Towards an Agent and Knowledge Enacted Dynamic Workflow Management System for Intelligent Manufacturing Grid

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Abstract. To cope with the dynamism of the intelligent manufacturing grid environment, an agent and knowledge enacted dynamic workflow management system is proposed to support the manufacturing process modeling, control and management, smoothing the integration of the flow of the work during collaborative manufacturing process. Autonomous software agents are used to implement the functional components and to encapsulate the end user and participating resource in the system. The domain knowledge is constructed to support the agent conversation and abstract workflow modeling; Knowledge based rule mechanisms is applied to support process scheduling and enactment in the multi-agent environment. The design and prototype implementation of the system is discussed and demonstrated with a case study.

1 Introduction

Manufacturing grid[1] ,as an analog to computing grid, was proposed to enable the sharing, selection, aggregation and integration of manufacturing resources and services distributed geographically and owned by different organization ， and supply them to users with the appearance of a single virtual manufacturing resource over the internet seamlessly, transparently and dynamically when needed. With the complexity of the collaborative manufacturing job and diversity and heterogeneity of resources in the grid, there is a growing requirement for intelligent manufacturing grid to accomplish the manufacturing job submitted by the user by gathering all the resources required by each tasks in the job and map and dispatch the tasks onto corresponding resources for execution in an intelligent way.

The manufacturing job and process in intelligent manufacturing grid should be modeled, scheduled and managed with the support of workflow systems to achieve operational efficiencies. The manufacturing grid is a highly dynamic environment since the participants are subject to frequent changes. The grid node representing participating enterprise can join and leave the system at will, and grid service may added, evolve, removed or updated, and actor for workflow activity can't be specified in the workflow model in advance. Also, a detailed manufacturing process may not be

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obtained at the outset. The initial model may includes high-level sub processes which will be refined gradually or even modified during the execution. Finally, the manufacturing job is a cross-organizational process and the workflow manager requires flexibility to select partners dynamically. Duo to the unreliable nature of manufacturing resources in the manufacturing grid, dynamic and flexible workflow is required to support integration of business process scattered across enterprises.

2 The Related Works

The use of agent has been proved a good means of intelligent tasks distribution and adapting to changing circumstances in the manufacturing grid. Agent technology is naturally suitable to support dynamic workflow and process management by providing flexible, scalable, distributed and intelligent solutions for negotiation, scheduling and resource allocation at run time [2]. Agent based workflow can be considered as a workflow process that is planned, performed, communicated and coordinated in a multi–agent environment, in which agent are either invocated by a central workflow engine to implement certain tasks contributing the process or used to represent the process logic and take full responsibilities to analyze, automate and inspect workflows [2]. Dynamic assignment of tasks to actors during the process execution rather than established at build time increase the workflow flexibility. [3]proposes an e-service mediating inter-enterprise workflow management architecture in which activities are dynamically bond to the implementation at run time through service mediation and selection mechanism to achieve enactment flexibility. Web service model has been embraced in current workflow initiatives to support automatic process execution. The future trends will be integrating agent and web service for flexible workflow enactment and management [4-5].

Workflow management for computing gird, or grid workflow, has been extensive investigated to enable users to compose and execute complex grid applications on distributed heterogeneous and unreliable computing resources without taking case of lower level details [6]. In this paper, agent based architecture, dynamic task assignment through resource and service mediation, knowledge based rule for process description and execution are combined to provide a dynamic workflow management system to meet the requirement of intelligent manufacturing grid.

3 Agent and Knowledge Enacted Dynamic Workflow System

3.1 System Architecture

Agent and knowledge enacted dynamic workflow management system is designed to support the operation of intelligent manufacturing grid by offering the definition of manufacturing process at a high level of abstraction and their automatic execution on the basis of the available resource agents in the grid. The system architecture is shown in figure1 with 4 layers.