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"Web services" is the emerging paradigm for web-based distributed computing. This article by OGC's Carl Reed describes how OGC is integrating geoprocessing with web services, making publishing, discovery, access, and use of geodata and geoprocessing resources much easier and less expensive than before, via your web browser.

Title: OGC's View of Web Services

Subtitle: An In-Depth Look at Technology that will Revolutionize Your Work

by: Carl Reed, Ph.D., Open GIS Consortium, Inc. (OGC)

During 2001, a new technology framework called "Web Services" emerged as a viable model for Internet based applications. Simply, Web Services reflects the advantages of the Web and the Internet as a platform for *services*, not just data. This paper discusses the current OGC position and on-going work related to GeoSpatial Web Services.

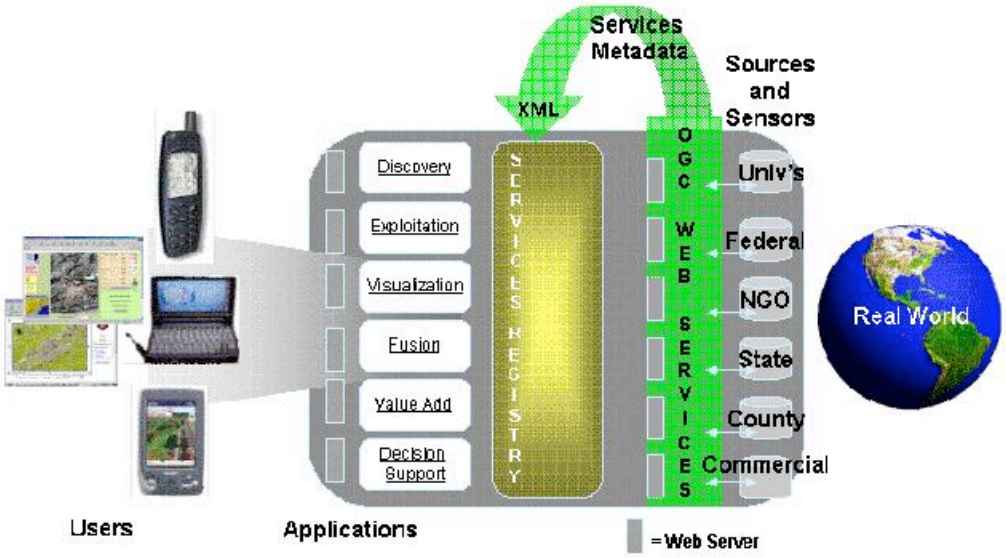

Figure 1. OGC Web Services will "spatially enable" the Web, making it a rich source of spatial information for virtually everyone.

First, what are Web Services? By "services", we mean component services that can be plugged together to build larger, more comprehensive services and/or applications. As defined in ISO Standard 19119, a service is a collection of operations, accessible through an interface, that allows a user to invoke a behavior of value to the user. Examples of

geospatial services are “polygon overlay”, “point to grid interpolation” and “coordinate transformation”. A formal definition of a web service may be borrowed from IBM's tutorial on the topic: *Web services are a new breed of Web application. They are self-contained, self-describing, modular applications that can be published, located, and invoked across the Web. Web services perform functions, which can be anything from simple requests to complicated business processes…. Once a Web service is deployed, other applications (and other Web services) can discover and invoke the deployed service.*

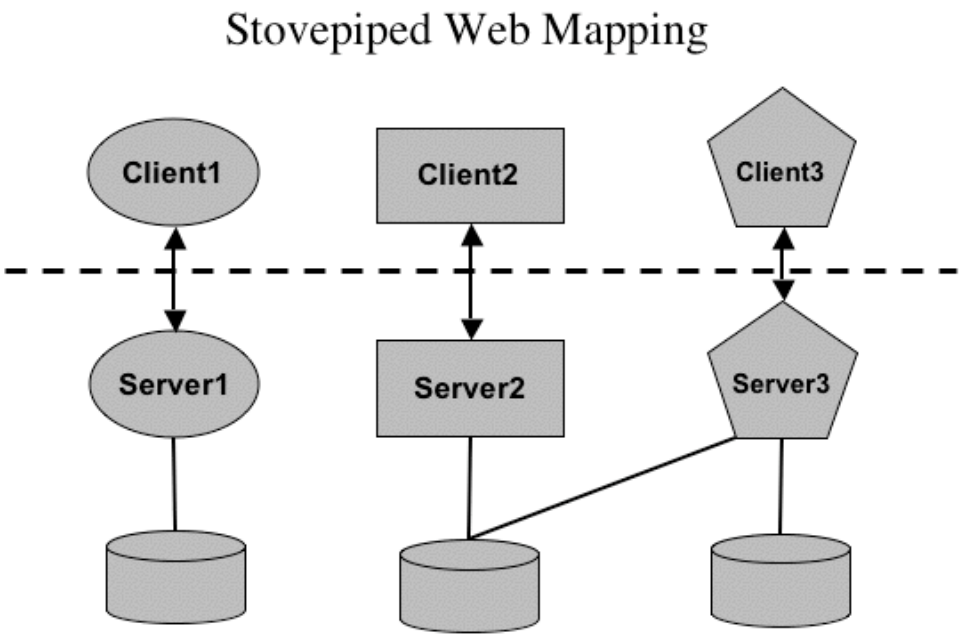

Figure 2. Stovepiped Web Components. Pre-web non-interoperability among systems continues on the web. Users are familiar with these limitations, which are imposed by the proprietary formats and closed interfaces of vendors, and the basic differences in processing approaches used in vector GIS, imaging, and CAD-based Facilities Management systems.

The IT industry vision for Web Services is closely aligned with the OGC vision for interoperable and ubiquitous geo-services. The OGC and our membership have just completed the OGC Web Services Phase 1 Interoperability Initiative (OWS-1). Much of what is presented in this paper is the result of the work in OWS-1.

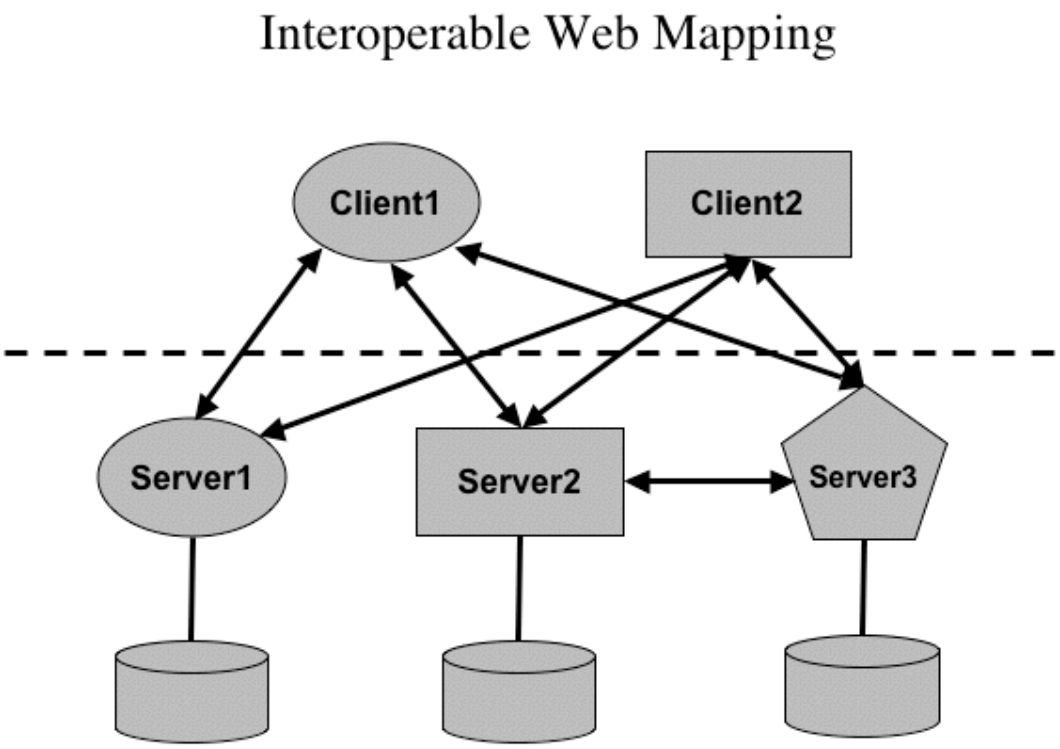

Figure 3. Interoperable Web Components. Web components that share common interfaces can communicate, requesting and receiving data and services from each other despite their dissimilarities.

What is the Power of Web Services?

Unlike complex and tightly bundled software packages, Web Service implementations encourage significant decoupling and dynamic binding of components: Thus, the commonly identified characteristics of a Web Services framework are:

- Self-contained, modular applications that can be described, published, located, and invoked over a network, generally, the World Wide Web.
- Three roles: service provider, service requester and service broker; and three basic operations: publish, find and bind.
- Services are dynamically composed into applications stemming from capabilities-based look-up at runtime, instead of the traditional static binding of software functions in an application.
- Platform- and programming language-neutral, and communications mechanism-independent.
- Applications will be based on compositions of services discovered and marshaled dynamically at runtime (just-in-time integration of services).

Open, standard interfaces allow the implementations to be platform- and programming language-neutral and communications mechanism-independent, while creating innovative products, processes, and value chains.

The Web Services architecture is the logical evolution of object-oriented analysis and design. It is also the logical evolution of the architecture, design, implementation, and deployment of e-business solutions. Both approaches have been proven in dealing with the complexity of large systems. As in object-oriented systems, some of the fundamental concepts in Web Services are encapsulation, message passing, dynamic binding, and service description and querying. Fundamental to Web Services, then, is the notion that every process is a service, accessible across the network.

What are OGC Web Services?

The OGC Web Services (OWS) concept is to enable distributed geoprocessing systems to communicate with each other across the Web using familiar technologies such as XML and HTTP. OGC Web Services provide a vendor-neutral, interoperable framework for web-based discovery, access, integration, analysis, exploitation and visualization of multiple online geodata sources, sensor-derived information, and geoprocessing capabilities.

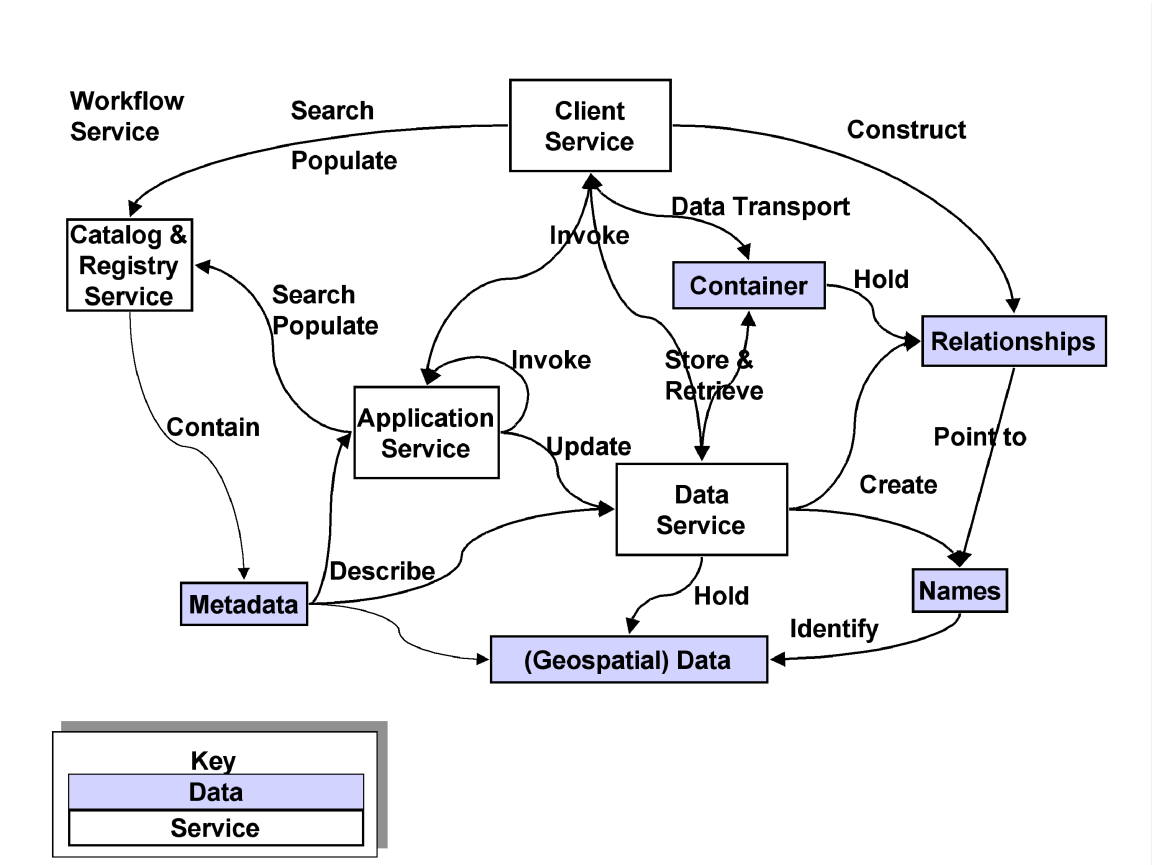

Figure 4 describes two major groupings of components: “operation” components and “data” components.

“Operation” components fall into four major groups:

- Client Services (e.g., Viewers & Editors) - These are primarily user-interface application components that provide views of the underlying data and operations and allow the user to exert control over them.
- Catalog & Registry Services (e.g. Service Registry Services) – These services support access to catalogs and registries, which are comprised of collections of metadata and types. Catalogs can contain information about *instances* of datasets and services.
- Data Services – The foundational services that serve geospatial data. Data Services provide access to collections of data (repositories).
- Application Services (e.g. Geocoder Service) – The foundational application services that operate on geospatial data and provide “value-add” services. Application Services are components that, given one or more inputs, perform value-add processing on data to produce outputs. They can transform, combine, or create data. Application Services can be tightly or loosely coupled with Data Services.

“Operation” components operate on or with the following “data” components:

- (Geospatial) Data–Data are information about things, or just plain information. Data can be created, stored, operated on, deleted, viewed, etc. Taken as a group (or individually) data can have metadata, which itself is a type of data.
- Metadata–Data about data. Metadata about collections of resources and resource types can be stored in catalogs or registries. If a catalog/registry holds metadata records about many different resources/resource types, it is possible to find and use these resources/resource types.
- Names–Names are identifiers. There are many different naming schemes in use today. The most well known is the URL of the WWW. Names themselves are only meaningful if you know the context in which the name is valid (this is called the "namespace"). Names can refer to data or to operators (and by extension to metadata, relationships, other names, application services, catalog/registry services, data services, and client services).
- Relationships–Links between any two information elements form relationships. These can be simple links such as WWW hyperlinks, or they can be complex, n-way relationships among many elements. OGC refers to geospatially-oriented relationships as “geolinks” (see GML specification).
- Containers–An encoded, transportable form of a collection of data or content on the Web. Containers have well-known namespaces, schemas and protocols. OGC has developed two related specifications: Location Organizer Folders (LOF) and XIMA, both which are based upon Geography Markup Language (GML).

All of the components and their operands have internal and external semantics. In particular, the data and metadata take on the semantics of the *Information Community* from which they originate. (Refer to OGC Abstract Specification Topic 14, Semantics and Information Communities for a full description of the term “Information)

The vision for OWS is to enable applications to be assembled as desired from web accessible geoprocessing and location services. OGC Web Services are self-contained, self-describing, modular applications that can be published, located, and invoked across the Web. An OGC Web Service can thus be treated as a "black box" (Operations) that performs a task, such as providing driving directions. Since the operation or operations performed by an OGC Web Service can be described in Metadata, it is possible for a program (or a human) to search for services and understand what operations a given web accessible service can perform.

The Foundation for OGC Web Services: The OGC General Services Model

The OGC General Services model is the overall model governing the structure of OGC Web Services. The GSM details how geospatial software can plug into broader interoperability infrastructures to use and extend diverse, loosely coupled sources of data and services. The GSM focuses specifically on current technologies, platforms and mechanisms (such as UDDI, SOAP, and WSDL) for enabling implementation of interoperable services. The vision is that applications can be dynamically composed of services discovered and marshaled at runtime. The GSM recognizes that there are many ways to instantiate a service and therefore describes the principles and basic model for creating dynamic, loosely coupled systems, but it mandates no particular implementation.

There are a number of reasons for having a General Services Model as the foundation for OGC Web Services.

Promote interoperability: It should be possible to implement services using a large number of different underlying infrastructures. The interaction between services should be completely independent of platform and language. As individual projects produce systems that look less and less like islands of functionality, whatever is built has to play well with other systems that live in the end users' information environment. Users will demand interoperability.

Enable just-in-time integration: Discovery of services should be possible dynamically at runtime. A service requester should be able to describe the capabilities of the service required. Once a provider of service is found, there must be enough information to connect and access it. Dynamic service discovery and invocation (publish, find, bind) and message-oriented collaboration yield applications with looser coupling, enabling just-in-time integration of new applications and services. This yields systems that are self-configuring, adaptive and robust with fewer single points of failure.

Reduce complexity: All components in Web Services are services. What is important is the type of behavior a service provides, not how it is implemented. System complexity is reduced when application designers do not have to worry about implementation details of the services they are invoking. Substitution of a different implementation of the same type of service, or multiple equivalent services, is possible at runtime, enhancing flexibility and scalability.

Support legacy implementations. By "wrapping" existing components, systems or applications with OpenGIS Specification-defined interfaces and exposing them as services, the GSM should enable new levels of interoperability between and with legacy as well as new applications.

Concluding remarks

OGC Web Services development will continue into the future. We are continuing to define the OGC Services model and architecture. Further OGC Interoperability Initiatives will define and test new interfaces and capabilities. A Geospatially enabled Web Services infrastructure represents the next evolution in how we view and use geospatial data, technology, and applications.

Acknowledgements

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Biography of the Author

Dr. Carl Reed is the Executive Director for the OGC Specification Program. Prior to his current position, Dr. Reed was an independent GIS consultant, and before that, Dr. Reed was VP of Infrastructure Marketing at Intergraph. Before Intergraph, Reed was President and CTO for Genasys II, a GIS software company. He obtained his Ph.D. in GIS from SUNY Buffalo in 1979. His accomplishments include designing and implementing two major GIS packages, MOSS and GenaMap. Dr. Reed has published dozens of papers and given numerous GIS conference presentations and keynotes.

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