Chapter 205
Design a New Manufacturing Model: Cloud Manufacturing

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Abstract Cloud computing is a general term for anything that involves delivering hosted services over the Internet, meanwhile which is a kind of methodology that can be applied in manufacturing. To solve more complex manufacturing problems and perform larger scale collaborative manufacturing, a new manufacturing model names Cloud Manufacturing is presented. It can be decomposed into four layers: physical layer, cloud Layer, semantic web layer and application layer. In this paper, it is focus on the business of this model, including cloud computing platform and cloud customer. At last, we make a conclusion and put forward the future work.

Keywords Cloud computing • Cloud manufacturing model • Cloud manufacturing platform • Cloud manufacturing service

205.1 Introduction

The surge in the growth of information technology over the past two decades has significantly reshaped manufacturing. The rapid advancement of network technology has a tremendous influence on enterprise. In order to survive, manufacturing enterprises must adapt themselves to this trend by changing their manufacture mode. Network manufacturing [1] based on Application service provider [2, 3] which promotes the use of software as-a-service, so enterprise obtain application. Service solution at lower cost by networked manufacturing system provides service (application configure, production design and resource management etc.). With the

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appearance of grid computing [4, 5], grid manufacturing realizes the share and integration of enterprise and social resource, supports the collaborative operation and management. There are many other advanced manufacturing patterns be presented such as Agile manufacturing [6, 7], Holonic Manufacturing systems [8], Green Manufacturing [9], Virtual Manufacturing [10, 11], etc.

Theses advanced manufacturing model improve the performance in resources sharing, cooperation, security, transparent of using, and so on. However, with the industry chain and international development, both in technical or business model, there are still some bottlenecks. At first, there are some problems about business mode, including the lack of centralized management and operation of services, lack of benefit distribution mechanism. That is why so hard to guard the efficiency, quality and timeliness. Second, from the technology, it could not achieve the real sharing of resources and fast matching. Third, users usually worry about the safety of the open source and business deal.

The Cloud Computing [12, 13] is one kind of emerging business accounting model. It will calculate the duty to distribute on the resource pool which the massive computers constitute, enables each kind of application system according to need to gain the computation strength, the storage space and all kinds of software service. The most important point is that the cloud computing business model have separated the service providers, which make the computing resource is a kind of professional service.

This paper addresses a new manufacture model which name is Computing Manufacturing model based on cloud computing. The benefits of our work are that will enable the manufacturing information achieve a high degree. It will reduce the cost of products lifecycle management of enterprises and social resources and make them more focus their good at. Therefore, it will successfully improve their competitive in the global market.

The rest of this paper is organized as follows:

Section 205.2 discusses the related research on advanced manufacturing model and cloud computing.
Section 205.3 presents the Definitions and Characteristics of cloud manufacturing.
Section 205.4 gives the four layer of cloud manufacturing architecture.
Section 205.5 describes the Business of Cloud manufacturing services platform.

Finally, the conclusions for future research are presented.

205.2   Related Research

Several researches have been carried out in this field and here we discuss in brief some of the works. An explanation on advanced manufacturing model is first given. To solve more complex manufacturing problems and perform larger scale collaborative manufacturing, cloud computing are discussed, which will give manufacturing a new solution and chance. The fundamental of Cloud computing is to provide service

platform for developers to use and develop their own application, such as computing resource, storage resource, some of own service, and so on. Therefore, the cloud service provider is a resource provider, which does not directly service for ordinary users and semantic Web technology will be given.

205.2.1   Advanced Manufacturing Mode

As the development of information technology, changes in technology and market demand, and personalization, the failure of traditional manufacturing mode, Advanced Manufacturing mode (AMM) arises. AMM is based on new technologies, especially on the basis of information technology; it will must adapt to changes in market demand, and have the appropriate organization to ensure implementation. AMM has several characteristics as the following:

AMM is based on Advanced Manufacturing (AM). According to the Paul Fowler of the National Association of Advanced Manufacturing (NACFAM), celebrating its twentieth anniversary this year, the definition of AM is:

> The Advanced Manufacturing entity makes extensive use of computer, high precision, and information technologies integrated with a high performance workforce in a production system capable of furnishing a heterogeneous mix of products in small or large volumes with both the efficiency of mass production and the flexibility of custom manufacturing in order to respond quickly to customer demands.

Intelligence is the twenty-first century manufacturing technology trends. Intelligent Manufacturing Technology (IMT) is the artificial intelligence into all aspects of the manufacturing process, by simulating the intelligent activities of human experts to replace or extend the mental part of manufacturing systems, in the manufacturing process, the system can automatically monitor the running state, in the From outside interference or internal motivation can automatically adjust its parameters to achieve the best and have the ability to self-organization.

To support resource sharing and cooperative work between enterprises for global manufacturing.

Now it seems that the main advanced manufacturing mode are Lean Production (MIT 1990), Agile Manufacturing (GM 1988), Virtual Manufacturing, CIM and so on.

205.2.2   Cloud Computing

Theses advanced manufacturing model improve the performance in resources sharing, cooperation, security, and so on. However, it is independent systems that provide service for the users by the fixed number resources or established solutions, which is lack of dynamic, intelligent client and effected business model.

From Wikipedia, the technical description of cloud computing is as the following: "Cloud computing is computation, software, data access, and storage services that do not require end-user knowledge of the physical location and configuration of the system that delivers the services. Parallels to this concept can be drawn with the electricity grid where end-users consume power resources without any necessary understanding of the component devices in the grid required to provide the service." A cloud service has three distinct characteristics that differentiate it from traditional hosting. First, it is sold on demand, typically by the minute or the hour; it is elastic—a user can have as much or as little of a service as they want at any given time; and the service is fully managed by the provider (the consumer needs nothing but a personal computer and Internet access). Second, significant innovations in virtualization and distributed computing, as well as improved access to high-speed Internet and a weak economy, have accelerated interest in cloud computing. Third, a cloud can be private or public. A public cloud sells services to anyone on the Internet. (Currently, Amazon Web Services is the largest public cloud provider.) A private cloud is a proprietary network or a data center that supplies hosted services to a limited number of people. These services are broadly divided into three categories [14]. Infrastructure-as-a-Service like Amazon Web Services provides virtual server instanceAPI and Sun to start, stop, access and configure their virtual servers and storage; Platform-as-a-service in the cloud is defined as a set of software and product development tools hosted on the provider's infrastructure, like Salesforce and MorphLabs; In the software-as-a-service cloud model, the vendor supplies the hardware infrastructure, the software product and interacts with the user through a front-end portal, like SAP.

205.3   The Proposed Cloud Manufacturing Model

Based on cloud computing, utility computing and service computing, Cloud Manufacturing is a new manufacturing business model that meet the needs of user through the dynamic construction supply chain, design chain and manufacture chain, which can search, organize and use the cloud manufacturing resource and cloud manufacturing service. A huge of manufacturing resources together which provide a variety of manufacturing services and achieve the high degree of open collaboration and sharing of resources.

Cloud Manufacturing Model has several characteristics. First, it is based on cloud computing technology, it will concentrate all manufacturing resources, and can be managed automatically and intelligent dynamic distribute the resource pool. This make users will not be worried by the tedious details and concentrate his own business. Second it supports PLM (Product Lifecycle Management) services. The entire product lifecycle consists of a set of processes, which are functions or tasks, including product design, manufacturing planning, process design, supply production, client service, recycling and so on. Therefore, companies can find required service related PLM from appropriate service providers. Third, it is based on semantic web that is very critical, including agent and intelligent infrastructure service.

205.4 Cloud Manufacturing Architecture

Cloud manufacturing architecture is proposed as shown in Fig. 205.1, which is to achieve these characteristics. The framework includes the following four levels.

Physical layer: The Physical layer provides the physical resources, including computational resources, such as CAD (Computer-Aided Design), CAE (Computer-Aided Engineering), CAM (Computer-Aided manufacturing) and other services, human resources, manufacturing equipments services, such as machine, fixture and so on, business services, such as PLM (Product Lifecycle Management), CAPP (Computer-Aided Process Planning), ERP (Enterprise Recourse Planning), CRM (Customer Relationship Management), SCM (Supply Chain Management) and other business service, manufacturing places services, such as machining center, and so on. This layer provides interface support for the package of virtual cloud resources.

Cloud Layer: This layer include cloud manufacturing virtual resource, infrastructure services and cloud service operation. Through the cloud platform or
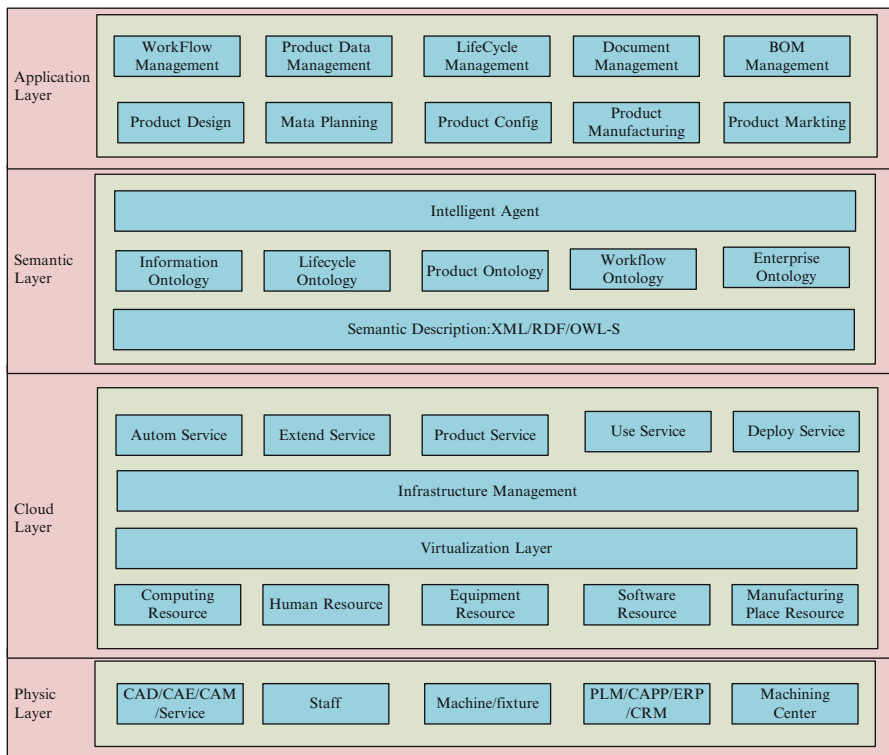

Fig. 205.1 Cloud manufacturing architecture

virtualization tools, cloud manufacturing virtual resource is mainly to gather various types of network resource into virtual resource, and then pose to the cloud service center. Infrastructure services provide a variety of core services and functions, including deployment service, scheduling service, standardization service, and other service. Cloud service operation is mainly used by service providers and service users through the cloud platform, which provide atomic services, extend services, product services and so on.

Semantic Web Layer: In the proposed architecture, the Semantic Web layer contains agent and intelligent infrastructure services. The agent on the semantic web will receive some manufacturing service request or tasks from the service user, discover suitable cloud resources, communicate with other agents, select the best choices and give the answers to the service user. The core of intelligent infrastructure services is as follows: Metadata will be used to identify and extract information from collaboration manufacture resource; ontology will be used to assist in web searches, to interpret retrieved information, and to communicate with other agents. Logic will be used for processing retrieved information and for drawing conclusions. This layer plays the most important role in our proposed cloud manufacturing as it handles all computational processes used to coordinate and evaluate the network for the service user.

Application layer: The application layer support by semantic web and cloud computing, which realize automated reasoning, intelligent computing and service integration. It will support various applications, such as workflow management, product data management, lifecycle management, document management, bom management, project management, supply management, product designing, product manufacturing, product configuration and so on. For the service user, who are do not care about the services where are from or who are the suppliers. However, theirs choice is the best, whatever the cost or the quality. Theirs services can track with real-time and lifecycle.

205.5 Business of Cloud Manufacturing Services Platform

The model is composed of the cloud manufacturing services platform (Platform), the cloud manufacturing service users (Users), and cloud manufacturing services providers (Providers), which is as shown in Fig. 205.2. According to a certain rules and requirements, Providers provide services or distribute capacity through the Platform; Users proposes needs or tasks by the platform; due to a series of rules and techniques, Platform effectively deal with the requirements through the distribution, find, match, group packages and implementation services. The model makes the Platform, the Provider and the Users to achieve maximum use of their resources and profits.

Platform plays an important role in the cloud manufacturing model, which allow users to order travel or secretarial services and that then coordinates the service
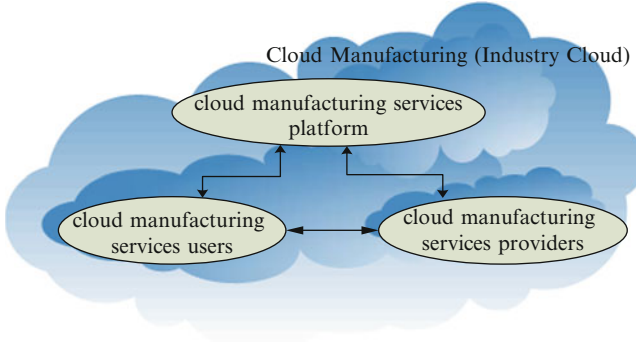
Fig. 205.2 Cloud manufacturing model

delivery and pricing within the specifications set by the User. The platform consists of various on-demand services and on-demand sub-platform, from supplier to end-use customers.

The business process of manufacturing service platform is as shown in Fig. 205.3:

Cloud manufacturing service users submit needs or tasks through cloud manufacturing platform.

Task is a collection of a set of requirements, T = {d1, d2, d3... dn};

The requirement description is defined by the constraints, d = {d|C}, C is the constraints.

Constraints C contains a variety of task types, task configuration, a variety of match conditions.

Distribution the task

According to the configuration and mating constraints, cloud platform will distribute some categories, such as suppliers, design, manufacturers and dealers and so on.

Match the task

There are two methods match the task, as A and B.

A, designated service providers:

If the configuration of the task constraints that already contains the specified service providers, which will directly establish relationships between the task and the service providers, which means order to the providers.

B, matching service providers:

If the configuration of the task constraints does not contain the information specified in the service provider, that will search for the best service provider in the platform, if still not found, it can complete through A way.

Draw the information about the selected provider

Get through the platform; it will draw the information of the selected provider, which has the relationship with the tasks.
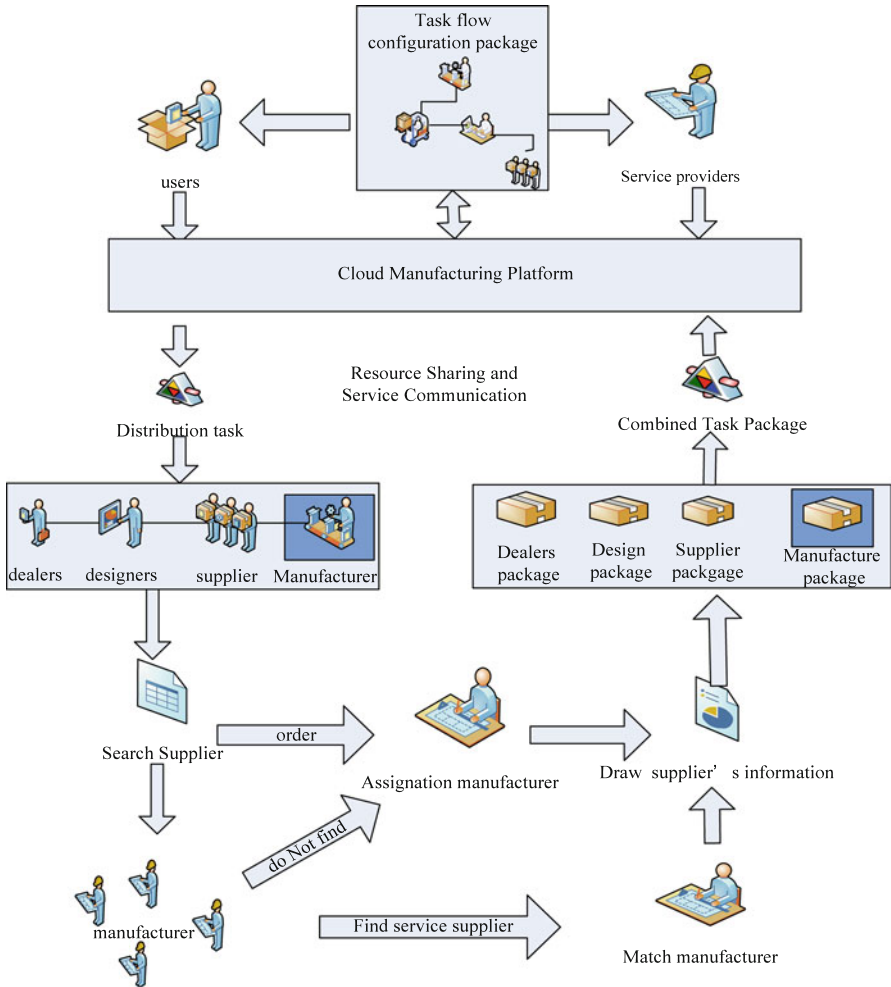
Combine task Package into service packages

Fig. 205.3 The business process of manufacturing service platform

Through the cloud platform service providers automatically provide the required services into service packages, such as the supply of services, package design services, manufacturing and marketing services.

Form the configuration package

Through the established relationship of tasks and service providers, the cloud platform combine the service package form the task configuration package, and return to the platform.

Output service flow configuration package

Through the platform, output all service flow configuration package.

Back to the service users

And then, come back the task of process configuration packages to the service users.

Distributed task

Finally, it will distribute the task flow configuration package to the service providers around the world by the cloud platform.

205.6   Conclusion

Cloud manufacturing model outlined in this work will achieve high degree of sharing of manufacturing resources and open collaboration, which is based on cloud computing and semantic web technology. Through establishing a public service platform (Cloud Manufacturing Service Platform), it will connect with a huge of manufacturing resource pool and provide a variety of manufacturing services. There is no need to buy some manufacturing services for the Enterprise users, such as Simulation equipments, software, and other resources. It is important to point out that enterprise users can purchase or lease manufacturing capacity through the platform in this model. It is a helpful exploration to the development of cloud manufacturing system. Therefore future research should focus on effective resource description, accurate semantic analysis, manufacturing cloud engine, standardized cloud services and so on.

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