# THE US NATIONAL SPATIAL DATA INFRASTRUCTURE:
## WHAT IS NEW?

Alan R. Steven

Federal Geographic Data Committee, 590 National Center, USGS,Reston, Virginia, 20192, USA
astevens@gsdi.org

## ABSTRACT

Initially the US Federal Geographic Data Committee (FGDC) and the National Spatial Data Infrastructure (NSDI) major development focus has been almost completely at the federal level.  With time and much promotion, FGDC's vision has found its way into states and local governments.  The central focus of the NSDI is carried into the current political administration through the President's management agenda consisting of 25 major programs with a vision to improve the federal government's value to the citizen by an order of magnitude. The challenge is to make information, data and decisions available in minutes or hours, not weeks or months to other government agencies and the general public.  This e-government (E-gov) is focused on using digital technologies to transform government operations in order to improve effectiveness, efficiency, and service delivery.  Geospatial One-Stop (GOS) grew from this vision and raises the visibility of the strategic value of geographic information.  It is another mechanism to accelerate the NSDI development in the US.  Specifically it is to build framework data standards, breathe life into portal development, accelerate data inventory, and promote data and its application throughout the marketplace. Concurrently, the FGDC, the NSDI and GOS began to look strategically at the next steps in the evolution of the NSDI.  International examples of infrastructure development have been examined and the strategy has been formulated with three principal goals: creating partnerships with purpose, making framework real, and communicating the message.  The major message is that in order to create a truly national spatial data infrastructure, one needs to involve the people and data at the day-to-day working level – cities, counties, and utilities.  New and different policies and partnerships need to be developed before all meaningful data can be made available for critical decision making.  This massive effort involves components of the US Federal Government as well as State, County, City, and community Governments.  The team also has considerable input from NGOs and the private sector.  Early findings indicate that it is critical to build a formal national council involving all potential generators, users, and distributors in the public and private sectors.  This plan is being reviewed at the current time and will yield a completely new approach to building the US NSDI.

## 1. GEOGRAPHY IS THE COMMON LANGUAGE

Cities, provinces, nations, and the world are largely built and can be described in layers. Beneath ground one finds the bedrock, soils, aquifers, sewers, subways, gas pipe lines, transmission lines, etc.  On the surface we find streets and highways, land ownership, political boundaries, hydrography, water and waste treatment plants, hazardous dumps/pipelines, building footprints, farmland, forests, deserts, and a multitude of infrastructure that evolve over time.  We also have several cultural layers of significance like demography, housing quality, poverty, pollution, etc.  Above one might find the air quality, the atmosphere, and the planes that fly over.  If a disaster disrupts any or all of these, it involves hundreds of federal, state, local and private groups with separate knowledge, jurisdiction and interest in these layers. No one group alone has all the data needed to do the job or to coordinate with others in performing critical tasks. Geography provides the common language and reference system for all response and recovery efforts.

I am not here today to tell you that geographic information and geographic information systems (GIS) are the keys to disaster prevention and remediation.  That fact is well established.  A common framework is critical.  Agreements among those that collect, process, archive, and distribute disparate geospatial information do so using common standards and interoperable systems and techniques…and share as much as possible via the web.  It is essential that, when resource managers try to integrate these disparate data sets, for whatever reason, they fit together vertically and horizontally.

Without a common framework there is no way to quickly tie together the essential information used to coordinate any unified response.  A unified framework and base information have been and will continue to be critical to emergency managers and government officials responsible for response and recovery efforts regardless of the type of disaster.  Imagine the confusion if the separate elements of information (roads/highways, sewer lines, water supply, gas lines, electrical transmission, building foot prints, land tenure, subways, toxic wastes, etc.) in a dense urban setting were available but in separate formats, collected via different standards, and with different reliability and at resolutions.

## 2. SPATIAL DATA INFRASTRUCTURE (SDI) – WHAT IS IT?

The single most important element to the success of any emergency response operation is the human contribution.  Beyond that, standards for data quality and access become time critical.   What are these critical ingredients to a successful emergency operation requiring geospatial data and information?  They correspond to the components of a National Spatial Data Infrastructure (NSDI.)

**GEODATA** – the actual geospatial data and information collected, processed, archived and potentially distributed by multiple agencies/organizations to meet disparate mission needs. It can be property ownership, political boundaries, land use/land cover, transmission lines, transportation/energy grids, geology, soils, surface and groundwater hydrology, demography, disease vectors, economic service areas, and many more.

**META DATA** – standardized data elements that describe the data (content, quality, condition, resolution, scale, time of collection, other times it was collected, areas of coverage, ownership, and other characteristics of the actual data).

- Permits structured search and comparison of data without having to spend the time examining the data itself.
- Potential users can compare similar data collected and held by multiple organizations in one sitting and make a studied opinion as to which data best fits the user's needs.
- Provides the end user with adequate information to take the data and use it in an appropriate context.

**FRAMEWORK** –

- The base layers of data that most users agree is the base information that they will key their data to
  - Will most likely be different from location to location
- Mechanisms for identifying and describing the data using features, attributes and attribute values
- Mechanisms for updating the data periodically without complete recollection
- Interactions among organizations for data collection and sharing.

**CLEARINGHOUSE** – A place for me to go to find out who has what data.

- Each ministry may have a clearinghouse for its data
- Need to point to the data held by others
- Supports uniform, distributed search through a single user interface
- Either allows user to obtain data directly or directs user to clearinghouse worldwide where data may be obtained
- May or may not allow a user to actually get the data

**STANDARDS** – created and accepted locally, nationally and globally.

- Less important to build your own standards
- More important to agree to use those standards promulgated by the International Standards Organization (ISO)
- Participate in and contribute to your national standard organization.
- Promote additions/modifications to standards that facilitate your ministry's data holdings through your national standards organization.

**PARTNERSHIPS** – fabric that allows all of this to happen efficiently and effectively.

- To identify policy barriers and recommend practices and policies to overcome these barriers
- To reach agreements as to who is the best data stewards for the principal data sets
- Promote data sharing
- Reduces duplication costs of collecting the same data several times
- Extends local/national/global capabilities in technology, skills, and sharing

## 3. WHAT IF ………?

It is bad enough to have to deal with one disaster. Not having access to data and information that can be fully and rapidly integrated is another disaster.

Without common standards and interoperable practices, many of the emergency services, relief ministries, media, NGOs, academia, and private companies would have to generate their own views of the effected area(s) to remediate the effects of any disaster and its aftermath. The goal of a National Spatial Data infrastructure (NSDI) is to allow these groups to communicate, collaborate and leverage disparate assets and specialists in real time with a maximum of efficiency and effectiveness.

## 4. ONE MODEL

The United States has one model for the building of a National Spatial Data Infrastructure (NSDI), but it is only one model. What works well in the US may not work in other nations. There are several success stories, but there are lessons to be learned from those things that need improvement in the US model.

In the early 1990s the USA established a Federal Geographic Data Committee (FGDC.) Its goal is to promote and establish an NSDI. The responsibility was assigned to the Secretary of the Department of the Interior. In the US the Department of the Interior is responsible largely for managing the public lands of the federal government. It is not similar to many nations in which the Ministry of the Interior means the federal police. The FGDC is administratively assigned to the US Geological Survey (USGS), but it facilitates the work of the Secretary of the Interior.

Today the FGDC is really two entities. On the one hand, it is a staff of about 26 people assigned or detailed to the USGS. Their job is to facilitate the work the Secretary of the Interior to build an NSDI. On the other hand, the real answer is that the FGDC is an intergovernmental committee made up of 19 federal agencies who have come together to build the NSDI.

- Department of the Interior (co-chair)
- Office of Management and Budget (Co-chair)
- Department of Agriculture
- Department of Defense
- Department of Energy
- Health and Human Services
- Housing and Urban Development
- Department of Justice
- Department of State
- Department of Transportation
- Environmental Protection Agency
- Federal Emergency Management Agency
- Library of Congress
- NASA
- Archives
- Department of Commerce
- National Science Foundation
- Tennessee Valley Authority
- General Services Administration

## 5. FUNCTIONS OF THE FGDC

Over the years and currently, FGDC's mission includes collaboration to identify institutional barriers for the components of the NSDI eg. Policies that inhibit sharing data

and identifying one ministry to be responsible for a data type. After identifying the barriers, the committee works to recommend new policies that will remove these barriers and facilitate the building of an NSDI.

The FGDC also discusses, evaluates, and recommends the most effective ways to collect, process, archive, and distribute geospatial data and information. Ideally this leads to recommending data stewards -- the one best agency/ministry to collect, process and archive a given type of data. It makes little business sense for several ministries to collect the same data. It is duplicative and wasteful, particularly when governments have limited resources to support critical programs.

Another major task is to reach consensus on base framework data and mechanisms for update. The US has agreed on 7 framework data layers.
- Transportation
- Hydrography
- Elevation
- Cadastral
- Political boundaries
- Geodetic control
- Ortho-imagery

For good reasons, it is unlikely that all nations or governmental components will agree on the base framework data layers. Framework data is often considered that data commonly found on maps. It is only important that your NSDI body reach consensus as to the base data layers.

Framework does not stop at identifying the base data layers. It involves a feature-based model; permanent and unique feature identification codes; reference to modern horizontal and vertical geodetic datums; seamless integrated data for adjacent or overlapping geographic areas; and it reaches into the development of the metadata model. It also has operational aspects to include transactional changes; access to previous data versions; and allows for location of data from and through the Geospatial One-Stop portal.

Agreement of metadata development and standards is another critical component of the NSDI mission. Metadata is really data about the data. It typically tells one something about the data scale, resolution, time of collection, coverage, other times the steward collected the same data, etc. It allows a user to quickly review multiple sources of data and decide which data set best fits his or her application without having to spend considerable time reviewing each data set. The metadata standard, among other things, identifies the number and types of data fields to be included in the metadata. Frequently, data providers balk at having to fill in all data fields because of the alleged amount of time required. The US metadata model calls for 22 data fields. However, it allows data stewards to fill in 8 critical fields for it to be considered fully metadata compliant.
Yet another task assigned to the NSDI is promoting clearinghouse development. The clearinghouse is a decentralized system of servers located on the internet that contain field-level descriptions of available digital spatial data. The metadata facilitate query and consistent presentation across multiple participating sites. The Clearinghouse functions as a detailed catalog service with support for links to spatial data and browse graphics. Clearinghouse sites are encouraged to provide hypertext linkages within their metadata entries that enable users to directly download the digital data set in one or more formats. Where digital data are too large to be made available through the Internet or the data products are made available for sale, linkage to an order form can be provided in lieu of a data set. Through this model, clearinghouse metadata provides low-cost advertising for providers of spatial data, both non-commercial and commercial, to potential customers via the Internet.

## 6. INCENTIVES

Providing policies to over come barriers is important. Frequently, however, using policy is viewed by participants as forcing compliance. Another route is to cajole others into compliance by providing incentives for their full participation. The US model has developed the Community Agreements Program (CAP) Grants. The CAP provides seed funds to engage organizations in building components of the NSDI, which can include metadata documentation, national standards development and implementation, clearinghouse and web mapping, and framework development, and collaboration. The CAP is open to all U. S. organizations and seeks new participants annually. With the goal of GIS infrastructure development, the CAP program does not support GIS startups, data collection, or data purchases. Annually the NSDI allocates between $300,000 to $1,500,000 USD toward the program.

## 7. WHERE IS THE NSDI CURRENTLY?

Since it started the NSDI has been successful in:
- Gathering high level support through three completely different political administrations
- Recommending and receiving policy encouragement
- Building an elaborate network of partnerships reaching beyond the purely federal structure into states, NGO, academia, the private sector, and communities
- Major player in the national and international standards organizations for data standards development
- A partner with the Open GIS Consortium (OGC) and the private sector in interoperability specifications promulgation
- An interrelated global network of 277 clearinghouse nodes is available for users
- Open policy for federal spatial data sharing
- Major contributions to the development of a Global Spatial Data Infrastructure
- Many more noteworthy accomplishments

## 8. HOMELAND SECURITY WORKING GROUP

The Federal Geographic Data Committee's Homeland Security Working Group ensures that the National Spatial Data Infrastructure supports the preparation for, prevention of, protection against, response to, and recovery from (1) threats to the nation's population centers and critical infrastructure that are of natural, accidental, terrorist, or criminal origin and (2) related adverse events.

The working group has regular participation from the Departments of Agriculture, Commerce, Defense, Energy, Homeland Security, the Interior, and Transportation; the Environmental Protection Agency, Federal Communications Commission, National Aeronautics and Space Administration, and National Capital Planning Commission; and the National States Geographic Information Council.

One initiative within working group is map symbology: Use of different map symbols for the same information slows and

degrades communication, especially when many organizations need to work together. The working group is compiling a set of standard map symbols to support homeland security applications, with initial efforts concentrating on emergency response. The community review of the first draft of the symbols closed in January; these symbols can be viewed through http://www.fgdc.gov/HSWG (case sensitive). Revised symbols and the working group's response to comments from the community review will be available during the summer of 2004. The group plans to submit the symbols for formal adoption through the FGDC and ANSI INCITS L1 standards processes.

## 9. POLICY SUPPORT

The working group developed guidelines that provide procedures to identify sensitive information content of geospatial data sets. Should such content be identified, the guidelines help organizations decide what access to provide to such data sets and still protect sensitive information content. The geospatial data community's use of a common approach to identify data sets that have sensitive content and to provide appropriate access to such data will increase the effectiveness of individual organization's actions.

The white paper "Homeland Security and Geographic Information Systems", available on the group's web site, describes how geographic information system and mapping technologies can help save lives and protect property.

For more information one can visit the working group's web site at http://www.fgdc.gov/fgdc/homeland/index.html, or contact Michael Domaratz, Co-Chair, U.S. Geological Survey, phone (703) 648-4434 or email mdomarat@usgs.gov.

## 10. WHAT'S NEXT?

While it is clear that the FGDC and NSDI have come a long way in the last 14 years, there is still much to do. If the goal is to build a truly national spatial data infrastructure, it not sufficient to have federal stakeholders exclusively in the decision making positions. Typically, when a disaster hits a region, resource and emergency managers want working level data. It is not sufficient to have fully integrated data at the federal and state level only. It is essential to have city/community scale information fully integrated as well.

## 11. GEOSPATIAL ONE-STOP

Geospatial Information One-Stop was instituted as a part of the President's Management Agenda under the heading of Expanding E-Government. It focuses on moving to a citizen-centered way of providing information and services to constituents. Geospatial Information One-Stop will provide a geographic component for use in all E-Government activities. Geographic Information (GI) is a national asset, an essential requirement for just about every program at every level of government, and one of the key elements underlying the President's Management Reform Agenda.

Using the available tools and technical capabilities of e-government, we can expedite and improve the business of government, reform government management, eliminate redundancy, save money, increase agency productivity gains

from technology, and provide citizen-centered information and services. Geospatial information is one of our most important and underutilized tools. To implement the President's e-government objectives, we need to focus on geospatial information.

Geospatial One-Stop is an important element in the overall national effort of achieving a common vision of accurate, accessible geospatial information for the nation that will transform the way government at all levels addresses the increasingly complex issues of the 21st century by using geographic information to:

- Simplify and unify business processes
- Respond to the information needs of citizens, producers and users of GI everywhere
- Integrate and engage the coordinated effort of government at all levels, and the private sector
- Align resources and foster co-investment in GI among all levels of government
- Collect data once and uses it many times
- Provide easy and secure access 24/7 to current, accurate GI
- Enable timely and improved decision making for Homeland Security.

## 12. A NATIONAL STANDARDS EFFORT

While specific applications of geographic data vary greatly, users have a recurring need for seven basic themes of data that are the foundation or framework for almost all applications. Framework data are characterized by a minimal number of attributes needed to identify and describe features such that they can form the foundation or framework of many applications.

To ensure its standards efforts were not viewed only from a 'federal prospective', Geospatial One-Stop, has aggressively solicited national input from all stakeholders through its Board of Directors, the FGDC and their various outreach vehicles (newsletters, conferences, email lists and existing GIS working groups). This effort was successful in encouraging involvement from the Board's constituents with Over 500 participants from Federal, State, local, tribal and the private sector sighing up to help write, review or comment on the developing draft standards.

## 13. THE PORTAL

The portal is essentially a window or funnel to locate and view distributed geospatial data holdings from key communities or stakeholders such as the federal, state, local, tribal, acedemic and private sectors. This data coupled with geospatial data integration and services can be used to support the businesss of government with enhanced decesion making tools.
The centerpiece of the Geospatial One Stop strategy is geodata.gov . The initial implementation of the Portal designed is to facilitate publishing and searching of metadata, and enable viewing live web mapping services, is known as GeoData.Gov, and will feature intergovernmental and private sector collaboration. The National Map, led by the U.S. Geological Survey, as a starting point. It will allows easy searches for existing and planned data with a goal of "two clicks to content."
The portal is based on a distributed architecture allowing all the data to remain with the data owner. However, metadata from

NSDI Clearinghouse Nodes will be harvested and copied to a centralized database for faster search and retrival. In addition a central inventory of live web map services will be published in the portal and made available for viewing.

The portal is an Internet-based organizational umbrella for federal agency data categories or channels addressing geospatial activities. Data Category teams or 'stewards' from the communities of interest are forming to actively seek and monitor available thematic geospatial data products and services, assess and promote premier thematic data products, and showcase real success stories.
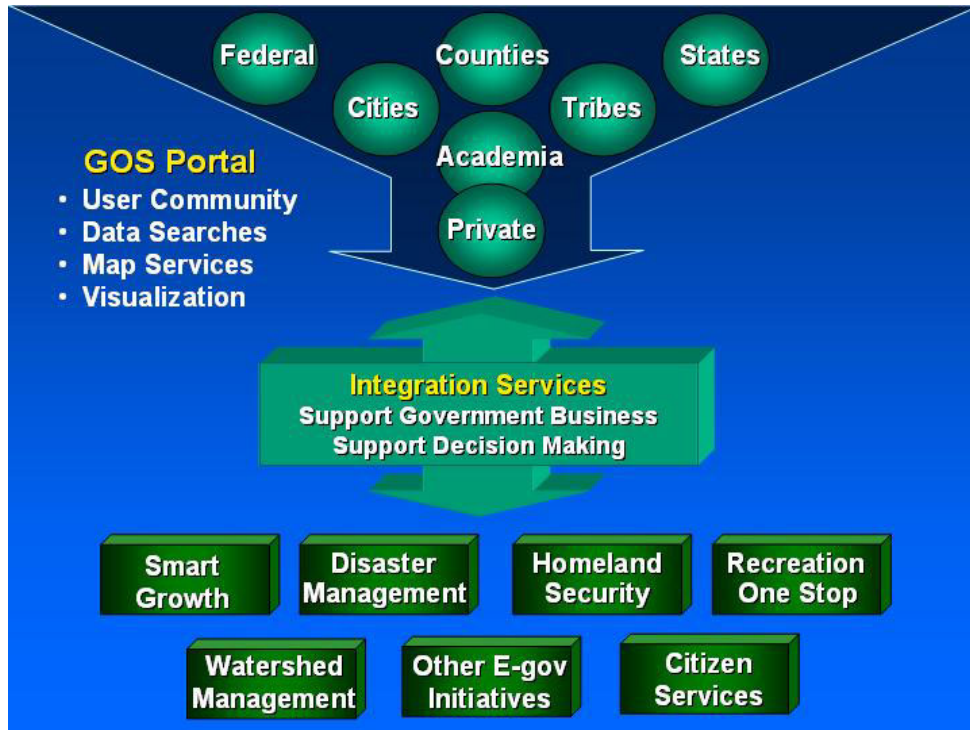


## 14. FUTURE DIRECTIONS

In 2003 the FGDC staff was charged by the FGDC Steering Committee to pursue the NSDI Future Directions Initiative. The purpose of the initiative was to craft a national geospatial strategy and implementation plan to further the development of the NSDI. There were several reasons for looking at a new plan at this time:

- The last FGDC/NSDI strategies were formulated in 1994 and 1997,
- The organization had put out a major effort for the Geospatial One-Stop that identified several needs,
- The staff Director position had transitioned from John Moeller to Ivan DeLoatch,
- Questions had surfaced about the interrelationships among the NSDI, Geospatial One-Stop, and the National Map, and
- The high level interest in Homeland Security.

It is clear that the NSDI has come a long way in forging partnerships and streamlining mechanisms for data availability. However, one of the serious shortcomings has been that federal stakeholders exercise principal management and control. Others like states, counties, communities, NGOs, the private sector, etc. are encouraged to play significant roles. None-the-less, the federal establishment controls the vote.

If one is to build a truly national spatial data infrastructure, one needs to provide fully integrated geospatial data all the way to the ground and under it. It is critical to involve all those that collect, process, archive, use, and distribute such data in the decision making process.

Ideas and perspectives for the Future Directions Initiative were solicited and collected through interviews, Coordination Group meetings, workshops, forums, staff meetings, and conferences held between December 2003 and April 2004. Out of this a vision was formulated.

*Vision – Current and accurate geospatial data will be available to contribute locally, nationally, and globally to economic growth, environmental quality, sustainability, and social progress.*

Three key actions were articulated repeatedly – Forging Partnerships with Purpose, Making Framework Real, and Communicating the Message -- providing the structure for the goals, objectives and the strategic action plans of this initiative.

*Forging Partnerships with Purpose* -- It is critical to engage people that deal with digital data at all levels from the smallest to largest scales. Mechanisms need to be developed to put city/county/utility practitioners on the FGDC Steering Committee with a full voting rights. Their concerns for things like policy barriers, and intellectual property rights need to be treated along with the concerns for those that deal with smaller-scale data. A new governance model needs to be developed. Toward this end the following actions were identified.

- By 2006, a governance structure that includes representatives of all stakeholder groups guides the development of the NSDI.
- By 2005, options for restructuring the FGDC to make it more effective and inclusive are identified, evaluated and acted upon.

- By 2005, agreements are in place to facilitate participation of the private sector and utility industry in building the NSDI.
- By 2006, twenty tribes are engaged and contributing to the development of the NSDI.
- By 2006, fifty state coordinating councils are in place and routinely contributing to the governance of the NSDI.
- By 2006, ten non-geospatial national organizations are engaged in and contributing to the NSDI.

*Making Framework Real* -- As in forging new partnerships, data managers from states, communities, utilities need to be involved in day-to-day decision making for building a truly national SDI. Framework categories defined by the federal sector at scales of 1:25,000 and smaller, probably have little meaning to public and private utilities. Similarly, data standards defined by the federal sector probably do not co-line with cities and counties/provinces. Accordingly if the US is to build a NSDI truly to-the-ground, definitions for standards and framework need to be reconsidered. The following actions were defined here:

- By 2007, nationally coordinated programs that include collection, documentation, access, and utilization of data are in place for generating the framework data themes.
- By 2005, American National Standards (ANS) for framework data themes are approved, adopted, and implemented.
- By 2005, FGDC member organizations use FGDC−accepted metadata standards and publish to the Geospatial One-Stop portal.
- By 2006, consensus-based standards and Web protocols for access to framework data are adopted and used by Federal, state and local agencies.
- By 2006, 50 percent of the 133 urban areas have data for all framework themes.
- By 2008, American National Standards (ANS) for additional data themes of national significance as

identified in revised OMB Circular A-16 are adopted by the Federal departments and independent agencies.

*Communicating the Message* -- To become recognized across the nation as the primary source for the availability and use of reliable spatial data. The following tasks and timelines have been generated for this goal:

- By 2007, the NSDI is recognized across the nation as the primary mechanism for assuring access to reliable geospatial data.
- By 2005, a comprehensive business case that demonstrates the value of geographic data to government, business and academia is compiled and articulated.
- By 2005, a strategic communications plan is developed and implemented.
- By 2006, training and education programs are in place to support implementation of framework standards and national initiatives to develop the NSDI.

## 15. CONCLUSION

The US Federal Geographic Data Committee and the National Spatial Data Infrastructure have evolved for the last 14 years. The movement has lived through three completely different political administrations because it promotes better governance – doing things better, faster, cheaper. 'Collect it once; use it many times.' Making data available in a usable form to governments and the public. To live through three different administrations, is not an accident. The right policy makers needed to play leadership roles in NSDI development. The over-arching message stays the same, but the focus changes slightly to meet the needs of policy makers of the day.
This is just the US model. It is only one example. What works here may not work in other nations. The over all goal needs to fit the needs of your nation. In convincing Ministry level people, however, I am certain that they will resonate with making government more efficient and effective.