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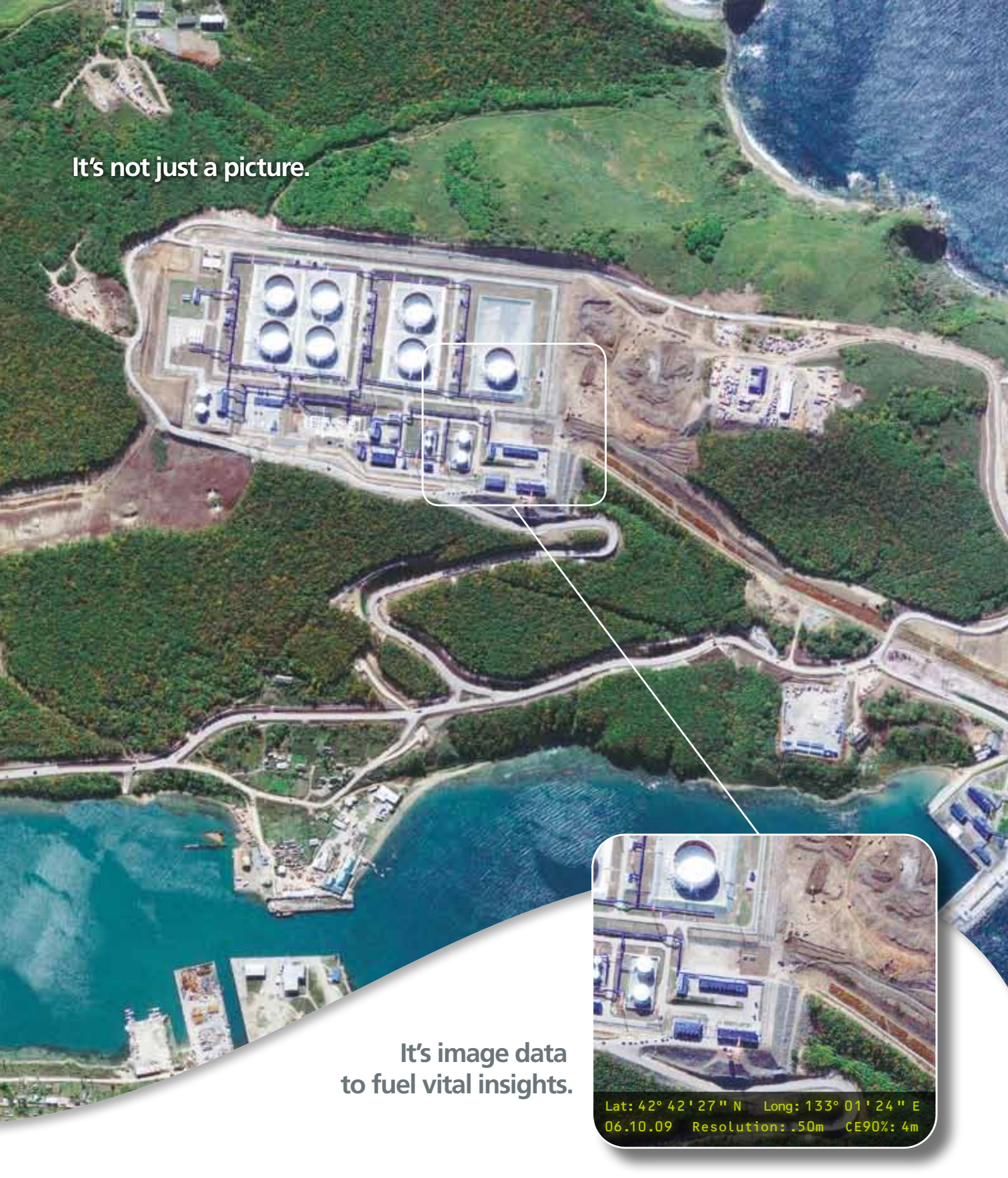

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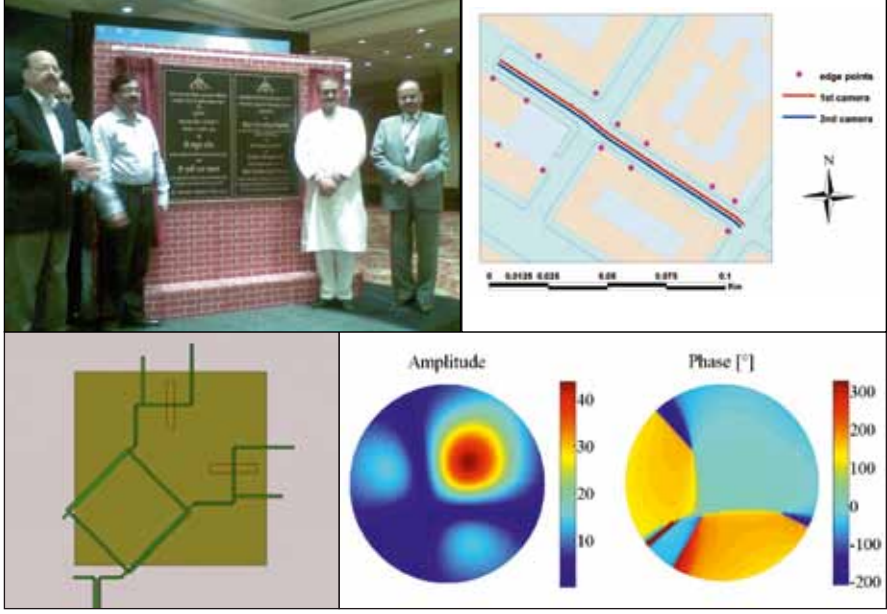

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What about the competition?

Bal Krishna, Editor
bal@mycoordinates.org

Phase centre determination on the basis of far-field measurements

This paper investigates the phase centre variations (pcvs) of a single antenna element as well as of a 2x2 array of such elements designed for gnss reception.

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Phase centre is defined as a point (or a set of points) in space from which, when emitted, far-field phase-fronts or, correspondingly, group-delay fronts are spherical or substantially spherical [1-2]. That is, the phase value is constant in a certain angular area of interest when measured with respect to the coordinate system whose origin is in the PC. However, PC is ambiguous for most of the real-life antennas and its position varies for different aspect angles, so it is rarely situated in the origin of the adopted coordinate system. In GNSS, the aspect angle of interest is usually around the direction of arrival (DOA) of the desired satellite signal.

GNSS antenna arrays introduce additional effects like mutual coupling, weighting factors and, due to adaptivity, a non-constant radiation pattern.

Description of the method

The phase contribution of displacement of the PC with respect to the coordinate system can be described by the scalar product of propagation and displacement vectors $\vec{k} \cdot \overrightarrow{r_{PC}}$ [2]:

$$\Psi(\theta,\varphi) = \Psi_0 + k(x_{PC}\cos\varphi\sin\theta + y_{PC}\sin\varphi\sin\theta + z_{PC}\cos\theta) \quad (1)$$

where Ψ is the far-field phase, Ψ_0 a constant and (θ,φ) directional spherical coordinates. Equation (1) represents a sphere (ideal far-field front) affected by PCVs (second term). This figure represents actually a 3D cardioide shape whose unknown coefficients are Ψ_0, x_{PC}, y_{PC} and z_{PC}. Unfortunately, these four coefficients are not constant throughout all of the (θ,φ)- space except in the case of isotropic radiator. As said before, PC position of realistic antennas depends on the observed direction, so the following assumption has been taken in this study: the phase pattern is considered to have constant coefficients (independent of θ and φ) around certain angular area: $\theta \in [\theta_d - \Delta\theta, \theta_d + \Delta\theta]$, $\varphi \in [\varphi_d - \Delta\varphi, \varphi_d + \Delta\varphi]$ where (θ_d, φ_d) is the DOA. The goal is to fit the presumed cardioide to the measured phase samples. Let $\Psi(\theta_n, \varphi_n)$ be the spatial samples of the phase.

$$\begin{bmatrix} \cos\varphi_n \sin\theta_n & \sin\varphi_n \sin\theta_n & \cos\theta_n & 1 \\ & \vdots & & \end{bmatrix} \begin{bmatrix} x_{PC} \\ y_{PC} \\ z_{PC} \\ \Psi_0 \end{bmatrix} = \begin{bmatrix} \Psi(\theta_n,\varphi_n) \\ \vdots \end{bmatrix} \quad (2)$$

Fitting is done in linear least squares manner. Short notation of (2) yields

$$\mathbf{R\beta} = \mathbf{\Psi}. \quad (3)$$

Solving for the normal equations of the linear system, one obtains optimal coefficients through pseudo inversion:

$$\boldsymbol{\beta}_{\text{opt}} = (\mathbf{R}^{\mathrm{T}}\mathbf{R})^{-1}\mathbf{R}^{\mathrm{T}}\mathbf{\Psi}. \quad (4)$$

Optimal solution gives the phase centre coordinates adopted for the direction (θ_d, φ_d). The quality measures of the fitting are the residuals, introduced here as averaged rms sums of the distances between data

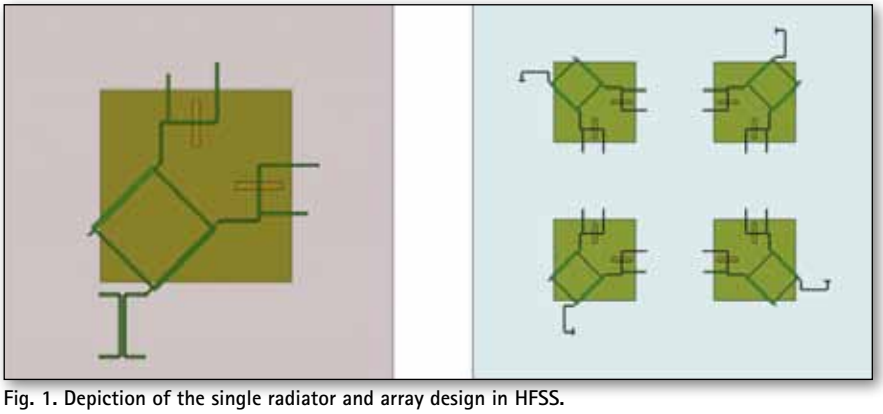

Fig. 1. Depiction of the single radiator and array design in HFSS.

points and fitted curve or surface:

$$\hat{\boldsymbol{\Psi}} = \mathbf{R}\boldsymbol{\beta}_{\mathbf{opt}}$$

$$\mathrm{Res} = \sqrt{\frac{1}{N}\sum_{k=1}^{N}\left(\Psi_k - \hat{\Psi}\right)^2} \qquad (5)$$

where N is the number of sample points enclosed by the solid angle range.

Parameters of the antennas

The radiator is a right hand circularly polarised (RHCP) square patch antenna, designed for operation in L1 band (1.575 GHz) [4]. The antenna is fed through two slots in the ground plane, which are excited by microstrip lines.

The array consists of four such patches arranged in a 2x2 configuration with sequential rotation feeding scheme. Hereby each successive element is rotated 90° in circular manner and the initial signal phases of the elements are also accordingly incremented by 90°. This results in improved axial ratio for the desired polarisation (RHCP).

Simulation setup

Simulations are conducted in Ansoft HFSS™ commercial tool and then imported to MATLAB®, for calculation of PC. The patterns are recorded with 1° resolution in both θ and φ coordinate. Because of the planar configuration of the antennas, zenith angle $\theta \in [0°,90°]$ has been observed in each φ-cut.

A solid angle for determination of PC is defined as shown in Fig. 2 in a polar coordinates representation. For a given direction (θ_d, φ_d) blue circular area takes into account all data points of the antenna far-field phase which fall in it. The angular range of the tested area should be large enough to eliminate the noisy effects of the measurement but also sufficiently small for representing the local PCV effects.

For accurate estimation of the phase centre, one must first acquire the phase front data points with as less bias as possible. A typical bias is azimuthal linear trend of the antenna far-field phase incorporated in RHCP. This can be described by $\Psi_{RHCP} = -\varphi + const$. So in order to consider all of the directions equally this trend has to be compensated in the calculations by normalising for zenith direction.

Simulation of a single radiator

For the following simulations, an arbitrary angular test range of 20° was taken. Due to the feeding method (Fig. 1), simulated phase pattern of the patch antenna is asymmetrical as shown in Fig. 3. A set of directions for PC determination was defined as a single cut by: φ=0° and $\theta \in [0°,90°]$ Fig. 5. The results show that PC is stable and stays within a 10 mm range for most of the chosen directions accept for the ones close to the horizon (Fig. 4).

Simulation of the array

Since the structure designed in HFSS™ is rotationally symmetrical, only one of the four radiators was excited in the simulation, thus the pattern of a single radiator together with the mutual coupling effects was obtained. This allows acquiring of the total array pattern and beamforming in software (MATLAB®). The main beam direction was steered to $\theta_{max} = 45°$, $\varphi_{max} = 45°$.

It is evident that the array phase pattern has discontinuities where amplitude pattern has zeros (Fig. 5). These phase shifts are often difficult to filter out performing *unwrapping*, due to the slow transition of the phase in space.

For this study, focus was on the determination of the phase centre in the area where the radiation is significant (main beam). In that area, results show mild PCV within ± 40 mm (Fig. 6).

Measurement setup

In the measurement, the same geometrical setup has been used as in previous

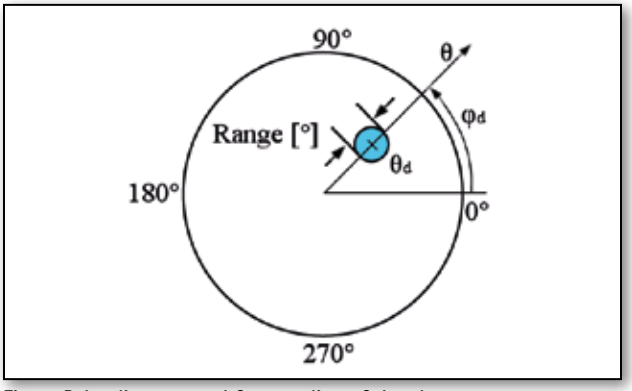

Fig. 2. Polar diagram used for sampling of the phase pattern.

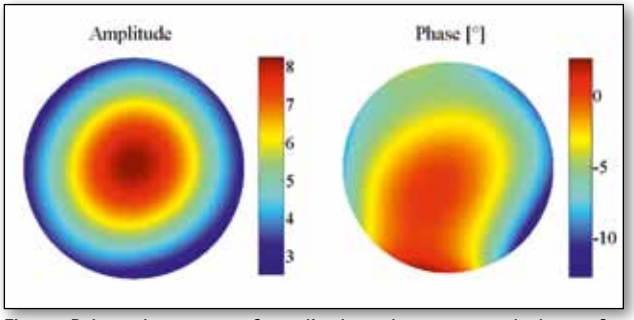

Fig. 3. Polar colour maps of amplitude and compensated phase of a simulated single patch.

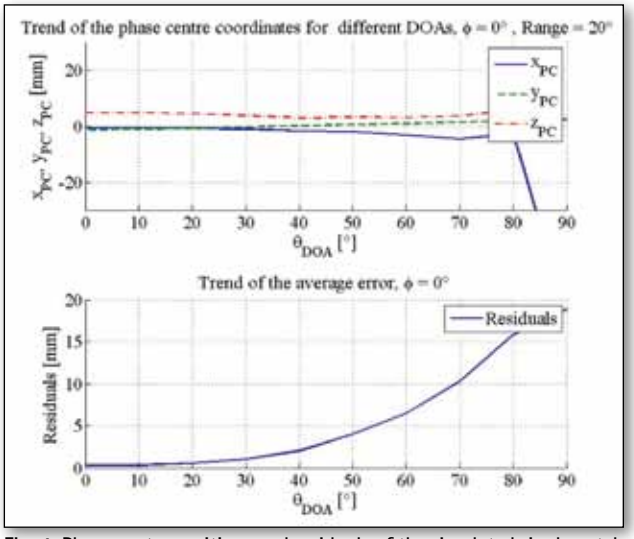

Fig. 4. Phase centre positions and residuals of the simulated single patch for an azimuthal cut.

sections. Only the azimuth resolution is somewhat lower (5°) because of the extensive measurement procedure required for recording of the detailed phase front. Although the antennas are intended for GNSS reception, for convenience, they were set in the transmission mode in this investigation, accounting for the reciprocity theorem. Physical setup included mounting of the antenna under test (AUT) on a step motor which is in charge of azimuth. AUT and this motor are situated on a pole (7.5 m high) at the foundation of which is another step motor for scanning of zenith angle (Fig. 7). Also, like in previous sections, azimuthal phase decline of the RHCP was eliminated before the calculations of the PC.

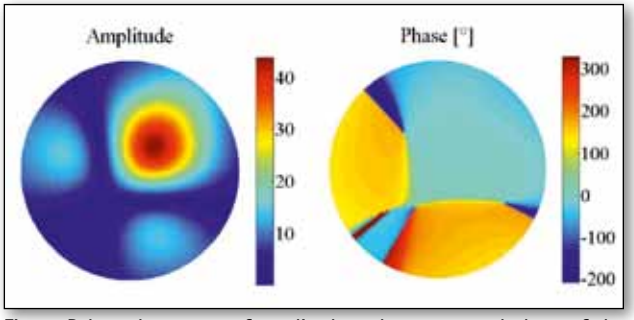

Fig. 5. Polar colour maps of amplitude and compensated phase of the simulated array.

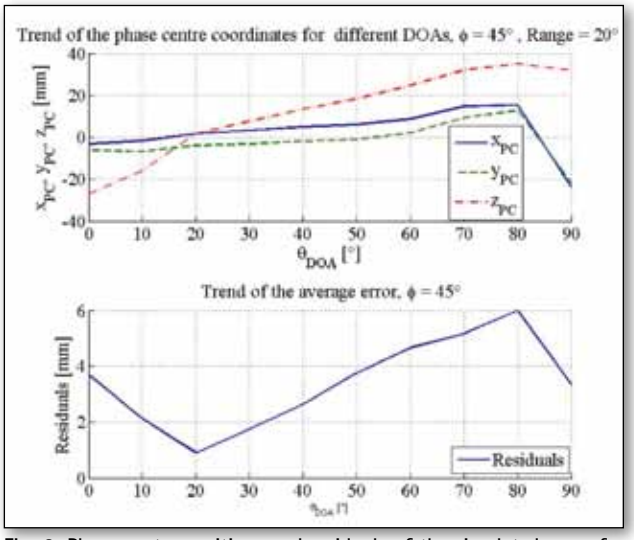

Fig. 6. Phase centre positions and residuals of the simulated array for an azimuthal cut.

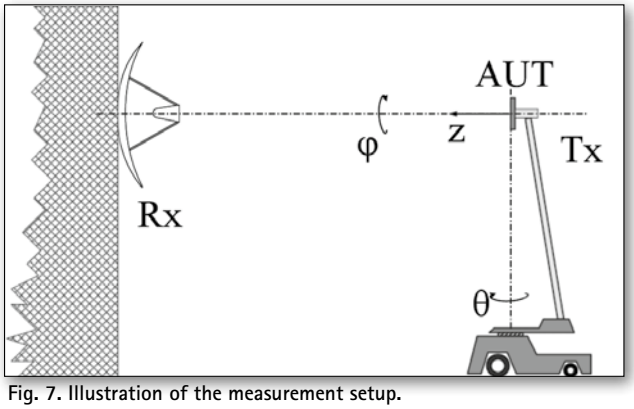

Fig. 7. Illustration of the measurement setup.

Measurement of a single radiator

Fig. 8 shows polar diagram of the measured amplitude and phase patterns. Measured data, due to presence of unwanted effects, require more caution than the smooth and robust simulated data even when it comes to a simple radiator. In this case, following the phase characteristic in an arbitrary single φ =30° cut and having the measurement angle resolution in mind, it was decided for a 30° angular range. Estimation of the PC in that cut is shown in Fig. 9.

The recorded phase pattern is rather noisy (Fig. 8). The variations of the PC rise considerably for $\theta \geq 50°$, but for the rest of the angular domain the coordinates stay within boundaries of ± 80 mm. It is noticeable that the PCVs as well as the residuals are higher than in the simulation example of the single element antenna.

Measurement of the array

For simplicity, similarly to the simulation case, only pattern of one active element was measured and then imported in MATLAB® for addition and beamforming.

After applying the adequate weighting for maximum radiation in direction , $\theta_{max} = 45°$, $\varphi_{max} = 45°$, resulting patterns were obtained (Fig. 10). In this case PC solutions (Fig. 11) are steady for $\theta < 70°$. This can be explained by constructive wave superposition in the angular area of interest (beamforming) where phase undergoes minor variations.

Conclusions

As expected, the phase front curves obtained in the simulations are much less distorted than the measured ones, thus introducing less error in the least square estimation. Therewith calculated PC positions are stable with respect to the zenith angle (Fig. 4). The proposed method allows for estimation of the phase centre variations.

However, in a real-life measurement like one described above, one must account for several unwanted influences, like the impact of the immediate environment, precision of instruments, noise, tolerances, calibration, etc. In the process of antenna fabrication, many unforeseen effects may occur contributing to the deviation of performance of the manufactured models from the initial designs.

Some of these imperfections can be recognised in displayed examples: for instance, in Figs. 8 and 10 phase response shows ripples, especially on the edges of the observed angular domain. This clearly illustrates the problem of the mechanical tolerances of the step-motor, as well as the potential echo contributions due to the environment. This is understandable considering the construction of the positioner, high mounting of the AUT (Fig. 7) and the fact that the measuring system is of the outdoor type.

Antenna array as a multielement radiating structure produces lobes and zeroes in its amplitude radiation pattern and discontinuities in the field phase when going over the spatial zeroes. If concentrating on the angular area of the

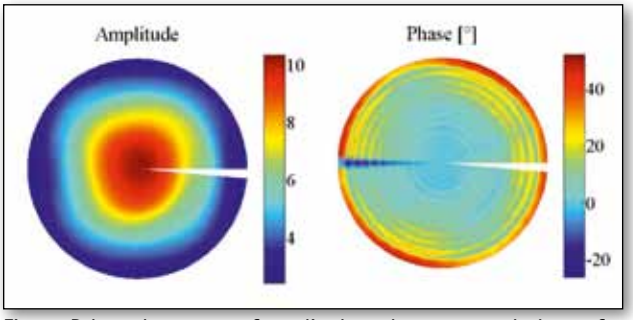

Fig. 8. Polar colour maps of amplitude and compensated phase of a single patch.

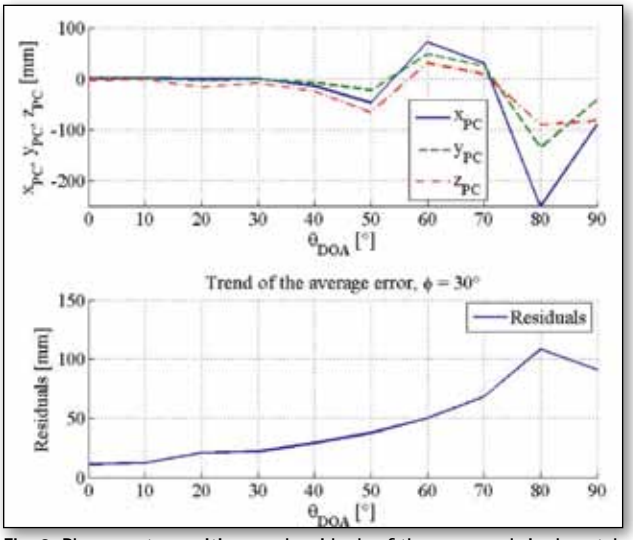

Fig. 9. Phase centre positions and residuals of the measured single patch for an azimuthal cut.

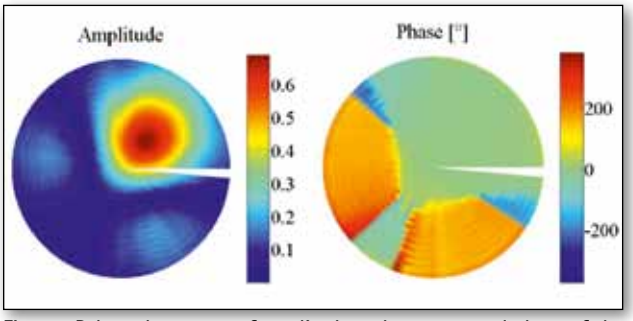

Fig. 10. Polar colour maps of amplitude and compensated phase of the measured array.

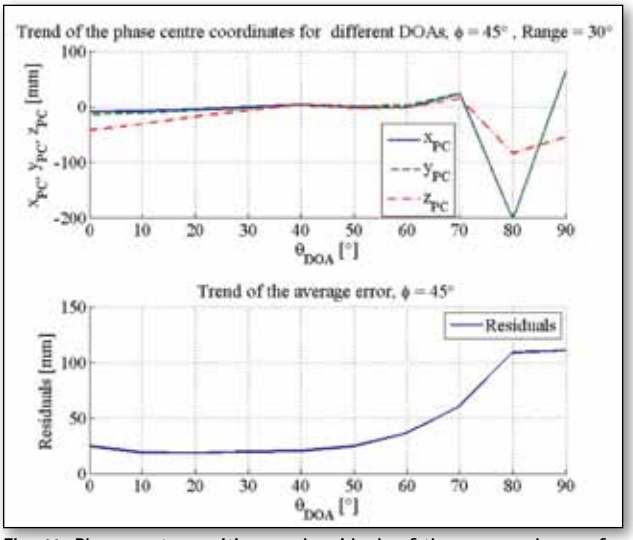

Fig. 11. Phase centre positions and residuals of the measured array for an azimuthal cut.

main lobe, the phase is rather steady and the estimated phase centre locations are consistent between the simulations and measurements.

One general trend can be noticed with both measured and simulated data. The variance of the estimated PC is increased for the directions close to the horizon ($\theta = 90°$). Planar antennas tend to have very low field intensity in that angular area, which leads to higher numerical and measurement noises.

In general, the presented scheme for the phase centre estimation demonstrates very good performance and stability when used with simulated data, but the experiments with the measured data confirm that it is also possible to achieve acceptable precision even with complex antennas like adaptive arrays. Nevertheless, when dealing with far-field data at GHz-frequencies and antennas with non-fixed radiation patterns, a high accuracy positioner and anechoic chamber measurements can be recommended for avoiding considerable mechanical and electrical error effects on the far-field phase.

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"Eventually all receivers will be multi-GNSS"

Says John Pottle Marketing Director, Spirent Communications, Positioning Group

2009 was seen as a difficult year for most businesses. However, 2009 was 'as expected' for Spirent in terms of revenues and profits, how did Spirent manage this?

Spirent sells test systems for navigation and positioning across the industry, from government to consumer products, from R&D through to field test. Our customers are spread over 30 countries around the world. Many organisations had to be more careful about investment in 2009, although some of our customers saw growth and opportunities themselves and bought more test equipment than usual. Spirent's response was to remain focused on innovation and our customers' needs. For example, in 2009 we launched new ranges of multi-GNSS simulators focused at the commercial and production test markets.

Multi GNSS' is the buzz word today; do you think eventually single GNSS receivers will be phased out?

I think this depends on the application. For navigation in urban areas, multi-GNSS improves availability, with more satellites visible from the urban canyon. So in many consumer applications, yes, I do think that eventually all receivers will be multi-GNSS. In these areas, I think that additional sensors (such as MEMS) and other technology (such as

Wi-Fi positioning) will also become the norm. Where a clear view of the sky is available (e.g. in the air, on the open road, in many professional applications), GPS only is often sufficient. However, even in these applications I think multi-GNSS will be introduced, partly for consumer choice and partly because the incremental cost of implementing multi-GNSS over GPS-only is reducing.

'We relish public tests involving our customers and ferociously guard our unique tradition of being entirely neutral.' How does Spirent manage to stay 'neutral' when the success of its products depends on the success of the tests that are performed on them?

Spirent's reputation is built on test systems that deliver the best signal quality. Test equipment should be an order of magnitude more accurate than the devices under test. So, we remain "neutral" by striving to provide the best test tools to the navigation and positioning industry. In addition, our business is test. We don't compete with our customers by making GNSS receivers or navigation systems.

Could you elaborate on Spirent's GPS modernization and multi-GNSS simulator portfolio for our readers?

Spirent's core product families now all support multi-GNSS. We also offer test systems for the new GPS signals – GPS L1C, GPS L2C, GPS L5 and M-code. Many of our customers are now testing multi-GNSS and/or modernized GPS.

With GNSS applications becoming more mainstream and available in a growing number of devices, what do think will drive this technology for the masses – functionality or price?

The only way to drive technology for consumers is to have great functionality at a great price. In many ways, consumers are the most demanding of users, expecting faultless performance everywhere, for little outlay. However, consumers regularly walk or drive in many places where GNSS really struggles like urban areas and indoors.

In the coming months, which navigation and positioning applications will emerge as the frontrunners in your opinion?

Solutions that combine multi-GNSS, low cost inertial sensors and wi-fi positioning are becoming a very strong solution for consumers. More generally, inertial navigation is an excellent compliment to GNSS, in that inertial continues to work well where GNSS is not available. I think the frontrunners will combine symbiotic technologies like GPS and inertial to provide the best performance for customers, whatever the application.

The US and Europe are seen as matured markets as far as navigation and positioning technology products go, which other regions around the world do you think are going to be the 'hot spots' for this technology in 2010?

Keep an eye on BRIC (Brazil, Russia, India, China)!

GPR data georeferencing using photogrammetry and digital maps

This paper presents the first results of a feasibility study of a system where photogrammetry, digital maps and GPS are combined to georeference GPR surveys

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Ground Penetrating Radar (GPR) provides a picture of the different materials or structures underground up to a few meters of depth. To provide a 3D map of underground objects such as pipelines, the georeferencing horizontal tolerance should be around 20 cm, a figure achievable by GNSS systems. The conditions of GPR urban surveys, though, make it impossible to rely on GPS alone for positioning. In front of large blocks, in narrow streets, or in tree-lined avenues GPS is not sufficient to guarantee uninterrupted coverage. To overcome the problem, systems combining GPS and inertial navigation can be used (Zhang et al., 2005) although rather expensive. Another possibility is to use photogrammetry to georeference the GPR trailer. This paper presents the first results of a feasibility study of a system where photogrammetry, digital maps and GPS are combined to georeference GPR surveys.

Georeferencing by photogrammetry

The GPR-trailer will host at least a pair of reflex digital medium resolution cameras, installed on a rigid frame, high enough to minimize occlusions by parked cars and looking leftwards and rightwards; each will acquire a strip of the building façades at the side. A GPS antenna will be mounted on the top of the frame. Data acquisition from the different sensors will be synchronized, in order to allow time interpolation of the trajectory; cameras will be triggered by an odometer; calibration will account for lever arms and misalignments between the sensors.

Tie points along each strip will be automatically extracted and matched by a robust Structure and Motion algorithm (Pilu, 1997; Fischler and Bolles, 1981; Hartley and Zisserman, 2000; Forlani, Roncella, Remondino, 2005). Using calibrated cameras, the orientation of each pair in an arbitrary metric frame can be recovered through the essential matrix; approximate point coordinates can be computed by forward intersection using a linear algorithm. By alternating intersection and resection, each strip will be oriented in an arbitrary frame.

Maps standards prescribe a 95% tolerance of 40 cm for 1:1000 scale (Blachut et al., 1979): therefore map points may be used as GCPs to georeference the photogrammetric strip. Full (3D) GCPs can be easily recognized and measured on the images at building block corners (at ground level); 2D GCPs can also be measured along vertical edges of a building.

Since the accuracy of the perspective centres decreases along the strip with the distance from the closest GCP, the relative orientation (RO) and the distance between left and right cameras, known by calibration, can be enforced, to constrain the solution.

A final bundle adjustment will provide the projection centres of the images, combining the available information: the GCP coordinates, the relative orientation constraint, any available GPS position.

As long as the camera records building façades, tie points will be extracted and matched seamlessly, because of the rich texture and optimal viewing geometry. When crossing large roads or squares, though, finding tie points is difficult. If the GPS position is available, no photogrammetric solution is necessary; otherwise manual measurements must be used to improve tie point distribution.

Simulations

In order to verify the accuracy of the positioning in different conditions, simulations have been performed. The test area is Milan (Italy), where a recent city base map at 1:1000 scale is available (Bezoari et al., 2005).The simulation characteristics are:

– 3D scene set up using the City Base Map;
– tie points on buildings distributed on a grid with 4 m spacing;
– some tie points on the ground, located on large crossroads;
– a full GCP at every building corner (at ground level);
– 6 Mpixel camera with 18 o 12 mm lens;
– acquisition of a synchronous image pair every 3 m;
– tie points measurement accuracy = 1 pixel.

For trajectories close to building face, short focal lenghts and camera axis tilt (from –3° to +9°) were used to get more coverage of the building façade on the images. Exposure time must avoid image blurring due to motion, a possible limiting factor for the operating speed in narrow streets.

Since in most buildings the demarcation between floors is clearly distinguishable, it has been assumed that one horizontal point can be measured at every floor along a building vertical edge. Eaves, although in principle all suitable as height points, are seldom imaged: in a single strip therefore the height points will be located only at ground level, often quite aligned. In this case, the rotation of the whole strip along an axis parallel to camera trajectory is not controlled by the GCPs, yielding large uncertainties for rotations and elevations of the camera centres. Running two opposite-looking strips and enforcing the relative orientation reduces the problem, although not completely.

The accuracy of the camera projection centres has been computed by error propagation from the image coordinate errors. Three test cases will be described:

Site 1 – Viale Romagna (Figure 1):
- Road width = 50 m;
- blocks about 100 m long;
- two road crossings (23 and 31 m large).

Site 2 – Via Cosimo del Fante:
- Road width = 16 m;
- one block about 230 m long.

Site 3 – Via Felice Casati (Figure 2):
- two different road widths: about 19 m and about 12 m.

In each site five different block configurations (2sA, 2sB, 2sC, 1sA, 1sC) have been simulated varying:
- number of strips used: 2s: both left and right; 1s: only right
- ground control:

  ○ A: 4 full GCP, two per strip, at ground level, at the strip ends;

  ○ B: same as A plus 4 horizontal GCP (one on the same vertical building edge as the full GCP);

  ○ C: 1 full GCP at ground level at each building corner plus an horizontal GCP on the same vertical building edges.

When both strips are used, the relative orientation (RO) from the left and right synchronous images is always enforced (this allows also to use the otherwise rank-deficient ground control of case A).

Results

Site 1 – Viale Romagna

Although these figures seem to depict a strong block (the redundancy ratio is larger than 4) in fact the height GCP is poor, unless also points on building eaves can be measured.

Table 1 summarizes the results: for each coordinate of the camera projection centres, the RMS value of the variances computed from error propagation are shown.

It is apparent that, with the same GCP, combining the two strips increase the overall accuracy of the projection centres.

Horizontal accuracy requirements can be met with sufficiently dense GCP. The accuracy of the attitude angles is quite large for omega and kappa: more than 13° even in the best case, because a too little area of the image format is covered by tie points. By tilting the camera axis above the horizon by 9° the results are significantly better in terms of attitude (0.2°) and in (E, N) while the elevation accuracy does not change very much, at least for the two strips (see table 2).

Site 2 – Via Cosimo del Fante

In this case, though, GCP B and C actually coincide, since there are no other GCP except at the block ends. Results in table 3 for the single strip refer to the right strip only.

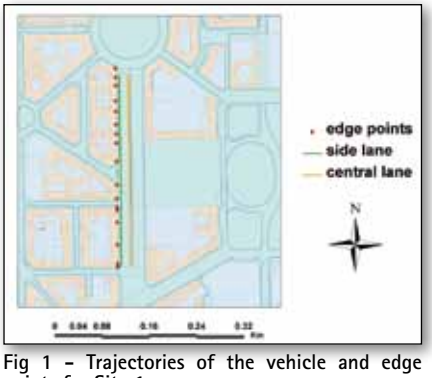

Fig 1 – Trajectories of the vehicle and edge points for Site 1.

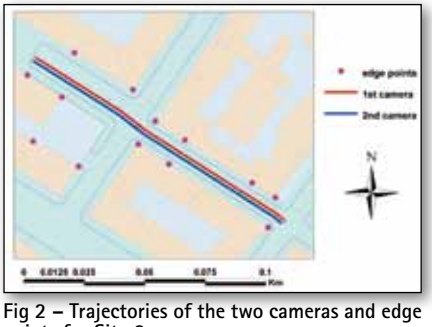

Fig 2 – Trajectories of the two cameras and edge points for Site 3.

	Camera distance from buildings	Camera principal distance	Image sequence lenght	# Images
Site 1 – Viale Romagna left sequence	22 m	18 mm	320 m (see Figure 3)	108
Site 1 – Viale Romagna right sequence	29 m	18 mm	320 m (see Figure 3)	108
Site 2 – Via Cosimo del fante left strip	4.4 m	18 mm	100 m	28
Site 2 – Via Cosimo del fante right strip	12 m	18 mm	230 m	68
Site 3 – Via Casati left strip	min 7 m, max 30 m	12 mm	120 m	38
Site 3 – Via Casati right strip	min 7 m, max 30 m	12 mm	120 m	38

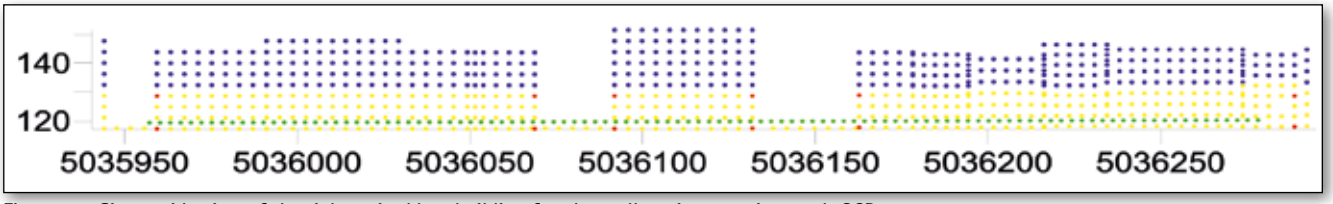

Figure 3 – Site 1: side view of the right strip: blue: building façades; yellow: image points; red: GCP; green: camera centres.

RMS(σ^2) [mm]					
	2sA	2sB	2sC	1sB	1sC
E	146	124	63	203	103
N	123	98	59	221	103
H	122	122	82	547	285

Table 1–Site 1: average accuracies of the camera projection centre coordinates; horizontal camera axes.

RMS(σ^2) [mm]					
	2sA	2sB	2sC	1sB	1sC
E	118	92	47	93	84
N	115	96	47	95	86
H	115	118	77	137	137

Table 2– Site 1: average accuracies of the camera projection centre coordinates; camera axes tilted by 9° above horizon.

RMS(σ^2)					
Block type	2sA	2sB	2sC	1sB	1sC
(mm)	RO, 2 GCP /strip	RO, 2+2 GCP /strip	RO, all GCP	1 strip, 2+2 GCP	1 strip, all GCP
E	123	68	37	157	76
N	125	67	37	148	67
H	118	119	79	345	210

Table 3 – Site 2: average accuracies of the camera projection centre coordinates for 5 different block configurations and ground control; camera axes tilted by 9° above the horizon.

RMS(σ2) [mm]					
	2sA	2sB	2sC	1sB	1sC
E	118	92	47	93	84
N	115	96	47	95	86
H	115	118	77	137	137

Table 4 – Site 4: average accuracies of the camera projection centre coordinates; camera axes tilted by 9° above horizon.

The accuracy figures with respect to the other sites are less good, because of the sparse GCPs. It is interesting to notice that, even if one strip is somehow fragmented in patches, it still helps to make the block more stable, especially in elevation but also in horizontal: this was not the case in the other sites.

Site 3 – Via Casati

Block relative redundancy is 3.1; on average, there are 11 pts/photo and 3.6 rays/pt.

When both strips are used, the RO from left and right synchronous images is always enforced (see table 4). With respect to Site 1, the accuracy figures show that the shorter average distance of GCP partly compensates for the smaller number of tie points per image and rays per point. A shorter focal of 12 mm is necessary, due to the closeness to the building façades. As in Site 1, with all GCP , the gain in accuracy when using both strips is about 100%.

Conclusions and perspectives

The results obtained from this three simulations suggest that the objective can be achieved, provided that GCP can be recognized on images at intervals not much larger than 200-250 m, with precisions below 10 cm. Preliminary tests with real image sequences show that automatic image orientation can deal with sequences of 30-40 images without problems.

Before moving to an implementation stage of the method, optimization of several system components and surveying parameters is though still needed.

Acknowledgements

The authors wish to thank the Milan Municipality and the Province of Milan for the City Base Map.

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FOIF GNSS Receiver A20

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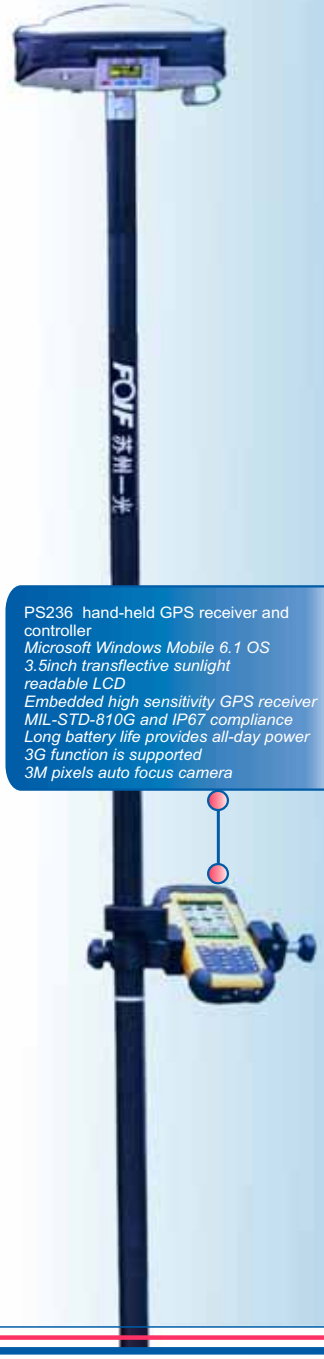
- Field software: FOIF Survey_GPS or FOIF FieldGenius



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By 2013, India will have a certified GAGAN

Says V P Agrawal, Chairman, Airports Authority of India

In what specific areas of operation is AAI using the GPS technology today?

GPS Technology is used in AAI in the following areas:

a. Performance Based Navigation- Area Navigation COSPAS-SARSAT –Search and Rescue systems (satellite based)

b. Land Survey and Land Management

c. Preparation of Airport Maps and Charts – Cartography

Please tell us about some of the initiatives taken by AAI to improve Air Navigation Safety in recent years?

Augmentation of Communication, Navigation and Surveillance Systems for effective Air Traffic Management through implementation of state-of- the-art technologies, safety management systems and building up safety nets in ATM.

Communication:

- Automatic Message Handling System
- Integrated voice and data communication systems
- Controller Pilot Data Link Communications
- MODE-S communications
- Remote control Air ground (RCAG- connecting vast areas through VHF network
- Digital Automatic Terminal Information System (DATIS)

Navigation:

- Augmenting the Ground based Navigation system by installing additional DVOR/DMEs.
- Provision of Instrument Landing System (ILS) at majority of airports
- Implementation of Space Based Navigation System – GAGAN
- Implementation of Performance Based Navigation (PBN) procedures
- Implementation of Ground Based Augmentation System (GBAS)

Surveillance:

- Flight Data Processing System
- Surveillance Data Processing System including Safety nets
- Automatic Dependent Surveillance systems(ADS-C)
- Implementation of ADS-B (Broadcast)
- Radar Coverage over entire Continental Airspace by installing 9 additional Radars (MSSR) (Process in Progress)
- Provision of Terminal Approach Radars at busy airports
- Provision of ASMGCS at major international airports

The advancements in GNSS technology have made many of the earlier air traffic control systems redundant, please comment. What is the impact of the GNSS technology in AAI?

It is not true to generalise that the advancements in GNSS Technology have made many of the earlier ATC systems redundant. The existing Navigation systems are ground based and hence are having siting & range limitations. GNSS, being a space based system overcomes most of these limitations. Even after GNSS is fully implemented, the ground based systems may continue to exist as a fallback system in case of failures. As far as India is concerned, it is expected that by 2013, AAI will have a certified SBAS system named as GAGAN (GPS Aided GEO Augmented Navigation) in place. It may take some more years to achieve CAT1 status.

Which area of training is AAI focussing on for its personnel to meet the challenges of new technologies?

Training is always a top priority in AAI. The Civil Aviation Training College situated at Allahabad is an institution of international repute which takes care of the training requirements. As and when new equipments are inducted, our personnel get proper training from the respective manufacturers. Moreover, AAI encourages its personnel to participate in International Seminars, Workshops, and Exhibitions, etc to enrich their knowledge and keep themselves abreast of the latest technologies.

What kind of upgrades will be needed by the aircraft to match the new technology being implemented by AAI at the airports?

Most of the modern aircraft are fitted with appropriate avionics to meet the new technology being implemented by AAI.

What objectives were achieved for AAI in the 'Technology Demonstration Phase Extended' of GAGAN?

- GAGAN-TDS established the feasibility of an operational Space Based Augmentation System in the Indian Flight Information Region.
- The Final Systems Acceptance Test

GAGAN: Final Operation Phase launched

"With GAGAN, the air navigation in India is set to be redefined," said Praful Patel, the Hon'ble Minister of Civil Aviation while launching the "Final Operation Phase" of GAGAN (GPS Aided Geo Augmented Navigation) in New Delhi on August 10, 2010. GAGAN is an ambitious project that Airports Authority of India (AAI) has embarked upon in a joint venture with Indian Space Research Organisation (ISRO). Mr Patel applauded the great work done by AAI and ISRO. He told that this step would not only benefit the country as a whole but also enhance India's stature globally. He also emphasized the need to look at the commercial aspects of the project.

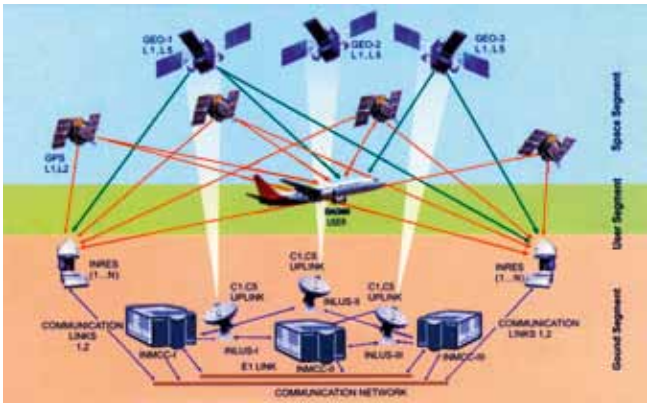
On the occasion, Mr M M Nambiar, Secretary, Ministry of Civil Aviation, in his welcome address gave a glimpse of the work undertaken by the AAI in modernizing the airport infrastructure, be it terminal buildings or the CNS-ATM facilities/ procedure systems. He said that GAGAN would help to leapfrog in air navigation. Dr Nasim Zaidi Director General of Civil Aviation highlighted the significance of the GAGAN project. He mentioned the importance of the accuracy, integrity, reliability and continuity of the signals. In due course, we need to look at the legal regime in India and neighbouring countries in this context.

GAGAN has been taken up with an objective to implement the SBAS technology over the Indian region. This joint project by AAI and ISRO aims to provide a seamless navigation facility in the region, which is interoperable with other SBAS. Although primarily GAGAN is expected to provide satellite based navigation for civil aviation across South and East Asia, and will provide India with the most accurate, flexible and efficient air navigation system deployed meant for civil aviation, it will also be beneficial for other users. AAI's efforts towards implementation of operational SBAS can be viewed as the first step towards introduction of modern CNS/ATM system over Indian airspace.

GAGAN will provide augmentation service for GPS over India, Bay of Bengal, South East Asia, and Middle East expanding upto Africa. The project involves establishment of a full complement of Satellite Based Augmentation System consisting of 15 Indian Reference Stations, 3 Indian Navigation Land Uplink Stations, 3 Indian Mission Control Centres, 3 Geo-stationary Navigation payload in C and L Bands and with all the associated software and communication links.

on August 12-14, 2007, demonstrated several of the key performance parameters of SBAS in India.

- The vertical and horizontal accuracy of the corrected position solution after processing by GAGAN—TDS and broadcast from the satellite was between 1 and 2 meters and is well within the 7.6 meter requirement for LPV approaches.
- The availability during the 24 hour FSAT test period of RNP 0.3 service, using just the eight Indian Reference Stations (INRES) of the TDS configuration was highly satisfactory.
- The LPV availability during the 24 hour FSAT test period, using baseline algorithms and just the eight Indian Reference Stations (INRES) of the TDS configuration was also satisfactory.
- It demonstrated the successful integration of ground element subsystems, communications network, and ultimately the space component. All parties to the project gained valuable insight into each other's requirements, identified what practices work, and established confidence in the others.



GAGAN is still to achieve full functionality, in the meantime how is AAI managing the air traffic?

GAGAN is an upcoming system. AAI has a vast ground based CNS/ATM system which takes care of the present air traffic requirements. As explained earlier, many initiatives are in place to meet the Air Traffic Management requirements.

What improvements do you envisage in AAI's functioning with the implementation of GAGAN?

With the implementation of GAGAN, the following benefits are likely to be achieved:

- Precision approach at all Runways
- Improved Efficiency/Economy because of:
  - Direct Routes
  - Increased Fuel savings
- Significant cost savings due to reduction of ground aids
- Reduced workload of Flight Crew and ATCOs
- Improved Capacity through reduced aircraft separation
- Higher Accuracy, Global Coverage
- Improved Safety
- Reduced Controlled Flight into Terrain (CFIT) incidents
- Enhanced Air-to-Air Surveillance: ADS-B
- Reduced Noise Pollution through implementation of continuous descent approach

Besides the financial, technical manpower and other supplementary support that AAI is providing to the GAGAN project; what are the changes that need to be effected within AAI to integrate its present activities with the GAGAN capabilities?

No additional changes will be required are needed to integrate GAGAN with systems of AAI.

GAGAN is dependent on GPS, how do you see the IRNSS fitting into the picture?

IRNSS is a regional set up compared to GPS which is a Global technology.

As ISRO is developing IRNSS it will be possible to integrate GAGAN with IRNSS at a later date.

What is your opinion about non-aviation market (ground users) for GAGAN?

GAGAN can be utilised by many other ground users for applications like:

- Surveying and mapping
- Ease of Search & Rescue operations
- Precision Farming including aerial spraying
- Precision Timing
- Navigation of Road and Sea transport
- Location based services like vehicle tracking system
- Mining

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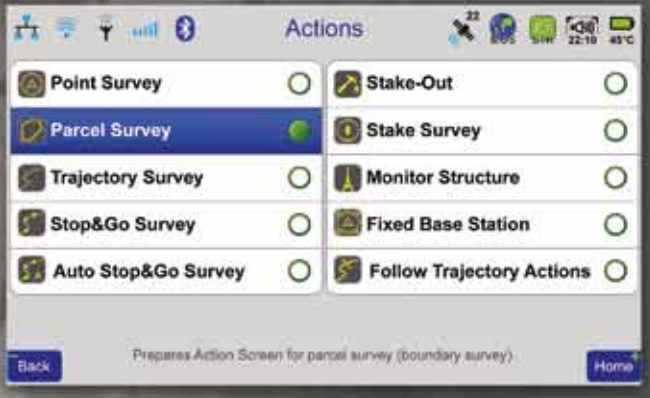

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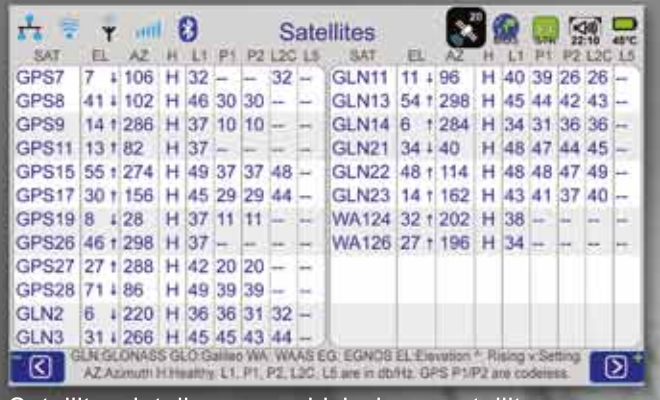

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CONGO chooses JAVAD receivers...

We have primarily chosen the Javad Triumph receivers in late 2008 because they were the first (and at that time only) multi-frequency (L1/E1, L2, L5/E5b) and multi-constellation receivers (GPS, Galileo, GLONASS and SBAS) which offered GIOVE tracking support for general users. The Triumph technology offers a huge number of tracking channels, which puts no known restrictions on all-in-view tracking of all supported signals.

An important aspect that distinguishes the Triumph receivers from various other products is the availability of semi-codeless L1 P(Y) pseudorange and phase measurements in parallel to the corresponding L1 C/A code tracking. This appears important because it avoids problems with differential code biases when consistency with GPS clock products is important, e.g. in precise point positioning applications. Besides the legacy GPS signals and the L2C signals of the Block IIR-M satellites the receiver has demonstrated to properly track the new GPS L5 signal (both the PRN1 test signal, and, most recently, the new PRN25 signal of the first Block-IIR satellite; see http://www.gpsworld.com/gnss-system/gps-modernization/news/gps-l5-the-real-stuff-10086). With respect to Galileo, the receiver is ready to track the future Galileo signals due its full support of memory codes (not only the shift register codes used for Galileo). It presently supports tracking of GIOVE E1 Open Service signals (combined E1B/C including CBOC support) and the E5a (combined I/Q) signal. This enables ionosphere-free linear combinations of measurements and provides the basis for the generation of GIOVE orbit and clock information from CONGO data. While E5b and E5 AltBOC tracking is not supported by the present generation of Triumph receivers, E5a is considered to be fully sufficient for precision navigation and has the evident advantage of a common frequency with GPS. Also, many advantages of the AltBOC signal can only partly be materialized when combining the measurements with the lower grade E1 signals. For completeness, we note that the Triumph receivers support a total of four GLONASS signals on L1 and L2 as well as two SBAS signals (on L1 and L5). All of these aforementioned signals and constellations can be tracked concurrently in view of the large number of channels.

Concerning the measurement quality, the Triumph receivers offer a flexible choice of tracking loop bandwidths and smoothing options. These allow the user to optimally adapt the measurement generation to its specific needs (be it high dynamics aircraft or stationary geodetic reference stations). Most notably the receivers offer a superior multipath suppression technique that contributes to an excellent overall User Equipment Error (UEE). As a noteworthy example, the Triumph receivers successfully mitigates the impact of the satellite internal signal reflection of the PRN1 (SVN49) GPS satellite on all L1 and L2 signals. Here the reflected signals exhibit a path delay of only 10m which forms an extremely hard test case and underlines the high quality of the Triumph correlator design and multipass suppression technique. Overall, the Triumph receivers in the CONGO network showed a highly competitive tracking performance across all signals and constellations, which more than justifies their choice for a geodetic reference network.

As a side note, we may add that a Triumph receiver has also recently been proposed to fly as part of a European experiment on the International Space Station (ISS). Besides low noise, high quality measurements, the receiver has demonstrated a superior cold start time-to-first-fix of less than a minute in signal simulator tests under the extreme dynamic conditions of an Earth orbiting platform.

Even though a growing number of manufacturers is now offering alternative multi-constellation GNSS receivers, we believe that the Triumph receivers offer a highly competitive product (at an attractive price) which presently best fits the needs of our network. A highly responsive technical support and development team has furthermore contributed to continuously improve the receivers and to properly meet all user demands.

Regards and best wishes,

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Oberpfaffenhofen
D-82234 Wessling
Germany

GEO-spatial data accuracy and its legal implications

The paper reflects on the law and standards pertaining to data accuracy and its legal implication due to the lack of accuracy by tracing the source or basis of data inaccuracy i.e. primary data source, processing of the data and the human factor.

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Department of Survey
and Mapping Malaysia

GIS was first introduced in Malaysia about a decade ago. Amongst the major issues that arose, was the absence or lack of digital geospatial data. GIS users then, needed to digitize their own data from hardcopy maps or survey plans to convert them to digital data. This conversion was certainly time-consuming and expensive, so much so, that accuracy of data was not of paramount importance. At present, with the realization of GIS as a tool capable of storing massive data, manipulating, displaying and querying, modeling, visualization applicable to multiple discipline, has lead to a rapid demand for GIS data and spatial data. The producers and suppliers of these data are no longer restricted to the Department of Survey and Mapping Malaysia as the government agency for mapping, but GIS users can now obtain digital geospatial data from other government agencies such as the Agriculture Department, Local Government Authority, Department of Director-General of Lands and Mine as well as commercial data suppliers and geographic service providers. Consequently, the problems today are caused more by the increasing availability of digital geospatial data rather than the absence or lack of them.

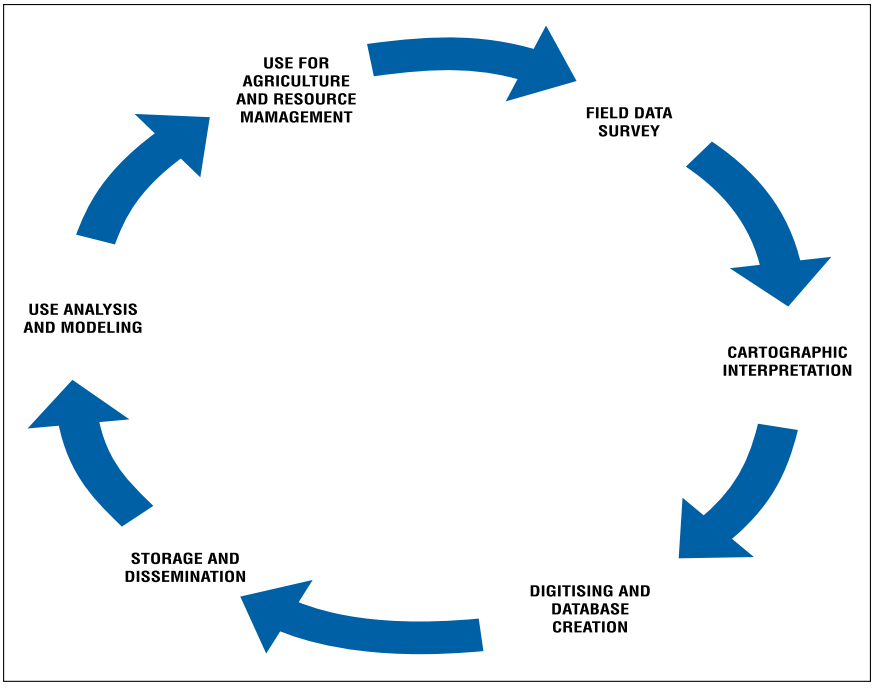

Fig 1: Uncertainty exist in every phase of the life cycle of geospatial data

Due to the scores of available data, users are in a dilemma as to which data to access and what is relevant to their needs. Very often, users are simply unaware of the types of data that are in existence and its location. To add to their predicament, with the numerous data providers, the users also have to choose from which acceptable or correct source to access and use, as data may be available from different sources. Disparate data from these sources, though could be integrated, are usually incompatible in terms of storage format, map projection, map scale, symbols, accuracy, and other cartographic specifications. These data therefore need to be evaluated and most often converted. Hence the question of merits of the data came into being.

Users' perception of GIS data has been positive as they generally believe that it is accurate and reliable. The users of GIS data in Malaysia can be categorized into four broad groups, namely, the experts in GIS, the moderate users, the less expert users, and the non-expert users. The non expert users are often impressed by the beguiling attractiveness and the high aesthetic quality of cartographic products from GIS so much so the accuracy of data is not of much concern. This group of users usually use GIS to display graphics for reports. Although many use GIS, they however, seldom question the accuracy and reliability of this data. Matters such

as the map scale in use, the map projection adopted, and above all, the reliability of the base map from which the map is derived were not often broached. While not realizing these factors can affect their decisions, users interpret the information in GIS data according to whatever knowledge and experience they possessed. On the other hand, expert users such as the land surveyors, due to the nature of their profession, emphasis the need for the data to be precise, accurate, relevant and complete. GIS professionals that undergo formal education in GIS both locally and especially from abroad by now know the difference between GI System and GI Science. However many professionals from other disciplines still maintain GIS as a tool for decision making, although some may now know how to use GIS, to do prediction or to model their alternative solutions. Unfortunately these professionals have little or no knowledge of map making and surveying and hence fail to assess the quality of the data used. Moreover, their exposure to GIS is limited to short term training or courses on GIS which are inadequate in content. It can be summarized that Malaysians, except for professionals whose job requires the use of maps, are mostly not accustomed to map reading in their daily activities. Therefore it is understandable that users may not be aware of the accuracy of GIS data.

Geospatial data production

Data Life Cycle

It is observed that changes that occur during the data life cycle (Figure 1) may affect data accuracy. As has been pointed out by Russell G, Congalton H, Todd Morer in their book Quantifying Spatial Uncertainty in Natural Resources : Theory & Application for GIS and Remote Sensing, (2000), common occurrence of changes of data in its life cycle are: during observation;

- during interpretation of observations, e.g. interpretation of vegetation boundaries on air photographs which creates linear entities;
- during digitization e.g. replacement of a smooth, analogue line on a map with a polyline in GIS database
- during resampling associated with projection change or change of spatial resolution: generalization of data; &
- during assembly of results in support of decision or for archiving

In addition to the occurrence of changes during the data life cycle which may affect data quality, the following circumstances show instances when inaccuracy comes about. Geometric incompatibility occur when digital geospatial data captured from different map sheets or obtained from different sources fail to match. This may be due to changes to the geo-referencing standards in which new datum replaces old datum. These problems frequently occur during the transitional period when geospatial data referenced to original datum and new datum are in concurrent use.

Another instance where inaccuracy occurs is during the data collection stage where geospatial data is collected at different scales and with different map projections. National small-scale (1:750,000 and 1:500,000) and medium scale (1:50,000) maps were based on the cylindrical Rectified Skew Orthomorphic projection. On the other hand, large scale cadastral maps (1:5,000) is based on the rectangular grids of the Cassini Soldner projection. Data inaccuracy may also occur even when similar map projection and similar scale were used as the maps are produced by different agencies for different purposes at different times. It requires reconciliation of mismatching features across map boundaries which is clearly not a trivial task requiring human decisions to apply logic to resolve the problem. Another common phenomenon that causes data inaccuracy is the quality degradation due to time. Although data collection and digitizing are carried out using relatively stringent specifications as a rule, the same level of requirements is not always enforced when digital databases are updated. This has resulted in the degradation of geometric accuracy in the contents of the database. It also tends to invalidate the data quality information attached to the metadata of the data sets concerned.

Quality is also degraded when digital databases are not maintained properly. Ideally, a geo-database is a faithful snapshot of the status of human activities and natural features that are found at a particular geographic area of interest at a specific point in time. When these features or activities change, the database must also be updated accordingly. This requires continuous monitoring of human activities and the natural environment in order to check all the changes that have occurred. When such database is not updated, it will lead to serious uncertainties when data is used for time-sensitive spatial problem solving.

Data producers/ providers

In Malaysia, geospatial data producers could be conveniently categorized into two, i.e. government and private sector data producers. Most, if not all of these producers rely on the Department of Survey & Mapping, Malaysia's (widely known by its Malay acronym JUPEM) cadastral parcel fabric or topographic data as the base data to collect and produce their own geospatial information. At national level, a committee known as the National Malaysian Spatial Data Committee (formerly called the National Mapping Committee) was formed to coordinate the data acquisition activities of these government geospatial data producers.

Related issues of data acquisition and production, including addressing the needs of members and data quality were worked upon by the various sub-committees formed under it. The activities of geospatial data producers in the private sector were however left uncoordinated and not very much controlled except for the conduct of cadastral surveys and production of cadastral survey data. Information on their activities are only known in two circumstances, i.e. when application is made to JUPEM to collect data and when those acquired data were submitted to JUPEM to obtain clearance for geospatial information production. Unlike in the case of cadastral data,

vetting of other geospatial data by JUPEM only involves the filtering of security sensitive information, and not quality or more specifically accuracy inspection.

JUPEM remains inarguably the major producer and provider of geospatial data in Malaysia. It retains ownership over those data in the form of copyright over its product. Nevertheless, data ownership has brought about issues of legal liability founded on the "harm-based concept" in which harm or injury incurred as a result of errors or shortcomings or incorrect decision could well be due to data inaccuracy. In such instances, in determining the liability of parties involved in the handling of geographic information, i.e. from the original data providers/ producers, software producers, secondary producers and finally the users, the law will look at those in the information chain and consider whether they have exercised appropriate standard of duty to prevent the occurrence of the damages. The law that is applicable to ascertain liability is the law of contract and tort. However, there is no specific legislation on the matter. JUPEM had in the past provided disclaimers exempting them from liability, on its printed maps and recently, on its digital map products; however, other government agencies had varied practices pertaining to this matter. Although there has not been any known litigation against them, all currently acknowledged the fact that users are getting more sophisticated and increasingly aware of their rights and as such many had taken steps to protect themselves in the eventuality of providing inaccurate data to their clients.

However, the liability in geospatial products and services relating to computerized geographic information systems is difficult to determine by traditional legal theory. This is because of the wide array of current as well as potential application of geographic information technologies. Each application requires integration of information specific to the application and often will involve different attributes, analytical method, spatial features and accuracy requirements. Other legal issues that have to be tackled by JUPEM and other data providers should include identifying duties which are mandatory as data providers regarding the quality of data; duties that every professional is expected to do (Bedard, Devillers, Gervais & Jean-soulin, 2004). Among these duties are the responsibilities of informing users about the datasets, that not only provide users with information pertaining to the content of the data but the limitation or defect or potential risk in the data utilization. In other words, the data producers need also consider users' intended usage of the data and warn them accordingly. These legal obligations or ethical requisites may be provided under the code of conduct as provided by the Licensed Land Surveyors Act 1958 (Revised 1991) or the consumer protection legislations.

Data accuracy

The standards of data accuracy vary from one producer to the other, and may be very significantly different due to the fact that their production serves differing purposes. In the case of JUPEM, their town and city maps are produced at scales ranging from 1:1,250 to 1:10,000; the planimetric accuracy of these maps range respectively from 0.6m to 5.0m. Additionally, topographic maps are produced at scales of 1: 25,000 and 1: 50,000 and their planimetric accuracies are 12.5m and 25.0m respectively. On the other

hand, the height accuracies would be at half the contour intervals depicted on those maps.

Another source of geospatial data produced by JUPEM is the cadastral survey database. The database was originally developed through the keying-in of bearing and distance values appearing on certified plans, which were derived from actual ground surveys. These cadastral surveys vary in accuracies as they were performed previously under three different categories or classes, according to the needs of meeting the required level of accuracies; for instance surveys in town areas would need to achieve higher than 10cm level of accuracy, whereas in the countryside accuracy of 50cm is considered adequate. Currently, geospatial data produced from the conduct of cadastral surveys evidently were the most accurate and as such were relied upon to serve as base data for geospatial data production by others. With the most dependable accuracy attribute, it also served as one of the core datasets of the nation's spatial data infrastructure.

Beginning 2006, the development of the National Utility Database was started by JUPEM, whereby data on the location of underground utilities such as gas, water and sewage pipelines as well as telecommunication and electric cables were captured and stored in the said database. Those data were initially sourced from the utility providers and due to the differing reliability of the information provided, they had to be segregated into four quality levels, i.e. Quality Levels (QL) A to D, with QL A being the highest level in terms of accuracy, with ±10 cm planimetric and height (depth) accuracies.

Other governmental producers of geospatial data such as the Departments of Agriculture, Mineral and Geoscience, Planning, Forestry etc., have their own accuracy criteria to meet their needs and specifications but is clearly not as demanding as that of JUPEM.

Apparently, the need for high accuracy geospatial data is most evident in the case of underground utility data production and use. It would be obvious that erroneous data can lead to erratic digging in the course of emplacing new facilities and this could further cause accidents resulting in extensive damages, including the loss of lives. The need for highly accurate cadastral surveys too has been recognized as being imperative and given a lot of emphasis in the past. As such, concerned surveys have been traditionally very tightly regulated and this has resulted in a reliable cadastral survey system that underpins the highly progressive land market of Malaysia.

Geospatial data accuracy specifications or statements were in the past not given much attention. Nevertheless, over the last decade or so, demands have been made by users for data producers to publish quality or at least accuracy statements for their data. JUPEM has responded to this call by publishing data accuracy statements in the metadata published through their on-line JUPEM Geoportal (a dedicated departmental website to provide on-line sales of data and services to users).

Efforts to standardize the measure of data quality (including data accuracy) and publishing them had been initiated over the last few years. JUPEM has taken the lead in this effort, whereby the task of determining data quality through field measurements and verification had been conducted for the map sheets that they had produced. This form of verification, albeit laborious, is deemed necessary and the outcome of this quality check is published in the metadata produced by the department. JUPEM had also been engaged in developing the data quality standards which would eventually be utilized by all geospatial data producers.

Legal implication from data inaccuracy

Malaysian is a non-litigious society. There is no known legal suit pertaining to injuries or damages arising from data inaccuracy. However, court cases with regard to damages suffered as a result of data inaccuracy, in developed countries where GIS originated are on the rise. Issues of liability as a result of loss of earnings, opportunities, property and even life gave rise to questions of ownership or authorship which have become more uncertain as data can be easily manipulated and mixed with data from other sources, sometimes of unknown lineage and perhaps at inappropriate scale. Liability has been shown to possibly arise from inaccurate, incomplete and misleading information of data as well as incorrect decisions. The first indications that there are serious problems with the data are when accidents take place (Cho, 2005).

It has to be noted that on the international front, Malaysia had on two occasions appeared in the International Court of Justice in disputes with her neighbors, Indonesia, over the islands of Ligitan and Sipadan, and with Singapore, over Pedra Branca. Amongst a multitude of factors put forth in the arguments, aspect of data inaccuracies was also hinged upon in both of the aforementioned cases.

Since there are no court cases from Malaysia to illustrate the damages or injury that occur owing to data inaccuracy, the following cases from USA and Australia are referred to indicate the legal implication as a result of error in maps, that can be fatal:

Case 1

According to a report in the US journal Point of Beginning as cited by the Asian Surveying and Mapping (11 March 2009), mistakes by surveyors in Texas are being blamed for millions of dollar losses suffered by local landholders as a result of flooding in the aftermath of Hurricane Ike, the third most destructive hurricane in the USA. Some of the damage in the US was due to flooding, where housing had been built below the Base Flood Level. This is a contour defined by the Federal Emergency Management Agency to correspond to a 100 year flood level. The position of the Base Flood Level was fixed by the National Geodetic Survey long ago and marked by concrete and brass monuments. In the 1980's the Federal Emergency Management Agency (FEMA) re-measured the contour and found that the flood plain was about a meter above the old marks. It issued a new map that become the document of reference for insurance companies and other authorities. However, the surveyors continued to rely on the old elevations. As a result of the mistake made by the surveyors, 20 homes near the town of LaBelle were built in the flood plain as people who thought their new homes

were being built above flood level were actually building a meter below it. To add to the homeowners' nightmare, they had no flood insurance and FEMA would not permit them to rebuild their homes because they were in the flood plain.

Case 2

Four New South Wales, National Parks & Wildlife Service (NPWS) officers were killed from smoke suffocation in a burn-off operation. The officers were given maps that showed two possible escape routes, but which ended in impenetrable bush or line of cliffs. The Senior Deputy State Coroner informed the court that there were deficiencies in the maps used in the operations as information contained in the map issued by NPWS showed a cleared hilltop, which potentially could have provided shelter from the fire. Unfortunately, the map did not show a 30m cliff which stood between anyone trying to escape the fire and the cleared area. The map also showed a path known as Wallaby Track running directly towards a local motorway. In reality this path twists into impenetrable bush. It was found by the court that the original botanical map had not been ground-truthed to include specific details and did not mark areas with safe refuges to retreat to as required in the fire management procedures guidelines (Cho, 2005).

The above two cases demonstrate the classic issues of standards to be attained if liability is to be avoided. The duty to take care, the responsibility of due diligence to those who may be affected by a lack of care, the reliance on information to one's detriment, and the subsequent injury, damage and loss that occurs, are established legal standards. Such standards are set either by statutory mandates or through the common law. In Malaysia, however, there's no statutory mandate in order to ensure compliance. However, the common law of tort may be applicable in failure to meet the required standard of care by the profession.

Conclusion

The rapid growth of GIS users in Malaysia has raised the need for data accuracy and the appropriate management of these data. There is no specific law concerning data quality, and no consistent legal framework on the management of GIS or geospatial data; what exists is simply a patchwork of self regulation in the form of government circulars and statutes. It is thus important that Malaysia have a codified policy on managing geospatial data as the country moves towards a spatially enabled government. This will enable relevant bodies to be given statutory mandate to ensure effective and up to date collection of data and the imposition of standards to be followed by data producers so as to ensure data quality. It is also important for the government and institutions of higher learning to give adequate emphasis in formulating appropriate programs to create awareness on the importance of data accuracy.

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This was an invited paper at the Eighteenth United Nation Regional Cartographic Conference for Asia and the Pacific , Bangkok, 26-30 October 2009.

Into the orbit

Latest Indian RS Satellite Cartosat-2B and a 'Dream' of students

India's Polar Satellite Launch Vehicle (PSLV-C15) successfully launched CARTOSAT-2B from Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota on 12 July 2010.

In addition to CARTOSAT-2B; PSLV-C15 carried four auxiliary satellites namely STUDSAT a pico-satellite weighing less than 1 kg, built jointly by students from a consortium of seven engineering colleges form Karnataka and Andhra Pradesh, India; two nano satellites NLS 6.1 and NLS 6.2 from University of Toronto, Canada; and ALSAT-2A, a micro-satellite from Algerian Space Agency.

along as well as across the direction of its movement to facilitate imaging of any area more frequently. The satellite also carries a Solid State Recorder with a capacity of 64 Giga Bits to store the images taken by its camera.

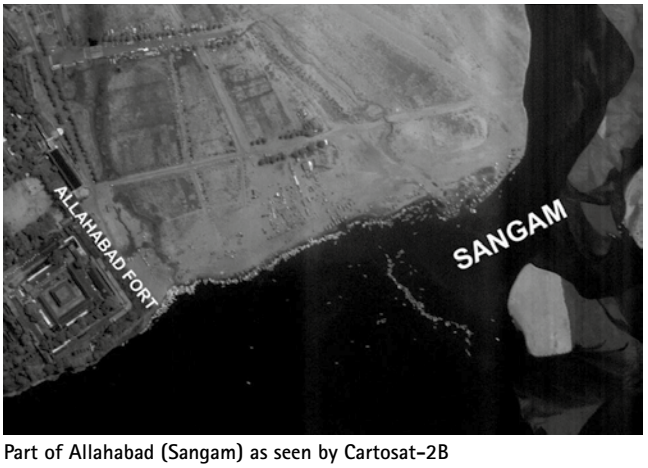
The satellite's health will be continuously monitored from the Spacecraft Control Centre at Bangalore with the help of ISTRAC network of ground stations at Bangalore, Lucknow, Mauritius, Biak in Indonesia, Svalbard in Norway and Troll in Antarctica.

The initial phase of operation of the satellite has been successfully completed.

STUDSAT – a Pico Satellite	
Mission:	Experimental / Small Satellite
Dimensions:	10 cm x 10 cm x 13.5 cm
Weight:	About 850 gm
Volume:	1.1 litre
Altitude:	630 km
Orbit:	Polar Sun Synchronous

STUDSAT has the objective of promoting space technology in educational institutions and encourage research and development in miniaturized satellites, establish a communication link between the satellite and ground station, capture

Part of Madurai city as seen by Cartosat-2B



Part of Allahabad (Sangam) as seen by Cartosat-2B

CARTOSAT-2B

The 694 kg CARTOSAT-2B is the seventeenth remote sensing satellite of India. Data from the satellite will find applications in cartography at cadastral level, urban and rural infrastructure development and management, as well as Land Information System (LIS) and Geographical Information System (GIS).

CARTOSAT-2B carries a state-of-the-art panchromatic camera (PAN) whose imagery will have a spatial resolution of 0.8 meter. The camera has a swath of 9.6 km. The highly agile CARTOSAT-2B is steerable up to ± 26 degrees

The camera has been switched on, and images of high quality are being received. *http://www.isro.org/pressrelease/scripts/pressreleasein.aspx?Jul21_2010*

STUDSAT

STUDSAT (Student Satellite) is a unique satellite technology endeavor undertaken by under-graduate students from seven different Academic Institutions in India under the guidance of the Indian Space Research Organization (ISRO). STUDSAT is the first Pico-Satellite being launched by India.

the image of earth with a resolution of 90 meters and transmit the payload and telemetry data to the earth station.

The subsystems of the satellite include: Communication sub-system, power generation and distribution sub-system, attitude determination and control sub-system, on-board computer, payload (camera), mechanical structure. *http://www.teamstudsat.com/gallery.html*

A Ground Station has been established in Nitte Meenakshi Institute of Technology (NMIT), Bengaluru to communicate with STUDSAT. On 12 July 2010 the STUDSAT beacon signal was received at

Where there is a will...there is a way!

The idea for the STUDSAT project crystallized during the International Astronautical Congress, 2007, between four students from different academic institutions, from Hyderabad and Bengaluru, after their epochal interaction with the Project Director of Small Satellites, ISRO Satellite Centre.

The initial student team completed the conceptual design of the satellite. They then approached their institutions to persuade them to contribute funds for the realization of the ambitious project. The institutions wholeheartedly supported the team.

The team and institutions then approached ISRO for a Preliminary Review of the Student Satellite project. After a detailed review, ISRO approved the project. Subsequently, the team grew to around 45 students from ten different academic institutions. Of the ten participant colleges, seven formed a consortium in order to sponsor the project. An internal MoU was signed between the colleges, and they chose Nitte Meenakshi Institute of Technology, Bengaluru as their representative to sign the official MoU with ISRO on their behalf.

the tracking station in NMIT. It was also heard by HAMs all over Bangalore. On 15 July 2010 NASTRAC received the Telemetry Data with packets separated and confirmed the satellite is in mission mode.

The satellite has thus completed the beacon mode of communication and has entered the mission mode, where in it will transmit encrypted data at 437.505 MHz. *Based on material available at: www.isro.org and www.teamstudsat.com*

"Our strategy is to provide best services meeting the user demand"

says Shri KR Sridhara Murthi, Managing Director, Antrix Corporation with reference to the Indian Remote Sensing Satellite.

What are the added features in CARTOSAT-2B as compared to CARTOSAT-2A? What will be its marketing strategy?

CARTOSAT-2B is an identical satellite of CARTOSAT-2A and is meant for continuity of services. They are not available for commercial distribution. As of now it is only available for use of government of India.

China has also launched a Remote Sensing satellite recently and is planning to launch a high resolution mapping satellite in 2011. Do you think the competition is going to get tougher or the market is big enough for all?

There are many developments happening and resolution of satellites is improving. It is the trend of the day and even many developing nations are coming up with small and micro satellites. As the satellites are increasing the technology is developing, the demand is increasing so are the applications. So, though competitors are increasing, the market is also expanding and there is space for everybody to play.

Our strategy was never to directly compete with anyone in the international market since these satellites are not purely commercial in nature. Our strategy is to meet all our domestic needs with our own satellites and sell the spare capacity to international users.

We hope to continue to play a lead role with our large constellation of satellites, with more satellites in the discussion or planning phases. We welcome more providers coming in and more satellites being available.

One advantage that Antrix has vis-à-vis its product portfolio when compared to other such service providers globally?

The uniqueness of the product portfolio is the diversity of the data and continuity of the data services. Data availability is assured even for long term projects. Also it is the largest constellation and also cost effective. The data provided is technologically equal and the dollars paid per imagery are relatively lower.

What is your concern about the remote sensing market in the days to come?

There is no concern about the technology or the satellites. But there is a concern about the turn around time and about meeting the customers' demands in a timely manner. There is a gap between the expectations and availability. So we have to address issues of better delivery mechanism, faster turn around time and better technology. Earlier users asked for stereo data, then high resolution, now they want multi-spectral high resolution and multi-spectral stereo, so the needs are expanding. Our strategy is to provide best services meeting the user demand.

The International Committee on GNSS 2010 report

The ICG has published a report on "Current and Planned Global and Regional Navigation Satellite Systems and Satellite-Based Augmentation Systems (SBASes)," which provides an overview of the current status and plans for the world's GNSS systems and associated regional and SBASes. It is based on the reports submitted by the members of the ICG Providers' Forum on their planned or existing systems and on the policies and procedures that govern the service they provide. The purpose of this publication is to provide the user community and receiver-producing industry with a clear and consistent description of the global and regional systems that are currently operating and that will operate in the future. In order to reflect changes that will take place in the future, the publication will be updated as necessary. *www.unoosa.org*

Small variance noted in L5 signal

Researchers at the German Aerospace Center (DLR) have found a small variance in the L5 signal on GPS IIF-1. The signal variation results in no more than a 5-cm error with a predictable periodicity of about 6 hours. DLR also reports that the signal appears to be "hot" or stronger than anticipated or advertised by about 1/2 db. Initial reaction from the GPS Wing and Air Force experts at Schriever Air Force Base is that the signal fluctuation appears to be temperature-related, as the periodicity correlates directly to the temperature extremes the satellite is experiencing at this time of year in its MEO orbit. *www.ngs.noaa.gov*

IG-500N: GPS aided miniature AHRS

The IG-500N is a small GPS enhanced miniature Attitude and Heading Reference System (AHRS). It includes a MEMS based Inertial Measurement Unit, a GPS receiver and a pressure sensor. It provides a precise and drift-free 3D orientation and position, even in high G maneuvers at high updates rates, up to 100 Hz. *www.sbg-systems.com*

FAA asks industry for GPS backup ideas

The US FAA will hold a 3-day public meeting in August, in Stanford, California to gather industry ideas on alternative positioning, navigation and timing (APNT) methods that could be used if GNSS services are interrupted. At present, the FAA uses a variety of non-GNSS equipment, including distance measuring equipment, VHF radio, ILS and radar surveillance, for APNT services. *www.flightglobal.com*

Use of foreign GNSS services to strengthen GPS authorized

A recently announced U.S. National Space Policy says that foreign GNSS services may be used "to augment and strengthen the resiliency of GPS." In a document that underlines the Obama administration's intention to rely more on international cooperation in space-related activities and "energize competitive domestic industries to participate in global markets," the new policy reaffirms recent efforts "to engage with foreign GNSS providers to encourage compatibility and interoperability, promote transparency in civil service provision, and enable market access for U.S. industry." The policy document charges U.S. governmental departments and agencies to identify potential areas for international cooperation including GNSS and related fields. *www.grace.ac.uk*

U.S. Air Force may slow planned GPS III production pace

The primary payload for the U.S. Air Force's next-generation GPS III navigation satellites recently was cleared for production even as the service contemplates slowing down the program based on the health of the current GPS constellation. The U.S. DoD, in a 2010 budget reprogramming package, is seeking permission to redirect $2.7 million that had been appropriated for GPS III parts procurement to other activities. It is not clear whether the request has any connection to a possible slowdown of the program. *www.spacenews.com*

Egis to study on impact of solar activities on GNSS-based aviation

Taking into account upcoming high solar activity, a need was felt for EUROCONTROL the European Organization for the Safety of Air Navigation to study ionosphere effects on GNSS applications to plan mitigation measures for future GNSS-based aviation applications. Egis has been awarded a contract with EUROCONTROL in partnership with the French Air Navigation Service Provider, the French Space Agency, the Civil Aviation University as well as CLS and M3 Systems companies. *www.egis.fr*

GPS new tool in reading tropical storms

One of the new pieces of data that meteorologists are using to help predict the intensity of tropical storms is GPS signals. GPS signals, transmitted by satellite and received on the ground, are slowed down and bent by water vapor in the earth's atmosphere. The effect used to be considered a problem, as it related to GPS systems, but now scientists have learned to "read" this effect to measure the area's water vapor content. Moisture rich air can make a hurricane more intense, while dry air can weaken it.

In the past, it was difficult to collect such water vapor measurements over the ocean. Frisbee-sized satellite antennas have been placed atop stationary platforms in the Gulf of Mexico, and scientists will incorporate this new GPS water vapor data into forecast computer models, which should result in improvements in storm forecasts. *www.spokesman.com*

GPS to curb electoral irregularities

Interim Independent electoral Commission (IIEC) with the support of strategic partners is working on a GPS-based system for mapping polling centers in Kenya. The technology will identify the electoral units based on constituency rather than administrative boundaries *www.standardmedia.co.ke*

GISRoam brings GIS to the iPAD

Cogent3D GISRoamT is a new iPad and iPhone application that allows the user to load, view, collect, search, edit and save ESRI GIS Shapefiles. It includes searching, feature attribution editing, and GPS enhanced creation of new Polygon, Line, and Point features in new or existing Shapefile layers while you roam. *www.Cogent3D.com*

Sybase SQL Anywhere 12

Sybase has released its SQL Anywhere 12 database and synchronization solution. It is optimized for mission-critical database applications running outside traditional data center environments requiring little or no onsite IT support. Its enhancements include support for storage and synchronization of spatial data, iPhone devices and large-scale synchronization environments; and new self-management features. *www.sybase.com*

Space expertise helps expo visitors

Insiteo supported by ESA's Business Incubation Centre has developed a new mobile phone indoor navigation system, which will soon help the six million annual visitors find their way around at the largest exhibition centre in Paris. This navigation system is effective for large inside spaces such as exhibition grounds, because the vast, complicated layouts of such tradeshows can be confusing. *www.insiteo.com*

TomTom extends global coverage

TomToms latest digital map products, including Tele Atlas MultiNet 2010.06 now cover more than 32 million km across 102 countries and territories globally. The map database is constantly validated by millions of drivers who use it in GPS devices, smartphone applications and online. Nearly half a million edits were sourced from community input in the latest release. *www.tomtom.com*

Magellan launches Next Gen of eXplorist

Magellan's new eXplorist 510, 610 and 710 devices allow adventurers to navigate to outdoor destinations worldwide, capture geotagged photos along the way, and share their experiences online when they return home. All three new eXplorist handheld GPS units come equipped with a camera, microphone, and speaker. *www.magellangps.com*

Map Oil Spill with mobile app

Trimble has launched Map the Spill, a free mobile app and website that empowers Gulf Coast residents and the public to report on the oil spill. It allows those directly and indirectly impacted by the spill to capture and chronicle what they see happening to the land, sea and wildlife in their areas. *www.trimble.com*

At a Glance

- Bentley acquires minority interest in Charlotte, N.C.-based BLUERIDGE Analytics, Inc., provider of SITEOPS
- The Urban Redevelopment Authority (URA) of Singapore, ESRI Inc. and ESRI Singapore to collaborate in developing and integrating 3D digital urban model system into the ArcGIS 10.
- Infoterra has launched a new Geographical Software Business Unit - Symetri Geo
- Telogis acquires Remote Dynamics.
- Autodesk and FARO announces their collaboration.
- Abu Dhabi Systems and Information Centre received the 'Making a Difference Award' from ESRI
- Israel has launched an advanced remote sensing satellite, OFEQ 9
- First Indian forestry satellite in 2013
- Lockheed Martin has opened a GPS exhibit in the UN Office at Vienna.
- Russia to earmark 800 million USD for a new cosmodrome near the town of Uglegorsk in the Far Eastern Amur region.
- According to ABI Research market data, global number of traffic information users will exceed 370 Million by 2015.
- According iSuppli, the number of smart-phone-based OEM and aftermarket on-board navigation systems is projected to rise to 81 million units in 2010.
- KEE Technologies Pty Ltd. will now be known as Topcon Precision Agriculture Pty Ltd.

Galileo update

Users drive innovation in Satellite Navigation

A Living Lab is a user-driven open innovation system that speeds up the innovation process by addressing the user's needs. In a Living Lab firms, public agencies, universities, institutes and users collaborate for creating, prototyping, and validating new service-products and societal infrastructures in realistic contexts such as cities, villages and rural areas or industrial plants.

For the first time in 2010 the European Satellite Navigation Competition will award a special prize for the best application ready to be tested in a suitable Living Lab. The 'GNSS Living Lab Prize' will be awarded to three winners, who will get the opportunity to conduct a 'reality check trial' in a suitable Living Lab with the involvement of relevant user communities and potential future customers. *www.galileo-masters.eu*

Inauguration of Galileo in-orbit test facilities in Redu

ESA's Redu centre in Belgium has inaugurated its in-orbit testing facilities for Galileo. As part of the Galileo programme, the infrastructure at Redu has been expanded to host Galileo's satellite in-orbit testing facilities and a Galileo sensor station. The main purpose of the testing facilities is to verify the performance of the payloads on the four Galileo In-Orbit Validation (IOV) satellites. The testing involves measuring radio frequency and baseband parameters for the navigation L-band downlink and the C-band uplink. The first two IOV satellites are scheduled for launch in mid-2011 atop a Soyuz rocket from Europe's Spaceport in French Guiana. *www.esa.int*

ESSP certified as Air Navigation Service Provider

The European Satellite Services Provider (ESSP SAS) received a certificate of Air Navigation Service Provider according to the Single European Sky Regulation 2096/2005. This is an important milestone towards making the EGNOS Safety of Life (SoL) services available to the aviation community. The certification was delivered by the French National Supervisory Authority (NSA - Direction de la Sécurité de l'Aviation Civile) in cooperation with the national supervisory authorities of Belgium, Germany, Italy, Portugal, Spain, Switzerland, and United Kingdom. *www.esa.int*

I²GPS

I²GPS (Integrated Interferometry and GNSS for Precision Survey) is a project that aims at developing a novel, integrated approach to the use of synthetic aperture radar interferometry (InSAR) and GNSS for use in the monitoring of subsidence, tectonic changes or other environmental hazards, which can only be identified by millimeter-precision surveying techniques. The consortium is composed of Systems Engineering and Assessment Limited, Delft University of Technology, Geological Survey of Slovenia, Septentrio Satellite Navigation NV, Société d'Applications Technologiques de l'Imagerie Micro-Onde SA, Linwave Technology Limited, and Fugro NPA Limited. *www.i2gps.eu*

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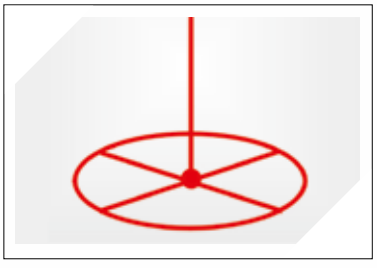

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DigitalGlobe: High-resolution imagery for handheld GPS, releases Ortho Product Series

DigitalGlobe is to provide high-resolution imagery for DeLorme's Earthmate series, including the PN-30, PN-40 and PN-60 models. Hikers, climbers and other outdoor enthusiasts will be able to update their GPS device with accurate imagery. Its Ortho Vision line is designed for professional users in need of quality images for analysis and identification. Images classified as Ortho Vision Premium will feature less than 3% cloud cover; geometric breaks less than one meter and tonally balanced imagery in addition to no haze, pollution or fog. *www.digitalglobe.com*

Food grain output in India seems stagnant for 10 years

A nine-member team of scientists from NASA, the Boston University and the Indian Institute of Tropical Meteorology, Pune, analyzed the satellite remote sensing data from 1982-2006 and has confirmed that the growth rate of food grain production in India has been stagnant in the last decade. *http://economictimes.indiatimes.com*

Remote Sensing Applications (e-Book)

National Remote Sensing Center, India has brought out a book on "Remote Sensing Applications" covering land, water, atmosphere and natural disasters. The book has been compiled and edited by P.S. Roy, R.S Dwivedi and D. Vijayan. The book can be viewed/downloaded at *www.nrsc.gov.in/Remote.html*

Topcon's IP-S2 HD Mapping System

Topcon Positioning Systems has released the IP-S2 HD Mapping System – a vehicle-mounted surveying and mapping system featuring a high-definition LiDAR scanner. It includes high-precision GNSS receivers, IMU, vehicle wheel encoder, 360-degree digital cameras and Velodyne's HDL-64E S2.2 LiDAR scanner. *www.topconpositioning.com*

Water resources conservation in China using ERDAS IMAGINE

The Ministry of Water Resources, China recently announced a project that uses ERDAS IMAGINE to facilitate conserving and protecting China's water resources. It is being used to identify the areas where the water is being adversely affected by soil erosion. *www.erdas.com*

FARO introduces break resistant SMR

FARO Technologies announced the release of its break resistant spherically mounted retroreflector as a part of their newly expanded line of laser tracker targets. These new targets are available in three models: standard accuracy, long range, and high performance. *www.faro.com*

Global Forest Monitoring service

DMCii's Global Forest Monitoring service uses satellite imagery to produce easily-understood maps of forest cover change. The service's wide-area forest surveys can be updated annually, monthly - or more often still for areas judged most at risk – delivering the timely data necessary for operational management. It is based around a constellation of six satellites known as the Disaster Monitoring Constellation which work together to provide rapid mapping services. *www.dmcii.com*

Cooperation to promote satellite technology application

JAXA, Japan and the ADB has agreed to cooperate in providing technical assistance to ADB supported projects using satellite data and will work on capacity development on the use of satellite data through the training of persons from national institutions in Asia and the Pacific region. *www.jaxa.jp*

Image analysis toolbox for ESRI® ArcGIS® platform

ITT Corporation announced the third phase of its software technology with the ArcGIS. Building on the multi-year integration of the two platforms, this latest phase will give ArcGIS users the ability to access ENVI tools for analyzing geospatial imagery directly from within the ArcGIS desktop and server environments. *www.itt.com*

DALSA announces expanded capabilities

DALSA announced expanded capabilities including backside illumination (BSI) in custom image sensors for aerospace applications in earth observation and remote sensing. New technologies in multispectral filters allow DALSA to capture images from not only the traditional RGB visible color bands but also a number of near-infrared bands in a single compact and cost effective package. The new custom back side thinning capability enables the high quantum efficiency. *www.dalsa.com*

African observatories will gather biodiversity data

Scientists are pooling remote-sensing satellite data and GIS services for two pan-African digital observatories that will provide accurate and readily accessible information on biodiversity and forest cover for policymakers. Under a grant the European Commission's Joint Research Centre is supporting the development of the observatories. One is the Observatory for the Forests of Central Africa; the other is the Digital Observatory for Protected Areas. *http://allafrica.com*

Inventory of Russian forest using space technologies

Satellite imagery based on the State Forest Inventory Program on behalf of the Russian Federal Forestry Agency is being acquired by ScanEx Research & Development Center. VHR data from SPOT 5 and Formosat-2 satellites (resolution: 2,5m) covering a territory of more than 128 million ha will be delivered in the coming months. *www.scanex.ru*

ArcGIS 10 from ESRI

ArcGIS 10 release makes it much easier to see data in 3D and introduces the notion of time in both visualization and analysis. Users can create, manage, and visualize time-aware data. They can also display and animate temporal datasets as well as publish and query temporal map services. *www.esri.com*

MAPPS asks Congress to revise legislation

In USA, MAPPS has sent a letter opposing proposed legislative language that would limit the use of "precise geolocation information". The draft bill threatens data collection, applications and growth in the private geospatial profession. It believes the current bill language threatens information that is collected by private and government entities to perform E-911 and emergency response management, environmental protection and many other tasks that are conducted by geospatial professionals. *www.mapps.org*

18 domestic firms get nod for Net mapping in China

Authorities in China have approved 18 domestic companies, to be announced soon, to provide Internet mapping services in the country. The domestic companies were selected out of about 30 applicants *China Daily*

Urban Transport Planning in India

Ministry of Urban Development, India has decided to rope in some of the premier technological institute of the country in the planning of urban transport. It has signed MoUs with IIT Delhi, IIT Chennai, NIT Warangal and CEPT University Ahmedabad for setting up of Center of Excellence for Urban Transport Planning and Development. These institutes would work in the area of urban transport design, planning and development of intelligent traffic system, management of BRT etc. *http://pib.nic.in*

Thai Govt invests in GIS to end land disputes

The Natural Resources and Environment Ministry, Thailand, has invested over 2.3 billion baht in GIS as a tool to settle land disputes between locals living in forests and the authorities.

It is scheduled for completion in 2012. It will be a key tool in proving the legal rights to forest land for about 600,000 people living in forest reserves and national park areas, who are now waiting for their land rights to be clarified. *www.bangkokpost.com*

Abu Dhabi city base map

The Municipality of Abu Dhabi City is in the final stage of producing a base map depicting all urban areas within the administrative boundaries of the City Municipality and the Western Region Municipality covering an approximate area of 18,500 square km. The project is intended to build and update the base map and further extend the geographic range of the spatial database. *http://gulfnews.com*

GXP Xplorer desktop product

GXP Xplorer is a new BAE Systems software data library that makes it easy to find and share geospatial data on a local network and across an enterprise. The product is ideal for users in work groups who are searching for images, terrain, features, videos, documents, and other files. *www.socetgxp.com*

GIS to help agriculture in Pakistan

GIS is being introduced in Pakistan to help farmers increase production, reduce input costs and manage the land more efficiently. The GIS would also help manage agriculture by storing, retrieving, manipulating, analyzing and displaying information through maps. *http://pakobserver.net*

Blue Marble Geographics Desktop 2.2

Blue Marble Geographics has released Desktop 2.2 with Geographic Calculator 7.5 and Geographic Transformer 6.2. It features support for raster DEM like Digital Terrain Elevation Data and USGS Spatial Data Transfer Standard. *www.bluemarblegeo.com*

Hexagon acquires Intergraph

Hexagon has acquired Intergraph for a cash purchase price of 2 125 MUSD on a cash and debt free basis. It intends to pursue a rights issue corresponding to 850 MUSD as soon as practically possible following completion of the acquisition. *http://investors.hexagon.se*

Sokkia Singapore renews the Automatic Level lineup

Sokkia Singapore Positioning Sales has released new B series automatic levels – B20, B30 and B40 – that replace the previous lineup of the B and C series. The water protection rate of the B series models has been increased from IPx4 to IPx6. *www.sokkia.com*

Release 2.1 of UltraMap and UltraMap/AT

Vexcel Imaging GmbH announced the release of version 2.1 of its UltraMap 2.1 and UltraMap/AT photogrammetric software. Project-based color balancing, 1-click system reports, and level-2 quality visualization are key new capabilities in UltraMap 2.1. *www.microsoft.com*

Hemisphere GPS: new products

Hemisphere GPS has released the Crescent Vector II OEM board and a broad range of Crescent Vector II GPS compass products: V101 Series, VS101 Series, and LV101 OEM board. The OEM board brings a series of new features including heave, pitch, and roll output, more accurate timing, lower phase noise, and an improved accelerometer. This design provides precise

heading and positioning accuracy even while sitting still. *www.hemispheregps.com*

SPA joins BE Careers Network

School of Planning and Architecture (SPA), New Delhi has joined the Be Careers Network Academic SELECT subscription program. It provides students with lab and classroom access to more than 60 software products; unlimited no-fee home-use software licensing for faculty and students; LIVE training in Bentley's virtual classroom and much more. *www.bentley.com*

New Total Stations by GeoMax

GeoMax has released GeoMax Zoom30 and Zoom20 total station series. It has accXess™ reflectorless measurements technology measuring up to 600 meters, integrated Bluetooth®, USB memory stick port, 36h operating time with one battery, operating temperature down to -30°C. *www.geomax-positioning.com*

Introducing PAD118 with iPPP

Nexteq Navigation announced its PAD118 enclosure, which is equipped with both high-performance RTK and Nexteq iPPP technologies. It offers centimeter level RTK positioning accuracy and better than 10cm single point positioning accuracy with real time precise orbit and clock corrections. It also offers 20cm stand-alone accuracy under the coverage of SBAS. *www.nexteqnav.com*

Rolta signs Agreement with PCI Geomatics and MOU with CBSE

Rolta in an agreement with PCI Geomatics, Canada, has acquired licenses with perpetual rights to the complete portfolio of PCI's geo-imaging technologies, including source code, design and software architecture exclusively for India and non-exclusively throughout the rest of the world. It has also purchased all assets of PCI Geomatics India Pvt Ltd, and has acquired exclusive perpetual rights for these technologies and its customers in the Indian subcontinent. *www.rolta.com*

Rolta has also signed a formal MOU with Central Board of Secondary Education (CBSE) India as the Resource Partner, for providing Geospatial Technology Vocation Course, for XI & XII standard students. It will provide technical assistance, develop and create the curriculum, and also impart advanced training to CBSE teachers across the country. As part of the curriculum for Standards XI and XII, Rolta will provide Rolta Geomatica. *www.rolta.com*

Leica CloudWorx-VR are for 3ds Max, 3ds Max design, and Maya. These plug-ins provide a convenient way for professionals to create more photorealistic models, renderings, and animations based on rich, High-Definition Survey™ data of sites & structures as collected by 3D laser scanners.

Leica GR10 reference station product range is a plug and play setup using a unique receiver hostname and DHCP support. The web interface makes configuration easier, reducing time and training requirements. It supports GPS L1/L2C/ L2P/L5, GLONASS L1/L2 and Galileo L1/E5a/E5b/E5a+b (AltBOC) tracking.

Leica original accessories are offered in three series for differing requirements - Professional 5000 Series meets the demands for precision, reliability, longevity and service; Professional 3000 Series meets standards in exactness, function, consistency and service; and Professional 1000 Series fulfils all requirements of the most common surveying tasks.*www.leica-geosystems.com*

Trimble introduces new solution, unveils Spatial Imaging System

Trimble® Field Inspector solution is suitable for utility infrastructure and smart grid asset maintenance and inspection. It comprised of the Field Inspector software for handheld computers and for Desktop. It is suitable to automate a wide variety of field applications for electric, gas, water, and wastewater utilities etc.

Trimble® MX8 Mobile Spatial Imaging System is a mobile data capture system that combines imaging and laser scanning capabilities to measure objects in 3D to produce 3D, 4D and 5D data sets for spatial imaging projects. The system is ideal for as-built modeling, inventory, inspection, encroachment analysis etc. *www.trimble.com*

Tallysman Wireless launches 9 new GNSS antennas

Tallysman Wireless has released TW2000 Antenna Series, comprised of a wide range of professional grade GPS/SBAS, GPS/GLONASS, Globalstar and Iridium magnet/screw mount and embedded antennas. It features dual-feed, wideband patch elements, which provide enhanced axial ratio over the entire frequency range of the antenna, plus very Low Noise Amplifiers and high performance SAW filters*. *http://tallysman.com*

Galaxeo® to start operation

Galaxeo has started operations - linking geomatics technologies vendors and resellers in Europe, Middle East, Africa and Asia. Galaxeo establishes the link between manufacturers, resellers and end-users and supports long term business development relations. *www.galaxeo.net*

Geospatial PDF App for Apple iOS by Avenza

Avenza Systems released geospatial PDF application for Apple iOS devices including the iPad, iPhone and iPod Touch platforms. It will give field personnel the power to interact with geo-registered PDF maps and images directly from their iOS device. *www.avenza.com*

u-blox expands production capacity

u-blox has expanded contract manufacturing capacity for its' LEON GSM/GPRS module to Brazil. The new production line is intended to meet the rapidly growing demand for wireless modems used for Automatic

Vehicle Location amongst other applications. *www.u-blox.com*

Juniper Systems Mesa Rugged Notepad

Juniper Systems announced the new Mesa Rugged Notepad™ handheld computers. It provides a platform for dedicated field data collection applications that can withstand the extreme outdoor environments. *www.junipersys.com*

Incubator space for GNSS companies

GRACE, based on the University of Nottingham Innovation Park (UNIP) has opened up incubator space specifically for businesses in the GNSS sector. It will now provide an environment for organizations operating in GNSS related domains to incubate new ventures and transform innovative ideas into business opportunities. *www.grace.ac.uk*

Ashtech introduces a new GNSS firmware upgrade for its ProFlex™ line of products, including the ProFlex 500, ProFlex 500 Marine, ProFlex 500 CORS, ProFlex Lite and ProFlex Lite Duo.

Ashtech MB 100 Board is a compact dual frequency RTK OEM board. It is designed to address L1 GPS+SBAS standard applications, L1/L2 GPS+SBAS and L1 GPS/GLONASS + SBAS applications in the smallest form factor and power consumption. It features a variety of output messages and data formats for extensive OEM solution interoperability.

Ashtech MobileMapper 100 is a GIS handheld for high-precision mobile mapping and data collection. It provides real-time sub-meter, to centimeter accuracies and integrates an open operating system, built-in communications and Ashtech's BLADE™ technology. It also supports ArcPad 10. *www.ashtech.com*

China renews Google license

The Chinese government renewed Google's license to operate in the country, with a condition that Google would stop automatically rerouting traffic of Google.cn to its Hong Kong counterpart. Users in the mainland can still access the Hong Kong version but it would require them to click a link. *http://dailycontributor.com*

Topcon releases Spatial Factory Software

Topcon Positioning Systems has released Spatial Factory software, which allows users of the IP-S2 3D mobile mapping system to easily work with the combination of point cloud, trajectory and panoramic image data that comes from the IP-S2. The IP-S2 system incorporates high-precision GNSS receivers, IMU (inertial measurement unit), vehicle wheel encoders, 360-degree digital camera and laser scanners. *www.topconpositioning.com*

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1-3 September
Shanghai, China
www.naviforum.org

ESA International Summer School on GNSS
1- 11 September
Denmark
www.munich-satellite-navigation-summerschool.org/

IPIN 2010
September 15-17, 2010
ETH Zurich, Campus Science City
(Hoenggerberg), Switzerland
www.geometh.ethz.ch/ipin/

ION GNSS 2010
21-24 September
Portland, Oregon, USA
www.ion.org

G-Spatial Expo
19 - 21 September
Yokohama, Japan
g-expo@jsurvey.jp
www.g-expo.jp/en/

GDI APAC
28 - 30 September
Kuala Lumpur, Malaysia
www.geospatialdefenceasia.com

International Astronautical Congress 2010
27 Sep - 01 Oct
Prague Czech Republic
iac2010@guarant.cz
www.iac2010.cz/en

Geospatial Intelligence Summit
28-30 September 2010
Vienna, Austria
www.jacobfleming.com

October 2010

INTERGEO
5 - 7 October
Cologne, Germany
www.intergeo.de

3rd Int Conf on Geoinformation Tech for Natural Disaster Management
19-20 October 2010
Chiang Mai, Thailand
http://www.egeoinfo.net/git4ndm2010/

GSDI-12 World Conference
19-22 October
Singapore
www.gsdi.org

CANEUS - Shared Small Satellites CSSP Int. Workshop
20 -22 October
Tuscany, Italy
www.caneus.org/sharedsmallsats

GEOINT 2010
25 -28 Oct
Nashville, Tennessee, USA
http://geoint2010.com

International Symposium on GPS/GNSS
26 -28 October
Taipei, Taiwan
http://gnss2010.ncku.edu.tw

November 2010

Trimble Dimensions 2010
8 - 10 November
Las Vegas, USA
www.trimble-events.com

XXX INCA International Congress
10 -12 November
Dehradun, India
www.incaindia.org

European Lidar Mapping Forum
30 November – 1 December
The Hague, Netherlands
www.lidarmap.org/ELMF/

November 2011

Regional Geographic Conference - UGI 2011
14 -18 November 2011
Santiago, Chile
www.ugi2011.cl

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