OGC
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Geodata Interoperability – A Key NII Requirement

An Open GIS Consortium (OGC) White Paper

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1 Statement of the Problem

A wide range of activities depend on digital geographic data and geoprocessing, and these information resources are rapidly becoming more important as commerce expands, information technology advances, and environmental problems demand resolution. Unfortunately, non-interoperability severely limits the use of digital geographic information. Spatial data exist in a wide range of incompatible and often vendor-proprietary forms, and geographic information systems (GIS) usually exist in organizations as isolated collections of data, software, and user expertise.

The potential uses for geodata in the context of the NII reach far beyond current uses, making current limitations even more disheartening. If legacy geodata and data generated by new technologies such as geopositioning systems (GPS) and high resolution satellite-borne sensors were easily accessible via networks, and if spatial data of various kinds were compatible with a wide range of desktop and embedded applications, the effects would be revolutionary in NII application areas such as emergency response, health and public safety, military command and control, fleet management, traffic management, precision farming, business geographics, and environmental management.

The problem of geodata non-interoperability will be solved in part by institutional cooperation: organizations need to create data locally in standard formats that can be used globally. But we need to plan a technological solution if we want systems in which diverse applications can transparently exchange diverse geodata types and in which applications can access remote spatial databases and spatial processing resources in real-time. The technological solution: develop a common approach to using spatial data with distributed processing technologies such as remote procedure calls and distributed objects.

This paper looks at the components of the geodata non-interoperability problem and describes the technical solution and the unique consortium that is providing that solution. This consortium approach, which involves users in the specification process and which organizationally isolates technical and political agendas, holds promise as a model means of simultaneously developing important technologies and developing and implementing technology policy.

2 Background

The importance of geospatial information and geoprocessing services:

The National Information Infrastructure broadly defines an information technology environment for the development and use of many information-based products of vital significance to the nation.

Fundamental to the design and function of many of these products is the use of geospatial data, more commonly known as "geographical information." So widespread and critical is the use of geographical information and the "geographical information systems" (GIS) that have been marketed to work with it in its many forms, that President Clinton issued Executive Order 12906 (April 11, 1994) to establish a "National Spatial Data Infrastructure" (NSDI) and commissioned the Federal Geographic Data Committee (FGDC -- chaired by Secretary of the Interior Babbitt) to document it, to give it operational form, and to provide a management structure designed to help it grow and become a focus for the combined efforts of both public and private sector organizations concerned in any way with the development and use of geospatial information.

In terms of the clear objectives that give it form and sustain it, as well as its highly focused data development and standardization activities, the NSDI is positioned to be a well defined and vital component of the NII, and a valuable resource for those working in a variety of the application areas targeted for intensive development by NII policy planners. The NSDI, however, although conceived as a distributed data resource, lacks the operational framework to support real time access to distributed geoprocessing resources and their associated database archives -- resources such as Wide Area Information Server (WAIS) and Government Information Locator Service (GILS) are available for catalog access and superficial browsing of spatial data sets, but the problem of remote query against the wildly heterogeneous assortment of spatial data sets that constitute the NSDI's "Clearinghouse" environment will not be solved until an operational model for the interoperability of distributed geoprocessing environments is developed and accepted by the geoprocessing community.

The nation's wealth of geospatial data is vast and of increasing use to developers and planners at all levels of operation in both the public and private sectors. Much of the information technology world is rapidly transforming its basis of computation from the tabular domain, the world of spreadsheets and accounting ledgers, to the spatial domain, the world of maps, satellite imagery and demographic distributions. Applications that merge digital mapping, position determination, and object icons are already being introduced in activities such as overnight delivery service and urban transit. These three technologies and new database management systems capable of handling multidimensional data will play an important role in operations decision support systems, maintenance management, and asset management wherever assets and processes are geographically dispersed. As the NII concept challenges organizations to adopt more comprehensive, enterprise processing models based on wide-area, multi-media communications technologies, the need increases to invest the NSDI with distributed processing capabilities that can ensure the full integration of geoprocessing resources into these models. Commercial need for better spatial data integration is already clear in areas such as electric and gas utilities, rail transport, retail, property insurance, real estate, precision farming, and airlines. Given the critical nature of applications positioned to combine "real-time" and geospatial attributes -- emergency response, health and public safety, military command and control, fleet management, environmental monitoring -- the need to accomplish the full integration of NSDI resources into the NII context has become increasingly urgent. The importance of interoperability standards to NII-based applications:

Fundamental to the development of enterprise information systems is the concept of "interoperability". The term "interoperability" is used at all levels of information technology development to define a user's or a device's ability to access a variety of heterogeneous resources by means of a single, unchanging operational interface. At the level of chip technology the interface is a backplane or a bus specification; at the network level the interface may be a hardware-based transmission protocol or a packet specification; at the operating system level the interface is a set of system calls or subroutines; at the object programming level the interface is a specification for the behavior of a object classes. In short, "interoperability" denotes the user's ability to function uniformly and without product modification in complex environments by applying a standard interface to heterogeneous resources.

In the geodata domain interoperability is defined as the ability to access multiple, heterogeneous geoprocessing environments, either local or remote, by means of a single, unchanging software interface. Interoperability in this context refers as well to accessing both multiple heterogeneous datasets and multiple heterogeneous GIS programs. By definition this view of interoperability assumes the sort of interoperable network environment envisioned by NII policy.

The interoperability profile of the NII is characterized by multiple hardware and software standards, some complete and some under development. Such standards are the product of years of concentrated effort on the part of both public and private sector organizations, as well as such recognized standards bodies as the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO). Within the operational framework established by these standards, it should be possible to exchange diverse information encoded in a wide variety of data formats among all known makes and types of computer, communications and video systems. Already significant strides have been taken towards integrating such forms of information as database tables with the result that both database applications and non-database applications such as spreadsheet and word processing documents can use database information without switching applications.

In order to integrate geospatial data into the application environment of the NII and to use it in a coherent way the FGDC has taken valuable first steps by organizing an approach to standardizing on an exchange format that includes entity attribute schemes for each of the significant geoprocessing application areas in the federal government and a standardized description of the content of geospatial data collections (i.e. their metadata). Associated with this effort is the establishment of the National Spatial Data Clearinghouse, a directory and metadata catalog accessible by the Internet describing a rich assortment of registered databases meant to define the resources of the NSDI. Taken together, the geodata standardization and Clearinghouse initiatives comprise the data resources needed to introduce geoprocessing into the mainstream of NII-based distributed application systems. They do not, however, address the interoperability issue, and remain available as a "static resource", requiring either that data be accessed by software that is familiar with its native format, or that entire datasets be converted to standardized transfer formats and reconverted to the user's processing format before any useful work can be done with them. Many databases are frequently updated, which adds to the cost of acquisition and conversion.

In order to make the NSDI data both freely available and useful in the NII environment it will be necessary to introduce a standardized interoperability mechanism specifically designed for remote access of geographical databases. Such a mechanism must embody the interoperability principles on which the NII is based. That is, it must enable transparent, barrier-free access to heterogeneous geospatial datasets in a distributed environment, relying on standardized interfaces for the generation of queries in real-time, and the consequent retrieval of query-derived datasets to the user's native environment.

A significant issue faced in recognizing the necessity of such an interoperability mechanism for geoprocessing is the fact that the geoprocessing community has been slow to adapt many recent advances in main-stream information technology. Traditionally GIS packages, whether commercial or public sector, have created highly structured and architecturally closed operational environments, tightly coupling display graphics with spatial analysis mechanisms, and relying on a tight coupling of spatial analysis with proprietary spatial database designs. Such packages tend to be operationally monolithic, lacking the modularity that is required for an efficient use of the distributed architectures that are more and more coming to characterize enterprise computing. In the past the GIS user worked primarily in a closed shop environment on limited datasets which could be archived and maintained in the local environment, and only intermittently updated by means of tape import or batch transfer over the network. With the advent of the Internet and the associated surging demand for "processed data" in real-time, such closed environments fail to provide geoprocessing professionals the same ready access to the nation's data resources as people in general are coming to expect of such institutions as libraries, legal archives, news and entertainment programming, and general information and interaction services on the Internet.

3 Analysis and Forecast

Contingencies and Uncertainties:

The growth of the NSDI subset of the NII, like the growth of the NII itself, is a complex, many-faceted phenomenon. As in a developing economy or ecosystem, there are many complex dependencies. Organized cooperative effort will characterize the growth in some domains, while chance, raw market initiatives, and surprise breakthroughs will dominate in others. The rise of geodata interoperability depends on the expertise, commitment, and user focus of those who are directly addressing the problem, but it also depends on the infrastructures that support their efforts and on the vagaries of the market.

In this section of the paper we describe a geodata interoperability standards effort that is in progress, and we note the other standards and new technologies upon which it depends. We also describe the process by which the standard is being developed, and the participation upon which that process depends.

The OGIS:

The Open Geodata Interoperability Specification (OGIS) is a specification for object-oriented definitions of geodata that will enable development of true distributed geoprocessing across large networks as well as development of geodata interoperability solutions. OGIS is like other emerging distributed object-oriented software systems in its basic structure and benefits, but it is the first large scale application of object technology to GIS and to the management of spatial data in the global and national information infrastructure contexts. It is being made sufficiently general so that it can be implemented using software methodologies other than object technology, including remote procedure call (RPC) architectures such as the Open Software Foundation's Distributed Computing Environment (DCE) or application linking schemes such as Microsoft's Object Linking and Embedding (OLE).

The OGIS will specify a well ordered environment designed to simplify the work of both developers and users. Developers adhering to OGIS-defined interface standards will easily create applications able to handle a full range of geodata types and geoprocessing functions. Users of geodata will be able to share a huge networked data space in which all spatial data conforms to a generic model, even though the data may have been produced at different times by unrelated groups using different production systems for different purposes. In many cases automated methods will bring older data into conformance. The OGIS, and the object technology that underlies it, will also provide the means to create an extremely capable resource browser that users will employ across networks to find and acquire both data and processing resources. Searches will be executed using powerful, object oriented distributed database technology developed to handle large, complex, abstract entities that canít be managed in conventional relational database management systems. Queries will potentially return only the data requested, not whole datasets that will require further reduction and preparation before the user can begin.

With the OGIS in place, the GIS industry will have the tools it needs to address the expensive geodata incompatibility problems faced by federal agencies, large private enterprises, and state and local governments. The OGIS will provide a technological boost to organizations committed to spatial data transfer standards. By providing a "smart" generic wrapper around data, OGIS will achieve the objectives of a universal data format while respecting the widely varying missions of data producers. Making good use of distributed processing on high bandwidth networks, OGIS will multiply the utility of geospatial databases and reduce the size and duration of data transfers.

Object Technology:

To understand how the OGIS will work, one must understand the basics of object technology. Object technology will, over the next five years, change the way we conceptualize, build, use, and evolve computer systems. It provides a way to integrate incompatible computer resources and a way to build software systems that are much easier to maintain, change, and expand. Its robust components can be quickly assembled to create new or modified applications. It is synergistic with the Information Highway, offering a model in which adaptable agents spawned by a userís local computer can act across the network. In harmony with todayís emphasis on sharing of data and resources within enterprises, it breaks out of the earlier model that sequesters proprietary software and data within isolated systems. Object technology will make it much easier for non-technical people to access and customize information and information systems, because many instances of data conversion and manipulation will become transparent.

The old way of programming, procedural programming, segregates data from programs that operate on the data. Procedural programming makes sense when processing resources are in short supply and programmers are available in abundance to maintain and debug aging software systems that have grown into "spaghetti code." The world is moving away from this model. Processing power is abundant and cheap, and large enterprises now look to object technology to reduce escalating software maintenance costs (and data conversion costs) that are straining their budgets.

Moving beyond standalone programs that operate on specific kinds of data to perform specific tasks, developers of large enterprise systems are now beginning to write software in special modules called objects. Objects typically include both data and behaviors. Data is spoken of as being "encapsulated" in an object. The capsule that contains the data is a set of behaviors (or procedures, or methods) that can act on the data and return a result when requested to do so by another object. If an object is requested to do something it canít do, it returns an error message. Older, pre-existing data and applications can be encapsulated so that they will work in the object environment.

Client objects in distributed object systems can learn other objectsí contents and capabilities and invoke operations associated with those capabilities. In other words, objects interact as clients and servers. The object-to-object messaging that is central to object technology gains efficiency through a system by which objects belong to classes with common properties. Classes can be nested in hierarchies. In these hierarchies, classes inherit attributes (data and procedures) from classes that are higher in the hierarchy. Inheritance allows objects to efficiently represent the large amount of redundant information that is common to all the objects of a class.

Large object systems, especially distributed systems, typically have an interface layer called an Object Request Broker (ORB) that keeps track of the objects and activities in the system. The ORB screens for improper requests, mediates between competing requests, makes request handling more efficient, and provides an interface through which dissimilar applications can communicate and interoperate.

Just as a Microsoft Word user can now, without changing applications, run analyses on a Microsoft Excel spreadsheet embedded in a Word document, a GIS user will, through the development of the OGIS and the object technology environment, access a full set of GIS capabilities while working in an application that may not be a GIS application. Just as the Word user no longer needs to convert the spreadsheet to tab-delimited text before importing the static data into the Word document, the GIS user will not need to convert data formats and projections.

The OGIS Architecture:

The OGIS will provide:

- A single "universal" spatio-temporal data and process model that will cover all existing and potential spatio-temporal applications.
- A specification for each of the major database languages to implement the OGIS data model.
- A specification for each of the major distributed computing environments to implement the OGIS process model.

By providing the above interoperability standards, the OGIS will provide the means for creating:

- An interoperable application environment consisting of a configurable user workbench supplying the specific tools and data necessary to solve a problem.
- A shared data space and a generic data model supporting a variety of analytical and cartographic applications.
- An interoperable resource browser to explore and access information and analytical resources available on a network.

The two main components of the architectural framework of the OGIS are the OGIS Geodata Model (OGM) and the OGIS Reference Model (ORM).

The OGM is the core component of the framework. It consists of a hierarchical class library of geographic information data types which comprise the shared data environment and unified data programming interface for applications. Cohesive, comprehensive, and extensible, encompassing all current geospatial and temporal descriptions of data, presentation issues, analysis modes, and storage and communication issues, the OGM will be the language of OGIS. The OGM will be the interface to geodata transfer standards such as the Spatial Data Transfer Standard (SDTS); Spatial Archive and Interchange Format (SAIF); and Digital Geographic Standard (DIGEST). It will be interoperable with SQL3-MM, the next generation of SQL, which will be object oriented and which will support multimedia entities, including geospatial data.

The OGM will support object queries, read/write of multiple formats, temporal modeling and long duration transactions. It will, to accomplish these objectives, include sophisticated GIS definitions of spatial objects, fields, and functions.

The ORM describes a consistent open development environment characterized by a reusable object code base and a set of services. The design approach for the OGM determines the set of services that must be supported in the ORM. As a result, the ORM requires directories of services and databases, which will support complex query processing. It also specifies standard methods for requesting and delivering geospatial transformations and processing tasks. The ORM will also facilitate transformations between "private" data and OGM constructs, as well as coordinate conversion and raster/vector conversion. It also manages visualization and display, and it supports data acquisition.

Other emergent IT standards and their relationship to OGIS:

As mentioned above, implementations of the OGIS will be layered on interfaces such as CORBA, DCE, and OLE. These are, in fact, the three major interfaces that are likely to be used. So the success of the OGIS will ultimately depend on the robustness, completeness, stability, schedule, and market acceptance of these standards. CORBA and DCE are the products of consortia, OLE is the product of Microsoft. The success of a consortium-produced standard depends very much on whether the members put in enough time and money to finish the standard in a timely and complete fashion, and whether the members understand the needs of the community that might use the standard. The success of a vendor-produced de facto standard like DCE depends very much on the vendor's market penetration. The success of any standard depends on whether the standard solves a problem for a sufficient number of users, with sufficient cost/benefit advantage to make the standards-based solution more attractive than alternative non-standards-based solutions.

The robustness, completeness, stability, schedule, and market acceptance of other aspects of the NII also bear on the success of the OGIS. Everything from the installation schedule of broadband cable to the security of network-based payment schemes will affect the demand for geodata and remote geoprocessing. Reciprocally, working geodata and geoprocessing solutions will help drive the demand for bandwidth, payment schemes, and network-ready devices, as well as the demand for more data and applications.

In the domain of GIS, the standards work of the FGDC and other groups focused on institutional solutions to interoperability will contribute to acceptance of OGIS-based solutions. These groups are focusing the attention of tens of thousands of traditional GIS users. These users will be motivated to publish their data electronically, and at the same time their need for data will increase the demand for remote access to others' data. The expense of manually bringing data into conformance will, we believe, often be greater than the expense of using OGIS-based automated methods, thus increasing the demand for OGIS-based solutions.

Factors in making the Business Case: Who will build the OGIS and why?

The Open GIS Consortium, Inc. (OGC) is a unique membership organization dedicated to open system approaches to geoprocessing. By means of its consensus building and technology development activities, OGC has had a significant impact on the geodata standards community, and has successfully promoted the vision of "Open GIS" as the vehicle for integration of geoprocessing with the distributed architectures of the emerging worldwide infrastructure for information management.

OGCís direction is set by a board of directors selected for their ability to represent key constituencies in the geoprocessing community. The OGC board speaks on behalf of both public and private sector users interested in finding more integrated and effective ways to use the worldís increasing wealth of geographical information to support problem solving in such areas as environmental monitoring and sustainment, transportation, resource management, global mapping, agricultural productivity, crisis management and national defense.

The OGIS Project Technical Committee of the OGC operates according to a formal consensus process structured to be fair and equitable and to ensure the technical completeness of the specification. To ensure the eventual adoption of OGIS as an official standard, the OGIS Technical Committee is represented on key geodata, GIS, and geomatics standards committees, including the ISO (International Standards Organization) TC211 GIS/Geomatics Committee and the ANSI (American National Standards Institute) X3L1 Committee. In addition, the OGIS Technical Committee maintains close ties to the Federal Geographic Data Committee (FGDC).

The OGIS Project Management Committee is composed of representatives from the Technical Committee, representatives of the Principal Member organizations, and others who represent particular constituencies. The Management Committee maintains a business plan for the Project and sets overall policy for the Project. The dual committee structure serves to separate technical and political issues.

OGC was founded to create interoperability specifications in response to wide-spread recognition of the following problematical conditions in the geoprocessing and geographic information community:

The multiplicity of geodata formats and data structures, often proprietary, that prevent interoperability and thus limit commercial opportunity and government effectiveness.

The need to coordinate activities of public and private sectors in producing standardized approaches to specifying geoprocessing requirements for public sector procurements.

The need to create greater public access to public geospatial data sources.

The need to preserve the value of legacy GIS systems and legacy geodata.

The need to incorporate geoprocessing and geographic information resources in the framework of national information infrastructure initiatives.

The need to synchronize geoprocessing technology with emerging Information Technology (IT) standards based on open system and distributed processing concepts.

The need to involve international corporations in the development and communication of geoprocessing standards activity, particularly in the areas of infrastructure architecture and interoperability, in order to promote the integration of resources in the context of global information infrastructure initiatives.

OGC is a not-for-profit corporation supported by Consortium membership fees, development partnerships, and cooperative agreements with federal agencies. As of April 26, 1995 the Consortium included 40 members. Though organized to manage multiple project tracks, OGCís initial focus is on the development of the OGIS. OGC plans to establish other project tracks in areas related to implementations of the OGIS architecture.

Who will use the OGIS and why?

The OGIS will be used by at least the following groups:

Software vendors have already begun writing software that conforms to the object-based paradigm exemplified by the OGIS. GIS Database, visualization, desktop mapping, and application tool vendors will all be able to provide capabilities that will seamlessly integrate into applications targeted for specific end-user communities. Just as the new paradigm will transform monolithic desktop applications into environments of compatible components (such as printing modules that work with spreadsheet or word processor, making it unnecessary for the spreadsheet or word processor to contain its own printing software), OGIS-based components will perform specific analysis and display functions, and they will work seamlessly with other non-GIS applications.

Integrators working on systems that require the ability to access geodata and geoprocessing resources are already building OGIS compliance into their frameworks.

Data providers, public and private, who are preparing to serve data across networks, are planning and prototyping encapsulation schemes and database approaches that will depend on the OGIS. This group will ultimately include public digital libraries; remote sensing data vendors like SPOT and EOSAT; state and federal agencies that need to distribute data to agency offices and/or that are obliged to make their data publicly available; major corporations with spatial data in their corporate databases; military intelligence, planning, and training groups; etc.

Ultimately, the OGIS will be an invisible but essential enabler of ready access to remote geodata in all of the application areas mentioned above, and probably in others that we have not imagined. Like other standards, it will not be noticed or understood by most people who use it. It will make an extraordinarily complex activity simple.

What can the Federal Government do to facilitate the process?

Many agencies of the Federal Government have a critical interest in geodata interoperability, and some are already providing support to OGC. Though most of OGC's funding and technical participation comes from the private sector, OGC was started with funding from the US Army Corps of Engineers Construction Research Laboratories (USACERL) and the DoA Natural Resources Conservation Service (NRCS). Both of these agencies are still involved with OGC. Also, the Universal Spatial Data Access Consortium (USDAC), a NASA-funded digital library technology project, has joined the OGIS Testbed Program of OGC. Funding for USDAC comes from a Cooperative Agreement Notice, "Public Use of Earth and Space Science Data Over the Internet," provided by NASAís High Performance Computing and Communications Program. Other Federal agencies that are members include USDoC NOAA-Nautical Charting Division, USDoD Defense Mapping Agency (DMA), and USDoI Geological Survey - National Mapping Division.

Other Federal agencies with a critical interest in geodata interoperability would benefit from participating in the development of the OGIS, because their specific needs would be represented and they would be in close touch with the organizations best able to help them. Also, their support would help ensure timely completion of the OGIS and thus they would begin to reap the benefits of OGIS-based solutions as early as possible.

The Federal Government can also encourage other distributed computing standards efforts upon which the OGIS will depend, such as the Object Management Group's Common Object Request

Broker Architecture (CORBA). The OGIS will have value in non-distributed environments, but its greatest potential lies in the potential for remote geodata access.

Perhaps the most important way the Federal Government can help the cause of geodata interoperability -- which is to say, to bring the NSDI into the NII -- is to make the OGIS Project a special focus for the National Information Infrastructure Task Force (NIITF). Technology policy at the NIITF level needs to stress private sector support for the standards activities of OGC. The NIITF is positioned to strongly encourage major corporations, particularly telecommunications companies, to put significant resources into supporting OGIS development work, testbed activities, and finally, OGIS-based products and services. The NIITF can provide solid leadership in showing major corporations why this kind of interoperability ought to be viewed as a high priority development issue.

Projections, including barriers:

OGIS-based implementations will become available in the same time frame in which underlying and auxiliary NII capabilities will become available. Early prototype work has begun at testbed sites, even though the specification is not complete. The specification will be complete in about a year, and several testbed projects and independent efforts by vendors are expected to begin yielding useful implementations at about that time. The OGIS merely prepares the world of geodata and geoprocessing to participate in the general progress of Information Technology (IT) that industry experts forecast. The OGIS is being developed concurrently with other essential software standards and components of the NII that will be developed, released, and tried in the real world of the marketplace in the next five years.

Dissension in the software community is the principal barrier to this general progress and to the progress of geodata interoperability. The long history of UNIX shows how industry giants seeking dominance can thwart standards efforts and stunt the growth and acceptance of a useful technology. Every standards consortium confronts the tendency for industry leaders to fly apart because of competitive issues. From the standpoint of the OGIS, it is important that underlying standards like CORBA and DCE succeed, and that the members of OGC stay true to the vision of geodata interoperability across the industry.

4 Recommendations

How can the problem be addressed by a public and private partnership?

As described above, the problem of geodata non-interoperability is being addressed by a standards consortium, the Open GIS Consortium. OGC is developing not another geodata standard, but a standard approach to using distributing computing methodologies, primarily object technology and RPCs, in geodata and geoprocessing applications. participation by public and private organizations is particularly important in this case because so many public agencies are critically dependent on geodata and geoprocessing, and because most geodata is a product of public agencies. The public agencies have everything to gain and nothing to lose from their support of OGC, because 1) the OGIS Project gives them an opportunity to increase the certainty that the specification, and solutions based on it, will meet their needs, 2) agency representatives have the opportunity to learn about and learn from the most knowledgeable technology providers, and 3) the capabilities unleashed by the OGIS will enable them to vastly improve their ability to fulfill their missions.

OGC members, public and private, recognize the wonderful opportunity afforded by the timing of this effort: At this point in time, no vendor has dominated the market with object-based GIS solutions that might hinder the effort to create a rational, comprehensive, standardized approach that can potentially benefit everyone. Vendors and integrators have, through the consortium, an opportunity both to involve sophisticated users in their common technology specification effort, and to share the costs of this development. All of the members believe that their collective efforts will lead to greatly expanded markets, though they also recognize that their existing products and services will need to change to accommodate the new paradigm. Most understand that change is inevitable in the IT industry whether they embrace it or not, and OGC offers a way for them to exert a degree of control, stay at the leading edge, and make relatively sound business projections.

OGC's goal is to create successful standards for geodata interoperability, and many of the discussions surrounding its founding focused on the failings of other consortia that tried and failed in their attempts to create standards. Leading consortium lawyers and experts in technology standardization contributed to the formation of OGC and its bylaws, and their guidance continues. The challenge is to carefully craft an organization and a set of goals that make all participants winners, and to be sure that all the interests of all affected constituencies are represented.

OGC has a unique organizational structure that resulted from the process described above. It has a Board of Directors, a full-time professional staff, and separate project tracks. The Board of Directors has responsibility for approving business plans from each track, for organizing new tracks, and for setting overall Consortium direction and strategy. Each project track has its own membership and is managed by a Management Committee that is responsible for strategic and business planning, technical oversight, and product approval. (OGC products are IT standards related to geodata interoperability.) Each track also has a Technical Committee responsible for technology development and mediation of the different technical views of the membership. A testbed program in each track coordinates early implementation efforts and provides feedback to the Technical Committee. The Technical Committee is responsible for product development, which it then delivers to the Management Committee for final approval. This organizational structure isolates technical issues from management issues and allows a better overall progression of product development. It also isolates the Board from each project track.

The NIITF is positioned to help OGC succeed by encouraging key NII-building companies to participate in OGC's efforts. Clearly, the technology policy mission of the NIITF is perfectly aligned with the mission of OGC. But OGC also offers the NIITF a higher-level benefit: the opportunity to observe and evaluate a state-of-the-art consortium that may be the forerunner of tomorrow's technology policy planning bodies. The continuing acceleration of technological change forces a new, more anticipatory and proactive approach to technology policy planning, an approach based on community-wide discussion of objectives followed by development of standards that channel vendors' efforts in agreed-upon directions.

5 References

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