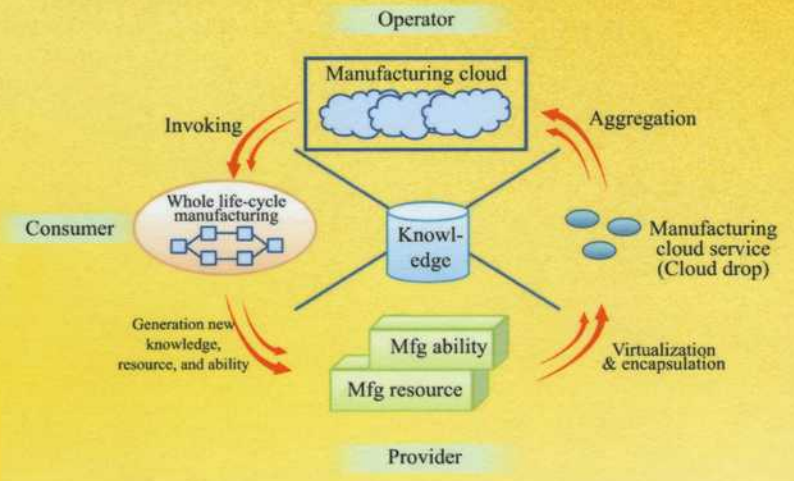
RESOURCE SERVICE MANAGEMENT IN MANUFACTURING GRID SYSTEM



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"To our families for their continuous love, encouragement, and support."

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Fei Tao, Lin Zhang, Yefa Hu
Beijing, September 2011

Preface

In order to realize the goals of TQCSEFK (fastest Time-to-market, highest Quality, lowest Cost, best Service, cleanest Environment, greatest Flexibility, and high Knowledge), many advanced manufacturing technologies and models such as computer-integrated manufacturing (CIM), networked manufacturing (NM) virtual manufacturing (VM), intelligent manufacturing (IM), green manufacturing (GM), agile manufacturing (AM), concurrent engineering (CE) have been proposed. These technologies or models have played very important roles in manufacturing related fields, and have made great contributions to the development of digital manufacturing. Manufacturing grid (MGrid) is a new manufacturing model combining grid technology with the supports of some common and unified architecture, standards, and criteria computing (e.g., web service, WSDL, UDDI, SOAP, WSRF, OGSA, OGSI).

The aim of this book is to make advanced computing technologies (service computing, grid computing, and cloud computing) to be fully used in manufacturing so as to enhance the utilization and sharing of manufacturing resources, and to speed up the transformation from production-oriented manufacturing to service-oriented manufacturing. It achieves this by constructing a concrete theory for MGrid and by detailing implementation methods for MGrid resources and services. Specifically, the book:

(1) Breaks through the application research field of grid technology, turning grid technology from traditional large-scale science computing to application in manufacturing.

(2) Establishes the theoretical foundation for MGrid Resource Service Optimal Allocation (RSOA). From the perspectives of manufacturing science, systematic, ontology, fuzzy mathematics, information theory, set theory, and social psychology, this book explains the basic theory and the implementation method for addressing MGrid RSOA in many aspects such as implementation framework of RSOA, digital description, match and search, Quality of Service modeling and evaluation, optimal-selection, composition of resource service, and resource service combination network, failure detection and recovery of RSOA.

(3) Provides relevant theories and methods of MGRSOA, such as resource service match and search, QoS evaluation, optimal selection, composition, failure-tolerance management. The theories can be used not only in addressing the RSOA problem in MGrid, but also in resolving the RSOA problem in other related SOA-based distributed system.

Outline of This Book

This book consists of 15 chapters.

In Chapter 1, the motivations and driving forces of MGrid are introduced. The connotation of MGrid, including the concept, basic features, and differences between MGrid, networked manufacturing, and computing grid are investigated. The key research contents and technologies of MGrid, including its four commonly known categories and thirty one items, are also studied.

In Chapter 2, the service-oriented architecture of MGrid is proposed, as well as an MGrid collaborative manufacturing prototype platform. The resource service optimal-allocation system which supports the running of the MGrid collaborative manufacturing platform is investigated. The key functions and components for the system are described, as well as its key implementation technologies.

In Chapter 3, the issue of digital description of resource service (DDoRS) in MGrid is investigated. A method for establishing an MGrid-Ontology is presented and an MGrid-Ontology is built. A method for DDoRS based on established MGrid-Ontology is proposed. An MGrid-Ontology based MGrid resource service discovery framework is proposed.

In Chapter 4, the resource services match and search (RSMS) is studied. The describing information of resource services are classified into four categories: word concept information, sentence information, number information, and entity class (or data structure) information. The similarly matching algorithms (SMAs) for the four kinds of basic describing information are presented, including word matching algorithms (WMAs), sentence matching algorithms (SeMAs), number matching algorithms (NMAs), and entity class matching algorithms (ECMAs).Under the supports of the proposed SMAs, the process of resource services match and search are divided into four steps: basic-matching, I/O-matching, QoS-matching, and integrated-matching.

Chapter 5 studies the evaluation indices system of resource service including special evaluation indices (SEIs), individual evaluation indices (IEIs), and general quality of service (QoS) evaluation indices. The evaluation framework and method for SEIs and IEIs are studied. The modeling of MGrid QoS from the points of QoS whole-lifecycle management, MGrid architecture views, and QoS attributes parameters are investigated. A QoS-based MGrid resource service management framework is proposed.

In Chapter 6, the concept of resource service trust-QoS is presented and introduced in order to enhance the validity and success rate of MGrid resource scheduling, and provide high credible resource service abilities and results to user. The trust problems existing in the resource service transaction are put forward. The trust-QoS relationship model which is capable of capturing a comprehensive range of trust relationships exist in MGrid system is put forward. A two-layer resource service trust-QoS evaluation model (intra-domain trust-QoS and inter-domain trust-QoS evaluation models) are put forward. The quantitative evaluating algorithms of trust-QoS degree value are proposed, as well as the real-time and dynamic updating algorithms of trust-QoS degree value. A trust-QoS based

MGrid resource service scheduling framework and associated realizing algorithms are proposed to illustrate the application.

In Chapter 7, an MGrid resource service optimal-selection and composition framework (MGrid-RSOSCF) is investigated. The process of resource service optimal-selection and composition is divided into five steps in MGrid-RSOSCF and the five key problems to realize MGrid-RSOSC are analyzed. The proposed MGrid-RSOSCF consists of five layers and each layer provides the corresponding necessary services and algorithms to address one problem. The five layers are: (1) *T-Layer* is responsible for MGrid task decomposition, (2) *S-Layer* is responsible for resource service match and search, (3) *Q –Layer* is responsible for QoS processing, (4) *O-Layer* is responsible for evaluating and ranking the candidate resource service, and (5) *C-Layer* is responsible for resource service composition and optimal-selection.

In Chapter 8, user's feeling is taken into account in resource service optimal selection (RSOS) in MGrid system. The non-functionality QoS evaluation of resource services is based on users' feeling and transaction experiences using intuitionistic fuzzy set (IFS).The dynamics of non-functionality QoS is considered, and a time-decay function is introduced into non-functionality QoS evaluation. A method is proposed for resource service optimal-selection based on IFS and non-functionality QoS. The performance and advantage of the proposed method are discussed.

In Chapter 9, the issue of correlation-aware composite resource service in MGrid is considered. Three kinds of correlations relationship (i.e., combinable correlation, business entity correlation, and statistical cooperate correlation) in services composition are investigated. The impact of each kinds of correlation relationship on the whole quality of resource service composition is investigated, and QoS computation model based on the three correlations is proposed. The case study indicates that the higher quality of services composition can be achieved when considering the correlations in resource services composition.

In Chapter 10, the multi-objective MGrid resource service composition and optimal-selection (MO-MRSCOS) problem is studied. The formulation is presented for an MO-MRSCOS problem with the given multi-objective (e.g., time minimization, cost minimization and reliability maximization) and multi-constraints. The basic resource service composite modes (RSCM) for composite resource

service are described, and the principles for translating a complicated RSCM into a simple sequence RSCM are presented for simplifying the resolving process and complexity of MO-MRSCOS problem. A method based on the principles of particle swarm optimization (PSO), is proposed for solving MO-MRSCOS problem. Unlike previous works: (a) the proposed PSO algorithms combine the non-dominated sorting technique to achieve the selection of global best position and private best position; (b) the parameters of particle updating formulation in PSO are dynamical generated in order to make a compromise between the global exploration and local exploitation abilities of PSO; and (c) To maintain diversity of solutions in population, *permutation-based* and *objective-based* population trimming operators are applied in PSO.

In Chapter 11, the concept and the classification of resource service composition (RSC) flexibility are presented, and the measurement method of RSC flexibility is investigated to achieve the optimal-selection of RSC based on flexibility.

In Chapter 12, the resource service composition network based on complex network theory is investigated. The principles for establishing and modeling combinable relationship-based composition service network (CoRCS-Net) are studied, and nine combinable relationships among services in CoRCS-Net were investigated and fourteen elementary evolving operators for CoRCS-Net dynamic evolution are designed.

In Chapter 13, the potential failures that would generate during MGrid resource service scheduling are investigated. Thirteen failures are defined in detail, which are classified into four classifications: (a) virtual link related failures, (b) resource service related failures, (c) task related failures, and (d) application related failures. A failure management system is proposed, which provides failure-tolerance service in MGrid resource service scheduling. Corresponding detection mechanisms and methods to each defined failure are presented in detail, associated with the corresponding failure recovery methods.

In Chapter 14, the related works on the application of grid technology in manufacturing are investigated, including research on manufacturing grid (MGrid) theories and applications, and then several key future research issues of MGrid are discussed.

In Chapter 15, combing the new technologies and existing theories and technologies of current enterprise information, a computing and service-oriented manufacturing model, i.e., cloud manufacturing (CMfg), which is the future commercial realization of MGrid, is discussed based on the previous work of this book. The concept, architecture, core enabling technologies, and typical characteristics of CMfg are abstractly studied. Four typical CMfg service platforms, i.e., public, private, community, and hybrid CMfg service platforms are investigated. The key advantages and challenges for implementing CMfg are analyzed, as well as the key technologies and main research contents.