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

No: DL(E)-01/5079/14-16
Licensed to post without pre-payment U(E) 28/2014-16
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ISSN 0973-2136

Coordinates

Volume XI, Issue 10, October 2015

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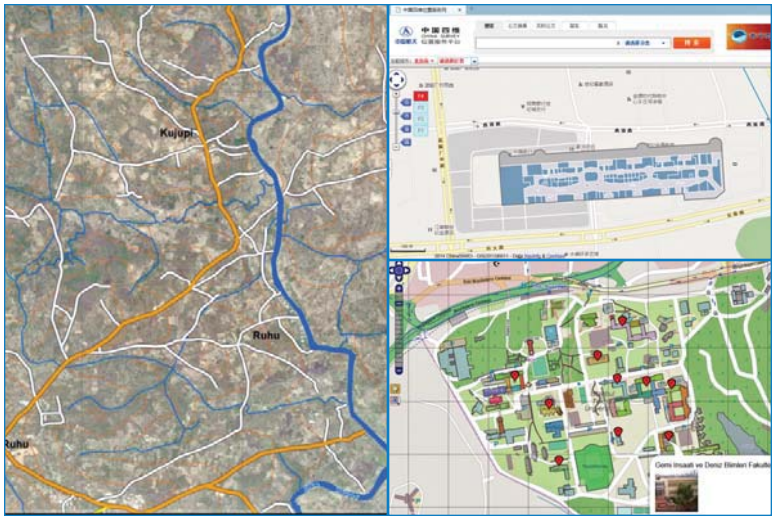

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This issue has been made possible by the support and good wishes of the following individuals and companies Anindya Bose, Carla Wheeler, Ibrahim Usman Jibril, Jürg Kaufmann, Ma Yang, Pang Zhe, Rahmi Nurhan Çelik, Rouhollah Nasırzadeh Dızajı, Shreya Sarkar and Zhao Fangfang; Antcom, Effigis, HiTarget, Javad, Navcom, Pentax, Riegl, Spirent, South, Trimble, and many others.

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Web www.mycoordinates.org

Annual subscription (12 issues)
[India] Rs.1,800 [Overseas] US$100

Printed and published by Sanjay Malaviya on behalf of Coordinates Media Pvt Ltd
Published at A 002 Mansara Apartments, Vasundhara Enclave, Delhi 110096, India.
Printed at Thomson Press (India) Ltd, Mathura Road, Faridabad, India

Editor Bal Krishna
Owner Coordinates Media Pvt Ltd (CMPL)
Designed at Spring Design (ajay@springdesign.in)

This issue of Coordinates is of 60 pages, including cover.

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Towards self reliance

GNSS User Meet 2015

Held on October 8 in Bangalore

Organised by Indian Space Research Organisation and Airports Authority of India

Assumes significance and relevance

In the background of availability of services of GAGAN

And commissioning of first four of seven satellites of IRNSS.

Presentations on various applications

Like aviation, transport, LBS, weather, geology, etc

Using GAGAN and IRNSS signals

Were encouraging and promising.

However, to achieve a critical mass

To optimize the potential of GAGAN and IRNSS

Would need many more such meetings

Highlighting many more success stories.

Bal Krishna, Editor
bal@mycoordinates.org

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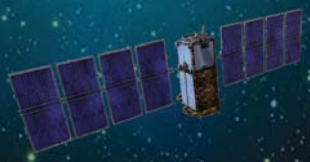

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The Comprehensive Cadastre

The Tool comprising the Wisdom of the Ages to master the Challenges of the Modern World

Jürg Kaufmann
Dipl. Ing. ETH Jürg Kaufmann, Kaufmann Consulting, SLM Swiss Land Management Foundation, Rüdlingen, Switzerland

The Statement 1 of the FIG Brochure 'Cadastre 2014' stipulates *Cadastre 2014 will show the complete legal situation of land including public rights and restrictions*.

Based on this statement the author launches the 'Comprehensive Cadastre' as a tool for sustainable land management, becoming increasingly important to master the future challenges. The paper explains the design, the content, and the processes of the Comprehensive Cadastre and outlines the criteria and the preconditions for successful implementation with the help of practical developments in this field.

In addition, the paper shows the value of the Comprehensive Cadastre for mastering the Challenges of the Modern World.

Development of cadastres

The first cadasters date back to roman times to recover state owned lands that had been appropriated by private individuals, and thereby recover income from such holdings. With the fall of Rome the use of cadastral maps effectively discontinued. Medieval practice used written descriptions of the extent of land rather than using more precise surveys. In the sixteenth and early seventeenth centuries did the use of cadastral maps resume, beginning in the Netherlands. Napoléon, after taking the power about 1800, commanded to survey the parcels and to install cadastral systems for the land taxation wherever he invaded. Since then the official cadastre systems were spreading over the world and they served for the documentation of land rights and for land taxation.

These purposes remained unchanged for a long time until the issues of overcrowding and environment protection became obvious mainly after World War II. Emission cadasters, pipeline cadasters and multi-purpose cadastre arose, in many cases as parallel facilities to the property cadastre.

In view of the developments taking place in the field of cadastre, FIG Commission 7 launched in 1994 a working group with the following terms of reference:

'Study cadastral reform procedures as applied in developed countries, take into consideration automation of the cadastre and the role of the cadastre as part of a larger land information system, evaluate trends in this field and produce a vision of where cadastral systems will be in the next 20 years, show the means by which these changes will be achieved and describe the technology to be used in implementing these changes'.

The result of the work was published 1998 under the title CADASTRE 2014 - A Vision for a Future Cadastre System by the chair Jürg Kaufmann and the secretary Daniel Steudler with the Working Group 1 of FIG Commission 7.

CADASTRE 2014 after the publication was translated in about 30 languages (www.fig.net publications) and influenced the thinking about cadastral systems.

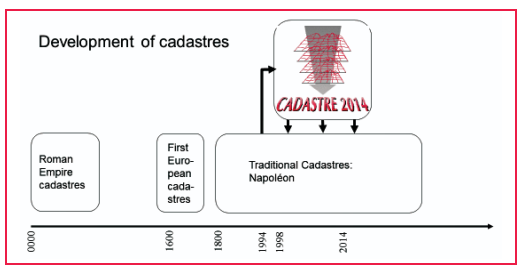

Figure 1: Development of cadasters

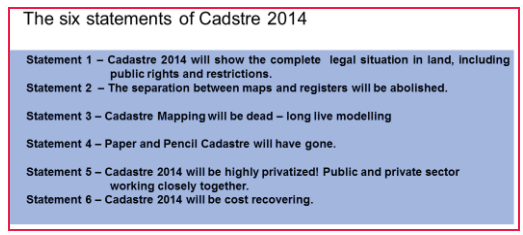

Figure 2: The six statements of CADASTRE 2014

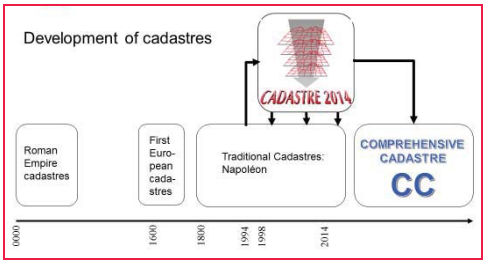

Figure 3: The next development step: The Comprehensive Cadastre

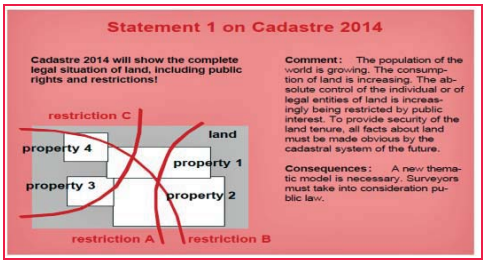

Figure 4: Statement 1 of CADASTRE 2014

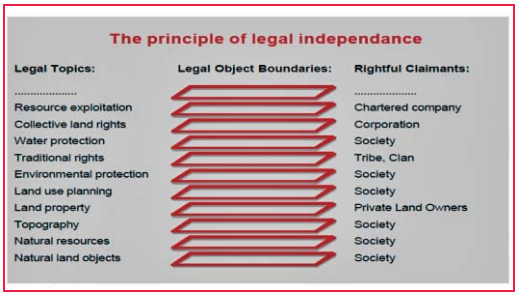

Figure 5: The principle of legal independence

The brochure Cadastre 2014 launched six statements showing the developments expected in the next 20 years (Figure 2).

Statement 1 describes the idea of a Comprehensive Cadastre being a further development of the traditional cadastre to an infrastructure documenting not only the land property rights but also all the rights restrictions and responsibilities imposed on land by official or traditional whether written or unwritten regulations.

The Comprehensive Cadastre must cover a wider field than the traditional cadastre has since its introduction. The circumstances of the resource land have changed significantly since its inception.

During the development of the legal systems, the private laws were dominant. The constitutions of most countries defined the rights of the citizens, one of which is the guarantee to own property. Civil codes have reinforced this guarantee and defined clear procedures and institutions to protect the rights of citizens against alienation.

The growing world population and the development of new technologies lead to an intensified use of natural resources including land. To protect the natural resources from being totally consumed, damaged, or destroyed, the absolute right to use the natural resources was restricted in the name of the social necessity.

Especially after World War II, the number of new public laws grew significantly. Public law regulation of land use planning, environment protection, noise protection, construction laws, protection against danger caused by natural phenomena, etc. arose.

While these definitions under public law have an impact on the property rights of the landowner, they are not part of the official register. Despite the boundary definition process of the rights and restrictions defined under public law follows democratic legal rules, there is no boundary verification, no title verification, and no registration of the right in an official legal register.

Aside from land objects from private and public law, we can find a third category of legal land objects, namely areas where traditional rights, e.g. tribal land use rights exist. They can overlap other legal land objects, such as private property rights and public rights and restrictions, and concessions for the exploitation of natural resources. A feasible documentation of these traditional, customary rights, creating legal security, is often absent.

The Comprehensive Cadastre must correct this situation, which is becoming more and more precarious. It must document, in a safe manner, all legal aspects of land.

Structure of the comprehensive cadastre

The structure of the Comprehensive Cadastre is to follow the principle of legal independence stipulated by CADASTRE 2014.

The principle stipulates that:

- legal land objects, being subject to the same law and underlying a unique adjudication procedure, have to be arranged in one individual data layer; and
- for every adjudicative process defined by a certain law, a special data layer for the legal land objects underlying this process has to be created.

The Comprehensive Cadastre is therefore based on a data model, organized according to the legislation for the different legal land objects in a particular country or district.

While the traditional cadastre consists in general of one information layer representing the information about boundaries between different properties, in the Comprehensive Cadastre are added information layers representing the boundaries between land objects defined by different legal topics, which exist in a jurisdiction.

Daniel Steudler and Abbas Rajabifard designate this principle in the FIG Publication No 58 Spatially Enabled Society (Spatially Enabled Society FIG Publication Nr. 58) as institutional independence. With this term, they indicate that this structure is suitable to assign the responsibility for the data layers to the authority charged with the enforcement of a certain Act.

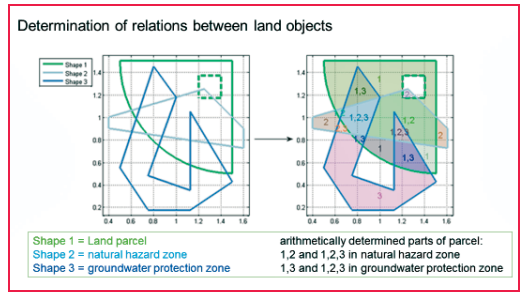

Figure 6: Arithmetic determination of relation between objects

Precondition for the comprehensive cadastre

A further principle stipulated in Cadastre 2014:

To make sure that legally independent organized land objects can be combined, compared, and brought into relation to each other, it is necessary that they will be localized in a common reference system. The combination and comparison of the thus located land objects can be realized by the method of polygon overlaying. This method was published in already in 1973 by Kaufmann and Bigler [1973] (Kaufmann & Bigler: New Techniques in Land Consolidation).

The Comprehensive Cadastre will only function in an efficient manner when the relations between land objects can be derived from their location. This avoids links between land objects in different information layers. According to experience in many cases, traditional and distorted maps are anyway to be replaced by data sets located in a common reference system in order to enable modern geographic information systems be able to render the expected services.

Steps to implement a comprehensive cadastre successfully

Introduce the possibility for the Comprehensive Cadastre in your legal framework

It is wise to fix the principle of a Comprehensive Cadastre before starting with the setup. Switzerland decided to introduce the cadastre of Public Law restrictions on Landownership, which can be considered as a first step of the Comprehensive Cadastre. A short article was introduced in Switzerland's Federal Act of 5 October 2007 on Geoinformation (Geoinformation Act) http://www.admin.ch/ch/e/rs/c510_62.html:

Cadastre of Public-law Restrictions on landownership

Art. 16 Subject matter and form

1. *The Cadastre of public-law restrictions shall contain public-law restrictions on landownership rights which, in accordance with the provisions of the Civil Code are not part of the Land Register.*
2. *The Federal Council determines which official geodata under federal legislation are entered in the Cadastre of public-law restrictions.*
3. *The cantons may define additional official geodata of proprietary nature that must be recorded in the Cadastre of public-law restrictions.*
4. *The Cadastre of public-law restrictions shall be made available in electronic form either online or by any other method.*
5. *The Federal Council shall determine the minimum requirements with regard to the organization, management, data harmonization, methods and processes for the Cadastre of public-law restrictions.*

In the Principality of Liechtenstein the legal base was laid in the Law on the official surveying as follows:

Documentation of the public-law restriction of the landownership

Art. 57 Basic principle

1) The public-law restrictions with geometric characteristic as, in particular land use and development plans, protection zones or building lines, are represented in specific information layers.

2) The government determines the spheres, were information layers are defined.

Develop an enactment on the Comprehensive Cadastre

Because the rules for the Comprehensive Cadastre are the same as those for the traditional cadastre a regulation can be kept short. In Switzerland we developed an Ordinance on the Cadastre of Public-law Restrictions on Landownership (PLR-Cadastre) with 33 articles regulating the details.

Switzerland: Content of the Ordinance on The Cadastre of public-right Restrictions of the Landownership

Section 1:	General provisions
Section 2:	Content and Information
Section 3:	Inclusion into the Cadastre
Section 4:	Forms of Access
Section 5:	Authentification
Section 6:	Function as official gazette
Section 7:	Organization
Section 8:	Financing
Section 9:	Participation
Section 10:	Final Provisions

Figure 7: The content of the Swiss Ordinance on the PLR-Cadastre

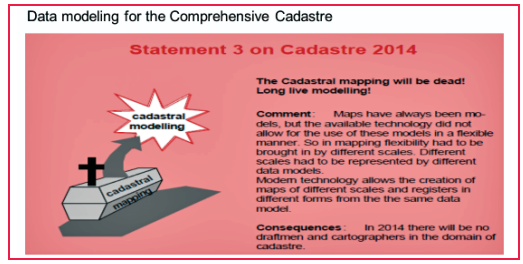

Figure 8: Data modeling

Introduce data and representation modeling as mandatory

One important aspect for the successful implementation is the provision to use data modelling for the description of all data topics of the Comprehensive Cadastre and representation models to define how these data are to be represented on maps or other documents.

Switzerland regulated this in the framework of the Federal Act of 5 October 2007 on Geoinformation. As modeling standard we use INTERLIS 2. Please consult www.interlis.ch for details.

Determine a responsible authority for the Comprehensive Cadastre

In every country a responsible authority must be designated to organize the Comprehensive Cadastre. To allocate this task to the authority already taking care of the traditional property cadaster seems to be appropriate and advantageous.

Scan your legal framework including traditional rules

A first task of the responsible authority is the scanning of the existing legal

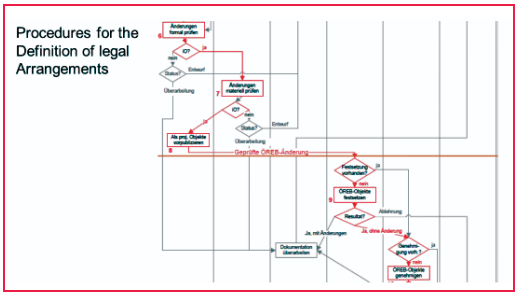

Figure 9: Definition procedures for legal arrangements

framework and also all existing unwritten traditional legal arrangements. As soon as a law or a regulation contains arrangements concerning maps, sketches, schemes, boundaries, building lines, etc., it is to be supposed that the respective land objects are candidates for inclusion in the Comprehensive Cadastre.

Identify the stakeholders

A further result of this scan shows the institutions responsible for the enforcement of the law. These institutions are the stakeholders to be involved in the implementation of the Comprehensive Cadastre. The further steps will be undertaken together with these stakeholders.

Create data models for all legal topics included into the Comprehensive Cadastre

It is important to describe all data of the Comprehensive Cadastre in a precise and easy to interpret manner in cooperation with the respective stakeholders. The modeling paradigm was launched by statement 3 of Cadastre 2014.

A tool for data modeling is determined in the ISO/TC211 – Geographic information/ Geomatics Standards. The ISO 19152 standard published in 2012 deals with the Land Administration Domain Model (LADM). The standard describes the data model with Entity-Relationship-Diagrams but does not offer automatic model and data checking possibilities. Switzerland uses since 1993 the standardized data description language INTERLIS, which allows computer-assisted model and data checking. Recently the developers of the LADM from The Netherlands and Swiss data modelling specialists undertook an initiative to combine these modeling approaches by description of the LADM in INTERLIS 2 to profit from automatic checking facilities.

Switzerland has developed data models for all data topics to be included in the Swiss PLR-Cadastre. The models are public and can be found on http://models.geo.admin.ch/

Identify the procedures for the definition of legal arrangements

Similar to the traditional cadastre the effective procedures are to be learned and pursued by to make sure the Comprehensive Cadastre works correctly. Sometimes these procedures are complicated and in many cases not handled correctly. It is worthwhile to analyze the procedures carefully and to take the opportunity

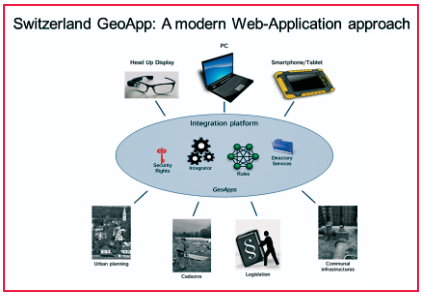

Figure 10: Modern approach in Switzerland

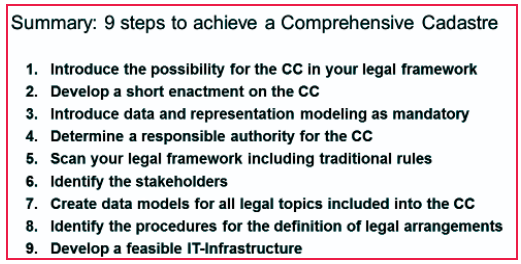

Figure 11: Achievement of the Comprehensive Cadastre

to simplify them, if this is possible.

Develop a feasible IT-Infrastructure

A Comprehensive Cadastre is unthinkable without the help of IT. In a modern environment it makes sense to base the Comprehensive Cadastre on internet-technology.

In Switzerland's PLR-Cadastre a modern solution GeoApp replacing WebGIS by Web-Application was chosen to realize an integration platform organizing the access to the different information systems of the stakeholders by governing the directories, controlling the access rights, integrate data from different sources, and managing the rules to be applied. Figure 10 shows the possible web-application GeoApp used for the Swiss PLR-Cadastre. Further information can be found under www.fig.net/pub/fig2014/papers/ss31/SS31_luethy_7031.pdf .

Wisdom of the ages to master the challenges of the modern world

The Comprehensive Cadastre is the tool containing the wisdom of the ages to master the challenges of the modern world. Based on the cadastral principles valid for thousands of years it helps to master the challenges of the modern world.

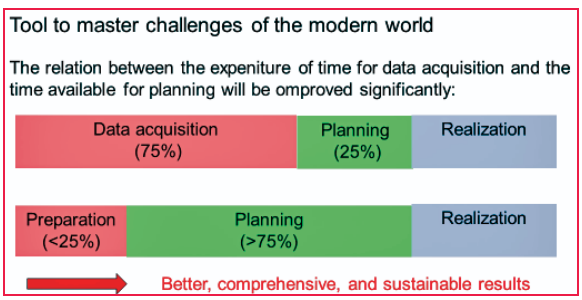

Figure 12: The Comprehensive Cadastre improves planning

Base for the economic development

A sustainable economy is only possible on the base of a functioning land market. The traditional cadastre was for a long time the guarantor for the functioning land market. Meanwhile the traditional cadastre, neglecting public-law arrangements affecting the property right, tells only part of the truth. The Comprehensive Cadastre is a precondition for a sustainable economic development.

Regularization of informal legal conditions

Many countries suffer from informal conditions emerged in a time when the authorities have lost the control about developments. A reliable documentation of the existing unpleasant situation by a Comprehensive Cadastre is indispensable to master this challenge.

Poverty reduction

Sustainable poverty reduction can be achieved only when the citizen's ownership rights are protected by a reliable infrastructure. The Comprehensive Cadastre is the tool to guarantee ownership taking into consideration the complete legal situation of land.

Prevention from land grabbing

Prevention from land grabbing implies a sound knowledge on the rights and restrictions concerning land. The tool for this is the Comprehensive Cadastre.

Implementation of Spatially Enabled Societies (SES)

To enable societies to deal with spatial information is a prerequisite for mastering the future challenges. The Comprehensive Cadastre is the base for the provision of reliable spatial information.

Land consolidation

Improvement of the efficient land use and the effective production of food and fibre needs complete and precise knowledge about the situation and the potential of resources. The existence of a Comprehensive Cadastre creates optimal starting conditions for land management measures.

Better planning

A Comprehensive Cadastre helps to improve and accelerate the planning processes.

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The paper was presented at FIG Working Week, Sofia, Bulgaria, 17-21 May 2015.

Contribution of GLONASS in Multi-GNSS Solution Accuracy

This paper presents the advantages of using GLONASS with GPS and calls for better GPS-GLONASS interoperability for robust Multi-GNSS

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With fully operational GLONASS, scope for use of Multi-GNSS has increased as GLONASS may be used along with GPS. This paper describes a study from India on the use of GLONASS with GPS for position solution. Increasing number of GLONASS satellite signals were used sequentially with 4 or more GPS satellites to explore the contribution of GLONASS in position solutions. It was found that sequentially increased number of GLONASS signals proportionally improved the achievable accuracy in GPS+GLONASS solutions for lower number of GPS. For higher GPS numbers, the effect is less prominent. The results may be helpful in exploring the importance and advantages of Multi-GNSS for unaided, low-cost, medium to low accuracy applications in degraded satellite visibility scenarios and calls for better GPS-GLONASS interoperability for robust Multi-GNSS operations.

Introduction

Currently GLONASS is the only alternative to GPS as a fully operating global satellite based navigation system after its revitalization since late 2011 [1]. As a result, user efforts are ongoing to avail the benefit from both the systems together, specifically for the Asia-Oceania region [2-4]. Therefore from India, use of Multi-GNSS is an interesting option for satellite based navigation due to expected high number of such signals [5] using commercial geodetic receivers capable of using GPS and GLONASS signals together. This paper describes an experiment and the results to explore the contribution of GLONASS in improving position solution accuracy, while operating with GPS. The experiment has been done from a fixed station located at The University of Burdwan, India. The results obtained suggest sequential improvement in stand-alone, unaided position solutions using increasing number of GLONASS satellites together with a fixed number of GPS signals for solution for lower number of GPS.

Experiment and data analysis plan

Aim of the experiment presented here is to observe the contribution of GLONASS signals, while operating together with GPS for Multi-GNSS (GPS+GLONASS or MIX) mode. For this, position solution data are collected using a single frequency, multi-mode GNSS (GPS and GLONASS) receiver from a fixed site (The University of Burdwan, India 23^0 15.2755' N, 87^0 50.8071' E). Sets of 04 to 07 GPS satellites are chosen for solution together with increasing number of GLONASS satellites to observe the effect of GLONASS in solution accuracy. The efforts start with a set of 04 GPS satellites; from all the usable GPS satellites present, 04 GPS satellites that are well scattered over the sky are selected and used for position solution. The selection of 04 well scattered satellites ensures modest satellite geometry and Position Dilution of Precision (PDOP) values, while satisfying the minimum requirement for 3-dimensioanl (3D) position solution. Now, GLONASS satellites are introduced sequentially with the previously selected set of 04 GPS satellites for position solution starting

from a single to 5 GLONASS satellites. The satellites are selected manually from all usable satellites above a predetermined elevation cut-off angle with good PDOP values using the receiver control software. Position solution data @ 1 Hz for various days has been collected for each set of observation with increasing GLONASS satellites used together with 04 GPS (04 GPS+ 01 GLONASS, 04 GPS + 02 GLONASS, 04 GPS + 03 GLONASS, etc.). Data was collected for around 15 minutes' duration so that the satellite constellation geometry does not change much during the observation period maintaining similar PDOP values. Subsequently, increasing number of GLONASS satellites are used for solution with sets of 05, 06 and 07 GPS satellites respectively and data are recorded for further analysis for further analysis.

To find out the effect of GLONASS in MIX mode of operation, firstly 2 dimensional (2d) and 3 dimensional (3d) errors for individual solutions are found out w.r.t. a predetermined reference point following the method as described below. Very long-time GPS-only position solutions for the same experimental set-up are collected together and averaged; the average values are taken as the reference point of the antenna with latitude (La_0), longitude (Lt_0) and altitude (h_0) [6].. Using these predetermined reference position coordinates, the instantaneous errors in latitude, longitude and height associated with each observation were found out. Then 3d and 2d errors for individual instantaneous solution were calculated in meters using Equations 1 and 2. It is assumed that 1 minute of arc of the earth curvature is equivalent to 1,852 m.

$$Error_{3d} = \sqrt{\Delta h^2 + (1852 \cdot \Delta Lt \cdot \cos(La_0))^2 + (1852 \cdot \Delta La)^2} \quad (1)$$

$$Error_{2d} = \sqrt{(1852 \cdot \Delta Lt \cdot \cos(La_0))^2 + (1852 \cdot \Delta La)^2} \quad (2)$$

where -

$Error_{3d}$ = Error in 3-dimension of the instantaneous solution w.r.t., the reference (horizontal error) for the instantaneous solution w.r.t. the reference point

Δh = Difference of the instantaneous height from the reference height, m

ΔLt = Difference of the instantaneous and reference longitude value, minute of arc

ΔLa = Difference of the instantaneous and reference latitude value, minute of arc

$Error_{2d}$ = Error in 2-dimension

Average and standard deviation (jitter) of error values for 2d and 3d errors for each slot of data duration (around 15 minutes) are calculated for each set of satellite configuration and the results are discussed in the following section.

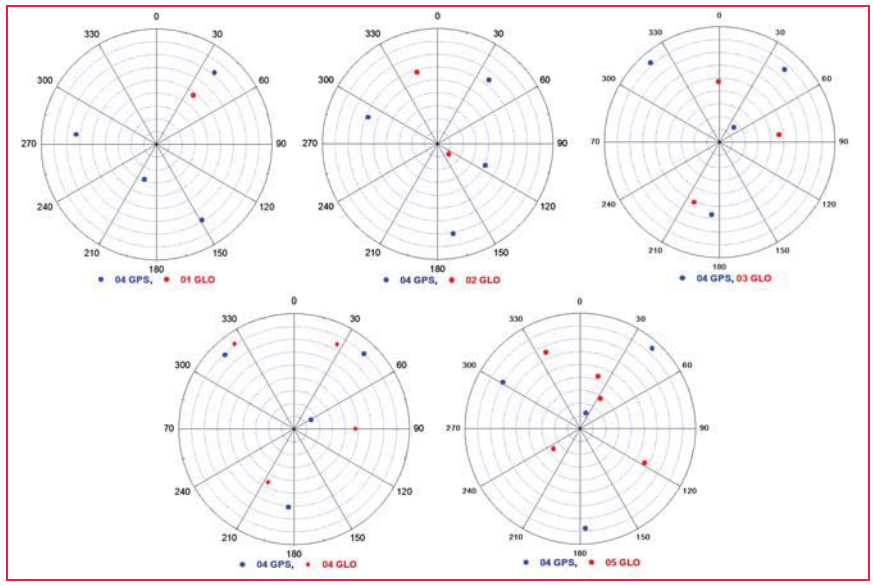

Figure 1: 'Skyplots' showing the relative position of the selected 04 GPS and increasing number of GLONASS satellites used for position solution; Date: 27/05/2014

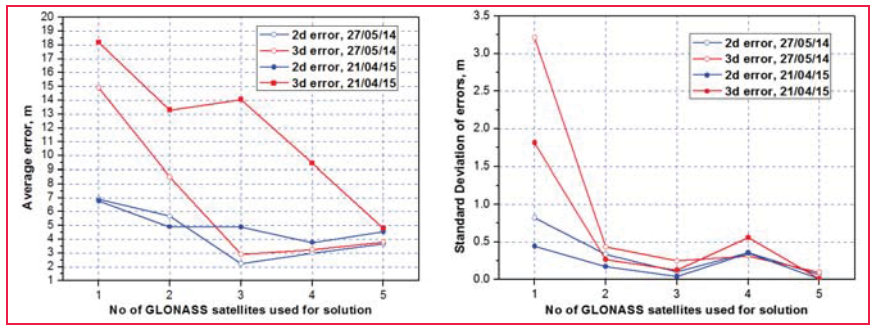

Figure 2: Variation of average errors and standard deviation of errors for increasing number of GLONASS satellites used with 04 GPS satellites

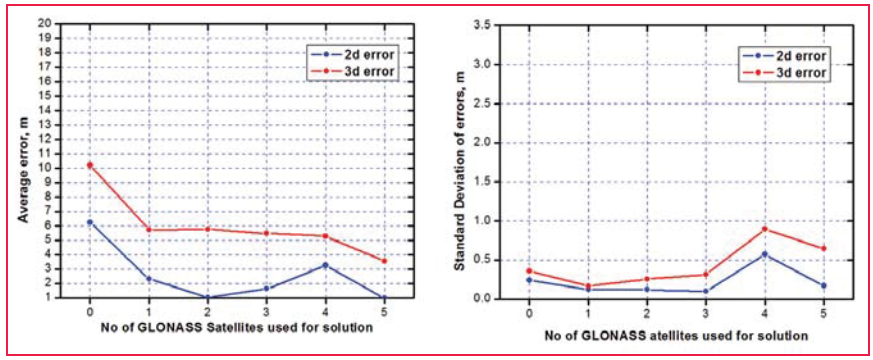

Figure 3: Variation of average errors and standard deviation of errors for increasing number of GLONASS satellites used with 04 GPS satellites. (Date: 25/08/2015)

Table 1: Average errors and jitter (standard deviation) of errors with increased in number of GLONASS is used with 04 GPS satellites for position solution

Date	GPS	GLONASS	Average 2d Error (m)	Average 3d Error (m)	Jitter of 2d Errors (m)	Jitter of 3d Errors (m)	Initial PDOP (GPS only)	Average PDOP (GPS+ GLO)
27.05.14	4	1	6.88	14.90	0.824	3.216	2.97	2.98
		2	5.66	8.48	0.337	0.432	3.49	2.65
		3	2.22	2.91	0.105	0.247	2.58	2.05
		4	3.00	3.25	0.358	0.316	2.22	2.00
		5	3.65	3.78	0.066	0.098	2.05	1.91
21.04.15	4	1	6.78	18.20	0.443	1.815	2.59	3.03
		2	4.90	13.30	0.175	0.267	2.65	2.34
		3	4.88	14.06	0.043	0.125	2.81	2.21
		4	3.76	9.45	0.350	0.561	3.55	1.79
		5	4.56	4.80	0.008	0.010	3.15	1.45
25.08.15	4	0	6.22	10.20	0.241	0.359	2.75	2.84
		1	2.30	5.72	0.120	0.169	3.02	3.02
		2	1.03	5.76	0.120	0.256	2.84	2.82
		3	1.61	5.47	0.098	0.315	2.86	2.40
		4	3.25	5.28	0.570	0.895	2.31	1.93
		5	0.96	3.55	0.171	0.647	2.01	2.18

Table 2: Average errors and jitter (standard deviation) of errors with increasing number of GLONASS used with fixed number of GPS satellites for position solution

Date	No of data	GPS	GLONASS	Average 2d Error (m)	Average 3d Error (m)	Jitter of 2d Errors (m)	Jitter of 3d Errors (m)
24.08.15	908	5	0	6.58	7.22	0.118	0.336
	903		1	4.42	5.28	0.249	0.220
	343		2	3.60	5.31	0.087	0.194
	1138		3	2.44	4.27	0.537	0.996
	1058		4	2.65	4.64	0.168	0.191
	1316		5	1.25	6.04	0.315	0.308
24.08.15	1050	6	0	3.12	5.47	0.317	0.351
	609		1	2.45	6.58	0.074	0.179
	1165		2	2.74	2.76	0.138	0.133
	1085		3	4.12	4.36	0.194	0.351
	1075		4	1.35	1.38	0.177	0.196
	724		5	1.79	2.18	0.107	0.213
25.08.15	715	7	1	0.42	3.78	0.164	0.145
	971		2	2.17	5.00	0.125	0.530
	1020		3	1.23	5.42	0.093	0.480
	1046		4	1.90	8.52	0.151	0.108
	976		5	1.61	5.47	0.164	0.237

Results

The experiment begins with a set of 04 GPS and increasing number of GLONASS. GPS and GLONASS satellites selected for observation are shown in Figure 1 (skyplots) for 27/05/2014, wherein the relative positions of the selected satellites are shown to provide idea about the satellite geometry. Here the azimuth angles are shown along the circumferences of the circles in a clockwise direction- the top showing 0^0/ 360^0. The elevation angles are shown radially with the centre of the circle as zenith and the circumferences represent the horizon. Similar observation procedures were followed for other days also. Results for variation of 2d and 3d errors in solution for the set of 04 GPS and increasing number of GLONASS satellites for three observation days are shown in Table 1 and in Figures 2 and 3.

The results implies decrement of average error and standard deviation of error values with increased number of GLONASS signal contribution with 04 GPS , improving the position solution accuracy in 2d and 3d. Figure 3 also shows the benefit of using GLONASS over GPS-only

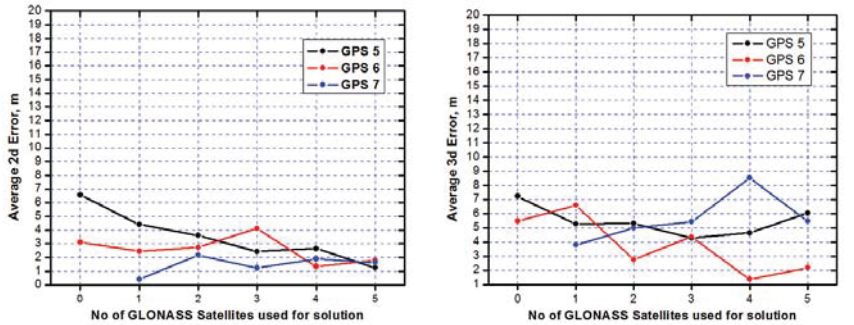

Figure 4: Variation of average errors and standard deviation of errors for increasing number of GLONASS satellites used with sets of 05 to 07 GPS satellites (Date: 24–25/08/15)

operations (when no GLONASS is used). Varying error-levels for the different days may be attributed towards the selection of available satellite sets with different geometries during individual observations. Another interesting feature observed is the slight increase of jitter values all observation days when 04 GPS and 04 GLONASS satellites are used together.

Next phase of the study involves use of sets of 05 or more GPS satellites for position solution with increasing number of GLONASS to observe the contribution. The data collection procedure and analysis methods remain the same as described earlier for the set of 04 GPS satellites. Care has been taken to select and maintain modest PDOP values for the selected set of satellites used during the data recording periods. Generally, such conditions could be maintained for duration of approximately 15 minutes. Results obtained for average 2d and 3d position errors, and the standard deviation of errors (jitters) for each set of data are shown in Table 2 and the variation of average error values are shown graphically in Figure 4.

It may be initially observed that use of at least one GLONASS satellites with GPS helps in improving solution accuracy as has been observed earlier also. For up to 5 GPS satellites, the beneficial effect of GLONASS can be clearly observed beyond which (06 or more GPS) gradual improvement of accuracy with increasing GLONASS becomes less prominent. For these cases, use of more than 03 GLONASS does not improve the situation much. However, the values presented in Tables 1 and 2 point towards the improvement of accuracy due to the GPS+GLONASS mode of operation using a large number of available satellites. The results supports the idea of using GPS+GLONASS together over single-constellation operations for various stand-alone, single-frequency and mass-market applications [7].

Conclusion

Presented results here firstly show the advantages of Multi-GNSS (GPS+GLONASS) over single-mode operation providing improved solution accuracy in stand-alone, unaided operations. Presence of GLONASS, in general, supports to obtain better solution accuracy. The study also indicates that, when low number of GPS satellites are augmented with GLONASS, favourable improvement of solution accuracy is observed. Combinations of higher number of GPS satellites with increasing number of GLONASS though do not present similar benefit for improvement of solution accuracy. This may be attributed to the differences of GPS and GLONASS reference frames and other associated interoperability issues; the findings calls for better resolution of this problems to fully exploit the advantages of Multi-GNSS environments.

When low number of GPS satellites are augmented with GLONASS, favourable improvement of solution accuracy is observed. Combinations of higher number of GPS satellites with increasing number of GLONASS though do not present similar benefit for improvement of solution accuracy

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Development and application of indoor/outdoor integrated location-based service

By establishing complex indoor-and-outdoor integrative map models based on semantics and topology, standards and forms of data and production standard specifications of indoor-and-outdoor integrative maps have been worked out

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As smartphones with function of satellite navigation positioning become popular, the public can enjoy LBS very conveniently. However, the traditional LBS has been restricted outdoor over a long period of time, which can't meet people's needs to find the nearest service facilities and shops of certain brands or share indoor location with friends in a shopping center, etc. However, 80% of the activities in people's life are conducted indoors, so there is an increasing demand for indoor LBS. A series of important documents issued domestically such as 'Mid-and-long Term Development Plan of National Satellite Navigation Industry', 'The 12th Five-year Special Plan on Navigation and LBS Technological Development' and 'A Special Notice on Significant Application and Demonstration of Developing Beidou Satellite Navigation Industry', all advocated developing indoor-and-outdoor LBS technology and products, building indoor-and-outdoor integrative LBS system, extending LBS's service scope and improving LBS's capacity through core technologies such as indoor map and indoor positioning.

The construction of LBS system which can be applied indoor is based on the synergetic development of indoor positioning technology and indoor geographic information technology. Currently, the indoor positioning technology is in its infancy. Achievements include local indoor positioning technology, such as Wi-Fi positioning and RFID positioning, and the wide one, such as TC-OFDM. However, the corresponding indoor map technology is relatively backward. For this reason, China Siwei Surveying & Mapping Technology Co., Ltd. carried out key technology research of indoor-and-outdoor high-accuracy seamless navigation and positioning. The study is the representative achievement in industrial application of this research.

Achievements and shortcomings of domestic and foreign technological development

Achievements of domestic and foreign development

Currently, many domestic and foreign enterprises are carrying out research on indoor map technology and application and provide indoor LBS. Google, Nokia and other international representative LBS enterprises have made an attempt on high-accuracy mobile indoor navigation application. The mobile map service of Google Inc., provides indoor maps of large-scale malls and airports. In addition to the internal maps of buildings, a specific room can be searched and the route from the current location to the destination can be shown. Nokia's Here map service can provide indoor map service in shopping malls, airports, transportation hubs and other facilities in 38 countries throughout the world. At present, domestically, Baidu, AutoNavi, Palmap+, Diandao, Rtmap and other enterprises have also launched independent indoor map products that make themselves independent applications

upon the convergence of certain indoor places, or provided stand-alone service in mobile phone map service products. All these provide indoor LBS to industries with intensive indoor activities like business industries based on indoor maps.

Existing problems

Currently, all indoor map products have certain limitations that restricts the overall development of indoor LBS.

(1) The data and contents of indoor navigation are too simple with unitary form, and the acquisition and update of indoor high-accuracy data are unavailable. The main data source of indoor maps is plan sketch whose geometrical figures are of relatively high difference and low accuracy, and the element attribute feature is of relatively poor verisimilitude.

(2) Indoor navigation data lacks unified format standards and specifications. Existing CityGML 3D urban general data model concentrates on data display and visualization when displaying indoor elements' space and attribute, while indoor navigation data model mainly focuses on indoor navigation and LBS, so it needs to establish indoor navigation map model and lay out data standards and formats from the perspective of navigation and LBS.

(3) Indoor-and-outdoor maps are different with respect to data contents, display, accuracy and spatial reference. Indoor maps' spatial location can hardly match outdoor ones. Indoor-and-outdoor maps are discontinuous, and indoor-and-outdoor integrative LBS, such as spatialization, route planning and guidance, can't be achieved due to lack of integrative data model.

Overall design of indoor-and-outdoor integrative LBS system

Research goals and contents

In the research, we plan to establish a set of effective indoor-and-outdoor integrative data organization, and index ways and establish the basis of technical theories of indoor-and-outdoor integrative LBS by designing indoor-and-outdoor navigation map model. By laying out indoor navigation map data standards, specifications, collection & manufacture of the technical process, we plan to research indoor navigation map manufacture tools and collect indoor map data to set up indoor-and-outdoor integrative data base. What's more, we will develop LBS system and validate the feasibility of technological achievements with industrial application on such basis.

Overall structure of the system

Indoor-and-outdoor integrative LBS system is composed of technical support layer, function layer and interface layer, as shown specifically in Figure 1:

Technical support layer includes indoor-and-outdoor integrative map theoretical model, technical standard system (data standards, formats, standards and specifications for production and manufacture) and production tools; function layer includes display of indoor-and-outdoor integrative maps in 2D and 3D ways, data management, route planning, navigation, POI retrieval and so on; and interface layer is suitable for Web, Android and IOS. Key technical breakthrough, indoor-and-outdoor integrative map models, technical standard system, map production tools, 2D and 3D display engine, etc., will be introduced as follows.

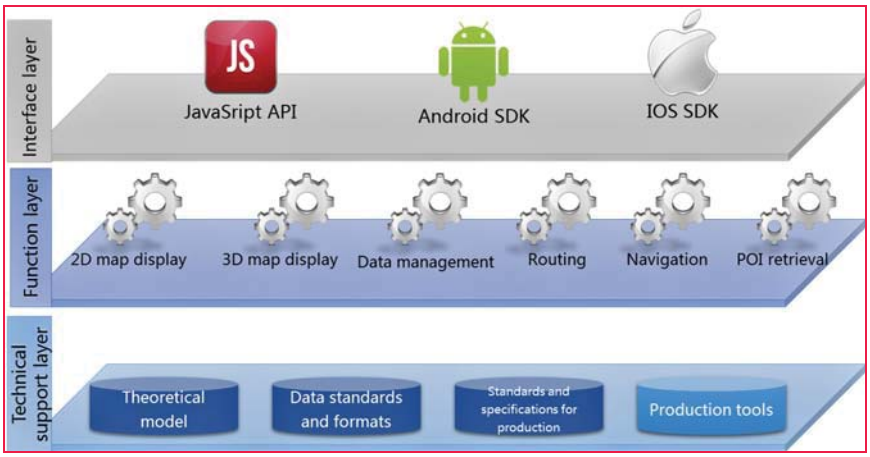

Figure 1: Structure of Indoor-and-outdoor Integrative LBS System

Key technology of the system

Integration technology of Multi-source heterogeneous data

Data organization and storage in indoor navigation system mainly involve vector data, multimedia data, etc. Vector data consists of interest points and other index data, road topology data, indoor spacial unit, sectorization data, administrative division, spacial utilization, etc. Multimedia data such as image, audio and video are related to specific space locations such as interest points and indexes, so multimedia data's spatiality should be managed. The data obtained through various channels adopt different spacial reference standards, so semantics and coordinates should be transferred to unify space-time datum. The project adopts collection at fixed time and locations, semantic superposition agreement, coordinate transfer error model, extraction of association rule and other means to integrate multisource data through key technologies. Some key technologies are multisource road network data matching, automatic registration between POI and road network data, automatic correlation of semantic information with geometrical elements, setting data source extraction categories of various elements and specifying processing principles of situations, such as attribute inconformity and position relation contradiction.

Update technology of maps of crowdsourcing mode

Indoor data, mainly indoor spatial layout and feature information, is updated

frequently. User data update agreement and collection specifications are defined based on UGC indoor map data collection, and update to support update iteration and progression of users' location information differences. Indoor maps are divided into several classes and small files through incremental update technology and store them in the format of structurized data to update LBS system and realize quick rendering and retrieval when data changes.

Visualization representation technology of 2D and 3D integrative indoor maps

Through researching and developing 2D and 3D integrative indoor map engines innovatively, stories that displayed two-dimensionally originally will now be displayed three-dimensionally to more intuitive display split-level structure, void structure and other structures inside large buildings. These in turn provide users with intuitive and real visual navigation and LBS. Regarding data structure, the original two-dimensional spatial data is integrated with the three-dimensional one, so that both displays and editing are completed within a unified data structure to ensure consistency and integrity of data.

Realization of indoor-and-outdoor integrative LBS system

Indoor-and-outdoor integrative map models

Indoor navigation data models, mainly providing indoor navigation and LBS, are supposed to support route planning, map display, route guidance and POI retrieval. Establishing indoor navigation map models should start from navigation and LBS.

The current project researches and improves the indoor map data model, namely composite model, that is a data model based on semantics. Its spatial information is expressed by entities, attributes and the relationship between entities and attributes. Based on topology, it's a data model whose spatial connection between elements is expressed by the spatial relationship between entities and the network topology. The composite model defines the completed and exquisite standards for POI classification and coding standards of indoor maps, and supports the indoor panoramic and 3D extension. Users can customize map samples according to the classification and coding, which supports indoor panorama and three-dimensional extension. The indoor data contains the spatial information of elevation, and records the location and landform of inaccessible areas. Integrated with map matching technology, it can achieve high-accuracy indoor positioning and guidance as a map sensor. The model consists of road data, index data, background data, topological data and attribute data, jointly providing service for the navigation application. Elements are classified according to themes including index, channel, sectorization and spatial units. And a topology relationship is built between elements of channel, sectorization and spatial units, through which the relationship between index and channel, or that between index, sectorization and spatial units are stored.

Meanwhile, the traditional construction of planar road network fails to meet the needs of indoor navigation. Besides the planar connectivity, the indoor navigation electronic map needs to express the connectivity of vertical transportation (namely the connection of vertical road network between stories), directionality of roads and travel restriction information. Therefore, in order to meet the needs

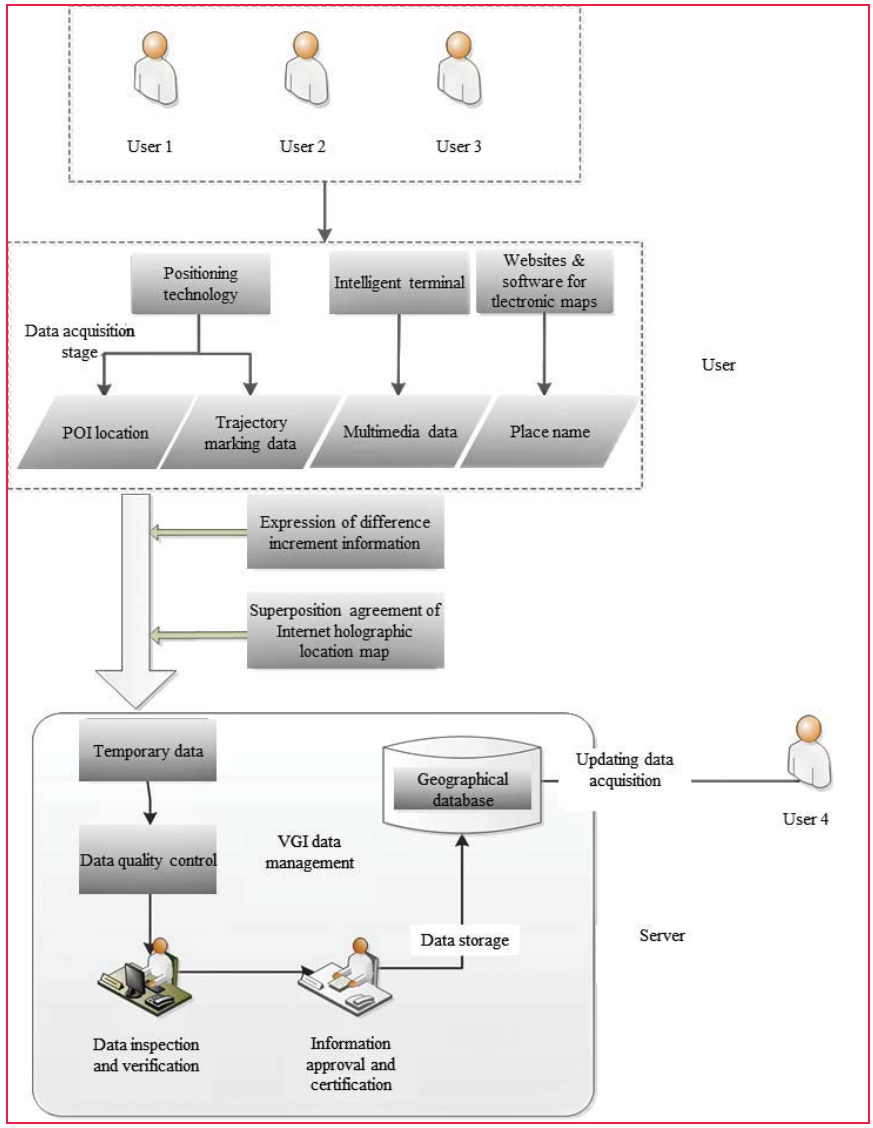

Figure 2: Roadmap of UGC Indoor Map Data Increment Updating Technology

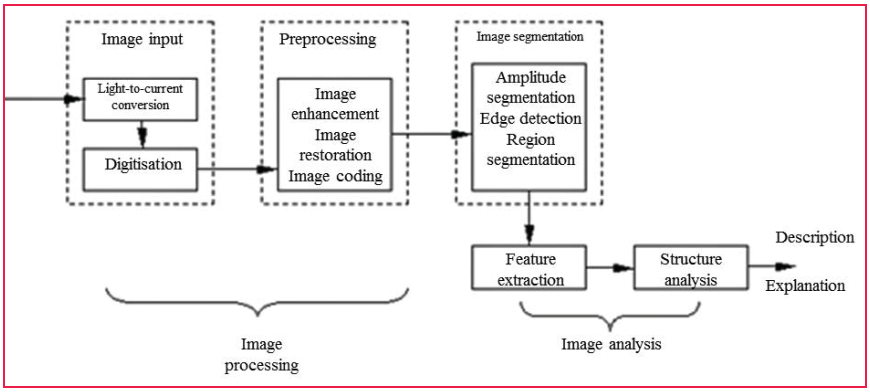

Figure 3: Graph Processing Procedure of Pattern Recognition

Figure 4: Indoor Map Production Tool Based on Pattern Recognition Technology

Figure 5: UGC Indoor Map Production Tool

of indoor navigation, the topology of planar and vertical traffic integrative indoor spatial road network is supposed to be established towards planar road network and vertical road network through solving key problems, such as handling network connectivity, establishing network topology, specifying optimized-weighted elements of road network, inspecting road network and establishing stereoscopic road network.

Technical standard system

Based on the indoor map models, the current navigation data models are extended; standards and formats of indoor-and-outdoor integrative map data are established; Unified definition and convention have been given to the coordinate system, projection, data sheet, field specification, forms of expression, data classification, rendering specifications and physical storage formats, promoting unified storage and release of indoor-and-outdoor navigation data, which are convenient for sharing and applying data.

Meanwhile, a set of standards and specifications are established for indoor maps, and a detailed description has been given to spatial features, attribute features and the spatial interrelations of navigation elements that provides the basis for field collection, data processing within industry and production of indoor navigation electronic maps. Routes of map data increment updating technology are set up in the current project based on UGC, enabling users to complete updating geometric figures and attribute contents of indoor maps with the assistance of mapping tools, as shown in Figure 2.

Map production tools

Compared with outdoor maps, indoor map production imposes higher requirements and quick changes, so convenient and easy-to-use indoor map production tools are the premise and foundation of producing, updating and maintaining indoor maps in batches. It's particularly difficult for map producers to update and maintain indoor maps constantly, for indoor maps are diverse and complex, and change frequently.

Map production tools adopt operation methods based on pattern recognition. Pattern recognition is widely used in image recognition, but indoor mapping is a relatively new application field for

Figure 6: Indoor-and-Outdoor Integrative LBS on Web Client

it. The process is specifically divided into several parts, namely, graph preprocessing, image segmentation, feature extraction, structure analysis, vector quantization, as shown in Figure 3.

There are some demerits in collecting manually digitalized indoor navigation map, including the disunity between map/road network and the reality, big deviation in collection, high cost for inspection and long collection period. Map-making software based on pattern recognition technology (see Figure 4) is developed to improve the automation for map operators in map collection, diminish the deviation and reduce workload and increase mapping efficiency, thus making indoor mapping more standardized.

Based on the technological route, indoor map production technique and production tools have been developed (see Figure 5), which realizes indoor map production in the way of UGC.

2D and 3D map engine

The 2D and 3D integrative indoor map is conducted based on the extension of 2D indoor map. Its functions include data organization, data rendering, route navigation, formation of temporary object, data retrieval and so on. Through the data reading interface, the core layer transforms the data read from the data layer into its own data organizational structure. In this case, even if there is any change in the data structure of data layer, the 2D and 3D data can be wholly rendered if the data reading interface is modified.

Meanwhile, the cross-platform application of 2D and 3D integrative indoor map engine has been realized. A set of underlying code can be compiled in different environments to meet application needs of various platforms, thus increasing code reuse rate and development efficiency and diminishing error rate. The 2D and 3D integrative indoor map has visualizing functions like loading 3D indoor map, line of sight rotating around the central point by tilting 45 degrees up, translating the line of sight when sliding, POI turning toward the line of

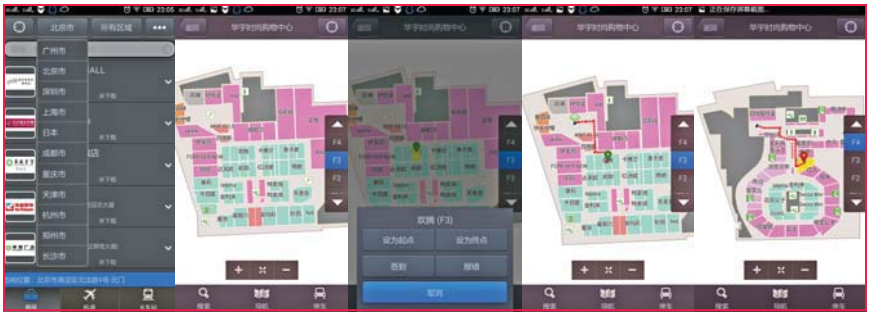

Figure 7: Indoor-and-Outdoor Integrative LBS on Smartphone Client

Figure 8: Application Products for Indoor-and-Outdoor Integrative Commercial Service of Jinyuan New Yansha Mall

Figure 9: 3D Indoor Map Display Effect of Jinyuan New Yansha Mall

sight direction, zooming in & zooming out and turning around the central point and stereoscopic route planning, that are much better than those of 2D indoor maps.

Achievement test on system construction

Currently through systematic development, the indoor-and-outdoor integrative map database on more than 100 important sites' indoor maps has been formed. Those sites include large commercial shopping malls and major transportation hubs such as railway stations and airports mainly situated in over ten big cities of the country like Beijing, Shanghai, Guangzhou and Shenzhen. The system provides indoor-and-outdoor integrative LBS for computers and smartphones, and supports such functions as indoor-and-outdoor integrative map display, POI retrieval and route planning (see Figure 6 and Figure 7).

In our country, there are about 4,000 large commercial shopping malls generally characterized by grand size, complex indoor layout, and constant change in stores and so on. The large commercial shopping malls are selected to be the application pilots for the indoor-and-outdoor integrative LBS, which serves as a demonstration for further commercial development. Therefore, Jinyuan New Yansha Mall, the largest monomeric shopping mall in Asia, is selected for demonstration for indoor LBS. The location-based services such as one-stop indoor navigation, delivery of preferential information from the mall, parking and locating cars are provided for users, and multiple one-stop services like instruction, shopping guide, propaganda, information, entertainment, new message, membership service are provided for malls, dealers and consumers (see Figures 8 and 9).

Conclusion

By establishing complex indoor-and-outdoor integrative map models based on semantics and topology, we worked out standards and forms of data and production standard specifications of indoor-and-outdoor integrative maps. Some breakthroughs were also made in a few key technologies, such as integration of multi-source heterogeneous data, update of maps of crowdsourcing mode and visualization of 2D and 3D integrative indoor maps, with which we developed effective map production tools and 2D & 3D map engines. Based on the above achievements, we successfully developed the indoor-and-outdoor integrative location-based service (LBS) system and produced indoor-and-outdoor integrative map data on a large scale. Moreover, we conducted preliminary industrial application of the system in Jinyuan New Yansha Mall. The potential value of indoor-and-outdoor integrative LBS will be further explored through increasing usability, analyzing the information about the e-commerce based on the data, providing shopping malls and branding companies with business data analysis, business marketing and other service products.

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Open source geo-information technology for making special purpose web-mapping application

It is possible to implement web mapping systems based solely on open-source software that are not only significantly more cost-effective but also feature higher graphical quality, interactivity and flexibility

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According to the fast growth and development of the urban environment and its subsidiaries, including universities, research centers, health, sports and recreation, shopping malls and stores ... the growing needs to access and rapid web-based responses, thereby need for an intelligent or smart system of visual and web-based are inevitable.

Summary

For creating a Web-GIS application first step is to create GIS data. There are many GIS software application to generate, modify and manipulate GIS data. Storing the created GIS data is the second step. In order to storing GIS data for the web there are many Data Base Management System (DBMS) that support spatial data. After that GIS data stored on the database, publishing map and the data from database is the third step. To do so, there are applications which allow to share, process and edit geospatial data. Therefore, by interaction and interoperability of user interface applications, server applications and database applications enable us to create our own web-GIS application.

Web-GIS and Anatomy of a web-mapping application

Often the terms Web-GIS and web mapping are used synonymously, even if they do not mean the same. In fact, the boundary between web maps and web-GIS is blurry. Web maps are often a presentation medium for web-GIS, and web maps are increasingly gaining analytical capabilities. Web mapping is the process of designing, implementing, generating, and delivering maps on the World Wide Web. While web mapping primarily deals with technological issues, web cartography additionally studies theoretic aspects: the use of web maps, the evaluation and optimization of techniques and workflows, the usability of web maps, social aspects, and more. Web Geographical Information Systems (web -GIS) or Internet GIS are related to web mapping but with an emphasis on analysis, processing of project-specific geodata, as well as exploratory aspects. [1] To put it bluntly, it's some type of Internet application that makes use of a map. This could be a site that displays the latest geo-tagged images from Flickr, a map that shows markers of locations we've traveled to, or an application that tracks invasive plant species and displays them. If it contains a map and it does something, we could argue that it is a web map application. The term can be used in a pretty broad sense. Web-GIS emphasizes geodata processing aspects more involved with design aspects such as data acquisition and server software architecture such as data storage and algorithms, than it does the end-user reports themselves. The term location-based services refers to web mapping consumer goods and services. Web mapping usually involves a web browser or other user agent capable of client-server interactions. Figure 1 shows what are the main components of

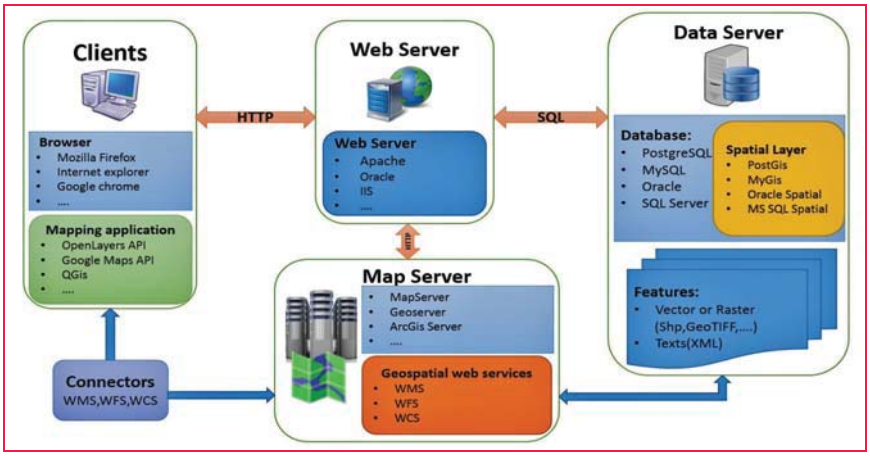

Figure 1: Structure of Web Mapping (Web-GIS).

the web-GIS application system and how they are interacting with each other.

Within the past few years, the popularity of interactive web maps has exploded. In the past, creating interactive maps was reserved for large companies or experts with lots of money. But now, with the advent of free services like Google and Yahoo! Maps, online mapping is easily accessible to everyone. Today, with the right tools, anyone can easily create a web map with little or even no knowledge of geography, cartography, or programming. Web maps are expected to be fast, accurate, and easy to use. Since they are online, they are expected to be accessible from anywhere on nearly any platform. There are only a few tools that fulfill all these expectations.

OpenLayers is one such tool. OpenLayers is an open source, client side JavaScript library for making interactive web maps, viewable in nearly any web browser. Since it is a client side library, it requires no special server side software or settings. It's providing both novice developers and seasoned GIS professionals with a robust library, OpenLayers makes it easy to create modern, fast, and interactive web-mapping applications. OpenLayers is a powerful, community driven, open source, pure JavaScript web-mapping library and HTML toolkit to quickly make crossbrowser web maps. With it, it is possible easily to create web map mashup using WMS, Google Maps, and a myriad of other map backends. [2]

Open source software make it possible to creating completely free web-GIS application.

This work explains that for each component of web-GIS application which of open source software is used. Clients, Web Server, Data Server and Web Map Server are the main components of a web-GIS. Figure 1

Client

Client is referring to the user's computer, specifically their web browser. The only thing that needs to have to make OpenLayers work is the OpenLayers code itself and a web browser. OpenLayers works on nearly all browsers and can served by any web server. It is usable in a modern, standard-based browser such as Firefox, Google Chrome, Safari, or Opera. Nevertheless, OpenLayers is an **API** that provides with tools to develop web maps. Instead of building a mapping application from scratch, it is possible to use OpenLayers for the mapping part. API, is a set of routines, protocols, and tools for building software applications. The API specifies how software components should interact and are used when programming graphical user interface (GUI) components.

In order to display any feature once user ask to appear on the map it needs to import GIS dada. Features, which are using as a GIS data, can be any vector or raster layers (Shp, GeoTIFF…) and can be Text (XML). Spatial information on a computer deal with GIS applications. There are many different GIS Applications available and are normally programs with a graphical user interface that can be manipulated using the mouse and keyboard. **Quantum GIS** is a type of GIS Applications which is a cross-platform free and open-source desktop geographic information systems (GIS) application for viewing, editing, and analyzing geospatial data from a variety of vector, raster, and database formats. QGIS provides integration with other open source GIS packages, including PostGIS, GRASS, and MapServer (e.g. GeoServer) to give users extensive functionality. Plugins, written in Python or C++, extend the capabilities of QGIS. There are plugins to geocode using the Google Geocoding API, perform geoprocessing (fTools) similar to the standard tools found in ArcGIS, interface with PostgreSQL/PostGIS, SpatiaLite and MySQL databases.

Web Server

A web server is a computer system that processes requests via HTTP, the basic network protocol used to distribute information on the World Wide Web. The term can refer either to the entire system, or specifically to the software that accepts and supervises the HTTP requests.

The most common use of web servers is to host websites, but there are other uses such as gaming, data storage, running enterprise applications, handling email, FTP, or other web uses. The primary function of a web server is to store, process and deliver web pages to clients. The communication between client and server takes place using the Hypertext Transfer Protocol (HTTP). Pages delivered are most frequently HTML documents, which may include images, style sheets and scripts in addition to text content. While the primary function is to serve content, a full implementation of HTTP also includes ways of receiving content from clients. This feature is used for submitting web forms, including uploading of files. [3]

Data Server (Data Base Management System)

A Data Base Management System is a database program. Technically speaking, it is a software system that uses a standard method of cataloging, retrieving, and running queries on data. The DBMS manages incoming data, organizes it, and provides ways for the data to be modified or extracted by users or other programs.

There are many DBMS's but some more known examples include MySQL, PostgreSQL, Microsoft Access, Microsoft SQL Server, SQL Server, FileMaker, Oracle, RDBMS, dBASE, Clipper, FoxPro, SAP and IBM DB2.[3] Since there are so many database management systems available, it is important for there to be a way for them to communicate with each other. For this reason, most database software comes with an Open Database Connectivity (ODBC) driver that allows the database to integrate with other databases. For example, common SQL statements such as SELECT and INSERT are translated from a program's proprietary syntax into a syntax other databases can understand. Database management systems are often classified according to the database model that they support; the most popular database systems since the 1980s have all supported the relational model as represented by the SQL language. Sometimes a DBMS is loosely referred to as a 'database'.

In this work for mange and store the GIS data **PostgreSQL/PostGIS** is used**.** A complete, functional open source DBMS, Postgres (as it's commonly referred to) seems to be the most popular for open-source web mapping. It requires OSGeo's PostGIS extension, which comes with the standard Postgres installation, to handle georeferenced data. It is used by OpenStreetMap, GeoServer, MapServer, and CartoDB. Because as it mentioned **PostGIS** is an open source software program that adds support for geographic objects to the **PostgreSQL** object-relational database. PostGIS follows the Simple Features for SQL specification from the Open Geospatial Consortium (OGC). [4]

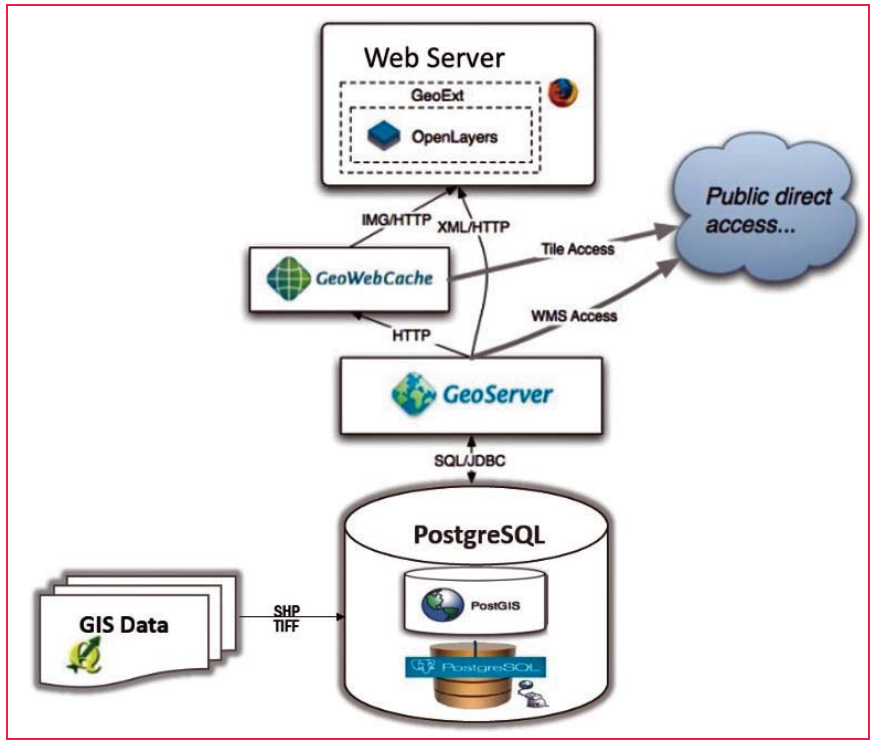

Figure 2: Arrangement of products to create web GIS map application.

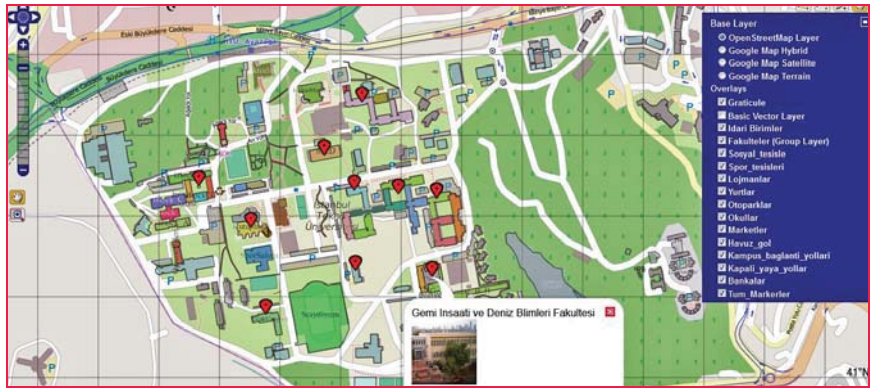

Figure 3: Sample web-map application created by using open source softwares (Turkey-ITU Ayazağa smart campus map on the web)

Web map server

A map server (or map service) provides the map itself. There are a myriad of different map server backends. A small sample includes WMS, Google Maps, Yahoo! Maps, ESRI ArcGIS, WFS, and OpenStreetMaps. [5] The basic principle behind all those services is that they allow us to specify the area of the map we want to look at (by sending a request), and then the map servers send back a response containing the map image.

With many web map servers to use those, just supplying a URL to them in OpenLayers is enough. OSGeo, OpenStreetMaps, Google, Yahoo!, and Bing Maps, for instance, provide access to their map servers (although, some commercial restrictions may apply with various services in some situations). Fortunately, there are numerous of free and/or open source web map servers available that are remotely hosted or easy to set up our self, such as **GeoServer** which is used in this work.

After storing GIS data on the database (PostgreSQL/PostGIS), GeoServer is used to publish map and the data from database which is written in Java allows to share, process and edit geospatial data. Designed

Galileo update

New Galileo satellites being moved into position

Galileo satellites 9 and 10 so far are functioning perfectly during the launch and early orbit phase (LEOP). The pair is undergoing a series of configurations and verification by mission team in Darmstadt, Germany.

The satellites will be part of a network that will provide navigation information, rivaling the US-based GPS.

"The overall mission status is fully nominal, and we conducted the first burn, on 14 September at 16:58 UTC [18:58 CEST]," Jérémie Benoist, co-Flight Director from CNES, said on an ESA blog.

The European Space Agency (ESA) and Centre national d'études spatiales (CNES) are jointly monitoring the mission.

The satellites will now undergo thruster burns designed to move the satellites to their target orbits. The thrusts will run anywhere from a few dozen seconds to a few dozen minutes

"Following the burns performed during the LEOP phase, the satellites will continue naturally drifting, ending up in their final desired operational orbits at about 23,222 km after another set of thruster burns, planned to achieve fine positioning in orbit, around the end of October," Liviu Stefanov, ESA co-flight director said.

The ESA/CNES will continue to provide some support even after the satellites are turned over to the Galileo Control Centre, near Munich, for routine operations.

Most of the team, though, will start to prepare for the next pair of Galileo satellites to be launched in mid-December 2015.

This success is in contrast to the fifth and sixth Galileo satellites, which were launched Aug. 22, 2014, after delay of a year due to production problems.

At first the launch was hailed a success, with several EU politicians making congratulatory remarks. Quickly it became apparent that something had gone drastically wrong and the Soyuz launcher had put them in highly elliptical orbits that made the useless for navigation.

After a series of complicated maneuvers, satellite 5 reached a useful orbit in November 2014 and satellite 6 did in March 2015.

The orbits are still not what were intended. Instead of covering the same ground every 10 days, they will repeat their positions every 20 days.

The launch of Galileo satellites 7 and 8 went much better, reassuring scientists and politicians that the program was getting back on track. *http://praguepost.com/*

for interoperability, it publishes data from any major spatial data source using open standards. GeoServer has evolved to become an easy method of connecting existing information to Virtual Globes such as Google Earth and NASA World Wind as well as to web-based maps such as OpenLayers, Google Maps and Bing Maps. GeoServer functions as the reference implementation of the Open Geospatial Consortium Web Feature Service (WFS) standard, and also implements the Web Map Service (WMS), Web Coverage Service (WCS) and Web Processing Service specifications.

Figure 2, illustrates how these components are working together to create a web map GIS application.

Therefore, by interaction and interoperability of user interface (OpenLayers, QGIS), server application (GeoServer) and database (postGIS/postgreSQL) enabled to create web-GIS application, Figure 3.

Conclusion

The result of the current work illustrates that it is possible to implement web mapping systems based solely on open-source software that are not only significantly more cost-effective than many commercial systems but also feature higher graphical quality, interactivity and flexibility. The advantage of this system is that each sections can be produced by different products and any component of the structure can be replaced with other products and vice versa.

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[3] Url-1 Web server & webdevelopersnotes, < http://en.wikipedia.org/ & http://webdevelopersnotes.com/ >

[4] Url-2 PostgreSQL/PostGIS Official page, < http://www.postgresql.org/>,

[5] Url-3Web Mapping Services Overview, http://wicoastalatlas.wordpress.com/

Don’t need Total Station

I was attempting to demonstrate that all could be done entirely with the TRIUMPH-LS with photogrammetry and give results that are sufficiently accurate for cadastral land surveying.

Continue reading Shawn Billings article (pages 3-6)

BEAST MODE RTK

Real 5-Hz Base Station Transmission

All RTK base stations (including RTNs) transmit data once per second. We are introducing The BEAST MODE RTK, real 5-Hz Base Station Transmission. Here are testimonials:

Well this just about has to be the most amazing single improvement I have observed.

I am most assuredly getting faster fixes under tree cover. And the ability to collect 5 times as many honest epochs in the same time period is wonderful.

My quick little test doing 3 epoch, lift to start topography actually made me laugh because it is so fast.

The only thing users need to know is that if they must use the RTK Delay setting of None for the allowable correction age, otherwise they will only see 1Hz updates. As Javad told us, extrapolate is a sin we should avoid.

I have a feeling that we are now seeing fixes, that are actually occurring 5 times as fast under tree cover. In my “bad spot” under a tree, I am making it through 10 resets in less than 10 seconds. This is simply amazing.

John Evers, PLS

In a test I just did under a tree, I would reset the RTK engines and use a stopwatch to time how long it took 2 engines to fix.

With 1 Hz it was averaging over 30 seconds and with 5 Hz it is in few seconds.

Mine is up and running fine. This thing is so fast now it is hard to believe!

Matthew D. Sibole, PLS

Be aware that increasing the transmission rate increases the battery usage of the radio and will also increase the heat generated inside it. For 2 Hz corrections you should use D8PSK or D16QAM modulation. D16QAM has the most bandwidth and is required for 5 Hz transmissions but may reduce the range of the radio some. If you are using a 35 watt radio the fan should be used with 5 Hz corrections if the output power is more than 4 watts.

Matt Johnson, PLS

Complete the Job with One Complete Tool

This is my photogrammetry test from yesterday. After taking some baby steps Saturday and Monday, I felt I was ready to try a real job. We already did the job a few weeks ago, and it is close to home, so it was a good place to test. Originally we did 80% of this job with the Triumph-LS and 20% total station. What I was attempting to demonstrate was that this could have been done entirely with the Triumph-LS with photogrammetry and give results that are sufficiently accurate for cadastral land surveying.

The 3.705 acre project site. It is a gas station and convenience store. There is the main building (approximately 180'x50'), the gas pumps with canopy, the storage building in the back and a large pylon sign. All of which must be located for the survey.

In performing the photogrammetry survey, I divided this job into six sub-projects (or scenes):

- Canopy (6 photos)
- East Side (12 photos)
- North End (6 photos)
- Sign (9 photos)
- South End (5 photos)
- West Side (10 photos)

By dividing the job up this way, I was able to limit the number of photos in each Camera Offset Survey Project to less than 12. Not only is this a practical limitation for J-Field processor, it also limits the number of photos the user must keep up with at one time. I began each scene by considering the points I wanted to collect remotely by photogrammetry and determining how to capture them with good geometry. Once I had a general idea of where I wanted my photos to be taken, I then set targets (rolls of survey ribbon) in several places that would be visible to at least a few of the images I'd collect for the scene. I then collected control points by normal RTK survey methods. Once I had my control for the scene collected, I would then begin collecting images in Camera Offset. Ideally I attempt to have each point of interest captured in 5 photos that spray from the point with at least 90° of dispersion (preferably wider). It's important to remember that photogrammetry is 3D which requires specific points be identified. While I may not be interested in the elevation of a building corner, I need to specifically target a consistent point on the building corner for the results to work properly. When taking the images, I make sure that the image includes the point on the building corner that I am locating, not just the corner itself. I also attempt to vary the distance from the scene and the height of the camera as I capture images. While collecting the Sign scene, I didn't have a good place to establish a control point, but I noticed a pipe post that was in most of my photos, so I located it after I collected the photos to be used as a control point. Control points don't need to be artificial targets, but they need to be able to be resolved 3 Dimensionally, from any angle. Because the pipe is cylindrical it is a good target horizontally.

If the vertical angle though is too severe, the height may be difficult to distinguish. That was not the case with this pipe.

While I was collecting them in the field, I gave the Camera Points (the points collected at the camera location) names that related to the scene. For instance CANOPY1, CANOPY2, CANOPY3, etc. and E1, E2, E3, etc. Control Points were named CP1, CP2, etc., regardless of what scene they may have appeared in. Tie Points (points selected from the photos) were also named based on the scene, I included a T in the name to distinguish them from the Camera Points (e.g. ET1, ET2, ET3).

I ended up with:

- Canopy (19 points)
- East Side (33 points)
- North End (18 points)
- Sign (12 points)
- South End (14 points)
- West Side (12 photos)

I am a neophyte with photogrammetry. I realize that in most cases regarding positioning, the less adjustment the better as adjustments may mask a problem. Thus far, I have kept Adjust Focal Length and Use Control Points checked with Adjust Principal Point unchecked and Adjust Image Coordinates unchecked. A few times I would select the wrong control point while registering points in the image. This would cause J-Field to take a very long time to process as it continued to iteratively attempt adjustments to make the wrong point work in the solution. I found that it is a good idea to uncheck Use Control Points for adjustment (minimally constrained) and see what the residuals are for the control point before proceeding. Then if the residuals are reasonable, include them in the final adjustment for the scene. Thus far, it seems that the error estimates are reliable. If a point is showing error estimates that are disproportionate to the other points in the scene, it is likely due to the point being poorly identified on the image or having a weak geometry establishing it. Here are some examples of adjustment results of the six scenes:

Adjustment accuracy report, South End

Adjustment accuracy report, North End

Adjustment accuracy report, Canopy

Adjustment accuracy report, Sign

Adjustment accuracy report, West Side

Keeping up with so many points in a scene, I found it helpful to keep a scratch pad handy. I drew a rough sketch of the scene and as I created points, I would note it on the sketch. Then as I registered the points in other images I could look on my sketch and quickly recall which point belonged to which feature.

The results from the adjustment appear to be fantastic. Far superior to my expectations. So how did they compare to the RTK/total station survey from a few weeks ago?
Horizontal Residuals (vertical in parenthesis):

0.19' NNWC Building - NT6
0.06' NWC Concrete (0.10' Height) - NT5
0.08' NEC Building (from North End scene) - NT18
0.09' NEC Building (from East Side scene) - ET26
0.22' NEC Concrete (0.02' Height) - ET27
0.06' NEC North Awning - ET25
0.10' SEC North Awning - ET22
0.07' NEC Center Awning - ET19
0.21' SEC Center Awning - ET9
0.19' NEC South Awning - ET6
0.25' SEC South Awning - ET3
0.10' SEC Building (from South End scene) - S1
0.25' SEC Building (from East Side scene) - ET2
0.29' SEC Concrete (0.05' Height) - ET1
0.06' SWC Concrete (0.04' Height) - S14
0.07' SWC Building - S13
0.11' SWC South Building extrusion - W9
0.07' NWC South Building extrusion - W10
0.19' SWC Center Building extrusion - W7
0.14' NWC Center Building extrusion - W6
0.11' SWC North Building extrusion - NT2
0.09' NWC North Building extrusion - NT4
0.02' SWC South Storage Building - W1
0.00' SEC South Storage Building - W2
0.13' NEC South Storage Building - W3
0.05' SEC North Storage Building - W4
0.04' SWC Canopy - CT18
0.06' SEC Canopy - CT20
0.04' NWC Sign - SIT4
0.04' NEC Sign - SIT5

(I realize from making this report that I messed up my point naming scheme. Point W1, for example, should have been WT1 and S1 should have been ST1).

If my math is correct, the average horizontal residual is 0.106'. It should be noted that is a comparison of coordinates from the job we did a few weeks ago RTK/Total Station and the job done RTK/photogrammetry. The RTK used the same control point, 8200' away. When viewing these residuals, remember that this includes differences in positions with RTK between the two jobs as well as errors in the total station ties that were made. Thus not all of the residuals can be attributed to photogrammetry.

From a quick look at the adjustment results, it does appear that the re-projection error estimate can indicate lower accuracy even if the linear error estimate appears to be small, as some of the higher residuals shown above also have higher RE, px error estimates.

The total time spent last night registering the 100+ points I created from the photos took about 4 hours. As I mentioned earlier, the time in the field was just under 1.5 hours. As I get more proficient, I expect I will be able to reduce processing and field time somewhat. This was only my third attempt at this! This likely wasn't as efficient as a total station survey for the points I actually needed. The total station setups (there were four) required an equivalent amount of time in the field with no post processing required. But I ended up with a lot more data than I had with the total station. Because I pick as many precise points that are common to several photos as I can, I end up with extra information, such as the location of windows and the height of the roof or the elevation of the door threshold. Also, because it is vital to get good coverage of the scene with photos, I am guaranteed to have great photo documentation in my archived file.

There are many instances in commercial industrial environments where sites are very open, but there are no places to set up an total station. For this survey, I mounted the Triumph-LS to a surveyor's extendable prism pole and bipod, which can be set up almost anywhere. I was collecting for 20 epochs at 5Hz, so the time per point was very small. In high traffic environments, this means I could get the data (photo) very quickly and move, then determine the actual position(s) I am interested in at some later time through post processing. Even the quickest total station setup generally takes me 15 minutes. The real limitation to this is the required geometry. If you have mobility around your scene, this is not difficult to achieve. However, if the points you are interested in are obscured from all but only a few directions, or a single direction, photogrammetry may not be the right tool. I can't quite say I'm ready to sell my total station, but with a bit more practice, I think I'll be able to produce results that are almost as good and in some environments much safer and more efficient.

One of the things that impresses me, is that I am getting these kind of results on my third attempt. I've only read about photogrammetry in the past and have no practical experience with it. This speaks well for the interface as well as the processing algorithms. Yes I agree the desktop software would be more convenient; having said that, it is truly remarkable that I was able to generate every bit of this from the LS without any outside hardware or software required.

Regarding scale, the building is 180' long and 50' wide, just to give some perspective, and of course the entire site is much larger.

Shawn Billings, PLS

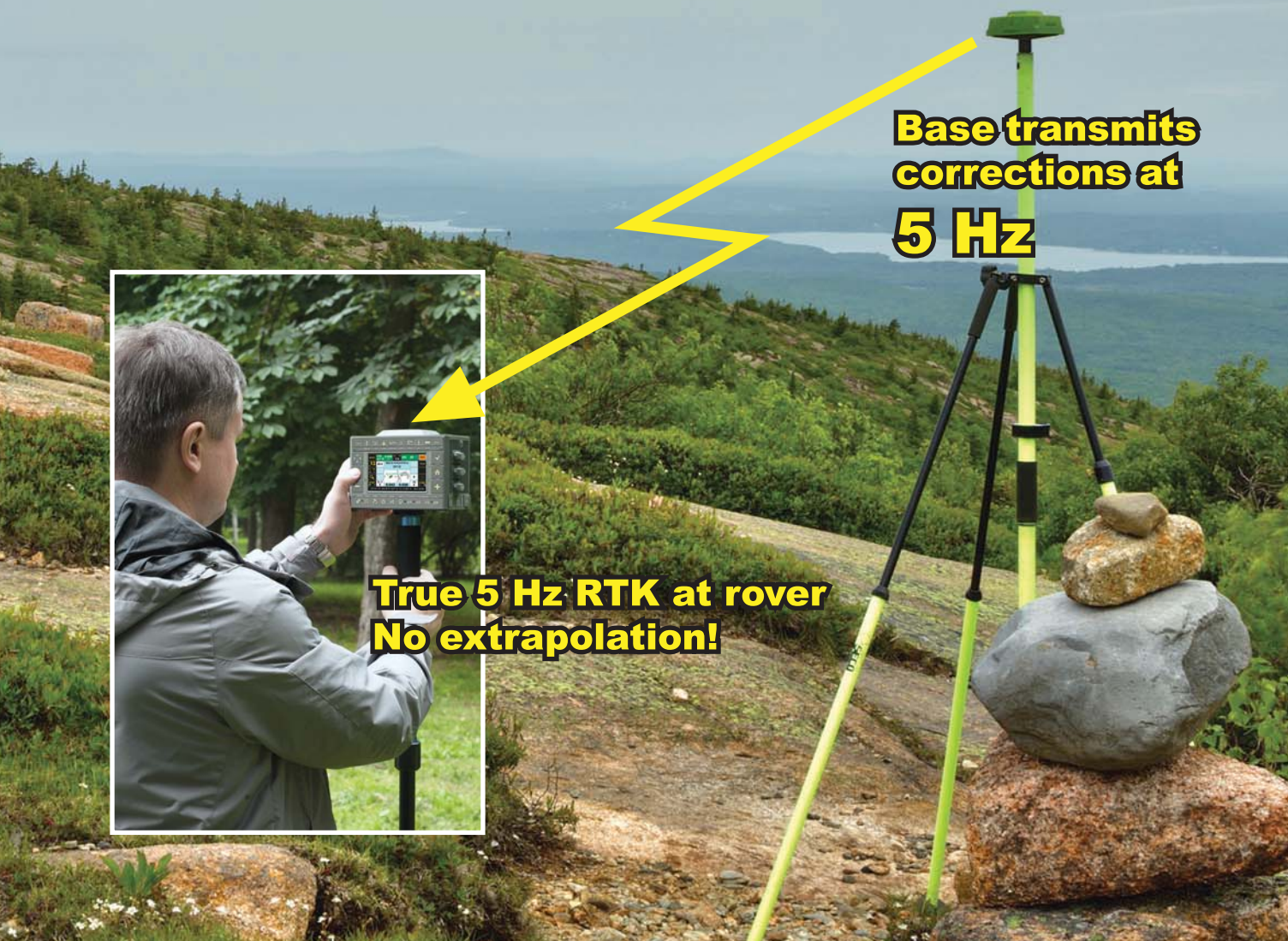
TRIUMPH-LS users, please update to the latest version of TRIUMPH-LS software set (released today) to benefit from all these features. Set the TRIUMPH-2 or TRIUMPH-1 at base to 0.2 Sec transmission rate. TRIUMPH-LS will do the rest.

Javad,

Today was incredible. We had a chance to test the Beast….

Stopping to take a shot I would fix and know the position of the line in seconds. This is truly a big deal for me since we are constantly staking line in heavy multi path environment. The LS is truly becoming a receiver to beat. Javad if I were to thank you for anything it would be for the Beast Thank you.

Doug Carter, PLS



Double Bubble

Survey results can be documented with the on-screen image of the vial.

The vials can be viewed on the TRIUMPH-LS screen via the bottom camera.

The internal electronic levels can be calibrated with the mounted vials.

A 40 min vial for fast set up. Next to it is an 8 min vial for precision set up. All in a small package.

SDI: Lessons from Nasarawa state experience

Nasarawa State Government, Nigeria embarked on a large-scale land-based investment of US$16,876,561.00(2.7 billion Nigerian Naira), using modern geospatial technologies to develop a modern geospatial data infrastructure for the state

Ibrahim Usman Jibril
Nasarawa Geographic Information Service (NAGIS), NAGIS Service Center, Karu Nasarawa State, Nigeria

Nasarawa State is one of the thirty six (36) federating states of Nigeria. It was created in 1996 and is located in the north central part of the country. It is bound by the Federal Capital Territory (FCT), Abuja to the west, Kaduna and Plateau States to the north, Taraba State to the east and Benue and Kogi States to the south (See Figures 1 & 2). It has a total land area of 27, 290sq km. with a population of over two million people, where most of them practice subsistence agriculture.

Presence of naturally made land is a very important resource to the government and people of the state. In this context, the proper management of land in the state is imperative. Its close proximity to Abuja, FCT (See Figure 2) has made the state to always react to events that it has no control over. Development activities within Abuja, FCT in the last 38 years has significantly affected in Nasarawa State. Most of the impact has been on land and could be said to always be negative in a lot of cases. For instance, a large number of the FCT's work forces are resident in the neighboring Karu Local Government Area of the state. Though no reliable official figures are available, various estimates put the figures at between 45% and 50% of the FCT work force living in Nasarawa State and commuting daily. This has multiple effects on housing needs, transport and other social services. Past administrations of the state have unfortunately not been able to address land issues within the entire state. Land and important means of production were completely ignored until the year 2012.

The state government realized early in 2011 that the entire system of land administration and management within the state was in chaos. Records available within the lands department are old and not easily retractable if and when needed. Under this scenario it was easy to see that no meaningful development could be achieved without putting in place a modern system that could address the serious issues in a holistic manner once and for all. In addition to this the state government was (and is still) in a precarious financial situation. It could not depend on the federation account

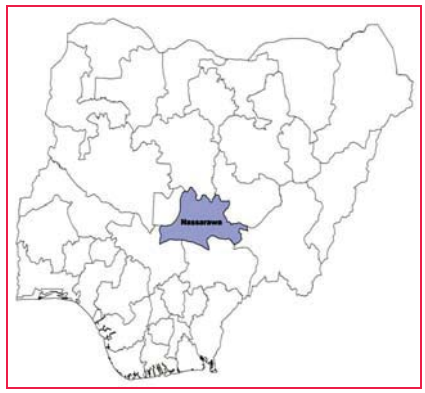


Figure 1: Map of Nigeria Showing the Location of Nasarawa State (Source: NAGIS 2012)

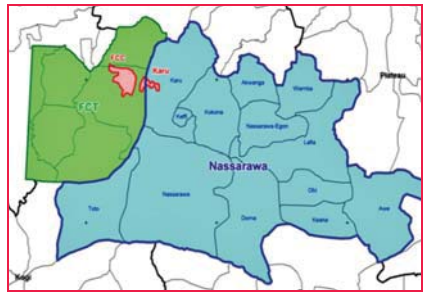


Figure 2: Map of Nasarawa State (Source: NAGIS 2012)

allocation for its sources of funds if it wants to serve its people properly. Due to this issue, the state government decided to look inward and harness the land resources at its disposal. It decided to embark on a large scale land-based investment of US$16,876,561.00(2.7 billion Nigerian Naira), using modern geospatial technologies in order to develop a modern geospatial data infrastructure for the state. The project has three components - Orthophoto Mapping, Geographic Information Service and Urban Planning & Urban renewal, commenced in May 2012.

Under this project, the state land mass of 27, 290sq km was flown. Six townships were flown at 10cm GDS, while the remaining parts of the entire state were flown at 25cm GDS. The data acquired were stored in a GIS platform of Nasarawa Geographic Information Service (NAGIS). Land use and land cover maps were also produced for the entire state. This is an unprecedented development as not more than one state in Nigeria has performed such a feat so far.

This paper essentially set up to examine the impact of this large scale land-based investment by the state government:
- The development of spatial data infrastructure in the last two and half years as well as the challenges faced during the implementation stages. Lessons learnt so far as well as the remarkable improvement in service delivery recorded in land administration and land management practices are unprecedented.

Project overview

The development of spatial data infrastructure in the state – known as Nasarawa Development Platform Project – was conceived to address the many issues of Land Administration and Management within Nasarawa State. The sharing of a common border with Federal Capital Territory (FCT) and Abuja City makes for a strong case for addressing squarely the problem of urban poor in respect of land ownership and its attendant social consequences. This project has three components:-

- Digital Aerial Mapping of the Whole State and Six selected Urban Areas Nasarawa Geographic Information Services (NAGIS).
- Urban Renewal & Planning of three Townships (Lafia, Keffi & Karu)

Commenced in May 2012, the project spilled over to the year 2015 even though it had an initial completion period of 24 months at a total cost of UD$ 16,876,561.00.

Existing situation before the NDP project

All the major townships of Nasarawa State suffer from lack of proper planning and near total neglect of the environment. It would be an understatement to say that all of them are a mess and Karu area suffers most – unstructured with a lot of economic potential that are untapped and completely neglected. Poverty is so glaring in this area and almost near similar situation is replicated in most of the state's townships. This is in sharp contrast to the well planned environment of its immediate neighbor – Abuja City (See Figure 3).

The area is characterized by large scale acquisitions by private individuals as well as cooperate organizations. This is a direct consequence of the areas' close proximity to Abuja City. Almost all these developments were not based on any plan nor were they ever regulated or coordinated by either the Town Planning Department of the MLUD or the Nasarawa State Urban Development Board (NUDB). Most of these developments or properties do not have any record in any of these government agencies. Where there are records, the agencies lack the technical competence and equipment to monitor and enforce compliance of building codes and or regulations. As a result of this gap, the area is now characterized by unplanned and unregulated (in some cases squatter) settlements with all the attendant environmental hazards that go with such areas (see Figures 4 & 5).

Within these areas there is also lack of proper drainage systems and where they are available, garbage is dumped in them. This blocks the free flow of storm water and increases the risk of flooding during the wet season (see Figure 5).

There is also the preponderance of large numbers of small and large scale farm holdings from both indigenous farmers of this area and from different parts of the country. Farming is a primary economic activity of the people. The gradual takeover of such lands for housing and

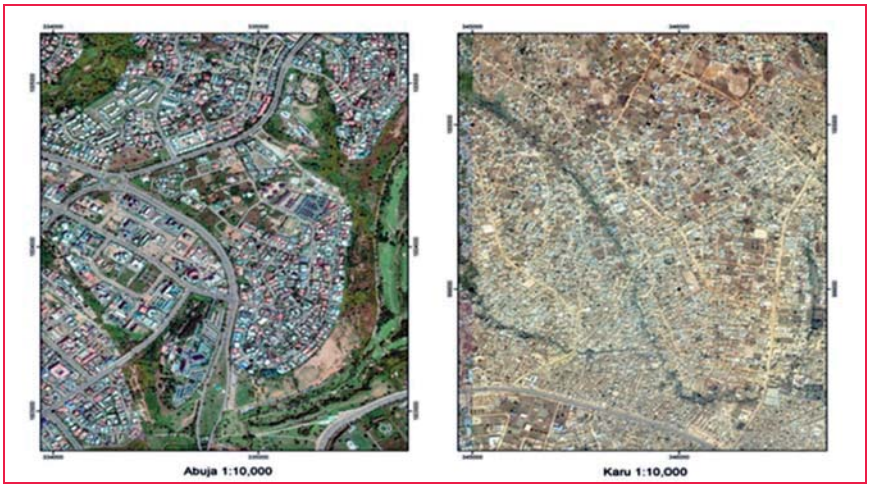


Figure 3: Satellite Images of Abuja City (FCT) & Karu Town (Nasarawa State) (Source: NAGIS 2012)

Figure 4: Refuse Dump Sites in Karu Area (Source: Envicons 2013)

Figure 5: Poor drainages in Karu Urban Area (Source: Envicons (2013)

Figure 6: Commercial Activities & Traffic Logjamalong Abuja-Karu-Keffi Expressway (Photo: Evicons /NAGIS, 2013)

commercial development from such people is a major concern that is already posing a problem for the people and state administration. A lot of the farmers have been forced to become tenants on their own lands, having sold the same to more affluent people who were attracted to the area because of its proximity to Abuja City. Some have become farmers without farm land thereby increasing the level of poverty in the area.

Since the commencement of physical development within the FCT in the early 1980s, physical and unplanned development within Karu axis has been going on in several directions at an alarming rate. However the most significant areas and direction of growth are along the major highway of Abuja – Karu – Keffi. This has led to traffic grid lock particularly right from the boundary of the FCT through Mararaba to Masaka area (see Figure 6) all year round, despite the two-lane highway.

The vision of the state government is to develop the area as a twin city that can compete favorably with Abuja in terms of all the social and economic activities. This vision cannot be achieved without a reliable and up-to-date spatial data infrastructure in place. The Nasarawa Development Platform program is therefore a conscious and well planned attempt in setting up a modern spatial data infrastructure aimed at addressing these challenges in a holistic manner for short and long term benefit to the people and state government.

It is important to note that a real gap existed for long in the state regarding land titling. Very few people and corporate organizations have real title documents to their holdings despite the fact that the state has a long history of land title (records of the 1930s are available in the archives of the State Ministry of Lands). In cases where such titles to land holding are found, they are mostly in the township areas of Karu, Lafia and Keffi in that order of importance. Other township areas include Nasarawa and Akwanga.

A lot of the people have customary titles much of which are undocumented. Very few property owners hold statutory title to land. Many have no certificate of occupancy evidencing their grant and or holdings. A certificate of occupancy is an instrument that can be registered in Nigeria and an evidence of a grant for a right of occupancy. It is the only title document that almost all financial institutions accept as collateral in order to secure a mortgage. It is therefore easy for one to see why the lack or absence of such documents could be a major source of concern not only for the state government but for other stakeholders, particularly financial institutions willing to invest or borrow money to real estate developers.

Figure 7: Samples of the Orthophoto 10cm captured December 2012 (Source: NAGIS, 2012)

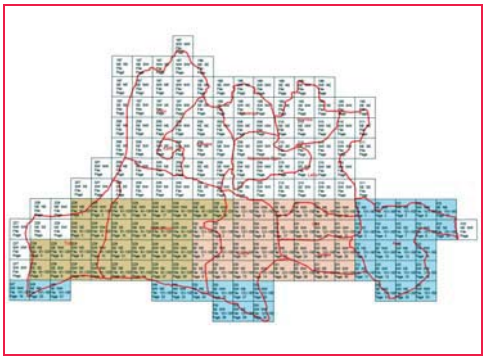


Figure 8: Map Index of Nasarawa State (Source: NAGIS 2012)

Figure 9: VectorMaps 1:25,000 scale: Land-Cover (Source: NAGIS, 2013)

There were similar attempts to address these challenges in the past, but all failed due to lack of strong political will and technical know-how. This project is the first major attempt by the state government to address the issue of proper land records in a well-structured GIS database that would be easy to retrieve if and when needed. It came when the government understood its importance and became willing to invest and support the investment to fruition. It came because the government is showing strong political will knowing fully well that this would also assist her in taking decisions from an informed position as well as provide the basis for titling which would not only ensure security of tenure for the poor and the not so poor alike, but also assist the government in harnessing the much needed but long neglected land revenue.

Digital aerial mapping of the state

A significant milestone was attained on December 28, 2013 when flying of the entire land mass of the State was completed, making Nasarawa the first state in Nigeria to achieve such a historic goal. So far all the six (6) townships areas have been flown at 10cm resolution which led to the production of Orthophoto maps and 1 m contour lines. (See Figure 7 for the samples of the 10 cm images).

Linemaps & land covermaps

Figure 8 is the index map of the entire Nasarawa State. This project has produced land cover and line maps of the entire state for both official use and any other use by private citizens.

These maps are at the scale of 1:25,000 (See Figure 9 for samples).

This is a significant achievement if viewed from the fact that nothing of this nature ever existed in the state. Most of the available topographical and cadastral maps were very old and mutilated and most often not very useful.

Pilot project of roof count using orthophoto

Using the 10cm Orthophoto of the six townships, the project was able to conduct a pilot study of rooftop count of existing buildings/properties. This led to actual identification of the extent of most of the urban sprawl areas which is now giving us a more refined figure per square kilometer. It is also

Table 1: Preliminary Results of Building Counts from Orthophoto 10cm of Six Townships (Source: NAGIS, 2014)

#	Town	Area Surveyed in km² (Ortho Coverage)	Building Count	Buildings per SQM
1	Akwanga	158	30,184	191
2	Doma	158	27,230	172
3	Karu	650	229,341	353
4	Keffi	148	48,310	326
5	Lafia	406	113,239	279
6	Nasarawa	147	26,014	177
	Total	**1667**	**474,318**	

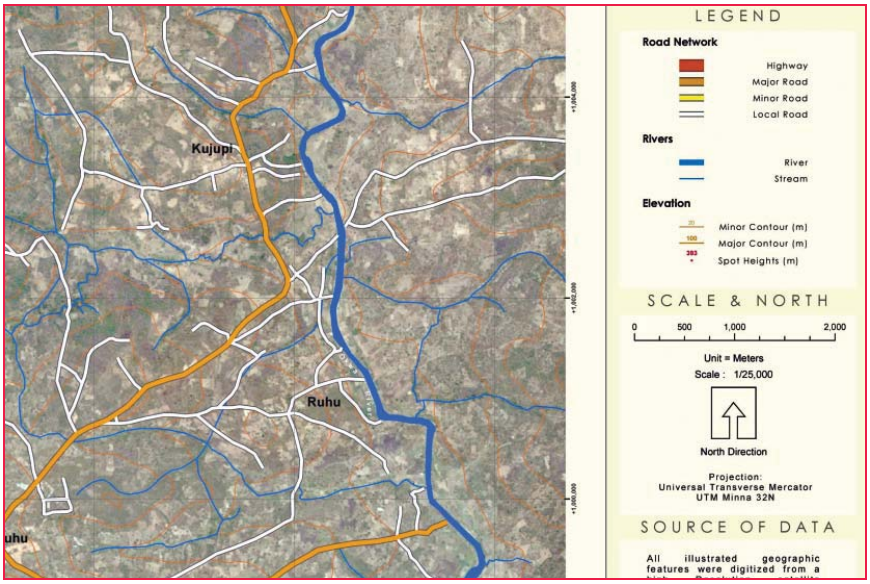


Figure 10: Sample Line Map at 1:25,000 Scale (Source: – NAGIS 2013)

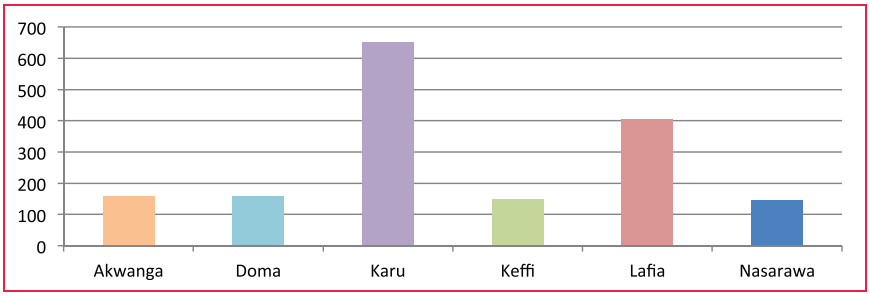


Figure 11: Area Surveyed in Km² (Source:– NAGIS 2014)

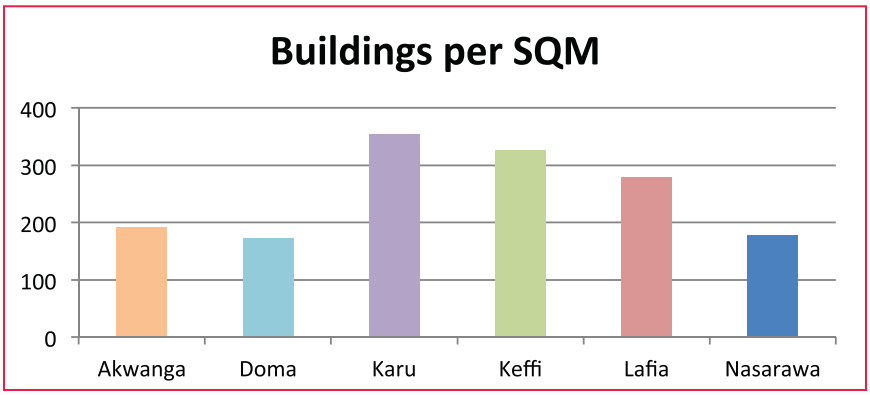


Figure 12: Buildings count from Orthophoto per Square meter (Source:– NAGIS 2014)

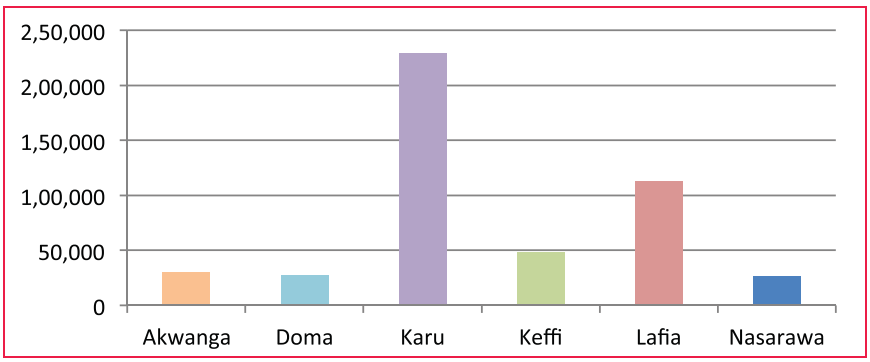


Figure 13: Building Count from Orthophoto of 6 Townships (Source: NAGIS 2014)

giving us an accurate identification of the slum area, local business districts, other areas of interest, major land marks etc. within these urban areas. Plans are under way to share this information with the National Population Commission to assist them in future planning and combining of data sets for useful government services. Preliminary results (see Table 1) have given us up to 474,318 buildings spread over an area of 1,667 sq km in the six townships.

The next stage is to use the data in population estimation. It is believed that a near accurate population figure could be obtained for these townships and ultimately for the state after a careful study and collaboration with the National Population Commission. Figures 11, 12 &13 give a graphic idea of the preliminary results of the building counts from the orthophoto.

Pilot project for rural cadastral and conservation

These images would help in setting up a Rural Cadastral System for the state as well as establishing Regional Development Plan for sustainable planning. Recently we started exploring the possibility of partnering with the Federal Ministry of Environment in respect to the REDD+ program. Using our Orthophoto we were able to produce a sample land use map of one of the old forest reserves that is under threat and would therefore need more serious conservation efforts. (See Figure 14 &15).

This collaborative effort would go a long way to assist in the global fight against climate change by identifying forest reserves across the state that are under serious threat as a result of unsustainable human activities.

We are also assisting the State Agency in charge of the Millennium Development Goal (MDGs) by mapping all the areas of their activities across the state. This is part of the effort towards development of GIS-based Land Information System (LIS) and development of a reliable rural cadastral for sustainable development in the state.

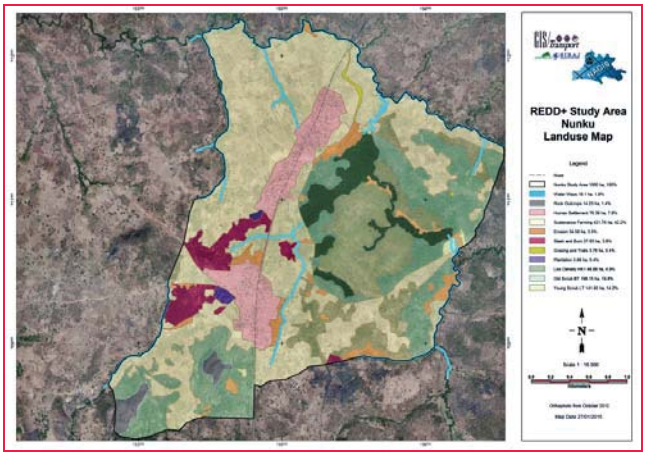


Figure 14: Land Use Map Nunku Forest Reserve Produced from Orthophoto (Source: NAGIS 2015)

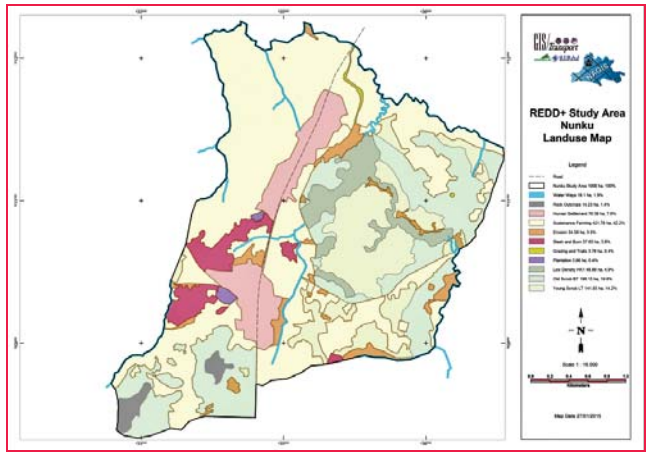


Figure 15: Land Use Map Nunku Forest Reserve Produced from Orthophoto (Source: NAGIS 2015)

Figure 16: Orthophoto of Unplanned part of Old Lafia Township (Source: NAGIS 2012)

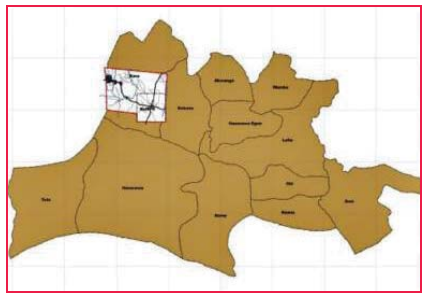


Figure 17: Keffi-Karu Project Area (Source: Envicons/SirajConsulting/NAGIS, 2013)

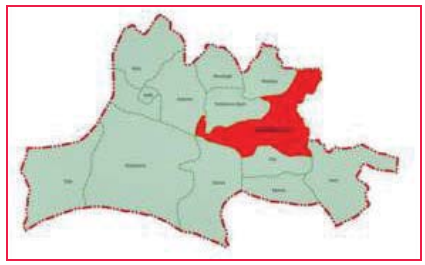


Figure 18: Lafia Project Area (Source: Envicons /Siraj Consulting/ NAGIS, 2013)

Urban planning & urban renewal

This component of the project is addressing the following issues:-

- Existing unregulated, unplanned settlements and the environment,
- Squatter settlements in Karu Area (and other Townships of the State), and
- Lack of infrastructure that has for long been a source of concern to the people. (See Figure 16).

This would aid the state government's efforts of Urban Renewal Plan, General Land Use Plan and Development Control Capacity. As earlier seen, the proximity of the state with Nigeria's new Federal Capital Territory has led to massive development of urban slums in Karu area.

Draft final reports of Karu/Keffi and Greater Lafia areas were submitted by the Consultants in October 2013. These reports were based on survey conducted by the consultants as well as detailed appraisal and analysis of existing development based on mapping information, Orthophoto images and satellite imagery. This was done from middle of 2012 to the end of 2013. This report covers Draft Detailed Land Use Plan, including the proposed development plans and the draft Final Land Use Plan & Detail District plans including Urban Renewal and Upgrading Scheme. From these reports, the planning concept was laid out by the planners in line with the vision of the state (See Figures 17 & 18).

Urban renewal

This aspect addresses the issues of urban poor because most of the areas slated for renewal are populated by them. Past neglect by the government is a contributing factor to the constant unprecedented growth rate in these areas. The consultant's report laid a broad view of the Urban Renewal Master Plan of Karu, Keffi and Lafia area. From the report it is clear that the population of Karu area would continue to increase beyond 205,477 (recorded in 2006 National Census). Already the 2011 projection is put at 254,175 [at annual growth rate of 4.7% (Envicoms Team, 2013)]. (See Figure 19).

Other towns that make up the urban area of greater Karu are Mararaba, Ado, New Nyanya, Masaka and Auta-ba-

Figure 19: Orthophoto of the Proposed Urban Renewal Site (Source: Envicons / NAGIS 2013)

Figure 20: Conceptual Karu – Masaka Commercial Corridoralong Abuja - Karu - Keffi Express Road (Source: Evicons / Siraj / NAGIS, 2013)

lefi. All these areas are slated for urban renewal program (See figure 19). The proposal has spelt out details and methods of how the program will progress. It is however significant to note that the problems have been brought to focus and placed as a priority that deserves prompt attention of the government even if there is no immediate funding.

Commercial activities

Part of the submission also proposed a commercial corridor along the existing Abuja – Karu – Keffi high way. This is significant because of the haphazard and unregulated commercial activities that are taking place here. Most of the urban informal sector activities of small scale traders, artisans, hawkers, etc., carry out their businesses on the side of the major highway of Abuja – Karu – Keffi. This in turn, led to the occupation of the road shoulder as well as the outer lane of the highway, thereby leading to constant traffic gridlock almost all day long. This no doubt is always a source of concern to commuters and the government (See Figure 6). To arrest the situation a commercial corridor was proposed and it will stretch from Karu to Masaka, a distance of about 10 km (See Figure 20).

The concept is to provide 'articulated development along a highly viable city suburb axis' (Envicons 51, 2013). Some of the features of this development corridor include:

- 'A central highway with a right of way of 200 m. A 100 m bus and rapid transportation for mass transit – to and fro carriageways to be completely separated, 50 m each way for the vehicles,
- Bus stations at district/ sector centers, and
- Interchange to link to and fro outer carriage way.

District planning

This project would select 11 districts for detail planning. Greater Karu has 5 districts, GreaterLafia and Keffi, 2.The draft final report has provided 12 districts in Karu, 8 in Keffi and 17 in Lafia for selection. Details can be seen in Figure 21. The criteria to be applied in delineation would include land use and uncommitted spaces, population concentration,

Figure 21: Proposed Land Use for Karu / Keffi & Lafia (Source: Evicons Consulting / Siraj Consulting / NAGIS, 2013)

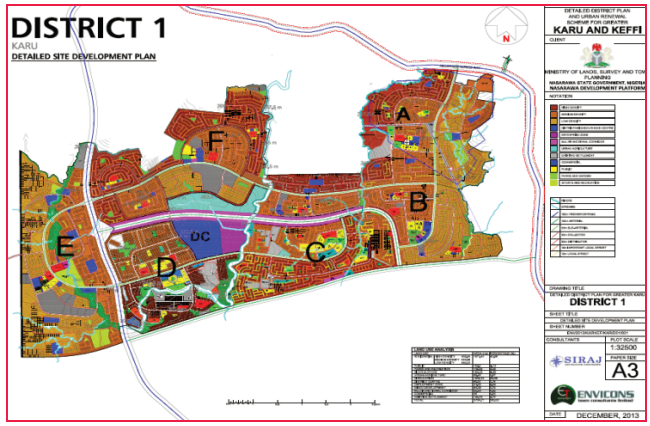


Figure 22: Detailed Land Use Plan of District 1 (Source: Evicons /Siraj/NAGIS, 2013)

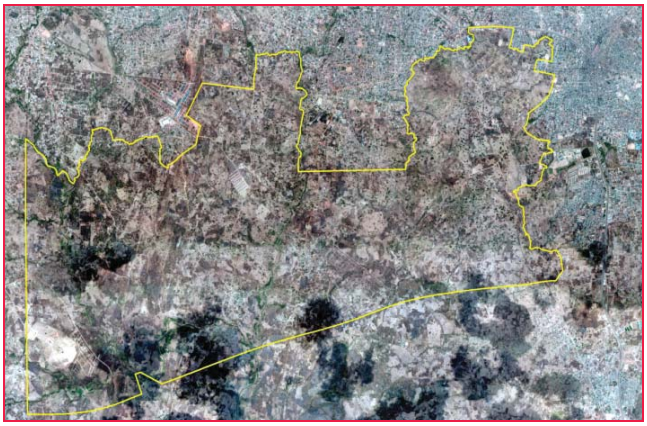


Figure 23: Images of District 1 (Source: Evicons /Siraj/NAGIS, 2013)

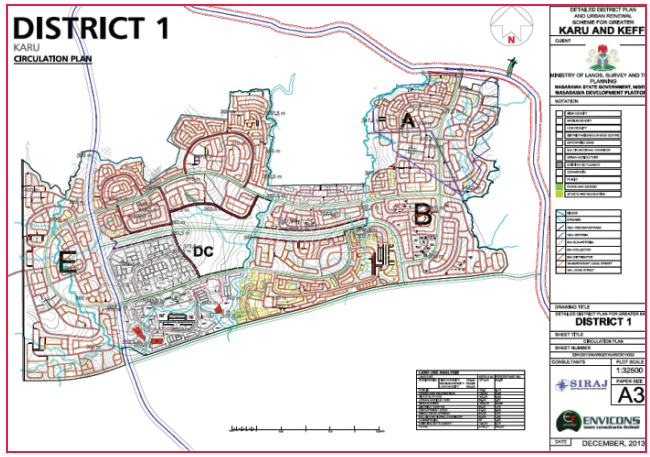


Figure 24: Detailed Transportation Plan of District 1 (Source: Evicons /Siraj/NAGIS, 2013)

administrative and cultural boundaries, natural and man-made boundaries, nature and character of economic activities as well as committed and legal sitesby government and their agents.

A sample selection of District 1 in Karu area (Figures 22 & 23) gives details of the facilities that would be provided if and when the plan is finally implemented. It is also worthy of note that each district is further subdivided into smaller neighborhoods with detailed land use for proper implementation.

The report has been studied and would soon be passed into law for proper implementation by the state government. This is to ensure peoples participation in what is most likely going to affect their living conditions. However, it is significant to note that the proposal has taken care of creating some industrial areas in order to attract investors from within and outside Nigeria. This would no doubt create employment opportunities to the people, particularly the youth and reduce poverty, crime rate and the added insecurity. Agricultural development is crucial to the state. So agro allied industries would also go a longway towards solving the problem of ford security. Above all, these plans would assist tremendously in increasing their venue base of the state.

Transportation plan

This is a key component of the land reform program of the NDP project. The new proposal has taken care of this adequately. This is worth noting in view of the persistent traffic gridlock in Abuja-Karu– Keffi road and constant loss of man-hours. This is no doubt the busiest road in the whole state. Accordingly construction of two parallel by-passed, one on each side of the Karu–Keffi corridor has been proposed. This is in line with the vision of the state government. Once this is done, it would reduce the amount of time that is constantly wasted on the existing highway, open up new areas to orderly development and generate more economic activities that would in turn put more money into the pockets of the low income and increase the revenue base of the state through taxation.

Apart from the above, there is also the proposal for the extension of the Abuja Rail line to Keffi knowing fully well that most residents of Greater Karu work in the FCT. This makes it necessary for daily commuting and so a rail extension would fit perfectly and assist greatly to ease a lot of travel stress. Details of the proposal can be seen in Figure 26.

General features

It is important to highlight the most prominent feature of this report and

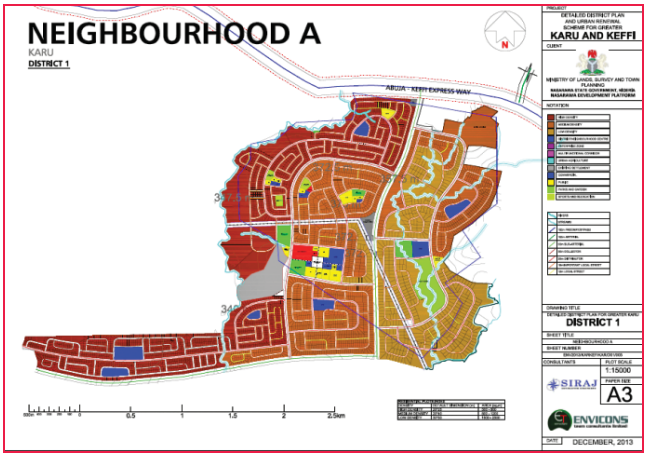


Figure 25: Detailed Land Use Plan of Neighbourhood a of District 1 (Source: Evicons /Siraj/NAGIS, 2013)

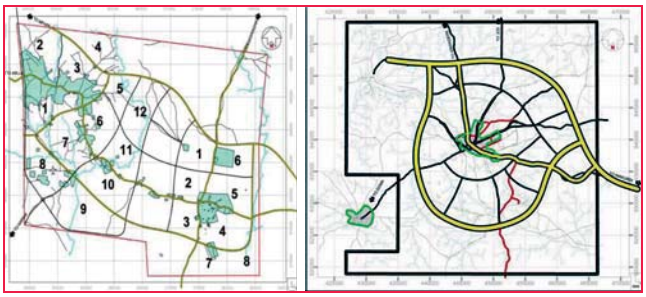


Figure 26: Proposed Transportation Plan for Karu/Keffi & Lafia (Source: Evicons Consulting/Siraj Consulting/NAGIS, 2013)

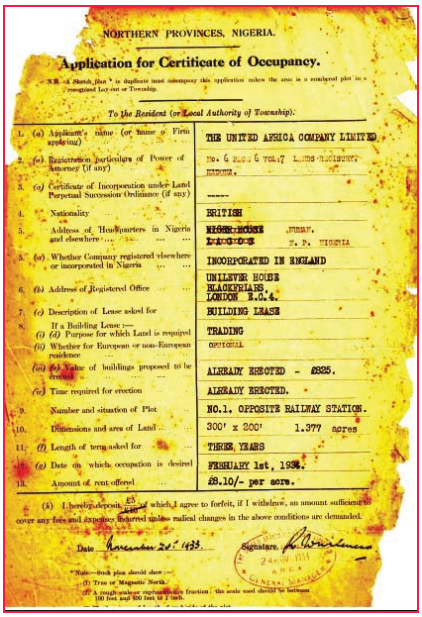


Figure 27: Copy of Old Land Document Dated 24 November 1933 (Source: MLUD/NAGIS,2015)

proposal. We are already aware of the existing settlements particularly in Greater Karu area. It would not be feasible to think of uprooting the entire settlement in order to create a well planned environment that is eco-friendly. To this end the basic concept is that of integration of existing settlements without compromising quality of the environment. To achieve this, a gradual program of upgrading to improve the quality of building and its environment has to be adopted. 'The whole city' would be organized to'graduate from the household to the cluster, neighborhood, district and sectors. Each level of residential organization is to be given its appropriate complement of services to meet its threshold demands.' (Envicons Report, 2013, p. 35).

Similarly commercial activities would be regulated and developed in hierarchies, starting from a neighborhood centers through district centers up to a central area where highest order of commercial, administrative/cultural functions would be located. There would also be a good network of transport organized in hierarchy. The express ways would be the highest and the local access roads at the lower rung. There would also be pedestrian walkways that would ensure safety of the people. Above all, these proposals are intended to be carried out in phases over a period of 30 years.

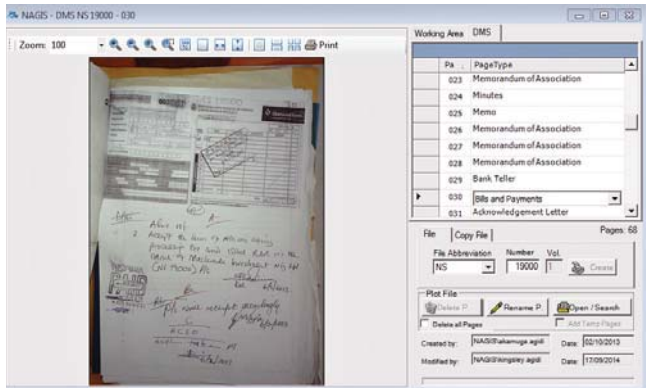


Figure 28: Sample Copy of a Page in NAGIS EDMS Data base (Source: NAGIS 2015)

Nasarawa geographic information service (NAGIS)

Is important to note that the State Ministry of Land has a rich record of land documents dating back to the colonial time when modern land administration was first introduced by the colonial administration in Nigeria. Records from the existing land files in the Ministry covers from those of old Northern Nigerian Government which was later transferred to the old Benue Plateau State in 1966, then transferred to Jos with the creation of Plateau state in 1976. Nasarawa State inherited these old records in 1996 when the state was separated from the old Plateau State. Accordingly the earliest land records and survey activities dates back to the early part of the last century. Records are available for documents of 1933 in the land archive. (See Figure 27).

In establishing NAGIS all these records were captured into the NAGIS database.

Land data capture

By the end of the year 2014 over 25,178 files were captured into the Land Information System (LIS) of NAGIS, while 24,205 of the above figure were captured into the Electronic Document Management System (EDMS). Of these files, 21,838 are linked directly to the LIS. These 24,205 files totaled up to 628,503 pages scanned into the EDMS with over 368,029 pages properly renamed and indexed for easy reference (See Figure 28).

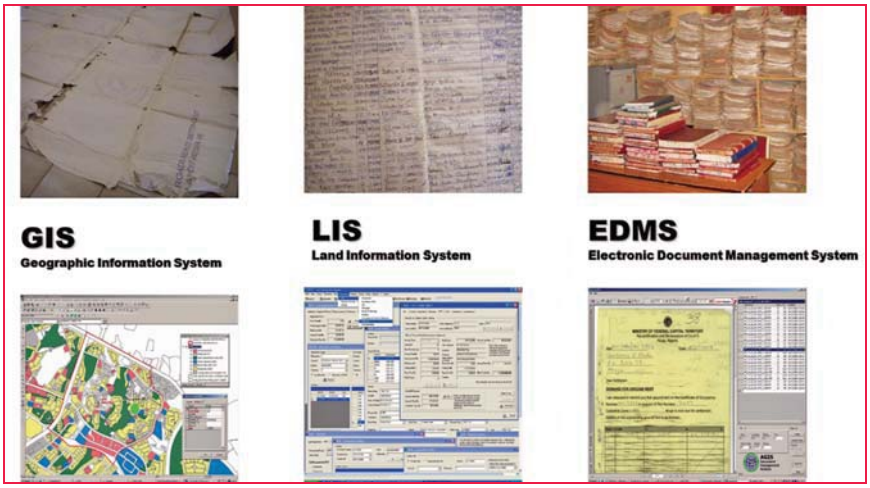


Figure 29: Sample Documents from the old Analogue format to the new data base (Source: NAGIS 2013)

More than 90% of the data captured have undergone proper data clearing exercise and quality control. This gives a reliable database with high integrity. This is an essential element in obtaining public confidence when services are being delivered to them by the service agency. With this development, the state has now developed a well-structured spatial data infrastructure of international standard that can stand the test of time in delivering services according to world best practices. All documents are now accessed from the database. Paper maps are scanned and stored in a GIS, while other land documents are now in the LIS and EDMS (See Figure 29).

Land titling

About 1073 titles to land were granted since the creation of the state 19 years ago. The first two years (during a military administration) witnessed the issuance of 310 titles (or 28.89 %). The next eight years of civil administration witnessed 214 (19.94%).

This followed a period of stagnation between 2007 and 2011, when only24 title documents were issued – a mere 2.24%. However in the last three and half years, an unprecedented 525 titles (48.93%) were issued using the new NAGIS database (See Table 2 & Figure 30). This became possible because of the increase in speed and efficiency when the LIS, linked to the GIS became fully automated in October 2013. From this period, NAGIS systems processed all new applications for Right of Occupancy (RofO) and produced all bills, with the Ministry of Lands and Urban Development (MLUD) standing down all manual operations.

There is also a corresponding increase in the number of new applications requesting for the issuance of title documents. In the year 2014 the number of new applications almost hit 1,000 (See Figure 31).

This is good omen for the property market and a positive step for the people and state.

Revenue generation

Before the commencement of this project, very little was collected from land charges, rents or taxes. Revenue from land contributed only 1% of the state's internally generated revenue (IGR). A combination of Ground Rent, Development Fees, Registration Fees, Premium on Certificate of Occupancy and Application and Processing Fees as well Consent Fees for various transactions on land were what constituted land revenue earlier. It was difficult to collect such revenues in the absence of reliable and easy to access land records. The development of this spatial data infrastructure made it easy for the state to pull together all the records in one central database. This in turn led to an instant and dramatic increase in the amount of revenue generated and

Table 2: Land titles Issued since 1997 (Source NAGIS 2015

Period	No. of Titles	%
1997 – 1999	310	28.89
1999 – 2007	214	19.94
2007 – 2011	24	2.24
2011 – 2014	525	48.93
Total	**1073**	**100**

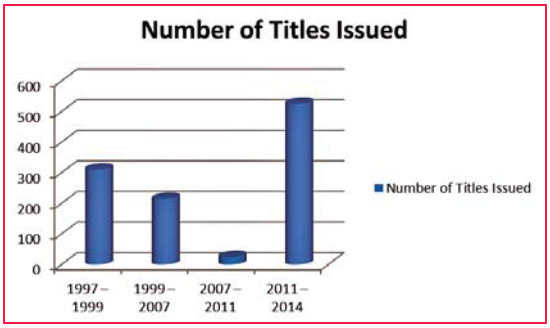


Figure 30: Number of Land Titles Issued 1997 – 2014 (Source: NAGIS 2014)

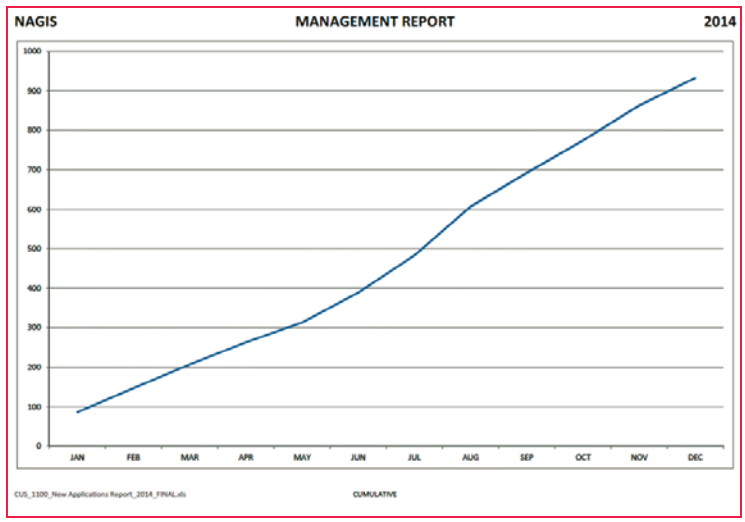


Figure 31: New Application Report For the Year 2014 (Source: NAGIS, 2014)

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Table 3: Land Revenue Generated Between 2011 and 2014 (Source: MLUD/NAGIS)

MONTH	2011 (US$)	2012 (US$)	2013 (US$)	2014(US$)
JANUARY	27,879.62	52,247.16	197,275.23	169,375.36
FEBRUARY	53,670.88	54,839.65	273,305.99	407,862.78
MARCH	28,670.88	143,443.57	244,288.60	217,845.58
APRIL	8,115.99	154,251.21	202,642.87	137,720.72
MAY	16,233.51	132,228.88	149,924.09	177,993.29
JUNE	8,600.31	141,364.61	232,984.68	397,655.66
JULY	11,871.63	107,883.36	130,835.22	240,972.82
AUGUST	5,111.09	242,962.23	185,849.57	186,033.52
SEPTEMBER	14,527.95	294,716.36	433,807.36	169,029.86
OCTOBER	13,494.98	174,995.91	307,381.17	543,393.34
NOVEMBER	14,417.90	117,942.88	218,508.94	242,743.12
DECEMBER	16,274.72	367,036.48	223,264.06	850,682.80
TOTAL	**218,869.46**	**1,983,912.30**	**2,800,067.78**	**3,741,308.85**

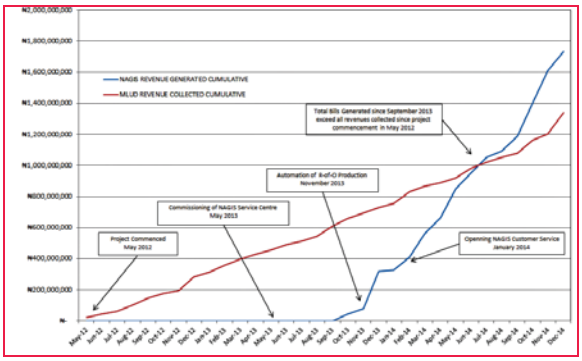

Figure 32: Revenue Profile & Analysis (Source: MLUD/NAGIS, 2015)

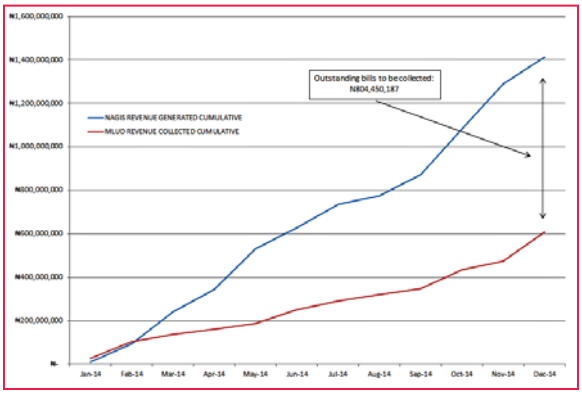

Figure 33: Cumulative Revenue Profile & Analysis for the Year 2014, (Source: MLUD/NAGIS, 2015)

collected in the last two to three years when this project started its operations.

Total revenue generated and collected in the year 2011 was US$218,869.46. This contrasted sharply with the increase of a total collection of US$1,983,912.31 in the following year. The 2013 figures were even more impressive with an all-time high record of US$2,800,067.78.

The collection for the year 2014 almost doubled that of 2012 at US$3,741,308.85. The month of December 2014 was a significant month because of the record collection US$850,682.85. (This figure was more than the total revenue collected for the three years of 2007 – 2009, which stood at US$753, 791.57 only). See Table 3.

This dramatic increase has now lifted the revenue profile of the state and made the contribution of the Land Ministry to rise from only 1% to over 30, thereby making it the largest single contributor of IGR to the state.

The development of a robust spatial data infrastructure is one of the most significant determining factors that have led to this increase in revenue collection. The determination of the state administration to pursue the project vigorously is another factor that led to the upward revision of land fees and charges and the subsequent rise in the revenue profile. The automation of the system has proved to be robust, consistently producing all forms of land documents.

All new applications and transactions are managed by the systems, which makes it easy to retrieve files and process fast.

Billing and issuance of such bills became simpler and more vigorous. Similarly issuance of demand notices started and is now more regular unlike the past when no such notices were issued. Recent trend has shown that public has now realized the determination of the administration to issue title documents. This has also increased the awareness and willingness of property owners to pay land charges in order to obtain a more secure land title document. This is an important positive sign for the state.

This can be seen from the number of applicants that come forward on a daily basis to file new applications in the land records section (See Figure 31). The billing system that used to take a lot of time for the Land Revenue Officers to calculate and dispatch to land title holders for payment because it was done manually, has now been automated. The result is a dramatic reduction in the amount of time spent now to process title documents. A more efficient revenue collection is in place, further preventing any form of sharp shady practices that may have been in place old system. So far the initial results has have shown a promising future for the state government. Figure 33 shows the revenue profile as generated by NAGIS and collected by MLUD. From the figures one can see clearly that the generation of revenue is by far ahead of the actual collection. While more than ₦1, 400,000,000.00 (approximately US$8,750,000.00) was generated, only ₦608,689,414.32 (approximately US$3,741,308.85) was actually collected. This leaves us with an outstanding figure of over US$5,027,813.67 yet to be collected.

The above scenario has clearly shown that the project is well on its way to recover cost of the initial investment made by the state government. Figure 34 illustrates the actual project cost and what was recouped as in January 2015. This figure of 70% is extremely impressive as no state agency has ever performed such a feat.

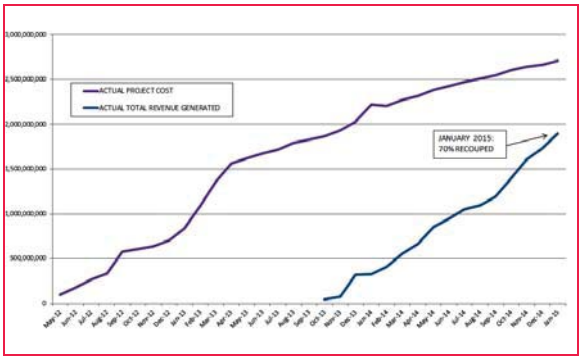

Figure 34: Project Cost Recovery, (Source: NAGIS, 2015)

Table 4: Record of Survey Data in NAGIS Data Base, Source:-NAGIS 2014.

Class Field	Number of SDA	%
big Shift	982	24%
Encroachment	88	2%
Location	99	2%
major Shift	48	1%
medium Shift	427	10%
on Top	204	5%
Orientation	213	5%
Shape	504	12%
small Shift	868	21%
total Wrong	744	18%
	4177	**100%**

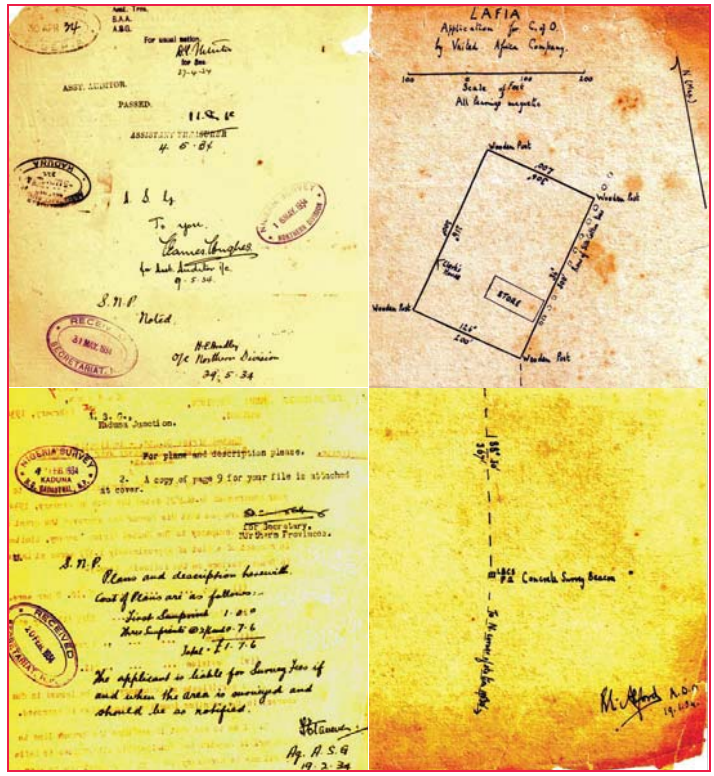

Figure 35: Old Land Documents Stored in NAGIS Data Base (Source: NAGIS 2015)

Our realistic projection based on actual past performance is for a complete cost recovery of the initial investment made by the state government till July 2015.

Challenges

Data cleaning exercise & quality control

A significant achievement in this project is the improvement in the quality of data that is now available in the NAGIS data base. Prior to the commencement of this project it was common practice to obtain title documents over a parcel of land with an ordinary site plan.

The drawback of this old system is that the site plan does not give an accurate representation of the actual size and location of the property in question. This has led to many problems and disputes over boundaries and in a lot of cases outright wrong locations and in some cases series of litigations. It should be noted that the state has a long history of land administration and land management issues. Oldest survey data/ records (so far identified) and captured in the land archive, dates back to 1933 (82 years). See Figures 27 & 35.

With a structured GIS driven data base it became absolutely necessary to use accurate an survey order to arrive at exact locations. This has necessitated the use of modern high precision survey equipment with attendants' accuracy that is of world standard. This no doubt has brought about so many challenges. So far more than 34,615 coordinates of Property Beacons (PBs) have been captured into the GIS. An analysis of the records of 4,177 sets of survey data carried out so far has revealed a variety of results. (See table 4)

It is significant to note that only 5% of the analyzed 4,177 set of data are classified as accurate. Of this, 18% are totally wrong, while 12% have a changed shape, and 24% have a significant or big shift from their actual locations (See Figures 36 & 37). These issues are attributed to multiple reasons, among which are old survey equipment, unqualified and ill-equipped personnel carrying out survey activities, using wrong reference points, etc. It is common knowledge that there are errors in the geodetic network in Nigeria. Arinola (2006) observed errors in the Nigerian Geodetic Network (in some cases up to 9 m).

In recognition of this challenge the project has moved ahead to establish two Continues Reference Station (CORS) as well as 100 primary ground control stations across the state's land mass in order to strengthen the geodetic network in the country. This would go a long way to compliment the efforts of the office of the Surveyor General of the Federation of Nigeria (OSGF) as well as assist both public and private survey and cadastral activities in the state (See Figure 38).

Some significant milestones & other challenges

Past practice of missing paper documents are now over with all the land data fed in a data base. The implication of this development is that unlike in the past

Figure 36: Sample of Accurate Survey Data, Source NAGIS, 2014

Figure 37: Sample of an Inaccurate Survey Data, Source NAGIS 2014

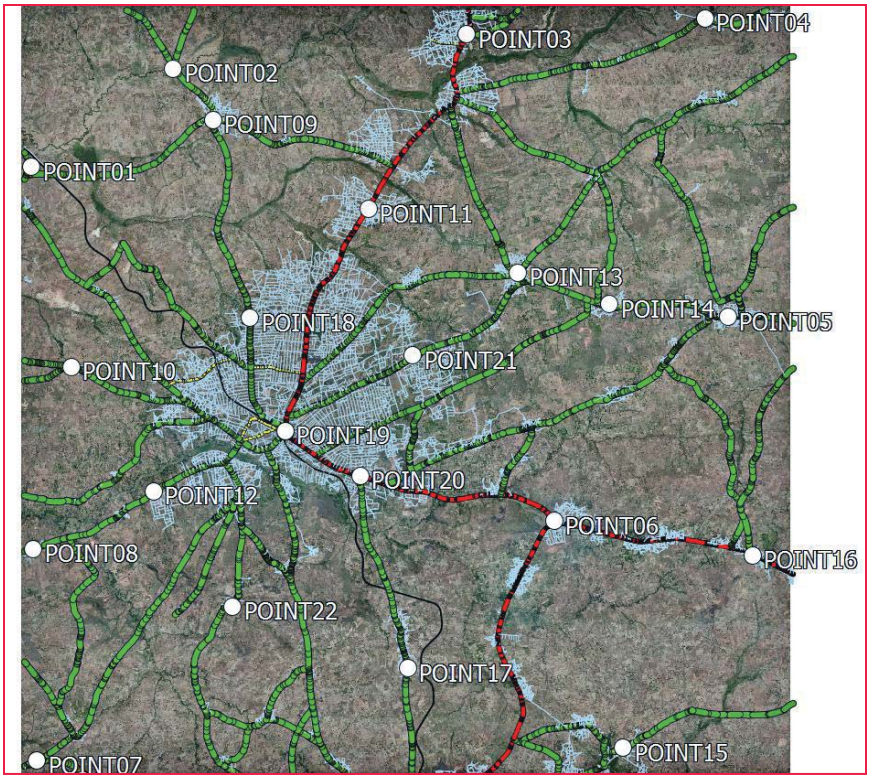

Figure 38: Survey Control Points in some Parts of Nasarawa State Source NAGIS 2014

when land files could be misplaced, lost (or even hidden by some unscrupulous staff members), now, any file that is misplaced, its electronic copy could be reproduced and processed without any problem for the applicant.

The computerized system is able to bring out the errors inherent in the old analog system. Though this has been a source of constant friction with the existing surveyors, field verifications are underway in order to get to the root of all the challenges and sort them out.

Training is also given a prominent place in the new system in order to ensure smooth transition from the old analog system to the new digital format.

Another source of friction is the resistance and the fear of the unknown for senior government staff. However training is given prominence in this project. This has assisted tremendously and has gone a long way in reducing the fear as well as restoring confidence of the staff.

Summary of lessons learnt and the benefits of the project to the state

NDP/ NAGIS project and subsequent development of Spatial Data Infrastructure benefits the state government and organizations of all sizes, and stimulates economic development by enabling citizens and private enterprises to register land and property, securing their investment in a transparent and safe system. Good governance is enhanced and achieving sustainable development is now a realistic goal.

Cost savings resulting from greater efficiency

These are associated either with carrying out the mission (e.g. labour savings from automating and optimising workflows) or improvements in the mission itself (secure documents such as receipts and Certificates of Occupancy underpinned by electronic systems). For example,

GIS is reducing the time taken to register land in Nasarawa state.

Significantly increased revenue generation

People are encouraged by the efficient system and the secure documentation to register their land. More people have obtained Certificates of Occupancy (C-of-O) since the inauguration of NAGIS than previously. This has resulted in significant increases in the revenues generated.

It is important to note that these revenues are sustainable, as conveying more C-of-O's will result in increased Ground Rent collections. As more people obtain C-of-O's investment in the development of new property surges, resulting in development control charges and increased property tax and tenement rates.

District Planning and improved decision making

District Planning typically has to do with making better decisions about location and zoning, with typical examples such as housing (real estate site selection),transportation (route/corridor selection), industrial and commercial centres, agriculture and conservation, natural resource extraction, etc. There is recognition that making the correct decision about a location is strategic to the success of government initiatives and strengthens sustainable development.

NAGIS is undertaking extensive field surveys in key urban areas to provide data that can aid city and district planning, bringing together field data and 10 cm orthophotos in a variety of maps that can support the provision of other vital services such as storm water management and security.

Improved communication

GIS-based maps and visualizations greatly assist in understanding situations and in storytelling. They are a new language that improves communication between different teams, departments, disciplines, professional fields, organisations, and the public.

Senior administrators and executives at the highest levels of government use GIS to communicate, using a visual framework for conceptualising, understanding, and prescribing action. Examples include briefings about land use, crime, homeland security and defence, the environment, and economic opportunities.

Better geographic information recordkeeping and management

Despite the fact that Nigeria is an oil rich nation approximately 70% of the people live in poverty, presenting a challenge to the efficient management of civil administration. Added to this, many people migrated to Karu and Keffi areas of Nasarawa and created dwellings due to the proximity with Abuja and the lure of jobs, adding additional planning and socio-economic challenges.

Government ministries have a primary and statutory responsibility to maintain authoritative records about the status and change of assets and natural resources, including examples such as land use (zoning), land ownership (cadastral), administrative boundaries, infrastructure (including roads, hospitals and schools), forest inventories, agriculture inventories, environmental measurements and water flows, and a whole host of geographic accounting.

Assets and resources can be maintained using an expanded GIS enterprise information system to support day-to-day work, management tasks, and to provide a broader context for assets and resource management. GIS provides a strong framework for managing these types of systems with full transaction support and reporting tools. These systems are conceptually similar to other information systems in which they deal with data management and transactions, as well as standardized reporting of changing information. However, they are fundamentally different in the use of maps containing specified data.

Conclusion

The state government has so far paid the consultants more than 90% of the total sum. The revenue generated so far has gone up to 70% of the total sum so far invested since the beginning of the project. A full recovery is expected within the middle of this year. No project in the state has shown greater potential of revenue generation than the NDP project. It is so far a pace setter and when fully consolidated in the second stage other arms of the state government would be expected to key in and use the GIS tool for effective service delivery. This project has shown that well-focused planning, proper funding and careful supervision can deliver a modern spatial data infrastructure to immensely benefit the people and government. This is the most important lesson that could be learned from the Nasarawa State experience. It is our hope that other states in Nigeria would follow this good example in order to better serve humanity.

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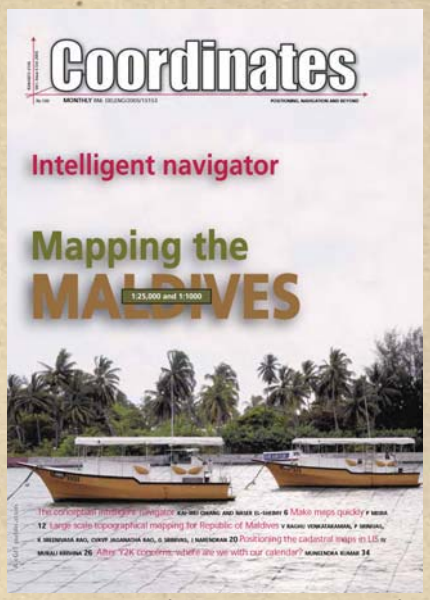

mycoordinates.org/vol-1-issue-5-october-05/

The conceptual intelligent navigator

DR KAI-WEI CHIANG AND DR NASER EL-SHEIMY

Given the fact that the incorporation of artificial intelligence to the navigation algorithm is new to the navigation community, it needs more extensive research to accelerate wider inclusion of such an idea to commercial products. However, the results presented in this article strongly indicate the potential of including the artificial intelligence as the core navigation algorithm for the next generation land vehicular navigation system.

Make maps quickly

Innovative use of controlled photogrammetric models allows for faster map making

PROF P MISRA

The motivation for this paper started from seeking a solution of a real problem of the map users i.e. the inordinate delay in getting map-data. The concept of generating the Photogrammetric – Date – Base does solve this problem in two ways. Firstly, by procuring the aerial photography at the earliest and secondly by storing the value added models (partially completing the photogrammetric process). Once the user organizations understand the advantages of the concept, the implementation of the model is quite easy.

Large scale topographical mapping for Republic of Maldives

NRSA has carried out mapping of entire Maldives at 1:25000 and sixteen selected islands at 1:1000 scale for the first time in the history of Maldives

V RAGHU VENKATARAMAN, P SRINIVAS, K SREENIVASA RAO, CVKVP JAGANAATHA RAO, G SRINIVAS, J NARENDRAN

NRSA has carried out mapping of entire Maldives at 1:25000 and sixteen selected islands at 1:1000 scale for the first time in the history of Maldives. Many organizations and firms tried in the past to map the Republic of Maldives and they ended in failures.

The highlights of the project are

1. Establishment of a reference network in WGS-84 datum for Maldives.
2. Pre-targets & KGPS were effectively implemented.
3. Aerotraingulation for atolls, which is a group of scattered islands, was a very difficult task. We have gained valuable techniques and knowledge to carry out aerotriangulation and block adjustment for a difficult terrain.
4. Mapping numerous tiny islands and its environs was a unique mapping experience.

NRSA due to its vast experience in the area of mapping, took this task as a challenge, planned and executed each and every step carefully in a systematic manner and successfully completed the project in time.

What's Trending in GIS?

Seven Tech Takeaways from the 2015 Esri User Conference Plenary Session

More than 16,500 people from 130 countries who work with GIS technology attended the 2015 Esri User Conference, which Esri hosted last July in San Diego, California. They came for a multitude of reasons: to get new ideas on how to put GIS to work at their organizations; to dig deep into the technology at the popular tech sessions; to ask Esri staff questions; and to brush up on their skills using Esri ArcGIS at the Hands-on Learning Lab. While it's impossible to recapture the spirit of personally interacting with peers, trying out GIS apps, and watching live demonstrations, the following seven takeaways from the conference's Plenary Session will steer you toward technology you can try out now or what you should keep an eye out for in the very near future:

R – ArcGIS community launches on GitHub

Esri just launched the R - ArcGIS Community on GitHub. The new initiative's goal is to build a collaborative community for R and ArcGIS users. R is an open source programming language for statistical analysis. "Now R users can directly access all their organization's GIS data, and ArcGIS users can directly integrate R into their geoprocessing workflows," said Esri's Steve Kopp. Watch Kopp's presentation, Statistical Integration with R.

Analyze very big data with ArcGIS

Mansour Raad, a senior software engineer for Esri, gave the audience a sneak preview of Esri's Big Data GeoAnalytics extension for ArcGIS for Server, which is scheduled for release next year. He showed how Big Data GeoAnalytics was used to analyze where to plant 87 varieties of corn hybrids sold by Indiana-based seed company Beck's Hybrids based on soil type, a specific time window, and heat and soil moisture. This added up to 300 billion spatial and temporal calculations. "We did these calculations in 10 minutes. Pretty impressive," Raad said. "When small seeds are analyzed using Big Data GeoAnalytics, it yields big understanding. We believe Big Data GeoAnalytics will unleash new ways of looking at our world that we have never seen before." Watch the demonstration.

Buzz builds for Esri App for Drone Imagery

Esri's Tony Mason previewed Esri's soon-to- be released mapping app for drones, which he said "streamlines the processing of drone data." Within 83 minutes of collecting still imagery of the Oatlands Historic House and Gardens in Leesburg, Virginia, with a drone, the raw data from a Secure Digital (SD) memory card was loaded, verified, processed, turned into a tile cache, and shared via an ArcGIS Online portal. "The app built a stunning mosaic from hundreds of images collected by the drone," Mason said. "The imagery is so detailed, you can even see individual plants." See how the imagery looks in ArcGIS.

Vector tiles are coming soon

Esri's Nate Bennett got the audience up to speed on the fast, responsive vector tiles. "Data is prerendered at various map scales, cut into tiles, then cached for quick delivery," he told the crowd at the Esri UC, as he showed an example of vector map tiles on-screen. "This looks like a regular raster base mount. But it's not. As the map rotates, watch the labels dynamically orient." Very cool! See vector tiles in action.

Start making Apps with AppStudio for ArcGIS

Esri's Ismael Chivite, Sathya Prasad, and Elvin Slavik demonstrated how to create native apps for multiple platforms quickly using the configurable application templates and other functionality in the new AppStudio for ArcGIS. Best of all, there's no coding required. AppStudio for ArcGIS is now in beta. View the demonstrations.

Choose from ArcGIS Ready-to-Use Apps

Chivite also introduced Esri's lineup of ready-to-use ArcGIS apps in an entertaining app speed dating session, complete with songs performed by an app rapper and a country singer. The apps include Operations Dashboard for ArcGIS, Navigator for ArcGIS, Explorer for ArcGIS, ArcGIS Pro, and Web AppBuilder for ArcGIS. All the apps are available today, so watch the video and then decide: Which app or apps do you want to use?

See what's popular in the world of web GIS

Esri's technology evangelist Bern Szukalski walked the audience through top trends in web GIS, including the establishment of public and private portals for geospatial information, the growing amount of authoritative content that's available through sources such as the Living Atlas of the World, and easy-to-use analysis tools and smart mapping capabilities such as data-driven web cartography available in ArcGIS Online. Watch the entire demo.

Want to attend next year's Esri User Conference? First save the dates June 27-July 1, 2016, and visit the conference website regularly for registration information and other updates.

– Carla Wheeler, Esri

Handheld and SOTI alliance

Handheld Group, a leading manufacturer of rugged mobile computers, and SOTI, the world's leading provider of Enterprise Mobility Management (EMM) have announced a strategic alliance. Certification of Handheld's devices within the SOTI OEM partner program enables Handheld's reselling partners to offer SOTI's advanced technology to quickly provision devices, content and applications without end user intervention or downtime. Handheld chose SOTI based on the company's vertical expertise and device control. *www.handheldgroup.com*

Intergraph Acquires IPR to NZ Police OnDuty Mobile App

Intergraph has acquired the Intellectual Property rights to OnDuty, a new suite of mobile applications developed in collaboration with New Zealand Police. Under this first-of-its-kind agreement for New Zealand Police, Intergraph Security, Government & Infrastructure (SG&I) will further develop and take to market the OnDuty suite to public safety agencies beyond New Zealand. Once commercialized, New Zealand Police would receive royalties for further technology investment and innovation.

OnDuty is expected to help streamline workflow and reporting, and provide greater collaboration, thereby optimizing police time and productivity. It is designed to provide unified access to information from various police systems. OnDuty allows officers to easily receive alerts, view information, update statuses, complete paperwork and attach multimedia files from their mobile devices in the field without having to return to station. *www.intergraph.com*

Indoor Mapping Project Attracts Funding from Google

School of Information Studies (iSchool) Assistant Professor Yun Huang has received funding from Google's Faculty Research Awards Program that will help her continue research on an indoor mapping project. The award of $38,514 is for Dr. Huang's work on the research initiative, "General University Feed specification (GUFS) for Google Indoor Map.

Improving awareness about and potential uses of facilities to enhance learning is the basis for Dr. Huang's concept for creating a system to better map indoor environments, capabilities, and resources, she said. In developing the idea, she wondered how much people know about and understand the unique details of their indoor environments, as well as being aware of all the resources that are available in their surroundings, such as the centers and buildings where they work and study on a daily basis, she explained. That cognizance is a facet of location awareness that is especially useful in learning environments such as college campuses, and also of interest to a company such as Google, the professor noted. Her model offers a system that proposes to capture how people use and interact with indoor resources and information for different kinds of learning interactions. *https://ischool.syr.edu/articles/news/*

MapmyIndia Launches SafeMate, a GPS-Based Personal Safety Device

MapmyIndia, has launched SafeMate, a dedicated personal safety device for women, children, and families. Weighing just 50 grams, it is a matchbox-sized device that can fit in a school bag, purse, or pocket, and uses its built-in GPS and Internet connectivity to securely transmit live locations to the mobile phone and desktop. An SOS button can be pressed in case of an emergency, which sends an email and SMS alerts to designated people.

OriginGPS gets $1.75m funding

OriginGPS, a manufacturer of miniature GNSS solutions, has closed US$1.75 million of funding from existing shareholders and the technology accelerator, Lab IX.

Lab IX is a part of Flex, a sketch-to-scaleT solutions company that designs and builds intelligent products for a connected world. *www.m2mnow.biz*

New Tsunami Scenarios for Indonesian Early Warning System

The recent earthquake and tsunami in Chile showed once again how important a precise early warning system is. Scientists of the Alfred Wegener Institute are supporting Indonesians in creating new tsunami scenarios for the northeast of the archipelago. The Australian-Indonesian Facility for Disaster Reduction initiated the project and provides a Linux cluster with 212 compute cores for the simulations in the Indonesian capital of Jakarta. This corresponds to the computing power of 50-100 typical workstation PCs.

The Indonesian early warning system was developed and installed by a team of German scientists, led by the German Research Centre for Geosciences (GFZ), after the devastating tsunami of 2004.

At the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) a simulation code "TsunAWI" and also a database of 4,400 detailed scenarios for possible earthquakes with magnitudes from 7.2 to 9.0 in the Sunda Trench were developed. In case of a warning there is access to a very fast and simple real-time simulation which estimates the warning level well. However, this simulation is much coarser and doesn't allow for example a detailed look at individual stretches of coastline or the possible flooding.

Red Cross Offers Interactive Tool to Access and TrackLive, Wildfire Info

The American Red Cross has launched an interactive online map that consolidates multiple sources of disaster data into a real-time, interactive tool to get information and updates about the Western Wildfires. The tool is a high-tech, user-friendly visual database for media and the public to learn the size and scope of current disasters and locate services such as Red Cross shelters. The Red Cross "Map Journal" pulls together in one location multiple layers of GIS data from the Red Cross and government sources. The Map Journal leverages the power of Esri's ArcGIS Online Technology to create a customizable web mapping application that is also mobile friendly.

Cadcorp launches Notice Board™

Cadcorp, has launched Notice Board™, a responsive smart searching product for local government websites. Notice Board enables a local authority to add a mobile-friendly spatial searching capability to their existing website. Cadcorp has developed the product on the premise that many people who visit a council website, are not browsing, but are looking for information about a particular locality – very often their home address or current location. *http://cdcp.io/nbd*

UN-GGIM: Europe offers inspiration for global data delivery

European initiatives to deliver harmonised dependable geospatial information could help provide a global solution to meet demand for interoperable data, says UN-GGIM: Europe. The workshop, part of the fifth session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM), demonstrated how Europe is managing, sharing and distributing harmonised, dependable and seamless geospatial information across boundaries.

It highlighted how the INSPIRE Directive provides a framework for cooperation to ensure compatibility between national spatial data infrastructures (SDI) whilst the European Location Framework provides the practical means for delivering operational cross-border data and pan-European services. The side event, at UN Headquarters in New York, featured speakers from the European Commission, Belgium, Norway and Slovenia as well as UN-GGIM: Europe and attracted a global audience from other UN-GGIM regional committees.

Esri Partners with U.S. Census Bureau

In support of the U.S. Census Bureau's launch of its free online tool Census Business Builder, Esri has committed to provide data and mapping capabilities to small-business owners that help guide their research for opening a new business or expanding their existing business. The Census Business Builder is one of the first applications combining American Community Survey (ACS) data, Demographic and Economic Statistics along with Esri consumer spending data in a shared services managed cloud environment. It blends all data sets into one seamless application by leveraging Esri's ArcGIS platform.

StreetMapperIV from 3D Laser Mapping

The new 'StreetMapperIV' mobile mapping system has been launched. StreetMapper first came onto the market in 2004, driven by client demands to survey roads and structures above the road with unparalleled safety, speed and accuracy. What resulted was a first-of-a-kind system from 3D Laser Mapping, paving the way for mobile mapping systems to come. The original StreetMapper system used four Riegl laser scanners and the best commercially available IMU at the time. The technology was a game-changer for its day, but one which needed to be refined to reach the needs of ever changing modern markets. Alternative versions were developed in 2010 and 2012.

Dr G Satheesh Reddy Conferred Royal Aeronautical Society "Silver Medal"

The Royal Aeronautical Society (RAeS), London conferred Dr. G Satheesh Reddy, Scientific Adviser to Raksha Mantri and eminent Missile Scientist of DRDO with the prestigious Silver Medal. He was given this medal in recognition of his contributions as one of the leading navigation and avionics experts, under whose leadership India has developed state-of-the-art avionics sensors and systems for key national strategic programmes and other defence applications. His pioneering contributions in promoting Aerospace and Aeronautics in India were also acknowledged.

Scientists win $6.4 million to crack the code of smell navigation

A team of scientists, including a UC Berkeley pioneer in odor mapping, has received a $6.4 million grant from the National Science Foundation to dig deeper into how humans and animals navigate by using their sense of smell and converting odors into spatial information.

Death's head roaches will be among the insects whose smell navigation skills will be studied as part of a project just funded by the National Science Foundation. The NSF awarded $15 million to three interdisciplinary teams of scientists to "crack the olfactory code" as part of President Obama's BRAIN initiative.

"Olfaction is one of the last frontiers of neuroscience, the least understood of the five senses, so this is a big win," said UC Berkeley psychologist Lucia Jacobs, one of 30 researchers who hashed out ideas and presented research proposals at the NSF's Ideas Lab in Virginia in June. "We can create a virtual olfactory landscape for the animals and see how they respond behaviorally and in terms of neural activity," she added. *http://news.berkeley.edu/*

The system "ERA-GLONASS" is in the standard equipment of LADA Vesta

LADA Vesta is the first stock car in Russia which works in the emergency alert system "ERA-GLONASS". The system is designed to transmit a signal about the accident and other incidents to emergency services. When a car gets into an accident, the terminal installed in the vehicle automatically determines its location and through mobile communication channel transmits to the "ERA-GLONASS" an information about exact coordinates, time and severity of the accident, as well as the VIN-number of the car – to the System-112, or to the duty of the Ministry of Internal Affairs. *www.tltnews.net*

Mini RTK Receiver for UAS and Mobile Platform

SkyTraq Technology Inc. has introduced S2525F8-BD-RTK, a cost effective, low power, small size, single frequency RTK receiver for unmanned aerial systems and mobile platforms requiring centimeter-level position accuracy. It is a multi-constellation GNSS RTK receiver that supports GPS, BDS, QZSS, and SBAS; simultaneously tracks up to 28 satellites. Its 25mm x 25mm form factor, 300mW power consumption, and 3 gram weigh makes it ideal for any outdoor applications requiring high precision RTK positioning. *www.skytraq.com.tw*

Brazil and Russia Boost Space Cooperation with New Glonass Station

The decision was announced at the end of the ninth meeting of a Russia-Brazil intergovernmental commission on scientific and technological cooperation. The two countries have been looking to boost space cooperation, with Glonass as a focal point.

Russia has targeted Cuba and Brazil to host Glonass stations in the Western hemisphere. Stations have already been established in Brazil and Antarctica, but nowhere else. *www.themoscowtimes.com*

Joint Satellite Navigation System Receiver by Russia & China

Russia and China are negotiating the development of a joint four-system satellite navigation receiver which would include access to China's BeiDou satellite navigation. Currently, navigation receivers are either dual-system, including access to Russia's Glonass satellite navigation and GPS, or three-system, which also include EU Galileo satellite navigation. The creation of a four-system navigation receiver would be a new market niche for Russia and China to fill. *http://sputniknews.com*

Railways, ISRO tie-up for improving safety

Indian Railways will join hands with ISRO to get online satellite images for improving safety and enhancing efficiency. "We will undertake a massive exercise of GIS mapping of the entire rail route and assets including buildings, land, workshops and other facilities in the network using geospatial technology," said a senior Railway Ministry official involved with GIS mapping project.

The official said geospatial services will be available from satellite-assisted navigational support through the GPS aided geo-augmented navigation (GAGAN) system of ISRO. The MoU will facilitate getting images and communications through the satellite system. While the images will help in mapping the area, communications will enable the introduction of Wi-Fi service in trains in a larger way. *http://www.thehindu.com/news/*

Applanix introduces two new direct georeferencing solutions

Applanix Corporation introduced today two new solutions to its POS LV™ (Position and Orientation Solution for Land Vehicles) portfolio, the POS LV 125 and the POS LVX. With these additions, Applanix offers high-performance solutions for a wide cross-section of land-based applications, including large fleet mobile mapping, autonomous vehicle guidance and field robotics applications. It is a compact, fully integrated, turnkey position and orientation system, utilizing integrated inertial technology to generate stable, reliable and repeatable positioning solutions for land-based mobile mapping and guidance applications.

senseFly's global service network

senseFly's global service network, Drone Connector, now features over 700 professional drone operators, connecting these operators with organisations that require their help to produce geo-referenced imagery and data products. Created just six months ago, it spans over 90 countries right around the globe. Operators provide services across fields as diverse as land surveying, agriculture, GIS, mining and more. The service is free of charge to both parties — the end client and the drone operator they choose to use. *www.DroneConnector.com*

TopoDrone-4Scight

The TopoDrone-4Scight is an easy-to-use multi-rotor accurate mapping drone, which will complement the capabilities of the TopoDrone-100 fixed-wing mapping drone. It easily collects photogrammetric mapping data of unprecedented accuracy (20mm horizontal and better than 25mm vertical) for rapid integration into a wide range of industries including Surveying, Urban Mapping, Civil Engineering, Mining, Agriculture, Bridge and Dam Wall Mapping, Post Disaster Mapping and other industries. *www.dronemetrex.com*

New optical RS satellites out of Thales Alenia Space and CNES partnership

Thales Alenia Space and French space agency Centre National d'Etudes Spatiales (CNES) are jointly conducting a feasibility study on developing a high-resolution, optical remote sensing satellite system. The new system will be a successor to the Pleiades satellites in the next decade. Pleiades comprises two optical Earth-imaging satellites that provide images for defence purposes, as well as civilian purposes with a repeat cycle of 26 days. Beginning in the second half of 2016, the partners will identify an optimal design for the new system, and select appropriate technologies to be applied.

Under a co-contractorship with Airbus Defence & Space, Thales will oversee design selection for the satellites, as well as the payloads and associated systems. *www.aerospace-technology.com*

China launches Gaofen-9 remote sensing satellite

China conducted its second launch in a 37-hour time span by blasting off a Long March 2D rocket with the Gaofen-9 Earth observation satellite. The lift-off took place at 12:42 a.m. EDT (04:42 GMT) on Sept. 14, from the Launch Area 4 at the Jiuquan Satellite. The Chinese *Xinhua News Agency* reported that the Gaofen-9 spacecraft is a remote sensing satellite, capable of providing photographs with a resolution of less than 1 meter (3.3 ft.). It will be used in land survey, urban planning, road network design, agriculture, and disaster relief.

"Developed by the Shanghai Academy of Spaceflight Technology, Gaofen-9 can also serve key national strategies such as the Belt and Road Initiative and national defense," Xinhua added. *www.spaceflightinsider.com*

Aibot^{X6} Version 2

Aibotix GmbH has presented a new solution for high-precision surveying with Version 2 of its hexacopter Aibot^{X6}: High Precision GNSS. The precision and quality of the surveying data can be significantly improved by using RTK technology on the basis of the SmartNet (Leica Geosystems AG) correction data service. Post-processing is also a possible alternative. *www.aibotix.com*

Trimble Indoor Mobile Mapping System

Trimble® Indoor Mobile Mapping Solution (TIMMS) produces fast and accurate maps of even the most difficult-to-navigate indoor spaces and translates them directly into 2D and 3D models of structured interiors. TIMMS 2 is the optimal fusion of technologies for capturing spatial data of indoor and other GNSS denied areas. It provides both LiDAR and spherical video, enabling the creation of accurate, real-life representations of interior spaces and all of their contents. *www.trimble.com*

Rockwell Collins wins DARPA award

Rockwell Collins has been selected by the Defense Advanced Research Projects Agency (DARPA) to develop technologies that could serve as a backup to GPS. The research, being conducted as part of DARPA's Spatial, Temporal and Orientation Information in Contested Environments (STOIC) program, aims to reduce warfighter dependence on GPS for modern military operations. *www.rockwellcollins.com*

VeraPhase™ 6000 by Tallysman™

Tallysman has announced the commercial availability of the outstanding VeraPhase™ 6000 antenna Series. This family of antennas provides the lowest axial ratios (horizon to horizon, through all azimuths) across all GNSS frequencies (<0.5dB at zenith, <2 dB at horizon), great front to back ratios at all elevations, high efficiency (>70%), a tight PCV (± 1mm through all frequencies, azimuths, and elevations), and a consistent PCO through all frequencies. *www.tallysman.com*

Septentrio announces the AsteRx-U

Septentrio has launched two successors to the highly successfully APS-U. The AsteRx-U and the AsteRx-U Marine are multi-constellation dual antenna receivers which incorporate the latest GNSS tracking and positioning algorithms and interference mitigation. *www.septentrio.com*

Two new products for the SAILOR satcom range

Both the SAILOR 656X GNSS and new SAILOR 657X DGNSS are black-box products designed to be part of an eco-system that the company refers to as its'Multi-Function Universe'. The touch-screen SAILOR 6004 control panel forms the heart of this 'universe', providing full control for all products connected to it from a single device. These two products join the already available SAILOR 6391 Navtex and SAILOR 628X AIS as new generation products designed to work with the SAILOR 6004 control panel. *www.tankeroperator.com*

Smallest MediaTek Multi-GNSS Module

GlobalTop Technology has launched FireFly X1, the smallest MediaTek-based Multi-GNSS module in the world. With an ultra-compact size of 9.0 x 9.5 x 2.1 mm, it's one of the smallest Multi-GNSS modules in the industry. It uses the latest MT3333 engine with full support for GPS, QZSS, Glonass, Beidou and is also Galileo ready. *www.gtop-tech.com/*

Trimble Transforms Satellite Data into Intelligence

Trimble® Remote Sensing Suite is a new software suite that enables geospatial professionals to efficiently extract high-quality information from satellite imagery for environmental,

Spectra Precision Introduces New and Enhanced Survey Solutions

Spectra Precision introduced new and enhanced products to its Spectra Precision® portfolio of survey solutions. It includes

FOCUS 35 RX – A new range of motorized total stations providing high-speed, accuracy and precision in measurement. Its robotic instrument moves the power of the observer from the instrument to the range pole, improving efficiency.

Nomad 1050 Data Collector – The Nomad 900 has been updated with new features and capabilities. The Nomad 1050 has more RAM, more Flash and more speed. The base processor is now 1 GHz compared to 806MHz on Nomad 900 and the Nomad 1050 has 512MB RAM and 8GB flash storage.

Survey Pro 5.7 Field Software – It contains significant changes to enable more productive field data collection. Included in this update are new map displays that enable viewing and managing most of the map features that are located on the main map display. The GNSS and robotic staking screens can also display a map view to include background maps along with the standard dynamic guidance control option.

Survey Office v3.60 Software – It now includes enhanced functionality; support for the Spectra Precision FOCUS DL-15 Digital Level and the import of leveling data from any DiNi level; least squares and 5 and 7 parameter Helmert transformations with reports; Geoid 12B support and grouping by country in the Coordinate System Manager; Point Cloud support.

MobileMapper Field GIS Application for Android Devices –This new software is dedicated to GIS data collection and focuses on simplicity to maximize the number of field personnel contributing to the geospatial business. Primarily for MobileMapper 300 users, the application will be the key component of Spectra Precision's Bring Your Own Device (BYOD) solution. *www.spectraprecision.com*

urban planning, agriculture, oil and gas, mining and engineering applications. It is a powerful combination of Inpho® SATMaster module for satellite imagery processing and eCognition® software for object-based feature extraction.

Hemisphere GNSS Introduces Atlas, AtlasLink

AtlasLink, the multi-GNSS, multi-frequency smart antenna, is preconfigured to receive corrections from the new Atlas platform. The bundled AtlasLink solution provides users worldwide with the easiest way to utilize Atlas corrections — either directly from AtlasLink, or on their existing receivers via innovative new technologies built into AtlasLink. It offers innovative and accessible correction service options, providing leading performance in demanding applications and environments. Available today through various subscription and bundle options, it is a flexible correction service with correction data delivered via L-band satellites or over the Internet at accuracy levels ranging from meter-level to sub decimeter-level.

PCTEL launches new GNSS Micro Helix Antenna Series

PCTEL, Inc. has announced the commercial availability of its GPS/GLONASS high performance asset tracking and synchronization helix antennas. These antennas capture the frequencies needed for GPS, Galileo, and GLONASS satellite reception. This cross-compatibility allows global OEMs to use one standard platform to serve both European and U.S. markets. *www.antenna.com*

New Leica Viva GS14 GNSS Boosts Field Connectivity

Leica Geosystems is taking a big step in GNSS with the addition of a new hybrid communication technology to its Leica Viva GS14 GNSS. It now supports Verizon CDMA solutions, along with all standard 2G/3G networks and UHF TX/RX radio in a single device. Users simply slide in their SIM card to experience instant connectivity for faster and easier field communications and SmartNet RTK corrections.

Telit SE873

Telit has introduced the Jupiter SE873, currently the most advanced GNSS module on the market. This complete GNSS receiver is packaged in a 7 x 7 x 1.85 mm QFN module and includes SQI Flash memory, an integrated Low Noise Amplifier (LNA), SAW filter, and Real Time Clock (RTC). It supports Assisted GPS plus SBAS which improve Time-To-First-Fix and position accuracy.

Rx Networks Announces location.io

Rx Networks Inc. has launched location.io, a feature-rich, highly modular location platform. Location.io enables advanced, seamless indoor and outdoor positioning whether for mass market consumer devices, IoT devices, or specialized, high-accuracy applications. *www.prweb.com*

Teledyne Optech launches Lynx SG-S mobile surveying solution

Teledyne Optech announced the addition of the Optech Lynx SG-S system to its line of Lynx mobile survey systems. The Lynx SG-S dramatically raises the bar for absolute data accuracy with mid-range mobile lidars. Boasting a high-performance lidar sensor combined with the industry-leading Optech LMS Pro software, high performance inertial navigation system, and deeply integrated Ladybug 5 camera, it is built for surveyors conducting demanding, high-performance projects. To improve portability and avoid time-consuming boresight routines, all these components are mounted on a single light-weight platform, letting operators easily move the system from one vehicle to another or even remove it every night for operational security.

PCI Geomatics Releases Geomatica Developer Edition

PCI Geomatics has released the **Geomatica Developer Edition (GDE)**. **It** puts the power of Geomatica into the hands of developers to create innovative and automated solutions and workflows to address complex geospatial image processing challenges. It offers access to all Geomatica modules and extensions, ensuring developers are working with the latest version of the software. **GDE** provides Python level access to over 550 algorithms as well as core Geomatica functionality such as rasters, coordinate systems, metadata, control points, math models and raster elevation data.

YellowScan – Lightest all-in-one LiDAR system

Since its commercial launch in 2014, YellowScan® has been used extensively on multiple UAV platforms in order to meet customer demands and various mission requirements. It flew over numerous geographical and topographical regions, capturing high-precision geo-referenced land surface volumes and relief, even through vegetation. Delivering highly accurate measurements in a very short time, the it is used by surveyors and researchers all over the world for a variety of applications, including 3D cartography, topography, linear infrastructure maintenance, civil engineering, geology, mining, forest management, and archeology.

New Generation 3D Indoor Scanning System by SBG SYSTEMS and VIAMETRIS

SBG SYSTEMS joins VIAMETRIS to present the new generation of the "iMMS", called now "iMS 3D", a mobile 3D indoor scanner generating continuous 3D point clouds. For this brand new model, VIAMETRIS chose SBG SYSTEMS' miniature AHRS, the Ellipse-A. With its brand new design, the iMS 3D is easier to transport, install, and set up. The iMS 3D also integrates new sensors including the Ellipse-A from SBG Systems. Based on the SLAM technology, the iMS 3D is equipped with three LiDARs profilers, each taking 40,000 points per second. The main LiDAR provides the horizontal profile, which also contributes to the continuous calculation of the iMS 3D position in the building. The other two lateral LiDARs give vertical profiles including the ceiling.

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Joint International Geoinformation Conference
28 - 30 October
Kuala Lumpur, Malaysia
www.geoinfo.utm.my/jointgeoinfo2015/index.html

November 2015

ICA European Symposium on Cartography
10 - 12 November
Vienna, Austria
http://eurocarto.org/

IMIA Asia Pacific Conference
15-17 November
Brisbane, Australia
www.imiaconferences.com/ap

International Technical Symposium on Navigation and Timing
16 - 17 November
Toulouse, France
http://signav.recherche.enac.fr

ISGNSS 2015
16 - 19 November
Kyoto, Japan
http://www.isgnss2015.org/

Drone World Expo/MAPPS Conference
17 - 18 November
San Jose, CA United States
www.droneworldexpo.com

HxGN LIVE
18-20 November
Hong Kong
http://hxgnlive.com/las2015

GEOTECH RWANDA
18 - 20 November
Kigali - Rwanda
www.geotechrwanda2015.com/

International Workshop on the Role of Land Professionals and SDI in Disaster Risk Reduction
25-27 November
Kathmandu Nepal
www.workshopnepal2015.com.np

December 2015

Esri India User Conference
2 - 4 December
New Delhi, India
http://www.esri.in/events

7th Multi-GNSS Asia (MGA) Conference
7 - 10 December
Brunei Darussalam
www.multignss.asia/workshop.html

The Geoinformation Technologies for Natural Hazards Management (7th GiT4NDM)
8 - 10 December
UAE University
http://conferences.uaeu.ac.ae/eogc-git4ndm/en/index.shtml

9th International Symposium on Mobile Mapping Technology (MMT 2015)
9 - 11 December
UNSW, Sydney, Australia
www.mmt2015.org

XXXV INCA International Conference
15- 17th December
New Delhi, India
www.inca35newdelhi.org/

February 2016

EuroCOW 2016 Workshop
10 - 12 February
Lausanne,Switzerland
www.eurocow.org

March 2016

Munich Satellite Navigation Summit 2016
1 - 3 March
Munich, Germany
www.munich-satellite-navigation-summit.org

April 2016

IGRSM 2016
13 - 14 April 2016
Kuala Lumpur, Malaysia
http://www.igrsm.com/igrsm2016

May 2016

FIG Working Week 2016
2 - 6 May
Christchurch, New Zealand
www.fig.net/fig2016/call.htm

10th Annual RIN Baska GNSS Conference
8 - 10 May
Baska, Krk Island, Croatia
www.rin.org.uk

NAVITECH 2016
10 - 13 May
Moscow, Russia
www.navitech-expo.ru/en/

European Navigation Conference
30 May - 02 June
Helsinki, Finland
www.enc2015.eu

June 2016

6th International Conference on Cartography & GIS
13-17 June
Albena, Bulgaria
www.iccgis2016.cartography-gis.com

2016 Esri International User Conference
27 June to 1 July
San Diego, USA
www.esri.com

September 2016

ION GNSS+ 2016
12 - 16 September
Portland, Oregon USA
www.ion.org

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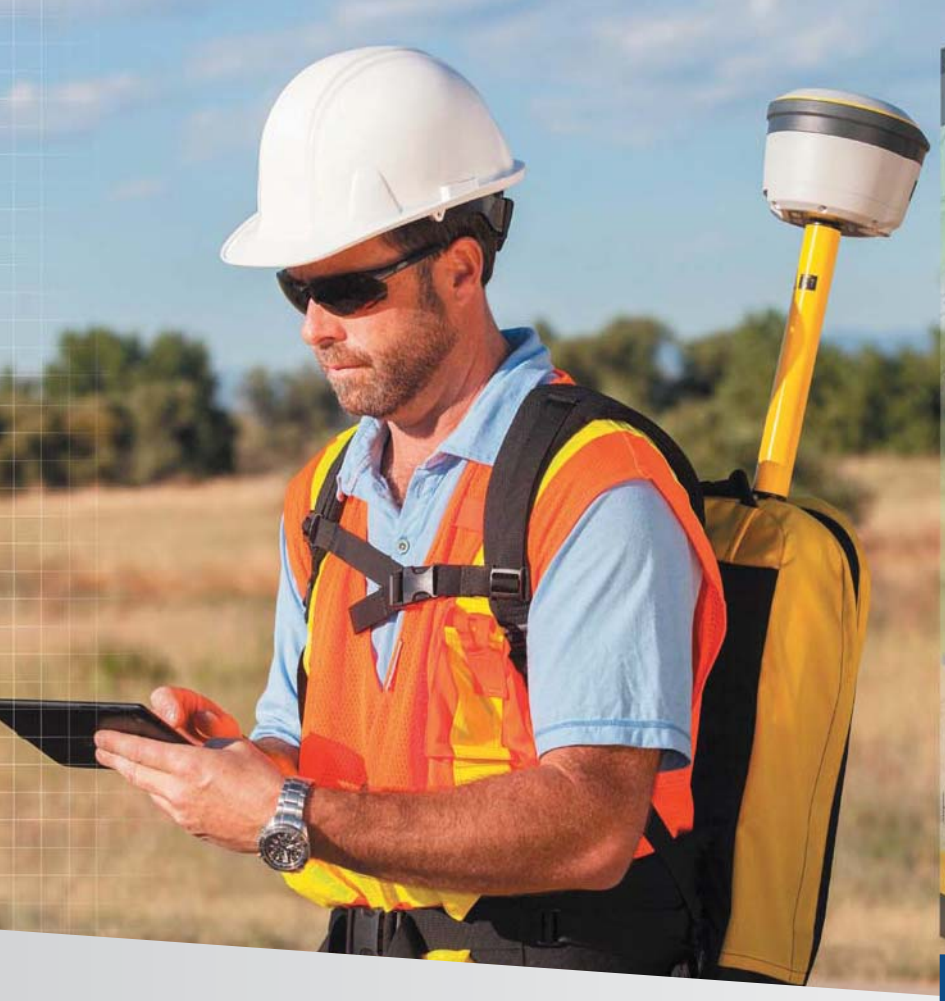

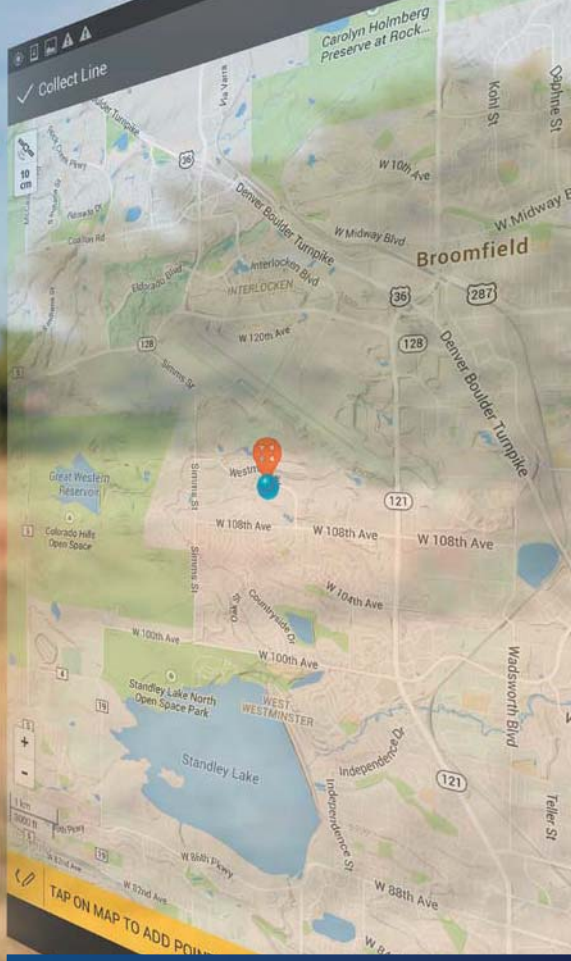

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