

Regulatory Ontology–Based Interagency Information and Service Customization

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INTRODUCTION

The government services needed by citizens or businesses often require horizontal integration across autonomous government agencies. The information and services needed are typically scattered over different agencies in diverse formats, and therefore are not interoperable. This results in the so-called “stove-pipe” service and information paradigm, which raises a number of challenges. First, the service consumers, both citizens and businesses, face the challenging task of locating relevant services and information from a large number of documents scattered at different locations on the Web. Therefore, it is beneficial to have a system to locate and integrate available services that are tailored to individual preferences and needs according to regulations. Second, due to the fact that information is not shared among the different agencies, service consumers are required to re-enter certain data repeatedly to obtain interagency services. Service integration should allow sharing among agencies.

Digital governments have been evolving with different focuses in terms of information and transaction services. The evolution has shown at least four different stages. At the first stage, with the Internet and the WWW, governments digitized paper forms and started to disseminate information with static Web pages, electronic forms, and data displays. The focus of this initial stage has been to make information digitally available on the Web. The transaction services tended to resort to off-line paper-based traditional methods (e.g., by submitting the printed form with a payment) such as by credit cards.

In the second stage, governments started to provide services for the citizens by developing applications for service delivery and databases to support the transactions. The citizens and businesses can “pull down” the needed services and information through “active” in-

teraction with individual agency Web sites separately, as in self-services. In both of these stages, the digital government efforts did not consider what other government agencies have been doing and how their services may be related to other agencies’ services. The information and service consumers need to “visit” each agency separately and actively search for information and services. The digital government up to this stage mimics the physical government, and citizens and business entities navigate digital boundaries instead of physical boundaries for complex services, such as business registration or welfare benefits. When agency interactions are needed, data and forms are forwarded in batch mode to other agencies through paper or fax, where the data is re-entered, or the digital data captured from a form is forwarded in a file via CD-ROM or a floppy disk. The streamlining of business processes within individual agencies may have been achieved, but not the streamlining of business processes across agencies.

In the third stage, digital government agencies strive to provide seamless, integrated services by different agencies with sharing necessary information. The services and documents are organized such that they are easily identified and the consumers do not have to scour large amounts of information for the right ones. This stage of digital government is characterized as one-stop portal stage. In the fourth stage, the governments create digital environments where citizens’ participation is encouraged to define government policies and directions. The services up to the third stage are often enforced by government regulations and policies. These very rules and policies can be modified by citizens’ participation. In this fourth stage, digital government efforts focus on developing collaborative systems that allow collaboration among government agencies and citizens in order to reflect the constituents’ inputs.

Today’s digital governments characterized by “self-service” and “one stop portal” solutions, between stages

two and three, need to provide front-end (citizen-facing) tools to deliver relevant, customized information and services, and a back-end (processing) infrastructure to integrate, automate, manage, and control the service delivery. The service integrations vary according to user requirements and need to be dynamically achieved in an ad-hoc manner with personalized processes as end results.

BACKGROUND

Web-based electronic commerce applications or digital government services applications support the interaction between different parties (customers or citizens) and management of data involved in the process. In Electronic Commerce, integrating a variety of available applications creates value-added services for customers and new business opportunities for providers. The integrated applications allow comparative shopping services where customers have a uniform interface for different stores. The integration of complementary services allows one-stop services, such as airline, train, hotel, and car rental services as one service. The application integration faces a number of challenges, such as diversity of applications, disparity of interfaces, and heterogeneous data and API formats. In addition, the integrated services may be loosely coupled involving different participants, playing different roles, in an ad-hoc manner, involving different flows, and complicating the coordination. Thus, the discovery of available services for flexible customization and coordination is required. There are a variety of technologies and standards for solving these issues.

- **Database Schema Integration:** Heterogeneous data formats in each application need to be integrated for integrating autonomous business applications. ERP solutions such as SAP R/3 or EAI (Enterprise Application Integration) use consolidated common data and message exchange models (e.g., XML) for enterprise-wide and cross-enterprise application integration (Lee, Siau, & Hong, 2003)
- **Middleware Approaches:** Invoke a set of software libraries (components) to locate the needed application components and data. CORBA (Common Object Request Broker Architecture) (Vinoski 1997) is an example. The client makes high-level requests for objects and the CORBA middleware locates necessary components and implementation objects
- **Workflow Systems:** Have been used for interorganizational processes or virtual enterprises where processes span multiple organizational boundaries and are composed of loosely coupled cooperating workflows executed in different organi-

zations (Alonso et al., 1999; Casati & Discenza, 2000; CrossFlow, Georgakopoulos, Shuster, Cichocki, & Baker, 1999; van der Alst 1999). The workflow systems typically include components for the modeling and specification of virtual business processes, their execution, process monitoring and analysis, and message communication among process participants

- **Agent-Based Integration:** An agent is a software module having local decision-making capabilities and intelligence to perform specialized tasks by interacting with users, other agents, and information sources. It communicates with other agents to locate the needed services to fulfill the requests from the user or another agent (Wiederhold, 1992). The information and services are integrated by tasks performed by a set of agents
- **Web Service Composition:** The growing trend for B2B or enterprise application integration is using Web services that are platform independent. Each service is published with a set of descriptors about its input, output and behaviors. A set of XML-based standards is used to describe these Web services (WSDL—Web Service Description Language), to be published in a public repository (UDDI—Universal Description, Discovery and Integration), and to be invoked via SOAP (Simple Object Access Protocol). Individual Web services are composed for integration and customization and can be specified in BPEL (Business Process Execution Language) (Hull & Su, 2004).

Using these technologies, one may integrate the applications, services, and business processes, but putting these services together remains mostly manual. Web service technologies try to automate the service identification and discovery utilizing the Web service descriptors such as input and output matching, which are mostly syntactic descriptors. More semantic and pragmatic approaches may be needed for automatically identifying the needed component services for integration and customization (McIlraith, Son, & Zeng, 2001).

ONTOLOGY-BASED CUSTOMIZATION

Consider an entrepreneur, John, who wants to develop an open lot to start a new automobile repair shop as follows:

Scenario: The open lot is located in an environmentally sensitive area near wetlands and a river in the New Jersey Meadowlands designated as "Light Industrial and Distribution B zone." (HMDC, 1999) John will have

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