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Multi-Int Fusion

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Introduction

The late Speaker of the U.S. House of Representatives "Tip" O'Neil once stated that "All politics is local." We can say the same about intelligence information. "Where", or location, is always a key part of intel information – an anti-government demonstration in Jackson County, Oregon, is of little interest whereas the same activity in Baghdad, Iraq, makes international headlines. Previously, the "location" component of intelligence was recognized and accounted for by human beings. The information age has changed that. Computer-based discovery, collection and exploitation of location (spatial and geospatial) information from many diverse sources is what "multi-int fusion" is all about.

Despite advances in information technology, multi-int fusion continues to be hard work because the data is so “unruly”. Even the intelligence community, which has good control over its data, has been unable to marshal it all into a single "family" of formats and content that enables easy data fusion. Future reliance on commercial imagery and other less controlled sources will only exacerbate the difficulty of enforcing order on information sources.

The solution is a system of *standard interface specifications* that embraces diversity and enables applications to bring data together in a coherent fashion at the time of fusion, leaving each of the information providers free to work with the formats and systems that suit them best. This approach not only avoids the need to closely coordinate and control what each provider does internally -- which they resist -- but it also allows easy exploitation of legacy data and systems and the easy integration of new data and systems. Being vendor-neutral helps agencies protect their equity in installed systems. In addition, the use of standard interface specifications leverages existing Web technologies to provide new data integration capabilities that were not available before, even in "closely coupled" systems running in all-proprietary or custom environments. In this article we look at the open, Web-based distributed geoprocessing interfaces that make this possible.

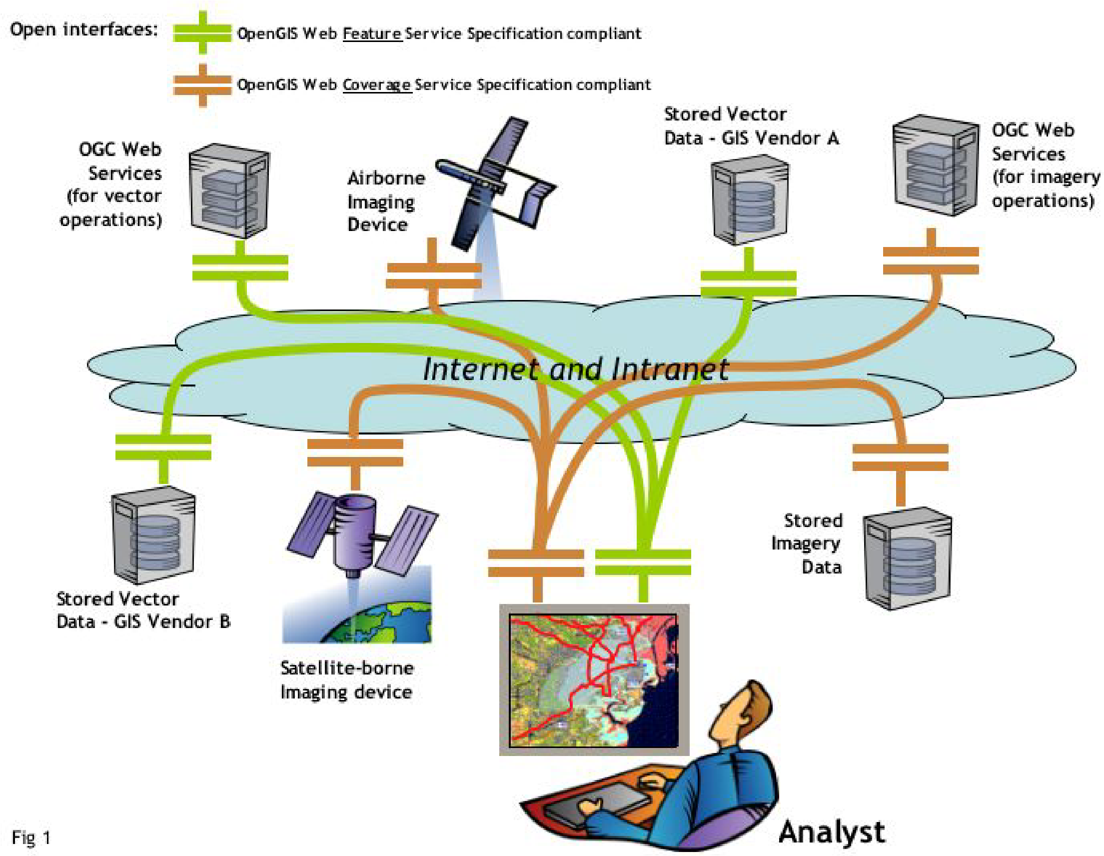

Fig 1

Figure 1: Implementation of OGC's OpenGIS Specifications open interfaces – vendor-neutral and technology neutral – enables a "Spatial Web" in which diverse spatial data and spatial processing resources are available and can be used together. The different interfaces for "features" (vector data) and "coverages" (imagery and sensors) are based on the same geometry model and services architecture; thus easily enabling the fusion and exploitation of multi-int data.

A new architecture for multi-int fusion

In the Open GIS Consortium (OGC), more than 250 companies, government agencies and universities from around the world participate in a consensus process to design, develop and maintain publicly available interface specifications for geoprocessing. Many US federal agencies participate so they can influence and then promptly leverage commercial implementations of OGC's OpenGIS® Specification standards. For a detailed overview of these standards, see the OGC Reference Model (ORM) (http://www.opengis.org/specs/?page=orm). The ORM provides an overall conceptual framework for using OpenGIS Specifications to build geospatial processing into distributed systems in an incremental and interoperable manner. The ORM is a tool for building open enterprise architectures for access to spatial data and services.

Though the ORM is distributed computing platform independent (as well as providing inter-application interoperability on standalone computing platforms), most OpenGIS Specification development in recent years has focused on interface standards that operate on the World Wide Web. "OGC Web Services" are OpenGIS Specifications that define interfaces to Web Services that perform geoprocessing, data access, and encoding operations. Like other Web Services (see http://www.w3.org/2002/ws/), OGC Web Services are processing services that respond to clients that present an interface that matches an interface exposed by the server. An interface is simply an agreed-upon collection of parameters and instructions sufficient to invoke an operation and return the result.

OGC Web Services are open in the sense that HTTP and HTML are open. That is, they are free and available for use by anyone who wants to use them. Further, the OGC promotes a non-exclusive consensus process for dealing with proposed changes to existing OGC specifications. HTTP and HTML have no real competition, other than their "offspring" (such as XML). OGC Web Services have no competition other than proprietary Web services interfaces that define GIS or imaging services.

Just as HTML specifies the structural rules for every Web page on the Internet and HTTP provides the message protocol to allow any user to ask for these pages, OGC Web Services structure the "loosely coupled" interoperation of Web clients and servers that provide spatial data and spatial processing services. "Loosely coupled" means the specification defines everything necessary for interoperation between diverse vendors' software systems. Loosely coupled architectures based on asynchronous communications can provide a lightweight and resilient foundation for applications that do not require tight coordination. By using a well-defined cross-component interface abstraction, it becomes possible to replace the technology at either end of the interface with different technology without changing any of the other components. Essentially, "loosely coupled" means "vendor neutral." Any developer can write a specification-compliant service that will work with any specification-compliant client.

Geoprocessing encompasses an extraordinarily diverse and complex body of technology, so there are necessarily different OpenGIS Specifications for bitmapped maps, vector data, terrain models, imagery, location based services, etc. Not all of them have been fully developed and finally adopted by the OGC membership, but several important specifications have been developed and adopted and are already widely implemented in commercial products (see http://www.opengis.org/resources/?page=products). Many other OpenGIS Specifications are in various stages of development and adoption.

Benefits for multi-int fusion stakeholders

- Intelligence analysts and the agencies in which they work frequently need access to other offices' and agencies' spatial information (and geoprocessing capabilities, in the new distributed computing paradigm). It is helpful to be able to do this without copying, transmitting and converting whole data sets. Maintaining a data set on one server and providing "access" instead of "copies" ensures that analysts always have the most current data.

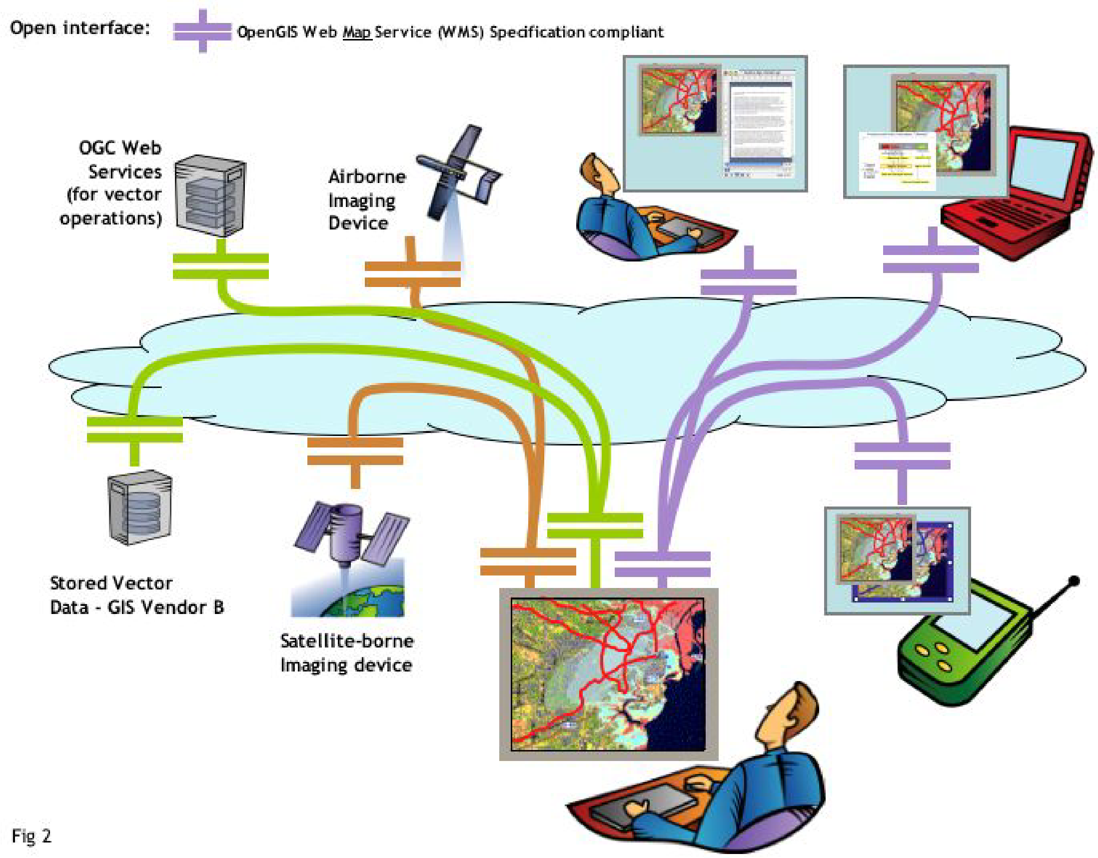

Figure 2: Imagery analysts can publish the results of their work as simple bitmapped images (JPEG, GIF, etc.) using interfaces compliant with the OpenGIS Web Map Service (WMS) Specification. These intelligence situation "overlays" can be viewed overlaid on a WMS base map or other OGC compliant data representation.

- Different analysts and agencies often use different vendors' software systems, and they need to pass data and instructions between these different systems. The open interface strategy described in this article avoids the need, as mentioned in the introduction, to closely coordinate and control what each software provider does internally (different formats are no longer a problem).

- The open interface strategy also allows 1) easy exploitation of legacy data and systems and 2) easy addition of new data and systems. Analysts need to have the pieces of a solution work together. In a recent Delphi survey on the value of standards, the two top survey responses were: Standards increases the value of existing and future investments in information systems and Standards allow the portability of data.[1]

- Analysts need to integrate information stored in various data models. This is possible with the OpenGIS Geography Markup Language (GML) Specification, which specifies an XML (eXtensible Markup Language) schema for encoding spatial data. In combination with XML tools, GML enables a degree of "automated translation" between similar but not identical feature definitions stored in different data models.

- GML also allows data to be fused through dynamic links. That is, a ‘fused’ picture graphic is nice, but a ‘fused’ composite dataset composed of brief or enduring linkages between items from disparate databases is even better. The technology provides the capability for near real time updates to the Common Relevant Operational Picture.

- Analysts need to integrate different data in various coordinate systems. Services accessible through interfaces compliant with the OpenGIS Coordinate Transformation Services Specification provide "on the fly" conversion to a common coordinate reference system for automatic overlay of data (or bitmap views of data) from different servers.

- Analysts need to visually integrate map displays (symbology) from different data servers. GML, like other XML schemas, separates data from presentation styling, so different datasets can be represented with a common set of symbols for a particular group of users.

- In OGC, new opportunities for multi-int fusion have arisen:

  a. The opportunity to organize, discover and quickly access geographic data stored in text and on video, audio, and other media.

  b. The opportunity to access and process on-line sensor data (including data from Webcams and live airborne imaging systems) from multiple sources.

  c. The opportunity to take advantage of grid computing for geoprocessing applications.

How to implement an open architecture for multi-int fusion

Like the Mad Hatter said to Alice in Wonderland, "The place to begin is at the beginning." The Reference Model for Open Distributed Processing (RM-ODP), an ISO/ITU/IEEE/OMG sponsored document (ISO/IEC 10746), leads enterprise system architects through a process that begins by establishing a vocabulary of architecture terms and principles. It explains how to document a high level "Enterprise viewpoint" (business perspective) that describes what the system must do for all its stakeholders. From the Enterprise viewpoint it proceeds through the Information viewpoint (semantics and

[1] 2003. The Delphi Group. The Value of Standards.

information perspective), Computational viewpoint (system functionality), Technology viewpoint (technology and products), and Engineering viewpoint (system distribution). The goal is to create an architecture within which there is integrated support for distribution, collaboration, portability and conformance testing. The RM-ODP guides architects through a process of "architecting a little, prototyping a little, and learning a lot." The RM-ODP approach to building an architecture based on open interfaces allows defense planners to think the big vision, but start their implementations in a small, pragmatic, flexible and scalable way.

By definition, an open architecture depends on standards. Speaking about the transition of defense systems to COTS (Commercial Off-The-Shelf systems), Dawn Meyerriecks, Principal Director for GIG Enterprise Services, Defense Information Systems Agency (DISA), US Department of Defense, had this to say:

"We want to have standards applied to all important interfaces. Then, if a vendor for a particular product goes away, it will have less of an impact. So we won't care as much who supplies the software, as long as they are using the standard interfaces that we have defined. By abstracting through a standard … we are less dependent on a particular vendor and we can minimize the impact of any corporate changes. " http://www.opengroup.org/comm/interviews/meyerriecks.htm.

ISO, the World Wide Web Consortium (W3C), OASIS and other standards organizations recognize OGC as the authoritative source for industry consensus on geoprocessing interoperability specifications. OGC works closely with these organizations to ensure that OpenGIS Specifications stay in the mainstream of Web-based distributed processing.

"Architecting a little, prototyping a little" in an intelligence organization will help stakeholders learn quickly what open interfaces are necessary for successful multi-int fusion. If there is no open standard for a particular interface, the next step is to learn which industry consortia are addressing or could address the problem. OGC is the appropriate consortium for spatial technologies, but for other technologies it may be necessary to look at Oasis or another industry organization. By cooperating and aggressively pushing for specification development to fill architectural gaps, teams of technology using organizations can avoid waiting too long for open standards and getting forced into proprietary lock-in, and they can avoid being stuck with standards that don't address their needs. There is no better way to steer technology than to participate in standards consortia.

How to buy interoperating multi-int components

When an open interface needs to be incorporated as part of an enterprise architecture and that interface specification is available from a standards setting organization, the next step is to learn which vendors implement that specification in their products. For geoprocessing software products, buyers can look at http://www.opengis.org/resources/?page=products to see which vendors implement which OpenGIS Specifications. Procurement language for software in Requests for Quotes can easily include, "Must comply with specification X." Because compliance with interface specifications does not necessarily guarantee interoperability, the procurement process might include an opportunity for competing vendors to show interoperability among their products and/or interoperability with the buyer's "open interface wrapped" legacy systems.

Summary

Multi-int fusion involves interoperability among different spatial technologies such as Web map servers, spatial analysis, earth imaging, etc. and perhaps also Web-connected cameras and sensors. It also involves interoperability among different vendors' products in these technology domains. Fortunately, interoperability in this domain is possible because the mainstream of information technology has moved comprehensively toward standards-based information system architectures, and OGC has largely kept pace. Thus spatial technology providers can provide Multi-int fusion applications and online services that communicate through interfaces that implement OpenGIS specifications. The ORM helps system architects and integrators understand how to provide standards-based access to, or else how best to replace, standalone stovepipe geoprocessing systems based on proprietary architectures.

In addition, by layering open spatial specifications on top of Web technologies, new multi-int fusion capabilities are possible. These include linkages between features in disparate databases; semantic interoperability between data in different data models; discovery of, access to and control of diverse remote sensors and imaging systems; and methods to organize and quickly access geographically referenced data stored in text and on video, audio, and other media.

The benefits of an OGC compliant architecture are maximized when all ‘users’ of geospatial data and all those who ‘share’ their data within the defense community put their systems online with OGC compliant interfaces. The addition of OGC compliant interfaces to legacy systems is neither complex nor expensive. Enhancing legacy systems in this way and specifying OGC compliant interfaces in new systems can enable near ‘plug-and-play’ integration benefits within and between defense and intelligence organizations.

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