The 11th International Seminar on GIS

Collaborative GIS toward Geospatial Information Society

Korea Research Institute for Human Settlement

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-Hun 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-Hun 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-Hun Kim Young-Joo Lee Jae-Il Han

Opening Address

Good morning!

Honorable Mr. Myoung-Ro Lee, Director General of the Ministry of Construction and Transportation, presenters and discussants at home and abroad, distinguished guests, ladies and gentlemen!

On behalf of the Korea Research Institute for Human Settlements, I'd like to extend my appreciation to all you for attending the 11th International Seminar on GIS today, and I'd like to offer my warm welcome to all of you to the seminar.

Every year since 1996, KRIHS is providing a venue for discussions on policy directions to the National GIS and technological development through this seminar, inviting GIS scholars and professionals at home and abroad, and today's meeting marks the 11th anniversary.

Korea has been promoting National GIS projects at the government level primarily by the Ministry of Construction and Transportation since 1995. Despite numerous difficulties, these projects have played a major role in establishing the base for geospatial information of the nation, and since 2006, KRIHS has been devoted to construction of a ubiquitous territory following the third National GIS Project commencement.

KRIHS is also committed to effectively promoting geospatial information projects in the nation, and to this end, KRIHS is pushing forward a range of strategic projects for the National

GIS, including establishment of the National GIS Master Plan over three time periods and support for relevant legal systems, and construction of an application system for land, underground facilities and spatial image, consequently contributing to GIS application in both the public and private sector.

However, in spite of compressed growth of National GIS projects over the past decade, demand for the GIS application system increases every day with development of state-of-the-art geospatial information technology, thus raising the need for innovative efforts for this.

In respect of GIS demand, need to develop the geospatial information application system is growing which is aimed at enhanced quality of people's lives. Such policies as balanced territorial and regional development, urban regeneration, the U-eco City and innovation in territorial amenities reflect this demand.

In terms of GIS technology, cutting-edge information technology including ubiquitous technology is rapidly developing, and it is urgently needed to develop a geospatial information service model utilizing the technology.

In respect of GIS information, it is time we contribute to construction of a support system for various decision-making that involves territorial space, providing data comprising both attribute information such as statistics and situation information. This is intended to improve application of spatial information accumulated so far.

In order to accommodate the geospatial paradigm shift in GIS demand, technology, information, and so forth, it is regarded that we should explore methods to solve problems introducing concerted efforts among agencies, regions and nations, going beyond the specific agency or field level.

In this vein, it is my sincere hope that, through presentations and discussions among the participating scholars and professions, this seminar serves us well in advancing the geospatial information society that will enhance quality of people's lives.

Further, I sincerely hope that this seminar will provide an opportunity to leap the geospatial information industry forward on the basis of new GIS technologies and GIS application system development directed towards geospatial information society formulation.

Once again, I'd like to offer many thanks to presenters and discussants for their valuable contributions to the seminar.

In closing, I'd like to express my appreciation to those involved from the Geospatial Information Team of the Ministry of Construction and Transportation, the Korean Association of Geographic Information Studies, Korea National Housing Corporation and Korea Land Corporation, for providing unsparing support for the seminar, and to other participants in the seminar for their keen interest and affection for the National GIS.

Thank you.

October 24, 2007

Byung-Sun Choe, President

Korea Research Institute for Human Settlements

Congratulatory Remark

Dear reverent President of KRIHS!
Dear ladies and gentlemen!

First of all, I would like to express my pleasure to attend here and speak congratulatory remark to KRIHS for holding 「The 11th International Seminar on GIS」

Since the year of 1995 when GIS was first introduced in Korea, KRIHS has been contributing to the advancement of GIS in the fields of geospatial data construction, analysis and application, including GIS-related national policies.

In particular, through supporting researches KRIHS has contributed to the 1st to currently the 3rd Master Plan for the NGIS(National GIS), which is widely-recognized as the most comprehensive long-range plan on national level, proposing the future vision of GIS in Korea.

Opportunely, last year MOCT(Ministry of Construction and Transportation) and KRIHS jointly held a public hearing for the 3rd Master Plan for the NGIS in this auditorium.

Based on the keynote of 'the Construction of Intelligent Cyber National Territory toward Ubiquitous Era', the 3rd NGIS-led projects focus on 'the quality enhancement of user-centered information services', 'cooperative approaches with geospatial information-related technologies' and so on.

Just at the right time, I believe it is very timely to hold this precious discussion opportunity under the title of 'Collaborative GIS toward Geospatial Information Society'.

Indeed, despite a short period of a bit more than 10 years, GIS has been being widely used in wide range of fields, such as national territory management, underground facilities management, environmental conservations, and so forth.

Through active participations from private sector, too, like GPS Navigation systems, Internet-based map and mobile services, GIS has grown up to became one of modern people's 'daily-life infra'.

It means that, in the 21st century, the advancement of telecommunication technologies including GIS are putting down roots as the core methods to establish cooperative inter-relationships among a spectrum of different social sectors.

Under these circumstances, I would like to put much meaning to choosing GIS, Web, and SDSS(Spatial Decision Support Systems) as today's discussion topics for 'the Utilization of Cooperative GIS' under the epoch-making paradigm of 'Geospatial Information Society'.

While GIS as core technology linking between physical and cyber space, and Web as an important communication tool in the current open information society, SDSS has a profound meaning as an effective method to realize successful cooperations.

In brief, as future society approaches featuring Ubiquitous technology, the role of geospatial information, its utilization technology and the degree of utilization itself are expected to increase pretty much. And GIS will play its role as a primary method for cooperations among people, technology and institutions.

By all means, expecting that today's discussion could serve as a good chance to draw closer to an advanced country of information, I wish growth and victory to all GIS people.

Lastly, I would like to thank presenters and discussion panel for participating here today in spite of tight personal schedules.

Also, GIS people from government, industry, academia and institutes! And ladies and gentlemen participating here today!

I express my honest gratefulness to you all, too.

Thank you so much.

October. 24 2007

Myoung-Ro Lee, Director of Land Planning
Ministry Of Construction & Transportation

Seminar Program

09:30～10:00 Registrations
10:00～10:15 Opening Address (President of KRIHS)
Congratulatory Remarks
(Director of Land Planning, Ministry of Construction & Transportation)

Session 1 GIS in Society

10:20～10:50 The NSDI Law & Prospects for Geospatially Enabled Society
(Ryosuke Shibasaki, Professor, University of Tokyo, Japan)
10:50～11:20 Digital City and GIS
(Anthony G.O. Yeh, Professor, Univ. of Hong Kong, Hong Kong)
11:20 - 11:50 Panel Discussion
- HyungBok Kim (Director, Land Information Team, Korea Land Corp., Korea)
- YunSoo Choi (Professor, University of Seoul, Korea)
- HoSang SaKong (Director, Geospatial Information Research Center, KRIHS, Korea)

11:50 - 13:30 LUNCH

Session 2 Web &GIS

13:30～14:00 Towards GIS 2.0 : Spatial Thinking and PPGIS change Society
(Hiromichi Fukui, Professor, Keio University, Japan)
14:00～14:30 The User-paticipated Geospatial Web as Open Platform
(SeokChan Yun, Technical Evangelist, Daum Communications Corp., Korea)
14:30～15:00 Google Maps : Reshaping PPGIS (Wansoo Im, President, Vertices, USA)
15:00～15:30 Panel Discussion
- HanJu Lee (Director, Urban Information Team, Korea National Housing Corp., Korea)
- JongHyun Park (Director, Telematics Research Group, Electronics and Telecommunications Research Institute, Korea)

15:30～15:50 Coffee Break

Session 3 Spatial Decision Support Systems

15:50～16:20 The Strategies of Developing the Korea Planning Support Systems
(Kirl Kim, Associate Research Fellow, KRIHS, Korea)

16:20～16:50 GeoSemantic Web Service Framework for Spatial Decision Support System
(Chih Hong Sun, Professor, National Taiwan University, Taiwan)

16:50～17:20 Analysis of MetroScope's Practical Impelmentation of the Planning Support System
(KyungHwa Kim, Principal, Portland Metro USA)

17:20～18:00 Panel Discussion

- JongBae Cho (Director, Geographic Information Planning Team, Ministry of Construction & Transportation, Korea)
- BongMoon Choi (Professor, Mokwon University, Korea)

Profile

Ryosuke Shibasaki

Ryosuke Shibasaki is a professor and the director of Center for Spatial Information Science (CSIS), the University of Tokyo, Japan, since 2005. CSIS is the national center for Geospatial information science and engineering in the Univ. of Tokyo, supported by the Ministry of Education, Science and Technology.

He specializes in mapping and remote sensing for urban objects including vehicles and people, design and planning of spatial data infrastructure including geospatial ontology. He is a driving force of new legislation for NSDI of Japan and serves for national local governments as a number of committeechair and member. In the international arena, he is the president of Asia GIS Association and one of co-chairs of Architecture and Data Committee of GEOSS (Global Earth Observation System of Systems). He received Dr.Eng. from Graduate School of Civil Engineering, University of Tokyo in 1986.

Anthony G.O. Yeh

Anthony Yeh is a Chair Professor of the Centre of Urban Planning and Environmental Management and also Dean of the Graduate School, Director of the GIS Research Centre and Institute of Transport Studies, University of Hong Kong. He is an Academician of the Chinese Academy of Sciences and a Fellow of the Hong Kong Institute of Planners (HKIP), Royal Town Planning Institute (RTPI), Planning Institute of Australia (FPIA), British Computer Society (BCS) and the Chartered Institute of Logistics and Transport (CILT). His main areas of specialization are in urban development and planning in Hong Kong, China, and S.E. Asia and the applications of computers in urban and regional planning, especially geographic information systems (GIS). At present, he is the Secretary-General of the Asian Planning Schools Association and Asia GIS Association. He has been the Chairman of the Hong Kong Geographical Association, Viceof the Commonwealth Association of Planners, VicePresident of the Hong Kong Institute of Planners, Chairman of the Geographic Information Science Commission of the International Geographic Union (IGU) and Founding President of the Hong Kong GIS Association.

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.

ChihHong Sun

ChihHong Sun is a professor at Geography Department, National Taiwan University and Past President of Taiwan Geographic Information Society (2005-2006). He received his undergraduate education at the National Taiwan University (1977) and his Ph.D. degree in geography from the University of Georgia, USA (1986). He served as director of the Global Change Research Center, National Taiwan University from 1998 to 2004 and the executive secretary of the Commission on Sustainable Development Research, National Science Council from March, 1998 to June, 2000. Prior to that, He also served as chairman of the geography department, National Taiwan University from August 1994 till July 1997. His research specialties are in geographic information system, decision support system, hazards mitigation, and sustainable development. His recent researches are concentrated in developing spatial decision support system for natural hazards mitigation and for sustainable development issues. He is the project leader for the design of the National Geographic Information System.

Wansoo Im

Wansoo Im is the founder of VERTICES, LLC, a geospatial information services company that provides innovative interactive map-based solutions. He is also the founder and Executive Director of the Center for Community Mapping (CCM).

He specializes in unique decision support systems that utilize spatial data visualization and modeling techniques. He is an adjunct faculty member at Rutgers University and the University of Medicine and Dentistry of New Jersey (UMDNJ). He received his Ph.D. from the School of Planning and Public Policy at Rutgers University and his Masters in Urban and Regional Planning from the University of North Carolina at Chapel Hill. In 2006 he was featured in The New Yorker magazine for his community participatory Internet mapping project and in the Urban Regional Information System Association's News.

KyungHwa Kim

KyungHwa Kim is a Principal Transportation Planner at Metro in Portland, Oregon, where she has been employed for 20 years as a transportation system modeler. Her 20 model development.

Her strength in data understanding and model structure has lead to involvement with region's the most challenging projects, such as Land Use Transportation and Air Quality(LUTRAQ) study, Transportation Analysis and Simulation System(TRANSIMS), Activity Model Development, and Regional Freight Modeling Project.

She has served on numerous peer modeling review committees, is a member of the Oregon Modeling Steering Committee, Transportation Research Board (TRB) Transportation Survey Methods Committee, and Transportation Research Board (TRB) Task Force on Moving Activity-Based Approaches to Practice Committee.

SeokChan Yun

SeokChan Yun has worked at Daum Communications Corp. as a technical evangelist to promote Open APIs and support 3rd party developers since 2004. His interests are Web 2.0, Open Source Software, Open Standards and Geospatial Web.

He majored in Geology and GIS in Pusan National University and studied Geospatial Web at GIS Research Institute of Handong University in 1998. His academic focus was open geodata based on web standards. So he was joined W3C SVG working group to combine geodata in web browsers. And then he has continued to study geospatial web in view of open web standards. He also has been Korean developers for Mozilla project since 2002. Now he is an invited expert of W3C's new HTML working group in 2007.

Kirl Kim

Kirl Kim obtained his Ph.D. degree from the department of geography at the Florida State University in 2006. He is now an associate research fellow and working for Geospatial Information Research Center at the Korea Research Institute for Human Settlements

He's major research field is urban political economic geography and GIS. He specializes in spatial decision support systems for urban regeneration that integrate urban theory and GIS methodology. He is now constructing the urban regeneration models in the Korea Planning Support Systems project using the spatial data visualization and modeling techniques. His representative papers are "Housing Redevelopment and Neighborhood Change as a Gentrification Process in Seoul, Korea (2006)" and "A Study on Urban Sprawl Monitoring Systems (2006)."

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Section Ⅰ : Papers

The NSDI Law & Prospects for Geospatially Enabled Society

Ryosuke Shibasaki

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1. The NSDI Law

Some two and a half years after work began on the draft law and one year after its introduction to the Diet, the Basic Law for the Promotion of Geospatial Information Uses was passed on 23 May 2007 under the co-sponsorship of the Liberal Democratic, Komeito and Democratic parties. Termed the NSDI Law in reference to the impetus it gives to a national spatial data infrastructure, the great distinguishing feature of this basic law is the ambition to construct a common basis for organizing, surveying and making flexible use of the variety of information linked to positions and locations. While a GIS action program is in place for existing geographical information systems, and government ministries have pursued coordinated policies, these have primarily involved geographical information, i.e., mapping information. There seems to have been but faint recognition of the need to build a platform for allowing anyone to readily obtain positional and locational information anywhere at any time. Why is it that the combination of information plus position and location is now winning attention?

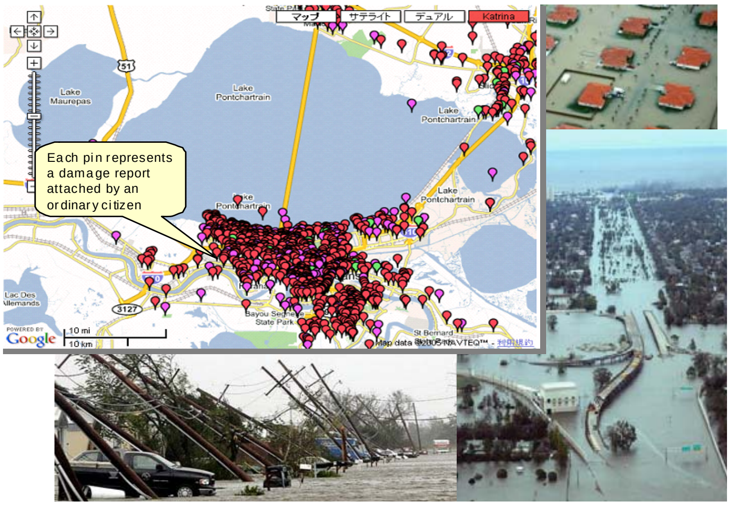
2. What Is Geospatially Enabled Society?

When an emergency is reported, the information that someone's injured needs to result in a quick action that leads to that person's rescue. No action can be taken, however, if the location is unknown. Of course, other information such as when and in what condition is also required, but this may easily be supplied by the person present at the scene and reporting the emergency. Providing accurate information about the position, however, is more difficult than it might seem. What is the address? What is the place called? What is the building called? Since April 2007 it has been mandatory for mobile phones to be equipped with GPS receivers so that when an emergency is reported the latitude and longitude of the phone will be transmitted in a form that is universal and has little ambiguity. "Attaching" position and location to such information greatly enhances its value.

When the southeastern United States was beset by Hurricane Katrina in August 2005, ordinary citizens provided information via Google Maps on the resultant damage, as shownin Figure 1. Google Maps is a digital map service operated by Google, the well-known Internet search engine firm. Google Maps allows anyone to attach information to a map. Displaying reported damage information on a map allows one to grasp the larger picture and helps tremendously with devising an overall relief strategy. That Google Maps may be viewed by anyone facilitates the sharing of damage information, which may have the further effect of enhancing solidarity and making it easier for ordinary citizens to help each other. Because police, fire fighting and other emergency services are unable to do all that needs to be done when an earthquake or other major disaster strikes, the help that members of the local community provide each other is of great importance, and the sharing of information mediated through clearly presented maps should prove of great significance. Figure 2 shows a similar example from the Great Hanshin Earthquake of January 1995.

Shared maps thus become a shared social communications space for communicating positions and locations to other people. A Geospatially Enabled Society is one in which anyone can easily identify a position or location anywhere at any time and then use it to transmit or share information, a society in which one can collect and organize diverse information from positions and locations and then utilize it in technologically sophisticated ways.

As it happens, positional and locational information may be contrasted historically with time and duration information. Historically, we have obtained our notions of time and duration intuitively from such phenomena as sunrise and sunset, the change of the seasons and the movement of the constellations. Such constructs as the Julian calendar, dating from c.50 BCE, and the Gregorian calendar, dating from the late 16th century, gradually standardized and globalized the definitions and expression of time and duration. With the invention of a portable clock (or chronometer) by the Englishman John Harrison in the 18th century, it became possible to keep accurate track of time and duration anywhere (nothing less than the advent of transportable timekeeping; see Figure 3). In short, society was now empowered by a culture of time information. This is considered to have made a great contribution to the formation of modern industrial society through advances in labor management and process control, as it enabled the orchestration of factory operations according to a timetable.



<Figure 1> Transmitting and sharing Hurricane Katrina damage information*

<Figure 2> Map-mediated information sharing for the Great Hanshin Earthquake

* Sources: http://www.scipionus.com/ and http://en.wikipedia.org/wiki/Hurricane_Katrina [23 September 2007]; the former site has now closed.

<Figure 3> Chronometer H4 (1761), the world's first mobile high-accuracy clock, and its developer John Harrison*

The ability to take an accurate reading of standard time from any location further permitted one to easily and accurately obtain a longitudinal position from standard time at the sun's crossing of the meridian. The only method of determining position for a long time prior to this development that was generally available was to determine the latitude by measuring the zenith of the sun. There was no easy and practical method of determining latitudinal position. Cartographers predating Harrison therefore could not avoid introducing great latitudinal distortions. Looking at Ptolemaic cartography as in Figure 4, for example,we see that while the position of the Equator and other features is surprisingly accurate along a north-south axis, placement along an east-west axis is grievously distorted. The development of the chronometer enabled improvements in the accuracy of latitudinal measurements with ease. Moreover, equipping ships with transportable chronometers made it possible to measure the positions of those ships accurately and in real-time, and the improved accuracy in mapping had a major impact on naval and military affairs. The chronometer in fact emerged from the offer of a monetary prize for the development of a "positioning device" that would give an accurate fix on the positions of ships. GPS and other satellite positioning systems became possible only when satellites were equipped with accurate atomic clocks, and considering the tremendous social impact they have had, from on-board car navigation systems and surveying to precision-guided munitions, the similarities between the two are deeply fascinating.

* http://ja.wikipedia.org/wiki/ and http://www.crichtonmiller.com/Navigation.htm [3 September 2007]

<Figure 4> Ptolemaic cartography*

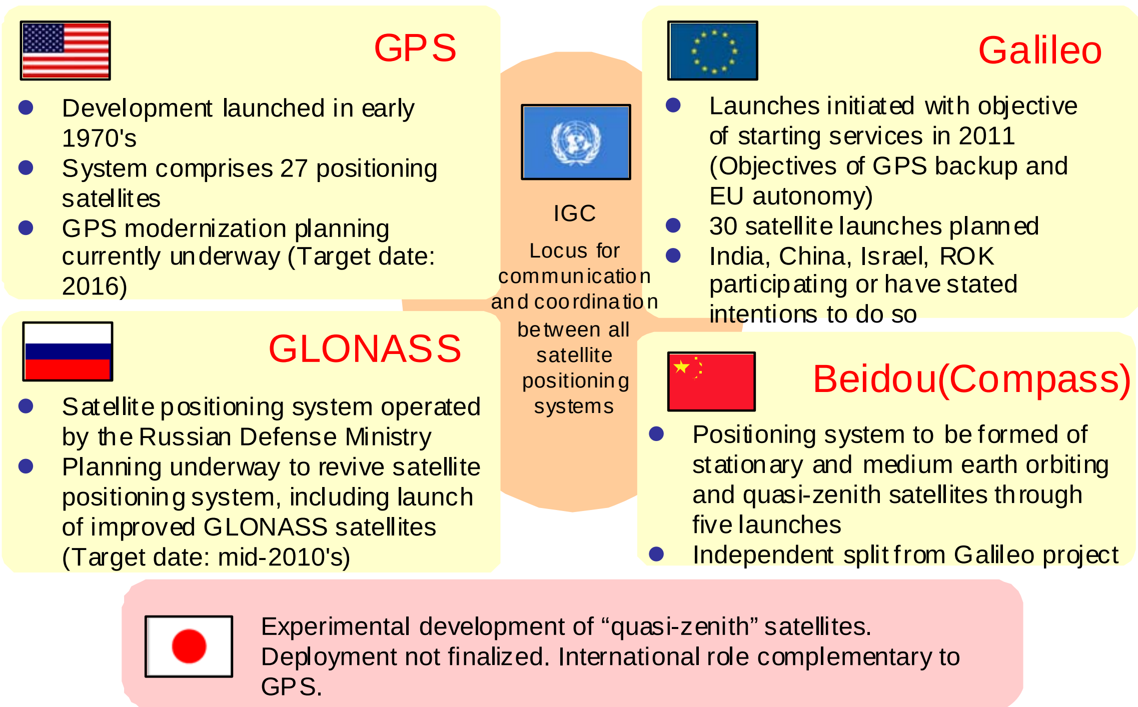
3. Satellite Positioning Systems and Basic Map Information as New Forms of Social Infrastructure

Satellite positioning systems are another important element of social infrastructure that allows anyone anywhere at any time to easily identify positions and locations. A satellite positioning system now operating is the global positioning system (GPS) run by the United States, which is widely employed in devices from car navigation systems to mobile phones. As security concerns have heightened, the importance of satellite positioning systems has gained prominence around the world. The European Union (Galileo Project), Russia (GLONASS) and China (Beidou or Compass) are all developing and planning to launch new global positioning systems with target dates in the mid-2010s. The United States is also seeking to implement its next-generation GPS around the same time. Development is

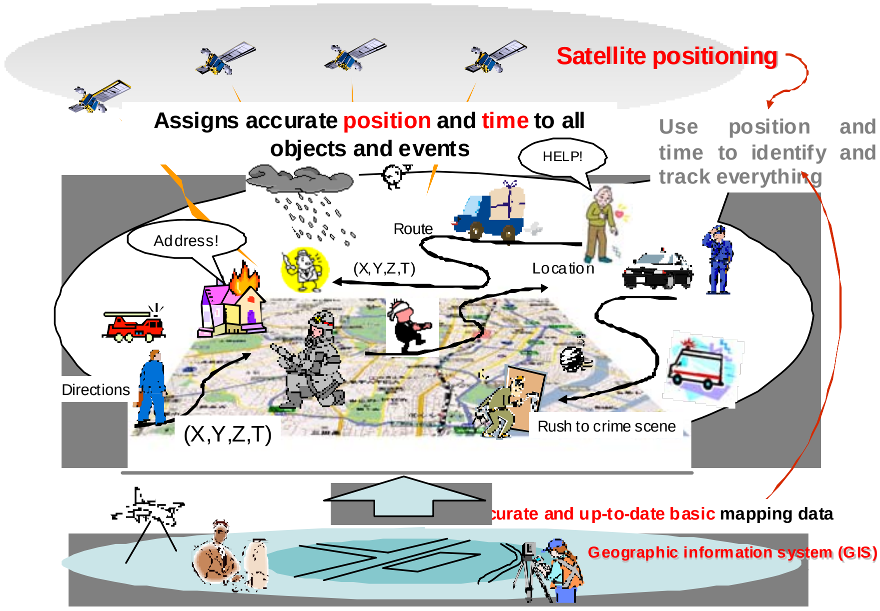
* http://en.wikipedia.org/wiki/Ptolemy

underway of a "quasi-zenith" Japanese satellite positioning system specifically for use in Japan. The first launch of this system is targeted for 2009,which will enable the use of a new signal in advance of Galileo and the next-generation GPS. The plan is currently for slightly more than 40 satellites, with the number to grow later to around 120. The addition of new signals and frequencies will expand the geographical range and times of day in which satellite positioning will be usable outdoors. High-precision positioning instruments currently suffer from instability and are little used for anything other than surveying. However these should stabilize considerably as new signals become available, making it possible to obtain positions anywhere in real-time to a precision of around 10 centimeters (see Figure 5).

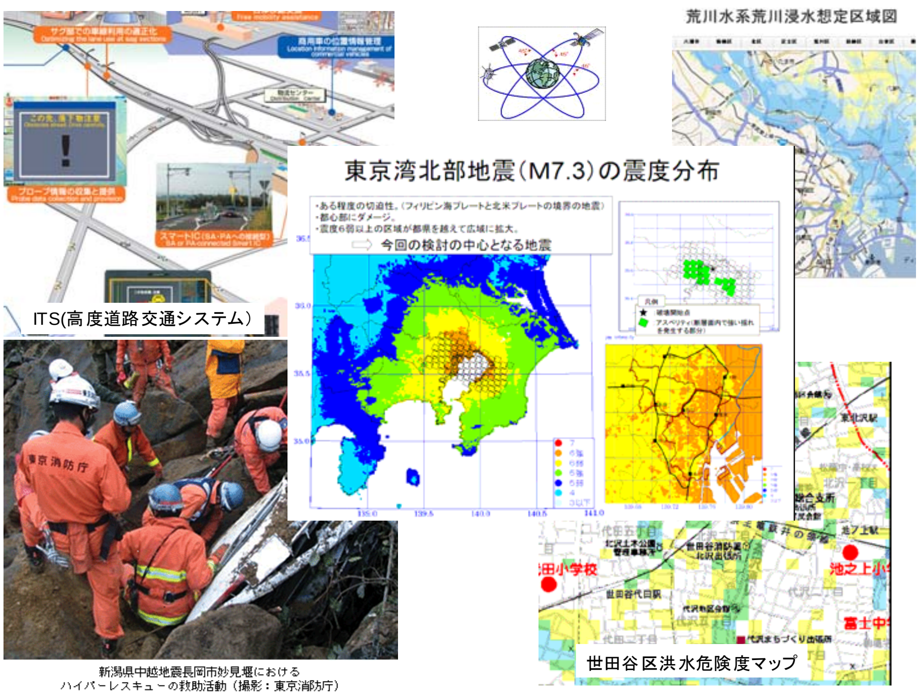
Combining satellite positioning systems that provide positional information in real-time with common base maps will permit us, as shown in Figure 6, to keep track of what is happening where at all times. This national spatial data infrastructure should be thought of as essential common social infrastructure for the purpose of achieving a wide range of public services, from disaster relief to intelligent transportation systems (ITS). (See Figure 7.)



<Figure 5> International competition in satellite positioning systems



<Figure 6> Satellite positioning and GIS underpinning society informed by spatial data



<Figure 7> Positional and location information common and essential to myriad public services*

* Cabinet Office, MLIT, MIC, Tokyo; annotation by author.

4. Keys to Building and Operating NSDI: Concluding Remarks

We use the term "infrastructure" to refer to the basic structures and facilities shared throughout and essential to the many and various activities of our societies. Implementing infrastructure entails funding it with small levies from a broad base of its beneficiaries and requires that someone take responsibility for construction and operation of the facilities. For infrastructure of long standing like roads, a system is in place by which taxes cover the funding and the public administration granted the trust of the populace takes responsibility for construction, management and operation. However, such a framework is direly inadequate for the purpose of deploying a national spatial data infrastructure. There have been attempts to include it in individual public works projects such as road information systems, river information systems or disaster information systems, but there is inadequate coordination between the different projects.

The ready availability of high quality software would permit technologically sophisticated utilization of digital information, and when everyone uses that software the ease of exchanging and sharing data would further amplify the benefits. Not only do disparate, underfunded systems fail to function adequately, they actually impede the interchange of data—we can never expect one plus one to equal more than two. And one plus one may even equal zero when it is essential that information be shared but cannot be due to the existence of multiple incompatible systems, for example if distress information is reported but not passed to rescue teams resulting in no one being rescued.

The successful deployment of basic social mechanisms for the free exchangeand use of digital information, as with NSDI, requires all the organizations that will be transmitting and using the information to work together in the design, operation and use of those mechanisms. Since the sources and users of that information will be private firms and citizens as well as government agencies and other public bodies, a broad outlook and long-term perspective are essential. Such is the background to the advocacy, as an innovation in the land, infrastructure and transport field in 2007, of a "geospatial information platform," i.e. the construction of a framework for circulating and sharing information assembled from locational and positional data.

Cooperation among the many and various bodies involved with common basic maps (what the NSDI Law refers to as "basic mapping information") in particular will permit the generation of maps that are far more up-to-date and accurate than those currently in use. Since roads and other features on maps are sure to be surveyed as they are completed, the inclusion of that surveying data directly into maps will permit the maps to show roads as exactly as they are when "open to traffic" simultaneously with their physical opening to traffic. And to encourage use of new roads, with everyone using more up-to-date maps of greater accuracy, it will be of greater importance to include all road data in the maps without exception and as early as possible, which means that maps will be constantly updated in fast cycles. Much will of course be required in terms of improved data quality control and care and effort on the part of organizations managing the system overall, but this is precisely what the NSDI Law has pronounced to be national policy, and we may consider ourselves to have taken a first big step towards this goal.

Digital City and Geographical Information System

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Abstract

This paper discusses the key concepts and components of digital city and the relationships between GIS and digital city. The use of GIS in digital city can provide 24 hours, year round services, reduce transport, and save traveling time of users. It can help to coordinate urban infrastructures, enhance the services of industries, and develop new industries. At present, GIS is under used in digital city, especially web GIS. Limited applications and user unfriendliness, difficulties in getting GIS data, lack of interoperability and data sharing and cooperation and resources sharing mechanism amongst departments and businesses are some of the constraints that limit the use of GIS in digital city.

Keywords: digital city, GIS, physical space, cyber space

Introduction

Since January 1998, when the former U.S. Vice President Al Gore first proposed the concept and framework of digital earth in his speech entitled "The Digital Earth: Understanding Our Planet in the 21st Century" (Gore, 1998), the concept and practice of digital city have spread into many disciplines and industries, such as e government, digital libraries, and e commerce. More than half of the world's population are becoming urban dwellers. This makes cities the major arena in the application of digital technology because of the high concentration of information, and political, economic, and cultural activities in the cities.

1. Definition of Digital City

A city is traditionally defined by its physical space, including buildings, roads, public facilities, shops, and schools. Objects within the city are linked by transport system and it takes time to cover the physical distance between one location and another within a city. Cyber space, however, emerges with the help of information technology, which encompasses various digitalized urban information, like traffic information, policy directives, public opinions, e business and e government. In the modern urban environment, much time could be saved through the downloading of information and doing business and government transaction via the cyber space. People do not have to have to travel to government departments, banks, or shops in order the obtain information and services.

With the rapid development of information technology, more and more elements of the physical world are being digitalized. Voices, images, text messages, and data can be recorded, edited, stored, retrieved, and transmitted electronically. The realm of cyber space is broadened by the invention and application of new technologies. In this process, cyber space is increasingly integrated with the physical space, which enables it to perform even more functions. Besides traditional urban information services, more can now be achieved in cyber space through emails, web pages, and online shopping, which could only be done in the physical space in the past.

Although it has been quite long since the birth of the concept of "digital earth" in 1998, a widely agreed upon standard definition of digital city is still absent. There can be different definitions according to different perspectives. From a technical point of view, a digital city is a technical system that automatically collects information about, dynamically monitors the running of, and supports the decision making concerning urban infrastructures and functions, employing techniques such as databases and webpages (Xu and Sun, 1999). From a practical point of view, a digital city is an urban information system for government, enterprises, and the public to operate on.

The concept of digital city has at least two connotations (Schuler, 2001):

1) A digital city is based on reality and meant to reduce real world travelling.

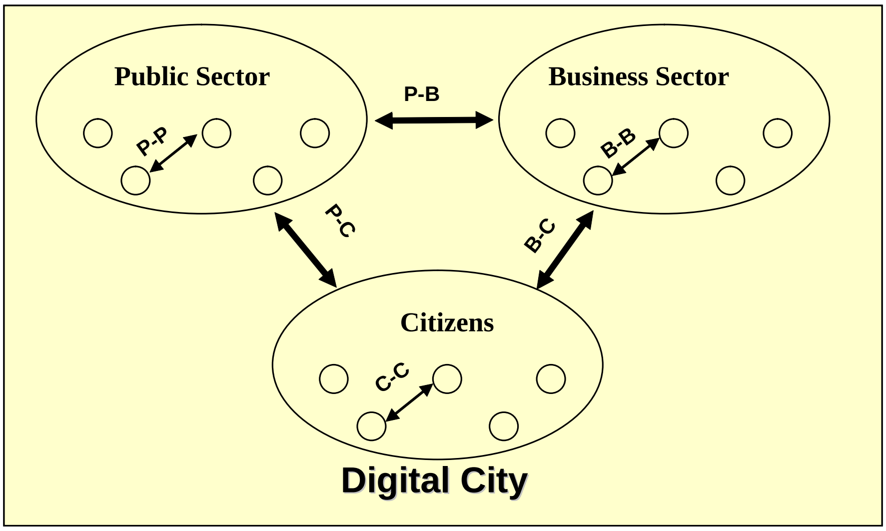
2) A digital city is a reproduction or reflection of a real city in cyber space.

In the first connotation, a digital city must have a real world counterpart, every part of which has a corresponding reflection in the cyber space. And the digital technology that creates digital cities also makes an impact on the way the real world cities are functioning and evolving. The second connotation implies that a digital city is not merely a duplicate of its real world counterpart, but a reflection that transcends the latter due to the intrinsic characteristics of a cyber space. The first connotation is a more generally used connotation for digital city.

2. Implications of Digital City

2.1 Components of Digital City and Their Relationships

A digital city should contain the rich content of the complex nature of a city. A digital city reflects various elements of the real world urban system, and, more importantly, it integrates them in the cyber space using information technology and network technology. In the real world, a city is mainly composed of the public sector, business sector, and citizens. Their relationships in a digital city can be illustrated by Figure 1.



<Figure 1> Relationships between components of a digital city

From the public sector's point of view, a digital city can facilitate the interactions between different government departments(P-P), and the exchange of information between the public sector and the business sector(P-B), and the public sector and the citizens(P-C). The citizens can enjoy varieties of online services provided by the government without traveling around and going through tedious waiting time in obtaining the information or services. At the same time, the government's management and services can be better implemented and provided through intelligent decision making supporting systems.

From the business sector's point of view, the connections between individual business entities(B-B) are enhanced as a result of the way information is now being exchange through the platform of digital city. And, digital technology allows business operators to reach potential customers on a larger scale with their commercials by providing online services(B-C), creating even more business opportunities.

From the citizens' point of view, every aspect of their life, such as travel, shopping, entertainment, work and recreation is directly influenced by digital city technology, which greatly eases the communication and interaction between people(C-C). Citizens can get the services from the government(P-C) and make their purchases(B-C) more conveniently in the cyber space. And they are also able to have information about all parts of their city through the digital urban information broadcast system which makes it possible for them to participate in urban management decisions.

2.2 Sample Applications of Digital City

Digital city technology is now widely used in many fields. Some of the typical applications are:

■ City Image Marketing

Image is of vital importance for a modern city. Besides providing efficient and high quality infrastructure and services in the real world, a city should also have an excellent city image marketing system in the digital world which brings its features and services to tourists and visitors even before their arrival. At present, many cities have already established websites as their marketing effort, and with remarkable results. For example, "The Window to Beijing" (www.ebeijing.gov.cn).

■ Management and Broadcast of Traffic Information

Traffic jams and the resulting problems have been plaguing many cities. A well established urban traffic information broadcast system can improve the situation by sharing the real time traffic information with all citizens, and supporting the decision making of transport department. One example is the Virginia Online Transportation Information System (www.virginiadot.org/projects/prOTIM.asp). Users can sign in and find out the real time traffic information of Virginia for helping them to make appropriate decisions on the means and timing of their travel.

■ **Publication of Administrative Information**

Computerization of administrative information is an important subsystem of a digital city. It informs the public about policies, statistics, and new through multi media. For example, the Census and Statistics Department of Hong Kong SAR publishes its statistics through the web to the public. The publication of administrative information can help to achieve transparency and efficiency by putting activities of the government under the scrutiny of the public without the need to visit their offices for obtaining such information. It saves a lot to traveling time and unnecessary printing of papers.

■ **Public Participation**

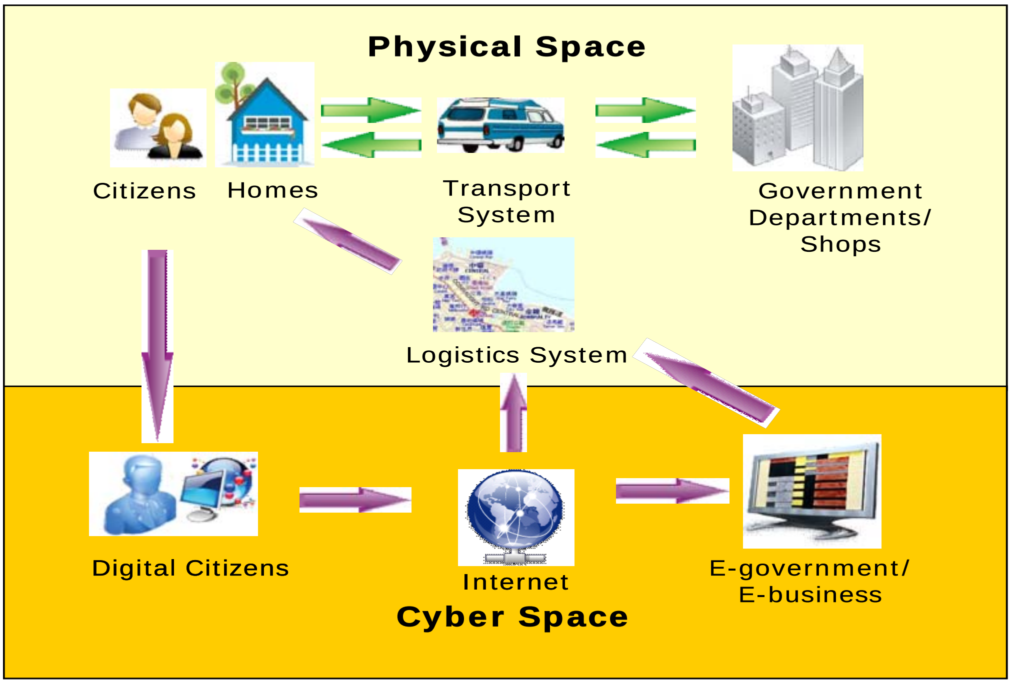
The public could be involved in all urban planning and construction projects, which have a great impact on every citizen's life, such as public transport network planning and urban regeneration, through the digital city. Taking the advantages of a digital city, more means of communication and more interactions between various government bodies and the public have become possible. This could help the citizens to better comprehend the public projects and their impacts, and then make well informed decisions and suggestions based on their own points of view. The Harbour front Enhancement Committee in Hong Kong (www.harbourfront.org.hk) is a good example for such public participation. It releases important information of harbour font projects to the general public, such as their background, plans, and environmental appraisal in order to facilitate public participation.

3. Relationship between GIS and Digital City

It is believed by some people that everything can be done in the cyber space in the future with the ever increasing functions that a digital city can perform. But many functions of a digital city must eventually be completed in the real world, for instance, entertainment, traveling, and transportation, which makes GIS to be an essential component of a digital city.

3.1. Relationship between GIS and Digital City

The life style of citizens has changed profoundly with the advancement of digital city. In Figure 2, the green arrows indicate the actions that citizens have to take to do their government related affairs or to purchase something. The purple arrows show how these can be done through e government or e commerce in the cyber space.



<Figure 2> How citizens do their business in cyber space

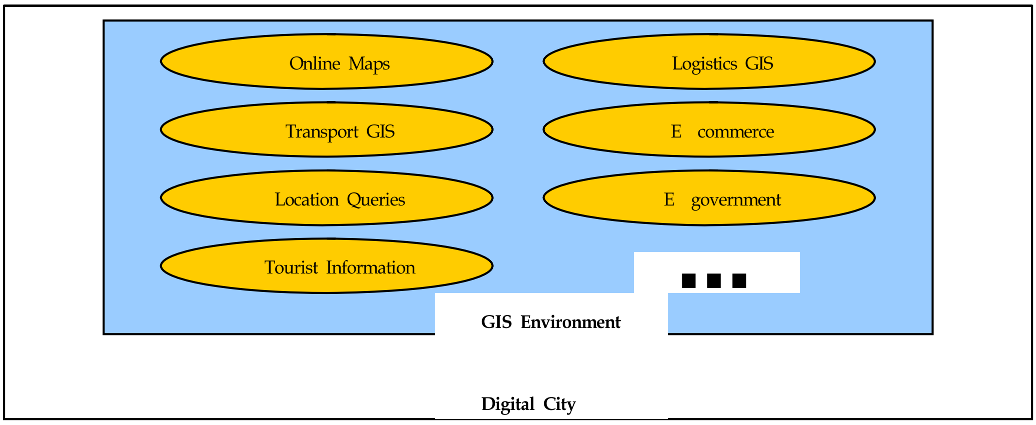
Apparently, physical flow (documents and commodities) and information flow become independent of each other; because citizens can get what they want through the cyber space without spending time traveling and putting extra burden on the urban transport system. But the transactions they make in the cyber space can only materialize in the real world through the logistics system which can benefit from GIS. GIS can help to locate the homes of the buyers and find the shortest route in delivering the goods. GIS can provide locational support to a digital city. GIS also provides a unique platform for the interaction between cyber space and the real world.

As every component of a city is increasingly being contained in a digital city, development in fundamental theories of GIS has been boosted by problems that arise in the application of it in digital city. New theories and technologies have emerged in this process. For example, Open GIS was designed to achieve interoperability and scalibility which were missing in traditional GIS.

The subsystems of GIS provide a wide range of technical support for a digital city, such as Web GIS which can supply the users with online positioning information in the form of internet maps. By embedding GIS technology in mobile phones, PDA, vehicle navigation equipment, and other electronic devises, people can enjoy locational services provided by a digital city, such as navigation and spatial queries.

3.2. Typical applications of GIS in Digital City

The application of GIS technology in a digital city is always associated with spatial locations, such as queries about locations and tourist attractions. Its typical applications are shown in Figure 3:



<Figure 3> Application of GIS in a digital city

3.3. Advantages and Problems in the Application of GIS in Digital City

A digital city is based on a real world city, but it transcends a real city because it has certain advantages that cannot be achieved in a real city :

■ 24 hours, year round services, reduce transport and save time

The application of GIS in a digital city can provide a wide range of services for the public and business sectors and the citizens 24 hours a day throughout the year through e commerce and e government, therefore reduce the burden on the urban transport system and cut down physical flow. Transport of goods can be carried out by professional logistics companies where it is necessary, which helps to achieve a fine division of labor and a highly efficient society. It can save the commuting time of users.

■ Coordination of urban infrastructures

City is a very complex system which poses great challenges for its managers. For example, a modern city has an intricate system of municipal facilities, including roads, drains and water supply network, gas pipelines, fiber optic cables, and subways, both on the ground and underground. Due to the lack of a coordinated management and information system for existing municipal facilities, breakdown of facilities often occurs. For example, cable lines and gas pipes are accidentally snapped when other civil projects are being carried out on the same spot. These accidents happen at the expenses of great economic loss and public inconvenience. A 3D GIS platform in a digital city, which has all the information about the design, construction, and inspection of facilities, and is supplemented by computer 3D visualization technology, would empower city managers to have a holistic view of the entire city's planning and management, to better coordinate the running of facilities and better serve the public.

■ Enhance the services of industries, and develop new industries

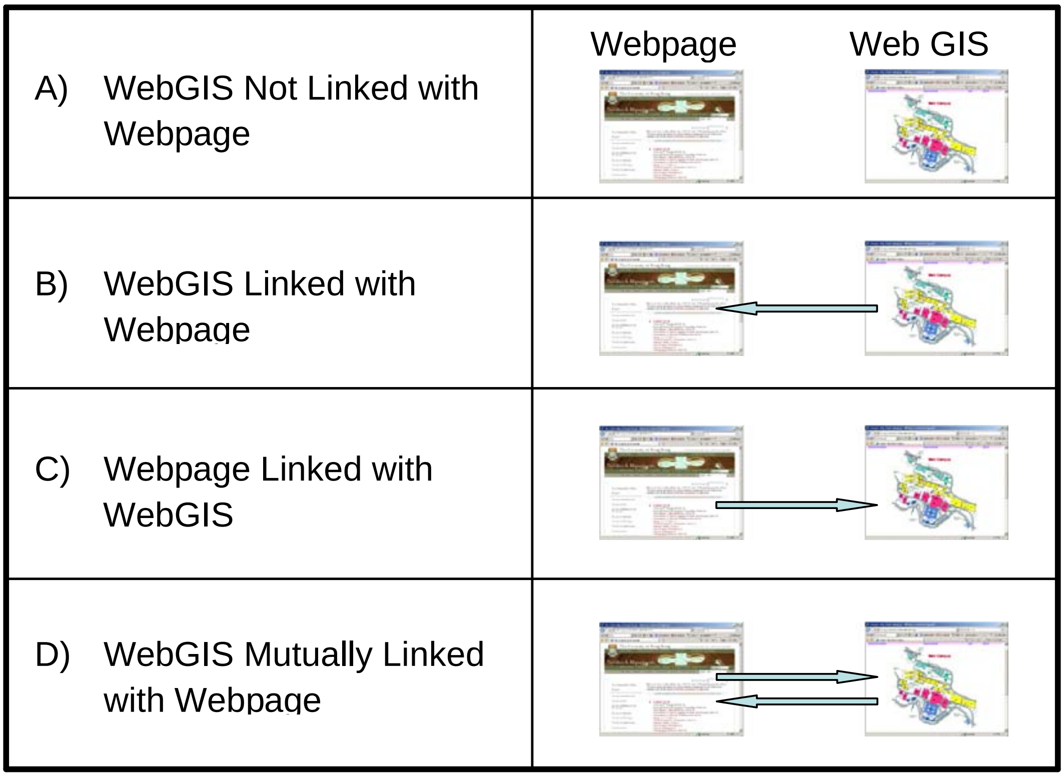
Not only have GIS and digital technology changed the way conventional industries work, but also brought many new business opportunities for the IT industry. Currently, there are already a large number of professional companies that specialize in developing technologies for the application of GIS in a digital city, such as Information Management System for Tourist Spot, Vehicle Navigation System, Express Logistics Query System, and Urban Cadastral Information Management System. These new business opportunities create more jobs and enhance the services of industries.

Although a lot of achievements have already been made in the development of digital cities in the world, GIS has still not being used to its full potentials :

■ Underused of Web GIS

At present, the text information on many websites is not mutually hyperlinked with the corresponding spatial information contained in web GIS (see A, B, and C in Figure 4).

Hyperlink from a location in web GIS to its corresponding webpage are generally available, but not the other way around. For instance, when users login into a government website, they often can only find the relevant information, but not the location of the responsible department on a web GIS if they need to visit that department (see C in Figure 4). They still do not know how to get there. Most of the entities in a digital city have their real world counterparts, and some of its functions eventually have to be completed in the real world. Providing location information is one of the vital services of a digital city. The full power of GIS in a digital city has not been fully utilized due to the general lack of mutual linkages among webpages and web GIS (see D in Figure 4).



<Figure 4> Liinkage between Webpages and Web GIS

■ **Limited application and user unfriendliness**

Recent years, great progress has been made in the application of information technology in the world. In order for GIS to better serve the people, two measures should to be taken. First, promulgate the usefulness of GIS and educate the public with basic knowledge about GIS. Second, increase the accessibility of GIS technology, and make it more user friendly.

■ Difficulty in getting geo referenced data

The market potential for GIS technology for digital city is enormous. Many companies are exploring different potentials in the use of GIS in digital city, such as Goolge Earth. Difficulties in obtain up to date useful geo referenced data is increasingly becoming a bottleneck for the development of GIS technology (Yeh, 1998; Yeh and Zhu, 2004). These may be due to political considerations and the expensiveness of GIS data which may it formidable to be applied to digital city.

■ Lack of interoperability and data integration

Because there are no unified standards, information systems in different cities use different data types and different system designs, which makes interoperability and data integration between them very difficult. As a result, there is a low level of information sharing. This challenges the application of GIS in digital city. It is crucial to examine how to retrieve, convert, optimize, and integrate these data despite their difference in source, structure, property, scale, and resolution (Bian and Wang, 2004).

■ System maintenance and data update

Urban infrastructure is being constructed and upgraded rapidly which requires the constant maintenance and frequent upgrade of information systems. Unfortunately, digital city is merely viewed as an "image project" in some cities, and the maintenance and upgrade of these systems are overlooked. As a result, the data provided by them are outdated. This undermines the public confidence in using them.

■ Cooperation and resources sharing mechanism among various departments

Besides technical problems, the attitude of related government departments can also be a barrier for the further application of GIS in digital city. Government departments may refuse to share the data they collected for their own interests. It requires national legislation and organization structure to coordinate government departments for sharing their data.

4. Future Development

Digital city is a product of the integration of urban physical space and digital space in the information age. It contributes to high efficiency and transparency of the administration system, favorable business environment, accessibility to new markets, and better services for the public. As a lot of activities have to take place in the physical space of the real world, GIS is a powerful tool for helping citizens to find the location of the places that they would like to visit and to explore what are available in the nearby area in the place that they will visit.

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Towards GIS 2.0
: Spatial Thinking and PPGIS Change Society

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Abstract

Web GIS services are rapidly increasing. Google is on the forefront of leading these changes. In Japan, Zenrin corporation, provides large scale map contents data to Google Map. In traditional queries, there is no spatial context, but Google Map provides a local retrieval service, which adds a spatial context to the search query, enabling data around a specific location to be retrieved. Microsoft is also providing similar geo-spatial services in its MSN Virtual Earth platform. Google Earth has changed the scope of GIS. The 3d spinning globe interface and multi-resolution satellite image data, represents a highly realistic model of the earth. Until now, regular net users who were not familiarwith maps or satellite imagery, have become more interested in maps and spatial thinking. These tools have allowed non-traditional stake holders to more easily become spatial data providers, enabling a more broad understanding of spatial data. By using the APIs and PPGIS process these users can more easily share their data with others. These fundamental changes in GIS thinking have given rise to the next generation of spatial technology called "GIS 2.0." The era of GIS as a social infrastructure tool has begun.

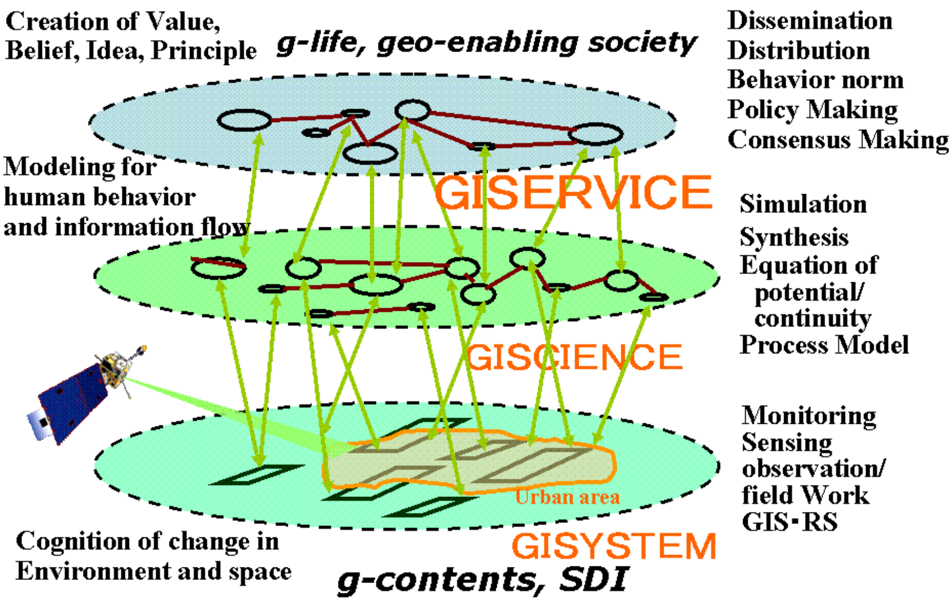
1. Overview of GeoInformatics

There are various problems which we must overcome when we are working with spatial data from a regional to global scale. If we are dealing with regional or global studies we need to learn about the earth. There are various stake holders in each region, and we must talk to them "Chiki-Joho-ryuku" (Regional Information Potential) is the sharing of geospatial information and develop the ability of emergent evolution. To grow or cultivate this Regional Information Potentialwe need GeoInformatics. In GeoInformatics there is a three layer model, consisting of GIS, GI-Science, and GI-Services. The combination of these components is GeoInformatics.

In order to deal with global scale environmental issues from regional levels, a correct grasp of the history and the current status of the regions and the earth is essential, and we must share a common recognition of the issues. The first step to build a sustainable society is to monitor, identify, store the data of phenomena on the earth, then process and interpret the raw data, turn them into understandable information to display, publish and distribute.

Much of this information refers to some specific location on the earth, therefore it is referred to as geospatial information. Traditionally this information has been acquired and processed by maps and statistics. However, since the 1970's, revolutionary advancement in quantitative geography and computers have developed GIS -Geographic Information System a tool that utilizes digital map, and stores, searches, and displays such information combined with statistic property data, while analyzing and operating spatial information for analyzing various human activities on the earth's surface. In the 80's, technology of RS (Remote Sensing) was also introduced. This analyzes observational information captured by space satellites and aerial photography. Today, frequencies at which such observatory information is acquired, and data resolution have drastically improved, so has collecting data for strategic purpose and a better understanding of the global environment. In fact, the amount of data supplied in real time is now far over one-terabit per day, in other words, the speed of data collection is surpassing the processing speed.

And now, the collective act of active utilization of GIS and RS, displaying the earth's surface in multi-dimensional and easily understandable visual form, analysis of fluctuating phenomena on the earth surface, in other words, conducting process model analysis(GISci: Geographic Information Science) to find any regularities on the formation of the earth surface, then estimating future phenomena based on simulation, planning regulation and policies, publish such information(GIServ: Geographic Information Service):This is referred to as Geoinformatics. (Figure 1).



<Figure 1> Three layers model in geoinformatics

The Keio University graduate school of Media and Governance Research Course, where we teach, has started a geoinformatics program this spring to nurture policy making experts who should not only master presentation and analysis of spatial information but also acquire skills in modeling, simulation, achieving consensus and planning.

2. Current Situation of GIS Software

From the text book "Geographic Information Systems and Science," by Longley, Goodchild, Maguire and Rhind (2005, Wiley, PP517), the history of GIS software is described in detail. Traditional GIS software was comprised of the following functions: data collection, archiving, management, retrieving, analysis and presentation.

Generally, GIS software is distributed as COTS, Commercial Off the Shelf software packages. In the present leading software vendors, as described by Market Research Firm Daratech(2003) are ERSI(Arcgis: 34% market share), Intergraph(Geomedia: 13% market share), Autodesk(Mapguide: 9% market share), GE Energy(Smallworld: 8% market share). Recently shareware, freeware(restriction of copyright) public domain software(no copyright restriction), opensource software is now increasing. Such promotional and development activities are described on the freegis.org web site.

GIS is evolving because of the rapid overall changes in IT. Such as in the early 1970s we were using command line interfaces to work with GIS. In the 1980s, GUI was a common form of operation. Gradually this has evolved into the use of Visual Basic and Java, more users are customizing their own applications these days. The result of this customization has resulted in AM/FM systems, land information systems, location based management services, and other specialized support systems. On the other hand, stand alone systems, for single projects, have developed into a shared networked based operationdepending on the LAN functions. From the 1990s due to the rapid expansion of the Internet, GIS has merged with other web services and Internet GIS use has grown rapidly.

3. Era of Social Geospatial Tools: GIS 2.0

In the summer of 2005, there was a major shift in GIS. With the advent of Google Earth, GIS now took on the form of a Social-ware or Social Infrastructure type of application. This is symbolized by the Where 2.0 Conference, which was held in San Francisco near the end of June, 2005. This conference was sponsored not only by GIS vendors, but by major internetplayers, such as Microsoft and Google. A broad range of people, from researchers, developers, and executives participated in the conference. This conference discussed the future of web based location services and the internet. Web 2.0 is the framework, expressed by Google Earth and Yahoo Maps and their open APIs(application programinterfaces) which users could freely use. Now organizations where GIS was not used were able to easily customize theirweb sites to support map interfaces based on these open APIs. For example, Google Earth opened KML(Keyhole Markup Language) and the other tools such as SketchUp and DProfiler allowed for users to created point, line and 3d polygon data which could be overplayed on Google Earth. These were then viewed using KML files which were shared on various web blogs. Ease of use facilitated the spread of KML use, through a number of various web sites to provide developers with code examples. Users with mobile phones and other GPS devices could use Google Earth to input waypoints along their journeys and share this data on their personal blog sites. It is a combination of these factors which allowed a more social use of GIS than ever before. These tools allowed non-traditional stakeholdersto more easily become spatial data providers, enabling a broader understanding of spatial data. The era of GIS as a social infrastructure tool has begun.

These developments have had a profound effect on the field of PPGIS. Now large well-known brand name providers, like Google, Yahoo and Microsoft have enabled more easy access to high quality data. When coupled with simple and powerful applications allowing more people than ever before to access and use this data societal benefits. In the past GIS was an unfamiliar discipline, but now, virtually anyone can easily use and understand he new type of GIS services which are taking shape. This is GIS 2.0

4. Future Directions: From GIS 2.0 to Digital Earth

The digital information revolution is moving towards future developments such as ubiquitous computing, field computing and wearable computing. The combination of all of these developments will be a type of realistic cyberspace.

The real quality of the information-orientatedsociety is that decision making in cyber space (a digital world, a virtual space created by computer networks, separated from the real space) plays a guiding role in the real world(the real world, economy, lifestyle, industries, environment etc. Therefore, it is a crucial task to build an adequate cyber space that can be a metaphor of the real world, without lacking necessary information. For this, conventional tools that process numbers and text as "desk top metaphor" are no longer best suited. Rather, we need an "earth metaphor" tool that captures vast quantities of geospatial data, and turns them into a multi-resolution, time-based three-dimensional representation of the earth in real time.

Building the cyber space based on digitized geospatial information enables an accurate shift from the real to the virtual space, also enabling a virtual visualization of natural phenomena or socio-economic activities. For the people who share this virtual space, it also provides an opportunity of communication, mutual understanding and cooperative working.

Digital Earth is the cyber space recreated by multi-resolution and multi-dimensional utilization of geospatial information. At the end of January 1998, former United States Vice President Al Gore presented "The Digital Earth Concept", aiming at developing such a tool and data base, in order to encourage better understanding of the planet earth in future generations. Mr.Gore launched the concept in projects such as the GLOBE Project. For example, as a part of the "K-12"program that introduced the internet into primary education, students in primary schools in various countries of the world collected data on atmospheric temperature and acidic rain and e-mailed their results to NASA. The geographic distribution was then visualized on Digital Earth. Such is an example of an attempt to provide an hands-on grasp of the environmental issues for children.

The emergence of Google Earth is one of the enabling platforms for the concept of Digital Earth.

Some of the first global spatial data infrastructure projects were started by ICUS/IGBP. In 1994, Japan's Geographic Survey Institute started the Global Mapping Project. Now additional discussionsare taking place on a Global Spatial Data Infrastructure(GSDI: http://www.gsdi.org).Other international organizations, like UNEP-GRID have been involved with the creation of global geospatial data. In 2002 at the Global Environmental Summit in Johannesburg South Africa, there was a proposal to develop a global environmental database. In the EU, the INSPIRE Project is focusing on building an EU spatial data infrastructure. The GMES(Global Monitoring of Environment and Security) project (http://www.gmes.info), is also being proposed by the EU will develop a database and services to support environment and global security issues. The target date for this project is 2008.

In 2003, the G8 Summit and the Earth Observation Summit established the GEO project to promote international cooperation of global earth observation. In 2005 the GEO 10 Year Implementation Plan was approved.

Recently as shown in Google Earth, Google and Microsoft have begun to collect information content, not only related to geospatial data. The previous situation shows the public sector and research community are developing the content. However in the private sector, other IT companies are collecting this data. There are two streams here, but how do we associate or relate these activities sets together.

In order to address these issues, I propose that a test bed is needed to better understand the requirements of each group. The test bed will focus not only on interoperability issues but also examine legal data policies and security matters, and the mandate for core applications which are essential to the various disciplines, such as environmental, education, human security, etc.

In the future, a Digital Earth will be made available for use in a variety of regions through high-speed networks and the internet. For example, one of the first public gateways to a Digital Earth would be built at facilities such as museums. Children will be able to visit museums, see the earth in the space, then zoom in freely on any continents, regions, countries, cities, or communities, using higher and higher levels of resolution, as if exploring a 3D visualized landscape on a magic carpet. They can also obtain a broad range of hyper-linked multimedia information such as digital maps, news images, newspaper articles or voice-documented records. It is also possible to assess future environmental changes in a particular region, or reverse in time and reconstruct a 4.6-billion-year history of earth or ancient environment, or even experience a virtual "silk road" trip by a legendary Chinese Buddhist monk.

So we are entering an era where we can travel through time and space in our daily life. Our children will use a Digital Earth to examine the future of the planet, and actually participate in a respective region's fieldwork.

Through development of assembly microchips with internet accessibility, future society will realize a ubiquitous environment where all objects and people in the real world exist within provision of some sort of computer systems. It is anticipated that such information will be maintained along with respective location information. Ultimately, that information will be all network connected, and a complete copy of the real world will be constructed in cyber space through a Digital Earth.

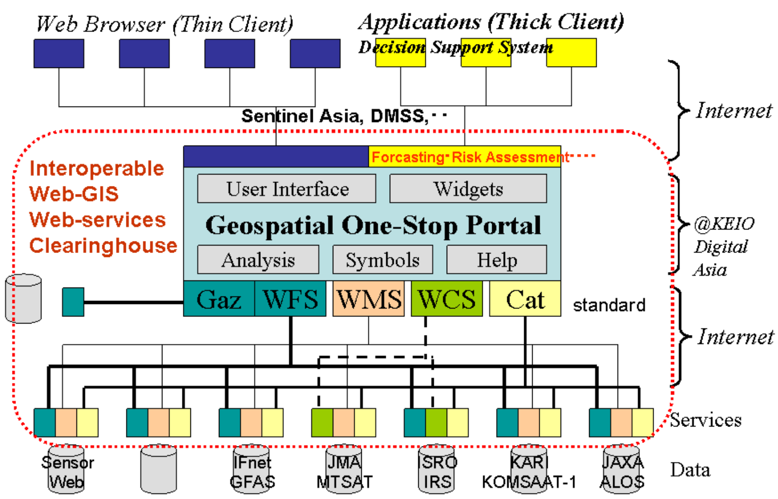
Through seamless visualization of information ranging from global to the local level, and easily understandable overall representation of global issues, we can expect a formation of "knowledge of the global community" based upon shared sympathy of the majority of the global population. The potential of the Digital Earth as a media to nurture a tactile sense of being part of one connected planet and humankind is enormous. I have strong expectations that building such world will further enrich us and realize concepts such as "global citizenship" and "global society."

5. Conclusion: The realization of Digital Asia

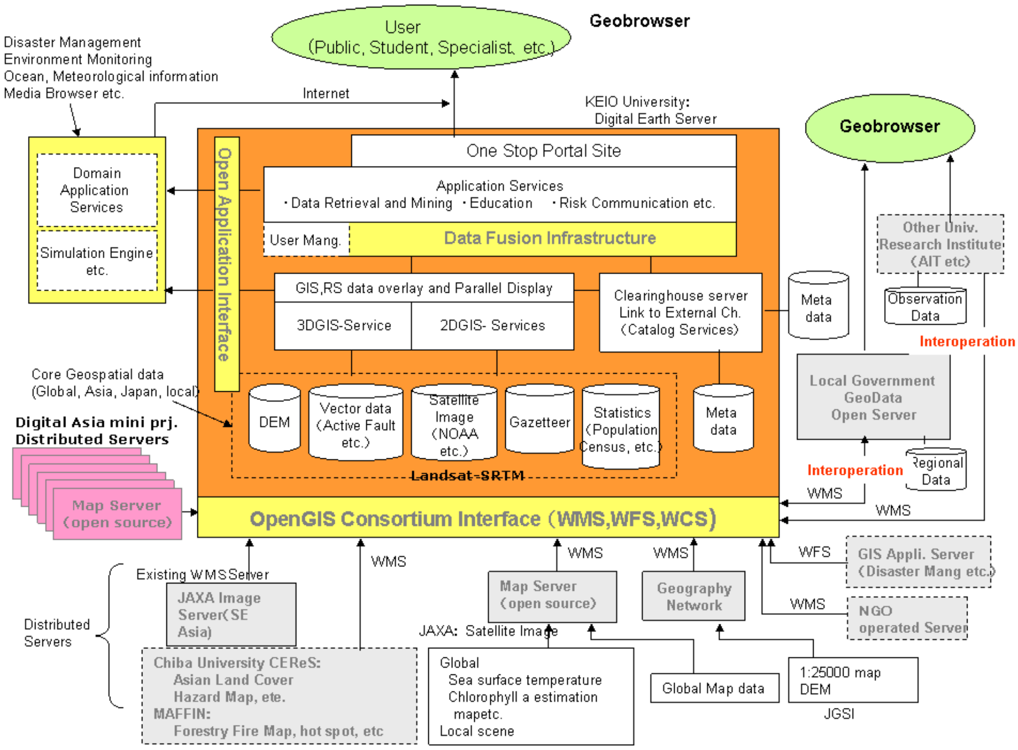
We have started the Digital Asia project based on Digital Earth constructs. Using web-gis technologywe want to create a participatory process, whereby each country shares their data and services with the other members of the project. The current project web site is "http://www.digitalasia.sfc.keio.ac.jp." In Asia, remote sensing and other spatial data are key components to all types of spatial analysis such as urban planning, forestry and resource management, disaster prevention, environmental planning and monitoring, etc. At this moment there are no data sharing mechanisms in place between the related organizations and the users. Also, there is no interoperability between the systems that are in place.

Since 2004, Keio University initiated Digital Asia data sharing project with the sponsorship of the Ministry of Education, Culture, Sports, Science and Technology of Japan. A project office referred to as Digital Asia Regional Strategy Research Center(DARSRC) to coordinate and manage projectactivities. This project targets to develop an infrastructure for data sharing via Internet in the region with the collaboration of potential agencies who will participate on voluntary basis. It is expected that there will be 30 nodes in the network before the end of 2009 supporting the system as data and information providers. This phase is referred to as Phase 1 of the project covering establishment of nodes, development of web map servers, web map browsers and finally the content in each server. In parallel to this, the media browser as community wear being developed providing easy and fast access to news and information that related to social and community activities in the region. This will perform a better "browsing" system that helps to look intoall possible relationship of information anyone is interested. Finally, the project develop a process to identify most appropriate system in solving problems associated with any society with most appropriate way using enormous data coming from various agencies and individuals in the region for the sustainable future.

Using interoperable web mapping standards such as WMS, WFS and WCS, which were developed by the OpenGeospatial Consortium(OGC), we can implement systems that can enable organizations to register their data sets and share it more easily and in a more standardized method. We can achieveglobal environmental conservation and sustainable development, which are two of the goals of the Digital Asia Project by these information infrastructure technologies, which are GIS 2.0.



<Figure 2> GeoWeb Services in Digital Asia



<Figure 3> Digital Asia Framework

The User-participated Geospatial Web as Open Platform*

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Abstract

The effect of broadband penetration leads Web 2.0 as data platform of user participated contents in the world. Especially Google Maps enables for users easy to add annotations, location data via Open APIs. There are some of characteristics in recent innovation of web GIS. 1) easy way to use base maps such as satellites images, 2) mashup of social data, 3) open standards for annotations, 4) open sources for GIS softwares and 5) connection between desktop and web services. Google, Yahoo! and MapQuest haveoffered own web APIs for user with open standards. It evolves mapping platform as a service for user to be participated. For example, this paper shows some of mashup examples the combination of base map such as Naver and Google.

Keywords: Web Mapping APIs, Mashup, Open Source GIS

Introduction

Nowadays the Web 2.0 has been popular terms in the internet business. The new era of Web 2.0 is presented by "Web as a Platform." It often applied to aperceived ongoing transition of service as softwares. In past, web sites only offered read-type services such as books, magazines. But, new trends covers read-writable services based on user-generated contents by collaborative intelligence, tagging, blogging and etc. It covers from a collection of user's data, Ajax style web applications like Gmail, Google Maps to participations of end-users. It expects that ultimately Web 2.0 services will replace desktop computing applications for many purposes. During a couple of years, these explosive growths made the

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* This report is edited by various source in final references to understand new GIS trends.

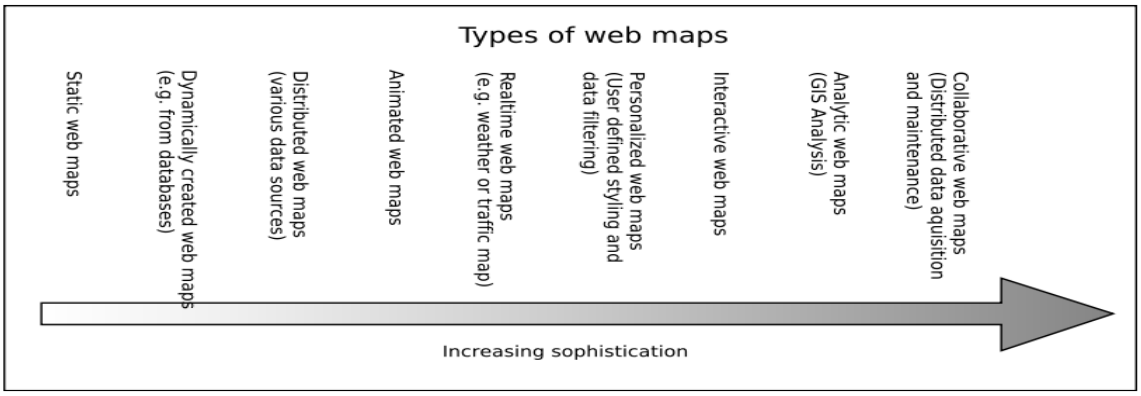
world to recognize new trends and started to impact other rest of software areas.

The geospatial Web was made slow progress until various web based map APIs were offered. Most of geospatial web vendors just continued their services as an application service provider(ASP) such as MapQuest. Vendors of traditional Geological Information Systems(GIS) such as ESRI, MapInfo were not interested in geospatial web as a service to end-users. he change came from Google Maps that offered Ajax-based mapping service that can be navigated by dragging the mouse, or using the mouse wheel to zoom in(mouse wheel up) or out(mouse wheel down) to show detailed street information. Users may enter an address, intersection or general area to quickly find it on the map. Google created the Google Maps API to facilitate developers integrating Google Maps into their web sites with their own data points.

Also there are various convergencesof technology that excellent base map services(street map, satellites etc) easy to be used, mapping APIs that can be integrated with other web sites and user-participated annotations to can be determined locations(geo-code based marking), and 3-dimentional softwares that present geographical features. These are recent innovations from outer traditional GIS industry that anyone could not be expected. It originated by web mapping platform(read-type) and user's participation(write-type) based on these platform. This report will compare features of geospatial web in now and past and review various characteristics of user-participated geospatioal web.

1. New Geospatial Data Platforms

Traditional web mapping distinguished static made in raster images and dynamic web maps by servers. However, today in the light of an increased number of different web map types, this classification needs some revision. According to classifications of Web mapping in Wikipedia, there are additional possibilities regarding distributed data sources, collaborative maps and personalized maps. It means there are many methods to gather user's geodata and combine between them and geomaps.



<Figure 1> Type of Web Maps*

Especially Web 2.0 focused on 3rd party web developers and alpha users who consume Yahoo!, Google, Amazon, eBay, Salesforce.com, and Flickr APIs and produce cool and useful web applications from them. It seems like ecosystem of software plaforms such as Microsoft's .NET framework or Sun's Java technology.

While GIS also restricted to normal programmers and users caused by expensive programs can be used by highly-trained specialists. Just MapQuest and Yahoo! Maps brought easy-to-use mapping tools to the public. Recentlythe release of Google Maps demonstrated to web developers and users the possibilities of navigation and opened a floodgate of interest in online mapping. Google Maps was not released with an application programming interface(API), but some of developers hacked its structure and combined their data to that.

After release of Google Maps API, the speed of its adoption shows the essentialdemand for location-based services that normal programmers can use although itwas not easy way you incorporate it into their own applications. It means developers want to build own applications around the locations in all our data, but that their needs aren't being met by the existing geospatial offersings such as traditional GIS vendors

Nat Torkington was firstly introduced the terms of "Where 2.0" of another web as a platform based on location based services by normal users and grassroots developers with open based map providers.

Table 1 shows differences between traditional application platforms and Where 2.0 platform.

* http://en.wikipedia.org/wiki/Web_mapping

<Table 1> Comparision Chart between Where 1.0 and 2.0

Where 1.0	Criteria	Where 2.0
USGS, Landsat	**Base Map**	Google, Yahoo!, Microsoft
ESRI, MapInfo SDK	**Softwares**	Web Maps APIs
Topography, River, Building	**Layers**	Photo, Video, Tour Spots, Blog
Oursourced digitizing vendors	**Participators**	Web users
GML, WFS, WMS	**Standards**	GeoRSS, KML
Government, local GIS vendors	**3rd Party**	Mashup developers

Where 2.0 consists of a set of techniques and tools that fall outside the realm of traditional GIS. Where 2.0 developers use a mapping API like Google Maps, talk about KML, GeoRSS versus GML, and gathers and show his photos to make a map of his favorite trips. And its 3rd party is normal web developers and alpha users rather than local GIS vendors.

Business model is not yet clear in Where 2.0 model. But, there are many tryout to connect location data and big search business. It's a multi-billion dollar market that overlaps with online search, local advertising and is applicable to vast range of commercial applications.

2. Geospatial Web APIs

Recently most of the major online service providers offers a mapping service for users and a mapping API for developers. So competition is fierce, the stakes are very high. There are over 50 APIs related to mapping and geo-location in Programmable Web(http://programmableweb.com/apis) that offers classified Web APIs. That's a lot of mapping-related APIs and constitutes about 10% of all the APIs listed at that.

2.1. Mapping API providers

Major players are Google, Yahoo!, Microsoft and AOL MapQuest. Each of these major vendors offer developers a free level of service as well as fee-based commercially licensed options. These for-fee services include Pushpin is a an enterprise-friendly licensed offering with advanced GIS features such as custom layers along with Google API compatibility.

Table 2 is an informative comparison of different mapping APIs such as Google, Yahoo, AOL MapQuest and Microsft Live. Each providers have pros andcons for different parts. When choosing a provider it is worth considering various things such as geocoding, traffic, routing and local search APIs. In its comparison, Google Maps comes out on subjective top. Though Google's was the first API people used to build mashups, the momentum could quickly decline if it became cumbersome to work on.

<Table 2> Comarision Chart of major mapping API providers

	Pros	**Cons**
Google Map	First Ajax based brilliant looking map International base map (Europe, Japan) Detail world-wide aerial photos Largest developer based APIs Lots of hacks and mash-up	Only Javascript libray
Yahoo! Map	First external geocoding capability Very flexible and open API's Rate limiting by IP instead of appID GeoRSS support Flash/Flex version available	U.S. and Canada only Flyouts not quite as spiffy as Google
AOL MapQuest	Frist routing (driving directions) capability Geocoding capability Large users and big market share	No smooth Ajax client (yet) Slow functional changes Weak documentations
Microsft Virtual Earth	Well documented and sample sites Detail Building shape and 3D view	Low Performance

In contrast, traditional data source vendors also offered their business APIs for location-based advertising. The deCarta offers many features of interestto commercial applications like routing. GlobeExplorer offers this API with access to the world's largest database of aerial and satellite imagery. In local scale, Multimap offers european mapping APIs and in Australia and New Zealand there's the Whereis API and ZoomIn API.

In Korea, Naver has offered their own map API buying map data since 2006 whreas most of internet portals offered mapping services by application service provider(ASP) such as Congnamul and Sundo Soft. Most of ASPs in Korea changed their raster based map service to dynamic Ajax technology, but publicAPIs are not released yet because it may threaten their business models.

2.2. Location data providers

There have been many service providers gathering user-generated location data and mapping them in base maps. Users can simply mark favorite places and add annotation, photo and review. For "personal geography" and social community mapping there's the Platial and WayFaring API. Platial makes maps of unique places, a socially networked mapping platform which makes it easy to find, create, share, and publish maps and places.

Smilarly Plazes connects you to the people and events around you by sharing your activities. You can use it to share your current location and activities or your favorite hangouts with others or to find out what your friends are up to. Or use it to keep track of all the cool Plazes, activities and people in your life, and share your location and discover others nearby with the Plazes API.

Also GeoIQ is an open platform that allows you to create applications integrating your data and other folks' data using Google Maps and Microsoft Visual Earth APIs. This combination provides not only interesting visualizations such as heatmap, it also allows for fairly complex analysis in an easy-to-use interface. GeoIQ operates as a Web service; the API lets you configure its usage, the data sources and the level of analysis.

2.3. Open source providers

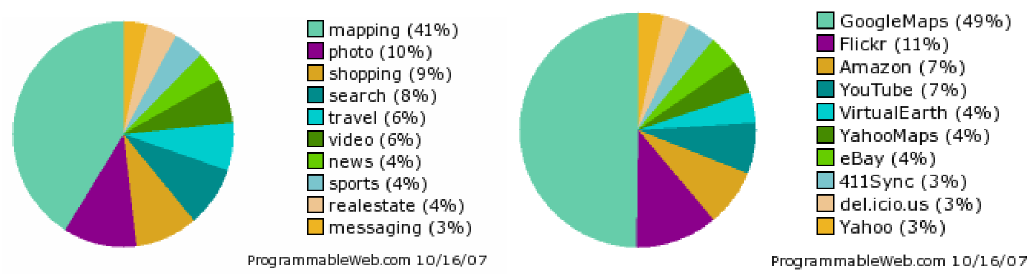
Some of providers give free code and data based on a philosophy of open source softwares. OpenLayers open source JavaScript mapping library initially developed by MetaCarta. It makes it easy to put a dynamic map in any web page and can display map tiles and markers loaded from any source. MetaCarta developed the initial version of OpenLayers and gave it to the public to further the use of geographic information of all kinds. OpenLayers is completely free released under the BSD License. Also if you want to write a single set of code that spans multiple mapping APIs you might want to try Mapstraction, a JavaScript library that provides a common API to Google, Yahoo! and others.

This includes APIs like the USGS Elevation Query Service from the Geological Survey returns the elevation in feet or meters for a specific latitude-longitude point. NASA provides mapping images via their satellite image API. If you are looking for alternate Mapping solutions you can also try Modest Maps, Mapstraction. All of the open source frameworks have their advantages and all of them support the larger mapping providers.

3. Mashup of Social Data

We reviewd various map API providers can be mixed each other. Mashup is web application that combines data from more than one source into a single integrated tool such as map API. There are many open APIs to treat data and make a transaction between API providers and customers via open standards such as XML and REST protocol.

Especially Map mashups are so popular and are such a quintessential use of online APIs that a lot of people incorrectly assume that all mashups use maps. The first real use of the phrase "web mashup" in this new era can be traced back to Paul Rademacher's HousingMaps.com http://www.housingmaps.combuilt in early 2005 shortly after the Google Maps service was released (but beforeGoogle even had an official API). Paul created a popular service that used real estate data from Craigslist and plotted property listings on Google maps to make something genuinely more useful than the sum of the parts.



(a) Top Mashup Category (Total: 2,114) (b) Top APIs List (Total: 533)

<Figure 3> Popularity of Maping APIs for Mashup

Figure 3 shows how many map APIs use to make mashup services. Over 40% of mashup are mapping between socialdata and base map. Also Over 50% of APIs are almost mapping tools such as Google Maps(49%), VirtualEarth(4%) and Yahoo! Maps(4%).

As followings are typical sample lists of mashup between mapping APIs and other data.

Google Maps Examples

1. Chicagocrime http://www.chicagocrime.org - A freely browsable database of crimes reported in Chicago overlaid onto Google Maps APIs
2. BBC News http://www.benedictoneill.com/content/newsmap - See where the latest news is happening in the UK
3. Quebec Wines http://www.quebecwines.com/qw_quebecwineriesmap.php Show the location of the wineries in Quebec and related wine information APIs: Amazon E-commerce, Google AdSense, Google Maps, Google Search
4. World of Warcraft Map http://mapwow.com/ A World of Warcraft Map that includes Herbs, Ores and Treasures APIs

Yahoo! Maps Examples

1. Themed Maps http://justin.everett-church.com/ymaps/radarMaps.html Flash developer Justin Everett-Church used the Yahoo! Maps Flash API and some crazy Flash 8 filters to create really nice looking themed maps.
2. Flickr Maps http://www.sodascope.com/FlickrMapsExt/ For cities across the US, Michael Hoch puts Flickr photos on Yahoo! Maps using the Flex API. This application is another great example of how Yahoo! Maps APIs give you full control over the look and feel of your mapping application.
3. MashUpcoming http://www.mashupcoming.com Beau Ambur shows the power of Yahoo! Maps with Flash & Events from Upcoming.org to deliver a rich experience. Kudos to Beau for integrating smart features like Traffic and Local Search.

Microsoft Virtual Earth Examples

1. MSNBC News Map http://poly9.viavirtualearth.com/Poly9/MSNBC/ Mashup with MSNBC plots the location of news events around the world and allows searching by news department and time period.
2. Virtual India http://research.microsoft.com/virtualindia/ Virtual India is a research project by Microsoft Research India, in collaboration with the Government of India's Department of Science and Technology.

3. Geotag It http://atlas.dotnetslackers.com/Mashup.aspx This applicaition allows any location in the world to be geotagged. It also allows you to associate del.icio.us posts and Flickr photos with a location.

4. Open Standards for Annotations

As the number of mapping platforms increases, standards start to be more important. If data providers wants to offer access to its database for people to include in their own mashups or applications, what data format or web services API standards should they adhere to? Of course, there are also standards format to be exchanged between each GIS vendors that have each different formats.

The Open Geospatial Contotitum(OGC) has beend developed this work since 19976. It defines several web services: WFS(Web Feature Service) and WMS(Web Mapping Service) are the two big ones. WMS describes the basic map(either as tiles or as lines) and WFS describes the features on theat map. NASA Worldwind gets its imagery through WMS, and they're adding WFS support. There are hacks to get Google Earth to display WMS data, but it's very heavy to be treated by general users and normal developers.

GeoRSS arose out of this need to share lists of points. It is an extension to the common RSS(Really Simple Syndication) used on web sites to notify readers of new articles or updates. GeoRSS adds geographic coordinates and features to RSS and Atom items. It was firstly adopted by Yahoo! Maps.

```
<entry>
<title>M 3.2, Mona Passage</title>
<link href="http://example.org/2005/09/09/atom01"/>
<id>urn:uuid:1225c695-cfb8-4ebb-aaaa-80da344efa6a</id>
<updated>2005-08-17T07:02:32Z</updated>
<summary>We just had a big one.</summary>
<georss:point>45.256 -71.92</georss:point>
</entry>
```

Whereas Google Earth had a similar need several years ago, and created KML(Keyhole Markup Language) for its particular needs. KML is like GeoRSS, but with camera angles, styles, overlays, and many other presentation features built in. GeoRSS and KML are just data interchange file formats.

Google Maps already supported both format:

1. GeoRSS (http://maps.google.com/maps?q=http://slashgeo.org/index.rss)
2. KML(http://maps.google.com/maps?q=http://kml.lover.googlepages.com/my-vacation-photos.kml)

Also OGCdefines the GML format, which KML bears some resemblance to. GML is notorious for being a superset of features of the products whose companies worked together to define the format. This means that it's complex and quite scary--KML is more accessible, and GeoRSS even more so.

Microformats are used in web pages to identify common data such as people, places, or events. It adds meaning to the HTML by providing a standardized schema appliedto the class and ID of HTML attributes, permitting manipulation of this information by other programs. There are currently two interesting Microformats: adr and geo. adr is the definition of an address:

```
<div class="adr">
<div class="street-address">23 Main St.</div>
<div class="extended-address">Suite 104</div>
<span class="locality">Northville</span>,
<span class="region">MI</span>
<span class="postal-code">48167</span>
<div class="country-name">U.S.A.</div>
</div>
```

geo defines a geographic coordinate in latitude and longitude:

```
<span class="geo">
<span class="latitude">42.4266</span>,
<span class="longitude">-83.4931</span>
</span>
```

If you use Firefox Operator extention to analyze Microformat, you can see directly map data from web contents.

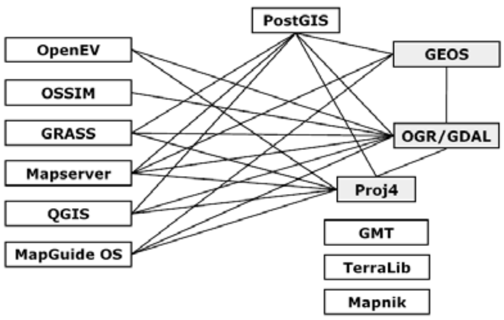
But, because all the traditional GIS applications support WFS and WMS, as do storage systems and analysis tools. When you graduate from a hack to really building location intelligence into your application, you'll want to start using some of these sophisticated tools.

For example, you might want to start using PostGIS, the geospatial extensions to the popular PostgreSQL open source database so you can easily search by location. Or you might want to use the GRASS open source GIS for entry and analysis. Or, of course, you might buy commercial systems from ESRI, MapInfo, or others. So open standards are important because they let you move from mashups to infrastructure.

5. Open Source in GIS

The open source software is technically defined as software in which the source code is available for modification and redistribution by the general public. It is easy to become overly distracted by licenses and source code when evaluating open source software, or considering them as a corporate or project strategy. But, successful open source projects are not created by releasing free source code - they are created through the growth of communities of shared interest. It means open souce softwares have been based on participations and contributions of developers

The development of open source geospatial software is an exciting part of the new geospatial landscape. Open source project offerings cover the spectrum of tools: command-line data conversion, spatially aware enterprise databases, internet mapping applications, desktop Geographic Information System(GIS) applications, geoprocessing libraries, and more. Eager developers, companies and organizations are collaborating on the new generation of geospatial technologies, providing desktop and server-side applications, APIs, and development platforms that are changing the way we work and do business.



<Figure 4> Open Source GIS Tools*

The Open Source GIS space includes products to fill every level of the OpenGIS spatial

* The State of Open Source GIS,http://www.refractions.net/white_papers/oss_briefing/2006-06-OSS-Briefing.pdf

data infrastructure stack. Existing products are now entering a phase of rapid refinement and enhancement, using the core software structures that are already in place. Open Source software can provide a feature-complete alternative to proprietary software in most system designs.

Many geospatial projects require significant amounts of data conversion. It is not uncommon to spend as much as 80 percent of your time converting data between formats and fine-tuning the way the data is organized. De facto data format standards (for example, ESRI shapefiles for vector data; GeoTIFF for raster/image data) can help you choose a format to use if you are flexible, but depending on the programs used in a project, a particular format may be required. GDAL/OGR is a translator library for raster geospatial data formats that is released under an X/MIT-style open source license.

Data often requires manipulation. There are many types of manipulation that may be needed, such as removing unwanted features, adding fields, changing attribute values, clipping features with other features, creating buffered polygons from a line, and so on. The GDAL/OGR command-line utilities are not just good for converting data, but can also manipulate rasterand vector datasets. PostGIS has the ability to manipulate data as well as store it. This provides GIS-like abilities within an SQL database environment. If you are writing your own applications, particularly in C++, you can use GEOS libraries to give you spatial manipulation capabilities.

Projects that have a mapping component need some sort of visual output. The output could be a graphic file or paper printout. There are a couple of frameworks for building MapServer applications using PHP such as MapBender and Chamelon. Also MapGuide can be deployed on Linux or Windows, supports Apache and IIS web servers, and offers extensive PHP, .NET, Java, and JavaScript APIs for application development. MapGuide Open Source is licensed under the LGPL released by Autodesk.

Especially OpenStreetMap(OSM) is a collaborative project to create free editable maps. The maps are created using data from portable GPS devices and other free sources. The makers of OpenStreetMap are aiming for a wiki-like approach to map editing. Inspired by sites such as Wikipedia, the map display features a prominent 'Edit' tab, taking the user to a simple editing interface.

There are many activities in Open Source Geospatial Foundation(OSGF, http://osgeo.org) has been created to support and build the highest-quality open source geospatial software: desktop applications such as GRASS, OSSIM, Quantum GIS and gvSIG, geo spatial libraries such as FDO, GeoTools and GDAL/OGR. Open source geospatial applications and programming environments can fill all of the standard components of a geospatial project. The geospatial landscape is becoming rich with choice.

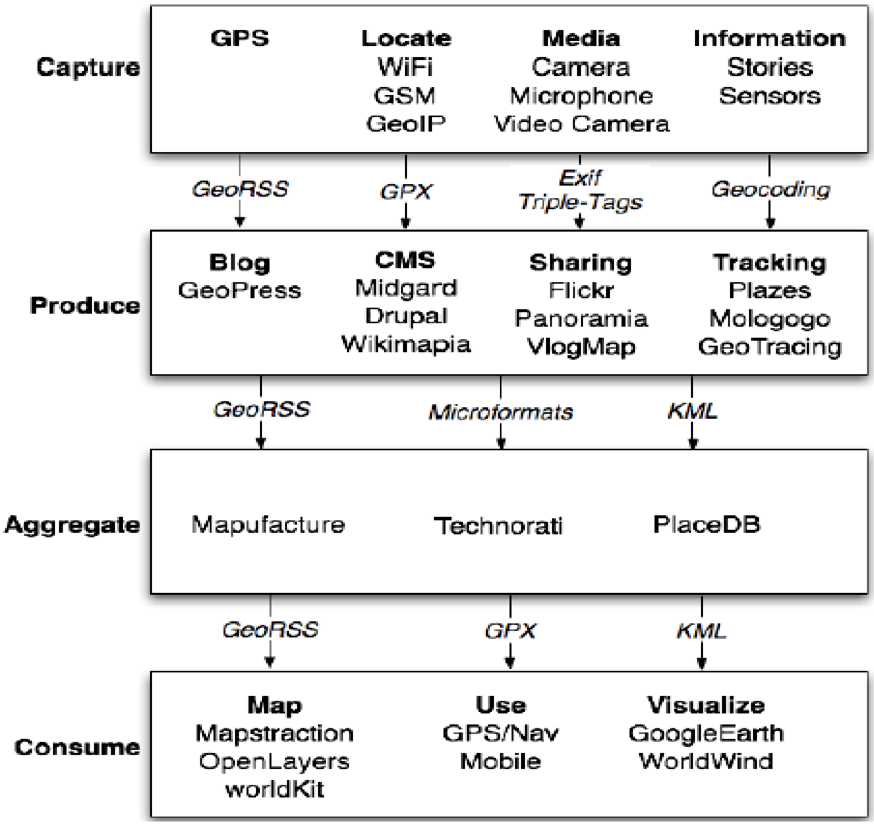
6. Connection between desktop and web services

There are currently two high profile projects aiming to provide a 3D world experience: Google Earth and Microsoft Virtual Earth. The 3D objects in Google Earth are built with manual labour; Google SketchUp enables users to "build and modify 3D models quickly and easily". Key landmarks have been prioritised and built by Google. For Virtual Earth, Microsoft have gone a step further and retained complete control over construction. Their world is built from photographs gathered by photographers, commissioned "to take millions of pictures of urban landscapes from planes, vans and motorbikes". These photographs are then stitched together and photogrammetry algorithms used to determine the structure of the 3D world. NASA World Wind 3D visualization technology also provides for proprietary use by business and government, while bothwill forever benefit from evolution of the code base by Java developers everywhere.

Both of these approaches suffer from several drawbacks. First, in the Microsoft approach, one organisation is both data provider and data consumer, isolated from other data which might help them build their world. Second, the geographical coverage of the 3D elements in each application is limited. Finally, these applications have a significant installation overhead, which includes the .NET framework for Virtual Earth.

Meanwhile, web users are rapidly creating their own records of what is located where. They are doing so by geotagging their photos, blogs, and even sound recordings. With the use of a GPS device, users can specify the exact latitude and longitude which best describes their resource, and(perhaps surprisingly) many people do. Flickr, which is currently one of the leading photo sharing and archiving websites, contains over 475,000 photos tagged with geo:lat.

Furthermore, since the launch of the Flickr Map in August 2006, users have been able to geolocate their photos without using a GPS device. At the time of writing the map contains almost 14 million geolocated photos. This ever-growing body of photographs and metadata is made available via the Flickr API. Flickris not the sole data provider in this field. As of April 2007, ProgrammableWeb lists 17 photo-related APIs. Building a navigable 3D world from user contributed photographs is therefore an exciting possibility.



<Figure 5> The GeoStack encompasses the entire life cycle of geospatial data, from capture to consume using a variety of tools, formats, and applications*

The enthusiasm for photo-related mashups is second only to those based on mapping, and at the time of writing, at least 84 fall into both categories Many use the Google Maps API and Flickr API to position photo thumbnails or markers onto a map, (e.g. loc.alize.us, Zooomr) or Google Earth, (e.g. Panoramio, FlickrFly) . A recurring problem is that by presenting significantly different images side by side, the mashups lose the ability to represent what it is actually like to be at that point. Thus, thumbnails of photographs taken from the top of the Empire State Building looking down are displayed in exactly the same way as photographs taken from the bottom looking up.

So Google Earth allows to embed local images from Flickr and other sources and make another layers. Microsoft Photosynth takes a large collection of photos of a place or an object, analyzes them for similarities, and then displays the photos in a reconstructed

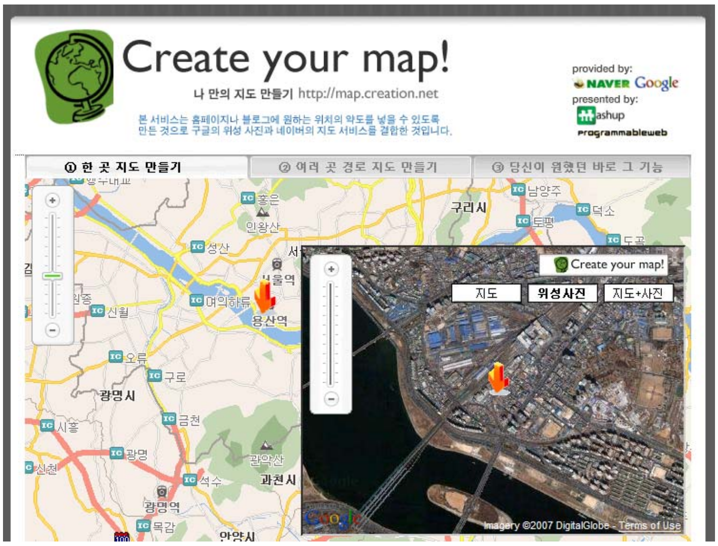
* http://www.oreilly.com/catalog/neogeography/

3-Dspace, showing you how each one relates to the next. Quakr is a project to build a 3-dimensional world from user contributed photos.

7. Masup example of Naver and Google Maps

In Korea, there is wide broadband and mobile environment. So many unique services were developed. First, I want to introduce history of korean web based mapping services. it has been served the interactive map service such as Google Maps since 2000.

Unfortunately, it was made by ActiveX and Java applet not Ajax. In broadband and IE exclusive system, it was proper choice. It offered zoom in/out, drag-n-drop, measuring distance and squaring area, drive directions and layering bus stop and subway line etc. Last year, some of korean map services changed Ajax based and gave street photo service such as Amazon street photo service. Especially Naver released their map API to make mashup service with data from other API providers.



<Figure 6> Screeshot of Mashup between Naver and Google Maps.

As following example(Create your map! http://map.creation.net) is to make sketch map to let people know the direction of a specific place. You can view Naver Map and Google Satallet Image together.

Conclusion

All of evidences shows that Web GIS has evolved from traditional GIS software platform to user-particiapted platform. Gathering of geo location data is very easy with digital cameraand mobile GPS devices. User's annotations on the map also can be done by various mash-up services such as Platial and WayFaring. Open standards such as GeoRSS, KML and GML can be possible to share and publish them. It can be output by Open source GIS softwares developed by voluntary developers.These new trend has changed traditional GIS software platforms to more open platform based on user's participation.

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Google Maps: Reshaping PPGIS

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Introduction

Public Participatory GIS (PPGIS) is an approach to getting the public more involved in the planning and decision making process. Despite the enormous potential of PPGIS in empowering the public to participate, there have been several obstacles. Thecomponents of GIS--hardware, software, data, operations and technicians--each have been a barrier to overcome before PPGIS could become mainstream. There has been an significant change in GIS technology since its inception, particularly with the introduction of MapQuest, Yahoo Map, Google Maps, and other GIS-related, web-based portals. These commercial geoexploration tools (freely available for public use) have allowed GIS to become a transparent part of everyday life accessible and usable to any layperson. In this presentation, we review how Google Maps affected PPGIS practices, its current implications and future concerns.

1. Brief Overview of PPGIS

Public participation geographic information systems (PPGIS) were introduced at a National Center for Geographic Information and Analysis (NCGIA) Workshop at Orono, Maine, USA in 1996, as an intersection of planning, community interests and GIS technology. Since then, the PPGIS acronym has been applied to describe a variety of government and private actions togarner input and commentary to planned development projects by those who will reap the benefits the improvements. The spatial and pictorial nature of GIS has made it a

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* This paper was written by Wansoo Im and Janel A. Bisacquino(GIS Center at Stony Brook Pennington, NJ 08534)

focal tool to empower professional planners with new knowledge and information from under represented groups that may otherwise be unable to enter the planning process. (Craig et al. 2002; Seiber et al. 2002; IAPAD 2007)

Early PPGIS initiatives focused on projects including indigenous peoples and impoverished communities where language barriers might hinder collaboration. In most cases, PPGIS consisted of printed maps presented to and commented on by the local residents. Map visualization is effective nonverbal communication that provides both a common organizational focus (geography) and overall analytical understanding. In addition to using GIS technology to produce these maps, commenting often was accomplished through photography. Participants were asked to take photographs of their community depicting features they liked and wanted to protect and features they disliked and wanted to change (Dennis 2004, IAPAD 2007).

PPGIS grew to be used in mainstream planning and decision making processes concerned with quality of life and social justice issues. Those initiated by government and development remain reactive in nature, allowing community members and grassroots issues alliances to pick from a number of design alternatives (Seiber et al 2002). Nevertheless, Preservation-minded individuals, community groups, and non-government organizations and universities have used GIS to find solutions specific to their missions and communicate them with authorities (Ghose 2000; Laituri and Ramasubramanian 2006). The ability to produce maps creates tremendous power for community groups via its effective visualization. Maps are attractive, can provide clarification to community problems and are more likely to draw the attention of important government officials to issues.

The dimensions of PPGIS are growing and it seems that this emergent practice defies conventional definition among professionals; with questions of bottom-up vs.top-down coordination, how much participation is needed and at what stage of the process, and concerns of over-reliance on technological solutions and quantitative vs qualitative data hotly debated (Ghose 2000; Seiber et al. 2002). It is agreed that PPGIS is an interdisciplinary approach that can and should be used as a tool to help communities analyze and help find solutions to their problems (Craig et al. 2002; Laituri and Ramasubramanian 2006; Seiber 2006). Owing from its GIS origins, PPGIS proves a medium to coordinate, view and share knowledge and information.

PPGIS however, can provide more than map production and decision-making. Sheppard (1995) argues that PPGIS also include information collection and management. Information dissemination can also be added to the above functions since the advent of Internet mapping technology (Laituri and Ramasubramanian 2006). While PPGIS has found acceptance in planning as well as such disciplines as natural resource management, it has slowly been applied to a wider range of subjects by diverse communities. As a tool to provide a powerful voice in decision-making processes, PPGIS has lead community groups across both North and South America (IAPAD 2007), and increasingly in cyberspace (Chuang and Huang 2004), to engage in its use to help with their individual missions

PPGIS applications now range from governmental showcases that allow the public to view detailed information about their neighborhood or place of choice, to virtual or physical geospatial collaborations on local community issues, to real-time distributed collaborations on universal issues of social and environmental wellbeing and geo-blogging.(Chuang and Huang 2004)

PPGIS's adoption however, was retarded due to lack of access to the basic resource requirements on which GIS relies. This deficit was only overcome by the technological and commercial innovations of the past decade. (Chuang and Huang 2004; Laituri and Ramasubramanian 2006)

2. Barriers in PPGIS and Implications of Current Web-based GIS Technology

Although some non-government groups have used PPGIS to achieve their organization's goal, existing government- and private industry-oriented GIS technology has prevented many community groups from benefiting from PPGIS due to lack of computer hardware and software resources, technical expertise, access to data and understanding of GIS, the basic components of GIS. The origins of this emphasis on heavy costs and technological specialization can be traced to its prime intended users--the private sector, researchers and governmental agencies (Sheppard 1995). We see the lack of resources of most non-profit organizations and individual to be the main reason for little GIS implementation in this sector due to its financial and personnel constraints. The emergence of PPGIS has created a demand to develop technology that would allow groups to overcome these barriers (Sheppard 1995).

Initially, obtaining GIS-related base data for PPGIS was a long standing and major obstacle. With the significant advance in Internet technology, most data at the federal and state level are now available via a web portal (Chuang and Huang 2004). While there are some agencies and websites that provide data for free, the information available may not be relevant to a specific group's cause. Moreover, many community organizations do not have the necessary hardware and software to analyze the available GIS data. Additionally, when groups are able to acquire data,hardware and software, they still face the barriers of technical expertise and personnel development needed to use GIS (Craig et al. 2002). Thus, the investment of GIS has a substantial entry price which many groups cannot afford.

Nevertheless, groups surmounting these barriers also report high staff turnover rates, which further complicates the maintenance of a GIS knowledge-base of its procedures, projects and data. The development of PPGIS applications should exploit the fact that more and more people are becoming comfortable in using computer and are familiar with basic functions.

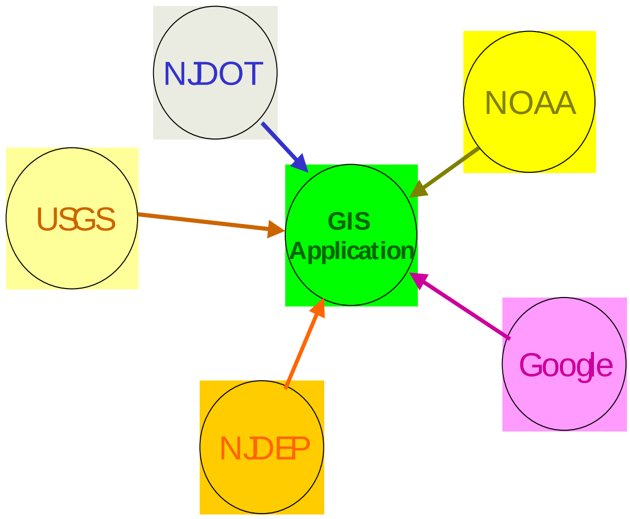
It is ironic, nonetheless, that some of these barriers of implementing PPGIS have been resolved by major web portal companies simply by using a different revenue model in order to provide geoexploration tools free to the public. When MapQuest began its services in 1996, people no longer needed to rely on commercially available desktop software applications to find a location or driving directions. Web portal providers followed soon after with Yahoo Maps, Google Maps and Microsoft MapPoint.

Furthermore, the Google Maps application programming interface (API) allows user communities to customize Google Maps for their own needs. Many other web portals again followed creating a trend of providing their own API. In addition, 3D visualization tools like Google Earth and Microsoft Virtual Earth have captured the publics attention. These many geoexploration tools have raised awareness GIS data and shed light on the potential for using GIS in possibly endless subjects and sectors. There are now many public and commercial tools available which enable community users to customize Internet geoexploration applications for their own needs at extremely low or no cost. (Miller 2006)

In addition, there has been a significant change in computer hardware, GIS data accessibility, and process of creating a GIS. The speed of computing power has increased while price has been decreased. At most Internet portals, people can access free, secure, data storage spaces. Users can exchange their knowledge freely and openly with community members via websites, blogsites, electronic bulletin-boards and listserve sites.

Another recent notable phenomena important to GIS is "Interoperability" or the "Open GIS"concept. Interoperability refers to the capability to communicate, execute programs, or transfer data among various applications and operating platforms. In addition, users do not need to have an extensive knowledge to use or share the data. Open GIS can provide users the ability to exchange data freely over a range of GIS software systems and networks. There is no need to covert a GIS data format to use in a specific GIS application. The concept could allow GIS data in be included into an application similar to the way that we currently copy and paste text or graphs among word processing, spreadsheet, and presentation applications. Figure 1 shows the Open GIS concept-- various GIS data from different government agencies and commercial web portals can be served and used to develop a unique GIS product or custom application for a specialized use or community.

The Open GIS concept enables many non-GIS specialists to create their own location-based mapping applications by using Google Maps API. This current development of Open GIS can be summarized as an "effort to enhance user-friendly interfaces, interoperability between data repositories, web GIS services, and affordability."



<Figure 1> WebGIS Service in PPGIS

3. Potential of Google Maps for PPGIS

Google Maps is currently a free web-based geoexploration tool. Its main functions are providing detailed street maps, satellite images, address matching, and routing functions in addition to providing businesses with data. The potential of Google Maps for PPGIS is allowing communities to have access to relevant maps without significant resources and technical expertise. A web-based map expands the limitations of a simple printed map allowing for the re-purposing of the location-based data for multiple communications campaigns, projects and planning efforts.

Since its introduction, Google Maps has added many new features. Most notable is "My Maps," which lets users add markers, polylines and polygons on a map. My Maps modifications can be saved and publicly viewed. My Maps amplifies the value of the traditional printed product of most PPGIS efforts and further empowers the community by enhancing the effect and range of their voice.

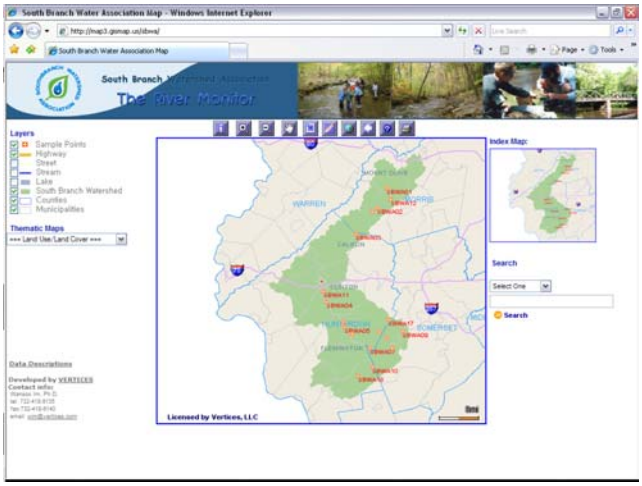
Moreover, Google Maps API was created to facilitate developers integrating Google Maps into websites, display custom markers and incorporate other web applications. While it is a free service, Google reserves the right to display ads in the future.

4. Example Cases of Non-Profit Organizations using Google Maps: South Branch Watershed Association in New Jersey

The South Branch Watershed Association (SBWA) is a not-for-profit organization dedicated to protecting the environment in the region defined by the watershed of the South Branch of the Raritan River in New Jersey. SBWA assists local governments, schools, community groups, and citizens with protecting natural resources through education and outreach. One of the main programs promoted by SBWA is a volunteer stream monitoring program. The program started in 1994. The objective of the program is to obtain baseline data to be used as an indicator of water quality. Volunteers from the community collect and identify benthic macroinvertebrates from local waterways. The data was stored in spreadsheet files and reported in a printed table format. While SBWA realized the potential of GIS in watershed planning operations, their limited resources prohibited the group from fully implementing GIS. Further concern over the required initial training and continued keeping up of both the technology and the personnel skill set contributed to their averse to adoption beyond this level.

Nevertheless, SBWA envisioned a GIS for their voluntary water monitoring system, where volunteers could enter water monitoring data into the mapping program, view historical water monitoring data and perform spatial analysis of the data. In 2005, VERTICES created an Internet mapping application for the organization using GIS data downloaded mainly from NJ State Department of Environmental Protection Agency (http://www.state.nj.us/dep/gis).

Community members and the public can view the SBWA's monitoring data in a graph along with photos of each monitoring site and other features within the watershed, such as streets, highways, municipal boundaries, streams, and lakes as well as land use. There are also various GIS tools which can help users to view and analyze the data in spatial context.



<Figure 2> Screenshot of The River Monitor - South Branch Watershed Association

In 2005, using Internet mapping technology was an innovative idea for small organization like SBWA. The following advantages were identified:

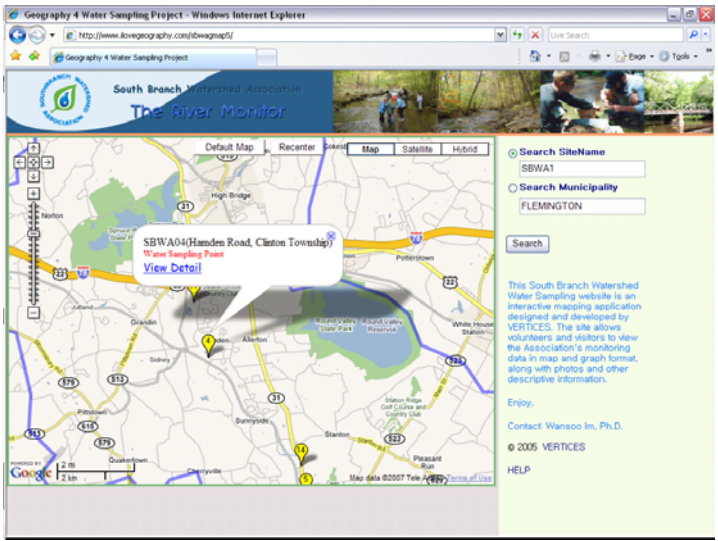
- The Internet mapping application is customized to the needs of the organization for a specific purpose. Instead of a general GIS data viewer, the application is designed to display historical water monitoring data.
- The Internet mapping technology does not require intensive training.
- Since most people are familiar with using an Internet browser, accessing a mapping application via a web browser encounters little user resistance.
- Public participation in the organization's mission is encouraged by sharing information in a visual, non-intimidating and attractive format.
- No installation or upkeep of any software or data is required by the organization or end user.
- Easy data updates and maintenance can be performed via a web browser.
- The organization and itconstituency increases the number of GIS data users, which supports continued development by the source agencies.

While utilizing Internet mapping technology was an innovative idea at that time, we identified several potential problems (and their possible solutions as well). The foremost potential problem is that most of non-profit grassroots environmental conservation organizations have very limited budgets. Despite the benefits of Internet mapping applications, the cost of development makes it unfeasible for small non-profit organizations. While most organizations could have similar project scopes, the following items need to be done for each individual organization:

- Design scope of the application,
- License Internet mapping software,
- Ensure access to a reliable server,
- Process GIS data layers to put into application, and
- Train organization staff to manage and update site content.

Even considering the availability of Open Source GIS software such as MapServer, which can significantly reduce licensing and development fees, GIS data processing and application development are still likely to incur costs too high for smaller groups.

As a possible solution, we identified Google Maps API as a base for similar application development. Since basic GIS data layers and functions (such as street data layers, aerial photos, geocoding and routing functions) are already available via Google Maps, GIS data processing time can be reduced significantly. Figure 3 shows the screen capture image of the application.



<Figure 3> Google Maps API Based Development of The River Monitor

In the end, we were able to create an interactive mapping application based on Google Maps API with the following benefits.

- Time and resources previously necessary to createaerial photos and basic street map layers can be eliminated.
- Relatively low entry barrier to the technology due to time and cost deduction.
- Since aerial photos and street layers are served by Google servers as WMS, the server requirement for hosting a water monitoring database or other community-created database, is minimal and performance of the application is fast.
- The application can be easily duplicated for other organizations with similar project scopes. For example, there are thousands of watershed organizations which could benefit from a Google Maps API-based water monitoring mapping application.
- People are already familiar with Google Maps applications, so there is less reluctance to using the application and less time required for orientation to the tasks of data entry and upkeep.

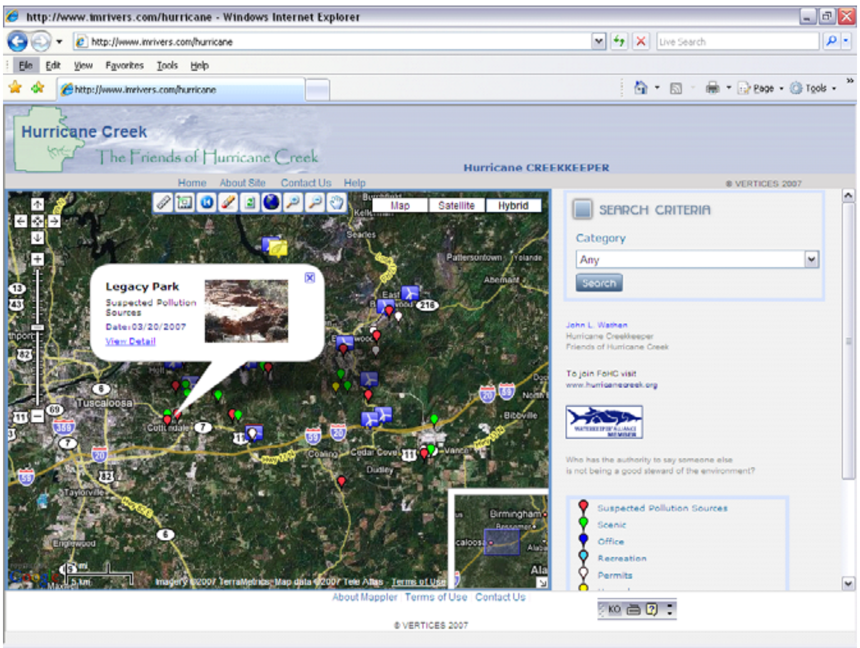
5. Case of Non-Profit Environmental Organizations using Google Maps Interactive Mapping Rivers (Interactive Mapping Portal for Watershed Communities)

IMRivers.com is an interactive mapping web portal designed for watershedand river environmental conservation groups. The project was conceived and developed by several environmental organizations with VERTICES, when Dr. Im was invited to present the potential of Google Maps API at Alabama River Conference on March 7, 2007. While customized My Maps applications were being used by a few environmental groups, resources were needed to develop a customized Google Maps API application for individual organizations. After a series of meetings, the IMRivers.com domain was registered and the website was created. IMRivers.com is a web portal mapping service where individual organizations can customize and maintain Google Maps. The entire architecture was built based on Open Source software on a Linux platform utilizing Google Maps API.

IMRiver.com allows individual environmental groups develop watershed and waterway maps with data contributed from community members through an interactive web interface and make them available to the public. Ten organizations in Alabama are successfully using IMRivers.com in a pilot project to show how this tool can enhance their environmental missions. The Alabama pilot projected was funded by World Wildlife Fund. The following example shows how one of the pilot projects participant is using IMRivers.com.

5.1 Hurricane Creekkeeper, Alabama

Hurricane Creekkeeper is a member of the Waterkeeper Alliance, also know as river keepers. The organization has a small number of staff (two). Its main mission is to enforcement anti-pollution laws and investigatingvarious pollution sources. They inspect the Creek at regular intervals in search of pollution-related problems. When developers do not address pollution problems for which they are found responsible, the group takes legal actions necessary to bring the violators into compliance. Using the IMRivers.com mapping tool, they can report polluters via the web to officials and the public. In addition, they use their IMRivers.com map site to show various cultural scenic inventories to potential visitors and underscore the need for protection of the waterway. John Wathen, the Hurricane Creekkeeper, did not have any previous knowledge about GIS or web-based mapping before using the IMRivers.com application. He however, was able to create an interactive map site for his organization by himself within an hour by using IMRivers. Figure 4 shows the application interface that Mr. Wathen created.



<Figure 4> Hurricane Creekkeeper, Alabama IMRivers Site

The Hurricane Creekkeeper interactive mapping site is now one of the most successful tools that the group has available in forwarding their purpose because of the following features:

- Instant data update via any Internet connection. To quote the Creekkeeper, " ou're out on the river and see a violation. You take a photo or video, plot the GIS coordinates and upload to your IMRivers website - either directly on the river or when you get back to the office."
- People view the pollution data in relation to the real location.
- Once data is posted on the web, it becomes public record and developers are more likely respond to it. To quote the Creekkeeper, "Within minutes, agency officials, stake-holders, the media and the public can see what is going on. The violation's time and place are precisely documented and recorded - just like that!"
- The public outreach and information dissemination does not require any additional costs.
- It's fun to use. As a final quote from the Creekkeeper, "IMRivers is, without doubt, the most phenomenal interactive mapping program I have ever used. I am not a computer person and I can operate IMRivers with ease. My map is growing and will be a uniform databank that anyone can visit."

Don Elder, the president of the River Network--one of the most respected watershed conservation organizations, stated that "We must understand our rivers and their watersheds in order to protect and restore them. The interactive maps you can create with this tool will broaden and deepen appreciation and understanding of our watershed ecosystems".

The IMRivers.com program is being endorsed and supported and joined by more conservation groups via conferences or seminar presentations. It is currently being used within USA and several international communities.

The following lessons were garnered beyond those learned from South Branch Watershed Association case:

- Environmental conservation organizations are fully aware of GIS and its potential to achieve their missions, however cost and ease of use of the traditional technology make it unable to benefit smaller organizations.
- Google Maps API applications can enable small non-profit environmental organizations to utilizing interactive GIS-like mapping with almost no (or no significant) entry cost.
- Customize applications can be built without any GIS knowledge

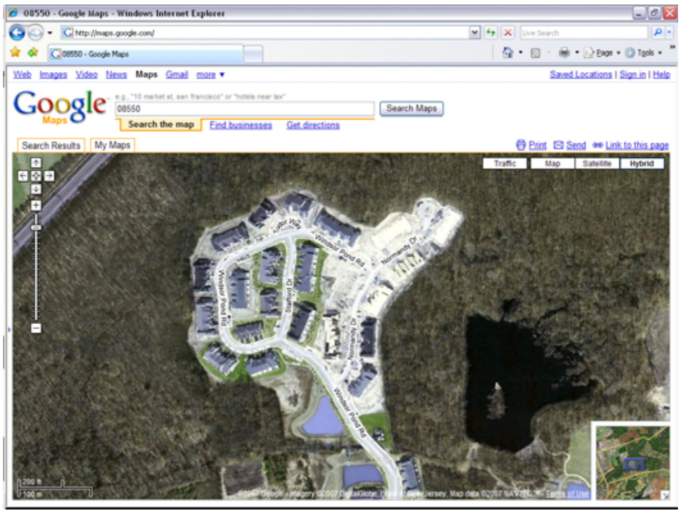
- Mapping applications can be developed for a specific community group which can then be easily duplicated by utilizing another group's existing or publicly available GIS data.
- Environmental data collected by each community member within an organization canbe shared and utilized by the organization and communicated to government and public entities as well as to other watershed organizations.
- Environmental data will be geo-tagged automatically and metadata can be entered via the application, making data more valuable as a time-stamped and reusable record.
- Encourage public participation and education via visual communication of information and participating data collection, too.

6. Issues of Using Google Maps

Despite enormous potential benefits of utilizing Google Maps API or other web portals' Maps APIs, there are several concerns identified that may bar adoption of this technology by some organizations. Each will be outlined below to better inform all of the potential limitations and risks associated with the potential benefits.

6.1 Lack of Metadata

Metadata is an essential component of GIS. It describes the origin, quality, condition, date of creation and other characteristics of a GIS dataset. Google Maps API's power to composite various photogrammatic and other GIS datasets is also a detriment because metadata descriptions of each dataset cannot be clearly determined, causing a potential for incorrect interpretation of information as well as a loss of value. Google Maps provides a visual identification of datasets on the bottom right corner of its viewing window. Sometimes this source identification can be confused. When viewing New Jersey, Google Maps serves aerial images based on 2002 High Resolution Orthophotography developed by the New Jersey Department ofEnvironmental Protection (which provides the original infrared version via their website: http://www.state.nj.us/dep/gis). However, Google Maps states "©2007 DigitalGlobe, State of New Jersey, Map data" (See Figure 5). The reference is not clear that only the copyright is dated 2007, not the data source. Most users may assume that the origin of the dataset is from 2007. Based on the assumption that what they are viewing is 2007 reality, community groups or individuals might make a suggestion or decision based on what Google Maps shows. It is important to make the public aware of the condition and limitation of the Google Maps conglomerated datasets.



<Figure 5> Screenshot of Google Maps in West Windsor, NJ

6.2 Uncertainty of Advertisement Placement

Many potential community users are also concerned that Google Maps API may not be free forever. While we do not expect Google to go out of business in the near future, many organizations are concernedabout investing their own resources if they are guaranteed to be able to freely use the maps.

More readily possible is their concern of Google Maps API's potential for online advertisement. Currently the Google Map API service does not include advertising in the map image. Google however, reserves the right to include advertising in the map images provided through their services with a ninety (90) day notice. Detailed information about the terms and conditions can be found at: http://www.google.com/apis/maps/signup.html.

Currently Yahoo Maps puts advertisements on their maps. It is foreseen by many in the Google Maps API blog and Google Maps API group that Google Maps will eventually serve advertisements. While it may be acceptable to many individual Google Maps API users, it would be prohibitive for many organizations if commercial advertisements were to pop up on their mapping application. Due to this dilemma, many organizations have been reluctant to adopt applications based Google Maps API. However the trend is changing. Organizations seeing the constant expansion of beneficial applications using Google Maps

API are growing less reluctant to use this "free" technology, although Google Maps remains silent about their advertisement policy. From our perspective, many web portals' APIs are being developed toward a standard protocol as interoperability becomes important to continued success in Internet mapping services. We anticipate that Google Maps API applications can be easily migrated to Microsoft Virtual Earth, Yahoo Mapsor other map services, if needed.

6.3 Unequal area of coverage

Temporal and spatial resolutions of photoimagery is important in developing most of GIS applications. Most high resolution images in Google Maps cover urban areas and some of aerial and satellite images are fairly old. As we mentioned above, New Jersey aerial photography is dated to 2002. Many rural and mountain areas are not represent by detailed aerial photoimagery and instead are made up by low resolution satellite tiles. Therefore rural groups wishing to keep such spaces rural are at a disadvantage that they cannot utilize Google Maps API based mapping applications to plan and make decisions with clear visualization of their region. Since enormous cost is required to take detailed aerial photography even with today's constantly more inexpensive technological advances, it would be difficult to expect an area to be covered by detailed photoimagery unless there is a financial incentive. In addition, security and even personal privacy dictates obscurity of certain areas whether they are in urban or rural locations. Despite the above concerns, the number of customized Google Maps API applications increases significantly everyday with a new use, customization or "mash-up" found almost daily.

7. Implication of Google Maps for PPGIS

It is clear that most of PPGIS initiatives will get benefit from the current services by commercial web mapping services as well as government provided Internet geoexploration sites. In addition, traditional GIS technology is moving rapidly to meet the requirements of the Open GIS concept with interoperability over various different GIS platforms, data formats and different sources.

The Google Maps service provides a new entrance to the power of PPGIS for many organizations. Community mapping is a proven method of engaging citizens in civic action. Many organizations are beginning to explore a Google Maps approach to representing and communicating local environmental knowledge, community values and land use preferences due to low entry cost and easy of use.

There are many web portals which provide Google Maps-based interactive mapping with just a few simple mouse clicks. Not only markers (point data) but polylines and polygons can be created and even traditionally created GIS datasets can be uploaded and displayed. Spatial analysis and data graphing can be provided due to standards among web applications. Powerful interactive web-based mapping tools for communities with little or no technical expertise or resources now are readily available. Some defying any past definition of public participatory GIS. These living maps become dynamic resources for and by their community.

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The Strategies of Developing the Korea Planning Support Systems*

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Introduction

Korea central government has set up the various spatial plans through the procedure of plan-do-see to construct livable national spaces. However, unpredicted errors in a spatial planning caused another problems. To minimize the errors and problems, it is necessary for the government to make the spatial decision support systems(SDSS) that can analyze and solve the expected problems in the process of setting up the spatial planning. The rapid growth in GIS-based spatial analysis technologies increases the expectation related to applications of information technology in the fields of the spatial planning. The various existing databases based on the Land Management Information Systems(LMIS) and the Architecture Information Systems(AIS) that have been developed since the mid 1990s also increase the expectation to construct the SDSS.

The Korea Planning Support Systems(KOPSS) refer to a kind of the SDSS that provides the spatial information using various data and appropriate analytical methods in order to support reasonable spatial planning. The purpose of this study is to suggest the development strategy and establish the theoretical framework of KOPSS by considering the comprehensive basic composites of GIS-based spatial decision support systems. The objects of this study are the various spatial plans and national policies that the central government and local governments set up.

Literature review method was used to identify the theory and case of the SDSS. Advisory

* This paper was written by reference to "A Study on the Korea Planning Support Systems(2006, 2007)" that the KRIHS undertakes and the MOCT provides the funds, and "A Study on Constructing National Policy Decision Support Systems(2007)."

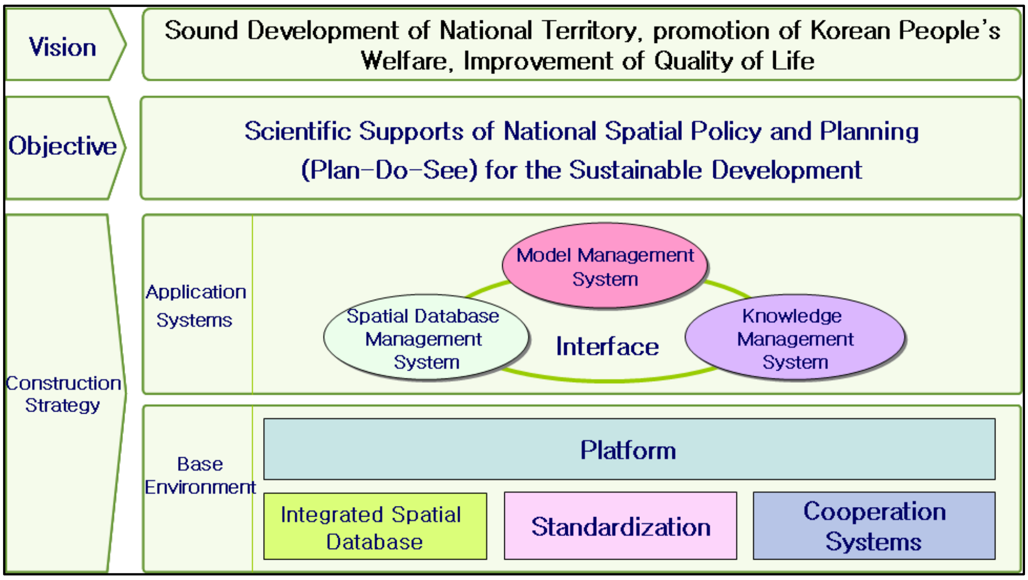
meeting was held to elicit the consensus of GIS experts. Semi-structured interviews with central and local governments' officials were performed to investigate the practical issues in relation to the spatial planning.

The KOPSS project started from 2006 and will be finished in 2010. The Ministry of Construction and Transportation(MOCT) provides the funds and the Korea Research Institute for Human Settlements(KRIHS) performs the project. As the case study areas, four local governments participates in the project to reflect the opinions of practical requirements. The KOPSS development research committee is composed of the MOCT's relational team and local government officials. The KRIHS researches models with help of working group composed of spatial planning experts and the system development corporation has responsibility for the development of KOPSS models.

1. The Basic Concept of the KOPSS

Korea National Territory Law describes spatial policy and planning for the sustainable development of national territory. The purpose of KOPSS development lies in the scientific support of spatial planning for the sustainable development. Thus, the vision of the KOPSS is to suggest the sound development of national territory, the promotion of Korean people's welfare, and the improvement of quality of Korean people's life(Figure 1).

To achieve the vision of the KOPSS, it is necessary to construct application systems and assure the strategy of basic environment of systems. Application systems are sub-systems that deal with various data and knowledge in reasonable methods in order to elicit required information in the process of the spatial planning. Application systems are composed of user-oriented communication interface, data management system, model management system, and knowledge management system in the perspective of system composition. Base environment of systems refer to the platform that develops and operates application systems. Base environment strategies are divided into the platform, the integrated spatial database, the standardization, and the cooperation of system development.

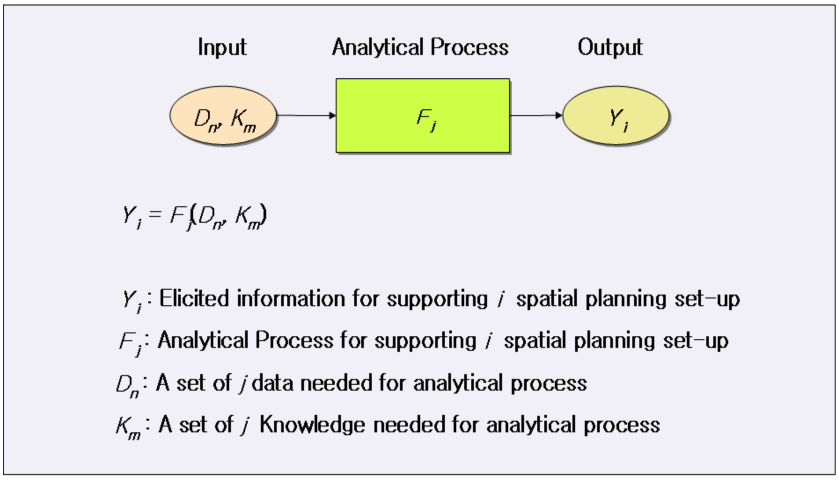


<Figure 1> The Basic Concept of the KOPSS

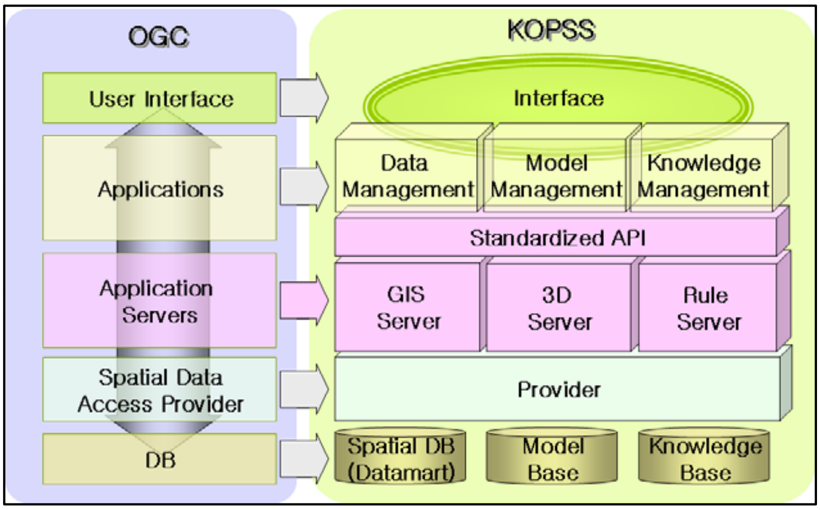
2. The Strategies of Developing the KOPSS

2.1. The Conceptual Structure of the KOPSS

The various data and knowledge as input data can be treated by suitable analytical methods. The treated data and knowledge can elicit the information required to support a spatial planning. It can be represented as the process of a mathematical function with order of input-process-output(Figure 2). In the perspective of system, data and knowledge represent the input and analytical methods refer to the process. The elicited information means the output. It is required to manage the data, knowledge, and analytical methods systematically to construct and operate the KOPSS effectively. For the KOPSS, the data management system, the knowledge management system, and the model management system should be constructed. In addition, user interface should be constructed to elicit the information effectively and provide the treated results as a type of report.



<Figure 2> The Analytical Procedure of the KOPSS



<Figure 3> The Conceptual Structure of the KOPSS

The KOPSS is composed of 4 sub-systems of the data management system, the knowledge management system, the model management system, and the user interface. These sub-systems are application systems of the KOPSS. The application systems include platfor m* that supports the construction and operation of the KOPSS(Figure 3). The development of the KOPSS means the construction of application systems using the development tool.

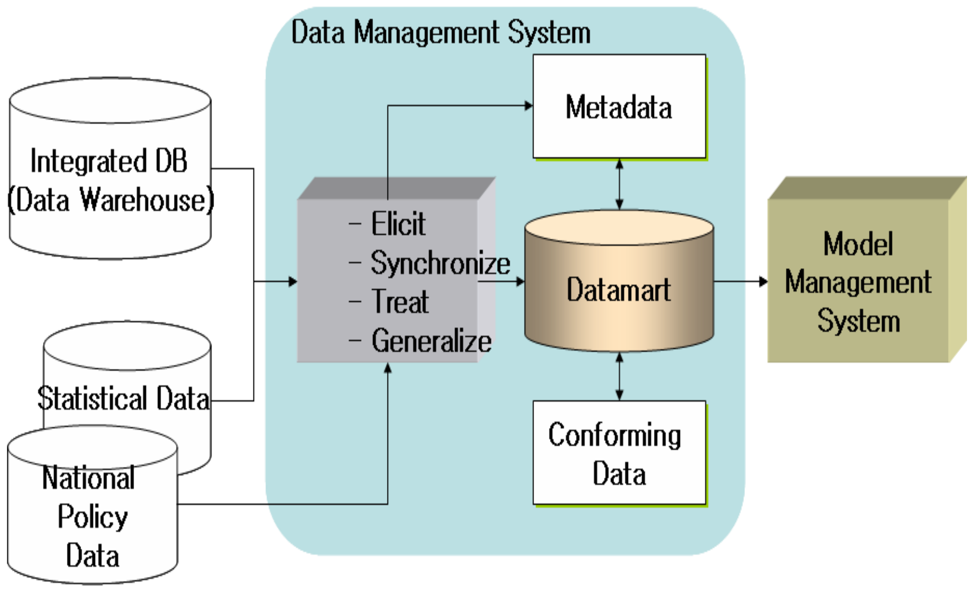
* Platform is similar to application server, GIS development tool, and GIS engine regarding the structure of the Open Geospatial Consortium(OGC).

2.2. The Strategies of Developing Application Systems: Sub-System Development Strategies

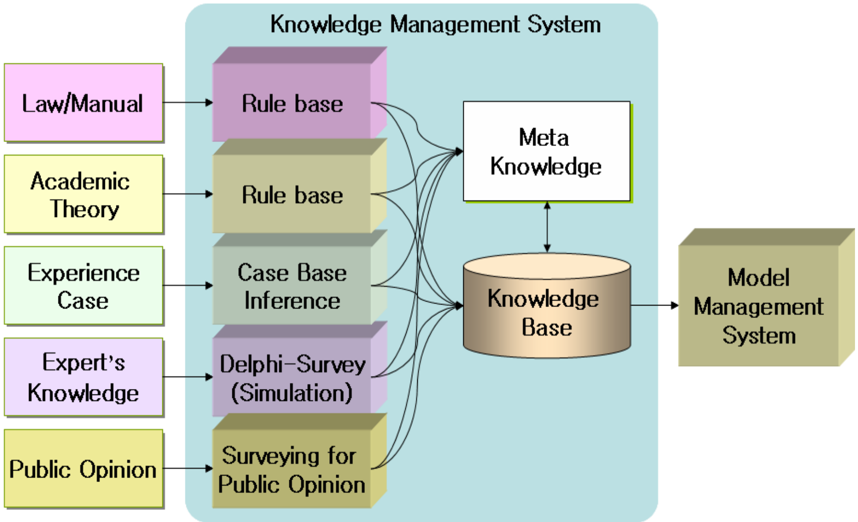
2.2.1. Data Management System

The KOPSS uses the existing individual database obtained from Architecture Information Systems(AIS) and Land Management Information Systems(LMIS). Many systems have been constructed by information businesses for 10 years. Thus, the KOPSS needs to use the data obtained from the existing systems. The individual models of the KOPSS need the data management system that constructs the data mart of the KOPSS using database obtained from the existing other information systems(Figure 4).

The Data Management System should have functions that can elicit, synchronize, treat, and generalize data. It also should provide functions that treat, manage, and supply the data obtained from the existing database. The synchronizing function refers to the function that harmonizes the update of data between the KOPSS data mart and the existing database. The generalization means the function that continues to keep the scale of data.



<Figure 4> The Structure and Function of Data Management System



<Figure 5> The Structure and Function of Knowledge Management System

The quality of the KOPSS data mart depends on that of the existing data. To keep the good quality of data, it is required to standardize the existing database. The methods to conform the quality of the existing data include meta data analysis, topological relation analysis, and cross-comparison analysis. The next step is the cooperation between public institutions that provide their database for the KOPSS. If we cannot know where the data are and how the data are used, we cannot construct the database. It is also necessary to set up the update-system to keep the good quality of data and consider the feedback system between the user and the system. For this, the individual institutions with their own information systems should have common rules or standards in promoting the cooperation between the related institutions.

2.2.2. Knowledge Management System

The spatial planning is set up by the experts' knowledge, technology and experience. The experts' knowledge, technology and experience has a big effect on the spatial planning. Thus, the KOPSS should use many experts' knowledge, technology, and experience. The knowledge is usually used for evaluating the variables' standards or thresholds at the stage of each spatial planning. For this, the knowledge management system should be constructed in the KOPSS. The Knowledge Management System should systematize and objectify the experts' knowledge, technology, experience with valid methods, standards, laws, customs and practices.

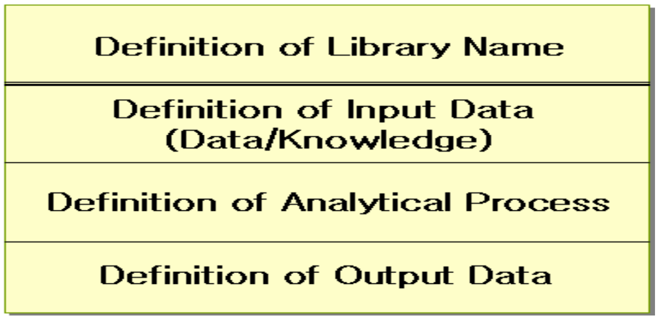
The first knowledge to be managed includes laws, practices, customs, and academic theories systematized by rule-based methods. The second knowledge includes experiences and cases of the experts based on the case base reasoning methods. The third knowledge can be collected by the surveys and interviews with the experts. The last knowledge can be compiled by model analysis process of What-If system. In addition, participants' public opinions should be added in the knowledge. These knowledges have a relationship with the development of collaborative spatial planning support systems.

However, it is also important to consider the experts' artistic characteristics in a spatial planning. In case the experts make a reasoning solution, they may not consider the creativity and artistic characteristics. Although many experts agree with the knowledge, there can exist alternative knowledge. Such a consideration of artistic knowledge will not be disregarded because the KOPSS has its role in supporting stakeholders' decision-making.

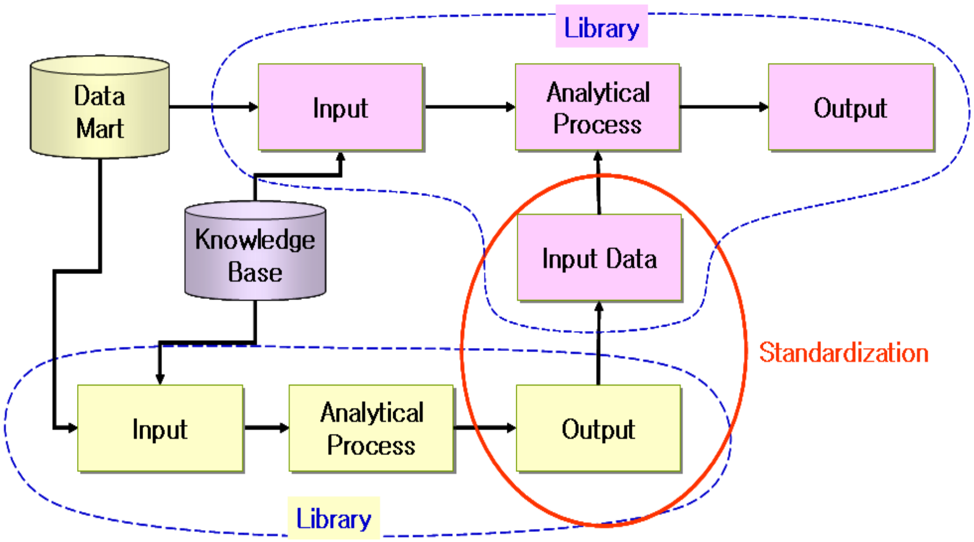
2.3.3. Model Management System

The various data and knowledge as input data can be treated by suitable analytical methods. The analytical methods depend on the themes suggested and users. An user has his own option for decision-making. For this, the KOPSS should have various methodologies and manage them systematically. The Model Management System is a sub-system of the KOPSS that revises, renews, and manages the suitable methodologies and analytical methods.

An analytical method can be represented as (Figure 6). The KOPSS calls it a LIBRARY composed of input, processes, and output. The spatial planning has many stages of process and its analytical procedure is performed by various methods. Thus, LIBRARY means a methodology that supports the analytical procedure. A LIBRARY can be incorporated into a network of LIBRARY(Figure 7). In this paper, a network of LIBRARY can be defined as COMPONENT. A component is composed of a number of libraries. A set of sequenced components becomes a task. Thus, information required for a spatial planning can be elicited and supported from a set of sequenced components.



<Figure 6> The Definition of a Library As an Analytical Basic Unit



<Figure 7> The Definition of a Component Corresponding to Analytical Process

Analytical methods have a huge impact on the results of a model. It is necessary to consider which analytical methods are suitable for the solution. Thus, the development of a model can be achieved by the cooperation between the model developers and planners. A model should be constructed by the way that can provide the decision makers with various scenarios.

2.3.4. User Interface

Most spatial planning is conducted by the central government in Korea and is performed by professional institutes such as research institutes and planning engineering corporations.

The end-users dealing with the KOPSS are planning experts in the research institutes, planners in engineering companies, and central and local government's officials engaged in a spatial planning. The users depend on the scale and subject of a spatial planning.

The success of the KOPSS depends on the design of the well-made interface that can be easily used for the users. The interface of the KOPSS should be constructed by considering as follows: First, central and local government's officials are not computer experts. Second, the users are trying to find the most suitable alternatives. Third, the results should be easily understood for the officials. Fourth, the analytical procedure should be guaranteed by objectivity and transparency.

A spatial planning needs a high level of professional knowledge because it is a non-structured decision-making process. Thus, the development of the KOPSS avoids the automation of a spatial planning's analytical procedure and seeks for user-friendly system. For this, it is very important to consider the users' opinion.

The user interface has multi-directional dialogue functions composed of menu and icons. Such an interface is useful to manage the variables, parameters, and analytical methods in the analytical process. The analytical results should include graphics, reports, and maps and be compared. Log files should be included to trace and identify the used variables, parameters, and analytical methods.

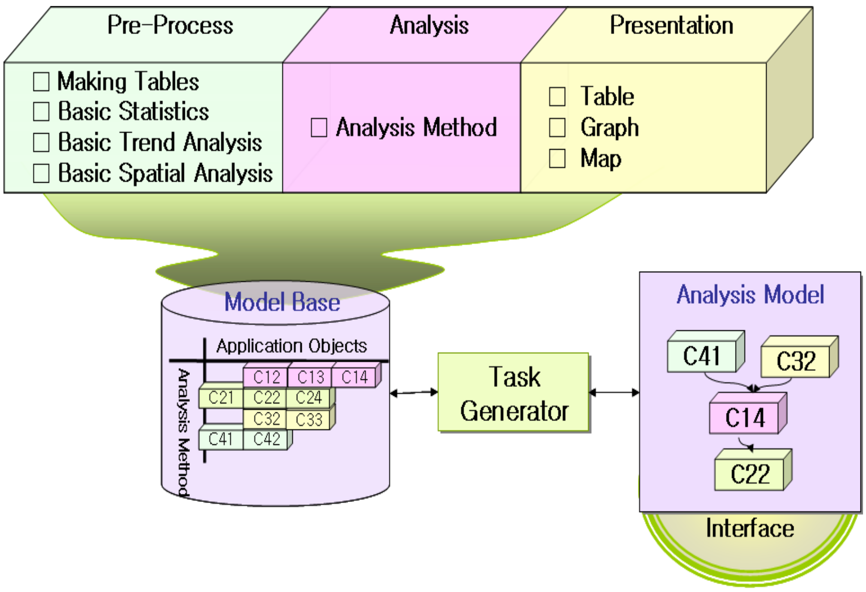
2.4 The Strategies of Developing Application Systems : Component-based Application Systems

Most spatial planning is based on a serial of task procedures. The task procedures are divided into a number of processes called "component*" and their processes are divided into a number of analytical methods called "library". This division is based on the concept of top-down. Inversely, in terms of bottom-up concept, planning scenarios as a task are incorporated into components. The task procedure follows the spatial planning process. Thus, component-based systems can reflect the spatial planning process effectively. The KOPSS is being developed by component-based methods and each component of the KOPSS is being connected into the standard interface. The component-based application systems are useful for the KOPSS's reusability, flexibility, and expansion.

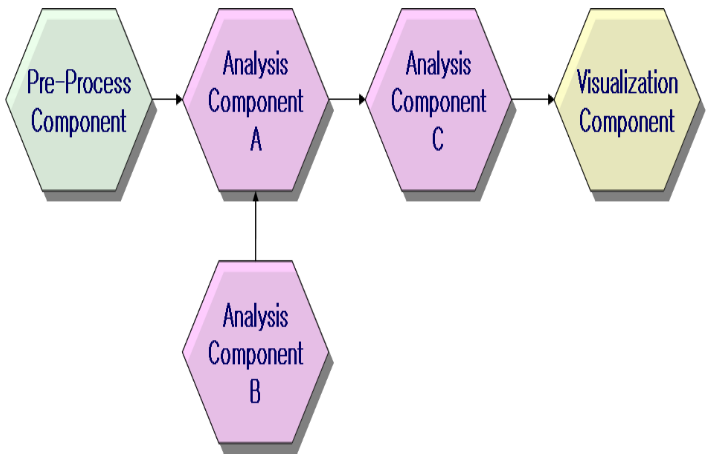
The development procedure of the KOPSS is divided into three stages<Figure 8>. The

* A component means the software's unit that users can combinate the composites at their intentions.

first stage is the pre-process that has a role in incorporating input data. The second one is the analytical process that deals with input data. The third one is the presentation process that prints out the results of output. The presentation methods are visualized by a type of tables, graphs, and maps. A set of above three stages become a component and a set of components can be defined as a model or task(Figure 9).



<Figure 8> The Development Concept of Components of the KOPSS



<Figure 9> The definition of a Model or Task As a set of Components

3. The Strategies of Developing Base Environment

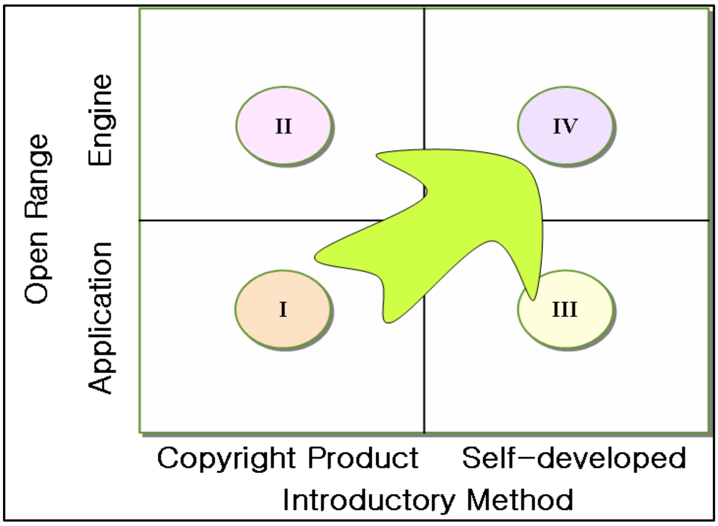
3.1. The Strategies of Development Tools

The choice of development tools is very important because the function of development tools has a huge effect on the implementation of application systems. The general strategy is to buy most suitable commercial products. The What If is the most representative commercial product for a spatial planning(Lee, 2005). However, the open source software such as UrbanSim and MetroScope is getting more and more as time goes on(Waddell, 2002; Larson, 2000).

The development tools for the KOPSS should have the following characteristics: First, the KOPSS's platform should be a standardized tool to guarantee the interoperability* in different platform environments. Second, it should have a function to treat huge scaled spatial data by saving time. Third, it should be easily and conveniently made to correspond to the changes in rapid economic, social and technological environments. Fourth, the development tools should be developed based on future technological growth speed.

The introductory strategy of development tools depends on the criteria of selection. Domain I means that the development tools have the characteristics of safety and sustainability(Figure 10). Domain IV represents that the development tools have a huge effectiveness in terms of transparency, expansion, specialty, and cost. In particular, it is very important to guarantee the openess that everyone can access in order to find out the suitable verification or error-monitoring method for the KOPSS. The KOPSS's development strategy of platform seeks for domain I and IV. However, domain IV's introductory strategy has a weakness in technical limitation and time consuming. Thus, in terms of safety and sustainability, the domain I will be more useful than the domain IV for the KOPSS. In current situation, it is necessary to consider step-by-step approach into the domain IV strategy by trying to make a R&D business and pilot project. When considering the domain IV, the KOPSS should not be a complete information system but a self-developed and flexible platform.

* Interoperability refers to share of information between different computer systems.

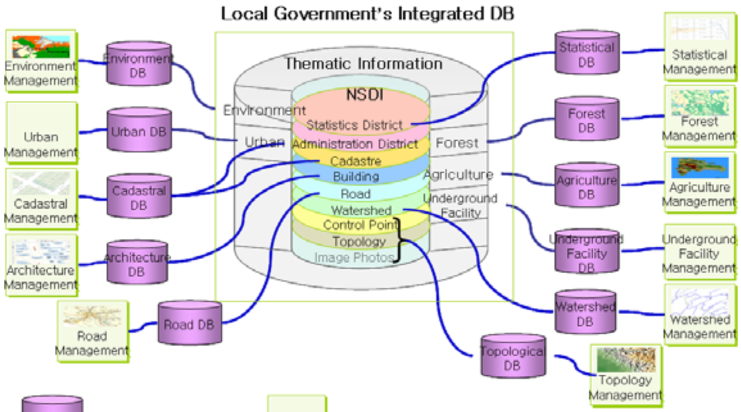


<Figure 10> The Introductory Strategy of Platform Tools

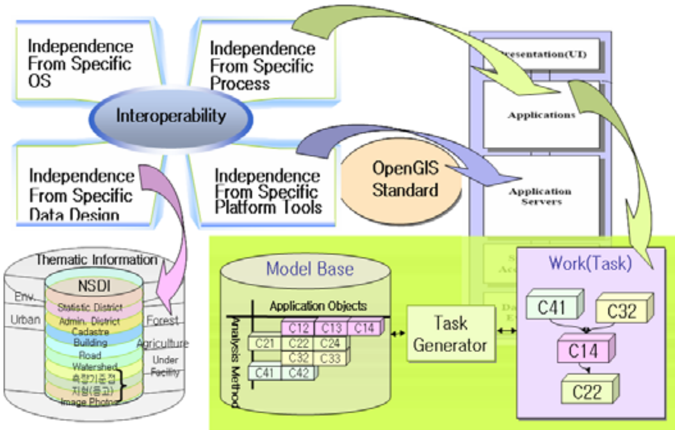
3.2. The Strategies of Developing Integrated Spatial Database

The integrated spatial databases are a kind of data warehouses that store a required information to respond the change of situation. If data for a spatial planning are constructed only by their needs, it will not catch up with the time of decision-making and it will be a cost consuming. Thus, it is necessary for the KOPSS to prepare for the standardized integrated spatial database composed of existing individual databases. The integrated spatial database is not only for the KOPSS, but also for the central and local governments and public institutions.

To maintain and provide the standardized integrated spatial database, the central government should construct National Spatial Data Infrastructure(NSDI) based on the Act on the Implimentation and utilization of the National Geographic Information System. The local governments should construct their own integrated spatial database based on the standard of NSDI(Figure 11). The central government should construct the structure of the national information infrastructure that combines the local governments' integrated spatial databases by vertical and horizontal methods between the central and local governments. It also should construct the share system that everyone can access to the integrated spatial databases.



<Figure 11> The Structure of Local Government's Integrated Spatial DB



<Figure 12> The Strategies of Standardization of the KOPSS

3.3. The Strategies of Standardization

The standardization of the KOPSS refers to a planned system that shares the information between different computer systems or performs the application programs. In the perspective of developing the KOPSS, the objects to follow the existing standards are operation systems, GIS S/W(development tools), and integrated spatial database*.

The development tools and existing developed copyright products should follow the standardization of the NSDI. In the fields of GIS, the international institutions such as Open

* The Integrated Spatial Databases should continue to follow the standards of the NSDI.

Geospatial Consortium(OGC) and ISO describe their standards. Most copyright products and open source software* are keeping the international standards. Current development and revitalization of open source GIS softwares is based on the standard base environment of GIS. The standard infrastructures of OGC and ISO have an advantage of linkage and reuse between open source GIS software and copyright products**. Thus, the development tools of the KOPSS should follow the standardized development tool.

The objects to need the standardization are the components of application systems in the KOPSS. The components in the KOPSS models need the standards to guarantee the interoperability. In other hands, we should keep in mind that the excessive share of information and the frequent interoperability between information systems will disturb the development of specific application systems.

3.4. The Strategies of Developing Cooperation System

The Korean central government has set up the spatial planning with the help of planning experts. However, there are many objections and demonstrations to set up a spatial planning. Although Korea has rapidly grown in social and economic aspects, the conflicts between participants who seek for interests and the phenomena such as Not In My Back Yards(NIMBY) are getting more.

To solve the conflicts and regional egoism, it is necessary to consider public participation in the stages of a spatial planning. In relation to public participation, there are many articles dealing with Public Participation GIS(PPGIS).***

PPGIS uses the combination of spatial information-based tools composed of GPS, GIS, and 3-dimensional model of aerial photos and satellite images. Citizens can suggest their opinion on the web or 2D/3D maps. Such maps have an important role in supporting the exchange of information, analysis, and policy on urban space. PPGIS makes the participants improve the access and share to spatial information using existing spatial information technology and GIT&S.

PPGIS is an informative and technological method that supports the participation of

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* Open source softwares refer to the softwares that have open source codes of the program and can be distributed or redistributed freely.

** Nam, K. W. et. al., 2006. A Study on Developing the Manual of Constructing the GIS based standard/open source, National Information Society Agency: Seoul, Korea.

*** Rambaldi and Weiner, 2004. Summary Proceedings of the "Track on International PPGIS Perspectives." Third International Conference on Public Participation GIS(PPGIS), University of Wisconsin-Madison: 18-20 July Madison, Wisconsin, USA.

interest groups and achieves transparent and reasonable spatial planning set up. A spatial planning is differenciated by the purpose and stage of planning. The characteristics and roles of participants who take part in the planning are changeable. The participants can live in scattered areas or segregated areas and they can be planning experts. Thus, it is necessary to develop the KOPSS by considering the participants′ characteristics and roles. The basic participation mede is to elicit participants′ reasonable opinion by supporting and visualizing a variety of spatial planning scenarios. For this, it is required to block the digital divide. It is also necessary to block specific groups′ intended participation by the introduction of log-in system. The KOPSS should consider the construction of PPGIS that can collect the various interest-participants′ opinion.

4. Conclusion: The Promotion Strategy of the KOPSS

A nation has various types of the spatial planning. Thus, the objects for the spatial planing can be divided into entire city at a large scale and individual facilities at a small scale. The urban master planning dealing with entire city and national territory at a large scale will need the comprehensive simulation. Reversely, the urban facility planning at a small scale will need specific simulation for individual facilities. Thus, the characteristics of information systems depend on the objects for the spatial planning.

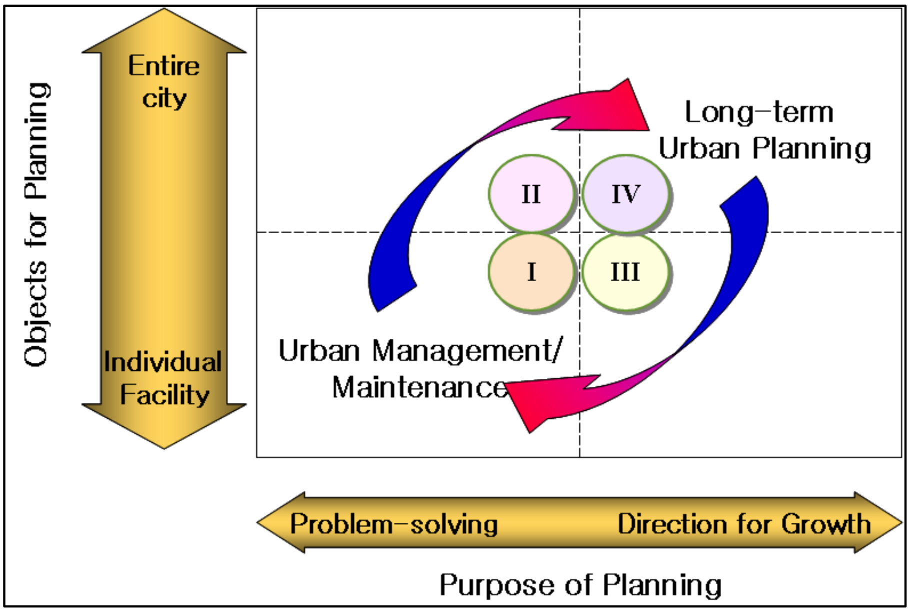
The purpose of the spatial planning can be divided into the specific problem-solving and the broad direction(management) for growth. The urban growth management is the long-term spatial planning for urban sustainable development over 10 or 20 years. However, the urban facility planning is the short-term spatial planning to solve the lack of facility. Thus, the characteristics of information systems depend on the purpose of the spatial planning.

It is necessary to consider that the spatial planning is not independent but interactive. A spatial planning has a hierarchical and interactive relationship with the other planning. Thus, the KOPSS should consider the relation between the spatial planning.

The purpose of developing the KOPSS is to provide the decision-makers with the required information to solve the problems caused by the incongruity between supply and demand of individual facilities. Thus, the KOPSS falls into the domain I(Figure 13). The domain IV is for the long-term urban master planning and needs the comprehensive simulation. UrbanSim and MetroScope will fall into the domain IV because UrbanSim and

MetroScope are long-term and comprehensive simulation models for the metropolitan spatial planning.

The KOPSS will be developed into a long-term and comprehensive simulation model for urban growth management by considering the hierarchical and interactive relationship between the spatial planning. The KOPSS will be expanded and upgraded in terms of its function and capacity.



<Figure 13> The Promotion Strategy of the KOPSS

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Appendix: The Analysis Models of the KOPSS

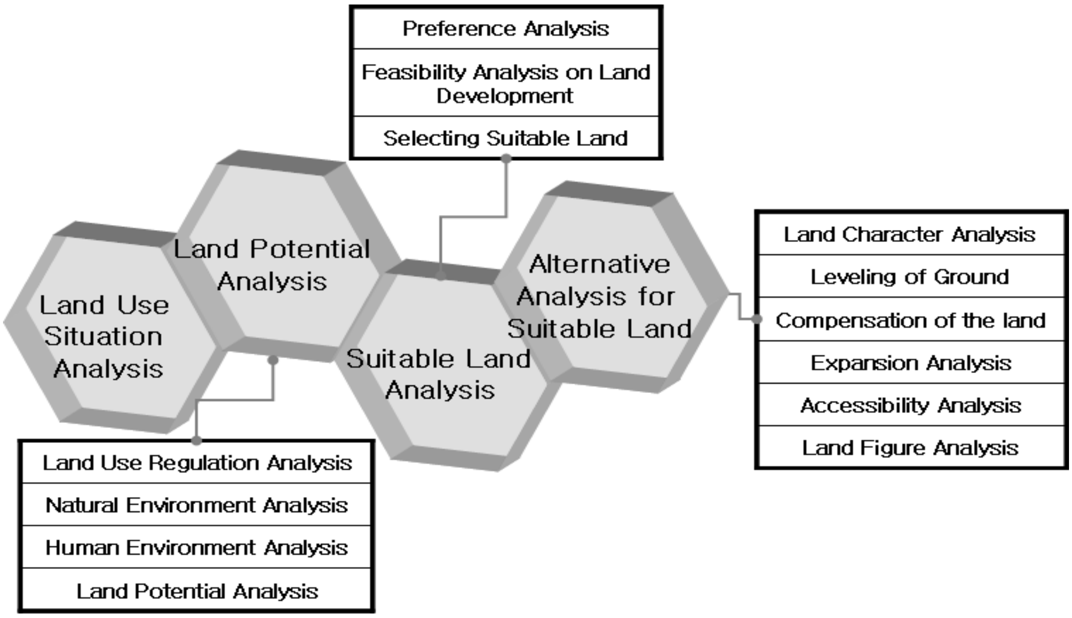
This appendix reviews the analysis models of the KOPSS. The KOPSS has nine analysis models until now. The five models were developed in 2006 and are being upgraded in 2007. The four models will be developed until 2007 and the six new models will be added to the KOPSS by 2010.

The Suitable Land Searching Model(SLSM) is the spatial decision support model that selects the suitable land in a rational and systematic way. This model supports stakeholders' decision-making by using the GIS-based technology and the Multi-Criteria Evaluation method.

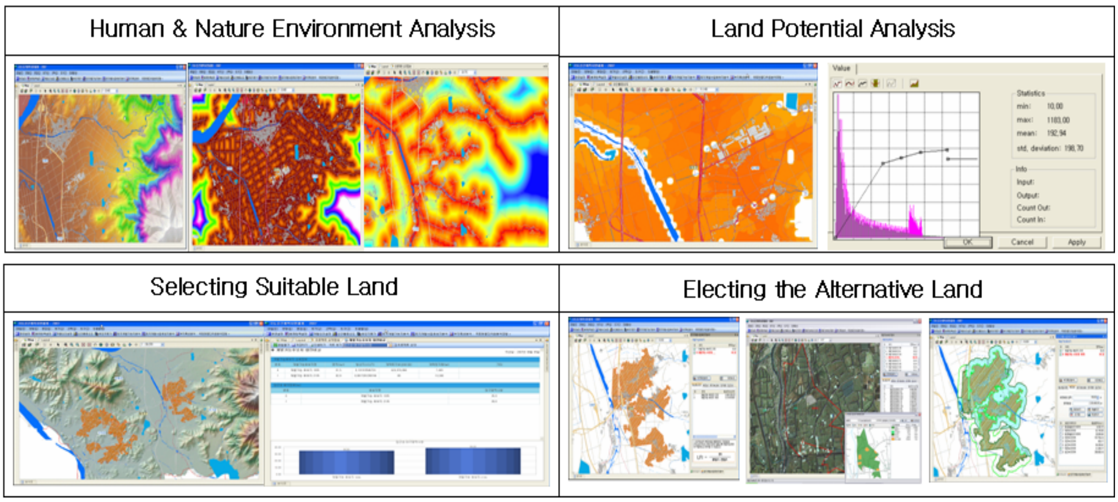
The basic concept of this model starts from considering both physical development and the conservation of natural resource. To achieve the suitable land searching, it is necessary to analyze the land potential, suitable land and alternatives based on natural & human environment, the preference of the citizen, the legislative systems. Thus, this model is composed of four components such as land use situation analysis, land potential analysis, suitable land analysis and alternative analysis for the suitable land(Figure 1-1).

The procedures of analysis are as follows: (1) Performing human and nature environment analysis, (2) Researching land potential analysis, (3) Selecting suitable land, (4) Electing the alternative lands(Figure1-2). This model is useful to support many decision makers with different interests such as government officials, local residents, firms, academic institutes, and so on.

Ⅰ. Suitable Land Searching Model

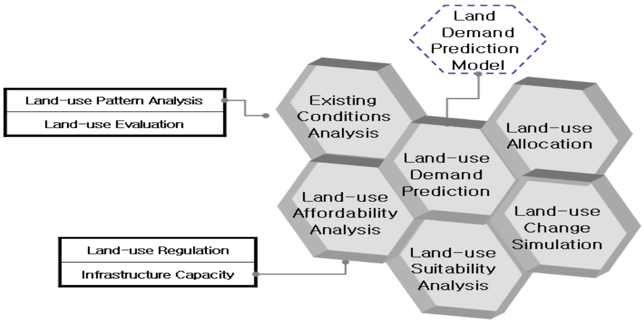


<Figure 1-1> Composition of the Model

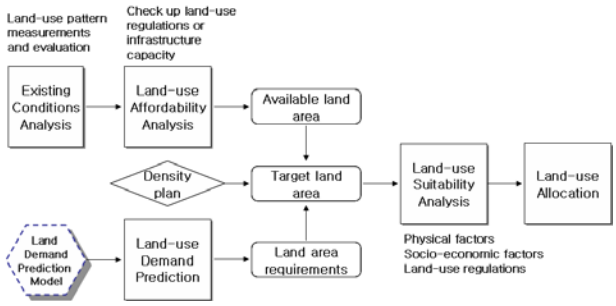


<Figure1-2> Procedure of Analysis

II. Land-use Planning Model



<Figure2-1> Composition of the Model



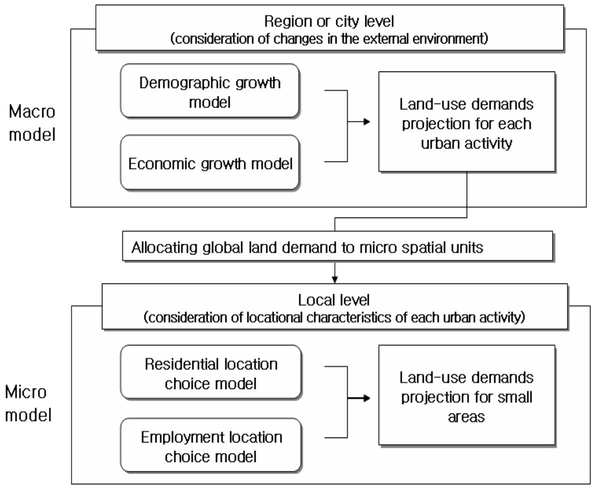
<Figure 2-2> Procedure of Analysis (Land-use Design)

The land-use planning model is a GIS-based spatial planning support system that analyzes land-use suitability, allocates projected land-use demands, and simulates land-use change according to different policy scenarios.

The basic concept of this model starts from considering land-use demand and supply. This model considers economic efficiency, environmental compatibility, and social equity as a key principle of the evaluation of existing land-use conditions and future land-use planning. We designed the proposed model organized into six components to implement the basic concept(Figure 2-1).

The procedures of analysis for future land-use design are as follows: (1) Existing conditions analysis that measures and evaluates existing land-use pattern, (2) Land-use affordability analysis that estimates available land area, (3) Land-use demand prediction that projects land demand for each land-use using the external land demand prediction model, (4) Land-use suitability analysis that determines the suitability of different locations for each particular land-use using the multi-criteria analysis(MCA), (5) Land-use allocation that assigns the projected demand for each land-use to different locations(Figure 2-2). This model is useful to support planning and policy decision-making tasks for the sustainable land-use.

III. Land Demand Prediction Model



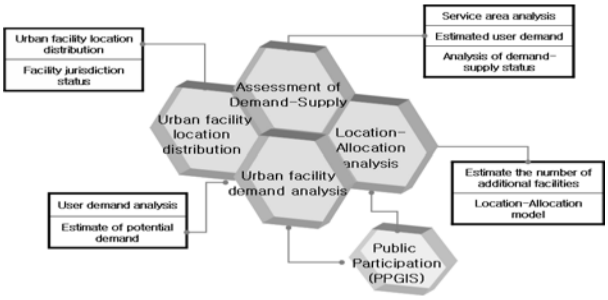
<Figure 3-1> Basic Concept of the Model

The land demand prediction model estimates the future demand for each land use type. The model will be composed of two sub-models including macroscopic and microscopic models(Figure 3-1).

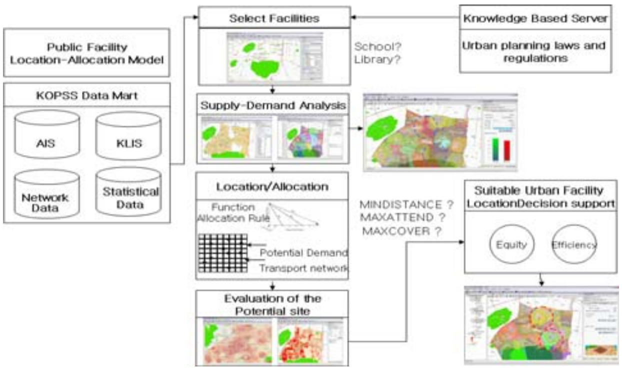
The macroscopic model estimates global land use demand with consideration of the changes in external environment such as population or economic growth. The population growth model is used to estimate the changes in population or household. Based on this, residential land use demand can be calculated. The economic growth model is used to estimate the changes in employment population based on industrial category.

The microscopic model allocates global land demands into the micro spatial units. Global Land demand shows some variations at a local level depending on the distribution characteristics of the inner-city activities such as residential choice or employment location choice. Therefore, this model estimates spatial distributions of urban activities based on residential location choice model or employment location choice model. From this, microscopic model estimates the land use demand for the small scaled urban areas.

Ⅳ. Public Facility Location-Allocation Model



<Figure 4-1> Composition of the Model



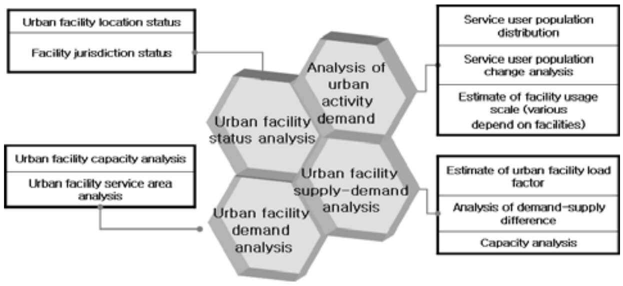
<Figure 4-2> Procedure of Analysis

The public facility location-allocation model is used to analyze the service areas of infrastructure facilities by the facility types and facility-user demands using the GIS-based spatial analysis methods. It then utilizes network analysis to find out the potential location site. The purpose of this model is to support the urban planners' decision-making by suggesting an ideal site for the urban facilities location under the concept of efficiency and equity.

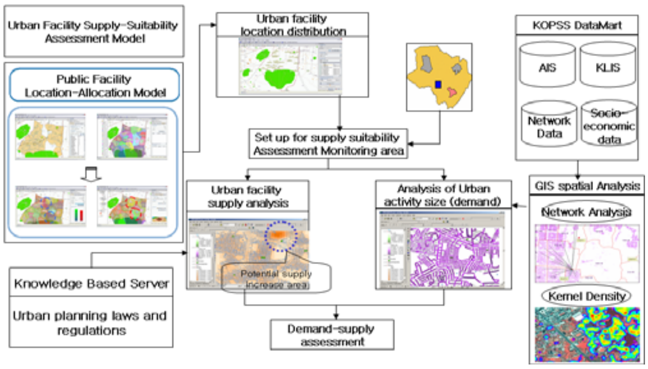
The model is composed of four components such as the urban facility location distribution, the urban facility demand analysis, the assessment of demand-supply, and the location-allocation analysis(Figure 4-1).

The procedures of analysis are as follows: (1) Selecting the target facilities for the analysis, (2) Analyzing demand-supply based on its service area and estimating facility-user demand, (3) Allocating the suitable potential site(Figure 4-2). This model is useful to support decision-making of the optimized location of urban facilities.

V. Urban Facility Supply Suitability Assessment Model



<Figure 5-1> Composition of the Model



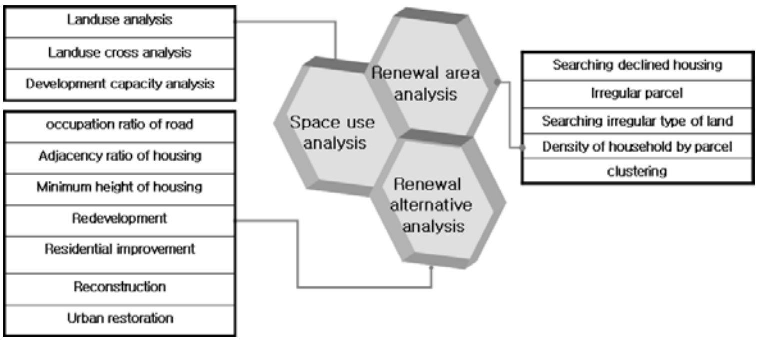
<Figure 5-2> Procedure of Analysis

The Urban Facility Supply Suitability Assessment Model is used to prevent excess carrying capacity which is often caused by high-density development in the urban area. To achieve this aim, this model analyzes the supply suitability based on the standard urban carrying capacity described in the Korean land planning law. The supply-capacity of urban facility and the scale of urban activity demand are considered for this process.

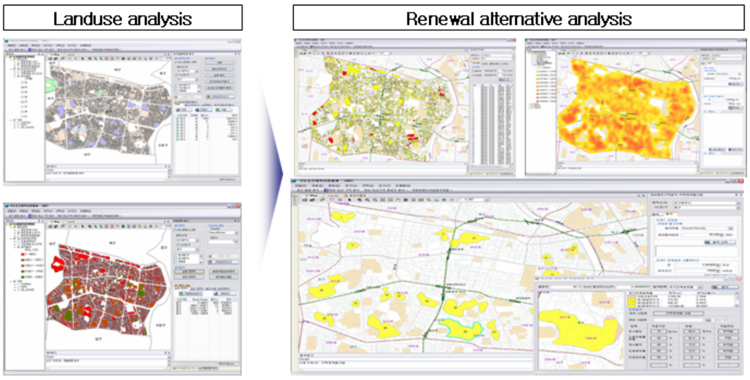
This model is composed of four components such as the urban facility status analysis, the analysis of urban activity demand, the urban facility demand analysis and the urban facility supply-demand assessment(Figure 5-1).

The procedures of analysis are as follows: (1) Visualization of urban facility location distribution that gives information about the current status, (2) Set up the monitoring area for supplying suitability assessment, (3) Supply and urban activity size analysis, (4) Demand-supply of urban facilities assessment (Figure 5-2). This model is useful to give information to the policy makers' decision-making that adjusts the development density or adds extra urban infrastructure facilities when the new urban development activities occur.

VI. Urban Renewal Model



<Figure 6-1> Composition of the Model

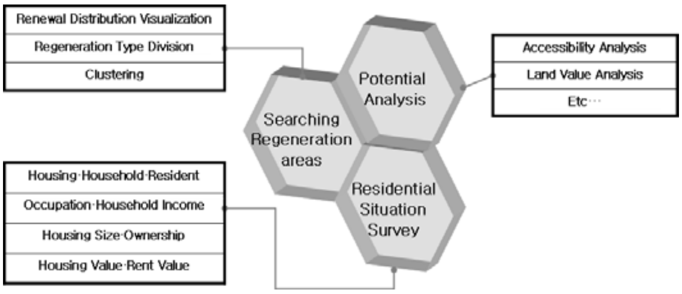


<Figure 6-2> Procedure of Analysis

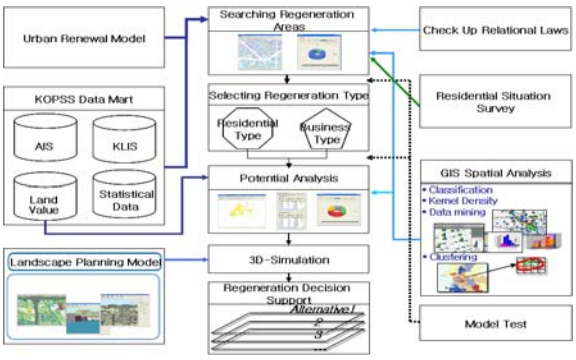
The urban renewal model is used for analyzing declined or undeveloped areas and supporting to search brown fields in the inner-city. The scope of this model lies in an improvement of physical environment in the inner-city. The purpose of this model is to support the spatial planning tasks related to Act on Urban Renewal describing the condition of urban restoration, reconstruction and redevelopment.

This model is composed of three components such as space use analysis, renewal alternative analysis, and renewal area analysis(Figure 6-1). The procedures of analysis are as follows(Figure 6-2): (1) Analyzing current space use, (2) Analyzing renewal alternative proposed, (3) Drawing the renewal alternative by applying the criteria of the law. This model is useful to support decision-making of urban renewal tasks by providing the planning stakeholders with information required for renewal.

Ⅶ. Urban Regeneration Model



<Figure 7-1> Composition of the Model



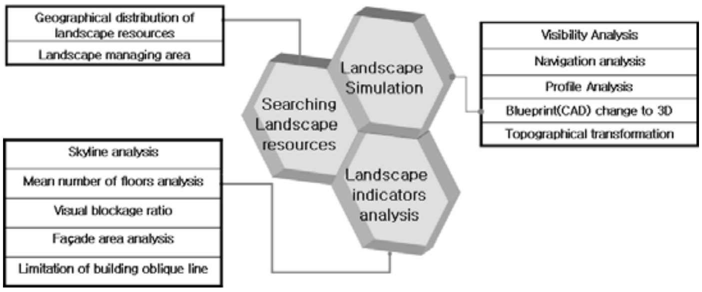
<Figure 7-2> Procedure of Analysis

The urban regeneration model is used for searching redevelopment areas and analyzing the characteristics of redevelopment areas and their neighborhoods using GIS-based spatial analysis methods. The purpose of this model is to support the spatial planning tasks related to urban regeneration that incorporates individual redevelopment areas systematically and effectively.

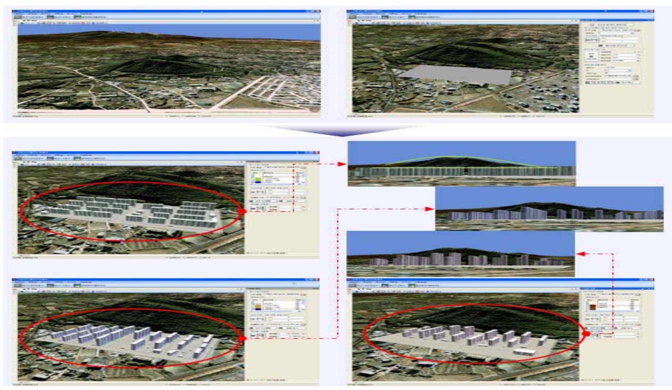
The basic concept of this model starts from considering the physical upgrading, functional restoration, market force, and public policy. To achieve the urban generation, it is necessary to analyze the redevelopment areas and their potentials based on architecture, transportation, property, and population information. Thus, this model is composed of three components such as searching regeneration areas, potential analysis, and residential situation survey(Figure 7-1).

The procedures of analysis are as follows: (1) Searching the regeneration areas, (2) Analyzing potentials of areas, (3) Suggesting alternatives for regeneration(Figure 7-2). This model is useful to support decision-making of regeneration tasks by providing the planning stakeholders with information required for regeneration.

VIII. Landscape Planning Model



<Figure 8-1> Composition of the Model

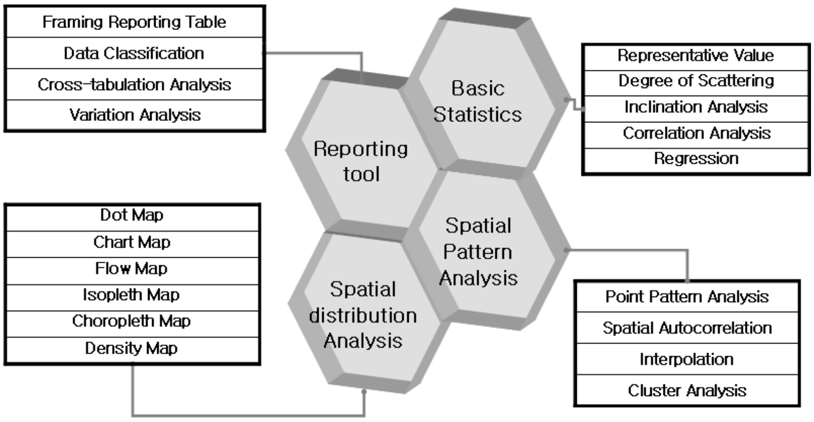


<Figure 8-2> Procedure of Analysis

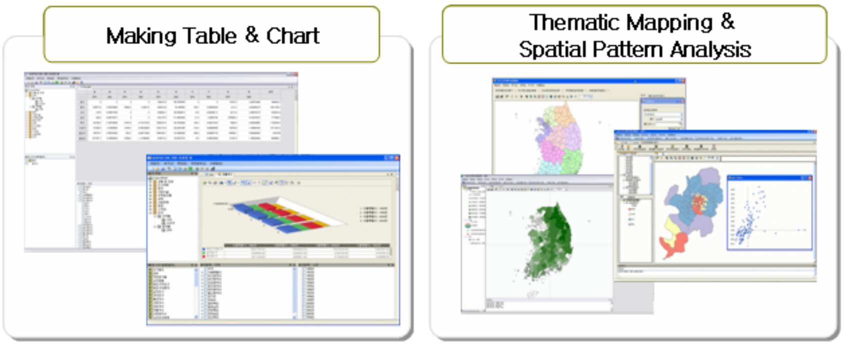
The landscape planning model is used for supporting the creation and management of landscape using 2D or 3D-based spatial analysis methods. The basic concept of this model starts from the analysis of current landscape and the computer simulation in terms of beauty and amenity. Thus, it can grasp the current landscape resources and accompany both landscape analysis and 3D simulation to the buildings. The purpose of this model is to support the landscape simulation to construct large scale buildings or new town.

This model is composed of three components such as searching landscape resources, landscape indicator analysis and landscape simulation(Figure 8-1). For example, the procedures of analysis are as follows(Figure 8-2): (1) Searching the landscape resources of the object field to analyze landscape, (2) Leveling the topography of the areas where the buildings are located by the average altitude , (3) Suggesting alternatives for regeneration, (4) Changing from blueprint(CAD) to 3D and then taking blueprint's position. This model is useful to support decision-making of landscape planning tasks.

IX. Multi-dimensional Analysis Model



<Figure 9-1> Composition of the Model



<Figure 9-2> Model Application

The multi-dimensional analysis model is used for sorting and classifying the national planning data, visualizing the distribution of the variables, and performing the basic statistics related to the spatial planning. The purpose of this model is to summarize the national statistics data and knowledge required for the spatial planning and analyzes the spatial pattern of specific phenomenon using basic statistical methods.

The multi-dimensional analysis model is composed of four components such as reporting tool, basic statistics, spatial distribution Analysis, and spatial pattern analysis to provide tables and charts and analyze spatial patterns(Figure 9-1).

This model can be used to make charts and maps easily using the function of drag and drop from national statistics and census data. It also can be used to provide thematic maps by visualizing the spatial patterns by themes (Figure 9-2).

GeoSemantic Web Service Framework for Spatial Decision Support System

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Abstract

Advanced geographic technology has triggered many geospatial data, software, hardware, and services. However, two impediments for GIS interoperability have been produced: syntax and semantic problems. In this research, we (1) focused on the semantic impediment in GIS, which is considered as a high prioritized research area by NCGIA and UCGIS, and (2) presented an architecture for the geosemantic web services, including four components: an users' portal, spatial and domain ontologies, searching in SDI (spatial data infrastructure), and service chain. Users can log in the portal and discover suitable GIServices, GIS data and GIS function services, with more accuracy and results with discovered GISerivces can be generated (semi) automatically for users' evaluation. This study has also (3) integrated spatial and domain ontologies in Taipei city, Taiwan, to fulfill the need of the geosemantic web services. The framework not only provided a suitable and flexible architecture in SDI to solve the geo semantic problem but also presented a knowledge based and web GIS services based spatial decision support system framework.

Keywords: semantic web, ontology, GIS services, spatial data infrastructure

* This paper was written by Chinte Jung and ChihHong Sun

Introduction

Users of geographic technology are both blessed and cursed by the growing availability of geospatial data, software, hardware, and services (Goodchild et al., 2004). These GIS software has evolved largely in the absence of any widely accepted body of theory or concept, with each vendor adopting a distinct terminology and set of data format standards, and with each product forming the nucleus of its own information community (Goodchild, 2000). These are present major impediments for GIS interoperability which is included two parts: (1) Syntax and structure problem. GIS data format are different with different vendors, and there are different data type (e.g. raster and vector data) and coordinate systems to present the real world. When people deal with different geospatial data syntax and structure, they often face challenges. (2) Semantics problem. Difference of spatial cognition can form invisible boundary in geospatial data and information sharing, because of different conceptualization in geospatial domain, for example the different definition of geospatial entities, geospatial processes, and geospatial relationship. These would indicate different geospatial semantics.

Moreover, spatial data infrastructure (SDI) (Groot and McLaughlin, 2000; Nebert, 2004; Masser, 2005) is currently being set up with regions, countries, and across national borders to facilitate management and access to geospatial information (Lutz, 2006). GIServices include GIS data services and geoprocessing services (Tao, 2001) which are the main components of SDI to provide remote, standard, and reusable geospatial data and function services. The information, metadata or input/output data description, would all be recorded in catalogue services (OGC, 2004) for users to discover suitable GIServices. However, how to efficiently discover suitable GIServices and overcome GIS syntax and semantic problems in Catalogue services on SDI would be a critical task.

Although open geospatial consortium (OGC) and International Standard Organization (ISO) have developed some standards for achieving geospatial data syntactic or structure interoperability, for instance web map service (WMS) (OGC, 2006), web feature service (WFS) (OGC, 2005a), and geography markup language (GML) (OGC, 2002), the geospatial semantic problems, either in geospatial data or concept, still exist. Researches in geospatial interoperability, however, must go beyond geometry related and database structure concerns to take into account semantics (Egenhofer, 1999; Rodriguez, 2000; Brodeur et al., 2003).

Therefore, NCGIA specialist meeting on spatial webs had pointed out that geospatial semantics would be the recommendation for future work for spatial webs (Goodchild et al., 2004) and USGIS had considered geospatial semantic web to be one of the research priorities (Fonseca and Sheth, 2002). In this study, the solutions and architecture for the geospatial semantic problems would be presented through the following steps:

■ **Appling Ontology into the architecture of SDI**

Using ontology of a domain, we can more clearly understand what classes (or objects) and relationships are needed in a domain. In this research, we would apply ontology for knowledge oriented search to discover and combine GIServices in SDI with more accurate. Additionally, through this process, we can more easily incorporate GIS data and functions with proper knowledge.

■ **Building a GeoSemantic Web (service)**

Besides ontology on SDI, we would build an architecture of geosemantic web for GIS semantic interoperability. It contains: (1) semantic portal, an interface for users to key in the terms and choose the domain to find GIS data or functions on SDI; (2) ontologies management, which transfers the terms of the domain into semantic format, thus associated terms of the domain can be found and implicit relationships in ontologies can be reasoned; (3) semantic catalogue, which uses these associated terms and relationships to search suitable and high precision GIS data or functions in the traditional architecture of SDI; (4) service chain, which uses the discovered GIServices in SDI and domain ontologies to produce results in (semi)automatically forming an executive chain. Finally, the results would be show on semantic portal for users' evaluations.

1. Background and Related Works

1.1. Semantic Web

In this section, Section 1.1.1 introduces the problems of semantics. Section 1.1.2 and 1.1.3 discusses what the semantic web is, why we need it, and what components are needed to build a semantic web. Finally, the geospatial semantic web is presented in Section 1.1.4.

1.1.1 Semantic problems

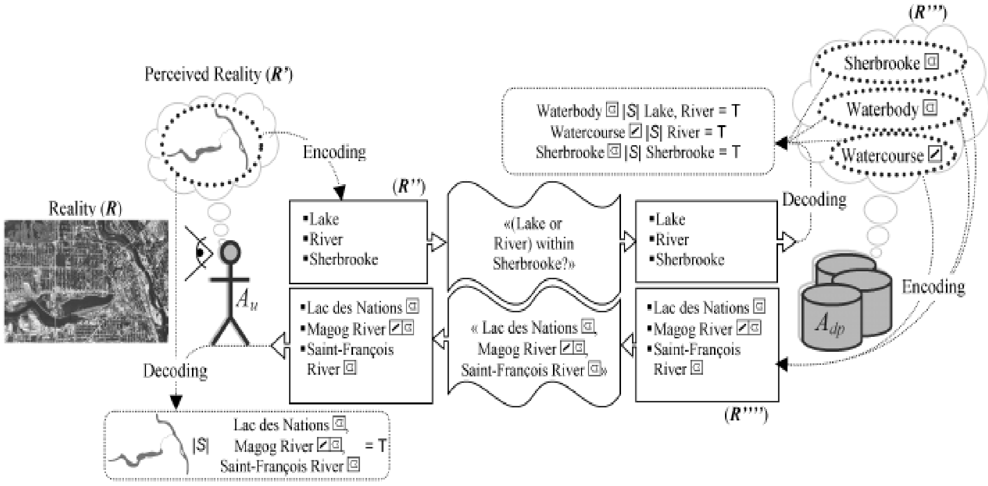
Today, we often use keywords to search information on search engines, including Google and Yahoo!. However, the results returned for our search is usually large in quantity, with high recall and low precision(Antoniou and Harmelen, 2004). That is because machine cannot understand what people think and what contents or concepts that people really need. This in turn produces semantic problems. What factors cause these semantics problem? Brodeur et al. (2003) believed that human communication resulted in the semantic problems and they explained process in Figure 1.

First, an individual(A_u) is looking for information about the hydrographic network, representing the reality (***R***). Au would capture the reality by his(her) sensory system and brain to select interesting items of the reality into his(her) memory as perceptual symbols (Downs, 1970; Barsalou, 1999) to form the perceived reality (***R′***) as a perception or concept.

Secondly, when A_u wants to find the information on a search engine, he(she) should transfer his (her) perception of the reality into concept representation, using signals of different types, for example words, symbols, pictograms and so forth. The concept representation, denoted ***R′′***, becomes the physical component depicting partly or wholly the concept to which it refers(Brodeur et al., 2003), which is illustrated by “Lake”, “River”, and “Sherbrooke” in Figure 1.

Thirdly, the search engine operator, A_{dp}, initiates a decoding operation. When it receives the concept representations from A_u, the concept representations are assigned with appropriate meanings by A_{dp}′s perceptions, which would form the other concept (***R′′′***). It is illustrated by “Sherbrooke”, “Waterbody”, and “Watercourse” in Figure 1. Fourthly, the concept of A_{dp} would be encoded into concept representations and passed to A_u. It is denoted by ***R′′′′*** and illustrated by “Lac des Nations”, “Magog River”, and “Saint Francois River” in Figure 1.

Finally, once the conceptual representations from A_{dp} is received, A_u initiates to decode these conceptual representations and he(she) analyzes them to assess if they refer to the previous concepts of ***R′***. If so, the concept interoperability occurred during the interaction between the two agents (A_u, A_{dp}); if not, A_u has to add some restrictions on his(her) conceptual representations and send it back to A_{dp} again to get better results.



<Figure 1> A concept framework of geospatial data interoperability(Brodeur et al., 2003)

The reality represented by ***R***, ***R′***, ***R″***, ***R‴***, and ***R⁗*** are either partly or entirely different. It would cause semantic problems that set barriers to semantic interoperability, including the following types (Probst and Lutz, 2004):

1. Naming Heterogeneity: Two data with the same data type and refer to the same domain concept, but have different names.
2. Data Type Heterogeneity: Two data with the same name and refer to the same domain concept, but represented with different data types.
3. Conceptual Heterogeneity: Two data with the same name and same data type but refer to different domain concepts.

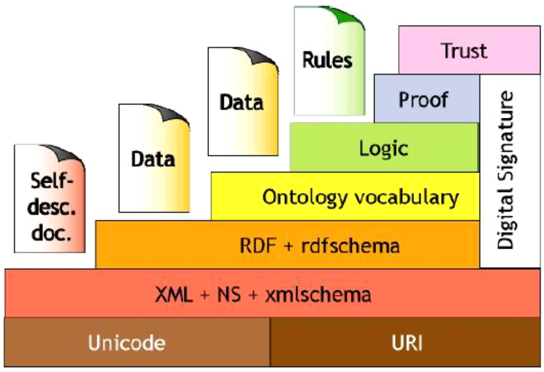
1.1.2. What is a Semantic Web?

The World Wide Web has changed the way how people think and communicate information with each other. However, the contents of the web nowadays are mostly made suitable for humans, not for machines. Therefore, we need an semantic transformation interface that machines can be used to access our concepts and further communicate information with other machines.

Created by Tim Berners Lee, the very person who invented the WWW in the late 1980s, the semantic web is a web of data that can be processed directly or indirectly by machines (Berners Lee, 2002). It is an extended web of machine readable information and automated services that amplify the Web far beyond current capabilities(Daconta et al., 2003), in which the web content would be represented in a form that is more easily machine processable and would use intelligent techniques to take advantage of these representations(Antoniou and Harmelen, 2004).

1.1.3. Components of Semantic Web

The components of the semantic web are first depicted by Berners Lee(2000) in Figure 2, which are called a layer cake of the semantic web.



<Figure 2> Layer cake of the Semantic Web (Berners Lee, 2000)

At the bottom is XML(extensional markup language), a language that lets users write structured web documents with user defined vocabularies composed by Unicode and URI (universe reference indicate). NS(name space) classifies the vocabularies of XML into different spaces to avoid repeated vocabularies. XML schema is a data model of XML to describe data type and domain of XML. RDF(resource description framework) is a basic data model for writing simple statements about Web Objects(resources), similar to the entity relationship model. The RDF schema provides modeling primitives for organizing Web Objects into hierarchies. Key primitives are classes and properties, subclass and subproperty relationships, and domain and range restrictions.

RDF schema can be viewed as a simple ontology which models some basic primitives of resources. However, more powerful ontology language is needed to extract more complex relationships and classes between resources. By ontology, we can use logic to reason and find some implicit relationships between resources, whereas proof layer would be used to valid these implicit relationships. Finally, the trust layer will emerge through the use of digital signatures and other kinds of knowledge, based on recommendations by trusted agents or on rating and certification agencies and consumer bodies.

1.1.4. Geospatial Semantic Web

In a rich data and functions of geospatial information domain, the semantic problems also confused us. Using keywords to search for appropriate data in a large spatial database often result in some uninteresting datasets or geospatial information. For instance of a search phrase "the departments in National Taiwan University", it would be a difficult task for the nowadays search engines to understand what geospatial relationship of "in" means. Therefore, the development of semantic web needs special attentions from geospatial perspective so that the particularities of geospatial meaning are captured appropriately. UCGIS(university consortium for geographic information science) also considered that the geospatial semantic web would be one of critical research priorities for geographic information science(Fonseca and Sheth, 2002).

The geospatial semantic web is to capture, analyze, and tailor geospatial information. It is much beyond the purely lexical and syntactic level which needs (1) the development multiple spatial and terminological ontologies; (2) the representation of those semantics such that semantics are available both to machines for processing and to people for understanding; (3) and the processing of geospatial queries against these ontologies and the evaluation of the retrieval results based on the match between the semantics of the expressed information need and the available semantics of the information resources and search systems(Egenhofer, 2002).

The effort of OGC has set up a series of standards of geospatial information, such as GML, GML schema, WFS, WMS, and so forth. These standards provide significant foundation for building the bottom layers of the geospatial semantic web, as shown in Figure 2. Therefore, the geospatial domain is more realistic and more possible to build the geospatial semantic web for knowledge interoperability than any other domains.

1.2 Ontologies

According to the previous section about the semantic web, ontology plays a significant role for the semantic web. In this section, we would explain what ontology is and the difference in concept between philosophy and information domain in section 1.2.1. Then, an architecture of ontologies was applied to manage multi ontologies and integrated knowledge in different sources in section 1.2.2. Section 1.2.3 introduces OWL(web ontology language) to describe terms and relationships in ontology. The basic theory of OWL, description logics, is presented in Section 1.2.4. Finally, how to cognize the concept of people's thinking about geospatial reality and how to build up geospatial ontology would be explained in section 1.2.5.

1.2.1. Ontology

The term "ontology" came from the domain of philosophy that deals with "the nature and the organization of reality"(Guarino and Giaretta, 1995) or the science studying of being(Hendler, 2001). Ontology seeks "what and why there is" and primarily establishes the types of entities that reality contains and how these entities are related(Mark et al., 2004). The scientists in information domain have applied the concept of ontology from philosophy into information systems and knowledge management systems. Ontology is defined as "an explicit specification of a conceptualization"(Gruber, 1993), where a conceptualization can be defined as a way of thinking about some domain(Uschold, 1998), included terms and relationships in some domain. This is to explicitly and formally describe terms and relationships in a domain to make them machine readable, which would be use by intelligent machines to simulate human thinking and concepts of the complex reality.

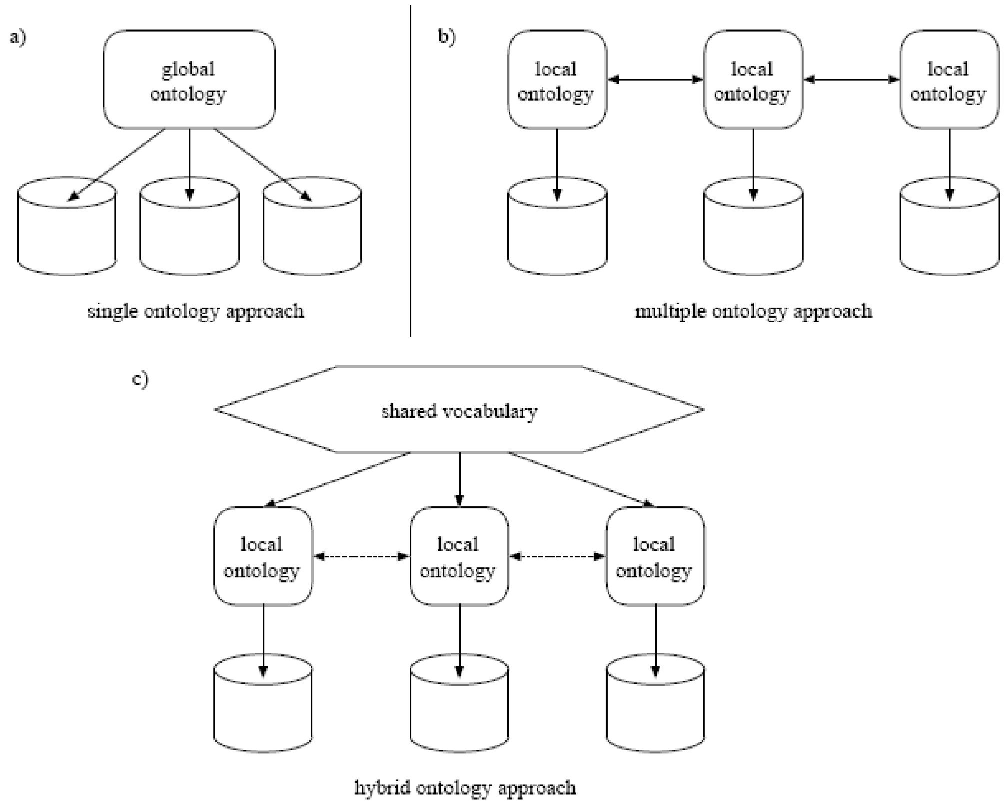
1.2.2. The architecture of Ontologies

Perspectives from different domains, applications, space, and time may conduct different abstraction and description, or ontologies, of the reality. Therefore, to focus on different perspectives, it is necessary to provide a multi hierarchy architecture to integrate different ontologies depending on the accuracy needed in a given situation, as shown in Figure 3 (Wache et al., 2001) and Figure 4(Brodeur et al., 2003).

In Figure 3, Wache et al.(2001) provided three architectures for information integration:

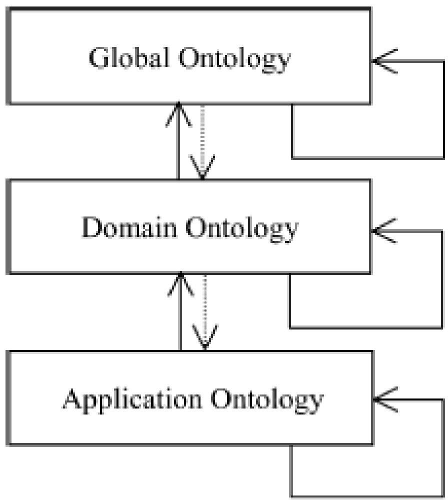
a) Single ontology approaches use a global ontology to provide a shared vocabulary for the specification of the semantics. All information would be integrated with this global ontology. This approach is only suitable for very similar views of a domain, because if views or information is from different domains, global ontology would not provide a flexible approach to cooperate this information.
b) In multiple ontology approaches, each information source is described by its own ontology. In principle, each of these application ontologies can be a combination of several other ontologies. However, it cannot be assumed that several application ontologies share the same vocabulary, or a global ontology, which provide the same basic concept or vocabulary to integrate these different application ontologies.

c) Hybrid approaches are similar to multiple ontology approaches in that the semantics of each source is described by its own ontology. But in order to make the local ontologies comparable to each other they are built from a global shared vocabulary. Through this approach, these application ontologies would be cooperated and integrated based on the same vocabulary to represent domain knowledge more proper, as shown in Figure 4.



<Figure 3> Different ontology architectures for information integration(Wache et al., 2001)

The hybrid approach divides 3-tiers hierarchies to integrated different ontologies (Brodeur et al., 2003). First, global ontology is on a high and extensive level to provide the most basic entities and relationships to integrate and communicate with different domain ontologies. Second, domain ontology focuses on domain knowledge to extract terms and relations among them. It is like a shared vocabulary to share basic terms and definitions in a domain. Of course, it has to follow the rules which are defined by the global ontology to communicate with other domain ontologies. Third, application ontology focuses on an application of a domain and we can add more restrictions and relations in an application ontology to satisfy the need of an application based on the shared vocabularies of a domain ontology.



<Figure 4> Multi hierarchies architecture of ontologies (Brodeur et al., 2003)

Such a multi hierarchies architecture would provide us a more flexible way to extract different abstractions and descriptions of the reality from different perspectives of the domain, applications, space, and time.

1.2.3. Ontology languages

Ontology languages allow users to write explicit, formal conceptualizations of domain models which include the following main requirements (Antoniou and Harmelen, 2003): (1) A well defined syntax is necessary to describe meaning clearly for programming language. (2) A formal semantics describes the meaning of knowledge precisely. "Precisely" here means that the semantics does not refer to subjective intuitions, nor is it open to different interpretations by different people or machines. (3) Convenience of expression and sufficient expressive power describe classes and relationships more expressively. (4) Efficient reasoning support is very important for finding implicit knowledge in ontology(Antoniou and Harmelen, 2004), including:

- *Class membership:* if x is an instance of a class C, and C is a subclass of D, then we can infer that x is an instance of D.

- *Equivalence of classes*: if class A is equivalent to class B, and class B is equivalent to class C, then A is equivalent to C, too.
- *Consistency*: if x is an instance of class A, and A is a subclass of B∩C, A is a subclass of D, and B and D are disjoint. Then we have an inconsistency because A should be empty, but has the instance x. This produces an error in ontology.
- *Classification*: if we have declared that certain property value pairs are a sufficient condition for membership in a class A, then if an individual x satisfies such conditions, we can conclude that x must be an instance of A.

In order to satisfy the previous four needs, we use OWL (web ontology language), which was developed by the Web Ontology Working Group of W3C*, to be the foundation ontological language of this research. OWL is based on the effort of the DAML+OIL (DAML, DARPA Agent Markup Language** and OIL, Ontology Interchange Language***) to develop an ontological modeling language to sufficiently express classes and relationships of domain knowledge and to provide an efficient reasoning support to reason implicit knowledge in ontology.

OWL can be categorized into three species for different purposes (Knublauch et al., 2004):

- OWL-Lite is the basic species of OWL and only simple class hierarchy and simple constraints are used to express classes and relationships of domain knowledge. However, because of its simplicity, OWL Lite cannot reason classes or relationships in ontology.
- OWL-DL is the advanced species of OWL, in which DL stands for Description Logics, a formal language for representing knowledge and reasoning about it (mentioned in Section 1.2.4). Therefore, OWL DL is much more expressive than OWL Lite and is able to reason classes and relationships in ontology. OWL DL is used for this paper to express and reason the geospatial domain knowledge.
- OWL-Full is the full species of OWL which express high complex classes and relationships in ontology. However, it is not possible to perform automated reasoning in high complex classes and relationships of ontology.

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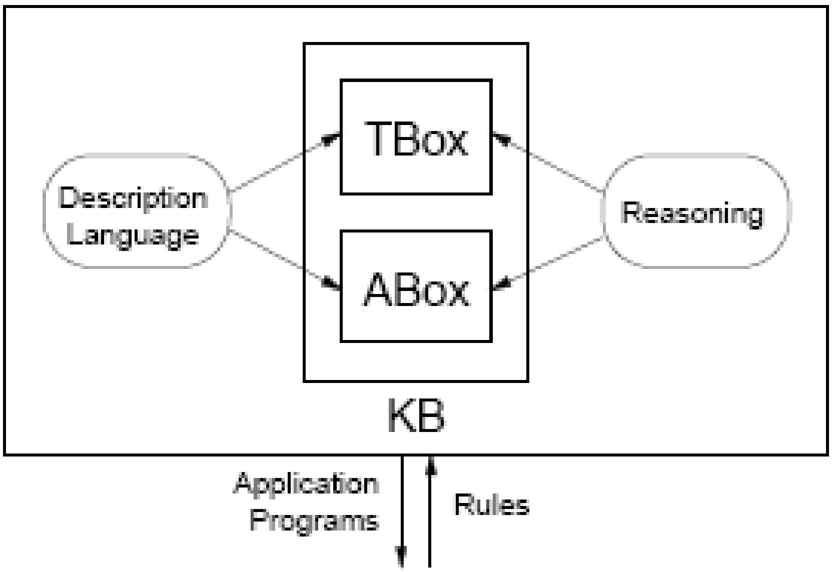
* http://www.w3.org/2001/sw/WebOnt/
** http://www.daml.org/2000/10/daml ont.html
*** http://www.ontoknowledge.org/oil/

1.2.4. Description Logics

Logic is the science of reasoning and helps people to determine truth or false. Description logics (DL) is a family of knowledge representation formalisms which uses logic based semantics for representing knowledge of an application domain by defining the relevant *concepts*, the properties of the concepts, the *relationships* between the concepts, and the *individuals* (i.e. the realized objects of concepts) of the domain (Baader and Nutt, 2003). For example, *father* and *child* are the concepts of a family domain. The relationship of these concepts is *hasChild* or *isChildOf*, while the individuals may be that *John* is a father and *Jonny* is his child. *John* and *Jonny* are both individuals of the concepts(*father and child*) which are the realized objects of the concepts. By knowledge representation formalism in logic based semantics, DL can not only be used to express domain knowledge logically but also reason or infer implicit knowledge based on the knowledge which is logically formalized.

Figure 5 shows the architecture of a knowledge representation based on description logics. A knowledge base(KB) has two components: (1) TBox contains the terminology which declares the vocabulary of a domain knowledge, including *concepts* and binary *relationships* between concepts, while (2) ABox contains assertions about the individuals in terms of the concepts in a domain (Baader and Nutt, 2003; Lutz, 2006).



<Figure 5> The architecture of a knowledge representation based on description logics (Baader and Nutt, 2003).

In order to describe concepts, relationships, and individuals logically in a domain, a description language is needed. The language $\mathcal{AL}$ (attributive language) is a minimal and basic description language which has been introduced by Schmidt SchauB and Smolka (1991). The expression syntax of $\mathcal{AL}$ language is shown in Figure 6. *A* and *B* stand for concepts, whereas *R* and *Q* stand for relationships (role).

Expression	Syntax
Top	$\top$
Bottom	$\bot$
Concept name	A,B
Concept conjunction	$A \sqcap B$
Concept disjunction	$A \sqcup B$
Concept negation	$\neg A$
Role name	P,Q
Role conjunction	$P \sqcap Q$
Role negation	$\neg P$
Universal quantification	$\forall P.A$
Existential quantification	$\exists P.A$

<Figure 6> a $\mathcal{AL}$ language expression syntax (Duckham et al., 2006)

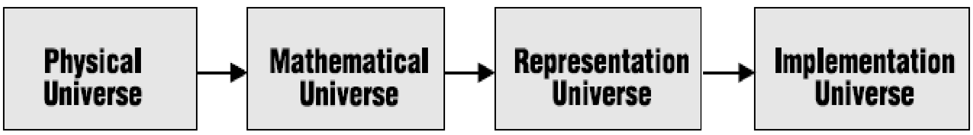
For example, we supposed *A* is the concept of **Person**, and *B* is the concept of **Male**. Then, **Person** $\cap$ **Male** and **Person** $\cap \neg$**Male** describe the concepts that those persons are male and those persons are not male, respectively. If *R* is supposed to be a relationship of **hasChild,** then **Person**$\cap \exists$**hasChild** and **Person**$\cap \forall$h**asChild.Male** denote the concepts that those persons at least has a child, and those persons' children are *all* Male. Finally, the concept of **Father** can be defined as **Father** $\equiv$ (**Person** $\cap$ **Male**) $\cap \exists$**hasChild**, where "$\equiv$" denotes a definition. By the expression syntax, concepts and relationships in a domain can be expressed in a logical description language. The language can be further reasoned, for instance by RACER (renamed ABoxes and concept expression reasoner) (Haarslev and Moller, 2001), to check consistency and to discover implicit knowledge in a domain.

1.2.5. Geospatial Ontologies

Geospatial ontology uses ontology in geospatial domain to explicitly describe the classes and relationships of geospatial concept, terms, and relationships to provide geospatial semantic interoperability. It is divided into two parts to process geospatial ontology: one focuses on using ontology to manage the GIS data and functions(discussed in Section 1.3) and the other focuses on the nature of geospatial domain to cognize the geospatial concept that people think. Because different people have different concepts about geospatial domain, it is necessary to find out the consensus of cognitive concepts about geospatial reality, the ontology of geospatial domain(Egenhofer and David M, 1995; Fonseca et al., 2002; Smith and Mark, 2003; Mark et al., 2004).

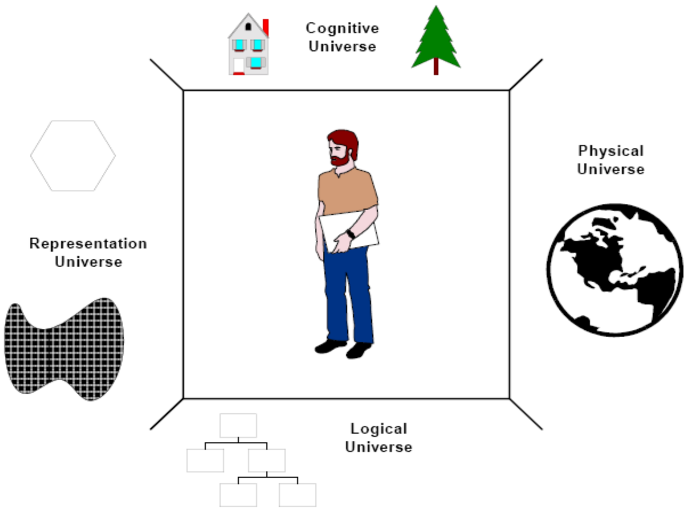
How to extract the cognition of human thoughts about geographic information and how to explicitly describe them into structure forms would be a critical point for geospatial ontologies. Gomes and Velho (1995) presented four paradigms for abstracting concepts from the realty, as shown in Figure 7:

1. Physical universe presents many elements and relationships of reality.
2. Mathematical universe uses logic to describe elements and relationships of reality in mathematical ways that can be analyzed by computers.
3. Representation of the universe represents the symbolic description of the elements in mathematical universe.
4. Implementation of the universe used to map the elements from the representation of the universe into data structures implemented in a computer language (Fonseca et al., 2002).



<Figure 7> The universe's paradigm (Gomes and Velho, 1995)

However, to model the logical universe, Fonseca et al. (2002) considered that one more universe, a cognitive universe, should be added between the physical and the mathematical universe to capture what people perceive about the physical universe by logic (Figure 8).



<Figure 8> Four paradigms from Fonseca et al. (2002)

The physical universe is the real world, the cognitive universe has concepts such as rivers, land parcels and soils, the logical level has the formal concept of geographic objects, and at the implementation of the universe are the data structures that are used to implement the concept of the previous level (Fonseca et al., 2002).

1.3. Discovery GIServices on SDI

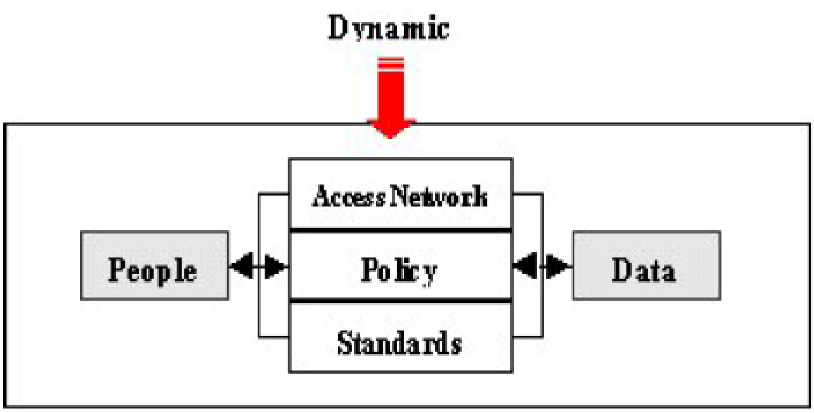
In the future, there will be more and more GIServices on the Internet. How to manage these GIServices and how to discovery these GISerivces will be very important tasks for us. In this section, we would introduce what SDI (Spatial Data Infrastructure) is, what its components are, and how to apply the concept of SDI to the era of web services in section 1.3.1. In section 1.3.2 and 1.3.3, what web services and GIServices are will be explained. How to discover suitable GISerivces on SDI by ontology is in section 1.3.4.

1.3.1 SDI

Since the first international conference on "Emerging Global Spatial Data Infrastructure" held in Bonn in 1996, the concept of spatial data infrastructure (SDI) has rapidly experienced a rising awareness in the geographic information community (Wytzisk and Sliwinski, 2004). The growing need to organize spatial data across different disciplines and organizations has also resulted in the concept of SDI.

The term SDI is often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. The SDI provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non profit sector, academia and by citizens in general (Nebert, 2004). SDI is an initiative intended to create an environment that will enable a wide variety of users to access, retrieve and disseminate spatial data and information in an easy and secure way (Rajabifard et al., 2004). However, the definition of SDI is varied by different institutes, governments, and situations. Wytzisk and Sliwinski (2004) had given a more broader and flexible definition of SDI as "a multi levelled, scalable, and adaptable collection of technical and human services, which are interconnected across system, organizational, and administrative boundaries via standardized interfaces". Those services enable users from different application domains to participate in value chains by gaining a seamless access to spatial information and geo processing resources.

The components of SDI include the following (Rajabifard and Williamson, 2001), as shown in Figure 9: (1) Data are distributed among heterogeneous sources. (2) Access Network builds a basic network to access data from different sources, for example, the Internet. (3) In order to cooperate and reuse these data on the access network, Standards have to be followed for interoperability. (4) Policy is to build, maintain, access and apply standards and datasets (e.g. broker or catalogue for storing, managing and discovering the information of datasets) for (5) People to transact, process and make decisions. Moreover, the three components(access network, policy, and standards) are very dynamic due to the rapidity with which technology develops and the need for mediation of rights, restrictions and responsibilities between people and data change.



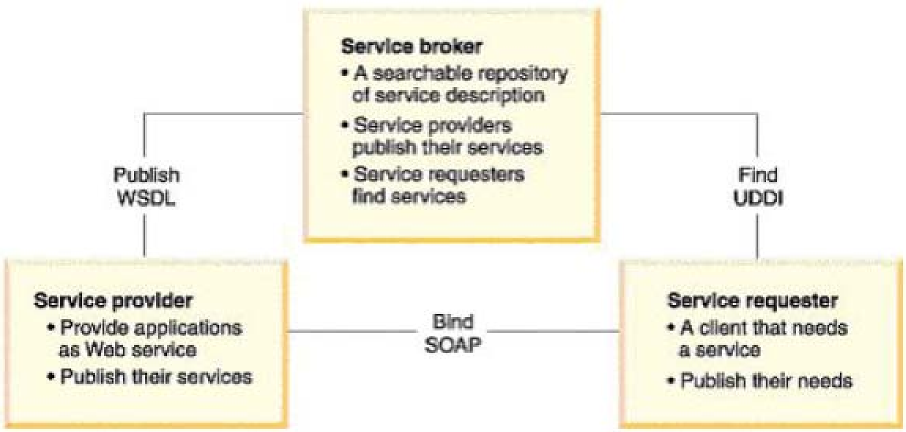
<Figure 9> The components of SDI (Rajabifard and Williamson, 2001)

In the era of web service, the components of SDI would be also applied, but a little difference. First, access to network would be the Internet. Second, data would be changed by web services or GIServices, which would be reusable to provide data accessing services or data processing services. Third, Standards would be created and maintained by international consortium, for instance, OGC or ISO(international standard organization). Standards would be set for the interoperability of web services, including WMS, WFS, and GML, which would be created by OGC. Fourth, Policy would be replaced by catalogue services (OGC, 2004) to store, manage and discover the suitable datasets. In the following sections, we would introduce what web services and GIServices are and present some semantic problem in discovering GIServices on SDI.

1.3.2. Web Services

A web service is a networked application that is able to interact using standard application to application. Web protocols over well defined interfaces is described using a standard functional description language (Curbera et al., 2001). We can combine and reuse these web services under standard circumstances to assemble a work flow for our needs instead of buying desktop applications.

Three components are adapted by OGC to identify web service architecture (OGC, 2003a) to build GIService architecture, as shown in Figure 10. (1) Service Provider offers data or process as services and publishes or advertises these services to the service broker. (2) Service broker is a searchable repository of service description for service provider publishing their services and for service requesters to find services. (3) Service requester is a client that needs a service.



<Figure 10>: Web Service Architecture (Zhang and Hutchison, 2002)

When a service requester needs a service to solve the question, he (she) needs to find the service in service broker which would be based on needs by requester to find the suitable service provider. If a service provider is found, the connection would be bonded between the service provider and the service requester without a service broker.

1.3.3. GIServices

The development of GIS has been greatly influenced by Information Technology (IT), which changes GIS from mainframe GISystem to Desktop GISystem to Internet GIServices. Internet GIServices are network based geographic information services that utilize both wired and wireless Internet to access geographic information, spatial analytical tools and other GIS resources (Peng and Tsou, 2003). For the desktop GISystem, users have to purchase the whole GIS package to solve simple spatial tasks. It costly and is not efficient for the users. If users only require simple spatial functions such as "buffer", why is it not possible for us to just provide the spatial functions on the Internet, where users can choose and combine them for their need? Therefore, GIServices have emerged the service oriented approach that allows users to access, assemble and rent geoprocessing components that are distributed across a network via standard Internet browser (Tao, 2001). Therefore, GIServices include the services of GIS data and geoprocessing or GIS functions for users to access the GIS data remotely and combine the geoprocessing components on the internet to do spatial tasks.

However, if GIS data and functions do not have standards on the Internet, there would be difficulty in the exchange of GIS data or information. OGC has promoted some standards of GIServices to achieve interoperability:

1. WFS (web feature service) allows a client user to retrieve and update geospatial data encoded in geography markup language (GML) from multiple web feature services (OGC, 2005a).
2. WMS (web map service) produces maps of spatially referenced data dynamically from geographic information (OGC, 2006).
3. WCS (web coverage service) extends the WMS interface to allow access to geospatial "coverages" (raster datasets) that represent values or properties of geographic locations, rather than WMS generated maps (pictures) (OGC, 2003b).
4. WPS (web processing service) provides access to calculations or models which operate on spatially referenced data. The data required by the service can be available locally,

or delivered across a network using data exchange standards such as GML (OGC, 2005b).

5. Catalog service defines a common interface that enables diverse but conformant applications to perform discovery, browse and query operations against distributed heterogeneous catalog servers

GIServices are so powerful for users to solve daily spatial tasks without buying and using traditional desktop GIS applications. But, where can users discover these useful GIServices on the Internet and know how to use them? In the following, SDI would be introduced to build an infrastructure to integrate different GISerivces from different sources.

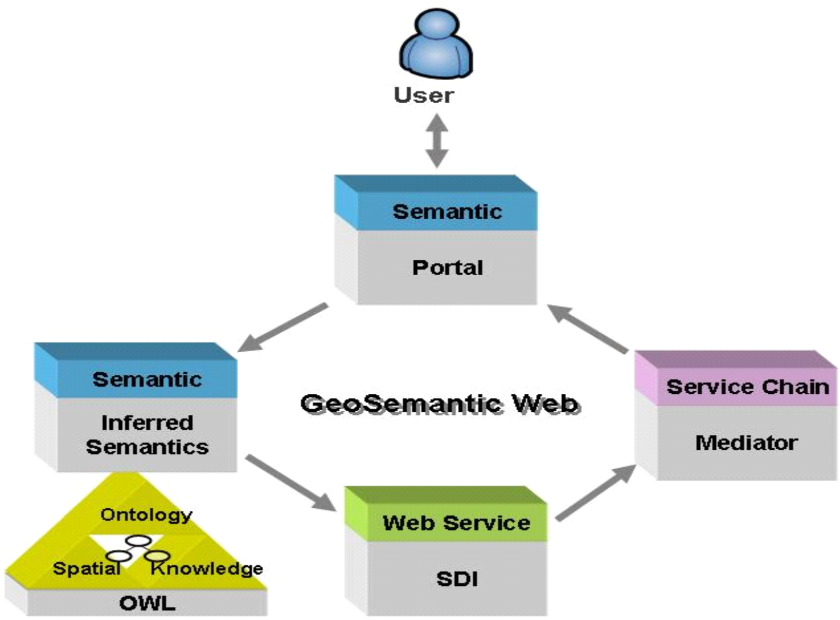
1.3.4 Discovery GIServices on SDI

Currently, service discovery relies on the labels of input and output descriptions and on the labels of data types given in WSDL (web service description language) or similar service metadata (Probst and Lutz, 2004). In SDI, the available datasets and GISerivces are typically published and registered in catalogue services(OGC, 2004), which provide the basic syntactic interoperability based on GML or other specifications of OGC. Users can use keyword based searches or spatial filters to discover GIService in SDI. However, as well as web search engine, it would produce lots of datasets with low recall if different terminology is used or low precision if terms are homonymous or because of limited possibilities to express complex queries(Bernstein and Klein, 2002; Lutz, 2006). Therefore, ontology based searches are needed, such as semantic reference systems(Kuhn, 2003), for semantic interoperability in SDI.

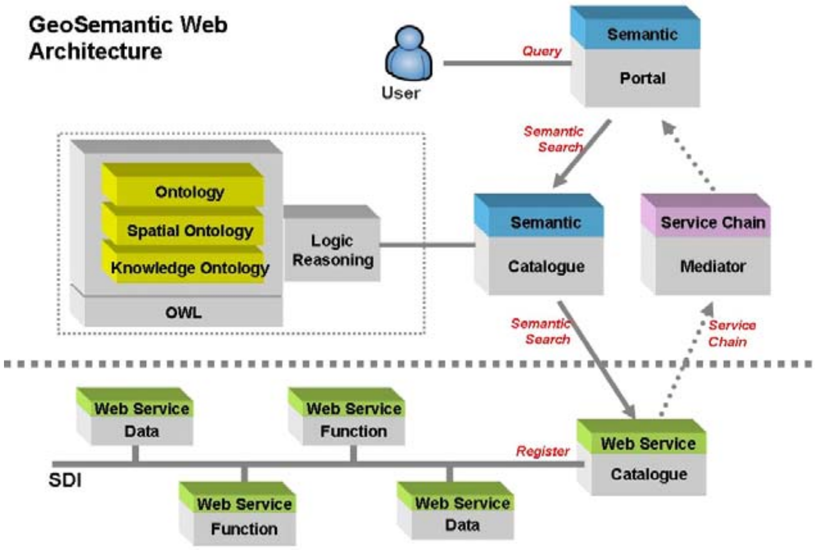
In previous literatures, there are two main parts of ontology applied in SDI: (1) Discovering GIServices based on ontology search helps users find geospatial datasets in SDI more precisely(Bernald et al., 2003; Bernard et al., 2003a; Probst and Lutz, 2004; Klien et al., 2006; Lemmens, 2006; Lutz, 2006); (2) Using ontology for semantic interoperability composes GIServices in SDI to be a GIServices chain (Bernard et al., 2003b; Einspanier et al., 2003; Probst and Lutz, 2004; Lutz, 2006). These literatures, especially Lutz (2006), provide perfect concept and architecture of ontology based search and compose GIServices in SDI. However, these literatures are just scenarios and are seldomly applied to a real domain and built to test whether or not the architecture or concept is suitable. This is what we want to improve: domain knowledge would be built by ontology and we will follow the architecture of Lutz (2006) to test it in a real GIServices in SDI.

2. The Concept Framework Of Geosemantic Web Service

The concept framework of geosemantic web services is divided into four parts, as shown in Figure 11. and Figure 12. (1) **Portal** interacts with users to choose locations and concepts in a domain that the users want to know from the geosemantic web service. The detail is described in Section 2.1. (2) The location and concepts are inferred to discover the implicit semantics by **inferred semantics**, which is based on spatial and knowledge ontologies, and description logics reasoning (Figure 12). This is presented in Section 2.2. (3) The relevant concepts and relations, which are reasoned by inferred semantics, are discovered in **SDI** to search suitable GIS data and function services (Figure 12), are as described in Section 2.3. (4) The discovered GIS services are assembled in a **GIS service chain**, which is based on spatial and knowledge ontologies, are executed to generate results for users.



<Figure 11> General framework of geosemantic web

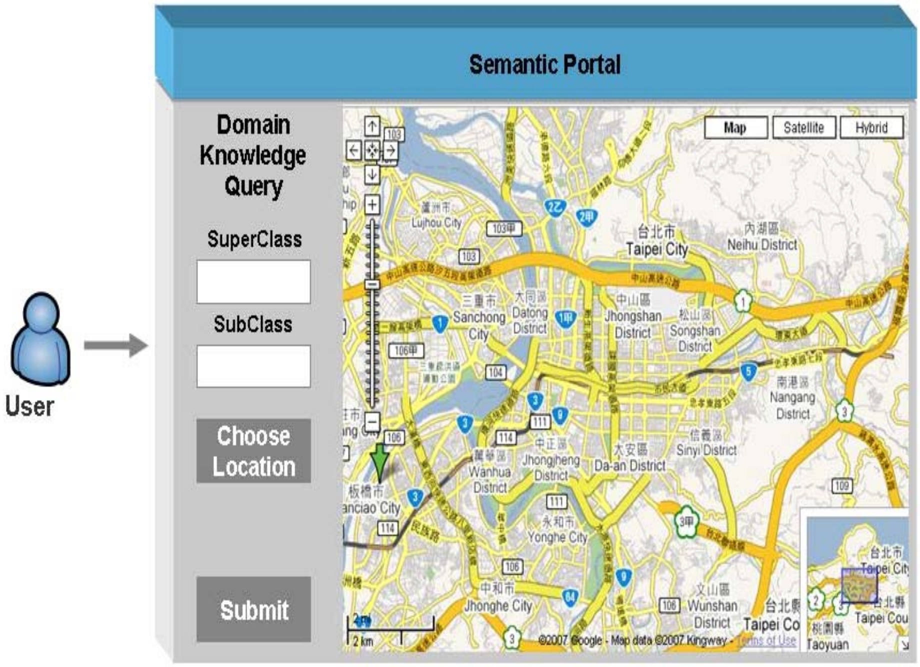


<Figure 12> The architecture of GeoSemantic web

2.1. Users' Portal

The portal is an interface between the users and the geosemantic web services. The portal provides a map and some criteria of domain knowledge, which are based on spatial and knowledge ontologies (Figure 13). Users can choose a location and set some criteria of a domain to discover domain knowledge about the location. For example, if a user wants to understand what disasters have happened near a particular location, the user can choose that location on the map and select the disaster domain to discover what kind of disasters in spatial objects (e.g. roads, rivers, and railroads) near the location have happened and useful solutions the user can learn to avoid the disaster.

After choosing locations and criteria of a domain, the geosemantic web services would infer the users' semantics and discover implicit knowledge based on spatial and knowledge ontologies in the following part of semantic catalogue and ontologies.



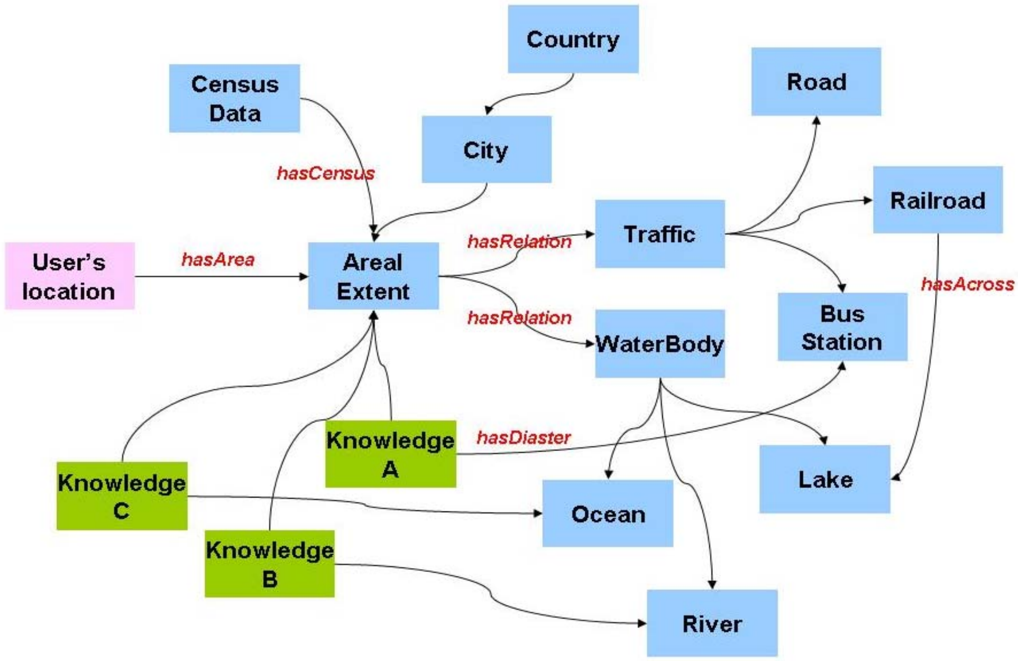
<Figure 13> Users' Portal

2.2. Semantic Catalogue and Ontologies

The domain and location that users choose would infer relevant semantics based on spatial and knowledge ontologies, as shown in Figure 14. The ontologies are divided into two parts and are encoded in the OWL DL language: (1) spatial ontology is an explicit specification of spatial conceptualization which describes spatial concepts, relationships, and individuals in an area. Therefore, a spatial term can be inferred to different spatial concepts based on spatial ontology. For example, the location from users is inferred to an areal extent that is contained by a city or a country. Additionally, the areal extent has a relation with census data and with other spatial concepts (e.g. traffic and waterbody). These spatial concepts can be further divided into different spatial concepts (e.g. traffic can be divided into road, railroad, and bus station), which is used to discover web GIS services in SDI.(2) Knowledge ontology is an explicit specification of domain knowledge conceptualization, for instance, a disaster domain. Concepts in domain knowledge can be related to spatial concepts in spatial ontology. When domain knowledge concepts are inferred, the spatial concepts in spatial ontology would also are inferred. Using Figure 14 as an example, the knowledge A has relations, hasDisaster, with the concept of bus station in spatial ontology.

It may mean that the concept of bus station has some disaster classes in knowledge A.

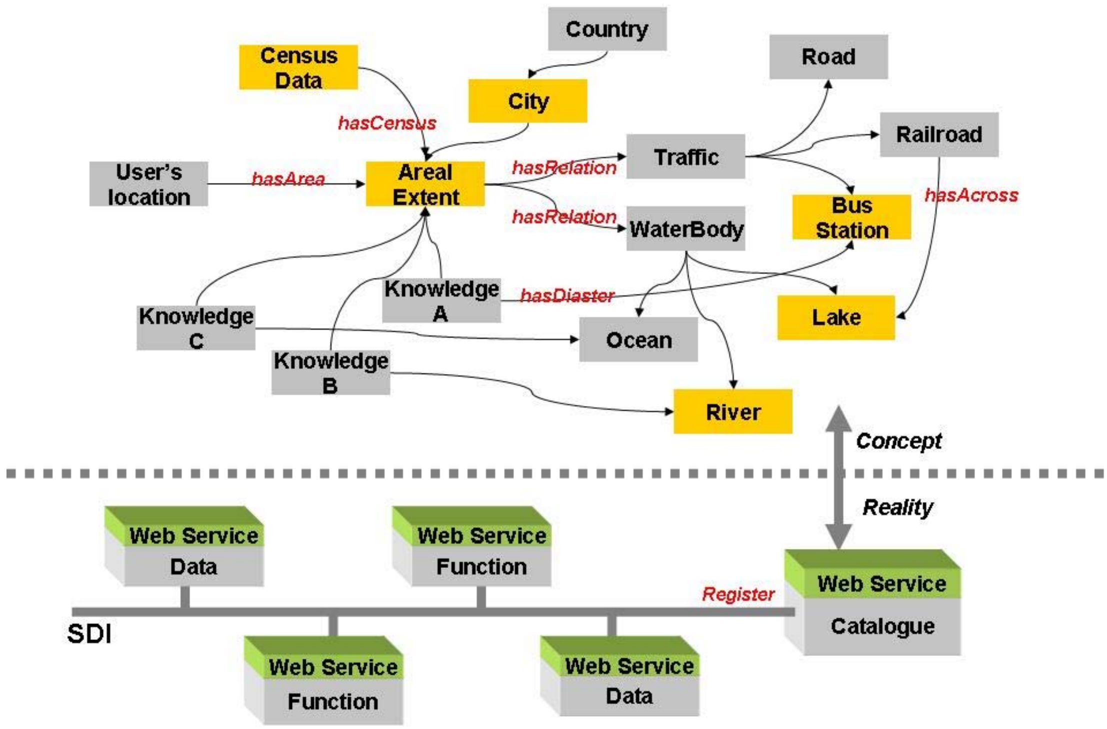
By relations in different ontologies, concepts can be connected together to avoid losses of knowledge and to improve the drawbacks in keyword search.



<Figure 14> Spatial and knowledge ontologies

2.3. Combination with ontologies and SDI

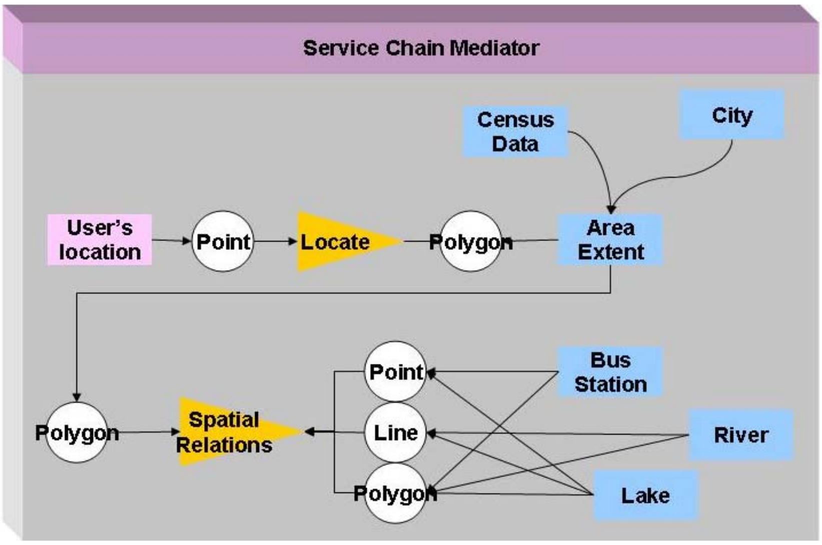
In order to connect with the concepts in ontologies and web GIS services in reality, relevant web GIS services should be discovered in SDI based on the concepts which are inferred in spatial and domain knowledge ontologies. For example, in Figure 15, the inferred concepts (Census data, areal extent, city, bus station, lake, and river) and relations (hasCensus, hasRelation, hasDisaster) are used to discover suitable web GIS data and function services in the catalogue of SDI.



<Figure 15> Combination with ontologies and SDI

2.4. Service chain mediator

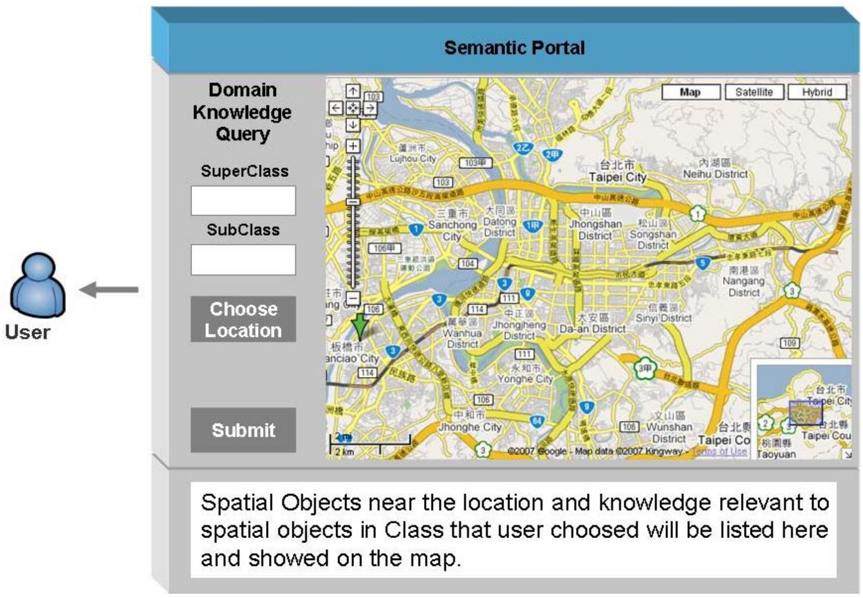
After discovering the needs of web GIS services, it is important to (semi) automatically assemble these web services to become a service chain to generate the result. We followed the method of Peachavanish and Karimi (2007) shown in Figure 16, where squares mean concepts, triangles mean functions, and circles mean roles. Roles are the data type of input and output in a function. For example, the location chosen by the user plays a role of a point and is the input to the locate function, while the output is a polygon represented by the concept of areal extent. Moreover, the concepts of bus stations, rivers, and lakes can play different roles (points, lines, and polygons, respectively) to be the output of the spatial relations function. It is because different institutes produce different spatial data based on different purposes and scales. Therefore, using roles can prevent problems of inconsistency and form a service chain to generate results.



<Figure 16> Service chain mediator

2.5. Output

The result includes relevant spatial concepts and domain knowledge generated by the service chain, shown directly on the map and listed in an information window to tell the users the knowledge that they are interested in Figure 17.



<Figure 17> Output

Conclusions and Future Works

1. The paper presented a practical framework to integrate spatial and domain knowledge from human mind (ontologies) with web GIS services in reality. The framework contained four parts (the portal, ontologies, SDI, and service chain) to provide a knowledge based search (semantic search) and to entail web GIS services in a service chain for (semi) automatically generating results.

2. The portal provided an interface between the users and the geosemantic web service to understand what spatial and domain knowledge the users needed, and to provide the result of relevant spatial and domain knowledge for the users.

3. Spatial and domain ontologies (including concepts, relations, and individuals) used OWL DL language to explicitly encode the knowledge with the syntax of description logics. The implicit knowledge can be reasoned or inferred in the ontologies to extend searching criteria and knowledge that were used in SDI to discover suitable web GIS services.

4. The GIS services that satisfied the users' needs were assembled in a service chain based on spatial and domain ontologies to (semi) automatically generate the result.

5. In the future, spatial objects and relationships in Taipei city will be implemented in the spatial ontology and Geo domain ontology. Furthermore, the ontologies will be applied into the framework of GeoSemantic web to evaluate their efficiency and accuracy.

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Analysis of MetroScope's Practical Implementation of the Planning Support System

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1. What is Metro?

In the United Sates an urban population of 50,000 or more people must have a metropolitan transportation planning process as a precondition for the federal funding of transportation projects. A Metropolitan Planning Organization (MPO) is designated by agreement between the governor and units of general-purpose local government representing at least 75 percent of the affected population. An MPO is a transportation policy making body composed of local representatives, elected officials, representatives of public transportation agencies, and appropriate state officials.

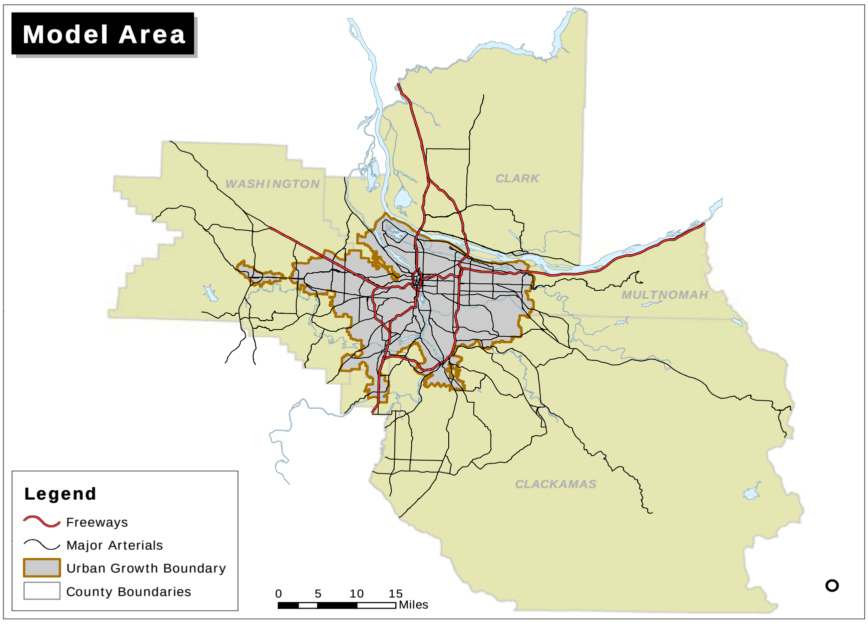
The Portland Metro is the directly elected regional government and designated Metropolitan Planning Organization (MPO) for Portland, Oregon. There are 1.6 million residents in the metropolitan area and it covers about 3,000,000 acres. A seven member Metro council representing districts within Metro's jurisdiction boundaries comprises three counties and 24 cities. The model system at Metro supports a variety of transportation and land use planning activities and responsibilities. The most recent regional econometric model projects a 1.5% annual growth rate and 1.85% total employment growth. The Portland Metropolitan region has been seen as a pioneer in planning and protecting the environment in the United States. Table 1 shows the snap shot of modeling area and Figure 1 shows the modeling area at Metro.

<Table 1> Regional figures for year 2005 (Includes Clark County)

Total Households	767,020
Total Persons	1,899,407
Average Household Size	2.48
Total Employment	1,032,246
Total Retail Employment	179,288
Total Non-Retail Employment	852,958
Total Workers	1,001,713
Total Cars	1,395,087
Average Cars Per Household	1.82
Total Vehicle Trips	5,146,167
Total Person Trips	8,170,426

2. Why Metro needed MetroScope?

Models are the basic tool of analysis for planners working in the fields of transportation and land use forecasting. Two key elements of planning are the evaluation of alternative transportation operating and capital investment strategies. Travel forecasting models are used to study proposed investments in the transportation system and to determine which of those investments will best serve the public's needs for future travel and economic development. The models are also used to evaluate the travel impacts of alternative land use scenarios. The model outputs are used to determine the air pollutants made by automobiles, trucks, and buses as well. Analyzing this data, we can understand how the proposed transportation projects will impact air quality. Travel forecasting models play a principal role in the planning process and land use forecasting is the key exogenous for travel forecasting models. The most important elements of transportation models are land use, demographics, and transportation service characteristics.



<Figure 1> Model area

MPO's work is under increasing scrutiny by stakeholders like local elected officials, state transportation agencies, federal agencies, the business community, the environmental community, and the public. Some MPOs have even faced legal action or the threat of such action against their transportation planning process based on the quality of their travel forecasts.

Compared to the travel demand models which have been used in transportation planning for some four decades, the land use model has been used at MPO less than two decades due to lack of the model's practicality and theoretical foundation.

MetroScope is the land use model for Metro. Metro is one of the few agencies among the 384 other national MPOs where in house staff developed land use models. Metro's interest in integrating transportation ad land use modeling initially began in 1992 and continues to be stimulated by a growing number of Federal, State, local government, special interest group, and compliance requirements. Beginning in the 1990's with Federal legislation such as the Intermodal Surface the Transportation Efficiency Act (ISTEA) & Transportation Equity Act for the 21st Century (TEA 21) along with the Environmental Protection Agency (EPA) air quality conformity requirements put an emphasis on land use and associated air quality effects of transportation investment.

About the same time, many MPOs such as California and Illinois failed court challenges of account of the land use impacts of planned transportation improvement by private and environmental groups. This litigation further stressed the need to explicitly represent the relationship between land use and transportation within the frame work of a consistent, formal simulation model.

In 1991 Metro's project, The Land Use Transportation and Air Quality Connection (LUTRAQ) became the first transportation model linked to land use variables such as pedestrian environmental factors which describe the connection between mode choice and land use patterns. LUTRAQ's story has been referred to in metropolitan planning efforts across the country. Metro is the first agency that developed the transportation model integrated with land use and urban design variables interactively. Metro's advanced transportation model included non vehicle mode such as biking and walking. In order to accurately estimate the number of trips particularly using the non vehicle mode, higher accuracy, more details, and other GIS information are required.

The State Transpiration Planning Rule requested a 20% reduction in per capita VMT (Vehicle Miles per Travel) over a 20 year period. This VMT reduction rule was certainly challenging for the planning agency. The State of Oregon and the local government demanded information that must be supported by integrated transportation land use models. Without consistent and analytical tools, it was impossible to evaluate how policy might be implemented.

Oregon State has the unique feature of the Urban Growth Boundary (UGB). The UGB is required to be in the Metro Region. Throughout the 1980's the UGB amounted to a set of new oversized areas relative to the growth needs of the region. The Metro Region began to grow into the boundary in the early 1990's. By the mid to late 1990's Metro began to grow out of the UGB. The integrated transportation land use models were the solution to be able to answer the inter relationship between housing price/rent, urban densities, redevelopment, infill rates, travel time, the share of the economic region's growth, and other complicated questions relate to the UGB. Properly formulated transportation land use models are the only unbiased and logical tool for any combination of UGB expansion, zoning capacity, and transportation infrastructure investment policy that might be proposed.

A final component of need for the land use models came from the development and adoption of Metro's "2040 Plan". The Metro 2040 Growth Concept defines the form of regional growth and development for the Portland metropolitan region. The Growth Concept was adopted in the Region 2040 planning and public involvement process in December 1995. This concept is intended to provide long term management of the region.

The plan embodies much of the State transportation and the UGB requirement discussed above. In addition the 2040 Plan seeks to attain a more compact urban form, build communities rather than subdivisions, increase mixed use development and increase transportation mode choices. While much of the initial 2040 planning was driven by urban design considerations, subsequent questions have arisen as to how the market will respond to the envisioned land uses, and what regulatory tools and/or financial incentives are necessary to achieve them.

Beyond the policy and legally driven needs for land use modeling, at the technical level, travel demand modelers were becoming increasingly aware that transportation models benefit of consistent land use feed back with travel time interaction. Independent population and employment forecast confronted the most sophisticated travel demand models. It was obvious that Metro's land use model got more pressure and attention from various users due to Metro's travel forecasting model's reputation as state of the art. These integrated transportation land use models are in some way unique to Oregon and Metro; an increasing number of them impact many other regions of the country.

3. History of MetroScope Development & Staff Resource

Metro's interest in developing integrated transportation land use models was driven by demands at the Federal, State, and local level to better reflect how land use policies and transportation investments impact each other.

In the late 1980's, Metro tested Putman's DRAM EMPAL models. This was considered to be the first fully operational transportation land use modeling software package in the United States. It was called Integrated Transportation and Land Use Package (ITLUP). There were several scenarios tested by travel demand modeler and the results of the models were raised serious questions about consistency, reliability, and predictability. Therefore Metro dropped the idea of using DRAM EMPAL for their land use modeling purpose early on.

Compared to the long history of travel forecasting model to the history of short land use modeling, there is similar evidence that can be observed from staff resources. While one full time modeler is working on travel forecasting model development and nine full time modelers are working on travel related planning projects, a quarter of full time modeler is allocated for land use planning. Metro developed the MetroScope incrementally over time with a relatively small allocation of staff and material resources. Metro didn't rely on expensive consulting assistance that was often unusable. That is true for the travel forecast models. Metro's travel forecasting models are developed in house with staff. Metro also tried to avoid expensive, one time only data collection efforts for model parameter estimation and calibration. Instead, we reviewed the data that has been collected on a continuing, periodic basis. Models are developed based on this existing accessible data. Metro also used national data such as the Survey of Consumer Expenditures because it was necessary to estimate key demand and supply relationships.

Currently, Metro's Data Resource Center (DRC) has fifteen planners excluding two managers.

There are two economists, four GIS planners for data maintenance and updating GIS information, one land use planner, four programmers, and four map store planners. Among four programmers, one programmer is working on the MetroScope model. It is difficult estimate to how many planners solely working on MetroScope modeling. If I have to guess, it would be two full time employees (FTE).

The estimated resources for the MetroScope model are listed in the following table in details:

<Table 3> Current MetroScope Resource Requirements*

GIS Staff Support	.5 FTE
Economist	.25 FTE
Transportation Modeler	.25 FTE
Residential Real Estate Model	.5 FTE
Non-Residential Real Estate Model	.5 FTE

Approximately over head cost is 100%. If this FTE convert to dollars, it would cost around $300, 000 to $400,000 per year to operate MetroScope for various projects after all of the models are built in.

Since Metro developed MetroScope incrementally overtime, the approximate estimation of the cost can be difficult to identify. Also DRC' service is working not only for MetroScope, but also for other department's request at Metro, other public, private agencies, and the public in general. The data usage of MetroScope could only be 10% of over all usage of DRC data resource.

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* Source: from interview with MetroScope modelers

San Diego MPO(SANDAG) reported the estimate of their resource requirements for the model development and production of forecasts. This information was shared at the Transportation Planning Capacity Building Program peer exchanges session in 2003.

The following table shows the resource requirements behind the model development and production of forecasts estimation for SANDAG.

<Table 3> SANDAG Resource Requirements*

IT costs(one-time)	$50,000
Data Acquisition	$15,000
Consultant	$60,000
Staff(2.5 FTE)	$380,000

The following list is the chronological mile stone for MetroScope:

Originally it started as one zone residential model used for housing needs analysis in 1992.

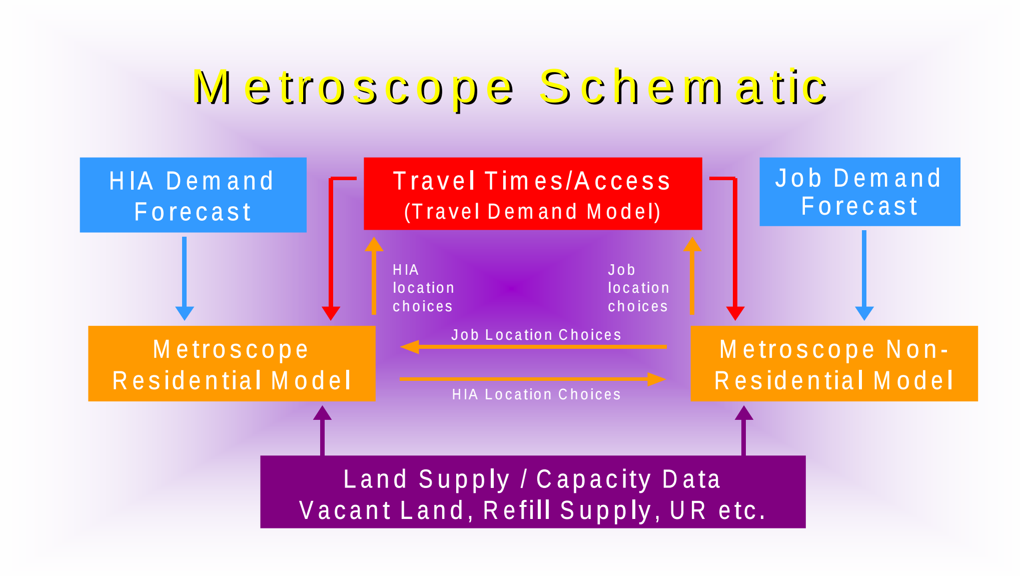
- 1996/1997: Developed entirely "in house" by Metro technical staff
- 1998: Multi zones added
- 1999: Non residential model added
- 2001: MetroScope Nation Peer Review Panel Meeting
- 2001 2002: partial conversion from entirely spreadsheet to Visual Basic
- 2004: Complete Visual Basic
- 2005: Addition of internal travel demand assignment model (PTV)
- 2006: Conversion to open source R code (PTV)
- 2006: Database and programming integration as one model (PTV)

4. MetroScope Model Structure

MetroScope is an urban growth simulation model designed to test the residential

* (Source: Peer Exchanges Report)

employment, and land use impacts of various policy scenarios, given certain assumption. It generates the population and employment inputs to the regional travel demand model. MetroScope is a set of decision support tool to model changes in measures of economic, demographic, land use, and transportation activity.



<Figure 2> Metroscope General Schematic

MetroScope includes four models inside this frame work and a set of geographic information system(GIS) tools that keep track of the location of development activities and produce usual representations from the models output. The four models that interact with each other within the MetroScope framework are: The economic the model, travel model, two real estate location models, one residential location, one non residential location, and the GIS database and tools. Above Figure 2 shows the flow of information between the models. The purpose of bringing the four models together into a single, integrated frame work is to allow them to interact with each other, production get more accurate prediction of future conditions and allowing them to better reflect the full range of effects of policy decisions.

MetroScope incorporates a theoretical structure to determine the general character and number of equations and what arguments are determined within the model and outside the mode. MetroScope is not nearly as rigorous as purely theoretical models. Equations have been statistically measured weights. Therefore estimated equations need to be tested against a range of variable arguments and compared to literature and common senses.

It is important to do sensitivity testing with common sense. That is the most important step in modeling. A full system of estimated equations and logical accounting variables need to be "conditioned/matched" to the initial measurements (year) of the region. This process is identified as calibration and validation for the future scenario. Also a model needs to be repeatedly run in forecast mode with a wide range of input assumptions from the destructive testing to finding the variances.

MetroScope has the ability to test multiple scenarios. MetroScope allows the testing of a wide range of policy scenarios. Here, some examples of its capabilities:

- Land availability and capacity includes changing in zoning capacity, changing in the urban growth boundary, implementation or removal of urban renewal areas, and subsidies/penalties for development in specific areas.
- Cost of development
- Changes in the regional econometric model, such as changes in personal income, changes in demographics, and employment by industrial sector.
- Changes in transportation infrastructure, transit availability, and transportation pricing options, and Traffic Demand Management options.

5. Usage of MetroScope

MetroScope is an excellent land use model and is state of the art in integrated urban land use transportation modeling. The model is highly suited for informing the region's policy discussions. The results of MetroScope have been incorporated in regional policy decisions in various studies. Most importantly, the models being used are in the process of making important contributions to the development of regional land use and transportation policies as well as producing explicable, data rich forecasts.

All of the important projects MetroScope has been working on can be grouped into three main categories and they are:

1) Transportation Planning
   - Corridor Studies (HOV, Tolling, Bridge, Capacity Improvement, etc)

- Regional Transportation Plan (RTP)
- Transit Studies(Light Rail, Commuter Rail, Street Car, Express Bus, etc)

2) Land use Planning
- Jobs and Housing Needs Analysis
- Periodic Review
- Urban Growth Boundary(UGB) analysis

3) Policy Planning
- Testing Alternative Land use and Transportation Policies (about 100 scenarios for year 2060)

6. Recommendation from the past

It's always been difficult communicating the "modeling process" including inputs, outputs, assumptions and other details with decision makers. There is also the long process to find common ground and consensus with other jurisdiction's planners, officials, and project partners. Even planners often find in a situation where they can't communicate well enough to understand other model's behavior. Continuing communication is the key for the improvement of the models.

It is necessary to have a good vacant land accounting system, a building permit tracking system and a method of periodically locating employment within the region. All of the above data tracking systems provide useful information and provide a good bench mark for the models. GIS database and tools are essential for this purpose. The accurate data quality is the best bench mark for the model calibration.

Old implementation of MetroScope required six different software programs. Data management and scenario management was a nightmare. It was natural for a strong need of new implementation to arise. Metro contracted PTV to develop the one process software. It was completed in 2006. MetroScope running time for one scenario reduced from 2 weeks to 36 hours. This integration of all modules enabled not only a quick turn around on model run, but also simplified and made data management efficient. Even though, the integration mad everything faster, there should still be more time to check various reasonableness.

Here is the list of recommendation from the lessons learned.

- Experienced staff
- Dedicate sufficient resource
- Maintain "transparent" inputs and operation
- Balance production responsibilities with research and development
- Improve model accuracy and reasonableness
- Keep up with demand for increasing spatial and variable detail
- Turn around model results in a timely manner
- Finding a way to make integrated models faster, cheaper and less complex
- Emphasis on consistency, accuracy, reliability, and flexibility
- Secure support for a multi year development process and commitment of in house esources from the management team

7. Conclusion

Models of transportation and land use change have evolved significantly since their early applications more than few decades ago. Unfortunately, few of the land use models have yet to reach the level in which they can be fairly evaluated and examined from a theoretical and practical perspective. It has been noticed for a long time that land use forecasting is the key exogenous for travel forecasting models, but unfortunately the land use model hasn't been paid much attention until recent years. The land use models were rather done by politics and local planner's professional judgment for a long time instead of using an objective, unbiased, and logical tool.

Increasing awareness and recognition of importance connections between transportation and land use models became a strong force for improvement of the land use model. Still, the travel land use models are not widely used by many MPO planners due to lack of knowledge of the land use model, intensive data management and maintenance, modeling complexity, and shortage of staff. Also it needs organizational patience and persistence support that in many agencies often lack due to their heavy work load.

Beyond the policy and legally driven needs for land use modeling, Metro has been institutional support for developing the best practical working models for travel forecasting and land use. Improvement of GIS data management and fast computing evolution contribute immensely to land use modeling work. The complicated operating systems of MetroScope are now one software package system. Also MetroScope's coding became an open source program. Metro plans to apply the MetroScope to Mid Willamette Council in the Salem area to test transferability, applicability, practical usability for other agencies. We will learn more about the result of portability of the MetroScope case study by year 2008.

Improvement of the GIS system is vital for transportation and land use modeling, and other Metro planning works. More detailed spatial information is growing in demand as more users are working with the GIS data. MetroScope has been a great tool for shaping our region's future. Excellent work will continue to thrive at Metro. The travel forecasting model is in progress of developing the activity based travel models, traffic micro simulation, and dynamic traffic assignment. That will lead to micro level of land use model will be required soon. MetroScope is continuing to face new challenges.

Today's MetroScope will be different in tomorrow.

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Travel Forecasting Model Documentation, Metro (2007)

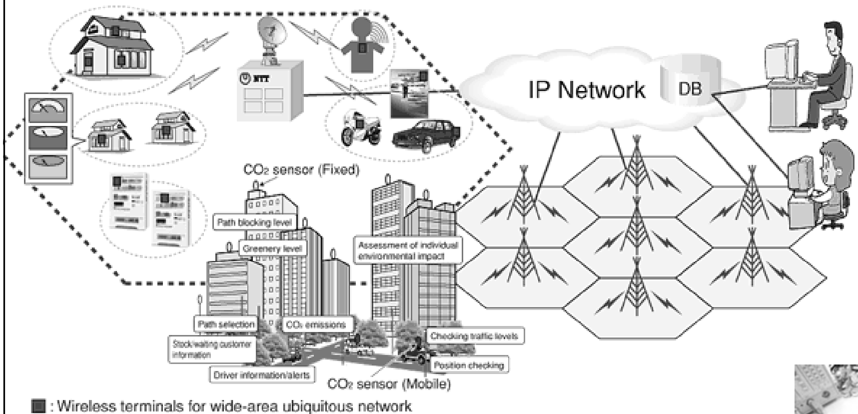
Alternative Futures for Transportation and Land use Integrated Models Contrasted with "Trend Delphi" Methods: The Portland Results by Sony Conder and Keith Lawton (2001)

Tour Based Travel Demand Model Development at Metro by Keith Lawton and Mark Bradley (2000)

Geospatially Enabled Society and NSDI Law of Japan

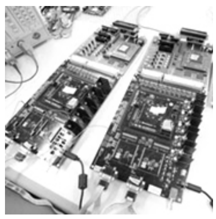
Ryosuke Shibasaki
Director, Professor,
Center for Spatial Information Science,
The Univ. of Tokyo, Japan

Ubiquitous network society



http://www.ntt.co.jp/RD/OFIS/active/2006pdfe/hot/nw/05.html

http://www.jec.ac.jp/yt/news/2005/archives/000704.html



http://recruit.fujitsu.com/jp/newgraduate/group/company/2007/0262/attention.html

http://jp.fujitsu.com/about/journal/282/topstory2/

Information "explosion"

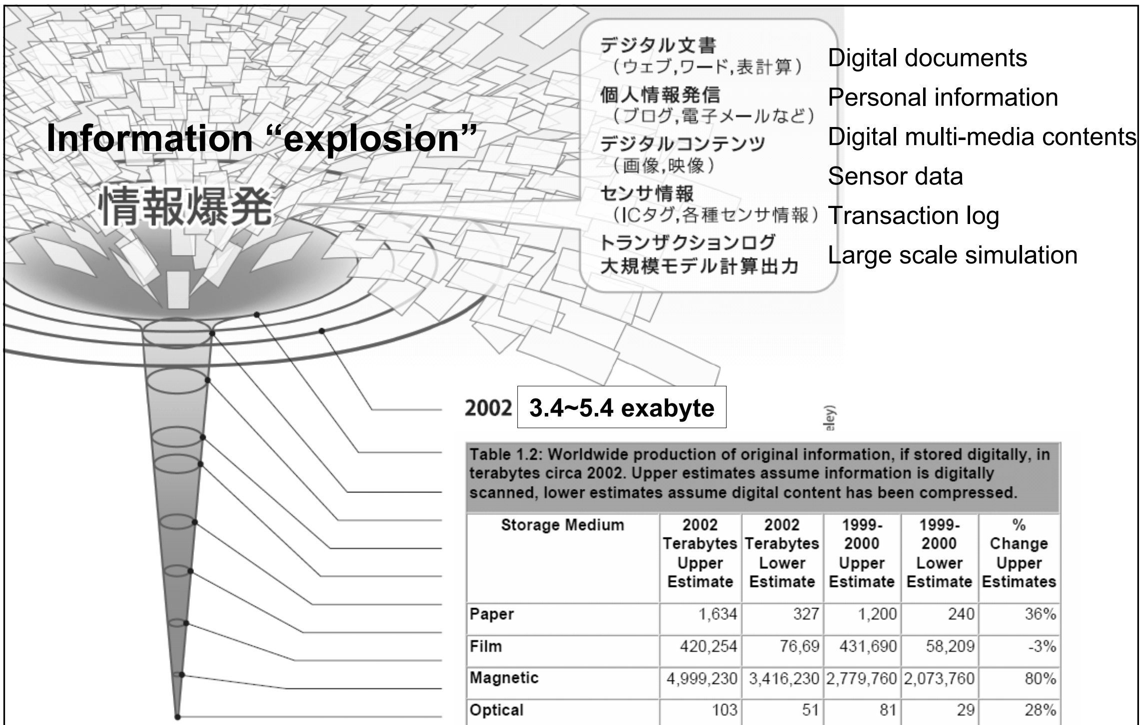


Table 1.2: Worldwide production of original information, if stored digitally, in terabytes circa 2002. Upper estimates assume information is digitally scanned, lower estimates assume digital content has been compressed.

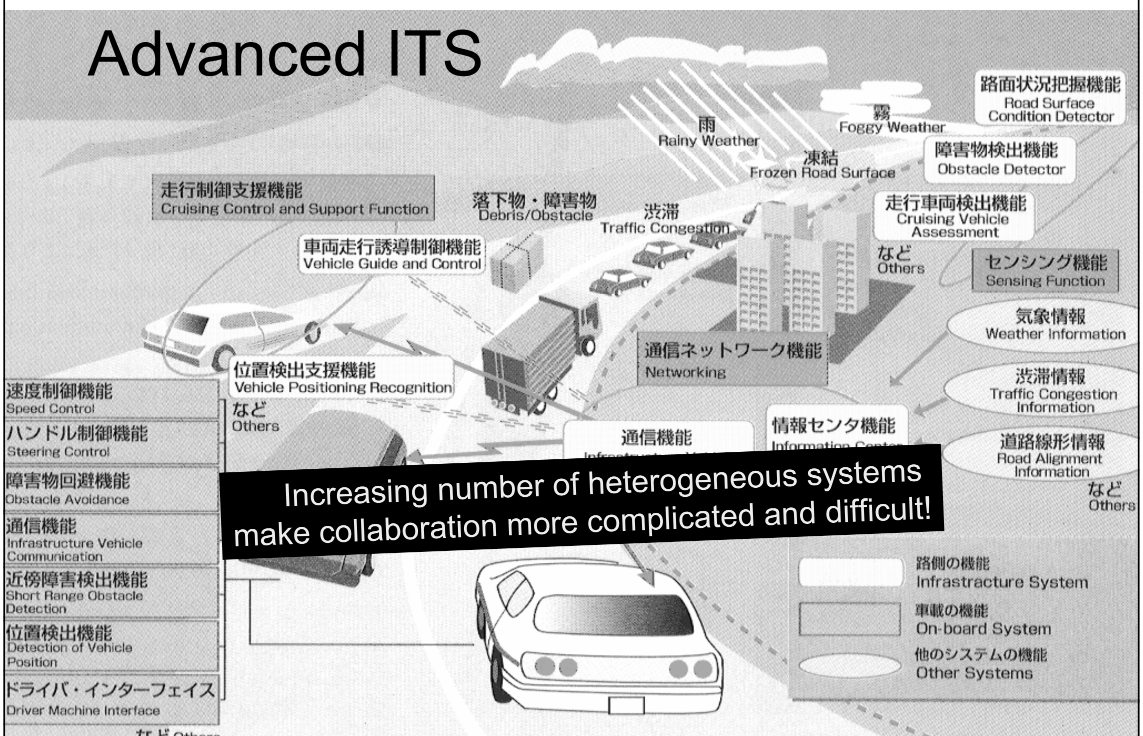
Storage Medium	2002 Terabytes Upper Estimate	2002 Terabytes Lower Estimate	1999-2000 Upper Estimate	1999-2000 Lower Estimate	% Change Upper Estimates
Paper	1,634	327	1,200	240	36%
Film	420,254	76,69	431,690	58,209	-3%
Magnetic	4,999,230	3,416,230	2,779,760	2,073,760	80%
Optical	103	51	81	29	28%
TOTAL:	5,421,221	3,416,281	3,212,731	2,132,238	69%

Source: How much information 2003

http://www.infoplosion.nii.ac.jp/i-explosion/

5.4 exabyte=5,400,000,000giga byte

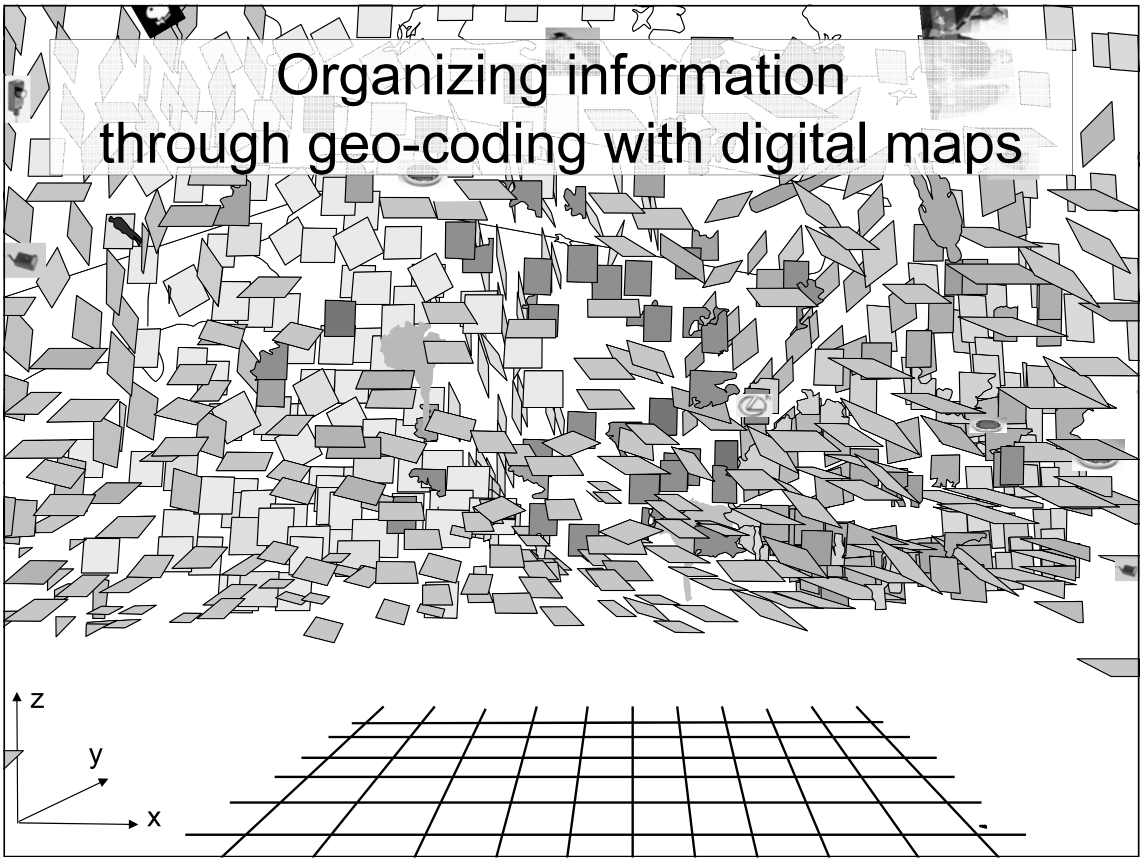
Advanced ITS

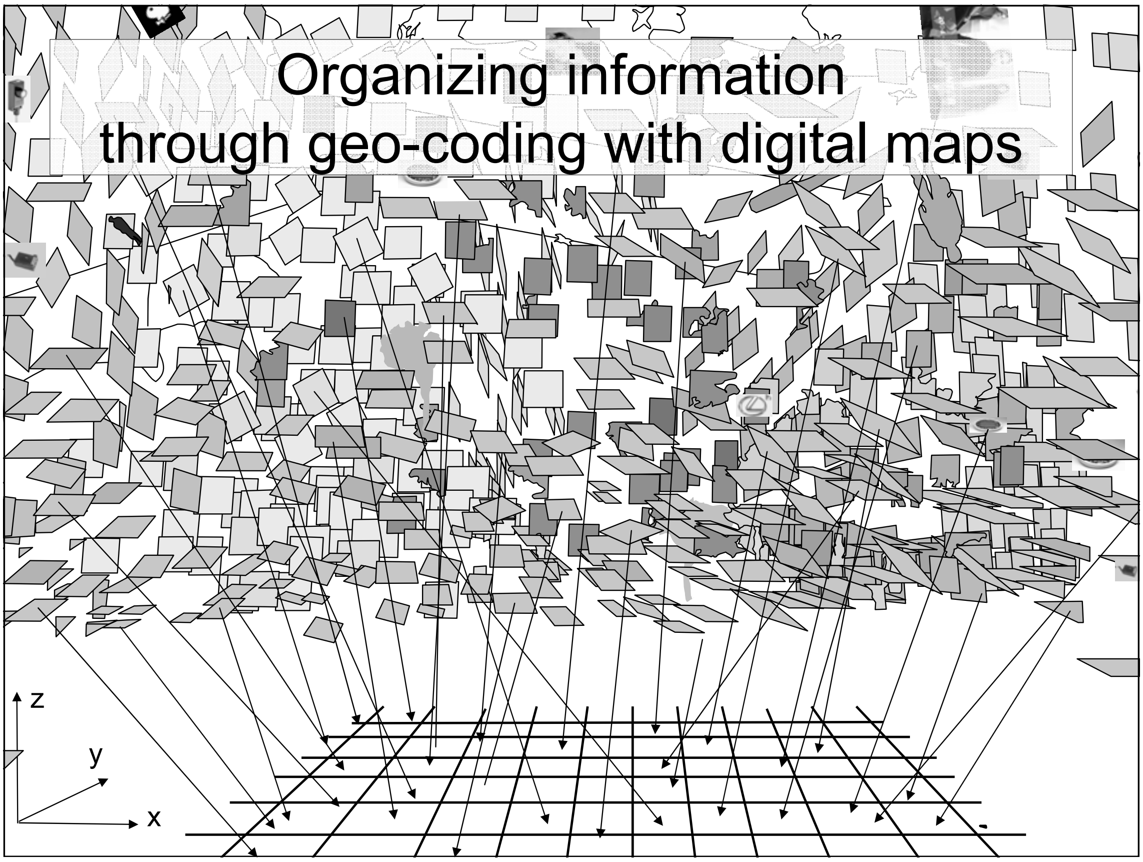


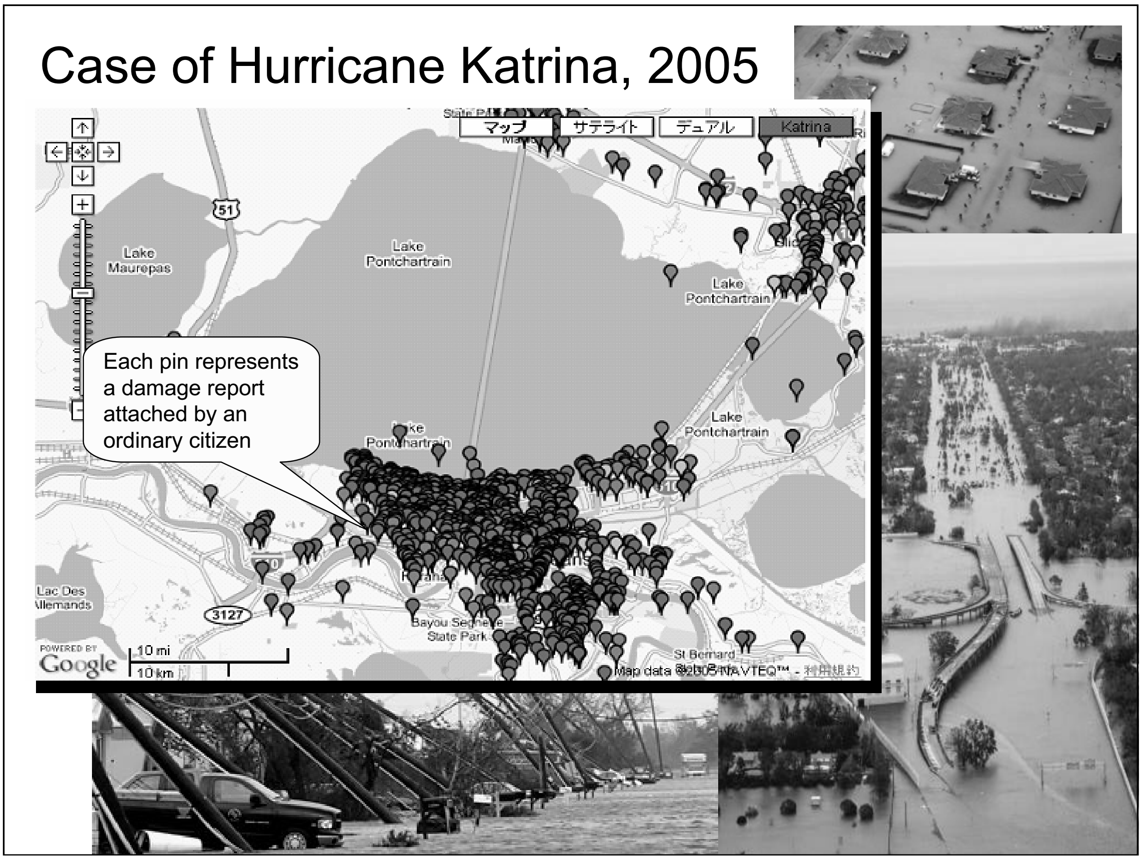
Contribution of geospatial information in Ubiquitous Network Society

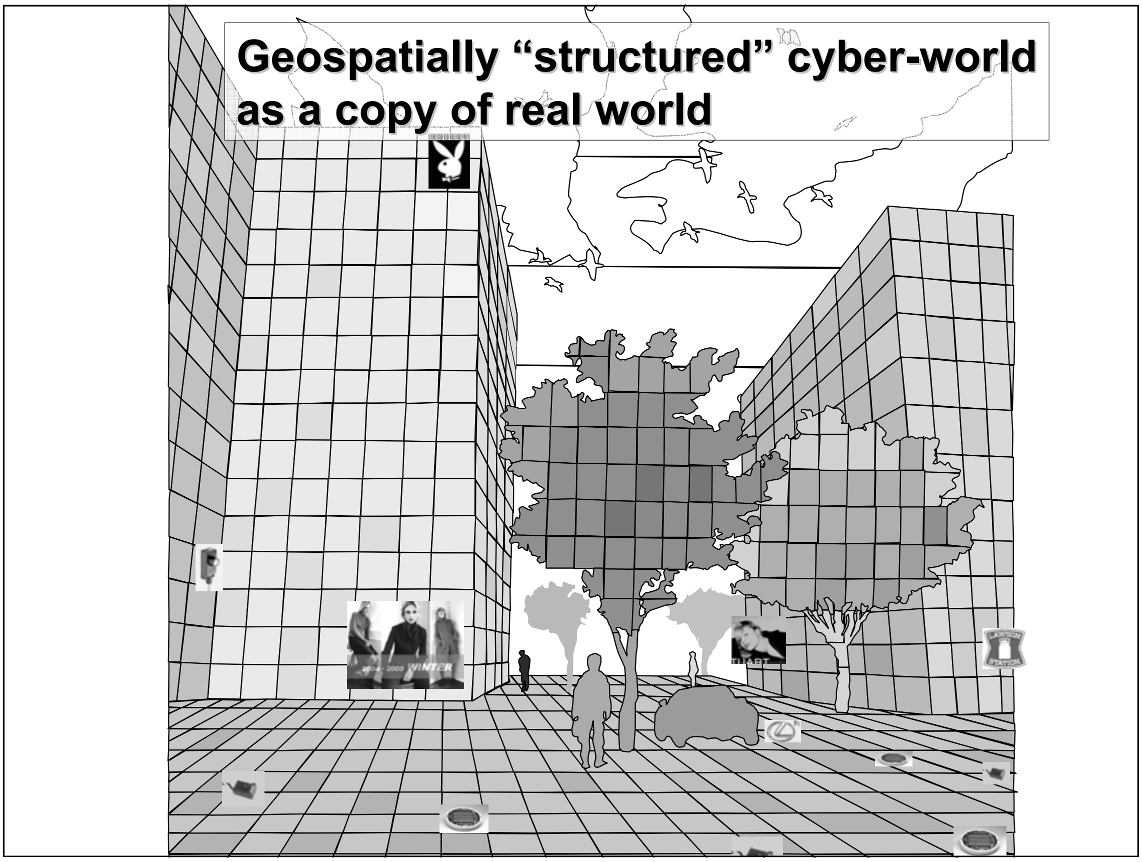
1. *Organize and share* a variety of information through geo-coding with a common map.
2. Develop "*structured" Cyberspace* directly linked with real world that can be effectively used by and shared among heterogeneous systems/services.

- GNSS (Global Navigation Satellite Systems)

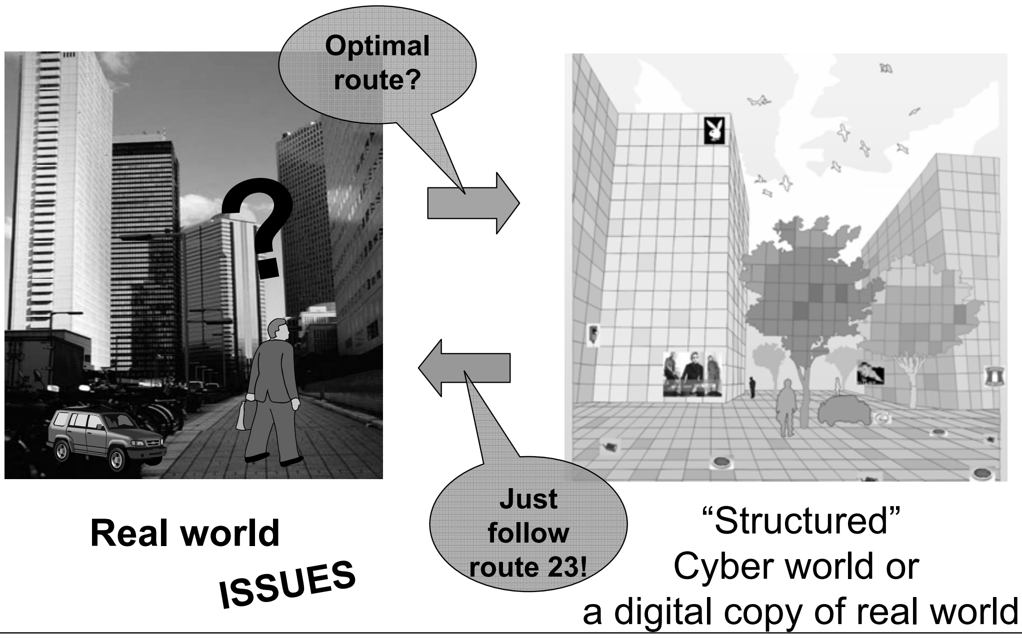



Organizing information
through geo-coding with digital maps
z
y
x


Case of Hurricane Katrina, 2005
マップ
サテライト
デュアル
Katrina
Lake Maurepas
Lake Pontchartrain
Lake Pontchartrain
Lake Pontchartrain
Each pin represents
a damage report
attached by an
ordinary citizen
Lac Des Allemands
3127
51
Bayou Segnette State Park
St Bernard
POWERED BY Google
10 mi
10 km

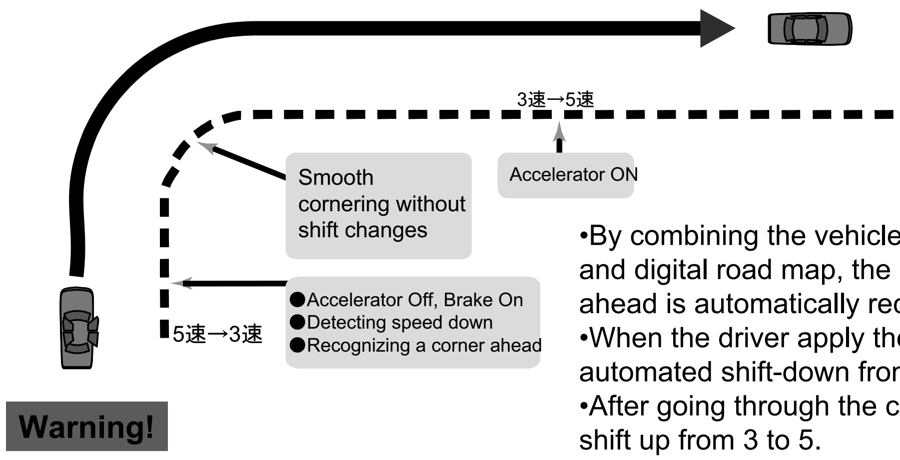


Providing services to solve real-world issues
using “structured” cyber world



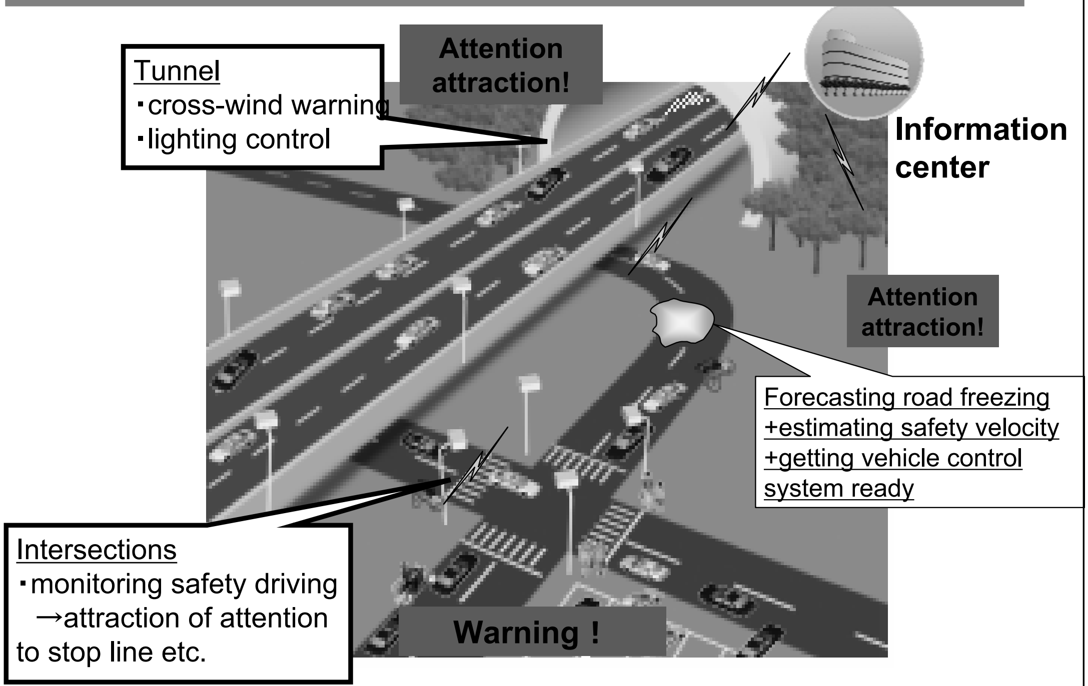
Support for safety driving using digital road maps

地図データを利用した「ナビ協調シフト」制御動作例
Automated shift-down guided by digital road map



•By combining the vehicle position and digital road map, the corner ahead is automatically recognized.
•When the driver apply the brake, automated shift-down from 5 to 3.
•After going through the corner, shift up from 3 to 5.

Safety drive assistance with a common digital map



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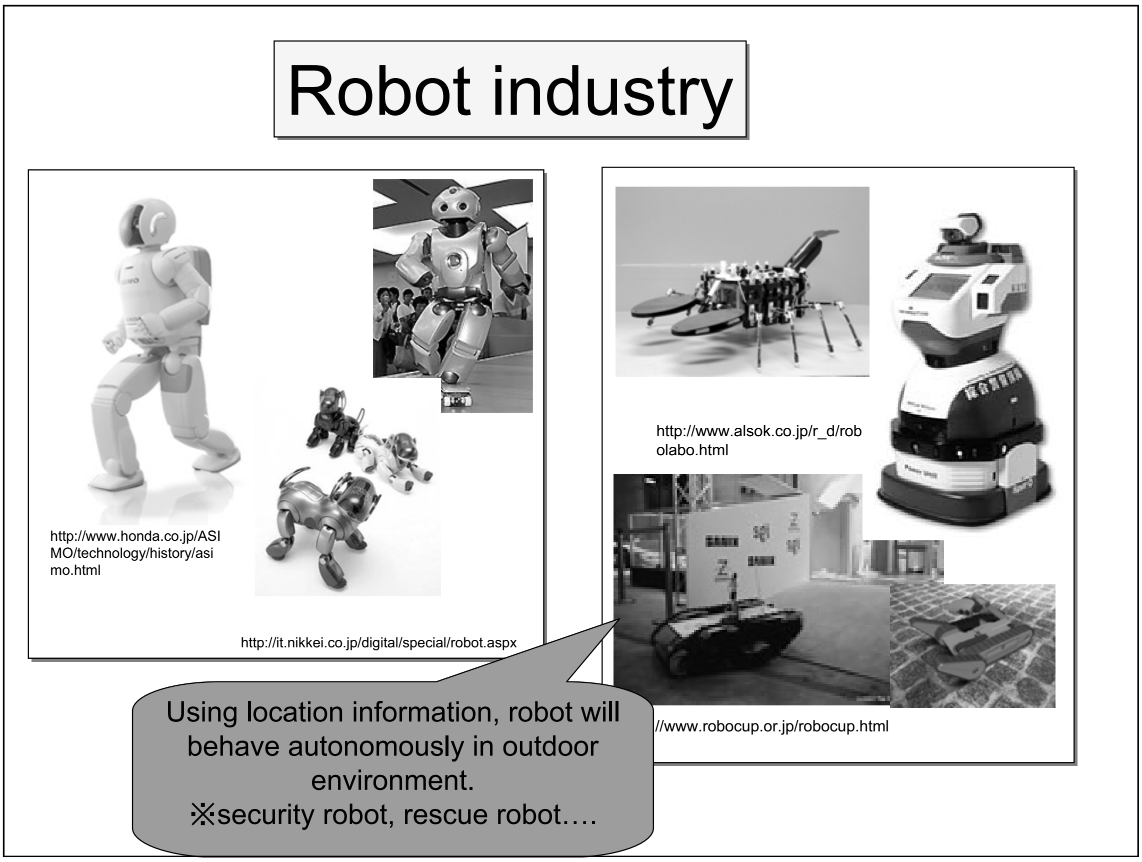
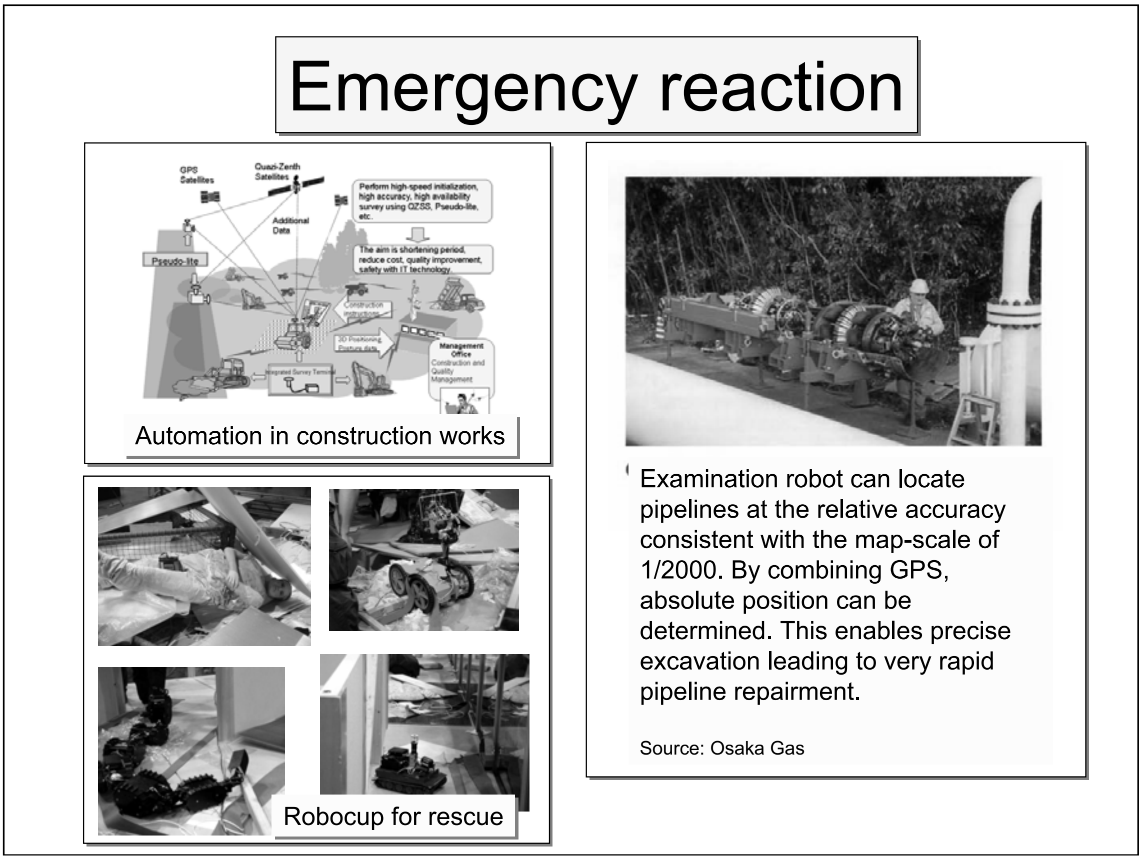
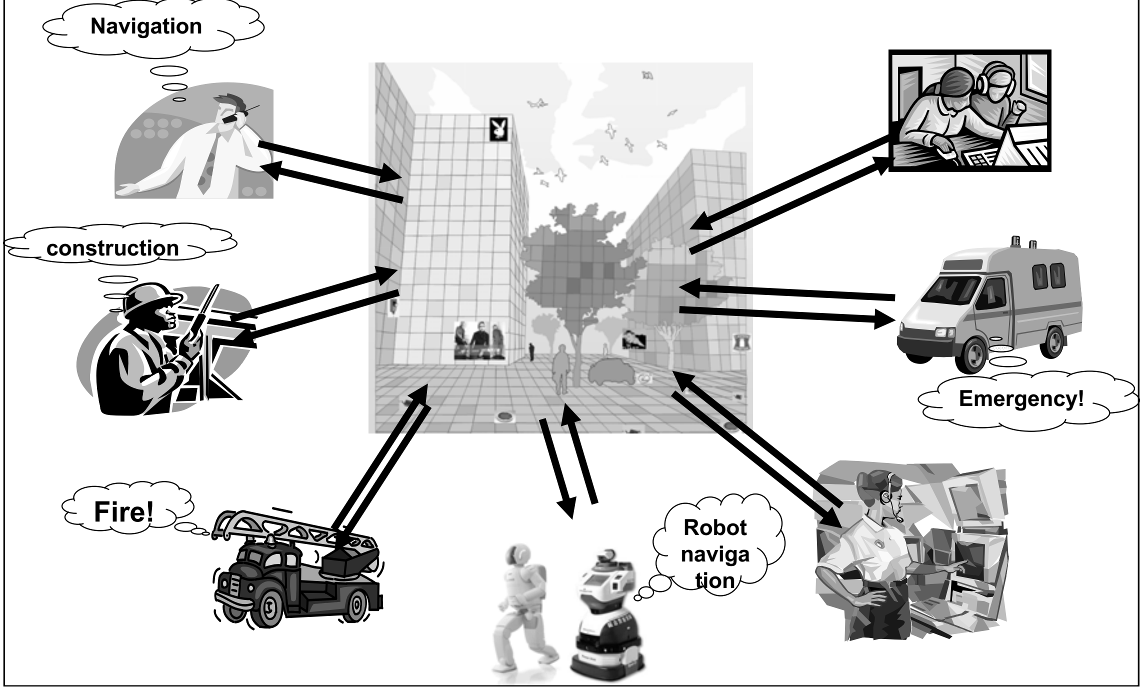
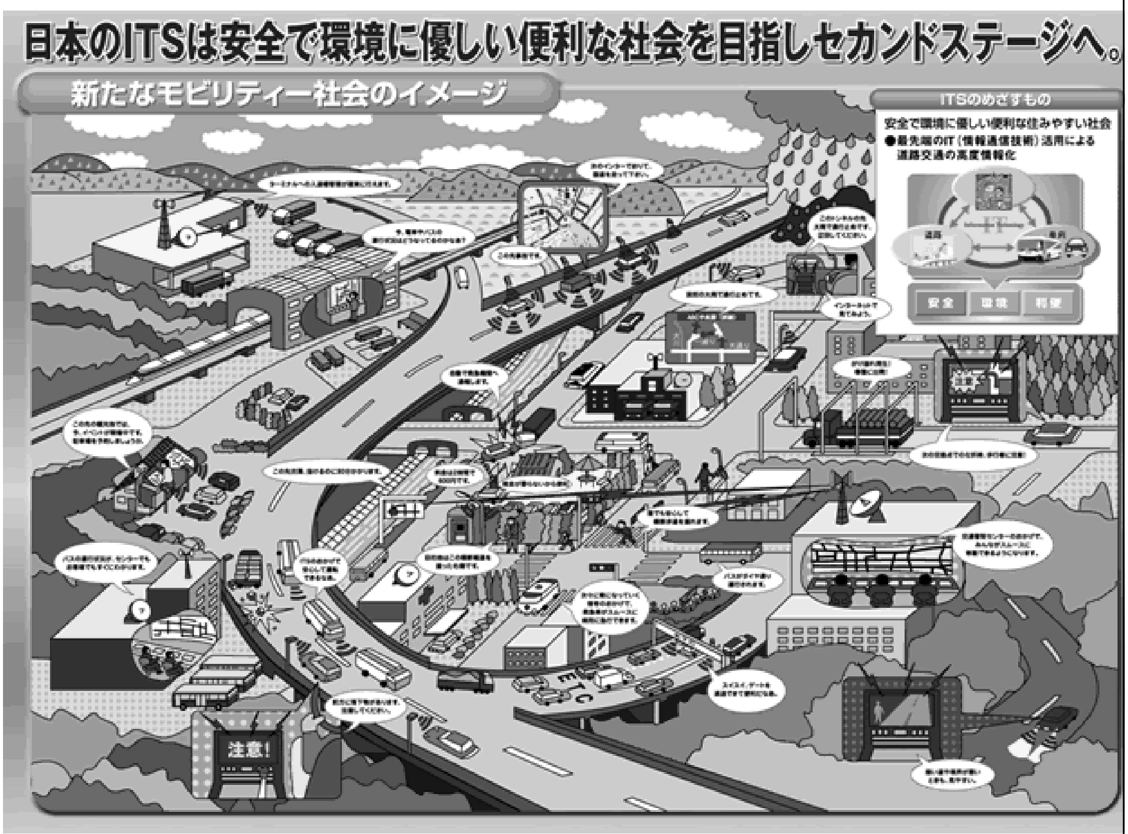

Robot industry
http://www.honda.co.jp/ASIMO/technology/history/asimo.html
http://it.nikkei.co.jp/digital/special/robot.aspx
http://www.alsok.co.jp/r_d/robolabo.html
//www.robocup.or.jp/robocup.html
Using location information, robot will behave autonomously in outdoor environment.
※security robot, rescue robot….


Emergency reaction
GPS Satellites
Quazi-Zenith Satellites
Perform high-speed initialization, high accuracy, high availability survey using QZSS, Pseudo-lite, etc.
Additional Data
The aim is shortening period, reduce cost, quality improvement, safety with IT technology.
Pseudo-lite
Automation in construction works
Robocup for rescue
Examination robot can locate pipelines at the relative accuracy consistent with the map-scale of 1/2000. By combining GPS, absolute position can be determined. This enables precise excavation leading to very rapid pipeline repairment.
Source: Osaka Gas

Sharing structured cyber-world through diverse services





Future plan of GNSS's of major countries

GPS

- Development launched in early 1970's
- System comprises 27 positioning satellites
- GPS modernization planning currently underway (Target date: 2016)

GLONASS

- Satellite positioning system operated by the Russian Defense Ministry
- Planning underway to revive satellite positioning system, including launch of improved GLONASS satellites (Target date: mid-2010's)

IGC

Locus for communication and coordination between all satellite positioning systems

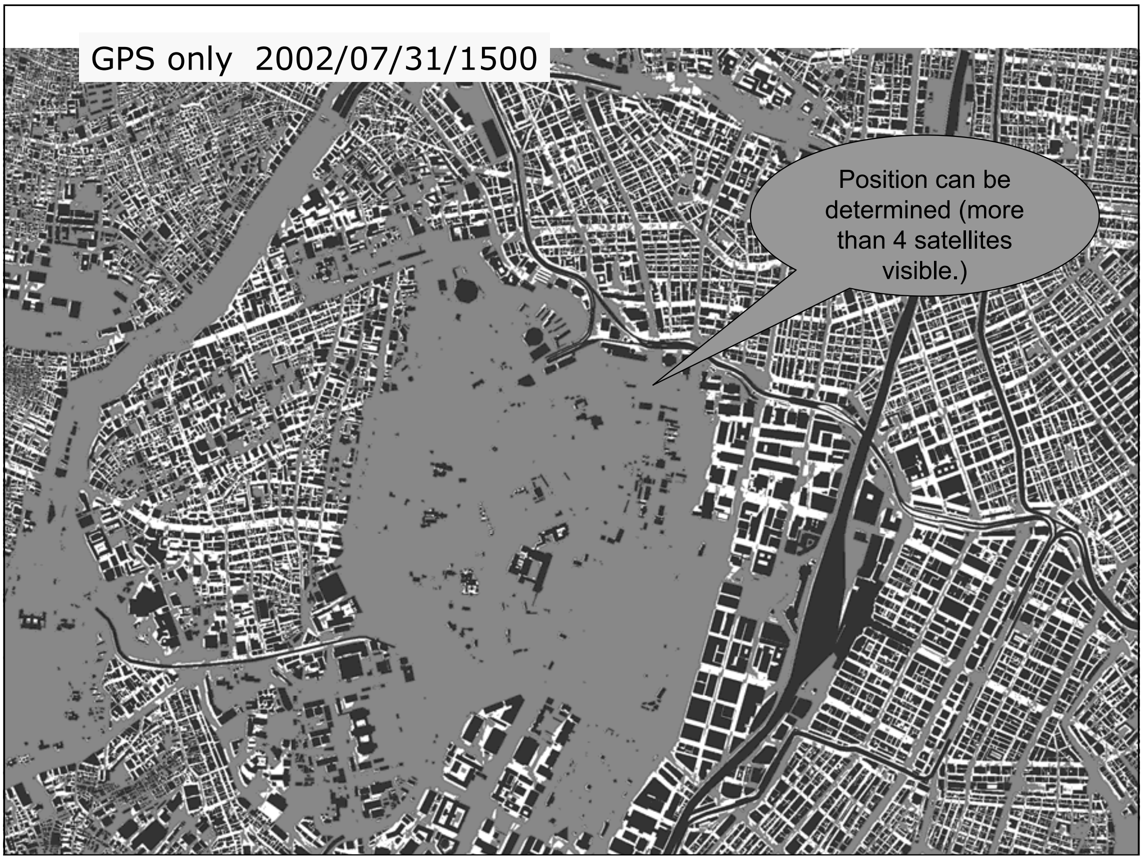
Galileo

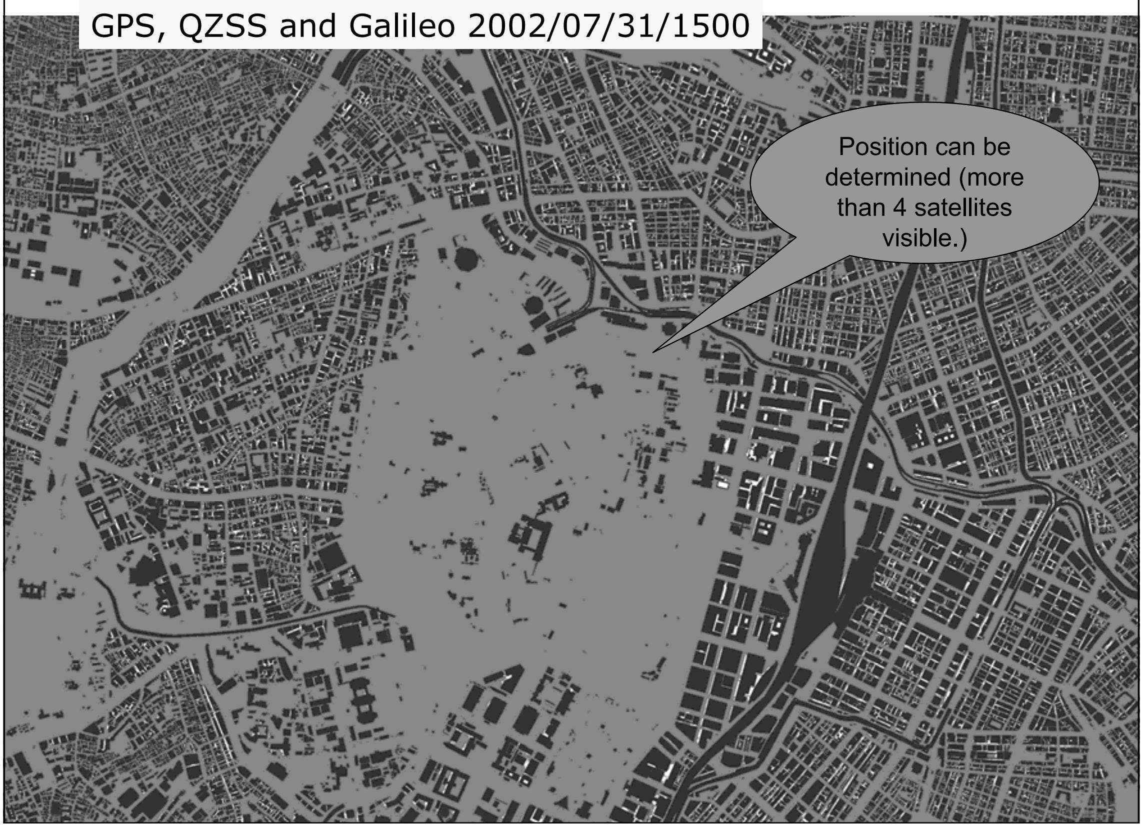
- Launches initiated with objective of starting services in 2011 (Objectives of GPS backup and EU autonomy)
- 30 satellite launches planned
- India, China, Israel, ROK participating or have stated intentions to do so

Beidou(Compass)

- Positioning system to be formed of stationary and medium earth orbiting and quasi-zenith satellites through five launches
- Independent split from Galileo project

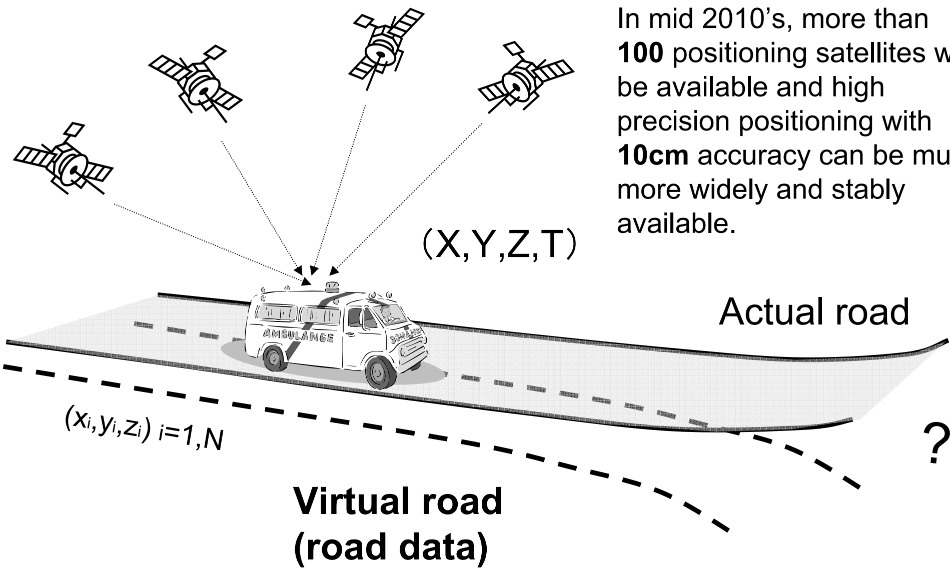
Experimental development of "quasi-zenith" satellites. Deployment not finalized. International role complementary to GPS.





Next generation GNSS requires accurate and current maps

In mid 2010's, more than **100** positioning satellites will be available and high precision positioning with **10cm** accuracy can be much more widely and stably available.



Contribution of geospatial information in Ubiquitous Network Society

- Common Digital Maps
- GNSS (Global Navigation Satellite Systems)

NSDI or National Spatial Data Infrastructure

enables

***Ubiquitous access** to accurate and reliable position/location information*

A Key to effectively integrate heterogeneous data and systems in ubiquitous network society and for advanced ITS.

Coordinated efforts to improve NSDI

- Digital maps
- GNSS

How to efficiently improve accuracy and currency ?

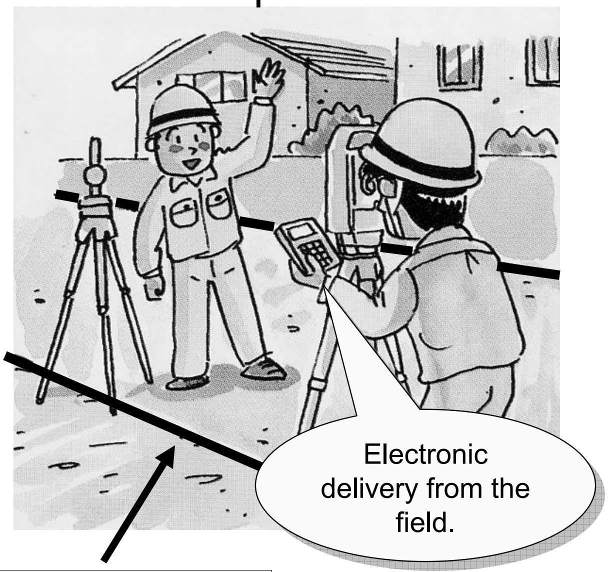
~~Having independent Japanese GNSS?~~

How to secure the environment of stably using GNSS of other countries?

Coordinated diplomatic efforts + accumulation of technological knowledge

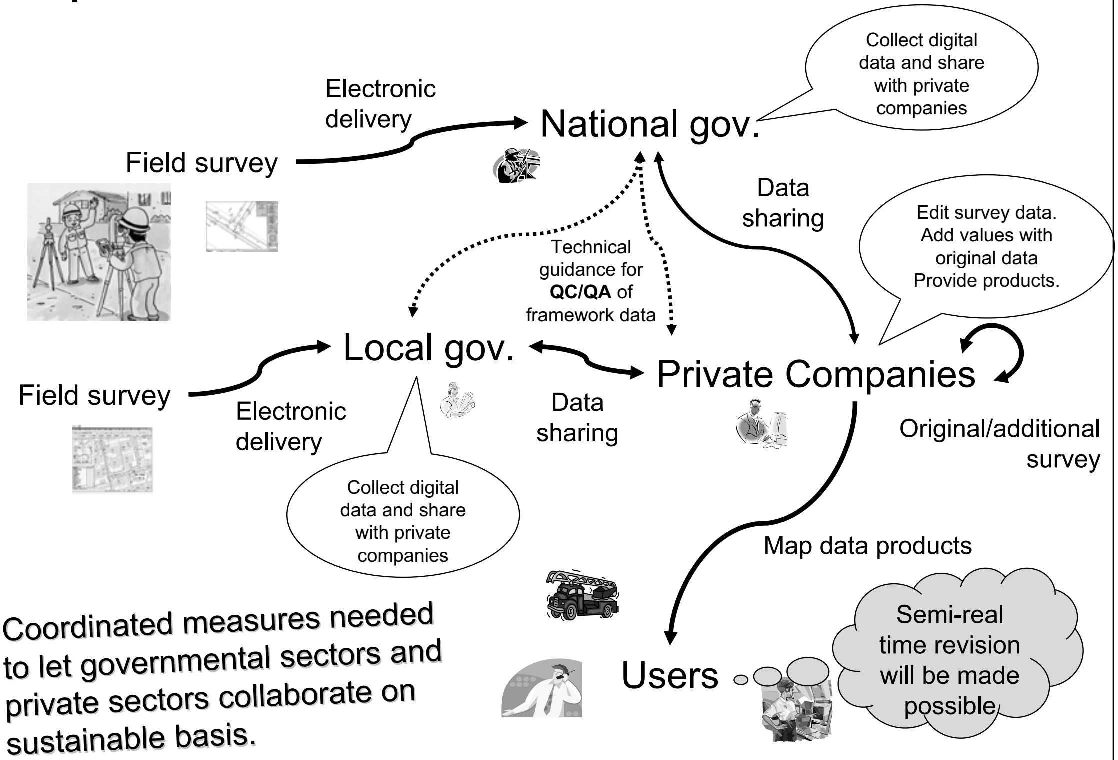
Collect survey data

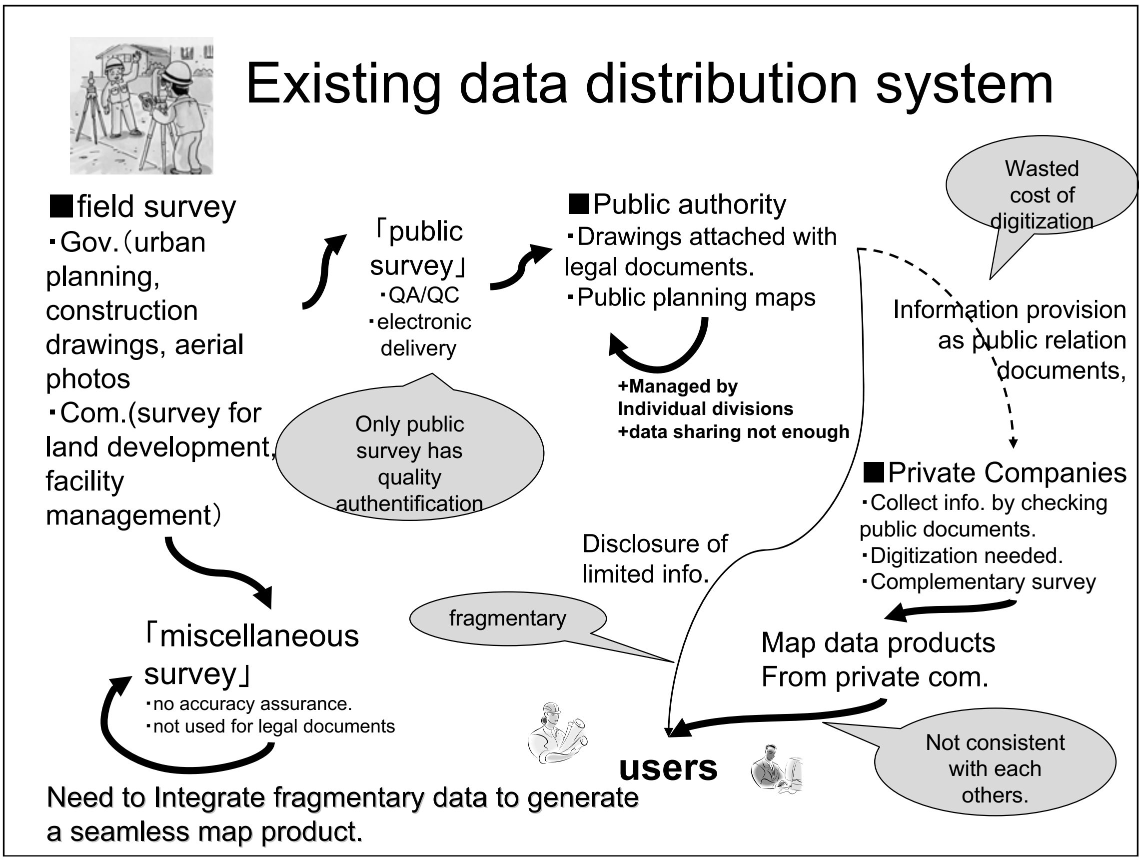
generated in routine field works for keeping a common map current

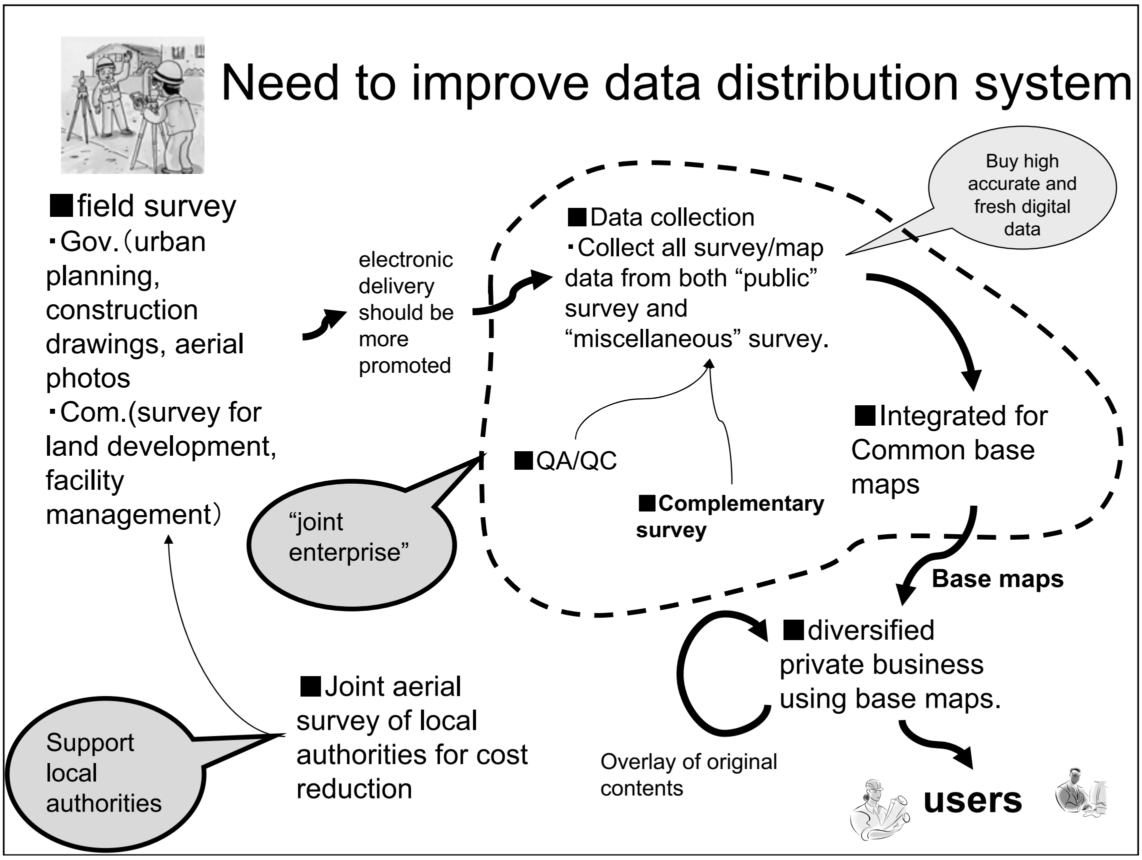


Common basic features

Expected data flow from fields to users




Existing data distribution system
■field survey
・Gov.（urban planning, construction drawings, aerial photos
・Com.(survey for land development, facility management）
「public survey」
・QA/QC
・electronic delivery
Only public survey has quality authentification
■Public authority
・Drawings attached with legal documents.
・Public planning maps
+Managed by Individual divisions
+data sharing not enough
Wasted cost of digitization
Information provision as public relation documents,
■Private Companies
・Collect info. by checking public documents.
・Digitization needed.
・Complementary survey
Disclosure of limited info.
「miscellaneous survey」
・no accuracy assurance.
・not used for legal documents
fragmentary
Map data products From private com.
users
Not consistent with each others.
Need to Integrate fragmentary data to generate a seamless map product.


Need to improve data distribution system
■field survey
・Gov.（urban planning, construction drawings, aerial photos
・Com.(survey for land development, facility management）
electronic delivery should be more promoted
■Data collection
・Collect all survey/map data from both “public” survey and “miscellaneous” survey.
Buy high accurate and fresh digital data
■QA/QC
■Complementary survey
■Integrated for Common base maps
“joint enterprise”
Base maps
■diversified private business using base maps.
■Joint aerial survey of local authorities for cost reduction
Support local authorities
Overlay of original contents
users

Case studies

for coordinated efforts of different organizations

Basic Act for Geospatial Information is needed

New Legislation for a Basic Act

- Initial submission of the bill during the June 2006 Diet Session:
  - *Basic Act for the Advancement of Utilizing Geospatial Information*
  - Resubmitted by MPs from two ruling and one opposition parties in May 2007 during the last Diet Session and
  - enacted by all parties except one opposition party.
- Was put into effect on 29 August 2007.

Basic Act for the Advancement of the Utilization of Geospatial Information (NSDI Act)

- *Definition*: *Geospatial Information*
  - Any information related to a position in 4D space.
- *Basic principles*
  - Develop an infrastructure that enables the maximum use of geospatial information.
  - Take comprehensive measures to enhance the synergy between GIS and SBP (Satellite-based Positioning).
  - Ensure stable and reliable SBP services.
  - Improve efficiency and enhance functionality of administrative management using geospatial info.
  - Pay due attention to the national security and personal information.

New Legislation: NSDI Act
Basic Policies

- Capacity building and enhanced use of GIS in governments.
- Development, timely update, distribution of *geospatial framework information* by State and local government offices.
  - Technical standards for enhanced interoperability are to be developed by the Government.
- Use of *geospatial framework information* in preparing maps that are mandated to governments.
- Liaison and coordination with organizations that operate global SBP systems.

New Legislation: NSDI Act
Basic Plan

- Will be developed around the end of the year by the Government to implement the basic policies.
- Supposed to be endorsed by the Cabinet Members.
- Will list specific actions of the Government to bring about tangible outcomes for the development of NSDI.

Definition of *Geospatial Framework Information*

- Draft ordinance of MLIT for <u>information items</u>
  - Geodetic control points, Coastlines, Boundaries of public facilities, Administrative boundaries, Road edge line, River bank edge line, Center line of rail tracks, Shorelines, Building outlines, Street block outlines.
- Draft ordnance of MLIT for <u>quality criteria</u>
  - Must be prepared by public surveying & mapping.
  - Horizontal accuracy < 2.5 m (SD) for designated areas for urban planning (25 m for outside)
  - Vertical accuracy < 1.0 m (SD) for the designated areas for urban planning (5.0 m for outside)

Technical Standards for Enhanced Interoperability

- Procedures on
  - how existing *geospatial framework information* is to be used when developing or updating another.
  - how existing *geospatial framework information* is to be seamless connected to adjacent data.
- List of ISO and JIS standards
  - ISO19100 series and JIS X7100 series.

NSDI Act: What's Next?

- The Act was just enacted and still at the beginning stage of its implementation.
- The promulgation of two ordinances and technical standards will trigger substantive discussions on how the Act should be put into practice in the real world.
- Discussions on Basic Plan involving all sectors will hopefully provide some insight on the future practice of the Act.
- Amount of funding from the Government could also define how far we could get the ball rolling toward the geospatially-enabled society.

Concluding remarks

- Common digital map + GNSS: social infrastructure (NSDI) to provide ubiquitous access to position/location information
  - ➔Geospatially-enabled Society
- Collaboration of gov. and private sectors is a key to realize NSDI in an efficient manner.
- Basic act for NSDI provides framework for the collaboration.


Research
Research
End
shiba@csis.u-tokyo.ac.jp

Digital City and GIS

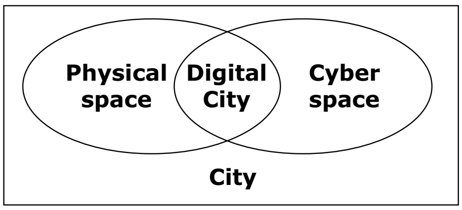
Anthony Yeh

Centre of Urban Planning and Environmental Management

GIS Research Centre

The University of Hong Kong

What is Digital City?



Physical Space contains municipal infrastructure, roads, governments, shops etc. that exist physically in cities.

Cyber Space contains information or services such as internet, cellar phone, GIS etc that exist virtually in cities.

Digital City is the overlapped part for a city.

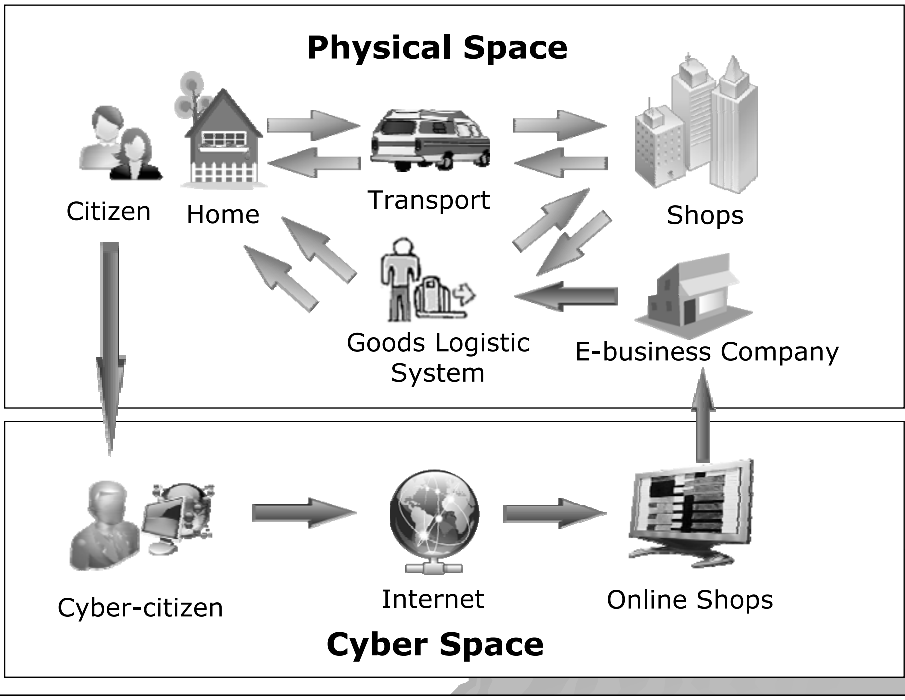
Along with development of information technology, the scope of digital city will continue to grow.

What is Digital City?

- Definition of Digital City
  1) A city that is being transformed or re-oriented through digital technology
  2) A digital representation or reflection of some aspects of an actual or imagined city.

What is Digital City?

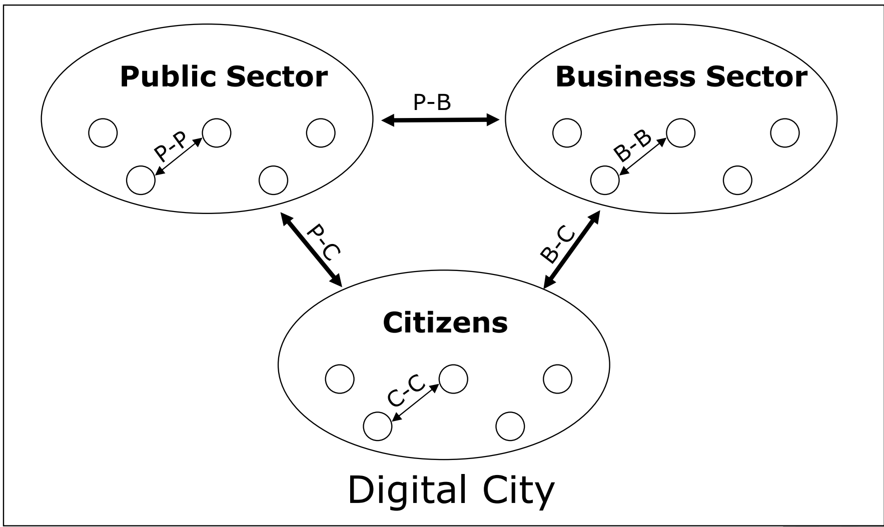
- An example - shopping



Digital City

- 24 hours services (convenience)
- Do all transactions without the need of travelling (save time)
- Visit every corner in the city, deal with everything in the world, at any time in the day and year without leaving home (足不出戶，年日無休，走遍城中每一角落，辦理一切天下事)

Relationships Among Components of Digital City



Contents of Digital City

◆ Case 1 – Information Dissemination

Website for “首都之窗” （Beijing International）

Contents of Digital City

- Case 1 – Information Dissemination

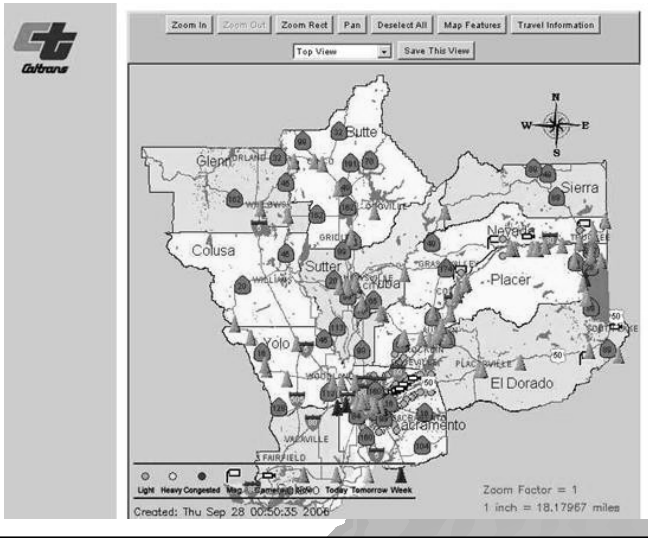
Contents of Digital City

- Case 1 – Information Dissemination

Contents of Digital City

◆ Case 2 – Specific Information Dissemination

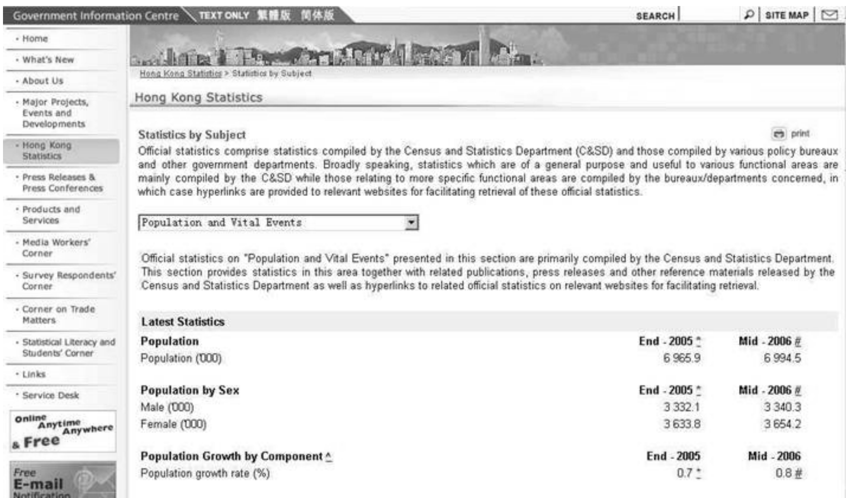
Real-time Traffic Information Disseminating System of California DOT (P-C)



Contents of Digital City

◆ Case 3 - Government Report

Statistics provided by Census and Statistics Department, HKSAR (P-B and P-C)



Contents of Digital City

◆ Case 4 - Public Participation

Website for Hong Kong Victoria Harbor Reclamation Planning Project (P-C)

Contents of Digital City

◆ Case 5 – E-business

Amazon, one of the most successful online book retailers (B-C)

Contents of Digital City

- Case 5 – E- shopping

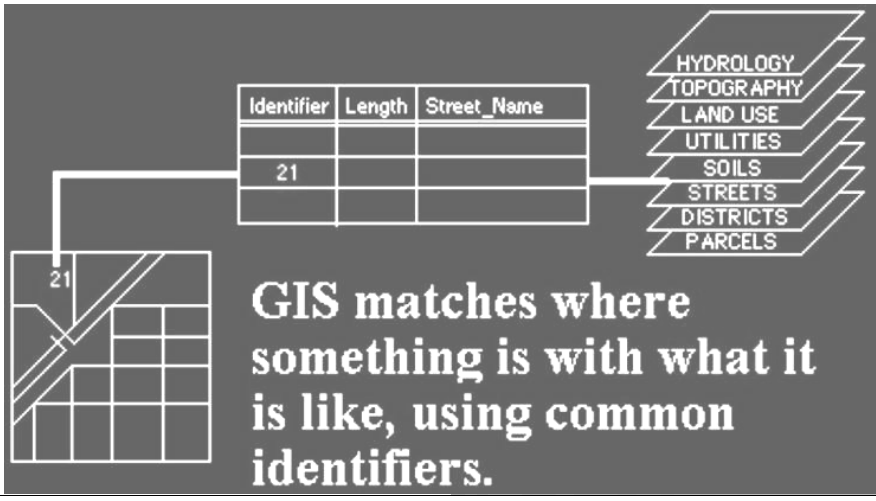
  Ebay, a virtual market where customers can make transactions (C2C)

Contents of Digital City

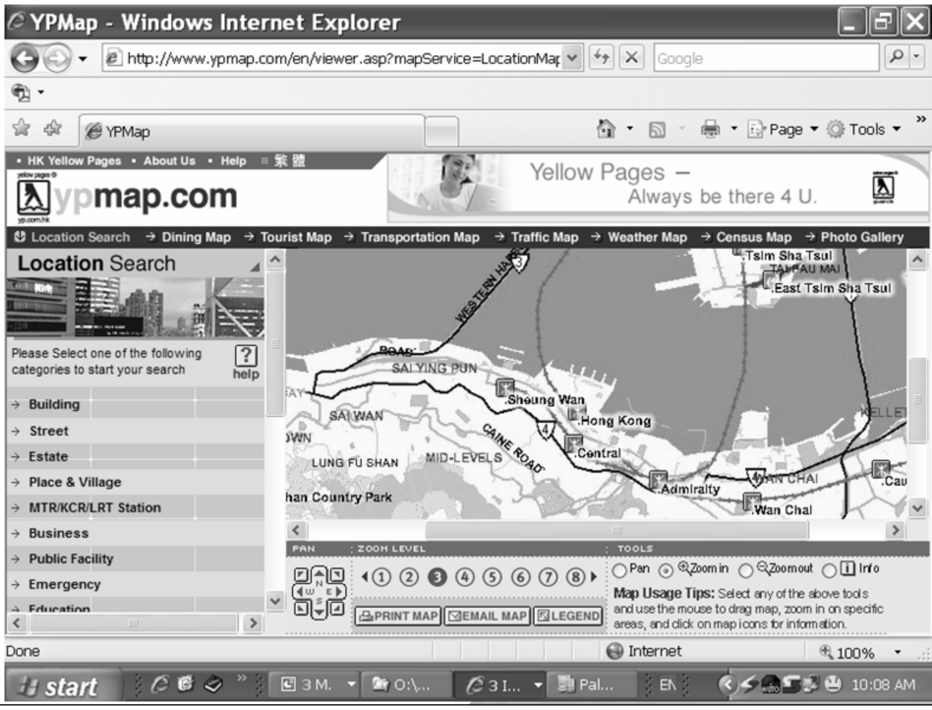
- Case 5 – E-shopping 淘宝网

Geographic Information System (GIS)

GIS is a system for creating, storing, analyzing and managing spatial data and associated attributes.



Web GIS

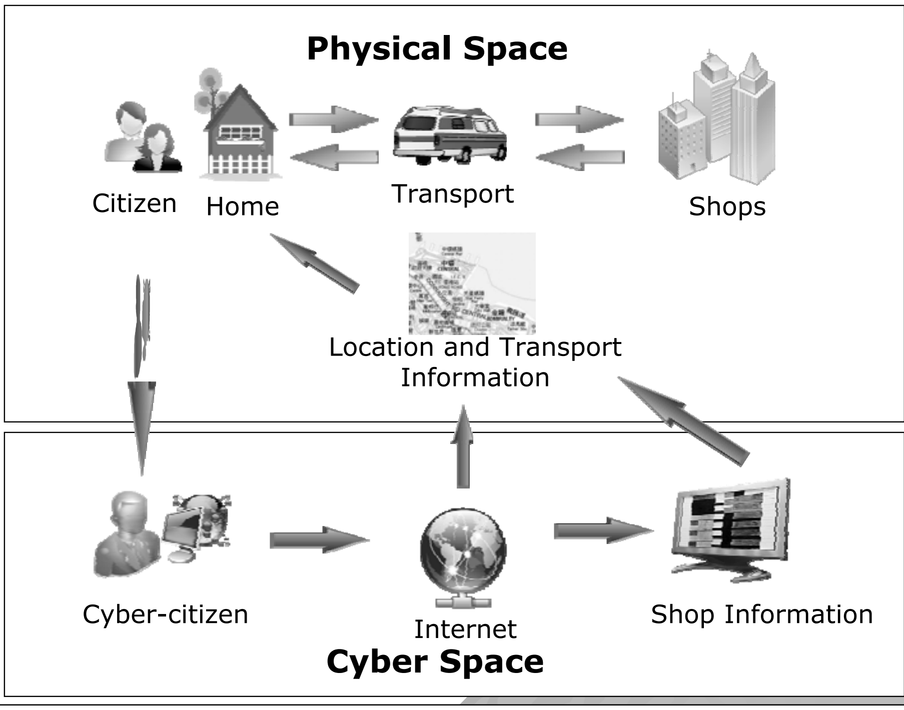


Interface between Digital City and GIS

- Shops, government offices, tourist areas and homes all exist in geographical space

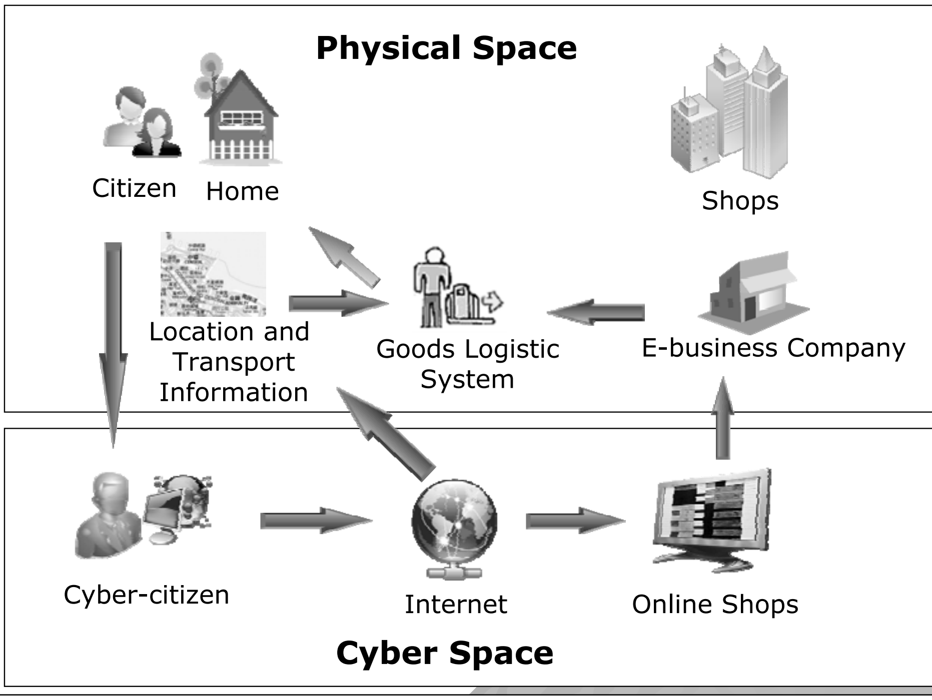
Digital City and GIS

Visiting Places (shops, government offices, tourist areas)



Digital City and GIS

Delivery of Goods and Services

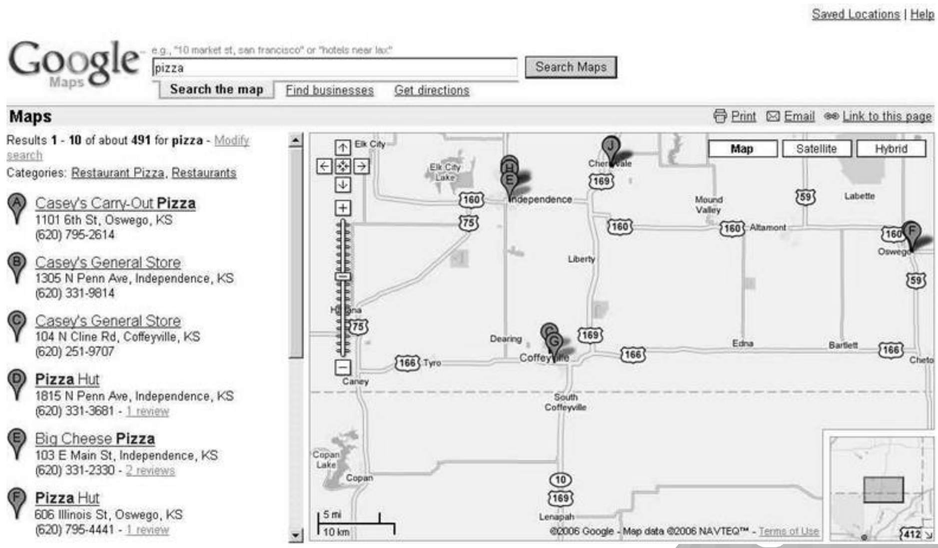


GIS and Digital City

- Map functions

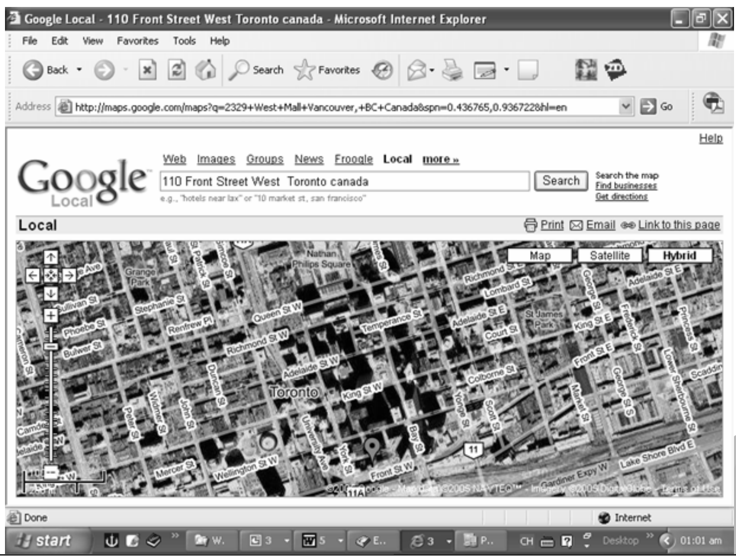
GIS and Digital City

- Spatial Query – Finding nearby pizza huts



GIS and Digital City

- 2D visualization – For virtual reality browsing or pre-trip tourism experience



GIS and Digital City

- 3D visualization – For virtual reality browsing or pre-trip tourism experience

GIS and Digital City

- 3D visualization – For virtual reality browsing or pre-trip tourism experience


广州地图-三维地图-广州三维地图-地图广州-广州电子地图-立体地图-都市圈 - Windows Internet Explorer
http://gz.o.cn/index.jspa?locale=zh_CN
www.o.cn
Connecting...
地图搜索
分类搜索
公交查询
登录 | 注册 | 简/繁体 | 切换城市 | 帮助
都市圈
www.o.cn
楼房实体 / 道路 / 河流
搜 索
屏内搜索
首 页
立体黄页
分类信息
都市论坛
热门：水玲珑盐疗会馆 食临盛宴 食临雅宴 南海城韩、日料理 KTV 洛城明月馆
引导
聊天
公交
测距
纠错
便签
平面
立体
卫星
全屏
广州火车东站
©2007 都市圈
http://gz.o.cn/index.jspa?locale=zh_CN#
Internet
100%
start
Microsoft PowerPoint ...
广州地图-三维地图-...
EN
5:49 PM


广州地图-三维地图-广州三维地图-地图广州-广州电子地图-立体地图-都市圈 - Windows Internet Explorer
http://gz.o.cn/index.jspa?locale=zh_CN
广州地图-三维地图-广州三维地图-地图广州-广州...
地图搜索
分类搜索
公交查询
登录 | 注册 | 简/繁体 | 切换城市 | 帮助
都市圈
www.o.cn
楼房实体 / 道路 / 河流
搜 索
屏内搜索
首 页
立体黄页
分类信息
都市论坛
热门：水玲珑盐疗会馆 食临盛宴 食临雅宴 南海城韩、日料理 KTV 洛城明月馆
引导
聊天
公交
测距
纠错
便签
平面
立体
卫星
全屏
天誉花园1期
广州火车东站
天河体育中心
800 m
©2007 都市圈
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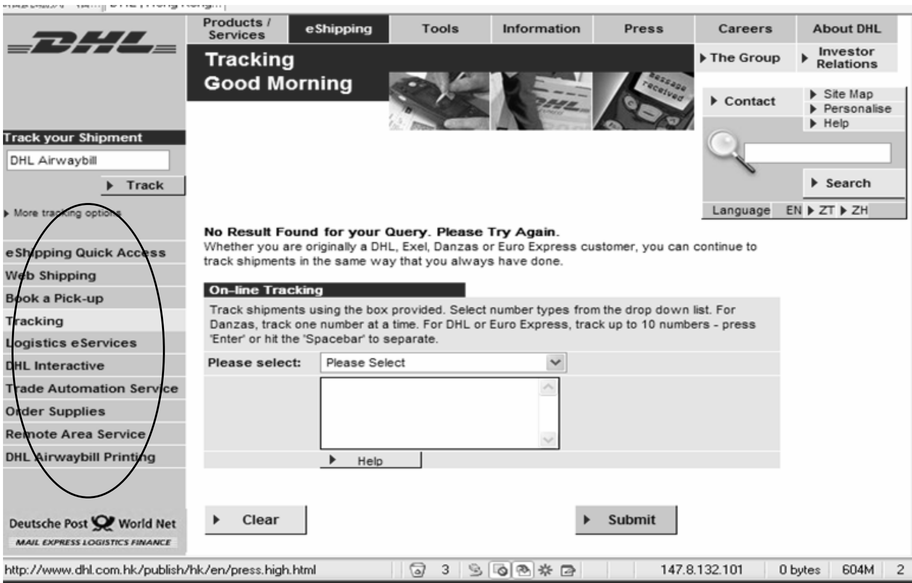
Internet
100%
start
OfficeAutomation...
DigitalCityandGIS...
广州地图-三维...
EN
5:55 PM

What GIS functions can be used in Digital City?

- In general, it can be used as a platform on which all other geographically related components of digital city are incorporated

Online Map
Spatial Query
Transport GIS
E-business
Tourism
E-government
Information dissemination
...
GIS Environment
Digital City

Delivery of Goods and Services Case - DHL

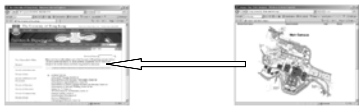
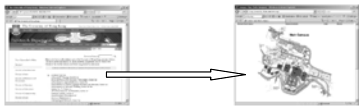
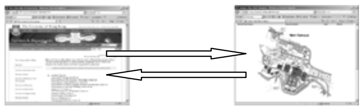


Use of GIS Information in Digital City

- Touring
- Shopping
- Route Planning
- Logistics

Problems of GIS Applications in Digital City

- Availability of digital maps
- Interoperability
- Ease of use
- Lack of crosslinking of webpages and web GIS

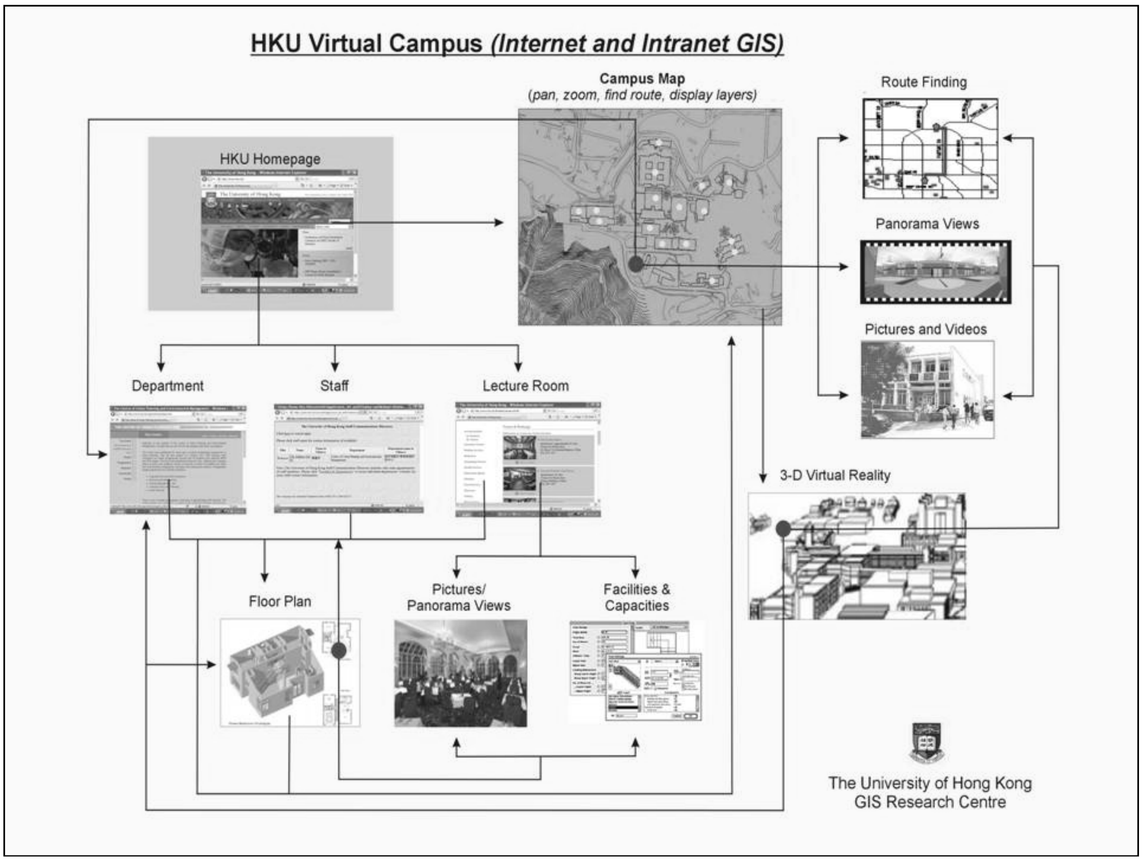
	Webpage / Web GIS
A) WebGIS Not Linked with Webpage	
B) WebGIS Linked with Webpage	
C) Webpage Linked with WebGIS	
D) WebGIS Mutually Linked with Webpage	

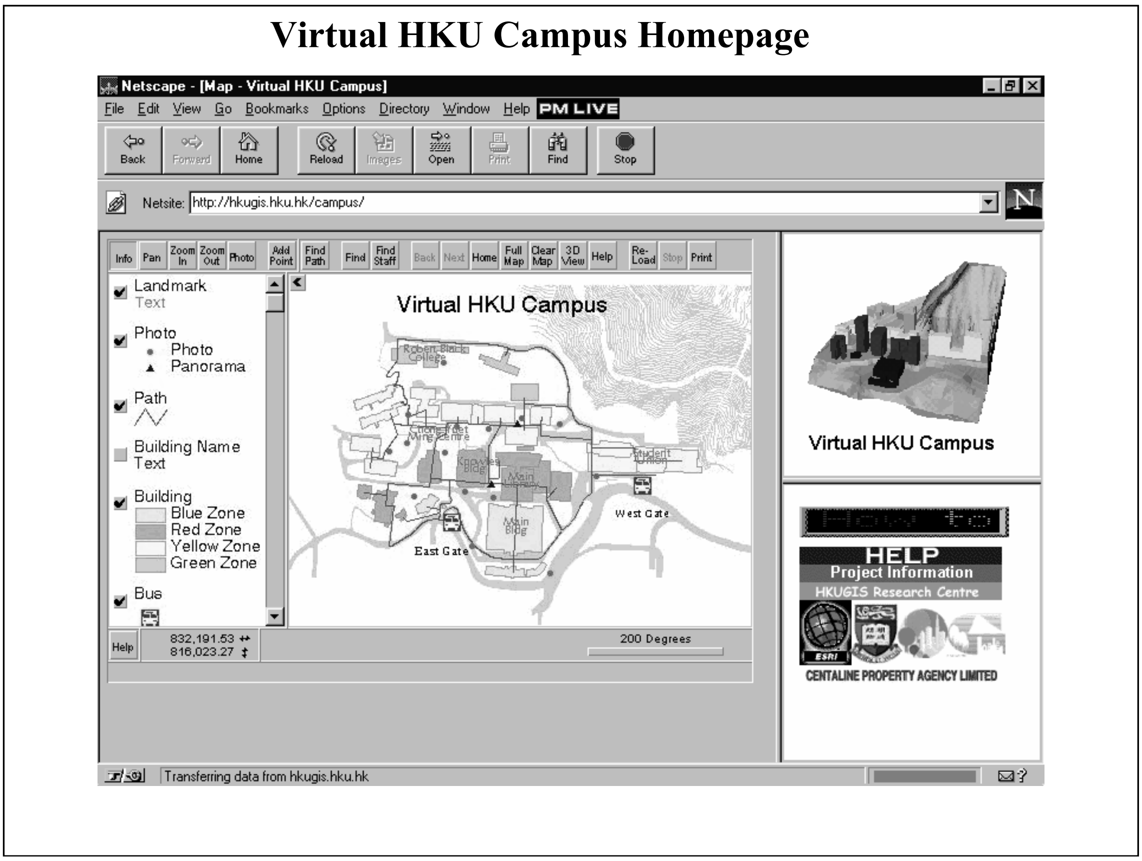
Crosslinking of webpages and web GIS

Problems of GIS Applications in Digital City

- Availability of digital maps
- Interoperability
- Ease of use
- Lack of crosslinking of webpages and web GIS
- Data Updating
- Haven’t fully utilized functions of GIS in digital city


1999 ESRI
USER CONFERENCE
Best ArcView IMS Application Competition
1st Place
Awarded to
"Virtual HKU Campus"
GIS Research Center, University of Hong Kong
Anthony Gar-On Yeh and Poh-Chin Lai
SHARING
GIS
GEOGRAPHIC • KNOWLEDGE


HKU Virtual Campus (Internet and Intranet GIS)
Campus Map
(pan, zoom, find route, display layers)
Route Finding
HKU Homepage
Panorama Views
Pictures and Videos
Department
Staff
Lecture Room
3-D Virtual Reality
Floor Plan
Pictures/
Panorama Views
Facilities &
Capacities
The University of Hong Kong
GIS Research Centre


Virtual HKU Campus Homepage
Netscape - [Map - Virtual HKU Campus]
File Edit View Go Bookmarks Options Directory Window Help PM LIVE
Back Forward Home Reload Images Open Print Find Stop
Netsite: http://hkugis.hku.hk/campus/
Info Pan Zoom In Zoom Out Photo Add Point Find Path Find Find Staff Back Next Home Full Map Clear Map 3D View Help Re-Load Stop Print
Landmark
Text
Photo
Photo
Panorama
Path
Building Name
Text
Building
Blue Zone
Red Zone
Yellow Zone
Green Zone
Bus
Virtual HKU Campus
West Gate
East Gate
Help
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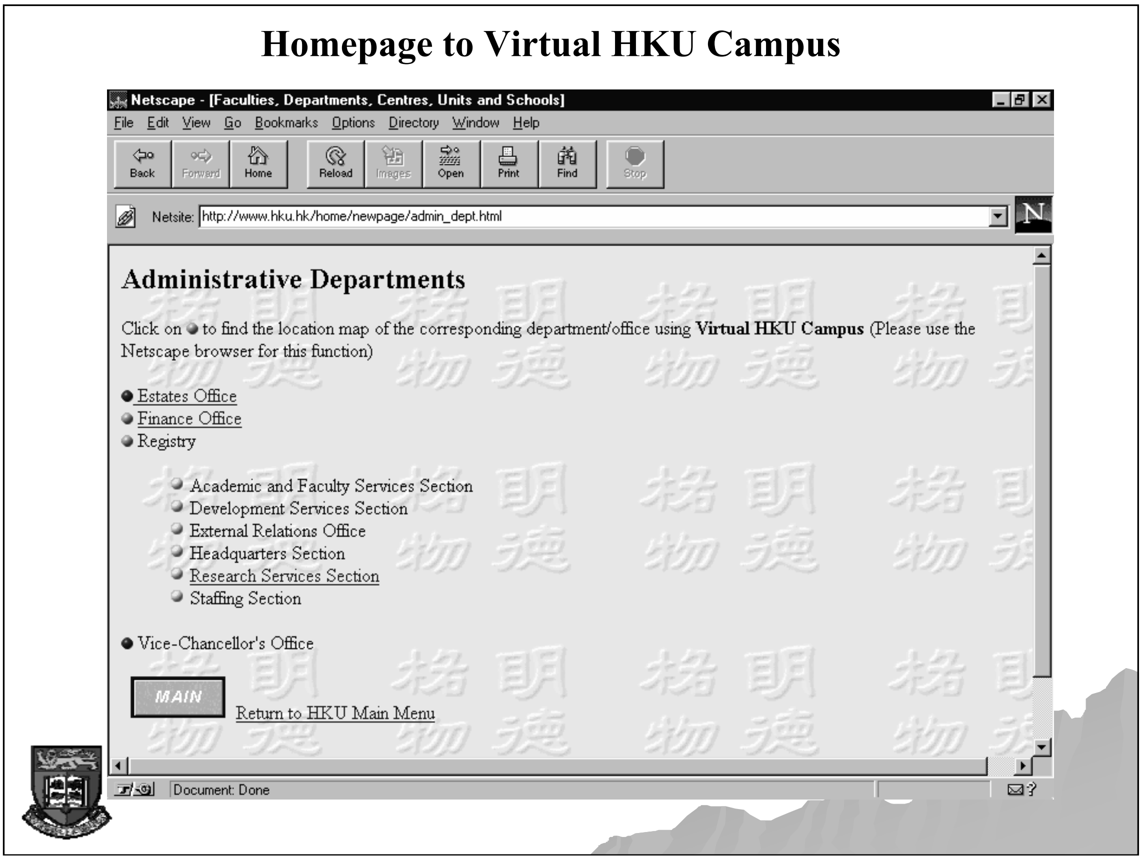
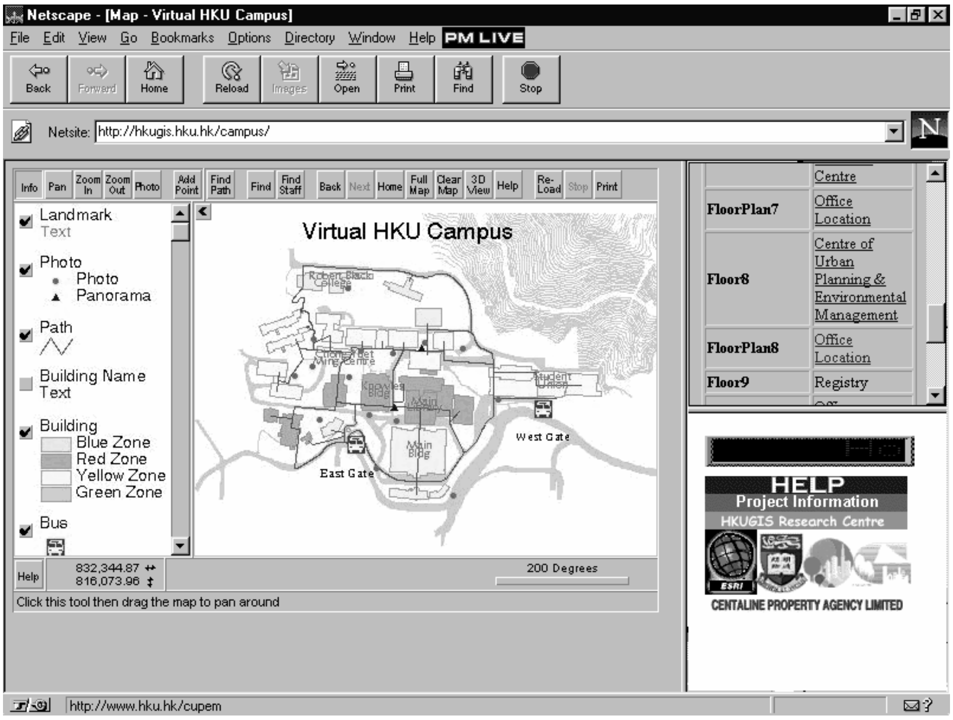
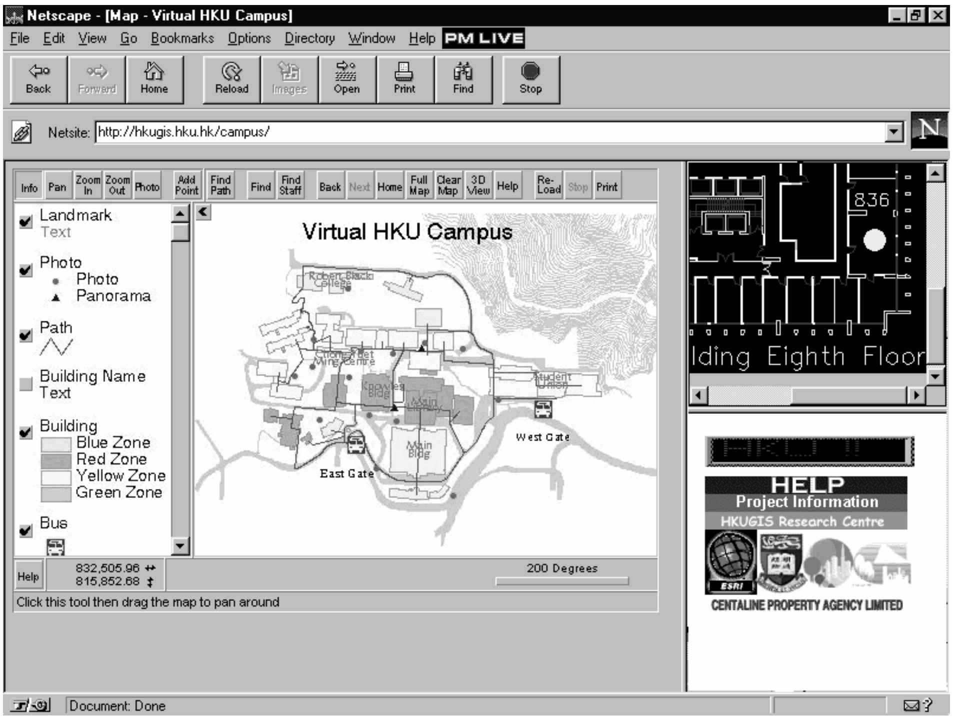
816,023.27
200 Degrees
Virtual HKU Campus
HELP
Project Information
HKUGIS Research Centre
ESRI
CENTALINE PROPERTY AGENCY LIMITED
Transferring data from hkugis.hku.hk


Homepage to Virtual HKU Campus
Netscape - [Faculties, Departments, Centres, Units and Schools]
File Edit View Go Bookmarks Options Directory Window Help
Back Forward Home Reload Images Open Print Find Stop
Netsite: http://www.hku.hk/home/newpage/admin_dept.html
Administrative Departments
Click on ● to find the location map of the corresponding department/office using Virtual HKU Campus (Please use the Netscape browser for this function)
Estates Office
Finance Office
Registry
Academic and Faculty Services Section
Development Services Section
External Relations Office
Headquarters Section
Research Services Section
Staffing Section
Vice-Chancellor's Office
MAIN
Return to HKU Main Menu
Document: Done

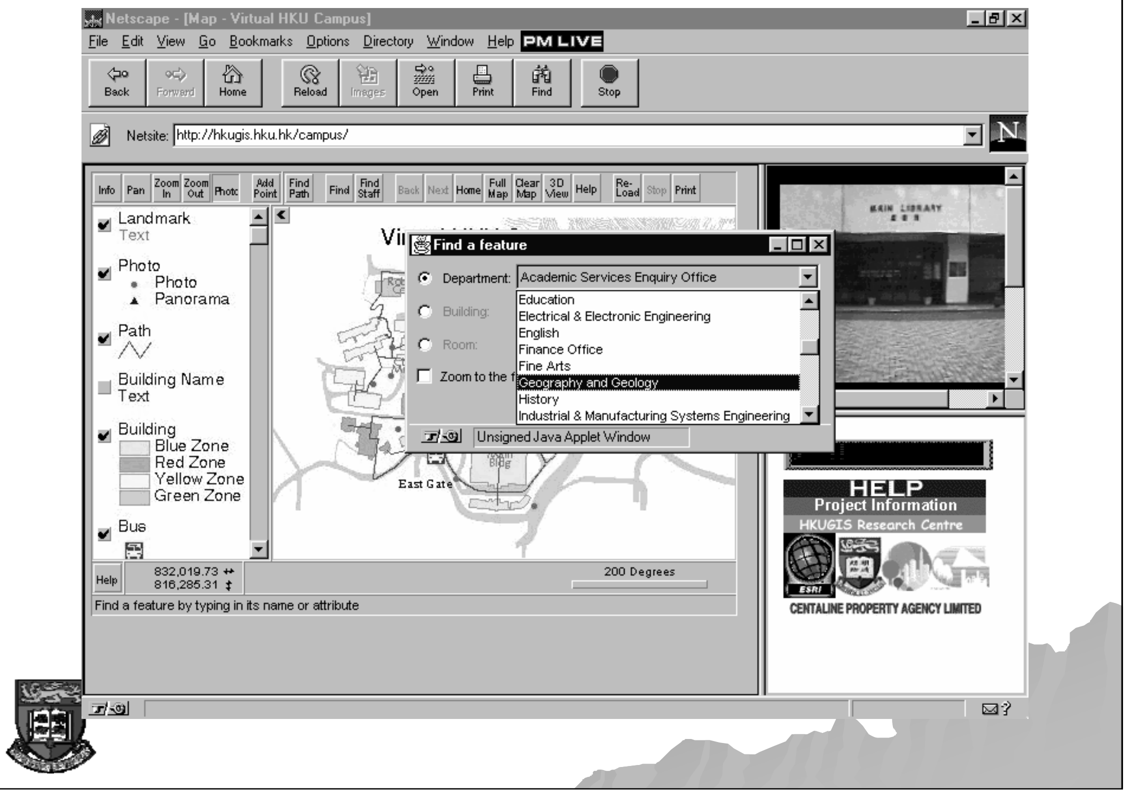
Floor Directory of Selected Building



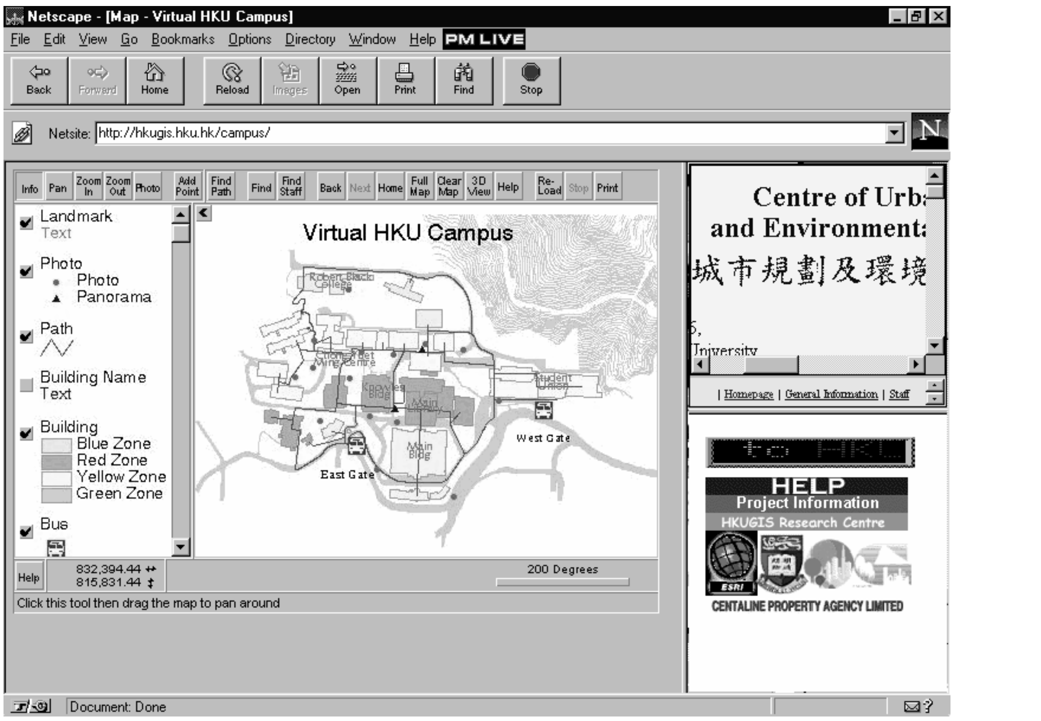
Floor Plan of Selected Building



Find Department



Department Homepage



From Virtual HKU Campus to Virtual Hong Kong

GIS Research Centre

Thank You

Anthony Yeh

Centre of Urban Planning and Environmental Management

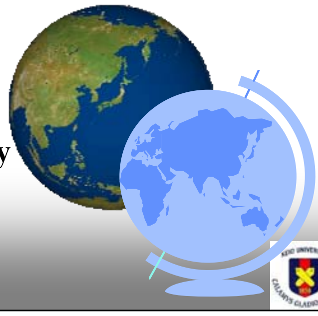
GIS Research Centre

The University of Hong Kong

Towards GIS 2.0

--- Spatial Thinking and PPGIS change Society

Hiromichi FUKUI
Faculty of Policy Management,
Global Security Research Center, Keio University
JAXA
hfukui@sfc.keio.ac.jp



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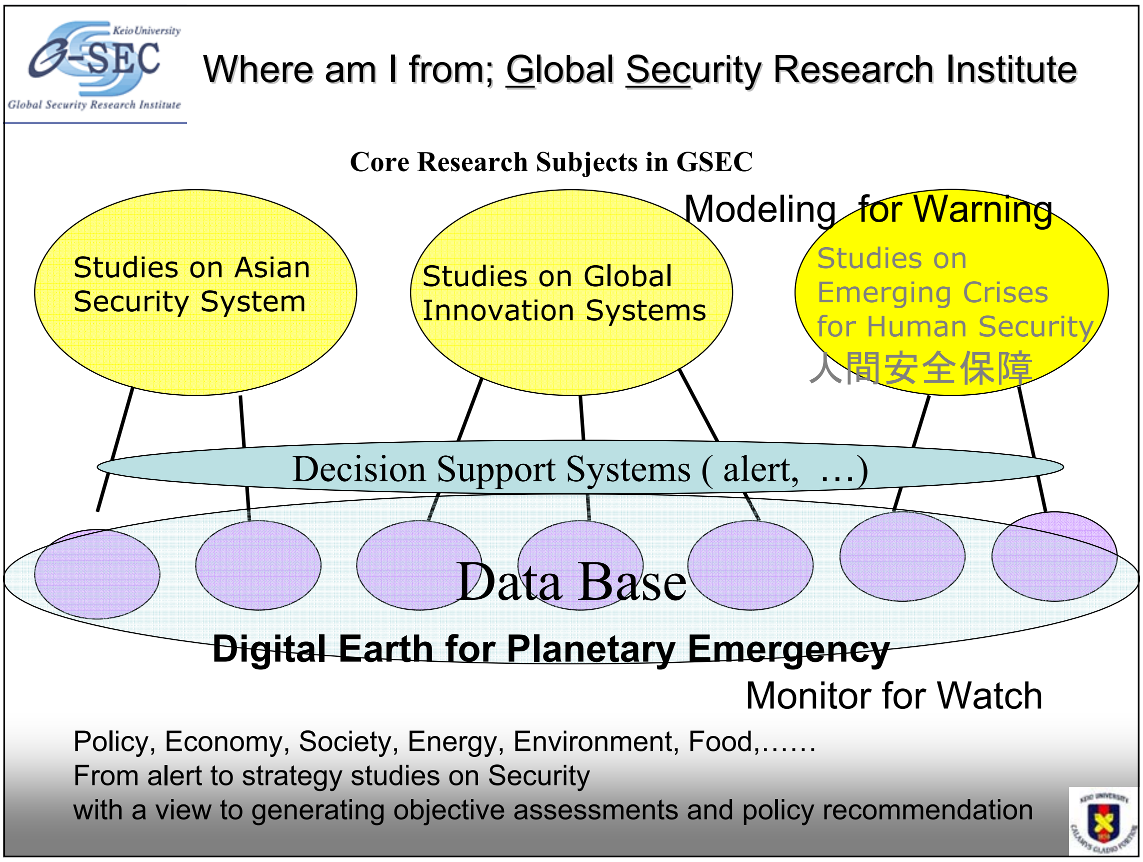
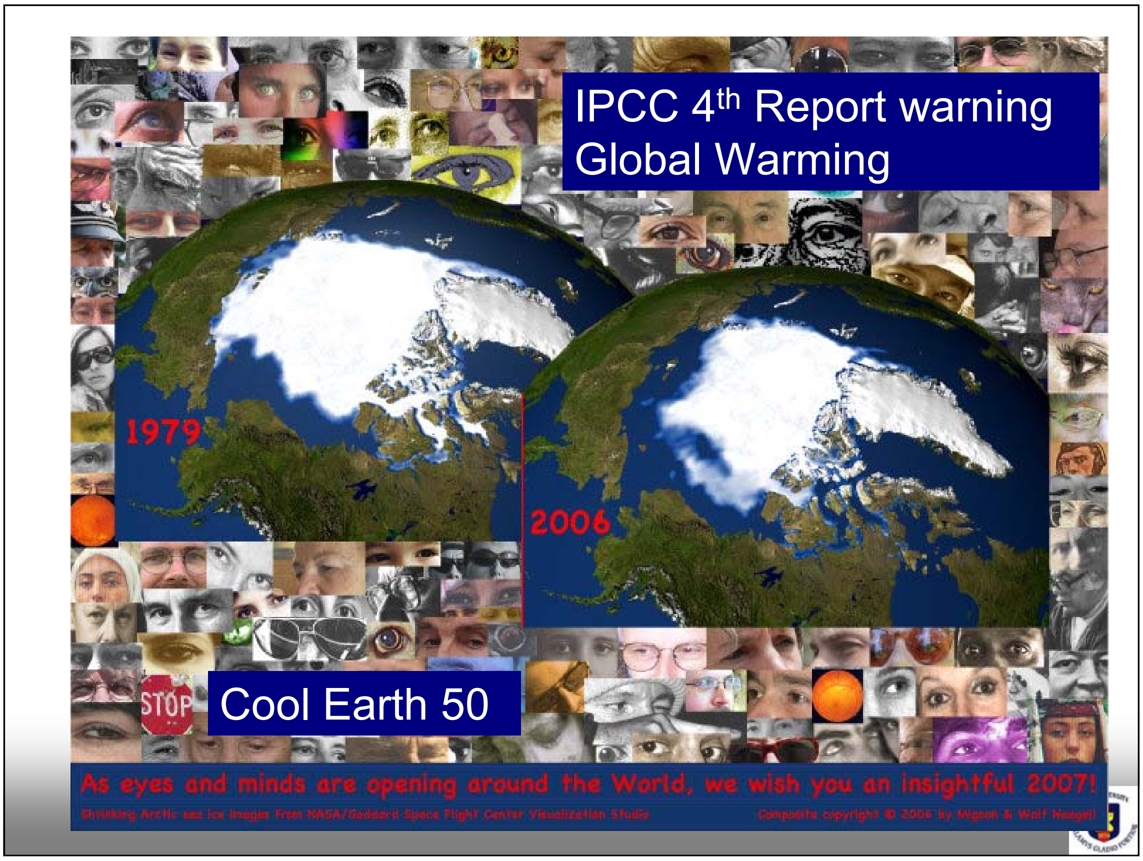

Keio University
G-SEC
Global Security Research Institute
Where am I from; Global Security Research Institute
Core Research Subjects in GSEC
Modeling for Warning
Studies on Asian Security System
Studies on Global Innovation Systems
Studies on Emerging Crises for Human Security
人間安全保障
Decision Support Systems (alert, …)
Data Base
Digital Earth for Planetary Emergency
Monitor for Watch
Policy, Economy, Society, Energy, Environment, Food,……
From alert to strategy studies on Security
with a view to generating objective assessments and policy recommendation


IPCC 4th Report warning Global Warming
1979
2006
STOP
Cool Earth 50
As eyes and minds are opening around the World, we wish you an insightful 2007!
Shrinking Arctic sea ice images from NASA/Goddard Space Flight Center Visualization Studio
Composite copyright © 2006 by Mignon & Wolf Naegeli

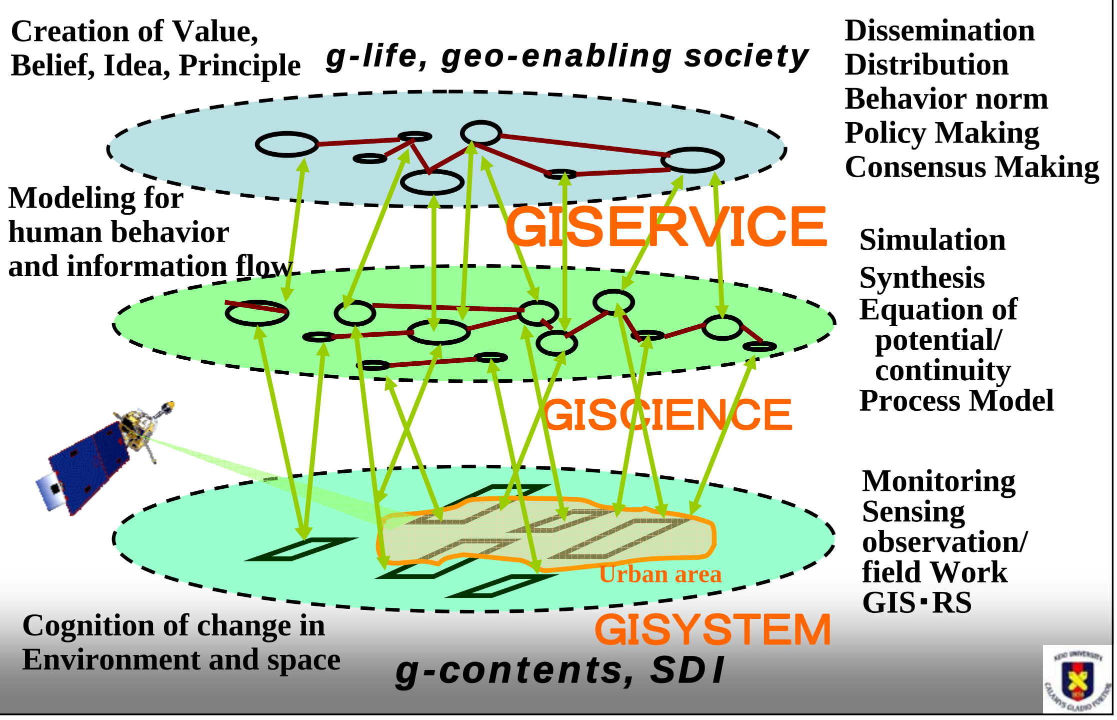
Planetary Emergency

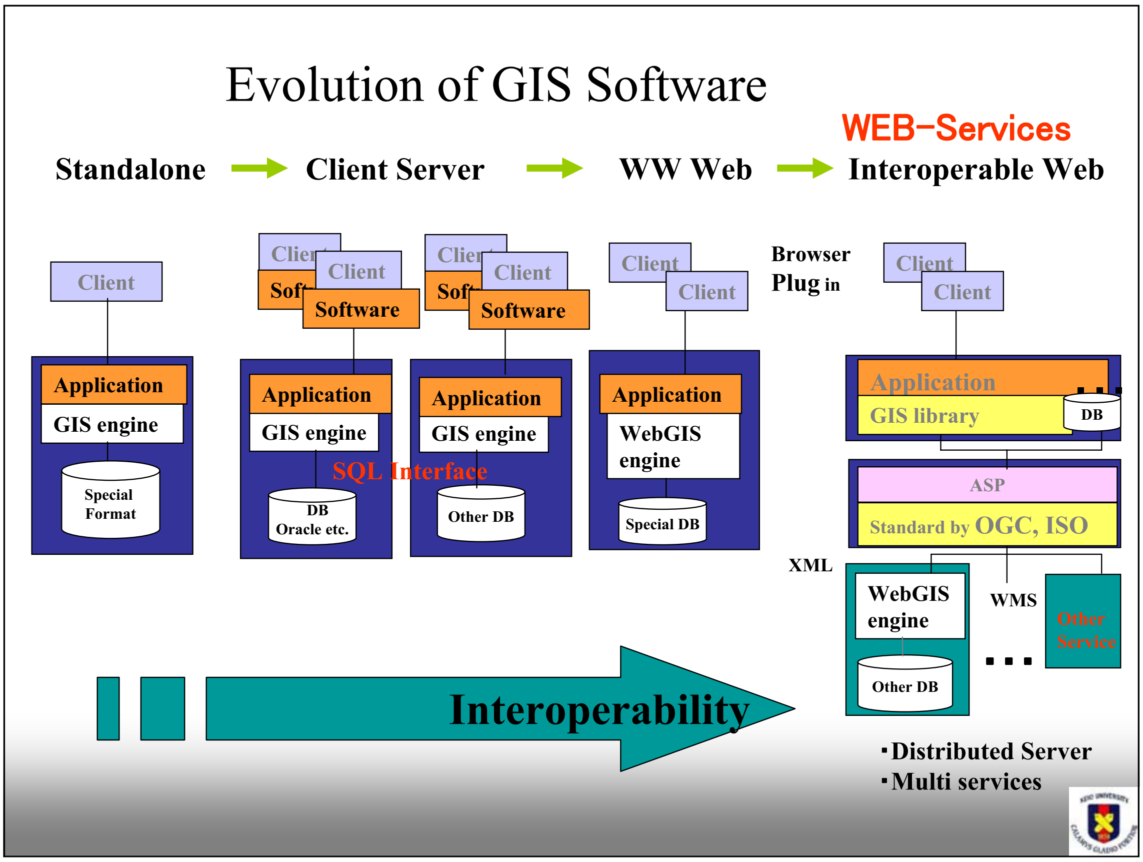
Emerging Crisis and Security Management

- A: Atomic
- B: Biotechnology
- C: Chemistry, Crime
- D: Disaster
- E: Economy
- F: Finance
- G: Global Environmei
- H: Human Security
- I : Internet
- …..
- Water Crisis

--- We live in a world full of risk
as taking revenge for our own careless behavior

Three Layer Model in Geo-Informatics





Emerging Trends in Geo-spatial World

1. Geoportal providers focus on local content (Where2.0)

"Web 2.0" is the "read-write" Web (participatory Web)

Google (Maps/Earth), Microsoft (Virtual Earth)…

- Portal providers also provide APIs for application developers

"Mash-ups" combine data with Map content

- Estimate of ＞10,000 Google Map mash-up applications

2. Open Source GIS maturity

- Geospatial IT thru standards (GML, OGC W*S services..)
- Standards available thru Open Source (Mapserver, PostGIS..)
- Mapserver is the No. 2 "Web mapping" platform – ＞50,000 sites

Open Source Geo Foundation – OSGEO.org

- Mission: "*to support and promote the collaborative development of open geospatial technologies and data*"
- Key components/projects: Mapserver, GeoTools, GDAL, Grass, MapGuide, MapBender, MapBuilder, OSSIM…

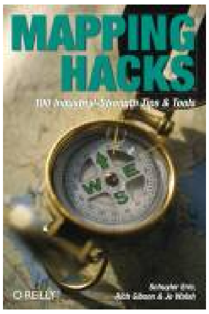
3. UbiGIS and Sensor Web expanding

Where 2.0 ; GIS 2.0

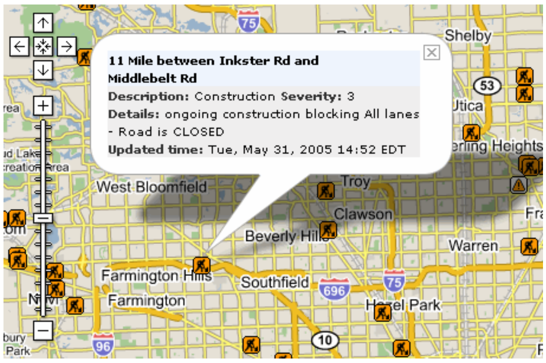
Google Map API

Yahoo Map API

KML, GEORSS



Google Maps BETA

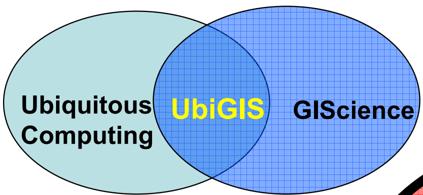


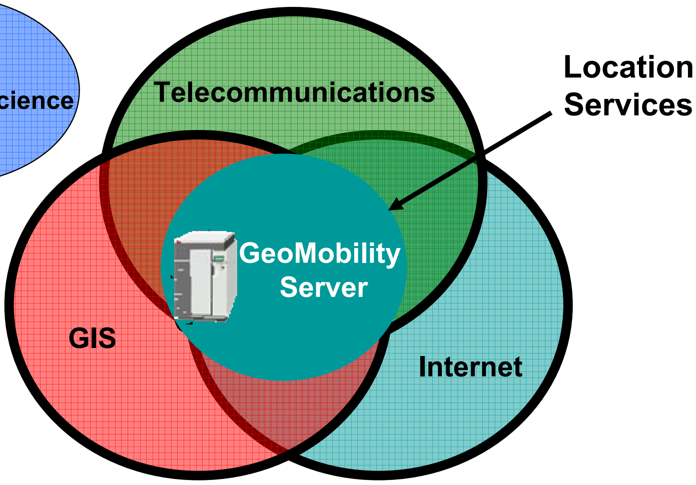
YAHOO! DEVELOPER NETWORK

Yahoo! Maps Web Services

Communication in geo-portal
with function of (Read／Write ; Web2.0)

Ubi-GIS :
Computer、Sensor、Mobile phone ＋ GIS





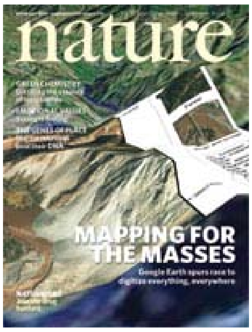
Wherever, Whenever, Whoever gets Geospatial Services
Geospatial Information Society

Case of Ubiquitous Computing

Location Based Service

where 2.0 CONFERENCE

The Power of Where



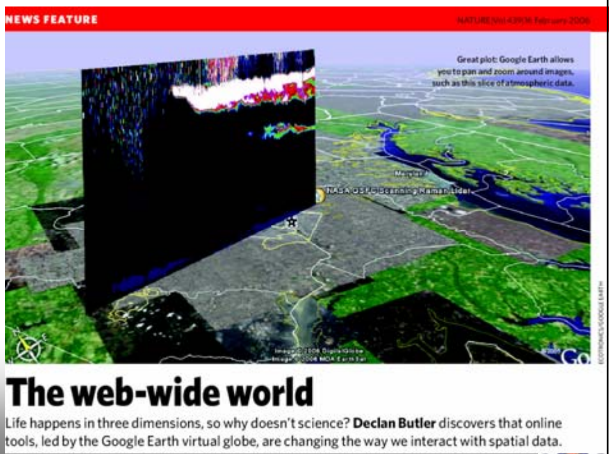
Impacts of Google Earth
Nature Vol.439, 16 February,2006

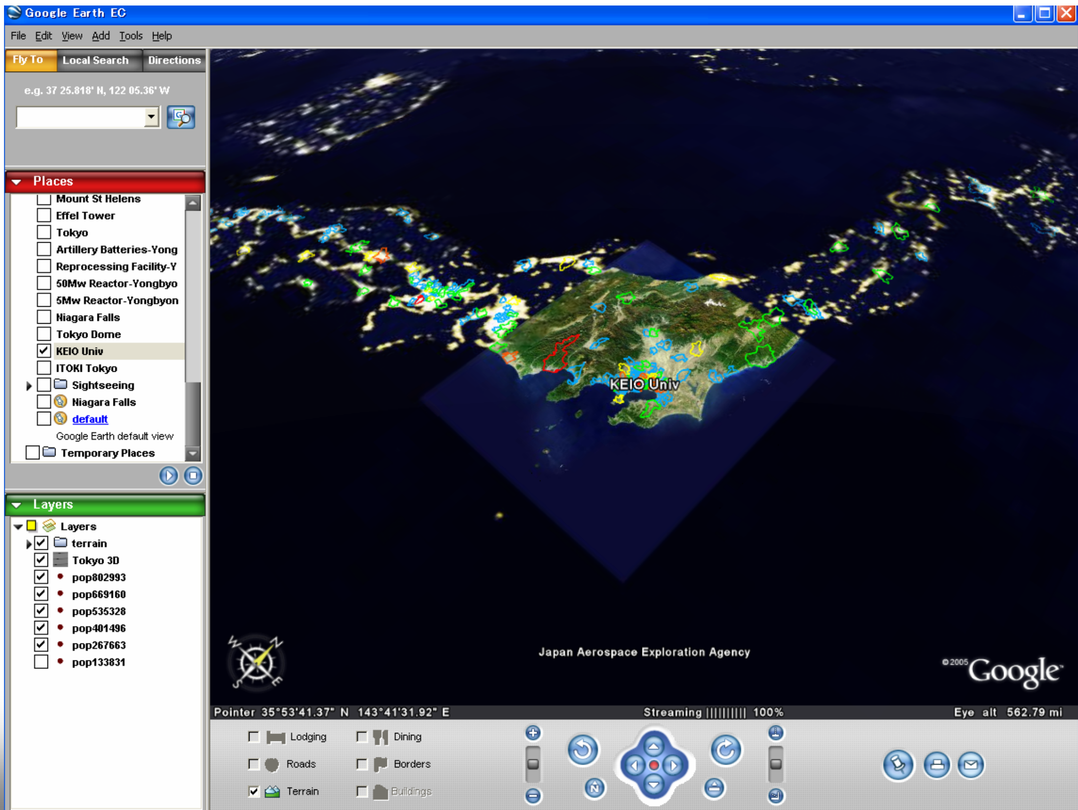
With Google Earth in place, there is much wider demand and better understanding what is possible and what's available.

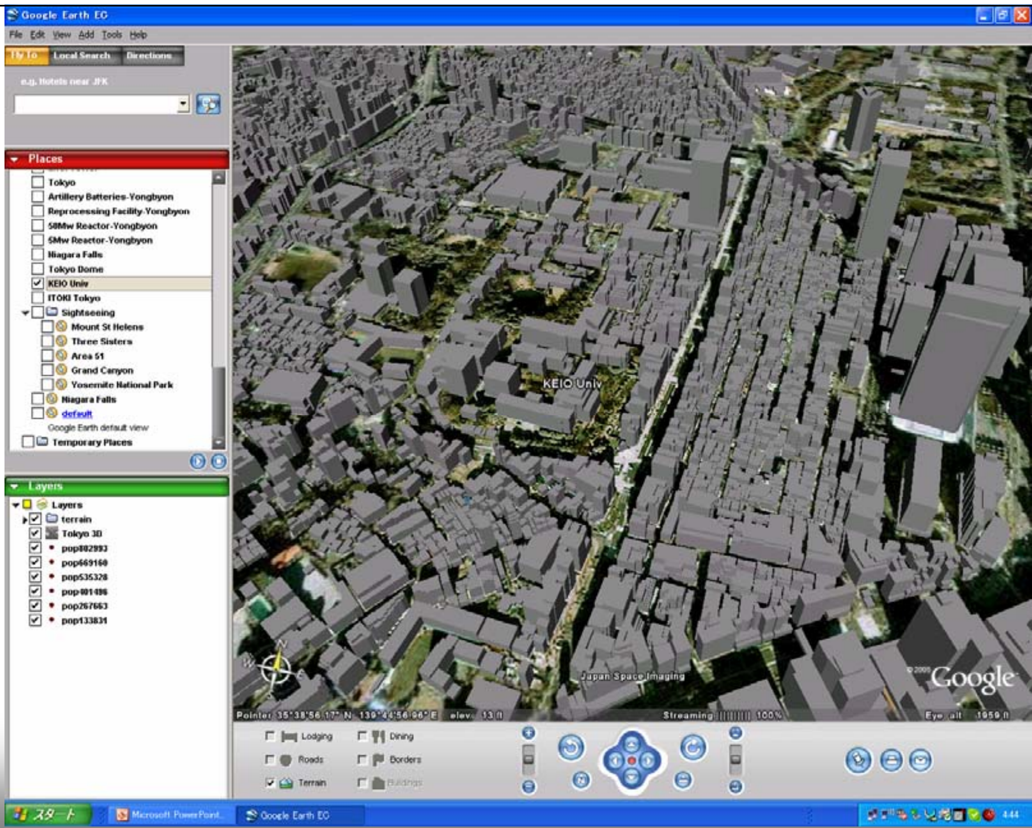
"Just as the PC democratized computing, so systems like Google Earth will democratize GIS."

Google Earth Population >200,000,000

Is Google Earth disruptive to people who are creating information?



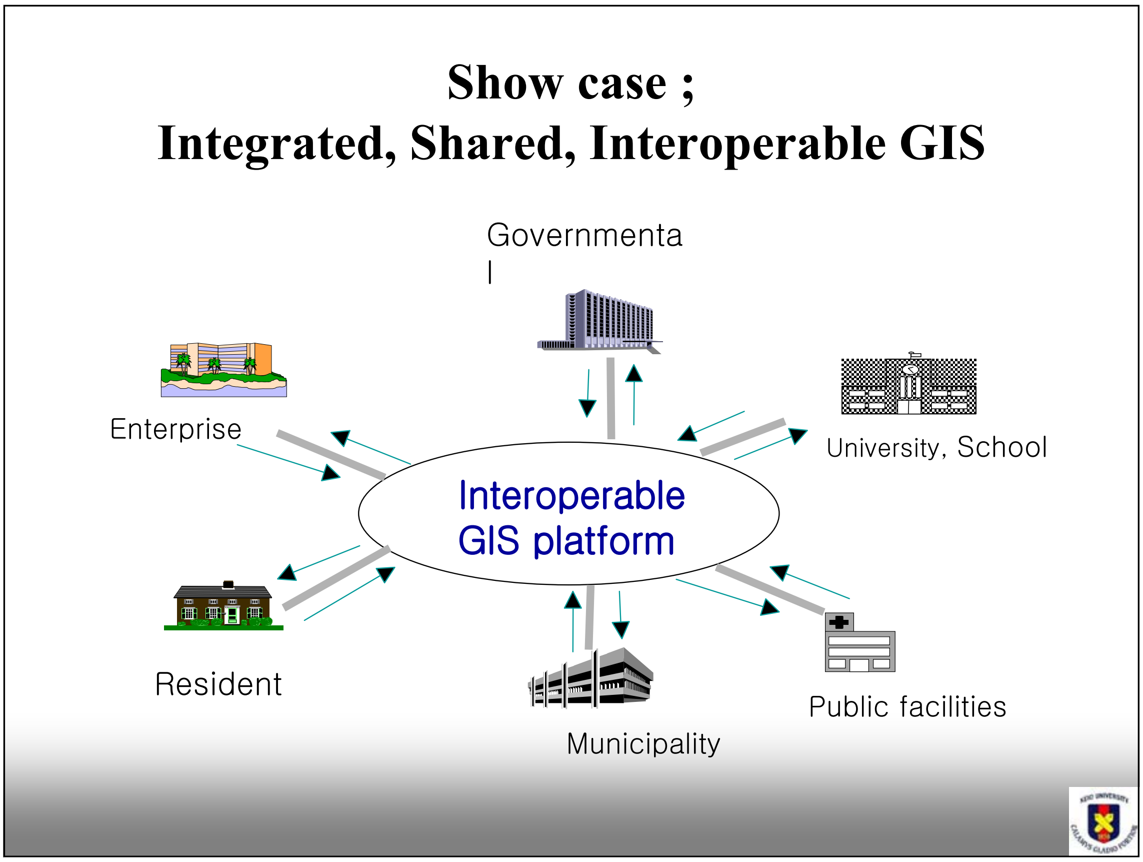




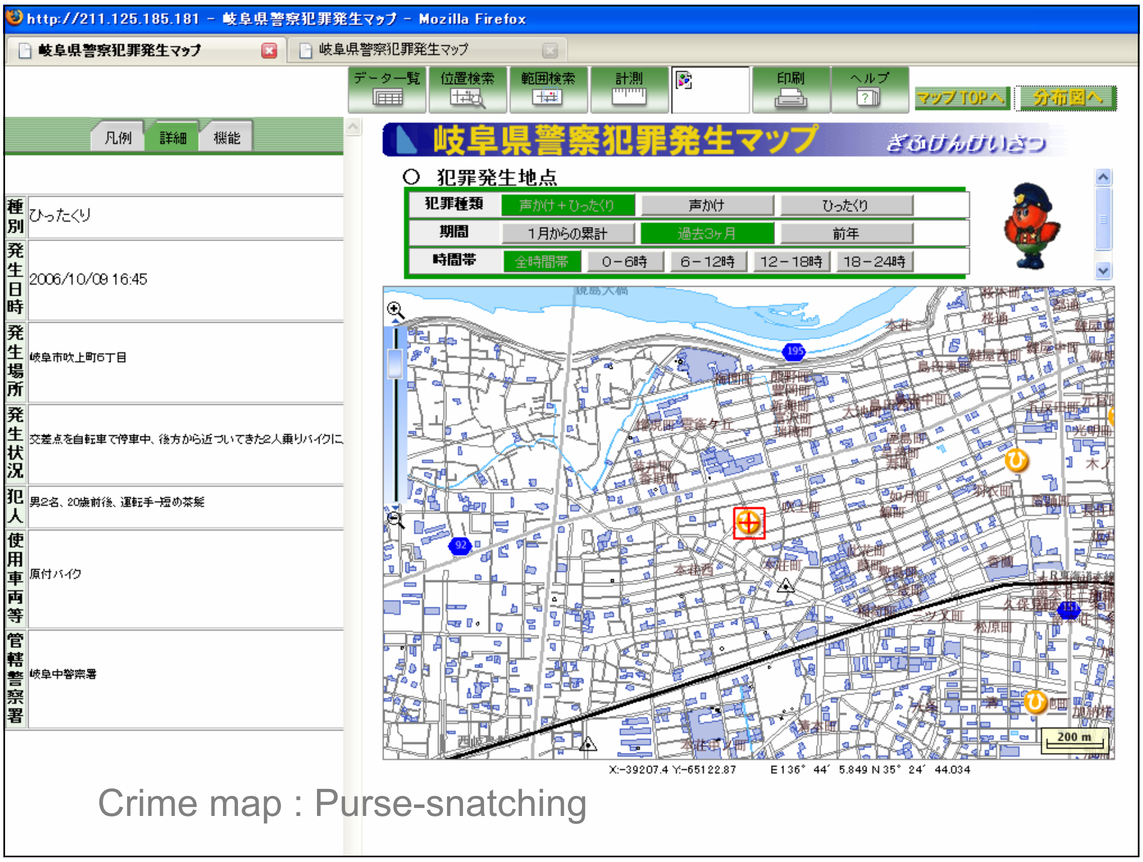
Where2.0 promote Participatory GIS

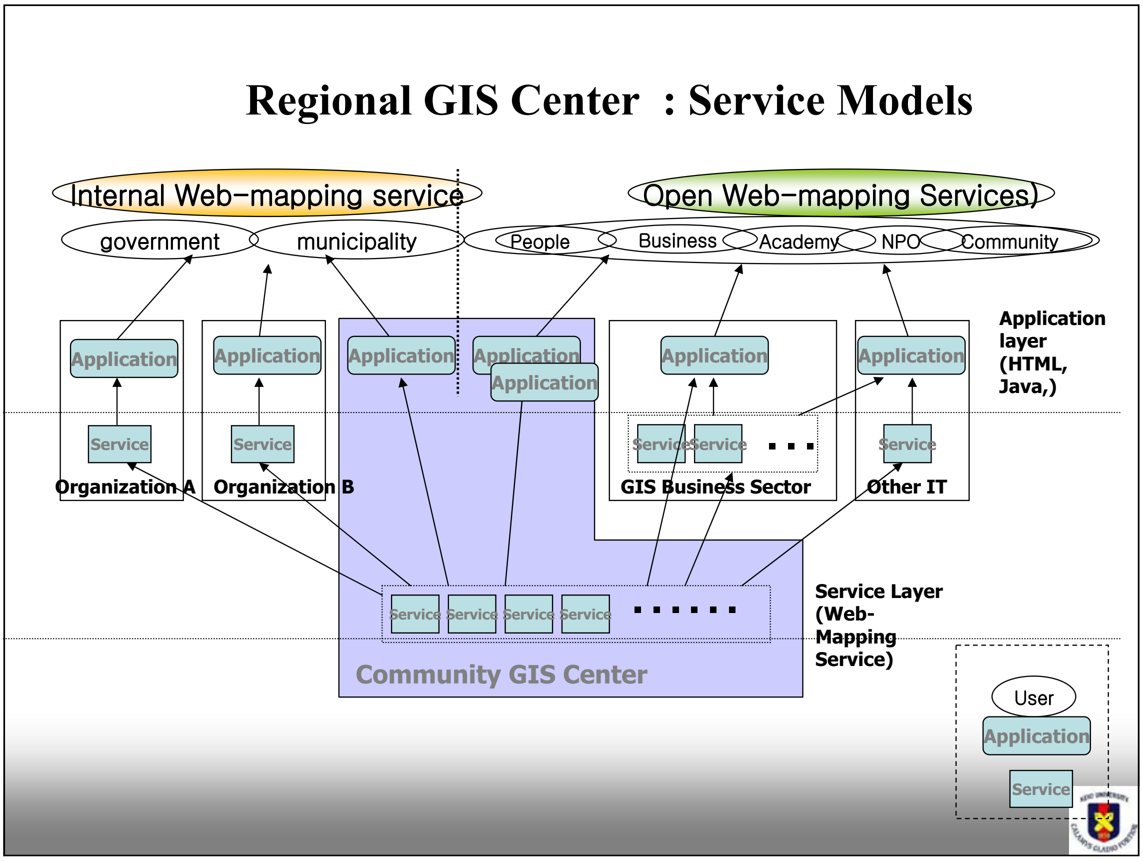
- Participatory Rural Appraisal: PRA
- Participatory learning and action: PLA
- Public Participation GIS: PPGIS, URISA
- Community Geography
- Community Mapping
- GIS in action
- Democracy in Practice

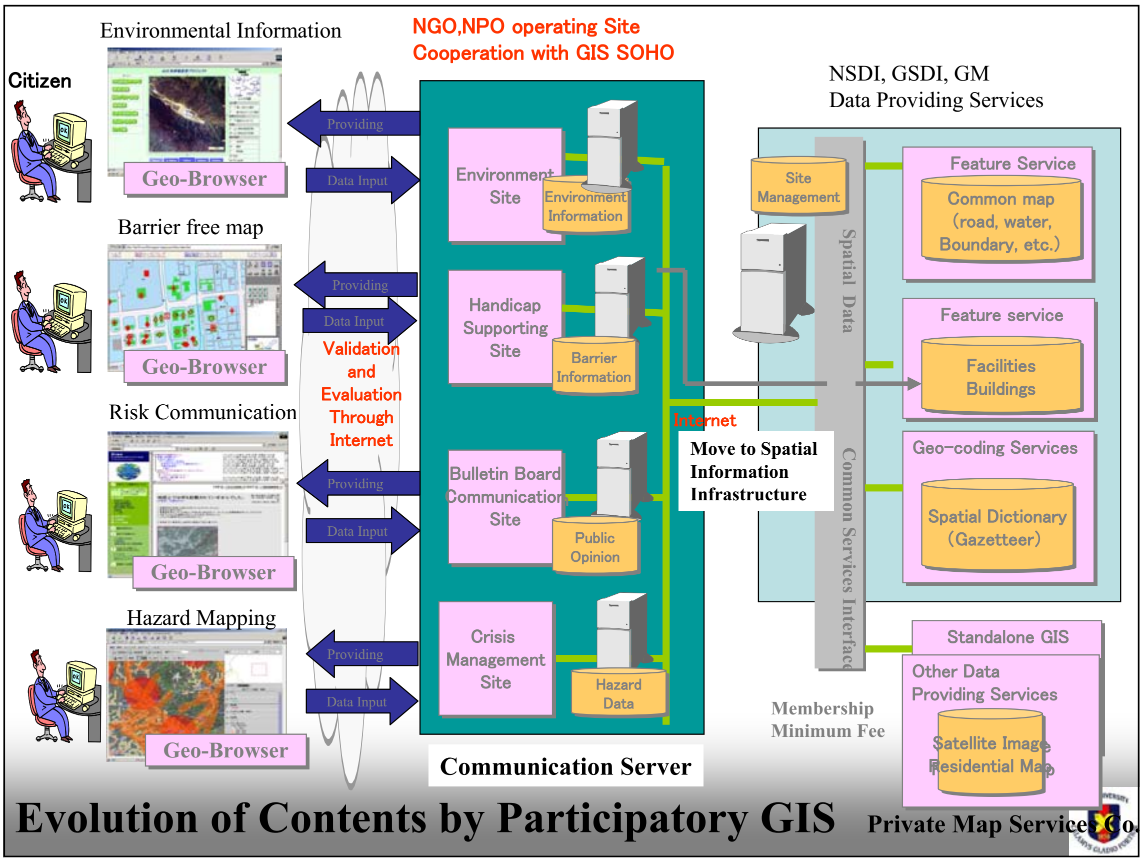
Participatory GIS practices democratize
GIS-based decision making processes
for marginalized groups

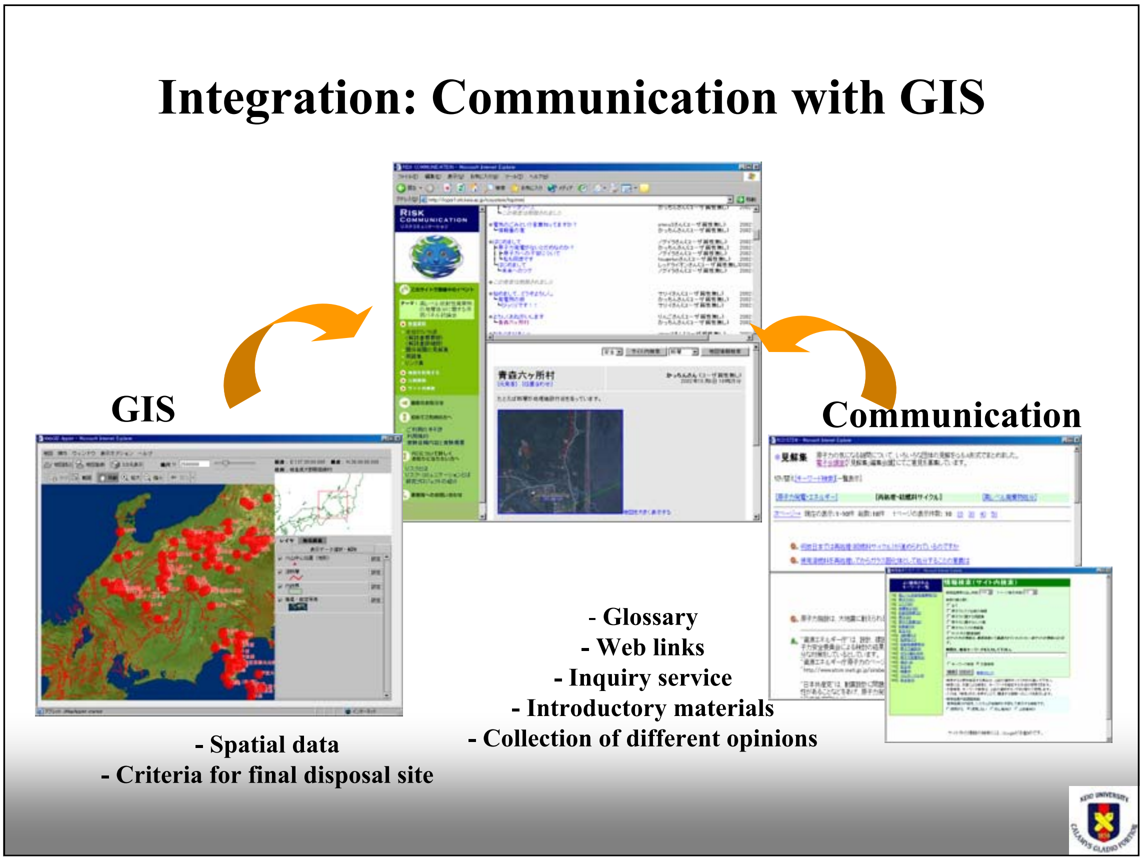

Show case ;
Integrated, Shared, Interoperable GIS
Governmental
Enterprise
University, School
Interoperable GIS platform
Resident
Municipality
Public facilities

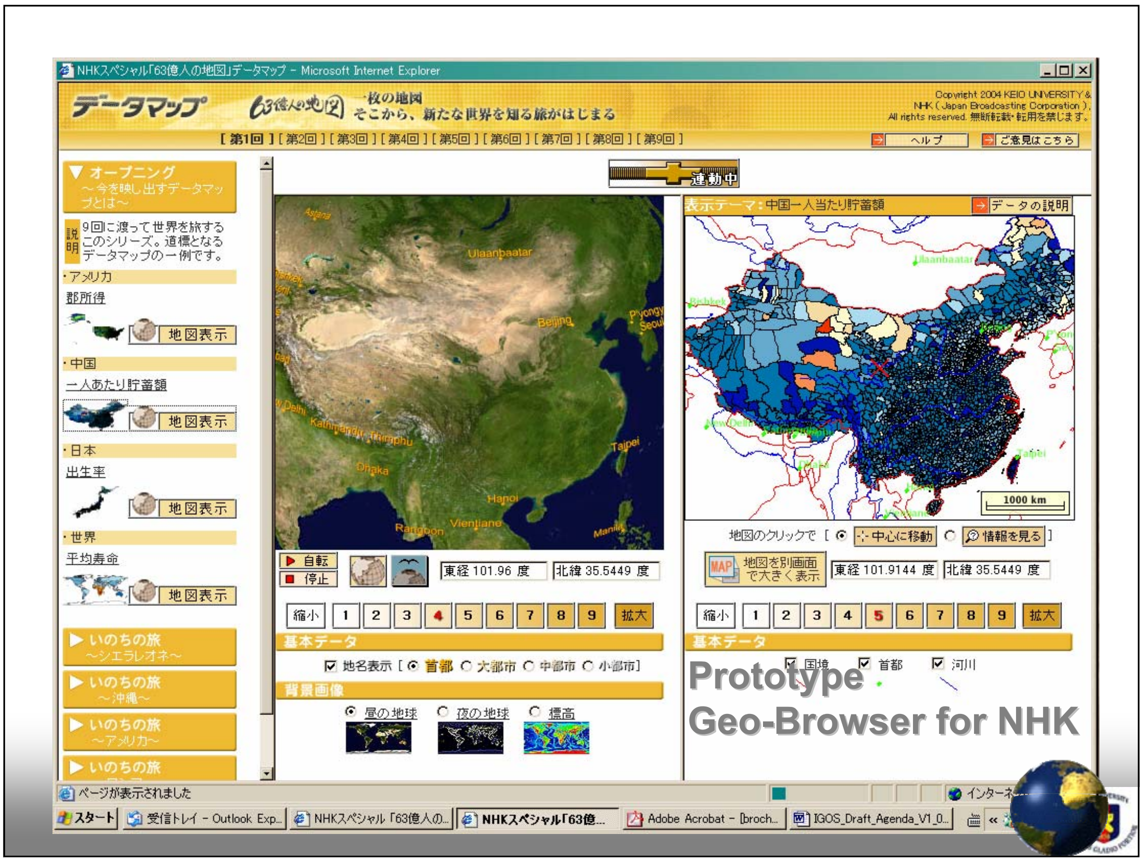

県域統合型GIS ぎふ
財団法人岐阜県建設研究センター
GIS
オリジナルマップを作る
みんなのマップを見る
みんなでマップを作る
オプションサービスのご案内
製品仕様、各種技術資料
住所一覧から探す
目標物一覧から探す
岐阜県の地域から探す
Topics おしらせ
New Map 新しいマップのお知らせ

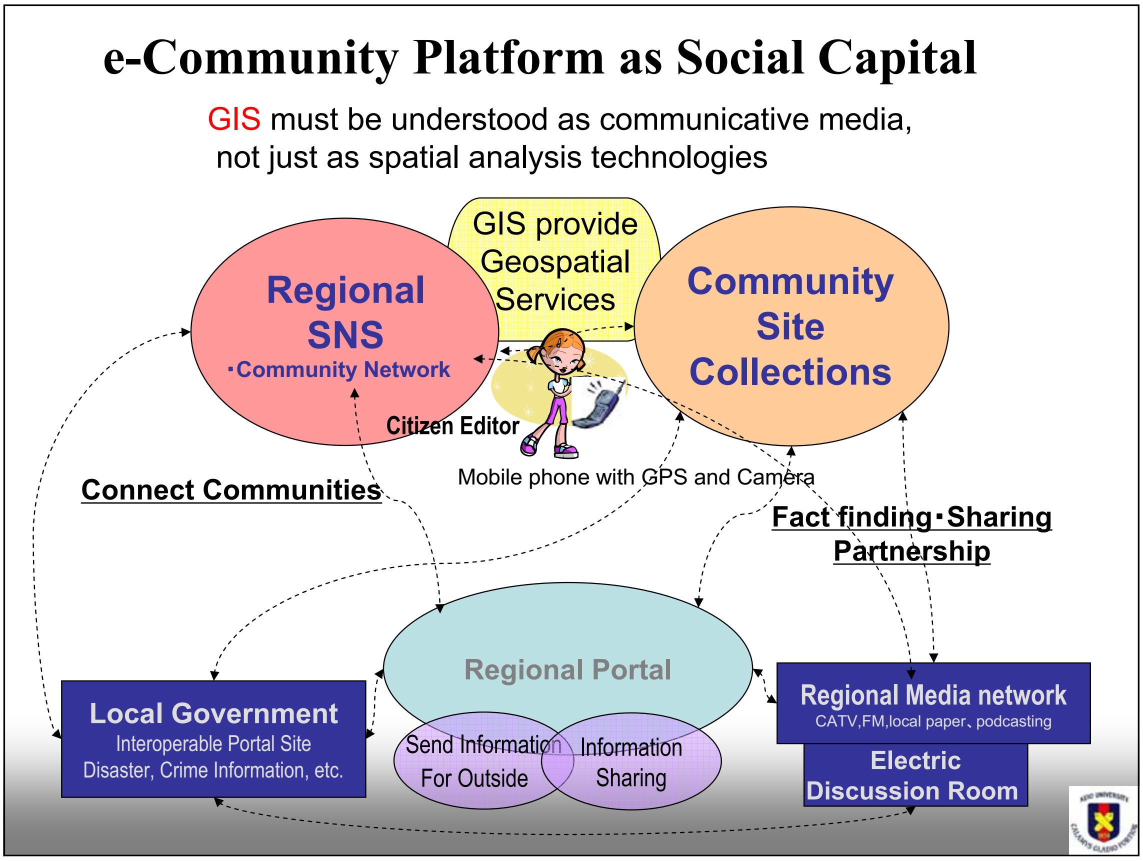

http://211.125.185.181 - 岐阜県警察犯罪発生マップ - Mozilla Firefox
岐阜県警察犯罪発生マップ
データ一覧
位置検索
範囲検索
計測
印刷
ヘルプ
マップTOPへ
分布図へ
凡例
詳細
機能
岐阜県警察犯罪発生マップ
ぎふけんけいさつ
犯罪発生地点
犯罪種類
声かけ＋ひったくり
声かけ
ひったくり
期間
1月からの累計
過去3ヶ月
前年
時間帯
全時間帯
0－6時
6－12時
12－18時
18－24時
種別
ひったくり
発生日時
2006/10/09 16:45
発生場所
岐阜市吹上町6丁目
発生状況
交差点を自転車で停車中、後方から近づいてきた2人乗りバイクに
犯人
男2名、20歳前後、運転手-短め茶髪
使用車両等
原付バイク
管轄警察署
岐阜中警察署
200 m
Crime map : Purse-snatching


Regional GIS Center : Service Models
Internal Web-mapping service
Open Web-mapping Services)
government
municipality
People
Business
Academy
NPO
Community
Application
Application
Application
Application
Application
Application
Application
Application
Application layer (HTML, Java,)
Service
Service
Service
Service
Service
Organization A
Organization B
GIS Business Sector
Other IT
Service
Service
Service
Service
Service Layer (Web-Mapping Service)
Community GIS Center
User
Application
Service


Environmental Information
NGO,NPO operating Site
Cooperation with GIS SOHO
Citizen
NSDI, GSDI, GM
Data Providing Services
Providing
Data Input
Geo-Browser
Environment Site
Environment Information
Site Management
Feature Service
Common map (road, water, Boundary, etc.)
Barrier free map
Handicap Supporting Site
Barrier Information
Spatial Data
Feature service
Facilities Buildings
Validation and Evaluation Through Internet
Risk Communication
Internet
Move to Spatial Information Infrastructure
Geo-coding Services
Spatial Dictionary (Gazetteer)
Bulletin Board Communication Site
Public Opinion
Common Services Interface
Hazard Mapping
Crisis Management Site
Hazard Data
Standalone GIS
Other Data Providing Services
Membership Minimum Fee
Satellite Image
Residential Map
Communication Server
Evolution of Contents by Participatory GIS
Private Map Service Co.


Integration: Communication with GIS
GIS
Communication
- Glossary
- Web links
- Inquiry service
- Introductory materials
- Collection of different opinions
- Spatial data
- Criteria for final disposal site


NHKスペシャル「63億人の地図」データマップ - Microsoft Internet Explorer
データマップ
一枚の地図
そこから、新たな世界を知る旅がはじまる
Copyright 2004 KEIO UNIVERSITY &
NHK (Japan Broadcasting Corporation),
[第1回] [第2回] [第3回] [第4回] [第5回] [第6回] [第7回] [第8回] [第9回]
ヘルプ
ご意見はこちら
オープニング
9回に渡って世界を旅するこのシリーズ。道標となるデータマップの一例です。
アメリカ
郡所得
地図表示
中国
一人あたり貯蓄額
日本
出生率
世界
平均寿命
いのちの旅
連動中
表示テーマ：中国一人当たり貯蓄額
データの説明
地図のクリックで
中心に移動
情報を見る
東経 101.96 度
北緯 35.5449 度
東経 101.9144 度
北緯 35.5449 度
縮小
拡大
基本データ
地名表示
首都
背景画像
昼の地球
夜の地球
標高
国境
河川
ページが表示されました
Prototype
Geo-Browser for NHK

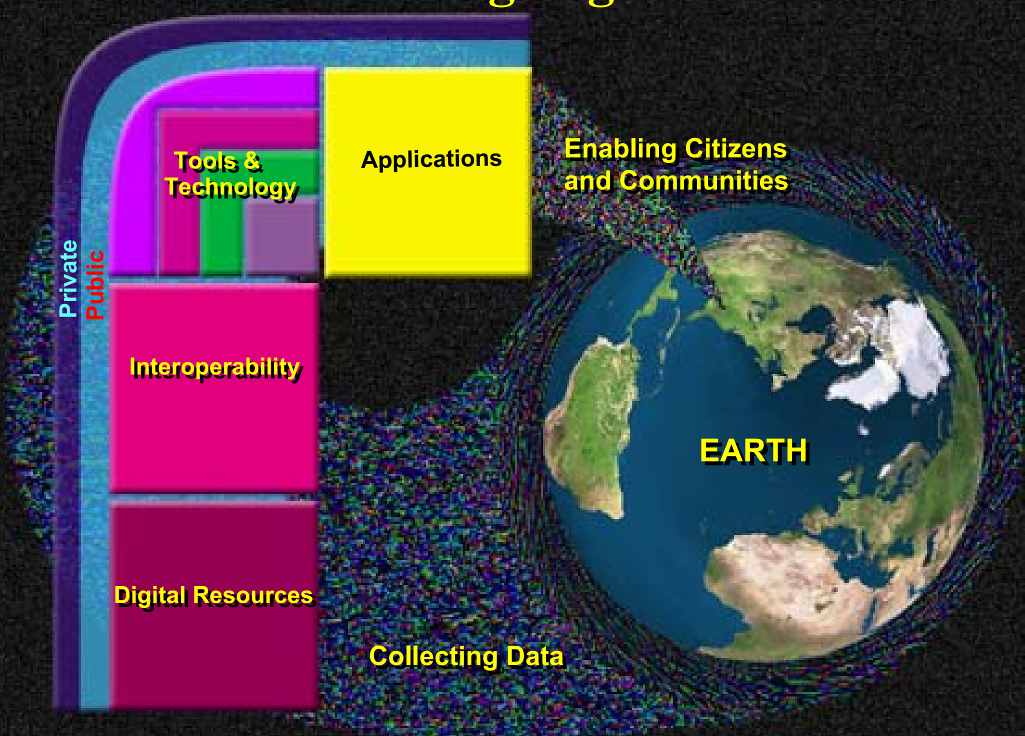

e-Community Platform as Social Capital
GIS must be understood as communicative media,
not just as spatial analysis technologies
GIS provide Geospatial Services
Regional SNS
・Community Network
Community Site Collections
Citizen Editor
Mobile phone with GPS and Camera
Connect Communities
Fact finding・Sharing
Partnership
Regional Portal
Send Information For Outside
Information Sharing
Local Government
Interoperable Portal Site
Disaster, Crime Information, etc.
Regional Media network
CATV,FM,local paper、podcasting
Electric Discussion Room

The Digital Earth Vision

- I believe we need a ' Digital Earth', a multi-resolution, three-dimensional representation of the planet, into which we can embed vast quantities of geo-referenced data.
- a 'collaboratory' for research scientists seeking to understand the complex interaction between humanity and our environment.
- a 'user interface' -- a browsable, 3-D version of the planet available at various levels of resolution, a rapidly growing universe of networked geospatial information, and the mechanisms for integrating and displaying information from multiple sources.

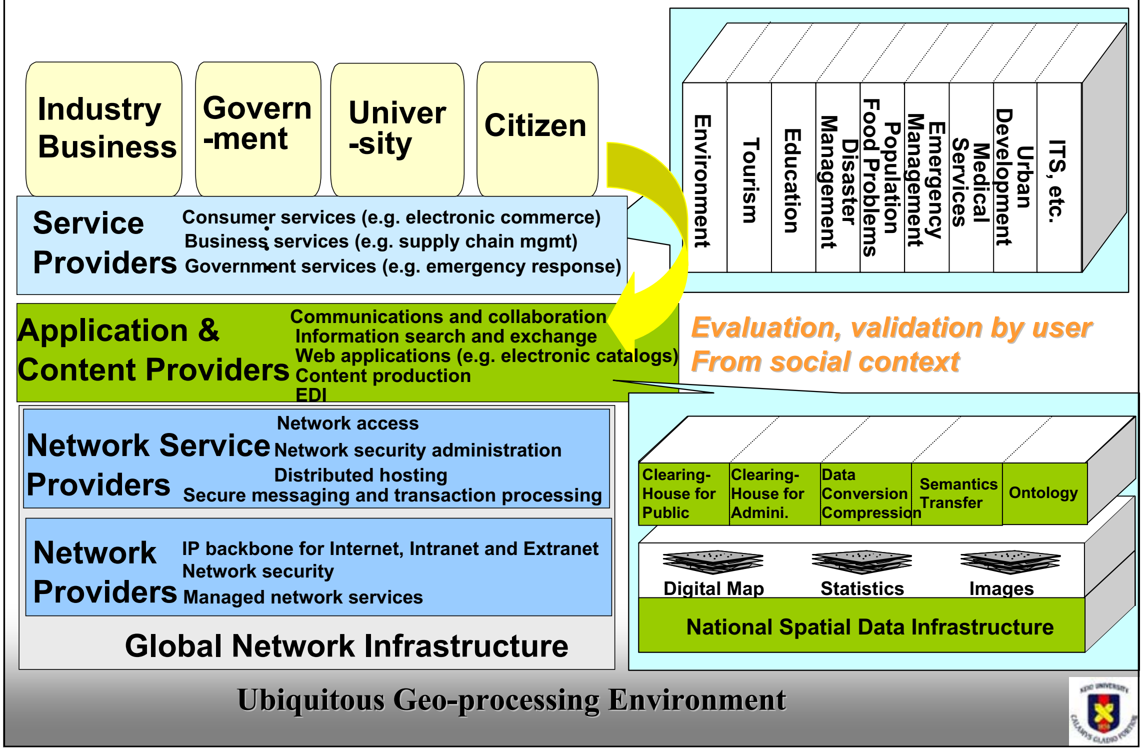
(Gore,1998)

Understanding Digital Earth



(White paper by NASA Digital Earth office, 2000)

Framework of Digital Earth



Digital Earth History

1999 -1st Inter. Sympo., CAS, *Beijing*, China, *Towards DE*
Established "International Steering Committee for ISDE

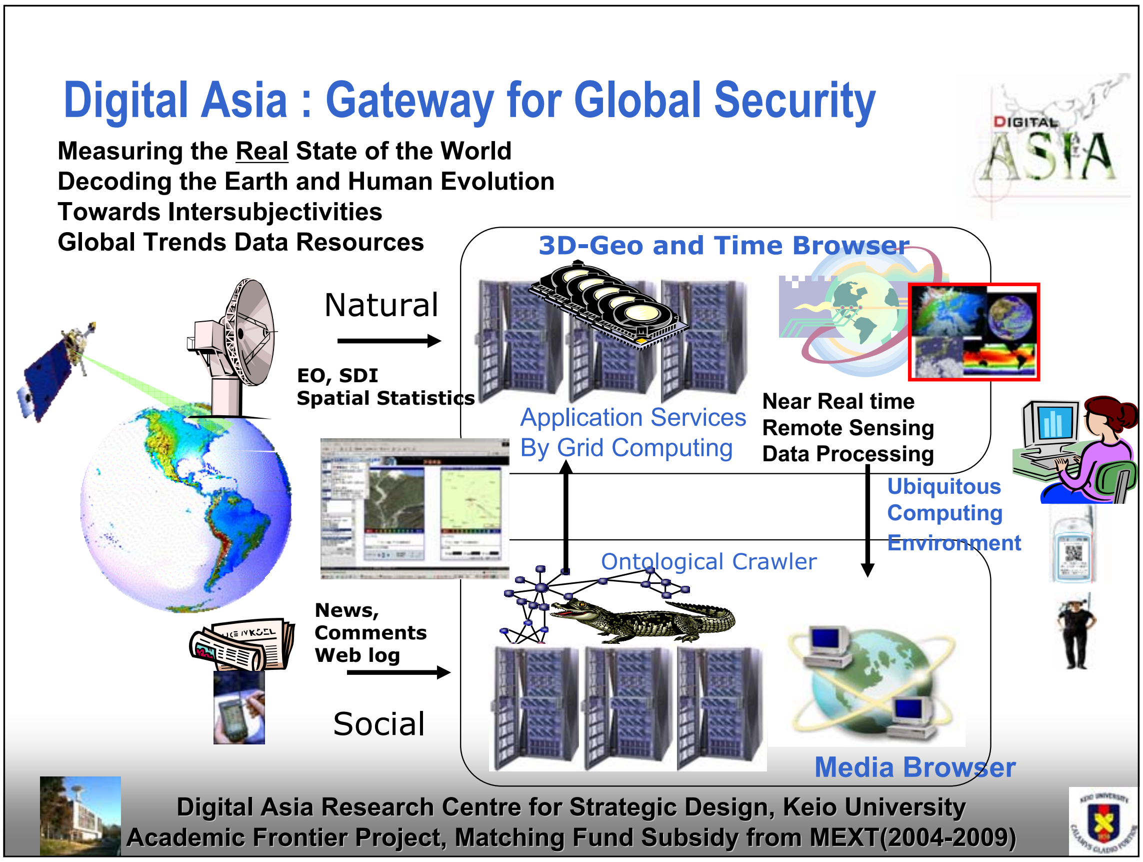
2001 -2nd Inter. Sympo., *New Brunswick*, Canada, *Beyond Inf. Infra.*

2003 -3rd International Symposium, *Brno*, Czech Rep.
DE -- Information *Resources for Global Sustainability*

2005 -4th International Symposium, March 28-31, *Tokyo*, Japan
DE as the Global Commons

2006-1st International Society of Digital Earth launched on May 21, at Beijing

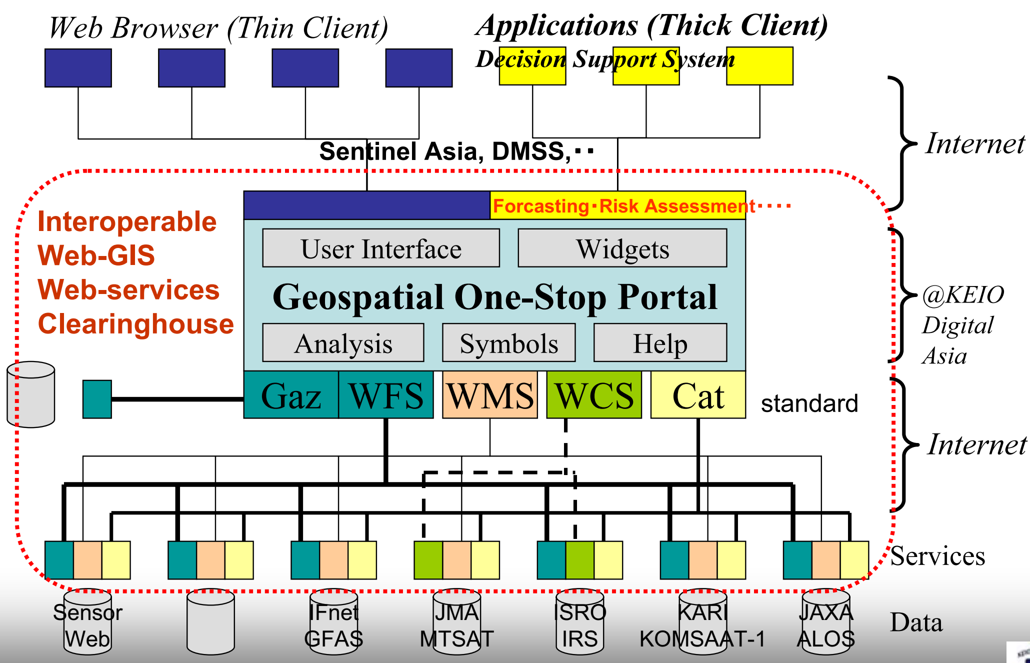
2007- 5th International Symposium, June 5-9, San Francisco, USA
Grand challenge Digital Earth 3D visualization Contest



Action Plan 1 : Digital Asia (DA) Geospatial Data Portal project for data sharing

- To co-ordinate DA node network activities in the area of improving access to both global and local EO datasets and Geospatial data infrastructure including multi-resolution, multi-sensor and multi-date environment and socioeconomic data.
- To encourage the use of OGC standards to support the interoperability of data services.
- To prototype OGC-based web-services in order to generate Guidelines & Lessons learnt Documents to assist with the implementation of operational systems.
- To maintain a DA Geospatial Data Portal Web-site containing links to the OGC-compliant data servers of DA node network as well as CEOS members and others.

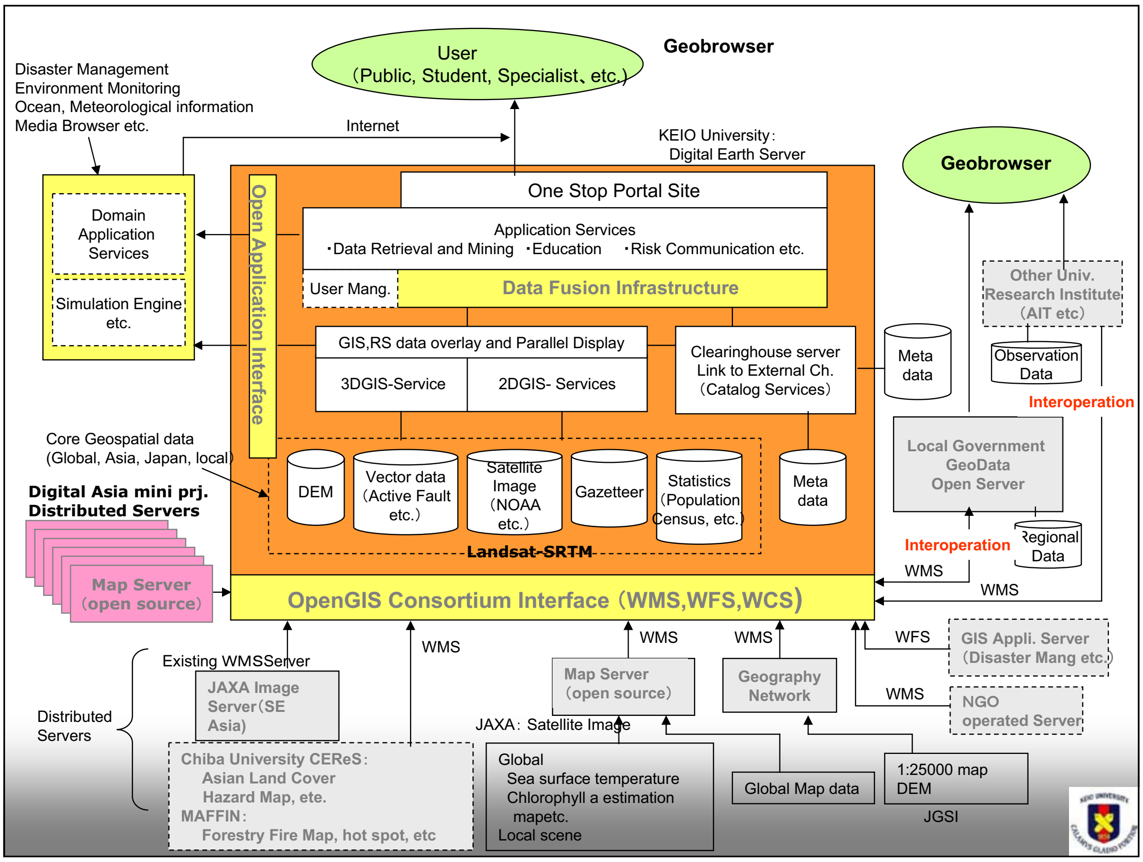
Geo Web Services

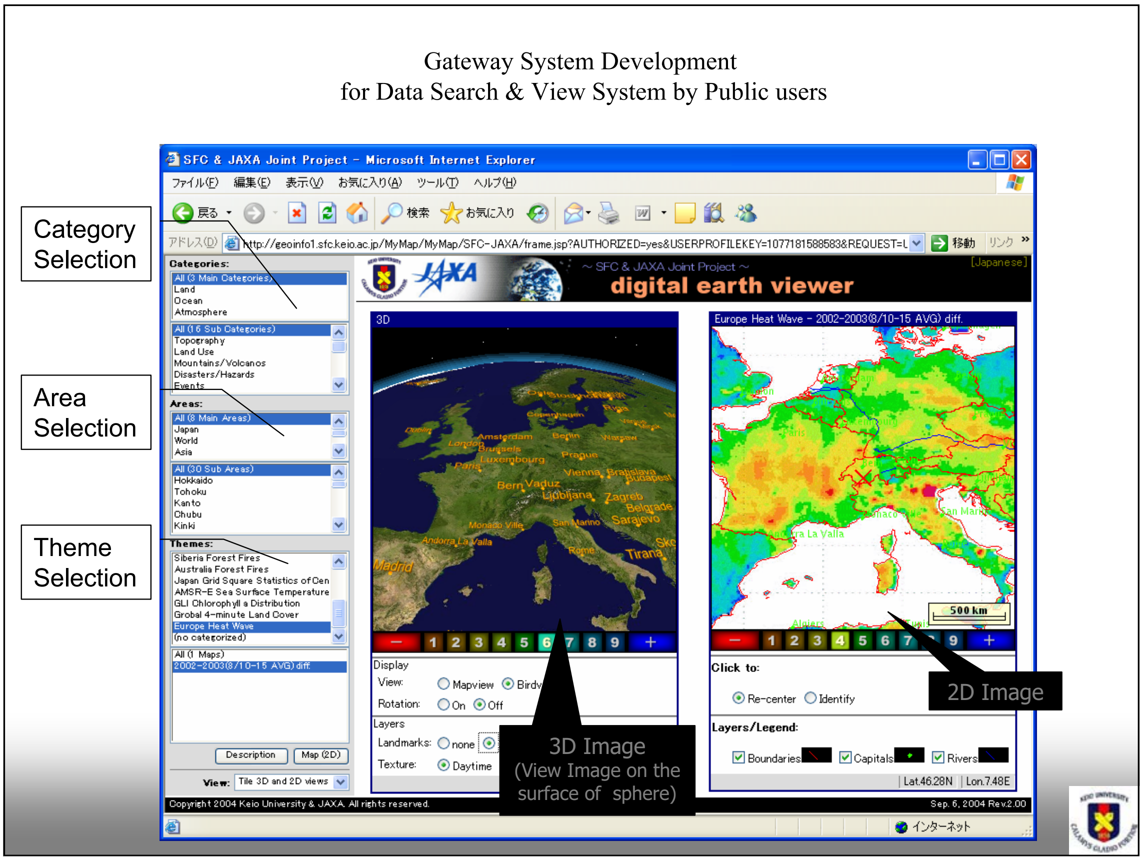


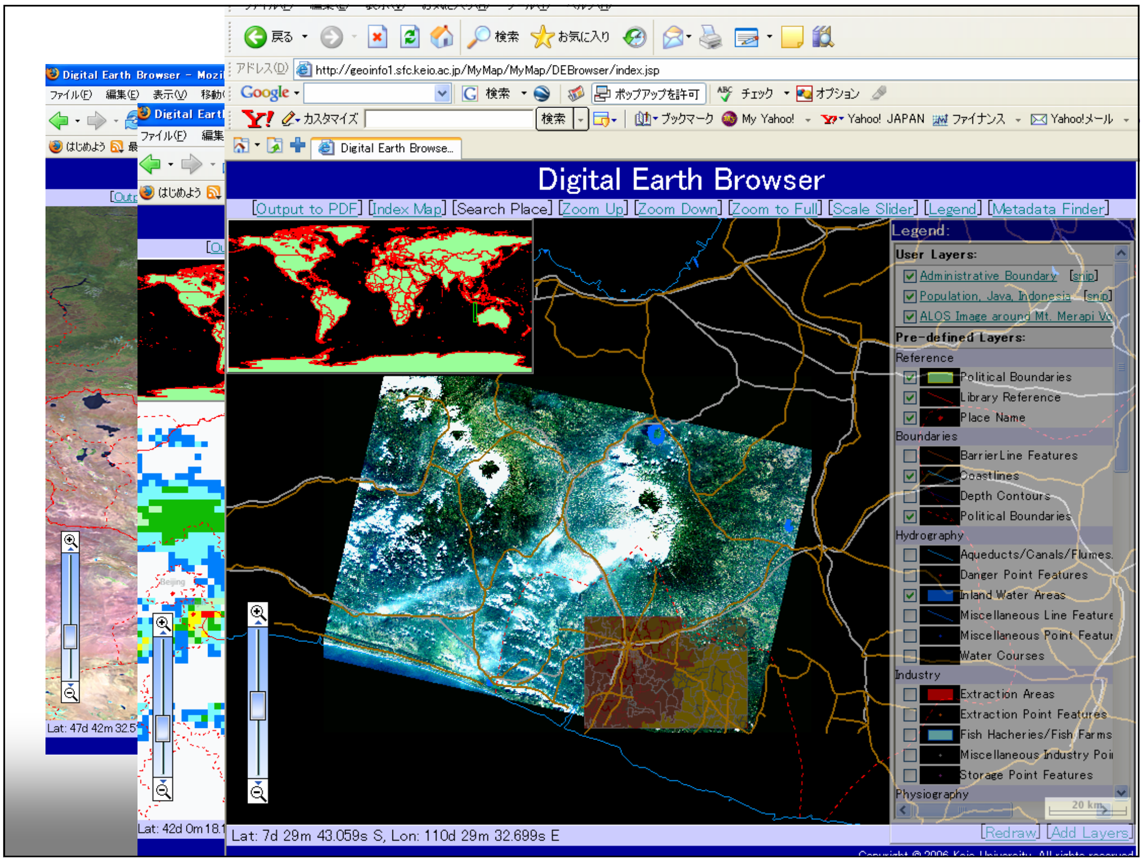
Digital Asia Node Network

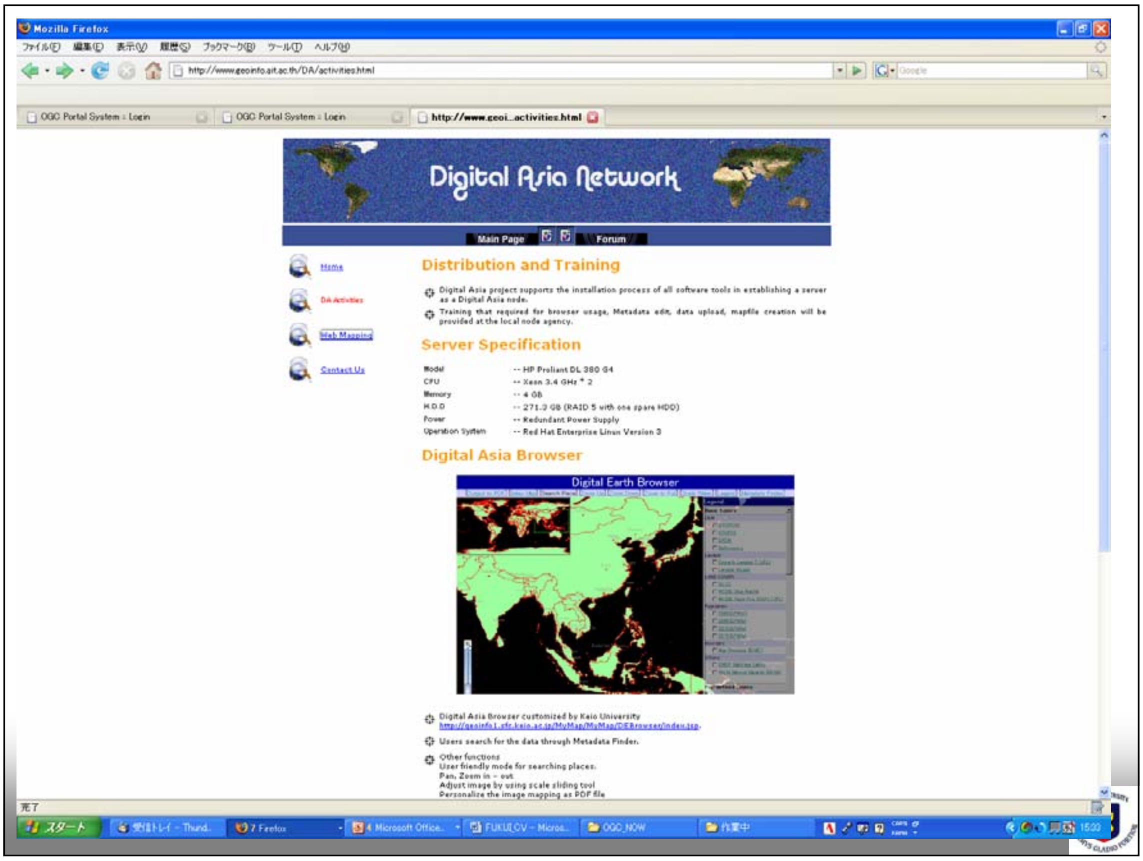
- 1. AIT/GISTDA, Thailand
- 2. LAPAN, Indonesia
- 3. Survey Department, Sri Lanka
- 4. Institute of Geography/VAST, Vietnam
- 5. ICIMOD
- 6. UNEP-AP
- 7. Beijing Normal University
- 8. NAMRIA, Philippine
- 9. National University Mongolia
- 10. Fuzho University
- 11. CRISP Singapore
- …..

Keio Univ.provide WebGIS-base Platform
30 terminals in 5 years


Geobrowser
User
(Public, Student, Specialist、etc.)
Disaster Management
Environment Monitoring
Ocean, Meteorological information
Media Browser etc.
Internet
KEIO University:
Digital Earth Server
Geobrowser
One Stop Portal Site
Open Application Interface
Domain Application Services
Simulation Engine etc.
Application Services
・Data Retrieval and Mining ・Education ・Risk Communication etc.
User Mang.
Data Fusion Infrastructure
Other Univ. Research Institute (AIT etc)
GIS,RS data overlay and Parallel Display
3DGIS-Service
2DGIS- Services
Clearinghouse server
Link to External Ch.
(Catalog Services)
Meta data
Observation Data
Interoperation
Core Geospatial data
(Global, Asia, Japan, local)
Digital Asia mini prj.
Distributed Servers
DEM
Vector data (Active Fault etc.)
Satellite Image (NOAA etc.)
Gazetteer
Statistics (Population Census, etc.)
Meta data
Local Government GeoData Open Server
Landsat-SRTM
Interoperation
Regional Data
Map Server (open source)
OpenGIS Consortium Interface (WMS,WFS,WCS)
WMS
WMS
WMS
WMS
WMS
WFS
WMS
Existing WMSServer
JAXA Image Server(SE Asia)
Map Server (open source)
Geography Network
GIS Appli. Server (Disaster Mang etc.)
NGO operated Server
Distributed Servers
JAXA: Satellite Image
Chiba University CEReS:
Asian Land Cover
Hazard Map, ete.
MAFFIN:
Forestry Fire Map, hot spot, etc
Global
Sea surface temperature
Chlorophyll a estimation
mapetc.
Local scene
Global Map data
1:25000 map
DEM
JGSI

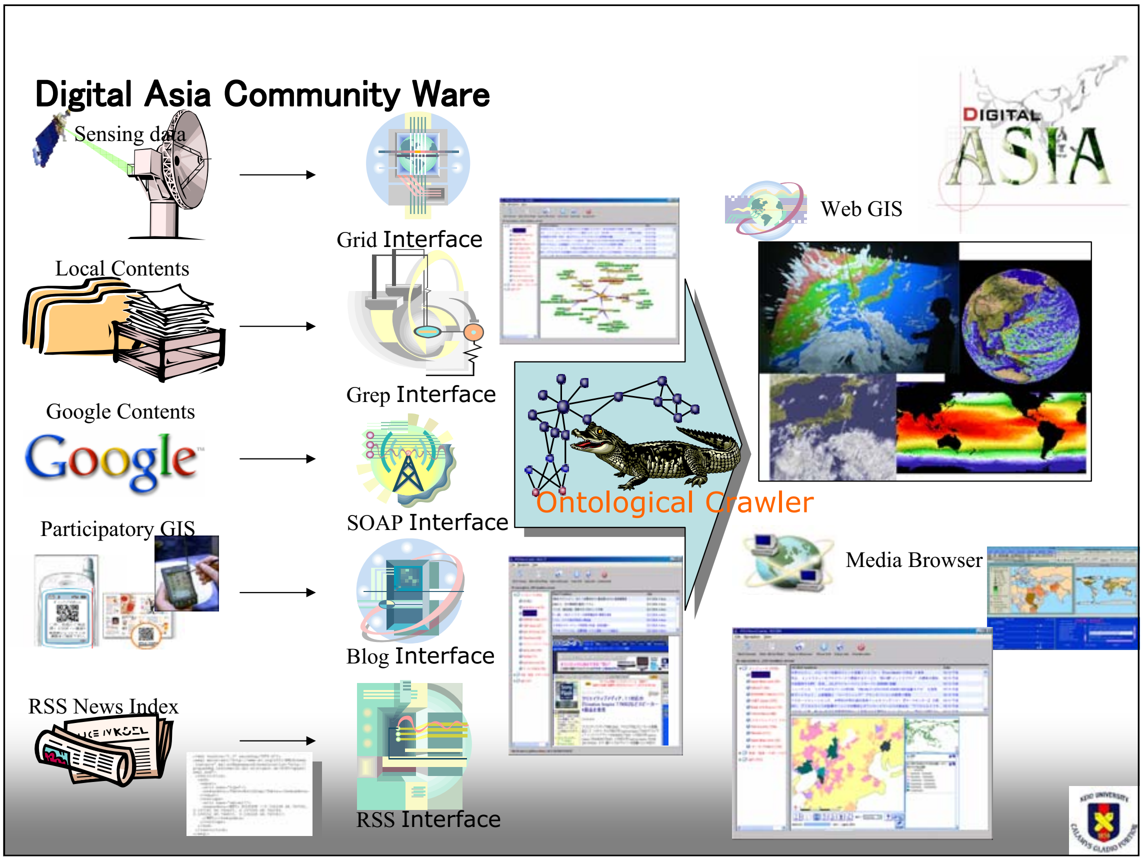

Gateway System Development
for Data Search & View System by Public users
Category Selection
Area Selection
Theme Selection
SFC & JAXA Joint Project - Microsoft Internet Explorer
digital earth viewer
Europe Heat Wave - 2002-2003(8/10-15 AVG) diff.
2D Image
3D Image
(View Image on the surface of sphere)
Copyright 2004 Keio University & JAXA. All rights reserved.


Digital Earth Browser
[Output to PDF] [Index Map] [Search Place] [Zoom Up] [Zoom Down] [Zoom to Full] [Scale Slider] [Legend] [Metadata Finder]
Legend:
User Layers:
Administrative Boundary
Population, Java, Indonesia
Pre-defined Layers:
Reference
Political Boundaries
Library Reference
Place Name
Boundaries
BarrierLine Features
Coastlines
Depth Contours
Political Boundaries
Hydrography
Aqueducts/Canals/Flumes
Danger Point Features
Inland Water Areas
Miscellaneous Line Feature
Miscellaneous Point Featur
Water Courses
Industry
Extraction Areas
Extraction Point Features
Fish Hacheries/Fish Farms
Miscellaneous Industry Poi
Storage Point Features
Physiography
Lat: 7d 29m 43.059s S, Lon: 110d 29m 32.699s E
[Redraw] [Add Layers]


Digital Asia Network
Main Page
Forum
Distribution and Training
Digital Asia project supports the installation process of all software tools in establishing a server as a Digital Asia node.
Training that required for browser usage, Metadata edit, data upload, mapfile creation will be provided at the local node agency.
Server Specification
Digital Asia Browser
Digital Earth Browser

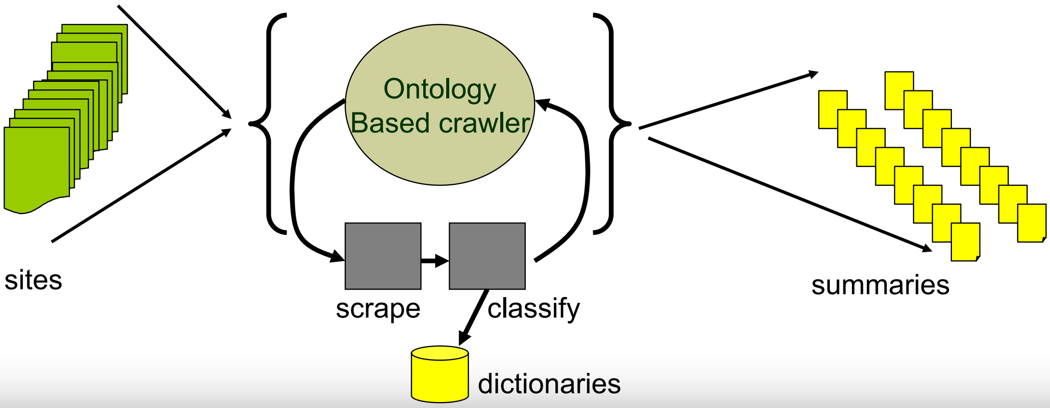
Action Plan2:
Digital Asia Community ware Project

- This component is aimed at fabrication and operation of an automated internet Newsbrowser running on an ontological engine.
- It releases crawlers into the ocean of information, retrieves ripples of socioeconomic incidents or ambivalences of environmental issues from numerous WWW news sites, and exhibits relativity of viewpoints held by communities.
- It is more geared toward recognition of disparity rather than alert detection or news tracking. This media browser and the Digital Asia Platform of the first component are designed to be complementary to each other. While the latter provides scientific measurements, the former reveals how facts echo in communities. In other words, **the platform offers a point of reference, and the media browser informs communities their relative positions in an ontological (semantic) space.**
- This components will exceed existing IT apparatus such as WEB-GIS, BBS or weblog, and enable envisioning of "better" future for Asia.

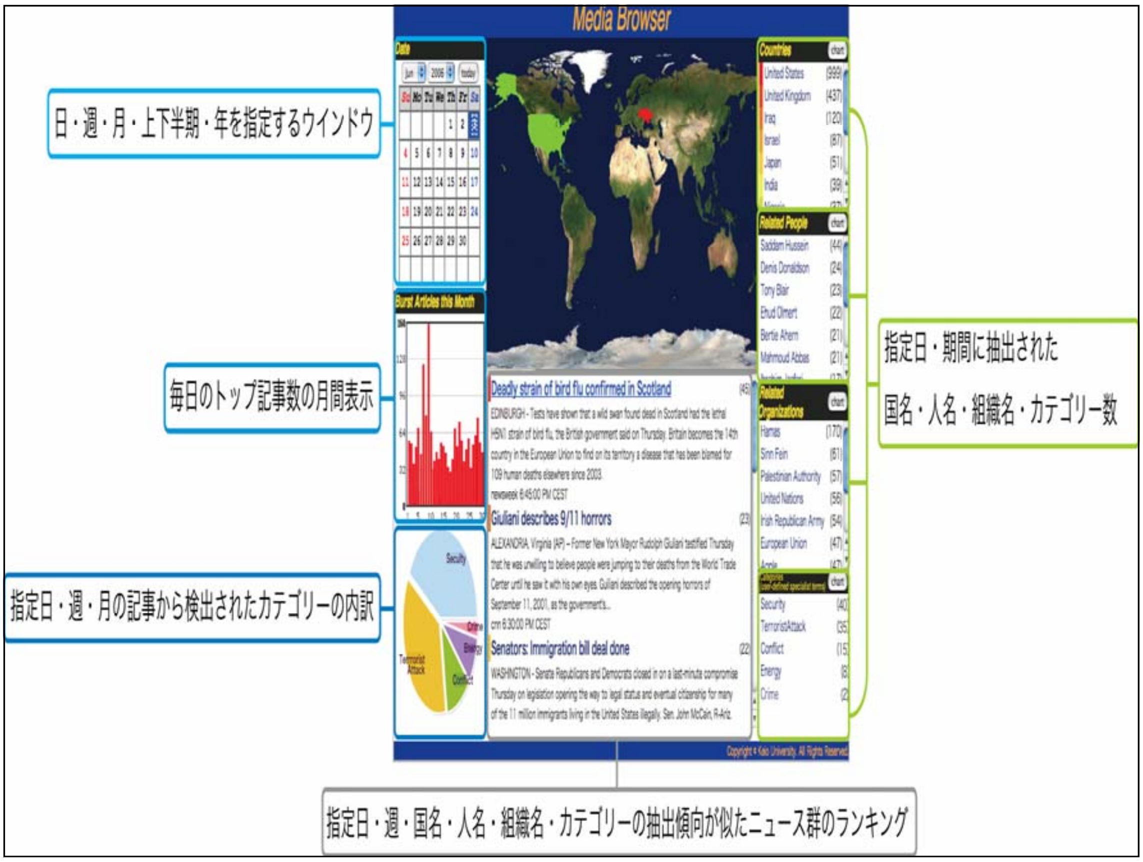


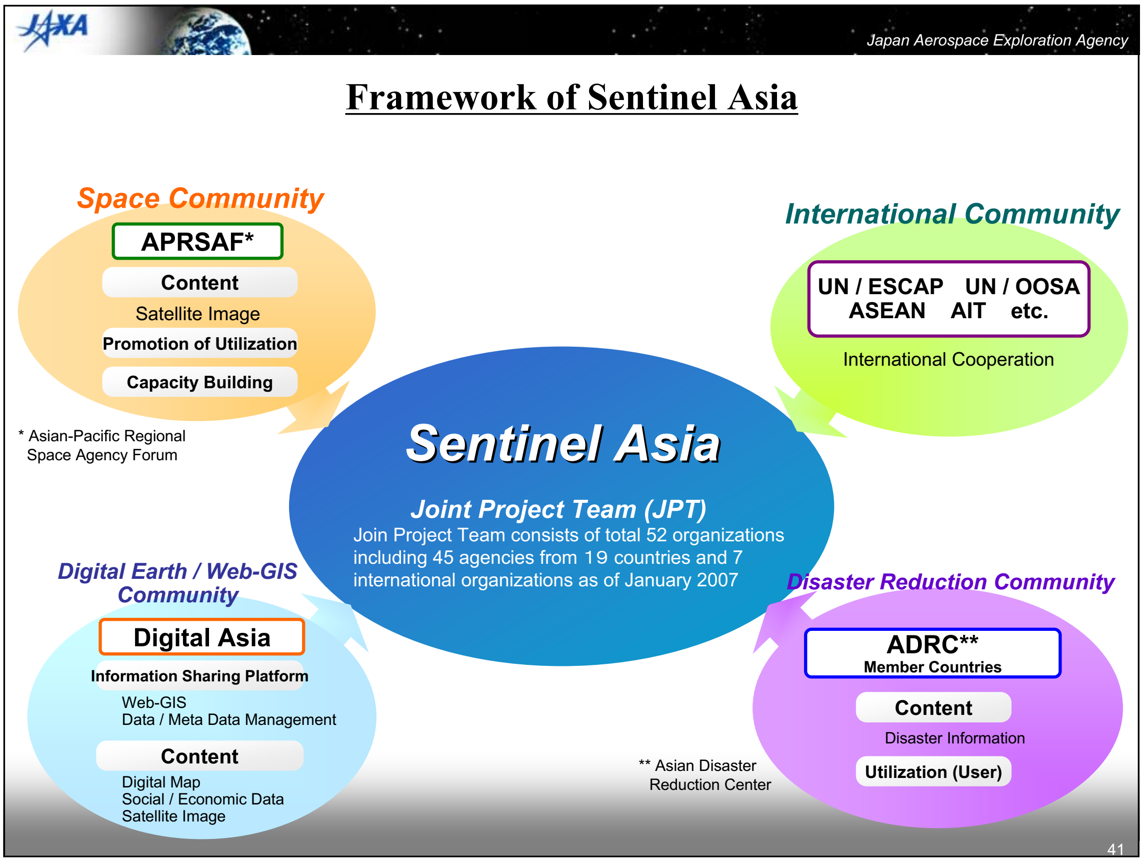
Application to Semantic Web
by Ontology

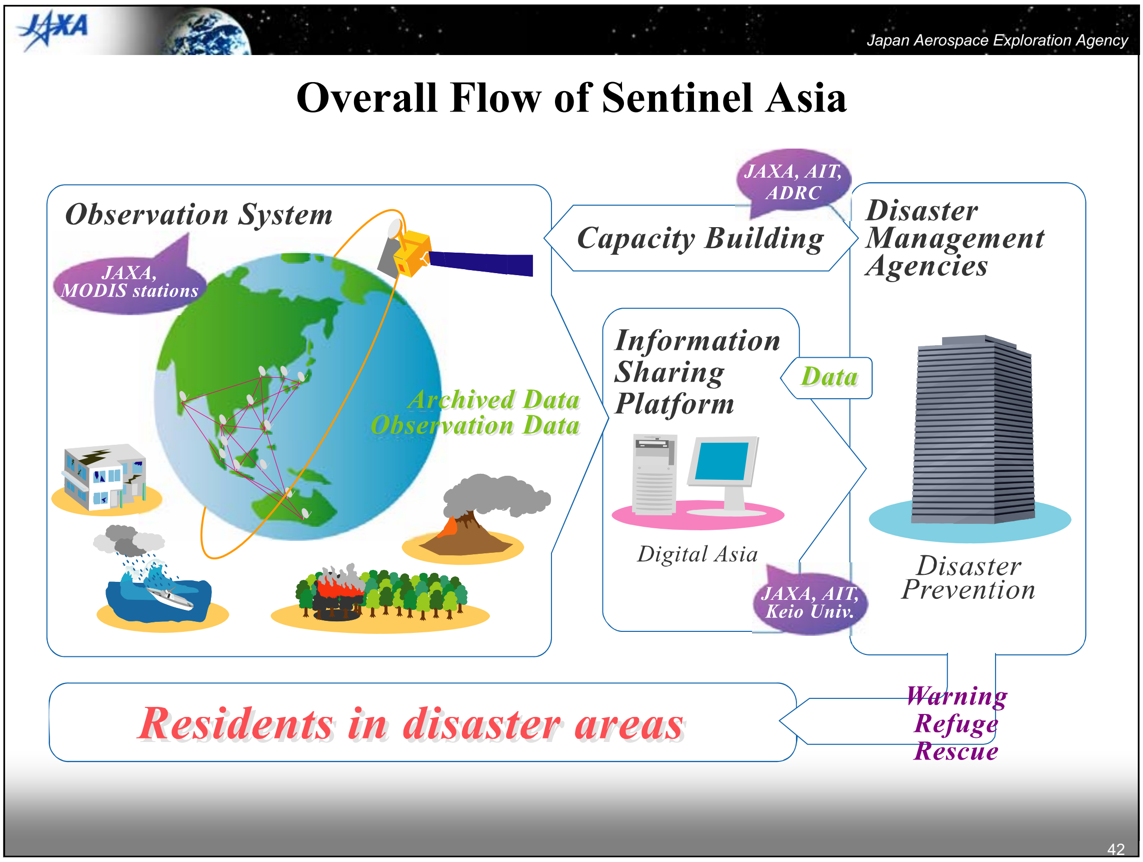
- a smart crawler for Global Securities such as Economics, Food, Health, Environment, Individual Freedom, Communities, Politics….



Lists of target Web Sites




JAXA
Japan Aerospace Exploration Agency
Framework of Sentinel Asia
Space Community
APRSAF*
Content
Satellite Image
Promotion of Utilization
Capacity Building
* Asian-Pacific Regional Space Agency Forum
International Community
UN / ESCAP UN / OOSA
ASEAN AIT etc.
International Cooperation
Sentinel Asia
Joint Project Team (JPT)
Join Project Team consists of total 52 organizations including 45 agencies from 19 countries and 7 international organizations as of January 2007
Digital Earth / Web-GIS Community
Digital Asia
Information Sharing Platform
Web-GIS
Data / Meta Data Management
Content
Digital Map
Social / Economic Data
Satellite Image
Disaster Reduction Community
ADRC**
Member Countries
Content
Disaster Information
Utilization (User)
** Asian Disaster Reduction Center
41


JAXA
Japan Aerospace Exploration Agency
Overall Flow of Sentinel Asia
Observation System
JAXA, MODIS stations
Archived Data
Observation Data
JAXA, AIT, ADRC
Capacity Building
Disaster Management Agencies
Information Sharing Platform
Data
Digital Asia
JAXA, AIT, Keio Univ.
Disaster Prevention
Residents in disaster areas
Warning
Refuge
Rescue
42

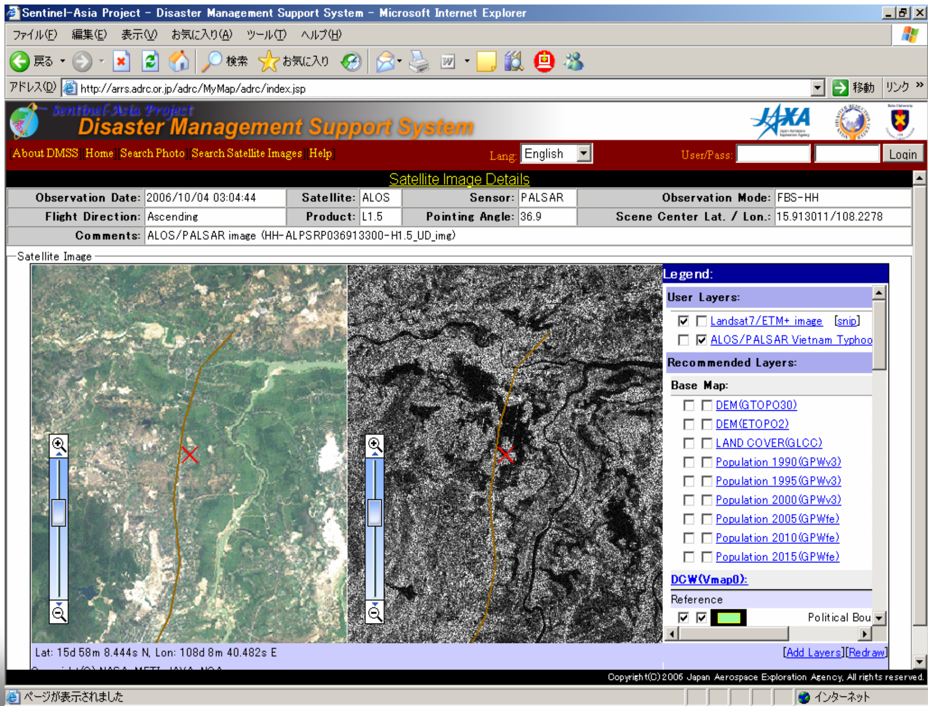
Japan Aerospace Exploration Agency

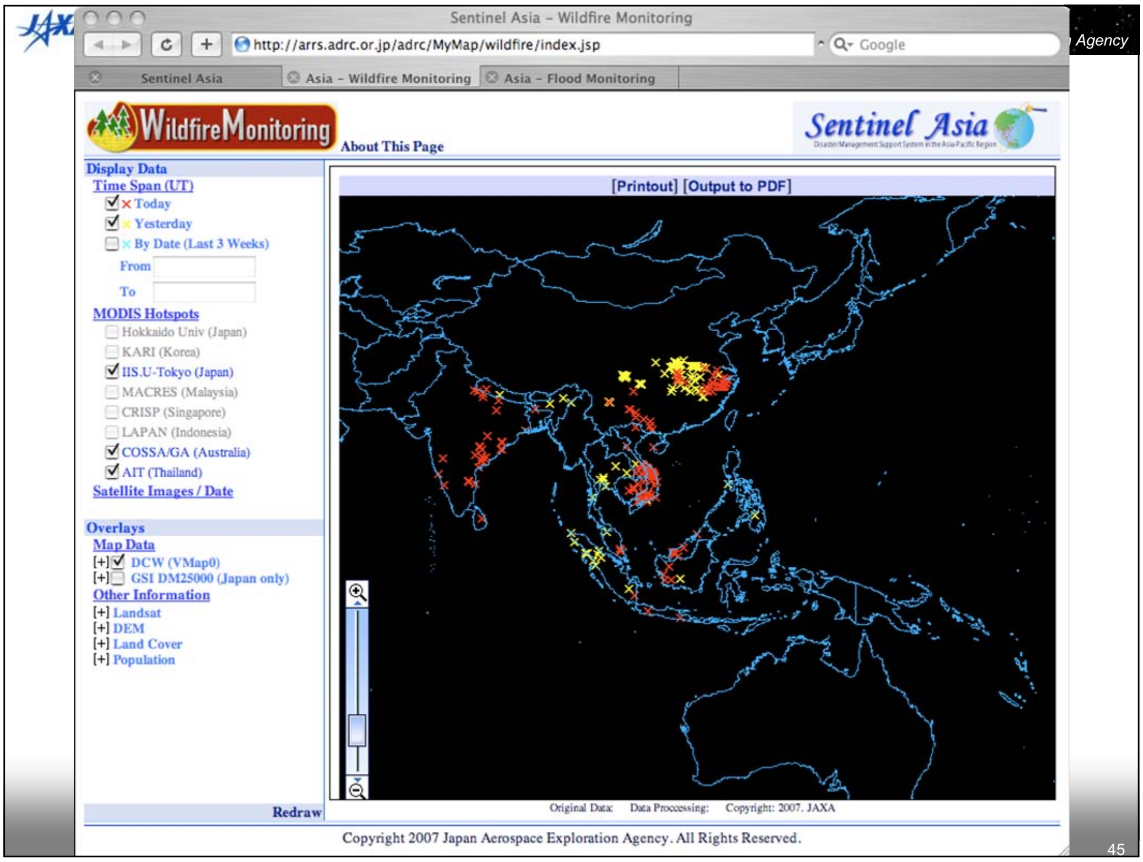
Sentinel Asia Web Site

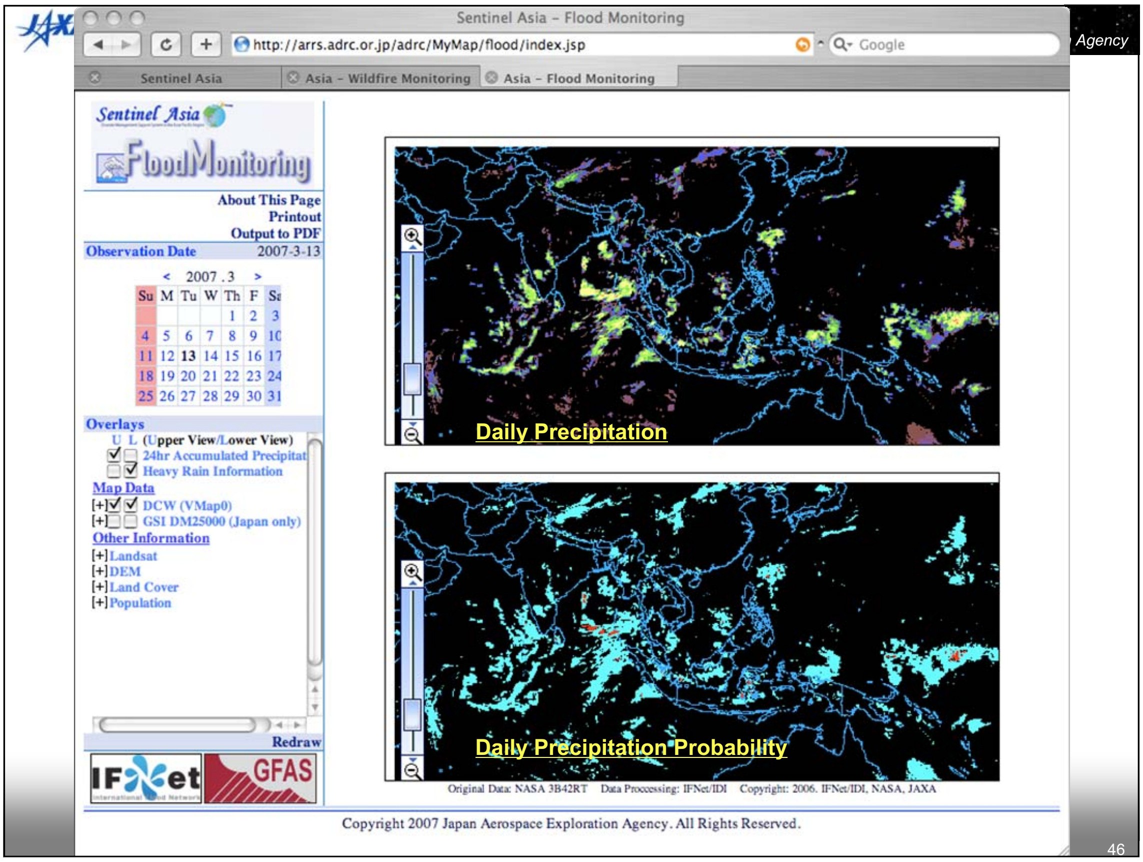
http://dmss.tksc.jaxa.jp/sentinel/

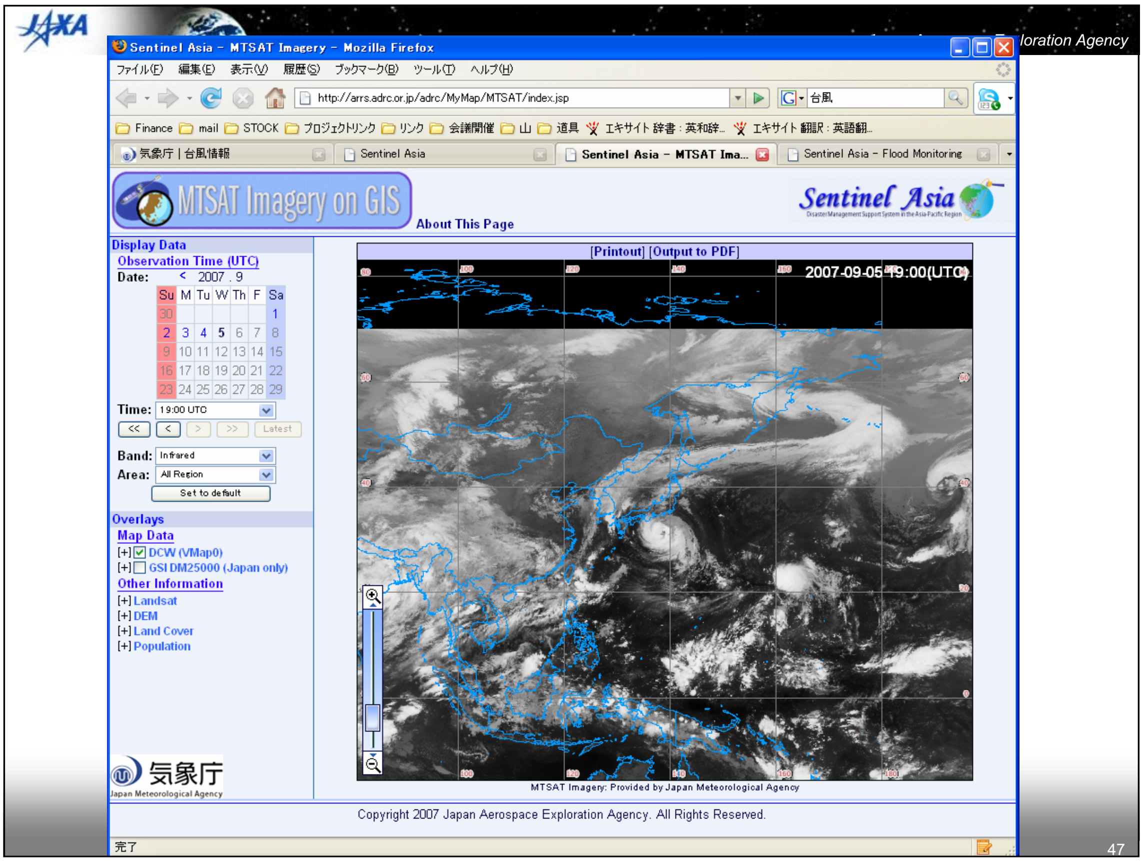
Japan Aerospace Exploration Agency

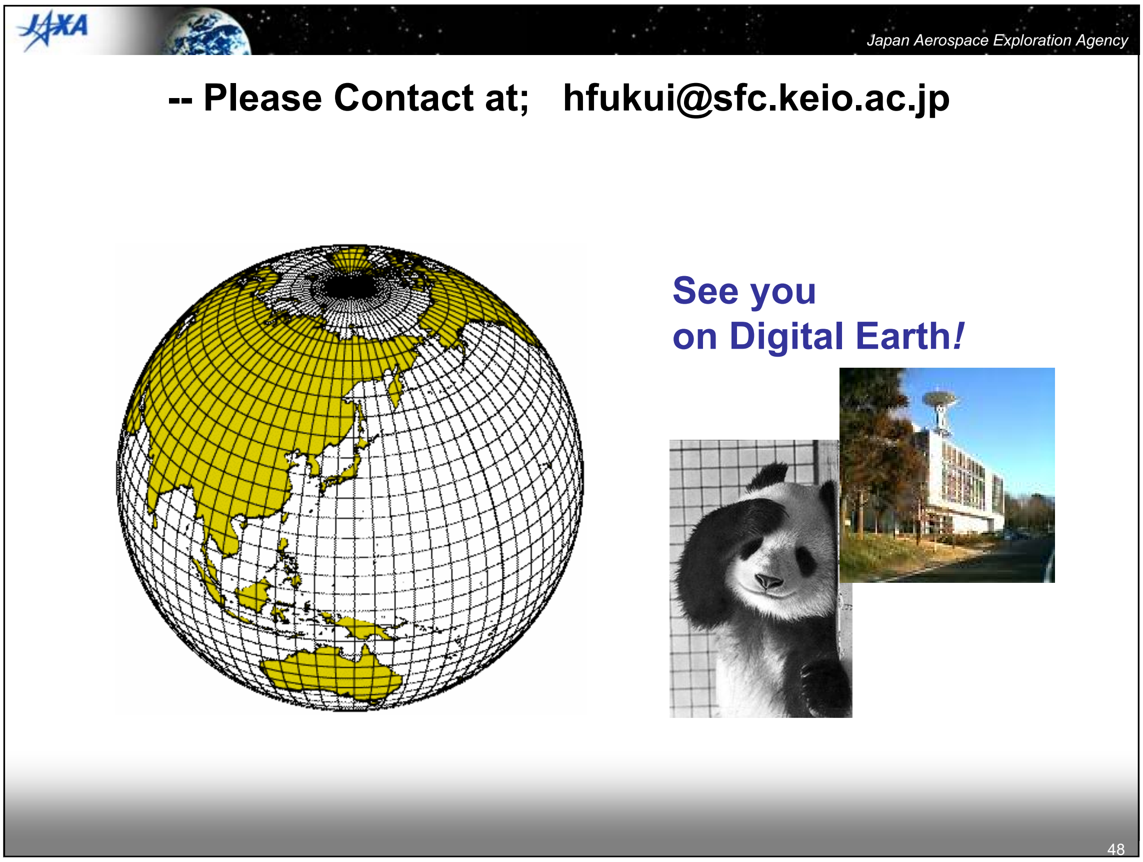
Comparison of different Sensor Images




Sentinel Asia - Wildfire Monitoring
http://arrs.adrc.or.jp/adrc/MyMap/wildfire/index.jsp
Sentinel Asia
Asia - Wildfire Monitoring
Asia - Flood Monitoring
Wildfire Monitoring
About This Page
Sentinel Asia
[Printout] [Output to PDF]
Display Data
Time Span (UT)
Today
Yesterday
By Date (Last 3 Weeks)
From
To
MODIS Hotspots
Hokkaido Univ (Japan)
KARI (Korea)
IIS.U-Tokyo (Japan)
MACRES (Malaysia)
CRISP (Singapore)
LAPAN (Indonesia)
COSSA/GA (Australia)
AIT (Thailand)
Satellite Images / Date
Overlays
Map Data
DCW (VMap0)
GSI DM25000 (Japan only)
Other Information
Landsat
DEM
Land Cover
Population
Redraw
Original Data: Data Processing: Copyright: 2007. JAXA
Copyright 2007 Japan Aerospace Exploration Agency. All Rights Reserved.
45


Sentinel Asia - Flood Monitoring
http://arrs.adrc.or.jp/adrc/MyMap/flood/index.jsp
Sentinel Asia
Asia - Wildfire Monitoring
Asia - Flood Monitoring
Sentinel Asia
Flood Monitoring
About This Page
Printout
Output to PDF
Observation Date 2007-3-13
2007 .3
Su M Tu W Th F Sa
Overlays
U L (Upper View/Lower View)
24hr Accumulated Precipitat
Heavy Rain Information
Map Data
DCW (VMap0)
GSI DM25000 (Japan only)
Other Information
Landsat
DEM
Land Cover
Population
Redraw
IFNet
GFAS
Daily Precipitation
Daily Precipitation Probability
Original Data: NASA 3B42RT Data Processing: IFNet/IDI Copyright: 2006. IFNet/IDI, NASA, JAXA
Copyright 2007 Japan Aerospace Exploration Agency. All Rights Reserved.
46


JAXA
loration Agency
Sentinel Asia - MTSAT Imagery - Mozilla Firefox
http://arrs.adrc.or.jp/adrc/MyMap/MTSAT/index.jsp
MTSAT Imagery on GIS
About This Page
Sentinel Asia
Display Data
Observation Time (UTC)
Date: 2007 . 9
Time: 19:00 UTC
Band: Infrared
Area: All Region
Set to default
Overlays
Map Data
DCW (VMap0)
GSI DM25000 (Japan only)
Other Information
Landsat
DEM
Land Cover
Population
[Printout] [Output to PDF]
2007-09-05 19:00(UTC)
MTSAT Imagery: Provided by Japan Meteorological Agency
気象庁
Japan Meteorological Agency
Copyright 2007 Japan Aerospace Exploration Agency. All Rights Reserved.
47


JAXA
Japan Aerospace Exploration Agency
-- Please Contact at; hfukui@sfc.keio.ac.jp
See you
on Digital Earth!
48

제11차 GIS 국제세미나
The 11th International Seminar on GIS

The User-participated Geospatial Web as Open Platform

Seokchan (Channy) Yun
channy@daumcorp.com

Daum Communications Corp.

즐겁게 세상을 변화시키는 기업 Daum

Web as Platform?

즐겁게 세상을 변화시키는 기업 Daum

Definition

- I'm talking about the emergence of what I've started to call Web 2.0, the internet as platform.... it's about the way that web sites like eBay, Amazon, and Google are becoming platforms with rich add-on developer communities; it's about the way that network effects and data, rather than software APIs, are the new tools of customer lock-in;

  http://www.oreillynet.com/pub/wlg/5630 Tim O'Reilly Sep. 21, 2004

- Web 2.0 design patterns"- architecting systems so that they get smarter the more people use them, monetizing the long tail via a combination of customer-self service and algorithmic management, lightweight business models made possible by cooperating internet services and data syndication, data as the "intel inside", and so on.

Web as a Platform

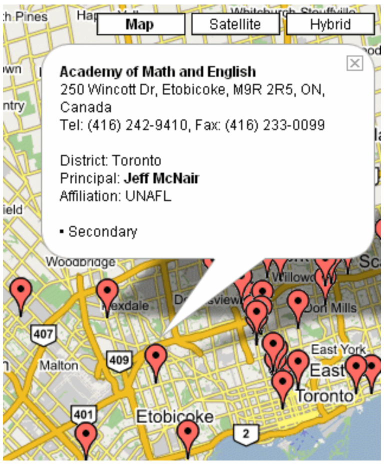
- The Web evolved to user-participated platform as like software platform.
- Offering Open APIs based on User data

Web 2.0: Software vs. Web

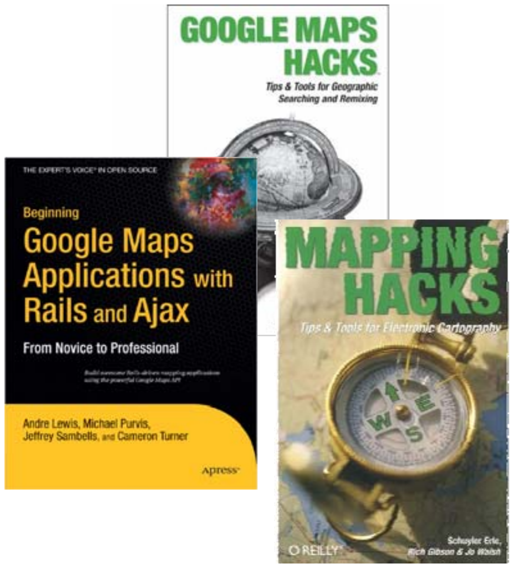
JVM	Platform	Web site
Java API	Interface	Web Services
Java Application	Software3	Data
Developer	Participators	User, Small Biz.
API Lock-in	Key Factor	Data Lock-in

Where 2.0: Software vs. Web

Where 1.0	Criteria	Where 2.0
USGS, Landsat	**Base Map**	Google, Yahoo!, Microsoft
ESRI, MapInfo SDK	**Softwares**	Web Maps APIs
Topography, River, Building	**Layers**	Photo, Video, Tour Spots, Blog
Oursourced digitizing vendors	**Participators**	Web users
GML, WFS, WMS	**Standards**	GeoRSS, KML
Government, local GIS vendors	**3rd Party**	Mashup developers



〈Google Map API Examples〉



〈Book for Mapping APIs〉

Where 2.0 Conference

- O'reilly Media
- Every year / Over 800 participators
- Sponsors
  - MSN, AT&T, Outcast, Google, Yahoo, Akamai, sxip, AskJeeves, Fenwick&West, Laszlo, Morfik, SocialText, Newsgator
- Main Theme
  - Local Search and Advertising, Mobile, GeoIndex
  - GeoTagged Life and DIY Data Platforms,
  - Crowd Sourced Data and Realtime Data
  - Open Source GeoStack
  - Disaster Relief/Environment/NGOs:
  - Sensorweb and Geotargeting
- Technology
  - Geo Support in Web Application Frameworks:
  - Mapping APIs
  - GeoBrowsers
  - Protocols & Formats

The Status of Where 2.0

- **Data Visualization**
  - Google Earth, Yahoo Maps, MSN Virtual Earth, NASA World Wind
- **Social Data**
  - Social Location Mash-up
- **The Needs for Standards**
  - GML, KML, GeoRSS…
- **Movement of Desktop**
  - ESRI, GDAL, GLASS, UDIG
- **Location Sensing**
  - Plaze, Skyhook

Participation Open Source/Open Standards

- **Open Source**
  - Lightweight development framework for every developers
    - Ex) LAMP (Linux+Apache+MySQL+PHP), Ruby on Rails, Python et. al
  - Free library to treat XML data
    - Ex) Firefox Extensions, RSS Aggregator, JSON et. al
  - Various tools for developer-participation
    - Ex) Wiki, Wordpress, Movable Type, Tattertools et.al
- **Open Standard**
  - Data distribution with RESTful applications
    - Ex) Google Maps, Flickr, Del.icio.us, Amazon, Ebay et. al
  - Data exchange with XML specifications
    - Ex) RSS/Atom, Microformat, Attention.xml,

Conventional GIS Vendors

- **Mapquest**
  - The largest U.S based web map service provider
  - OpenAPI Best service (2006)
- **ESRI**
  - The largest GIS vendors
  - Start-up to Web GIS.
- **Skyline**
  - 3D Modeling Company.
  - Patent issue with Google (Keyhole)
- **Autodesk**
  - Heading to Open Source (MapGuide Server)

1. Map APIs : pros and cons

	Pros	Cons
Google Map	First Ajax based brilliant looking map International base map (Europe, Japan) Detail world-wide aerial photos Largest developer based APIs Lots of hacks and mash-up	Only Javascript libray
Yahoo! Map	First external geocoding capability Very flexible and open API's Rate limiting by IP instead of appID GeoRSS support Flash/Flex version available	U.S. and Canada only Flyouts not quite as spiffy as Google
AOL MapQuest	Frist routing (driving directions) capability Geocoding capability Large users and big market share	No smooth Ajax client (yet) Slow functional changes Weak documentations
Microsft Virtual Earth	Well documented and sample sites Detail Building shape and 3D view	Low Performance

Location Data APIs

- Plaze API : http://www.plaze.com
- GeoIQ API : http://www.geoiq.com

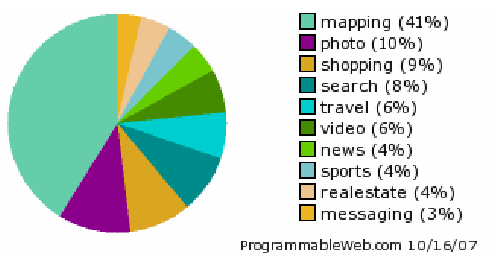
Open Source Data APIs

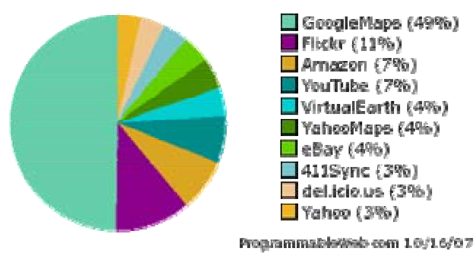
- OpenLayers http://openlayers.com
- OpenStreetsMap http://openstreetsmap.com

Local Data APIs

- Naver in Korea http://openapi.naver.com
- Multimap in Europe
- Where is in AU, Zoomin in NZ

2. Mashup of Social Data

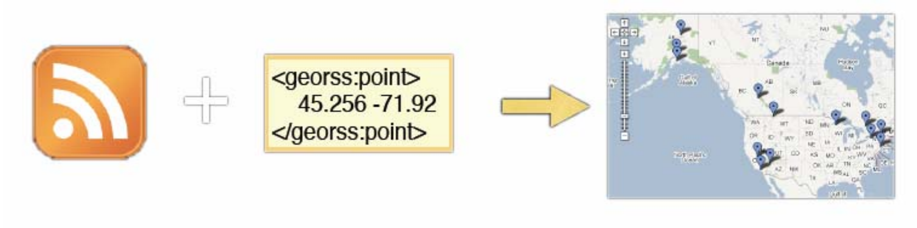




Mashup Examples

- Chicagocrime http://www.chicagocrime.org
- World of Warcraft Map http://mapwow.com
- Themed Maps http://justin.everett-church.com/ymaps/radarMaps.html
- Flickr Maps http://www.sodascope.com/FlickrMapsExt
- MSNBC News Map http://poly9.viavirtualearth.com/Poly9/MSNBC

3. Open Standards: GeoRSS vs. KML

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<kml xmlns="http://earth.google.com/kml/2.1">
  <Folder>
   <name>Ground Overlays</name>
   <description>Examples of ground overlays</
description>
   <GroundOverlay>
    <name>Large-scale overlay on terrain</name>
    <description>Overlay shows Mount Etna erupting
       on July 13th, 2001.</description>
    <Icon>
      <href>http://code.google.com/apis/kml/
documentation/etna.jpg</href>
    </Icon>
    <LatLonBox>
      <north>37.91904192681665</north>
      <south>37.46543388598137</south>
      <east>15.35832653742206</east>
      <west>14.60128369746704</west>
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   </GroundOverlay>
  </Folder>
</kml>
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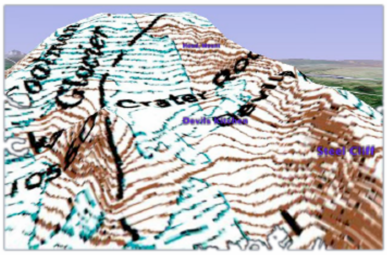
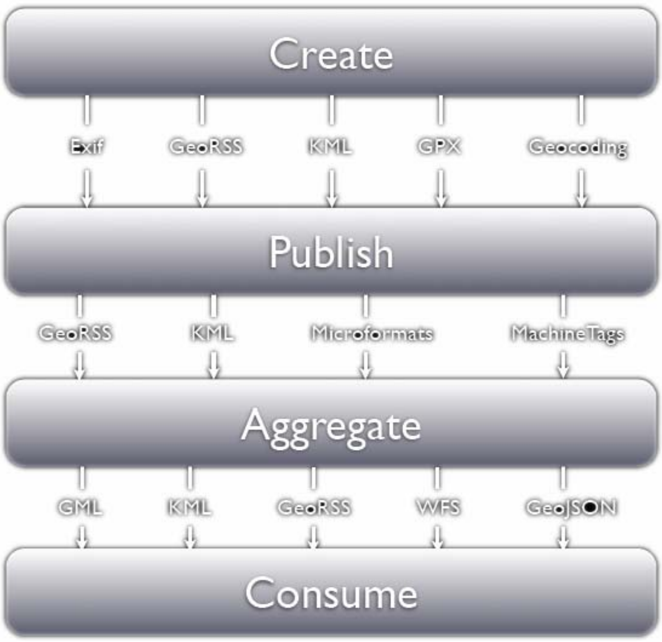


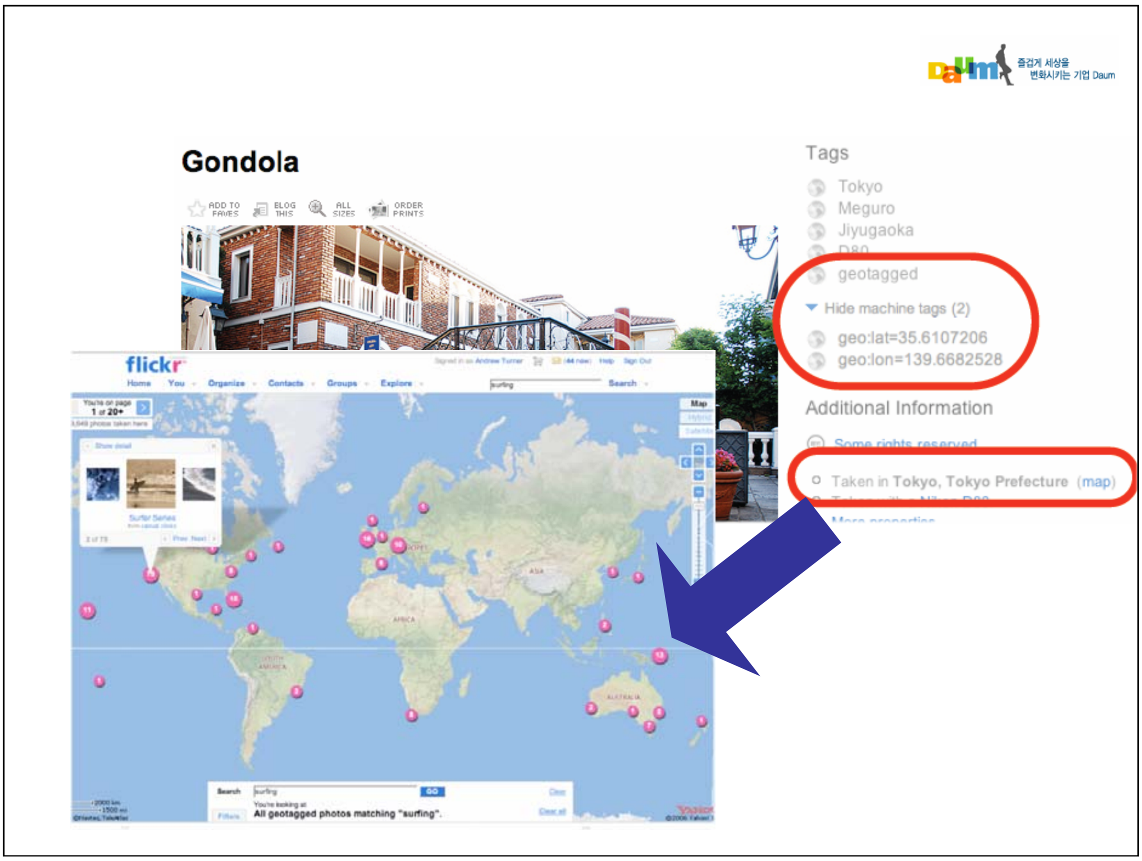
4. Open Source Maps

- **OSGeo.org**
  - Mapping Software and Map Data
  - Projects
    - GDAL: the base library in various mapping project such as Google
    - GeoTools : Java based mapping software
    - GRASS : US Army GIS SW. Open Souce
    - MapBuilder : Web-based mapping platform
    - MapGuide Open Source: Autodesk's new release
    - OSSIM : Open Souce Image proccessing software
- **NASA World Wind**
  - Open Source based 3D Geo Mapping S/W
- **Openstreetmap.org**
  - GPS based map data aggregation service.

GeoStack: Cycle of Geodata

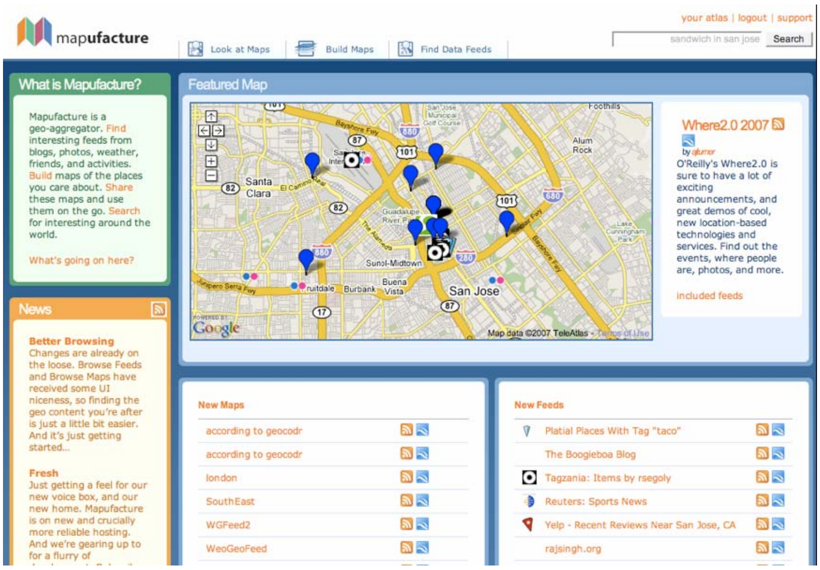


Creating Geo Data

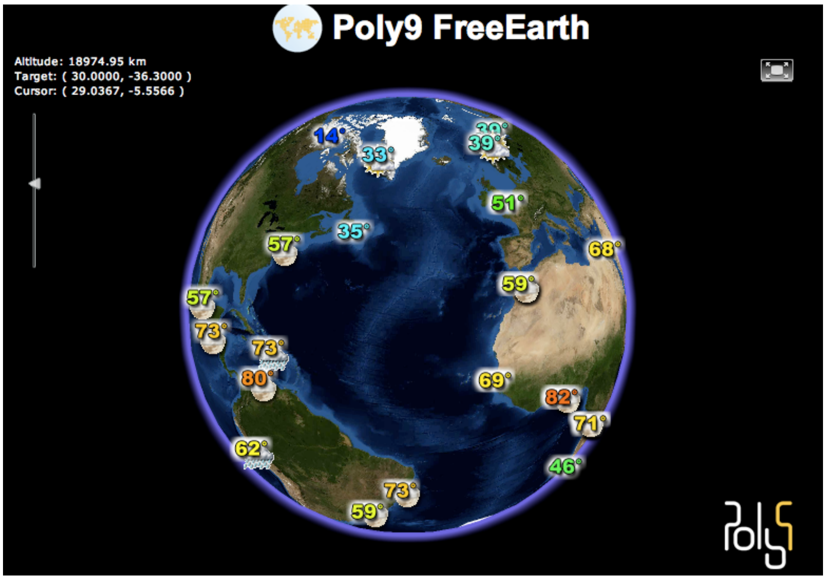

Gondola
Tags
Tokyo
Meguro
Jiyugaoka
geotagged
Hide machine tags (2)
geo:lat=35.6107206
geo:lon=139.6682528
Additional Information
Taken in Tokyo, Tokyo Prefecture (map)
flickr
All geotagged photos matching "surfing".


Publishing : Platial, Blog
Platial the people's atlas
Portland Radical History - Tour
Jason's Portland Radical History - Tour
Curling Bonspiels: Edit Entry: Northville Rocks
Entry
Title
Detroit Curling Club
Status
Published
Entry Date
2007-05-21 02:16:09
Entry Body
Founded in 1885. The Detroit Curling Club is one of the oldest curling clubs in the United States. The club is a volunteer-based organization that provides its members opportunities to curl and participate in other social activities. In order to participate in the Club's activities you must be a member or a guest of a member. Our membership
Location
Name
Address
DCC
1615 E. Lewiston, Ferndale, MI 48220
Geocode
Saved Locations
--choose one--
Reset Map
Map
Satellite
Hybrid

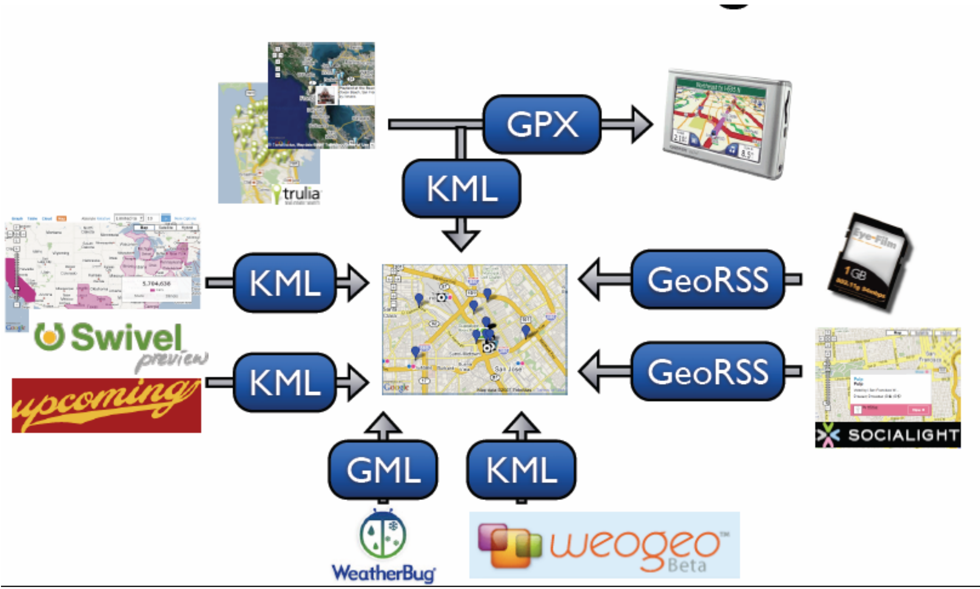
Aggregation/Search : mapufacuture



Consuming: FreeEarth

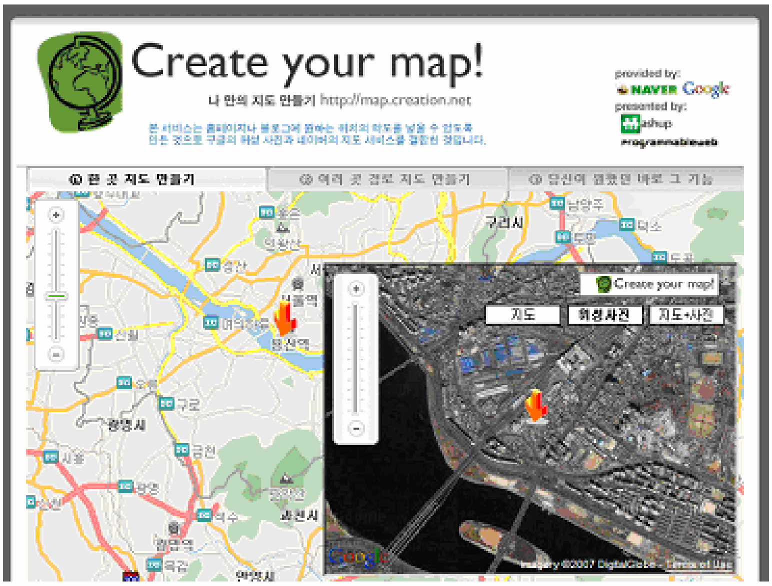


User-participation : Finding House



User-participation : Responding Disaster

Ex: Naver-Google Map Mashup



http://map.creation.net

The 11th International Seminar on GIS

Collaborative GIS toward Geospatial Information Society

Google Maps – Reshaping PPGIS

Wansoo Im, Ph.D.
VERTICES
Email: wim@vertices.com

While the exact definition of what public participation geographic information systems (PPGIS) actually is has yet to come to a general consensus, PPGIS can be more than just representing the ends of a mean; it can and should be used as a tool to help communities analyze and help find solutions to their problems

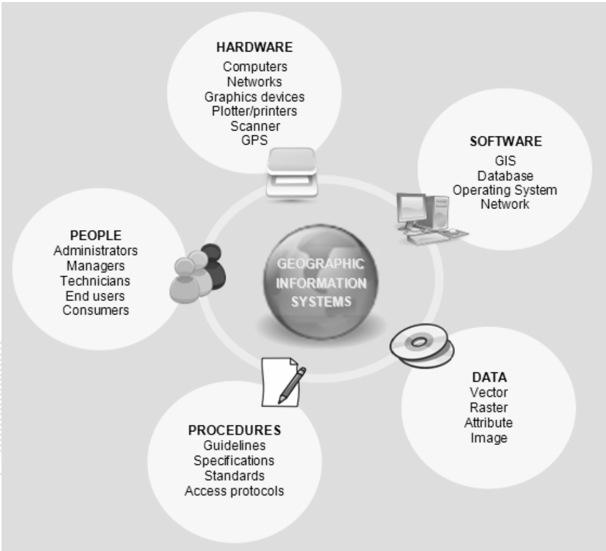
(Sheppard 1995; Elwood and Leitner 1996; Harris and Weiner 1998; Obermeyer 1998; Seiber 2006).

We see PPGIS as an approach to getting public more involved in decision making process of their communities. PPGIS has the potential to be a process of constructing and visualizing the representation of ideas brought by the community.

Products of PPGIS

- ▶ Visualization (Maps)
- ▶ Data Collection & Management
- ▶ Spatial Modeling
  - ▪ Network Analysis
  - ▪ Spatial Analysis
- ▶ WebGIS & Mobil GIS
  - ▪ Data Dissemination and Sharing

Five Components of GIS



http://ioc.unesco.org/oceanteacher/OceanTeacher2/02_InfTchSciCmm/01_CmpTch/03_GIS&SDI/01_Fundamentals/Components.html

~~Five Components of GIS~~

Obstacles to PPGIS

What is happening….

Hardware

- ►Fast speed
- ►Lower cost
  - Computers
  - Internet Services
  - Color Printers
  - GPS
  - Digital Camera and GPS
- ►Free data storage places

Software

- ►Open Source GIS (e.g., MapServer)
- ►Free GIS software by Commercial Vendors
  - ArcExplorer (ESRI)
  - MapGuide Open Source (Autodesk)
- ►Free GIS Websites
  - Federal, State, and Local gov't
  - Commercial Web portal
- ►Free Software for photo & video editing

Data

- ►Publicly available GIS Dataset
  - Federal, State, and Local gov't
    - ►OPRA (Open Public Record Act)
- ►Commercially Available (but free) Web Services
  - Google Maps
  - Google Earths
  - Microsoft Virtual Earths
  - Yahoo Map

People

- ►Easy to exchange knowledge via Internet
  - Online Tutorial/Help files
  - GIS related Blog Sites
  - Online Community Sites

Key Words of Current Mapping Technology

Open GIS

- Full integration of geospatial data into mainstream information technology
- Users freely exchange data over a range of GIS software systems and networks
- No format conversion or proprietary data type concerns

Open API (Application Program Interface)

- A set of routines, protocols, and tools for building software applications
- A good API makes it easier to develop a program by providing all the building blocks.
- A programmer puts the blocks together.

Interoperability

"capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units"

Source: OGC Abstract Specification Topic 12: Services. Derived from ISO 2382-1.

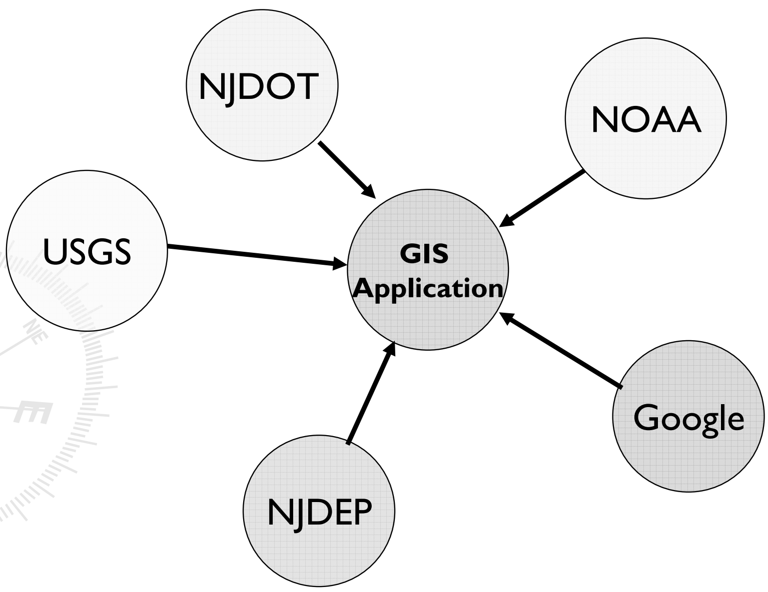
Web 2.0

- **Web 2.0** generally refers to a second generation of services available on the World Wide Web that lets people collaborate and share information online. In contrast to the first generation, Web 2.0 gives users an experience closer to desktop applications than the traditional static Web pages.

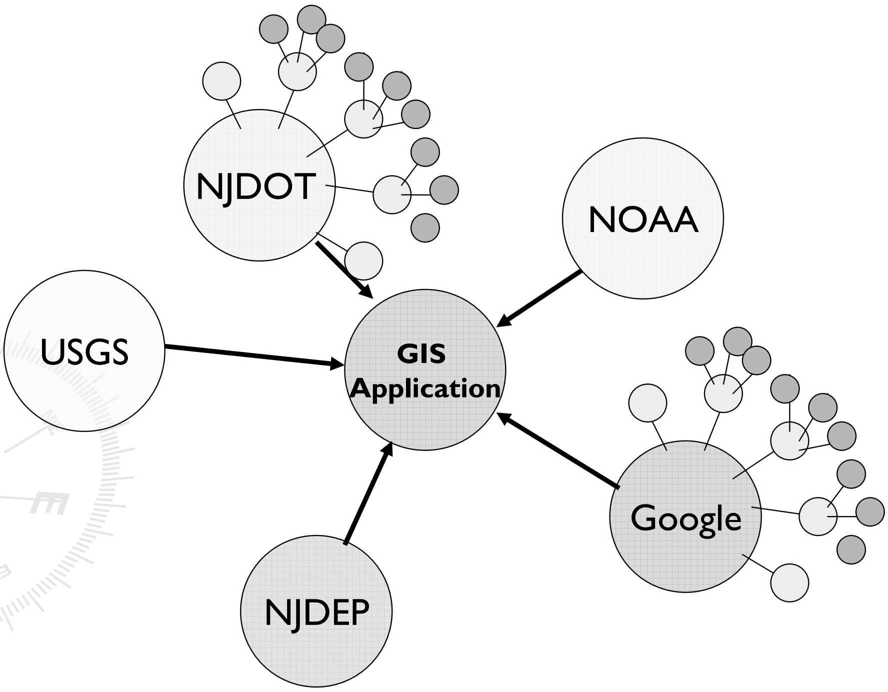
Source: http://en.wikipedia.org/wiki/Web_2

Efforts to enhance user-friendly interfaces, interoperability across data repositories, web GIS services, and affordability

GIS Web Services

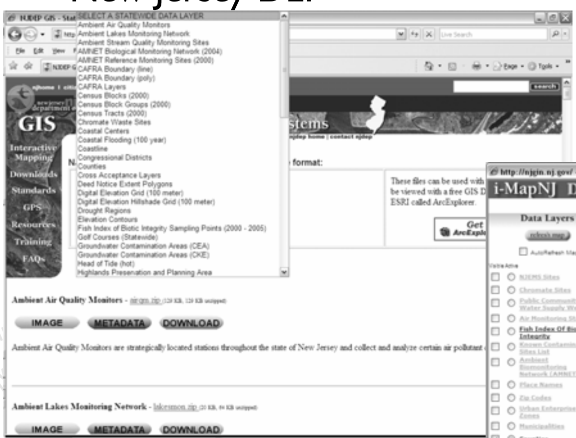


GIS Web Services (Web 2.0)



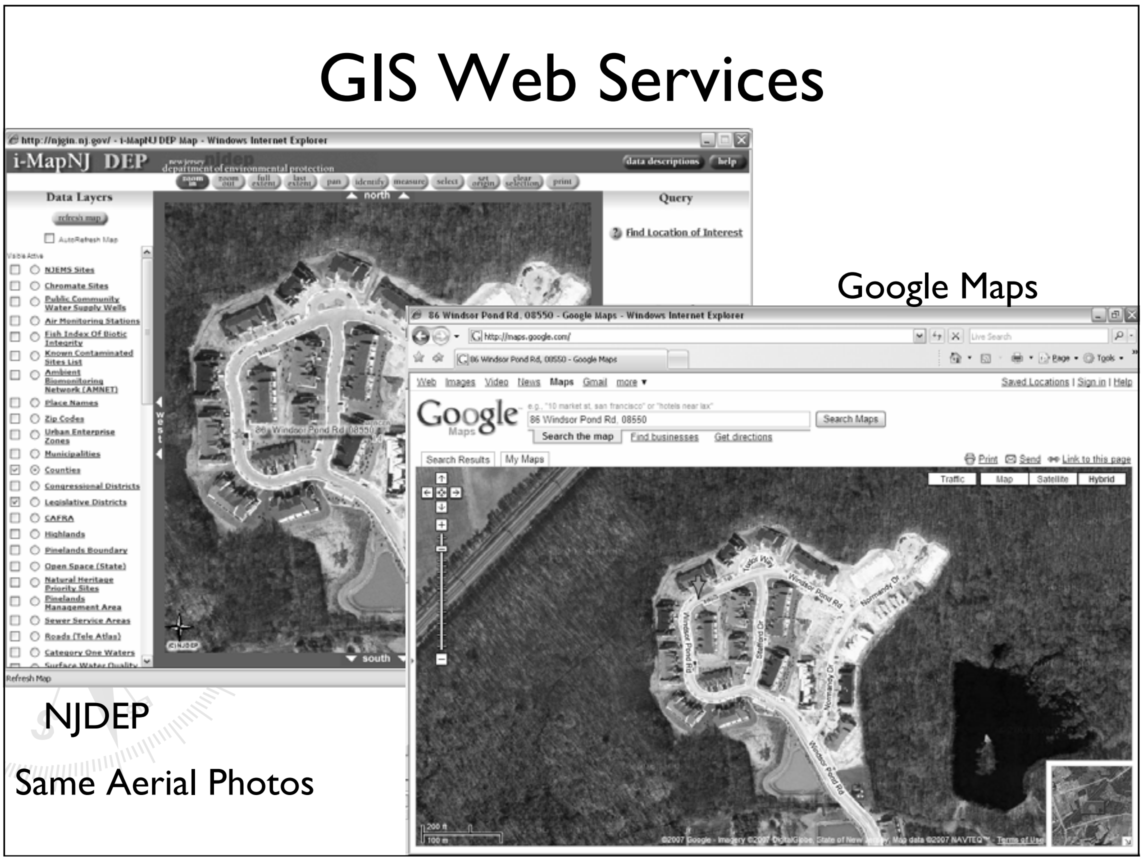
How GIS data are being distributed

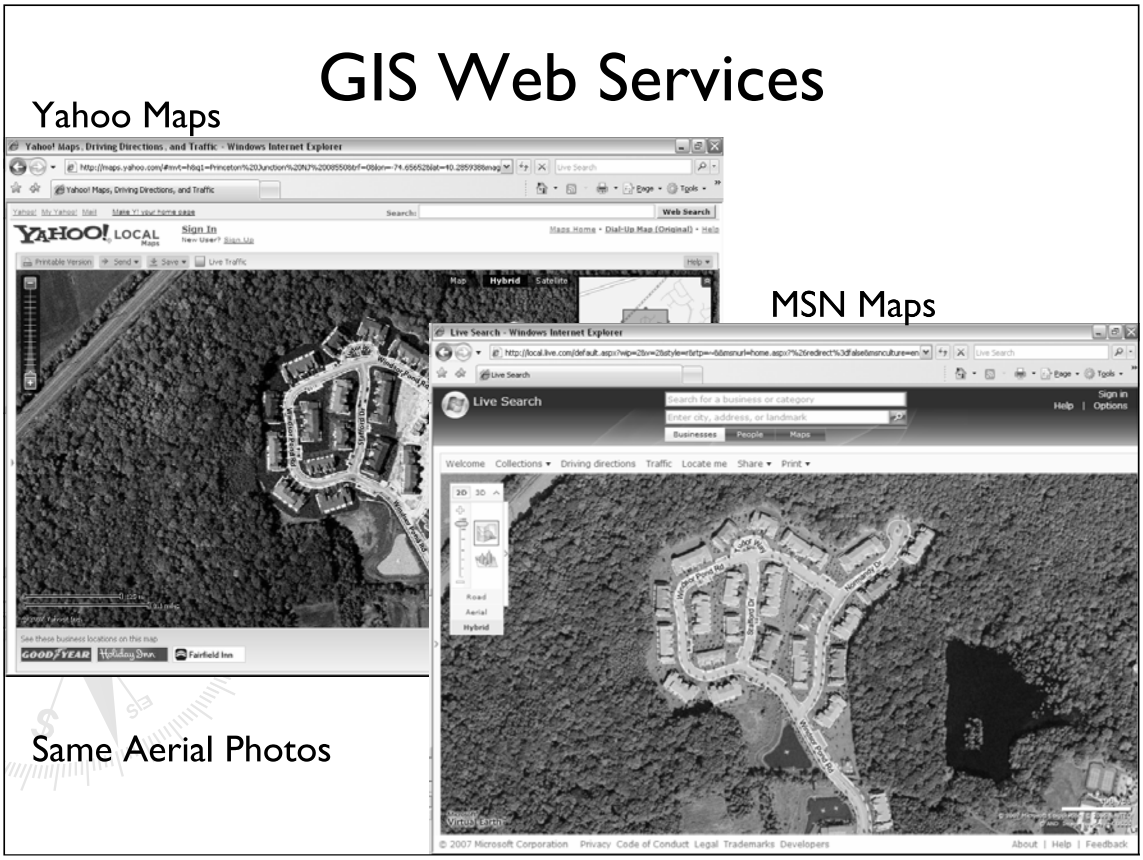
New Jersey DEP



Shape file format

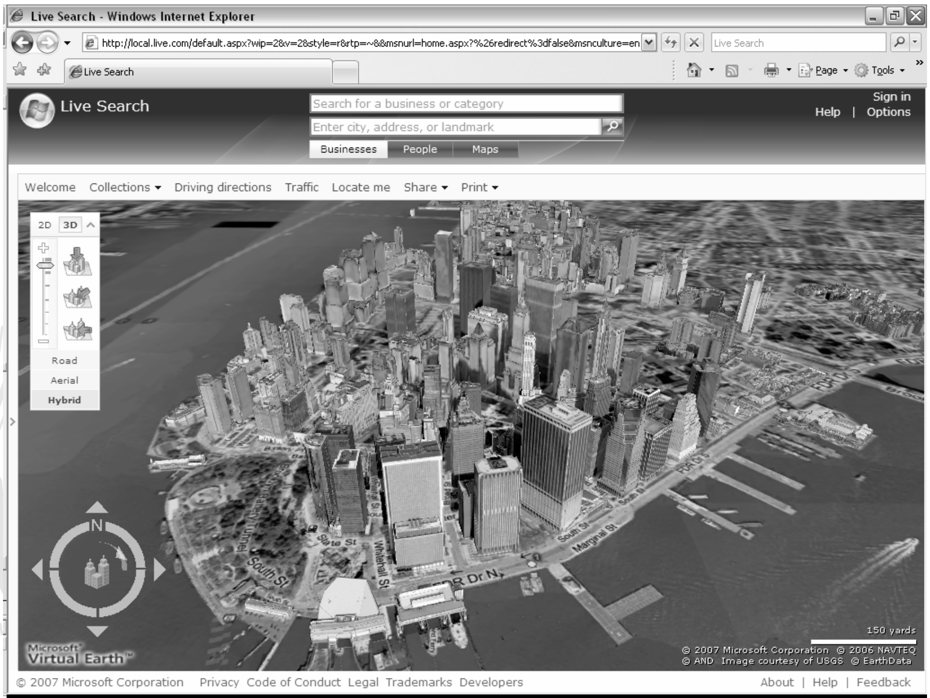
Web GIS


GIS Web Services
Google Maps
NJDEP
Same Aerial Photos

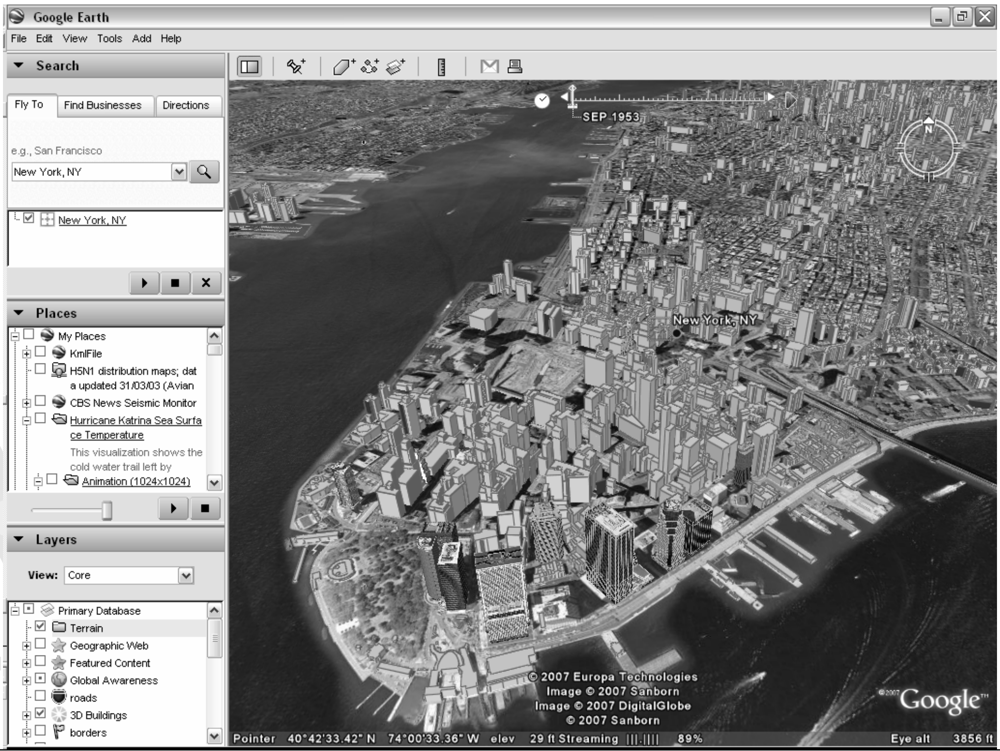

GIS Web Services
Yahoo Maps
MSN Maps
Same Aerial Photos

GIS Web Services
Oblique Aerial Imagery

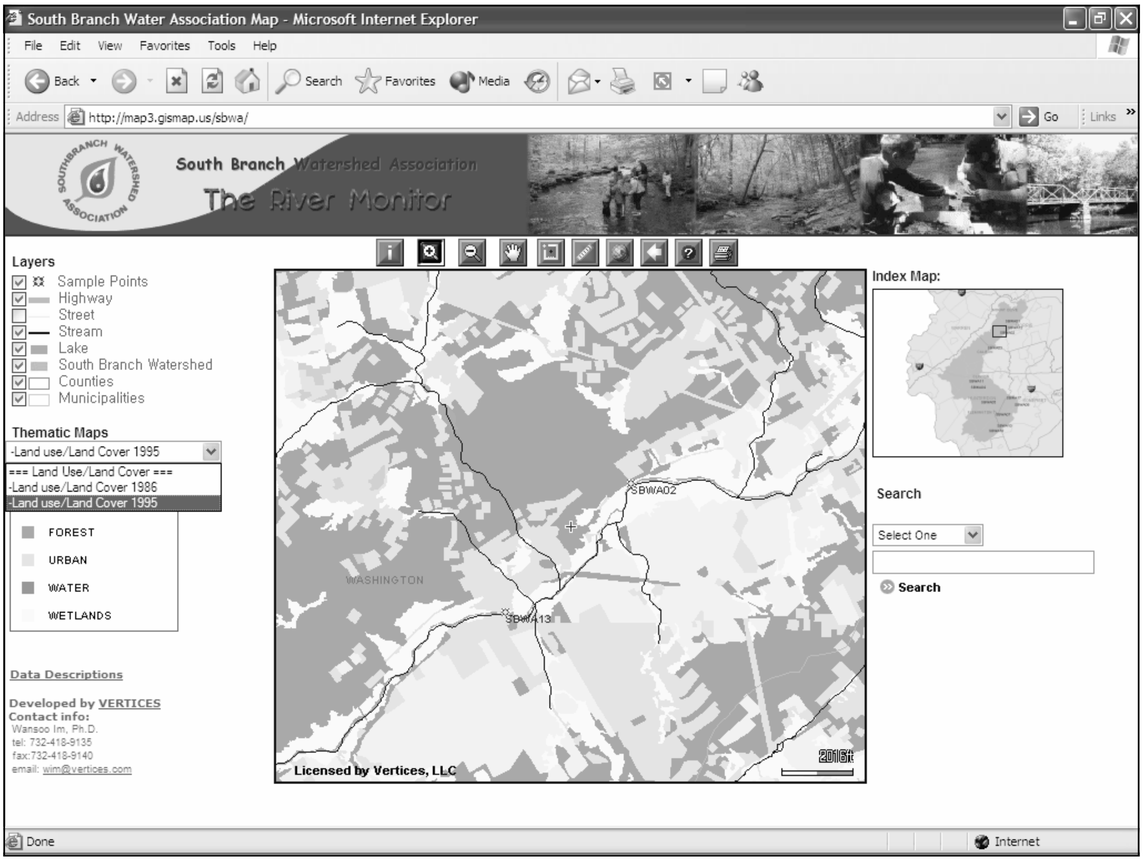
3D Visualization



3D Visualization



360° Street View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File Edit View Favorites Tools Help
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Address http://map3.gismap.us/sbwa/
Go Links
South Branch Watershed Association
The River Monitor
Layers
Sample Points
Highway
Street
Stream
Lake
South Branch Watershed
Counties
Municipalities
Thematic Maps
-Land use/Land Cover 1995
=== Land Use/Land Cover ===
-Land use/Land Cover 1986
-Land use/Land Cover 1995
FOREST
URBAN
WATER
WETLANDS
Data Descriptions
Developed by VERTICES
Contact info:
Wansoo Im, Ph.D.
tel: 732-418-9135
fax:732-418-9140
email: wim@vertices.com
SBWA02
WASHINGTON
SBWA13
Licensed by Vertices, LLC
Index Map:
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Select One
Search
Done
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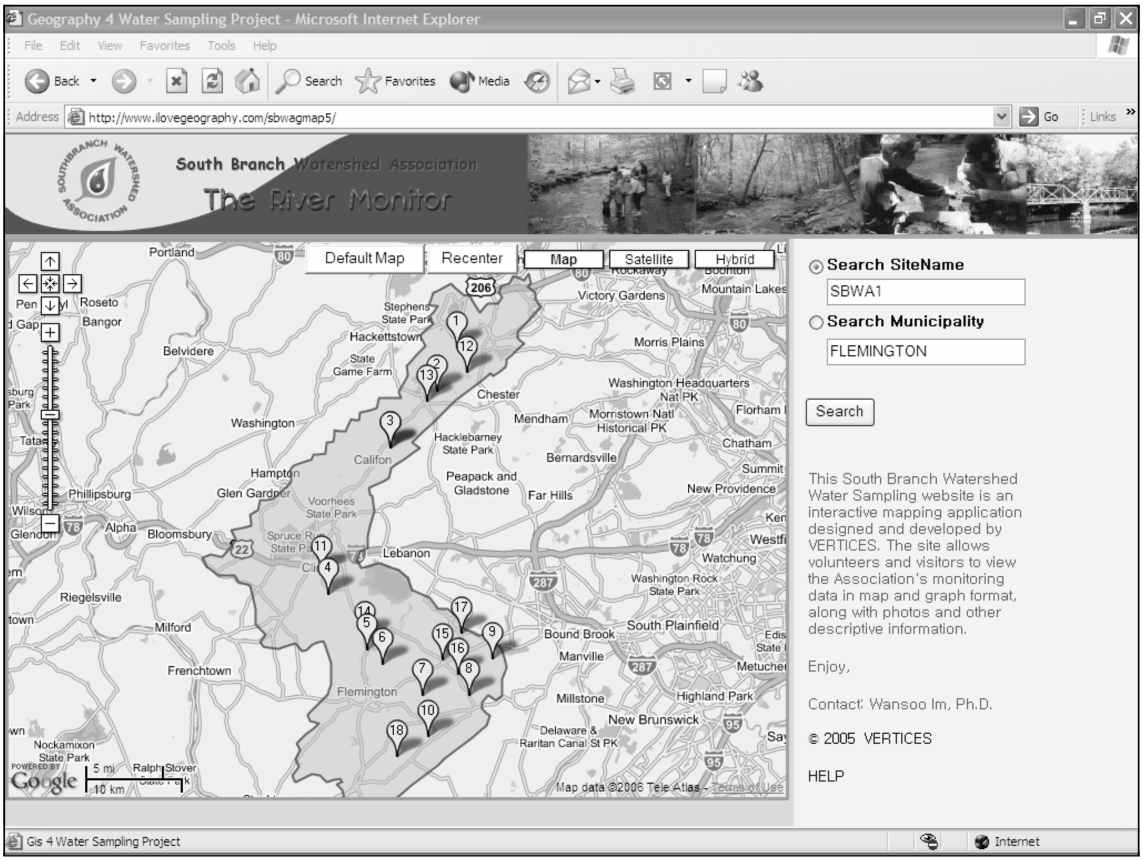
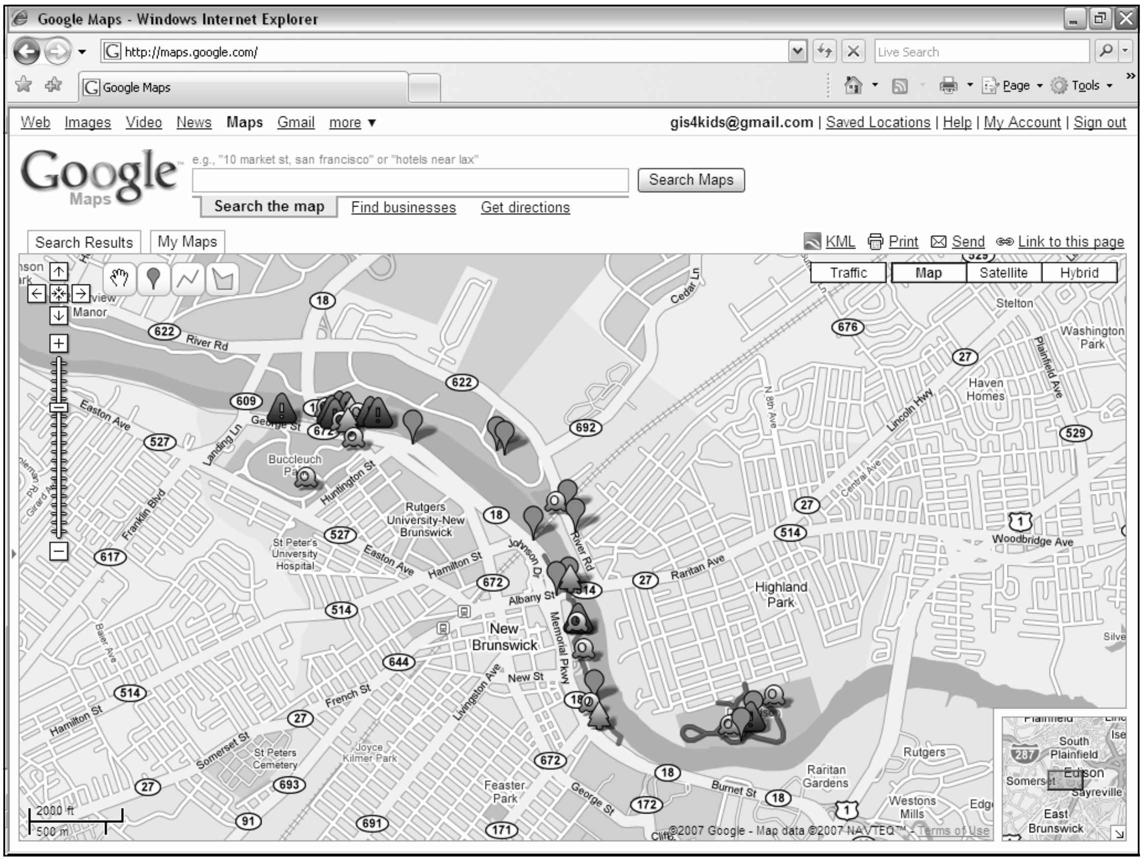
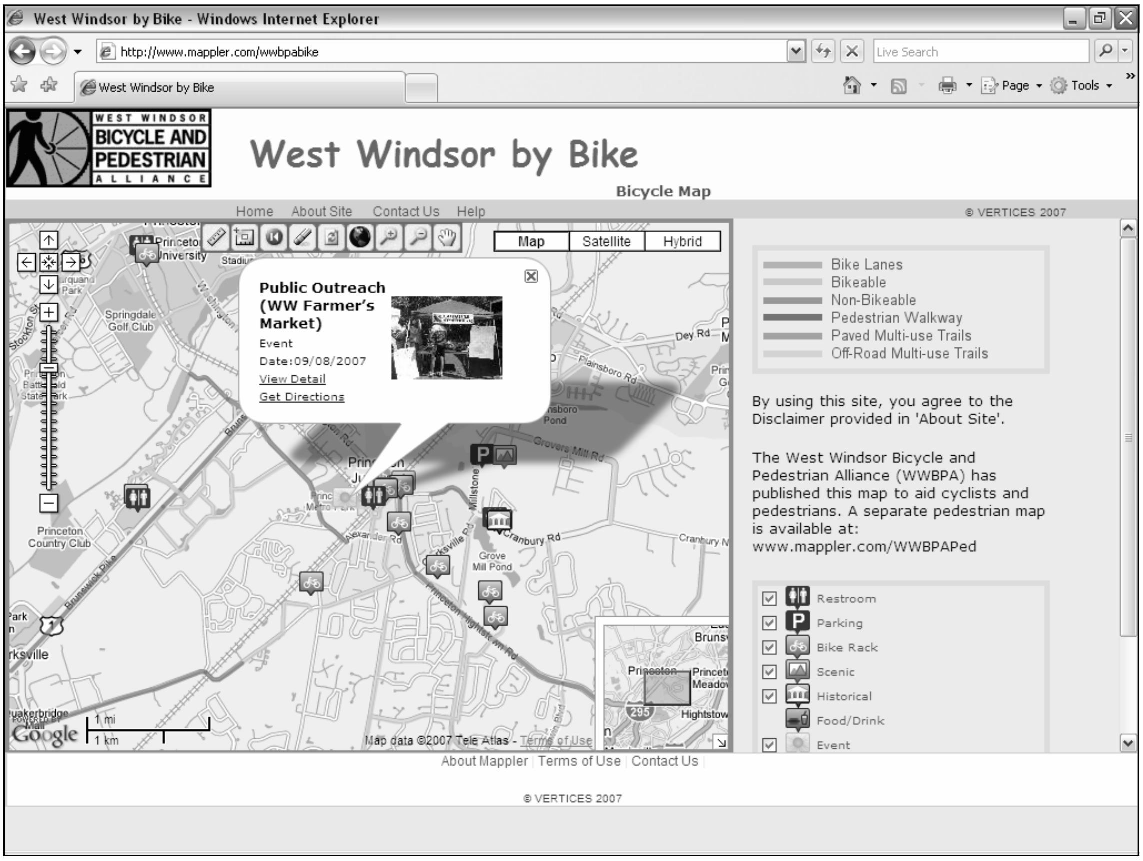

Geography 4 Water Sampling Project - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://www.ilovegeography.com/sbwagmap5/
Go Links
South Branch Watershed Association
The River Monitor
Default Map
Recenter
Map
Satellite
Hybrid
Portland
Roseto
Bangor
Belvidere
Washington
Phillipsburg
Alpha
Bloomsbury
Riegelsville
Milford
Frenchtown
Flemington
Califon
Chester
Hackettstown
Lebanon
Mendham
Bernardsville
Far Hills
Peapack and Gladstone
Morris Plains
Victory Gardens
Mountain Lakes
Chatham
Summit
New Providence
Watchung
Bound Brook
Manville
South Plainfield
Millstone
Highland Park
New Brunswick
Nockamixon State Park
Map data ©2006 Tele Atlas - Terms of Use
Search SiteName
SBWA1
Search Municipality
FLEMINGTON
Search
This South Branch Watershed Water Sampling website is an interactive mapping application designed and developed by VERTICES. The site allows volunteers and visitors to view the Association's monitoring data in map and graph format, along with photos and other descriptive information.
Enjoy,
Contact: Wansoo Im, Ph.D.
© 2005 VERTICES
HELP
Gis 4 Water Sampling Project
Internet


Google Maps - Windows Internet Explorer
http://maps.google.com/
Web Images Video News Maps Gmail more
gis4kids@gmail.com | Saved Locations | Help | My Account | Sign out
Search Maps
Search the map Find businesses Get directions
Search Results My Maps
KML Print Send Link to this page
Traffic Map Satellite Hybrid
New Brunswick
Highland Park


West Windsor by Bike - Windows Internet Explorer
http://www.mappler.com/wwbpabike
WEST WINDSOR BICYCLE AND PEDESTRIAN ALLIANCE
West Windsor by Bike
Bicycle Map
Home About Site Contact Us Help
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Map Satellite Hybrid
Public Outreach (WW Farmer's Market)
Event
Date:09/08/2007
View Detail
Get Directions
Bike Lanes
Bikeable
Non-Bikeable
Pedestrian Walkway
Paved Multi-use Trails
Off-Road Multi-use Trails
By using this site, you agree to the Disclaimer provided in 'About Site'.
The West Windsor Bicycle and Pedestrian Alliance (WWBPA) has published this map to aid cyclists and pedestrians. A separate pedestrian map is available at: www.mappler.com/WWBPAPed
Restroom
Parking
Bike Rack
Scenic
Historical
Food/Drink
Event
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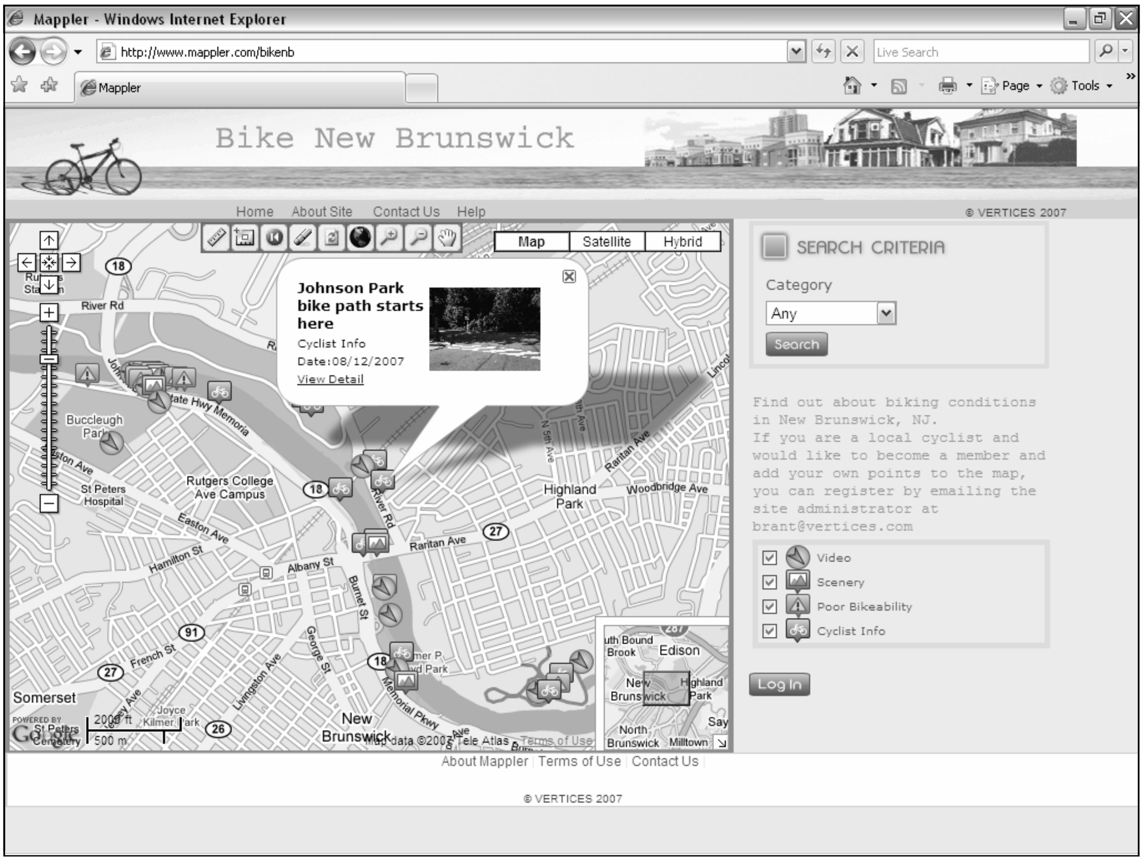
Mapper - Windows Internet Explorer
http://www.mappler.com/bikenb
Bike New Brunswick
Home About Site Contact Us Help
© VERTICES 2007
Map Satellite Hybrid
Johnson Park bike path starts here
Cyclist Info
Date:08/12/2007
View Detail
SEARCH CRITERIA
Category
Any
Search
Find out about biking conditions in New Brunswick, NJ.
If you are a local cyclist and would like to become a member and add your own points to the map, you can register by emailing the site administrator at brant@vertices.com
Video
Scenery
Poor Bikeability
Cyclist Info
Log In
About Mappler Terms of Use Contact Us
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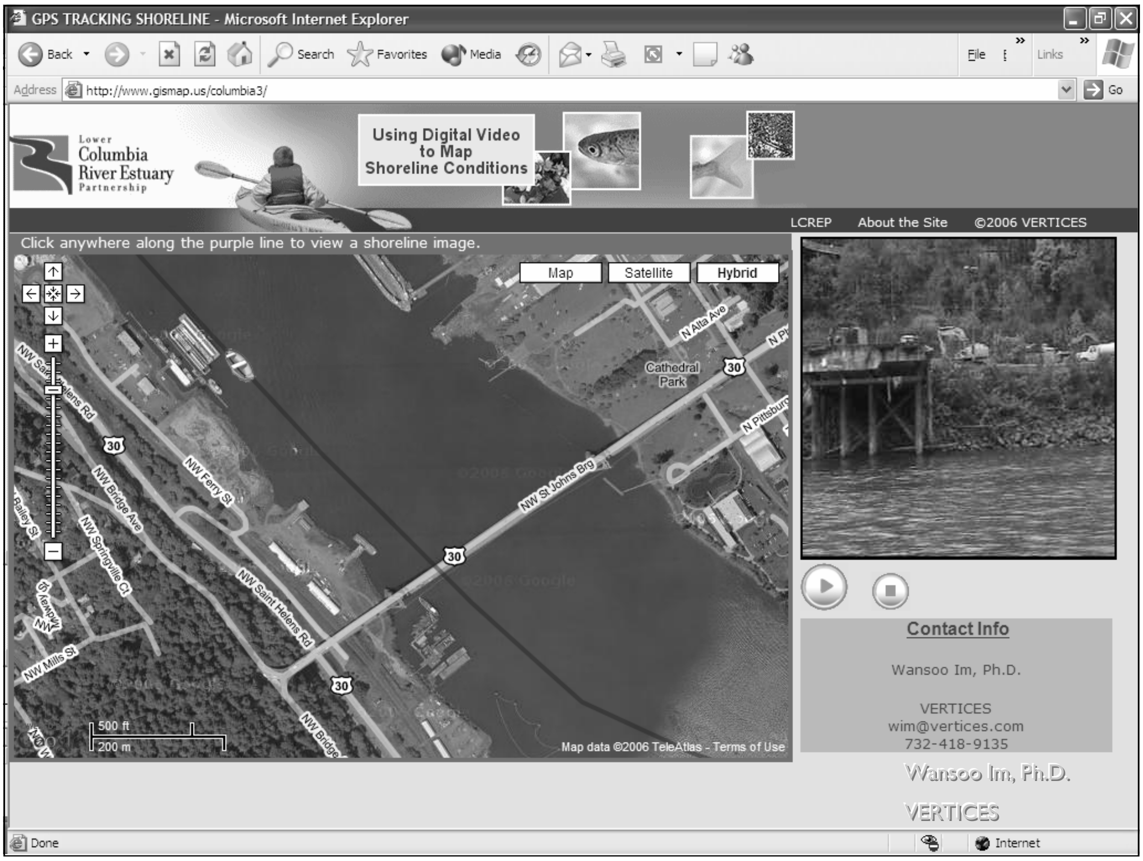
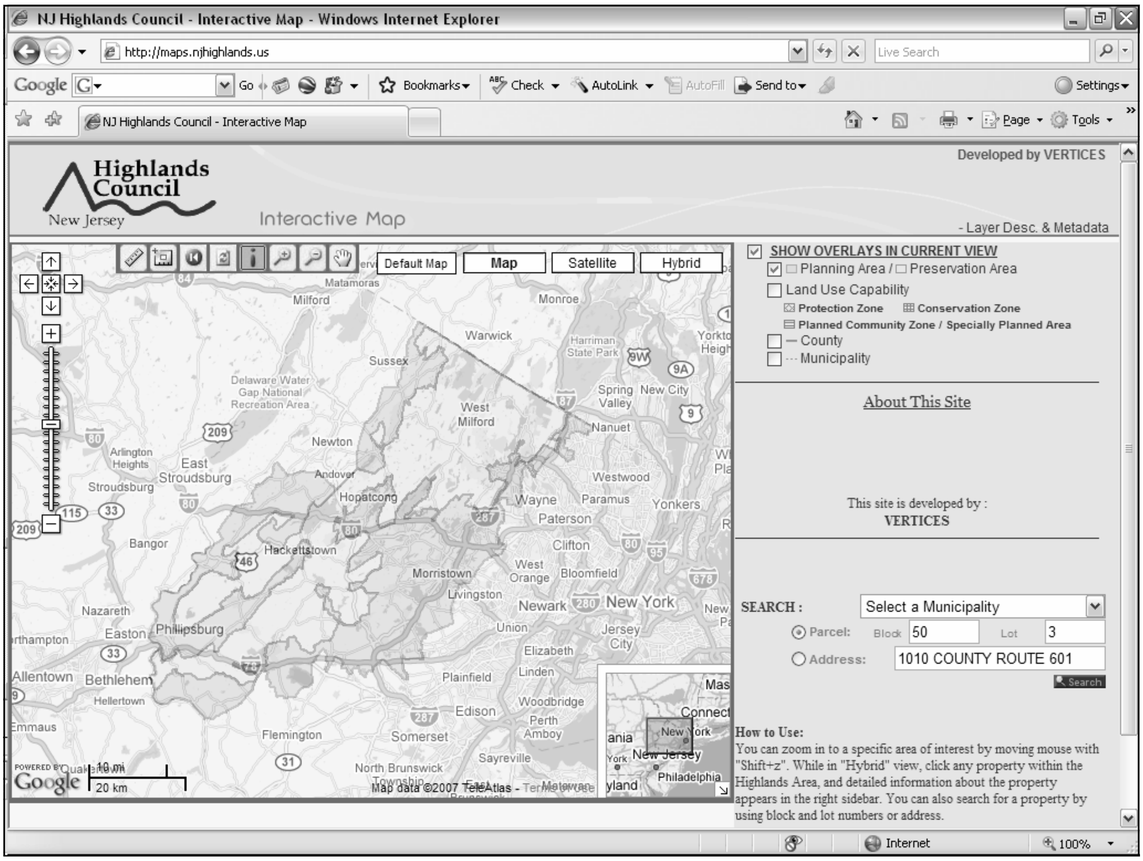
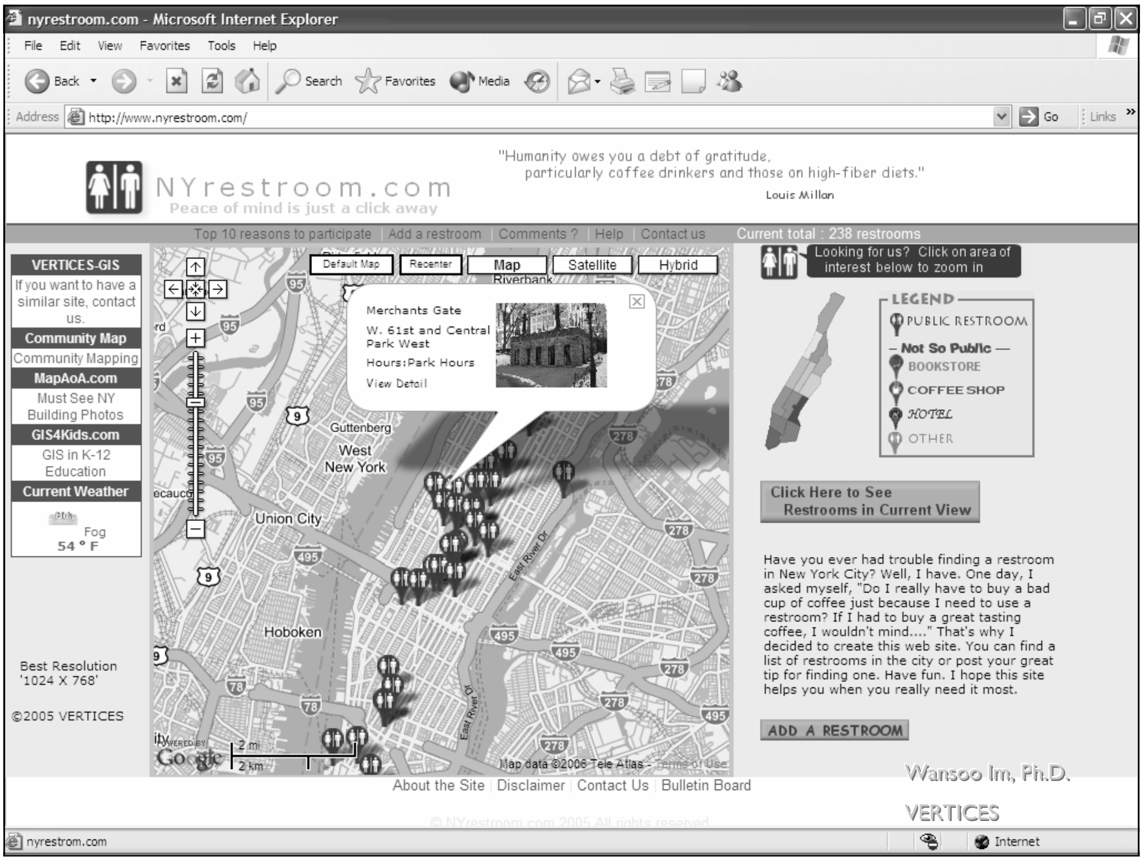

GPS TRACKING SHORELINE - Microsoft Internet Explorer
http://www.gismap.us/columbia3/
Lower Columbia River Estuary Partnership
Using Digital Video to Map Shoreline Conditions
LCREP About the Site ©2006 VERTICES
Click anywhere along the purple line to view a shoreline image.
Map Satellite Hybrid
Contact Info
Wansoo Im, Ph.D.
VERTICES
wim@vertices.com
732-418-9135
Wansoo Im, Ph.D.
VERTICES


Visit NJ Farms - Windows Internet Explorer
http://www.visitnjfarms.org/
Visit NJ Farms
HOME | SEARCH BY ACTIVITY | SEARCH BY LOCATION | LINKS | CONTACT US
CONSUMERS
SEARCH BY:
Activity | Location
FARMERS
Register
Login
Upcoming Special Events
Upcoming Events:
Semi Annual bridal Show
2/18/2007 ~ 2/18/2007
Tomasello Winery
Hammonton
Show All Upcoming Events
Welcome to Visit NJ Farms!
SUNFLOWERS
New Jersey is home to some of the most beautiful farmland and hard working farmers in the region. And, on many of those diverse farms, there are things to do and learn that the whole family would enjoy. It is what we call agricultural tourism, or agri-tourism in New Jersey. There are many opportunities for affordable, family-oriented recreational and educational activities where visitors can learn about the production of food and agricultural products and the state's rich farming heritage while helping to encourage the preservation of agricultural lands. Activities include hayrides, corn mazes, pick-your-own operations, farm stands, school tours, farm festivals, and winery tours. There are four seasons of fun on New Jersey's farms. You don't have to live on a farm to enjoy New Jersey agriculture! Come out for the day. There's always plenty to do!
SPONSORED BY
NEW JERSEY DEPARTMENT OF AGRICULTURE
FOOD POLICY INSTITUTE
NJ AGRICULTURAL EXPERIMENT STATION RUTGERS COOPERATIVE RESEARCH & EXTENSION
RUTGERS COOK COLLEGE
Internet
100%


NJ Highlands Council - Interactive Map - Windows Internet Explorer
http://maps.njhighlands.us
NJ Highlands Council - Interactive Map
Highlands Council
New Jersey
Interactive Map
Developed by VERTICES
- Layer Desc. & Metadata
Default Map
Map
Satellite
Hybrid
SHOW OVERLAYS IN CURRENT VIEW
Planning Area / Preservation Area
Land Use Capability
Protection Zone
Conservation Zone
Planned Community Zone / Specially Planned Area
County
Municipality
About This Site
This site is developed by :
VERTICES
SEARCH :
Select a Municipality
Parcel:
Block 50
Lot 3
Address:
1010 COUNTY ROUTE 601
Search
How to Use:
You can zoom in to a specific area of interest by moving mouse with "Shift+z". While in "Hybrid" view, click any property within the Highlands Area, and detailed information about the property appears in the right sidebar. You can also search for a property by using block and lot numbers or address.
Milford
Monroe
Warwick
Sussex
West Milford
Newton
Stroudsburg
Hopatcong
Wayne
Paterson
Bangor
Hackettstown
Morristown
Newark
New York
Nazareth
Easton
Phillipsburg
Allentown
Bethlehem
Plainfield
Edison
Flemington
Somerset
Map data ©2007 TeleAtlas
Internet
100%



Concerns of Google Maps

- ▶ Metadata (e.g. NJ aerial photos, 2002)
- ▶ Owned by commercial entity - may not be permanently free
- ▶ Advertisement
- ▶ Unequal area of coverage
- ▶ Dependency on Google (superpower?)

Contact:

Wansoo Im, Ph.D.

Tel: 732-418-9135

email: **wim@vertices.com**

http://www.vertices.com

The Strategies of Developing the Korea Planning Support Systems

October 24, 2007

Kirl Kim
kirlk@krihs.re.kr
Associate Research Fellow
Geospatial Information Research Center
Korea Research Institute for Human Settlements

Contents

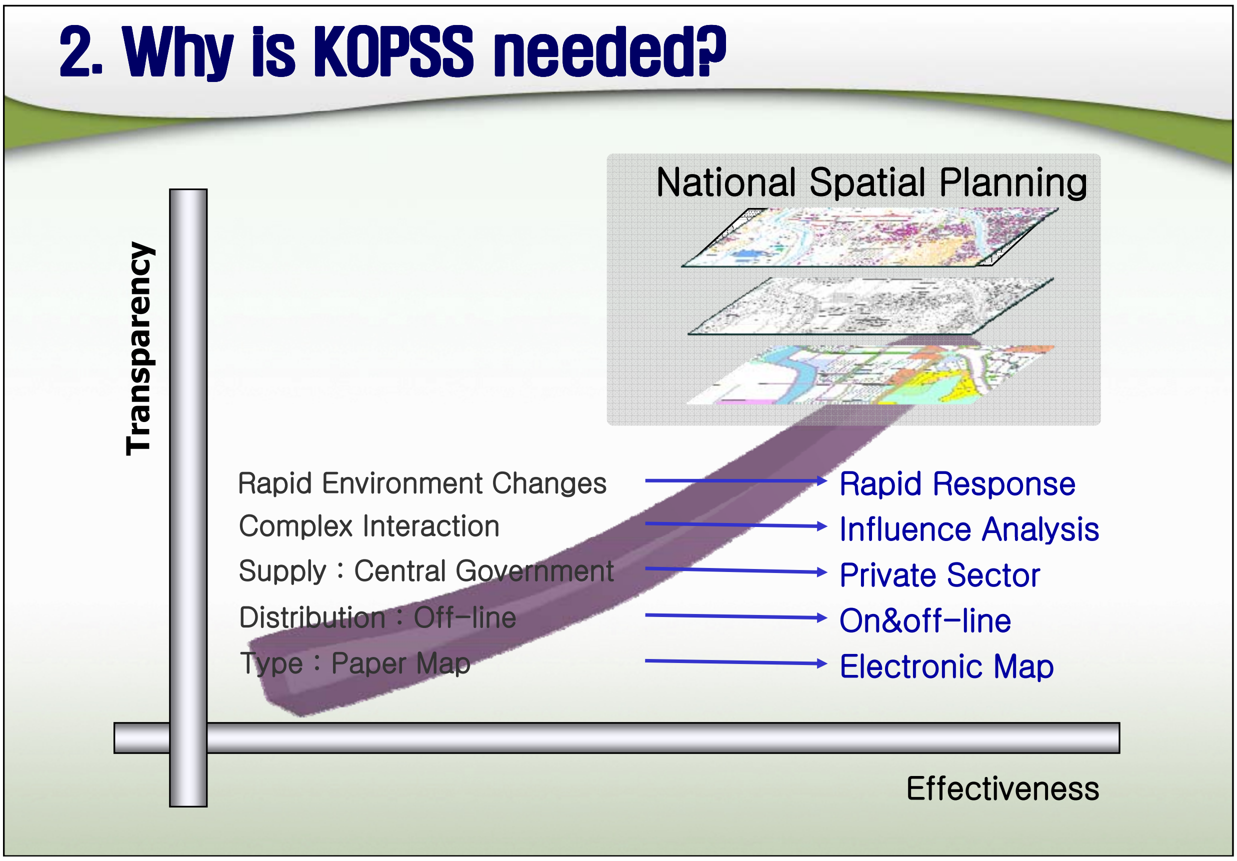
I KOPSS Outline

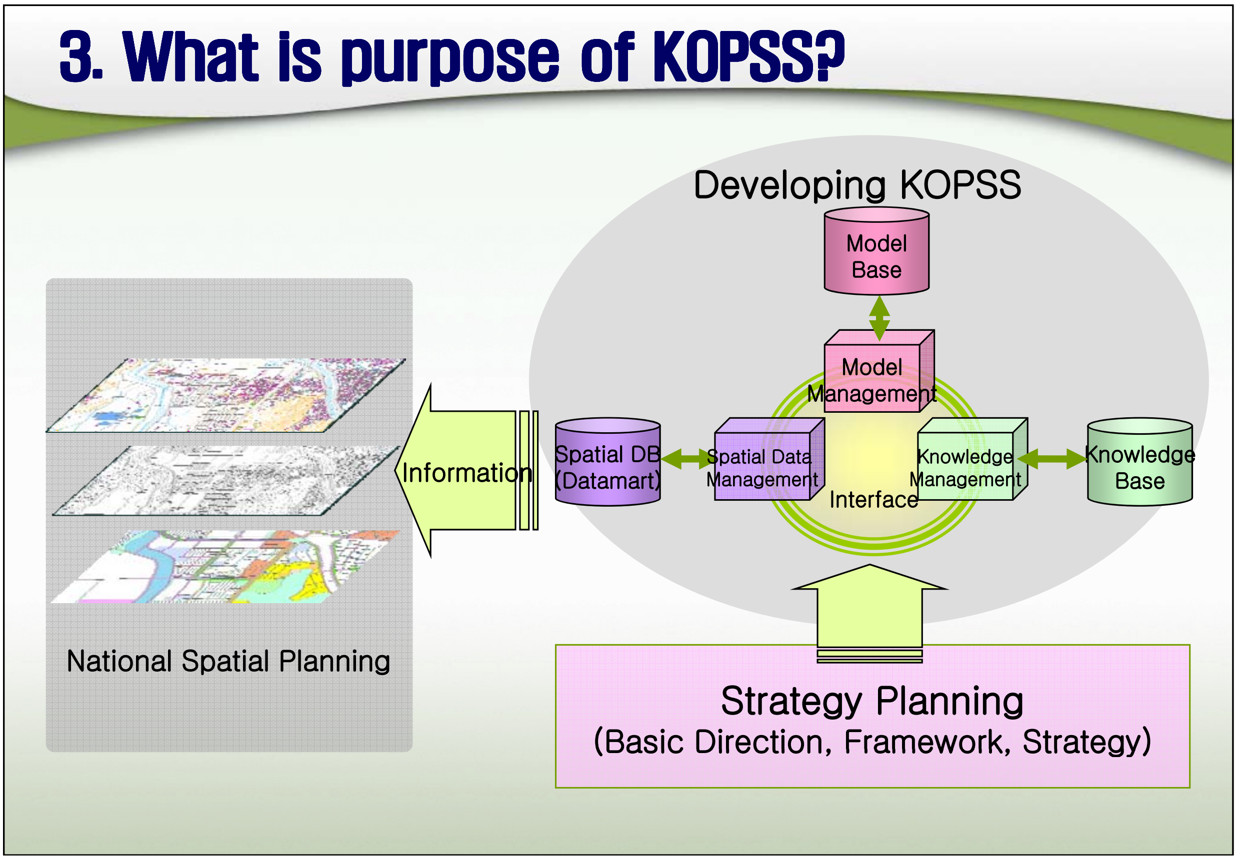
1. What is KOPSS?
2. Why is KOPSS needed?
3. What is purpose of KOPSS?
4. Who participates in KOPSS?

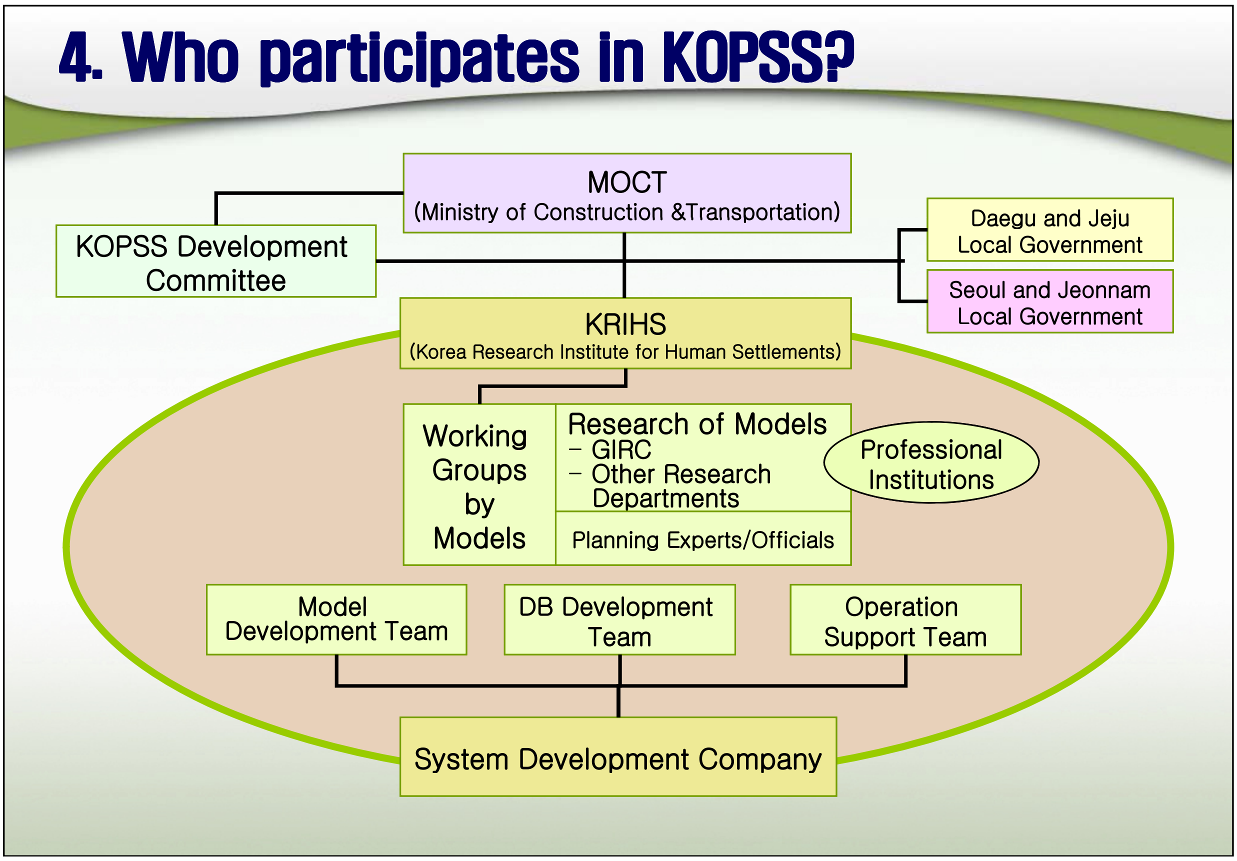
1. What is KOPSS?

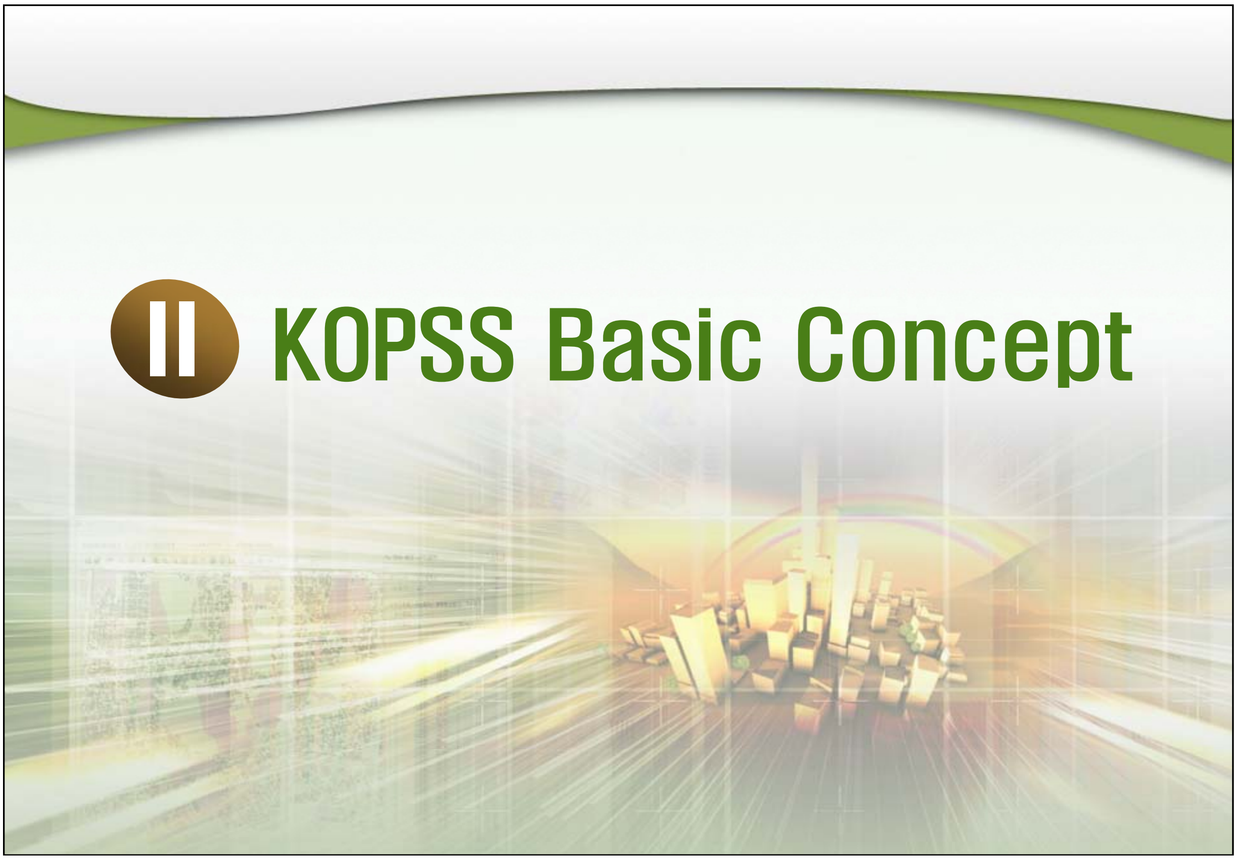
KOrea **P**lanning **S**upport **S**ystems

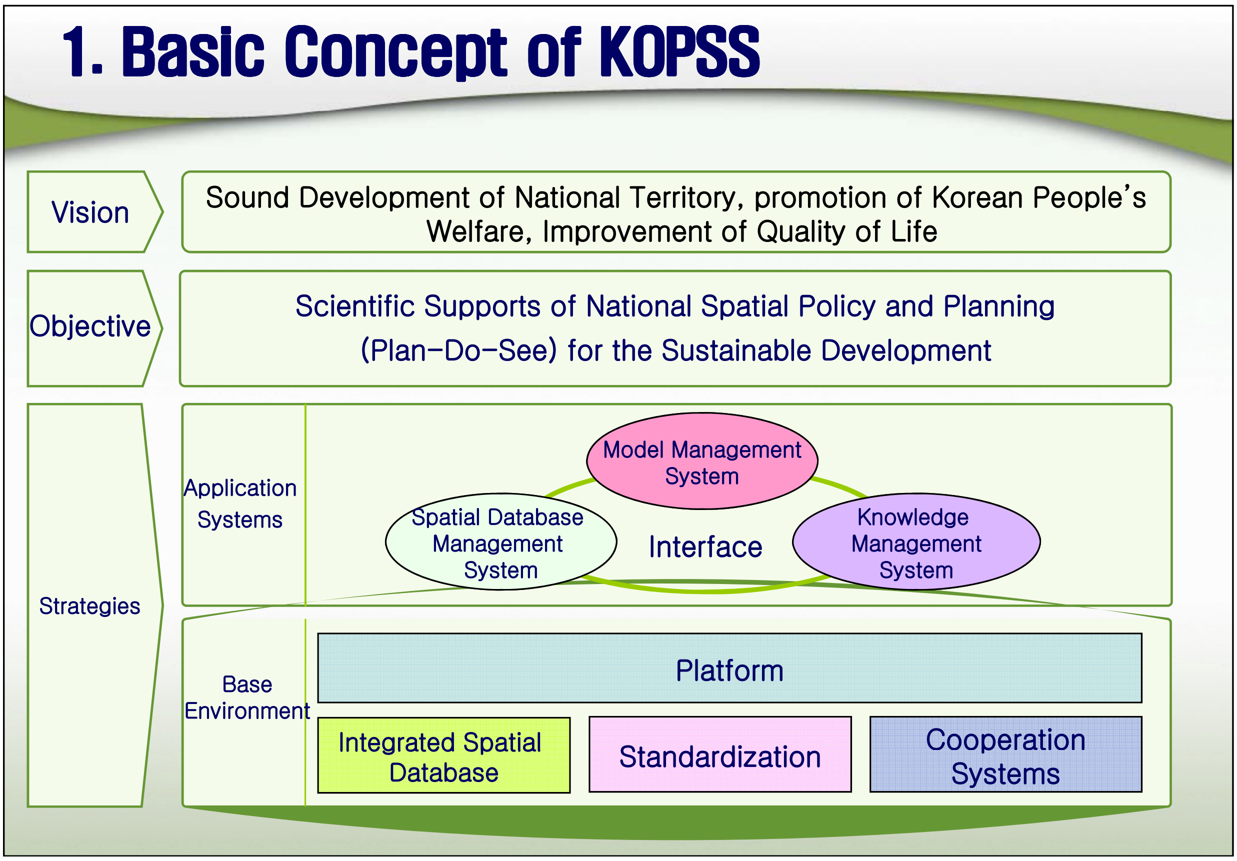
Korean style national policy and planning decision support systems using GIS-based spatial analysis methods


2. Why is KOPSS needed?
National Spatial Planning
Transparency
Rapid Environment Changes
Complex Interaction
Supply : Central Government
Distribution : Off-line
Type : Paper Map
Rapid Response
Influence Analysis
Private Sector
On&off-line
Electronic Map
Effectiveness


3. What is purpose of KOPSS?
Developing KOPSS
Model Base
Model Management
Spatial DB (Datamart)
Spatial Data Management
Interface
Knowledge Management
Knowledge Base
Information
National Spatial Planning
Strategy Planning
(Basic Direction, Framework, Strategy)


4. Who participates in KOPSS?
MOCT
(Ministry of Construction &Transportation)
KOPSS Development Committee
Daegu and Jeju Local Government
Seoul and Jeonnam Local Government
KRIHS
(Korea Research Institute for Human Settlements)
Working Groups by Models
Research of Models
– GIRC
– Other Research Departments
Planning Experts/Officials
Professional Institutions
Model Development Team
DB Development Team
Operation Support Team
System Development Company

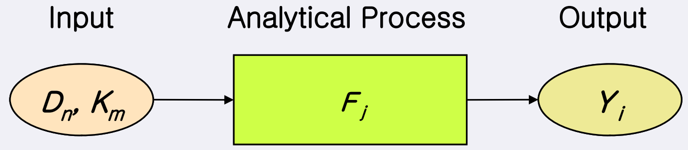

II KOPSS Basic Concept


1. Basic Concept of KOPSS
Vision
Sound Development of National Territory, promotion of Korean People's Welfare, Improvement of Quality of Life
Objective
Scientific Supports of National Spatial Policy and Planning (Plan-Do-See) for the Sustainable Development
Strategies
Application Systems
Model Management System
Spatial Database Management System
Interface
Knowledge Management System
Base Environment
Platform
Integrated Spatial Database
Standardization
Cooperation Systems


III Development Strategy
1. Conceptual Structure of KOPSS
2. Sub-System Development Strategies
3. Component-based Application Systems

1. Conceptual Structure of KOPSS

Analysis Concept of KOPSS



$Y_i = F_j(D_n, K_m)$

Y_i : Elicited information for supporting i spatial planning set-up

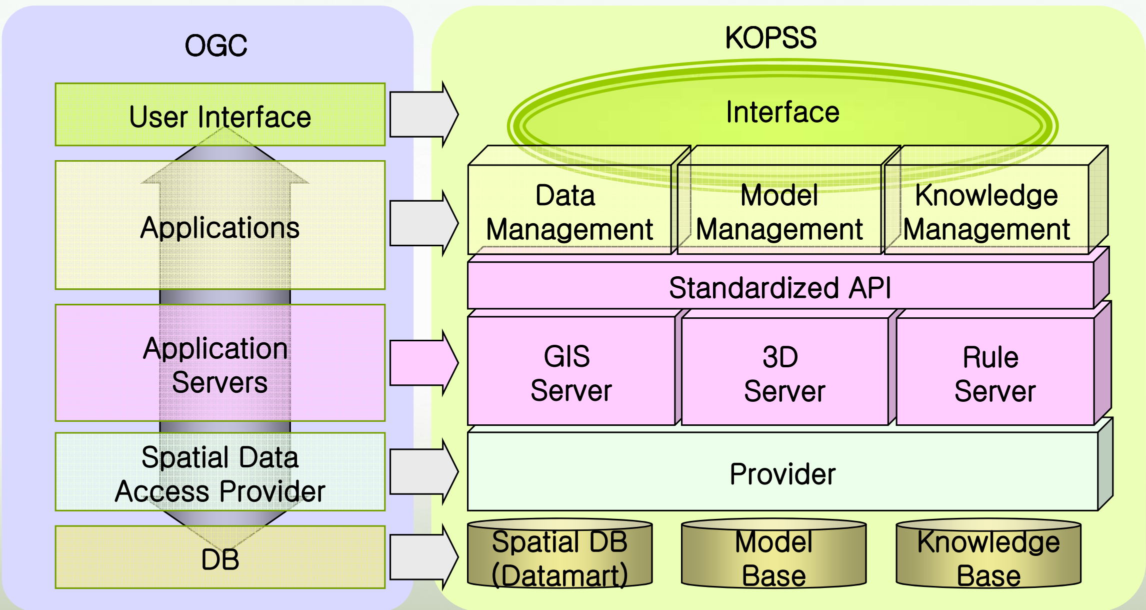
F_j: Analytical Process for supporting i spatial planning set-up

D_n : A set of j data needed for analytical process

K_m : A set of j Knowledge needed for analytical process

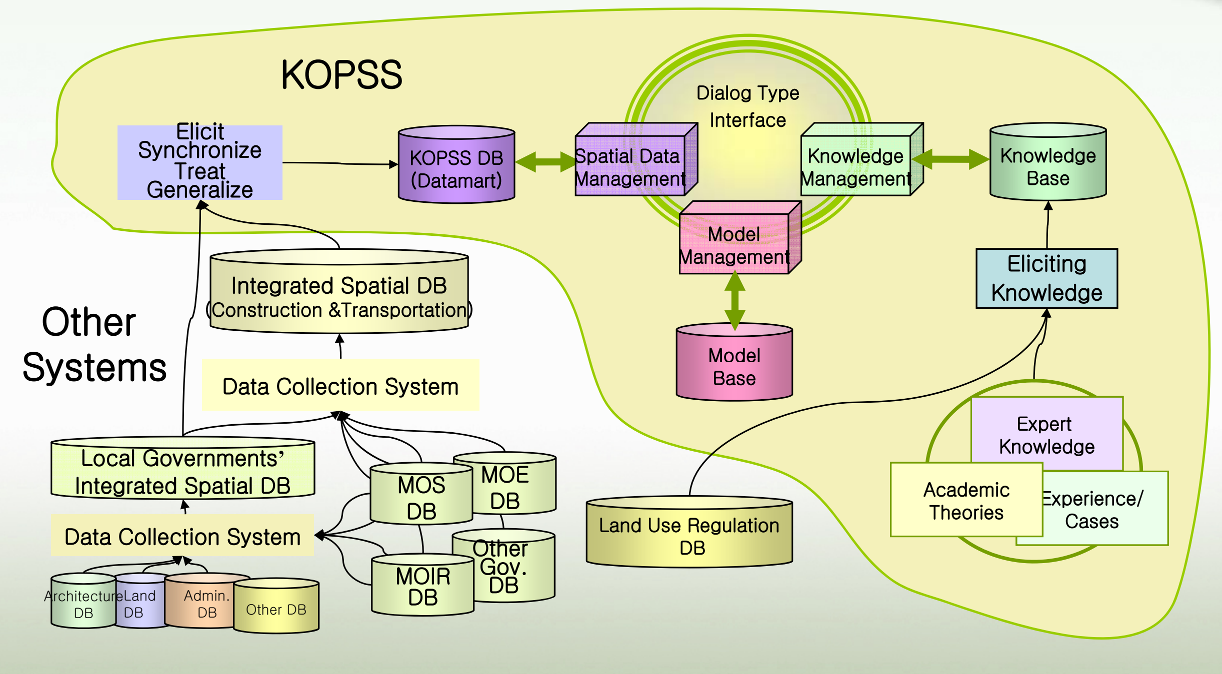
1. Conceptual Structure of KOPSS

Conceptual System Structure of KOPSS



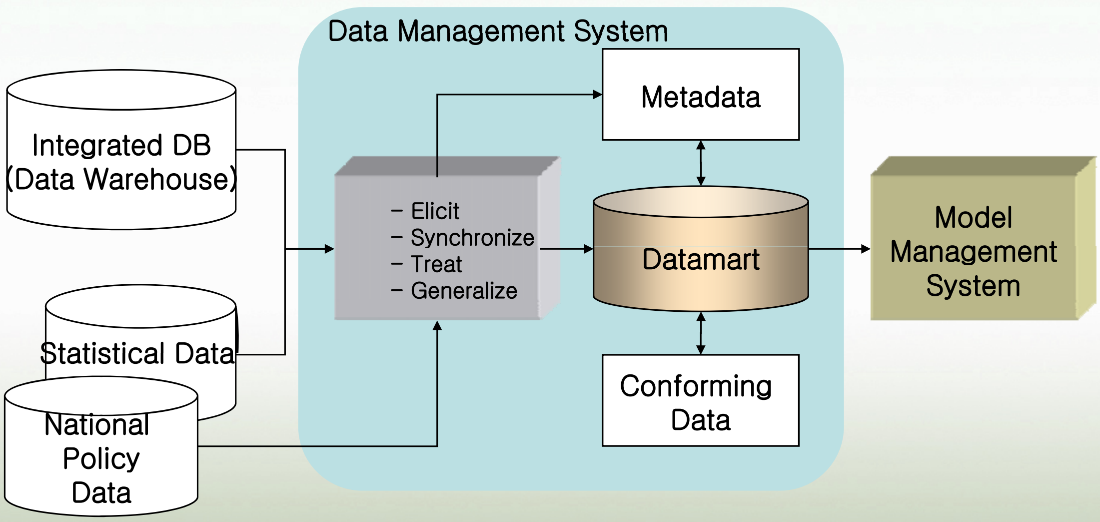
1. Conceptual Structure of KOPSS

■ **Composition of Target Systems**



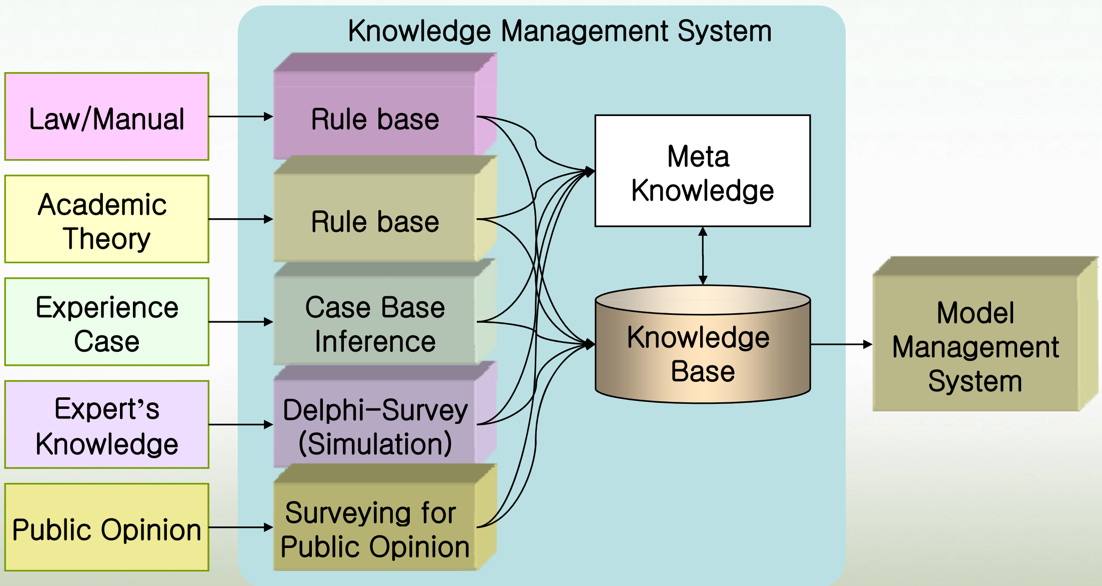
2. Sub-System Development Strategies

■ **Strategy of Data Management System Development**



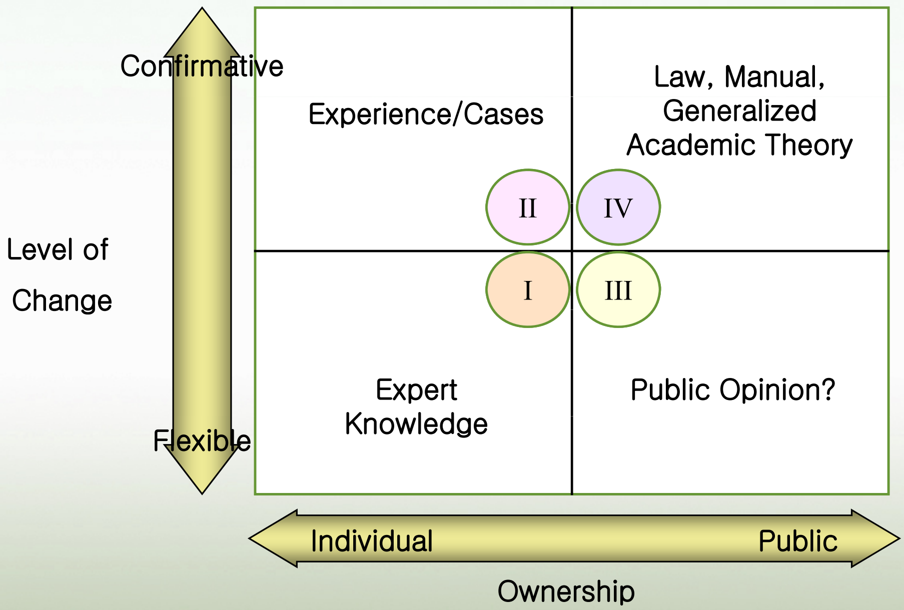
2. Sub-System Development Strategies

Strategy of Knowledge Management System Development



2. Sub-System Development Strategies

Strategy of Knowledge Management System Development



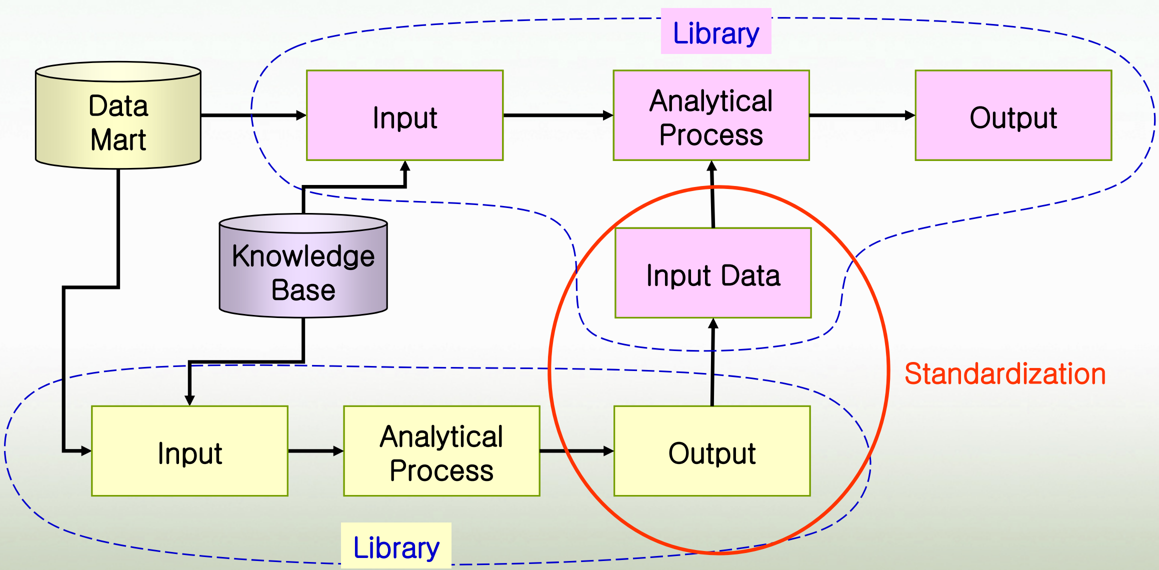
2. Sub-System Development Strategies

■ **Strategy of Analysis Model Management System (Library)**

Definition of Library Name
Definition of Input Data (Data/Knowledge)
Definition of Analytical Process
Definition of Output Data

2. Sub-System Development Strategies

■ **Strategy of Analysis Model Management System (Component)**

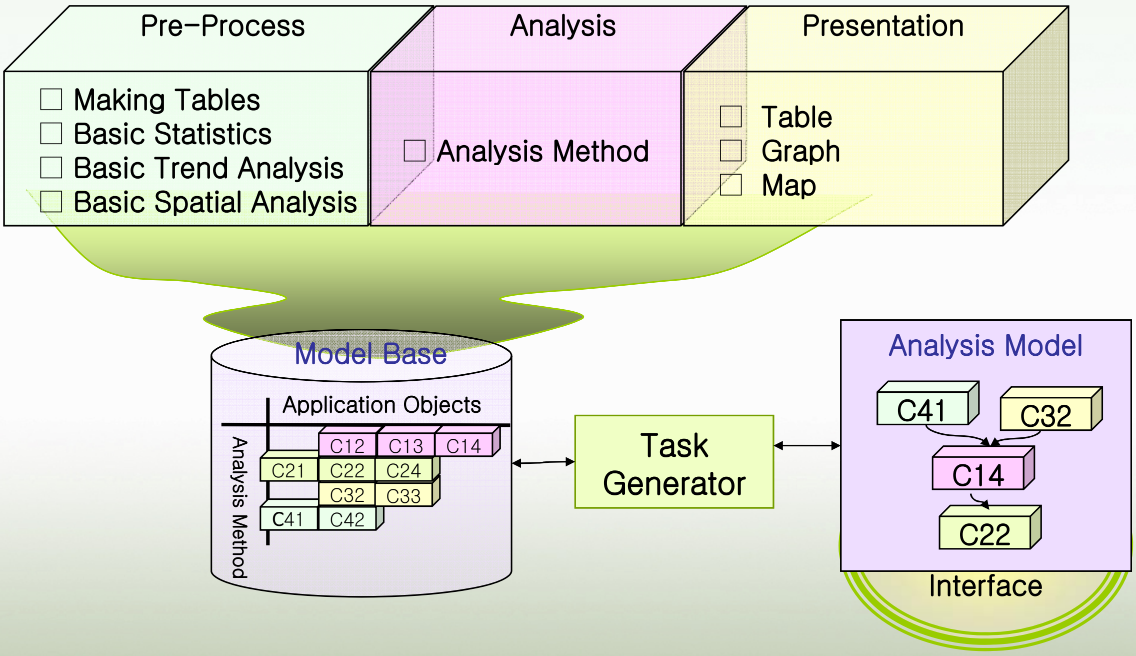


2. Sub-System Development Strategies

User Interface

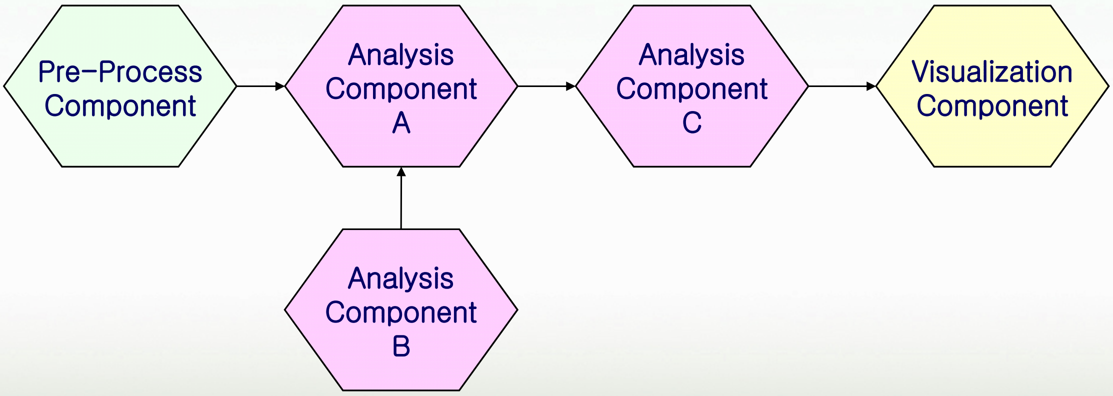
Considering Points	Interface Functions
Users are Not computer experts	Dialogue type interaction interface
Searching suitable alternatives responding to situation changes	Users' participation into analysis process
Suggesting presentation methods for easily understanding	cross-checking and printing out of tables, graphs& maps
Guaranteeing transparency and Objectivity of analysis results	Tracing the analysis process

3. Component-based Application Systems



3. Component-based Application Systems

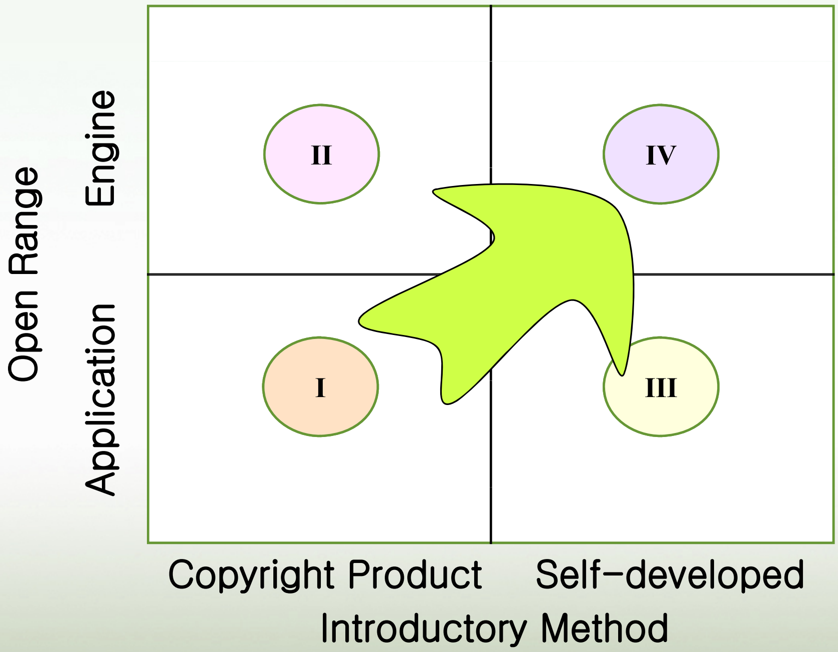
■ Definition of Task : A Set of Ordered Components



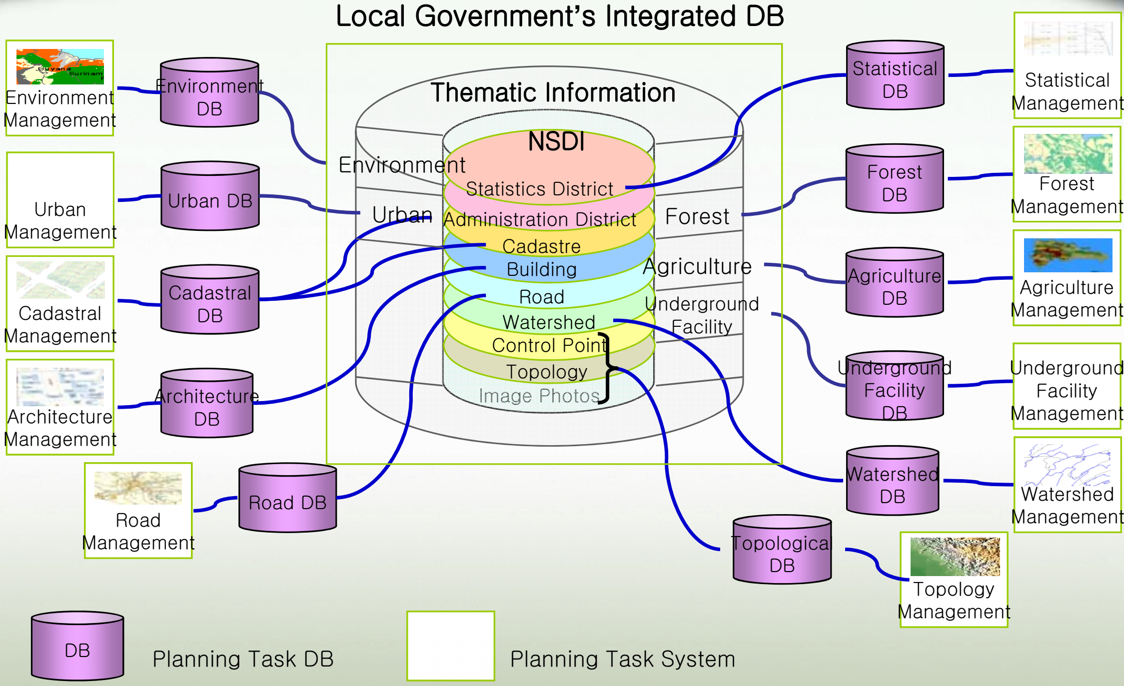
IV Base Environment Strategy

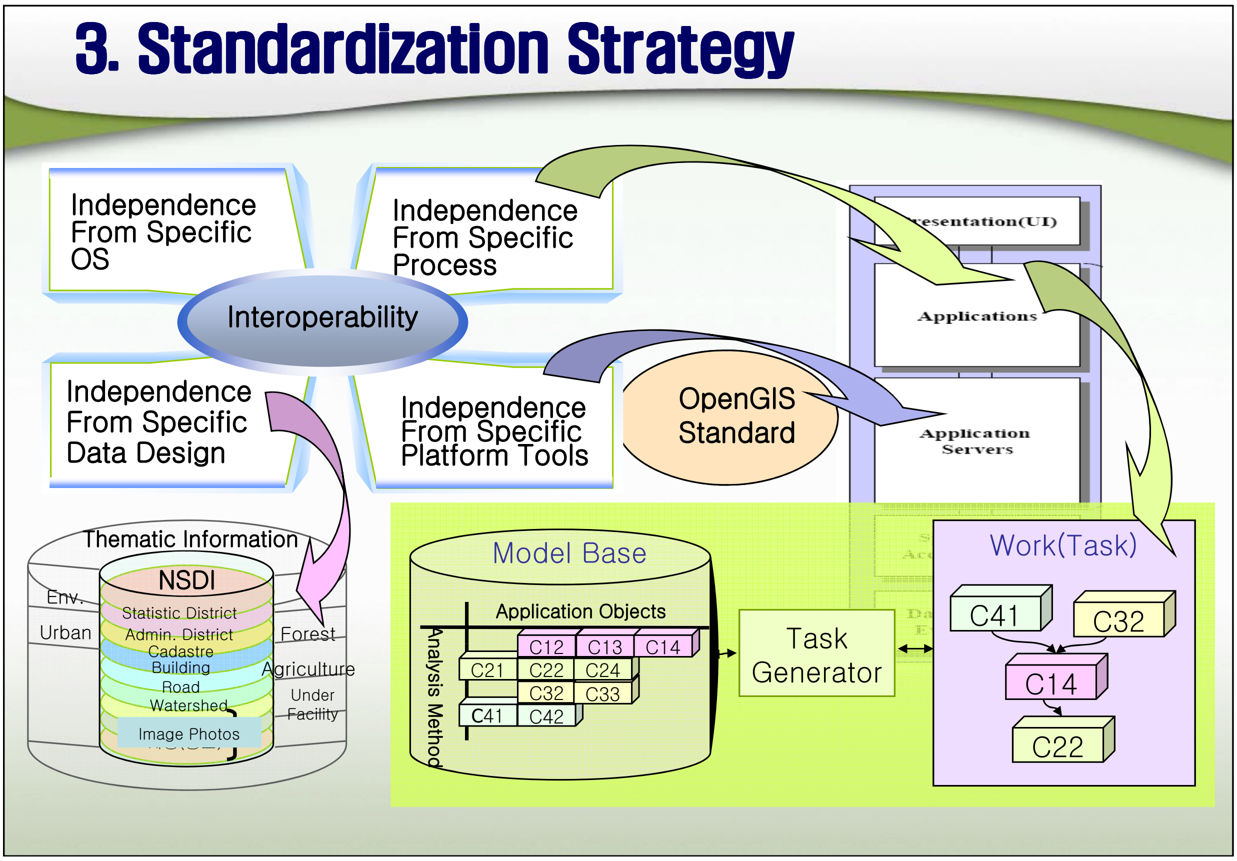
1. Development Tool Strategy
2. Integrated DB Development Strategy
3. Standardization Strategy
4. Cooperation System Development Strategy

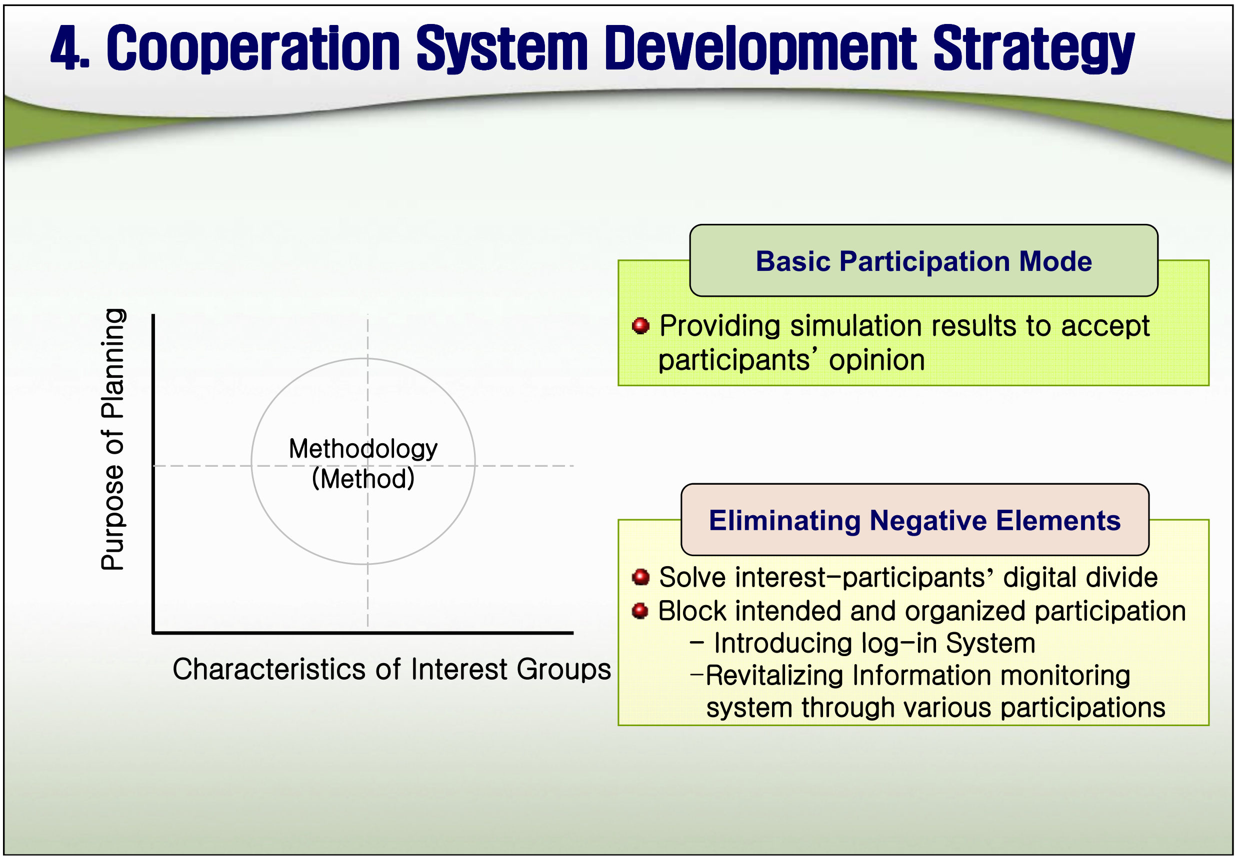
1. Development Tool Strategy



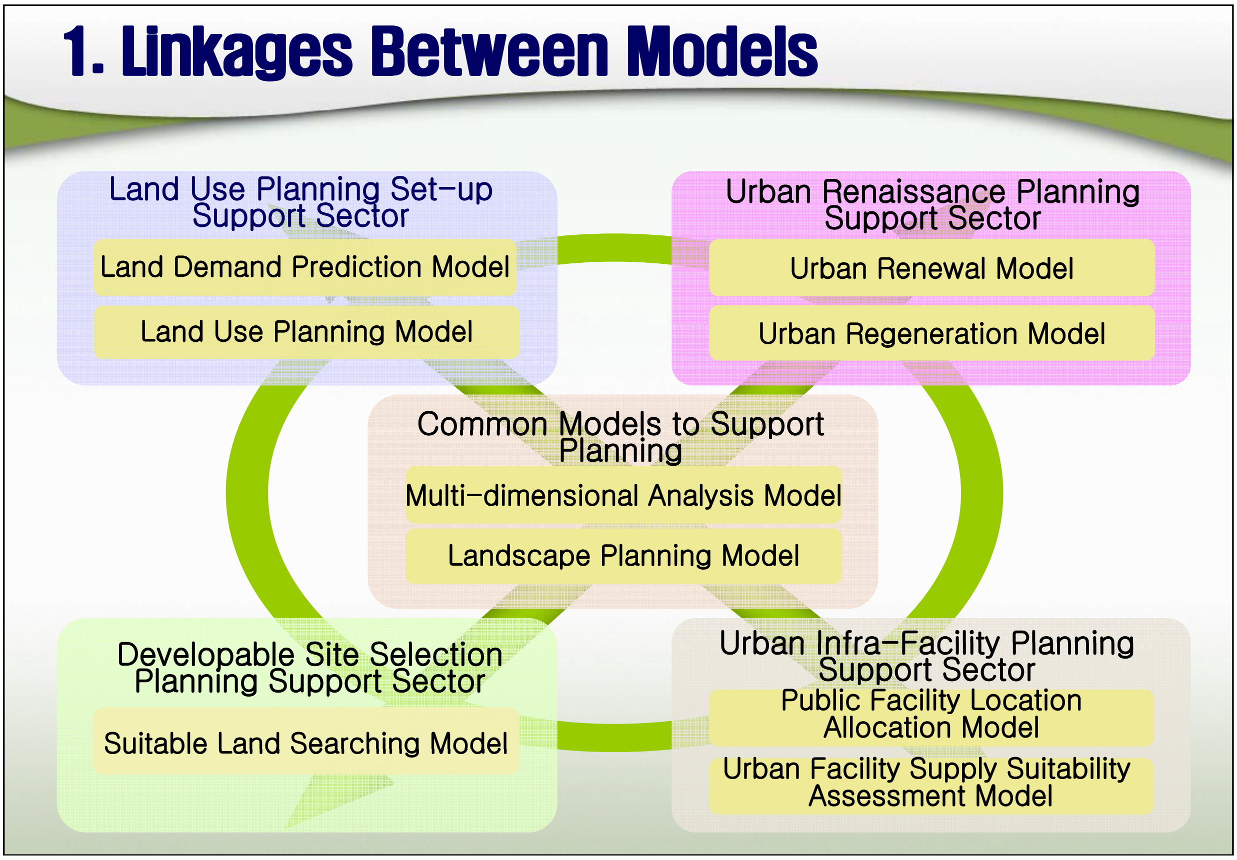
2. Integrated DB Development Strategy



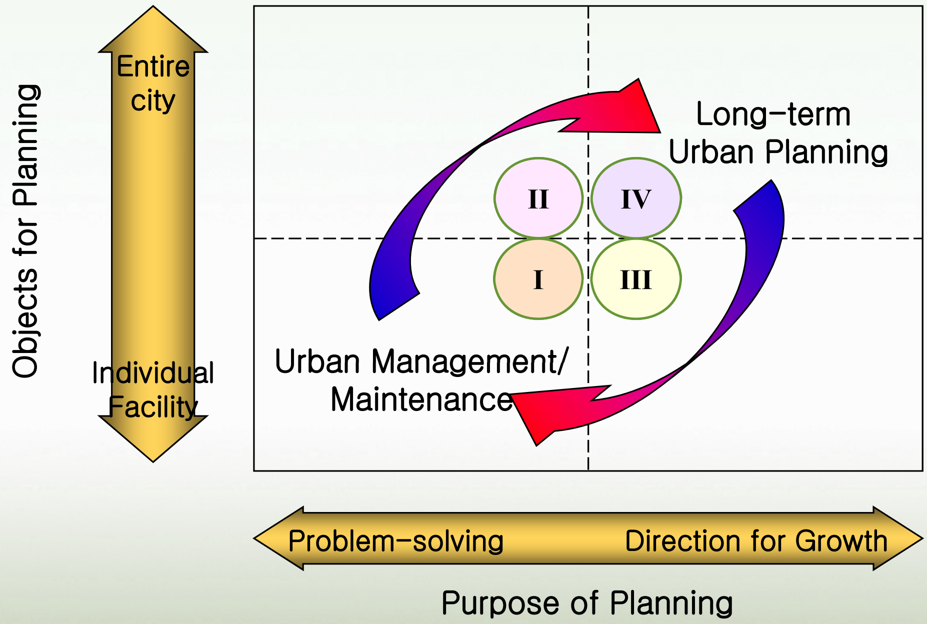

3. Standardization Strategy
Independence From Specific OS
Independence From Specific Process
Interoperability
Independence From Specific Data Design
Independence From Specific Platform Tools
OpenGIS Standard
Applications
Application Servers
Thematic Information
NSDI
Env.
Urban
Statistic District
Admin. District
Cadastre
Building
Road
Watershed
Image Photos
Forest
Agriculture
Under Facility
Model Base
Application Objects
Analysis Method
C12
C13
C14
C21
C22
C24
C32
C33
C41
C42
Task Generator
Work(Task)
C41
C32
C14
C22

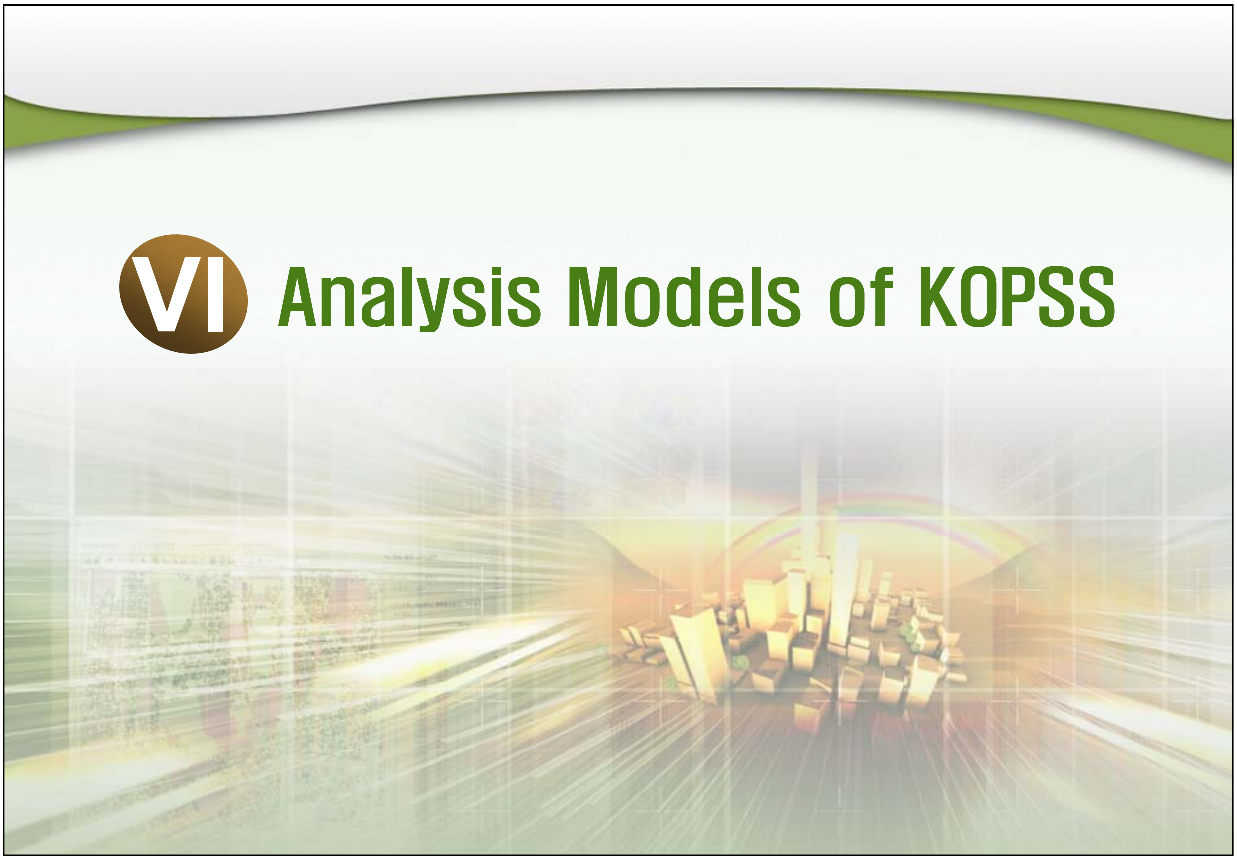

4. Cooperation System Development Strategy
Purpose of Planning
Methodology (Method)
Characteristics of Interest Groups
Basic Participation Mode
Providing simulation results to accept participants' opinion
Eliminating Negative Elements
Solve interest-participants' digital divide
Block intended and organized participation
– Introducing log-in System
–Revitalizing Information monitoring system through various participations


V
Promotion Strategy
1. Linkages Between Models
2. KOPSS Promotion Strategy


1. Linkages Between Models
Land Use Planning Set-up Support Sector
Land Demand Prediction Model
Land Use Planning Model
Urban Renaissance Planning Support Sector
Urban Renewal Model
Urban Regeneration Model
Common Models to Support Planning
Multi-dimensional Analysis Model
Landscape Planning Model
Developable Site Selection Planning Support Sector
Suitable Land Searching Model
Urban Infra-Facility Planning Support Sector
Public Facility Location Allocation Model
Urban Facility Supply Suitability Assessment Model

2. KOPSS Promotion Strategy

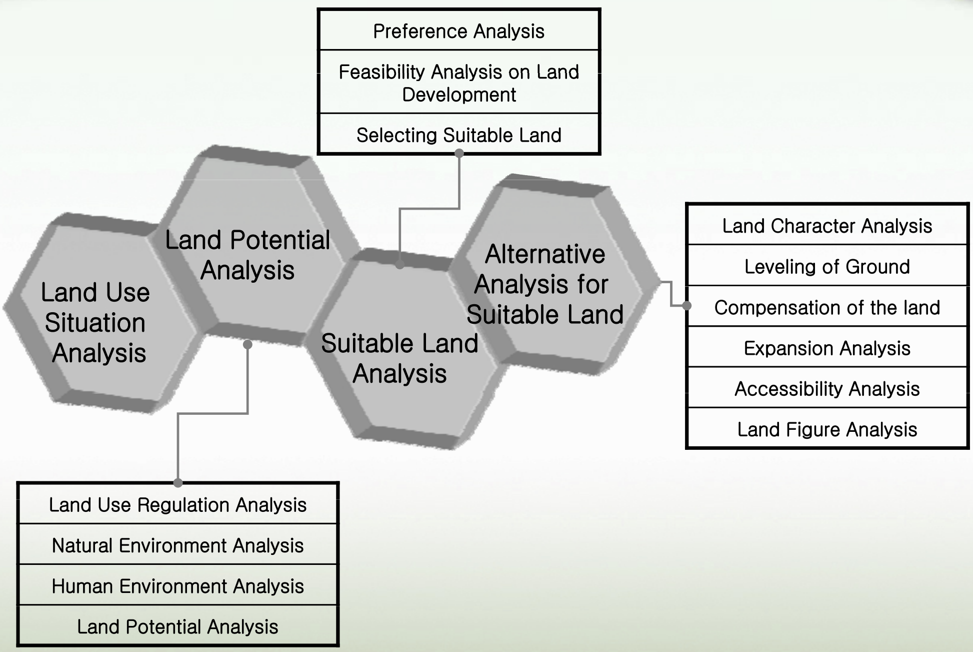




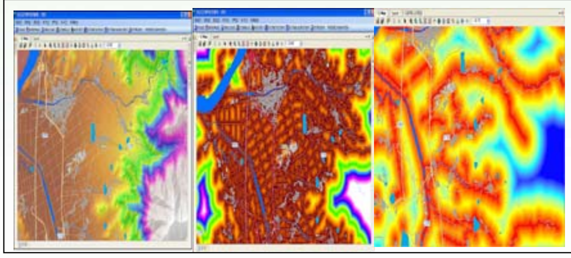
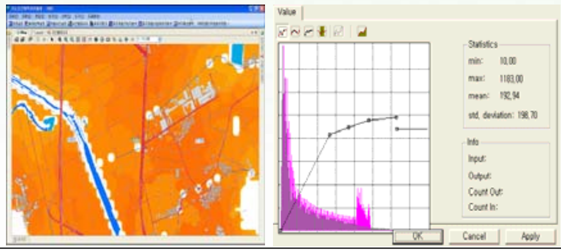
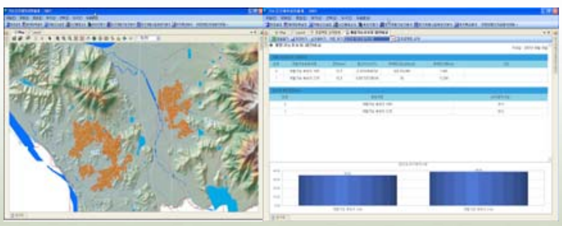
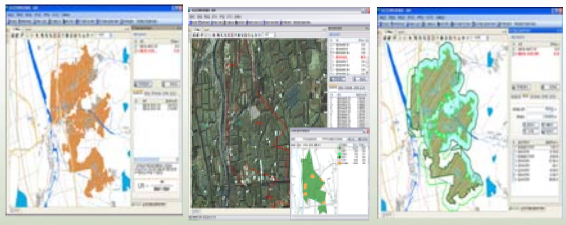
Outline of KOPSS Analysis Models

Model	Function	Status
Suitable Land Searching	Support selection of the suitable developable land	Developed In 2006
Multi-dimensional Analysis	Support making chart, map, and table and visualization of thematic map	
Urban Renewal	Support analysis of declined areas and search of brown fields in the inner cities	
Landscape Planning	Support landscape simulation and management	
Public Facility Location-Allocation	Support analysis of urban facility location distribution and search of the potential location site	
Land Demand Prediction	Support estimation of future land use demands	On-going in 2007
Land Use Planning	Support analysis of land use suitability, allocation of projected land use demands, and simulation of land use changes	
Urban Regeneration	Support search of predicted redevelopment areas and analysis of potential areas	
Urban Facility Supply Suitability Assessment	Support analysis of supply suitability based on the standard urban carrying capacity	

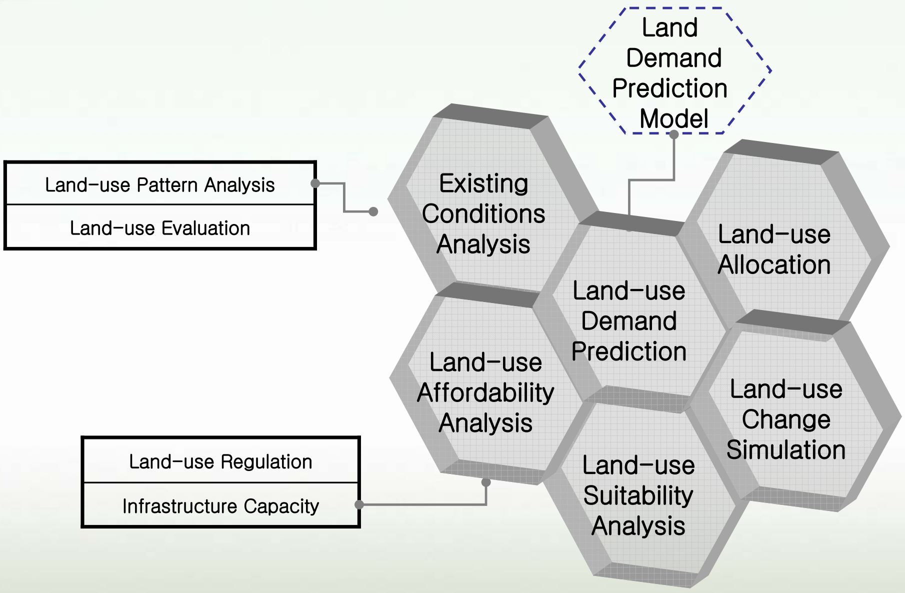
1. Suitable Land Searching Model

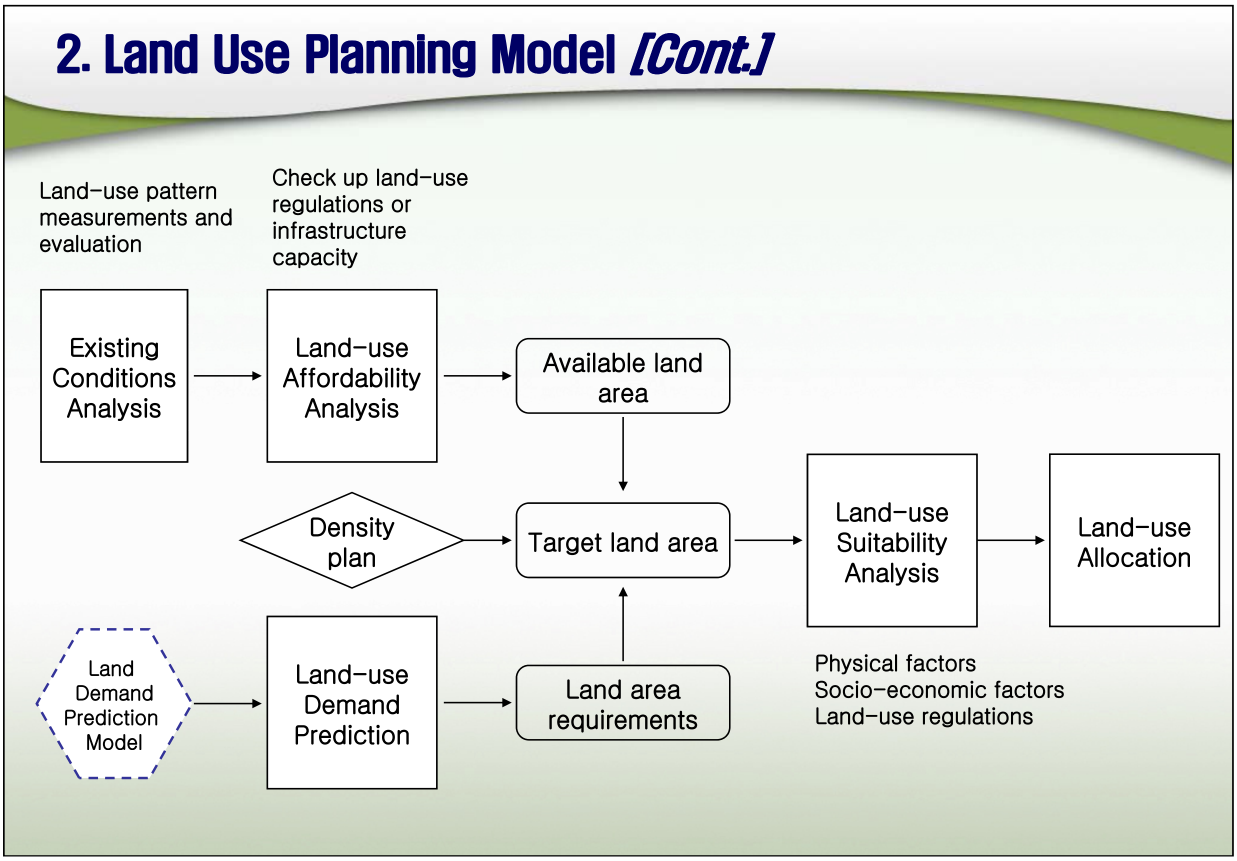


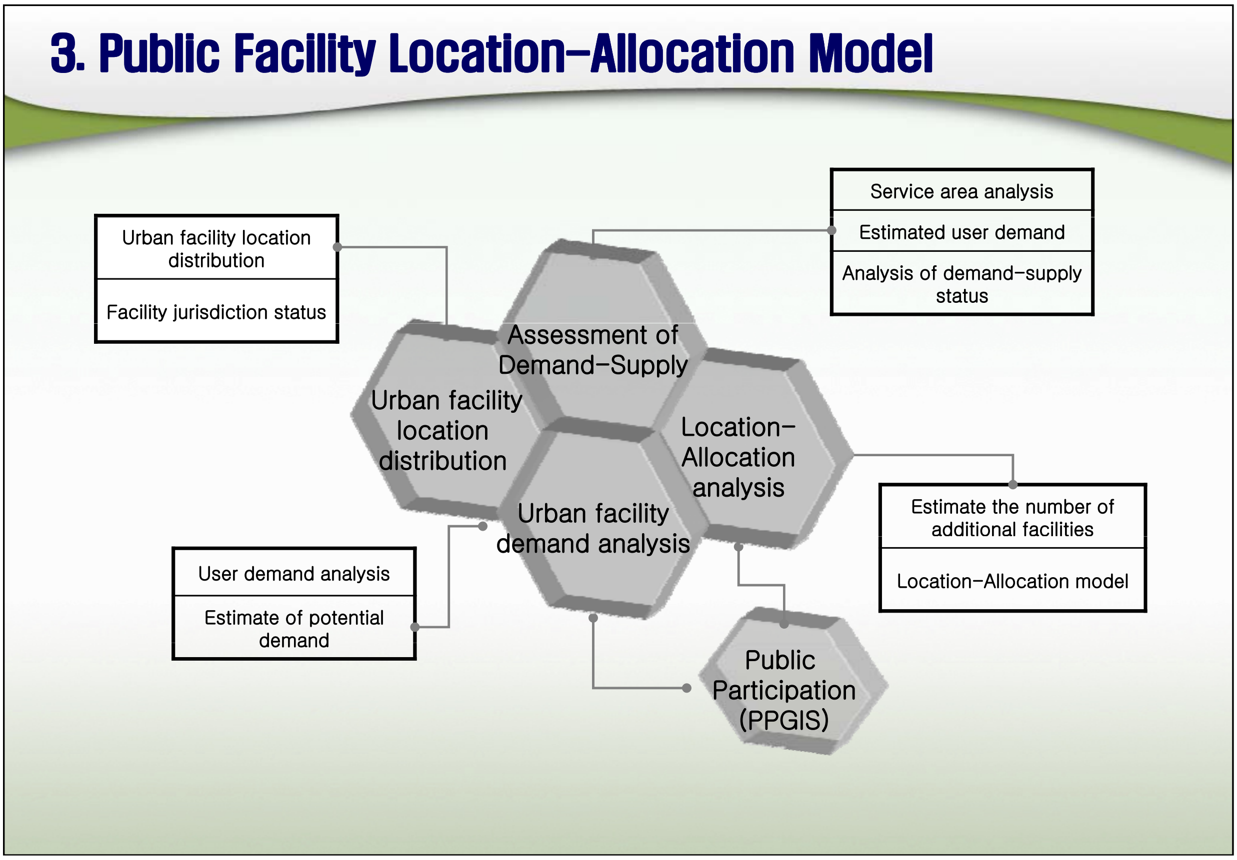
1. Suitable land searching model *[Cont.]*

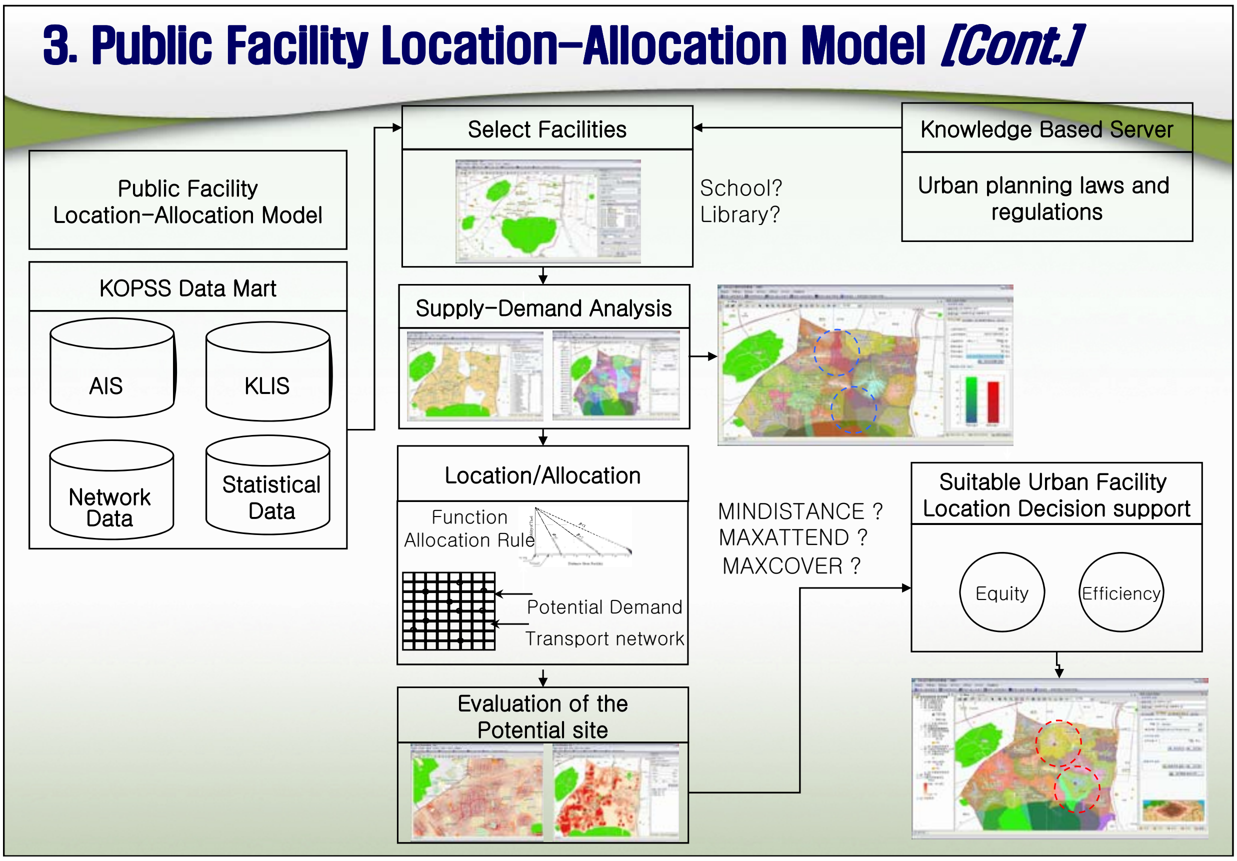
Human & Nature Environment Analysis	Land Potential Analysis
	
Selecting Suitable Land	Electing the Alternative Land
	

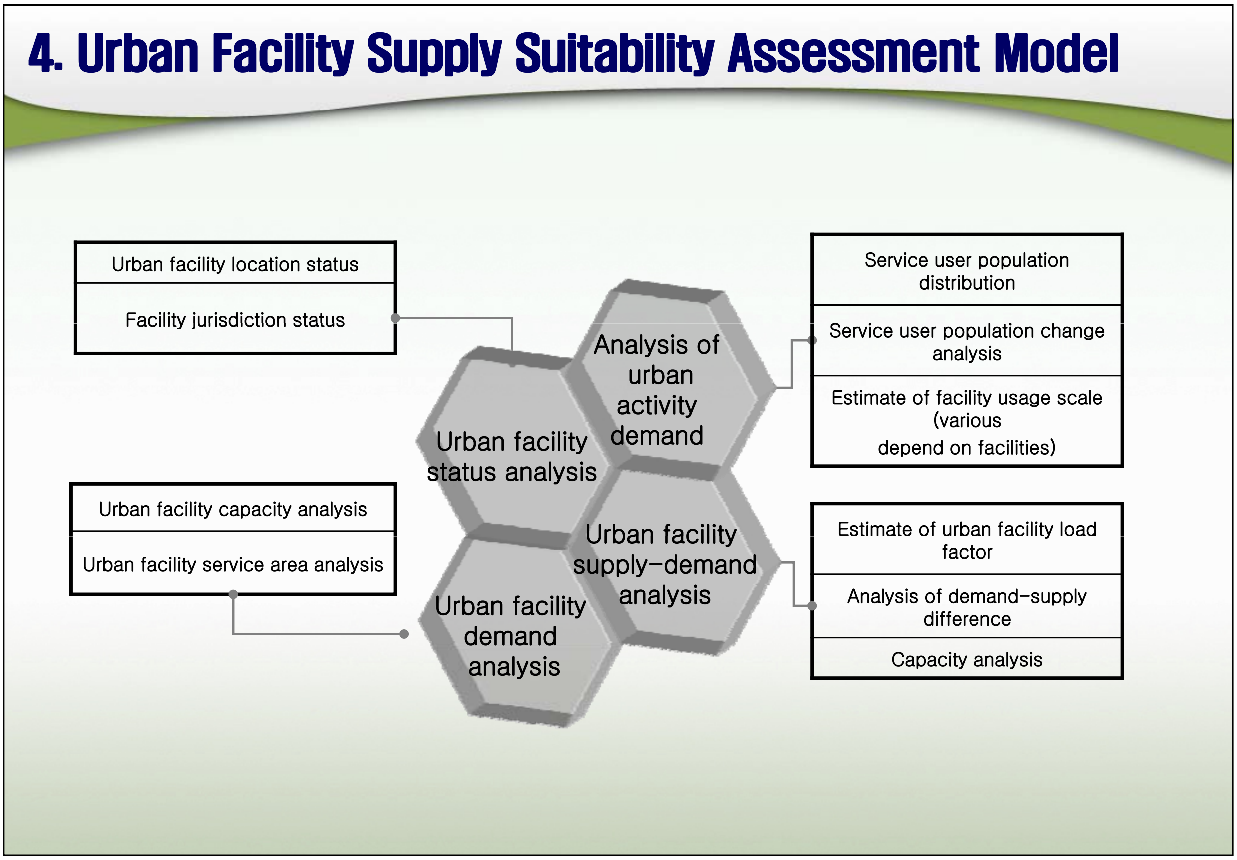
2. Land Use Planning Model

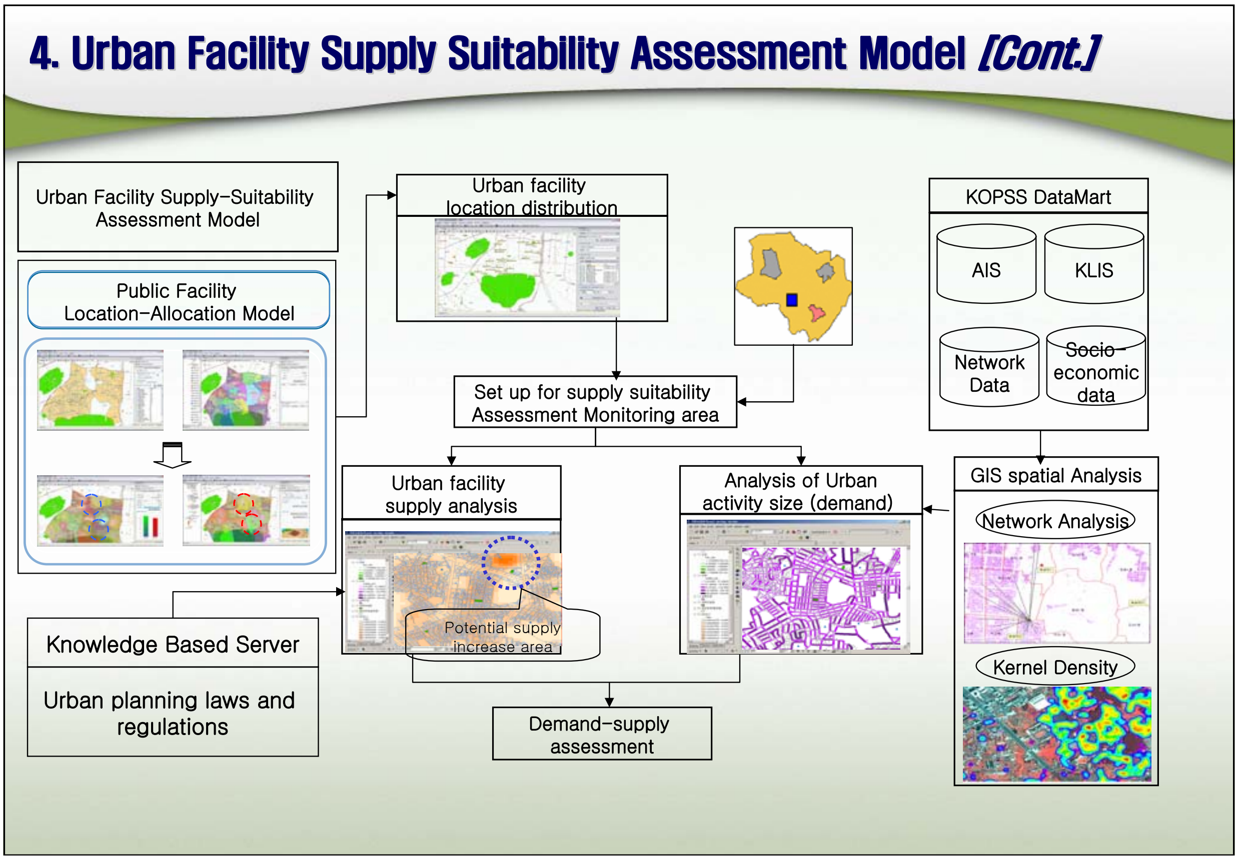


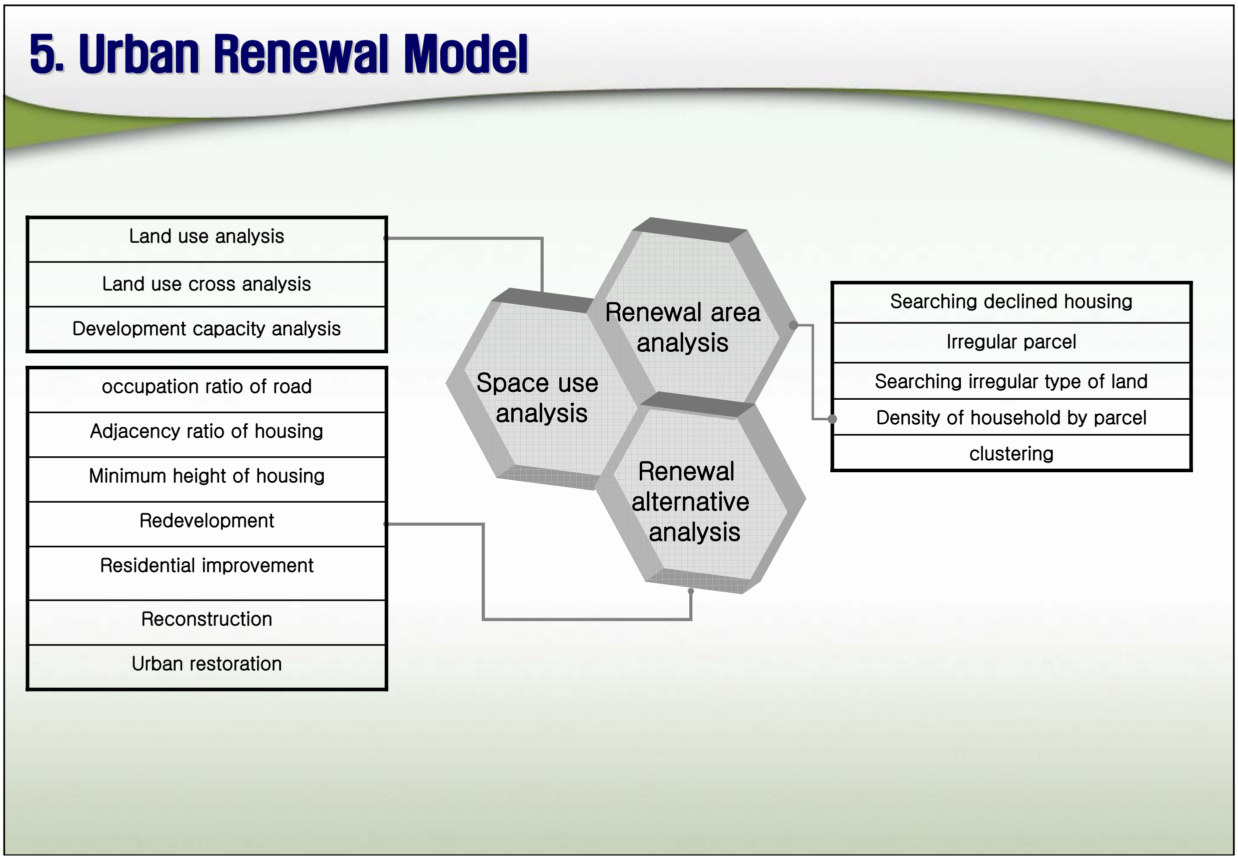

2. Land Use Planning Model [Cont.]
Land-use pattern measurements and evaluation
Check up land-use regulations or infrastructure capacity
Existing Conditions Analysis
Land-use Affordability Analysis
Available land area
Density plan
Target land area
Land-use Suitability Analysis
Land-use Allocation
Land Demand Prediction Model
Land-use Demand Prediction
Land area requirements
Physical factors
Socio-economic factors
Land-use regulations


3. Public Facility Location-Allocation Model
Urban facility location distribution
Facility jurisdiction status
Service area analysis
Estimated user demand
Analysis of demand-supply status
Assessment of Demand-Supply
Urban facility location distribution
Location-Allocation analysis
Urban facility demand analysis
Estimate the number of additional facilities
Location-Allocation model
User demand analysis
Estimate of potential demand
Public Participation (PPGIS)

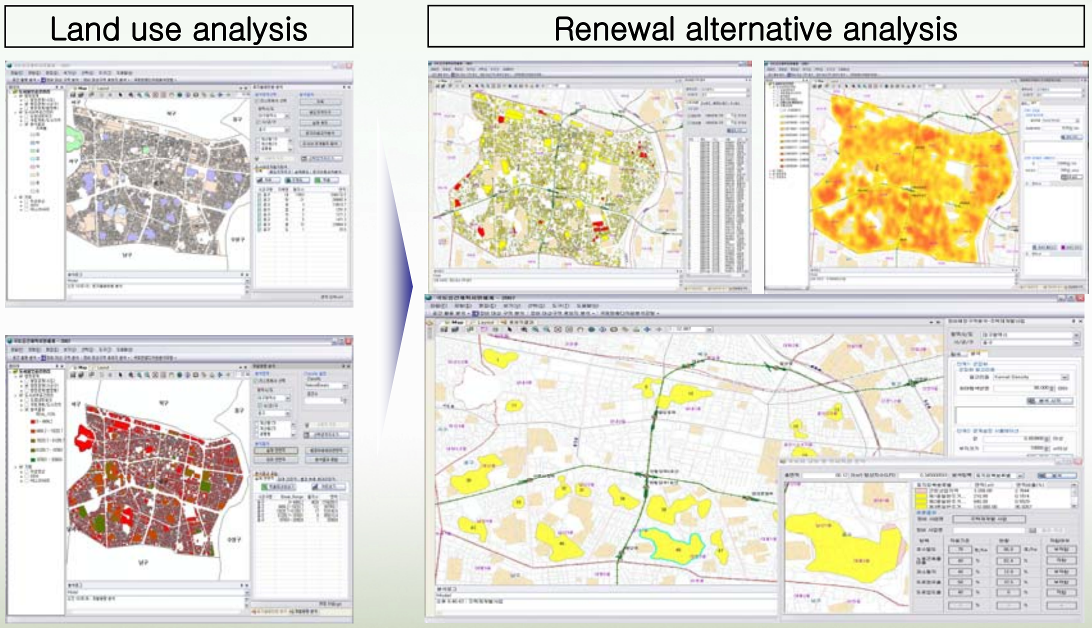

3. Public Facility Location-Allocation Model [Cont.]
Public Facility Location-Allocation Model
KOPSS Data Mart
AIS
KLIS
Network Data
Statistical Data
Select Facilities
School?
Library?
Knowledge Based Server
Urban planning laws and regulations
Supply-Demand Analysis
Location/Allocation
Function
Allocation Rule
Potential Demand
Transport network
MINDISTANCE ?
MAXATTEND ?
MAXCOVER ?
Suitable Urban Facility Location Decision support
Equity
Efficiency
Evaluation of the Potential site


4. Urban Facility Supply Suitability Assessment Model
Urban facility location status
Facility jurisdiction status
Urban facility capacity analysis
Urban facility service area analysis
Analysis of urban activity demand
Urban facility status analysis
Urban facility supply-demand analysis
Urban facility demand analysis
Service user population distribution
Service user population change analysis
Estimate of facility usage scale (various depend on facilities)
Estimate of urban facility load factor
Analysis of demand-supply difference
Capacity analysis

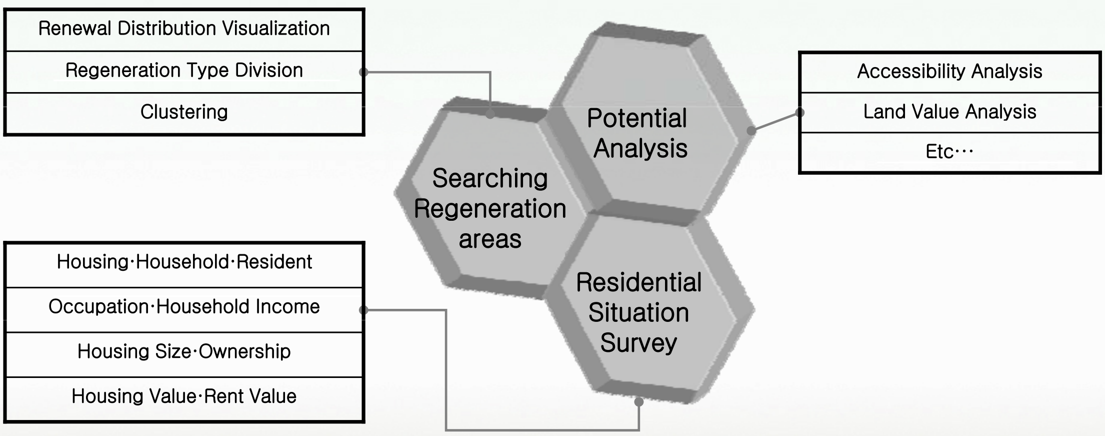

4. Urban Facility Supply Suitability Assessment Model [Cont.]
Urban Facility Supply-Suitability Assessment Model
Public Facility Location-Allocation Model
Urban facility location distribution
KOPSS DataMart
AIS
KLIS
Network Data
Socio-economic data
Set up for supply suitability Assessment Monitoring area
Urban facility supply analysis
Potential supply increase area
Analysis of Urban activity size (demand)
GIS spatial Analysis
Network Analysis
Kernel Density
Knowledge Based Server
Urban planning laws and regulations
Demand-supply assessment

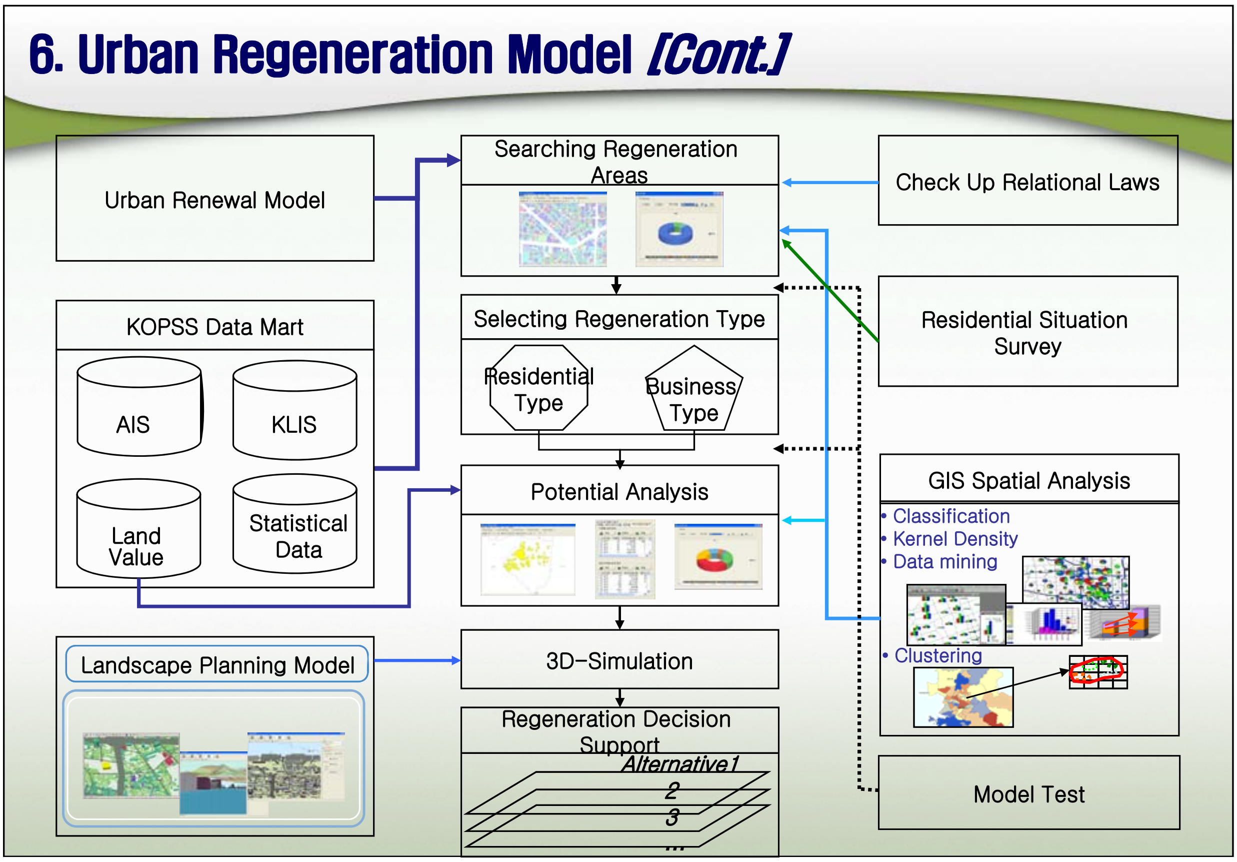

5. Urban Renewal Model
Land use analysis
Land use cross analysis
Development capacity analysis
occupation ratio of road
Adjacency ratio of housing
Minimum height of housing
Redevelopment
Residential improvement
Reconstruction
Urban restoration
Space use analysis
Renewal area analysis
Renewal alternative analysis
Searching declined housing
Irregular parcel
Searching irregular type of land
Density of household by parcel
clustering

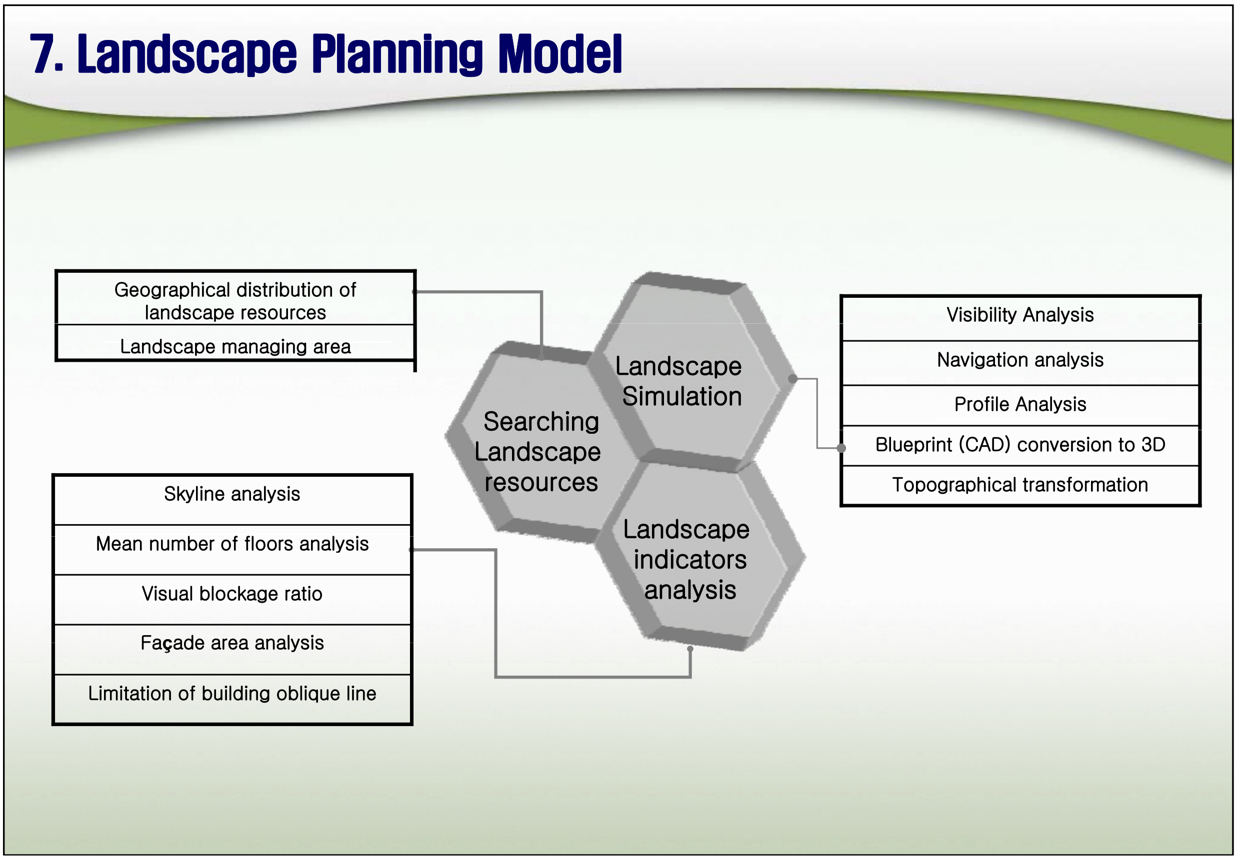
5. Urban Renewal Model [Cont.]



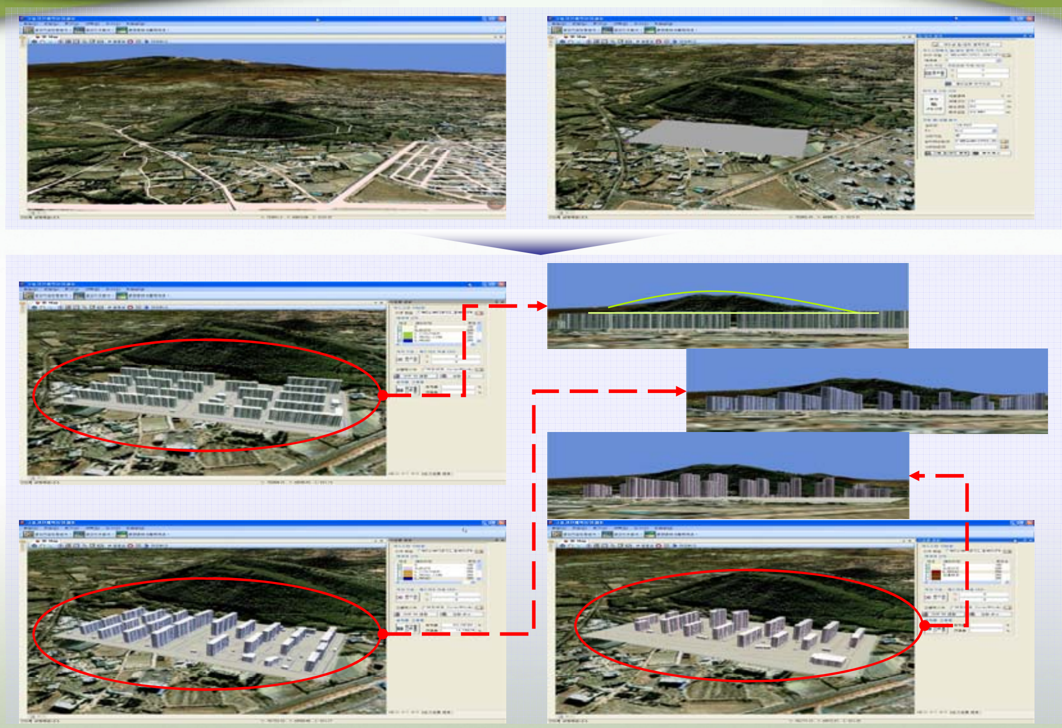
6. Urban Regeneration Model



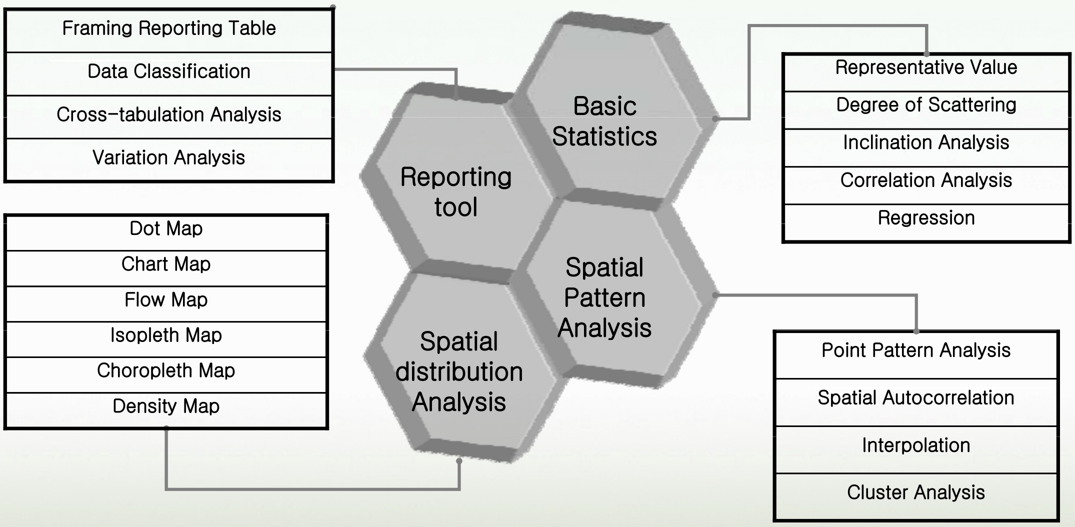

6. Urban Regeneration Model [Cont.]
Urban Renewal Model
KOPSS Data Mart
AIS
KLIS
Land Value
Statistical Data
Landscape Planning Model
Searching Regeneration Areas
Selecting Regeneration Type
Residential Type
Business Type
Potential Analysis
3D-Simulation
Regeneration Decision Support
Alternative1
2
3
...
Check Up Relational Laws
Residential Situation Survey
GIS Spatial Analysis
• Classification
• Kernel Density
• Data mining
• Clustering
Model Test


7. Landscape Planning Model
Geographical distribution of landscape resources
Landscape managing area
Skyline analysis
Mean number of floors analysis
Visual blockage ratio
Façade area analysis
Limitation of building oblique line
Searching Landscape resources
Landscape Simulation
Landscape indicators analysis
Visibility Analysis
Navigation analysis
Profile Analysis
Blueprint (CAD) conversion to 3D
Topographical transformation

7. Landscape Planning Model *[Cont.]*

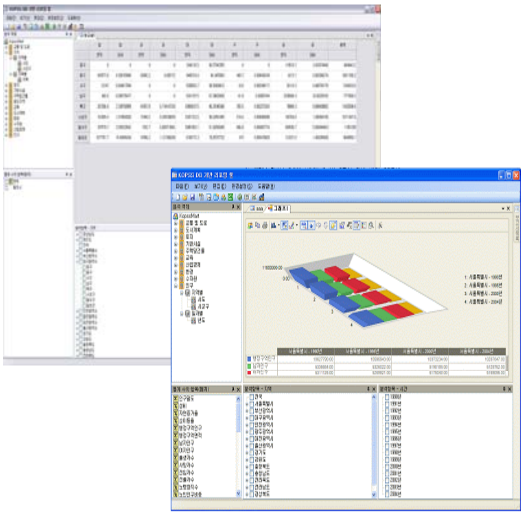


8. Multi-dimensional Analysis Model

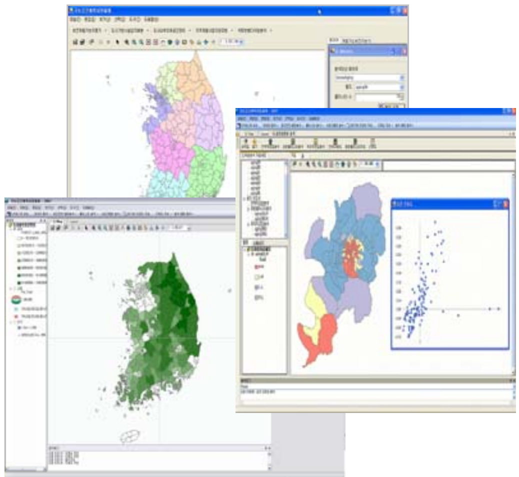


8. Multi-dimensional analysis model *[Cont.]*

Making Table & Chart



Thematic Mapping & Spatial Pattern Analysis



9. Land Demand Prediction Model

Macro model

Region or city level
(consideration of changes in the external environment)

Demographic growth model

Economic growth model

Land-use demands projection for each urban activity

Allocating global land demand to micro spatial units

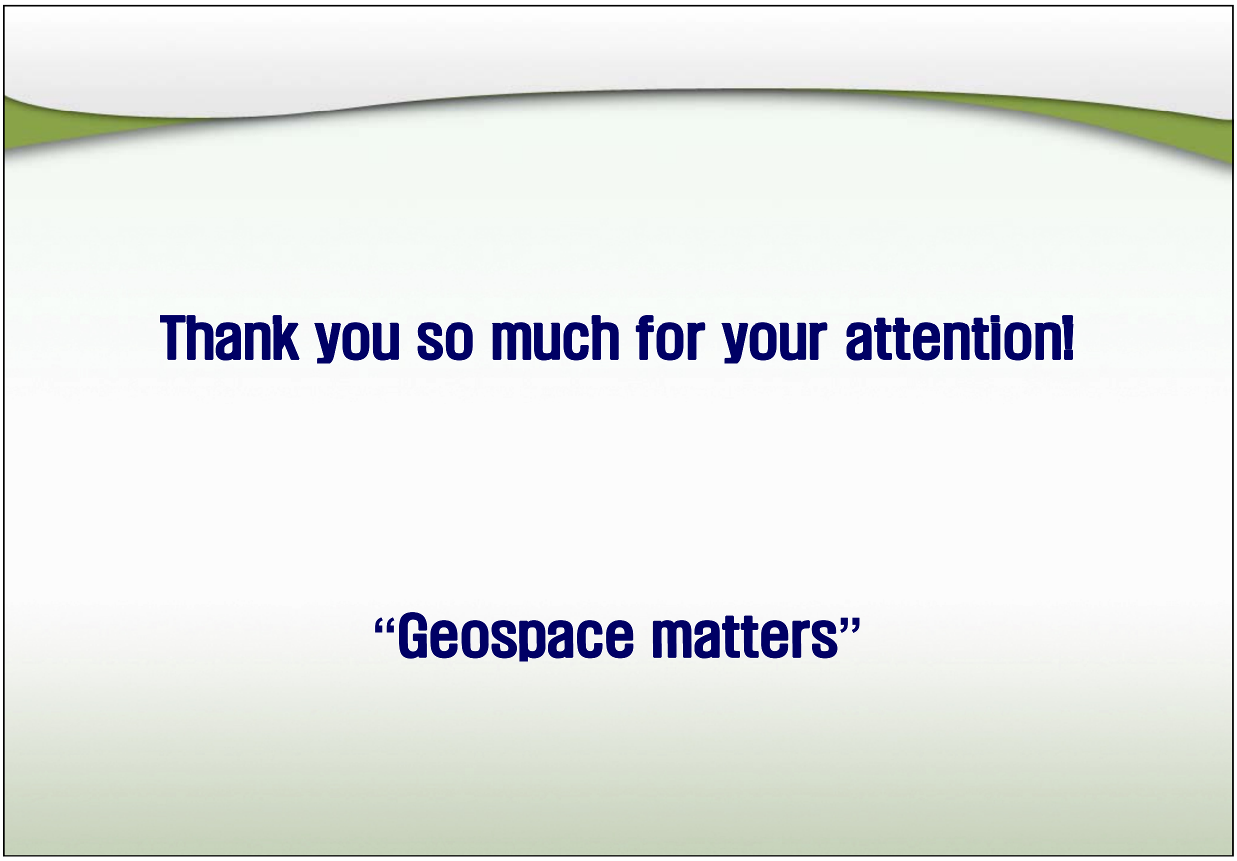
Micro model

Local level
(consideration of locational characteristics of each urban activity)

Residential location choice model

Employment location choice model

Land-use demands projection for small areas


Thank you so much for your attention!
“Geospace matters”

GeoSemantic Web Service Framework for Spatial Decision Support System

Chih-Hong Sun

Department of Geography
National Taiwan University
Taipei, Taiwan

Outline

- **Introduction**
- **What is GeoSemantic Web Service**
- **What is Ontology**
- **Discovery GIServices on Spatial Data Infr astructure**
- **The Conceptual Framework for GeoSema ntic Web Service**
- **Conclusions**

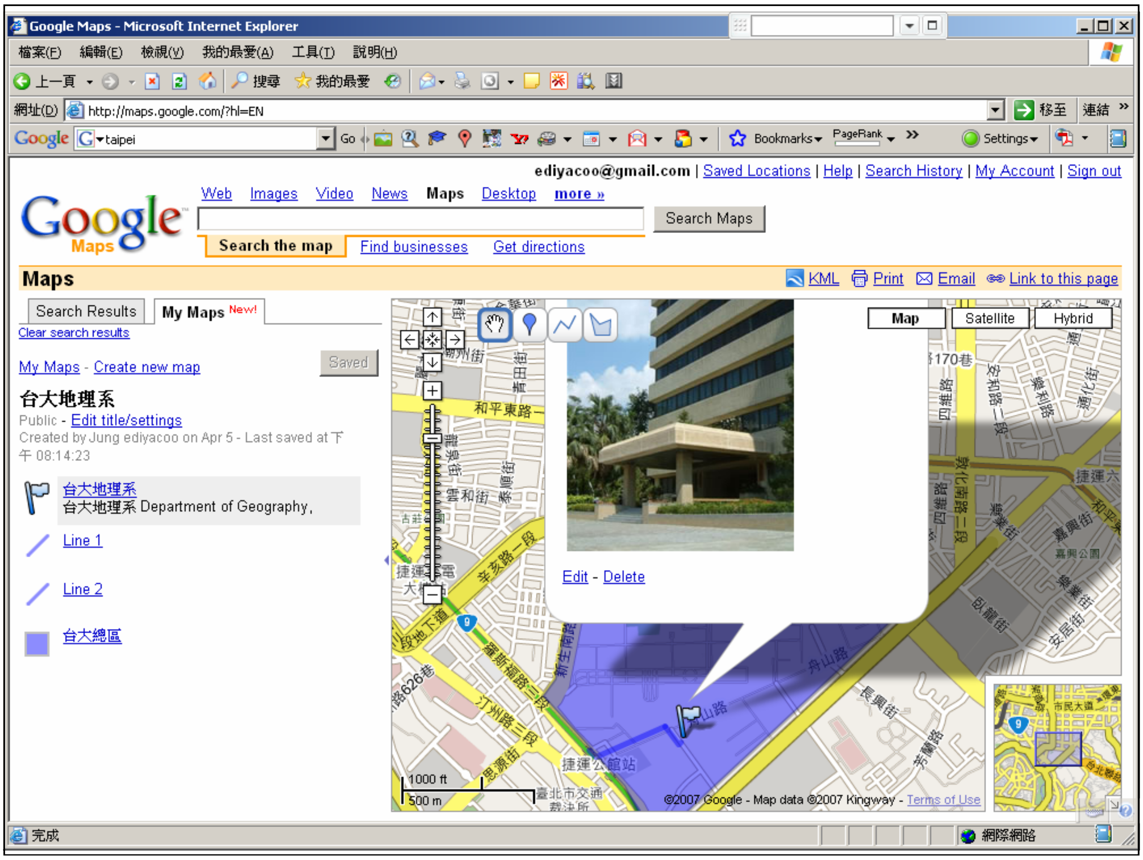
Introduction

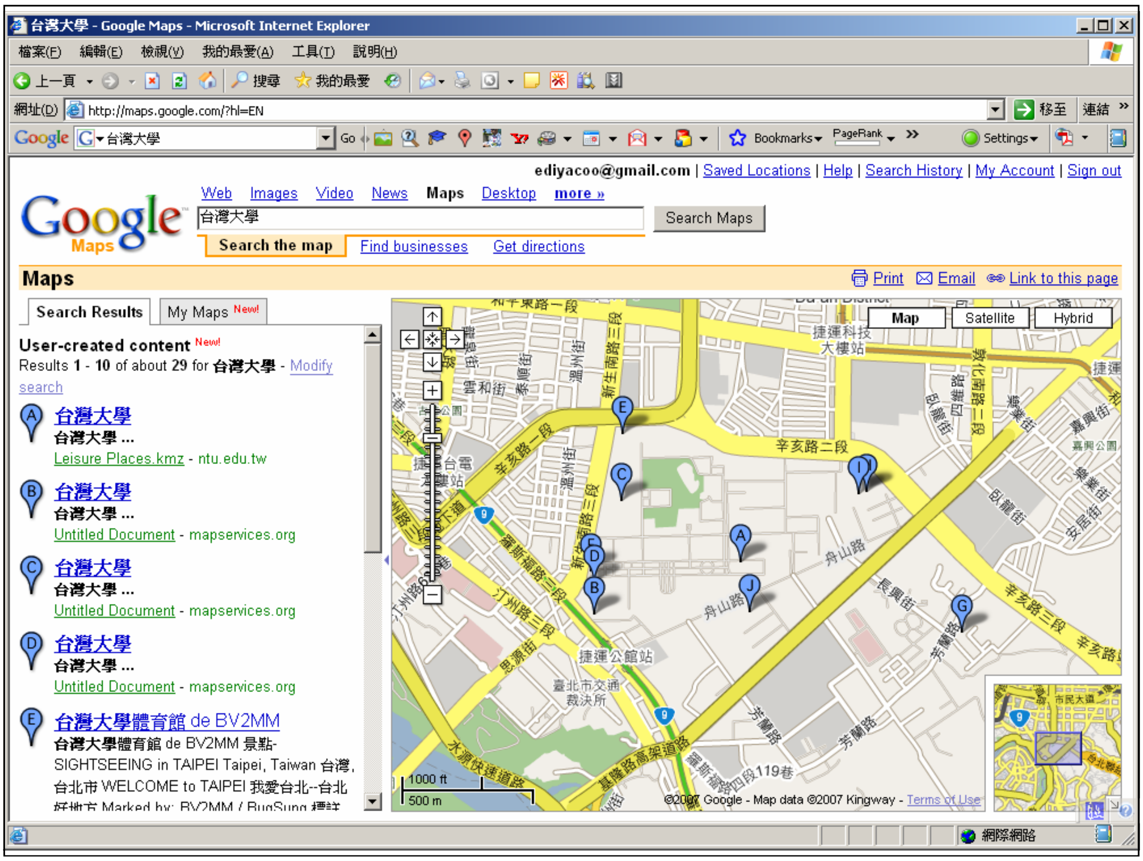
- **Building a framework for GeoSemantic Web**
  GeoSemantic Web = GIS services +
  GeoSpatial Semantic (Ontology)
- **The Ontologies = Spatial + Domain ontology**
- **Appling Ontology into the architecture of SDI**
- **Integrating spatial and domain knowledge into the GeoSemantic web service.**
- **Knowledge-oriented GIS platform**

Related Works

Semantic Web

- Web 1.0
- Web 2.0: Wiki Web
- Web 3.0
- ....
- Web GIS
- Web GIS 2.0
- Web GIS 3.0 ?
- ....





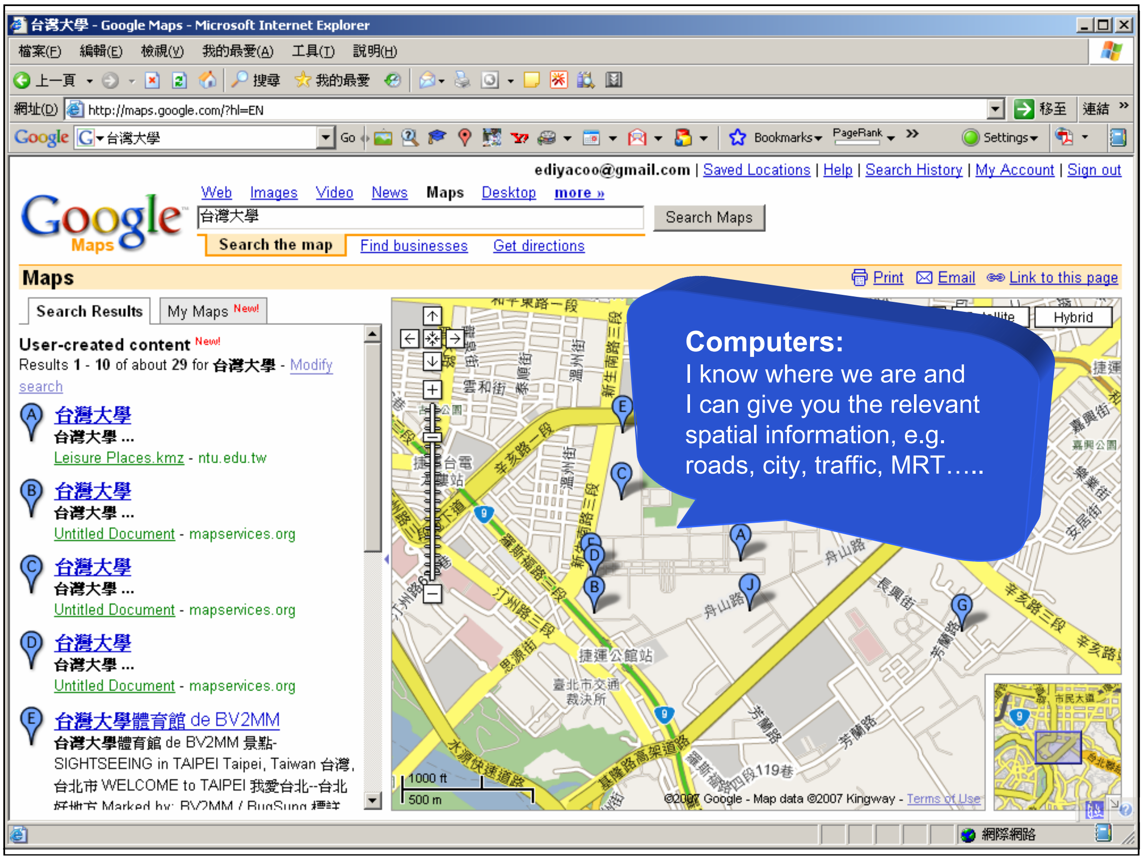
Semantic Web

- Can we know the relevant information about NTU?
  Of course, we see the map and think it !
  But……..
- Can the relevant information be automatically coll ected ?
  or Can computers know what we see and think ? a nd automatically collect the relevant information f or us?
- Web 3.0: Semantic Web
- Web GIS 3.0: GeoSemantic Web

WHY GeoSemantic Web ?

- **80% data contains spatial dimension, so as i nformation.**
- **Where ? Where? Where?**
- **If computers can help us collect the relevant spatial information and exactly know what we want,**

  isn't it GOOD?



Can GIS achieve this ?

- The idea is good, but………
  can GIS achieve this ?
- Geographic Information System
  → Geographic Information Science
  →→Geographic Information Service
- At last, let computer KNOW what we think in spatial domain.
- GeoSemantic Web = GIS services + Spatial Semantic

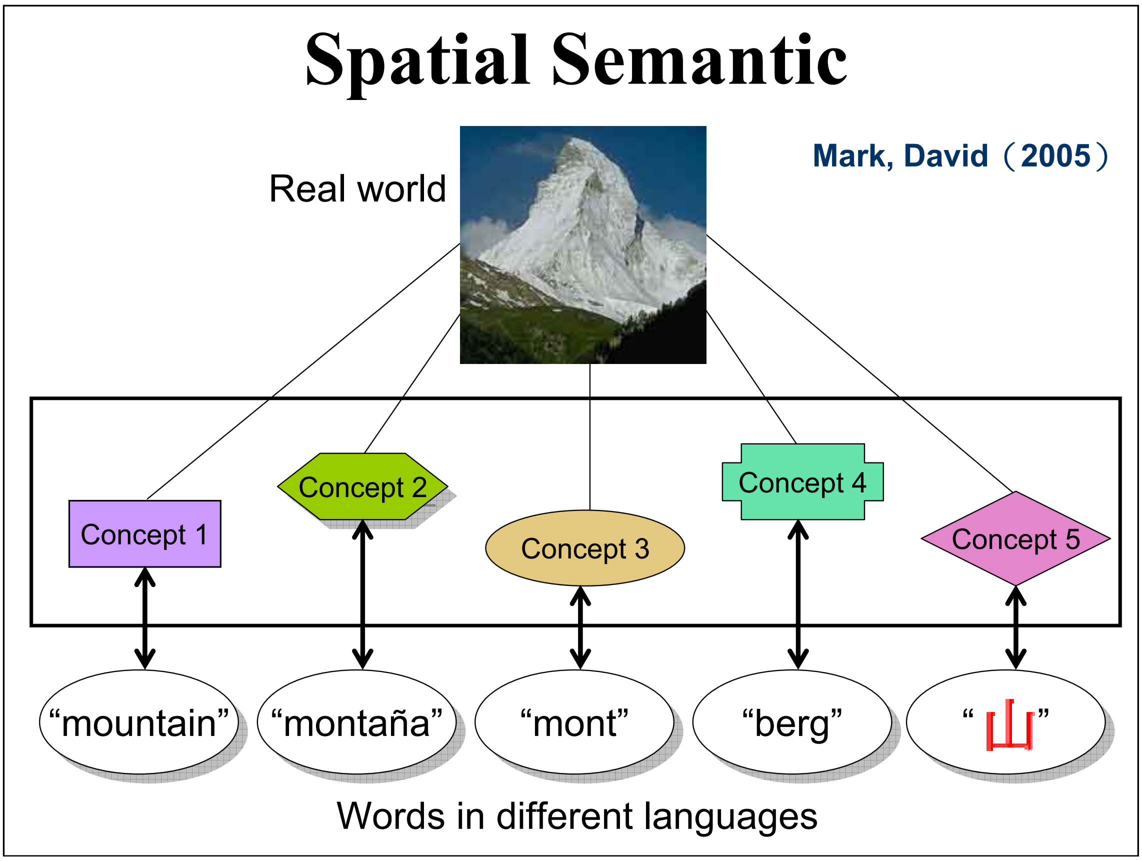
Can GIS achieve this ?

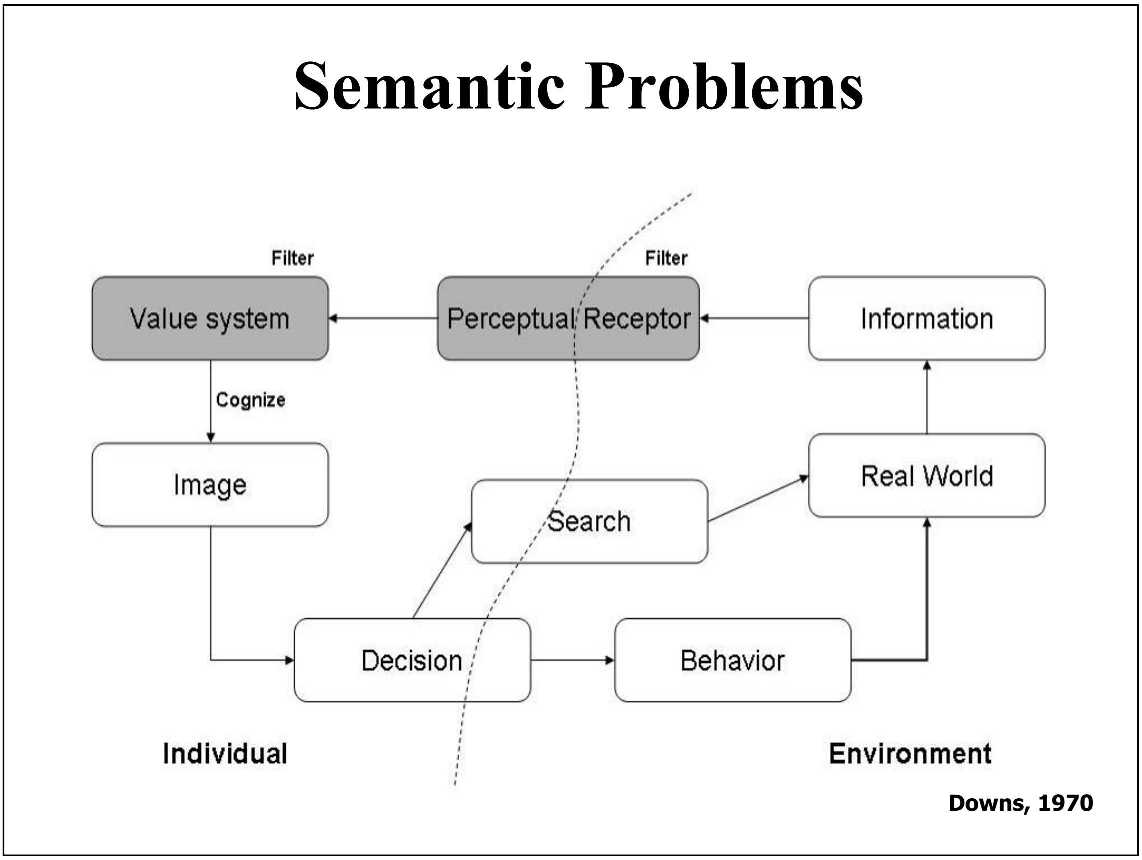
"When you start querying properties of geog raphic features,

it's no longer just a geographic system.

It becomes generic Semantic Web query"

Berners-Lee (2006)

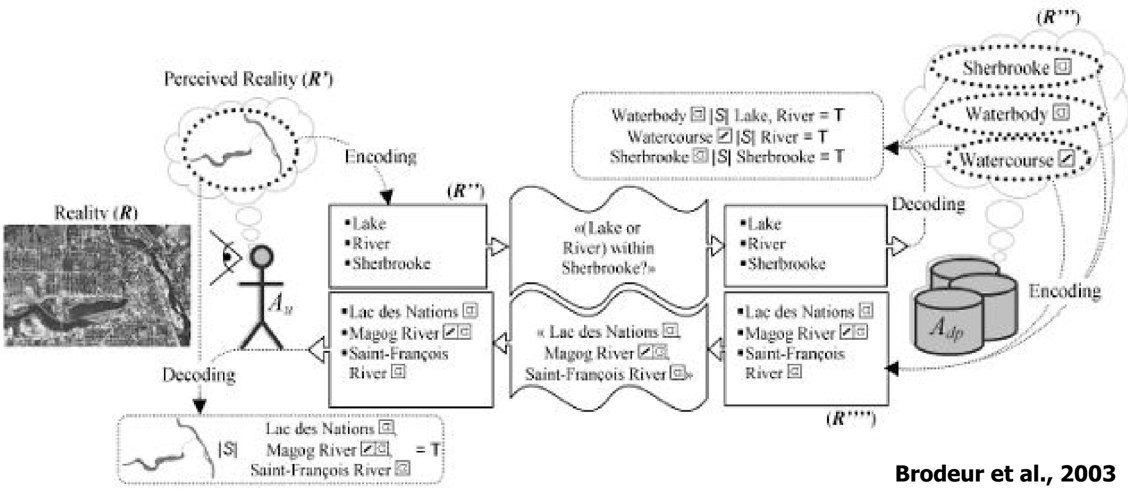

Spatial Semantic
Real world
Mark, David（2005）
Concept 1
Concept 2
Concept 3
Concept 4
Concept 5
"mountain"
"montaña"
"mont"
"berg"
"山"
Words in different languages


Semantic Problems
Filter
Filter
Value system
Perceptual Receptor
Information
Cognize
Image
Real World
Search
Decision
Behavior
Individual
Environment
Downs, 1970

Spatial Semantic

Nati

Semantic Problems



Brodeur et al., 2003

Ontology

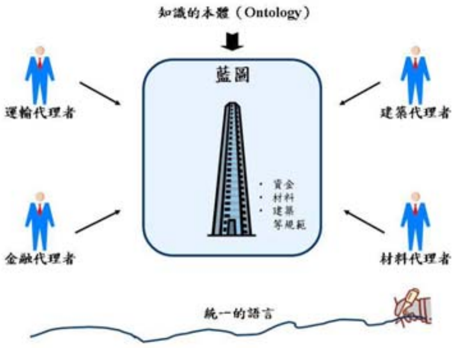
- **What is Ontology?**
  - **Philosophy:**
    - the nature and the organization of reality.
  - **Information Science:**
    - an explicit specification of a conceptualization (Gruber, 1993).
      - Classes
      - relations

Dictionary ?

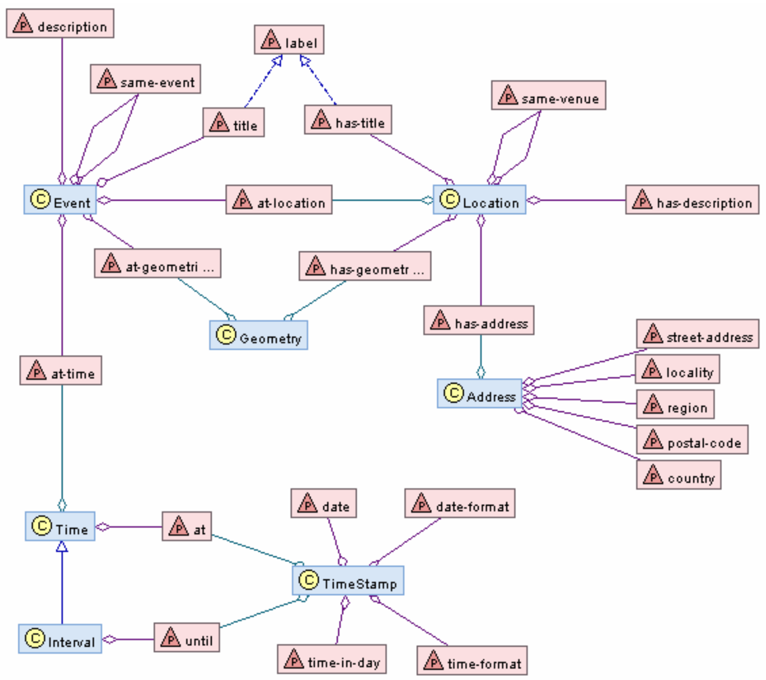
Thesaurus ?

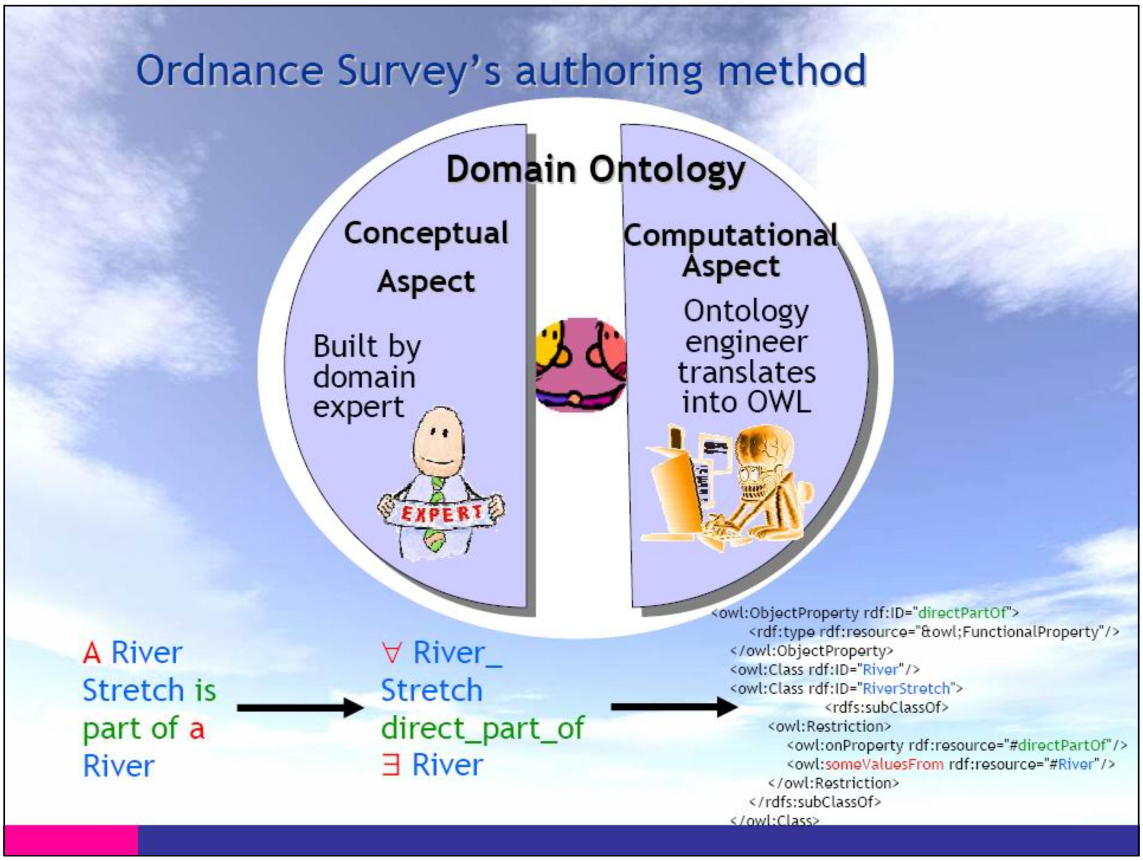
Classification ?

Expert System ?



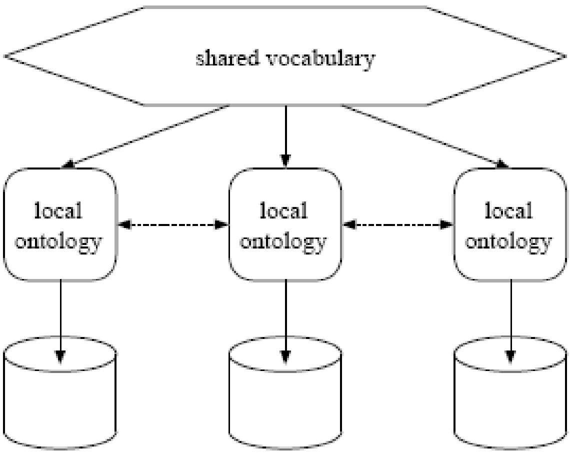
Ontology



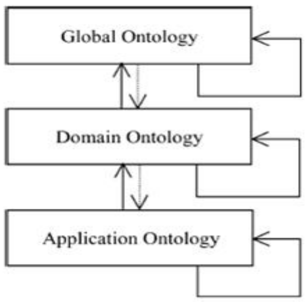


Ontology

- The architecture of Ontologies (Wache et a l., 2001)



hybrid ontology approach



Ontology

- **Ontology languages**
  - Ontology languages allow users to write explicit, formal con ceptualizations of domain models.
- **OWL by World Wide Web Consortium (W3C)**
  - OWL-Lite
  - **OWL-DL (Description Logics)**
  - OWL-Full
- **OWL Software**
  - **Protégé** (http://protege.stanford.edu/)
  - **RACER** (http://www.sts.tu-harburg.de/~r.f.moeller/racer/)

What is Description Logics ?

- Description logics (DL) is a family of knowledge repr esentation formalisms which used logic-based semanti cs for representing knowledge of an application domai n by defining:
  - the relevant ***concepts***,
  - the properties of the concepts, the ***relationships*** between the concepts, and
  - ***individuals*** (i.e. the realized objects of concepts) of the dom ain

- Also, description logics can **reason** or **inferred** implic it knowledge in an ontology.

What is Description Logics ?

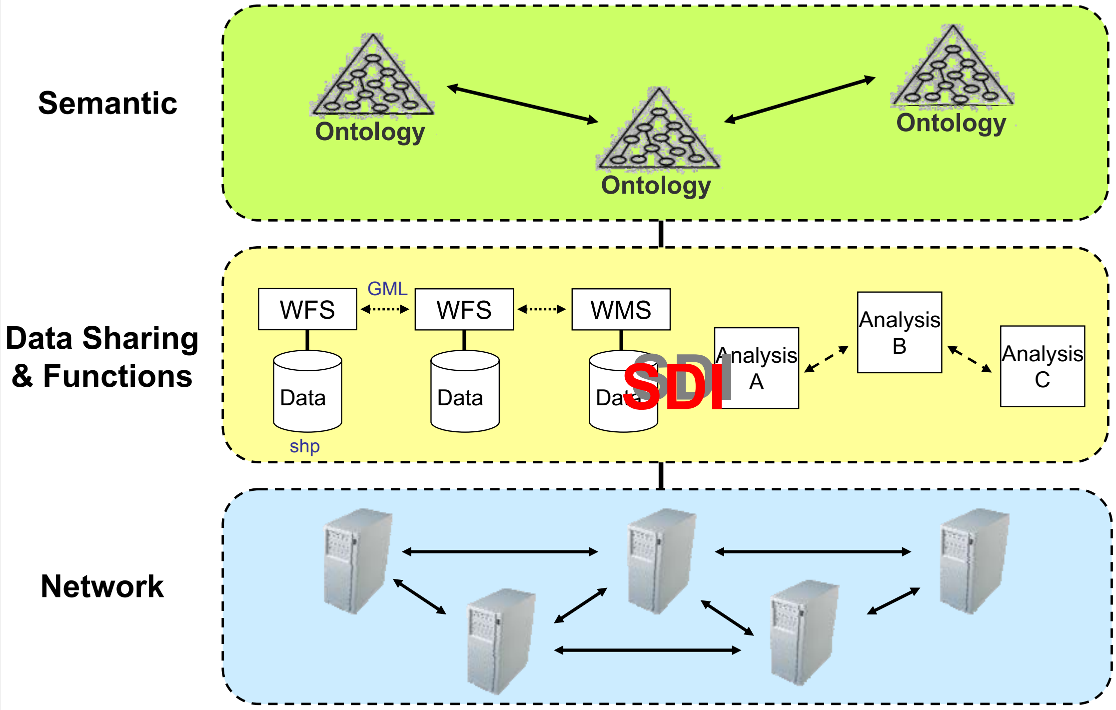
Expression	Syntax
Top	$\top$
Bottom	$\bot$
Concept name	A,B
Concept conjunction	$A \sqcap B$
Concept disjunction	$A \sqcup B$
Concept negation	$\neg A$
Role name	P,Q
Role conjunction	$P \sqcap Q$
Role negation	$\neg P$
Universal quantification	$\forall P.A$
Existential quantification	$\exists P.A$

- *A,B* : Concept ; *R,Q* : Rel ation
- A: **Person**, B: **Male**
  Person ∩ Male, and **Person ∩ ¬ Male**
- **Father :**
  Person∩∃hasChild.
- **Person has *at least* a child :**
  Person∩∀hasChild.Male
- **Person has children and *all* of those are male**

GeoSemantic Web

- UCGIS considered that the geospatial semantic web would be o ne of critical research priorities for geographic information scie nce (Fonseca, 2002).
- The Geospatial Semantic Web is to capture, analyze and tailor geospatial information, much beyond the purely lexical and syn tactic level which needs (Egenhofer, 2002):
  - **Geospatial Ontology**
  - **Representation**
  - **match**
- **OGC (Open Geospatial Consortium):**
  - **GML (Geography Markup Language): xml-based**
  - **WFS (Web Feature Services), WMS (Web Map Services)…**

Motivation

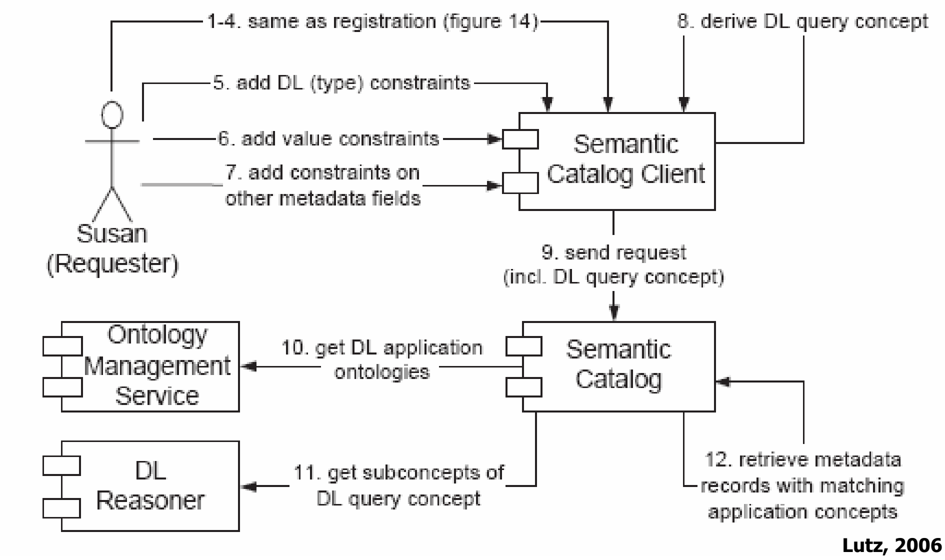


Discover GIServices on SDI

- **Discover GIServices on SDI**
  - In previous literatures, there are two main parts use d ontology applied into SDI:
    - Discovering GIServices
      (Bernald et al., 2003; Probst and Lutz, 2004; Klien, Lutz, and Kuhn, 2006; Lemmens, 2006; Lutz, 2006)
    - Using ontology for semantic interoperability composes
      (Bernard, Einspanier, Lutz et al., 2003; Einspanier et al., 2003; Probst and Lutz, 2004; Lutz, 2006)

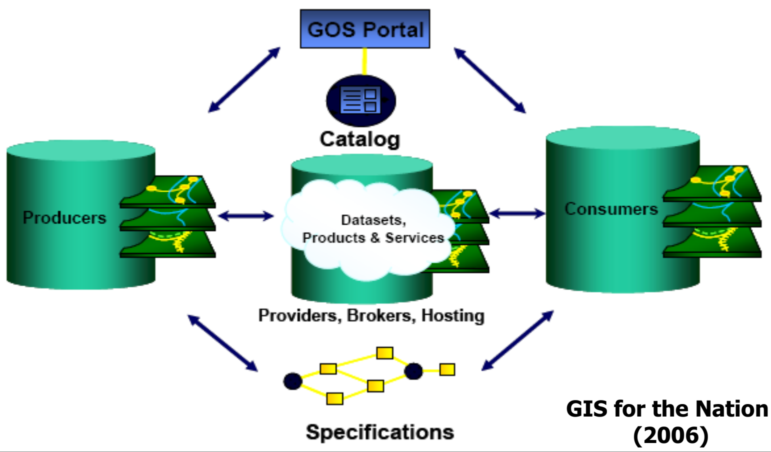
Discover GIServices on SDI

- Discover GIServices on SDI



Discover GIServices on SDI

- **Spatial Data Infrastructure (SDI)**
  - **a multi-levelled, scalable, and adaptable collectio n of technical and human services, which are int erconnected across system, organizational, and a d interf a**



Discover GIServices on SDI

- **GIService**
  - **network-based geographic information services that utilize both wired and wireless Internet to access geographic information, spatial analytical tools and other GIS resources.**
  - **GIS Data Access services & Geo-processing services**

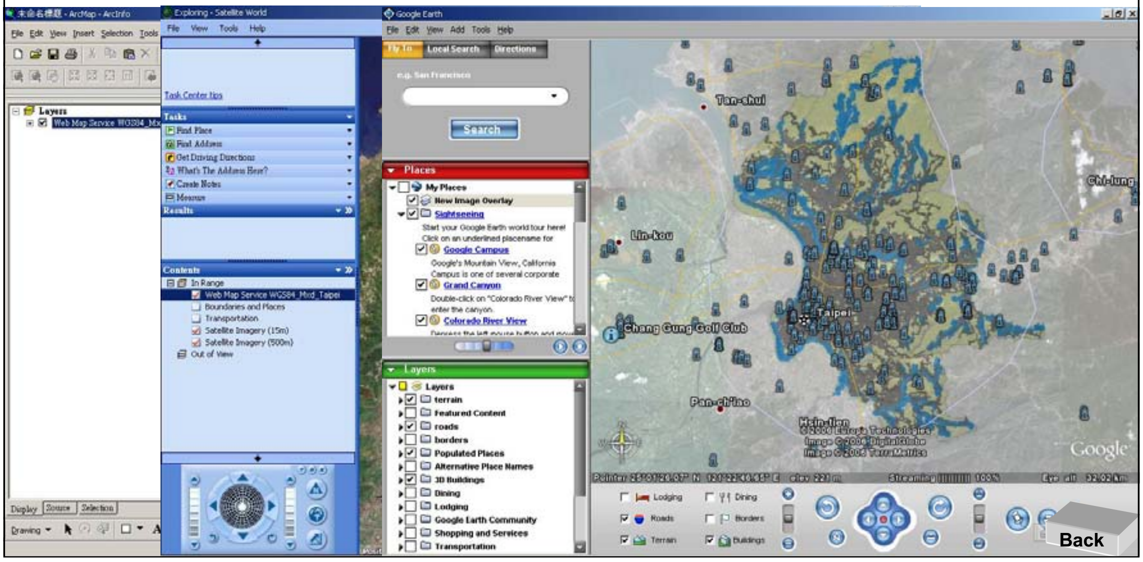
Discover GIServices on SDI

- **OGC**
  - **WFS (Web Feature Service)**
  - **WMS (Web Map Service)**
  - **WPS (Web Processing Service)**
  - **CS (Catalogue Service)**

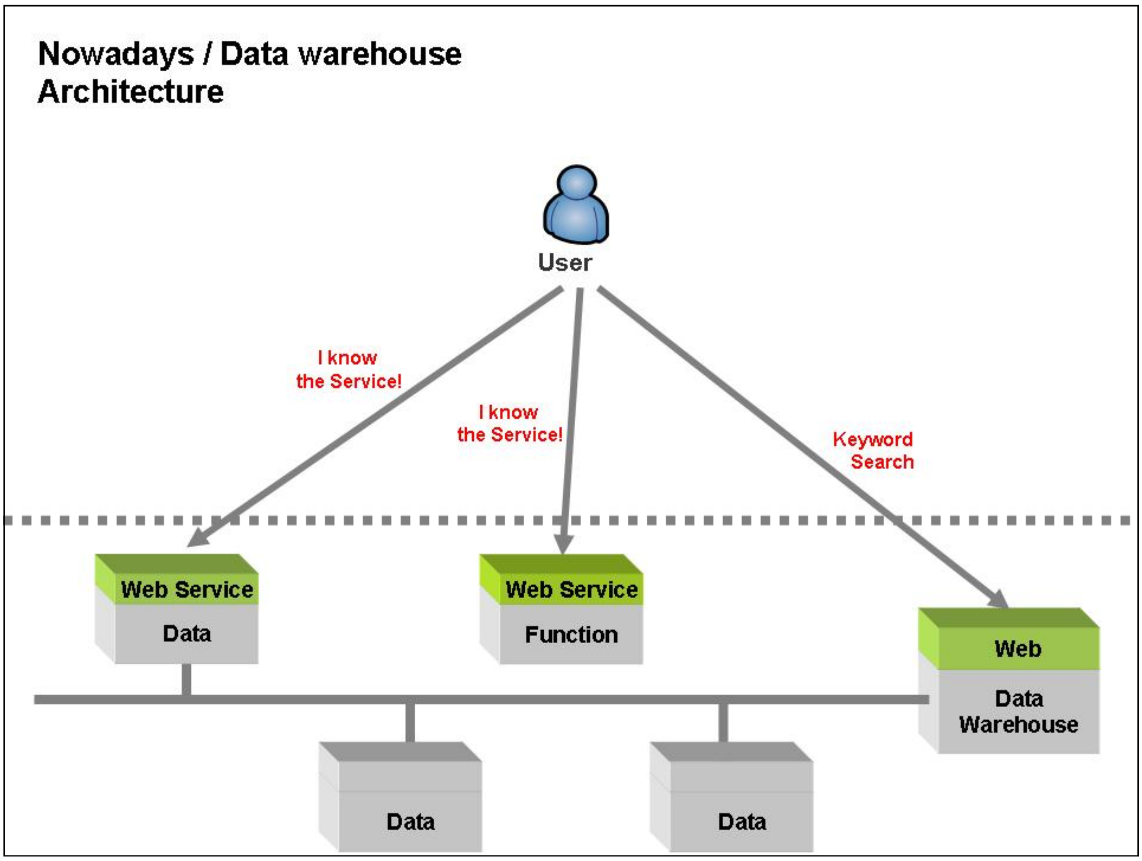
Discover GIServices on SDI

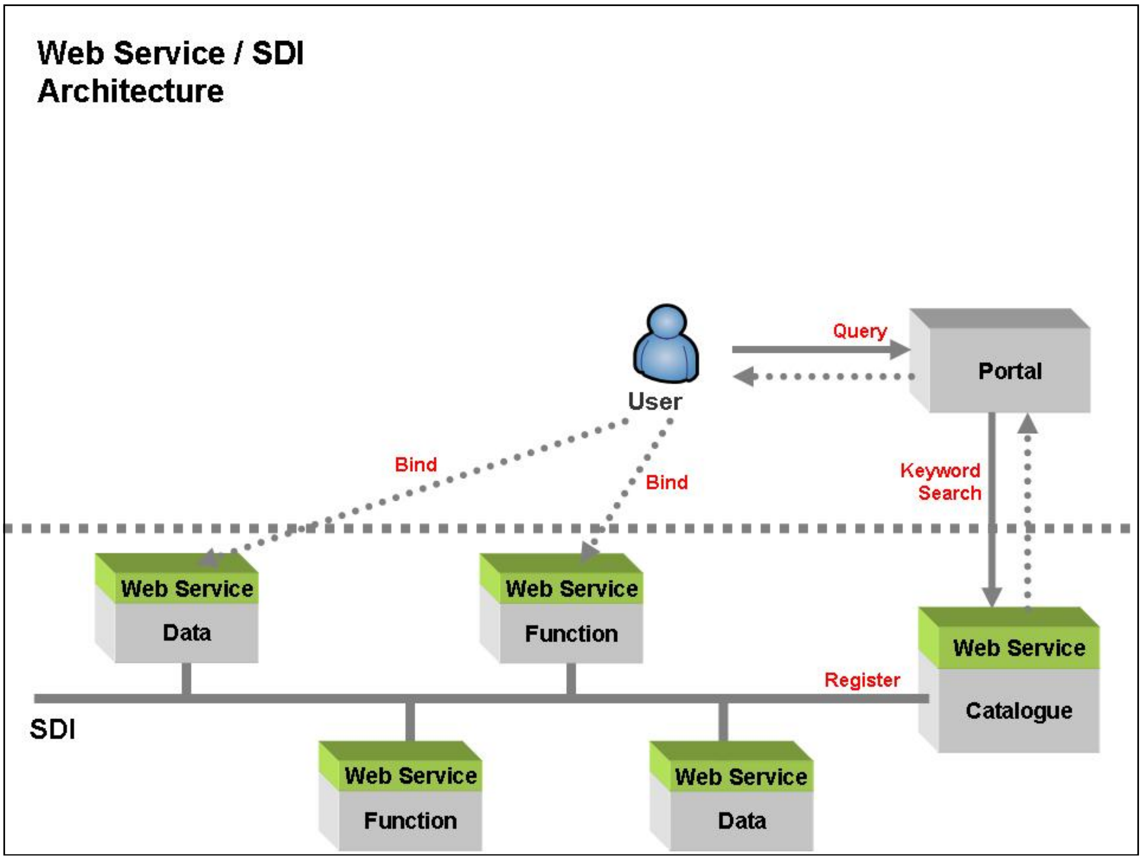
- **WMS example**

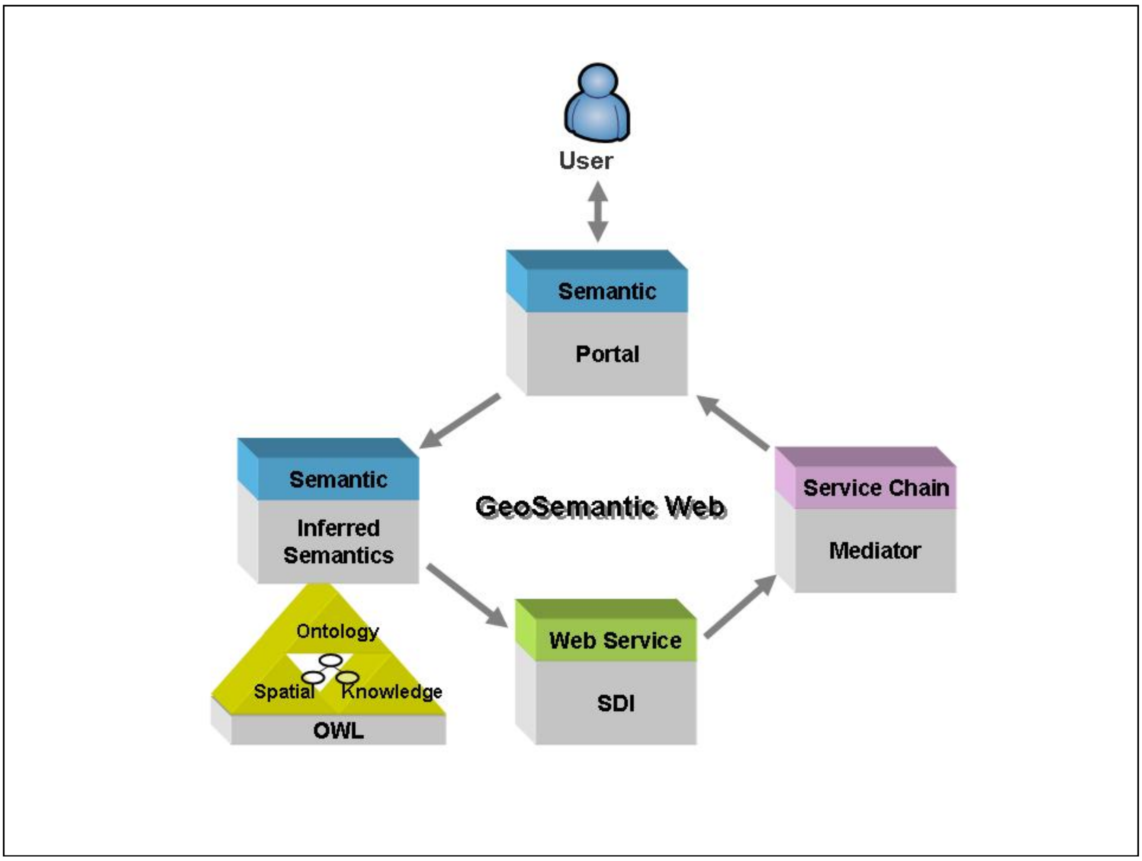
  http://140.112.64.249/wmsconnector/com.esri.wms.Esrimap?ServiceName=WGS84_Mxd_Taipei

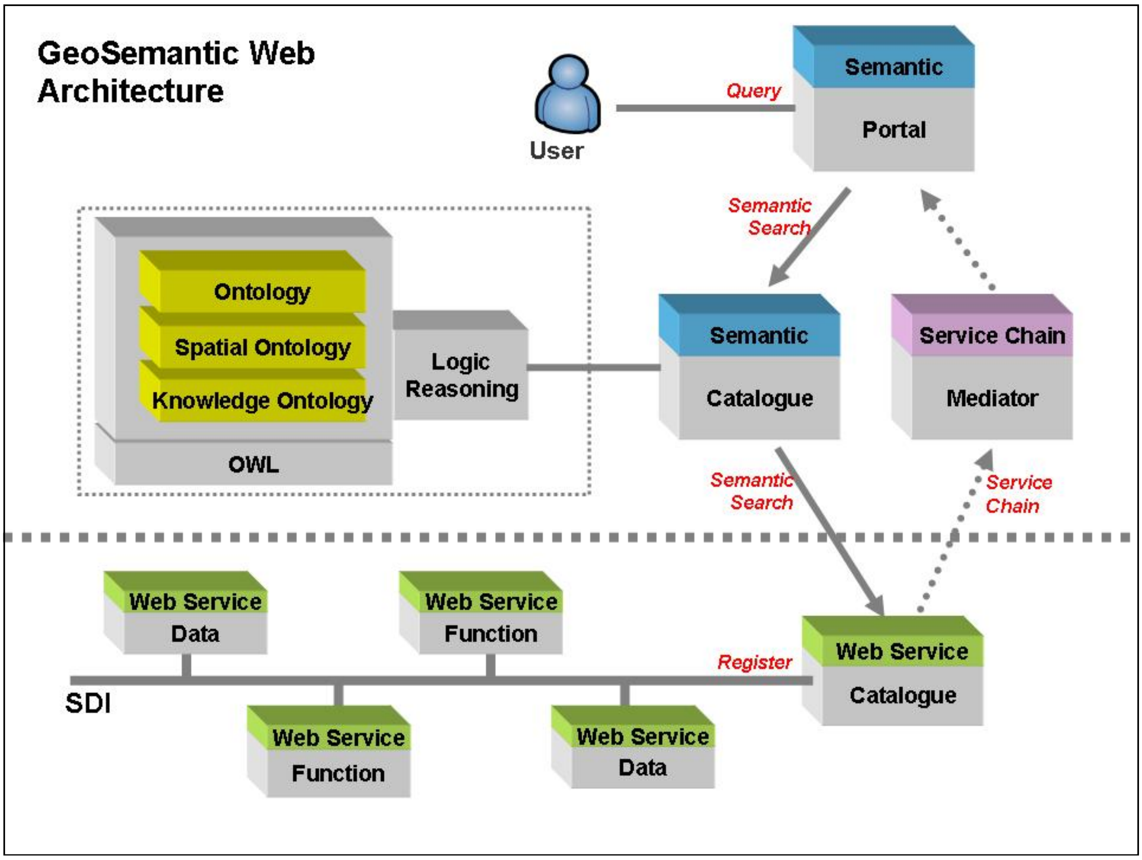


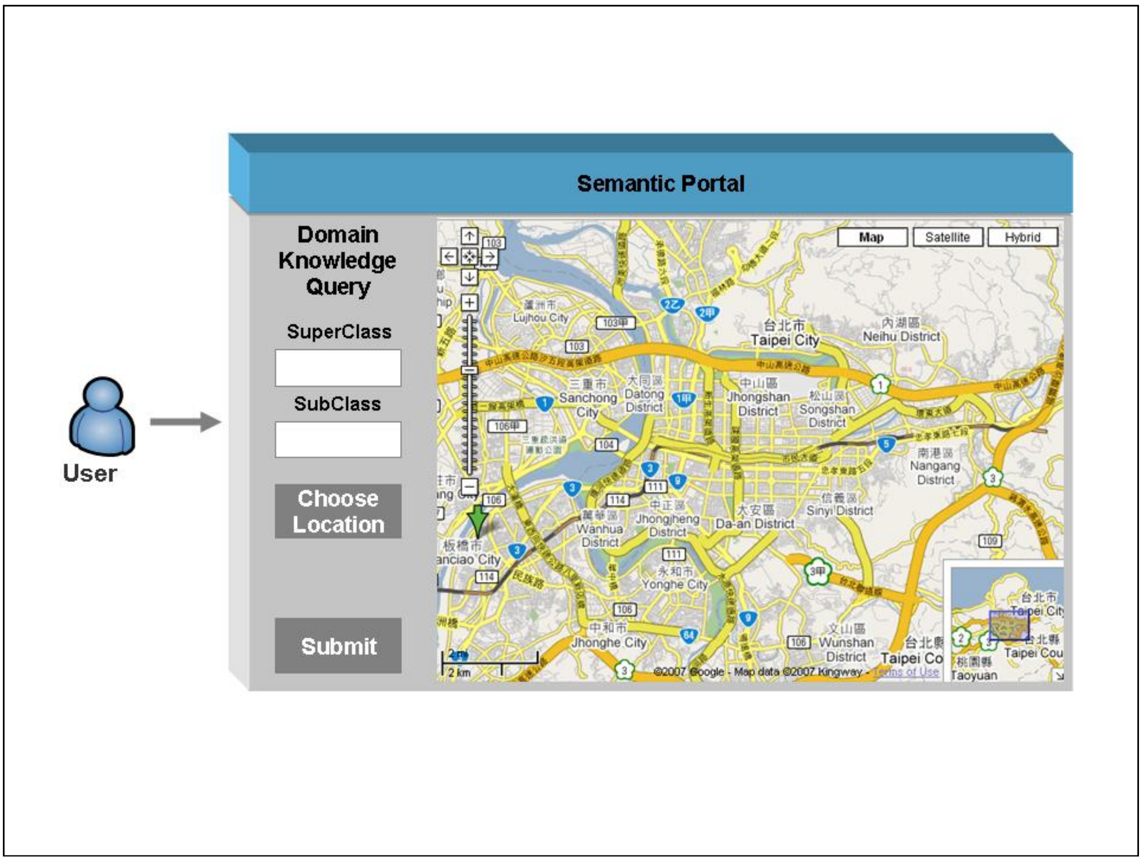
The framework of GeoSemantic Web Services

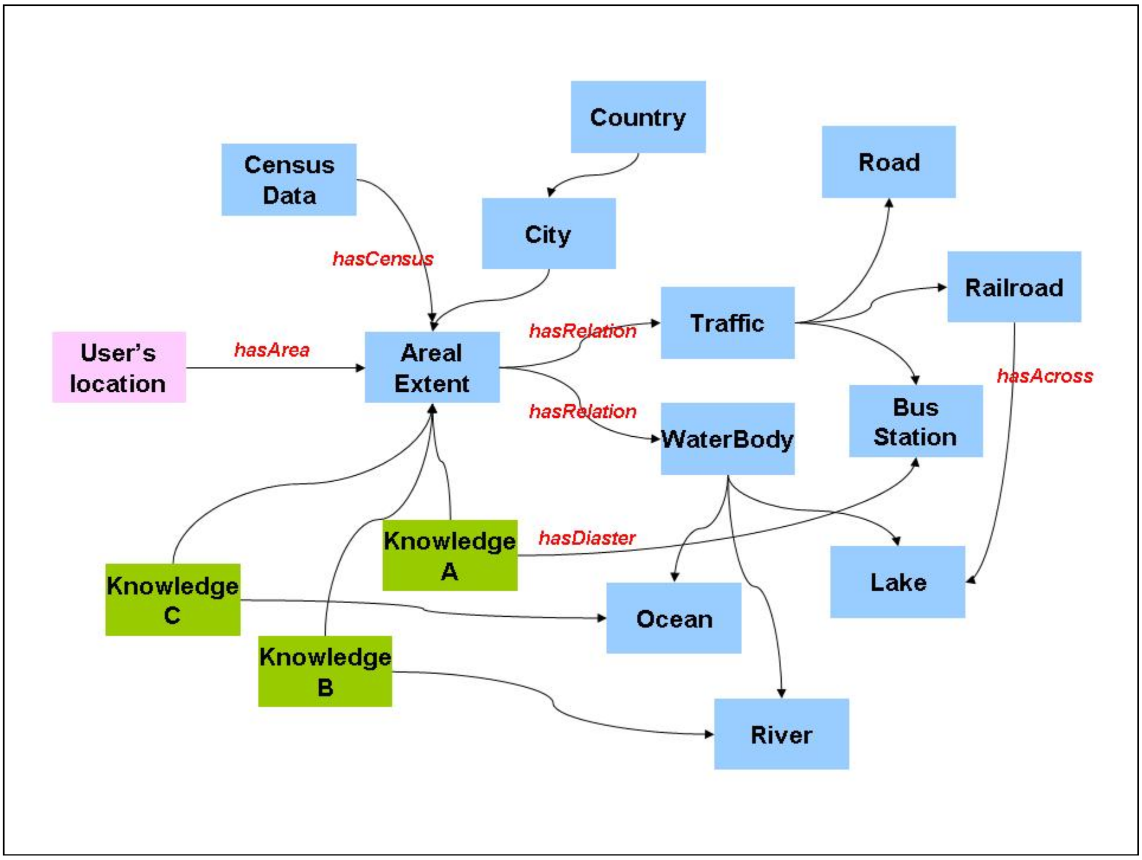

Nowadays / Data warehouse
Architecture
User
I know
the Service!
I know
the Service!
Keyword
Search
Web Service
Data
Web Service
Function
Web
Data
Warehouse
Data
Data

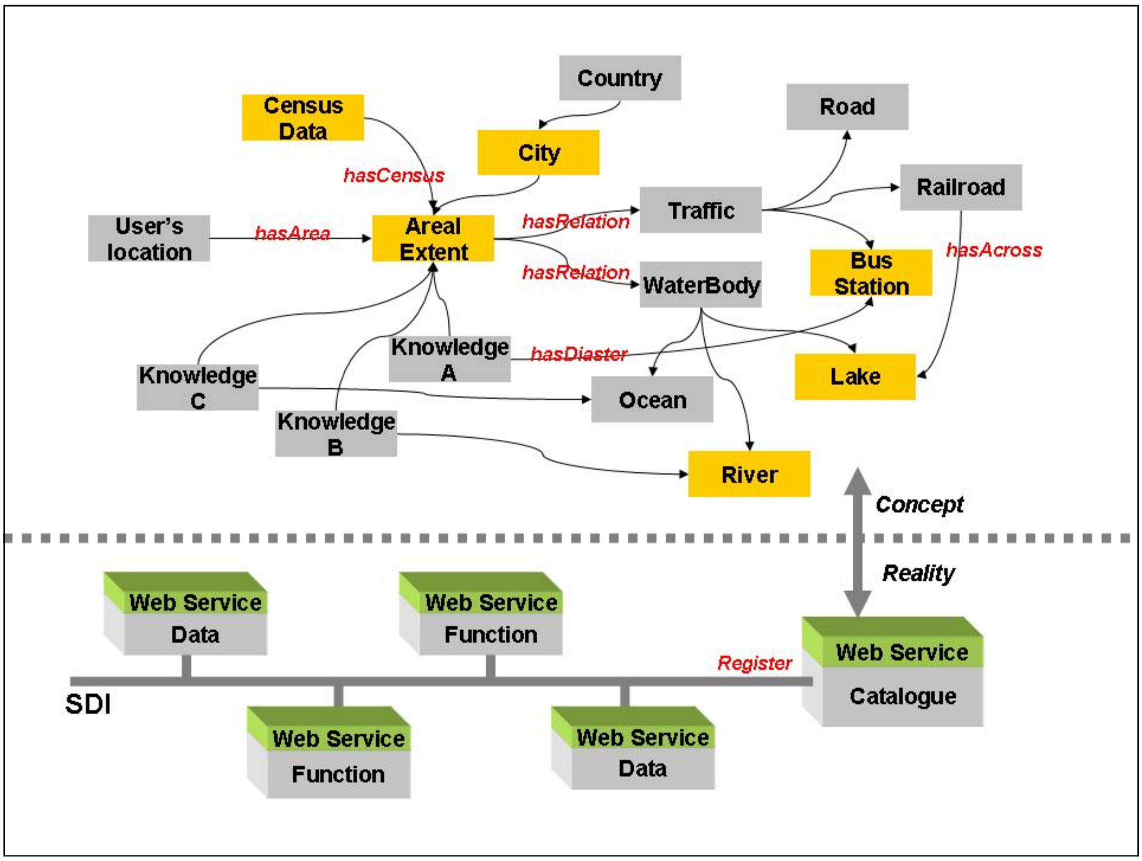

Web Service / SDI
Architecture
User
Query
Portal
Bind
Bind
Keyword
Search
Web Service
Data
Web Service
Function
Web Service
Catalogue
Register
SDI
Web Service
Function
Web Service
Data

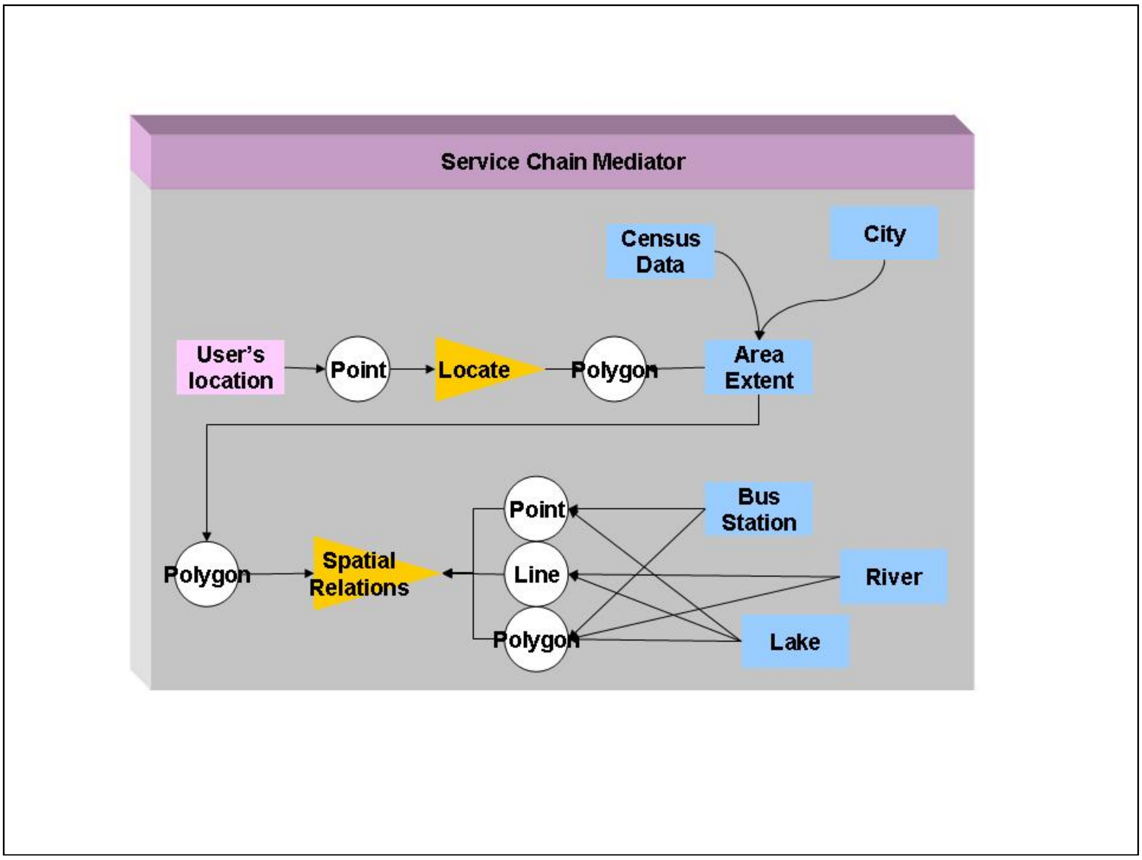

User
Semantic
Portal
Semantic
Inferred Semantics
GeoSemantic Web
Service Chain
Mediator
Ontology
Spatial
Knowledge
OWL
Web Service
SDI

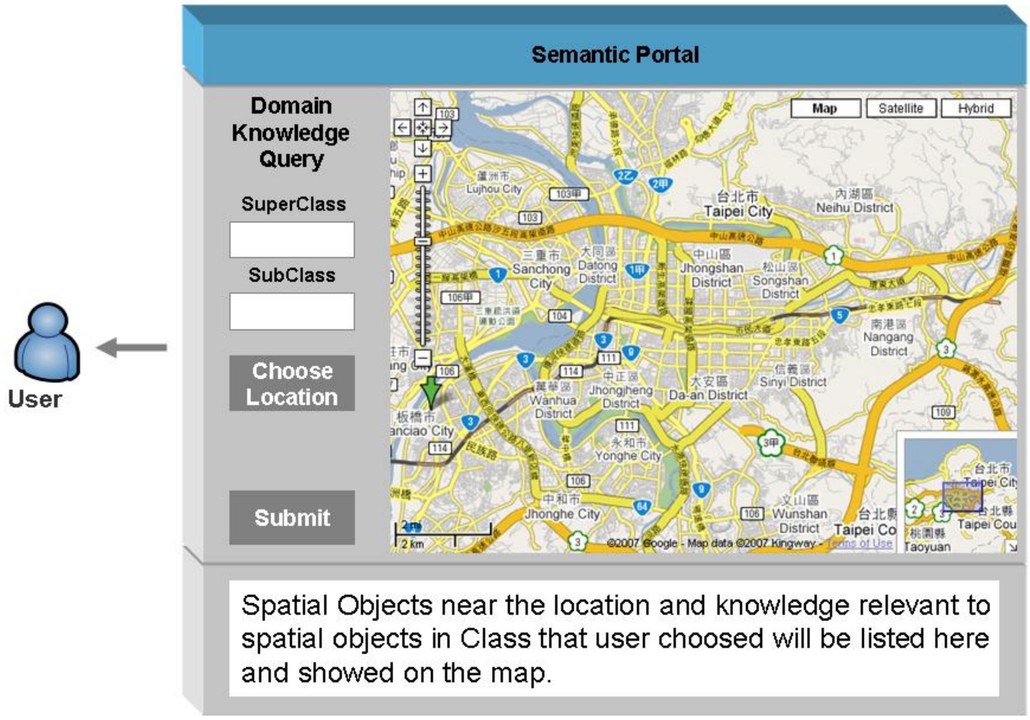

GeoSemantic Web Architecture
User
Query
Semantic
Portal
Semantic Search
Ontology
Spatial Ontology
Knowledge Ontology
OWL
Logic Reasoning
Semantic
Catalogue
Service Chain
Mediator
Semantic Search
Service Chain
Web Service
Data
Web Service
Function
Register
Web Service
Catalogue
SDI
Web Service
Function
Web Service
Data


Semantic Portal
Domain Knowledge Query
SuperClass
SubClass
Choose Location
Submit
User
Map
Satellite
Hybrid
Taipei City
Neihu District
Sanchong City
Datong District
Jhongshan District
Songshan District
Nangang District
Wanhua District
Jhongjheng District
Da-an District
Sinyi District
Yonghe City
Jhonghe City
Wunshan District
Taoyuan
©2007 Google - Map data ©2007 Kingway


Country
Road
Census Data
City
hasCensus
Railroad
Traffic
hasRelation
User's location
hasArea
Areal Extent
hasAcross
Bus Station
hasRelation
WaterBody
Knowledge A
hasDiaster
Lake
Knowledge C
Ocean
Knowledge B
River


Country
Census Data
City
Road
hasCensus
Railroad
User's location
hasArea
Areal Extent
hasRelation
Traffic
hasRelation
WaterBody
Bus Station
hasAcross
Knowledge A
hasDiaster
Lake
Knowledge C
Ocean
Knowledge B
River
Concept
Reality
Web Service Data
Web Service Function
Register
Web Service Catalogue
SDI
Web Service Function
Web Service Data

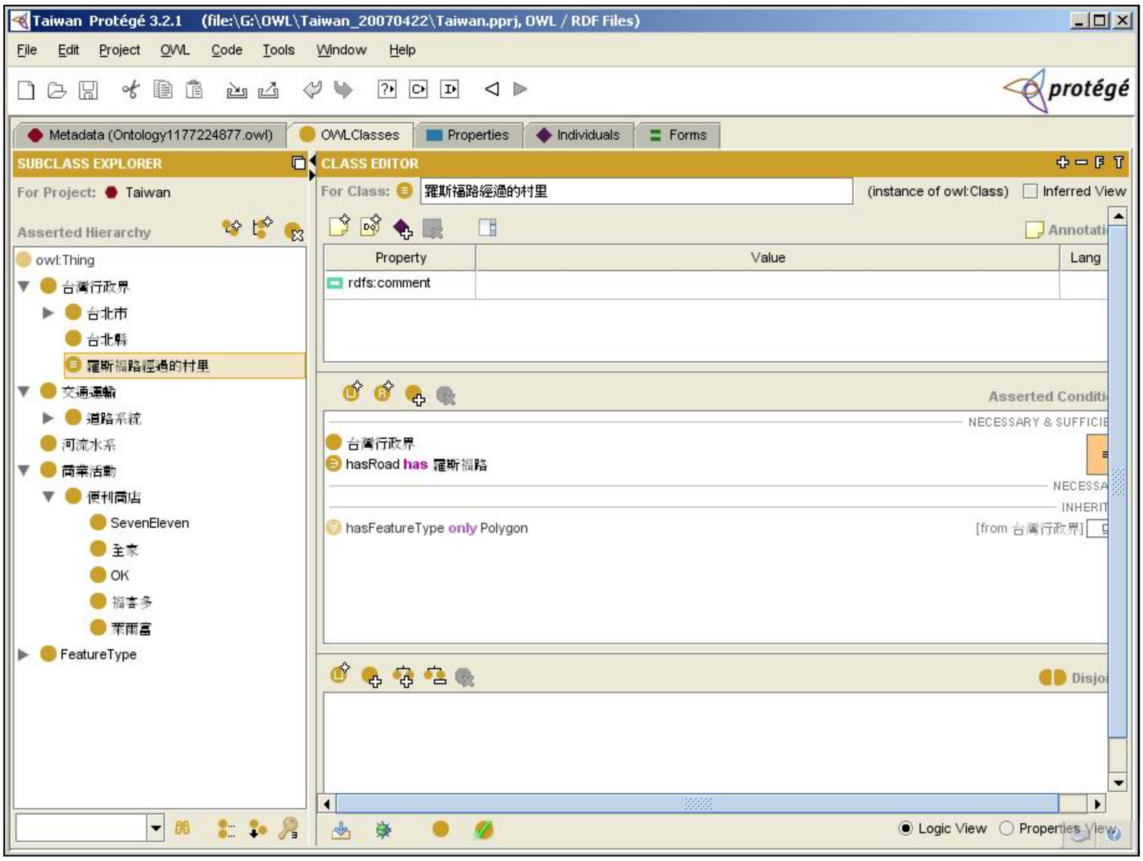

Service Chain Mediator
Census Data
City
User's location
Point
Locate
Polygon
Area Extent
Point
Bus Station
Polygon
Spatial Relations
Line
River
Polygon
Lake

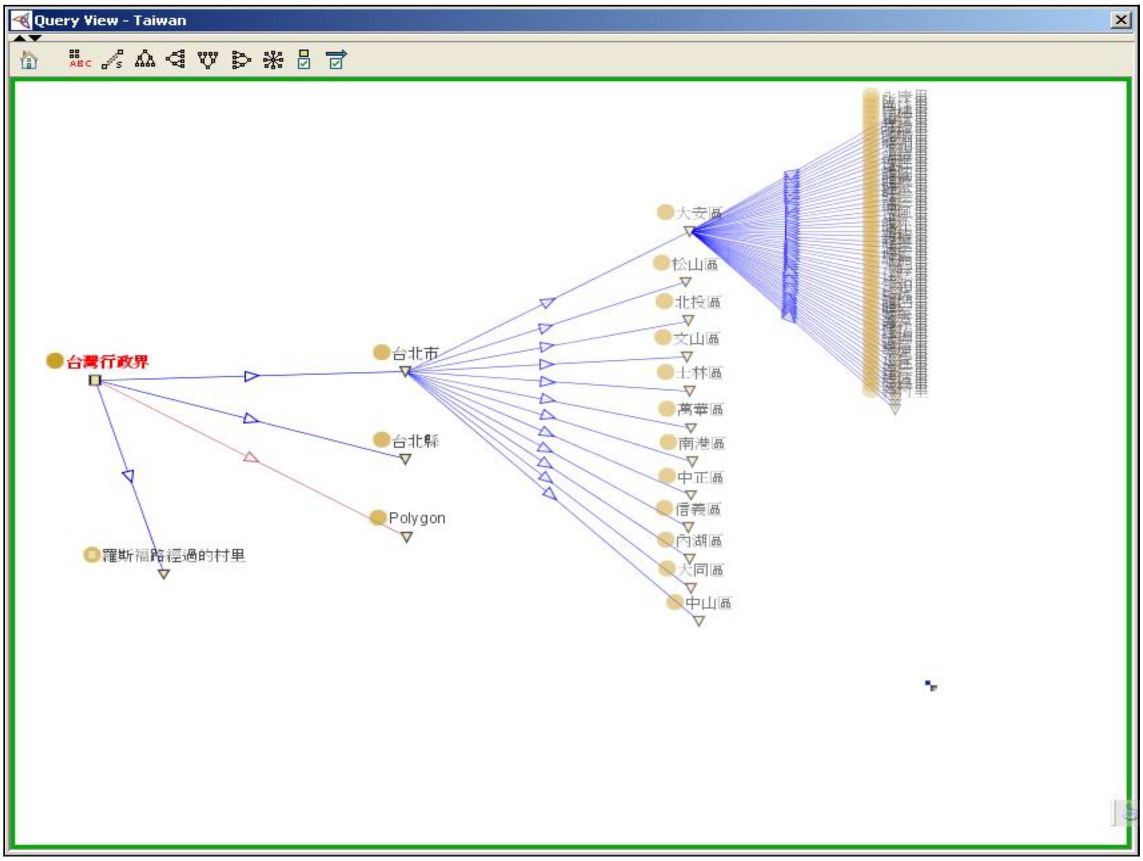


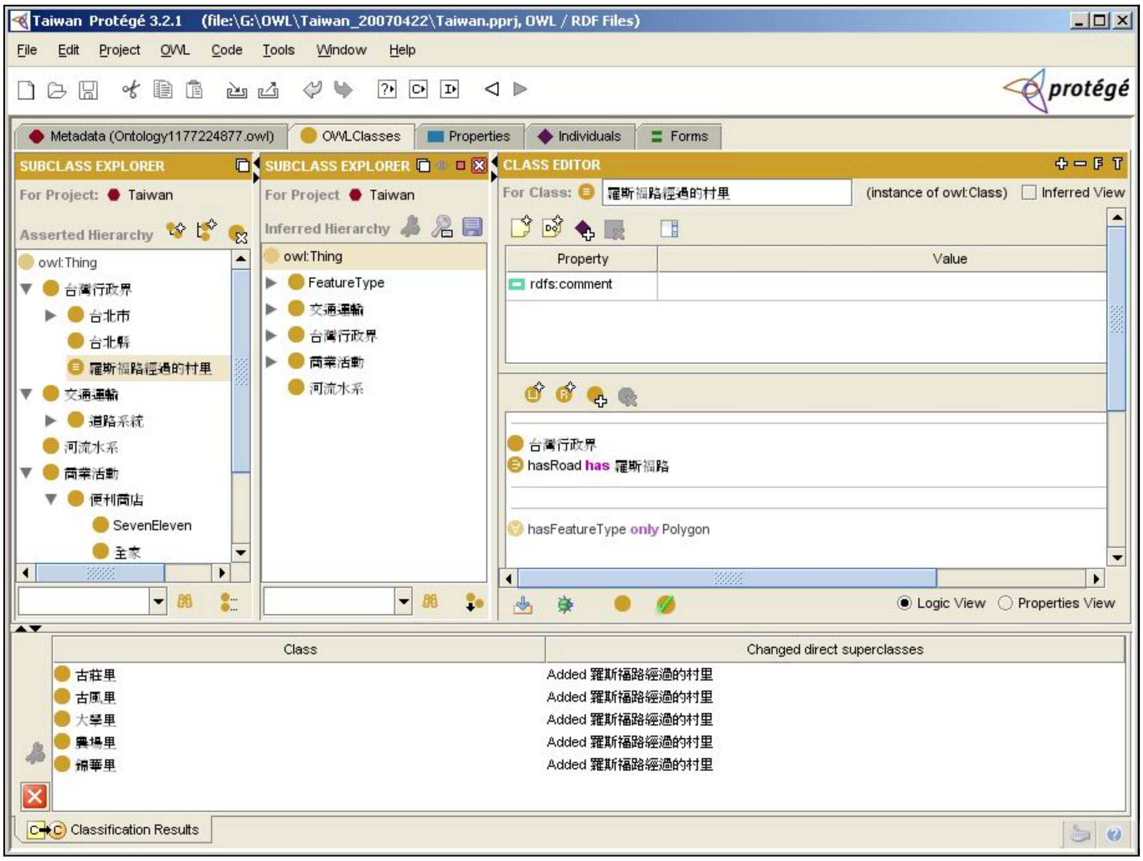
Some Ideas !!

- Spatial ontology
  - Taipei city
- Domain ontology
  - Disaster
  - News

- CA (cellular automata) + ontology


Taiwan Protégé 3.2.1 (file:\G:\OWL\Taiwan_20070422\Taiwan.pprj, OWL / RDF Files)
File Edit Project OWL Code Tools Window Help
protégé
Metadata (Ontology1177224877.owl)
OWLClasses
Properties
Individuals
Forms
SUBCLASS EXPLORER
For Project: Taiwan
Asserted Hierarchy
owl:Thing
台灣行政界
台北市
台北縣
羅斯福路經過的村里
交通運輸
道路系統
河流水系
商業活動
便利商店
SevenEleven
全家
OK
福客多
萊爾富
FeatureType
CLASS EDITOR
For Class: 羅斯福路經過的村里
(instance of owl:Class)
Inferred View
Property
Value
Lang
rdfs:comment
Asserted Conditi
NECESSARY & SUFFICIE
台灣行政界
hasRoad has 羅斯福路
NECESSA
INHERIT
hasFeatureType only Polygon
[from 台灣行政界]
Disjo
Logic View
Properties View


Query View - Taiwan
台灣行政界
台北市
台北縣
Polygon
羅斯福路經過的村里
大安區
松山區
北投區
文山區
士林區
萬華區
南港區
中正區
信義區
內湖區
大同區
中山區



Conclusions

- A practical framework to integrate spatial and domain kn owledge from human mind (ontologies) with web GIS se rvices in reality.
- The framework contained four parts (**the portal**, **ontolog ies**, **SDI**, and **service chain**) to provide a knowledge-bas ed search (semantic search) and to entail web GIS servic es in a service chain for (semi)automatically generating r esults.

Conclusions

- In the future, spatial objects and relationships in Taipei c ity will become the spatial ontology and Geo-domain ont ology will be implemented.
- Further, the domain ontologies will be applied into the fr amework of GeoSemantic web to evaluate the efficiency and accuracy.

Analysis of MetroScope's Practical Implementation of the Planning Support System

제 11차 GIS 국제 세미나
The 11th International Seminar on GIS

Kyung-Hwa Kim
Principal Planner
Metro
503-797-1773
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METRO

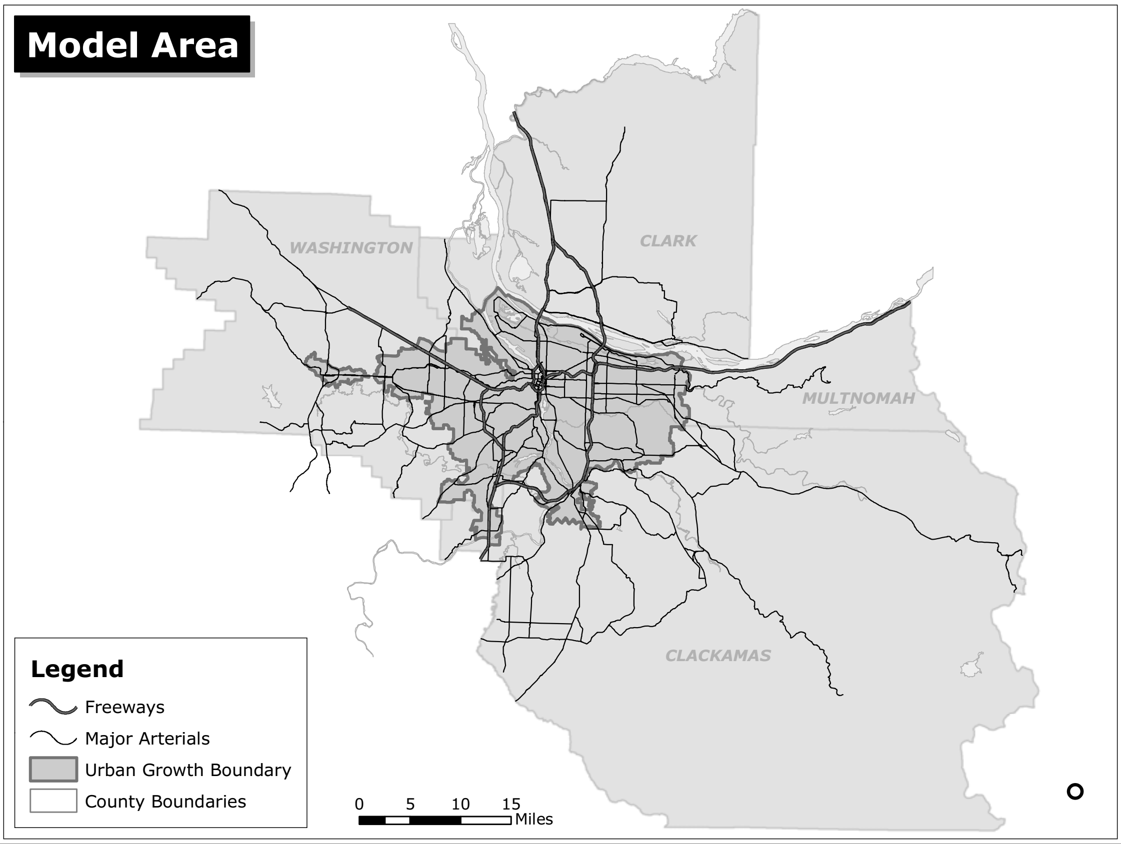
Introduction

- **What is Metro?**
- **Need for MetroScope**
- **History of MetroScope**
- **MetroScope Model Structure**
- **Usage of MetroScope**
- **Redesign Implementation**
- **Recommendations**
- **Next step**

What is Metro?

- **Directly elected regional government**
- **Metropolitan Planning Organization (MPO) for Portland, Oregon**
- **Seven council members**
- **Planning Department :**

  - Data Resource Center
  - Transportation Research & Modeling Services
  - Regional Transportation Planning
  - Long Range Planning
  - Regional Travel Options
  - Corridors Planning
  - Transit Oriented Development Centers



Growth in the Region

Population Base

- **1.7 million people**
  1.3 million in Metro boundary
  - 554,100 people in the City of Portland
  - 24 smaller cities (315 to 95,000 people each)
  - Growth rate twice the national average

Major Economic Trends

- **Growing industries**
  - Hi-tech
  - Metals
  - Transport equipment
  - Printing
  - Sportswear
  - Retail & Service sector
- **Declining industries**
  - Lumber/wood
  - Paper
  - Food processing
  - Manufacturing

Need for MetroScope

- **Principal role in planning process:
  Travel forecasting models**
- **Principal role in travel forecasting:
  Land use information**
- **Federal, state, Metro requirements
  (law=pressures)**

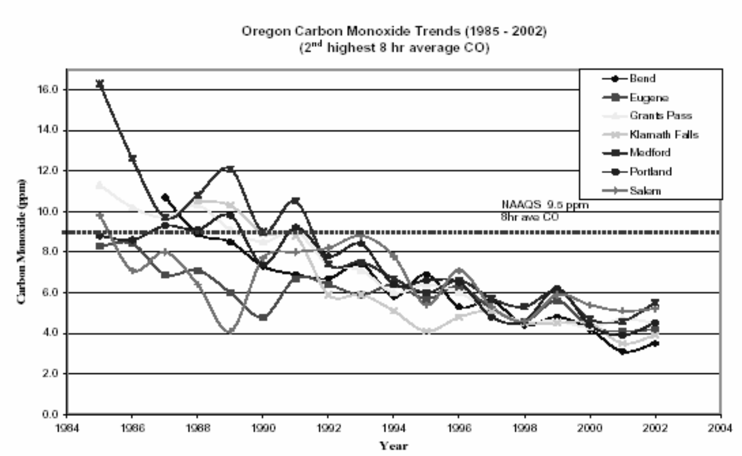
Federal Context

- **Intermodal Surface Transportation Efficiency (ISTEA)**
- **Transportation Equity Act for the 21st Century (TEA 21)**
- **Environmental Protection Agency air quality conformity**

- **MPO approval of federal transportation funds**
- **20-year plan, policies, needs**
- **National Environmental Policy Act**
- **Local coordination and public outreach**
- **Multi-modal/inter-modal plans and congestion management**
- **Air quality conformity of financially constrained system**

2040 Implementation: Air Quality Trends

Oregon Carbon Monoxide Trend 1985-2002



State Context

- **State land use planning goals**
- **Public outreach**
- **Hierarchy of plans: state, regional, local**
- **Strategies to reduce reliance on the automobile**
- **Land use alternatives**
- **Linking land use and transportation**

Metro Context

- **Elected regional government**
- **Manages growth, transportation, regional parks and solid waste**
- **Operates zoo, convention center, performing arts centers and exposition center**
- **Serves as MPO for Portland region**
- **Allocates federal transportation funds to 24 cities and 3 counties**

1970's Quiet Revolution

- **National environmental policy**
- **Urban renewal backlash**
- **Highway protests**
- **Urban support programs**

Portland's Backlash

- **Opposition to a plan for massive freeway building that would continue a pattern of destruction of urban neighborhoods**

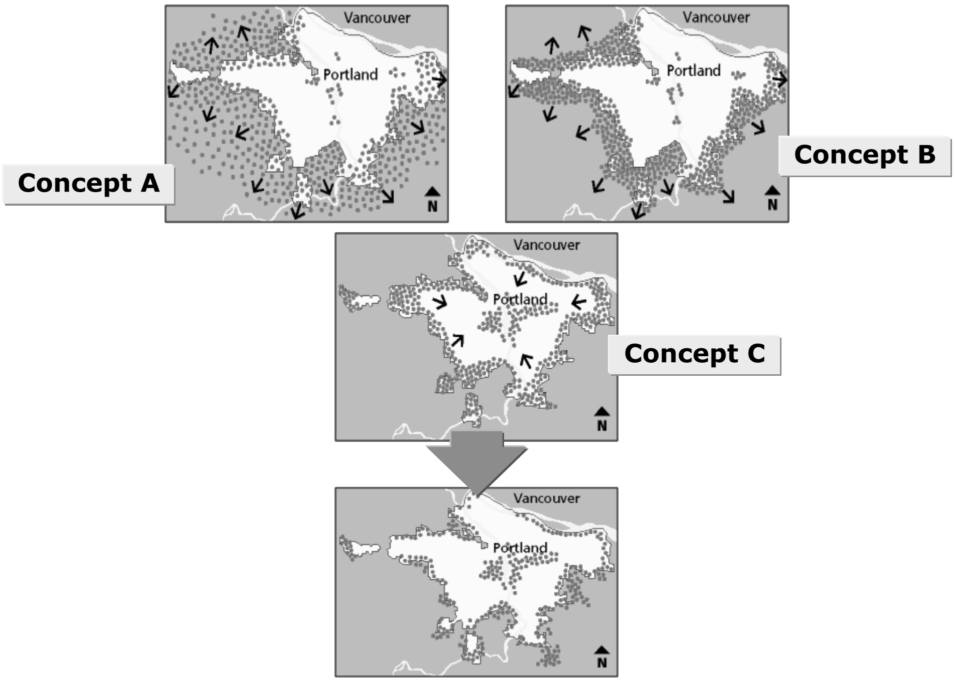
Highway Revolt

- Harbor Freeway removed in 1976 to make way for Tom McCall Waterfront Park
- Mount Hood Freeway withdrawn in favor of light rail transit along the Banfield freeway
- Shift freeway money to multi-modal projects

2040 Growth Concept

- Adopted in 1995
- 50-year vision for managing region's growth
- Incorporates best parts of "Concepts for Growth" options
- Kicks off a major effort to enact the new regional vision through local plans

2040 Concepts



Promote Central City

Protect Industry

- **Maintain freight mobility on highways**
- **Ensure quality freight access to ports and industrial areas from region's highway and rail network**

Protect Rural Areas

- **Create Green Corridors along rural state highways**
- **Mitigate urban overflow on rural routes**
- **Maintain rural separation between Metro region and neighbor cities**

Nature in the City

- Network of parks, trails and open spaces
- Protections for streams and upland natural areas
- Green Streets - designs that minimize runoff
- Manage hazardous waste to protect streams and groundwater

What is MetroScope?

- Land use-transportion model for Metro
- Urban growth simulation model
- Testing various policy scenarios
- Generates the population and employment

Usage of MetroScope

Transportation Planning

- **Corridor Studies**
- **Regional Transportation Plan**
- **Transit Studies**

Land use Planning

- **Jobs and Housing Needs Analysis**
- **Periodic Review**
- **Urban Growth Boundary analysis**

Policy Planning

- **Testing Alternative Land use and Transportation Policies**

Development Progress

- **Started one-zone residential model**
- **1996/1997: Developed entirely "in house" by Metro technical staff**
- **1998: Multi-zones added**
- **1999: Non-residential model added**
- **2001: MetroScope Nation Peer Review Panel Meeting**
- **2001-2002: partial conversion from entirely spreadsheet to Visual Basic**
- **2004: Complete Visual Basic**
- **2005: Addition of internal travel demand-assignment model**
- **2006: Conversion to open-source R code**
- **2006: Database and programming integration as one model**

Resource Requirements

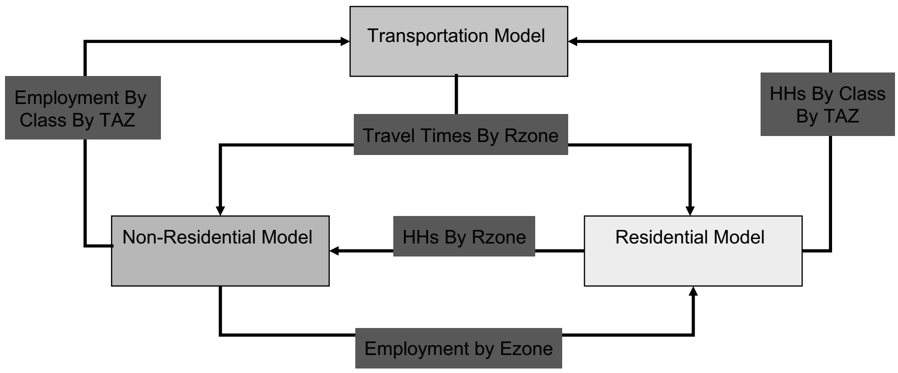
Current MetroScope Resource Requirements

- **GIS Staff Support**
- **Economist**
- **Transportation modeler**
- **Residential Real Estate modeler**
- **Non-Residential Real Estate modeler**

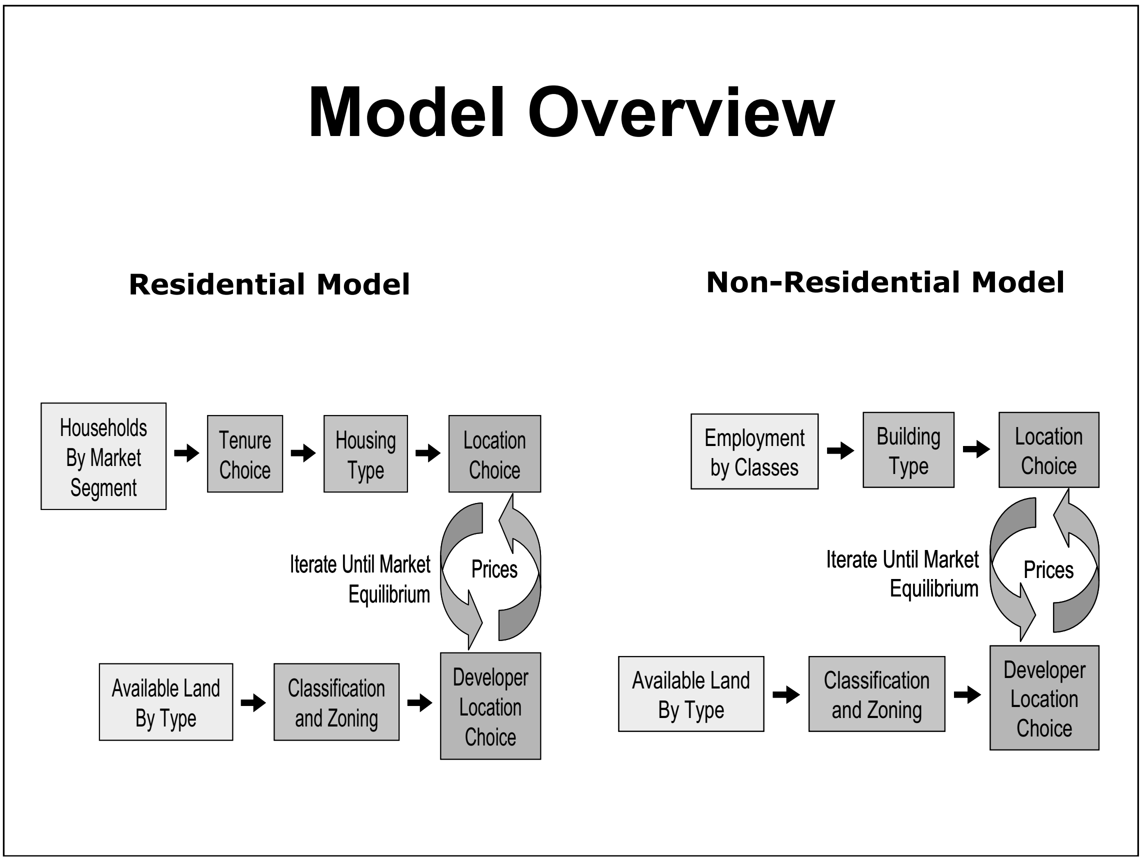
SANDAG Resource Requirements

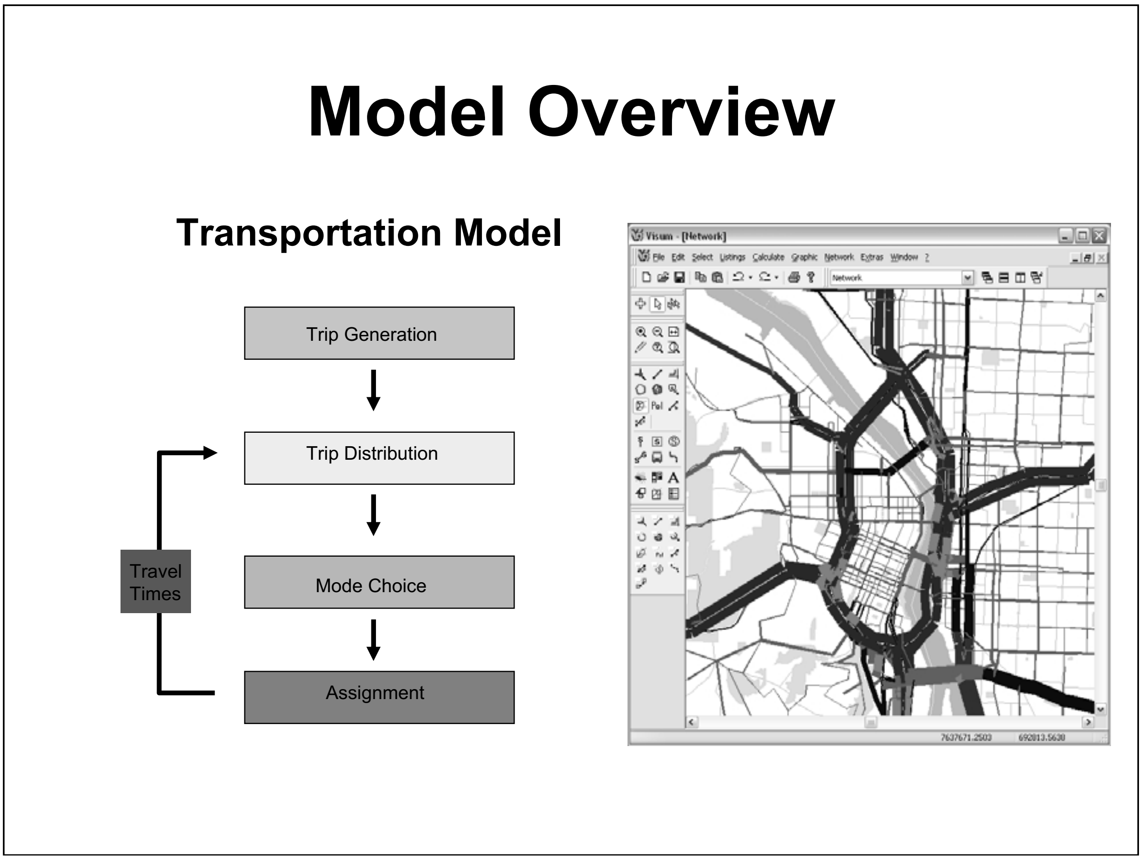
- **IT cost (one-time): $ 50,000**
- **Data acquisition: $ 15,000**
- **Consultant: $ 60,000**
- **Staff(2.5 FTE): $380,000**

Model Interaction



HHs By Rzone: Employment location choice based on access to households (Weight travel time by quantity HHs)
Employment By Ezone: Given employment location, choose residential location


Model Overview
Residential Model
Non-Residential Model
Households By Market Segment
Tenure Choice
Housing Type
Location Choice
Iterate Until Market Equilibrium
Prices
Available Land By Type
Classification and Zoning
Developer Location Choice
Employment by Classes
Building Type
Location Choice
Iterate Until Market Equilibrium
Prices
Available Land By Type
Classification and Zoning
Developer Location Choice

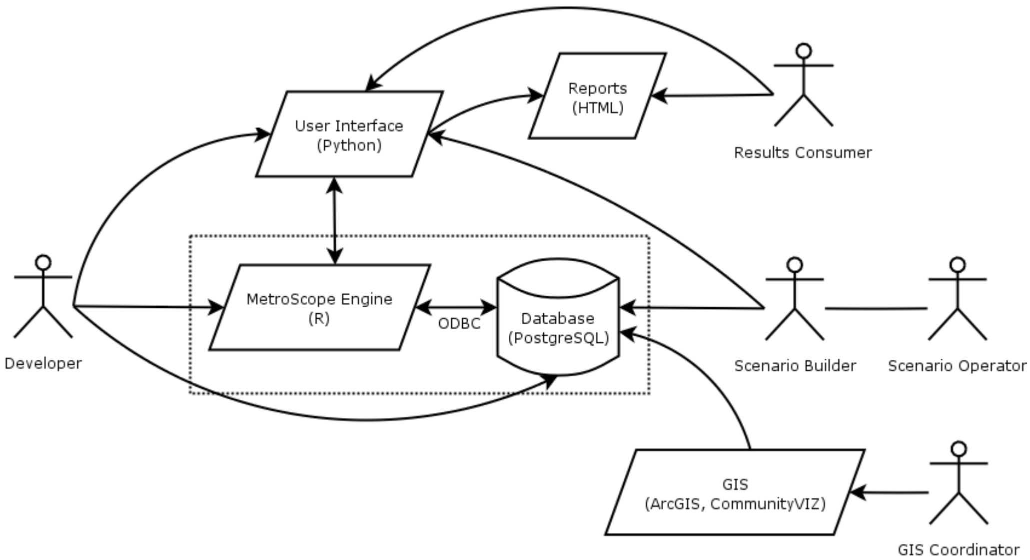

Model Overview
Transportation Model
Trip Generation
Trip Distribution
Travel Times
Mode Choice
Assignment

2035 Housing Tenure

Rental

Ownership

New Implementation



Benefits

- **Integration of all modules enables quick turnaround on model runs**
  - **6 hours for 1 run**
  - **48 hours for 40-year run**
- **The benefits of automated accounting are very important (central open DB that stores everything)**
- **Knowledge transfer of database design, programming, and model framework/structure**
- **Open-source so other agencies can utilize the model**
- **Metro can run at least 100 scenarios for an upcoming study**

Recommendations

- **Experienced staff**
- **Dedicate sufficient resources**
- **Maintain "transparent" inputs and operation**
- **Balance production responsibilities with research and development**
- **Improve model accuracy and reasonableness**
- **Keep up with demand for increasing spatial and variable detail**
- **Turn around model results in a timely manner**
- **Finding a way to make integrated models faster, cheaper and less complex**
- **Emphasis on consistency, accuracy, reliability, and flexibility**
- **Secure support for a multi-year development process and commitment of in-house resources from the management team**

Next Steps

- **Can MetroScope be set up and be useful to a middle to large sized MPO?**
  - **Will be answered by next year**
- **Merge with Activity Forecasting Model and Microsimulation Model**

No GIS, No Models