Chapter XIII
Building a Semantic-Rich Service-Oriented Manufacturing Environment

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ABSTRACT

Service-orientation has emerged as a new promising paradigm for enterprise integration in the manufacturing sector. In this paper, we focus on the approach and technologies for constructing a service oriented manufacturing environment. The service orientation is achieved via virtualization in which every thing, including machines, equipments, devices, various data sources, applications, and processes, are virtualized as standard-based Web services. The virtualization approach is based on the emerging Web Services Resource Framework (WS-RF). A case study of virtualizing an AGV system using WS-RF is described. The use of Semantic Web Services technologies to enhance manufacturing Web services for a semantic-rich environment is discussed, focusing on OWL-S for semantic markup of manufacturing Web services and OWL for the development of ontologies in the manufacturing domain. An enterprise integration architecture enabled by Semantic Web service composition is also discussed.

INTRODUCTION

Service-oriented architecture (SOA) has emerged as a new promising paradigm for building loosely coupled, standard-based and Web-enabled distributed applications and systems. SOA is an architectural style for building software applications that use services available in a network such as the Web, and the concept of services refers to as network-enabled entity delivered over the Web using XML-based technologies. *Services* provide the highest level of abstraction and support the right kind of programming model for open distributed systems in the following ways:

- Services are network-enabled components with well-defined interfaces that are implementation independent.
- Services are self-contained to offer functionality as defined in interfaces. Services can be dynamically discovered and their consumptions are by message exchange; Consumers are not concerned with how these services will execute their requests.
- Services are loosely coupled, only thin message-level connection exists, and thus more independent.
- Composite services can be built from aggregates of other services, providing the ability to choreography their behaviors so that the local policies can be applied autonomously and yet creates a coherent cross enterprise processes.

SOA provides a new opportunity for solving long-standing problems in industry and enterprises, for example, the notorious integration problem. In a nutshell, the integration problem can be viewed as a problem of service integration or service composition. This in turn imposes a new challenge of building a service-oriented environment. In this article, we focus on the approach and technologies for constructing a service-oriented manufacturing environment. The service orientation is achieved via *virtualization* in which every thing, including machines, equipments, devices, various data sources, applications, and processes, are virtualized as standard-based Web services. The virtualization approach is based on the emerging Web Services Resource Framework (WS-RF). We illustrate how WS-RF is used to virtualize an AGV system as Web services.

The full potentials of service-oriented environment can be fulfilled by enhancing it with semantics, creating a semantic-rich environment. We leverage Semantic Web technologies for this purpose, and use OWL-S for semantic markup of manufacturing Web services and OWL for the development of ontologies in the manufacturing domain.

SERVICE-ORIENTED ARCHITECTURE FOR MANUFACTURING

The overall semantic-enhanced service-oriented architecture is shown in Figure 1. Fundamental to the service orientation is the *virtualization layer*. Via a virtualization, all manufacturing systems to be integrated are exposed as Web services, and they can offer their services and functionality in a standard Web service environment. The emerging WS Resource Framework provides a standardized way for the virtualization (Graham, Karmarkar, Mischkinsky, Robinson, & Sedukhin, 2004). Using WS-RF, each manufacturing resource will be modeled as a WS-Resource, which is the combination of the Web Service and the stateful resource. The ultimate objective of virtualization is the construction of a service-oriented manufacturing environment, and all services are hosted in a standard Web service platform. The basic Web service infrastructure (SOAP, WSDL, UDDI) is augmented with Business Process Execution Service to support automated business process execution. This is the *Web services infrastructure layer*.