The Next Wave of **Interoperability** Via Web Services

Rarely has a better match been made than between the collective capabilities of GIS and the distributive capabilities of the Web. The power of the Web to reach anywhere in the world for content rests on standard protocols such as TCP/IP and HTTP, which enable diverse computer technologies to form a single community. A worldwide geographic community is also being built on evolving standards for the specific exchange of GIS content and services.

ESRI's long-standing commitment to standards and interoperability in the geospatial realm has taken a significant step forward with the introduction of the ArcGIS Interoperability Toolkit. The toolkit represents the productization of a set of Open GIS Consortium (OGC) compatible interface connectors for use with ESRI Web-enabled software. It will empower ArcGIS users to exchange geospatial information not only with every other connected ArcGIS user but also with users of any other software compatible with those same interfaces.

Why Standards and Interoperability?

The toolkit is an embodiment of the philosophy that, in order to fully realize the global capability and benefits of geographic information and GIS technology, spatial data must be able to be shared with ease and dynamically integrated into highly distributed, enterprise-scale applications. Such ad hoc systems can only be built from loosely coupled and freely interoperable components that can be utilized as needed without changing the essential functioning of the system itself.

What Is Interoperability?

One view of interoperability describes layers of shared understanding, each layer building more specific meaning on top of the previous layer. The Internet and the Web are themselves built on a foundation of layers such as the transport protocol TCP/IP, the conversational protocol HTTP, and the content-encoding standard XML (which can be thought of as a generalization of the HTML found in every Web page). These standard interoperability layers level the Internet playing field across different computational platforms and technologies.

Virtually any Web-enabled device (e.g., server, desktop computer, mobile phone) can exchange XML messages with another such device. But how does a client know it is making the right request and how does the server know it is providing the right information?

The solution is straightforward when both client and server share technology, design, and address books but more difficult for arbitrary components trying to work together in the ad hoc spirit of the Web.

This is where Web services and standards organizations such as OGC and International Organization for Standardization (ISO) enter the equation. Web services utilize an evolving set of XML message standards to make specific geospatial software functionality, such as finding the location of an address, able to be discovered and requested meaningfully over the Web without regard to the specific underlying technology supplying that functionality. The consumer of such a Web service may only be able to guess from the speed of response whether the result was supplied by an ArcGIS geocoder or by a roomful of computer operators with phonebooks. Its functionality and use are the same.

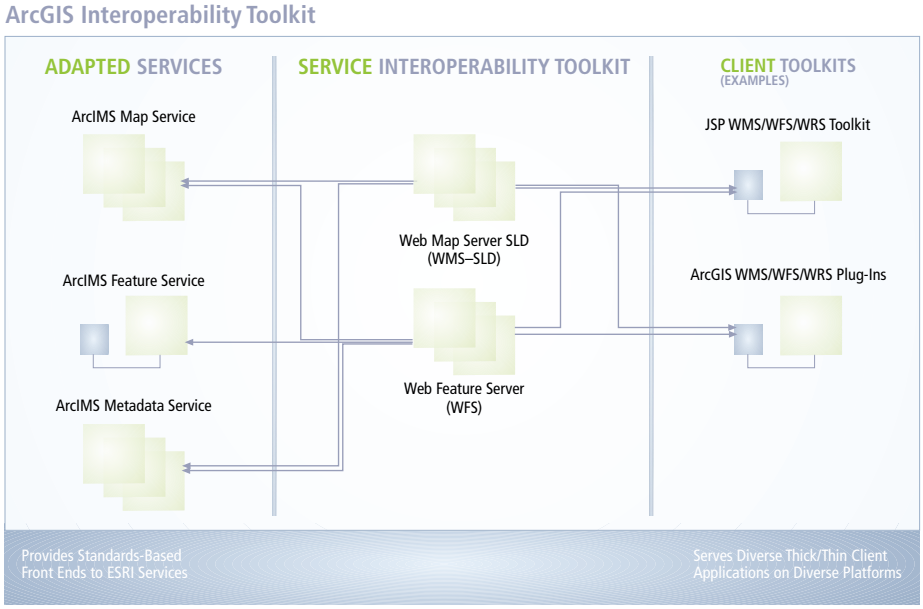
The OGC and ISO have pursued a series of geospatial content encoding standards and service interface specifications in the Web services paradigm, utilizing XML for the collaborative discovery, exchange, display, and analysis of spatial content. Chief among these are the Web Map Service (WMS) and Web Feature Service (WFS) interface specifications as well as the Geography Markup Language (GML) and Styled Layer Descriptor (SLD) encoding standards.

From the initial efforts of OGC to establish the OpenGIS Simple Features Specification to the most recent Open Web Services work, ESRI has maintained a leadership role as a member of the OGC Board of Directors and the Planning and Technical Committees and as a participant in numerous test beds, pilot projects, and specification products published by OGC. The ArcGIS Interoperability Toolkit is a productization of a suite of OGC-compliant server connectors for ArcIMS, client plug-ins for desktop products in ArcGIS, and toolkit additions for custom thin client development using JavaServer Pages (JSP).

WMS and WFS Connectors for ArcIMS

The ArcGIS Interoperability Toolkit contains two newly updated connectors for ArcIMS. The OGC WMS connector enables ArcIMS to provide Web map services that fully implement the current OpenGIS Web Map Service Specification. In particular, this component responds to OGC WMS requests and supports dynamic styling of maps through the OGC SLD encoding as part of a GetMap request. This component also supports dynamic specification of features (UserLayer), either in-line or through a WFS GetFeature request to a remote service, which is then rendered on top of the other requested map layers. It supports the GetFeatureInfo request to provide information (e.g., GML-encoded features) about a location within a requested map. In addition, it responds to GetCapabilities requests with appropriate service and content information about itself to facilitate discovery of its offerings from across the Web.

A single connector installation will support multiple dynamic service endpoints corresponding to multiple map services within the ArcIMS instance to which it is installed. In other words, the default behavior will be for the connector to expose automatically, for each ArcIMS map service published, a separate WMS endpoint for that map service.



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Three modes of SLD layer/style definition are supported by the connector.

- NamedLayer/NamedStyle—Preconfigured map layer, predefined style
- NamedLayer/UserStyle—Preconfigured map layer but with a dynamic feature rendering specified by SLD style elements.
- UserLayer/UserStyle—Map features also specified dynamically, either via a GetFeature call to a remote WFS or through in-line GML, with dynamic feature rendering specified by SLD style elements.

In all cases, the actual SLD map composition document may either be specified in-line with the map request or referenced by way of a URL. Since the WMS connector will style either preconfigured map layers (NamedLayers) or external feature collections (UserLayers), it can be said to function as both an integrated SLD WMS in the former case and a component SLD WMS in the latter case.

The OGC WFS connector enables ArcIMS to provide Web feature services that implement the OpenGIS Web Features Service Specification. The connector provides client access to geographic (vector) data, supports complex OGC filter queries, and returns collections of features encoded in GML. A particular "shape-like" profile of GML has been defined for the feature types that may be accessed through the connector.

An essential characteristic of OGC-style services, such as WMS or WFS, is that they are self-describing through support for a GetCapabilities operation. The end user, through any WMS/WFS client, such as a JSP browser application or a plug-in equipped ArcCatalog, will be able to invoke the GetCapabilities operation on a specific service as described above to receive an XML encoding of metadata about the service and its content. The service administrator will have two functional options.

- Trigger a refresh of the WMS or WFS service metadata from ArcIMS for a given map service.
- Update additional metadata that is stored as one XML document for each service, either as a document on disk or as a document maintained on an ArcIMS Metadata Service.

The latter functionality is required for providing metadata (especially content metadata) to be accessed through the WMS or WFS interface that is not provided by ArcIMS directly. Initial registration of a map service through the WMS or WFS connector will cause an outline XML document to be generated. Subsequent refresh of that metadata will preserve, as much as possible, the additions and modifications made by the operator.

ArcGIS Plug-Ins for WMS, WFS, WRS

This client toolkit consists of a set of custom ArcObjects that enables users of the ArcObjects applications, ArcMap and ArcCatalog, to form map layers from Internet data sources with WMS or WFS interfaces in addition to the existing support for native ArcIMS map services. An additional ArcCatalog plug-in allows users to query service or content metadata from OGC catalogs through the Web Registry Service (WRS) interface.

The functionality of the plug-ins will follow closely the built-in capability of ArcCatalog and ArcMap to make use of ArcIMS map services. Users will be able to connect to a Web map or Web feature service, browse its contents, and, in the case of ArcMap, add one or more map layers or feature collections to a map as RasterLayers or FeatureLayers respectively. Information is returned for any subset of WFS feature collections, but only information about features at a single point on the image is returned for WMS layers, consistent with the WMS GetFeatureInfo operation.

The WRS plug-in will augment the built-in ArcCatalog search functionality by adding an OGC Catalog option to the search dialog supporting a small core set of search parameters.

JSP Client Add-In for WMS, WFS, WRS

This component is a toolkit add-in that extends the Java Connector and JSP Toolkit included with ArcIMS and enables the Toolkit applications to access WMS, WFS, and WRS services. The JSP add-in comprises a package of proxy/helper classes along with a custom tag library and sample JSP pages for implementing HTML Viewers with or without JavaScript augmentation. This provides several paths that require minimal XML processing to develop thin clients that make use of data and services through any combination of ESRI and OGC interfaces.

The ArcGIS Interoperability Toolkit includes documentation and installation notes including three installers—the Windows ArcIMS Installer, the Windows ArcObjects Installer, and the UNIX ArcIMS Installer.

How Much Interoperability Is Good for You?

This may sound paradoxical, but the real goal of the ArcGIS Interoperability Toolkit is operability. While interoperability is essential for taking advantage of Web-like universal access, it always comes at the cost of a lowest common denominator in specific functionality.

The toolkit allows the fortunate ArcGIS user to avoid the horns of this troublesome dilemma. It provides a seamless transition from high-quality OGC Web Service interoperability to high-powered ArcGIS-specific functionality, enabling each ArcGIS user to choose a balance or mix appropriate for a specific application, rather than have to choose sides.

Conclusion

The ArcGIS Interoperability Toolkit has been designed to let ArcGIS users have their cake and gobble up the benefits of interoperability as well, wherever those benefits have been targeted by organizations charged with promoting a level of cross-platform, cross-technology geospatial integration. The full benefits of interoperability are available to any ArcGIS user. Critical layers of geographic information can be discovered, integrated, queried, and displayed by almost anyone, anywhere, while at the same time the custodians of the data can maintain this information as they see fit—maintained locally and accessed globally. At the same time, all the advanced functionality of pure ArcGIS solutions is built in and ready for use.

ESRI has made major investments in the development and implementation of open GIS standards not only to serve its customers but also to promote the sharing of geographic data across all GIS platforms in the belief this policy will result in the most open and interoperable GIS technology ever deployed.

The ArcGIS Interoperability Toolkit will be available in the third quarter of 2003. For more information, visit www.esri.com/standards.

Global Map/GSDI Grant Program

In 2002, ESRI made more than 100 Global Map/Global Spatial Data Infrastructure (GSDI) grants valued at $50,000 (U.S.) to national agencies. The program, established in memory of GIS pioneer John E. Estes, has attracted interest from national mapping agencies throughout the world.

ESRI is underwriting the program with a comprehensive package of software, training, and support to encourage the building of national spatial data infrastructures in countries around the world. The program will also promote the sharing of geospatial data to expand the GSDI movement. GSDI provides an important framework of standards, policies, data, procedures, and technology to support the effective coordination and dissemination of geographic information.

For more information on this program, visit www.esri.com/industries/internationaldev/grants/index.html.