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Cloud manufacturing

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ABSTRACT

Cloud manufacturing is a service-oriented, knowledge-based smart manufacturing system. It is integrated with cloud computing technology, Internet of Things, and high-performance computing. Through cloud manufacturing, manufacturing resources are virtualized and offered as consumable in the same way as for electricity, gas, and water. The manufacturing resources are provided to users as services over the Internet (cloud) in a pay-as-you-go manner. A brief introduction to cloud manufacturing is herein presented.

KEYWORDS

cloud manufacturing; cloud-based manufacturing; manufacturing-as-a-service; manufacturing cloud service; manufacturing cloud; cloud manufacturing service platform; cyber manufacturing; smart manufacturing

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INTRODUCTION

Today's manufacturing sector includes a wide range of industries, from food to automobile and aerospace, from computer to electronic product manufacturing [1]. Modern manufacturing has changed significantly due to intense global competition and remarkable advances in information technology. Information technology is transforming the manufacturing industry by digitizing virtually every facet of modern manufacturing process, shifting from production-oriented manufacturing to service-oriented manufacturing [2].

Cloud Manufacturing (CM) is an emerging and promising manufacturing paradigm. It refers to a customer-centric approach for enabling ubiquitous, convenient, on-demand network access to a shared pool of manufacturing resources and capabilities that can be rapidly provisioned and released with minimal management effort. It transforms manufacturing resources and manufacturing capabilities into manufacturing services. The term "cloud" means that the software, data, and related infrastructure are hosted through the Internet. The enabling technologies for cloud manufacturing include cloud computing technologies, Internet of Things (IoT) technologies (such as RFID, wireless sensor network, embedded system), virtualization, service-oriented technologies (SOA), Cyber-Physical Systems (CPS), and manufacturing data management.

CLOUD COMPUTING BASICS

Cloud computing represents the underlying platform technology enabling cloud manufacturing. It is a newly emerging service-oriented computing technology. It is the provision of scalable computing resources as a service over the Internet. It allows manufacturers to use many forms of new production systems such as 3D printing, high-performance computing (HPC), industrial Internet of Things (IIoT), and industrial robots. The key characteristic of cloud computing is the virtualization of computing resources and services. In cloud computing, everything is treated as a service (i.e. XaaS). There are three major services: software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS). These services are explained as follows [3-5].

(1) SaaS

This is a software delivery model in which software and associated data are hosted on the cloud. In this model, cloud service providers offer on-demand access to computing resources such as virtual machines and cloud storage. This is also known as "software on demand."

(2) PaaS
The platform is provided as a service. This allows the end user to create a software solution using tools or libraries from the platform service provider. In this model, cloud service providers deliver computing platforms such as programming and execution.

(3) IaaS
This provides hardware resources (such as computers, storage, servers, etc.) as a service and allows users to customize their own IT infrastructure dynamically. Just like cloud computing, CM services can be categorized into four major deployment models (public, private, community, and hybrid clouds) [6]:

(4) Private cloud
This refers to a centralized management effort in which manufacturing services are shared within one company or its subsidiaries. A private cloud is often used exclusively by one organization, possibly with multiple business units.

(5) Community cloud
This is a collaborative effort in which manufacturing services are shared between several organizations. Services are provided to multiple organizations from a certain community with similar business goals.

(6) Public cloud
This realizes the key concept of sharing services with the general public. Public clouds are commonly implemented through data centers operated by providers such as Amazon, Google, IBM, and Microsoft.

(7) Hybrid cloud
This spans multiple configurations and is composed of two or more clouds (private, community, or public), offering the benefits of multiple deployment modes. Cloud manufacturing system consists of four layers: manufacturing resource layer, virtual service layer, global service layer, and application layer [7].

APPLICATIONS, BENEFITS, AND CHALLENGES
Some common applications of cloud manufacturing include:

(1) Machining Industry
The machine-tool manufacturing enterprises use cloud manufacturing to develop intelligent machine tools and novel business models to increase their competitiveness and gain profits [8].

(2) Cloud Robotics
The availability of new technologies, such as computing cloud and big data, and their possible uses in robotics have led to a new line of research called Cloud Robotics, which are used for grasping and navigation the use of cloud robotics is based on the integration of cloud computing and industrial robots. Storing large amounts of data in the cloud is a key solution addressing robot limitations [9, 10].

(3) Semiconductor industry
The concept of cloud manufacturing has been applied to the semiconductor manufacturing operations such as wafer fab simulation, chain management, test operations management [11].

Using cloud-based systems to streamline key areas of their business, manufacturers are freeing up more time to invest in new products and sell more. The important benefits of cloud manufacturing include [12]: Rapid implementation; users can be up in weeks, not months; Giving customers some measure of control over upgrades; Consistent support and streamlining of global operations; Allowing for rapid and frequent upgrades; Automating customer service, taking orders online; Better inventory management; Solving manufacturing resource data consistency problems; Applying company-wide intelligence through the use of analytics, business intelligence.

However, CM is in its infancy and there are a lot of problems that need to be resolved for it to become mature. The main challenge involves the security of mission-critical applications. Trust and reputation play a crucial role in the service-oriented network manufacturing paradigm. Human factors can have a pivotal role in enabling the adoption of CM while ensuring the safety and well-being of users involved in a CM environment. These are no small concerns; they are being rapidly addressed because most companies are not ready to run high-speed manufacturing productions systems in the cloud.

CONCLUSION

Cloud manufacturing is a new manufacturing model that is service-oriented, knowledge-based, high performance, and energy-efficient. It is a service-oriented, data-centric, and demand-driven business model to share manufacturing capabilities and resources on a cloud platform. Although cloud manufacturing is still in the juvenile stage of development, it is gaining significant attention from academia, industry, and government. Cloud manufacturing is poised to become the new service-oriented manufacturing model. It is the future of manufacturing.

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