BIOGRAPHICAL INFORMATION

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Specific Responsibilities

Dr. Ignacio Guerrero is responsible for the Geospatial Product Center at Intergraph. He is directly accountable for managing all aspects of the development process leading to the generation of foundation and industry specific products for Intergraph Mapping and Geospatial Solutions. This comprises strategic product planning, technical direction and strategy, software engineering and general day-to-day operations.

Past Experience

Ignacio joined Intergraph in 1981. In the past 23 years he has worked as a software engineer, designer and manager in a broad spectrum of Geospatial products. Before joining Intergraph, he was involved in university teaching and research for 6 years.

Educational Information

Ph.D. – Mathematics, State University of New York at Stony Brook (1975)

Emerging Technologies in the Geospatial Industry

Ignacio Guerrero
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Introduction

Component architectures have matured into robust distributed computing platforms that leverage new software and hardware infrastructures. Many geospatial solutions companies have kept up with this evolution, while adopting new technologies as they emerge. Service Oriented Architecture (SOA) in particular provides the new conceptual frame work for distributed systems.

Technology drivers shaping the future of the geospatial industry include : universal availability of the Internet, wireless and mobile technology, global positioning systems (GPS) and other sensors linked via wireless communications. Web Services and more generally SOA provide a distributed computing platform linking all of these technologies together.

This paper discusses the important geospatial trends of today and projects how they will evolve into the future. In particular, Web Services and mobile technology are at the forefront of new information technology (IT) and will play an important role in this presentation.

Component Architectures

A component is a unit of software that encapsulates functionality, hiding its internal details and exposing the functionality through a well-defined application-programming interface (API). Reusability of software components has been an issue in the IT industry for decades. For example, in the 1970s and 1980s, software components were implemented as function libraries – accessible by computer languages, such as FORTRAN. Since the 1990s, object orientation is omnipresent in the industry. As the foundation for new component architectures, object orientation itself is not sufficient to support a robust component system architecture. A component model includes standard protocols for object creation and destruction, standard protocols for method invocation, security and a robust foundation of object libraries.

In the early days of GIS, components were assembled into monolithic programs that executed in a single machine. Improvements to network technology enabled the design of distributed systems, in which components execute in multiple network nodes. Out of this evolution emerged the concept of Distributed Computing Platform (DCP) – a component model that can be realized over a network.

The OpenGIS Consortium™, Inc. (OGC) has accepted a leading role in investigating how this emerging field would impact interoperability within the geographic information science field. A reference to this work is contained in a May 1996 GIS World article entitled, “How OGIS Spans Distributed Computing Platforms,” which can be found online at http://www.opengis.org/ under the “Press Coverage” section.

Today, two DCP platforms – COM, with extensions DCOM and COM+, and Java – have matured and are adopted extensively throughout the industry. With the tremendous growth of the World Wide Web and the need to distribute functionality across Web sites, the Web has become the medium for a new DCP. Service Oriented Architectures in particular provide the conceptual base for distributed computing on the Web.

Service Oriented Architecture (SOA)

Service Oriented Architecture (SOA) is a conceptual base or approach for building distributed systems that implement application functionality as services. A services is a re-usable component that packages application functionality. Central to the service concept are the actions of a service requester and a service provider. Services are software components that have the following characteristics:

- Loosely-coupled. The interactions between service requestors and service providers is via standard messages that have no knowledge about the software internal details, platforms or languages.
- Well-defined interfaces
- State-less. This means that each service request is independent and the service provider "does not remember" information regarding previous requests.

SOA includes the concept of services discovery – the process by which a software component can search for complementary functionality, find it, and use it as needed. Services are advertised through service brokers, who advertise via catalogues or electronic yellow pages

Figure 1 – SOA

To illustrate this, we will examine credit card validation, a common function used in e-commerce Web sites. The credit card validation process is a very complex process requiring secure access to multiple private databases that contain customer-sensitive information. Such a process, however, can be packaged in a way that hides the internal complexities and exposes a simple interface. Users simply input a card number and expiration date, and the output is a binary flag of either valid or invalid. Internally, the credit card validation program is an aggregation of dozens of objects performing specialized functions. From an external point of view, credit card validation can be seen as a "super object," or service with very simple interfaces.

In order to clarify the services broker concept, we can draw on a non-IT analogy, such as plumbing service. A plumber – the service provider – will publish the service availability via a service broker – the telephone directory yellow pages. If we – the service requestor – are looking for a plumber, we will find the services and "bind" to it, establishing a work order or contract.

SOA Business Drivers

What is the SOA value added? The business community recognizes that the world is not homogenous from an information technology perspective. In order to enable business transactions between enterprise systems, interoperability is essential. Interoperability refers to the ability of software systems to communicate with each other independent of vendors and platforms. SOA brings in a conceptual framework to enable interoperability.

Interoperability adds value within the enterprise or in business-to-business activity. Often today's IT infrastructure has evolved into heterogeneous systems resulting form changing internal strategies, modernization programs, mergers and acquisitions and other factors. Interoperability via SOA enables new levels of integration within the enterprise. In term of business-to-business scenarios interoperability enables the integration of functionality creating better and more robust applications. A good example of this is found in the Microsoft web site case study on Dollar Rent A Car (search for Dollar Rent A Car in http://www.microsoft.com/)

Web Services

The SOA is a conceptual model and does not specify exactly how the software should be built. In contrast, Web Services provide specific guidelines on how services are described ad how services interact. Thus Web Services can be regarded as a specific instance of SOA. Web Services rely on standards:

- Communications: XML, SOAP over http
- Description: Web Services Description Language (WSDL)
- Registry: Universal Description, Discovery and Integrations (UUDI)

XML, SOAP and WSL are W3C standards that are enjoying wide IT industry adoption. Other organizations that are shaping web services standards -- in addition to W3C – are OASIS (http://www.oasis-open.org/) and WS-I (http://www.ws-i.org/)

The publishing/discovery concept is still lagging in development and deployment. Even though the publishing/discovery concepts are not yet mature, it is clear that SOA can bring immediate tangible benefits, including:

- Legacy systems can be made interoperable with new systems – upgrades do not require a "big bang."
- GIS systems can be integrated with other business support systems.
- Multi-vendor interoperability can be achieved.

Geospatial Web Services

As it has been described the IT industry is defining standards for the implementation of SOA in the form of web services. In order to realize the full potential of web services it is necessary to create domain specific standards. Many organizations today are beginning to do this for a variety of disciplines. In particular for Geospatial information, the Open Geospatial Consortium (OGC) (http://www.opengeospatial.org/) has taken a leadership role inn developing open geospatial interoperability standards.

The Web Mapping Testbed (WMT), OGC's first interoperability initiative, took place in 1999, culminating in a presentation on September 10, 1999. This initiative was a significant milestone for several reasons. First, it introduced an innovative "coopetition" methodology that brought together competing vendors and their customers to work toward common objectives. Second, it demonstrated truly interoperable Web Services for the first time – several years before service-oriented architectures became the preferred form of distributed computing. In addition, WMT was the catalyst for explosive growth in the OGC interoperability program.

The years between 1999 and 2003 were an exciting period with great creative energy generating innovative open technologies. In this timeframe, OGC technologies were validated through numerous pilot projects and implementations. For more information on OGC web services activity we refer to the OCG web site mentioned above.

Mobility

Mobility is a rapidly expanding technology – fueled by several factors.

- New low-cost smart devices (PDA, Smart Phones, and Tablets) with fully functional operating systems
- Price of wireless communications (cell and WI-FI) has fallen dramatically, wireless coverage has increased, and bandwidth and reliability are steadily increasing
- Cost of GPS has steadily decreased and the systems are now very affordable

In the future most computing activities will be affected by an ubiquitous network, which will provide unprecedented levels of wireless and wired connectivity. Mobile resource management (assets and people) and mobile data access are topics of special interest to the geospatial industry.

Mobile resource management encompasses a variety of functions that enable organizations to manage mobile resources in space and time. Resource management includes tracking; spatially enabled rules processing, such as a trigger and alarm event when a vehicle enters a restricted zone; resource planning; and optimization.

Mobile data access refers to the extension of the enterprise database to mobile computing devices that may be connected, disconnected, or occasionally connected.

SOA is the natural software infrastructure to support mobile applications since it is based on loosely coupled components that communicate via messages. Complementing SOA, IT infrastructure vendor are developing data synchronization systems that will allow extension of the enterprise database to mobile devices.

In summary…

- (Web) Services are key for enterprise application integration
- Service Oriented Architecture (SOA) is a conceptual base or approach for building distributed systems that implement application functionality as services
- Services rely on standards to achieve interoperability
- IT drives standards via organizations such as W3C, Oasis and WS-I
- Geospatial standards are driven by the Open Geospatial Consortium (OGC) and ISO
- In the future most computing activities will be mobile
- SOA is the natural software infrastructure to support mobile applications