

Chapter 3.3

Flow-Based Adaptive Information Integration

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ABSTRACT

Assembling a coherent view of distributed heterogeneous information and their processing is challenging but important for inter-organizational business collaboration and service provision. However, traditional integration approaches do not consider dynamic and adaptive issues such as human intervention and exception handling. Therefore, we propose a Workflow-based Information Integration (WII) approach, which is particularly suitable in a loosely coupled Web services environment. Our implementation framework comprises five layers: semantic, application, workflow, service, and message. We focus on the workflow layer for providing

adaptiveness from the aspects of various types of flows such as control-flows, data-flows, security-flows, exception-flows and semantic-flows by using the Business Process Execution Language for Web Services (BPEL). We further extend this with our proposed data-integration, semantic-referencing, and exception-handling assertions in order to achieve dynamic and adaptive workflow-based information integration plans. We map information into SOAP messages and link the proposed exception-handling assertions in BPEL to SOAP-fault implementations. We also define semantic referencing in BPEL by using OWL Web Ontology Language. Lastly, we demonstrate the feasibility of our adaptive approach with an intelligence information integration case study at the application layer and examine some typical use cases of exception-handling with semantic support.

DOI: 10.4018/978-1-60566-669-3.ch008

INTRODUCTION

There is a growing need for an integrated view of information from different sources with the blooming of information sources and services over the Web. Automation for the assembly of a coherent view of distributed heterogeneous information and information processing resources is a challenging and important process for inter-organizational collaboration and service provision. This process is defined as *information integration*, which deals with the problem of making heterogeneous, external data sources accessible via a common interface and an integrated schema. Users should perceive the collection of data as being managed by a single database system (Leymann & Roller, 2002). Information management involves dynamic and adaptive plan execution, involving steps such as access approval, continuous querying, query result accumulation, local persistent storage, and the linking of other actions to the results of queries (Barish et al., 2000). In this chapter, we advocate a workflow approach to address this problem. We further propose a formulation of information integration plans in a loosely coupled Web services environment in which each service provider acts as a data custodian or provides certain data analysis services.

Current trends in information and communication technology (ICT) accelerate the widespread use of Web services in information integration (Aversano et al., 2002). In this chapter, a Web service refers to an autonomous unit of application logic that provides some information processing resources to other applications through the Internet from a service provider (such as an enterprise). Here, an activity, i.e., a logical unit of work, is performed by a Web service. Web services are based on a set of XML standards such as Simple Object Access Protocol (SOAP), Universal Description, Discovery and Integration (UDDI), and Web Services Description Language (WSDL) (Weerawarana et al., 2005). In many cases, information integration plans may have

to combine more than one information services to fulfill a need. Thus, information Web services must evolve to support interactions with access control in addition to simple procedures (Wiederhold, 1992). In addition, these Web services may require long duration enactment of multi-step activities, which can involve information processing tasks, interactions between information services providers, and human intervention (e.g., decision for approval). Thus, workflow technologies help providing dynamic and adaptive capabilities as further explained below.

A Workflow Management System (WFMS) (Georgakopoulos et al., 1995; Van der Aalst & Van Hee, 2002) is the application to support the specification, decomposition, execution, coordination, and monitoring of workflows (Jeston & Nelis, 2008). In general, a workflow includes many different entities, such as, activities, humans, events, and flows. An event is an atomic occurrence representing a specific state change of the system itself or an user application, which arise during the execution of an activity. We partition events into different types such as events related to control, data, semantic, exceptions, and security. A *flow* is a directed relationship that transmits events from a source activity to a sink activity. Hence, events partition activity relationships into corresponding types of flows, such as control-flows, data-flows, semantic-flows, exception-flows, and security-flows. In this way, a workflow specification is defined as a set of activities connected by these flows: every activity starts when one or more relevant events arrive; and when the activity finishes one or more events are generated inform other dependent activity/activities.

The Semantic Web helps providing explicit meaning to information available on the Web for automatic process and information integration based on the concept of ontology (Fensel, 2001). An ontology defines the terms used to present a domain of knowledge that is shared by people, databases, and applications. In particular, ontologies encode knowledge for providing adaptive ca-

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