RNI: DELENG/2005/15153
Publication: 15th of every month
Posting: 19th/20th of every month at NDPSO

No: DL(E)-01/5079/05-07
Licensed to post without pre-payment U(E) 28/2006-07
Rs.100

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Coordinates

Volume III, Issue 9, September 2007

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

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Bal Krishna, Editor
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This issue has been made possible by the support and good wishes of the following individuals and companies Adam Weintrit, Chaojian Shi, D R Fraser Taylor, F Michael Swiek, Dr Guenter Heinrichs, Jim Doherty, Jin Ding, Jon Westbrook, Brig M C Dhamija (Retd), Melanie Vritschan, Miguel Romay Merino, Rajneesh Gupta, Ronald R Hatch, Umberto Guida, Vivek Bansal, and; Autodesk, Digital Globe, GeoEye, GMV, Hemisphere GPS, HP, Kolida, Leica, Magellan, Navcom, Novatel, Spirent, South; and many others

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[advertising] sam@mycoordinates.org
[subscriptions] iwant@mycoordinates.org

Web www.mycoordinates.org

Annual subscription (12 issues) [India] Rs.1,200
[Overseas] US$80

Printed and published by Sanjay Malaviya on behalf of Centre for Geoinformation Technologies at A221 Mangal Apartments, Vasundhara Enclave, Delhi 110096, India.

Editor Bal Krishna

Owner Centre for Geoinformation Technologies

Designer TSA Effects, www.tsa.in

Printer Sonu Printer, B 82, Okhla Phase I, New Delhi, India.

This issue of Coordinates is of 40 pages, including cover.

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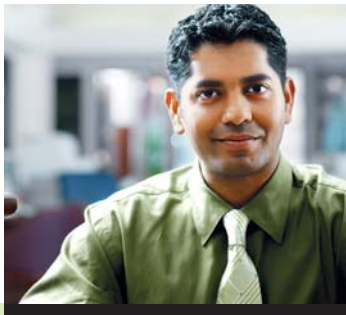

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Will GALILEO happen?

Eurobarometer opinion survey says that Europeans are extremely positive about the GALILEO programe. We sought the opinion of experts and fingers are firmly crossed.

ACCORDING to a recent Eurobarometer opinion survey, Europeans are highly positive about the GALILEO program, which aims to develop Europe's own satellite-based navigation system. The survey indicates that most of EU citizens are aware of the role global positioning systems play in their everyday lives, know about possible applications and are firmly behind the development of such new technologies. Furthermore, an overwhelming majority consider that Europe should set up an independent navigation system even if this involves securing additional public funds.

"Europeans recognise that GALILEO could have a big impact on their life in the future and they expect greater effort at European level to develop this technology", said European commission Vice-President, Jacques Barrot, in charge of Transport. "Therefore, we will continue the work with Member States and industry to complete this major European innovation project and get the most out of our investments."

The Eurobarometer survey questioned around 26 000 citizens all over the European Union on a range of issues linked to GALILEO, and satellite positioning systems in general. The survey has revealed valuable information about EU citizen's knowledge, attitudes and perceptions related to this new technology. The responses clearly show that most Europeans are highly positive about this major European project. The principal conclusions are as follows:

The survey indicates that the majority of Europeans (68%) are familiar with the concept of satellite-based navigation – with 20% currently using such a system and 15% planning to use one in the future. An overwhelming majority – 80% of respondents – consider that the European Union should set up its own independent system, while only 12% think that there is no need for such a development. 40% have already heard about the European GALILEO project. This ratio reaches 60% in Germany and Luxembourg.

In each Member State, the majority of respondents support the idea of having the EU secure the missing funds. Overall, 63% of respondents consider that the EU should secure the necessary funds to complete the GALILEO project as soon as possible and only 23% are opposed to increase investments. A slight majority also agrees that the abandonment or significant delay of the GALILEO project would harm the image of the European Union (44% consider it harmful while 41% not).

Last but not least, the survey reveals that 71% of European citizens "rather agree" that the EU launches globally important technology projects, even if they require high investments, and only 18% "rather disagree" with EU involvement in such resource-intensive projects.

The full Eurobarometer report is available at: http://ec.europa.eu/dgs/energy_transport/galileo/index_en.htm.

Galileo will happen

Dr Guenter Heinrichs
Director Business Development, IFEN GmbH, Germany

A clear YES, from IFEN's point of view. The reason for this answer is that Galileo is the largest industrial project ever organised on a European scale and the first infrastructure owned by the EU. Thus, as the first truly European infrastructure project, Galileo has become a lighthouse project in Europe. This means that Europe cannot stop the project in the present stage any more without suffering from a great loss of face and taking politically big damage worldwide. From the industry political point of view, we still believe that Galileo will bring an added value to the user community. Nobody denies today that navigation and its obliged applications will be an integral component of our everyday life in future. The introduction of Galileo as another GNSS has already led to new product developments, which will lead to many new market opportunities also for Small and Medium Enterprises like our company IFEN GmbH. We, however, see a certain uncertainty at the equipment manufacturers and also with the users due to the recent delays in Galileo lately again.

Despite all difficulties in the recent past, at its June 8 meeting the Transport Council of the EU reaffirms the value of Galileo as a key project of the European Union. The council's backing for Galileo was buttressed by a survey asking 25,664 EU citizens about their opinion of satellite navigation, Galileo, and public funding of a European GNSS. Some 80 percent of respondents endorsed a European system and 63 percent were in favour of it being publicly funded. In our opinion, this is a clear sign also from the EU citizens for an independent European GNSS. Can be held tight summarizing, that Galileo goes on. At the end of the day, Galileo will happen.

Time to inject realism

Miguel Romay Merino
Head of the GNSS Business Unit of GMV Aerospace and Defence S.A.

Even if it seems to be a difficult question, especially when considering the current situation of the Galileo programme, the answer is certainly 'yes'.

Satellite Navigation is playing a crucial and ever increasing role in our society and it is today quite obvious that multiple Satellite Navigation Systems will be operating simultaneously in the future. Europe has always been very active in the field, and despite all of the hurdles that the Galileo programme may be facing, Europe's interest in Satellite Navigation is continually growing.

Notwithstanding the difficulties that the Galileo programme is facing, it is also true that significant achievements have been reached during the last years. The development of Galileo at the industrial level is progressing at a good pace, and Critical Design Reviews are already taking place or are planned for the short term for most of the key elements of the Galileo system. Furthermore, the Galileo System Test Bed activities continue to provide better insight as to the system characteristics through the analysis of the first Galileo test satellites (GIOVE-A) experiments, and the planned launch of additional test satellites in the coming months will only increase this understanding.

The roots of the situation that Galileo is suffering today at the programme level can be traced to the very optimistic and enthusiastic decisions made at the start of the Programme:

- A difficult balance between Programme objectives, schedule and costs. Very ambitious objectives have been defined for Galileo which have not properly taken into account the limitations of the available budget, as well as the difficulties of achieving them within the planned schedule. The combination of these factors has placed the European industry in a difficult situation.

- The management structure of the programme is spread among several strong institutional and industrial groups. This situation has sometimes created confusion due to the fact that there is no clear entity ultimately responsible for the overall programme. This is in part a consequence of another optimistic undertaking: the Public Private Partnership.

It is now time to inject more realism into the Galileo Programme and define a credible programme in terms of objectives, cost and schedule, and establish a clear management structure. The European institutions and industry continue to be strongly motivated for and see Galileo as key to the future of Satellite Navigation growth in Europe. This motivation will drive all partners to overcome these hurdles and set up the basis for transforming the on-going work on Galileo into a complete reality within the next few years.

PNT infrastructures should be publicly funded

Jim Doherty
IDA, USA

I have long held the following three views: (1) that it would be built, (2) that it would prove more difficult than anticipated, and (3) that there was no business case for a public-private partnership. Thus, one could say that I anticipated some of the issues that seem to be occurring today.

Galileo's first test satellite is flying today—GIOVE-A—and appears to be performing well. This demonstrates a commitment to the program. As a new satellite development project, it was truly impressive—about 30 months from concept to operations. If there are technical difficulties with the more complicated GIOVE-B design, this confirms that developing such a system as Galileo is harder than it appears.

Finally, I believe position-navigation-time (PNT) infrastructures should be publicly funded, at least to a fundamental level of capability. GPS is successful in supporting safety-of-life, quality-of-life, and economic applications because its development and operations have been publicly funded, while applications, including some augmentations, have been privately developed. My belief is based in part on a classic example of a government-provided "free economic good" from my macro economics class—lighthouses in the days of sailing ships.

Although critical for safety and efficiency, no private shipping company would provide the basic system; it was a major cost for the provider, yet available as a free service to all competitors. Hence, it fell to government to provide the system and to reap benefits through tax revenues from a growing economy.

So, I still expect to see Galileo develop, and my greatest hope is that when it does finally arrive it will be fully interoperable with GPS.

Europe's political will to create Galileo is clear

F. Michael Swiek
Executive Director
United States GPS
Industry Council,
Washington DC

Satellite navigation is hard. It requires complex infrastructures, huge amounts of initial capital, large budgets for sustainment, and must deliver its services with near 100% reliability and stability. Even though the technology has been known for about 30 years, and commercial markets established for nearly 20, there is still only a single fully populated and continuously operational global satellite navigation system – the US GPS system, the de facto global standard.

If the ability to reap profits from operating a satnav constellation was easy, then everybody, or at least a few somebody's would already be doing it.

What the Europeans are trying to do with Galileo is daunting technologically, frightening financially, and maddening by the complex layers of intra-European political hurdles they face. They should be admired for their courage to attempt it, commended for the progress made thus far, and perhaps pitied for the seemingly endless stream of pitfalls and barriers that have emerged from political, financial and engineering realms.

Yet they press on. Europe's political will to create Galileo is clear, even if the resources at times are not. I am almost sure that something called Galileo will happen. A better question as to whether there will be a Galileo, is, perhaps, "What Galileo will there be ?" Galileo is a complex concept of satnav infrastructure and services for public sector, private sector and general use, all overseen by an equally complex multinational administrative tangle.

Galileo's first vision of a self-sustaining commercial venture through a public private partnership has now given way to the more realistic concept of public funded infrastructure. So, which operational elements of Galileo will eventually emerge, and on what schedule ?

Galileo can and most likely will provide a valuable supplement and augmentation to the foundation already established by GPS. Certain elements will provide Europe with the degree of sovereignty and control it desires over satnav within its borders. If Galileo is to be accepted in the commercial world, it cannot stand as an island, but must be seen as openly compatible and interoperable with GPS, with clearly open standards and non-discriminatory access to market opportunities by non-European players.

Galileo will neither replace nor displace GPS from European or global markets, but has the potential to complement and extend what GPS has and can offer to users in public, private sector and personal applications and services. Galileo will most likely not emerge in full grown form, offering its complete originally intended plate of services. Instead, only those parts that make sense in terms of public need and commercial market acceptance will survive.

Roadblocks, primarily of a political nature

Ronald R. Hatch
NavCom
Technology, Inc.

Yes, I believe Galileo will happen. I will be very disappointed if it does not. Yes, there are major roadblocks, primarily of a political nature. It will be difficult to reach agreements with all of the states, businesses and organizations involved. However, I believe that too much has been accomplished and the goal too important to the European community to allow it to falter. The prestige of building the system and the dependence upon a foreign system of navigation otherwise, both argue for a continuation of Galileo. The European public also favors a continuation according to surveys. Yes, it will be delayed, but I think the system will be built. Technically, Galileo has much to offer. Receivers that will track both GPS and Galileo signals are easily built. With two common frequencies at L1 and L5/E5A the diversity of signals will allow operation of high precision receivers in much more restricted environments. In addition, for very high precision RTK implementations the third frequency on both the next generation GPS satellites and the Galileo satellites will dramatically improve the ability to resolve the whole cycle of carrier phase ambiguity. Though the middle frequency is not common, the Galileo E6 signal is actually a better choice than the GPS L2 signal for ease in simultaneously resolving ionospheric effects and determining the whole cycle ambiguities. Again, it would be a great disappointment if Galileo does not happen.

Understanding EGNOS

EGNOS System Operations are advanced and under qualification and EGNOS Open Services are used by an ever growing public

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Umberto Guida
Business Development Manager, European Satellite Services Provider

Jon Westbrook
European Satellite Services Provider

THIS paper describes of the activities performed by the European Satellite Services Provider (ESSP) and its partners in the establishment of the EGNOS system operations organization, the implementation and utilization of the operations processes and procedures and the operations products baseline as well as describing the management processes used within EGNOS operations with respect to preparation for Safety of Life Services.

The activities required to ramp up, stabilize and qualify the EGNOS operations baseline in the context of introducing an EGNOS Safety of Life service are highlighted and their inputs towards the EGNOS certification process are further presented and discussed.

Background and objectives

The European Satellite Services Provider (ESSP) has been created in 2001 to operate the EGNOS system and provide Safety of Life Services for different user communities.

The EGNOS system is providing wide area differential corrections and integrity information to the European Satellite Navigation Community, delivering enhanced performances for users with demanding navigation requirements.

The current period of EGNOS operations is entitled the "EGNOS Initial Operations Phase" and started in July 2005 and is due to complete in March 2008. It is managed under a European Space Agency (ESA) contract by a consortium coordinated by the ESSP. This phase prepares and facilitates the handover of operations management responsibilities from ESA to the European GNSS Supervising Authority (GSA) and the EGNOS Operator.

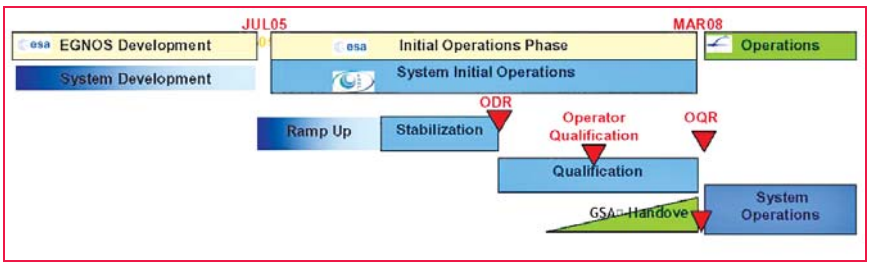

Fig 1: EGNOS Initial Operations

The objectives of the Initial Operations Phase are: to increase ESSP's staff and resources to fully support EGNOS Safety of Life Operations; to transfer knowledge and operation experience from the European Space Agency to the European Satellite Services Provider; establish, test and validation of the operations and procedures designed to stabilize EGNOS Operations to a level of performances commensurate with the system requirements.

The baseline of the EGNOS Operations Management consists mainly of organization, staff, processes, procedures and tools. A dedicated EGNOS Operations Qualification Program has been designed to qualify the EGNOS Operation baseline for the support of safety-critical applications; such program runs during the whole Initial Operations Phase.

Specific aspects of the EGNOS Operations Management are:

- the establishment of management processes for the use of EGNOS applicable to the whole system
- operating and maintenances procedures in accordance to the specific equipment level
- implementation of a strategy for processes and procedures evolution and improvement
- the qualification of processes and procedures in an operational context, using operators and engineering support staff
- Different qualification levels for processes and procedures according to their status and maturity in the qualification process
- Recurrent operational qualification management processes to ensuring good maintenance of the qualification results achieved

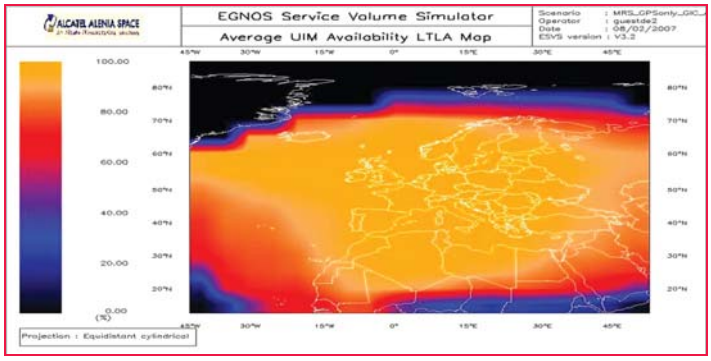

Fig 2: EGNOS Service Extension

- Gathering of evidence to support certification inputs

EGNOS has entered the qualification phase of Initial Operations, which is the final part of the operations qualification program. It demonstrates that the EGNOS operations organization, staff, procedures and documentation, can support EGNOS operations performances. The qualification phase concludes with the Operations Qualification Review (OQR) and the Safety of Life service provision will follow this milestone.

As such, in the furtherance of the objective to use EGNOS for the full support of Safety of Life operations, the availably of the EGNOS Signal-in-Space has been progressively increased. All EGNOS ground components, such as the 34 Ranging and Integrity Monitoring Stations (RIMS), the 4 Mission Control Centers (MCCs), the 2 Support Facilities, the 6 Navigation Land Earth Stations (NLES), the EGNOS Wide Area network (EWAN) and the relative EGNOS Operations Team are now under ESSP contractual and technical control.

Status of the EGNOS Space Segment

Today the PRN120 and PRN126 broadcast EGNOS messages; the EGNOS operation signal broadcast since July 2006 contains the Test mode Message Type MT0/2.

The PRN 124 is used by ESA and industry for the test of the EGNOS system releases.

The current EGNOS signal is broadcasted by the v2.0.3 Ground Segment Configuration. Such configuration has provided a sensible improvement in the navigation performance and the system stability. The preparatory activities for the ESR v2.2 'Certifiable Version' are ongoing for handover to GSA mid 2008 as part of the final phase of the Initial Operation.

The EGNOS Service area is the ECAC'96, limited by 70 degree North and 40 degree East. In the framework of the ESA GNSS Support Program, new RIMS are going to be added to the existing EGNOS ground network, in order to extend his service in:

- ECAC Northern latitude – EPINOL (in two Norwegian Northern Islands)
- Mediterranean and Middle East Area – MEDA:
  - Abu Simbel, Egypt
  - Agadir, Morocco
  - Tamanrasset, Algeria
  - Tel Aviv, Israel

EGNOS certification

EGNOS represents the first European GNSS component: as such, it provides bench marking for European GNSS certification.

In the Civil Aviation domain, the European Commission's regulations for the Single European Sky provide the rules for the EGNOS Certification for civil aviation. In this frame, the following Regulations are considered of interest for the EGNOS services provision. Such regulations are in place; their applicability for the European GNSS components is foreseen to be supervised and supported by the European GNSS Supervisory Authority (GSA).

According to the EC Regulation (EC/549/2004), laying down the framework for the creation of Single European Sky (the "Framework Regulation"), in addition to the designated

Fig 3: Test procedure at Limoges airport for approaches CAT_I like (ATR-42) October 2006

Air Traffic Service providers, a navigation services provider can be individually certified. The following articles are of interest:

- Reg.549/2004, Article 2.4. 'air navigation services' means air traffic services; communication, navigation and surveillance services; meteorological services for air navigation; and aeronautical information services;
- Reg.549/2004, Article 2.5. 'air navigation service providers' means any public or private entity providing air navigation services for general air traffic;

Such definitions are applicable to the GNSS services, then such regulation, and the following derived for the same frame, are applicable to the GNSS case.

The EC Regulation 550/2004 on the provision of the Air Navigation Services in the Single European Sky (the "Service Provision Regulation") is applicable for the certification of the EGNOS operating entity as Service Provider. According to such regulation, the EGNOS operating entity apply to the National Supervisory Authority of the Country where his principal place of business is located. Then the NSA, supported by a Notified Body if the case, release the "certification of conformity" to the Common requirements (reg. 2096/2005) for the Navigation service provision of the EGNOS operating entity. Such certificate shows the capability to operate and control the configuration of the system according to the ICAO standards.

Finally, the EC Regulation 552/2004 about the interoperability of the European Air Traffic Management network (the "Interoperability regulation") require the achieved performance and safety requirements to be documented. On this purpose, the European GNSS certified service provider issues to his NSA a "declaration of verification", together with a technical file, which confirm the compliance to the implementing rules for interoperability in order to make the system be integrated in the EATMN; such implementing rules could need to be specifically issued for the GNSS. Such "declaration of verification" contains also the "declaration of conformity" or "suitability use" of the system constituents to the implementing rules.

Important inputs for the preparation of the technical file for the "declaration of verification" are the EGNOS Safety Cases. The EGNOS System Safety Case has been developed by ESA and will be updated with each new ESR. During the Initial Operations Phase, ESSP is working on the development of the EGNOS Operation Safety Case, which will be maintained throughout the system's life time.

The challenges and issues to be tackled with regards to EGNOS certification are the following:

- Clarification of the service provision organizational scenario
- Designation of the authority and responsibility
- Provider's certification by the competent National Supervisory Agency supported by Notified body/ies

Fig 4: 1st APV approach performed at Valencia by a Regional Airline with an operational aircraft (Air Nostrum Dash-8), Nov '06, GIANT project (GJU 2nd Call)

Fig 5: Helicopter instument approach with EGNOS on Lausanne Hospital helipad, July 2007, GIANT project (GJU 2nd Call)

- Clarification of liability issues
- Issues linked to the complexity and number of different actors involved
- Necessary time scales for the certification process

Major European actors are working together to develop the EGNOS certification framework on the basis of such legislation:

- EGNOS Certification Task Force has been established and follows the safety cases development
- Analysis of the service provision chain
- ESSP is working in collaboration with National Supervisory Agencies (NSAs)

EGNOS service aspects

On the 5th June 2003, the 2515th EU Transport, Telecommunications and Energy Council conclusions was: "calling for an optimal of appropriate integration of the EGNOS program in the Galileo program…." The last EC COM(2007)261 on 16th May 2007 to the 7th June 2007 EU Transport, Telecommunications and Energy Council "…invites the Council to recognize that EGNOS will achieve operational capability by early 2008 and that immediate action is required to implement its services as a pre-cursor to Galileo". The activities related to such actions are foreseen to speed-up after such council.

Recently, the resolution n 94550 of the 2805th Transport, Telecommunications and Energy Council meeting, held in Luxembourg from the 6th to 8th June 2007, explicitly invites the Commission the continue with the implementation of a certifiable EGNOS in line with relevant requirements, with the initial service availability by 2008.

The preparation of the EGNOS Safety of Life service provision requires involvement of all European Satellite Navigation actors, to define the service environment, and to implement the relative enablers as required by the rules and regulations specific for the applicative domain. In the short term, during the start of the services transitory phase and the uptake of the market, the continuation of EGNOS SIS and data provision would need to be ensured by European Institutions.

The finalization of the EGNOS service provision chain with the final allocation of roles and responsibilities between the concerned actors is required, and the consequent preparation of the legal and institutional environment is under development at European institutional level.

As seen, the operational qualification of the EGNOS operations entity is required and under progression as well as the required certification according to EC SES regulations. The development of a suitable operational framework for EGNOS service provision is then on-going at the European institutional level.

Fig 6: Perspectives for the near future. APV approach by an Air Nostrum's Bombardier CRJ200 with an EGNOS integrated avionic on board

ESSP and EGNOS

ESSP has important assets in view of EGNOS operations and service provision. ESSP has been created to be the EGNOS operator and Safety of Life service provider.

Operating the system since 2005, ESSP has considerable experience with regard to its operations and is now preparing for the Safety of Life service provision and the Single European Sky certification by engaging itself in introductory activities for EGNOS Service Provisioning.

ESSP is involved in several different projects related to GNSS service introduction in different the transport domain and also in the areas that will be covered by the EGNOS service extension, like MEDA.

ESSP has created a network of institutional entities which play a role in the service provisioning, and also future interested and target user communities, in order to identify and promote the benefits, and to define and implement with them the enablers required by the different transport markets.

In the near future, an aircraft, an Air Nostrum CRJ-200 of "Air Nostrum" Regional Airline will be equipped with an integrated SBAS avionics configuration, including also the modification to the Flight Management System (FMS) required by flying LPV procedures.

Conclusion

In conclusion, it can be said that EGNOS is today the first European Satellite Navigation system available. EGNOS System Operations are advanced and under qualification and EGNOS Open Services are used by an ever growing public. The activities for its service preparation are progressing. EGNOS addresses main shortcomings of GPS, which provides positioning data without any guarantees of integrity or service continuity. EGNOS will achieve operational capability in the first half of 2008 and soon after it will start its services as a pre-cursor to Galileo. The existence of an independent and reliable European system is of great benefit. As such, users will be able to use the same terminal to receive both GPS+EGNOS and also Galileo signals.

Unconventional applications with single frequency DGPS

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CURRENTLY the trend is that more and more project authorities are mandating use of GPS for control work and private surveyors have to comply with this requirement. Dual frequency DGPS have been beyond the financial reach of these surveyors as such most prefer to invest in single frequency DGPS, which cost almost one third the cost of dual frequency DGPS.

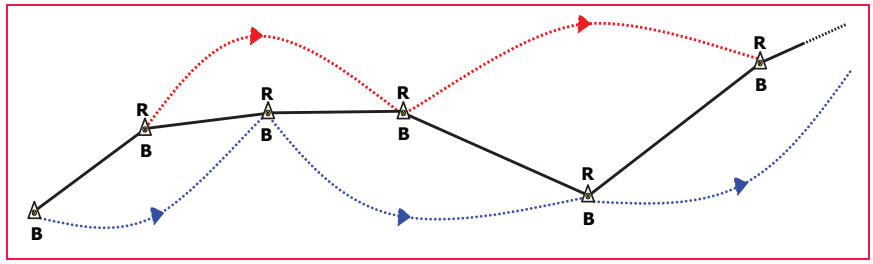
Conventionally DGPS have been used so far for horizontal control. Recently however there have been a number of articles on using GPS for leveling. All the authors have used a dual frequency DGPS. These authors belong to national mapping agencies or academic institutions as such had access to leveling Bench Marks (BMs) of their countries. However, India being a very price sensitive market compounded with the fact, that private surveyors have no access to spirit level height BMs. Even if they work for govt. agencies, obtaining height data involves lot of hassles, security implications, takes unviable time frames and is quite expensive. Finally, when height data is made available, there is no certainty that the BM's would be found intact on ground. Therefore, the general practice by private surveyors is to make do with alternatives such as commencing leveling from an arbitrary point with arbitrary height value assigned to it. To be competitive in pricing, hardly anybody does a closed loop, nevertheless the work is by and large acceptable by the consultants and project contractors for survey requirements relating to planning, design and checking as built of highways, pipelines, SEZ and so on.

As is well known, DGPS come in two modes i.e. Dual Frequency and Single Frequency. The generally specified accuracies for both are 5mm +1ppm for Horizontal and 10mm +2ppm for vertical in static post processing solutions albeit with a range limit of approx 15 km for single frequency DGPS and upward of 50 km for a dual frequency DGPS. The versatility of both considerably differs for various applications.

Single frequency DGPS can also be used in Static PP, Stop & GO Kinematic Post Processed (PP) and continuous Kinematic PP. Besides single frequency DGPS can also be used for GIS data acquisition with PP accuracy of sub meter for Base lines up to 50 km.

Background

Many of our colleagues in the Institution of Surveyors (India) and private surveyors had been querying us to suggest methodology for utilizing single frequency DGPS for extended range to cover their projects involving large distances. This article is an endeavor to present some experiments with single frequency DGPS both for distance as well elevation accuracies over large distances.



Diag 1 Schematic Diagram of Leap – Frog

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Pan India has been an accredited in house R&D agency by the Dept. of Scientific & Industrial Research, Ministry of Science & Technology, Govt. of India. Pan India in its ambit of R&D activity has undertaken a detailed study to examine some of the unconventional solutions for surveys using a single frequency DGPS in project spanning distances over 100-150 km.

However, before undertaking investigations we had a wide ranging discussion with various experts, it has been our experience that there are mainly 3 classes of users, the first is an organization such as Survey of India (SOI), who are very well versed with equipment as well as technology and surveying practices.

The second category of surveyors are those such as M/s Punj Lloyd / M/s Jaypee etc. who's main job is construction related and surveying is a essential component mainly for acquiring Base data for design, subsequently for ground layout and finally for checking as built. The projects are related to Highways, Pipelines and layouts for townships or SEZ etc.

The third category of users are private surveying companies who generally work as sub-contractors for survey works for infrastructure companies and consultants undertaking preparation of DPRS designs etc.

It is for benefit of last 2 categories of surveyors that we had undertaken different projects to evaluate the utility of single frequency DGPS beyond the range of 12-15 km. These survey companies need establishment of control over a distance of 100 to 200 km for highways, L Section and Cross section, layout surveys for pipelines extending over distances in excess of 100 km, DEM/DTM for town planning & SEZ's and soon.

The project

Four different types of projects were selected for the unconventional procedures undertaken for evaluation of utility of single frequency DGPS as follows:

1) Control work for highway alignment covering a distance of over 118 km in UP.
2) L section & Cross section survey for about 2 km.
3) Data acquisition for DEM for 20 Acres Part of SEZ.
4) As built survey of 130 km part of Oil pipe line.

The procedure

As already mentioned the Single Frequency DGPS has optimum range of to 12-15 km to achieve specified accuracy in post processing. In order to increase this range the obvious solution is to use Base and Rover in leap-frog mode i.e. first set up DGPS on Base and Rover on stations about 8-10 km apart. Next while keeping the Rover intact, remove Base GPS and put it on to the next station as Rover 8-10 km further away, in this way the DGPS unit acting as Rover earlier will now act as Base. The control points were thus extended in similar way by making leap frog point between 6 to 11 km apart for the complete route of about 120 km. During post processing, it was made mandatory that data for 1st Base & 1st Rover position was processed. In the second Base-Rover processing the Base (which was Rover in first observation) was assigned the same coordinates derived from earlier processing & so on. For automatic processing in similar way for all position the utility existing in the software though never used earlier, was utilized. With this utility, the processing is ordered in the desired sequencing of Base-Rover-Base with automatic assigning of processed co-ordinates which were obtained for the position as earlier Rover to that of Base in subsequent processing to follow the procedure as mentioned above. In a route spanning 120 km a total of 12 stations were established in this manner (see diag 1).

Table – 1

Reference	Rover	Proc_Length	δH Ortho	δ h Ellipsoid	Variation (N=δH – δh)
401	402	7708.737	-15.619	-15.742	-0.123
402	403	9706.687	-5.875	-6.144	-0.269
403	404	8811.175	-0.185	-0.316	-0.131
404	405	8643.081	-3.994	-4.083	-0.089
405	406	9134.605	-1.42	-1.476	-0.056
406	407	8617.829	-1.033	-1	0.033
407	408	6198.915	-1.736	-1.711	0.025
408	409	10572.741	-2.349	-2.244	0.105
409	410	7257.297	-4.234	-4.236	-0.002
410	411	10087.205	-1.511	-1.254	0.257
411	412	10811.242	-1.397	-1.261	0.136
412	413	4591.84	0.033	0.053	0.02
413	414	9578.226	-3.208	-3.071	0.137
414	415	7158.366	-5.386	-5.504	-0.118

Results

Extension of Control Points

To check the over all accuracy of results, a single quadrilateral was observed over entire distance using Dual Frequency DGPS and processed by trilateration. The initial azimuth was taken as the one between Base & 1st Rover. The closing azimuth was checked with the last Base & Rover station. The averaged value of coordinates of 1st Base observed over a period of 2 hours was taken as starting co-ordinate in UTM zone 43 and WGS-84 Datum.

The results on comparison showed that the distance vector between end points, which were 107 km direct devised by single frequency GPS in Leap frog mode are in agreement with in 4 ppm. The azimuth is in agreement in less than one second. The ellipsoidal elevation by both single frequency DGPS at 1st Base and last Rover (approx 107 km direct) & (118 km

by leap-frog) were in agreement to with in single tertiary Class II specification as compared with Dual Frequency.

Since absolute MSL height of starting & end point was not available, EGM 96 was applied to obtain Orthometric Heights. Comparison between Δh and ΔH was done to study the variation in ΔN with respect to EGM-96 which showed that the value of N in this project area was varying between -0.269 to + 0.257 over a distance of 118 km in generally flat terrain (table 1).

Subsequently a BM found near point 401 which is a canal BM and second near point 413 which is a railway BM. These are in different series and by different departments. However when the heights were observed at these points by DGPS and substituted for point 401 instead of value obtained in EGM 96 and with this height fixed, all other points ware datumed on to it.. The value of height of railway BM at point 413 as compared with the height inscribed on the railway BM was found to be in agreement in better than 47 cms in the leap-frog series (table-2).

Table – 2

Point No.	Ellipsoidal Height	EGM96 Height	Height of BM
401 (Canal BM)	100.951 meters	157.094 meters	155.96 meters
413 (Railway BM)	140.365 meters	195.288 meters	194.62 meters
Difference	39.414 meters	38.194 meters	38.66 meters

Even though apparently it falls short of double tertiary class II standard, the fact remains that the average correction per linear km is less than 5 mm and per leg of average distance 8 km (i.e. 107÷13) the error is with in 6 cms for each leg of 8 km, which after adjustment where accurate BM heights are known is acceptable for most surveys relating to highways and pipeline & other infrastructure surveys as well as are adequate for topo surveys. Where VI for contouring is 1 meter or more.

DEM/DTM

Under normal conditions, Single Frequency DGPS stipulates that 15 epoch acquisition of data is adequate to achieve the specified accuracy in X, Y & Z. For any DEM / DTM all three values of X, Y & Z are necessary. In our trials, an area of about 20 Acres was taken up for preparation of DEM / DTM. Single frequency DGPS was used in Stop & Go mode for acquisition of xyz for points spaced approx every 5 meters. The Base was established in centre of area and Rovers were initialized using initializing bar. The recording interval was kept at one second so that time for data acquisition at each point is not more than 20 seconds. Besides one Base station, 3 Rovers were utilized for data acquisition in grid pattern. In this configuration, the XYZ for approx 3000 points acquired in one day, which was considered to be very economical out turn as compared with other conventional instruments. Alongwith the grid pattern data acquisition, the surveyors picked up positions of break

points as well as features of interest. Repeat observation was taken on well spread 50 points for comparison. The average ellipsoidal height discrepancy on the repeat points was with in 1cm and the maximum discrepancy in repeat point at extreme ends was with in 2 cms. Standard software with 8 degree polynomial was used for drawing DEM. A check line at random was carried out which showed that all elevations were in agreement with in 1.5 cm.

L Section & Cross Section

In the third trial one L section of 500 meters with cross section at every 50 meters was observed by single frequency DGPS in stop & go Kinematic mode and post processed part of this was checked using the auto level. The discrepancy in relative ellipsoidal heights for this small area was maximum of 3mm at the extremity.

As Built Survey

The fourth project involving survey of 'As Built' of oil pipeline was carried out by surveyors M/s Punj Lloyd for their project Dahej-Uran gas Pipeline (DUPL) for GAIL. The pipeline had been laid over a distance of 132 km with turns, curves, and river crossings. The work involved in co-ordinating turns as well as level grading that the as built pipelines adhered to. This was successfully carried out using single frequency DGPS in leap-frog mode by surveyors of M/s Punj Lloyd with our active involvement and under the continued monitoring by their consultant and resulted in considerable time saving, as compared to the conventional systems.

Discussion

In the absence of MSL bench marks, all elevations over longer distance were converted to orthometric heights using EGM-96. However where ever SOI leveling bench marks are made available a suitable Geoid model with interpolation based on suitable polynomial curve fitting should meet the specifications of project indenters. Presently hardly any contactor has access to SOI bench marks and they usually commence their work from an arbitrarily established point. However by & large accuracy of single tertiary class II suffices for their projects. Accordingly they are able to meet their client's requirements with relative difference of ellipsoidal heights with EGM96 orthometric heights datumed to mean value of elevation of beginning point which is derived from SOI TOPO maps, so that the elevation data is not too much in variation with absolute M.S.L. elevation in the project area. Hopefully, this situation would improve with technology awareness and opening up measures that SOI has initiated for data availability as well as availability of INDGEOID on which G&RB, Survey of India is currently working. We hope this Geoid model will be available to private surveyors as well.

The 118 km road line was completed in 3 working days. The DEM observations and processing was completed in 2 days and the L section X section was completed in one working day. The as-built pipe line of 130 km (approx) was completed in about 25 days under constant scrutiny of the consultant's engineers.

Concluding remarks

We may also add a word of caution that as far as possible in road/canal/pipeline projects in generally flat areas the GPS derived heights should as a rule be done section by section of limited lengths. In extremely flat areas where the slope measurement is very critical to the project a few small sections of spirit leveling as checkup may be done. One must make appreciation of the tolerance threshold and if this threshold is single tertiary class II, the relative height information can be confidently derived by single frequency DGPS, in leap frog procedure.

Single Frequency DGPS are very versatile, handy and give precise results. The cost of ownership is much lower than those of Dual Frequency as such ROI is realizable in just one or two survey projects. Dual frequency DGPS of course have their own applications.

Acknowledgements

The initial inspiration & guidance for undertaking this study was provided by Brig (Dr.) B. Nagarajan, Director, Geodetic & Research Branch, Survey of India.

The second impetus has been various articles & regular column in various issues of Co-ordinates by Dr. Muneendra Kumar, Chief Geodesist (Retd.) USNGIA. Dr. Kumar has been a strong proponent of utilizing ellipsoidal heights for engineering and Topo survey projects.

The acknowledgement can not be complete without mentioning Prof. P. Misra whose pearls of wisdom exhorts that merely having high level of knowledge of technology is of no help to any body. The challenge before professionals is to be aware of the problem solving abilities of technology and then utilize it for the same.

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Zheng He's sailing to West Ocean

An important waypoint on passage of navigation history

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ZHENG He's Exploration of the Western Pacific Ocean and the Indian Ocean was an important event at the turning point of the world history. It was a golden opportunity for China to strengthen itself and make greater contributions to human beings. Unfortunately, to some extent, Zheng He's magnificent feat in the history of navigation was later considered as a sheer waste of energy and money and a "failure policy", and thus was put an end to. Zheng He's trip, therefore, did not produce long-term effects. China still cut off itself from the out side world and stopped her exploration of ocean navigation, while Europeans, along the routes opened up by their expeditions, reached America, Africa and Asia and established colonies all over the world, which greatly promoted the capitalist development. In spite that the scale of Zheng He's navigation far exceeded that of Columbus's "Great Discovery" which followed some 80 years afterward, the former had much less effect on the progress of the world history.

The reasons behind the suppression are complicated (Chen 2005, Lin 2003, Ma et al 2006). Confucian culture focusing on harmony and not conquering limited the achievements of collecting wealth and expanding territory. Agriculture oriented policy refrained exploration of nature and undervalued the scientific findings and technological innovations. The reasons may also include seeking the undeserved reputation of "emperorship of the whole world", and spending too much money and resources without the expected effects. However, Zheng He's sailing to West Ocean did mark an important waypoint on the passage of world navigation history. Never before in the world had there been any such adventure that was in such a scale, lasted for such a long time, had so many people under command, fared so far into the ocean, and had such advanced navigation technologies. It was suggested that the strength of Chinese naval exceeded the total strength of all the other countries of the world in that period of time (Wang 2005).

Figure 1. Map of Ming China and Zheng He's voyages

Zheng He and his time

Historical background

In the Ming Dynasty (1368-1644), China became a unified strong multinational feudal empire. Emperor Yong Le, who named Zhu Di, was a man of vision and strategy. At the beginning of his reign, the country enjoyed political stability, economic prosperity and a considerable level of science and technology. While promoting economic and cultural development in the country, Emperor Zhu Di actively carried out diplomatic activities, expanding China's relations with foreign countries and developing foreign trade. Although Zhu Di lifted the ban to the seas imposed at the beginning of the Ming Dynasty, he had no intention of expand the territory. The principle of "bullying no weaker states" he formulated was the continuation of the policy of "never conquering other states" pursued by his father who was the First Emperor of Ming Dynasty (Information Office of Fujian Province 2005). In order to strengthen ties with other countries, spread China's civilization and engage in international trade, Emperor Zhu Di ordered Zheng He to go for a voyage down the western seas, taking with them luxury gifts.

After the emperor Zhu Di took over power, council of ministers was in its course of recomposing. Confucian officer

and eunuch were striking openly and secretly (Zhou 2006). He was going to gain support from the council of ministers where Confucian officer usually occupied the major part in the former time, but it were eunuchs who contributed a lot to Zhu Di's ascending the throng. So he put eunuchs in a very important position.

One of the duties of Chinese emperor was to attract "all under heaven" to be civilized in Confucian harmony. When foreign ambassadors came to the Chinese court, they "kowtowed" (the process of "kowtow" was to kneel three times and bow one's head to the floor three times at each kneeling). In return for tribute from other countries, the emperor sent gifts and special seals that confirmed their ruler's authority. In fact, these foreign kings were officially made part of the Ming Dynasty.

About Zheng He

Zheng He (also known as Cheng Ho) was born in Kunyang, Yunnan (present-day Jinning County, Yunnan Province) around 1371 AD. He was originally surnamed Ma, and was known as San Bao (Three Treasures) subsequently. Raised as a Muslim, Zheng He started to study the teachings of Islam at an early age. Both Zhang He's father and grandfather had made the pilgrimage to Mecca, and so were quite familiar with distant lands. Listening to his father and grandfather's stories, young Zheng He developed a consuming curiosity about the outside world. His father's straight character and altruistic nature also made a lasting impression on the boy.

Zheng He was captured by Ming Dynasty forces during their defeat of the remnants of the Yuan Dynasty in Yunnan, around 1381 AD. He was taken to Nanjing, where he was castrated and put into imperial service. He was then sent to Beiping (Beijing) to serve in the palace of Zhu Di, the Prince of Yan and the fourth son of the Ming Emperor.

During Zheng He's time in the palace, his brilliance and loyalty won him Zhu Di's trust. As a result, the prince chose Zheng He to serve as his personal bodyguard during his quest to become emperor. It was during this period that Zheng He's genius and leadership abilities became apparent. For four years, Zheng He went through fire and water at the side of Prince Zhu Di, accompanying him on countless campaigns and battles throughout China. Amassing victory after victory, Zheng He was instrumental in Zhu Di's seizure of imperial power. Zhu Di often discussed and consulted matters of state with him, offering him numerous opportunities to learn about politics, military affairs, and strategy. After Zhu Di ascended the throne as the Yong Le Emperor, he promoted many of the military and civil officers who had supported him. Among them was the eunuch officer Zheng He. Zhu Di changed Zheng He's surname from Ma to Zheng, and elevated him to the position of Grand Eunuch.

Considering his extraordinary abilities and loyal service, Emperor Zhu Di deemed Zheng He the best choice for ocean voyage. Then, Zheng He was promoted to the third rank, acting as an envoy of the imperial court to foreign countries, thus beginning the greatest voyage in the world history.

The Expeditions

Pre-sail preparations

The objectives or motivation of Zheng He's voyages can be divided into two phases: the first three voyages, and the next fourth to seventh voyages. For the first phase, the aim is to stabilize the emperor's status as well as show off China's richness and military strength. For the latter phase, the objective was set to establish a friendly international relationship with other countries, and meanwhile to put emphasis on tribute trade. It is believed that to search for Kirin (we call it giraffe) was as well a purpose in the latter phase, because it was the symbol of power and auspice in ancient China (Qian 2005). Another argument is that pilgrimage was also one of the major motivations of the expedition (Ma 2002).

In 1402-1424, during the reign of Emperor Zhu Di, the imperial court ordered the building and modification of 25 batches of sea-faring boats, totalling 2860. They included four batches of what is known as "treasure ships", totalling 343, the sea-faring vessels especially for the voyages to the western seas. There still remain seven docks for building ships at the ruins of Nanjing Long Jiang Shipyard and the Treasure Ship dockyard.

Some historical records show that the sea-faring fleet under the command of Zheng He consisted of more than 200 vessels and 61-63 Treasure Ships. As the boats were built in different places, they varied in types, such as "FU" boats, "WU" boats, "GUANG" boats and "SHA" boats. The division of labour among the boats also varied according to different tasks they were assigned. There were large, medium and small sized treasure ships and boats for carrying water, soldiers, passengers, horses and foods. By "treasure ship", it means exquisitely made boats for shipping official seals, official robes and all kinds of treasures to and from China. It also carried back rare animals, souvenirs and rare raw materials, spices, herbal medicines and crop seeds given to China as gifts from foreign countries. The king-size treasure ship measures 133.2 meters long; mid-size ones measure 111 meters long; and the smallest ones measure 60 meters long for carrying supplies. In Zheng He's fleet, there were also eight-scull boats, which measures about 24 meters long, with two masts. It used masts in tailwind and when there was no wind, it used sculls.

The seven voyages

From 1405 to 1433, Zheng He made 7 voyages down to the Western Ocean.

The first voyage sailed in an orderly formation, "forging ahead in full sail day and night, against towering waves, just like going through a thoroughfare" just as a Chinese historian described.

In order to avail the tailwind of the Northeast monsoon, Zheng He defied fatigue and completed preparations in less than one month and set sail from Liujia Port of Taicang. The second voyage, Zheng He visited Champa, Siam

(Thailand), Java, Malacca, Nanwuli, Ceylon (Sri Lanka), Kayal (on the east shore of the southern end of the Indian Peninsula), Cochin and Calicut.

By the time of the third expedition, 1409 to 1411, Zheng He had established a settled program. The fleet used Malacca as its forward base and there the fleet was divided into squadrons that sailed independently to separate destinations.

The fourth voyage was the largest scaled expedition ever. After left Champa, the fleet split into two. One visited the Malaysian Peninsula. The other, led by Zheng He, continued the journey down the line of Java, Sumatra, Palembang and Malacca.

The mission of Zheng He's fifth voyage was to escort envoys of 19 countries home and to procure all kinds of rare animals and spices from the Arabian Peninsula and East Africa.

Zheng He was order to go on the sixth voyage to escort the envoys of 16 countries include Mogadishu and Brawa in East Africa home. In order to sail directly to the eastern coasts of Africa, Zheng He used stellar diagrams to measure the height of the stars to position the fleet. Menzies (2003) suggested that the fleet had not merely rounded the Cape of Good Hope and traversed the Atlantic, they had been gone to explore Antarctica and the Arctic, North and South America, and had crossed the Pacific to Australia.

On the last voyage, when the fleet, carrying with rare animals and native produce, were sailing toward Calicut, Zheng He died of illness. According to the sea-faring tradition, he was buried at sea.

Figure 1 and Table 1 show some more information about the voyages.

Table 1. Time and Size of Fleet of Zheng He

Time	Duration	Time Interval	Total number of vessels	Total number of people
1405-1407	21-22	-	62	27800
1407-1409	20	3	-	-
1409-1411	18-19	4	48	27 000
1413-1415	19-20	29-30	63	27 670
1417-1419	21	28	63	27 411
1421-1422	19-20	18-19	>100	>20 000
1431-1433	19	111	-	27 550

The Technology

Various advanced technologies of the time were employed by Zheng He and his fleet to make the great feat. He successfully inherited the practice of former navigators in Chinese history and assimilated their ocean-going knowledge. He selected excellent sailors, made thorough preparations and built various types of seaworthy ships equipped with well-designed devices such as stabilization boards, watertight compartments, precise compass, and star boards. The following subsections are contributed to part of the technologies employed by Zheng He and his fleet.

Ship building

China has a long history of building ships. The general design featured vertical sails, with neither horizontal sails nor fastening ropes. The sails were usually made of cloth or woven by bamboo chips stiffened by bamboo poles for wind-efficiency. With centuries of experience in building ship to sail storm-tossed oceans, the Chinese marine engineers had evolved a robust frame built in sections. Each section was contained by watertight bulkheads at either end, resembling the internal partitions of a bamboo. The watertight sections were bolted together with brass pins weighing several kilograms. Three layers of hardwood were nailed to a teak frame, and then the planks were caulked (made waterproof) with coir (coconut fibre) and sealed with a mixture of boiled tung-tree oil and lime. This hard, waterproof lacquer had been used to seal Chinese ocean-going ships since the seventh century, but so much tung-tree oil was required to build Zheng He's treasure fleets that acres of land along the Yangtze banks were acquired to plant orchards of tung trees.

Marine engineers at the Longjiang shipyards designed their ships to survive the fiercest storms on the open ocean. Reinforced bows enabled the vessel to smash through the waves, and at either side of the bow were channels leading to internal compartments. As the square bow pitched in heavy seas, water was funnelled in; as the bow surfaced above the waves, the water drained out, modifying the pitching motion. A teak keel bound together by iron hoops ran the length of the ship, and specially cut, large rectangular stones - or composite stone and mud balls - were packed around it for ballast. Additional keels that could be raised and lowered were fitted at either side for more stability. In a storm, semi-submersible sea anchors could also be thrown overboard to reduce rolling. Even in the roughest weather and sea conditions, pitching and rolling were greatly reduced by these ingenious modifications. With the sophisticated technologies China was able to build largest ship of the world at the time. Some record noted the treasure ship is as large as 132m in length and 54m of width. Figure 2 compares the treasure ship to Columbus's St. Maria.

The giant ship could survive typhoons and the sectional construction reduced the risk of sinking in case of a collision with a reef

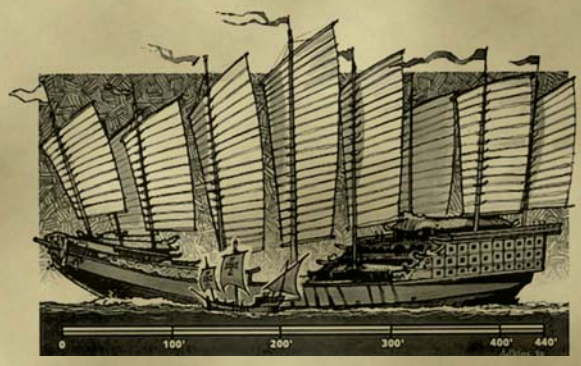

Figure 2. Comparison – Zheng He's treasure ship (440 feet) and Columbus' Santa Maria (85 feet), by Caroline Hsu

or an iceberg. A story tells that Zheng He's flagship was once holed on a reef but its triple hull and watertight compartments enabled him to reach Malacca without sinking, according to some legend.

It is also proposed that we can envisage the development of modern shipping industry by comparing that of Zheng He's time. Shipbuilding at the time had shown the characteristics of large size, high speed and specialization (Yang & Jin 2005).

Celestial fixing

Zheng He developed a whole set of navigation technology by looking at stars. Accompanying Zheng He's nautical chart, there were four stellar diagrams. Figure 3 shows portions of two of them. Those diagrams passed on by Zheng He have not only enabled us to recapture the stars observed by navigators but also revealed the secrets of ancient navigation.

Zheng He was able to determine his latitude by measuring the height of Polaris to the north and Southern Cross to the south. Twelve star boards (Fig.4) were used depending on the different height of the stars. The size of the largest board is around 24 cm by 24 cm (12 fingers as it was termed at the time, using the size of human thumb) and the smallest, 2 cm by 2 cm (1 finger), with 2 cm difference in succession (Zhao 2005). By using the attached thread, around 60 cm in length, the observer was able to fix the distance from the eye to the board, thus fix the angle of observation of the board, about 1.9° per finger. When observing the celestial bodies, the observer aligned the star on the upper side of the board and the horizon to the lower side, and thus the height of the star was determined. According to different heights of the stars, different sized boards could be used. By using Zheng He's method, the positioning error could be controlled within 4.5 nautical miles, which was far superior to the general level at that time (Zhao 2005).

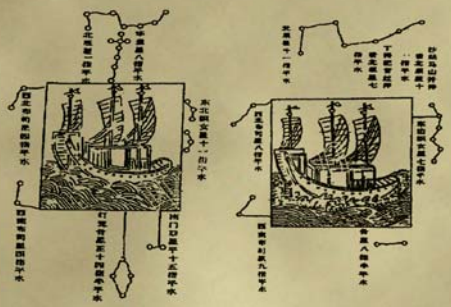

Figure 3. Portions of stellar diagrams

Figure 4. Star boards

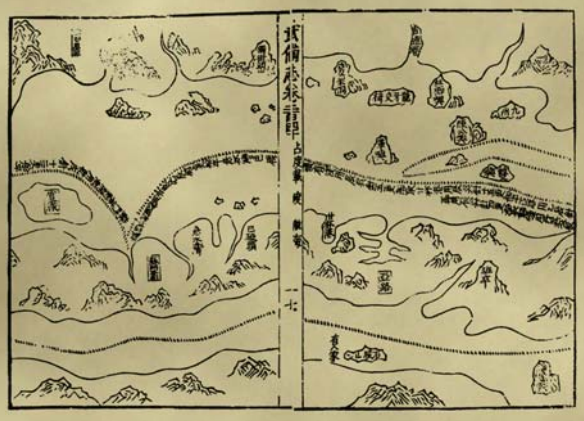

Figure 5. Zheng He's Nautical Chart

Menzies (2003) describes quite clearly astro-navigation of the fleet. The fleet used Polaris in the northern hemisphere. But when they were in Indian Ocean, and altered course to the southwest, southern Africa. Polaris, the Chinese guiding star, would have sunk closer and closer to the horizon and become invisible at 3°40′N, north of Mogadishu in Somalia. Until they found another guiding star in the southern hemisphere to fulfil the same purpose as Polaris in the north, they were sailing into the unknown. The Chinese needed a star in the southern hemisphere to replace Polaris in the northern, and in the event they selected two: Canopus for latitude and the Southern Cross for navigation, they would have to sail far into the icy waters of the Deep South to locate the stars. To use Canopus for latitude, the Chinese had to determine its precise position by sailing to a point directly underneath the star. The Southern Cross points to the South Pole, but unlike Polaris, it is not directly above the Pole. To be able to use the Southern Cross for accurate navigation, the Chinese also had to locate its position in the sky - its height and longitude. Once again, the only way to calculate the precise position of the Southern Cross was to sail to a position directly beneath it. Menzies believes that only when Canopus and the Southern Cross had been located could new lands in the southern hemisphere be accurately placed on charts. When they reached Mount Adams in the West Falklands, the Chinese cartographers were nearly underneath Canopus. They were taking such pains to fix their position so that they could calculate their precise latitude: 52°40′S. By cross-referencing Canopus to Polaris they could establish Canopus's height and then use that star to obtain their latitude anywhere in the southern oceans.

Nautical charts

Zheng He Hanghai Tu (Zheng He's Nautical Charts) provides comprehensive records of Zheng He's western voyages. The original chart is a long scroll called "Chart of the course taken by the treasure ship from its start at Longjing to the destinations of foreign lands". That is one of the achievements of Zheng He in his western sea voyages and also the earliest international chart in the world (Information Office of Fujian Province 2005).

The charts utilize traditional Chinese landscape painting techniques to portray features such as mountains, islands, bridges, temples, and cities in detailed perspective. Figure 5 illustrates a portion of the chart. These graphic representations enabled the navigators to more easily identify important geographical features from shipboard. The charts include over 530 place names, including over thirty Asian and African countries and regions. Over fifty separate routes are delineated. Navigational

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Figure 6. Magnetic compass

data inscribed along the routes, such as compass headings and time notations.

Zheng He's nautical charts are of great both historical and practical value. These charts fully reflect the high level of navigational expertise of the time, and indicate that China's maritime technology had essentially been perfected. It has been proposed that when Columbus, da Gama, Magellan and Cook later made the "discoveries', they were carrying copies of the Chinese maps with then when they set off on their own journeys into the "unknown" (Menzies 2003).

Course and speed measuring

Compass was the main means used by Zheng He in his epic ocean voyages. The compass was used to fix the direction and "geng" which recorded by Chinese era is used to measure distance. The compass used in the treasure ship was a kind of "wet compass", that is a needle floating in water contained in a circular box with the compass points carved on wooden rim. On the compass there are 24 scales. Each scale, marked by different Chinese characters, represents a direction. The characters provided a way to mark the

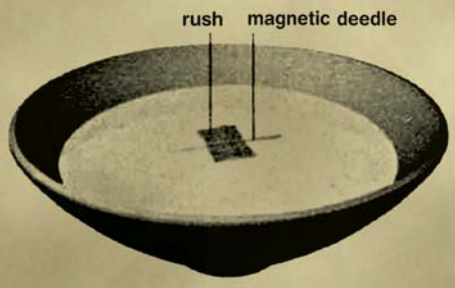

Figure 7. Simple form of "wet compass"

direction course route lines on the charts. The ship may follow one particular scale mark or follow a point between two scales.

Figure 6 shows the magnetic compass used by Zheng He's fleet. The lower part of the figure is a replica of the compass and the upper shows the bearing correspondents of the Chinese character marks. Figure 7 shows a simple form of a "wet compass" (Xin Yuan-ou 2003).

Zheng He's fleet used hourglass to measure the distances it covered. It was an instrument for measuring time by the trickling of sand through small opening from one glass bulb to another below it in fixed period of time, usually a "geng" (Information Office of Fujian Province 2005). "Geng" is a time recording unit, representing one of the five two-hour periods of a night, but here it refers to a unit of distance. Usually one "geng" was 60 li, about 30 kilometers. When taking the measure, they threw a wooden plank into the sea and then walked to the rear of the ship at a certain fixed speed to gauge the ship's speed. Then route and distance were calculated and drawn on a map. That is what we see as the navigation chart, a precious material for studying Zheng He's western ocean voyages.

By using compass and the "geng", navigators would know the position of the ship in the vast seas.

Organization

The eunuch captains and admirals of these great treasure ships were men of awesome ability but, like the European explorers who followed them, they often drew their crews from the lowest levels of society. Most were criminals, sent to sea in lieu of imprisonment or internal exile, and in some respects life as a crewman was far better than a prison sentence. They were provided with a uniform - a knee-length white robe - food and wine, and were well cared for when at sea. The admiral's staff included 180 medial officers, and every ship and company of soldiers had a medical officer for every 150 men. There was a varied and plentiful diet on the treasure ships, but the perils of voyaging through uncharted waters meant that life expectancy was short: only one in ten returned from the great voyages of exploration and discovery. But those who had survived the earlier voyages of the treasure fleets had been well rewarded. They were often freed and given endowments or pensions.

Like all soldiers, the Chinese were superstitious. Each of Zheng He's ships had a small cabin dedicated to Ma Tsu, the mariners' deity, and prayers were said to her every evening before supper. When the crew went ashore in foreign lands, they carried round bronze mirrors to ward off evil spirits; on the reverse was the eight-spoked Taoist wheel.

The elite of the crew were the navigators and compass-men, operating from an enclosed small bridge and living and dinning separately from the rest of the man. The junks also carried artisans and craftsmen of every description, capable of performing any task. Caulkers, sail-makers, anchor- and pump-repairers, scaffolders, carpenters and tung oil painters would keep the ships in good repair on their long voyage into the distant oceans. Tone-carvers and stonemasons were also embarked to leave permanent legacies of the fleets' voyages across the world (Menzies 2003).

Provisions

Provisions were fundamental and critical for sustaining the long voyages at sea. The staple foods - Soya beans, wheat, millet and rice - were carried in separate grain ships, enabling a fleet to stay at sea for several months without replenishing supplies. Soya beans, grown in tubs all year round, were used in several ways. Soaked in water, they sprouted yellow curls from the green bean. The sprouting process increased the content of ascorbic acid, riboflavin and nicotinic acid, the basis of vitamin C, and protected the crew from the deficiency disease scurvy.

Some of the rice was brown, not polished, and the husks contained vitamin B1. As a result, beriberi - a disease causing degeneration of the nervous system - was rare among the crew. Fresh vegetables mainly comprised cabbages, turnips and

Figure 8. 1763 Chinese map of the world, claiming to incorporate information from a 1418 map. Discovered in Shanghai by Liu Gang in 2001

bamboo shoots. When they ran out, the sprouting soya beans were particularly valuable. Soya beans also produced "mike". When boiled, it became curd, or tofu, rich in vitamin D, while fermentation of soya produced soy sauce. Tofu and vegetables were flavoured with a sauce made from fermented fish, soy, dried herbs and spices, or glutamate made by chewing wheat flour. The grains were chewed, spat out into a container and left to ferment. The method is still used in South America today. Noodles, pasta, and dumplings were also made from wheat flour. Sugar cane was used to sweeten dried fruit and was also chewed raw by the crew.

Fruit and vegetables were preserved in ingenious ways. Meat was limited, for the most part comprising Chinese pigs, dogs bred for purpose and frogs kept in tubs. Chickens were kept for divination and were never eaten on board, but fresh, salted, dried and fermented fish were plentiful.

Wine was also distilled into liqueurs, brandy and vinegar. The junks required huge quantities of fresh water for crew and horse and replenished their tanks whenever an opportunity arose, but they also knew how to distil it from seawater, using paraffin wax or seal blubber for fuel.

Impacts and spirit

Zheng He's expedition scores perpetual contribution to the politics, economy, and culture, external contacts of the ancient China, as well as the world civilizations and other expeditions followed. It helped China know the world in ancient time (Fig 8). It has turned to be a spiritual wealth and an excelling cultural legacy of China and even of the world. According to Menzies (2003), Magellan never claimed to be the first man to have circumnavigated the world; never the less, he was still in an amazing feat. Magellan, Dias, da Gama and Cabral were very skilful navigators and seamen; they were also brave and resolute men with awesome qualities of leadership, but not one of them actually discovered "New Lands".

When they set sail, each one of them had a chart showing where he was going. All their "discoveries" had been made nearly a century earlier by the Chinese. Nor did Christopher Columbus 'discover' the Americas. Far from setting sail full of fear that his fleet might fall off the edge of the world, he knew where he was going, as can be seen in excerpts from his logs when he was still in mid-Atlantic. Since that Vasco da Gama was not the first to sail to India round the Cape of Good Hope, that Christopher Columbus did not discover America, that Magellan was not the first to circumnavigate the world, why they deserve these glories? Because they were on the shoulders of giants! All the charts they used contain information that can only have come from cartographers aboard the pioneering Chinese fleets.

Unlike conquering other nation, collecting treasure or expanding territory, peace and amicability are Zheng He's spirit. In undertaking the ocean-going voyages, Zheng He pursued a policy of peace as laid down in the imperial edict, which said: "you may go the way of the heavenly kingdom, strictly abide by words, keep in bounds, and refrain from bullying the weak and share peace and happiness in the world" (Information Office of Fujian Province 2005). Through the voyages, Zheng He safeguarded peace, sowed the seeds of amicability/ friendship and deepened the understanding of the people of other countries.

As a friendly envoy of the Chinese people, Zheng He got on quite well with the local people. During his voyages, group after group of foreign envoys and business people came to China and more and more Chinese went down the seas to seek a living outside China and they got melt into the local communities.

Zheng He treated countries with a relatively backward economy and culture equally and spread the civilization of the Chinese nation, thus contributing to the cultural exchange and mutual understanding between China and foreign countries. Many neighbouring countries sent their envoys to China. In some countries, even the kings went in person to China to conduct exchanges. The kings of the kingdoms of Sulu and Borneo all headed their ministers and other official to China to learn. When the King of Sulu died in China, the Ming government buried him with a ceremony.

According to statistics, there were 90 diplomatic missions coming to visit China during the period of Emperor Zhu Di alone. During the more than 30 years, 292 Asian and African countries sent 400 diplomatic missions to China, with each mission making up of 60-70 people or even as many as 500-600 people. Historical records show that in the 21st year of the reign of Emperor Zhu Di, a diplomatic mission of more than 12000 people came to visit China (Information Office of Fujian Province 2005).

Conclusions

Zheng He was a great navigator in the history of China and the world and a momentous pioneer in the great geographical discoveries. Zheng He's voyages were the record-breaking feats in the history. He carried out the expeditions earliest in time and largest in fleet scale. He developed and employed the most advanced shipbuilding technology in his time. The most sophisticated and systematic navigation techniques were fully demonstrated in the voyages. And the most powerful navy force was well established. Zheng He's great voyages are the magnificent landmarks not only in China's political and diplomatic history but also in navigational annals of the world.

The detailed paper with complete references can be seen at www.mycoordinates.org.

The Global Map Experience

Progress in the creation of an operational Global Spatial Data Infrastructure

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THE United Nations Conference on Environment and in Rio de Janeiro recognized the need to coordinate environmental data and spatial information as an aid to decision making in formulating responses to the challenges of global environmental change and to support sustainable development. The concept of Global Map as a means of doing this was introduced by the Government of Japan and became a formal part of the Agenda 21 action plan. Global Map is a digital map of the world at the scale of 1:1 million which is produced by a cooperative effort of the national mapping organizations of the world. At the time of writing (May 2007) 172 countries and regions were involved in the creation of Global Map. Global Map has eight data layers, four in vector format and four in raster format. These are transportation, boundaries, drainage, population centres (in vector format) and elevation, vegetation, land cover and land use (in raster format). See Figure 1.

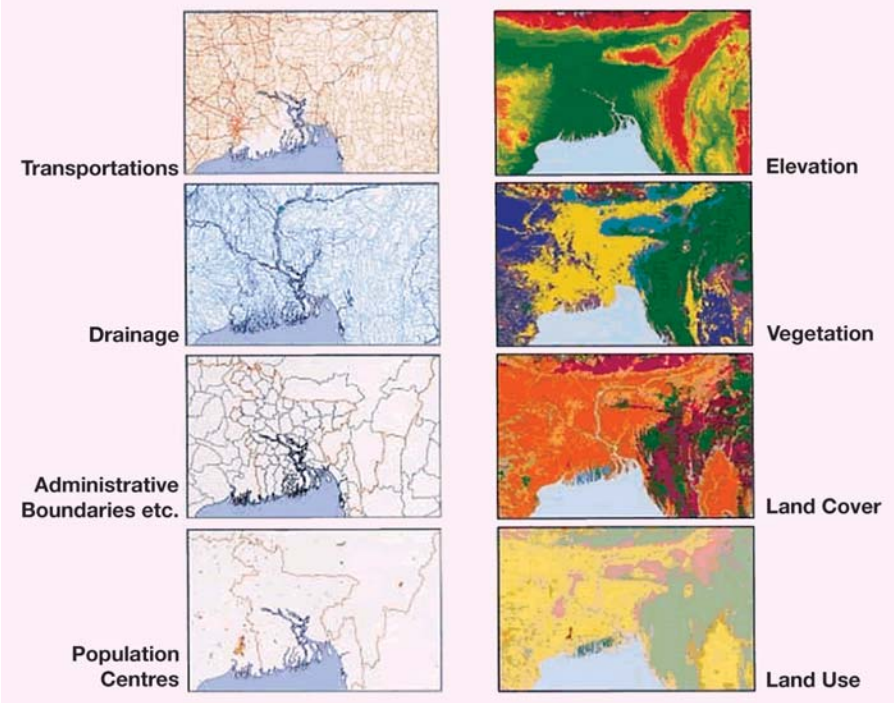

Figure 1 Global Map Database at 1 km Resolution

The International Steering Committee for Global Mapping (ISCGM) was established in February 1996 to implement the Global Mapping Project. A secretariat for the Committee was established in the Geographical Survey Institute of Japan and the current Chair of ISCGM is Dr. D. R. Fraser Taylor of Carleton University in Ottawa, Canada. The Committee consists of 18 heads of national mapping organizations with the Scientific Committee on Antarctic Research representing Antarctica and Eurogeographics representing Europe. In addition there are two advisors and 11 representatives of a number of liaison organizations including ICA.

The first version of Global Map was released in 2000 using existing global datasets as a basic resource. These included GTOP030 for elevation, GLCC for land cover and VMAP0 for sector data. Common standards and specifications were established and, utilizing the initial global datasets, each nation prepares and verifies its own coverage. At the World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002 Global Mapping was recognized in the political declaration of the Summit and ISCGM was registered as a Type 2 implementation agency for this purpose.

Progress of the Global Mapping Project

In September 2007, 172 countries and regions were participating in the project corresponding to about 95% of the land surface of the earth. Global Map data for Brazil has just been released. This brings the total number of countries for which Global Map data has been released to 40 countries and 2 regions equivalent to 43.4% of the world's land surface. Data from a further 81 countries and six regions have been submitted for verification and when these are added coverage exceeds 70% of the earth's surface making completion of Global Map by the target date of December

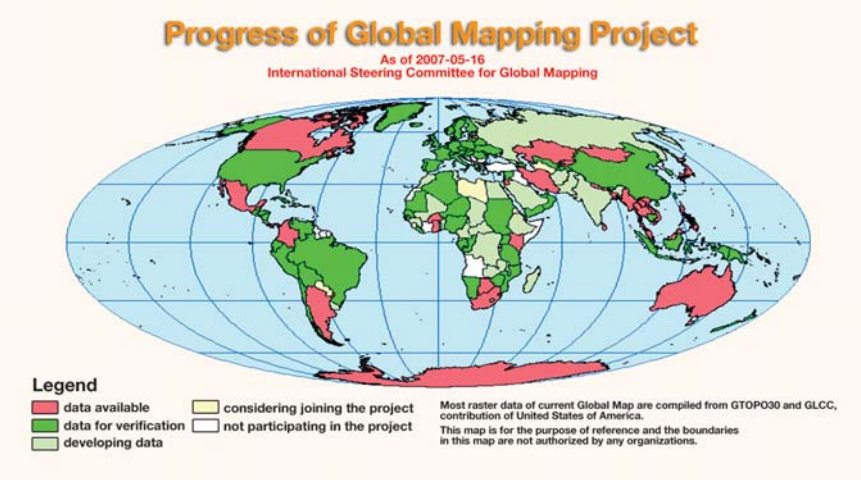

Figure 2 Progress of Global Mapping Project

2007 attainable although problems exist, such as coverage for states where conflict exists. In addition, a few countries are still not participating in the Global Map project and efforts are being made to engage them. Figure 2 shows the state of progress as of May 2007. Detailed information on Global Map can be found at www.iscgm.org.

Global Map as an Operational Global Spatial Data Infrastructure

Global Map was not initially designed as a spatial data infrastructure but in both organizational and technical terms Global Map meets all of the specifications of a spatial data infrastructure. Global Map is, in essence, an operational Global Spatial Data Infrastructure. Global Map can also be useful in establishing Spatial Data Infrastructures at larger scales such as a region or a nation. Through participation in Global Map national mapping organization can create small-scale framework data for their country but at the same time develop the human and institutional capacity to deal with geo-information. ISCGM has an active capacity building program which includes courses and funding for training both By JICA and GSI. Japan, supplemented by grants of software and training by both ESRI and Intergraph. They also gain experience and knowledge of ISO/TC211 and OGC standards and specification processes as well as some of the legal aspects of copyright, intellectual property and related issues. Members of ISCGM also form a support network with individual members helping other neighbours in developing the Global Map infrastructure.

As a result several nations, such as Kenya and Brazil, have used the Global Map infrastructure to develop their national spatial data infrastructure.

Global Map is also a useful framework for the development of regional spatial data infrastructures. In Latin America there is an initiative to develop a seamless data framework for the continent based on Global Map. This initiative is led by Chile and involves the Cartography Commission of PCIDEA. A similar effort is being made for the Asia and the Pacific Region through PCGIAP. Euroglobal Map has already been completed and is an important component of the INSPIRE initiative and through CODI and the Mapping Africa for Africans project progress is being made for Africa.

Challenges for the Future of Global Map and SDIs

Global Map is an important set of framework data but Global Map coverage needs to be updated on a regular basis. There is also a need to ensure that Global Map standards and specifications are updated and become more fully interoperable with emerging standards and specifications being developed by both ISO and OGC. When Global Map was first initiated in the 1990s it used the best standards and specifications available at that time. Since then, however, technological progress has been very rapid and, as a result, Global Map standards and specifications are now being revised to meet the current situation. Interoperability is central to any SDI regardless of the scale of operation at global, regional, national and sub-national levels. It is, perhaps, the major challenge and opportunity for the geo-spatial community. In this respect interoperability between emerging products, such as the KML based Google Earth and the GML/XML based GIS World are of special importance.

Another challenge for Global Map is increasing its visible contribution to the central issues for which is was designed – environmental issues and sustainable development. Global Map must move from a supply-driven initiative to much more of a demand-driven initiative. New uses for Global Map, especially in education, are emerging and one important new initiative is the use of the Global Map network for disaster management and mitigation.

Global Map also has an important role to play in global observation and is playing a very active role in GEOSS, especially in the area of framework data creation.

Global Map is by definition a small-scale initiative and for many problems the scale is too small to effectively address them. This is also true for small nations, especially small island states. Global Map is now accepting data at 1:250,000 for such states which will help to address the problem. A more effective solution, however, is to ensure that Global Map as an operational global spatial data infrastructure is interoperable with larger scale regional national and sub-national SDI initiatives so that maximum use can be made of geospatial information.

Conclusion

Global Map is an important international initiative. Unlike the International Map of the World which failed to meet its objectives Global Map is on track to complete its coverage by the end of 2007 and to create a sustainable long term framework for digital maps of the world at a global scale.

RIM, Vodafone release BlackBerry Curve 8310 in Germany

Vodafone and Research In Motion (RIM) introduced the new BlackBerry Curve 8310 smartphone in Germany, with built-in GPS navigation and advanced multimedia functionality. The integrated GPS functionality works with pre-installed Vodafone Navigator software enabling users know exactly where they're going. *www.rim.net*

SingTel launches location-based search service in Singapore

SingTel launched MAPS, a service in Singapore that allows customers, having GPRS-enabled phones and WiFi-enabled devices to search for services, events and promotions from around their current location. It allows them to view their current location on a map from their device. *http://home.singtel.com*

Mio Technology introduces A501 GPS PDA phone

Mio Technology has released A501 GPS PDA phone. Its an all-in-one device solution that offers users the full-functionality of a PDA, phone and GPS navigation system. *www.mio-tech.com*

Alltel Wireless to launch WHERE LBS

Alltel Wireless customers will have access to WHERE, a LBS application. It provides customized informations including maps and directions for thousands of locations, directly to Alltel phones which could be downloaded in Alltel's Axcess Shop. It is available on five phones: The Wafer, The Alltel Hue and u520 by Samsung as well as The Wave and AX8600 by LG. *www.alltel.com*

QUALCOMM equips 300 M mobile handsets worldwide with GPS

QUALCOMM has marked a milestone in the adoption of the Company's gpsOne position-location technology. More than 300 million mobile handsets worldwide have now been shipped with the gpsOne solution, helping the wireless industry meet worldwide user demand for accurate, easy-to-use location services on mobile devices. *www.qualcomm.com*

Mobile phones to determine the next catch!

Fisherman from Veerampattinam, a fishing village in South India will soon have something going for them that none of their peers anywhere else in the country do: a mobile phone enabled intelligence system that will tell them - where to fish to when to venture home because the weather could turn ugly.

M.S. Swaminathan Research Foundation (MSSRF), a Chennai-based research body that works on issues of access to communication for poor village communities together with Qualcomm Inc., is looking to providing real time information to the fishermen on mobile phones.

Information regarding fish concentration is gathered through satellite pictures, which MSSRF analyses, converts into digital form, and feeds onto a computer server, which, in turn, can be accessed from a CDMA handset. The information comes to the fisherman in the form of latitude and longitude. The pilot project involving 10 fishermen is running on the Tata Teleservices Ltd , whose coverage extends to a range of 15-20 km off the coast, covers about 80% of the fishermen's requirement. It is currently in Phase 0— which shall move through four phases over a period of one and a half years. Qualcomm is working on incorporating GPS capability in the phones, so the exact location of the phones can be tracked. This would make rescue operations much easier.

Fujitsu Siemens to pull out of PDA GPS business

Fujitsu Siemens announced its pull out of the PDA and GPS business by the end of the year. FS currently offers a range of handhelds under its Pocket Loox brand, the line-up divided into traditional PDAs with integrated GPS and Wi-Fi, and Blackberry-style devices with integrated phones and email-friendly micro-keyboards. However, the range hasn't been updated since the July 2006. *www.channelregister.co.uk*

Market reports on LBS, telematics, personal navigation

Berg Insight forecasts that more than 60 percent of all WCDMA devices sold in 2010 will have integrated GPS/ Galileo receivers. The EU is most likely to follow the US and Japan in requiring high accuracy of mobile emergency calls from 2010 when the Galileo system will be operational. Demand is also driven by consumer applications such as navigation. Gain detailed insights about the complete GNSS value chain spanning from GPS/ Galileo receiver developers and handset chipset vendors to handset manufacturers in its 100+ pages report. *www.lbszone.com*

Sprint maps sex offenders on cell phones (Include)

Sprint, USA announced FamilyWatchdog Mobile, a service that enables Sprint customers to view maps of where registered sex offenders live and work from Sprint or Nextel capable phones. Users can search the areas surrounding specific addresses such as their homes or children's schools and view offender photographs, descriptions and conviction details.

Microsoft brings MSN Direct Traffic and gas prices to laptop navigation (To include)

Microsoft has launched Streets & Trips 2008. It combines the mapping software for the USA and Canada, a USB GPS and MSN Direct receiver, providing drivers with current traffic updates and competitive gas prices without needing an Internet connection. GPS version of this software is available at a premium.

GIS to fight dengue epidemic in Bangkok

Authorities in Bangkok are resorting to a GIS to ease the dengue epidemic in the Thai capital. According to Bangkok governor, a longer rainy season and changing temperatures have favored the breeding of the mosquito that transmit the fatal disease. He added, the GIS will help the city officials to find critical epidemic areas. *www.allheadlinenews.com*

Gaia 3 enhances interoperability of NSDI environment initiative

Gaia 3 software, Carbon Project has been selected for 2007 National Spatial Data Infrastructure (NSDI) Cooperative Agreement Program (CAP) under a project grant called "Framework NSDI and Beyond". The Project is a collaborative effort between the North Carolina Dept. of Environment and Natural Resources (NC DENR), the U.S. Environmental Protection Agency (EPA), CubeWerx, The Carbon Project and the geoLeaders Network. *www.TheCarbonProject.com*

Survey for GIS map of Indore city begins

Indore will be among the few cities of India where GIS technology is being implemented wherein all the available infrastructure of the city its property, roads, water, sewage lines, main holes etc. can be identified separately on the map after being surveyed. Survey using DGPS will be carried out at as many as 42 places in the city. Corporation sources informed that the city will soon have computerized geographical map which will be based on GIS. M/s Ispect System Private shall carry out the survey. *www.centralchronicle.com*

C3S, GIS and surveillance cameras for Dhaka

To enhance traffic management and effective crime control, Dhaka Metropolitan Police has decided to install the digital surveillance system for traffic management and crime control, setting up a unified control room. Under this initiative, 155 sophisticated surveillance cameras will be installed at 59 points in the capital, including its nine entrances and exits. It will facilitate the law enforcers with Automatic Vehicle Location (AVL) system with GIS. *www.cctvcore.co.uk*

Police force puts crime on the map

South Yorkshire Police has implemented crime mapping technology using intranet mapping service (IMS) based on a GIS. It gives all members of the force access to crime and anti-social behaviour information. Police analysts produce the latest neighbourhood crime trends and resource allocation data using the Crime Analyst technology. IMS will give police officers direct access to the results up to 20 times faster than making a traditional manual request as the data is refreshed on the IMS every two weeks. *www.vnunet.com*

Land, Maritime, Air Transportation and Clearance Information at a Glance

The National Logistics Information Center will be established to manage overall land, maritime, and air transportation by connecting individual logistics information network across the nation in Korea. The Ministry of Construction and Transportation has consulted with related Ministries and private companies on specific plans involving other stakeholders of logistics industry, academia, research institutes, and other experts. As for logistics information, database has been built up by individual organization or sector as the current database has limitations in providing information on the entire logistics flow, and lack interconnection among various sectors. The project will be completed in five years *http://www.moct.go.kr/EngHome/News/*

Global digital geology map

Geoscience Australia is collaborating with similar organisations from more than 40 countries to begin an ambitious geological mapping programs ever undertaken, titled OneGeology. It will provide internet access to the most up-to-date, worldwide geological map data at a scale of 1:1 million as part of the International Year of the Planet Earth program. *lesley.wyborn@ga.gov.au*

ADB presents Village Development Plans of Aceh Province

The Asian Development Bank presented a set of Village Development Plans to the Governor of Aceh Province recently. These plans provide a framework for housing and infrastructure reconstruction as per guidelines issued by the Badan Rehabilitasi dan Rekonstruksir. ADB is providing $15 million for spatial planning technical assistance in Aceh and Nias following the 2004 Tsunami and March 2005 earthquake. *www.adb.org/Documents/News/*

Newcastle And The Central Coast Of Australia Now In Living Colour (Include in GIS)

Earthinsite.com, Australia has released free on-line access to high resolution colour aerial photography of Newcastle, and the whole of the Central Coast area of Australia.This new photography, has a spatial resolution of 10cm for the urban areas and 20cm for the rural areas - one of the highest resolutions offered on the web worldwide. Quality is 36 times better than Google Earth.

United Arab Emirates – Hydrographic Survey

The United Kingdom Hydrographic Office has been contracted by the Military Survey Department of the UAE to advise and assist on the planning and management of the Hydrographic Survey of their Territorial Waters. The project shall improve the safety of navigation and enhance the protection of their environment through the provision of modern high quality hydrographic data. The survey area encompasses up to 30,000km^2. The large areas of the survey will be completed with airborne systems, supported by surface units. *robert.wilson@ukho.gov.uk*

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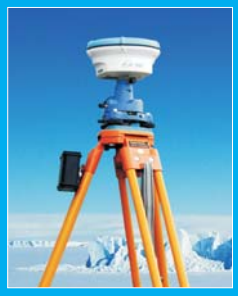
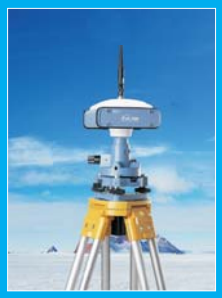





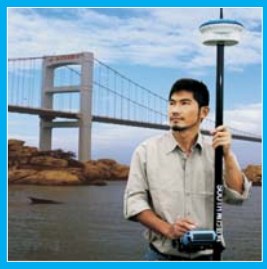







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Leica Geosystems introduces GMX902 GG GPS + GLONASS receiver

Leica Geosystems has introduced Leica GMX902 GG GNSS, a GPS + GLONASS receiver, developed to monitor sensitive structures and crucial topographies. It provides precise dual frequency code and phase data up to 20 Hz, enabling precise data capture as the basis for highly accurate position calculation and motion analysis.

Leica has also announced the further continuation ATHENA Program – a formalized purchase scheme designed to help Universities, Research Organisations and UNAVCO members to better facilitate the use of GNSS Reference Station and Structural Monitoring technology for both teaching and scientific research purposes. ATHENA stands for 'Advanced Technology for Higher-Education and Non-profit Associations' *www.leica-geosystems.com*

Tele Atlas announces availability of digital map of China

Tele Atlas MultiNet China, complete digital map of the country is now available with street level coverage for more than 3,000 provincial and county cities. Tele Atlas has also opened a Display Technology Center in Shanghai, focused on producing visual enhancements such as 3D landmarks, 3D city maps and crossing magnifications for the Asia Pacific region designed to help make navigation systems clear and compelling to end users. *www.teleatlas.com*

NavCom releases StarControl

NavCom has announced the release of StarControl, a utility designed to adapt commercially available handheld controller solutions and programs to support its GPS receivers. It supports multiple off-the-shelf Windows-based handheld controller devices to work with select NavCom GPS receivers, utilize application-specific parameter profiles for its products, thus enabling rapid setup capability, enable snapshots of receiver diagnostics and initiate internal data logging with lower-cost platforms. *www.navcomtech.com*

@Road adds real-time GPS to Taskforce 7.5

@Road has integrated its GPS location technology and new street-level mapping capabilities into its Taskforce 7.5 Field Service Management solution allowing automated field service work allocation and dispatch decisions to utilize real-time location of mobile workers as well as their technical expertise and availability. *www.road.com*

Magellan launches Triton handheld series

Magellan has introduced new Triton series of portable handheld GPS receivers for outdoor enthusiasts. As a result of the alliance between Magellan and National Geographic, it is the first outdoor handheld to offer users access to downloadable National Geographic topographic maps offering full, onscreen compatibility, usage and display. *www.magellangps.com*

u-blox integrates EPSON Toyocom gyroscope in dead reckoning reference design

u-blox has improved its groundbreaking GPS dead reckoning system by integrating a gyroscope sensor from Epson Toyocom into the reference design for the product. It will shorten time-to-market and reduce the risk of GPS integration for applications that require accurate, uninterrupted positioning regardless of GPS signal conditions. *www.u-blox.com*

Hemisphere GPS introduces Outback S-Lite

Hemisphere GPS has introduced Outback S-Lite from the Farm Progress Show in Decatur, Illinois. It is a entry-level GPS guidance solution for non-precision spraying, spreading, and broad-acre tillage and seeding, which includes Straight Guidance, Contour Guidance, and Return to Point.

Hemisphere GPS has won a patent infringement lawsuit brought against the Company by Trimble Navigation Ltd. The US District Court of Northern District of California has granted Hemisphere GPS' motion for summary judgment as to non-infringement of Trimble's patent, effectively negating the lawsuit against the Company. *www.hemispheregps.com*

Bushnell GPS adds DigitalGlobe satellite images

DigitalGlobe has partnered with Bushnell Outdoor Products to enhance the navigational capabilities of the company's devices, including ONIX200 and next-generation ONIX200CR and ONIX400. The imagery will be part of the Bushnell interface that combines layers of various data to offer a safe, useful and engaging outdoor experience. *http://media.digitalglobe.com*

Trimble Opens Manufacturing Facility in Shanghai

Trimble is opening a manufacturing facility in Shanghai, China. It is located in the Waigaoqiao Free Trade Zone, will add a highly competitive supply chain and assembly facility to Trimble's worldwide capabilities. *www.trimble.com.*

NovAtel delivers GII reference receiver for Australian GRAS program

NovAtel shall supply its GII reference receivers to Honeywell worth US$750,000 in support of the Australian Ground-based Regional Augmentation System (GRAS) program. The receivers will be built into an initial GRAS long baseline ground reference network, which monitors GPS satellite performance and provides augmented GPS information to aircraft. It is anticipated that this ground network will be expanded to extend coverage in subsequent phases of the GRAS program. *www.novatel.com*

Pitney Bowes MapInfo Updates StreetPro Indonesia

Pitney Bowes MapInfo has released version 4 of its premier Indonesian street data product, StreetPro Indonesia

which includes data enhancements to provide comprehensive, current street and location information that easily integrates into location-based information systems. *www.mapinfo.com.sg*

GeoTranslate to support 3-D ESRI Shapefiles

Blue Marble Geographics announced the addition of support for 3-D ESRI Shapefiles, as well as enhanced support of 3-D AutoCAD files (DWG/DXF) and 3-D MicroStation Design files (DGN). Its users can also look forward to enhanced layer level renditions and other minor enhancements. *www.bluemarblegeo.com*

Topcon TopPAD 7.0.1 software released

TopPAD 7.0.1, Mobile GIS field software from Topcon allows users to take GIS layers into the field for verification and update. When installed on Topcon's hand-held GMS-2 or a field controller, it can collect and update position and attribute information using customized forms. *www.topconpositioning.com*

MapmyIndia.com v. 2008 launched

MapmyIndia.com has launched new version of the portal MapmyIndia.com v2008, which features landmark-based directions, localised Indian search, improved print page for print-and-go option, improved readability and detailed maps, etc. It captures the online maps space and is the brand of CE Info Systems. The company has also received an investment of Rs 10 crore (2.5 mn USD) from venture capital firm, Nexus India Capital. *www.efytimes.com*

Geokosmos surveys Vietnam using LiDAR

Geokosmos has carried out LiDAR surveying in Vietnam. The project was aimed at acquiring accurate, up-to-date geospatial data on Vietnamese southern regions. It surveyed the Mekong Delta using ALTM 3100 (by Optech), LiDAR system, with the integrated inertial measurement unit (IMU), by SAGEM. The total territory covered was 2100 square km. Airborne laser scanning was conducted at the height of 1500 m with high density of laser points, 2 points per 1 sq.m. It provided the customer with preprocessed data for interpretation and further processing of the data along with Geokosmos 3D Modeler. *www.geokosmos.com*

Rolta India sets up academy

Rolta India is setting up an academy to train people in engineering and GIS. The company, providing IT-based GIS, engineering design automation solutions etc., will set up the academy with an initial cost of Rs 40-50 crore. It will have four batches in a year for a duration of three months comprising 250 executives each. Course fee shall be Rs 2.5 lakh. It has already tied up with a few banks, which will give 100 per cent education loan. *www.business-standard.com*

Intermap Technologies wins MAPPS Award

Intermap Technologies has been awarded the MAPPS Geospatial Products and Services Excellence Awards under the Photogrammetry / Elevation Data Generation category. Intermap's "Torino 2006 IFSAR Mapping Project" was conducted on behalf of the Italian mapping agency Istituto Geografico Militare using the Company's proprietary Interferometric Synthetic Aperture Radar digital mapping technology covering 5,600 sqkm of northwestern Italy's varied terrain. *www.intermap.com*

AAMHatch wins 2007 BE Award

AAMHatch, has won a 2007 BE Award in the "Geospatial 3D GIS" category for its development of a true orthophoto and 3D model of the City of Melbourne, Australia. With the help of MicroStation VBA macros and GEOPAK, it was able to generate in minutes what would have taken 400 hours using manual plotting. *www.bentley.com*

Septentrio opens in North America

Septentrio, opens a business development office in Los Angeles, California. Septentrio welcomes J. Christopher Litton as Business Development Manager to start up and run the North-American operations for Septentrio.

Sokkia GIR1450 L1 DGPS System

Sokkia Japan has released the GIR1450 L1 DGPS System for the surveying, mapping, industrial measurement and construction industries. It provides accurate and reliable positioning solutions for mining, navigational, agricultural, hydrographic and similar applications. The receiver features beacon, OmniSTAR, WAAS/EGNOS and other SBAS technologies.

GPS technology aids biologists in research

Satellite tracking technology may help state biologists learn more about the habits of mountain goats while helping keep track of them. Two goats shall be the test animals for the tracking experiment, said officials of district wildlife biologist for the Oregon Department of Fish and Wildlife in Baker City. Biologists equipped two of the goats with GPS, collars programmed to pinpoint the goats' position every 30 minutes for the next couple of months, then every three hours. They can adjust that interval to as often as every 10 minutes by remote control. The collars will also record temperatures. *http://seattletimes.nwsource.com*

Russia starts serial production of new navigation systems

Russian manufacturers are starting serial production of new navigation systems on the basis of the Glonass technology for strategic aviation, according to the first deputy general director of the Moscow-based Kompas design bureau. It will be serial production of PUIN indication and navigation control panels. Production will be for Tu-160 [Blackjack], Tu-95 [Bear] and others that resumed on the Russian president's instruction. *http://en.rian.ru*

NVision – Boeing Co. & Navteq demonstrates tool for counter-terrorism

NVision Solutions Inc., The Boeing Company, and NAVTEQ recently demonstrated a prototype emergency management "common operating picture" at the 2007 Pacific Northwest Asymmetric Warfare Initiative. It streamed real-time emergency notifications from observers around the Port of Tacoma onto a high-resolution map depicting aerial photography as well as map data, enhanced GIS attributes, and parcel boundaries in the Exercise Control Center. Boeing employees acting as mock first responders logged simulated terrorist attacks using wireless, GPS-enabled, handheld computers. Simulated terrorist attacks involved live actors, pyrotechnics, and boats. *www.nvisionsolutions.com*

Cow herd to be tracked from space

A herd of 50 cows in the Yorkshire Dales, UK shall be monitored by GPS collar in a conservation project.The devices will track the movement of cows helping to preserve rare vegetation. *http://news.bbc.co.uk*

BAE Systems develops tools for GOOGLE Earth™ and ESRI

SOCET GXP v2.3, interacts with Google Earth in real time for quick, 3D color visualization and gives geospatial context to objects of interest. With additional tools for detecting changes from one day to the next, analysts can anticipate conditions such as rough terrain or collapsed bridges and pinpoint operational routes more accurately.

GPS in Tamil Nadu, India

TNCSC to install GPS in 2 districts

The Tamil Nadu Civil Supplies Corporation, India shall float tenders for putting in place the GPS in two districts - Tiruvallur and Krishnagiri, soon. It is based on studies of GPS installed by the Chennai Corporation on its garbage vehicles. Next year, the GPS will be put in place in other 30 other regions according to corporation chairman. *www.hindu.com*

GPS to keep track of mail vehicles

The movement of mail vehicles in Chennai, India will be monitored with the help of GPS. According to Postal Department,Tamil Nadu Circle, five vehicles were being monitored on a trial basis. If found successful, it would cover the other vehicles as well. *www.hindu.com*

GPS for fire tenders

Fire control room in Chennai is procuring GPS as a part of modernizing process. It is proposed to give one GPS to each of the 28 fire stations in the city for being fitted on the water tender ensuring better planning and monitoring of the movement of fire tenders by control room personnel, according Fire and Rescue Services official. *www.hindu.com*

Nothing Succeed like Success! GSLV-F04 successfully launched – Places INSAT-4CR in Orbit

India's Geosynchronous Satellite Launch Vehicle, GSLV-F04, had a successful launch on September 2, 2007. It placed India's INSAT-4CR into the Geosynchronous Transfer Orbit. This was the fifth flight of GSLV and the fourth successful one.

GSLV was commissioned after both its developmental test flights conducted in April 2001 and May 2003 were successful. GSLV was designed and developed by Vikram Sarabhai Space Centre, Thiruvananthapuram, India. Russian supplied cryogenic stage was used for third stage propulsion, the guidance and control of the stage has been implemented by ISRO. INSAT-4CR was developed by ISRO Satellite Centre, Bangalore. The payloads were developed by Space Applications Centre, Ahmedabad. The successful launch of GSLV-F04 demonstrated the operational reliability of GSLV as well as reiterated the end-to-end capability of ISRO. *http://www.isro.gov.in/gslv-f04/photos/index.htm*

Google Earth's planetarium i

Google has launched Sky - a new feature that enables users of Google Earth to view the sky as seen from planet Earth. All Earth users can view and navigate through 100 million individual stars and 200 million galaxies. The new feature introduces seven informative

layers that illustrate various celestial bodies and events. *www.google.com*

Google announces a simple new way to embed Google Maps

Google Maps users can now add a map to their website or blog just by copying and pasting a snippet of HTML. This new functionality enables Google Maps users to share and disseminate geographic information in the same way that YouTube users share videos. *www.google.com*

DigitalGlobe announces launch date for WorldView-1

Ball Aerospace & Technologies Corp., ITT Corporation, and DigitalGlobe have announced delivery of their WorldView-1 satellite from Vandenberg Air Force Base in California for its scheduled launch on September 18, 2007. WorldView-1 is the first of two new next-generation satellites DigitalGlobe has planned to launch. *www.ballaerospace.com*

Thai satellite to be launched in November

Thailand's first satellite for surveying natural resources, THEOS (Thailand Earth Observation Systems), is scheduled to be launched in November. The satellite data shall aid the state officials deal with natural disasters, suppress drug trafficking and predict crop estimates. According to Thai Space Agency, GISTDA, agreements had already been signed with several state agencies to use the satellite's services like Royal Irrigation Department, the Office of the Narcotics Control Board (ONCB) and the Defence Ministry. *www.bangkokpost.com*

Australian researchers discover dozens of new temples at Angkor

Australian researchers using NASA technology to map the medieval city of Angkor have discovered at least 74 new temples using radar imaging and other satellite data, according to the deputy director of the University of Sydney-based Greater Angkor Project.

Galileo update

Galileo to support global search and rescue

The detection of emergency beacons will be greatly improved by the introduction Galileo. It will carry transponders to relay distress signals to search and rescue organisations. In connection with this, representatives of the Galileo project attended the recent 21st annual Joint Committee Meeting of COSPAS-SARSAT, the international programme for satellite-aided search and rescue. The partners in Galileo are committed to developing the Galileo search and rescue component as an integral part of MEOSAR (Medium Earth Orbit Search And Rescue, the future worldwide search and rescue satellite system. Galileo joined the meeting in a formal capacity as a major contributor to the MEOSAR programme, following the signature of the 'Declaration of Intent to Cooperate on the Development and Evaluation of MEOSAR'. It is a programme to equip satellites that operate in medium-Earth orbits with payloads that receive signals from distress beacons on Earth. These signals are then relayed to rescue organisations, giving them the location of the emergency. *www.gpsdaily.com*

The scientific aspects of Galileo

A colloquium on the scientific and fundamental aspects of the Galileo (satellite navigation) programme will take place in Toulouse, France, from 1 to 4 October addressing three major issues: The fundamental aspects of navigation by satellites and Galileo; Scientific applications in meteorology, geodesy, geophysics, space physics, oceanography, land surface and ecosystem studies; and in Scientific developments in physics and dealing with future systems. *www.congrex.nl/07a06/*

EADS, Thales, Finmeccanica in pact on their future Galileo project role

EADS, Thales and Finmeccanica have reached an agreement in principle on sharing responsibilities for pressing ahead with their roles in the troubled European satellite navigation network Galileo, the daily Les Echos said, citing a source. *tfn.paris@thomson.com mjs/lce*

Giove-A test Campaign Completed

The test campaign using the large antenna at Chilbolton Observatory to analyse the navigation signals transmitted by Giove-A, has been successfully completed. Following its launch in December 2005, Giove-A began transmitting navigation signals. Analysis of these signals has involved several facilities, at ESA's European Space Research and Technology Centre, in the Netherlands, the ESA ground station at Redu, in Belgium, and the Rutherford Appleton Laboratory Chilbolton Observatory in the UK. Analysis of the signals has allowed some adjustments to be made, re-programming the spacecraft's navigation signal generation unit to compensate for changes to the signals introduced by the amplifier that boosts them for transmission to Earth and by a filter that protects adjacent frequency bands from interference.

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28 October - 2 November, Christchurch, New Zealand
http://www.conference.co.nz/index.cfm/surveyors2007/

Nav 07 The Navigation Conference & Exhibition
30 Oct 2007 -01 Nov 2007
www.rin.org.uk, conference@rin.org.uk

November 2007

IMTA (Asia Pacific) Annual Conference & Trade Show 2007
November 2 - 3, Gold Coast, Australia
imtaaspac@chariot.net.au, http://www.maptrade.org/events/displayevent.php?id=79

International Symposium and Exhibition on Geoinformation & International Symposium on GPS/GNSS
05 - 07 Nov 2007, Johar Bahru, Malaysia
http://www.fksg.utm.my/isg07/index1.html

Trimble Dimensions 2007
November 5-7, Las Vegas
www.trimbleevents.com

4th International Symposium on LBS and TeleCartography
8-10 November, Hong Kong, SAR, China
http://www.lsgi.polyu.edu.hk/LBS2007/

ACRS2007
November 12-16, 2007, Kuala Lumpur, Malaysia
http://www.macres.gov.my/acrs2007

27th INCA International Congress
Visakhapatnam, India
21-23 November 2007
http://www.hydrobharat.nic.in/lst_Circular_INCA_2007.pdf

14th Session of the Asia-Pacific Regional Space Agency Forum
21-23 November
Bangalore, India
www.aprsaf.org/text/ap14_info.html

ESRI South Asia User Conference 2007
29 - 30 November
Singapore
uc2007@esrisa.com
http://www.esrisa.com/pages/uc2007

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bseng@batelco.com.bh, http://www.engineer-bh.com/mest2007/

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GSDI-10 St. Augustine, Trinidad
February 25-29, 2008
http://www.gsdi.org/gsdi10/

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