No: DL(E)-01/5079/05-07
RNI: DELENG/2005/15153
Rs.100

ISSN 0973-2136

Coordinates

MONTHLY Volume II, Issue 7, July 2006

POSITIONING, NAVIGATION AND BEYOND

nsdi

Put together brick by brick

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Articles

Columns

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This issue has been made possible by the support and good wishes of the following individuals and companies AA Pavelyev, Adam Mowlam, Amitabha Pande, AG Pavelyev, C-Y Huang, Jim Smith, KM Jagdeesh, K V Ravindran, Dr K Kasturirangan, Maj Gen M Gopal Rao, Mukund Rao, NK Agarwal, P Nag, Promod K Singh, Philip Collier, R Sivakumar, RP Singh, Rajesh C Mathur, Roger Fraser, SD Baveja, S N Das, Prof VS Ramamurthy, Vandana Sharma, YA Liou and; Autodesk, Contex, HP, Leica, Navcom, TraceMe; and many others.

Printed and published by Sanjay Malaviya on behalf of Centre for Geoinformation Technologies (cGIT) at A221 Mangal Apartments, Vasundhara Enclave, Delhi 110096, India.
Editor Bal Krishna | **Owner** Centre for Geoinformation Technologies | **Designer** TSA Effects, www.tsa.in | **Printer** Sonu Printer, A110 DDA Sheds, Okhla, New Delhi, India.

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This issue of Coordinates is of 44 pages, including cover.

Building NSDI: Brick by brick

India, a happening place.

Right to information, New Map Policy, and now a government resolution on NSDI.

A visible change in attitude and temperament.

And in mindset too.

Having right policies are must for the growth of the industry.

Hence, our crusade continues on policy issues.

Hopefully, this resolution will bring NSDI on the policy priority of the government which otherwise was more pursued by a few enthusiasts.

We would like to take the discussion beyond the realm of euphoria to stricter parameters of measuring a success.

The success does not lie in a resolution, although it may be construed a step ahead.

The issue remains basic and fundamental.

Easy access to spatial information.

And parameters to measure the success will not be defined by the data providers.

It has to be judged by the users.

Bal Krishna, Editor
bal@mycoordinates.org

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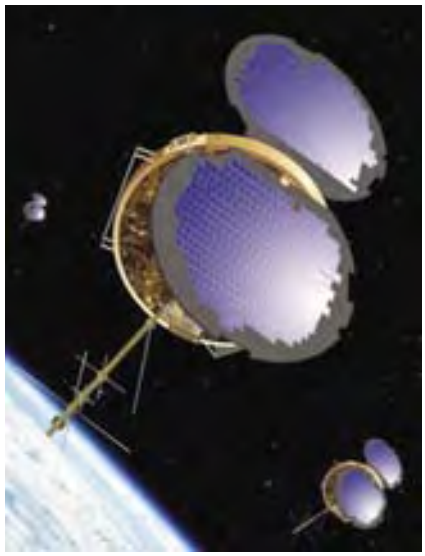
FORMOSAT-3 GPS radio occultation mission

The preliminary results of the FORMOSAT-3 mission indicate its high accuracy and promising perspectives

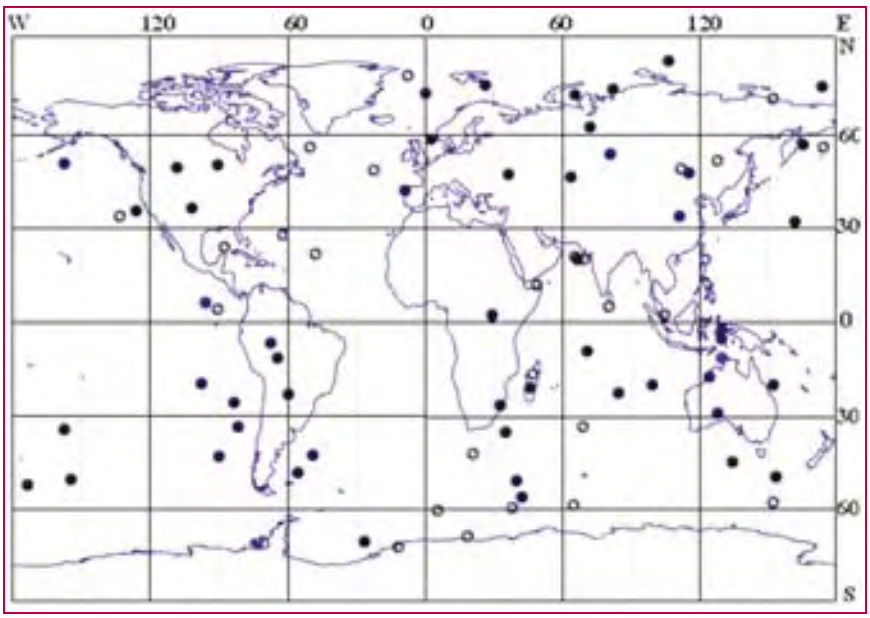
YA Liou, AG Pavelyev, C-Y Huang, AA Pavelyev

Six tiny FORMOSAT-3 satellites that were sped into space on April 15, 2006 are designed for systematic mass scale radio occultation (RO) studies of the Earth atmosphere and ionosphere at different altitudes by use of the GPS signals. Termed as the Formosa Satellite-3/ Constellation Observing System for Meteorology, Ionosphere, and Climate (FORMOSAT-3/COSMIC) mission, the new constellation's primary science goal is to obtain in near real time the vertical profiles of temperature, pressure, refractivity, and water vapor in the neutral atmosphere, and the electron density in the ionosphere with global coverage. The measurements during five years of mission life will provide about 2,500 soundings per day, thus generating extensive information to support operational global weather prediction, climate change monitoring, ionospheric phenomena, and space



weather research. The theory of RO measurements has been described previously (Gurvich and Krasilnikova, 1988; Yunck, 1988; Yakovlev, 2002; Hajj et al., 2002). During last four years, essential modernization in the RO technique has been introduced (e.g., Liou et al., 2002, 2006; Pavelyev et al., 2004 and references therein).

Fig. 1. Geographical distribution of the first 10-day FORMOSAT-3 RO events from April 21 to 30, 2006.

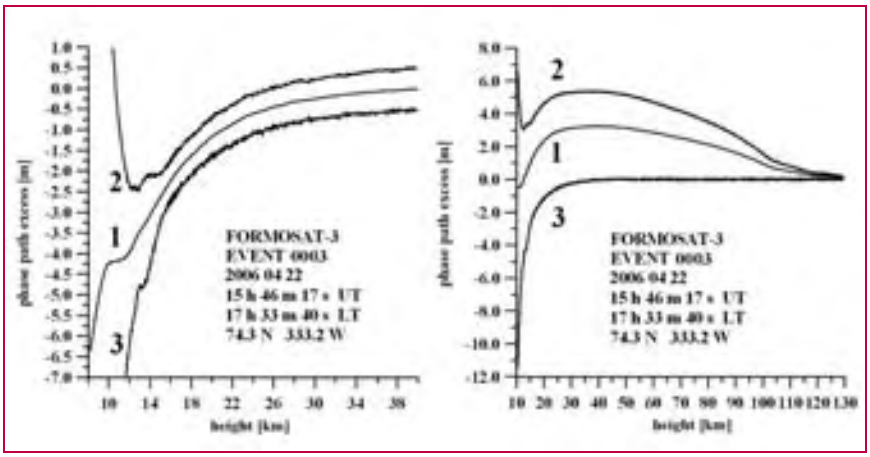


The geographical distribution of the first 10-day FORMOSAT-3 RO mission events is given in Fig. 1 from April 21 to 30, 2006. The total number of the RO events is 86. The polar orbit of the FORMOSAT-3 satellite allows global monitoring including North and South Polar regions, and ocean areas.

The records of the RO signals along the LEO trajectory during motion to radio shadow region at two GPS frequencies f_1=1575.42 MHz and f_2=1227.6 MHz are the radio-holograms, which contain the amplitudes $A_1(t)$ and $A_2(t)$, respectively, along the phase path excesses $\Phi_1(t)$ and $\Phi_2(t)$ of the radio field as functions of time. The phase path excess is measured as the difference between the real phase path in the atmosphere and ionosphere and the phase path corresponding to the propagation in the free space along the line of sight. The vertical velocity of the occultation beam path $v\perp$ is about 2 km/s. This $v\perp$ value is many times greater than theos corresponding to the motion of layers in the ionosphere and atmosphere. Therefore, the satellite radio-holograms contain quasi-instantaneous image of the Earth environment in the RO region.

To exclude the transmission of noise from frequency F_2, the ionospheric model is applied to the phase path excesses F_1 and F_2 at frequencies f_1 and f_2, respectively, and the atmospheric phase path excess F_0, obtained after standard ionospheric correction, are shown in Fig. 2 (right panel) by curves 1, 2, and 3, respectively. The results, shown in Fig. 2 (left panel), have been obtained after subtracting from the phase excesses

Fig. 2. The phase excesses before (right panel) and after (left panel) ionospheric correction. The curves 2 and 3 (left panel) are displaced by 0.5 m for better comparison.

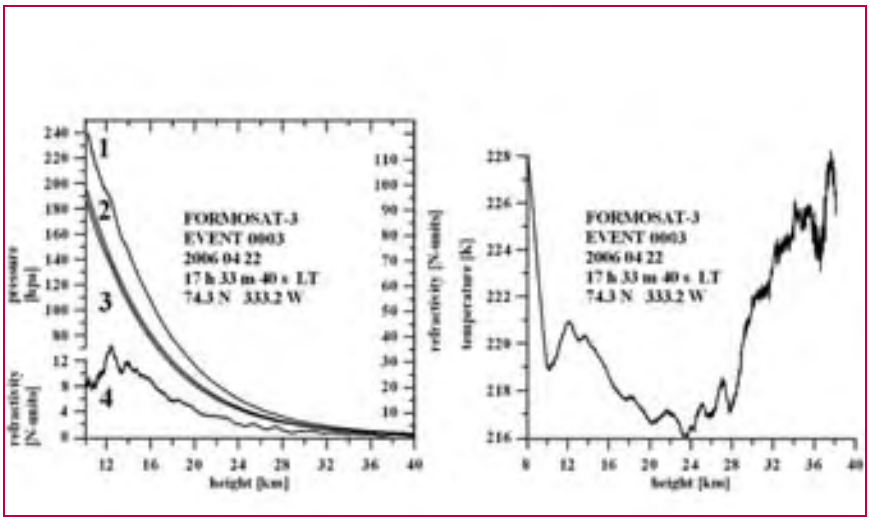


F_1, F_2, F_0 the phase delay, calculated using model of standard refraction in the atmosphere (Pavelyev et al., 1996) (curves 1–3 in Fig. 2, right panel) as function of height h in the atmosphere. For better comparison with results of linear ionospheric correction (curve 3), the curves 1 and 3 are displaced by 0.5 m in the opposite sites (Fig. 2, left panel).

The model dependent ionospheric correction minimizes the noise level in the retrieved atmospheric refractivity (Fig. 2, left panel).

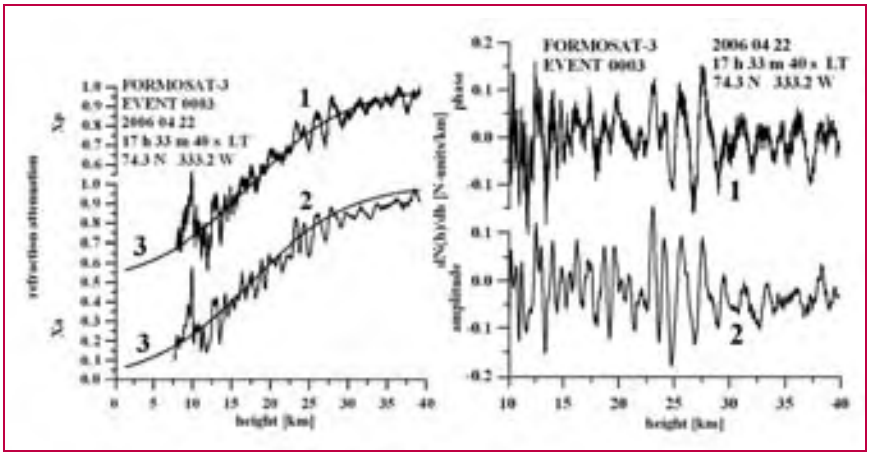
The results of retrieved vertical profiles of refractivity *N(h) [N-units]*, pressure *P(h) [hpa]*, and temperature *T(h) [K]* from the phase delay F_1 are demonstrated in Fig. 3. The data, shown in Fig. 3, left panel, are relevant to the vertical profiles of pressure *P(h)* (curve 1), refractivity $N_m(h)$, obtained from the standard model of the atmosphere (curve 2), refractivity *N(h)*, retrieved from the phase delay F_1 (curve 3), and to the difference $N_m(h)$–*N(h)* (curve 4). The retrieved vertical profile of the refractivity is below the standard atmospheric refractivity profile because geographical location in the North Polar Region where the cold temperature in the lower troposphere necessitates the higher rate of diminishing of refractivity and pressure with altitude. The vertical profile of temperature *T(h)* obtained after the model-dependent ionospheric correction from the phase delay F1 is shown in Fig. 3, right panel. The changes of temperature T(h) are concentrated in the 216–228 K interval when the altitude is increasing from 10-40 km (Fig. 3, right panel). The influence of tropopause, where the vertical gradient of temperature changes from -5 K/km to +2 K/km is evident in the 8–11 km altitude interval. The influence of the internal wave structures with amplitudes of about 1–3 K and vertical periods 1–3 km is clearly seen in the 11–28 km height interval. The 11 K temperature increase with vertical gradient 0.9 K/km is visible in the 28–40 km altitude interval. Therefore, the results shown in Fig. 3 indicate high accuracy of the FORMOSAT-3 RO frequency F1 data and reveal advantages of application of the RO method to study meteorological parameters.

Fig. 3. Left panel: Results of retrieving the vertical profiles of refractivity N(h) [N-units] **and pressure** P(h) [hpa] **from the phase delay F_1. The top left vertical axis corresponds to pressure (curve 1) and the bottom left vertical axis is relevant to the refractivity perturbations (curve 4). The right vertical axis corresponds to the vertical profiles of the refractivity calculated by use of standard atmospheric model (curve 2) and the refractivity retrieved from the RO data (curve 3). Right panel: Results of retrieving the vertical profile of temperature** T(h) [K]**.**



The RO method is a new tool for studying the internal gravity waves (GW) on a global scale (Pavelyev et al., 2004; and Liou et al., 2002, 2006). Curves 1 and 2 in Fig. 4, left panel, demonstrate the refraction attenuations X_p and X_a evaluated from the phase acceleration and amplitude data at the first GPS frequency F_1. Smooth curves 3 describe the results of modelling of the refraction attenuation. The excellent correspondence between the refraction attenuations obtained from the amplitude and phase data is clearly seen in Fig. 4, left panel (curves 1 and 2). The results of modelling of the refraction attenuation coincide well with experimental data. Thus, the phase acceleration has the same importance for the RO experiments as the well-known Doppler frequency. Note that by use of the phase data one can correct the amplitude data for systematic errors caused by the trends in the antenna gain and direction,

Fig. 4. Left pane: The refraction attenuations X_a, X_p retrieved from the phase and amplitude data (curve 1 and 2, respectively). Curves 3 indicate the results of simulation of the refraction attenuation in the atmosphere. Right panel: The variations of the vertical gradient of refractivity retrieved from the phase and amplitude data (curve 1 and 2, respectively).



and the receiver's noise variations. The interesting feature of the phase acceleration consists in the diminishing of the ionospheric influence. The slow ionospheric trend, which is clearly seen in Fig. 2 (left panel, curves 1 and 2), introduces a systematic error in the phase path excesses at the frequencies F_1 and F_2. This error is more than contribution of the neutral component in the upper stratosphere. However, the slow ionospheric trend is not seen in the refraction attenuation (Fig. 4, left panel) because of the effect of double differentiation on time. The theoretical values of the refraction attenuation (curves 3 in Fig. 4, left panel), calculated without accounting for ionospheric influence, have significant agreement with the experimental curves 1 and 2 obtained from the amplitude and phase data. This differential effect can be used to develop a new tool for ionospheric correction.

The variations of the vertical gradient of refractivity $dN_p(h)/dh$ and $dN_a(h)/dh$ *[N-units/km]* found from the FORMOSAT-3 RO phase and amplitude data are compared in Fig. 4, right panel (curves 1 and 2, respectively). There is a good correlation between $dN_p(h)/dh$ and $dN_a(h)/dh$ up to altitude 28 km (Fig. 4, right panel). Typical values of the vertical gradient variations are about ±0.12 – 0.18 N-units/km, and typical vertical periods are 0.8–2.5 km. Changes in the vertical gradients of the refractivity may be connected with the GW propagating through the tropopause areas and, consequently, may correspond to the changes in the horizontal wind velocity. At the 28–40 km altitudes, the amplitude and form of wave structure are quickly changed. This indicates the wave-breaking zone in the 28–30 km interval. The amplitude of wave structure diminished by 2–3 times corresponds to energy dissipation by 4–9 times. The wave-breaking effect and the instantaneous radio image of wave-breaking area are obtained by the FORMOSAT-3 mission in the first time in RO practice simultaneously in the amplitude and phase data. This observation supported the preliminary conclusion, made earlier by Liou et al., 2006, on a possibility to study the wave-breaking areas in the atmosphere by the amplitude RO method.

Conclusions

The preliminary results of the FORMOSAT-3 mission indicate its high accuracy and promising perspectives. A preliminary analysis of the FORMOSAT-3 RO data indicates new directions of application and necessitates the modernization of the RO method. A perspective direction for modernizing the RO method is connected with a new method of analysis of amplitude and phase variations in the RO signal. It is shown in this paper that the amplitude and phase variations of the RO signal contain important information on the vertical structure of the upper troposphere and lower stratosphere. This information is primarily useful for studying quasi-periodical internal waves propagating through the tropopause to stratosphere and is capable of characterizing GW in the 5-100 km range. The phase acceleration allows recalculating the phase delay to the refraction attenuation, which is important for the future RO mission aimed to measure the absorption in the atmosphere caused by water vapor and minor gas constituents. The phase acceleration and amplitude of the RO signal are important source of information on the wave structures and give the radio image of the internal wave in the atmosphere. The application of this and other new techniques will generate extensive information on the internal wave properties in their propagation region.

Acknowledgments

We are grateful to NSPO of Taiwan for the access of the FORMOSAT RO data. The work has been supported by National Science Council of Taiwan (NSC) grant NSC 94-2811-M-008-055, Russian Foundation for Basic Researches (RFBR) grant No. 06-02-17071, and Russian Academy of Sciences, programs OFN-16 and OFN-17.

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Galileo update

Galileo – the European Programme for Global Navigation Services for civil purposes is an initiative led by European Union. We provide regular updates to our readers on the Galileo programme.

Galileo already over budget

Galileo Joint Undertaking, the organisation leading European development of a global satellite navigation system, has admitted it is already €404 million ($513 million) over budget, mainly due to miscalculating the cost of building and launching two technology pathfinder spacecraft, the first of which, GIOVE-A, was launched from Baikonur Cosmodrome in Kazakhstan in December.
The total budget for the Galileo programme, which will comprise 30 operational satellites, will be about €4.5 billion, of which €1.5 billion has already been spent. Initially, a four-satellite constellation of operational spacecraft will be launched.
www.flightglobal.com

Galileo and GPS III future satnav interoperability

EADS Astrium and Lockheed Martin will work together to ensure the interoperability of future European and US satellite navigation systems. Galileo Joint Undertaking is managing a European consortium led by EADS Astrium developing the Galileo space-based radio positioning, navigation and time distribution system. The US military is also working on an upgraded block III of its existing Global Positioning System (GPS), with Lockheed Martin the prime contractor. Under an agreement announced, the companies say they will "perform systems engineering and technical assistance tasks for each other in the areas of interoperability, integrity and optimization of joint constellation performance".The companies will also offer reciprocal bids on operational hardware and software, subject to European and USA export policies.
www.flightglobal.com

ESA Selects Esrange

Swedish Space Corp. will provide northern telemetry, tracking and command services for ESA's Galileo satellites at its Esrange Space Center near Kiruna. The 13-meter TT and C antenna to be located at Esrange will play a key role in the global infrastructure needed to operate the fleet of Galileo satellites, the company said in a news release.
www.spacedaily.com

QinetiQ joins Galileo development

QinetiQ has announced that it has signed a contract to join the European consortium conducting Phase CDE1 of development of the Galileo satellite constellation. Under its 7.3 million euro, ($9.4 million) four-year contract, QinetiQ will perform security module development and test-support-tool design, construction and use. In addition, QinetiQ's Centre for Propagation Analysis and Atmospheric Research will perform an ionospheric propagation analysis, which theoretically should validate Galileo's expected performance.

Everest in South Africa


Portrait of Maclear

It was the 25 November 1820 when Everest reached Table Bay and the chance to recover from the fevers to which he had succumbed. Little is known of the year he spent there other than the work he did on the meridian arc that had been observed by M. l'Abbé de LaCaille some 70 years earlier. Prior to leaving India he had discussed with William Lambton, the apparent inconsistency between the arc measured at the Cape by LaCaille when compared with the results from various other measures around the world. Both Everest and Lambton were familiar with observing in the vicinity of large mountain masses and they knew of the experiments of Pierre Bouguer who went on the Peruvian Survey Expedition of 1735.[3]

Everest could not make any progress until he had obtained a copy of LaCaille's Journal from Europe and it was July 1821 before it arrived. Unfortunately it gave little numerical data to go on although he was able to recover some of LaCaille's station positions. In addition to the base terminals there were four major stations connected in two triangles. LaCaille's observations had suggested that a degree at 33º S. of 57 037 toises was almost equal to a degree at 45º N. of 57074 toises or, in other words, the earth was more flattened towards the South Pole than towards the North Pole. Was that suggestion correct?

In visiting the sites he was struck by the nearness of both the north and south ends of the Arc to mountain masses. Everest considered that rather than any effect at these stations cancelling out it was likely that the reverse would have occurred. In which case the arc would have been too great by the combined effects of the mountains at each end of the arc. To quantify this Everest inter-compared various arc measures and from knowledge of the earth's semi-axes a and b he determined values of the compression of the earth's form.

In taking this to its final stage Everest quoted LaCaille's arc value from "a very old edition" of Hutton's Philosophical Dictionary [2], as most of his reference works were still in India, and would appear to have perpetuated a transcription error. The figure of 410 814 Paris feet quoted by Hutton should read 418 014 feet to agree with the measure quoted by LaCaille of 69 669.1 toise. The value is then erroneously turned back to toise as 68 469-the value used by Everest. How easy it is to perpetuate mistakes! [4]. Luckily the effect of the error hardly changed Everest's conclusion. Where the figures he used gave a difference of 8.99" to attribute to attraction, it should have been 9.15". From this Everest calculated a need to increase the amplitude of LaCaille's

LaCaille's triangulation scheme

arc by 8.99" to compensate for the possible effect of local attraction. If this were done the arc would fall into harmony with an ellipticity of 1/300.

By 31 December 1821 he was back in India ready to renew his efforts on behalf of the Great Trigonometrical Survey . He summed up his stay in South Africa as "...the fine climate of which had most thoroughly renovated my health..." [1]

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India's NSDI – Back into the future

June 13, 2006.

A resolution by the Government of India on NSDI.

A significant step.

Coordinates initiates a discussion.

On what was envisioned, and what has been achieved.

On challenges ahead.

A time to celebrate.

To get nostalgic.

To revisit moments of euphoria and despair.

To remember heroes.

To share their views, experiences and expectations.

While Mukund Rao narrates the story of NSDI in India, we pay our tributes.

A humble tribute.

To those who contributed in this mission.

Bal Krishna
Editor

Mukund Rao

The Government of India has formally approved the National Spatial Data Infrastructure (NSDI) programme – I told myself AT LONG LAST, IT IS DONE!!! I also heaved a sigh of relief – a sigh which has been weighing on my mind for the past 5 years (from February, 2001 onwards). In that sense of relief – that marked a feeling of achievement and success for the benefit of the country, I closed my eyes and …

The initial phase

My thoughts went back to December 5, 2000 – when the first meeting of the then NGDI Task Force was held in Department of Science and Technology (DST) to consider the National geographic Data Infrastructure (NGDI) programme. Fortunately, a great personality of Indian Space – Dr K Kasturirangan – whom I have the highest regard and respect for, had nominated me to that committee and I met yet another great person – Dr V S Ramamurthy, then Secretary, DST. These two were the torch-bearers of India's NSDI who laid a foundation for a movement that was visionary and way ahead of times. At that first meeting, I vividly recall my first interaction with an ebullient and dynamic personality – Mr Amitabha Pande, then Joint Secretary, DST who is yet another driving force for NSDI. In that committee, I also developed close association with many friends from Survey of India (SoI), Geological Survey of India (GSI), National Informatics Centre (NIC), industry and many other agencies and committed team was formed. Each member was charged and motivated and wanted a good vision for NSDI – un-shackling the Indian spatial data community to contribute to a successful nation-building enterprise.

Soon within two months we had a blue-print for NSDI – NSDI Strategy and Action Plan document. I worked with Mr Pande assiduously to see that ISRO produced a beautiful document for the country. I always believed that NSDI was a programme that had to be owned by all and thus strived always to obtain technical and programmatic consensus for NSDI from all stake-holders. It was not an easy task (in 2001) when the concept

Better late than never

Dr K Kasturirangan
Member of Parliament, Rajyasabha, Former Chairman ISRO

I must say better late than never. I am happy that we have a system in place to make spatial data available to the users for various specific and multiple applications. Now not only methodologies have to be evolved but institutional framework should further be strengthened. It is an evolutionary phase. The proposed set up is a good beginning. We have to try out various options as there is currently no standard practice available. The main objective is that it has to succeed in ensuring easy accessibility and availability of multiple layers of spatial data in a standard format.

Having Minister of Science and Technology chairing the NSDC would be advantageous as it would ensure a smooth interfacing with policy issues. I am sure that all the stakeholders will join the initiative. I feel that they are very enthusiastic. There has been several round of consultation to ensure their participation. Participation in NSDI should not be interpreted as parting with data, but as accessing multiple layers of information.

of "sharing and owning" had different connotations. I recall the innumerous debates we had – is it NGDI or NSDI; what is the concept of SDI; is NSDI a monolith or a distributed architecture; technologies required for NSDI; organisational structures required for NSDI; sensitizing to the multi-farious drivers of different agencies – binding them to a common goal and many other aspects. But the tenacity of the Committee, and a good leadership role by Dr Prithvish Nag brought all issues to a common understanding. And soon the blue NSDI document was ready … and that was January, 2001.

Looking back, my grand time came when I, thanks to the magnanimous and motivating vision of Dr Kasturirangan, Dr Ramamurthy and Mr Pande, was called upon to present the NSDI Strategy and Action Plan to the Indian Community at the 1st NGDI Conference on February 5, 2001. The Strategy was adopted and February, 2001 saw the dawn of a new dream for all of us – the dream of a NSDI.

The Ooty high and a dampener

We soon moved on to Ooty for the 2nd NSDI Conference – we in the NSDI (finally NSDI was chosen) Committee felt that the NSDI movement required constant high-profile visibility and focus. Ooty Conference, in July, 2002, was a watershed of a sort for NSDI. Expectations were high and the "iron was hot" (as they say). Six key Secretaries of Government of India (GOI) and about 180 Indian NSDI stakeholders and a fantastic action plan brought a forward-looking Ooty communiqué – which brought the NSDI dream a bit closer to reality. I continued my saga in the Committee of envisioning great things for NSDI and led the NSDI Metadata Standard effort and after excellent interactions with many colleagues – we brought out the Metadata Standard document in a successful manner. At the same time other groups addressed the NSDI Exchange Standard and the NSDI Applications protocol and the NSDI Network Framework – all of which brought out the intense and high-level of technical knowledge and professionalism of the Indian spatial technology experts.

I must mention an important incident that happened at Ooty. I was involved,

There is no shortcut

Prof V S Ramamurthy
Former Secretary, Department of Science and Technology, Government of India

The resolution on NSDI is a first step to make quality GIS database available to the entire country in a structured manner. The cabinet level decision provides an official stamp of approval. The National Spatial Data Committee is to be chaired by the Minister of Science and Technology. This gives not only a political signal but also ensures that the message comes from the top. The major data producing agencies in the government will accept it as a norm.

While the realization of NSDI took more time than anticipated, that never frustrated me. In ambitious programmes, it takes time to reach consensus. There is no shortcut to success. The committees that have been constituted have to evolve standards in alignment with international practices. They should also endevour to make the NSDI portal functional.

A dream and a passion

Amitabha Pande
Principal Resident Commissioner, Government of Punjab. Former Joint Secretary, Department of Science and Technology

When we thought of NSDI five years before, it was a dream, a passion, a purpose, a commitment and a movement. The whole purpose was to enable easy access to spatial data. There were four critical components of the initiative - standards, centralized access, open sharing of the data and building of partnerships for value addition. It was thought to involve players at every level like states, villages, communities that will eventually lead to the creation of not only NSDI but also SDIs at state, districts and village levels too. This larger vision does not appear to have been fully encapsulated in the recent government resolution. A major drawback is that the National Map Policy still does not allow open access to the ordinary citizens to maps. A willingness to bring map information in the open public domain has to precede the creation of a NSDI.

This willingness is still largely absent within the ambit of the National Map Policy. The present resolution of the government was originally intended to create an overarching institutional framework and an organization which would have sufficient clout to administer and implement policy, and to design policy which would make spatial data infrastructure a powerful tool of social transformation and improved governance.

This needs something far beyond the creation of government committees with little or no administrative and financial powers to enforce its policies. In addition, it needs professional leadership through a full time CEO who is the convener/ coordinator of both the committees. Such a CEO would also require a core team of committed professionals to assist him.

Without a CEO and a core team, the organizational framework can easily slide into performing bureaucratic rites and rituals. I do not see any sign of how this is proposed and implemented.

with the best of ISRO colleagues and colleagues from SOI and GSI (of course, supported by industry), in developing a NSDI Portal that was to be unveiled in Ooty. Our thinking was that once the NSDI Portal was shown and then unveiled – it would be proof of what NSDI can bring benefit to different stake-holders and we felt that we would have crossed a major milestone then. It was all done and the NSDI Portal was ready for unveiling on July 29, 2002 at Ooty. But, at the nick of time, came a dampener – a query from the Defence to get the clearance for the Portal and its data content of maps. Just one night before the unveiling in Ooty, in a serene Cottage room, it was agreed that the unveiling would be deferred and that we should work for a formal government clearance for NSDI. So a Powerpoint presentation was made up to simulate the unveiling (but for a few of us the world did not know about this). Even then, Ooty Conference was a great success – the right chords had been stuck and it was decided to get Government Clearance for NSDI.

The development of the NSDI Portal was enhanced and it was to be shown in an important Secretary-level meeting. 18 July, 2003 – I still remember that date. I was closely involved and steered an extremely good and on-line presentation and demonstration of NSDI to a group of Secretaries (we actually set up a Metadata Server that was accessed on network and data was transferred to the meeting – actually doing a full-scale NSDI transaction). The demo and presentation was a grand success and it was agreed that the country must have a NSDI. Once again our dreams were fired-on – we thought that this time we have it and soon we shall show the world India's NSDI.

The trudge

Then started the trudge ahead – and it has been a long wait of 4 years.

Building consensus

Maj Gen M Gopal Rao
Surveyor General of India

The NSDI movement has been driven by a few individuals of a few organizations. Although it started with a lot of enthusiasm, this slowly waned away. The initial larger participation was slowly taken over by a sense of indifference.

We should understand that processes that need consensus are generally time consuming. The positive thing was that despite all the frustration that was creeping in, the taskforce stayed together. Some of the working groups persevered and due to them, continuity was maintained. Now the government has given an authority and the entire movement is now set to move with greater momentum. We can expect that all the organizations who have participated in this endeavor with great enthusiasm will rejoin with same vigor.

Significant groundwork has already been done. Standards are in place. Interoperability of large datasets is to be demonstrated in September this year. The misapprehensions of many government agencies have already been resolved. The very fact that many organizations have spoken to each other and agreed to pool their datasets itself is an achievement. The academia is a part of this effort. However, the industry so far has been passive in its response. I look forward for their active participation.

The other area of concern is to involve state governments. We need to think how to get them on board through state level SDI. Survey of India state level Geo-spatial Data Centre (GDC) should act as facilitator for this. Although major data producing agencies are at central level but at micro level most of the datasets are with the state governments. We expect all the stakeholders to put in place their portal gateway for data sharing. Survey of India will soon be setting up a portal to service NSDI. We also need to understand the process of data sharing. It should serve the need user needs with least hassles. The SOI is already in compliance with OGC standards.

The challenge as Member Secretary is the implementation of an action plan within a given timeframe. And also to get all the government partners work at the same pace. Most importantly, it has to be done through consensus. Some of the working groups who could not make progress at the desired pace will be restrengthened.

Despite all, we succeeded

Dr R Sivakumar
Head, NRDMS and NSDI Division, Dept of Science and Technology

I have a great sense of achievement. We are very happy as it came the way we wanted it. Although, initially we wanted a legislation but to start with a government resolution is no less. Ultimately we may have to go in for a legislation. We were successful in keeping the interest for NSDI alive despite being ridiculed by many including media at various forums. The consensus was evolved after a series of meetings. We managed to generate interest that helped various stakeholders to participate and contribute. Keeping people together, itself was a challenge. We have great expectations from industry and ready to collaborate. We have done enough ground work for NSDI to take off. The NSDC will soon hold its first meeting to discuss various issues and to prepare a road map. Personally, for me it was a great learning experience to sharpen my managerial and technical skills. I also take this opportunity to thank ITC, OGC, NRCan, Ordnance Survey for helping us to achieve this.

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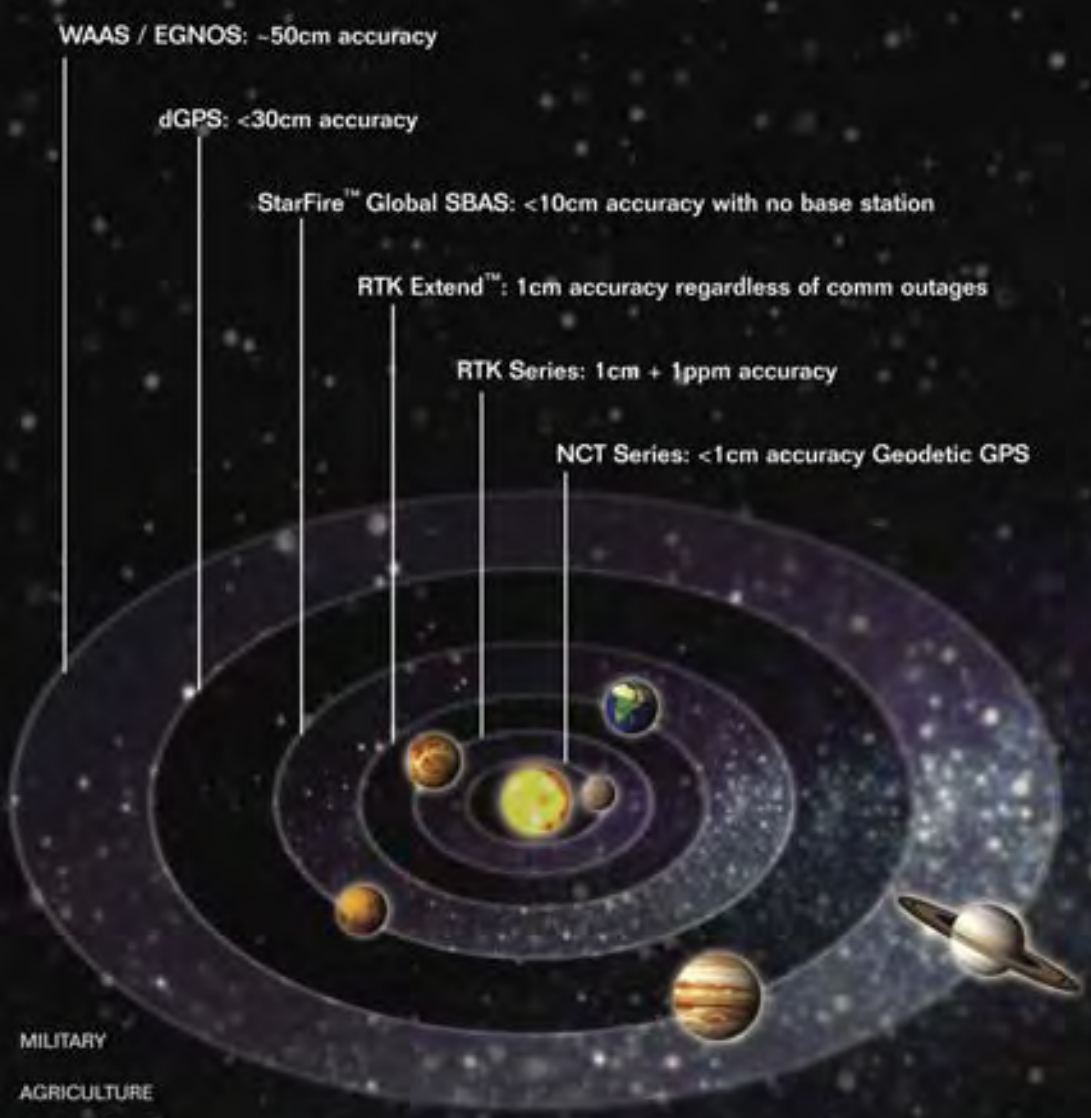

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What happened between August 2003 and June, 2006 is now history – which some of us know.

Incidentally the proto-type NSDI Portal was later unveiled in Agra in November, 2003 and whatever was developed as the proto-type NSDI Portal was then released as part of NNRMS Portal by the Hon'ble President of India in July, 2004. Madhavan Nair, Chairman, ISRO provided the visionary lead for this initiative; Dr Jayaraman was supportive and my colleagues – Dr Rajeev Jaiswal and Ms Padmavathy and a few other colleagues from ISRO played a vanguard role.

Then came Lucknow in November, 2004 and Hyderabad in December, 2005. While NSDI Conferences became a ritual, progress was slow. Things changed and a feeling of despondency crept in. But many of us had still the fire and passion for NSDI and relentlessly pursued the goal of holding on for NSDI and making it a reality. Here I must mention Dr Sivakumar; Maj Gen Gopal Rao and many of my colleagues in ISRO and SOI, NIC, GSI, NBSSLUP, FSI etc who were committed and never let the "string-loosen".

Shaken concepts

But looking back, one thing I can say that somewhere down the line – the basic concept of NSDI – "collective ownership and a good for all" was shaken. I always believed that NSDI was not of one agency – it had to be COLLECTIVE; NSDI was not just for government – it had all stakeholders and citizens were the greatest beneficiaries; NSDI was not a turf-war – it was intelligent networking and collective action for the good of the country; NSDI was not a "take all" - but give some and take some for success; NSDI was a modern movement – it was not just a programme or a project; NSDI was not crafted for a few individuals – but was driven by a few individuals for success and benefit in the country. Somewhere, I personally feel, these issues lost focus – maybe because of delays and changing scenarios – change of people, change of strategies, change of environment and change of technologies. I personally believe that we would have been far ahead of Google-Earth – at least for India.

Parallel developments

I must mention here a very good development that happened at that time and was concertedly driven by the NSDI Committee. It was the New Map Policy. There was intense discussions and debates and drafts on the Map Policy issue – there was overall consensus that a more pragmatic policy was required but the definition of such a policy addressing all concerns took a lot of time. In this activity again, many of our colleagues in Defense, Home and agencies like DST/SOI, ISRO, NIC etc have played a leading role – pragmatism was everywhere on this issue but "nailing" a policy was a tough task. At last hat too was achieved last year when a New Map Policy has been announced.

In the meantime there were many other developments that spurred the spatial data and applications – India had excellent images from Resourcesat and then Cartosat; India also hosted the Global Spatial Data Infrastructure Association Conference in Bangalore in February, 2004 (I had the privilege of serving as the President of GSDI in 2004 and 2005; that gave me great insights to the SDI movement all over the world); agencies embarked on creating a wealth of GIS databases and activities etc – all these helped create the right environment in the country.

So things were moving – slowly and steadily but certainly moving.

Let me get back to the future…

Now my dreams are back and once again I dream … soon we shall have India NSDI Portal and we shall have the best of SDI programmes in the world. I believe in this and feel it can easily happen. What are the stakes for the future?

Resolution

No. SMP/25/003/05 Government of India, Ministry of Science and Technology, Department of Science and Technology. New Delhi, the 13th June, 2006. Excerpts:

The Government of India propose to establish a national infrastructure known as the National Spatial Data Infrastructure (NSDI") for the purposes of acquiring, processing, storing, distribution and improving utilistation of spatial data which would be a gateway of spatial data being generated by various agencies of the Government of India. The Government of India has accordingly decided to establish National Spatial Data Committee (NSDC) with the composition, functions and powers as specified in this resolution:-

Constitution

The NSDC shall consist of the permanent Members (ex-officio-capacity) as mentioned in table 1.

On and from such date and term as may be decided by the NSDC, the NSDC can appoint the following additional Members:

(a) maximum of 5 (five) Secretary rank officials of the Government of India or State Government department whose activities are related to the NSDI.

(b) maximum of 5 (five) Experts having experience and qualifications in the fields related to NSDI- Geographical Information System (GIS), Remote Sensing, Digital Mapping, Photogrammetry, Spatial and Non-spatial databases, information Technology, Networking, Software, Business Management, Law and other related fields.

(c) maximum of 5 (five) representatives from industry, academia and NGOs.

Functions and Powers

The NSDC shall be the apex national authority for formulating and implementing appropriate policies, strategies and programmes for the establishment, operation,

management of the NSDI and utilistation and any other activities related to spatial data in the country. As part of this, the NSDC will:

- determine the requirement of spatial data in the country and require the creation or collection of spatial data to fill such requirement;
- formulate and position policies on all aspects related to the NSDI including its establishment, access, pricing etc.;
- decide and arbiter on issues relating to spatial data generation and its availability;
- promote and enable investment in the spatial business sector and to create an environment that encourages competitive excellence;
- promote the development of human resources in the spatial data sector by encouraging existing training institutes, universities, institutions offering specialized courses, etc to undertake human resources development activities for NSDI;
- promote advanced research related to the NSDI activities and enable an ambience of R&D for NSDI in the country;
- require any member, persons, entities or organizations to provide access to any data at such costs as may be reasonable;
- aid and advise the Central Government on any matter related to or connected with the NSDI;
- enter into appropriate arrangement with any third party to undertake any specific activity conneted with or related to any of the activities of the NSDI, including marketing, data generation, data assimilation, access, consulting, commercial exploitation of any data, etc.;
- do all such acts and deeds that may be necessary, beneficial or otherwise desirable to achieve the objectives of the NSDI.

Table 1

• Minister of Science & Technology	President
• Secretary, Dept of Science and Technology	Minister
• Secretary, Dept of Space	Member
• Secretary, Ministry of Home Affairs	Member
• Secretary, Ministry of Defence	Member
• Secretary, Ministry of Water Resources	Member
• Secretary, Dept of Land Resources	Member
• Member Secretary, Planning Commission	Member
• Secretary, Ministry of Environment and Forest	Member
• Secretary, Ministry of Urban Development	Member
• Secretary, Dept of Ocean Development	Member
• Secretary, Ministry of Mines	Member
• Secretary, Ministry of Information Technology	Member
• Registrar-General, Census of India	Member
• Surveyor General, Survey of India/Director, NRSA	Member Secretary

Table 2

• Surveyor General of India	Chairman
• Director, NRSA	Co-Chairman
• Jnt. Secretary, Dept of Science & Technology	Member
• Jnt. Secretary, Dept of Space	Member
• Director General, Geological Survey of India	Member
• Director, National Bureau of Soil Survey & Landuse Planning	Member
• Director, Forest Survey of India	Member
• Chairman, Central Ground Water Board	Member
• Chairman, Central Water Commission	Member
• Director General, India Meteorology Department	Member
• Director General, National Informatics Centre	Member
• Representative of Registrar General, Census of India	Member
• Director, NATMO	Member
• Chief Executive Officer, NSDI	Member Secretary

Executive Committee

The NSDI Executive Committee shall have the members (ex-officio capacity) as mentioned in table 2. In addition, the NSDC may appoint for a specified term, on recommendation of the Chairperson of NSDI Executive Committee, Eight (8) Experts having experience and qualifications in the fields related to NSDI- Geographical Information System (GIS), Remote Sensing, Digital Mapping, Photogrammetry, spatial and Non-spatial Database, Information Technology, Networking, Software, Business Management, Law and other related fields.

Functions and powers of the Executive Committee:

NSDI Executive Committee shall undertake any and all implementing and executive functions for and on behalf of the NSDC including functions as may be prescribed by regulations framed by the NSDC in this connection or otherwise as directed or delegated upon the NSDI Executive Committee by the NSDC. Such functions and powers would include:

- To define and ensure implementation of national standards for NSDI activities and to enable a smooth establishment and access to NSDI;
- To constitute technical, financial or other sub-committees to establish the NSDI and any
- other objectives and functions under the Act;
- To define and formulate rules and procedures for enabling NSDI databases, servers, networks and access rules and filters;
- To aid and advise the NSDC on any matter related to or connected with its functions and the NSDI;
- To advise the NSDC on expanding the scope of NSDI by including newer spatial and non-spatial data and enabling a larger participation in NSDI;
- To undertake activities to attract new entrants, private sector participation and stimulate innovation related to NSDI;
- To encourage and set into operations value-added-services relating to the usage of NSDI for supporting developmental and economic activities;
- To do all such acts and deeds that may be necessary, beneficial or otherwise desirable to achieve the objectives of the NSDI.

According to me there are six important issues that need to be addressed for the success of NSDI today. The first, is the availability and easy accessibility to spatial data – unhindered but regulated, maybe, and requiring sound and adaptive policies for spatial data sharing. We need the foundation of good, reliable and basic GIS databases (Make data available and applications, demand, market will follow through). This leads to the second, good "GIS Process Standards" – a standardisation of the entire process of "spatial technology" - images, mapping, GIS database creation,

A result of many parallel initiatives

Dr P Nag
Director, NATMO,
Government of India

The clearance of NSDI by the Government of India is definitely an achievement. However, this development should not be seen in isolation. There have been several activities and processes going on in parallel that contributed considerably to progress in right direction. The efforts regarding modernization of spatial data, map digitization, reforms at Survey of India, National Map Policy and creation of the NSDI should be looked in a holistic way.

When we initiated this process five years before, there were doubts in many data producing agencies about the intention itself. Many took it as an effort to exercise control on them. In due course of time, the initial hesitation at least in government departments is over and now we can look forward to a major role to be played by all the stakeholders. However, we still need to make efforts to convince the non-government data producing groups like industry and NGOs to actively participate in this initiative.

Industry is having a greater role in producing spatial data for the country. Efforts should be made to evolve model for public-private partnerships. Such partnerships should be beneficial to government and industry both.

Needless to say that the digital data henceforth produced by the National Atlas and Thematic Mapping Organisation (NATMO) will meet the NSDI data specification.

Definitely a positive step

Dr Vandana Sharma
Senior Technical
Director, National
Informatics Centre

National Informatics Centre (NIC) and NSDI have been complementary and supplementary in the field of GIS although both started on a different note.

NIC focused on creation of datasets, value addition to database with GIS component and creating infrastructure for dissemination of these databases. The NSDI mainly deliberated on metadata, standards, data exchange formats, OSM etc from the very beginning.

We at NIC are convinced about the potential and applicability of spatial data for developmental purposes, hence we took GIS as a millennium planning tool that will change the decision making process forever. Traditionally at NIC, we already have a large number of relational datasets of infrastructure and natural resources with details up to village level. These datasets along with GIS technology can yield immediate results for developmental planning and e-governance even at village level.

Today, data is not a prime issue. However, it is important to have an effective delivery system of these data. We also need to develop innovative, imaginative and customized data products keeping users in our mind.

The clearance of NSDI is definitely a positive step. However, now when NSDI is a reality our focus should be to ensure that it delivers too.

Need a business model

K M Jagadeesh
Reliance Digital
World Limited

Although the progress initially was slow but it was necessary to be optimistic. In addition, we had a conviction that such a Spatial Data Infrastructure will be vital for extensive use of GIS for the benefit of people.

The role of private sector is to develop a viable business model to reach masses. This has to be supported by resolutions of Government to take up such ventures. Improvements in communication infrastructure and economic growth scenario of the country are favourable for deployment of applications to reach masses.

Planning, engineering, operations & maintenance of large infrastructure projects to harness power of GIS for rapid and effective implementation and productivity enhancement aimed at business benefits.

A few points that need attention are

1. NSDI should develop a business model along with private sector and not in isolation. The business model to be reviewed annually to make it more friendly to private sector.
2. Private sector should also be involved in development of NSDI and operational utilisation of NSDI.
3. Government organisations should focus on simpifying regulatory / policy issues. (viz., TRAI for Telecom).
4. NSDI to work with NASSCOM to facilitate in GIS integration with mainstream IT.

Spatial outputs, Spatial data Quality Assessment and Spatial Services (If all GIS data available is as per common and agreed standards, applications, demand and market development will be easier). The third is technical inter-operability - integration using the Services Oriented Architecture (SOA) and based on Web standards (Spatial data and Application Services will be the order of the day for GIS in the future). The fourth requirement would be spatial modelling and applications which brings new perspectives and visualization of spatial information and new insights to societal and economic processes of society - natural resources management, land planning, engineering and infrastructure, disaster management, education, health services and business (GIS Services will broaden and touch almost all aspects of society and citizens). The fifth important parameter is partnerships and enterprise for GIS - replete with the infrastructure, mission critical capabilities, and robust architectures associated with other enterprises. The "forced" boundary between Spatial Technology and conventional Information Technology will disappear – and horizontals of a new kind would emerge (the more inclusive GIS will be with other technologies/enterprises the more success for GIS). This leads to the last of the important issue – developing the GIS user communities by educating and orienting levels of society to become Spatial-savvy and benefit from the spatial technologies (if every citizen learns and benefits from GIS, it is he who will ultimately drive GIS technology and its future growth).

The databases

Core to all this and the most critical element for the success of NSDI – which I have realized and re-iterate is databases – both spatial and otherwise are KEY "engines" for NSDI to be developing and protecting our society and our people and generating commerce. A society that has a good, reliable and detailed database of its resources, assets, people and infrastructure is able to better manage,

Private sector has an active role

Rajesh C Mathur
ESRI india

I must compliment Surveyor General of India and other officers of Government of India who worked relentlessly with missionary zeal in spite of several challenges. Private sector also played a very active and constructive role in conceptualizing NSDI and building a road map. I appreciate the gesture of the Government in involving private sector in the NSDI Task Force and various sub committees - I had the opportunity to chair one of them.

Going forward, the NSDI Committee should define a clear road map for the next 3-5 years with defined milestones, individual responsibilities and goals. Private sector should continue to play an active role and must be involved in building the implementation plan. Some of the specific areas where private sector can contribute to NSDI are:

- Creation of value added products
- Usage of spatial data in implementation of projects for end users
- Creation for data portals and platforms for service delivery
- Providing Web based geo-spatial services to end users
- Distribution of spatial data in the domestic market
- Development of applications to enable deployment of GIS in various verticals
- Development of product plans based on market requirements – present and future.
- Building marketing and promotional strategy for NSDI products and services
- Pricing and other commercial terms

In addition, NSDI can also contribute in creating standards, formats for data exchange etc. NSDI can also provide the framework for dissemination of the data created by the private sector.

The NSDI journey has just begun for our country. As we progress, we will have to overcome several challenges. Some of these would be:

- Building a road map for the next 5 years for NSDI
- Development of product and services plans
- Reaching a consensus among all participants on the short and medium term goals.
- Pricing and other commercial terms for data and services
- Creating a business model for public – private partnership
- Providing budgetary support to participating agencies for data creation

Interoperability is crucial

Dr R P Singh
Deputy Registrar General (Map),
Office of Registrar General India

Census department is very much prepared to be a part of NSDI. Besides attribute data, census have a large number of maps up to village level. There are different layers of these data and some of them are already available on Internet. However, one of our concerns have been interoperability. The Survey of India toposheets and census maps have different characteristics as our objective has been to display attribute data. The other issue is of standardization. Everything needs to be standardized like legends, names, etc. When we discuss such issues we should also consider the needs of departments other than Survey of India.

Many departments need map for village level planning and where attribute data play a very important role. I think we need more intensive deliberations to address the concerns of data producing agencies other than Survey of India.

Nevertheless, the clearance of NSDI is a major step forward as in one go it will address many issues pertaining to data accessibility and duplicacy.

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We have huge datasets that can be linked to NSDI

Dr S N Das
Chief Soil Survey Officer, All India Soil and Landuse Survey, Ministry of Agriculture

All India Soil & Land Use Survey (AISLUS), has a repository of spatial data for watershed prioritasation for macro-level planning on 1:50,000 scale of 200 m ha. In addition, there is detailed database on soil and land characteristics on 1:4000/8000/15000 scale for 13.5 m ha and district wise distribution of degraded lands on 1:50,000 scale of 65 districts.

AISLUS has completed 20 consultancy projects on application of RS and GIS for development of digital soil data and impact evaluation of watershed development and watershed prioritization.

We would have appreciated had Ministry of Agriculture as a member to NSDC and also AISLUS as a part of this NSDI initiative.

develop and protect itself and also generate successful business. We need a national effort for the database that provides a first-level snapshot of the world – and this may be "stitched" from many national perspectives; a national database that provides in-depth assessment of national disparities and opportunities and through to a city-level or property-level database of land/property assets. Mainly a GIS DATBASE ENTERPRISE – a national GIS System of Systems is what will drive NSDI. My urge would be - India, please get the collective act together and put in all resources and efforts to develop and make available the best and systematic GIS databases – it will be an investment for the present and future generations!!!

Public-private partnership

Another major amalgam for NSDI is Public-Private partnerships – it would be just impossible for a single entity (even government) to fully establish the NSDI on its own. Partnerships will have to be the core mechanism to make NSDI successful. There could be self-defined stake-boundaries – agencies providing data assets; agencies developing applications; agencies providing services; agencies maintaining the systems and so on – but all of them knit on a value-based "royalty" model that will make a successful enterprise for each. In this individual successful enterprise, NSDI will emerge as the most succsessful enterprise of enterprise.

The dream

Now I dream - that to develop GIS applications and value-add, provide development alternatives, generate GIS business, protect and empower our society and people we would be able to search, locate and seek reliable and accurate map and image data and spatial information from a "merabharat search" and find varying details of Indian map and image data on NSDI servers and (at a "proverbial click") download them to desktops by making an e-payment. Mera Bharat is certainly Mahaan and I am sure that Mera Bharat's NSDI will also be Mahaan - SOON!!!

That is what I dreamt in February, 2001… Is somebody pinching me to wake up?

Mukund Rao
Chief Executive Officer
Navayuga Spatial Technologies Pvt Ltd
Bangalore
mukundr@blr.vsnl.net.in

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Theme

Developing North East Geospatially

A cGIT initiative

Organized by
Coordinates

Co-organized by
IIT Guwahati, North Eastern Regional Institute of Water and
Land Management, National Informatics Centre, Survey of India,
Department of Science and Technology

Background

The North Eastern Region comprises 8 states: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. The Region has different habitat, heavy rainfall, extremely rich bio-diversity, mountains and hills, high seismicity and a drainage pattern marked by lateral valleys in the north and transverse valleys in the south, dissected by major rivers. The region has the potential of its own natural resources for economic development. The development of the North East Region arises from its unique situation. There is a need of identification and removal of infrastructure bottlenecks, provision of basic minimum services, and optimization of natural resources for development purposes without compromising environmental issues.

Why NEGeo 2006 conference

- To explore the interface of developmental focus and priorities with Geoinformation Technologies (GIT) like GIS, GPS, Remote Sensing etc
- To understand the potential, limitations and challenges of GIT in local context and circumstances
- To bring together the technology practitioners and decision makers of the region
- To exchange ideas among regional streams with national trends
- To provide a platform to discuss and deliberate
- Education and awareness

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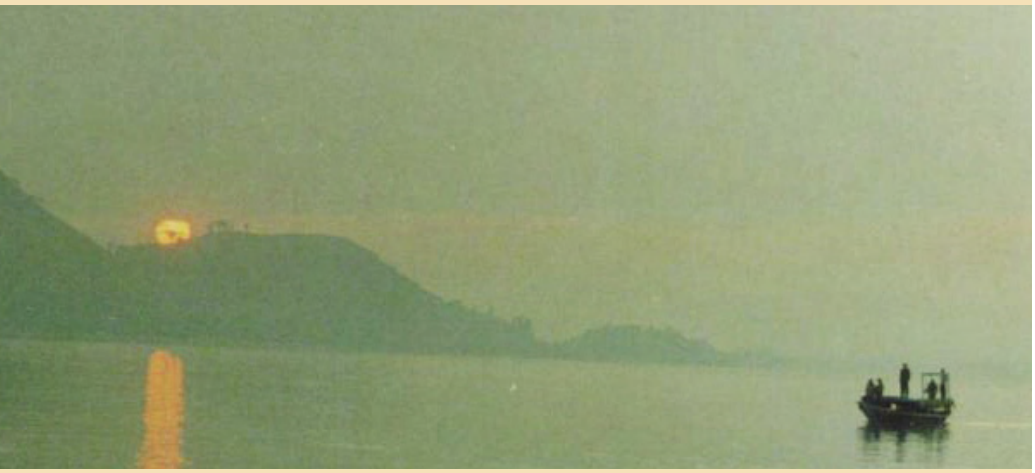
- Disaster Management
- Environment & Forests
- Health Applications
- Oil & Mineral Exploration
- Spatial data infrastructure

Intended participants

- Academia
- Scientist
- Product and Solution providers from Industry
- Researchers and Students
- Government Organisations
- Policy Makers
- End users

Training Programme

A three-day training programme on Geoinformation Technologies and their applications shall be held on 18-20 September, 2006 at IIT Guwahati. Faculties and experts in the field of Geographic Information Technologies shall conduct the program. IIT Guwahati shall be the academic partner for this training program.



Exhibition

An exhibition will be organized for technology demonstration and product display by various industry players, software and hardware vendors. It shall also have demonstrations and displays by various government organizations, academic institution projects using GIS, GPS, Remote Sensing and allied technologies.

Important dates

Abstract submission:	10 August, 2006
Acceptance:	16 August, 2006
Full paper submission:	30 August, 2006

Organizations expected to participate

- North Eastern Council
- North East Space Application Centre
- North-Eastern Hill University (NEHU)
- State Forest Departments
- State IT Departments
- Institution of Engineers
- Planning Commission
- State universities
- Central Water Commission
- Brahmaputra Board
- National Power Training Institute
- Assam Science, Technology and Environment Council
- Coal India
- Geological Survey of India
- National Institute of Rural Development
- Brahmaputra Board
- Defense Research Development Organization
- ONGC
- North Eastern Electric Power Corporation

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Coordinates, a monthly magazine on Positioning, Navigation and other related technologies like GIS, Remote Sensing etc is an initiative of Centre for Geo-Information Technologies (cGIT). cGIT, an NGO, is engaged in promotion of geo-information technologies to existing and potential user groups in various application segments. In addition, it also organizes workshops, conferences and training programmes.

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A new move(ment)

Readers may recall that **Coordinates** printed Implementation Guidelines of the Indian National Map Policy (NMP) in June. We present here some more observations

License raj

S D Baveja
MD-RCE-(I)

I welcome Survey of India (SOI) efforts to issue clarificatory guidelines on NMP in a year's time.

Availability of OSM sheets

I had hoped that by now Open Series Map would be available but regret to point out that but for inauguration ceremony for release of one map of the OSM Series our dream for getting OSM sheets are still very far away to be realized. Why can't private agencies be engaged to produce them within Survey of India (SOI) Campus and make them available to general public.

Layout of OSM sheets

A lot of midnight oil seems to have been burnt on OSM lay out of sheets as give in Annexure 'A' but the methodology evolved is quite cumbersome for a common man to understand as the 1:1m scale base for lay out being different i.e. 40x40 index for SOI map sheets numbering & 40x60 indexing for OSM sheet numbering and 24 alphabet subdivisions.

In fact the easiest way was to retain the numbering of SOI Toposheet Nos. as they are and suffix the internationally well known after SOI sheet no. i.e. zone no. 53A/12-43N it, as the dimensions of 1:50,000 scale & 1:250,000 scale maps have been kept the same i.e. 15'x15' & 10x10 this would avoid confusion.

Licensing of Digital Topographical data is likely to take us back to License Raj and is a step backward as Digital maps are being supplied only to bona fide users with permission though SOI and specially when records as per MTR are being maintained of each user. It would be worse than present filling up of forms 57 (a) etc. and like NRSA, users could be made to give certificate or follow laid down conditions as being done by NRSA.

To elaborate this point further let us examine the present scenario and the scenario as result of proposed guidelines

Existing scenario

The existing maps of SOI are available in Analogue form and Digital form,

The digital maps of entire country were made available only after following the procedure as applicable for restricted data ie. completing the formalities of o57 (a) form of SOI. The entire digital data for restricted and non restricted area has been made restricted. Analogue maps for restricted areas are made available by following the procedure of completing form o57 (a).

Analogue maps for non restricted area are made available to the general public on SOI sale counters or authorized distributors without completing any formalities but their export is prohibited.

Proposed scenario

In the present OSM series of digital maps, licensing procedures are being introduced. This licensing procedure appears to be the same as it was for restricted map, earlier and will restrict the availability of digital maps for general public.

Analogue maps for OSM for entire country shall be made available to general public irrespective to Restricted or Non restricted, area but when is a million questions.

In view of above it appears that the procedures for getting the digital data, even for OSM are made restricted as one has to get licensed key/ ID.

Observations

1) In the Para 3 it is mentioned that digitization of analogue map is prohibited. In the present scenario where all data by individuals or companies are collected in digital form can only be integrated with existing analogue map after theme specific part digitization only or fresh surveys which is time taking. So the digitization of the theme specific portion of the analogue maps should be permitted. Proposed Digitization of part of analogue maps shall not only be helpful to the users but it will be very beneficial to the researchers and academic institutions.
2) Layout of the OSM maps is similar to UTM sheets lay out which closely resemble with International sheet numbers. It should have been more convenient if the sheet numbering is given similar to our topographical sheet numbers but with a tag indicating UTM zone number say 53 j-43n or 53j/12-43n or 53j/12/4 -43n where 43n indicate the zone number 43 north. This may be easier for the users who are conversant with existing topographic sheet numbers.
3) It is mentioned in the contents of OSM, that contours and height shall not be shown on the maps falling in restricted area. In order to follow the restriction policy for restricted area, contours may be of vital importance but few spot heights could be given on maps so that the general idea of the topography could be seen if the map belongs to restricted area.
4) Regarding height information on OSM it should be made clear

that the heights are in MSL term, and Datum is WGS 84.

5) Shall Map Transaction Registry (MTR) be applicable for analogue map users? We think that all OSM maps in analogue form shall be available to all users at all sale counters with out having unique transaction ID.
6) Can value addition on the maps on different scales other than SOI published scales i.e. 1:250,50,25,10 K, be done without licensing? The earlier policy was that the part of map in the unrestricted areas could be published in the books but not the full map.

Incomplete

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I am pleased to state that at least my one major concern published in July'05 issue of Coordinates has been addressed. It is mentioned in the guidelines that registration of users and licensing is required in respect of digital data/maps. This by implication means that it may not be necessary for hard copies. It, however, has not been made absolutely clear that it will be so. It appears that none of the other concerns have been addressed.

It has again been emphasized in Para 9 of guidelines that previous instructions issued from time to time will hold good, but for these modifications. This clearly indicates that NMP and the guidelines are thoroughly incomplete as existing or previous map policy or instructions are not available in public domain. It will be in order if these previous instructions are compiled and made available on the website.

Para 10(ii) General- "highest accuracy" needs to be defined in quantitative terms.

Annexure 1A of NMP appears as Annexure B in Guidelines. It appears that it has been modified. It is noted that it suffers from the same shortcomings. A few are discussed here:

a) Limits of cultivation was appearing in NMP but it is omitted form the guidelines.
b) Transmission lines have not been explained or elaborated.
c) Chimney, monuments, brick kiln etc. are missing.
d) Drains, water pipe lines etc. have not been mentioned.
e) "All bungalows" is vague and needs to defined/elaborated.
f) "Relative heights" is missing from item 7 "Relief".
g) Coastal features like High Water Line, Low Water Line are missing.
h) Mountain features like Cliff, Sheet rocks etc. are missing

It would therefore be proper if list of details/features, which should not appear on OSM series maps is given instead of the other way round. It is suggested that the authorities should consult the booklet "Instructions to Plane-Tablers" published by Survey of India in order to prepare a comprehensive list of details to be shown or not to be shown as the case may be so that such omissions do not occur.

It is mentioned as a footnote that "Contours and Heights" will not be available as per MOD instructions. Restricted zone for OSM maps will then have to be defined. Does it mean that there will be no contours and heights in OSM maps representing a very large portion of territory of India?

UTM projection has been decided for India though TM or LCC would have been more suitable. Even if UTM is decided its grid values and ticks should be shown on OSM maps.

Para 2 d – Export of all maps/data on scale larger than 1:250,000 are prohibited as per orders of 1963. Should this not be revised in view of Internet and various websites such as goggle? Should we not be more realistic?

It is again pointed out that there should be serious reconsideration on producing maps in WGS 84.

Dampening

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The announcement of the guidelines for NMP has dampened the euphoria generated last year by the NMP declaration. The skeptics have been proved right once again. While announcing the NMP last year, the government had admitted that "the technological changes around the world rendered many features of the existing map policy redundant and anachronistic "and" its continuance tended to impede free flow of information and engendered high opportunity costs for a developing economy". Unfortunately the guidelines do not reflect this concern. It was hoped that with the bifurcation of the maps into OSM and DSM series, the OSM maps needed for civilian purposes would be easily available without much hassle. The guideline document shows that even OSM series of maps will not be free from the fetters of bureaucracy and overplayed security obsessions.

The provision that strictly forbids the digitization of SOI analog maps will put a serious impediment to increasing geo-spatial technology applications in which SOI maps are used as base for projection and geo-referencing. People have been clandestinely digitizing SOI maps for their projects and were hoping that this restriction would be lifted , but their hopes now being razed, they will be forced to continue it stealthy.

Maintenance of Map Transaction Registry (MTR) would also put restrictions on the free exchange of data between collaborating organizations and even within the same organization working from different centers. When the data is already classified as OSM the logic of again restricting its free use is difficult to comprehend.

The document says that the SOI encourages value addition. But

here again the provisions are highly restrictive. Submitting 'a business model indicating the products to be generated and marketing strategy' and executing an MOA with SOI would be necessary for large organizations and industry, but it would dampen the initiative and innovation of small users and individuals who contribute greatly to the technological advancements.

Exaggerated security concern seems to be the main problem afflicted to Indian mind. In the world today with the easy accessibility to high resolution satellite pictures, no information can be kept secret. Air Chief Marshal SP Tyagi's statement that the satellite images of the country's defence installations displayed on the Google Earth website do not pose a threat to the Indian Air Force is a pointer in this regard. Then, how the free use of maps which are classified as OSM can impact our security?

A misnomer

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A NMP should encompass all the geospatial data products: survey maps, satellite imagery, aerial photographs, and various thematic maps etc. It should be able to specify role of all the major stakeholders. It should be futuristic, should encompass and promote technological innovations and should reflect present and future paradigm of development. However, the present NMP revolves around the survey maps of SOI. It puts SOI on the driver's seat and role of other stakeholders are merely a value adder. What about the huge amount of spatial information developed over the years by various other government departments and private sector? In all, the NMP is nothing more than guidelines of dissemination for SOI's topo maps. The name NMP seems to be a misnomer.

The second objective of the NMP is 'to promote the use of geospatial knowledge and intelligence through partnerships and other mechanisms by all sections of the society'. However, both the policy and the guidelines are silent about partnership process with the major stakeholders dealing with spatial information. The MNP mandates SOI to decide issues of liberalizing access of spatial data to user groups. Other spatial data creating organizations have to abide by the instructions of SOI.

Committing by the SOI to have available all information at all SOI offices and on the website is a commendable step. However, it does not mention the time frame. SOI must specify the time frame of data availability area as well as scale-wise.

The initial press announcement of May 19, 2005 had mentioned that aerial photographs, after masking of vulnerable areas/vulnerable points would be freely available for processing and project generation. It was also mentioned that private agencies would be permitted to carry out aerial surveys in all parts of the country using Public Domain Datum, provided they be registered and accredited by Survey of India. However, both the earlier policy document and the recent guidelines are silent on aerial photography or aerial photographs.

Section 3 (c) of the recent guidelines mentions that "unauthorised copying and distribution of SOI digital data are strictly prohibited". But what this copying means, is not clear, because once an organization is licensed by SOI it should be able to make copies for its organizational use.

Section 4 of the recent guidelines states that digital data will be available in single/ multiple/ commercial licensing for general use, value adding and marketing. At the same time it warns that encryption technology has been incorporated into the digital products. The original data will be destroyed if the data were subject to copying activities. The issue here is how any organization can make use of the data in order to add value to it unless decryption key is provided for various GIS analysis and value addition.

Section 6 (iv) of the recent guidelines mentions differential pricing of SOI products with concession to universities, research organizations and deserving NGO's, which is a welcome step.

The guidelines also mentions that contours and heights will not be available in restricted zones as per MOD,s instructions. In the Twenty First Centaury, when high resolution satellite-derived contour information is freely available to potential enemies, 5-10 meter contours may not be of strategic importance for our country. Considering the importance of contours especially for water resource management and urban planning, 5-10 meter contour information may be made available for the entire country.

India has a very long tradition of systematically collecting spatial data through various organizations at national and state levels, creating a broad and powerful installed base. However, the institutional aspects of the same installed base create lock-in effects. These institutions have historically acted in a compartmentalized manner with limited sharing of data or applications not only for citizens and the private sector, but also for other government agencies. This reflects a poor appreciation of information dissemination by these organizations. The current NMP neither has spirit nor regulations to break these lock-in effects.

The NMP along with legislation on right to information in India is a paradigm shift towards openness and access to information. However, these are not going to pay much dividend in terms of sharing of spatial information amongst all the major stakeholders unless there is change in the very culture of sharing with each stakeholder. A more comprehensive 'National Spatial Policy (NSP)' covering all important sources of spatial information along with a vibrant NSDI is need of the hour. The NSP must provide ways ahead to NSDI.

Augmentation of low-cost GPS receivers

The Web services architecture is examined as a viable protocol and communication alternative for disseminating DGPS augmentation information over the Internet

Roger Fraser, Adam Mowlam and Philip Collier

There are numerous types of GPS receivers in the current international marketplace, ranging from inexpensive, low accuracy handheld devices to expensive, high precision geodetic equipment. By and large, low–cost GPS receivers (whether sold as a plug–in hardware device or as a complete navigation and positioning receiver) have almost assumed mass market status in the consumer electronics industry. Recent advances in micro and wireless technology, reductions in consumer costs, and the apparent growth of the Location Based Services (LBS) industry have somewhat fuelled the need for mobile (information communications and technology) consumers to become "location aware".

Notwithstanding current levels of maturity in GPS hardware and algorithms, low-cost GPS receivers still suffer from large positioning errors mainly attributable to atmospheric effects, broadcast ephemeris errors, multipath and receiver noise. As a result, they have a limited use in real time applications despite being able to produce positioning and navigation information almost instantaneously. When higher levels of precision and accuracy are required, some form of correction or augmentation must be applied so as to reduce the influence of random and systematic errors on the autonomous positioning solution.

There are a host of augmentation options, in general, that are available for minimising the influence of random and systematic errors in GPS positioning. These include Local Area Augmentation Systems (DGPS, VRS, Network RTK, Pseudolites, US LAAS); Wide Area Augmentation Systems (EGNOS, MSAS, US WAAS, GAGAN); integrated positioning and navigation sensors (gyro, precise clocks, INS, digital compass); various correction algorithms (integrity monitoring, noise filtering, atmospheric modelling, code–carrier phase smoothing, multipath detection); and in the foreseeable future, integrated satellite systems (GPS, Galileo, GLONASS, QZSS). To improve the accuracy of low–cost GPS receivers, the most practicable form of augmentation is via DGPS corrections obtained either from a local broadcasting service or from a nearby reference station. Historically, local area DGPS corrections have been provided through the RTCM protocol over the conventional means of radio transmission.

In recent times, research and development has seen the implementation and analysis of real time Internet based DGPS systems. For instance, the German Federal Agency for Cartography and Geodesy (BKG) together with other partners have developed a dissemination standard called Networked Transport of RTCM via Internet Protocol (NTRIP) for the real time streaming of DGPS or RTK corrections to mobile receivers (Lenz, 2004). Similarly, the Jet Propulsion Laboratory (JPL) has developed a Global Differential GPS (IGDG) system, which facilitates the exchange of corrections to the orbits and clocks of the GPS constellation over the Internet (Muellerschoen et al, 2002). These two developments, together with other independent tests (Gao et al, 2002, Kechine et al, 2003, for example) show that the Internet is able to provide satisfactory levels of accuracy and latency in the dissemination of GPS augmentation information.

In all cases mentioned, the dissemination of corrections is provided over the Internet via constant streaming of data. The purpose of this paper is to examine the XML Web services architecture as an alternative mechanism for exchanging DGPS augmentation information between Continuously Operating Reference Station (CORS) networks and mobile devices over the Internet. The key difference between disseminating data via Internet streaming data and Web services is that the latter requires two–way "request and response" communication. To illustrate the capabilities and performance of an augmentation system based on the Web services architecture, a simple prototype has been developed. The differential positioning technique implemented within the prototype uses the DGPS code range model described by Hofmann–Wellenhof et al (2001). The Web service prototype is consistent with international Internet technology standards established by the Open Geospatial Consortium (OGC) and the World Wide Web Consortium (W3C) and as such, may be accessed and implemented using any standards–compliant software and/or platform.

Principal results from prototype testing confirm that the Web services architecture is a viable option for exchanging GPS augmentation information over the Internet. Tests conducted over peak and off–peak periods using a mobile phone and GPRS show a typical latency of 1–3 seconds in medium– to high–density

urban environments. The disadvantages of using the Web services architecture for an Internet based DGPS system relate primarily to the bloat in the message caused from XML tags.

Before the prototype and preliminary test results are discussed in detail, some basic principles concerning Web services and low–cost GPS receivers are outlined.

Web Services

Web services provide a standardised way of interoperating between different software applications, running on various platforms and/or frameworks distributed on a network or over the internet. In particular, a Web service is a piece of application logic residing at a specific network location (or network address) that is accessible to programs via standard internet protocols. When called, a Web service performs one or more functional tasks and then sends a response back to the calling agent. During the process, a Web service may call other Web services and/or run other software applications. The response may be in the form of an entire data set such as a map, a database entry, or simply the result of a computation.

Web services use standardised protocols (i.e. OGC, W3C) so that raw data can be exchanged between operating systems and software components, whether compatible or not, in a platform independent way. The key to the success of Web service interoperability therefore, is in the implementation of open standards for data encoding, communication and transport protocols. The interoperability stack shown in Figure 1 illustrates the standards based enabling technologies upon which Web services are implemented and deployed.

Universal Discovery Description and Integration (UDDI) enables the publishing of services in a directory (similar in concept to the yellow pages), making it possible for other developers to locate and consume a Web service. A Web service's interface is described using Web Service Description Language (WSDL). Simple Object Access Protocol (SOAP) is a standardised, lightweight protocol for connecting service endpoints distributed over network environment.

Formats for data encoding are described in a schema language such as XML Schema (XSD) or Document Type Definition (DTD). HyperText Transfer Protocol (HTTP) and Transmission Control Protocol/Internet Protocol (TCP/IP) permit the connectivity between software components and Web services by enabling them to send and receive messages. The lifecycle of a Web service request and response is shown in Figure 2.

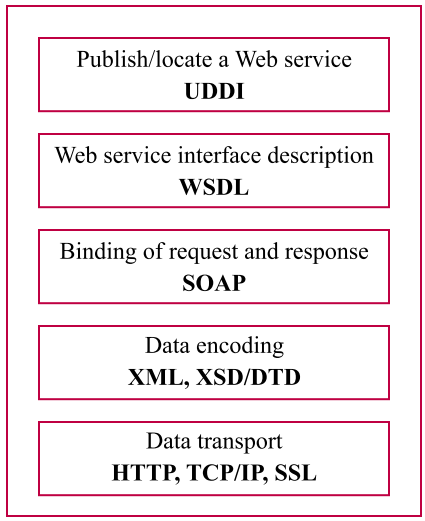

Fig. 1 Web services interoperability stack

The Web service lifecycle is based on the concept of bind–once, consume–many. Thus, once a Web service has been located (2) and software written to consume it according to its interface description (3), the software sends a request (4) to a Web service and waits for a response (5) synchronously or asynchronously. Steps (4) and (5) are repeated as many times as required. For every request, raw data is serialized (or encoded) into XML format and bound in a SOAP envelope, which in turn is conveyed over the Internet (or network) using HTTP and TCP/IP.

Low–Cost GPS receivers

For the purposes of this paper, low–cost GPS receivers are regarded as those typically used for general purpose positioning and navigation, low accuracy data capture, reconnaissance, bushwalking, marine and in–car navigation, and the like. With an unobstructed sky, low–cost GPS receivers have an expected horizontal and vertical positioning precision in the range of ±10–20 metres and ±20–30 metres respectively. After applying local DGPS corrections, many spatially correlated (or

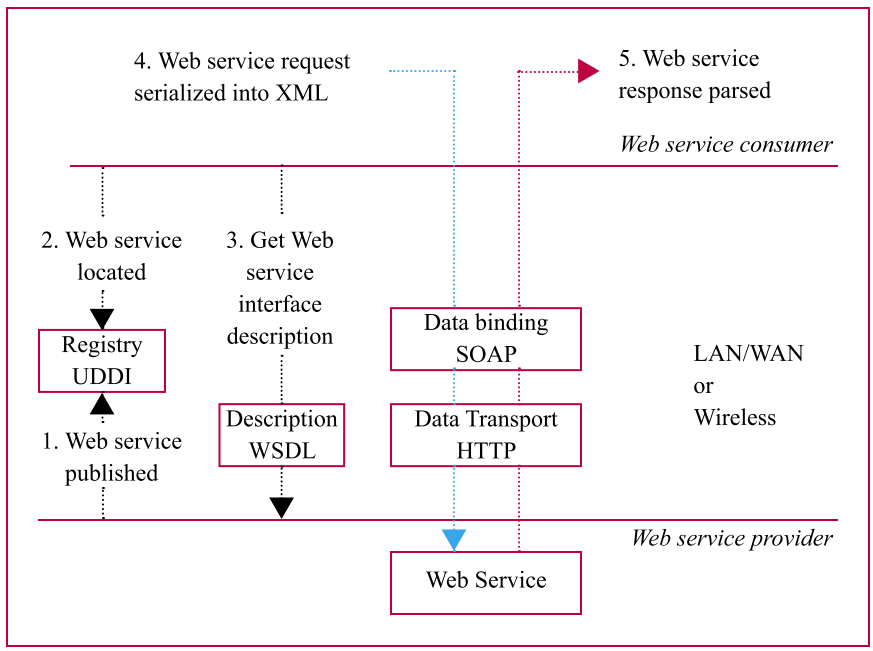

Fig. 2 Web services lifecycle.

systematic) errors can be removed and hence, it is not unreasonable to expect some low–cost GPS receivers to achieve a horizontal positioning accuracy better than 5 metres.

A practicable means for augmenting low–cost GPS receivers using the Web services technique is via custom software which is able to read the output GPS measurement information. The low–cost GPS receiver used in this investigation contains a SiRF chipset and outputs GPS information in the SiRF Binary protocol (SiRF, 2004). The SiRF Binary protocol provides an extensive list of input and output messages concerning the original measurements, the positioning and navigation solution, and commands for configuring the GPS chipset. For instance, the SiRF binary protocol supports the output of pseudorange and (integrated) carrier–phase measurements, subframes 1 to 5 of ICD–GPS–200C, receiver clock bias and drift, and various other observation and navigation messages (SiRF, 2004). The SiRF protocol also provides the ability for receivers to be supplied with DGPS corrections from either the US WAAS or broadcasting beacons in RTCM SC–104 format.

Although a (low–cost) SiRF–based receiver has been used for this investigation, it can be shown that any GPS–enabled device (i.e. which outputs time–stamped pseudorange measurements) capable of reaching the Internet can be used to take advantage of a Web services augmentation system.

Prototype for a web services DGPS system

To demonstrate the feasibility of a Web services DGPS system, a simple prototype has been developed. The prototype is comprised of three components: a GPS and Web enabled client (PDA), a server-enabled PC, and a single CORS receiver. Two Web services are hosted on the server ¾ (1) a CORS Web Service for logging the reference station receiver–determined pseudorange corrections and (2) a DGPS Web Service for disseminating those corrections to roving receivers. Accordingly, software has been developed for the PDA to facilitate the request, response and application of DGPS corrections. The architecture of the prototype is given in Figure 3. The specifications of the prototype components developed for this paper are given in Table 1.

CORS Network and Logging software

For the purposes of demonstration, only a single CORS receiver was used for the prototype. The reference station receiver was configured to output a Type 1 RTCM message (Differential DGPS corrections) via a RS232 serial port every second. Software was developed to read the output RTCM messages and in turn send the corrections to the CORS Web service. Figure 4 shows the flow of tasks performed by the reference station software.

Client Software

The client (or mobile device) software has been developed to perform three basic tasks:

1. Obtain the smoothed pseudoranges and position from the SiRF protocol
2. Handle the request and response of differential GPS corrections
3. Apply the pseudorange corrections and display the augmented GPS position

To obtain a set of DGPS corrections, GPS time (t) and an approximate position (f, l) are sent to the Web service. Each request is made asynchronously to allow the client to continue operating without waiting for a response. When a response is

Table. 1 Prototype component specifications

Component	Specifications
PDA (client)	iPAQ 3850, Bluetooth expansion pack, custom software
Low–cost GPS receiver	Pretec CompactGPS (SiRF Binary & NMEA 0183)
Mobile Phone	Ericcson Bluetooth phone (GPRS-only internet account)
PC (Web server)	2.0 GHz Pentium 4, MS W2K/IIS 5.0/ASP.NET, custom software
CORS receiver	Leica GPS System 500

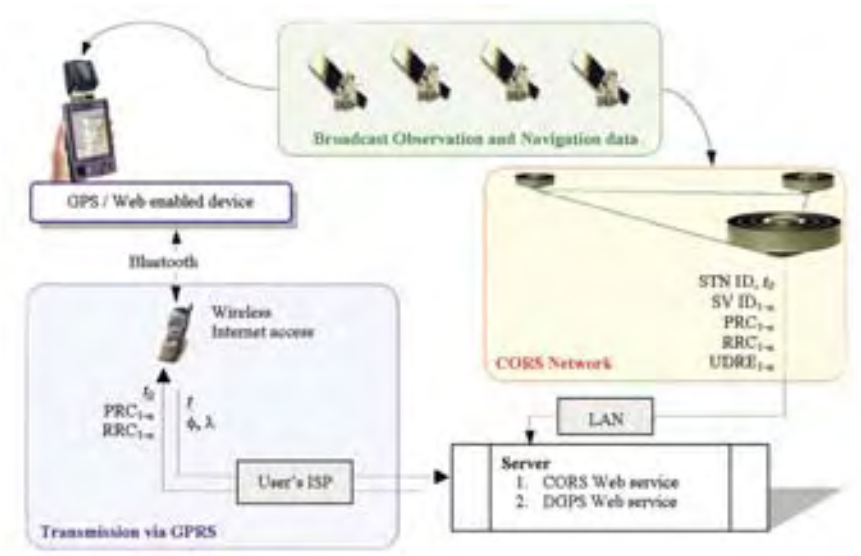

Fig. 3 Architecture of the Web services DGPS augmentation prototype

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- ★ Land Applications
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- ★ Aviation Applications
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- ★ GNSS Space Based Augmentation
- ★ Space and Satellite Applications
- ★ GNSS Antenna & Radio Technology
- ★ Galileo Integrity, Multi-constellation RAIM
- ★ Galileo and GPS/Galileo Reference and User Receivers
- ★ GNSS Ground Based Augmentation Systems
- ★ Galileo Institutional, Standardization and Application Development
- ★ Galileo Signal Structure, GPS/Galileo Interoperability
- ★ GPS and GLONASS Modernization, QZSS
- ★ Remote Sensing With GPS and Integrated Sensors
- ★ Integrated Navigation Systems Using GNSS, INS & Auxiliary Sensors
- ★ GNSS Civil Interference and Spectrum Aspects

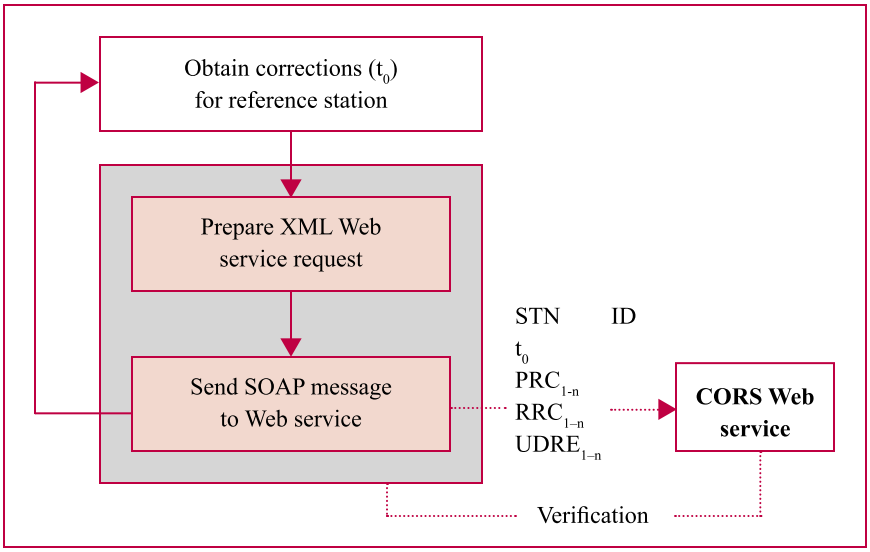

Fig. 4 Flow of tasks performed by the reference station receiver software

received, a new position is computed from the corrected pseudoranges. Prior to making a call to the DGPS Web service, the client verifies whether an internet connection has been established. Figure 5 shows the general flow of the prototype client software.

Differential GPS and CORS Web Services

To provide real time DGPS augmentation, the two Web services (hosted on the server) operate independently to facilitate the logging and dissemination of real time corrections. Firstly, when sent by the custom reference station software, the computed pseudorange corrections are logged by the CORS Web service according to the GPS time and satellite ID. Secondly, when and as requested by the roving client, the DGPS Web service retrieves the pseudorange corrections based on the GPS time and sends that data to the roving client.

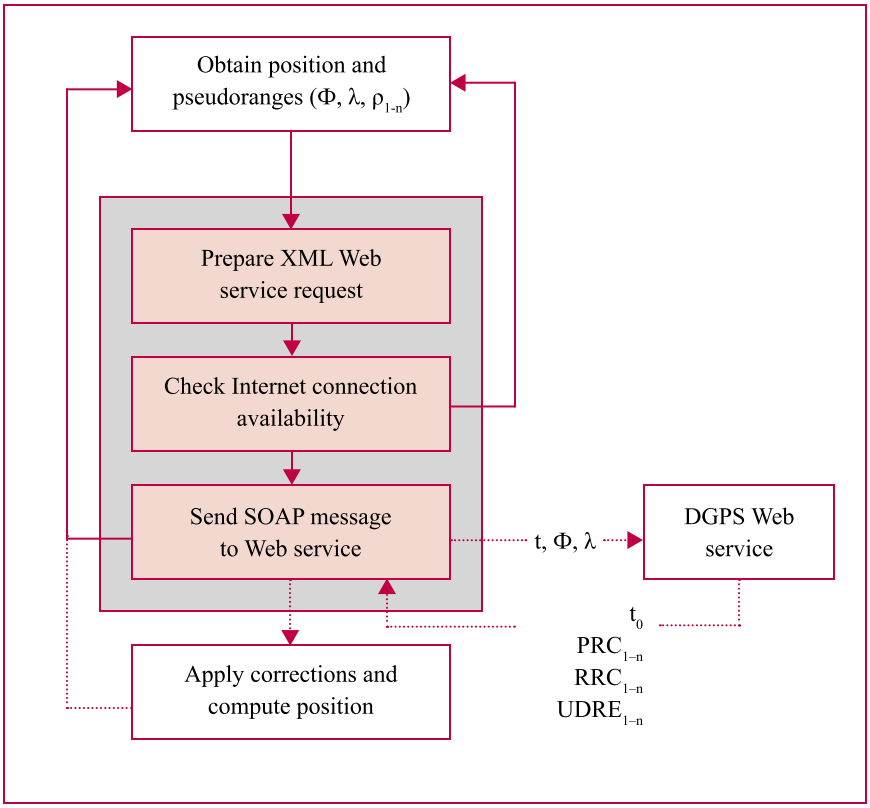

Fig. 5 Flow of tasks performed by the client software

Although the client's approximate position is sent to the DGPS Web service, it is not used in this prototype. The purpose of sending the client's position is simply to illustrate that, given an appropriate mathematical model for multi–station interpolation, the DGPS Web service could be extended to provide a set of location–centric pseudorange corrections.

Preliminary test results

Latency in data Transmission

Critical to real and near real time applications is the delay (or latency) in the time taken for a DGPS correction to be received by the rover. In contrast to the streaming technique, the latency considered in this paper is the time taken for (1) the request to be sent to the DGPS Web service, (2) a correction to be determined and (3) the corresponding corrections to be sent back to the client.

Figure 6 shows the latencies in transmission of DGPS corrections during peak and off–peak periods using a mobile phone and a GPRS connection. The average latencies from various tests show a mean of 1.86 seconds during off–peak periods and 2.12 seconds during peak periods. These results are based on a series of tests conducted over two weeks and are representative of the Melbourne CBD environment only. In all cases, none of the messages were found to be corrupted or degraded in any way. The latencies associated with the sending of reference station information to the CORS Web service (over a 1.5 Mb/s connection) is almost instantaneous and such, is not presented herein.

Previous research and development in Internet–based DGPS systems using data streaming has indicated similar results (Weber et al, 2004, for example). However, the (two–way) Web services architecture generally shows

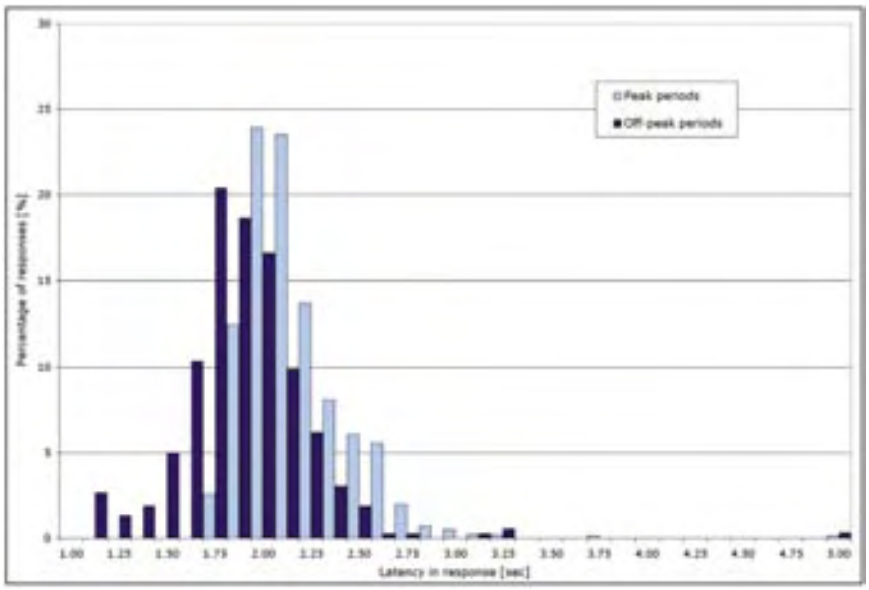

Fig. 6 Latency in request/response of DGPS pseudorange corrections for 6 satellites using a mobile phone (over GPRS) during peak and off–peak periods

greater latencies over those achieved through (one–way) Internet streaming. Notwithstanding the influence of bandwidth, network congestion, mobile phone infrastructure performance, server performance and the like, the primary cause of the additional latency comes as a result of XML tag bloat and sending data in plain text. If each message were compressed into binary format, the latencies could be reduced. The latency may be further reduced if the entire message was sent as a character delimited string. However, sending multiple data elements in a single string would be contrary to the intention of the OGC and W3C interoperability standards.

DGPS Corrections

Table 2 shows the positioning accuracy results achieved by the Web services DGPS prototype described in this paper. The results show the difference between the average (or expected) values and standard deviations obtained from the autonomous GPS and DGPS–corrected positions over 30 minutes (1 second observations) with a 15° elevation mask.

As shown by Table 2, the effect of the spatially correlated GPS errors are greatly reduced by the DGPS technique. However, as indicated by the standard deviations in both GPS and DGPS estimates, the DGPS–corrected positions still suffer from large random errors.

Web Services for other GPS applications

This paper has focussed on the single baseline (differential) pseudorange correction technique for augmenting autonomous GPS positions. However, the principle of the Web services architecture may be used for exchanging a variety of GNSS related data, and applied to other GNSS positioning applications. Typical applications may include multi–station relative positioning, the dissemination of satellite orbit and clock corrections for Precise Point Positioning (PPP), and the monitoring of CORS network and receiver performance.

The one–way streaming of data over the Internet has been shown by other research to be a satisfactory method of disseminating DGPS corrections. As described in §5, results from this prototype indicate that Internet streaming offers marginally better latencies than the Web services architecture. However, where the method of augmentation requires the specific location of the roving receiver relative to one or more reference stations, two–way communications is needed. For instance, the interpolation of the differential correction for a rover based on the nearest surrounding CORS receivers requires the rover's approximate location. As indicated by the prototype, the Web services architecture facilitates applications of this nature by enabling the user to supply measurements of any type, such as approximate position, observed pseudoranges and/or carrier–phase measurements. In the interest of multi–station RTK and Virtual Reference Station (VRS) applications, Web services can provide an efficient, secure and reliable source of platform–independent (or receiver independent) communication.

Web services offer significant advantages for platform independent monitoring of CORS network receivers. Notwithstanding the fact that many systems have long been in place for exchanging data between reference station receivers, Web services offer the ability to integrate receiver types of any make, provided that there is a means for sending data over TCP/IP. It follows that Web services can be used to interact with (or configure) remote GPS receivers from a central processing system securely from any location, wirelessly or not. Experience has shown that Web services communications over a (wired) 1.5 Mb/s Internet connection is almost instantaneous, showing that multi–reference station application performance would not be significantly degraded.

		Easting	Northing	E height	ΔE	ΔN	Δh
GPS	μ	320469.61	5814432.62	79.52	2.34	–0.43	16.17
	σ	1.73	2.56	3.74			
DGPS	μ	320466.70	5814432.98	66.13	-0.57	-0.07	2.77
	σ	1.67	2.58	3.64			

Table. 2 Comparison of results from Autonomous GPS and DGPS–corrected positions

Discussion and conclusion

This paper shows that XML Web services are a simple, efficient and secure means for exchanging GPS augmentation information over the Internet. Web services offer some considerable advantages. Web services offer a platform independent way of augmenting GPS and Web enabled mobile devices capable of reaching the Internet (wirelessly or not) with correction information from existing CORS networks. It follows that software to consume a Web service can be developed by almost any programming language. Almost any hardware device capable of sending data over TCP/IP may be used. Since the Web services architecture allows for two–way communication, location–centric applications (i.e. multi–reference station approach) can benefit from this method of Internet augmentation. Web services can further provide opportunities for implementing encryption algorithms, secure transaction monitoring, and user authentication. Typical latencies for Web services communications can, in general, be expected to decline as mobile communications infrastructure is upgraded.

The exchange of GPS augmentation information via the Web services architecture also has its disadvantages. Strictly speaking, Web services architecture introduces larger latencies than streaming methods due to XML–message bloat. Since the Web services architecture disseminates information via two–way "request and consume" communications, additional latencies are introduced. For sub–second applications, Web services offer less than optimal performance over wireless connections. Whilst not necessarily restricted to the Web services approach, the main disadvantages come as a result of:

- Poor wireless/mobile coverage across rural areas which are dominant throughout Australia.
- Network congestion has the potential for introducing large latencies, even for simple data transmission.
- There can be no guarantee that a data packet will arrive by a certain time, if at all.

Acknowledgements

The authors would like to gratefully acknowledge the scholarship funding provided by Natural Resources, Mines and Energy (NRM&E, QLD) and the department of Geomatics, University of Melbourne. All hardware and software development tools used in this investigation have also been provided by NRM&E and the Department of Geomatics.

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This paper was published in the Journal of Global Positioning Systems, Vol 3, No 1-2, pp 85-94.

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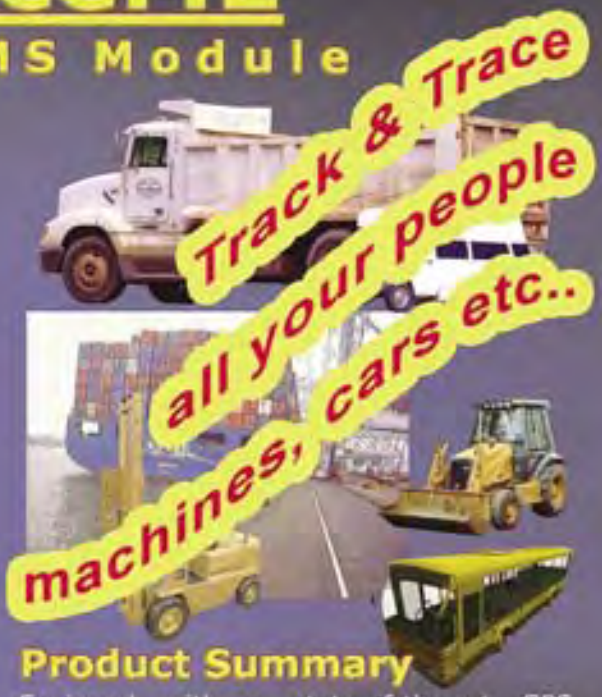
KCS TraceME

GPS / GPRS / SMS Module



Distributors welcome!

The KCS TraceME/TrackME GPRS/GPS Module enables you to remotely track & trace a variety of objects, e.g. cars, trucks, containers or ships. Its small, lightweight aluminum design makes it easy to install and together with the extended position logging, it's ideal for use in fleet management, anti-theft and M2M applications.
Furthermore, the numerous I/O connections allow monitoring and control of a range of external hardware. For surveillance and security purposes, a tiny camera is available, so you can see what's going on at a glance... anywhere, anytime!

Key Features

- Extremely small and lightweight
- Ultra low power consumption
  - Car/truck battery
  - Solar panel with small battery
  - Power supply
- Excellent GPS accuracy
  - Autonomous, MS-A or MS Assisted A-GPS
- Versatile interfacing
  - More than 25 I/O lines
- Maximum flexibility
  - Remotely configurable to fit any application
- Integrated SIM card reader
- Wide operating temperature range
- Ruggedized aluminum enclosure designed for rough environments
- Fully EMI shielded

Product Summary

Equipped with a state-of-the-art GPS receiver, the KCS TraceME/TrackME Module provides reliable and accurate navigational data. All communication is handled rapidly and effectively by a GPRS/GSM modem (dual/tri-band version available) through a GPRS network or, if not available, by means of a GSM network. In areas with no GPRS/GSM coverage, position-data and events are stored in memory. As soon as communication is restored, all information is transmitted.
A unique feature is the user-configuration menu, which controls events like sending position-information and switching of external hardware. Changing this configuration is possible remotely or on-site. Virtually every parameter can be controlled, to adjust the TraceME/TrackME Module exactly to your needs!

Applications

- Fleet management
- Public transport
- Railway industry
- Logistics
- M2M
- Security and surveillance
- Remote control and diagnostics
- Vehicle immobilisation

Evaluation Kit / Support

- KCS TraceME evalution kit
  Order code EVAL01

KCS BV
Kuipershaven 22
NL-3311 AL Dordrecht
Fax: +31-20 5248130

WWW.TRACEME.TV
KCS@KCS.TV

Product

602 series of Nikon total stations

Nikon-Trimble Co. introduced the 602 Series of Nikon® Total Stations, new high-precision mechanical total stations that includes both a prism and prismless (reflectorless) model. It also added a reflectorless model to Nikon 502 Series. The new Nikon products are expected to be available soon through Tripod Data Systems (TDS) in the United States and Trimble internationally. *www.nikon-trimble.com*

GPS/Galileo OEM receiver platform

Septentrio announces AsteRx1TM, a compact high-end single-frequency GNSS receiver for demanding industrial and professional applications. AsteRx1TM incorporates capabilities for full use of the European Galileo L1 signal. Septentrio receivers have successfully been tracking all signals transmitted since January 2006 by the new navigation satellite, Galileo. It is is a creditcard-sized OEM board with low power consumption and high update rates, offering excellent measurement quality for high-precision positioning even in challenging environments. It is compatible both with the GIOVE-A signal and with the operational Galileo signal. *www.septentrio.com.*

Leica GPS900 and MNS1200

Leica Geosystems introduces Leica GPS900, a mid-range RTK GPS system. It consists of a Leica RX900 Controller and a Leica ATX900 GPS Antenna the all-on-the-pole GPS900 RTK rover is ideal for one-person stakeout and topographic tasks. Its reference station offers an easy, convenient and cost-effective solution.

Leica MNS1200 GNSS solution presents a new machine navigation system specifically designed for construction and mining machine operation supporting full GNSS signals (L2C and GLONASS).

Supporting GPS and GLONASS satellites thanks to a new Measurement Engine supporting ultra-precise GNSS signals with 72 channel, this solution optimises working around trees, in canyons, mines and sites with overhead obstructions, and it is also equipped to support future GNSS signals such as Galileo or GPS L5

Autodesk Civil 3D 2007 Extension for Google Earth

Autodesk, Inc. is introducing Autodesk Civil 3D 2007 Extension for Google Earth-Technology Preview. It is designed specifically for civil engineers and surveyors who need to keep all constituents involved in a project, from the planning stages through public approval, apprised of the latest design information.

With a wizard-driven interface, engineers and surveyors can rapidly publish Civil 3D objects and design data in Google Earth. *www.autodesk.com/google*

Stereoscopic 3D technology

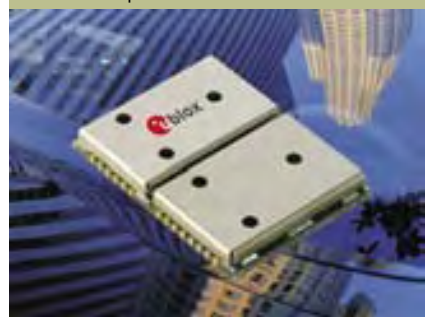
Planar Systems introduced the latest in stereoscopic 3D technology to address imaging applications in geospatial intelligence and photogrammetry.

Planar designed its initial offering with its specific customers in mind due to the demand for a high-quality 3D imaging solution and the need to replace discontinued CRT-based systems. Planar's SD1710 provides a new dimension of digital image quality and user comfort. *www.planar.com/stereomirror*

Waterproof Shield for Marine POS Product

Applanix announced availability of a new waterproof exterior casing for its marine-based onboard position and orientation (POS) technologies, POS MV. The new case allows Applanix POS MV inertial measurement units to be set up in exposed areas that may become vulnerable to water submersion or severe exposure to the elements. The cover is compliant with IP68 specifications and is waterproof in depths up to 10 meters. *www.applanix.com*

LEA-4S ROM-based Module with SuperSense



u-blox AG, announced the release of its new LEA-4S GPS module, which combines unrivaled sensitivity, exceptionally low power consumption and a USB port for flexible connectivity in a module measuring just 17 x 22 mm. The software runs from the Read-Only Memory (ROM) in the GPS baseband chip. The software extends positioning coverage to weak signal areas such as indoor car parks. The ANTARIS 4 GPS engine inside provides outstanding navigation performance in the most challenging conditions. *www.u-blox.com*

Differential Corrections via NTRIP and Direct IP

MobileMapper CE, Thales' offers differential corrections via NTRIP and direct IP. The new functionality will be available for delivery and via upgrade for current MobileMapper CE owners starting August, 2006 and also offer a free firmware update at the Thales FTP site. With the embedded Microsoft Windows CE .NET operating system,

the product users have the flexibility to choose the field software that's best for them. *www.thalesgroup.com/navigation*

Intergraph releases Z/I Mission

Intergraph Corporation announced the availability of Z/I Mission, a photo flight management system that provides a solution for aerial survey procedures. It provides a data environment that can access geo-referenced raster backdrop, vector mapping data, and digital orthophotos for flight planning. *www.intergraph.com*

New version of GeoConcept 6.0

This new version of the GeoConcept GIS is designed to make both map analysis and sharing results, both faster and easier.

The GeoConcept developers in Paris have made major advances in ease of use, enhanced display options, faster analysis and improved control over user access rights.The key advantage of a GIS is the ability to bring together data from disparate sources, using geography as the common theme. *GeoConcept@vsnl.com*

GeoCalc 6.2 developer tool kit

Blue Marble Geographics announces an update to their GeoCalc 6.2 developer tool kit. This fully object-oriented, cross platform version of Blue Marble's coordinate conversion libraries was created to meet the accuracy and data conversion needs of GIS and mapping programmers. *www.bluemarblegeo.com*

MapInfo Professional version 8.5 launched

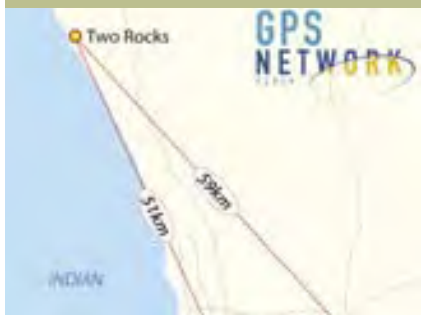
MapInfo Corporation has introduced MapInfo Professional version 8.5, the first version of the company's location intelligence application with Web services connectivity. MapInfo Professional users can now access dynamic data available on the Internet and perform detailed analysis of information in a single environment to make better informed decisions. www.mapinfo.com

Business

Thales Adds GeoSpatial Experts to Business Partner Program

Thales' navigation announced formation of another partnership in its Business Partner Program, GeoSpatial Experts, which offers GPS-Photo Link software, now fully compatible with the Thales MobileMapper CE handheld GIS data collector. This powerful solution delivers easy and affordable digital photo geo-referencing capabilities for nearly any GIS application including asset management, utilities, forestry, national parks services and many more. *www.thalesnavigation.com*

Perth builds first infrastructure network



Trimble has announced that it has supplied GNSS reference stations and VRSTM (Virtual Reference Station) software to establish a GNSS infrastructure network in Western Australia. Located in Perth, Western Australia's capital, the high-precision network is built solely with Trimble® NetR5 reference stations and is the first VRS network with GNSS capabilities. The GNSS network supports both the next-generation GPS L2C and L5 signals and GLONASS signals. *www.trimble.com*

GeoEye awarded Airport Mapping Database contract

The National Geospatial-Intelligence Agency (NGA) Stereo Airfield Collection programme has awarded GeoEye a $3.7 million contract to image 365 airfields and produce Airport Mapping Databases (AMDB) over a 12-month period. GeoEye will deliver IKONOS stereo imagery and perform three-dimensional airport feature extraction services in accordance with NGA specifications.

Autodesk to focus more on India, China

Autodesk is increasing its focus on India and China. To concentrate more on these two countries, the company has split the Asia-Pacific region and formed the Asia-Pacific Emerging Geography consisting of India and China, according to Rajiv Nair, Regional Director, India and SAARC region. The company's expansion in India includes increasing the channel partner network and authorised training centres *www.thehindubusinessline.com*

ER Mapper opens office in Singapore

ER Mapper (Australia) has opened a new office in Singapore. The main role of this office is to manage the distribution channels of ER Mapper's geospatial imagery technologies and solutions in South and South-East Asia. *www.ermapper.com*

US$2.5m mapping contract for Southeast Asia

Intermap Technologies Corp. has been awarded a US$2.5 million contract for radar mapping in Southeast Asia. Under the agreement, Intermap will collect and deliver geographic 3-D elevation and imagery data utilising IFSAR radar mapping technology. *www.intermap.com*

Personal navigation most profitable LBS in Europe

Berg Insight made the survey among LBS professionals at mobile operators, vendors and consultancies. There were two sets of questions asked to the 200 respondents, one to operators and another set to vendors and consultancies. We asked the operators which LBS applications they already have deployed and got the reply that the most common services today are information services. On second and third place came navigation services and tracking. We also asked the operators which positioning technology they think will be the most important the coming years. The majority, 65 percent, replied a combination of two or more technologies, while 35 percent said A-GPS. It is obvious that satellite positioning is coming up as a preferred technology among operators in Europe. *www.lbsinsight.com*

Andrew awarded international geolocation contract

Andrew Corporation has been awarded the second phase of a strategic multiyear contract from a Tier 1 operator in the Middle East for a major geolocation system deployment. The phase two contract award is valued in excess of $10 million, bringing the total contract value to date to more than $20 million.

deCarta adds China to global deployment of LBS

deCarta (formerly Telcontar) has announced the launch of its Drill Down Server (DDS) 4.1. The newest version adds China map data and a host of customized performance enhancements that enable deCarta customers to deploy dynamic location-enhanced applications that meet the region-specific needs of China's burgeoning market.

2007 Global LBS Challenge in Europe

NAVTEQ has officially launched its second Global LBS Challenge in Europe. The contest challenges developers to build LBS applications for wireless devices and plays an important role in heightening the awareness of new value-adding LBS to the wireless industry.

Terion Deploys ObjectFX Technology

ObjectFX Corporation announced that Terion Incorporated has deployed ObjectFX technology in the Web-based FleetView 3 trailer management solution. It combines Terion's wireless technology with SpatialFX, the patented Java/J2EE geospatial software platform from ObjectFX. The system provides location information, travel history, load status, expected delivery time, and other data.

New mobile local search technology

Intelligent Spatial Technologies announces the availability of a unique mobile local search and content delivery platform that allows users to search the internet or query databases simply by pointing a wireless phone or other mobile device at a building, landmark, or point of interest. *www.i-spatialtech.com*

IRNSS to be independent of other constellations

The Indian Space Research Organisation (ISRO) will be establishing a satellite navigation system on the lines of the US GPS. The proposed Indian Regional Navigation Satellite System (IRNSS), which will consist of a constellation of eight satellites, is likely to be operational in six years time.

The Union Cabinet had approved the Rs 1,600 crore project in May this year. According to Madhavan Nair, Chairman ISRO the IRNSS would be developed indigenously and will be independent of other constellations.

Cars to dominate mapping industry

Navigation in motor vehicles will be the most significant application of spatial technology by 2010, according to figures released at a conference in Taiwan. The market will reach around US$30 billion. By way of contrast, the annual Daratech survey of the spatial industry put the value of land information systems at only $8 billion last year. The best estimates of industry growth suggest this might rise to $10 billion by 2010. The information is contained in a report released at the Autotronics conference and exhibition held in Taipei last month. The report says each will have around 20 per cent of the market.

GPS mapping to aid education scheme in India

Madurai district is one of the districts in Tamil Nadu, India, which is using GPS to map the schools and areas as a part of project called SCHOOLGIS, funded by Ministry of Human Resources through Sarva Siksha Abhiyan (Education for All) scheme, Government of Tamil Nadu, A Sundaram, Department of Future Studies, Madurai Kamaraj University and S Vasudevan, Department of Geology, Bharathidasan University.

By using the outcome of the present project, the user can find out the areas which remain inaccessible to primary schools within the user specified distance against the backdrop of the sufficient number of general population and also school-going population as per SSA indicators. *www.newindpress.com*

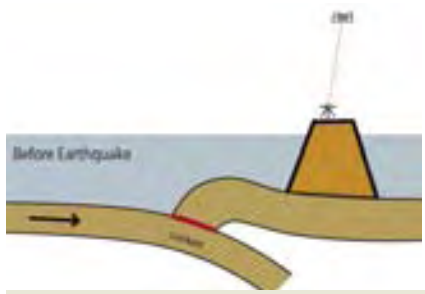
Satellite guidance for the visually impaired

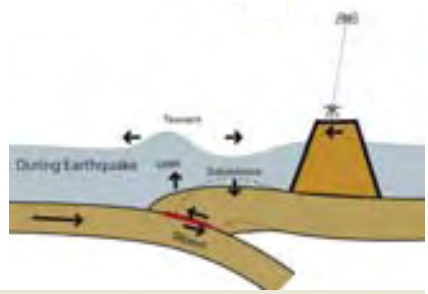
A prototype satellite navigation system accurate enough to direct vision-impaired pedestrians to their destination has recently been successfully demonstrated in Madrid. Developed by ESA, with the Spanish firm GMV Sistemas, this device offers greater autonomy for the visually impaired. The system is not intended to replace a white cane or a guide dog but to complement them with an 'audible map'. The user no longer needs to seek frequent guidance from other pedestrians; the guidance equipment follows his every move and advises him accordingly.

This system, designed with the advice of the Spanish National Organisation for the Blind (Organisacion Nacional de los Ciegos de España -ONCE), is based on EGNOS, a positioning system that processes GPS data to provide improved accuracy.

This is rather important for a blind person, since a one metre localisation accuracy makes the difference between being on the path or in the road. *www.esa.int*

GPS to aid in Tsunami Warnings





University scientists using Global Positioning System software, developed by NASA, have shown GPS can determine, within minutes, whether an earthquake is big enough to generate an ocean-wide tsunami. This NASA-funded technology can be used to provide faster tsunami warnings.

A team led by Geoffrey Blewitt of the Nevada Bureau of Mines and Geology and Seismological Laboratory, University of Nevada, Reno, demonstrated that a large quake's true size can be determined within 15 minutes using GPS data. This is much faster than current methods. The new method, called GPS displacement, works by measuring the time radio signals from GPS satellites arrive at ground stations located within a few thousand kilometers of a quake. From these data, scientists can calculate how far the stations moved because of the quake. They can derive an earthquake model and the quake's true size, called its 'moment magnitude.' This magnitude is directly related to a quake's potential for generating tsunamis. *www.nasa.gov/home*

Geospatial industry poised for growth

Information systems alone, based on maps and satellite imagery is set to touch Rs 576 crore by 2010. At present, the market estimates for these services are Rs 12 crore. The optimism is based on the current growth rates of around 200 per cent and the huge potential. Geospatial Today and Spatial India, geospatial publications in association with Antrix Corporation and Survey of India, have brought out the report. According to the highlights of the report, the domestic market estimates for these geospatial services amounted to about Rs 562 crore in the financial year 2005. The market for these services is expected to grow at a CAGR of 17.57 per cent per annum and reach Rs 1,824.98 crore by year 2010. The key driver for this increased growth is the expected investments in land information systems (ILIS) in several states of the country. It also provides an optimistic overview in as much as the total market in our country (domestic and exports markets) is expected to record a potential growth from Rs 962 crore in the year 2005 to Rs 2,820.30 crore at a CAGR of 14.5 per cent. India has emerged as a major data conversion centre for geospatial services. In FY 2005, this sector marked Rs 720 crore with an expected growth rate of 20 per cent. *www.blonnet.com*

Tokyo Metropolitan Government begins new era in city planning

The Tokyo Metropolitan Government (TMG) has implemented a Web based system that promises broad new capabilities and greatly expanded use throughout the government." In order to make more effective use of its GIS for city planning, it was decided to build an urban planning system using ArcGIS Server," commented Chiharu Masaki, Managing Director at ESRI Japan. The new Tokyo Metropolitan Urban Planning GIS is a Web-based system. www.esri.com

Nashik to implement GIS for civic administration

The Nashik Municipal Corporation (NMC) will soon use GIS and other technologies for increasing its efficiency in civic administration. Nashik is among the eight cities chosen for a pilot project that is being conducted by Maharashtra Remote Sensing Application Centre (MRSAC), Nagpur in co-ordination with NMC. *www.dnaindia.com*

MENRIS upgrades Mountain GIS portal

Mountain Environment and Natural Resources' Information Systems (MENRIS) - ICIMOD, launched an updated version of the 'Mountain GIS Portal' a platform aimed at sharing and exchanging geographic information and knowledge resources of mountain ecosystems and its services from the HKH region. *http://menris.icimod.net*

Maps for numerous Pakistan cities

Geographic databases of city streets for the Pakistan cities: Islamabad, Rawalpindi, Peshawar, Lahore, and Karachi to support asset-tracking, government, military, and commercial GIS applications was released by LeadDog Consulting, LLC. Designed to help companies track their assets and provide accurate base level mapping, It provides numerous vector layers and attributes. *www.goleaddog.com*

$2.4 million for satellite imaging

Mr. Gary Lunn, Minister of Natural Resources, announced a five-year, $2.4-million project to provide access to new, high-quality satellite images of Canada and also the improved and standardized satellite images will be available to all Canadians for free over the Internet.

The newer and higher-quality images will be used for mapping, monitoring Canadian wetland areas and managing natural resources, and will support government decision and policy makers in the fields of public safety, health and the environment, as well as our northern and Aboriginal communities. Natural Resources Canada will coordinate and manage the project, ensure the quality of the data and liaise with the contractors, TELUS Corporation and Iunctus Geomatics Corp., who are supplying the satellite images.*www.NRCan.gc.ca*

Certification for CARTOSAT-1 image processing

PCI Geomatics has achieved complete certification for its Geomatica®, to be used for processing data from the CARTOSAT-1 satellite, from the Indian government-contracted ANTRIX Corporation. This certification states that the software has complied with all six identified levels, which include: image import and image processing, single image triangulation, stereo pair triangulation, block triangulation for mono imagery, block triangulation for stereo imagery, digital topographic mapping. *www.pcigeomatics.com*

ISRO opens up space to private industry

The Indian Space Research Organisation (ISRO) is preparing to throw open its once closely guarded rocket programme to the private industry."To start with, we'll outsource non-critical applications that constitute 50 per cent of the rocket programme to the private sector," said Dr M Annamalai, Director, Satish Dhawan Space Centre, Sriharikota Range. "For certain operations, we've invited tenders from the industry. We'll give you the names (of industries) once the formalities are completed."ISRO now plans to outsource a chunk of the work in the manufacture of indigenous rockets -- the Polar Satellite Launch Vehicle (PSLV) and the Geosynchronous Satellite Launch Vehicle (GSLV) -- to the industry. It intends to hand-hold companies through the manufacturing process. www.hindustantimes.com

Indian Air Force to acquire military satellite

The Indian Air Force (IAF) is planning to acquire 'military satellite' with the assistance of Defence Research and Development Organisation (DRDO), Vice-Chief of Air Staff Air Marshal, Ajit Bhavanani, said. Addressing a programme of the 'Aero Space Manufacturers Association' organised by Aeronautical Society of India, he said an exclusive military satellite would provide information for defence forces to utilise modern weapons. *www.hindu.com*

Remote sensing satellite launched from Baikonur

A Russian Soyuz rocket launched a civilian Earth observation satellite into orbit to begin a three-year mission to keep tabs on natural resources and emergencies from space for both government and commercial users. The payload was the first such craft launched since 1999. The three-stage Soyuz rocket lifted off at 0800 GMT (4:00 a.m. EDT) from the Baikonur Cosmodrome in central Kazakhstan. The almost 15,000-pound Resurs DK1 spacecraft successfully separated from the Soyuz upper stage less than nine minutes later in an orbit with an apogee of approximately 230 miles, a perigee of around 125 miles, and an inclination of about 70 degrees. The newest member of the Resurs satellite fleet is the first in an upgraded series of spacecraft with improved capabilities in imaging resolution and communications. *http://en.rian.ru*

Beijing-1" satellite starts remote sensing service

China's satellite "Beijing-1", launched from Russia in October last year, started to provide a wide range of remote sensing services. It will be used to survey land resources, for geological research and water resources research, and to monitor floods and winter wheat, and used by urban planners and archaeologists. Government departments will also use the satellite during emergencies to aid decision-making of the central government. *Source: Xinhua*

Surrey Satellite Technology delivers Beijing-1 EO satellite

British satellite manufacturer Surrey Satellite Technology Ltd (SSTL) has just completed a landmark commercial satellite contract with the Beijing Landview Mapping Information Technology Co., Ltd (BLMIT) in order to commercialise the data services from Earth observation (EO) satellites. At a ceremony held in Beijing, BLMIT signed the formal in-orbit acceptance of the high resolution EO microsatellite (Beijing-1) system built in cooperation with BLMIT.The 166 kg Beijing-1 is the EO satellite, carrying two payloads that provide high-resolution (4-metre) panchromatic images alongside medium-resolution (32-metre) multi-spectral images with an ultra-wide 600km imaging swath. www.earsc.org

12th IAIN World Congress

2006 International Symposium on GPS/GNSS

18 – 20 October, Jeju, Korea

Hosted and organized by GNSS Technology Council (GTC) and Korean Institute of Navigation And Port Research (KINPR), IAIN/GNSS 2006 will be held in the International Convention Centre Juju, Korea from 18 to 20 October, 2006.

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This symposium is open to all aspects of GPS/GNSS research, development and application:

- Future of GNSS and Augmentation
- GNSS Receiver Technology and Positioning Algorithm
- Navigation System Integration Technology
- Application Technology of GNSS
- Technology and infrastructure for maritime / inland waterway
- Marine and mobile communication navigation

Important Dates

Submission of Abstracts:	May 31, 2006
Submission of Full Papers :	August 31, 2006
Notification of Authors:	July 7, 2006
Early-Registration:	September 22, 2006

*Authors should register by August 31, 2006

Symposium Secretariat
CES Co., Ltd.
#511 Hanshin Building, 136-1 Mapo-Dong,
Mapo-Gu, Seoul 121-736 Republic of Korea

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E-mail dodream10@cescon.co.kr
Web www.gnsskorea2006.org

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July 2006

GeoWeb 2006
24 - 28 July, Vancouver, BC, Canada
khenton@gita.org

2006 IEEE International Geoscience and Remote Sensing Symposium & 27th Canadian Symposium on Remote Sensing
31 July – 4 August, Denver, Colorado, USA
http://www.igarss06.org/

August 2006

International Workshop on 3D Geoinformation
7-8 August, Kuala Lumpur Malaysia
alias@fksg.utm.my
www.fksg.utm.my/3dgeoinfo2006

26th ESRI User Conference and 4th Survey and GIS Summit
07- 11 August, San Diego, CA, USA
uc@esri.com
www.esri.com

The GISnet'12 Conference and Exhibition on GIScience, RS, GPS, Space Science and Technology Applications
14-18 August, Hochiminh, Vietnam
gisnet@ditagis.org
www.ditagis.org

2006 GITA Annual Conference
21-23 August, The MCG, Melbourne
chris.stoltz@gita.org.au
www.gita.org.au

400 Years of Mapping Australia, MSIA Conference
23-25 August, Darwin, Australia
menzies2@bigpound.net.au.
http://www.mappingsciences.org.au/

First Indonesian Geospatial Technology Exhibition Hosted by National Coordinating Agency for Surveys and Mapping of Indonesia (BAKOSURTANAL).
23-27 August, Jakarta, Indonesia
info@bakosurtanala.go.id,
marketing@ptmediatama.com.
http://www.geospatial-exh.com

Digital Earth 2006
27-30 Aug
www.digitalearth06.org.nz
james@eventdynamics.co.nz

September 2006

3rd National Cartographic Conference GeoCart'2006
4-6 September, Auckland, New Zealand
www.cartography.org.nz/

ISPRS Technical Commission VIII on: "Remote Sensing Applications and Policies" 2004-2008
4-7 September, Haifa, Israel
www.commission8.isprs.org/

13th ESRI South Asia User Conference
6-8 September, Subang Jaya, Malaysia

WALIS Forum
14 - 15 September Perth
Convention Centre, Australia
davidls@walis.wa.gov.au
www.walis.wa.gov.au

17th UNRCC for Asia and the Pacific/ 12th Meeting of the PCGIAP
18-22 September, Bangkok
http://www.gsi.go.jp/PCGIAP/

5th Trans Tasman Survey Conference
19-23 September, Cairns, Australia
cairnsspatial2006@icms.com.au
http://www.icms.com.au/cairnsspatial2006/

Second International Symposium on Geoinformation and Disaster Management
25-26 September, Goa, India
subhan_kp@sac.isro.gov.in
http://www.commission4.isprs.org/

ION GNSS 2006
26 - 29 September, Fort Worth TX, USA
www.ion.org/meetings#gnss

October 2006

27th Asian Conference on Remote Sensing
9-13 October, Ulaanbaatar, Mongolia
www.acrs2006.mn

Intergeo 2006
10 -12 October, Munich, Germany
ofreier@hinte-messe.de
http://www.intergeo.de

XXIII International FIG Congress
8-13 October 2006, Munich Germany
http://www.fig2006.de/

The 12th IAIN World Congress 2006
18-20 October, Jeju, Korea
http:// 203.230.240.83/

Geoinformatics 2006
28-29 October, Wuhan, China
lilyshi@lmars.whu.edu.cn

November 2006

GSDI-9 - Geospatial Information: tool for reducing poverty
03-11 November, Santiago de Chile, Chile
gsdi9@igm.cl
http://www.igm.cl/gsdi9

Trimble Dimensions
05 - 08 November, Las Vegas NV
http://www.trimble.com

AFITA-2006
9-11 November, 2006
The Indian Institute of Science, Bangalore
http://www.afita2006.org

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