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THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

National GIS
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- Performance evaluation of QZS on precise positioning
- Need for new services in land administration
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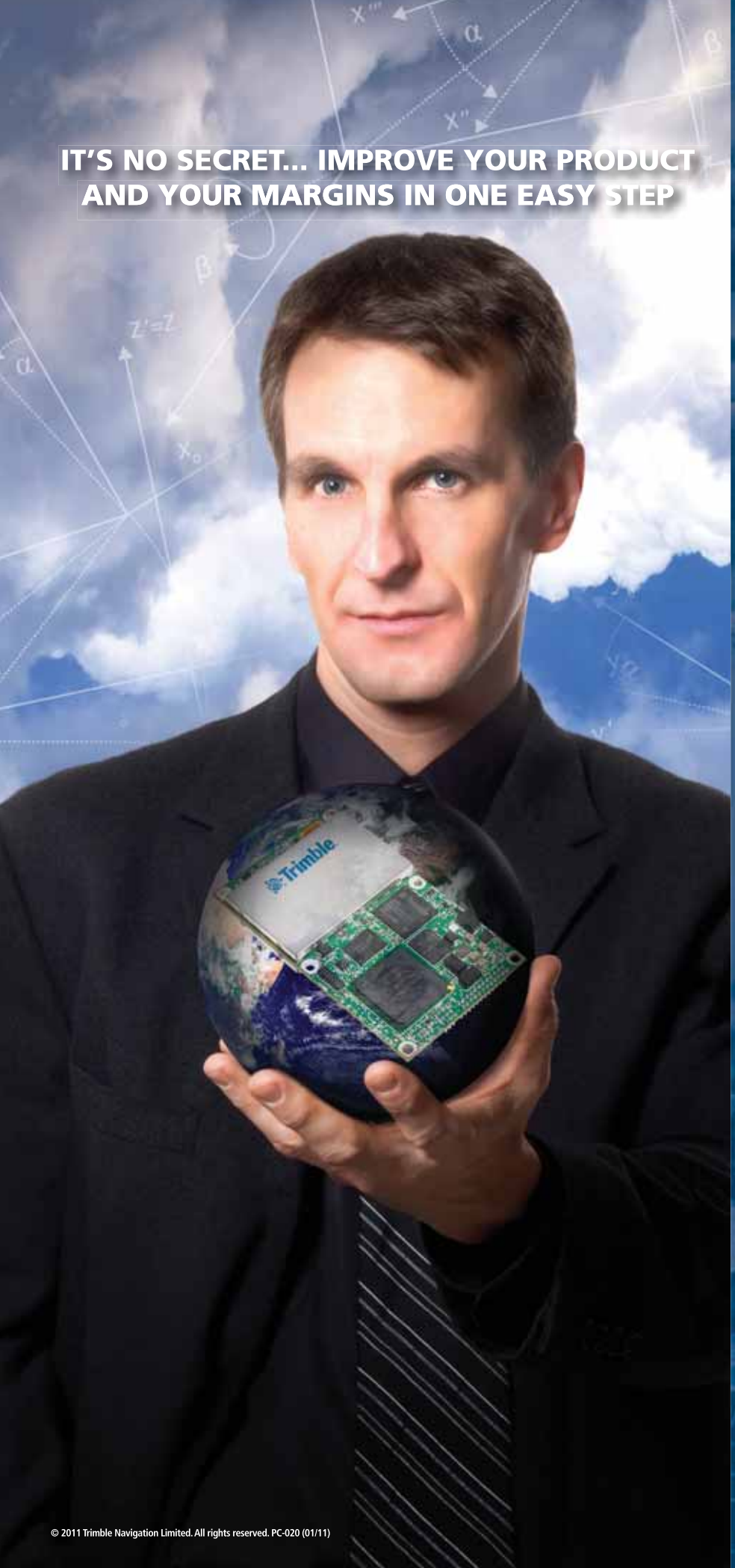

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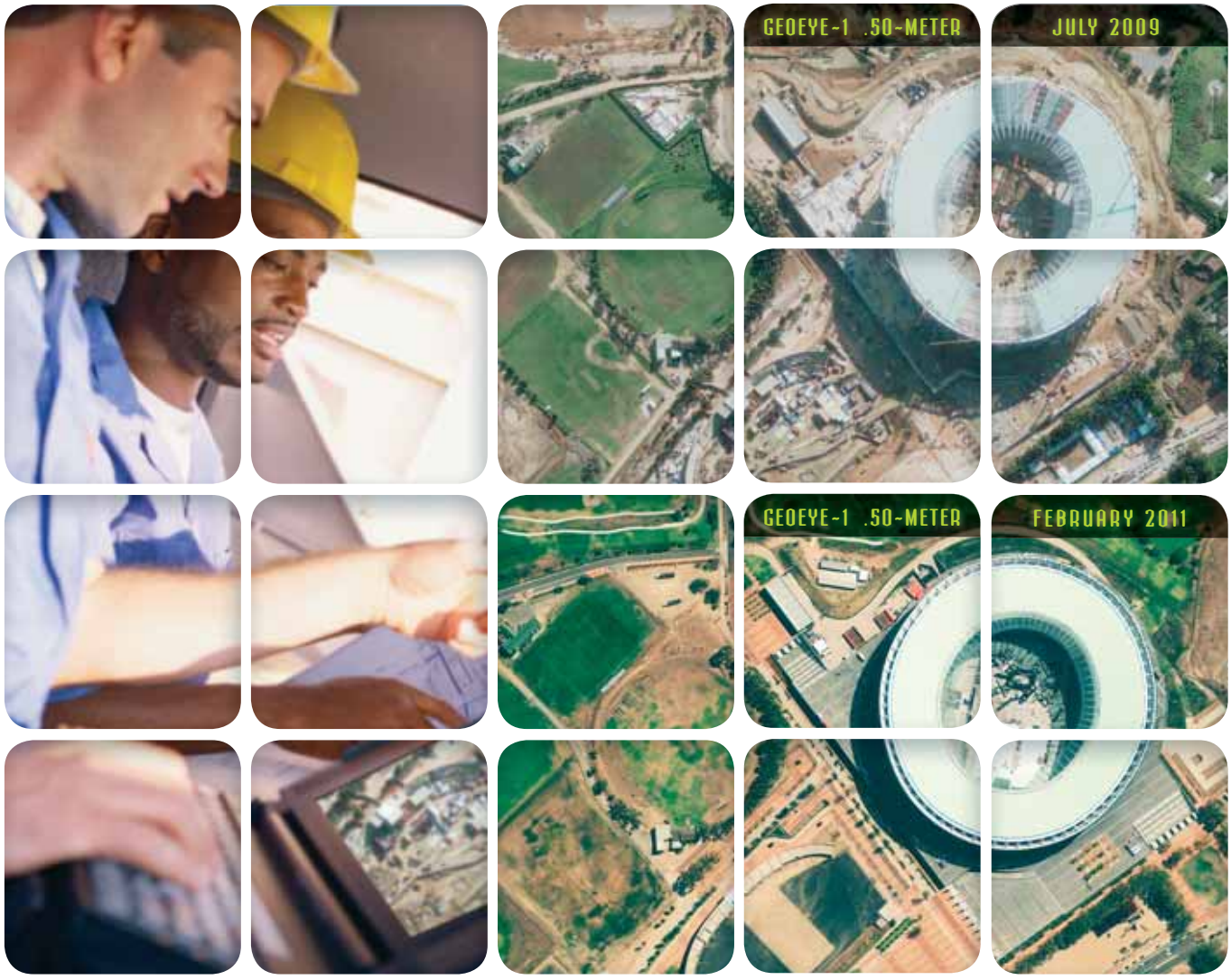

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Walk the talk

About a decade back

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have the same national view of GIS data.

This has recharged the debate, the discussions, the deliberations…

India starts talking and is talking again.

Will it act?

Bal Krishna, Editor
bal@mycoordinates.org

Performance evaluation of the effect of QZS on precise positioning

An overall real performance evaluation was conducted base upon stand-alone positioning and RTK positioning in several environments

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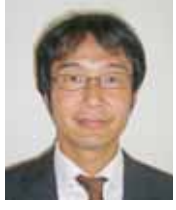

Satoshi Kogure
Associate Senior Engineer
Japan Aerospace Exploration Agency, Japan

A QZS (quasi-zenith satellite), which was anticipated to be the original Japanese positioning satellite, was launched in September, 2010. As an augmentation system of GNSS, two MTSATs had already been put into orbit and their main purpose is to broadcast the correction data for wide-area DGPS. This has actually improved the accuracy of wide area DGPS as a result of reception of the correction data from MSAS (MTSAT Satellite-based Augmentation System). The QZS also enhances the ranging function and it already has signal characteristics for the GNSS that are expected in the near future.

The main feature of QZS is that it stays at a high elevation-angle over Japan for a long time, a feature that was expected to have a positive effect upon high-accuracy positioning. This paper reports several experiments that were conducted to verify the expected effect, particularly in urban areas, because a high-elevation satellite can improve the total performance in terms of the number of visible satellites. In section 2, we describe an outline of the QZS, and we also present real data from QZS, including elevation, azimuth, and stand-alone positioning. The general performance of RTK in urban areas and the algorithm used in this paper are then discussed in Section 3. The steps taken to improve RTK performance are also described briefly. Finally, in Section 4, several test results based upon the use of GPS+QZS in Tokyo are verified.

Overview of QZS

Configurations of QZS

Typical signal parameters of QZS are presented in Table 1. The ground track of QZS's orbit is shown in Figure 1. QZS also transmits an L1C signal for future GNSS. The signals used in our algorithm are L1-C/A and L2C, as shown in Table 1. It is known that the signal strength of L2C is greater than the signal strength of L2P(Y) transmitted by GPS. The number of GPSs transmitting L2C was 8 in April 2011. The received signal power of GPS L2P(Y) is approximately -161.5 dBW (in case of Block-IIR-M/IIF) [3]. For the sake of consistency, in this analysis, an L2P(Y) signal is used for all GPS satellites. It is strongly expected that the L2C signal will be able to be used in the near future because the signal strength in dense urban areas decreases especially in the L2 band. Figure 1 shows the ground track of the QZS orbit. As can be seen in the figure, QZS spends a long time over Japan. Figure 2 shows the temporal elevation-angles of QZS in Tokyo for 24 h. Figure 3 shows the temporal azimuth angles of QZS in Tokyo for 24 h. These data were obtained on the rooftop of our laboratory in Tokyo from January 13- to 14, 2011. The receiver used in this test was a JAVAD DELTA, a receiver that was custom-designed to process QZS signals. The signal strength of L2C of the QZS is shown in Figure 4. The signal strength of L2C and L2P(Y) of GPS PRN31 are also shown in Figure 5.

A period in which the signal was unstable was omitted from Figures 2, 3, and 4. During this period, the elevation angle was less than 10°. As can be seen in Figure 2, QZS stays for about 7 h over 80° and about 9 h over 70° (The scale interval of the horizontal axis is 6 h). The carrier-to-noise ratio of L2C is sustained at least 40dBHz as long as the elevation angle

Frequency Band	L1	L2C	L5
Carrier Frequency [MHz]	1575.42	1227.6	1176.5
Chip Rate [MHz]	1.023	1.023	10.23
Bandwidth [MHz]	24.0	24.0	24.0
Received Power [dBW]	-159	-160	-155

Table 1. Typical Signal Parameters of QZS

is greater than 10°. The dark line (upper line) in Figure 5 shows the carrier-to-noise ratio of L2C for GPS PRN31, and the light line (lower line) shows the carrier-to-noise ratio of L2P(Y) for GPS PRN31. It can be seen that the signal strength of L2P(Y) is much lower than that of L2C.

Stand-alone positioning of GPS+QZS

The stand-alone positioning horizontal results of GPS and GPS + QZS are shown in Figure 6 and Figure 7. In these figures, the light line indicates the errors in latitude and the dark line indicates the errors in longitude. Although there is not a big difference between the results for GPS and those for GPS + QZS, the results for GPS + QZS fluctuate a little. In fact, the standard deviation of the horizontal errors for GPS was 1.90 m and that for GPS + QZS was 2.44 m. Although the height results are not presented in this paper, it can be seen that the height results deviate greatly for a short period in the case of GPS + QZS. Further investigation of these issues can be expected with the use data for a very long time-period.

General RTK performance in urban areas

Algorithm of RTK used in this paper

In this paper, LAMBDA method is used to search for correct ambiguities because this technique is able to search for the best solution using the integer least-squares method [4]. It is quite important to resolve the ambiguities in a single epoch in urban areas because there is no influence when cycle slips in the carrier phase take place in the phase-lock loop. In this paper, a single epoch solution is used. No multi-epoch solution or filtering methods are used. A Ratio test is used to determine whether the ambiguities produced by the LAMBDA method are acceptable. The general threshold for the Ratio test is set according to [5].

Threshold/NVS	4	5	6	7
1.0	96.34	98.07	97.51	95.24
1.5	96.63	99.04	99.66	99.35
2.0	96.63	99.33	99.96	99.92
2.5	96.59	99.45	99.99	100
3.0	96.53	99.54	100	100
3.5	96.38	99.56	100	100
4.0	96.30	99.56	100	100

Table 2. Correct Fixing Rate in Each NVS for One Week (%)

	Under 4	4	5	6	7	Over 7
Percentage	20.1	16.2	19.1	18.6	12.9	13.1

Table 3. Percentage of NVS in Tokyo (%)

	GPS	GPS+QZS
First	81.6%	89.8%
Second	37.3%	84.1%
Third	65.5%	77.9%
Fourth	66.4%	73.8%
Fifth	64.3%	70.3%

Table 4. Percentages of Stand-alone positioning

	GPS	GPS+QZS
DGPS	81.5%	93.7%
RTK	27.0%	52.2%
Doppler support RTK	46.7%	70.3%

Table 5. Summary of First Test

RTK performance under open-sky conditions

Single-epoch RTK performance under open-sky conditions was investigated using the reference stations of GEONET (GPS Earth Observation Network), which are operated by the Geographical Information Authority of Japan. GEONET, which consists of 1200 permanent GPS stations, is the largest GPS network in the world. Hamaoka 1 was set the reference station. Daito 2 was set as the rover station. The baseline was about 8 km. Observation data for one week were used in this analysis. The mask angle was set at 30° because RTK performance under low visible satellites must be checked in this case. Table 2 shows the results for the correct fixing rate in each NVS (number of visible satellites) according to the threshold of the Ratio test. The first line shows the NVS, and the first row shows the threshold of the Ratio test. As these results clearly show, the level of performance depends on the NVS, even under open-sky conditions. Even when the threshold for the Ratio test was set at 3, the performance was approximately 96% when the NVS was 4. On the other hand, the correct fixing rate with five or more visible satellites was clearly over 99%.

RTK performance in dense urban areas

The NVS of GPS in urban areas was investigated in order to determine the satellite's visibility in urban areas. Raw GPS data accumulated over 12 h was used in this analysis. These raw data were obtained by car in Tokyo. Table 3 shows the NVS percentage in

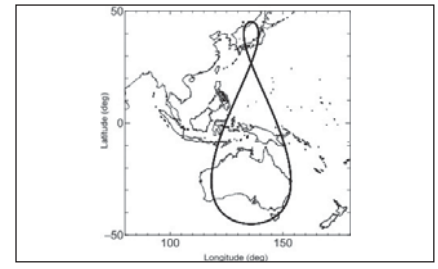

Fig 1 Ground Track of QZS

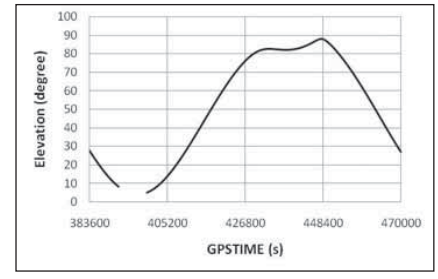

Fig 2 Temporal Elevation of QZS

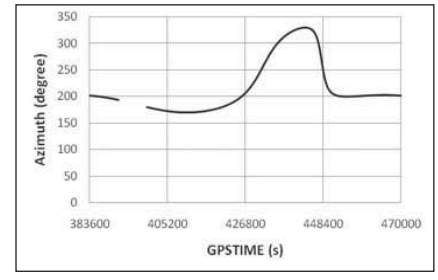

Fig 3 Temporal Azimuth of QZS

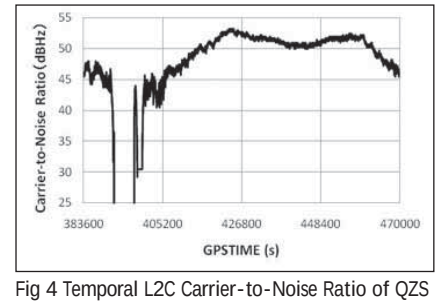

Fig 4 Temporal L2C Carrier-to-Noise Ratio of QZS

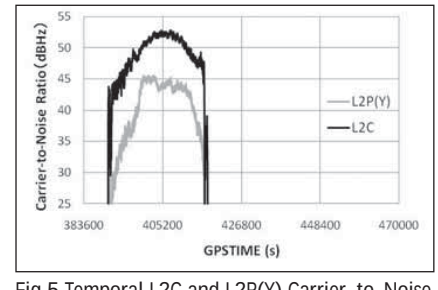

Fig 5 Temporal L2C and L2P(Y) Carrier-to-Noise Ratio of GPS (PRN31)

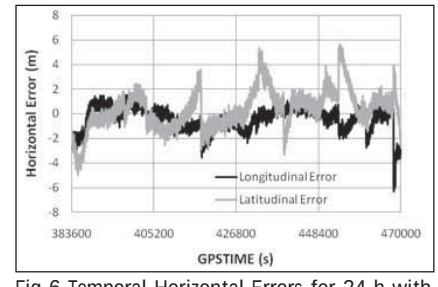

Fig 6 Temporal Horizontal Errors for 24 h with Stand-alone Positioning by GPS

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total epochs. The GPS receiver used in this study was a NovAtel OEM4.

The ratio in which the NVS is less than 4 accounts for 20%. The ratio in which the NVS is more than 4 accounts for 64%. It is thus easy to conclude that the environment in urban areas is not good for RTK. In addition, the relationships between the NVS and the reliability of RTK were investigated. Figure 8 shows the relationships between the percentage of epochs within a 1m error and the threshold of the Ratio test according to the NVS. These raw data were obtained by car for 30 min in the center of Nagoya. As reference positions, POSLV was used in this test [6]. This reference-positioning system guarantees an accuracy of about 10 cm in this test. The blue line shows the case in which the NVS is 4. Each line is classified by the NVS in the same manner. It is surprising that the reliability within a 1m error was only 89% when the threshold of the Ratio test is set at 3 in the case of NVS = 4. On the other hand, with five or more visible satellites, the reliability was maintained at over 99% as long as the threshold of the Ratio test is set at 3. Based on these results, it is expected that the role of QZS will be quite important for urban navigation because the ratio in which the NVS is 4 in the case of GPS accounts for 20%, as shown by the above statistical data from Tokyo.

Experimental results

The experimental results are presented in the following sections.

Stand-alone positioning results

The temporal visibility of satellites in dense urban areas was investigated. As an indicator, the percentage of stand-alone positioning was checked using raw data that were obtained in the vicinity of Shinjuku Station in Tokyo on January 12, 2011. This location is quite suitable for this test because it has many high-rise buildings. Figure 9 shows the route of the test course which took about 25 min to circumnavigate. From 09:00 AM to 12:00 PM, five tests were conducted along the same route. The GPS receiver used in this test was a JAVAD DELTA and the antenna was also a JAVAD GrAnt. This receiver is able to output raw data not only GPS and QZS, but also GLONASS and Galileo. Table 4 shows the percentages of stand-alone positioning in each test. The mask angle was set at 10° and the minimum carrier-to-noise ratio was set at 30 dBHz.

Time	DGPS	RTK	Doppler support RTK
AM 10:00	95.0 / 98.6	36.8 / 56.3	51.8 / 73.6
AM 12:00	83.6 / 94.6	7.9 / 10.5	15.0 / 23.3
PM 2:00	93.1 / 96.7	29.1 / 35.3	46.5 / 55.7
PM 3:30	94.7 / 95.5	29.0 / 27.7	43.7 / 37.5

Table 6. Summary of Second Test

The results clearly show that the addition of one QZS improves the availability of stand-alone positioning. In the second test in particular, the degree of availability improves from 37 % to 84 %. This means that the NVS was almost 3 during the second period with only GPS. Such a situation frequently takes place in the major cities of Japan, so it can be said that QZS offers a great advantage in dense urban areas. Moreover, it can be said that it is quite important for a general consumer receiver that has only the L1 frequency to have increased availability of stand-alone positioning.

RTK results

Two RTK experiments are described in the following two sections. The receiver and antenna used in these tests are exactly the same as those used in the test described in Section 4.1. Carrier smoothing in the receiver was set at 100 s. The reference station was set on the roof top of our laboratory and 1-Hz raw data were obtained. 5-Hz raw data were obtained in a car. The mask angle was set at 10° and the minimum carrier-to -noise ratio was set at 30 dBHz. The minimum HDOP was set at 10. Another signal-quality check was also conducted using carrier-to-noise ratio information. This checking process was quite simple, its details are given in reference [7].

First test

A car equipped with receiver and antenna followed a route from our university to Tokyo Station. Except for the area around the university, the route passed among many high-rise buildings and included several overpasses. The raw data were obtained from 10:50 AM to 11:30 AM on March 1, 2011. The total number of epochs was about 12 000. Figure 10 shows the route of this test. The area enclosed in the black line is the central business district, which include many skyscrapers. Figure 11 shows the sky plots of GPS+QZS in this period. The elevation angle of QZS was 85° or more and the GPS allocation was also ample.

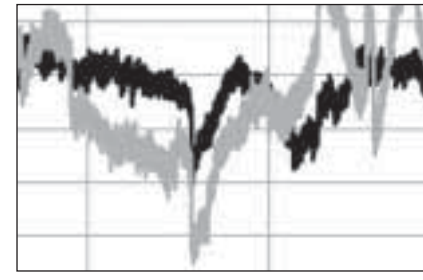

Fig 7 Temporal Horizontal Errors for 24 hours in Stand-alone Positioning by GPS + QZS

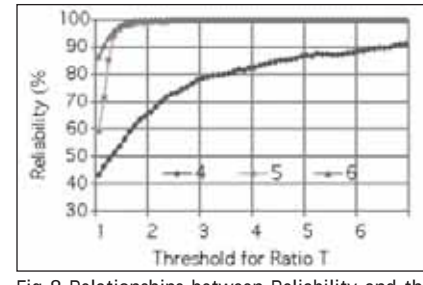

Fig 8 Relationships between Reliability and the Threshold for the Ratio test

Fig 9 Test course in Shinjuku.

Fig 10 Test course around Tokyo Station

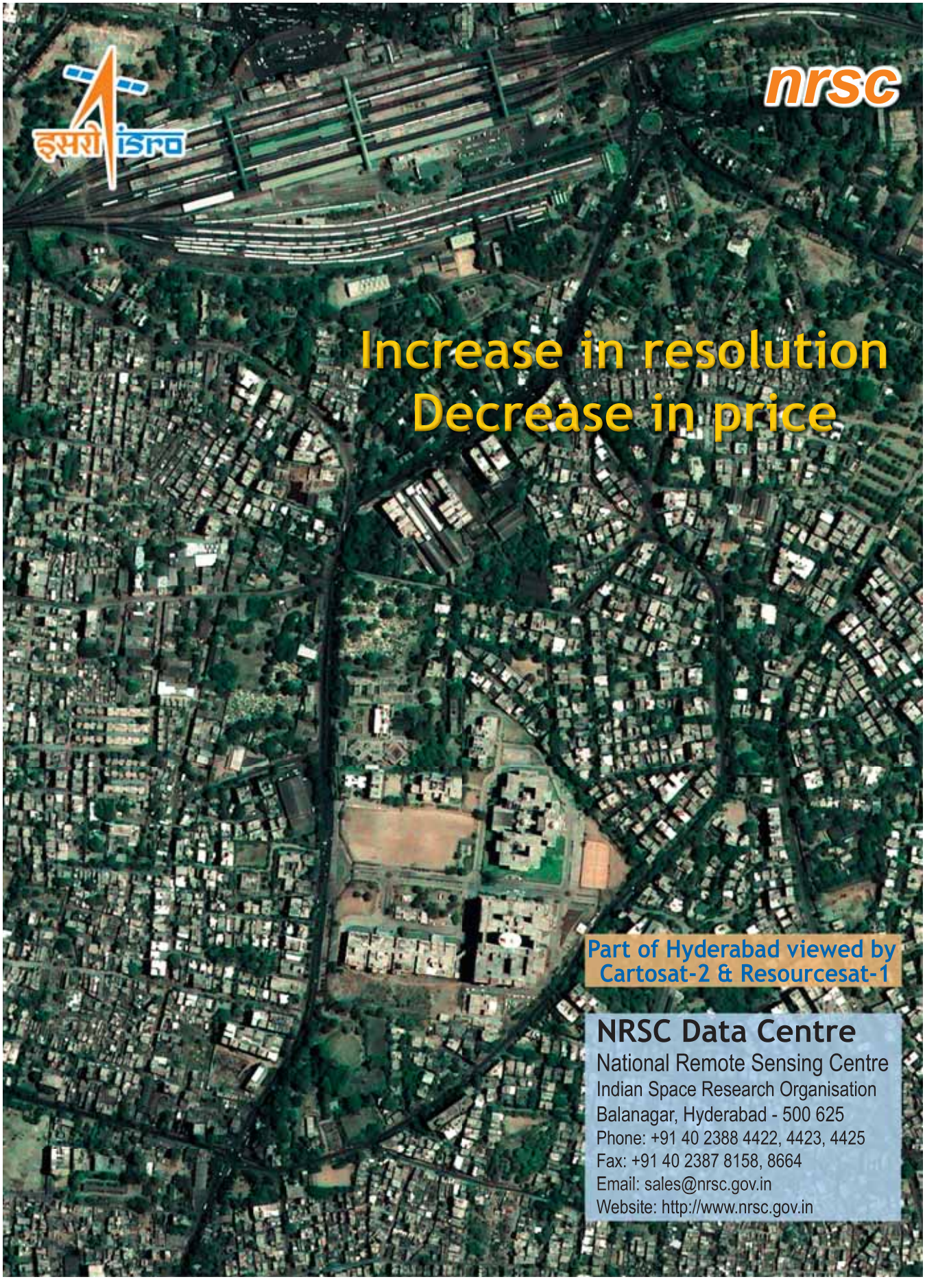

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Table 5 summarizes the availability of pseudo-range DGPS and the fixing rate for RTK. In RTK, the solutions that satisfy the Ratio test were regarded as fixing solutions. The threshold for the Ratio test was set at 3. As can be seen in Table 5, the availability of DGPS improved from 81% to 93%. Looking at the RTK performance, we see that the fixing rate improved dramatically from 27% to 52%. Furthermore, the fixing rate improved from 46% to 70% even in the case of Doppler support RTK. It is notable that the fixing rate improved approximately 25% with the addition of only one satellite, namely QZS. The details of the Doppler support RTK are given in reference [8]. The results of Doppler support RTK revealed

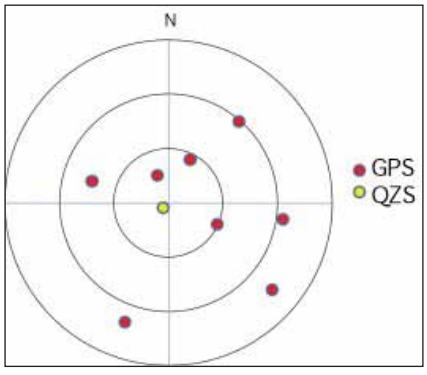

Fig 11 Sky Plots


Fig 12 Test course in the second Test

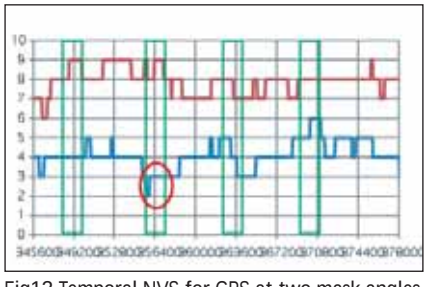
Fig13 Temporal NVS for GPS at two mask angles (15° and 40°)

that the maximum period of continuous non-fixing was 140 s in the case of GPS only. On the other hand, the maximum period of continuous non-fixing was 45 s in the case of GPS + QZS. These results indicate that QZS will contribute not only to RTK performance but also to the coupling of GNSS with INS.

Second test

This section shows the results from the viewpoint of QZS elevation change. The test route is surrounded by many high-rise buildings and the street is wide. The raw data were obtained by car on four occasions on March 24, 2011. Figure 12 shows the route of this test; the same route was used for all four events. Figure 13 shows the transition of the NVS for GPS during this test. The red line shows the temporal NVS in the case where the mask angle was set at 15°, and the blue line in the case that of 40°. There were 4 events in the green square that is shown. During this period, the elevation of QZS was changed from 80°, 60°, 40° and 15°. Table 6 summarizes the availability of pseudo-range DGPS along with the fixing rate for RTK as compared with GPS and with GPS + QZS. In each column, the left side shows the results of GPS and the right side shows the results of GPS + QZS. As these test results show, the advantage of GPS + QZS was clear. Although the fixing rate was low in the second period, the reason for this is that the NVS over 40° for GPS was low. Also, the last test shows that the GPS performance exceeds the performance of GPS + QZS. The reason for this is that a positive contribution from QZS cannot be expected in this period because of low elevation-angle. Sometimes low-elevation satellite is not good for precise positioning.

Conclusion

The contributions of QZS to precise positioning were investigated in this paper. Although we cannot solve a position using only QZS, our results showed that adding QZS to GPS was quite effective for navigation under difficult conditions. The availability of stand-alone positioning was improved, even within cluster of high-rise buildings.

Also, the availability of precise RTK positioning was significantly improved in dense urban areas. For QZS, it is possible that after further satellites are launched, further improvement of its performance in dense urban areas can be expected.

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National GIS
Shaping India

Dr Shailesh Nayak, Chairman, National GIS Interim Core Group (IGG) and Secretary to the Government of India, Ministry of Earth Sciences

"The success of the National GIS would be in its effective utilization for various applications"

The Planning Commission, Government of India has floated the idea of the National GIS.

It has established an Interim Core Group (ICG) to prepare a blueprint for the development of the National GIS.

With a vision to establish a national "GIS Platform" through an organizational structure of Indian National GIS Organization (INGO).

Coordinates joins the discussions.

The discussions will continue as the National GIS progresses.

We will discuss the need, the rationale, the context, the idea,...

The issues, the agendas…

The road ahead and the roadblocks…

To start with, we present here the views of Dr Shailesh Nayak, Chairman, ICG and Dr Mukund Rao, Member Secretary, ICG.

Bal Krishna, Editor

What has triggered the idea of National GIS?

The idea of National GIS (NGIS) has been driven by the needs of the Planning Commission, Government of India. The Planning Commission looks for lot of information which helps them in the process of planning. The need has been felt to integrate many of these information so that they can utilized effectively for various planning processes and applications. There has been discussion going on for quite some time in the Planning Commission under the leadership of Dr K Kasturirangan, Member, Planning Commission, where GIS is perceived as an effecting tool that can be integrated in the developmental plans and programmes of the Planning Commission. This is how the idea of the NGIS has emerged.

The Planning Commission envisages that the NGIS could become a fundamental component of India's planning and developmental infrastructure, providing visibility into various aspects of the national economic and governance process, development process, etc and at the same time also bringing value to enterprise commerces and citizen services, truly making it a national system.

What is the role of Ministry of Earth Sciences in the NGIS?

As of now, the Ministry of Earth Sciences has been given the lead-task by the Planning Commission, through the ICG which is a team of geospatial experts, to prepare a blueprint for the development of the NGIS.

We are focussing on mainly three aspects. The first is to understand the user requirements. This will provide the base for NGIS needs. The second important aspect is the availability of different types of data that could be easily organised into a nation-wide GIS and made accessible, and utilized for developing decision support systems for various applications. Thirdly, we are also looking at what kind of infrastructure (considering the tremendous advancements in Imaging/Mapping/Surveying; geospatial databases; GIS applications; IT, computing, etc) would be needed so that national GIS Applications on a standardised national GIS data/information can be easily served/accessible to users for various applications, even for real time applications.

We have decided to undertake all-round consultations – with government, industries, academia and NGOs - and obtain inputs so that a true 'national character' can be in-built into the system.

All users/data generators/service providers/ researchers/social scientists can participate and "own" the national system. We are debating on the organisational set up required for such a system - the structure, role of various players, and other organisational focus aspects. Many of these issues will evolve in due course.

What are the challenges before the National GIS?

The main focus of National GIS is to position a strong foundation of a Decision Support System of GIS Applications which depend not only on developing wide variety of GIS Application

software, but also on the currency of the GIS data/information, its availability/usability in an easy-manner, and how it is presented/served to the prospective users. In this context, I would like to highlight three challenges. The first challenge is to keep the GIS data/information 'always' updated and establish a mechanism for this to happen regularly.

The second challenge is to make GIS data/information and applications that any user could easily use it. When the users are most comfortable to use the system, then they will drive it towards success.

The third and the real challenge is developing a GIS system that supports real time decision making – a decision to be taken NOW has to be taken now and must be supported with the right GIS Apps and GIS data. For example, if there is a fire in a large area of a city, then the GIS system should be able to support the firemen in planning and executing rescue operations by providing them the insights of city area, roads, building structures, etc and even integrated with real time video capturing. Or say, if Planning Commission wants to allocate funds for education sector, then the GIS system must be able to provide an analysis of schools in the country, their density, access distances, population served, investment status of each school already made in earlier plans, and so on. So the success of a National GIS really comes when "users" are served what they want in an easy-manner – we are even listing performance metrics for measuring (at any time) the success factor of National GIS.

Does that mean that technological advancements have to be utilized in effective application developments, and NGIS has a role there?

That's true. In this context, I would like to share the example of Tsunami Warning System. The system has been possible because we have adopted the most advanced and sophisticated technology that has enabled us to get the required data in a reliable manner without any disturbances. Moreover, we must also realise that a range of technologies – measurement technologies, GIS technology, IT, etc may all in a "combined manner" be making these applications successful and operational – thereby, recognising that technology platforms have to be viewed seamlessly and integrated across national applications platforms.

Do you think that data availability will be an issue?

On a comprehensive data level, data related issues are there (just like in any country). A large number of GIS Apps and DSS applications can be easily developed and positioned based on available data sets. To that extent there is not constraint – we have many examples. You know how GPS positioning data is easily available and integrated in India. I, myself, have found GPS very useful while moving around in Delhi when I had not much idea of Delhi roads and streets. One needs to clearly understand the type of data that is required for a specific purpose. One may not use Google maps for cartographic purposes but for common man it is a useful tool. The point I would like to emphasize here is that a lot of applications can be positioned with the GIS data/information are available, and to ensure that the GIS data/information serve the purpose.

How are organizations responding to the initiative of NGIS? Do you also have to deal with data sharing and ownership issues?

We are getting very good response. In fact, there has been increasing realisation in government organisations that data sharing is in the larger interest of society and national development. By sharing data we do not lose but in fact we get access to the data of other organisations as well. The approach towards data sharing is changing.

How is it going to be different from National Spatial Data Infrastructure (NSDI)?

In the ICG, we have debated on this and recognised that NSDI has been an excellent enabling mechanism for GIS standardization and also for generating testbeds for inter-operability. In fact, Planning Commission has clearly envisioned that National GIS is a DSS on a national GIS dataset and thus is unique and distinct from NSDI. In fact, I must mention that the experiences of NSDI and NNRMS – especially in the excellent work on standards, GIS databases and even the various GIS projects that have been done have been considered while defining National GIS. Thus, the NGIS would focus upon developing decision support system on a standardised and updated/maintained nation-wide GIS data/information for various applications.

The National GIS

The Planning Commission proposed to the establishment of "National GIS" under Indian National GIS Organization (INGO). Its is envisaged that the National GIS for the country and INGO as an organizational mechanism would greatly benefit the nation:

- be a major support to GOVERNANCE by embedding GIS in all aspects of planning and development at national/state/local levels; bringing transparency and geo-spatial information support in decision-making; enable a sound process of monitoring development and identifying "gaps in development"; make GIS data available at all levels – that helps bringing accountability and responsibility in governance.
- support the accelerated development of a number of Enterprise-GIS solutions being undertaken by private enterprise and help align these to national development – by allowing integration of the National GIS with enterprise solutions in an appropriate manner and also contribute innovative content/applications for larger and wider use.
- serve the basic needs of citizens by providing access to nation-wide maps/image/geo-spatial information; geo-enabling e-governance and public services and also enabling a "crowdsourced" interactive process of citizen involvement in providing feed-back/inputs/data as a virtual geographical ingest.
- It is proposed that the National GIS be established through INGO.

A National GIS Interim Core Group (ICG) has been set up under the Chairmanship of Dr Shailesh Nayak, Secretary, Ministry of Earth Sciences by the Planning Commission to prepare a blueprint for the development of the National GIS. The ICG comprises experts from the government, academia and private sector. **Dr Mukund Rao, Expert Consultant** (National GIS), Planning Commission is the Member Secretary of ICG.

Source: ICG draft ver 1.0 for discussions/consultations only

"The nation needs a GIS based decision support for governance, enterprises and citizens"

Says Mukund Rao, Member-Secretary, National GIS ICG while explaining the working of the ICG for the National GIS

Why National GIS?

I think this is the right time for a National GIS. There are 2 major reasons why I think so. First, see how as a nation we are tremendously progressing and growing and this will grow manifold in the coming 5-10 years. With such high growth, society will demand very high efficiency in governance and quality services; government will have to depend upon much more efficient and guaranteed methods of nation-building and bringing equity in quality of life and best addressing the vulnerable groups of society with care and touch. All of these will require much different practices and methods of planning, monitoring and development – which must be equitable, fast, measurable and impacting.

What will make impact is sound decision-making based on scientific data and mapping aspirations of society by involving citizens and positioning a modern governance system. This is where GIS as an indispensable tool for planning and development becomes extremely important and most relevant. The Planning Commission has been looking at this for quite some time and this thinking of basing planning and monitoring on GIS has been gaining wider acceptance. This is why the idea started and the concept of National GIS (NGIS) has come into the fore. In fact, even as the basic tenets of the 12th plan are being worked out by the Planning Commission, starting the use of National GIS is a good opportunity right now.

The second aspect is to look at what is happening in the GIS-space in India. Even though the nation has GIS activities for almost 20-30 years, the usage has yet to be impacting and meaningful. An organisational focus is now being discussed for National GIS – which will bring the much-needed thrust to GIS activities with a mandate (responsibility and accountability) for the GIS DSS for governance. Of course, it must be recognised that for the GIS DSS to be positioned, India has to develop a nation-wide dataset which is hitherto un-available in GIS form (though map sheets and images area available – which in-turn have to be processed/mapped to make a GIS database amenable for use). This data asset must also be current and regularly updated – then only the DSS becomes reliable and useful. It is this thinking that Geographic Information of the country is now being seen as an Asset of the country and this national GIS asset has yet to be organised, developed and maintained.

The need for a nation-wide GIS is coming from the decision makes, planners or the users and that, according to me, is a very significant change because user demand will "drive" rather than the spectrum of data generators, GIS technologists and so on which has been a trend till now. NGIS is thus a focus for a decision support system rather than a technology driven system.

> ICG is clear that the National GIS efforts must not be duplicating the work already done in the country

What is the proposed structure of NGIS?

Actually, Planning Commission has discussed the need for a GIS internally some time back and for preparing for the National GIS, it has established an Interim Core Group (ICG) and tasked it to work out a programmatic vision for the National GIS based on a wide consultation amongst government, industry and academia/ NGO user community. The ICG is also to help the Planning Commission in the necessary apporoval process. Thus, the ICG has presently initiated the activity of preparing a Vision Document for National GIS – a draft Ver 1.0 has been prepared and is being used for a wide-level of consultation which has already started.

As of now, the ICG has envisioned the National GIS as a "GIS Platform" on which GIS DSS for governance, enterprises and citizen services would be offered based on a standardised seamless, (and regularly updated) nation-wide GIS Asset. Of course, there are associated issues of a very user-centric GIS infrastructure that is being envisioned where user "just consumes the services" and does not have to bother about anything at all. The issues of GIS capacity-building and training with research needs in GIS applications is also being discussed. The major thing that ICG is discussing is that an organisational focus is most essential for National GIS and has outlined the characteristics of such an organisation in INGO.

What are the challenges?

The biggest challenge before all of us is to get the concept behind the NGIS well understood – that now GIS has to be user-driven and whatever users need must be met (if possible) ASAP. It is just not enough to say "this is available" and expect users to "struggle" to use and adopt the GIS. To me that is unfair because the technology of GIS has now a tremendous service focus. GIS must be service-ready and must have a customer-centric focus with service as a motto. As I see it, National GIS is a service offering to the nation's user community so that users could just get what they want. I think that is the reason that the NGIS is being initiated by Planning Commission – which will define what is needed by the nation, as far as GIS is concerned, and all efforts (by data generators, by technologists etc) must be made to meet those national needs. This is very significant shift and we will have to strongly found this "service focus" and cater to whatever the nation wants.

Of course, many government agencies (and private agencies too) are using and building their own GIS in their own way – but I think the time now is to really "integrate" all these efforts to a national goal of a National GIS, even as each agency works for its own agency-goals (be it providing topographic maps for the country or soil maps for the country or high-resolution images for the country). To me, the most important aspect (again based on

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experience of past) is the organisational focus that is being outlined in National GIS. GIS as an activity has been there for many years now but the need for an organisational mandated focus is increasingly being felt now – which I think is rightfully being considered now. It is only this mandated organisational focus that will bring responsibility and accountability – if something of GIS does not happen somebody will have to answer and make best efforts to meet the needs. No more GIS can be seen as a project activity (which can have a start and an end) but has to be a continuous and service-oriented activity – thus requiring the responsibility and accountability. This concept has also been seen as quite important in some of the recent things that have happened in the country – be they in infrastructure, social security, Census etc. At the same time, the thinking in ICG is that the organisation focus must be to bring performance and efficiency and thus modern methods of organisational development with clearly defined and measurable performance metrics for the organisation must be implemented. The need is to be as effective and as performance oriented and as successful as possible to make India immensely benefit from GIS and also make India one of the best places for GIS activities.

Would you like to say something on the linkages between NSDI and NGIS?

The NSDI movement started in 2001 and I was closely associated right from then (and thus have a very special attachment to it). I have also been studying the SDI movement across the world and according to me, the Indian NSDI has done pretty well (when compared to others). It has triggered and helped initiate a large amount of GIS activity in the country – many agencies have established good GIS projects. NSDI was driven by data-generators and the emphasis was on "sharing" and making data available – a more cooperative effort. These had challenges just like in many other countries too. NSDI has also made good efforts at standardisation (in Metadata and Exchange and others) and most importantly, through its annual meets, has "kept the flag of SDI flying". I know that NSDI Secretariat also tried to position some good projects. Thus, NSDI has maintained sufficient momentum for SDI attention in the country and has helped all of us to learn and has given us good experience. So, with the way NSDI was structured, I think it has done pretty well and those are very valuable experience to us.

The ICG has drawn on these and many other experiences and it is clear that National GIS is not "duplicating" any efforts – in fact, National GIS is envisioning to fill the many gaps that still exist for a nation-wide GIS DSS for governance, enterprise and citizens. ICG is also clear that National GIS efforts must not be duplicating the work already done in the country – but should build upon those and achieve the larger goal of a GIS DSS for governance, enterprise and citizens. For example, the excellent standardisation efforts of NNRMS in 2005 and NSDI in 2003/2008 have all been studied and after also considering the much recent experiences and technological developments, the standardisation definitions of National GIS are getting defined. I am sure good linkages will be there. Ultimately, the idea is that the country should benefit from a larger value-proposition of a GIS for its planning, development and governance.

Planning Commission

The Planning Commission was set up by a Resolution of the Government of India in March 1950 in pursuance of declared objectives of the Government to promote a rapid rise in the standard of living of the people by efficient exploitation of the resources of the country, increasing production and offering opportunities to all for employment in the service of the community. The Planning Commission was charged with the responsibility of making assessment of all resources of the country, augmenting deficient resources, formulating plans for the most effective and balanced utilization of resources and determining priorities. Planning Commission plays an integrative role in the development of a holistic approach to the policy formulation in critical areas of human and economic development. An integrated approach can lead to better results at much lower costs. From a highly centralized planning system, the Indian economy is gradually moving towards indicative planning where Planning Commission concerns itself with the building of a long term strategic vision of the future and decide on priorities of nation. The Prime Minister of India is the Chairman of the Planning Commission.
http://planningcommission.nic.in

What would be the parameters to measure the success of NGIS?

The Planning Commission and the ICG is very clear on this. ICG feels that any new organisation (like for National GIS) must be performance oriented. The organisation must be agile, slim-and-trim but bring high efficiency and performance for success. A measurable performance metrices are being proposed so that at any time the nation can evaluate and measure the progress and the success of NGIS. The performance metrics is not only going to be a set of analytical parameters for the organisation achievement but also for individual staff achievements so that such methods can also help in improving the quality of the work for future.

What would be the timeframe to move to the next level?

The Planning Commission has given the ICG a duration of 6 months. The Version 1.0 Vision document has already been circulated to all the government agencies, almost 50+ GIS/IT industries and to almost 20+ academia/NGOs as part of the consultation process. We have also taken a campaign to elicit specific feedback and inputs from government user agencies. Other consultations/discussions at higher levels are also happening. Based on all these discussions/ consultations, the Ver 2.0 of the Vision document would be prepared and will be taken up for discussion in a proposed National workshop – thus, the National GIS Vision would have all the inputs and materials to be taken up necessary approvals and implementation. The ICG is adopting a very open and inclusive process and maintaining transparency in its activities and will go all ends for getting the best of inputs so that the nation gets the BEST VISION for a National GIS. In fact, all of the ICG members are actively addressing specific aspects of the vision and are bringing in tremendous thinking and inputs for discussion. So even now, we are adopting pretty good work methods – just as we envision INGO to be most modern and efficient organisations. As Member-Secretary, I can assure that anybody who has a good idea and a good way of addressing the DSS GIS, they would certainly be discussed and could find their inputs in the Vision.

Once the Vision is made and submitted to Planning Commission as a national vision, Planning Commission will decide what they want to do with it and take up activities ahead.

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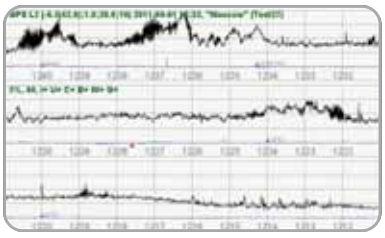


Question 1

TRIUMPH-VS has 216 channels. The spectrum analyzer feature of TRIUMPH-VS scans GNSS bands and shows the presence of jammers and interferences using:

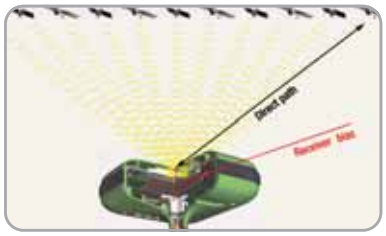
A	60 channels for jammer detection while normal satellite tracking continues using the remaining 156 channels.	○
B	60 channels for jammer detection but normal satellite tracking stops during jammer detection.	○
C	10 channels for jammer detection while normal satellite tracking continues using the remaining 206 channels.	○
D	216 channels for jammer detection and normal satellite tracking stops during jammer detection.	○
E	108 channels for jammer detection and 108 channels for normal satellite tracking.	○
F	3 channels for each band for jammer detection and the remaining channels for normal satellite tracking.	○

Question 2

A commercially available $430 GJ6 jammer can:

A	Completely knock out all GPS bands and significantly damage GLONASS bands.	○
B	Completely knock out all GLONASS bands and significantly damage GPS bands.	○
C	Completely knock out all GPS L2 and GLONASS L1 bands.	○
D	Completely knock out only GPS and GLONASS satellites that are in its direct line of sight.	○
E	Completely knock out all P-Codes with minimal affect on C/A codes.	○
F	Create huge amount of multipath in all GPS and GLONASS bands.	○

Visit www.javad.com website and enter your answers.



Question 3

GLONASS signal quality in JAVAD GNSS receivers is as good as GPS because we dynamically remove the effects of GLONASS inter-channel biases with the accuracy of:

A	Better than 2 meters.	○
B	Better than 20 centimeters.	○
C	Better than 2 centimeters.	○
D	Better than 2 millimeters.	○
E	Better than 0.2 millimeters.	○
F	Better than 20 microns.	○

Question 4

Superior performance of JAVAD GNSS six-pack RTK V6 engine is achieved by:

A	Assigning 3 engines to GPS and 3 engines to GLONASS.	○
B	Randomly assigning satellites to each engine.	○
C	Engines operating sequentially to obtain the best combination.	○
D	All engines operating simultaneously but each with a different algorithm and their weighted averages providing the final RTK solution.	○
E	All engines operating with the identical algorithm and their sum providing much better results.	○
F	Engines being divided between GPS and GLONASS satellites according to the relative number of visible satellites of each system.	○

Visit www.javad.com website and enter your answers.

Question 5

You can assemble points in your computer and transfer them to the TRIUMPH-VS for stakeout (or other purposes) and get points back to your computer using the following JAVAD GNSS software:

A	JustinLink.	○
B	Giodis.	○
C	NetView.	○
D	NetHub.	○
E	SteakWare.	○
F	Tri-VU.	○

Question 6

To create your own local coordinate systems in the TRIUMPH-VS do the following:

A	Have your local points in one layer and surveyed points in another layer of the current map and click localize.	○
B	Have each local point together with its corresponding surveyed point in a layer of the current map and click localize. 10 layers support up to 10-point localization.	○
C	Have your local points and surveyed points in the same layer, but identify them with “L” and “S” prefixes and click localize.	○
D	Have your local and surveyed points in any layer but provide a matrix to show their relationships and click localize.	○
E	Have your local and surveyed points in “Localize” matrix and click localize.	○
F	Have your local points in the “Local” map and surveyed points in “Survey” map and click localize.	○

Visit www.javad.com website and enter your answers.

Question 7

The TRIUMPH-VS contains all you need to perform RTK survey using VRS (Virtual Reference Station) or RTN (Real Time Network). In addition to Wi-Fi, LAN, and GPRS, it also supports the "Edge" connection. Compared to Standard GPRS, Edge is an advanced and special GPRS protocol that is:

A	More secure but slower.	○
B	Slower but less expensive.	○
C	Much faster.	○
D	Same speed but less expensive.	○
E	Same speed but more secure.	○
F	Same speed but uses much less power which saves battery life significantly.	○

Question 8

We continue to improve TRIUMPH-VS software. To update all TRIUMPH-VS software components to the latest version you must:

A	Download updates from www.javad.com to computer and then transfer to TRIUMPH-VS using Windows Mobile Device Center or Active Sync.	○
B	Download updates from www.javad.com to computer and then transfer to TRIUMPH-VS using JustinLink software.	○
C	Download updates from www.javad.com to computer and TRIUMPH-VS will take them automatically.	○
D	Download updates from www.javad.com to computer and transfer to TRIUMPH-VS using NetHub.	○
E	Connect the TRIUMPH-VS directly to the Internet (LAN, Wi-Fi, or GPRS) . On the "Software Update" screen click "Update". Decide which software versions you want to update and click "Download".	○
F	Connect the TRIUMPH-VS directly to the Internet (LAN, Wi-Fi, or GPRS). On the "Software Update" screen click "Update".	○

Visit www.javad.com website and enter your answers.

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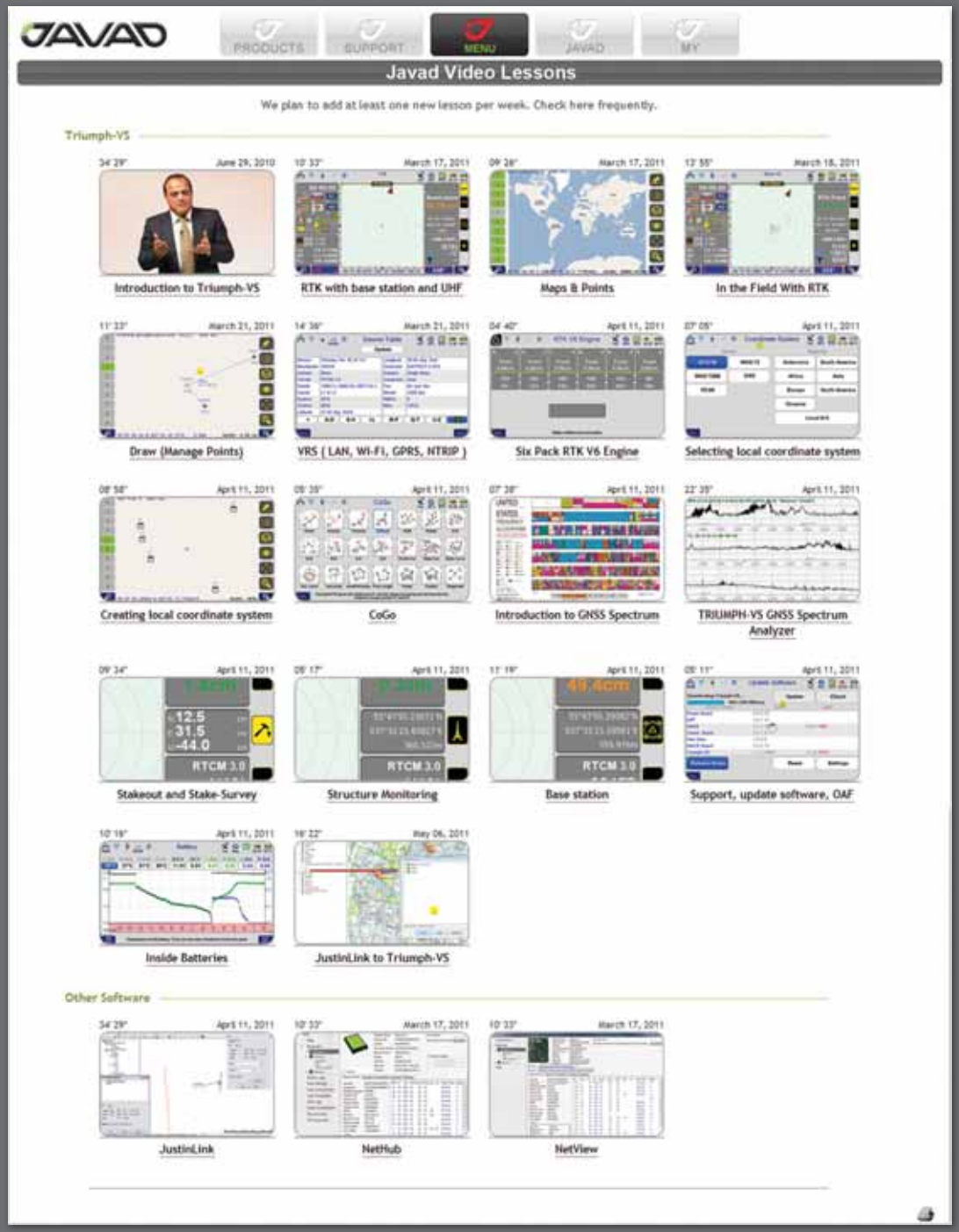

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Need for new services in land administration

Land administration institutions have been facing challenges to fulfill the needs for data and services

András Osskó
Advisor, Institution of Geodesy Cartography and Remote Sensing (FÖMI), Budapest, Hungary

There is a general consensus among the land administration professionals and different players of the economy in the developed countries and more and more in the developing world as well, that the Land Administration is one of the most important infrastructure for the economic growth and the implementation of sustainable development. This fact is proved by statistical data. In developed countries the value of the land and real estate properties, together with mortgages is about 60-65 % of the state assets. The land and real estate property related activities generating about 30-35% of the GDP. The value of mortgages on properties is 30-35 % of the GDP in developed countries and 3-8 % in transition countries.

The land and real estate properties have been registered in the cadastre, land registry or integrated land administration institutions. These institutions are maintaining, updating legal and mapping data related land and real estate properties and in the same time providing data and other services. This means the registration and maintenance of a huge, high value of databases and also services which are essential for the economy and the entire society.

In respect of above it's obvious that the role and importance of land administration has been increasing world wide and there is an increasing demand for land administration data and services. To guarantee the security of property and other rights related to land and real estates is fundamental in the existing democracies therefore the land administration data and other services became top priority required by the economy and the society. To fulfill the growing demands, besides the traditional services, new kind of services, legal changes and transparent procedures, without bureaucracy are needed. This also means the necessary extension of electronic services, digital data and also user friendly approach. To answer new challenges it's clear the modernization of land administration institutions and introduction of new attitude are essential as well.

Changing role of land administration

In the majority of European countries the cadastre and legal registries were established in the XIX th. and at the beginning of the XX th. century, separately, under different authorities. The activity of the two registration systems was parallel, partly overlapping and mutual data exchange took place between them. On one hand land and real estate cadastre was created for the purpose of the state and politics for taxation, on the other hand there was factual land registry, which negotiable and mortgaged real estate was involved in. The land registers were aiming at the security of ownership the unperturbedness of the land transactions as well as the creditors' interests. The difference between the land registers and the land tax cadastre can be recognized by the diverging structure and authorization. The land registers were within juridical scope while the land cadastre was part of the public administration.

It was common up to the middle of the XXth. century, the data and other services haven't played too much role in their activity. After the World War II, especially since 1970s the land and real estate related activities have been changed and multiplied very much. The importance and number of real estate investments have dramatically increased and became one of the engines of the economic growth. The importance and roles of mortgage system also increased and the total value of mortgages has been

grown rapidly. Nowadays the land and real estate is not property only but goods as well and the land, real estate related activities services generating huge incomes and contributing to the GDP significantly. Besides of the changing role of land and real estate properties in the economy, the IT development ,which is still rapidly developing also accelerated the growing demands for data and services. The new technology has made the extension of data, quick direct access and new format of services possible. The changing role of real estates, the importance of real estate investments in the economy, the new IT technology and the increasing demands for data and services forced the reorganization, modernization of the legal and institutional framework in land administration especially in developed countries to fulfill the demands of the economy and the entire society.

Modernization of land administration institutions

The land administration institutions had to answer the new challenges in order to fill the needs of the economy and the society for data and services. To achieve above goals the renewal, modernization of land administration institutions became essential. The majority of countries used step by step approach and different ways.

Possible solutions

- development of multipurpose cadastre
- integration of cadastre and legal registry (unified system)
- cost recovery approach, self financing institutions
- new agency model in land administration

Development of multipurpose cadastre

Originally Cadastre and legal registry achieved special tasks. In countries where the land book (Grundbuch) is still existing, under courts, separately, working traditional way. In many countries the Cadastre still serves taxation purposes, but they extended their activities during recent years. Creation of new digital cadastral maps, maintenance, updating of cadastral maps. Digital databases became more and more important allowing them to provide cadastral data and other services. Cadastre also deals with the establishment and maintenance of control point networks and other mapping activities. This model is existing for example in Spain, Belgium and some Latin American countries.

Integration of cadastre and land registry, unified system

During the last decades, following the professional trends and demands of the economy, it became quite obvious, that the unified system, the integration of cadastre and legal registry on legal basis and institutional level is the most efficient land administration institution, with special regard to the increasing demands for services. The integrated system contains huge number of data and information, generating, providing wide range of services. As I mentioned earlier the security of property and other rights related land and real estate is fundamental in the developed countries the data and other services became top priority in land administration institutions, demanding by the economy and the society. The integrated institutions can provide more efficient, quality services. Based on above facts, more and more countries integrated the cadastre and land registry .

The Dutch Kadaster has been operating unified system since decades, Hungary since 1970, Czech and Slovak Republic since 90s. It's remarkable that during the passed years Norway, Sweden and Finland decided about the integration of cadastre and land registry and other mapping activities. The aim was to create such an institution which can fulfill the increasing demands for legal and mapping data and other services related to land and real estate properties.

The centralized IT system, one decision maker (authority), avoiding overlapping activities and other circumstances make the institutions more efficient, reducing operational costs and creating user friendly environment. Unified system is operating, in many countries in Europe, for example in The Netherlands, Hungary, Norway, Czech Republic, Slovak Republic, Romania, Moldavia and will operate in Sweden and Finland soon.

Self financing land administration institutions

The majority of cadastres, land administration institutions provide services for fees. It can be registration fee, fee for data and other services, etc.

As the result of the increasing demands for land administration services the income generated by services has been continuously growing. The growing revenue could cover a high rate of the budget and in many cases the total budget of institutions. In the last case we can speak about self financing, cost recovery institutions. Of course there are still cadastre, land registry institutions 100% financed by the state.

The financing solution is the question of political decision. In case of self financing institutions the revenue generated by services must cover the total budget but the price of services have to be accepted by the external users and citizens. To keep reasonable prices it's also important to minimize the number of free data and services.

It's obvious that a self financing institution must operate different way than an institution financed by governmental budget. To operate self financing governmental institution for long term, changing of institutional structure and business like approach is needed. Some of the examples of the self financing institutions: The Netherlands, Sweden, Hungary, England, etc.

Agency model in land administration

Integrated Cadastre and land (public) registry agency as institutional model is existing in more and more countries in Europe. The Cadastre agency with integrated multipurpose activities provides official tasks and business like services as well. It operates different way comparing with traditional governmental institutions. One of the main difference

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that the agency is quite independent they have more authority to make decisions. In many cases their supervisory body is not a ministry but the government itself. The agency can decide not only in professional but also in financial matters.

This kind of institutions can answer challenges, like the recent financial crises, quicker and more effective way. The income of land administration institutions, generated by data and other services, dramatically dropped during the last years due to the economic crises. Based on experience, the income of the independent land administration agencies have been decreased to a lesser degree during the economic crisis. Some example of the agency model. The Netherlands, Norway, Czech Republic, Sweden, Romania, Moldova.

Necessary legal changes in land administration

To modernize land administration institutions and to create new kind of services, concerning contents and technology, legal changes are necessary. There is an increasing need of legal changes in land administration in Hungary and the European Union but I think all over the world, but the achievement in the majority of countries is always a long process because of the bureaucracy. Fortunately the economy needs always force the changes. The legal changes must support the extension of data, electronic services and free movement of cross border land administration services in the European Union.

Possible extension of cadastral data and services

Condominium registration, legal and mapping information of public utilities, introduction of 3D Cadastre, etc. can be the future possible extension. Extension of electronic services is also important, like electronic conveyance, signature, payment, mobile phone services and others. For the extension of land administration data and activities, legal changes are needed. Many countries have already introduced changes but still a lot to do.

Free movement of cross border land administration services in the EU

The Lisbon Treaty in 2003 declared that the European Union must be the most competitive economy in the world in 2010. To achieve this goal the member states have to guarantee the free movement of cross border services within the EU. Unfortunately none of the goals have been achieved. There are a lot of barriers of different cross border services including land administration ones, due to the wide range of variety concerning legal and institutional environment in land administration (cadastre, land registry). It's obvious if the European Union wants to achieve above goals, legal changes and harmonization are needed in the field of land administration in the EU member countries. The European Union must formulate basic principles and recommendations supporting legal harmonization which is a very difficult task according to experience.

The needs for new services in land administration, cadastre

The increasing needs for land administration data and services world wide by the economy and the entire society, continues rapid development of the IT, the integration of land and real estate property activities and other circumstances allowing to provide new services considering the extension of data and formats. The integrated multipurpose land administration databases contain huge number of data and information and could be extended any further. The number and kind of data and other services very much depends on the political and professional decisions, the existing legal environment and the level of democracy. The needs of the economy and the society must be top priority. To fulfill the demands of the economy and the society the implementation of user friendly servicing state is fundamental.

Some example of extension of data and services :

- statistical data for the economy and government
- condominium registration
- public utilities registration, information property tax information
- public restrictions
- 3D cadastre

Changes in format and way of services

In the majority of developed countries the paper based analogue services have been replaced by electronic services. In the less developed countries it would be essential to develop the full IT infrastructure to guarantee the equal right to access of data and information for all citizens. Public data and transparent procedures are also essential.

E- government

The introduction of operational e-government is an important task in the European Union member states. In many countries the e-government activities have been coordinated by cadastre institutions, mapping authorities as the most suitable institutions. These institutions are responsible to keep and maintain the mapping, spatial and legal data related to land and real estate properties which are important to carry out many of the activities like environment protection, transport, traffic control, disaster management, police, ambulance and many others. The professional staff of these institutions have sufficient knowledge as well to manage, coordinate e-government activities.

e-Cadastre, u-Cadastre

Land administration, Cadastre services have been operating via internet in many countries since years. In the recent years, especially in the developed Asian countries (South Korea, Singapore, Malaysia and others) introduced "ubiquitous", so called u-Cadastre. This means the cadastral, land administration information, services can be accessible by mobile phone everywhere for all.

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Analysis of integrated navigation with GPS source variability

At UNSW, an Attitude and Heading Reference System known as AhrsKF has been developed for a new generation of guidance and steering control system

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Guidance and steering control systems that are now in widespread use by farmers for ploughing and cultivating the land with unprecedented accuracy, require centimetre-level position as well as attitude information accurate to a few degrees. Additionally, position and attitude update rate of no less than 10Hz is required for successful guidance in agricultural environments. Guidance and steering control systems rely particularly on heading and roll measurements to steer the tractor on parallel straight lines or curves known as plough lines.

At UNSW, an Attitude and Heading Reference System known as AhrsKF has been developed for a new generation of guidance and steering control system (operated commercially by Leica Geosystems as "mojoRTK"). A Kalman filter (KF) is the most common estimation engine for integrated navigation systems. The AhrsKF system is based on a closed loop KF. It uses strapdown Inertial Navigation System (INS) computation equations in the navigation coordinate system (n-frame). The hardware system makes use of automotive-grade MEMS inertial sensors. In AhrsKF, the GNSS solutions of position and velocity are fed into the Kalman Filter for state error estimation of the INS measurements [1]. A dual frequency survey grade GPS/GLONASS receiver provides position information. An alternative position information source to RTK (Real Time Kinematic) is used in AhrsKF. This is a positioning algorithm that benefits from a relative Pseudorange/Delta-Phase (PDP) filter (commercially know as GL1DE) leading to an enhanced solution of 1 meter accuracy over 20 minutes [2]. The PDP filter provides a filtered position and velocity solution based on assumed vehicle dynamics, and relies heavily on Doppler measurements.

The PDP is not regarded as the main position input for the mojoRTK system. The reason the PDP algorithm is used in the mojoRTK system is to provide stable position inputs when the line of sight to the RTK based station is obstructed. In this paper it is shown that the attitude solutions from AhrsKF are more accurate when PDP, which provides much less accurate positions than RTK, is used. For integrating the PDP solution into the AhrsKF, first both PDP and RTK solutions are sequentially fed into the AhrsKF. Then the integration uses a Multiple Model Kalman Filter (MMKF) that enables the AhrsKF to accommodate both GPS input sources. The sequential and MMKF algorithms attitude solutions are tested with reference to multi-antenna GPS or long boom attitude solutions.

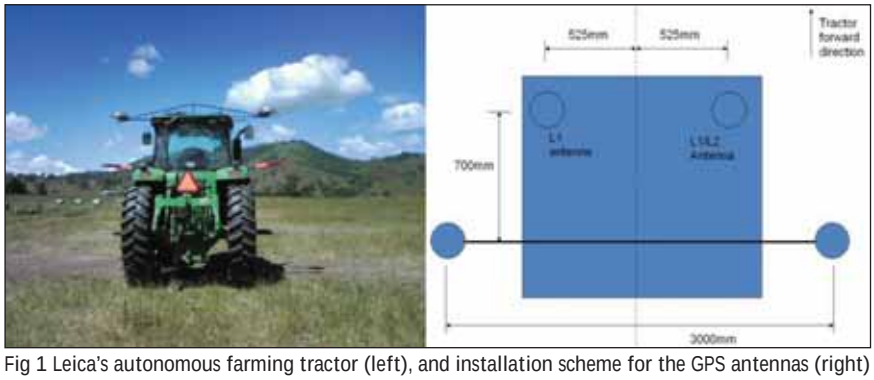

Fig 1 Leica's autonomous farming tractor (left), and installation scheme for the GPS antennas (right)

AhrsKF hardware system

The guidance and steering control system sensors consist of three rate gyros, a three axis accelerometer, and a 2-axis magnetometer. In addition to these sensors, the system includes two GPS receivers – a dual frequency L1/L2 GPS/GLONASS receiver and a low-cost L1-only single frequency GPS

Characteristics	Specifications
Gyro Sensitivity Error	±6%
Gyro Linearity	±0.3%
Gyro Bias Variation at Constant Temperature	±0.4 °/S
Gyro Bias Stability over one hour	±0.4 °/S

Table 1 Technical specifications of MEMS gyros [3].

Fig 2 The trajectory of the tractor during the test

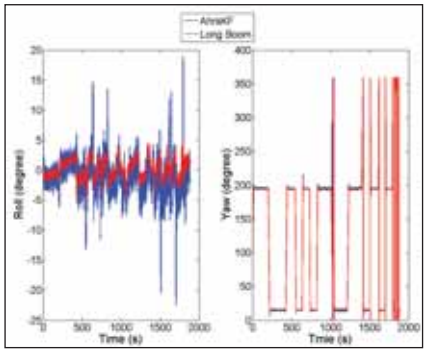

Fig 3

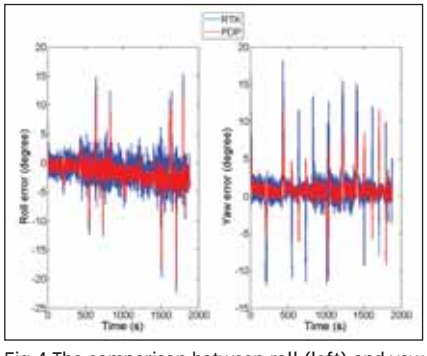

Fig 4 The comparison between roll (left) and yaw (right) errors for post processed AhrsKF solution with RTK and PDP positions relative to multi-antenna attitude solution.

Mode/coefficient	a	b	c
Carrier phase (RTK)	0.02	0.02	0.03
Pseudorange/Phase Difference (PDP)	1	1	1.2

Table 2 Standard deviation of the position in AhrsKF [1].

	With RTK		With PDP	
	Roll	Yaw	Roll	Yaw
Mean (Degree)	-1.35	0.97	-1.68	0.84
STD (Degree)	2.67	3.08	2.36	1.47

Table 3 Static results for the comparison between post processed AhrsKF solutions with different information sources and long boom attitude solutions

receiver which produces a two axis attitude solution used for estimating the biases of the inertial sensors. The inertial and GPS data are then processed by an embedded 400MHz PowerPC processor. The specifications of the MEMS gyros in the guidance and steering control system are listed in Table 1.

In this guidance and steering control system the temperature-compensated inertial data are fed into the integration Kalman filter. In AhrsKF software the GPS position and velocity are used to derive the position and velocity errors of the INS in a closed loop. This means that the error corrected INS position and velocity solutions are integrated with the next epoch GPS solution. The AhrsKF state vector is [1]:

$$\mathbf{X}=[\phi_E,\phi_N,\phi_U,\delta V_E,\delta V_N,\delta V_U,\delta L,\delta\lambda,\delta h,\varepsilon_x,\varepsilon_y,\varepsilon_z,\nabla_x,\nabla_y,\nabla_z]^T \quad (1)$$

The first three states are attitude errors, then velocity errors, and position errors. The final 6 states are sensor error terms (respectively related to three gyros and three accelerometers), which are modeled as a random walk in the AhrsKF. The measurement equations for velocity and position are [1]:

$$\mathbf{Z}_v(t)=\begin{bmatrix} v_{IE}-v_{GE} \\ v_{IN}-v_{GN} \\ v_{IU}-v_{GU} \end{bmatrix}=\mathbf{H}_v\mathbf{X}(t)+\mathbf{V}_v(t)$$

$$\mathbf{Z}_p(t)=\begin{bmatrix} L_{IE}-L_{GE} \\ \lambda_{IN}-\lambda_{GN} \\ h_{IU}-h_{GU} \end{bmatrix}=\mathbf{H}_p\mathbf{X}(t)+\mathbf{V}_p(t) \quad (2)$$

When the speed of the vehicle is high enough, e.g. 3m/s, the GPS velocity can be used to derive the heading at an accuracy of about 0.57deg (assuming a GPS velocity error of 3cm/s). The heading derived from the GPS velocity can then be used to correct the INS heading in the integration Kalman filter [1]:

$$Z_\psi(t)=\psi_{INS}-\psi_G=\phi_u+V_M \quad (3)$$

So the equation of measurement is written in a matrix form as below:

$$\mathbf{Z}=\begin{bmatrix}\mathbf{Z}_v\\ \mathbf{Z}_p\\ Z_\psi\end{bmatrix}=\begin{bmatrix}\mathbf{0}_{3\times2} & \mathbf{0}_{3\times1} & \mathbf{I}_{3\times3} & \mathbf{0}_{3\times3} & \mathbf{0}_{3\times3} & \mathbf{0}_{3\times3}\\ \mathbf{0}_{3\times2} & \mathbf{0}_{3\times1} & \mathbf{0}_{3\times3} & \mathbf{I}_{3\times3} & \mathbf{0}_{3\times3} & \mathbf{0}_{3\times3}\\ \mathbf{0}_{1\times2} & 1 & \mathbf{0}_{1\times3} & \mathbf{0}_{1\times3} & \mathbf{0}_{1\times3} & \mathbf{0}_{1\times3}\end{bmatrix}\mathbf{X}+\mathbf{V} \quad (4)$$

The system model in the Kalman filter is:

$$\dot{x}(t)=Fx+Gw \quad (5)$$

where ***F*** is the system model matrix described in [4] and ***G*** is the system noise distribution matrix and w is the system noise vector. Matrix **w** contains the variances of accelerometers and gyros. ***F*** and ***G*×*w*** must be discretized for discrete systems. Matrices ***Φ*** and ***Q*** are the result of discretization process and are used in the Kalman Filter State vector estimation equations through time propagation:

$$\begin{aligned} x_k^- &= \phi_{k-1}\hat{x}_{k-1}^+ \\ P_k^- &= \phi_{k-1}P_{k-1}^+\phi_{k-1}^T+Q_{k-1} \\ K_k &= P_k^-H_k^T(H_kP_k^-H_k^T+R_k)^{-1} \\ \hat{x}_k^+ &= \hat{x}_k^-+K_k(z_k-H_k\hat{x}_k^-) \end{aligned} \quad (6)$$

The expected values of the corrections are zero in closed loop filters, thus $\widehat{x_k^-}=0$.

The covariance of the measurement noise in AhrsKf is described [1]:

$$R_k=I_{7\times7}\left[0.04 \quad 0.04 \quad 0.09 \quad a^2 \quad b^2 \quad c^2 \quad \left(\frac{3^\circ\times\pi}{180}\right)^2\right] \quad (7)$$

where a, b, and c are the standard deviation of the 3D GPS positions, with the adopted values listed in Table 2.

Test and Setup

A test was conducted at Boonah, at Leica's test farm near Brisbane, Australia, on 12 July 2010. In the test, multiple GPS receivers (used to derive the attitude solution as the reference to evaluate the AhrsKF solution) and the mojoRTK were mounted on the tractor. The installation of the GPS antennas is illustrated in Figure 1. The longest baseline is 3m, from which the heading and roll can be derived with an accuracy of 0.056deg (3mm/3m=0.056deg by assuming 3mm accuracy of the double-differenced carrier phase measurements). The forward component of the baselines is 700mm, and the derived pitch has an accuracy of 0.25deg (=3mm/700mm), thus the boom GPS-derived attitude is accurate enough to evaluate the AhrsKF solution. Details of the GPS attitude

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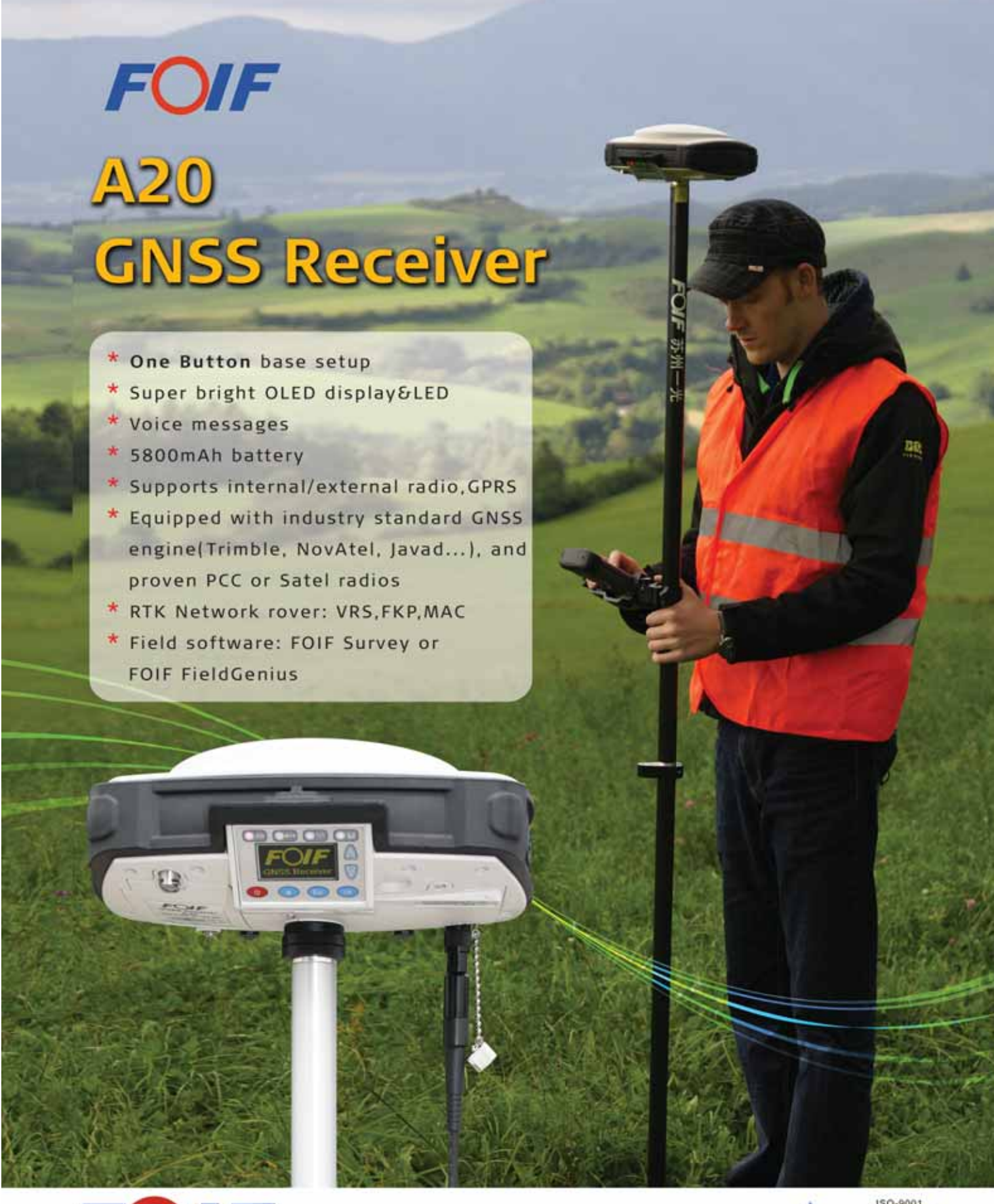

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algorithm used for this test can be found in [4]. There was no obstruction to the RTK base station line of sight during the test.

The tractor was driven at a speed of 2-5m/s along straight lines, and about 2m/s at turns. The field is relatively flat, with both the roll and pitch angles being within ±2deg (1σ). The AkrsKf and multi-antenna GPS attitude solutions are depicted in Figure 3, where the AhrsKF solution is plotted as the blue line and the boom GPS solution in red. It can be seen that the AhrsKF solution coincides with the GPS solution and correctly tracks the changes of all attitude angles. It can also be seen that the AhrsKF solution is noisier than the GPS solution. The AhrsKF solution is obtained by post processing the collected data during the test. Only yaw and roll outputs are plotted here since the auto steering system only uses the yaw and roll measurements.

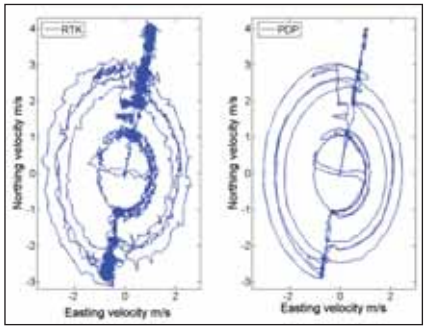

Figure 5. The velocity trajectory for RTK solution (left) and PDP solution (right). The PDP {this is the first tiem you've mentioned Glide – use either that, or PDP or if you use both use them both earlier} trajectory is visibly smoother.

Figure 4 and Table 3 show that AhrsKF can produce less jittery (noisy) and smoother attitude solutions when it is supplied with PDP position, velocity and heading solutions relative to when it is operating with RTK solutions. The table shows the static results of the attitude error relative to the long boom attitude solution. Generally speaking the STD of attitude error for both roll and yaw are lower for the PDP-driven solution. The sudden hikes in the errors are related to time lags when the tractor has sharp turns. The reason for the better performance of AhrsKF with PDP relative to RTK rests in the mechanism by which PDP solutions are derived and also in the excellent quality of velocity measurements. The PDP solution optimizes the absolute positioning accuracy of the GPS code observation and leverages the relative stability of the GPS carrier phase and Doppler observations [2]. Thus, the PDP filter produces a very smooth solution with consistent rather than absolute position accuracy. There is typically less than 1 cm difference from epoch to epoch [2]. Figure 5 shows the velocity trajectory of RTK and PDP solutions. It is clear that the velocity trajectory of PDP is smoother and has less jitter or noise. The high quality of velocity measurement reflects excellently on the performance of AhrsKF. This is because the northing and easting velocities are used to derive the heading (or yaw) as a measurement input (see Equation 3) to the AhrsKF at each epoch.

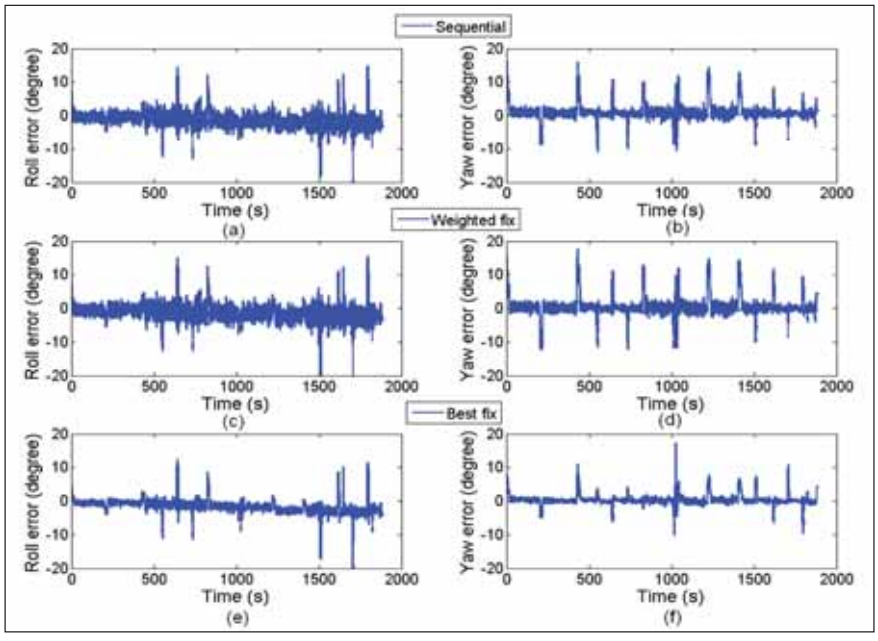

Fig 6 The roll and yaw errors for sequential algorithm (a and b), weighted fix MHKF (c and d) and best fix MHKF (e and f).

	Sequential RTK and PDP		MMKF weighted fix		MMKF best fix	
	Roll	Yaw	Roll	Yaw	Roll	Yaw
Error Mean (Degree)	-1.42	0.92	-1.32	0.46	-1.43	0.37
Error STD (Degree)	2.54	2.51	2.69	3.11	2.34	1.50

Table 4. Static results for the comparison between different algorithms based on the post processed AhrsKF solutions simultaneously fed with both GPS/RTK and PDP with long boom GPS attitude solution.

Multiple model Kalman filter

A Multiple Model Kalman Filter (MMKF) is a way to combine several parallel KF solutions together and to from a *filter bank*. This is also known as a federated KF. Each KF denoted by an index *i*, is based on independent information from other filters, e.g. different measurement sources, different *R* or *Q* matrices or even different initial *P* matrices.

The MMKF is the default candidate for making use of both the PDP and RTK solutions in AhrsKF simultaneously and in parallel to each other. The MMKF enables integrating the solutions of two KFs, one operated by RTK and the other operated by PDP in a single estimator. The simplest ways to perform this are one of the following [5]:

Weighted fix: weighted averaging of the solutions and their process covariance noises.

Best fix: accepts the solution with the highest probability and rejects others.

In either case the weights are calculated by [5]:

$$p_{k,i} = \frac{p'_{k,i}}{\sum_{i=1}^{I} p_{k,j}} \qquad (8)$$

$$p'_{k,i} = \frac{p_{k-1,i}}{\sqrt{(2\pi)^m \left| H_{k,i} P_{k,i}^- H_{k,i}^T + R_{k,i} \right|}} \exp\left[-\frac{1}{2} \delta z_{k,i}^{-T} \left(H_{k,i} P_{k,i}^- H_{k,i}^T + R_{k,i} \right)^{-1} \delta z_{k,i}^- \right]$$

where *m* is the number of components of the measurement vector, *l* is the number of filter models and the measurement innovation is generally defined as:

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$$\delta z_k^- = z_k - H_k \hat{x}_k^- \qquad (9)$$

The best fix filter simply chooses the solution (hypothesis) with the highest weight. The weighted fix process can be based on predetermined fixed weights. In the weighted fix MMKF with adaptive weights, the filter model or hypothesis with the smallest normalized measurement innovation is allocated the largest probability, and is regarded as most consistent with the measurement stream. Over time the probability of the best hypothesis will approach unity, while others approach zero. If that's the case the filter cannot go back to the adaptive mode. To avoid this, the weights must be reset to an initial value after a fixed interval of epochs if the zeroing happens. The overall state estimate and error covariance are obtained as follows [5]:

$$\begin{aligned} K_{k,i} &= P_{k,i}^- H_{k,i}{}^T \left(H_{k,i} P_{k,i}^- H_{k,i}{}^T + R_{k,i} \right)^{-1} \\ \hat{x}_{k,i}^+ &= \hat{x}_k^- + K_{k,i} \delta z_{k,i}^- \\ \hat{x}_k^+ &= \sum_{i=1}^{l} p_{k,i} \hat{x}_{k,i}^+ \\ P_k^+ &= \sum_{i=1}^{l} p_{k,i} \left[P_{k,i}^+ + \left(\hat{x}_{k,i}^+ - \hat{x}_k^+ \right) \left(\hat{x}_{k,i}^+ - \hat{x}_k^+ \right)^T \right] \end{aligned} \qquad (10)$$

Simultaneous RTK and PDP

For the purpose of making simultaneous use of RTK and PDP solutions in AhrsKF, three algorithms were used. First, integrating the PDP solution into the AhrsKF, the PDP and RTK solutions can be fed into AhrsKF sequentially. This means that if at epoch *k,* the AhrsKF is fed by PDP solution then the next epoch it is fed by the RTK solution. Note that both frequencies of the RTK/GPS and the PDP were set at 10 Hz. The other two approaches to RTK/PDP simultaneous utilization in AhrsKF include weighted-fix MMKF and best-fix MMKF. All three algorithms results were obtained by post processing using PDP and RTK data from the same test already described. The long boom GPS solution was again used as the reference and the static results are shown in table 4, as well as Figure 6a and 6b. The quality of the sequential algorithm solution is exactly between that of AhrsKF with RTK and AhrsKF with PDP, in terms of both the error mean and the error STD. On the contrary, the MHKF with weighted fix technique leads to no better performance than AhrsKF with RTK or with PDP.

However, the best performances for both roll and yaw and in terms of both error mean and error STD are achieved by the best fix MHKF. This may be due to the fact that the PDP positions are not stable over longer periods than 20 m, suggesting that RTK helps in stabilizing the overall solution.

Conclusion

GNSS/INS (Global Navigation Satellite System/Inertial Navigation System) systems have found widespread use in industry, especially in automated agriculture. Automated agriculture requires high frequency, precise, steady and smooth attitude solutions. These together with stringent cost requirements, necessitate smart integration algorithms. Given that navigation solutions can be derived from different information sources, combining several information sources can result in smoother attitude solutions relative to when a single information source is utilized. A Multiple Model Kalman Filter (MMKF) is used for this purpose. The results show that the fine attributes of both information sources, namely RTK and PDP, are adequately captured bvy best fix MHKF.

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Google Street view hits roadblock in India

Commissioner of Police of Bangalore in India has asked Google to stop photographing streets of Bangalore. However, before Street View cars started operating, Google claimed it took permission from the traffic department of Bangalore police. The police have reservations regarding legality of Google's Street View in India. The police reportedly acted because there were several restrictions on photography by foreigners or foreign firms in India. Even though Google Street View has proven immensely popular with users, the service has faced resistance in several parts of the world. The data in it is not shown to users in real-time but there have been privacy concerns over its use. *www.timesofindia.com*

Esri creates Ocean Basemap

Esri has created and released Ocean Basemap, a comprehensive map of the world's oceans and coastal areas. It is now available as a cached map service in ArcGIS Online. It has been designed to support a variety of maritime GIS applications. It includes fine-grained bathymetric and altimetric data from coastal areas, where most of the human activity takes place. *www.esri.com*

ESRI India agreement with NAVTEQ

NAVTEQ has completed an Enterprise Reseller Agreement with NIIT GIS Ltd. (Esri India) to offer the complete suite of NAVTEQ-enhanced data solutions to its range of enterprise customers. Clients of Esri in India will benefit through access to the full suite of NAVTEQ Enterprise digital map-based products and services. This includes high quality digital mapping data for enhanced mobile asset management, internet applications, GIS applications, geomarketing applications, call centre applications and telematics services. *www.newswiretoday.com*

Delhi to put land ownership data on GIS platform

All records, data, ownership details of properties under the jurisdiction of land & development office of Delhi State

Government in India will be soon available to all state departments and civic agencies through the GIS platform of the Delhi State Spatial Data Infrastructure Project (DSSDIP). The property records includes those in Lutyens' Delhi, and details of housing schemes, markets, community facilities, parks, roads, drainage and waterbodies under the purview of Delhi Development Authority in India. The step is seen as a move to cut red-tape in urban planning process. *www.timesofindia.com*

India releases National Wetland Atlas

India released a National Wetland Atlas to form the basis of a comprehensive wetland conservation strategy. The atlas includes satellite imagery-based maps. It categorizes wetlands into 19 different classes. The maps are available at a 1:50,000 scale resolution. The atlas is prepared by the Space Applications Centre of Ahmedabad. *www.abclive.in*

Egypt GIS-based information portal

Digital Egypt launched Egypt's first spatial information website powered by GIS. The company spent over three years to map out the country's streets, landmarks, hotels, businesses and virtually every other point of interest, and superimposing this information on a digital map. *www.thedailynewsegypt.com*

China mandate for mapping cos

China has made it mandatory for overseas web mapping companies to operate mapping services only through a tie up with Chinese companies, according to a notice issued by SBSM. The notice cited an amended regulation on overseas organizations and individuals that offer online mapping services. It also states that, for joint ventures with Internet mapping as their sole business, foreign investors cannot own more than 50 percent of the enterprise. The regulation also bans foreign companies and individuals surveying and mapping of borders between administrative regions in China, as well as surveying and mapping of oceans. *www.xinhuanet.com*

Galileo update

Galileo 'can deploy 24 satellites with existing funding'

European Commission (EC) Vice President Antonio Tajani has announced that sufficient savings have been found in Europe's Galileo sat-nav project for at least six additional spacecraft to be bought for the system before 2014.The EC says it has about 500m euros (£440m) "in its pocket" which it will use to make the extra purchase. It would take Europe's version of GPS from 18 operational satellites in the next few years to 24. EU member states had already committed 3.4bn euros to get 18 satellites into orbit by the end of 2014, and were told recently they might have to find a further 1.9bn to get a completed "constellation" of 30 satellites later in the decade. *www.bbc.co.uk*

Commission awards final contracts making Galileo a reality

The final two contracts, out of six, for Galileo will be signed by the European Space Agency on behalf of the European Commission at the prestigious Le Bourget Aerospace Fair in Paris. The combined valued of the two contracts is EUR 355 million. The contract signed with Thales Alenia Space (FR), for a value of EUR 281 million, ensures the formatting of navigation information for broadcast by the satellites. The contract signed with Astrium (UK), for a value of EUR 73.5 million concerns the "housekeeping" of the satellites including the maintenance and correct positioning of the satellites in orbit. *www.defense-aerospace.com*

Bulgarian Natalia on Galileo's satellite

Nine year old Natalia from Bulgaria will have her name on one of the first two operational Galileo satellites to be launched on 20th October as she has won the Bulgarian part of the Galileo children's drawing competition. The European Commission is running the Galileo drawing competition for children in each of the Member States. Natalia has been presented with a trophy, to represent the satellite that will be named after her, at a special awards ceremony at the European Commission Representation in Sophia. *www.galileocontest.eu*

Europe must get rid of others' GNSS

Experts attending the INTERGEO Round Table in Karlsruhe, Germany, made it clear that for Galileo is essential for European countries. The unanimous conclusion was that Europe must be independent of other GNSS systems such as GPS and GLONASS if it is to safeguard its future as a hub for research and business. It was unanimously agreed that if the entire spectrum of application fields is to be fully utilised, there will need to be more communication and cooperation, not least between satellite navigation and geo-information. *intergeo.de*

EC furthers GMES operations

The European Commission (EC) signed an agreement with European Space Agency (ESA) to provide EUR 104 million fund for the initial operations of the Global Monitoring for Environment and Security programme (GMES). GMES will provide decision-makers with access to accurate and timely information services to manage the environment, understand and mitigate the effects of climate change, and ensure civil security. Since the success of GMES hinges largely on the provision of robust satellite data, ESA is tasked with coordinating the programme's space component. *www.esa.int*

US $18bn subsidies to GPS industry

The commercial GPS industry has received an estimated USD 18 billion in implicit subsidies from the US government and is essentially using the GPS satellite network at no cost. In contrast, commercial wireless broadband providers must invest billions of dollars in building and maintaining a network of transmission sites and satellites and ensuring that there is no interference with GPS receivers. By using the GPS satellite network free of charge, commercial GPS device manufacturers enjoy substantial benefits at no cost. However, in order to offer the same geo-location services, these commercial users would have to rely on some equivalent system. This is a cost that the commercial GPS users do not face, because the federal government allocates valuable spectrum for GPS transmissions and invests in GPS satellite infrastructure and operations. *www.battle.com*

Gagan in final operational phase

The initial phase of GPS-Aided Geo Augmented Navigation (GAGAN) system is now over. The project is currently in the final operational phase. It is now going through the certification stage of the Satellite-Based Augmentation System (SBAS) which will be completed by June 2013. After its final operational phase completion, the estimated cost of GAGAN would be over INR 780 crore. GAGAN's certification process is also being carried out with Directorate General of Civil Aviation and other bodies, with the AAI and the Indian Space Research Organisation (ISRO) developing it. *www.dnaindia.com*

Panchayat using GPS-based attendance system in India

Patan District Panchayat in Gujarat, India, has come up with 'Present please project'. Under this project, every employee will be given one number. When employees reach the place of their work, they will have to SMS the District Panchayat. This will be an SMS based attendance verification system powered by GPS, so it can show the location of the officer. If the person is late or has not messaged then it will be considered absence. *www.deshgujarat.com*

Six GLONASS satellites in 2011

Russian Space Agency Roscosmos will launch five Glonass-M satellites and one Glonass-K satellite in 2011. The first launch of the Glonass-M satellite is scheduled for August and the second is slated for October. The Glonass-K is expected to be launched in December. *www.gpsdaily.com*

South Korea to curb illegal GPS jammer

The Korea Communications Commission in Seoul will conduct a crackdown to curb the production and sale of GPS jamming devices, which are illegally sold in the market. They will develop low-cost equipment that can quickly detect where GPS jamming originates.*english.donga.com*

GPS data can detect buried nuke tests

A computer program that uses data from GPS satellite receivers placed in nearby countries pinpoints the explosion, uncovering the clandestine act. When a nuclear weapon is detonated - even thousands of feet underground - a shockwave radiates in the atmosphere. This changes electron density in the field of charged particles in the part of the upper atmosphere known as the ionosphere. Jihye Park, 30, a South Korea native and doctoral student in geodetic science at Ohio State, created the computer program using GPS data to detect this change in the ionosphere. *www.dispatch.com*

First Quasi-Zenith Satellite 'MICHIBIKI' begins

The Japan Aerospace Exploration Agency (JAXA) confirmed that the quality and reliability for positioning signals (L1-C/A and L2C*1) of the First Quasi-Zenith Satellite (QZS) "MICHIBIKI" satisfied the QZSS system user interface specifications (IS-QZSS) through technological verification, thus lifting the alert flag*2 for the L1-C/A and L2C positioning signals on June 22. *www.jaxa.jp*

Japan GPS satellites cut from 7 to 4

The Japanese version of the GPS likely will operate with four satellites not the initially planned seven to save money, although this will not reduce the system's accuracy. By supplementing and reinforcing the U.S. GPS, the Japanese version will be 10 times more accurate than current positioning information. Having four satellites will ensure signals can better reach locations in mountainous regions and areas surrounded by high-rise buildings. Michibiki can be used only for eight hours a day--the time it is in orbit above Japan. *www.yomiuri.co.jp*

Eyeing for Philippine aerospace

The Civil Aviation Authority of the Philippines (CAAP) will develop a performance-based navigation (PBN) system in cooperation with the French Civil Aviation Authority and Quovadis, an Airbus company specializing in flight operations systems. The Required Navigation Performance allows an aircraft to fly accurately defined and contained trajectories without relying on ground-based navigation aids. The navigation technology allows for optimal use of airspace by making approaches more stabilized and managed. *newsinfo.inquirer.net*

Software improves forests management

New software developed by the Polytechnic University of Valencia (UPV), Spain can generate maps of forest areas with information on timber volume, biomass or height of the trees, among other variables. The development of this software by the Group of Geoenvironmental Cartography and Remote Sensing is part of the INFOREST project coordinated by COTESA (Center for Observation and Spatial Remote Sensing S.A.U) and funded by the Spanish Ministry of Industry, Tourism and Trade. *www.sciencedaily.com*

Iran receives first images from Rasad

Iran received the first images and data sent by its indigenous earth-observation satellite, 'Rasad'. It was launched on June 15, 2011. Rasad weighs 15.3 kgs and was designed to be launched into the 260 kms orbit of the earth. It rotates around the earth 15 times in 24 hours.*www.iranwpd.com*

Mapping rainforest biodiversity

A new airplane-based remote-sensing and analysis system will enable scientists to catalog tree species as they create 3-D maps of tropical forests. The newest version of the Carnegie Airborne Observatory (CAO) will offer powerful insights into the composition and biology of tropical forests. CAO combines optical, chemical and laser sensors aboard aircraft to create high-resolution, 3-D maps of vegetation structure. *www.news.mongabay.com*

Satellite images to combat avian flu

It is not only domestic poultry but also wild waterbirds that play a significant role in the spread of the avian influenza variant H5N1. With the aid of satellite data, it is possible to create risk maps for the spread of the virus by wild waterbirds. This has been shown in research by Yali Si of The ITC, University of Twente. This research has revealed a strong correlation between the outbreak of the virus and the migration patterns of migratory waterbirds, over short as well as long distances.

Bahrain uses GeoEye imageries

The Directorate of GIS, Central Informatics Organisation (CIO), Kingdom of Bahrain carried out satellite imagery-based agricultural survey for the first time using imageries from GeoEye. The survey determined 61216.250 acres of green areas in the Kingdom and 10922.365 acres of agricultural crops area. *www.bsdi.gov.bh*

Belarus, Russia and Ukraine work on virtual RS satellite constellation

Belarus, Russia and Ukraine are looking into an opportunity to develop and mutually use a virtual remote sensing satellite constellation. The use of a virtual remote sensing satellite constellation involves the use of their information resources. Any exchanges of information can be either free of charge or provided on a paid basis. *www.news.belta.by*

iMapWeather radio application

Weather Decision Technologies, Inc. has announced the full suite of Location-Based Service features on the iMapWeather Radio App. The app sends alerts only to a user in a geo-referenced polygon of dangerous weather, reducing false alarms and keeping alerts focused on exact areas of impact. The app also boasts features like "Follow Me" where users can move around and still receive alerts wherever they go. The app "wakes up" the phone and provides an early voice and text warning to help individuals and families seek safety - even in the middle of the night, or when the power goes out. *www.wdtinc.com*

LBS worth $10bn by 2016

Location-based services are expected to bring in $10 billion in revenue by 2016, according to research firm Strategy Analytics. The biggest chunk, just over 50 percent, will come from location-based search advertising. The firm said the biggest obstacle is consumer privacy concerns about location data, but if location services provide enough transparency about how they use and store this information, it should not derail the approaching money train. *www.cmo.com*

Sensor simplifies system design

Freescale Semiconductor introduces a new high-precision pressure sensor for altitude detection designed to help users further leverage advanced navigation capabilities and emerging location-based services such as GPS assist and e911. The Xtrinsic MPL3115A2 smart digital pressure sensor processes pressure and temperature data locally, requiring fewer computations assigned to the applications processor and thereby reducing power significantly compared to systems using basic sensors directly managed by the host processor.

A Look at the boom in LBS

The search for local products and services continues to shift away from the Yellow Pages and online directories and search engines to location-based services via a plethora of mobile apps. Services like Foursquare, Facebook Places and ShopKick are leading the charge, as consumers shop on the go and share details about purchases with friends. The power of a personal recommendation is coming full circle as it becomes easier to share and find reviews and ratings on local shopping apps. There are 6,000 location-based apps for the Apple iPhone alone, allowing users to share photos, videos and reviews. *blogs.forbes.com*

China's LBS market hits 6.55 million

A study by EnfoDesk released via Analysys International revealed that China reached 6.55 million location-based accounts by the end of the first quarter this year. LBS in China includes Jiepang, Bedo, and Dianping. Jiepang, which recently partnered with Louis Vuitton for a location-based campaign in China, reported that it has over one million users. *www.penn-olson.com*

UK consumers uncomfortable with LBS

Most consumers in the UK would not be comfortable with businesses accessing their location data in exchange for improved services. Even assuming location-based services improved customer service, 61% of UK respondents said they were uncomfortable with the idea, compared to 16% who said otherwise. *www.information-age.com*

Nokia renews mission for mobile

Nokia's revised mission is related to mobile and location-based services. The Location & Commerce business will develop a new class of integrated social location products and services for consumers, as well as platform services and local commerce services for device manufacturers, application developers, internet services providers, merchants, and advertisers. It will also create integrated social location offerings in support of Nokia's strategic goal in smartphones, including its products with Windows Phones, as well as support for bringing the internet to the next billion. *www.nokia.com*

SOUTH releases new products

In an event held in New Delhi on June 2, 2011, South Precision instrument Pvt.,Ltd, India, launched and introduced the latest and upgraded portfolio of its products - MINI WINDOWS Total station NTS370R, GPS RKT S86T, S82T and Static GPS H66 to Indian customers in a. The event had demonstration and display of latest GNSS hardware products and technical exchanges. The event was well attended by South customers, mainly from Delhi and other neighbouring cities.

Ashtech simplifies accuracy check

Confirming the accuracy of as-built plans for recently buried fiber optic, gas and electric lines has become much simpler and more efficient with the aid of the Ashtech ProMark 500 GNSS receiver and a new EdiPocket GIS software module, claimed Ashtech. SIEA, a French association that manages energy, communication, electricity and gas networks for the 419 communes of the Ain department in eastern France, has found the innovative new method both simple and efficient, and it expects that it can lead to improved contractor performance. *www.ashtech.com*

Garmin Ltd. acquires German GPS

Garmin Ltd. is going to buy privately held Navigon AG, making the German GPS company a subsidiary. By purchasing the company, it perhaps saves Navigon and adds incrementally to its own sales in Europe. *www.kansascity.com*

New Leica ScanStation C5

Leica ScanStation C5 Laser Scanner is a fast, complete for as-built and engineering surveys. It provides professionals with a combination of quality scan data with a significantly lower cost of scanner ownership. It is a fully integrated, cable-less system. It has an easy-to-learn onboard interface with high-resolution, color touch screen and integrated, high-resolution zoom video besides many other features. *www.leica-geosystems.com*

New High-Power Advanced Data Link by Pacific Crest

Pacific Crest ADL Vantage Pro is an advanced, high-speed, wireless data link built to survive the rigors of GNSS/RTK surveying and precise positioning. It provides high accuracy and application flexibility with more features and options than previously offered by Pacific Crest professional-grade radio links. *www.pacificcrest.com*

MicroSurvey releases embeddedCAD™

MicroSurvey has announced an all-new product in its CAD line-up. It bridges the gap between MicroSurvey's IntelliCAD-powered MicroSurvey CAD and Autodesk's CAD tools; providing users with a slick interface, but also a complete survey drafting toolkit, including COGO, DTM, traversing, adjustments, volumes, contouring and more. Gone gold with two available versions – Premium and Standard – embeddedCAD gives users the choice between two tiers of features. *www.microsurvey.com*

Shallow water mapping solution

Optech has announced its compact shallow-water mapping solution for its Airborne Laser Terrain Mappers. The new ALTM Aquarius provides simultaneous terrestrial and water depth measurement capability, enabling the collection of data sets that span the entire land-water interface to depths in excess of 10 meters. It is available either as a simple sensor head addition to the ALTM Gemini product line or as a complete survey solution on its own. *www.optech.ca*

Hong Kong mobile mapping service

Hong Kong government has launched "GeoMobile Map Hong Kong", a new mobile mapping service that allows users to view detailed government maps or to search for community facilities in the surrounding area while they are on the move. "GeoMobile Map takes advantage of multi-touch technology, allowing users to smoothly zoom in and out of a map on their mobile devices. It also incorporates a strengthened geographic search engine. *www.map.gov.hk*

Leica enlarges its Zeno GIS series

Leica Zeno GG02 plus is a versatile cm accurate GNSS SmartAntenna combining dual-frequency GPS and optional GLONASS support. In addition, Leica Zeno Connect and new versions of Zeno Field v2.0 and Zeno Office v2.0 are released. *www.leica-geosystems.com*

UltraCamLp gets USGS certification

UltraCamLp has successfully completed the United States Geological Survey (USGS) Sensor Type Certification Process. USGS found the UltraCamLp to be designed, manufactured, tested and supported to the level required to reliably meet the performance claims of the manufacturer when operated within manufacturer's intended operational parameters. *www.microsoft.com*

Hemisphere long-range RTK solution

Hemisphere GPS has announced the availability of long range RTK for Outback Guidance systems featuring Hemisphere GPS' Eclipse GNSS receivers. The new Outback A220 series receivers allows farmers to expand their areas of operation and complete more work in less time. Now farmers now have the capability to complete much larger areas at one time - up to 18 miles from base station to rover. *www.hemispheregps.com.*

ArcGIS explorer has GPS capability

Esri has released the new version of ArcGIS Explorer Desktop, the free GIS viewer. It now has integrated GPS capability, enhanced support for querying features, and a new feature that allows users to add geotagged photos directly to a map. It can be used with GPS devices to capture the user's current location, along with waypoints and tracks, whether on foot or in a moving vehicle. www.esri.com

Russian location system to hit US market

By the end of the year, most of the world's major mobile-phone chipset makers will have chips in the market that support both GPS and the GLONASS. The access to more positioning satellites will provide better location data for those in urban canyons. Qualcomm announced its product support for the GLONASS system in May. In February, Broadcom announced two new system-on-a-chip (SoC) solutions that support GLONASS. Even ST-Ericsson launched a receiver called the CG1950 that is able to see both GPS and GLONASS satellites. *urgentcomm.com*

Fastrax IT600 GNSS receiver modules

Fastrax, has recently unveiled the IT600 GNSS receiver module, including Russian-based Glonass, Japanese QZSS and SBAS in a single receiver module. It would also support GALILEO and Chinese COMPASS in future. *www.ferret.com.au*

MARK YOUR CALENDAR

July 2011

ESA International Summer School on Navigation Satellite Systems 2011
20-30 July
Berchtesgaden, Germany
www.munich-satellite-navigation-summerschool.org

August 2011

XXV Brazilian Cartographic Congress
21-24 August
Curitiba - State of Paraná, Brazilia
sbc.tatiana@gmail.com

7th International Symposium on Digital Earth
23-25, August
Perth, Australia
www.isde7.net

HealthGIS
4-6 August
New Delhi, India
http://e-geoinfo.net/healthgis2011

Scientific and Fundamental Aspects of the Galileo Program
31 August – 2 September
Copenhagen, Denmark
www.congrex.nl

September 2011

ICG-6: Sixth Meeting of the International Committee on GNSS
5-9 September
Tokyo, Japan
www.unoosa.org

53rd Photogrammetric Week
Stuttgart, Germany
5 – 9 September
www.ifp.uni-stuttgart.de

Middle East Geospatial Summit
13 - 15 September
Doha, Qatar
barbora.kuckova@flemingeurope.com

UAV-g 2011: Unmanned Aerial Vehicle in Geomatics
14 – 16 September
Zurich, Switzerland
www.geometh.ethz.ch/uav_g

ION GNSS 2011
20-23 September
Portland, USA
www.ion.org

INTERGEO
27 - 29 September
Nuremberg, Germany
www.intergeo.de

October 2011

ACRS 2011
3-7 October
Taipei, Taiwan
www.acrs2011.org.tw

AfricaGIS 2011
10-14 October
Cairo, Egypt
www.eis-africa.org/EIS-Africa

November 2011

Joint International Symposium on Deformation Monitoring
2 - 4 November 2011
Hong Kong, China
JISDM.2011@polyu.edu.hk

IMTA Global Conference & Trade Show
10-11 November
Bangkok, Thailand
www.imtamaps.org

2011 Precise Time and Time Interval Systems and Applications Meeting
14-17 November
Long Beach, California USA
www.pttimeeting.org

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

International Symposium on GPS & GNSS
15-17 November
Sydney, Australia
www.ignss.org

Surveying & Spatial Sciences Conference 2011
21 – 25 November
Wellington, New Zealand
www.sssc2011.com

Best Practices for Risk Reduction and Rapid Response Mapping
22 – 25 November
Beijing, China
www.unoosa.org

ENC 2011
29 November-1 December
London, UK
www.enc2011.org

December 2011

United Nations International Meeting on GNSS
12 – 16 December 2011
Vienna, Austria

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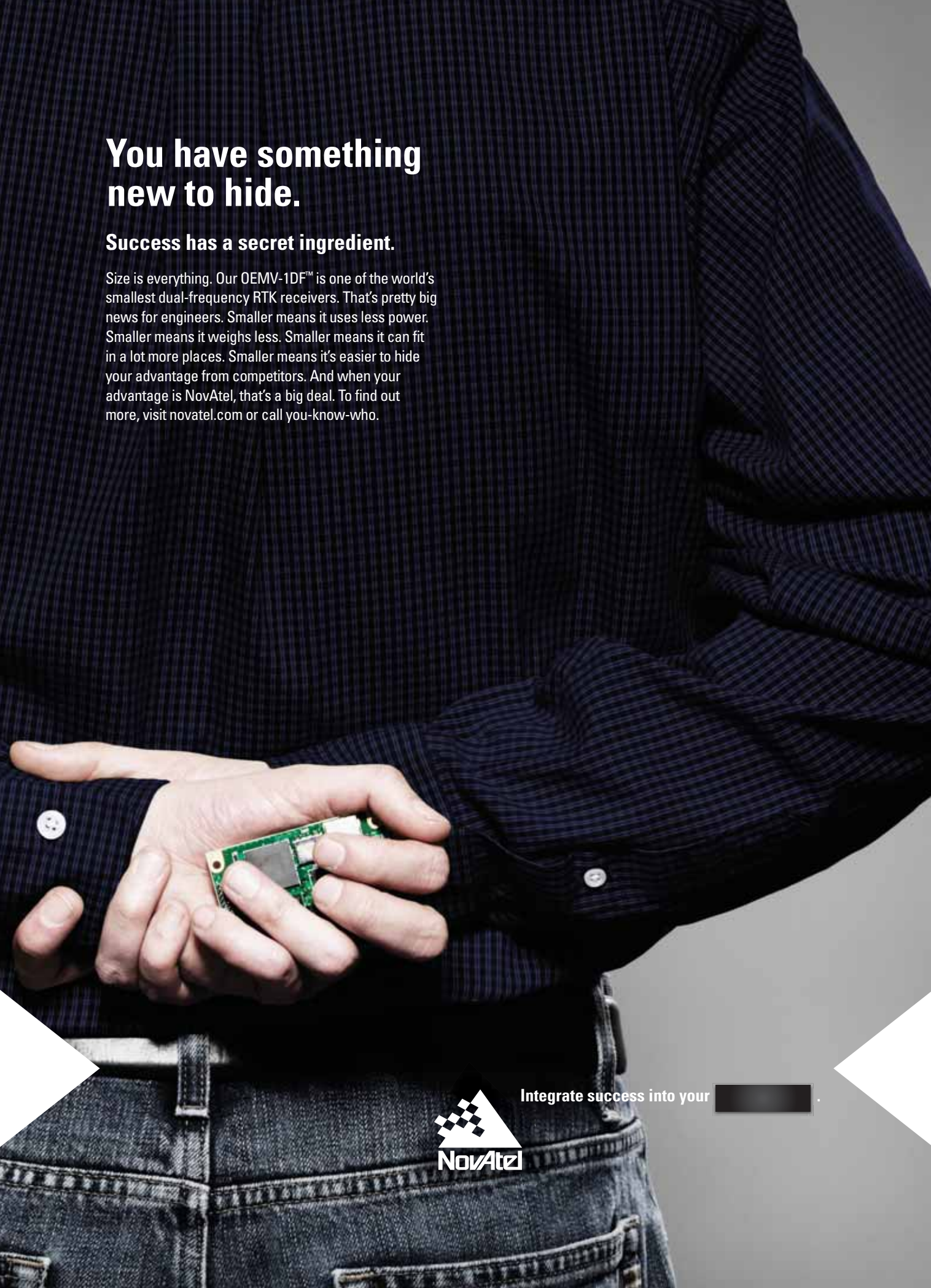
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