Chapter IX

Integration in Cooperative Distributed Systems: Privacy-Based Brokering Architecture for Virtual Enterprises

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ABSTRACT

A cooperative distributed systems approach is a promising design paradigm for many application environments, such as virtual enterprises, distributed manufacturing, e-business, and tele-learning. However, coordination is a major challenge in developing cooperative distributed systems in open environments. This chapter discusses in detail, brokering as a capability-based aspect of coordination in cooperative distributed systems. Architecturally, the brokering is viewed as a layer of services where a brokering service is modeled as an agent with a specific architecture and interaction protocol that are appropriate to serve various requests. The architecture of the proposed brokering layer supports ad hoc configurations among distributed, possibly autonomous and heterogeneous entities with various degrees of privacy requirements in terms of three attributes: entity’s identity, capability, and preferences. A prototype of the proposed architecture has been implemented to support and provide information-
gathering capabilities in healthcare environments using a FIPA-compliant platform (JADE).

**INTRODUCTION**

A cooperative distributed systems (CDSs) approach is a promising design paradigm that is suitable for many application domains, such as virtual enterprises, distributed manufacturing, e-business, telecommunication, and tele-learning. A virtual enterprise (VE) is an organization that consists of multiple cooperating autonomous entities (enterprises) that jointly act in a specified limited domain to fulfill a common enterprise mission (Amin, 2002). VEs are supported by geographical distribution and heterogeneous entities with no central control. Therefore, building VEs involves dealing with challenges that go beyond traditional integration approaches and design paradigms. The future success of building systems in terms of more sophisticated components, often entire systems, and integrating them requires an engineering and scientific basis that supports a high-level of abstraction for connection and interaction in VEs.

VE integration, as opposed to vertical integration, requires the right information and services at the right time. This, in turn, requires explicit knowledge of the dynamically changing information and functionalities of the different activities in the VE operation (Hammer, 2000). Also, it highly depends on the degree of cooperation in sharing the participants’ activities and their supporting systems to support new or composed legislations, new customer demands, and new technology or paradigm.

Fundamentally, we view integration as an abstraction level at which a distributed system environment can be viewed collectively as a coherent universe. Within this context, we model VE as a cooperative distributed system in which the entities are able to exercise some degree of authority in sharing their capabilities. In a cooperative distributed system, entities usually need to work together to accomplish individual or social tasks. However, in open environments, this becomes a challenge where it is no longer feasible to expect designers or users to hardcode, to determine or to keep track of the entities and their capabilities.

*Brokering* is a coordination and cooperation activity among heterogeneous entities in a cooperative distributed systems environment that can be used effectively to support integration in VEs. From the user perspective, the unification and integration of the ubiquitous diverse heterogeneous services means that a user can access these services from anywhere and at any time, but unfortunately, dealing with integration in such environments is rarely easy. The main integration challenge is to hide the distribution nature and provide a virtual homogenous environment.

With the rapidly growing development of applications in open VE environments, such as e-business, privacy is becoming a critical issue. Consequently, distributed systems architects, developers, and administrators are faced with the challenge of securing the requester’s privacy as well as the provider’s. In general, requesters and service providers are concerned about their privacy from different perspectives. For example, they may wish to protect their identities from being used, or decide by whom it will be revealed, and for what purposes, or retain the choice about whether or not to reveal their personal interests or capabilities.

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