Geospatial Profile of the Federal Enterprise Architecture (FEA)

Version 2.0

Architecture and Infrastructure Committee
Federal Chief Information Officers Council
and Federal Geographic Data Committee

March 06, 2009

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Executive Summary

Geospatial[1] is a term which conveys knowledge of geographic space, places, and locations. It is an information resource integral to virtually all federal, state, local and tribal government functions. Unfortunately, many government organizations do not effectively consider geospatial as a component of the data, technologies, and services which support their businesses. Thus the Executive Office of the President, Office of Management and Budget (OMB), supports the development of this Geospatial Profile for the Federal Enterprise Architecture (FEA). The goal of the document is to ensure architects and executives have reference for how to:

- Enhance the business processes that are essential for fulfilling agency missions with geospatial data, services and technologies.
- Optimally collect, manage, and utilize geospatial data in efficient and effective ways within an enterprise architecture.
- Leverage geospatial standards and coordination efforts to enable the sharing of geospatial resources across an organization and with partners.

The Geospatial Profile is an educational resource for determining how and where geospatial approaches and associated geospatial resources fit into enterprise architectures..

Chapter 1 of this document outlines the vision, purpose, and intended audience for the Profile.

Chapter 2 contains an overview of federal geospatial data activities, coordination, and policies.

Chapter 3 describes how geospatial perspectives, approaches, data, and technologies can be defined and improved through segment architecture. This chapter also illustrates, through case studies and examples, how geospatial capabilities are integrated into the approaches outlined within the five FEA reference models.

Chapter 4 provides a methodology for integrating geospatial information and supporting technologies into business processes. This content is structured as a series of steps which architects and executives can use to identify business areas which could benefit from geospatial approaches and procure the resources to enable the change.

The appendices provide more detailed information on various geospatial topics. Please refer to the A-16 Supplemental Guidance for a glossary of common geospatial terms found throughout this document.[2]

[1] Pertaining to the geographic location and characteristics of natural or constructed features and boundaries on, above, or below the earth's surface; esp. referring to data that is geographic and spatial in nature

[2] Http://www.fgdc.gov/policyandplanning/A-16-supplemental-guidance-endorsed-dec08.pdf

1 Introduction

Government agencies provide many services. The majority of these services can be tied to a location such as an address, regulated or managed site, delivery route, or incident. This knowledge of place is referred to as geospatial information. Geospatial information offers an important operational context and is a critical component for efficient government business. The integration of location with services or supporting technologies results in an agency developing a geospatial capability. This capability can be leveraged, extended, or modified to support a wide range of agency business needs where geographic context is a consideration or operational requirement.

Despite the potential benefits of incorporating geospatial capabilities into an agency's business, many organizations have not leveraged location as an information asset nor developed the infrastructure to implement spatial context as part of their business processes.

Why Geospatial?

The ability to store and analyze information in its geographic or geospatial context opens up areas for new and innovative applications that may support various business processes. The concepts and supporting technology may appear specialized, but the benefits of integrating geospatial data and services should be appreciated while developing enterprise architecture. This Profile explains how this can happen.

This document, the *Geospatial Profile of the Federal Enterprise Architecture (FEA)*, provides approaches to address these issues. Additionally, the Geospatial Profile outlines approaches for developing a "geospatial architecture" that is nested and managed within the overall enterprise architecture of an organization. This will allow geospatial resources to be fully leveraged, as appropriate, by all aspects of the organization to support the agency mission. The approaches described within the Profile are provided within the context of the FEA reference models—the framework for the FEA—and can be adopted in the deployment of agency enterprise architecture.

The Geospatial Profile, like the Security and Privacy and Records Management Profiles of the FEA, is defined by a horizontal segment that supports the traditional vertical lines of business. Rarely are geospatial activities conducted as a primary outcome; they are typically deployed in support of primary agency business processes that provide access to information in support of mission requirements. Although the isolation of geospatial capabilities in most organizations will be difficult, the identification of common geospatial capabilities that can be applied to meet a variety of needs is of benefit to the enterprise.

The applicability of the Geospatial Profile is not restricted to the federal government; its scope and relevance are applicable to any organization interested in incorporating geospatial capabilities into their business activities. The activities of partnering government agencies and other organizations, public and private, are often related to common geographic areas, creating opportunities to leverage interests in specific, common locations. Recognizing the common needs of multiple organizations, the Geospatial Profile promotes broad use of geospatial standards, data, and services among public and private sector entities.

1.1 Objectives

The Geospatial Profile will provide architects and executives with an understanding of how geospatial approaches, data, and associated technologies can be incorporated into the agency enterprise architecture to "geo-enable"[3] business. The phrase "geo-enable" includes three constructs in this Geospatial Profile.

1. Develop an infrastructure of staff and services that work together to provide geospatial resources in support of the organization's business.
2. Identify the business activities that depend on location and support them with appropriate geospatial data and services to improve performance.
3. Incorporate geospatial functionality into traditional business activities not previously optimized to support geospatial information and services.

The Geospatial Profile promotes leveraging and reusing geospatial resources in standard, cost-effective, and efficient ways within the overall agency enterprise architecture (EA). It does so by using the five FEA reference models as taxonomy to define components of geospatial segment architecture. The Federal Segment Architecture Methodology (FSAM) is presented to provide a structured process for assembling geospatial segment architectures. This Profile, like other FEA Profiles, provides reference on how to incorporate geospatial as a cross-cutting discipline in the context of the many FEA Lines of Business where it may apply. The Geospatial Line of Business, Technical Architecture Working Group, has developed this Profile which is sponsored by the Architecture and Infrastructure Committee (AIC) of the Federal Chief Information Officers Council in partnership with the Federal Geographic Data Committee (FGDC).

1.2 Intended Audience

The Geospatial Profile is primarily intended for agency architects and executives but may also be of interest to Geospatial Information Officers (GIO), Data Management Councils (or equivalent) and those managing enterprise architecture programs. Additional audience types that may find the Geospatial Profile helpful as a reference include:

- Agency business owners and program managers who support activities where location matters.
- Information technology planners and implementers, including Chief Information Officers (CIO).
- Geospatial resources experts, including discipline practitioners, data stewards, portfolio managers, capital planners, solutions providers, and geospatial vendors and consultants.

[3] Geo-enable is a term which implies a business service leverages geographic information in some form or fashion to provide location as context or as an operational construct. At present there is no formal definition for geo-enable, it is a term understood in the geospatial industry and can be found in the lexicon of many geospatial participants such as the Open Geospatial Consortium.

For each agency, there are potentially a number of participants involved with the development, execution, or management of geospatial enterprise architecture. Exhibit 1-1 describes these potential participants.

Role	Responsibility and Use of the FEA Geospatial Profile
Agency Executive	Provides general oversight, direction, and leadership for an agency or a major program in an agency. Will use the Geospatial Profile to better understand how geospatial resources and activities can support the agency mission. Serves as the executive champion for the use of geospatial resources to better support agency or program business.
Chief Enterprise Architect	Develops and promotes implementation of the enterprise architecture within an agency. Will use the Geospatial Profile to incorporate geospatial activities within the EA of the organization and align them with the FEA. Will interact with the Geographic Information Officer (GIO) and the Senior Agency Official for Geospatial Information (SAOGI), and Program Business Managers as appropriate.
Chief Information Officer (CIO)	Manages agency information resources. Will use the Geospatial Profile to better understand and manage geospatial resources as a component of information resources. (Note: CIO, GIO, and/or SAOGI may be the same individual in some agencies.)
Chief Knowledge Officer (CKO)	Manages intellectual capital and is the custodian of Knowledge Management practices in an organization. Will uses the Geospatial Profile to help an organization maximize the returns on investment in geospatial knowledge, exploit their intangible geospatial assets, repeat successes, share best practices, improve innovation, and avoid knowledge loss after organizational restructuring.
Geospatial Information Officer (GIO)	Oversees development and use of geospatial resources within an agency. May serve as the primary technical officer and developer of geospatial architecture. May serve as the SAOGI to oversee investments. Will use the Geospatial Profile as a framework to design and build the geospatial architecture, to integrate geospatial aspects into the overall enterprise architecture, to ensure compliance with standards, and to promote intra- and inter-agency interoperability.
Senior Agency Official for Geospatial Information (SAOGI)	Specified by OMB as a required position in federal agencies and is accountable for fiduciary aspects of geospatial resources. and acts as the agency representative to the Federal Geographic Data Committee Steering Committee. May be the GIO and/or CIO. Will serve as a champion for the geospatial architecture, especially if there is no GIO. Will use the Geospatial Profile to work with business managers to geo-enable business processes.
Program Business Managers	Administers the business of an agency, drives decisions about investments, and plans and budgets program-specific applications of geospatial approaches and technologies. Will examine business needs from a spatial perspective and determine geo-referencing, geospatial data, and application requirements needed to achieve program goals and objectives. Will use the Geospatial Profile as a road-map for analyzing business needs and select appropriate approaches for data, services, and technologies.

Role	Responsibility and Use of the FEA Geospatial Profile
Geospatial Resource Experts	Develops and supports the use of geospatial data, services, and associated technologies within the overall enterprise architecture of the agency. Works with Program Business Managers to ensure that the geospatial services needed to support their business are operational. Specific technological expertise is often useful in identifying opportunities for location-based business approaches. It is essential to include Geospatial Resource Experts as part of an overall target architecture design effort to ensure that opportunities to incorporate geospatial approaches are realized.
Data Management Committee	Data Management Committee's are involved in creating data management, access, and usage policies, and support policies involving information security and retention. The Geospatial Profile will provide necessary context for incorporating geospatial information into agency data management policies or procedures.
Statistical Reporting Unit	These groups contribute or acquire information in support of program reporting. The information contributed or acquired may have a location component. As such, these groups should have a background in how geospatial information is developed and how it can improve agency business. This background is provided by the Geospatial Profile.

Exhibit 1–1: Potential FEA Geospatial Profile Audiences and their Roles and Responsibilities

1.3 Structure of the Document

The Geospatial Profile is organized to provide an understanding of the importance of geospatial resources and approaches to appropriately use those resources in support of an organization's business. The structure builds on the FEA reference models and provides a clear means to link these models through a methodology for a geospatial architecture fully integrated with agency enterprise architectures.

The document is structured as follows:

- Chapter 1 provides an introduction, discussion of audience, and vision for the Geospatial Profile;
- Chapter 2 provides contextual and background information, describing why a Profile is needed. The chapter describes the nature of geospatial data and location, the policy objectives and approaches taken by OMB to coordinate geospatial data, current coordination activities, recent technical advances in geospatial technology, and the component models of the FEA. The chapter will be of interest to architects and executives who do not have an extensive background in geospatial resources;
- Chapter 3 provides a summary of how the Federal Segment Architecture Methodology (FSAM) can be used in relation with the FEA Reference Models to identify the role geospatial plays in an agency. The concepts in this chapter provide reference for understanding geospatial segment architecture and how it might be developed.
- Chapter 4 provides a methodology for geo-enabling business processes. This example is meant to provide architects or executives with a series of steps that

can be used to identify business areas which could benefit from geospatial approaches and procure the resources to enable the change; and

- Appendix A provides references to sources cited in this document, many of which will provide good context to architects or executives seeking further background into the federal guidance, standards, or initiatives informing geospatial policy and adoption.
- Appendix B provides examples of how lines of business can leverage geospatial approaches.
- Appendix C provides a listing of service components with representative examples of how geospatial can be applied to the service components.
- Appendix D provides a list of how geospatial systems and standards apply to Technical Reference Model components.

2 Context and Background

This chapter provides context and background for development of the FEA Geospatial Profile. Included are an introduction to geospatial capabilities, policy origins and implications, and institutional support for geospatial coordination. Geospatial standards, policies, capabilities, and services have been established within the government over the years. These are described so that they may be incorporated into the business architecture of government. Existing geospatial initiatives are described to increase awareness of and access to available data and services.

2.1 Geospatial Data Are Everywhere

Location is inherent in many endeavors. People frequently organize information within a geospatial context – where they live, where they work, the path they commute, where they vacation, distance to relatives, or tracks of storms. In addition, they think in terms of spatial boundaries – What is the population of the county or school district? What is the average home price in this neighborhood? What is the range of their wireless router? Geospatial data infers location. It exists in many places and can take many forms including place names, street addresses, highway names and markers, latitude-longitude coordinates, and maps and images of places or resources of interest. When location is processed with other data, such as the name of an individual, a particular building, the name of a hurricane, or the victims of an accident, it becomes geospatial information.[4] Location is a piece of information which can be structured, stored, combined with other information resources, and presented in a variety of ways to answer many questions related to "place."

Geospatial information is used in a variety of business processes. This includes asset and personnel management; natural resource, environmental and health management, transportation, homeland security, intelligence, and defense. Specific geospatial or geospatially enabled data used for these business processes includes property records, building addresses, routing vehicles, species ranges, crime patterns, electronic health records, traffic congestion, utility networks, hazardous waste management, airspaces, watersheds, election results, satellite and airborne imagery.

A common use of geospatial information is in emergency planning and response. For example, a forecast of the progression of the track and intensity of a hurricane is based on geospatial information represented as a map, as shown in Exhibit 2–1. Many sources of geospatial information were joined together to make this map: base maps of the political boundaries and place names, current position of the storm, and the output and projected location coming from a hurricane prediction model. This map and the data behind it could be used in other software systems for display with other data, such as population, highway networks, evacuation routes, emergency facilities, etc. in support of emergency response.

[4] The distinction between geospatial data and information is subjective and depends on the outlook of the observer and the context of the observation. The terms are used interchangeably throughout this document.

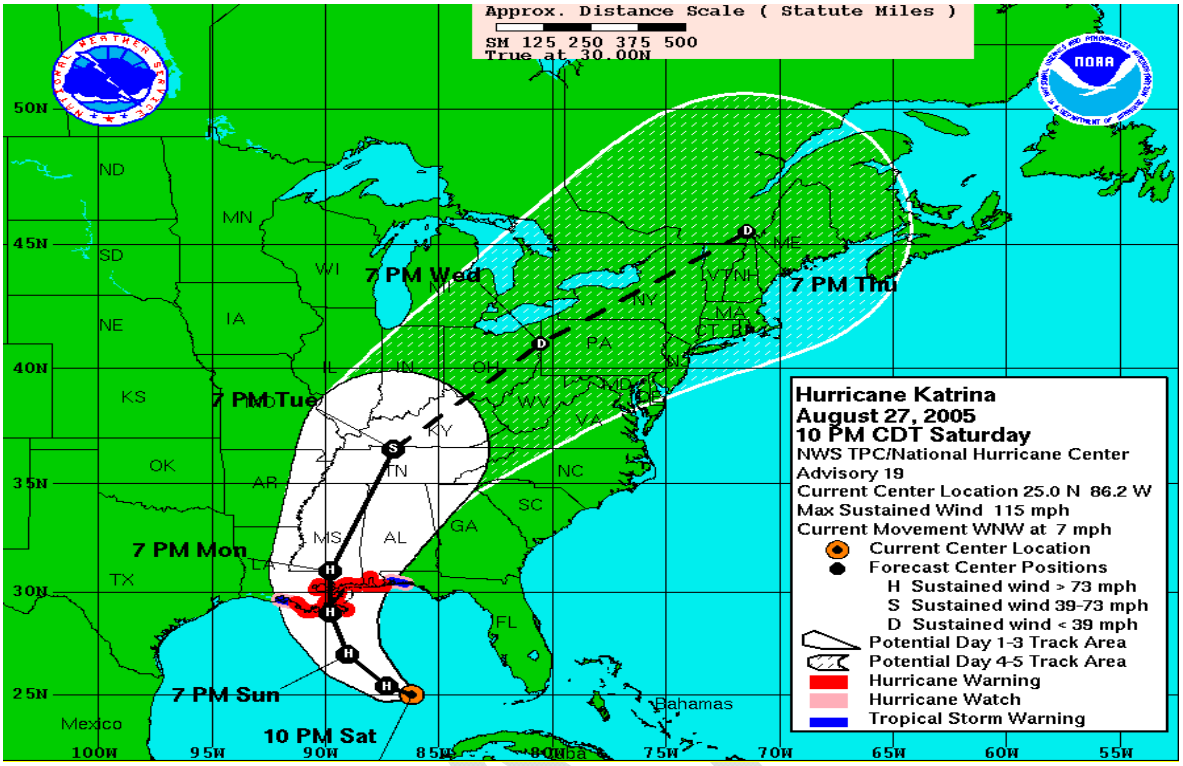


Exhibit 2–1: Predicted Path and Intensity of Hurricane Katrina over the Gulf Coast and Inland States

Geospatial information includes not only information that is obvious to most people such as driving routes and maps, but also other types of data, including elevations, satellite imagery, and location information acquired from a global positioning system (GPS). Additionally, location is often an important feature of other types of information that many people may not think of as geospatial:

- Human resources systems capture the location of office buildings and rooms as well as home addresses for each employee, enabling optimum distribution of resources against a specific geography.
- Inventory and asset management systems generally identify where a piece of equipment is stored or used, enabling optimum utilization of assets from an enterprise perspective.
- Business performance reports often itemize results according to an organization's regions or jurisdictions, allowing for comparisons of performance between different organizational units and locations.
- Grants and funds to cleanup or address specific community concerns are often distributed based on proximity to population centers or other relevant factors, maximizing the business utility of grants or funds to the population as a whole.

Other situations may require that a moving asset or phenomenon may be tracked according to its geographic location to enhance or optimize its business utility, e.g., search and rescue equipment. Examples of a moving asset can include aircraft, trucks,

vessels, or even individuals on a watch list. Commercial shipping companies track every truck and package and can plan delivery routes to optimize or minimize travel distance.

Business operations based on the use of location, as well as collaboration in the effective use of geospatial information, can provide government and private sector organizations with many benefits, such as:

- Rapid decision making using geographically referenced information provides a means for organizations to collaborate with other government agencies or organizations, particularly in times of emergencies or where rapid decisions are needed for business purposes.
- Improved sharing of data and services based on common semantics and functional capabilities, which foster geospatial partnerships contributing to inter-agency and inter-governmental interoperability.
- Enhanced availability of spatial data infrastructure services and networks in the Web environment that facilitates development and use of geospatial information and functionality within organizations.
- Standards-based geospatial information resources created and documented using standards (e.g., metadata) by many organizations, making the resources potentially accessible and usable to many others.
- Proven coordination mechanisms and examples of partnerships for shared data acquisition within the geospatial community to serve as models for those new to the use of geospatial resources.

Hurricane Katrina response efforts required significant use and cross-agency collaboration of geospatial resources and represent a specific example of how the above benefits can be applied to real world situations. The geographic tagging of business data can be a key element in business process re-engineering, and can result in large returns on investment in terms of improved workflow and resource savings resulting from broader use.

2.2 Advances in Geospatial Technology

Numerous advances over the last 30 years have contributed significantly to the ability to productively use geospatial data within business processes. Although these represent general advances in the world of computing and networking, geospatial applications and processing would not have evolved as quickly without them. For example, the advances in both computer processing power and telecommunications capacity ensure that large and complex geospatial data files can be processed in a more efficient and timely manner. Several of these advances critical to geospatial architecture are described in this section.

Technologies and data that were either completely unavailable, or highly costly and restricted to skilled and uniquely trained staff, are now widely available at reasonable or even no cost to millions of individuals. Non-expert professionals are now able to take advantage of geospatial information on the desktop and through the Web. The Web in particular is leading a transformation in the availability and ease of use of place based

content or applications. Commercial vendors are rapidly leveraging geospatial technology into a variety of Web based geographic services for consumers. Opening of development platforms and standards, increases in technical interoperability, and access to content have led to a dynamically expanding list of "mash-ups",[5] applications which are capable of providing new or enhanced geographic services or information. The integration of Global Positioning Systems technologies into common mobile applications is leading to an emerging culture of location awareness. These capabilities can be leveraged to support a wealth of geographic centric business processes identified within an agency's Enterprise Architecture.

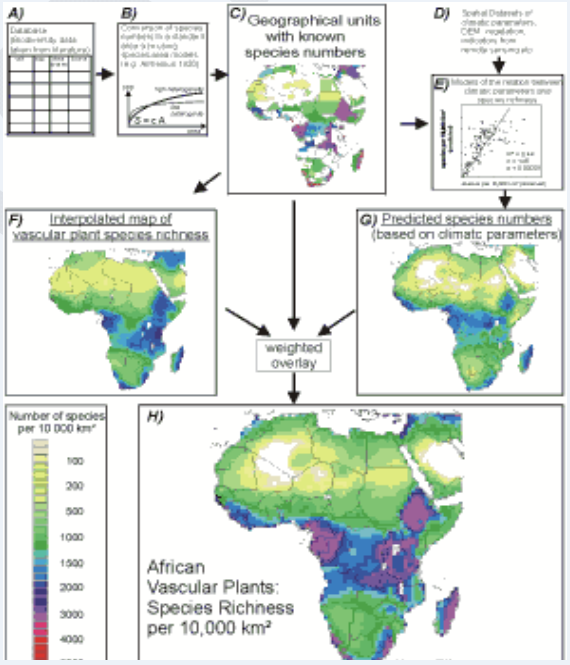
2.2.1 Geographic Information Systems (GIS)[6]

A geographic information system, or GIS, is often defined as the hardware, software, data, and skilled staff needed to capture, manage, analyze, and display geospatial information. GIS, originally known as "computer mapping," originated in the early 1960s. For many years agencies that bought and attempted to use GIS software were faced with a significant level of effort to digitize or geo-code their data in a way that allowed the hardware and software to manipulate those data. Increasing availability of data based on significant investments and thousands of organizations using GIS and the proliferation of means to share those data (e.g., via the Web) have made it far easier to access and use GIS software to address real issues.

Initially GIS was thought of only as a mapping tool, but unstructured maps (rather than data) served as a barrier to integrating geospatial analysis into operational business process. Over the last decade, software companies have increasingly added functionality to GIS and these tools now support complex data management and analytical functions through the desktop and the Web. The emergence of server based

Geographic Information Systems

Geographic Information Systems (GIS) software facilitates the combination, clipping, and processing of multiple coincident geographic datasets to support problem-solving. In this figure, three spatial datasets were numerically combined to create a new dataset that quantifies a model of plant species richness. GIS functions may include data storage, transformation, geo-processing, and map display.



[5] http://en.wikipedia.org/wiki/Mashup_(web_application_hybrid)

[6] http://en.wikipedia.org/wiki/Gis

technologies and extraction of GIS business logic means organizations can craft custom GIS support applications for enterprise specific purposes.

Over the last decade, the cost of GIS hardware and software has decreased and the availability of Enterprise licenses for geospatial software and data has increased significantly. This allows a variety of tools to be accessible to nearly any organization with the interest in managing data based on location.

2.2.2 Global Positioning System (GPS)[7]

The Global Positioning System (GPS) is a satellite system that provides the means to capture highly accurate location information via GPS receivers. GPS devices allow staff to locate facilities or sites with significant accuracy often using hand-held devices with basic mapping capabilities to collect location data and either upload the position data via wireless networks or through office networks. A number of vendors have enhanced GPS services that provide better accuracy than the nominal 15 meters offered by GPS. This supports the collection of more precise positions required by some business practices (e.g., facility management, emergency response). These capabilities allow agencies to affordably collect and then use or share location information where such positions are linked into the mission databases and systems.

2.2.3 Remote Sensing[8] and Image Processing

Satellites and aircraft have collected increasing volumes of digital data in multiple spectra and formats that provide almost limitless means to measure and examine features and phenomena on the Earth's surface. Additionally, GIS and image processing software have evolved to provide the means to integrate a multitude of data formats and resolutions to support the means to fully utilize remotely sensed raster data with traditional map (vector) information. Continuously increasing quantities of accessible and usable remotely sensed data offer rich opportunities to monitor trends, changes, and characterize locations. Many commercial organizations have begun to use remotely sensed data in the services they are providing on the Internet which leads to enhanced public visualization of geospatial information.

2.2.4 Geospatial Simulation Models

Advances in computer technology—processing speeds and storage, in particular—have made it possible to run complex models that rely on massive volumes of data, as geospatial data activities frequently do. Many types of modeling applications are increasingly available (many at no cost) for different business purposes, including contaminant plume modeling, agricultural crop models, epidemiology, urban development, and scenario simulation. Simulation models offer a geographic visualization capability for mission driven business processes.

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[7] http://en.wikipedia.org/wiki/Global_Positioning_System

[8] http://en.wikipedia.org/wiki/Remote_sensing

2.2.5 Geospatial Web Services

Web services support interoperable machine to machine interaction over a network.[9] When geospatial parameters are applied, a Web service provides a means to support sharing and application of geospatial data. Information that has an associated location can be used in geospatial queries, analyses, intelligence, and visualization over the Web. Combinations of data from different sources may be needed to provide an integrated view over time of events, tracked entities, and their locations to support decision-making during operational planning, preparedness, prevention, response, and remediation. An example of such a Web service is Fire Weather Forecasting[10] as shown in Exhibit 2–2.

Geospatial Web services are business, application, or technology services that process data and information to support and address specific user requirements. Geospatial Web services can cut across all lines of business in a multitude of applications. Systems that process geospatial information have tremendous potential to integrate information from seemingly disconnected activities and a variety of sources. Geospatial services can be used to transform, manage, or present geospatial information to users. Examples of geospatial services of potential use to many business applications and users include:

- Displays of agency information within a geospatial context to visualize situations or events in relation to other relevant geographic features and entities of interest.
- Determination and display of the geographic coordinates corresponding to an address (geo-coding) to assist with locating assets.
- Identification of routes and directions to provide context for navigating from one location to another.
- Queries to retrieve geospatial information based on regions and/or political boundaries to support geographic based analysis.
- Conversion of geographic data from one coordinate system to another to support geospatial data sharing.

Geospatial services may be made accessible to users through Web browsers, Web-based applications, or desktop client applications. They can also be seen as *producers* that are made available to *users, consumers* or *consuming applications.*

[9] http://en.wikipedia.org/wiki/Web_service

[10] http://www.spc.noaa.gov/exper/firecomp/sw/

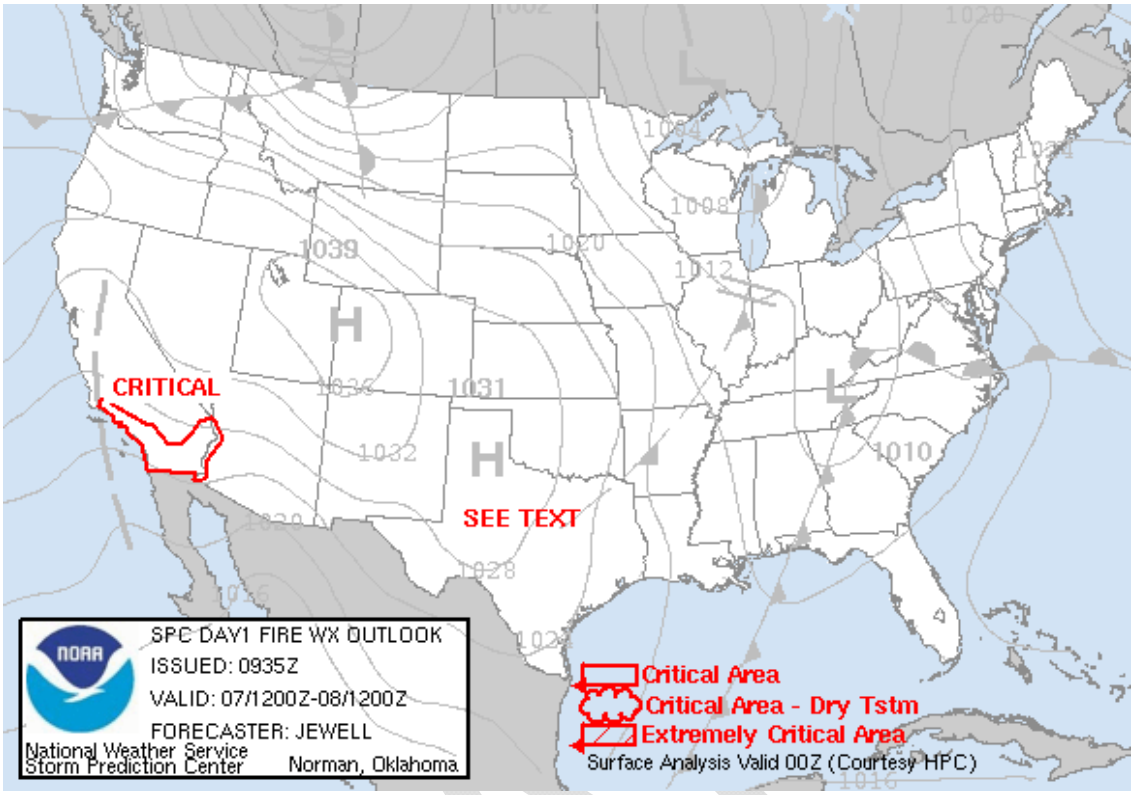

Exhibit 2–2: Fire Weather Forecasting – Example of a Geospatial Web Service

2.2.6 Virtual Geospatial Environments

Commercial vendors, the open source community, and some government agencies have helped to popularize geospatial data as a tangible business or personal information resource by releasing Web-mapping application programming interfaces (API's) and virtual globe services. Business owners and citizens now have a readily available source of geographic information and standardized geospatial capabilities to assist with location based analysis.

Virtual globe services have opened new opportunities for geospatial analysis by offering three dimensional capabilities. For many agencies vertical position is just as important to business services as horizontal position and the combination of both is required to

Virtual Alabama

In October 2005, the Alabama Department of Homeland Security (AL DHS) initiated a project to access new technologies in 3D visualization. At the request of Governor Bob Riley, AL DHS began exploring and identifying ways to leverage existing state asset imagery and infrastructure data into a visualization tool that is affordable, scalable, maintainable, and capable of employing the power of existing and evolving internet based applications. As a result, the Virtual Alabama program was created.

Virtual Alabama leverages virtual globe technology to allow users to retrieve information from a merged global imagery dataset. In doing so, Virtual Alabama serves a wide user base of state and local officials at various levels of technological proficiency.

Source:
http://www.dhs.alabama.gov/virtual_alabama/home.aspx

adequately support operations. Further advances in geospatial virtual reality are possible where data sources such as Light Detection and Ranging (LIDAR) offer the fourth dimension component of time.

2.3 Policy Context for Geospatial Resource Sharing

OMB Circulars, Presidential Executive Orders, and other strategic initiatives have provided guidance specific to geospatial data and generally to the management of information resources for approximately 50 years. The goal is more effective creation, use, and dissemination of geospatial resources across the federal government through various coordination mechanisms including this Geospatial Profile. All these means are important to consider in the design of agency enterprise architecture so each organization can leverage government-wide investments and become part of the national geospatial infrastructure.

2.3.1 Office of Management Budget (OMB) Policy and Directives

OMB policies and directives provide the policy framework for the development and use of common government investments in business and IT. Key polices and directives follow.

- OMB Circular A–16[11] was first issued in 1953, and revised in 1967, 1990, and 2002. The purpose of the 1953 circular was "to insure (sic) that surveying and mapping activities may be directed toward meeting the needs of federal and state agencies and the general public, and will be performed expeditiously, without duplication of effort." Circular A–16 describes the management and reporting requirements in the acquisition, maintenance, distribution, use, and preservation of geospatial data, including specifically the development of various common themes of data and metadata most prevalently used to support government business processes. Additionally, the Circular establishes and clarifies the responsibilities of the Federal Geographic Data Committee and development of the National Spatial Data Infrastructure (NSDI). A-16 supplemental guidance defines portfolio based management of nationally significant geospatial datasets and outlines how lead agency data architectures should leverage key themes as well as associated datasets as reliable sources of federal geospatial data.
- OMB Circular A–119[12] specifies that federal agencies will develop their geospatial data and technologies in compliance with international voluntary consensus standards, as defined by the circular. Use of these standards enables consistency and increases the ability to share data and reproduce various analytical operations across organizations and countries.
- OMB Circular A–130[13] directs that federal agencies manage and make accessible all public information (including geospatial resources) at no or low

[11] http://www.whitehouse.gov/omb/circulars/a016/a016_rev.html

[12] http://www.whitehouse.gov/omb/circulars/a119/a119.html

[13] http://www.whitehouse.gov/omb/circulars/a130/a130trans4.pdf

cost through established policies for the management of federal information resources.

- The E-Government Act of 2002 addresses geographic information in Section 216[14] ("Common Protocols for Geographic Information Systems"). The purpose is to reduce redundant data collection and information and to promote collaboration and use of standards for government geographic information.[15] Section 216 assigns responsibilities for common protocols for ensuring the compatibility, accessibility, and interoperability of geographic information.
- The OMB FEA Program Management Office's (PMO) 2005–2006 Federal Enterprise Architecture Action Plan[16] (March 2005) includes a strategic initiative, "Create a Geospatial Profile," which is described as follows: "The FEA PMO is supporting geospatial efforts through its FEA reference models and contribution towards establishing a Geospatial Profile. The FEA models will help define information in terms of a common service component that will assist in leveraging geospatial services across federal, state, local and tribal agencies - The purpose of this Profile is to provide a consistent framework that can be applied within and across agencies to identify the geospatial implications across lines of business."
- OMB Memorandum M–06–07:[17] Designation of a Senior Agency Official for Geospatial Information. OMB asked 27 executive departments and agencies to designate a senior agency official who has agency-wide responsibility, accountability, and authority for geospatial information issues to assist agencies and ensure consistency across the government. Among other responsibilities these individuals oversee, coordinate, and facilitate an agency's implementation of geospatially related requirements and represent their agency on the Federal Geographic Data Committee.
- OMB has directed 25 agencies to participate in the Geospatial Line of Business in February 2007. The purpose of the Line of Business is to ensure effective and efficient development of:
    - Productive intergovernmental collaboration for geospatial-related activities and investments across all sectors and levels of government.
    - Optimized and standardized common geospatial functions, services, and processes that is responsive to customers.

[14] Section 216 ("Common Protocols for Geographic Information Systems", Public Law 107-347) is part of the E-Government Act of 2002, available at http://www.access.gpo.gov/nara/publaw/107publ.html.

[15] In U.S. Federal law and policy, the terms "spatial", "geospatial", "geographic", "mapping", and "locational" when linked with the terms "data" or "information", and/or the terms "system" or "resource", are used interchangeably unless noted otherwise.

[16] http://www.enterprise-architecture.info/Images/Documents/2005_FEA_PMO_Action_Plan_FINAL.pdf

[17] http://www.whitehouse.gov/omb/memoranda/fy2006/m06-07.pdf

- Cost efficient acquisition, processing, and access to geospatial data and information.

2.3.2 The National Spatial Data Infrastructure

The National Spatial Data Infrastructure (NSDI) was initiated by OMB in the early 1990s to develop the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve geospatial data. Its goal is to enable geospatial data from many sources (including federal, state, local, and tribal governments, academia, and the private sector) to be used together to enhance users' understanding of the physical and cultural world. Executive Order 12906[18] issued in April 1994 outlined the major components of the NSDI, including a clearinghouse, framework data, and metadata. All are considered part of the NSDI and need to be taken into consideration when developing agency enterprise architecture. The 2002 revision of the A-16 guidance provides further development and clarification of the National Spatial Data Infrastructure (NSDI)

The Federal Geographic Data Committee (FGDC), Geospatial One stop (GOS), and The National Map are three national geospatial initiatives that share the goal of building the NSDI. FGDC focuses on policy, standards, and advocacy; GOS focuses on discovery and access; and The National Map focuses on integrated, certified base mapping content. The National Geospatial Programs Office (NGPO) of the USGS is the organizational host for these complementary activities.

2.3.3 The Federal Geographic Data Committee (FGDC)

For the past 16 years, the FGDC[19] has provided coordination for geospatial data activities at a national level. The FGDC has membership from federal departments and independent agencies and maintains liaison with non-federal governmental and professional organizations. The committee structure is composed of agency-led subcommittees and Working Groups. Subcommittees are organized by data themes such as transportation, cadastral, and hydrography. Working groups play a cross-cutting role, dealing with issues that span many of the subcommittees.

The FGDC facilitates the establishment and implementation of strategic guidance and specific actions that support improved collection, sharing, dissemination and use of geospatial data, as well as standards development. For example, the FGDC Standards Working Group (SWG) actively promotes, coordinates, and provides guidance on geospatial standards policy and procedures. It facilitates coordination among the FGDC subcommittees, and reviews and makes recommendations on the approval of standards proposals, draft standards for public review, and draft standards for FGDC Steering Committee endorsement. The FGDC also advocates that federal agency enterprise architectures leverage existing cross-agency resources such as the Geospatial One Stop.

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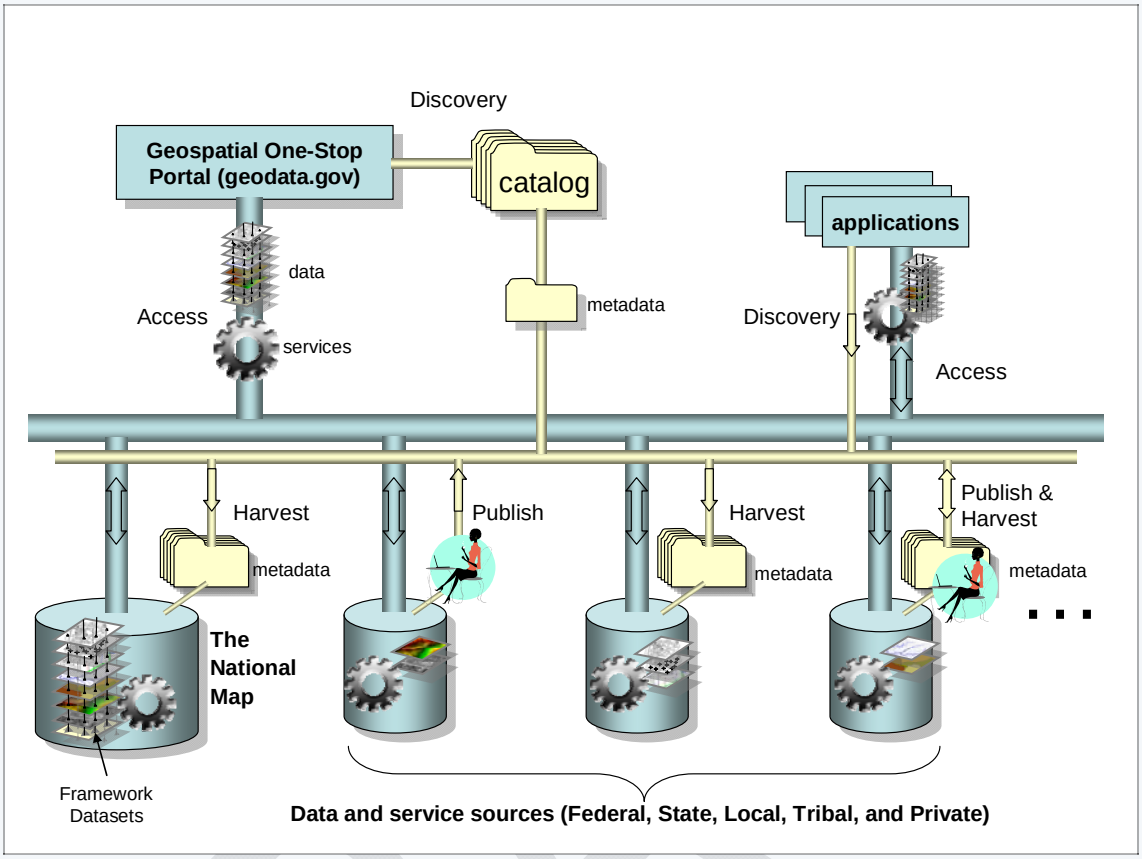
[18] http://govinfo.library.unt.edu/npr/library/direct/orders/20fa.html

[19] www.fgdc.gov

Conceptual Architecture of the NSDI



Key Technology Components of the National Spatial Data Infrastructure (NSDI)

The “thin network” corresponds to the ability to discover, harvest, and publish metadata, and can be thought of as the Clearinghouse network. Metadata can be published to the Geospatial One Stop (GOS) catalog or a local metadata collection. Local metadata can be harvested to populate another catalog, such as the GOS catalog. Local metadata collections or GOS can be searched via distributed search protocols to perform discovery on behalf of an application. Metadata can be published into any of the catalogs that allow this capability, and in this way, participants in the NSDI do not necessarily have to host a Clearinghouse node to participate as publishers of metadata.

The “thick network” corresponds to the ability to access data and services made available via “common geographic protocols.” Once an application (or the GOS portal) knows that a dataset and/or that a service exists, then the application can access the service and make use of it.

The National Spatial Data Clearinghouse is an electronic service providing access to documented geospatial data and metadata from distributed data sources nationwide, each with a catalog, describing their data and/or services. Under the various OMB and Executive Office initiatives, Federal agencies are required to use FGDC data content standards and the FGDC Content Standard for Digital Geospatial Metadata (available at http://www.fgdc.gov/metadata/geospatial-metadata-standards), and to make metadata available online through an NSDI-registered catalog. In addition to standards developed through Community Standards Development Organizations (SDO’s) as defined by OMB circular A-119, agency specific standards and protocols can also be applied to the geospatial data and services provided to NSDI.

2.3.4 Geospatial One stop (GOS)

E-Government Strategy[20] identifies Geospatial One stop (GOS)[21] as the component of the NSDI that provides a single-point of access to map-related data. It also provides the primary user interface to the NSDI Clearinghouse and serves as the register of datasets. A registry for planned dataset acquisitions via a "marketplace" functionality is another component of GOS that enables users to coordinate and potentially share geospatial data acquisition costs. The GOS portal system has a registry/catalog that contains the metadata records for current datasets and planned data acquisitions. The portal also provides access to "geospatial services," such as Web-based mapping.

Most data cataloged in GOS are not federal data. Organizations contribute to GOS at their own discretion, therefore the most accurate and up-to-date data are those collected, maintained, and used locally. The quality, context, content, and accessibility of this data are conveyed through metadata prepared by the data provider and registered with the GOS catalog.

2.3.5 The National Map

The National Map[22] is another key component of the NSDI. It contains many of the datasets associated with "framework" and other key themes described in OMB Circular A–16 generated by federal agencies. This consolidated set of nationally significant geographic information can be obtained through the National Map server or as one of the many geospatial data and services available through the diverse holdings of GOS. Datasets currently in the National Map include:

- High-resolution digital orthorectified[23] imagery from aerial photographs or satellite imagery that will provide some of the feature information now symbolized on topographic maps.
- Medium-resolution surface elevation (land) data.
- Vector data for hydrography (rivers and water bodies), transportation (roads, railways, and waterways), structures, government unit boundaries, and publicly owned land boundaries.
- Geographic names for physical and cultural features to support the U.S. Board on Geographic Names and other names such as for highways and streets.
- Additional land attributes data (geology, land cover, land use).

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[20] E-Government Strategy is available at http://georgewbush-whitehouse.archives.gov/omb/inforeg/egovstrategy.pdf .

[21] http://gos2.geodata.gov/wps/portal/gos

[22] http://nmviewogc.cr.usgs.gov/viewer.htm

[23] Orthorectification is the process of transforming raw imagery to an accurate orthogonal projection. Without orthorectification, scale is not constant in the image and accurate measurements of distance and direction can not be made.

In summary, the NSDI is intended to support the business of agencies and organizations across and beyond the federal government as follows:

1. Provide access to geospatial data and services by federal, state, local and tribal agencies, private businesses, academic organizations, and the general public via implementation of the Clearinghouse network, National Map, and Geospatial One stop.
2. Enable the widest possible use of geospatial data and services by ensuring that providers and users have knowledge of lineage, quality and security context of data and services through metadata.
3. Facilitate sharing of data and services through standards and specifications for interoperability via the standards adopted by the FGDC.
4. Provide a user-oriented delivery system enabling multiple means of delivery.
5. Ensure that redundancy and waste are minimized via the sharing of data and services.

2.3.6 Geospatial Standardization Organizations

There are several organizations that contribute to the effective use and sharing of geospatial data and services through standards and specification development. Standards supply an effective and consistent context for implementing geospatial capabilities and should be incorporated into agency architectural policy. While standards organizations provide a consistent framework upon which implementation approaches can be designed, the actual implementation, testing, and adherence to standards is at an agency's discretion. Two of the major standards organizations are described below.

2.3.6.1 International Organization for Standardization Technical Committee 211 (ISO/TC 211))

ISO is the world's largest developer of standards. Within ISO, the Technical Committee 211[24] (ISO/TC 211) Geographic information/Geomatics is responsible for the geographic information series of ISO standards. It is the internationally recognized standards body for the geospatial community with representatives from 29 different countries. ISO/TC211 has published 32 standards related to digital geographic information.[25] The International Committee on Information Technology Standards, Committee L1 (INCITS L1) is the U.S. Technical Advisory Group to ISO/TC 211. The work of L1, Geographic Information Systems (GIS) consists of adopting or adapting information technology standards and developing digital geographic data standards.

[24] http://www.isotc211.org/

[25] http://www.iso.org/iso/en/stdsdevelopment/tc/tclist/TechnicalCommitteeDetailPage.TechnicalCommitteeDetail?COMMID=4637

2.3.6.2 Open Geospatial Consortium (OGC®)

The Open Geospatial Consortium (OGC)[26] is a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services. The OGC represents an industry consortium of over 300 companies, government agencies, and universities participating in a consensus process to develop publicly available interface specifications. OpenGIS® Specifications support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT. The specifications empower technology developers to make complex spatial information and services accessible and useful within a wide variety of applications.

[26] http://www.opengeospatial.org

3 Managing and Improving Geospatial Capabilities

This chapter is intended to assist architects and executives in examining, defining, and improving various agency activities by exploring geospatial segment architecture for their agency. A Profile, such as the Geospatial Profile, is focused on a specific architectural viewpoint across multiple agencies. It is relevant to multiple stakeholders contributing to enterprise architecture. Resources such as the FEA Reference Models, the FSAM, the Practical Guide to Service Oriented Architecture (PGFSOA), and the Federal Transition Framework (FTF) should be used in tandem with the Geospatial Profile to integrate geospatial segment architecture into the organization's overall enterprise architecture.

Why Use Segment Architecture?

As architecture has evolved in the Federal government, the need for more standardization in the way agencies document their enterprise architectures has become necessary. In addition, agencies need to be able to describe their architectures in more detail for specific programs and services.

Many agencies are using segment architecture to provide more detail on a specific mission area, enterprise service or business service of the enterprise. The Office of Management and Budget (OMB) and the Architecture Infrastructure Committee (AIC) have developed the Federal Segment Architecture Methodology (FSAM) to provide agencies more guidance on how to document segment architecture.

Segment architecture will help architects understand the current state of geospatial capabilities and identify where geospatial stakeholders would like to make improvements. As a dynamic document the Geospatial Profile will be continuously updated to reflect cross-agency best practices in architecture design and implementation

The Geospatial Profile is not meant to be prescriptive, instead it:

- Provides a single reference for existing geospatial initiatives, tools, standards, templates, etc.
- Offers reference for documenting geospatial functions and services in a segment architecture
- Discusses how the FEA reference models can be leveraged to design and document a geospatial segment architecture
- Provides a reference of significant federal geospatial initiatives and artifacts which may influence development of an agency's geospatial segment architecture

3.1 Introduction

Historically, geospatial capabilities in the federal government were developed through a series of early technology adopters focused, in many cases, on independent applications to serve individual projects or programs. Over time, governance evolved leading agencies to develop standard approaches to interconnecting, building upon, and more appropriately using established geospatial foundations. A need still exists however, for an architect to define the precise nature of geospatial components within an agency's enterprise architecture and how to best integrate these components into mainstream business processes and IT.

While many approaches exist for geospatial component integration, the Geospatial Profile leverages the Federal Segment Architecture Methodology as a means for architects to define the geospatial components of agency enterprise architecture and engage in planning activities which produce actionable, measurable, improvements to agency geospatial business processes. The FSAM consists of a series of process steps which provide a measured, repeatable process for documentation of an agency's geospatial segment. As such, the FSAM provides a method for each agency to incorporate geospatial components from the five FEA reference models: business, services, data, technology, and performance into segment architecture. Prior integration of geospatial components as well as agency enterprise architecture maturity[27] should be considered as well the FSAM during new integration efforts.

Architects should review and refer to the lexicon of geospatial vocabulary available in the A-16 supplemental guidance, published December 2008.[28] The lexicon will help architects understand the geospatial components of enterprise architecture, as well as facilitate discussion of how geospatial is incorporated in the FSAM and FEA. The terms in the lexicon ensure consistency across all federal guidance pertaining to geospatial resource management.

3.2 Application of FSAM to Geospatial Functions and Activities

A segment architecture is a detailed results-oriented architecture (baseline and target) and a transition strategy addressing a vertical or horizontal portion (or segment) of the enterprise.[29] Segment architecture helps architects understand the current state of geospatial capabilities, identifies where geospatial stakeholders would like to make improvements, and allows for transformation of agency business processes to a more efficient state. As illustrated in Exhibit 3-1 below, geospatial resources and activities comprise an enterprise service segment with cross-cutting capabilities that support core mission areas and business services (vertical lines of business). Due to this, geospatial resources and activities are most likely viewed and implemented as a horizontal segment, although in some organizations, like the National Geospatial Intelligence Agency (NGA), it might also represent a core mission area, and thus be articulated as a vertical segment. Regardless of implementation, the FSAM provides a repeatable, proven, and federally endorsed process for defining and transitioning geospatial capabilities.

[27] Office of Management and Budget, Enterprise Architecture Assessment Framework 3.0

[28] Office of Management and Budget, Supplemental guidance *Circular A-16: Coordination of GeographicInformation, and Related Spatial Data Activities (Revised)*, December 2008

[29] Federal Segment Architecture Methodology Overview

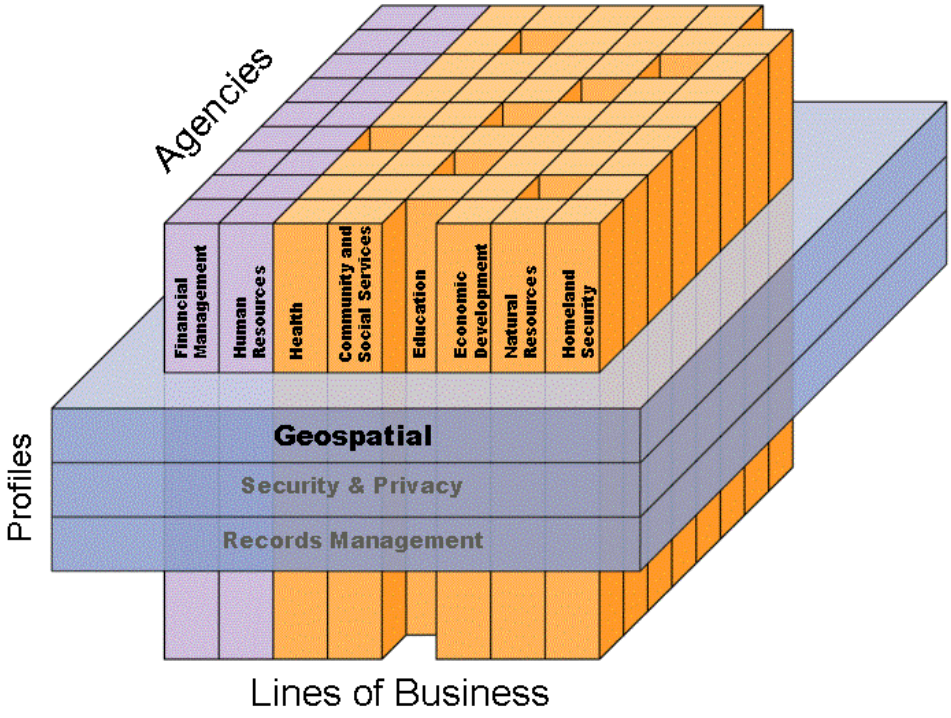


Exhibit 3-1: Geospatial As A Horizontal Segment Architecture

The following sections will provide a high level overview of how an architect or executive can use the FSAM process steps to transition geospatial resources from a baseline to a target state. By using the FSAM process architects or executives will:

- Understand the nature of strategic drivers which affect geospatial operations and how agencies might respond to these drivers.
- Be able to determine and organize geospatial participants in the context of a project.
- Define the scope and intent of changes to the geospatial segment.
- Define geospatial business and information requirements for the segment.
- Define a conceptual geospatial solution architecture which acts as a framework for translating requirements into a physical implementation.
- Author a modernization blueprint to enable transition of a geospatial segment to its target state. The blueprint defines how the physical implementation of the solution will occur.

Because a standardized geospatial methodology for segment architecture is still premature, reference is limited to a high level FSAM overview tied to the process steps

outlined in Exhibit 3-2 below. The next version of the Geospatial Profile will provide more focus for how geospatial resources and activities can be considered in architecting enterprise/inter-enterprise segments. This focus will be based on review of agency geospatial segment architecture efforts and identified best practices.

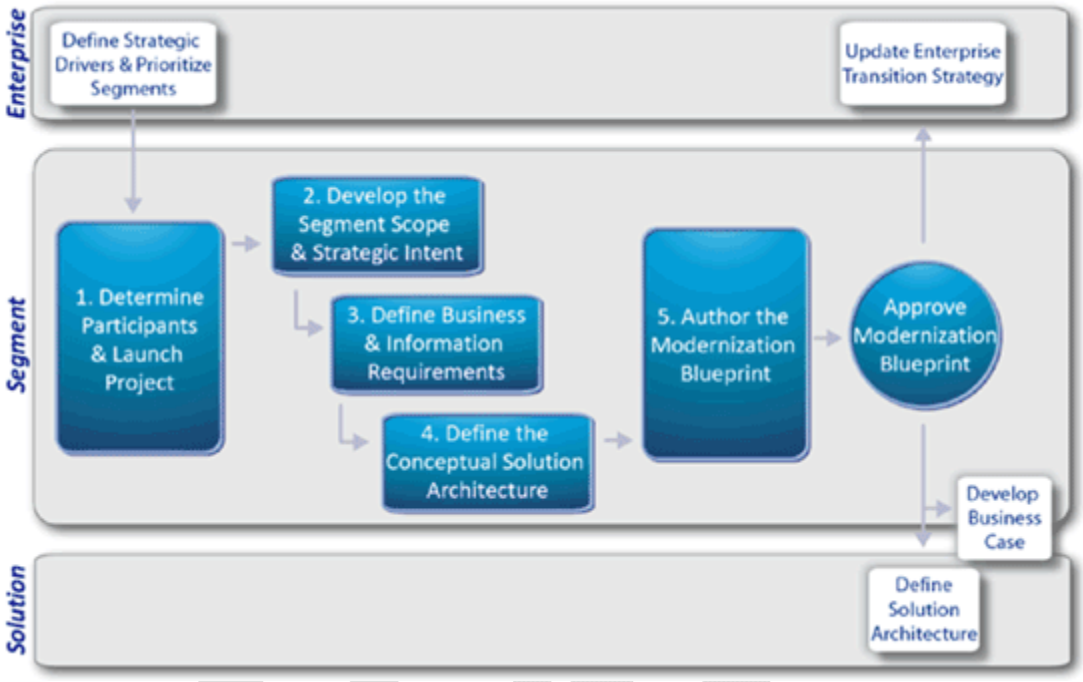


Exhibit 3-2: High Level Overview of FSAM Process Steps

For complete understanding of the FSAM including detailed activities and tasks for each process step and alignment of the FSAM to other key documents such as NIST 800-39, the Federal Transition Framework, and other FEA Profiles, please refer to the full FSAM Guidance.[30]

3.2.1 Strategic Drivers

Strategic drivers define strategic enterprise priorities. These drivers may be internal or external. Internal drivers are agency oriented and align to an agencies legislative mission, strategic goals, business requirements, objectives, or mandates. For example, the implementation of Web-mapping solutions may occur as a response to a mandated reduction in software licensing costs and the need for more efficient distribution of geographic content.

External drivers are implemented at the federal level and may cross agency boundaries. The Federal Transition Framework (FTF) catalog includes the Geospatial Line of Business and Geospatial One Stop as a means for addressing common strategic

[30] Federal Segment Overview Methodology

drivers. These external programs or facilities promote interoperability, reuse, collaboration, and transparency of government geospatial systems and information. The methods of promotion vary and can range from stated goals to technical implementations which foster or lead to adoption of more efficient geospatial operations. It is an agencies responsibility to ensure that interoperability or reuse is implemented in a responsible manner which is collaborative in fashion and transparent to other stakeholders.

A specific example of an external strategic driver is to enhance the utility of Geospatial One Stop by standardizing diverse geospatial formats. Whatever the driver of segment architecture may be, architects should consider alignment of geospatial segments with broader federal standards and initiatives. The following bullets list typical strategic drivers of geospatial segments as well as relevant geospatial examples for how an agency might respond to each driver:

- **New or modified program reporting requirements** – As programs change, geospatial information may be required to respond to reporting requirements. For example, the Farm Service Agency (FSA) maintains geospatial representations of farm boundaries as Common Land Units (CLU). This CLU data may need to be included in Farm Subsidy reports to illustrate the extent of farm property or use types. Congressional Districts, watersheds, postal codes, county, city, and state identifiers are other means of geographic reference often used in reporting. The Geospatial LoB, Geo-Enabled Business work group, provides agencies with supporting resources for incorporating geospatial information into business processes and seeks to identify cross-agency applications.

- **Reducing costs** – Geospatial licensing, especially for desktop products, can be very costly on an enterprise scale. Geospatial server applications tied to Web-based viewing clients are one means for reducing agency geospatial expenditures. Other options include implementing Open Source solutions or repurposing code from prior investments. Additionally, the General Services Administration (GSA) offers a SmarBuy procurement vehicle which offers discounts to geospatial software and data while also streamlining the purchase process. Development of the geospatial SmartBuy procurement is a process of the Geospatial LoB Common Services and Grants and Contracts work groups.

- **Data sharing** – Geospatial data acquisition and management can involve considerable expense in personnel time and infrastructure. Many agencies use the same geospatial datasets, for example the National Hydrographic Dataset (NHD), to support multiple programs. Ensuring all stakeholders within an agency or between agencies have access to a single physical copy of a geospatial dataset rather than multiple duplicative copies is more effective and cost-conscious. Furthermore, data sharing enables support for cross-cutting federal initiatives or concerns such as Homeland Security. A common operation picture comprised of nationwide geospatial assets such as imagery or infrastructure is a necessity for enabling homeland security operations. Enabling cross-agency data sharing is the focus of the Geospatial LoB Lifecycle Management work group.

- **Infrastructure improvements** – Geospatial technology is always changing offering improvements in performance as well as becoming more applicable to business functions across the enterprise. Implementing new technology, such as a geospatial database, often requires improvements to agency infrastructure. Similarly, agency Information Technology (IT) mandates may require reconfiguration of geospatial infrastructure. Horizontal segment architecture addresses reusable assets/facilities to reduce diversity and overall costs of geospatial technology. Effective use of technology in the context of architecture planning and management is supported by the Geospatial LoB Technical Architecture work group.

- **Business transformation** – Existing business processes can be improved and perform more efficiently by incorporating place based approaches for data use, display, or analysis. Transformation assesses where business decisions can be improved with geospatial information and then modifies approaches to incorporate geospatial resources. As an example, the Department of Defense (DoD) Base Realignment and Closure Process (BRAC) was revamped in 2005 to include spatial information as part of the decision framework. Previous BRAC efforts had only considered information in a tabular format which limits the effectiveness of decisions. Fifty acres of wetlands as displayed on a map in relation to other infrastructure or installation boundaries provides a very different picture than fifty acres of wetlands as a tabular line item of information. The Geospatial LoB Technical Architecture and Geo-Enabled Business work groups jointly support development of effective business transformation strategies.

3.2.2 FSAM Process Step 1: Determine Participants and Launch Project

Process Step 1 of the FSAM is started once an agency has defined the need to architect a geospatial segment in response to one or more strategic drivers. For many agencies, this architecting effort may be a first time occurrence and useful for understanding the extent or context of an agencies geospatial resources. Process Step 1 defines the framework for enabling transformation of an agency's geospatial segment to support implementation of better business practices. It ensures architects identify and assign roles to all relevant participants (core team, executive sponsor, geospatial business owners). Also, it formally defines the purpose of the effort and ensures all participants understand this purpose, if possible translating purpose into measurable objectives. Finally it acquires all required project management resources and gains formal approval and authority from all parties to proceed. The outcome of this step is an organized set of resources and applicable infrastructure required to complete the geospatial segment architecture. Some specific geospatial activities include:

- Identify how an agency's geospatial segment needs to change in response to a driver, considering FEA PRM guidance for maintaining a line of sight between technology and process inputs on one hand, and mission and customer results on the other e.g., an agencies geospatial data will be consolidated in a centralized server to respond to an agency mandate for maximum resource re-use and reduced management overhead.

- Identify the geospatial business stakeholders or data stewards affected by the proposed change(s) e.g., in the above scenario this might affect all geospatial data stewards whose data will be migrated to the central server, mission owners whose business may be affected by the migration, support personnel who must take on additional management responsibilities, or technologists whose systems may change in response to the migration.

- Organize the resources necessary to enact the change, e.g., develop a project charter and establish standard project management practices. A project management workspace may also be set up to manage the server migration effort. This workspace is populated with contact information, schedules, task descriptions, and project documentation libraries.

3.2.3 FSAM Process Step 2: Define the Segment Scope and Strategic Intent

As referenced previously, geospatial segment architecture typically represents a broad cross-cutting capability that supports implementation of a wide range of mission goals and business processes. Strategic drivers enable architects to focus improvements on specific aspects of a geospatial segment. A geospatial segment may comprise many FEA components (business, data, services, technology, and performance).

Process Step 2 of the FSAM leverages input from relevant stakeholders and analysis of improvement opportunities for selected components to craft the scope and strategic intent of geospatial segment architecture. The architect considers current geospatial investments, systems, and resources, as well as inherent geospatial segment deficiencies or inhibitors when defining the strategic intent.

The outcome of this step is a high-level target state vision for the geospatial segment (what it will be) as well as measurable performance goals to measure its contribution to target state performance. Some specific geospatial activities include:

- Identify which components of the geospatial segment require improvement e.g., business processes, geospatial databases, applications and/or infrastructure.

- Identify which stakeholders are affected by improvements and obtain their feedback regarding the type of improvements required e.g., current geospatial data stewards identify spatial accuracy, display, editing, and attribute requirements.

- Assess improvements in the context of existing geospatial segment strengths and weaknesses, identifying what strengths can be leveraged and what weaknesses will pose an issue to implementing the improvements e.g., geospatial data stewards are highly skilled and willing to compromise, which is important because the consolidation and use of single geospatial datasets will require developing non-standard or complicated schemas.

- Define improvements as a target state vision for the geospatial segment (what it will be) e.g., the agency will have a single, centralized point of access for

geospatial information minimizing duplicative infrastructure, data, and management.

- Define how progress towards the target state can be measured e.g., a schedule and quality standards will be used to migrate duplicative geospatial data from stand alone databases into the central server while also removing or repurposing non-essential infrastructure.

3.2.4 FSAM Process Step 3: Define Business and Information Requirements

Business and information requirements must be defined to focus the segment on specific business problems or opportunities and supporting information management capabilities. Process Step 3 of the FSAM provides a reference for architects in defining these requirements.

This step starts with a baseline assessment of geospatial business and information environments including the display and analysis of spatial information. We build on the high-level strengths and weaknesses established earlier to produce the assessment results that support the design of target state business and information environments. The architects produce actionable and realistic recommendations with the level of detail required to support transition to the target state. The outcome of this step is a set of requirements that define the target state. Some specific geospatial activities include:

- Assess the strengths and weaknesses of the current business and information environment (spatial data formats, infrastructure, processes, standards) for conveying geospatial information to end users e.g., geospatial data are in a format requiring limited conversion to reach the target state, some geometries are different and will need to be resolved to provide a consistent picture to end users.

- Compare strengths and weaknesses with improvement goals to design a target business and information environment e.g., all geospatial data will meet a set of standards for visual display, information content, and linkages to other business data.

- Identify the steps required to transition the current environment to the target environment e.g., all geospatial data needs to be scrubbed and modified as necessary (for example enforce consistent geometry) before loading into the central server.

It is at this step that the FEA BRM and DRM are leveraged, in the context of specific geospatial resources (agency or federal), to document the current and target states of the agency's geospatial segment and how it is integrated into the overall enterprise architecture.

3.2.4.1 Geospatial and the Business Reference Model (BRM)

This section summarizes how architects can use the BRM to describe geospatial support activities within an agency. Related to this section, Chapter 4 describes a structured process that an architect can provide to a business manager to facilitate the geo-enabling of an individual business function.

The FEA BRM is a function-driven framework for describing the business operations of the federal government as "lines of business" (LoBs) independent of the agencies that perform them. The BRM categorizes the LoBs into four business areas: Services for Citizens, Mode of Delivery, Support Delivery of Services, and Management of Government Resources. Geospatial data and services can support virtually all of these LoBs as a horizontal segment.

3.2.4.1.1 Services for Citizens

Services for Citizens are the ultimate purpose and mission of government, essentially the functions that the executive branch delivers and for which it is accountable. All other business areas within the BRM are a means to achieving Services for Citizens.

Enterprise architecture's ultimate purpose is to improve the quality and efficiency of these top-level citizen services. Virtually without exception, the high-level LoBs delineated within the FEA BRM can be supported and improved by integrating geospatial capabilities into the business processes of the organization. Exhibit 3-3 below notes some examples for the Natural Resources LoB (see Appendix B for a more comprehensive overview of Services to Citizens).

Business Area	Line of Business	Primary or Secondary Element—Line of Business Description	Geospatial Examples of the Activities
Services for Citizens	**Natural Resources**	**Primary—all activities involved in conservation planning, land management, and national park/monument tourism that affect the Nation's natural and recreational resources, both private and federal.**	**Establishing and managing outdoor recreational areas** **Planning and managing timber production and economic effects on nearby communities.** **Assessing biological health of wildlife populations and planning for species which may be at risk** **Collecting and maintaining basic mapping data for use in all government and services programs** **Conducting seeding, replanting or other rehabilitation actions after wildland fires** **Analyzing and defining areas suitable for conservation**

Exhibit 3–3: Example of "Services for Citizens" Natural Resources Line of Business

For example, a pollution control program might review equity issues across its activities by examining differential exposures to pollution across regions in relation to the demographics of affected populations.

3.2.4.1.2 Mode of Delivery

The Mode of Delivery layer of the BRM represents the mechanisms used to achieve Services to Citizens, not the services themselves. It identifies how the government delivers a high-level of service. Many of the modes of delivery can incorporate geospatial reources and, as a result, improve the outputs and outcomes for a particular Service to the Citizen. For example, emergency responders can plan and react to events more efficiently by using the spatial information and location based routing capabilities within a Geographic Information System.

3.2.4.1.3 Support Delivery of Services

Support Delivery of Services includes government functions that support top-level citizen services. These functions are cross-cutting—able to support a range of Services to Citizens—but they link closely to the specifics of those citizen services. Most of these functions can benefit from geospatial capabilities. For example, the Public Affairs LoB might prioritize its outreach activities by identifying areas of under-served populations.

If an agency has a program whose specific purpose is to design improved ways to deliver and coordinate geospatial services across mission functions, that program's function is appropriately placed at the Support Delivery of Services layer of the BRM. Such a function would include reducing duplicative acquisition of geospatial capabilities across project/ program initiatives, thus maximizing economies of scale from shared services, data and infrastructure across mission and functional areas.

3.2.4.1.4 Management of Government Resources

Management of Government Resources is another set of BRM support functions, but, unlike those listed under Support Delivery of Services; this set of functions is only loosely tied to an agency's mission. They include functions that are mostly the same at every agency, needing little tailoring to mission specifics. Geospatial enhancements to these functions might include leveraging common sets of geospatial information to provide better accounting of government assets as detailed in the Real Property Inventory case study presented below.

Management of Government Resources

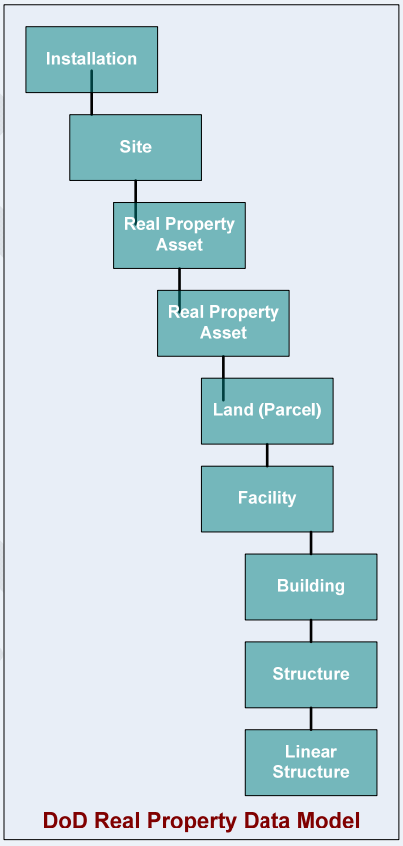
Case Example: Geo-enabling the Real Property Inventory (RPI) Process at U.S. Department of Defense

Real property data is essential for asset management and asset accountability. A recent DoD pilot project found, however, that not only was mapping the location of DoD assets out of synch with its real estate databases, the available information was often inaccurate in crucial ways and unavailable to the department on an enterprise basis.

Previous mapping efforts compiled property maps based on the location of fence lines. These were often inaccurate because fence lines are often set several meters inside an installation's legal boundary. In other cases, fence lines were built to be straight, even when legal property boundaries were not. Sometimes these fences encroached into other properties, leading to major problems when demolishing and rebuilding structures.

DoD's pilot project standardized the development of geospatial data in relation to the Real Property Inventory and created baseline digital datasets for 70 installations. Basing their work on deed and legal descriptions, and viewing parcels geospatially, GIS technicians easily identified unreconciled discrepancies (such as parcel overlaps) and were able to reconcile 90 percent of them. The remaining discrepancies were flagged for staff at the installations themselves to resolve.

This pilot project led to changes within the inventory process itself. Real property officers updated their records based on transactions, while the GIS community maintained their maps on a project-by-project basis. The new working relationship between property managers and GIS staffs has also established a common vocabulary around previously ambiguous terms such as "boundary" and "installation."



DoD Real Property Data Model

Stakeholders see many applications for geospatially updated land parcel boundaries across the enterprise. Parcel boundaries can be readily stored, shared, and updated. Data calls and last-minute reconciliation of GIS boundaries are avoided. The real property and geospatial communities can now perform reliable asset accountability analyses that help the environmental community identify environmental liability encumbrances. Overall, the pilot comprehensively geo-enabled an essential "Management of Government Resources" business function.

Source: http://themilitaryengineer.com/issues/March-April_2008/tme_0308.html, page 51

3.2.4.1.5 Mapping Geospatial Investments to BRM Functions

Although a process should map to the geospatial data sets that it uses, and to the geospatial applications or technologies that it employs, the business process itself remains mapped to its core mission/business function. A grant review function, even if it leverages geospatial technology or data, is still a grant review function.

Where the delivery of geospatial data or services is a mission-support capability in its own right, however, it needs to be called out in the agency's BRM as an agency-specific

sub-function to existing LoBs in either Support Delivery of Services or Management of Government Resources. Such functions are common geospatial support activities that an agency uses to deliver planning, governance, data, and IT support to its growing catalog of geo-enabled business processes. Agencies can adopt the following proposed sub-functions as third-level lines of business (e.g., functional breakouts under existing FEA sub-functions):

- **Geospatial Policy, Governance, and Planning** can be placed as a sub-function of Enterprise Architecture;
- **Geospatial Services** can be placed as a sub-function of IT Infrastructure Maintenance; and
- **Geospatial Information and Services Dissemination** can be placed as a sub-function of Information Management.

These geospatial support functions operate as the budget process does, providing management and coordinatio**n** across other functions and finding opportunities for reuse. Data sets originated by one agency or application may also be important to a different agency, or for a different mission or LoB within the first agency. For example, road infrastructure and address information can support emergency responders, evacuations, environmental assessments, or address matching. Geospatial support services are enhanced by a common library of geospatial data sets and technical services. This library can be documented internally for reuse or contributed to GOS. Management of an agencies internal common library should be recognized as a separate business sub-function and specifically mapped within an agency's BRM. Once mapped, it becomes visible to other programs, enabling them to avoid developing duplicative capabilities.

3.2.4.2 Geospatial and the Data Reference Model (DRM)

Geospatial data has traditionally been defined, managed, and disseminated in a variety of ways, both within and between agencies or Communities of Interest (COI's). The Federal Enterprise Architecture Data Reference Model[31] (FEA DRM) is a framework whose primary purpose is to enable information sharing and reuse across the federal government. This is accomplished via the standard description and discovery of common data and the promotion of uniform data management practices. See Appendix D for a listing of various data standards in use in the geospatial community.

Architects developing segment architectures need to understand how geospatial data supports business functions. This section of the Geospatial Profile provides a geospatial view of the elements of the FEA DRM. It addresses geospatial data context, description, and sharing in the interest of supplying architects with knowledge of how geospatial information applies to the BRM and how it can be managed to meet federal standards. Geospatial data follows a federally standardized data scheme illustrated in Exhibit 3-4 below. This scheme is set forth in the FEA DRM as follows:

[31] FEA PMO, "Data Reference Model, Version 2.0," November 17, 2005, is available at http://xml.coverpages.org/FEA-DRMv20Final-2005.pdf

- **Nationally Significant Geospatial Data**—Geospatial data themes of national significance and coverage providing the core, most commonly used set of base data, referred to as “National Spatial Data Infrastructure (NSDI) framework themes” in OMB Circular A–16. These datasets provide the core spatial visualization and analysis component of many geospatially enabled business functions. Nationally significant data are stewarded by lead federal agencies identified in OMB Circular A–16. Lead federal agencies must establish and maintain data taxonomies and data content schemas for nationally significant geospatial data as described in FEA DRM.
- **Other Geospatial Data**—Other geospatial data include those geospatial data with national or regional coverage that do not fit into the context of the NSDI framework themes set forth in OMB Circular A–16 and state, local, or tribal data that can be “nested” into the nationally significant geospatial data framework themes. Depending on the need these datasets can provide core or ancillary spatial visualization and analysis components for business functions. Other geospatial data must have their context, taxonomies, and data content schemas formally defined. COIs engage in standards development organizations such as the FGDC and ISO to define and adjudicate common taxonomies and schemas.
- **Administrative and Operational Data**—Administrative and operational data are those business data maintained and used by federal departments and agencies that are specialized or more dynamic in nature and used for specific events or analytic purposes. These data are typically non-spatial in nature but include one or more location attributes (address, etc.) that enable geo-referencing to facilitate fusion with nationally significant and other geospatial data to support specific visualization or analysis needs. COIs identify the business need (context) warranting the geo-referencing of administrative and operational data.

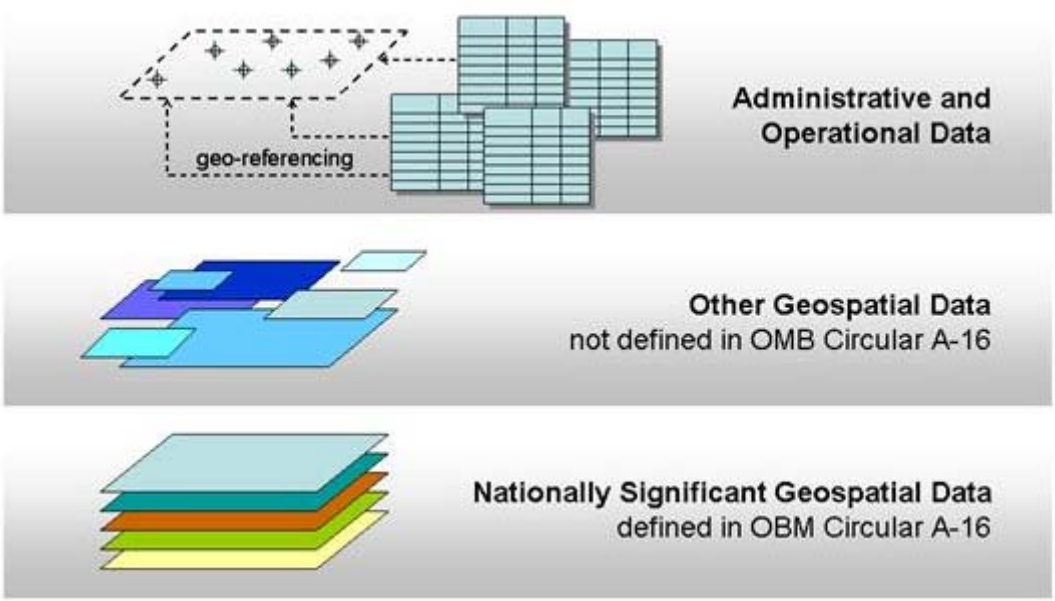


Exhibit 3–4: Geospatial Data Asset Categories

3.2.4.2.1 *Geospatial Data Context*

Taxonomies are important for all data—including geospatial data—to ensure a consistent understanding of how data are organized and how data model the real world. The FEA DRM Data Context enables the business context of data to be well understood, which enables the ability to track and align geospatial investments by Line of Business and the ability to establish business- and mission-oriented taxonomies for geospatial data.

Taxonomies describing nationally significant and other federally stewarded geospatial data should be documented using eXtensible Markup Language (XML) Topic Maps, Web Ontology Language (OWL), Resource Definition Format (RDF) hierarchies, or ISO 11179 classification schemes. Taxonomies describing geospatial data can then be made accessible via services to facilitate efficient search, discovery, and data translation capabilities and to facilitate development of more detailed data schemas and logical data models.

Geospatial data schema should be associated with existing business-oriented taxonomies (i.e., those taxonomies defined by and/or aligned with the FEA BRM) where applicable. This will enable synchronization of geospatial data schemas with business language and processes and facilitate the integration of geospatial data with departmental and agency-specific enterprise architectures.

The key context for of all geospatial data is location. Various frameworks exist for representing location, several are summarized here. Appendix D provides more information on the international (ISO) and national (ANSI/NISO) standards that govern the representation of location using these frameworks:

- **Spatial Referencing by Coordinates** (“Absolute Location”)—Geographic objects (points, lines, areas) can be represented by one-, two-, or three-dimensional coordinates and coordinate reference systems. Nationally significant geospatial data and other federally stewarded geospatial data should be referenced using absolute location.
- **Spatial Referencing by Geographic Identifiers** (“Relative Location”)—Geospatial data can also be referenced using relative location. Relative location is established by use of geographic identifiers that do not provide precise, explicit coordinate locations for a given data asset. Some examples of relative location include addresses, place names, and the U.S. Public Land Survey System. Relative location is typically appropriate when geo-referencing non-spatial administrative and operational data, but can also be associated with geographic objects (points, lines, areas) as attributes.

3.2.4.2.2 *Geospatial Data Description*

To facilitate business functions, the user must understand what information geospatial data represents and how it was developed. Geospatial data schemas define how geospatial data are organized, how geospatial objects relate to each other, and list the attributes associated with each object. For maximum interoperability, these schemas must be based on standards identified by lead federal agencies or COIs for logical (abstract/database design) and physical (encoding/exchange) applications. The

National Information Exchange Model (NIEM) is an example of a federally developed data schema which incorporates geospatial content. Community collaboration and harmonization of semantics and exchange schema is used to provide common approaches and resolve discrepancies.

Federally stewarded geospatial data should have established logical data models. These logical data models would then govern physical implementation of geospatial data. Logical data models will be developed by lead federal agencies responsible for NSDI themes and by COIs for other federally stewarded geospatial data. All nationally significant and other federally stewarded geospatial data should be documented with descriptive metadata to enable discovery, assessment of fitness-of-use, and sharing of geospatial data resources. Geospatial metadata should be organized by a common schema to be applied across the federal sector that:

- Is organized in accordance with ISO metadata specifications (ISO 19115 and ISO 19139), documenting key properties of geospatial data resources including but not limited to the following:
    - **Identification information** (e.g., context/topic, search keywords, dataset title)
    - **Data quality information** (e.g., positional accuracy and precision, adherence to data accuracy standards, completeness)
    - **Spatial representation and reference system information** (e.g., geometric properties, coordinate systems, projections, datum)
    - Other relevant information [e.g., maintenance frequency, data steward (POC) information, content description, distribution protocol and constraints]
- Contains, to the maximum extent possible, normalized and well-defined metadata descriptive attributes ("pick-lists") to enable efficient discovery. "Free-text" metadata tags should be kept to a minimum
- Utilizes ISO 19115 topic categories to categorize data to facilitate keyword searches and structured queries. ISO 19115 topic categories should be mapped to FEA BRM functions and sub-functions to enable linking between geospatial data resources and the FEA BRM (as previously described in the Data Context section)
- Explicitly defines distribution rights and restrictions to enable role-based access implemented through federal e-authentication initiatives and strategy

3.2.4.2.3 Geospatial Data Sharing

Geospatial data sharing facilitates more efficient business functions by ensuring consumers and applications are leveraging the same set of information. The FEA DRM provides an architectural pattern for sharing and exchanging data through a services-oriented strategy. Geospatial data should be encoded using appropriate interface standards and specifications to enable data exchange (fixed recurring transactions between data suppliers and consumers) and less structured requests for data access.

The FEA DRM recommends development of a supplier-to-consumer matrix to identify organizational (or COI-oriented) information exchange requirements to guide development of service components and information exchange packages. The number of potential consumers of federal geospatial data assets is too large to warrant an explicit data supplier-to-consumer matrix as recommended by the DRM. Geospatial architectures should leverage metadata catalogs as exposure mechanisms to enable consumers to discover availability and fitness-of-use of relevant geospatial data while also providing an effective means to connect consumers with authoritative geospatial data through service-oriented discovery, brokering, and access. Service components defined in Appendix C provide examples of cross-cutting capabilities that can be exploited by the full range of potential consumers of federal geospatial data resources.

OGC Web Services (OWS)

The Open Geospatial Consortium (OGC) Web Services family of specifications should be used as they are based on and adhere to the fundamental requirements listed above. Geospatial data should be encoded and exposed to services using OGC encoding standards including but not limited to the following:

- Web Map Service
- Web Feature Service
- Web Coverage Service

To facilitate data sharing geospatial standards should:

- be open and vendor-neutral to enable exploitation by a broad range of technology solutions;
- be based on consensus (ISO/ANSI/FGDC/OGC) or community standards; and
- Promote encoding of full geographic information (i.e. raster and vector spatial data and their attributes) in support of multiple mission requirements.

3.2.5 FSAM Process Step 4: Define the Conceptual Solution Architecture

In Process Step 4 of the FSAM the architect analyzes the requirements developed during prior FSAM steps to produce a conceptual solution architecture. This architecture is an integrated view of the geospatial systems, services, and technology required to support the performance, business, and data goals of the target geospatial segment. It reviews existing geospatial systems and services to determine where components may be retired, consolidated, or reused to support transition to the target architecture; analyzes conceptual solution risks, constraints, dependencies, and issues to ensure necessary alternatives are identified. The outcome of this step is a defined geospatial solution with recommendations for transitioning from the baseline to target state. A conceptual solution architecture serves as a framework for translating requirements into an actual physical implementation. Some specific geospatial activities include:

- Assess the existing geospatial architecture and define a status for components (a matrix is helpful for organizing and evaluating this content) based on their applicability to the target state e.g., does an existing server meet the requirements for a centralized geospatial server?

- Indicate a future status for components for transition to the target state (what do they need to become or how should they be configured) e.g., an existing server will be modified with the new geospatial data schema to become the central geospatial data server.

- Arrange components according to their future status, along with new components in a conceptual solution architecture (an actual physical model of the target state) e.g., the new geospatial data server will integrate into the IT infrastructure and be accessed through a security protocols by desktop GIS software.

- Thoroughly assess the conceptual solution to ensure a clear path to implementation is documented e.g., if the solution is implemented by the Geo Integration Office technical staff it will be online at X date.

- Define steps for transitioning the current solution to the conceptual solution e.g., the existing server needs to have geospatial server software loaded, a geospatial database loaded, the data schema implemented, and data sequentially loaded and tested.

It is at this step that the FEA SRM and TRM are leveraged to document the current and target states of the agency's geospatial segment.

3.2.5.1 Geospatial and the Service Component Reference Model (SRM)

The FEA SRM is a business-driven, functional framework that classifies service components with respect to how they support business and performance objectives. As in the case of the FEA BRM, it is possible to create a geospatially-extended SRM which aligns geospatial capabilities with services. Appendix C presents a list of geospatial service components in the context of the SRM. This list provides architects with a more substantial view of how geospatial fits in the SRM and what type of geospatial capabilities might exist for each service domain, service type, or service component.

Geographic location is a cross-cutting information asset and a key resource in net-centric environments. As computing evolves and new approaches are defined for Web based communication and information analysis, geospatial capabilities will grow in use and applicability. Of particular importance to geospatial SRM and the integration of geospatial capabilities in net-centric environments is the development of Service Oriented Architecture (SOA).[32] SOA strives to achieve economies of scale in the development and implementation of business solutions via the reuse of services and service components. Geospatial processes, data, applications, and technology can all be more efficiently used and implemented by leveraging SOA principles.

The following bullets provide examples of geospatial service components which can be used independently or packaged into more complex services.

[32] http://en.wikipedia.org/wiki/Service-oriented_architecture

- ***Geospatial Distributed Component:*** A coordinate transformation service—a low-level function that transforms geospatial data between different coordinate reference systems, datum, and units.
- ***Geospatial Business Component:*** A GIS is the premier example of a geospatial business component. Its operation includes such distributed components as a coordinate transformation service, Web mapping, and other spatial analytical tools.
- ***Geospatial Business Component System:*** A facilities management system can be integrated with a GIS. The Federal Emergency Management Agency (FEMA) operates FEMA MAC (Mapping Analysis Center) that produces Emergency Declarations Maps for a variety of clients, including state governors. Together, these combine to provide a staff-based service operation with GIS mapping capabilities.
- ***Geospatial Federated Component****:* A federated component includes numerous business component systems exposed as an integrated service across the government to multiple end-users in different organizations. Virtual Alabama, presented in section 2.2.5 of this Profile is an example of federated geospatial components. Following the Virtual Alabama model, the Geospatial LoB initiative seeks to identify additional common services and federated geospatial components in the future.

3.2.5.2 Geospatial and the Technical Reference Model (TRM)

This section of the Geospatial Profile extends the TRM to include geospatial capabilities. This is provided to encourage the standards-based integration of capabilities, particularly in a multi-agency information sharing and processing environment. Conformance testing of standards should occur as part of an agencies deployment checklist and development lifecycle.[33] Service level agreements ensure all parties understand their roles in integrating geospatial technology and what the desired outcomes should be.

The technological element[34] of solution architecture typically includes a listing of the products and standards required to meet needs of the architecture being described. This section establishes the basic referenced necessary to help ensure that proposed information technology solutions that include or should include a geospatial component (or components) are in compliance with industry standards and are, therefore, likely to integrate efficiently into a multi-agency information sharing and processing environment. Specifically, this section supports technological solutions by supplying a standard vocabulary and categorization scheme which mainstreams geospatial technology into IT

[33] Refer to Chief Information Officers best practices for guidance in technology integration

[34] Typically a TRM in an architecture developed using the Federal Enterprise Architecture Framework (FEAF), a TV-1 in an architecture developed using the DoD Architecture Framework (DoDAF), or simply a Technology Architecture in The Open Group Architecture Framework (TOGAF).

architecture. A geospatially-extended TRM and a list of specific geospatial standards are contained in Appendix D.

Neither this section nor Appendix D enumerates technological products. The reader is directed to other sources, such as the annual Geospatial Industry Technology Association (GITA) Geospatial Technology Report,[35] for a list of technological products.

The geospatially-extended TRM must be viewed within the context of a geospatially-extended SRM. The functionally-oriented capabilities described in the geospatially-extended SRM are enabled by technical services, protocols, and interfaces (Exhibit 3-5).

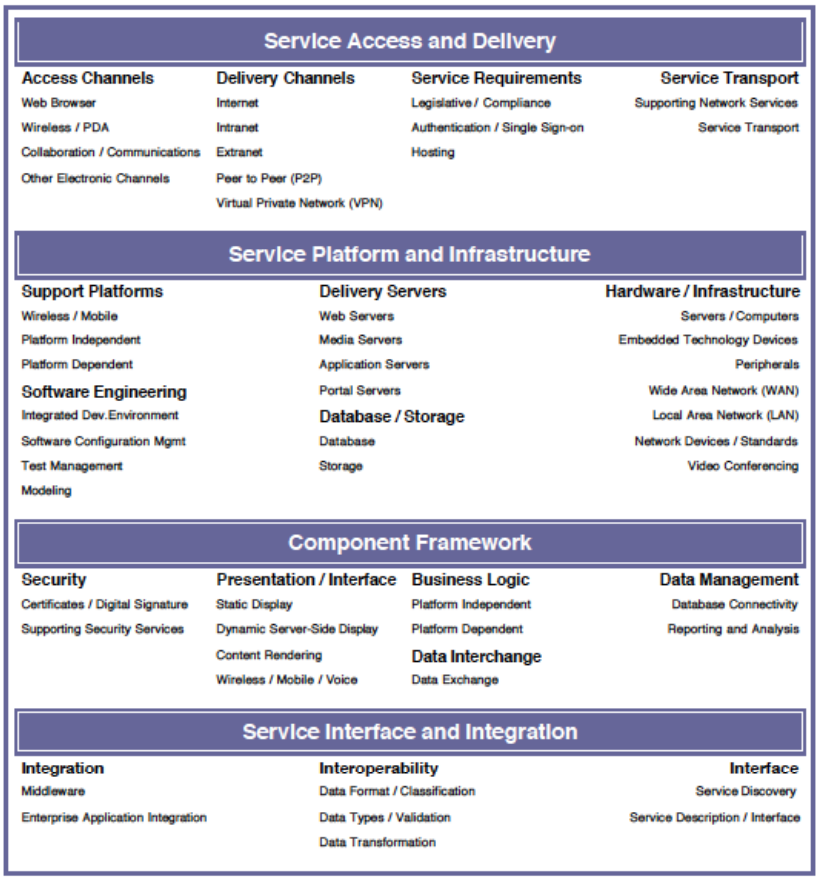


Exhibit 3–5: TRM Technical Services, Protocols, and Interfaces

At the Service Platform and Infrastructure, Component Framework**,** and Service Interface and Integration levels, the geospatial industry has defined a number of specialized systems and standards described in Appendix D.

[35] http://www.gita.org/

3.2.6 FSAM Process Step 5: Author the Modernization Blueprint

Process Step 5 of the FSAM builds upon all prior steps to develop a geospatial segment architecture blueprint including sequencing and transition plans. New architectural components should be evaluated according to Capital Planning and Investment Control (CPIC) program guidelines to assess cost, benefits, and risk with the best options selected for the transition. The transition of the geospatial segment must be actionable; and the blueprint and related plans guiding this transition must receive final approval. Outcomes from this step include an approved modernization blueprint leading to an updated enterprise transition strategy, a fully developed business case, and a well-defined and implementable solution architecture. Some specific geospatial activities include:

- Clearly define the benefits of the solution and its alignment with broader agency or federal goals (Geospatial Line of Business, Geospatial One Stop) – The centralized geospatial server will make it easier for the agency to contribute information to Geospatial One Stop as well as reduce duplication of data resources and infrastructure in the agency.

- Develop a plan with action items, dates, quality measures, and approval processes to guide implementation of the solution – The centralized geospatial server will be implemented in five phases by members of the GIO technical team and will have to pass four quality tests before being approved.

- Obtain approval for the solution and implementation plan – the Chief Architect, GIO, and Branch Chief will review and approve the solution.

Once the geospatial architecture components are in place, they are measured for efficiency and effectiveness using the FEA PRM.

3.2.6.1 Geospatial and the Performance Reference Model (PRM)

The PRM provides a structure for analyzing inputs and outcomes and focuses on setting targets for action and measuring the degree of transformation achieved. The PRM can be used as a tool for focusing scarce geospatial resources more effectively and for communicating the benefits of geospatial programs.

The PRM is of particular use to the development of fledgling geospatial programs across government because it provides a structure for analyzing both means and ends. Using performance measures allow agencies to define how much more effective their business processes are by incorporating geospatial resources, approaches, or methods. To date, use of the PRM is only required as part of the FEA for major investments under the Capital Planning and Investment Control (CPIC) program. However, the PRM provides an opportunity to support performance evaluation of business programs, processes, and services as well as information technology systems.

All activities of an agency's geospatial program—developing policies and using standards, implementing geospatial services and geo-enabling functions within the organization, and implementing and providing geospatial data services both inside and

outside the agency—can benefit by evaluating performance. There are two primary measures for evaluating performance:

- Measures of the performance of business processes incorporating geospatial resources and investments (how much does the business process save by using geospatial technology and data, how many users does it support).
- Measures of the maturity of a geospatial program responsible for developing an agency's geospatial architecture (is the program progressing towards offering better services to more customers and does its geospatial data meet quality standards).

A simple methodology for application of the FEA PRM to geospatial programs and resources includes construction of a line of sight. For example, an agency may possess a geospatial portfolio of information and technology which is implemented to provide varying levels of geospatial capability. This portfolio is generally managed by a a Geospatial Information Officer (GIO). The GIO can define the current state of geospatial resource use in the agency and then propose an end state whereby agency programs better leverage these resources. The extent to which programs incorporate geospatial resources, and use these resources effectively, can be measured over time to assess the pervasiveness and effectiveness of the GIO approach.

3.3 Geo-enabled Organization

Architects can leverage the FSAM and FEA to develop geo-enabled organizations or better understand the extent to which their organization may already be geo-enabled. A geo-enabled organization is one that deploys the staff and technological infrastructure necessary to provide enterprise geospatial data, services, and technological support to business processes across an organization, while also promoting economies of scale and reuse. This includes supporting agency-wide access to geospatial data and services for multiple business processes and deploying mechanisms for external partners to access the agency geospatial assets. A successful team will engage in effective outreach and communications appropriate to different audiences within the enterprise to identify business processes that may benefit from geospatial approaches. Once these are identified, the team will work closely with business process and program managers to aid in geo-enabling these processes.

Successfully geo-enabled organizations have a governance structure in which senior management are engaged in integrating geospatial approaches and practices into the business architecture. At the implementation level, the organization must also promote the adoption of standards and geospatial policies among all current and potential users. A geo-enabled organization will support mission programs in the development of their own geospatial architectures consistent with the larger enterprise geospatial infrastructure to:

- Tag business processes associated with a place.
- Determine which aspects of the business process could benefit from geospatial approaches.
- Re-engineer business processes through:

    - Identifying program geospatial data needs.
    - Procuring, maintaining, storing, and sharing program-specific data.
    - Identifying geospatial service component needs.
- Procure, maintain, and share geospatial service components at an agency level or through www.core.gov.
- Promote reuse of geospatial resources within and across multiple lines of business/business processes and agency boundaries.

4 Geo-Enabling Business Processes

This chapter provides architects or executives with a methodology for geo-enabling business processes. The series of steps provided offer a means for architects or executives to identify business areas which could benefit from geospatial approaches and procure the resources to enable the change. The information presented in this chapter is augmented by example geospatial approaches for Lines of Business in Appendix B. Exhibit 4–1 below presents a structured overview of the process methodology in three stages: identification, analysis, and selection. Each step in the process is described in turn. A grant award process, taken from the U.S. Environmental Protection Agency (EPA), is used as an example.

The methodology presented here is mainly aimed at using geospatial business processes to improve business processes for end-user benefits to citizens. To geo-enable a business process, architects or executives focus on the identification and analysis stages, which take them through the steps of identifying location-based approaches for mission functions and analyzing the most cost-effective combination of possible approaches. The "Select" phase is where investments in infrastructure are authorized.

Over time, the geospatial architecture should evolve to produce the best combination of infrastructure services necessary to support the widest array of geospatially-enabled services to citizens. With today's technology, the use of geospatial information within a business process can and should be entirely transparent to the user. Geospatial services no longer require users to be experts in the technology and mathematics that make such services possible.

4.1 Stage I: Identification

A critical first step in geo-enabling an agency's business is to identify new or existing business processes associated with a place and whose implementation would improve by incorporating geospatial approaches into their procedures. The following questions are examples that agency architects can use in discussions with program and business managers to determine if geo-enabling the business process is beneficial:

- Is the business process/function associated with a place or a location?
- Does the process/function's description contain geospatially-relevant key words?[36]
- Does place affect how the process/function is conducted (e.g., does the function vary by place or do the characteristics of a place affect the function)? For

[36]For example: address (physical), address (postal), area, bearing, bearings, city, community, compass, country, direction, distance, district, domicile, event, facility, geography, house, household, incident, latitude, locale, locality, locate, location, longitude, neighborhood, pinpoint, place, point, port, position, post, property, region, reservation, residence, river reach, route, scene, site, situation, space, spot, station, street, suburb, terrain, territory, topography, town, tract, venue, vicinity, village, watershed, where, whereabouts, ZIP code, zone.

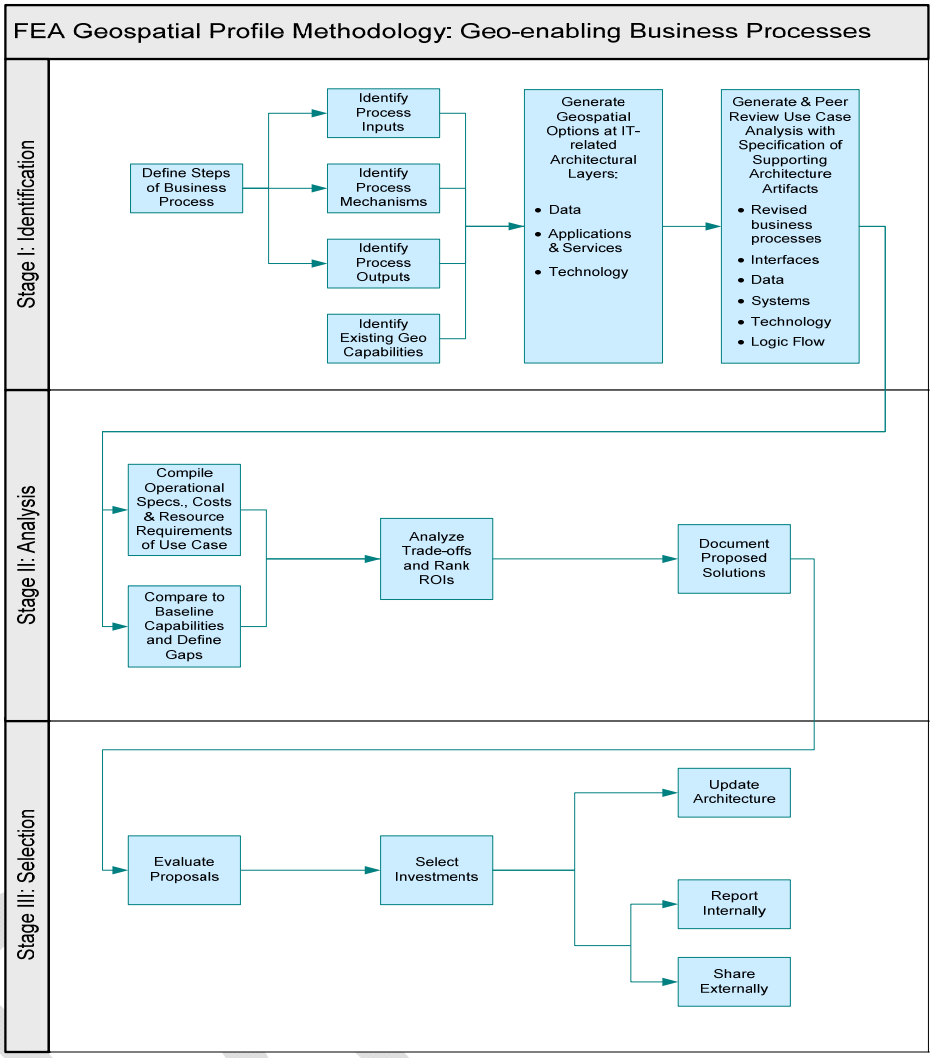


Exhibit 4–1: Overview of Methodology for Geo-enabling Business Processes

4.1.1 Define Steps of Business Process

If the answer to these questions is “yes,” the architect can work with the program manager to map the principal steps within the business process and determine where geo-enabling is appropriate. The data inputs, documents, and outputs at each major step within the business process should be defined at a general level—ideally within an architecture modeling tool so that relationships between elements are captured. Exhibit

4-2 illustrates part of an EPA grant award process that was used to identify opportunities for location-based approaches.[37]

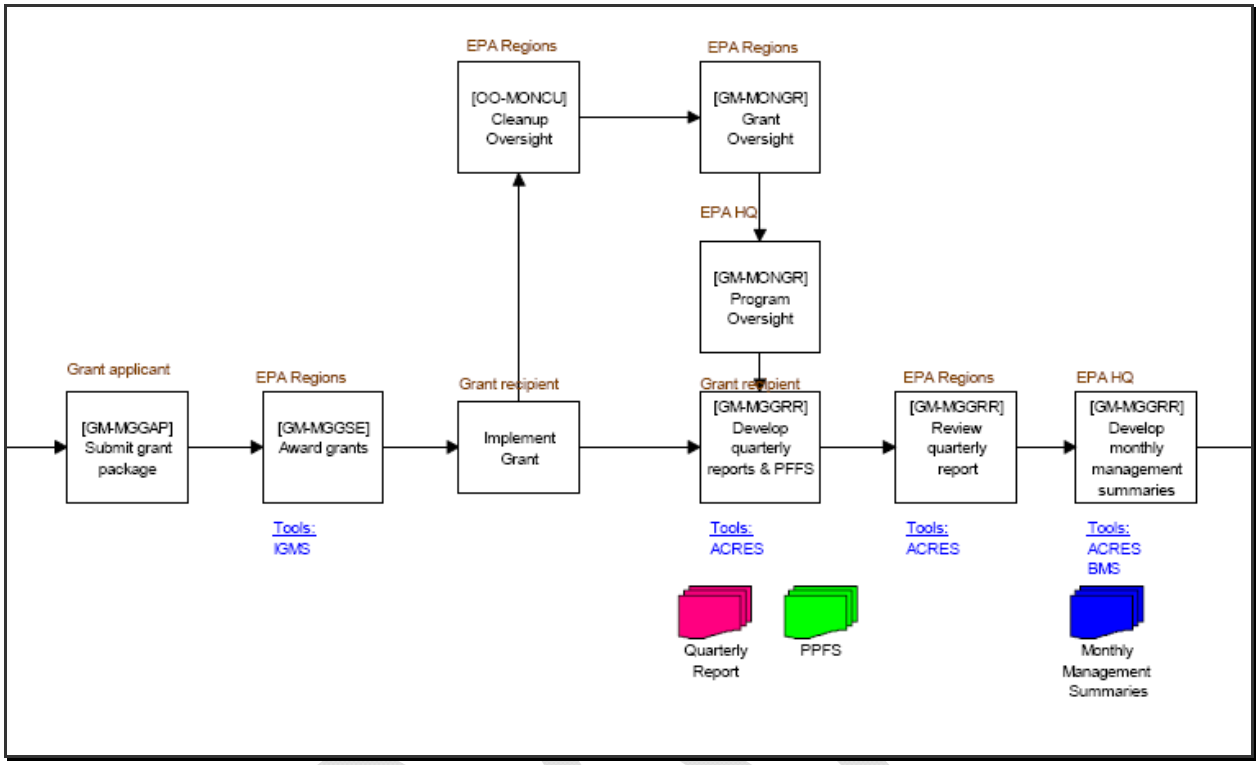


Exhibit 4–2: Portion of Diagram Used to Define Steps of a Business Process

Note that virtually all the steps in this process relate in one way or another to location. For example:

- Is the location of the grant applicant important? Is the location to which it sent its application important?
- Would the grant award process benefit from knowing more about the prospective grant location than is available in the current application?
- In implementing a grant, could the awarding agency provide the grantee with useful information about locally available implementation assistance?
- In overseeing multiple cleanup grants, would it be helpful to generate geographically efficient routes for inspectors to follow?

4.1.2 Identify Process Inputs, Mechanisms, and Outputs

The next stage of the methodology is to define the inputs, mechanisms, and outputs of each step, as illustrated in Exhibit 4–3 below, and to note any existing geospatial

[37] In the example above, the grant award process in question had already been reviewed for potential applicability of location-based approaches, and was *not* flagged as a likely candidate. As will be seen in this example, significant opportunities were nevertheless found.

capabilities used in relation to opportunities for expansion or the need for a technical upgrade. The more detail available, the more opportunity there is to find new opportunities to apply geospatial techniques.

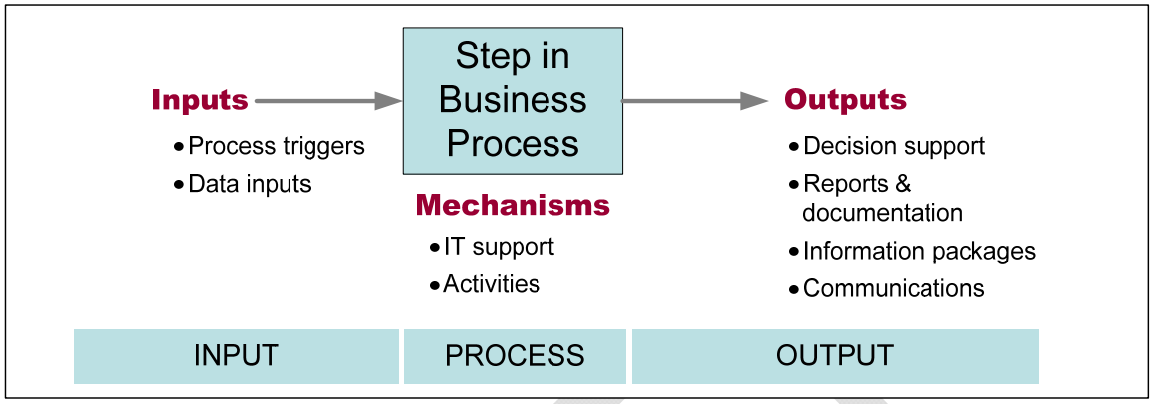


Exhibit 4–3: Identifying Process Inputs, Mechanisms, and Outputs

Business managers and architects review the flow of a business process step by step, identifying the basic process triggers, input data, and process mechanisms (IT support, activities), asking the following questions with the geospatial services staff:

- Are there geospatial services or activities that can improve the business process (e.g., using geospatial tools to find the distribution of individuals around a facility undergoing clean-up)? These can be characterized as geospatial information inputs to the business process, as shown in Figure C–3.
- Are there specific geospatial technology tools that might change the business process itself to be cheaper or faster (e.g., aerial photo vs. on-the-ground visit)?
- Are there ways that the outputs of the process could be changed to more effectively communicate and use results (e.g., visualization of various scenarios)?

4.1.3 Generate Geospatial Options

Next, business managers and geospatial staff generate options for improving the business process—opportunities to conduct the process better, faster, or cheaper—by applying geospatial capabilities. Exhibit 4–4 discusses each of the elements shown in Exhibit 4–3.

Element	Description	Example Geo-enabled Options
INPUT	**Process triggers:** Example: receipt of a particular type of information (data trigger), an action by an IT system (system trigger), or an input from a technological platform (such as a GPS unit)	GPS-enabled wireless sensors on field vehicles automatically trigger emergency response action if hazardous gases are detected Automated analysis of multi-spectral satellite data identifies locations of crop blight for analysis
	Data inputs: Geospatial data that could be used by the process (e.g., proximity of individuals to hospitals or other sites for health services) Converting addresses or place names in existing input data into digital coordinates	Access geo-spatial data from a digital library to provide adequate knowledge of local conditions Convert list of employee addresses to digital coordinates to plot commuting time or possible recruitment locations
PROCESS	**Mechanisms:** Use of digital imagery avoids need for on-ground site inspection	NEPA[38] Assist provides access to background information quickly and organized by location, would previously have taken weeks to gather all the info Wireless GPS sensors provide real-time knowledge of the location of emergency response staff, rather than relying on staff phoning in their positions.
OUTPUTS	**Decision Support** Complex report results are mapped and used to make management briefings clearer and more effective. Spatial statistics may offer business managers sophisticated new approaches to making decisions based on the results of a process step.	Managers can know the exact location of a problem and/or the location of nearby response resources. Analysts can combine a wide variety of datasets by geo-coding them. They can bring new information to bear on decisions by using indirect locational information such as addresses, place names, or membership in a location-based community.

Exhibit 4–4: Types of Options and Examples for Geo-enabled Processes

The output of Stage I should be a reasonably detailed scenario or use case that includes:

- A statement of the goal of the proposed solution, relationship to existing business process, perceived gaps or problems, and technical opportunities available for improving the process with geospatial functionalities.
- One or more operational scenarios or narratives detailing how the revised business process would make use of geospatial capabilities.
- An inventory of the baseline architectural elements or “artifacts” (business functions/processes, data assets, applications and services, and technologies) that would be included in, or affected by, the solution.

[38] NEPA: National Environmental Protection Act

The use case can be circulated to the staff or organization(s) involved for review and comment, and updated or refined as appropriate.

4.2 Stage II: Analysis

The Analysis stage involves conversion of scenarios or use cases for applying geospatial capabilities into explicit operational statements. These are then compared as operational needs to define baseline geospatial capabilities to reveal opportunities for the reuse of existing services and resources and to identify gaps between existing capabilities and those required to implement the solution. The baseline geospatial capabilities may be unique to an agency or may exist as capabilities common to multiple organizations within the NSDI. Business managers and geospatial staff then conduct a return on investment (ROI) analysis of net costs, estimated schedules, and other resource requirements to yield a complete proposed solution.

4.2.1 Compile Operational Specifications and Resource Requirements

The first step in Stage II is to develop a detailed operational statement of the proposed solution that will consider all layers of the system, including required business process changes, data and data flows, applications and services, and associated technology.

Throughout this stage of the methodology, the architecture team works through each function and process of the use case, defining all operational specifications required to implement the solution outlined in the use case. Where more than one option exists for implementing a proposed function, the team develops all options in sufficient detail to compare implementation needs to existing capabilities (internal and external).

4.2.2 Compare Operational Specifications to Baseline Capabilities, Define Gaps

The resulting operational specifications—whether described in the swim lane format illustrated here or using some other notation—can then be compared to existing capabilities documented in the agency's baseline ("as-built") architecture. The team notes as gaps those requirements not satisfied by available components. Whereas some gaps may be filled by modifying or enhancing existing components, others may require the acquisition or construction of new components.

For each gap, the team compiles preliminary cost estimates based on existing documentation and best professional judgment. These estimates can be refined in the next step as needed.

4.2.3 Analyze Trade-offs and Rank ROIs

In developing scenarios for geo-enabling a business process, teams are likely to note multiple ways that geospatial services might make an improvement. Where there are multiple options for geo-enabling a particular function or sub-function, or where different activities within a process can make use of different geospatial capabilities, trade-offs will be analyzed among the options and returns on investment ranked for each option.

The output of this step is creation of a cost-effective combination of geospatial capabilities for the functional improvement gained by a placed-based approach. The

analyses may identify a need to change existing, or propose new, capabilities as a solution to gaps or sub-optimal capabilities. These can lead to trade-off analyses of alternative solutions. Multiple solutions to each problem may introduce different levels of residual risk and varying implementation costs. OMB directs agencies to consider alternative solutions and evaluate them based on functionality, risk, cost, and interoperability. Trade-off analyses result in a set of proposed investments that can then be mapped to the agency's to-be architecture. Options to be explored include internal, government-wide, and commercial packages. When agencies evaluate options for leveraging, they should consider solutions from other agencies as well as solutions in their own agency. Reuse of solutions among federal agencies is a goal of FEA efforts.

The results of the trade-off analysis support the investment prioritization process, both at the programmatic level and for the agency's information technology investment review board. The trade-off analysis performed in the business cases, the references to the risk analyses, and the enterprise architecture content provide the basis for informed risk-based decision-making during investment review, prioritization, and funding decisions.

4.2.4 Stage III: Selection

Stage III is a program-wide, bureau-wide, or enterprise-wide evaluation of the geospatial solutions proposed in Stage II and the selection of major and non-major investments.

4.2.4.1 Evaluate Proposals

In Stage III the implementation team works with the appropriate level of agency financial officers and the appropriate level of IT investment review boards to integrate outputs from previous stages into the broader capital planning process to ensure the:

- Evaluation of individual proposals such that each fully reflects the outputs of Stages I and II.
- Selection of individual geospatial proposals that best support the business needs of the organization, including potential reuse of geospatial assets and capabilities across the agency.
- Documentation of the updated target architecture and sharing of reusable components.
- Documentation of operational performance metrics and improvement processes to continually monitor and upgrade selected proposals.

The appropriate financial officer and investment review board begin by evaluating all proposals using consistent criteria. Ideally, the Stage II trade-off analysis is consistent with the evaluation criteria. The financial office and review board are then merely enforcing expectations articulated in enterprise architecture principles and OMB Exhibit 300 budget justification criteria.

While not every proposal from Stage II will be a major investment, proposed solutions should undergo executive review to ensure they meet agency criteria and are consistent

with the target architecture. Reuse solutions should be pursued wherever possible to ensure they meet agency criteria and are consistent with the target architecture.

4.2.4.2 Select Proposals

Stage II promotes solutions consistent with enterprise needs. Ultimately, it is the role and responsibility of the review board to select a mix of proposals that optimize business needs and maximize available funds. Review boards may wish to prioritize proposals based on various agency needs; OMB promotes selecting shared or sharable capabilities or unique, non-shareable solutions.

4.2.4.3 Update Architecture, Report Internally and Externally

Once the financial officer and review board make their selections, the program, bureau, or agency will document and capture the new capabilities in the agency enterprise architecture. The new capabilities will be reflected in the target architecture and transition plan. Agencies will communicate results internally to ensure program offices and geospatial stakeholders are aware of the new capabilities. Agencies should also consider publicizing externally leveraged capabilities registered at http://www.core.gov or available through OMB's Geospatial Line of Business (GeoLoB).

APPENDIX A: References

Office of Management and Budget, *FY 2003 Report to Congress on Implementation of The E-Government Act,* March 8, 2004, http://georgewbush-whitehouse.archives.gov/omb/egov/fy03_egov_rpt_to_congress.pdf

Federal Enterprise Architecture Program Management Office, *Enabling Citizen-Centered Electronic Government: 2005-2006 FEA PMO Action Plan*, March, 2005, http://georgewbush-whitehouse.archives.gov/omb/egov/documents/2005_FEA_PMO_Action_Plan_FINAL.pdf

Office of Management and Budget, *Circular A-16: Coordination of Geographic Information, and Related Spatial Data Activities (Revised)*, August 19, 2002, http://www.whitehouse.gov/omb/circulars/a016/a016_rev.html

Office of Management and Budget, Supplemental guidance *Circular A-16: Coordination of Geographic Information, and Related Spatial Data Activities (Revised)*, December 2008

Office of Management and Budget, *Circular A–11: Preparation, Submission, and Execution of the Budget (Revised)*, June 2005, http://www.whitehouse.gov/omb/circulars/a11/current_year/a_11_2005.pdf

Federal Enterprise Architecture Program Management Office, *Data Reference Model Version 2.0,* November 17, 2005, *http://georgewbush-whitehouse.archives.gov/omb/egov/documents/DRM_2_0_Final.pdf*

Federal Enterprise Architecture Program Management Office, *Security and Privacy Profile, Phase I Final*, 2005, http://www.cio.gov/documents/FEA_Security_Profile_Phase_I_Final_07-29-2004.pdf

Federal Enterprise Architecture Program Management Office, *Security and Privacy Profile, Phase II Draft*, 2005, Not currently available to the public.

Federal Enterprise Architecture Program Management Office, *Records Management Profile, Version 1.3*, 2005, http://www.cio.gov/documents/RM_Profile_v1.pdf

Federal Enterprise Architecture Program Management Office, *FY07 Budget Formulation: FEA Consolidated Reference Model Document*, May 2005, http://georgewbush-whitehouse.archives.gov/omb/egov/documents/CRM.PDF

Office of Management and Budget, *Circular A–130, Transmittal Memorandum #4, Management of Federal Information Resources*, November 28, 2000, http://www.whitehouse.gov/omb/circulars/a130/a130trans4.pdf

Office of Management and Budget, *Circular A–119, Transmittal Memorandum, Federal Participation in the Development and Use of Voluntary Standards*, February 10, 1998, http://www.whitehouse.gov/omb/circulars/a119/a119.html

107th Congress of the United States of America, *E-Government Act of 2002 (Public Law 44 USC Ch 36)*, 2002, http://thomas.loc.gov/cgi-bin/query/z?c107:H.R.2458.ENR: or http://www.archives.gov/about/laws/egov-act-section-207.html

Office of Management and Budget, *Implementing the President's Management Agenda for E-Government*, April, 2003, http://georgewbush-whitehouse.archives.gov/omb/egov/documents/e-gov_strategy.pdf

NASA Geospatial Interoperability Office, *Geospatial Interoperability Return on Investment Study*, April 2005, http://www.egy.org/files/ROI_Study.pdf

Federal Enterprise Architecture Program Management Office, *Enterprise Architecture Assessment Framework Version 2.0*, December 2005, http://georgewbush-whitehouse.archives.gov/omb/egov/documents/OMB_EA_Assessment_Framework_2_FINAL.pdf

National States Geographic Information Council, *NSGIC State Model for Coordination of Geographic Information Technology*, May 22, 2004, http://www.nsgic.org/states/statemodel_git.pdf

Department of Homeland Security, *Geospatial View of the DHS Enterprise Architecture, Draft Version 0.61*, June 2004, http://colab.cim3.net/cgi-bin/wiki.pl?HomelandSecurityGeospatialEnterpriseArchitecture

Federal Geographic Data Committee, *Geospatial Applications and Interoperability Working Group, A Geospatial Interoperability Reference Model (GIRM)*, December 2003, http://www.nonmonotonic.net/ISOTEIA/metadata/girm1.1.pdf

Federal Chief Information Officers Council, Architecture and Infrastructure Committee, *Service Component-Based Architectures, Version 2.0*, June 2004, http://colab.cim3.net/file/work/geocop/SCBA_2.0_FINAL.pdf

APPENDIX B: Approaches for Geo-enabling Lines of Business

Business Area	Line of Business	Primary or Secondary Element—Line of Business Description	Geospatial Aspects of the Activities
Services for Citizens	Homeland Security	Primary—protecting the Nation against terrorist attacks. This includes analyzing threats and intelligence, guarding borders and airports, protecting critical infrastructure, and coordinating responses to emergencies	Training exercises Assessment of and planning for areas of vulnerability Conducting response operations Tracking potential suspects Monitoring border areas
Services for Citizens	Intelligence Operations	Primary—collecting and analyzing information to meet the national security challenges of the U.S. by processing reliable, accurate foreign intelligence and disseminating intelligence products to policymakers, military commanders, and other consumers	Planning operations in areas of potential conflict Conducting assessments of threat Integrating information from multiple sources Tracking movements of groups of individuals who may be targets for international terrorist threats
Services for Citizens	Defense & National Security	Primary—involves information to understand the needs for where to establish national and multinational military objectives, sequence initiatives, define limits and assess risks for the use of military and other instruments of national power, developing global plans or theater war plans to achieve these objectives	Developing a common operating picture of an area Planning troop operations and movements Determining optimal logistics supply routes Monitoring opposition forces Providing assistance to civilian populations to minimize risk from threats.
Services for Citizens	International Affairs and Commerce	Primary—the non-military activities that promote U.S. policies and interests beyond our national borders, including the negotiation of conflict resolution, treaties, and agreements; also includes foreign economic development and social/political development, diplomatic relations , humanitarian, technical and other developmental assistance to key nations, and global trade	Identifying factors contributing to conflict and seeking resolution Identifying areas with need for foreign economic development assistance Addressing social/political development priority needs in regions of the world Maintaining knowledge of borders of nations and of trans-boundary issues Producing maps to enhance foreign policy analysis

Business Area	Line of Business	Primary or Secondary Element—Line of Business Description	Geospatial Aspects of the Activities
Services for Citizens	Disaster Management	Primary—involves information to conduct the activities required to prepare for, mitigate, respond to, and repair the effects of all disasters, whether natural or manmade regardless of where the threat may come from or the disaster may occur	Tracking deployment of resources Tracking distribution/location of evacuees Targeting and setting priorities for monitoring and response activities Status of infrastructure operations Providing an overview of damage to natural and manmade entities Delineating areas which are more susceptible to regional natural hazard events
Services for Citizens	Law Enforcement	Primary—activities to protect people, places, and things from criminal activity resulting from non-compliance with U.S. laws; this includes patrols, undercover operations, response to emergency calls, as well as arrests, raids, and seizures of property	Crime tracking Pattern-based crime prediction (e.g., analysis of the relationship between newly developed transportation corridors and increases in crime rate); deployment of enforcement resources to maximize effectiveness Connecting information from different departments to create a bigger picture
Services for Citizens	Education	Primary—activities for all government programs that promote the education of the public, including formal school, college, university, or other training program at any location	Tracking of results of programs Geographically displaying and analyzing school performance, trends, and corrective actions taken Tracking of resources by district Tailoring programs based on demographics Determining boundaries for schools Developing school buses routes
Services for Citizens	Energy	Primary—all actions performed by the government to ensure the procurement and management of energy resources, including the production, sale, and distribution of energy, as well as the management of spent fuel resources	Siting for man made facilities such as power plants Overview of location of natural resources such as coal, oil, and natural gas deposits Determination of transportation facilities such as power lines, pipelines, and railroads Determining impacts of energy operations and risks due to natural events such as weather

Business Area	Line of Business	Primary or Secondary Element—Line of Business Description	Geospatial Aspects of the Activities
Services for Citizens	Environmental Management	Primary—all functions required to monitor the environment and weather, determine proper environmental standards and ensure their compliance, and address environmental hazards and contamination	Assessing ecological impacts from development Monitoring air and water quality and determining impact on specific populations Determining levels of pollutants released from a hazardous materials spill and predicting impacts upon humans as well plant and animal species Predicting future air quality levels for transportation corridors based on differing emission standards Setting priorities for monitoring, permitting, inspections, compliance assurance activities, enforcement, etc. Designing monitoring networks Characterizing populations around hazardous release sites and/or stacks/outfalls and to protect potentially sensitive sub populations Monitoring environmental restoration and clean up
Services for Citizens	Health	Primary—federal programs and activities to ensure and provide for the health and wellbeing of the public, including the direct provision of health care services and immunizations as well as the monitoring and tracking of public health indicators for the detection of trends and identification of widespread illnesses/diseases	Monitoring emergent infectious diseases or outbreaks of disease and their spread Planning for the distribution of vaccines to meet needs of aging or young populations Determining the distribution of medical personnel in an area to meet the needs of populations Planning for the location of medical facilities to take advantage of transportation routes Studying historical health trends to understand potential future issues
Services for Citizens	Natural Resources	Primary—all activities involved in conservation planning, land management, and national park/monument tourism that affect the Nation's natural and recreational resources, both private and federal	Establishing and managing outdoor recreational areas Planning and managing timber production and economic effects on nearby communities Assessing the biological health of wildlife populations and developing management plans for species which may be at risk Collecting and maintaining basic mapping data for use in all government and services programs

Business Area	Line of Business	Primary or Secondary Element—Line of Business Description	Geospatial Aspects of the Activities
Services for Citizens	Community and Social Services	Primary—information about location for activities aimed at creating, expanding, or improving community and social development, social relationships, and social services in a community in the United States; this includes all activities aimed at locality-specific or nationwide social development and general social services	Planning the level of social services which are needed by communities Determining underserved communities and providing facilities and services to meet needs Monitoring impact of programs on the health or educational achievement of communities Identifying locations in need of after school facilities Planning maintenance and upgrade of playgrounds and community recreational facilities
Services for Citizens	Economic Development	Primary—information to know where to promote commercial/industrial development and to regulate the American financial industry to protect investors nationally; it also includes the management and control of the domestic economy and the money supply and the protection of intellectual property and innovation across the Nation.	Planning Rural Development programs based on community needs Planning for and stimulating the recovery of business affected by natural disasters Developing a picture of the flow of commerce domestically and its economic effects Identifying areas that can benefit most from commercial and industrial development
Services for Citizens	General Science and Innovation	Secondary—all federal activities to meet the national need to advance knowledge in general research and technology programs, space exploration activities, and other research and technological programs that have diverse goals	Understanding the research capabilities for different geographic areas of the Nation Coordinating research activities to share results Supporting the establishment of research priorities
Services for Citizens	Correctional Activities	Secondary—federal activities that ensure the effective incarceration and rehabilitation of convicted criminals	Making site selection decisions for the placement of new facilities within a community Identifying areas prone to inmate violence in institutional settings Assigning probation and parole officers by geographic location Directing probationers and parolees to services and treatment centers Identifying Patterns of offenders and targeting efforts to high-risk areas Tracking probationers in terms of risk and need for resources

Business Area	Line of Business	Primary or Secondary Element—Line of Business Description	Geospatial Aspects of the Activities
Services for Citizens	Litigation and Judicial Activities	Secondary—activities relating to determining an issue of fact and reaching a decision based on that evidence, determining a legal question or matter or attempting to prove guilt/responsibility	Monitoring compliance and required public notification Tracking and enforcing land use controls by red-flagging properties that have residual contamination after cleanup. Mapping the physical situation on the ground immediately after a spill or the air after a release to prove liability Analyzing demographics for civil rights actions
Services for Citizens	Income Security	Secondary—activities designed to ensure that members of the public are provided with the necessary means – both financial and otherwise – to sustain an adequate level of existence. This includes all benefit programs, hat promote these goals for members of the public	Targeting programs to benefit the poor – households (income generation, health, housing, and sanitation) Estimating extent of poverty in a regions / Mapping where the poor live and/or regions with less potential for economic development to help target resource allocation Planning and targeting infrastructure programs Analyzing the spatial relationships between the providers' infrastructures/ public service centers and the clients' locations to help optimize the delivery of services Codifying objective criteria for needed geographic distribution of assistance
Services for Citizens	Workforce Management	Secondary—those activities that promote the welfare of the Nation's workforce by improving their working conditions, advancing opportunities for profitable employment, and strengthening free collective bargaining	Providing view of where workers are located, the work being performed, and what resources are needed Analyzing clusters of jobs and workers Determining if a proposed public transportation will connect workers to jobs Targeting recruitment efforts
Services for Citizens	Transportation	Primary—all federally supported activities related to the safe passage, conveyance, or transportation of goods and/or people including air, ground, water, and space operations	Evaluating a proposed roadway or other transportation /transmission corridors Identifying highway deficiencies and applies economic criteria to select the most cost-effective mix of highway system improvements Summarizing freight movement trends in the United States Evaluating the scope and performance of the transportation system

Business Area	Line of Business	Primary or Secondary Element—Line of Business Description	Geospatial Aspects of the Activities
Support Delivery of Services	Legislative Relations	Secondary—activities aimed at the development, tracking, and amendment of public laws through the legislative branch of the federal government	Assessing regional impacts/benefits of proposed and existing legislation Tracking the implementation of public laws Assessing public support for proposed legislation over regions, states, districts, etc. Assessing conditions that would support the passage of legislation
Support Delivery of Services	Regulatory Development	Secondary—involves activities associated with developing regulations, policies, and guidance to implement laws	Assessing economic impacts in specific areas related to implementation of proposed regulations Assessing chemical levels in waterways, air, etc. to determine need for regulation Providing visualization to regulated communities on applicability of laws and compliance requirements
Support Delivery of Services	Public Affairs	Secondary—the exchange of information and communication between the federal government, citizens, and stakeholders in direct support of citizen services, public policy, and/or national interest	Outreach to potential applicants for assistance in underserved areas or among populations Informing local and state legislators Ensuring environmental justice Providing the public with access to information about their neighborhoods Communicating about natural/manmade disasters Summarizing alternatives in public meetings Providing travelers to public sites with the ability to plot their course for visits Providing easy access to information, thus reducing need to travel into a government center/office
Support Delivery of Services	Planning and Resource Allocation	Secondary—determining strategic direction, formulating and executing budgets, identifying and establishing programs for defining and allocating the organizational workforce and technological requirements among those programs and processes	Targeting funding decisions to maximize their effectiveness Planning for deployment of emergency assistance resources Identifying the crew in closest proximity to a new, urgent work site for optimal dispatching Tracking distribution of grants, contracts, and assets

Business Area	Line of Business	Primary or Secondary Element—Line of Business Description	Geospatial Aspects of the Activities
Support Delivery of Services	Revenue Collection	Primary—includes the collection of government income from all sources, except for tax collection, which is accounted for in General Government	Evaluation of patterns of loan delinquencies Evaluation of distribution of publication sales by region
Support Delivery of Services	Internal Risk Management and Mitigation	Primary—all activities relating to the processes of analyzing exposure to risk in the event of a catastrophic or damaging event and determining appropriate countermeasures	Assessment of health, environmental, or economic risk from environmental or economic hazards in specific areas or of specific projects Targeting areas for preventive activities Evaluating effectiveness of risk planning and countermeasure after event occurs
Support Delivery of Services	Controls & Oversight	Primary—operations and programs of the federal government and its external business partners determine the effectiveness of and the extent to which they comply with applicable laws and regulations and prevent waste, fraud, and abuse	Identifying geographic patterns of fraud or identification of waste or fraud by a single entity across similar geographic areas Targeting compliance and/or enforcement actions Evaluating effectiveness of control measures
Support Delivery of Services	General Government	Primary—general overhead costs of the federal government, including legislative and executive activities; provision of central fiscal, personnel, and property activities; and the provision of services that cannot reasonably be classified in any other line of business. Includes Tax Collection	Tracking resource distribution and use Managing facilities and properties Tracking real estate transactions that take place Gathering organizing and analyzing information on properties Collection of statistics relating to population (and its demographic characteristics), housing, and business/government organizations
Manage Government Resources	Financial Management	Secondary—the use of financial information to measure, operate and predict the effectiveness and efficiency of an entity's activities in relation to its objectives. The ability to obtain and use such information is usually characterized by having in place policies, practices, standards, and a system of controls that reliably capture and report activity in a	Tracking and allocation of grants and/or contract dollars by state, congressional districts etc and assessing against goals

Business Area	Line of Business	Primary or Secondary Element—Line of Business Description	Geospatial Aspects of the Activities
		consistent manner	
Manage Government Resources	Human Resource/ Resource Management	Secondary—all activities associated with the recruitment and management of personnel	Identifying locations of academic centers of excellence for targeted recruitment in relationship to recruiting personnel Tracking the distribution of workers throughout an organization's various facilities/locations Comparing regional economic conditions when determining salaries to support raises and compensation packages Assessments of demographics to assess deployment and/or redeployment of employees Assessment of minority populations in various components of an organization
Manage Government Resources	Admin Management	Primary—the day-to-day management and maintenance of the internal infrastructure. Includes maintaining and operating office buildings, fleets, machinery, and other capital assets; the physical protection of an organization's personnel, assets, and facilities and business related travel for an organization's employees	Managing phone/network/cubicle management; personnel rosters by facility for emergency evacuation purposes Providing information on public utilities supporting government facilities
Manage Government Resources	Information and Technology Management	Secondary—involves the coordination of information and technological resources and systems required to support or provide a service	Identifying facility/personnel locations in planning network/bandwidth leasing
Manage Government Resources	Supply Chain Management	Primary—the purchasing, tracking, and overall management of goods and services	Tracking shipments of sensitive cargo; manifest tracking/management Assessing purchase patterns for future procurement Maintaining inventories

APPENDIX C: Geospatial Service Components

This appendix lists the set of geospatial service components that might apply within an agency services architecture. This list will be updated periodically to reflect changes as they become known by the Geospatial Enterprise Architecture Community of Practice Working Group (GEA COP WG).[39]

The first three columns in the table below represent the service domains, service types, and service components represented in the FEA SRM. The last three columns identify and describe the geospatial service components. The description includes the level of service component granularity defined, where BCS represents Business Component System, BC represents Business Component and DC represents Distributed Component. The distinction is important because it emphasizes opportunities for integration, interoperability, and component sharing, which is important in OMB Exhibit 300 formulation and improved business effectiveness.

To submit a modification to this list, send an e-mail with the subject, "Geospatial Service Components Modification Request" to geo-forum@colab.cim3.net. In the content of the e-mail include the following information:

Requesting Organization—the name of the organization making the change request

Requesting POC Name—the name of a point of contact with the requesting organization

Requesting POC Telephone—the telephone number of a point of contact with the requesting organization

Requesting POC Email—the e-mail address of a point of contact with the requesting organization

Modification Type—one of Update (to update an existing entry), Insert (to add a new entry), or Delete (to delete an existing entry)

FEA Service Domain—the FEA service domain for the entry

FEA Service Type—the FEA service type for the entry

FEA Service Component—the name for the FEA service component entry

FEA Service Component Description—the description for the FEA service component entry

Geospatial Service Component—the name for the geospatial service component entry

Geospatial Service Component Description—the description for the geospatial service component entry

[39] Please see the following URL for the most up-to-date listing: http://colab.cim3.net/cgi-bin/wiki.pl?GeoSpatialCommunityofPractice/GeospatialServiceComponents

Component Granularity Level—the component granularity level for the entry (must be BCS, BC, or DC)

Justification—text that justifies the modification requested

Implications—text that describes any implications of note that would result from accepting the modification (e.g., this change will require the deletion of another entry, the addition of another entry, or similar)

A separate geospatial service components modification request should be made for each desired modification. All requests will be registered for processing at the next meeting of the GEA COP WG.

The asterisk (*) on a geospatial service component is used to indicate that there is more than one entry for this component. This is done for cases in which the geospatial service component does not fit neatly under the FEA SRM taxonomy of service components. There are also instances where the list suggests new, recommended FEA service components.

Exhibit C–1: Proposed Geospatial Service Components

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Back Office Services Domain	Assets / Materials Management	Facilities Management	Defines the set of capabilities that support the construction, management and maintenance of facilities for an organization	Facilities Management System	A GIS-based Facilities Management System	BCS
Back Office Services Domain	Assets / Materials Management	Property / Asset Management	Defines the set of capabilities that support the identification, planning, and allocation of an organization's physical capital and resources	Property / Asset Management System	A GIS-based Property - Asset Management System	BCS
Back Office Services Domain	Data Management	Data Exchange	Support the interchange of information between multiple systems or applications; includes verification that transmitted data was received unaltered	Geospatial Data Exchange and Translation Services	The ability to import/export, manipulate, and convert geospatial data through standard data exchange and trans-formation services. Services to transform geospatial data schemas between disparate systems.	DC
Back Office Services Domain	Data Management	Data Exchange	Support the interchange of information between multiple systems or applications; includes verification that transmitted data was received unaltered	Coordinate Transformation Service	The ability to transform geospatial data between different coordinate reference systems, pieces of data, and units. Support map re-projections on the fly for map viewing, as well as permanent coordinate transformations that result in a transformed output dataset.	DC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Back Office Services Domain	Data Management	Data Exchange	Support the interchange of information between multiple systems or applications; includes verification that transmitted data was received unaltered	Geospatial Information Broker	A key component used in moving geospatial data between systems. Involved in data sharing and collaboration operations. Involved in Geospatial Data Roll-up/Roll-down Operations.	BC
Back Office Services Domain	Data Management	Extraction and Transformation	Defines the set of capabilities that support the manipulation and change of data	Feature Update Service	An application and supporting services for selection, browsing, extraction, transformation, integration and update of a feature database. Assures that requestor credentials are sufficient for requested changes and that changes requested do not violate validation rules.	BC
Back Office Services Domain	Data Management	Extraction and Transformation	Defines the set of capabilities that support the manipulation and change of data	Coverage Update Service	An application and supporting services for selection, browsing, transformation, integration, and update of a coverage (e.g., imagery) database. Assures that requestor credentials are sufficient for requested changes and that changes requested do not violate validation rules.	BC
Back Office Services Domain	Data Management	Extraction and Transformation	Defines the set of capabilities that support the manipulation and change of data	Gazetteer Update Service	An application and supporting services to support browsing, data entry, transformation, integration and update of a gazetteer database.	BC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Back Office Services Domain	Data Management	Extraction and Transformation	Defines the set of capabilities that support the manipulation and change of data	Geospatial Resource Metadata (Catalog) Update Service	An application and supporting services for browsing, data entry, transformation, integration and update of the metadata for geospatial resources, and optionally, update of associated geospatial resource records. (Geospatial resources include maps and data from which maps may be derived, and may include ancillary products and services. A geospatial catalog includes various ways by which geospatial resources are characterized and associated.) Assures that requestor credentials are sufficient for requested changes and that changes requested do not violate validation rules. Accesses one or more resource catalog servers.	BC
Back Office Services Domain	Data Management	Extraction and Transformation	Defines the set of capabilities that support the manipulation and change of data	Geospatial Service Metadata (Catalog) Update Service	An application and supporting services for browsing, data entry, integration, and update of the metadata for geospatial services. Assures that requestor credentials are sufficient for requested changes and that changes requested do not violate validation rules. Accesses one or more Service Catalog Servers.	BC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Back Office Services Domain	Data Management	Data Classification	Defines the set of capabilities that support classification of data			
Back Office Services Domain	Data Management	Data Cleansing	Defines the set of capabilities for cleansing data to remove it of deficiencies			
Back Office Services Domain	Data Management	Loading and Archiving				
Back Office Services Domain	Data Management	Metadata Management				
Back Office Services Domain	Data Management	Geographic Data Management (GIS)[40]	A general-purpose set of capabilities for extracting, loading, transforming, integrating, storing, archiving, and managing geospatial information and related metadata	Geographical Information System*	An integrated system for collecting, storing, accessing, sharing, disseminating, integrating, manipulating, visualizing, analyzing, and otherwise exploiting geospatial information. GIS focuses on producing and exploiting "digital maps" that convey geospatial information in graphical form. It is used widely in government, education, and business.	BCS

[40] A complex business component system such as a GIS, featured here, does not fit neatly under the FEA SRM taxonomy. GIS cuts across many FEA service domains and types. A new geospatial service component, GIS, has been created here and elsewhere, to reflect the predominant role of GIS in an enterprise.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
					Also, a general-purpose collection of tools for processing geospatial data. Normally consists of one or more applications with one or more databases. May be configured as a desktop application and/or as a collection of client and servers.	
Back Office Services Domain	Data Management	Geographic Data Management (GIS)	A general-purpose set of capabilities for extracting, loading, transforming, integrating, storing, archiving, and managing geospatial information and related metadata	GIS Server*	Comprised of one or more bundled geospatial processing services that support the generation, revision, management, processing, and output of geospatial data. Server-based GIS	DC
Back Office Services Domain	Data Management	Geographic Data Management (GIS)	A general-purpose set of capabilities for extracting, loading, transforming, integrating, storing, archiving, and managing geospatial information and related metadata	Native Geospatial DBMS Server	The capabilities for an Enterprise DBMS to provide native support for storing and managing all types of geospatial data. Capabilities should include geospatial indexing, open SQL query support with geometry and topology operators, geospatial analytics, geospatial data mining, coordinate transformation and linear referencing.	DC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Back Office Services Domain	Data Management	Imagery Data Management (GIS)[41]	A general-purpose set of capabilities for extracting, loading, transforming, integrating, storing, archiving, and managing geospatial imagery and related metadata	Imagery Processing System (IPS)*	An integrated system for collecting, storing, accessing, sharing, disseminating, integrating, manipulating, visualizing, analyzing, and otherwise exploiting geospatial imagery. IPS focuses on producing and exploiting "digital orthoimagery" that conveys geospatial information in raster image form. It is used widely in government, education, and business. Also, a general-purpose collection of tools for processing geospatial imagery.	BCS
Back Office Services Domain	Data Management	Imagery Data Management (GIS)	A general-purpose set of capabilities for extracting, loading, transforming, integrating, storing, archiving and managing geospatial imagery and related metadata	Geospatial Imagery Processing Server*	Comprised of one or more bundled geospatial imagery processing services that support the generation, revision, management, processing, and output of geospatial imagery. Server-based Imagery Processing System.	DC
Business Analytical	Analysis and Statistics	Geographic Analysis (GIS)[42]	A general-purpose set of capabilities for analyzing	Geographical Information	An integrated system for collecting, storing, accessing,	BCS

[41] A complex business component system such as an Imagery Processing System (IPS), featured here, does not fit neatly under the FEA SRM taxonomy: IPS cuts across many FEA service domains and types. A new geospatial service component, IPS has been created here and elsewhere, to reflect the predominant role of IPS in an enterprise.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Services Domain			and processing geospatial data	System*	sharing, disseminating, integrating, manipulating, visualizing, analyzing, and otherwise exploiting geospatial information. GIS focuses on producing and exploiting "digital maps" that convey geospatial information in graphical form. It is used widely in government, education, and business. Also, a general-purpose collection of tools for processing geospatial data. Normally consists of one or more applications with one or more databases.	
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	GIS Server*	Comprised of one or more bundled geospatial processing services that support the generation, revision, management, processing, and output of geospatial data. Server-based GIS	DC
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Geocoder / Reverse Geocoder Service	Able to determine geospatial coordinates, given an address (Geocoder), or determine address, given geospatial coordinates (Reverse	DC

[42] A complex business component system such as a GIS, featured here, does not fit neatly under the FEA SRM taxonomy. GIS cuts across many service domains and types. A new geospatial service component, GIS is created here and elsewhere, to reflect the predominant role of GIS in an enterprise.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
					Geocoder). A Geocoder transforms a description of a feature location, such as a place name, street address or postal code, into a normalized description of the location, which includes coordinates. A Geocoder Service receives a description of a feature location as input and provides a normalized address with coordinates as output. The feature location descriptions are any terms, codes, or phrases that describe the features such as a street addressing or postal coding scheme. These services are very important across many enterprises, as they enable enterprise users to exploit the geospatial-temporal context of business data that contain location references.	
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Geolocate Service	The capability to use GPS or some other means to determine a geospatial location for a fixed or mobile object of interest (e.g., geospatial feature, person, asset, conveyance, goods, cargo, device, etc.) Mobile Objects must be equipped with GPS, Radio Frequency ID (RFID), and/or other position determination technologies.	DC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Gateway Service	Determines the geospatial position of a known mobile terminal from a wireless network. Position is expressed in geographic coordinates. Mobile terminals (cell phones, PDAs, etc) must be equipped with GPS or some other position determination technology. An important service used in LBS, in the wireless realm	DC
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Route Service	Able to determine (or fetch a predetermined) route and navigation information for autonomous or semi-autonomous navigation between two or more points on a network. An important service used in LBS, in the wireless realm.	DC
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Navigation Service	An enhanced version of the Route Service, which determines routes between two or more points with enhanced navigation information. An important service used in LBS.	DC
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Monitoring Service	Able to determine (or fetch a predetermined) location/time/identity/status/activity series for a location.	DC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Tracking Service	Able to determine (or fetch a predetermined) location/time/velocity/identity/status/activity series (track) for a mobile object (e.g., persons, goods, assets, devices, etc.)	DC
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Weather Service	The means to access weather conditions for an area of interest or location for a specified time period	DC
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Traffic Service	The means to access traffic information regarding incidents and/or conditions for a specified area of interest, road, or road segment, for a specified time period. Also, the means to access traffic information regarding incidents and/or conditions for a designated route for a specified time period.	DC
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Model Service	Able to determine and access the extent and nature of a geospatial model (e.g., Toxic Dispersion Model—plume for a chemical or biological event in air or water). The model output is characterized by features. "Toxic Dispersion" refers to the effects of introducing a chemical, radioactive, or biological agent into the atmosphere or a water supply at a point source. Simulation is	DC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
					employed to understand the effects of a toxic agent within its medium. The objective of the simulation is to ascertain contamination levels in a geospatial-temporal context, and thus, to understand the nature of toxic plumes, danger zones, warning zones, and related features, and to be able to view or analyze the output from a simulation run in conjunction with any other geospatial data, e.g., as plumes or danger/warning zones within a geospatial decision support tool. Also, the ability to determine and access weather, hydrographic, and other environmental parameters through environmental simulation. The simulation output is characterized by observations.	
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data.	Geoparser Service	Geoparsing refers to the capability to scan and parse a textual document, identifying key words and phrases that have geospatial-temporal context. A Geoparser Service works in the context of two bodies of information: a reserved vocabulary (a dictionary of place names, a gazetteer or a directory of points of interest (POIs) and a text source (e.g., a newspaper	DC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
					or cable.). The Geoparser returns all occurrences of the use (in the text source) of any term in the reserved vocabulary. Each occasion establishes a geolinks (geospatial/temporal-aware hyperlink) between text terms and the geospatial location associated with the reserved word.	
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Sensor Planning Service	A service by which a client[43] can determine sensor collection feasibility for one or more mobile sensors/platforms, or the client may submit collection requests directly to these sensors/platforms.	DC
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Sensor Observation Service	A service by which a client can obtain observations from one or more sensors/platforms (can be mixed types). Clients can also obtain information that describes the associated sensors and platforms.	DC
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data.	Sensor Alert Service	The SASs produce alert messages when given observation conditions are met by a sensor. Provides the means for client services/users	DC

[43] Client, as used here, means any software component or application that invokes a service.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
					to specify and register user Profiles that contain user information, applicable sensors/observations, alert conditions (e.g., maximum/minimum values), and alert actions (what happens if conditions are met). Also, the means for client services/users to update user Profiles. Clients are able to control the nature of alerts. For example, a client is able to activate/deactivate an alert capability. Also provides the means to support push/pull capabilities, e.g., to wait for observation input from associated sensors (for on/off sensors like a detector), or to actively poll for (current/historical/predicted) sensor observations.	
Business Analytical Services Domain	Analysis and Statistics	Geographic Analysis (GIS)	A general-purpose set of capabilities for analyzing and processing geospatial data	Topology Service	The ability to detect topological errors (e.g., overshoots and undershoots of common linear and polygonal features within a definable tolerance), automatically correct errors, if possible, and define topological relationships between connected/collocated linear, polygon, and point features	DC
Business Analytical	Analysis and	Imagery Analysis	A general-purpose set of capabilities for analyzing	Imagery Processing System	An integrated system for collecting, storing, accessing,	BCS

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Services Domain	Statistics	(IPS)[44]	and processing geospatial imagery and related metadata	(IPS)*	sharing, disseminating, integrating, manipulating, visualizing, analyzing, and otherwise exploiting geospatial imagery. IPS focuses on producing and exploiting "digital orthoimagery" that conveys geospatial information in raster image form. It is used widely in government, education and business. Also, a general-purpose collection of tools for processing geospatial imagery.	
Business Analytical Services Domain	Analysis and Statistics	Imagery Analysis (IPS)	A general-purpose set of capabilities for analyzing and processing geospatial imagery and related metadata.	Geospatial Imagery Processing Server*	Comprised of one or more bundled geospatial imagery processing services that support the generation, revision, management, processing, and output of geospatial imagery. Server-based Imagery Processing System.	DC
Business Analytical Services Domain	Analysis and Statistics	Tagging and Aggregation				

[44] A complex business component system such as an Imagery Processing System (IPS), featured here, does not fit neatly under the FEA SRM taxonomy. IPS cuts across many FEA service domains and types. A new geospatial service component, IPS, is created here and elsewhere, to reflect the predominant role of IPS in an enterprise.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Analytical Services Domain	Knowledge Discovery	Simulation	Defines the set of capabilities that support the representation of the interaction between real-world objects	Terrain Simulator	The application and supporting services for viewing 3D geospatial information. Many specialized types of this service. Accesses one or more terrain servers.	BC
Business Analytical Services Domain	Reporting	Ad-Hoc	Ad Hoc - defines the set of capabilities that support the use of dynamic reports on an as needed basis	Location Report Generator*	The application and supporting services for composing a report based upon location-based (geospatial) information. Many specialized types of this service, e.g., situation reports, after action reports, alert/warning reports, incident reports, activity reports, etc.	BC
Business Analytical Services Domain	Reporting	Standardized - Canned	Defines the set of capabilities that support the use of pre-conceived or pre-written reports	Location Report Generator*	The application and supporting services for composing a report based upon location-based (geospatial) information. Many specialized types of this service, e.g., situation reports, after action reports, alert/warning reports, incident reports, activity reports, etc.	BC
Business Analytical Services Domain	Reporting	OLAP				

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Analytical Services Domain	Visualization	Imagery	Defines the set of capabilities that support the creation of film or electronic images from pictures, paper forms, or graphics for static or dynamic use	Coverage Client*	An application that provides the means to visualize and interact with coverages (e.g., geospatial imagery and raster data). Provides tools to select coverage data for viewing, enhancement, annotation layer control, setting view window, display chosen view, coordinate transformation, measure and pinpoint, navigate through view with pan and zoom, etc. Usually associated with one or more coverage servers.	BC[45]
Business Analytical Services Domain	Visualization	Imagery	Defines the set of capabilities that support the creation of film or electronic images from pictures, paper forms, or graphics for static or dynamic use	Annotation Service*	A service that accesses map/image annotations. Annotations are useful for any activity that requires linking or tagging geospatial data in order to present and discuss it with others, to make joint decisions, collaborate, or to communicate spatially.	DC

[45] May come bundled with one or more Coverage Servers, and/or may be more open-ended and integrate with one or more Distributed Component Coverage Servers.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS[46]	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Map(ping) Client	An application that provides the means to visualize and interact with geospatial data in rendered map form. Provides tools to select base map/image data for viewing, layer control (e.g., Features, locations, structures, routes, observations, and mobile-objects), set view window, display chosen view, coordinate transformation, measure and pinpoint, navigate through view with pan and zoom, etc. Optionally choose symbology, map display template or select previous views. Usually associated with one or more Map Servers.	BC[47]
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Situation Awareness	An application and associated services for viewing an area of interest, incident, or event in a geospatial context. May include related geospatial services for selection, analysis, manipulation, reporting, collaboration, etc.	BC

[46] This is the only reference having to do with geospatial in the entire FEA SRM, version 1.0. (This FEA Service Component could be changed to "Geospatial Visualization", described as "Provide for the representation of geospatial information.")

[47] May come bundled with one or more Map Servers, and/or may be more open-ended and integrate with one or more Distributed Component Map Servers.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Coverage Client*	An application that provides the means to visualize and interact with coverages (e.g., geospatial imagery and raster data). Provides tools to select Coverage data for viewing, enhancement, annotation layer control, setting view window, display chosen view, coordinate transformation, measure and pinpoint, navigate through view with pan and zoom, etc. Usually associated with one or more Coverage Servers.	BC[48]
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Feature Client	Sends requests to one or more feature servers for detailed information pertaining to a particular feature within a map. Provides the means to visualize feature information. Provides tools to query feature data, display chosen view, and designate target coordinate transformation system. Often combined with Map Client.	BC[49]

[48] May come bundled with one or more Coverage Servers, and/or may be more open-ended and integrate with one or more Distributed Component Coverage Servers.

[49] May come bundled with one or more Feature Servers, and/or may be more open-ended and integrate with one or more Distributed Component Feature Servers.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Personal Map Software	Personal Map Software includes a variety of tools for viewing, annotating, and manipulating map data. Typically include map data for standalone operations. Often includes Global Positioning System (GPS) capability for mobile applications. Commercial map software for desktop or Personal Digital Assistant (PDA).	BC
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Geospatial Client	An application that provides the means to visualize and interact with a variety of geospatial data, including maps, features and coverages. Provides tools to select data for viewing, enhancement, annotation layer control, setting view window, display chosen view, coordinate transformation, measure and pinpoint, navigate through view with pan and zoom, etc. Usually associated with one or more geospatial data servers.	BC[50]

[50] May come bundled with one or more geospatial data servers, and/or may be more open-ended and integrate with one or more Distributed Component servers.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Specialized Geospatial Business Components (Various)	Geospatial-based business applications and associated services that provides visualization and interaction with geospatial data. Provides access to underlying business components and geospatial services. Many such specialized geospatial business components will exist within enterprises, each of which may have a client application and one or more business components and/or geospatial services	BC[51]
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Location Client*	Sends requests to one or more location servers for a) geo-coding an address, yielding a coordinate; b) reverse geo-coding a coordinate, returning an address; c) routing from a start point to an end point (perhaps with intervening via points); d) a point of interest given a coordinate or an address. Provides the means to visualize location.	BC[52]

[51] May come bundled with one or more geospatial data servers, and/or may be more open-ended and integrate with one or more Distributed Component servers.

[52] May come bundled with one or more Location Servers, and/or may be more open-ended and integrate with one or more Distributed Component servers.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Gazetteer Client	Sends requests to one or more gazetteer servers a for place names by a given location or for locations by a given place name. Provides the means to visualize gazetteer information. Provides tools to query gazetteer data and display chosen view. Often combined with other clients	BC[53]
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Style Management Service (SMS)	The means to create update and manage styles and symbols. The SMS must manage distinct objects that represent styles and symbols and provide the means to discover, query, insert, update, and delete these objects. Styles provide the mapping from feature types and feature properties and constraints to parameterized symbols used in drawing maps. Symbols are bundles of predefined graphical parameters and predefined fixed graphic "images."	BC

[53] May come bundled with one or more Gazetteer Servers, and/or may be more open-ended and integrate with one or more Distributed Component servers.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Analytical Services Domain	Visualization	Mapping, geospatial (GIS), elevation, GPS	Provide for the representation of position information through the use of attributes such as elevation, latitude, and longitude coordinates	Annotation Service*	A service that accesses map/image annotations. Annotations are useful for any activity that requires linking or tagging geospatial data in order to present and discuss it with others, to make joint decisions, collaborate, or to communicate spatially.	DC
Business Management Services Domain	Supply Chain Management	Catalog Management	Defines the set of capabilities that support the listing of available products or services that an organization offers	Services Catalog Client	An application that sends requests to one or more service catalog servers for geospatial service catalog records. Includes tools to select and view this information	BC
Business Management Services Domain	Supply Chain Management	Catalog Management	Defines the set of capabilities that support the listing of available products or services that an organization offers	Resources Catalog Client	An application that sends requests to one or more resource catalog servers for geospatial resource catalog records. Includes tools to select and view this information. (Geospatial resources include maps and data from which maps may be derived, and may include ancillary products and services. A geospatial catalog includes various ways by which geospatial resources are characterized and associated.)	BC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Business Management Services Domain	Supply Chain Management	Catalog Management	Defines the set of capabilities that support the listing of available products or services that an organization offers	Location Client*	Sends requests to one or more location servers for information about a point of interest (e.g., store) and associated products and services. Provides capabilities to support a) geo-coding an address, yielding a coordinate; b) reverse geo-coding a coordinate, returning an address; c) routing from a start point to an end point (perhaps with intervening via points); d) a point of interest given a coordinate or an address (either precisely or within proximity). Provides the means to visualize point of interest information. Provides tools to query point of interest data and display chosen view, often on a map. Normally implemented as wireless, location-based services (LBS)	BC
Business Management Services Domain	Supply Chain Management	Program/Project Management				
Digital Asset Services	Content Management	Map Production (GIS)[54]	A general-purpose set of capabilities for authoring,	Geographical Information	An integrated system for collecting, storing, accessing,	BCS

[54] A complex business component system such as a GIS, featured here, does not fit neatly under the FEA SRM taxonomy. GIS cuts across many service domains and types. We have created a new geospatial service component, GIS, here and elsewhere, to reflect the predominant role of GIS in an enterprise.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Domain			publishing and sharing softcopy and hardcopy digital map data	System*	sharing, disseminating, integrating, manipulating, visualizing, analyzing, and otherwise exploiting geospatial information.	
Digital Asset Services Domain	Content Management	Map Production (GIS)	A general-purpose set of capabilities for authoring, publishing, and sharing softcopy and hardcopy digital map data	Map Publication Service	A lightweight application for publishing maps. Able to automatically generate and publish maps of interest for inclusion in a plan, report, or other document, with select content and symbolization (map template; e.g., to produce a map for inclusion in a word or graphic document).	BC
Digital Asset Services Domain	Content Management	Map Production (GIS)	A general-purpose set of capabilities for authoring, publishing, and sharing softcopy and hardcopy digital map data.	GIS Server*	Comprised of one or more bundled geospatial processing services that support the generation, revision, management, processing, and output of geospatial data. Server-based GIS	DC
Digital Asset Services Domain	Content Management	Mathematical				
Digital Asset Services	Content Management	Imagery Production (IPS) [55]	A general-purpose set of capabilities for authoring,	Imagery Processing System	An integrated system for collecting, storing, accessing,	BCS

[55] Likewise, a complex business component system such as an Imagery Processing System (IPS), featured here, does not fit neatly under the FEA SRM taxonomy. IPS cuts across many FEA service domains and types. A new geospatial service component, IPS, has been created, here and elsewhere, to reflect the predominant role of IPS in an enterprise.

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
Domain			publishing, and sharing softcopy and hardcopy geospatial imagery data	(IPS)*	sharing, disseminating, integrating, manipulating, visualizing, analyzing, and otherwise exploiting geospatial imagery. IPS focuses on producing and exploiting "digital orthoimagery" that conveys geospatial information in raster image form.	
Digital Asset Services Domain	Content Management	Imagery Production (IPS)	A general-purpose set of capabilities for authoring, publishing, and sharing softcopy and hardcopy geospatial imagery data	Geospatial Imagery Processing Server*	Comprised of one or more bundled geospatial imagery processing services that support the generation, revision, management, processing, and output of geospatial imagery. Server-based imagery processing system	DC
Digital Asset Services Domain	Knowledge Management	Information Sharing	Defines the set of capabilities that support the use of documents and data in a multi-user environment for use by an organization and its stakeholders	Feature Server	Responds to requests from a feature client for detailed information pertaining to a particular feature within a map. Optionally supports coordinate transformation from a source coordinate reference system to a target coordinate reference system	DC
Digital Asset Services Domain	Knowledge Management	Information Sharing	Defines the set of capabilities that support the use of documents and data in a multi-user environment for use by an organization and its stakeholders	Coverage Server	Responds to requests from a coverage client to deliver a rendered orthoimage/map. Optionally supports coordinate transformation from a source coordinate reference system to a target coordinate reference system. May act as a proxy to	DC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
					multiple remote coverage services to return a single composite orthoimage/map	
Digital Asset Services Domain	Knowledge Management	Information Sharing	Defines the set of capabilities that support the use of documents and data in a multi-user environment.	Map(ping) Server	The means to render 2D views of geospatial data. Responds to requests from a map client to deliver a rendered map.	DC
Digital Asset Services Domain	Knowledge Management	Information Sharing	Defines the set of capabilities that support the use of documents and data in a multi-user environment for use by an organization and its stakeholders	Terrain Server	The means to render 3D views of geospatial data. Responds to requests from a terrain simulator to deliver a rendered 3D data. Supports coordinate transformation from a source coordinate reference system to a target coordinate reference system. Supports the specification of layer styles. May act as a proxy to multiple remote terrain services to return a single composite view	DC
Digital Asset Services Domain	Knowledge Management	Information Sharing	Defines the set of capabilities that support the use of documents and data in a multi-user environment for use by an organization and its stakeholders	Gazetteer Server	Responds to gazetteer client requests for place names by a given location or for locations by a given place name	DC
Digital Asset Services Domain	Knowledge Management	Information Sharing	Defines the set of capabilities that support the use of documents and data in a multi-user environment for use by an organization and its	Location Server	A service with multiple functions that responds to location client requests for (a) geo-coding an address, yielding a coordinate; (b) reverse geo-coding a	DC

FEA Service Domain	FEA Service Type	FEA Service-Component	FEA Service Component Description	Geospatial Service Component (* = multiple entries)	Geospatial Service Component Description	Component Granularity Level
			stakeholders		coordinate, returning an address; (c) routing from a start point to an end point (perhaps with intervening via points); (d) a point of interest given a coordinate or an address (either precisely or within a proximity).	
Digital Asset Services Domain	Knowledge Management	Information Sharing	Defines the set of capabilities that support the use of documents and data in a multi-user environment for use by an organization and its stakeholders	Resource Catalog Server* (or Registry Service)	Responds to client requests for geospatial resource metadata. (Geospatial resources include maps and data from which maps may be derived and may include ancillary products and services. A geospatial catalog includes various ways by which geospatial resources are characterized and associated.)	DC
Digital Asset Services Domain	Knowledge Management	Information Sharing	Defines the set of capabilities that support the use of documents and data in a multi-user environment for use by an organization and its stakeholders	Service Catalog Server*	Responds to client requests for geospatial service metadata	DC
Digital Asset Services Domain	Knowledge Management	Knowledge Capture				
Digital Asset Services Domain	Knowledge Management	Knowledge Distribution and Delivery				

APPENDIX D: Geospatial Standards and Extended TRM

At the service platform and infrastructure, component framework, and service interface and integration levels, the geospatial industry has defined a number of specialized systems and standards described in the following sections.

Service Platform and Infrastructure

Database / Storage

Database / Storage refers to a collection of programs that enables storage, modification, and extraction of information from a database, and various techniques and devices for storing large amounts of data.

Refers to a collection of information organized in such a way that a computer program can quickly select desired pieces of data. A database management system (DBMS) is a software application providing management, administration, performance, and analysis tools for databases.

"Geospatial database support" at a minimum means that the database software has:

- A native geospatial data **format.**
- Geospatial **indexing.**
- Geospatial data access and processing **functions**.

Less common is geospatial database support for advanced functions such as replication, long transactions, ACID[56] transactions, etc. This level of geospatial awareness, if present, is usually found only in products with native geospatial support described above.

Component Framework

The component framework consists of the design of application or system software that incorporates interfaces for interacting with other programs and for future flexibility and expandability. This includes, but is not limited to, modules that are designed to interoperate with each other at runtime. Components can be large or small, written by different programmers using different development environments, and may be platform independent. Components can be executed on standalone machines, a LAN, Intranet, or the Internet.

Presentation / Interface

This refers to the connection between the user and the software, consisting of the presentation that is physically represented on the screen.

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[56] According to Wikipedia, "In databases, ACID stands for Atomicity, Consistency, Isolation, and Durability. They are considered to be the key transaction processing features/properties of a database management system, or DBMS. Without them, the integrity of the database cannot be guaranteed" (http://en.wikipedia.org/wiki/ACID).

Content Rendering

This defines the software and protocols used for transforming data for presentation in a graphical user interface. The following are available standards:

- OpenGIS® Styled Layer Descriptor Implementation Specification (SLD) version 1.0 https://portal.opengeospatial.org/files/?artifact_id=1188

SLD is an XML encoding for how the Open GIS Web Mapping Service (WMS) specification can be extended to allow user-defined symbolization of feature data.

- OpenGIS Web Map Service Implementation Specification / ISO:19128 2005 (WMS) version 1.3 http://portal.opengeospatial.org/files/?artifact_id=5316

Provides three operations (GetCapabilities, GetMap, and GetFeatureInfo) in support of the creation and display of registered and superimposed map-like views of information that come simultaneously from multiple sources that are both remote and heterogeneous.

- ISO Geographic Information—Portrayal (ISO 19117:2005)

This is an abstract document and is not intended for direct implementation. It gives general guidelines to application developers about the mechanism that shall be used to portray the feature instances of a dataset. The portrayal mechanism described makes it possible to have general rules valid for the whole dataset, and at the same time rules valid for a specific value of a feature attribute only.

Wireless / Mobile / Voice

This consists of software and protocols used for wireless and voice enabled presentation devices. Standards include

- OpenGIS Location Service OpenLS: Core Services Implementation Specification (OpenLS) version 1.1 http://portal.opengeospatial.org/files/?artifact_id=8836

The primary objective of OpenLS is to define access to the Core Services and Abstract Data Types (ADT) that comprise the GeoMobility server, an open location services platform. The GeoMobility server provides content such as maps, routes, addresses, points of interest, traffic, etc. It can also access other local content databases via the Internet.

Data Interchange

Define the methods in which data are transferred and represented in and between software applications.

Data Exchange

Data exchange is concerned with the transmission of data over a communications network and the definition of data communicated from one application to another. Data exchange provides the communications common denominator between disparate systems.

Relevant standards:

- OpenGIS Web Feature Service / ISO 19142 (WFS) version 1.1 https://portal.opengeospatial.org/files/?artifact_id=8339

  Allows a client to retrieve and update geospatial data encoded in OpenGIS Geography Markup Language (GML) from multiple Web Feature Services. The requirements for a Web Feature Service are:

  1. The interfaces must be defined in XML.
  2. GML must be used to express features within the interface.
  3. At a minimum, a WFS must be able to present features using GML.
  4. The predicate or filter language will be defined in XML and be derived from Collection Query Language (CQL) as defined in the OpenGIS Catalogue Interface Implementation Specification.
  5. The data store used to store geographic features should be opaque to client applications and their only view of the data should be through the WFS interface. The use of a subset of XPath expressions for referencing properties.

- OpenGIS Web Coverage Service Implementation Specification (WCS) version 1.1.2 https://portal.opengeospatial.org/files/?artifact_id=3837

  Initially designed to extend the OpenGIS Web Mapping Service (WMS) interface to allow access to whole or portions of geospatial "coverages"—regularly varying *gridded* datasets such as aerial imagery. Over time WCS has diverged from WMS and become more targeted towards the remote-sensing community (note that WMS *may* also output geospatial coverages, but must always output standard Web formats such as JPEG and PNG).

- OpenGIS Filter Encoding Implementation Specification / ISO 19143 (Filter) version 1.1 http://portal.opengeospatial.org/files/?artifact_id=8340

  This document defines an XML encoding for filter expressions based on the BNF definition of the OpenGIS Common Catalog Query Language as described in the OpenGIS Catalog Interface Implementation Specification, Version 1.0.

- OpenGIS Coordinate Transformation Service Implementation Specification (CT) version 1.0 http://portal.opengeospatial.org/files/?artifact_id=999

  To minimize errors associated with projecting a 3D surface (the earth) into a 2D plane, different earth *projections* are used by various state, local, and federal agencies. This makes it crucial to have the ability to transform data from one projection to another as needed.

- Spatial Data Transfer Standard (SDTS): FGDC–STD–002 http://mcmcweb.er.usgs.gov/sdts/

  The SDTS was designed by the USGS working with academic, industrial, and federal, state, and local government users of computer mapping and GIS[57] that saw a requirement for a robust way of transferring earth-referenced spatial data between dissimilar computer systems with the potential for no information loss. The SDTS is a standard for data transfer, as opposed to a standard for data processing. SDTS does not replace existing Geographic Information System (GIS) processing formats.

  NOTE: A modified version was adopted as ANSI INCITS 320:1998, which is undergoing periodic review through INCITS Technical Committee L1.

- SDTS Part 5: Raster Profile and Extensions: FGDC–STD–002.5 http://www.fgdc.gov/standards/projects/FGDC-standards-projects/SDTS/sdts_pt5/index_html

  Contains specifications of a Profile for use with geo-referenced two dimensional raster data, and excludes vector data and three dimensional and higher dimension raster data. It is intended to provide a common transfer format to be used for interchange of raster image and raster grid data among all members of the data producer and user community.

- SDTS Part 6: Point Profile: FGDC–STD–002.6 http://www.fgdc.gov/standards/projects/FGDC-standards-projects/SDTS/sdts_point/index_html

  Contains specifications for a SDTS Profile for use with geographic point data only, with the option to carry high precision coordinates (by increasing the number of decimal places or significant figures) such as those required for geodetic network control points can be attained.

- SDTS Part 7: Computer-Aided Design and Drafting (CADD) Profile: FGDC–STD–002.7–2000 http://www.fgdc.gov/standards/projects/FGDC-standards-projects/SDTS/sdts_cadd/index_html

  Contains specifications for an SDTS Profile for use with vector-based geographic data as represented in CADD software. The purpose of this Profile is to facilitate the translation of this data between CADD packages without loss of data, and support the translation of this data between CADD and mainstream GIS packages. This Profile supports two-dimensional vector data and three-dimensional vector data, where the third dimension is the height of the object. These data may or may not have topology.

[57] http://mcmcweb.er.usgs.gov/sdts/whatsdts.html

Service Interface and Integration

Integration

Integration defines the software services enabling elements of distributed business applications to interoperate. These elements can share function, content, and communications across heterogeneous computing environments. In particular, service integration offers a set of architecture services such as platform and service location transparency, transaction management, basic messaging between two points, and guaranteed message delivery.

Middleware

Middleware increases the flexibility, interoperability, and portability of existing infrastructure by linking or “gluing” two otherwise separate applications.

Relevant Standards:

- Information technology—Database languages—SQL multimedia and application packages—Part 3: Spatial: ISO 13249–3:2006 http://www.iso.org

  ISO/IEC 13249-3:2006 defines spatial user-defined types, routines, and schemas for generic spatial data handling. It addresses the need to store, manage, and retrieve information based on aspects of spatial data such as geometry, location, and topology.

  Implementations of ISO/IEC 13249–3:2006 may exist in environments that also support geographic information, decision support, data mining, and data warehousing systems. Application areas addressed by implementations of ISO/IEC 13249–3:2006 include, but are not restricted to, automated mapping, desktop mapping, facilities management, geo-engineering, graphics, location-based services, multimedia, and resource management applications.

- Simple Features for SQL version 1.2.0 http://portal.opengeospatial.org/files/?artifact_id=829

  The OpenGIS Simple Feature Specification application programming interfaces (APIs) provide for publishing, storage, access, and simple operations on Simple Features (point, line, polygon, multi-point, etc.). This specification describes a SQL implementation of Simple Features.

Data Format / Classification

Data format and classification defines the structure of a file. There are hundreds of formats, and every application has many different variations (database, word processing, graphics, executable program, etc.). Each format defines its own layout of the data. The file format for text is the simplest. Standards include

- OpenGIS Geography Markup Language Encoding Specification (GML) version 3.2.1 http://portal.opengeospatial.org/files/?artifact_id=4700

  The Geography Markup Language (GML) is an XML encoding for the transport and storage of geographic information, including both the geometry and properties of geographic features.

- OpenGIS Web Map Context Implementation Specification (Context) version 1.1
  https://portal.opengeospatial.org/files/?artifact_id=8618

  This document is a companion specification to the OpenGIS Web Map Service Interface Implementation Specification version 1.1.1 (WMS 1.1.1). WMS 1.1.1 specifies how individual map servers describe and provide their map content. The present context specification states how a specific grouping of one or more maps from one or more map servers can be described in a portable, platform-independent format for storage in a repository or for transmission between clients. This description is known as a "Web Map Context Document," or simply a "Context." Presently, context documents are primarily designed for WMS bindings. However, extensibility is envisioned for binding to other services. A Context document includes information about the server(s) providing layer(s) in the overall map, the bounding box and map projection shared by all the maps, sufficient operational metadata for client software to reproduce the map, and ancillary metadata used to annotate or describe the maps and their provenance for the benefit of human viewers. A Context document is structured using eXtensible Markup Language (XML). Annex A of this specification contains the XML Schema against which Context XML can be validated.

- ESRI Shapefile Technical Description 1998[58]
  http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf

  A shapefile stores non-topological geometry and attribute information for the spatial features in a dataset. The geometry for a feature is stored as a shape comprising a set of vector coordinates. This document provides all the technical information necessary for writing a computer program to create shapefiles without the use of ESRI® software for organizations that want to write their own data translators.

- OpenGIS KML (Keyhole Markup Language) version 2.2.0
  https://portal.opengeospatial.org/files/?artifact_id=27810

  KML, or Keyhole Markup Language, is an XML grammar and file format for modeling and storing geographic features such as points, lines, images, and polygons for display in various geospatial browsers and clients. KML is an XML language focused on geographic visualization, including annotation of maps and images. Geographic visualization includes not only the presentation of graphical data on the globe, but also the control of the user's navigation in the sense of where to go and where to look.

  KML can be used to:

  - Specify icons and labels to identify locations, lines, areas, and extruded volumes with respect to the planet surface.
  - Create different camera positions to define unique views for each feature.

[58] The shapefile is a very common format for geospatial information and the technical description is openly published on the Internet.

- Use image overlays attached to the ground or screen.
- Define styles to specify feature appearance.
- Enclose HTML descriptions of features, including hyperlinks and embedded images.
- Use folders for hierarchical grouping of features.
- Display COLLADA textured three-dimensional data (e.g., buildings).

Data Types / Validation

Refers to standards used in identifying and affirming common structures and processing rules. This technique is referenced and abstracted from the content document or source data.

Relevant standards:

- Content Standard for Digital Geospatial Metadata (version 2.0): FGDC–STD–001–1998 http://www.fgdc.gov/standards/projects/FGDC-standards-projects/metadata/base-metadata/index_html

  The objectives of the standard are to provide a common set of terminology and definitions for the documentation of digital geospatial data. The standard establishes the names of data elements and compound elements (groups of data elements) to be used for these purposes, the definitions of these compound elements and data elements, and information about the values that are to be provided for the data elements. ISO harmonization efforts are underway.

- ISO Geographic Information—Metadata (ISO 19115:2003) http://www.iso.org

  This document defines the schema required for describing geographic information and services. It provides information about the identification, the extent, the quality, the spatial and temporal schema, spatial reference, and distribution of digital geographic data. (See ISO 19139 for encoding.)

Geographic information–Metadata–XML schema implementation (ISO TS 19139:2007)
http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=32557

This technical specification documents the XML encoding of the ISO 19115 standard.

- ISO Geographic information—Metadata—Part 2: Extensions for imagery and gridded data (ISO 19115–2) http://www.iso.org (Draft International Standard)

  ISO 19115–2 defines metadata elements to support imagery and gridded data and will extend the UML model for metadata to include the following:

  - it will support the collection and processing of natural and synthetic imagery produced by remote sensing and other imaging processes;
  - it will support the collection and processing of geospatial metadata for imagery, gridded, and coverage data; and

- it will define a data model for information describing geographic imagery and gridded data, establishing the names, definitions, and permissible values for new data elements including new classes relevant to imagery and gridded data.

The following specification describes an extension of FGDC metadata for biological applications.

- Content Standard for Digital Geospatial Metadata, Part 1: Biological Data Profile: FGDC–STD–001.1–1999 http://www.fgdc.gov/standards/projects/FGDC-standards-projects/metadata/biometadata/index_html

  Provides a user-defined or theme-specific Profile of the FGDC Content Standard for Digital Geospatial Metadata to increase its utility for documenting biological resources data and information. This standard supports increased access to and use of biological data among users on a national (and international) basis. This standard also serves as the metadata content standard for the National Biological Information Infrastructure (NBII). This standard can be used to specify metadata content for the full range of biological resources data and information. This includes biological data which are explicitly geospatial in nature, as well as data which are not explicitly geospatial (such as data resulting from laboratory-based research). This also includes information categories, such as research reports, field notes, or specimen collections.

- Content Standard for Digital Geospatial Metadata: Extensions for Remote Sensing Metadata: FGDC–STD–012–2002 http://www.fgdc.gov/standards/projects/FGDC-standards-projects/csdgm_rs_ex/MetadataRemoteSensingExtens.pdf/view

  These extensions define content standards for additional metadata, not defined in the Metadata Content Standard, that are needed to describe data obtained from remote sensing. They include metadata describing the sensor, the platform, the method and process of deriving geospatial information from the raw telemetry, and the information needed to determine the geographical location of the remotely sensed data. In addition, metadata to support aggregation, both the components of an aggregate dataset and the larger collection of which a data item may be a member, will be supported.

- Metadata Profile for Shoreline Data: FGDC–STD–001.2–2001 http://www.fgdc.gov/standards/projects/FGDC-standards-projects/metadata/shoreline-metadata/index_html

  First in a series of standards that will define a Shoreline Data Content Standard. The metadata Profile is to be used as an extension or Profile to the existing Content Standards for Digital Geospatial Metadata (CSDGM). Because the CSDGM only allows for the documentation of generic geospatial data, the Bathymetric Subcommittee felt it was necessary to develop a metadata Profile that addressed shoreline data and data that intersects with the shoreline. The objective of the metadata Profile is to capture the critical processes and conditions that revolve around creating and collecting shoreline data. The

metadata produced using this standard will be important for clearinghouse activities to locate potential datasets and to indicate the fitness for use and accuracy of a given dataset. This standard is intended to serve the community of users who are involved with geospatial data "activities" that intersect the U.S. shoreline. The purpose is to clarify (standardize) some of the complexities of shoreline data by developing a metadata Profile, bibliography, and glossary, which will be an extension or Profile of the FGDC CSDGM.

- Cadastral Data Content Standard: FGDC–STD–003 http://www.fgdc.gov/standards/projects/FGDC-standards-projects/cadastral/index_html

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

- Classification of Wetlands and Deepwater Habitats of the United States: FGDC–STD–004 http://www.fgdc.gov/standards/projects/FGDC-standards-projects/wetlands/index_html

  Provides a system that allows communication about wetlands and their features in a national context. Doing so enhances the ability of all agencies and individuals to interpolate and extrapolate wetland resource data, wetland loss and gain data, and restoration efforts in the same semantic and ecological context. The classification system was developed by wetland ecologists with the assistance of many private individuals and organizations and local, state, and federal agencies.

- Vegetation Classification Standard: FGDC–STD–005 http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/index_html

  Supports the use of a consistent national vegetation classification system (NVCS) to produce uniform statistics in vegetation resources from vegetation cover data at the national level. It is important that, as agencies map or inventory vegetated Earth cover, they collect enough data accurately and precisely to translate it for national reporting, aggregation, and comparisons. Adoption of the Vegetation Classification and Information Standards in subsequent development and application of vegetation mapping schemes will facilitate the compilation of regional and national summaries. In turn, the consistent collection of such information will eventually support the detailed, quantitative, geo-referenced basis for vegetation cover modeling, mapping, and analysis at the field level.

- Soil Geographic Data Standard: FGDC–STD–006
  http://www.fgdc.gov/standards/projects/FGDC-standards-projects/soils/index_html

  This document proposes a set of data standards for the inventory, mapping, and reporting of the soil resources of the United States. It includes a description of the proposed data elements to be used when reporting and transferring data which describes soil map units and their components. These map units are associated with soil maps developed by the National Cooperative Soil Survey.

- Content Standard for Digital Orthoimagery: FGDC–STD–008–1999
  http://www.fgdc.gov/standards/projects/FGDC-standards-projects/orthoimagery/index_html

  Defines the orthoimage theme of the digital geospatial data framework envisioned by the FGDC. It is the intent of this standard to set a common baseline that will ensure the widest utility of digital orthoimagery for the user and producer communities through enhanced data sharing and the reduction of redundant data production.

- Content Standard for Remote Sensing Swath Data: FGDC–STD–009–1999
  http://www.fgdc.gov/standards/projects/FGDC-standards-projects/swath_data

  The standard defines the minimal content requirements for a remote sensing swath and the relationships among its individual components. It also discusses the treatment of optional supporting information within the swath model. In the classification system of the Federal Geographic Data Committee Standards Reference Model (FGDC 1997), this standard is a data content standard. Data content standards provide semantic definitions of a set of objects and of the relationships among them. This standard defines a concept called a swath that provides a means for associating certain kinds of remote-sensing data with their geolocation. To that end, it defines those items of information content that are necessary for the realization of the swath concept. As a content standard, the Content Standard for Remote Sensing Swath Data does not specify encoding. Encoding may be specified at some future time by a separate standard or standards.

- Utilities Data Content Standard: FGDC–STD–010–2000
  http://www.fgdc.gov/standards/projects/FGDC-standards-projects/utilities/index_html

  This Utilities Standard supports large-scale, intra-city applications such as engineering and life cycle maintenance of utility systems. The components of each utility system described in this Utilities Standard are considered to represent features located outside the foundation of an enclosed structure. This Utilities Standard describes eleven feature classes: compressed air, electrical distribution, electrical monitoring/control, fuel distribution, heating/cooling systems, industrial waste, natural gas distribution, saltwater, storm drainage collection, wastewater collection, and water distribution. This standard does not contain all features necessary to describe or model communications, alarm

systems, or long distance utilities networks that stretch between cities. As with the Spatial Data Transfer Standard (SDTS), this standard uses a logical data model.

Data Transformation

Data transformation consists of the protocols and languages that change the presentation of data within a graphical user interface or application.

Relevant standards:

- OpenGIS Styled Layer Descriptor Implementation Specification (SLD) version 1.1.0 https://portal.opengeospatial.org/files/?artifact_id=1188

  SLD is an XML encoding for how the Open GIS Web Mapping Service (WMS) specification can be extended to allow user-defined symbolization of feature data.

- OpenGIS Web Map Service Implementation Specification / ISO:19128 2005 (WMS) version 1.3.0 http://portal.opengeospatial.org/files/?artifact_id=14416

  Provides three operations (GetCapabilities, GetMap, and GetFeatureInfo) in support of the creation and display of registered and superimposed map-like views of information that come simultaneously from multiple sources that are both remote and heterogeneous.

Interface

Interface defines the capabilities of communicating, transporting, and exchanging information through a common dialog or method. Delivery Channels provide the information to reach the intended destination, whereas Interfaces allow the interaction to occur based on a predetermined framework.

Service Discovery

Defines the method in which applications, systems, or Web services are registered and discovered. Standards include:

- OpenGIS Catalogue Service Implementation Specification (CAT) version 2.0.2 http://portal.opengeospatial.org/files/?artifact_id=5929&version=2

  Defines a common interface that enables diverse but conformant applications to perform discovery, browse, and query operations against distributed and potentially heterogeneous catalog servers.

Service Description / Interface

Defines the method for publishing the way in which Web services or applications can be used.

OGC has done work in this area. Services may use WSDL as a way to describe endpoint bindings. More information is usually available by invoking a given service's *GetCapabilities* operation. This operation provides the calling application with more detailed, service domain-specific information. For example, in the case of the OGC Web

Mapping Service, the *GetCapabilities* operation catalogs such features as available data layers and supported image formats. Standards include

Relevant Standards:

- OpenGIS Reference Model (ORM) version 0.1.3
  http://portal.opengeospatial.org/files/?artifact_id=3836

  The ORM describes a framework for the ongoing work of the Open Geospatial Consortium and its specifications and implementing interoperable solutions and applications for geospatial services, data, and applications.

- OpenGIS Web Service Common Implementation Specification (OGC Common) version 1.1.0 https://portal.opengeospatial.org/files/?artifact_id=8798

  This document specifies many of the aspects that are, or should be, common to all or multiple OWS interface Implementation Specifications. Those specifications currently include the Web Map Service (WMS), Web Feature Service (WFS), and Web Coverage Service (WCS). These common aspects include operation request and response contents, parameters included in operation requests and responses, and encoding of operation requests and responses.

Standards List

A list of the geospatial standards that might apply within an agency technology architecture can be found at the link below. This list will be updated periodically to reflect changes as they arise.

http://colab.cim3.net/cgi-bin/wiki.pl?GeoSpatialCommunityofPractice/GeospatialStandardsList

To submit a modification to the list, send an e-mail with the subject, “Geospatial Standards List Modification Request” to geo-forum@colab.cim3.net. In the content of the e-mail include the following information:

Requesting Organization—the name of the organization making the change request.

Requesting POC Name—the name of a cognizant point of contact with the requesting organization.

Requesting POC Telephone—the telephone number of a point of contact with the requesting organization.

Requesting POC E-mail—the e-mail address of a point of contact with the requesting organization.

Modification Type—one of Update (to update an existing entry), Insert (to add a new entry),
or Delete (to delete an existing entry)

Organization—the organization entry for the standard affected by the modification

Identifier or Nickname—the identifying entry or entries for the standard affected by the modification

Title—the title entry for the standard affected by the modification

Revision—the revision entry for the standard affected by the modification

Description—the description entry for the standard affected by the modification

Purpose/Benefit/Limitation—the purpose entry for the standard affected by the modification.

Justification—text that justifies the modification requested.

Implications—text that describes any implications of note that would result from acceptance of the modification (e.g., this change will require the deletion of another entry, the addition of another entry, or similar).


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