite images, and also characterized Geographic component, such as information about projects projection and attribute. Metadata needs to develop many procedures to implement a seamless mechanism for all users of spatial digital data. Spatial Metadata is very important to serve the NSDI. Throughout the world, the users of NSDI have been utilizing the Content Standard for Digital Geospatial Metadata (CSDGM). The standards or policies of international Metadata should have the legacy and merge in community (FGDC, 2005), as the figure (2) below describes the Metadata.

## Standards

In order to facilitate using, sharing, developing and transferring the national geospatial data, there is need to find standards to arrange and manage all spatial data aspects - metadata, dictionaries, quality, models, and transfer (Anzlic, 1998; FGDC, 2005). Many sources provide data. Each one generates its own data based on its own needs, standards and requirements that will obviously be revealed when sharing the data by using the clearinghouse. Most of the SDI data have different standards and structures. From this point, the users need access to unique standards to make the spatial data easy to share between different users at national level, and to increase the consistency of data. For example, the FGDC in the US developed data standards for sharing, cooperation and implementation of NSDI at different levels; local, province, state, nation and region between the government agencies, academic communities and private sectors. The FGDC generated these standards based on the OMB Circular A-119. (FGDC, 2005).

## NSDI Clearinghouse Network

NSDI clearinghouse is a server to describe, advertise, distribute and supply the geo-spatial data. The data suppliers publish their own metadata that characterize the data, quality of data and accessibility. The host organizations collect the metadata to advertise and characterize their own geo-spatial data within the NSDI. These metadata provide the users a quick and good assessment of available SDI (Anzlic, 1998; FGDC, 2009), as figure (3) demonstrates the search and retrieve mechanism inside the clearinghouse and below is the explanation of the steps of this mechanism:

1) Users using the ability of communications like email and phone to send some questions by using HTTP/HTML to the web portal;
2) Using Z39.50 the web portal will translate the request;
3) Send the request to search server;
4) Search Server will responds to the web portal by using Z39.50;
5) Converting responds to HTTP/HTML; and
6) Sends back to the user.

## People (Partnership)

The components of NSDI are based on a partnership. In another words, the cooperation that occurs between all those involved into processing of NSDI. Also in spatial data community, the ability of data sharing, developing and maintaining standard datasets will be increased by the relationships that are created by NSDI (Tosta, 1995). In addition, people will make the decisions, and all these decisions require data to be retrieved in a good and right manner. Without people data will not exist. So, the dealing with concepts of data sharing, data accuracy and data accessibility are dependent on the relationships between the people. The activity of the NSDI model will increase the relationships (Rajabifard, 2001).

## Institutional framework

The institutional framework is collaborative, dependent on efforts in which the data are collected, developed, modified and integrated by different sectors of private and government organizations within the same geographic area. The frameworks are important for building data factors of SDI. In US, the representatives of country, state, region, nation and other organizations under the federal geographic

data committee (FGDC) they have been developed on the concept of a framework. And most of providers and users of NSDI in local, province or region level admit that the framework is the better way to improve, share and manage the SDI, and it makes the data efficiency at the highest level. There are three aspects of framework - technology, procedures and data. The framework has been used to make the use of geo-spatial data or its products more easy to help the user in making decision and make the cost of getting NSDI at a satisfying level (FGDC, 2005).

## Challenges and issues of NSDI

NSDI was introduced in 1994. It is important to understand these issues and also discuss the implications of these constraints.

### Digital data availability

The governments' agencies develop, controll, generate and manage different types of spatial datasets. The accurate geo-spatial data should be available at different levels to be utilized for economic, environment and social growth and national development. Availability of the accurate spatial data will enable the decision-makers to take right decisions. In addition, it will also decrease the efforts and the cost of data generation by minimizing the data duplications. However, some of the data are not available. Ready dataset framework is very essential, particularly the topographical maps, which are used in providing the basis for several spatial data that will be used by government agencies or private sectors. And many times, many of the datasets are not available in digital forms. Non-availability of data in digital form can be one of the difficulties in the implementation of NSDI. Data in digital form will make it easier to share the spatial datasets between the organizations, especially those using technology such as the Internet (Sen et al., 2006).

### Digital data accessibility

Most government agencies and private sectors finally recognize the advantages of having accessibility to geo-spatial datasets of others. The financial aspect is the biggest issue which has to be considered in many processes, such as (sharing cost, accessing data and services). The access mechanism is completely based on standards of accessibility and sharing the data. Standards, transfer procedures, and the system are considered as the important factors in NSDI implementation. The continuity of progress in NSDI is related to the issues it faces and affected by successful accessibility to the data. But still there are some constraints when it comes to sharing the data, and these constraints are related to institutions and organizations' aspects to customize the policies for sharing data. (GINIE, 2004).

### Adoptions of standards

Sharing the spatial data faces several constraints, but the major ones are those that lack of national standards to arrange sharing the spatial data, inconsistency in classification and absence of documentation of spatial data (metadata). The spatial data should have common standards to make the integration of data easy with other datasets.

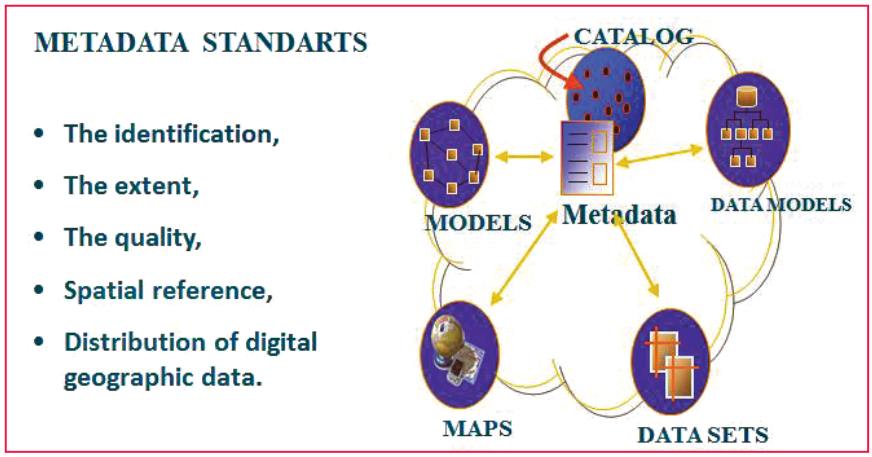


**Figure 2: Describing of Metadata** (Source: FGDC, 2005)

This integration allows availability of effective and efficient solutions for people who use or are concerned with this kind of data that will lead data providers to make the data available via NSDI. Identification of priorities will foster consistency of spatial data to match the users needs. Development of geo-database can be easy considering common systems, spatial referencing system, standards and models. In many cases, the temporal resolutions and spatial coverage area, formats and projection coordinates of maps are incompatible. The technical constraints are matching different standards and communicating between the complex standards. Adopting standards leads to focus on documenting the quality of the spatial datasets and the interoperability. (Noor H. et al., 2010; Rajabifard, 2003).

## Availability of metadata

The availability of Metadata is another issue that challenges the development of NSDI. It is a serious issue, as many users do not have the ability to know the content of this data without metadata. Generation of metadata must be given the highest level of priority. The data that has metadata becomes more informative and has good quality. ISO19115 - is one of the famous standards of metadata that has been proposed recently, and it became an international standard for geo-spatial datasets. However, several government agencies and private sectors have suggested different types of metadata profiles. (Minh et al, 2009; Sen et al, 2006)."

## Data interoperability

Data interoperability is considered as an important issue among the processing and utilization of spatial data. Many of the spatial data that are collected by different organizations and private sectors are incompatible as they are collected by using different standards though they are of the same area. There is a strong requirement for interoperability for many applications, especially with the applications that are related to municipality and government.

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The geo-spatial datasets have to be seamless data as far as possible. Almost all national data that are collected, stored, processed, analyzed and maintained without considering spatial standards (National) that generate other difficulties with the data. When users need to integrate them together, there is no interoperability between the data (Minh et al, 2009).

### Institutional arrangements

Sharing the spatial data is linked to authority and hierarchy in almost all the government agencies, organizations and private sectors. There is no truthful attempt to share the spatial data among various sectors. Each government agency or private sector undertakes their mandate attempting to generate their own spatial database system by following their needs and priorities. The spatial data is used in vertical dimension and hierarchy (NALIS, 1997; Noor H. et al, 2010).

### Lack of awareness in NSDI and GIS

Lack of awareness is a major problem in implementation of NSDI. The majority of spatial data users and producers are not very familiar with using SDI, and that is simply because the channels communications between them and NSDI is still at a generating level not widely known to them. By increasing the level of awareness among the SDI users it will help establish implementation of NSDI with high level of benefits from its products(NALIS, 1997;Arshad et al, 2010).

### Lack of knowledge and skills

Successful development and dealing with all NSDI elements into organizations requires skills, knowledge, and know-how about how much should be obtained outside assistance. Many times, there is a lack of experience and knowledge in GIS. Thus, there is a need to focusing on the capacity building of NSDI staff through training programmes to meet the requirements skilled manpower. Understanding and applying of capacity building in implementation of NSDI will assist the agencies to boost the progress of NSDI development and its implementation. (Minh et al, 2009; Arshad et al, 2010).

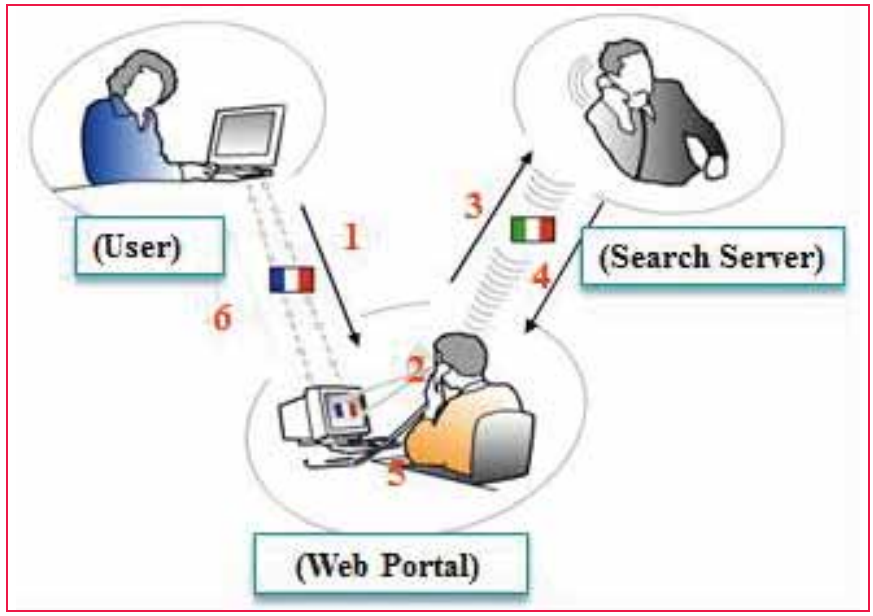


**Figure 3: Clearinghouse Network** (Source: FGDC, 2005)

### Difference in languages

NSDI management faces many problems. The difference in languages is one of the important factors that affects the management of NSDI. The NSDI must have a support system that is able to deal with multi variables in any language that is involved in the system. However, the difference in languages fosters challenges that not considered as a part of NSDI management processing. Users often use translation ability, when they are looking for novel or modified functionality to coordinate the processing of translation. The web application brings many multilingual problems, for example, catalog services have to be supported by language data retrieval. There are several geo-spatial datasets resources that have been cataloged by one language. On the other hand, the users make queries in another language. These users could be interested in some kind of data (documents, images, and database) described in another language to them. So, the catalogs should supply the users mechanisms search that give them the ability to overcome the problem to describe the data in different languages. The problem of multilingual will cause difficulties in doing any search, collection, analysis and processing of data and that will have a big influence in performing of NSDI (Alhubail, 2004; Minh et al, 2009;Arshad et al, 2010).

### Poor cooperation

Cooperation is mostly a factor that can push forward the implementation of NSDI. The more cooperation it receives, the more successful will NSDI be. Some of the projects of NSDI will be implemented with multi stakeholders when the partnerships have geo-spatial datasets that can make the NSDI project a success. (GINIE, 2004; Manisa et al, 2007; Minh et al, 2009; Arshad et al, 2010).

### Partnership arrangements

Using and sharing of geo-spatial datasets normally occurs among governments agencies and private sectors, but they do not share the responsibilities of generating, maintaining, and distribution of the spatial datasets. The cost of all these processes should be justified in terms of public advantages. The access arrangement of NSDI spatial data should have a high confidentiality, high level of security, privacy and intellectual property rights (IPR). Considering the agreement the partners have to contribute in the costs accrued in collection, analysis and management of the geo spatial data, and should integrate the output of these data in their database to be distributed to their users or customers. They should make or try to make harmonious terms and standards between them (Manisa et al, 2007; Arshad et al, 2010).

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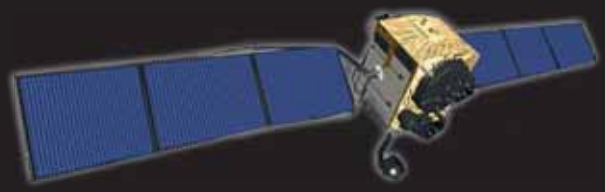

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### Policy and legal issues

An appropriate policy framework that encourages and facilitates the easy access to spatial data can be a key for the success of any NSDI initiative. In addition, legal issues pertaining to intellectual property rights, copy rights, ownership, liability, etc should be clearly defined.

### Absence of technology infrastructure

Many countries around the world suffered from the deficiency of the technology like Service (WFS), Architecture, Web Feature, Web Map server (WMS), and Clearinghouses, etc. Sharing any type of spatial datasets will be with using these technologies. The lack in technologies is a negative factor that affects in the sharing of data among different types of organizations and agencies (Sen et al, 2006; Minh et al, 2009).

### Funding limitation

There is a clear limitation in the resources that use and analyze the geo-spatial datasets among the geo-spatial data agencies. Any spatial projects or applications needs massive and various types of data for conduction stages. The users must get this kind of expensive hardware and software to obtain accurate results. Hence, providing any type of spatial datasets to solve any scientific problem and social problem, the factors related to the expenses have to be overcome. Therefore, few private sectors and organizations can carry out this work. The key element of different spatial datasets products and services is that the thematic data that has been used in different disciplines such as industries or in societies. The customers require specific data to meet the requirements of the decision making, planning and processing needs. Users should buy the products to get all these data. (Minh et al, 2009; Arshad et al, 2010).

### Public private partnerships

To create NSDI, cooperation between all kind of parties is important to know and realize its potential. All parties of NSDI should arrange and define the responsibilities among them. The public sector should carry out the responsibility of standard, legislation and policy. However, public and private sectors work together for developing and designing the infrastructure, and both of them work to mark the NSDI services and develop technologies of the NSDI initiative. (Minh et al, 2009; Arshad et al, 2010).

## Conclusion

SDI can create a successful environment for both stakeholders and decision makers to achieve goals at different levels (administrative or political) when they both cooperate with their work, share their achievements, and use technology that will improve their work without wasting time and cost. Recently, SDI has been employed in many countries throughout the world due to its importance, and was employed across different levels (global, regional, national, private sectors and other organization). NSDI faces several challenges in its implementation. NSDI gives the opportunity to share data, avoid wasting of time, efforts and the resources that lead to duplication of work, in order to achieve the same result (data) among different agencies or government departments.

## References


Alhubail, S. S. (2004). Framework Data Modeling For The Proposed National Spatial Data Infrastructure Of United Arab Emirates (p. 239). Canada.

Anzlic. (1998). Spatial Data Infrastructure for Australia and New Zealand. Discussion Paper, at, http://www.Anzlic.org.au/, [accessed 14 September 2012].

Arshad, N. H., & Hanifah, F. A. B. U. (2010). Issues and Challenges in NSDI Implementation. Proceedings of the 9th WSEAS International Conference on System Science and Simulation in Engineering (pp. 65-70). Japan

Clinton, B. (1994). Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure. Federal Register, 59(71), 1-4.

Coleman, D. & McLaughlin, J. (1998). Defining global geospatial data infrastructure (GGDI): components, stakeholders and interfaces. Geomatica, 52(2), 129-144.

Crompvoets, Joep. (2006). National Spatial Data Clearinhouses Worldwide Development and Impact. PhD Thesis. Wageningen University, Wageningen

Feeney, M., Rajabifard, A., Williamson, I. 2002. Future Directions For The Development Of Spatial Data Infrastructure. International Journal of Applied Earth Observation and Geoinformation. Vol. 1: 1–12.

FGDC. (2005). Components of the NSDI. at http://www.fgdc.gov/components, [accessed 12 November 2012].

Foresman, T. W. (2004). Progress with the Digital Earth Global Infrastructure. Paper Presented at 7th GSDI Conference, 2-6 Feb 2004 India, at, http://www.gsdidocs.org/docs2004/stratim.html, [accessed 14 January 2011].

FGDC. (2009). NSDI Clearinghouse Network., at, http://www.fgdc.gov/dataandservices, [accessed 24 October 2011].

GINIE. (2004). GINIE: Geographic Information Network in Europe. Rowards a European GI strategy; Lessons Learnt from GINIE (p. Report D 1.5.1). UK, at, http://www.ec-gis.org/ginie/doc/GINIE_finalreport.pdf, [accessed 18 November 2012].

Masser, I. (2002). Report on A comparative analysis of NSDI ' s in Australia , Canada and the United States. October (p. 9). UK., at, http://www.ec-gis.org/ginie/doc/SDIComparative_report_Final.pdf, [accessed 15 November 2001].

Manisa et al, (2007). Developing Botswana Spatial Data Infrastructure : From Concept to Reality. FIG working week: Strategic Integration of Surveying Services,at,http://www.fig.net/pub/fig2007/papers/ts_1d/ts01d_04_manisa_nkwae_1376.pdf, [accessed 23 October 2012].

Masser, I.(2007). The First Generation of National Geographic Information Strategies. Paper presented at the Third Global Spatial Data

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Infrastructure Conference, Canberra, at, http://gsdidocs.org/docs1998/canberra/masser.html, [accessed 21November 2012].
Minh, H. T. (2009). Current status and challenges in establishing NSDI in Vietnam. Applied Geoinformatics for Society and Environment (AGSE). Stuttgart, Germany: 1-13.
Noor H. et al,.(2010). Issues and Challenges in NSDI Implementation 9th Wseas International Conference on System Science and Simulation in Engineering. (ICOSSSE' 2010), Iwate, Japan October 4-6: 65 – 70.
Nalis, (1997).Public Service Progress Circular. Guidelines for The development and implementation of National Infrastructure for Land Information System (Nalis), 1997.
PCGIAP. (1998). A Spatial Data Infrastructure for the Asia and the Pacific Region. PCGIAP publication No. 1. Canberra.
Pulusani, P. 2004. Enabling Interoperable Spatial Data Infrastructures for Sustainable Development, Intergraph Mapping and Geospatial Solutions. Proceedings of the Global Spatial Data Infrastructure Conference.
Rajabifard, A. (2001). Spatial data infrastructures: concept, SDI hierarchy and future directions. Proceedings of GEOMATICS (p. 10). Australia, at, http://www.irpds.com/FileEssay/joghrafi-1386-11-29-agh(2).pdf, [accessed 10 November 2012].
Rajabifard et al,. (2002). Diffusion of Regional Spatial Data Infrastructures: with particular reference to Asia and the Pacific. PhD_Thesis, The University of Melbourne, Melbourne,Australia.
Rajabifard, (2003). A. Developing Spatial Data Infrastructure: Highlighting Issues and Influencing Factors. Paper presented at 16th United Nation- Regional Cartographic Conference for Asia and Pacific (16th UNRCC-AP) , Okinawa Japan.
Rajabifard, A., Binns, A., Masser, I. & Williamson, I.( 2006) The Role of Sub-National Government and the Private Sector in Future Spatial Data Infrastructures. International Journal of Geographical Information Science,. 20(7): 727-741, at, http://www.geom.unimelb.edu.au/research/publication, [accessed 9 October 2012].
Sen, S., Somavarapu, S., Sarda, N. L., & Sivakumar, R. (2006). Schema Matching as a step towards Interoperability : Experiments in the Indian NSDI. Beyond Spatial Data Infrastructures International Workshop at the GIScience (p. 6). Münster, Germany.
Tosta, N. (1995). Data Policies and the National Spatial Data Infrastructure. Law And Information Policy For Spatial Database. FGDC, at, https://sites.google.com/site/gissinan/student-of-the-month/johndoe, [accessed 17 October 2012].
Williamson, I., Rajabifard, A., Holland, P., & Johnstone, G.(2007). From local to global SDI initiatives: a pyramid building blocks. Proceedings of the 4th GSDI Conference, 2000. Cape Town, South Africa, at, http://www.geom.unimelb.edu.au/research/publication, [accessed 2 October 2012].

## IGS launches Real-Time service for high-precision GNSS

The International GNSS Service (IGS), a worldwide federation of agencies involved in high-precision GNSS) applications, has launched Real-Time Service (RTS). The RTS is a global scale GNSS orbit and clock correction service that enables real-time precise point positioning (PPP) and related applications requiring access to IGS low latency products. The RTS is offered in beta as a GPS-only service for the development and testing of applications.

GLONASS products are initially provided on an experimental basis and will be included within the service before the end of 2013 as the RTS reaches its full operating capability, according to the IGS Institute. Other GNSS constellations will be added as they become available. The RTS is operated as a public service, providing free access to subscribers. Interested parties are invited to visit the service's website.

## Russian rockets to launch European navigation satellites

Russian rockets will assist in the deployment of the European Galileo navigation satellite network, head of the European Space Agency (ESA) Permanent Mission in Russia Rene Pischel said. The first two experimental Galileo satellites were launched with Soyuz rockets from Baikonur, he said. *http://rbth.ru/*

## China's Beidou navigation system expands in Southeast Asia

Two more Southeast Asian countries have signed up to the Beidou satellite navigation system. Laos and Brunei will be adopting the navigation system in an initial stage through research and co-operation agreements, China's Ministry of Science and Technology said. Earlier, Thailand became the first overseas customer of China's home-made navigation system when the two countries signed a similar deal. The system already covers all of Southeast Asia and aims to cover the entire planet by 2020. The Ministry of Science and Technology did not indicate the cost of implementing the system in Laos or Brunei. The 2-billion-yuan bill (HK$2.5 billion) of bringing the system to Thailand is to be largely met by the Chinese government, Xinhua said. *www.scmp.com*

## Judge rules state GPS contract expansion violated bidding laws

When California corrections officials found what they described as alarming defects in half of the GPS monitors worn by sex offenders and other parolees statewide, they moved immediately to break the contract with the company that supplied them. Their concerns justified refusing to give the company more work, but he also ruled the state should not have given its existing work to a firm without competitive bidding. Judge Timothy Frawley's decision upheld California's decision to reject the low bid from a division of 3M Co. for a statewide parole monitoring contract worth $51 million. But Frawley said GPS program director Denise Milano failed to show 3M's equipment already in use created a public emergency. *www.latimes.com*

## China mobile phones to adopt Beidou navigation system

China is promoting the use of its homegrown Beidou Navigation Satellite System and plans to make it available for commercial mobile phone services. In a Xinhua report, Yang Qiangwen, a leading scientist with the China Satellite Navigation Office, said the Beidou system has been performing well and its navigation precision improving steadily since it opened up the service to Asia-Pacific users on December'12.

"We are seeking favorable policies and attracting investment to promote the technology for public use. It will not be long before mobile phones adopt the Beidou system," said Yang. *www.zdnet.com*

## New GLONASS-M Satellite launched

Russia has successfully launched a satellite for the GLONASS navigation system recently. After reaching a designated orbit, the satellite will complete several weeks of commissioning and testing before entering regular service. *http://en.ria.ru*

## New technology to replace GPS

The US Army is working to limit its dependence on GPS by developing the next generation of navigation technology, including a tiny autonomous chip, the director of the Pentagon's research agency said. DARPA, the research group behind a range of spy tech and which helped invent the Internet, was also the driving force behind the creation of the GPS, director Arati Prabhakar said at a press conference. Researchers at DARPA and the University of Michigan have created a new system that works without satellites to determine position, time and direction, all contained within a eight-cubic-millimeter chip. The tiny chip holds three gyroscopes, three accelerometers and an atomic clock, which, together, work as an autonomous navigation system.

Prabhakar emphasized there "will not be a monolithic new solution, it will be a series of technologies to track and fix time and position from external sources." *http://zeenews.india.com*

## Seoul plans anti-GPS jamming system to thwart NORKS

South Korea is finalising plans to track down and block GPS jamming signals emitted by its neighbor N Korea. Relevant technologies developed by the government's Electronics and Telecommunications Research Institute (ETRI) will apparently be transferred to a private firm, which will be tasked with setting up the system. *www.theregister.co.uk*

## BAS dropping GPS-equipped surveying javelins on Antarctica

The British Antarctic Survey (BAS) has built advanced surveying equipment into javelin-like projectiles that they intend to drop into some of the most inaccessible parts of Antarctica in order to accurately measure the continent. The BAS has assembled 25 of the pieces of the equipment in order to track the

# Galileo update

## EUR 1 million in prizes beckons innovators using satellite navigation systems

The ESNC is once again inviting entrepreneurs from research and industry to present value-added business applications for the emerging satellite navigation market. The current market for satellite services – such as for mobility, health, or safety – is already worth more than EUR 100 billion, and is expected to rise to EUR 240 billion by 2020. The ESNC supports participating innovators in realising their applications and business cases through an extensive partner network that covers the technical, economical, and legal aspects involved.

In this edition of the competition, participants can choose between more than 20 partner regions worldwide. Each partner will award a prize designed to support its regional winner's business case. In 2013, the ESNC is welcoming Flanders/Belgium, Japan, Mexico, the Netherlands, North Rhine-Westphalia/ Germany, and Norway as new partner regions. *www.galileo-masters.eu*

## Six Czech firms cooperate on applications for Galileo

Six domestic companies and scientific workplaces cooperate on projects using the signal from European satellite navigation system Galileo, the Transport Ministry, the umbrella institution for space activities in the Czech Republic, said. Among the results of these activities are less expensive satellite units for toll collection from lorries on which the Czech Technical University (CVUT) in Prague cooperates. The Institute for Atmospheric Physics of the Academy of Sciences takes part in the development of a receiver for Galileo's satellite signal. *http://praguemonitor.com/*

## Real-time PPP with Galileo Demonstrated by Fugro

Fugro Seastar AS has been looking forward to demonstrating Real-Time Precise Point Positioning (PPP) based solely on Galileo signals since the last two satellites were launched October 12. Those two satellites brought the constellation to a total of four satellites, the minimum required to permit calculation of a Galileo-only position.

## President Barroso visits the European GSA in Prague

The President of the European Commission José Manuel Barroso visited the headquarters of the GNSS Agency (GSA) in Prague. "With the European GNSS Agency, Prague has become one of the hubs for all those who are engaged within the space industry across Europe and in the Czech Republic." – He said. "Galileo is a strategic project to ensure the European Union's independence in space technology and policy, a sector of major importance for the competitiveness of our industry and that has also become critical for the well-being of our citizens." *www.investineu.com*

## STMicroelectronics chip performs Galileo system test

STMicroelectronics Teseo II single-chip satellite-tracking ICs performed successfully in the first ground location test using Galileo. The European Space Agency (ESA) conducted the tests at their technology center in the Netherlands, and ST collaborated from its GNSS software development labs in Italy. *www.satellitetoday.com*

progress of the Pine Island Glacier (PIG), one of the largest and fastest-moving ice streams on Antarctica. The hardy javelins contain advanced GPS equipment that will allow the BAS to monitor the speed and nature of the ice movement. The darts are being dropped from aircraft flying over the region, and are equipped with parachutes and small 'ice brake' fins to lessen the force of their impact with the ice and stop them from driving too deeply. *www.surveyequipment.com*

## Russia's economic gained exceeds $25 864 b from GLONASS projects

The economic benefit gained from the use of GLONASS technology in Russia is estimated at over $25 864 billion, annually, said President of the GLONASS noncommercial partnership Alexander Gurko. *http://rbth.ru*

## GPS receiver station opened in Jaisalmer, India

A permanent GPS receiver station was opened at Weather Radar Station, Jaisalmer recently to study the earth's plate movement. The GPS receiver station is the first in the state. As many as 250 such stations would be opened in the country. Three more such stations in Kota, Bikaner and Ganganagar will be opened soon. *http://articles.timesofindia.indiatimes.com*

## Japan to build fleet of navigation satellites

The Japanese government has ordered three navigation satellites from Mitsubishi Electric Corp., expanding the country's program to augment GPS navigation signals for users in the Asia-Pacific region. Japan's Cabinet Office announced the expansion of the Quasi-Zenith Satellite System on March 29, approving a $526 million contract with Mitsubishi Electric for the construction of three satellites for launch before the end of 2017. The Cabinet Office, which is chaired by the Japanese prime minister, approved another contract with a special-purpose company led by NEC Corp. to operate QZSS for 15 years. *www.spaceflightnow.com*

## Satellite imagery helps fight locust plagues in N Africa

DMC International Imaging is helping The Algerian Space Agency to predict the spread of locust plagues across North Africa as part of a pro-active approach to tackle the destructive phenomenon using satellite imagery. Every year, North Africa is subjected to locust plagues that threaten to decimate crops and endanger countries' food security. The satellite imagery is used to assess vegetation conditions, which helps to predict the locations of locust breeding grounds. The imagery is used in conjunction with weather data to help create locust forecasts and focus the application of pesticides to prevent the spread of swarms. *www.dmcii.com*

## Proteus wins contract in Ireland

Proteus, a provider of satellite-derived bathymetric mapping and seabed classification services, has been awarded a major contract by the Geological Survey of Ireland (GSI) to deliver complete bathymetric surveys of five Irish bays. In addition to operational mapping, Proteus will use satellite data to create a seabed classification map and perform water quality monitoring on one of the bays for proof-of-concept purposes. *www.proteusgeo.com*

## Environmental monitoring solutions by 3D Laser mapping

3D Laser Mapping has launched a range of remote satellite monitoring solutions that will allow data to be transmitted from inaccessible and inhospitable environments. The CatchR range of solutions include systems for water flow, depth and level monitoring, equipment status reporting, detection of toxic substances and weather reporting. *www.3dlasermapping.com*

## Digital tips to aid UP, India farmers raise produce

UP farmers would soon get digital tips to improve the quality of land and better farm practices. In a study that can have far-reaching results for farmers, the state government is preparing a database of agricultural land using remote sensing and GIS.

The digital maps of the agricultural land will help identify waste, degraded, gullied and waterlogged land in UP. The agriculture department would then work on land reclamation and help farmers to increase farm production. *http://articles.timesofindia.indiatimes.com*

## Thailand, China to cooperate on space survey, remote sensing

Thailand and China have signed an agreement on space technology development, aimed at trade and investment cooperation on remote sensing and survey. The deal was signed between the Thai Geo-Informatics and Space Technology Development Agency (GISTDA) and the Chinese Wuhan Information Technology Outsourcing Service and Research Centre (WITOSRC).

A ground station and administration office, with an initial investment of 300 million yuan (Bt 1,500 million or US$50 million), will be built by China on Thai soil. *www.pattayamail.com*

## J&K, India: Satelite images to improve education system

The state government has decided to use satellite imagery to identify remote hamlets where no schools have been set up so far. The state's remote-sensing department has been tasked to map the existing primary, middle and higher secondary schools in the state using a "geographic information system". *www.hindustantimes.com*

## Chinese news outlet to use drones

Chinese news outlet Hubei Daily Media Group reportedly plans to begin employing unmanned drones to take aerial photographs. Hubei will purchase two unmanned aerial vehicles, or UAVs, and is seeking a drone operator. Chen Yong, head of the company's Aerial Photography Center, said that the move will enable the company to obtain unique photographs while bypassing the high costs associated with renting helicopters. *www.ibtimes.com*

## Kazakhstan to launch first remote sensing satellite this year

The Kazakh space agency said that it plans to launch the country's first Earth remote sensing satellite by the end of this year. The system includes two optoelectronic satellites, and the cost will be about 260 million euros. Astrium is a strategic partner in the Kazakh remote sensing program. *www.spacedaily.com*

## Ecuador launches its first satellite

Ecuador launched into orbit the first satellite, indigenously manufactured, called 'Pegasus', from the Jiuquan space center, in China. The satellite was launched by Chinese rocket Long March 2D. The 'Pegasus', a cube 10 by 10 inches and weighs 1.2 kilograms, will broadcast live images and video of earth having educational and scientific purposes. *www.elcomercio.com*

## OS VectorMap by Europa Technologies

Europa Technologies has announced an innovative new way to license OS VectorMap Local map data for Great Britain. This new offering consists of three off-the-shelf *urban packages* specifically designed to meet the needs of organisations that focus on the nation's population. The entry level *Urban* package includes cities and large towns, covering approximately 62% of the population.

## The big data rush

The research, conducted by Marketforce, UK, the Chartered Insurance Institute (CII) and the Chartered Institute of Loss Adjusters in conjunction with Ordnance Survey, found that 82% of those questioned believed that insurers that do not capture the potential of Big Data will become uncompetitive. The survey of members of the CII's Underwriting Faculty also revealed that 9 out of 10 underwriters think that access to real-time claims data would help price risk more accurately, with motor (88%), household (76%) and health (60%) being cited as the insurance lines, where pricing accuracy could be 'transformed' by Big Data-enabled pricing models. *www.seethedetail.co.uk*

## 3D mapping system to protect cultural heritage sites

Australian researchers developed a mobile laser 3D mapping system called Zebedee to preserve some of the country's oldest and most culturally significant heritage sites, according to CSIRO, Australia's national science agency. This new joint research is an initiative between CSIRO and The University of Queensland aims to collect detailed 3D maps of historic sites of Moreton Bay. At the core of the technology, developed by CSIRO's Autonomous Systems Lab in Brisbane, is a laser scanner that swings back and forth on a spring to capture millions of detailed measurements. *http://news.xinhuanet.com*

## Iran plans 'Islamic Google Earth'

The Iranian authorities have long accused Google Earth of being a tool for western spy agencies, but now they have taken their attacks on the 3D mapping service one step further – by planning the launch of an "Islamic" competitor. Iran's minister for information and communications technology, Mohammad Hassan Nami, announced this week that his country was developing what he described as an "Islamic Google Earth" to be called Basir (spectator in Farsi) which will be ready for use "within the next four months". *www.guardian.co.uk*

## Spain might limit online mapping

In order to protect the country from possible terrorist attacks, the Constitutional Commission of the Spanish Congress is contemplating a non-legislative proposal made by the Popular Party regarding access to online mapping in the country. The political group highlights that satellite mapping on the Internet can provide information of sensitive settlements, such as military facilities, that could put at risk national security and international stability. *www.neurope.eu*

## SuperGIS Desktop 3.1a new interfaces

SuperGIS Desktop 3.1a now supports Indonesian and Turkish user interfaces. It provides users with a professional GIS platform to efficient accomplish diverse GIS tasks such as spatial data analysis, display, editing, management, query, etc. *www.supergeotek.com*

## GIS to improve emergency response in Taipei

In a bid to improve the city's emergency response capability, the Taipei City Fire Department developed a GIS-based Incident Command System which will provide first responders with critical information needed to efficiently carry out rescue operations.

The system provides a user-friendly interface which integrates spatial information crucial for the city's Emergency Dispatch Centre to manage and mobilise rescue operations. This includes information derived from

## U.R. Rao honoured in the US

Top Indian space scientist U.R. Rao has been inducted into the Satellite Hall of Fame in Washington DC by the Society of Satellite Professionals International, in the US.

"Rao is the first Indian space scientist to be inducted into the Satellite Hall of Fame and joins the select group of about 50 members, including Arthur C. Clarke, Van Allen, Harold Rosen, Peter Jackson and Robert Berry, among others," the state-run Indian Space Research Organisation (ISRO).

Rao, who is chairman of the Physical Research Laboratory in Ahmedabad in Gujarat, has contributed to the development of Indian space technology and its application to communications and remote sensing of natural resources since the 1960s. *http://india.nydailynews.com*

digital maps, building and block maps, aerial photographs and water resource maps among others. It also allows policy makers to make well-informed decisions on how to improve the city's emergency response plan to minimise both economic and social losses brought about by disasters. *futuregov*

## Violators of national map to be fined up to $2,400 in Vietnam Society

Under the draft law document, the act of providing maps of Vietnam's sea territories without showing the Hoang Sa (Paracel) and Truong Sa (Spratly) archipelagoes in the East Sea and other islands will be given a fine of VND20-50 million (US$2,400).

The act of providing maps that show incorrect national borders, sovereignty, land and sea territories of the Socialist Republic of Vietnam will be fined the same rate. In addition, a warning or a fine of VND1-3 million is proposed to impose on acts of using maps without indicating their legal origin. *http://tuoitrenews.vn*

## Handheld Algiz 10X shipping now

Handheld Group has started shipping its new Algiz 10X rugged tablet PC for field professionals. It is a rugged tablet computer that is lightweight and built to withstand the harsh conditions that come with all kinds of industry fieldwork, and that can display detailed maps and other visuals even in bright sunlight. It has also started shipping the new version Algiz XRW rugged notebook. *www.handheldgroup.com*

## Sprint selects u-blox

Sprint U.S. and u-blox have announced the expansion of their collaboration in support of Sprint's commitment to the 2G (1xRTT) CDMA network. Both companies believe 2G remains an important network option for business customers, including those that deploy Machine-to-Machine (M2M) solutions as part of their service or product offerings. This collaboration will allow business customers to extend the product lifetime of their existing 2G M2M devices by seamlessly migrating to the CDMA network with minimal effort. *www.u-blox.com*

## Asustek, Toyota launch smart car navigation system

Taiwan's Asustek Computer Inc. launched an integrated navigation system for Toyota electric cars as part of a government pilot program to build a low-carbon tourism environment. The cloud-based navigation system has been installed in 35 Toyota electric cars.

The tablet-like device combines functions such as voice navigation, sightseeing guidance for scenic spots around the lake, weather forecast updates, and the locations of nearby charging centers for the vehicles. *http://focustaiwan.tw/news/ast/201304230034.aspx*

## Navigate Ghana with Google maps

Google Ghana introduced Google Maps Navigation recently to enable owners of android devices such as smart phones and iphones have comprehensive, accurate and easy-to-go maps with built in local search, voice guided turn-by-turn navigation to all kinds of places. *www.ghanabusinessnews.com*

## IndoorAtlas magnetically attracts $640,000 seed round

IndoorAtlas, Finland, snagged a seed-round investment of about $640,000 from Dallas-based Mobility Ventures to help develop its vision of using magnetic anomalies inside buildings and smartphones to accurately pinpoint positions. It began last year as a spin-off from the University of Oulu, Finland. *www.fiercebroadbandwireless.com*

## AND launches worldwide LBS platform

AND has launched the AND LBS Platform to provide worldwide LBS including geocoding, local search, customised maps and routing. It is based on LBS technology that has powered many of the largest LBS services globally. *StockMarketWire.com*

## 4M users of Hoppr on feature phones alone

Hoppr, a location-based service developed by Gurgaon, India-based Y2CF Digital Media Pvt Ltd in partnership with Bharti SoftBank, claims to have crossed 85 million check-ins and 4 million registered monthly users in about 10 months of operation. *http://techcircle.vccircle.com/*

## Apple buys WiFiSlam (probably a repeat news, need to check)

In a move that could improve the quality of Apple Maps, the Cupertino tech company has purchased WiFiSlam, a Silicon Valley start-up that specializes in indoor mapping for USD20million. *www.latimes.com*

## Locata Positioning will underpin future crash avoidance research

Locata Corporation has announced that the Insurance Institute for Highway Safety (IIHS) plans to install a Locata network as the core positioning technology in a $30 million upgrade soon to be under way at their famed Vehicle Research Center (VRC) near Washington DC. A LocataNet will provide the vitally important high-precision positioning required by the VRC to perform rigorous, consistent and repeatable scientific evaluation of new vehicle crash avoidance systems. Now research into new technology systems which allow cars to avoid crashes in the first place will elevate the value of the Institute's safety ratings to new levels. *www.locatacorp.com*

## Mobile Location-Based Advertising will be worth 6.5 billion in 2017

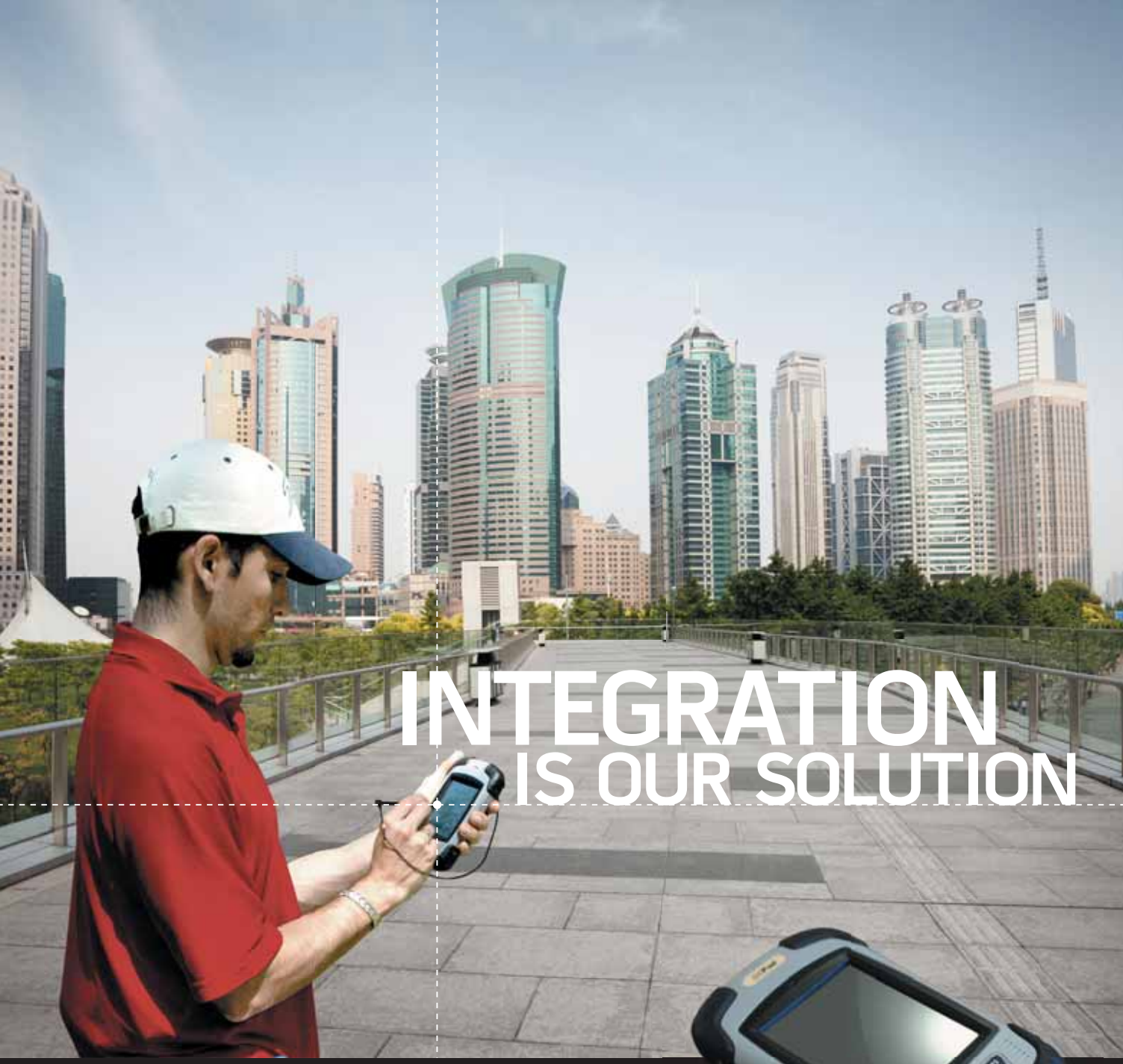
According to Berg Insight report, the total value of the global real-time mobile location-based advertising and marketing (LBA) market will grow from € 526 million in 2012 at a compound annual growth rate (CAGR) of 65 percent to € 6.5 billion in 2017. This will then correspond to 32.8 percent of all mobile advertising and marketing. This means that location-based advertising and marketing will represent around 5 percent of digital advertising, or more than 1 percent of the total global ad spend for all media. SMS, mobile search and coupons are today important high-volume LBA formats. *www.twitter.com*

## MapmyIndia partners BlackBerry

MapmyIndia is betting on its partnership with BlackBerry to widen its reach among in burgeoning community of smartphone users and challenge the stranglehold of Google Maps. BlackBerry has tied up with the Delhi-based maker of online maps and navigation devices as Google is yet to release its map application for the Canadian smartphone company's new platform, Blackberry10. *http://timesofindia.indiatimes.com/*

## Future Mobility Research Lab

BMW Group and Nanyang Technological University (NTU) have unveiled the joint Future Mobility Research Lab, the first for BMW Group in Southeast Asia. This new research facility will study and develop key areas relating to future transportation, which includes advanced battery materials for electric vehicles, human-machine interfaces, and mobility patterns and concepts. A key focus will see how research outcomes can benefit the Asian market based on the needs of the region.



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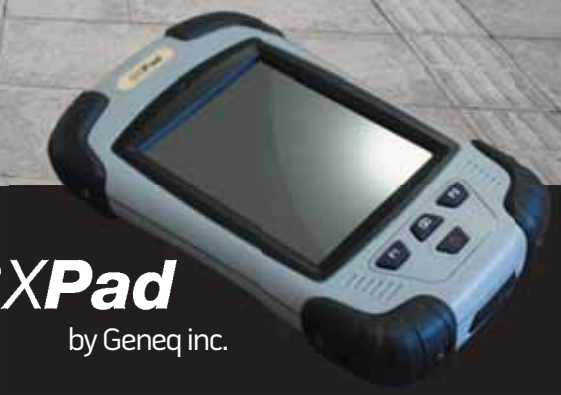

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## NovAtel launches new series of SPAN IMUs

NovAtel Inc. new SPAN-IGM series of micro-electromechanical system (MEMS) are inertial sensor products, including the IMU-IGM-A1 MEMS enclosure and the SPAN-IGM-A1 GNSS/INS enclosure.

The IMU-IGM-A1 is a small, rugged enclosure that houses a MEMS inertial sensor, which can be configured from the factory as an integrated GNSS + Inertial Navigation System (INS) or as a standalone IMU sensor for pairing with a customer's existing SPAN-enabled OEM6 receiver. Its dimensions are 152 (length) x137 (width/diameter) X 51 (height) millimeters. The IMU-IGM-A1 features regulated 10-30 VDC input and a dedicated wheel sensor input to enhance GNSS outage-bridging capabilities and offers a 200-hertz navigation solution and raw measurement output.

## Agilent Technologies unveils Beidou GNSS Signal Simulation

Agilent Technologies Inc has enhanced the capabilities of its Signal Studio for Global Navigation Satellite Systems (GNSS) software and added real-time multi-satellite simulation of China's Beidou system. A key enhancement to Agilent's N7609B Signal Studio software, Option WFP, supports these development efforts by enabling real-time simulation of Beidou B1I satellite signals. The software enables engineers to simulate stationary or moving receivers. A scenario-generation capability enables them to create and edit custom scenarios. *www.agilent.com*

## Spatial Dual released

Advanced Navigation has released Spatial Dual, their new dual antenna GNSS/INS. It is a ruggedized miniature GPS aided inertial navigation system and AHRS that provides accurate position, velocity, acceleration and orientation under the most demanding conditions. It combines temperature calibrated accelerometers, gyroscopes, magnetometers and a pressure sensor with a dual antenna RTK GNSS receiver. Spatial Dual contains the Trimble BD982 GNSS receiver, which is a triple frequency dual antenna RTK GNSS receiver. *www.advancednavigation.com.au*

## Septentrio GNSS Receivers for Airborne Geophysical Surveys

GeoDuster Technologies of South Africa has selected the Septentrio TERRASTAR-D® "Precise Point Positioning (PPP)" service and Septentrio GNSS receivers for use in airborne geophysical surveys for mining geology, exploration, and environmental applications. *www.septentrio.com*

## Applanix POSPAC MMS V6.2 Software

Applanix has introduced POSPac™ MMS V6.2, its latest generation of industry-leading software for directly georeferencing mobile mapping sensors using GNSS and inertial technology. It is designed to improve the productivity and accuracy of mapping from mobile platforms in the air, on land or at sea. *www.applanix.com*

## DAT/EM Systems Indonesia formed

DAT/EM Systems International has expanded their brand to Indonesia. As a separate legal and business entity, the new DAT/EM Systems Indonesia organization will provide superior customer service and sales support to clients in the region. In addition, it will also offer a training center. *www.datem.com*

## New version of Trimble RealWorks software

Trimble has announced Trimble® RealWorks® version 8.0 software that includes a new 3D database engine, automated targetless registration and Web viewing capability incorporating RealWorks' Scan Explorer interface. These new enhancements will allow surveyors, contractors, engineers and geospatial professionals to rapidly process 3D laser scanning data and expedite the creation of deliverables for their clients, increasing productivity and reducing costs. *www.trimble.com*

## Belgian contract for TerraStar

DEME, the Belgian dredging and hydraulic engineering group, is to use Aberdeen based TerraStar GNSS's TerraStar-D precise point positioning service in support of worldwide nearshore operations of its multi-functional fleet of dredgers and auxiliary vessels. Using Septentrio positioning and AsteRx2eH heading receivers,it will provide the fleet with seamless high precision decimetre-level accuracies combining GPS and Glonass satellites *www.maritimejournal.com*

## Carlson MC Pro Vx5 3D Machine Control Sensor

Carlson has announced the MC Pro Vx5 3D machine control sensor. The MC Pro Vx5 is 26.32 inches long, 8.23 inches wide, 4.8 inches high and weighs 5.1 pounds, making the sensor portable and easy to install. The rugged IP69K unit provides GPS plus GLONASS L1/L2 high precision positioning and heading – up to 20Hz, integrated UHF RTK radia and a new gen 2 dual axis slope.

## Low Cost Fully Integrated GPS OCXO Time & Frequency Module

Spectratime has announced its smart, low-cost, ultra-small and fully integrated GPS/GNSS receiver and OCXO crystal oscillator module. Packed with the latest integration technology, including the patented SmarTiming+ GPS/GNSS disciplining software operating at 1nanosecond resolution, the GXClok™-500 reduces the price point for the next generation of high-performance timing applications. *www.spectratime.com*

## ITT Exelis detects GNSS interference

ITT Exelis offers the Signal Sentry 1000, a system designed to detect, geolocate, and characterize sources of intentional and unintentional interference to GPS and other GNSS ssignals and provide actionable intelligence to the user. It leverages GNSS signal domain knowledge, using commercially available GPS receiver and computer server/data

# Now With More Options


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We understand that to do the job right, you need all the right tools. No matter your software choice, NavCom's FieldGenius & SurveyCAD bundle or NavCom's SurvCE & Survey software bundle, you'll still have a complete land survey system that also includes full GNSS support, an online video training library, GNSS post processing software, all hardware & accessories, a three year warranty, and our 5cm global accuracy StarFire™ Network Included.

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Our LAND-PAK complete survey system offers the power of RTK level accuracy with the added benefit of 5cm StarFire global accuracy when RTK corrections are not available. With StarFire Over IP delivery, LAND-PAK users can now have reliable, continued service even when the receiver loses communication with the StarFire satellite. StarFire Over IP delivery allows users to ride through comunication outages over extended periods, whether you're working in an urban canyon or high latitude conditions.

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technology. Actionable intelligence is available in the form of pin mapping of interference sources in addition to longitude/latitude/altitude data. It can be used to defend against disruption of GPS guidance, traffic, and asset control systems and interference of GPS tracking of high-value assets. *www.exelisinc.com*

## Furuno to launch new multi-GNSS receiver chips

Furuno Electric Companys new multi-GNSS receiver chips eRideOPUS 6 and eRideOPUS 7 — with active anti-jamming, multipath mitigation, and dead reckoning interfaces — will be available to the market beginning August 2013. *www.furuno.com*

## Lockheed Martin completes Delta PDR success for GPS III

Lockheed Martin has successfully completed a Delta Preliminary Design Review for the next GPS III satellite vehicles planned under the U.S. Air Force's GPS III program. GPS III satellites will deliver three times better accuracy and up to eight times improved anti-jamming signal power while enhancing the spacecraft's design life and adding a new civil signal designed to be interoperable with international global navigation satellite systems. *www.satnews.com*

## GNSS sensor system meets airborne laser scanner in UAV

According to RIEGL Laser Measurement Systems GmbH, Applanix Corporation's AP50 GNSS-Inertial sensor system was successfully integrated with its VQ-820-GU topo-bathymetric airborne laser scanner on board the Schiebel Camcopter S-100 unmanned aerial vehicle (UAV).

RIEGLs VQ-820-GU is specifically designed to survey sea beds and the grounds of rivers and lakes. It is also well suited for combined land and hydrographic airborne survey. *www.sparpointgroup.com*

## MARK YOUR CALENDAR

### June 2013

**Hexagon 2013**
3- 6 June
Las Vegas, USA
**http://www.hexagonmetrology.us**

**New Navigator Seminar 2013**
13 June
London, UK
**conference@rin.org.uk**

**12th SEASC – Geospatial Cooperation towards a sustainable future**
18 - 20 June
Manila, Philippines
**www.seasc2013.org.ph**

**MundoGEO#connect**
June 18-20, 2013
Sao Paulo, Brazil
**http://mundogeoconnect.com/2013/en/**

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

**RIEGL LIDAR 2013 International User Conference**
25 – 27 June
Vienna, Austria
**www.riegllidar.com**

**ICL-GNSS 2013**
25 – 27 June
Torino, Italy
**www.ICL-GNSS.org**

### July 2013

**GI Forum 2013**
2 – 5 July
Salzburg, Austria
**www.gi-forum.org**

**Survey Summit**
6 – 9 July
San Diego, USA
**www.esri.com/events/survey-summit/index.html**

**CASLE International conference on Management of Land and Sea Resources**
7-10 July
Glasgow, Scotland
**www.casle.org**

**Esri International User Conference**
8 – 12 July
San Diego, USA
**www.esri.com**

**ESA International Summer School on GNSS 2013**
15 - 25 July
Davos, Switzerland
**www.congrexprojects.com/13m07**

**IGNSS 2013**
16-18 July
Gold Coast, Australia
**www.ignss.org**

**International Geoscience and Remote Sensing Symposium (IGARSS 2013)**
22-26 July
Melbourne, Australia
**www.igarss2013.org**

### August 2013

**International Summer Seminar on GNSS**
19-24 August 2013
Tokyo , Japan.
**http://www.gnss-pnt.org/summer_seminar/index.php**

**8th International Symposium on Digital Earth 2013 (ISDE 2013)**
26-29 August
Kuching, Sarawak, Malaysia
**http://isde2013.utm.my/**

### September 2013

**Multi-GNSS environment for sustainable development**
9 - 13 September 2013
Hoi An, Vietnam
**http://navis.hust.edu.vn**

**Geo-Empower Middle East Summit**
16-18 September
Dubai, UAE
**www.flemminggulf.com/All-Categories**

**ION GNSS 2013**
16 – 20 September
Nashville, Tennessee, USA
**www.ion.org**

**GDI APAC 2013: Geospatial Defence & Intelligence 2013**
17-18 September
Singapore
**www.geospatialdefenceasia.com**

**International Symposium & Exhibition on Geoinformation (ISG 2013)**
24 - 25 September
Kuala Lumpur, Malaysia
**www.voronoi.com/isg2013**

### October 2013

**Intergeo 2013**
8 – 10 October
Essen, Germany
**http://www.intergeo.de/en/index.html**

### November 2013

**GSDI World Conference (GSDI14) and the AfricaGIS 2013 Conference**
4 - 8 November
Addis Abbaba, Ethiopia
**www.gsdi.org/gsdiconf/gsdi14/**

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10 year ULTRACAM anniversary

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The UltraCam Osprey brings UltraCam performance and quality to your oblique aerial data acquisitions. This new UltraCam sensor system collects oblique imagery along with nadir PAN, RGB and NIR data all in a single pass and at image footprints of 13,450 (oblique) and 11,674 (PAN nadir) pixels across the flight strip. In doing so, the UltraCam Osprey provides you with a highly efficient and ideal system for a wide range of projects ranging from 3D urban mapping to classification to photogrammetric applications requiring high-geometric accuracy and superior radiometry.

The UltraCam Osprey is fully supported in the UltraMap 3.0 workflow software to perform aerotriangulation (AT) and to generate high accuracy point clouds, DSM, DTM, and DSM/DTMorthos.

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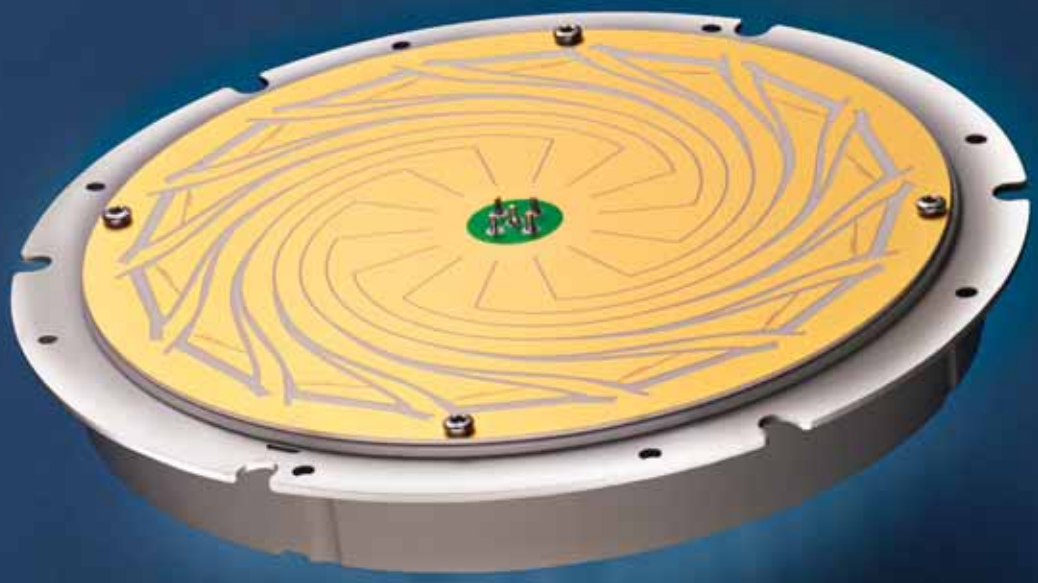
ULTRACAM OSPREY ULTRAMAP 3.0 Workflow Software System Microsoft



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