Article for Geospatial Today's July/August 2005 special edition on Standards and Interoperability

Title: **Open Geospatial Standards – Key to Global Markets**

Author: Mark Reichardt
President
Open Geospatial Consortium (OGC), Inc.
483B Carlisle Drive
Herndon VA 20170
+1 301 840-1361 Voice
+1 240 899-8026 GSM
mreichardt@opengeospatial.org

1 Introduction

Tens of thousands of kilometers of optical fiber laid around the world in the last decade are now highways for high speed digital communications. One consequence is that software developers, data providers, portal providers, expert users of geospatial software, application providers, and knowledge workers of many other kinds now have access to an unprecedented global market.

Another consequence is that businesses and those who would start Web-based businesses now have access to a gold mine of useful knowledge. Anyone can get on the Web and discover software interface and data encoding specifications, business plans, business opportunities, best practices, source code examples, tutorials, products and commentary that are useful in starting and running a Web-based business.

Much of this progress is a result of standards and interoperability. Now, users and providers of information technology in both the developed and developing nations are discovering the role that geospatial standards can play in this great opening up of opportunity. In this article, we look at the Open Geospatial Consortium's (OGC)'s international, open geospatial standards and look at how open standards can support business development in any country.[1]

2 An open standard is an open, common system for communication.

Standardization is the reason for the success of the Internet, the World Wide Web, e-Commerce, and the mobile wireless revolution. The reason is simple: our world is going through a communications revolution on top of a computing revolution. Communication means "transmitting or exchanging through a common system of symbols, signs or behavior." Standardization means "agreeing on a common system."

Organizations such as the OGC, the World Wide Web Consortium (W3C), the Internet Engineering Task Force (IETF), OASIS and others are open, consensus standards organizations in the sense that any organization can participate, the topics of debate are largely public, decisions are democratic (usually by consensus), and specifications are free and readily available. Each of these organizations has a different standards focus. Each has their own internal politics (much is at stake!) and no standards organization is perfect. But they are, overall, transparent and democratic international organizations whose visibility, transparency and broad social and economic importance attract careful scrutiny. And they are effective, as evidenced by

[1] This article is adapted from an OGC White Paper, "The Importance of Going 'Open'".

the broad adoption of open standards throughout the global information technology environment. OGC works closely with other standards bodies to ensure that its standards are harmonized and complementary.

3 Open systems and open interfaces

An "open" process is necessary to arrive at an "open" standard. Open systems are usually considered to be systems that interoperate through **open interfaces**[2]. An **interface** is simply a common boundary, a means to make a connection between two software components. An interface on the client presents an ordered set of parameters (with specific names and data types) and instructions (with specific names and functions) to an interface on the server that is structured to read and respond to just such a set of parameters and instructions. Thus an interface enables one processing component to exchange data and instructions with another processing component.

An open interface is an agreed set of variable names and parameters, data types, etc. that enables communication between dissimilar systems.

Some interfaces satisfy part but not all of the "openness" definition above. Systems from some geoprocessing software companies use interfaces that the companies have published for coding by integrators and application developers. From today's perspective, there are reasons not to depend on such **published, but proprietary interfaces**:

The biggest advantage of open interfaces is "build once, access many." With truly open systems, solution providers no longer need to build custom interfaces. Users are no longer isolated in technology **stovepipes**[3] and no longer **captive to ("locked in to") single vendor solutions**[4].

[2] Another paradigm for interoperability is based on *brokers*, such as OMG's Common Object Request **Broker** Architecture. Such a "broker" converts one product's interface into another product's interface "on the fly."

[3] "Stovepipe" is a metaphor commonly used to describe systems that are integrated "from top to bottom" but isolated laterally, i.e., from other systems. A stovepipe system might be a system from a single vendor or it might be a system built by an integrator, but it is not an open system.

[4] "Captive to a vendor" means a buyer must buy from a particular vendor. This might be because all the buyer's potential data sharing partners use that vendor's software, or because the buyer's legacy systems are from that vendor, or because the buyer's institution mandates that purchases shall be only from that vendor.

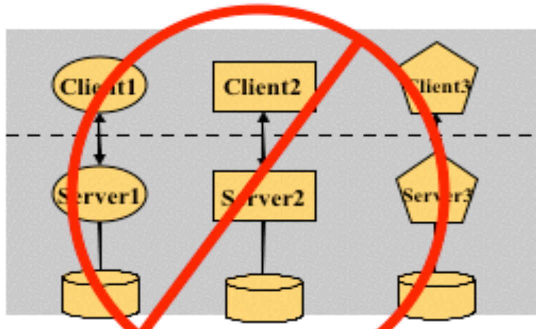


Figure 1: "Stove Pipe" Systems

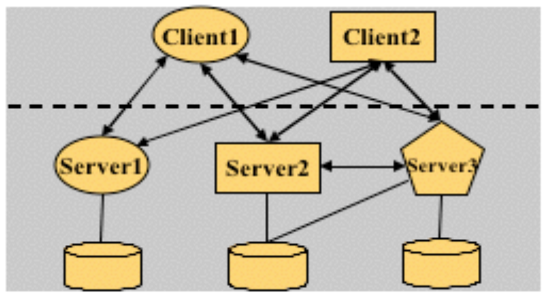
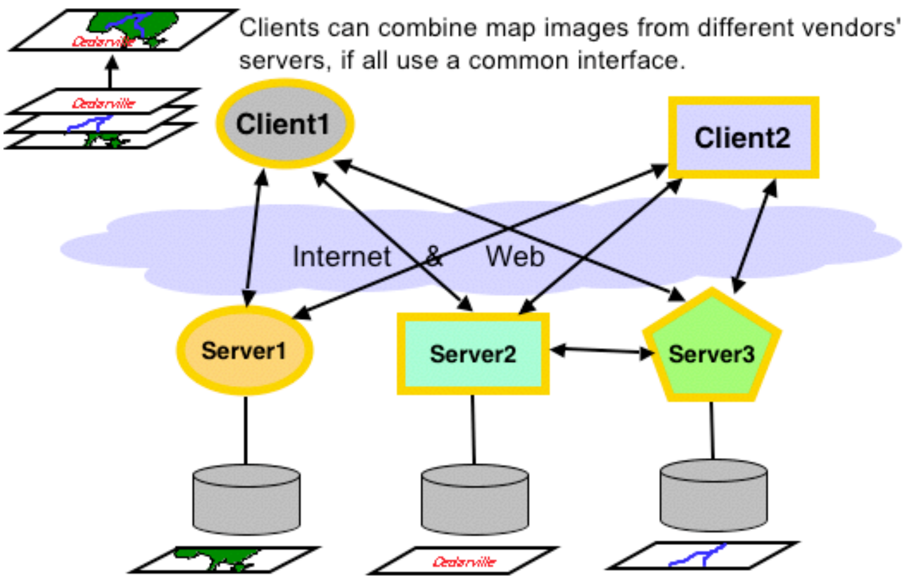


Figure 2: Network of Systems

From time to time, **vendors change or enhance their proprietary interfaces, forcing client systems to change and forcing users to upgrade**, perhaps without notice or opportunity for input. In contrast, the consensus process in a consortium gives users, integrators and developers both notice and opportunity for input, increasing continuity. Open standards impose a few constraints on developers, but there are huge opportunities in using standards, as demonstrated by the explosion of innovation and business opportunity that has resulted from the Web.

Integrators and application developers would spend more time learning how to use multiple proprietary interfaces than they will spend learning how to use OGC's interfaces. One reason **open systems result in greater innovation** is that they remove this burden from development budgets, freeing resources for innovation. One bad result of the old paradigm has been that integrators tend to learn and then use one system exclusively simply because the cost of mastering more than one is too high, which further limits the choices available to the user.

4 User needs underlie the trend toward open geoprocessing



The function of the OGC process it to define, document, and agree to geospatial standards[5], addressing user needs that can only be addressed by cooperation among vendors. Overall, users want to maximize the value of past and future investments in geoprocessing systems and data. That general need points to the following three more specific classes of user needs:

1. The need to share and reuse data in order to decrease costs (avoid redundant data collection), get more or better information, and increase the value of data holdings.

2. The need to choose the best tool for the job, and the related need of reducing technology and procurement risk (i.e., the need to avoid being locked in to one vendor).

3. The need for more people with less training to benefit from using geospatial data in more applications: That is, the need to leverage investments in software and data.

Those three classes of user needs point to the following still more specific needs:

1. The need for organizations to have access to each other's spatial information without copying and converting whole data sets. Users want to be able to pass data and instructions between different vendor's systems. They want to be able to integrate various data models, formats and coordinate systems. They want to visually integrate map displays (symbology) from different data servers. And they want to find and evaluate data and services held in other locations.

2. Users need to have the pieces of a solution work together. This includes: The need to add or replace a capability in a current vendor solution, with minimal integration costs, and have it work seamlessly; the need to understand the interoperability requirements of application domains and define architecture profiles and application design strategies for each; and the need to integrate geoprocessing Web services with mainstream Web services, and to develop "loosely coupled systems" using network-resident services.

---

[5] The OGC sets standards for geographic information systems (GIS) and digital systems for Earth imaging, Web mapping, location based services, surveying and mapping, CAD-based facilities management, Webs of geolocated sensors, navigation, cartography, automated mapping etc.

3. Users typically want to base geoprocessing on the World Wide Web open architecture, which includes common best practices, “reusable” data and Web Services-based components. The Web presents new opportunities/needs that require a standards foundation, such as those below (related OGC initiatives are in parentheses):

   - The need to organize geographic data stored in text and on video, audio, and other media (Geospatial Fusion Services)
   - The need to access and process on-line sensor data from multiple sources (Sensor Web Enablement)
   - The need for Location Based Services portable across devices, networks, and providers (Open Location Services)
   - The need for "semantic translation" from one data model to another (Translating Web Feature Server)

5 Technology providers benefit

Technology providers benefit from standards that meet these user needs, or they wouldn't participate in OGC.

First, providers have the opportunity to cooperatively develop the standards. This reduces each company's development costs, risks and lead time for developing interfaces. Providers also gain early insight into user requirements for interoperability. Products that implement OpenGIS Specifications give providers broader market reach. For example, "third party products" now can be add-ons to multiple platform vendors' product suites instead of just one vendors' suite. This applies both to major geospatial technology vendors seeking to support enterprise systems and to smaller geospatial vendors who want their products to work with those of the major geospatial technology vendors. Developers have opportunities in OGC to demonstrate their capabilities to potential customers and partners, they get to know those potential customers' and partners' needs, and they also get a clearer picture of their competitors' (and potential partners') offerings.

Integrators gain increased economies on system integration and enterprise systems development. They can offer customers more choice of geospatial applications and services that can be plugged into an OpenGIS-ready architecture. They can also offer customers flexibility and vendor freedom in future enhancement of applications and services. (See "Integration needs interoperability" below.)

6 The Spatial Web needs real “openness”

OGC defines an open standard as one that:

1. Is created in an open, international, participatory industry process, as described above. The standard is thus non-proprietary, that is, owned in common.
2. Has free rights of distribution: An “open” license shall not restrict any party from selling or giving away the specification as part of a software distribution. The “open” license shall not require a royalty or other fee.
3. Has free, public, and open access to all interface specifications. Developers are allowed to distribute the specifications.
4. Does not discriminate against persons or groups: “Open” specification licenses must not discriminate against any person or group of persons.

5. Ensures that the specification and the license must be technology neutral: No provision of the license may be predicated on any individual technology or style of interface.

A de facto standard established by one company or an exclusive group of companies or by a government is not an open standard, even if it is published and available for use by anyone at no charge.

7 Frameworks, open architectures, and reference architectures

An **architectural framework** is a tool for assisting in the production of organization-specific architectures. An architectural framework consists of a ***technical reference model***, a method for architecture development and a list of component standards, specifications, products and their interrelationships which can be used to build up architectures. In other words, a "framework" is a broad, high level, conceptual model for a technology system that provides interoperability among diverse systems.

A **Technical Reference Model** (TRM) is a structure that allows the components of an information system to be described in a consistent manner. In OGC, our TRM is ISO RM-ODP[6]. Our architectural framework is the ***OpenGIS Reference Model***[7].

An **interoperability platform** generally refers to the actual interfaces, based on a framework, that are available to support interoperability. An "architecture" is a more specific kind of model, usually for either a specific enterprise information system or a specific vendor's set of products, that lays out in detail how specific types of processing modules will use specific interfaces to enable specific information flows involving specific kinds of data. An "open architecture" is thus an architecture that specifies certain open interfaces and open data models (see "Open formats and GML" below). A **reference architecture** is an open source (see "Open source" below) architecture intended to provide architecture developers with a template and implementation guidance.

8 OpenGIS®, Open GIS®, and open GIS™

OGC registered the trademark "Open GIS" and OpenGIS" in countries around the world to assert the importance of open standards in geoprocessing and to protect its standards with a legal brand. OGC supports compliance testing and certification.

9 Interoperability

Software **interoperability** describes the ability of locally managed and heterogeneous systems to exchange data and instructions in real time to provide *services*[8]. Interoperable systems are generally *distributed* (i.e., at different places on the network), though in OGC's case, interoperability also applies to different types of systems or similar systems from different vendors communicating while running on the same computer.

---

[6] The ISO Reference Model for Open Distributed Processing (ISO RM-ODP) can be seen at http://www.enterprise-architecture.info/Architecture_Standards.htm .

[7] *OpenGIS Reference Model*, OGC document no. OGC 02-077, August 8, 2002. The ORM documents a framework of interoperability for geospatial processing. To download the ORM, visit http://www.opengis.org/info/orm/.

[8] A service here is an activity, such as data access or coordinate transformation, performed by a server component on behalf of a client component.

Typically, proprietary algorithms run unseen in the “black box” component whose public face is the open interface. Some server components will outperform others and/or offer capabilities not offered by others, though they may all communicate with clients through a common interface. In an interoperable environment, competition among vendors is based on such differences in capabilities and performance, and is not based on which format the user’s data is stored in, or which software provides the display function.

Interoperability also refers to interoperability across *time* (evolution of systems over time with **backward and forward compatibility**). When users participate in standard setting, backward and forward compatibility have a high priority.

10 Open platforms

Today, the term *platform* usually describes an application programming interface (API) or set of APIs that provide access to computing power, database, GIS or other services hidden “underneath” those APIs. The acronym “API” is giving way to “interface” in programmer-speak. By the definition of “open” in this article, no single vendor provides an open platform unless all the exposed interfaces are open interfaces, as described below. An open platform needs to be like the IT industry’s Web Services platform, which is still, as of May, 2005, largely unencumbered by proprietary restrictions and is the product of a consensus process.

11 Open formats and GML

In the not so distant past, it was important to know whether your data was in a particular vendor’s (published or unpublished) format, such as SHAPE or DXF, or in an open government format. Now, format is not a major issue when vendors’ systems communicate through open interfaces. People sometimes want to archive whole data sets in the format native to the software they are using, or in an exchange format, but bulk conversion of data files from one format to another is becoming less and less necessary. The new world of "open" enables "transparent" conversion of small amounts of data “on the fly” when the data are needed. This avoids the enormous investment in converting extra data that may never be used afterwards, and also provides access to up-to-date data.

The interesting twist here is that the Web provides justification for something like a universal open format: Virtually all Web browsers now include software to process text encoded in the eXtensible Mark-up Language (XML). XML can be described as a language for creating self-describing data files, that is, data files whose headers explain how to interpret the data that comes after the header. This has turned out to be a very powerful concept. Scores of industries and professional domains have seized on the opportunity to develop XML schemas (schemas are essentially formats) to capture the specific kinds of information that need to be shared within those industries and domains by organizations whose legacy systems are very different from each other’s.

Similarly, the members of the OGC developed the Geography Markup Language, which is well on its way to becoming the standard approach for encoding geospatial information for transport and communication. ISO conformant XML-encoded geospatial metadata, (parts of which conform with GML) are a keystone element of the OGC Web Services architecture that makes possible detailed, complex, automated searches for spatial data and spatial services on the Web. Also, GML separates content from presentation, so the way in which data is presented (on desktop systems and PDAs, for example) is entirely under program control and can thus be tailored on the fly to suit display device capabilities.

Very importantly, one of the major breakthroughs with GML is that, when used with XML tools, GML makes it possible to resolve many of the difficulties associated with incompatible data models (see Standard data models below).

It is not difficult to create profiles (application-specific variations) of GML, and this is what most data developers will do. The Ordnance Survey of Great Britain and the US Census Bureau (in its TIGER data) have committed to GML.

12 Standard data models

A nationwide data model standard that meets both local and national needs is very difficult to achieve, and the cost of attaining consistent data content seems (particularly to those at the local level) to make this an impractical goal. Such standard data models will, however, have an important role as “Rosetta stones” that enable each user to map their data to a common model so software can go from one local model to the national model and thence to the user’s own local model that is different from the first. One-to-one mapping of data models is unworkable when there are thousands of models to map between. GML enables a one-to-many solution.

This is made possible by XML tools. The XML tools (prototyped in OGC's GOS-TP and CIPI-2 pilot projects) map GML-encoded data from a local model to the national model and vice versa. The data thus becomes “as useful as possible” to the data sharing partner who uses a different model. Certain elements of one model do not map to the other, but the XML tools make these inconsistencies plain in all their details, so that it is easy for data managers to focus on the critical schema elements that don’t map.

This technology makes content standards easier for software vendors and integrators to support. Currently, content standards are expensive to support, and smaller companies that do not support them are at a disadvantage. The new approach thus enhances competition, increasing the choices available to users in the market.

13 Open source

“Open source” and “open standards” are entirely different. The special licenses that govern use and sale of open source software exist to ensure that the software’s source code remains in the public domain (free to all), though companies are allowed to sell products that include the source code. Open source software is usually developed not by single company but by a distributed, informal team of developers. Open source software developers use OpenGIS Specifications for the same reasons commercial developers use them: to make their products interoperate with others.

14 Open portals

A portal is a Web site that gives visitors organized access, typically through catalog services (services not too different from those provided by search engines), to data and processing resources on the Web, and perhaps also to people, organizations and publications. A portal offers an organized collection of links to many other sites. A portal thus can be used to aggregate content. And by attracting a large number of visitors who share a common interest, a portal also aggregates content seekers for the benefit of content providers and advertisers and potentially for the benefit of that community of content seekers.

Users of geospatial portals that are based on OpenGIS Specifications for software interfaces and GML encodings can immediately access – pan, zoom, compose, save and print – views of digital geospatial content held on diverse Web-connected servers. Multiple maps from multiple servers can be overlaid and “flipped through.” Data providers register their data for access via the portal.

Applications (and other portals) can integrate portal resources into information offerings and work flows.

15 Integration and interoperability

Integration in our industry means making spatial data accessible from multiple technologies and software vendors and making spatial data and spatial functionality available to other IT systems such as customer response management, logistics, location-based services for wireless devices, etc. The benefit is that users can thus access, combine, and disseminate geospatial information from distributed and varied information sources. Integration streamlines workflow and reduces costs of information production, maintenance and dissemination.

Integration offers significant immediate and downstream cost savings if the integration can be accomplished with open standard interfaces instead of proprietary and/or custom interfaces. Enterprise systems integrated using open interfaces can enjoy the "network effects" that result from the same interfaces being used in the world outside the enterprise. OGC’s goal is to create a single, vendor-neutral infrastructure for geospatial integration that works everywhere, across all platforms, technologies and types of devices.

16 Conclusion: Standards create opportunity

Interoperability is a value multiplier. Technology developers, whether multinational companies or individual contractors, can profit in many ways from building with standards, as outlined in this article. Developers who familiarize themselves with OGC standards and OGC-harmonized standards from other standards organizations are able to tap into a vast and growing "Spatial Web" that is rich in resources and possibilities. Much of the necessary infrastructure for geospatial application development is embodied in freely available materials from the OGC that describe how to build and weave together countless geospatial software and data products and online services. Hundreds of commercial and open source products from around the world implement these standards (see http://www.opengeospatial.org/resources/?page=products), and these products are easily discoverable and obtainable over the Web.

Standards are a key resource for developing nations that are taking advantage of the new global information infrastructure to compete with industrialized nations in offering their products to global and regional markets. Standards also introduce efficiencies, reduce costs, and reduce technology risk in the information systems that will help these countries address the goals of sustainable cities, competitive industries, agriculture, consumer services and many other important domains.