

# A Study on the National Spatial Data Infrastructure of U.S.A.

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## Abstract

By the rapid development of Information Communication Technology (ICT) and Geo-spatial Technology (GT) and the increased usage of spatial data for planning and infrastructure management, the National Geographic Information System (NGIS) for more efficient and effective utilization of spatial information has been developed by the central government in Korea since 1995. NGIS is the base of Spatial Data Infrastructure (SDI). SDI is developed as one of National Information Infrastructures (NII). Among the hierarchy of SDI, National Spatial Data Infrastructure (NSDI) has very important role in the success of SDI development. Many research articles show that the USA's NSDI initiatives, development strategy have been strongly influenced all over the world. In these viewpoints, to propose the future directions of Korean NGIS, the development of NSDI strategy of USA is reviewed by literature through published book and internet resources. The conclusions of this study are as follow: 1) top-down and bottom-up approach are needed for integrated data sharing and standardization. 2) the creative and evolutionary vision and strategy has to be suggested. 3) the training program and lecture material has to be developed and diffused to the users and providers of spatial data. 4) governance system has to be built for NSDI evaluation. 5) the formation of geo-spatial forum to discuss the spatial-related problems and make research agenda, etc.

Keywords : NII, SDI, NSDI, NGIS, Geospatial Line of Business

## 1. Introduction

The geo-spatial data is essential information for urban and regional management and planning, infrastructure management, car navigation, etc. By the rapid development of Information Communication Technology (ICT) and Geo-spatial Technology (GT) and the increased usage of spatial data, many countries are trying to construct National Spatial Data Infrastructure (NSDI) as National Information Infrastructure (NII). The purpose of this study is to propose the future Korean NGIS strategy by reviewing the advanced and leading USA NSDI strategy. Longley, et. al. (2005, 450) use the USA example as a case study since this was probably the earliest coherent scheme and it has influenced many other countries. The framework of this study is based on the historical review of NSDI vision and strategy, implementation and research, etc.

In Korea, Chung and Kim (2003) introduce the concept, model and strategies of NSDI to re-establish the role of central government and draw new policy

directions of NGIS projects. Kim (2005) suggests the strategies for the future Korean NGIS in terms of 6 NSDI components: data, access and metadata, standard, technology, partnership, and law/regulations and institutional policy. Each component is analyzed in the perspective of integration, interoperability and intelligence.

Tosta (1999) who was the one of the key players contributed to the formative stages of NSDI, suggests U.S.A. was one of the first countries to engage in NSDI development for its spatial data community. After the initial NSDI strategy was introduced in 1994 and implemented, FGDC (1997, 2004b) revised it twice and many researchers try to assess the NSDI (Kok and van Loenen, 2005). NAPA (1998) and MSC (2001) also contribute to build the new strategy. NCGIA (2001) evaluates of NSDI Grants Program. NSDI has been re-examined in Congress by the Committee on Government Reform. The increased focus on Homeland Security after 9/11 is also forcing a re-think of some aspects of NSDI (Longley, et. al., 2005, 456). GAO (2004) responds to the congressional requestors. E-Gov (2006) makes a Geospatial

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Line of Business (LoB) to establish a new and more citizen- centric collaborative model for geospatial- related activities and investments. Longley, et. al. (2005, 458) suggest the great success of NSDI has been as a catalyst, acting as a policy focus, publicizing the importance of geographic information, and focusing attention on the benefit of collaboration. Rajabifard et. al. (2002 and 2003) evaluate the new strategy is moving from the product-based to a process-based approach to SDI development in order to neutralize difficulties arising from existing approaches. Also it was considered as second generation of NSDI initiatives.

Wytzisk and Sliwinski (2004) propose a user-centric and evolution-oriented understanding of SDI as an alternative approach to contemporary SDI definitions.

Also the NSDI-related research activities are reviewed to suggest the future research areas. To analyse the characteristics of NSDI and set the implications to Korean NGIS strategy, FGDC's strategy NSDI and research articles will be reviewed in the following chapters.

## 2. Historical Background

The relatively easy and inexpensive availability of

federal government data in the USA has its origins in the formation of democracy. Thomas Jefferson believed that it was the government's responsibility to make all information about the activities of government available to the people such that they might correct any perceived wrongs of government. The public's right to know and their right of access to information is reinforced with the belief that public has paid, through taxes, for the collection of government information. The president's OMB has reinforced the beliefs of Jefferson by issuing a Circular that established federal policy mandating that federal agencies provide access to their information (Tosta, 1999, 13).

The Circular A-16 was originally issued in 1953, revised in 1967, and revised again in 1990 by the Bureau of the Budget (now the OMB). The original Circular references Executive Order No. 9094, dated March 10, 1942. Federal Board of Surveys and Maps is established by Executive Order No. 3206, dated December 30, 1919. Executive Order No. 3206 superseded an Executive Order, dated August 10, 1906. The major characteristics of Circulars are as Table 1.

The FGDC is an interagency committee responsible for facilitating Circular A-16 related activities and implemen-

Table 1. Circular A-16's History

Year	Circular's major characteristics
1906	Executive Order (dated August 10, 1906) - to review mapping projects to avoid duplication and to facilitate standardized mapping.
1919	Executive Order No. 3206 - to make recommendations to agencies and to the President regarding the coordination of all governmental map making and surveying.
1942	Executive Order No. 9094 - to coordinate and promote the improvement of surveying and mapping activities of the Government.
1953	Original Circular No. A-16 - to insure that surveying and mapping activities may be directed toward meeting the needs of federal and state agencies and the general public, and will be performed expeditiously, without duplication of effort.
1967	Revised Circular A-16 - the addition of a new section on Responsibility for Coordination. - providing a guide for the development of annual programs of the individual agencies and, through the Exhibits, established extensive reporting requirements.
1990	Second Revised Circular A-16 - to include not only surveying and mapping, but also the related spatial data activities. - Specifically, it included geographically referenced computer-readable (digital) data. - In addition, the Exhibits are no longer referenced and a short reporting requirements section is added.
2002	Updated Circular A-16 - to reflect the changes that have taken place in geographic information management and technology, and to clearly define agency and FGDC responsibilities. - displays an integrated infrastructure system approach to support multiple government services and electronic government.

Source: [http://www.whitehouse.gov/omb/circulars/a016/a016\\_rev.html](http://www.whitehouse.gov/omb/circulars/a016/a016_rev.html). Appendix C. History and background of Circular A-16

tation of the NSDI. FGDC (2004a) has the long history as Table 2<sup>1)</sup>.

In 2005, the USGS created the National Geospatial Programs Office (NGPO) to consolidate national geospatial programs. NGPO organizationally housed in the Geospatial Information Office (GIO). With the creation of the NGPO, the essential components to implement the NSDI

will be managed as a unified portfolio that benefits the entire geospatial community (Siderelis, et. al., 2005, 7).

Many NSDI-related researches are conducted by Mapping Science Committee (MSC), and they are reflected to the FGDC's Strategy. Table 3 shows the relationship between research and strategy<sup>2)</sup> chronically.

### 3. NSDI

#### 3.1 Definition and Vision

Discussions about the NSDI in the USA began in the late 1980's, primarily in the academic community, although federal agencies had also begun to use the term by 1989 (MSC, 1993). In the MSC's report Spatial Data Needs, NSDI appeared several times, its meaning clarified only by context (MSC, 1993, 10).

In the US, geographic data collection is a multibillion-dollar business. The problems was stated by FGDC (1994) are data duplication, data sharing difficulties, public access and lack of metadata. The creation of NSDI is urged by 1994 MSC report. There are four critical principles that need to guide the development of the NSDI: availability, ease of use, flexibility, and a foundation for other activities (MSC, 1993, 112).

US Executive Order 12906<sup>3)</sup> signed by President

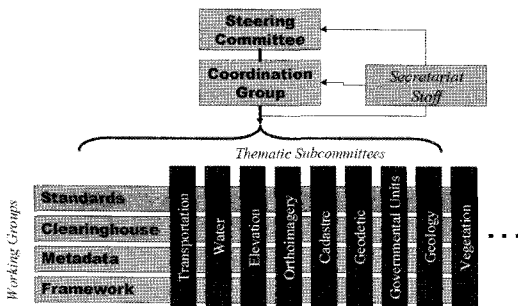


Fig. 1. FGDC Committee

Table 2. History of FGDC

Year	Agency
1973	Federal Mapping Task Force
1983	Federal Interagency Coordinating Committee on Digital Cartography (FICCDC)
1990	Federal Geographic Data Committee (FGDC)

Table 3. NSDI-related Research and Strategy

Year	MSC's Research Title	FGDC's Strategy
1990	Spatial Data Need: The Future of the National Mapping Program	-
1993	Toward a Coordinated Spatial Data Infra- structure for the Nation	-
1994	Promoting the National Spatial Data Infrastructure through Partnerships	The 1994 Plan for the National Spatial Data Infrastructure: Building the Foundations of an Information Based Society
1995	A Data Foundation for the National Spatial Data Infrastructure	-
1997	-	A Strategy for the National Spatial Data Infrastructure
2001	National Spatial Data Infrastructure Partnership Programs: Rethinking the Focus	-
2003	Weaving a National Map	-
2004	-	NSDI Future Directions Initiative: Towards a National Geospatial Strategy and Implementation Plan,

1) <http://www.fgdc.gov/library/whitepapers-reports/white-papers/fgdc-history>

2) <http://www.fgdc.gov/policyandplanning/nsdi-strategic-plans/>

3) <http://www.archives.gov/federal-register/executiveorders/pdf/12906.pdf>

Clinton in April 11, 1994 defines the NSDI as “the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data”. This document called for the establishment of a coordinated NSDI to support public and private sector applications geospatial data in such area as transportation, community development, agriculture, emergency response, environmental management and information infrastructure (Clinton, 1994).

MSC (1993, 113)’s early components of the NSDI include the data bases (and metadata) and their sources, the spatial data networks and their users, the technology, the institutional arrangements, and the policies and standards required to coordinate all of the various parts

The latest six basic components of the NSDI are metadata, clearinghouse, standards, framework, geospatial data, and partnerships (Fig. 2). Each of these components serves as a cornerstone in establishing consistency and structure when it comes to documenting spatial data for everyday applications, as well as in building a distributed network of producers and users that facilitate data sharing.

According to the 1994 plan for NSDI (FGDC, 1994), NSDI has the vision, “Current and accurate geospatial data will be readily available to contribute locally, nationally, and globally to economic growth, environmental quality and stability, and social progress”. A Strategy for the NSDI of 1997 is the revision of the 1994 plan to implement and advance the NSDI. The vision remains the same. The goals of strategy focused on public outreach, standardization of procedures, developing a national geospatial data clearinghouse and building

institutional relationships to create a community of data-sharing stakeholders.

In OMB’s revised Circular A-16<sup>4)</sup>, the NSDI “assures that spatial data from multiple sources (federal, state, local, and tribal governments, academia, and the private sector) are available and easily integrated to enhance the understanding of our physical and cultural world.”

To craft a national geospatial strategy and implementation plan to further the development of the NSDI, the NSDI Future Directions Initiative Report (FGDC, 2004b) was submitted by the NSDI Future Directions Planning Team (FGDC, 2004).

Beginning as a conceptual construct, the NSDI has evolved into a complementary set of actions implemented by a range of programs dealing with geospatial data and application activities. These programs are managed by government agencies participating in the NSDI and dedicated to achieving the goals of the NSDI as defined in OMB Circular A-16. The FGDC, Geospatial One-Stop (GOS), and The National Map (TNM) are three examples of separate but interrelated activities, contributing to the development of the NSDI (FGDC, 2004, 4).

NSDI concepts have had a wide influence around the world on Spatial Data Infrastructure (SDI) developments (Craglia and Masser, 1998).

### 3.2 NSDI evolution

Tosta (1999, 20) summarized the progress of NSDI, the NSDI has served to raise the visibility of geospatial data and the potential need for and value of data sharing. This has been the result primarily of high-level political endorsement and availability of funding to encourage data partnerships. The technological and institutional changes that will both hinder and help evolution of the NSDI are likely to be dramatic. Productive evolution of the NSDI must be consider the following real-world changes, such as the easy- access-to-Internet data world, Open GIS Consortium, Private sector. She suggest the key strategies needed to evolve the NSDI further as Table 4.

As a result of the difficulties in developing NSDI in the USA, at the end of 1999 the FGDC started to develop

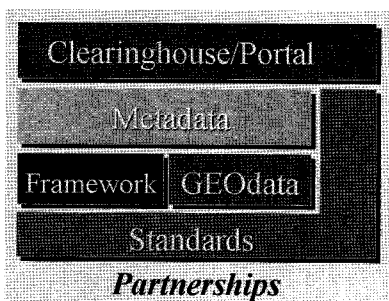


Fig. 2. The Components of NSDI

4) [http://www.whitehouse.gov/omb/circulars/a016/a016\\_rev.html](http://www.whitehouse.gov/omb/circulars/a016/a016_rev.html)

a new GeoData Organizational initiative for the geo-spatial data community. This new strategy appears to show that the FGDC moving from a product-based to a process-based model of SDI development in order to neutralize difficulties arising from existing models (Rajabifard et. al., 2003, 103). For the first generation, data was the key driver for SDI development and focus of initiative development. However, for the second generation, the use of that data (and data application)

and the need of users are the driving force for SDI development. One of the important outcomes of the first generation has been the inclusion of people. This has resulted in a shift to a socio-technical viewpoint in the second generation from the first generation, which had a more techno-centric position (Fig. 3, Rajabifard et. al., 2003, 104).

There are many similarities and differences between the first and second generations of SDI development (Table 5). It will make possible to facilitates awareness of future directions to improve participation and design

Table 4. Key Strategies needed to evolve the NSDI

No	Strategies
1	Political opportunities should always be seized
2	A primary goal should be established and it should be to improve access to data
3	To improve data access, bureaucracy and central control should be minimized
4	Technology changes and accompanying organizational changes should be tracked and taken advantage of.
5	Evolution should be anticipated

Source: Tosta (1999, 23)

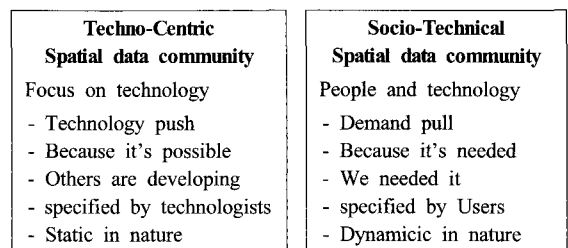


Fig. 3. From a Techno-Centric Position to a Socio-Technical Position

Table 5. Similarities and Differences Between First and Second Generations of SDI Development

Similarities & Differences	First Generation	Second Generation
Nature	Explicitly National	Explicitly National within the hierarchical context and therefore more flexible for cross jurisdictional collaboration
Development motivation	Integration of Existing Data	Establishing the Linkage between People and Data
Expected Outcomes	Linkage into a Seamless Database	Knowledge Infrastructures, Interoperable Data and Resources
Development Participants	Mainly Data Providers	Cross-Sectoral (Providers, integrators, users)
Funding/ Resources	Mainly no specific or separate budget	Mostly include in National Mapping program, or having separate budget
Driving/ coordinating Agency	Mainly National Mapping Organizations	No independent organizational committees/Partnership groups
Awareness	Low awareness at the beginning, gradually learning more	More aware, knowing more about SDI and its requirements
Capacity Building	Very low	Communities are more prepared to engage in ongoing activities
No of SDI initiatives	Very low	Many more
SDI Development Model	Predominantly Product-based	Increasingly Process-based, or hybrid Product-Process approach depending on the jurisdiction
Relationship with the other SDI levels and International Initiatives	Low	Much more
Measuring the Value of SDIs	Productivity, savings...	Holistic socio-cultural value as well, measuring the expense of not having

Source: Rajabifard et. al., 2003, 106, Table 6.2

of SDI. Developing a successful SDI initiative depends at least as much upon issues such as political support within the community, clarifying the business objectives, securing sufficient project funding and enlisting the cooperation of all members of the community, as upon technical issues relating to spatial data quality, standards, software, hardware and networking. Therefore, developing a successful NSDI within a political and/or administrative level must be seen as a socio-technical, rather than a purely technical exercise (Rajabifard et. al., 2003, 105).

### 3.3 Current Status of the NSDI

FGDC (2004b)'s "NSDI Future Directions Initiative" and Siderelis et. al. (2005)'s "The National Geospatial Program Office: A Plan for Action" are the key reports show the current status of NSDI. Also the FGDC's NSDI web site<sup>5)</sup> shows all about the NSDI.

The goal of the NSDI Future Directions Initiative is to craft a national geospatial strategy and implementation plan to further the development of the NSDI. Drawing on the collective insights of the geospatial community, three overarching action areas have emerged (FGDC, 2004b, 1).

(1) Forging Partnerships with Purpose: Adopting a governance structure that includes representatives of all stakeholder groups guides the development of the NSDI.

(2) Making Framework Real: Implementing nationally coordinated programs that include collection, documentation, access, and utilization of data for generating framework data themes.

(3) Communicating the Message: Ensuring that the NSDI is recognized across the nation as the primary mechanism for assuring access to reliable geospatial data.

The three overarching actions is conducted by teams such as Table 6.

Since the mid 1990s, the NSDI has served as an overarching vision for the geospatial community. Beginning as a conceptual construct, the NSDI has evolved

into a complementary set of actions implemented by a range of programs dealing with geospatial data and application activities. These programs are managed by government agencies participating in the NSDI and dedicated to achieving the goals of the NSDI as defined in OMB Circular A-16. The Federal Geographic Data Committee (FGDC), Geospatial One-Stop (GOS), and The National Map (TNM) are three examples of separate but inter-related activities, contributing to the development of the NSDI. (FGDC, 2004b, 4)

- FGDC<sup>6)</sup> - coordinates and facilitates the implementation of the NSDI and related geospatial data activities.
- GOS<sup>7)</sup> - implements the basic elements of the NSDI by providing an Internet portal to facilitate data sharing for decision support systems and by encouraging partnerships across organizations.
- TNM<sup>8)</sup> - integrates base geographic data in partnership with content producers at all levels.

Other current initiatives and programs are designed to facilitate advancement towards the vision of a robust spatial data infrastructure. The initiatives listed below represent only a small sampling of the growing list of programs contributing to the NSDI development (FGDC, 2004b, 4).

Table 6. The Teams by Key Actions in NSDI

Key Actions	Team
Partnerships with Purpose:	Governance Action Team
	Tribal Action Team
	Non-Geospatial Organizations Action Team
	Fifty States Initiative Action Team
Communicating the Message:	Business Case Action Team
	Communications Action Team
	Training and Education Team
Making Framework Real:	Standards Working Group
	Team to Identify New Themes for Standards Development
	Publishing Metadata Team
	Standards and Web Protocols Team
	Urban Areas Team

Source: [http://www.fgdc.gov/nsdi/library/factsheets/documents/future\\_directions.pdf](http://www.fgdc.gov/nsdi/library/factsheets/documents/future_directions.pdf)

5) <http://www.fgdc.gov/nsdi/nsdi.html>

6) <http://www.fgdc.gov/>

7) <http://gos2.geodata.gov/wps/portal/gos>

8) <http://nationalmap.gov/>

- HAZUS<sup>9)</sup> - a program sponsored by the Federal Emergency Management Agency (FEMA) to develop methodologies and software tools to model and estimate potential hazards from natural disasters such as floods, earthquakes, and hurricanes.
- National Integrated Lands System (NILS)<sup>10)</sup> - a partnership between the Bureau of Land Management (BLM) and the US Department of Agriculture (USDA) Forest Service to “develop a common data model and software tools for the collection, management, and sharing of survey data, cadastral data, and land records information.”
- Regional Crime Analysis Geographic Information System (RCAGIS)<sup>11)</sup> - an initiative spearheaded by the Department of Justice and the City of Baltimore to develop spatial data and application tools for the regional analysis of crime patterns.

### 3.4 The Putman NSDI hearings in Congress

Congressman Putman’s sub-committee on technology, information policy, inter- governmental relations and the Census had held two hearings with witness. The first hearing was setting the scene. Amongst the conflicting views expressed at the second meeting were (Longley, 2005, 457):

- A complete and up-to-date strategic plan is missing, federal agencies are not complying with General Accounting Office (GAO) direction on coordination and OMB’s oversight methods to prevent duplication have proved ineffective (GAO).
- Considerable progress has been made but more needs to be done (OMB).
- The GOS portal in mid-2004 held information from 155 federal and state sources and received visits from 6600 different individuals per month. It will continue to be developed (USGS).
- Data sharing between local governments, states, and federal government has to meet the most exacting requirements - for local detail - and hence is more expensive than data created for federal agencies

alone but is more up-to-date. A single model does not fit all states in regard to NSDI. The US needs a single federal agency, with cross-cutting authority, that can direct and speak all federal agencies on geospatial development and coordination. Legislation constraints collaboration, e.g. the Federal Advisory Committee Act prevents federal agencies from putting local, state, or tribal organizations on their advisory bodies (National States Geographic Information Council)

- Federal government geospatial programs would benefit from the private sector being a full partner in developing plans and policies. A well-funded business plan is required for the NSDI (Spatial Technologies Industry Association)
- We are not proceeding with a good road map. Numerous studies detail the lack of coordination of federal mapping and geospatial activities and government’s duplication with the private sector (Management Association for Private Surveyors)
- We are basically on the right track but some mid-course corrections are needed. policy makers have overlooked the importance of the Open Geospatial Consortium (OGC)’s interoperability standards effort. the FGDC and other federal agencies need to continue to participate in the OGC to ensure that unfinished standards reflect the needs of the public and the requirements of the government agencies entrusted to serve the public interest (OGC)
- The FGDC has done a good job, especially in metadata standards. [but] voluntary partnership are not working and the federal government must find new carrots and sticks to realize the potential of the NSDI (Mapping Science Committee)

It is obvious that the NSDI is controlled by statutory, political, legal, commercial/ financial, and other factors as well as technical ones (Longley et. al., 2005, 457).

### 3.5 NGPO

USGS’s NGPO Home Page<sup>12)</sup> shows NGPO is “A bold

9) <http://www.fema.gov/plan/prevent/hazus/>

10) <http://www.blm.gov/wo/st/en/prog/more/nils.html>

11) <http://www.icpsr.umich.edu/NACJD/RCAGIS/>

12) <http://www.usgs.gov/ngpo/>

step for the NSDI” and explains it as the essential components of delivering the NSDI and capitalizing on the power of place will be managed as a unified portfolio that benefits the entire geospatial community. The USGS Director has realigned the geospatial programs for which the USGS has a leadership responsibility into a NGPO to serve the needs and interests of the geospatial community throughout the Nation. This realignment brings TNM, GOS, and the FGDC into a single program office.

By connecting the components of TNM (integrated base data), FGDC (coordination, policy, and standards), and GOS (information discovery and access), and by embracing and communicating the message of the importance of the NSDI, the geospatial community and the Nation will realize the vision of “current and accurate geospatial data will be available to contribute locally, nationally, and globally to economic growth, environmental quality and stability, and social progress” (Siderelis et. al., 2005, 14)

According to the Siderelis et. al. (2005)’s report<sup>13)</sup>, the purpose of the NGPO is “Providing leadership to place geographic knowledge at the fingertips of the Nation”. The vision of the NGPO is “By June 30, 2006, transform the processes of Government necessary to implement key components of the NSDI”. The NGPO envisions three transformations that will be necessary to fulfill the vision of the NSDI as follows:

- Toward a national geographic information system
- Toward matters and places of national importance
- Toward management excellence.

Establishing and championing a national geospatial enterprise architecture, promoting a governance structure for the future, and providing business value through incentive-based partnerships are the cornerstones on which to build the NSDI (Table 7).

### 3.6 Geospatial Line of Business (LoB)<sup>14)</sup>

GAO (2004) made report on “Geospatial Information: Better Coordination Needed to Identify and Reduce Duplicative Investments” to respond the congressional requesters. Although steps have been taken to coordinate geospatial activities, redundant investments remain as follows (GAO,

2004, 19-34)

- FGDC and others have taken steps to coordinate GIS activities governmentwide, but lack a complete and up-to-date strategic plan to guide them.
- Individual federal agencies have coordinated specific geospatial investments, but have not fully complied with OMB guidance.
- OMB’s oversight of federal geospatial assets and activities has not identified redundant investments
- IT investment business cases do not completely describe geospatial data assets
  - The Federal Enterprise Architecture is not yet effective in identifying potentially redundant geospatial investments
  - FGDC-administered agency reporting does not provide adequate information for identifying redundant geospatial investments
  - OMB’s supplemental data requests have not provided sufficient information to identify potentially redundant investments
- Federal agencies continue to collect and maintain duplicative data and systems

Current geospatial efforts are largely conducted independently across Federal agencies based on limited geospatial business requirements definition. There are limited efforts for increasing internal and enterprise effectiveness and efficiency or creating new geospatial resources and

Table 7. The Cornerstones to build the NSDI

Cornerstones	Strategic Actions
National Geospatial Enterprise Architecture	<ul style="list-style-type: none"> <li>• Adopt geospatial enterprise architecture principles</li> <li>• Establish advisory council and technical working group</li> <li>• Promote use of common standards</li> </ul>
Governance Structure for the 21st Century	<ul style="list-style-type: none"> <li>• Explore governance models and review FGDC governance efforts</li> <li>• Promote national governance and its benefits</li> <li>• Create a national geospatial coordinating body</li> </ul>
Incentive-Based Partnerships	<ul style="list-style-type: none"> <li>• Promote an incentive-based partnership model</li> <li>• Implement best practices for incentives</li> <li>• Support NGPO demonstration pilots</li> </ul>

13) <http://pubs.usgs.gov/of/2005/1379/of2005-1379.pdf>

14) <http://www.fgdc.gov/geospatial-lob>



services (E-Gov, 2006, 4-5). This inability to better coordinate, organize, and manage business needs yields a situation where:

- Disenfranchised stakeholders perceive that their business requirements are not met and have little incentive to partner financially or share their geospatial assets with the Federal government
- Disparate efforts are underway to complete the NSDI which has delayed its completions and inflated its cost
- Independent geospatial data, services and applications have been developed multiple times to support the same or similar business processes
- Multiple licenses and contracts for the same product or service are in place across the government, reducing the opportunities for economies of scale and increasing the overall cost to the government
- Operational data and services used to support mission specific business functions have not been “geo-referenced” or “geospatially enabled” decreasing their value and use
- Wide disparities in geospatial capabilities exist across Federal agencies resulting in many programs not taking advantage of innovative technologies that are available

The Geospatial LoB<sup>15)</sup> has set forth ambitious and transformational goals to better serve the Nation’s interests. Building on the policy foundation of the OMB Circular A-16 and the President’s Management Agenda, the Geospatial LoB will establish a new and more citizen-centric collaborative model for geospatial-related activities and investments. This will create a framework for sustainable participation from non-Federal partners, and create a more coordinated and leveraged approach to producing, maintaining, and using geospatial data and services. Future cost savings and greater satisfaction of customer and business needs will be realized by optimizing, and where appropriate, consolidating geospatial assets and activities through enhanced performance accountability and compliance mechanisms and coordinated budget planning and cost avoidance strategies. Provisioning the Nation with easy to use geospatial capa-

bilities will promote cheaper, smarter and more efficient government business, services and information.

OMB and the Geospatial LoB are focused on business-driven, common solutions (s) aligned with the Federal Enterprise Architecture (FEA) and guided by the FEA Geospatial Profile and the NSDI in order to support operations across the Nation and beyond. The common solution consists of three solution tracks. Each solution track plays a critical role in supporting the vision, goals, and objectives of the Geospatial LoB.

- Enhanced Governance - Includes the development of a stakeholder centric governance model and robust performance, evaluation, accountability, and reporting mechanisms required to make the NSDI operational, and improve Federal Agency geospatial program coordination and performance.
- Planning and Investment Strategy - Incorporates, coordinated requirements analyses, planning and budgeting efforts across LoBs, standardized budget coding to allow automated evaluation and tracking of Federal geospatial assets and expenditures; and a common acquisition strategy that includes shared acquisition vehicles and services to reduce or avoid unnecessary costs.
- Optimize and Standardize Geospatial Data and Services - Utilizes known best practices and open standards to establish widespread, shared and re-useable geospatial asset discovery, access/delivery, analysis, training, and brokering services. It also includes mechanisms to standardize agency approaches to geospatial business, technology, services, and data.

### 3.7 The NSDI Cooperative Agreements Program (CAP)<sup>16)</sup>

One of the major initiatives was the establishment of the NSDI CAP. This merit-based funding assistance program provides seed money to encourage collaborative NSDI resource sharing projects between and among the public and private sector. Since it’s inception, this grant program has provided funding for over 200 projects involving more than 1000 organizations. Many of those organizations have institutionalized NSDI practices and

15) <http://www.whitehouse.gov/OMB/egov/c-6-8-glob.html>

16) [http://www.fgdc.gov/grants/documents/FactsheetCAP\\_General052007.pdf](http://www.fgdc.gov/grants/documents/FactsheetCAP_General052007.pdf)

have become anchor tenants on the NSDI, and thereby attracted others to use and become a part of the infrastructure.

NCGIA's report on the Evaluation of FGDC's NSDI Grants Program describes the results of a postal survey of organizations that applied for FGDC metadata clearinghouse grants over the period 1994-1999. The main goal of the survey was to evaluate the effectiveness of FGDC's grants program. A further goal was to compare the characteristics of successful versus unsuccessful applicants, as well as non-applicants. Overall, the picture that emerged from the analysis can be summarized as follows (NCGIA, 2001, 1-2).

- First, FGDC grants contribute significantly to the development of metadata clearinghouses among successful applicants. The existence of a critical mass of in-house GIS specialists appears to be the chief discriminator between successful versus unsuccessful applicants.
- Second, projects that were supported by FGDC were in most cases associated with spillovers to other organizations (demonstration effects). In addition, virtually all of these projects have been supported by postgrant investment from within the recipient organization itself.
- Third, FGDC grants have improved the in-house technical capacity (or broadened the range of in-house activities) of many of the grant recipients. Fourth, all of the successful applicants have created metadata clearinghouses. A substantial majority of the successful applicants ranked the importance of FGDC support either highly or very highly.
- Finally, the main reason that eligible non-applicants failed to submit proposals was that they were unaware of the existence of FGDC grants.

CAP is an annual program to assist the geospatial data community through funding and other resources in implementing the components of the NSDI. This program is open to Federal, State, local and tribal governments, academia, commercial, and non-profit organizations. This program provides small seed grants to initiate sustainable on-going NSDI implementations. The program emphasizes partnerships, collaboration and the leveraging of geospatial resources in achieving its goals. Some of the

activities supported by the CAP include:

- Standards implementation through guide development and training
- Participation in the Clearinghouse and Geospatial One-Stop Portal
- Implementing OpenGIS Web Mapping and Web Feature Services
- Demonstrating to Federal business managers the value of incorporating geospatial approaches into business processes
- Establishing participation in The National Map
- Building organizational collaboration and cooperation among organizations

Starting in 2004 the FGDC, GOS and TNM programs are jointly sponsoring the CAP program. These three programs are national geospatial programs with Federal leadership that share the common goal of building the NSDI. The objective is to develop a model incentives program that will encourage other federal programs to participate in upcoming years to take advantage of partnerships, leverage resources and provide a more efficient process for applicants (USGS, 2006).

### 3.8 The NSDI-related research activities

The above mentioned implications induce high requirements on current and future SDI-related research-activities. Especially the expectation of an increasing heterogeneity, complexity, and dynamics of user requirements as well as the increasing diversity, availability, and interconnectivity of SDI-resources lead to a number of fundamental research topics which are crucial to investigate. It depends on the outcome of these research activities if flexible, user-centric SDI concepts become technologically feasible in the future. Against this background, Wytzisk and Sliwinski propose an intensification of the following - partially more and more arising, partially already established - research activities, especially with regard to SDI-needs.

- Dynamic Chaining of GI-Services
  - Semantic Interoperability of GI-Services
  - Spatial Decision Support Services
  - Authentication, Authorization, and Accounting - Security and Commercial Marketing in SDIs
- They conclude that dynamic chaining of GI-services,

the semantic interoperability of GI-services, the specification and development of spatial decision support services, as well as security enhancements and commercial marketing issues will constitute the key pillars of future research on SDI (Wytzisk and Sliwinski, 2004, 45-47)

Onsrud et. al. (2005, 240-241) proposed four broad areas in which research will help strengthen the future of the nation's spatial information infrastructure as follows: information policy (intellectual property rights, information privacy, and liability), access to government spatial information, economics of information (cost recovery, pricing, markets for geographic data), and integration and local generation of spatial information. The results achieved from the recommended research should help policy-makers, scientists, business leaders, and community groups better understand the relationships between information policies and spatial information resources, products, and services - and by doing so to facilitate the accelerated growth and utilization of geographic information resources in meeting society's future needs.

Masser (2006), suggested the four challenging areas for SDI related research as follows: SDI diffusion, SDI evolution, data sharing in SDIs, and the hierarchy of SDIs. The most important conclusion to be drawn from his analysis is that SDIs must be viewed as social phenomena.

Williamson et. al. (2006, 24) introduced six challenges and issues facing the development of SDIs which will be able to meet the sustainable development objectives of society. These issues and challenges include:

- SDI to facilitate spatially enabled government
- Role of government, private and academic sectors
- Development of SDI vision, mission and road map - where are we heading?
- SDI to facilitate integration of natural and built environment datasets
- SDI to support marine administration- Seamless SDI model
- Capacity building

SDI and geoportals are one of the key technology trends that will shape GIS. The others are GIS servers, Services-oriented architectures, Sensor webs, Modelling

and analysis, Data management, and Visualization (Longley et. al., 2005, 475-476).

#### 4. Implications of NSDI to Korean NGIS

In the review of historical background of NSDI, the USA's easy and inexpensive availability of federal government data has its origins in the formation of democracy. Original Circular A-16 was originally issued in 1953 to insure that surveying and mapping activities may be directed toward meeting the needs of federal and state agencies and the general public (Table 1). FGDC is established in 1990 to facilitate Circular A-16 and implement the NSDI. NGPO also created to implement NSDI effectively in 2005. Although the USA's NSDI concepts have influenced to many countries in the developing National SDI, according to the article of Rajabifard et. al. (2003, 103), at the end of 1999 the FGDC started to move from a product-based to a process-based model of SDI development in order to neutralize difficulties arising from existing models.

The third NGIS plan of Korea (MOCT, 205) will belong to the second generation of NSDI and process-based model. The strong leadership and incentive-based approach is needed in the early stage. But, the success is resulted in the good cooperation among stakeholders, funding, training and education are needed. The success of the NSDI depends to a great deal on the involvement, participation.

As the GAO (2004) report pointed out the problems of NSDI activities, it was made possible by the Congress's concern and request. Also the OMB's continuous effort to improve the government's performance will be the one of solutions.

The Geospatial LoB<sup>17)</sup> has set forth ambitious and transformational goals to better serve the Nation's interests.

MSC (1990-2003), NAPA (1998), NCGIA (2001) and URISA (2005) have studied the NSDI's performance and suggested the strategy for NSDI.

#### 5. Conclusions

The conclusions of this study are as follow. Firstly,

17) <http://www.whitehouse.gov/OMB/egov/c-6-8-glob.html>

top-down and bottom-up approaches are needed for integrated data sharing and standardization. The top-down approach is required to specify a strategic goal and vision, prioritize plans, arrange core funding, contribute to the definition of fundamental datasets, build a clearing house, develop metadata standards, and resolve information policy issues. The bottom-up approach aim to promote various local initiatives and build application-specific and enterprise-wide geospatial databases. The policy mix to complement the bottom-up and top-down approaches is needed in the future generation of NSDI.

Secondly, the creative and evolutionary vision and strategy has to be suggested. The user-centric and evolution-oriented understanding of SDI (proposed by Wytzisk and Sliwinski in 2004) as an alternative approach to contemporary SDI definitions is needed. As Rajabifard et. al. (2005) had evaluated, the new strategy has to move from the product-based to a process-based approach.

Thirdly, the training program and lecture materials have to be developed and diffused to the users and providers of spatial data. As Harvey (2000) pointed out the scarce knowledge and awareness of the NSDI in the developing NSDI, we have to include it in the MOCT-funded university training program.

Fourthly, the governance system has to be built for NSDI evaluation. Like FGDC and NGPO will be lessons to build the good governance system for the building of lead agency. Geospatial LoB will be the good example of the coordination between NSDI and enterprise architecture. We have to incorporate MOGAHA (2006)'s ITA framework in NGIS plan as Geospatial LoB did.

Finally, the formation of inter-agency geo-spatial forum to discuss the spatial-related problems and make research agenda, etc.

As Longley, et. al. (2005, 458) suggested, the great success of NSDI has been as a catalyst, acting as a policy focus, publicizing the importance of geographic information, and focusing attention on the benefit of collaboration.

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