Toward A New Strategic Vision for the National Spatial Data Infrastructure: A Report to the Federal Geographic Data Committee

National Geospatial Advisory Committee
July 2013

1. SUMMARY

The National Geospatial Advisory Committee (NGAC) has been asked by the Federal Geographic Data Committee (FGDC) for advice on a possible revision of the Vision and Strategic Plan for the future development of the National Spatial Data Infrastructure (NSDI). This document represents the NGAC's response, and contains a review of the changing role of the NSDI, a suggested future vision statement and a discussion of the implications of a revised vision for federal, tribal, state and local government, and for private sector, academic and other members of the geospatial community.

2. BACKGROUND

The Federal Geographic Data Committee (FGDC) was established to promote the coordinated use, sharing and dissemination of geospatial data in the United States. The Secretary of the Interior is the Chair of the FGDC and the Deputy Director for Management of OMB is the committee's Vice-Chair. Since 1953, Office of Management and Budget (OMB) has released several iterations of Circular A-16 that covers federal information technology systems and their effective use. The revisions to encourage avoidance of duplicative mapping and surveying efforts were reinforced in 1994 by Executive Order 12906, by the Clinger-Cohen Act of 1996 and the E-Government Act of 2002. FGDC coordinates activities of the National Spatial Data Infrastructure (NSDI) "the technologies, policies and people necessary to promote sharing of geospatial data throughout all levels of government, the private and non-profit sectors and the academic community."

In 2007, National Geospatial Advisory Committee (NGAC) was created to provide the Interior department and the FGDC with advice and recommendations related to the management of Federal and national geospatial programs, development of the NSDI and implementation of related Federal guidance. The committee includes representatives from Federal, tribal, state, regional, county and local governments, the private sector and academia. The FGDC provides annual guidance to the NGAC identifying areas of significant concern that would benefit from review by the NGAC. In November 2012, the Government Accountability Office published "*Geospatial Information - OMB and Agencies Need to Make Coordination a Priority to Reduce Duplication"* (GAO-13-94). GAO recommended that the Director of OMB and the Secretary of the Interior direct the development of a *national geospatial strategic plan*, and that the Director of OMB develop criteria for assessing interagency coordination on proposals for potential geospatial investments and strengthen oversight of geospatial projects.

The FGDC has begun to update the strategic plan for the NSDI. Agencies are working with partners and stakeholders in the geospatial community to include a set of goals and objectives for the Federal government's role in continued sustainable development of the NSDI. An updated NSDI strategic plan is important and timely for two reasons. First, while the FGDC has engaged in the strategic initiatives of the Geospatial Line of Business and the Geospatial Platform, the current NSDI strategic plan is has not been revised since 2005. Secondly, geospatial technologies, industries and applications have seen

tremendous growth and change over the past 8 years, so strategies need to be modernized to align with and leverage these changes.

The NGAC, and the many organizations represented by its members, have been tasked by the FGDC with providing input and feedback on the strategic plan as it is developed. In its 2013 Guidance to NGAC, the FGDC designated participation in the development of the NSDI strategic plan as the primary activity for the NGAC. The mandate to NGAC includes the following:

- Provide input to help define key external factors and trends in the geospatial community, which will have an impact on the continued development of the NSDI.
- Provide input to help define the current and future role of the Federal government in advancing the development of the NSDI, and provide input to help collaboratively define the roles and relationships among Federal agencies and non-Federal partners and stakeholders.
- Provide input to review, validate and provide perspectives to help develop a shared vision of the NSDI.

NGAC's response was to create an NSDI Strategic Plan Subcommittee, consisting of three work groups, to provide input on these three tasks. The input was assembled and submitted to the NGAC as a whole for further analysis and comment during April and May of 2013. This document summarizes the consensus NGAC response.

3. WHAT EXTERNAL FACTORS WILL INFLUENCE THE FUTURE OF THE NSDI?

The External Factors/ Emerging Trends Working Group undertook the task of identifying the important external factors, including technology, economic, political and organizational trends, that should be considered for national-level geospatial strategy.

3.1. Evolving Information Management

Innovation in data collection, management, processing, dissemination and application are becoming available largely through private sector advancement of sensors, crowd-sourcing, big data storage/analytics and information distribution technologies, and through academic and government funded research. The origins of many geospatial innovations and operational successes have their roots in past government investment in research and implementation of computing and communication technology, geospatial software systems, framework data development, remote sensors, and GPS.

Nevertheless, the role of government is transitioning from building framework spatial infrastructure to ensuring that specific programmatic goals and the greater public good are served by trusted information resources that meet criteria for fitness for use. Such information has new requirements for transparency, currency, accuracy and accessibility. Instead of being found in Federal web portals that serve out data or maps, next generation resources will be information sourced and served from a combination of the private sector, the public sector, individuals, non-government groups and public-private partnerships.

Geospatial analysis, recently a domain consisting of standalone desktop software, specialty professionals and *ad hoc* information sharing, is now viewed as one component of the overall information management fabric. Geospatial infrastructure must provide value via connected services to a diverse set of devices operated by end users comprising a full range of roles and skills. It must balance the same demands as other information management (accessibility, security, persistence, reliability, confidentiality and cost-efficiency), while providing the spatial capabilities that are its core strength:

visualization, analytics, and the ability to bring together disparate information resources using location as the organizational index.

3.2. Economic and Political Assumptions

Forecasts for planning are built upon assumptions about the political and economic climate. First is an assumption of the continued evolution and expansion of the geospatial industry and its value to stakeholders. This implies an increasing demand for consumer, business and government use of geospatial and location-based services to improve performance throughout human activities. Disruptive conditions are a recurring theme in technology and are difficult to anticipate. Future innovation is generally expected to amplify these current trends, some of which are evident today, while it may also spark new patterns of demand. A second assumption is that future federal and other government budgeting will expect technological transformations within the lifetimes of existing organizations and projects. Thirdly, political pressure to further leverage advantages -- found in the activities of the private sector and state, regional, tribal and local government -- are assumed to apply to geospatial needs and to apply at least at current rates.

3.3. Important Trends

Other trends impacting the strategy for a national geospatial infrastructure can be characterized by four themes: technology; workforce; communications; and legal/policy.

3.3.1. Technology

The next NSDI will need to engage with the following trends in technology:

- The 'internet of things' will connect billions of stationary and mobile sensors with human users.
- The value of integrated geospatial information (3D, 4D, indoor, unstructured, linked, archived) will be magnified by high-powered processing and analytics capabilities, and by the ability to provide succinct intelligence to decision-makers.
- Static ad hoc data will yield to 'big data' transactional models based on Internet-based service models for infrastructure, software, and information content.
- The needs and practice of general IT and geospatial will converge.
- Increasingly, geospatial information resources and application source code will be built collaboratively, using open, rapid deployment strategies and open standards.

Impacts: Geospatial technologies will be called upon to organize a much larger information domain, to provide trusted analysis of complex 'big data' holdings, and to effectively visualize and communicate knowledge so that it can be turned into operational efficiencies. Open data and open government initiatives built on the desire for efficiency and transparency will be the norm, so must be balanced against traditional IT requirements for appropriate levels of information security and risk management. Strategy should be formed using life-cycle approaches that factor in time-to-market and future agility as change becomes embedded into systems.

3.3.2. Communications

The next NSDI will need to engage with the following emerging factors.

- Systems for information delivery will be ubiquitous and highly mobile, will utilize web-based services and will be components of more advanced information workflows.
- Few, if any, traditional media will survive the changes initiated by dynamic social media channels.

- Agencies and individuals will have far higher expectations of quality, timeliness, currency and accessibility of geospatial data and services, yet will have ubiquitous access to information with vastly different lineages and degrees of uncertainty.
- Geospatial metadata standards efforts have not kept up pace, so standardization for discovery and search will be increasingly difficult.

Impacts: There is a heightened need to collect, store, and process data from sensors and the wisdom of the crowd and connect it to decision-making processes as actionable information. Harnessing content provided by sensors and social media, in particular as feedback to enhance authoritative processes and products, needs research and strategy. Information regarding data, processes and products must be an order of magnitude more usable and reliable to ensure meaningful applications of data to create knowledge and inform decisions. Additional attention is needed with regard to the measurement and expression of the uncertainty inherent in information and related analytical products.

3.3.3. Workforce

The next NSDI will need to engage with the people who are already in the employment and training chain, yet the demands are increasing.

- Increasing demand for skill sets positioned at the intersection between the traditional IT and geospatial realms such as: application and services development, geoinformation fusion, crowd-sourcing, social networks and human- geography, visual analytics and forecasting/modeling.
- There will be increasing acceptance of professional competency from non-traditional sources: massive open online courses (MOOC) and other online training and information resources.
- Responsibilities for geospatial data and capability operations will increasingly be assigned to information technology and chief information officers.

Impacts: The current capabilities and organization of the geospatial workforce will be called upon to transform at a rapid pace (NAS, 2013). This is no small task, as it will require a combination of finding, retraining, reorganizing and replacing existing staff. Successful geospatial organizations will build and maintain agile workforces closely-aligned or within IT divisions.

3.3.4. Legal/Policy

The next NSDI will face an evolving legal and political environment.

- Views on geospatial privacy will evolve. Overall public interest in legislating it is growing, and at the same time, a generational gap in public opinion is widening. Legislation will take at least a generation to catch up with technology and behavior.
- Capabilities of local, tribal, regional and state geospatial resources continue to improve and, in many areas, will provide the best sources for ongoing current and accurate information.
- Government policy and private practice will increasingly demand information transparency. Data will be considered an integral and accountable part of decision-making, including its use in models and forecasts.

Impacts: Proactive approaches are needed to develop consensus terminology, develop policy and educate citizens and decision-makers with regard to geospatial data gathering, dissemination, licensing, and usage practices. Privacy, confidentiality and security issues must be addressed for sensitive geospatial information, especially when directly linked to personally identifiable information, to protect the interests of both individuals and commerce. A priority of privacy policy efforts should be on developing consensus-based acceptable practices with immediate use, such as “Pretty Good Privacy”

(PGP). Issues at the margins of privacy acceptability should not delay important work to aggregate and utilize geospatial data and services from local to national levels in a timely manner.

3.4. Summary: What External Factors will Influence the Future of the NSDI?

There are many external factors that are driving trends in technology, communications, workforce and legal/policy of importance to a future NSDI. They signal a strong need to comprehensively rethink national-level geospatial strategy to align with both mainstream and emerging information technology practices and with related trends. The NSDI leverages investments in people, technology, data, and procedures to efficiently create and provide the geospatial knowledge required to protect and promote our national interests. Geospatial technologies provide attractive integrative approaches for meeting current requirements to "do more with less." New approaches are demanded, supported and must be implemented quickly for technology, collaboration, workflow, funding and other resources; and to facilitate policy. Geospatial technology is IT and national geospatial strategy should reflect its place in the broader ever-evolving technology ecosystem.

4. WHAT ARE THE ELEMENTS OF A SHARED VISION FOR THE NSDI?

The Shared Vision Working Group considered three key issues: A comparison of the NSDI past and a view of the future NSDI; the sorts of products or services it will offer; and a vision for the NSDI defined in terms of the value it should will bring to its stakeholders and customers.

4.1. NSDI Past and Future

The following highlights the emphasis of the NSDI at its inception (Past) and a view for the Future.

PAST	FUTURE
Enable the access, sharing and use geographic data across agencies.	Focus on applied information for improved place based decision-making.
Establish spatial data and metadata standards.	Leverage shared and standards-based services.
Reduce duplication of effort among agencies collecting spatial data.	Promote place-based business intelligence and smart, shared applications.
Improve the quality, quantity, and reduction of costs related to geographic information (Pooling resources not only saved money, but allowed for large datasets that would otherwise be unobtainable to get collected).	Core set of data layers that interface with other non-spatial data being generated.
Collect and make geographic data more accessible to agencies.	Use real-time data feeds and sensor webs for improved monitoring, control, situational awareness, and decision-making.
Establish key partnerships with states, counties, cities, tribal nations, academia and the private sector to increase data availability	Establish policies and service level agreements to access and share real time geographic data operations management and decision support.
Increase the benefits of using existing agency data.	Use of multi-temporal information linked to place.
Reduce the monolithic systems storing and managing duplicate spatial data and applications.	Integrate and use advanced technologies (e.g., Web-based, sensors, GPS, and mobile technologies) and their associated standards and best practices.

PAST	FUTURE
Collaborative efforts are centered around spatial data.	NSDI is infrastructure in that it extends far beyond data – it includes and integrates people, hardware, software, and procedures.
Establish a framework for the management of Federal geospatial data resources which involved public/private/non-profit shared governance.	Makes data discoverable for innovation by all.
Provide a process for creating and managing geospatial data and services standards.	Movement toward community driven open standards.
Create institutional knowledge about Federal geospatial data needs and subsequent collaborative acquisition and use.	Nurture and incorporate a social fabric/network with its own intelligence and institution knowledge extending beyond a government entity (Virtual Organization)/ to create both consensus and community.
Create a framework of personnel dedicated to understanding and supporting the geospatial needs of the Federal government.	Provide government, businesses and citizens with a way to visualize and explore data to derive information and knowledge, including the creation of a network of resources and services for seamless integration of location referenced information into broader information assets to serve the needs of government, business and citizens.
Provide the fabric for our National Map. (This was not meant as "The National Map," but rather the efforts at maintaining a nation-wide map as the means of visualizing NSDI data and deriving information and knowledge through said cartographic constructs. To continue to develop NSDI as strictly a data resource without a capability for users to derive meaning from the data will severely limit return on investment.)	Position the NSDI as an enabling resource for discovery, access, integration and application of location information for a growing body of uses.

4.2. Products and Services of the Emerging NSDI

The following includes some characteristics that should be part of the vision for the new NSDI.

- OMB Circular A-16 mandated collaborative purchasing and sharing of geospatial data as guided by the Federal Geographic Data Committee and as implemented primarily through a clearinghouse or portal construct. However, to achieve these objectives, OMB Circular A-16 required not just collaborative efforts centered about spatial data, but supporting personnel, operational policies and procedures, governance, budget, space, and computing resources, thereby transforming from simply data into tangible infrastructure.
- In essence, OMB Circular A-16 set the stage for a National Spatial Data Infrastructure, one that is always available, trusted local to national location information resource to improve government services, stimulates the economic growth, promotes environmental quality, and to supports citizen empowerment for improved place-based decision-making. The NSDI is our new National Map: all of the current and future geospatial data and the combinations thereof which may be assembled to derive nearly infinite meaning about the geographic nature and well-being of our nation.

- The NSDI has grown beyond the capacity of a coordinating body comprised of dedicated support staff managed by proxies sent by agency executives. NSDI is the basis for domestic intelligence about the health and welfare of our nation and the solutions to our most daunting challenges lie in the capture, assemblage and interpretation of spatial data. Greater priority on the importance of NSDI and that it should focus less on data assembly and management and far more on the translation of data to information and its subsequent use as part of governance must occur if true return on investment is to be realized. In other words, what we're losing financially with respect to potential duplication of effort in collection (not that this is acceptable) is likely trivial when compared to the overall under-utilization of geospatial data as a source of information that may be used to solve problems.
- The NSDI should encompass the broad policy, organizational, technical and financial arrangements needed to support ready access to placed-based information, and include the necessary policies, organizational responsibilities, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the national, state, regional, and local scale are not impeded in meeting their objectives.
- The potential implications of geolocation privacy must be considered as part of the future NSDI. As yet, no agency has taken a leadership role in talking this critical aspect of the future of geospatial information, and the costs of inaction compound annually.
- The NDSI should enable the development of the next generation technology, standards, and enhanced content necessary to support improved place-based decision-making.
- The NSDI should leverage the significant work being accomplished through organizations supporting international standards, technology, and best practices.
- The NSDI needs to move rapidly on to new and enhanced efforts aimed at continuing to populate the Framework database in a sustainable production mode; developing and disseminating the procedures and technologies needed for effectively and efficiently building, maintaining, integrating, distributing, and using the data; and continuing the process of establishing clearinghouses and promulgating the necessary standards to support the NSDI.

4.3. Potential Vision Statements

The following are vision statement examples provided by the Subcommittee.

1) NSDI will leverage investment in people, technology, data, and procedures to efficiently create and provide the geospatial knowledge required to protect and promote our national interests.
2) NSDI will leverage investment in people, technology, data, and procedures to efficiently create and provide the geospatial knowledge required to **understand**, protect, and promote our national **and global** interests.
3) NSDI will be an always-available, trusted and local-to-national location information resource to improve government services, stimulate economic growth, promote environmental quality and support citizen empowerment for improved place-based decision-making.
4) NSDI will be a common and shared national repository of placed-based information services and data for use by public and private organizations to improve government services, stimulate the economic growth, and to promote environmental quality.
5) NSDI will be a sustainable infrastructure comprised of people, data, hardware, software and procedures through which geospatial data are assembled and converted to knowledge and/or information for the purpose of protecting and promoting our national welfare.

5. ROLES AND RESPONSIBILITIES OF THE FEDERAL GOVERNMENT

The Federal Roles and Responsibilities Working Group considered two key issues:

1) What is the role of the Federal geospatial community in the further development of the NSDI?
2) What are the roles of tribal, state, regional, county and local governments, the private sector and the academic community in the NSDI and what are the relationships of these entities with the Federal geospatial community?

5.1. Current and Anticipated Roles of the Federal Community

The Work Group felt strongly that the Federal geospatial community should focus on those things it does really well and that no one else can do and eliminate those things that it does not do well, that are too costly or do not have sufficient return on investment.

5.2. Six Federal Roles

The Working Group identified six key roles for the Federal geospatial community, as well as the forces affecting the roles.

5.2.1. Content Provider Role

- NSDI must move from providing data alone to providing geospatial services. This includes the National Map and framework data, the A-16 categories, metadata and catalogs, inter-agency communications.
- NSDI should focus on the Geospatial Platform for pragmatic implementation rather than developing committee studies and papers.

5.2.2. Facilitator Role

- The NSDI should facilitate collaboration between and across multiple government levels, tribes, academia, and the private sector for research and to create data and information services.
- For example Census/USDOT/states are collaborating to create standards and processes to integrate street files among DOT, Census plus state and local governments with road networks and addresses.
- Bring key experts, decision-makers and stakeholders together to address issues and solve problems.
- Work with other national governments to share data, approaches, services, and develop best practices to meet global needs.
- Identify and promote compelling business cases for partners to participate in national level initiatives; ensure that partners' needs will be met.
- Engage partners with compelling examples and clear, non-bureaucratic language.

5.2.3. Curator Role

- The NSDI should focus effort on providing services and normalizing data in a standardized time-stamped format.
- The NSDI should build and maintain an online catalog for transparent web discovery and access to Federal and other data through the Geospatial Platform.

5.2.4. Leadership Role

- In a future NSDI the Federal community needs to embrace a leadership role.
    - The NSDI should recognize a transition in audience from the Fed Government alone to include states/local/tribal government and citizens, educators and scientists, and

businesses. This audience increasingly demands transparent, open and standards based information services.

- A future NSDI should re-engineer individual services initially developed for Federal, State or local government to provide government- to-citizen services.
- In a future NSDI, the Federal government needs to provide institutional leadership for the development and coordination of national and international policies and the legal support framework. In addition, the NSDI needs acquisition leadership, to establish acquisition authority – establish mechanisms for joint acquisitions of geospatial data and services (e.g., Smartbuy) with buy-up options for partners.
- There are great talent and resources within the Federal government that can be used to support growing the broader geospatial community by providing "Convening Leadership."

5.2.5. Enabler Role

- The Federal government can play an enabler role in a revised NSDI by making data and services more accessible to an expanded audience and by publishing more timely, accurate and superior resolution local data to national databases. In this way the federal government can make local information play an enhanced role in national government and business.

5.2.6. Standards and Research Role

- For a future NSDI, the Federal government can help direct and develop a multi-scale ontology of spatial information that has scale-specific content and corresponds to map display standards.
- Ontologies can be application specific, or promote data fusion across diverse domains e.g. agriculture and climate.
- All standards activities are relevant, but the FGDC's role has reduced and been replaced by that of the OGC for NSDI-relevant standards. Data standards have been replaced by more client-server based standards, and have a much broader audience given location based services, mobile computing, etc.

5.3. Additional Recommendations Concerning the Federal Role

The following functional areas, initiatives and issues should be considered, and may influence the future role of the Federal Community in the NSDI:

- The Geospatial Platform as a Focal Point for Federal Activities
    - Make the Geospatial Platform the home for the discovery and sharing of geospatial data and applications with the ability to re-skin/brand within by agency.
    - Make the Geospatial Platform functional for the business of the Federal government.
    - The Geospatial Platform should be open to many vendors of data and software that could constitute a new marketplace, for partnerships and data.
        - Within this effort the Federal government, through GSA, should negotiate contract schedules with private sector data suppliers for access by governments at all levels.

- The Federal Government should create a standing policy on framework data sets
    - Clarity in future data acquisitions will allow better government-business partnerships.
    - Federal government could invite bids around new acquisitions of major data layers (parcels, imagery, elevation, street address).

- Setting requirements should be a collaborative effort of Federal, local, State & and tribal governments.
- Procurement should be done by GSA backed by the appropriate Federal agencies.

- Implement A-16 Guidance And Stewardship
  - An NSDI scorecard should be released every two years to measure programmatic success.
  - Federal role can focus on stewardship of resources.

- International Collaboration
  - The Federal government should be ready to play a global leadership role, but to focus on those activities which are legal mandates.
  - Pursue international collaboration when it is the best interests of the NSDI to do so.

- Capitalize On The Missions Of Other Organizations
  - There are many organizations that have missions that intersect with the FGDC and Federal geospatial enterprise, clarifying the intersections and minimizing overlap would be advantageous.
  - Examples of these intersections include: OGC and standards, and UCGIS and STEM education.

- Use cost benefit analysis to determine whether the best role for the Federal government for a specific data or services should be as data developers or data consumers
  - The Federal government could encourage the development of Web Map Services – live, linked views of a database – and share information in a services environment. Such an approach could make the need for normalization obsolete, by using mashups of data in a common view, providing a new agile environment for data integration and views back to the database.

- The NSDI should provide map integration services
  - USGS currently does map integration both as a manual and semi-automated process, but is not the only Fed agency that integrates and normalizes data from multiple sources.
  - Map integration services should provide cross-cutting solutions to allow the use of data for different purposes at different scales of use – especially incorporating highly transactional local and state data/services.

5.4. Interaction of the Federal Geospatial Community and Other Entities

The Working Group identified the following potential future roles for the Federal geospatial community in facilitating interaction among other sectors and partners with respect to the NSDI.

1) Explore Potential Relationships of Federal Geospatial Community with the Private Sector
   - Integrate the acquisition of private data for use by across governments.
   - Exemplar: NGA and Homeland Security Set up purchase agreements so other levels of government can opt in individually.

2) Enhance the relationship between the Federal Geospatial Community and Academia
   - Academia has a role in research and training for government and private workforce
     - NSDI could include linking and integrating major university libraries' geospatial data and services holdings.
     - Allow public domain publication of data into shared libraries.
     - Develop a public data commons with a supporting virtual community.
     - Contribute models/apps which can be added to the Geospatial Platform and evolve NSDI.

3) Enhance the Role of Federal Geospatial Community in State, Local and Tribal Government Activities
   - Showcase and illuminate examples of multi-governmental cooperation as best practices (e.g. National Map, National Hydrographic Database, USDOT-21, Broadband mapping).
   - Promote the value of geospatial information to government.
   - Federal role can be as facilitators and arbiters.

6. CONCLUSION

The NGAC was charged with examining the issues surrounding a new strategic plan for the NSDI, a key element of which is a new vision and its statement. Three sub-committees were formed and their reports merged to respond to this charge. This report has presented the following: a statement of the conditions leading to and describing the current state of the NSDI; a roadmap showing the changing demands and technological factors that will influence a future NSDI; a prototype vision statement; Federal roles and responsibilities in a revised NSDI and their changes; and descriptions of changes in the broader relations with governments, business, and academia that a new NSDI will encounter. Where specific recommendations are stated, they represent the consensus of the NGAC after considerable discussion. The committee looks forward to providing continued input as the NSDI evolves into the 21st century.

In addition to the technical issues addressed in this document, the NGAC expresses a concern that stable funding mechanisms for cooperative development efforts must be identified. These mechanisms take into account issues related to the "budget sequester" that began in 2013. They also must take into account the long-term funding requirements related to issues such as Landsat and similar remote sensing platforms. These funding mechanisms should logically be tied to independent Return on Investment analyses for the funded programs.

7. REFERENCES

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