An Introduction to OpenGIS

By Adam Gawne-Cain and Chris Holcroft

OpenGIS is the activity pursued by the Open GIS Consortium (OGC). OpenGIS seeks to achieve transparent access to disparate geo-data and geo-processing resources in a networked environment by providing a rich suite of open interface specifications. These interface specifications will enable GIS developers to create inter-operable components that provide this transparency.

The difference between OpenGIS and previous attempts to standardise GIS is that OGC agrees interfaces, and not neutral file formats. The problem with neutral file formats (e.g. SDTS or NTF) was that specifications grew so complex that each GIS could only support a sub-set of the format. This meant that when the file was copied between systems, some entities were lost or misinterpreted. With the OpenGIS interface-based approach, however, GIS products can support some or all of the specified interfaces, and wherever two systems support a common interface, they can use that interface to communicate accurately.

A second advantage of OGC's interface-based approach is that users can be sure that they are looking at genuine, live data, and not at a static file generated some time in the past.

A third, practical advantage of interfaces is that OGC can publish the interface definitions one-by-one. This lets the GIS community get the advantage of openness in the major areas quickly, with the promise of openness in niche areas later.

As will be outlined below, a lot has been achieved already. Specifications for handling vector data, raster data, coordinate transformation, online Web searching for GIS services and Web Mapping have been either published or adopted by OGC.

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Who are OGC's members?

There are three main levels of OGC membership: Principal, Technical and Associate. The higher membership levels confer more voting rights. There are now over 300 members featuring 20 Principal members and 25 Technical members from around the globe.

The membership of OGC is impressively broad. Most major GIS companies are members, along with database companies, operating system companies, national mapping agencies, large government departments, universities and research institutes. The membership is international, but mainly focused in North America and Europe.

How does OGC make Interface Specifications?

Every two months, the OGC Technical Committee (TC) and Management Committee (MC) meet for a week. The meetings are held in different locations around the world, hosted by one of the OGC members.

The main mechanism for publishing specifications has been via Request For Proposals (RFP). Initially, the TC members agree on an Abstract Model of a topic of interest. This Abstract Model is then used as the basis for the Request for Proposal (RFP). The RFP is a document issued by OGC to the GIS industry at large, asking for proposed interface specifications. The proposals must conform to the Abstract Model described in the RFP. After a predefined time the RFP responses are collected, and the RFP responders are asked to merge their proposals into a single response. This single response is then voted on by OGC, and assuming it passes, it becomes the published OGC specification.

The RFP mechanism is fairly time consuming, since it takes a long time to create the Abstract Model. However, this time ensures thoroughness and quality. Furthermore, it gives the OGC members' views and opinions time to converge. In practice, the responders to the RFP are the same people as the GIS vendors within the TC, so time spent working on the Abstract Model is not wasted.

In an attempt to short-circuit the RFP process, there is another mechanism for publishing specifications called a Request For Comment (RFC). In this second mechanism, any interested parties can

directly create their own interface specification. This specification is then given to OGC, who issue the specification as an RFC to the GIS industry at large. After a predefined time, any comments are collated and passed back to the specification originators for consideration. The resulting specification is then voted on by OGC.

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What has been achieved?

OGC has completed five interface creation cycles, resulting in either published or adopted specifications for Simple Features, Grid Coverages, Catalog Services, Coordinate Transformation Service and Web Mapping Testbed. These specifications include interfaces for the COM and CORBA distributed computing platforms, and database schema for SQL and OLE-DB.

As well as the above, OGC is working in the longer term on a larger collection of Abstract Models, which form the topics in an overarching view of GIS. As these Abstract Models reach maturity they may be used as the basis for future RFPs.

Simple Features

The first RFP was for Simple Features (SF); in other words, a proposal for handling GIS vector data (geometry), such as that representing streets, administrative areas, land use zones, property lines, watersheds, etc., represented in lines and polygons. The Abstract Model for SF consisted of two parts: spatial reference systems and geometry. The spatial reference system model is identical to that used by the European Petroleum Survey Group (EPSG).

Why start with geometry? In information systems number and text data types have been standardised. For example, Numbers have been standardised by IEEE, English Text has been standardised by ASCII. These standards bodies have made sure that all computers handle text and numbers in the same way. For the businessman, GIS is really just the same as any other IS, but with one new data type – Geometry. In a GIS you need to mix Geometry, number and text data together. Starting with Geometry as the first OpenGIS interface was therefore an extremely appropriate step.

The geometry model used in Simple Features is very tightly defined from a theoretical point of view. The geometry model consisted of points, line- strings, polygons and arbitrary combinations of these three fundamental types. Initially, the geometry was 2D, but it has recently been extended to include Z values. The theory behind Simple Features geometry unambiguously defines the "correct" answer for questions like "Do these two polygons touch?" and "Is this point inside this line?" For people outside GIS, it may be surprising to know that different GIS systems used to come up with different answers to these simple questions! What OGC have achieved is to provide a benchmark against which future GIS systems can be checked and validated. This will allow IT systems to use geometry as just another data type, like IEEE floating- point numbers, in a reliable and consistent manner.

The Simple Features specifications for SQL and OLE-DB show how geometry can be treated as just another data-type within relational databases, and how normal database queries can be extended to include spatial questions. For example, the SF specifications let users ask questions like "Show me all the prices and owners of all houses which are within 50 metres of this road", and this question can be fired at any conformant product in a consistent way.

Because different OGC members preferred different Distributed Computing Platforms (DCP),OGC adopted three methods (SQL,COM,CORBA) to implement OGC specification. Nevertheless all 3 use the same geometry model, and the same Spatial Reference System model.

Grid Coverages and Catalog Services

The second and third RFP cycles finished concurrently. They were for Grid Coverages and Catalog Services. The Grid Coverages specifications define interfaces for accessing grid data (e.g. aerial photography, satellite imagery and Digital Elevation Models) using COM or CORBA components. Grid Coverages complements Simple Features by handling the raster side of things. OpenGIS Catalog Services Specifications provide a common architecture for seeking out online automated directories of web-based geospatial data and geoprocessing services.

Coordinate Transformation Services

This CTS specification provides interfaces for general positioning, coordinate systems, and coordinate transformations.

The CTS specification consists of two major packages:

- Coordinate System package
- Coordinate Transformation package

Coordinates can have any number of dimensions. So this specification can handle 2D and 3D coordinates, as well as 4D (space + time), 5D etc. The Coordinate System package could eventually replace the 2D Spatial Reference package contained in the Simple Features specifications. However, it has been designed to work in conjunction with Simple Features during any transition period.

The Coordinate Transformation package allows points to be transformed between any coordinate system. There are also hooks for allowing the same coordinate transformations to be used for transforming arbitrary geometries and images, with full and robust support for warping and tearing.

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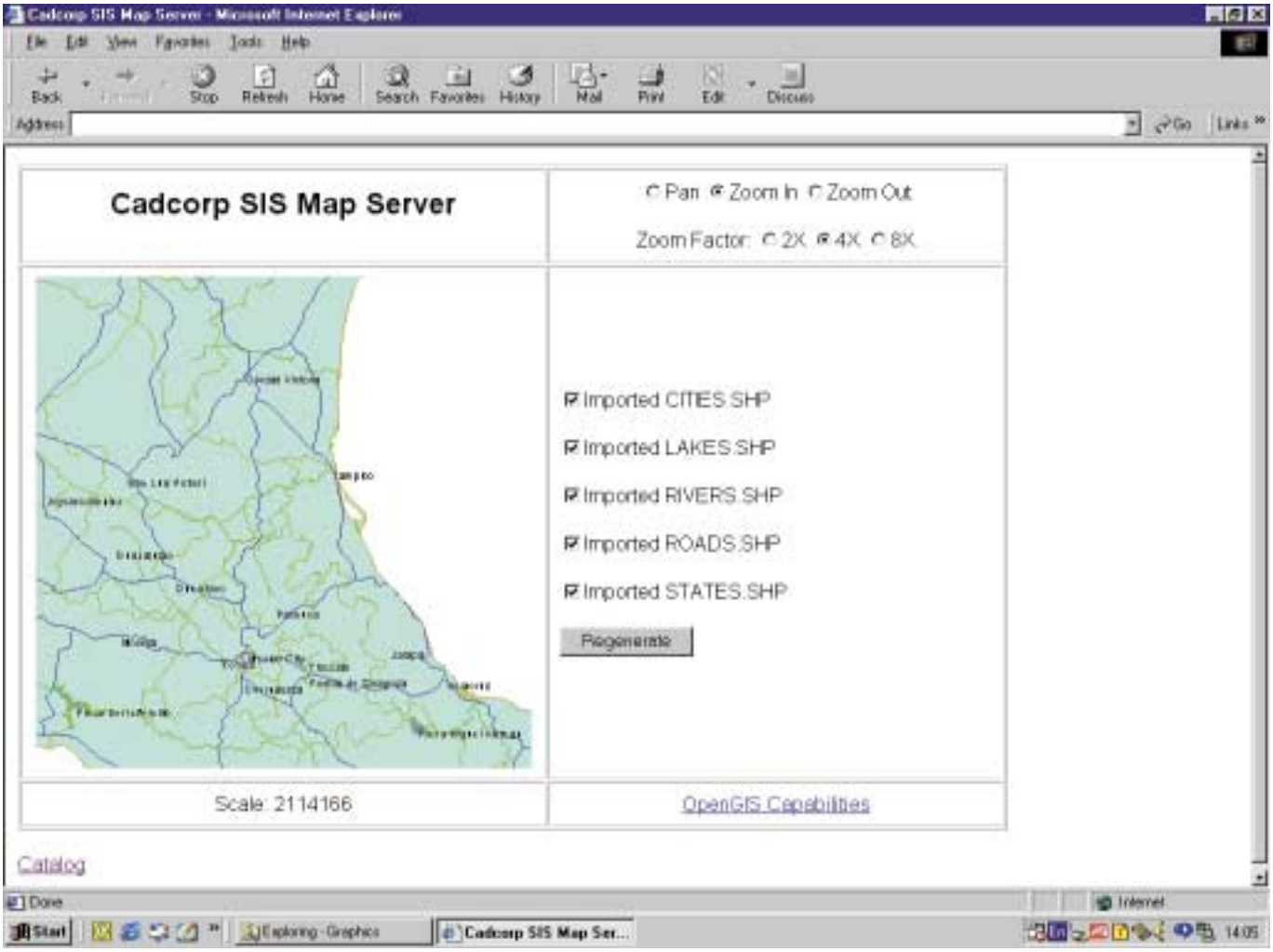
The example on page 57 an image grabbed from an OpenGIS Web Mapping server, and transformed using Cadcorp's prototype implementation of the OpenGIS Coordinate Transformation



A Web Mapping Testbed server in action – access is via a normal HTML browser.

Specification. Notice the warping and tearing in the bottom hand image.

Web Mapping Testbed

One of OGC's ongoing activities is the Web Mapping Testbed, which after adoption of the specification is now in Phase 2. This is a forum for demonstrating and testing Internet-related GIS software, with the objective of making Web access to diverse geo-spatial data transparent and easy. In September 1999 OGC rolled-out the project in Washington DC, demonstrating images generated from several Internet Map Servers being overlaid within a browser environment. The GIS developers who created these servers are now working outside the official OGC umbrella to specify what they did.

The Web Mapping Testbed is the first of OGC's planned Interoperability Initiatives, which involve sponsors and participants. Sponsors provide finance and a set of OpenGIS objectives. Participants – mainly vendors and integrators – are partially funded for their efforts during the effort to meet the sponsors' objectives. For the Web Mapping Testbed, Lockheed Martin Management and Data Systems provided a testbed laboratory plus integration and logistical support. The city of Mobile, Alabama, and numerous other organisations provided data and support for the testbed's hurricane disaster management scenario.

Web Mapping Testbed sponsors include the US Dept. of Defense National Imagery and Mapping Agency (NIMA), US Army Corps of Engineers Topographic Engineering Center (TEC), the Federal Geographic Data Committee (FGDC), NASA, the US Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), and the Australian World Wide Web Mapping Consortium, a group of 24 Australian government and commercial organisations, led by the Australian Surveying and Land Information Group (AUSLIG).

Web Mapping Testbed participants include: Autodesk (US), BBN Technologies (US), Blue Angel Technologies (US), Cadcorp (UK), Compusult (Canada), CubeWerx (Canada), ESRI (US), Galdos Systems (Canada), Geodan IT (Netherlands), Geomatics Canada (Canada), Hitachi (Japan), ILOG (France), Intergraph (US), Ionic Software (Belgium), Laser-Scan (UK), Litton/TASC (US), Lockheed-Martin (US), MapInfo (US), Microsoft (US), Massachusetts Institute of Technology (US), Mitsubishi Corporation (Japan), NTT Data (Japan), Object/FX (US), Oracle Corporation (US), Ordnance Survey (UK), PCI Geomatics (Canada), Penn State University (US), SICAD Geomatics (Germany), Social Change Online (Australia), Sun Microsystems (US), and Universal Systems (Canada).

OpenGIS Specifications resulting from the Web Mapping Testbed build on OGC's OpenGIS Specifications for Grid Coverages, Simple Features, and Catalog Services. As vendors implement these open standards, Web users will easily find, view, overlay, and combine different thematic maps for a given region.

An example of a WMT server in action is shown above. Here a standard browser is

being used to access maps from a WMT server (Cadcorp SIS Map Server). In this instance local data cannot be overlaid but the client is a plain vanilla browser with no requirement for plug-ins or Java applets. However, the browser user can still pan, zoom and switch layers on and off using normal HTML controls.

OpenGIS conformant products

Once an OpenGIS interface is published, conformance tests are subsequently developed to allow vendors to become officially certified as conformant with the published interfaces. Of course, vendors can use an interface as soon as it is adopted and before any conformance tests are likely to exist. Nevertheless, the conformance certification gives the vendor a route to demonstrate to the marketplace OpenGIS conformance and an official logo on their product packaging.

To date four vendors have achieved OpenGIS conformance certification for the Simple Features interface, namely Cadcorp, ESRI, Hitachi and Oracle.

Details of conformant products are available from the OGC Website www.opengis.com.

What OpenGIS means for the end-user

By investing time in developing Abstract Models, OGC is ensuring that concepts in different GIS systems will converge. This will make GIS less of a black art, and more of a science, where skills are carried between project, companies, and software products. Eventually, geometry and coverages will be seen as every-day data types, and GIS will enter the mainstream of computing.

In future, GIS software will be made up of discrete components, which communicate with each other using specified, open interfaces. These components will be Standardised and Commercially available Off The Shelf (SCOTS) in mainstream GIS products.

SCOTS will make the process of GIS procurement easier, since purchasers will know exactly what they are getting from vendors. Purchasers will be able to make direct comparisons of cost, functionality and performance between different vendors. Significantly, GIS users will find that their skills and experiences are more transportable between GIS systems.

Since components from different vendors can be individually tested and compared, vendors will feel a commercial pressure, and reap a commercial benefit, from making their software more open and reliable. The promise of better performance, better reliability and better interoperability will help all GIS users. In looking at the commitment shown by industry, government and academia supporting OGC, the user can be assured that OpenGIS is a major ongoing GIS initiative. GI News

Adam Gawne-Cain and Chris Holcroft, work for Cadcorp. Cadcorp is a member of the OpenGIS Consortium Technical Committee.

Before and after transformation – Cadcorp SIS prototype implementation of the Open GIS Coordinates Transformation Specification.