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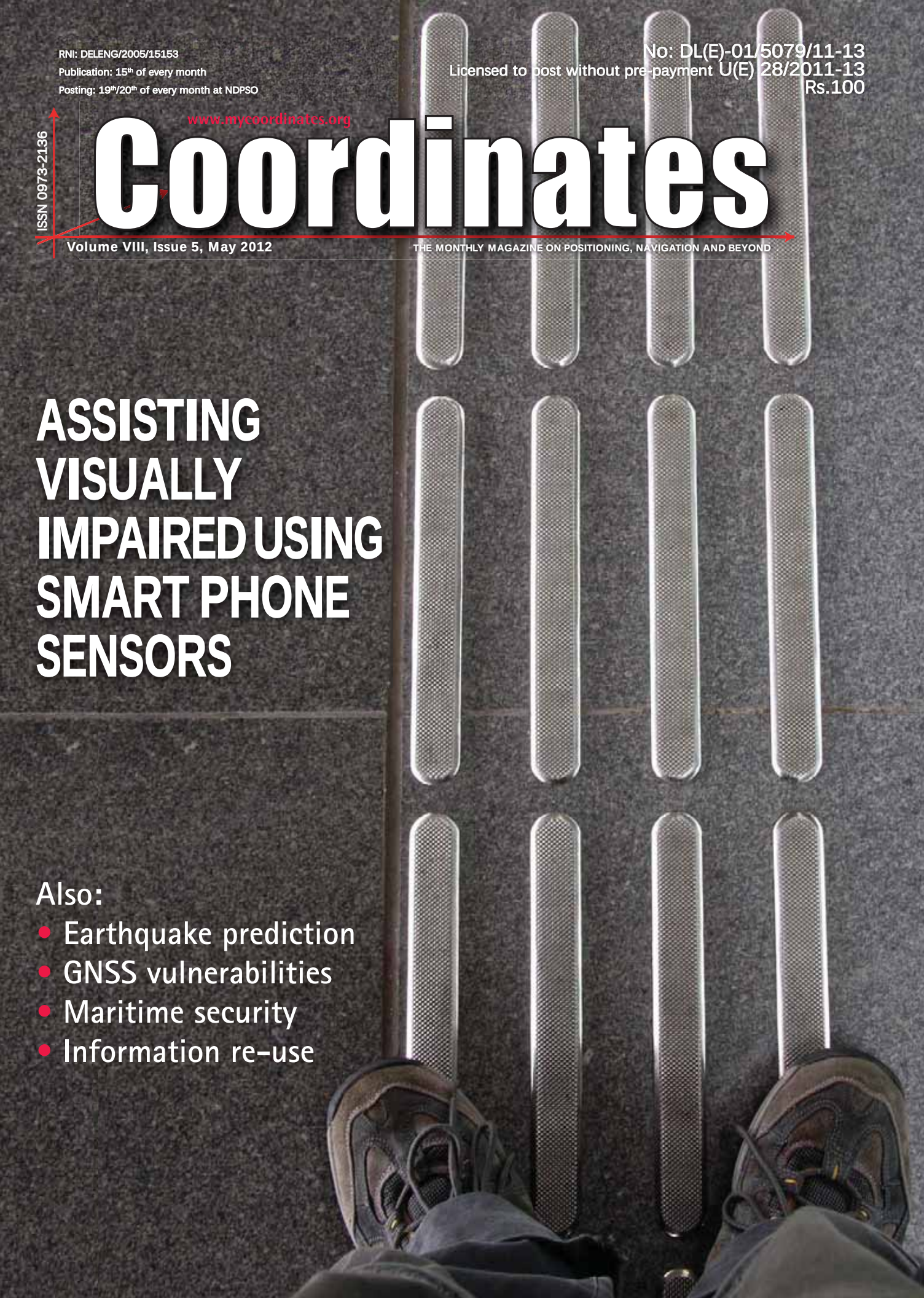

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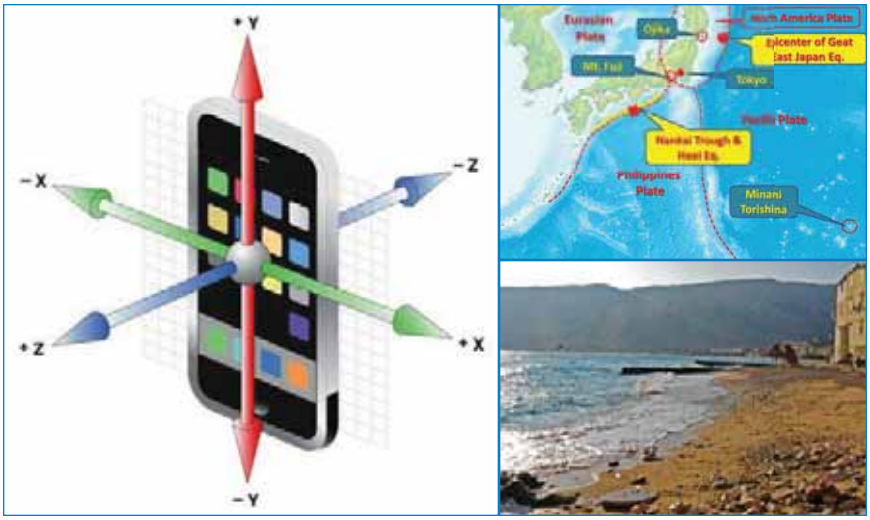

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Crustal movement before and after the Great East Japan Earthquake

This paper summarizes the pre-signals before the earthquake which may be important information for predicting the occurrence of earthquakes as well as the crustal movement after the earthquake

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The crustal movement at GPS based control points in Japan has been recorded all over Japan before and after the Great East Japan Earthquake (M9.0) which occurred at 2:46pm on the March 11, 2011. About 20,000 people were killed mainly by the Great Tsunami of 10 to 30 meters in height.

This paper summarizes the pre-signals before the earthquake which may be important information for predicting the occurrence of earthquakes as well as the crustal movement after the earthquake. At last a case study of simulation of future catastrophic earthquakes and Tsunami which may happen in coming a few hundred years by using archeological excavation data of the past great earthquakes.

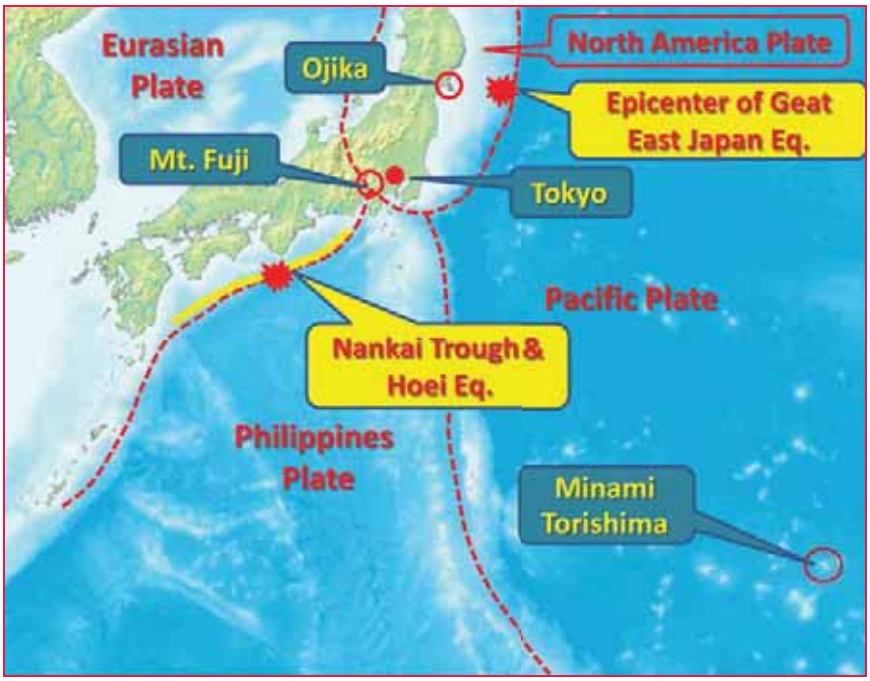

Figure 1: Location of GPS stations of interest

Pre-signals before the Great East Japan Earthquake

The authors presented several papers to this magazine "Coordinates" on the possibility of prediction of earthquakes with GPS data by tracing back to those big earthquakes in the past. A key point to predict earthquakes is to find or analyze pre-signals before earthquakes from GPS daily data. The authors have already analyzed 162 big earthquakes which occurred from January 1, 2000 to December 31, 2007 (eight years) with larger than Magnitude 6 in Japan and the vicinity. As the result we found that the above 162 earthquakes showed abnormal pre-signals with larger than 3 to 5 sigma of the standard deviation.

As the epicenter of the Great East Japan Earthquake was located 130 km offshore from Ojika, Miyagi Prefecture, GPS station at Ojika showed the largest movement with 5.3 meters to east south east direction and with 1.3 meters sunk. The epicenter was just at the border between North America Plate and Pacific Plate. The Japanese geodetic origin of latitude and longitude located in Tokyo, about 300 km apart from the epicenter moved about 30 cm.

Mt. Fuji, the highest mountain in Japan is located at the junction of three plates; namely North America Plate, Eurasian Plate and Philippines Plate showed an interesting movement because the great earthquake occurred at the border between Pacific Plate and North America Plate. Mt. Fuji erupted in 1707 in the nearest past just 49 days after a huge earthquake named "Hoei" Earthquake with M 8.4 (or

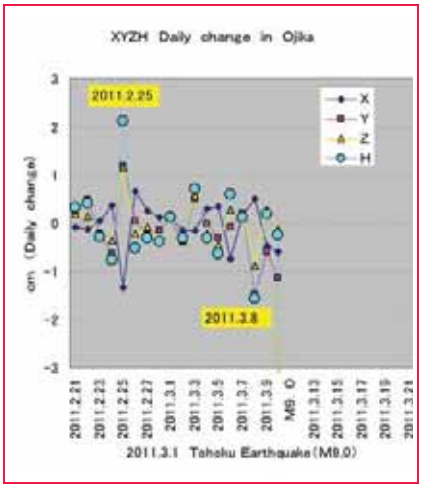

Figure 2: GPS data at Ojika

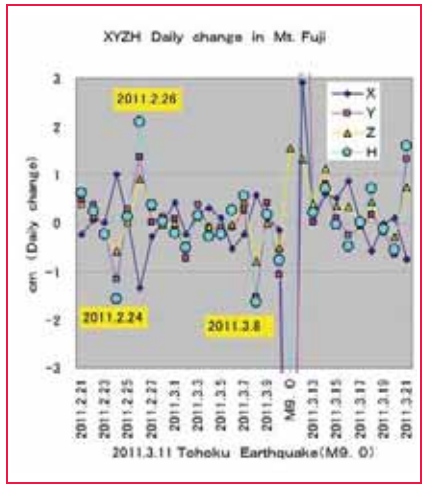

Figure 3: GPS data at Mt. Fuji

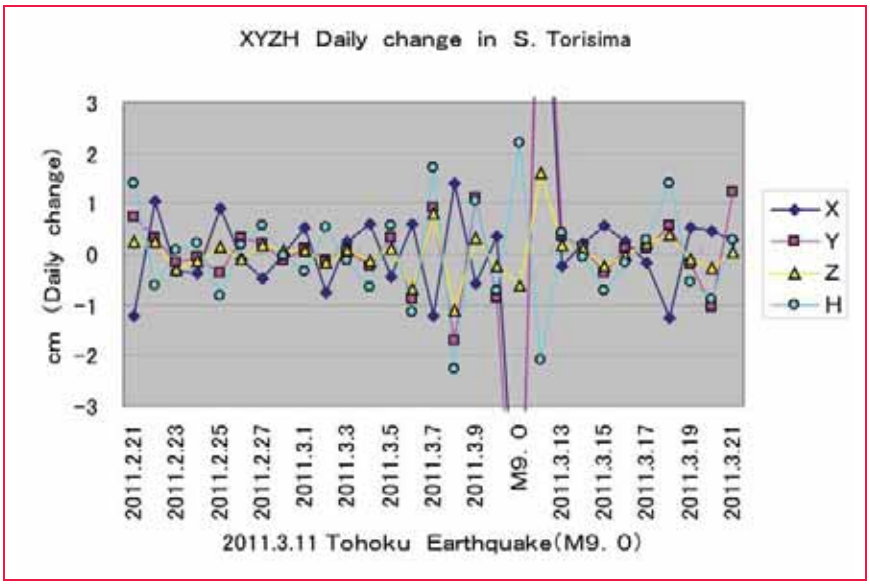

Figure 4: GPS data at Minami Torishima

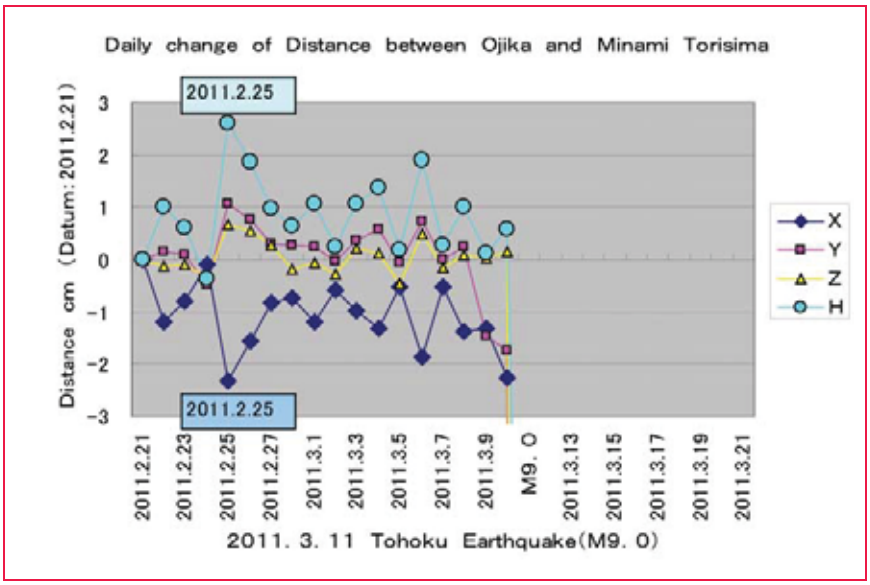

Figure 5: Daily change of distance between Ojika and Minami Torishima

M 9.0?) occurred in the Nankai Trough. Therefore many Japanese concern the possibility of eruption of Mt. Fuji after such huge earthquake this time. As there is only one GPS station in Pacific Plate, the crustal movement of GPS station of Minami Torishima would be interesting. Figure 1 shows the location of the three GPS stations of interest and also the four Plates.

Figure 2 shows the pre-signals of GPS data at Ojika GPS Station while Figure 3 shows the pre-signals of Mt. Fuji GPS Station. X, Y, Z and H (ellipsoid height) of GPS station are shown. If carefully watched, the movement of H shows abnormal pre-signals of more than 2 cm at Ojika on the 25th February 2011 and 8th March 2011 before the great earthquake. Similarly Mt. Fuji shows abnormal pre-signals on the 24th and 26th February 2011 and the 8th March 2011. It would be obvious that such pre-signals will provide very useful information about the prediction of huge earthquakes in future. GPS data at Minami Torishima (means by south bird island or Marcus Island in English) located 1,800 km from the mainland of Japan which is on the Pacific Plate shows similar movement with Ojika and Mt. Fuji as shown in Figure 4. On the 7th and 8th March 2011 just 4 and 3 days before the earthquake showed some sort of abnormal movement in H. Figure 5 and Figure 6 shows the daily change of the distance between Minami Torishima and Ojika and between Minami Torishima and Mt. Fuji. Figure 7 shows the daily change of the triangle area connecting Ojika, Mt. Fuji and Minami Torishima.

Crustal movement after the Great East Japan Earthquake

Drastic crustal movement continued almost a half year after the earthquake, by which Geo-spatial Information Authority (GSI) could not fix the coordinates of geodetic control points in Japan before the end of October 2011.

Figure 8 shows the horizontal movement after the great earthquake which was analyzed by GSI. 5.3 meters in

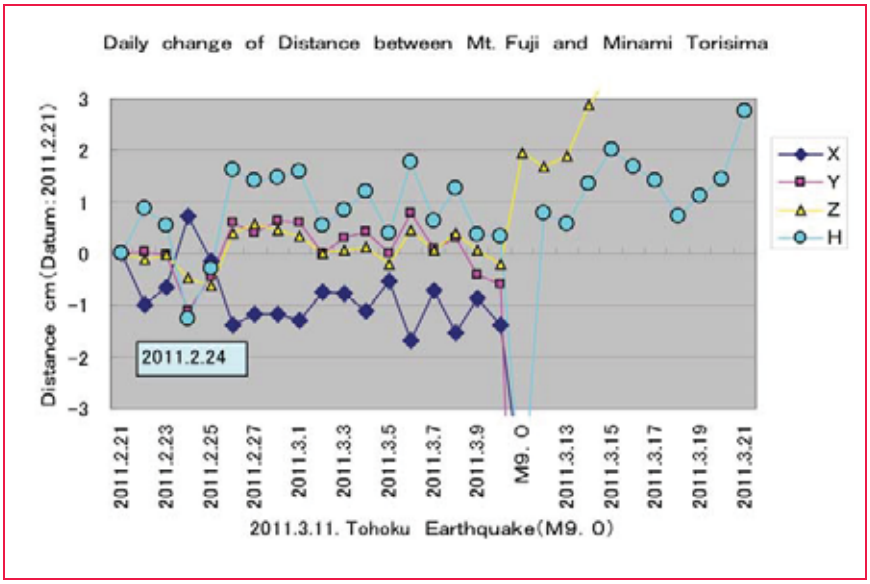

Figure 6: Daily change of distance between Mt. Fuji and Minami Torishima

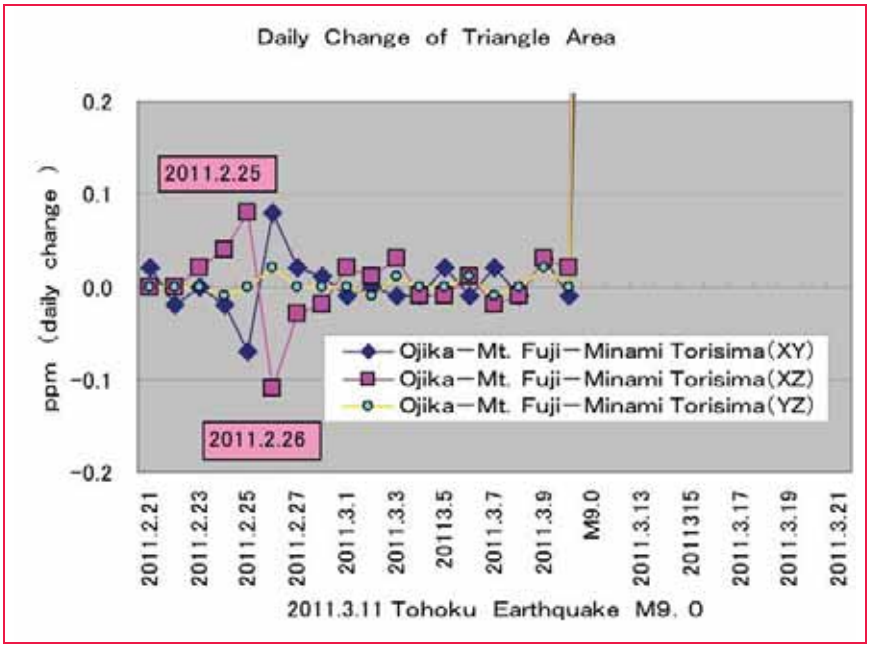

Figure 7: Daily change of triangle area

maximum moved horizontally and 1.3 meters in maximum sunk at Ojika.

Figure 9 shows the horizontal crustal movement of sea bottom control points near the epicenter, which are constructed by Japan Coast Guard. About 24 meters moved horizontally to east south east direction and rose 3 meters vertically which generated the great Tsunami.

Assumption of catastrophic Earthquakes and Tsunami in future

The Japanese government has initiated to reconsider the assumption of catastrophic earthquakes and Tsunami which may occur in future because

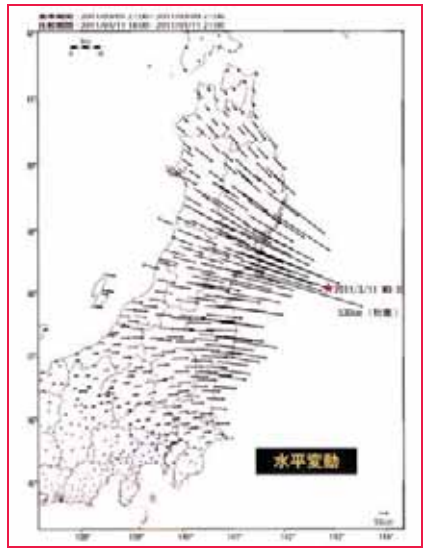

Figure 8: Horizontal movement of GPS stations after Eq

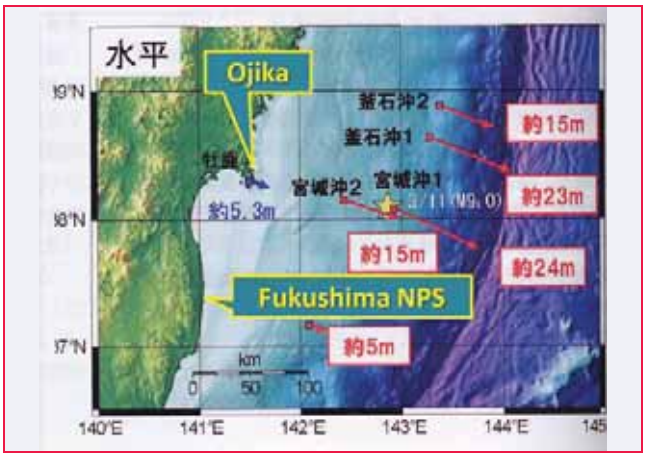

Figure 9: Horizontal movement of sea bottom control points after Eq

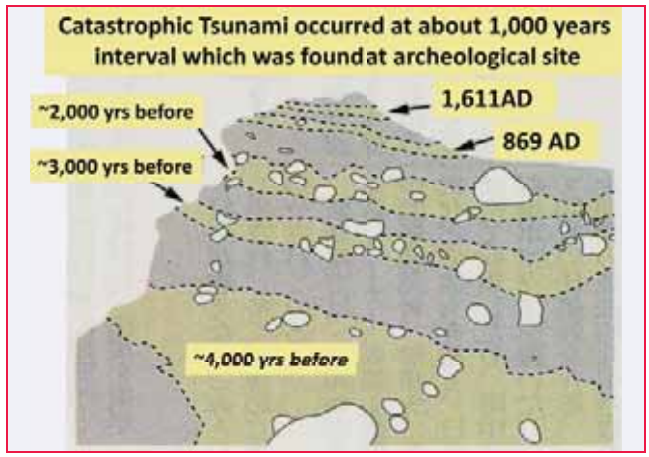

Figure 10: Past tsunami layers found in archeological site

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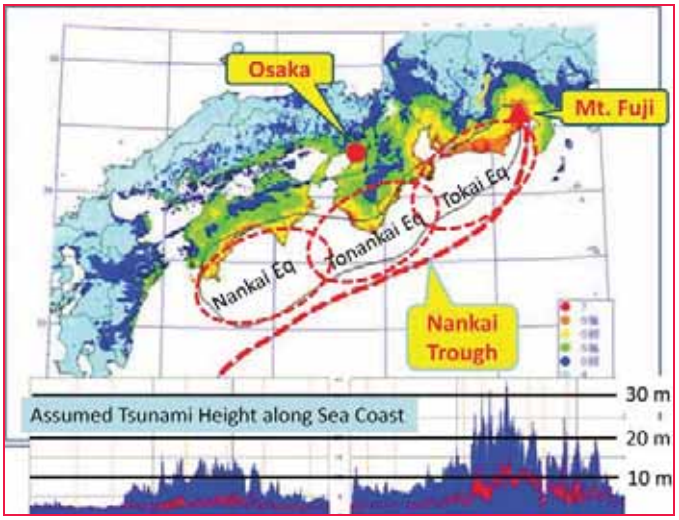

Figure 11: Assumption of catastrophic earthquake damages and tsunami height

the biggest mistake at this time was under-estimation of the occurrence of possible disasters. There were few scientific records about the past catastrophic earthquakes and Tsunami except recent disasters. Historical documents are thought unreliable. However recently archeological excavations in coastal regions showed many evidences of multiple layers of past catastrophic Tsunamis as shown in Figure 10. Such scientific evidences are used for computer simulation to check how large earthquake and Tsunami may occur in future.

One of the most critical assumptions would be simultaneous occurrence of earthquakes in the three regions; Nankai, Tonankai and Tokai (means the south sea, the east south sea and the east sea) along Nankai Trough (see Figure 11). If such catastrophic earthquake occurs in Nankai Trough of deep ditch of 4,000 m similarly in the case of Hoei Earthquake occurred in 1707, several hundred kilometers along the pacific coasts of Japan will be devastated with great Tsunami of 39 meters in maximum, as shown in Figure 11 in blue color. Red color in the figure shows assumed Tsunami height which was assumed without scientific evidence such as archeological data. The central and local governments of Japan have just started how to prepare against such catastrophic earthquake and Tsunami in future. Maybe the best mixture of hardware (breakwater) and software (evacuation system) would be a smart solution. Most serious case would be the case of accident at nuclear power stations (NPS) which are located along sea coast. Similar accident such as Fukushima NPS might happen. Japanese nations are now given a big question; “to be with NPS or not to be with NPS?”.

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The importance of mitigation of GNSS vulnerabilities and risks

Growing number of technological and socio-economic systems relies upon satellite navigation, making it a backbone component of national infrastructure. Mitigation of GNSS vulnerabilities and risks has become a mandatory task not only for GNSS operators and national authorities, but for a wide range of GNSS stakeholders and users

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Consciously or not, all humans are navigators, so it is without wonder that satellite navigation has swiftly become a backbone of modern civilisation. All of the sudden, situation awareness and management become significantly improved by introduction of the helpful and inexpensive technology that provides positioning services of unprecedented quality.

It is hard to find a technological or socio-economic systems that has not yet utilised the benefits of integration of satellite navigation systems. The way the transport works is completely changed by utilisation of the GNSS-based traffic management and safety systems on roads (GNSS-based fleet management, eCall in Europe), on the sea (AIS/VTMIS, GMDSS), and in the air (GNSS/GPS/EGNOS as the air navigation systems). Land and asset management segments flourish, while position details of spatial objects can be efficiently mapped to the information landscape. Agriculture benefits enormously from the ability to accurately map the spatial distribution soil data, and devise advanced soil treatment procedures based on evidence. Systems like power distribution networks, mobile telecommunication networks, and the financial systems increasingly take advantage of the ability of satellite navigation systems to provide a very reliable and accurate time synchronisation. Personal navigation has expanded from navigation-only devices to GNSS-enhanced smart-phones, allowing for introduction of the whole segment of location-based services, both commercial (navigating an user to the nearest point of interest, for instance), regulated (road charging service, as an example), and safety-related (E112 and eCall in Europe, and E911 in the US, VIPs' and disabled individuals tracking).

Figure 1: A pleasant day at the Earth's surface can be at the same time subject to a severe space weather disturbance that significantly deteriorates GNSS performance (Baska, Krk Island, Croatia)

The GNSS applications heavily rely upon the performance, availability and robustness of the core GNSS systems. Every deterioration of GNSS performance and operation may cause severe consequences on performance and operation of the GNSS-based technological and socio-economic systems. While not a single applications should rely upon only one fundamental (in many cases: positioning) system, the over-reliance on GNSS is already evident.

GNSS vulnerabilities and risks – What can go wrong?

Almost everything can go wrong. Position estimation using satellite systems, like the other positioning determination methods, is a measurement-based process. Real world environment often brings many challenges to measurement processes in a form of a set of influencing physical quantities (variables) that caused measurement errors and, consequently,

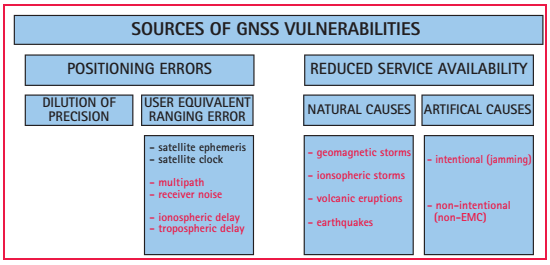

Figure 2: Summary of sources of GNSS performance and operation deteriorations and disruptions

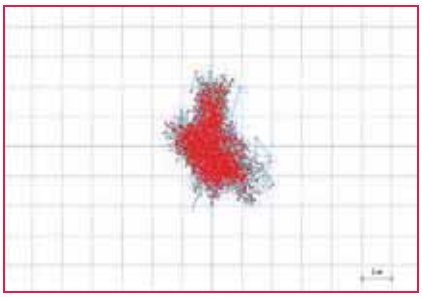

Figure 3: Graphical representation of horizontal positioning errors observed with 30 s-sampling periodat at the (stationary) reference GPS station in Dubrovnik, Croatia on 13 October, 2011

the uncertainty of measurement results. In the case of position estimation using satellite navigation systems, certain scenarios may lead to the complete inability to perform position estimation.

In essence, the technology environment of a GNSS comprises four main components:

- satellite components
- (terrestrial or ground) control component
- user equipment component
- propagation media.

While several components are controllable providing certain prerequisites are met (for instance, satellites will most probably operate as expected in quiet space weather conditions), the others are completely out of any reasonable influence of a GNSS operator. For instance, a sudden ionospheric storm, a part of propagation media environment, is completely out of control of a GNSS operator, leaving the users at risks of getting either an inaccurate position estimate, or not getting any estimate at all.

Potential sources of GNSS performance and operation deteriorations and disruptions, summarised in Fig 1, can be considered the causes of GNSS vulnerabilities and risks. More generally, they can be split into two major groups, one consisting of those sources that cause the position estimation errors, while the other gathers sources affecting positioning and timing service availability.

Positioning errors (Fig 2) are caused by dilution of precision and the user equivalent ranging error. Dilution of precision results from reduced availability of satellite GNSS signals often caused either by intentional or unintentional obstructions of the sky view. User equivalent ranging error comprises positioning error sources related to satellite and control components (satellite ephemeris and satellite clock errors), user component (multipath and receiver noise errors) and propagation media (ionospheric- and tropospheric-induced errors). The GNSS ionospheric delay is the single most important contributor to the GNSS positioning error budget.

Reduced service availability may cause various levels of GNSS disruptions, from limited deterioration of GNSS performance and operation, to complete denial of service. Causes of the reduced service availability may be of natural or artificial origins, as depicted in Fig 1. Geomagnetic storms, significant disturbances of the Earth's geomagnetic field, and ionospheric storms, considerable modifications of the vertical ionospheric profile, pose particularly important threats to GNSS performance and operation, as revealed by numerous studies conducted worldwide. Caused by space weather (mostly solar) disturbances, geomagnetic and ionospheric storms have global outreach and can last from several hours to several days, while reaching various levels of intensity. In addition, the ionospheric storms may be induced in spatially limited areas by natural processes affecting local distribution of charging particles in the ionosphere, such as volcanic eruptions and earthquakes. Local ionospheric disturbances pose especially dangerous threats to GNSS performance since they often go unnoticed, depending on the region of the world where the local ionospheric storms take place.

The intentional causes of GNSS performance deterioration and disruptions are on the rise, especially jamming and spoofing. At the same time and considering increasing demand for radio spectrum, the increased number of non-intentional artificial effects on GNSS performance should be expected.

The GNSS vulnerabilities and risks affect different GNSS-based applications in different manners, depending on the quality of positioning service required for particular applications. A commercial information service providing guiding information to the nearest petrol station will not be strongly affected with a sudden increase in position estimation error, while the same will cause serious consequences in the case of positioning for the E112 emergency call.

Mitigation of GNSS vulnerabilities and risks

With the wide-spread utilisation of GNSS, and apparent and unavoidable GNSS vulnerabilities and risk in effect, the enhancement of the GNSS resilience through mitigation of GNSS vulnerabilities and risks becomes a necessity for all stakeholders involved in GNSS utilisation: GNSS operators, national authorities responsible for radio spectrum management and protection, GNSS-based systems designers and operators, GNSS-based service providers, regulators, and GNSS and GNSS-based systems and services users.

The GNSS operators have already deployed mitigation methods addressing sustainable positioning performance, providing positioning assistance and augmentation services, performance monitoring, and facilitating the improved user equipment design.

Still, a considerable space of GNSS vulnerabilities and risk remains uncovered for a very simple reason that GNSS operators cannot control the whole GNSS operation environment. Here we propose a GNSS resilience scheme that comprises all GNSS stakeholders' actions in an effort to build the sustainable GNSS vulnerabilities and risks mitigation, as depicted in Fig 4.

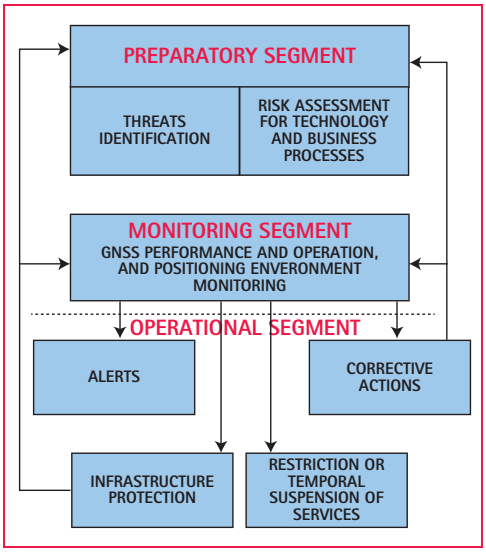

Fig 4 GNSS resilience scheme

The proposed GNSS resilience scheme is composed of the three segments:

- preparatory segment,
- monitoring segment and
- operational segment.

Preparatory segment identifies potential threats to the GNSS and GNSS-based systems and services performance and operation, and assesses the potential technology and business processes disruptions due to GNSS vulnerabilities and risks. In due course, conducting controlled stress tests is highly recommended for agencies, organisations and companies with process that heavily rely on GNSS. As a part of preparatory activities curbing the GNSS vulnerabilities and risks, the establishment of the reasonable and educated utilisation of GNSS arises as an absolute necessity. The users of GNSS-based systems and services must be aware of the limitations of technology and potential GNSS vulnerabilities and risks. The preparatory segment should yield a knowledge base of potential threats, as well as risk assessment and the book of resilience methods and corrective actions for every technology and business process utilising GNSS. Third-party expertise should be considered in conducting the activities related to the preparatory segment of the GNSS resilience scheme.Monitoring segment comprises activities and methods related to continuous monitoring of GNSS performance (accuracy, availability) and operation (satellite health, accuracy of satellite ephemeris and standard ionospheric correction model parameters), as well as positioning environment (space weather and ionospheric disturbances monitoring and forecasting, jamming and spoofing detection). Monitoring activities should be performed in a timely manner and with the spatial distribution of monitoring probes that provide the equal level of the national coverage and the appropriate time margins for initiation of operational activities.

In the case of detection of any GNSS risk in effect, the operational segment should be launched. Depending on the quality of risk identification and forecasting quality, the appropriate alert should be issued to the operators of the GNSS-vulnerable systems and services. This will allow for deployment of the internal mitigation procedures, resulted from the activities of the preparatory segment, and may involve temporal reduction of even suspension of vulnerable systems and services that are based on GNSS. Operators of GNSS-based systems and services exposed to GNSS vulnerabilities and risks in effect should consider deployment of corrective actions, such as: closing subsystems temporarily and utilisation of alternative auxiliary systems. Finally, depending on the intensity of threatening conditions, the protective measures maybe implied on national infrastructure (power and telecommunication networks, financial systems etc.) if GNSS performance deterioration may cause the lasting damage.

Conclusion

Growing importance of GNSS results in increased vulnerabilities and risks of systems and services utilising the GNSS, and requires risk-aware GNSS deployment. While a number of technology-related mitigation actions have already been deployed and then new and enhanced ones are under development, building the GNSS resilience should be extended to the user segment. National authorities should accept the responsibility for deployment of essential protective and mitigation activities addressing the GNSS-based systems and services of national importance. Operators of commercial and regulated services should do the same in their field of responsibility, at the same time assessing the potential effects of GNSS performance deteriorations and disruptions to their technology and business processes, devising procedures for corrective actions and mitigations. End-users should enhance their awareness of potential threats, vulnerabilities and risks related to GNSS-based systems and services they use, and assess the potential effects on their personal activities.

The advanced assessment of potential effects of the GNSS vulnerabilities and risks can be performed by utilisation of the actions including stress tests in controlled positioning environments (either real or simulated). As the result, the case-studies should help to build a dedicated knowledge base. Further consolidation of the acquired experience and knowledge on the effects on the international basis should become a foundation for sustained utilisation of GNSS as a component of national infrastructure.

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Assisting visually impaired using smart-phone sensors

A project at the University of Nottingham, is working to investigate indoor positioning and object recognition to aid the blind. As part of that project, tests were conducted to assess the quality of the various sensors of a smart-phone, the aim was to assess whether the smart-phone could be used as the sensor platform to enable the development of assistive technology for the visually-impaired

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The ability to navigate in an outdoor or indoor environment and recognise objects is one which is taken for granted by sighted people. However for the visually impaired this task is less 'trivial'. Spatial orientation depends on coordinating one's actions relative to the surroundings and the desired destination. It refers to the ability to establish and maintain an awareness of one's position in space relative to landmarks in the surrounding environment and relative to a particular destination (Ross and Blasch, 2000). Maintaining spatial orientation is a significant challenge for individuals with visual impairment. Way-finding or navigation is the means by which a person utilises their spatial orientation in order to move through the dynamic surroundings and arrive successfully at their destination. This successful navigation requires continuous feedback from the environment. A major part of this feedback information are cues used to monitor "environmental flow". According to Ross and Blasch (2000), "Environmental flow refers to the ordered changes in a pedestrian's distances and directions to things in the surroundings that occur while walking" (pp. 193). Therefore, maintaining orientation is largely about keeping track of this environmental flow. The environmental flow of walking can be perceived through various senses such as sight, hearing, smell, and the ability to detect heat.

For the blind and partially sighted the visual cues which are a significant part of monitoring the environmental flow are either severely limited or non-existent. Thus the challenge is to be able to use man-made sensors and technology such as the smart phone based sensors to assist such individuals in monitoring the environment and collecting cues/ data about the environmental flow.

Tests were conducted to assess the quality of the various sensors on the phone that can be used to aid positioning and object recognition. The aim of the tests was to assess the quality of the following sensors on a mobile phone: GPS, Accelerometer, Gyroscope, Compass and Camera.

Several tests were conducted using various smart phones. For the GPS, accelerometer, gyro and compass tests the iPhone 4 was used. For the camera tests the iPhone, HTC Wildfire and a Nokia 6500-Slide were used. These were considered as being representative of mid to high end off-the-shelf smart phones currently available. An iPhone Application was written to

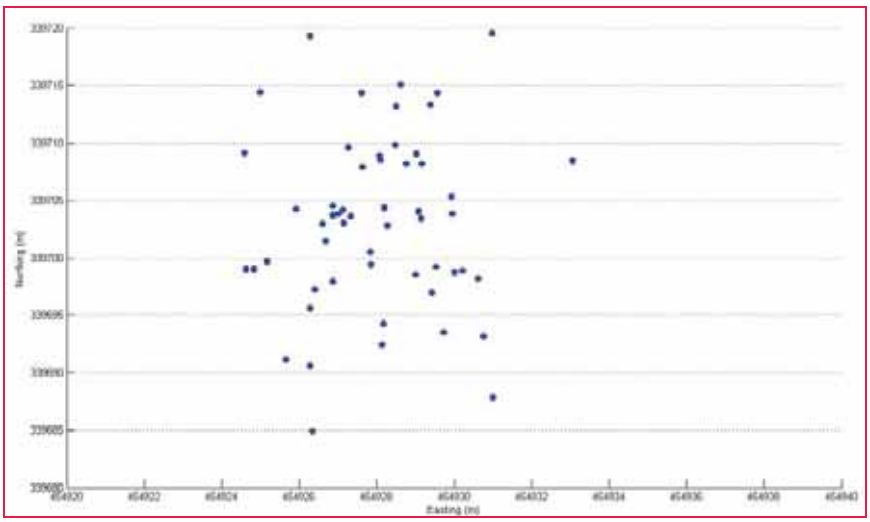

Figure 1: Plan view showing spread of points per epoch (Eastings vs Northings)

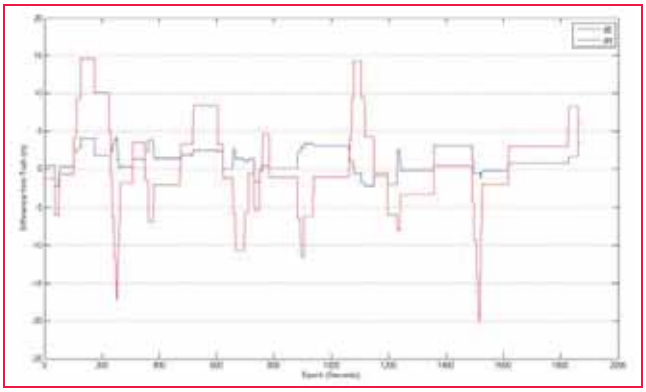

Figure 2: iPhone GPS Easting and Northing error for static period

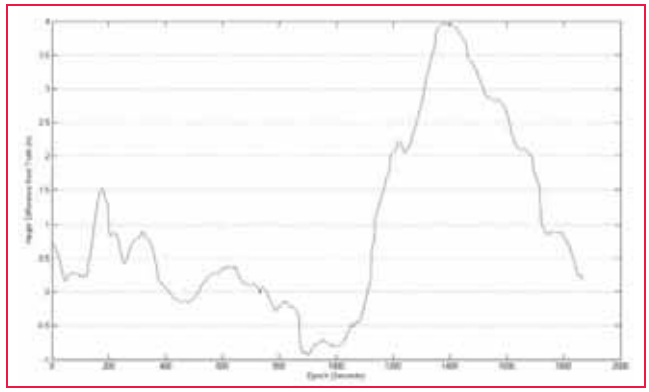

Figure 3: iPhone GPS height error for static period

record data from the GPS receiver, tri-axal accelerometer, tri-axial gyro and digital compass present on the iPhone.

GPS, compass, accelerometer and gyro tests

Tests were conducted to assess the accuracy and precision of the GPS receiver in the smart phone tested. Both static and moving tests were conducted. While the GPS receiver is mainly aimed at outdoor positioning, the ability to navigate seamlessly between outdoor and indoor environments using a single device is important to users. Therefore an assessment of the GPS position quality is required. The GPS data rate was at 1Hz while the accelerometer and gyro data collection rate was at approximately 10Hz.

Test 1: Static GPS

The phone was placed for a static period on a pillar on the roof of the Nottingham Geospatial Building (NGB) whose coordinates are known. The measured coordinates from the iPhone for a ~30minutes period, was compared with the known coordinates of the pillar. The latitude, longitude and ellipsoidal height results recorded from the phone was converted into Ordnance Survey (OSGB36_02) Eastings, Northings and Height using Grid Inquest™. The iPhone position error in the east, north and height components are shown in Figures 1 - 3. For the ~30 minutes static period, the statistics summarises the results as mentioned in table 1.

Table 1: Summary of static position results

	Easting (m)	Northing (m)	Height (m)
Mean	454928.0	339705.4	43.7
Mean Error	1.2	0.4	1.0
Standard Deviation	1.6	5.7	1.3

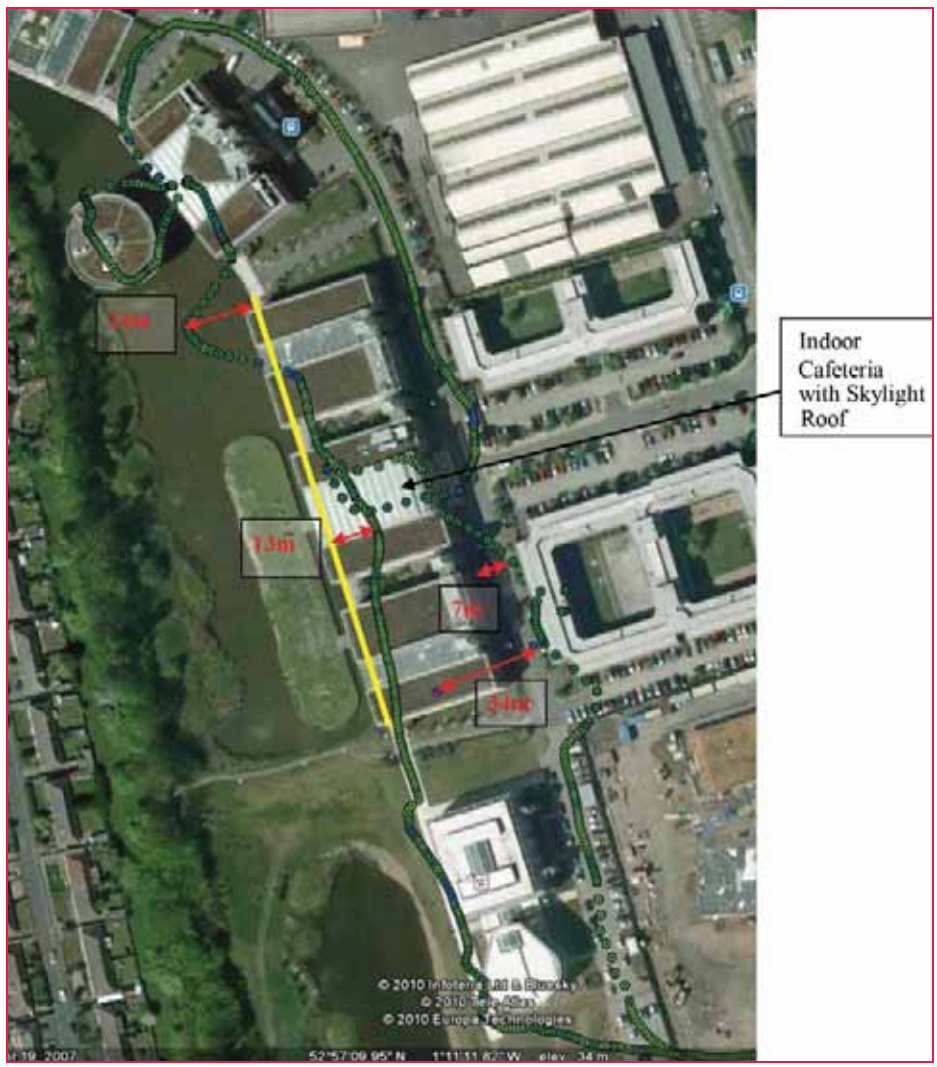

Figure 4: Point tracks with deviations from true path highlighted (© 2010 Google, ©2010 Infoterra Ltd & Bluesky, © 2010 TeleAtlas, © 2010 Europa Technologies)

The results in the heights appear to be better than the plan which is contrary to expectation. This may be to due to the effect of multipath or alternatively some internal filtering of the height data.

Test 2: Kinematic GPS Tests – Outdoors and Indoors

This test was aimed at assessing the quality of the smart phone GPS receiver in a variety of environments. This ranged from open outdoor, to partially obscured, to indoors (with skylight roof). The smart phone was held in the palm of the hand in front of the walking user.

Route: walking from the Nottingham Geospatial Building (NGB) → along Triumph road → along a straight path → turn about 100 degrees → and then along a covered pathway, → around the Library (partially obscured area) → then along the open pavement close to buildings → inside the cafeteria (indoors but with skylight type roof structure) → back to NGB.

Figure 4 shows a view of the route around the buildings with the deviations from the true path travelled highlighted.

The yellow line shows the covered pathway. The size of the deviation from the desired path at certain locations is highlighted in red. In the covered path the deviation increases up to about 13m in the middle and about 24m at the end. Good to medium quality position solutions are available in the indoor cafeteria area as lock to the satellites was maintained. This is due to the type of roof structure which is either glass or some form of clear plastic. Along the footpath between two buildings the position deviates by about up to 34m at a point. This is because of poor satellite visibility due to obscuring by the buildings.

Test 3.1 – Compass Test (Outdoor)

The aim of this test was to assess the quality of the inbuilt compass in the smart phone tested in the context of an outdoor environment.

This test was carried out on the Jubilee campus, walking in a straight line and then making a turn and walking in a straight line for about 70 metres then stopping. The compass measurements were extracted from the iPhone and are shown in Figure 5. There are likely to be small errors due to there being some misalignment between how the phone was held during the test and the direction of travel.

'True' values for the two heading directions travelled were taken from Google Earth. These are 277º and then 341º.

In Figure 5 above the change in direction can be seen in the compass readings.

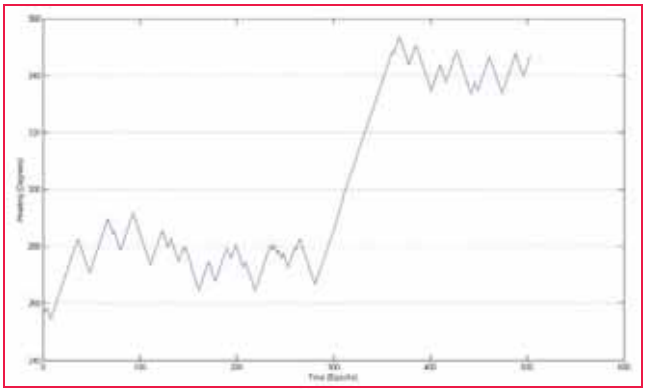

Figure 5: Compass heading results for outdoor test

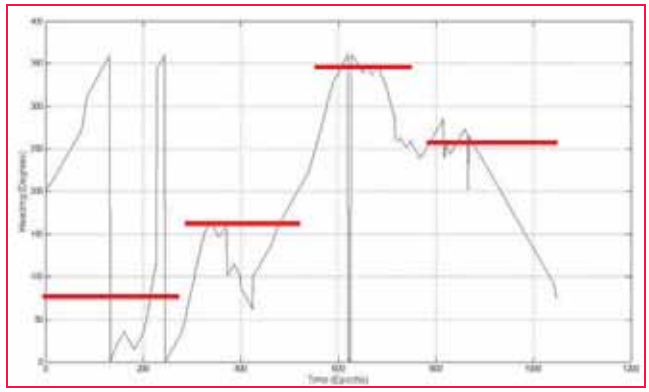

Figure 6: Result of indoor compass test

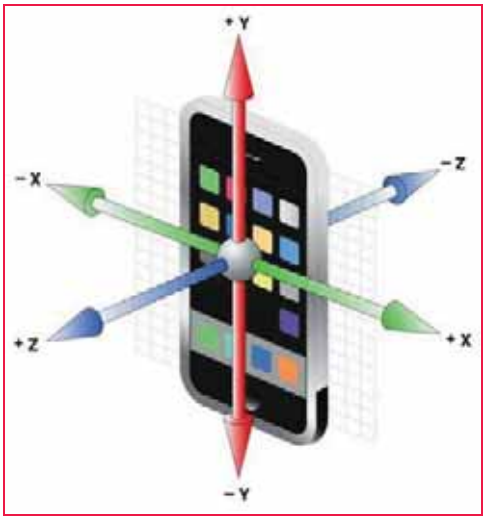

Figure 7: iPhone axes (Apple, 2010b)

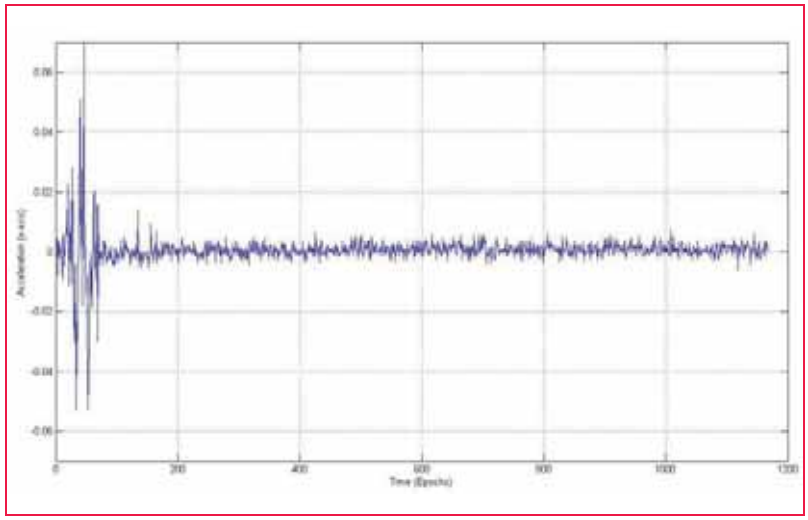

Figure 8: X – Axis user acceleration

The compass readings for each direction fluctuated around a mean value.

Mean1 = 276º and Std.Dev1 = 7º
Mean2 = 345º and Std.Dev2 = 5º

For a 5º heading error, after 1 m (assuming no other errors) the deviation from the desired end point would be 0.09 m while after 10 m it would be 0.87 m. For a 10º heading error after 10 m the deviation will be 1.74 m. Therefore in the outdoor context tested, the smart phone compass provided good orientation information which could be used in assisting navigation for the blind and partially sighted.

Test 3.2 – Indoor compass test

This test involved walking in the open plan office area of the B floor in the Nottingham Geospatial Building (NGB). Firstly walking parallel to the wall from front to back, (walking past some metal cabinets). Then turning 90º and walking in a straight line parallel to the back wall, turning around 180º, then returning back, turning 90º and heading back to the starting point.

Using the coordinates of the high precision GPS receivers on the NGB roof to determine the building heading, the general heading values for the manoeuvre conducted should be 79º →169º →349º →259º. This has been approximately indicated by the red overlay on the graph in Figure 6 (NB: the transition time for the red line is approximate).

The metal cabinets were a source of error for the digital compass in the iPhone which is a magnetometer (The GPS receiver is then used internally to compute the difference between true north and magnetic north). During the tests while walking past one of the metal cabinets a message regarding disruption error to the compass was flashed. It can be seen in the results that the indoor environment is quite challenging for the digital compass due to the close proximity of metal objects. Thus leading to errors of up to 100º in the compass heading as can be seen in Figure 6. Calibrating the compass for each new environment may improve the results but would be impractical to expect to user to calibrate for every indoor environment or room.

Test 4 – Noise resolution of accelerometer and gyro

This test was a static test where the iPhone was placed stationary and undisturbed on top of a desk in the office. The user acceleration in the x, y and z directions was recorded, as well as the attitude and compass heading. The iPhone axes are shown in Figure 7.

Acceleration:

The iPhone application recorded both the acceleration (with gravity) values and the user acceleration where the gravity component has been removed. The user acceleration result in the X, Y, and Z axes are shown in Figures 8 to 10 respectively.

The acceleration spike at the beginning of Figures 8 – 10 was due to the

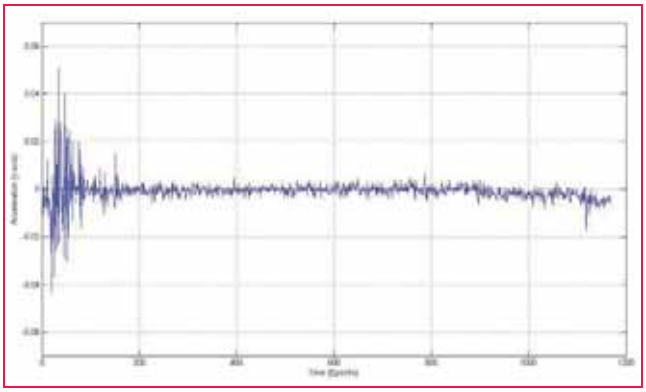

Figure 9: Y-Axis user acceleration

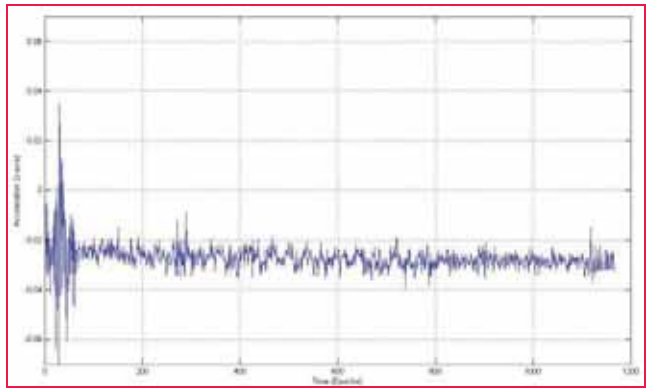

Figure 10: Z-Axis user acceleration

Table 2: Mean of acceleration static test (from epochs 200 – 750):

Acceleration ~(g)	x-axis	y-axis	z-axis
Mean	0.0007	-0.0004	-0.0272
Standard Deviation	0.0020	0.0017	0.0035

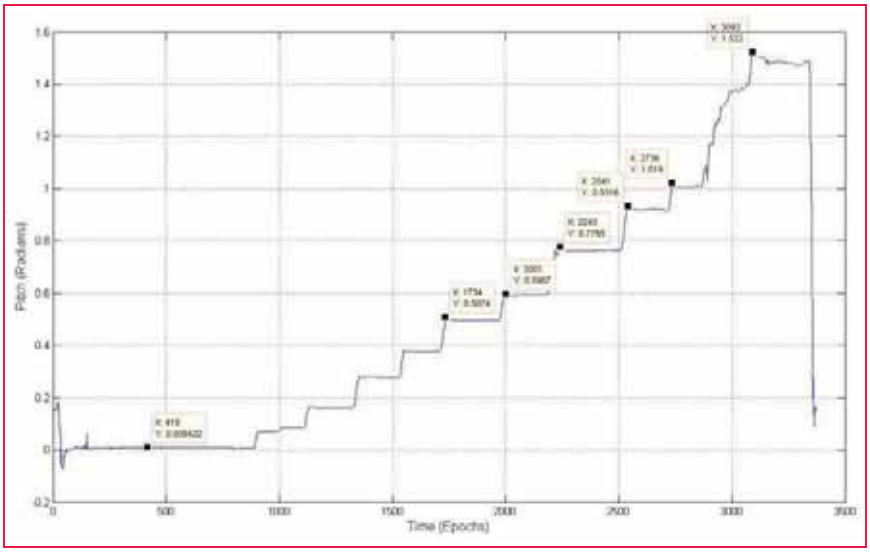

Figure 11: Pitching the iPhone in Increments with Key Pitch Values Labelled

Table 3: iPhone pitch measurements vs computed pitch values

iPhone Measurement /radians	**Computed based on vertical distance measurement** / radians	**Difference** /radians
1.522	1.571 (90º)	-0.049 (-2.8º)
1.019	1.044	-0.025 (-1.4º)
0.932	0.922	-0.010 (-0.6º)
0.777	0.792	-0.015 (-0.9º)
0.597	0.678	-0.081 (-4.6º)

placing down of the phone onto the table after data recording had been initialised. After that the acceleration values were close to 0g for all axis. Although the z-axis had a larger offset from the 0g value (Table 2).

Attitude Test – Pitching (Turning about the iPhone's X-axis)

The phone was rotated about the x-axis in small increments every 10-20 seconds. The user attitude information from the iPhone was extracted and is shown in Figure 11. The gyro actually measures angular velocity. The pitch and roll values are computed from the accelerometer values which is then smoothed by the gyro data.

The phone was pitched up in gradual increments up to 90 degrees (standing on edge). This can be seen clearly. Some measurements were taken of the horizontal projection of the phone during this procedure. This was used along with the length dimension to get an independent approximation of the pitch values. The comparison of the results are shown in Table 3.

The above attitude tests show an orientation error of up to about 5º in the pitch. These results show that the smart phone accelerometer and gyro have better stability than the compass and thus for indoor environments the accelerometer and gyro can be used to provide relative orientation information to the blind or partially sighted user.

Comparison to other low cost IMU specifications

The foot-tracker developed by Hide *et al*. (2009) utilises MicroStrain 3DM series (3DM-GX1 or 3DM-GX3-25) inertia sensors. The MicroStrain 3DM-GX1® and 3DM-GX3® -25 are high-performance, low-cost miniature Attitude Heading Reference System (AHRS), utilizing MEMS sensor technology. It combines a triaxial accelerometer, triaxial gyro, triaxial magnetometer, temperature sensors, and an on-board processor running a sophisticated sensor fusion algorithm to provide static

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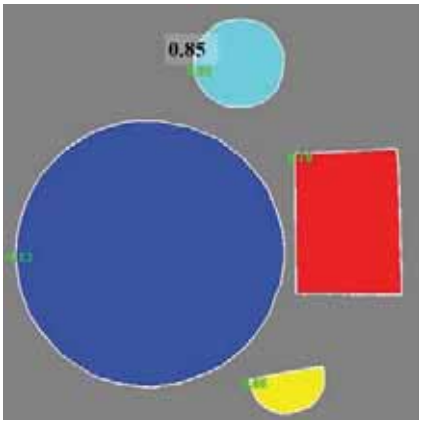

Figure 12: HTC image processed through the circle identification routine

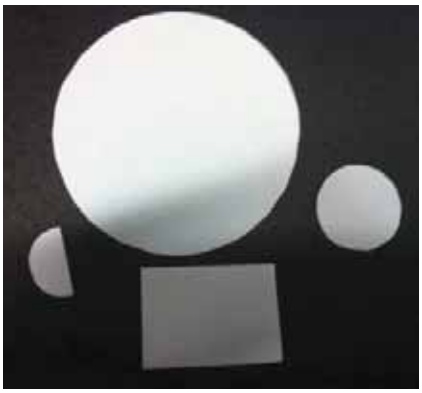

Figure 13: Original image taken with iPhone 4 camera

Figure 14: iPhone 4 image converted to binary with noise cleaned off

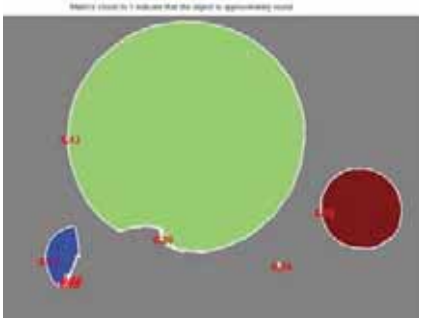

Figure 15: iPhone 4 image processed using the circle identification script

and dynamic orientation, and inertial measurements (Microstrain, 2011), (CMU, 2010). It has an orientation accuracy of:
± 0.5° typical for static test conditions
± 2.0° typical for dynamic (cyclic) test conditions & for arbitrary orientation angles

And an accelerometer bias stability of:
± 0.005 g for ± 5 g range
± 0.003 g for ± 2 g range

Its other bias specifications can be found in (Microstrain, 2011). The accelerometer and gyro on the iPhone are a lower quality of inertia sensors than the MicroStrain 3DM range.

Camera – Object detection tests

Tests were conducted to assess the quality of the images produced by various types of smart phones and the ability to extract feature information from such camera photo images. Matlab was used for the image analysis. Three phones were used in the image analysis tests, the HTC Wildfire, the iPhone 4 and the Nokia 6500 slide. The following are their camera specifications:

HTC Wildfire:– 5 megapixel colour camera with LED flash (HTC, 2010).
iPhone 4: – 5 megapixel still camera with LED flash, VGA-quality photos (Apple, 2010a).
Nokia 6500 slide: – a 3.2 megapixel camera with Carl Zeiss optics, auto focus, and 8x digital zoom. Has a powerful double LED flash (Nokia, 2010).

Simple Shape ID – Circle Identification:

The following was used as a metric to identify round objects in an image:
Metric = (4 x pi x area) / perimeter^2.

This metric is equal to one only for a circle and it is less than one for any other shape. The discrimination process can be controlled by setting an appropriate threshold. Different shapes were cut out from white paper and placed on a black background. These were photographed using the selected smart phones. The photographs were taken in an indoor environment with indoor lighting on, hence the presence of shadows as can be seen in Figure 13. Photos were taken using the three phones one after the other at the same time of day and under the same lighting conditions. The position it was taken from was approximately the same. The images were converted to binary and noise in the data was cleaned off before analysis.

HTC Wildfire

The various shapes in Figure 12 have been highlighted in different colours and their boundaries traced. It can be seen that the circular shapes have a higher metric of 0.83 and 0.85 respectively. The fact that the shapes were hand cut out, as well as the clarity of the image are likely to be the contributors to why the metric is < 1 for the circular shapes. In this image a threshold of about 0.78 can be applied to discriminate between the circular and not circular objects in the image. This indicates that a smart phone image can be used for shape identification.

iPhone 4

The iPhone photo was more impacted by the shadow on the image. This resulted in the rectangular shape which was in the shadow area being removed when the image was converted from colour to grayscale and then binary. Thus the circle identification was not effective as the large circle was distorted leading to a low index value of 0.42. The smaller circle was clearly outlined with an index value of 0.70 (lower than that from the HTC). It is possible to perform some further pre-processing or to use a different grayscale threshold to reduce the shadow effect for the iPhone image. However for this comparison test it was desired that the same script be run for all the photos for proper comparison.

Nokia 6500 Slide

The original Nokia image compared to the others initially appeared to be a lesser quality than the others. However the shape identification routine performed well with it. The large circle had a metric of 0.82 while the smaller circle had a metric of 0.78 (Figure 16).

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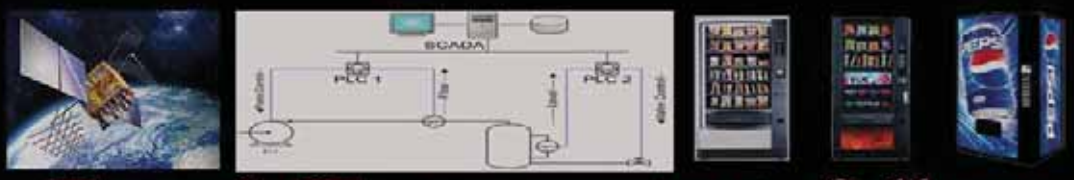

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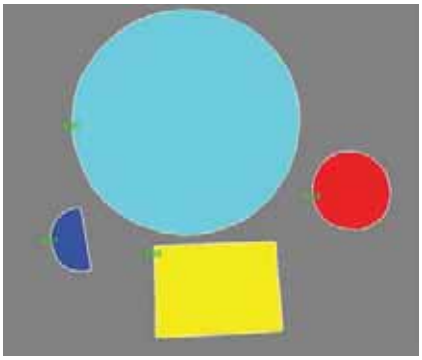

Figure 16: Nokia 6500 image processed using the circle identification script

The tests show that it is possible to identify shapes based on images taken from a smart phone camera. This can then be used as part of an object identification routine such as detecting the shape of a Fire Exit or the symbol of a toilet sign. In the test conducted the HTC Wildfire 5 mega pixel camera showed the best results. The iPhone camera also of 5 megapixel showed poor results due to the impact of the shadow. While the Nokia 6500 although only 3.2 mega pixels gave good results. The type of flash used may be a contributing factor as the Nokia 6500 has as dual LED flash. Further tests to investigate the impact of camera orientation and lens distortion on shape detection is also required.

Conclusion

Currently available off-the-shelf mid to high-end smart phones are today equipped with a range of sensors such as GPS receivers, cameras, accelerometers and gyros. These sensors were introduced to enable activities such as the changing of view from portrait to landscape when the phone is tilted, image stabilization, and outdoor position guidance. This has further evolved into the playing of games and other such applications. These sensors are low cost, low grade sensors which were not designed for high accuracy or high reliability applications. The tests conducted showed that the Compass on the phone tested was able to provide fairly stable results outdoors however, in the indoor environment tested it proved unreliable due to the influence of metal objects in the indoor area. Nevertheless, the tests conducted showed that if this data is integrated with gyro data it can provide useful orientation information.

The iPhone GPS receiver had an accuracy of a few metres and was able to provide positions in an indoor environment with a clear roof structure. However after navigating underneath the covered walkway (Figure 4), the position solution drifted by up to 24 metres. Integration with the onboard inertia sensors would assist in correcting such errors. Further research has been done in this project utilising the smart phone inertia sensors to detect the walking dynamics of the user and based on this, computing the distance travelled.

The camera tests conducted have shown that object identification can be conducted on the images from the various phones including the 3.2 Megapixel Nokia 6500 camera. However, it could also been seen that effects such as shadows in the image could adversely affect the object recognition capability. The camera can be utilised in detecting objects/symbols such as Fire exit or wet floor signs (Bail, 2009), or can also be incorporated in the navigation algorithm (Kessler et al., 2010).

The tests results in this paper have shown that the smart phone sensors while having some limitations, if integrated effectively can provide useful information on the environmental flow of the user and thus aid in positioning and navigation within an indoor context. Further tests conducted as part of this research have also shown that the smart phone sensors can be used to provide context awareness (Collins, 2010) information as well as a measure of orientation and distance travelled by the user. This is an area of ongoing research at the Nottingham Geospatial Institute - University of Nottingham.

Acknowledgements

This research project was funded by Caecus Ltd a social enterprise developing technology for the blind and partially sighted. The data collection iPhone application was written by my colleague Gary Wang at the GNSS Research and Applications Centre of Excellence (GRACE), University of Nottingham.

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JAVAD's good filter

Coalition's bad filter

Bad GPS filters invite harmful extra noise which exists everywhere. The spectrum will get even more congested as the need for modern communication increases. It is selfish, impossible, unfair and unwise if we expect to block modern communication because GPS manufacturers design bad filters.

Our talented and dedicated team of scientists designed this filter to protect GPS by not looking into other spectrums; and at the same time improve the GPS performance.

This is the filter that Coalition team uses. Instead of focusing on science, they employed talented and dedicated team of lawyers and lobbyists. Their leaders in their letter to PNT declared that a good protective filter could not be build even in a decade. We did it in one month!

Unfortunately sometimes politics wins over science.

Most GNSS receivers soon will face the "retrofit" problem because of their bad filters and because they don't track all modernized GPS signals of new GPS satellites and others.

- **GPS L1, L2, L5**
- **GLONASS L1, L2, L3**
- **QZSS L1, L2, L5**
- **Galileo L1, E5A, E5B, altBoc**
- **Compass B1, B2**

The black Sheep saved GPS by building a smart filter, not a senseless coalition!

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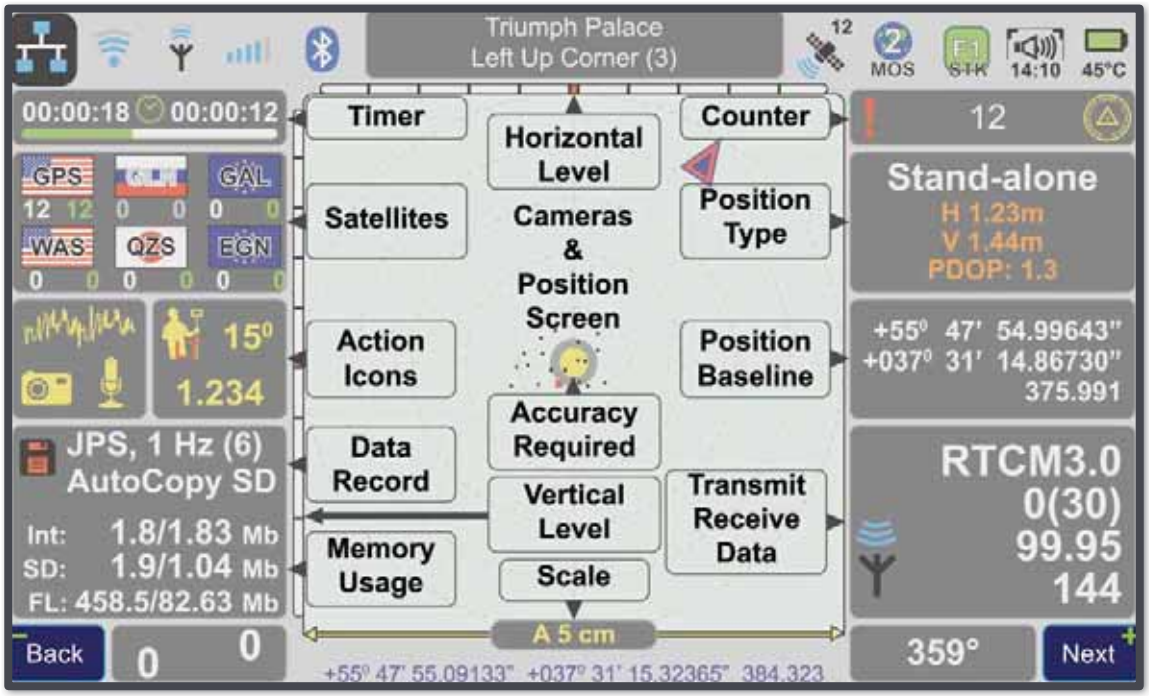
- GLONASS L1, L2, L3
- QZSS L1, L2, L5
- Galileo L1, E5A, E5B, altBoc
- Compass B1, B2

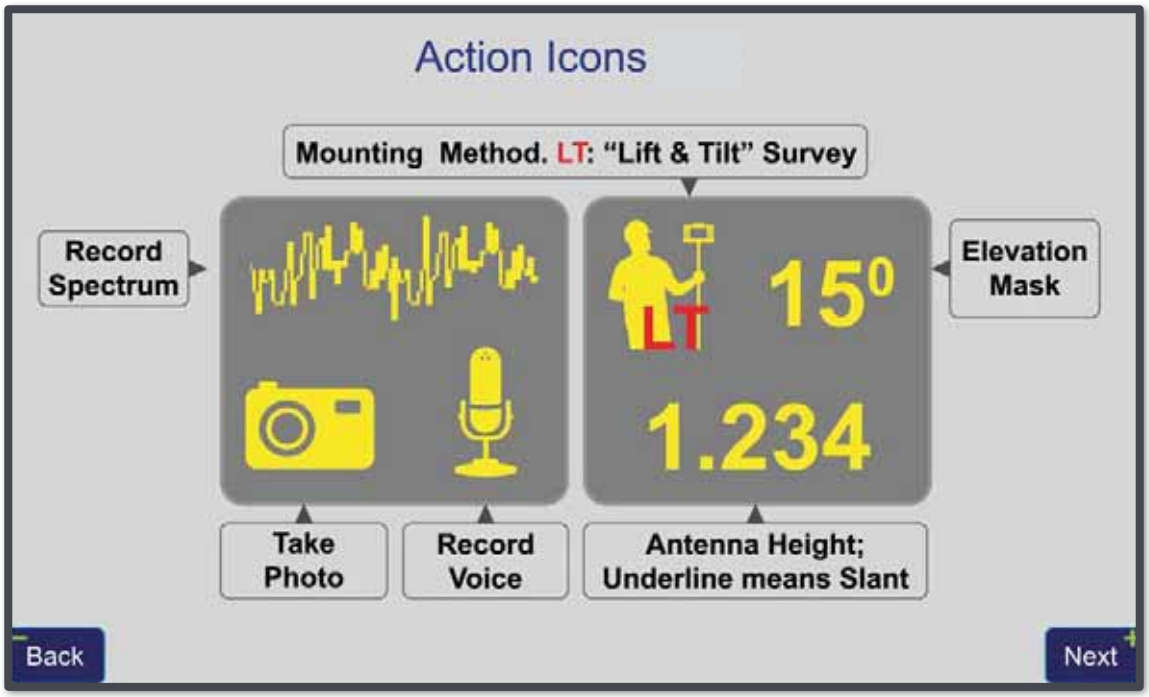
Victor-VS is the new generation of rugged and modern field controllers. It automatically connects to JAVAD GNSS receivers via its internal Bluetooth and guides you through field operations.

VICTOR-VS

Action Screen shows status of all

• After you define Settings and select your desired operation, click the Action button to take you to the Action screen

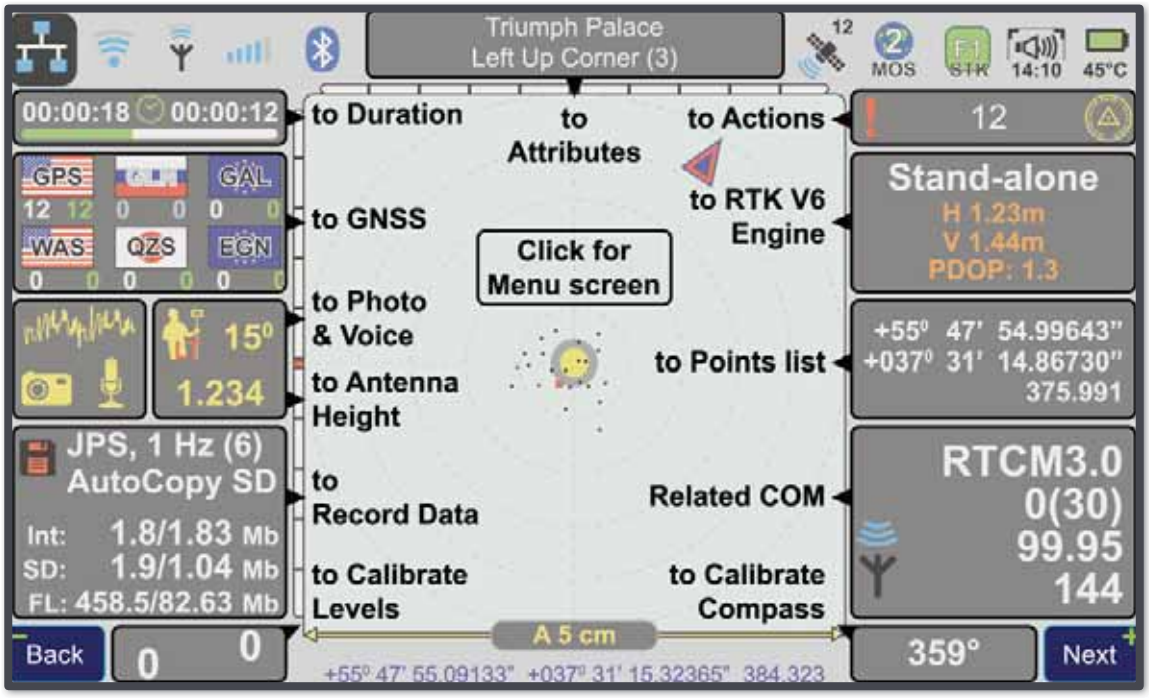


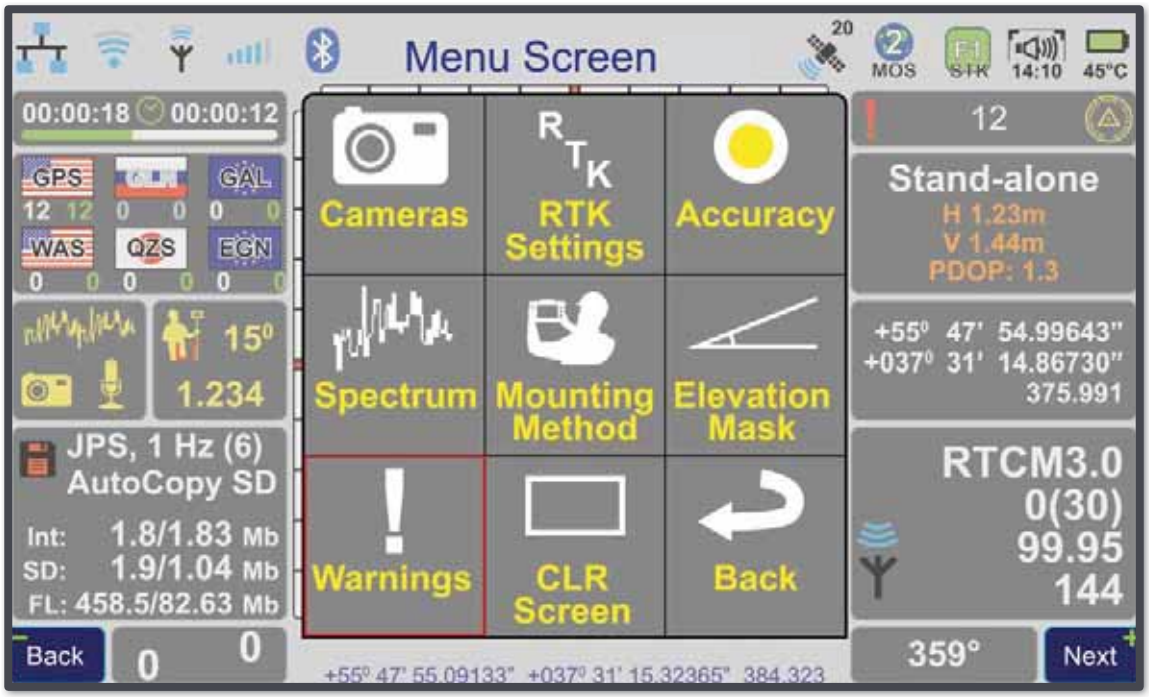


• In Lift & Tilt mode ("**LT**") you only need to lift the unit to near vertical on top of the survey point to start survey and then to tilt it to end the survey.

All segments/icons are active

Most functions can be reacted by a single click.

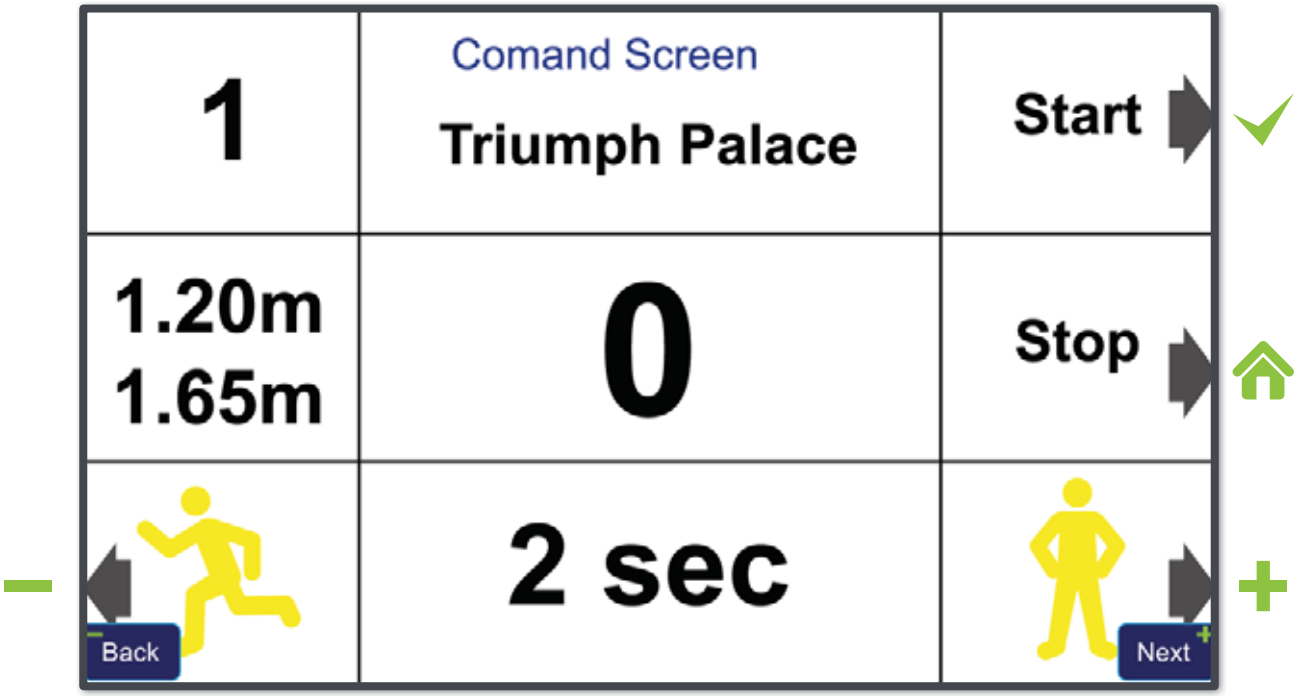




- Click the center of the Action Screen to take you to other actions with a single click.

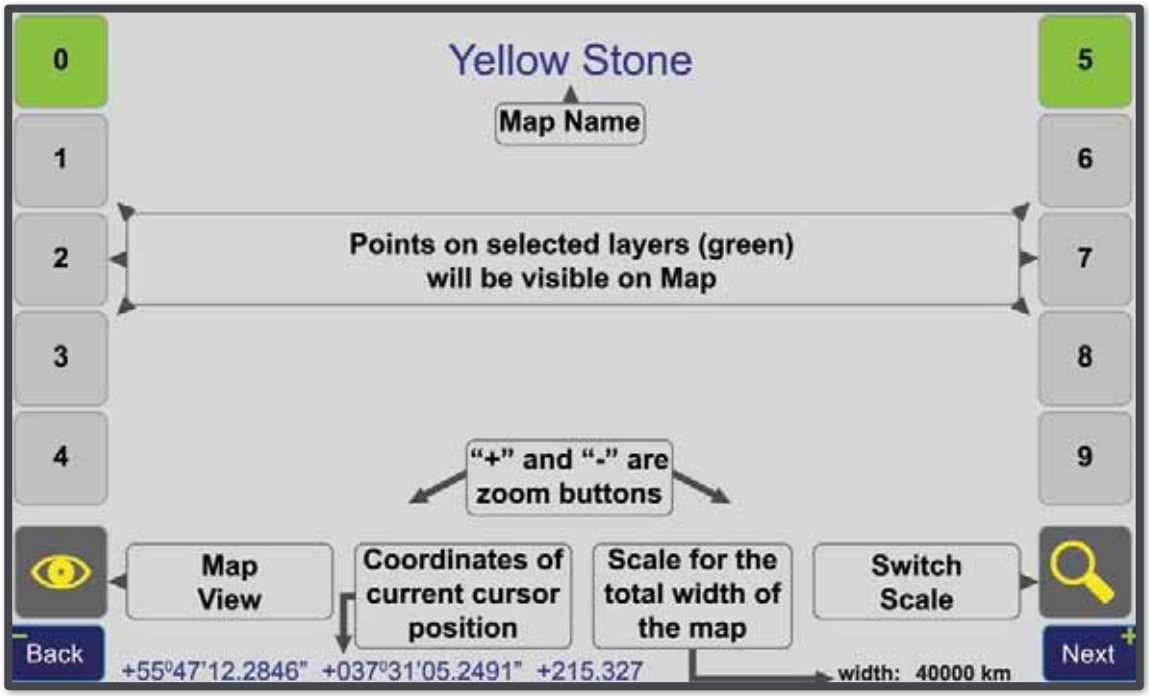
Command screen starts/stops & controls

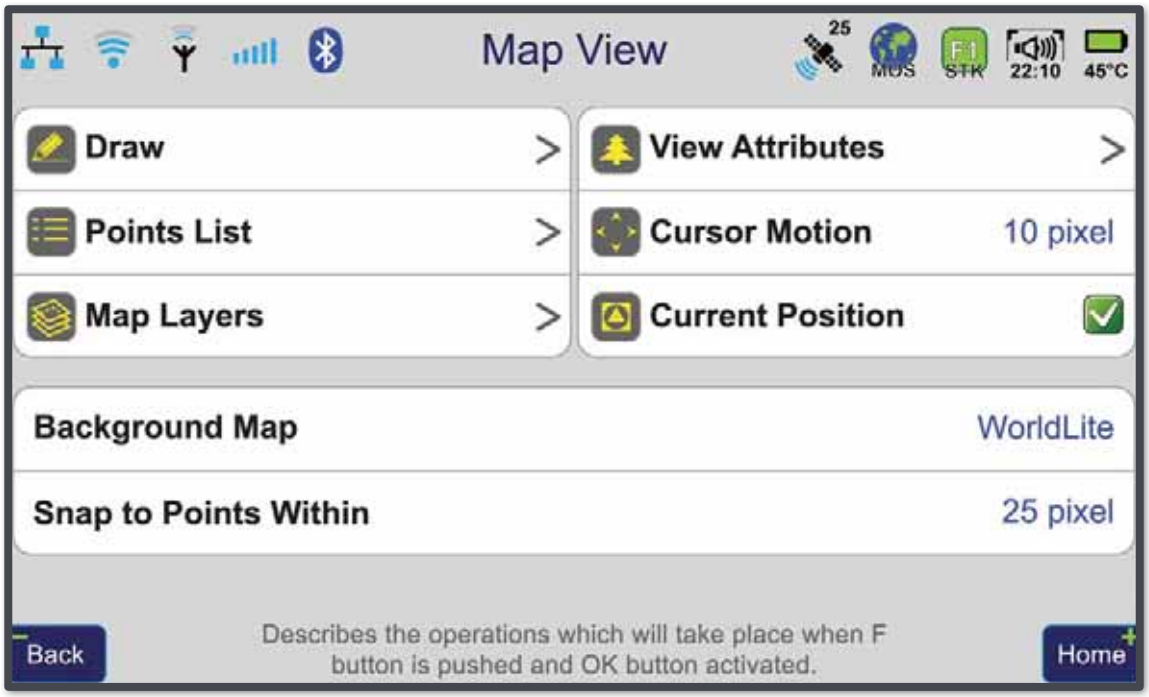
- Click Action button again to see some important items in large fonts and to start/stop and command actions (depending on the current action settings).



Active map shows positions on active map

• Points, and their attributes, are stored in the selected layers of the Current Map.





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Same as TRIUMPH-VS but without internal GNSS antenna, inclinometers, compass and cameras.

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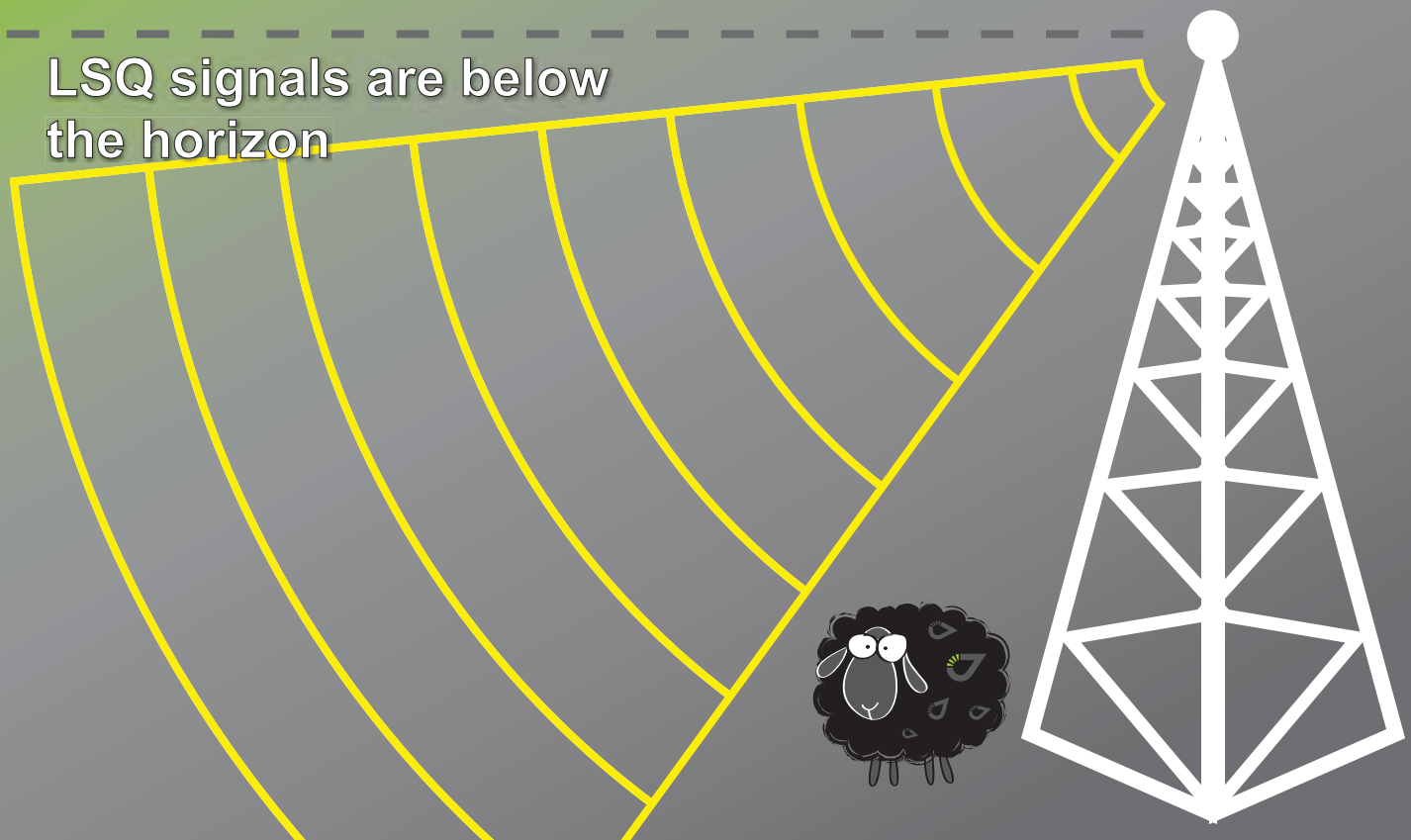
We love LightSquared because we want to establish RTK reference stations in LightSquared transmitting towers and use their infrastructure to provide low cost nationwide RTK networks for the benefit of all surveyors and high precision users. The existing RTK networks have limited coverage, limited performance and are very expensive.

Special interest groups use scare tactics to block LightSquared. Example: “LightSquared signals interferes with GPS receivers in airplanes and planes will crash”.

This is not true. Even if GPS receivers in airplanes do not have required protective filters, they still are not affected. The reason is that all LightSquared transmitting antennas are tilted six degrees below the horizon and less than 1% of their power is transmitted above the horizon (where airplanes fly). The Coalition ignores this fact in their test reports.

Please see www.javad.com for other examples of how lawyers and lobbyists of special interest groups attempt to beat science.



LAPSI: An EU thematic network for enabling public sector information re-use

Many legal aspects remain unclear and lots of doubts are there as to the technical issues, with particular reference to interoperability

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One of the pillars of the European Union is the creation of a single market. Therefore, the European Union (EU) Institutions intervene at different levels in order to create conditions for fostering a fair and competitive cross-border market in the entire EU area, as well as in the European Free Trade Area (EFTA).

Information generated and collected by public sector bodies (PSI) represents a veritable minefield in both democracy and market perspectives; it may make a much greater contribution to EU economies and societies, in particular if current legal barriers to access and re-use were removed. This is why the EU Commission in 2003 issued a Directive on the re-use of Public Sector Information (hereinafter the PSI Directive). In a three steps model of

1. Arrange for information to be publicly available,
2. Allow re-use of such information
3. Ensure practical and legal conditions foster alternative uses of PSI, the PSI Directive clearly operates only at stage 3, and in a modest manner at that.

Even if an upcoming revision of the said PSI Directive will lead to a duty for Member States to allow re-use, the decision about what information or data is made public would remain a domestic one. There are sound reasons for this; an important one is that the legislative competence of the EU to regulate access to national government information is limited.

In 2009 the European Commission launched a call for creating a thematic network supposed to provide with some policy support for the impact assessment of the PSI Directive and for its review, scheduled for 2012. The Nexa Research Center for Internet and Society gathered a consortium of twenty partners from thirteen different EU member state, drafted a proposal and won the call. This is how the LAPSI Thematic Network saw the light. Since the beginning the LAPSI project intended to build a network apt to become the main European point of reference for high-level policy discussions and strategic action on all legal issues related to the re-use of the PSI – but also to the access - , namely in the digital environment.

During this two years, the Legal Aspect of Public Sector Information (LAPSI) Thematic Network intensively worked on the legal aspects of PSI re-use without neglecting the legal issue of access and some technical issues, such as interoperability; in addition the Thematic Network also focused on some economic aspects, such as charging policies. In particular the LAPSI Thematic Network engaged in policy document production, such as draft policy recommendations, position papers and guidelines.

As to position papers, the LAPSI Thematic Network produced four advanced draft so far. As outlined in the introductory section of the first position paper on the "Consultation On behalf of the Comité de Sages on boosting cultural heritage online

(Ricolfi M., *LAPSI Position Paper on the Consultation on behalf of the Comité de Sages on boosting cultural heritage on line*, http://lapsi-project.eu/lapsifiles/DigitalheritageconsLAPSI.pdf)", the thematic network LAPSI wants not only to express the views which have surfaced in the discussion which took place among its members, but also compare them with the position taken on a topic by stakeholders and other players in the field. Furthermore, LAPSI advocated an approach combining total opposition against any restrictions concerning digitized content upstream with express and unlimited acceptance of commercial re-use downstream.

The second position paper concerns public undertakings and suggests to reconsider the exclusion of these subjects per se from the PSI Directive, mainly for complying with competition law general principles. In this context, LAPSI reflects on several issues: "*Should public undertakings be covered by the PSI Directive? The definitions of public sector bodies and bodies governed by public law (Art. 2, recital 10), to which the PSI Directive applies, are currently taken from the public procurement Directives and public undertakings are not covered by these definitions. Should public undertakings be considered as public sector bodies in the meaning of the Directive? Are there public undertakings holding "interesting" PSI? Is e.g. the UK Royal Mail a public undertaking in the meaning of the Directive? Are there different definitions of national legislation leading to situations where bodies holding similar (public sector) data are in some Member States of Europe considered as public sector bodies (falling under the PSI Directive) and in other Member States considered as public undertakings (PSI Directive not applicable)? If public undertakings were to be covered by the PSI Directive, how should the definitions of public sector bodies and bodies governed by public law be amended? Should the definitions be detached from the public procurement definitions? Could data be considered as PSI if it was held by a privatised former public sector body*? *(*Ricolfi M. And Drexl J., Van Eechoud M., Salmeron M., Sappa C., Tsiavos P., Julian Valero (and Pavoni F., Patrito P. - EVPSI), *The exclusion of "public undertakings" from the re-use of public sector information regime,* http://lapsi-project.eu/lapsifiles/lapsi_public_undertakings_paper_adv_draft.pdf).*"*

The third position paper concerns charging policies and suggests to Public Sector Bodies (PSBs) to introduce marginal cost as a general principle for re-use, while higher costs should be applied only on exceptional basis. Two main problems are here identified. The first is related to how the exception should be drafted. The second is related to whom should identify and draft them: should the exception be identified by local PSBs, there would not be harmonization on this and consequently a lot of legal uncertainty. Should these exception be determined by national or supranational subjects, the risk is that local needs are not taken into account appropriately. Therefore the paper suggests that EC issues guidelines on the determination of exceptions (Ricolfi M. And Drexl J., Van Eechoud M., Janssen K., Maggiolino M. T., Morando F., Sappa C., Torremans P., Uhlir P. (and Iemma R. - EVPSI and De Vries M.), *The "principles governing charging" for re-use of public sector information,* http://www.lapsi-project.eu/lapsifiles/lapsi_charges_paper_adv_draft.pdf).

The fourth position paper concerns licenses and suggests that the EC issues guidelines on licensing models. In this context, the issue for which LAPSI's contribution is sought is described as follow: "*Are there licensing issues further facilitating re-use of PSI that could be brought forward by legislative measures, by amending the current provision of Article 8 of the Directive, or other measures? If yes, which could/should they be*?" (Ricolfi M. And Van Eechoud M., Morando F., Tsiavos P. (and Ferrao L - EC), *The "Licensing" of public sector information,* http://lapsi-project.eu/lapsifiles/lapsi_licensing_paper_adv_draft.pdf).

As to guidelines, the LAPSI Thematic Network is currently working on guidelines on charging principles and on licenses and therefore trying to complete the work started with the position papers on both these specific and crucial issues. In particular the LAPSI Thematic Network is studying how different licenses could be drafted in order to satisfy the need of re-use data of different nature, without creating obstacles to their cross-border circulation.

As to policy recommendations, the six working groups of the LAPSI Thematic Network are working in several areas. More precisely they issued advanced drafts on privacy and personal data, intellectual property, competition law, cultural institutions, access, regulatory bodies, the principle of proportionality, trade secrecy. These drafts are works in progress and the intermediate versions are available on the wiki page of the LAPSI project.

With the aim of disseminating the views and the results of their research and of the discussions among its members, LAPSI tries to find synergies among different communication channels, including the public conferences, the competitions directly involving stakeholders (citizens, companies and especially public bodies) and the exploitation of tools made possible by the Internet, such as mailing-lists, wikis and social networks.

LAPSI held its first public conference entitled "PSI at the Crossroads: Current Challenges and New Opportunities" on 5th and 6th May 2011 at the Bocconi University of Milan (Italy) (The presentations from the speakers of LAPSI 1st Public Conference are available at: http://lapsi-project.eu/meeting5may#3). On this occasion LAPSI also gave its 1st Award concerned the best dissertation on legal aspects of PSI re-use. The very purpose of this award was to support any scientific initiative which could be beneficial to PSI re-use policies for moving forward. Antonio Legrottaglie is the winner of the 1st LAPSI Award with the dissertation "Sui generis copyright protection on PSI: which future for the re-use" (the abstract from the dissertation, together with the other best abstracts, is available on the publications archive page http://www.lapsi-project.eu/publications)

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Web: www.kanq.com.cn

After the experience acquired in collaboration with Open Knowledge Foundation (http://okfn.org) at Open Data Challenge (http://opendatachallenge.org/), the most important competition on open data in Europe, the idea of LAPSI was to propose a contest for building the best portal on public data. So, during the 2nd LAPSI public conference "A First Discussion after the Proposal for a Revision" taken place in Brussells on 23rd and 24th January 2012 (The presentations from the speakers of LAPSI 2nd Public Conference are available at: http://lapsi-project.eu/meeting23jan#2), it was given the award to the most user-friendly design of a public sector information portal in the European Union (The prize went to the Spanish portal datos.gob.es http://datos.gob.es/).

The thematic network LAPSI combines international meetings with an advanced use of the tools offered by the Internet. In addition to the web site http://lapsi-project.eu/, in which are published news related to public sector information and initiatives directly concern the thematic network, there are two public mailing lists (http://www.lapsi-project.eu/listinfo): a list for a general discussion about the Legal Aspects of Public Sector Information and a one-way list for announcements related to the LAPSI project. In order to provide further material for those wishing to explore the theme of PSI, on the website are available a glossary of PSI-related terminology (http://lapsi-project.eu/lapsifiles/lapsi_glossary.pdf), a bibliography (http://www.lapsi-project.eu/biblio), a collection of documents and norms on the PSI (http://www.lapsi-project.eu/norms) and a selection of remarkable PSI decisions rendered by various EU Member States' Domestic Courts (http://www.lapsi-project.eu/decisions).

The updated version of all the LAPSI Policy Recommendations are available on the wiki page at http://www.lapsi-project.eu/wiki/index.php/LAPSI_Policy_recommendations. LAPSI also oversees the most important social networks like Twitter (https://twitter.com/lapsi_project), Linkedin (http://www.linkedin.com/groups?home=&gid=4266110&trk=anet_ug_hm) and Facebook (https://www.facebook.com/lapsiproject). In order to be involved in LAPSI project there is a stakeholders online registration form available on the LAPSI website (http://www.lapsi-project.eu/stakeholders-form).

All the production of the LAPSI Thematic Network will be presented at the final conference of the 9th and 10th of July in Turin (More information are available at: http://www.lapsi-project.eu/final). Intermediate drafts were discussed during the seminars and conferences organized so far. The two-days meeting is jointly organized with the EVPSI research project Final Meeting (http://www.evpsi.org/).

Clearly lots of work still needs to be done in the field of PSI. Many legal aspects remain unclear and lots of doubts are there as to the technical issues, with particular reference to interoperability. This is why the EC launched another call, so that once the LAPSI project ends, in September 2012, a LAPSI 2.0 Thematic Network can take the passing of the torch.

Let's click GIS into gear! Data is the fuel

3rd HUNAGI Conference, 21-22 March 2012 Budapest, Hungary

Established in 1994, the Hungarian Association for Geo-information HUNAGI is a non-for-profit, non-governmental umbrella organisation with the mission goal to encourage and facilitate the availability, accessibility, share and usabilities of geographic information according to the EU INSPIRE directive. To achieve the goals HUNAGI provides forums for industry stakeholders and relevant governmental entities and other learned societies to build partnership which can benefit from use of geospatial data and related technologies. HUNAGI is registered as Spatial Data Interest Community at DG JRC of the European Commission.

This year at the 3rd HUNAGI Conference the theme Mobile GIS and Related Data Services was selected. In order to strengthen competitiveness of the small and medium enterprises, the event was organised in conjunction with three external communities namely: Intelligent Transportation Systems (ITS Hungary), Hungarian Association of Logistics, Purchasing and Inventory Management (HALPIM), Hungarian Space Industry Cluster (HUNSPACE). The escorting exhibition reflected trendy technological tools and solutions provided by (Autodesk, Varinex, HungaroCAD, Pitney Bowes, Esri Hungary), INSPIRE compliant, user-friendly services (FÖMI) and standards (GSI Hungary) and introduced solutions provided for mobile environment GeoX, GPScom and InterMap Ltds).

In the opening session governmental civil servants and NGO officers taking part in strategy formulation and implementation of the chosen fields delivered introductory overviews and highlighted policy issues such as the legislation framework development for ITS in Hungary in line with the European road map. Additional highly timely talk was given by the ex INSPIRE national contact on the recent coordination changes. Finally, the GIS-related developments were introduced in the context of the upgrade of the capital's transportation system.

Further presentations gave in-depth view on the capabilities of promising mobile GI-based technologies in city logistics from data collection to cost-effective cloud-based services and from supply-chain traceability to city information management. The issue of data availability ad usability were addressed from were addressed both by the urban planners and core GI service providers.

Intelligent transportation systems (on-demand based, flexible and dynamic) can save energy, time and costs from citizens to enterpreneurs. The state of the art of ITS services in Hungary was discussed in light of the European trends. As invited speaker, editor of the International Coordinates Magazine made contribution on Mobile GIS: Road and Roadblocks", while from Czechia a register on level crossings was developed as part of the integrated rescue system. Terrestrial laser scanners are effective tools for use in urban planning as it was clearly demonstrated by technical representative of a sophisticated scanner manufacturer Faro. Benefits and dangers - experiences gained by COWI Hungary have been shared based on evaluation of different ITS-related developments.

Based on a survey, among the student participants the Volunteered Geographic Information session was found as the most popular. The engagement of the citizens became evidence especially in the field of nature protection (Wilderness Watch program etc). The countrywide landscape Value Cadastre supports entries using mobile technologies as well. Environmental Democracy and VGI were the keywords of the speakers of Törökbálint municipality and the ViaMap Ltd. Activist of the Hungarian OpenstreetMap delivered presentation as well.

The three thematic sessions were escorted by two complementary ones devoted to the data collection and services (incuding their share) as well as the GI-related technologies where all major solution providers (eg. VARINEX, Esri Hungary, DigiTerra, Geodézia Zrt, Compet-Terra, Intermap) made contributions. Smart phone applications were discussed in disaster management and spatial planning.

In the closing session the newly established UN OOSA SPIDER Regional Support Office hosted by Károly Róbert College in Gyöngyös were highlighted the 7th Framework Program project LAPSI on PSI-reuse was introduced. The participants received an in-depth overview on the Hungarian Space Strategy by representative of the Ministry of National Development, finally Prof. Bárczi, chair of the Space Industry Clusterhad a talk on their contribution to the Sentinel 2 flight segment.

About 180 participants were attracted including governmental officials (National Land Authority, Ministry of National Developments, Ministry of Public Administration and Justice, Central Statistical Office) market actors (innovators, developers, service providers, users), from NGOs, Universities and Colleges, representatives of local governments and different application domains. Having internal conference in Budapest hosted by HUNAGI, some experts of the EU project on 'legal aspects of public sector information' (LAPSI) attended the conference as well.

*- **Gabor Remetey**, Secretary general of HUNAGI, the Hungarian GI Association*

Use of geospatial technologies for maritime security

This paper is an attempt to look at the use of modern technology and the traditional maps to secure maritime security

S S Pendse
Tolani College of Commerce, Mumbai, India

Mumbai, the commercial and financial capital of India has seen two major terrorist attacks in last two decades; once in 1993, when Mumbai rocked in a series of blast and second time in November 2008 when Mumbai faced a fidayeen attack where less than a dozen terrorists held the city at ransom for almost 60 hours. On both the occasions, sea was used to land the arms, ammunitions and men. The scale and magnitude of both these attacks have left us awestruck and wondering about how far we and our city and our security agencies are prepared to face this type of horrendous acts of terror.

The question that arises is what made it possible for the terrorists to make such a successful attack on our city? There are a series of reasons.

In November 2006, the Union Ministry of Home Affairs had alerted security agencies that Indian nuclear power plants were highly vulnerable to terrorist attack. It was also mentioned that some LeT operatives were being specifically trained for sabotage of oil installations and these militants could use sea-routes to infiltrate into India. This statement was based on intelligence outputs. It was also added that the terrorists "planned to induct arms and ammunition through the sea-route. Other than the installations of oil and natural gas, establishments like those of, defense, communications and IT sector were also equally vulnerable." In spite of such reports from security agencies, we have failed to foil such eventualities and protect ourselves. We failed to act on time. What were the reasons?

Lack of clear maritime policy

Forming a maritime policy involves coordination amongst 8 coastal states and 4 Union territories other than these 12 ministries and 8 departments of the Central Government. This results in delays, lack of understanding the gravity of the need of such policy, inability to provide integrated quick decisions and responses. This framing of a maritime policy is lost in the bureaucratic labyrinth.

Involvement of multiple agencies

Multiple agencies have been entrusted with the responsibility of guarding our maritime borders. These include the Navy, Cost Guard, State Police, and DG Shipping, further ads to the problem. Each has its own areas of jurisdiction, authorities, inadequate resources, training and manpower. For e.g The Navy and Coast Guard are authorized to stop or detail a vessel within territorial waters/contiguous zone if she is suspected of smuggling/fiscal violations. The Coast Guard's western region, which polices the sensitive 3,300 kilometer coastline between Gujarat and Kerala, has a fleet

Maritime Statistics of India

Total Length of Coastline	:	7516 Kms
Mainland	:	5422 Kms
Lakshadweep Islands	:	132 Kms.
A & N Islands	:	1962 Kms.
Island Territories	:	1197 Kms.
Off West Coast Mainland	:	447 km.
Off East Coast Mainland	:	151 Kms
Maritime Jurisdiction	:	UNCLOS Ratification dated 29 June 1995
Territorial Waters	:	45,450 sq nm/155,889 sq km.
Extent of EEZ	:	587,600 sq nm/20,13,410 sq km.
Deep Sea Mining Area	:	150,000 sq km, Pioneer Investor – 1987, Posn – 180 Cape Comorin 1080 nm Antarctica Dakshin Gangotri – 1983, Maitri – 1989

of just 14 ships of various sizes and eight surveillance aircraft, where as the actual need is of at least 50 ships and 36 aircraft.

The state police machinery is not yet clear on their coastal jurisdiction and its role in maintaining the security along the coast under their control. Secondly police stations along the coast are understaffed and underequipped.

Intelligence failure

Another major gap is the failure of intelligence agencies and the police. Multiple agencies further cause problems. Research and Analysis Wing (RAW), is in charge of external intelligence, the Intelligence Bureau (IB), which is supposed to gather intelligence relating to internal security, and Central Bureau of Investigation (CBI), its premier investigation agency. Then there is the National Technical Research Organization (NTRO), which collects technical intelligence from satellites and unmanned aerial vehicles (UAV). Besides, there are the intelligence units of the police, the armed forces and so on.

The question is co-ordination among these agencies and possibly to some extent interdepartmental rivalry which leads to complications.

Apathy of states

The state government of Maharashtra received 44 million INR in 1995 for four patrol boats. Boats were constructed but not used for surveillance due to the State Government's unwillingness to bear the costs of operation and maintenance. In May 2006, the boats were declared un-seaworthy. Similar cases have been reported in other states e.g. Karnataka received INR 22 million for two patrol boats in between 1994-95 and 1996-97, Kerala received INR 63 million for six boats, The boats were, however, not used for the intended purpose and, in February 2006, Tamil Nadu spent INR 45 millions to construct five patrol boats, which were lying un-utilized at the Chennai harbor, Andhra Pradesh acquired "Sagar Rakshak-I and II" for surveillance of its coast, spending INR 18 million, INR 18 million was given to Orissa in three phases between 1993-94 and 2006, West Bengal received INR 36 million for four patrol boats All the State Governments did not effectively use any of these financial resources citing lack of funds for operations and maintenance or never put the boasts into operations.

Coastal security schemes

In 1993, the Union Government approved a three layered coastal security scheme called Operation Swan. It involved 1) joint patrolling along the most vulnerable coasts of Maharashtra and Gujarat by the Navy, State Police and Customs Forces.2) Setting up 73 Coastal Police Stations, 97 check-posts, 58 outposts and 30 barracks, with the cost to be borne by the omnibus Coastal Security Scheme. 3) Financing security support to littoral states by the Centre.

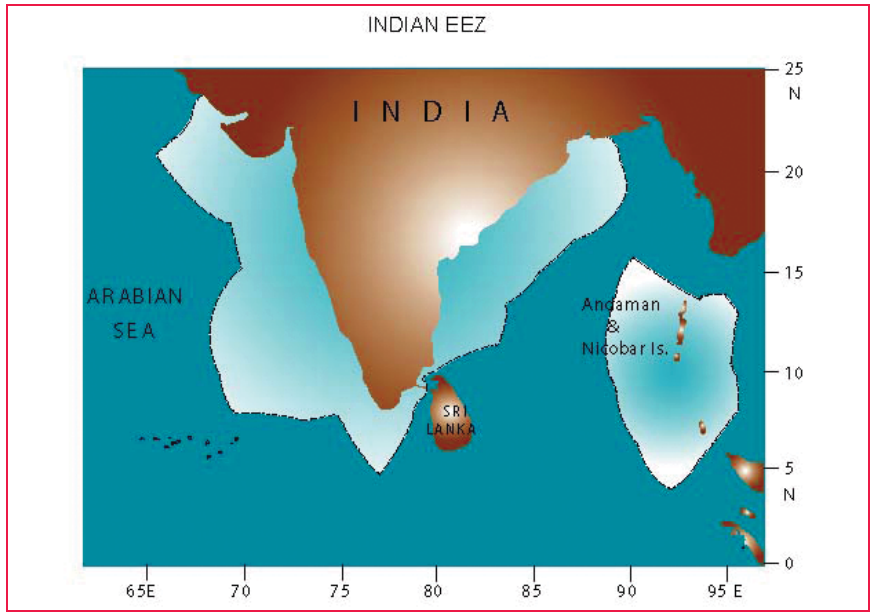
The central government formed another plan for coastal security for nine coastal States in 2005-06. After three years of the scheme, the Union Ministry of Home Affairs (MHA), in its review in January 2008, found that only 47 out of 73 sanctioned coastal police stations were operational. The core issue in the implementation of the Coastal Security Scheme" – was yet to start, due to the unavailability of boats (204 were sanctioned).

26/11 happened in spite of this multi-layered coastal security mechanism. Lack of 'actionable' intelligence has been widely attributed as the main reason for this failure. But there are certain inherent inadequacies in the coastal security mechanism, making it incapable of preventing infiltration through the coast. These deficiencies are:

- Insufficient Manpower
- Poor Training
- Inadequate Infrastructure and Equipment
- Insufficient Resources
- Systemic Flaws.

There are certain sensitive issues that also need to be looked into. These terrorist although equipped with satellite phones also had detailed maps of their targets which would not have been possible without local help.

Now the questions that arise is what is to be done. After 26/11 exposed such gaps in coastal security, the Union Government, on February 28, 2009, designated the Navy as the central authority responsible for the country's overall maritime security. "The Navy will be assisted by Coast Guard, State Marine Police and Central agencies for the coastal defense of the nation," Joint Operation Centers are to be set up at Mumbai, Visakhapatnam,



Exclusive Economic Zone of India (Source: www.niobioinformatics.in)

Kochi and Port Blair under the charge of Naval commanders-in-chief.

Use of geospatial technologies for maritime security

Maritime security has become a major concern for all coastal nations. A number of issues and questions emerged regarding our perception, preparation, mitigation and gaps in any maritime threat. To secure our maritime security we need to effectively use human intelligence and artificial intelligence. This supplemented by Topographic Maps, Hydrographic Charts as well as geospatial technologies like the GIS, Satellite imageries and Digital mapping, will go a long way to achieve this goal.

Artificial intelligence

To acquire artificial intelligence it is necessary that it has to be supplemented with the benefits and advances of information technology. These include GIS, GPS, Digital Mapping, Remote Sensing etc. which can be effectively used for planning and actual tactical deployment during such a disaster.

There are three basic steps in this process will include 1) Identification and gathering of information of sites susceptible to attack 2) Having a unified central command fully supplemented by C4ISTAR and 3) Coastal Surveillance.

First step towards preparedness includes:

- Identification of facilities and operations susceptible to attack.
- Identification of critical infrastructure like telecommunications; electrical power systems; oil and gas production, storage and distribution; banking and finance; water supply systems; emergency services.
- Accurate employment data tied to specific locations.
- Detailed and current "framework" data, including transportation, elevation, political boundaries, property ownership.

The second step will include development of a central command. The lack of a central command to respond in case of terrorist attack on Mumbai was a major lacuna during the operations in 2008. The C4ISTAR *Command, Control, Communications, Computers, Intelligence, Surveillance, Target Acquisition and Reconnaissance* would have been of a tremendous help.

The security agencies need to work with digital battlefield environment of today. They also need to effectively use the Geospatial information, based on intelligent digital maps and Geospatial data, enabling them to make effective command and control decisions in the field. Thus existing Geospatial data and technology at the defense forces, provides the very foundation for a unified C4ISTAR. The use of GIS and Remote Sensing can be effectively for used strategic planning and for actual tactical deployment during a disaster.

The third step is coastal surveillance. For an effective surveillance it is necessary to have maritime domain awareness and a Command and Control of maritime forces. The fundamental requirement is maritime domain awareness via identification, tracking and monitoring of vessels within their waters with help of technologies such as AIS. The AIS or the Automatic Identification System was developed as an advanced tool to assist navigation; this is an efficient tool to exchange positioning data among participating naval units and land control centers.

High resolution Satellite Imageries, Aerial Photography and LIDAR, incorporated with GIS mapping applications can be an effective tool to guard our coasts. Coastal surveillance systems must provide a means of detecting unknown vessels, allowing them to be identified and monitored, as well as providing 'Command and Control' to permit direction and interception. A combination of high performance coastal surveillance radar with sophisticated signal processing and powerful trackers and the radar output combined with AIS network, Patrol Boat Transponder system, and small craft/fishing vessel 'Electronic Passport' transponder tracks. The data thus gathered and analyzed could be sent to command centre via communication network and then relayed to the patrol vessels for necessary interception and action.

The development and advances in Digital mapping / Geographic Information System (GIS), and Information Technology have come up as effective tools in coastal security. But the capabilities of human intelligence cannot be undermined. It is only when man and technology come together they can make a difference to guard our country from any such incidences in future.

Human intelligence

Presently the coastal security can be categorized into five layers. These layers include the Fishing Co-operatives to Customs Department, Local Police, Coast Guard and finally the Indian Navy.

The Fishing Co-operatives can form the base for collecting the basic data on the number of boats, their registration and most importantly boat owners profiles. The societies issues papers to the boats and their crew which has to be countersigned by the Customs department for an entire season, but this is hardly implemented. The movement of the boats also can be monitored as these societies provide the required diesel to the boats every time the boats go out. Thus the society gets to know the movement. This in itself is a major source of information. Further the existence of VHF wireless and the GPS on board almost all the boats also aid in tracking the movement of the boats. If this communication is linked up with local police it will be of tremendous help. Fishing Co-operatives can be made use of as it is these people who can help to identify a foreign vessel from that of local.

- The local police are understaffed, undertrained and just do not have the necessary equipment thus have their own limitations. They are not geared to tackle any eventualities of coastal security. Presently police stations have copies of boats and photo passes, and, being local, can form an effective network for gathering intelligence. The police lack maritime training. Most policemen deployed on these duties are predominantly landlubbers with no exposure to sea training.
- The local people and fishing communities can become a major source for gathering intelligence and help in

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Galileo update

Septentrio and QinetiQ partnership delivers first Galileo PRS signal reception

Septentrio and QinetiQ, working in close partnership with the European Space Agency (ESA) and their industrial partners, achieved the world's first successful reception of the encrypted Galileo Public Regulated Service (PRS) signal from the first Galileo satellites (launched in November 2011).

The signal was received on the Galileo PRS Test User Receiver (PRS-TUR) jointly developed by Septentrio and QinetiQ under an ESA contract. For the reception test, the receiver was installed in the Galileo Control Centre in Fucino, Italy and operated by technical experts from ESA.

From the lecture hall to the board room

The University Challenge - part of the European Satellite Navigation Competition (ESNC) 2012 - invites students and research assistants from any field of study to show off their innovative business ideas. These ideas can propose new potential uses for satellite navigation in virtually any area - from logistics and healthcare all the way to mobile apps. The ESNC has been searching for the best application ideas for GNSS such as GPS or Galileo every year since 2004. To bridge the gap present in this field between the worlds of academia and business, the University Challenge was introduced as a new special prize category in the 2010 iteration of the competition. The winner of the ESNC University Challenge will receive EUR 1,000 through the FP7 project GENIUS (GNSS Education Network for Industry and Universities). *www.galileo-masters.eu*

Galileo passes in-orbit signal test

The first two in-orbit validation vehicles (IOV) in Europe's Galileo satellite navigation system have passed key tests. Spaceopal, the joint venture managing the mission confirmed that the encrypted signals that will provide Galileo's Public Regulated Service, have been received and validated, a key stage in the verification of the hardware design and services. *www.flightglobal.com*

UK Satellite Navigation Competition launched

A competition to find innovative every day applications for satellite navigation data has been launched. The European Satellite Navigation Competition (ENSC) wants entrants to come up with new ideas for satellite navigation data in technologies like smartphone applications and location-based services.

The ENSC aims to commercialise the new ideas and drive growth in the fast-growing space sector, which the government predicts could become a GBP 40bn industry by 2030, generating up to 100,000 new hi-tech jobs. *http://eandt.theiet.org*

monitoring any suspicious movements of men and material. It is these local people who will provide with the required human intelligence and can identify an outsider. They need to be trained to use communication facilities to inform law enforcement agencies. The fishing co-operatives, local police and custom posts if work together, can go a long way in helping to provide coastal security.

- If this existing system is used effectively with proper co-ordination it might as well be an effective deterrent for any further attempts from the sea.
- With all said and done it is necessary to realize the fact that there are still marked flaws in our system. First and the foremost here is a need of strong political will to do something concrete. Secondly a strong and clear maritime policy (strategy), with clear-cut designation of duties and roles to be played by the respective agencies. There is also an urgent need to adequately equip and train the concerned staff. A network of local police, Fishing Co-operatives and Customs needs to be built up to gather intelligence and last but not the least co-ordination between intelligence agencies and the law enforcers.
- In other words to maintain our coastal security we need focus on WATCH i.e. Wherewithal (Resources), Attitudes, Technology, Coordination, Human resources.

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$10 bln budgeted for Glonass to 2020

More than 300 billion rubles ($10.1 billion) have been budgeted to the year 2020 for developing the Glonass satellite navigation system, Deputy Prime Minister Vladislav Surkov said recently. He said the government will make every effort to lend support to the satellite system and to develop its capabilities, including commercial ones, Interfax reported. He said Russia estimates that the navigation market in Russia was worth 12 billion rubles last year. *www.themoscowtimes.com*

New sensor sought to enable military missions in GPS-denied areas

Many U.S. Military systems, such as missiles, rely on the GPS to provide accurate position, orientation and time information while in flight. When GPS is inaccessible, information critical for navigation must be gathered using the missile's on-board sensors. DARPA's Chip-Scale Combinatorial Atomic Navigator (C-SCAN) effort seeks an atomic inertial sensor to measure orientation in GPS-denied environments. Such a sensor would integrate small size, low power consumption, high resolution of motion detection and a fast start up time into a single package. "Platforms such as missiles rely on GPS for a variety of information," explained Andrei Shkel, DARPA program manager. "When GPS is not available gyroscopes provide orientation, accelerometers provide position and oscillators provide timing. The new C-SCAN effort focuses on replacing bulky gyroscopes with a new inertial measurement unit (IMU) that is smaller, less expensive due to foundry fabrication and yields better performance." *www.darpa.mil*

Raytheon and Lockheed Martin complete integration milestone

Raytheon and Lockheed Martin successfully completed the first significant integration milestone between Raytheon's GPS Next Generation Operational Control System (OCX) and Lockheed Martin's GPS III satellite system. The joint Lockheed Martin/Raytheon team successfully exchanged satellite commands and telemetry data between the GPS III satellite simulator in Newtown, Pa., and the OCX development site in Aurora, Colo. The integration of the two sites will facilitate development testing of the OCX system and allow early risk reduction testing of the ground-satellite interface in a test-like-you-fly configuration. *www.marketwatch.com*

£6 million for UK space technology industry

As part of the National Space Technology Programme, the UK Government will grant nearly GBP 6 million to co-fund major new research projects that will develop commercial products and services using space technology and data from space-based systems. The grant funding, from the UK Space Agency and the Technology Strategy Board, will support four major research and development consortium projects. *www.bis.gov.uk*

Mumbai, India to use GPS to keep track of city's trees

BMC's Tree Authority is finally catching up with technology: it has decided to use GPS to keep a track of all trees in the city and its suburbs. The civic body hopes that once all trees in the city are identified through their GPS locations, it will become to easier to track their growth and identify if any have been illegally chopped. *www.mumbaimirror.com*

'Navipedia': the reference for satellite navigation know-how

Satellite navigation is progressing swiftly, in fact so swiftly that its printed textbooks can't keep pace – so ESA has introduced its own wiki-based information source, Navipedia, which is also the first ever ESA technical wiki opened to the public. With ESA preparing to launch its next Galileo satellites, ground-based augmentation expanding rapidly, all other Global Navigation Satellite Systems (GNSS) evolving and new satnav applications emerging every day, this website's launch comes at the right time. Written and reviewed by experts, there are more than 400 articles on the site to date covering the fundamental principles of satellite navigation, how receivers operate, the various systems in current or future operation around the globe and GNSS-related services and applications. *www.esa.int*

GNSS receive front-end modules by Infineon

Infineon Technologies has introduced a new series of Receive Front-End Modules for implementation of GNSS functionality in smart phones and other handheld devices. The new BGM104xN7 products feature the best noise figure in the industry, which is a critical parameter for the performance of a GNSS receiver. The new modules are a pin-to-pin compatible upgrade with the previous generation BGM103xN7, and thus remain as the world's smallest Receive Front-End Modules for this application, with a package size of just 2.3 x 1.7 x 0.73 mm3. *www.infineon.com.*

Delhi's cars no faster than pedestrians

New research shows that for 20% of their running time - 12 minutes every hour - Delhi's cars are no faster than pedestrians. An ongoing pilot study by the research group UrbanEmissions.info has found that a fifth of a car's traffic time is spent idling or crawling at less than 4 kmph due to heavy congestion on roads and too many signals. For the study, IIT students equipped with GPS devices drive across the NCR at different hours to collect speed data. So far, they have logged 120 hours on the road travelling to Noida, Greater Noida, Gurgaon, Dwarka and across South Delhi. The plan is to collect data for around 1,000 hours of motoring. *www.timesofindia.com*

RFID market USD 70 bn by 2017

According to ABI research report, the market for radio frequency identification (RFID) transponders, readers, software and services will generate USD 70.5 billion from 2012 to the end of 2017. The market was boosted by a growth of USD 900 million in 2011 and the market is expected to grow 20 percent YOY per annum. Government, retail, and transportation and logistics have been identified as the most valuable sectors, accounting for 60 percent of accumulated revenue over the next five years. *www.abiresearch.com*

Consumers in Asia eager to adopt location-based services

For marketers looking to leverage mobile's popularity, location-based services (LBS) are their best bet, according to TNS. The insights firm's 'Mobile Life Study' found that more than 60 per cent of mobile-phone users worldwide who don't yet use LBS said they want to. TNS' annual Mobile Life study explored mobile use among 48,000 people in 58 countries. The study showed that the majority of people around the world recognize the value of sharing their location to benefit from a range of services. Globally, almost 30 per cent of the world's 6 billion people are using smartphones, and in developed Asia-Pacific countries (which includes Japan, Korea, Australia, Singapore, Taiwan, Malaysia and New Zealand), this figure climbs to over 42 per cent. *www.campaignasia.com*

Integrating location-based intelligence with IVR

Voxeo has taken the mobile customer experience one step farther by incorporating LBS into its interactive voice response (IVR) platform for voice, text and mobile web interactions. It identifies a caller's exact location, making it easier, safer and more convenient than ever for mobile customers to access location-based information and services, such as finding a retailer's nearest store, obtaining traffic information or requesting roadside assistance without entering a location or downloading an app. *www.voxeo.com*

URA, Singapore considering satellite solution for its car parks

The Urban Redevelopment Authority (URA) is exploring the feasibility of using the GNSS enhance planning and management of its car parks. The authority administers about 46,000 lots in Singapore. The URA is also exploring the use of this system to accurately locate vehicles when they are stationary in a parking lot. It may help facilitate automated collection of parking charges and reduce or eliminate the need for enforcement in these car parks. *www.todayonline.com*

New Satellite Tracking Device

NexTraq GPS asset tracking device works solely with satellite technology and is not dependent on any mobile network, enabling NexTraq customers to affordably track anything, anywhere. For assets located in remote locations, such as oil fields, barges and rural areas, satellite tracking is the most advanced technology available. *www.nextraq.com*

3D navigator by MapmyIndia

MapmyIndia have combined handheld navigator with 3D technology and launched Zx250. This device offers an augmented reality-like experience with full 3D landmarks, 3D buildings and 3D elevation across hills and mountains, apart from the regular features. It will also have the latest MapmyIndia Maps v7.0. *www.zigwheels.com*

S Korea pushes for radioactive source-tracking system in Vietnam

South Korea is pushing a pilot project to install a radioactive source-tracking system in Vietnam as a measure to ensure nuclear security. South Korea, the International Atomic Energy Agency (IAEA), and Vietnam agreed to introducing the Radiation Source Location Tracking (RADLOT) system in the Southeast Asian country, the event's Preparatory Secretariat said. The RADLOT, developed by the Korea Institute of Nuclear Safety, is capable of tracking radioactive sources in real time through GPS satellite signals and mobile telecommunication networks, according to the secretariat. The state-run nuclear safety regulator currently uses the system to track nearly 1,400 radioactive sources in the country. *http://english.yonhapnews.co.kr*

u-blox launches GLONASS/GPS/QZSS positioning module

u-blox has released LEA-6N. It is a low-power, cost-effective module delivers fast, high-accuracy positioning and is targeted at industrial telematics applications in Russia such as vehicle tracking, mobile resource management and the ERA-GLONASS emergency call system. The module works with GPS, Russian GLONASS, and Japanese QZSS satellite positioning systems. It also supports all civilian Satellite Based Augmentation Systems (SBAS). *www.u-blox.com*

New iPad, iPhone app helps mariners avoid endangered right whales

For the first time, mariners operating along the U.S. east coast can receive a visual display of all relevant right whale management initiatives and warnings via their iPad or iPhone, including Seasonal and Dynamic Management Areas, Mandatory Ship Reporting areas, recommended routes, and automatic whale alerts triggered by acoustic detection buoys. A GPS system in the iPad shows the ship's location relative to the management measures, simplifying mariner compliance. Clicking on a screen or icon activates a pop-up window with additional information.

Delhi, Mumbai traffic updates to be on Nokia smartphones

Nokia has added a new feature to its location-based services, enabling its smartphone users in Delhi and Mumbai, India to get real-time traffic updates in their cities. "Powered by NAVTEQ Traffic Pro, the 'traffic feature' will offer users detailed information on traffic speeds on motorways, main and secondary roads and enable users to plan their travel and save time and fuel and frustration *www.business-standard.com*

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GPS

GLONASS

GALILEO

QZSS

N° of GNSS Signals	Number of channels	13	17	21	26	30	34	38	42
1	GPS L1 (including SBAS)	✓	✓	✓	-	-	-	-	-
	GLONASS G1	✓	✓	✓	-	-	-	-	-
	Galileo E1	✓	✓	✓	-	-	-	-	-
2	GPS L1 (incl. SBAS)+ QZSS L1	✓	✓	✓	-	-	-	-	-
	GLONASS G1 + QZSS L1	✓	✓	✓	-	-	-	-	-
	Galileo E1 + QZSS L1	✓	✓	✓	-	-	-	-	-
	GPS L1 (SBAS) + GLONASS G1	✓	✓	✓	✓	✓	✓	✓	✓
	GPS L1 (SBAS) + Galileo E1	✓	✓	✓	✓	✓	✓	✓	✓
	Galileo E1 + GLONASS G1	✓	✓	✓	✓	✓	✓	✓	✓
3	GPS L1 (SBAS) + GLONASS G1 + QZSS L1	✓	✓	✓	✓	✓	✓	✓	✓
	GPS L1 (SBAS) + Galileo E1 + QZSS L1	✓	✓	✓	✓	✓	✓	✓	✓
	Galileo E1 + GLONASS G1 + QZSS L1	✓	✓	✓	✓	✓	✓	✓	✓
	GPS L1 (SBAS) + GLONASS G1 + Galileo E1	✓	✓	✓	✓	✓	✓	✓	✓
4	GPS L1 + GLONASS G1 + Galileo E1 + QZSS L1	✓	✓	✓	✓	✓	✓	✓	✓

- Supporting all global, regional and augmentation satellite navigation systems. Software licensable GNSS capabilities at any time.
- Available from 13 to 42 RF signal channels. Scalable performance growing smoothly with your needs.
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Geostellar teams with GeoEye

GeoEye has announced a strategic relationship with Geostellar, an innovative technology company that is transforming the solar energy industry to supply Earth imagery, digital surface models and other mapping data to help Geostellar dramatically expand its service. Geostellar has built a breakthrough analytics platform that automatically determines how quickly a given property owner can recoup an investment in solar energy. It has built solar maps in Washington D.C., Boston, Indianapolis, Philadelphia, Pittsburgh and New Jersey, where government agencies have made aerial imagery freely available. *http://geoeye.mediaroom.com*

RISAT-1 satellite launch a "grand success": ISRO

The PSLV-C19, the newest in the series of polar satellite launch vehicles of the Indian Space Research Organisation (ISRO), burst off the launch-pads of Sriharikota in the wee hours of April 26, 2012 on its space mission of placing indigenously developed Radar Imaging Satellite the RISAT-1 in a polar circular orbit.

The RISAT- is a state-of-the-art Active Microwave Remote Sensing Satellite carrying a Synthetic Aperture Radar (SAR) payload that will operate in the C-band. It can beam back imaging of the earth surface features during day and night and under all imagined weather conditions. The SAR which gives the RISAT-1 its magic lens also makes it superior to the generation of optical remote sensing satellites in terms of clearer imaging at all times and under any condition. The satellite's applications will range across agriculture and management of natural disasters like flood and cyclone and could greatly assist food security planning in India. *www.thehindu.com*

China to help Pakistan to install Remote Sensing Satellite

China is all set to help establish Pakistan Remote Sensing Satellite in Islamabad, Karachi, Lahore and Rawalpindi after playing pivotal role in launching Pakistan satellite-1R on August 12, 2011. The cost of project has been worked out at Rs 19.695 billion. *http://pakobserver.net*

Astrium and PASCO continue their long-term collaboration

PASCO Corporation and Astrium GEO-Information Services reinstate their long-term collaboration with the extension of the licence and maintenance contract for the three Pixel Factory™ systems owned by the company. These systems allow PASCO to produce high-end cartographic databases based on their own aerial sensors as well as on several satellite sensors, including ALOS. *www.pasco.co.jp*

DMCii's detailed satellite imagery helps Brazil stamp out deforestation

DMC International Imaging Ltd (DMCii) has signed a contract with Brazil's National Institute for Space Research (INPE) to deliver near real-time satellite imagery to monitor forest clearing in the Amazon rainforest and target illegal logging as it happens. INPE's groundbreaking DETER service uses regular satellite images to detect forest clearance as it happens – rather than surveying the damage afterwards – guiding Brazil's enforcement officers to provide effective forest clearing control. *www.dmcii.com*

Report urges lifting some satellite export controls

Officials from the Defense and State departments in USA released a report that urges Congress to move communications and some remote-sensing satellites off the tightly controlled U.S. Munitions List and into the commercial enterprise. The report summarizes a risk assessment of U.S. space export control policy, concluding that most commercial communications and remote sensing satellites and their components can be moved from the USML to the CCL without harming national security. The items include communications satellites that contain no classified components, and remote-sensing satellites with performance parameters below certain thresholds. *www.defense.gov*

DigitalGlobe unveils new details of worldview-3 satellite

DigitalGlobe has unveiled unique capabilities of its WorldView-3 satellite, slated for launch in mid-2014. WorldView-3 will extend the already industry-leading capabilities of DigitalGlobe's commercial imaging constellation, which today is comprised of QuickBird, WorldView-1 and WorldView-2. *http://investor.digitalglobe.com*

ISRO to launch French remote sensing satellite

The Indian Space Research Organisation (ISRO) will launch a French advanced remote sensing satellite in a few months. Sources said Isro's commercial arm, Antrix Corporation, signed a Rs 100 crore deal to launch the 800kg satellite, SPOT 6, built by Astrium SAS, a subsidiary of France's EADS. It will be launched by Isro's polar satellite launch vehicle (PSLV). *http://articles.timesofindia.indiatimes.com*

China makes public satellite data products

The State Oceanic Administration (SOA) on gave the public access to data products of the oceanic surveying satellite Haiyang-2, which monitors maritime environment and extreme weather. The satellite provides services for oceanic disaster prevention and relief, resources exploitation, environmental protection, oceanic research, as well as safeguarding oceanic rights, according to the SOA. *http://news.xinhuanet.com/english*

U.S. Army Geospatial Center releases "HyDRA" smart device app

The U.S. Army Geospatial Center (AGC) and Engineer Research and Development Center recently released the Hydrologic Data Resources Application (HyDRA) - a Web-based data survey and analysis tool created to provide the Dept. of Defense (DoD) logistics and geospatial intelligence-related water communities with information on water resources data collection, visualization and dissemination in a mobile, enterprise-enabled environment. HyDRA allows users to view, collect and edit unclassified water resources features via Android 2.2+ OS smart devices using Google MapsTM and Google EarthTM applications. *www.agc.army.mil*

E&Y to prepare GIS based data system for Indian mineral sector

India's Mines Ministry has mandated advisory firm Ernst & Young (E&Y) to prepare the detailed project report (DPR) for an online computerised Mining Tenement System (MTS), to bring the functions of the directorates of mining and geology (DMGs) of 11 provinces, the Indian Bureau of Mines (IBM), the Geological Survey of India (GSI) and the Mines Ministry, onto a single web-enabled platform with database server. The MTS would have GIS database with geospatial data as well as a registry component database with attribute data.The GIS component will be based on village cadastral maps of 1:4000 scale and the registry component database on an appropriate database platform. *http://www.miningweekly.com*

Bentley Descartes V8i

Bentley Systems has released Descartes V8*i* (SELECTseries 3) – 3D modeling that combines point clouds, raster imagery, and geometry. The resulting models expand the utility of point clouds by supporting hybrid design workflows that deliver "as-operated" 3D models to serve the operations and maintenance needs of owner-operators. Bentley set the stage for this innovation by incorporating scalable terrain models (STMs) and, soon after, point clouds as fundamental data types across its information modeling applications and engineering information management services. *www.bentley.com/descartesAIM*

Drone completes military mapping mission in NW China

An unmanned Chinese military drone recently completed its first digital mapping mission near north China's Helan mountain, capturing high-definition imaging data during more than five consecutive hours of aerial photography. The success of the mission marks the Chinese military's creation of a drone-based emergency mapping support mechanism in north China, said Zhang Zhiyuan, the mission's field commander. *http://english.eastday.com*

Esri ArcGIS app for Kindle Fire

Esri users can now access ArcGIS data and mapping capabilities on Kindle Fire. It is also available on iOS devices, Windows Phones, and other Android devices, letting users access, edit, and share maps. The free app can be downloaded directly from the Amazon Appstore. *www.esri.com*

Open government data plan of Government of Canada

The Government of Canada has announced its Open Government Action Plan. The fundamental principle is the issuing of a government-wide directive that will make government information and data available to the public by default. The pilot Open Data Portal now has a total of over 272,000 data sets including geospatial data from 20 organizations. *http://geospatial.blogs.com*

Efkon India to invest Rs 100 crore in the next 4–5 years

Efkon India will invest more than Rs 100 crore in the domestic urban transportation and highways tolling business over the next four to five years, company announced recently. It offers solutions for the transportation market including toll collection systems and services, holds about 50% market share in the segment. It operates two toll plazas on the Bangalore and Vijaywada highways. While toll system equipment and services make up the bulk of the company's revenues, logistics management, GIS mapping and vehicle tracking system contribute 10%-15%. *http://articles.economictimes.indiatimes.com*

Boeing releases geospatial data management tool

Boeing released DataMaster 5.1, an advanced version of its geospatial data tool that offers defence and intelligence community customers improved map, terrain and full-motion video management. Some of its features include: - Enhanced support for maps, imagery and terrain, including National Geospatial-Intelligence Agency Raster Product Format and Digital Terrain Elevation Data,- Enhanced video text tagging for improved exploitation, management and retrieval of video, - The addition of a content manager for better control of the situational awareness (SA) view, which provides the user with a 3-D geospatial display of the collection, and - Expanded compatibility with Windows 7, RHEL 5 64-bit and Solaris 64-bit operating systems. *http://boeing.mediaroom.com*

GIS based online disease surveillance system in India

The prototype of a Web-based application, which helps online tracking of communicable diseases such as swine flu and dengue at the level of primary health centres (PHCs) and provides the analytics to evolve emergency response and long-term epidemiological strategy, will be launched this month in Tiruvallur. The GIS application developed by a team at the unit of Environmental Health and Biotechnology, Loyola College, provides field staff and clinicians unique IDs and passwords for reporting disease using smart phones, basic mobiles or internet-enabled computers. *www.thehindu.com*

Intergraph® SmartPlant® P&ID ISO 15926 Export Utility

Intergraph® has released its SmartPlant® P&ID ISO 15926 Export Utility, a commercially available solution to support interfaces based on the ISO-based data exchange. It offers data exchange benefits between the process design schematics

and the 3D physical design for engineering companies, as well as facility owners. This allows piping and instrumentation diagrams (P&IDs) to be exported in the ISO 15926 format, which means data as well as graphical content can be exchanged with other ISO-compliant plant design and information management solutions. *www.intergraph.com*

NBN Co selects G NAF for accurate address information

NBN Co have entered into an agreement pursuant to which NBN Co will use Australia's geocoded national address file, G NAF, for address information to support the planning, roll-out and operation of the national broadband network. Data by G NAF will be used to support NBN Co's business. Developed and managed by PSMA Australia, G NAF provides an authoritative geocoded record of more than 13.2 million physical addresses in Australia, with an average of more than 50,000 new addresses added every three months. *www.psma.com.au*

Annual utility spending on GIS tools and services $3.7 billion by 2017

Spatial data underlies everything an electric utility does. An intelligent power grid requires deep situational awareness of power generation, transmission, distribution, and customer assets in order to optimize performance and to meet reliability commitments. Land-based and street-level data, ownership/real estate, vegetation, network topology, GPS location data, census data, and many others forms of geospatial information are critical to the successful performance of the smart grid. According to a new report from Pike Research, utility spending on GIS services, software, and tools will increase steadily over the next five years, reaching $3.7 billion in 2017. *www.pikeresearch.com*

New TRiLOC™ GPS Locator for Autism and Alzheimer's

iLOC Technologies Inc. (iLOC) has announced the upcoming launch of TRiLOC™ GPS locator. It is a blend of cellular, GPS and Bluetooth 4.0 wireless technologies. Designed specifically to be wrist worn by individuals with special needs such as Autism Spectrum Disorder (ASD) and Alzheimer's disease, the TRiLOC™ GPS Locator can also be used by women in distress, lone workers, cruise ship & theme park patrons and many other applications. *www.iloctech.com*

Where in the world is e-learning?

A pilot project is underway to boost entrants into the spatial information industry and raise skill levels for technicians through greater use of e-learning in the vocational education and training sector. The project has been supported through co-investment of $100,000 from the Australian Government's National *VET* E-Learning Strategy, backing over $260,000 in industry funding and in-kind services."Surveying and geospatial technologies and services have been identified as the key to Australia's future productivity," says project director George Havakis. "However, there is a wide spread and serious skills shortage in all sectors of the industry at all technical levels, and with decreasing numbers of graduates from universities, this is expected to get worse. *www.cpsisc.com.au*

Log on to end illegal logging

In a bid to reduce illegal logging cases, Transparency International-Malaysia (TI-M) has come up with a user-friendly website for Malaysians to monitor rainforests and alert the authorities over suspicious activities. Its executive director Alan Kirupakaran said that the website would provide a platform for stakeholders to become efficient monitors and hoped it would become an effective measure to conserve forests in Malaysia. "I believe with the co-operation of the Malaysian Anti-Corruption Commission (MACC), using simple tools like the *Google* Earth Geospatial Technology (satellite, imagery, aerial photography and GIS 3D globe) will allow the public to become active participants in protecting our forests,".

Getmapping Launches Maps API

Getmapping has launched its own 'Maps API' which enables customers to introduce interactive maps to their websites, or web-based applications. It provides access to Getmapping's own hi-resolution aerial photography and high quality Ordnance Survey OpenData mapping, together with a comprehensive reverse geocoding service. *www.getmapping.com*

18-year-long national mapping project ends

An 18-year-long project to produce a new series of geological maps of New Zealand has just finished. Known as QMAP (Quarter million scale map), the project started in 1994 and has produced 21 geological maps covering all parts of New Zealand. The series replaces earlier maps, mostly made in the 1960s, and has brought many improvements in accuracy and interpretation, as well as a versatile range of digital map products. The series is a world-first example of a national geological mapping project conceived and implemented using GIS technology. *http://www.voxy.co.nz*

Government of India launches centre for crop forecast, drought assessment

The government of India has launched an integrated centre which will provide estimates of agricultural output and assess the drought situation in the country through latest technologies. The centre, in collaboration with *ISRO*, will also work towards preparing sub-district level drought assessment in the entire country. The Department of Agriculture and Cooperation prepares advance estimates of crop output through various technologies like remote sensing and *GIS*. The Indian Space Research Organisation (ISRO) through its programme the National Agriculture Drought Assessment and Monitoring System (NADAMS) provides data on drought assessment in various states during the monsoon season. *http://articles.economictimes.indiatimes.com*

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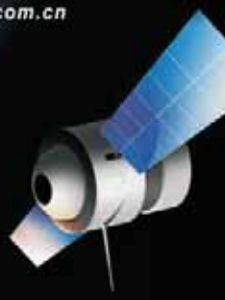

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Trimble Pro series GNSS receivers

Trimble has introduced Pro 6H and Pro 6T receivers for GIS and mobile mapping. It has advanced features that allow mobile workers to configure a solution for a wide range of applications, delivering unparalleled flexibility in professional GIS data collection. The series offers a new streamlined form-factor and dramatic productivity improvements in difficult GNSS environments with Trimble Floodlight™ technology. With its IP65 rating, the receivers offer reliable operation, even after prolonged exposure to water and dust. *www.trimble.com*

Trimble acquires Gatewing

Trimble has acquired privately-held Gatewing of Gent, Belgium, a provider of lightweight unmanned aerial vehicles (UAV) for photogrammetry and rapid terrain mapping applications. The acquisition broadens Trimble's industry-leading platforms for surveying solutions. The Gatewing business will be reported as part of Trimble's Engineering and Construction segment. *www.gatewing.com*

New Trimble® Business Center Software and Trimble Access

Trimble released Trimble® Business Center Software version 2.70 and Trimble Access™ software version 2012.10. The software is part of Trimble's portfolio of Connected Site® survey solutions. The new software enhancements allow surveyors to collect, share and deliver data faster to improve accuracy, efficiency and productivity. *www.trimble.com*

New Research about Locating Wireless 9-1-1 Calls

TruePosition, a provider of wireless location technologies and solutions and industry analyst firm Ovum has announced a new white paper that details the importance of locating indoor 9-1-1 phone calls, which are made from cell phones. The paper reviews the significance of an upcoming FCC ruling on indoor 9-1-1 location. Additionally, it offers an in-depth overview of previous 9-1-1 mandates. In an effort to further educate readers, the report describes the two main wireless location technologies – Assisted-GPS (A-GPS) and Uplink Time Difference of Arrival (U-TDOA) – and addresses some misconceptions about their performance. The white paper also reveals test results from testing conducted in Wilmington, Delaware, where both wireless location technologies were used to locate wireless 9-1-1 calls. *www.trueposition.com*

ProFlex 800 GNSS for positioning applications

Spectra Precision new ProFlex™ 800 is a powerful GNSS solution with revolutionary Z-Blade™ GNSS-centric technology. It delivers fast and reliable RTK positioning, even in environments where GNSS signals may be difficult to acquire. Rugged and IP67 rated, it is built to withstand harsh operating conditions for a variety of positioning applications. *www.ashtech.com*

Leica GeoMoS Web v2.2

Leica Geosystems releases an update of Leica GeoMoS Web, the web-based service for visualization and analysis of monitoring data via the Internet. It provides an advanced graphical representation of monitoring data along the transversal and longitudinal profiles, further enhancing the visualization and analysis capabilities. *www.leica-geosystems.com/monitoring*

GNSS receiver covers all multi-constellation standards

Designed for smart phones and other portable navigation devices, Broadcom's BCM4752 covers all of the multi-constellation standards. The third-generation receiver's new architecture provides the industry's first true multi-constellation support by simultaneously collecting GPS, GLONASS, QZSS, and satellite-based augmentation system (SBAS) data and using the best received signals, resulting in faster searches and more accurate real-time navigation. *www.broadcom.com*

NVS Technologies AG releases raw data output enabled Firmware

NVS Technologies AG has released the optimised & raw data output enabled Firmware v0204 for its NV08C-CSM and NV08C-MCM GPS/GLONASS Receivers.The Firmware provides significant performance improvements, as well as a group delay calibrated raw data (Carrier phase, Code phase & Doppler) output function, to the highly integrated NV08C-CSM SMT receiver module and NV08C-MCM BGA SiP receiver. The Firmware enables both the receivers to be utilised in a wide range high precision applications. *www.nvs-gnss.com*

Cambridge Pixel targets ECDIS digital navigation market

Cambridge Pixel has introduced its SPx-ECDIS radar kit. It will allow systems integrators building Windows-based Electronic Chart Display and Information Systems (ECDIS) for commercial ships to add radar interfacing, scan conversion, chart display, target tracking, a GPS interface and record/replay functionality into their ECDIS solutions. *www.cambridgepixel.com*

Thales to provide GPS receivers for French Navy Lynx Helicopters

Thales has been awarded a contract by the Service Industriel de l'Aéronautique (SIAé), France's military aircraft maintenance, repair and overhaul service, to supply stand-alone GPS receivers for the French Navy's Lynx helicopters. Thales's GNSS 1000-S receiver relies on SAASM (Selective Availability Anti-Spoofing Module) technology to access military GPS encrypted signals. This technology also uses state-of-the-art signal processing offering extended satellite tracking capabilities in terms of precision, integrity, availability and jamming resistance in severe operational conditions.

CHC releases the LT30 GPS/GIS handheld collector

CHC's new LT30 series enters the GIS data collection market with a cost-

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http://conf.ncku.edu.tw/mmt2013/intro01.htm

New Navigator Seminar 2012
14 June
The University of Nottingham, UK
http://rin.org.uk/events

20th International Conference on GeoInformatics
15-17 June
Hong Kong
http://old.nabble.com

Geospatial EXPO 2012
21-23 June
Yokohama, JAPAN
www.g-expo.jp/en/

July 2012

COM.Geo 2012
1-3 July
Washington DC, USA
www.com-geo.org/conferences/2012/index.htm

2012 Brisbane International Geospatial Forum
8 - 11 July 2012
Queensland, Brisbane, Australia
www.imtamaps.org/events/

ESA – International Summer School on Global Satellite Navigation Systems
16 – 26 July
Toulouse, France
www.munich-satellite-navigation-summerschool.org

Exploration and Mapping in Mining
17 - 19 July
Perth, Australia
www.explorationinmining.com

Survey Summit
21–24 July
San Diego, USA
www.surveysummit.com/index.html

ESRI International User Conference 2012
23-27 July
San Diego, USA
www.esri.com

August 2012

The XXII Congress of the ISPRS
25 August-1 September
Melbourne, Australia
www.isprs.org

September 2012

ION GNSS 2012
September 17-21, 2012
Nashville, Tennessee, USA
www.ion.org

October 2012

IAIN 14th Congress & Melaha 2012 Conference
1 – 3 October
Cairo, Egypt
www.ainegypt.org

INTERGEO 2012
9-11 October
Hanover, Germany
www.intergeo.de/en

19th United Nations Regional Cartographic Conference for Asia and the Pacific
29 October - 2 November
Bangkok, Thailand
http://unstats.un.org/unsd/geoinfo/RCC/unrccap19.html

November 2012

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

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

NAV12
26 - 29 November
Nottingham, UK
www.nav12.org.uk/

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

December 2012

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

February 2013

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

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

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

effective, rugged and connected GPS/GIS handheld collector for a wide range of applications such as natural resources, forestry, utilities, agriculture, emergency response. Designed for real outdoor conditions, LT30 combines superb brightness and crisp 3.7" full VGA sunlight readable display, all day battery life and a high-sensitivity 20-channel GPS receiver to capture data wherever you need. It is powered by Windows™ Mobile 6.1 Pro operating system. *www.chcnav.com*

Enhancements for GNSS NavX®-NCS Simulators

IFEN in partnership with WORK Microwave announced enhancements to the NavX®-NCS GNSS multi-frequency simulator. The NavX-NCS solution supports GPS, Galileo, GLONASS, and SBAS constellations, providing the leading GNSS signal capability for research and development of GNSS safety and professional applications, as well as system integration and production testing of mass market applications, such as automotive satellite navigation, mobile phone apps, chip-sets, and handheld personal navigation devices.

The NavX-NCS platform includes a two-year maintenance contract, the broadest range of frequencies and satellite navigation systems per chassis, as well as the flexibility for users to install software updates easily when they become available. *www.ifen.com*

ESA awards Atomic Clock contract to SpectraTime

SpectraTime has been awarded a €1-million contract to improve rubidium atomic frequency standards (RAFS) as part of the European Space Agency (ESA) GNSS Evolution Program. SpectraTime is the existing supplier of atomic clocks for the Galileo satellites and other GNSS systems, including China's Compass/BeiDou-2 program. *www.spectratime.com*

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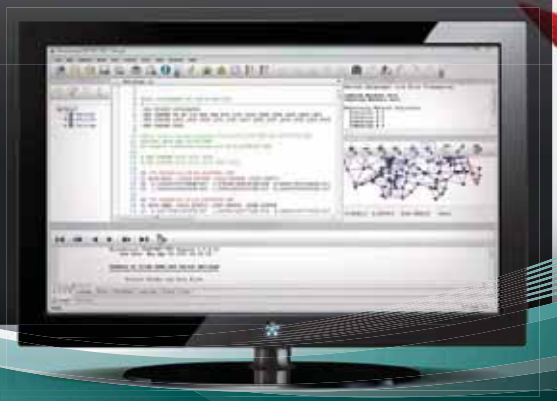

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Hunting treasure

I was having breakfast at Warren College, Sydney last November when Claus-Sebastian Wilkens from Institute of Aerospace Systems, Germany asked me if I was aware of 'geocaches'. Geocaches – what? I expressed my ignorance. He explained that Geocaching is a real-world outdoor treasure hunting game. Players try to locate hidden containers, called geocaches, using GPS-enabled devices and then share their experiences online (www.geocaching.com). I realized that this was something which is popular among GPS enthusiasts.

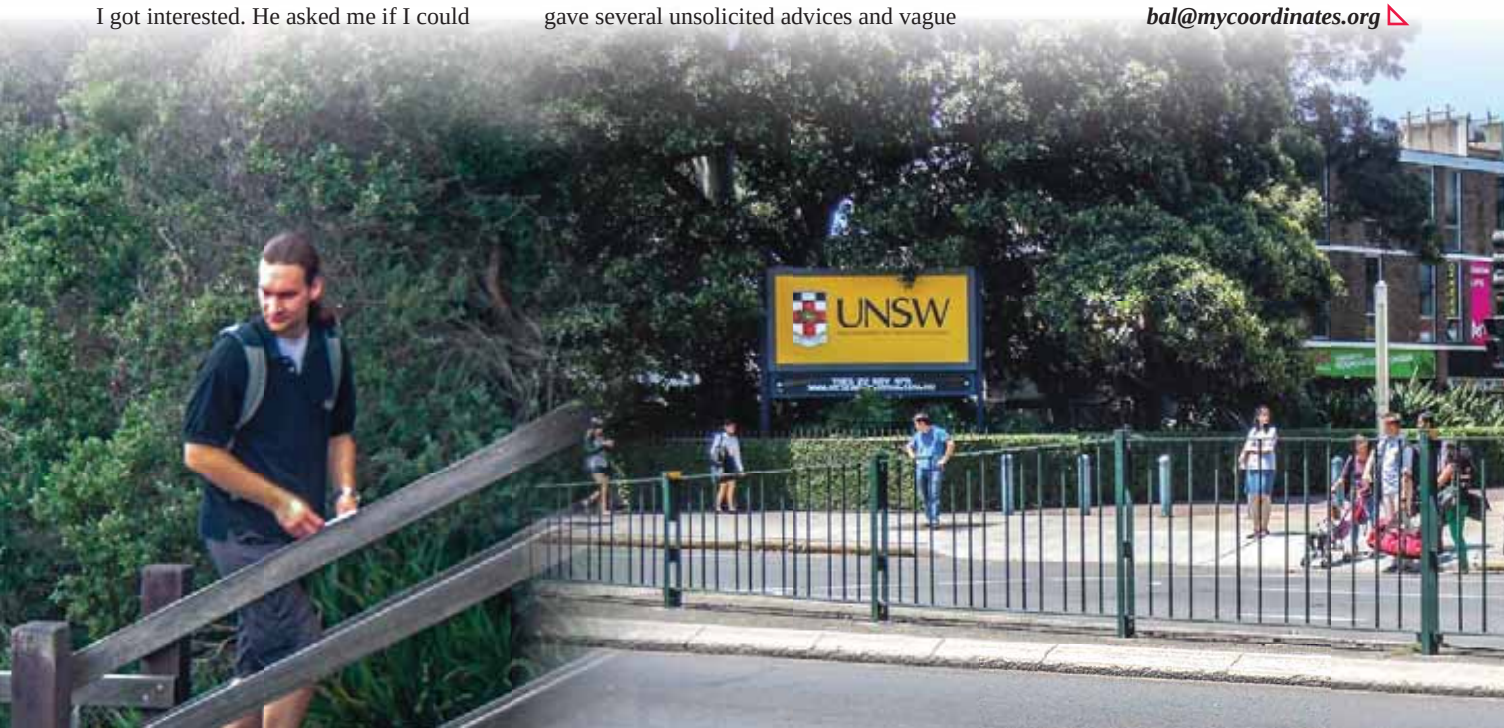
I got acquainted with Claus during the IGNSS conference that was held at the University of New South Wales (UNSW), Sydney, Australia during November 13 – 15, 2011. He came to make a presentation there.

So, when Claus told me about 'geocaches' I got interested. He asked me if I could join him for a treasure hunt at Coogee beach. After the conference, I was relaxed and planning my date with Sydney city. I thought why not and agreed to accompany him. Coogee beach, how far from UNSW? By bus 5 minutes and if we walk may be 15 minutes, someone told at breakfast table.

Cluas looked at his GPS and told that it seemed there was considerable distance and we might not be able to reach there in 15 minutes. Since I do not mind walking, rather walk a lot, insisted to walk. We kept on walking, walking and … and finally reached the beach in around 45 minutes. A long walk on sunny morning was quite exhausting. Claus was being guided by the GPS towards the treasure and I kept following him. Finally, we reached the place where the geocache was supposed to be hidden. We looked around, here and there, everywhere, but it was not found. I gave several unsolicited advices and vague ideas to locate the treasure but that also did not help. He kept on trying and finally gave up… Actually, he did not. He told me that we could try the treasure hunt at UNSW campus itself. There was a location in the campus where we could search. The long walk to Coogee beach made us wiser and we returned to UNSW by bus. At campus, search for treasure started again. We tried, err…rather I will say, he tried but again could not. I asked if he could ever locate the geocache. He started defending, "you know Bal, it is a container, hidden around the indicated place. It is not that easy to locate but not that difficult too." He told me that he had located it several times earlier but that day… Claus could n't. Would you like to try?

As far I was concerned, I got my treasure. The 'experience' itself.

- Bal Krishna
bal@mycoordinates.org



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The SkyNav GG12W is ideally suited for integration within Technical Standard Order (TSO) Flight Management Systems (FMS), ground-based reference stations for GPS aircraft landing systems (SCAT I and LAAS) and other avionics. In addition to traditional GPS receiver design and ISO 9001 engineering practices, the SkyNav GG12W adheres to all FAA/RTCA design criteria.

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Z-Blade

Ashtech's Z-Blade™ Technology is a unique patented method using multiple GNSS constellations for high-accuracy positioning. Z-Blade technology secures the best possible measurements from the GPS, GLONASS and SBAS constellations and mixes multiple observables with no compromise between quality and availability. This leads to an incredibly robust and dependable measurement processing resulting in optimized productivity.

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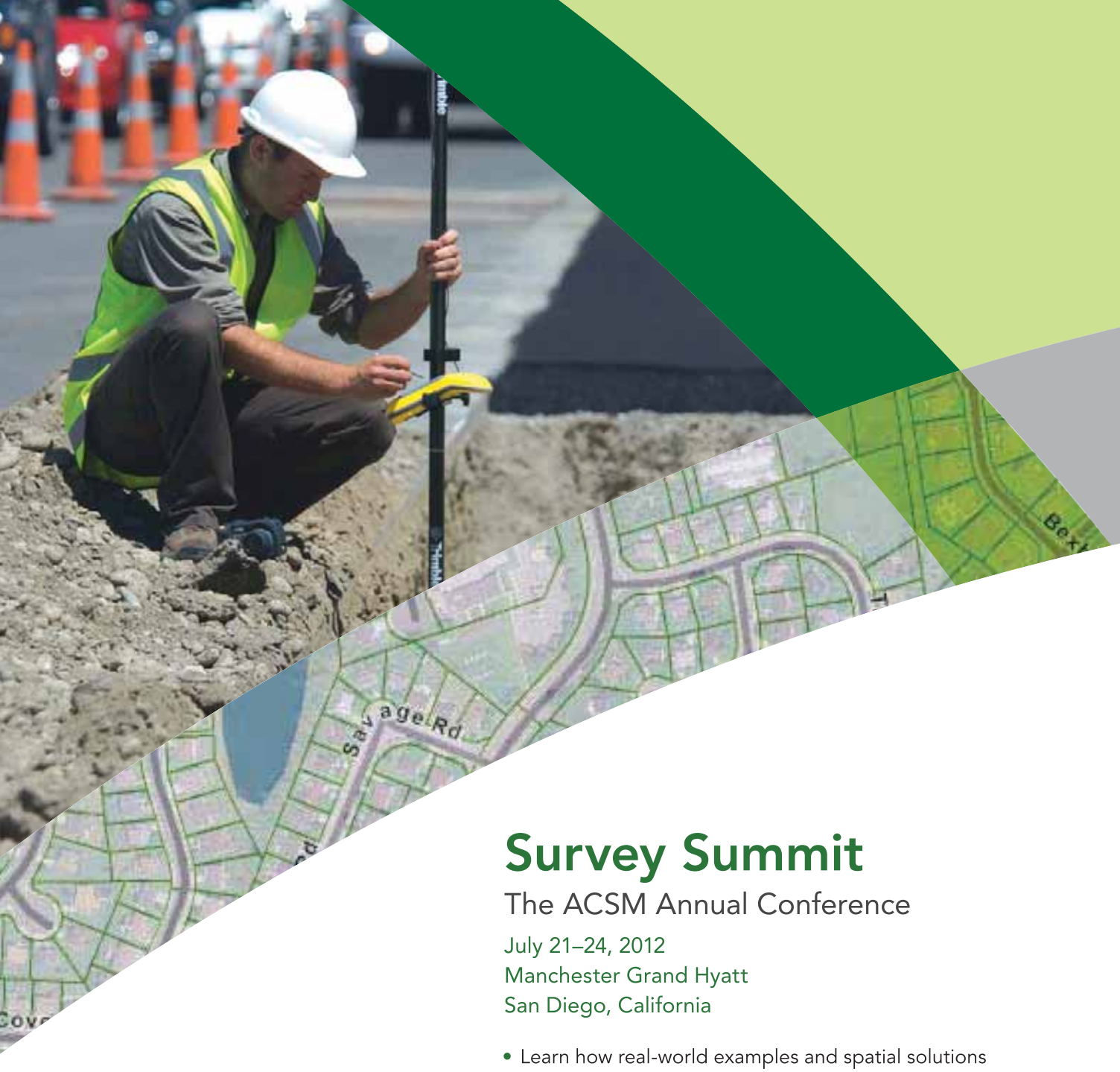

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