Improving Government Policy Development And Service Provision With Interoperable Geoprocessing

An Open GIS Consortium (OGC) White Paper

Note: This paper was written for a US Government e-Business Report published by the Saringa Group.

1 Introduction

E-Government encompasses the use of digital communications media to support both policy making and the delivery of government services. In this paper we explore the ways in which E-Government will be served by easy access to the "Spatial Web," a vast networked library of geospatial data and sophisticated services and tools for spatial analysis and geographic display. The spatial component is critical to successful E-Government and E-commerce. Use of GeoSpatial data enhances decision-making, improves analysis of complex problems, and improves delivery of services to citizens and consumers where they live, work and travel.

The Spatial Web is a fast growing reality. Like the Internet and the Web, the Spatial Web depends on open standards that enable interoperability. These standards are under development, and E-Government programs are in a position to both use them and help shape them.

"Spatial data" are digital data that relate people, things, and phenomena to a point, area, or volume on or near the earth's surface. Geoprocessing includes Geographic Information Systems (GIS) that overlay and operate on digital "map layers". Geoprocessing also includes earth imaging (such as aerial photography and satellite-based earth images); automated mapping and facilities management systems (AM/FM); navigation and routing software; and database queries that include spatial elements. "Spatial services" refers to geoprocessing services available to other software processes via a network (usually the Web). Location Services, for example, deliver information based on location to people who are using wireless, position-aware devices such as cell phones and PDAs.

Governments have been the largest customers of geospatial data and technologies because so many of the issues and mandates that the government must address are geographic by nature. The importance of spatial information can be summed up in the statement, "Everything and everyone is someplace." Crime management, emergency services, property taxes, public health, public works, waste removal, permits, environmental management, urban planning, transportation planning, disaster management, defense - almost all the things that governments do can be done more efficiently with the help of geoprocessing.

US federal, state, and local governments' investment in spatial data over the last fifteen years totals hundreds of billions of dollars. Despite this huge investment, digital spatial information has been absent from use by many citizens and public servants because it is technically complex and because the diverse kinds and brands of geospatial software have not exchanged data easily. The limited use of spatial data is also linked to the uncoordinated choices people make about the naming and describing of geographic features, feature relationships, and data sets. The inevitable semantic mismatch between different collections of spatial data that cover the same geographic area has been a daunting obstacle to wider use of geoprocessing. This difficulty in data sharing results in redundant data collection and wasted investment.

For some time, the Federal Geographic Data Committee (FGDC) has been promoting the concept of a National Spatial Data Infrastructure (NSDI). The term "Spatial Data Infrastructure" (SDI) denotes the matrix of technologies, policies, standards, human resources and institutional arrangements that facilitate the availability of and access to spatial data for all levels of government, the commercial sector, the non-profit sector, academia and citizens in general.

Technical advances in Information Technology (IT) and the accelerating advance of standards in the geoprocessing industry are contributing significantly to the growth of the NSDI. NSDI progress can continue only if government managers encourage the acceptance of interoperability for geoprocessing software and geospatial data. This paper concentrates on the benefits of promoting consensus-based interfaces and standards, and looks at what government managers must do to reap the benefits for themselves and their constituents.

2 Standards and the Growth of the NSDI

The public sector and the private sector both have much to gain from the development of the NSDI. Consider the following scenario: A real estate broker is talking to a client who is interested in buying a particular house. The broker and client are sitting at an online computer, and the broker is helping the client find answers to the following questions:

- Where is the property, exactly?
- Let me see the boundary on an aerial image.
- Where is the nearest supermarket, and what will be my drive time?
- Where is the nearest middle school, and where are the bus stops?
- Where is the nearest park (state, county, federal)?
- What is the shortest route to my office?
- Where is the nearest toxic spill to my location?
- What are the demographic trends?

Each answer is likely to draw on information from different databases. Imagine that each question might be answered by simply clicking to a particular Web site. It would be even better if many of these sources could be merged into customized maps that have special value for the client. It isn't hard to imagine citizens and public employees benefiting from similar information services. It isn't hard to imagine the many businesses and jobs supporting the creation, maintenance, and provision of these data and services.

But standards need to be in place to realize the "spatially enabled Web" that underlies the scenario above. The two initiatives described below provide the essential ingredients for the Web's spatial layer: The OpenGIS Consortium, Inc. (OGC) provides the specifications for geospatial applications interoperability. FGDC and a national (non-federal) network of cooperating data coordination groups provide the semantic standards.

3 OGC and Technical Geoprocessing Interoperability Standards

In the 1950s, computer technologists began using computers to store, display, manipulate, and analyze spatial data. As early as 1960, companies began to provide GIS and other kinds of geoprocessing software. Each company had a particular approach and a proprietary internal data format, and at that early stage in the development of the market the companies had little to gain from "opening" their formats to competitors. They sold monolithic, full-featured, "soup to nuts," "stovepipe" systems designed to provide a total solution for a customer's need.

Because of the complexity and "differentness" of these systems and because many large customers became single-vendor shops so their users could share data, the geoprocessing industry at first lagged behind the rest of the Information Technology (IT) industry in the trend toward component-based, distributed computing characterized by interoperability between heterogeneous systems. But that lag has turned to a lead.

Since 1994, industry, academia and government organizations have worked together using the OGC consensus process, reaching agreement on open software interfaces and protocols that provide a "lingua franca" that support geoprocessing interoperability. Virtually all vendors of geoprocessing systems have begun to augment their systems by offering interfaces that implement OpenGIS Specifications. Through these interfaces, different systems can "talk to each other." A geoprocessing system that implements an OpenGIS Specification-conformant interface can respond to commands sent across a network from other systems that implement the same interface. Thus users can "get at" data held on remote and dissimilar systems, even though the software that stores and serves that data uses a format and a processing approach different from those employed in the user's software. Development of new OpenGIS Specifications is accelerating, broadening the range of geoprocessing functions that interoperate across systems.

In the last two years, OGC's specification output has been boosted by a rapid prototyping approach established by OGC in the 1999 Web Mapping Testbed. Now formalized as the OGC Interoperability Program, this approach brings together one or more initiative Sponsors, usually federal agencies, that have a particular geospatial interoperability problem to solve. Sponsors provide a set of requirements and in some cases funding for an Interoperability Initiative, which might be a Testbed, Feasibility Study, Planning Study, Pilot Project, or Insertion Project.

---

1 A list of software suppliers who have implemented OGC interfaces can be found at www.opengis.org.

OGC Interoperability Program, this approach brings together one or more initiative Sponsors, usually federal agencies, that have a particular geospatial interoperability problem to solve. Sponsors provide a set of requirements and in some cases funding for an Interoperability Initiative, which might be a Testbed, Feasibility Study, Planning Study, Pilot Project, or Insertion Project.

In these Interoperability Initiatives, technology provider Participants work together to develop candidate OpenGIS Specifications and provide other technical support and feedback for improvements and additions to approved OpenGIS Specifications. Candidate specifications then go through a formal OGC Technical Committee review to become approved OpenGIS Specifications.

User organizations (Sponsors) benefit because they get early access to tested interoperable commercial products that meet user-defined interoperability requirements. They reduce procurement risk and lower life cycle costs for products that implement new technologies. Greater competition and choice in the market derive from vendors' interoperable (plug and play) offerings.

OGC is being driven by overall market requirements, not just those of E-Government. However, Federal agencies and vendors that have long-term requirements for interoperability within the E-Government context are sponsoring recent OGC Interoperability Initiatives such as the OGC Web Services Initiative and the Open Location Services initiative.

4 FGDC and Geodata Semantic Standards

There is a longstanding problem of semantic mismatch between different sources of spatial data, because spatial data production frequently is done in the absence of well-accepted standards for classification schemes, naming conventions, interpretation conventions, and metadata standards. In response to this problem, OMB established the FGDC in 1990 to facilitate spatial data coordination at the federal, state and local levels.

The FGDC has produced a Metadata Content Standard, which addresses the naming and description of both metadata and geospatial features. This standard has been developed with participation from federal, state and local governments and the private sector, and has been harmonized as an international standard through the International Organization for Standardization (ISO). As more data producers in the public and private sectors follow the standard, the following benefits accrue:

- Many data sets can be joined and used together if the creators of the data have followed the same standard (for example, enabling state or federal agencies able to use data created by local government).
- Data maintenance becomes easier.
- Data errors are reduced
- Municipal agencies can make use of each other's data.
- Private companies can offer improved scales of economy by undertaking data collection over adjacent cities or states where there is agreement on standards.

5 Implementing Spatially Enabled E-Government

The Spatial Web Supports Decision Makingtransfers.

Policy makers in governments at all levels need good decision support resources. This includes not only information but also decision support software of different kinds, and tools for multimedia presentations that help policy makers to inform and persuade. Spatial analysis and display can figure importantly in most government decisions. Where should the new airport be built? Which homes are in the disaster relief zone? What will be the boundaries of the new school district? How can reductions in the snow removal budget be implemented fairly and with the least disruption to traffic flow? On which properties must restrictions be imposed to protect the public water supply? Clearly, the Spatial Web described in this paper represents critical information infrastructure for such decisions.

The Spatial Web Supports Delivery of Government Services

Much of the information citizens seek from governments is related to transportation, parks, regulations, licenses, trash collection, water, property taxes, zoning, districting, and other real world functions that have a spatial context. Emergency and disaster management services depend on spatial information. Spatial data is infrastructure in the sense that it serves many purposes and many people. The same spatial data used to make trash collection more efficient might be used to save lives threatened by a hurricane. Information stored in a government's online maps and address lists might be maintained rigorously for 911 purposes, but that same data might be used for water department mailings or voter registration. Web-based distributed computing and modern spatial applications can make governments' use of spatial data much more efficient.

What can Governments Do?

- **Enforce the use of accepted standards:** Financial aid provided by Federal and state agencies to more local levels of government for physical infrastructure projects usually requires the collection of certain kinds of spatial data. If governments require that such data conform to FGDC and international standards, and if they require that geoprocessing software purchases conform to appropriate OpenGIS Specifications, they will improve their ability to maintain and reuse data, to "plug and play" vendor solutions, and reduce life cycle costs.

- **Explore the benefits of data consortia:** Common criteria for data help justify consortia of users pooling and aligning their spatial information and spatial software procurements and maintenance

- **Develop policies for access scenarios** that address the needs of citizens, corporations and governments for security, privacy, freedom of information, commerce, and intellectual property protection. Governments are well advised to study and try out, in limited and experimental ways, technology solutions in these areas that support varied policy decisions. (OGC is also addressing these in the context of spatial interface development and validation.)

- **Assure data coordination within and between Information Communities** - Similar data is being collected and maintained for different purposes by different professions. The result is a great deal of similar information that may not be known to others, and/or may not be maintained to support multiple uses. Differences in accuracy, currency, resolution, and semantics all complicate the sharing and reuse of information. Any opportunity for multiple organizations to share the costs of data can result in lower costs for all. OGC is developing interfaces to help deal with semantic differences and help provide for distributed discovery, access, integration and application of spatial information and services.

- **Provide for intelligent location-based information discovery:** Governments ultimately need to offer information discovery tools that can provide information by topic and by location rather than by agency mission. "Useful information" means data that are organized and offered for presentation to a user in multiple ways - by type of service, by a requestor's location, by subject interest, by combination of parameters, etc. "Data discovery" today means much more than searching electronic files to return lists of document titles and subject words or static HTTP pages. Technologies that make use of XML need consideration. The OGC XML-based Geography Mark-up Language (GML) specification, the Open Location Services, and "geospatial fusion" interfaces provide an extraordinary foundation for development of "intelligent" and location aware information services for government.

- **Establish ways for government information providers to register different types of spatial information**, to include their "areal extent", and the content that is to be made available, so that their information can be accessed transparently during discovery. As in other E-Government programs, they will need to define what information will be available, how to access it, and the taxonomy involved. Globally accepted standards for cataloging spatial data and spatial processing services have been developed in OGC.

- **Offer combined spatial and textual search capability to enhance traditional text-base searches**. For existing text and spatial content clearinghouses, create mechanisms that support global discovery, i.e., the ability to search multiple providers' holdings easily to find the distributed holdings of interest.

- **Consider formation of a public-private partnership for E-Government** to harness industry, academic and other government participation on relevant issues at the levels of policy, program and technical solution building.

2 Information communities refer to a group of individuals and/or organizations whom have similar information requirements. Examples of information communities are Defense and Intelligence, Natural Resources, or Transportation Engineering.

6 Conclusion

There is a promising convergence of developments in E-government with developments in open, distributed access to geodata and geoprocessing software and services. Because governments' constituents, mandates, and assets are geographically distributed, it makes sense to leverage E-government initiatives with spatial technologies. Because interoperability is key, E-government initiatives have much to gain from participation in OGC's geoprocessing interoperability activities and FGDC's geodata interoperability activities.