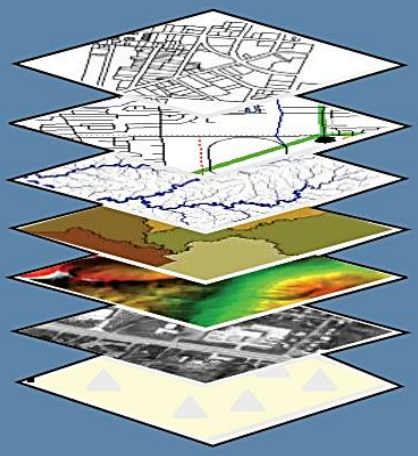
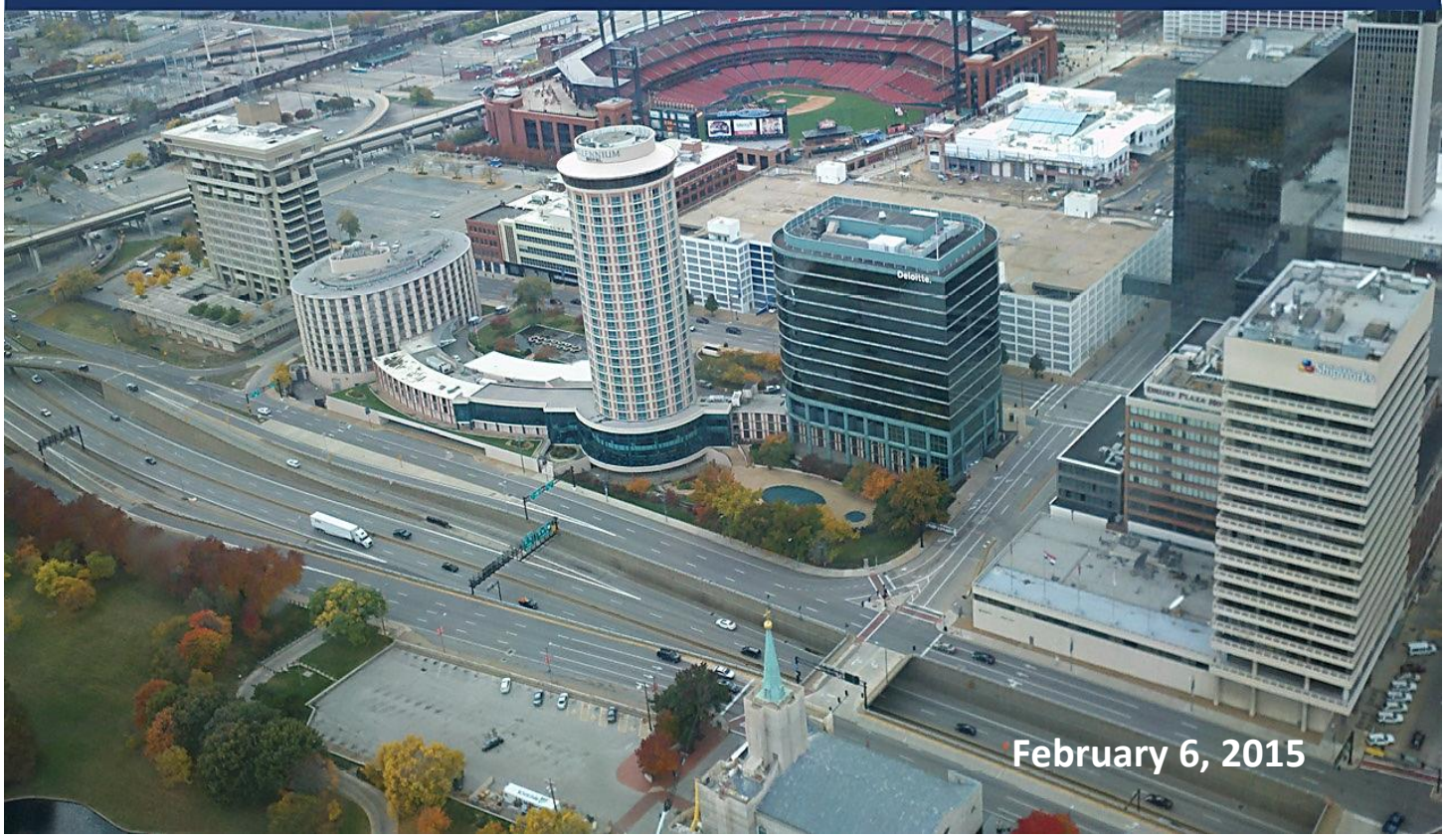


COALITION OF GEOSPATIAL ORGANIZATIONS

American Society of Civil Engineers (ASCE)
American Society for Photogrammetry and Remote Sensing (ASPRS)
Association of American Geographers (AAG)
Cartography and Geographic Information Society (CaGIS)
Geographic and Land Information Society (GLIS)
Geographic Information Systems Certification Institute (GISCI)
International Association of Assessing Officers (IAAO)
Management Association for Private Photogrammetric Surveyors (MAPPS)
National Society for Professional Surveyors (NSPS)
National States Geographic Information Council (NSGIC)
United States Geospatial Intelligence Foundation (USGIF)
University Consortium for Geographic Information Science (UCGIS)
Urban and Regional Information Systems Association (URISA)

REPORT CARD ON THE U.S. NATIONAL SPATIAL DATA INFRASTRUCTURE



February 6, 2015

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FOREWORD

The Coalition of Geospatial Organizations (COGO) recognizes the individual contributions of all Federal, state, regional, tribal, and local government agencies that have worked in concert with the private and academic sectors to develop the National Spatial Data Infrastructure (NSDI) as it exists today. This work has spanned entire careers, and COGO applauds the sincerity of their efforts and the value of their contributions.

However, without the proper guidance, authority, or resourcing to do this important work, the Federal government has not been able to envision the NSDI Framework concepts that were first laid out in Executive Order 12906. Without a strong Federal infrastructure, the other sectors cannot build the NSDI as it was originally envisioned.

COGO commissioned an Expert Panel to develop this Report Card for the NSDI. The Expert Panel focused on the NSDI Framework to grade Federal efforts, and candidly point to some of the shortcomings of those efforts. This Report Card is the work of the Expert Panel, but it has been fully endorsed by the COGO Member Organizations shown at right. COGO offers its profound appreciation for the volunteer work completed by the members of the Expert Panel.

The COGO Member Organizations represent approximately 170,000 individual geospatial practitioners. Together, they are delivering this assessment to help Congress, the Administration, Federal agency executives, and others understand the shortcomings of the NSDI. The Member Organizations would like to engage Congress, Federal agencies, and the FGDC to discuss and identify common sense improvements that will lead to a more robust National Spatial Data Infrastructure.

COGO Member Organizations

American Society of Civil Engineers (ASCE)

American Society for Photogrammetry and Remote Sensing (ASPRS)

Association of American Geographers (AAG)

Cartography and Geographic Information Society (CAGIS)

Geographic and Land Information Society (GLIS)

GIS Certification Institute (GISCI)

International Association of Assessing Officers (IAAO)

Management Association for Private Photogrammetric Surveyors (MAPPS)

National Society for Professional Surveyors (NSPS)

National States Geographic Information Council (NSGIC)

University Consortium for Geographic Information Science (UCGIS)

United States Geospatial Intelligence Foundation (USGIF)

Urban and Regional Information Systems Association (URISA)

For more information on COGO, please see http://www.cogo.pro/

Expert Panel Members

Chair
The Honorable James E. Geringer

Co-Chairs
Dr. David J. Cowen and John J. Moeller

Members
Dr. John D. Bossler
Susan Carson Lambert
The Honorable Thomas D. Rust
The Honorable Robert T. Welch

Please use the following citation for this report.

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EXECUTIVE SUMMARY

Executive Order 12906 (April 11, 1994), stated that "*In consultation with State, local, and tribal governments and within 9 months of the date of this order, the FGDC shall submit a plan and schedule to OMB for completing the initial implementation of a national digital geospatial data framework ("framework") by January 2000 and for establishing a process of ongoing data maintenance*." Subsequent to Executive Order 12906, Framework projects have pursued, but not achieved, the concept of using "best available" locally-produced data sources.

The Federal government jump-started many of the innovations and collaborations that create the current geospatial environment. However, as noted in the 2009 National Geospatial Advisory Committee (NGAC) report "*The Changing Geospatial Landscape*," the Federal government is no longer the dominant data producer. Federal providers of geographic information cannot continue to think of themselves as players separate from the community of private sector, state, local, tribal, and other stakeholders. The NGAC Report further stated:

- *The detailed street maps that support Web-based mapping applications and in-car navigation systems can be traced to the innovations made by the Census Bureau approximately forty years ago.*
- *Nearly all the data, technology and applications we see today can be traced to innovative policies and government practices of the past. As such we require similar innovative policies now to keep pace with this remarkable sea change. Government-based geographic information providers can no longer think of themselves as a players outside of or immune from the community of private sector, state, local or even public stakeholders. In many cases these stakeholders have embraced technology and processes which have rapidly outpaced anything the federal government can provide. At a minimum, what is needed is a commitment to improved spatial data, recognition of the place of multiple stakeholders in this brave new world, and coordinated investment.*
- *The relative shifts in data production from the federal government to the private sector and state and local government call for new forms of partnership. Furthermore, the hodgepodge of existing data sharing agreements are stifling productivity and are a serious impediment to use even in times of emergency. There is an urgent need to reexamine the relationships between data providers and users to establish a fair and equitable geospatial data marketplace that serves the full range of applications.*

In light of the two decade history of the NSDI, and this realistic assessment of the current situation, the Expert Panel concludes that the Framework requires attention, and that several actions need to take place:

- The concept of the Framework needs to be reaffirmed.
- A new model for Framework data needs to be adopted, and this new model must acknowledge the importance of local partners.
- The Federal Geographic Data Committee (FGDC) needs to emphasize that the Framework is part of its Strategic Plan, and that it will work in collaboration with non-federal and non-governmental partners to build an effective NSDI Framework.

A new model for Framework data acknowledges the importance of local

partners and builds on successful elements of the Census Bureau's new Community TIGER program, which makes it easier for local partners to create and share data. With that program in mind, the panel is suggesting a Framework model that emphasizes the use of current information technologies, federated and web-based capabilities, and private-sector location-based searches and applications. A Framework that builds on and supports web-based services and applications can be traced to innovations made by FGDC member agencies many years ago.

This updated approach also captures the original vision of the NSDI Framework by building modern systems that make it easier for local partners to create the data they need, and to share it through the NSDI. In effect, this is a "bottom-up" rather than a "top-down" approach that is possible in today's information technology environment.

This initial Report Card by the Coalition of Geospatial Organizations (COGO) is a qualitative assessment of the status of the Framework data components of that program. This evaluation specifically examines the status of the seven data themes that serve as the backbone required by users to conduct most mapping and geospatial analysis tasks. While Framework data have been collected and made available for use over the past two decades, a digital geospatial Framework that is national in scope, is not yet in place and may never exist. Based on the following analysis, the overall grade assigned to the comprehensive NSDI Framework is C-.

The importance of geospatial technologies is demonstrated by our universal dependence on web maps, GPS systems, and location-based systems. To support a myriad of decisions every day, citizens and public officials require online access to basic information about the location of streets, buildings, services, and environmental features.

The clear objective of the NSDI was to create a dependable utility that would provide accurate, consistent, and current data to all users. The goals of the program were to:

- Reduce duplication of effort among agencies.
- Improve the quality of data and reduce costs related to the acquisition of geographic information.
- Make geographic data more accessible to the public.
- Increase the benefits of using available data.
- Establish key partnerships with states, counties, cities, tribal nations, academia, and the private sector, to increase the availability of geographic data.

The NSDI includes a number of connected components, including the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve the utilization of geospatial data. However, the cornerstone of the program is a common digital base map that would aggregate the best representations of fundamental data from all levels of government. These Framework data layers are intended to serve as the unified foundation upon which all other geographic information could be created and shared. By maintaining a standardized, high-quality series of Framework data the NSDI would provide access to reliable, current data from all of the above partners, not just Federal agencies. This would minimize duplication of effort and promote the use of the most complete and reliable information.

The Framework data layers include:

- ***Cadastral*** – Information about land ownership.
- ***Elevation*** – The height of the land and depth of water bodies.
- ***Geodetic Control*** – The precise location of features in relation to other features using a common reference system for coordinate positions.
- ***Governmental Units*** – The boundaries and names of government service and management areas at all levels of government.
- ***Hydrography*** – The path of streams and drainage areas, and the location of water bodies and shorelines.
- ***Orthoimagery*** – Aerial and satellite imagery processed by removing inherent distortions to make them accurate like a map.
- ***Transportation*** – The path of roadways and rail lines, and the location of supporting features such as train stations and bus stops. However, in the context of Framework, we generally just refer to Road Centerline data.

The status of these seven data layers is the focus of this initial Report Card. By evaluating the Federal government's efforts to lead and coordinate the creation and maintenance of these data, this report reflects on how well the NSDI is meeting its goals.

The panel of experts that prepared this initial Report Card has conducted a qualitative evaluation of the status and condition of the NSDI and its Framework data layers. The report card should serve as a starting point for frank discussions about the role of the Federal government to provide common geospatial data for all users. The timing of this evaluation follows a decision by the Federal Geographic Data Committee (FGDC) to reduce its emphasis on the concept of Framework data and move towards portfolio management for a much larger number of data layers. Consequently, it raises questions about whether the new portfolio management approach to managing National Geospatial Data Assets (NGDA) will even meet the fundamental purposes of a common digital base map available to all users. This assessment suggests that the Federal agencies charged with the stewardship of the seven Framework data layers face serious obstacles in terms of authority and funding. The hallmark of the NSDI was designed to be the partnership among all levels of government. In today's environment the most accurate and current geospatial data are routinely collected by local government. Therefore, a successful NSDI demands that these high resolution data become part of the Infrastructure. It is also imperative to recognize that the most consistent information about roads and land records exist in proprietary databases that Federal agencies lease from commercial firms. This commercial data cannot become part of the NSDI due to licensing restrictions. At a minimum, the Report Card suggests that there is a critical need for a serious assessment of user needs and requirements for a modern data system.

The NSDI Report Card does not include a cost estimate for completing the NSDI, or for bringing the Framework to a specified level or grade.

The panel recognizes that there have been many positive actions in the implementation of the NSDI Framework. For example:

- Individual thematic datasets have been developed.

- Metadata and data standards have been adopted and are generally used by data collectors.
- Government agencies routinely make their data assets publicly available through data portals and spatial data clearinghouses.

Thanks to these positive actions, the NSDI Framework provides substantial value to users by making large amounts thematic data available to the public.

We are reminded, however, that the original vision and the greatest potential value of the NSDI Framework have not yet been fulfilled. While multiple datasets for each of the themes can be accessed through the National Geospatial Platform, definitive sets of nationally consistent, fully integrated, and reliable data do not exist for the entire nation. The current representations exist as seven separate themes rather than a fully integrated system.

REPORT CARD GRADES (Figure 1)

The average grade for the seven Framework data themes is C. The NSDI as a comprehensive entity is assigned a grade of C-. Individual grades are identified below. The rationale for these grade assignments can be found in the remainder of this report.

GRADE REPORT OF: National Spatial Data Infrastructure (NSDI) **SEMESTER:** Fall 2014

Subject	Dept.	Grade
CADASTRAL DATA	DOI	D+
GEODETIC CONTROL	DOC	B+
ELEVATION DATA	DOI	C+
HYDROGRAPHY DATA	DOI	C
ORTHOIMAGERY DATA	DOI & USDA	C+
GOVERNMENT UNITS DATA	DOC	C
TRANSPORTATION DATA	DOT	D
OVERALL DATA GRADE		C

Subject	Dept.	Grade
CAPACITY	FGDC	C
CONDITION	FGDC	D
FUNDING	Various	D
FUTURE NEED	FGDC	D
OPERATION & MAINTENANCE	FGDC	C
PUBLIC USE	FGDC	C
RESILIENCE	FGDC	C
COMPREHENSIVE GRADE		C-

TO: Federal Geographic Data Committee
590 National Center
Reston, Virginia 20192

FROM: Coalition of Geospatial Organizations (COGO)
http://www.cogo.pro
See the full report for an explanation of each grade.

INTRODUCTION

The Coalition of Geospatial Organizations (COGO) serves as a forum for thirteen nonprofit organizations concerned with national geospatial issues. The COGO organizations represent approximately 170,000 individual geospatial practitioners. COGO works to improve communications among member organizations, and to align and strengthen their ability to address national issues related to the use of geospatial technology and information. The member organizations agreed to develop this report card on the National Spatial Data Infrastructure, loosely modeled after the American Society of Civil Engineers (ASCE) *Report Card for America's Infrastructure*. To do this, a panel of experts (Appendix A) was appointed by COGO to evaluate the status and overall condition of the NSDI and the Framework data.

Currently, there are no effective metrics to gauge the Federal government's progress in implementing the NSDI. This has prevented NSDI proponents from providing the Office of Management & Budget (OMB) and Congress with status information, or from making a compelling case for adequately funding Federal agency efforts.

The NSDI Report Card is a qualitative evaluation of the status and condition of the NSDI and its Framework data layers. It does not include cost estimates for completing the NSDI or for bringing the Framework to a specified level. The goal of this evaluation and report is to bring attention to the need for current and accurate geospatial data for the United States.

BACKGROUND

The need for a coordinated approach to manage the survey and mapping data of the United States was recognized in the mid-1800s. By the early 1900s it was acknowledged that a more coordinated approach was needed. In 1906, President Roosevelt signed an Executive Order establishing the U.S. Geographic Board which was to advise on projects, take measures to avoid duplication, and improve the standardization of maps. Over the next 84 years, other Orders and Circulars would be issued to improve the coordination and use of mapping and surveying data within the United States. In 1990, OMB Circular A-16, originally issued in 1953, was revised. This revision of A-16 created the Federal Geographic Data Committee (FGDC) to *"coordinate surveying, mapping and related spatial data activities and to promote the coordinated development, use, sharing and dissemination of surveying, mapping and related data across the Federal Government."* A major objective of the Revised Circular was the eventual *"development of a national digital spatial information resource with the involvement of Federal, state, and local governments and the private sector."* This resource would also be linked through criteria and standards that would enable the sharing and efficient transfer of spatial data between producers and users.

On April 11, 1994, President Clinton issued Executive Order (EO) 12906 that chartered the Federal Geographic Data Committee (FGDC) to lead and coordinate the development of the National Spatial Data Infrastructure (NSDI). The EO broadly defined the NSDI as *"the technology, policies, standards, and human resources necessary to acquire, process, store, distribute and improve utilization of geospatial data."* This definition was built from one provided by the National

Research Council (NRC) Mapping Science Committee that stated, "The NSDI should be the means to assemble geographic information that describes the arrangement and attributes of features and phenomena of the Earth." Among other deadlines, EO 12906 specified a deadline of January 2000 for the initial implementation of a national digital geospatial data Framework. The plan for this was to be prepared in consultation with state, local, and tribal governments and submitted to OMB within nine months from the date of the EO.

The 1990s was a time of significant forward movement in the development of the United States as an information society. During this time, there was also recognition that an information society depended on spatial data and information. For example, the NRC issued reports in 1993, 1994, and 1995 that addressed the concepts, needs, and potential contents of an NSDI.

In particular, the 1993 NRC Report "*Toward a Coordinated Spatial Data Infrastructure for the Nation*" was important for laying the groundwork for Executive Order 12906. According to the report, an ad hoc NSDI already existed. The report recommended a series of actions with two specific goals: "*first, to make the existing NSDI more coherent and coordinated; and second, to position the U.S. more competitively in the growing and increasingly international geospatial data and technology arena.*"

While these NRC Mapping Science Committee Reports helped define the NSDI, they also identified four principles to guide the NSDI's development:

- Data should be widely available.
- Accessing spatial data should be easy.
- The NSDI should be flexible and not dependent on current technology, data, or organizational structures.
- The NSDI should be a foundation to foster new applications, services, and industries.

EO 12906 reinforced many of the issues and concepts described by the NRC. EO 12906 recognized that geographic information is critical to promote economic development, improve stewardship of natural resources, and protect the environment. It also emphasized that the FGDC "shall develop, to the extent permitted by law, strategies for maximizing cooperative participatory efforts with State, local, and tribal governments, the private sector, and other nonfederal organizations to share costs and improve efficiencies of acquiring geospatial data consistent with this order.

The concept of the NSDI has evolved since the 1990s but continues to retain the original vision of the NRC Reports and EO 12906. Today, it is understood that the NSDI must be:

- A geographic resource for both the present and the future.
- A foundation for helping the public and private sectors use geospatial data for better decision making.
- A resource for many people and organizations working together towards common goals.
- A collection of current and accurate geospatial data available for local, state, national, and global use.
- An infrastructure for geospatial applications and services.
- A flexible resource that changes as technology, business requirements, and user needs change.

COMPONENTS OF THE NATIONAL SPATIAL DATA INFRASTRUCTURE

Infrastructures can be physical or cyber-based systems with sets of interconnected elements needed to carry out the operations of society, a single enterprise, or a group of enterprises. Just like our transportation, banking, and financial infrastructures, a spatial data infrastructure such as the NSDI is an interconnected system designed to facilitate a state of cooperation and connectivity. This enables government, businesses, private institutions, and citizens to share and use spatial information and services to meet their basic operational needs.

The purpose of the NSDI is to:

- Reduce duplication of effort among agencies.
- Improve quality and reduce costs related to geographic information.
- Make geographic data more accessible to the public.
- Increase the benefits of using available data.
- Establish key partnerships with states, counties, cities, tribal nations, academia, and the private sector to increase the availability of geographic data.

The NSDI has come to be seen as the "technologies, policies, organizations and people necessary to promote cost-effective production, ready availability, and greater utilization of high quality geospatial data among a variety of sectors, disciplines and communities" (DOI 2003). It should provide a common structure of practices and relationships among data producers and users to facilitate data sharing and use, and new ways to access, share, and use geographic data.

The NSDI is made up of a number of connected elements including:

- Clearinghouses, catalogues, and portals for discovery and access.
- Metadata or information that captures the basic characteristics of data or information technology resources.
- Framework data, a reliable and standardized source of commonly used data.
- Thematic data developed and used for particular business requirements.
- Standards for geospatial data and technology—developed through a voluntary, consensus-based processes to promote interoperability and effective sharing and use.
- Collaborative partnerships between the private sector, academia, and state, local, and tribal governments to efficiently and cost-effectively collect, integrate, maintain, disseminate, and preserve spatial data, building on local data wherever possible.
- Public policies that promote greater public access to government data, data sharing, privacy protection, simplified and unified business processes, and reduced duplication of data collection and government services.

A core element of the NSDI is standards. As described above, standards are the key to interoperability and will allow organizations to effectively share and use geospatial data and technology. A variety of existing standards are cited throughout this report. These standards may be endorsed by different standards development

organizations, but each is important in providing a level of conformity and consistency. For example:

- FGDC-endorsed standards are required for use by Federal agencies.
- American National Standards Institute (ANSI) standards are required for use in the U.S. marketplace.
- The International Organization for Standardization (ISO) develops international standards for products, services, and systems to ensure quality, safety, and efficiency; and to facilitate international trade.

Standards from any of these organizations - as well as technology standards and specifications from organizations such as the Open Geospatial Consortium (OGC) - may be appropriate for use by an organization. Standards may also move from national or governmental approval to international approval. A key part of the standards development and maintenance process of these recognized organizations is the periodic review of adopted standards. Reviews are conducted to determine if standards meets current user needs and are up to date with accepted practices and technology. Good management practices call for standards to be checked to ensure they are current prior to being promoted for use in major new initiatives.

WHY DID COGO ONLY GRADE THE FRAMEWORK?

Assessing the status of the entire NSDI is not feasible without significant funding and cooperation from all Federal agencies. Since the Framework is recognized as the data backbone of the NSDI, it was selected for this assessment. Most organizations have business requirements for the same Framework data for their operations and systems. Data are often collected by multiple organizations within a particular level of government, or between levels of government, resulting in waste and costly duplication of effort. Organizations that cannot access the right data, or afford the costs of data collection and production, will simply use outdated or unreliable data, resulting in inaccurate information and less effective decision making. The Framework is intended to help address this need for accessible, accurate data by providing a reliable and standardized source of the seven most commonly needed and used geographic data themes.

The importance of the Framework as a fundamental building block of the NSDI has been recognized since the issuance of EO 12906. The Framework has been a focus of Strategic Plans for the NSDI and was one of three Goals of the NSDI Future Directions Initiative endorsed in 2005.

In December 2013, the FGDC's 2014–2016 Strategic Plan for the NSDI was adopted to update and modernize the strategic direction of Federal geospatial programs. The Strategic Plan sets priorities and describes the actions that the FGDC community will take, in collaboration with partners, to develop and maintain the NSDI. The NSDI Framework was shown on page 11 of the Plan as one of the 1992 priorities, but this current Plan does not specifically address the Framework. Each of the Plan's goals is very relevant to successful development of the NSDI Framework as a resource for the entire geospatial community. The Plan lacks a focus on this core NSDI capability, but it does include the development and tracking of Performance Measures for each of the Goals and Objectives. These Performance Measures should be very useful for future assessments such as this, as well as for their intended purpose of implementing the Plan.

The three goals of the 2014-2016 NSDI Strategic Plan are to:

- Develop Capabilities for National Shared Services.
- Ensure Accountability and Effective Development and Management of Federal Geospatial Resources.
- Convene Leadership of the National Geospatial Community.

The Federal Geographic Data Committee in accordance with OMB Circular A-16 Supplemental Guidance, has begun using a Portfolio Management approach. This approach coordinates development of Federal geospatial data assets and investments to most efficiently support national priorities and government missions. The focus of Portfolio Management is to apply consistent management approaches that help increase the quality of data through best practices and documentation to reduce duplication and cost; provide greater accessibility and support shared services across the Federal Government.

The Portfolio Management process identifies Federal datasets that could be considered National Geospatial Data Assets (NGDA). These are Federal geospatial data assets and investments that support mission goals of

multiple federal agencies; are statutorily mandated; or support national or Presidential priorities as expressed by Executive Order or by OMB. These datasets are organized into management units called Themes which are managed by Theme Leads.

Framework data are not specifically identified as such in the Portfolio, but are part of the construct of 16 Themes identified in the NGDA Portfolio.

These recent Federal actions of the 2014-2016 Strategic Plan and Portfolio Management approach appear to have diminished Federal emphasis on Framework as a national resource and on the importance of state, local, tribal and private data as much of the best geospatial data available for use as a common integrated widely available resource.

The Panel believes that the NSDI Framework is important to the continued development of interconnected system that enables government at all levels, businesses, private institutions, and citizens to share and use spatial information and services to meet their basic operational needs.

The Framework involves all of the elements of the NSDI and its progress is illustrative of overall NSDI coordination and progress. While the Framework is difficult to assess, the panel determined that an assessment was achievable.

THE NSDI FRAMEWORK

The NSDI Framework is a collaborative effort to create a widely available source of basic geographic data, including:

- Seven themes of digital geographic data that are commonly used.
- Procedures, technology, and guidelines that provide for integration, sharing, and use of data.
- Institutional relationships and business practices that encourage the maintenance and use of data.

"The Framework represents "data you can trust"—the best available data for an area, certified, standardized, and described according to a common standard. It provides a foundation on which organizations can build by adding their own detail and compiling other datasets." (http://www.fgdc.gov/framework/frameworkoverview)

In light of the Framework's importance, the FGDC in consultation with state, local, tribal, and non-government stakeholders has built on the NRC Report Recommendations and policy established by the EO and OMB Circulars to further define guiding principles for building the Framework data, including:

- The Framework should be a preferred data source representing the best available data for an area—the most current, complete, and accurate data.
- The Framework should be openly available; exist in standard, nonproprietary formats; conform to approved standards; and originate from reliable sources.
- The Framework should be widely used and useful, with users able to integrate Framework data with their own data.
- The Framework should be a public resource that provides access to Framework data at the lowest possible cost. Charges for access to Framework data should be limited to the costs of providing access and dissemination.
- The Framework should avoid restrictive practices and restrictions on use and dissemination. Information about limitations should be included as part of the metadata.
- Duplication of effort should be minimized. Sharing the development and maintenance of Framework data reduces the costs to individual users.
- The Framework should be based on cooperation, built through the combined efforts of many participants who work together in its development and implementation.

The NSDI Framework has the following seven designated themes of data, and two of these themes, Elevation and Cadastral, have two parts.

CADASTRAL DATA THEME

Custodians: DOI-BLM (land) & BOEM (offshore)

Cadastral information refers to property interests. Cadastral data represent the geographic extent of the past, current, and future rights and interests in real property. The spatial information necessary to describe the geographic extent, and the rights and interests in property. It includes surveys, legal description reference systems, and parcel-by-parcel surveys and descriptions.

The offshore cadastre is the land management system used on the Outer Continental Shelf. It extends from the baseline

to the extent of United States jurisdiction. Existing coverage is currently limited to the conterminous United States and portions of Alaska. The maximum extent of United States jurisdiction is not yet mathematically calculated.

ELEVATION DATA THEME

Custodians: DOI-USGS (terrestrial), & DOC-NOAA (water)

Elevation data provide information about terrain. Elevation refers to a spatially referenced vertical position above or below a datum surface. The Framework includes the elevations of land surfaces as well as the depths below water surfaces (bathymetry).

GEODETIC CONTROL DATA THEME

Custodian: DOC-NOAA

Geodetic control provides a common reference system for establishing the coordinate positions of all geographic data. It also provides the means for tying all geographic features to common, nationally-used horizontal and vertical coordinate systems.

GOVERNMENTAL UNITS DATA THEME

Custodian: DOC-Census

Governmental Units data include the nation, states and statistically equivalent areas, counties and statistically equivalent areas, incorporated places and consolidated cities, functioning and legal minor civil divisions, Federal and state recognized American Indian reservations and trust lands, and Alaska Native regional corporations.

HYDROGRAPHY DATA THEME

Custodian: DOI-USGS

Hydrography data include surface water features such as lakes and ponds, streams and rivers, canals, oceans, and shorelines. Each of these features has the attributes of a name and a feature identification code.

ORTHOIMAGERY DATA THEME

Custodians: USDA-FSA (leaf-on) & DOI-USGS (leaf-off)

Orthoimages are positionally correct images of the Earth. An orthoimage is a georeferenced image prepared from an aerial photograph or other remotely sensed data from which displacements of images caused by sensor orientation and terrain relief have been removed.

TRANSPORTATION DATA THEME

Custodian: USDOT-BTS

Transportation data include the following major common features of transportation networks and facilities: roads, trails, railroads, waterways, airports, ports, bridges, and tunnels.

ASSESSMENT METHODOLOGY

The Expert Panel developed the following general criteria that are modeled on the criteria used by the American Society of Civil Engineers (ASCE) Report Card for America's Infrastructure. These criteria are used in the following seven sections for each of the individual Framework data themes.

A = FIT FOR THE FUTURE

The data theme is generally in excellent condition and meets the needs for the present and the future. Few geographic areas of the nation require attention. Standards for data and assured public access are met. Specific data are identified as Framework and are integrated for use consistently across the United States. Data identified as Framework are also in a standards-based form that can be readily incorporated into an integrated Framework data network across the United States. Users are able to easily identify, integrate, and use data from this theme in a wide variety of applications.

B = ADEQUATE FOR NOW

The data theme is in good to excellent condition, but some geographic areas of the nation require attention for significant deficiencies. A substantial majority of the theme data that have been designated as Framework follow appropriate standards and are available. Data identified as Framework is integrated for use consistently across the United States and can be incorporated into an integrated Framework data network with minimum work by users. Users are able to find, integrate, and use data for a majority of U.S. locations.

C = REQUIRES ATTENTION

The data theme is in fair to good condition, but it requires attention for many geographic areas of the nation. Standards for this data theme exist and are used for most of the data that are designated as Framework. Users have some difficulty finding, integrating, and using data, and a consistent integrated network for this theme is not in place across the United States. Significant effort will be required to incorporate data identified as Framework into an integrated Framework data network. Some locations in the U.S. are missing Framework data for this theme.

D = AT RISK

The data theme is in poor to fair condition and mostly below the goals envisioned for the NSDI. A large portion of the data for this theme have not been developed sufficiently to make them accessible, or are unable to be integrated with other data from this theme. Standards exist for data designated as Framework for this theme, but the standards are not being consistently used among data providers and developers. For many locations, data are not useful without significant work by the user and cannot be integrated into a network for consistent use across the United States.

F = UNFIT FOR PURPOSE

The data for this theme is in an unacceptable condition and provides little to no value to users. Standards for the data theme do not exist or are not being used by most of the users, providers, or data developers. Most of the data cannot be found or used in applications at national or local levels and cannot be integrated into either a network for the theme or an integrated Framework data network for use across the United States.

Over the past 20+ years, stakeholders, including COGO organizations, have suggested policies and practices aimed at implementing the NSDI from local to national levels. The National Geospatial Advisory Council has prepared position papers on a number of issues related to the NSDI, and has promoted policy positions to the FGDC Chair. In addition, the NRC's Mapping Science Committee has prepared Reports on the NSDI and the Framework data. Government agencies such as the Office of Management and Budget, Government Accountability Office, and Congressional Research Service have also conducted studies or provided direction to the FGDC and member agencies. Collectively the initiatives and reports of these organizations have provided significant input and stimulus to the implementation of the NSDI. Many of these actions have been directed towards development of the NSDI Framework and specific data themes. These sources are not discussed in detail in this Report, but the panel has included in its research, the following sources that are relevant to the Framework.

The Coalition of Geospatial Organizations (COGO) includes thirteen Member Organizations and four Advisory Organizations. COGO participants have been active in efforts to improve the development, sharing, and use of geospatial information by all sectors and the general public. This Report Card includes inputs from the COGO Member Organizations. A brief description of each Member Organization is included in Appendix B.

The National Geospatial Advisory Council (NGAC) is a FACA Advisory Committee to the Department of Interior. It has prepared position papers on a number of issues related to the NSDI and has promoted policy positions to the FGDC Chair.

The initiatives of COGO Member Organizations and NGAC will not be discussed individually, but the panel has considered those that are relevant to the Framework data in the preparation of this Report Card.

The National Research Council (NRC) Mapping Science Committee has prepared several reports on the NSDI and the NSDI Framework. Government agencies such as the Office of Management and Budget (OMB), Government Accountability Office (GAO), and Congressional Research Service have also conducted studies or provided direction to the FGDC and member agencies. Where these reports and their recommendations are relevant to the NSDI Framework, they have been specifically mentioned or referenced.

The National States Geographic Information Council conducts a baseline assessment methodology to routinely and continuously monitor and validate statewide geospatial capabilities. This assessment is known as the Geospatial Maturity Assessment (GMA).

As part of the GMA, the District of Colombia, the Virgin Islands, Puerto Rico, and each state was asked to answer 83 detailed questions characterizing their geospatial programs. The GMA was first published in 2011, and the survey results were used to develop a GMA score and rank. The information collected includes Statewide Data Status and Clearinghouse availability. The Statewide Data Status information included categories for most of the NSDI Framework themes.

The GMA was updated in 2013, and these most recent scores and rankings have been used to help assess each of the relevant Framework data themes.

Additional tools are being created that will help provide a more detailed assessment of geospatial development at the regional and local government level. For example, URISA has developed a GIS Capability Maturity

Model. This model is a key component of the GIS Management Institute, and it is meant to provide a theoretical model of a capable and mature enterprise GIS operation within a designated organization. The URISA GIS Capability Maturity Model will serve as a stand-alone document to define the framework for an effective enterprise GIS. The model was developed initially with a focus on local government agencies (cities, counties, regional agencies, and similar entities), but it is intended for future use by any enterprise GIS. The model will help GIS managers and decision makers discuss the appropriate components of a capable enterprise GIS, the characteristics of a well-managed GIS, and the effectiveness and ROI from a given level of investment.

URISA launched its online geospatial capability and maturity assessment program in late 2014. While it was not used in this assessment, it should prove valuable in future assessments.

The FGDC has completed a new NSDI Strategic Plan for 2014-2016. One of the specific actions of the Plan is:

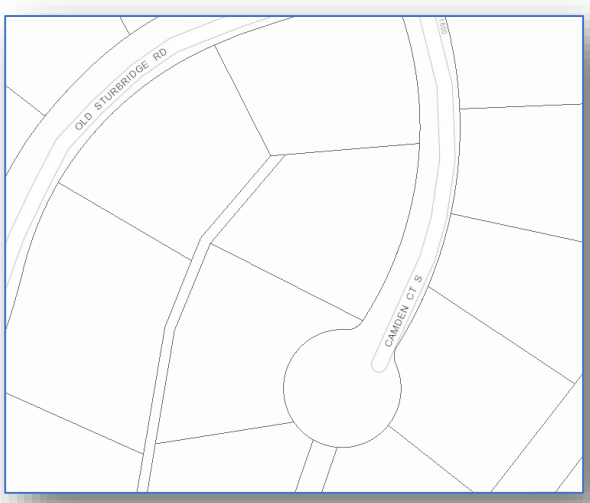
> *"Action 2.1.4. Develop a process for monitoring and reporting on the progress of Circular A–16 Data Themes and Geospatial Platform Community management responsibilities, including the use and proliferation of content and technology standards."*

Taken together, the above tools, reports and other sources of information, can help refine state and national assessments, and they will provide a much more robust and accurate means for future assessments of the status of the NSDI Framework and the NSDI in its entirety.

CADASTRAL DATA THEME

GRADE: D+

(At Risk)



Parcel boundaries from Maryland's MDiMAP

Note: The terms *authoritative*, *cadastre*, and *cadastral* as used in this document are not intended to imply the accurate location of real property boundaries.

Discussion: The grade is based on the fact that a comprehensive parcel database for cadastral information does not exist. Nor is there a program to create a "sustainable and equitable intergovernmental funding program for the development and maintenance of parcel data" as recommended by the 2007 National Research Council Report "National Land Parcel Data: A Vision for the Future" (NRC, 2007). Furthermore, in light of the discussion and analysis within this chapter, perhaps the Cadastral Data Theme should be considered for removal from the Framework layers and re-addressed as a separate significant initiative.

This situation does not reflect negatively on either the BLM as the designated steward, or the FGDC Cadastral Subcommittee, both of which have worked diligently to coordinate cadastral information across the country. Parcel polygons and associated land record information are simply not like the other categories of Framework data. The data for approximately 150 million non-federal land parcels are maintained by approximately 6,700 land records (cadastral or parcel) data stewards, including over 3,200 counties and equivalent units of local government.

The grade reflects that the Federal government is unwilling to adequately address the needs of Federal agencies for parcel data, even when the recent financial crisis dramatically illustrated the disastrous consequences of not monitoring such information. Therefore, until the FGDC supports a comprehensive approach to assembling parcel information from local stewards, it should acknowledge that the United States does not have a program to create and support a Cadastral data theme.

The startling reality is that while the Department of Justice is penalizing financial institutions tens of billions of dollars for fraudulent mortgage lending practices, the Federal government has chosen not to implement a national Cadastral Framework program to effectively manage these issues. Consequently, as noted by the Government Accountability Office (GAO), the numerous Federal programs (including the new National Mortgage Database) that require access to parcel data will license the data from the private sector.

The coordination to assemble these data into a national Framework theme will require a comprehensive program such as the one outlined in the NRC study. This program and its nine recommendations were endorsed by the National Geospatial Advisory Committee,

but no concrete actions were taken. Furthermore, when the BLM requested resources to implement the NRC plan, the DOI concluded that it "does not have the statutory authority or funding to provide national parcel coordination" (NGAC, 2012).

It must be emphasized that the absence of national coordination of cadastral data in the United States is in stark contrast to the 28 countries of the European Union (EU), which made cadastral parcels the foundation of the Infrastructure for Spatial Information in the European Community (INSPIRE). As they state:

> *"The cornerstone of the specification development was the definition of the Directive on the cadastral parcels: "areas defined by cadastral parcels or equivalent."*

Impacts: The lack of comprehensive cadastral data is significant, and its impact has been shown by a number of recent events.

First, the collapse of the mortgage market focused a spotlight on the consequences of the United States' failure to maintain cadastral data. In the 2009 paper "*What Have Americans Paid (and Maybe the Rest of the World) for Not Having a Public Property Rights Infrastructure*," Roberge and Kjellson [1] concluded:

> *"In effect, we believe that a good property rights infrastructure could have mitigated the effect of the land market crisis and thereby avoided the loss of many hundreds or even thousands of billion dollars."* (Roberge and Kjellson, 2009)

The nation's poor response to Hurricane Katrina also highlighted the need for better parcel information that could help officials more effectively prepare for and respond to major disasters. In addition, wildfires like those in the Western United States cause extensive damage in the suburban/wildland interface, showing the need for a parcel data infrastructure to protect citizens and communities from the effects of wildfire outbreaks.

Lastly, from the local level to the national level, cadastral data that describe the geographic extent of rights, title, and interests in land parcels are used in many aspects of government and business. Cadastral data are used in areas like property assessment, law enforcement, business location, transportation planning, national disaster response, and hazardous materials clean-up. The economic costs of the lack of cadastral data have not been calculated, but the example of the mortgage crisis alone shows

[1] Daniel Roberge is currently (2009) Director of the Office of the Surveyor General of Québec. He has been involved in the design, the development and the implementation of two of the most extensive land reforms ever undertaken in North America: the reform of the Quebec cadastre, which covers all privately-owned land in Quebec, and the modernization of the system to record rights on public land. Mr Roberge is member of the board of the Champlain Branch of Canadian Institute of Geomatics. He also participated to the foundation of the Fédération des géomètres francophones. He is the FIG Commission 7 Past-Chair.

Bengt Kjellson is head of the Land Registration Division within Lantmäteriet, Sweden's national Mapping, Cadastre and Land Registration Authority. He has considerable experience from various land administration projects in different parts of the world. He was chair of UNECE Working Party on Land Administration between 2001 and 2005, and is a Past-Chair of EuroGeographics' Cadastre and Land Registry network.

that these costs easily run into the billions of dollars.

A. Introduction

BLM's Effort to Coordinate Cadastral Framework Data

The Federal government has concluded that it does not have either the mandate or the proper incentives to assemble parcel data as a standardized public domain database for the nation. This is particularly disappointing given the demonstrated needs and efforts of the past decade. Seven years ago the BLM, the Census Bureau, the FGDC, the Department of Homeland Security (DHS), and Environmental Systems Research Institute (Esri – a private company) commissioned the NRC to conduct an objective study that would:

- Identify the benefits of accurate parcel databases for all stakeholders (public and private).
- Describe the current status of parcel databases across the nation at all levels of government.
- Document what has been shown to be possible at a local, regional, and state level, using examples of successful systems.
- Provide a vision of what could be possible nationwide, and identify a strategy to achieve that vision, including the role of Federal agencies and accounting for challenges that must be overcome.

Even before the mortgage crisis erupted, the federal demand for parcel data was well documented. In the wake of the dismal response to Hurricane Katrina, HUD and DHS expressed how important parcel data are to prepare for and respond to disasters. As a representative from DHS stated in a public forum:

- *"Parcel data are the fundamental building blocks for all geographic analysis and serve as the raw material for most applications—most geographic analysis benefits from the ability to understand the result at the parcel level.*
- *National response centers such as IMAAC depend on the availability of local data for accurate hazard predictions and health recommendations such as "shelter in place."*
- *Most DHS programs depend on geographic data that are at the parcel scale—for example the Critical Infrastructure Program."* (NRC, 2007, p 47-48)

The authors of the report provided the following vision:

> *"The committee's vision for nationally integrated land parcel data is a distributed system of land parcel data housed with the appropriate data stewards but accessible through a central web-based interface. It would have a minimum set of attributes, and the development and integration of the national data set would be overseen by a national coordinator, working with coordinators for federal lands, Indian lands, and each state. These data would serve as the cadastral data layer of the NSDI."* (NRC, 2007)

The report offered a model of how parcel data should flow from local government producers to a full range of users (Figure 2).

The NRC developed nine specific recommendations about how to implement and fund this approach to the collaboration of a cadastral data system. The first

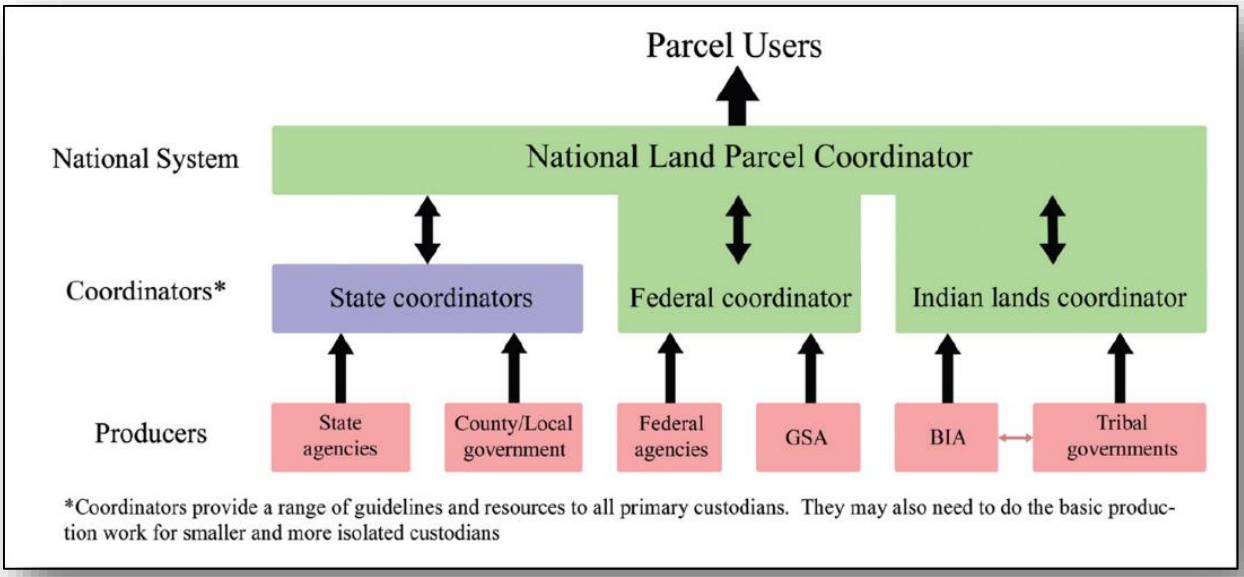


Figure 2.

Model for coordination of national land parcel data (Source: NRC, 2007)

recommendation defined the role of BLM as the steward:

> *"In order to achieve nationally integrated land parcel data, there should be both a federal land parcel coordinator and a national land parcel coordinator. A panel should be established to determine whether BLM has the necessary and sufficient authority and capacity to serve as the federal and/or national land parcel coordinator, and if not, either it should be given the authority and resources, or some other agency should be named. The panel should conduct a review of BLM's existing stewardship responsibilities for cadastral and federal land ownership status under OMB Circular A-16, as well as its current legislative authorities and budget priorities."* (NRC, 2007)

This recommendation, along with eight others, was debated by the National Geospatial Advisory Committee (NGAC), which recommended that the FGDC should immediately address the stewardship issue. At their February 2009 meeting, BLM reported to NGAC that the DOI had begun to "examine the statutory and policy authorities of BLM to coordinate federal and national parcel activities."

Furthermore, the FGDC decided to make parcel data the focus of its 2009 Annual Report, which included this statement from its chair:

> *"Land parcel data combined with other geographic information are essential to such functions as the management of emergency situations, development of domestic energy resources, management of private and public lands, support of business activities, and monitoring of regulatory compliance. The feature story of this year's report underscores the need for a coordinated system of land parcel information across the country."* (FGDC, 2009)

Following an internal review of NGAC's request to clarify BLM's stewardship responsibilities, the FGDC reported:

> *"In response to this recommendation, DOI conducted a review of legal authorities to conduct land parcel coordination activities. The review noted that while the Bureau of Land Management (BLM) had lead responsibility under OMB Circular A-16 for the Federal cadastral data theme, DOI did not have statutory authority or funding to provide national parcel coordination as described in the NRC report. The BLM has continued to provide active leadership of the FGDC Cadastral Subcommittee."* (NGAC, 2012)

To summarize, the BLM and other partners commissioned an objective evaluation of the need for Federal coordination of the Cadastral data theme. The plan and recommendations were endorsed by the most important Federal advisory committee. The BLM asked for resources to implement the plan and recommendations. The DOI did not give BLM additional resources, or a mandate to implement such a program.

Mortgage Crisis

The collapse of mortgage markets demonstrated the need for an early warning system that would have alerted Federal regulatory agencies to the impending crisis. This is particularly disturbing in light of the fact that the National Task Force on Predatory Lending published the 2000 report "*Curbing Predatory Home Mortgage Lending*," which specifically stated that:

> *"Federal Housing Administration will customize data from its Neighborhood Watch system to develop early warning indicators of emerging foreclosure "Hot Zones.""* (National Task Force on Predatory Lending, 2000).

Again, from the 2009 paper "*What Have Americans Paid (and Maybe the Rest of the World) for Not Having a Public Property Rights Infrastructure*," Roberge and Kjellson concluded:

> *"…the lack of a sound property rights infrastructure in the USA has contributed to the collapse of its land market. Of course, this is not the only cause of the mortgage crisis. The negligence of the government to control the banking system and the fact that banks have been too loose in their loan controls is obvious. But in crisis times, good, reliable, and accessible information available on time is of critical importance."* (Roberge and Kjellson, 2009)

In the aftermath of the recession, the Department of Justice vowed "to hold accountable those whose actions threatened the integrity of our financial markets and undermined the stability of our economy." It is clear that risky securities based on bundles of mortgages were an underlying cause of the crisis.

As the financial crisis emerged, members of the White House staff, which had encouraged the expansion of home ownership, admitted that they were not monitoring the situation. According to the *New York Times*:

> *"There is no question we did not recognize the severity of the problems," said Al Hubbard, Mr. Bush's former chief economics adviser, who left the White House in December 2007. "Had we, we would have attacked them." Looking back, Keith B. Hennessey, Mr. Bush's current chief economics adviser, says he and his colleagues did the best they could "with the information we had at the time." But Mr. Hennessey did*

say he regretted that the administration did not pay more heed to the dangers of easy lending practices." (*New York Times*, 2008)

Recently, the Department of Justice has begun to fine the institutions that misrepresented mortgages and encouraged predatory lending practices. For example, in August, Bank of America agreed to pay $16.65 billion dollars in penalties for its role in the financial crisis. This is the largest settlement ever between the U.S. government and a private corporation. According to Money, the Attorney General's office concluded that:

"Both BoA and Merrill ... knew with increasing certainty that many of their loans were troubled or at least likely to be risky, and didn't fully disclose this." (*Money*, 2014)

National Mortgage Database

The Federal Housing Finance Agency (FHFA) and Consumer Financial Protection Bureau (CFPB) are joining forces to create the National Mortgage Database. This new database:

"…will primarily be used to support the agencies' policy making and research efforts and help regulators better understand emerging mortgage and housing market trends in this evolving and changing finance market." (FHFA, 2014)

This important program is a direct outgrowth of the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act. That law was modified to allow parcel information to be included under the Home Mortgage Disclosure Act (HMDA). This additional requirement evolved from specific recommendations made at the 2009 FGDC sponsored stakeholders meeting "Using Land Parcel Data for Monitoring, Evaluation, and Management of Financial and Mortgage Issues." Organized by the FGDC Cadastral Subcommittee and the International Association of Assessing Officers, the meeting developed three specific recommendations:

1. Add the local Parcel ID to the HMDA data.

2. Develop a Parcel Early Warning System.

3. Complete the standardization and availability of parcel data nationwide.

(FGDC Cadastral Subcommittee, 2009)

A national mortgage database will enable the FHFA and CFPB to establish an "early warning system" that can accurately monitor where deceptive lending practices are occurring. In the absence of a cadastral layer, the National Mortgage Database may need to be supported by proprietary commercial data.

Federal Land Cadastre

The Federal government has an obligation to maintain a cadastre of Federal land. Nevertheless, the coordination of a Federal property cadastre is in such a flux that the Congressional Research Service found that:

"a coordinated approach to federally managed parcel data still did not exist and that the best method for obtaining an accurate tally of federal lands is to contact each land management agency directly." (Congressional Research Service, 2009)

Much of the confusion is based on inherent ambiguity in the database design. When the FGDC defined National Geospatial Data Asset (NGDA) Themes and created multiple databases under the cadastre and real property data themes, it failed to follow appropriate spatial data design principles with respect to the role of parcel data.

In successful systems, parcels provide the fundamental spatial entity to distinguish public from private land, register ownership, record land use, and define any number of administrative areas. In order to prevent gaps and overlaps, the database architecture describes clear topological relationships between parcels, roads, and other features. Attributes linked to unique parcel identification numbers contain authoritative information about ownership, use, value, and other characteristics of the parcel. Good database design principles create mutually exclusive and non-redundant categories and responsibilities. In creating the NGDA themes and databases, the FGDC did not follow common practices or the NRC recommendation:

> *"FGDC should identify the role of parcel data in the collection and maintenance of the following data themes: Buildings and Facilities, Cultural Resources, Governmental Units, and Housing."* (NRC, 2007)

In addition to the problems with feature representation and integration with other themes, the new databases are inherently ambiguous and duplicative. Logically, the datasets for national parks, forests, and wildlife refuges should simply be subsets of the Federal parcel dataset, which complements a non-federal land category. Similarly, one would assume that Federally-owned real property would be associated with Federal parcels. The states (e.g. Montana) have implemented this logical database model for years (Figures 3 and 4).

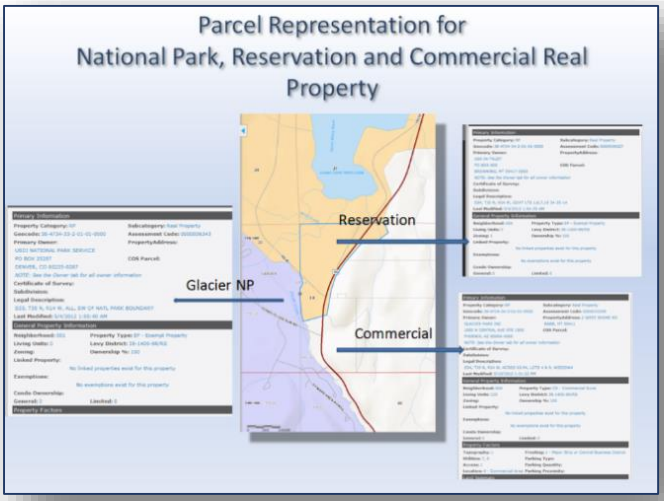


Figure 3 - Shows that the parcel polygon is the key geographic feature, and that other factors such as ownership and use are attributes of the parcel (Source: Cowen, 2012)

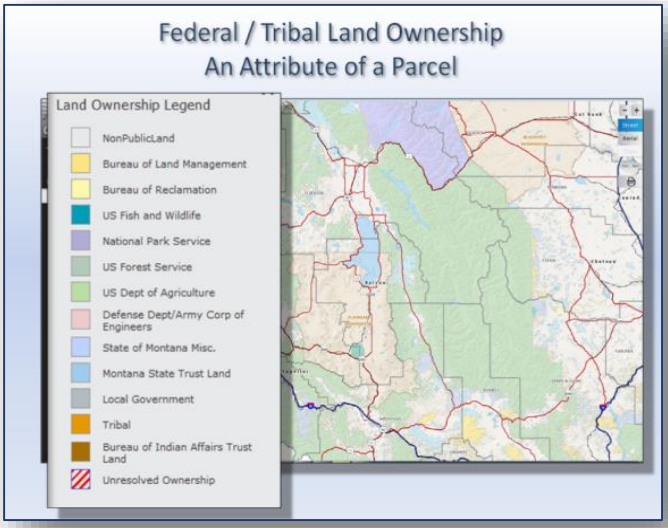


Figure 4 – Showing the statewide integration of Federal and tribal land ownership in Montana (Source: Cowen, 2012)

Resolving the confusion over Federal lands was the intent of the proposed Federal Land Asset Inventory Reform (FLAIR) Act of 2013 (H. R. 916). The bill would have required the DOI to create a Federal land cadastre. Specifically, the bill is designed:

> *"To improve Federal land management, resource conservation, environmental protection, and use of Federal real property, by requiring the Secretary of the Interior to develop a multipurpose cadastre of Federal real property and identifying inaccurate, duplicate, and out-of-date Federal land inventories, and for other purposes."* (GovTrack, 2014)

This Bill would have required the Secretary of Interior to review all the existing inventories and would provide a program to cost share the inclusion of non-federal parcels.

B. Theme Definition

The original cadastral theme definition from OMB Circular A-16 is:

> *"Cadastral data describe the geographic extent of past, current, and future rights, title, and interests in real property, and the framework to support the description of that geographic extent. The geographic extent includes survey and description frameworks, such as the Public Land Survey System, as well as parcel-by-parcel surveys and descriptions."*

The proposed NGDA Theme definition for cadastral—which was endorsed by the FGDC Steering Committee on August 19, 2011, and listed in the 2012 GAO report "*Geospatial Information OMB and Agencies Need to Make Coordination a Priority to Reduce Duplication*"—is defined as follows:

> *"This theme describes past, current, and future rights and interests in real property, including the spatial information necessary to describe geographic extents. Rights and interests are benefits or enjoyment in real property that can be conveyed, transferred, or otherwise allocated to another for economic remuneration. Rights and interests are recorded in land record documents. The spatial information necessary to describe geographic extents includes surveys and legal description frameworks, such as the Public Land Survey System, as well as parcel-by-parcel surveys and descriptions. This theme does not include federal government or military facilities."* (GAO, 2012)

The A-16 cadastral theme is also included offshore cadastre as Framework data. The offshore element was defined in 2002 as follows:

> *"Offshore Cadastre is the land management system used on the Outer Continental Shelf. It extends from the baseline to the extent of United States jurisdiction. Existing coverage is currently limited to the conterminous United States and portions of Alaska. Maximum extent of United States jurisdiction is not yet mathematically calculated."*

The new definition is:

> *"Offshore cadastre is the land management system used on the Outer Continental Shelf. It extends from the baseline to the extent of U.S. jurisdiction. Existing coverage is currently limited to the conterminous United States and portions of Alaska."* (GAO, 2012)

The offshore component of the cadastral data theme is best defined by the following three cadastre-related datasets maintained by the Bureau of Ocean Energy Management (BOEM):

- BOEM Protraction Polygons (Official Protraction Diagrams - Atlantic, Pacific, Gulf of Mexico, and Alaska).
- Outer Continental Shelf Lease Blocks.
- Outer Continental Shelf Active Oil and Gas Leases.

NOAA is the steward for the Maritime Limits and Boundaries of the United States of America, which is a dataset under the Water – Oceans and Coasts theme. This database is not considered a Framework dataset.

C: Lead Agency

The Bureau of Land Management (BLM) has always been the lead agency for the cadastral database. BLM and the FGDC Cadastral Subcommittee provide government-wide leadership for cadastral data coordination that is carried out under the policy guidance and oversight of the Federal Geographic Data Committee.

Under the National Geospatial Data Asset (NGDA) program's concept of shared portfolio management, the FGDC has weakened BLM's stewardship situation by identifying 20 different cadastral datasets (Table 1) managed by nine different agencies: the Bureau of Land Management, the Bureau of Ocean Energy Management, the Army Corps of Engineers, the Department of Defense, the Bureau of Indian Affairs, the National Parks Service, the Fish and Wildlife Service, the Forest Service, and the USGS. Under the new realignment, it is not clear which of the 20 datasets actually comprise the cadastral theme.

By definition, the cadastre data for Federal parcels managed by the BLM should constitute the umbrella category of all parcels owned and managed by Federal agencies. Since the current definition of the cadastral theme specifically states that it "does not include Federal government or military facilities," why is there a cadastre dataset for the DoD land parcels and sites?

NGDA Datasets Under the Cadastre Theme	Agency
Army Corps of Engineers Lands	ACOE
Department of Defense Land Parcels and Sites	DoD
BIA Indian Lands Dataset	DOI-BIA
BLM Lands (BLM Administrative Unit Boundaries and Office Locations)	DOI – BLM
Federal Parcels Dataset	DOI – BLM
Geographic Coordinate Data Base (GCDB)	DOI – BLM
U.S. Official Cadastral Survey Records	DOI – BLM
BLM's Public Land Survey System Dataset (PLSS)	DOI – BLM
General Land Office Dataset of Scanned Authoritative Documents Related to Ownership of Federal Parcels of Lands (BLM, General Land Office Records System)	DOI – BLM
Index of all Federal Surface and Subsurface Estate Datasets	DOI – BLM
Surface Management Agency Estate Dataset	DOI – BLM
BLM Mineral Estate – Solids Dataset	DOI – BLM
BLM Mineral Estate – Fluids Dataset	DOI – BLM
BOEM Protraction (diagrams) Polygons (Official Protraction Diagrams – Atlantic, Pacific, Gulf of Mexico, and Alaska)	DOI - BOEM
Outer Continental Shelf Lease Blocks	DOI - BOEM
Outer Continental Shelf Active Oil and Gas Leases	DOI - BOEM
NPS National Parks Dataset	DOI-NPS
FWS National Wildlife Refuges Dataset	DOI-FWS
FS National Forests Dataset (U.S. Forest Service Proclaimed Rights)	USDA-FS
PADUS (Protected Areas Database of the US)	DOI-USGS
Count	**20**

Table 1 - NGDA Cadastre Datasets (Source: Spreadsheet provided by the FGDC)

It is interesting to note that after the DOI failed to strengthen or clarify BLM's stewardship role, HUD examined its possible leadership role in the management of cadastre data. HUD concluded that:

"Providing a national portal to link to state-hosted data services could be a shared activity among multiple federal agencies. As a longer term goal, HUD could either build or cooperate with other federal agencies to build a national access site, as well." (HUD, "The Feasibility Of Developing A National Parcel Database: County Data Records Project Final Report")

Real Property

Even though the definition of cadastre data says that "rights and interests are benefits or enjoyment in real property," the FGDC has created a new real property data theme with 15 datasets managed by four different agencies (Table 2). It is unclear how these real property datasets are integrated into a logical database schema. As noted previously, parcels typically are the building block for property records including real property. Ownership and use are simply attributes of parcels.

The General Services Administration is the theme lead and has responsibility for the inventory of government owned and leased property. HUD is responsible for 12 datasets related to housing. Hopefully, the stewards for the real property will coordinate their activities with those who are maintaining the various cadastre datasets.

From the traditional viewpoint of Framework data, BLM has stewardship of the following four datasets:

- Federal Parcels Dataset.
- Geographic Coordinate Data Base (GCDB).
- U.S. Official Cadastral Survey Records.
- BLM's Public Land Survey System Dataset (PLSS).

Real Property Data Assets	Agency
Assisted Housing (Census Geography or point based)	HUD
Public Housing Authorities	HUD
Public Housing Developments	HUD
Public Housing Buildings	HUD
Low Income Housing Tax Credit Properties	HUD
HUD Assisted Multifamily Housing (Multifamily Assistance Section 8 Contracts)	HUD
HUD Insured Multifamily Properties (Insured Multifamily Mortgages Database)	HUD
Fair Market Rents (Fair Market Rents for the Section 8 Housing Assistance Payments Program)	HUD
HUD Grantee Activities	HUD
FHA Insured Single Family Properties	HUD
FHA Insured Multifamily Properties	HUD
HUD Real Estate Owned Properties	HUD
Military Installations, Ranges, and Training Areas	DoD
National Structures Dataset – National Map	DOI-USGS
Inventory of Owned & Leased Properties Dataset	GSA
Count	**15**

Table 2 - NGDA real property datasets (Source: Spreadsheet provided by the FGDC)

The GCDB is a collection of geographic information representing the PLSS and other official surveys.

The PLSS data have been formatted as the Cadastral National Spatial Data Infrastructure (CadNSDI) that complies with the latest FGDC guidelines and is available online for viewing and download. It represents a Framework data theme for the PLSS.

FGDC Cadastral Subcommittee

The confusion relating to Federal parcels is reflected in the organization of FGDC work groups over the past 20 years. Since its inception, the FGDC Cadastral Subcommittee, sponsored by BLM, has been a model for all

other FGDC work groups. Its mission is to "improve the availability, currency and quality of real property information to support decision making at all levels of government and industry."

The FGDC Cadastral Subcommittee has been a true collaborative forum that engaged stakeholders from Federal land agencies, states, counties, tribes, and the private sector. Working closely with its members, it developed a consensus-based standard that was approved in 2008. It also conducted the important FGDC-sponsored "The United States Mortgage Crisis and Cadastral Data" forum. It continues to maintain an excellent website that provides online access to a number of reports, standards, cost estimates, best practices, and inventories.

The Subcommittee is now organized into the following work groups:

- PLSS Work Group
- U.S. Rights Work Group
- State/National Parcel Work Group
- Cadastral Metadata Work Group
- Wildland Fire Work Group
- Mortgage/Economy Work Group
- Energy Work Group
- Hurricane Work Group
- Marine Work Group
- Homeland Security Work Group
- IAAO Workgroup

<u>The Current Status of Federal Parcel Coordination</u>

As noted previously, the inventory of Federal lands is in a state of flux and may require legislation to fix the problem. Much of the confusion is based on the inherent ambiguity in the integration of databases and the poor articulation of responsibilities.

Concurrent with the efforts of the FGDC Cadastral Subcommittee, several Federal committees have addressed the coordination of Federal parcel data. The original Interagency Cadastral Coordination Council (ICCC), which was established in the 1980s, became inactive around 2009.

In 2010, a Federal parcel work group was established by the FGDC Cadastral Subcommittee. This work group published "Federal Parcels – Summary" that included status reports from several Federal agencies. It also initiated an effort to develop a draft Federal Parcel Publication Standard.

In 2012, that work group was replaced by the Federal Lands Workgroup, which includes representatives from USFS, BLM, NPS, FWS, Census, USGS, BOEM, BIA, BOR, and DoD. According to its website, the Federal Lands Workgroup is:

> *"…focused on the development and maintenance of a parcel-level federal lands geodatabase that can be used to meet common federal agency needs."*

During the realignment under the National Geospatial Data Asset (NGDA) Themes, the Federal Lands Workgroup is now a subgroup of the comprehensive National Boundaries Group (NBG). The NBG includes 25 Federal agencies and is co-chaired by representatives from the USGS and the Census Bureau. The objectives for the NBG are:

- *Identification of the national authoritative sources and national authoritative integrators for boundary data.*
- *Application of enterprise supply/value chain principles. Who collects what? When is the data needed?*

- *Identification and development of boundary standards including recommendations for legal documentation.*
- *Identification of boundary data used by each agency including its current status, quality, and availability.*
- *Coordinating boundary data with the FGDC A-16 and Data Life Cycle efforts.*
- *Work closely with other FGDC subcommittees – e.g. the Coastal Subcommittee in the development of an authoritative coastline dataset of the U.S.*

(Waggoner and Pierce, 2014)

While this new arrangement for the coordination of governmental units may make sense under the portfolio management program, it further obfuscates the role of cadastral parcels, the stewardship of BLM, and the supportive role of the Cadastral Subcommittee.

D. Collaboration and Partnering

Land parcels and associated cadastral data are critical to the business needs of local government. Therefore, any attempt to create a Framework data theme for such data must involve a partnership with the state, local, and tribal government offices that collect and maintain the data.

Policies regarding the sharing of these locally maintained datasets vary greatly across the nation. Some stewards have established online sites that provide unrestricted access, while other governments restrict the extent to which they share their data and/or charge a licensing fee for accessing their data. Although an increasing number of states have worked to create a consistent statewide coverage, many of these efforts are limited to government-to-government access policies.

The challenges associated with assembling parcel data from local partners were well documented in the recent HUD report "*The Feasibility of Developing a National Parcel Database: County Data Records Project Final Report*." In 2010, HUD hired consultants to assemble parcel data from 127 counties. After months of effort the consultants were only able to obtain useful data from 86% of the counties. According to the consultants, the remaining counties:

> *"…were not collected for reasons that included not having electronically available data (3 counties); having parcel data in the hands of municipalities within the counties rather than those of the counties themselves (2 counties); fees (3 counties); data-sharing requirements (1 county); and other expressions of reluctance, including lacking the internal resources to process the request (9 counties)."*

The report also noted major challenges including:

- *Lack of full data documentation from many of the study counties.*
- *Variations in each dataset's comprehensiveness, attribute definitions and formats, and accuracy.*
- *Unclear and very diverse methods for internally validating data in each county.*
- *Wide variations in nomenclature and definitions for attributes (from land use codes to even basic assessment values).*
- *Incorrectly identified or duplicate values for similar attributes within datasets.*

(HUD, 2013)

E. Standards

The Cadastral Subcommittee was one of the first FGDC subcommittees to create and

publish a data content standard for a Framework data theme. This standard was the Cadastral Data Content Standard for the National Spatial Data Infrastructure, FGDC-STD-003-2008. The approved 2008 standard is available at: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/cadastral/index_html

According to the Cadastral Subcommittee:

> *"The Cadastral Data Content Standard is intended to support the automation and integration of publicly available land records information. It is intended to be useable by all levels of government and the private sector. The standard contains the standardization of entities and objects related to cadastral information including survey measurements, transactions related to interests in land, general property descriptions, and boundary and corner evidence data. Any or all of these applications are intended to be supported by the standard. The standard is not intended to reflect an implementation design."* (FGDC, 2008)

The Subcommittee also created the FGDC Framework Data Standard Part 1 – Cadastral:

> *"The primary purpose of this part of the Geographic Information Framework Data Content Standard is to support the exchange of cadastral (real property) data. This part seeks to establish a common baseline for the semantic content of cadastral databases for public agencies and private enterprises. It also seeks to decrease the costs and simplify the exchange of cadastral data among local, Tribal, State, and Federal users and producers. That, in turn, discourages duplicative data collection. Benefits of adopting this part of the standard also include the long-term improvement of the geospatial cadastral data within the community."* (FGDC, 2008b)

Cadastral Standards have been widely reviewed by Federal and non-federal organizations before adoption. In keeping with the Cadastral Subcommittee's practices of community involvement, these standards should be reviewed to ensure that they meet current user needs and technological capability prior to their use in any future National Parcel Database initiatives.

F. Estimate of Completeness

Measuring the current status of cadastral data in the United States is not a straightforward process. The creation and maintenance of the geometric features and related attribute data are primarily a function of local government. These data are only shared with state or Federal agencies through partnerships, most of which are voluntary.

It is estimated that there are approximately 150 million parcels that define the privately owned property in the United States and another 8 to 10 million that represent public lands. Surveys conducted by the FGDC Cadastral Subcommittee suggest that about 123 million or 82% of the private parcels are "GIS ready." Since Federal lands constitute about 650 million acres or about 28% of the land area, there are only about 55% of the U.S. land areas with parcels that are "GIS ready." In addition, the National States Geographic Information Council (NSGIC) GMA estimated that 17 states have no program for developing statewide parcel data.

At the same time, the common interest in dealing with wildfires in the Western states has led to significant success in assembling a collection of parcel data west of the Mississippi River.

More information about the quality and completeness of parcel data can be found in the report "*An Assessment of Parcel Data in the U.S. 2009 Survey Results*," December 2010, available from the FGDC Subcommittee for Cadastral Data at nationalcad.org/download/an-assessment-of-parcel-data-in-the-us-2009-surv/.

G. Accessibility

The BLM's Public Land Survey System Dataset (PLSS) is available through a web mapping service:

> *"This service contains layers based on Geographic Coordinate Data Base (GCDB) coordinate data. The locations of Public Land Survey System (PLSS) corners, as represented in geographic coordinate pairs, were derived from a variety of source documents, which include U.S. General Land Office and BLM survey plats/notes, as well as survey data obtained from other U.S. Government agencies, private sector survey firms, and local governments."*

In addition, the BLM maintains its own website where it provides data:

> *"BLM is providing updated downloadable PLSS data called the Cadastral National Spatial Data Infrastructure (CadNSDI) that complies with the latest Federal Geographic Data Committee (FGDC) guideline for PLSS data."* (BLM, 2014)

In their GMA responses, 19 states indicated that their data were not publicly available without restrictions.

Commercial Parcel Data

The December 2012 GAO report "*Geospatial Information OMB and Agencies Need to Make Coordination a Priority to Reduce Duplication*" highlighted issues relating to the coordination of parcel data. The report also listed six Federal agencies that currently license proprietary parcel data.

While several firms create, consolidate, and standardize parcel data for parts of the country, Core Logic, a publicly traded company, has a business plan to build a national coverage. Core Logic has made several presentations to NGAC and generates a status map on a quarterly basis. According to its website:

> *"ParcelPoint is a geospatial solution that captures boundary and centroid data for 2,658 counties, accounting for 140.8 million parcels nationwide—137.1 million of which are actual parcel boundaries."* (Core Logic, 2014)

In addition to its Federal clients, Core Logic provides a parcel base for many online real estate and mortgage sites.

It must be noted that the success of this commercial effort demonstrates that it is possible to overcome the stewardship and standardization issues.

H. Authority, Governance, and Management

The Congressional Research Service has recently taken an interest in the status of a national parcel database. Its 2011 report concludes:

> *"The federal government has direct and indirect responsibilities for coordinating and managing land parcel data on federal land. An example of a direct responsibility is that of the Department of the Interior's (DOI's) Bureau of Land Management (BLM), which is steward of federal land parcel data. An example of an indirect role is that of the Federal Geographic Data Committee (FGDC),*

which serves to coordinate federal geospatial activities." (Congressional Research Service, 2011)

After extensive analysis of NRC and other reports by experts in land information and cadastral issues, the clear conclusion is that the U.S. Federal government does not have the authority to develop and maintain a national cadastral data layer. Years of effort have resulted in progress towards a nationally coherent cadastre that will serve multiple purposes, but still the prospects for a National Cadastre or NSDI cadastral data layer are dim. The results have shown that a collaborative model will not work in such a complex situation. New authority will be needed to bring a National Parcel Dataset to a reality.

The value and utility of these data are important to the nation, and the economic benefits of addressing the problem are enormous. Without change the situation will not improve, but the legislative will to take action does not exist. In view of this current reality, a new model for Framework data that acknowledges the importance of local partners must be adopted. This model should be transaction based and emphasize the use of current information technologies, federated, and web-based capabilities, and support web-based services and applications. Local partners hold most of the parcel data in the United States and the budgetary and leadership investments to ensure a "bottom-up" rather than a "top-down" approach must be made in order to bring about the creation of a national cadastral/parcel data layer. If these investments which take advantage of the current information technology environment do not occur, the cadastral data theme should be strongly considered for removal from the list of Framework data layers.

ELEVATION DATA THEME

GRADE: C+

(Requires Attention)

Shaded Relief Image from USGS National Map

Discussion: Elevation data are generally available across the nation, but they are not suitable for many purposes, and more work needs to be done to better leverage budgets, coordinate data collection efforts, and collaborate across levels of government.

Elevation data have consistently been identified as a critical dataset for a wide variety of uses. Terrestrial elevation data have been required by a greater number of users and their importance is widely recognized. While bathymetric data are not as widely needed, they are also necessary for a large number of critical applications spanning all sectors.

A large volume of elevation data is available, and the National Elevation Dataset (NED) produced by the USGS provides consistent and accessible terrestrial elevation data nationwide. Bathymetric data covering U.S. Coastal and Great Lakes regions are likewise available through NOAA programs. However, the suitability of these data for certain purposes (e.g. flight navigation) are questionable in some locations.

Standards for terrestrial elevation and bathymetric data have been developed and approved through FGDC as well as other U.S. and international standards development processes. Elevation data are now publicly available through the National Map, agency data portals, Federal clearinghouses and portals, and state and local access points. Federal leadership for the collection, production, and distribution of elevation data has been consistent with good coordination among the agencies that require these data for their program and mission needs.

In addition, in September 2014, the USGS released Circular 1399. While the Circular does not specify the NSDI Framework, it does address USGS's responsibilities as outlined in OMB Circular A-16. The USGS is developing a three-dimensional elevation data collection program, and the new products and services from this effort will be provided to partners and the public in 2015. This can result in a significant improvement in the quality and quantity of elevation data available nationally. In October 2014, the Washington Post published a front page article entitled "*Alaska's outdated maps make flying a peril, but a high-tech fix is slowly gaining ground*." This article highlighted the dangers in Alaska that stem from the lack of adequate map data. The 3-D Elevation Program (3DEP) is a program to collect accurate, up-to-date data for all states using LiDAR or IfSAR.

Impacts: The elevation theme currently requires attention. Most users are able to find and use elevation data for basic tasks and analyses. Better coordination will enable users to efficiently obtain the most

appropriate and accurate data for their requirements and use. While the data generally exist, they require more knowledge and effort than desired to acquire and use them effectively. As noted earlier, they are often not suitable for some critical purposes and higher resolution data are often needed.

A. Introduction

The elevation theme for the NSDI Framework is comprised of two sections: terrestrial and bathymetric.

The National Elevation Dataset (NED) represents the NSDI terrestrial elevation theme and is the primary elevation data product of the USGS. The NED is a seamless dataset with the best available terrestrial elevation data of the conterminous United States, Alaska, Hawaii, and territorial islands.

The NED is derived from diverse source datasets that are processed to a specification with a consistent resolution, coordinate system, elevation units, and horizontal and vertical datums. The NED is the logical result of the maturation of the long-standing USGS elevation program, which for many years concentrated on the production of topographic map quadrangle-based digital elevation models. It is updated on a nominal two-month cycle to integrate newly available and improved elevation source data.

The NED serves as the elevation layer of the National Map and provides basic elevation information for Earth science studies and mapping applications in the United States. Scientists and resource managers use NED data for global change research, hydrologic modeling, resource monitoring, mapping and visualization, and many other applications.

Specifications for the NED include the following:

- Coordinate system: Geographic (decimal degrees of latitude and longitude).
- Horizontal datum: North American Datum of 1983 (NAD 83).
- Vertical datum: North American Vertical Datum of 1988 (NAVD 88) over the conterminous United States, and varies in other areas.
- Elevation units: Decimal meters.

The term "bathymetry" originally referred to the ocean's depth relative to sea level, although it has come to mean "submarine topography," or the depths and shapes of underwater terrain. In the same way that topographic maps represent the three-dimensional features (or relief) of overland terrain, bathymetric maps illustrate the land that lies underwater. Variations in sea-floor relief may be depicted by color and contour lines called depth contours or isobaths.

Bathymetry is the foundation of the science of hydrography, which measures the physical features of a water body. Hydrography includes not only bathymetry but also the shape and features of the shoreline; the characteristics of tides, currents, and waves; and the physical and chemical properties of the water itself.

Nautical charts are based on data acquired during bathymetric surveys. These charts guide mariners much as road maps guide motorists, ensuring safe and efficient maritime transportation.

The USGS published "*The National Map Customer Requirements: Findings from Interviews and Surveys*" in 2009 as Open-File Report 2009–1222. Elevation was ranked as the third highest requirement by the persons interviewed in the survey. (Bathymetry was not part of the survey report.)

B. Theme Definition

Elevation data provide information about terrain. Elevation refers to a spatially referenced vertical position above or below a datum surface. The Framework includes the elevations of land surfaces and the depths below water surfaces (bathymetry).

Terrestrial elevation data contain geo-referenced digital representations of terrestrial surfaces, natural or manmade, which describe vertical position above or below a datum surface. Digital elevation data may be encapsulated in evenly spaced grids (raster form) or in randomly spaced formats (including a triangular irregular network, hypsography, or single points). The elevation points can have varying horizontal and vertical resolution and accuracy.

Bathymetric elevation data for inland and coastal waterways are highly accurate bathymetric sounding information collected to ensure that federal navigation channels are maintained to their authorized depths. Bathymetric survey activities support the nation's critical nautical charting program. These data are also used to create Electronic Navigational Charts (ENCs). The bathymetric sounding data support the elevation layer of the geospatial data Framework.

C. Lead Agency

The elevation theme has two theme leads: USGS is the lead for elevations of land surfaces, and NOAA is the lead for bathymetry or depths below water surfaces.

The FGDC does not have an elevation subcommittee. Elevation data coordination within the FGDC was conducted through the Base Cartographic Subcommittee, but the actual committee work was carried out by the National Elevation Committee. The FGDC Base Cartographic Subcommittee was discontinued in the 2002 timeframe, and leadership and oversight are provided by the National Digital Elevation Program (NDEP) Committee which includes a Steering Committee, a Technical Subcommittee, and a Project Coordination Subcommittee.

The Steering Committee provides leadership and program oversight. It is responsible for establishing the vision, direction, and goals of the program. It also provides oversight of the technical and project coordination subcommittees.

The Technical Subcommittee addresses technical issues related to the research, production, archiving, distribution, and application of digital elevation data. It leads the development of national specifications and guidelines for the collection, distribution, and use of digital elevation data.

The Project Coordination Subcommittee is responsible for coordinating the requirements of the NDEP members, developing and monitoring production and funding plans, and addressing specific program issues.

For the bathymetric component of the elevation theme, the Subcommittee on Marine and Coastal Spatial Data serves as the FGDC lead. This subcommittee was formerly the FGDC Subcommittee on Bathymetric and Nautical Charting Data. The Subcommittee determines which categories of marine and coastal spatial data are to be included as Framework datasets and recommends the addition of other categories of marine and coastal spatial data not currently being collected. The Subcommittee also helps NOAA establish and publish standards and specifications for marine and coastal spatial data, and establish priorities for marine and coastal spatial data collection, processing, and dissemination. The Subcommittee membership includes Federal agencies as

well as representatives from state and local governments and academic and private organizations.

D. Collaboration and Partnering

The NDEP committee consists of approximately 13 Federal agencies. These agencies have collaborated effectively on the production of the National Elevation Dataset and on standards which support the NED. They understand the benefits of partnering and are working together to acquire data under the 3DEP program.

The Subcommittee on Marine and Coastal Spatial Data interacts with members of the following:

- U.S. Integrated Ocean Observing System (IOOS).
- National Ocean Council and Ocean Community for Marine Planning.

E. Standards

The FGDC has developed the Geographic Information Framework Data Content Standard, which was endorsed in 2008 as FGDC-STD-014-2008. Elevation data are included, but it appears that the standard is focused primarily on surface land elevations.

In 2010, a Framework Standard Guidance Document Version 1.0 was developed by the Wyoming Geographic Science Center through an award from the FGDC. It is now available on the FGDC website. The purpose of the document was to facilitate the process of creating new standardized data, to harmonize and transform existing data to match standardized content, and to generally assist in understanding and implementing the standard. The document covers elevation very well but appears to primarily address land surface elevations.

There are several endorsed standards for coastal and marine data, but these standards do not pertain specifically to bathymetric data. Existing standards include:

- Content Standard for Digital Geospatial Metadata: Part 2, Metadata Profile for Shoreline Data
- Geospatial Positioning Accuracy Standards, Part 5: Standards for Nautical Charting Hydrographic Surveys
- Coastal and Marine Ecological Classification Standard (CMECS)

F. Estimate of Completeness

The National Elevation Dataset (NED) is available through the USGS National Map. The NED is a seamless raster product primarily derived from USGS 10- and 30-meter digital elevation models (DEMs) and, increasingly, from higher resolution data sources such as light detection and ranging (LiDAR), interferometric synthetic aperture radar (IfSAR), and high-resolution imagery.

NED data are available from the National Map Viewer as 1 arc-second data (approximately 30 meters) for the conterminous U.S., and as 1/3 and 1/9 arc-second data (approximately 10 and 3 meters, respectively) for parts of the United States. The NED resolution for Alaska is primarily 2 arc-seconds (approximately 60 meters) but is rapidly being replaced with 5-meter resolution IfSAR data statewide and LiDAR data over select areas. A visual representation of NED's currency is shown in Figure 5 on the following page.

More information on status and completeness may be obtained in Figure 2 of USGS Circular 1399 (2014).

The NSGIC GMA included questions about elevation data, but not about bathymetric data. The GMA results for elevation were:

- Of the 51 respondents, 19 indicated that coverage was 96% or greater completeness, and 19 reported less than 96% completeness.
- 13 states have no program for developing statewide elevation data.

The most recent report from the Subcommittee on Marine and Coastal Spatial Data indicates that there is a seamless, nationwide dataset of:

- 12 nautical mile (nm) Territorial Sea
- 24nm Contiguous Zone
- 200nm EEZ
- International boundaries through Great Lakes and international maritime boundaries.

Data updates are occurring in accordance with U.S. Baseline Committee reviews of accretion and erosion of the low water line that appear on NOAA nautical charts.

G. Accessibility

The NED is accessible for download as public domain data through the National Map Viewer and Download Platform. The National Map is part of the NSDI Clearinghouse Network as well as Data.gov and other platforms that provide access to geospatial and NSDI Framework data.

In their GMA responses, 33 states reported that elevation data were publicly available without restriction and 5 states indicated that they were not. In addition, 25 said that elevation data were available through state-maintained web mapping services.

Bathymetric and other ocean data are available as public domain data through the data portals of the NOAA Office of Coast Survey. Bathymetric data are also available through the NSDI Clearinghouse Network, Digital Coast, and Data.gov.

H. Authority, Governance, and Management

USGS Circular 1399 (posted on September 15, 2014) describes the 3D Elevation Program (3DEP) initiative, which was developed to respond to the growing need for high-quality topographic data and a wide range of other three-dimensional representations of natural and constructed features in the United States. The primary goal of 3DEP is to systematically collect enhanced elevation data in the form of high-quality LiDAR data over the conterminous United States, Hawaii, and the U.S. territories, with data acquired over an 8-year period. IfSAR data are being collected over Alaska, where cloud cover and remote locations preclude the use of LiDAR over much of the state.

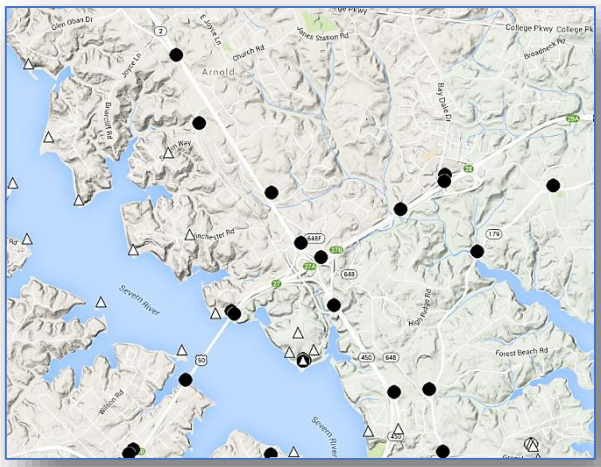
The 3DEP initiative is based on the results of the National Enhanced Elevation Assessment (NEEA), which was completed in 2011. The NEEA clearly documented this need within government and industry sectors. The results of the NEEA indicated that enhanced elevation data can generate $13 billion in new benefits annually. The benefits apply to flood risk management, agriculture, water supply, homeland security, renewable energy, aviation safety, and other areas.

The 3DEP initiative was recommended by the National Digital Elevation Program Committee and its 13 federal member agencies. It was also endorsed by the National States Geographic Information Council (NSGIC) and the National Geospatial Advisory Committee (NGAC).

The lead agencies have provided effective leadership, and along with their partners, have made considerable progress in incremental steps. Collaborative approaches have enabled the use of Federal and state appropriated funds to expand the availability and use of elevation data.

GEODETIC DATA THEME

GRADE: B+
(Adequate For Now)



Geodetic Control Locations from National Geodetic Survey Data Explorer

Discussion: The National Geodetic Survey (NGS), a component of the National Oceanic and Atmospheric Administration (NOAA), developed its *"Ten Year Strategic Plan 2013-2023,"* 2013. Goal 3 of that plan is important to this report, because it demonstrates the serious nature of NGS's desire to foster the goals of the NSDI. A shortened and paraphrased version of Goal 3 is:

> *Goal 3: Expand the National Spatial Reference System (NSRS) Stakeholder Base through Partnerships, Education, and Outreach.*

Goal 3 concerns the public, or the current users of the NSRS and those groups who would greatly benefit by engaging with NGS. Its focus is on reaching new stakeholders, providing training and education to existing stakeholders, and improving NGS's ability to meet its mission by engaging outside experts. This is supported by six objectives, which display the sensitivity and diligence of NGS to its Federal colleagues and all other national stakeholders. The objectives and the actions to be taken by NGS are described in its 10-year plan located at the following URL: http://www.ngs.noaa.gov/web/news/Ten_Year_Plan_2013-2023.pdf.

Based on the information available, the geodetic control theme is felt to be B+. In some areas (for example, the 10-year plan and CORS activities), it is rated as an A+. The Geodetic Theme is adequate to meet current needs, but needs to improve for future use. These needs include replacing outdated reference frames, expanding interoperability, improving collection methodologies, and developing geodetic surveying standards. In addition, GAO's criticism of the (NSDI-related) government at large is also true here (see "Geospatial Information," GAO, 2004), resulting in the overall grade of B+ for this theme.

Impacts: Accurate and accessible geodetic data are readily available on a consistent basis across the nation. Government, industry, and the general public are able to accomplish their missions and perform a wide variety of tasks and analyses requiring detailed location information.

A. Introduction

Prior to 1975, geodesy focused on supporting its historical definition: to determine the size and shape of the Earth, and to determine the precise position of numerous points on the surface of the Earth. With the advent of the Global Positioning System (GPS) and its ability to measure both short and long distances with unprecedented accuracy, geodesy found itself in a renaissance period. Surveying and mapping professionals could quickly determine high-accuracy positions of

points in a state or national coordinate system.

The demand for geodetic data quickly increased and NOAA responded. Websites were developed to provide this data, and both the private and public sectors began using these databases. GPS and geodesy in general were soon applied to new areas including precision agriculture, early hazard warning, and critical sea level measurements. It also became routine to combine GPS with Inertial Navigation Systems (INS) ("Precise Geodetic Infrastructure," 2010), and the data from these integrated sensor systems are readily available from NGS and other sources.

In 2009 the USGS published the report "*The National Map Customer Requirements: Findings from Interviews and Surveys*" as Open-File Report 2009–1222. Vertical and horizontal control was ranked as a high requirement by about one-third of the persons interviewed in the survey.

Geodetic control provides a common reference system for establishing coordinates for all geographic data. All NSDI Framework data and user applications require geodetic control to accurately register spatial data. The National Spatial Reference System (NSRS) is the fundamental geodetic control system for the United States.

B. Theme Definition

OMB A-16 provides the following theme definition:

> *"Geodetic control provides a common reference system for establishing coordinates for all geographic data."*

C. Lead Agency

The NGS, a component of NOAA, is responsible for this Framework data layer.

The Federal Geodetic Control Subcommittee (FGCS) of the FGDC also exercises government-wide leadership in the following areas related to geodetic data:

- Coordinating the planning and execution of geodetic surveys.
- Developing standards and specifications for these surveys.
- Exchanging geodetic survey data and technical information.

FGCS also coordinates agency responsibilities, including standards setting, testing new geodetic instrumentation and operational systems, coordinating user agency requirements, and disseminating government data to user agencies.

D. Collaboration and Partnering

The NGS has continuously cooperated with Federal and local agencies in the spirit of enhancing the NSDI. An example list of this federal cooperation, including a website summarizing each project, is shown below.

Collaboration with the National Geospatial Intelligence Agency (NGA) on the LiDAR test and evaluation site in Corbin:

www.ngs.noaa.gov/web/news/Online_Map_of_Corbin_LiDAR.shtml

Collaboration with numerous agencies on Hurricane Response:

www.ngs.noaa.gov/web/news/NGS_Responds_to_Hurricane_Sandy.shtml

Collaboration with the USGS and the National Park Service (NPS) on LiDAR technology:

www.ngs.noaa.gov/web/news/NOAA_Evaluates_New_LIDAR.shtml

Collaboration with NPS to survey the National Mall:

www.ngs.noaa.gov/web/news/Surveying_on_the_National_Mall.shtml

Collaboration with the Federal Emergency and Management Agency (FEMA) and the U.S. Army Corp of Engineers (USACE) at the Homeland Infrastructure Foundation-level Data Working Group:

www.ngs.noaa.gov/web/news/NGS_at_Homeland_Infrastructure_Group.shtml

Cooperative Effort with USGS and Harris-Galveston Subsidence District:

www.ngs.noaa.gov/web/news/NGS_Cooperates_with_USGS.shtml

Collaboration with NGA on the LiDAR test and evaluation site in Corbin:

www.ngs.noaa.gov/web/news/Online_Map_of_Corbin_LiDAR.shtml

E. Standards

There are several important standards relevant to this Framework theme.

The Framework Data Standard, described at www.fgdc.gov/standards/projects/FGDC-standards-projects/framework-data-standard/framework-data-standard, provides important background information.

The FGDC-endorsed standards developed by the FGDC, described at www.fgdc.gov/standards/projects/FGDC-standards-projects/fgdc-endorsed-standards, are important because of their endorsement by the FGDC.

Finally, the FGDC-endorsed externally developed standards are described at www.fgdc.gov/standards/fgdc-endorsed-external-standards/index.html.

F. Estimate of Completeness

The National Spatial Reference System (NSRS) encompasses some 1,500,000 passive geodetic control points, of which 800,000 are publicly distributable, and of which about 80,000 have been surveyed with Global Navigation Satellite System (GNSS) technology. The NSRS also includes about 2,500 Continuously Operating Reference Stations (CORS), the use of which NGS monitors and coordinates ("*Rich Rewards from NOAA's CORS and GRAV-D Programs*," 2011). This network provides more than $2.4 billion in potential annual benefits to the U.S. economy according to a study provided by Leveson Consulting ("Socio-Economic Benefits Study," 2009). This study also estimates that an additional $522 million in annual economic benefits could be generated by implementing a new vertical reference system, with approximately $240 million saved from improved floodplain mapping alone.

The CORS network is a near-perfect example of the recent success in national collaboration. The network is operated by over 200 organizations, with the data managed and maintained centrally by NGS. It is utilized by thousands of unique users every month.

CORS users process GPS data that they have collected at a location of interest, together with associated GPS data from a CORS site, to calculate the coordinates of their data-collection points relative to the CORS site. With its associated tools, such as OPUS (Online Positioning User Service), CORS provides free access to highly accurate

(centimeter level) geometric positions in the NSRS using GPS. This yields a substantial improvement over standalone GPS, which can be as inaccurate as several meters.

CORS data are used extensively for traditional horizontal positioning (e.g. latitude and longitude), including asset inventory (e.g. locating property boundaries). CORS data are also used for establishing the relative location of natural and manmade structures such as rivers, roads, buildings, water pipes, and power lines. CORS data also allow users to monitor the motion of critical structures such as dams, bridges, and nuclear power plants. The ability of users to accurately and quickly determine horizontal positions anywhere in the U.S. using CORS and GPS has been available for many years now.

The use of CORS for determining vertical information is growing, and accuracy needs are getting stricter. CORS plays a central role in maintaining the integrity of the NSRS in all three dimensions. The quality of both horizontal and vertical CORS data is excellent.

However, CORS and GPS by themselves only yield ellipsoid heights. Combining that with a hybrid geoid model is a growing method of accessing the orthometric height component of the NSRS. The CORS/geoid method is significantly faster than traditional leveling, but traditional leveling remains the most accurate way to access differential orthometric heights over distances under about 50 km. As such, the approximately 500,000 leveled benchmarks in the U.S. remain a critical component of the NSRS.

The NSGIC GMA collected information about whether states had accessible clearinghouse sites, and the results for geodetic were as follows:

- Of the 51 respondents, 16 reported a 96% or greater completeness and 14 reported less than 96% completed.
- 21 states have no program for developing statewide geodetic control.

G. Accessibility

NGS products and services are available from the NOAA website at www.geodesy.noaa.gov, as well as from the NSDI Clearinghouse and other government portals.

In their GMA responses, 26 states reported that geodetic control data were publicly available without restriction and 3 indicated that they were not. In addition, 19 states said that these data were available through a public state-maintained web mapping service.

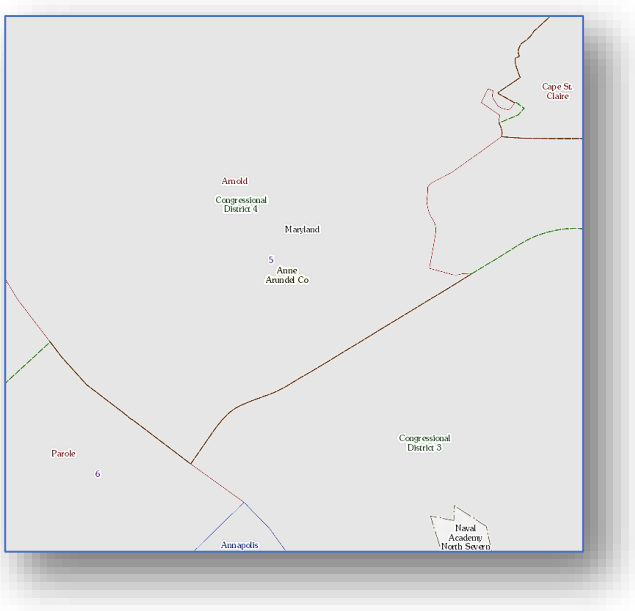
H. Authority, Governance, and Management

The NGS is a part NOAA. NOAA's roots date back to 1807, when the first scientific agency of the U.S., the Survey of the Coast, was established. The NGS is responsible for defining, managing, and providing public access to the National Spatial Reference System (NSRS), a consistent national coordinate system that provides the foundation for mapping and charting; state boundaries; transportation, communication, and land records systems; and numerous scientific and engineering applications. NGS's spatial data, models, and tools are vital for the protection and management of natural and manmade resources and support economic prosperity and environmental health.

Governmental Units Data Theme

Grade: C

(Requires Attention)



Governmental Units from the USGS National Map

Discussion: The Expert Panel's grade of C reflects positively on the ease of access to nationally consistent, digital representations of numerous governmental units. The "C" grade reflects the challenges in obtaining the most current reliable information, as well as uncertain methods for integrating governmental boundaries with other Framework data. Of particular concern is the need for the Bureau of the Census to suspend the annual Boundary and Annexation Survey (BAS) and the fact that only six states have formal cooperative agreements to provide boundary and annexation information.

Impacts: Governmental units and boundary information is important to the thousands of government jurisdictions in the United States. In general, users are able to accomplish their missions with the governmental units data provided.

A. Introduction

Governmental units comprise several comprehensive datasets that represent areas sharing a common legal, administrative, or statistical attribute. These units are critical for the support of constitutionally mandated voting districts and many other administrative functions. When the USGS published "The National Map Customer Requirements Findings from Interviews and Surveys" in 2009, the need for civil boundaries and Federal and Native American lands were ranked in the top ten of data requirements.

Through TIGER Web, the Census Bureau has done an excellent job of providing free and convenient access to most governmental units data in GIS-compatible formats. The authoritative source for any governmental unit is the corresponding local, state, or national organization that is legally charged with enforcement of its boundaries. The Census Bureau works with local governments, international boundary commissions, and marine boundary working groups to assemble a consistent representation of these boundaries. The boundaries are an integral part of its TIGER database.

The topological structure of TIGER ensures that there is a consistent representation of shared boundaries for units that are part of a nested hierarchy (for example, states, counties, tracts, and so forth). Through its annual Boundary and Annexation Survey (BAS) the Bureau established partnerships with thousands of local governments to maintain a current set of these boundaries. Unfortunately, for budgetary reasons, many parts of BAS are currently suspended.

The Governmental Units data layer is closely linked to the operational needs of the Bureau. As a pioneer in creating a national digital database, the Bureau has incorporated numerous boundaries into TIGER. The original 1990 centerlines were based on 1:100,000 scale USGS digital line graphs and were not designed to be accurate cartographic features. Since that time the Bureau has worked to continuously improve the quality and resolution of the data.

The maintenance of TIGER is dependent on inputs from a multitude of partners. Therefore, the quality of any of the 65 types of governmental, administrative, or statistical areas maintained by the Census Bureau depends on the local resources that have been shared with the Bureau. The Bureau has done an outstanding job of placing this data into the public domain and providing effective tools for users to access, visualize, or download it in GIS format.

The long-term questions relate to the procedures that will be used to maintain TIGER. The quality of TIGER was greatly improved for the 2010 decennial Census, and the Geographic Support System Initiative (GSS-I) represents a "plan to provide the most current, accurate, and complete address, feature, and boundary data" on an annual basis (Bureau of the Census, 2014). But data maintenance may face significant challenges, especially relating to the maintenance of street centerline data.

The fundamental structure of TIGER and related boundaries is dependent on the representation of street centerlines. The process of maintaining these street centerlines forces the topological adjustment of coincident boundaries as street centerline data changes. This makes accurate street centerline data a critical, foundational component of the data the Bureau provides.

It is important to note that even though the Bureau continuously maintains TIGER street centerlines based on information provided by partners and its internal sources, the Bureau is not the steward for transportation features. Consequently, a significant question relates to the impact of the set of street centerlines currently being created by the Department of Transportation under the MAP 21 initiative (DOT, 2014). Since this new representation of roads will be assembled and standardized at the state level, they will become the road component of the Transportation data layer. If the Framework is to serve as a truly integrated set of data themes, then the Bureau will have to adjust its boundaries to these roads.

Under the new portfolio management approach to data themes, the FGDC recently expanded governmental units data to include administrative and statistical boundaries. The theme now includes 70 separate datasets. The Bureau maintains 65 of these, and the other five are the responsibility of USEPA, HUD, NOAA, and BLM. This change consolidated all of the statistical units into this theme and dissolved the Cultural and Demographic Statistics Subcommittee. The Bureau has initiated a new National Boundary Group (NBG) that will work with the Cadastral Subcommittee and other Federal partners to develop nationally consistent boundaries that are geographically integrated.

B. Theme Definition

The theme includes:

- Governmental Units — These data describe, by a consistent set of rules and semantic definitions, the official boundaries of Federal, state, local, and tribal governments as reported/certified to the U.S. Census Bureau by responsible

officials of each government for purposes of reporting the nation's official statistics.

- International Boundaries—International boundary datasets include both textual information to describe, and geographic information system (GIS) cartographic data to depict, both land and maritime international boundaries, other lines of separation, limits, zones, enclaves, exclaves, and special areas between states and dependencies.
- Marine Boundaries—Marine boundaries depict offshore waters and seabeds over which the U.S. has sovereignty and jurisdiction.

Under the current portfolio management program, the governmental units and administrative and statistical boundaries are combined into a comprehensive theme which is defined as:

"…data that describe political, governmental, and administrative (management) type boundaries that are used to manage people and resources. It includes geopolitical boundaries (county, parish, state, city, etc.), tribal boundaries, federal land boundaries, federal regions, international boundaries, and governmental administrative units, such as congressional districts, international lines of separation, limits, zones, enclaves, exclaves, special areas between states and dependencies, and all jurisdictional offshore limits within U.S. sovereignty. Boundaries associated with natural resources, demography, and cultural entities are excluded and can be found in the appropriate subject themes." (GAO, 2012)

Additional definitions were provided by the cultural and demographic subcommittee:

"A governmental unit is a geographic area with legally defined boundaries established under Federal, Tribal, State, or local law, and with the authority to elect or appoint officials and raise revenues through taxes.

An administrative unit is a geographic area established by rule or regulation of a legislative, executive, or judicial governmental authority, a non-profit organization, or private industry for the execution of some function.

A statistical unit is a geographic area defined for the collection, tabulation, and/or publication of demographic, and/or other statistical data."

As part of the new portfolio management arrangement, the National Geospatial Data Asset (NGDA) governmental units and administrative and statistical boundaries theme consists of 70 datasets. The FGDC defines these datasets as:

"Political, governmental, and administrative (management) type boundaries that are used to manage people and resources. Includes geopolitical boundaries (county, parish, state, city, etc.), Tribal Boundaries, Federal land boundaries and Federal Regions, International Boundaries, Governmental administrative units such as Congressional Districts, international lines of separation, limits, zones, enclaves/exclaves and special areas between States and dependencies as well as all jurisdictional offshore limits within U.S. sovereignty. Boundaries associated with natural resources, demography, and cultural entities are excluded and can be found in the appropriate subject themes." (FGDC, 2012)

C. Lead Agency

The theme lead is the Census Bureau. It should be noted that international

boundaries are handled by the International Boundary Commission (IBC) (US/Canada) and the International Boundary and Water Commission (IBMC) (US/Mexico). Neither of these commissions is affiliated with the FGDC, but they do share information with the Bureau, which incorporates the data into its state boundaries.

Furthermore, marine boundaries are now datasets under the data theme managed by the Marine and Coastal Subcommittee. That Subcommittee is chaired by a representative from NOAA's Coastal Service Center. There is also an Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM) that is co-chaired by DOI USGS, USACE, and NOAA. This group is developing a National Coastal Mapping Strategy and the National Shoreline Data Content Standard.

decennial census. To implement this process, it established and maintains a series of tabulation units that form a nested hierarchy from blocks all the way to the national boundary. It also tabulates population and housing information for special administrative areas such as school districts. The detailed boundaries of many administrative units are modified through annexation and incorporation processes.

In order to ensure that the boundaries contained in TIGER are current, the Bureau partnered with local governments to conduct a voluntary annual Boundary and Annexation Survey (BAS), which is authorized by Section 6 of Title 13 - Census of the United States Code. These partnerships provided the high-resolution data to accurately portray municipal boundaries, and to ensure that

Figure 5 - Comparison of Charleston, SC, parcel-based boundaries (left) and the TIGER representation (right) showing the misalignment of these two data sources in the right side image. (Source: Cowen, 2011)

survey responses are accurately assigned to the proper tabulation units.

The importance of this relationship with local governments is demonstrated by the boundaries portrayed in Figure 6. In this example, the boundary of Charleston, South Carolina, can only be accurately represented at the parcel level. Any mis-registration of these boundaries creates erroneous gaps and overlaps as shown on the right side image.

D. Collaboration and Partnering

The Census Bureau is constitutionally mandated to tabulate the population for the

The Office of Management and Budget (OMB) approves the BAS survey materials. The current valid OMB control number is OMB No. 0607-0151, and approval expires on December 31, 2015. As noted in the Federal Register:

"No other Federal agency collects these data nor is there a standard collection of this information at the State level. The Census Bureau's BAS is a unique survey providing a standard result for use by federal, state, local, and tribal governments and by commercial, private, and public organizations."

The BAS also provides an opportunity for participants to review the names and geographic relationships for these areas. The Census Bureau uses this information to provide a record for reporting the results of the decennial and economic censuses, and to support the Population Estimates Program and the American Community Survey.

As described at www.census.gov/geo/partnerships/bas/bas_suspension.html:

"The Census Bureau conducts the BAS each year to provide state, county, minor civil division, and local governments; as well as tribal governments the opportunity to submit changes to their legal boundaries, names, and governmental status effective on or before January 1 of the survey year. However, a subset of the 40,000 legal governments nationwide forms the core 'reporting universe' for BAS production each year. The reporting universe consists of governments known to experience boundary changes. The BAS is voluntary and every legal government has the opportunity to participate each year. In the 2013 BAS, 2,522 governments reported boundary updates."

The Census Bureau works closely with the U.S. Bureau of Indian Affairs to ensure that the BAS reflects official boundaries for Federally-recognized American Indian reservations, off-reservation trust lands, and tribal subdivisions.

The Census Bureau currently maintains BAS state agreements with six states and is working to establish new agreements with interested state governments. Two types of BAS state agreements are available to states.

Under the first type of agreement, the state reports boundary changes for all incorporated places, minor civil divisions (if applicable), and counties within its jurisdiction to the annual BAS. The Census Bureau currently maintains this type of state agreement with Alaska, Kentucky, Maine, and Massachusetts.

Under the second type of agreement, the state provides the Census Bureau with a list of local governments that reported boundary changes to the state. The Census Bureau uses this list to target those local governments for the BAS. The Census Bureau currently maintains the second type of agreement with Georgia and Michigan.

The Bureau has established a variety of ways for its partners to share boundary information. This includes everything from paper maps to GIS-based digital submissions. Unfortunately, for budgetary reasons the Bureau has suspended the BAS for fiscal year 2014. However, it is maintaining the governmental inventory as an exception to this suspension. As the Bureau has stated:

"The U. S. Census Bureau has suspended the Boundary and Annexation Survey (BAS) in fiscal year (FY) 2014, which runs from October 1, 2013 to September 30, 2014. The FY 2014 budget for the Department of Commerce and the Census Bureau reflects an effort to balance the desire to fund the many

important statistical programs and services the Census Bureau provides within the current budget environment. That effort required the Census Bureau to make some difficult resource allocation decisions that unfortunately resulted in the suspension of the BAS in 2014." (Bureau of Census, 2014)

Under the portfolio management program, the Census Bureau and the USGS co-chair the new National Boundaries Group (NBG), which includes 25 federal agencies. The purpose of the NBG is:

"…to develop nationally consistent boundaries that are integrated using the same geographic base. The goal is to make sure federal boundary sources are consistent, accurate, and integrated."

Under the new model there are three categories of units:

- Governmental unit boundaries (for example, county boundaries)
- Administrative boundaries (for example, school districts)
- Statistical boundaries (for example, census tracts)

The objectives for the NBG include:

- *Identification of the national authoritative sources and national authoritative integrators for boundary data.*
- *Application of enterprise supply/value chain principles. Who collects what? When is the data needed?*
- *Identification and development of boundary standards including recommendations for legal documentation.*
- *Identification of boundary data used by each agency including its current status, quality, and availability.*
- *Coordinating boundary data with the FGDC A-16 and Data Life Cycle efforts.*
- *Work closely with other FGDC subcommittees – e.g. the Coastal Subcommittee in the development of an reliable coastline dataset of the United States*

(Waggoner and Pierce, 2014)

E. Standards

Historically, development of standards for governmental units was handled by the FGDC Subcommittee on Cultural and Demographic Data (SCDD). This Subcommittee was chaired by the Census Bureau. As early as 1997, the FGDC Subcommittee on Cultural and Demographic Data started a project to create a data content standard for governmental units boundary data. However, that effort was superseded by the FGDC's decision to create a comprehensive set of Framework Data Content Standards.

The Subcommittee created Part 5 of the Framework standard for Governmental Units and other Geographic Area Boundaries. The document provides a useful set of definitions, topological relationships, and codes.

The final version FGDC-STD-014.5-2008 was accepted in May 2008.

F. Estimate of Completeness

Since 65 of the 70 datasets included in this theme are the responsibility of the Census Bureau, the coverage and quality are based on the representation maintained by its TIGER database. Originally TIGER was created at a scale of 1:100,000 with the boundaries often topologically tied to street

centerlines. TIGER has undergone continuous revisions including a major upgrade prior to the 2010 decennial census and the data are available.

Information regarding the current status of any internal boundary is based on the BAS partnership program. Since BAS is a voluntary program, the quality and currency of local governmental boundaries can vary considerably across the country. The optimal maintenance operation exists when there is a partnership with a state that has worked with its local governments to build a consistent set of boundaries. In either case, the BAS has been suspended and the data will require additional maintenance in the future.

The NSGIC GMA included questions about governmental units data. The GMA results for governmental units were:

- Of the 31 respondents, 24 responded that coverage for governmental units was 96% or greater.
- 7 states have no program for developing statewide governmental boundaries.

G. Accessibility

The primary access to governmental units is through Census Bureau websites. There are also links from the GeoPlatform. The Bureau provides a useful table that describes alternative ways of accessing the data, including through web mapping services or by downloading data in Esri and Google formats.

The TIGER database is the *de facto* source of governmental units. The governmental units extracted from this database are the official source for tabulation of the decennial census and voting districts created from them. Numerous private mapping companies have incorporated these boundaries into their products.

In their GMA responses 29 states indicated that "this data layer is publicly available without restrictions," and 3 states indicated that it was not.

H. Authority, Governance, and Management

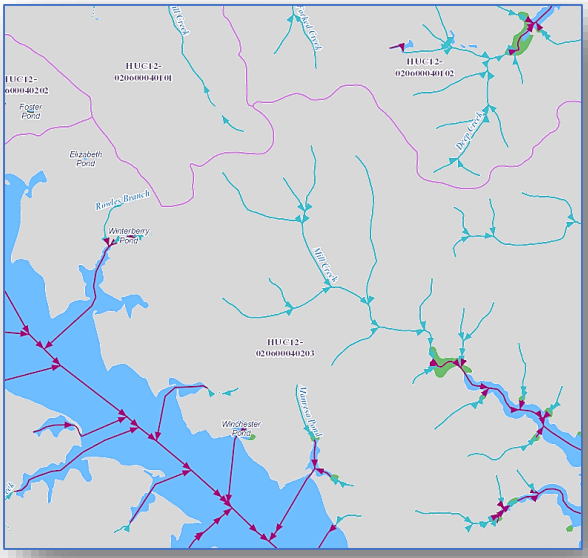
The Bureau of the Census is governed by title 13 of the United States Code. These laws pertain to protection of information collected from individuals and businesses. Therefore, they rarely have anything to do with governmental units.

The Bureau is dependent on voluntary partnerships with local, state, and Federal partners to fulfill its Constitutional mandate to conduct a decennial census. In addition, the accuracy of the annual American Community Survey (ACS) is dependent on the continuous update of the TIGER database. The continuous maintenance of TIGER is a major operational function of the Geography Division of the Bureau.

Hydrography Data Theme

THEME GRADE: C

(Requires Attention)



Hydrography Data from the USGS National Map

Description: Federal leadership for the collection, production, and distribution of hydrography data have been provided by the USGS and EPA. There has been good coordination among the Federal agencies that require these data for their program and mission needs and with non-federal entities. However, as with other types of Framework data, more work needs to be done to better leverage budgets, coordinate data collection efforts, and collaborate across levels of government.

Hydrography data are consistently identified as a critical dataset for a wide variety of uses at all levels of government and within the non-governmental sectors. The National Hydrography Dataset (NHD) produced by the USGS and the EPA provides consistent accessible hydrography data across the nation. Standards for hydrography data have been developed and approved through FGDC as well as U.S. and international standards development processes. Hydrography data are publicly available through the National Map, EPA data portals, Federal government clearinghouses and portals, and state and local access points.

Impacts: Hydrography data provided as part of this theme have assisted government agencies in performing their mission responsibilities.

A. Introduction

The NSDI Framework Hydrography data are based on an approach developed for the EPA and the USGS. This approach has resulted in the National Hydrography Dataset (NHD), which is the primary national hydrography data product representing the NSDI Framework.

Hydrography is important to many applications. As with other data themes, many users need hydrographic features as reference or basemap data. Other applications, particularly environmentally oriented analyses, need the information to analyze and model water supply, pollution, flood hazard, wildlife, development, and land suitability.

The USGS published "The National Map Customer Requirements: Findings from Interviews and Surveys" in 2009 as Open-File Report 2009–1222. Hydrography was ranked as the fourth highest requirement by the persons interviewed in the survey. While the NHD was cited as a major accomplishment, it was also one of the datasets most often cited as needing better quality control. In addition, the level of integration with the National Elevation Dataset (NED) was not sufficient to meet analysis or basic mapping needs

B. Theme Definition

This data theme includes surface water features such as lakes, ponds, streams and rivers, canals, oceans, and coastlines. Each hydrography feature is assigned a permanent feature identification code (EPA Reach Code) and may also be identified by a feature name. Spatial positions of features are encoded as centerlines and polygons. Also encoded is network connectivity and direction of flow.

In addition to representing the NSDI Framework, the NHD is the surface-water component of the National Map. The NHD is a comprehensive set of digital spatial data that represents the surface water of the United States using common features such as lakes, ponds, streams, rivers, canals, stream gages, and dams. Polygons are used to represent area features such as lakes, ponds, and rivers; lines are used to represent linear features such as streams and smaller rivers; and points are used to represent point features such as stream gages and dams. Lines also are used to show the water flow through area features, such as the flow of water through a lake. The combination of lines is used to create a network of water and transported material flow so users can trace movement in downstream and upstream directions.

C. Lead Agency

The lead agency with OMB A-16 designated responsibility at the Federal level is USGS. EPA has also played a large role in the development of the hydrography data.

The lead subcommittee with FGDC coordination responsibility is the Spatial Water Data Subcommittee. In operation, this Subcommittee is also part of the Advisory Committee on Water Information (ACWI), which operates under authority of OMB M-92-01: Coordination of Water Resources Information. ACWI represents the interests of water-oriented organizations including Federal, state, and other government agencies, professional and technical societies, the academic community, and the private sector. Members are selected from among from a wide variety of organizations including:

- Federal agencies
- Professional water-related associations
- State and county water-related associations
- Academia
- Private industry
- Water utility associations
- Civil engineering societies
- Watershed and land conservation associations
- Ecological societies
- Lake, coastal, and ocean associations
- Environmental and educational groups

The ACWI can have a maximum of 35 members and their alternates, who are appointed by the Secretary of the Interior.

D. Collaboration and Partnering

Through participation in the ACWI, key Federal programs participate in the coordination of Federal water information programs, and non-federal water information users and professionals advise the Federal government on the activities, plans, and effectiveness of Federal programs.

The Spatial Water Data Subcommittee has the responsibility to develop water resources components of the NSDI and is jointly sponsored with the FGDC. The NSDI

Framework is not specifically listed as a responsibility of the Spatial Water Data Subcommittee, but responsibilities established by OMB A-16 are clearly delineated as roles for this Subcommittee.

E. Standards

The FGDC has developed the Geographic Information Framework Data Content Standard. The standard was endorsed in 2008 as FGDC-STD-014-2008, and hydrography is one of the parts of this standard.

According to the standards document, the goal of the hydrography part of the Framework Data Content Standard is to provide common definitions and syntax to enable collaborative development, use, and exchange of hydrography data. The standard defines the components of networked and non-networked surface water features and supports the exchange of hydrographic feature and network information by general and expert users. The standard sets a common baseline of information content for exchange within the hydrographic community and will enhance data sharing and applications development when used with standards-based web services or file transfer.

The standard anticipates that multiple representations of hydrographic features will exist within the broader community. According to the standard, policies have been, or will be established for describing, maintaining, and exchanging the various representations of features within specific application communities, such as the NHD. The standard will accommodate the exchange of these multiple representations.

Through an award from the FGDC, the Wyoming Geographic Science Center developed a Framework Standard Guidance Document Version 1.0. The purpose of the document was to facilitate the process of creating new standardized data, harmonize and transform existing data to match standardized content, and generally assist in understanding and implementing the standard. The Guidance Document was prepared in 2010 and is available on the FGDC website.

In addition, an American National Standards Institute (ANSI) standard entitled "Codes for Identification of Hydrologic Units in the U.S. and the Caribbean (Outlying) Areas" was developed to update a 1986 version. This update was endorsed in the late 2000s through the INCITS/ANSI process.

F. Estimate of Completeness

The NHD is available nationwide in two seamless datasets: one based on 1:24,000-scale topographic mapping, known as the high-resolution NHD, and the other based on 1:100,000-scale topographic mapping, known as the medium-resolution NHD. It is also becoming available in select areas based on larger scales such as 1:5,000-scale mapping.

National coverage and the quality of that coverage have progressed in recent years, as summarized by the following timeline:

2001 - National coverage of 100K NHD is completed.

2002 - USGS, USFS, state agencies, and others begin work to produce 24K NHD.

2007 - National coverage of 24K NHD is completed.

The NSGIC GMA included questions about hydrography data. The GMA results for hydrography were:

- Of the 51 respondents, 29 have 96% or greater completeness, and 17 have less than 96% completed.
- 5 states have no program for developing statewide hydrography data.

G. Accessibility

NHD data are available from the USGS. The NHD includes datasets covering all streams and lakes at scales of 1:24,000 and 1:100,000. In some areas, the NHD is being supplemented with data larger than 1:24,000 scale. The NHD provides a network that supports the analysis of any type of movement (such as navigation, sediment transport, and effluent dispersion) by surface waters. Further information and downloadable data are available at nhd.usgs.gov. The NHD is also accessible through the NSDI Clearinghouse at the Geoplatform.gov portal.

In their GMA responses 17 states indicated that this data layer was publicly available without restrictions, and 26 states indicated that it was not. In addition, 34 said that it was available through a public state-maintained web mapping service.

H. Authority, Governance, and Management

The USGS is a bureau within the Department of the Interior. The USGS is a science organization that provides impartial information on the health of our ecosystems and environment, the natural hazards that threaten us, the natural resources we rely on, the impacts of climate and land-use change, and the core science systems that help us provide timely, relevant, and useable information.

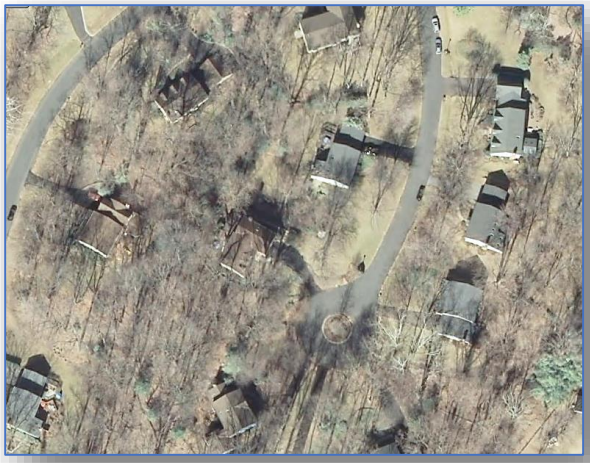
Created by an act of Congress in 1879, the USGS has a mission to provide reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

Orthoimagery Data Theme

GRADE: C+

(Requires Attention)

NAIP Imagery from Maryland's MDiMAP highlighting the approximate location of the hi-resolution image below.



Maryland Hi-Resolution, Leaf-Off Orthoimagery from Maryland's MDiMAP.

Discussion: The "leaf-on" orthoimagery layer warrants a grade of A-, given coverage, standards, and collaboration among supporting agencies. However, "leaf-off" orthoimagery, a documented requirement, lacks coverage. As a result, the grade for the combined layers is a C+.. The coordination and collaboration on orthoimagery is a leading example of cross-agency and cross-sector working relationships. However, there are additional opportunities to eliminate redundancies and leverage budgets across the different levels of government.

The National Agriculture Imagery Program (NAIP) provides excellent services and products. Many Federal, state, and local government programs have clear needs for high-resolution leaf-off imagery. No comprehensive national program exists for this product.

Orthoimagery and other types of imagery data are undoubtedly one of the most widely recognized and used Framework datasets. With the widespread availability of commercial mapping and web viewing, imagery data are almost ubiquitous across the United States.

There is a large volume of orthoimagery data across the nation, collected by many agencies and private sector organizations. For years, national programs have been coordinating the collection, production, and dissemination of orthoimagery. Federal leadership for imagery programs has been provided by the National Digital Orthoimagery Programs (NDOP) Committee which has been particularly effective in providing ways to share budget resources and in building a common standards-based data resource. Standards for imagery data have been developed and approved through FGDC as well as U.S. and international standards development processes. Orthoimagery is

publicly available through the USDA Geospatial Data Gateway, the National Map, agency data portals, Federal clearinghouses and portals, and state and local access points.

The consistent orthoimagery products currently provided are an indication of the true value of the NSDI.

Impacts: The orthoimagery data provided are assisting government agencies and others in performing their missions. They could better meet user needs by providing comprehensive leaf-on and leaf-off coverage.

A. Introduction

Orthoimagery data typically are high-resolution aerial images that combine the visual attributes of an aerial photograph with the spatial accuracy and reliability of a planimetric map. Digital orthoimagery resolutions generally vary from 6 inches to 1 meter.

An aerial photograph and an orthophoto or orthoimage may look alike, but there are several important differences between them. A conventional aerial photograph contains image distortions caused by the tilting of the camera and terrain relief (topography). It does not have a uniform scale, so you cannot easily measure distances on an aerial photograph like you can on a map.

With an orthophoto, however, the effects of tilt and relief are removed from the aerial photograph by a mathematical process called rectification. This makes an orthophoto a uniform-scale image. Since an orthophoto has a uniform scale, it is possible to measure directly on it like other maps. An orthophoto may also serve as a basemap onto which other map information overlaid.

The process of orthorectification removes feature displacements and scale variations caused by terrain relief and sensor geometry. The result is a combination of the image characteristics of an aerial photograph or satellite image and the geometric qualities of a map. These attributes allow users to:

- Measure distance
- Calculate areas
- Determine shapes of features
- Calculate directions
- Determine accurate coordinates
- Determine land cover and use
- Perform change detection
- Update maps

The USGS published "The National Map Customer Requirements: Findings from Interviews and Surveys" in 2009 as Open-File Report 2009–1222. Orthoimagery was ranked as the highest requirement by the persons interviewed in the survey. Orthoimagery consistently was cited as one of the top datasets needed to support geospatial activities regardless of the business activity or application level.

B. Theme Definition

This dataset contains georeferenced images of the Earth's surface, in which displacements caused by sensor distortions, sensor orientation, and terrain relief have been removed. For very large surface areas, an Earth curvature correction may be applied. Digital orthoimages encode the optical electromagnetic spectrum as discrete values modeled in an array of georeferenced pixels. Digital orthoimages have the geometric

characteristics of a map and the image qualities of a photograph.

C. Lead Agency

The FGDC Base Cartographic Subcommittee was initially assigned responsibility for the orthoimagery theme. As theme lead under OMB A-16, the USGS was Chair of the Subcommittee. As digital orthoimagery coordination grew between Federal agencies, the FGDC and A-16 roles transitioned to the National Digital Orthoimagery Program (NDOP) Subcommittee, and the Base Cartographic Subcommittee of the FGDC was deactivated.

The NDOP Subcommittee was formally chartered as the National Digital Orthoimagery Program in 1993 by the Natural Resources Conservation Service (NRCS), the Farm Service Agency (FSA), the U.S. Forest Service (USFS), and the USGS. It was formed to develop and promote a national strategy that acquires or accesses the best orthoimagery data for Federal agencies while creating partnerships with state, local, tribal, and private organizations. NDOP then became a chartered subcommittee of the FGDC in 2010.

The NDOP Subcommittee includes a Steering Committee, a Project Management Subgroup, and a Technical Management Subgroup.

The Steering Committee provides leadership and program oversight. It is responsible for establishing the vision, direction, and goals of the program, and oversees the two subgroups. Leadership of the Steering Committee alternates among the member agencies on an annual rotation.

The Project Management Subgroup is responsible for coordinating requirements among the NDOP members and partners, developing and monitoring production and funding plans, and addressing specific program issues.

The Technical Management Subgroup addresses technical issues related to the research, production, distribution, and application of digital orthophotos, product specifications, and standards.

D. Collaboration and Partnering

Numerous Federal and state programs comprise the imagery components of the NDOP, including:

- The National Agriculture Imagery Program (NAIP) of the U.S. Department of Agriculture (USDA),
- The USGS Orthoimagery Program,
- Numerous state aerial photography and orthoimagery programs, and
- Programs such as the National Geospatial-Intelligence Agency (133 Urban Areas), the Federal Emergency Management Agency (FEMA) Risk Map Program, and the Census Bureau MAF/TIGER Modernization Program.

Many states have their own orthoimagery programs, many with requirements for 1-foot leaf-off imagery or finer coverage. Requirements gathered from the states are forwarded to the NDOP Project Management Subgroup, which coordinates with Federal requirements in an effort to leverage the various programs and products. Coordination eliminates duplication and lessens the costs to partners.

The existing collaboration and partnering is working well. The USDA's National Agricultural Imagery Program (NAIP) collects data during the growing season, with plants fully emerged and leaves on the trees. This kind of imagery is called "leaf-on" imagery. The data are 1-meter resolution and cover a

state's agricultural area, including forest lands.

Other Federal agencies work with USDA and pay for extending the flights to cover non-agricultural areas. State and local governments sometimes pay for higher resolution imagery. The USDA has established mechanisms to accept this additional work. It is very cost-effective for planes to cover larger areas or use multiple data collection techniques once they are airborne.

E. Standards

The FGDC has developed the Geographic Information Framework Data Content Standard. The standard was endorsed in 2008 as FGDC-STD-014-2008.

In 2010, a Framework Standard Guidance Document Version 1.0 was developed by the Wyoming Geographic Science Center through an award from the FGDC. It is available on the FGDC website. The purpose of the document was to facilitate the process of creating new standardized data, to harmonize and transform existing data to match standardized content, and to generally assist in understanding and implementing the standard.

Orthoimagery is covered very well in the Framework Data Content Standard, and the digital orthoimagery part applies to NSDI Framework orthoimagery data produced or disseminated by or for the Federal government. According to Executive Order 12906, "Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure":

> *"Federal agencies collecting or producing geospatial data, either directly or indirectly shall ensure, prior to obligating funds for such activities, that data will be collected in a manner that meets all relevant standards adopted through the Federal Geographic Data Committee (FGDC) process."*

Because of rapidly changing technologies in the geospatial sciences, the orthoimagery part of the Geographic Information Framework Data Content Standard covers a range of specification issues, many in general terms. The orthoimagery part builds on previously adopted standards as it is based on an approved FGDC standard (Content Standards for Digital Orthoimagery, FGDC-STD-008-1999).

Additionally, national mapping technical instructions titled "*Standards for Digital Orthophotos*" were issued by the USGS in 1996. This established technical criteria is used in the production of digital orthophotos for USGS partners in the National Digital Orthoimagery Program and other USGS cooperative agreements. These instructions were integrated with other national mapping program technical instructions and specifications for data-specific metadata by the FGDC. The instructions are requirements for the collection, processing, and quality control of digital orthophoto data entered into the National Digital Cartographic Data Base, which existed at that time.

An additional ISO standard (ISO 19115-2:2009 *Geographic information - Metadata - Part 2: Extensions for imagery and gridded data*) extends the existing geographic metadata standard by defining the schema required for describing imagery and gridded data. The standard provides information about the properties of the measuring equipment used to acquire the data, the geometry of the measuring process employed by the equipment, and the production process used to digitize the raw data. This extension deals with metadata needed to describe the derivation of geographic information from raw data, including the properties of the

measuring system, and the numerical methods and computational procedures used in the derivation. The metadata required to address coverage of these data is addressed sufficiently in the general part of ISO 19115.

F. Estimate of Completeness

The National Digital Orthoimagery Program (NDOP) provides complete coverage of the U.S. and its territories and possessions with 1-meter leaf-on orthoimagery. The NDOP historically updated digital orthoimagery coverage every 3 to 10 years to maintain data currency. It is currently estimating a 2-year cycle based on projected funding. The NDOP supports partnerships for higher resolution (1') leaf-off digital orthoimagery in coordination with state-managed orthoimagery programs when requirements are aligned. In the past, this has been done in coordination with the NGA 133-cities imagery program and other specialized Federal requirements. The result is a patchwork of high-resolution imagery that has limited value for many government functions.

The NSGIC GMA included questions about orthoimagery. The GMA results for orthoimagery were:

- Of the 51 respondents, 34 have 96% or greater completeness and 7 had less than 96% completed.
- 10 states have no program for developing statewide orthoimagery.

G. Accessibility of data for this theme

The National Map offers free downloads of public domain, 1-meter orthoimagery for the conterminous United States, with many urban areas and other locations at 1-foot or finer resolution. Data downloads and additional information are available at www.nationalmap.gov/viewer.html.

Orthoimagery data are also accessible through the NSDI Clearinghouse at the Geoplatform.gov portal. In their GMA responses, 36 states indicated that "this data layer is publicly available without restrictions," and 5 states indicated that it was not. In addition, 36 said that it was available through a state-maintained public web mapping service.

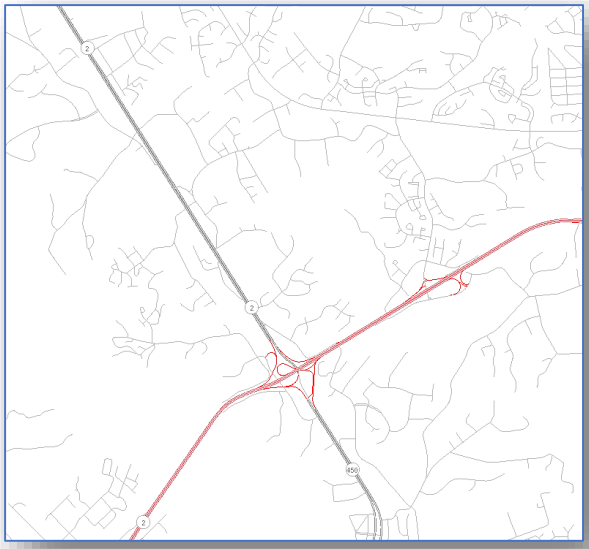
H. Authority, Governance, and Management

Orthoimagery provides an excellent example of how individual agency authorities can work with shared governance and management to build a widely useful and commonly accessible data resource. All of the organizations that contribute to this data operate under their own basic authority. No single organization has the funding resources to complete the entire national digital orthophoto program. Governance, management, and sharing of funding resources are conducted through common agreements worked out by the participating entities. Key to NDOP's success is that data and products are collected according to adopted standards and are shared for use by both the participants and the public.

Transportation Data Theme

GRADE: D

(At Risk)



Road Centerline Data from the USGS National Map

Discussion: The grade reflects poor stewardship in the past as reflected by the multiple sources of road centerline data (e.g. TIGER, ARNOLD, and privately produced) in use by Federal agencies. The DOT has begun to improve its stewardship responsibilities through recent collaborations, including the All Roads Network of Linear-Referenced Data (ARNOLD) and the MAP 21 programs. The Bureau of Transportation Statistics (BTS) has also developed goals for the development of a comprehensive road centerline, though these goals do not address all the modes of transportation covered by the data theme, such as railroads or waterways.

As the GAO recently reported (2012), the DOT has not been an effective steward for the transportation theme. It had not "*prepared and implemented a strategy, nor developed a policy for metadata or adopted procedures for accessing clearinghouse*." In fact, highways represent only one of four modes of transportation that has a standard. There are also concerns that the new DOT road file and the Census TIGER centerlines will not be synchronized, resulting in duplication of effort.

Impacts: The lack of effective stewardship of the Transportation data theme results in significant duplication of data, particularly road data. Transportation data are critical for many government and business needs and applications. The lack of a consistent, integrated, and publicly available layer of the nation's road network increases costs and hinders the operations of many organizations.

A. Introduction

Transportation networks constitute a critical component of the Framework data concept. The USGS customer survey identified the Transportation data theme as one of the seven most important geospatial datasets, and customers expressed the need to have unrestricted access to the data (USGS, 2009).

From the beginning of the NSDI, the DOT has been charged with the creation and maintenance of the spatial representation of the networks that depict roads, railroads, air, transit, and inland waterways. At the same time, the Census Bureau has created and maintained separate representations of street centerlines and railroads as a key component of the TIGER system. Over time, the Bureau's centerlines have become the *de facto* transportation data layers.

However, since TIGER was designed to meet the Bureau's specific requirements, these centerlines do not meet the level of precision required for many applications. For example, they do not support geocoding, which is

necessary for navigation to buildings. The Bureau has done an outstanding job of maintaining TIGER, and it is an extremely valuable asset, but it should not be considered the Transportation data theme.

The poor stewardship of the transportation theme was highlighted by the 2012 GAO report "*Geospatial Information OMB and Agencies Need to Make Coordination a Priority to Reduce Duplication*." The report highlighted the duplicative activities related to street centerlines including:

- *Census Bureau's Topologically Integrated Geographic Encoding and Referencing (TIGER) system, which uses data procured from local sources for census enumeration and demographic applications. These data were built and are maintained by the Census Bureau.*
- *USGS's National Map website, which uses licensed data from a commercial provider to create viewable maps on the National Map. These data are managed by USGS.*
- *The Department of Defense's Homeland Security Infrastructure Program, which uses licensed commercial data procured by the National Geospatial-Intelligence Agency for emergency management.*

In terms of the Framework data, the GAO prescribed specific actions:

- *Develop and implement a plan for the nationwide population of the transportation theme that addresses all datasets within the theme; and that includes:*

  (1) the development of partnership programs with states, tribes, academia, the private sector, other federal agencies, and localities that meet the needs of users;

  (2) human and financial resource needs;

  (3) standards, metadata, and the clearinghouse needs; and

  (4) a timetable for the development for the theme.

- *Create and implement a plan to develop and implement transportation theme standards. Further, to improve OMB oversight of geospatial information and assets, and minimize duplication of federal geospatial investments, we recommend that the Director of OMB develop a mechanism, or modify existing mechanisms, to identify and report annually on all geospatial related investments, including dollars invested and the nature of the investment*

It must be noted that the November 2012 GAO report did not include any reference to the multiyear Moving Ahead for Progress in the 21st Century Act (MAP 21) that became law in June of the same year. Under the new act, DOT is creating a new public domain set of street centerlines. Although the DOT and Census Bureau have been discussing ways to collaborate, a merger of their two representations will be difficult. Since scores of boundary features are linked to the TIGER centerlines, mass realignment to the new MAP 21 centerlines would be a major undertaking for the Bureau.

Furthermore, the DOT MAP 21 centerlines do not require states to include address ranges (although some states are including them). This will be a serious omission for many transportation applications. As a result, the Bureau is leading a major new initiative to create a point-level national address database. While addresses are not a Framework dataset, this initiative is a major step forward.

B. Theme Definition

Transportation data describe the means and aids for conveying persons and goods. The transportation system includes both physical and nonphysical components related to all modes of travel that allow the movement of goods and people between locations.

According to the current National Geospatial Data Asset (NGDA) plan, transportation data describe the means and aids for conveying persons and goods. The transportation system includes both physical and nonphysical components related to all modes of travel that allow the movement of goods and people between locations.

C. Lead Agency

The DOT Bureau of Transportation Statistics (BTS) is the lead for the data theme:

> *"The U.S. DOT is the lead agency responsible for the identification, coordination, and dissemination of information on best practices, standards for data exchange, standards development, and use of geospatial data in transportation. The U.S. DOT has delegated lead agency responsibilities to the Research and Innovative Technology Administration (RITA). This organization will lead the development and implementations of plans to coordinate transportation data related activities among Federal and non-Federal agencies and will report its activities to the FGDC. In carrying out its government wide leadership in transportation data coordination, the RITA is directly responsible to the FGDC and ensures compliance to the objectives and guidance provided by the FGDC."*

NGDA Transportation Dataset Names	Agency
Census Address Range-Feature Name Relationship File	DOC-Census
Census Address Ranges Relationship File	DOC-Census
Census All Roads Dataset	DOC-Census
Traffic Analysis Zone (Census 2000)	DOC-Census
Inland Electronic Navigation Charts	DoD-USACE
National Transportation Dataset – National Map	DoD-USACE
Airports	DOI-USGS
Runways	DOT-BTS
Transit (Combined Lines and Stations)	DOT-BTS
Rail	DOT-BTS
Bridge	DOT-BTS
Intermodal	DOT-BTS
Ports	DoD-USACE
Locks	DoD-USACE
Transportation Count	**14**

Table 3 NGDA transportation dataset names (Source: FGDC A-16 NGDA Data Set by Data Theme List - August 11, 2014)

There are 14 datasets listed under the new portfolio data management program for transportation that are assigned to four Federal agencies as the stewards (Table 3).

The creation of these datasets under the general transportation theme suggests an expansion of the traditional transportation features. The Census Bureau is the designated steward for "all roads" and "address ranges." This implies public domain access to address range geocoding based on TIGER.

USGS is listed as the steward for the "National Transportation Dataset – National Map." However, the USGS is not maintaining highway features and licenses commercial data to display on the National Map.

As noted by the GAO, there is a great deal of duplication related to transportation data. Even before the advent of the DOT MAP 21

highway data, different Federal agencies were using TIGER data and at least two licensed commercial representations of road features. For example, one of the most important users of highway features is the Department of Defense's Homeland Security Infrastructure Program. Their requirement to support routing and parcel-level geocoding necessitates the use of commercial data licensed by the National Geospatial-Intelligence Agency.

Given the ubiquitous free access to routing and geocoding services, the primary function of the transportation features managed by Federal agencies is integration with other themes.

The FGDC Transportation Subcommittee was reinstated in October 2010 with this mission:

> *"This Subcommittee is established to assist the lead agency to coordinate Federal and non-Federal interests in transportation data, including the facilitation of best practices, information exchange and data sharing; the establishment and implementation of standards for quality, content, and transferability; and the coordination of the identification of requirements and the collection of spatial data to minimize duplication of effort where practicable and economical. The Subcommittee will review and assess the lifecycle of the transportation data and the core requirements of data and applications throughout the federal government."*

The FGDC has established the Transportation Subcommittee Coordination Group which is undertaking an Intermodal Survey. This group is working to:

> *"Identify and standardize an intermodal facility database that can serve as a geographic foundation for all organizations dealing with modes of transportation. This includes passenger and non-passenger activities. The goal is to design the database in a way that will allow it to be adaptable."*

The survey's objectives are:

- *To assess its existing data resources and lay the groundwork for future efforts,*
- *Explore an intermodal framework that can be used by both the public and private sectors, and*
- *Determine the commonalities of the data by the user community.*

D. Collaboration and Partnering

Transportation for the Nation

The emergence of Transportation for the Nation (TFTN) is a unique collaboration between NSGIC and DOT. According to the DOT description of TFTN:

> *"Street networks (road centerline data) are one of the most widely used geospatial information products in today's society. They support E-911 dispatching, mail and parcel delivery, response and relief efforts during major disasters, online sales tax collection, mapping, geo-coding, intelligent transportation systems, and automated vehicle routing and location systems, to name but a few applications. Their use is pervasive in American society, yet there are scant figures available to demonstrate the true value of street network data to society."*

So far, nationwide programs that collect and assimilate transportation geospatial data from local, state, regional, and Federal sources are usually done with a single purpose, rather than a multi-purpose use, in mind. Several commercial data providers buy, partner, or recreate the data produced by government agencies. In the absence of an

effective and organized national program, and without incentives to cooperate, each level of government continues duplicating efforts by creating transportation data to meet only their individual and specific business needs. This practice leads to duplicative spending, wasted taxpayer dollars, and inefficient government. The true business value of shared transportation geospatial data is only beginning to be realized.

TFTN was originally put forth in a 2008 "Issues Brief" from the National States Geographic Information Council (NSGIC). NSGIC highlighted the importance of transportation, the inefficiencies, the high cost of multiple representations of street centerlines, and the need for DOT to take a lead role in stewardship.

In preparation for the new transportation bill Moving Ahead for Progress in the 21st Century Act (MAP 21), DOT used the NSGIC advocacy papers to initiate an external review of TFTN. The final report published in May 2011 provides the best review of various approaches to the creation and maintenance of the street networks of the transportation data theme.

This study puts forward a simple and direct strategic goal:

> *"Commence the development of comprehensive, publicly available, nationwide transportation data sets. Ultimately, Transportation for the Nation (TFTN) will encompass data sets covering multiple modes of transportation; however, the initial focus will be on producing a road centerline data set that includes all types of roads, both public and private. The initial TFTN data set will include consistent, current, high quality road centerline data for the entire country. Fundamental to a TFTN program is that all resulting data will be widely available and in the public domain."*

Key components of TFTN include:

- *Nationwide data that spans all states, territories and tribal lands.*
- *The inclusion of all roads, not just those funded by the federal government.*
- *Coordinated work across multiple levels of government (Federal, state, county/local) to create and maintain TFTN.*
- *TFTN will provide a common geometric baseline, persistent segment ID numbering and road naming that can be built on by other stakeholders to allow advanced capabilities such as routing, linear referencing systems (LRS), expanded attribute data collection, and addressing/geocoding.*
- *Data will be in the public domain.*

The strategic plan includes a useful comparison of the pros and cons of using TIGER and commercial road centerline data which can be found at the following URL: http://www.nsgic.org/public_resources/TFTN_StrategicPlan_vFinal.pdf

The plan includes an interesting assessment of the role of the Census TIGER files and affirms the DOT's stewardship responsibility:

> *"While Census Bureau became a transportation data provider by default and necessity, they are Census domain experts and are more of a transportation data integrator, in principle. In addition, the Census Bureau is a user of roads, railroads and other transportation centerlines. They are used for orientation of field staff during censuses and surveys, geocoding addresses to census blocks, address range determinations*

and delineation of statistical and administrative boundaries. The collection of housing unit locations required a shift in accuracy requirements from a relative approach to a highly accurate positional approach using GPS technology and high resolution imagery. Thus, transportation is neither the U.S. Census Bureau's line of business, nor their OMB A-16 Theme responsibility and TIGER is not designed as a transportation data set (e.g., its integrated topological structure contains many nodes not related to a transportation network)."

In addition:

"Census road centerline data maintenance schedule does not meet the more frequent needs for current road centerline data, such as E-911 and local needs."

The report also evaluated centerlines available from volunteered geographic information (VGI) sources like OpenStreetMap, and provided a useful comparison of TIGER, commercial, and VGI data sources.

In summary, the TFTN advocacy position and the strategic plan have become the cornerstones for the DOT current programs.

MAP 21

By far the most significant transportation related activity has been the Moving Ahead for Progress in the 21st Century Act (MAP 21). As part of this major transportation bill signed in June 2012, FHWA embraced the recommendations of the TFTN Strategic Plan and will develop the "basemap" using Highway Performance Monitoring System (HPMS) networks.

Specifically, MAP 21:

- Funds surface transportation programs at over $105 billion for fiscal years 2013 and 2014.
- Includes funding of $4.8 billion for a Highway Safety Improvement Program (HSIP).
- Requires the development of a "basemap" of all roads onto which safety attributes can be attached.

This program requires and provides funding for each state DOT to provide a complete road network as part of the annual HPMS submittal. This road network includes both paved and unpaved roads and dual carriageway representation where appropriate. It is significant that in addition to HSIP funds, FHWA waived the match requirement for using State Planning and Research Funds. As part of the implementation, each state was required to file a plan of action by June 2013. They were required to meet all of the new requirements by June 2014, including all public roads, LRS for all public roads, and dual carriage way representation. Twenty-nine states and Washington D.C. made complete submissions. The remaining states made submissions, but didn't meet one or more of the three criteria.

An initial focus for MAP 21 will be the creation of nationwide street centerlines that span all states and territories. According to their plan the MAP 21 effort will include:

- *All roads, not just federally funded roads,*
- *A common geometric baseline,*
- *Road naming,*
- *Persistent segment ID numbering, and*

- *Advanced functionality built on top of the baseline.*

From the viewpoint of Framework data, the MAP 21 road network will provide high-quality, nationwide transportation data that are in the public domain.

E. Standards

The original standards development consisted of the 2008 Framework data standards for the transportation base, rail, road, transit, and inland waterways. The standard for air was not endorsed. A second initiative was the 2011 United States Thoroughfare, Landmark, and Postal Address Data Standard, which was created by the Subcommittee for Cultural and Demographic Data. The inclusion of addresses that may be attributes of road features was sponsored by the Urban and Regional Information Systems Association (URISA) and the National Emergency Number Association (NENA).

The existing transportation Framework data standards are summarized as follows:

"The Geographic Information Framework Data Content Standard, Part 7: Transportation Base defines the data model for describing transportation systems components of transportation systems for five modes that compose the Transportation theme of the NSDI. The primary purpose of this part of the standard is to support the exchange of transportation data related to transportation systems. It is the intent of the Transportation Base part to set a common baseline that will ensure the widest utility of transportation data for the user and producer communities through enhanced data sharing and the reduction of redundant data production. At a high level, the transportation system described in this part of the Framework Data Content Standard is made up of transportation features, which can have geographic locations and characteristics."

Part 7a: Air

Not endorsed.

Part 7b: Rail

"Rail defines components of a model for describing the railway system, which is one of five modes that compose the Transportation theme of the NSDI framework data. The primary purpose of this part of the standard is to support the exchange of transportation data related to the railway system. It is the intent of the part to allow the widest utility of railway transportation data for the user and producer of transportation information by enhancing data sharing and reducing redundant data production."

Part 7c: Roads

"The Geographic Information Framework Data Content Standard, Part 7c: Roads defines the components of a model for describing roads which, along with Air (Part 7a), Rail (Part 7b), Transit (Part 7d), and Inland Waterways (Part 7e), is one of five modes that compose the Transportation theme of the digital geospatial data framework. The primary purpose of this part of the standard is to support the exchange of transportation data related to road systems. It is the intent of the Roads part to develop a consensus around a set of common definitions for real world features in order to advance the goals of the NSDI."

Part 7d: Transit

"The Geographic Information Framework Data Content Standard, Part 7d: Transit defines components of a model for describing public transportation (transit) systems, which is one of five modes that compose the Transportation theme of the digital geospatial data framework. The primary purpose of the Transit part of the standard is to support the exchange of spatial and temporal data related to public transportation. The emphasis in developing this part has been on supporting data exchange on a regional level to support itinerary planning, infrastructure inventories, and re-routing applications. It is the intent of this part to develop a consensus around a set of common definitions for real world transportation features to advance the goals of the NSDI."

Part 7e: Inland Waterways

"Inland Waterways provides common definitions and syntax to enable the use and exchange of geospatial data content as compiled for the IENC. The part describes authoritative data content derived from the IENC. It is expected that in conjunction with the other parts of the Transportation theme, this data will support the construction of a complex multi-modal model from disparate data collections and from a variety of different government entities."

F. Estimate of Completeness

The Census Bureau TIGER line files represent the *de facto* Framework data source for road and rail networks. TIGER also provides the basis for governmental units. However, TIGER was never designed to be the source for transportation features in the NSDI Framework.

The NSGIC GMA did not ask about all of the elements of the transportation theme but did gather information about road centerlines. The GMA results for road centerlines were:

- Of the 51 potential respondents, 23 responded that coverage for road centerlines was 96% or greater, and 18 reported less than 96% coverage.
- 10 states have no program for developing statewide road centerline data.

G. Accessibility

TIGER line files are updated at regular intervals and are easily accessed through TIGER Web. With an extensive set of attributes including names and address ranges, the TIGER road files have been widely used for numerous applications including geocoding. Access to files for various road and railroad features is available from the Census Bureau website, the Geoplatform, and Esri's ArcGIS Online.

In their GMA responses, 27 states indicated that the road centerline data layer is publicly available on state-maintained web services and without restrictions, and 12 states indicated that it was not.

H. Authority, Governance and Management

The Department of Transportation was established by an act of Congress on October 15, 1966. The mission of the Department of Transportation is to:

"Serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future."

Under OMB Circular A-16, DOT has always been the steward for Framework data relating to transportation. It chairs the Transportation Subcommittee, which is responsible for the coordination of transportation data-related activities among agencies and establishes a mechanism for the coordinated development, use, sharing, and dissemination of best practices, standards, and data for transportation.

OVERALL NSDI FRAMEWORK ASSESSMENT

This chapter conveys an overall impression of the NSDI Framework as a cohesive effort. The previous chapters on individual data themes provided information about the status and condition of each of the Framework's thematic categories and sub-elements. Each individual Framework data theme is critical to the successful implementation of the National Spatial Data Infrastructure. However, these data themes also play a role beyond their separate individual strengths, and together they can reflect the overall state of the Framework itself.

The NSDI Framework was envisioned to be an integrated data resource that would serve as the "data backbone of the NSDI." It was to be a collaborative effort to create a widely available source of basic geographic data. Its purpose was to provide the most common geographic data that users will need, and to serve as a building block for the NSDI. The Framework was intended to provide data that were trusted, standardized, described according to a common standard, and publicly available at minimal or no cost to the user.

The seven Framework data themes have each been developed through the efforts of the designated lead agencies, the FGDC, participating committee members, and other partners. Each theme has achieved some level of success, and each needs additional work, as discussed in earlier chapters.

ASSESSMENT CATEGORIES AND GRADING CRITERIA FOR THE NSDI FRAMEWORK

The assessment categories and grading criteria used for this report are adapted from those used by the American Society of Civil Engineers in its Report Card for America's Infrastructure.

The Categories for assessment are Capacity, Condition, Funding, Future Need, Operation and Maintenance, Public Use, and Resilience. These categories are defined as follows.

CAPACITY: The Framework's capacity to meet current and future demands.

CONDITION: The existing or near-term condition of the Framework themes as an integrated whole.

FUNDING: The funding capability of the Framework.

FUTURE NEED: Whether future funding prospects will be able to meet the need.

OPERATION AND MAINTENANCE: The ability of key lead organizations to develop and maintain the Framework and to adopt new technology, procedures, and standards.

PUBLIC USE: The Framework's ability to provide data resources that meet the everyday needs of organizations and the general public, and to provide data resources that meet the need to respond to public safety incidents, natural disasters, and other emergencies.

RESILIENCE: The ability of the geospatial community to participate in development of the Framework and to contribute to its sustainability as a long-term asset of value for the nation.

GRADING CRITERIA ARE:

A = FIT FOR THE FUTURE

The Framework is generally in excellent condition and meets capacity needs for the future. Few themes require attention. Standards for data and assured public access are met, and all themes form an integrated data network across the United States. Users are able to easily identify, integrate, and use Framework data from all themes.

B = ADEQUATE FOR NOW

The Framework is in good to excellent condition, but some themes require attention for significant deficiencies. Users are able to find, integrate, and use data from a majority of themes in any U.S. location.

C = REQUIRES ATTENTION

The Framework is in fair to good condition, but requires attention for most themes of data. Users have some difficulty in finding, integrating, and using data in general, and some locations in the U.S. are missing data for individual themes.

D = AT RISK

The Framework is in poor to fair condition and mostly below the goals envisioned for the NSDI. A large portion of the data themes have not been developed sufficiently to make them accessible or able to be integrated with other Framework data. Data for many locations is not useful without significant work by the user.

F = UNFIT FOR PURPOSE

The Framework infrastructure is in unacceptable condition and provides little to no value to users. Most of the data cannot be found or used in applications at national or local levels.

OVERALL GRADE FOR THE NSDI FRAMEWORK AND DATA THEMES

GRADE: C-

(Requires Attention)

Discussion: The NSDI Framework exists and provides substantial value to users through the large amounts of publicly available thematic data. The vision of the NSDI Framework, however, has not yet been fulfilled. While there are many datasets for the Framework themes, definitive sets of reliable and certified Framework data are not available. The Framework is not an integrated whole, but still remains mostly as seven separate themes.

There have been many positive actions in the implementation of the NSDI Framework. For example, individual thematic datasets have been developed. Metadata and data standards have been adopted and are used by data collectors. Government agencies generally make their data assets publicly available through data portals and spatial data clearinghouses.

The grade of C- represents that the entire Framework is in fair to good condition, but requires attention for most individual themes of data. Users generally have some difficulty finding, integrating, and using data, and some locations in the U.S. are missing data for individual themes. Therefore, the condition, state of development and use is: REQUIRES ATTENTION.

Impacts: The availability of large amounts of reliable geospatial data in the seven thematic Framework categories represents a great benefit to the nation. However, it is difficult for users to know which data sets are the definitive Framework data. While there are still many concerns about Federal agencies focusing almost exclusively on Federal needs and programs, many datasets that could be part of the NSDI Framework are being developed at state and local levels. Many users in government, business, academic, and NGO sectors are able to use this data to do their jobs. It is very probable that most of these users, including general public users, do not associate the data they use with the NSDI or with the Framework. This signifies that the Framework is not readily identifiable (branded), and that it does not exist as an integrated entity.

INDIVIDUAL CATEGORY DISCUSSIONS AND GRADES

The panel of experts engaged in significant discussion about grading the collective NSDI Framework. Views of the appropriate grades varied depending on the perspective of the individual expert. However, the panel was of unanimous consent that the Condition, Funding, and Future Need categories should be graded "At Risk." Grades were assessed as follows:

CAPACITY

GRADE = C

(Requires Attention)

The Framework's capacity to meet demands is quite strong from the perspective of individual themes of data. Many of the themes are robust with extensive collections of data covering much of the United States. Data collection will continue to expand as technologies develop and grow, and as events such as natural disasters and climate change continue to affect the nation.

However, the ability to effectively use this current and increasing amount of data is not certain. The Framework data resources are currently difficult to identify and integrate. As new or updated data are added across the nation, the ability of users to determine what data are integrated Framework data will likely be even more difficult than at present.

CONDITION

GRADE = D

(At Risk)

Individual themes of data for Framework categories are generally in good shape. Ongoing data collection activities are updating and adding too many of the datasets in these themes. Data holdings are extensive and generally accessible through government data portals and clearinghouses at Federal, state, and local levels. Most of these data have standards-compliant metadata that helps users understand the lineage and use characteristics of the data.

However, the Framework has significant shortcomings as an integrated whole. First, it is very difficult to identify which of the potentially numerous datasets is actually Framework data for a specific theme, or for a given geographic area. In addition, the NSDI Framework has not developed an integrated set of all Framework data themes. Because of these shortcomings, a user must find individual theme data and also tie all of the themes together before they can form a comprehensive view of their area of interest.

There are benefits to having extensive amounts of data available for a particular area to address the many different needs of users. However, the vision of an integrated Framework that is a data backbone and building block for the NSDI is not yet fulfilled.

FUNDING

GRADE = D

(At Risk)

Geospatial data are collected and used in a number of different ways. Across government, specific programs are funded for the collection and provision of some themes of data. Orthoimagery and geodetic control are two examples. Other programs are authorized and funded to achieve certain government missions, such as maintaining the Public Land Survey System or understanding and managing the water resources of the nation. These mission programs require and produce geospatial data as a direct outcome. Federal cadastral data and hydrography data of the National Hydrographic Dataset are examples of these types of programs. A third government source of Framework theme data are those programs and projects that exist to provide government services such as public safety, flood hazard protection, navigation safety, and public transportation construction. Geospatial data are collected as part of these programs and projects. Many times these data are related to a Framework theme and can become part of the Framework if they are collected and managed to meet Framework standards and specifications.

The current funding for these various data collection and management activities would be difficult if not impossible to identify. Lack of funding has often been identified as a barrier to the development and implementation of the NSDI Framework. A tremendous amount of geospatial data has been collected and disseminated over the more than 20 years since the NSDI was established. This growth in geospatial data resources is largely because most governments and private companies

understand how important these resources are in meeting their missions and addressing their business needs.

Many of the Framework themes have national coverages that are accessible to users from government and private sector data portals and clearinghouses. Efforts at education and outreach have helped to enhance the management and use of geospatial data. However, continued outreach to determine best practices for collecting and maintaining Framework data should be maintained and enhanced.

The development of an integrated NSDI Framework is a collaborative effort that requires participation from the entire geospatial community. Funds for this type of collaboration and for better management of Framework theme data—including activities around standardization, documentation, dissemination, and integration— are lacking. In addition, we haven't effectively architected an integrated system for the NSDI Framework to enable the full exploitation of data, including location and delivery of the data that are most suitable for individual purposes.

FUTURE NEED

GRADE = D

(At Risk)

The NSDI Framework was envisioned to be an integrated resource of seven common data themes most often needed by users. Funding initiatives for a number of efforts related to Framework data have been proposed. These initiatives are identified in theme chapters earlier in this report. These initiatives are specific to individual Framework themes and will be greatly beneficial for those themes if implemented. In addition to funding Framework data projects, there is a critical need to fund the infrastructure that supports data coordination, management, maintenance, and distribution functions. These are typically not "sunk costs" that have already built adequate infrastructure. They are ongoing costs that are essential for maintaining data accuracy and currency, and changing technologies. Given the current budget climates, approval of adequate funding for data and associated infrastructure costs is not anticipated in the near term.

OPERATION AND MAINTENANCE

GRADE = C

(Requires Attention)

The FGDC and lead agencies for Framework themes generally have the capability to maintain the current condition of the Framework and to operate it in much the same way as in the past several years. State governments continue to develop state-level spatial data infrastructures and portions of the Framework based on their respective priorities. New technologies, processes, and standards will undoubtedly be adopted or acquired as part of normal agency operations, resulting in incremental steps forward. While these efforts should keep a status quo, it does not promise significant steps forward for the Framework component of the NSDI.

PUBLIC USE

GRADE = C

(Requires Attention)

Framework theme data resources are readily available to the public through a variety of data portals and clearinghouses that are part of the NSDI. The datasets provide a wealth of

data for a wide variety of needs. The vast majority of this data is documented according to standards and available for public access and use at no charge.

However, there is no definitive designation that identifies specific data as the Framework data that are "authoritative." This problem has been difficult to address and often makes users unsure if a specific dataset is Framework. Users must determine which data should be considered Framework, and this can lead to significant inconsistency among users, governments, and companies. While these individual theme datasets are often easy to find and access, they are not well integrated, nor are they available as a comprehensive NSDI Framework.

RESILIENCE

GRADE = C

(Requires Attention)

The NSDI was envisioned as a national effort with leadership by the Federal government and with active partnerships, participation, and contributions from other levels of government and non-government sectors. State, local, and tribal governments, professional associations, and companies have all played important roles in the development and implementation of the NSDI and the Framework. Individual Framework data themes have had major contributions by non-federal participants. Cadastral data are collected primarily at the local level in the United States. Orthoimagery is collected in a strong partnership with many states and a number of local governments, which collaboratively fund private-sector contractor collection. This coordination and collaboration has served to broaden the number of organizations with a stake in the success of the NSDI. This should serve to provide a measure of resilience and sustainability.

The basic leadership, responsibility, and authority for the NSDI is with the Federal government. Neither the other levels of government, nor the private sector, are positioned to provide national leadership. All levels of government and the private sector are willing to develop new working relationships and new ways of sharing responsibility.

Appendix A
Expert Panel Membership

John D. Bossler is a consultant who retired from The Ohio State University where he was a Professor and Director of the Center for Mapping. Prior to that Dr. Bossler was the Director of the Coast and Geodetic Survey (C & GS) and the National Geodetic Survey (NGS). As Director of C & GS, he was an Admiral in the NOAA Commissioned Corps.

Dr. David J. Cowen is a Distinguished Professor Emeritus and former chair of the Department of Geography at the University of South Carolina. He served as chair of the Mapping Science Committee of the National Research Council and the National Geospatial Advisory Committee. He is a National Associate of the National Academy of Sciences and former member of the NRC Board on Earth Sciences and Resources.

Jim Geringer served as Wyoming Governor from 1995 to 2003, an early adopter and proponent of GIS for Executives. He served several years with the U.S. unmanned space program including launch of and maintaining remote sensing satellite systems and the Global Positioning Satellite System. Recent involvement includes serving on special committees under the National Research Council, such as the Mapping Science Committee. He is currently a director at Environmental Systems Research Institute (Esri).

Susan Carson Lambert is a geographer. She was with the USGS Water Resources Division. She was the Executive Director of the Kentucky Office of Geographic Information. She was president of the National States Geographic Council. In 2000 she was the winner of the prestigious John Wesley Powell Award from USGS for efforts in developing partnerships in state-wide base mapping. She also served on USGS Mapping Division headquarters staff as an intergovernmental partnership adviser. She served on the Mapping Science Committee of the National Research Council.

John Moeller is the President of JJ Moeller & Associates, a former Senior Principal Geospatial Intelligence Engineer at Northrop Grumman Corporation, and the Staff Director for the Federal Geographic Data Committee (FGDC). He previously was a Manager in the National Biological Service and Bureau of Land Management and served as a Combat Engineer Officer in the U.S. Army. He has led or served on numerous geospatial committees and is a past recipient of the Federal 100 Award.

Delegate Tom Rust, PE AICP serves in the Virginia House of Delegates and is vice-chairman with Pennoni Associates. He is chairman of the House Transportation Committee as well as the Joint Commission on Technology and Science. He has won numerous awards and achievements and has been recognized as one of the most Effective Leaders in the General Assembly.

Robert Welch is President of The Welch Group, a public affairs consulting firm in Madison. He has been a professional land surveyor since 1982, founding Welch Land Surveying that same year. For 20 years, Welch served in the Wisconsin Legislature including stints as the Assistant Minority Leader in the State Assembly and Senate President Pro Temp. He was very influential in starting the Wisconsin Land Information Program and served on its initial board.

APPENDIX B
Coalition of Geospatial Organizations - Member Organizations

American Society of Civil Engineers (ASCE) - Geomatics Division

The American Society of Civil Engineers (ASCE) represents more than 145,000 members of the civil engineering profession worldwide and is America's oldest national engineering society. ASCE's mission is to provide essential value to our members and partners, advance civil engineering, and serve the public good.

ASCE advances technology, encourages lifelong learning, promotes professionalism and the profession, develops civil engineer leaders, and advocates infrastructure and environmental stewardship.

The purpose of the Geomatics Division is to provide leadership, within the engineering profession, for the acquisition and management of spatial data required as part of scientific, administrative, legal, and technical operations for surveying, cartography, photogrammetry, multi-purpose cadastre, remote sensing, and geographic information systems; to foster the development of policy, guidelines, and specifications; to encourage the advancement of geomatics education; and to foster the dissemination of information.

American Society for Photogrammetry and Remote Sensing (ASPRS)

The American Society for Photogrammetry and Remote Sensing (ASPRS) is a scientific association serving more than 7,000 professionals worldwide. Our mission is to promote the ethical application of active and passive sensors, the disciplines of photogrammetry, remote sensing, geographic information systems, and other supporting geospatial technologies; to advance the understanding of the geospatial and related sciences; to expand public awareness of the profession; and to promote a balanced representation of the interests of government, academia, and private enterprise.

The Association of American Geographers (AAG)

The Association of American Geographers (AAG) is a nonprofit scientific and educational society founded in 1904. For more than 100 years the AAG has contributed to the advancement of geography. Its members from more than 60 countries share interests in the theory, methods, and practice of geography, which they cultivate through the AAG's Annual Meeting, scholarly journals, and the online AAG Newsletter.

The AAG promotes discussion among its members and with scholars in related fields, in part through the activities of its affinity groups and more than 60 specialty groups. The meetings and activities of our regional divisions provide the opportunity to network with colleagues.

The Cartography and Geographic Information Society (CAGIS)

The mission of the Cartography and Geographic Information Society is to support research, education, and practice to improve the understanding, creation, analysis, and use of maps and geographic information to support effective decision-making and improve the quality of life. The society serves as a forum for the exchange of original concepts, techniques, approaches, and experiences by those who design, implement,

and use cartography, geographical information systems, and related geospatial technologies.

Geographic & Land Information Society (GLIS)

The mission of GLIS is to encourage the appropriate use of surveying and mapping technologies in the development and use of geographic and land information systems. In line with this mission, GLIS aims to promote communication between GIS and surveying professionals; ensure the integrity of large-scale geographic and land information systems; promote the use of sound surveying and mapping principles in the development and use of land information systems; foster the development and adoption of useful standards, specifications, and procedures for the development and operation of land information systems; increase educational programs in GIS and US; work with other organizations in the GIS and LIS community; promote the development of reliable large-scale land information systems; provide a continuing forum for communication and coordination between GIS and surveying professionals; develop useful educational events and materials; and foster local, regional, and national cooperation among GIS and surveying organizations.

The GIS Certification Institute (GISCI)

The GIS Certification Institute (GISCI) is a tax-exempt, not-for-profit organization that provides the geographic information systems (GIS) community with a complete certification program, leading to GISP recognition. GISCI offers participants around the world, from the first early years on the job, until retirement, a positive method of developing value for professionals and employers in the GIS profession. We offer the only industry-wide, internationally-recognized, software-agnostic Certification available to geospatial professional around the world.

International Association of Assessing Officers (IAAO)

IAAO is a nonprofit, educational, and research association. It is a professional membership organization of government assessment officials and others interested in the administration of the property tax. IAAO has a membership of more than 7,400 members worldwide from governmental, business, and academic communities. The mission of IAAO is to promote innovation and excellence in property appraisal, assessment administration, and property tax policy through professional development, education, research, and technical assistance.

The Management Association for Private Photogrammetric Surveyors (MAPPS)

The Management Association for Private Photogrammetric Surveyors (MAPPS) is the only national association of firms in the surveying, spatial data, and geographic information systems field in the United States. MAPPS member firms are engaged in surveying, photogrammetry, satellite and airborne remote sensing, aerial photography, hydrography, aerial and satellite image processing, GPS and GIS data collection, and conversion services. Our associate members include firms that provide products and services to our member firms, as well as other firms world-wide. MAPPS' primary objective is to develop strength and unity on matters affecting the interests of its member firms. It is intended to promote a quality, profitable profession, interaction among firms, and advance education, both professional and

public. The organization monitors and works to affect legislation that impacts the profession. It is the purpose of MAPPS to promote the business interests of the profession.

National Society of Professional Surveyors (NSPS)

NSPS strives to establish and further common interests, objectives, and political effort that would help bind the surveying profession into a unified body in the United States. NSPS aims to advance the sciences and disciplines within the profession; enhance the image of the surveying profession in the eyes of the public; build self-esteem and professionalism; encourage cooperation between the public and private practices; establish channels of communication with other societies and assist in the exchange of information on laws, education, professional practice, and other concerns; promote the profession through an active public relations program; advance the protection of public welfare relative to surveying and mapping issues; encourage high standards of ethical and professional behavior; promote public faith and confidence in the profession; support new practical methods of surveying; promote good business practice; monitor national and state laws and regulations; encourage improved higher education curricula for surveyors; and honor persons for service to the public, the surveying profession, and the NSPS Foundation Inc.

National States Geographic Information Council (NSGIC)

NSGIC's mission is to promote statewide geospatial coordination activities in all states and to be an effective advocate for states in national geospatial policy and initiatives, thereby enabling the National Spatial Data Infrastructure (NSDI). The National States Geographic Information Council (NSGIC) is an organization committed to efficient and effective government through the prudent adoption of geospatial information technologies (GIT). Members of NSGIC include senior state geographic information system (GIS) managers and coordinators. Other members include representatives from federal agencies, local government, the private sector, academia, and other professional organizations. A rich and diverse group, the NSGIC membership includes nationally and internationally recognized experts in geospatial information technologies, data creation, and management as well as information technology policy.

The University Consortium for Geographic Information Science (UCGIS)

The University Consortium for Geographic Information Science (UCGIS) is a non-profit organization that creates and supports communities of practice for GIScience research, education, and policy endeavors in higher education and with allied institutions. We aim to be the professional hub for the academic GIS community. The UCGIS mission is to advance research in the field of geographic information science; expand and strengthen geographic information science education; advocate policies for the promotion of the ethical use of and access to geographic information and technologies; and build scholarly communities and networks to foster multi-disciplinary GIS research and education.

United States Geospatial Intelligence Foundation (USGIF)

USGIF's purpose is to promote the geospatial intelligence tradecraft and to develop a

stronger community of interest between government, industry, academia, professional organizations, and individuals who share a mission focused around the development and application of geospatial intelligence to address national security objectives.

Toward this end, the Foundation shall seek to accomplish the following broad objectives: sponsor, conduct, and support public discussion groups, panels, lectures and forum, for an interchange of views and the instruction of the public on the topics under review; publish and distribute educational publications relevant to civic associations, governmental bodies, libraries, schools, universities, and other interested groups; conduct sponsor or promote educational programs including, but not limited to, programs for teachers, administrators, and students; and award scholarships to students at accredited institutions of higher education to pursue geospatial intelligence disciplines.

Urban and Regional Information Systems Association (URISA)

The Urban and Regional Information Systems Association (URISA) is an independent, not-for-profit 501c (3) organization established in 1966. From webinars and workshops to multi-day conferences, URISA presents an abundance of educational programs, offers volunteer GIS expertise through its GIS Corps program, and assists government agencies with benchmarking GIS maturity through its GIS Management Institute.

URISA fosters excellence in GIS through its programs, guiding and supporting GIS professionals throughout their careers. URISA is considered to be the premier organization for the use and integration of spatial information technology to improve the quality of life in urban and regional environments. URISA promotes the effective and ethical use of spatial information and information technologies for the understanding and management of urban and regional systems. In addition to numerous educational programs, URISA publishes the peer-reviewed URISA Journal, The GIS Professional newsletter, and the thousands of conference proceedings papers included in the URISA Body of Knowledge.

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