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

No: DL(E)-01/5079/08-10
Licensed to post without pre-payment U(E) 28/2008-10
Rs.100

ISSN 0973-2136

www.mycoordinates.org

Coordinates

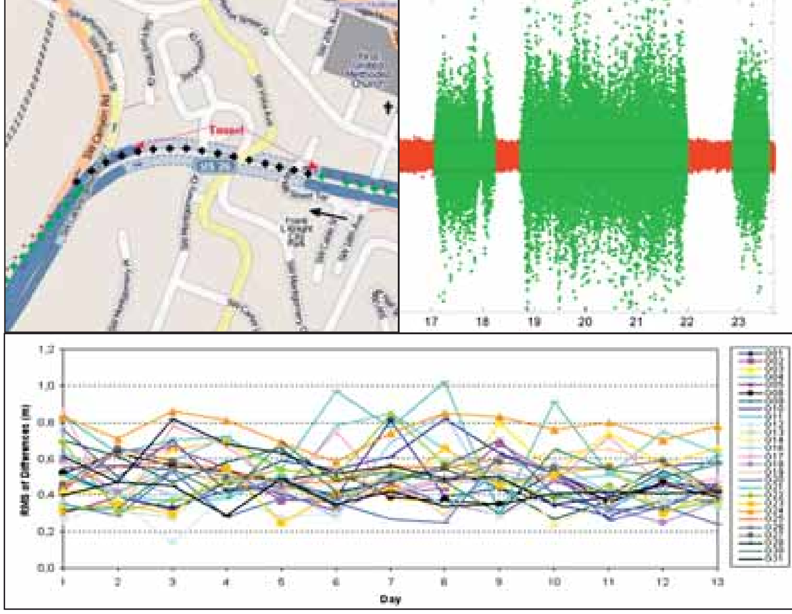
Volume VI, Issue 6, June 2010

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

PND vs MOBILE


SOUTH
http://www.southinstrument.com
http://www.southprecision.in
STAR S82T
Combine the high productive capacity of SOUTH with world's top-class technology. S82T helps you maximize the power of your employees
Trimble
Main board BD970 inside
SOUTH PRECISION INSTRUMENT PVT.LTD
Adress:FA-229B, Mansarover Garden, New Delhi-110015
Tel: +91-11-64563666
Fax: +91-11-45530854
Email:india@southsurvey.com

It's not just a picture.
It's image data
to fuel vital insights.
Lat: 42° 43' 60" N Long: 133° 04' 57" E
06.10.09 Resolution: .50m CE90%: 4m



In this issue

Coordinates Volume 6, Issue 6, June 2010

Articles

Columns

This issue has been made possible by the support and good wishes of the following individuals and companies André Malm, Bernd Zimmermann, Caroline Chow, Dominique Bonte, François Erceau, Gale, Hua Su, Jani Hautamäki, Jarmo Takala, Jussi Collin, Pavel Davidson, Roger Jollis, Rohan verma, and Tomas Miranda, and Ashtech, Foif, GeoEye, Hemisphere GPS, Javad, Navcom, NovAtel, Omnistar, South; and many others.

Mailing Address
11C Pocket A
SFS Mayur Vihar Phase III
Delhi 110 096, India.
Phones +91 11 22632607, 98102 33422, 98107 24567
Fax +91 11 22632607

Email
[information]talktous@mycoordinates.org
[editorial]bal@mycoordinates.org
[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

Designed at Thomson Press India Ltd.

Printer Thomson Press India Ltd., B 315, Okhla Phase I, New Delhi-110020, India

This issue of Coordinates is of 44 pages, including cover

ProMark 500

THE WINNING COMBINATION

BLADE™ TECHNOLOGY INSIDE

NEW VERSION AVAILABLE

More features, enhanced performance and a new price offer

ProMark™ 500

Multi-constellation RTK Surveying by Ashtech

The new ProMark™ 500 offers GPS+GLONASS+25 years of field-proven Ashtech technologies. Designed by our GNSS experts, this powerful survey solution delivers state-of-the art RTK features in a light, cable-free rover that gives you maximum mobility and flexibility in the field. Its unique GNSS engine insures fast initialization, long-range accuracy, robust signal tracking, and secures future constellation evolutions.

Offering a wide range of built-in communications and extensive equipment interoperability via the new FAST Survey™ field software, ProMark 500 is also the only survey equipment featuring a handheld GPS as field terminal ready for navigation and GIS data collection.

ProMark 500 encompasses all the RTK features that land surveyors expect for productive and reliable positioning and concentrates the best Ashtech technologies for the survey market.

Competitive Advantage:

- **BLADE™ GNSS technology**
- **Enhanced RTK accuracy**
- **Wide range of communications**
- **Cable-free lightweight design**
- **Rugged base & rover solution**
- **Multi-application field terminal**

For more information:
France(HQ) +33 2 28 09 38 00
China +86 10 5802 5174
APAC +65 983 842 29

professionalsales@ashtech.com

Visit www.ashtech.com today

ashtech™ BY MAGELLAN PROFESSIONAL

Adapt and survive

It is not the strongest,

Nor the most intelligent,

But the ones most responsive to change,

Survive.

So said Darwin.

With the advent of new species - Smart Phones, MIDs..

The landscape of satellite navigation industry is changing.

Once considered a powerful and promising navigation force,

The space of PND appears to be shrinking.

Probably there is a need to adapt.

And evolve.

Bal Krishna, Editor
bal@mycoordinates.org

PND vs mobile
Is landscape shifting?

With the growth of mobile phone and smart phone users and application builds upon it, PNDs are set to face a tough challenge from GPS-enabled mobile phones. While Google and Apple are set to redefine the navigation ambience, with terms like Mobile Internet Devices (MID) getting clearer definitions, it is still too early to say which direction the navigation markets will move in or what niche each one will create for itself. In the sphere of navigation, there are arguments in favor of PNDs but the same holds true for mobile based navigation also. So, the debate remains, is it PND or Mobile or both?

A shifting competitor landscape

Tomas Miranda
Consultant at Point Consulting, Singapore
Tomas.Miranda@point-consulting.com

On the back of recent announcements by Google and Nokia signaling their intentions to provide free turn-by-turn satellite navigation as applications on their smart phone devices, it is more clear than ever that the satellite navigation industry is on the brink of experiencing drastic changes. Once an industry dominated almost entirely by Personal Navigation Device (PND) manufacturers like Garmin and TomTom, mobile device manufacturers are emerging as a force to be reckoned with.

Critical success factors for smart phone entrants

The increased importance of smart phone manufacturers in the satellite navigation industry is a direct result of two trends – a natural tendency towards device convergence and an increase in demand for Location-Based Services (LBS). In a world governed by Moore's Law, in which increasingly powerful devices predictably become smaller and cheaper, there has always existed a trend towards device convergence in the realm of consumer electronics.

Device convergence happens consistently, as what was once an independent product becomes just a feature in a set – the combination of an email client and a telephone yield the Blackberry, adding a digital music player and a camera to the Blackberry yields an iPhone. With this trend in mind, it was inevitable that GPS and 3G-enabled smart phones would sooner, rather than later, incorporate turn-by-turn navigation applications, once only offered in PNDs. The inevitability of smart phones entering the satellite navigation industry is further driven by an increase in demand for LBS as in an increasingly interconnected world, 'where' people do things is becoming as relevant to consumers and marketers as 'what' it is that they are doing. Of course, the eventual success (or lack thereof) of smart phones in the industry is not to be taken for granted.

As in any case of device convergence, the combined tool must perform each task at least as well as the stand-alone device or at the very least, the benefit of convenience must outweigh the loss of functionality. While smart phones, primarily due to their inferior GPS technology and reduced screen sizes, are not yet able to fully substitute PNDs, they are also bound by other critical success factors that may further impede user acceptance around the world.

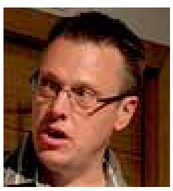
The uptake of smart phones as satellite navigation devices relies primarily on three key factors – the availability of affordable devices, the affordability of data plans and the reliability of the 3G infrastructure. While in certain advanced markets, like the United-States or Western Europe, for example, smart phones and data plans may be affordable to the average consumer, this is far from true in emerging markets, like most of South-East Asia. Also in stark contrast to the experience of the average American user experience, the issue of data roaming charges in markets in which cross-border travel is frequent can have a significant impact on the affordability of the 3G connection required for most turn-by-turn applications on smart phones. Meanwhile, while the 3G infrastructure is clearly much more ubiquitous and stable than ever before, its reliability is even being called into question in the United-Sates as more and more mobile devices are using it to surf the internet and are consequently overwhelming its current capacity.

With the rise of the iPhone and other smart phones, netbooks and the awaited emergence of tablet computers that all rely heavily on 3G networks, issues of dropped calls and general connectivity problems are all due to worsen and could impose a real obstacle for the use of 3G-reliant smart phones as satellite navigation devices – at least until network providers upgrade their network infrastructure to 4G.

What the future holds

Understanding the inevitable rise of smart phones as satellite navigation devices as well as the factors that will determine their eventual success, it is interesting to take a moment to ponder about the possible effects of this shift on the players involved. Smart phone device manufacturers and application developers seem determined to take as much market share as possible from PND manufacturers by offering their turn-by-turn applications for free. However, these new entrants should not assume that consumers will automatically accept their all-in-one device offerings. It was, for example, assumed that camera-phones would substitute digital cameras; instead, the two are now complimentary products. On the flipside are PND manufacturers that, while they need to be alert to the rising threat from smart phones, but also need to understand that the future is not as challenging as it may seem at first glance. The decreasing cost of PNDs, the currently low penetration levels in emerging markets and the rise of affordable in-car navigation systems all represent areas of growth for PND manufacturers. In particular, PND manufactures would do well to exploit their inherent advantage in the driving navigation segment, a result of their bigger screens and non-reliance on network infrastructures. In terms of the companies that produce the underlying maps used across navigation devices, the future looks bright. Creating a good map database is very costly and difficult and it therefore seems likely that any company looking to provide satellite navigation services – smart phone and PND manufacturers alike – will continue to look to purchase the underlying maps from third parties. With all this in mind, it can be concluded that while the underlying trends and drivers are clear, the winners and losers are far from picked. The winners will be those who can appropriately assess and take advantage of opportunites and defend their positions against emerging threats. These companies will need to develop strategies based on a robust understanding of the new environment, looking at both their internal capabilities and matching those with the demands of the evolving landscape they compete in.

The PND is destined for extinction



Gary Gale
Director of Engineering for the Geo Technologies group at Yahoo!
gary@vicchi.org

Attempts to predict the growth, success and uptake of technology are rife. Accurate predictions, less so. “There’s no reason for any individual to have a computer in his home”, said Ken Olsen, then founder and CEO of DEC in 1977. “I think there is a world market for maybe 5 computers” is apocryphally attributed to Thomas Watson of IBM in 1943.

It’s easy to say “well ... duh” with the benefit of hindsight in 2010 but consider this. The first generation of in-car GPS units appeared in 1996. If anyone had told you that 14 years later you’d be running something infinitely more sophisticated and customisable, more powerful than one of Olsen’s DEC VAX computers that I started out on, on a device that you stuck in your pocket and which, by the way connected to a global network of computers and was also a telephone, you’d probably not have believed them or suggested that at a minimum they cut their coffee intake back.

Fast forward back to 2010; the big two mapping data providers, Teleatlas and Navteq, have both been acquired, Garmin, once synonymous with GPS is looking increasingly less and less relevant and both Google and Nokia are offering full turn by turn navigation on mobile devices, for free.

So how will this play out? What will dominate? PNDs, telematics dashboard “info-tainment” systems or mobile phones? It’s probably going to be all three but not in their current form thanks to the headlong convergence of computer, phone, camera, internet terminal and PND.

In 1996 the first GPS navigation systems were the preserve of the high end, executive car marques; both prestigious and viewed as a luxury commodity they were the precursor of today’s info-tainment consoles. Skip to 2004 and TomTom’s GO was one of the first of the now ubiquitous PNDs at commodity prices. Six years later and GPS enabled mobile phones are capable of running the same, turn by turn navigation systems but for free and they come preloaded with the handset. Sensing that most consumers are unlikely or unwilling to pay for a dedicated PND when they can have a free navigation system on their mobile the market is reacting and we're seeing the first interfaces between smartphone and info-tainment consoles such as that from Harman and Nokia (http://www.gpsbusinessnews.com/Harman-and-Nokia-to-Interface-Cars-with-Smartphones_a2248.html).

Surely this means that we've come full circle and moving back to in-car based systems? I doubt it. The mobile offering has all the advantages; multi modal routing, pedestrian routing, your music collection, a camera, a phone, an internet console with email and social media apps yet none of the disadvantages; additional subscription cost, another gadget to carry, only works in the car.

The mobile phone and the in-car console are here to stay; the PND is destined for extinction. But like Messrs. Olsen and Watson, I could be wrong.

The PND is best suited for navigation

Roger Jollis
Marketing Director and Business Segment Leader, Garmin's Automotive OEM business
Roger.Jollis@garmin.com

The Portable Navigation Device, mobile phone navigation and embedded factory navigation all play a role and each has its own unique benefits and tradeoffs. Which system to recommend really comes down to segmenting the market and understanding user requirements. Let's briefly look at each solution space and discover where it might provide an optimized solution.

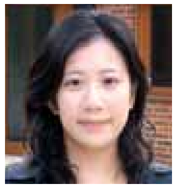
The PND has seen explosive growth over the past 4 years. Penetration has reached a point where it is no longer a curiosity for the gadget minded, but a mass market tool that can be relied upon to save time, money and nerves. Mass adoption has come with much lower prices which enables consumers to buy their second and third products which are left in the car, not circulated for family use. As single use device, the PND is best suited for its designed purpose: navigation. It does very well at this. But these affordable systems come with strings –or more accurately, with wires and suction cups.

Navigation on a smart phone is not a new concept, but it has taken off with the launch of app stores. As a multi use device, the smart phone provides the convenience of providing access to many applications. These phones don't come cheap even if maps are "free". When network costs area added up, a smart phone can be many times more expensive than a PND. Also, the navigation experience on these devices is not always as useful as a purpose-made device. Small screens and poorly tuned interfaces require user focus which can contribute to driver distraction. Applications are often poorly integrated resulting in conflicts between other features of the phone. Smart phone navigation might be best suited for the occasional/casual user. It is an attractive alternative for the pedestrian, where driving safety is not compromised.

The embedded factory navigation system is best suited to deliver a cleaner and much more convenient implementation. The device is always there in the vehicle. In vehicle systems are also better suited to include voice activated interfaces which reduce driver distraction. Vehicle data can facilitate other services such as eco-routing, eco-driving and to enhance driving economy and driver safety. All these conveniences come at a higher price at the time of vehicle purchase. But some of the cost of on-board navigation can usually be recovered when the vehicle is sold. Also, it has been found that vehicles sell 16% faster when they are equipped with navigation.

Garmin addresses all three embodiments of navigation. Whether it is a nüvi PND, a nüvifone or a Garmin factory navigation system, the central focus is intuitive ease-of-use and a robust navigation experience.

PNDs remain relevant



Caroline Chow
Analyst, Canalys
caroline_chow@canalys.com

The PND and smart phone industries performed very differently over the last 18 months. Despite the economic crisis that began in the second half of 2008, Canalys estimates that total smart phone shipments hit a new peak in 2009 with 166 million units, of which 81% had integrated GPS functionality. By 2013, Canalys expects 96% of smart phones will have integrated GPS. In contrast, the PND market shrunk worldwide last year after growing 18% in 2008. Canalys forecasts the PND market will continue to grow in Asia Pacific and Latin America between 2010 and 2013, but this will do little to offset the rapid declines in Western Europe and North America, which represented 82% of global PND shipments in 2009.

Assessing the development of the mobile phone and PND industries for the last two years, handset vendors have clearly shown they can satisfy consumers' needs and deliver revolutionary products. The entry of phones into the mobile navigation space has made it hard to promote the idea of using a dedicated device for turn-by-turn navigation to non-PND users, reducing the potential addressable market for PNDs. Hardware and user interface improvements, together with the wider availability of handset-based applications, have substantially changed smart phones' positioning and increased the popularity of using them as one of the main platforms for turn-by-turn navigation. The market dynamics were further transformed when Google and Nokia announced their respective free turn-by-turn navigation solutions in the last few months.

Conversely, the pace of innovation in PND hardware and software remained relatively slow over the same period. Moreover, PND vendors made various cost-cutting measures and substantially reduced their marketing spend in response to the poor global economic conditions in 2009.This, together with the wider availability of free or cheaper map updates, has provided fewer incentives for existing PND users to upgrade, extending the replacement cycle for this device category. Connected PNDs, which should provide a more revolutionary user experience, failed to impress the mass market and there are few reasons to believe this will change in the near future.

Despite the tangible connection between phones and PNDs, it is vital to highlight that one should not make a direct comparison between the market performances of the two categories. They are different platforms for turn-by-turn navigation, and a sale of an integrated GPS handset does not equate to one less PND being sold. PNDs and handset-based navigation solutions are optimised and much needed for different modes of travel, especially when the market still lacks a single user-friendly device that can truly provide a seamless, multi-modal mobile navigation experience.

Existing PND players are now in a much stronger position to defend the pricing and positioning of their products as the market continues to consolidate. They are also in a better position to work closely with their channel partners and devise more effective and mutually beneficial marketing campaigns. PND vendors must continue to deliver more distinct, revolutionary products – both hardware and software – at a much faster pace to attract existing and new customers.

Ongoing, relevant content developments will be vital to provide additional differentiators for PNDs in the future. Leading vendors, such as Garmin and TomTom, already have partnerships with various car manufacturers in different countries and products for both high-end and mass-market car models, but substantial scaling up of these automotive partnerships globally is desperately needed to increase PND penetration. Canalys does not believe the PND market will disappear, but market players will have very tough battles ahead. It will require considerable perseverance and resilience to evolve with the market and stay in the game.

The balance in favor of mobile navigation

Dominique Bonte
Practice Director, Telematics and Navigation
ABI Research
bonte@abiresearch.comabiresearch.com

The debate pitching PNDs versus handset-based mobile navigation continues unabated. While until about a year ago there was broad consensus about the strong position of PNDs due to their larger screens, optimized navigation user experience, and low price points several recent events have now shifted the balance in favor of mobile navigation.

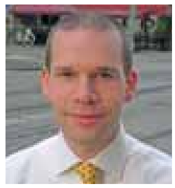
Firstly the unexpected boom in smartphones with large touch screens since 2009 – initially driven by the iPhone but soon copied by all major handset manufacturers – has brought the user experience of handset-based navigation much closer to the experience offered by PNDs. Secondly, both Nokia and Google have launched free turn-by-turn navigation on their Symbian and Android smartphones, further undermining the value proposition of PNDs. As smartphones continue to attract more users, mobile navigation will soon become a standard feature. Moreover, both Nokia and Google also offer free traffic information, Nokia even adds free city guides.

However, all this does not mean PNDs will disappear. Rather PND vendors will have to reposition their solutions by adopting a more segmented approach to the market. On one hand they will have to continue to develop state of the art, superior, connected PNDs offering a second to none navigation experience. However, obviously this will only attract the high end of the market consisting of high frequency, demanding users for which navigation is a critical function. On the other hand there will still be a market for very cheap basic PNDs addressing the low end of the market consisting of users preferring an out of the box experience which cannot be offered by mobile navigation.

PND vendors can no longer ignore mobile navigation. A look at the latest financial results of both Garmin and TomTom clearly shows the PND market is saturating in developed regions at best – even declining in regions such as Europe. Asia-Pacific and other developing regions still can expect growth but will also see the emergence of mobile navigation.

Finally, a new category of connected multi-purpose portable devices such as MIDs will also eat into the PND market, though in this case they will rather assimilate the PND category rather than displace it.

The PND is facing increased competition



André Malm
Senior Analyst, Berg Insight
www.berginsight.com

There are now more than 175 million turn-by-turn navigation systems worldwide, including about 35 million factory installed and aftermarket in-dash navigation systems, over 100 million Personal Navigation Devices (PNDs) and close to 40 million navigation-enabled mobile handsets with GPS. The PND device category is facing increased competition due to the adoption of handset-based navigation services and greater availability of low cost in-dash navigation systems. Berg Insight forecasts that PND shipments in both Europe and North America will peak around 2011 at roughly 20 million units per annum in each market respectively and decline thereafter. New markets in other parts of the world will partly compensate for the decline in Europe and North America. However, handset-based navigation services are likely to become especially competitive in markets where relatively few users can afford multiple devices.

In the past, PNDs have often provided a better user experience than handset-based navigation services thanks to

FOIF TS810 Ready!!!

- Windows CE 5.0 Operating System
- 300m Reflectorless Range(OTS)
- Large Full Colour Graphic Display
- Guide Light System
- Touch Screen
- Dual-Speed Drives
- Multiple Interface Options
- Built-in Temperature and Pressure Sensors

Perfect onboard software

FOIF FieldGenius 2010

TS810 combines with the most powerful surveying data collection software FOIF FieldGenius, they make your surveying work more productive and efficient.

- Map view with colored lines
- Powerful road module(3D)
- All the staking tools you will ever need
- Rich programs: azimuth/distance, area offsetting, intersection, poly-line, curve
- Volume calculations
- Import and stake directly from a DXF file
- Data import/export:DXF, SHP Rw5, LandXML
- Same user interface for TS810 &GNSS A20

FOIF Since 1958
It's professional
Suzhou FOIF Co.,Ltd.

For more information please visit at:
www.foif.com.cn
or email to: internationalsales@foif.com.cn

Or please contact with FOIF Dealer in India
JANAK POSITIONING&SURVEYING SYSTEMS PVT.,LTD
E-mail:janakji@vsnl.com Website: www.janakindia.com
Tel: 011-23515400,23515399 Fax: 011-23682185

larger touchscreens and user interfaces optimised for a particular task. However, new handset models such as smartphones with large screens and user interfaces optimised for touch control have closed the gap considerably. Rapid developments in handset user interfaces, software integration and hardware performance will make handsets even more competitive in the future. This will be true also for emerging low cost smartphones that will enable true mass market adoption of mobile applications. Increasing competition from players such as Google and Nokia is also leading to lower prices for handset-based navigation services.

What is more, handset navigation services are well suited as a complement to other solutions, especially for occasional users and those primarily interested in guidance outside the car. Pedestrian navigation features gradually being introduced include improved map data and multimodal navigation, which will enable users to plan routes taking into account all available modes of transportation including trains, busses and walking. Handsets are also better suited for other types of location aware applications beyond navigation that many users can benefit from on a daily basis.

PND vendors are increasingly focusing on new connected PND models and online services. Connected PNDs that make use of wireless connectivity to access dynamic content can improve the value of navigation devices in everyday situations. Features such as local search, traffic flow information and speed camera locations can be useful in both familiar environments as well as on trips to new places. PNDs are likely to be favoured by the minority of users that need navigation frequently and are therefore willing to purchase a dedicated device for this purpose.

Large screen is important

Rohan verma
Director
MapmyIndia
rohanv@mapmyindia.com

Users will choose to use navigation on those devices which offer a large enough screen to clearly view map and visual instructions, and also wherein they can have an uninterrupted navigation experience. Whichever device can provide users the best experience will win. What is important to note is that, navigation has become an integral part of the smartphone experience. We see more and more OEMs wanting to bundle navigation, and MapmyIndia powers some of the best smartphones in the business - Motorola Milestone and Micromax W900 to name a few. We see the PND and in-dash markets still growing fast as car manufacturers too want to offer this value to customers.

"We are now better, bigger and different"

says François Erceau vice president and general manager of Ashtech

While commenting on the name change from Magellan Professional to Ashtech you said, "Ashtech brings a remarkable legacy of technology, precision, and innovation, but the 'new Ashtech' is a venture for the 21st century." Would you like to elaborate?

Founded in 1987, Ashtech® has long played an important role in the progress of the precision positioning industry. We have been at the forefront of GPS technology, beginning with Z-tracking. We were the first to take advantage of the GLONASS constellation, the first with a GLONASS GNSS board (GG12, 1998), the first cable-less Survey GPS system (Locus, 1997), the first Internet-enabled GPS reference station (iCGRS, 2002) and the first Survey/GIS combined instrument (ProMark 3, 2005).

More recently, we introduced a line of incredibly compact professional grade GNSS products and an innovative series of handheld GPS/GIS receivers, the MobileMapper™ series. We are now better, bigger and different, which is why we say that Ashtech is a new venture for the 21st century. The initial business of the Ashtech brand was high-end precision products. The new Ashtech is composed of those high-precision products, but also now includes handheld solutions for GIS and survey users.

One noticeable change in the 'new' Ashtech is that it is without the Magellan Consumer Products Division. How does this change fit in with the overall strategy of Ashtech?

The original and lasting identity of the Ashtech brand was always been high-end precision products. The new Ashtech retains this high-precision product focus, adding handheld solutions for GIS and survey users. As Magellan Professional, we existed as a division of Magellan, the well-known GPS firm that focused on global consumer sales. Our owners then and now, Shah Capital Partners, have always placed a high priority and emphasis on Engineering. This focus continues as demonstrated by the extraordinary number of new offerings we are bringing to market this year. I think it is also interesting to note the same core employees have been through all these changes, and our mission has always stayed close to the Ashtech roots. As a leading GNSS solutions manufacturer, we intend to be visible and active on every market where GNSS positioning and precision are needed, on the highest end as well as on the entry level.

François Erceau

"We plan through 2010 a number of product launches and initiatives providing new and compelling Ashtech offerings to GNSS professionals." Can this statement be inferred as a 'back to business' strategy or an'expansion' strategy.

Both are true. We continue to serve the GNSS and GPS professionals with our well-known line of MobileMapper professional handheld GIS and mapping products and our GNSS land-survey products led by the ProFlex™ and ProMark™ product lines. The Ashtech product-launch roadmap for 2010 is very ambitious, with an unprecedented number of new products and initiatives for survey professionals. We've already launched several major upgrades to enhance our latest generation of products, as well as several completely new product introductions. These upgrades impact our GNSS board offerings, as well as marine and land-survey receiver product lines. It is our intention to maintain a fast pace in new technology and product introductions throughout the year.

In addition to incorporating GPS and GLONASS technology, Ashtech is also watching the emergence of other GNSS systems, including Galileo and Compass, and assessing the right time to add those capabilities to its products. "Right feature, right time, right price" is our motto. We want to further grow our OEM board and sensor business, and we are currently involved in many projects with machine control/guidance integrators. We are bringing innovation not only to the product side, but also on the business model side. We are, for example, very open to business partnerships.

Magellan is a well-established brand in the market today, what is your strategy to enable users to accept the 'Ashtech brand' without creating confusion between the two names?

The Magellan brand is well established, particularly in the consumer marketplace. It is equally true that Ashtech is a well established in the precision and professional market. In January 2009, when the consumer division of Magellan was sold to MiTAC a company based in Taiwan that transaction included the

Magellan brand name itself. We could have kept Magellan Professional name for three years based on our agreement with MiTAC, but we decided to accelerate the transition to a new brand name. We had the choice between either inventing something new or leveraging one of the best GNSS professional brands in the market. We have a powerful brand in Ashtech. In conversations with customers, distributors, and other business partners, we found a unanimous preference for the Ashtech name. Our professional customers are very happy to have the Ashtech brand back.

2009 with its financial crises saw a very cautious approach in most businesses. How you see the overall 'market' situation evolving in the coming months of 2010?

Thus far we are seeing good signs of recovery around the globe compared to 2009, and we expect this recovery to continue. Construction surveying suffered a great deal in 2009, and we see already that surveying is back up again, and we envision good growth for the remainder of 2010. GIS suffered less in 2009 than survey, since GIS is largely tied to public money. We don't expect to see growth in GIS as big as in survey in 2010, however the GIS/mapping segment is developing nicely for us, and the Ashtech MobileMapper range is winning market share on a steady basis. The most stable segment is our OEM technology group, which has always been an important and growing business for us.

Our global strategy is unified, but we approach each region differently. Some territories in particular are really successful for Ashtech. In Asia for instance, we have many projects in India, we are growing our dealer network in South-east Asia and we are making good inroads in China, where OEM customers are integrating our technology. We have also big plans for Australia where we have just signed Cody Corporation, a new master distributor.

In the Americas, the dynamics are particularly good in Latin America, especially Brazil and Argentina. In the EMEA region (Europe, Middle East and Africa), we are already up in 2010. We have really good and stable channels in Europe, and we are rapidly growing the African and the Middle East channels, where business is pretty good.

The Asian markets like India and China have embraced this technology in the past few years only, where do you see them five years from now?

India and China are rapidly growing areas and Ashtech is very well positioned in both regions. As a matter of fact our motto 'Right features, Right time, Right price' makes great sense in those markets which adopt technologies at a quick pace but also want to access solutions at affordable conditions. More specifically our MobileMapper and ProMark product ranges have been selected by big national civil or military organizations to improve the productivity of their mapping jobs. Our ProFlex products are also currently tested very successfully by various organizations with large scale needs in Surveying. Here again and every single time Ashtech is coming with the bespoke, easy-to-use and easy-to-learn solution as expected by each customer group.

> Our motto 'Right features, Right time, Right price' makes great sense in those markets which adopt technologies at a quick pace but also want to access solutions at affordable conditions.

The short term future looks very promising both in India and China. The initiatives of each government - GAGAN and Compass navigation systems - are contributing at all levels to a larger adoption of the GNSS equipments. It is clear that both areas will exhibit outstanding market growth both in quantity of users and in value and the whole industry will benefit from it. For those rapidly developing countries it is our belief that the Ashtech offering will be specifically of interest as granting incredible performances without unnecessary barriers of complexity to technology adoption.

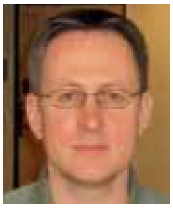
The world is headed for multi GNSS systems, how ready is Ashtech for such a scenario?

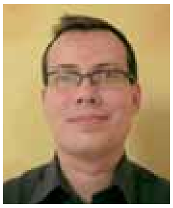
Ashtech has always been at the forefront of the technology. This has proven over the years with multiple patents and many firsts as explained beforehand. Today Ashtech is still ahead with our unique and patented BLADE technology optimizing the usage of GPS and GLONASS dual constellation. But BLADE is already tuned to accommodate the future constellations as GALILEO, COMPASS or the GPS modernization part of it. BLADE allows incredible RTK performances with long range and ultimate availability in urban canyons and under canopy. But BLADE also secures cross compatibility with other brands and within any RTK networks in a seamless manner.

Beyond current benefits Ashtech is already paving the way for the future steps in GNSS through strong contributions in the RTCM committee. Ashtech is for example leading the design of the suitable multiple signal messaging and formats for all the future signals to come. As part of the GNSS innovators Ashtech feels obligated to serve the user community to take the greatest benefits of the bright future that the GNSS modernization will bring.

GPS integrated sensors in mobile phones

The paper presents the development of portable car navigation system that can provide continuous reliable positioning even when GPS signals are not available


Pavel Davidson
Researcher
Department of Computer Systems, Tampere University of Technology, Finland
pavel.davidson@tuf.fi


Jani Hautamäki
Research Assistant
Department of Computer Systems, Tampere University of Technology, Finland


Jussi Collin
Senior Researcher
Department of Computer Systems, Tampere University of Technology, Finland


Jarmo Takala
Professor
Department of Computer Systems, Tampere University of Technology, Finland

Accurate and continuous position computation is a key task for vehicle navigation and telematics applications. In most portable car navigation and telematics devices, the position is determined based only on GPS data. However, in urban canyons stand-alone GPS suffers signal masking and reflections of the signal from buildings, large vehicles, and other reflective surfaces. Driving tests in such metropolises as Hong Kong, Tokyo, and New York show that the chance of receiving four GPS satellites required for navigation can be as low as 20% of total driving time [1]. Even when four or more satellites are available, strong multipath effect might cause a positioning error of more than 100 m.

In order to obtain uninterrupted navigation data in urban environment, GPS data can be augmented with a complementary navigation system that can work continuously in any type of urban environment [2]. This is known as an integrated navigation system. This article presents such an integrated GPS/DR (Dead Reckoning) navigation system.

We consider a DR configuration consisting of one gyro for directional measurements and 3D accelerometer. Both the gyro and accelerometers satisfy the requirements for mass market portable consumer devices: low cost, light weight, and low power consumption. An odometer is not used in the proposed system as it requires additional car installation; this system is intended mainly for portable devices such as mobile phones, GPS-based peripherals, and handheld GPS navigation devices. This paper shows how GPS data can be augmented with DR sensor data using an Extended Kalman Filter (EKF) to achieve the required navigation performance in urban environment. In the proposed system, the DR sensors are calibrated when GPS is available. If GPS signal is not available or GPS position accuracy suffers from multipath, the calibrated DR sensors are used to determine the position of the vehicle. Our field tests with a real-time prototype show that the proposed method improves the performance of vehicle positioning in high multipath signal environments and during short GPS signal outages.

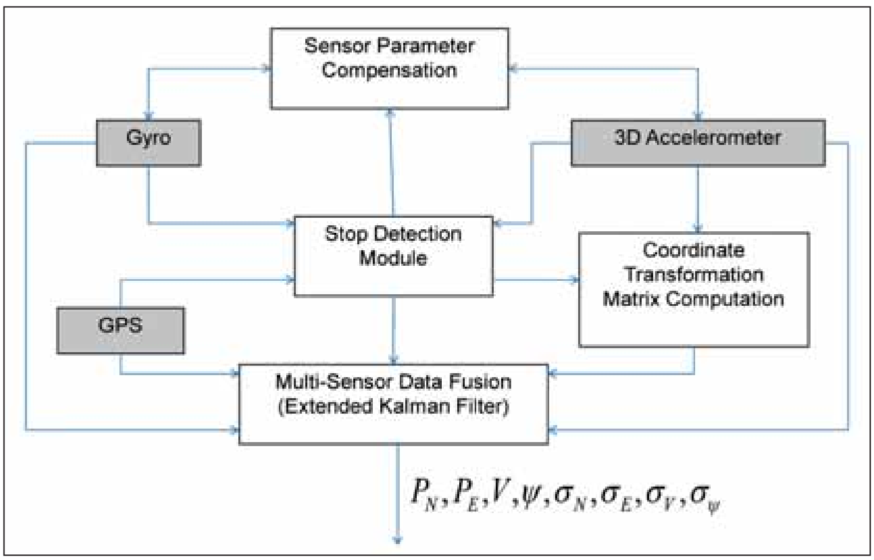


Fig1. Conceptual description of the navigation information sources and data flow for our portable car navigation system.

Integration concept

The proposed car navigation system includes different types of navigation sensors and technologies. Our concept of data fusion from multiple sensor technologies is illustrated in Fig. 1.

This methodology comprises several stages of data processing:

- Inertial sensors data for a stop detection;
- Inertial sensor data for position, velocity, and heading computations (DR computations);
- Calibration of the inertial sensors when a vehicle is stationary; and
- Integrated GPS/DR navigation solution.

The hardware parts of our navigation system are the shaded boxes.

To evaluate the performance of the proposed GPS/DR navigation system, a real-time prototype was built (fig. 2); a yaw-rate gyro (Analog Devices ADXRS150 [4]) and a 3D accelerometer

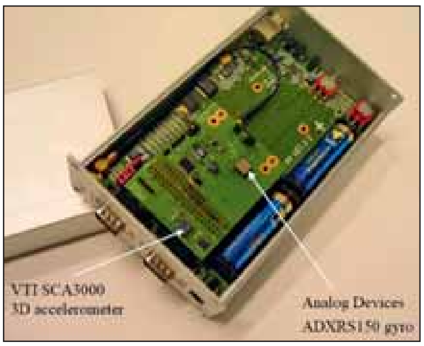


Figure2. Evaluation kit hardware. GPS receiver chip is located below the sensor board.

(VTI Technologies SCA3000 [5]) were selected as the dead reckoning sensors to augment an L1 GPS receiver (Fastrax IT03 [6], which is based on chipset by Atheros).

GPS and inertial sensors data fusion

The real time data fusion algorithm employs an extended Kalman filter (EKF) to combine computed GPS position, velocity, and heading with the acceleration and heading rate measurements provided by the 3D accelerometer and heading gyro. The EKF uses the values of the filter states to predict the future states through a dynamic model which is based on dead reckoning equations to estimate position, velocity, and heading. The dynamic model is given by

$$\dot{x} = \begin{bmatrix} \dot{P}_N \\ \dot{P}_E \\ \dot{V} \\ \dot{\psi} \end{bmatrix} = f(x) = \begin{bmatrix} V\cos\psi \\ V\sin\psi \\ a_L \\ \omega \end{bmatrix} \qquad (1)$$

where P_N, P_E are the vehicle north and the east positions, ψ is the vehicle heading, ω is the measured heading rate, V is the speed over ground, and a_L is the measured vehicle acceleration in the longitudinal direction. The vehicle frame longitudinal acceleration is calculated by transforming three-dimensional acceleration vector measured by accelerometers in the sensor frame into vehicle frame and calculating projection of the transformed vector on vehicle's longitudinal axes. It also includes the effect of gravitational forces due to unknown road grade. The measured acceleration in longitudinal direction is defined by

$$a_L = a + b_L + g\theta + w_{abc} \qquad (2)$$

where a is the vehicle longitudinal acceleration, g is the local gravitational acceleration, θ is the road grade, and b_L is the longitudinal acceleration error. In order to model accelerometer and gyro measurement errors and unknown road grade properly, the state vector x is augmented with two additional states: $\delta\omega$ gyro bias, and δa acceleration bias and misalignment (including unknown road grade). The augmented state vector is

$$x = [PN \quad PE \quad V \quad \Psi \quad \delta\omega]^T \qquad (3)$$

The states for the gyroscope and acceleration measurement errors were modeled as the first order Gauss-Markov processes. The observation vector is calculated by taking the difference between GPS and DR corresponding positions and velocities, and in some cases heading.

Alignment and calibration

In order to assist GPS with the gyro and accelerometers, initialization procedures have to be completed: initial alignment and calibration. The initial alignment procedure includes horizontal alignment based on the accelerometers outputs, yaw angle estimation using horizontal components of vehicle velocity, and azimuth alignment using external heading information. The initial calibration includes estimation of the accelerometer bias and misalignment, and also calibration of the gyroscope bias.

The horizontal alignment includes the estimation of the sensor frame orientation with respect to the pseudo vehicle frame [2]. The pseudo vehicle frame can be defined as follows: X axis corresponds to longitudinal axis of vehicle, Z axis corresponds to vertical axis of the local level, and Y axis completes the triad. When the vehicle is stationary, the outputs

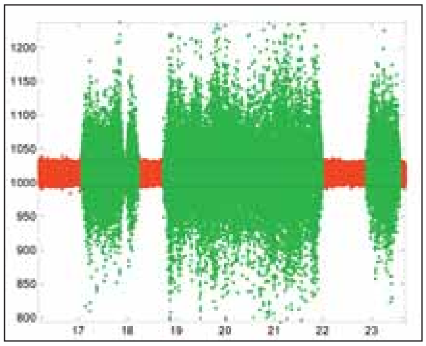


Figure 3. Magnitude of the acceleration vector. Red points show the acceleration (mg) during detected stop vs. time (min).

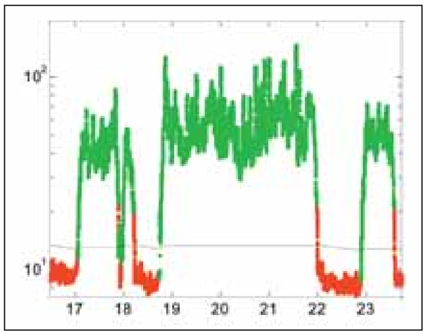


Fig 4. Mean quadratic deviation calculated in (6). Vertical axis is in logarithmic scale and time in minutes. The dashed line is the decision threshold. Red dots above the decision line are due to the time lag.

from the horizontal accelerometers are caused by the tilt of the sensor frame with respect to the local horizon and accelerometer biases. This effect can be compensated in the following manner:

$$\begin{bmatrix} 0 \\ 0 \\ g \end{bmatrix} = D_V^S \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix} \qquad (4)$$

where a_x, a_y, a_z are measured accelerations in the sensor frame, g is the gravitational acceleration and D_V^S is a coordinate transformation matrix from the sensor frame S to the pseudo-vehicle frame V. The horizontal alignment gives two Euler angles for transformation matrix D_V^S.

In reality, the alignment is usually performed in a place, which is tilted with respect to the local horizon by some small angle. In this case, the transformation matrix D_V^S will include this misalignment error, which in turn will result in errors when calculating the projection of the acceleration vector on vehicle's longitudinal axes. However, this misalignment error can be estimated quite accurately when the velocity computed by DR is compared with the GPS velocity. Therefore, the detrimental effect of misalignment error can be reduced when the vehicle's longitudinal acceleration is compensated with the estimated misalignment error.

Fig 5. Portland tunnel road test. The tunnel is about 300 m long.

Fig 6. Portland urban canyon test. This test route goes between tall buildings.

The yaw angle between sensor frame and vehicle frame can be estimated when vehicle is accelerating with constant direction [2] using the following kinematic relation:

$$\gamma = \arctan\left(\frac{V_y^H}{V_x^H}\right) \tag{5}$$

where V_x^H, V_y^H are the horizontal components of the vehicle velocity. The calculation of the yaw angle gives the third angle necessary for computation of the transformation matrix D_V^S.

In our navigation system, both the alignment and calibration are implemented in real-time and can be performed at any time when vehicle is stationary. It takes about 20 seconds to complete all these procedures in fully automatic mode. There is no need for the user to take any special actions. During and after the alignment the portable navigation device has to be fixed into a cradle.

The system has the capability to re-initialize alignment and calibration parameters at any time when it is not moving. The need for re-computation of alignment parameters may arise due to change in orientation of the device while on the move but the algorithm can detect such a change. This change can affect the gyro scale factor. The need for re-computation of accelerometer and gyro calibration parameters is caused by changes of accelerometer and gyro bias mainly due to temperature variations.

Stop detection module

The stationary state is detected by a stop detection module based on accelerometer information. Our stop detection algorithm is based on the analysis of the vehicle acceleration measured by the accelerometers and its variance. When GPS signals are available the velocity computed by a GPS receiver can also be used.

Since this algorithm has to be independent of the mounting angle of the device, the original measurements at time t_k from three accelerometers, $a_x(t_k)$, $a_y(t_k)$, $a_z(t_k)$, in sensor frame are transformed to a norm of the acceleration vector, $\vec{a}(t_k)$, since the norm of acceleration vector does not depend on the angles to which the device is mounted.

A typical example of the magnitude of measured acceleration vector during a test drive is shown in Fig. 3. Vehicle acceleration in horizontal plane depends significantly on the movement of the vehicle including road imperfections, measurement bias, and noise. As it can be seen from the curve, during a complete stop the variance of the signal is noticeably smaller since it contains only the gravitational acceleration, accelerometer noise, and engine vibrations. The short time bias drift is negligible. The sampling frequency of accelerometer in this example was 100 Hz.

During complete stops the variance of $\|\vec{a}\|$ drops down significantly. The optimal threshold can be found during a short initial learning phase. The mean and variance of $\|\vec{a}\|$ during a complete stop, μ_s and σ_S^2, respectively, are computed and stored.

The real-time implementation of this algorithm is based on the analysis of accelerometer data inside time window of predefined length. The time window length is one of the design parameters in this algorithm and usually chosen as 0.6–1.0 sec. Then the mean quadratic deviation of the acceleration samples from μ_s inside this time window is calculated as

$$\sigma_n = \sqrt{\frac{1}{N}\sum_{k=1}^{N}\left(x_k - \mu_s\right)^2} \tag{6}$$

where $x_k = \|\vec{a}(t_k)\|$ is the magnitude of accelerations at time t_k, $\vec{a}(t_k) = \left[a_x(t_k) \quad a_y(t_k) \quad a_z(t_k)\right]^T$, and N is the number of samples inside the time window. The decision about vehicle being moving or stationary is made based on computed deviation, σ_n, and variance of $\|\vec{a}\|$, σ_S^2; when $\sigma_n < p\sigma_s$, a complete stop is assumed. The parameter p was chosen empirically based on the results of drive tests.

This algorithm can work in all types of vehicles and has the ability to adapt to different conditions during short learning phase when GPS is available. The real-time version of stop detection algorithm employs the probabilistic approach. It analyses the accelerometers data within a moving window.

Experimental results

Our portable car navigation system was tested in road tests in urban environment that included tunnels, parking garages, urban canyons, and road interchanges. Figure 5 displays the system positioning performance during driving test in Portland, OR that included a 300 m long tunnel. The direction of the car motion is shown by the arrow. Magenta dots correspond to the standalone GPS receiver position measurements. It should be noted that there are no GPS solution in the tunnel. The green crosses for the trajectory on the map correspond to the combined GPS+MEMS computed position. The black dots correspond to the dead-reckoned solution when GPS signals were not available. The first GPS position fix was received approximately 4 sec after the car passed the tunnel making the total GPS outage about 18 sec. The error of GPS+MEMS computed position at that time was less than 20 m. This test shows that the combined GPS+MEMS solution provides significant improvement; accurate position, velocity, and heading information were available even in the absence of GPS signal.

Figure 6 depicts the test route in Portland downtown. This test route included high-multipath urban canyon environment in the vicinity of high-rise buildings. In some places, GPS position error caused by multipath was about 35 m. There are some time instances when the GPS signals were not available (black dots). This test shows improvements of the combined GPS+MEMS system performance in high-multipath environment, which is explained by the ability of the combined GPS+MEMS algorithm to filter out GPS position outliers.

Conclusions

This paper has shown that low-cost inertial sensors can significantly improve GPS positioning by continuing to output position during short GPS outages with sufficient accuracy for most of car navigation applications. The integrated GPS+MEMS system has also demonstrated improvement of position and velocity accuracy in high multipath urban canyon environment and the ability to provide continuous output of the vehicle heading even when vehicle is not moving. This is useful if we apply the map-matching algorithm. This device does not require any installation in the vehicle. It works in all vehicles and can be easily transferred between vehicles. Finally, it should be noted that our design is suitable for portable navigation devices since the cost, size, and power consumption of inertial sensors meet the requirements for mass market consumer electronics.

References

Zhang, X., Wang, Q., and Wan, D., "Map-matching in road crossings of urban canyons based on road traverses and linear heading change model," IEEE Trans. Instrumentation and Measurement, vol. 56, no. 6, pp. 2795–2803, Dec. 2007.

Chowdhary, M., Colley, J., and Chansarkar, M., "Improving GPS location availability and reliability by using a suboptimal, low-cost MEMS sensor set," in Proc. ION GNSS Int. Technical Meeting Satellite Division, Fort Worth, TX, Sept. 25–28 2007, pp. 610–614.

Davidson, P., Hautamäki J., Collin, J., and Takala, J., "Improved Vehicle Positioning in Urban Environment through Integration of GPS and Low-Cost Inertial Sensors", in Proc. ENC-GNSS , Naples, Italy, May 2009.

Analog Devices Inc., "ADXRS150 ±150°/s single chip yaw rate gyro with signal conditioning," datasheet, *http://www.analog.com/en/prod/0,2877,ADXRS150,00.html*

VTI Technologies Oy, "SCA3000-D01 3-axis low power accelerometer with digital SPI interface," datasheet, http://*www.vti.fi/en/products-solutions/products/accelerometers/sca3000-accelerometers/*

Fastrax Ltd., "IT03 development kit," technical specification, *http://www.fastrax.fi*

At a Glance

- GeoEye signs a multi-million dollar contract with ScanEx
- SuperGeo Technologies partnership with Datascrip in Indonesia.
- Infoterra France SAS and Spot Image SA fully integrated.
- Tele Atlas and Telogis agreement
- FLIR Systems, acquires Raymarine Holdings Limited.
- Pictometry agreement with Peace Map for China.
- GeoDigital International acquires Airborne 1 Corporation.
- Geosys, S.A. sole distributor of RapidEye in France.
- GISTEC appointed Master Distributor of PCI Geomatics in the Middle East.
- TomTom revenue up by 26% to €268 million in Q1 of 2010.
- Garmin revenue down 1% to $431 m, from $437 m Q1 2009.
- GeoEye revenue up by 77.8% to $80.4 m for Q1 ended March 31, 2010.
- Motorola is switching to Skyhook Wireless to provide hybrid positioning to their Android devices. Institute (CASI) C.D. Howe Award.
- The French defense procurement agency DGA awarded a $35 million contract to EADS Defense & Security and Thales.
- OSI Geospatial Inc. receives $4.0 million contract.
- The ION announced Dr. James Huddle winner of the Kershner Award.
- Allan Carswell, Founder and Chairman of Optech In, has been awarded the 2010 Canadian Aeronautics and Space Institute (CASI) C.D. Howe Award.

GPS + GLONASS + Galileo

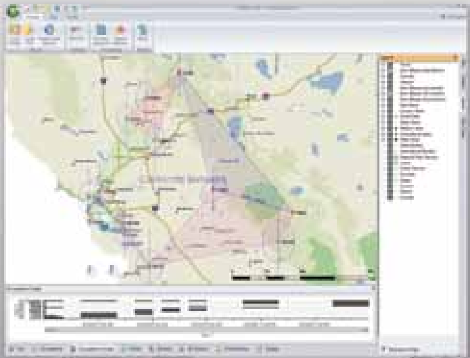
TRIUMPH 1

216 channels

TRIUMPH Technology

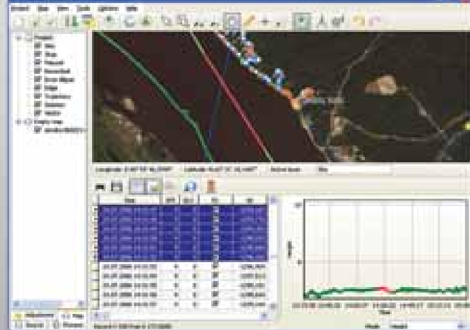
GISmore

stand-alone or inside the hat



Giodis

Full-featured office post-processing software



Justin

A comprehensive Survey and GIS software

You've ›

In 1983 I co-pioneered high precision GPS at Trimble, introducing the four-channel Trimble 4000-S geodetic receiver. I single-handedly wrote its complete software. It was the first commercial GPS geodetic receiver and it changed the geodetic survey industry.

June 30, 2010...

come ›

I founded Ashtech and in 1989 we introduced the first All-in-One, All-in-View 12-channel Ashtech L-12 GPS receiver, followed by Ashtech Z-12. These were the first truly portable geodetic receivers. We were also the first to integrate GPS and GLONASS satellites.

three new

a long way, ›

In 1998 I founded Javad Positioning Systems and introduced Legacy, Odyssey, and Regency GNSS geodetic products, followed by the 76-channel Prego and HiPer receivers. Other companies later copied HiPer. Today many GNSS receivers look like it.

revolutionary

survey.

In 2007 I founded Javad GNSS and introduced 216-channel TRIUMPH products and their OEM versions of ALPHA, DELTA, and SIGMA. We are again the first to commercially offer receivers which track current and future Galileo Satellites.

Javad Ashjaee

products!

4x4... ALL WILL DRIVE... RTK!

TRIUMPH-4x

Tracy
A versatile and powerful field software

JAVAD ArcPad Extension

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

- JAVAD ArcPad Extension enhances the spectrum of ArcPad's surveying capabilities by adding state of the art JAVAD GNSS solutions. JAVAD ArcPad Extension provides a full range of functions to control the GNSS receiver and manage the surveying process.
- JAVAD ArcPad Extension establishes a connection to the receiver via serial, USB, or Bluetooth and configures the base station parameters that govern the RTK and UHF radio setups, and GSM modem settings.

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

Please see www.javad.com for details.

Precise orbit determination of a Galileo/GIOVE-A satellite

Using double differences of carrier phase measurements between GPS/Galileo satellites

Hua Su
Thales ATM GmbH
hua.su@thalesgroup.com

Bernd Zimmermann
CAM Systems GmbH
bernd.zimmermann@cam-systems.de

Galileo is a satellite radio navigation system initiative launched by the European Union and the European Space Agency. Galileo will consist of a constellation of 30 satellites and ground stations providing position information to users.

Two experimental satellites were launched in 2005 and 2008 as part of the Galileo System Test Bed V2: GIOVE-A (Galileo In-Orbit Validation Element) and GIOVE-B (formerly GSTB-V2/B). The objectives of this mission are:

- to secure the Galileo frequency allocations by providing a signal in space
- on-board clock characterization
- MEO radiation environment characterization
- additional experimentation

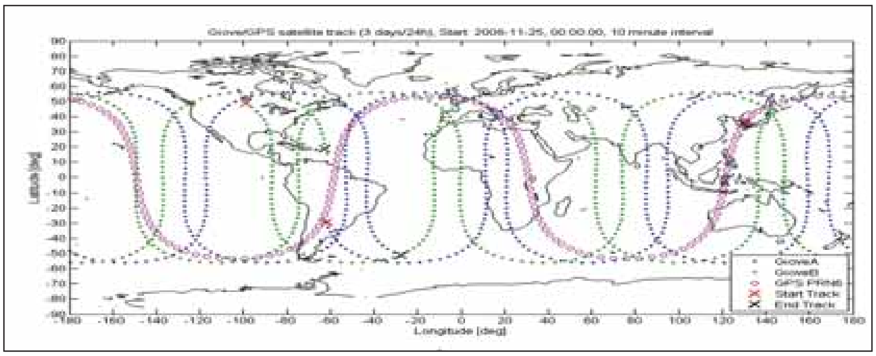


Fig 1 – Ground Tracks of GIOVE-A and GPS Satellite Orbits

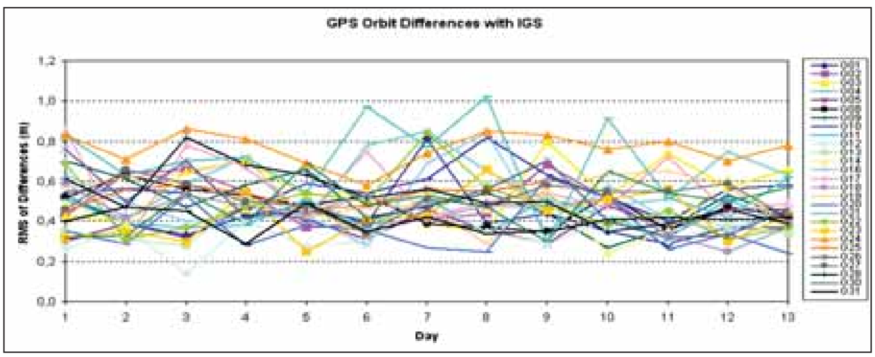


Fig 2 – Accuracy of GPS Orbit Compared with IGS Final Orbit

The GIOVE-A satellite payload transmitted two frequency signals at L1+E5 or L1+E6 [1]. There are 13 world wide located Galileo Experimental Sensor Stations (GESS) to track and monitor the GIOVE-A signals.

High accuracy of Galileo ephemeris or orbit is a key for successful application of Galileo satellite system for navigation. There are some reports [5], [6], [7], [8] about GIOVE-A orbit determination using code or carrier-phase smoothed code measurements. It is well known that the highest accuracy of satellite orbit can be achieved using double differences of carrier-phase measurements. For the GIOVE-A satellite, however, it is difficult to form such double differences as enough Galileo satellites are not in space. Therefore in this paper, a new innovative approach to form such double differences of carrier-phase measurements between a GIOVE-A satellite and GPS satellites is presented. The initial results using this method to determine a GIOVE-A satellite orbit are also presented. This method is called Double Differences of Carrier Phase Measurements Inter Constellations of GPS/Galileo (DDIC) [1].

The new method is developed and implemented based on the Bernese GPS software version 5.0 further reworked for the GalTeC REF (Reference) component [4].

GalTeC is a development project under contract with the German Aerospace Center DLR and supported by the Federal Ministry of Economics and Technology (BMWi).

The application of GalTeC [3],[4] is to provide value added services related to the provision of GNSS satellite-only services. It provides services linked to GPS, GLONASS, EGNOS and Galileo satellite systems. The services comprise offline functional and performance analysis of the GNSS systems. GalTeC in addition offers prediction capability for service level and service volume assessment.

Giove-A satellite Orbit vs. GPS satellite orbit

From the navigation users point of view, the GIOVE-A satellite orbit is a little different from a GPS satellite orbit. Each GPS satellite will complete two orbital revolutions around the earth for one day and the satellites will appear about 4 minutes earlier each day. For the users on the same sites the GPS satellite visibility is almost the same each day due to this reason. The GIOVE-A satellite, however, will complete 1.7 orbital revolutions around the earth for one day. Therefore the GIOVE-A satellite moves more slowly around the earth than GPS satellites. The satellite will rise about 6-7 hours later after one day and have a completely different path over the sky than the day before. Due to this difference, the ground monitoring stations can obtain more measurements from GIOVE-A satellite than from GPS satellites for the satellites with same altitude. About 3-4 days of measurements taking from one station can cover a whole arc of GIOVE-A satellite orbit. This is certainly a benefit for the accuracy improvement for orbit determination for GIOVE-A satellite, even with 13 GESS ground tracking stations.

Overview of GIOVE-A and GIOVE-B monitoring performance

Thales ATM started to monitor GIOVE-A and GIOVE-B SIS (signal-in-space) performance since 2007 using a Septenterio GPS/Galileo receiver in the frame of the project GalTeC.

Reception Status of GIOVE A and B

In table 1 the reception status of GIOVE-A and B for the months October and November 2008 are shown. A '1' means that there was a reception of GIOVE signals or the received data are valid. A '0.5' stands for partly correct reception (e.g. half a day) and a '0' means no or no valid data. Within this time period every day signals were received from the two satellites (columns: Reception). At the beginning of October no valid ephemeris (Eph) were sent from both GIOVE satellites (i.e. all data were zero or not reasonable). In the last two columns the received pseudoranges (PR) are evaluated. With the exception of 1.5 days GIOVE-A PRs are in the expected limits. GIOVE-B PRs are valid since October 22[nd]. The two red marked days mean that there was received a set of ephemeris, but without clock correction parameters (i.e. af0, af1 and af2 were zero). At the orange marked days the pseudoranges are partly out of the expected range limits (>40000 km for Giove B, < 18000 km for Giove A).

Due to the receiver setting a clock jump appears if the receiver clock error exceeds 500 µs. This leads to the jumps in the PR and carrier phase plots. The signal is tracked once the C/N_0 is bigger than 28 dBHz.

With the received ephemeris the orbits of GIOVE-A and B were calculated and compared with a solution derived from TLE (Two Line Elements). The differences in the norm of the position vectors reached from 40-100 km. The differences for GPS satellites are in a similar range.

After three days the GIOVE-A satellite has covered a distance of about 5.1 orbits (revolution time of approximate 14 h 05 m) (Figure 1). The start points are marked with red crosses and the final points with black crosses. For comparison a GPS track (from PRN6) is also shown in the figure. After one day the GPS PRN6 is almost at the same position as at the beginning of the track (revolution time of 11 h 58 m).

Giove-A orbit determination using DDIC

In order to use DDIC (Double Differences of Carrier Phase Measurements Inter Constellations of GPS/Galileo), some problems shall be solved in advance, first of all the synchronization of GIOVE-A

Table 1 – GIOVE-A/B Reception Status

		A	B	A	B	A	B
Date	DoY	Reception		Eph Valid		PR Valid	
Oct.01	275	1	1	0	0	1	0
Oct.02	276	1	1	0	0	1	0
Oct.03	277	1	1	0	0	1	0
Oct.04	278	1	1	0	0	1	0
Oct.05	279	1	1	0	0	1	0
Oct.06	280	1	1	0	0	1	0
Oct.07	281	1	1	0	0	1	0
Oct.08	282	1	1	0	0	1	0
Oct.09	283	1	1	0	0	1	0
Oct.10	284	1	1	0	0	1	0
Oct.11	285	1	1	0	0	1	0
Oct.12	286	1	1	0	0	1	0
Oct.13	287	1	1	0	0	1	0
Oct.14	288	1	1	0	0	1	0
Oct.15	289	1	1	0	0	1	0
Oct.16	290	1	1	0	0	1	0
Oct.17	291	1	1	0	0	1	0
Oct.18	292	1	1	0	0	1	0
Oct.19	293	1	1	0	0	1	0
Oct.20	294	1	1	0	0	1	0
Oct.21	295	1	1	0	1	1	0.5
Oct.22	296	1	1	0	1	1	1
Oct.23	297	1	1	1	1	1	1
Oct.24	298	1	1	1	1	1	1
Oct.25	299	1	1	1	1	1	1
Oct.26	300	1	1	1	1	1	1
Oct.27	301	1	1	1	1	1	1
Oct.28	302	1	1	1	1	1	1
Oct.29	303	1	1	1	1	1	1
Oct.30	304	1	1	1	1	1	1
Oct.31	305	1	1	1	1	1	1
Nov.01	306	1	1	1	1	1	1
Nov.02	307	1	1	1	1	1	1
Nov.03	308	1	1	1	1	1	1
Nov.04	309	1	1	1	1	1	1
Nov.05	310	1	1	1	1	1	1
Nov.06	311	1	1	1	1	1	1
Nov.07	312	1	1	1	1	1	1
Nov.08	313	1	1	1	1	1	1
Nov.09	314	1	1	1	1	1	1
Nov.10	315	1	1	1	1	1	1
Nov.11	316	1	1	1	1	1	1
Nov.12	317	1	1	1	1	1	1
Nov.13	318	1	1	1	1	0	1
Nov.14	319	1	1	1	1	0.5	1
Nov.15	320	1	1	1	1	1	1
Nov.16	321	1	1	1	1	1	1
Nov.17	322	1	1	1	1	1	1
Nov.18	323	1	1	1	1	1	1
Nov.19	324	1	1	1	1	1	1
Nov.20	325	1	1	1	1	1	1
Nov.21	326	1	1	1	1	1	1
Nov.22	327	1	1	1	1	1	1
Nov.23	328	1	1	1	1	1	1
Nov.24	329	1	1	1	1	1	1
Nov.25	330	1	1	1	1	1	1
Nov.26	331	1	1	1	1	1	1
Nov.27	332	1	1	1	1	1	1
Nov.28	333	1	1	1	1	1	1
Nov.29	334	1	1	1	1	1	1
Nov.30	335	1	1	1	1	1	1
Days		61	61	39	41	59.5	40.5
Percentage		100.0	100.0	63.9	67.2	97.5	66.4

satellite measurements with the GPS time reference; secondly the determination of different time reference biases between GIOVE-A and GPS satellites; thirdly the determination of different system biases between GPS and GIOVE-A satellites due to different coordinate systems and different system configuration and finally the weight normalization of GIOVE-A and GPS measurements for unified processing.

Time Synchronization

The synchronization of GIOVE-A satellite measurements with the GPS time reference is implemented as follows.

- perform PVT to get the GNSS receiver clock solutions using GPS broadcast ephemeris only
- applying the receiver clock corrections to both GPS and GIOVE-A measurements

The receiver clock correction related to the GPS time reference is solved and applied to GIOVE-A measurements. The step (2) implies that GIOVE-A measurements are synchronized with the GPS time reference. The remaining time errors in GIOVE-A measurements are GIOVE-A satellite clock errors including the different time reference bias which can be corrected after the GIOVE-A satellite clock errors are determined in the later steps. Then the GIOVE-A satellite can be treated as another GPS satellite for further processing. The next steps for data processing are to form single differences of measurements and to detect and repair cycle slips in the measurements.

RINEX3	C1	C2	P1	P2	L1	L2
GPS	C1C (C/A)	C1P (P1)	C1P (P1)	C2P (P2)	L1C (L1)	L2P (L2)
GIOVE-A	C1B (E1)	C5I (E5a)	C1B (E1)	C5I (E5a)	L1B (E1)	L5I (E5a)

Table 2–GPS and GIOVE-A Measurement Relations

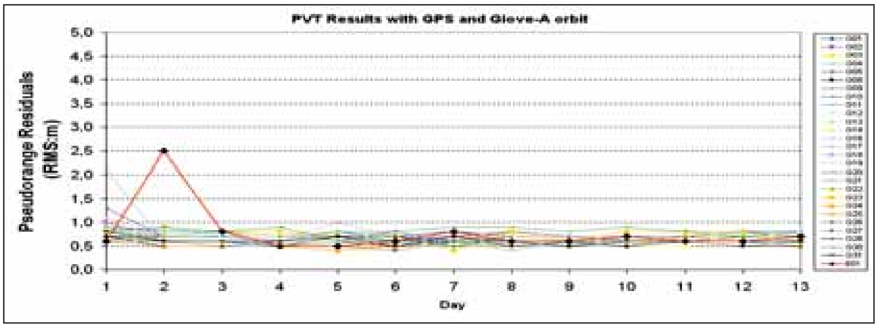


Fig 3 - PVT Results with GPS and GIOVE-A Satellite Orbit for the Site Kiruna

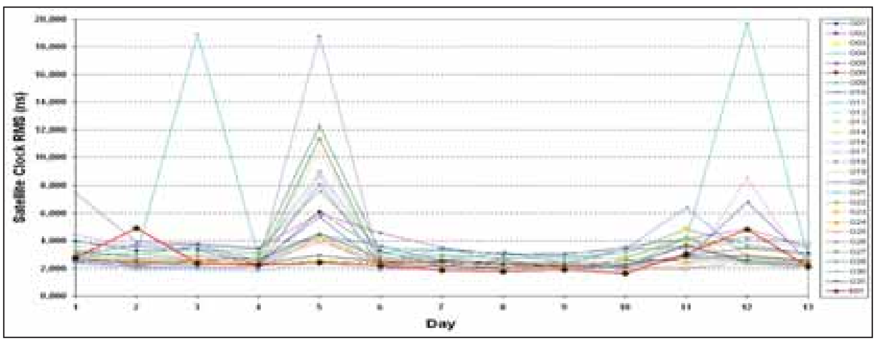


Fig 4 – Satellite Clock Solution (RMS: ns)

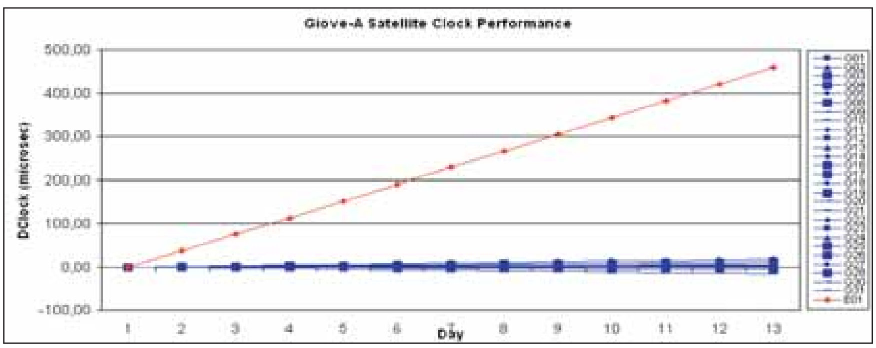


Fig 5 – GIOVE-A and GPS Satellite Clock Performance

Different System Bias

The different system bias (or inter-system bias) is caused by different coordinate systems and the different system configuration between GPS and GIOVE-A satellites. The different system bias is introduced into the data processing for GIOVE-A and GPS orbit determination, but it cannot be directly separated at first. The bias is solved in a sequential approach, i.e. for the initial orbit determination, the different system bias is assumed to be zero. Thereafter GIOVE-A and GPS orbits as well as satellite clock corrections are determined. Then a PVT for each monitoring station will be performed again to solve the different system bias. The final orbit determination will be executed after the GIOVE-A measurements are corrected for the solved system bias.

Weight of GIOVE-A Measurements

The following factors are considered for the weighting of GIOVE-A measurements: satellite orbit characteristics (altitude and movement, etc.) and measurement accuracy. Since GIOVE-A measurements are synchronized with the GPS time reference, the GIOVE-A satellite is treated like another GPS satellite in the data processing. In order to simplify data processing for GIOVE-A and GPS measurements together, the weight of GIOVE-A carrier-phase measurements is assumed to be the same as for GPS measurements. The standard error is assumed to be 1 mm for GIOVE-A carrier-phase measurements.

Initial Orbit

In order to perform orbit determination of GNSS satellites or orbit improvement, the so-called initial orbit of GIOVE-A and GPS satellites is necessary. The initial GIOVE-A orbit can be obtained from the NORAD TLE or GIOVE-A broadcast ephemeris if the navigation ephemeris from GIOVE-A is valid or a predicted GIOVE-A orbit e.g. from ESTEC. The initial GPS orbit can be easily generated from the GPS broadcast ephemeris.

GIOVE-A Orbit Determination and Satellite Clock Solution

With initial GIOVE-A and GPS satellite orbits and all measurements from GIOVE-A and GPS satellites synchronized with the GPS time reference, double differences of carrier-phase measurements of ionosphere-free combinations between GIOVE-A and GPS satellites inter constellations (DDIC) can be formed to determine GIOVE-A and GPS satellite orbits together, i.e. DDIC can be formed as follows:

- If GIOVE-A measurements are synchronized with the GPS time reference, the time scale of the GIOVE-A satellite can be considered as GPS time and the GIOVE-A can be considered as another GPS satellite. For GPS and GIOVE-A carrier-phase measurements DDIC are then formed as follows.

$$\nabla\Delta\varphi^{ddic} = \Delta\varphi_{kl}^{GPS_i} - \alpha\Delta\varphi_{kl}^{Giove-A}$$

- For GPS carrier-phase measurements among GPS satellites, DD can be formed as usually by the following equation:

$$\nabla\Delta\varphi^{dd} = \Delta\varphi_{kl}^{GPS_i} - \Delta\varphi_{kl}^{GPS_j}$$

where

$\Delta\varphi$ is the single difference between stations k and l for one of the GPS satellites or for the GIOVE-A satellite. The superscript indicates the satellite types. $0<a\leq 1$ is determined by GIOVE-A carrier frequencies.

In forming double differences, the GIOVE-A satellite is not used as a reference satellite, therefore except for the GIOVE-A satellite, most of the double differences of measurements are still formed among GPS satellites and in this case the best accuracy of GPS and GIOVE-A orbit determination can be achieved.

In the orbit determination, the double differences among GPS satellites (DD) and the double differences between GPS and GIOVE-A satellites (DDIC) are processed together. Therefore, the accuracy of the GPS orbit determination is also impacted by the GIOVE-A measurement errors due to DDIC and vice versa for the accuracy of GIOVE-A satellite orbit. The orbit determination results are generally called DDIC results.

After the GIOVE-A and GPS satellite precise orbits are determined, the precise satellite clock solution can be obtained using pseudorange or carrier-smoothed pseudorange measurements with the new improved GIOVE-A and GPS satellite orbit determined by the orbit determination phase.

Initial results

Precise Orbit Determination Results

The raw measurements in the period from January 9, 2008 to January 21, 2008 from a ESA/ESTEC 13 GESS monitoring station network are used for GIOVE-A and GPS orbit determination [2].

The GIOVE-A and GPS satellite raw measurements with a sample rate of 1 second are in RINEX 3 format. This data set has been kindly provided by ESTEC.

Table 2 shows the measurement types used for GIOVE-A and GPS orbit determination. The orbit determination is processed on a daily basis, i.e. a one-day satellite orbit arc is determined using all measurements on that day. If the precise GIOVE-A and GPS satellite orbits are determined for a day, the orbits are predicted for the next day as the initial orbits, then the measurements from the next 24 hours are used for the precise orbit determination for that day. The process goes on in this way until all data has been processed.

When the residuals of the double difference among GPS satellites (DD) and the residuals of double difference between GIOVE-A and GPS satellites (DDIC) are plotted no significant differences between DD and DDIC are found. The residuals of DD and DDIC are both at ± 6 mm levels. It shows that the DDIC method is correct and able to be used for orbit determination of the GIOVE-A satellite with GPS satellites together.

In order to further demonstrate the accuracy of daily orbit determination using the DDIC method, the results of precise GPS satellite orbits determined with the GIOVE-A satellite together are compared with IGS final orbits, the accuracy is evaluated as follows:

$$\sigma_x^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i^{ddic} - x_i^{igs})^2$$

$$\sigma_y^2 = \frac{1}{N-1}\sum_{i=1}^{N}(y_i^{ddic} - y_i^{igs})^2$$

$$\sigma_z^2 = \frac{1}{N-1}\sum_{i}^{N}(z_i^{ddic} - z_i^{igs})^2$$

$$\sigma^2 = \sigma_x^2 + \sigma_y^2 + \sigma_z^2$$

where

x_i, y_i, z_i are coordinates of a satellite in the WGS 84 coordinate system for a time epoch. The superscript *ddic* means the results of the orbit determination using DDIC method and *igs* the IGS final orbit.

The comparison results (σ) are shown in the Figure 2. In the figure the accuracy of the GPS orbit determination on a daily basis can achieve a level of around ±0.5 m. As the GIOVE-A satellite orbit can not be directly compared with a corresponding IGS orbit, its accuracy between ±0.2 m and ±0.8 m levels can be indirectly deduced from the shown GPS results in Figure 2 because no significant differences of residuals are found between DD and DDIC.

The accuracy of the GIOVE-A orbit can be further checked by comparing PVT results solved with GPS satellite orbits only and with both GPS and GIOVE-A satellite orbits together. Figure 3 shows the PVT results solved with GPS and GIOVE-A orbits. The figure displays that the RMSs of residuals of GPS pseudorange C/A code measurements are below ±1.0 m. The RMSs of residuals of GIOVE-A pseudorange measurements (C1B/E1) are also below ±1.0 m except on the second day (i.e. January 10, 2008). It is also indirectly shown that the accuracy of the GIOVE-A satellite orbit is compatible to the accuracy levels of GPS satellite orbits.

When PVT results are solved with the GPS broadcast ephemeris only, the RMSs are worse and reach values of up to ±5 m.

Results of Satellite Clock Solutions

Satellite clock corrections can be determined using pseudorange or carrier-smoothed pseudorange measurements after the GPS and GIOVE-A satellite orbits are determined. The Figure 4 shows the satellite clock daily solutions from January 09, 2008 to January 21, 2008, obtained from the data processing using pseudorange measurements with the GIOVE-A and GPS orbits determined using the DDIC method. From the figure it is seen that most of satellite clock solutions are in ns (10^{-9}) levels of accuracy. Figure 5 shows the satellite clock accumulation errors from January 09, 2008 to January 21, 2008. The accumulation errors of the satellite clocks since 09.01.2008 are calculated as follows,

$$\Delta clock_i = clock_i - clock_0 ,$$

where $clock_0$ satellite clock corrections at 00:00:00 on January 09, 2008

$clock_i$ satellite clock corrections from 00:00:00 January 09, 2008 to 00:00:00 January 21, 2008

From the figure it can be seen that the GIOVE-A satellite clock correction changed about 450 µs from January 09, 2008 to January 21, 2008, but the GPS satellite clock corrections changed only about 18 µs (see Figure 6) during the same period. It is unclear why the GIOVE-A clock shows such large changes. The Figure 7 and Figure 8 show the satellite clock daily change rates. GPS satellite clock corrections show about ±1.5 µs of daily change rate, but GIOVE-A shows about 40 µs daily.

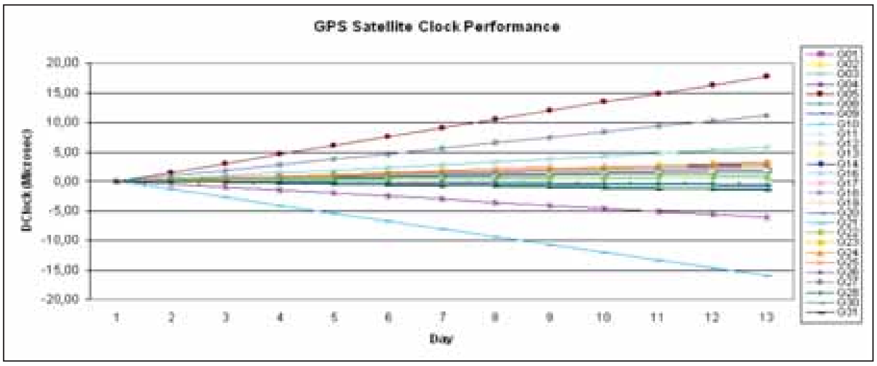


Figure 6 – GPS Satellite Clock Performance

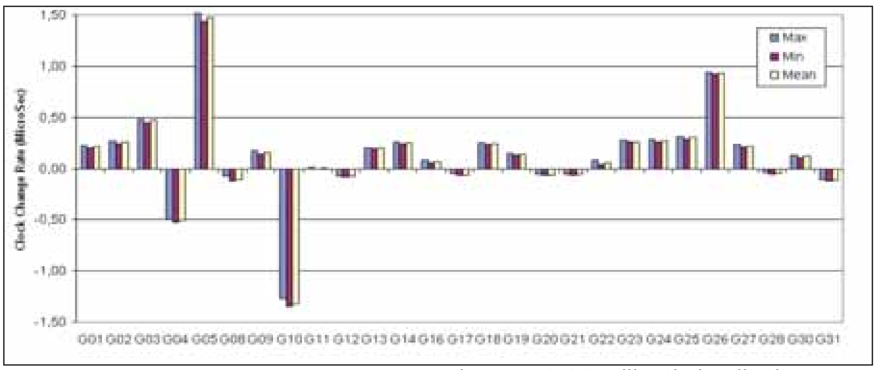


Figure 7 - GPS Satellite Clock Daily Change Rate

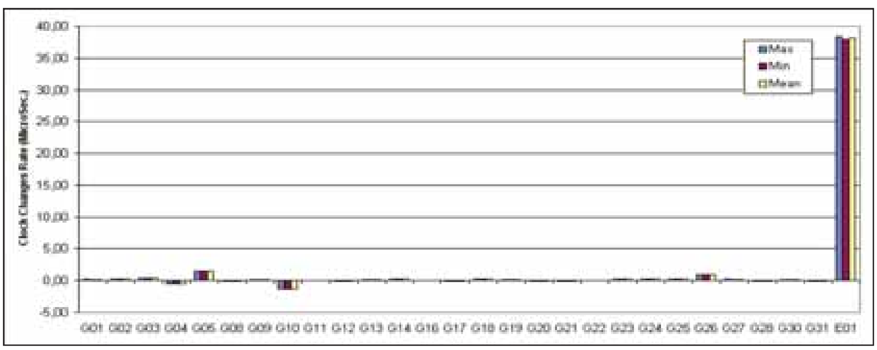


Fig 8 – GIOVE-A and GPS Satellite Clock Daily Change Rate

Conclusion

The GIOVE monitoring shows that since end of October 2008 the data are continuously received and are reliable and usable for navigation purposes (with GPS satellites). The orbit parameters with the received ephemeris were checked with TLE orbits as a first rough evaluation whether the ephemeris data are applicable.

Using double differences of the GIOVE-A satellite carrier-phase measurements for precise orbit determination can achieve relatively high accuracy of results. Due to fact that currently not enough Galileo satellites are in space, the only way to form double differences of carrier-phase measurements is to form double differences between GIOVE-A or GIOVE-B and GPS satellites (DDIC). In order to form such double differences, the GIOVE satellite measurements shall be synchronized with the GPS time reference. The different time reference bias, system bias and so on shall also be solved. The results of daily orbit determination using the DDIC method and the related PVT results with the GIOVE-A orbit show indirectly that the accuracy of the such determined GIOVE-A satellite orbit can achieve ±0.2 m – ±0.8 m levels. The most of satellite clock solutions can also reach ns levels. Therefore, the DDIC method as a new approach can be used for high accuracy of Galileo satellite orbit determination.

Acknowledgments

The DDIC method is developed and implemented based on the Bernese GPS software version 5.0 within the project GalTeC supported by the DLR on behalf of the German Ministry of Economics and Technology.

The GIOVE-A measurements used for the development and validation

of the method was kindly provided by ESTEC/ESA in Noordwijk.

We would like to take this opportunity to thank our colleagues, Dr. Blomenhofer, Mr. Ehret, Mr. Glaser, Mr. Kubitz, Mr. Monzel and Mr. Rosenthal for their support and comments.

References

H. Su, B. Zimmermann: Precise Orbit Determination of a Galileo/Giove-A Satellite using Double Differences of Carrier Phase Measurements Inter Constellations of GPS/Galileo and Initial Results, ION ITM 2009, Anaheim, CA, USA *http://www.giove.esa.int*

W. Ehret, H. Su, E. Kubitz, O. Glaser, E. Blomenhofer: Continuous GNSS Performance Monitoring, Prediction and Information Services via GalTeC, ION GNSS, 16-19 September 2008, Savannah, Georiga, USA

E. Rooney, M Unwin, G. Gatti, M. Falcone, S. Binda, M. Malik, D. Hannes: GIOVE-A In Orbit Test Results, ION GNSS 2007, Fort Worth, TX, USA

A. M. Garcia, R. Piriz, V. Fernandez, D. Navarro-Reyes, F. Gonzalez and Jörg Hahn: GIOVE Orbit and Clock determination and Prediction: Experimentation Results, ENC 2008, Toulouse, April 22-25, France

M. Heinze, D. Svehla, D. Voithenleitner: Kombinierte Prozessierung der GIOVE-A- und GPS-Beobachtungen der Galileo Experimental Sensor Stations, FGS Workshop, 16.-18.07.2008, Bad Kötzting, Germany

Jörg H. Hahn, Francisco Gonzalez, Pierre Waller, Daniel Navarro-Reyes, Ricardo Píriz, Álvaro Mozo, Virginia Fernández, Marta Cueto, Patrizia Tavella, and Ilaria Sesia: GIOVE-A Apparent Clock Assessment and Results, 39th Annual Precise Time and Time Interval (PTTI) Meeting, November 26 – 29, 2007, Long Beach, California, USA

The complete paper is available at www.mycoordinates.org

Galileo update

Galileo sat-nav contest gets underway

An industry group is attempting to drum up interest in the European Galileo satellite positioning system with a contest featuring £435,000 in prizes. The 2010 Competition looks to kick-start commercial exploitation of the Galileo system and has a large prize pot to get businesses interested. Winners from each country participating in the contest will also be entered for the Galileo Masters Prize, which promises an additional £17,000 to the business with the best idea. *www.V3.co.uk*

Galileo satellite engineering model testing

The Engineering Model of the Galileo In-Orbit Verification satellites has completed several phases of testing in cooperation with the ground segment and is now being prepared for electromagnetic compatibility testing. The second in a series of System Validation Tests (SVT-0B1) has been executed from the Galileo Launch and Early Orbit Phase Operations Control Centre at CNES in Toulouse, France. A number of important tests were performed on the platform subsystems, including Attitude and Orbit Control System mode transitions, power subsystem and transponder functional tests and onboard computer tests. The purpose of an SVT is to verify the ground infrastructure needed to operate the satellite during its mission, including the flight operations procedures. Following completion of the SVT-0B1 tests, the Engineering Model (EM) satellite has been placed in its final, closed-panel configuration and transferred to the electromagnetic test chamber at Thales Alenia's facility in Rome. Here, the Integrated Satellite Test (IST) and electromagnetic compatibility (EMC) testing will be performed after a period of test development. *www.esa.int*

All four IOV platforms together for the first time

While the engineering model is undergoing testing, all four platforms for the Galileo In-Orbit Verification satellites have now arrived in the integration cleanroom at Thales Alenia Space in Rome. The first platform, for the proto-flight satellite, is fully assembled and is undergoing its final functional tests. Upon delivery of the payload, the two elements will be mated before undergoing a series of environmental tests. Flight Model 2 is completing its avionics function tests and being prepared for integration of the power subsystems. The avionics units are being mechanically and electrically integrated on FM3. The platform is now ready for the functional test. FM4 arrived in Rome in March and is having its harness installed and instrumentation integrated. *www.esa.int*

EU`s Satellite Navigation Coordinator visits Taiwan

Michel Bosco, the European Commission`s GNSS Coordinator for Applications, was in Taiwan to take part in the 2010 Galileo Executive Forum. Bosco called upon Taiwan high-technology companies including MediaTek Inc., SkyTraq Technology Inc., Garmin Corp., and Quanta Computer Inc. to discuss possible cooperation opportunities. The Ministry of Economic Affairs (MOEA) estimated that Taiwanese companies are expected to win US$20 billion in business opportunities in the Galileo satellite system in the initial stage if all goes as planned. *http://news.cens.com*

GPS problems pose security concerns

The most recent upgrade to the GPS ground control segment created an incompatibility issue with a specific type of military GPS receiver used on at least 86 different US weapon systems, some of which cannot be used until the problem is fixed, according to the US Air Force. In current circumstances, approximately 8,000 to 10,000 Selective Availability Anti-SpoofingModule (SAASM) GPS receivers deployed in a variety of weapon systems are having trouble authenticating a new messaging format implemented as part of an upgrade to the GPS Operational Control Segment. The prime contractor for the GPS ground system is Boeing Defense, Space & Security of St. Louis. The only other affected weapon system is the US Navy's X-47B, an unmanned combat aerial vehicle demonstrator built by Northrop Grumman. *www.spacenews.com*

GPS IIF satellite launched

The US Air Force finally launched the first GPS Block IIF satellite recently. GPS IIF is the first of a new generation of GPS satellites going into orbit. This will be the first GPS mission to launch on a Delta 4, after 49 missions launched atop the smaller Delta 2 between 1989 and 2009. *www.11alive.com*

Compass M1 Signals problematic.

Researchers at Septentrio reported anomalies in the signal from the Compass M1 satellite. Analysis of high rate Doppler data from the E2 and E5b carriers revealed frequent spikes in the frequency of these carriers. These spikes were present in both the E2 and E5b bands (E6 had not been monitored in this analysis), and in both carrier and spreading code waveforms. They clearly indicate a problem onboard the satellite, possibly due to malfunction of the frequency reference of the signal generation unit. The glitches occur about 2 to 3 times per minute at seemingly random intervals. Depending on the design of the receiver tracking loops, they can lead to losses of lock or cycle slips. Septentrio doesn't know when this problem started. Processing of previously collected data has shown that shortly after the launch the frequency was quite stable. *www.septentrio.com*

NOAA updates its GPS system

The U.S. National Oceanic and Atmospheric Administration is modernizing its GPS to utilize advances in technology. Scientists at NOAA's National Geodetic Survey said the effort is important for activities requiring accurate positioning information. It said the proposed changes will affect civilian-federal mapping authorities, as well as state and municipal governments that have adopted the National Spatial Reference System. *www.noaa.gov*

Ukraine, Russia planning to sign deal on development of GLONASS

The governments of Ukraine and Russia are completing preparations for signing an agreement on cooperation in the use and development of the GLONASS satellite navigation system. Ukraine's demand for receivers for the GLONASS satellite system was estimated at 100,000 units per year. *www.kyivpost.com*

GPS helps check kerosene black marketing

In the first of its kind initiative in Pune, India the state government has started tracking kerosene oil tankers with the help of GPS to keep a check on black marketing. The system has been installed in the kerosene tankers that get oil from depots of oil companies. The movement of tankers is tracked from the depots to the dealer depots on specified government routes. *www.indianexpress.com*

Indian Lion census ends

More than 1,600 forest officers participated in the four-day long census of Asiatic lions at Gir, Gujarat. For the first time, GPS and GIS were used and headcount was done instead of tracking pugmarks, as was the case earlier. *www.indianexpress.com*

PBBI launches SaaS-Based solution

Pitney Bowes Business Insight announced MapInfo(R) Stratus(TM), a Software as a Service (SaaS)-based solution for publishing and sharing location-based data and services. It is a Web-based solution that allows customers to push maps and data created in a desktop application, such as MapInfo Professional(R), to a cloud-based interactive mapping environment. *www.pbinsight.com*

TeleNav offers GPS Tracking hardware

TeleNav and Sendum released Sendum PT200 tracking device for Sprint wireless enterprise customers using the TeleNav Asset Tracker platform. The device provides highly accurate location information allowing TeleNav Asset Tracker users to monitor the real-time location of assets, such as high-value packages, cargo or equipment, using a secure, Web-based portal. *www.TeleNavTrack.com*

TomTom unveils new PND

TomTom GO Live 1000 with new software will bring HD traffic and real-time speedcam information to 16 European countries (including roaming) and the rest of the connected services – weather, local search, etc. – to 33 countries. *www.tomtom.com*

Leica's GPS-Enabled Compact Cam

Leica V-LUX 20, a 12.1 megapixel digital compact camera with a 12x optical zoom lens and built-in GPS. It is the first Leica camera to feature GPS tagging. *http://en.leica-camera.com*

Helioversal - global tracking device

u-blox is delivering mass production volumes of its AMY GPS and LEON GSM modules to Taiwan-based Helioversal Technology. The company has designed the modules into their miniBee GPS Tracker, a compact unit providing real-time tracking and logging of global position. *www.u-blox.com*

Towards conclusive land titling in India

The Department of Land Resources (DoLR), Ministry of Rural Development, Government of India, has prepared a preliminary draft of the Land Titling Bill. The Bill hopes to usher into the country the system of Conclusive Property Titles with title guarantee and indemnification against loss due to incorrect title entries by the Government, instead of the current system of registration of deeds and documents and "presumptive" property titles. *http://dolr.nic.in*

TerraGo Publisher for GeoMedia

TerraGo Publisher for GeoMedia version 5 software gives Intergraph GeoMedia customers the capability to publish complex maps and images as highly portable and interactive GeoPDF files for easy dissemination and use by field personnel. *www.terragotech.com*

Bhutan's forests to be tracked

The Forestry Department is planning a National Forest Inventory (NFI) project, which will help in capturing comprehensive data on forest and its resources. Chief Forestry Officer Kinley Tshering said they would measure more than 26,000 plots across the country, divide them into grids and using GIS, the inventory will identify the exact forest coverage. The pilot project was carried out in Toebesa, Punakha, last year to determine the project's feasibility, which proved successful. *www.kuenselonline.com*

New rules for Net mapping in China

An updated standard for Internet map servers will be implemented next month to avoid State secrets being disclosed and uncertified maps published online. The new standard issued by the State Bureau of Surveying and Mapping in China, one year after the first standard was launched, requires all Internet map servers to keep servers storing map data inside the country and provide public Internet protocol addresses. The new regulation includes all maps downloaded or copied from the Internet onto cell phones and handheld computers. *www.chinadaily.com.cn*

MAPPS applauds Parcel Provision in Senate-Passed Bill

MAPPS applauded the inclusion of a parcel geocoding provision providing for an 'early warning system' in S. 3217, the "Restoring American Financial Stability Act of 2010," that passed the U.S. Senate. The bill makes amendments to the Home Mortgage Disclosure Act (HMDA), including a provision for the newly-created Bureau of Consumer Financial Protection within the Federal Reserve to collect the "parcel number to permit geocoding" on mortgage transactions. *www.MAPPS.org*

ESRI support for Oil Spill Disaster

ESRI is providing a number of support activities for the oil spill disaster in the Gulf of Mexico. It has deployed its disaster response team to provide assistance to users in local, state, and federal government agencies as well as the private sector. The team is supplying software, technical support, GIS data, and personnel. *www.esri.com*

OS VectorMap District now available

OS VectorMap District is now available for developers to download, order on disc and view via Ordnance Survey's free mapping portal. The new dataset has been specifically designed for use online and created to support the aims of Data.gov.uk, offering a clear and customisable background on which to display a whole range of other information. *www.ordnancesurvey.co.uk*

Yunnan Power Grid selects Ashtech®

Yunnan Power Grid, China has ordered 160 Ashtech MobileMapper 6 GPS/GIS units. The new units will be used by Yunnan Power Grid to more efficiently manage the maintenance of the corporation's electric pole and tower network. *www.ashtech.com*

At a Glance

- ▶ The Center for International Business Ethics in Beijing China, the Dynamic City Foundation, and Bentley Systems announced the inaugural Future Cities China design competition.
- ▶ Google introduces Turn-by-Turn Nav in the UK.
- ▶ According to IDC report growth of the smartphone market was 56.7 percent in the first quarter of the year
- ▶ Lining Up Data in ArcGIS: A Guide to Map Projections, a new reference guide from ESRI Press, helps resolve the problem of aligning disparate map projections with GIS technology.
- ▶ Clark Labs have released a DVD archive of monthly global NDVI Normalized Difference Vegetation Index) and EVI (Enhanced Vegetation Index) MODIS data.
- ▶ PlanetObserver and the French Cartographic Institute (IGN) sign a new agreement for the cross-distribution of their geodata.
- ▶ Blom and Gardline Geosurvey Limited announces collaboration.
- ▶ ABA Surveying Limited has selected a LANDINS inertial navigation system for its kinematic mapping system.
- ▶ Berg Insight predicts 894 million mobile banking users by 2015.
- ▶ Tele Atlas and Telogis announces agreement
- ▶ WindSim and Intermap Technologies to jointly market a solution to help wind farm designers easily combine high-resolution elevation data with advanced modelling that optimizes wind turbine placement for more profitable wind farms.

NTS-360R SERIES TOTAL STATION

SOUTH

www.southinstrument.com
www.southprecision.in

SOUTH, where splendid comes up!

NTS-360R Series

Large LCD for Six-Line Display
Absolute Encoding & Double Axis Compensation
SD Extended Capacity & USB Interface
Added-in Program: Road Measurement, Road Design
Measuring Time: Fine mode 1.8s, Coarse mode <1s, Tracking mode 0.6s
Proven Structure for Dustproof & Waterproof
Laser Plummet (optional)

2”or 5”
Measuring range without prism: 300m
Accuracy: 5mm+3ppm
Measuring range with single prism: 5000m
Accuracy: 2mm+2ppm

Extended CAD & GIS Data support in ERDAS APOLLO

ERDAS released ERDAS APOLLO Feature Interoperability, a new product extending ERDAS APOLLO's native vector support by adding support for additional CAD and GIS formats and tools. It provides access to GIS data formats, including a DGN Connector to ERDAS APOLLO that enables direct access to MicroStation's DGN v7 and v8 format files via web services. *www.erdas.com*

Joint satellite launch mooted

South Africa, India and Brazil have agreed to jointly develop a satellite to be launched into orbit for purposes of detecting natural disasters and for scientific research. They will benefit IBSA countries as well as other friendly nations. *www.defenceweb.co.za*

Mapping Brunei's terrain in 3D

The Survey Department is in the process of mapping out Brunei's entire terrain in 3D. The department was using Lidar to map out the terrain to an accuracy of 15cm. Some projects that the department is carrying out include underground utility mapping and Brunei Darussalam Spatial Data Infrastructure which aims to have all information available on the Internet. *The Brunei Times*

Aerial mapping in North Sri Lanka

The Japan International Cooperation Agency (JICA) is to assist Sri Lanka's Survey Department to update and prepare topographic maps with GIS to the national standards, using aerial photography. The available maps for the Northern Province are decades old, and could not be updated due to security conditions during the conflict.

Gulf of Mexico oil spill in the Loop Current

Scientists monitoring the US oil spill with ESA's Envisat radar satellite say that it has entered the Loop Current, a powerful conveyor belt that flows clockwise around the Gulf of Mexico towards Florida. The Loop Current joins the Gulf Stream — the northern hemisphere's most important ocean-current system — sparking fears that oil could enter this system and be carried up to the US East Coast. *www.esa.int*

Space technology project for disaster

An emergency management platform, GEO-PICTURES will be developed in Oslo with several partners, and form a seamless solution hosted by United Nations (UNOSAT-UNITAR) on the CERN campus in Geneva. This project is lead by AnsuR Technologies AS of Norway and co-funded by the European Commission under the 7th Framework programme. It is targeted to mitigate disaster effects on environment. It would be the combination of state-of-the-art in satellite communication, navigation and earth observation. *www.physorg.com*

China, Brazil ink MoU on satellite data sharing

China and Brazil signed an MoU which gives both countries direct access to data from the China-Brazil Earth Resources Satellite Program (CBERS). It is a jointly operated remote sensing system for agriculture, meteorology and the environment. *www.globaltimes.cn*

Launch of PSLV-C15 rescheduled

The launch of ISRO`s Polar Satellite Launch Vehicle (PSLV-C15) has been rescheduled. A marginal drop in the pressure in second stage of the vehicle was noticed during the mandatory checks carried out on the PSLV-C15 vehicle. The new date for the launch of PSLV-C15 mission will be decided after preliminary results of the analysis are obtained. PSLV-C15 is planned to launch India`s Cartosat-2B, an Algerian satellite ALSAT-2A, two nano satellites NLS 6.1 and NLS 6.2 from University of Toronto, Canada and STUDSAT, a satellite built by students from academic institutions in Karnataka and Andhra Pradesh. *www.isro.org*

NoiseWave offers jamming, interference Tester

The NoiseWave NW-ATE series noise generator, covering from 10 MHz up to 40 GHz in bands, is designed for test applications including noise, interference, and jamming for GPS receivers and component testing. *www.noisewave.com*

AshtechR - ProFlexT 500 CORS

Ashtech ProFlex 500 CORS is an advanced, multifunctional Continuously Operating Reference Station (CORS) designed to collect, store and transmit high quality GNSS data for multiple applications, including a CORS and a field campaign receiver, for either post-processed or RTK applications. *www.ashtech.com*

AvMap Geosat 4x4 available

AvMap launched Geosat 4x4 wild, a navigator dedicated to the off-road world, in the International markets. The product will be available in Europe, Russia, North America and Brazil, where the off road sector has registered positive results, despite the economic downturn. It was born from the collaboration between AvMap and the Military Geographic Institute in Italy (IGM), to be the first GPS navigator dedicated to off-roaders, the one and only to integrate the IGM topographic maps 1:50.000 IGM and the Tele Atlas terrestrial data. *www.avmap.it*

Pacific Crest-New advanced Data Link

Pacific Crest introduced the new ADL Sentry, a UHF radio for remote communications. It is an advanced, high-speed, data radio modem built to survive the demanding environments of remote sensing and environmental monitoring. It joins the growing Advanced Data Link (ADL) product line that includes the ADL Foundation, a transceiver OEM modem board; the ADL RXO, a receive-only OEM board; and the ADL Vantage, a 4-Watt programmable UHF radio for survey applications. *www.PacificCrest.com*

BEYOND THE LIMIT CALLED SKIES
BENGALURU SPACE EXPO 2010
International Exhibition & Conference "World Space Biz"
25TH-28TH AUGUST 2010
Bangalore International Exhibition Center (BIEC)
Tumkur Road, Bengaluru, Karnataka, India
BS
BENGALURU SPACE EXPO 2010
25th - 28th August, 2010
Bangalore International Exhibition Center (BIEC)
Tumkur Road, Bengaluru, Karnataka, India
www.bsxindia.com
Organised by
CII
Confederation of Indian Industry
Since 1895
In association with
ANTRIX
इसरो isro
For further details or space booking kindly contact:
Ms Rachna Jindal, Confederation of Indian Industry, Trade Fairs Division,
249-F, Sector 18, Udyog Vihar – Phase IV, Gurgaon –122 015,
Haryana, India. Tel: 00-91-124-4013871 (D) / 4014060,
Fax: 00-91-124-4234170/4014080 / 83 Email: rachna.jindal@cii.in

NovAtel Inc.-New OEMStar™ Models, OEMV® Precision Receiver Firmware

NovAtel introduced five new models to its low cost, L1 OEMStar receiver card product line and four new models to the OEMStar supported FlexPak-G2™ enclosure product line. Four new DGPS models support the transmit of DGPS code corrections and are available in GPS and GPS plus GLONASS versions supporting 1Hz and 10Hz data rates. These new models allow a customer to develop low-cost base station applications for transmitting DGPS code corrections. These models are also available in the new FlexPak-G2 enclosure for those customers looking for a rugged integrated solution.

NovAtel has also launched Version 3.800 firmware for its OEMV family of GNSS precision receivers. This latest firmware upgrade features optimizations to NovAtel's AdVance RTK for industry leading GPS-only and GPS+GLONASS RTK positioning performance. Significant research and algorithm adjustments have been made to AdVance RTK, increasing solution availability and accelerating ambiguity resolution in real world conditions while maintaining high accuracy. *www.novatel.com*

Bentley News

New 'Learning Qualification' Program

It helps Bentley users gain well-deserved recognition for milestones in professional learning and skills development. It builds on existing Bentley Institute programs, including Bentley LEARN, that empower infrastructure professionals to advance their careers and infrastructure organizations to secure new work.

Structural Engineer for Plant Design Passport Subscription

The Structural Engineer for Plant Design Passport Subscription makes available the right balance of software for analyzing, designing, documenting, and detailing industrial plant models. It includes STAAD.Pro V8i, STAAD.Pro Advanced Analysis Module, STAAD. Foundation, ProSteel Professional V8i, RAM Connection V8i, ProjectWise Passport, ProjectWise Navigator V8i, Structural Synchronizer V8i, and Structural Dashboard V8i.

Navigator Passport Subscription

For a single annual fee, the Navigator Passport Subscription provides access to the full range of software, training, and content practitioners need for collaborative workflows. Through this "professional upgrade" in software toolset and skills, individual practitioners quickly make their work more valuable. *www.bentley.com*

Geneq integrates DGPS beacon inside SXBlue II GPS

Geneq Inc. have integrated a DGPS Beacon receiver inside their SXBlue II GPS product. The SXBlue II-B GPS is capable of receiving sub-meter corrections from SBAS (WAAS/EGNOS/MSAS) or from any of the more than 200 DGPS beacon transmitters broadcasting in over 38 countries around the globe free of charge. *www.sxbluegps.com*

IDV Solutions debuts Piracy Watch

As attacks on shipping generate worldwide headlines, Piracy Watch, a new Bing Maps App from IDV Solutions, lets people view the location and details of recent pirate attacks. *www.idvsolutions.com*

Trimble releases new FME Extensions, new Airborne Laser Scanning System

Trimble has released new Trimble® SSF and DDF data format extensions for FME, the spatial ETL solution from Safe Software. These extensions enable mapping and GIS professionals to easily move GNSS field data collected on Trimble handhelds and processed through the Trimble GPS Pathfinder® Office software to more than 225 widely used formats supported by the FME software platform.

Leica News

Enhancements for ScanStation C10

New system enhancements to the Leica ScanStation C10 laser scanner are based on new versions of scanner firmware (v1.2) and Cyclone software (v7.0.3) - part of a continuous upgrade program for ScanStation C10 platform users who are on maintenance.

Viva Uno

Leica Viva Uno is a handheld GNSS solution for centimeter surveying. The Leica SmartWorx Viva software makes any task simple. The Viva Uno addresses a growing need for large scale data collection, e.g. utilities, agriculture, and road infrastructure. *www.leica-geosystems.com*

IPAS Freebird

The new version of IPAS GNSS-IMU processing software is available now and is designed to improve flight economy and simplify GNSS-IMU processing. *www.leica-geosystems.com*

Trimble also introduced the Trimble® Harrier 68i system. Designed for aircraft and helicopter operation, it is ideal for long-range corridor, project, and wide-area mapping. *www.trimble.com*

O2 gives free navigation on mobile phone

Telefónica O2 Germany is giving its customers a complete search, mapping and navigation system, effective immediately. It doesn't matter whether one is travelling by car or on foot: almost any GPS-enabled mobile phone will become a pocket-sized route planner with Telmap Navigation. *www.o2.de*

Applanix introduces Software Version 3.0 for POSTrack

Applanix has introduced version 3.0 for

POSTrack™, its Direct Georeferencing and Flight Management System. It incorporates a worldwide ASTER digital elevation model (DEM) product for flight planning. The DEM is used to automatically and quickly determine the optimal flight path to fly an aircraft to best meet the acquisition requirements of photo scale, ground sample distance and image overlap. *www.applanix.com*

Autodesk expands power of AutoCAD 2011

Autodesk, Inc. has released 2011 AutoCAD software products, including AutoCAD 2011 software, a 2D and 3D design and documentation platform, and AutoCAD LT 2011 software for professional 2D drafting and detailing. These products are Microsoft Windows 7 certified and are compatible with and supported on Windows 7 Home Premium, Professional, Enterprise, and Ultimate as well as Windows Vista and Windows XP operating systems. *www.autodesk.com*

Metro Traffic-Traffic Data Collection enhanced

Metro Traffic has enhanced its traffic data collection infrastructure by purchasing the newest TIC generation, a traffic and traveler information processing platform from GEWI . The TIC software will enable Metro Traffic's 24/7 network of local operations teams, producers and reporters to more quickly collect, and better locate and reference, real-time traffic information. *www.metrotraffic.com*

Enhanced GPS tracking functionality in MapInfo Professional 10.5

Blue Marble Geographics successfully demonstrated the newest version of Geographic Tracker for MapInfo Professional 10.5. It is a GPS application that supports streaming live GPS position data, playback of recorded GPS log files and transfer of spatial data both to and from various GPS units. The tool ships as a free install in MapInfo Professional.

High-Resolution Digital Aerial Cameras

Intergraph is adding four new large-format digital aerial cameras to its Z/I Imaging acquisition platform to meet the customized needs of aerial imagery providers around the world. The new cameras - RMK DX, DMC II 140, DMC II 230 and DMC II 250 - are based on the technology of the Intergraph DMC and RMK D. *www.intergraph.com*

SAFEcommand product suite

Infoterra has launched SAFEcommand - a suite of products designed specifically for public safety and emergency organisations. It integrates core data management, mobile and emergency response solutions to increase operational effectiveness and service delivery for both 'blue light' and homeland security organisations. *www.infoterra.co.uk*

SUBSCRIPTION FORM

YES! I want my **Coordinates**

I would like to subscribe for (tick one)

☐ 1 year	☐ 2 years	☐ 3 years
12 issues	24 issues	36 issues
Rs.1200/US$80	Rs.2100/US$145	Rs.2700/US$180
		SUPER saver

First name ....

Last name ....

Designation ....

Organization ....

Address ....

....

City .... Pincode ....

State .... Country ....

Phone ....

Fax ....

Email ....

I enclose cheque no ....

drawn on ....

dated .... towards subscription

charges for Coordinates magazine

in favour of Coordinates.

Sign .... Date ....

Mail this form with payment to:

Coordinates
11C Pocket A, SFS
Mayur Vihar Phase III
Delhi 110 096, India

If you'd like an invoice before sending your payment, you may either send us this completed subscription form and we'll bill you, or send us a request for an invoice at **iwant@mycoordinates.org**

MARK YOUR CALENDAR

June 2010

GEA'2010
22 -24th June
Cracow, Poland
jacek@gea.com.pl
http://gea.com.pl/targieng.php

July 2010

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

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

August 2010

Bengaluru Space Expo
25 - 28 August
Bangaluru, India
www.bsxindia.com

September 2010

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

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

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

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

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

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

October 2010

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

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

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

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

November 2010

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

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

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


You have something new to hide.
Success has a secret ingredient.
Size is everything. Our new OEMV-1DF™ is the world's smallest dual-frequency RTK receiver. That's pretty big news for engineers. Smaller means it uses less power. Smaller means it weighs less. Smaller means it can fit in a lot more places. Smaller means it's easier to hide your advantage from competitors. And when your advantage is NovAtel, that's a big deal. To find out more, visit novatel.com or call you-know-who.
Integrate success into your [redacted].
NovAtel