# Distributed Geospatial Processing Services

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## INTRODUCTION

The development of geographic information systems (GISs) has been highly influenced by the overall progress of information technology (IT). These systems evolved from monolithic systems to become personal desktop GISs, with all or most data held locally, and then evolved to the Internet GIS paradigm in the form of Web services (Peng & Tsou, 2001). The highly distributed Web services model is such that geospatial data are loosely coupled with the underlying systems used to create and handle them, and geospatial processing functionalities are made available as remote, interoperable, discoverable geospatial services.

In recent years the software industry has moved from tightly coupled application architectures such as CORBA (Common Object Request Broker Architecture—Vinoski, 1997) toward service-oriented architectures (SOAs) based on a network of interoperable, well-described services accessible via Web protocols. This has led to *de facto* standards for delivery of services such as Web Service Description Language (WSDL) to describe the functionality of a service, Simple Object Access Protocol (SOAP) to encapsulate Web service messages, and Universal Description, Discovery, and Integration (UDDI) to register and provide access to service offerings. Adoption of this Web services technology as an option to monolithic GISs is an emerging trend to provide distributed geospatial access, visualization, and processing. The GIS approach to SOA-based applications is perhaps best represented by the spatial data infrastructure (SDI) paradigm, in which standardized interfaces are the key to allowing geographic services to communicate with each other in an interoperable manner. This article focuses on standard interfaces and also on current implementations of geospatial data processing over the Web, commonly used in SDI environments. We also mention several challenges yet to be met, such as those concerned with semantics, discovery, and chaining of geospatial processing services and also with the extension of geospatial processing capabilities to the SOA world.

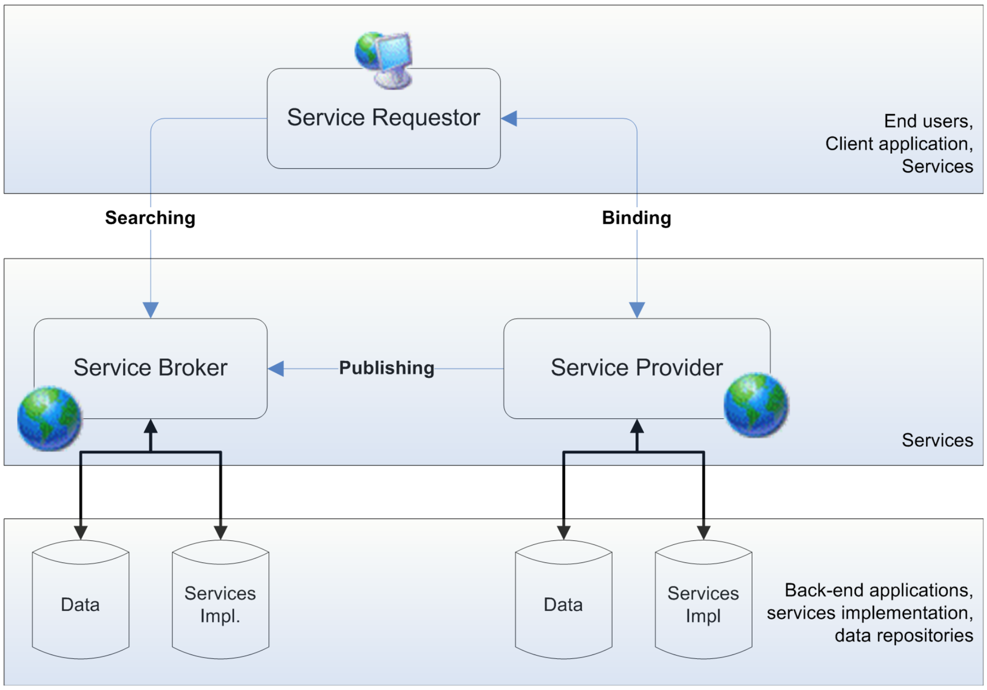
## BACKGROUND

### Service-Oriented Architecture

A Web service is an executable program available on the Internet. Services are the basic units for creating distributed applications in the context of SOAs. As Papazoglou (2008) stated, SOA is an architectural style to design service-centric applications relying on published and discoverable interfaces. Web services are, by definition, loosely coupled (independent units) and are well described (interface description contains functional properties), thereby promoting one of the goals of SOA: enabling interoperability or the ability of software components to interact with minimal knowledge of the underlying structure of other components (Sheth, 1999). Interoperability is achieved by using standard interfaces (SOA does not focus on the concrete implementations of components) and also by decomposing an application's functionality into modular and flexible services. Such building-block services can be published, discovered, aggregated, reused, and invoked using standard protocols and specifications, independently of the specific technology used to create each component. Essentially SOA introduces a new philosophy for building a pyramid of distributed applications where Web services can be published, discovered, and bound together to create more complex value-added services (Alameh, 2003; Lemmens et al., 2006).

Figure 1 illustrates some of the roles and operations in SOA-based applications. There are three different main SOA roles: service provider, service requestor, and service broker. Each SOA role interacts with others utilizing three basic operations: publication, search, and binding. The service provider publishes service descriptions to the service broker. The service requester searches the required services by querying the service broker and then consumes (binds to) them. Note that often the role of service requester is assigned both to end users (and client applications) and to other services. The latter makes use of two key mechanisms in SOA: service reuse and service chaining to create new,

Figure 1. Roles and operations in SOA




complex, value-added services from simpler, discoverable services. In this sense, services can play the role of service requestor and service provider.

## The OWS Service Framework

Within the GIS community, the Open Geospatial Consortium (OGC)—an international industry consortium created in 1994 to develop consensus-based open standards and specifications to support the exchange, sharing, and processing of geospatial data—has adopted a general set of interfaces for a wide range of geospatial Web services (ISO 19119, 2005). Table 1 lists a sample of key OGC Web Services (OWS) categorized as defined in ISO 19119.

These OWS services fall into five categories as follows:

- *Application services* are client-side applications that provide an entry point for end users to find and access geospatial data and services. Among the notable

Table 1. Examples of OGC Web Services

| Service Category | Service Name |
|---|---|
| Application Services | Discovery Application Services<br>Map Viewer Application Services<br>Sensor Web Application Services<br>Geoportal (one-stop portal) |
| Registry Services | Catalog Service (CSW) |
| Data Services | Web Feature Service (WFS)<br>Web Coverage Service (WCS) |
| Portrayal Services | Web Map Service (WMS)<br>Coverage Portrayal Service (CPS) |
| Processing Services | Web Coordinate Transformation Service (WCTS) Geocoder Services<br>Gazetteer Services<br>Route Determination Services<br>Web Processing Services (WPS) |

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