GSDI Depends on Widespread Adoption of OGC Standards

Mark REICHARDT, USA

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SUMMARY

OpenGIS© Specifications for interfaces and encodings that enable interoperability between geoprocessing systems are an essential part of the GSDI. Just as email and the World Wide Web – based on standards – have revolutionized communications in both developed and developing nations, OGC standards are revolutionizing communication involving geospatial information. Exchanging GIS data between systems has become much easier. It also it is becoming much easier and less expensive to integrate all kinds of spatial data, including GIS, remote sensing, database records, AEC and facilities mapping, navigation and location services, and to integrate this spatial information into applications of all kinds. In the OGC Web Services environment, an application requiring a service such as a coordinate transformation service or a pixel classification service can make use of such a service hosted halfway around the world. The standards platform also provides a level playing field that encourages competition among software providers and among commercial data providers, and this competition benefits users.

Most vendors of geoprocessing software have implemented OpenGIS Specifications in their products, and an increasing number of major procurements require that products comply with OpenGIS Specifications. Open source geoprocessing software developers are providing implementations of the specifications that are useful for commercial providers and also for solution providers who provide the "glue" between various commercial and non-commercial components. Because network access to legacy systems and data is important, most vendors offer upgrades that provide OpenGIS Specification Compliant open interfaces.

The OGC will continue to provide new GSDI-enhancing standards. Strategies using existing OGC specifications enable an unprecedented degree of information interoperability ("semantic translation" between data models), a longstanding user community requirement at the local, regional, national and international levels. Work is onging in areas such as intellectual property rights management, sensor webs, and geospatial "fusion" of multimedia data. This progress depends on sufficient participation by users and providers of geospatial technology, and on vendors' and buyers' commitment to implementing and demanding standards.

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1. INTRODUCTION

The Global Spatial Data Infrastructure (GSDI) is an infrastructure for communicating geospatial information. Communication means “transmitting or exchanging through a *common system* of symbols, signs or behavior.” Standardization means “agreeing on a *common system*.” Thus, continuing global adoption of the technical geoprocessing standards developed in OGC's global consensus process is critical to the development of the GSDI.

The OpenGIS® Implementation Specifications described below have been approved by OGC's international membership:

1.1 Web-based Specifications

OpenGIS Catalog Services Specification defines common interfaces that enable diverse applications with these common interfaces to perform discovery, browse and query operations against data metadata and services metadata held in distributed and potentially heterogeneous catalog servers.

OpenGIS Filter Encoding Specification defines a standard encoding for query predicates using XML. Using XML encoding, a query operation can be defined that retrieves objects that lie in a particular region.

OpenGIS Geography Markup Language Specification (GML) defines a data encoding in XML – an XML "namespace" – for geographic data and its attributes.

OpenGIS Styled Layer Descriptor Specification (SLD) provides a standard way to associate presentation rules with properties of features.

OpenGIS Web Feature Service Specification (WFS) supports the dynamic access and exploitation of feature (vector) data and associated attributes.

OpenGIS Web Map Context Documents Specification works with the OpenGIS Web Map Service Specification to describe how context information can be defined in XML and saved so that web maps created by users can be reconstructed and augmented by the user or other users in the future.

OpenGIS Web Map Service Interface Specification (WMS) provides uniform access by Web clients to maps rendered by map servers on the Internet.

OpenGIS Web Coverage Service Interface Specification (WMS) extends the Web Map Server (WMS) interface to allow access to geospatial "coverages" that represent values or properties of geographic locations, rather than WMS generated maps (pictures).

1.2 Specifications that are not Web-based

OpenGIS Coordinate Transformation Services Specification provides a standard way for software to specify and access coordinate transformation services for use on specified spatial data.

OpenGIS Grid Coverages Specification specifies interfaces that provide for requesting and viewing a grid coverage and performing certain kinds of analysis such as histogram calculation, image covariance and other statistical measurements.

OpenGIS Simple Features Specifications for OLE/COM, Simple Features for CORBA and Simple Features for SQL specify interfaces for OpenGIS Simple Features that are tailored for three different distributed computing platforms other than the World Wide Web.

Interfaces and encodings based on these specifications enable diverse software applications and web services to discover and use geodata and geoprocessing services on remote servers that implement the same OpenGIS specification. Hundreds of products now implement these specifications.

Fortunately, around the world, in programs like Europe's INSPIRE, the USA's Geospatial One-Stop, Spain's IDEE, and Canada's National Forest Information Service, OGC's geoprocessing interoperability standards are being cited as Spatial Data Infrastructure (SDI) requirements.[1]

Such mandates are essential, but are they being followed? Are OGC standards "catching on?" How many public sector and private sector data providers are making their data, or views of their data, discoverable and available on the World Wide Web through interfaces that implement these specifications?

2. TESTING THE EXTENT OF ADOPTION

On January 17, 2005, at the opening plenary meeting of the OGC Technical Committee, Paul Ramsey of Refractions Research (http://www.refractions.net) (Canada) reported the results of a study (www.refractions.net/ogcsurvey) he undertook late in 2004 to identify publicly addressable OGC based services. He created a SOAP (Simple Object Access Protocol) tool that used a Google API to "google" the entire internet for OGC-based web services. The tool first looked at each of the 8 billion URLs on the internet to see if it contained a URL pattern with "Request=GetCapabilities." It then checked to get answers to the following questions:

- Can we connect to that URL?
- Does it return XML we can parse?

[1] These standards are necessary but not sufficient. For geospatial content, the ISO 19115 and ISO19119 metadata standards are considered to be industry best practices, and are usually part of NSDI mandates.

Then the tool stored the URL and XML in a database, and it extracted the names of the WMS layers and stored them, too.

He found, in January, 2005:

	175	Web Map Servers
+	17	Web Feature Servers
+	16	Web * Servers (Web Coverage Servers, Web Terrain Servers, etc.)
+	14	Standard Errors
=	222	Open Geospatial Servers

These servers were in: the United States (79), Canada (68), Germany (32), Australia (11), United Kingdom (6), Netherlands (5), and other (17).

All together, 9253 WMS layers were accessible through the 175 WMS servers.

222 servers is lower than we might expect. But, as Paul Ramsey explained, this number does not represent OGC web services that are:

- Behind firewalls, in the classified environment, or on other private servers
- On servers with no public link to a Capabilities document (effectively private servers.)
- Servers with a link that does not include “request=getcapabilities” (a non-clickable link)
- Servers not otherwise yet harvested by Google's crawler

Also, as he points out, the numbers change with each Google index update.

Ramsey expects the February update will show another increase, but there is clearly a need to make OGC Web Services more discoverable, both for use of those services and to help advance the build out of local, national, regional and global SDI’s.

3. THE CALL FOR A SERVICE REGISTRY

On the web, "web crawlers" like Google's create indexes for efficient text searches of the web's many text resources. The discoverability of these resources adds to their value, and their discoverability adds to the overall value of the web and applications that use it. That value multiplication factor motivates more people, businesses and organizations to make their information available on the web.

How do we motivate the hosting of more geospatial data and geospatial services on the web, through open – and thus "web-like" – interfaces? How do we create the supportive environment in Google and other search engines for discoverability of geospatial resources? Doug Nebert of the US Federal Geographic Data Committee, speaking to the OGC Planning Committee on January 21, 2005, suggested that we use UDDI (see below) to register, explore and mine services. We have lots of communities who are interested in these resources, so we need to implement a "public library" model to register and parse the services.

Doug Nebert reiterated that Paul Ramsey's survey of Googled WMS and WFS accessible resources significantly under-represents the available OGC services. The study also underscores the fact that the number, type, quality and reliability of services is unknown. A registry of all OGC Web Services is needed for the community – a global Online Service Directory. Construction of applications or portals depends on such a 'yellow pages'. The capability does not yet exist, though the components are available.

A recent OGC internal document (OGC Document 04-060) presents the result of the OWS 2 Common Architecture thread, which yielded guidelines on adding WSDL/SOAP/UDDI support to existing OpenGIS Web Services.[2]

UDDI (see footnote) is a set of standards-based specifications for service description and discovery, being developed by industry and business, in an effort led by Microsoft, IBM, and SAP. Although UDDI can be used to integrate and locate services within a private business intranet, it is also the basis for a global business registry that describes businesses (service providers), their service offerings, and the means by which one can connect to a service (bindings). It provides links to service type descriptions and other classification schemes to assist in finding services. The 'public UDDI' is realized through the associated Universal Business Registry (UBR) or "Public Cloud" – a set of UDDI Registries that form a global distributed registry of information about web services. UBR nodes, including those managed by Microsoft, IBM, and SAP, replicate the content of the Public Cloud. A common set of SOAP APIs is supported by all nodes. Private UDDI registries, built for businesses or entire communities, can be synchronized with the UBR for public promotion of Web Services outside the traditional OGC community.

A community UDDI synchronized with the UBR could publish a directory of all known OGC Web Service instances: Web Map Servers, Web Feature Servers, Catalogs (Z39.50), Web metadata folders, and Web Applications. It would answer the question, "What services exist globally?" An organization operating an OGC service could register their service with an OGC catalogue or, through a simple form, the OGC community UDDI. National or regional

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[2] As defined in OGC Document 04-060:

SOAP is a lightweight protocol for exchange of information in a decentralized, distributed environment. It is an XML based protocol that consists of three parts: an envelope that defines a framework for describing what is in a message and how to process it, a set of encoding rules for expressing instances of application-defined datatypes, and a convention for representing remote procedure calls and responses. SOAP can potentially be used in combination with a variety of other protocols....

Universal Description, Discovery and Integration, or UDDI, is the name of a group of web-based registries that expose information about a business or other entity[2] and its technical interfaces (or API's). These registries are run by multiple Operator Sites, and can be used by anyone who wants to make information available about one or more businesses or entities, as well as anyone that wants to find that information.

WSDL is an XML format for describing network services as a set of endpoints operating on messages containing either document-oriented or procedure-oriented information. The operations and messages are described abstractly, and then bound to a concrete network protocol and message format to define an endpoint. Related concrete endpoints are combined into abstract endpoints (services). WSDL is extensible to allow description of endpoints and their messages regardless of what message formats or network protocols are used to communicate....

catalogues and portals would use the UDDI both as a place to publish links to known services and as a resource to locate, harvest, and support more detailed search on the services and data found. From a multi-disciplinary, global perspective, users with an interest in available services across all communities of practice would be able to use the OGC community UDDI to find all available OGC catalogues, as well as individually-registered OGC services for more detailed query and assessment.

If such a directory were available, OGC Web Service implementers and testers would have a ready base of targets with a known level of compatibility. UDDI Version 3 also supports two-way assertions about Web Services that could be used to affirm and confirm the quality and conformance of services to given specifications. Applications, portals and catalogs would have a place to begin deeper queries to locate potential services for harvest or inclusion. The OGC community would then have a way to determine the number, location, quality, and diversity of online services available. And OGC services would be advertised into a wider Web Services community through the UBR, so more people could use them and thereby increase their value.

Such a directory should be maintained as an OGC public resource. However, it would require collaboration with affiliated organizations (GSDI, national SDIs, Communities of Practice) for adoption and promotion. For the resource to be viable, OGC, its implementing members, and SDI organizations would need to jointly shape and adopt policies and practices to populate and update the directory.

4. ON THE WAY TO REGISTRIES: CANADIAN FORESTRY SERVICE

The following description of the Canadian National Forest Information System (NFIS) is excerpted from an article in the March, 2005 issue of *GeoSpatial Solutions,* "Open, Standards Based Architectures Scale Up," by Carl Reed, Chief Technology Officer, OGC. It demonstrates why and how a major government agency undertakes to build a geospatial data sharing system based on OGC Web Services. The WMS and WFS services online in NFIS are among those that were found by Paul Ramsey's search tool. They are currently accessible through the NFIS portal and would be easily registered in a Universal Business Registry like that described by Doug Nebert. The NFIS team has contributed, with GeoConnections, to the OpenGIS Catalog Interface Specification v2.0, which addresses service registries as well as data registries.

4.1 The Challenge

In August 2000 the Canadian Council of Forest Ministers (CCFM) agreed on the need to establish an information infrastructure, called the National Forest Information System (NFIS), to support reporting on sustainable forest management in Canada. The Ministers charged the CCFM-NFIS Steering Committee with the phased implementation of NFIS addressing issues such as governance model, information needed, opportunities for co-operation and co-ordination, and prior investments in their inventory programs.

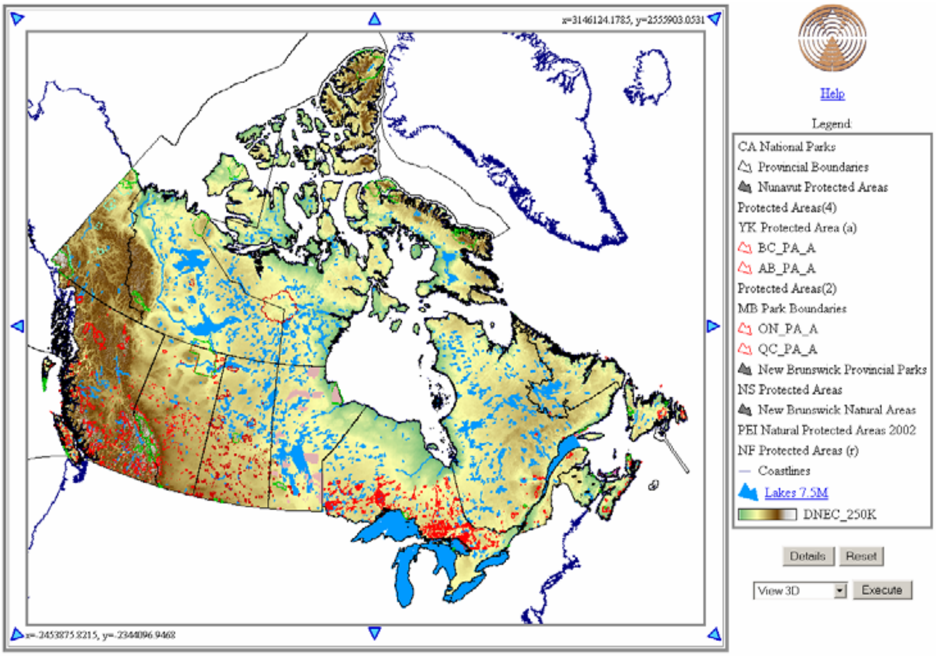


Figure 1: This map, composed of data from a variety of servers, overlays provincial parks and protected areas (red) and national parks (green), major water bodies and jurisdictional boundaries.

4.2 Defining Principles for the NFIS approach to an Open Architecture for a Portal

As Dr. Robin Quenet, Project Manager, Canada's National Forest Information System (NFIS) put it, "We needed to rationally address data sharing." The NFIS team studying the problems associated with multiple data sources developed four key principles:

- The solution had to be vendor neutral. ("We didn't want to buy into a single system.")
- The solution had to have a low cost of entry. (Funding for partners varied widely.)
- The solution had to ensure that intellectual property rights stayed with the agency/government that created the data.
- The solution, to address low cost of entry, should have an open source option. (Open source software is software for which the original source code is made available so that users can modify and redistribute it.)

During 1998 and 1999, The Canadian Forest Service (CFS) of Natural Resources Canada (NRCan) had studied alternative approaches to integrating their spatial information holdings. The fourteen CCFM partner organizations had to provide a variety of different forest reports; they wanted to make effective and efficient use of their diverse investments in IT and data; they wanted to be able to choose new technology in the future; and each organization wanted to maintain responsibility for their own data and, at the same time, make their data available for broader use by others.

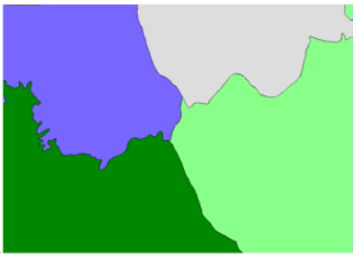
CFS dubbed the vision "distributed interoperability." Soon CFS received the support of the Canadian Council of Forest Ministers (CCFM), the federal, provincial and territorial ministers responsible for forests. The collaboration of GeoConnections, CFS and CCFM resulted in the National Forest Information System (NFIS), an initiative to implement the necessary standards-based information technology framework to support sustainable forest management reporting in Canada. The NFIS Project Office, staffed by CFS scientists, was established to deliver the information technology framework.

4.3 Making it Happen

NFIS was one of the earliest implementers of OGC Web Services. Rick Morrison, former NFIS Technical Lead, selected CubeWerx's implementation of the OpenGIS Web Map Service Specification (WMS) even before WMS was fully implemented in CubeServ, the server-side product. As an early adopter, NFIS was able to share its requirements, test out new versions, and actively participate with the CubeWerx development team.

At the same time, Brian Low, Geospatial Scientist and now NFIS Technical Lead, learned of the University of Minnesota's open source MapServer Web mapping solution and began speaking to Steve Lime from Minnesota Department of Natural Resources, one of its key developers. Lime pointed him to a Canadian company, DM Solutions, a group just beginning its work with MapServer. Low explained to DM Solutions that for the NFIS vision to work, MapServer would need to support WMS. Not long afterward, DM Solutions, with funding from CFS, CCFM and GeoConnections Access, began work. Funding from CCFM and GeoConnection GeoInnovations fueled further NFIS-required enhancements to the open source MapServer.

Several of the NFIS partners already had Web mapping solutions, including ESRI's ArcIMS, and they crafted their own solutions to make them compatible while waiting for WMS-compliant vendor offerings. One CARIS user went directly to the vendor to explain the necessity of the addition, and the open interface appeared in the software not long afterward. NFIS was pleased with the fast turnaround of several small Canadian firms in meeting its partners' needs.

1  2  3 

IOPA (Image Overlay chained to Pixel Area) Report

Total Area = 2115083.669 ha

Bounding Box: CRS = EPSG:42102 Min x = 1098138.117812704 Min y = 1277780.129734528 Max x = 1273355.895587296 Max y = 1409193.463065472

Resultant				Image 1		Image 2	
Name	Colour	Area (ha)	Pixel Count	Name	Colour	Name	Colour
Protected Boreal Plains		64.414	22	Boreal Plains		Protected Area	
Protected Taiga Plains		4854.460	1658	Taiga Plains		Protected Area	
Protected Montane Cordillera		81070.658	27689	Montane Cordillera		Protected Area	
Protected Boreal Cordillera		82856.678	28299	Boreal Cordillera		Protected Area	
Non-Protected Taiga Plains		430287.298	146961	Taiga Plains		Non-Protected Area	
Non-Protected Boreal Cordillera		473418.212	161692	Boreal Cordillera		Non-Protected Area	
Non-Protected Montane Cordillera		490628.415	167570	Montane Cordillera		Non-Protected Area	
Non-Protected Boreal Plains		720749.744	246166	Boreal Plains		Non-Protected Area	

Figure 2: An online service allows users to combine raster data. Here map 1 which depicts ecozones is intersected with map 2, which depicts protected areas (red is protected, gray is not protected). Map 3 shows the result and the accompanying area report . For now this application requires a client-side installation, but in time, the plan for the entire application to reside on the server.

Today, about 2/3 of the NFIS partners are running MapServer, with implementations of CARIS Spatial Fusion, CubeWerx' CubeServ, ESRI's ArcIMS and other products filling out the roster. Partners are sharing data in ways not dreamed possible only a few years ago.

The CFS has recently mounted an initiative to deploy an interoperable infrastructure, dubbed CFSNet, across the Canadian Forest Service. CFSNet, which leverages NFIS developments, will provide the infrastructure for sharing and integrating research information holdings held on a distributed network of servers located across Canada. It will have full connectivity with NFIS and hence connectivity to federal, provincial and territorial information holdings and visa-versa. Additionally, the system will allow granting of access to external agencies for the access to CFS information holdings and provide the necessary infrastructure for Web based access to external agency information holdings. As part of this initiative the Canadian Forest Service is building a packaged ‘CFSNet-in-a-Box’ which will include hardware and software requirements and provide a downloadable baseline system for OGC compliant services and applications including full documentation and configurations. The applications being supported include servers and clients of WMS, WFS, WCS, GDAS and a number of mid-tier focused applications leveraging existing OGC services.

4.4 Security Considerations

With data sharing come data security concerns. Some of the data involved in the required reports is quite sensitive. Some is tied to cost recovery and requires a "payment for use." Some provinces feel strongly about controlling what data is released to the federal government. Those issues meant that just linking up a series of WMS servers would not solve all of CCFM’s needs. "Security is paramount," says Low.

Security is a key part of the NFIS system. All users are carefully screened before being given credentials to use the system. The public has a simpler registration process but more limited access to the capabilities of the NFIS portal application.

What NFIS needed wasn't a simple security solution with a password, but one that went deeper. The security solution would need to set security by coverage (layer) of spatial data. After contracting with another small Canadian firm, Distributed Systems Software, Inc. of Richmond, BC, NFIS had what it needed.

In 2002 the software was made open source and the resulting security architecture was incorporated into an OGC interoperability report as part of the Critical Infrastructure Protection Initiative work on a security standard. CubeWerx was the lead on this initiative. OGC interoperability reports often lead to approved OGC specifications.

4.5 Beyond the Current OpenGIS Specifications

The NFIS Project Office has developed a number of "mid-tier services" that are essentially small, focused specifications for web services. One, for example, is a service that allows for WMS servers to contribute thematic layers as jpegs that are then processed to form a new map using spatial analysis functions such as intersect, buffer, and "corridor." The service returns the intersected image along with the resultant areas. Quenet notes, "It's perfect to find out if an area is worth exploring further with detailed data and robust desktop analysis software." NFIS is working on other "mid-tier services" such as a tool to run simple statistics on attribute data, then run more detailed reports on attributes of interest. The NFIS team hopes one day these mid-tier services will filter back to OGC for inclusion in its set of specifications.

Other organizations implementing OGC Web Services also bring their requirements to the specification development process. And increasingly, as enterprises become familiar with service-based architectures, designers of these architectures discover how geospatial services work with other kinds of enterprise services. Catalogs and registries, as described above, draw heavily on non-spatial technologies. Other areas where OGC's specification work is branching out include:

- CADD/Geospatial data and service integration, necessary to enable integration of building and other AEC (architecture/engineering/construction) data with geospatial data
- Geospatial Digital Rights Management (GeoDRM). With the implementation of OGC web services, we need to test our standards with mainstream standards based DRM capabilities to verify that licensing, pricing, authentication and other related issues can be dealt with.
- Sensor Web Enablement. OGC is drawing from OASIS standards to provide web notiification and alert capabilities for OGC’s growing SWE framework, which is also being harmonized with IEEE sensor and actuator control standards.
- Web Processing Service. Members of OGC are participating in a Web Processing Service Interoperability Experiment to test and refine a draft implementation specification that enables geoprocessing via the Internet. The draft specification is described in the Web Processing Service (WPS) Discussion Paper[3]. This specification can be used to implement any kind of geospatial calculation or model as a web service, so that it can easily be found and invoked by a client.
- Geo-Decision Support Services (GeoDSS). OGC's OWS-2 testbed included DSS as part of the Image Handling for Decision Support (IH4DS) thread which provided for chaining of image processing services. In the upcoming OWS-3 testbed, GeoDSS will include service chaining, information interoperability and an integrated DSS client.

Deployment of OGC Web Services becomes increasingly attractive as the scope of this set of spatial services expands to dovetail with other technology domains that are also important parts of enterprise architectures. Service based architectures that specify open interfaces will not suddenly displace all older systems, but the trend is clear, across application and technology domains. We believe that adoption of OGC Web Services will follow this trend.

REFERENCES

Douglas Nebert, FGDC Secretariat. "Establishing a Global Directory of Services for Multiple Uses," Presentation to the OGC Planning Committee, January 21, 2005. ddnebert@fgdc.gov .

Paul Ramsey, Refractions Research. "A Census of Public OGC Web Services," Presentation to the OGC Planning Committee, January 21, 2005. pramsey@refractions.net .

Carl Reed, OGC. "Open, Standards Based Architectures Scale Up," *GeoSpatial Solutions,* March, 2005.

Jerome Sonnet, IONIC Software. "WSDL SOAP UDDI," OpenGIS IP initiative document (DIPR) (OGC Document 04-060), August 20, 2004. js@ionicsoft.com.

[3] The Web Processing Service (WPS) Discussion Paper can be found at http://www.opengeospatial.org/specs/?page=discussion .

BIOGRAPHICAL NOTES

Mark Reichardt is President of the Open Geospatial Consortium, Inc. (OGC). Mr. Reichardt has overall responsibility for Consortium operations, overseeing the development and promotion of OpenGIS® standards and working to ensure that OGC programs foster member success. Mr. Reichardt joined the Consortium in November 2000 as Director of Marketing and Public Sector Programs and became the President of OGC and a member of the Board of Directors in September, 2004.

Before joining the OGC, Mr. Reichardt was involved in a number of technology modernization and production programs for the Department of Defense. In the mid 1990's, he was a member of a DoD Geospatial Information Integrated Product Team (GIIPT) formed to help transition the DoD mapping mission to a more flexible and responsive geo-information based paradigm. Under Mr. Reichardt's leadership, the GIIPT Production Team validated the ability of commercial off the shelf hardware and software to meet many of the DoD functional requirements for geospatial production operations.

In 1998, Mr. Reichardt accepted a temporary assignment with the Administration to improve federal to local coordination in the use of geospatial information and technologies to improve decision-making. In early 1999, Mr. Reichardt was selected to establish and lead an international Spatial Data Infrastructure (SDI) program for the Federal Geographic Data Committee. In this position, Mr. Reichardt helped to establish globally compatible national and regional SDI practices in Africa, South America, Europe, and the Caribbean. He was instrumental in establishing several nation-to-nation collaborative agreements regarding SDI. Mr. Reichardt serves on the Board of Directors of the Global Spatial Data Infrastructure Association.

Mr. Reichardt holds a Bachelor of Science Degree in Agriculture from the University of Maryland. He has also pursued graduate studies in Telecommunications Management at Maryland.

CONTACT

Mark Reichardt
Open GIS Consortium (OGC), Inc
483B Carlisle Drive
Herndon VA 20170
USA
Tel. + 1 301 840 1361
Fax + 1 301 840 0198
Mobile + 1 301 466 0263
GSM + 1 240 899-8026
Email: mreichardt@opengis.org
Web site: http://www.opengeospatial.org