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A cautious welcome to 2009

Economic slowdown, meltdown, recession…

Cost cut, retrenchments, ...

Fears, uncertainty, survival issue…

Is geomatics industry immune?

No, if we talk about banking, retail or auto segments…

To an extent yes, if we think about government-driven infrastructure projects.

Defence, internal security, …

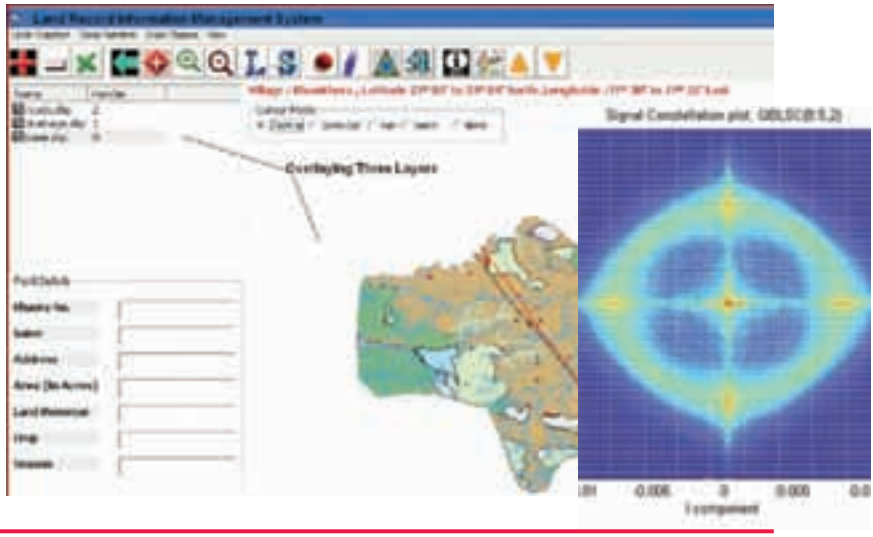
Appears, we are heading towards difficult times.

It is also a time to correct fundamentals.

Focus on forgotten sectors like agriculture.

And to innovate.

Bal Krishna, Editor
bal@mycoordinates.org



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This issue of Coordinates is of 44 pages, including cover

Signal design criteria and parametric analysis

This paper addresses the analysis of band-limited and time-limited signal design criteria for the C-band portion

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Current global navigation satellite systems (GNSSs) [1] are based on signals lying within the L-band of the radio-navigation satellite service (RNSS) spectrum. Since the need for more systems and signals is emerging, new alternative frequency resources are needed. In particular, the C-band frequency portion is envisioned as an option for future GNSSs.

Recent studies [2], focusing on comparing C-Band navigation performance with L-Band performance for global Earth coverage, have shown that C-band signals might be an interesting option in combination with L-band signals, considering forthcoming technology development. Focusing on the C-band reserved for Galileo, this is partitioned into the uplink service band (5000-5010 MHz) and the RNSS band (5010 and 5030 MHz), the latter currently unoccupied.

In addition, new aeronautical mobile (R) service (AM(R)S) are being proposed in the 5000-5010 MHz and 5010-5030 MHz bands. The analysis of compatibility issues of such AM(R)S and RNSS services calls for more specific definition of system parameters of a potential GNSS System in C-Band, especially considering the upcoming technology development in space, ground and on the receiver market envisaging in the next 10 to 15 years.

In the current phase of defining new navigation signals for the C-band case, it is fundamental to identify trade-off criteria and issues to deal with in the new allocated band, and then to span the possible signal options that can be adopted to exploit the available bandwidth.

With respect to signal design, in the recent past, several signal options have been introduced, ranging from new chip waveforms [3]-[5], to combining existing signals, like multiplexed binary offset carrier (MBOC) [6]. These solutions resulted in general in an improvement of the performance of the L-band services and could be used as a starting point for the definition of a C-Band signal.

The objective of this study is thus to compare some possible signal options on the basis of identified criteria responding not just to performance improvement but also taking into account generation and emission constraints.

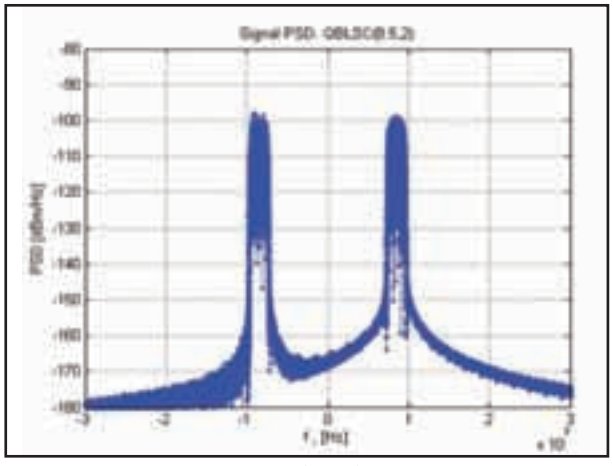

Figure 1: Signal PSD. Case QBLSC (8.5, 2).

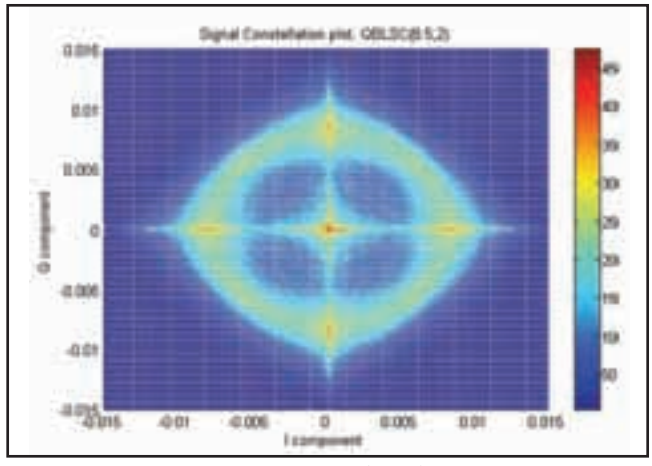

Figure 2: Constellation plot. Case QBLSC (8.5, 2).

This paper is not meant to contain a complete and exhaustive analysis of the identified options, rather it intends to anticipate possible issues to be further analysed, and/or to establish criteria to guide the selection.

In particular, it will be shown that the existing regulatory constraints of 20-Mhz band-limitation, limits considerably the possibility to improve positioning accuracy, namely, maximization of mean-squared bandwidth (Gabor bandwidth, GB) of the radio signal. The idea of band-limited signals is also taken into consideration, given the strong Out of Band emission constraint in the adjacent Radio Astronomy band. As an example, in [2] a simple raised cosine (RC) pulse shape is compared with those of time-limited signals under similar conditions.

C-band constraints and comparison criteria for signal design

When designing signals for satellite positioning, user positioning accuracy is the main driving factor, that is directly related to time delay estimation (TDE). By using conventional parameter estimation techniques [7], such as the Cramér-Rao bound (CRB), the key factor for optimizing signals in an additive white Gaussian noise (AWGN) channel has been identified in the maximization of the GB [6]. That is, the more the signal PSD is concentrated at the edge of the band, the more the accuracy is enhanced.

Nevertheless, several works [1]–[6], have also shown that multipath (MP) is one of the dominant sources to the error budget, due to its random nature. As a consequence, MP mitigation has become another relevant design driver for new signal-in-space (SIS) formats. Recent studies [5] have shown that maximizing the GB bandwidth with a constraint on the autocorrelation sidelobe levels represents an effective optimization criterion for designing spreading signals with higher robustness against MP. It follows that, generally speaking, the two main issues in signal design are fulfilled by the maximization of the GB.

When focusing on the C-band portion, a certain number of specific issues arises and they need to be taken into account. First of all, an intrinsic constraint is the strict allocated bandwidth (20 MHz), less than half the bandwidth available for the Galileo L-band E5 signal, that automatically limits the achievable accuracy. Moreover, differently from the L-band portion, a new impairment becomes relevant: the level of the emissions in the adjacent band portions. To this regard, ITU [8] specifies the maximum tolerable absolute values of power flux density (PFD) in the out of band regions. The requirement for the microwave landing system interference (5030-5150 MHz) allows a maximum PFD of –124,5dBW/m2 in a band of 150 kHz, while the requirement for the radio-astronomy interference (4990-5000 MHz), choosing a worst case of 10 interfering satellites, allows a maximum PFD of –196.5 dBW/m2 in a bandwidth of 10 MHz. It follows that, while the requirement in the upper bandwidth is not so strict, the one in the radio-astronomy band is so stringent that the need for low out of band emissions (OOB) becomes a driving factor in defining new SIS for C-band. It is worth to be noticed that, to the best of our knowledge, the requirement for the C-band uplink region has not been fixed yet, but we believe it should represent a driving criterion as well.

Finally, we prefigure that the impact of non-linearities will be another important trade-off criterion. In fact, a C-band signal needs to be transmitted at an increased power than an equivalent L-band signal due to the increased signal attenuation in the C-band region. In order to be conservative, we envision the use of a travelling wave tube amplifiers (TWTA) that guarantees a larger gain. The drawback is the enhanced effect of non-linearities, that needs to be taken into account from the very beginning of the signal design process.

Concluding, the identified criteria lead to a trade-off between two different trends in SIS design: on one hand, it would be desirable a signal with a power concentrated at the edge of the band (following the GB principle it can better perform in terms of TDE accuracy and MP robustness) and, on the other hand, it is requested a signal that has its power concentrated at the center of the band (it guarantees lower out of band emissions). This could be achieved either with band-limited or time-limited signals, examples of which are analysed in the following.

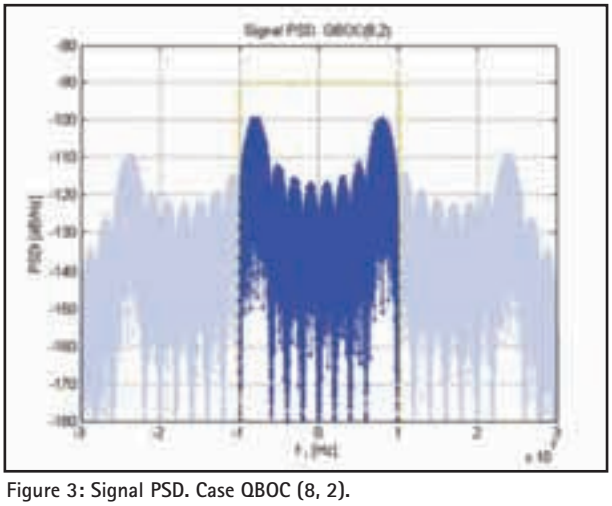

Figure 3: Signal PSD. Case QBOC (8, 2).

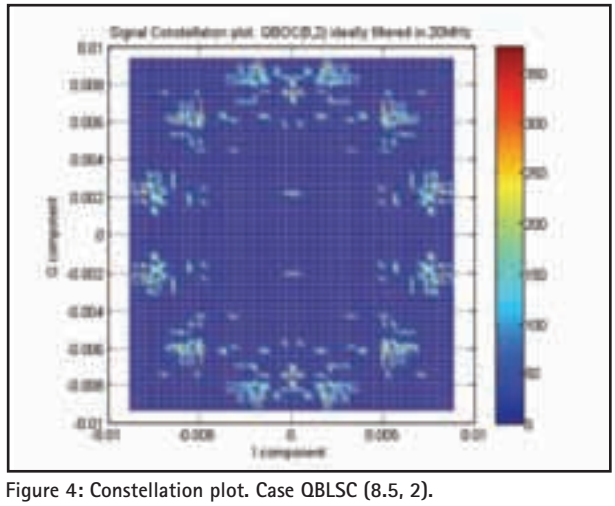

Figure 4: Constellation plot. Case QBLSC (8.5, 2).

Signal definition

Quadrature Band-Limited signals with SubCarriers (QBLSC)

The band-limited signals we propose are a class of square root-raised cosine (SRRC) signals with chiprate fc and with

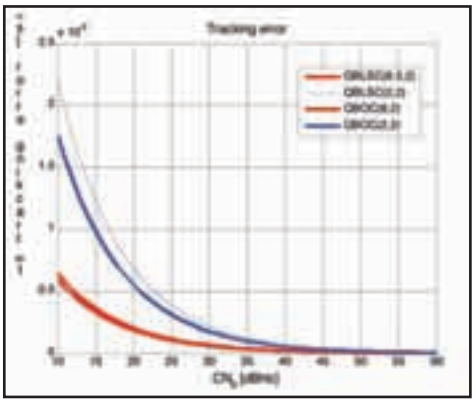

Fig. 5. Tracking error.

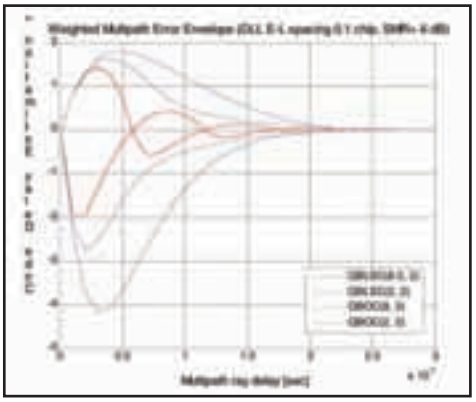

Fig. 6. Weighted multipath error envelope.

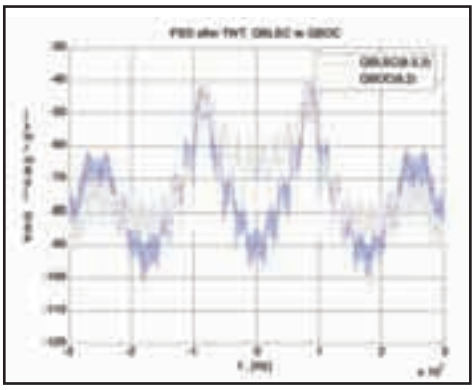

Fig. 7. PSD after TWT. QBOC(8,2) vs QBLSC(8.5,2).

sinusoidal subcarriers f_{sc}. This represents a simple example of bandlimitation with a high GB when f_{sc} is sufficiently large. We will call this SIS, quadrature band-limited signal with sub-carrier (QBLSC). In the following, they will be referred to hence as QBLSC(n,m), with the two parameters n and m such that $n*f_{ref} = f_{sc}$, $m*f_{ref} = f_c$, where f_{ref} =1 MHz.

The complex envelope is of the form:

$$\tilde{s}(t) = s_c(t)\cos(2\pi f_c t) + j\, s_s(t)\sin(2\pi f_c t) \quad (1)$$

where $s_c(t)$ and $s_s(t)$ are two band-limited modulated waveforms defined as

$$s_c(t) = \sum_k c_c(k)\, g_T(t - kT_c), \quad c = \{c, s\} \quad (2)$$

where $T_c = 1/f_c$; $\{c_c\}$ and $\{c_s\}$ (c = cosine, s = sine) are two orthogonal binary code sequences with length L; and $g_T(t)$ is the band-limited SRRC pulse shape with roll-off factor α and bandwidth (BW) $B_T = (1+\alpha) / T_C$.

For the moment, no assumptions on the services and the type of spreading of navigation data are made, but we focus only on a pilot signal $s_p(t)$ of the form:

$$s_p(t) = \sum_k \tilde{s}(t - k \cdot L \cdot T_c) \quad (3)$$

Once the code sequences are defined, the pilot is a deterministic signal, given by the periodic repetition of the elementary signal $s_p(t)$, with period equal to LT_c.

The power spectral density (PSD) of $s_p(t)$ is of course discrete with line amplitudes also depending on the Fourier transform of the auto- and cross- correlation functions of the sequences $\{c_c\}$ and $\{c_s\}$. In particular if the (deterministic) cross-correlation of the two sequences is non zero, the PSD is asymmetric w.r.t. the centre of the transmission band [9], as in Fig. 1. Here, the spectrum is given by two main lobes located at $\pm f_{sc} = \pm$ 8.5 MHz, with a bandwidth of 2.4 MHz when $\alpha = 0.2$ and $f_c = 2$ MHz. The periodic signal has line spectra at the multiples of the fundamental frequency $f_0 = 1 / (L \cdot T_c)$. Using the standard two long sequences of Galileo E5 signals (L=10230), $f_0 = f_c / L = 196$ *kHz*. Similar considerations can be properly done for each couple (f_{sc}, f_c), thus parameterizing the performance w.r.t. the spectral occupancy of the signal within the given C-bandwidth. Figure 2 describes the I/Q "constellation" plot of the QBLSC signal for a high f_{sc}/f_c ratio. The constellation is symmetric and presents five "high density" spots, as can be easily derived from the signal in the time domain. The five "high density" spots are dipped in a crown of "medium density" points that corresponds to the slow signal transitions. Each transmitted symbol is determined by the order the spots are covered during one T_c.

Filtered Quadrature Binary Offset Carrier (QBOC)

In order to make a fair analysis, we compare the QBLSC signals with a binary offset carrier (BOC) signals with similar spectral occupancy within the 20 MHz C-Band and comparable envelope construction. We address this as quadrature BOC (QBOC) signals.

The QBOC(m,n) signal is of the type:

$$s_{QBOC}(t) = s_{BOC_c}(t) + j\, s_{BOC_s}(t) \quad (4)$$

where

$$s_{BOC_c}(t) = \sum_k c_c(k)\, BOCx(m,n)(t - kT_c), \quad x = \{c, s\} \quad (5)$$

The $s_{BOCc}(t)$ and $s_{BOCs}(t)$ are given by the modulation of the BOCx (c=cosine, s=sine) signals, respectively, and of the two binary code sequences used for the QBLSC signals. The $BOCx(m,n)$ are the usual square-wave subcarriers defined as in [6], with reference frequency $fref$ = 1 MHz. To meet the C-band constraint, we also adopt a low-pass filtering of the QBLSC signal, as in Fig. 3. Figure 4 depicts the constellation plot of the (ideally filtered) QBOC signal for a high fsc/fc ratio. The constellation is asymmetric w.r.t. real and imaginary components. The C-band filter cuts off differently the spectral components

Singal	CRB for C/NO=0 DB [NS]	OOB in 4990-5000 MHz [dBc]	OOB in 5000-5010 MHz [dBc]
QBLSC(2,2)	69	-48.1	-31.0
QBOC(2,2)	56	-34.4	-20.6
QBLSC(8.5,2)	20	-20.1	-20.3
QBOC(8.2)	20	-28.6	-24.7
QBOC(9,1)	18	-27.8	-23.8

Table I: Summary of out-of-band emission and tracking error.

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of the two I/Q components of the QBOC signal: the BOCs has more energy between the two main lobes than the BOCc, so its spectral components are better preserved.

Numerical results

A comparison between different QBLSCs and QBOCs has been performed with respect to the identified trade-off criteria. A mix of theoretical analysis and simulation was used to derive our performance results.

In terms of tracking performance and robustness against MP, we can observe from Figs. 5-6 that both the classes of signals follow the GB principle, as expected. Figure 5 represents the tracking error as a function of the signal to noise ratio, whereas Fig. 6 plots the weighted MP error envelope [10] on the benchmark two-ray channel. In the weighted MP error envelope, the classical MP error envelope is scaled according to a typical exponential distribution of the path delay of the second ray. From the GB principle it follows that, as the power spectrum of the signal concentrates to the edges of the band, the CRB decreases and the robustness against MP increases. When comparing the two classes of signals for the same (*fsc, fc*) configurations, performance are equivalent as long as the occupied bandwidth is equivalent. It is worth noticing that the bandwidth (BW) for the analysed QBOC is always limited to BW=20 MHz, whereas the QBLSC is intrinsically limited by the choice of the fsc, therefore for configurations with small *fsc* / BW the QBOC allows more energy to be put at the edge of the band.

All the signals above are amplified by an highly non-linear high power amplifier (HPA) at a radio frequency. The re-growth of the sidelobes of the spectrum thus become an issue. . In terms of the effect of non-linearities and out of band emissions, the performance has been analysed assuming a Travelling Wave Tube Amplifier (TWTA) working at saturation, and measuring the level of power over the band with respect to the carrier (dBc)

The out of band emission between 4990 and 5000 MHz band are mostly defined by the non linear characteristics of the TWT curve, so the band-limiting is not really an advantage because of the inevitable re-growth, as depicted in Table I.

Conclusions

Some important conclusion can be drawn. Without strong output filtering it is impossible to limit the emissions for any signal to the required level between 4990 and 5000 MHz. Feasibility/complexity analysis of the needed output filtering will be a key point to be examined during the payload design. Depending upon the absolute value of satellite EIRP required to achieve a given C/N0 threshold, the out-of-band emissions in the Radio Astronomy Band may cause levels of power flux density on-ground in excess of ITU limits. Proper output filtering shall then be made to protect such band. Other more complex generation schemes could be used to limit the emissions in the case of the QBLSC (spectrum asymmetry, non binary codes etc.). More difficult will be for the QBOC to accommodate these type of changes. Band limiting could be an advantage for the adjacent band emissions, spectrum which is currently allocated to the uplink for which the requirement will come from the spacecraft design. Depending on how much these emissions prove to be a constraint in the link budget, it will be difficult to filter and to generate unwanted spurious peaks in these bands. Spurious could be limited by using a linearised version of the TWT (LTWT), solution that has shown to produce reduction of 5 dB in average of emissions w.r.t. the TWT at the same input power.

Table I summarises the results for different signal configurations. As expected, performance is mostly driven by the position of the main lobes in the dedicated band. The actual generation mode of the signal (intrinsic or a-posteriori band-limitation) appears to have a secondary impact on performance although SRRC baseband shaping is much more hardware friendly than generating square pulses followed by a brick-wall analogue filter.

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"We let our brands and subsidiaries work and "live" as individual companies"

says Ola Rollén, CEO Hexagon AB while discussing Hexagon brand and strategies

Please elaborate on the strategic businesses of Hexagon.

The strategic businesses of Hexagon are within the area of measurement technologies. We are active in the macro and the micro segment of the measurement technologies market.

There are over 35 brands listed as part of the Hexagon family, so what really is 'Hexagon'?

The Hexagon brand is the Group brand. One could say it is the "mother brand" of all brands within the Hexagon Group. It is supplemented with its subsidiaries' brands which target specific customer segments and/or geographical areas. Each of these individual brands represents strong traditions and is well known in its individual sector. We work continuously to strengthen the Hexagon brand globally, and to utilize the synergies between the individual brands.

When a jigsaw puzzle is completed the bigger picture emerges, but the outline of each individual piece is also seen distinctly. Can we compare Hexagon to a jigsaw puzzle?

This is a nice analogy. For us at Hexagon, it is vital to let our brands and subsidiaries work and "live" as individual companies. They each have their history, their culture, a deep knowledge of their market's needs and a very professional approach to their customers. These strengths Hexagon wants to preserve. At the same time, our brands and companies are part of the "mainframe" called Hexagon. Within this, they can benefit from a whole network of professionalism – knowledge, people and technologies, and of course also from a global culture.

Is it deliberate for Hexagon brands to have a strong individual identity?

Yes, this is part of the brand strategy of Hexagon. Different brands are used depending on product category or technology in the measurement technologies market.

Leica Geosystems, Novatel, Erdas, Geomax, Elcome Technologies – are names in an ever growing list of Geospatial and GNSS sector acquisitions. Does this indicate a deliberate shift in the overall Hexagon outlook?

Hexagon aims to create profitable growth in selected segments through a combination of acquisitions and organic growth. We constantly monitor a large number of companies to find acquisitions that can strengthen the Hexagon product portfolio or improve our distribution network.

How does Hexagon plan to achieve a synergy between its various geospatial brands?

Hexagon employees collaborate across divisions and geographic boundaries to ensure the best possible use of available knowledge and expertise. Our teams work globally, sharing their knowledge and professional skills, and within the Hexagon Group there is a vivid exchange of information – this not only on management team level, but down to single employees working together on comprehensive projects. This is one of the advantages of a being a global group of companies. We not only profit from the professional knowledge of our employees, but also from their individual "soft skills" such as cultural background and individual approaches. This way, we can look upon new challenges in different ways – ensuring that our customers get the best out of Hexagon's worldwide network.

To what extent are the Hexagon brands and services able to meet the 'end to end' needs of the customers?

Our customers demand optimal quality, maximum productivity and efficiency, minimum tolerance levels and scrapping, and the ability to quickly adjust processes and projects based on changes in requirements or demand. Hexagon is able to meet all of those demands. Also, our innovative capacity is of vital significance when customers choose a supplier. All brands within the Hexagon Group represent high quality and reliability.

Voices of future

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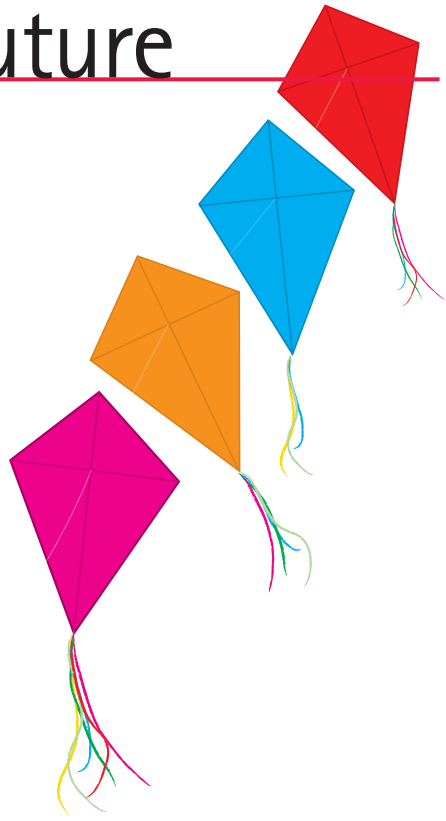

In this article students from around the globe were canvassed on their views on their studies in geomatics and GNSS. Interesting commentaries and views were received from twelve students. There were a number of common threads that run through their views and these include the major challenges of costs of equipment and software, distinctions between geomatic education, training and research, beyond space, time and everyday applications, multidisciplinarity, and commerce versus geomatic research.

Costs

Views here include the cost of the infrastructure, the software and how educational institutions have been unable to keep pace with the rapid changes and developments in the field. Included here are the difficulties of underwriting the costs while maintaining the accuracy, volume and breadth of the geospatial data generated by GNSS technologies.

Geomatic education, training and research

As geomatics includes other fields such as logistics, intelligent transport systems, environmental studies and urban planning, it is evident that the study area is both multi- as well as interdisciplinary. This alone makes the study interesting and intriguiging as some students found it difficult to distinguish between the discipline area and the study in regards to education, research and training. One identified it as beyond an individual technology but stressed that the technology's importance in everyday life is paramount. Quality education should give a broad perspective to the methodological aspects and to the variety of applications that deal with time and space. Students also identified the importance of having good basic foundations in the sciences in order to fully benefit from what geomatics as a discipline has to offer.

Commerce versus geomatic research

It seems that geomatics is seen as a follower rather than a leader. The needs of commerce are quite different from those in research. There is a common lament among some students that the commercial field requires technicians and skilled personnel. However, these do not offer the challenges that bright young minds are capable of. Herein lies the dilemma between commercial needs and the needs of satisfying inquiring minds. The latter find little or no support to further their research aspirations.

As the geomatics field is yet to become a well-known or mainstream study area there are only a small number of established departments or professional discipline areas that can provide employment. However, this is changing rapidly with geomatics becoming an enabler of all fields of endeavour as well as being a partner in research and commercial applications. There is hope yet that careers may be build out of this field and challenges satisfied.

New skills required to exploit spatial data

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While the rapid growth of land and geographic information systems around the world the high level of interest and activity is already causing a major dilemma in the personnel area. However, while the lack of technical and professional personnel is a barrier to the growth of the information industries in general, the public and private sectors must show greater commitment and recognition of the need for better educated and trained people within the industry.

I am currently studying PhD of Geomatics in the Department of Geomatics, University of Melbourne. In my opinion there are many problems and issues facing an educational institution recognizing that Geomatics is a multi disciplinary field. Professional practice in Geomatics faces a number of challenges for the future. The technical development requires new skills to exploit new spatial data sources and make use of new methodology. Furthermore, the growing demand of the society for the spatial related data dictates the multi-disciplinary approach in the practical as well as scientific areas of profession. The new technologies and methodologies in the fields of Geomatics are inevitably entering the everyday practice. The university study programmes are not always able to follow the quick development of every segment of this wide profession, also due to expensive equipment, data, specialized knowledge and teaching materials. Nowadays, there are several possibilities for students to gain the additional knowledge, practical experiences and different perspective of the profession, for example e-learning, international mobility etc. A supplementary short-term education such as summer school can be further a nice opportunity to gain a specialized knowledge on selected topics for students and young researchers from different profession.

Need to know capabilities of GNSS

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The studies on geomatics and GNSS cover a broad spectrum of engineering and sciences. These areas require knowledge in electronics, astronomy, geomatics and economics. Students should be firstly educated on the system architecture and fundamentals, which are including GPS, Galileo, GLONASS, Beidou/Compass, and other augmentation systems such as WAAS and EGNOS. These GNSS systems offer at least three services which are location-based services (LBS), precise timing and scientific services such as for the monitoring of the Total Electron Content (TEC) of the atmosphere.

Students also need to know capabilities and limitations of GNSS. On a differential mode (DGNSS), GNSS could give positioning accuracy to 2-3 meters only and height to about 5-7 meters. With the use of carrier phase measurements, position accuracy would be up to about several centimeters. Limitations to GNSS services are what interrupt the operation of its system, such as the delays in medium of the signal caused by the atmosphere and troposphere, and signal blockages by dense tree foliage and structures. To reduce these limitations a new generation of GNSS is being developed now. Finally students who are studying GNSS are strongly recommended to know the extent of applications. Actually the GNSS systems are being applied to military services and space vehicles as well as personal navigation. By educating these applications of GNSS, the students should expect the marketability of GNSS.

In conclusion, the education for the students who want to research GNSS should provide the fundamentals, capabilities and limitations, and applications of GNSS.

Challenge is high cost of equipment

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As a student in this field, in my opinion GNSS/Geomatic educations has great possibilities and challenge to move forward in order to produce an excellent student in this new era. As I go through the course in this field, there are many challenges need to be faced by the students. One of the challenges is that, in order to understand the theory of GNSS/Geomatic, the students should also have a strong knowledge on engineering study. They need to fully understand the operation of satellite in GNSS systems to obtain one coordinate from signal transmit to the suitable receiver. At least four satellites are required during operation. This kind of operation is very complex in technically and difficult to understand by some students as they cannot visualise how the signal was transmitted and received. These problems have high possibilities to be solved by introducing new type of learning by utilising the multimedia tools such as animation, simulation, and video training. The other challenge is that the signal could only be achieved outdoor with the open sky but not indoor. The signal cannot penetrate the building walls and dense foliage. So, the students can only do the practical training in the open space and during the clear weather but not in heavy rain. Sometime, in this type of condition the signal also not available. However, with the possibilities of 78 satellites (24 GPS, 24 GLONASS, and 30 GALILEO) in the orbit by 2018, the above problems could be possibly solved as it will increase the satellite availability and enhanced the accuracy. The positioning inside the building also will be made possible. In my view the most trivial challenge is high cost of equipment and software related to the field. This will make the availability of the equipment during the hands on training is inadequate that may affect the learning process.

There are unlimited opportunities

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I believe that Geomatics is a very rich discipline. It is rich because it is applicable in various fields of research and businesses. Generally, information is obtained by providing answers to the "where", "what" or "why" questions. Geomatics/GNSS meets these needs for researchers, governments and businesses.

We are in a very demanding information age. GNSS or Geomatics in general, together with the Internet, now play an even greater role in the information delivery process. Quick access to spatial information is now possible because of advances in GNSS/Geomatics. Navigation by GPS or finding information using popular web based services like Google maps, Yahoo Maps are some of the notable applications that have emerged from this development. These developments have improved the quality of life for people around the whole world. Being associated with such developments and technologies is a source of great joy for me.

Studying at the University of Applied Sciences Stuttgart (Germany) has exposed me to a variety of technologies in Photogrammetry and Geoinformatics. That has made me fully convinced that there are unlimited opportunities for business and formal employment in the Geomatics profession. As GNSS/Geomatics become even more applicable to other disciplines, the domain is getting wider. This in effect increases the job opportunities for the discipline.

The Geomatics industry is changing so fast. New instruments, software packages and techniques come on the market every year. The challenge in this field is to keep abreast with these new developments.

A competitive advantage in career

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The Department of Land Surveying and Geo-Informatics of the Hong Kong Polytechnic University is the only academic unit that provides geomatics education, training and research in Hong Kong. Traditionally, its programme has been specialized in Land Surveying and Geo-Information Technology, which has satisfied the requirements of Hong Kong and overseas professional bodies.

During my three-year undergraduate study, I learnt a variety of things ranging from theories to applications and from practical techniques to sophisticated technology, developing myself towards a professional. The integration of concepts subjects and variegated applications, such as satellite orbit determination, location-based services (LBS), and natural hazards monitoring has always enlightened me, giving me useful ideas about research topics and further sustainable development.

Our Chief Executive of the HKSAR Government announced in his 2007-08 Policy Address the undertaking of 10 major infrastructure projects in the coming years. A total of US$32 billion in total expenditure will be committed and around 250,000 new jobs will be created in related industries. The policy anticipates a significant demand for geomatics professionals in the near future.

Furthermore, due to advances in computer technology and the improvement of spatial data handling algorithms, the number of GIS users in other fields including Logistics, Intelligent Transport Systems, Environmental Studies and Urban Planning has increased dramatically over recent years. I am confident that our graduate will have a competitive advantage in their career development.

Economic crisis will lead to innovation

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The GNSS education is not a simple "science per se": it is interdisciplinary and it can be extremely rich of interactions with different private companies. The specialization in GNSS/Geomatics topics might be today the right answer for a young student in this so critical world-wide period. I hope economical crisis would lead to a burst for a new innovation rush that rewards the more productive sectors for the medium and short time market period. University masters or Ph. D. programs focused on the localization/navigation field introduce to a very active scientific community, both for the basic research and for the R&D areas. Obviously, our future strictly depends on the interest of small medium enterprises in investment for new services and products ICT oriented. Nevertheless, the acquisition of personal skills on the navigation field can create competitive profiles for production and management of innovative navigation-oriented applications, in a world-wide market that today reach out from the USA to the Australia via China and India. Among the topics in Satellite Navigation I had the chance to face several interesting opportunity: the Galileo advent and in particular its Safety of Life services, will contribute to the development of applications focused on security aspects and on certification of the GNSS signal. The fully-software migration from traditional hardware technologies represents one of the major fascinating challenge of the last years, assuring more flexibility, more system control and easier integration for embedded applications. This will integrate dedicated software for the quality signal monitoring, for example for interference detection and mitigation, assuring reliability for the future GNSS based services.

The challenge is to increase the accuracy

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I am a Chinese student studying GNSS at University of Colorado at Boulder. GNSS caught my eyes initially through its application in car navigation system. Believing that the civilian applications of GNSS will have promising future, I started my research journey of GNSS in Japan and now continue it in US.

I personally believe that students in the field of GNSS will have a great career in future no matter in academia or industry. The GNSS applications, from personal navigation in cell phones to precise applications in precise agriculture and seismic monitoring have enormous industrial values and attract interests from both government and private companies.

Besides, the family of GNSS is growing that Europe is building the Galileo Navigation Satellite System, and China will implement the Beidou (Compass) Navigation Satellite System. The science and engineering of GNSS is becoming a world wide hot topic, as a student in this domain, I am very confident about its future and my own.

The challenges of the GNSS technology are how to increase the sensitivity and accuracy of the GNSS receiver without largely increasing the cost or introducing any latency. In future, the cooperation of GPS, Galileo, GLONASS and even Beidou could bring more visible satellites to the user, thus the dilution of precision will be greatly improved.

The indoor navigation or GNSS navigation under urban environment are also the challenging parts for the GNSS scientists and engineers.

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An endless source of discovery

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PhD student
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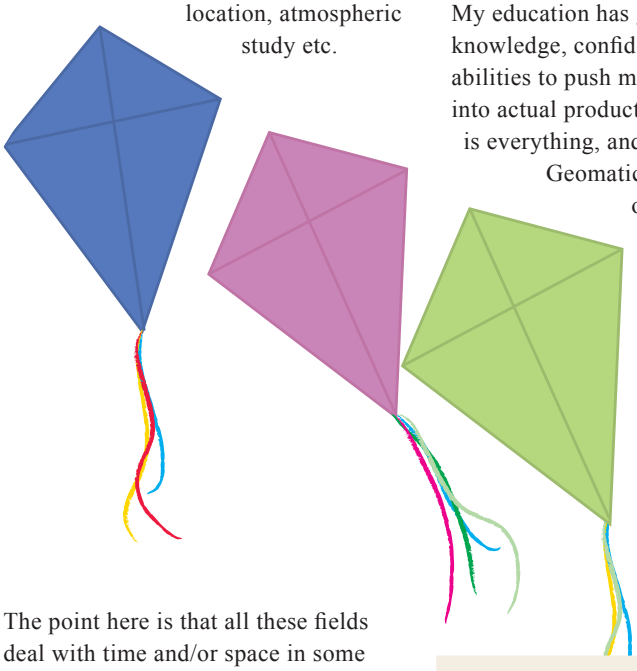
From my perspective, as a PhD student planning to finish in less than a month, the Geomatics realm goes far beyond individual technologies, such as GNSS. There are many different fields such as geodesy, mapping/surveying, positioning & location, atmospheric study etc.



The point here is that all these fields deal with time and/or space in some way, which means their importance to everyday life is paramount. The measurement of space and time brings about nearly all of the applications that are widely grouped into Geomatics.

While this description is broad, it should be appreciated that a focused education gives a student many of the details for a single application. A quality education not only does this but also gives the student a broader perspective of how the methods can be applied to a variety of applications dealing with time and space.

Geomatics does exactly this by combining elements of electrical, mechanical, civil, aerospace, systems design and computer engineering. Since Geomatics is so wide reaching the challenge here is to stay focused long enough to understand the details of one's research before being lured off to learn about something new and exciting. My particular field, positioning and location, is an enabler of other services that are required on a daily basis. The Geomatics education I have received has given me an opportunity to pursue my own product development that will be rolled into a business. Even in uncertain economic times people still need to know where their UPS parcel is, if their holiday flight is on time, where the closest gas station is, or where their children are.

My education has given me the knowledge, confidence and networking abilities to push my academic learning into actual products. To me knowledge is everything, and from my experience Geomatics is an endless source of discovery which will only grow faster as more ideas are put forward. Staying current with all this information is the hard part, but there's nothing wrong with lifelong learning.

Graduates need to "market" themselves strategically

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I have been a student and instructor in the field of Geomatics/GNSS for over 15 years and I readily admit I am a certified geospatial data junkie! I specialize in Geodesy and GPS; the former having been substantially revolutionized over the last 2 decades by the latter. Consider, for example, that Geodesy is defined as the science of measuring both the shape and the gravity field of the earth. However, because of GPS, determination of the Earth's shape is less difficult than it used to be. Plus, with the increasing numbers of orbiting satellites, gravity field determination is also morphing. The inevitable result? An implicit redefinition of geodesy and the role of the geodesist. This is but one example of an area of Geomatics that is changing the face of the profession at an amazing rate and placing a greater demand upon us as students to stay relevant.

A significant challenge to our students is the fact that Geomatics is not a well-known or mainstream engineering or science discipline. Therefore, the skill of a graduate may not be readily recognized or solicited, requiring that our graduates "market" themselves all the more strategically.

In this regard, presenting both a challenge and an opportunity is the need for geomaticians to function on multi-disciplinary teams. Consider that, electrical engineers have made a significant contribution to the advance of GNSS; and various types of geo-scientists and engineers have also been able to capitalize on the use of GPS technology. However, given the ease with which GPS promotes a "push-button, black box" mentality, the geomatician's expertise could potentially be overlooked.

Be that as it may, I still see Geomatics/GNSS as an extremely practical field which melds seamlessly with other disciplines. Hopefully, therefore, graduates will not be "pigeon-holed" into the traditional surveying and GIS roles but will increasingly be given opportunities to function in less traditional arenas.

Educational institutions should be in tandem with latest technologies

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Having started my academic career in the field of geomatics as an undergraduate in 1998, I have realized that GNSS will continue as one of the most promising space applications that have very high demand for a wide spectrum of positioning and navigation applications. As expected, presently GNSS have increasingly sought as a vital tool for the field of geomatics, surveying and mapping, transpotension and aviation, disaster management and environmental monitoring, etc. With the allied technology developments, however, GNSS have obliged to develop as a safer, more reliable and real-time high accuracy positioning and navigation service for civil use.

Meeting partly the above mentioned challenges, I have devolved a technique to stream real-time differential (DGPS) corrections via internet facilitating to attain positioning with considerable precision for GPS users in Thailand as my research component of the M.Sc degree. Yet, whatever precise augmentation techniques which are available presently have minimum possibilities to eliminate the errors caused by multipath which significantly contribute to the demolishing of positioning and navigation accuracies. A research has thus been formulated and at an advancing stage, towards earning my PhD, exploring possibilities that would enhance the accuracy of C/A code DGPS corrections generated at a GPS base station by mitigating the multipath error in real-time domain.

As a postgraduate student of AIT, I realize that the limitation of advanced instrumentation, lack of experts specialized in the field and very less number of workshops, seminars, conferences and forums through which students can earn new knowledge and improve their research methodologies catering the present technical and commercial needs are critical issues and challenges that need utmost attention for further development of the field of GNSS in the region. Moreover, in developing countries like Sri Lanka the benefits of the development and integrated applications of GNSS are not fully recognized for a variety of reasons; such as security issues, auxiliary equipment, and the un-matching cost of required instrumentation including computer hardware and software economic levels. Conclusively, I firmly believe that with infrastructure development of GNSS at educational institutions should be in tandem with latest and up-to-date technologies in order to ensure prospective carrier opportunities in the field of GNSS in this region of the world.

The problems in the dual-use of GPS and GLONASS remain

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I have been studying GNSS technology for 3 years as a post graduate student. The beginning was to take a seminar at the Laboratory of Satellite Navigation as a preparation for the graduation research, when I was a junior of the under graduate. I just had the knowledge about GPS that it was a tool of the car navigation devices. But I was interested in the mechanism of the GPS positioning. It was the first time to study about GPS as a student of Logistics Department, although there are some lectures on satellite navigation for the students at Maritime Systems Department. Reading the fundamental text in English and presenting what we presented each other at the small member seminar for half a year, we studied the fundamental principle of the positioning and GPS terminology. It was very helpful to understand the mechanism of the satellite positioning deeply to tackle the task to develop a positioning program using the pseudo-range measurements of GPS and GLONASS in the graduation research and also master course research. As the positioning mechanism in GLONASS is different from that of GPS and the papers on GLONASS were few, it takes a long time to solve the problems. But it helps me to deepen the understanding on the satellite positioning. And it will help to solve the problems in the multi-use of the GNSS including Galileo, Compass and QZSS in the near future.

As there remain the problems in the dual-use of GPS and GLONASS, I will continue to study to solve the problems.

In thinking about the educational problem, because the satellite navigation engineering needs the in-depth knowledge of physics, mechanics, electronic engineering and the communication engineering, it is necessary to learn the base of general engineering firmly in the faculty. And besides, studying there the mechanism of the GPS positioning as an applied problem of engineering helps the smoothly advance to the GNSS technical research.

Firms to take up a PhD student for meaningful research are highly rare

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Geoinformatics or Geomatics has been an emerging industry and a field of research in the world at large since the last decade of the previous century. Geoinformatics research and developments have been spurred by the needs of the industry throughout. Modern data acquisition systems have facilitated the procurement of high resolution data and the reduction of the prices in storage devices have economised their storage. Unfortunately, the geomatics industry in India has been primarily catering to the demands of set trends rather than bringing up a new trend or new technology.

The economical but skilled man power produced is liable to large scale exploitation satisfying vested interests of limited groups. Predominant jobs are now available which are based on the migration of data which is not very challenging to bright minds, thus causing an exodus of trained and highly skilled human resource to foreign lands. Firms that would like to take up a PhD student for meaningful research and development are highly rare.

Although the repository of the data is huge, there is a lack of research and/or development in terms of processing algorithms in order to extract information from them. In addition, lack of complete metadata creates hurdles in the path of researchers for development of processing methods. A data providing agency for a country should encourage researchers to work on its data either by inviting internships at their premises or by providing good quality data free of cost to one or many of the research and development organisations in that country.

There seems to be a big competition in the market between those who would prefer to have knowledge of software and those who prefer to procure the basics of geomatics. Some of the organisations in the country cater to the human resource requirement in the field by provision of explicit training on popular software, which may or may not be present in the organisation in which the student would be finally placed in. On the other hand, young people who have strong fundamentals in the field, find themselves handicapped as far as software training is concerned. Further, a rather large number of unskilled graduates are being churned out of newer engineering colleges cropping up every other day, with unspecialized faculty members and practically negligible infrastructure. These students need to be properly trained in Geomatics to make them more employable.

Opportunities for developing new products or services related to geoinformatics technology are abundant. Yet, most of the cities in India do not have high resolution maps, our transport and navigational system is not gaining benefits from GNSS, we are not coming up with indigenous data processing and managing software, there is no significant integration between GPS, Remote Sensing, GIS etc. which implies that there is a vast untapped related application areas required to be explored.

Recognising this imbalance, many geomatics professionals have suggested that education in this domain be taken to the school level. However, this would evidently trigger the redraft of the syllabi of the other basic courses taught in junior schools, as most of the topics in geomatics need the basic knowledge of physics, mathematics and computer science.

Since geomatics is a very powerful tool and is being used in diverse fields of core research like forestry, hydraulics and water resources, agriculture, human settlements analysis etc., and domains of applications such as environmental impact assessment, decision support systems, spatial planning etc., contemporary educational institutes and organisations should consider a redraft of their syllabi in terms of theory as well their applications in these fields.

Ideally one could target the research in an area which requires geospatial inputs and having business potential. The creation of a geospatial consortium where students, knowledge and best practice methods would be exchanged, along with the presence of sufficient funds, access to quality data and infrastructure would help spur research, development and also create a team of trained and upgradeable manpower which would help create services, processing algorithms and also shape products and deliver it to the world market.

As on date, Indian institutions should look forward to participate and collaborate in international fora like the ISPRS, and encourage the students to work on international research projects.

The geoinformatics division, under the aegis of the Department of Civil Engineering at IIT Kanpur, stresses largely on the theoretical understanding of the subject and gives freewill to the student about learning of the software. However, in the post graduate level programmes, working on software is seriously not seen in a very good perspective unless the amount of work done is really huge or there has been a development in terms of data processing and information extraction algorithms. The division is currently looking forward to forge developments and garner relationships in hitherto largely unexplored domains in India like archaeology, sound modelling and immersive visualization.

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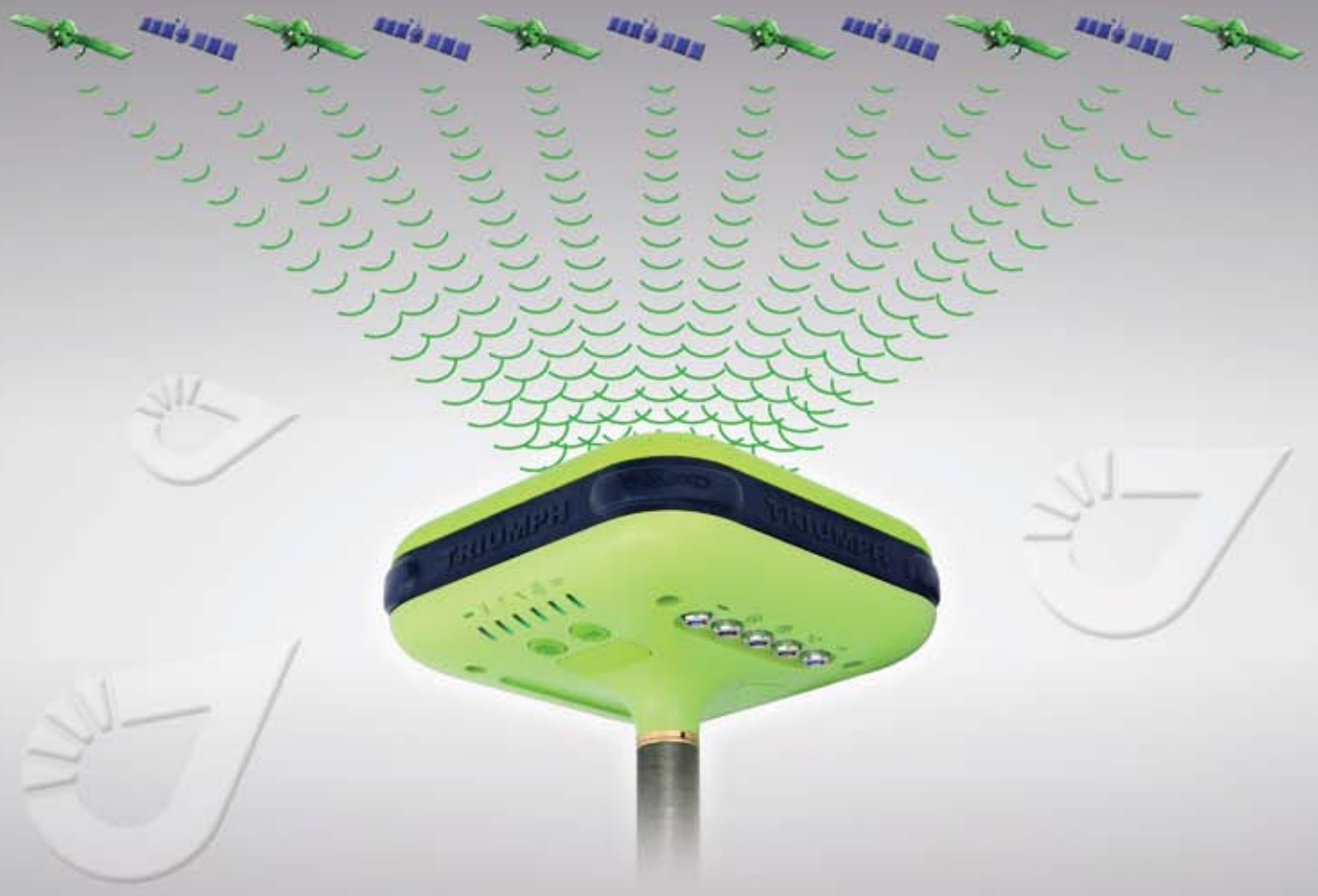

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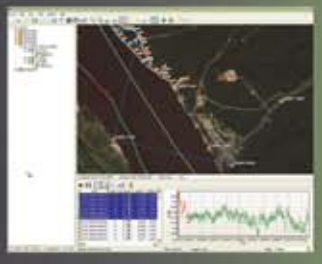

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Front panel connectors:

Power Input + serial port A + USB + Antenna

Back panel connectors:

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

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

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

DELTA

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

Front panel connectors:

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

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

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

Back panel connectors:

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

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

SIGMA

- Internal battery
- Charger
- Modem
- GSM

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

Front panel connectors:

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

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

Back panel connectors:

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

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

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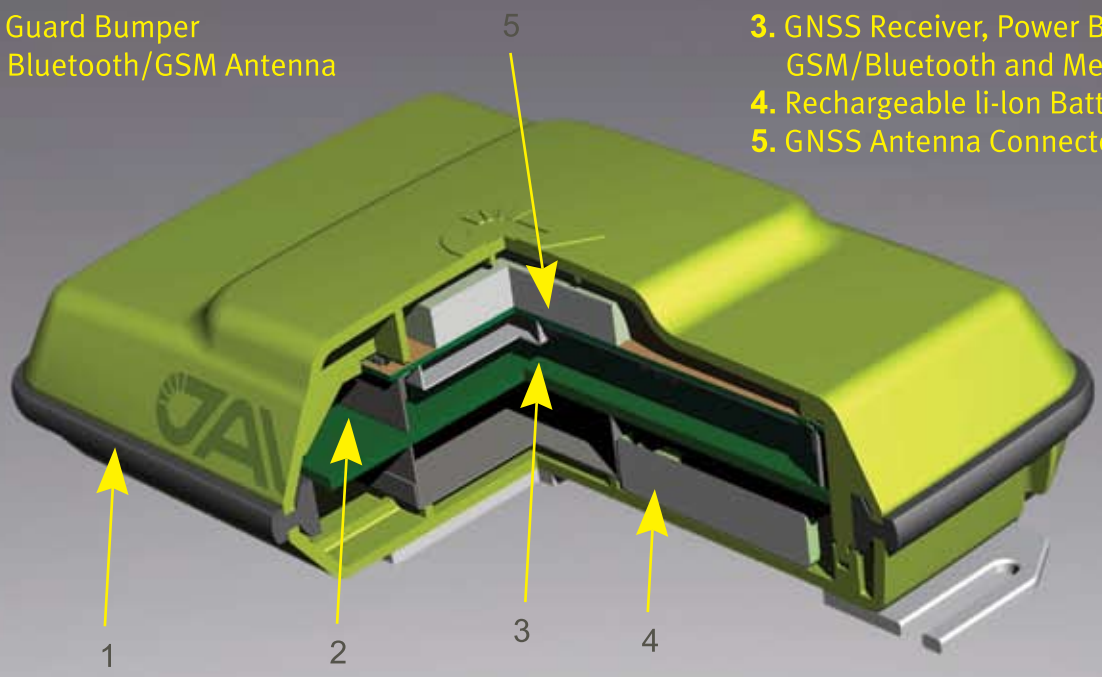

216-channel TRIUMPH

Tracking Specification

Tracking Channels
GPS L1/Galileo E1/GLONASS L1

Signals Tracked
L1 C/A, Code & Carrier

Power Specification

Battery
Internal Li-Ion battery (3.7 V, 1.05 Ah) with internal charger

Operating time	Standby mode
	Call mode
Input Voltage	+4.5 to +6.5 volts

GNSS Antenna Specifications

GNSS Antenna	Internal
Antenna Type	Microstrip (Zero Centered)
Ground Plane	Antenna on a flat ground plane

Radio Specifications

GSM/GPRS Module
Internal GSM/GPRS quad-band module, GPRS Class 10

GSM/GPRS Antenna Internal

I/O

Communication Port
Bluetooth V2.0+EDR Class 2 supporting SPP Slave and Master Profiles

External Power port	1 port
GSM Status Indicator	One LED

Performance Specifications

Static, Fast Static Accuracy
Horizontal: 5 cm + 0.5 ppm * base_line_length
Vertical: 5 cm + 0.5 ppm * base_line_length

Kinematic Accuracy
Horizontal: 5 cm +1 ppm * base_line_length
Vertical: 5 cm +1.5 ppm * base_line_length

RTK(OTF) Accuracy
Horizontal: 5 cm +1 ppm * base_line_length
Vertical: 5 cm + 1.5 ppm * base_line_length

DGPS Accuracy	< 0.25 m Post Processing, < 0.5 m Real Time
Cold Start	<65 seconds
Warm Start	<5 seconds
Reacquisition	<1 second

Memory & Recording

Internal Memory
Up to 256 MB of onboard non-removable memory for data storage

Raw Data Recording
Up to 100 times per second (100 Hz)

Data Type
Code and Carrier from GPS L1/Galileo E1/GLONASS L1

Environmental Specifications

Enclosure	Aluminum extrusion, waterproof
Operating Temperature	-40° C to +55° C
Dimensions	W: 79 mm x H: 33 mm x D: 131 mm
Weight	210 g

TR/TRE Evaluation Kit

The evaluation and development kit for all TR and TRE Javad GNSS OEM boards

Include 4 items:

1. **TR-G3T Cross Adapter**
2. **TRE-Interface Adapter**
3. **Power cable**
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Land record information system

The present study attempts to develop land record based software for storing, analyzing and displaying data about the land

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Sanjeev Saxena
PhD Scholar
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Akanksha Patil
Tata Consultancy Services, Pune

Land Information Management System is defined as the combination of human and technical resources, together with a set of organizing procedures that produces information on land in support of a broad range of managerial requirements. Data are raw collection of facts. Data relating to land may be acquired and held in alphanumeric form (for example books), or graphically (for example, as maps or aerial photographs), or digitally (for example, using electronic methods). To become information, the raw data must be processed so that it can be understood by a decision maker. Land information management system may be designed to serve one primary function or they may be multifunctional for supporting strategic planning. The focus is on determining organizational objectives and on the resources employed to achieve them. Some provide for management control and are concerned with the effective use of resources so as to accomplish an organization's objectives. Others are designed for operational control so that specific tasks can be carried out effectively and efficiently. Each requirement dictates a special set of information criteria and hence a special type of information system.

Computerization of Land Records

Land information has been used in a variety of systems over the years; from register of deed tract indexes to surveyors tie sheets or soil surveys. Today many organizations are moving land information into GIS. Land information is an integral part of government, non-profit, and private sector activities. Adopting GIS/ LIS techniques can advance broader social purposes by making more effective public decisions and by using natural resources in a more optimal way.

Satellite remote sensing is an important tool to generate cadastral map and spatial data about land. GIS supports spatial analysis and modeling procedure for solving complex planning and management problem. Information management system is an integrating technology where resources and activities are brought together to support the decision making process of an organization. By taking the advantage of Remote Sensing and GIS technology Land Record Information Management System for cadastral mapping is developed by integrating digital cadastral map and land record database.

Need of LIS Software

The software integrates the spatial and other kind of information within the single system. It offers a consistent framework for storing, analyzing and displaying land data. By putting cadastral map and other kind of information into the digital form, it allows the user to retrieve the information. Visual Basic is the powerful programming language, which is used to design excellent front-end tool.

Software is primarily concerned with the storage and integration of land data. In such system digital map provide the foundation to build real estate information using land parcels as basic building blocks. This software can be utilized by any organization to store and analyze the land records.

Study Area

Khamkhera village is situated in Goharganj tahsil of Raisen district in Madhya Pradesh. It lies between the latitude 23º03' to 23º 04' north and longitude 77º 30' to 77º 32' east and having boundaries of villages Nayapura Mewati in North, Sarkiya in East,

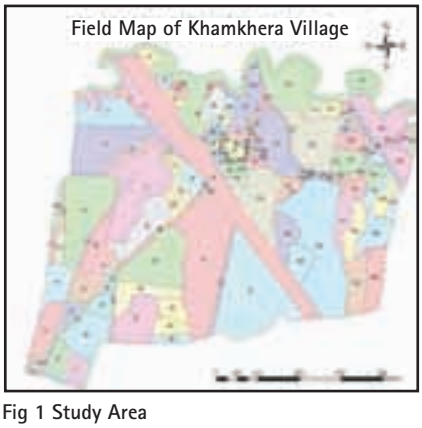

Fig 1 Study Area

Hameeri in west and Ityakala and Simrai in south with the area 200 hectare. Most of the land in the Khamkhera Village is Agricultural Land. Village is in the Malwa Plateau region and drained by the river Betwa and its tributaries.

Data and Software used

Input required for developing software at the village level are topographic sheets (Number 55E/8, 55E/12) covering entire village. Field boundaries have been delineated using merged Image of IRS 1D LISS III Sensor and CARTOSAT 1 Satellite with the spatial resolution 2.5 m. For analyzing land use/ land cover and crop distribution, images of the month Nov-2006 and Feb 2007 were used. Khasra map and Field Measurement Book details were obtained from the village Patwari. Following softwares were used for the development of Land Record Information Management System.

- Erdas Imagine 8.5 - Image Processing, Analysis
- Arc GIS 9.2- Analysis, Database Generation, Map Composition
- Visual Basic 6.0- Design and Development of Interface

Methodology:

The general methodology for the design of LIS was divided into three phases - Database Design, Data Analysis and Application Development.

Phase I – Database Design

Database designing phase starts with the data acquisition which leads to the preparation of maps and integration of the attribute data with map. Khasra map and Satellite Image in the raster format is imported into Erdas Imagine (*.img) software. Khasra map was geo referenced using satellite image by taking 10 GCPs with the Datum Modified Everest and Lambert conformal Conic projection. The digital database of Khamkhera village of Risen district was created after performing the editing operation. Field boundaries are classified as polygon. Attribute data like Khasra Number, Land Holder's Name, Address, Area, Land Revenue, Field Type and Season (Rabi/Kharif) was integrated with the digitized cadastral map.

Phase II- Data Analysis

Analysis is done on the basis of Visual Interpretation and Ground Truth Collection. Land use / Land cover and Crop distribution maps were made.

Land use/ Land Cover distribution:

There were nine classes identified for the land use and land cover distribution with the Built up land i.e. 0.81Ha, 86% land is Agricultural land, (Rabi crop -31%, Kharif Crop - 26%, double crop - 20% and 9% fallow land). National highway passed through the village covers the area (1.30Ha), which is the 1 % of the total land. Area along the Railway track comprises of 14.72 Ha i.e. the 7% of the land and Betwa River holds the area 8.68Ha i.e.4% of the total area. Remaining area of 4.66 Ha comes under the Others Class, which holds 2% of the land which is used for the different purposes.

Crop Distribution:

Crop distribution as shown in the bar chart (Fig .4.2.1),wheat, Chana, and Tivda crops are the most culitivating crops in the rabi season and Soyabean is the major crop in the kharif season. In some of the area Dhan and Maize crops are grown.

Phase III- Application Development

Application development phase proceeded with Interface design and Query Generation. User friendly Interface was design to access and display the land information. With the friendly interface user can query or search the information with spatial and non spatial data. Aim of the design

Fig 2 Merged Image of IRS 1D LISS III 2 Sensor and CARTOSAT I Satellite

Fig 3 Khasra map

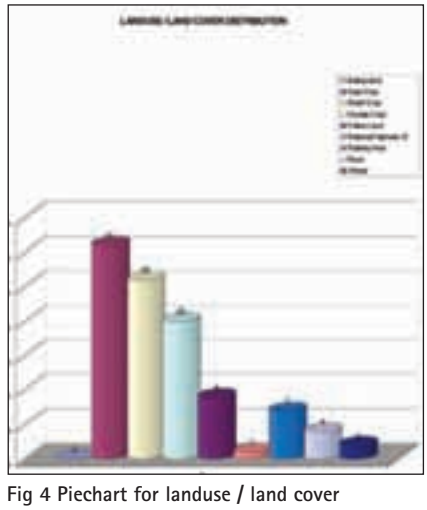
Fig 4 Piechart for landuse / land cover distribution

Fig. 5 Rabi Crop Distribution

is to provide User Friendly Interface, which is independent of GIS software like ArcGIS, Erdas etc with sufficient functionally to Land Information System. For interface design and query generation Visual Basic 6.0 programming language was used and MapwinGIS component was used to display map. Khasra map coverage was converted into shape files because the component only supports.

Functionality of the developed LIS software: According to the functions perform on the various layer functionality of LIS is divided into five main function under the Menu bar. These functions are as follow:

Results

The developed LIS with the functionality of Add layer, Remove layer, Zoom In, Zoom Out, Map view and tabular view etc is sufficient to effectively store, display, manage and analyze land data. Although Remote sensing data and GIS Software were used to prepare maps and database but the LRIMS is designed to run independent of the GIS software which adds the low cost to the software developed. Application was designed for the users who were not specialized in the remote sensing and GIS, little knowledge to operate computer is sufficient to use the designed LIS. As per the requirement of the project more functionality can be added to the application. More tools can be designed for the better functionalities.

The advantages of developed Land Information system were as follows;

- Digital forms of the Field Map provide easy access and analysis procedures.
- User will get benefits from the developed application, which provides effective management of data.

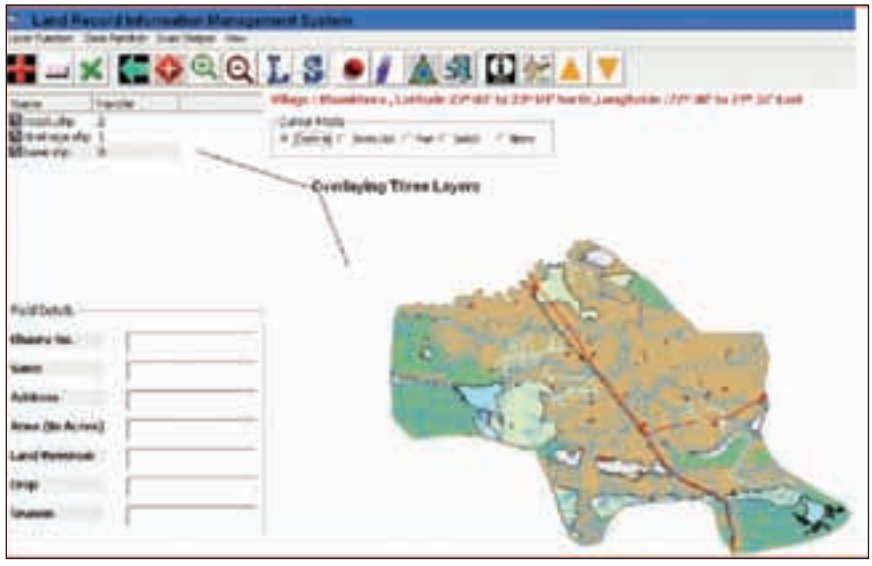

Fig 6 Land Record Information Management System Interface

- By using the developed application, it is easy to analyze all aspects of the land.
- It provides better understanding about the field and surrounding. It will help to reduce land related disputes with the better delineation of boundary and accurate calculations.
- Computerization of Land records and Digitalmaps get a rid off handlingpaper map and bulk of registers.

Commercial Policy matters

Information about land is of great value to government as well as the individuals. Transparency in land information will benefit the public immensely and also greatly reduce litigations and law and order problems. However it is important to lay down definite rules for legitimacy and ownership of information, which may now be more easily available. The following policy issues need to be addressed:-

- Ownership of information.
- Access control of information.
- Pricing of data and cost recovery.
- Copyrights and authority to replicate or distribute data.
- Value addition to data.

Conclusion

Land Information System for Khamkhera Village was design and developed successfully. Application developed with the functionality of Add layer, Remove layer, Zoom In, Zoom Out, Map view and tabular view etc was sufficient to effectively store, display, manage and analyze land data. Although Remote sensing data and GIS Software were used to prepared maps and database but the developed application was design to run independent of the GIS software which adds the low cost to the application. Application was designed for the users who were not specialized in the remote sensing and GIS, little knowledge to operate computer is sufficient to use the application. With the help of developed application user can visualize the ground realities and can better understands the land data. Application is very useful in planning and development of the village.

TABLE : VARIOUS FUNCTIONS OF LIS SYSTEM

	Layer Functions: Layer function is design to provide functionality of adding different layer, remove layers and clear all layers. Under the Layer function Pop up we have following commands.
	Zoom functions: Display the layer with different Zoom levels.
	Drawing Function: To draw shapes like point, line and polygon specific function are defined.
	View: In the View Popup, data can be display in the Map or Tabular form and can be view by moving layer up and down.
	Cursor Mode Function: This function can be used to set the mouse cursor or pointer mode to Zoom In, Zoom Out, Select and None.
	Searching: User can search land information using Khasra number, Landholder's Name, Address, Area, Land Revenue, Crop and Season.

Query Generation

To enquire the information about any land parcel field detail box is design. For querying, user have to select the specific land parcel, information will be display in the Field Detail box. Field details box shows the Khasra Number, Land Holder's Name, Address, Area, Land Revenue, Crop and Season (Rabi/ Kahrif) information related to the selected land parcel:

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GRANADA

Galileo Receiver ANalysis And Design Application

The Reference Galileo Simulation Toolkit

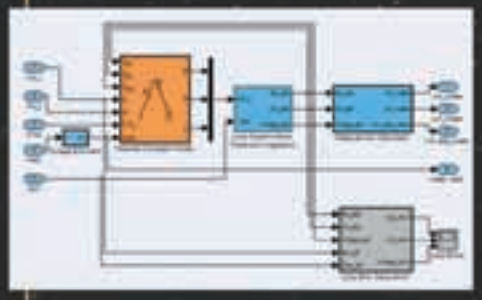
for GNSS Receiver Research and Development

ENVIRONMENT AND NAVIGATION SIMULATOR

- Multisystem navigation analysis (Galileo/GPS)
- Graphical user interface for constellation, environment and receiver configuration
- Raw data and range errors generation

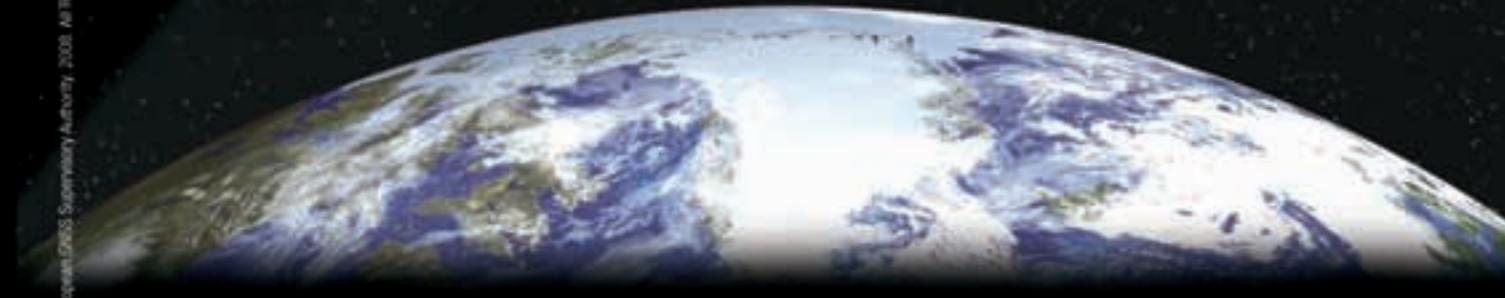
BIT-TRUE GNSS RECEIVER SIMULATOR

- Open MATLAB/Simulink environment for educational, R&D, and testing
- IF sample based signal generation and processing
- Fully configurable receiver architecture
- Up-to-date GPS/Galileo signals including MBOC



FACTORED CORRELATOR MODEL

- MATLAB / Simulink blockset for multichannel receiver simulation
- Intermediate tool for acquisition, tracking and raw data generation
- Swift, flexible and realistic solution based on analytical model of correlators



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GSA

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"With slashed products prices, coming days will see improved web based services"

says Dr V Jayaraman, director, National Remote Sensing Centre, Indian Space Research Organisation, in an exclusive interview with Coordinates

Dr V Jayaraman
Director
NRSC, ISRO

How will conversion of NRSA into NRSC benefit end user of remote sensing products?

With the conversion, NRSC will, as part of the Indian Space Research Organization (ISRO), fully integrate with other ISRO centres in the development and operations of the ground segment of the large constellation of IRS satellites and will also take a bigger role during the R&D phase of the IRS programme. NRSC will play the lead role in important national programmes, through easy linkages with all concerned government departments/ agencies such as Ministries of Agriculture, water resources, environment and forests, rural and urban development, home affairs, etc., including the National Disaster Management Authority (NDMA).

NRSC shall develop newer products and services and deliver them in rear real time in a much more cost effective manner for addressing societal needs (water, food, energy, and environment), national imperatives, diaster management, global climate change and international cooperation in these arenas. Already the products prices have been slashed by 30 to 50% in all categories, and the coming days will see improved web based services.

Will NRSC now be able to play a more proactive role in the kind of satellites that are developed in the future with reference to the Remote Sensing Satellites?

NRSC has always adopted a two pronged approach; It provided specific inputs to missions on sensor in-orbit performance and it enables ISRO to continuously improve the sensors and the data processing algorithms as well. Further it has always been proactive through various application projects under NNRMS and has been interacting with user agencies to get periodic feedback on sensor requirements. In fact, NRSC's inputs for future Indian EO programmes has always been well appreciated and relied upon while defining the Indian remote sensing satellites. These activities will become better synergised and integrated in an ISRO environment than as an autonomous organisation. Horizontal movement of personnel across ISRO centres from and to NRSC is another impetus.

Given the critical need for trained manpower in this sector, under NRSC, will we see more training institutes coming up in the country?

Emerging opportunities within the Remote Sensing and associated technologies/ techniques such as GIS, GPS & advances in image processing require developing competency models for newer geospatial applications for developing the necessary pipeline of skilled scientific manpower. NRSC is in the process of reassessing the future capacity building needs. At the moment we have training programmes offered at NRSC main campus & at IIRS, UN CSSTE-AP as well as IIST at various levels and on multitude of topics. Current topics like Hyper-spectral, LiDAR, satellite photogrammetry, microwave data processing, climate studies and modelling, GIS visualization etc will be further emphasised. Through strategic partnership and associations, many universities/organisations have Centre's of excellence for teaching and research in this field offering various courses at both undergraduate and post-graduate level and also short-term training modules for the working scientists. Considering the ubiquitous use of this technology, many private firms too are offering training in GIS technology today.

Research through the RESPOND project will get necessary boost too involving academia.

Could you please elaborate on the 'Bhoosampada' programme?

Mapping of Land use / land cover (LULC) on 1:25,000 scale has been envisaged under the NNRMS initiated Natural Resources Census (NRC) project using multi-temporal Resourcesat-1 AWiFS data on annual basis from 2004-05 to 2007-08. The major objective of this project was to make a rapid assessment of the national LULC with an emphasis on the net sown area for different cropping seasons. Boosampada is a web-based information portal for disseminating this Land use and Land Cover data, and to derive information on intra-annual variation. It also provides information on seasonal water spread and snow cover. Boosampada provides a multi-user cross platform environment to access, query and analyse geo-spatial data in a simple web browser environment. We are also in the process of completing the 1:50K LULC mapping which is planned for updation every 4-5 years. Eventually, all these efforts are becoming part of the National Resources Repository (NRR) and are expected to be made available to the community through NNRMS portal.

Will public-private collaboration be possible between NRSC and

private organisations?

We are aware that with the advent of high resolution satellite data being available and many infrastructure projects being implemented, many private industries are involved in geospatial projects. As per the Remote Sensing Data Policy (RSDP), NRSC is the single window delivery system for disseminating all types of satellite data and we have already been working in association with many private organisations in public-private collaboration mode as partner institutes for executing our user projects in different forms i.e. from data collection, digitization, and attribution to map production. However, depending on the sensitivity of the data, various possibilities are being explored including the arrangement of wet leasing facility in our campus.

How do you see the present remote sensing data market in India?

Remote sensing data market in India is very encouraging, with the use in public good services providing many opportunities for both industry and academia to work together with ISRO. India has major challenge on her hand in the coming years to cope up with issues such as food security & poverty alleviation, natural resources assets building, infrastructure building (both physical and social) weather & climate monitoring, and disaster management. All these need remote sensing and GIS inputs. We have already planned a series of thematic services of satellites for land and water resources management, weather & climate; and cartographic studies. So the coming days will see NRSC along with other ISRO centres taking up increased responsibilities in all these areas encompassing cartography to climate studies with enhanced emphasis on knowledge products services with quantitative remote sensing inputs. We do expect enhanced introduction of ICT products with multimedia application in the coming days with a host of remote sensing satellites providing multitude of inputs across the spectrum, and NRSC will be there in the forefront of these activities.

ICG-3 reflects GNSS's competing interests, cooperative objectives

Associate members representing key GNSS user communities – including the US, Russia, European Union, China, India, and Japan – met at the 3rd meeting of the International Committee on GNSS (ICG-3), a voluntary UN backed association that brings together GNSS and augmentation providers. An appeal for collaborative efforts that would move beyond interoperability to "interchangeability" was made.

This concept, which allows use of "any four [GNSS satellites] anytime," requires a closer alignment of GNSS system time and coordinate reference systems than currently proposed. *www.geolinks.org/icg3/*

Russia launches three new navigation satellites

A Russian Proton-M rocket was launched into space with three new satellites for Moscow's GLONASS navigation system. The 1.4-tonne satellites join 17 others that are part of the GLONASS system. *www.google.com*

Kontron and LynuxWorks release Intel COTS Safety Critical Platform

Kontron and Lynux Works have released an Intel based COTS platform for safety critical, deterministic real-time embedded applications, using the Kontron PENTXM2 single board computer running the LynxOS-178B RTOS. *www.kontron.com.*

RAM guarantees prevention of theft and retrieval of valuable asset

Remote Asset Management (RAM) has come with a GPS vehicle tracking system for the complete safety and security of various individuals and organizations. The device is integrated with 3 essential components, - GPS device, a data transmission system, and a software application. *www.remoteassetmanagement.co.uk*

JAXA joins UNESCO World Heritage Initiative

The Japan Aerospace Exploration Agency (JAXA) has joined a partnership with UNESCO, under which it will mobilise the Advanced Land Observing Satellite (ALOS) for the study and safeguarding of World Heritage sites. UNESCO member states, mainly in Asia, can now access JAXA technology for activities conducted as part of the Open Initiative on the Use of Space Technologies for World Heritage Sites. www.unesco.org

China launches Yaogan-4 satellite

China has launched the Yaogan-4 satellite, the 113th launch of China's Long March series of rockets. It would be used for scientific research, land resources surveying, crop yield estimate and disaster prevention and relief. *Xinhuanet.com*

Vietnam's New Space Technology Centre

Japanese expertise will help the Vietnamese build a US $350 million space technology research and development centre at the Hoa Lac Hi-tech Park in Hanoi to begin in 2010. When completed in 2017, the park will have four zones: research and development, hi-tech industry, software, and education and training. Vietnam also plans to launch its first remote sensing satellite, named VNREDSAT-1, by 2012. The country is now carrying out its satellite-launching project, worth about 100 million U.S. dollars. *www.jetro.go.jp*

Worldwide Governments spend 62 billion dollars on Space Programs

Euroconsult has announced that world government space program expenditures are at a historical high of more than $62 billion dollars in 2008, with planned satellite launches in the next ten years to increase 38% over the previous decade. According to Euroconsult's new report "Government Space Markets, World Prospects to 2017", governments

have clearly entered a new phase of investment, committing to the development of a new generation of programs worldwide. Furthermore, government space program expenditures worldwide are expected to grow at 4.5% per year through 2012, reaching nearly $70 billion. Emerging space programs - both large and small - are bringing new energy to space science, which will drive growth in the number of scientific satellites launched over the next decade (105 satellites planned for launch over 2008-2017 compared to 84 the last decade). *www.euroconsult-ec.com*

ISRO to build smaller, cheaper launcher

The Indian Space Research Organisation is building a smaller launcher, designed to put remote-sensing satellites weighing less than 500 kg into low earth orbits. It will cost 40% less than existing rockets. It currently costs Rs1 billion to launch a satellite on a Polar Satellite Launch Vehicle (PSLV), which is deployed for the bulk of Indian projects. *www.isro.org*

North Andover company gets $8 million for Afghanistan mapping

Last year, the U.S. Army awarded Flight Landata an $8 million contract to fly 800 hours of combat missions, mapping the terrain and taking high-resolution images of villages and cave complexes high in the mountainous borders along Pakistan. The military is renewing the company's contract for another $8 million to fly more missions over the next year or so. *www.flightlandata.com*

DMCii launches free Satellite Imaging Initiative

DMCii shall provide free DMC constellation satellite imagery for scientists to support global environmental monitoring projects. Scientists are invited to compete for the opportunity to use the DMC multispectral data in their research projects. *www.dmcii.com*

National Geo Data Regulatory Authority Bill

The 8th National Spatial Data Infrastructure (NSDI) meet was held at New Delhi during 22-23 Dec 2008. The meeting was organised by Ministry of Science and Technology in association with FICCI. The meeting was inaugurated by Union Minister for Science and Technology and Earth Sciences, Mr Kapil Sibal. In his address, Mr Sibal told the gathering the government was preparing a legislation on sharing of geospatial data amongst different agencies – public and private. A bill in this regard, National Geospatial Data Regulatory Authority Bill, is to be introduced in the next session of Parliament and is likely to be cleared by the Cabinet by February 2009.

The inaugural session was also addressed by Dr K Kasturirangan, Member of Parliament and Dr T Ramasamy, Secretary, Department of Science and Technology. During the meet, the Indian Geo-portal was also launched.

Ordnance Survey takes on Google

Ordnance Survey, UK marking out its copyright territory to keep its data out of the hands of Google. In a document titled Use of Google Maps For Display and Promotion Purposes and circulated to local government, OS prohibits the use of any OS-derived data for display on Google Maps. It states that OS data or data derived from OS data can only be supplied to a third party in 'limited circumstances' - which do not include display on Google Maps. *www.ordnancesurvey.co.uk*

Digital land records to aid UP farmers

In an effort to prevent land disputes among farmers and to benefit them through welfare schemes, the Uttar Pradesh government, India has roped in the services of Remote Sensing Application Centre (RSAC) to prepare land maps and digitise records with the help of GIS. The centre would prepare satellite images of a particular area with the help of GIS technique and compare it with the existing land records. With the help of overlay method the exact geographical situation and land use will be known. *www.timesofindia.com*

The SGTAT Award of Excellence for Professor G.S. Roonwal

The SGTAT Award of Excellence – 2008 was conferred on Professor G.S. Roonwal on 13 December, 2008 in Bhubneswar. Professor Roonwal, formally professor in Geology, University of Delhi, and currently visiting professor, Inter University Accelerator Centre, New Delhi in recognition of his academic achievements and scientific contributions in the field of geosciences, mineral exploration, geochemistry and environmental studies.

3D Laser Mapping wins order for StreetMapper 360

Geomaat, has placed an order for the mobile laser mapping system, StreetMapper 360. It employs the laser scanning technology for improved field performance and accuracy, precision navigation including a solution for reduced GPS coverage in urban areas, combined with a flexible, modular configuration and increased ease of use and deployment. *www.3dlasermapping.com*

ERDAS TITAN 2009 now supports OpenStreetMap

ERDAS announced that OpenStreetMap has been added to ERDAS TITAN 2009 as the default basemap in the TITAN Viewer. OpenStreetMap is a free, editable map of the world. *www.erdas.com/titan*

AtlasCT Releases Version 3.2 of AtlasWeb™ SDK

AtlasCT, has released AtlasWeb™ SDK 3.2, an advanced package for Internet-based maps and GIS applications development. It is a JavaScript based set of functions which enables mapping capabilities for web applications. *www.atlasct.com.*

With a tradition of innovation, NavCom continues to leave its footprint on the evolving GNSS industry. Propelled by our award-winning engineering team, our industry leading technology includes the StarFire™ network – the world's first global satellite-based augmentation system (GSBAS) – RTK Extend™ and Ultra RTK™. This unique expertise along with NavCom's precise positioning products allows our partners to create innovative GNSS solutions.

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First indoors GPS application for Nokia Phones

Tagggit has launched their mobile application for Nokia S60 phones with an accurate Indoors GPS. It can find a phone's position indoors, within a few seconds and accurate to 15 feet. *www.tagggit.com*

Genasys and CellTrack to provide LBS platform in Pakistan

Genasys and CellTrack for shall launch an LBS project in Pakistan from the first quarter of 2009. CellTrack has signed agreements with two operators, Ufone and Zong, to launch LBS in this country. *www.genasys.com*

Vodafone to acquire Wayfinder for $29.4m

Vodafone announced a takeover bid on Wayfinder System for $29.4 million. The board of directors of Wayfinder Systems AB unanimously recommended the public offer from Vodafone Europe. *www.wayfinder.com*

Theft of car navigation systems rising rapidly: NPA, Japan

According to National Police Agency in Japan, growing demand has seen thefts of car navigation systems increase rapidly in recent months. In the January-June period alone, there were 18,705 such cases. *www.npa.go.jp/english*

Polaris Wireless for Intercept Applications with Accurate Location

Polaris Wireless announced the deployment of lawful intercept location solution that allows Law Enforcement Agencies (LEA) to pinpoint the precise location of handsets for Lawful Intercept (LI) measures. The solution is based on the company's Wireless Location Signatures (Polaris WLSTM™) technology. *www.polariswireless.com*

TeleNav launches Vehicle Tracker with AT&T and GPS PND

AT&T Inc. has added TeleNav Vehicle Tracker to its portfolio of enterprise mobility services. It is a GPS-enabled device that is hard-wired or embedded onto a vehicle. It has also unveiled TeleNav Shotgun, two-way, Internet-connected GPS PND which leverages the wireless network to provide real-time, connected features for business travelers *www.telenav.com*

Nokia shop in India attacked by mob over mapping software dispute

The Nokia mapping software which shows Indian claimed Kashmir as being part of Pakistan, lead to a shop being attacked in central Jabalpur city in Madhya Pradesh state in India. The attack was lead by activists of the youth wing of the Hindu nationalist opposition party, the BJP. Political sensitivities are an increasing problem for map making software vendors - such as how to deal with disputed borders or even national claims on areas such as Taiwan or Cyprus. Back in 2001, Panasonic had a 12 month ban import imposed on it for selling phones in China which listed Taiwan as a separate country on the internal phonebook. *www.reuters.com*

Sygic and Tele Atlas team up to power McGuider 2009

Sygic and Tele Atlas, have launched McGuider® Europe 2009, the next generation of the software that turns users' mobile devices into powerful navigation systems. *www.mcguider.com.*

VTI Technologies: Accurate navigation now possible without GPS

VTI Technologies has announced an MEMS-based pedestrian navigation solution demonstrator. It is a small wearable device and relies solely on the information provided from the sensors within the device. It is ideal for navigating in areas when there is no GPS reception. *www.vti.fi*

3DVU releases enhanced version of Navi2Go software

3DVU has released new version of Navi2Go, its voice guided turn-by-turn mobile navigation application, which supports Symbian S60-based devices.*www.3dvu.com*

SLN Technologies to market vehicle tracking device in India

India's SLN Technologies has signed a deal with FleetM8, UK for marketing of vehicle tracking device in the Indian subcontinent, which can either be used via a mobile phone. *www.slntechnologies.com*

NIM integrates INRIX Total Fusion Traffic into Mobile Navigation

Networks In Motion (NIM) will use Total Fusion Traffic data from INRIX to enhance its AtlasBook Navigator™ application for mobile devices, empowering the AtlasBook user with the most accurate ETAs, optimal route recommendations and timely traffic alerts available on the market. *www.networksinmotion.com*

Microsoft Research, India develops Map Search for unstructured data

Microsoft Research India has developed technology allowing users to search maps in India where the addresses are often not in a structured format. Its called Robust Location Search.The technology is generic and has been designed to be deployed in any country that has unstructured addresses.*http://research.microsoft.com/en-us/labs/india/*

Microsoft to launch NAVTEQ navigator in India

NAVTEQ has been chosen by Microsoft to supply map data for Microsoft's Live Search Map in India. Features include Business Lookup, Category browsing, 1-Click Directions etc. *www.navteq.com*

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No to Chinese companies

The government of India will not allow Chinese firms to invest in security services, especially in the GPS-based products and operations. While rejecting a foreign direct investment (FDI) proposal of Chinese firms Jiansu Tianze and Wuxi Frank GMKP Energy Control Ltd, the ministry of home affairs said Chinese companies could track developments at locations and sensitive consignments and individuals under the garb of the joint venture. Mumbai-based Geld Consultancy Services, a company engaged in manufacture of GPS hardware and software had sought Foreign Investment Promotion Board's (FIPB) approval for setting up a joint venture in the same line of business with Chinese companies Jiansu Tianze and Wuxi Frank GMKP Energy Control.

The Chinese companies had sought FIPB nod to jointly hold 60% stake in the JV company. Though, the department of industrial policy and promotion (Dipp) and the department of telecom (DoT) had supported the proposal, the board had rejected it after home ministry's objection on the ground that allowing a Chinese company in manufacturing of GPS systems could be harmful to the country's internal security.

"Companies from some countries would be barred from investing in GPS-based systems and operations in India. However, investments from benign countries would also be subject to FIPB nod," said an official close to development who did not wish to be identified. The FDI policy is silent on allowing FDI in manufacture of GPS-enabled systems, even though there is 100% FDI in manufacture of telecom equipment in India. *http://economictimes.indiatimes.com*

Galileo update

Update from the International System Providers Meeting (ICG-3)

At the third meeting of the International Committee on GNSS (ICG-3), a voluntary United Nations–backed association that brings together GNSS and augmentation providers, Paul Verhoef, head of the Galileo unit for the European Commission Directorate-General for Transport and Energy, said that the EU expects to have contracts for building the Galileo FOC system in place by next summer. He noted that the target date for completion is 2013 had been given to prospective vendors in the Galileo invitations to tender (ITTs).

The European GNSS Supervisory Agency (GSA), which had been charged with overseeing development and operation of Galileo under the abandoned public-private partnership, will be given a different name next year to reflect its altered responsibilities under the public procurement now led by the EC and the European Space Agency. *www.geolinks.org/icg3/*

European Space Agency names Günter Hein to Galileo post

The European Space Agency (ESA) has appointed Prof. Dr. Günter Hein to serve as Head of Galileo Operations and Evolution with duties in Noordwijk, Netherlands, and Paris, France. With an initial four-year term beginning December 1, Hein will share responsibility for the evolution of the Galileo system, the relation and interoperability of Galileo and EGNOS to other GNSSs, preparation of the future operational phase of the Galileo infrastructure, implementation the related "technology actions," and associated activities. *http://www.esa.int*

GALILEO and EGNOS call for proposals published

The European Global Navigation Satellite System (GNSS) Supervisory Authority has issued a call for proposals under the Cooperation programme of the Seventh Framework Programme (FP7). Successful proposers are expected to provide support to the European Global Navigation Satellite System (GALILEO) and the European Geostationary Navigation Overlay Service (EGNOS). Topics called include a variety of activities and areas such as 'Exploiting the full potential', 'Providing the tools and creating the appropriate environment', 'Adapting receivers to requirements and upgrading core technologies' etc. *http://cordis.europa.eu/fp7/calls/*

Track Galileo signals at GIOVE website

The GIOVE website provides up-to-date information on the Galileo satellites GIOVE-A and GIOVE-B. The site includes the Signal-In-Space Interface Control Document (SIS-ICD) recently released to the public following successful in-orbit testing of GIOVE-B, to allow users to acquire and track both satellites ranging signals and to demodulate their navigation message. An effort has been made to update day by day the signal transmission page that provides up-to-date information on the current status of the GIOVE Satellites. The GIOVE Processing Centre located at ESA ESTEC in Noordwijk, the Netherlands, plans to deliver to users NAGUs (Notice Advisory to GIOVE Users), notifying of outages at the spacecraft level or ground stations/centers. *www.giove.esa.int*

www.southinstrument.com
www.southsurvey.com

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SOUTH

Scanning the Heritage

In a unique project aimed at preserving the country's rich heritage, the 16th century Humayun's Tomb in New Delhi, India will become the first monument in the country to be measured to sub centimeter accuracy. Each stone will be measured using a high-density laser scan, colour images and 3D visualisation. Leica Geosystems High-Definition Survey (HDS) technology will assist archaeologists and conservationists in getting near accurate data and records of the entire Humayun's Tomb complex within weeks. The technology developed by Leica Geosystems has been widely used at heritage sites across the globe, including the Blue Mosque in Turkey and Leaning Tower of Pisa in Italy. This project is being undertaken by the Aga Khan Trust for Culture as part of the ongoing partnership project with Archaeological Survey of India (ASI).

The process of HDS requires a 3D high definition laser scanner which scans the entire monument. While scanning depends on the size of the structure and takes only a few days' time, documenting all the details can take a few weeks with 99% accuracy. This is a significant leap from the traditional method of using a measuring tape and other such tools which takes several months. According to officials, this technology will give the ASI an opportunity to document the 5,000 monuments in its charge in a short span of five to six years.

Following are the excerpts of the interview conducted with Mr. Faheem Khan, Regional Segment Manager, GIS and Scanning, ISAK Region, Leica Geosystem about the HDS technology.

1. What are key the points about the procedure for scanning and documentation that will be used on the Humayun's Tomb?

Leica Geosystems' (HDS) High-Definition Surveying technology presents a quantum leap in technology offering users the ability to document sites and facilities, from crime scenes to oil platforms, in speeds, accuracy and quality that is not possible using traditional methods. This technology will allow site managers at Humayun's Tomb to use the automatic data collection capabilities offered by the ScanStation and capture complete and accurate data in minutes and stream the results over the internet using the free and easy-to-use Leica TruView web-publishing solution.

2. How does ScanStation manage to give such high accuracies?

As indicated in various independent studies carried out around the world the Leica ScanStation features some of the lowest data noise levels and ultra-fine laser spot size in the industry. This coupled with our heritage in optics and distance measurement technology and manufacturing quality allow our customers to enjoy unprecedented quality and accuracies in measurement results.

3. What all other kind of application can a Scan Station is useful for?

The ScanStation is actively used by the Forensic community for anti-terrorist and forensic mapping activities. In addition, various engineering users deploy ScanStation to carry out accurate plant as-builts to support the design, installation, operations and documentation process. Mining users are also taking full advantage of the speed and completeness in which the data is captured to calculate accurate volumes, monitoring excavation and support in engineering efforts. Higher education community are today educating students across the departments - Civil Engineering, Geomatics, Geography etc. to train them in HDS technology. One last example comes from the Survey fraternity where traditional topographic/civil survey is completed faster, cheaper and safer than traditional methods.

Leica's latest GNSS technology

A four constellation GNSS will soon become reality, and will deliver a new dimension in GNSS performance and efficiency. The Leica GPS1200+ supports the new GPS L5 signal, GLONASS L1 and L2, and will also be able to track Galileo and Compass satellites when available. The design of Leica GPS1200+ is now already compatible with the 4 GNSS. *www.leica-geosystems.com*

Fugro introduces high performance Satellite Navigation Service

Fugro introduced, G2. It combines the navigation satellites of both the American GPS constellation and the Russian GLONASS constellation, to produce a composite GPS/GLONASS position solution. The service utilises Fugro's own network of dual system reference stations to calculate 'orbit and clock' errors on a satellite by satellite basis for all 50 satellites of the two GNSS. *www.fugro.nl*

Intuicom releases RTK Bridge-C

Intuicom®, Inc., has released the RTK Bridge-C™, which provides a crucial communications hub in precision GPS applications. Now, Network corrections are available to any GPS that previously relied upon a base station and a radio. *www.intuicom.com.*

On-board OmniSTAR XP corrections for its POS AV products by Applanix

Applanix announced that its POS™ AV products now support on-board OmniSTAR XP™ real-time differential GPS corrections using a purpose-built GNSS+L Band aircraft antenna and an embedded BD960 GNSS receiver. *www.applanix.com.*

GMS-2 Pro by Topcon

Topcon has released GMS-2 Pro, the handheld GIS mapping solution with integrated auto-focus digital camera and

laser distance meter. The laser distance meter that can be used in conjunction with the internal compass for offset measurements. The combination of distance measurement and image capture technology eliminates manual measurements *www.topconpositioning.com*

Magellan announces new PC software

Magellan announced a PC software called Real Time Data Server that offers land surveying companies the opportunity of using GNSS equipment to build their own direct IP RTK corrections server. It will collect corrections sent by a GNSS base station and act as a gateway to make correction data available to any rover that connects to the software. *http://pro.magellangps.com*

Cohga targets Asian software market

Cohga, an Australian development company is looking for partners in Asia to help market its product Weave, which is essentially a software development kit wrapped in a spatial display. www.cohga.com

BAE Systems releases SOCET GXP v3.0

BAE Systems has released SOCET GXP v3.0, which provides upgrades that allow users to reduce dependency on multiple tools to record and analyze ground features. It combines image analysis and geospatial production tools into a single application. *www.baesystems.com*

600m range Laser Digital Theodolite

Sokkia Topcon released the LDT520, a 5" digital theodolite equipped with a telescope with laser beam emission capability. The LDT520 boasts the world's longest laser range, class-topping dust and water protection, and a continuous operation time over 2.5 times that of its predecessor. *www.sokkiatopcon.com*

Trimble acquires KOREC

Trimble has acquired the FastMap and GeoSite software assets from KOREC. It includes software development, professional services and business development teams, will allow Trimble to expand its Mapping and GIS solutions to provide optimized software and professional services in Europe, Africa, and the Middle East. *www.trimble.com*

Autodesk completes acquisition of iLogic Technology

The acquisition supports Autodesk's commitment to providing a comprehensive solution to manufacturers of all sizes, giving them the ability to design, visualize and simulate their products before they are built, reducing the reliance on constructing multiple physical prototypes. The iLogic technology will strengthen the Autodesk solution for Digital Prototyping. *www.autodesk.com.*

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conference@rin.org.uk
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Trimble Dimension 2009
23-25, February
The Mirage, Las Vegas, USA
http://www.trimbleevents.com/dimensions09

March 2009

Munich Satellite Navigation SummitConference
March 3-5,
Munich, Germany
www.munich-satellite-navigation-summit.org

GEOFORM+'2009
10-13 March
Moscow, Russia
www.geoexpo.ru

iGEOMAP 2009
March 20-21,IISc, Bangalore, India
www.igeomap.org

April 2009

GEO Siberia 2009
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Saint Petersburg, Russia
www.elektropribor.spb.ru

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11-14 May
Charlotte, NC, USA
www.bentley.com

2nd International Conference on Earth Observation for Global Changes (EOGC2009)
25-29 May 2009
Chengdu, China
http://www.eogc2009.com.cn/

June 2009

GSDI 11 World Conference
15-19 June
Rotterdam, The Netherlands
http://gsdi.org/gsdi11/

TRANS-NAV 2009
8th International Navigational Symposium
June 17-19
Gdynia, Poland
http://transnav.am.gdynia.pl

August 2009

SEASC 2009,
4-7 August
Bali, Indonesia
www.bakosurtanal.go.id/seasc2009/04/

September 2009

ISDE 2009
9-12 September
Beijing, China
www.digitalearth-isde.org

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