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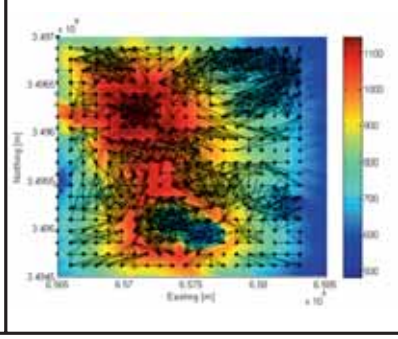

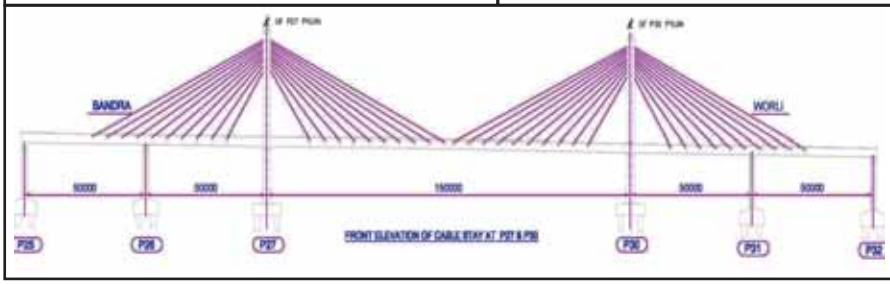

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Columns

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All the ingredients of a mega infrastructure project in India.

Yet, the Bandra-Worli Sea Link has happened (page 7).

The first sea link in India.

Mumbai has a new landmark.

India has a new benchmark.

Bal Krishna, Editor
bal@mycoordinates.org

Sea link- a Sea change

The marvel that has brought this sea change to the life and landscape of Mumbai is the Bandra-Worli Sea Link – the first ever sea link to be built in India

Mumbai: the financial capital of India. A tiny island bursting at the seams with its teeming millions. With real estate prices among the highest anywhere in the world, land is an extremely precious commodity in the city. Expanding the existing infrastructure especially transport has been a nightmare for the city planners.

But, one thing that Mumbai does have plenty of is the sea – surrounding the island on three sides. Finally when push came to shove, with the only connection between the western suburbs and 'town' - the Mahim causeway choked to its limit, the planners looked out to the sea.

The idea about a bridge in the sea seemed far fetched at first, but where there is a will there is a way. Many years in the planning and more years in the making, but finally Mumbaikers can now speed across the Mahim bay on a swanky new 8 lane 4.7 km bridge, cutting the earlier travel time of up to 60 minutes to just 15 minutes.

The marvel that has brought this sea change to the life and landscape of Mumbai is the Bandra-Worli Sea Link – the first ever sea link to be built in India.

The Bandra-Worli Sea Link (BWSL) is a part of the Western Freeway Sea Project, which, in turn, is a part of a larger proposal to upgrade the road transportation network of greater Mumbai. The project has been commissioned by the Maharashtra State Road Development Corporation Ltd (MSRDC) and the Maharashtra Government and has been built by Hindustan Construction Company (HCC).

The entire project was originally conceived as one large project comprising, different components, but in order to accelerate the overall construction schedule, the project was divided into five construction packages. Four of these packages involved work on the island, while one – Package IV involved construction in the sea.

"Package IV"

The largest and main phase of Bandra-Worli Sea Link Project was Package IV which included the construction of Cable-Stayed Bridges together with viaduct approaches extending from Worli up to the Toll Plaza at Bandra end and an Intelligent Bridge System (IBS). The work under this package was awarded to HCC.

The Bridge

The bridge consists of twin continuous concrete box girder bridge sections for traffic in each direction. Each bridge section, except at the cable-stayed portion, is supported on piers typically spaced at 50 meters. The bridge layout is categorized into three different parts:

- Part 1 - The north-end approach structure with Pre-Cast (PC) segmental construction.
- Part 2 - The Cable-Stayed Bridge at Bandra channel is with 50m -250m-250m-50m span arrangement and the Cable-Stayed Bridge at Worli channel is with 50m-50m-150m-50m-50m span arrangement.
- Part 3 - The south end approach structure with Pre-Cast segmental construction.

Toll Plaza

A modern toll plaza with 16 lanes is provided at the Bandra end. The toll plaza is equipped with a state-of-the-art toll collection system.

Intelligent Bridge System

The intelligent bridge system provides additional traffic information, surveillance, monitoring and control systems. It comprises CCTVs, traffic counting and vehicle classification system, variable message signs, remote weather information system and emergency telephones.

The marvel in the making

When one sets out to achieve a first, the challenges are bound to be many. Some problems on the project were unique and needed special solutions, while other problems were those faced on any other such project around the world. The project team of over 3000 workers, HCC engineers, foreign engineers and technicians met the challenges head on and overcame them to give Mumbai its latest landmark.

Foundation and Substructure

The project's site geology consists of basalts, volcanic tuffs and breccias with some intertrappean deposits. This highly variable geotechnical condition of the foundation bed in the intertidal zone needed suitable solutions solutions to lay the foundation and the substructure.

The foundations for the BWSL project consist of 2000-mm diameter piles numbering 120 for the cable-stayed bridges and 1500-mm diameter piles numbering 484 for the approach bridges. The key to success was a program of pier by pier in-situ testing. An extensive subsurface exploration and drilling program (total 191 bores inside sea) was undertaken to define the subsurface stratigraphy, determine the rock types and obtain material properties for optimizing the foundation design. The working load on the approach piles ranges from 700 tons to 1500 tons whereas for the piles below the cable-stayed bridge working load is 2500 tons.

For conducting the load test on the piles, the load to be applied varied from 4500tons to 9600tons. This was accomplished by a careful planning of load test using the Osterberg load cell method.

The award winning Osterberg Cell, or "O-Cell", gets its name from the inventor, Dr. Jorj O. Osterberg. The O-cell is a hydraulically driven, high capacity, sacrificial loading device installed within the foundation unit. Working in two directions, upward against side-shear and downward against end-bearing, the O-cell automatically separates the resistance parameters. By virtue of its installation within the foundation member, the Osterberg Cell load test derives all reaction from the soil and/or rock system. Load testing with the O-Cell continues until one of three things occurs: ultimate skin friction capacity is reached, ultimate end bearing capacity is reached, or the maximum O-cell capacity is reached.

At BWSL, four test locations were selected. Reverse Circulation Drilling method was adopted for foundation construction. The highly uneven foundation beds and the presence of intertidal zone brought in lots of difficulty in terms of Liner pitching. This problem was solved by constructing a gabion boundary at the bed level around the casing, pouring concrete between the casings to make an artificial penetration of the casing. After setting of the concrete under the water, drilling was commenced using RCD.

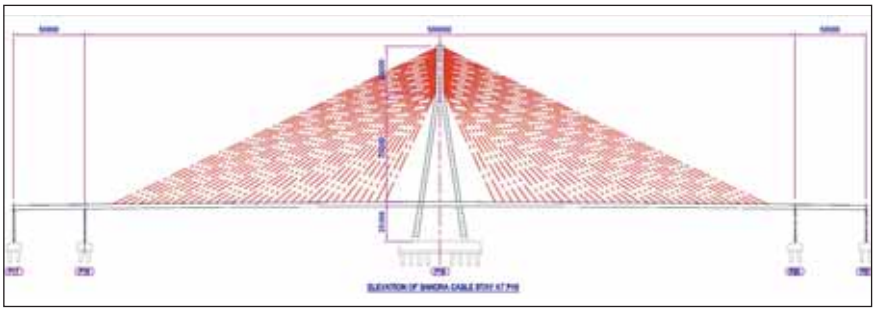
For several locations, cofferdam construction using steel liner and sheet piles was not possible due to very hard and uneven strata. Here the problem was solved using circular steel caissons. These caissons were fabricated outside and towed to location using A-frame barge. The caissons were sunk at the location using counterweights. The unevenness at the bottom was sealed using the gabion method. The benefit of this method was that it completely eliminated deployment of resources like Jack up Platform, Crane, Vibrohammer, Compressor, etc for liner pitching. It also eliminated substantial amount of field works and is pre-fabricated in principle.

Superstructure

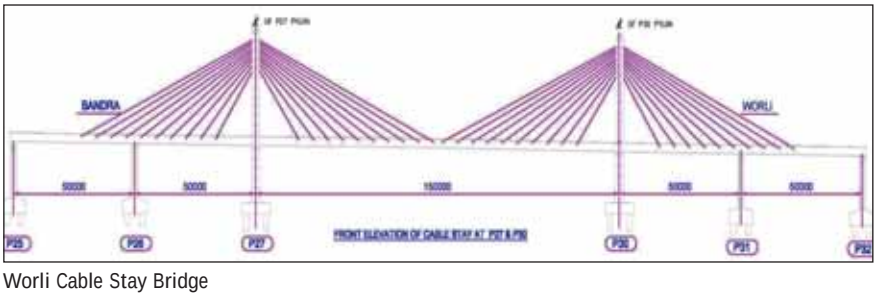
The BWSL Project has (9+2) approach bridge modules. These modules range from 3 continuous span units to 8 continuous span units. The deck of the carriageways consists of triple cell precast box girders supported on piers founded on independent substructure. The Concrete Grade for the superstructure is M60. The average weight of the span is 1800 tons, whereas the heaviest span in the bridge weighed 2000 tons. In addition, the trusses were designed to receive the segment from the already erected deck as well as from barges parked directly under the truss.

The erection gantry was a 1260MT truss designed to erect spans for the superstructure configuration. The unique feature of the truss was the maximum span weight it could handle and that it could launch the pier and EJ segment itself. The truss also had the capacity to align the total span in hanging condition after the gluing was completed. The truss was fully mechanized for self launching and aligning. An individual segment could be aligned on the truss using a set of four hydraulic jacks mounted on each suspension frame. In order to eliminate the casting or erection errors within a span, two wet joints were provided on either end of the span. The wet joints were cast after finalization of the span alignment.

A Typical 50m span of the approach bridges comprises 15 field segments, a Pier segment and 200mm (nominal) in-situ wet joints. During the span construction, all field segments were suspended from the Gantry, glued and temporarily stressed together. Once the gluing operation was



Bandra Cable Stay Bridge



Worli Cable Stay Bridge

Facts not fiction

- India's first bridge to be constructed in open-sea conditions.
- 2342 pre-cast segments for total bridge with varied width.
- 40,000 MT of reinforcement, 23,0000 cum of concrete, 5,400 MT of Post tensioning strands and bars used.
- Osterberg cell technology used for the first time in India to check pile strength.
- Engagement of Asian Hercules for shifting 1,260 MT launching truss from Bandra end to Worli end of the main cable stay bridge.
- Largest span for cable-stayed bridge in India.
- Up to 25-m high pier in open sea, giving ample headroom to marine traffic.
- Use of Polytron Disc in bearings on piers for the first time in India.

The pylon challenge

- The section decreases gradually with height.
- There are horizontal grooves at every 3m height and vertical grooves for circular portion that required special form liners as well as required attention for de-shuttering.
- The tower legs are inclined in two directions, which created complexities in alignment and climbing of soldiers.
- Construction joints were permitted only at 3m level. Inserts were permitted only in horizontal grooves provided at 3m height.

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"This project gave us an opportunity to showcase our equipment"

says Rakesh Kaul, General Manager, Elcome Technologies Pvt. Ltd., with reference to the survey equipment that they supplied for the Bandra-Worli Sea Link.

When did Elcome Technologies first get associated with HCC on the Bandra- Worli Sea Link Project?

Leica equipment has been used on most of the Sea Link projects around the world and based on this experience we approached Hindustan Construction Company (HCC) sometime at the end of 2000 with our range of specialised equipments for the Bandra-Worli Sea Link (BWSL). The first Leica Total Station was supplied by us to HCC in early 2001.

What were the equipment supplied for this project?

To meet the demand for high accuracy coordinate measurements on the BWSL project we supplied high performance Leica Total Stations including the TCA 2003, the TCA 1800, the TCA 1201, the TCRM 1201 R 300 and the TC 1800. We also supplied the SR 510 GPS equipment.

What kind of support did you provide HCC vis-à-vis the equipment that you supplied to them?

We gave comprehensive application trainings at their site towards effective and optimal usage of the equipment. Moreover, these equipments in keeping the desired accuracies that are required for such a project, needed timely calibration checks and corrections – for this, besides providing them complete service support during the warranty, we also got into annual maintenance contracts for these equipment post their warranty period. We were thus able to provide timely service and calibration of the equipment at our service centre.

Do you think being associated with the project gives Elcome Technologies any leverage for other similar projects?

It has been a privilege to be associated with BWSL and the HCC team we worked with. Moreover the challenges in geometric control on the project were highly demanding and exacting. This gave us an opportunity to showcase our equipment and our expertise. Our experience with BWSL project will be a basis for us to promote our technology on other such projects too.

completed, span alignment to the Piers was followed. After alignment, the wet joints were cast including grouting of bearings top plinth. Once the wet joints achieved the required strength, stressing of longitudinal PT was commenced followed by load transfer of Span to Piers.

The Cable Stay Bridges

It is for the first time that a cable stay bridge has been attempted on open seas in India. The aesthetically designed pylons have an extremely complex geometry and one of the longest spans for concrete deck – presenting a formidable engineering challenge.

The complex pylon geometry was another challenge for surveyors. HCC's Principal Surveyor devised a sophisticated technology to measure coordinates through a combination of total station and prisms mounted on pylon legs. The pylon legs were constructed within an accuracy of ±5mm, which speaks volumes about the technique employed.

Erection of Segments of Cable Stay Bridge by Derrick

The balance cantilever method was used for erection of segments at Cable-Stayed Bridge. During construction, the length of free cantilever for Bandra Cable-Stayed Bridge was 215m and for Worli Cable-Stayed Bridge it was 73m. The segments were lifted by a Derrick which was fixed on both ends of the pier table segment and then forwarded. Lifting operation was done simultaneously on both ends. At a time, Derrick could lift one segment. Deck is constructed of alternate stay and non stay segments joined to pier table segments.

Dry Matching, Epoxy and Temporary Stressing for Gluing

When the segment was positioned, it was to be joined with the existing segment. Therefore, the segment was first dry-matched with the already erected segment. On completion of dry-matching, the segment was moved back by sliding the lifting beam for a distance of 400mm of the derrick and epoxy was applied on the face of both segments. After application of the glue, the segments were joined together and were stressed by Temporary PT bars. Post this step, the segment lifting beam on derrick was moved forward to lift the next segment i.e. stay segment.

Erection of Stay Segment

These segments were also erected similarly as the non-stay segment and were also joined in the similar way. After this, guide pipes were installed over the ducts left behind during segment casting.

Stay Cable

Stay Cables used are 'Parallel Wire Stay Cables'. Each cable consists of a group of different number of steel wires. Each wire is made up of high tensile steel. Diameter of single wire was 7mm with a breaking limit of 6.28 Tones. Six different sizes of cables were used in the cable-stayed portion. The difference between them was only on the basis of number of steel wires in each cable. Six different types used were of 61, 73, 85, 91, 109 and 121 steel wires. Group of these wires was packed in two layers of HDPE (High Density Poly Ethylene) material to protect them from atmospheric effects.

Closure Pour

In Bandra Cable-Stayed Bridge, closure pour is provided between main

Engineering challenges

- The foundations of the bridge included 604 large diameter shafts drilled to lengths of 6m to 34m in geotechnical conditions that varied from highly weathered volcanic material to massive high strength rocks.
- The superstructure of the approach bridges were the heaviest spans in the country to be built with span-by-span method using overhead gantry through a series of vertical and horizontal curves.
- 128m high concrete tower with flaring lower legs, converging upper legs, unified tower head housing the stays and a throughout varying cross section along the height of tower.
- Erection of 20000 MT Bandra cable-stayed deck supported on stay cables within a very close tolerance of deviations in plan and elevation.

cable-stayed cantilevers and back span. In Worli Cable-Stayed bridge, closure pour is provided between two cable-stayed cantilever decks.

Longitudinal stressing and grouting

When all the segments and cables were erected, the segments were post tensioned longitudinally. This post tensioning was done by stressing the steel tendons placed in the ducts provided inside the body of segments. This helps the members to stay together and to increase their load carrying capacity as a large number of segments were joined together to make single unit. Once the stressing was done as per requirement, these holes or ducts were filled with cement grout and were plugged at both ends.

Fine Tuning

After completion of closure pour and post-tensioning of the deck, fine tuning of stay cables was done. Fine tuning involved fine force adjustments of the stay cables to achieve the required stresses in the deck and profile of the deck. During fine tuning, forces in the stay cables were adjusted to suit further addition of super-imposed dead loads such as wearing coat, crash barriers, handrails and also vehicle loads. During fine tuning operation, longitudinal and transverse deck profiles were also monitored to provide smooth curve.

Meeting challenges with innovation!

Col S Diwanji
Project Manager,
Bandra-Worli Sea Link Project,
Hindustan Construction Company
satish.diwanji@hccindia.com

When did the work on the Bandra-Worli Sea Link project start?

Hindustan Construction Company (HCC) was awarded Package IV of the Project and work started in September 2000, but was held up due to several reasons including environmental issues and protests by fishermen. In right earnest the work started in December 2004.

On what basis was the distance between the piers and the height of the bridge decided?

The span between the piers is 50m. This distance was arrived at after considering various factors, which included optimization between the foundation cost vs. the superstructure cost. If the piers are wide apart then the foundation cost comes down, but the superstructure becomes heavier and its cost goes up.

Also the navigational requirements as in an emergency the smaller trawlers and boats should be able to pass between the piers. Moreover, more number of piers provide better wind resistance to the bridge.

Why was the cable stayed bridge design chosen for the Bandra-Worli Sea Link?

A cable stayed design has some inherent advantages compared to other conventional designs, the main being that it allows for larger spans. There were three main reasons why a large span was needed in case of the Bandra-Worli Sea Link:

- A navigational channel for the fishermen and other sea faring vessels had to be maintained.
- There are plans to expand the present jetty.
- There are overseas communication cables on the seafloor which keep shifting and this had to be taken into consideration.

At what stage of the bridge construction was the need for precision survey instruments felt ?

We knew from the start of the project that high precision equipment would be needed and one of the first things we did was to mobilise the Total Stations – the first of which were procured in early 2001.

A triumph of precision engineering

The Indian Institution of Bridge Engineers (IIBE) awarded HCC the 'Most outstanding bridge-National award' earlier this year. Acknowledging the distinction, Mr Vinayak Deshpande, President & COO - HCC (EPC & Construction) said, "We are privileged to receive this honour for the very first cable-stayed sea bridge built in open sea in India. HCC has a long experience in infrastructure development, yet building this sea link offered complex engineering and environmental challenges that motivated us to be innovative and do our best."

With India looking to improve and enhance its infrastructure, many projects are being implemented or are in the pipeline around the country. The Bandra-Worli Sea Link will definitely be a benchmark for infrastructure projects in India for many years to come. - *Shubhra Kingdang*
Based on material provided by HCC and press releases. The detailed story is available at www.mycoordinates.org

"Survey related challenges for the Bandra-Worli were similar to most cable stayed bridges"

Len Gower
en.gower@gmail.com

Len Gower, Principal Surveyor on the Bandra-Worli Sea link Project Hindustan Construction Company shares his experiences on the project in an exclusive interview with Coordinates.

Could you please tell us briefly how a cable stayed bridge is different from other bridges?

Cable stay supported bridges are a type of suspension bridge. Cable stayed bridges have many smaller diameter cables, connecting the pylon legs to the deck at evenly spaced intervals. The most common style is to space the anchors from the pylon top downwards towards the deck called a modified fan.

The longest spans still require a suspension bridge, but for the medium spans (100 – 1000 metres), cable stayed bridges may offer cost benefits and shorter construction schedules to the client.

Please tell us about some of the survey related challenges you faced on the Bandra-Worli Sea Link Bridge?a

The survey related challenges for the Bandra-Worli were similar to most cable stayed bridges. The accuracy requirements are always demanding, especially in the fabrication of the cable anchor assemblies. The angular misalignment permitted is+- 0.5 degrees in the completed structure, so the fabrication and assembly tolerances are much tighter. We fabricated the bearing plate / guide pipe assemblies to +- 0.06 degrees from perpendicular. We placed them in the deck slab formwork (prior to concrete placement) within +- 0.125 degrees, to ensure that they would still be within +- 0.25 degrees after the concrete had been placed and the concrete curing shrinkage was complete. This procedure required custom design / manufacture of very accurate bearing plate/pipe sleeve assembly jigs, as well as special dual turnbuckle pipe sleeve support yokes and customized targeting and tooling for surveying the anchor assemblies in the deck sections.

The fabrication of the pylon head anchor boxes was even more complex, as weld shrinkage had to be anticipated, and unforeseen results dealt with during erection. The size of the base plate that the bearing plate rests on is only 700x400 mm in dimension, so that means the fit-up survey measurements had to be accurate to sub-millimetre, to ensure the 0.125 degree angular misalignment specification was met.

The pylon legs (below the tower head) were very slender, so were susceptible to thermal gradient deflections. Care had to be taken to ensure that all important surveys were performed in a thermally neutral state. The legs also deflected towards the pylon centre after concrete placement, so the 'as-set' positions were always different from the 'as-built' positions.

The reference geometry supplied by the designer is based on Time ∞, whereas we were constructing every element at Time 0, so allowances had to be made for future creep, shrinkage and elastic shortening. These allowances are referred to as pre-cambers and over heights/lengths. For example, the over height for the P19 pylon's tower head was +35 mm. As we completed the south carriageway first, the deck load was transferred into the pylon legs, causing the shared centre legs to shorten less than the single outer leg. This caused the pylon to temporarily incline away from bridge centreline by nearly 30 mm at the top of the tower head. This meant that we had to construct the north pylon's tower head on a similar inclination, with the expectation that the pylon would come back to plumb when the load of the north deck was in place, bringing the pylon sub structure and common foundation back into equilibrium.

Could you please elaborate on the role of the pylons in a cable stayed bridge and the survey methodology that was used to put them up in the Bandra-Worli Sea Link Bridge?

The pylons of a cable stayed bridge are used primarily to anchor the upper cable stay sockets. Many times the deck is firmly attached to the pylons (as in the case of the Bandra and Worli spans) but other bridges only have sliding pot bearings at the pylons (Ting Kau Bridge, in Hong Kong), or elastomeric bearings between the tower's cross beam and the underside of the deck (Alex Fraser Bridge, Cooper River Bridge).

The survey method utilized to construct the Bandra-Worli pylons was based on the fact that the pylon legs were inclined. Inclined pylon legs pose a significant challenge to the contractor, as the rebar cage will have a natural tendency to sag down hill during construction. If a rebar cage sags, it will be out of tolerance when completed and clash with the formwork adjustment procedure during the final as-set survey. Our solution was to implement a sacrificial rebar template assembly, to guide the construction of the rebar cages and to ensure that there would be no clashes of the steel embedments, like crane tie-ins and DOKA climbing cones.

Our surveyors set the rebar templates in the early morning hours, after the self climbing formwork was fixed for the next lift. These templates had 3 or 4 key points stamped onto them that the surveyors could shoot, and once the support framework was completely welded, formed a local survey network that moved with the pylon's thermal deflections, yet was still based on a thermally neutral pylon. At any time, and with any amount of pylon leg deflections present, our surveyors could set up their instrument on the special brackets attached to the DOKA framework, disable the internal compensators and then perform a 'resection' or 'free station' operation to determine instrument co-ordinates and orientation, for set-out work. Once the concrete was placed, the pylon would deflect downwards towards the bridge centreline, so new co-ordinates of the rebar template were measured (again in the early hours of the morning). The instrument was again transferred up to the top of the pylon, installed on the same bracket, where the as-built survey could be completed quickly and accurately.

The main challenge to these surveys was in the

formwork construction. On most bridge pylons, there are 2 fixed panels and two adjustable panels, so fine adjustment at each corner is possible. For the Bandra-Worli pylons, the formwork had no adjustability. Each panel butted up to the adjacent panels, so the entire shutter assembly acted as a solid body. To move the top into position, the entire shutter had to be tipped, similar to the survey alignment procedure of an elevator core shutter.

If an error in a panel length cutting operation occurred, there was no way to eliminate this. Small errors could be mitigated by setting the shutters so that half the error was on one corner and the other have was on the opposite corner. Our survey alignment criteria was therefore based on the centroid of the entire shutter (6 point average in the pylon leg sections & 12 point average in the tower head sections), and not on individual corner positions.

In the Bandra-Worli Sea Link project what were the phases in the construction where survey played a critical role.

The phases of construction most dependent on survey were the following:

- Offshore pile driving, cofferdam placement and marine foundation construction
- Deck segment match casting
- Deck segment installation
- Pylon leg casting
- Pylon leg junction below the tower head
- Cable anchorage fabrication
- Tower head anchor box fabrication
- Tower head installation
- Deck profile surveys
- Wet joint alignment between 16 deck segment 'blocks'
- Deck closure surveys, pre cable length fine tuning
- Post fine tuning deck profile surveys
- Kerb and asphalt grades

What kinds of survey instruments are best suited for the different survey works in a typical cable stayed bridge construction.

The best instruments for cable stayed bridge surveying are state of the art, high accuracy, vibration tolerant electronic total stations, with ATR (automatic target recognition) and on-board software for Free Station and Resection. GPS receivers can also play a role, when the pylons are extremely tall (as in the Millau Bridge in France) or far out to sea. Their lack of accuracy in Z measurements is their only weakness, in my opinion.

The exception to this high tech equipment is utilizing a pair of old fashioned tilting levels to perform accurate deck profiles. The vibrations present in cable stay supported decks makes internally compensated survey equipment susceptible to 'compensator excitation', producing a blurred image of the crosshairs in an auto level or randomly inaccurate vertical differences in total stations. A split bubble tilting level exhibits the deck vibrations in the movement of the tilting bubble – and the cross hair image is completely stable. By adjusting the level so as to balance the bubble movement evenly, a level observation is possible. The purpose of having two instruments observing a single staff is that long circuits can be run 'one way'. Each set-up produces two back sights and two foresights, so constitutes a closed level loop. The next set-up produces 2 back sights and two foresights, again a closed loop. It is like building a chain, link by link. It was quite common to be able to level from P17 to P21, a distance of 600 Metres, with a misclosure of only 1-2 mm.

Could you tell us about the kind of accuracies that are needed for various aspects of a cable stayed bridge?

There are many different accuracy requirements, in the steel fabrication/concrete casting and their related survey control measurements, as some types of errors can propagate or systematically multiply and others are essentially 'one off' – with no knock-on effects.

Deck segment lengths are a typical dimensional component that has potential for systematic error propagation. A +1mm error on every 3M long deck segment of a 600 metre span will produce +100 mm errors at each expansion joint at the end spans, or roughly 10% of the thermal gradient expansion range. This is still an acceptable range of error, but 200 or 300 mm wouldn't be, so deck lengths have to be measured accurate to the millimetre, and significant errors must be tracked during deck segment installation, and compensated for in the last in situ stitch joints cast.

Installation of the first deck segment of a 16 segment block is another example of a potential systematic error situation. For every 1mm rotational error (in either the horizontal or vertical directions) there will be a 16mm error at the next wet joint. When setting these segments during wet joint construction, we measure the horizontal positions to the millimetre and the vertical differences to better than 0.5 mm.

Cable anchorage placement errors in either the deck or pylon are minor, as there is usually a fairly generous range of cable length adjustment at the live end socket – either by split shims or by threaded sockets and lock nuts. A shift of 1 or 2 centimetres in longitudinal or transverse directions is insignificant, so normal survey procedures are quite capable of controlling installation and identifying absolute errors. The exception to this is angular misalignments.

The principal of multi-strand stays, or parallel wire pre-formed stays is that each wire or strand carries an equal proportion of the cable force. If the bearing plate isn't perpendicular to the cable force vector, then some wires will carry much more of their respective share of the force, and other wires will carry much less of the force. The over-stressed wires are therefore susceptible to premature fatigue failures. Most manufactures will provide a warranty period for their stays, providing the final angular alignments are within +-0.01 Radians (+-0.57 degrees). Even with this 'less than generous' installation tolerance, longer guide pipes with a misalignment close to the limit will pose problems during damper installation. This is the one phase of works that requires the best survey equipment and methodology available, to produce repeatable measurements at sub millimetre accuracy.

Pile driving and coffer dam positioning can be performed to +- 5mm without any detrimental effects, so is a perfect application for DGPS.

How important is the use of GPS for survey purposes in a cable stayed bridge project? How was it used in the Bandra-Worli Sea Link Bridge project.

The application of GPS in cable stayed bridge construction is quickly gaining acceptance, for specific tasks. While it can't replace all traditional survey equipment – it does have cost benefits in certain applications. Bridges far from shore, very tall pylons, marine plant positioning, bathymetric vessel positioning, and construction site control networks are all perfect applications for DGPS. You can even use static GPS receivers for as-builts, provided the Z co-ordinates are not critical.

In dynamic structures that require periodic monitoring, a DGPS system that logs reading once per second, over 24 hours is a much more cost effective solution than a two man crew with a total station and prism pole. As the Bandra-Worli Bridge is fairly close to shore, GPS played a limited role in construction control. *The complete interview can be read at www.mycoordinates.org*

Towards hazards prediction

This article investigates the capability of GNSS aided smart sensor network positioning and Radio Frequency technology to monitor 3D deformation associated with volcanic activity and other comparable hazardous events

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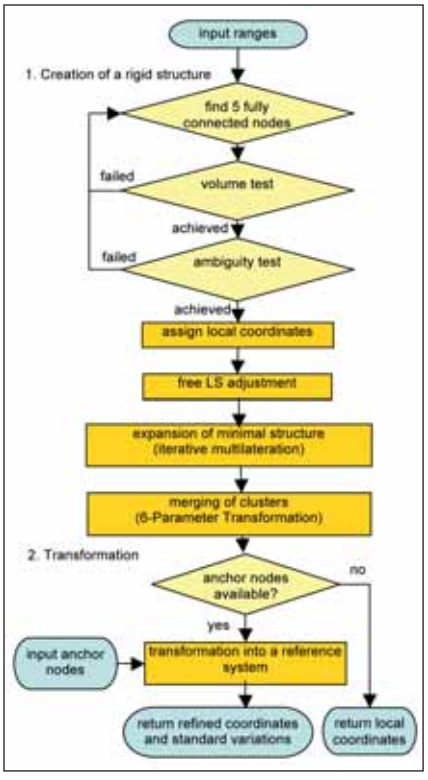

Fig. 1 Positioning algorithm, which does not require any initial approximate coordinates.

Many of the world's volcanoes that erupt, experience significant pre-eruption surface deformation. Internal magma pressure makes the surface bulge upwards and outwards. Thus, precise monitoring of surface deformation has the potential to contribute significantly to the realisation of a predictive capability of volcanic eruption. In particular, eruption source depth and evolution time can be estimated from surface deformation. The scale of this deformation is typically centimetric to decimetric over tens of square kilometres and over periods of weeks. Horizontal displacements show typically a radial pattern of movement of up to 10 cm with the displacement of the vertical components in the range of 4 to 6 cm per year (Wadge et al., 2005). Furthermore, Wadge demonstrated that SAR interferometry images could be used to detect displacements of 70 to 90 mm uplift. However, data rates of typically 35 days are too slow for an early warning system.

In addition to the use of precise positioning and timing information to facilitate direct monitoring of deformation, the positioning function is vital for spatio-temporal referencing of the relevant multiple and complementary data types for volcano monitoring (e.g., seismicity, ground surface deformation, geothermal, gravity, and geomagnetic). This approach is particularly useful for enhanced risk assessment and early warning of volcanic eruptions. In architectural terms the monitoring network is an array of distributed intelligent nodes (sensor motes), consisting of low-cost, commercially available, and off-the-shelf components (as far as possible) with built-in local memory and intelligence, with self-configuration, communication, interaction and cooperative networking capabilities. The nodes should be able to identify the type, intensity, and location of the parameters being measured, and collaborate in an inter-nodal manner with each other to perform distributed sensing for event confirmation and significance.

Janssen (2002) has shown that geodynamic applications such as volcano deformation monitoring, require a dense spatial coverage of sensor stations. Although the requirement for centimetre level accuracy points to the need for GNSS carrier phase measurements, the need to keep costs down (both in terms of technical complexity and power consumption), precludes the exclusive need to build expensive carrier phase GNSS chips into all nodes (Drescher et al. 2008). Hence, a compromise scenario is to have both types of nodes, some equipped with RF (Radio Frequency) as well as carrier phase GNSS chips that are used for absolute coordinate and time referencing but the majority of nodes equipped only with RF technology for communication and inter-nodal range measurements.

The limited GNSS aiding proposed here should enable RF positioning to deliver centimetre level positioning (and high accuracy timing) both in terms of error calibration and temporal synchronisation. In this case the sensors equipped with GNSS chips calculate their positions in a higher reference frame with high accuracy, and serve as anchor (= control or reference) points for the monitoring network. The communication function of the network should enable the exchange of the data required for positioning within the monitoring network. This includes communication between the sensors, and between the RF nodes and GNSS reference stations. This should enable GNSS aiding to take place but accommodate the flexibility of allowing the RF nodes to position themselves exploiting inter-node distance measurements. With a high density of RF nodes, the inter-node distances between volcanic activity sensors are expected to be short thereby enhancing positioning accuracy.

Such a monitoring system requires multiple key features including construction of the hardware that fulfil the requirements in terms of size, battery life and robustness, the extraction of ranges (distances) between sensor nodes, appropriate supporting network communications, protocol development, optimal routing and positioning. Currently various research activities are underway globally to study the feasibility of smart sensing for environmental applications. This study addresses specifically the position function and characterises the performance of a novel high positioning algorithm using simulated range measurements at the Sakurajima volcano in Japan.

Positioning strategy

RF positioning

Radio Frequency (RF) includes rates of oscillation within the range of about 3 Hz to 300 GHz. Recent advances in low-power computing platforms and wireless technologies, such as personal area networks (IEEE 802.15.4) have enabled the creation of sensor platforms that are capable of operating for extended periods while using wireless communications to relay sensor data. The radio technology used in a wireless sensor is usually short range (< 50 m) and low bandwidth to maximise the operating lifetime of the wireless node once deployed. A fundamental issue in positioning using RF signals is the determination of the distance between the wireless nodes.

Those methods that estimate the distances by exploiting the RSSI (Received Signal Strength Indicator) or cell-ID are not used for deformation monitoring due to their unreliability and inaccuracy. Here, the Time of Arrival (TOA) or Time Difference of Arrival (TDOA) methods are preferred, where the time delay is used to derive the distances between nodes if there is a direct line of sight. To date there has not been a practical demonstration of the capability of any of the current approaches to deliver centimetre level positioning in a continuous and reliable manner as required for monitoring of deformation associated with volcanoes. However, research has shown that there is not much likelihood that this will be the case in the near future.

For an unmodified WLAN (Wireless Local Area Network, IEEE 802.11) the ranging techniques TOA or TDOA can hardly be used due to the lag of time synchronisation (Müller 2004). Currently, only a metre-accuracy can be achieved by using time delay measurements (Uthansakul and Uthansakul 2008). Therefore, alternative signals for the extraction of ranges between two devices should be considered.

Ultra Wide Band (UWB) technology uses a pulsed, very low transmit power radio signal that provides very wide bandwidth. UWB is defined as signal with a fractional bandwidth greater than 25% or, above 2 GHz, any signal with a bandwidth > 500 MHz. One of the key advantages of UWB, which makes it interesting for positioning applications, is the fine time resolution that can be achieved, due to its wide bandwidth. This enables very accurate measurements of time of flight, leading to highly accurate positioning (Gezici et al, 2005). It also enables resolution and elimination of the closely spaced multipath propagation. An assessment of UWB has been made by Meier and Mühlebach (2005). Ubisense offers currently a 3D positioning system stating an accuracy of 15 cm. However, the technology has the potential to deliver sub-decimetre level positioning by time-of-flight measurements. Due to these advantages, the UWB signal technique can also be considered for network positioning.

Brodin et al. (2005), use the time of flight between two Bluetooth transceivers to derive inter-node ranges. A two-way ranging technique is used to cancel the clock bias and obtain accurate range between two devices. Certain short range ultrasound based positioning systems can reach cm-level accuracy (Priyantha, 2005). However, in hazardous outdoor environments with relatively large areas and temperature ranges to cover, such methods are not practical.

A significant part of a high accuracy positioning system to support deformation monitoring is the determination of 3D coordinate positions from the estimated ranges. This paper is based on a novel positioning algorithm (explained briefly in this section) for use with high quality range measurements. The algorithm allows for the determination of network sensor node coordinates based on a set of range measurements under certain circumstances and is independent of the type of signal used.

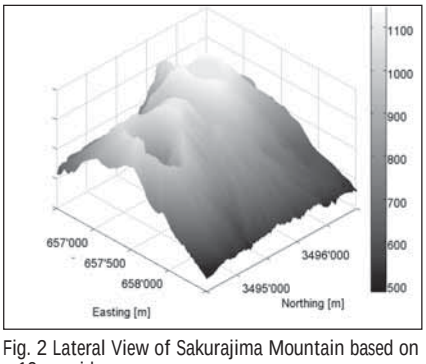

Fig. 2 Lateral View of Sakurajima Mountain based on a 10 m grid

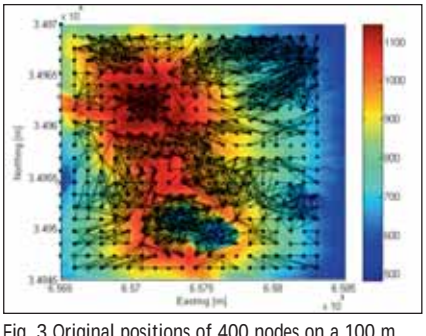
Fig. 3 Original positions of 400 nodes on a 100 m by 125 m grid. All 1838 lines of sight with less than 500 m are shown.

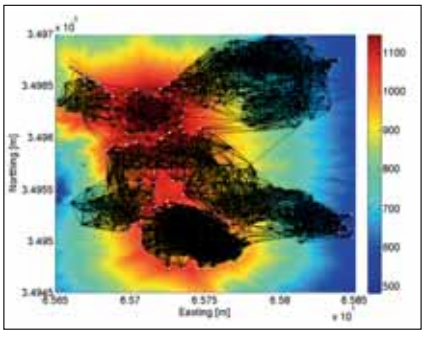
Fig. 4 Optimised positions of the 400 nodes. All 5024 lines of sight with less than 500 m are shown.

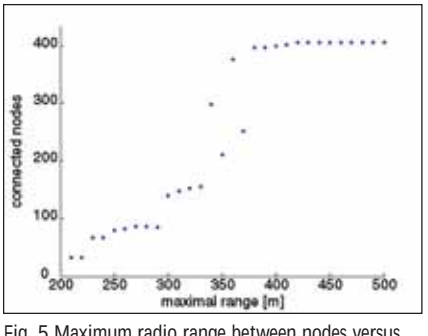

Fig. 5 Maximum radio range between nodes versus the number of 3D positions that can be determined precisely.

Positioning algorithm

The local 3D positioning algorithm presented in this paper takes into account the weaknesses of current wireless ad-hoc positioning methods and algorithms, including the absence of quality and integrity indicators for the positioning results and performs well even in the presence of high variances in range measurements.

The positioning strategy can be broken down into two phases:

1. Creation of a rigid structure: The key issue for anchor free positioning is to find a globally rigid graph, or in other words, a structure of nodes and ranges which has only one unique embedding, but still can be rotated, translated and reflected. In 3D, the smallest graph consists of five fully connected nodes in general position. If such an initial cluster passes statistical tests, additional vertices are added consecutively using a verified multilateration technique. These tests include a "folding-ambiguity test" that prevents the algorithm to create false rigid structures. If, for example four nodes are in one plane, the height of that tetrahedron can not be determined well. A "volume test" eliminates those cases.

2. Transformation of the cluster(s) into a reference coordinate system: If the local cluster contains at least four vertices that are also anchor nodes in a reference system, then the cluster is eligible for a transformation into that particular coordinate system. The process flow of the overall positioning strategy is illustrated in Figure 1.

A more elaborate discussion of the positioning algorithm and details of the mathematical background are presented in Mautz et al. (2007).

Optimised network set up for volcano Sakurajima

Sakurajima is an active volcano and a former island (now connected to the mainland) of the same name in Kagoshima Prefecture in Kyūshū, Japan. It is a composite volcano with the summit split into three peaks; its highest peak rises to 1'117 metres above sea level.

The volcano is extremely active erupting almost constantly. Thousands of small explosions occur each year, throwing ash to heights of up to a few kilometres above the mountain. Monitoring of the volcano for predictions of large eruptions is particularly important due to its location in a densely populated area, with the city of Kagoshima's 600,000 residents just a few kilometres from the volcano. Several institutions are involved in monitoring Sakurajima, including the Sakurajima Volcano Observatory (where data are captured by levelling, EDM and GPS) and Kagoshima University (which uses EDM and GPS). Additionally Landsat 7 images are analysed. However, a dense network of location aware nodes is still to be deployed. This section uses a Digital Surface Model (DSM) to simulate such a network and assesses the performance that could be achieved.

The Digital surface model

The network positioning analysis is based on a 10 m by 10 m reference DSM of the central parts of volcano Sakurajima comprising an area of 2 km by 2.5 km. A 3D view of the data is shown in Figure 2. In order to establish a useful network of sensors with positional awareness for Mount Sakurajima, several scenarios were simulated and assessed. The main driver for successful positioning in a sensor network is the geometry of the network, i.e. the locations of the nodes. Other key factors are the total number of nodes, number of anchors (i.e. reference) nodes, maximum range length and the mean error of the range measurements. Based on the positioning algorithm described in section 2, the performance of such a network can be quantified. Such a study supports a future real network implementation in general – not in particular for Mount Sakurajima.

Various simulation scenarios

In a first scenario 400 nodes were deployed on a 100 m grid. The assumption was made that the radio links are restricted to a maximum of 500 m assuming the usage of omnidirectional antennas and direct line of sight for RF signals in the chosen frequency band. Since the precise TOA ranging method requires direct line of sight, all observations with obstructed views were not considered. As a result, the network according to Figure 3 did not have the required density for positioning. In a second attempt the locations of the nodes were optimised for a maximum of line-of-sights using a heuristic global optimisation scheme, see Figure 4. The inter-nodal connectivity (i.e. the density of the network) is 3 times higher with 5024 ranges. In this case it was possible to compute the coordinates of all nodes in the network.

In another experiment the radio range, i.e. the maximal range observation

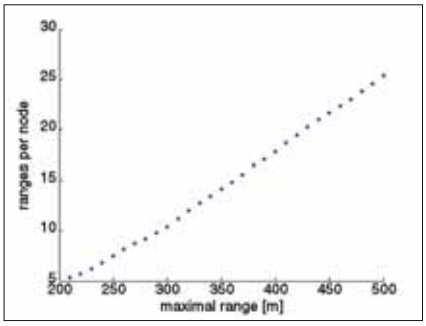

Fig. 6 Maximum radio range versus the average number of successful range measurements for each node.

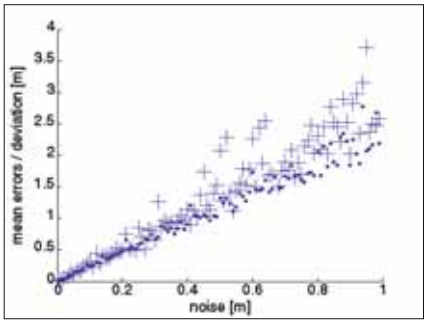

Fig. 7 Mean errors in the range measurements versus the mean position errors (•) and the deviations from "truth" (+).

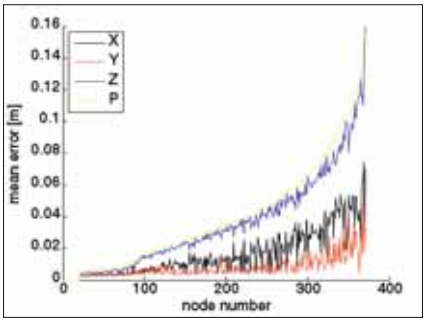

Fig. 8 Mean errors of the X- Y- and Z-components sorted by the mean position errors (P) of the wireless nodes.

Number of anchors	Anchor fraction	Number of located nodes	Number of ranges
3	0.8 %	3	3
5	1.2 %	191	3556
10	2.5 %	354	4553
15	3.8 %	371	4874
20	5.0 %	400	5024

Table 1 Success in precise positioning of network nodes in dependency of the number anchor nodes. The network size is 400 nodes.

between nodes was varied in a series between 200 m and 500 m. Figure 5 shows that the critical bound is at 350 m. The number of ranges to neighbours that the average node is able to observe is directly proportional to the maximal ranging distance, see Figure 6.

Another important parameter for a network configuration is the fraction of anchor nodes, i.e. the number of GPS reference stations. Results show that the minimum number for a 3D Helmert transformation of 3 reference points is not sufficient. Even the minimum number for our positioning algorithm of 5 reference stations does not mean that all nodes participate in the cluster with the anchor nodes. Deploying 5 anchors, not all nodes become part of the main cluster, see Table 1. In order to solve that problem, the number of anchors must be increased. Alternatively, the inter node connectivity can be enlarged.

The most problematic parameter in wireless positioning is the ranging accuracy, since the technology of precise ranging has not yet reached the level that most applications would need. According to Figure 7, the mean error (white noise) of the range observations was varied between 0 m and 1 m. Typically, the positional errors can be expected in the size of the range errors. Other factors, such as the network density, geometry, etc. also have an influence on the position errors. Since this is a simulation, we have the opportunity to compare the results with the true positions for a network with perfect ranges. At high noise levels, the estimated errors tend to be smaller than the true deviations – this effect is caused by undetected cases of folding errors, because a wrong embedding is not sensitive to error propagation.

One last observation – but nevertheless important – is that the errors of the height component are 2-3 times higher than the horizontal components, see Figure 8. This is a result of all nodes being deployed on the surface causing an unfavourable geometry for height determination.

Conclusions

This paper has shown that the implementation of a wireless deformation monitoring system is feasible if the current problem of extracting precise ranging is solved. The requirement to have direct line of sights between stations can be solved by locating the nodes for optimal directs sights. The number of required nodes depends on the transmission range. The required fraction of GNSS enabled reference nodes will be around 10%, depending on the network density.

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216 channels

JAVAD ArcPad Extension
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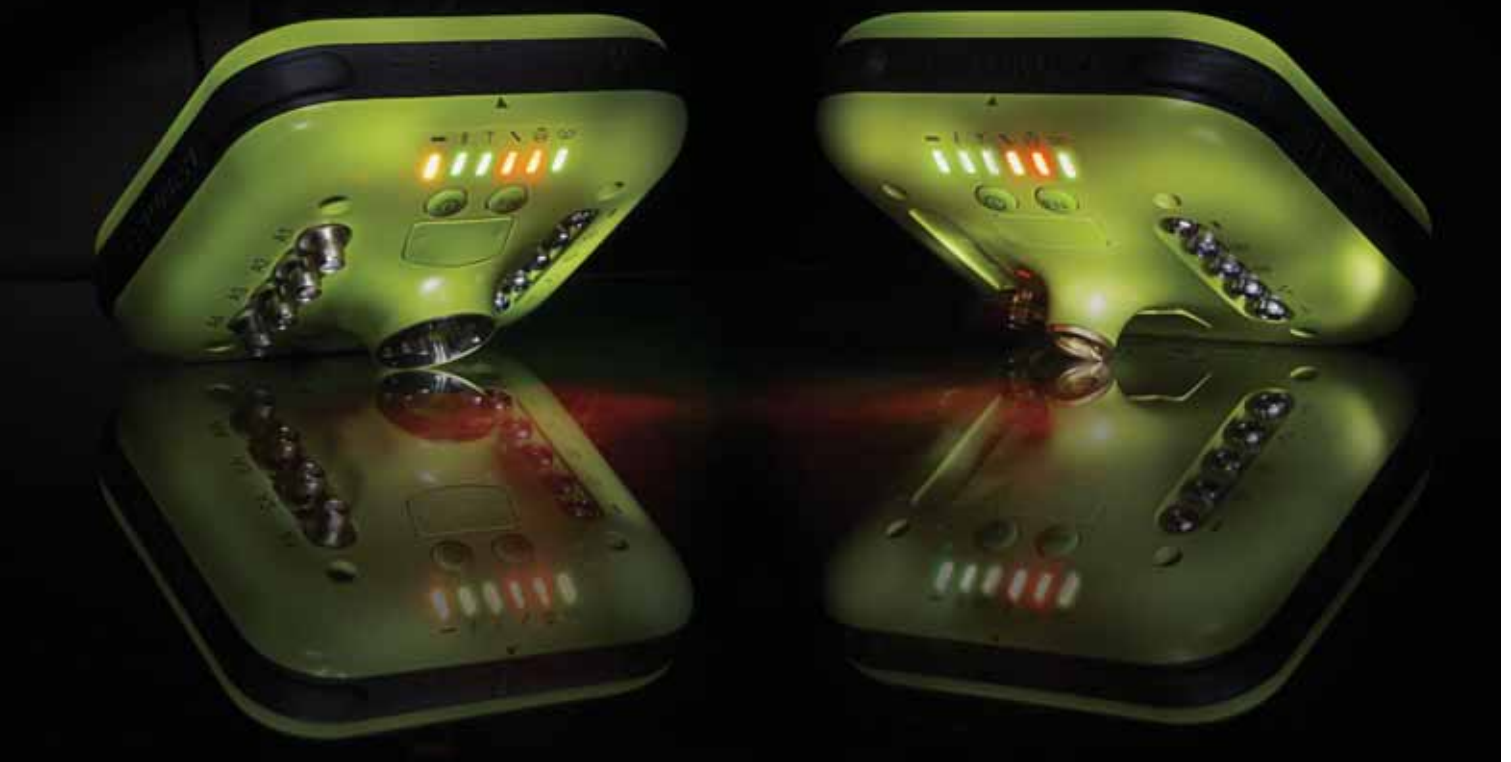

JAVAD ArcPad Extension

In response to a long-standing request from ESRI, JAVAD GNSS is pleased to announce that ArcPad users can now communicate directly with ESRI ArcGIS Server via our Triumph receiver so no additional devices (external radio) or settings are required. Real-time centimeter-level positioning is now possible in the field for ArcPad users.

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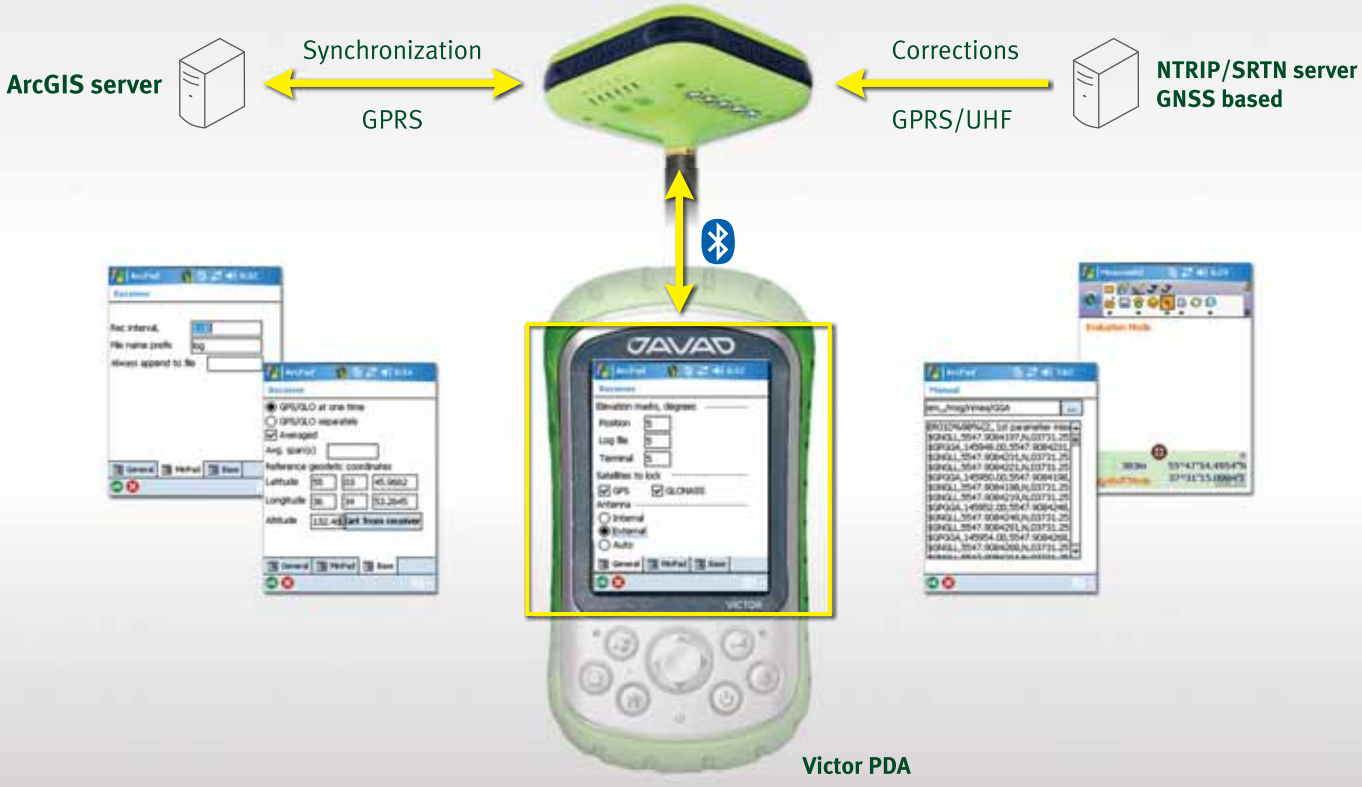
- JAVAD ArcPad Extension establishes a connection to the receiver via serial, USB, or Bluetooth and configures the base station parameters that govern the RTK and UHF radio setups, and GSM modem settings.



- Quality control of real-time positioning results are assured in the field. The JAVAD GNSS Victor PDA displays the status/process progress continuously via the Bluetooth connection to the receiver.
- Advanced RTK accuracy and ArcPad vector/raster map visualization capabilities deliver reliable object positioning and a new level of job control in the field.
- JAVAD ArcPad Extension is an optimal ESRI-compatible solution for a wide variety of civil engineering or cartography tasks where centimeter level accuracies are required. At the core of this solution lies highly integrated JAVAD GNSS technology optimized for use with ESRI's GIS software.

Please see www.javad.com for details.

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2. Bluetooth/GSM Antenna
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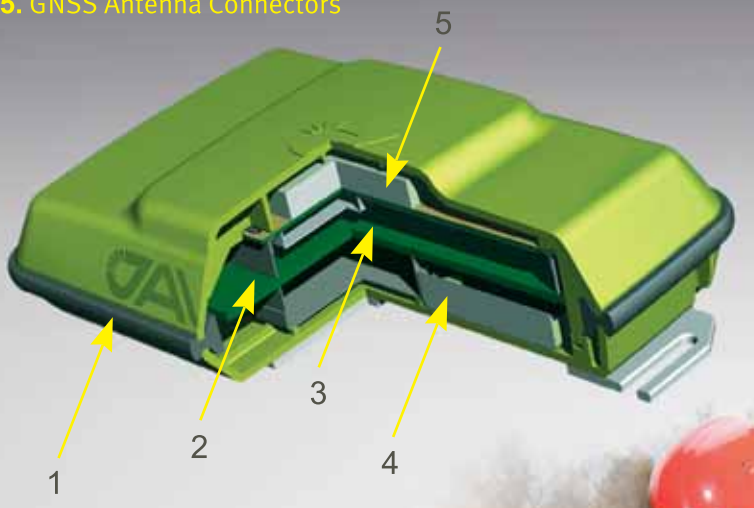

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- 100 Hz update rate
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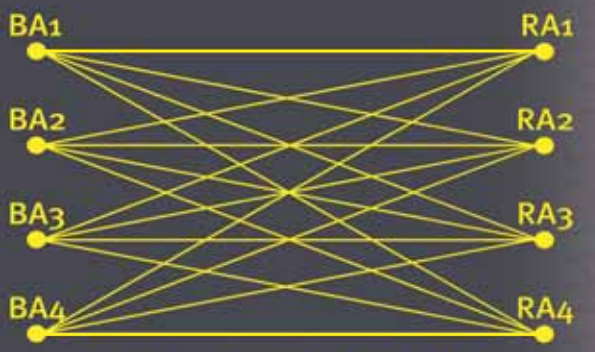

4 base — 4 rover, 16 baselines

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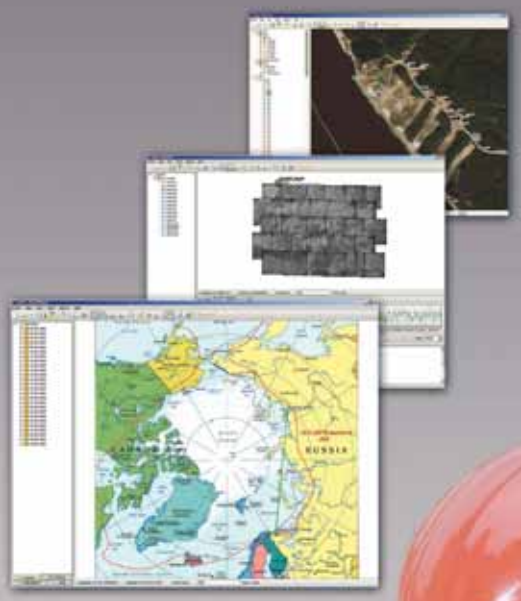

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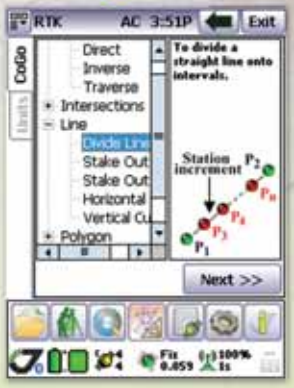
Giodis

Full-featured office post-processing software



Support for survey and stakeout projects

Static, Fast Static and Stop&Go surveying

Configuration of all hardware

Tracy

A versatile and powerful field software

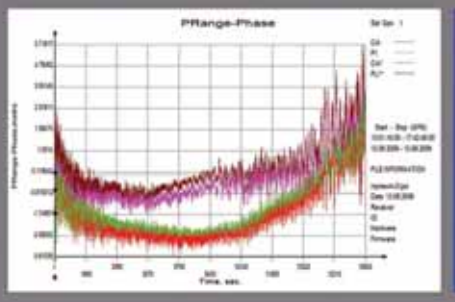
Software for Windows Mobile OS to control receivers, automated GNSS post processing surveying tasks (Static, Fast Static, Stop&Go, Data Acquisition), and to perform RTK survey and stakeout tasks.

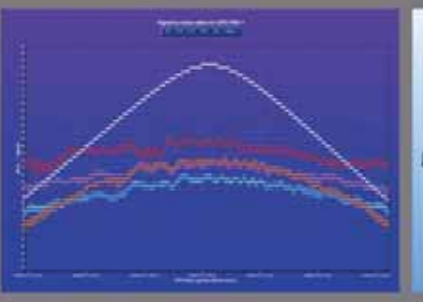
Javad eliminates GPS SVN 49 anomalies

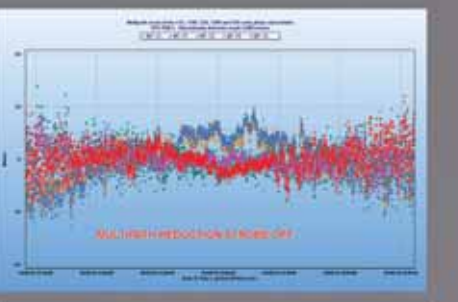
The anomalies in the recently launched SVN49(PRN1) was a chance to demonstrate the advanced multipath reduction capabilities of JAVAD GNSS Triumph technologies.

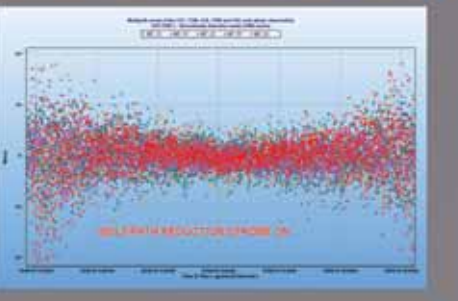
Figure below shows SNV49 (PRN1) code-minus-phase plot for usual correlator (magenta - C/A code, brown - P/L1 code) and for “mpnew” (red - C/A code, green - P/L1 code), which shows almost all anomalies and satellite multipath are removed.

Figures below also describe the multipath performance of a pair of Triumph-1 receivers we ran in a zero baseline test. The left figure depicts the code multipath errors of the GPS PRN1 pseudoranges measured by the receiver with the ‘normal’ strobe enabled. The right figure shows the code multipath as estimated for the second receiver, where the optimized multipath reduction strobe was enabled. The center screenshot displays the signal-to-noise ratios and elevation angles of GPS SVN49 over the time interval analyzed.

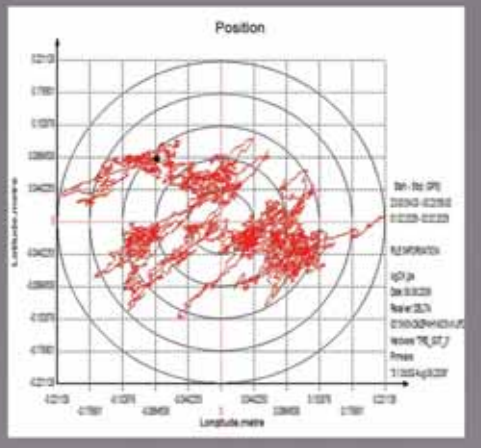








The optimized multipath mitigation technique implemented in our Triumph technology allows nearly complete compensation for the satellite-induced multipath anomalies that would otherwise badly affect GPS SVN49 measurements. The same multipath reduction capabilities which removed the SVN49 multipath anomalies can remove the multipath effects which are a major source of error in precision positioning.



JAVAD GNSS receivers tracked all current and future Galileo satellite signals

JAVAD GNSS receivers successfully tracked all Galileo satellites from Spirent simulator and produced Galileo-only and triple satellite (Gps+Glonass+Galileo) positions. Up to 27 satellites were tracked simultaneously.

The experiments were performed jointly by Spirent and JAVAD GNSS.

Sat	(Fn)	El	Az	C/A	P1	P2	TC	Count	F_C/A	F_P1	F_P2	Use
Gps	1	29	--	46	0	0	63	3818	0xA153	------	------	Y(0)
Gps	3	24	--	47	0	0	86	4986	0xA153	------	------	Y(0)
Gps	6	27	--	46	0	0	86	4986	0xA153	------	------	Y(0)
Gps	11	14	--	44	0	0	77	4622	0xA153	------	------	Y(0)
Gps	14	20	--	45	0	0	86	4986	0xA153	------	------	Y(0)
Gps	16	78	--	49	0	0	86	4986	0xA153	------	------	Y(0)
Gps	18	7	--	47	0	0	86	4986	0xA153	------	------	Y(0)
Gps	19	10	--	48	0	0	86	4986	0xA153	------	------	Y(0)
Gps	20	7	--	47	0	0	4	272	0xA153	------	------	Y(0)
Gps	22	38	--	47	0	0	86	4986	0xA153	------	------	Y(0)
Gps	31	23	--	45	0	0	86	4986	0xA153	------	------	Y(0)
Gln	6(-2)	24	--	51	0	0	87	4986	0xA153	------	------	Y(0)
Gln	7(-1)	28	--	51	0	0	87	4986	0xA153	------	------	Y(0)
Gln	9(1)	21	--	50	0	0	87	4986	0xA153	------	------	Y(0)
Gln	10(2)	76	--	52	0	0	87	4986	0xA153	------	------	Y(0)
Gln	11(3)	44	--	50	0	0	81	4911	0xA153	------	------	Y(0)
Gal	71	18	--	50	0	0	85	4986	0xA153	------	------	Y(0)
Gal	78	18	--	50	0	0	81	4892	0xA153	------	------	Y(0)
Gal	79	30	--	49	0	0	85	4986	0xA153	------	------	Y(0)
Gal	83	23	--	48	0	0	59	3572	0xA153	------	------	Y(0)
Gal	84	70	--	49	0	0	86	4986	0xA153	------	------	Y(0)
Gal	85	58	--	50	0	0	84	4986	0xA153	------	------	Y(0)
Gal	86	13	--	49	0	0	86	4986	0xA153	------	------	Y(0)
Gal	89	33	--	50	0	0	85	4986	0xA153	------	------	Y(0)
Gal	90	35	--	51	0	0	86	4986	0xA153	------	------	Y(0)
Gal	91	11	--	51	0	0	86	4986	0xA153	------	------	Y(0)
Gal	97	8	--	50	0	0	29	1742	0xA153	------	------	Y(0)

Other Receivers

ALPHA

- Internal battery
- Charger
- GSM
- Bluetooth

for: TR-G3, TR-G2T, TR-G3T

Front panel connectors:

Power Input + serial port A + USB + Antenna

Back panel connectors:

Can have up to 3 connectors of 1-PPS · Event Marker · IRIG · GSM Antenna (without Bluetooth antenna).

When Bluetooth antenna is installed only one extra connector can be installed.

Example 1: BT Antenna + GSM Antenna
Example 2: 1-PPS output + Event Marker + GSM Antenna

DELTA

for: TRE-G2T, TRE-G3T, Duo-G2, Duo-G2D, Quattro-G3D

Front panel connectors:

Option 1: Power Input + Serial A + Serial B + Serial C + Antenna

Option 2: Power Input + USB + Serial A + Serial C + Antenna

Options 3: Power Input + USB + Serial A + Serial C + Ethernet

Back panel connectors:

Can have up to 4 connectors of 1-PPS A · 1-PPS B · Event A · Event B · Antenna · CAN · IRIG B

Example: 1-PPS A + 1-PPS B + Event A + Event B

SIGMA

- Internal battery
- Charger
- Modem
- GSM
- Bluetooth

for: TRE-G2T, TRE-G3T, Duo-G2, Duo-G2D, Quattro-G3D

Front panel connectors:

Can have Power Input · Second Power Input · USB · Serial A · Serial B or C · Ethernet

and up to 4 connectors of 1-PPS A · 1-PPS B · Event A · Event B · Antenna · CAN · IRIG · RS422

Back panel connectors:

Can have SIM door and GSM Antenna connector and up to 4 connectors of 1-PPS A · 1-PPS B · Event A · Event B · Antenna · IRIG · Modem Antenna · Bluetooth Antenna

Example: GSM Antenna + SIM door + 1-PPS A + 1-PPS B + Event A + Modem Antenna

Sustainable Land Governance

This paper provides an overall understanding of the concept of land administration systems for dealing with rights, restrictions and responsibilities in future spatially enabled government. We present here the first part of the paper. The remaining part will be published in December issue

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All countries have to deal with the management of land. They have to deal with the four functions of land tenure, land value, land use, and land development in some way or another. National capacity may be advanced and combine the activities in one conceptual framework supported by sophisticated ICT models. More likely, capacity will involve very fragmented and basically analogue approaches. Different countries will also put varying emphasis on each of the four functions, depending on their cultural basis and level of economic development.

Today the accepted theoretical framework for all land administration systems is delivery of sustainable development – the triple bottom line of economic, social, and environmental development, together with the fourth requirement of good governance. Land Administration Systems are the basis for conceptualizing rights, restrictions and responsibilities related to people, policies and places. Property rights are normally concerned with ownership and tenure whereas restrictions usually control use and activities on land. Responsibilities relate more to a social, ethical commitment or attitude to environmental sustainability and good husbandry. This paper provides an overall understanding of the concept of land administration systems for dealing with rights, restrictions and responsibilities in future spatially enabled government.

Land administration systems

Land Administration Systems (LAS) are an important infrastructure, which facilitate the implementation of land policies in both developed and developing countries. LAS are concerned with the social, legal, economic and technical framework within which land managers and administrators must operate. These systems support efficient land markets and are, at the same time, concerned with the administration of land as a natural resource to ensure its sustainable development. This global approach to modern land administration systems is shown in Figure 1. The four land administration functions (land tenure, land value, land use, land development) are different in their professional focus, and are normally undertaken by a mix of professions, including surveyors, engineers, lawyers, valuers, land economists, planners, and developers. Furthermore, the actual processes of land valuation and taxation, as well as the actual land use planning processes, are often not considered to be part of the land administration activities. However, even if land administration is traditionally centred on the cadastral activities in relation to land tenure and land information management, modern LAS designed as described in Figure 1 delivers an essential infrastructure and encourages integration of the four functions:

Land tenure: the processes and institutions related to securing access to land and inventing commodities in land, and their allocation, recording and security; cadastral mapping and legal surveys to determine parcel boundaries; creating new properties or altering existing properties; the transfer of property or use from one party to another through sale, lease or credit security; and the management and adjudication of doubts and disputes regarding land rights and parcel boundaries.

Land value: the processes and institutions related to assessment of the value of land and properties; the calculation and gathering of revenues through taxation; and the management and adjudication of land valuation and taxation disputes.

Land use: the processes and institutions related to control of land use through adoption of planning policies and land use regulations at national, regional and local levels; the enforcement of land use regulations; and the management and adjudication of land use conflicts.

Land development: the processes and institutions related to building of new physical infrastructure and utilities; the implementation of construction planning; public acquisition of land; expropriation; change of land use through granting of planning permissions, and building and land use permits; and the distribution of development costs.

Inevitably, all the functions are interrelated. The interrelations appear through the fact that the actual conceptual, economic and physical uses of land and properties

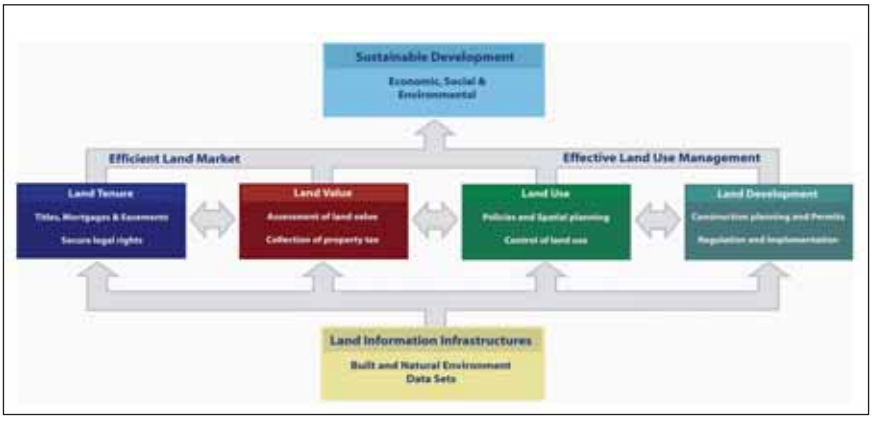

Figure 1. A global land administration perspective (after Enemark 2004)

influence land values. Land values are also influenced by the possible future use of land determined through zoning, land use planning regulations, and permit granting processes. And the land use planning and policies will, of course, determine and regulate future land development.

Land information should be organised to combine cadastral and topographic data, and to link the built environment (including legal and social land rights) with the natural environment (including topographical, environmental and natural resource issues). Land information should, this way, be organised through an SDI at national, regional, federal, and local levels, based on relevant policies for data sharing, cost recovery, access to data, data models, and standards. Ultimately, the design of adequate systems of land tenure and land value should support efficient land markets capable of supporting trading in simple and complex commodities. The design of adequate systems to deliver land use control and land development should lead to effective land use management. The combination of efficient land markets and effective land use management should support economic, social and environmental sustainable development.

From this global perspective, LAS act within adopted land policies that define the legal regulatory pattern for dealing with land issues. They also act within an institutional framework that imposes mandates and responsibilities on the various agencies and organisations. They should service the needs of individuals, businesses, and the community at large. Benefits arise through LAS guarantee of ownership, security of tenure and credit; facilitating efficient land transfers and land markets; supporting management of assets; and providing basic information and efficient administrative processes in valuation, land use planning, land development and environmental protection. LAS designed in this way forms a backbone for society and is essential for good governance because it delivers detailed information and reliable administration of land from the basic foundational level of individual land parcels to the national level of policy implementation.

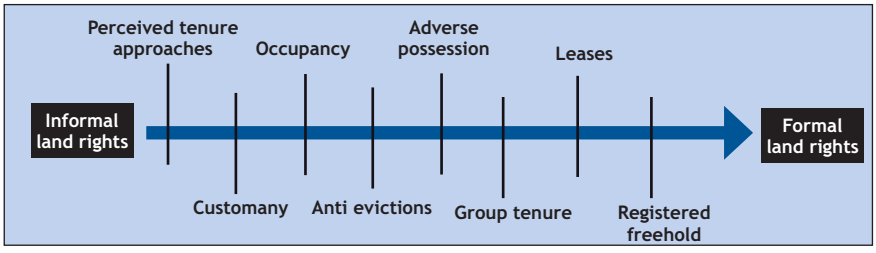

Figure 3. Continuum of land rights (UN-Habitat, 2008)

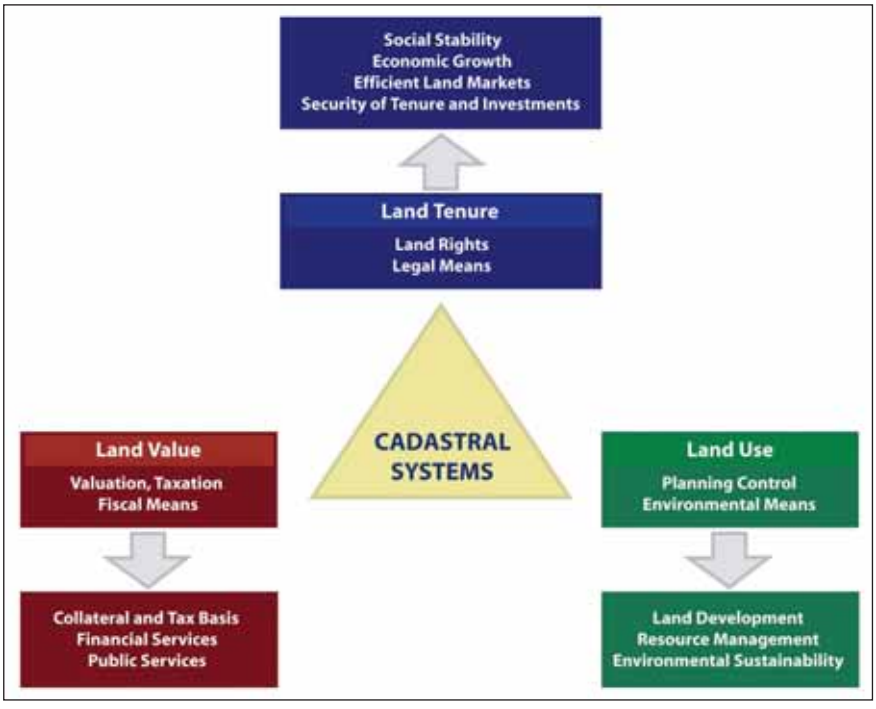

Figure 4. The concept of multipurpose cadastral systems (Enemark 2005)

Property rights

In the Western cultures it would be hard to imagine a society without having property rights as a basic driver for development and economic growth. Property is not only economic asset. Secure property rights provide a sense of identity and belonging that goes far beyond and underpins the values of democracy and human freedom. Historically, however, land rights evolved to give incentives for maintaining soil fertility, making land-related investments, and managing natural resources sustainably.

Therefore, property rights are normally managed well in modern economies. The main rights are ownership and long term leasehold. These rights are typically managed through the cadastral/ land registration systems developed over centuries. Other rights such as easements and mortgage are often included in the registration systems.

However, these legal or formal systems do not serve the millions of people whose tenures are predominantly social rather than legal. “Rights such as freehold and registered leasehold, and the conventional cadastral and land registration systems, and the way they are presently structured, can not supply security of tenure to the vast majority of the low income groups and/ or deal quickly enough with the scale of urban problems. Innovative approaches need to be developed” (UN- HABITAT 2003). This should include a “scaling up approach” that include a range of steps from informal to more formalised land rights. This process does not mean that the all societies will develop into freehold tenure systems. Figure 3 shows a continuum of land rights where each step in the process can be formalised, with registered freeholds offering a stronger protection, than at earlier stages.

Land, Water & Ocean Studies

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Cadastral Systems

Modern land administration theory relied on the history of cadastres to demonstrate their vitality as a central tool of government infrastructure, and then constructed their central role in implementing the land management paradigm. However, given the difficulty of finding a definition that suits every version, it makes sense to talk about cadastral systems rather than just cadastres (Figure 4). These systems include the interaction between the identification of land parcels and the registration of land rights, and they support the valuation and taxation of land and property, and the administration of present and possible future use of land. The concept of these multipurpose cadastral systems is shown as engaging the systems (the central triangle in Figure 4) to deliver the four functions of land tenure, value, use and development, and to deliver sustainable development outcomes. By 2000, cadastral systems were seen as a multipurpose engine of government operating best when they served administration functions in land tenure, value, use and development, and focused on delivering sustainable land management. A mature multipurpose cadastral system could even be considered as LAS in itself. This multipurpose design was the touchstone of best practice, sought by many LAS designers and managers. Achieving this however is another story because each unique existing system needs a different group of strategies to implement the proposed multipurpose design.

Comparing Cadastral Systems

A website has been established http://www.cadastraltemplate.org to compare cadastral systems on a worldwide basis. About 40 countries are currently included (August 2007) and the number is still increasing. The web site is established as a result of one of the objectives of Working Group 3 "Cadastre" of the PCGIAP (Permanent Committee on GIS Infrastructure for Asia and the Pacific). The cadastral template is basically a standard form to be filled out by cadastral organizations presenting their national cadastral system. The aims are to understand the role that a cadastre plays in a state or a National Spatial Data Infrastructure (NSDI), and to compare best practice as a basis for improving cadastres as a key component of NSDIs. The Cadastral template project is carried out in collaboration with Commission 7 "Cadastre and Land Management" of the International Federation of Surveyors (FIG), which has extensive experience in comparative cadastral studies. (Steudler, et.al. 2004). It is generally accepted that a good property system is a system where people in general can participate in the land market having a widespread ownership where everybody can make transactions and have access to registration.

The infrastructure supporting transactions must be simple, fast, cheap, reliable, and free of corruption. And the system must provide safety for housing and business, and for capital formation. It is estimated that only 25-30 countries in the world apply to these criteria.

To be concluded in December issue.

Landslide vulnerability

The paper studies the various soil characteristics that may increase the landslide in east district of Sikkim

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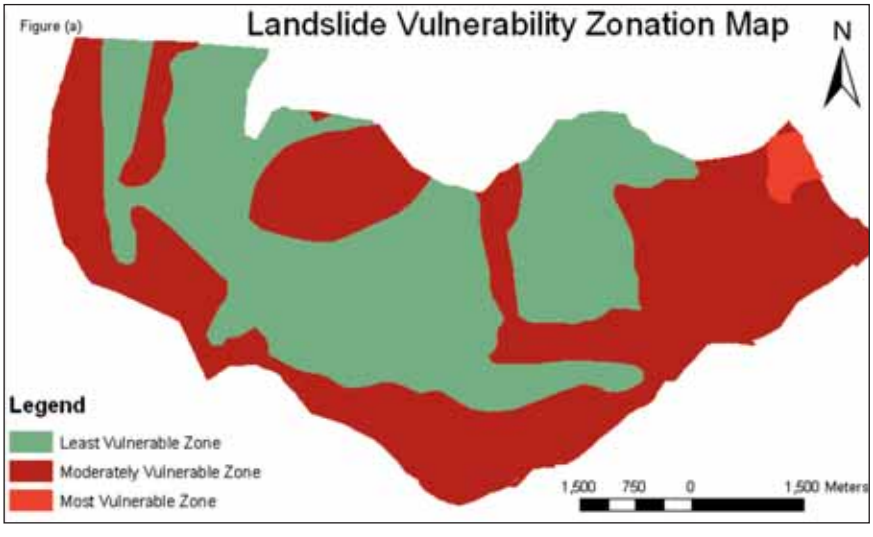
Landslide is a common hazard in the hilly regions which causes heavy losses to life and properties every year. Since 1980 various researches and analyses have been carried out in the GIS environment to identify factors responsible for causing landslides. The important conditioning factors identified by the researchers are slope, geological, geomorphologic structures and land use coupled with triggering factors like rainfall and a few of the anthropogenic activities. Soil forms the upper most part of he earth crust and it is expected that the various soil characteristics like depth, surface texture, depth texture, soil erosion, hydraulic conductivity, stoniness etc. play significant role in causing landslide in an area. This technical paper is an attempt to study in depth the various soil characteristics that may increase the landslide.

Landslide has been a perennial problem of the hills and various models have been designed for landslide vulnerabilities (Jibson et al, 2000; Luzi et al,2000; Zhou et al 2002; Carro et al 2003, Lee 2007, Burrough and McDonnel, 1998, Miles et al. 1999, Siddle et al 1991, Lee et al 1991, Hutchinson and Chandler 1991, Hutchinson et al 1991, Morgan et al 1992, Carrara et al 1991and 1992, Moon et al 1992,Wadge 1988, Gupta and Joshi 1990, Wang Shu-Quiang and Unwin 1992, Pachauri and Pant 1992,) .This study makes a detail study of the importance of various soil parameters with respect to their influence on slope instability and landslide vulnerability. The study area for this investigation is Sang Revenue Circle in east district of Sikkim, India and includes 15 (Fifteen) revenue villages. The area extends from east longitude 88o 26' 40.17" to 88o 33' 42.35" and North Latitude of 27° 13'48.85" to 27°17'22.24" covering an area of around 40 square kilometers. Since 1968 there is a prominent landslide at *Sirwani Revenue Village* that blocks the road between *Singtam* and *Sirwani* every year during the monsoon season. The data used for the study has been sourced from various agencies including, NIC-GIS/NBSS&LUP, NRSA, Rural Management Dev. Department, Govt. of Sikkim, and Wikipamia.



Methodology

The spatial data required for this study was acquired from the National Informatics Centre, Sikkim State unit's *Spatial Data Bank*. Soil maps were in shape file format with related attributes. Soil has eight different characteristics namely depth, inner texture, surface texture, erosion, slope, stoniness, drainage and hydraulic conductivity. Each of these parameters have been categorized into 3 to 5 types by assigning different weights with respect to stability and landslide susceptibility based on experts opinion and the common logic. Each of such parameter categories are assessed with respect to common logic and experts' opinion on one side and on the basis of evidence of their behavior with respect to landslide events on the other.

Important Soil Characteristics Considered

Depth

Depth of the soil forms one of the

Soil Parameters	Parameter Types	Area(km2)	No of LS*	LD*	Average Density	Density Diff (High-Low)	Parameter Ranking With Respect to Landslide			
							DD*	AD*	HD*	AR*
Soil Depth	Moderate Deep	1.83	1	0.5464481	1.038949	1.17768984	8	8	8	8
	Deep	35.5	30	0.8462623						
	Moderate Shallow	1.16	2	1.7241379						
Drainage Behavior	Well Drained	19.1	11	0.5756149	0.856871	0.5625124	5	5	5	5
	Some What Excessively Drained	19.3	22	1.1381273						
Inner Texture	Coarse Loamy	3.85	3	0.7792208	0.795734	0.26117877	2	3	2	2.3
	Fine Loamy	25.7	24	0.9345794						
	Loamy	8.91	6	0.6734007						
Slope	Mod-Steep (15-30%)	17.9	10	0.5580357	0.845912	0.64244448	7	4	6	5.6
	Steep (30-50%)	16.7	20	1.2004802						
	Very Steep(>50%)	3.85	3	0.7792208						
Hydraulic Conductivity	High	3.85	3	0.7792208	0.795734	0.26117877	2	3	2	2.3
	Moderate	8.91	6	0.6734007						
	Low	25.7	24	0.9345794						
Stoniness	Moderate	11.6	7	0.6039689	0.786156	0.36437371	3	2	3	2.6
	Low	26.9	26	0.9683426						
Erosion	Moderate	20.6	13	0.6313745	0.875911	0.48907373	4	6	4	4.6
	Severe	17.9	20	1.1204482						
Surface Texture	Coarse Loamy	14.8	18	1.220339	0.927026	0.58662542	6	7	7	6.6
	Loamy	23.7	15	0.6337136						

LS*=Landslides, LD*=Landslide Density, DD*=Density Difference, AD*=Average Density, HD*=Highest Density, AR*=Average Ranking

Table 1. Computation of Parameter Ranks

important factors for assessing the stability of the soil and landslide susceptibility of the land. With the increase of soil depth, the tendency of soil to absorb moisture is increased, resulting in reduced runoff rate. Hence shallow soil is considered to be more unstable and prone to landslide than the deep soil.

Soil Texture

The texture of soil represents the relative proportion of sand, silt and clay content. Soils with high percentage of clay form very stable aggregate resistant to detachment. On the other hand, light soils like sandy or coarse loams are easy to detach as they have low organic matter content (Das and Agarwal, 2002). Hence, soil with more sand, high slope and intensive rainfall which constitute most dominant factors of landslide cause severe damage to land (Patanakanog, 2001) .

Surface Texture

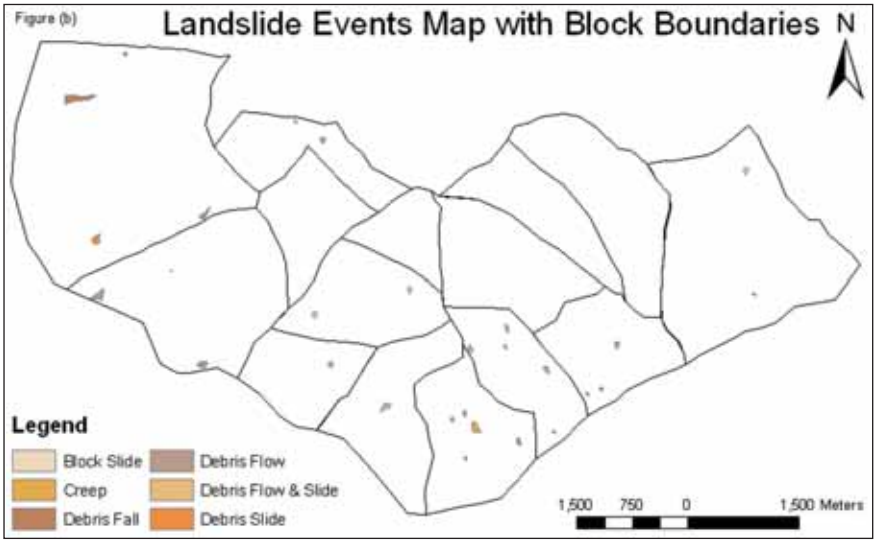
The texture on the surface of the soil may be different from the texture found below the surface.

Erosion

One of the principal reasons for landslide is the progressive deterioration of soil due to erosion. Soil erosion is the detachment and transportation of soil material from one place to another through the action of wind, water in motion or by the beating action of the rain drops. It is the outcome of many factors in combination that include the intensity of rains, porosity of soil, physical as well as chemical properties of rock. The slope of the land has direct relation to the soil erosion because soil erosion due to run-off is more on sloping and denuded lands (Samra and Sharma, 2002). As a result, the rate of soil erosion is very high in such areas where the soil is mostly sandy in nature, slope is high and rainfall is frequent. Thus, with the increase of soil erosion, the susceptibility of an area to landslide also increases. Soil is characterized by either severe erosion, moderate erosion or low erosion.

Stoniness

Soil stoniness is also an important characteristic of soil which influences the intensity of landslide. It refers to the proportion of stones (or rocks) within a unit volume of soil or on its surface. Stones left in place may provide for soil and water conservation by protecting the surface against raindrop impact or retarding water flow along the surface. Therefore, soils with more stones (or rocks) are less prone to the landslide as compared to that of soil with less stones.



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Slope

The degree and length of slope determine the amount of runoff and extent of soil erosion**.** As water flows down the slope, it accelerates under the force of gravity. If the percent of slope is increased four times, the velocity of water flowing down is doubled. Doubling the velocity quadruples the erosive power. Sediment transport capacity of runoff increases by 10 to 100 times at one percent slope compared to 0.2 percent slope (Reddy and Reddi, 1999). More so, during monsoon season or heavy downpour, the hills get saturated with water, resulting in instability of land mass. The complete surface portion of soil may slip down from its actual position causing landslides (Wischmeier and Smith, 1978). Since the study area is characterized by steep to very steep slope along with mostly sandy soil textures, it indicates a high degree of landslide.

Drainage

Drainage of an area is one of the most important aspects in determining the land use pattern and landslide probability. Drainage refers to the relative rate of outflow of water to which the excess amount of water can be absorbed by the soil. Slides often occur following intense rainfall, when storm water runoff saturates soils on steep slopes or when infiltration causes a rapid rise in groundwater levels. Human action can exacerbate sliding when drainage systems fail or when development increases runoff near steep slopes (www.ecy.wa.gov/programs/sea/landslides/help/drainage.html).

Hydraulic Conductivity

Hydraulic conductivity denotes the proportionality constant in Darcy's law, which represents the amount of water that flows through a unit cross-sectional area of an aquifer under a unit gradient of hydraulic head. Thus, a change in hydraulic conductivity greatly influences ground water table and slope stability. With the increase of hydraulic conductivity, the movement of water in the soil is increased. Therefore, higher the level of hydraulic conductivity of soil, higher is the probability of the landslide. The study area is classified into high, moderate and low hydraulic conductivity.

Parameter Ranking

Parameter ranking is done to understand which of the soil parameters considered are most influencing and which are the ones that are least influencing. This was done on the basis of landslide density in the area falling under each of the variable parameter as shown in table 1.

Conclusion

We identified eight important soil characteristics to deduce eight soil parameters and listed their types from past references and assigned weight to each parameter types based on common logic and the experts' opinion. Then based on the landslide density in the study area under each of the parameter types, three different parameters ranks based on density difference, average density and highest density were computed. Though all three type of ranks weighted almost equally, an average of them known as average rank was computed. Ranking was done in such a way that higher the rank more influencing is the parameter with respect to landslide. We deduced that soil depth is the most influencing soil parameter and the inner texture and the hydraulic conductivity to be the least influential parameters. The parameter type weights and the parameter ranks both can be used in conjunction for the study of landslide vulnerability. A landslide vulnerability map of the study area prepared on the basis of the deduced parameter is shown in figure 1 (a) where figure 1 (b) shows the landslide events of the study area.

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GPS IC shipments forecast for 2010

According to ABI research GPS IC shipment growth should see a 30% increase. The unabated interest in GPS-enabled smartphones during the recession has been a life-saver for the GPS IC industry, and future growth will be fuelled by the integration of GPS in feature phones across Europe and Asia. *www.abiresearch.com*

Bahrain joins global tracking system

Bahrain has become the first Arab state to tap into a global ship-tracking system using GPS and other navigation technologies. It will be helpful to better track its own growing fleet of vessels round the globe, within an estimated 1,000 miles of its coastal frontiers. Implementation of the Long Range Identification and Tracking of ships system was deemed obligatory by the International Maritime Organization, of which Bahrain is a member. *www.upi.com*

A new era for European Navigation begins

Mr Antonio Tajani, VP, European Commission, Transport Policy, has announced the official start of operations for EGNOS, the European Geostationary Navigation Overlay Service. This is a major milestone for the project: its primary service is now available to all users equipped with EGNOS-compatible receivers. *www.esa.int*

First U.S. Ground-Based Augmentation System

The U.S. Federal Aviation Administration (FAA) has approved Honeywell's Smartpath Precision Landing System, clearing the way for increased safety and efficiency at airports by providing precise navigation service based on GPS. It located in Memphis, Tennessee, and will become operational early next year. *www.honeywell.com*

Boeing advances security upgrade for GPS Ground Control System

Boeing has completed developmental system testing on the U.S. Air Force's GPS satellite ground control system, known as the Operational Control Segment (OCS), for the addition of a critical new security capability. The test demonstrated that the Selective Availability Anti-Spoofing Module (SAASM) software upgrade meets all contractual system requirements. SAASM is designed to protect GPS receivers against fake satellite signals sent by adversaries. *www.boeing.com*

GPS handsets a threat to PND market

The PND market is showing signs of maturity as price points decline sharply, consolidation occurs, and shipment growth slows, reports In-Stat. In addition, the increasing competition from GPS-enabled mobile phones represents the most significant threat the PND market will face. *www.instat.com*

Galileo update

First Galileo satellite repositioned

Surrey Satellite Technology (SSTL), UK, has completed the repositioning of the first Galileo test satellite, GIOVE-A, to a higher orbit to make way for the operational satellites of Europe's satellite navigation constellation. From the GIOVE-A operational headquarters, the operating team executed a series of precisely planned manoeuvres during July and August that have repositioned the satellite 113km above the orbit that the 27 operational Galileo navigation satellites will occupy. *www.sstl.co.uk*

Osmógrafo- The winner of the 2009 European Satellite Navigation Competition

The grand prize winner of the 2009 European Satellite Navigation Competition, Osmógrafo®, combines satellite positioning with wind measurement and rescue dogs' sense of smell in order to better determine which areas have already been covered by search teams. For this system - which was developed as part of the sixth framework programme of the European Commission - the Spanish company GMV was chosen as the Madrid regional winner and also received the special topic prize for the best safety-of-life application from Imade, the Madrid aerospace cluster and other sponsoring partners like Deimos and INDRA. The ESNC's international jury concurred, naming the Osmógrafo® the competition's overall winner. José Caro Ramon was in attendance at the Munich Residenz to accept all three awards on behalf of GMV. *www.galileo-masters.eu*

Launch of Galileo IOV Satellites delayed

Four Galileo in-orbit validation (IOV) satellites scheduled to launch in 2010 have already missed their first pad date. The European version of Russia's Soyuz rocket is now scheduled to carry the four IOV satellites into orbit in two launches in November 2010 and early 2011, as announced by European Space Agency (ESA) Director-General Jean-Jacques Dordain in October. The European Union and ESA plan to select a builder for the remaining 28 satellites late this year. Final bids from 11 companies bidding for on six Galileo work packages are expected in November. *www.esa.int*

European Commission reduces Galileo Satellite order

The European Commission has reduced the number of satellites it expects to order this year for the Galileo program to 22. The reduced order is being done to preserve the ability to modify the spacecraft design early in the system's life, according to European government and industry officials. The decision also allows the commission to save money and stay within the project's budget. The commission had asked the two final Galileo bidders — consortia led by Astrium Satellites and OHB System — to bid for 28 to 30 satellites, but the order is now for a maximum of 22 spacecraft. The commission has asked both bidders to quote prices for eight and 16 satellites as well, in case it decides to divide the work between the two consortia. Best-and-final offers are due in mid-November, with a decision scheduled for late December. The commission had budgeted 840 million euros ($1.24 billion) for the contract to build the Galileo satellites when it wanted 28 to 30 satellites. Officials said the bids they have received so far appear in line with that estimate. *www.esa.int*

Digital village in China

A two-year project to bridge the urban-rural digital divide in Yunnan Province in southern China is gathering pace. US$18 million so far has been spent in the creation of the 'Yunnan Digital Village', which will bring information technology to 16 cities, 129 counties and 130,000 villages in the province. The initiative was devised by Intel, which provided consulting services as well as technology and engineering solutions. *http://chinadigitaltimes.net*

Free access of OS mapping data

A range of new licences from Ordnance Survey provide users with free access to a wide range of mapping data for experimentation and development. It aims to further promote the innovative use of geographic information. The three new licences – 'Discover', 'Evaluate' and 'Developer' – make it easier for businesses, government agencies, social groups and entrepreneurs to experiment with OS data and realise the value of location-based information. *www.ordnancesurvey.co.uk*

NZ major map upgrade unveiled

A new topographical mapping series is being launched by Land Information New Zealand (LINZ). The new Topo50 map series was developed to be compatible with international mapping systems and GPS. The 1:50,000 scale maps use different longitude and latitude coordinates of points in New Zealand, to match the international settings on GPS units, making navigation easier for people. *www.linz.govt.nz*

Recovery.gov relaunched

Recovery.gov, the US government's official Web site for tracking federal stimulus spending, relaunched with a trove of new data that lets visitors see where the money is going by navigating through a series of maps. The GIS-based system "Will open people's eyes to the power of mapping as a way to communicate government policy. The vision is that people will be able to see their government's decisions

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and the consequences of those decisions," says Jack Dangermond, founder and CEO at ESRI. *www.esri.com*

Map View is Mappetizer now

MapViewSVG has a new name: Mappetizer. With Mappetizer 8, ArcGIS projects can be exported into the SVG (Scalable Vector Graphics) or into the Microsoft Silverlight format. It will be the solution for small and medium-sized project, and for projects which do not have to be frequently updated. *www.mappetizer.de*

Maps for the colour-blind

A new product from Ordnance Survey can be specifically styled to make mapping easier on the colour-blind eye. It allows creation of colour-blind-friendly styles, which to most people will look very strange but could help avoid future confusion for those with the condition. *www.ordnancesurvey.co.uk*

NSim Contour Beta

NSim Technology released Beta version of NSim Contour™. This interactive map application provides decision makers a way to efficiently manage geographic information online. It simplifies the management of a wide range of geographic resources (GIS, events, GPS, real-time data, GeoRSS, etc.) and communicates with a unique spatio-temporal database providing a full traceability of the actions executed on the map. *www.nsimtech.com*

US scientists to map Ganga stretch in Bihar, India

Scientists from the USA would work with the researchers of Tilka Manjhi Bhagalpur University (TNBU) to analyse the quality of water of river Ganga and prepare a map of riverbed through GPS. The Inland Waterways Authority of India will lend support to the effort with a well equipped vessel to aid the research. *http://bihartimes.com*

Integration of GPS Flight Tracking into Aviation Management SaaS

Trindigo has integrated Blue Sky Network's GPS tracking and automated flight following technology into Blue Sky aviation management suite. It will enable continuous monitoring location of flights within Trindigo's web-based solution using Blue Sky's near real-time GPS data. *www.blueskynetwork.com*

SpatialKey On-Demand Software

SpatialKey have released SpatialKey On-Demand software that enables decision makers to create and share map-based, interactive analyses and reports. It is an easy-to-use, software as a service (SaaS) enterprise solution. *www.spatialkey.com*

Fleet Management Telematics Device

Digi International introduced the ConnectPort X5 family of compact, ruggedized telematics devices. It is the industry's first family of telematics devices to incorporate cellular, satellite, GPS, Wi-Fi and vehicle area network (VAN) wireless technology in one device. Ideal for fleet management and asset tracking applications, it provides remote connectivity to mobile assets via cellular or satellite networks. *www.digi.com*

Spime launch

Spime Inc. has launched MapMan Onboard–Hybrid Map and Navigation Engine. It is an LBS mapping and navigation engine that powers customized map and LBS related applications to run on mobile handsets, netbooks, PNDs and MIDs. The MapMan SDK includes APIs that make it easy for developers to develop any map and LBS related application. *www.spime.com*

Oracle Trimble GeoManager Extension

Oracle has developed an extension which allows Oracle Field Service Applications users to add Trimble's GeoManager(TM) solution. The location-based features of GeoManager will allow organizations to improve fleet performance and the management of mobile workers and distributed assets. *www.trimble.com*

Alzheimer's Association launches Comfort Zone(TM)

The Alzheimer's Association Comfort Zone(TM) powered by Omnilink is a comprehensive location management system designed specifically for Alzheimer's. It is a web-based application that works with various location devices throughout the progression of the disease to proactively communicate the location of the person with Alzheimer's within two to 30 minutes, based on the family's selected plan. *www.alz.org*

Now all Mobile Phones location aware

GloPos software-only positioning technology shall make all mobile phones location aware - outdoors, indoors, and even underground. It requires only a cellular network to do so. No additional hardware like GPS or W-LAN is required. Its patent-pending, self-learning algorithms calculate an accurate position fix to within 1-40 meters. *http://glopos.com*

CSR unveils new built-in CPU GPS

CSR introduced the SiRFstarIV™ GSD4e, a new location processor with built-in CPU. New technologies embedded into this GPS such as "adaptive accuracy" and "SiRFGeoRecov" makes possible to instantly geo-tag images or videos with a camera or camcorder and improve the accuracy. *www.csr.com*

Latlong, launched in Bangalore

ONZE Technologies India introduced Latlong, a location search and driving directions service in SMS platform, in Bangalore. An SMS is easier to use, less time consuming and way cheaper than a GPS navigation service or other such services. *www.onze.in*

At a Glance

Mergers, Acquisitions and Partnerships

- RAMTeCH Software Solutions acquires Tier 3 Inc.
- Hexagon to acquire the Spatial Systems division of Loyola Enterprises Inc.
- Bentley has acquired 9SQ, South Korea. To acquire KSJ Beijing Software Technology Co. Ltd.
- China TransInfo acquires Beijing UNISITS.
- POWER Engineers acquires VELOCITIE.
- RapidEye appoints AAMHatch as distributor.
- Lotus appointed distributor of RapidEye data in Taiwan.
- NAVTEQ map data and content for the ALK Technologies CoPilot Live GPS products.
- ESRI Spain to be a distributor of 3-GIS.
- MAG Group to promote Spot Infoterra products and services in China.
- IGES, Japan, and ICIMOD Kathmandu has signed MoU in research on climate change, water, and forestry issues in the Hindu Kush-Himalayan region.
- Linfox has chosen Trimble in the US, and Telstra in Australia, to provide mobile resource management solution for its Asian operation.
- Rolta Asia Pacific has partnered with AAMHatch to provide Oblique Imagery throughout the Asia Pacific Region.
- AeroGRID has extended its European footprint by welcoming MGGP Aero as a partner.
- CR Kennedy appointed exclusive sales representative for IXSEA products in Australia.
- ERDAS and Observera to develop an integrated solution based on ERDAS APOLLO technology.

From ISRO's desk

India to launch satellites to study climate change

India shall soon be launching two dedicated satellites in polar orbit to study climate change through atmospheric research and detection of greenhouse gases. It will make India one of the few countries in the world to have such advanced facility to study the impact of climate change due to emission of greenhouse gases. *www.thaindian.com*

Oceansat-2 Progress

Oceansat-2, a new sea surface colour monitor launched by ISRO has begun beaming images and relaying data on sea surface wind speed and direction, according to the Indian Space Research Organisation. Its Ku-band, pencil beam Scatterometer, an active microwave sensor detects sea-surface wind speed and direction. The radio occultation sounder, developed by the Italian space agency, measures the lower atmosphere and ionosphere. *www.isro.gov.in*

ISRO to map Himalayan region

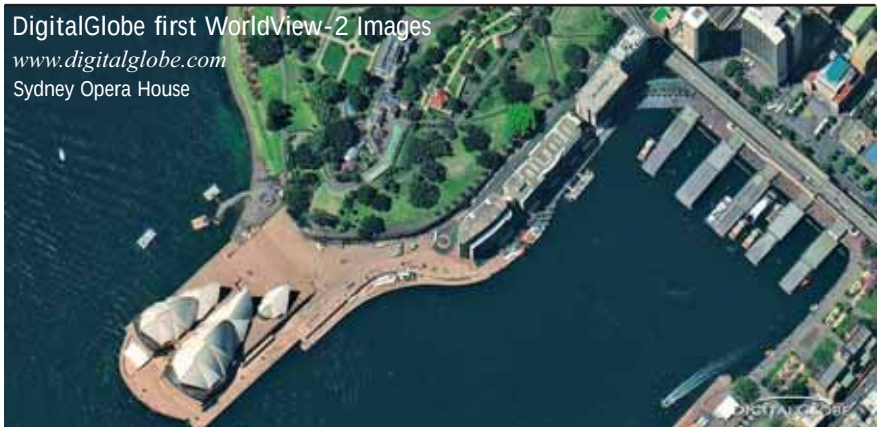
ISRO's Space Application Centre in Ahmedabad will undertake mapping and tracing of the Himalayan region to keep track of the movement of glaciers and their health. This is to put in place governance and management of the Himalayan eco-system. The mission aims to scientifically study the impact of climate change on Indian Himalaya and put in place adaptation measures to meet the growing challenge. *www.hindu.com*

Dr K Radhakrishnan takes over as Secretary, Department of Space, Chairman, Space Commission and Chairman, ISRO

Dr K Radhakrishnan, Member, Space Commission and Director, Vikram Sarabhai Space Centre, assumed the office of Chairman, Space Commission, Secretary, Department of Space and Chairman, Indian Space Research Organisation (ISRO).

Dr K Radhakrishnan is an accomplished technocrat with a distinguished career of more than 38 years in the fields of space technology, applications and space programme management. Dr Radhakrishnan graduated in Electrical Engineering from Kerala University (1970) and obtained his MBA from the Indian Institute of Management, Bangalore (1976). He was awarded PhD by the Indian Institute of Technology, Kharagpur, in the year 2000.

He was the key person in the Chandrayaan-1 mission, responsible for realisation of PSLV C-11 launch vehicle. Under his stewardship, five successful launches of Polar Satellite Launch Vehicles (PSLV) were realised and 20 spacecraft including Chandrayaan-1 were taken to the desired orbits precisely. *www.isro.org*



DigitalGlobe first WorldView-2 Images
www.digitalglobe.com
Sydney Opera House

ikeGPS™ powered by u-blox

u-blox and Surveylab has unveiled the successful integration of u-blox' LEA GPS receiver module into Surveylab's ikeGPS remote data capture products. It is a combination of positioning technology from u-blox with a 3D compass, laser rangefinder and digital camera. *www.u-blox.com*

NovAtel Precision Receiver Firmware

NovAtel Inc. has launched version 3.700 firmware for their OEMV family of GNSS precision receivers. It features L5 tracking capabilities and includes enhancements to NovAtel's single frequency RTK positioning solution, RT-2 L1TE, and to the company's ALIGN heading technology. RT-2 L1TE was upgraded to receive SBAS measurements as well as GPS and GLONASS signals. *www.novatel.com*

DataGrid launches New GNSS receiver

DataGrid Inc. has released its programmable DGRx-GNSS receiver for OEM integrators as well as a high-sensitivity mode for DGRx-GNSS that allows the receiver to track the L1 and L2C codes transmitted by GPS and GLONASS satellites down to a signal level of only 15 dB-Hz. *www.datagrid-international.com*

L-3 Interstate new GPS Receivers

L-3 Interstate Electronics Corporation (IEC) announced two additional configurations of its miniaturized hardened GPS receiver and one new configuration of its GPS-based guidance and navigation unit (GNU). It includes a 1.75 x 2.45-inch, low-power, high-accuracy design and a 3.07 x 0.93-inch design for projectiles. *www.iechome.com*

Navman Wireless debuts Jupiter3

Navman has released Jupiter3 GPS receiver module. It is based on SiRF Technologies' GSC3f/LPx chipset. Its low power consumption (11.5mA ATP), high sensitivity (-159dBm), and low cost is a good combination for vehicle, object, and even personal positioning products. *www.navmanwirelessoem.com*

IntergraphR unveils Public Safety Interoperability Framework

IntergraphR unveiled its advanced multi-agency and multi-jurisdictional data sharing with the introduction of its Interoperability Framework, an interoperability platform which supports industry standard information exchanges, such as the National Information Exchange Model (NIEM). The Framework enables public safety agencies to transfer CAD information using industry-standard formats, allowing for the easy multi-point exchange of information across software applications. *www.intergraph.com.*

Nexteq Navigation

Nexteq PAD110 series is a dual-frequency precise autonomous receivers offers sub 20 cm autonomous positioning with virtually no convergence and without using base stations or precise corrections. *www.nexteqnav.com*

New MapInfo® MapXtreme®

Pitney Bowes Business Insight announced new MapInfo MapXtreme v7.0, SDK for integrating location intelligence with existing business systems. It is a development solution for creating map-centric and location-enabled applications. The version features improved flexibility and data access, customization capabilities and interoperability with Bing and Google Maps. *www.pbinsight.com*

Ricoh's picture-based mapping for GIS handhelds

Ricoh Americas introduced a new solution that provides seamless integration between any WiFi-enabled handheld GPS devices and its 500SE-W digital camera. The solution addresses the needs of mobile GIS professionals that require high quality images to be associated to mapping points collected in different mapping applications. *www.ricoh.com*

Magellan introduces ProFlex 500 and MobileMapper™ 6

Magellan Professional ProFlex 500 base station is a new GNSS solution with enhanced multi-data streaming that offers easy access to RTK corrections for real-time centimetre-accurate land survey and high-accuracy GIS applications. It provides survey and GIS professionals an efficient and cost-effective alternative to public or private network corrections.

New MobileMapper™ 6 improves the "Go To" feature by allowing users to choose a new destination by entering point coordinates in the selected coordinate system. It also adds six new languages, Polish, Russian, Czech, Hungarian, Romanian and Bulgarian accessible through the user interface. *www.magellangps.com*

Autodesk pirated software seizures

Autodesk has seized pirated copies of its 'AutoCAD 2007' software with a total value of AED 1 million, from an engineering consultancy firm in Abu Dhabi. *www.autodesk.com*

ESRI Business Analyst Server

The new version of ESRI Business Analyst Server includes many new sharing and usability enhancements designed to speed report delivery and help users conduct more precise business analysis. Custom report templates can now be created and then uploaded to Business Analyst Server. Developers can also consume the report output in XML format to supply data for application features. *www.esri.com*

Pictometry Patent infringement suit

Pictometry International has filed a patent infringement suit against Geospan Corporation in the U.S. District Court

for the Western District of New York in Rochester, New York. The suit alleges that Geospan has infringed on its patent, U.S. Patent No. 5,247,356 which relates to its digital aerial oblique imagery and its photogrammetric method and apparatus. *www.pictometry.com*

ERDAS releases

ERDAS has released ERDAS IMAGINE 2010, LPS 2010, ERDAS APOLLO 2010 and other desktop and enterprise products. It has also introduced IMAGINE Feature Interoperability and IMAGINE SAR Interferometry. *www.erdas.com*

INSPIRE-ready technology

Snowflake has released GO Loader 1.6 and GO Publisher 1.4. It provide an out-of-the-box platform for organisations to realise INSPIRE compliance, as well as future proof their existing technology infrastructure and eliminate the threat of unnecessary software development or upgrade costs. *www.snowflakesoftware.com*

OmniSTAR receiver by Geneq

Geneq introduced an OmniSTAR-compatible receiver for sub-metre mapping wherever OmniSTAR VBS is broadcast. The SXBlue II-L is capable of receiving OmniSTAR sub-metre corrections in all regions of the world. It also incorporates SBAS signal processing for using WAAS, EGNOS and MSAS, and future SBAS signals. The ability to select from either OmniSTAR or SBAS provides GIS professionals a sub-metre mapping solution. *www.sxbluegps.com*

Safe Software in UNEP's WCMC

The United Nations Environment Programme's World Conservation Monitoring Centre (UNEP-WCMC) have invited Safe Software into their Proteus Partnership. The goal of Proteus is to provide industry decision makers with access to the best possible data on location and distribution of biodiversity to support risk management and safeguard the Earth's biodiversity and ecosystems. *www.safe.com*

HP expands Large-format portfolio

HP has expanded its large-format portfolio. The range of new workgroup printers, software solutions and media choices are designed to help technical firms that specialize in architecture, engineering and construction (AEC), GIS applications, and mechanical CAD to drive new business opportunities. *www.hp.com*

Blue Marble GeoTranslate beta

Blue Marble Geographics has released Beta Version of GeoTranslate 5.1 with Spatial Connect along with GeoTransform 6.1. They are incorporated into the Blue Marble's GeoCore SDK an all-in –one geospatial data translation developer toolkit that supports coordinate, geometry, vector, CAD, raster, and LiDAR data. *www.bluemablegeo.com*

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25-27, November 2009
Hyderabad, India
www.incois.gov.in/isprs

GPS/ IGNSS Symposium 2009
30 November-01 December
Tokyo, Japan
www.gnss-pnt.org/symposium2009

December 2009

IGNSS 2009
1- 3 December
Gold Coast, Queensland, Australia
www.ignss.org

Middle East Spatial Technology Conference & Exhibition
7 - 9 December
Kingdom of Bahrain
rizwan@mohandis.org
www.mest.bh

January 2010

Asia Oceania Region Workshop on GNSS
25-26 January 2010
Bangkok,Thailand
www.multignss.asia/workshop.html

March 2010

Munich Satellite Navigation Summit
9-11 March
Munich, Germany
www.munich-satellite-navigation-summit.org

GEOFORM+'2010
30 March –2 April
Moscow, Russia
www.geoexpo.ru

Digital Preservation of Archaeological Heritage
10 - 12 March, 2010.
IIT Kanpur, Kanpur, India
arch3d@iitk.ac.in
www.iitk.ac.in/arch3d

April 2010

XXIV FIG International Congress 2010
11 - 16 April 2010
Sydney, Australia
www.fig2010.com

Geo-Siberia 2010
27-29 April
Novosibirsk, Russia
www.geosiberia.sibfair.ru

June 2010

Toulouse Space Show 2010
8 - 11 June
Toulouse, France
contact@toulousespaceshow.eu
www.toulousespaceshow.eu

July 2010

ISPRS Centenary celebrations
4 July
Vienna, Austria
www.isprs100vienna.org

ESRI International User Conference
12–16 July
San Diego, USA
www.esri.com

September 2010

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

October 2010

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

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

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