NSDI KOREA 2008
2008 디지털국토엑스포
NATIONAL SPATIAL DATA INFRASTRUCTURE

The 12th International Seminar on GIS

NSDI Policy for National Spatial Data Integration

Korea Research Institute for Human Settlement
Korea National Housing Corporation

History of International Seminar on GIS

	Theme	Date	Place	Organizing Committee	
				Chair	Member
1st (1996)	Strategies for NGIS Development	4.18-19	Seoul Education & Culture Center, KRIHS	Young-Pyo Kim, Director, Geospatial Information Center	Woo-Seok Cho, Mi-Jeong Kim
2nd (1997)	GIS Applications in the Public Sector	10.16-17	Seoul Education & Culture Center	Young-Pyo Kim, Director, Geospatial Information Center	Yong-Bok Choi, Mi-Jeong Kim
3rd (1998)	GIS Development Strategies for the 21st Century	9.10-11	Renaissance Seoul Hotel	Young-Pyo Kim, Director, GIS Research Center	Mi-Jeong Kim, Sung-Mi Park
4th (1999)	GIS in Local Government	9.16-17	Renaissance Seoul Hotel	Young-Pyo Kim, Director, GIS Research Center	Mi-Jeong Kim, Sung-Mi Park, Hong-Jun Choi
5th (2000)	Toward a Knowledge-based Society: NGIS Policy and Technological Development	9.28-29	Ritz-Carlton Seoul Hotel	Young-Pyo Kim, Director, GIS Research Center	Sung-Mi Park, Hong-Jun Choi
6th (2001)	Present and Future of GIS Technologies	5.17-18	Seoul Education & Culture Center	Young-Pyo Kim, Director, GIS Research Center	Sung-Mi Park,
7th (2002)	GIS Workshop & Seminar	11.8	COEX Intercontinental Hotel	Hyung-Min Yeom, Director, GIS Research Center	Dong-Han Kim
8th (2003)	Envisioning Cyber-geospace and Spatially enabled E-government	11.20-21	COEX	Young-Pyo Kim, Director, GIS Research Center	Jung-Hoon Kim, Dong-Han Kim, Seung-Mi Hwang, Ki-Hwan Seo
9th (2004)	Emergency and Disaster Response with GIS	9.8-9	Seoul Education & Culture Center	Young-Pyo Kim, Director, GIS Research Center	Jong-Taek Park, Dong-Han Kim, Ki-Hwan Seo
10th (2005)	NGIS Policy in Ubiquitous Computing Environment	11.14-15	Seoul Education & Culture Center	Byoung-Nam Choe, Director, GIS Research Center	Jung-Hoon Kim, Dong-Han Kim, Jung-Yeop Shin Jin-Hyeong Park
11th (2007)	Collaborative GIS toward the Geospatial Information Society	10.24	KRIHS	Ho-Sang Sakong Director, Geospatial Information Research Center	Jung-Hoon Kim Young-Joo Lee Jae-Il Han
12th (2008)	NSDI Policy for National Spatial Data Integration	10.9	KINTEX	Ho-Sang Sakong Director, Geospatial Information Research Center	Jung-Hoon Kim Chun-Man Cho Mi-Jeong Kim Hae-Kyong Kang

Seminar Program

08:00～09:00	Registrations
09:00～09:50	Plenary Session

Session 1 National Policy for Spatial Data Integral Utilization

10:00～10:30	Can Japan Change the Geospatial Information Business after NSDI Law?: Through the Cooperation Act among Industry, Government and Academia [Dr, Yoshihide Sekimoto, University of Tokyo]
10:30～11:00	The Canada NSDI Experience: Policy and Implementation [Dr.David Coleman, University of New Brunswick]
11:00～11:30	Strategy for NSDI Integration in Korea [Dr. Mi-Jeong Kim, KRIHS]
11:30～12:10	Panel Discussion 1. (chair) Kye-Hyun Kim, Inha University 2. (discussant) Yun-Soo Choi, University of Seoul 3. (discussant) Ho-Sang SaKong, KRIHS
12:10～13:30	LUNCH

Session 2 Spatial Data Integration and Common Use in Local Government

13:30～14:00	From the Descriptive NSDI toward Prescriptive NSDI [Dr. Eun-Hyung Kim, Kyungwon University]
14:00～14:30	Integrated GIS Approach in Local Government: As A Case Study in Gift Prefecture in Japan [Dr. Hiromichi Fukui, Keio University]
14:30～15:00	Local Spatial Data Infrastructure: Building Spatial Data, Next Year's Great [Kwon-Han Lee, Korea National Housing Cooperation]
15:00～15:30	One-Click Spatial Data Warehouse for Geographic Information [Su-Cheon Kim, Daejeon City]
15:30～16:10	Panel Discussion 1. (chair) Myung-Hee Jo, Kyungil Univ. 2. (discussant) Hyung-Keum Nam, Daegu City 3. (discussant) Han-Joo Lee, Korea National Housing Cooperation 4. (discussant) Myeong-Jun Yu, Korea Local Information Research & Development Institute
16:10～16:30	Coffee Break

Session 3 Methodology & Technology for Spatial Data Integration

16:30~17:00	The Key Strategies of Spatial Data Integration in Response to System Re-implementation Cycle [Dr. Eun-Mi Chang, KSIC, Chief Strategy Officer, PhD.]
17:00~17:30	Development of Service Platform for integrating GIS Systems [Chang-Hun Lee, LBS Plus]
17:30~18:00	Sharing Geographic Knowledge: Towards a Services-Oriented Approach [Dr. Bill Shepherd, ESRI Asia]
18:00~18:40	Panel Discussion 1.(chair) Woo-Sug Cho, Inha Univ. 2.(discussant) Dong-Hun Han, Ministry of Environment 3.(discussant) Jong-Hyun Park, ETRI

Profile

Dr. Yoshihide Sekimoto

Yoshihide Sekimoto is an associate professor of Center for Spatial Information Science (CSIS), the University of Tokyo, Japan, since 2007. He got a doctor of engineering from the University of Tokyo in 2002. Then, he had worked for National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport, Japan, from 2002 to 2007.

He specialized in civil engineering. Especially, He is a core member of the research initiative for geospatially enabled society in Japan. Research Initiative for Geospatially Enabled Society Project aims to construct the geospatial information infrastructure and foster industries for accomplishing the geospatially enabled society. He is leading and managing many working groups related the geospatially enabled society among government, industry, and academia. Also he conducts many research activities for policy monitoring and recommendations related to NSDI of Japan.

Dr. David Coleman

David Coleman, P.Eng., FCAE is Dean of Engineering and a Professor of Geomatics Engineering at the University of New Brunswick. Prior to obtaining his PhD, he spent 15 years in the Canadian geomatics industry as a project surveyor and engineer, corporate executive and management consultant. Dr. Coleman has authored well over 150 publications and reports dealing with land information policy development, geomatics operations management, geographic information standards and spatial data infrastructure. He is a past President of the Canadian Institute of Geomatics, Fellow of the Canadian Academy of Engineering, a member of two Boards of Directors, three federal government advisory boards, and has acted as a consultant on projects in Canada, Australia, the United Kingdom and South America.

Dr. Mi-Jeong Kim

Mi-Jeong Kim is working for Geospatial Information Research Center at KRIHS(Korea Research Institute for Human Settlements) as associate research fellow. She obtained her Ph.D. degree from the department of geography at the Kon-Kuk University in Korea. Her major research field is land management system and natioanl GIS policy. Now She is focusing in integrating data and GIS systems. Major research works include "Strategy for national integrating information system(2008)", "Methods and strategies for Land Use Regulation Information System(2006-2007)" and "Development of Land Information System(1998-2006)".

Dr. Eun-Hyung Kim

Eun-Hyung Kim is a professor of Kyungwon University at Division of Landscape Architecture & Urban Planning, College of Engineering. He was a GIS Team Leader at Seoul Development Institute(SDI) from 1993 to 1995, a GIS Manager of University of Massachusetts at Amherst from 1886 to 1993 and a GIS Consultant of Havard Design & Mapping Co. in 1990. He obtained Ph.D. degree in Regional Planning at University of Massachusetts at Amherst. He is a member of Steering Committee for the NGIS project and a Korean Head of Delegate to the Technical Committee of the International Standard Organization on Geographic Information/Geomatics (ISO/TC211). His major research area is on NSDI policies, GIS standards, GIS implementations in local governments and recently, Geospatial Web and Ubiquitous City. His papers include A Study on Advanced Model for GIS Implementation in Local Governments(2007), A Study on the Usability of Spatial Information in Urban Integration and Operation System in u-City(2007), A Study on GIS Integration Strategies for the Future u-City Construction(2006), Comparative Study on Advanced NSDIs for the future NGIS Implementation in Korea(2006), A Study on Integration Strategies for e-Government and GIS in Korea(2005), A Study on a GIS ISP Model for Local Govetnments to Overcome the Problems in a Transition Period, In addition, he has published numerous research reports.

Dr. Hiromichi Fukui

Hiromichi Fukui is a professor of Faculty of Policy Management, Graduate School of Media and Governance, and research director of Global Security Research Institute at Keio University. He Joined Keio University in 1996. His current research interests include regional planning, ecological development and global environment issues with emphasis on spatial information sciences. He also has served on Secretary General of GIS Association in Japan, on board of director of Center for Environment Information Sciences, on adjunct professor of Chinese Academy of Science and so on. Before joining Keio Univ., he served as the team leader for Spatial Analysis Team at Sumitomo Trust Banking Research Institutes of Think Tank in Tokyo. He got a Doctor of Science in Earth Sciences from Nagoya University.

He had many experiences on technology transfer projects of JICA and World Bank related bodies, for example; Argentina, Indonesia, Bahamas Thailand and China.

Kwon-Han Lee

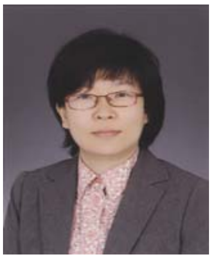
Kwon-Han Lee currently works in the Housing and Urban Information Center, Korea National Housing Corporation. He completed his M.S. degree and is now candidacy for the Ph.D. in the department of Urban Planning at Kyungwon University. He had participated in Land Informatization project among NGIS research programs from 1998 to 2005. In addition, he had worked for ISP (Information Strategy Plan) project at Ministry Land, Transport and Maritime Affairs as a chief adviser from 2006 to 2007. He is currently working at Building Spatial Data Construction project, co-operated with MLTMA.

His research interests include Urban Planning and Urban Renascence (Redevelopment) among other research fields.

Su-Cheon Kim

Su-Cheon Kim currently works as Director of Information Office for Daejeon Metropolitan City Government. He acquired BA in computer science and MA in information and telecommunications. Mr. Kim has led various city government initiated information and computerization projects. He is particularly interested in GIS and has been responsible for the GIS development and management for the City from 2003 through 2008. During this period of time, he successfully implemented many key GIS capacity building projects including 3 dimensional urban design simulation, realtime GIS database updating, development of coordinate transformation program in anticipation of the introduction of the World Geodetic System in 2010, and greatly contributed to the city's GIS development.

Dr. Eun-Mi Chang

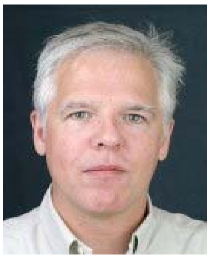


Eun-Mi Chang finished her Ph.D. in geography in University of Kansas in 1997. Samsung SDS was the first place to experience satellite imagery management system and to integrate hydrological models with GIS and various databases. The continuous activities to make public projects comply with GIS standards belong to her consulting realm as a member of ISO/TC 211 Korean national body. Her current interest is disaster management and simulation system for both public and private sector. She is working in KSIC (Korean geoSpatial Information and Communication) as a chief strategy officer and managing international projects for Typhoon Committee Disaster Information System and is training people of Sinsing mine in China for 3-D Disaster Management System. She has also taught environmental GIS and Remote Sensing in Sangmyung University as an adjunct professor since 2004.

Chang-Hoon Lee

Chang-Hoon Lee is working at LBSPLUS Corp. as a chief of the U-TECH laboratory. He has started the GIS with a pilot project of the Underground Facility Information System of GwaCheon in 1996, and after he promoted the Component-based GIS in the UIS of Busan and the Road Management System of Seoul. He has a lot of interest about development of the GIS product providing all from a Spatial Database Engine to a Client Application by the pure domestic technology. He also expects inducting and applying standard GIS to various fields to be acknowledged as a valuable GIS. Now the U-TECH Laboratory is researching and developing about Server and Client GIS products that using GIS Core Objects based on standard; therefore he is considering the organized approaching about it as a chief of Laboratory.

Dr. Bill Shepherd



Bill Shepherd is the Senior Manager for Strategic Business Development for ESRI Asia, the regional office of ESRI in Asia Pacific, located in Singapore. ESRI is the world's leading GIS technology company. ESRI Asia provides assistance to ESRI's country offices, business and industry partners and strategic clients throughout the region.

Bill has lived and worked in Asia for many years. He has a broad background in the application of GIS technology to a wide variety of industries and application areas. In his current role, Bill assists clients and partners in conceptualizing, architecting, and implementing systems that utilize the full capabilities and power of GIS. His current areas of major interest and focus include: the evolution of mapping agencies into geospatial information agencies, the application of GIS throughout the urban infrastructure lifecycle,as well as the evolution of SDI's at all levels: corporate, municipal, regional, national and international.

Bill received an undergraduate education in International Relations at Eisenhower College and a graduate education in Urban and Regional Planning from Cornell University.

Contents

Can Japan Change the Geospatial Information Business after NSDI Law?: Through the Cooperation Act among Industry, Government and Academia

Dr. Yoshihide Sekimoto

Center for Spatial Information Science
University of Tokyo
sekimoto@csis.u-tokyo.ac.jp

1. BACKGROUND

"The Fundamental Law for the Promotion of Geospatial Information Uses", (termed as NSDI Law, hereafter) was approved by a majority as legislation introduced by a Diet member, in May, 2007. It was a moment that the field of geospatial information was supported by law for the first timeuntil now. A ministerial ordinance by the Ministry of Land, Infrastructure and Transport started in August 2007, and afterwards, "The Fundamental Plan for the Promotion of Geospatial Information Uses" was decided by a Cabinet Council in April 2008, and each related policy has started. However, under a population decrease and an economic recession, tense financial situation for local governments is under going. Furthermore, as represented by GoogleMaps etc., IT related measures in the ring of international businesses have been accelerated more and more. Therefore, no delay is permitted for the industrial-government complex in Japan, also. It is now that industrial-government-academic complex should take hands with one another, practice the idea based on NSDI Law, and make the situation be sustainable and big undulation, without having it to be a transient movement. The outline of NSDI Law, the trend of industrial world, the trend of national and local government, and the science fields are summarized in this thesis, so that it might take a general view of the trend of Japan after NSDI Law had been approved.

2. NSDI LAW

Outline

NSDI Law is composed of Chapter 3 Article 21 and the additional clause. "geospatial information" and "national spatial data infrastructure" are defined in the Law, and the following points are specified as an idea though details are omitted.

- National and local government, etc. have obligations to strengthen their cooperation for the use of geospatial information, and carry out their comprehensive and systematic measures.
- The combination of spatial data infrastructure and the satellite measurement become the core of the measures.
- The law aims at the environment that can stably enjoy satellite measurement service with high reliability.
- The law aims to advance sharing of spatial data infrastructure, to abolish redundancies, and to increase efficiencies, especially in administrative works.
- The law considers it so that the intellectual faculties and productivity of private enterprises are utilized more.
- The law considers individual rights and the safety in our country.

Furthermore, the law describes the obligation as follows for each organization. The provinces are able to make a decision for their policy according to the characteristics in the region while national government settles on the overall policy, getting along with the trend of decentralization. At the same time, the law specifies about the cooperation of private firms with universities etc., keeping it in mind to be able to do sustainable maintenance by various organizations.

- National Government: settles on and executes overall policy.
- Local Government: settles on and executes their policy according to the characteristics in the region, assigning their role with national government.
- Private Enterprise: has an obligation to make an effort to provide good quality geospatial information, in cooperation with national and local government.
- Obligation of cooperation: national and local government, enterprise, and university, etc. work in cooperation with one another.

- Measures in legislation: National government implements legislative and financial measures.

Moreover, the national spatial data infrastructure that are assumed to be mainly maintained by national government are prescribed in a ministerial ordinance by the Ministry of Land, Infrastructure and Transport and composed of 13 items, e.g. road edges and road district fields.

Consideration

It is also important to classify the effect by NSDI Law and the future assignment though it is not long yetafter the law approved. The main effect for the law is that the idea for it has spread among local region because of the great impact for it, as it was the first legislationand also a fundamental law, in Japan. In addition to that, it can be said that it succeeded to give a broad concept to geospatialinformation data, though it had been narrowly admitted as a little computer-inclined matter before. Furthermore, as it is an obvious fact that the basic factor of geospatial information is social infrastructure, it became more important that many kind of organizations cooperate and act in harmony with, because they should support the social infrastructure so that it can be continuously and stably maintained.

On the other hand, as future assignments it can be mentioned that present NSDI law has no penal regulations, no time limit for measures, and no guarantee for updating data. It seems to be originated from the fact that securing fiscal resources is not seen at the present time. However, it necessitates securing special budget or uniting measures for expenses that can be managed from daily business without straining, because it is essentially important to show the quality of information for data

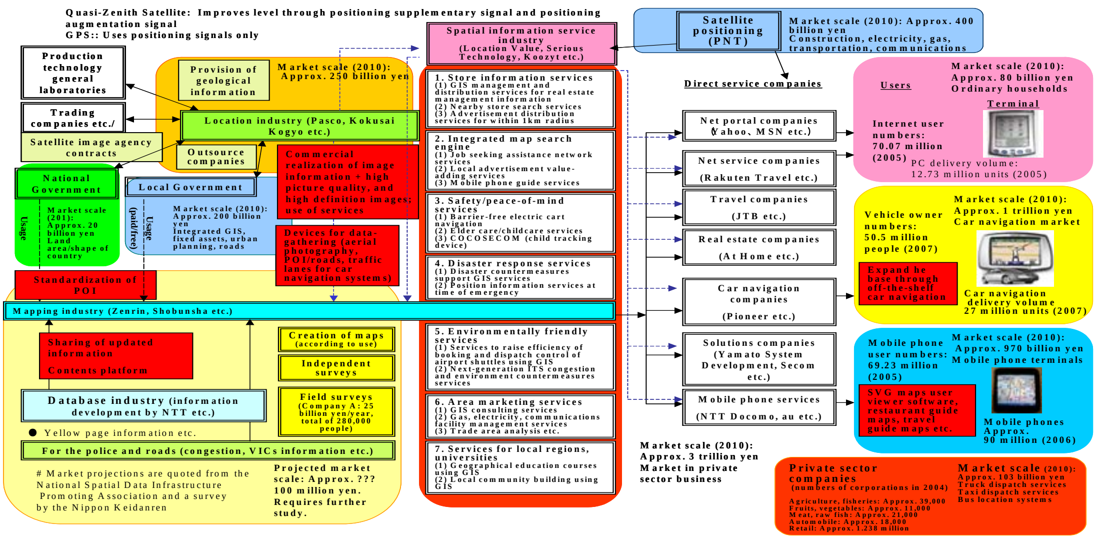
In addition, geospatial information uses should aim at uses by legal books like fundamental maps for city planning and road register etc., which are originally used in the maintenance work for public facilities. That is because geospatial information is more beneficial to be used in daily business.

3. OVERLOOK FOR THE WHOLE BUSINESS IN JAPAN

Overall industry structure surrounding geospatial information in Japan is overlooked in this chapter. Figure 1 indicates theindustry structure which are brought together by "Study

Meeting for the Promotion of Geospatial Information Uses (Chairman: Prof. Shibasaki, Univ. of Tokyo, Japan)" conducted by Ministry of Economy, Trade and Industry from December, 2007 to May, 2008, and the forecast of 2010 year's market scale of them.

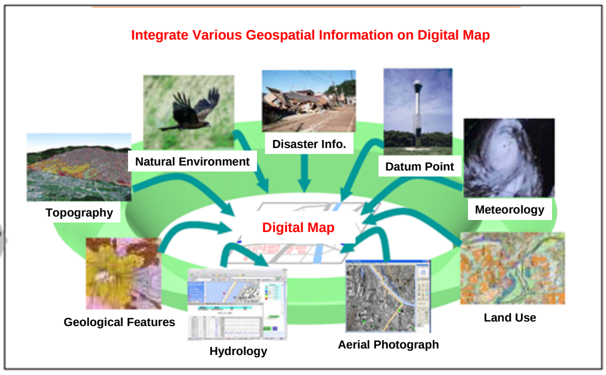
There are those industries as follows: surveying industry(350 billion yen) which mainly surveys land site, consignment contract by national and local government(220 billion yen), and mapping industry etc., that, maintain and update paper maps and geospatial database, using a part of those consignment work results. On the other hand, many kinds of services, such as internet portal sites, real estate information, car navigation systems, and various solutions by using PC, car navigation systems and mobile phone etc., have increased, using geospatial database because of the IT progress in the world. Spatial information service industry, in which several kinds of enterprises, big and small, exist and do services by adding value to several spatial information, is now expanding and about three trillion yen scale. The scale for the field of terminal unit is 80 billion yen for PC, one trillion yen for car navigation systems, and 970 billion yen for mobile phone, depending on the spreading conditions for the unit service. Moreover, as for the measurement services,satellite positioning (PNT) business is 400 billion yen.What we can say from these situation is those businesses mainly done by public sectors have shifted to that for private enterprises. From this report, Ministry of Economy, Trade and Industry announces the policy package called "G spatial project" publicly in order to accelerate those business.



<Figure 1> Industrial Structure Surrounding Geospatial Information Services
(Sources:「uA Report of the Study Meeting for thePromotion of Geospatial Information Uses"」
http://www.meti.go.jp/press/20080703007/20080703007.html)

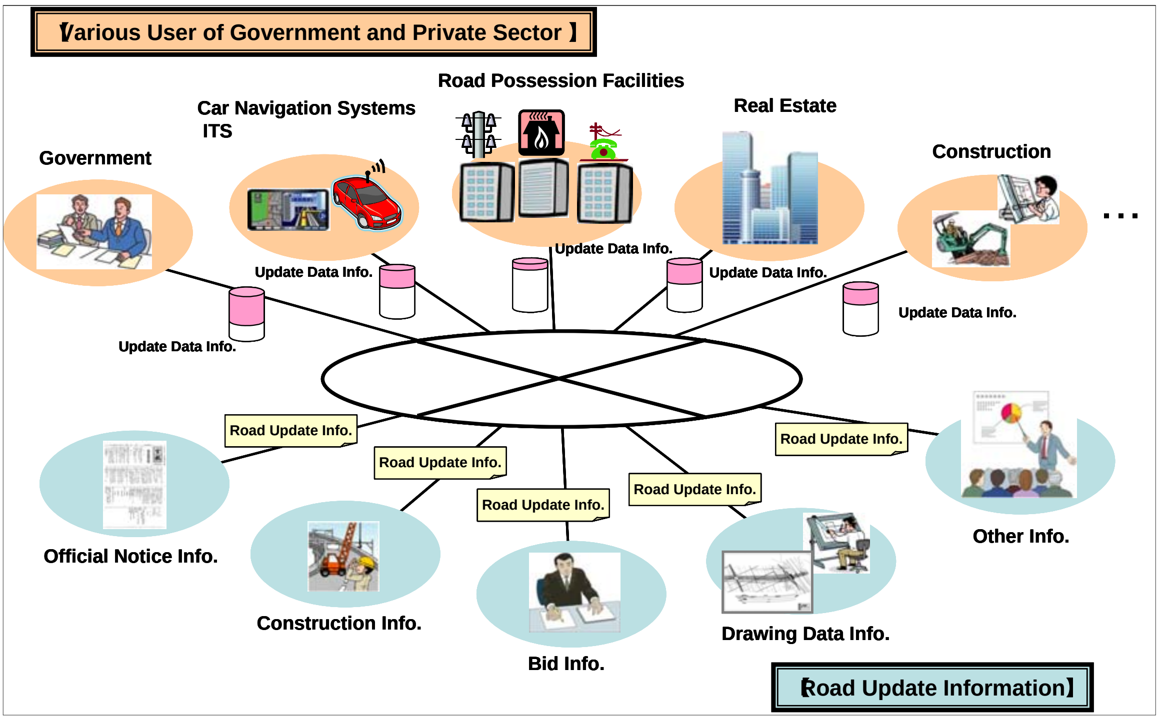
4. MAINTENANCE AND UPDATE FOR NATIONAL LAND INFORMATION

National land information are being maintained and updatedby mainly public sector, that has chiefly the role in the viewpoint of land management of the entire country rather than a part of region for the service. However, as practical map service for entire country and business ASP service, as represented by GoogleMaps, have come out, and the stage of them advances, the role of public sector should have been reconsidered, before and after the approval of NSDI law, though finance for public sector is under severe situation. In a word, national and local governmentare in a position to provide"@those changed and updated geospatial data without fail, for the use of source materials of various business situation as an administrative organization, not in a position to maintain generally wide and detail data. As examples for our activities, "Construction of Platform for Geospatial Information" and "Circulation of Information for the Change of Road Services" are introduced in this chapter. Platform for Geospatial Information makes public and circulates various kind of geospatial information which Ministry of Land, Infrastructure and Transportetc., possess and manage, by digital map on website. Ministry of Land, Infrastructure and Transport and Center for Spatial Information Science, University of Tokyo (termed as CSIS, hereafter) have implemented a joint research since December, 2007. We are going to design and build the platform systems, and adjust what kind of geospatialdata should be expressed on it, then complete experimental operation by 2009, and start full-scale operation in fiscal year 2010. More various information is scheduled to be expressed on the platform in the future, though it is now expressed those information about geological features which are important to evaluate the condition of building construction and land price, and the environment along river at the present stage (Figure 2).



<Figure 2> Image for the Platform for Geospatial Information
(Arranged by the source of press release material by Ministry of Land, Infrastructure and Transport: http://www.mlit.go.jp/kisha/kisha07/00/001213_.html)

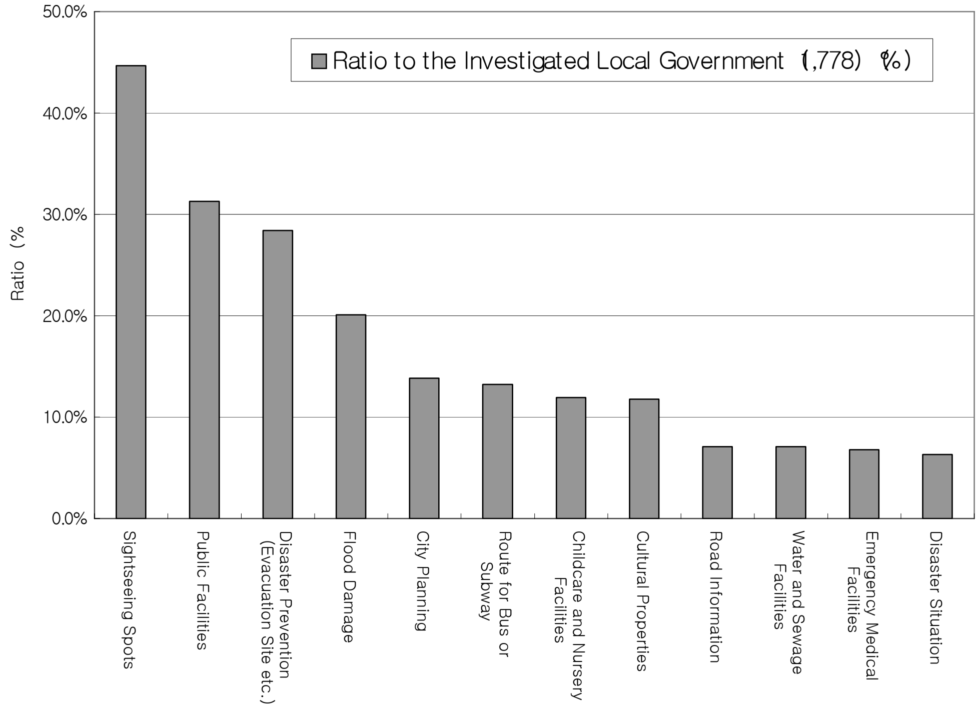
Especially, as for the activities for circulation of information for the change of road services, CSIS has organized "A Committee Meeting for Circulation of Information for the Change of Road Services" since August, 2008. Car navigationsystems were put on the market in the 1980's and evolved, for instance. Companies selling car navigation systems have the database itself for road map, but in most cases, it takes more time, cost and labor to check and confirm whether construction works for road changes complete or not, to survey fields and digitize the results, rather than building and making database before starting the navigation systems service. Necessities for such road update information do not limit to the car navigation systems, and rather related very much to the database, that road possession facilities business such as electric power, gas and water service, real estate business like housing lot development, and construction enterprises, etc. have held and managed. It is part of accountability and natural behavior as a daily business on road management that road administrator is sure to announce publicly the information about road changes, because it is public infrastructure. CSIS and the Committee Meeting examine and consider the ideal way of circulation of road update information and data, and are going to make practicalexamination, with such a frame explained in this chapter (Figure 3).



<Figure 3> Various Uses for Road Update Information

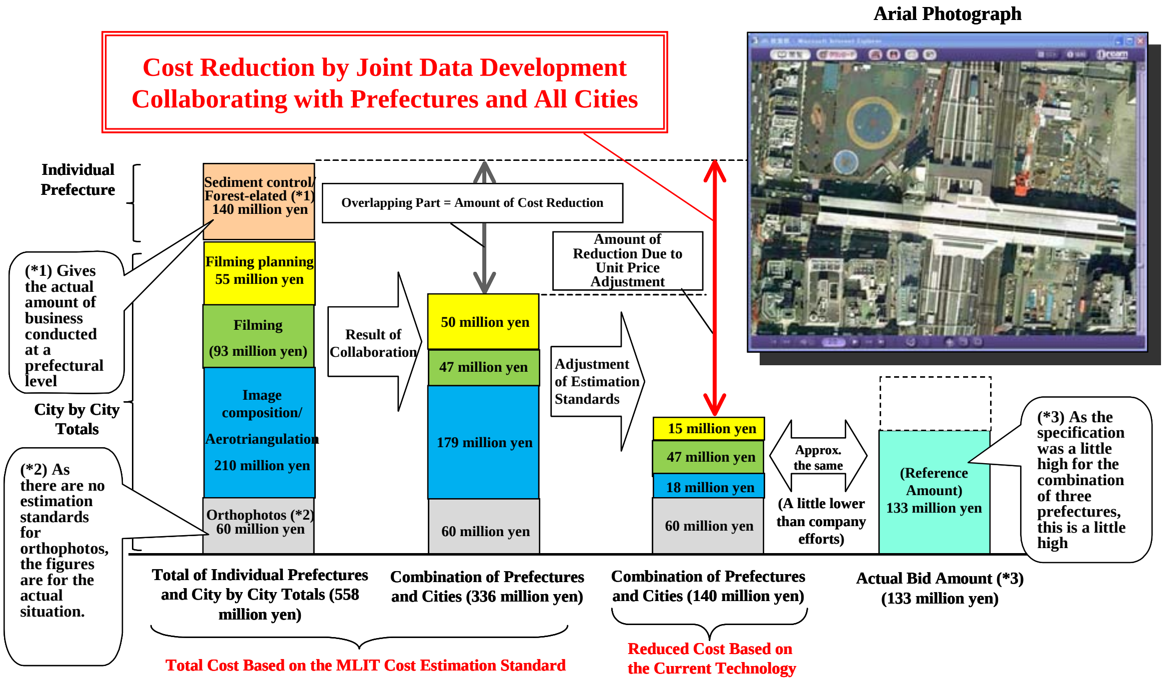
5. SIDE VIEW FROM LOCAL GOVERNMENT

About 1,800 local governments exist in Japan now, and there is no municipality where their website doesn't exist. There are a lot of municipalities that have expressed sightseeing information, disaster prevention information, and the information such as public facilities by using maps on the web in them. As there was no overall objective information before, CSIS ,with our collaborative researchers, have investigated the contents and the details of the maps on the web by each local government. For instance,as Figure 4 indicates the ratio of maps by use, map expressing sightseeing spots indicates the highest ratio, and next indicates public facilities, disaster prevention(evacuation site etc.), in order. It can be said that there are room and potential for advancing the way of providing those information in the future because such contents also have the possibility of leading an access increase for the municipality websites.



<Figure 4> Field of Utilization of Maps Expressed on the Website of Public Local Government

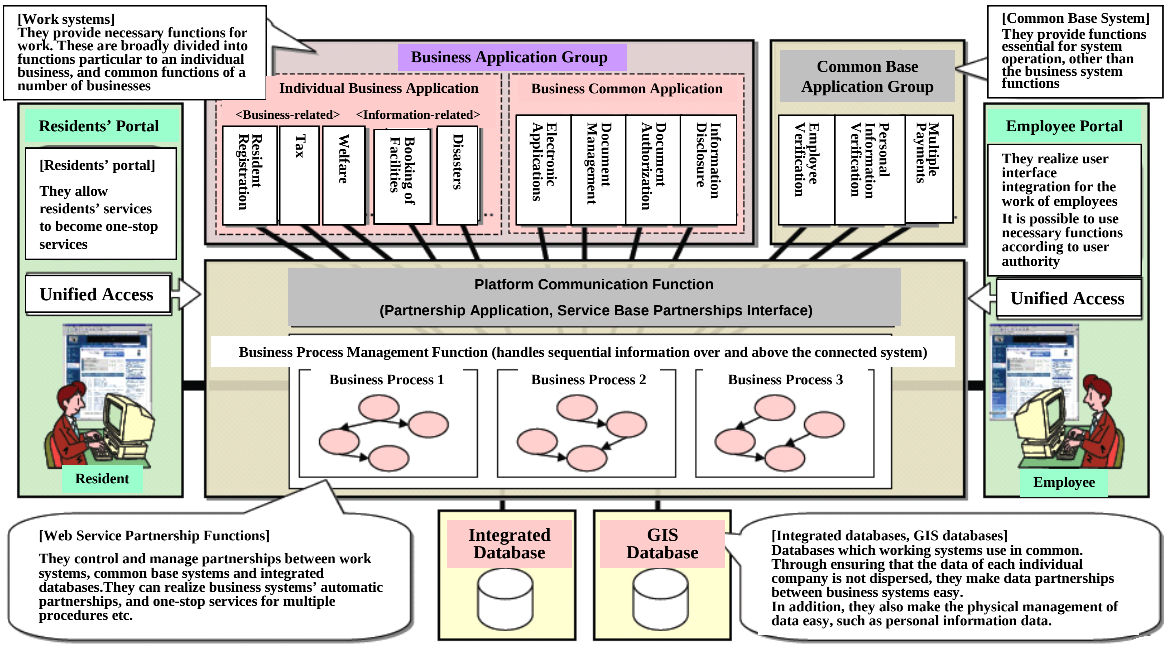
Moreover, the prefecture and cities, towns, and villages should have and maintain the drawings of various ledgers etc., as legal books, on the other hand. Then, examination for themap making by various collaborative organizations have recently been advancing because it is inefficient for the cost and the ordering procedure to build the map, by each city, town, and village, separately. For instance, it embarrasses with maintenance in the fundamental maps made by Mie Prefecture in 2001, and the business of making them cooperatively with the prefecture and cities, towns, and villages within the area is being advanced in around 2006. Actually, calculated the effect of making data cooperatively within the prefectural area, effectiveness of decreasing cost by about from 10 to 30 percent to prepare aerial photograph and numeric geographical information exists, and that is near an actual successful bid unit price(Figure 5). With such movementmentioned before, Ministry of Internal Affairs and Communications, places the integrated GIS project proceeded into that of joint outsourcing project enforced separately, and Local Authorities Systems Development Center(LASDEC) and CSIS, as cooperative secretariat, have investigated about the project by starting "A Committee Meeting of Integrated GIS for Collaborative Data Maintenance" since August, 2008.



<Figure 5> Trial Calculation for the Effectiveness of Cooperative Data Maintenance

Furthermore, it is necessary that those maps are not only built but also put in the environment used in daily business. The policy of the e-municipality is advanced separately, and "New E-municipality Guideline" is settled on by Ministry of Internal Affairs and

Communications. The ministry aims that "E-municipality that can achieve benefit and convenience, efficiency, and energies will be achieved by 2010". The examination of the regional information platform have started and especially GISWG was additionally settled on. Then, interface specification etc., on the assumption of including map in it, proof experiments are also being implemented (Figure 6).



<Figure 6> Image for Regional Information Platform
(Source: APPLIC website: http://www.applic.or.jp)

6. SIDE VIEW FROM SCIENCE FIELD

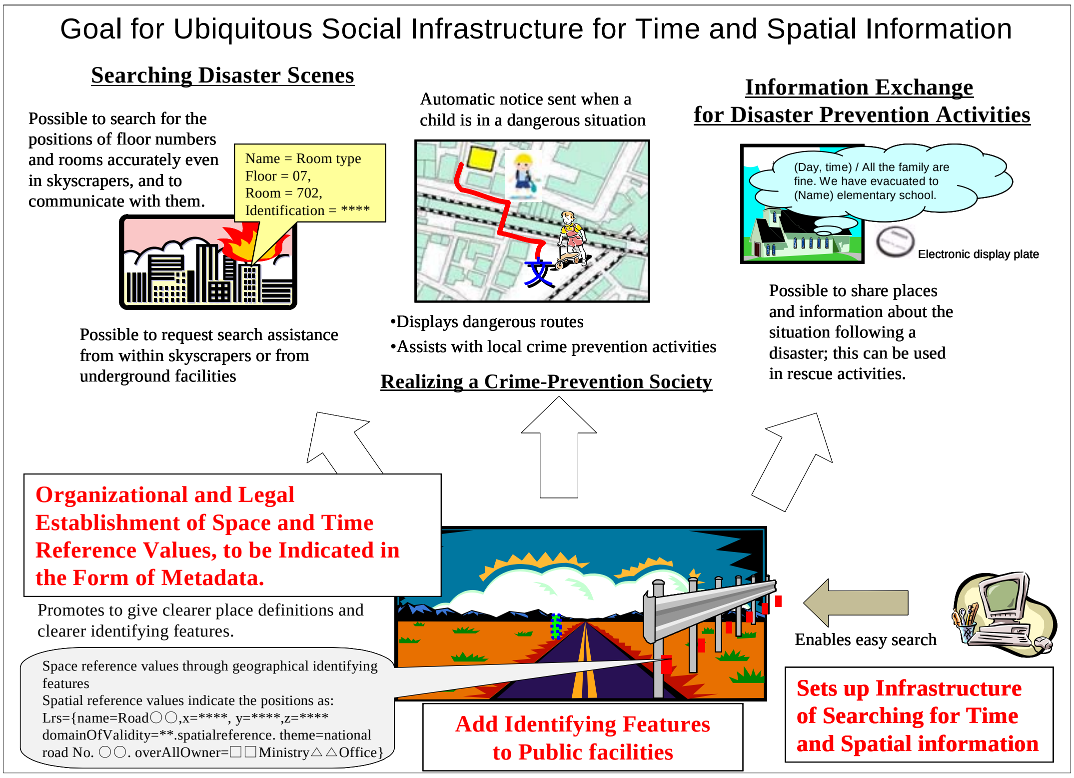
Independent movement has started from science research field. The conference after NSDI law is settled on, is organized as that of industrial-government-academic complex, not that of government-industrial complex before, is going to incorporate more special and objective knowledge, as GIS academic society etc. have positively proposed for organizing NSDI law. Moreover, the society for scientific field have worked in cooperation with various field of them when giving attention to the viewpoint of their cooperation. The society has organized "A Subcommittee for Ubiquitous Social Infrastructure for Time and Spatial Information (Chairman: Prof. Sakamura, Univ. of Tokyo, Japan)" in Science Council of Japan (belonged to Cabinet Office, Government of Japan) and make a suggestion "Toward the Construction of Stable and Lasting Ubiquitous Social Infrastructure for Time and Spatial Information" in June, 2008. In the suggestion, the ideal method of Social Infrastructure for Time and Spatial Information was arranged, from the viewpoint of those fields such as Robot, Support for Movement, Logistics, Statistics, History-Geography-Culture, Environment-Energy, Disaster prevention-Safety and three itemized suggestions are brought together as follows.

(1) Realization of the Infrastructure that can cooperate the various discriminating system with time and spatial reference system.

(2) Maintenance of legislation system that promotes to give place definition and identifier features.

(3) Promotion of the development of fundamental technology for information retrieval that uses time and spatial information and their mounting.

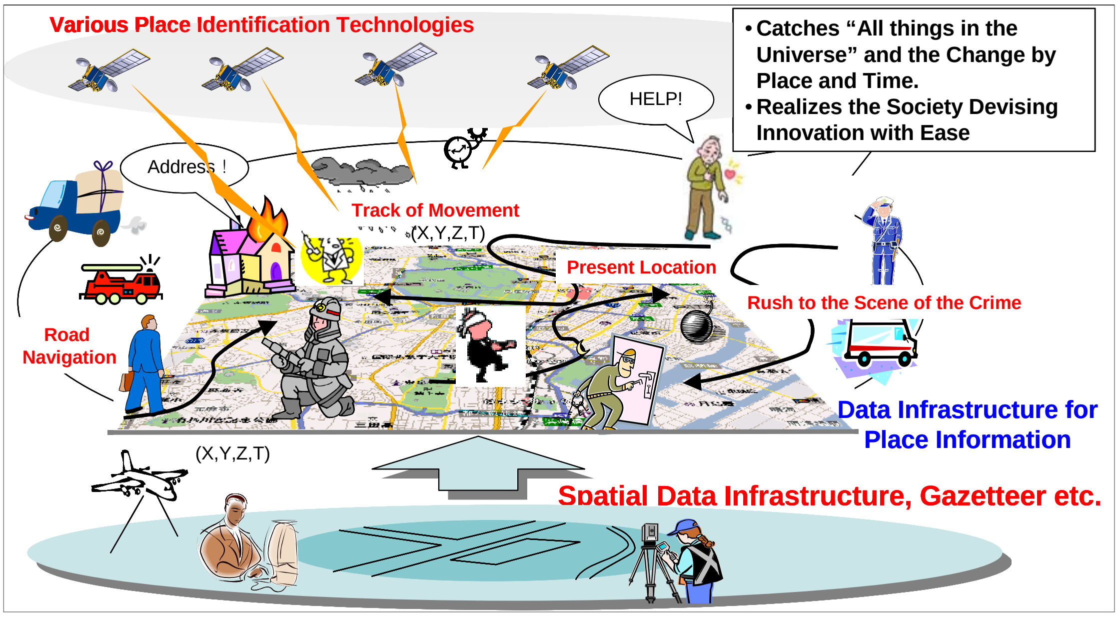
In the suggestion of (1), time and spatial expression system and referencing system, which are utilized in various fields, are clearly described and defined, and also means that common (registry) environment which can register, list and convert mutually those data in the system will be constructed as social common data infrastructure. In the suggestion of (2), systematic identifying featuresare clearly added to the public structures and facilities, and ground objects, that are used publicly and commonly in our life. The item of (2) suggests that legislation for promoting to set up the "Anchor point" which has the value of coordinates, based on the spatial expression system and referencing system that are described and defined, and requires that identifying features and spatial and time referencing value should be added, as metadata, to the data and information provided by the anchor point. Moreover, the item of (2) proposes that new organization, which can manage and certificate those identifying features, referencing systems and registries crossing in the field, should be formed in the government. Furthermore, in thesuggestion of (3), industrial society advances the development and mounting of the fundamental platform technology that can expand various services through referencing, collecting and integrating the data, information and knowledge, which are related to "All things in the universe" attached to theinformation of time and spatial identifying features, crossing in the field. The government also means that the cooperation of the horizontal industrial world and the talent's rearing will be promoted through those development projects.



<Figure 7> Suggestion for Ubiquitous Social Infrastructure for Time and Spatial Information
(Source: made by author based on the suggestion followed by URL:
http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-20-t58-1.pdf)

7. ACTIVITIES BY CSIS, UNIVERSITY OF TOKYO

The movement by the industrial-government-academic complex is what mentioned until the preceding chapters. CSIS supports those various activities as for the nationwide shared facility concerning spatial information science, and as for the organization which advances support for the industrial-government-academic professor and researcher. Especially since fiscal year 2008, CSIS have organized a business supported research division "Research Initiative for Geospatially Enabled Society", in which 13 private companies support our activities,in order to enhance the promotion of geospatial information field as an industry. The research division implements activities with industrial-academic complex independently, policy consulting, joint research with government etc., or the promotion of (BtoB) businesses for private companies among themselves, and holding open symposium as enlightenment activities (Figure 8 and Figure 9).



<Figure 8> Goal for "Research Initiative for Geospatially Enabled Society"
(Source: CSIS website, http://www.csis.u-tokyo. ac.jp/japanese/news/20080512/)

<Figure 9> Example of enlightenment activities
(Publication of explanatory about NSDI,
Source: http://i.csis.u-tokyo.ac.jp/news/20080807/)

The Canadian NSDI Experience: Policy and Implementation

Dr. David J. Coleman, P.Eng.
Dean, Faculty of Engineering
Professor of Geomatics Engg.
University of New Brunswick
Fredericton, N.B., CANADA E3B 5A3
E-Mail: dcoleman@unb.ca

Sylvain Latour
Director, GeoConnections
Earth Sciences Sector
Natural Resources Canada
Ottawa, Ontario, CANADA
K1A 0E9
E-mail: slatour@nrcan.gc.ca

Jeff Labonte
Director General, DMDB
Earth Sciences Sector
Natural Resources Canada
Ottawa, Ontario, CANADA
K1A 0E8
E-mail: labonte@nrcan.gc.ca

1. INTRODUCTION

Spanning 7000 km. from east to west, Canada is the second largest country in the world in terms of area. It has a population of over 33 million people, with more than 80 percent of them living in towns and cities within 250 kilometres of the United States border. Canada is a federation with a parliamentary system of government. Powers and responsibilities are divided between the federal government, the 10 provincial governments, and three territorial jurisdictions. In turn, municipal and regional governments operate within each province.

Canada has two official languages – French and English – with French being the mother tongue of over 20% of the population. There are three main groups of Aboriginal peoples in Canada - the First Nations, the Inuit and the Métis. Now home to immigrants from over 240 different nations, Canada today is a very cosmopolitan country.

2. INSTITUTIONAL ARRANGEMENTS

2.1. Framework Data

The Earth Sciences Sector of Natural Resources Canada (NRCan) provides nation-widegeodetic control, topographic mapping frameworks, and the land survey system and cadastral mapping on Canada Lands.* The Canadian Hydrographic Service**(CHS) possesses the mandate for charting of Canada's coastal regions and navigable waters.

NRCan has been traditionally responsible for map production at scales of 1:50,000 and smaller, while provincial government organizations have handled scales from 1:20,000 up to 1:2,000. Where needed, municipal governments have been responsible for creation of mapping at scales of 1:1,000 or 1:500.

Overlapping activities do exist at each level – as well as between levels-- of government in Canada. Such federal organizations as Statistics Canada, Canada Post also collect medium- to small-scale road network information, for example, while Public Works Canada, Transport Canada and others have the occasional need for larger scale mapping. Environment Canada, Agriculture and National Defence also have project- and program-driven mapping requirements that cannot always be satisfied with existing information.

As well, there has been considerable overlap in geodetic control and topographic data collection at the federal and provincial levels [HAL, 2001]. In an effort to streamline cooperation towards the common goal of full and up-to-date coverage, different strategic arrangements have been developed and implemented over the past 15 years [Coleman, 1999].

* Canada Lands consist of approximately 2600 Indian reserves, the National Parks system (including historic sites and canals such as the Rideau and Chambly), the Yukon, Northwest Territories, Nunavut and offshore areas of Canada.

** Canadian Hydrographic Service Website URL http://www.chs.gc.ca/pub/en/

2.2. Land Administration Activities

Except for Canada Lands, provincial governments* are usually responsible for production and distribution of cadastral (property) mapping, while property valuation and taxation may be either a provincial or local responsibility. Excellent integrated examples of such activities may be found in most provinces, although they may not be immediately apparent from the government Websites since many service their customers on a password-protected, subscription basis.

In partnership with other government organizations, the Canada Centre for Cadastral Management** within Natural Resources Canada supports the operation of the federal and territorial property rights systems on Canada Lands. The Surveyor General's Office within this Centre sets, maintains and updates survey standards, maintains and provides access to the Canada Lands Survey Records, establishes a regulatory regime, and manages both the digital cadastral databases and ground-based survey frameworks.

2.3. Coordinating Committees and Consortia

Over the past forty years, Canada has built a strong collection of institutions to govern geomatics activities at the federal and provincial levels. Each of these organizations has evolved over time in the face of changing political and socio-economic conditions in their respective environments.

2.3.1. Inter-agency committee on geomatics

The Inter-Agency Committee on Geomatics*** (IACG) was founded in 1988 to encourage coordination of federal geomatics activities. Current members include all of the key federal organizations involved in the collection, management and application of geospatial information. Recent activities include the adoption and implementation of standards and policies.

2.3.2. Canadian council on geomatics

In 1971, the Canadian Council on Surveys and Mapping was established to provide a

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* See *http://www.geoconnections.org/en/aboutGeo/partners* for a list of links to provincial government mapping organizations in Canada.

** See http://www.lsd.nrcan.gc.ca/english/index_e.asp for details on the Canada Centre for Cadastral Management.

*** See http://www.iacg-cmoig.org/index_e.php for details on IACG.

forum for formal discussions and mutual support among the directors of the surveying and mapping programs across Canada. Renamed the Canadian Council on Geomatics* (or CCOG) in 1996, its members include representatives from key federal agencies as well as from mapping programs in every provincial and territorial government. General policies promoting collaboration between federal and provincial geomatics organizations are coordinated through the CCOG, and this organization played a key early role in defining and promoting the need for a Canadian Geospatial Data Infrastructure in the mid-1990's [Loukes et al., 1996].

2.3.3. Geomatics industry association of Canada

The Geomatics Industry Association of Canada** (GIAC) is a national business association dedicated to serving the geomatics industry in Canada. While membership is voluntary and does not include all geomatics firms in the country, GIAC's members include over 70 of Canada's leading geomatics service and technology firms, and approximately 80% of the active exporters in this sector.

2.3.4. Geoide network of centres of excellence

The GEOIDE Network of Centres of Excellence was established in 1999. With a multimillion-dollar annual budget, its mission is to take advantage of Canada's capabilities in university-based research and development in order to develop strategic alliances between industry, government and academia, thereby consolidating and strengthening Canada's overall geomatics sector. Now having included in its projects faculty and students from most of the universities involved in geomatics in Canada, it has played a major role in bringing together geomatics researchers from the three sectors over the past nine years.

3. THE CANADIAN GEOSPATIAL DATA INFRASTRUCTURE (CGDI)

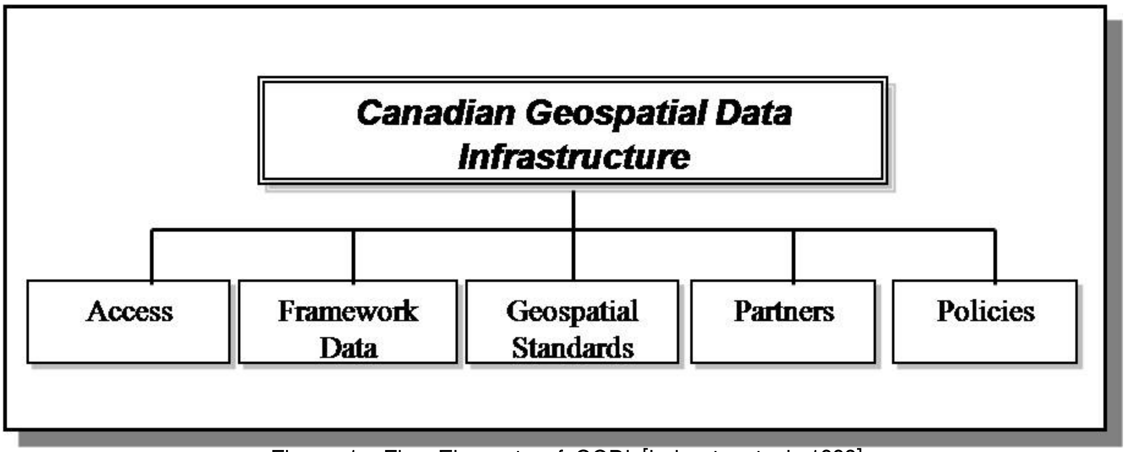
The Government of Canada's goal over the last nine years has been and continues to be the creation of a common and readily accessible national infrastructure and the creation of policies and standards that governments and Canadians can use for a variety of purposes

* See http://www.ccog-cocg.ca/index_e.html for details on CCOG.
** See http://www.giac.ca/home.asp?lang=en for details on GIAC.

[Corey, 2007]. Built correctly, its contributors intend the Canadian Geospatial Data Infrastructure (or CGDI) to support important public policy objectives that touch Canadians in their daily lives – from emergency planning and response, to tracking diseases and to land-use decision making - to name a few.

Spearheaded by the IACG and CCOG, the Canadian Geospatial Data Infrastructure initiative was launched with the intention of "…enabling timely access to geospatial data holdings and services in support of policy, decision making and economic development through a co-operative interconnected infrastructure of government, private sector and academia participants" [Loukes et al, 1996].

The basic "Principles for Data Partnership" implicit in CGDI are discussed in detail in [Labonte et al, 1998]. The five key elements of the CGDI are illustrated in Figure 1.



<Figure 1> Five Elements of CGDI [Labonte et al, 1998].

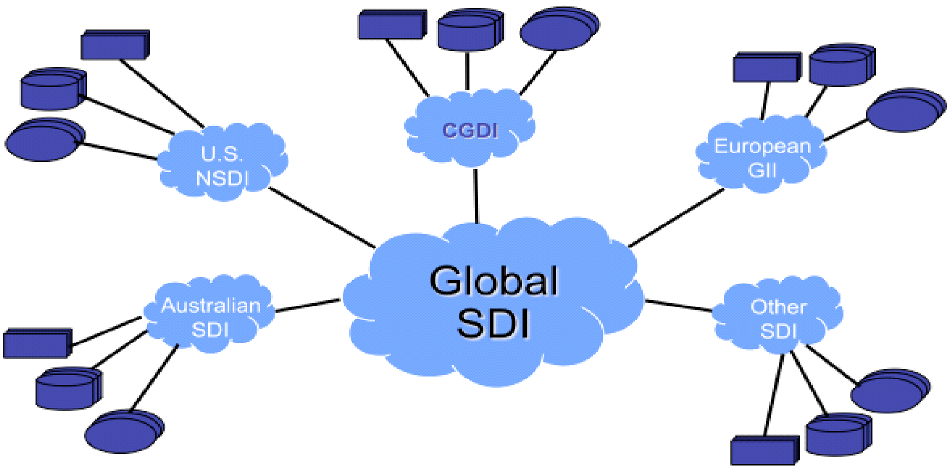
Access to data: The partners wanted to develop a geospatial data infrastructure that all Canadians — even those in the most remote communities — can access data and information through the Internet. What was needed was a "common window" for geospatial data - a repository where suppliers could deposit and share free data.

Framework data: The partners wanted a common base data that was standardized and seamless across Canada - a base that encouragedusers and agencies to add value, develop new applications and create more detailed databases.

This pointed out the need for a consensus on Geospatial Standards — the third element. These standards simplify access, improve data quality and integration, and encourage development of commercial software and applications.

All these require partnerships, which drove the drafting of formal and informal agreements and collaborative partnerships among various departments within the Government of Canada, the provinces and territories, the private sector and academia. These agreements were designed to share new developments and capitalize on emerging technology.

Lastly, accomplished all of this requires supportive Policies. By simplifying government policies and harmonizing the access and use of geospatial data, departments and agencies are able to share data among themselves and with other levels of government.



<Figure 2> The CGDI within a Global Spatial Data Infrastructure

Canada's CGDI efforts are linked to those in other countries on a variety of levels. For example:

1. Canadian and US government organizations formally cooperate in terms of data sharing, interoperability pilot projects, and technology exchanges;
2. Canadian companies build SDI-related software and data products based on international standards which are sold worldwide;
3. Canada has been an active and vocal member of the Global Spatial Data Infrastructure Association* since the organization's inception in 1998 (http://www.gsdi.org)

* See http://www.gsdi.org for details on the GSDI Association.

4. THE GEOCONNECTIONS PROGRAM

To address and cultivate these elements, Canada's GeoConnections* program was launched in 1999 with an initial investment of $60 million over five years. Supporting seven major projects, these funds leveraged an additional $90 million from Government of Canada departments and agencies, the provinces and territories and the private sector. This combined expenditure of $150 million had a major positive impact on the program andhelped keep Canadian companies at the forefront in the development of geomatics products, services and international markets.

Masser [2003] provides an excellent comparative overview of the early years of GeoConnections in relation to its counterparts in the USA and Australia. Staff support for GeoConnections is provided by Natural Resources Canada. A Management Board consisting of senior government officials from the IACG, the CCOG, and representatives from academia and industry guides its work. It is chaired by the Assistant Deputy Minister of the Earth Sciences Sector of Natural Resources Canada.

The focus of the first phase of GeoConnections was not data collection, although framework data is an integral part of the CGDI. Quite the contrary, with shared leadership, most of the programs within this phase focused on network design, alternative ideas for institutional change, development of common policies, capacity building, the creation of partnerships, and the promotion of data access and sharing through development of standards-based products and services [GeoConnections, 2003].

In 2005, the GeoConnections program was renewed with a second five-year mandate from the Canadian government, which will take the program up to 2010 [Labonte and Habbane, 2008]. In this second phase, GeoConnections is working to expand and evolve the CGDI and to help decision-makers to use this resource to address challenges in four priority areas: (1) public safety and security, (2) public health, (3) environment and sustainable development, and (4) matters of importance to aboriginal peoples. Along with delivering on these public policy objectives, it is intended that GeoConnections is to continue supporting development of a standards-based geomatics industry while supporting governments in their efforts to deliver on policy objectives in these priority areas.

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* See the GeoConnections Web Site at http://www.geoconnections.org/CGDI.cfm/fuseaction/home.welcome/gcs.cfm.

As pointed out by Labonte and Habbane [2008], the vision driving both stages of the GeoConnections initiative has been grounded in two important inter-dependent assumptions:

(1) that the CGDI would be built from the bottom up and
(2) that a host of diverse organizations - including public sector agencies, federal, provincial, territorial, and municipal governments, non-governmental organizations, private companies, consultants, associations and academia - would ultimately contribute to its creation and growth.

The strength and number of relationships between these organizations have fuelled GeoConnections' progress and accomplishments over the years.

5. THE GEOBASE INITIATIVE

One of the most ambitious examples of partnership development has been the implementation of the GeoBase* portal. A federal, provincial and territorial government initiative overseen by the Canadian Council on Geomatics (CCOG), the GeoBase project was undertaken to ensure the provision of, and access to, a common, up-to-date and maintained base of geospatial data for all of Canada. Through the GeoBase portal, users can access national road network information, digital elevation models, satellite imagery and hydrology information across the country at no cost and with unrestricted use. The GeoBase Portal offers an access to its data layers through a Web Mapping Service (WMS) in accordance with the Open Geospatial Consortium (OGC) specifications [Johnson and Singh, 2003].

GeoBase represents a significant milestone in cooperative collection and distribution of digital topographic mapping in Canada. While employing state-of-the-art standards-based technology, GeoBase is regarded by many practitioners more as an important institutionalrather than technological accomplishment. Creation of GeoBase was possible only through a series of individual negotiations between NRCan and representatives from each province. Each negotiation covereda similar set of technical and institutional concerns, but the details of operational priorities, reprocessing costs, pricing and distribution policies, and incentives differed in every case.

* See http://www.geobase.ca/geobase/en/index.html for details.

6. NEW CONSIDERATIONS IN MAINTAINING FRAMEWORK DATA

Advances ingeospatial positioning, Web mapping, and wiki-based collaboration technologies have now outpaced the abilities of large public organizations to manage geospatial data, attest to their reliability, and integrate them with other geospatial data sources in a timely manner. A growing body of literature is emerging to help expert amateurs relate (or "mash up") their own theme-based layers of content to Google base mapping ([Gibson et al., 2006]; [Purvis et al., 2006]). Commercial services like Flickr.com are allowing users to georeference their digital photographs shared over the Web, and the Everyscape.com service promises to relate detailed panoramic streetscape images to the Google base. Collaborative Web-based efforts like People's Map, Open Street Map and Platial: The People's Atlas, now enable experts and amateur enthusiasts alike to create and share limited, theme oriented geospatial databases.

Commercially, Google now provides GPS kits to citizens in India and Kenya to help populate and update Google Maps road centerline and attribute data in that country ([Jones, 2007]; [Tracks4Africa, 2008]). Firms like Navteq and TomTom already use Web-based customer input to locate and qualify mapping errors and/or feature updates required in their road network databases, but the results may take a year or more to appear on the mapping ([Biersdorfer, 2007]; [Helft, 2007]).

In a different context, project-based digital mapping produced today by professionals for clients in government and industry is in many cases of higher accuracy than that found in multipurpose national and regional government mapping databases. Similarly, the results of project-based LIDAR mapping and multibeam charting projects are usually of much higher-accuracy than the older DEM or bathymetric data still existing within national mapping and hydrographic charting databases. Early examples of how best to logically integrate such data are just beginning to emerge (e.g., [Warriner et al., 2005]). While some commercial software vendors have begunto offer "deconflicting" modules which incorporate DEM data from different sources into a shared master surface, the rule bases governing this integration are often simple and do not always adequately account for logical discrepancies in the resulting surface.

Public-sector mapping organizations are interested in the emergence of such services. However, the potential to even employ data from other authoritative government sources has only recently been implemented (e.g., NRCan's GeoBase mentioned above), and then only after considerable negotiation. The notion of employing data from public domain sources oremploying direct on-line updates to their own databases from expert amateurs has not yet been adopted because it can be problematic to assess the reliability of the contributor and, by extension, the reliability of the contribution itself. Moreover, there are legitimate concerns that some of the mapping updates provided might even be deliberately misleading.

That said, a significant number of users are moving away from existing government mapping in favour of generating and integrating their own data into commercial or open-source services, and sharing them within their own on-line communities. This may be a healthy challenge to the long-held paradigm of "create the base once and use it many times", which has guided the philosophy of public sector multipurpose base mapping programs for the past 40 years and still influences national spatial data infrastructure initiatives around the world. Others argue strongly that such "crowdsourcing" represents a disturbing trend that increases the influence of amateurs at the expense of legitimate experts(e.g., [Lanier, 2006]; [Keen, 2007]. Regardless of which argument one believes, the role of "users" and "providers" can get mixed up very quickly, and it clearly puts under scrutiny the processes employed by government mapping programs to keep their authoritative data reliable and up to date [Budathoki et al., 2008].

No question - the issues associated with data sharing between institutions and individuals are many and varied. That said, the potential exists to improve the accuracy and currency of existing mapping more quickly and at reduced cost if these new technologies and practices for data collection, sharing, and on-line collaboration can be leveraged. Similarly, formalapproaches exist to evaluate and authenticate information Web input from different sources [Flanigan et al., 2008], and there is potential to apply analogs of these to either public- or private-sector mapping programs. To address this opportunity, however, requires integrated technological, operational, and policy-level responses that address legitimate system-related, people-related and institutional concerns.

7. CONCLUDING REMARKS

In this paper, the authors have attempted to provide a snapshot of the current structure and activities of the institutions - and challenges facing the community - in the cooperative creation and maintenance of the Canadian Geospatial Data Infrastructure. Much has been done since 1999 to initiate the dialogue, build support, and reinforce the core principles of the initiative. While sometimes frustrating, the results of the capacity-building, the continued cultivation of partnerships, and the patient consensus-building among key stakeholders has begun to bear results.

That said, CGDI is still very much a fragile "work in progress". The need for effective governance and true collaboration remains critical. A technology for communication like the CGDI is only effective amongst a community that already wants to communicate. It starts and it ends with people talking and listening to other people.

The degree to which the vision, relationships and agreements developed over these first nine years can be sustained willdetermine the real success of the CGDI effort. Growing the CGDI will require active and engaged users who are prepared to buy into" existing collaborative governance structures and modify them over time as their needs mature, as technologies change, and as on-line cultures evolve. The CGDI architects will need to continue paying attention to ensure the necessary elements are present and the effort continues to be relevant.

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Strategy for NSDI Integration in Korea: National Integration Information System

Dr. Mi-Jeong Kim

Geospatial Information Research Center, Korea Research Institute for Human Settlements

mjkim@krihs.re.kr

Abstract

The objective of this research is to propose strategies to implement the spatial information infrastructure for the National Integration Information System. In order to implement the National Integration Information System, it is necessary to build the utilization process of the National Integration Information System through standardization and to have a detailed plan for establishing the preliminary environment. National Integration Information System will lay the groundwork for the spatial information infrastructure, furthermore it will take the role as a leader of the GIS technology in Korea.

1. INTRODUCTION

Since 1995 in Korea, the GIS business has been implemented by the federal and local government as well as other public organizations through various city, land, underground facilities and the general environment.

However, most GIS utilization systems have been designed by individual process and it lacked sharing capabilities. Identical data were processed in different ways among several GIS utilization systems, causing a waste of budget. To solve those problems, National Integration Information System should incorporate simultaneous functions in building the spatial system infrastructure for most administrations, public services, companies, and the general public.

The purpose of this research is to present ways to implement National Integration Information System for the spatial information infrastructure.

2. THE BASIC MODEL OF NATIONAL INTEGRATION INFORMATION SYSTEM

2.1. Concept and Phase

The purpose in the implementation of the National Integration Information System lies in the sharing of the spatial information, which denotes the methods in which to freely share data. Consequently, National Integration Information System is defined as the center to save and manage the datum of the shared information in a view of the information technology and the systematic framework to enable the spatial information to unify in the perspective of logical theory. Therefore, National Integration Information System will be the core factor of the latest information system and the spatial information industries in the coming generation.

In other words, it is projected that the National Integration DB will be the center of the spatial information to be shared among various administration process information systems as the data hub in the upcoming generation and based on the grand scale of National Integration Information System, its technology development strategy is expected to have heavy influence on the GIS S/W market in Korea.

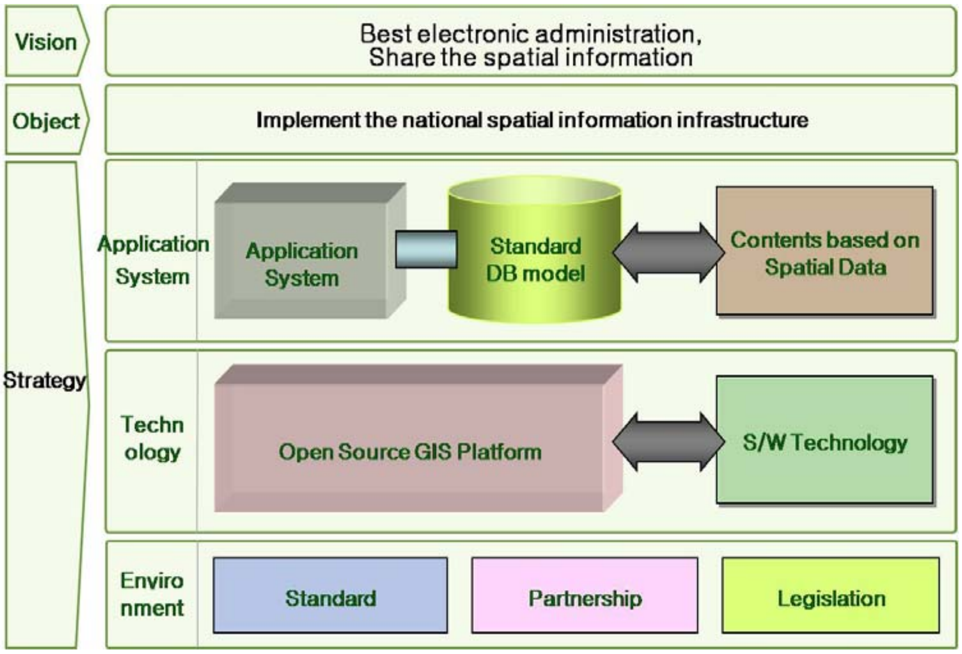
Also, the standardized spatial information of National Integration DB will be expected to have influence on the content industries directly with various contents.

2.2. Vision and Objective

The Vision of National Integration Information System is to lay down the foundations for implementing the best electronic administration in order to be able to share the spatial information regardless of the possible limitations in hardware, software, time and space.

The objective set to accomplish this vision is to implement the national spatial information infrastructure and enhanced utility. To reach this objective, first, the national integration DB has to be shared with internal or different organizations and implement the horizontal linking integration network. Second, the national integration DB should build the linking integration network horizontally and vertically to share among the vertical administration system. Third, based on these tactics, this system will promote the development and improved growth of spatial contents industries in Korea.

There are some additional strategies to build the available process of the National Integration Information System, for the acquisition of base technology and the promotion of the infrastructure and its essential environment.



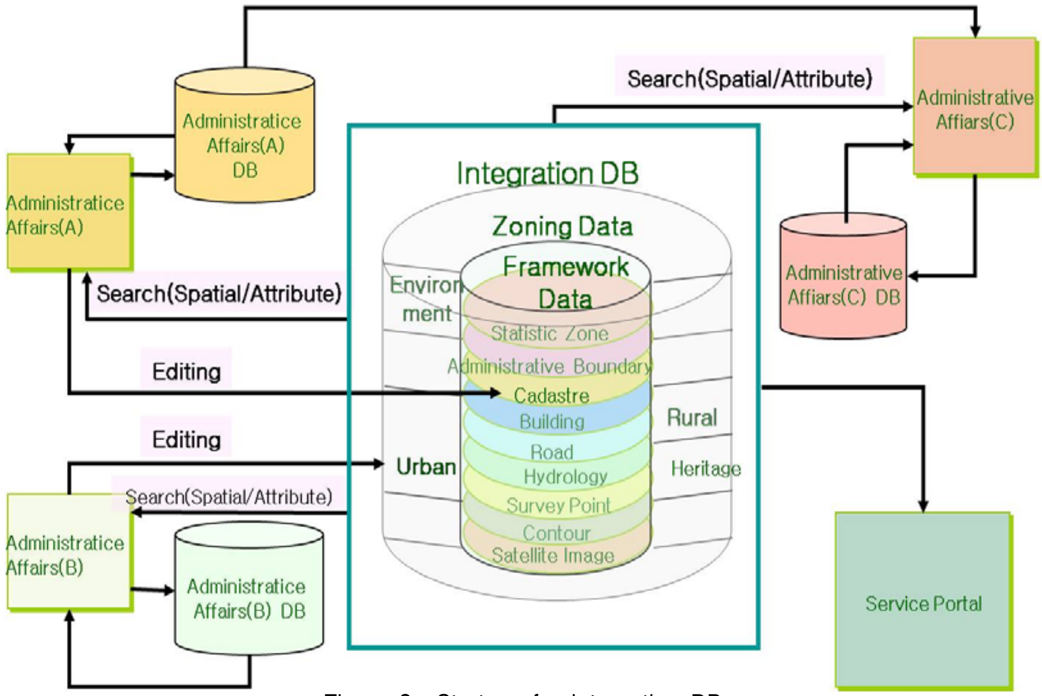
<Figure 1> Vision & Strategy

3. NATIONAL INTEGRATION INFORMATION SYSTEM UTILIZATION PROCESS IMPLEMENTATION

3.1. National Integration DB implementation and administration strategy

National Integration DB presents the topical information relating to the basic spatial information and local area information based on law. The national integration DB implements various users from the various kinds of organizations, simultaneously utilizing other spatial data production and management based on the spatial information through the standardized mode. The spatial information used for administration and public service and the basic spatial information are brought to database standard to fit to the framework of standard national integration DB.

In accordance with the basic spatial information, it has to survey the needs about the administrated area, the record of land registration, building, traffic and the basic spatial information is defined as law system in regard of managing individuals.



<Figure 2> Strategy for Integration DB

3.2. Application System Development

■ **National Integration Information System Architecture**

The position of National Integration Information System is that of a central data hub able to be shared by everyone and that of a linking integrated framework based on the spatial information of the standard system. For this purpose, National Integration Information System is built as the standardized way and the standardized framework of open type is crucial to establish the interoperability. National Integration Information System is implemented and developed with the web based data provision functions, data editing and analysis through C/S.

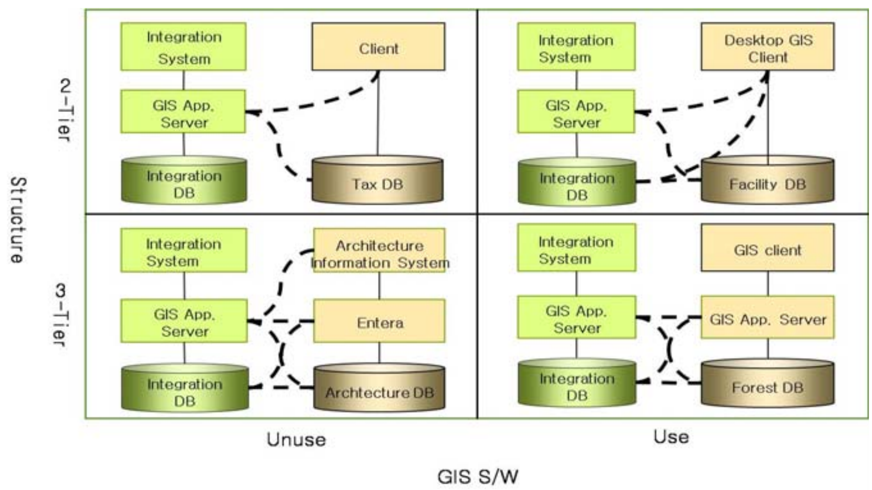
National Integration Information System Architecture consists of the data integration channel management, the national integration DB, open type standardized GIS platform, administration and available information, etc. It is developed by mixing web and client/server. That is, the data provision technology is built through web and the data editing and analyzing technology is built through C/S.

■ **National Integration Information System Configuration**

National Integration Information System is working according to a position of the information system, connected and integrated as a horizontal configuration. National Integration Information System has the information system to change National Integration DB , to share the spatial information by National Integration DB and "mash up" to carry out the administration and public service to refer to the data of National Integration DB and to share the spatial information of National Integration DB from public organizations and company.

The vertical configuration of National Integration Information System has to consider the data and work quantity to be managed and processed, the convenience of managing and control of the spatial information. The central operation should perform a role for offering and managing the national data to support monitoring and establishing the national policy from the government.

3.3. Other Information System Linked Strategy



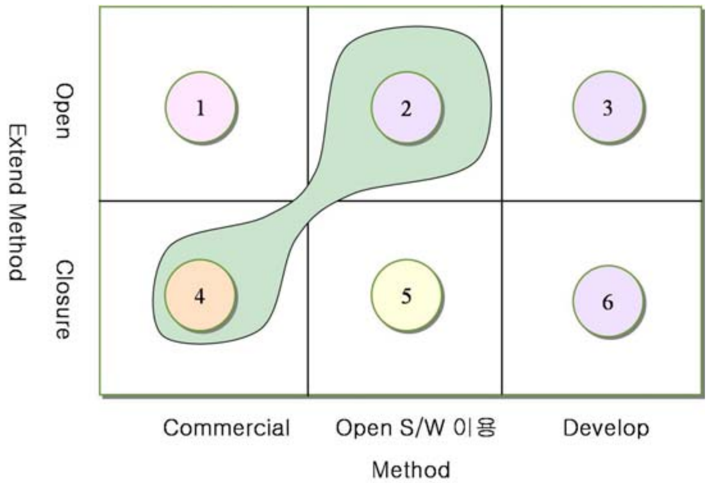
<Figure 3> Linking Methods Concerning Systems

A reasonable scheme should be reached among speciality of each information system with the ones works for National Integration Information System and the horizontal configuration strategy and considering the computing environment.

4. National Integration Information System Technology Assurance

To manage National Integration Information System efficiently, it has to be considered by the interoperability of Infrastructure technology, flexibility, extensibility and budget expenses. National Integration Information System will lead the technology development of GIS S/W in Korea and be requested as an activated strategy.

A strategy is needed for release S/W and commercial S/W and to adopt the open type standardized GIS platform.



<Figure 4> Strategy for Technology

Software to be the base of National Integration Information System is the concept which develops the release GIS S/W. Recently, GIS of public API such as Google Earth and Google Map type has been in the limelights, increasing the interest and the demand for GIS S/W. Public GIS S/W is expanding its borders from desktop GIS to wider fields such as web service server and GIS database system. Public GIS S/W to use National Integration Information System has to have some conditions:

First, National Integration Information System should be able to process 2D vector data and spatial pictorial image of each areas from different provinces. Second, National Integration Information System has to guarantee the interoperability to share the spatial information and information system. Third, National Integration Information System and other information systems have to be connected, being able to exchange data back and forth. Fourth, heterogeneous dispersion computing environment has to be integrated and built vertically and horizontally. Fifth, Development system language is required, achieving the development objective of National Integration Information System, and in preparation of future system expansion packs. Sixth, National Integration Information System needs to maintain security and stability in order to be approached by anyone who wants to use it. The above conditions need to be secured for the public GIS S/W.

5. NATIONAL INTEGRATION INFORMATION SYSTEM INFRASTRUCTURE ENVIRONMENT

5.1. The Standardization to Insure Interoperability

The interoperability and standards of National Integration Information System with various administration business information system has to be established. Accordingly, a data model standardization to build the standard National Integration DB and open type standard technology of the standard information service should be adopted.

■ **National Integration DB standardization**

The standardization of the basic spatial information is needed which is a key data of National Integration DB. The basic model has to adopt ISO19109 application Schema, and include update, version and meta data, etc. Application model presents application spatial information and its inter-relationships such as road, administration boundary and reference point. Feature model defines the top layer data type class belonged to application model and attribute class. Meta data model makes up the data set and classes from managing formation, update and deletion of object. Updated model consists of classes for presenting updated object information and relates with meta data information in manners such as updated origination and updated subject. After updating, the previous data manages by using classes of version model Finally, when version model becomes a raw data, it saves information by using model, version model controls and maintains the version of data.

■ **GIS Infrastructure S/W standardization**

National Integration Information System points to open type GIS platform and this is the OGC standard below. Key component implies saving, sampling and operation of the spatial information from the National Integration Information System GIS Application Server. When the key component is in Desktop client of the C/S structure, key component is connected with DB server directly to edit and analyze the spatial information. Web service component implies the spatial information service in Web GIS Application of National Integration Information System. The various spatial information is supplied for web client and desktop client.

<Table 1> National Integration Information System development OCG standard

Category	Standard Details
Web Service Component	OGC OWS (Open type web service) Specification - WFS : OGC Web Feature Service implementation details - WMS : OGC Web Map Service implementation details - WCS : OGC Web Coverage Service implementation details - CSW : OGC Catalog Service for Web implementation details
Core Component	OGC Geographic Object(GO-1) implementation details
Data Access Component	- SFA : OGC Simple Features for Access implementation details - SFA-SQL : OGC SFA for SQL implementation details - GML : OGC Geographic Markup Language implementation details - KML : OGC KML implementation details

5.2. Specialized Cooperation System Construction

■ Business Promotion Scheme

Business promotion scheme of National Integration Information System Development can be divided into 4 sections depending on the business policy and budget statistics: central government department, local association, secondary government department, and individual local association.

Analyzing the business promotion scheme based on chance of influencing the results, individual local association or central business promotion strategy potentially has the possibility of a serious information gap due to self supporting finance and the differences in budget. Also, information system mind-set of some local associations is very creative and positive but commonly lower than that of a government department. With the level of national standardization being very low nowadays, the business promotion of the individual local association causes duplicate development and presents difficulties in securing interoperability.

Additionally, generally information infrastructure business is becoming more of a challenge under the circumstances from individual local association and individual business promotion, such as the inability to secure sufficient data infrastructure.

Administration and information service of National Integration Information System is collaborating with local association administration department and national administration department. This collaboration brings budget issues presenting difficulties in determining financial obligations. Considering these factors, it is more plausible for the National Integration Information System Business to be run under a central government based operation.

■ **Business Promotion System**

In order to satisfy the demands of various users and implement them into the National Integration Information System, a solid foundation based on systematic solution and development is necessary.

National Integration Information System Implementation should be supported by national S/W technology development and the enhancement of theoretical development method. To accomplish this, the infrastructure search, system development and system management of National Integration Information System should be promoted consistently, implementing specialized collaboration systems. In other words, centralized by a government department, it is mandatory to cooperate with the other departments for the research and development of coordination and administration tasks.

5.3. Law System Maintenance

To implement and build National Integration Information System effectively, law system should be accepted and incorporated.

First of all, the definition, production and management of the basic spatial information from national integration DB are regulated for implementation, management and distribution of National Integration Information System. Second, to implement data and management of expenditure area chart, consistency of expenditure area chart should be regulated and shared by the standard and law. Additionally, in cases of generation and modification of expenditure area chart, the basic spatial information should be relayed to engineering companies. Third, to maintain the spatial information, the law has to be regulated through Individual administration information system. For example, regulations should be placed where facilities and blueprint should be made based on the basic spatial information.

6. CONCLUSION

To build National Integration Information System as the spatial information infrastructure is that the basic spatial information should be built as the standard and to develop the interoperability of National Integration Information System. To promote this effectively, it has to adopt collaboration for optimal performance and the system should be secured by the law in order to insure consistency. Based on these efforts, it is necessary to take the next step in the leading role of GIS infrastructure S/W technology.

To promote this effectively, first, the strategies for managing and implementing National Integration Information System must be developed consistently and constantly. Second, policies to adopt Korean GIS S/W should be considered for the benefit of the National Integration Information System.Third, problems arising in the process of implementing the National Integration Information System should be thoroughly analyzed and assessed to provide future problem-solving capabilities. Fourth, a leader who will take the leading role of implementing the National Integration Information System is needed.

Recently, information technology in Korea is getting improved by using GIS, making this a pivotal time in the development of GIS. All these are necessary steps that the National Integration Information System will need to carry out in order to build a successful GIS industry in Korea and worldwide.

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From the Descriptive NSDI Toward the Prescriptive NSDI

Dr. Eun-Hyung Kim

department of landscape architecture
Kyungwon University
ehkim@kyungwon.ac.kr

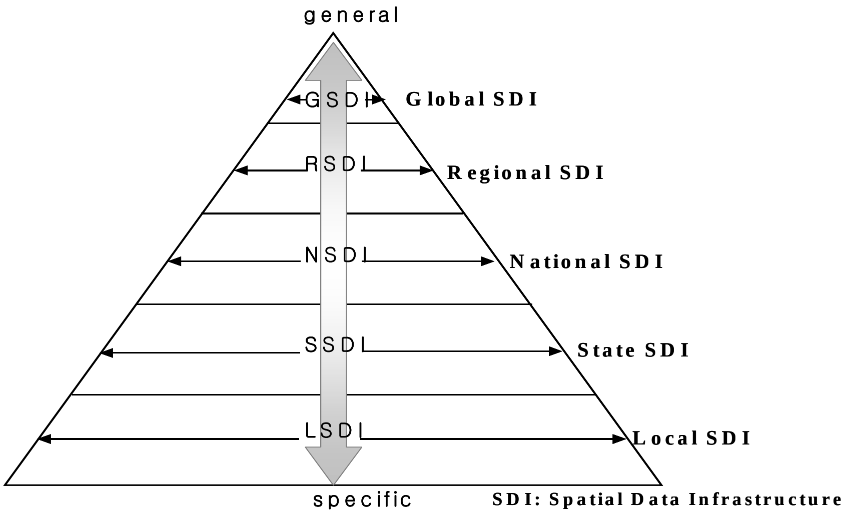
1. INTRODUCTION

Nowadays, a global world is rapidly changing, increasingly complex, challenging and crowded. With the increase of population and continuing quality improvement of life, development will happen continuously on the earth and increase complexity of our geospatial problems. To solve the emerging geospatial problems, more creative and effective spatial information infrastructures are required. As opposed to the past NSDI that can be defined as descriptive the future NSDI should serve each country as a useful integration vehicle for matters and places of national importance(Dangermond, 2007) such as national security and emergency prevention and management. In the USA, the 911 accident provided a historical momentum to recognize importance of geospatial data and transform the existing NSDI to a more integrated and problem-solving structure. To meet the emerging requirements properly, more specific data at the level of local government and the broader range of existing framework data are needed. Initially, the bottom-up approach of the NSDI in the USA now phases into a compromised stage with the top-down approach exemplified in the geospatial profile in the Federal Enterprise Architecture and geospatial bluebook.

<Figure 1> NSDI needs to support our understanding and behavior
source: Dangermond (2007)

In this context, one important question can be asked, "Is Korean NSDI good enough to deal with complex geospatial problems of national importance and utilize the NGIS in a citizen perspective?"

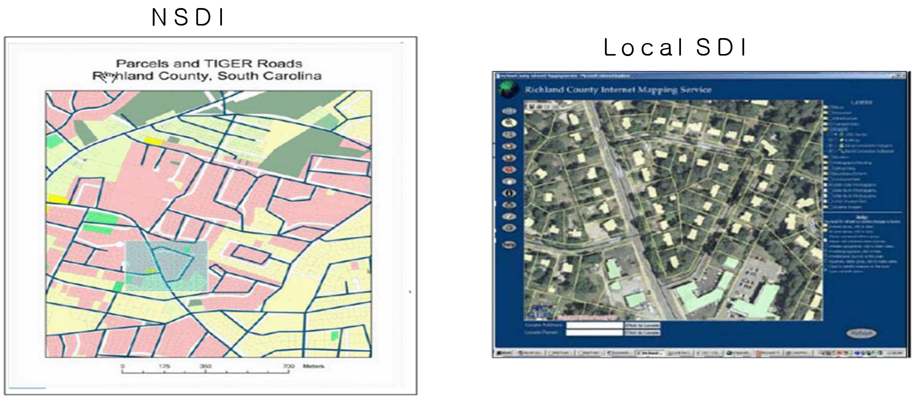
According to Williamson(2003), two generations of NSDI are introduced. In the first generation, data is the key issue for the NSDI development and the main focus is on techno-centric spatial data community. The second generation includes more socio-technical issues and focuses on the people as well as the data. Although the development of SDIs is explicitly at a national level, the second generation of the NSDI requires a collaboration model that facilitates greater inter-jurisdictional information exchange from a local level, through to a state, a national, a regional and a global level. The first generation can be considered "descriptive" and the second "prescriptive". The purpose of the paper is to identify "what can be done for the Korean NSDI to be more prescriptive."



<Figure 2> SDI hierarchy (Williamson, 2003)

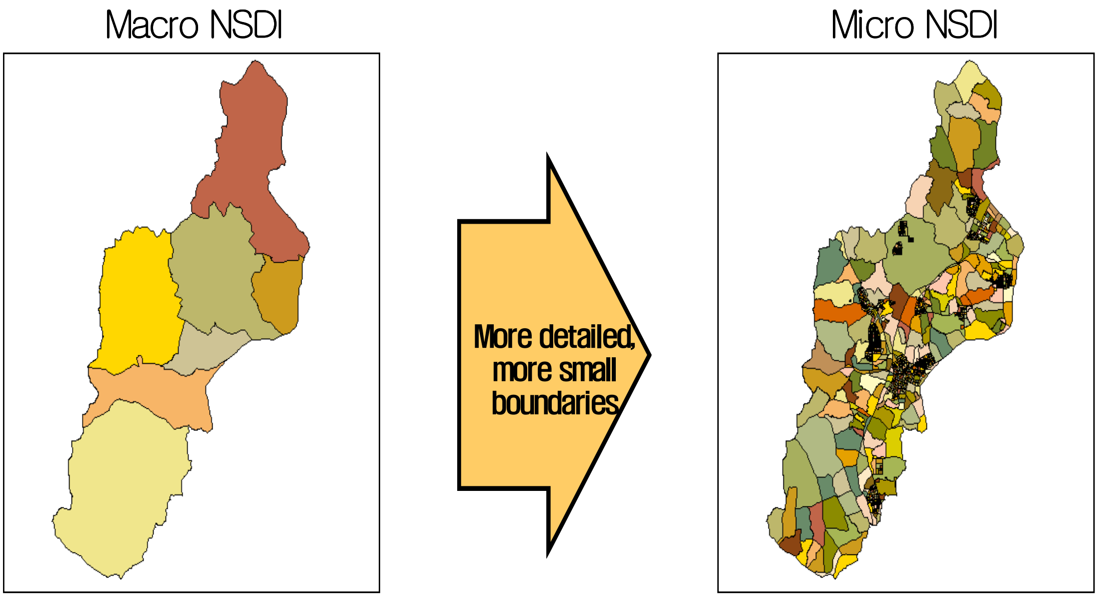
2. DESCRIPTIVE NSDI AS A PRESENT STATUS IN KOREA

Since the first NGIS phase initiated in 1995, diverse GIS projects have been established in the central and local governments. The present Korean NGIS in terms of a correct NSDI concept is difficult to be positioned in the prescriptive NSDI. In the previous NGIS master plans, there has not been a clear concept for local SDI and little recognition that it is a part of NSDI. To be more the prescriptive NSDI, the resolution of NSDI need to be more refined and the theme of NSDI to be expanded.(Figure 3 and 4)

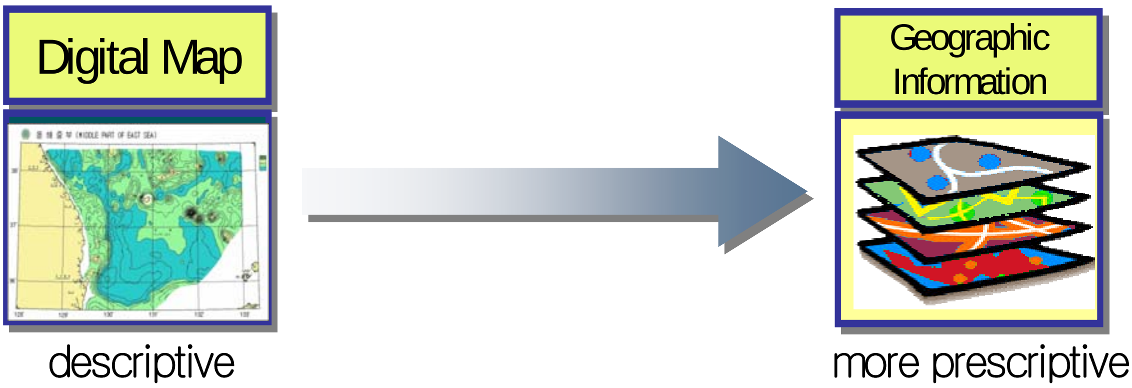


<Figure 3> Degree of Specificity in SDIs

So far, in the Korean NSDI concept, digital topographic maps are mostly considered as framework data and the descriptive maps need to be transformed into geographic information for the prescriptive NSDI(Figure 5).



<Figure 4> Increasing Demand on Micro Geospatial Information



<Figure 5> Digital Maps for more the Prescriptive NSDI

As shown in Table 1, the scale of the current Korean framework data is consistently on 1:5,000, which is more descriptive and hard to deal with local problems.

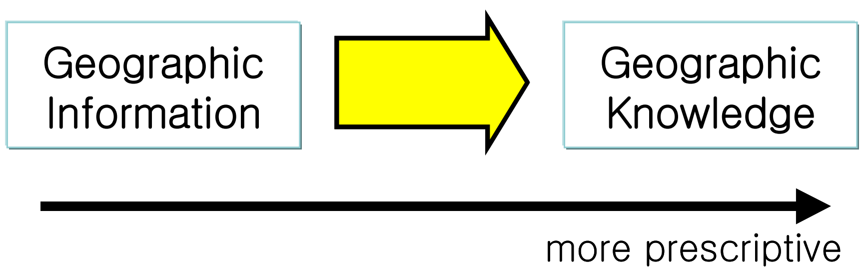
<Table 1> Current status of framework data in Korea

	Data theme		Scale
	[executive order 16890, revised to 20722 in 2008] NGIS law article15	present tatus (data model proposed:○, not proposed :×)	
Framework data	Administrative units	○	1/5,000
	Transportation	○	〃
	Hydrography	○	〃
	Cadastral	×	-
	Geodetic Control	×	-
	Topography	×	-
	Facilities	○	〃
	Orthoimagery	×	-
	Other extented data theme	×	-
source: http://www.ngis.go.kr			

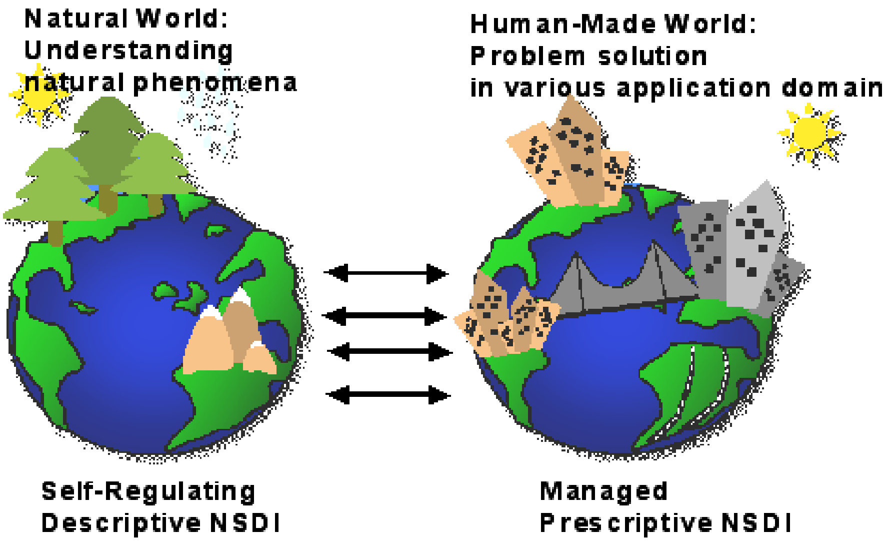
3. PRESCRIPTIVE NSDI FOR THE FUTURE KOREAN NSDI

The prescriptive NSDI includes the descriptive NSDI. The two NSDI are not a separate entity and the prescriptive NSDI in more advanced for various recipes. The understanding of patterns, relationships and processes, conceptualizing, modeling and visualizing of data are essential to be prescriptive.

The prescriptive NSDI requires geographic knowledge to solve human problems.

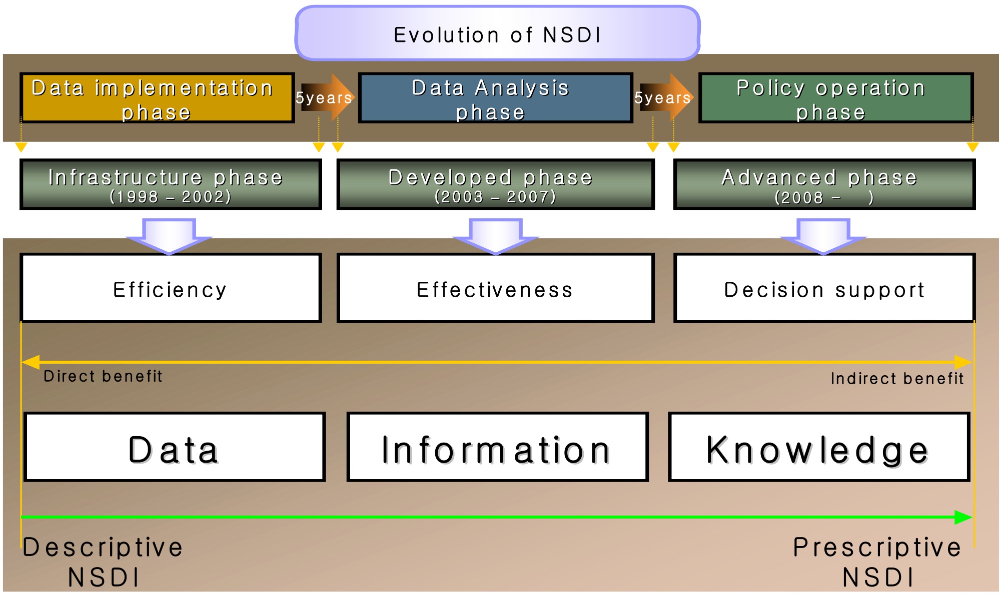


<Figure 6> Geographic knowledge for the Prescriptive NSDI



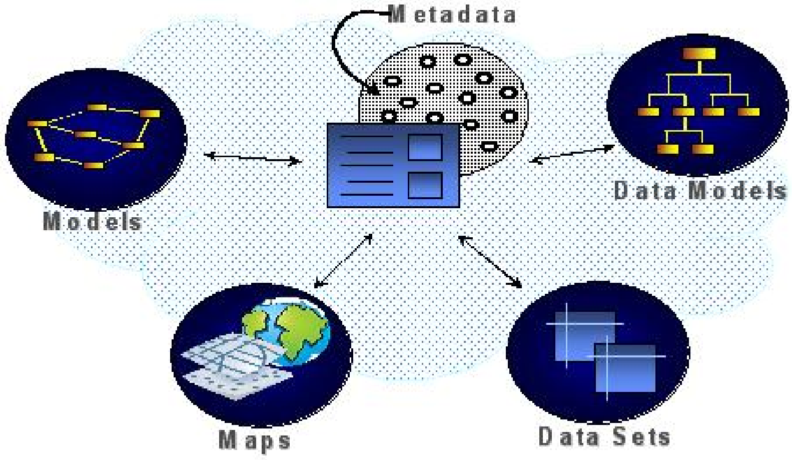
<Figure 7> Descriptive and Prescriptive NSDI

For the prescriptive NSDI, not only geospatial data but also geographic information and knowledges are required to deal with diverse human-made problems such as urbanization, human conflicts and crowed. To shift from the descriptive NSDI to the prescriptive NSDI, descriptive geospatial data need to be transformed into information and knowledges.



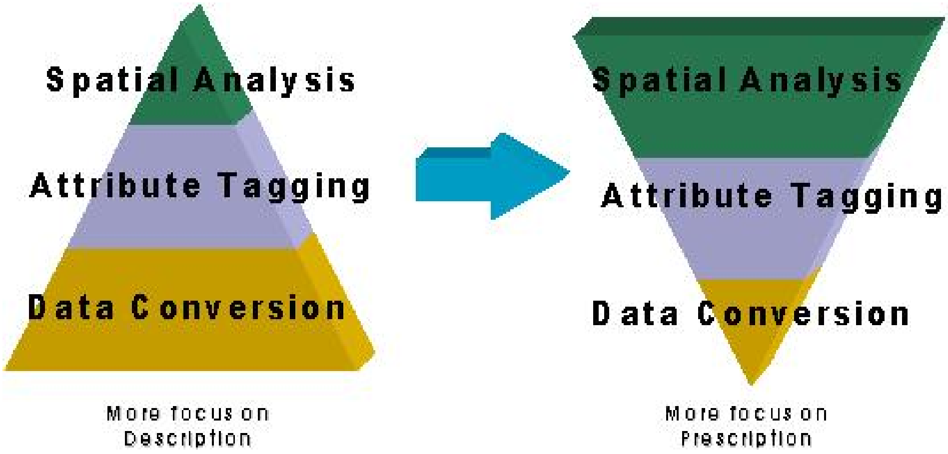
<Figure 8> Evolution of NSDI

Geographic knowledge can include maps, datasets, data models, domain models and metadata. Metadata for the other four elements is essential. Because metadata can group the four elements to integrate and transform various data and informations into knowledge(Figure 9).



<Figure 9> Possible elements of Geographic Knowledge Source: Dangermondl(2005)

As opposed that the descriptive NSDI has focused on data conversion, the prescriptive NSDI can mainly deal with spatial analysis for more added values.



<Figure 10> Business Structure of the Descriptive NSDI and the Prescriptive NSDI

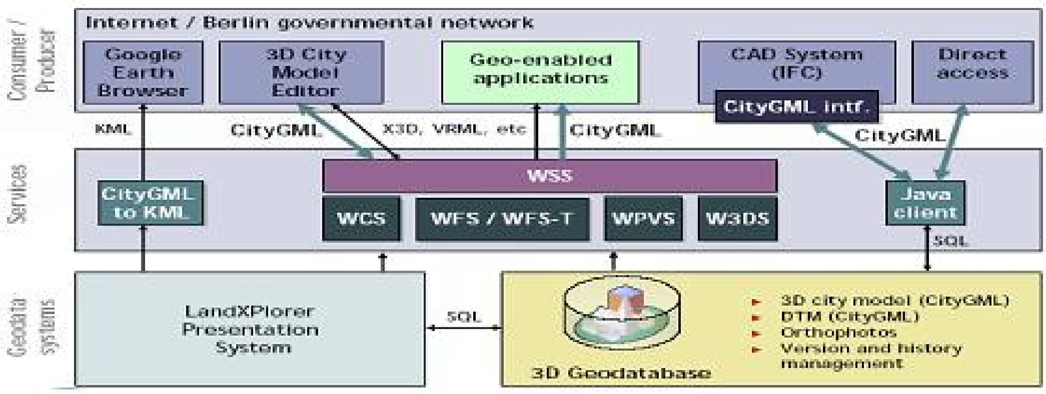
4. NEW ASPECTS OF THE PRESCRIPTIVE NSDI

4.1. 3D SDI with Geospatial Web

As seen in a 3D Spatial Data Infrastructure (SDI) for Berlin(2008)*, advanced NSDIs aim to develop a virtual 3D city model for applications like political issues and consulting, civic participation, marketing, service, promotion for companies and city and urban planning.

The other characteristics of advanced NSDIs, that is, using geoweb technologies can be found in a 3D Spatial Data Infrastructure (SDI) for Berlin(2008)(Figure 11). As shown in the figure 12, using standardized OGC web services, Google Earth (KML) and online streaming, access to the 3D geodatabase is realized.

<Figure 11> Berlin 3D SDI . Web Perspective View Service (WPVS)



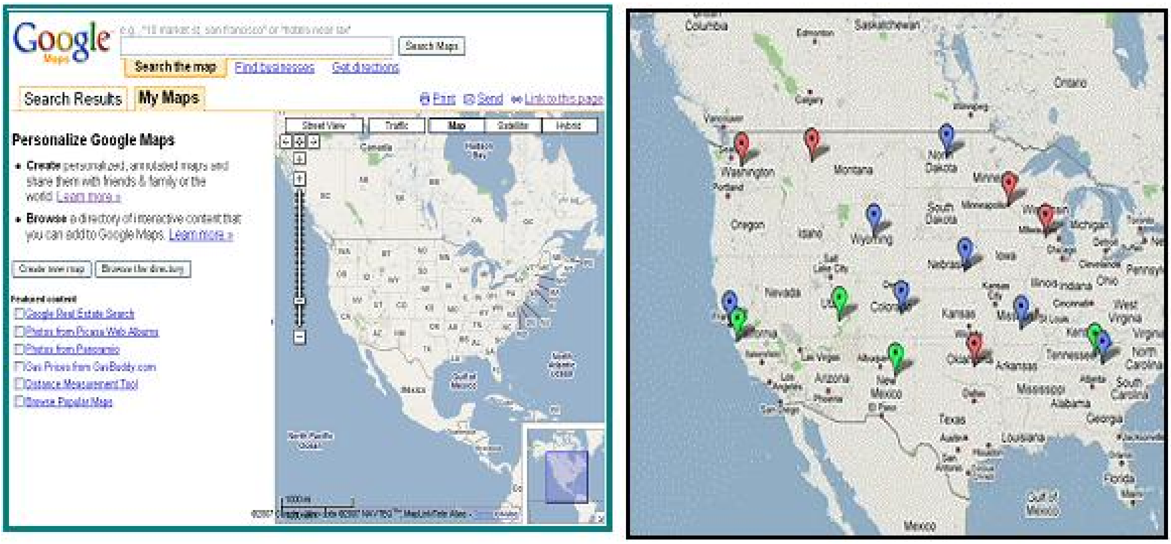
<Figure 12> Berlin 3D SDI – Architectural Model
source: Claus Nagel, Thomas H. Kolbe –
"A 3D Spatial Data Infrastructure (SDI) for Berlin", Geoweb 2008,

* Claus Nagel, Thomas H. Kolbe - "A 3D Spatial Data Infrastructure (SDI) for Berlin", Geoweb 2008.

4.2. NeoSDI with Geospatial Web

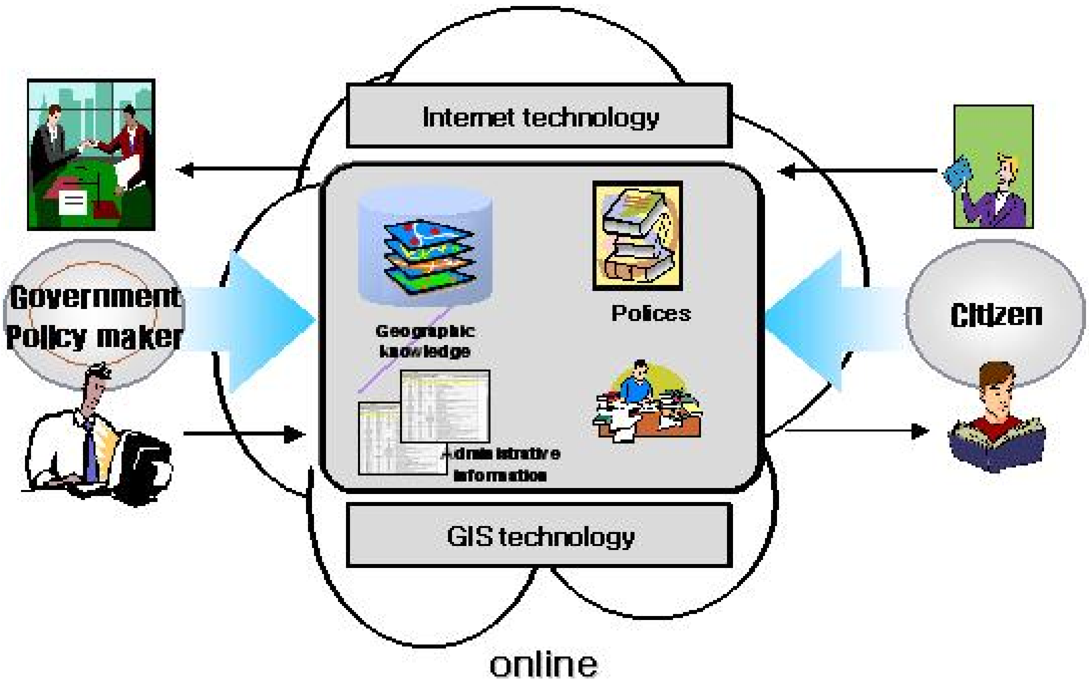
Emergence of neogeography with geospatial web technology, a new concept of NeoSDI is introduced*. Neogeography is an another way of broadening spatial literacy for the public. Increase in user-generated geospatial content and Volunteered Geographic Information** shows a unprecedented use patterns of geographic information. This trend can be seen in active collection of data such as OpenStreetMap, or passive collection of user-data such as Flickr tags for folksonomic toponyms. Neogeography prefers specific resolution of geographic information such as local SDI. NeoSDI allows more citizen participation through geospatial web. NeoSDI can provide many benefits, such as economic development, tourism, costs reduction, knowledge saturation, public engagement, effective disaster response and crowdsourcing.

For example, a user on the web, with Google My Maps, can create personalized, annotated, customized local map. Also, a user can add text and upload photos and videos to Google Maps and share them with other users.



<Figure 13> Google My Map- Increasing personal demand for geographic information
source: http://maps.google.com/

* Jason Birch, "NeoSDI for Local Government, Geoweb2008
** http://en.wikipedia.org/wiki/Neogeography



<Figure14> Public Participation in the Prescriptive NSDI

4.3. Semantics Interoperability

To deliver and exchange geospatial context-based knowledge, semantics interoperability can be a key element. Mapping one knowledge domain onto another typically requires human comprehension of both sets of semantics, more automated collaborative identification of semantic mapping is being researched using intelligent agent technologies. For example, semantic interoperability of metadata becomes mandatory in the prescriptive NSDI.

4.4. The Geospatial Bluebook

The "GIS for the Nation" in the USA means GIS for your neighborhood, your town, your state, and your country. The goal is to build an interoperable system that leverages standards and best practices to develop geospatial data infrastructure. The emphasis is on local data needs and local practices, along with data integration at State/Regional, and ultimately National levels. The project for the Geospatial Bluebook is a set of templates that demonstrate how a GIS for the Nation would be created.

<Figure 15> Integrated National Data Sets in the Geospatial Blubook
source: http://support.esri.com/

The Geospatial Bluebook begins the process of identifying practices that have served other communities; the goal is to offer a set of national implementation specifications for communities that choose to adopt those specifications.

In addition to the previous 7 data themes of the Framework data, The Geospatial Bluebook includes 14 data themes* specifications with data capture guidelines, case studies, data models and links to other resources. Each of 14 data themes is available on 4 scales of use - neighborhood, city, regional/country and national/county scale(Table 2).

* 14 Data themes are geodetic control, imagery, elevation, land use/land cover, base map, environmental, hydrography, cadastral, transportation, addresses, utility, governmental units, strucatures and emergency operations.

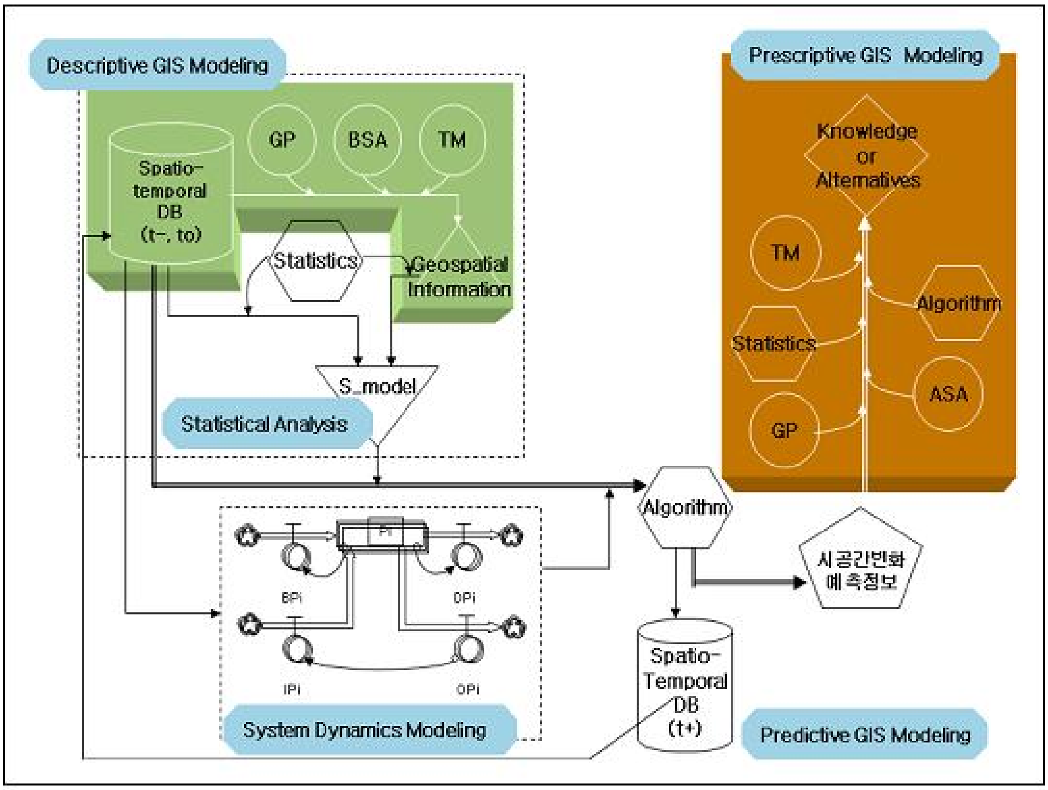
<Table 2> Comparison of Framework data and dataset of Geospatial Bluebook in the USA

	Framework data		Geospatial Bluebook	
data theme	7	Geodetic Control Cadastral Orthoimagery Elevation Hydrography Administrative units Transportation	14	Geodetic Control Cadastral Orthoimagery Elevation Hydrography Administrative(Government) units Transportation
				Land use/land cover Base map, environmental Hydrography, Addresses, Utility, Structures Emergency operations
scale	1	Federal	4	national/county
				regional/country city neighborhood

source:http://www.fgdc.gov/framework, USGS(2005)

4.5. NSDI for Decision Support

Young Pyo Kim's study(2007) introduces 4 GIS modelings based on system dynamics: descriptive GIS modeling prescriptive GIS modeling, system dynamics modeling, and predictive GIS modeling. Descriptive GIS modeling is useful for exploration of spatial patterns, Prescriptive GIS modeling for support of spatial decision making, and Predictive GIS modeling for forecast of space-time changes.



<Figure 16> NSDI for Decision Support
source: Young Pyo Kim(2007)

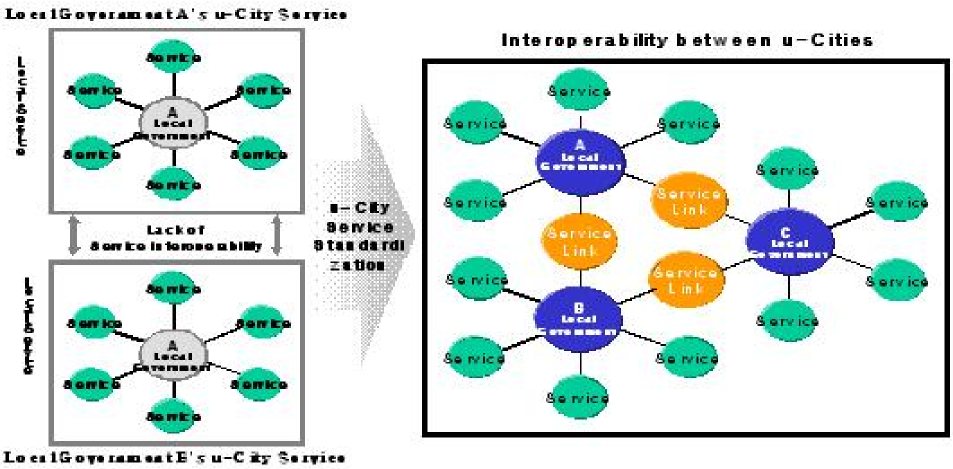
As mentioned above, an NSDI for decision support becomes much more important for the prescriptive NSDI. In this context, the proposal for KOPSS(KOrea Planning Support Systems) released in 2007* and the development of the pilot KOPSS need to be a part of the future NSDI in Korea. To support spatial decisions in national land planning, KOPSS needs to integrate individual systems at a national and local level.

4.6. NSDI for u-City

The GIS has grown in its quantity as local authorities established the urban information system for better city administration, civilian services and decision-making support services. Recently, local authorities have expressed much interest on the application of ubiquitous technology to improve citizens' safety and convenience. Construction of a u-City requires the multitude of information and telecommunication networks and digital contents; the existing

* http://www.krihs.re.kr

information resources need to be put to use in entirety for that end. u-Korea is a collection of u-Cities and local SDI will play a critical role for the construction. Interoperability has a first priority in the prescriptive NSDI and the implementation of u-Cities.

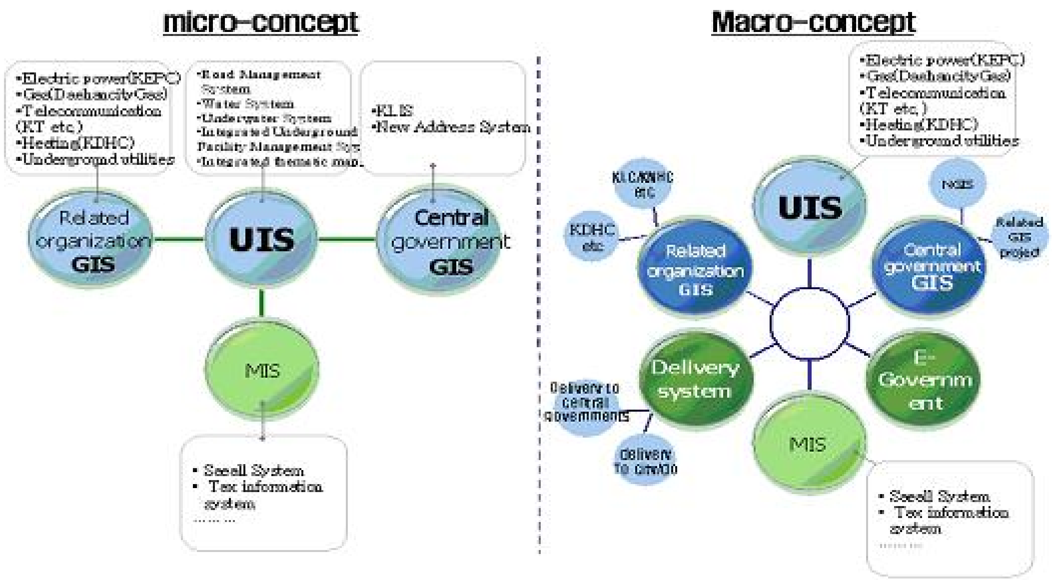


<Figure 17> Interoperability for the future u-Cities and the Prescriptive NSDI

4.7. Local SDI, Substance of the Prescriptive NSDI

Integration and linkage of geospatial information is a first task to be done to be more prescriptive in local governments. Two phases of the integration can be conceptualized at a micro and a macro level.

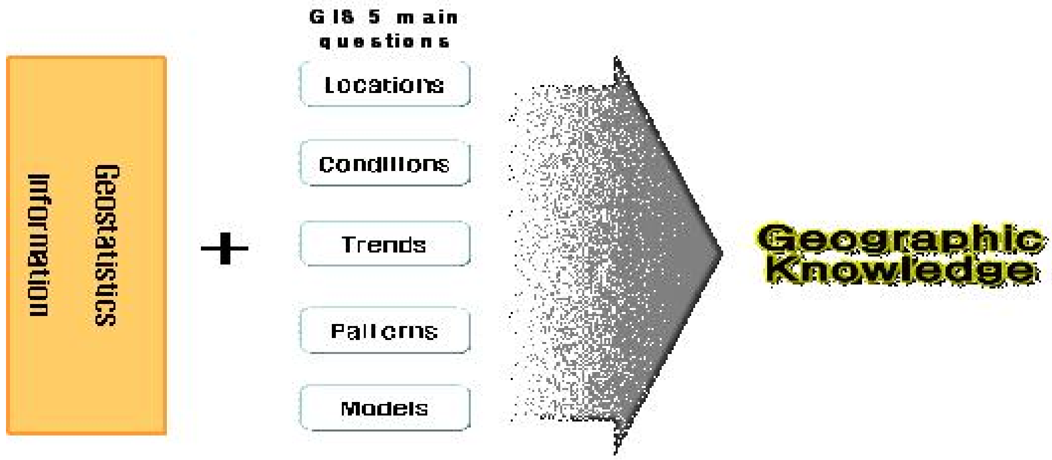
In a micro-concept, the GIS integration by local governments includes the physical integration or systematic linkage of the GIS established and currently operated by local authorities as one unified system. In a macro-concept, the GIS integration by local authorities refers to the linkage of GIS-based information system and management information system (MIS) within the local authorities, and thereby comprehensively integrating the information system of related agencies and central government with that of the private sector.



<Figure 18> A micro-concept and a macro-concept of GIS integration by local by local authorities

4.8. Geostatistics for Geographic Knowledge

Also, Geostatistics is important for the intelligent NSDI. To answer GIS 5 main questions - locations, conditions, trends, patterns and models - a use of geosatistics informations leads to geographic knowledge and intellingent NSDI.



<Figure 19> Geostatistics information as a basis for national geographic knowledge

4.9. Top-down Tasks for The Prescriptive NSDI

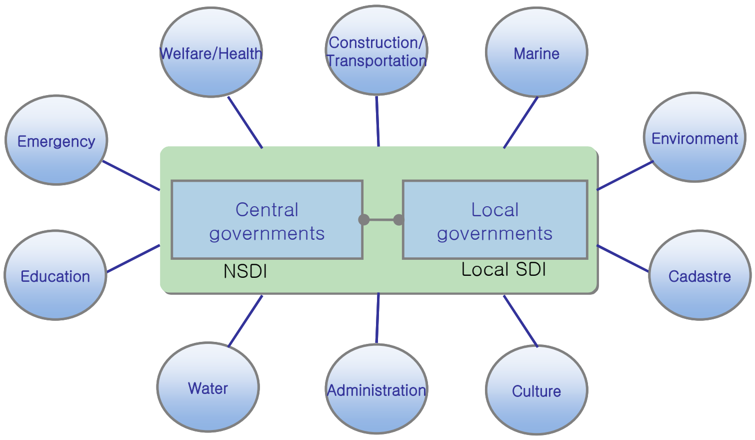
In the Kim's paper(2006), the future direction of the NGIS was summarized in terms of 6 NSDI components: data, access and metadata, standard, technology, partnership, and law/regulations and institutional policy. The tasks identified in the table can be considered for the central government in a prescriptive perspective.

<Table 3> Topdown Tasks for the Prescriptive NSDI in Central Government's Perspective

	Data	Access and metadata	Standard	Technology	Partnership	Law/ Regulations and institutional policy
Integration	NGIS Data specifications for framework data	Evolution of the Korean geospatial clearinghouse	Geospatial profile for the Korean e-Government Enterprise Architecture	Geospatial profile for the Korean e-Government Enterprise Architecture	Enhance collaborative partnership	More practical and feasible vision statement in the NGIS master plan
Interoperability	〃	More recognition of importance of metatdata and semantic interoperability	Standard for geospatial interoperability in e-Government	〃	〃	Adaptation of existing regulations for fitness for use of geospatial information
Intelligence	Data currency and intelligence with UFID	Knowledge based search for metadata	Standard for intelligent service	〃	〃	〃
source: Kim(2006)						

5. CONCLUSION

By having more prescriptive NSDI, administrative and civil services and decisions at a central and a local level can be supported in depth and width for various domains(Figure 20)



<Figure 20> Integrated NSDI with local SDIs

Based on the forementioned aspects of the prescriptive NSDI in Korea, the following tasks are identified:

① 1:1,000 scale and broader themes of the framework data need to be constructed.

② More detailed and informative metadata are needed for more intelligent geographic knowledge.

③ Geospatial web needs to considered as a basic platform for the future e-government and geospatial industry.

④ 3D SDI for all themes of framework data needs to be added.

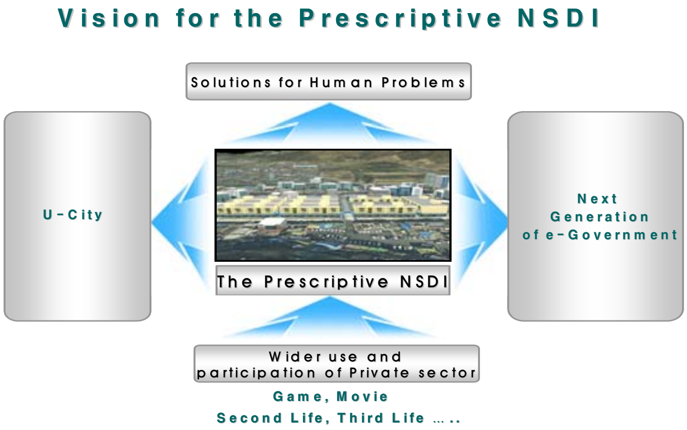
⑤ Geostatistics information for national geographic knowledge needs to be converged with all themes of framework data.

⑥ Upgrading efforts toward geographic knowledge are needed.

⑦ Linked and integrated local SDIs for the prescriptive NSDI are required.

⑧ Korean Geospatial Bluebook needs to be designed and published.

⑨ Top-down tasks for the Central Government need to be included in the 4th phase of NGIS master plan.



<Figure 21> Vision for the Prescriptive NSDI

As indicated in the vision of Figure 21, the roles of the prescriptive NSDI will expand be much more than expected. The previous NGIS projects have accomplished a lot of tasks in local and central governments. By sharing a right and holistic vision, the previous works can be linked and integrated for the better synergetic prescriptions of national importance.

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Integrated GIS Approach in Local Government: As a Case Study in Gift Prefecture in Japan

Dr. Hiromichi Fukui

The Furusato Geographic Data Center,
Gifu Prefecture

Keio University

hfukui@sfc.keio.ac.jp

Keywords: Integrated GIS, Spatial Data Infrastructures, Digital Map Preparation, Geobrowser

1. INTRODUCTION

In the last decade, Japan has developed GIS-based NSDI(National Spatial Data Infrastructures) to promote economic development, good governance, and livable and sustainable development. NSDIs that facilitate the more effective use of national geographic information resources are core contents in an information-based society. There are some key players or stakeholders with interests in geographic information and spatial data infrastructure field from the viewpoint of both producers and consumers side. The following players are listed: Central government organization, Local government organization, Commercial Sector (Information traders and publishers, Hardware/Software vendors, etc.), Not-for-profit or nongovernmental organizations (NGOs), Academics and Individual citizens. This paper focus on GIS related activities that realizing greater speed efficiency and advances in administrative operations in local government as a case study in Gifu prefecture.

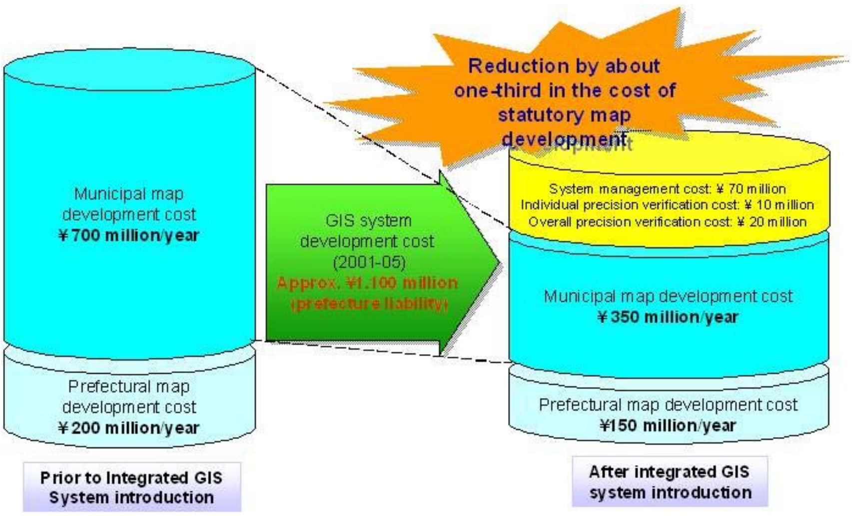
Gifu is situated approximately in the center of the Japanese archipelago, occupying a total land area of approximately 10,621 square kilometers, 2.8% of Japan's total landmass. Of this area, approximately one quarter is made up of highlands in excess of 1,000 meters above sea level. Gifu is abundant in nature, with 81.2% of its landmass covered by woods and forests. The population of Gifu was 2,102,259 in 2007 (Ranks 17th out of 47 prefectures in Japan), a 0.10% decrease from the previous year. There are 725,175 households (0.82% increase from 2006) with each household having on average 2.90 family members (2.93 in 2006).

2. DEVELOPMENT OF INTEGRATED GIS

2.1. Purpose for the Development of the Integrated GIS

Maps are currently developed separately for roadways, fixed assets, water supply and sewer systems, agricultural land and other operations and the cost of developing maps has increased considerably. As long as it is possible to use the same maps in various types of tasks, integrated GIS is an attempt to enable everyone to share and use the same basic maps and its utilization services.

expenses required for map updating by managing shared spatial data based on public surveying as shown in Figure 1.



<Figure 1> Reduction in administrative costs

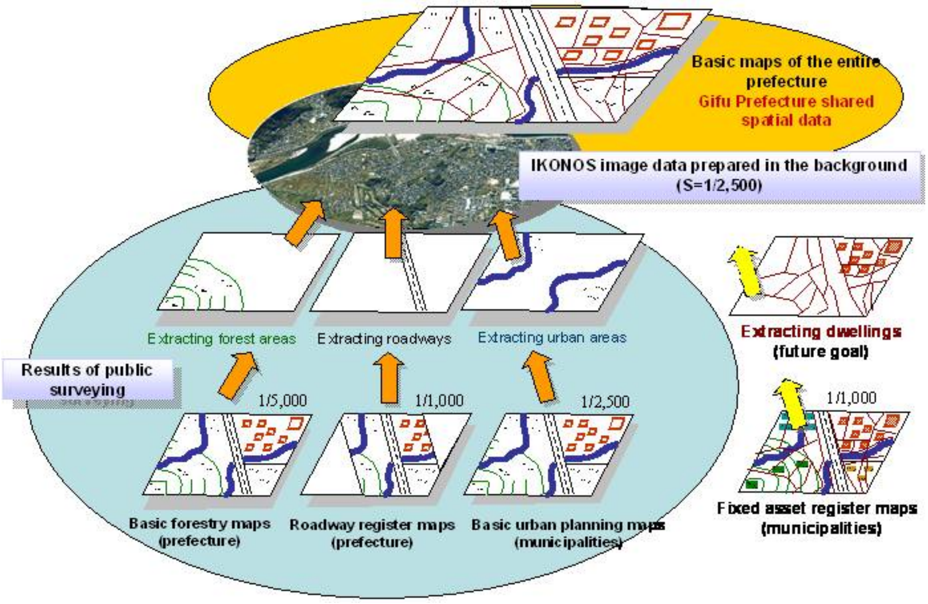
The Integrated GIS also reduce costs for managing and housing severs by integration of severs required for each tasks. It also can minimize and accelerate the work required for information collection, referrals, etc, by promoting the sharing of information on the Internet crossing over barriers between agencies and organizations.

Secondary, the Integrated GIS can improve citizen services. It make a unifiedprovision of disaster prevention and other information in the possession of the prefectural and municipalities closely linked to the local citizens by promoting the sharing ofinformation through an integrated system linking administrative agencies without any barriers between managers

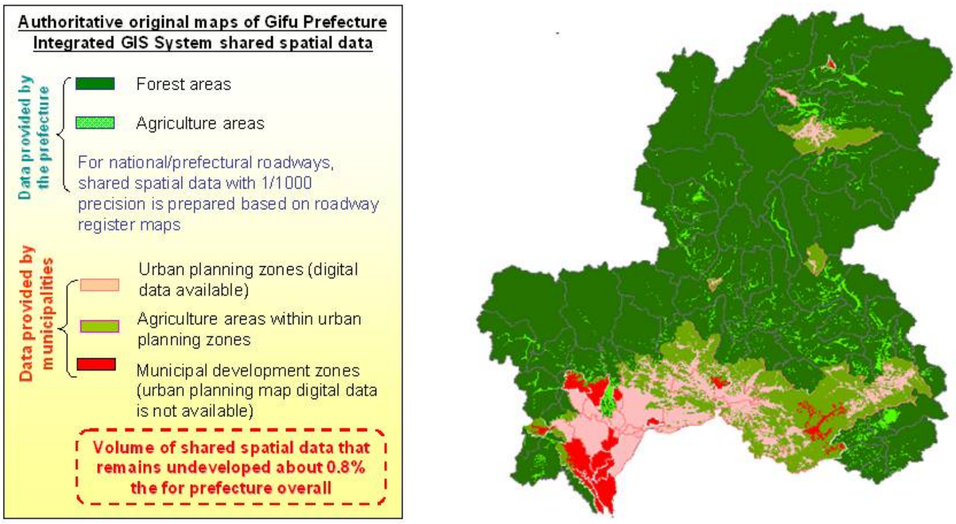
2.2. Development of Gifu Prefecture Shared Spatial Data

The Prefecture and municipalities are cooperating in the development of "Gifu Prefecture Shared spatial Data" which is large-scale maps based on the public surveying as shown in Figure 2. The state of "Shared Spatial Data" Development is shown in Figure 3.

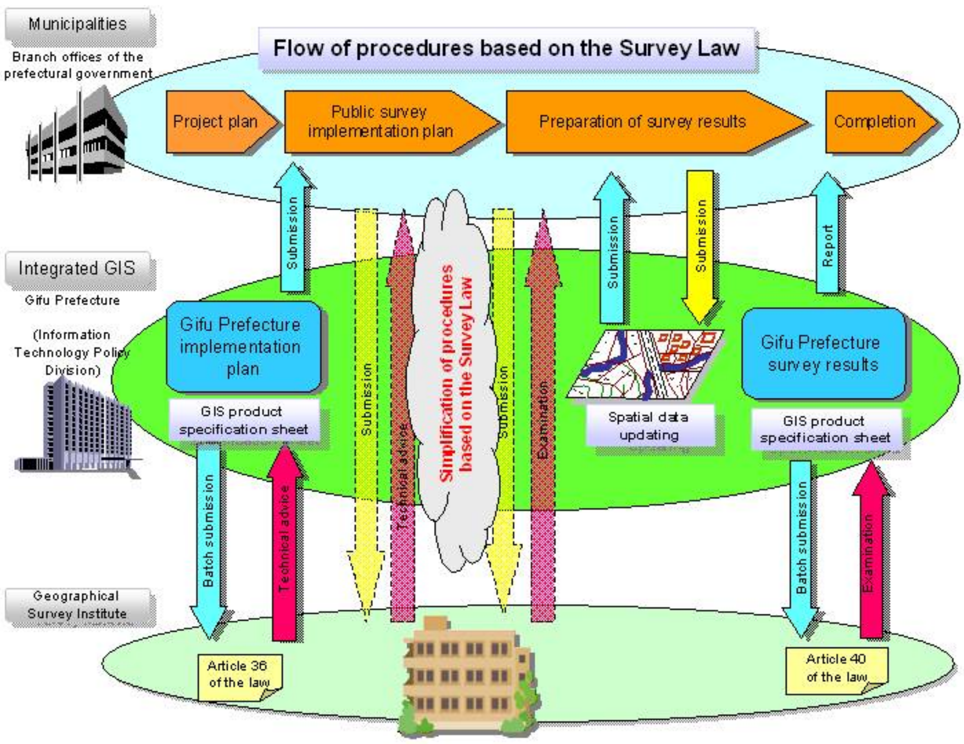
Surveying operations implemented by the national or local governments must be implemented based on survey operating rules pursuant to the current Survey Law in Japan. The survey operating rules provide for the procedures that serve as the basic assumption when preparing maps from the start. To achieve that, as with the Gifu Prefecture Regional Integrated GIS System, it is necessary when developing new maps by integrating existing maps to have product specifications prescribing map production methods that do not exist in the conventional rules. Gifu Prefecture set up product specification sheets in April 2004 with technical advice provided by the Geographical Survey Institute for implementation plans based on product specifications and these specification sheets are in compliance with the Japanese Standards for Geographic Information (JSGI) established by the Institute for the distribution and mutual utilization of the data. Since the prefectural government will implement the procedures under the Survey Law for the aggregate shared spatial data updated by managers based on the product specification sheets, it will be possible to promote the simplification of tasks under the law that have thus far been implemented individually by the municipalitiesas shown in Figure 4.



<Figure 2> The process of Gifu Prefecture Shared Spatial Data Development



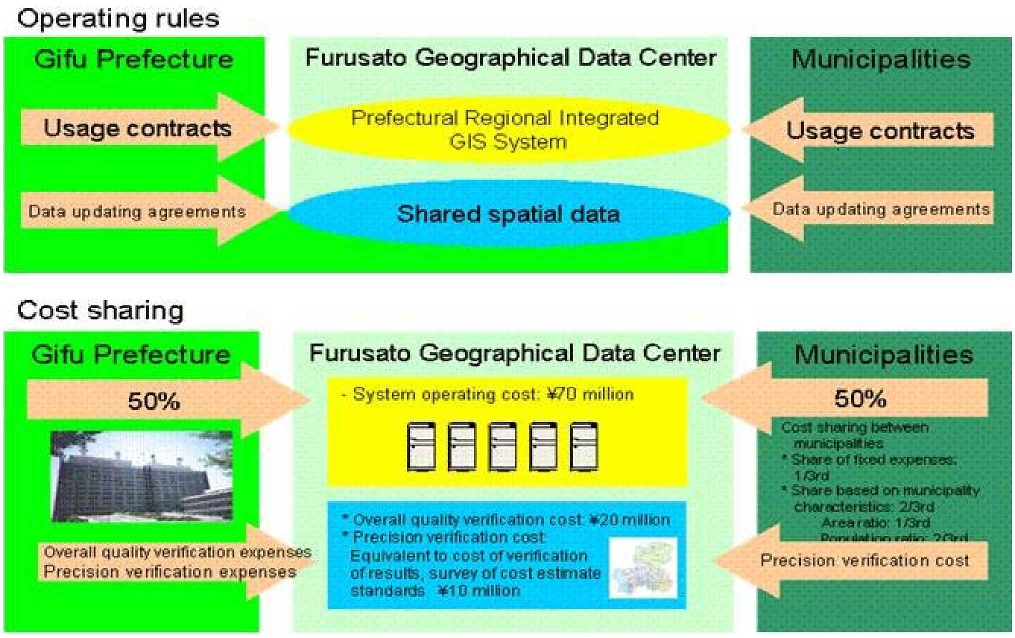
<Figure 3> State of Shared Spatial Data Development



<Figure 4> Aggregate implementation of procedures based on the Survey Law

2.3. GIS Operating Rules and Cost Sharing

The Furusato GIS Center was established for implementation of the development of the Integrated GIS and Shared Spatial Data under the GIS operating rules and cost sharing as shown in Figure 5. This GIS Center also covers Networking, Dissemination development and strengthening capacity of GIS. This Center provide Geo-browsing (browsing digital geographic information over the web by 2D and 3D) by everyone and spatial data registration service for citizens who volunteer new data.



<Figure 5> GIS Operating Rules and Cost Sharing

Services provided based on usage contracts as follows;

<u>A. Services for local residents</u>

(1) GIS data hosting service for local residents

- The capacity provided depends on the usage contract fee.
- If the maximum limit is exceeded, the charge is ￥1,250/GB/month (excluding tax).

(2) GIS mobile phone registration application for local residents"@"@"@

<u>B. Services for internal administrative use</u>

(1) Data hosting service for internal administrative use

- The capacity provided depends on the usage contract fee.
- If the maximum limit is exceeded, the charge is ￥1,250/GB/month (excluding tax).

(2) Data access service and individual spatial data editing function for administrative use

- Map display function
- Individual spatial data editing function
- Data display function
- Search function
- Printout function
- Measurement function

(3) GIS engine for development use

- Provision of GIS engine
- Provision of API specification data
- Provision of coding manual, sample code

(4) Family name and lot number search function

- Provision of Zenrin family name and lot number search function

<u>C. Services for user support</u>

(1) Help desk service

- Inquiries are accepted regarding system operation and use, system failures, etc.

(2) Technical advice for individual GIS system development

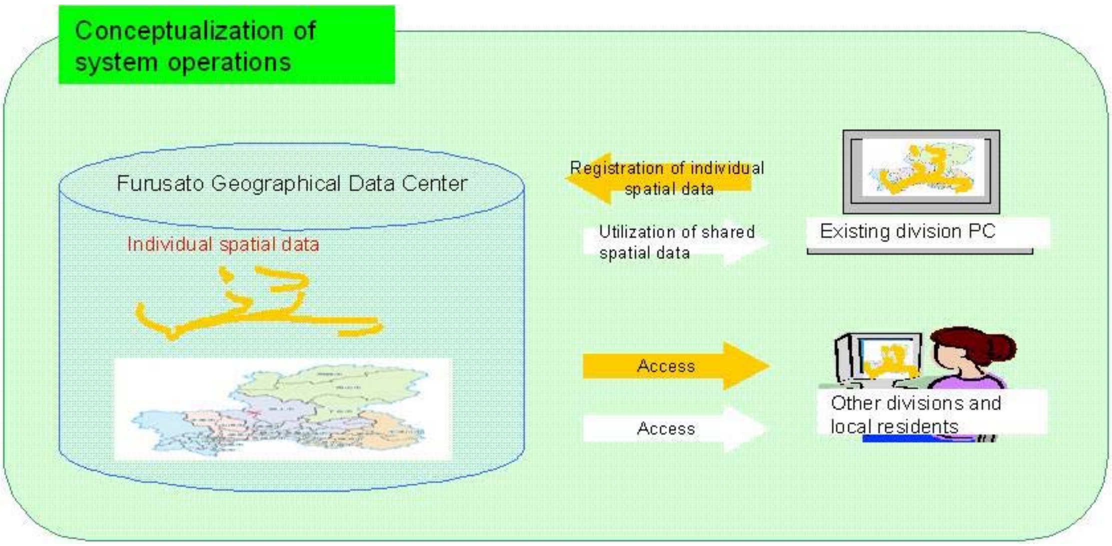
- Technical advice for the development of individual GIS systems established with linkage to the integrated GIS system.

Policies for the operation of the Gifu Prefecture Regional Integrated GIS are discussed as follows;

Section 1 Utilization of the Gifu Prefecture Regional Integrated GIS

Organizations located in Gifu Prefecture shall actively utilize the Gifu Prefecture Regional Integrated GIS ("Integrated GIS") in day-to-day operations with the intention of improving them and shall use it to the maximum in exchanges of information with municipalities. In addition, they shall also strive to reduce paper resources by utilizing it as a medium for the provision of information to the local residents.

Section 2 Basic principles for the updating of Gifu Prefecture shared spatial data



<Figure 6> Conceptualization of Integrated GIS Operations

1) The Road Maintenance Division (Construction Management Bureau) and the Forestry Resources Planning Division (Rural Development Bureau), which respectively manage and update the roadway registers (Roadway Law) and basic forest maps (Forest Law) that represent authoritative original Gifu Prefecture shared spatial data ("Shared Spatial Data"), shall implement the updating of Shared Spatial Data based on public surveying results implemented respectively by them (since the Shared Spatial Data of urban planning zones is considered to be the authoritative original source for basic urban planning maps, municipalities shall update Shared Spatial Data based on Agreements relating to the Operation of the Gifu Prefecture Regional Integrated GIS System concluded separately).

2) Updating Shared Spatial Data shall be implemented through the sharing of expenses by organizations that implement public surveying based on the Gifu PrefectureRegional Integrated GIS Updating Guidelines ("Updating Guidelines") provided for separately.

3) The Construction Research Center of Gifu Prefecture (the "Center") shall conduct quality assessments of updated Shared Spatial Data based on the Gifu Prefecture Regional Integrated GIS Quality Assessment Procedural Manual and shall maintain the quality of public surveying so that it is capable of withstanding examination by the Geographical Survey Institute pursuant to the Survey Law.

4) The division in charge of the Integrated GIS (Information Technology Policy Division, The Office of the Governor) shall submit the updated Shared Spatial Data to the Geographical Survey Institute pursuant to the Survey Law for examination.

5) Organizations other than those noted in item 1) above shall be permitted to update Shared Spatial Data if in compliance with item 2) above.

Section 3 Handling of individual spatial data

Individual spatial data shall, in principle, also be rendered accessible to other users that utilizethe Integrated GIS

Section 4 Development of individual GIS systems

1) When developing GIS systems in response to individual tasks ("Individual GIS Systems"), Web-GIS functions provided by the Integrated GIS System shall be used to the maximum and the reduction of development costs and the sharing of information shall be promoted.

2) Individual GIS that have their own shared spatial data independent of the Integrated GIS System shall, in principle, not be developed.

3. SUMMARY OF GIFU INTEGRATED GIS

The most important characteristic is the fact that the prefecture and municipalities are cooperating in the development of large-scale maps based on the public surveying of the entire prefecture extending over an area of some 10,000km2. This would make it possible not only for the prefectural government but also the municipalities in the prefecture to reduce the cost of map development and promote the sharing of information covering that entire area. Gifu Prefecture has become a focus of attention nationwide since it is currently the only local government in the nation that is developing large-scale maps on a prefectural level

Inquiries to the Furusato Geographical Data Center
http://www.gis.pref.gifu.jp/ (Email address: GIS@crcr.pref.gifu.jp)

Local Spatial Data Infrastructure: Building Spatial Data, Next Year's Great Challenge

Kwon-Han Lee

Center of Housing & Urban Information,
Korea National Housing Corporation
Khlee@jugong.co.kr

Abstract

The objective of this research is to suggest strategies of maintenance and construction of integrated building information as a spatial data infrastructure in a local government. First, we suggested how we can arrange a data model from our consumers in accordance with the international and national standard and a construction plan of integrated building information between spatial data and administrative data by writing a specific guideline for the integration. Second, we developed a plan of real-time updating system by using a blueprint of the most efficient maintenance system in the administration process. Third, we measured various application spheres and expectations in a local government. Finally, we derived possible problems and suggested the solutions of integrated building information for spatial data infrastructure of the federal and local government.

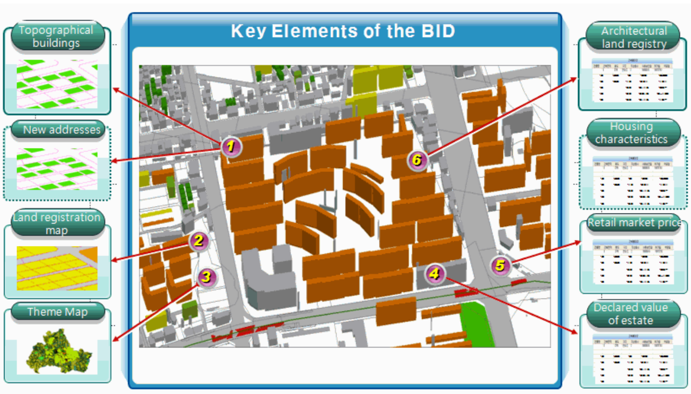
1. INTRODUCTION

In a local government, buildings and estates which include spatial data are treated as a basic data. Over 80% (urban-planning, urban-resuscitation, residence, environment, well-fare, tax etc.) of administration affairs need building and estate data. Therefore, the integrated data of estate and building which is based on spatial data are the core information for local administration. The spatial based estate and building data has been computerized since the mid-90's. The spatial based estate data(a topographical map, a land registration map, expenditure area chart, etc.) have been promoted as a national GIS project. Building attribute data have been promoted as a building administration data project. As a result, we partially obtained improved results for individual objectives from above projects. However, identical object data such as the architectural data was produced and maintained separately, resulting in inefficiency problems in the process of local administration affairs including providing public services.

To establish national land planning such as urban-planning, estate, urban-resuscitation, the government has to collaborate individual data for spatial and attribute data of the buildings. Buildings exist on the ground together, however the residents have to get specific administrative services. There are some cases the building registry exists, but the actual building itself is not on the map, or as in an opposite case the building exists on the map but the building registry is nowhere to be found. These cases decrease the credibility of current administration data. The problem can be solved through unification and consistency in the maintenance of spatial and attribute data. Since they are the core basic data of a local administration, it is urgent to establish the building integration data system.

2. BUILDING INTEGRATION DATA

BID(Building Integration Data) refers to the integrated data of building spatial data and the basic building registry on the numerical value topographical map about 7 milion buildings in Korea. AIS manages the building attribute data. The numerical value topographical map is commonly used for various local data system. KLIS is the representative organization in Korea.

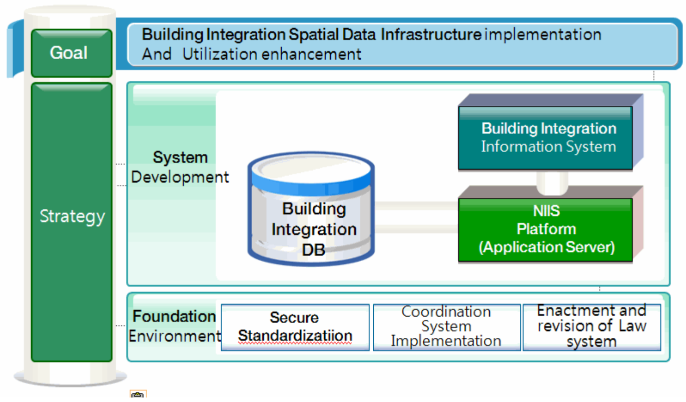


<Figure 1> BID Overview

BID integrates necessary data for local administration affairs from the enormous building attribute data. It includes about 15 basic data such as the date of building completion, structure, usage, the number of layers, etc.

3. ESTABLISHING THE DIRECTION OF BID

Building data is used for various administrational, public, economic, social, and industrial services. Therefore, we can also define this as "National Space Data Infrastructure." According to NGIS law Clause 1, Art. 15, the basic GIS(Geologic Information System) is defined as the facility information including the building information. Accordingly, BID as a National Space Data Infrastructure has to establish on the following conditions. First, it should be a geological information which can be used for national geological information system establishment. Second, it should provide a basic geological information for enormous and various aspects. Third, it should be easy to add various geological information geometrically and spatially.



<Figure 2> BID Implementing Direction

4. PLAN FOR BID DATABASE ESTABLISHMENT

4.1. Establishment Direction

The BIDB establishment can be divided into logical method and physical method. The logical method connects information through the ID. Building spatial data and a building registry are managed by separated DBMS. The physical method unifies the building spatial data and the building registry together and it is managed by DBMS. The most reasonable integration method could be different according to a local autonomous entity's computing environment. However, considering the following result, the physical method will be the best option. First, this method could be used directly without additional operation in terms of data connection and practical use. Second, physical method shows great performance when it inquires and analyzes data as well as having a very low rate of errors. Third, it is necessary to have highly demanding attribute information to become a basic geological information.

4.2. Database Establishment Plan

■ **Data Model**

BID(Building Integration Data)'s data model is based on the international standard drawn from ISO TC211 19100 series. The basic data model expresses geographical features based on general feature model of ISO 19109 (Rules for application schema) the international standard. Geometry and phase structure refer to ISO 19107. Other data models such as conceptual schema language, temporal schema and meta data are based on international standard. The attribute information which is contained in BID will be defined by the consumer (the ones who will use the DB in the future) through the survey.

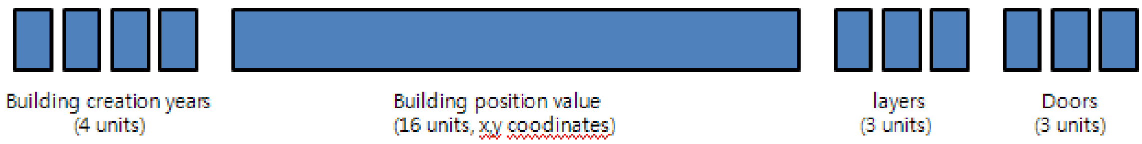
<Table 1>

Definition				
Name	Building	English	F_FAC_Building	
Definition	A structure with a roof, a wall and a pillar which exists on the ground and other facilities such as an office, a hall, a shop, a garage, a warehouse in underground or an elevated structures.(Construction Law: Item 1 of Art. 2)			
Definition of Attribution				
Name	Explanation	English	Type	Domain
Building Name	A name of a building.	a_FAC_Building_Kmname	Varchar2	None
Layer	A number of layer.	a_FAC_Building_Floor	Number	A division of layer
A lot number	A lot No. of a land with building.	a_FAC_Building_Jibun	Varchar2	None
UFID	Unique Feacher IDentifier	a_FAC_Building_Ufid	Varchar2	None
Area	Area of building(m2)	a_FAC_Building_Area	Number	None
Plottage		a_FAC_Building_TotalArea	Number	None
Plottage		a_FAC_Building_PlatArea	Number	None
Height	Height of a building.(m)	a_FAC_Building_Height	Number	None
Use	Building type for use defined by an attached tabel 1 of the construction law	a_FAC_Building_Usability	Varchar2	Building Usage
Structure		a_FAC_Building_Structure	Varchar2	None
The Building to Land Ratio		a_FAC_Building_BuildingRatio	Number	None
A Floor Space Index		a_FAC_Building_UsabilityRatio	Number	None
Spatial Information Source		a_FAC_Building_Bld_Src	Varchar2	Present
Property		a_FAC_Building_Att_Src	Varchar2	Present

Information Source				
Identification number Key	Identification number from a building register	a_FAC_Building_Number	Varchar2	None
Date of Approval	Date of Approval for use.	a_FAC_Building_Useapr_Day	Varchar2	
Error Code		a_FAC_Building_Err_Cd	Varchar2	Present

■ Unique Feature IDentifier (UFID)

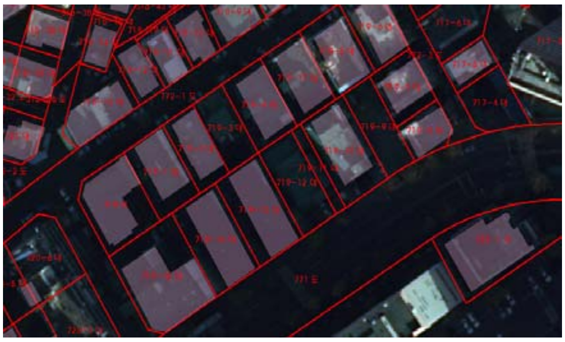
We need UFID as the functional link for effective BID connection and maintenance among related information systems. UFID requires the following fields. First, UFID should not be affected by external factors. Second, UFID needs to identify the minimum unit(elementary unit) of information for administration. Third, UFID can not be restricted to specific affairs. Forth, UFID could be produced and maintained by the department which makes the information for the first time. Fifth, UFID has to have enough space and a flexible allowance system. The BID UFID will be made for 26 units apply to those conditions mentioned above. The 26 units will be used for building creation years (4 units), a building position value which is based on international geodetic coordinate system standard(16 units), layers(3 units) and doors(3 units).



<Figure 3> Structure of the UFID

■ Spatial and Attribute Data Matching

We must use a series of number data for automatic matching between building object from a numerical topographical map and attribute data of a building registry. However, the building object from a numerical topographical map doesn't contain the lot number attribute. Therefore, the building object needs the lot number producing procedure. For this procedure, we need to make a barycenter point of building object at first. After that, create the lot number attribute of building object through overlap of a numerical topographical map which has the lot number attribute. And establish BID through an automatic matching of attribute data from a building object of a numerical topographical map and a building registry based on the created lot number attribute. According to some of the last tests, the automatic matching rate of a densely populated city (metropolis) was about 70% and a farming area showed about 60%.

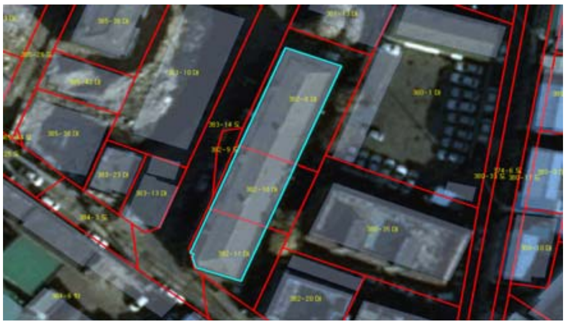


<Figure 4> Automated Matching

The attribute data which can't be matched automatically should be matched manually by an operator and he/she has to investigate the pattern and the cause. The common cases are as follows:

○ Multiple Land Piece :

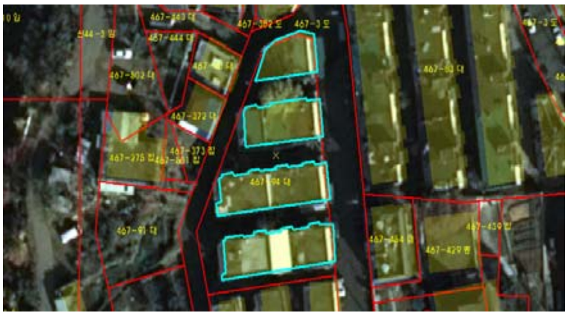
The picture number 6 shows the case of an independent building in multiple land piece(lot). This isn't an error, however it needs a program which can match those multiple land piece and an independent building. In this case, we can simply use a representative lot number from a building registry for the matching procedure.



<Figure 5> Multiple Land Piece: single building

○ A Single Land Piece : multiple buildings

There are many cases that a single land piece contains multiple buildings. This is a common example of an apartment complex and an apartment house in a single land piece. In situations like this, one lot number attribute should match multiple building objects. Therefore, it is necessary to inquire a building registry of each building and connect to register number.



<Figure 6> A Single Land Piece : multiple buildings

○ When the building exists in a building register but not in a topographical map

Most of the these cases occur when a blue print wasn't updated properly. In this case, the operator can solve the problem through a field survey, an air photo and a satellite video. To display buildings after the checking, use a planning permission or a blue print which submitted for the building completion.

○ When the building exists in a topographical map but not in a building registry

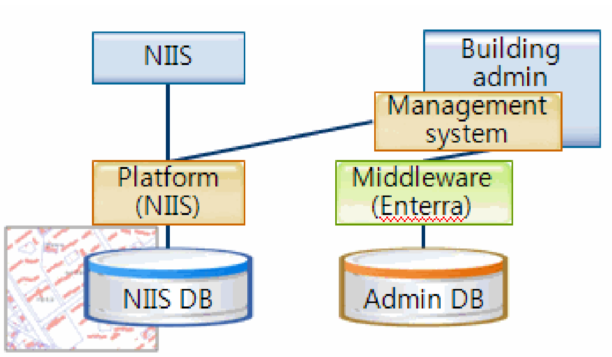
This case occurs when the building was constructed illegally so that it isn't registered or when the building was removed but still exists in a blue print. The operator has to delete this building after inquiring through a field survey or an air photo or a satellite video.

○ Miscellaneous

Sometimes a building shape is different from the shape represented on a numerical topographical map. This case occurs when the map isn't updated properly. This can be solved by changing it through a submitted blue print for a planning permission or a building completion. If the building in a numerical topographical map can't be matched with a lot number attribute in a registry, the problem can be solved if the picture changes after matching with related spatial information and environ lot numbers.

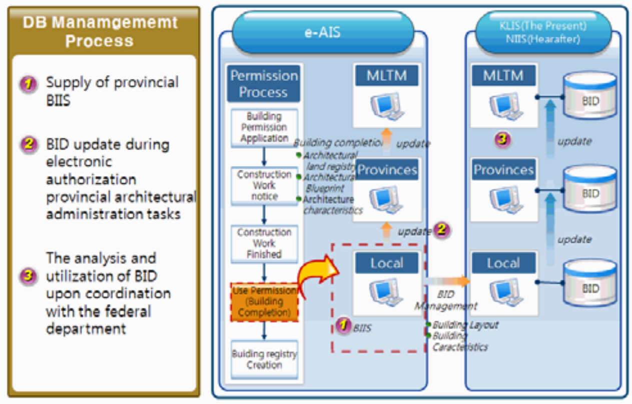
5. DIRECTION FOR BID MAINTENANCE AND DEVELOPING SYSTEM

To develop a maintenance system, we need to consider about a user, a DB updating period(cycle), budget and connections with information system. First, the developing system should be used by a user who can manage BID efficiently. It would be plausible to have a building administrator who produce and manage the related information relevant to the task.



<Figure 7> National Integrated Information System

It is better to use the existing computation resources than taking a new H/W or S/W in terms of the connection and economical aspect. We develop the program applying the maintenance system of Land Integration Data System and using computing resources of AIS.



<Figure 8> Maintenance Process

DB has to be updated as soon as there is a change in BID. There were planning permissions for 188,000 buildings(means total 133.3㎢) in 2007. There are new buildings approximately 15 times bigger than Yeo-yi-do in one year. It is very important to have the latest update especially for the very flexible information by reason of this, we need a real-time managing system. The updating needs to be contained in building administration process for this. It is necessary to force update BID first before go over the next step building administration. However, the submitted blue print standardization is the top priority for efficient updating.

In conclusion, it is ideal to set the BID managing system as a building administration sub program. The building administrators in a local autonomous entity will update BID through the managing system and the data will be reflected to the original BID in LIDS(Land Integration Data System) automatically. BID of fundamental self-governing local government bodies should be collected to the pertinent city or province in accordance with the LIDS. The final data will be collected by the Ministry of Land, Transport and Maritime Affairs.

6. THE ESSENCE OF BID ESTABLISHMENT AS A FRAMEWORK DATA OF A LOCAL GOVERNMENT

6.1. Practical Uses

Information oriented project at a local government has been carried out separately as an administration information plan and a spatial information establishment plan until now. This environment made BID for specialized purpose at a local autonomous entity when they needed. In this case, we face a limitation of information sharing due to absence of related standards. If we consider this situation, we may call the BID establishment plan in this year as the first national information project which will build spatial information and administration information with standardized integration information. It is expected that the new BID will show such a high efficiency for not only the central government but also for the local municipalities.

First, it will be used actively in facility management responsibilities. We can estimate a budget for water supply pipeline establishment and quantity of provision and processing by considering a location and a scale of building automatically. Furthermore, we can monitor water supply facility information in detail so we can check outworn equipment and prevent leaking.

We expect that this also will be useful for local tax and a house tax standard value estimate. The person in charge checks and collects information from a building manage register and does a field research at present. However, if one uses BID, he does not need to spend his time for those researches. In addition, BID can be programmed to PDA and other mobile equipment so that we can use it for the field research outdoors.

BID is especially useful for a demanding forecasting of urban restoration area(land and building) and analyzing data of a local government. It is also possible to select an urban restoration proposed site and analyze a simulation in accordance with a government policy.

BID which includes various information such as location, structure, material, blue print is the intrinsic information for fire and disaster prevention affairs.

Besides all of these aspects, BID will be used as key information in many other fields such as the realization of u-City, 3-dimensional GIS and customized public services.

6.2. Expected Results

Local governments can expect the following results from BID establishment.

First, public trust in the administration will increase. Coherency of spatial data and attribute data will satisfy many public services and potentially be capable of raising credibility of the administration.

Second, we can guarantee an authentic, accurate policy. This is because we can have authentic results by analyzing accurate building related information.

Third, we expect that the administration efficiency will be improved. We can check the data accuracy through comparison of land, building and spatial information in real-time so that we can save our time and staff-power for all the information research.

Forth, we will provide a better service for the public. They can have an integrated service instead of having individual approaching service. Furthermore, it will be used for various businesses which are aiming to make benefits based on land and buildings.

7. PROBLEMS TO BE SOLVED IN THE FUTURE

Source data to establish BID(Building Integration Data) is produced and managed by individual information system at present. Connections among systems are not smooth (connections between each systems do not run smoothly). It has different information even though it is the same object. This is not a system (systematic) problem but a transient phenomenon to become an information oriented nation. We need a partnership which can help to fix and adopt the mutual errors from BID establishment. This project can be completed successfully when all the related departments, such as Dept. of GIS, Land and Building, cooperate together from offering source data to DB inspection and maintenance so that we will achieve high quality BID.

There is no direct system for BID establishment and maintenance for the moment. Systematic policy is needed. It is necessary to arrange related decrees and need a detailed guideline. The decrees which should be arranged for BID establishment are the building law, NGIS law, the house law and regulation for a building register. In case of the building law, NGIS law, the house law need an arrangement for maintenance. The blue print standardization is also necessary to update BID efficiently through the blue print from a building completion.

Building Integration Data establishment is important project as a national framework data and that can build core information which has enormous demands in local autonomous entities. Pilot project for 6 local governments will be finished in this year and it would be a nation wide project in next year. We may face on unexpected problems during the nation wide project. This is the time that we need to have positive act and creative mind which is not afraid of failure or a process of trial and error. We must do enough research to solve problems from diverse aspects at the same time. All the efforts mentioned above can lead successful BID establishment project which will combine spatial information though a national GIS project and administrative information which is established for administration information plan.

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One-Click Spatial Data Warehouse for Geographic Information

Su-cheon Kim

Informatization Officer,
Daejeon Metropolitan City
sckim@daejeon.go.kr

1. IF YOU WANT TO ACQUIRE SPATIAL INFORMATION, JUST ONE CLICK WILL DO IT

What does the town where I live look like from the sky? Is there anything under my house? You do not have to agonize to figure the answers any longer. Just one click will do it. As Daejeon City established a spatial data warehouse, it became possible to effectively implement integrated management of various facilities related to roads, land, electricity, gas and communication lines dispersed in the wake of rapid urbanization in addition to digitalized aerial photographs and the Korea's first three dimensional virtual city, which makes it possible to acquire geographic information on Daejeon City at a glance. It has enabled the city to raise efficiency with regard to the provision of services and the implementation of administration and laid the foundation for informatization contributing to realizing a safer and more convenient city.

It aims to suggest a desirable blue ocean strategy on geographic information on the part of a local government based on a spatial data warehouse and an abundance of spatial information and general administrative information.

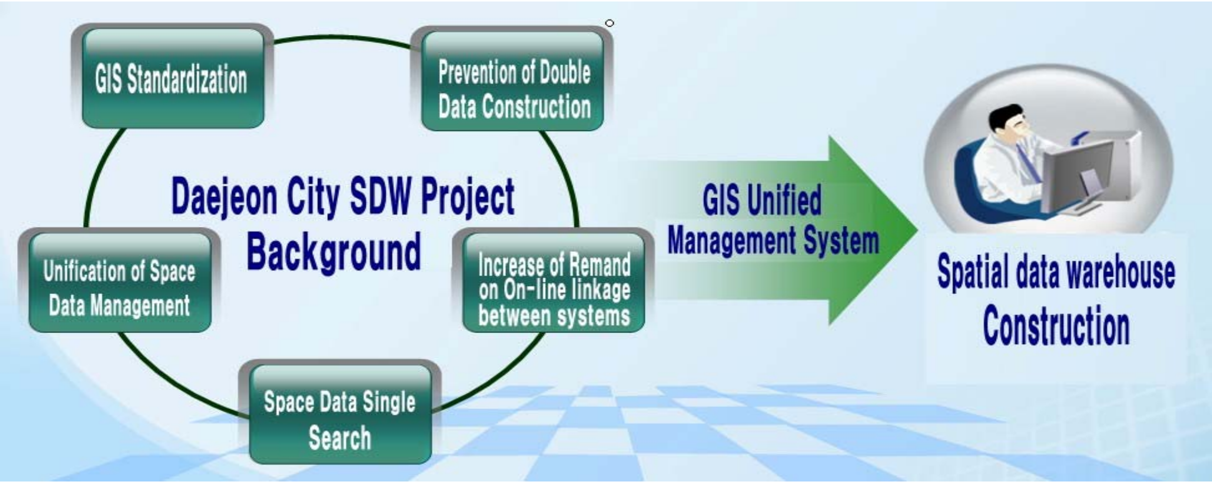
2. IS IT A WASTEFUL PROJECT?

Daejeon City that initiated the National Highway Information System in 1990 established a basic plan on the establishment of comprehensive city information system in 2002 and manufactured a topographical map and various geographic information systems by department. It has also established various systems on roads, water supply & drainage, underground facilities and land management to make use of them. However, since the geographic information system is high priced, the city invested as much as 21.6 billion won.

As the high priced geographic information system was developed centering around a unit work system failing to integrate departmental operations, technologies and standards varied depending on system development service providers making it difficult to link and share systems and costing the city a huge amount of money.

The lack of operational linkage of geographic information made it difficult to acquire the latest information, figure the location of data and contents established by each unit operation. It also resulted in wasting administrative capability and budget forcing the city to reprocess and use the same information by operation and failing to immediately reflect informational changes, which reduced informational consistency and administrative credibility. Against this backdrop, the city became interested in an integrated information enabling the systematic provision and management of various city information to counter complexity and diversification of urban systems.

As a result, the spatial data warehouse system was created based on an enterprise system that can organically and logically integrated and share the entire geographic information of Daejeon City through the introduction of comprehensive analysis system on the back of systematic management of data.



<Figure 1> Daejeon City SDW Project Background

3. IT STARTED LISTENING TO CUSTOMERS' OPINIONS

Daejeon City conducted survey of each and every department and geographic informationrelated departments for 2 months twice. 13 departments related to GIS were visited and surveyed to figure what is a problem and what is needed, and the entire departments were polled based on the result to figure what administrative information is used and needed by city officials

<Table 1> The Current State of Survey

Distinction	1st round of survey	2nd round of survey
Time	June 23 ~ July. 23, 2004	August 2 ~ August 16, 2004
Subjects	13 eographic information related departments including Land Information Department and Transportation Policy Department	Each and every department of the city, guns and offices
Method	Visits and questionnaires	Itemized investigation into demands
Contents	Investigation into the frequency of use of geographic information by each department	Examination on the use of a map manufactured based on the 1st round of survey by geographic information
Results of questionnaires	• Out of a total of 219 geographic information materials, 39 materials are used by 5 or more departments, and information on roads, buildings and administrative economy is universally used by departments related to geographic information. ※ 39 commonly used items : Standard point, road boundary, central road line, pavement, 3 D intersection part, tunnel, tunnel entry, railway boundary, central railway line, subway track, riverside expressway, contour, altitude point, river boundary, central river line, direction of flowing stream, lake/reservoir, continuous land registration, topography/land registration, administrative boundary, overpass, bridge, building, fence, embankment, floodgate, underground passage, subway station, digital ortho photo, satellite image, identical building boundary, basic interval line, map quadrangles line, gas, heating, electricity, communication, oil pipeline • Common data items need to be determined through comprehensive analysis on the flow of data between systems and the degree of importance and use of data.	

<Table 2> The Current State of Manufacture of Topographical Map

Scale	Size (㎢)	The number of map sheets	The year of manufacture	The department of manufacture	Area	Remarks
Total	436.44	1,592				
1/500	49.92	801	'90~'98	Road department	Downtown	
1/1,000	203	835	2002~2007	Informatization Office, Road department	Downtown	
1/1,200	39.30	105	'98~2003	Urban Planning Department	The suburbs	
1/3,000	206.70	108	'98~2003	Urban Planning Department	The suburbs	

<Table 3> The Current State of Image Materials

The name of image materials	Resolution (m)	The year of photographing	The purpose of manufacture	Area
Aerial photographs (film & photos taken at hand)	1/5,000	From 1972	The current state of management of use of land by year	The entire city
Aerial photo image map (black & white)	1/5,000 (photographing scale 1/20,000)	2001	Manufacture of an image map	The entire city
Aerial photo image map (color)	1/5,000 (photographing scale 1/10,000)	2003	Manufacture of an image map	Downtown
Digital image	0.2	2007	Establishment of digital image information	155㎢

<Table 4> The Current State of Establishment of DEM/LiDAR

Distinction	Lattice interval (m)	The year of establishment	The purpose of establishment	Area
DEM	1m	2003	Establishment of a three dimensional spatial information system	131.3
LiDAR(DEM & DSM)	(1m) accuracy 30㎝	2005	Establishment of a multi dimensional spatial information	540㎢

<Table 5> The Current State of Establishment of Geographic Information System

The name of system	Used areas	The amount of established data
Water service facilities management system	Water service facilities management	- Underground facilities : 1,701km - Materials, construction design and etc.
Integrated underground facilities management system	Prevention of accidents caused by damaged facilities due to construction including road excavation on the back of integrated management of 7 representative underground facilities	- Topography: 540㎢ - Road facilities: 190㎢ - Underground facilities: 10,112㎞
Road management system	Prevention of accidents on the back of systematic management of road related facilities and inquiry of road designs and etc.	- Topographical map: 540㎢ - Road facilities & underground facilities
Topographical map use system	Search and provision for the use of a topographical map	- 1,132 Topographical map sheets
KLIS	Provision of land related information	- Continuous land registration map : 540㎢ - Topographical map : 540㎢ - Thematic map (used area & district) : 540㎢
New address introduction system	Provision of geographic information including the introduction of addresses	- The entire city (540㎢)
Emergency rescue system	Detection of location of a reporter and a disaster area at a time of reporting through 119	- Use of new address data - Establishment of a fire prevention thematic map
ITS	Convenient provision of various transportation information to citizens	- Topography : 540㎢ - Electronic road network : 900㎞
Sewage facilities management system	Scientification and stabilization of maintenance and management of sewage facilities	- Sewage pipes and facilities
3-dimensional spatial information system	Provision of simulation with regard to right to view and sun light in accordance with city planning	- Topographical map and LIDAR DEM - Color image

4. THE ESTABLISHMENT OF A SPATIAL DATA WAREHOUSE WAS INITIATED IN EARNEST

Feeling the necessity of establishment of a spatial data warehouse that can effectively implement an integrated management of geographic information in which a huge amount of budget money was invested, Daejeon City pushed for a 3 step project from 2005 to 2007.

First of all, the city visited 13 departments dealing with GIS related operations and conducted analysis in detail in cooperation of departmental heads and people in charge.

The analysis found that the regular renewal of spatial data instead of real time update caused inconsistency, and needed data are sporadically dispersed in each and every department and that the dispersed data have not been effectively linked. Analyses on 10 systems related to a topographical map, road management and water service that Daejeon City is currently using also found a lack of management and integration of GIS data in addition a great risk of change in data and redevelopment of applications at a time of change in a GIS engine due to the fact that the current GIS DBMS is so dependent on a specific company.

In order to resolve the problems, a project has been introduced to effectively manage GIS data and establish GIS Council aimed to jointly use data in addition as well as a system that can be used regardless of engine type in consideration of the necessity of standardization to counter changes in engines and dependency of the DBMS engine on a specific company. In addition, the project aimed to help users establish a user friendly system through the use of common spatial data.

<Table 6> An effective spatial data warehouse for resource management was established in the following way

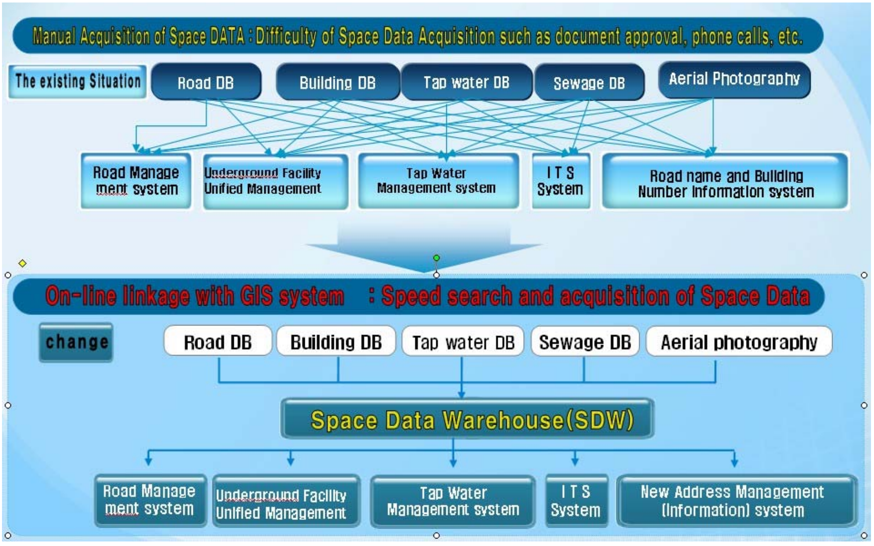
By step	Project cost	Contents
Step 1 (2005)	376 million won	• Establishment of a GIS integration strategy plan for Daejeon City • Establishment of a phased implementation plan for a spatial data warehouse • Establishment of a basic plan for a spatial data warehouse and a demonstration system • Establishment of a frequently renewed spatial data system through the use of a construction plan • Development of program to change coordinates of World Geodetic System
Step 2 (2006)	432 million won	• Pursuit of joint use of geological information system and administrative information system - Linkage of 10 geological information systems and 4 administrative information systems • Establishment of a system for joint use of urban information that can be used by all civil servants in the city
Step 3 (2007)	432 million won	• Establishment of an analysis theme data mart - Realization of 42 items in 8 sectors including population, housing and industrial economy • Establishment of a system to provide analysis materials required to analyze various city information in connection with administrative information - The current state of decrepit buildings, forecast of road opening costs, analysis of land costs and etc. • Establishment of a geographic information portal system for citizens

5. IT RAISES THE DEGREE OF USE THOROUGH THE LINKAGE AND INTEGRATED MANAGEMENT OF DATA

Daejeon City linked all geographic systems operated based on Daejeon City linked all geographic information systems operated based on topographical maps on line. Currently, as 10 geographic information system databases are linked (two way), a renewal interval has been reduced, and the latest data supply system has been established.

As seen in the following figure, the resources of database and related relationship diagrams are complicatedly linked, it was difficult to acquire data whereas the current system is based on 10 types of geographic information systems interlinked on line through the use of a spatial data warehouse, which makes it easier to search and acquire data.

Common spatial data commonly used in various geographic information systems was selected to establish a common base of database. A total of 5 types of administrative information systems were linked through the classification of general administrative information that can be interlinked with spatial information into building, land and administration based database. Spatial data analysis theme service in Daejeon City aims to select 66 types of themes in 11 sectors related to city planning, and a data mart was established through the processing of administrative data. The analysis theme service provides users with analysis results supplied to users through the use of easily accessible WEB, and since it can be saved in the form of spatial data or figures, it can be maximally used.



<Figure 2> Comparison of system composition diagrams

7. A HUGE AMOUNT OF GEOGRAPHIC INFORMATION IS SEARCHABLE BASED ON CLOSE COOPERATIVE SYSTEM

The spatial data warehouse in Daejeon City links the headquarters, 5 main ward offices and branches, and this network environment enables users to search an astronomical amount of geographic information.

The spatial data warehouse in Daejeon City is not a single handed operation system. It can be smoothly operated through the use of close cooperation among geographic information related departments. The cooperative system is realized by a geographic information task force team centering around Informatization Office.

The geographic information task force team consists of Informatization Office, System Operation Office and System Use Office, and Informatization Office deploys a task force team to implement integrated management of spatial data warehouse and geographic information. The System Operation Office runs systems linked to the spatial data warehouse and does not operate geographic information system, but it has close relationships with geographic information related obligations, so it uses the geographic information on a frequent basis.

Since the introduction of the spatial data warehouse, work process for the use of city information has sped up as shown in the following figures. Prior to the introduction of the warehouse, it was a 4 step process starting with the consultation step, but after the establishment of the system, the unnecessary 4 steps were eliminated.

8. EFFORTS TO REALIZE COMMON USE OF INFORMATION WITH OTHER INSTITUTIONS

It requires the linkage of systems and the common use of administrative information in order to realize integrated use of existing systems, but it went through difficulties due to complex administrative procedures and diversified consultation subjects. However, the commonly used system was established based on cooperation through 20 consultations with the central government agencies, 10 meetings by a task force teams, 2 surveys, 3 review of security and on line data linkage technology and the analysis of usage examples of other local governments.

In addition, it enabled all civil servants to use information provided in connection with the 3 dimensional virtual city system that is similar to a real world, which was jointly developed with ETRI for 2 years.

<Table 7> The Current State of Commonly Used System in Connection with the System

Distinction	Name of system
Geographic information system (10 types)	Integrated underground facilities management system, water service facilities management system, topographic map usage system, road management system, KLIS, new address introduction system, emergency rescue system, ITS, 3 dimensional spatial information system and disaster response system
Administrative information system (5 types)	Provincial and municipal administrative information system, administrative information system, architectural administration information system, resident registration system and e Settlement system

Linkage of administrative information was a stumbling block due to non standardized supply of data, discrepant coordinates and irregular address system, but it was resolved through additional conversion aimed to link with the system.

9. FREQUENT RENEWAL OF SPATIAL DATA THROUGH THE USE OF A CONSTRUCTION COMPLETION PLAN FOR THE FIRST TIME IN KOREA

Daejeon City pushed for effective maintenance of spatial data that is the basics of the geographic information system and conversion of coordinates of the World Geodetic System to be introduced in 2007 along with the implementation of a spatial data warehouse.

Currently, inefficient renewal of spatial data is a common problem facing all local governments. There have been a lot of studies and examples as to how to keep spatial data up to date, but Daejeon City applied practical measurement and field works in addition to research services, and as a result, the project figured the way to keep the spatial data up to date.

As a result of various reviews to figure the best way, a strategy to renew spatial data through the use of a construction completion plan was established, and demonstration areas were selected accordingly.

Accomplishments were compared with contents by sector including land development, road, water service and sewage service, and frequently renewable software was developed and whether renewal directives and calculated costs are practical was reviewed by related institutions in order to produce work directives.

A completion plan provider renews a GIS plan at a time of completion of construction, and GIS DB is renewed through the use of software developed by the project. Daejeon City concluded it saved 67% of the cost of establishment of GIS and reflected it in construction plan directives in February 2007.

<Table 8> Performance analysis on frequent renewals

Distinction	Before — As Is	After — To Be	Remarks
Costs (per ㎢)	33,972,000 won	11,019,000 won	67%
Renewal interval	It takes 4 to 7 years	It is renewed within 30 days of the completion of the project	
Use by related institutions	Separate renewal of DB by institutions	Use at the same time as the completion of renewal	
Service provided to citizens	Provision of services through the use of old fashioned topography and structures	Provision of the latest services regarding changes in topography and structures	

As the World Geodetic Coordinates were introduced in 2007, the city developed a program to convert existing spatial data for the first time among local governments and had National Geographic Information Institute verify it, and its appropriateness was notified in July 2006.

As the program was verified by the national institution, it is expected to be used to convert various geographic information into the World Geodetic System and distributed to the local governments free of charge so that they can save software development costs.

10. IMPLEMENTATION OF THE BEST SYSTEM DIFFERENTIATED FROM OTHER LOCAL GOVERNMENTS

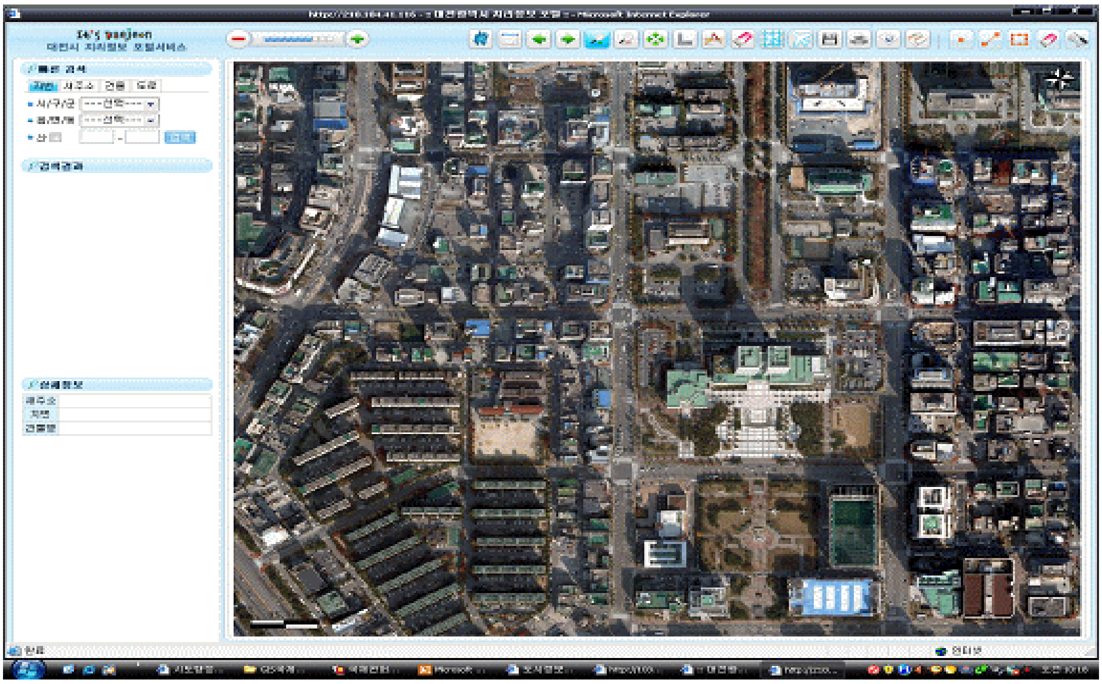
In order to establish a commonly used system through the use of spatial data warehouse, technologies aimed to share different types of data to be established in the future are required, so Daejeon City linked all geographic information systems in the city on line by establishing a system where data can be commonly used in different systems. It helped save costs due to redundant establishment and maintain the latest geographic information among systems.

※ DP (Data Provider) : Joint development of interface/ETRI for data compatibility among different types of GIS engines

In addition, the Korea's first aerial photo service provided to citizens is receiving good response from citizens by establishing aerial photos in all areas in Daejeon City through the use of advanced aerial photo manufacture technologies and providing aerial photos that are 4 to 25 times more precise than before. As a three dimensional spatial information system is implemented realizing a three dimensional simulation that is the same as the real world, it enables users to review post completion virtual results before establishing a city plan and implementing city development projects and road construction projects making it possible to reduce trials and errors at a time of establishing various policies and supporting scientific and rational decision making.

A three dimensional virtual city aims to establish all visible objects (mountains, rivers, roads, buildings and etc.) in a real world in a three dimensional way, and it is drastically differentiated from a two dimensional information aimed to express the location of various facilities on a map.

<Figure 3> The screen of analysis of right to sunshine in the 3 dimensional spatial information system



<Figure 4> The screen of high precision aerial photo service for citizens

11. SAVED BUDGET AND INCREASED SATISFACTION

Since common spatial data in the existing spatial data warehouse can be used, redundant establishment is not needed, and budget was saved. According to the example of the establishment of sewage facilities management system pursued in 2007, of 2265 million won required to establish a total of 41 layers (DB), 1615 million won of layer (DB) establishment cost was saved through the use of 23 layers (DB) of common spatial data provided by spatial data warehouse. More cost saving can be expected at a time of expansion of common spatial data in the future.

As comprehensive services on the entire geographic information were provided through commonly used city information system in the spatial data warehouse, the number of user accesses was 2300 early June in 2007, but it increased to 54,000 as of September 2008. In addition, they were mostly used in construction, city planning and housing sectors. Its use was concentrated on basics including data establishment and data search at first, but as time progressed, it was frequently used in decision making to support construction, city development and housing.

<Figure 5> Main screen of city information portal for citizens

<Figure 6> Commonly used city information system that links various geographic information

12. SUGGESTION OF AN INTEGRATED GIS MODEL FOR LOCAL GOVERNMENTS

The biggest advantage of the spatial data warehouse in Daejeon City includes the development of a globally standardized data provider that makes it possible to share data among different types of geographic information systems regardless of specific GIS engines, and the achievements by Daejeon City can be used in other local governments.

In addition, the city adopted the conversion of World Geodetic System and frequent renewals as instructed by National Geographic Information Institute, and so that other local governments can use the results.

The data provider and frequent data renewals are the basis for the GIS project, and it needs to be facilitated and systemized by the central government.

Daejeon City plans to maximize the accuracy and use of geographic information through the improvement of quality of geographic information data. It plans to support related departments, increase the number of geographic information users and introduce the geographic information as the basis for administrative works.

The spatial data warehouse laid the foundation for the integration of GIS, and it will continue a system of sharing based on linkage through GIS standardization in addition to physical integration. In addition, it will realize the gradual linkage of administrative data and develop it into a decision making support system in the entire sectors in Daejeon City based on connected administrative data.

☐ **2006 Selected Innovated Brand Project of Local Administration**
(The Ministry of Public Administration and Security, June 2006)

☐ **2007 Selected Innovative Masterpiece of Local Administration**
(The Ministry of Public Administration and Security, January 2008)

☐ **2008 Won the 25th Local Administration Informatization President Award**
(The Ministry of Public Administration and Security, June 2008)

The Key Strategies of Spatial Data Integration in Response to System Re-implementation Cycles

Dr. Eun-Mi Chang

Korean geoSpatial Information and Communication

emchang@ksic.net

Abstract

This paper aims to extract key elements for a spatial data integration based on the reviews of spatial data integration history in Korean Government among the different agencies. The reasons for the integration of text data, spatial data, and application services have been changed in many ways, depending on the agencies and institutes. The final goal of the integration of data can be defined in common "It should support decision making processes, facilitate business process and give one-stop information service for the users, with the conditions of lower cost and of greater benefits"

Here we discuss the patterns in the GIS integration levels in an agency and agencies in Korea. Five stages for system implementation are discussed in the aspect of spatial database integration. The current methods for quantify demand for integration were reviewed but it is difficult to come to conclusions. One of strategies was extracted based on enhanced PAT model: multi-source management system and integrated-service system.

Keywords: Integration levels, Life cycle of a GIS system, Korean GIS, PAT model

1. INTRODUCTION

The decline of system integration market has been predicted according recently published market research report in Korea (IDC, 2007) and newspapers. If the problems in the financial system persist, businesses will have less money to put to work, job cuts will spread and consumers will have less money to spend, and continuously expanding system integration for better information service will be suggested no more. The integration strategies, however, will become more important to not only policy makers but also GIS/IT experts. With the GIS market already saturated, governments have no choice but to minimize the upgrading projects scattered in agencies based on concrete integration plans. The aggressive and straightforward policy might break a more concrete throughout over the traditional and typical strategies in the past. Looking back the twenty years of GIS systems in Korea will give plausible strategies over benchmarking advanced counties'cases in affluent periods.

2. FIVE STAGES OF GIS IMPLEMENTATION IN KOREAN GOVERNMENT

In the aspect of the laws and policies, we are at the end of 3rd phases, and expecting 4th phase, but there have been changes in GIS players and technologies (Figure 1). We review entire trend into five stages in a sense of integration.

2.1. The 1st Stage : Database Building and Legacy GIS

The first stage of GIS in Korea can be summarized by computerization of text data and by database development including individual thematic maps. This approach focused on accomplishment of business process automation. There was no needs to have data integrate and standardization process focused on the conceptual framework. Various geographic information systems had been implemented in most academic fields, mapping agencies and natural resource. Getting the text data from the books, datasheets and files into legacy GIS. Some of systems were designed to integrate application models and algorithms to show the result. As each department of a agency wanted to develop GIS with continuous budget supply, it was necessary to build laws on specific purposes for the department. Many laws and regulations began to be made.

■ **Implications of Integration**

At the stage, data integration seemed to be equal to database development or to prepare all the dataset in order to prepare the data for running map algebra. Important issues in GIS Integration were geo-rectification and geographic coordinate systems layer by layer correctly.

The issues of mismatch in geographic coordinate systems have not fully solved until now, as the system for land parcel management has different the control points from the topographic maps and other digital maps.

2.2. The 2nd Stage: Specialization Process in Enterprise GIS

The second stage of the integration process appears in two directions: the integration among the departments in an agency and the integration of thematic integration among the agencies. As each law affect the way of life, for example, limits of economic activities in a certain area, no farming activities were not allowed in riparian forests according to Clean Water Acts, more data and information such as data of water amount were required from other agencies, from power plants or from water resource department in other agency. The integration of data was not easy for both agencies, as they have their own purposes and views on water; one was in charge of quality control, the other was in quantity control, and the third was in maximize the production of hydropower. The harmonizing group was organized for solve the issue under prime minister. It took four year to make standards on the watershed boundaries after long-term management of fourth cycles of geographic system issue- funding the system - implementing it - evaluate it - feedback to fund.

■ Implications of Integration

Data integration process in the second stage was translated into whether each GIS application have been implemented based on the standard code and into whether the data set and models were. One of the important items to evaluate each project was to how well standards were designed and implemented into the system with cooperation of different departments in the agency and other department outside of the agency.

Since the problems in horizontal integration in a department level and an agency level were fully went through, we can conclude the psychological barrier between the barriers was much higher than technical or semantic barrier. The semantic barrier was also based in the legal definitions in the systems funding budget at first and was complicated with a piece of advice from experts, scientists, modeler engineering side. We are still struggling for this problem and have found recognition of ontological studies resume in academic realms and standard society.

2.3. The 3rd Stage: Generalization and Enterprise GIS

The third stage is related to the separation of information service from data integration and management in the name of a thematic portal. At this stage, plenty of budgets were poured into application systems. The criteria to overrun the budget cut were three things: whether to contribute to small government (cost/benefit analysis, typical ROI), whether to contribute to develop economy and business, and how much beneficial the information service to the public. Based on the new guidelines, each GIS project was expanded into Standalone type to Client/Server enterprise type for management and to web-based service for the public.

The presentation side of system was made much account for, the more budget was poured to front page design of human interface, and then the heavier hardware specification was required. The safe and steady procedures of data acquisition were behind the luxurious demonstrations of systems. Homepages and information service providers flourished in general after the end of national lab programme and Science and Technology Frontier Projects. Even distinction between the simple homepage and information service provider began not to be clear.

http://www.wamis.go.kr/	**www.kict.re.kr**	**www.eckor.net**
www.nidp.or.kr	www.kwra.or.kr	www.river.re.kr
http://water.nier.go.kr/	http://ilovewater.or.kr	www.rainwater.or.kr
http://emc.or.kr	http://wateris.co.kr	www.drought.re.kr
http://kordic.re.kr	http://water.or.kr	www.water21.re.kr
http: www.kei.re.kr	http://www.rivernet.or.kr	www.kict.datapcs.cokr

Web-based GIS technology was shown to the public, but the ordinary people had not chances to be educated to an advanced search among the many menu and scroll bar without giving little metadata. Some of data was not from its own database but the other agencies. The gap between the management system of its own GIS data and web-based GIS service tended to increase. This gap keeps the contents in the web site out of date and generalization of similar system was in trend. There was less integration request than before, as experts began to know where the source data was available. The index of contents satisfaction was not measured in GIS specifically, so the less clicks become a burden of GIS managers.

■ **Implications of Integration**

The ownership of data acquisition and management in a public sector cannotbe claimed as the system was based on the national or local tax. But the sharing all the data with every system manager outside of an agency may results in many trivial sites, which don't have differences in contents. It is difficult to update content from other agency, so the total satisfaction to the information site tends to go lower and lower.

2.4. The 4th Stage: Information Service from Manipulated Management Systems

The fourth stage has been focused on the separation of service system from management system. The information management systems tend to have Client/Server architecture whether web-based or not. On the other hand, service systems are usually given to internet users using Active-X or other web browsers' functions. The module to manipulate the raw data is one of the main functions in the management system. The metadata of serviced data is different from the original raw data, but most of geographic information has their own metadata for management systems, not for the serviced systems.

■ **Implications of Integration**

The ownership of data acquisition and management in a public sector cannot be claimed at this stage, too. Integration of data from other agencies into management systems is not a problematic and internal analysis and reference may be enough for their own purposes. The main issue is whether the criteria of original data classification are not the same as the purpose of data integration for the second manipulation. For example, when the amount of transportation between two nodes was obtained from a transportation DB center, the criteria for the classification scheme of cars and trucks are not the same to that of an Emission Model for air pollution between the nodes on which the number of cylinders of vehicles is the most important. The there must an assumption to integrating data into the second-hand data set. The principle to selecting data for analyzing itself is the important point and should be explicitly expressed to system users and final service users.

The data sets from other agencies have different scales of original geographic data, the inconsistency in overlapped areas are always unavoidable and irritating to layman. The meticulous and precise quality control and quality assurance is required at this stage, without which the trivial inconsistency makes the integrated information service unreliable or incredible.

2.5. The Coming 5th Stage: Integrated Service from Distributed Management Systems

The fifth stage has been focused on the specialization of information service to targeted users. Most of systems seek to have rationale to keep the system continuously, so the inquiry of demand for the system is considered as an essential part. Users' demand can usually be measured by interviews or questionnaires at this stage. In general users can be summarized into the public at the 3th stage, but all-purpose site can not satisfy any group of people. So there is necessary for system engineers to consider different levels of integration of information based on targeted users. Scientific research group including professors and students and researchers in national scientific laboratories have a tendency to ask raw data without aggregating or analyzing, while general users who are interested in the specific themes want to have intuitional and summarized information. Administrators or government officers wants to integrate the specific information into daily business programs, so another issue in integrating GIS system into e-government system.

Seamless portal for the next generation, there are many new technology for integration of information service, on the fly. Open API and portlet site is being introduced into geographic information service. But the speed of application is still in problem and is in progress, too. To connect distributed information management to integrated information service, there has been discussion on the service platform embedded GIS like Google, MicroSoft other Korean Portal, Naver and Yahoo.

■ **Implications of Integration**

For the users, it is not important to have different GIS engines or platforms, but to have information of quality with metadata on time. The legal issue to the integrating services is critical at this stage. Quality control and quality assurance will be imposed on a service provider but the distributed data managers. The distinction data for service in an agency from data for management will be clearly defined. The gap between the raw data and serviced data should be overcome.

3. THEMATIC INTEGRATION OR REGIONAL INTEGRATION

In case of central government, thematic integration is the most important. On the other hand, regional integration is critical for prefectuals and cities. The local governments have a loosely-coupled system to central government, then it is easy to provide decision support functions for the local benefit to be maximized, but the central government does not want to the results of conflicting local government. In case of TMDL (total maximum daily load program for clean water), Ministry of Environment wants to have one thematic integration by gathering all the information and to run an appropriate model for each basin, and to allocate permissible loads to each local county for clean water. Between each county (si, gun) and national agency, there is also another regional integrator (prefectural: Do; 道). For example, Gyeonggi-do wants to integrate water-related information into their office to accomplish its own visions and objectives.

But all the statistics related to water are more than 276 data sets which had been produced by 14 agencies including MoE (Ministry of Environment), MoLTM (Ministry of Land, Transportation and Maritime Affairs, MoPAS (Ministry of Public Administration and Security), MiFAFF (Ministry of Food, Agriculture, Forestry and Fishery) and each Prefecturals and NSO (National Statistical Office) and KMA (Korean Meteorological Administration) and Kwater and MKE (Ministry of Knowledge Economy), etc. Even worse, water is one of element of environment, so thematic integration for only water is not enough for the Ministry of Environment.

Therefore, the integration level should be settled on the basis of demand. How can we quantify the demand? It is reconsidered that the method to distribute questionnaire and to take interviews tend to have a trap: not free from the organization's purpose, and not too seriously taken for answering. It is necessary for us to have power of insight instead of a bunch of reports.

4. INTEGRATION OF EA AND GIS? IS THAT THE SOLUTION? ORIGINAL PAT Model

In a sense of software engineering, Enterprise Architecture can be an answer to integration demand. However all the agencies and Ministries have not carried out the EA/ITA project? Periodicals or annually-published reports are still based on the previous workflows or from information systems. GIS has been classified into one part of Technical

Road Map(TRM) and not fully be interweaved into Business Reference Model yet, as the experts on ITA/EA do not understand GIS fully. On the other hand, GIS experts are not good at the methods at ITA/EA.

Semantic or ontological approaches are suggested for further intelligent integration, especially in GIS standardization field in these days. But it is necessary for us to realize each system has their own legal background, therefore, it is difficult to reconcile among legal concepts, scientific concept, and layman concept. It will take longer time to list all the jargons into an ontological table and even longer time to carry out system integration based on the ontological vocabulary tables.

So we should return to the re-implementation cycle for geographical information system. Korean geographical systems last five years in average, while those in Singapore last eight years. Practically to say, it is natural to check out the schedules of re-implementation of GIS for each system in every agency. Recycling hardware for data backup and GRID computing is a potential tip for integration. The most difficult job in Geographic Information Integration is Business Re-Engineering Process over the agency.

In the PAT model for explanation for human impact on nature, we can get the general rule to quantify the demands of integration:

Impact = P x A x T as in P(population), A(abundance) and T(time)

Population can be converted into number of users who may use the integrated service system and Abundance was interpreted into qualitative aspecton the system, originally from the average consumption of energy to effectiveness and efficiency of policy executing. Time can be converted into duration of service system or updating benefit. Each impact coefficients can be summarized and compared to each other for final decision with limit budget.

5. CONCLUSIONS AND FUTURE DEVELOPMENT

The level of integration was discussed at the seven layers' theory, DB level integration was regarded as a best integration. But distribute computing and world wide web provide better solution for integration level: Connecting multiple management systems which are full of fresh and clean data in a routine workflow into service platforms (integrated service for targeted users) is the direction of integration in the future.

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Development of Service Platform for Integrating GIS Systems

Chang-Hoon Lee

Chief of the U-TECH Laboratory
LBSPLUS Corp.
chlee@lbsplus.com

Abstract

The initial GIS system started from the data-oriented expert system. The GIS system independently configurated depending on the business areas laid the foundation to accumulate excellent GIS data per each business area, and allowed the person in charge of the business to experience how to deal with GIS effectively. However, the GIS is now required to be applied to more various areas as it has developed. In this context, the remaining problem is the 'close' attribute of the system, which can be resolved by the introduction of a standard service platform. The standard is the minimum condition to guarantee that the GIS can be utilized in the overall industry and to make sure that the service platform doesn't belong to a specific product and a certain technology.

The GIS services, their configuration and utilization required by the industry must be defined prior to the development of the service platform based on the standard. On top of that, the Data Provider has to be introduced to increase the service adaptability, and the GIS Core Objects must be developed to enhance the flexibility and extensibility of the system.

1. INTRODUCTION

Since the late 1980s, the GIS began to be introduced by universities with the purpose of academic research. The government-led NGIS project played as the starting point for its full-fledged development in 1995, and the phase 1 project of NGIS (1995-2000) and the phase 2 project (2001-2005) enabled the country-wide GIS infrastructure to be established for a relatively short time compared to other countries.

The GIS at an early stage had the application using local data. After that, as GIS data increased explosively, GIS began to depend on the database technology, and the GIS system with the structure of client/server application was introduced. The client GIS developed from package application to evolve into the component-based GIS, when various and well-designed GIS application went into the mass production stage. However, until then, GIS was constructed as the closed-type, focusing on the accumulation and management of GIS data, and the system users were largely experts who needed to understand the GIS technology. This trend was not limited to GIS system, but the widely-applied practices found in all software IT technologies. The development of network technology and the advent of World Wide Web allowed software IT technologies to shift their direction toward Web from C/S. Coupled with the trend, the web-based GIS technology was introduced and began to develop until now. However, from a interoperability perspective, it still can't be out of its 'close' attribute, by following the footsteps of the former C/S systems.

2. WHY STANDARD SERVICE PLATFORM

2.1. Limit of Current GIS System

As for the way that GIS is introduced to the public agencies in Korea, the dominating method is to produce GIS-oriented systems through a specific product by making an order project by project. Additionally, there is a strong trend to insert the business onto the GIS, instead of trying to construct the business-based GIS even when it's the business-handling GIS. As a result, there happen limit factors undermining the domestic development of GIS, and GIS has its own problems as follows;

First of all, as the configuration of closed-style system by each business area becomes the mainstream, the problem of redundant management for spatial data occurs. When data handled by other business area is needed, (ex. parcel) the relevant business system obtains the data through online or offline, and then keep it into its own database for service. In addition, data commonly used for most of business areas (ex. road boundary, buildings, river) can be obtained through different paths according to each business environment with different versions to provide service. At a time when the project is completed, it appears all data is properly configured, but without any plan and system for retention and management of data, the data loses its reliability and freshness shortly.

Next is the structure of closed-styled server-client. The short-term and low-cost GIS development project led to the tangible and function-centered development, and did not allow us to have keen interest in sub structure for expansion of the system, openness of service or compatibility of client. Focusing on performance and function, the development project produced a server that can deal with a certain task, and a client who perceive only that server. At the same time, the server also was developed as a bundle product only for the client. This kind of system configuration was not a problem when closed-style system was used in the past. But as the need for connection to other different systems increases, it reveals its limitations. It is difficult or impossible for the closed structure to have service-based connection due to its structural limit. And cost was paid more than necessary to embody the system connection. Besides, the more complicated connection is, the higher cost is needed, bringing about a setback into unstable system.

The trend of configuring GIS function-oriented system instead of business-centered system, does not allow a person in charge to experience the efficiency of system because it degrades degree of combination of business so that inherent functionality in GIS is not used. Except for editing of spatial data and work centering on spatial analysis, most of the text-based business are core business among works related to GIS, so GIS system should be configured as a part of text-based work system to reflect the real work.

2.2. Solution to Limits of GIS System

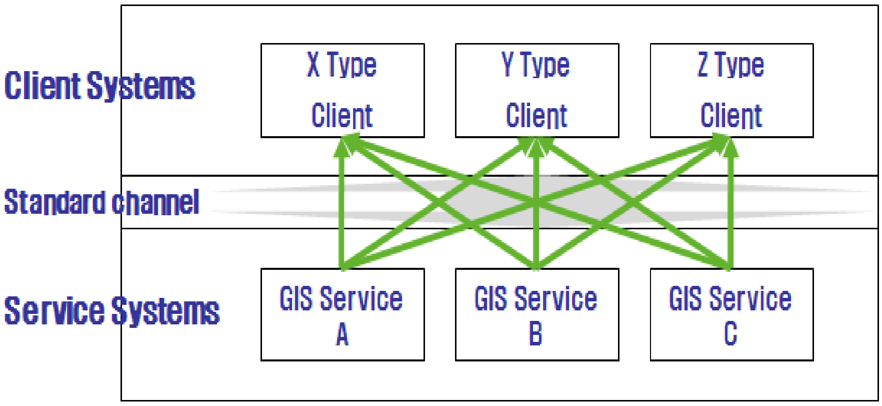
Efforts to resolve the redundant management problem for spatial data is paid off as national spatial data integration project like National Spatial Information System. The point is that while independent operation of business system is ensured, data that can be shared or commonly used is integrated and managed. Discussion for data integration as the alternative to solve the spatial data-related problem should continue.

There could be several alternatives to resolve the problem caused by closed GIS application structure but we also consider the following approach. First, the established server system is converted into a form that can provide standard-type service, and the client also is improved into a form that can accept standard service removing inter-dependence between server and client. (Of course, it is confined only to a valuable system. Systems that do not require service opening or must be operated in a closed way should remain as they are.) This means service operated in a closed way in the past is converted into an open format through communication method based on standard, or communication protocol, standard service API. Standard service provides the foundation to change service consumers from a certain type of client to various types of clients. It also provides the foundation for clients with a variety of services from diverse sites.

As the above mentioned, the GIS configuration based on business system should be configured as a GIS form built on a business-centered system and this is closely related to the introduction of standard GIS service. Business system should be independent from GIS service because various GIS functions needed for business can be utilized through GIS service.

2.3. Standard Service Platform for Integrating GIS Systems

To put it strictly, the integration of GIS system can be considered as the integration of client GIS system. From the server part, standard service is limited to the service interface part. Because there is no limit to internal handling, the sub structure of service can be freely selected and built in accordance with the operation environment. As the above mentioned, a client can build up GIS results by using various GIS services needed for purpose to implement particular work. The integration of GIS system can be realized through standard service and free service consumption shown by <Figure 1>.

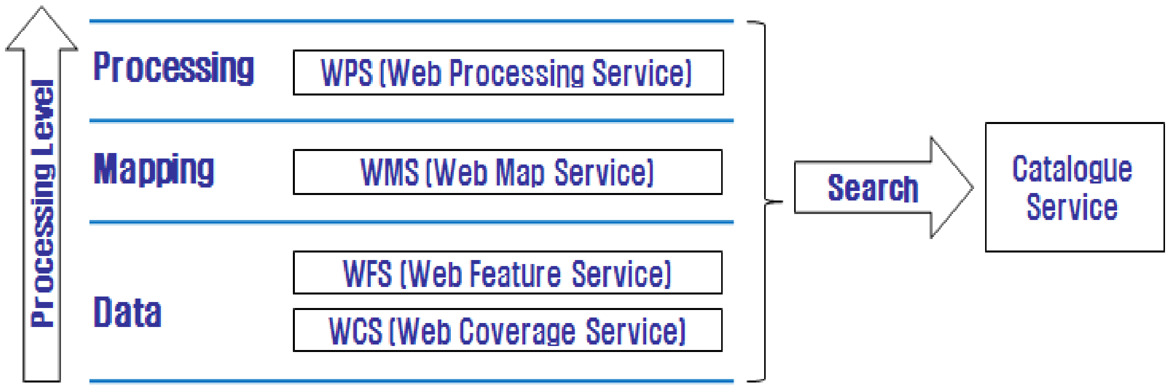


<Figure 1> Provision of service and consumption pattern

The integration on the service level simplifies approach methods for each individual back-end system. And by naturally inducing organic integration/connection between systems, it will provide advantages more than we can imagine. Once again, the establishment of standard service platform should be a prerequisite to realizing this goal.

3. DEVELOPMENT OF SERVICE PLATFORM

The GIS service platform that should be provided for the integration of GIS system includes WFS and WCS for data service, WMS for map service, WPS for GIS process, and catalogue service offering meta information on GIS service.



<Figure 2> Standard Service Platform

As shown by <Figure 2>, WFS with the lowest processing level services vector data as WCS provides coverage raster data as service. Above all these, there is WMS servicing map. Because WMS provides service by configuring map, basic map system can be built only based on this. On top of it, there is WPS for GIS processing which has not been widely used. Catalogue service makes it possible for individual service approach in a standardized way enabling the search of service.

Among these, WMS, WFS, WCS and Catalogue service can be regarded as the services that can increase efficiency compared to investment on the field. However, it is hard to touch upon all of these so in-depth discussions only for WMS and WFS will be provided. Before this, OWS (OGC Web Service), the upper specification of OGC web service, is firstly reviewed. Each version includes OWS 1.1, WMS 1.3, and WFS 1.1.

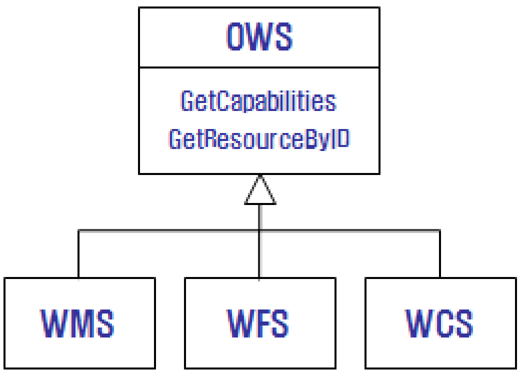
3.1. OWS(OGC Web Service)

OWS does not point out a particular service. Instead, it means a specification for the concept commonly applied to overall OGC web services. OGC web services inherit OWS so that common operation like GetCapabilites is implemented. The results of GetCapabilites include service metadata and data metadata provided by that service.

3.2. WMS (Web Map Service)

WMS plays a role in providing map according to requests of clients. Basically, information (data, layer style) needed for configuration of map is defined in advance. When information of map extent and image size are requested from a client, the relevant map is configured and transferred.

Service operations provided by WMS include three operations shown by <Table 1>, and GetCapabilites, GetMap must be implemented.



<Figure 3> OWS Architecture

<Table 1> WMS operations

Operations	Descriptions
GetCapabilites	Provide matadata to the relevant service
GetMap	Create and transmit map based on request of WMS Client
GetFeatureInfo	Provide information of feature for requested coordinates (geometry + attributes)

In addition, WMS Type is classified into two types according to operation. The contents are shown in <Table 2>.

<Table 2> WMS Types

WMS Type	Descriptions
Basic WMS	GetCapabilites, GetMap operation supporting
Queryable WMS	Basic WMS의 operation and GetFeatureInfo operation supporting

3.3. WFS (Web Feature Service)

WFS provides vector data upon requests of clients. The configuration of service data is previously defined. When a client requires information on layer, extent, and filter, the vector data for relevant layer can be transferred in a GML (Geography Markup Language) format.

WFS provides six service operations seen by <Table 3>, and GetCapabilites, DescribeFeatureType, GetFeature must be implemented.

<Table 3> WFS operations

Operations	Descriptions
GetCapabilites	Provide metadata to the relevant service
DescribeFeatureType	Describe the structure of any feature type it can service
GetFeature	Retrieve feature instances
GetGmlObject	Retrieve element instances by traversing XLinks
Transaction	Create, update, and delete operations on geographic features
LockFeature	Lock request on one or more instances of a feature type

Also, WMS is classified into three types according to operation. The contents are shown in <Table 4>.

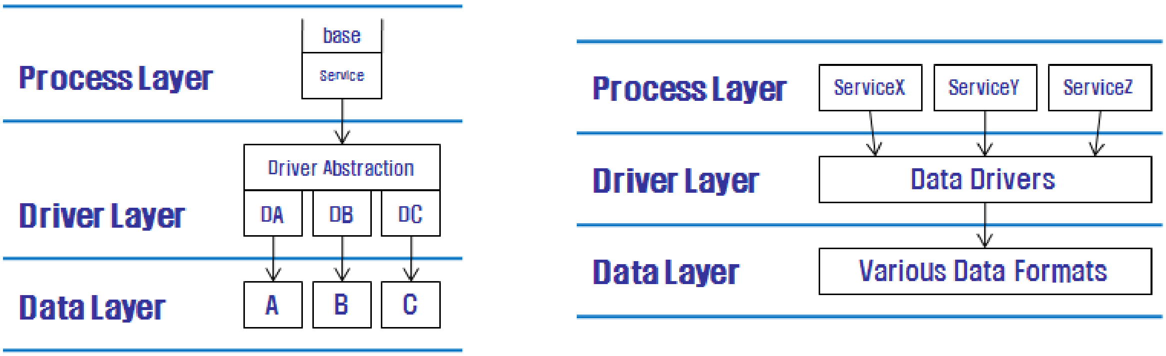
<Table 4> WFS Types

WFS Type	Descriptions
Basic WFS	Support the GetCapabilities, DescribeFeatureType and GetFeature operations
XLink WFS	Support all the operations of a basic WFS and in addition it would implement the GetGmlObject operation
Transaction WFS	Support all the operations of a basic WFS and in addition it would implement the Transaction operation. Optionally, it could implement the GetGmlObject and/or LockFeature operations

3.4. Infra Structure of Service Platform

Service API is selected as interface of standard service so it is just implemented as chosen. But there are some points that should be considered.

First of all, the range of data that service can cover. Currently GIS is established based on various types of data. To use such data, service process can perceive and handle the relevant data. In this case, if service accepts data without any certain standard, quality of the relevant service and processing of data approach can't be guaranteed let alone the redundant input of development cost. Such problems can be resolved by introducing data driver component that modularizes only parts for back-end GIS data. In fact, only data approach parts have direct connection to back-end data so the rest of parts can be integrated, developed, and managed so that they can be commonly utilized to develop various service platform if data driver component part is separated.

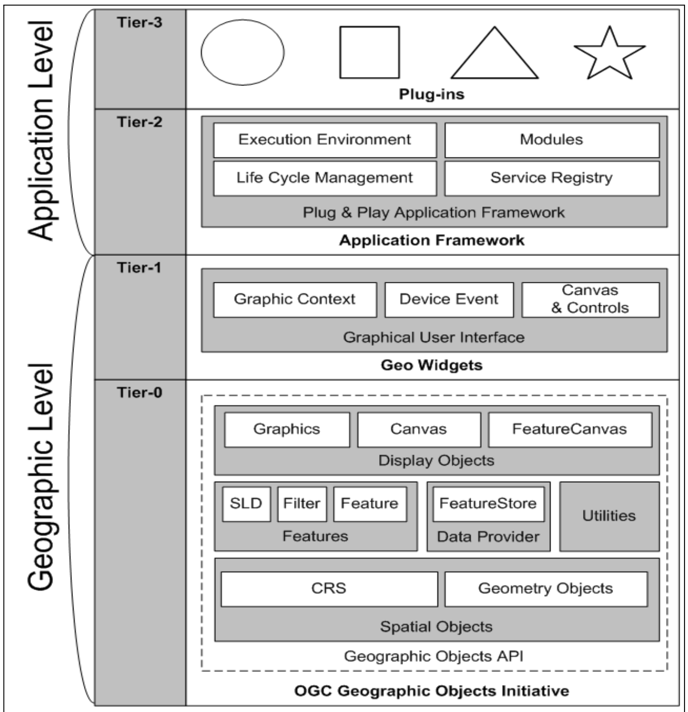


<Figure 4> Application and Usage of Data Driver

Another point is that such GIS service application requires a very complicated data process. The data approach issue can be solved through standard data driver but systematic and object-oriented approach is needed for coordinates conversion for data, handling of layer style, and spatial filter. There are several methods to realized this. it is rightly to say that accepting GO-1 (Geographic Objects Phase One) of OGC which were already studied about this field can enhance efficiency of development.

3.5. Development Model

<Figure 5> describes tiers of development model. Tier-0 Geographic Objects API, as the lowest tier, generalizes development of upper tiers and has expandable interface. Geographic Objects API observes GeoAPI. Geo Widgets of Tier-1 is composed of GUI Component Objects by display device and generalizes development of the upper application level tier. The purpose of GIS Core Objects is based on standard and prevents redundant development of application level through systematic development of Geographic Level shortening development period.

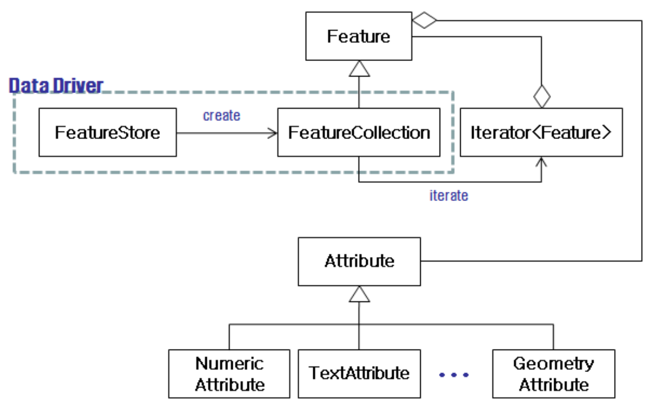


<Figure 5> Hierarchy of Development Model

4. OPEN DATA DRIVER COMPONENT

Standard interface for data driver component to build up effective service platform is defined so that all drivers should be realized according to the interface.

OGC (Open Geospatial Consortium) International Standard Organization defines GO-1 model fitted for this requirement. It goes even further to define GeoAPI, the implementation specification.



<Figure 6> Feature Model in GeoAPI

Of course, GO-1 model and GeoAPI standard include much larger range but the first intent was to make various types of GIS data approach through standardized and simple interface.

In particular, Open Data Driver Component points to open data driver componen developed based on this standard model so it will be a more general-purpose and compatible component than a component following non-standard interface.

The Feature model of GO-1 is a core model to standardize the approach for all spatial data. GoeAPI Implementation Specification defines this model to the level of interface right before the realization.

<Table 5> Data Driver-related Objects

Interface	Description
FeatureStore	Normalized interface to data provider that can serve up collections of Features.
FeatureCollection	Collection interface of features.
Feature	Normalized interface to real world phenomena, which contains attributes.
Attribute	Information interface defining a attribute of feature.

5. GIS CORE OBJECTS

5.1. Scope

It is imperative that homegrown GIS Core Objects should be developed as the mash-up service is facilitated among web-based open services and at the same time the establishment of open standard GIS platform for the national land integration project becomes an urgent issue. Furthermore, GIS Core Objects should support the actual development of domestic GIS and purse standard-oriented development. Thus, in consideration with the realistic circumstances, including development language, standardization trend, the degree of difficulty, and effectiveness, the development range is selected as the follows;

- GIS Core Objects accepts OGC GO-1 (Geographic Objects Phase One).
- GIS Core Objects ensures platform independence, vender independence, expandability, and compatibility through GeoAPI Java Interface.
- GIS Core Objects is developed to be used as a core library of Spatial Database Engine, and Server GIS and Desktop GIS software.
- General-purpose Spatial Database Engine and Data file etc. are recognized and the structure for consistent expansion is ensured.
- If there is the open source to meet the above conditions, it can be actively utilized. By doing so, community-based and sustainable development system is pursued.

* GeoAPI is a working group of the OGC technical committee. Interface-only Java API based upon existing and proposed OGC standards can use to interoperate in GIS project.

5.2. Objects Categories

GIS Core Objects Categories are as the below.

<Table 6> GIS Core Objects Categories

Objects	Descriptions	Sub Objects
CRS	- Coordinate Reference System - Describe standard coordinates system of the given data and Convert to different coordinates in real time - Projection coordinate system like TM and spherical coordinates like WGS84	Authority Projected CRS Geographic CRS Transformation
Display	- Object to screen describing map - Handling input Event done on the map screen	Canvas EventHandler
Feature	- Object proceeding unit space data - Proceeding for space, attribute, and information - Proceeding of data integration by collection - Edit handling	Attribute SimpleFeaure FeaureCollection Transaction
Coverage	- Object proceeding Raster data - Proceeding of Raster analysis function	Coverage
Filter	- Object to provide data suitable for particular condition based on space and attribute - Basic of space/attribute analysis	Comparison Logical Spatial, Expression
Geometry	- Topography object handled in Simple Feature	Point, Curve, Surface
Graphic	- Diagram object that a user can input additionally on the map screen	Label, Image, Polygon, Line, Icon
Layer	- Object proceeding collection of space data of a certain subject - Foundation of main subject	Layer, FeatureLayer
Metadata	- Object to explain about basic attributes of data	Citation, Identification
SLD	- Styled Layer Descriptor - Object proceeding style for Layer - Decide the way of coloring describing layer on the map - Exchange of information based on XML standard document (Compatible with other products)	FeatureStyle, Rule, Symbol

5.3. Open Source Status

JTS (Java Topology Suite) is LGPL Open Source developed as Prue Java, responsible for Geometry arithmetic treatment based on OGC Simple Feature model. JTS does not follow Geometry Interface of GeoAPI.

GeoTools is Major LGPL Open Source of GIS. GeoTools was developed not only based on JTS internally but also on various open sources. GeoServer is the representative model of Server Application developed by using GeoTools supporting WMS, WFS, and WCS etc. U-Dig is the main example as Desktop Application recognizing Catalog, DB2, ArcSDE, Shape file, WFS Feature Store and supporting editing and output. GeoTools follows only some Coverage, CRS, Filter, Metadata, Util Interface of GeoAPI. Up to now, the compatibility with GeoAPI is the most difficult challenge to replace GIS Core Objects and there is no GeoWidget part of Tier-1. So it is hard to develop and maintain domestic GIS system.

6. DOMESTIC STATUS

LBSPLUS GNIS 2.0, a product that standard service platform is included, acquried GS (Good Software) certification from TTA(Telecommunications Technology Association) on 8th, Sept. 2008. GNIS 2.0 include GNIS Server, GNIS Desktop products, and sub GNIS Objects that are used commonly. GNIS Objects implements the role of GIS Core Objects that belong to Geographic Level of <Figure 5>, realizing GeoAPI 2.1 Interface. They also include Geographic Widgets for the AWT and SWT environment of Java. When GNIS Objects were developed, various measures of using other open source like GeoTools and JTS were sought. But in case of GeoTools, only part of Interface of GeoAPI is embodied so it is not suitable to develop standard GIS Core Objects. On the other hand, JTS didn't realize GeoAPI Interface but it can use an additional tier that follows GeoAPI by wrapping JTS.

GNIS Server and GNIS Desktop of GNIS 2.0 belong to Application Level of <Figure 5>. GNIS Server supports standard WMS 1.3 and WFS 1.1. GNIS Desktop recognizes GNIS Spatial Engine, ArcSDE, Shape file, Cad, WFS, Feature Store etc., and supports WMS layer search, catalog management, feature editing, service document editing for server, and SLD style based Rendering. Also it was developed based on Eclipse RCP so it has expandable structure to add various plug-in fully supporting Plug & Play Application Framework model of Tier-2.

7. FUTURE WORK

The development of redundant system is reduced by preventing development of closed software through national land integration project and the GIS industry in the country can be advanced by using open standard based GIS Core Objects such as GNIS 2.0. In addition, the brisk growth of open source in the GIS field is expected, and especially, GeoAPT-based standardization is much expected for GeoTools. Along with these, the business model for using open source in the domestic market should be stabilized so that open source can be smoothly customized, maintained, and supported.

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Sharing Geographic Knowledge: Towards a Services-Oriented Approach

Dr. William Shepherd

Strategic Business Development
ESRI Asia
bshepherd@esri.com

1. GEOGRAPHIC KNOWLEDGE AND THE GEOGRAPHIC APPROACH

Today we live in a world with many problems: growing population, global warming, social conflicts, resource shortages, and loss of biodiversity. The complexity and severity of these problems are increasing, suggesting significant challenges for future of human societies. Today, more than ever, we need more knowledge and awareness of the world around us. We also need more comprehensive approaches to how we design and manage human activities, approaches that more fully consider and account for the impacts of our actions and guide us to a more sustainable future.

Geography, the science of our world, coupled with Geographic Information Systems (GIS) technology is helping us to understand the Earth and apply geographic knowledge to a host of human activities. Indeed, we are seeing the emergence of "a geographic approach"—a new way of thinking and problem solving that integrates geographic knowledge into how we understand and manage our planet. The geographic knowledge that we create by measuring the Earth, organizing our observations and data, and analyzing/modeling various processes and their relationships and interrelationships serves as an important foundation for more consciously acting, that is, planning, designing, and changing the world in which we live.

The geographic approach is not a new idea. It is the system by which geographers study and analyze our world. One of the best discussions of this approach was outlined by Ian L. McHarg in his book Design With Nature, in which he set out a philosophical context for why and how humans should manage their activities within natural and cultural landscapes.

2. GIS APPLIES THE GEOGRAPHIC APPROACH

GIS is an information system technology with geography as its fundamental organizing principle. GIS provides technology and methods for data modeling, data integration, spatial analysis, and collaboration. GIS also provides a science-based framework for organizing workflows that integrate all the factors that need to be considered for decision makingand action. GIS improves the way we work by facilitating better decision making; saving money, time, and resources; and allowing us to more effectively communicate through geospatial visualization.

Today GIS is being applied around the world to virtually all the problems confronted by our societies. The sheer number of applications suggests it is becoming a major platform for understanding the world around us and how our actions increasingly impact the planet. While some GIS systems are focused on the automation of technical workflows, such as cartographic production and image analysis, other systems organize society's key information systems, such as cadastral systems, national security, facility management, resource management, and land-use planning. Still others focus on decision support for site selection, logistics, and natural resource management.

3. GIS IMPLEMENTATION PATTERNS

GIS is typically implemented in three patterns: desktop, multi-user/server systems, and federated systems.

Desktop - The desktop pattern has been used for many years by the geospatial professionals who carry out ad hoc projects, such as data creation, mapping, spatial analysis, and modeling.

Multi-User / Server - The multi-user pattern is organized around a centralized database shared by a group of users. There are many examples of multiuser systems at both the department and enterprise levels. Generally, these systems involve a series of defined applications that use a geodatabase within structured workflows. These systems also organize and manage changes to the database as specific transactions, e.g., land record updates, facility changes, zoning changes. This type of system is often implemented using client/server architectures.

Federated - Today, however, GIS is increasingly being implemented and architected using services oriented architectures (SOAs). As standards for Web services have advanced, GIS users have started to implement federated systems. These federated systems use Web services as a framework to support applications that integrate data and services maintained in a variety of heterogeneous, distributed systems. They allow information from different departments and systems, e.g., planning, engineering, and surveying to be dynamically shared amongst many groups of users and applications. Rather than tightly coupled connections between systems, however, SOA uses Web services to integrate. This architecture allow users to easily integrate GIS services with other IT systems such as, ERP, CRM, and the like.

4. WEB SERVICE AND GIS IN THE ENTERPRISE

GIS technology has long been valued for enhancing communication and collaboration in decision making, effectively managing resources and assets, enhancing the efficiency of workflows, improving the accessibility of information, and generally offering tangible cost savings to organizations both large and small. As organizations become increasingly spatially literate, they are finding a greater need for open access to geospatial information and services across the enterprise. To deliver geospatial information and functionality throughout the enterprise, organizations are choosing to extend their GIS implementations with server-based GIS solutions that provide content and capabilities via Web services.

Web services are modular applications that correspond to recognizable business functions and offer a set of protocols by which they can be published, discovered, and used in a standards-based way. Organizationally, Web services are simply information technology (IT) assets that are often used as the basis for integration strategies that fuse content and capabilities in support of various business processes and initiatives. Web services provide the building blocks upon which broader IT strategies are based, such as the implementation of a service-oriented architecture (SOA).

Spatially enabling a SOA requires knowledge of the organization's business processes as well as a solid understanding of the robust capabilities and benefits of GIS. As with any services-based approach to IT, business processes are distilled into common functions that can be delivered throughout the enterprise in conformance with the overall mission and goals of that organization. To spatially enable these services, the business processes should be evaluated with an understanding of how GIS technology can extend and enrich those processes by providing value in overall efficiency, accuracy, accessibility, and cost savings. While these concepts are by no means revolutionary, the services oriented approach is an important evolution as theybring technology, policies, and practices in harmony with standard organizational IT business processes.

5. SOLUTIONS FOR GEOSPATIAL SOA

Implementing a geospatial SOA requires tools to author, manage and serve the geographic knowledge required by the organization. This includes

Maps and Globes - Interactive views of geographic data with which to answer many questions, to present results, and to use as a dashboard for real work. This geovisualization has been and continues to be a foundation of GIS in the enterprise.

Geographic Datasets and Data Services - File bases and databases of geographic information－features, networks, topologies, terrains, surveys, and attributes.

Processing and Workflow Models - Collections of geoprocessing procedures for automating and repeating numerous tasks that perform analysis.

Data Models - More than database tables, GIS data models incorporate advanced behavior and integrity like other information systems. Access to the full data models －the schema, behavior, and integrity rules of geographic datasets play a critical role in GIS in the enterprise.

Metadata - Documents describing the specifications and properties of the data. Metadata catalogs enable users to easily organize, discover, and quickly gain access to shared geographic knowledge.

Oftentimes, the authoring tools are architected as thick client applications possessing the rich tools needed to create and manage the geographic knowledge that becomes the basis for common, reusable spatial services. GIS professionalsleverage their existing geographic expertise to author and design geospatial content, such as maps, globes, geoprocessing models, locators, and data management functions.Once the content is created, it is published to the server for the benefit of the broader organization.

ArcGIS Server is a highly flexible and scalable technology that runs on world-class IT infrastructure and supports geospatial SOA initiatives. ArcGIS Server provides the technology foundation for organizations large and small to build and implement a set of GIS-based Web services. Some common services that support a geospatial SOA include map (2D) and globe (3D) services (transportation, demographics, physical environment, and asset maps/globes), locator services (geocoders and gazetteers), geoprocessing services (site selection models, dispersion/plume models, network analytics, raster analytics, image processing, etc.), and data management services (replication; data check-in/checkout; spatial extraction, transformation, and loading; and catalog services). Shared GIS services such as these can be used to add value to established business systems (e.g., work order, asset, and customer relationship management systems) and support enterprise-wide initiatives for collaborative computing.

6. WHO BENEFITS FRON GIS-BASED SERVICES?

Users across an organization benefit from shared GIS-based services. This includes GIS professionals, application developers, nontraditional GIS users, and IT administrators:

GIS Professionals - GIS professionals use the GIS Server as a platform to publish and promote their work in the form of shared maps, globes, processes, and functions. They also consume services that are published by others within their organization or the broader GIS community. GIS professionals with knowledge and expertise in specific domains can share their skills or tradecraft with other GIS professionals and users. For example, a GIS transportation engineer who is an expert in multimodal transportation models can publish and share network solvers that can be consumed by other GIS professionals and users within the organization. Sharing geographic knowledge helps GIS professionals standardize on geographic processing techniques and workflow scenarios, reduce software deployment costs, and ease implementation burdens.

Application Developers - Application developers can simply consume the services published by GIS professionals when building new or customizing existing applications without having to become a GIS expert. The application development framework for a GIS Server should offer a common, extensible, and task-oriented framework that supports Desktop and browser-based clients for the traditional desktop environment as well as thin-client and mobile clients for enterprise deployments.GIS Servers such as ArcGIS Server provides a rich Application Developer Framework (ADF) for both the J2EE and .NET 2.0 environments. It has multi-tiered components including fine-grained objects, coarse-grained objects, Web controls, Web services, and task assemblies. The Server ADF also provides a tight IDE (Visual Studio, Eclipse, and Sun Java), an extensive help system with platform-specific code examples, and rich Web user interface components that natively employ AJAX techniques and offer game-style navigation capabilities.

Nontraditional GIS Users - Nontraditional GIS users can consume GIS-based Web services via focused applications where geospatial services are infused into the fabric of their application. Depending upon the level of integration, users may not even realize they are implementing GIS techniques and processes. Making GIS transparent to users via services enriches their applications while ensuring they adhere to the best practices and techniques as defined by GIS professionals.

IT Administrators - IT administrators can consume and integrate GIS services into the broader IT landscape in support of various business workflows. For example, GIS services can be integrated with work order management systems, financial systems, supply chain management, business intelligence reporting, and executive dashboards to name just a few.

Using a web services and a GIS Server-based approach, GIS users in a public works department could publish a set of services and applications to satisfy the needs and requirements not only for their department (e.g., map the location of current construction projects),but also for other city departments (e.g., police or fire), other regional entities (e.g., emergency 911), or state agencies (e.g., such as departments of transportation). The sharing of services and applications can include multiple levels of government as well as private utilities, local businesses, or real estate firms.

Integrating GIS enabled web services with other key business systems can extend the value of those systems by increasing accuracy, efficiency, and productivity. For example, an enterprise resource planning (ERP) tool can be used to identify government personnel with specialized skills to assist in a chemical spill accident. GIS services can be leveraged by the ERP tool to more accurately understand the location of those personnel in relation to the event and use calculated travel times to allocate appropriate resources, while avoiding potentially dangerous areas downwind from the accident location. In this case, GIS services extend the value of the ERP system and provide a more timely and efficient response.

7. THE VALUE OF GIS WEB SERVICES IN THE ENTERPRISE

Organizations today are being challenged to be more efficient, accurate, and accessible. To deal with these challenges, IT departments are moving increasingly toward SOAs to provide a framework for technology, policies, and practices by which they can be organized in an effort to deliver the right services to the right people at the right time and in the right place. GIS is a proven and valued technology that plays an important role in today's SOA strategies and initiatives. With the right mix of desktop and server-based GIS solutions, organizations can integrate GIS services into their existing workflows and solve today's challenges of providing open access to common geospatial data, services, and applications from within their organizations and beyond.

7.1. From Web Services to Web GIS

While nearly all GIS implementations follow one of these three patterns outlined above, the Web is emerging as a new GIS platform for many types of applications. Web GIS doesn't replace the other three patterns; rather, it extends the federated pattern, implementing a rich array of GIS concepts and ideas in the Internet environment.

Web-based mapping was introduced and became popular in the mid-1990s. In the Web 1.0 environment, these on-line mapping services were based on an Internet Map Server such as ESRI's ArcIMS , "broadcasting" map services to many Internet clients. Today, there are thousands of Internet map servers serving hundreds of millions of maps each day.

The Web 2.0 environment (the world ofWeb services) enables many new opportunities to use GIS, including collaborative computing, integration of user-contributed content, mashups, and shared distributed data management.Indeed, in many ways, Web 2.0 provides a platform for the emergence of Web GIS, where Web GIS is a platform for creating, displaying, managing, analyzing and sharing all forms of geographic knowledge. This includes,

Maps and Globes - Interactive views of geographic data with which to answer many questions, to present results, and to use as a dashboard for real work. This geovisualization has been the hallmark of web-based mapping and will serve as a foundation of GIS on Web.

Geographic Datasets and Data Services - File bases and databases of geographic information—features, networks, topologies, terrains, surveys, and attributes.Not only the ability to share rendered maps, but to share the underlying features and associated data.

Processing and Workflow Models - Collections of geoprocessing procedures for automating and repeating numerous tasks that perform analysis. GIS on the Web becomes a collaborative platform for building, managing and sharing workflows and processes.

Data Models - More than database tables, GIS data models incorporate advanced behavior and integrity like other information systems. Access to the full data models —the schema, behavior, and integrity rules of geographic datasets will play a critical role in GIS on the web.

Metadata - Documents describing the specifications and properties of the data. Metadata catalogs enable users to easily organize, discover, and quickly gain access to shared geographic knowledge.

GIS on the Web will not only allow for the extensive sharing of maps and data, it will open up access to the full power of GIS applications, analyzes and services to everyone, with the web as the platform. When combined with the growing availability of georeferenced content and the ability to easily search, discover, and mash up the web services, GIS on the Web enables a whole new pattern and architecture for GIS. This pattern emphasizes open and interoperable services that can be used to support a broad array of geographically related applications.

This pattern has already been deployed by Google and Microsoft for supporting consumer map visualization and simple mashups. Google's KML standard (now adopted by the Open Geospatial Consortium, Inc.) has provided an easy way for anyone to participate. This phenomenon has led to millions of recorded observations by what some are calling the neo-geographers. While often of little direct value to GIS applications, the mashups nevertheless define a pattern of sharing geospatial data on the Web that is bothinteresting and promising for growing the reach and relevance of the GIS community.

Over the past several years, ESRI has taken major steps to integrate its flagship product, ArcGIS Server, into the Web 2.0 environment. This GIS on the Web capability allows GIS professionals to directly publish searchable metadata about their services, as well as serve maps, data, and a full range of services for others to view, use, and mash up to create and extend powerful geo-enabled applications.

In terms of functionality and applications, GIS on the Web movesbeyond simple mapping and visualization to support integration of full GIS-based services representing "authoritative source" knowledge (maps and data, of course, but alsoall other forms of geographic knowledge). Users will now be empowered to create new applications built from these services, applications that leverage the full power of GIS analysis based on dynamically distributed information.

7.2. Extending Enterprise Web Services – The Mashup

Of greater importance for many users is the fact that the concepts and standards of Web services and service-oriented architecture (SOA) are also providing a new platform for implementing GIS in the enterprise. The centerpiece of this new environment is the GIS server, which is increasingly being used to serve data, analytic models, and maps for use across organizations. Services represent a new and powerful way to share information and collaborate in its use. The mashup style for building applications will be very popular, not only for integrating distributed GIS services but also for integrating GIS with other IT applications across the enterprise.

ESRI's technology continues to evolve with a particular emphasis on server technology and Web-based services. The server platform allows the user to easily share applications, data, and knowledge with colleagues in other departments and organizations via the Web and simple geo-browsers. Using the SOA model with GIS services, users have begun to integrate their desktop and departmental solutions into implementations that connect many departments.

This Web services architecture allows users to both federate their distributed systems as well as integrate GIS and spatial processing with other IT business systems, such as ERP, CRM, and SCADA. While this has been possible for some time, the advent of SOA and simple technologies to integrate these services has made it much easier and promises to greatly expand the GIS market.

7.3. The Geographic View

Society is becoming more familiar with examining its world through geo-browsers closely integrated with search engines. GIS on the web is an extension of these powerful, intuitive tools. ESRI is providing an array of powerful tools to provide GIS professionals and users the ability to carry out their work in a Web 2.0 framework.

While a great deal of GIS data and services will not be served in the open Internet for security, cost, proprietary, and privacy reasons, many topics of great interest to the public－such as crime, natural hazards, land infrastructures, and environmental conditions－will be made available by the GIS professionals to the wider GIS community and to the general public.

GIS professionals and traditional GIS organizations will provide the backbone of GIS on the Web. From its early days, GIS has been about sharing and integrating geospatial information from many sources. The Web 2.0 and related Web services offer a new and powerful opportunity to share geospatial information and collaborate in its management, analysis and productive use.

7.4. Spatial Data Infrastructure

GIS on the Web has a crucial role to play in the development and deployment of Spatial Data Infrastructures, whether these are used to share and collaborate within and between organizations.

Spatial Data Infrastructure is a vision that involves the creation of a common and shared library of geospatial services that are created from multiple layers of geographic data that are managed and maintained by different mission agencies. The concept is that these layers are served as geospatial services for use by various applications across organizations and for citizen access.

For example, a state or national government may wish to create a network of distributed servers that manage and serve "framework or essential layers" set up as Web services, for example, roads, topography, administrative boundaries, land records, and vegetation. Each of these services can be integrated into a variety applications used to support the business processes within a number of organizations. This pattern has already been successfully implemented in a number of enterprise systems.

The key issue with this federated architecture involves ensuring that service levels provided by each of the contributing services are architected to support a variety of uses, maintained consistently and have enough capacity to support the applications.

Typically, the agencies maintaining any given layer of the infrastructure are funded only for their own mission and not mandated with the responsibility of providing services to other organizations. This can be an impediment to the establishment of the infrastructure. To make a common infrastructure work, agencies need to either be funded to take on the responsibility for serving common infrastructure or, alternatively, the enterprise as a whole needs to be set up as a separate (redundant) application server environment that is shared by everyone.

Over time, it is likely that GIS users will implement system architectures that combine their mission-focused servers with large, centralized servers that replicate the data and provide application services for the entire enterprise. In such hybrid systems, the individual thematic layers will typically be maintained in working databases (transaction-oriented databases) with select data layers being replicated to a central system that organizes them into cached map and data services for high performance access and support of cross cutting applications. These enterprise services can then be used in the Web 2.0 environment along with citizen-generated data and mashed up with other available data.

In order for the Web GIS vision to materialize, a number of enabling technologies must fall into place. These include:

Stronger Distributed Data Management and Transaction Processing of Geographic Data. This requires the development and evolution of geodatabases to include all spatial data types and the ability to update these geodatabases with a wide variety of client applications: Web, desktop, mobile, CAD, and the like.

Replication Services - These services allow data to be managed in a distributed fashion where database updates and transaction at the departmental or agency level can be easily and efficiently replicated to high performance enterprise serversfor caching and serving to a much wider audience.

Open Web Services – This represents the ability to serve maps, data, data models and processing/analytic models in a standards-based environment that enables developers as well as end users to orchestrate or mashup distributing services for application development. This includes standards-based technology that can integrate GIS servers with other standard IT systems such as ERP systems.

Web-based GIS Modeling and Analysis – Web GIS will require powerful Web-based geographic analysis and modeling tools that support customization and application development.

Support for Standards-based Interoperability – To support clients from a variety of vendors, Web GIS requires strong support for consuming and publishing data and services using leading interoperability standards: OGC, ISO TC211, W3C, OASIS. This includes strong support for the key metadata standards.

Beyond the technology, the vision of SDI requires governance systems that encourage, allow and support full participation across many organizations. SDIs are being implemented at and across many different scales of government: local, state, national, and regional. Likewise, it is also beginning to be deployed in large global companies. For these efforts to fully realize their potential, the governance structures in place must promote full participation and sharing of data and services.

Although many SDI efforts have floundered in the past, we are beginning to see real progress on many SDIs. In part, the success is due to strong governance systems that promote successful technology and process models. In the US federal government, for example, the FGDC is evolving and becoming more business focused with its geospatial lines of business. Similarly there are many successful SDI efforts underway, in Europe under the auspices of the INSPIRE program and in Canada in connection with the Canadian GeoConnections program.

Ultimately, the success of the SDI vision at any levels of government or private sector organization will result from the realization of significant benefits of lower costs and higher levels of efficiency and productivity from data development collaboration and sharing of GIS services. While SDIs are complex, GIS professionals working together have proven that it is possible to overcome the technical and organization issues.

7.5. The Rise of Volunteered Geographic Information

The Web 2.0 world recognizes user-generated content (UGC) as a concept that promotes greatly expanded interaction on the Web. Combined with Web GIS, UGC represents a notion that has the potential to alter how geospatial data is created and managed.

Several years ago, Dr. Michael Goodchild of the University of California, Santa Barbara (UCSB) introduced the concept of volunteered geographic information (VGI). VGI is basically a new name for georeferenced UGC. The wiki-genre site, Wikimapia, offers an excellent example of VGI. It encourages participants from various fields and professions to post comments about georeferenced locations. There are many other examples of VGI that have emerged. On Flickr, users can upload photos to latitude/longitude locations, and OpenStreetMap is an international effort to create a free source of map data through the efforts of volunteers using this methodology.

Oftentimes, much of the current VGI on the Web today represents casual observations or assertions about a place. VGI can also be expanded, however, to include data collected by traditional authoritative source organizations and agencies and shared openly on the Web. This is basically an expanded notion of the GIS concept of spatial data infrastructure (SDI), where multiple organizations share their data and services with each other across the Web.

Today, Web GIS is evolving into a technology platform that promises to deliver the full vision of SDI. With solutions for distributed data management and easily integrated GIS services, Web GIS will support a whole new era of inter-organization collaboration. Members of the wider and expanding GIS community will not only learn how to publish and share moresophisticated and useful services, they will also learn to develop institutional relationships that support and encourage collaboration (for example, electrical utilities serving their maps to local government agencies and vice versa).

7.6. Consumer Geospatial Technologies Provide Opportunities for Sharing Maps

Web mapping/visualization tools developed by Google and Microsoft provide very fast, easy-to-access views of images and maps. Although they do not support tools for the more complex work performed by GIS: data management, analysis, workflows, custom applications, and the like, the pervasive use of these new environments offers an opportunity for GIS organizations to share some aspects of their work for open viewing by many different users and user communities. Of particular interest are Web pages that tell stories about events, situations, and forecasts.

In order for Web GIS to integrate well with the consumer based technologies, a number of areas are being addressed. They include:

KML Services - Improved capability to author and publish KML-enabled services. This means GIS users can directly serve their maps and data into applications such as Google Earth and Microsoft Virtual Earth.

REST APIs – This includes support for publishing services into the Rich Internet Applications (RIA) and environments built in JavaScript, SilverLight and Flex/Flash. REST APIs are a key component in the support for mashing up information with a variety of services: ArcGIS services; maps from Google, Yahoo!, and Microsoft; and other services such as Craig's List.

HTML Metadata Services – The discovery of GIS data and map services is made infinitely easier when metadata service directories are created in HTML so that can easily be indexed by Web search engines.

The combination of Web GIS with the increasingly pervasive consumer mapping and geo-services promises to spread the power and potential of GIS well beyond its traditional users and communities.