GAO

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GEOSPATIAL INFORMATION

Better Coordination Needed to Identify and Reduce Duplicative Investments

GAO

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GEOSPATIAL INFORMATION

Better Coordination Needed to Identify and Reduce Duplicative Investments

Why GAO Did This Study

From homeland security to tracking outbreaks of disease, to investigating the space shuttle disaster to responding to natural disasters, the collection, maintenance, and use of location-based (geospatial) information has become critical to many federal agencies' abilities to achieve their goals. Local governments and the private sector also rely on such data to support essential functions.

GAO was asked to determine the extent to which the federal government is coordinating the sharing of geospatial assets, including through oversight measures in place at the Office of Management and Budget (OMB), in order to identify and reduce redundancies in geospatial data and systems.

What GAO Recommends

GAO is making recommendations to the Director of OMB and the Secretary of the Interior to direct development of a national geospatial strategic plan, and recommendations to the Director of OMB to develop criteria for assessing interagency coordination on proposals for potential geospatial investments, and strengthen its oversight of geospatial projects. In providing oral comments on a draft of this report, OMB and Department of the Interior officials generally agreed with its content and recommendations.
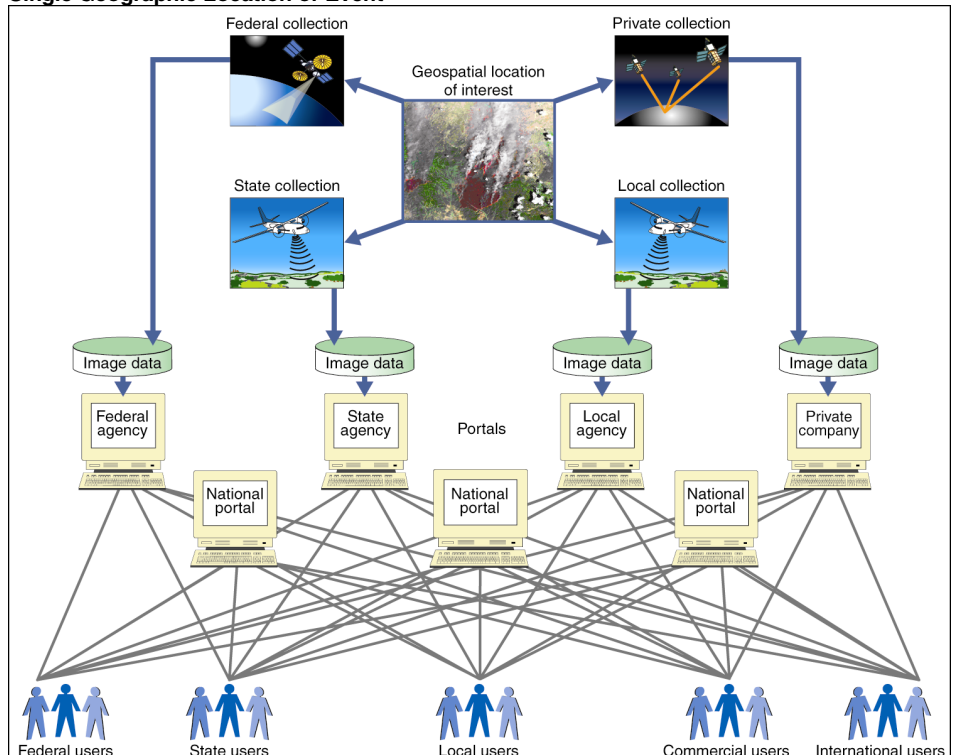
www.gao.gov/cgi-bin/getrpt?GAO-04-703.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Linda D. Koontz at (202) 512-6240 or koontzl@gao.gov.

What GAO Found

OMB, individual federal agencies, and cross-government committees and initiatives such as the Federal Geographic Data Committee and the Geospatial One-Stop project have taken actions to coordinate the government's geospatial investments across agencies and with state and local governments. However, these efforts have not been fully successful in reducing redundancies in geospatial investments for several reasons. First, a complete and up-to-date strategic plan for doing so has not been in place. Second, agencies have not consistently complied with OMB guidance that seeks to identify and reduce duplication. Finally, OMB's oversight of federal geospatial activities has not been effective because its methods—the annual budget review process, the federal enterprise architecture effort, and the Federal Geographic Data Committee's reporting process—are insufficiently developed and have not produced consistent and complete information. As a result of these shortcomings, federal agencies are still independently acquiring and maintaining potentially duplicative and costly data sets and systems. Until these problems are resolved, duplicative geospatial investments are likely to persist.

Entities That May Be Involved in Geospatial Data Collection and Processing Relating to a Single Geographic Location or Event

Sources: GAO (analysis); U.S. Forest Service (Earth photo) and Nova Development (clip art).

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Abbreviations

BLM	Bureau of Land Management
BTS	Bureau of Transportation Statistics
DHS	Department of Homeland Security
DOC	Department of Commerce
DOD	Department of Defense
DOI	Department of the Interior
DOT	Department of Transportation
EPA	Environmental Protection Agency
FEA	Federal Enterprise Architecture
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
FWS	Fish and Wildlife Service
GIS	geographic information system
GPS	Global Positioning System
GSA	General Services Administration
HHS	Department of Health and Human Services
HUD	Department of Housing and Urban Development
IT	information technology
MMS	Minerals Management Service
NILS	National Integrated Land System
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NSDI	National Spatial Data Infrastructure
NSGIC	National States Geographic Information Council
OMB	Office of Management and Budget
TIGER	Topologically Integrated Geographic Encoding and Referencing
USACE	U.S. Army Corp of Engineers
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey

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United States General Accounting Office
Washington, D.C. 20548

June 23, 2004

The Honorable Adam H. Putnam
Chairman, Subcommittee on Technology, Information Policy,
  Intergovernmental Relations and the Census
Committee on Government Reform
House of Representatives

The Honorable Pete Sessions
House of Representatives

The federal government collects, maintains, and uses geospatial information—information linked to specific geographic locations—to help in decision making and to support many functions, including national security, law enforcement, health care, the environment, and natural resources conservation. States, counties, cities, tribal governments, and the private sector also use geospatial information to support essential functions. Among the many activities that can depend on critical analysis of geospatial information are conducting the decennial census, the maintenance of roads and other critical transportation infrastructure, and actions in response to natural disasters such as floods, tornadoes, and fires.

Federal agencies, states, and local governments may each provide services at the same geographic locations and may independently collect similar geospatial information about those locations, thus raising the question of how well the nation's geospatial assets[1] are coordinated. You requested that we determine the extent to which the federal government is coordinating the sharing of geospatial assets, including through oversight measures at the Office of Management and Budget (OMB), in order to identify and reduce redundancies in federal geospatial data and systems. To address this objective, we identified key federal geospatial projects and reviewed capital asset plans, project plans, and other project documentation; conducted interviews with agency and OMB officials; and conducted focus groups with state, local, and private-sector representatives. Details of our objective, scope, and methodology are provided in appendix I. We conducted our work from October 2003 through May 2004 in accordance with generally accepted government auditing standards.

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[1]Geospatial assets include geographic information systems (GIS), data, technology, and standards.

Results in Brief

OMB, individual federal agencies, and cross-government committees and initiatives such as the Federal Geographic Data Committee (FGDC) and the Geospatial One-Stop project have each taken actions to coordinate the government's geospatial investments across agencies and with state and local governments. FGDC, Geospatial One-Stop, and other cross-government entities have established Internet-based information-sharing portals to support development of the National Spatial Data Infrastructure (NSDI); one goal of this effort is to address redundancy and incompatibility of geospatial information collected by many different organizations and stored and maintained at many different physical locations. In addition, FGDC has led geospatial standards-setting activities, and conducted various outreach activities. Individual federal agencies have also taken steps to coordinate specific geospatial investments in certain cases—the Departments of Agriculture (USDA) and the Interior (DOI), for example, have collaborated on a land management system. Finally, OMB has attempted to oversee and coordinate geospatial investments by collecting and analyzing relevant agency information.

However, these efforts have not been fully successful in reducing redundancies in geospatial investments for several reasons:

- A complete and up-to-date strategic plan has not been in place. The government's existing strategic plan for the NSDI is out of date and does not include specific measures for identifying and reducing redundancies.

- Federal agencies have not always fully complied with OMB direction to coordinate their investments. Many agency geospatial data holdings are not compliant with FGDC standards or are not published through its Internet clearinghouse.

- OMB's oversight methods have not identified or eliminated specific instances of duplication. The processes used by OMB to identify potentially redundant geospatial investments have not been effective, because the agency has not been able to collect key investment information from all agencies in a consistent way so that it could be used to identify redundancies.

As a result of these shortcomings, federal agencies are independently acquiring and maintaining potentially duplicative and costly data sets and

systems. Without better coordination, such duplication is likely to continue.

We are making recommendations to the Director of OMB and to the Secretary of the Interior to direct the development of a national geospatial data strategy with outcome-related goals and objectives; a plan for how the goals and objectives are to be achieved; identification of key risk factors; and performance measures. We are also making recommendations to the Director of OMB to encourage better agency compliance with Circular A-16 by developing criteria for assessing the extent of interagency coordination on proposals for potential geospatial investments; and to strengthen oversight actions to better ensure that agencies do not invest in potentially redundant geospatial systems or data gathering efforts.

We received oral comments on a draft of this report from representatives of OMB's Offices of Information and Regulatory Affairs and Resource Management and from the Assistant Secretary of the Interior—Policy, Management, and Budget. Both agencies generally concurred with the content of our report and our recommendations. In addition, the Departments of Defense and Health and Human Services, and the Bureau of the Census provided technical comments, which have been incorporated into the final report where appropriate.

Background

Geospatial information describes entities or phenomena that can be referenced to specific locations relative to the Earth's surface. For example, entities such as houses, rivers, road intersections, power plants, and national parks can all be identified by their locations. In addition, phenomena such as wildfires, the spread of the West Nile virus, and the thinning of trees due to acid rain, can also be identified by their geographic locations.

A geographic information system (GIS) is a system of computer software, hardware, and data used to capture, store, manipulate, analyze, and graphically present a potentially wide array of geospatial information. A GIS combines the disciplines of geography, cartography, computer science,

and mathematics to permit users to query and analyze the attributes[2] of any entity or phenomenon that has been identified by its geographic location, providing a powerful ability to integrate different kinds of location-based information. A fully functional GIS includes hardware and software to support data input, output, storage, retrieval, display, and analysis. A variety of platforms support GIS processing, ranging from large mainframe computers and minicomputers to scientific workstations and personal computers. In many cases, hardware used to support other applications (e.g., payroll, accounting, and digital image processing) can also be used.

A variety of technologies, including remote sensing systems and the Global Positioning System (GPS), are used to collect the geospatial data in a GIS.[3] Remote sensing systems collect data that are either emitted or reflected by the Earth and the atmosphere from a distance—such as from a satellite, airplane, or balloon. The GPS is a constellation of orbiting satellites that provides navigational data to military and civilian users around the world. With the proper equipment, users can receive signals from these satellites to calculate time, location, and velocity. GPS equipment is now being used on aircraft, ships, and land-based vehicles, and mobile hand-held units provide individuals with these capabilities as well.

The primary function of a GIS is to link multiple sets of geospatial data and display the combined information as maps with many different layers of information. Assuming that all of the information is at the same scale and has been formatted according to the same standards, users can potentially overlay spatial information about any number of specific topics to examine how the layers interrelate. Each layer of a GIS map represents a particular "theme" or feature, and one layer could be derived from a data source completely different from the others. For example, one theme could represent all of the streets in a specific area. Another theme could correspond to all of the buildings in the same area, and others could show vegetation or water resources. As long as standard processes and formats have been used to facilitate integration, each of these themes could be based on data originally collected and maintained by a separate organization. Analyzing this layered information as an integrated whole can significantly aid decision makers in considering complex choices, such as

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[2]Attributes describe the qualities or characteristics of an entity or phenomenon.

[3]For more information on remote sensing systems, see U.S. General Accounting Office, *Geospatial Information: Technologies Hold Promise for Wildland Fire Management, but Challenges Remain*, GAO-03-1047 (Washington, D.C.: Sept. 23, 2003).

where to locate a new department of motor vehicles building to best serve the greatest number of citizens.

Typical geospatial data layers (or themes) include cadastral—describing location, ownership, and other information about real property; digital orthoimagery—containing images of the Earth's surface that have the geometric characteristics of a map and image qualities of a photograph; and hydrography—describing water features such as lakes, ponds, streams and rivers, canals, oceans, and coastlines. Figure 1 portrays the concept of data themes in a GIS.

Figure 1: GIS Layers or Themes
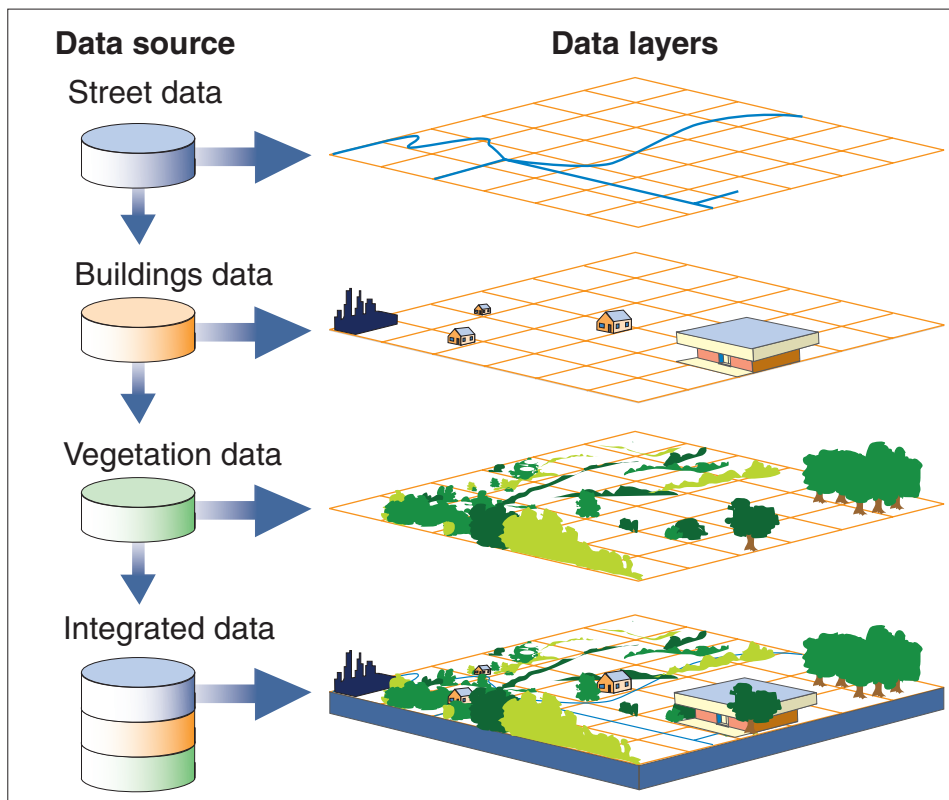
Source: GAO.

Geographic Information Systems and Data Provide a Broad Range of Benefits

State and local government agencies rely on geographic information systems to provide vital services to their customers. For example, local fire departments can use geographic information systems to determine the quickest and most efficient route from a firehouse to a specific location, taking into account changing traffic patterns that occur at various times of day. Highway departments use geographic information systems to identify intersections that have had a significant number of personal injury accidents to determine needs for improved traffic signaling or signage.

The usefulness of a GIS in disaster response situations was also demonstrated in connection with the Space Shuttle *Columbia* recovery effort. After the loss of *Columbia* on February 1, 2003, debris was spread over at least 41 counties in Texas and Louisiana (see fig. 2). Analysis of GIS data was critical to the efficient recovery and documentation of that debris. The Texas state GIS program provided authorities with precise maps and search grids to guide field reconnaissance and collection crews. Officials in charge of the effort used maps of debris fields, combined with GIS data about the physical terrain, to carefully track every piece of debris found.

Figure 2: *Columbia* Recovery Map
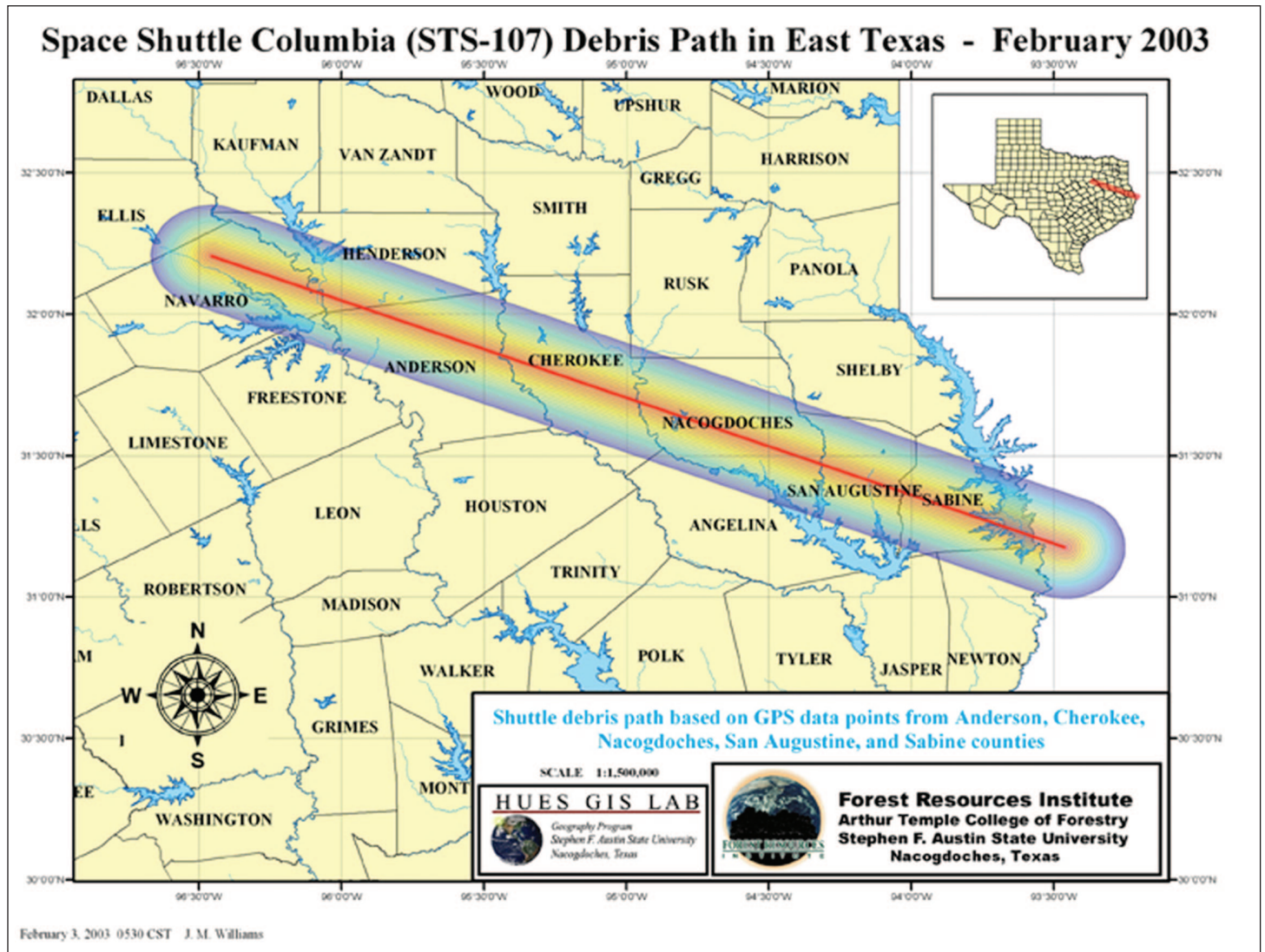
Source: Forest Resources Institute, Arthur Temple College of Forestry, Stephen F. Austin State University.

A GIS can also be an invaluable tool in helping to ensure homeland security by facilitating preparedness, prevention, detection, and recovery and response to terrorist attacks. For example, according to a March 2002

Gartner report,[4] New York City's GIS system was pivotal in the rescue, response, and recovery efforts after the September 11, 2001, terrorist attacks. The city's GIS provided real-time data on the area around the World Trade Center, so that the mayor, governor, federal officials, and emergency response agencies could implement critical rescue, response, and recovery efforts. Specifically, daily flyovers were performed to monitor changes in the elevation of the site to detect weaknesses in the underground structure. In addition, thermal imagery was compared with underground infrastructure maps to determine the locations where fires were still smoldering and to help the New York City Fire Department and emergency crews in detecting potential new explosion sites from nearby flammable substances. Further, maps generated by geospatial information systems were used to transmit critical information to the public and emergency personnel and provided the Army and Police Department with critical data on other potential terrorist targets such as bridges, tunnels, and reservoirs.

Another use for GIS is in the tracking and responding to natural disasters such as hurricanes. For example, the Federal Emergency Management Agency (FEMA) used its GIS capabilities and those of the National Oceanic and Atmospheric Administration (NOAA) to generate maps to track hurricane Isabel in September 2003. FEMA officials generated maps that estimated Isabel's track, and used a hurricane wind model to produce maps of projected damage-prone areas in affected states. These officials also produced wind damage estimates for structures and infrastructures, such as sewage treatment plants, nursing homes, schools, and hospitals. Further, the officials performed various demographic analyses that estimated the population and number of housing units in affected counties or other areas. Figure 3 shows an example of a hurricane-tracking map.

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[4]B. Keller and G. Kreizman, *To The Rescue: GIS in New York City on Sept. 11* (Gartner Inc., Mar. 11, 2002), www.gartner.com (downloaded Mar. 10, 2004).

Figure 3: Hurricane Isabel Tracking Map

Source: FEMA.

Similarly, many other federal departments and agencies use GIS technology to help carry out their primary missions. Examples include the following:

- The Department of Housing and Urban Development worked with the Environmental Protection Agency (EPA) to develop an enterprise

geographic information system, which combines information on community development and housing programs with other types of data, including environmental and transportation data. The program provides homeowners and prospective home buyers with ready access to detailed local information about environmental hazards and other information that otherwise would likely be difficult to obtain.

- The Department of Health and Human Services (HHS) uses GIS technology for a variety of public health functions, such as reporting the results of national health surveys. In addition, there are a variety of GIS-based atlases of national mortality from causes such as injury, cardiovascular disease, cancer, and reproductive health problems. Other GIS activities focus on disease surveillance and prevention of infectious diseases that are caused by environmental exposure. A variety of mapping tools are published on the Web to facilitate citizen access to public health resources and other information.

- The Census Bureau maintains the Topologically Integrated Geographic Encoding and Referencing (TIGER) database to support its mission to conduct the decennial census and other censuses and surveys by spatially locating all habitations within the United States and reporting the resulting census estimates and counts. Census provides the spatial information (not individual addresses) in this publicly accessible database through its Web site at http://www.census.gov/geo/www/tiger/index.html.

- NOAA provides access to maps and other geospatial information on subjects such as the weather and climate, oceans and fisheries, and satellite imagery used for global weather monitoring at http://www.noaa.gov.

- EPA maintains a variety of databases with information about the quality of air, water, and land in the United States. EPA's Envirofacts system (http://www.epa.gov/enviro/index.html) provides public access to selected EPA environmental data.

Appendix II provides additional examples of federal geospatial activities.

Coordination of Federal Geospatial Activities

The federal government has for many years taken steps to coordinate geospatial activities both within and outside the federal government. In 1953, the Bureau of the Budget[5] first issued its Circular A-16, encouraging expeditious surveying and mapping activities across all levels of government and avoidance of duplicative efforts. In 1990, OMB revised Circular A-16 to, among other things, establish FGDC within the Department of the Interior, to promote the coordinated use, sharing, and dissemination of geospatial data nationwide.

Building on that guidance, the President in 1994 issued Executive Order 12906, assigning to FGDC the responsibility to coordinate the development of the National Spatial Data Infrastructure (NSDI) to address redundancy and incompatibility of geospatial information. The infrastructure is defined by FGDC as the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and nonprofit sectors, and the academic community. The NSDI's goals are to reduce duplication of effort among agencies; to improve quality and reduce costs related to geographic information; to make the benefits of geographic data more accessible to the public; and to establish key partnerships with states, counties, cities, tribal nations, academia, and the private sector to increase data availability.

Further, in August 2002, OMB again revised Circular A-16 to reflect changes in geographic information management and technology and to more clearly define agency and FGDC roles and responsibilities. In addition to the responsibilities identified for FGDC, Circular A-16 outlines responsibilities and reporting requirements for individual federal agencies to help ensure that geospatial resources are used efficiently and contribute to building the NSDI. Among other things, the circular requires that agencies prepare geographic information strategies, use FGDC data standards, and coordinate and work in partnership with federal, state, and local governments and the private sector. These responsibilities are assigned to all agencies that collect, use, or disseminate geographic information or carry out spatial data activities.

More recently, in December 2002, the E-Government Act of 2002 was signed into law, requiring OMB to coordinate with state, local, and tribal governments as well as public-private partnerships and other interested

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[5]The Bureau of the Budget became the Office of Management and Budget in 1970.

persons on the development of standard protocols for sharing geographic information to reduce redundant data collection and promote collaboration and the use of standards.[6]

In addition to its responsibilities for geospatial information under the E-Government Act, OMB has specific oversight responsibilities regarding federal information technology (IT) systems and acquisition activities—including GIS—to help ensure their efficient and effective use. For example, the Clinger-Cohen Act of 1996[7] requires the Director of OMB to promote and be responsible for improving the acquisition, use, and disposal of information technology by the federal government to improve the productivity, efficiency, and effectiveness of federal programs. These requirements help to advance OMB's federal IT management responsibilities under the Paperwork Reduction Act of 1995,[8] which has a similar but more general requirement that the Director of OMB oversee the use of information resources to improve the efficiency and effectiveness of government operations to serve agency missions. Appendix III provides brief descriptions of key federal legislation, policies, and guidance that apply to IT and geospatial information and systems investments.

To help carry out its investment oversight role, OMB established requirements for the acquisition and management of IT resources in its Circular A-11. The circular establishes policies for planning, budgeting, acquisition, and management of federal capital assets. Specifically, it requires agencies to submit business cases to OMB for planned or ongoing major IT investments.[9] These business cases require agencies to answer questions to help OMB determine if the investment should be funded.

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[6]P.L. 107-347, section 216.

[7]40 U.S.C. § 11302(b).

[8]44 U.S.C. § 3504(a)(1).

[9]According to OMB Circular A-11, a major IT investment means a system or investment that requires special management attention because of its importance to an agency's mission; the investment was a major investment in the fiscal year 2004 submission and is continuing; the investment is for financial management and spends more than $500,000; the investment is directly tied to the top two layers of the Federal Enterprise Architecture; the investment is an integral part of the agency's modernization blueprint; the investment has significant program or policy implications; the investment has high executive visibility; or the investment is defined as major by the agency's capital planning and investment control process. Investments that are e-government in nature or use e-business technologies must be identified as major investments regardless of their costs.

Agency business case submissions must also include (1) the type of data used by the IT investment, including geospatial data; (2) whether the data needed for the investment already exist at the federal, state, or local level, and plans to gain access to that data; (3) potential legal reasons why existing data cannot be transferred; and (4) compliance with FGDC standards. According to Circular A-11, agency responses to these questions are reviewed as part of OMB's evaluation of the overall business case.

In addition to activities associated with Circulars A-11 and A-16, in a June 2003 congressional hearing, OMB's Administrator, Office of Electronic Government and Information Technology, stated that the strategic management of geospatial assets would be accomplished, in part, through development of a robust and mature federal enterprise architecture. In 2001, the lack of a Federal Enterprise Architecture was cited by OMB's E-Government Task Force as a barrier to the success of the administration's e-government initiatives.[10] In response, OMB began developing the FEA, and over the last two years it has released various versions of all but one of the five FEA reference models. According to OMB, the purpose of the FEA, among other things, is to provide a common frame of reference or taxonomy for agencies' individual enterprise architecture[11] efforts and their planned and ongoing investment activities.

State and Local Government and Private-Sector Geospatial Information and GIS Activities

State and local governments and the private sector independently provide information and services apart from those provided by the federal government, including maintaining land records for nonfederal lands, property taxation, local planning, subdivision control and zoning, and direct delivery of many other public services. These entities use geographic information and GIS to facilitate and support delivery of these services. In fact, local governments often possess more recent and higher resolution geospatial data than the federal government, and in many cases private-sector companies collect these data under contract to local government agencies.

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[10]OMB's E-Government Task Force identified 23 initiatives (two additional initiatives were subsequently added) aimed at improving service to individuals and businesses, intergovernmental affairs, and federal agency-to-agency efficiency and effectiveness.

[11]An enterprise architecture is a blueprint, defined largely by interrelated models, that describes (in both business and technology terms) an entity's "as is" or current environment, its "to be" or future environment, and its investment plan for transitioning from the current to the future environment.

For example, the state of New York hosts a Web site to provide citizens with a gateway to state government services at http://www.nysegov.com/map-NY.cfm. Using this Web site, citizens can access information about state agencies and their services, and locate county boundaries, services, and major state highways. New York also developed a clearinghouse (http://www.nysgis.state.ny.us/) to disseminate information about statewide GIS programs and provide information and services including state maps, aerial photographs, and a help desk to provide support for both general questions and specific questions regarding the use of GIS software. Many other states, such as Oregon (http://www.gis.state.or.us/), Virginia (http://www.vgin.virginia.gov/index.html), and Alaska (http://www.asgdc.state.ak.us/), provide similar Web sites and services.

For local governments, GIS applications have become integral resources for public works, and financial, public safety, and economic developments. A 2003 survey sponsored by Interior showed that GIS technology is recognized as an essential tool by many local governments. For example, Fairfax County in Virginia developed GIS applications to provide online products and services to the public that include

- a digital map viewer to see and download property, zoning, topography, or contour maps;

- an aerial orthoimagery[12] photo viewer to access aerial photographs of specific parcels, areas of interest, or addresses;

- a department of tax administration parcel finder to locate detailed information about a specific property and to view that parcel with the parcel viewer; and

- a map gallery that contains many common maps produced by the Fairfax County GIS and Mapping Department. The maps are letter size and available in many formats for downloading and printing.

The private sector also plays an important role in support of government GIS activities because it captures and maintains a wealth of geospatial data and develops GIS software. Private companies provide services such as

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[12]Orthoimagery is imagery prepared from perspective photographs in which the displacement of features due to sensor tilt and terrain relief has been removed.

aerial photography, digital topographic mapping, digital orthophotography, and digital elevation modeling to produce geospatial data sets that are designed to meet the needs of government organizations.

Figure 4 provides a conceptual summary of the many entities—including federal, state, and local governments and the private sector—that may be involved in geospatial data collection and processing relative to a single geographic location or event. Figure 5 shows the multiple data sets that have been collected by different agencies at federal, state, and local levels to capture the location of a segment of roadway in Texas.

Figure 4: Conceptual Diagram of Multiple Geospatial Data Collections and Processing Associated with a Single Geographic Location
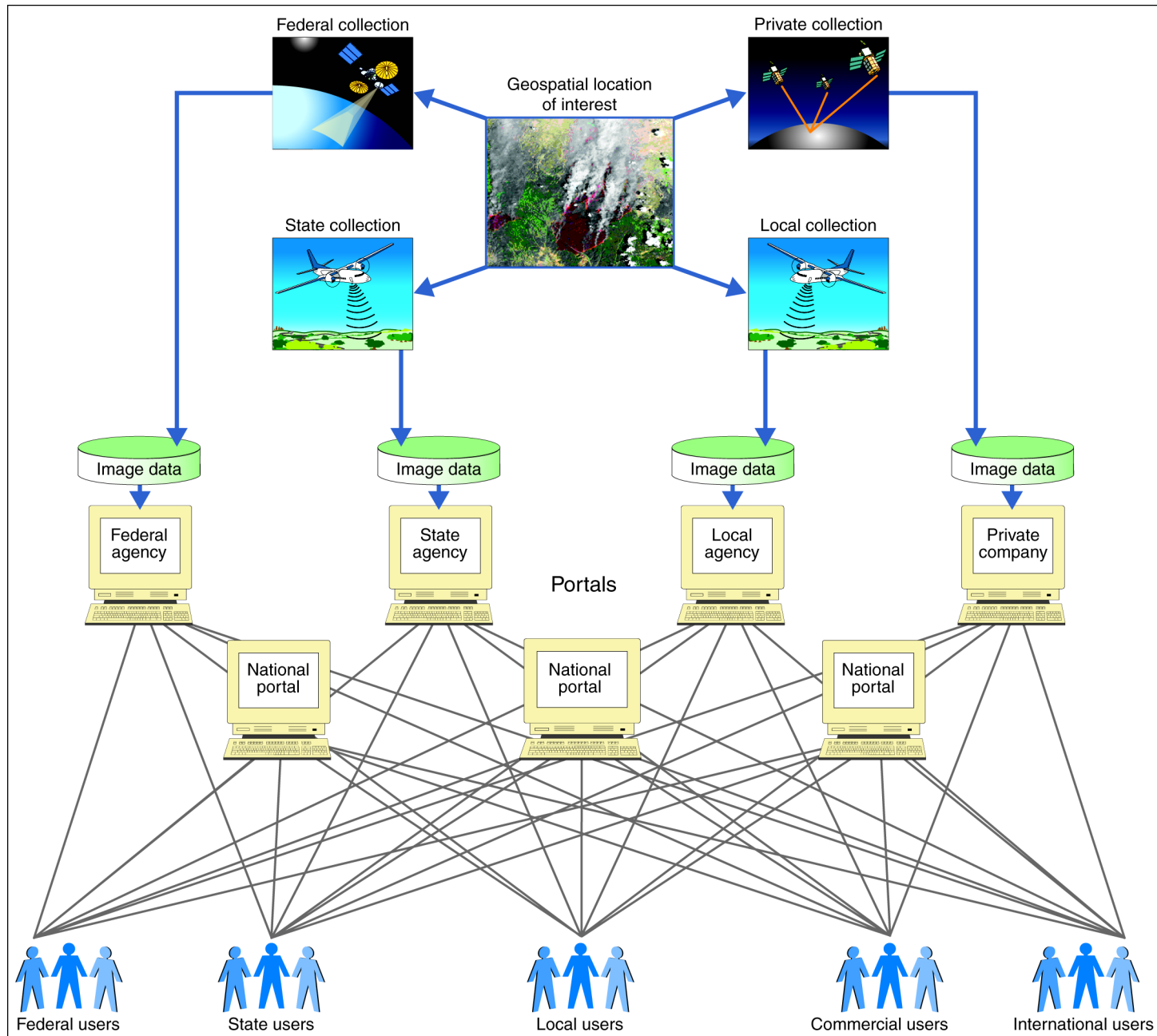
Sources: GAO (analysis); U.S. Forest Service (Earth photo) and Nova Development (clip art).

Figure 5: Multiple Street Centerline Data Sets Covering the Same Location in Texas

Texas Councils of Government Road Centerline Data
Texas Strategic Mapping Program Transportation Layer
Texas Department of Transportation (TxDOT) County Road Inventory
TxDOT Digital County/Urban Map Files
U.S. Census Bureau 2000 TIGER Line Data

Source: County Information Project, Texas Association of Counties.

Costs Associated with Gathering, Maintaining, and Using Geospatial Data Are Significant

Costs associated with collecting and maintaining geographically referenced data and systems for the federal government are significant. Specific examples of the costs of collecting and maintaining federal geospatial data and information systems[13] include

- FEMA's Multi-Hazard Flood Map Modernization Program—estimated to cost $1 billion over the next 5 years;

- Census's TIGER database—modernization is estimated to have cost over $170 million between 2001 and 2004;

- Agriculture's Geospatial Database—acquisition and development reportedly cost over $130 million;

- Interior's National Map—development is estimated to cost about $88 million through 2008;[14]

- The Department of the Navy's Primary Oceanographic Prediction, and Oceanographic Information systems—development, modernization, and operation were estimated to cost about $32 million in fiscal year 2003; and

- NOAA's Coastal Survey—expenditures for geospatial data are estimated to cost about $30 million annually.

In addition to the costs for individual agency GIS systems and data, the aggregated annual cost of collecting and maintaining geospatial data for all NSDI-related data themes and systems is estimated to be substantial. According to a recent estimate by the National States Geographic Information Council (NSGIC), the cost to collect detailed data for five key data layers of the NSDI—parcel, critical infrastructure, orthoimagery, elevation, and roads—is about $6.6 billion. The estimate assumes that the data collection will be coordinated among federal, state, and local

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[13]The scope of these cost estimates varies and may include development, operation, or both. The examples are for illustrative purposes and are not intended to be compared.

[14]This figure does not include costs for data acquisition. Some National Map data are acquired from Landsat satellites, which are estimated to cost about $95 million to operate through 2008.

government agencies, and the council cautions that without effective coordination, the costs could be far higher.

Although Steps Have Been Taken to Coordinate Geospatial Activities, Redundant Investments Remain

OMB, individual federal agencies, and cross-government committees and initiatives such as the Federal Geographic Data Committee (FGDC) and the Geospatial One-Stop project have each taken actions to coordinate the government's geospatial investments. FGDC and other cross-government entities have established Internet-based information-sharing portals to support development of the NSDI, led geospatial standards-setting activities, and conducted various outreach activities. In addition, individual federal agencies have taken steps to coordinate specific geospatial investments in certain cases—Agriculture and Interior have collaborated on a land management system. Finally, OMB has attempted to oversee and coordinate geospatial investments by collecting and analyzing relevant agency information.

However, these efforts have not been fully successful in reducing redundancies in geospatial investments for several reasons. First, a complete and up-to-date strategic plan has not been in place. The government's existing strategic plan for the NSDI is out-of-date and does not include specific measures for identifying and reducing redundancies. Second, federal agencies have not always fully complied with OMB direction to coordinate their investments. Many agency geospatial data holdings are not compliant with FGDC standards or are not published through the National Geospatial Data Clearinghouse. Third, OMB's oversight methods have not identified or eliminated specific instances of duplication. The processes used by OMB to identify potentially redundant geospatial investments have not been effective, because the agency has not been able to collect key investment information from all agencies in a consistent way so that it could be used to identify redundancies.

As a result of shortcomings in all three of these domains, federal agencies are independently acquiring and maintaining potentially duplicative and costly data sets and systems. Without better coordination, such duplication is likely to continue.

FGDC and Others Have Taken Steps to Coordinate GIS Activities Governmentwide, but Lack a Complete and Up-to-Date Strategic Plan to Guide Them

Both Executive Order 12906 and OMB Circular A-16 charge FGDC with responsibilities that support coordination of federal GIS investments. Specifically, the committee is designated the lead federal executive body responsible for (1) developing, implementing, and maintaining spatial data standards; (2) promoting and guiding coordination among federal, state, tribal, and local government agencies, academia, and the private sector in the collection, production, sharing, and use of spatial information and the implementation of the NSDI; (3) communicating information about the status of infrastructure-related activities via the Internet; and (4) preparing and maintaining a strategic plan for developing and implementing the NSDI.

According to OMB Circular A-16, FGDC is to develop standards, with input from a broad range of data users and providers. Geospatial standards are intended to facilitate data sharing and increase interoperability among automated geospatial information systems. In addition, according to Circular A-16, the committee is to adopt national and international standards in lieu of federal standards, whenever possible, and restrict its standards-development activities to areas not covered by other voluntary standards-consensus bodies.

To address these responsibilities, FGDC has created a standards working group that includes federal agencies, states, academia, and the private sector. The working group has developed, and the committee has endorsed, a number of different geospatial standards, including metadata[15] standards, and are working to continue developing additional standards. The committee's working group also coordinates with national and international standards bodies to ensure that potential users support their work.

Regarding coordination with federal and other entities and development of the NSDI, FGDC has taken a variety of actions. It established a committee structure with participation from federal agencies and key nonfederal organizations such as NSGIC, and the National Association of Counties, and established several programs to help ensure greater participation from federal agencies as well as other government entities. The committee structure is composed of (1) a steering committee that sets the high-level

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[15]Metadata refers to data that contain or define other data. For geospatial information, metadata provides information about, among other things, sources used, collection methods, and the date the data were collected.

strategic direction for FGDC and (2) agency-led subcommittees and working groups. The subcommittees and working groups provide the basic structure for institutions and individuals to interact and coordinate with each other during the implementation of the NSDI. FGDC membership includes 19 federal agencies, with the Secretary of the Interior and the Deputy Director for Management, OMB, serving as Chair and Vice-Chair, respectively.

Key actions taken by FGDC to develop the NSDI include implementing a National Geospatial Data Clearinghouse and establishing a framework of data themes. The clearinghouse is a decentralized system of Internet-based servers that contain descriptions of available geospatial data—over 300,000 metadata records, and information on over 2 million digital images are currently available through the clearinghouse. It allows individual agencies, consortia, or others to promote their available geospatial data. The framework of data themes is a collaborative effort in which commonly used data "layers" are developed, maintained, and integrated by public and private organizations within a geographic area. Local, regional, state, and federal organizations and private companies can use the framework as a way to share resources, improve communications, and increase efficiency. Appendix IV provides detailed descriptions of the framework data themes and other geospatial data layers.

OMB Circular A-16 also calls for FGDC to communicate information, via the Internet, about its activities related to NSDI development; committee memberships; and the status of agencies' work on committees, subcommittees, and working groups. FGDC is also to provide a collection of technical publications, articles, and reports related to the NSDI. To address these responsibilities, FGDC has established a Web site at www.fgdc.gov that provides information on its organizational structure and agencies' activities on its committees and subcommittees—including minutes of meetings for each. The Web site also provides, among other information, technical articles, fact sheets, newsletters, and news releases.

In addition to FGDC's programs to support developing and implementing the NSDI, two other efforts are under way that aim to coordinate and consolidate geospatial information and resources across the federal government—the Geospatial One-Stop initiative and the National Map project.

Geospatial One-Stop. Geospatial One-Stop is intended to accelerate the development and implementation of the NSDI to provide federal and state

agencies with a single point of access to map-related data, which in turn will enable consolidation of redundant geospatial data. OMB selected Geospatial One-Stop as one of its e-government initiatives,[16] in part to support development of an inventory of national geospatial assets, and also to support reducing redundancies in federal geospatial assets. The Department of the Interior was designated as the managing partner to lead the project, with development support from various other federal agencies. As of April 2004, over 9,000 metadata records were accessible through the Geospatial One-Stop portal, located at www.geodata.gov. According to the initiative's executive director, the portal will continue to add metadata records by implementing a metadata "harvesting" program to actively gather metadata from many sources, beginning with the clearinghouse. In addition, the portal includes a "marketplace" that provides information on planned and ongoing geospatial acquisitions for use by agencies that are considering acquiring new data to facilitate coordination of existing and planned acquisitions.

The National Map. The U.S. Geological Survey (USGS) is developing and implementing The National Map as a database to provide core geospatial data about the United States and its territories, similar to the data traditionally provided on USGS paper topographic maps. Through this project, USGS maintains an archive for the historic preservation of data and science applications; provides products and services that include paper maps, digital images, data download capabilities, and scientific reports; and promotes geographic integration and analyses. USGS relies heavily on partnerships with other federal agencies as well as states, localities, and the private sector to maintain the accuracy and currency of the national core geospatial data set as represented in The National Map.

According to Interior's Assistant Secretary—Policy, Management, and Budget, FGDC, Geospatial One-Stop, and The National Map are coordinating their efforts in several areas, including developing standards and framework data layers for the NSDI, increasing the effectiveness of the clearinghouse, and making information about existing and planned data acquisitions available through the Geospatial One-Stop Web site.

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[16]U.S. General Accounting Office, *Electronic Government: Selection and Implementation of the Office of Management and Budget's 24 Initiatives*, GAO-03-229 (Washington, D.C.: Nov. 22, 2002).

Table 1 summarizes the NSDI, Geospatial One-Stop, and National Map programs.

Table 1: Summary of the NSDI, Geospatial One-Stop, and National Map Programs

	National Spatial Data Infrastructure	Geospatial One-Stop	The National Map
Description	The technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve geospatial data.	An e-government initiative sponsored by OMB to enhance government efficiency and improve citizen service.	A resource to enable and communicate information related to geographic science.
Purpose	To ensure that geospatial data from multiple sources (federal, state, local, and tribal governments, academia, and the private sector) are available and easily integrated to enhance the understanding of our physical and cultural world.	To develop a geospatial portal to make easier, faster, and less expensive access to geospatial information available for all levels of government and the public.	To provide trusted, integrated, seamless, and continually maintained geospatial base data and archives, along with related models and applications.
Data collected	Data themes that include geodetic control, orthoimagery, elevation, transportation, hydrography, cadastral, and government units.	Seventeen data categories, representing all NSDI data themes.	Eight base data themes, including five NSDI framework themes, and related scientific models and applications.
Standards	Common and repeated rules, conditions, guidelines, or characteristics for data and related processes. NSDI standards are developed and promulgated by FGDC using an established process with input from a broad range of data users and providers.	Adopts, adapts, or develops standards and Internet protocols necessary for effective implementation of the NSDI; currently completing work on FGDC information content standards for the NSDI framework data themes.	Encourages and promotes the use of standards for database creation and developing and assuring conformance to standards, guidelines, and characterizations of technology.
Web site	www.fgdc.gov/nsdi/nsdi.html	www.geo-one-stop.gov	www.nationalmap.usgs.gov

Source: GAO.

In addition to its other responsibilities, OMB Circular A-16 charges FGDC with leading the preparation of a strategic plan for the implementation of the NSDI. Such a plan could ensure coherence among the many geospatial coordination activities that are under way and provide ways to measure success in reducing redundancies. In 1994, FGDC issued a strategic plan that described actions federal agencies and others could take to develop the NSDI, such as establishing data themes and standards, training programs, and partnerships to promote coordination and data sharing. In April 1997, FGDC published an updated plan—with input from many organizations and individuals having a stake in developing the NSDI—that

defined strategic goals and objectives to support the vision of the NSDI as defined in the 1994 plan. No further updates have been made.

As the current national geospatial strategy document, FGDC's 1997 plan is out of date. First, it does not reflect the recent broadened use of geospatial data and systems by many government agencies. In conjunction with EPA, the Department of Housing and Urban Development (HUD), for example, now makes geospatial information about housing available to potential home buyers over the Internet. This is one of several agency geospatial projects that did not exist in 1997. Second, significant governmentwide geospatial efforts—including the Geospatial One-Stop and the National Map projects—did not exist in 1997 and are therefore not reflected in the strategic plan. Finally, the 1997 plan does not take into account the increased importance that has been placed on homeland security in the wake of the September 11, 2001, attacks. Geospatial data and systems have a key role to play in supporting decision makers and emergency responders in protecting critical infrastructure and responding to threats.

In addition to being out of date, the 1997 document lacks important elements that should be included in an effective strategic plan. According to the Government Performance and Results Act of 1993,[17] such plans should include a set of outcome-related strategic goals, a description of how those goals are to be achieved, and an identification of risk factors that could significantly affect their achievement. The plans should also include performance goals and measures, with resources needed to achieve them, as well as a description of the processes to be used to measure progress.

While the 1997 NSDI plan contains a vision statement and goals and objectives, it does not include other essential elements. For example, FGDC's plan does not include a set of outcome-related goals, with actions to achieve those goals, that would bring together the various actions being taken to coordinate geospatial assets and achieve the vision of the NSDI. Specifically, the plan does not include a description of how the development and implementation of geospatial standards could foster coordination of national geospatial investments, and what actions FGDC is taking to help ensure that standards are implemented to effectively support such coordination. The plan also does not identify how the programs that FGDC uses to promote coordination among federal agencies and other

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[17]P.L. 103-62, section 3.

entities fit together in a cohesive approach to support and facilitate collaboration.

In addition to not developing a plan that integrates each of FGDC's activities to ensure that the actions it takes effectively contribute to its vision, the strategy does not identify key risk factors that could significantly affect the achievement of the goals and objectives. Identifying such risk factors would be the first step in mitigating them, helping to ensure that the plan's goals and objectives are achievable.

Finally, the current plan does not include performance goals and measures to help ensure that the steps being taken are resulting in the development of the National Spatial Data Infrastructure. Performance goals and measures, with processes in place to measure progress, are important factors to ensuring the overall effectiveness of the plan and whether the objectives of the plan are being met.

FGDC officials, in consultation with the executive director of Geospatial One-Stop, USGS, and participating FGDC member agencies, have initiated a "future directions" effort to begin the process of updating the plan. However, this activity is just beginning, and there is no time frame as to when a new strategy will be in place. Until a complete and up-to-date national strategic plan, with measurable goals and objectives for developing the NSDI, is in place, coordination will continue to be limited, resulting in unnecessary duplication of geospatial assets and activities.

Individual Federal Agencies Have Coordinated Specific Geospatial Investments, but Have Not Fully Complied with OMB Guidance

OMB Circular A-16 directs federal agencies to coordinate their investments to facilitate building the NSDI. The circular lists 11 specific responsibilities for federal agencies, including

- preparing, maintaining, publishing, and implementing a strategy for advancing geographic information and related spatial data activities appropriate to their mission, in support of the NSDI;

- using FGDC standards, including metadata and other appropriate standards, documenting spatial data with relevant metadata; and

- making metadata available online through a registered NSDI-compatible clearinghouse site.

In certain cases, federal agencies have taken steps to coordinate their specific geospatial activities. For example, Agriculture's U.S. Forest Service and Interior's Bureau of Land Management (BLM) collaborated to develop the National Integrated Land System (NILS), which is intended to provide land managers with software tools for the collection, management, and sharing of survey data, cadastral data, and land records information. BLM and the Forest Service signed a formal interagency agreement at the outset of the project, coordinated project planning and management, and shared project funding. At an estimated cost of about $34 million, a single GIS—NILS—was developed that can accommodate the shared geospatial needs of both agencies, eliminating the need for each agency to develop a separate system. In another example, HUD and the Environmental Protection Agency (EPA) worked together to develop an enterprise GIS that combines information on HUD's community development and housing programs with EPA's environmental data, as well as other agencies' data, to provide homeowners and prospective home buyers with ready access to detailed local information about environmental hazards and other pertinent information, including data about roadways, population, and local landmarks.

However, despite such examples of coordination, agencies have not always complied with OMB's broader geospatial coordination requirements. For example, only 10 of the 17 agencies that provided reports to FGDC reported having published geospatial strategies as required by Circular A-16. In addition, agencies' spatial data holdings are generally not compliant with FGDC standards. Specifically, the annual report shows that, of the 17 agencies, only 4 reported that their spatial data holdings were compliant with FGDC standards. Ten agencies reported being partially compliant, and 3 agencies provided answers that were unclear as to whether they were compliant. Finally, regarding the requirement for agencies to post their data to the clearinghouse,[18] only 6 of the 17 agencies indicated that their data or metadata were published through the clearinghouse, 10 indicated that their data were not published, and 1 indicated that some data were available through the clearinghouse.

According to comments provided by agencies to FGDC in the annual report submissions, there are several reasons why agencies have not complied with their responsibilities under Circular A-16, including the lack of

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[18]According to Circular A-16, agencies are required to publish only data that they are able to share with the public.

performance measures that link funding to coordination efforts. According to the Natural Resources Conservation Service, few incentives exist for cross-agency cooperation because budget allocations are linked to individual agency performance rather than to cooperative efforts. In addition, according to the USGS, agencies' activities and funding are driven primarily by individual agency missions and do not address interagency geospatial coordination. In addition to the information provided in the annual report, Department of Agriculture officials said there are no clear performance measures that link funding to interagency coordination.

OMB's Oversight of Federal Geospatial Assets and Activities Has Not Identified Redundant Investments

OMB has recognized that potentially redundant geospatial assets need to be identified and that federal geospatial systems and information efforts need to be coordinated. To help identify potential redundancies, OMB's Administrator of E-Government and Information Technology testified in June 2003 that the agency uses three key sources of information:

- business cases for planned or ongoing IT investments, submitted by agencies as part of the annual budget process;

- comparisons of agency lines of business with the Federal Enterprise Architecture (FEA); and

- annual reports compiled by FGDC and submitted to OMB.

In addition, OMB has asked for detailed information from federal agencies on specific types of geospatial information and systems assets as an additional means of identifying and minimizing redundant IT investments.

None of OMB's major oversight processes—the annual review process associated with development of the federal budget, the FEA effort, and the FGDC-administered Circular A-16 reporting process—have been effective tools to help OMB identify major redundancies in federal GIS investments. According to OMB officials responsible for oversight of geospatial activities, the agency's methods have not yet led to the identification of redundant investments that could be targeted for consolidation or elimination. The OMB officials said they believe that, with further refinement, these tools will be effective in the future in helping them identify redundancies. However, until more effective oversight measures are in place, duplicative and potentially costly geospatial data and projects are likely to continue, resulting in inefficient use of limited resources.

IT Investment Business Cases Do Not Completely Describe Geospatial Data Assets

In their IT business cases submitted annually as part of the budget process, agencies must report the types of data that will be used, including geospatial data. According to OMB's branch chief for information policy and technology, OMB reviews these business cases to determine whether any redundant geospatial investments are being funded. Specifically, the process for reviewing a business case includes comparing proposed investments, IT management and strategic plans, and other business cases, in an attempt to determine whether a proposed investment duplicates another agency's existing or already-approved investment.

However, business cases submitted to OMB under Circular A-11 do not always include enough information to effectively identify potential geospatial data and systems redundancies because OMB does not require such information in agency business cases. For example, OMB does not require that agencies clearly link information about their proposed or existing geospatial investments to the spatial data categories (themes) established by Circular A-16. Geospatial systems and data are ubiquitous throughout federal agencies and are frequently integrated into agencies' mission-related systems and business processes. Business cases that focus on mission-related aspects of agency systems and data may not provide the information necessary to compare specific geospatial investments with other, potentially similar investments unless the data identified in the business cases are categorized to allow OMB to more readily compare data sets and identify potential redundancies.

For example, FEMA's fiscal year 2004 business case for its Multi-Hazard Flood Map Modernization project indicates that topographic and base data are used to perform engineering analyses for estimating flood discharge, develop floodplain mapping, and locate areas of interest related to hazard areas. However, FEMA does not categorize these data according to standardized spatial data themes specified in Circular A-16, such as elevation (bathymetric or terrestrial), transportation, and hydrography. As a result, it is difficult to determine whether the data overlap with other federal data sets. Similarly, Census's fiscal year 2005 business case for its MAF/TIGER Enhancement project indicates that state, local, tribal, and private-sector spatial data are used for the realignment of the street centerlines and other features. However, like the Flood Map Modernization business case, the MAF/TIGER Enhancement business case does not categorize these data according to the Circular A-16 data themes, which would allow OMB to compare them with other agencies' holdings. Without categorizing the data using the standard data themes as an important step toward coordinating that data, information about agencies' planned or

ongoing use of geospatial data in their business cases cannot be effectively assessed to determine whether it could be integrated with other existing or planned federal geospatial assets.

The Federal Enterprise Architecture Is Not Yet Effective in Identifying Potentially Redundant Geospatial Investments

An FEA is being constructed that, once it is further developd, may help identify potentially redundant geospatial investments. It will comprise a collection of five interrelated "reference models" designed to facilitate cross-agency analysis and the identification of duplicative investments, gaps, and opportunities for collaboration within and across federal agencies. According to recent GAO testimony on the status of the FEA, although OMB has made progress on the FEA, it remains a work in process and is still maturing.[19] The five FEA reference models are summarized in table 2.

Table 2: FEA Reference Models

Reference model	Description	Status
Business Reference Model	Describes the business operations (lines of business) of the federal government independent of the agencies that perform them, including defining the services provided to state and local governments.	Version 2.0 released June 2003
Service Component Reference Model	Identifies and classifies IT service (i.e., application) components that support federal agencies and promote the reuse of components across agencies.	Version 1.0 released June 2003
Technical Reference Model	Describes how technology is supporting the delivery of service components, including relevant standards for implementing the technology.	Version 1.1 released August 2003
Performance Reference Model	Provides a common set of general performance outputs and measures for agencies to use to achieve business goals and objectives.	Version 1.0 released September 2003
Data and Information Reference Model	Describes, at an aggregate level, the types of data and information that support program and business line operations, and the relationships among these types.	Not yet released

Source: GAO.

[19]U.S. General Accounting Office, *Information Technology: The Federal Enterprise Architecture and Agencies' Enterprise Architectures Are Still Maturing*, GAO-04-798T (Washington, D.C. May 19, 2004).

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OMB has identified multiple purposes for the FEA. One purpose cited is to inform agencies' individual enterprise architectures and to facilitate their development by providing a common classification structure and vocabulary. Another stated purpose is to provide a governmentwide framework that can increase agencies' awareness of IT capabilities that other agencies have or plan to acquire, so that they can explore opportunities for reuse. Still another stated purpose is to help OMB decision makers identify opportunities for collaboration among agencies through the implementation of common, reusable, and interoperable solutions. GAO supports the FEA as a framework for achieving these ends.

According to OMB's branch chief for information policy and technology, OMB reviews all new investment proposals against the federal government's lines of business in its Business Reference Model to identify those investments that appear to have some commonality. Many of the model's lines of business include areas in which geospatial information is of critical importance, including disaster management (the cleanup and restoration activities that take place after a disaster); environmental management (functions required to monitor the environment and weather, determine proper environmental standards, and address environmental hazards and contamination); and transportation (federally supported activities related to the safe passage, conveyance, or transportation of goods and people).

The Service Component Reference Model includes specific references to geospatial data and systems. It is intended to identify and classify IT service components (i.e., applications) that support federal agencies and promote the reuse of components across agencies. The model includes 29 types of services—including customer relationship management and visualization service, which defines capabilities that support the conversion of data into graphical or picture form. One component of visualization service is associated with mapping, geospatial, elevation, and GPS services. Identification of redundant investments under the visualization service could provide OMB with information that would be useful in identifying redundant geospatial systems investments.

Finally, the Data and Information Reference Model would likely be the most critical FEA element in identifying potentially redundant geospatial investments. According to OMB, it will categorize the government's information along general content areas and describe data components that are common to many business processes or activities.

Although the FEA includes elements that could be used to help identify redundant investments, it is not yet sufficiently developed to be useful in identifying redundant geospatial investments. While the Business and Service Component reference models have aspects related to geospatial investments, the Data and Information Reference Model may be the critical element for identifying agency use of geospatial data because it is planned to provide standard categories of data that could support comparing data sets among federal agencies. However, this model has not yet been completed and thus is not in use. Until the FEA is completed and OMB develops effective analytical processes to use it, it will not be able to contribute to identifying potentially redundant geospatial investments.

FGDC-Administered Agency Reporting Does Not Provide Adequate Information for Identifying Redundant Geospatial Investments

OMB Circular A-16 requires agencies to report annually to OMB on their achievements in advancing geographic information and related spatial data activities appropriate to their missions and in support of the NSDI. To support this requirement, FGDC has developed a structure for agencies to use to report such information in a consistent format and for aggregating individual agencies' information. Using the agency reports, the committee prepares an annual report to OMB purportedly identifying the scope and depth of spatial data activities across agencies.

For the fiscal year 2003 report, agencies were asked to respond to a number of specific questions about their geospatial activities, including (1) whether a detailed strategy had been developed for integrating geographic information and spatial data into their business processes, (2) how they ensure that data are not already available prior to collecting new geospatial data, and (3) whether geospatial data are a component of the agency's enterprise architecture. However, additional information that is critical to identifying redundancies was not required. For example, agencies were not requested to provide information on their specific GIS investments or the geospatial data sets they collected and maintained. According to the FGDC staff director, the annual reports are not meant to provide an inventory of federal geospatial assets. As a result, they cannot provide OMB with sufficient information to identify redundancies in federal geospatial investments.

Further, because not all agencies provide reports to FGDC, the information that OMB has available to identify redundancies is incomplete. Eight of the FGDC partner agencies, including the Departments of Energy, Justice, and Homeland Security, and the National Science Foundation, did not provide reports for fiscal year 2003. In addition, nonpartner agencies, including the Departments of Education, Labor, Veterans Affairs and the Treasury, did

not provide reports, although all agencies that collect, use, or disseminate geospatial information, regardless of whether they are FGDC partners, are required to do so. According to OMB's program examiner for the Department of the Interior, OMB does not know in detail how well agencies are complying with the reporting requirements in Circular A-16. Until the information reported by agencies is consistent and complete, OMB may not be able to effectively use what information they do have to identify potential geospatial redundancies.

OMB's Supplemental Data Requests Have Not Provided Sufficient Information to Identify Potentially Redundant Investments

In addition to the three tools OMB uses to identify potentially redundant geospatial investments, it has also issued special requests to agencies to report on their geospatial investments to help support its oversight function for geospatial information, as required by OMB Circular A-16. For example, as part of the 2004 budget cycle, OMB initiated a pilot project to collect detailed cost information on one geospatial data theme—elevation data. Despite specifying criteria for identifying elevation data, the pilot encountered problems.

FGDC developed criteria for this pilot process, but OMB did not follow it. Budget examiners at OMB modified the criteria to take into account the agencies' widely varying missions, and broadened the criteria for individual agencies to make it easier for them to identify elevation data in the same way they tracked the data internally. As a result, elevation data were not reported consistently and could not be compared across agencies.

A data collection effort associated with the fiscal year 2005 budget process raised the same questions as the 2004 effort about its effectiveness to support OMB's oversight responsibilities. As part of the fiscal year 2005 budget cycle, OMB again requested supplemental information from federal agencies to identify which agencies are collecting geospatial data, for what purposes, and covering which geographic areas; federal expenditures related to data collection and the extent of leveraging of those expenditures; the extent of sharing of and public access to federal geospatial data; and the use of standards. Specifically, OMB asked agencies that spend $500,000 or more on any geospatial data to report information on all types of geospatial data, with a focus on the seven types of framework data identified by FGDC. However, because the earlier problems have not been addressed, the 2005 supplemental data request is also unlikely to provide useful information for OMB to identify redundant federal geospatial investments.

Federal Agencies Continue to Collect and Maintain Duplicative Data and Systems

Without a complete and up-to-date strategy for coordination or effective investment oversight by OMB, federal agencies continue to acquire and maintain duplicative data and systems. According to the initial business case for the Geospatial One-Stop initiative, about 50 percent of the federal government's geospatial data investment is duplicative. Such duplication is widely recognized. Officials from federal and state agencies and OMB have all stated that unnecessarily redundant geospatial data and systems exist throughout the federal government. The Staff Director of FGDC agreed that redundancies continue to exist throughout the federal government and that more work needs to be done to specifically identify them. DHS's Geospatial Information Officer also acknowledged redundancies in geospatial data acquisitions at his agency, and said that DHS is working to create an enterprisewide approach to managing geospatial data in order to reduce redundancies. Similarly, state representatives to the National States Geographic Information Council have identified cases in which they have observed multiple federal agencies funding the acquisition of similar data to meet individual agency needs.

We found that USGS, FEMA, and the Department of Defense (DOD) each maintain separate elevation data sets: USGS's National Elevation Dataset, FEMA's flood hazard mapping elevation data program, and DOD's elevation data regarding Defense installations. FEMA officials indicated that they obtained much of their data from state and local partners or purchased them from the private sector because data from those sources better fit their accuracy and resolution requirements than elevation data available from USGS. Similarly, according to one Army official, available USGS elevation data sets generally do not include military installations, and even when such data are available for specific installations, they are typically not accurate enough for DOD's purposes. As a result, DOD collects its own elevation data for its installations. In this example, if USGS elevation data-collection projects were coordinated with FEMA and DOD to help ensure that the needs of as many federal agencies as possible were met through the project, potentially costly and redundant data-collection activities could be avoided. According to the USGS Associate Director for Geography, USGS is currently working to develop relationships with FEMA and DOD, along with other federal agencies, to determine where these agencies' data-collection activities overlap.

In another example, officials at the Department of Agriculture and the National Geospatial-Intelligence Agency (NGA) both said they have purchased data sets containing street-centerline data from commercial sources, even though the Census Bureau maintains such data in its TIGER

database. According to these officials, they purchased the data commercially because they had concerns about the accuracy of the TIGER data. The Census Bureau is currently working to enhance its TIGER data in preparation for the 2010 census, and a major objective of the project is to improve the accuracy of its street location data. However, despite Agriculture and NGA's use of street location data, Census did not include either agency in the TIGER enhancement project plan's list of agencies that will be affected by the initiative. Without better coordination, agencies such as Agriculture and NGA are likely to continue to need to purchase redundant commercial data sets in the future.

Further, in a recent report on coastal mapping and charting, the National Research Council cited numerous examples of redundant activity in coastal mapping, including aerial imaging, shoreline mapping, and habitat mapping.[20] The council noted that redundancy in data collection is of most concern, as it is by far the most expensive of geospatial activities, and concluded that agencies do not have an efficient means of determining whether an area of interest has been previously mapped. Without better-coordinated activities, federal agencies are likely to continue to duplicate data collection.

Conclusions

The longstanding problem of effectively coordinating federal geospatial investments to reduce unnecessary redundancies and their concomitant costs has not yet been resolved. A number of activities have been initiated with the aim of better coordinating geospatial investments, including the OMB-required activities of FGDC, as well as the Geospatial One-Stop initiative and other projects such as The National Map. In addition, individual agencies have collaborated on specific geospatial projects, and OMB has adopted several processes for identifying redundant geospatial investments.

However, these efforts have not been very successful in reducing redundancies in geospatial investments. A complete and up-to-date strategic plan to coordinate the government's various geospatial activities is lacking, and federal agencies have not fully complied with OMB's Circular A-16 guidance. Similarly, OMB's processes for identifying duplicative federal geospatial investments have not proven effective.

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[20]National Research Council, *A Geospatial Framework for the Coastal Zone: National Needs for Coastal Mapping and Charting* (Washington, D.C., 2004).

Until a comprehensive national strategy is in place, the current state of ineffective coordination is likely to remain, and the vision of the NSDI will likely not be fully realized. In addition, without effective oversight by OMB, agencies might not have adequate incentives to fully coordinate their geospatial activities, and OMB will not be able to identify potentially duplicative geospatial investments. Until these shortcomings are addressed, cost savings from eliminating duplicative geospatial investments will not materialize.

Recommendations for Executive Action

In order to encourage more coordination of geospatial assets, reduce needless redundancies, and decrease costs, we recommend that the Director of OMB and the Secretary of the Interior, in coordination with the FGDC, establish milestones for the development of an updated national geospatial data strategic plan, ensuring that the plan includes

- outcome-related strategic goals and objectives;

- a plan for how the goals and objectives are to be achieved;

- identification of key risk factors that could significantly affect the achievement of the general goals and objectives and a mitigation plan for those risk factors; and

- performance goals and measures that will be used to ensure that the goals and objectives of the NSDI are being met.

To encourage better agency compliance with Circular A-16, we also recommend that the Director of OMB develop criteria for assessing the extent of interagency coordination on proposals for potential geospatial investments. Based on these criteria, funding for potential geospatial investments should be delayed or denied when coordination is not adequately addressed in agencies' proposals.

Finally, we recommend that the Director of OMB strengthen the agency's oversight actions to more effectively coordinate federal geospatial data and systems acquisitions and thereby reduce potentially redundant investments. Specifically, OMB should

- require that information about planned geospatial data acquisitions provided in agencies' business cases include specific categorizations of

all geospatial data according to the standardized data themes defined by FGDC and described in OMB Circular A-16; and

- require that all federal agencies submit annual reports to FGDC on their GIS investments, including geospatial systems and data sets already in place.

Agency Comments and Our Evaluation

We received oral comments on a draft of this report from representatives of OMB's Offices of Information and Regulatory Affairs and Resource Management and from the Assistant Secretary of the Interior—Policy, Management, and Budget. The officials from both agencies generally agreed with the content of our draft report and our recommendations and provided technical comments, which have been incorporated where appropriate. In addition, the Departments of Defense and Health and Human Services and the Bureau of the Census also provided oral technical comments, which have been incorporated where appropriate.

Concerning our recommendation that OMB strengthen its oversight to more effectively coordinate federal geospatial data and systems acquisitions, the OMB representatives stated that they are planning to institute a new process to collect more complete information on agencies' geospatial investments by requiring agencies to report all such investments through the Geospatial One-Stop Web portal. OMB representatives told us that reporting requirements for agencies would be detailed in a new directive that OMB expects to issue by the end of summer 2004.

The Department of the Interior's Assistant Secretary of the Interior—Policy, Management, and Budget noted that our report emphasizes geospatial investments rather than the broader and more comprehensive geospatial strategies outlined in OMB Circular A-16, and pointed out that encouraging the growth of a national spatial data infrastructure—versus tracking geospatial investments and minimizing duplication—required different approaches. In the department's view, activities by FGDC and the Geospatial One-Stop initiative to develop an infrastructure for information sharing have established business practices that can result in sound investments. We agree with the department that these are valuable activities that can promote sound investments. Moreover, a detailed strategic plan, coupled with improved oversight and agency compliance with coordination guidance, remain critical steps to achieving the objective of reducing duplication in federal geospatial investments.

We are sending copies of this report to the Chairman and Ranking Minority Member, House Committee on Government Reform, and the Ranking Minority Member, Subcommittee on Technology, Information Policy, Intergovernmental Relations and the Census. In addition, we are providing copies to the Director of OMB and the Secretary of the Interior, and the report is available at no charge on the GAO Web site at http://www.gao.gov.

Should you have any questions about this report, please contact me at (202) 512-6240 or John de Ferrari, Assistant Director, at (202) 512-6335. We can also be reached by e-mail at koontzl@gao.gov and deferrarij@gao.gov, respectively. Other key contributors to this report were Michael Holland, Steven Law, and Elizabeth Roach.

Linda D. Koontz
Director, Information Management Issues

Objective, Scope, and Methodology

Our objective was to determine the extent to which the federal government is coordinating the sharing of geospatial assets, including through oversight measures in place at the Office of Management and Budget (OMB), in order to identify and reduce redundancies in federal geospatial data and systems.

To address this objective, we reviewed relevant federal guidance and legislation, including The E-Government Act of 2002; The Clinger-Cohen Act of 1996; The Paperwork Reduction Act of 1995; Executive Order 12906: Coordinating Geographic Data Acquisition and Access; OMB Circular A-11: Preparation, Submission, and Execution of the Budget; OMB Circular A-16: Coordination of Geographic Information and Related Spatial Data Activities; and OMB Circular A-130: Management of Federal Information Resources. Appendix III provides additional information about each. We also reviewed agency IT business cases, known as Exhibit 300s, submitted as part of the annual budget process. In addition, we evaluated the Federal Enterprise Architecture reference models and various FGDC documents and interviewed officials from the following federal agencies in the Washington, D.C. metropolitan area:

- Department of Agriculture;

- Department of Commerce, including the Census Bureau and the National Oceanic and Atmospheric Administration;

- Department of Defense, including the National Geospatial-Intelligence Agency;

- Department of Health and Human Services;

- Department of Homeland Security, including the Federal Emergency Management Agency;

- Department of the Interior, including the Bureau of Land Management and the U.S. Geological Survey;

- Environmental Protection Agency; and

- Office of Management and Budget.

We interviewed program officials representing key federal geospatial projects, including the Federal Geographic Data Committee, Geospatial One-Stop, The National Map, and the TIGER Modernization project. For

these projects, we reviewed key documents such as capital asset plans, project plans, and other project documentation.

To better understand federal efforts to coordinate with state and local governments and the private sector, we interviewed state and local government and private sector officials at several conferences, including the ESRI Federal User Conference and the National Association of Counties Legislative Conference. In addition, we conducted focus groups at three national conferences in March 2004: (1) The National League of Cities Congressional City Conference; (2) the Management Association for Private Photogrammetric Surveyors Federal Programs Conference; and (3) the National States Geographic Information Council Midyear Conference. At these focus groups we asked state and local government and private sector officials for their views on what the federal government was doing to coordinate its geospatial activities with them and what could be done to improve the coordination of federal geospatial activities. A total of 34 state and local government and private sector officials attended these focus groups.

In addition, to determine the extent of state and local participation in the National Geospatial Data Clearinghouse and the Geospatial One-Stop portal, we obtained information from FGDC officials about the metadata records contained in the clearinghouse and conducted analyses of the data referenced in the Geospatial One-Stop portal.

We conducted our work from October 2003 through May 2004 in accordance with generally accepted government auditing standards.

Selected Agencies' Geospatial Activities

Many federal agencies have established geospatial activities to help them achieve their specific goals and objectives. Table 3 highlights selected federal geospatial activities at certain agencies. The table is not intended to be a comprehensive list of agency geospatial activities.

Table 3: Selected Geospatial Activities at Federal Agencies

Agency	Activities
Department of Agriculture (USDA)/Forest Service	The Forest Service uses GIS to provide information on vegetation, water, fire, and soil for specified forests. The agency also develops digital orthophoto quad images and maintains a clearinghouse with geospatial metadata. In addition, the Forest Service is working with Interior's Bureau of Land Management to develop the National Integrated Land System, to support the management of cadastral records and land parcel information.
USDA/National Cartography and Geospatial Center (NCGC)	NCGC Internet Mapping offers Web access to view samples of hydrography, digital orthophotography, digital topographic data, and other integrated data layers. In addition, NCGC supports an Aerial Photography Field Office with a library of over 10 million images dating from 1955 to the present.
USDA/Natural Resources Conservation Service (NRCS)	The NRCS Geospatial Data Gateway provides easy and consistent access to natural resource data by geographic area such as county or state. Users can search for data by theme, such as digital orthoimagery, digital elevation models, or soils.
USDA/Farm Service Agency (FSA)	The FSA is implementing software that will be important in the maintenance of the Common Land Unit (CLU), which will track all farming activity across the country. The CLU should be completed nationwide in fiscal year 2005.
Department of Commerce (DOC)/Census Bureau	The Census Bureau developed the Topologically Integrated Geographic Encoding and Referencing (TIGER) database, which automates the mapping and related geographic activities required to support the decennial census and the bureau's sample survey programs. Census is also working on the Master Address File/TIGER (MAF/TIGER) Accuracy Improvement Project, which seeks to improve accuracy in TIGER by acquiring and using, as a first priority among data sources, digital files prepared and provided by state, local, and tribal governments. In addition, Census maintains the TIGER Enhancement Database, which includes metadata about state and local geospatial data. Census also conducts the Boundary and Annexation Survey to update the information it has about the legal boundaries, names, governmental status, and types of municipalities in the United States.
DOC/National Oceanic and Atmospheric Administration (NOAA)	NOAA makes extensive use of GIS technology to store the large quantity of data it collects. For example, the Pacific Marine Environmental Laboratory and the Alaska Fisheries Science Center collect data about the physical and biological characteristics of the Bering Sea and the Gulf of Alaska, which are then stored in a GIS. In addition, NOAA's Coastal Services Center develops products and services through project partnerships that address specific technical needs and capacities of the coastal management community. These projects typically focus on data access and distribution, Internet mapping, and spatial data analysis and visualization as a means of addressing coastal hazards, smart growth, marine protected areas, or coastal permitting issues.
Department of Defense (DOD)/National Geospatial Intelligence Agency (NGA)	NGA provides timely, accurate, global aeronautical, topographical, and maritime geospatial information in support of national security objectives.

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Agency	Activities
DOD/Army Corps of Engineers	The Army Corps of Engineers collects hydrographic data along the Inland Waterway to ensure that navigation channels are dredged to authorized depths; aerial photography and elevation data of authorized projects to support a variety of planning- and construction-related activities, and uses geospatial technologies as part of its water control, real estate, planning and reconnaissance studies, emergency management, regulatory, environmental restoration, engineering and reconstruction missions.
DOD/Navy	The Navy's Oceanographic Information System collects, analyzes, processes, manages, produces, and distributes classified and unclassified oceanographic data and products. In addition, the system functions as the initial collection and processing entity for mapping and charting geodesy data and information.
Department of Energy (DOE)/Los Alamos National Laboratory	The Los Alamos National Laboratory's GISLab supplies geospatial information for internal and external users of geospatial data. Current projects include fire-related spatial data, floodplain mapping and hydrological modeling, field mapping for forest management, and mesoscale climate change modeling.
DOE/National Renewable Energy Laboratory	The National Renewable Energy Laboratory site provides dynamically generated maps of renewable energy resources that determine which energy technologies are viable solutions in the United States. These maps include GIS Clean Cities Map, Wind Map, Transportation Technologies Map, Map of Indian Lands, Solar Maps, and Federal Energy Management Program Maps.
Department of Health and Human Services (HHS)/Agency for Toxic Substances and Disease Registry	The Agency for Toxic Substances and Disease Registry manages a geospatial data warehouse that contains base map, sociodemographic, emergency response, environmental, hazard, and health resource data.
HHS/Centers for Disease Control and Prevention	The Centers for Disease Control and Prevention engages in a variety of GIS activities that serve disease surveillance and prevention themes. The National Center for Injury Prevention and Control publishes Web-based maps on injury statistics and mortality atlases; the National Center for Chronic Disease Prevention and Heath Promotion uses GIS to analyze and publish geospatial data, such as mapping risk factor data and the prevalence of fluoridated water systems, cardiovascular mortality atlases, etc.; and the National Center for Environmental Health (NCEH) has recently deployed the Environmental Public Health Geography Network, a system designed to publish and share geospatial data, metadata and maps. NCEH also deployed the Spatial Epidemiology and Emergency Management System, a Web-based system to provide easy and rapid access to and mapping of geospatial data.
HHS/National Institutes of Health/National Cancer Institute	The National Cancer Institute maintains the Cancer Mortality Maps & Graph Web Site, which provides information on geographic patterns and time trends of cancer death rates from 1950 to 1994 for more than 40 types of cancer.
Department of Homeland Security (DHS)	Various DHS components are frequent users of geospatial information, including the Federal Emergency Management Agency (FEMA), the Bureau of Transportation Security, the Coast Guard, and the Secret Service.
DHS/Federal Emergency Management Agency (FEMA)	FEMA provides a full range of GIS services to all FEMA program offices, including storm tracking and damage prediction maps, remote sensing maps, maps of federally declared counties in an affected state, basic census demographics about an affected area by county and census block, street locations, and summaries of teleregistered and service center applicants, housing inspection numbers, Help-line calls, disaster unemployment claims, Small Business Administration applicants, etc. In addition, FEMA's Flood Map Modernization Program will update FEMA's current stock of flood maps in order to produce more accurate and accessible digital flood maps and make those maps accessible via the Internet.

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Agency	Activities
Department of the Interior (DOI)/Bureau of Land Management (BLM)	BLM uses GIS to store and analyze public land and administrative jurisdiction information. In addition, BLM is working with the Forest Service to develop the National Integrated Land System (NILS) to provide business solutions for the management of cadastral records and land parcel information in a GIS environment.
DOI/Fish and Wildlife Service (FWS)	The Fish and Wildlife Service uses GIS technology to: maintain wetlands data, as referenced in OMB Circular A-16, and share that data through a cooperative agreement with The National Map; create and share a variety of information on endangered species, fisheries and habitat conservation, and national wildlife refuges; make metadata available on the NSDI through a cooperative agreement with USGS; and share an interactive mapping application with basic information on Fish and Wildlife Service offices through Geospatial One-Stop.
DOI/National Park Service	The National Park Service uses geospatial data to enhance preservation of park resources with scientific spatial analysis and modeling, enhance visitor experiences with GPS tools and tips; provide an Interactive Map Center to deliver base maps and park brochure maps for geographic reference and navigation to and within parks; and provide search and rescue maps.
DOI/U.S. Geological Survey (USGS)	USGS's Cooperative Topographic Mapping program works with partners in other federal agencies; in state, county, and local governments, and in the private sector to ensure that accurate, current, and complete data that locate and describe the Earth's features are available and that products such as the USGS topographic series maps are kept up to date. The Geographic Analysis and Monitoring program conducts research to understand the rates, causes, and consequences of landscape change over time and uses that research to model change processes for predicting future conditions. The Land Remote Sensing program, working with NASA, NOAA, commercial satellite companies, state and local governments, and international programs, collects, maintains, and distributes millions of images acquired from satellite and aircraft sensors. In addition, USGS provides a site that serves as a node of the NSDI for finding and accessing USGS spatial data related to hydrography. In addition, USGS is developing and implementing The National Map as a database to provide core geospatial data about the United States and its territories similar to the data provided on USGS paper topographic maps. Through this project, USGS maintains an archive for the historic preservation of data and science applications; provides products and services that include paper maps, digital images, data download capabilities, and scientific reports; and promotes geographic integration and analyses.
Department of Justice/Justice Programs Office for Victims of Crime	Uses GIS to map crime victim services.
Department of Transportation (DOT)/Bureau of Transportation Statistics (BTS)	The Bureau of Transportation Statistics maintains the National Transportation Atlas Data Shapefile Download Center, which is a set of transportation-related geospatial data for the United States, including transportation networks, transportation facilities, and other spatial data used as geographic reference.
DOT/Volpe National Transportation Systems Center	The Volpe National Transportation Systems Center uses GIS to identify data such as county boundaries, roadways, and railroads, measure ambient noise levels, and search for locations such as historic beacon sites and environmental data.
Environmental Protection Agency (EPA)	EPA uses a variety of geospatial data in order to support its mission to protect human health and the environment. Specific examples of activities supported by geospatial information include: conducting analyses to help manage urban/suburban growth, responding to oil spills and other emergency situations, identifying sources of pollution for source water protection, tracking toxic substances, cleaning up and monitoring Superfund sites, detecting and evaluating landscape patterns and changes, analyzing the relationship between health and environmental contaminants, and monitoring water quality. EPA also maintains the Environmental Information Management System (EIMS), the EPA node on the Federal Geographic Data Committee Clearinghouse. Users can obtain metadata about EPA Geospatial data through EIMS.

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Agency	Activities
Department of Housing and Urban Development (HUD) and the Environmental Protection Agency	The Enterprise Geographic Information System combines information on HUD's community development and housing programs with EPA's environmental data, and other agencies' data, to provide location, type, and performance of HUD-funded activities in every neighborhood across the country and select EPA information on brownfields, hazardous wastes, air pollution, and wastewater discharges. It also provides information on population, transportation and roadways, and local landmarks.
National Aeronautics and Space Administration (NASA)	NASA's Global Change Master Directory enables users to locate and obtain access to Earth science data sets and services relevant to the global change and Earth science research. The database holds more than 15,000 descriptions of Earth science data sets and services covering all aspects of Earth and environmental sciences.
Tennessee Valley Authority (TVA)	The TVA provides an interactive map of the entire TVA power system, a network of reservoirs and power plants.

Source: GAO.

Key Federal Laws, Policies, and Guidance Affecting Geospatial Information and Systems

The E-Government Act of 2002, Section 216: Common Protocols for Geographic Information Systems. The purposes of this section are to (1) reduce redundant data collection and information and (2) promote collaboration and use of standards for government geographic information. It requires the Director of OMB to oversee (1) an interagency initiative to develop common geospatial protocols; (2) the coordination with state, local, and tribal governments, public private partnerships, and other interested persons of effective and efficient ways to align geographic information and develop common protocols; and (3) the adoption of common standards.

The Clinger-Cohen Act of 1996. The Clinger-Cohen Act directs the OMB Director to promote and improve the acquisition, use, and disposal of information technology by the federal government to improve the productivity, efficiency, and effectiveness of federal programs, including through dissemination of public information and the reduction of information collection burdens on the pubic.

The Paperwork Reduction Act of 1995. This legislation directs the OMB Director to oversee the use of information resources to improve the efficiency and effectiveness of government operations to serve agency missions, including burden reduction and service delivery to the public. This includes developing, coordinating, and overseeing the implementation of federal information resources management policies, principles, standards, and guidelines.

Executive Order 12906: Coordinating Geographic Data Acquisition and Access. The National Spatial Data Infrastructure. This order, originally issued in 1994 and revised in 2003, establishes FGDC as the interagency coordinating body for the development of the NSDI and directs FGDC to involve state, local, and tribal governments in the development and implementation of the NSDI. The executive order also establishes a National Geospatial Data Clearinghouse, directs FGDC to develop standards for implementing the NSDI, and requires that federal agencies collecting or producing geospatial data shall ensure that data will be collected in a manner that meets all relevant standards adopted through the FGDC process. In addition, the executive order requires the Interior Secretary to develop 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.

OMB Circular A-11: Preparation, Submission, and Execution of the Budget. Part 7, Planning Budgeting, Acquisition, and Management of Capital Assets. This circular establishes policy for planning, budgeting, acquisition, and management of federal capital assets and instructs agencies on budget justification and reporting requirements for major IT investments. It requires agencies to submit business cases to OMB for planned or ongoing major IT investments[1] and to answer questions to help OMB determine if the investment should be funded.

OMB Circular A-16: Coordination of Geographic Information and Related Spatial Data Activities. This circular calls for a coordinated approach to developing the NSDI, establishes FGDC and identifies its roles and responsibilities, and assigns agency roles and responsibilities for development of the NSDI. The document states that "implementation of this Circular is essential to help federal agencies eliminate duplication, avoid redundant expenditures, reduce resources spent on unfunded mandates, accelerate the development of electronic government to meet the needs and expectations of citizens and agency programmatic mandates, and improve the efficiency and effectiveness of public management."

OMB Circular A-130: Management of Federal Information Resources. This circular requires agencies to ensure that improvements to existing information systems and the development of planned information systems do not unnecessarily duplicate IT capabilities within the same agency, at other agencies, or in the private sector. The OMB Director is designated to provide overall leadership and coordination of federal information resources management within the executive branch

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[1]According to OMB Circular A-11, a major IT investment means a system or investment that requires special management attention because of its importance to an agency's mission; the investment was a major investment in the fiscal year 2004 submission and is continuing; the investment is for financial management and spends more than $500,000; the investment is directly tied to the top two layers of the Federal Enterprise Architecture; the investment is an integral part of the agency's modernization blueprint (EA); the investment has significant program or policy implications; the investment has high executive visibility; or the investment is defined as major by the agency's capital planning and investment control process. Investments that are e-government in nature or use e-business technologies must be identified as major investments regardless of the costs.

OMB Circular A-16 Data Themes, Descriptions, and Lead Agencies

Table 4: OMB Circular A-16 Data Themes, Descriptions, and Lead Agencies

Data theme	Description	Lead department or agency[a]	Framework theme[b]
Baseline (maritime)	Baseline represents the line from which maritime zones and limits are measured. Examples of these limits include the territorial sea, the contiguous zone, and exclusive economic zone.	DOC/NOAA, DOI/MMS[c]	No
Biological resources	This data set includes data pertaining to or descriptive of (nonhuman) biological resources and their distributions and habitats, including data at the suborganismal (genetics, physiology, anatomy, etc.), organismal (subspecies, species, systematics), and ecological (populations, communities, ecosystems, biomes, etc.) levels.	DOI/USGS	No
Buildings and facilities	Includes federal sites or entities with a geospatial location deliberately established for designated activities; a facility database might describe a factory, military base, college, hospital, power plant, fishery, national park, office building, space command center, or prison.	GSA[c]	No
Cadastral	Describes the geographic extent of past, current, and future right, title, and interest in real property, and the framework to support the description of that geographic extent.	DOI/BLM	Yes
Cadastral (offshore)	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.	DOI/MMS	Yes
Climate	Climate data describe the spatial and temporal characteristics of the Earth's atmosphere/hydrosphere/land surface system. These data represent both model-generated and observed environmental information, which can be summarized to describe surface, near surface and atmospheric conditions over a range of scales.	USDA/NRCS, DOC/NOAA	No
Cultural and demographic statistics	These geospatially referenced data describe the characteristics of people, the nature of the structures in which they live and work; the economic and other activities they pursue; the facilities they use to support their health, recreational, and other needs; the environmental consequences of their presence; and the boundaries, names, and numeric codes of geographic entities used to report the information collected.	DOC/USCB[c]	No
Cultural resources	The cultural resources theme includes historic places such as districts, sites, buildings, and structures of significance in history, architecture, engineering, or culture. Cultural resources also encompass prehistoric features as well as historic landscapes.	DOI/NPS	No
Digital orthoimagery	Georeferenced images of the Earth's surface, where image object displacement has been removed for sensor distortions, orientation, and terrain relief.	DOI/USGS	Yes
Earth cover	The Earth Cover theme uses a hierarchical classification system based on observable form and structure, instead of function or use. This system transitions from generalized to more specific and detailed class divisions, and provides a framework within which multiple land cover and land use classification systems can be cross-referenced. This system is applicable everywhere on the surface of the Earth. This theme differs from the vegetation and wetlands themes, which provide additional detail.	DOI/USGS	No

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Data theme	Description	Lead department or agency[a]	Framework theme[b]
Elevation bathymetric	Highly accurate bathymetric (i.e., the measurement of water depths) sounding information.	DOC/NOAA, DOD/USACE[c]	Yes
Elevation terrestrial	Georeferenced digital representations of terrestrial surfaces, natural or manmade, that describe vertical position above or below a datum surface.	DOI/USGS	Yes
Federal land ownership status	Federal land ownership status includes information describing all title, estate, or interest of the federal government in a parcel of real and mineral property.	DOI/BLM	No
Flood hazards	The National Flood Insurance Program has prepared flood hazard data for approximately 18,000 communities. The primary information prepared for these communities is for the 1 percent annual chance (100-year) flood and includes documentation of the boundaries and elevations of that flood.	DHS/FEMA	No
Geodedic control	Geodetic control provides a common reference system for establishing coordinates for all geographic data.	DOC/NOAA	Yes
Geographic names	This data set contains data or information on geographic place names deemed official for federal use by the U.S. Board on Geographic Names as pursuant to Public Law 80-242. Geographic names information includes both the official place name (current, historical, and aliases) and direct (i.e., geographic coordinates) and indirect (i.e., state and county where place is located) geospatial identifiers. This information is categorized as populated places, schools, reservoirs, parks, streams, valleys, and ridges.	DOI/USGS	No
Geologic	The geologic spatial data theme includes all geologic mapping information and related geoscience spatial data (including associated geophysical, geochemical, geochronologic, and paleontologic data) that can contribute to the National Geologic Map Database as pursuant to Public Law 106-148.	DOI/USGS	No
Governmental units	These data describe, by a consistent set of rules and semantic definitions, the official boundary of federal, state, local, and tribal governments as reported to the Census Bureau by responsible officials of each government for purposes of reporting the nation's official statistics.	DOC/USCB	Yes
Housing	Geographic data on homeownership rates, including many attributes such as HUD revitalization zones, location of various forms of housing assistance, first-time home buyers, underserved areas, and race.	HUD	No
Hydrography	Includes surface water features such as lakes, ponds, streams and rivers, canals, oceans, and coastlines.	DOI/USGS	Yes
International boundaries	Includes both textual information to describe, and GIS digital 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.	Department of State	No
Law enforcement statistics	Describes the occurrence of events (including incidences, offenses, and arrests) geospatially located, related to ordinance and statutory violations and the individuals involved in those occurrences. Also included are data related to deployment of law enforcement resources and performance measures.	Department of Justice	No
Marine boundaries	Marine boundaries depict offshore waters and seabeds over which the United States has sovereignty and jurisdiction.	DOC/NOAA, DOI/MMS	No

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Data theme	Description	Lead department or agency[a]	Framework theme[b]
Offshore minerals	Includes minerals occurring in submerged lands. Examples of marine minerals include oil, gas, sulfur, gold, sand and gravel, and manganese.	DOI/MMS	No
Outer Continental Shelf submerged lands	Includes lands covered by water at any stage of the tide—as distinguished from tidelands, which are attached to the mainland or an island and cover and uncover with the tide. Tidelands presuppose a high-water line as the upper boundary, whereas submerged lands do not.	DOI/MMS	No
Public health	Public health themes relate to the protection, improvement and promotion of the health and safety of all people. For example, public health databases include spatial data on deaths and births, infectious and notifiable diseases, incident cancer cases, behavioral risk factor and tuberculosis surveillance, hazardous substance releases and health effects, hospital statistics, and other similar data.	HHS	No
Public land conveyance (patent) records	The records that describe all past, current, and future rights, titles, and interest in real property.	DOI/BLM	No
Shoreline	Represents the intersection of the land with the water surface. The shoreline shown on NOAA charts represents the line of contact between the land and a selected water elevation.	DOC/NOAA	No
Soils	Consists of georeferenced map data, describing the spatial distribution of the various soils that cover the Earth's surface, and attribute data, describing the proportionate extent of the various soils as well as the physical and chemical characteristics of those soils. The physical and chemical properties are based on observed and measured values, as well as model-generated values. Also included are model-generated assessments of the suitability or limitations of the soils to various land uses.	USDA/NRCS	No
Transportation	Transportation data are used to model the geographic locations, interconnectedness, and characteristics of the transportation system within the United States. The transportation system includes both physical and nonphysical components representing all modes of travel that allow the movement of goods and people between locations.	DOT/BTS	Yes
Transportation (marine)	The Navigation Channel Framework consists of highly accurate dimensions (geographic coordinates for channel sides, centerlines, wideners, turning basins, and river mile markers) for every federal navigation channel maintained by the Army Corps of Engineers. The navigation framework will provide the basis for the marine transportation theme of the geospatial data framework.	DOD/USACE	Yes
Vegetation	Describes a collection of plants or plant communities with distinguishable characteristics that occupy an area of interest.	USDA/USFS[c]	No
Watershed boundaries	This data theme encodes hydrologic watershed boundaries into topographically defined sets of drainage areas, organized in a nested hierarchy by size and based on a standard hydrologic unit coding system.	DOI/USGS, USDA/NRCS	No
Wetlands	Provides the classification, location, and extent of wetlands and deepwater habitats.	DOI/FWS	No

Source: OMB Circular A-16.

[a]Certain federal agencies have lead responsibilities for coordinating the national coverage and stewardship of specific spatial data themes. According to OMB Circular A-16, lead federal agencies are responsible for (1) providing leadership and facilitating the development and implementation of needed FGDC standards, (2) providing leadership and facilitating the development and implementation of a plan for nationwide population of each data theme, and (3) preparing goals that support the NSDI strategy.

[b]According to OMB Circular A-16, framework themes are data themes that provide the core, most commonly used set of base geospatial data.

[c]General Services Administration (GSA); Minerals Management Service (MMS); U.S. Army Corp of Engineers (USACE); U.S. Census Bureau (USCB); and U.S. Forest Service (USFS).

Glossary

Attribute	A characteristic of an object or feature on a map.
Base map	A map that shows the horizontal position of features on which additional information may be placed.
Bathymetry	The measurement and study of water depths.
Cadastral	Pertaining to extent, value, and ownership of land.
Cartography	The science and art of making maps and charts.
Digital elevation model	A digital file containing an array of regularly spaced elevations.
Digital orthoimagery	Georeferenced images of the Earth's surface, where image object displacement has been removed for sensor distortions, orientation, and terrain relief.
Ellipsoid	A geometric surface whose plane sections are either ellipses or circles.
Geodesy	The science of the measurement and mathematical depiction of the size and shape of the Earth and its gravitational field.
Geodetic control	A set of surveyed features with their locations referenced to particular survey monuments by latitude, longitude, and height above the ellipsoid.
Geospatial data	Information that pertains to the geographic location and character of natural or constructed features and boundaries on the Earth.

Geographic information system	A system of computer hardware, software, and data that collects, manages, manipulates, analyzes, and displays a potentially wide array of information associated with geographic locations.
Global Positioning System	A constellation of orbiting satellites that provides navigation data to military and civilian users around the world.
Hydrography	The science dealing with the physical features of oceans, lakes, rivers, and other surface waters often conducted in support of marine navigation and nautical charting.
Metadata	Data containing descriptive information about other data.
National Spatial Data Infrastructure	A national structure of policies, standards, technologies, and human resources that supports and facilitates the management and use of geographic information.
Orthophotograph	An image reproduction prepared from a perspective photograph in which the displacement of features due to sensor tilt and terrain relief has been removed.
Photogrammetry	The science of obtaining reliable measurements or information from images.
Raster data	A row of descriptive elements, such as pixels, represented as a regular two-dimensional arrangement of data values at discrete points, normally arrayed line by line across a given surface or area.
Remote sensing	Imaging or recording of physical phenomenon, at a distance, by detecting emitted or reflected energy.

Remote sensing systems	Remote sensing systems collect these data from a distance—such as from a satellite or an aerial platform—that are either emitted or reflected by the Earth and the atmospheres.
Rectification	The process of removing displacement in a photograph caused by the tilt of the recording device or variations in terrain relief.
Spatial data	Geographically referenced features that are described by geographic positions and attributes in an analog or computer-readable (digital) form.
Topography	The form of the physical features of a land surface or sea bottom; also called relief.
Topologically Integrated Geographic Encoding and Referencing	A database maintained by the Census Bureau that automates the mapping and related geographic activities required to support the decennial census and the bureau's sample survey programs.