TOWARDS SERVICE-ORIENTED SPATIAL DATA INFRASTRUCTURE

A Framework for GI-Services

The reliability and quality of information services delivered by a Geo-Information (GI) provider determines its success on the market. So geo-information business should not be limited to acquiring, storing and publishing data, but should also add value, integrate spatial data and develop information services. The author presents an example of the rigorous framework required.

Reliability and quality require that processes, data, operations and applications are put together in a service chain. Static implementation of such a chain would suffice if the requirements remained constant during its lifecycle. This is usually not the case, because users want to influence products in many ways, competition has intensified and new technology offers many opportunities. The design of geo-information provision systems that cope with dynamically changing requirements can become rather complex.

GI Services
The three main phases of the spatial data value-chain are generation, communication and use. Spatial Data Infrastructures (SDIs) try to play a significant role in communication by facilitating discovery and access to data. The â€˜useâ€™ phase, however, has mostly been largely neglected; this passive approach has led to data being collected and advertised but never used to its full potential. Increase in data use requires a proactive strategy, which is enabled by the development of information services. But this carries its own problems. To be useful a service has to fit user requirements, which mostly depend on the way data is perceived, expect-ed and used, and on the current forms of projects, markets and technology. A flexible approach can be achieved; for example, by identifying core (atomic) services that may be combined. A geo-information service is accordingly defined as a non-persistent collection of elements organised so that they have value for a user.

Integrated System
The traditional role of the SDI needs to change from being a data discovery and retrieval facility to an integrated system suited for the provision of customised information and services. Services are seen as the contribution of a system, or part thereof, to its surrounding environment. This contribution can be defined in terms of data, operations, processes, resources, value-added products, or any combinations of these. Normally, providers of GI address services by stringing together groups of functions in an ad hoc manner. This may satisfy a single need, but continually and separately providing in this way for different services hampers reusability. Moreover, lack of descriptions of the solutions obtained makes it hard to aggregate them to support more elaborated tasks.

GSI Infrastructure
Research is therefore focusing on the development of mechanisms to manage independent collec-tions of core services so that their combination improves reusability and flexibility while maintaining correctness of the compositions. Geo-information Service Infrastructure (GSI) aims at providing such a facility with the underlying principle that independent GI-resources can be described, accessed and combined to create elaborated service chains which satisfy given requirements. With-in GSI a common method is used to describe GI-resources and their interfaces and then make them available to users to create service chains that perform complex geo-processing tasks. Such GI-resources are available along an infrastructure of interconnected nodes that include data repositories, data brokers, service providers, service brokers and clients. This service concept builds on interoperability as defined by OpenGIS, which separates actual implementation from user definitions and perception of these services.

Reusing Resources
Combining or chaining sets of GI-resources (data, operations, processing units, sensors, etc.) located along distributed nodes makes possible large geo-processing tasks. Binding multiple GI-resources into a chain requires description of the participating resources. These descriptions, which are presented as instances of well-defined models, focus on exposing the behaviour (function) of the resource and its interaction mechanisms or points of composition, and enables interchange and reuse of the GI-resources. The so derived â€˜metadataâ€™ is made accessible through a service repository. The GSI system enables Geo-Service Providers (GSPs) to make use of functionality offered by others to supply a wide range of ser-vices. The GSP-nodes with which users interact to request their services may make use for creating another service of architectural elements available in other GSP-nodes. All connections are established through a network. Additional data located at non-GSP-nodes may still be accessed if needed by either users or service providers using the conventional data-discovery functionality of the clearinghouse server.

GSP Architecture
The service repository component contains descriptions of GI-resources; either data definitions, process definitions or previously assembled service chains. The geo-processing units are responsible for execution of node functions. These units use data and applications as specified by definitions in the service repository. The service-design component defines how services are created and communicates with other GSP-nodes. Generating service chains within the GSI consists of three major activities: defining and registering GI-resources, assembling service chains (GI-services) and delivering results. The roles that may be identified from these activities are:

- Service providers responsible for describing and making their elementary services available to others through a framework enabling the modelling of these GI-resources. Such models act as descriptors specifying the function and the interaction point(s).
- Service consumers use descriptions to design more complex services, using the same framework as that used by the service providers to assemble individual GI-resources into chains. They define these chains by adding control elements (mediators) to ensure satisfaction of constraints and conditions defined at interaction points of the GI-resources. The chain is created by instantiating behaviour portrayed in specification of the chain.
- End users trigger definition and execution of service specifica-tions by posting requests to the system.

Service Repository

Our approach to GI-services design focuses on the use of conceptual models as an intermediate step in the development process, sitting between requirements and actual implementation. This is done solely to enable and facilitate reuse and enhance flexibility; reuse means the inclusion of sing-le GI-resources within multiple services. The main benefit of these models is to serve as the basis for specification of complex services. A GI-resource can be easily re-used if the model properly describes the GI-resource; that is, with the relevant information at the correct level of detail one is able to determine what it does and how to access the functions. Since the models of GI-resources prescribe the behaviour of individual elements, a GI-service model can be used to arrange creation of the service. Additionally, once a service model is available it can be reused as a non-atomic GI-resource in another definition as part of a more specialised service. For this approach to work, models need not only to be interchanged but also to be understood by all parties involved. This can only be achieved if the models are based on the same â€˜metamodelâ€™, which should provide a rigorous abstract syntax for defining models. The metamodel enables implementation of a repository where compliant models of GI-services and GI-resources can be stored. Hence the repository becomes the central component in a GSI system and supports the exchange of models between service providers. It facilitates combination of these models to form more complex service models addressing specialised sets of requirements.

GI-services Framework

Enabling many geo-service providers to work together sharing several resources also requires provisions by the supporting infrastructure. To this end, a service classification scheme has been defined and administrative services established to support the operation of such an infrastructure. Registry services are those services necessary for storing, querying and using descriptions of GI-resources. These descriptions are created using XML-based languages read-able by both machine and human beings. Registry services provide all functionality needed for use of the repository; that is for classification, registration, description, maintenance, accessing and combining information on GI-resources. The core services are of the following types:

- data services, providing access to datasets available in data repositories or databases
- processing services, operating on spatial data, â€˜adding valueâ€™ to it and used to perform computations and transform, combine or create new data
- sensor services, providing access to sensor operations paths and almanacs and to raw images and data, and possibly including traffic cameras, satellites and weather stations
- portrayal services, providing visualisation functions to be applied to information
- HW-Resource services, providing access to hardware resources for storage or processing
- administration services, needed for the smooth-running of the infrastructure and including: design services used to define combinations of core services to create customised GI-services, workflow services which allow choreographing any service chains defined using design services, and resource management services which allow control of status and availability of HW-resources.

Concluding Remarks

The provision of tailored GI-services should allow the user to be given added-valued geo-information products as opposed to raw data, as is often the case. Approaches to design systems for the integration of disparate GI-resources to form GI-services enable providers to cope with the ever-changing requirements of geo-information users.
