Chapter XI
An Agent-Mediated Middleware Service Framework for E-Logistics

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ABSTRACT

Service-oriented computing promises an effective approach to seamless integration and orchestration of distributed resources for dynamic business processes along the supply chains. In this chapter, the integration and adaptation needs of next generation e-logistics, which motivates the concept of a middleware integration framework, are first explained. Then, an overview of a service oriented intelligent middleware service framework for fulfilling the needs is presented with details regarding how one can embed the autonomy oriented computing (AOC) paradigm in the framework to enable autonomous service brokering and composition for highly dynamic integration among heterogeneous middleware systems. The authors hope that this chapter can provide not only a comprehensive overview on technical research issues in the e-logistics field, but also a guideline of technology innovations which are vital for next generation on-demand e-logistics applications.

INTRODUCTION

Logistics, according to the Council of Supply Chain Management Professionals,[1] is defined as the process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements. It includes inbound, outbound, internal, and external movements, and return of materials. How to add further values to such kinds of business activities is especially important for regions with strong manufacturing economies, such as Pearl-River-Delta (PRD). PRD is a region inside Guangdong province, benefiting from China's economics boom in the recent 30 years, and has made itself one of the largest manufacturing bases in the world. The signing of the Mainland/Hong Kong Closer Economic Partnership Arrangement 2 (CEPA 2) further enlarges the PRD into nine Pan-PRD provinces/autonomous regions in China. According to an official newsletter published by the Hong Kong Trade Development Council,[2] the total import and export value of the nine Pan-PRD regions reached US$433.44 billion in 2004, with a year-on-year increase of 27.5%. The eight provinces/autonomous regions other than Guangdong that imported and exported goods were up 43.4%. Guangdong's import and export trade is growing at an annual rate of over 20%. The volume of logistics in the Pan-PRD is predicted to grow at an annual rate of nearly 20% over the next 10 years.

Such logistics booming has pushed for the need of more advanced logistics management and opens up opportunities for this research. In modern logistics management, tremendous coordination and scheduling effort is typically needed, and yet the respective processes may not be properly optimized. Achieving real-time management of business processes like logistics is generally considered to be important and challenging as there exist at least the needs of (1) managing items with

their geographic context (e.g., location, time zone) changing from time to time, (2) streamlining the information exchange among widely distributed heterogeneous partners, and (3) optimizing the logistics efficacy in an on-demand manner.

The recent advent of wireless computing has opened up new opportunities for tackling the challenges. For instance, inbound and outbound logistics activities used to be difficult to maintain but can be seamlessly recorded by tagging goods items with passive sensors like radio frequency identification (RFID) tags. That implies that up-to-minute status information of inventory and goods delivery could become highly available which can thus support better logistics services and planning. Also, delivery vehicles installed with global positioning system (GPS) sensors allow their locations to be accurately tracked for more effective fleet management. While the involved sensor technologies have been getting mature in recent years, integrating them together for building e-logistics infrastructure and networks demands middleware frameworks to enable different parties to communicate and collaborate in an efficient and effective manner. For smooth logistics operations with optimal performance, a well designed e-logistics framework and methodology must be in place to support agile and responsive logistics planning and business decisions based on timely information available from logistics participants' information systems.

In this chapter, an intelligent e-logistics middleware service framework (*i*MSF) for addressing the challenges is described. The *i*MSF adopts the concept of a service-oriented *meta-middleware* and is designed with event-processing and service provisioning components for providing management support for dynamic communication and interconnections among heterogeneous logistics participating middleware systems. The additional tier of abstraction can improve and streamline logistics operations through orchestrating various middleware systems for integrating business functions and systems, leading to, for

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