

Implementing a Municipal SDI with Service Oriented Architecture

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Abstract:

The highly dynamic and complex nature of today's metropolitans requires that any "service provision" of their municipality be fast, economical, and of high quality. This goal could only be reached through cooperating or interoperating applications. Spatial Data Infrastructures (SDI) are indispensable from this respect. Enabling Application-to-Application (A2A) integration, Services Oriented Architecture (SOA) promises the interoperation required by SDIs. Service Oriented Architecture strives to achieve economies of scale in the development and implementation of business solutions via the reuse of services and service components. Geospatial processes, data, applications, and technology can all be more efficiently used and implemented by leveraging SOA principles. However, there are a number of technical issues involved in implementing municipal SDI with SOA in an enterprise organization such as municipality of metropolitans. The aim of this work is to identify these issues and derive a framework out of them which will guide the design, development, and maintenance of a large scale organization SDI. Since there is no such framework in place, implementing a SOA based municipal SDI seems a very ambitious and difficult undertaking. Although there are sparse work on the issue, they either are so general or do not deal with the issues at the desired level of practicality and detail. Given the complexity of the issues involved and the immaturity of the SOA technologies, it is rather difficult to come up with a framework though. However, there are countermeasures and already stable components of available SOA technologies. This paper presents the specification of the service oriented approach which is used for developing the Tehran Municipality SDI. SOA constructed a distributed, dynamic, flexible, and re-configurable service system over Internet that could meet information and service requirements of many different users from inside departments of municipality or from outside by different urban organizations.

1. INTRODUCTION

City administrations of large cities, in particular of mega cities often are confronted with a multitude of key problems like informal settlements (land tenure, development approvals, building control), traffic management, natural hazards (floods, earthquakes, fires), unclear responsibilities and mandates (within or between administrations), uncoordinated planning, water management (fresh water supply and waste-water disposal), provision of continuous electrical power, visual pollution and garbage disposal, air and water pollution control. To manage such problems adequate urban governance urgently needs comprehensive, reliable and easy accessible spatial data, in other words, a well-functioning spatial data infrastructure (SDI) (Boos S and Mueller H, 2009). SDI extends a GIS by ensuring geospatial data and standards are used to create authoritative datasets and policies that support it.

The term "spatial data infrastructure" is often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. A spatial data infrastructure provides a basis for spatial data discovery, evaluation,

download and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and the general public.

According to one of the German SDI initiative Web sites (gdi.initiative.sachen), the components of an SDI include:

- Geospatial data resources as the repository for all spatial-related data
- Networks as the physical and logical infrastructure component
- Geographic information system (GIS) services for communicating the different elements
- Standards ensuring interoperability

Figure 1 shows the relationship between the different components. From a software technology point of view, services are the heart of the infrastructure.

Figure 1- The diagram shows the components of a spatial data infrastructure.



The requirement of today's highly dynamic and competitive business models that have the provision of rapid, qualified and economical services and these requirements can only be satisfied by collaborations of the involved parties, which actually require "interoperability infrastructures".

The need for interoperability infrastructures has been not felt only in the spatial data area but also in many areas such as "e-business" or "e-government" for the past several years. Spatial Data Infrastructures (SDIs) are "interoperability infrastructures" for the spatial data (AKINCI. H and CÔMERT. C, 2007).

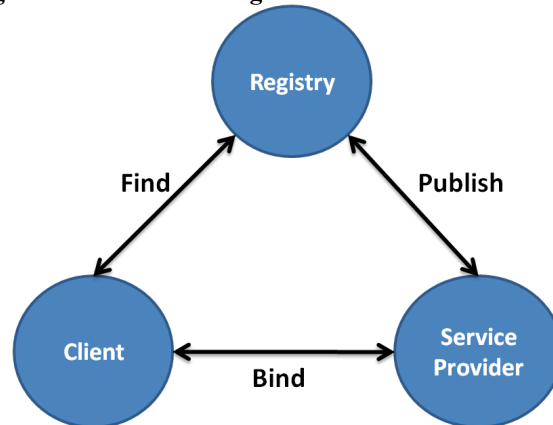
Interoperability can be defined as the ability, by which different applications that use different languages or concepts can talk to each other. Various systems and software architectures have been developed to enable interoperability between applications that have been written in different programming languages, located in different places on the network and reside on different hardware platforms. Service-Oriented Architecture (SOA) which is designed to implement interoperability is the most popular and widespread software architecture. Web services have been accepted as the best and the most popular way of implementing SOA.

2. Service Oriented Architecture (SOA)

Service orientation is a way of viewing software assets on the network—fundamentally, the perspective of IT functionality being available as discoverable Services on the network. Essentially, Service orientation provides business users with understandable, high-level business Services they can call upon and incorporate into business processes as needed. The Service orientation vision is therefore one of agility and flexibility for users of technology, coupled with an abstraction layer that hides the complexity of today's heterogeneous IT environments from those users (OGC 2004).

Service-Oriented Architecture (SOA) is an architecture that represents software functionality as discoverable Services on the network. SOAs have been around for many years, but the difference with the SOAs we talk about today is that they are based on standards, in particular, Web Services. Web Services provide standards-based interfaces to software functionality. Producers of these Services may publish information about them in a Service registry, where Service consumers can then look up the Services they need and retrieve the information about those Services they need to bind to them (Figure 2).

Figure 2- Service Trading Communication Structure



Applications designed using SOA can provide the same functionality as that found in a monolithic architecture coupled with the following additional benefits:

- Easier extension of legacy logic to work with new business functionality
- Greater flexibility to change without the need to constantly re-architect for growth
- Cost savings by providing straight-forward integration

Bocchi and Ciancarini (2006) point out that the most prominent technology that implements the SOA architectural approach today is web services. Web services are a particular class of services that use open Internet standards, such as connection and communication using the Hypertext Transfer Protocol (HTTP), identification using the Uniform Resource Identifier (URI), contents specification through the eXtensible Markup Language (XML), service descriptions expressed by the Web Services Definition Language (WSDL), and directory services using the Universal Description, Discovery and Integration (UDDI) protocol. Therefore, while services in general provide interoperability between different software components, Web services go a step further by facilitating cross-institutional interchange of data and services over the Internet, and by improving the sharing of resources among a variety of data sources.

The Open Geospatial Consortium (OGC) proposed an architecture for sharing of geographic data and functionality over the Internet, thus leading the standardization process regarding data formats, methods and interface specifications. The OpenGIS Services Framework does not necessarily use the usual Web services standards, such as the Simple Object Access Protocol (SOAP) and WSDL. Some basic Web services were specified by OGC, as services applied to registry, composition, visualization and codification (Davis Jr. C and Alves L, 2005).

The main drivers for implementing SOA are to facilitate the growth of large-scale enterprise systems, to facilitate internet-scale provisioning and use of services and to reduce costs in interorganisation cooperation. The value of SOA is that it provides a simple scalable paradigm for organising large networks of systems that require interoperability.

Putting together findings from researchers (Radwan, et. al., 2005), SOA can provide a foundation for business adaptability and the significant benefits of SOA are as follows:

- A SOA is inherently flexible because services can be reused in alternative configurations in response to external changes.
- Services can be invoked in a predefined order to form business process. Any one service may support several business processes.
- Support many independently developed implementations of services
- Establish service chains to build applications
- Enable ad-hoc chaining of services
- Vendor neutral

- Seamless integration of legacy system's functionality
- Minimum requirements on the technical equipment of users
- Build upon standards
- Maintainability & Interoperability

Even though the benefits of SOA are compelling, SOA also changes the dynamics of IT by introducing interdependencies across projects and applications.

3. Service oriented spatial data infrastructure

The focus of SDIs have moved from a data orientation in the 1990s to a process orientation in the late 1990s-2005 towards service-oriented SDIs. The SDI concept enhances mainstream Information Technology's (IT) widely accepted principle of Service Oriented Architectures (SOA) to include spatial features. The basic idea of SOA – providing functionality as a set of independent services – is based on dynamic integration and composition. Several well-established standards of the Open Geospatial Consortium (OGC) foster interoperability between data and services in order to set up a spatially enabled SOA (Loenen B et. al, 2009).

Technology has made it easier to access, manipulate, and exploit spatial data. Consequently, a more sophisticated spatial awareness has developed among users, resulting in growing dependence on people and organizations for spatial data. This translates to diverse and changing user requirements. This presents a challenge for any supplier. To address this development, spatial data infrastructures need to change from being a data discovery and retrieval facility to becoming a service-oriented infrastructure on which users can rely for the provision of geographic information services. Work then needs to flow across several companies, requiring the sharing of not only data but also resources, functions, and processes. This is achieved with a unified framework architecture for the provision of geographic information services across organizations and communities. It enables the integration of disparate systems, facilitating access and chaining of core services (sensor, visualization, processing and other services) to create customized user services in line with changing requirements.

Today's geoinformation business should not only focus on acquiring, storing, and publishing data but also give attention to adding value and integrating spatial data to enable the development of information services that can lead to improved spatial data use and better decisions (Javier Morales, 2006).

The modern spatial data infrastructure is changing from a simple data discovery and retrieval facility to becoming an integrated system suitable for the provision of customized information and services. Services are defined as the contribution of a system, or part thereof, to its users. This contribution can be data, operations, processes, resources, value-added products, singularly or any combination (Javier Morales, 2006).

A prime service needed to fully exploit the notion of SDI deals with the comprehensive access to the underlying data. Not only access to data is important, but also access to services that allow the data to really contribute to the user's needs. Web services are an effective way to make public sector geo-information available. They allow information to be accessed directly at the source and to be combined from different sources (Loenen B et. al, 2009). The most widespread standards adopted in web oriented spatial Information Technology are: Geographic Markup Language (GML), Web Map Service (WMS), Web Feature Service (WFS), Web Coverage Service (WCS), Catalogue Service for Web (CSW), Web Coordinate Transformation Service (WCTS).

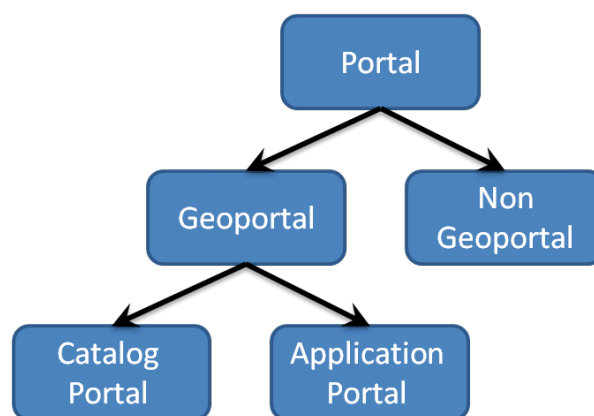
Portal technology is extensively used to implement SDIs. In geoportal literature, role of a geoportal is demoted the role of a catalogue service which is the key component of SOA. In other words, geoportal is recognized as a catalogue service. In many papers, it is indicated that prominent feature of all SDI geoportals is a catalog service and it is specified that a primary focus of a geoportal is the discovery of geographic content.

4. Geoportal in service oriented spatial data infrastructure

OGC defines a geoportal as “a human interface to a collection of online geospatial information resources, including data sets and services” (OGC, 2004). It is important to establish a distinction between the concepts of SDI and geoportal.

It is useful to subdivide geoportals into two groups (figure 3): catalog geoportals and application geoportals. Catalog geoportals are concerned primarily with organizing and managing access to GI; for example, GOS and The Geography Network. Application portals provide on-line, dynamic geographic web services; for example, Mapquest provides routing services (www.mapquest.com), National Geographic provides mapping services (<http://www.nationalgeographic.com/maps/>) and local and regional government portals support transport and planning portals for the UK. A prominent feature of all SDI geoportals is a catalog service for publishing and accessing metadata. The more advanced SDI programs are also beginning to feature application services (Maguire, D and Longley, P, 2005).

Figure 3- A classification of geoportals



A geoportal database is populated with metadata records of published geographic information Services. Users can issue queries against the database either from a lightweight web client, or a heavier-weight desktop GIS client, providing that they have an Internet connection. This allows users to discover what services are available on particular topic, geographic area, and time period combinations. The services can then be directly used in client applications.

5. CONCLUSION

City administrations of large cities, in particular of mega cities often are confronted with a multitude of key problems. To manage such problems adequate urban governance urgently needs comprehensive, reliable and easy accessible spatial data, in other words, a well-functioning spatial data infrastructure (SDI). SDIs are interoperability infrastructures. Interoperability can be defined as the ability by which different applications that use different languages or concepts can talk to each other. The recent software architecture which designed to implement interoperability is Service-Oriented Architecture (SOA). Web services have been accepted as the best and the most popular way of implementing SOA. Portal technology is extensively used to implement SDIs. In geoportal literature, role of a geoportal is demoted the role of a catalogue service which is the key component of SOA.

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