The 13th International Seminar on GIS

The World Geospatial Industry: Trends and Prospects

Korea Research Institute for Human Settlements
Korea National Housing Corporation

History of International Seminar on GIS

	Theme	Date	Place	Organizing Committee	
				Chair	Member
1st (1996)	Strategies for NGIS Development	4.18-19	Seoul Education & Culture Center, KRIHS	Young-Pyo Kim, Director, Geospatial Information Center	Woo-Seok Cho, Mi-Jeong Kim Moon-Sub Chung
2nd (1997)	GIS Applications in the Public Sector	10.16-17	Seoul Education & Culture Center	Young-Pyo Kim, Director, Geospatial Information Center	Yong-Bok Choi, Mi-Jeong Kim
3rd (1998)	GIS Development Strategies for the 21st Century	9.10-11	Renaissance Seoul Hotel	Young-Pyo Kim, Director, GIS Research Center	Mi-Jeong Kim, Sung-Mi Park
4th (1999)	GIS in Local Government	9.16-17	Renaissance Seoul Hotel	Young-Pyo Kim, Director, GIS Research Center	Mi-Jeong Kim, Sung-Mi Park, Hong-Jun Choi
5th (2000)	Toward a Knowledge-based Society: NGIS Policy and Technological Development	9.28-29	Ritz-Carlton Seoul Hotel	Young-Pyo Kim, Director, GIS Research Center	Sung-Mi Park, Hong-Jun Choi
6th (2001)	Present and Future of GIS Technologies	5.17-18	Seoul Education & Culture Center	Young-Pyo Kim, Director, GIS Research Center	Sung-Mi Park,
7th (2002)	GIS Workshop & Seminar	11.8	COEX Intercontinental Hotel	Hyung-Min Yeom, Director, GIS Research Center	Dong-Han Kim
8th (2003)	Envisioning Cyber-geospace and Spatially enabled E-government	11.20-21	COEX	Young-Pyo Kim, Director, GIS Research Center	Jung-Hoon Kim, Dong-Han Kim, Seung-Mi Hwang, Ki-Hwan Seo
9th (2004)	Emergency and Disaster Response with GIS	9.8-9	Seoul Education & Culture Center	Young-Pyo Kim, Director, GIS Research Center	Jong-Taek Park, Dong-Han Kim, Ki-Hwan Seo
10th (2005)	NGIS Policy in Ubiquitous Computing Environment	11.14-15	Seoul Education & Culture Center	Byoung-Nam Choi, Director, GIS Research Center	Jung-Hoon Kim, Dong-Han Kim, Jung-Yeop Shin Jin-Hyeong Park
11th (2007)	Collaborative GIS toward the Geospatial Information Society	10.24	KRIHS	Ho-Sang Sakong Director, Geospatial Information Research Center	Jung-Hoon Kim Young-Joo Lee Jae-Il Han
12th (2008)	NSDI Policy for National Spatial Data Integration	10.9	KINTEX	Ho-Sang Sakong Director, Geospatial Information Research Center	Jung-Hoon Kim Chun-Man Cho Mi-Jeong Kim Hae-Kyong Kang
13th (2009)	The World Geospatial: Trends and Prospects	9.10	KINTEX	Moon-Sub Chung Director, Geospatial Information Research Center	Ki-Hwan Seo Dae-Jong Kim Kyung-Hee Kim

Seminar Program

09:00~10:00 Registrations
10:00~10:20 Opening Address
(President, Korea Research Institute for Human Settlements)
Congratulatory Address
(President, Korea National Housing Corporation)

Session 1 Geospatial Industry ; Policies and Market

10:20~11:00 Characteristics of U.S. Geospatial Industry and Its Prospects
[Jeong Chang Seong, Professor, Univ. of West Georgia, U.S.]
11:00~11:40 Development Strategy to Promote Geospatial Industry
[Jong Sung Hwang, Research Fellow, NIA, Korea]

11:40~13:00 Luncheon

13:00~13:40 Resent Growth Trends in the Australia Spatial Industry and Future Opportunities and Prospects
[Graeme Kernich, Deputy CEO, CRCSI, Australia]
13:40~14:20 4D Geospatial Service Infrastructure for Human and Machine Collaboration
[Ryosuke Shibasaki Professor, University of Tokyo, Japan]

14:20~14:40 Coffee Break

14:40~15:20 Future Directions and Growth Prospects for the UK Geospatial Market
[Andrew Coote, Senior Vice Chairman of the AGI and Director of ConsultingWhere Ltd, U.K]
15:20~16:00 Innovation to Commercializtion
[Richard Worsfold, Director, Business Development Ontario Centres of Excellence, Canada]

16:00~16:20 Coffee Break

Session 2 Discussion

16:20~17:00 Panel Discussion

Profile

Jong-Sung Hwang

Jong-Sung is a research fellow in the National Information Society Agency. He received Ph.D from the Yonsei University, Seoul, Korea. He completed the information resource management course of the State University of New York. He was consecutively occupied the chair of a steering committee for u-Korea forum and u-City forum, the director of ubiquitous computing project team, the chair of UCI user's forum and the chief of Korea USN.

Ryosuke Shibasaki

Ryosuke Shibasaki is a professor and the director of Center for Spatial Information Science (CSIS), the University of Tokyo, Japan, since 2005.

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 committee chair and member.

Dr Graeme Kernich

Graeme is the Deputy CEO of the Cooperative Research Centre for Spatial Information (CRCSI). He has concluded a number of licencing and equity transactions to exploit CRCSI intellectual property and has led the establishment of commercial research and consultancy agreements with industry and government partners. He also directly manages a number of projects with clients, including the National Urban Digital Elevation Model Project. Graeme has academic qualifications in agricultural science, business management and corporate governance.

Richard D. Worsfold

Richard's career includes positions at Litton Systems Canada Limited, F.G, Bercha and Associates Ltd., REMOTEC Applications Inc., Centre for Cold Ocean Resources Engineering and a military career with the Canadian Forces.

Richard holds a Master of Engineering (Ocean Engineering), Memorial University of Newfoundland; Master of Arts (Geography – Glaciology and Electrical Engineering), Carleton University; Bachelor of Science with Honours (Geological Engineering), Queen's University; and a Diploma in Business Administration (Department of Business and Economics), Wilfred Laurier University.

Andrew Coote

Andy has over twenty-five years experience in the development and use of information systems, specialising in the management of location-enabled applications. He has held senior management positions in both the public and private sector in the UK and overseas (Seychelles and Middle East).

He is currently a Director of ConsultingWhere, an independent IT consultancy specialising in the provision of strategic information technology and business advice. His particular expertise lies in business case development, process transformation and programme management.

Jeong-Chang Seong

Jeong-Chang is an associate professor in the Department of Geosciences, University of West Georgia, USA. He received Ph.D (Geography) from University of Georgia, Athens, Georgia, and B.A. (Geography) and M.A. (Geography) from Seoul National University, Seoul, Korea.

He is specialized in Geographic Information Sciences, Remote Sensing and Cartography as well as spatial analyses. Currently, he is working on StateView Program Development and Operations for the State of Georgia.

Contents

Characteristics of U.S. Geospatial Industry and Its Prospects

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Abstract

This paper describes the characteristics and trends of the U.S. GIS industry. Recent trends show a steady growth while some sectors struggle. As a fundamental socioeconomic infrastructure, the integration of GIS with other enterprise systems becomes more and more important. Along with ever changing information technologies, GIS is expected to evolve into new shapes such as vertical integration, massive data processing, parallel processing and increasing applications in military and natural resources/disaster management.

Keywords: U.S. GIS industry, characteristics, housing market bust, prospects

1. Introduction

As the U.S. Department of Labor has identified the geospatial technology fields as “High Growth”, “New and Emerging”, or “Substantial Growth” industry since the turn of new millennium, the U.S. geospatial market has experienced steady increase. More and more public organizations are using geospatial technologies. With the widespread and diverse uses of geospatial technologies, the geospatial industry has grown at an annual rate of almost 35 percent, with the commercial subsection of the market expanding at the rate of 100 percent each year (DOL, 2009).

This paper focuses on the characteristics and prospects of the growing GIS industry in the

U.S. After reviewing the characteristics of the U.S. GIS industry, frequently used GIS applications will be explored in six industry types based on the GITA 2008 Survey (GITA, 2009). Then, the impact of housing market collapse on the geospatial industry will be examined with company revenue changes. Finally, some prospects will be discussed along with changing technologies and interests.

2. Characteristics

1) A Snapshot

The recent trend of US GIS industry shows some interesting characteristics. The revenues from the public sector that covers about one third of total geospatial market lead recent geospatial market growth. Particularly, more and more cities, counties and states are becoming important GIS consumers. The regulation industries such as utilities, telecommunications, transportation and pipeline, are still the largest consumers of GIS and geospatial solutions (Daratech, 2009).

Pervasive use of GIS applications in the public sector is because it provides various stake holders and citizens with fast and reliable services without sacrificing significant government resources. For example, an Internet map on new zoning decision will save a planning officer from being haggled by citizen's telephone queries all day long. Cumberland County, N.C., for example , found that online maps could be a useful and time saving tool for providing data to the public (Jackson, 2009). The county, home to more than 300,000 residents and two major military bases, recently posted a Web site where visitors can find all sorts of land related information the county maintains. The site is a culmination of many years of work, not only in building online maps for public and internal consumption, but refining how data can be indexed by geographic identification as well. Online mapping and GIS based management of county infrastructure eases county growing pains.

Georgia DOT (GDOT) may be a good example of using state wide GIS implementations. Started in the early 1990s with the Georgia Navigator System which is an Intelligent Transportation System application, GDOT manages GIS services with the annual budget of approximately $1.8 million, most of which comes out of State Planning and Research funds (FHWA, 2007). GDOT recently implemented an enterprise GIS system serving about 200 concurrent users accessing from the branch offices spread all over the state. GDOT's Transportation Explorer (TREX) is the department's flagship GIS application using the enterprise GIS system. Based on ESRI products, the web portal system serves as both an

internal GIS information clearinghouse (85 available layers) and an application that allows the public real time access to GDOT maps, reports, plans, video logs, and ITS cameras for the entire state (23 available layers). In 2005, TREX received the Georgia Technology Conference Best of Georgia Award for Redefining Government and was runner up for the URISA Exemplary Systems in Government Award.

2) Some System Characteristics

The numbers and trends in this section are based on the 2008 GITA Survey on geospatial technologies (GITA, 2009).

Backend DB Server

The GITA survey shows that about 37% of the total survey responses use Oracle, 35% MS SQL Server, and 19% Access. Compared with the 2007 GITA survey, more applications are developed using the MS SQL Server.

Data Update Cycle

Many sectors have gravitated toward one week maintenance cycles for facilities. Gas, water, and public sector gravitate toward longer than one month cycles. Sectors are generally less likely to maintain facilities on a daily basis, but it is more common with electric, gas, and pipeline utilities.

Accuracy Used

A primary factor in the cost of landbase data is the level of positional accuracy. GITA Survey participants were generally unwilling to spend their project budget on 6-inch levels of accuracy. Two-foot accuracy remained dominant in the water sector. Further indication that all sectors are increasing their level of landbase accuracy is the slight decrease in use of 50-foot accuracy and slight increase in use of 6-inch accuracy from 2007 to 2008. Use of diverse level of accuracy is a reflection of GIS users varying their landbase accuracy levels based on geography, density of population, and their distribution networks.

Workforces

While most sectors prefer undergraduate and Master's degrees, significant number of high school graduates appears in electric, pipeline and water sectors. The telecommunication sector shows the highest percentage of graduate degrees among compared. A significant amount of 2-year college graduates appear in the electric and pipeline sectors.

3. GIS Utilization and Best Practices

GIS has been used for facilities mapping and records management in enterprises. GIS is now becoming a geospatial data warehouse that integrates a wide range of business applications. From niche applications, GIS is now moving to a core enterprise system. In this section, popular GIS applications will be described after reviewing the enterprise asset management cycle.

1) Asset Management Lifecycle

In an enterprise, managing assets across their entire lifecycle requires a full and effective utilization of GIS and related systems. In capital intensive industries such as utilities, process/discrete manufacturing, healthcare as well as real estate, physical assets (buildings, infrastructure and equipment) form a significant proportion of the total assets of the organization. These industries face the harsh realities of operating in highly competitive markets and dealing with high value assets and equipment where each failure is disruptive and costly. At the same time, they must also adhere to stringent occupational and environmental safety regulations. It is thus important for organizations to maximize the return on investment from their asset base. Life cycle asset management (LCAM) and enterprise asset management (EAM) are paradigms employed to achieve that goal. Given a physical asset, the objective of LCAM is to extract maximum productivity from the asset and minimize the total costs involved in its acquisition, operations as well as maintenance. The objective of asset management is to strike an optimal balance between maximizing overall asset productivity and minimizing total cost of ownership. Furthermore, LCAM provides guidance on whether it is more cost effective to continue to maintain, overhaul or replace a failing asset.

Asset management is composed of five stages that are interrelated to each other. They are planning, construction, operation, maintenance, and renewing. GIS is the indispensible,

decision support tool in all five stages. For example, large organizations and municipal services need good knowledge of the territory to keep record of departmental objects, to provide operative mapping of problem parcels and rational distribution of available resources. The telephone company needs an electronic map of STS location, the emergency control service must know the locations of the most worn out sections of heat pipelines, the traffic police needs to know the road signs location. The GIS, in all these situations, is the unique basis to which any specific information for the user can be easily attached. GIS provides operational effectiveness by creating a connected work flow and asset management process across the lifecycle – from 'Plan' through the 'Construct', 'Operate', 'Maintain' and 'Renew' stages. GIS also becomes the basis of effective systems integration by eliminating multiple databases, improving data quality, and reducing system support costs. Finally, GIS provides enterprises with various analytical tools that can then be applied to optimize expenditures over the entire asset life cycle, maximizing return on asset investments.

2) Industry's Top 10 Applications

Electric

The 2008 GITA Survey shows engineering work order design taking the number one spot in applications. Work management moved up to fourth place compared with 2007 survey. Smart technology metering entered the list at seventh place. GIS integration, SOA (service-oriented Architecture), and Land Management were nominated as new applications categories.

Gas

Work management rose to the top of applications ranked, replacing regulatory compliance. These two top applications have traded places over the past several years. Mobile data collection and facility maintenance rose in rank in 2008. Applications making the top 10 list are the same as those on the last report's list, showing some stability in gas utility interest in these applications.

Pipeline

Regulatory compliance once again took first place in top applications. Risk management rose from third to second place. Applications appearing on the list were approximately the same through the first seven places. Public awareness, asset management, and land management entered the list in the latter places.

Supervisory control and data acquisition, as known as SCADA, takes the fifth place. SCADA systems are used to monitor and control a plant or equipment in industries such as telecommunications, water and waste control, energy, oil and gas refining and transportation. A SCADA system gathers information, such as where a leak on a pipeline has occurred, transfers the information back to a central site, alerting the home station that the leak has occurred, carrying out necessary analysis and control, such as determining if the leak is critical, and displaying the information in a logical and organized fashion.

Public

GIS applications list in public sector is very similar to 2007. Land records ranked as the top application area. With growing importance of storm water management and impervious surface management, water and sewer utilities remained in second place. Address management, real estate appraisal, and assessment (tax mapping) positioned at the upper tier. Asset management rose from fourth place in the 2007 survey to third place.

Telecom

Telecommunication networks are characterized by vast geographical expanse and large number of features. Continuously evolving telecom technology and tremendous competition has necessitated very tight financial & inventory controls, maximization of utilization of installed physical inventory and high quality of uninterrupted service to the customers. Facility maintenance, core GIS migration, facility model integration, and data management ranked highest this year. In all cases, the highest-ranking applications rose from lower ranking in 2007.

Water

Many of the top 10 applications and their rankings in the water sector are very similar to the previous lists. Noteworthy changes include facility maintenance moving up to second place on the list and work management moving up from eighth to fifth place.

3) Issues

Figure 1 shows major issues with GIS applications. The chart was made with top three issues surveyed from six industry sectors listed above. Across all industry sectors, data quality control and maintenance received the most concern followed by system/application upgrade and migration, data sharing, and others. The numbers indicate total responses.

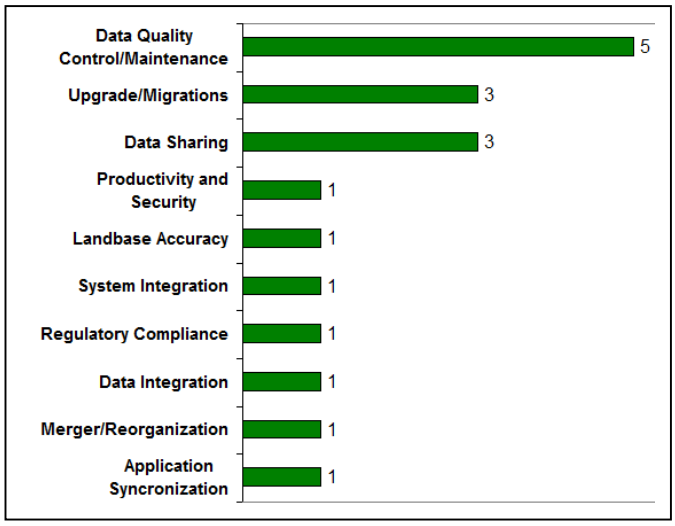

Figure 1. Major issues in GIS

4. Bust of U.S. Housing Market and GIS Industry

1) Housing Market Problem

Since 2007, the U.S. housing market has shown significant downfall in most areas of the U.S., specifically, in Nevada, Arizona, California and Florida. Failure of the housing market brought domino-effects in bank/finance, manufacturing and service industries.

House prices are estimated to keep falling in most places because those prices are still dangerously high compared to incomes and rents. Banks say a safe mortgage is a maximum of 3 times the buyer's yearly income with 20% down payment. Landlords say a safe price is a maximum of 15 times the tenant's yearly rent. Yet in coastal areas, both those safety rules are still being violated. Buyers are still borrowing 6 times their income and putting only 3% down, and sellers are still asking 30 times annual rent, even after recent price declines. Stock markets indicate at least 30% decreased market size compared with the 2006 market size.

2) GIS and Troubled Economy

Historically, the GIS market has continued to grow and advance even in recessionary cycles, because of the underlying premises of GIS such as creating efficiency, doing things faster or better or cheaper, improving the way people make decisions, and enhancing communication.

In this dismal economic crisis, many GIS companies, however, show growth even if growth rate got decreased.

Significant impacts appear in the software development and application service companies. In 2007, ESRI grew approximately 8 percent with approximately 10 percent of that growth in software sales. In 2008, the company made about 5% growth (ESRI, 2009), indicating GIS to be of strong interest across the full spectrum of organizations. It, however, shows that the growth rate is keep decreasing since 2006 indicating not quite immune to the economic downturn.

AutoDesk has shown a steady increase of revenue until 2008, but 2009 revenues show significant decrease (MSN, 2009). Compared with the last quarter in 2008 ($616M), the 3rd quarter revenue in 2009 shows 31% decrease ($426M).

PlanGraphics is a small company founded in 1979 by John C. Antenucci. The company served GIS implementations and automated mapping/facilities management systems. The trend of company's revenue shows a steady decrease since 2007. The latest revenue (0.6M) shows less than a half of 2007 revenue (1.4M) according to MSN MoneyCentral.

As an example of GPS industry, Trimble shows steady increase of revenue. In the imaging industry, GeoEye and DigitalGlobe show quite different trend (Figure 2). While DigitalGlobe soars up, GeoEye is plunging down since 2007. However, the most recent financial statement (FY09 2nd QTR) from GeoEye shows 112% increase compared with the same quarter in FY08.

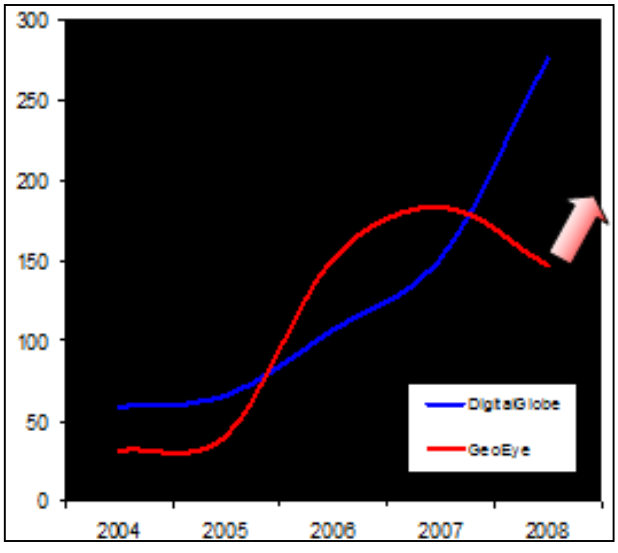

Figure 2. Revenues of imaging companies

Military related companies show steady or increasing revenue patterns. Boeing shows a hiccup in the FY09 first quarter with a rapid recovery in the following quarter. Lockheed Martin shows a steady increase. As one of the largest military oriented application/service company, SAIC shows a steady increase regardless of economic conditions.

3) Stimulus Plan and National GIS

In order to boost the troubled economy and reduce the unemployment rates, ESRI and Booz Allen Hamilton sent the first GIS proposal to the Congress to build 'National GIS' early this year. It was authored by Jack Dangermond, President and CEO of Environmental Systems Research Institute (ESRI), and Anne Miglarese, the Chair of the National Geospatial Advisory Committee to the Federal Geographic Data Committee (FGDC), and an executive with Booz Allen Hamilton, a large technology consulting firm. Their proposal, entitled "Building a National GIS" presents the argument that a publicly accessible national digital map can be built quickly and efficiently based on the existing GIS infrastructure (Dangermond and Miglarese, 2009). The proposal says that making a GIS investment will speed economic recovery by producing jobs, and provide the country with a modern geospatial information system. This proposal suggests that four information themes (imagery, parcel data, elevation data, and wildlife corridor and habitat data) be developed and integrated. It proposes the cost to do this at $1.2 billion over three years. Reportedly, this proposal has been presented to selected members of congress, and it has picked up a fairly long string of endorsements including the National States Geographic Information Council, the Urban and Regional Information Systems Association, the National Association of Counties, and the Wisconsin Land Information Association.

The second document proposing a connection between GIS and national economic recovery is written by seven authors and collaborators with no corporate affiliations stated. This proposal (Harrison et al., 2009) outlines a somewhat different approach than the first proposal. It is much more conceptual in scope, stating, "… to coordinate projects and protect our environment, online access to information and services is required. To do this, the authors propose it is time to build an information network combining online mapping with environmental data." They dubbed their proposal as "National Spatial Data Infrastructure (NSDI) 2.0." Unlike the first proposal, this approach does not propose any specific spending amount, but does claim that if implemented as the authors conceive, it will save the country billions of dollars a year, and create thousands of new jobs.

The third, and most recent, is presented in a paper titled, "A proposal for Invigorating the

American Economy through Investment in the U.S. National Spatial Data Infrastructure (NSDI)." It lists five authors affiliated with large, recognizable corporations: Autodesk, Microsoft, Oracle, Google, and Intergraph. This proposal (Campbell et al., 2009) presents the case that investment in information and communication technology will have immediate fiscal impact with long term economic growth. To realize this potential, the paper proposes to further develop of the NSDI by broadening its openness and interoperability. This will involve a two-pronged approach of data creation and a coordinated planning process of hosting and delivery. The paper outlines required technical fundamentals, leadership requirements, and associated costs. In this area it is very much parallel to the first proposal by ESRI and BAH in that it suggests the rapid collection and processing of key datasets is crucial. The datasets listed include imagery, elevation, parcels, ecosystems, and 3-D views of structures. The price tag for the aforementioned data is given at $1 billion. Added to this is an additional $250 million for data infrastructure design and deployment.

5. Prospects: where opportunities are

Even if gloomy clouds overcast current GIS industry, there are multiple silver rings behind them that may lead current GIS into the next level. This section describes those opportunities.

1) GIS Full Information Technology

In the early years, GIS was largely a proprietary technology. It invented its own standards for doing things. GIS has moved from that position to using IT standards and standards based technology. That has led to the embracing of GIS by the IT community as an enterprise platform. Today, GIS is increasingly focusing on the Internet that promises to leverage all of the knowledge that has been built over the years. Nowadays, GIS, data and human knowledge are harnessed with the Web 2.0 environment. Both the accommodation of GIS on the Web and the integration of GIS into mobile devices are going to make GIS pervasive and fundamental to all human activities.

2) Mashup

In web development, a mashup is a web page or application that combines data or functionality from two or more external sources to create a new service. In GIS, the mashup concept can be applied to mapping applications and Web services brought together into a

single mapping application. GIS mashups often provide users with a unique service or experience by combining a variety of mapping functions.

GIS mashups have a variety of benefits to both developers and users. Developers can save cost by simply mixing existing services with new services using AJAX and XML languages/specifications. Users also benefit from getting all information from one place.

3) Enterprise Systems

As the GITA 2009 Survey reveals, enterprise GIS implementations remain dominant and increasing. The telecom sector shows rapid transition to enterprise systems followed by the electric sector. The water sector shows slight increase at about 52%. Along with increasing Web applications and security concerns, more and more GIS architectures are expected to move to the enterprise architecture.

4) Vertical Integration

Most GIS applications developed during the past decade were created in isolation from one another, making it difficult or impossible for one agency to access data collected by another agency. For example, federal emergency responders might not be able to access a city's GIS data on locations of fire hydrants or sites that contain hazardous materials. However, that situation is changing quickly.

GIS applications and the data they deliver are increasingly being linked vertically thanks to informal information sharing efforts at local and state agencies and more formal, federally funded programs.

The whole essence of vertical integration is to take interoperability to a very different level.

One of the most visible and farthest reaching state GIS efforts is Virtual Alabama (http://www.virtual.alabama.gov). Launched in November 2007 by the Alabama Department of Homeland Security, the project uses Google Earth as its visualization engine and delivers data and query tools to more than 1,200 state and local officials, such as county sheriffs, assessors, firefighters and health care providers. Virtual Alabama delivers an array of data, such as geocoded imagery of properties statewide and the locations of gas stations, power lines, schools and other points of interest. The system even handles video feeds from highways and public facilities. In a major storm, agencies can monitor traffic flow on evacuation routes, search for open shelters, evaluate property and infrastructure damage, and locate stranded survivors.

Virtual Alabama might be unique in its breadth, but it isn't the only state effort. Currently, 22 states are working with Google to implement vertically integrated systems and, with strong federal support, people are envisioning VirtualUSA.

5) Military Applications

GIS plays a pivotal role in military operations as they are essentially spatial in nature. The concept of command, control, communication and coordination in military operations are largely dependent on the availability of accurate locational information in order to make quick decisions for operational orders. GIS, in this aspect, is an excellent tool for commanders and solders. Military forces use GIS in a variety of applications including cartography, intelligence, battle field management, terrain analysis, remote sensing, military installation management and monitoring of possible terrorist activity. Recent trend is the explosion of remote sensing and GIS technologies along with unmanned aerial/ground/underwater vehicles. Infrared, radar and visual sensor images are integrated with command control systems resulting in totally new shape of battlefields.

6) Natural Resources

Coupled with remote sensing, GIS has been used for natural resources/disaster management for a long time. Managing natural resources covers not only mapping species habitats but also various other aspects such as, but not limited to, renewable energy, energy saving, carbon accounting, conservation planning, and landuse and transportation planning for developing more sustainable environment.

Increasing number and magnitude of recent disasters also make more organizations build GIS-based disaster management system in all the stages of disaster management cycle, saying mitigation, preparedness, response and recovery. The international Charter which is an international cooperation on life-threatening disasters is a typical example of teaming up internationally with the help of geospatial technologies.

7) Data driven Decision Making

Sensors are everywhere. Infinite storages are available. Clouds of processors work simultaneously. Our ability to capture, warehouse, and understand massive amounts of data is changing science, medicine, business, technology, and GIS.

Sixty years ago, digital computers made information readable. Twenty years ago, the

Internet made it reachable. Ten years ago, the first search engine crawlers made it a single database. Now companies like Google are making a new history by treating this massive datasets as a laboratory of the human condition. They are the children of the Petabyte Age. The Petabyte Age is different because more is different. It calls for an entirely different approach, one that requires us to lose the bind of data as something that can be visualized in its totality. It forces us to view data mathematically first and establish a context for it later. In Petabyte Age, traditional hypothesis based sciences may be obsolete because massive data shows what is going on even before hypotheses are set up.

Petabyte GIS opens new opportunities in many areas. For example, in October 2008, agricultural consultancy Lanworth not only correctly projected that the US Department of Agriculture had overestimated the nation's corn crop, but also it nailed the margin: roughly 200 million bushels that is just 1.5 percent fewer kernels but still a significant shortfall for tight markets, causing a 13 percent price hike and jittering the emerging ethanol industry (Paynter, 2008). Using massive data on every corner of the world, the consulting firm provides a timely heads up on fluctuations in wheat, corn, and soybean supplies.

Massive data are also used for analyzing hot zones, predicting voting patterns, and pricing terrorism in GIS. It is expected to see more and more decision support systems coming up based on massive geospatial datasets.

8) GIS Supercomputing on Desktop

Development of fast, multi-core hardware architectures opens another opportunity in GIS. NVIDIA's CUDA technology is, currently, leading the trend followed by Intel's Thread Building Block and Apple's OpenCL. A GIS company, Manifold, took a fast step on using the CUDA technology in GIS software engineering selling off-the-shelf parallel processing GIS software package since 2007. A test of CUDA with satellite imagery showed significant performance increase in local and focal operation types – specifically, for example, a 56-times performance boost with the k-nearest neighbor filtering algorithm for removing radar image noise as shown in Figure 3 (Seong, et al., 2009). It is expected that more and more systems will use the multi processor architectures in geospatial data processing in the very near future, which will eventually help in creating new geospatial industry markets.

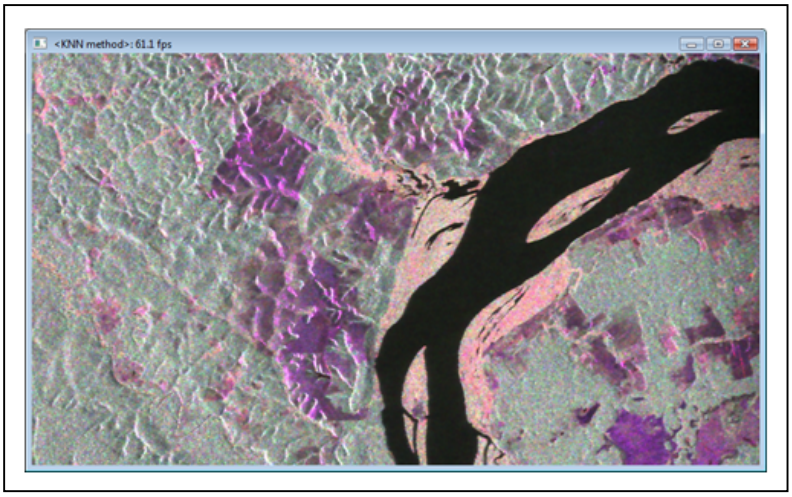

Figure 3. Example of CUDA applications

6. Summary

With growing importance of GIS as the indispensible tool set for managing societal infrastructure, the U.S. GIS industry has grown steadily. Recent economic problem, however, slowed down its growth rate and some software/application development companies experienced significant decreases of revenue. Some characteristics of US GIS industry are, continuing growth in public/military/engineering sectors, increasing number of applications with higher spatial resolution datasets, more centralized/integrated enterprise systems, and vertical integrations. The U.S. GIS industry is also changing rapidly toward a new GIS that integrates other enterprise information systems. In the tract of GIS evolution with new hardware technology, software architecture, massive datasets, military applications and natural resources/disaster management, the U.S. GIS industry is expected to bring new services to our society.

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"Geospatial Information"(GSI) Industry Development Plan

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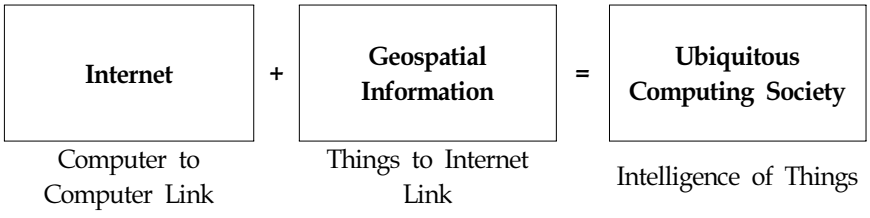
1. Why Geospatial Information Industry?

□ Generally speaking, there are four reasons why priority should be given to the promotion of the geospatial information industry:

o First, the GSI is a fast-growing blue ocean industry in this era of information society. According to the statistics released by the US Department of Labor, the nation's GSI has annually expanded by an average of 35 percent. Particularly when it comes to the commercial sector, its average growth has doubled. However, it is only in the baby-step stage with no super power in the global market, which means the market still remains as a wide open blue ocean. In this light, a country with a concerted effort can seize the opportunity to become a dominant market power across the globe.

o Second, it is a platform industry that will eventually boost other industries. While the internet has been on the forefront of the information society to date, the GSI is expected to emerge as another major platform for the ubiquitous society. In this regard, it is considered to produce a strong effect of network externalities, giving a boost to other industries.



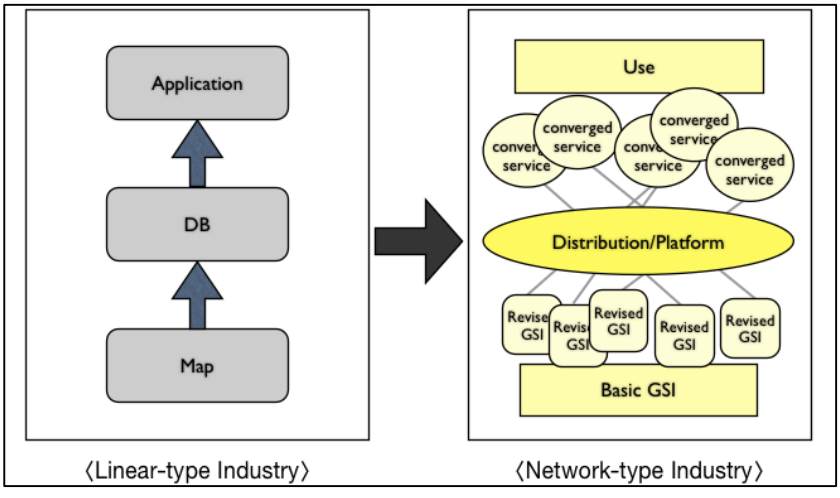
o Third, the GSI serves as fundamental infrastructure for 'green development', as it supports pollution-free industries and environment-friendly development and encourages the utilization and conservation of the nation's nature and land. In addition to this, energy efficiency can be maximized by applying geospatial information.

o Lastly, it is a strategic industry for sharpening Korea's global competitive edge. Korea has been already equipped with the most advanced high-speed communication networks and mobile infrastructure. Its government and people also have strong digital capabilities to use information technology. Therefore, if Korea make use of such leading conditions to develop the next-generation geospatial information service in the local market and have it verified as early as possible, it will be unrivalled in the global market.

□ What is Geospatial Information Industry?

o In the Geospatial Information Industry Promotion Act legislated in February 2009, the GSI is defined as an "industry which produces, manages, revises or distributes geospatial information and builds new systems or provides service by merging or combining with other industries."

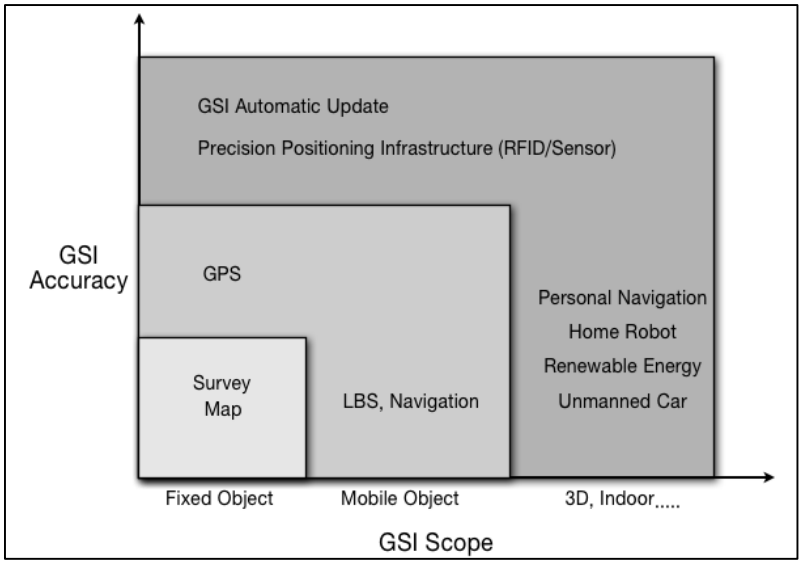
o Recently, the GSI is evolving into a highly sophisticated stage, shifting from a simple task of producing maps. While in the past supplying map has formed a 1:1 relationship with use, the future relationship between supply and demand will be like N:N, creating enormous synergy effects in comparison to linear industries.



□ Industrial Trend by Sector

o Production and Processing Sector

- In the past, the main subjects of geospatial information were fixed geographical features and structures built on them. Now it deals with a wider range of subjects, including geospatial information about mobile objects not just fixed objects.
- In the future, the scope of geospatial information will be significantly expanded. For one thing, two dimensions will go further to three or four dimensions, and indoor geospatial information will be enhanced. Also, with the improvement of the precision (accuracy) of geospatial information, a plenty of applied services will be avaliable.



o Distribution Sector

- In the past, distribution was limited to downloading digital maps at a primitive level. Currently, distribution channels are increasingly diversified with the technological development of information sharing. The three major distribution channels are:

① download: a user downloads a digital map file and makes it over for his purpose.

② open API: a user makes a real-time exchange of geospatial information through servers between user and provider connected by API.

③ open platform: equipment required for utilizing spatial information is provided online to minimize a user's labor.

o Application Sector

- Geospatial information was mostly put to use in checking geographical features and locations. Today, combined with other elements of information society, its scope of service has been broadened. The major services are:

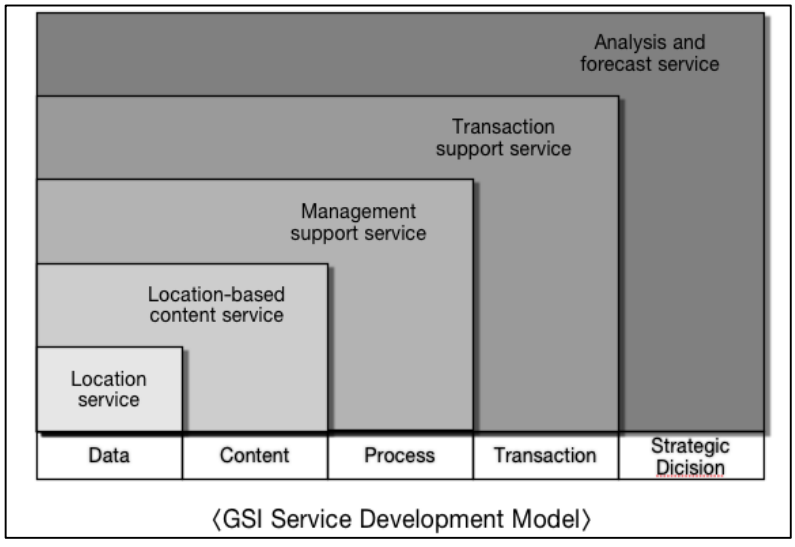
① Location service

② Location-based content service (geo-information+digital content)

③ management support service (geo-information+business process)

④ transaction support service (geo-information+transaction)

⑤ analysis & forecast service (geo-information+strategic analysis)



〈GSI Service Development Model〉

2. GSI Industry in Korea

□ The geospatial information market expanded by an average of 44 percent annually over the past four years, with its volume worth 1.7 billion USD in 2007. It is expected to continue to spiral upward for the meantime with its volume worth 11 billion USD and the number of employees reaching 200,000 by 2012 after an annual increase of 28.7 percent.

	2005	2006	2007
Market size (billion USD)	0.89	1.36	1.79
employees	28,428	40,384	47,110

〈GSI Market Size in Korea〉

□ Features of Korea's GSI

1. (Industrial structure) Despite the substantial growth of the market for map production, the market for applied service is still weak and the public sector accounts for 58.7 percent of the entire market.

2. (Corporate structure) Given sales volumes and the number of employees, most companies are still small sized businesses. Survey companies make up 67.6 percent of the entire businesses.

3. (Technology) Although its core technologies are currently highly dependent on foreign countries, the national GIS project has paved the way for the national system of long-term technological development.

4. (Employment) The employment multiplier is 26.2 persons for 1 billion won, much higher compared to the manufacturing industry (9.2 persons) and the construction industry (16.8 persons).

□ Challenges Facing Korea's GSI

1. As the public sector accounts for most of demand, the private sector is given very limited opportunities. In particular, even financial organizations and large conglomerates, which have strong demand for geospatial information, could not make the good use of geospatial information.

2. Industrial development has been hampered by poor sharing of the public sector's huge information not only with private sectors but also within the government. Due to stringent security regulations, a large part of geospatial information is not open to the

public. Worse, a lack of effective geospatial information sharing services restricts the utilization of currently accessible information.

3. As innovative specialized companies are increasingly weak in their businesses, the dynamics of the industry has diminished as a consequence. With the scale of geospatial information projects ordered by the government going upward, there is less room for small sized companies.

4. The lack of original technologies for national competitiveness works as a stumbling block for industrial growth. Except for map production, softwares mostly come from abroad with 80 percent of them imported. One of the reasons for the problem is the shortage of technological workforce and specialists with master's and doctor's degrees. However, a more fundamental reason is the lack of awareness of the government and residents, which leads to a decline in investment.

3. Development Strategy for GSI

□ **The Korean government is mapping out a basic plan for the industrial development for the period from 2010 to 2015.**

o The plan takes aim at progressing the GSI as one of the major IT industries by 2015. For this goal, three strategies have been designed:

1) actively creating demand from the public sector to grow a market large enough for industrial development.

2) Sharing the public sector's enormous geospatial information with the private sector and easing restrictions on the private sector for development led by the private sector.

3) Strengthening industrial foundation in response to fast-changing industrial conditions for sustainable development

4. Major Policies for GSI

4-1. Broaden the demand base for the GSI industry

o Despite a rapid annual average growth rate of 44 percent from 2005 to 2007, its demand should be restructured for further development. For example, map production and sales created 58.8 percent of demand in 2007, while there were little demand for applied service with high-added values - mostly for g-CRM. Also, demand mainly come from the public sector, and little from companies and individuals.

o The Korean government plans to restructure demand through a step-by-step mechanism of 'demand creation ⇒ service development ⇒ demand spread.' Under this mechanism, the government will create demand itself as a user in the public sector and, in the private sector, will create an environment that will help create demand.

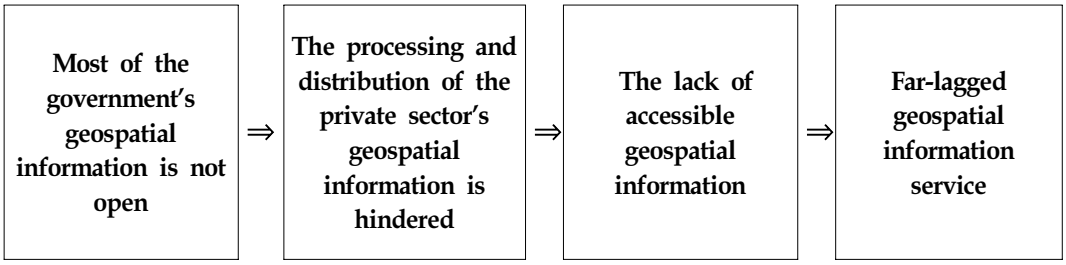
o The Korean government is working on a plenty of programs to create demand. The major ones are as follows:

- to do a regular survey on demand for geospatial information in the public and private sector and construct a service road map based on the results,
- to implement an active promotion program to raise awareness by building a center where visitors can experience future geospatial information service and launching geospatial information culture programs like geoWeb movement,
- to start pilot projects with commitment to developing geospatial information service, for which the government has chosen five agendas - green development, social security, disaster control, public health/welfare, and education/culture,
- to designate towns as geospatial information model cities and create an environment very similar to a fully developed geospatial information infrastructure of the future. Geospatial information enterprises will be given an opportunity to develop innovative service, free from scores of regulations.

4-2. Promote production, distribution and sharing of geospatial information

o The most essential condition for the promotion of the GSI is to create an environment where geospatial information is smoothly and unrestrictedly exchanged. However,

immature distribution systems in Korea present the biggest obstacle to developing the industry and its next-generation services.



o Therefore, the government intends to open its geospatial information as much as possible and improve the role structure so that the private sector can play a leading role in the processing and distribution of geospatial information.

Production	Processing	Distribution	Utilization
government monopoly ➡ government+ private (basic geospatial information will be produced by government)	government-led ➡ private-led (administrative information will be provided by government)	government-led ➡ private-led (public sector distribution by government)	separation of government and private sector ➡ connection between government and private sector

o There are several plans the government has designed to realize this goal.

- The government will disclose the entire information to the public except some information that must be kept confidential. Highly demanded information will be sorted out according to surveys on public demand, and be gradually open to the public under an annual information disclosure plan, which will be established by the government.
- The government will put in place a highly sophisticated distribution system for the effective delivery of geospatial information to the public. Currently, downloading digital maps is the only available service. However, the open API and open Platform will be added to improve service.
- To encourage geospatial information distributors in the private sector, the government will establish a center for API service and provide technological supports for small-

and medium-sized enterprises. Rather than developing open Platforms on its own, the government will primarily use open Platforms developed by a private company.

- For assisting the growth of the private sector, the government will purchase geospatial information produced by private companies rather than obtaining it on its own.

4-3. Lay the groundwork for industrial growth

o The GSI, which is going through sweeping changes in the industrial structure and conditions, needs to overhaul its base and be geared toward becoming a new industry of tomorrow. Also, a healthy business environment should be built for the harmonious operation of existing GIS companies and new companies and existing service and new service.

o The main programs the government is drawing up are as follows:

- The government will devise a quality certificate system, which will lead to technological progress. As products with quality certificates will be preferentially purchased by the government and be given various benefits, companies will be encouraged to receive a certification in an active and voluntary manner.
- The government will support the establishment of industrial standards, which will make a practical contribution to the industry. Particularly in response to the increasing convergence among different industries, a cooperative committee on the establishment of industrial standards will be set up together with relevant sectors like energy and logistics.
- The construction of an institution and an organization for the promotion of the GSI is scheduled to be completed by 2010. The industrial promotion institution will support technology-intensive start-ups, while the association of the geospatial information companies will reinforce the industrial potential.

4-4. Strengthen technological development and global competitiveness

o The GSI is a knowledge-intensive industry, where technological capability determines competitiveness. However, geospatial information technologies in Korea is far behind advanced countries. To address the issue, strategic technologies will be chosen for intensive technological development.

o For this purpose, the government is working out the following plans:

- Strategic technologies for the future will be selected to develop the world-best technologies. '2020 Road Map of Geospatial Information Technological Development' will be established to advance in the field as far as developed countries by 2020.
- The environment for the technological development of geospatial information will be improved. The government will also try to raise a fund for the promotion of geospatial information technology to offer steady and stable support.

Improving Access to Spatial Information in Australia: A brief update

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Introduction

Spatial Information is critical to Australian society today. It underpins decision making in a wide range of industries such as energy, agriculture, health, defence, emergency management, and natural resources and has widespread consumer use through applications such as personal location, transport mapping and routing. Its direct impact on Australia's economy has now been quantified for the first time through a study commissioned by the Cooperative Research Centre for Spatial Information. This paper draws together the recent quantification of the value of spatial information in Australia, with several government initiatives on data access policy and outlines research planned by the Cooperative Research Centre for Spatial Information to facilitate better information access by commercial and non commercial organisations.

The Cooperative Research Centre for Spatial Information

In 2003 The Cooperative Research Centre for Spatial Information, (CRCSI) was founded by 50 Government, University and private company partners with US$62 million in cash and in-kind for a seven year period. The CRCSI uses its substantial partner network to 'accelerate industry growth, generate intellectual property, seek efficiency gains for government, and better position the research and education programs of universities and other institutions' (Woodgate and Coppa, 2008). In August 2009, the CRCSI received further commitments of US$135 million cash and inkind for a further eight years from an expanded partner base of 100 and the Australian Government.

The Spatial Information industry and industry growth

ACIL Tasman estimated that the size of the Australian Spatial Information industry in 2006-7 as measured by revenue was US$1.1 billion (ACIL Tasman, 2008). For the purposes of ACIL Tasman report the definition of the industry was that the spatial information industry:

> 'acquires, integrates, manages, analyses, maps, distributes, and uses geographic, temporal and spatial information and knowledge. The industry includes basic and applied research, technology development, education, and applications to address the planning, decision making, and operational needs of people and organizations of all types.'

A survey in 1999 2000 by Corporate GIS Consultants valued the Australian spatial information industry at $US640 million (Commonwealth of Australia 2001). This represents an average Australian industry growth of approximately 8% per annum when compared with the ACIL value. This estimate is lower than other global data. For example, global GIS industry growth was estimated to be 14% by Daratech[1)] over 2000-2005. ASPRS estimated the remote sensing market would grow at almost 14% from 2000–2005 (Mondello, Hepner, & Williamson 2005). Interestingly these growth estimates are significantly lower than CRCSI member growth rates, where over the 2003- 2005 period, private member company revenue growth was around 30% for GIS companies and software supplies, 40% for survey companies and 60% for digital data suppliers. It is possible that this sample represents the more innovative companies in the spatial information sector, as companies involved in innovation may generate greater revenue growth through new or improved processes, techniques or products.

Quantifying the Value of Spatial Information to Australia

In 2008 CRCSI, as Australia's largest spatial information research conglomerate together with the Australian Spatial Industry Business Association, the peak body for private spatial companies, commissioned a report to

> 'establish the verified and quantified economic impact of spatial information to the

1) Compiled from Daratech press releases and reports, and online news releases : http://www.directionsmag.com/article.php?article_id=403http://www.gim international.com/news/id1796 GISGeospatial_Market_Grew__in.html;http://www.gisuser.com/index2.php?option=content&do_pdf=1&id=9317;Daratech (2000), GIS Markets and Opportunities: 2000 Forecasts and Opportunities, Daratech, MA.

> Australian economy in 2006 7' and to 'estimate the cost of inefficient access to data and identify the factors operating to create these inefficiencies '(ACIL Tasman 2008).

The report covered 22 sectors of the Australian economy, including the large export areas of mining and resources, agriculture, forestry, fisheries, oil and gas, and manufacturing as well as local industries such as tourism, transport, energy utilities, communications and government.

ACIL Tasman (2008) estimated that the accumulated impact of spatial information on the Australian economy was 'a cumulative gain of between US$5.1 billion and US$10.1 billion in Australia's Gross Domestic Product (GDP). This was equivalent to 0.6% and 1.2% of GDP respectively'. The Report went further, estimating that there was also an increase in trade exports of US$1.0-1.8 billion and imports of US$0.9-1.8 billion as a result of the use of spatial information. Household consumption was said to have increased by between US$3.6 billion and $6.9 billion. ACIL Tasman (2008) also estimated that the 'economic footprint of the spatial information industry is considered to be larger than this and that 'spatial information is increasingly being used in most sectors of the economy where it is having a direct impact on productivity.'

The analysis excluded other impacts, such as the impact of environment and social benefits, indicating that the value of spatial information to the Australian economy would be substantially higher where indirect impacts were factored in. However as spatial information becomes further integrated and used in society, the benefits will be substantially greater, through further integration into:

> 'the operation of water markets, carbon markets, natural resources management and environmental management and monitoring programmes more generally'(ACIL Tasman 2008).

There has been significant progress since the ACIL study was released last year. Anecdotal evidence is that adoption rates within industry have increased and that further applications not documented in the 2008 study have emerged. There has also been a wider penetration in the use and awareness of spatial and emerging evidence that the role of government is very important in the early stages of spatial industry growth (Alan Smart, ACIL Tasman, Pers. Comm.). The ACIL Tasman study authors have further concluded (Alan Smart, ACIL Tasman, Pers. Comm.) that

- 'Government productivity improvements in delivery of services deliver higher outputs/ lower costs for the Australian taxpayer
- Government held data is the foundation of the wider industry – critical to

realisation of economic, social and environmental benefits

- Government policies and strategies for data management, infrastructure, innovation shape the operating framework for the spatial sector.'

Improving data access and Recent Information Access Reports

The second aspect of the ACIL Tasman (2008) study was to examine the costs of inefficient access to data.

ACIL Tasman (2008) estimated that constraints on access to data

> 'reduced the direct productivity impacts in certain sectors by between 5% and 15%' and calculated that the Australian GDP was 7% lower (around $0.5 billion) than it might otherwise have been'.

There is some evidence that access to government data is limited. For example, the Government of Queensland (2008), estimated that only 8% of 2,600 Queensland data sets were available to the public, and that a further 2% of data sets were available to industry. In addition of these 2600 data sets, 71% were confined to single government unit usage. Anecdotal evidence suggests this is not an isolated case and that significant benefits will accrue from opening up data stores. ACIL Tasman (2008) has succinctly described the costs of this as slower development of applications and less than optimal levels of application and innovation among users. They indicated that it is:

> 'likely to have had an impact in the property and services, construction, government, transport and agricultural sectors and reduced the extension of spatial information into areas such as asset management in utilities, transport and storage applications and in emerging areas of consumer markets and applications in other industries.'

Over the past year Australia has increasingly begun to recognize the value of its information stores. Initiatives such as the Government Information Licencing Framework which is described as 'a simple open content licensing framework to assist in the management of government intellectual property, and encourage the use of public sector information through increased availability and accessibility' (www.gilf.gov.au) have come to fruition. Several Australian Federal and State Government Departments have released reviews, reports and polices specifically addressing the question of information access and

making recommendations to better facilitate the use and reuse of public information. These provide effective frameworks to advance significantly the access to public sector information in Australia across its jurisdictions. These recent reviews and policy frameworks are summarized in the following discussion.

Review of the Australian Government's Use of Information and Communication Technology

The review by Sir Peter Gershon was released in October 2008 and was tasked with the examination of the efficiency and effectiveness of the Australian Government's current use of Information and Communication Technologies. With respect to Geospatial data it highlighted that the:

> 'duplication, the lack of common standards and sharing of best practice in the use of geospatial data by the Government are issues which have recently begun to be addressed on a whole of government basis, but it should have been resolved much earlier before agencies began to pursue independent courses of action' (Gershon, 2008)

Powering Ideas- An Innovation Agenda for the 21st Century

In May 2009 the Australian Federal Government released its innovation policy framework that will guide the development of Australia's innovation system for the next decade (Commonwealth of Australia 2009a). The 'Powering Ideas (2009) strategy acknowledged

> 'the role of better information in decision making, and that as a significant custodian of data, innovation will be fuelled by making more of this vast national resource accessible to citizens, businesspeople, researchers, and policy makers'.

The strategy recognised the current role of the Australian Bureau of Statistics, the Bureau of Meteorology, and Geoscience Australia in collecting and disseminating datasets. However the report acknowledged the Government will:

> 'start by taking steps to develop a more coordinated approach to Commonwealth information management, innovation, and engagement involving the Australian Government Information Management Office and federal agencies.

The Government proposed to appoint a statutory Information Commissioner, to help 'develop a more consistent and coordinated approach to managing information and making it accessible to the community.' It also indicated that it would:

> 'speed implementation of the National Government Information Sharing Strategy which

aims to encourage government agencies-Commonwealth, state, territory, and local to share information that will help deliver better services to the community.'

Inquiry into Improving Access to Victorian Public Sector Information and Data

In July 2009, the Government of Victoria, a state of Australia, released its Inquiry Report into improving access to Victorian Public Sector Information (Economic Development and Infrastructure Committee 2009). The Report was commissioned to examine the potential economic benefits and costs to Victoria of maximising access to and use of Victorian Government information for commercial and non commercial use, including the use of the open source and open content licensing models. The report made three key recommendations for access to and re use of Government information:

> The Victorian Government develop an Information Management Framework for the purpose of facilitating access to and re-use of Victorian Government information by government, citizens and businesses. The default position should be that all public sector information produced by Victorian Government departments from now on be made available at no or marginal cost.
>
> The Victorian Government make use of the Creative Commons licensing model for the release of public sector information. Remaining Victorian Government public sector information should either not be released, or released under licences tailored specifically for restricted materials.
>
> The Victorian Government establish an on-line directory, where the public can search for and obtain information about public sector information held by the Victorian Government. Depending on the access conditions Government has attached to specific public sector information, people will be able to download information and data directly, or make contact with people in the Victorian Government to discuss access conditions.

Australia's Digital Economy: Future Directions

On 14 July 2009, the Australian Government also released its paper on the key areas of focus for Australian Government with respect to the digital economy. The paper acknowledged that:

> 'An open access approach to the release of public sector information is a logical response to the digital economy and innovation benefits that can result from new and

> emerging digital use and re use, subject to privacy, national security or confidentiality concerns. In this context, 'open access means access on terms and in formats that clearly permit and enable such use and re use by any member of the public. This allows anyone with an innovative idea to add value to existing public sector information for the common good, often in initially unforeseen or unanticipated ways.' (Commonwealth of Australia,2009b)

The paper also acknowledged the growing global need to develop and implement policies that would enable better public access to government held information and committed to collaborating with Australian state and territory governments

> 'to provide more open access to appropriate categories of public sector information, which do not raise issues such as privacy, national security or confidentiality.'

It is against the backdrop of these policy frameworks, with a growing public use and demand for spatial information and information in general, together with the economic benefits that improved data access brings, that the new research program for the CRCSI is framed.

CRCSI Spatial Infrastructures Research Initiatives 2009 - 2017

The governments of Australia and New Zealand, through their peak body ANZLIC – the Spatial Council – have recently agreed to coordinate their spatial resources and establish an Australian Spatial Marketplace. The Australian Spatial Marketplace will operate across all sectors: public, private and mass market. It will facilitate online spatial processing. ANZLIC have agreed that the primary research engine to support the development of the Australian Spatial Marketplace will be the CRCSI. It will review those systems currently under development by the Australian State land agencies such as SLIP (Shared Land Information Platform) in Western Australia, LYNX by PSMA, SIX in New South Wales, VMAS in Victoria and IQ in Queensland.

As previously stated, the spatial information industry contributes up to US$10 billion annually to GDP (ACIL Tasman, 2008), but this contribution could be 50% higher if the growth impediments were addressed, the most significant being accessing information. The new research program in the CRCSI is designed to address these impediments and it will specifically address information access through underpinning research on the Australian Spatial Marketplace. The Marketplace will address the licensing, governance and technical

restrictions on providing the vast stores of government held spatial data to the open market and to encourage the trade of other data. The intention is to unlock the potential of government spatial data holdings, most of which is presently not available to the private sector or general public.

The key research involves four areas; governance, technical, legal and market drivers. The program will develop online tools to manage digital rights, privacy and security for existing and emerging spatial infrastructure. It will implement a federated data model across all jurisdictions in Australia that spatially enables data currently locked in numerous government silos. It will develop an applications framework that enables highly interoperable, large scale and high data volume processing of online spatial information from public and private sources including those emerging from advanced positioning technologies and distributed sensor networks.

Conclusion

In recent years the Federal, State and Territory Governments of Australia have undertaken a systematic series of studies on the value of spatial information. These studies have helped these Governments form the view that improving access to spatial information, and in particular government-help information, will make a substantial difference to growth of the Australian economy, to social and environmental well-being, and the abilities of Australians to become more innovative. Australian Governments are collectively moving to create an Australian Spatial Marketplace, to progressively implement creative commons licensing, and to move further towards open access. These developments are estimated to increase the contribution of spatial information to Australian GDP by up to 50% from a level of around US$10 billion in 2007.

Authors note. All amounts have been quoted in US dollars, at a conversion rate of one Australian Dollar being equivalent to 80 US cents.

Acknowledgement

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Future Directions and Growth Prospects for the UK Geospatial Market

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Abstract

This report provides an assessment of future directions and growth potential for geospatial information products and services in the United Kingdom. It is based on information drawn from publicly available sources, interviews with industry opinion formers and informally gathered information from the authors' other contacts.

In terms of future growth prospects, the major market drivers include the integration of geospatial information into the IT mainstream, emergence of consumer market geospatial tools, such as Google Earth, and in the public sector, initiatives such as INSPIRE and the Location Strategy. Environmental concerns and changing patterns of social networking will also be significant.

It is particularly difficult to predict growth figures in the current economic crisis. However, we believe that the relative performance of various industries is likely to reflect our findings. They suggest that future prospects are very much market dependent:

- The traditional engines of local and central Government are unlikely to grow in real terms and may even go into reverse;
- The utilities markets is going through a welcome "spike" of activity driven by the need to replace outdated technology and regulatory pressure but is unlikely to be sustained;
- Commercial markets, particularly transport and insurance, still have considerable potential provided that individual projects can demonstrate a strong short term Return on Investment.

- Construction and land and property, may in the medium to longer term recover, but the collapse in the housing market will make this market very tough in the near term.
- The strongest area of growth will be in consumer Location based services but it is likely to benefit only a relatively small number of big players and some innovative start ups.

1. Introduction

1.1 Aim of this document

Assessments of the size of the global products and services market for geospatial information have been produced for many years. For instance, the Daratech[2] GIS / Geospatial Markets and Opportunities study has been in continuous publication since 1989. However, we are not aware of any recent detailed study specifically relating to the UK market which is publicly available. Individual organisations have made or commissioned their own assessments, but access to such documents is usually commercially restricted.

This report seeks to fill the gap by providing an assessment of current UK market size and growth potential, based on information drawn from publicly available sources, interviews with industry opinion formers and informally gathered information from the authors' other contacts.

1.2 Structure

The document is structured into sections concerning the audience and objectives, definition of the market, future trends and conclusions.

1.3 Acknowledgements

We are indebted to many "opinion formers" within and outside the geographic information industry for their insight and candid observations on the present state of the market and future growth trends. Where permission has been given, contributions are acknowledged, however, most were provided on a non attributable basis.

2) www.daratech.com/about/profile.htm

2. Audience

The report is designed to appeal to a wide audience. It seeks to be accessible to business leaders and investors by use of non technical language except where explicitly required. It will also be relevant to geographic information (GI) industry professionals planning to operate, or already operating, within the UK.

The assessment paints a picture of an industry that plays a substantial role in many parts of the economy and, as such, is also pertinent to the work of public policy makers.

3. Scope

3.1 Defining the Market

There is no one generally accepted definition for the scope for the geographic information market.

The Association for Geographic Information (AGI) defines geographic information as "about objects or phenomena that are associated with a location relative to the surface of the earth". A definition that is derived from the landmark Chorley Report[3] published in 1987.

However, this is not a sufficiently "tight" definition on which to base an assessment of the market that will be of use to practitioners, potential investors and other stakeholders.

The scope we have adopted can be defined as:

> "Economic activities where geospatial information is the main driver of the application, service or system component."

The choice of the word component is important as it allows us to include the contribution of geographic information within an enterprise wide system or service.

We have also included activities that are described using terms that can be reasonably regarded as essentially synonyms or subsets of geospatial information including geographical information systems (GIS), geographical information services, the geoweb and location based services.

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3) Department of the Environment (1987). Handling Geographical Information, Report of the Committee of Enquiry chaired by Lord Chorley.

4. Market Trends

In this section we examine some of the economic, social, technological and political trends that define the market for geospatial information, looking forward, and its consequent growth potential.

4.1 Introduction: Geography becomes Context

Over the last 20 years the geospatial industry has been changing but in relatively small increments. There have been many breakthroughs, but their effects have emerged at a rate businesses and Government could absorb and adapt to.

In contrast, what we are currently witnessing can justifiably be described as a paradigm shift. The simultaneous coming together of many changes, some driven by "disruptive" technologies but other aspects driven by social and environmental developments, is causing users to view geospatial information differently. The concept of geography as context is a powerful metaphor. It embodies the idea that geospatial data becomes a basic ingredient of an information system, ubiquitous to all applications. Consequently, we will stop talking about geospatial applications, as all applications will embed geography, it being only the extent to which this is relevant or explicit that will vary.

This paradigm shift is happening against a backdrop of what is viewed by most observers as the worst economic downturn for more than a century, with the UK being amongst the countries worst affected.

Consequently, it is our view that the market for geospatial information and the shape of the industry needed to support it will be radically transformed over the next few years.

4.2 Macro economic Outlook

The global meltdown in financial markets in the latter half of calendar 2008 has had a devastating effect on both consumer and business confidence in the United Kingdom. However, the worst predictions of the effect on the geospatial market appear not to have materialised. Evidence suggests that most businesses are seeing a downturn in new orders but that repeat business and enhancements to existing systems has helped revenues hold up relatively well. Certainly, for most companies, revenues for calendar 2008 advanced from the 2007 figures as the recession only took hold towards the end of the year.

At the time of this update, in mid 2009, signs of a modest recovery are beginning to show

in general economic indicators. However, the UK geospatial market is still heavily reliant upon the public sector and here, the burden of Government's huge borrowing during the crisis, is resulting in very severe cutbacks for the financial year 2009 10, which we believe will feed through into 2009 outturns and continue well in 2010.

4.3 Business Drivers

There are a number of major business trends currently affecting the geographic information market, both in the UK and more widely. In this section we highlight those that we believe will be most significant to the geospatial industry over the next 12-18 months:

i) **Integration of geospatial information into the IT mainstream**

It is widely recognised that the geospatial technology and data to support its integration with Customer Relationship Management (CRM), Enterprise Resource Planning (ERP) and other mission critical systems is now a mature "product". The leading Geographical Information System (GIS) packages are now built on industry standard software platforms and support Service Oriented Architectures[3] (SOAs). Furthermore, high quality, richly attributed geospatial data is now available for most parts of the UK. Consequently, geospatial systems are increasingly being seen as a viable component of enterprise IT transformation projects, both in both public and private sectors.

ii) **Emergence of geospatial tools focused on the consumer market**

The major players in this rapidly emerging area are Google, with their Google Maps and Earth products and Microsoft with Bing and, the recently purchased, Multimap.

These tools have made geospatial data accessible and intelligible to a much wider range of users. As business leaders, and politicians, discover these tools through leisure and social activities, they are recognising their applicability to the working environment. Neither Google or Microsoft appear to be moving to provide business transformation and systems integration services necessary to leverage the opportunities these tools provide, offering opportunities for professional services providers and application developers to fill the gap.

3) Wikipedia basic primer on SOA http://en.wikipedia.org/wiki/Service_oriented_architecture

iii) Generation Y

There is considerable evidence that the aspirations and attitudes of the 15-24 age group, those who have been brought up with the internet, and referred to often in research as Generation Y, are beginning to drive substantial social change and that this will accelerate as they enter the workforce.

One example of this, with wide ranging potential ramifications for any information based industry such as geospatial, is indicated by work quoted in the annual market report[4] of the communications regulator (Ofcom):

"A survey conducted by Human Capital, provides evidence of the attitude held by younger people towards the availability of music content; it suggests that two thirds of 15 24s think that downloading music for free is "morally acceptable"."

The limited appetite of Generation Y to pay for content on the internet and respect copyright is a trend those working in the area of geospatial Digital Right Management (DRM) would be wise to note.

Another recent report on Generation Y[5], commissioned in part by Ordnance Survey, identifies that they are not prepared to be "driven" by the work ethic of their parents and are willing to accept less material rewards for a better work / life balance. This will have significant impacts on employers, who will need to adjust their expectations of employees, as well as on demand for goods and services.

iv) Social Networking

Social networking continues to grow. Ofcom reports that Facebook reached a monthly unique audience of 19 million and Twitter had 2.6 million unique visitors in May 2009. Furthermore, the fastest increase in take up is among 35-54s – up by eight percentage points since Q1 2008 to 35%.

Current only a minority of people use advanced functions on their mobile phone handsets. However, the number of location based applications available for 3G Smartphones (such as Apple's iPhone, Google's Android and Blackberry) in the US grew from around 20 to an estimated 2500[6] over the 12 months to May 2009. The same report also quotes the US leader in location reference information Skyhook[7] that

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4) Office of the Communications Regulator (Ofcom) Communications Market Report (August 2009) http://www.ofcom.org.uk/research/cm/cmr09/cmr09.pdf

5) Generation Y: Unlocking the talent of young managers, Dr Alison Macleod, Chartered Institute of Management

6) **New apps spawn as geo becomes context**, Andy Coote, writing in GIS Pro August 2009

it provides 240m location fixes per day to its 40m subscribers.

Some of the most commercially interesting of these applications include locationally enabled dating, tracking of children from mobile phone signals and geo tagging photos and other content based on Wi Fi hotspot "triangulation". The research firm ABI estimate that location based mobile social networking will generate global revenues of $3.3bn by 2013[8] Although some commentators were suggesting this figure to be very optimistic even before recent recession, it is clearly a significant trend.

v) Location Strategy[9]

The publication of the strategy in November 2008 was heralded as a "new dawn" for public sector geospatial policy, providing much needed direction and potential for much improved cooperation between Government departments. The definition of a set of core reference data to underpin Government decision making and support for making these available for common, widespread and unrestricted use could make a National Spatial Data Infrastructure (NSDI) achievable for the UK. The focus on capacity building through education and training is also significant.

With the lead being taken by the Department of Environment, Food and Rural Affairs (Defra) the strategy signalled that the historical dominance of Ordnance Survey in Government geospatial policy formulation would be transplanted by a more collaborative culture. Unfortunately, the timing of its publication could hardly have been worse, in the depths of the economic downturn, and the initiative is now in danger of being "strangled at birth" by withdrawal of funds by some of the major Government players.

Furthermore, the focus of the strategy on the public sector is felt by many, to have missed a huge opportunity to engage the private sector as equal partners. Had the strategy been more widely drawn, the potential to leverage commercial sector money and, more particularly, resources might have prevented it being emasculated to the extent that now seems likely.

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7) Skyhook Wireless: http://www.skyhookwireless.com/

8) ABI Research study, "Location based Mobile Social Networking", August 2008

9) Place Matters: the Location Strategy for the United Kingdom. Communities and Local Government, November 2008.

vi) INSPIRE

A major European initiative, INSPIRE[10] (INfrastructure for SPatial InfoRmation in the European community) is going to have an increasing impact particularly on public bodies (e.g. central government, devolved government, government agencies and local authorities) in all countries of the European Union over the next few years. The INSPIRE Directive, aimed at achieving greater data interoperability between member states was approved by the European Commission in May 2007. Although primarily focused on supporting environmental initiatives, it will create shared services and data specifications, relating to over thirty themes, from addresses and transport networks to buildings and demographic statistics. Implementation and compliance phases of INSPIRE will run for up to ten years from late 2009.

Although not mandatory, it is expected that most member states will use the INSPIRE Directive to advance their own National Spatial Data Infrastructures (NSDIs), including the web services and supporting datasets conforming to pan European data specifications following transposition.

vii) Regulatory Compliance

This applies most obviously in the financial services sector. Here the ongoing impact of greater regulation has resulted in large proportions of IT budgets being sunk into projects for systems auditing and integration to the detriment of more "discretionary" applications such as GIS. However, regulatory pressure has had a beneficial effect in the UK utilities geospatial market, where greater reporting requirements and penalties for poor practice have been a major stimulus for improving asset management systems.

viii) Climate Change

Visualisation is the most obvious application of geographic information within the climate change debate. However, vast amounts of information must be processed and analysed, usually on a fundamentally geographical basis to validate the science. Flood control, coastal zone management and insurance perils assessment are all applications which are growing in importance as a result of climate change. In addition, many organisations are seeking to evaluate the carbon footprint of their activities – an exercise that requires information on location and travel distances whether by staff or within the supply chain of their products.

10) European Union INSPIRE Directive http://inspire.jrc.ec.europa.eu/

4.4 Commentary

The move of Geospatial information into the mainstream of Information systems development is particularly significant for commercial software and service suppliers. For decades the "holy grail" of practitioners, its increasing reality brings a negative side effect from the perspective of specialist organisations. Once Geospatial becomes part of the enterprise Information and Communications Technology (ICT) infrastructure it becomes part of the high value integration projects with life cycle costs that make priming by a large integrator almost inevitable. The consequential "loss of control" for the GIS vendor and intermediation from the customer, largely by system integrators, is potentially very uncomfortable.

4.5 Technology Directions

As alluded to earlier, the simultaneous emergence of a number of "disruptive" technologies is having a strong impact on the geospatial industry. In this section, we examine some of the most significant directions:

ⅰ) Spatially Enabled Database Management Systems

In 2008, Microsoft launched a new version of SQL*Server incorporating for the first time core support for spatial data types. Oracle Spatial has been in the market for several years and has reached a level of maturity that it is now the default for many customers who are corporately committed to that vendor. The increasing level and complexity being added to the functionality of Oracle spatial in version 11g particularly in raster data handling, network modelling and web mapping, suggest that they are looking to provide a more complete solution especially for business applications such as logistics and demographic analysis.

ⅱ) Mass Market Visualisation Tools

Google and more recently Microsoft (with their re launched Bing offerings) have "shifted the paradigm" in terms of the expectations of both the experience of accessing spatial data and its accessibility. For geo-centric organisations, their integration into the existing enterprise systems represents a significant challenge. For geo-enabled organisations it lowers the cost of entry. Google have recently made a number of new product announcements. Perhaps the most significant is the introduction of "geotargeted" advertising, allowing website builders to embed adverts into Google map

applications which are chosen for relevance to the recent map browsing history.

iii) Software as a Service (SaaS)

This development, being embraced most significantly by Microsoft, is based upon the notion that customers may find it more cost effective to "hire" software only when they need it. Users access the software they need over the internet and pay a transaction fee each time they do so. In difficult economic conditions this is a very attractive model for public sector organisations in particular. The rapid growth in popularity of, for instance, the SaaS based IShareMaps facility, which offers public focused hosted web mapping facilities using local authorities own data, is a significant development in this respect

iv) Open Source

A number of software packages have been developed in the last few years which are licensed either at the cost of distribution or free; these are collectively referred to as open source – as the source code is available to any user to modify as they wish. Open source GIS have been available for a number of years, however, recent moves to bring together components into a more coherent package may mean that they do start to offer a viable alternative to the leading commercial packages. Certainly, the major vendors are beginning to talk more seriously at a senior level about what has been until recently the "the elephant in the room". Moves in various European countries to mandate consideration by public bodies of open source alternatives, coupled with economic pressures, will accelerate the importance of what is referred to as the OpenGeo product stack.

v) Virtual reality Gaming

The plan by Microsoft to publish 6cm resolution imagery for over 300 cities worldwide at a rate of 20-30 cities per month and the arrival of Google's StreetView are highly significant. The availability of this ultra-high resolution imagery not only "raises the stakes" in the battle between the companies for domination of the consumer mapping tools market but also opens the possibility of high resolution 3D imagery feeding a new generation of massive multi player online games. The future may well include players with heads-up displays featuring such imagery moving out of the bedrooms of "generation Y" and onto the streets.

5. Growth Trends by Industry Sector

In this section, we look at the industries that are the major users of geographic information in the UK and provide some indicators of future growth trends.

5.1 Utilities

The utilities market has been a major driver of revenues for many of the major GIS software vendors for a number of years. The majority of water companies have a comprehensive asset management system with either embedded, or closely coupled, GIS capabilities. The water and gas industries have led the way, in part due to the simplicity of their networks compared to those of the electricity supply companies.

The Ordnance Survey GB's Positional Accuracy Improvement (PAI) programme has been a major stimulus for re evaluation of existing systems in recent years. This has been coupled with regulatory pressure for better reporting of, and financial penalties linked to, key performance indicators such a power outages and water main leakage for instance. The cost penalties being imposed by Ordnance Survey (GB) on companies who do not migrate to MasterMap® from Land Line® are a further impetus for change.

Industry commentators suggest however that the current round of system (and data) upgrades may be reaching a peak. Contracts have recently been let, for instance, for new systems at Welsh Water[11] and Southern Water[12] but there appear to be fewer large prospects than in the recent past.

Although there will clearly be potential revenues additional from leveraging the asset base into other applications such as logistics and marketing, the revenues for GIS companies are unlikely to be as significant as those generated by asset management. Similarly, there is a growing market for geospatial applications to support renewable energy sources, particularly wind farms, but this is likely to be small scale whilst planning permissions remain difficult to obtain.

The big target for the software and services vendors is now to stimulate a "4th generation" technology refresh by which geospatial data becomes part of the decision making fabric of these organisations embedded in strategic planning, maintenance and other "mission critical" applications. This will require engagement at a Chief Executive level and better proof of

11) ESRI Press release
12) Autodesk Press release

return on investment than is currently available.

Overall, our assessment is that revenues from this market are close to their peak and that once the current round of upgrades is complete revenues may start to plateau. However, should the market recognise the strategic decision support capabilities of geospatial information then this may well stimulate another phase of significant investment.

5.2 Telecommunications

The use of Geospatial information for fixed line and cable network providers is long established and to a great extent mirrors the other utilities with asset management and network planning as the primary drivers. The wireless network operators have also been active in its use particularly for network planning and visualising signal coverage. Other applications such as demand forecasting and strategic marketing are likely to be increasingly important in the future.

Most of the big players in this market are global companies and it is likely that investment decisions will be made at a corporate level. With many of these companies headquartered in the UK, this will continue to give an edge to local suppliers. Consequently, we see revenue growth "pulled through" from the strength of the consumer location based services market, referred to later, as likely to continue, particularly amongst the mobile operators.

5.3 Local Government

Local Government was amongst the first to embrace GIS in the 1980s. Although per contract revenues have never reached the levels of Central Government or utilities they have been the underpinning of many organisations, particularly ESRI, MapInfo and Cadcorp. Data providers, including those specialising in aerial imagery have also been successful in providing data and services linked particularly to environmental functions. The larger system integrators have been rather slower to penetrate this market than others, possibly due to the reputation of local authorities for reticence to embrace new technology.

This market is currently beset by multiple pressures which opinion formers seem to agree will limit its growth in the next few years. The recent reorganisation of Local Government, by which the number of authorities has reduced by about 10%, will be one factor. However, the pressure on budgets resulting from the economic downturn will be particularly hard felt in ICT departments, acting to substantially curb new investment.

Recent advice from Government increasing the pressure on local authorities to evaluate open source solutions will also be significant.

We predict that revenues from this sector will not grow in real terms over the next 1-2 years and, in the view of at least one commentator, may even fall significantly.

5.4 Central Government

The market is currently suffering from a lack of direction, coupled with severe constraints on spending resulting from the same Government spending curbs that are affecting local authorities.

Investment in software in previous years has been considerable, driven by large Government programmes, for instance, the revamping of systems at Ordnance Survey to support more complex data products, planning for the 2011 population census within the Office for National Statistics (ONS) and management of agricultural subsidies in what is now Defra.

Some departments have delayed making investment decisions on GI, in anticipation of the Location Strategy and INSPIRE. However, these now appear to have been put on hold along with much other discretionary (non-essential) spending .

In Northern Ireland the reorganisation which has brought together the Valuation and Lands Agency, Rate Collection Agency, Land Registry and Ordnance Survey has yet to "bed down" and major investment decisions are likely to be delayed until this has occurred.

Our overall assessment is that whilst INSPIRE and the UK Location Strategy may well stimulate some new investment, it is not likely to result in a resurgence of large infrastructural projects which sustained the growth in this market over the last decade or so.

5.5 Defence and Intelligence

The lack of publicly available information constrains what it is prudent to comment upon in the sector. However, there is little doubt that the potential of geospatial information to aid the operations of the armed forces and intelligent services is well recognised and reflected in the importance attached to it by software suppliers and systems integrators to the sector. The creation and maintenance of a common operation picture (COP)- a single view shared by all units of the current situation, is one of the more challenging and valuable application areas. However, the embedding of geospatial technology into operational systems is also highly significant.

Whilst substantial threats remain to our national security this is a market which is likely to continue to show strong growth.

5.6 Emergency Services

The use of geospatial information within the emergency services, particularly the police has for many years been dominated by gazetteer applications supporting command and control applications. Northgate information Systems, for instance, claims that their GIS supports 90% of Police 999 calls[13] Crime mapping, popularised by the London Mayor, Boris Johnso n[14], has also had a high public profile. In addition, there are many other potential applications including situational awareness and resource planning.

It remains to be seen whether geospatial information becomes part of the "mission critical" infrastructure across all police forces and fire and ambulance services, rather than a set of disconnected tactical tools. Certainly many of the major vendors seem to be gearing up for growth in this market and we expected this effort to be converted into new sales, although probably not at the rate they would like.

5.7 Health

The new arrangements for access to digital mapping data for NHS organisations under the framework agreement procured by the NHS Information Centre were announced last year[15]. The agreement, fronted by Dotted Eyes, will offer NHS Trusts their chosen products from a basket of digital mapping data included in a fixed price schedule available over the 4 year period. This is not a collective top-slicing of funds across all organisations, as in previous agreements. However, there are positive messages about the rates of take-up being achieved, with over 100 committed by May this year.

The ubiquitous use of geospatial information within the NHS probably relies upon the success of the National Programme for IT (NPfIT) the umbrella IT programme. This programme is running behind schedule and the current plans do not, we understand, include integration of geospatial information within the core records management systems. This will limit the degree to which the data can be exploited.

Our assessment is that revenues from the health sector will remain relatively small over the

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13) Northgate public services, Criminal Justice and Public Safety overview, November 2008.
14) See website http://maps.met.police.uk
15) http://www.ic.nhs.uk/statistics and data collections/population and geography/nhs digital mapping agreement.htm

next 2-3 years.

5.8 Consumer Location-based Services

The emergence of Google and Microsoft as major players in the geospatial information market has been explosive. The revenue estimated to be generated by what we have characterised as consumer location-based services has grown from just about zero three years ago. The revenue is currently coming predominantly from advertising, although pundits believe that subscription or transactional micropayments do have potential for premium services. In addition, we believe, there is a growing licensing stream for both players as the base product becomes the default user interface for many geospatial applications.

Sales of aerial and satellite imagery, navigational and other base data that underpins these services are also benefiting, as witnessed by the growth of companies such as Blom, AND [16], who are predicting a 5 fold growth in revenues in 2009/10, and Infoterra.

This market, we predict, will be the fastest growing sector of the geospatial industry over the next few years. However, the main benefactors of the expansion are likely to be Google and Microsoft and a few close partners. Should the burgeoning position of Google in the online advertising market be sustained, it will be unsurprising if the European Union and US administrations moves to invoke anti-trust legislation to force more open competition.

5.9 Marine

The Marine Bill[17] is likely to provide impetus for a range of GI-rich applications related to the creation of marine protected areas and the need to balance conservation with demand for offshore wind farms, gravel extraction and fisheries. Increasing incidence of flooding is also necessitating increased funding for coastal zone management.

Although small in size, marine applications will become an increasingly important niche market over the coming years.

5.10 Transport

Hard economic conditions will force many businesses to re examine their supply chain

16) Automotive Navigation Data (AND) Financial Statements 2008

17) Protecting our Marine environment through the Marine Bill, Defra April 2008

costs. Sales of logistics applications, the data which underpins them and related services are likely to benefit. Government policy on road congestion, including road pricing, should it come to fruition could also become a significant source of GI related revenue.

Similarly the growth in mobile social networking and in car navigation aids is stimulating a rapid growth in revenues for data provider organisations such as Navteq and Teleatlas. The recent purchase of both organisations by global players (Nokia and Tom Tom respectively) illustrates that control of this market will be fiercely contested in the next few years.

This is a sector to watch. Strong potential growth is likely to result in the emergence of new products and software in the near term.

5.11 Financial and Insurance

The meltdown in the banking sector has already led to the rapid consolidation. The nature of the recent spate of "rescues" means that organisations will take a considerable amount of time to work through the restructuring that will be required to allow these enlarged institutions to work effectively. Clearly rationalisation of retail outlets and operations centres will be opportunities for site location and geodemographic applications. However, the financial services world also presents a number of new "fringe" opportunities for GI.

One such opportunity is the use of geospatial information in the detection of online fraud. Using locational intelligence clues such as the geography of IP addresses, transmission times and unusual spatial patterns of use, credit card companies and online retailers are increasingly looking to systems and services from organisations such as Quova[18)]

The increase in the frequency of natural disasters as a result of climate change will continue to stimulate the need in the insurance sector for risk management solutions based on geospatial information. These projects are such an integral part of the way in which insurance and re insurance companies operate, that they are likely to be part of much bigger IT re architecting programmes.

Our assessment is that this is a market sector that will grow in importance to those companies within the geospatial industry that have sufficient experience of large IT projects to be credible in a market dominated by a few global system integrators.

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18) **Using location as a weapon for fighting Fraud,** www.quova.com

5.12 Retail

This sector is one where it is very difficult to generalise in assessing prospects for growth. It can be characterised as being very wide but very thin – the geospatial data needs of the supermarkets being very different from the automotive industry. However, what is true for all parts of the sector is that the key factor in buying decisions is the credibility of the data. The nature of the data required is changing, increasing volumes of consumer purchases are online and the population is becoming more transient, new models to analyse these new data sources are also required.

Larger companies still tend to use retained specialists analysis companies, who provide regular updates to their own specialised metrics supplemented by special assessments in areas of particular potential for growth. These companies make their own choice of GIS tools and adapt/extend the in built models for market analysis, site selection and territory management. Web based facilities which enable customers to upload their own data and run pre defined models have recently enabled small and medium size businesses to gain access to geospatial information without the need for purchasing systems and building internal expertise. This is perhaps one area where Software as a Service (SaaS) is gaining some traction.

The picture for the next two years is likely to be one of limited growth, probably concentrated on more medium size enterprises using shared data/modelling systems online. However, rationalisation of store networks as a result of the recession may provide one area of increased opportunity.

5.13 Land and Property

The creation of the National Land Information Service (NLIS) based on improving the efficiency of the conveyancing market has led to the formation of a new generation of web-based land and property data "aggregators", most notable being perhaps Searchflow (now owned by Macdonald Dettwiler Associates Ltd) and Landmark (owned by the Daily Mail group). Figures from Land Registry[19] show that revenues attributable to the ownership component alone showed a rise to £4.2m in 2007/8.

The implosion of the housing market in the last 12 months suggests that the good times have at least temporarily gone for these companies. However, the UK population profile

19) Land Registry Annual report 2007/8.

and social trends, as pointed out, will require substantial quantities of new homes in the next 10 years, so the market is expected to revive.

5.14 Construction

The construction sector continues to be depressed. The Royal Institution of Chartered Surveyors (RICS) recently reported[20] that "pprivate industrial and private commercial workloads continued to fall at pretty much the same rapid pace as in the previous quarter. Meanwhile, declines in infrastructure workloads accelerated and public non housing workloads resumed their decline having increased in the previous quarter."

Housing is also at a historical low point. The latest available statistics show annual housing starts figures continued to decline. They totalled 90,430 in 2008 09, down 42 per cent compared with 2007 08 and 51 per cent below their 2005 06 peak[21]. Despite this, new reporting regulations for housing associations, resulting from the Housing and Regeneration Act 2008, will generate some small increase in demand for systems that link asset management and GIS.

The concept of digital cities, merging photo realistic 3D models of cityscapes, with utilities network data and Computer Aided Design drawings, will become of increasing importance for big public and private projects. This will have beneficial effects, particularly for those software vendors and service companies with well developed capabilities of integration of geospatial and design data, such as Autodesk and Bentley.

The 2012 summer Olympic and Paralympic games in London are generating the need for a wide range of specialised applications. These will include systems that integrate geospatial information into CAD for the Olympic venues, transport modelling and security systems. There will also be a demand for geospatial skills within the services teams that build and run these applications. The CLG consortium[22], who are the prime sub contractor to the Olympic Development Authority are likely to be the main beneficiaries. However, many other organisations will be needed to make this vast project a reality, so this is likely to be a major generator of new business within this sector peaking within the next two years.

Overall, with Government finances struggling to fund new public projects, a general lack of consumer confidence and restrictions on loan availability affecting the house prices, we

20) RICS UK Construction Market Survey Q1 2009

21) Office of National Statistics House Building Survey http://www.communities.gov.uk/publications/corporate/statistics/housebuildingq12009

22) CLM – a consortium of Laing O'Rourke, MACE and CH2M HILL

assess this as a difficult market for the next few years, with the exception of the projects linked to the 2012 Olympics.

6. Conclusions

Future growth prospects are clearly highly dependent upon the overall prospects for the economy.

Nevertheless, we believe the analysis is sound and the relative performance of various industries is likely to reflect our predictions. What it shows is that the future prospects are very much market dependent.

In the next 2-3 years, we can expect that:

- The traditional engines of local and central Government are unlikely to grow in real terms and may even go into reverse;
- The utilities markets is going through a welcome "spike" of activity driven by the need to replace outdated technology and regulatory pressure but may not be sustained;
- Commercial markets, particularly transport and insurance, still have considerable potential provided that individual projects can demonstrate a strong short term Return on Investment.
- Construction, and land and property, may, in the medium to longer term recover, but the collapse in the housing market will make this market very tough in the near term.
- The strongest area of growth will be in consumer Location based services but it is likely to benefit only a relatively small number of big players and some innovative start-ups.

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Innovation to Commercializion

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Introduction

The Ontario Centres of Excellence is the pre eminent research to commercialization vehicle in Ontario. OCE takes ideas to income. Created in response to Ontario's most critical competitive challenges, OCE facilitates economic growth through support for industrially relevant R&D, the opening of new market opportunities and the commercialization of leading edge discovery. OCE build strong industry and academic relationships and stimulates knowledge transfer through the development of bright minds, moving their skills to the market. OCE develops its program as follows:

- Partnerships,
- Trust and Respect,
- Flexibility and Agility,
- Risk taking,
- Accountability, and
- Positive Work Environment.

OCE has been accelerating the commercialization of innovation since 1987. It has evolved a great deal over that time, while never losing sight of its primary function: to drive economic prosperity and growth for Ontario. OCE is the matchmakers between industry and Ontario's cutting edge researchers. And the matches it makes have the power to revolutionize Ontario businesses.

Programs

OCE's programs in Research, Commercialization and Talent focus on sectors and technologies key to the province's economic strength and future vitality. The OCE team

brings a unique combination of scientific, business and entrepreneurial expertise to the commercialization process. With the foresight to identify the research that promises next and the insight to accelerate the process of delivering next, it charts the path from idea to income. OCE helps organizations find the people and resources needed to get from here to next faster – and make Ontario more competitive along the way.

OCE's Research Program is focused on meeting the competitive needs of Ontario industry by tapping into the remarkable potential for Ontario colleges, universities and hospitals to act as generators of innovation. The Program invests to ensure that scientific excellence and commercial viability converge to drive Ontario's productivity and global competitiveness. The Program consists of four targeted initiatives:

- Interact: Research collaborations that create new industry academic relationships.
- Proof of Concept: Feasibility studies that test an idea to mitigate the risk of further research investments.
- Champions of Innovation: Research projects that develop disruptive technologies with the potential to create new markets and form the basis for new start up companies.
- Collaborative Research: Research collaborations between industry and academia that move technologies from the lab to the marketplace.

The OCE Commercialization program addresses the "innovation gap" between valuable research results and the new, marketable products and services that drive economic growth. It consists of three initiatives:

- Market Readiness: Prepares entrepreneurs and their technologies for the market by investing in a range of activities, including market analysis, technology validation and business plan development.
- Investment Accelerator Fund: The Investment Accelerator Fund (IAF) helps high potential Ontario technology companies by providing early stage investment of up to $500K.
- Martin Walmsley Fellowship for Technological Entrepreneurship: Supports a researcher creating a new technology based start up company.

The OCE Talent program generates the next generation innovators and entrepreneurs. It consists of five initiatives that support innovators at various stages of their development:

- Connections: Supports research collaboration between final year undergraduate students and companies – creating an early opportunity to conduct industry relevant research.
- International Scholarships: Gives student researchers opportunities to work with international leaders in their field.
- Professional Outreach Awards: Supports opportunities available to students who want to be further involved in the conference they are attending through such activities as chairing a session or volunteering to be a member of an organizing body for a conference and tradeshow.
- Value Added Personnel (VAP): Helps student researchers develop essential skills to complement their technical expertise.
- First Job: Makes it possible for companies to hire young researchers with significant academic experience and potential.

OCE Consists of Six Individual Centres

Centre of Excellence for Earth and Environmental Technologies

The Centre of Excellence for Earth and Environmental Technologies helps Ontario organizations compete by adopting innovative, environmentally responsible solutions. The Centre facilitates the development and execution of R&D that drives commercially viable outcomes contributing to clean air, water, land, and smart infrastructures. In this role, the objective is to enhance the capacity of organizations engaged in developing and maintaining the natural and built environment to innovate and commercialize technologies for global competitive advantage.

The Centre works with industry to solve problems, engaging the brightest minds at Ontario's universities and colleges in the medium term challenges faced by businesses. It co invests in the research and development of leading edge, industrially relevant technologies. It develops the team – partners and resources – required to deliver innovative solutions, including the recent graduates and young innovators who make organizations more competitive.

Innovation and commercialization services, offered in partnership with Ontario's university and college community, help to:

- Clarify innovation plans plans and medium term challenges
- Assemble partners and resources to develop solutions
- Build collaborative R&D teams to develop technology
- Access early stage commercialization support
- Engage students as future employees to build your organization

The Centre of Excellence for Earth and Environmental Technologies engages firms, clients, and academic partners in the following market driven strategic business units:

- Sustainable Agriculture
- Clean Water Technologies
- Waste Management
- Clean Air Technologies
- Resource Management
- Sustainable Infrastructure

Centre of Excellence for Energy

The Centre of Excellence for Energy was created in response to the significant challenges and opportunities posed by the current energy situation in Ontario. The Centre invests in and promotes cutting edge research collaborations between industry and colleges, universities and research hospitals. In this way, it fosters innovation in energy markets, systems and technologies.

The Centre works with industry to solve problems by engaging the brightest minds at Ontario's universities and colleges in the challenges faced by businesses. It co invests in the research and development of competitive, industrially relevant technologies. The goal is to bring these ideas to the market place in order to provide Ontarians with viable, affordable long term energy supplies while improving our net impacts on the environment and in the process, helping build a strong, competitive energy sector in the province.

The Centre is focused on energy issues aligned with industry interests. The areas of focus are:

- Energy Markets: The study of supply and demand balance, energy pricing, energy conservation and efficiency, demand management and consumer behaviour.
- Energy Systems: The study, development and demonstration of integrated networks for energy transmission, distribution and use.

- Emerging Energy Technologies: Research, development and demonstration of innovative energy technologies.
- Skills Development: The support, development and placement of the next generation of energy innovators.

Centre of Excellence for Communications and Information Technology

The Centre of Excellence for Communications and Information Technology is focused on fostering innovation in this vital area for Ontario's prosperity. The Centre works with industry to solve problems, engaging the brightest minds at Ontario's universities and colleges in the challenges faced by businesses. It does this by co investing in the research and development of leading edge, industrially relevant, technologies - and moving the results into the marketplace, through existing companies or new, spin off enterprises. The Centre of Excellence for Communications and Information Technology offers a wealth of expertise and experience. The Centre's solid track record of commercialization success has earned the trust of academic partners, industry and government, and venture capital and angel investors. Integrated with this offering is its role as a catalyst for next generation talent, connecting businesses with the people who bring competitive edge.

Communications and information technologies touch a vast array of applications. The Centre of Excellence for Communications and Information Technology invests in research that has potential impact in areas as diverse as:

- Wireless and wire line communications
- The Internet and packet switched networks
- Images, audio/video and graphics
- Human computer interaction
- Computer hardware, devices and semiconductors
- Information storage, management and retrieval
- Health and medicine
- Software design, development and management
- Network planning and administration
- Education and learning
- Security

Centre of Excellence for Materials and Manufacturing

The materials and manufacturing sector in Ontario directly employs more than one million people. Canada's largest business sector, manufacturing, accounts for 18 per cent of all economic activity in the country. The Centre of Excellence for Materials and Manufacturing addresses the future of the sector through investment in research partnerships that increase the competitiveness and productivity of Ontario businesses.

The Centre works with industry to solve problems by co investing in the research and development of competitive edge, industrially relevant technologies. The Centre engages the brightest minds at Ontario's universities and colleges in the challenges faced by businesses. It assembles the partners and resources required to deliver innovative solutions – including recent graduates and young innovators – to make organizations more competitive. Its R&D portfolio is driven by the needs of Ontario industry, especially those where the economic impact of technology and knowledge will be the greatest.

The Centre offers:

- Access to post secondary research capabilities including facilities, equipment, personnel and experienced research teams
- An interactive network of industry and academic participants
- Creative students trained in leading edge knowledge and technology areas
- Opportunities to participate in a broad range of research initiatives including consortia and collaborative projects
- Extensive intellectual property and project management expertise
- Technology and know how for commercialization and licensing
- The ability to access and attract other partners and resources

Centre of Excellence for Photonics

The Centre of Excellence for Photonics helps Ontario firms and organizations grow by finding innovative solutions for their challenges. Having everything to do with light, Photonics is a strategic technology that is making a significant impact on all industrial and healthcare sectors – sectors critically important to Ontario's economy and prosperity. The Centre supports the creation of new photonics knowledge and technology, fosters the supply of highly qualified people at all levels, enhances applications and commercialization, and establishes regional and international collaborations.

The Centre works with industry to solve problems, engaging the brightest minds at Ontario's universities and colleges in the challenges faced by businesses. We do this by co investing in the research and development of leading edge, industrially relevant technologies.

A foundation technology, photonics is found in everything from new medical treatments to the common CD player. Key application areas include:

- Medicine-including innovative imaging technologies that offer an unprecedented view into living tissues and new minimally invasive therapies that use lasers, or other energy sources, to destroy diseased tissue without the need for major surgery.
- Optical communications, processing and sensing-already light is used to transfer data across networks at high speed. Ongoing research is discovering ways to tap into photonic capabilities to better transfer, store and process information--at the speed of light.
- Materials technology-photonic technologies can be used to induce chemical reactions and manipulate matter to create useful materials. Laser micromachining also allows materials to be shaped and manipulated at the micro scale and can be used in the growing microelectromechanical systems (MEMS) field.

The Centre of Excellence for Photonics is a knowledge, partnership and commercialization portal for the research and development of photonic technologies. Strengthening the capability of Ontario industry through its support of regional photonics clusters, it advances and promotes the province as a global hub of photonic innovation.

Centre for Commercialization of Research (CCR)

The goal of the Centre for Commercialization of Research (CCR) is to generate economic benefits for Canada through the successful commercialization of technologies originating in Canadian universities, colleges and research hospitals.

By providing a focal point for OCE's commercialization efforts, CCR complements and extends existing research, talent and commercialization programs to cover the innovation continuum from initial research idea to market success. The Centre better enables OCE to directly support companies. It builds on OCE's 20 years of success supporting collaboration, innovation and entrepreneurship. Given its national scope, CCR develops partnerships with organizations throughout Canada and around the world.

CCR's primary focus is on economically crucial areas such as energy; the environment and natural resources; health and related life sciences; and digital media. In these growing fields of convergent technologies, the Centre is a vehicle to pull together multidisciplinary strengths with a keen eye on market opportunities. Established in 2008, CCR is funded by the Government of Canada through the Networks of Centres of Excellence.

CCR, in collaboration with OCE's other Centres of Excellence, works with companies whose latest Canadian research can spell business opportunity. Clients range from recently established companies, through developing companies, to mature companies looking for a competitive edge. CCR focuses on the business aspects of commercialization, working closely with its clients to ensure they have what they need to prosper at all stages of the commercialization cycle.

Companies can access OCE's own commercialization programs, as well as the capabilities of partner organizations across Canada. In particular, CCR is establishing strong ties to Canada's investment community. New services will ensure businesses have access to a comprehensive suite of resources and expertise. Through OCE's network, the Centre can help companies build relationships in the research community and deliver a continuous stream of talent and new ideas to support growth.

CCR is developing partnerships with Canadian research, business and investment organizations. Currently, fourteen partnerships have been established-including IBM Canada, OMERS, and the Waterloo Accelerator Centre-and CCR is developing more.

CCR is also expanding its international partnerships to tap into worldwide knowledge and talent, and to open up foreign market opportunities for products based on Canadian technologies. A key partnership in this area is with International Science and Technology Partnerships Canada.

The Innovation Ecosystem

OCE focuses its research using various means such as:

- Discovery Workshops
- Technology Transfer Workshops
- Conferences and Symposiums
- Meetings with Industry

- Strategic Calls for Proposal Applications
- Follow on Research
- Cold calls/cold responses
- Responses to Academic interests

From this process the focus is developed. For example, a focus was developed around geo based for inventory management. A number of projects were developed looking at various aspects of this problem. What resulted from this process was a very broad capability to innovate around the forest inventory focus common focus with companies that build sensors, platforms, develop software, develop and build navigation systems, develop additional applications to support the prime focus, develop alternatives approaches and provide services and operations. These companies can then broaden their scope and get involved in other applications. The result is the development of an Innovation Ecosystem.

The innovation ecosystem is the engine developed from one research need expanded to engage other and new research need. It leads to the development of a critical mass of new and innovative companies that can take on expanded opportunities and market.

Example Success Stories

A few success stories that showcase OCE at work developing Innovation Ecosystems follow.

Technology for 3D Internet Visualization

Born at York University and brought to the marketplace with help from the Ontario Centres of Excellence Accelerator Investment Program, technology for 3D Internet visualization is now becoming part of the MSN experience at Microsoft.

OCE is one of the few publicly funded institutions that build the bridges from university research to the marketplace. OCE helps provide what is needed for innovative science and technology to be transformed into profitable new businesses. Its Accelerator Investment Program is designed to accelerate the transition of research in Ontario's universities and colleges into viable business opportunities. It provides investment and support for academic researchers looking to commercialize their research results, and enables venture capitalists and other investors to access new innovation based companies that are primed for further

investment and growth.

"The research by my team at York University in 3D geospatial visualization and modelling became the Toronto based GeoTango company with help from OCE, Geomatics for Informed Decisions (GEOIDE) Network, and GEOIDE's Market Development Fund," says Dr. Vincent Tao of the University's Geospatial Information and Communications Technology Lab. "Once established, we caught the attention of Microsoft, and GeoTango was acquired by the corporation in December of 2005."

GeoTango is now a subsidiary of Microsoft Corporation. It is the developer of GlobeView™, an internet 3D visualization technology that allows online users to interactively explore the world in three dimensions. It also has created SilverEye™, the only software in the world for rapid 3D modeling and analysis using single satellite images or aerial photos.

GeoTango clients include organizations and agencies in defence, intelligence, homeland security, visualization and simulation, emergency response, telecommunications, municipalities, health, media, utilities and energy, and the United Nations. With its assets and expertise, GeoTango gives MSN the ability to deliver its experience in areas ranging from rich real world visualization to location centric community content. The product suite is being integrated into MSN's product and service offerings. "MSN will now be able to create immersive mapping and a local search framework that allows users to easily find, explore and share information and content anywhere on earth," says Dr. Tao. "This acquisition is an important milestone in the Canadian geomatics industry and has propelled our technology into the vanguard of geospatial innovations worldwide." It is a major career accomplishment, but also an example of what can happen when research and innovative ideas have the support they need to take the next steps toward commercialization.

Tiny Satellites for Earth Observation and Space Technology and Science

For some students at the University of Toronto's Institute for Aerospace Studies, getting a Master's degree is a lot more than classrooms and a thesis. For some, it is spending two years building a tiny satellite and launching it into space. With assistance from the Ontario Centres of Excellence's Centre for Earth and Environmental Technologies, the UTIAS Space Flight Laboratories are not only training a new generation of space specialists, they are breaking ground in the field of small and ultra small satellites that explore the solar system. Bringing together the people and institutions that create the ideas with those who help move them to reality is the essence of Ontario's competitiveness and innovation, and the partnerships behind UTIAS are a tribute to that spirit.

It was OCE support, in conjunction with the Ontario Challenge Fund that helped build the Space Flight Laboratories. The first Canadian Advanced Nanospace experiment (CanX) program was established in 2001, and the first CanX 1 satellite was launched in 2003. "We have had assistance from OCE with more than funding," says Dr. Zee. "They have helped with developing new proposals, and with ideas and expertise in marketing our facility." Ontario Centres of Excellence is one of the few publicly funded institutions that make connections from university research to marketplace. It helps make sure that innovative science and technology can have what is needed to become profitable new businesses. In the case of the Space Flight Laboratories, OCE helps to foster the relationships among university research, the innovation of new technologies and the training of a new generation of specialists who will move Ontario forward as a competitive entity in businesses that serve space exploration, space technology and earth observation.

CanX 1 helped demonstrate technologies in imaging of the earth, moon and stars, conducted experiments in star horizon tracking, and demonstrated global positioning satellites from space. It was built by a student led team with mentoring from staff. The next generations of CanX are allowing rapid access to space and carrying science payloads from research being conducted at the University of Calgary, York University, the University of Toronto and Carleton University.

The success for UTIAS came in November of 2005 when it launched its custom nanosatellite ejection system called the T POD v1.7 that deployed three 10 centimetre cube satellites from the Student Space Exploration and Technology Initiative (SSETI) Express microsatellite. SSETI Express is an educational satellite built by over 100 students across Europe under the mentoring of the European Space Agency. Dr. Zee says it was the UTIAS experience with nanosatellites that led them to think of using one ejection system per satellite – an innovation based on the years of work at the Ontario laboratory.

Ontario companies are benefiting from the research as well, feeding work at Dynacon Inc., MacDonald, Dettwiler and Associates Inc. (MDA) and ComDev Ltd. With the vision of Dr. Zee, the engagement of graduate students, assistance with the dream by OCE and partnerships with public and private agencies, the UTIAS Space Flight Laboratory is feeding innovation both on earth and with the stars.

Hydroponic Soil

There are some rather amazing and delicious sweet orange peppers they still talk about from a greenhouse demonstration project at the University of Guelph – not just because

they tasted so good but because they were grown in a new kind of hydroponic “soil” that will meet an important need for greenhouse operators in Ontario and Canada.

The growth medium was developed by SRI Petro Chemical with research supported by the Ontario Centres of Excellence (OCE). OCE is one of the few publicly funded institutions that build the bridges from university research to the marketplace. OCE helps provide what is needed for innovative science and technology to be transformed into profitable new businesses. Greenhouse production represents a $3 billion industry for growing food and ornamentals in Ontario, and hydroponic techniques are an important tool for growers.

The traditional “soil” in hydroponic productions systems has been Rockwool, but some of the problems with this medium are that it is costly to recycle and is undesirable as landfill. SRI Petro Chemical has developed a cellulose based material that can be re used several times and then recycled using conventional recycling technology. "Our product could easily reduce grower costs, reduce freight by 50% and reduce landfill of Rockwool by 1100 truckloads per year,” says SRI Petro Chemical President George Scott. “In addition, it can reduce the occupational health and safety issues for greenhouse employees working with the current fibre format."

In order to verify its new product, SRI Petro Chemical was introduced by OCE to researchers at the University of Guelph. Dr. Mike Dixon, Dr. Youbin Zheng and Masters of Science student Jeff Huber supervised the testing of the cellulose product under accepted testing protocols and proper comparison to the Rockwool product. The research verified, in a greenhouse setting, that the product met its claims. The Guelph SRI partnership has been a good one for student Jeff Huber. A recipient of the Ontario Centres of Excellence First Job Fellowship, Jeff is now employed by SRI as their Field Scientist and will be providing customer support in the changeover to the new growth media. Along the way he will document case studies on each new customer to provide needed commercial documentation for marketing into “We have a product that costs less at both the front and back end uses," says Mr. Scott. "We know our testing on growing cucumbers and tomatoes will be just as good, and feel that many greenhouse growers in Ontario and Canada will be pleased with the results." This product will also assist greenhouse growers in their efforts to comply with nutrient management legislation.

The collaboration has now led to the development of wireless technology within the greenhouse structure and the micro geopositioning of plants. This will lead to the application of plant systems in large building e.g. 50 story complexes that are self contained

with respect to air quality, waste elimination, water management etc all managed remotely from a central facility within the complex.

Summary

These three examples started out as separate projects. GeoTango was concerned with the application of geomatics using the Internet. The Tiny Satellites came from and Earth Observation focus. The Hydroponic Soil came from a focus in Greenhouse technology. Each contains an element of geomatics in its application. Each project collaboration, contributed to the geomatics innovation ecosystem and has taken companies to expanded heights in terms of market access and new products.

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