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Research Paper

A Solution for the Security Barrier of the Intelligent Manufacturing with Cloud Computing

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Abstract
The cloud manufacturing method is one of the most innovative key enabling technologies for modern manufacturing industry and is claiming increasing attention in manufacturing research. The existing manufacturing models are improved using cloud computing, the Internet of things (IoT), virtualization, service-oriented technologies, and advanced high-speed computing. Cloud manufacturing (CM) aims at a flexible, self-adaptive manufacturing foundation that is capable of dynamically exploiting manufacturing resources and services distributed across the network. As cloud computing is the major enabler for the manufacturing industry, it can transform traditional manufacturing business models into product innovation business models with the help of intelligent factory networks. The service provided by cloud computing for cloud manufacturing, layers, the flow of production service, the layout of production service, and key features is discussed and investigated. Flow criteria in a production service for a typical small, medium enterprise (SME) is introduced. A solution for the security barrier of the CM network is introduced with the help of recent computing technology in this paper.

Keywords
Cloud Manufacturing, Networked Manufacturing, Medium Enterprises, Security Barrier

1. Introduction

Cloud manufacturing is the newly service-oriented, network-based manufacturing mode as he most innovative key enabling technologies for modern manufacturing industry and is claiming increasing attention in manufacturing research. The resource-sharing technology of cloud computing is the central core of Cloud manufacturing. Cloud manufacturing vision is mainly designed to target small, medium enterprises (SME). Networked manufacturing is the presently used way of connecting methodology in the industry. When the ASP (Application Service Provider) and Manufacturing grid technologies combine a new revolutionary vision Cloud manufacturing is acquired [1].

The services provided in a cloud manufacturing system are production service, Design service, Testing, and Simulation service, and Operational management service. In this paper, the production service is taken into study. The flow and layout of the production service are explained in this paper. The paper gives a glimpse of the advanced security technologies that will make the system more secure.

The history of Cloud manufacturing begins when Hitachi Seiki, USA, Inc brought forth the idea that the CNC machine could be attached to the network (and therefore available to the Internet as well) by use of an on-board Ethernet port [2]. This Ethernet port would allow the owner to simply plug the CNC machine into a network jack and then send or receive part programs at network speeds. The Hitachi Seiki UUP machine interface was designed to plug into any network connection anywhere in the plant. If machines require relocation, the user could simply relocate a network cable and plug it into the nearest available network jack quickly putting the machine back online. This technology innovation can be stated as the first internet-enabled manufacturing step. The UUP approach was discontinued due to the financial crisis in the company. As the concepts were strong it was estimated that this concept may re-emerge in the industry in any non-proprietary format.

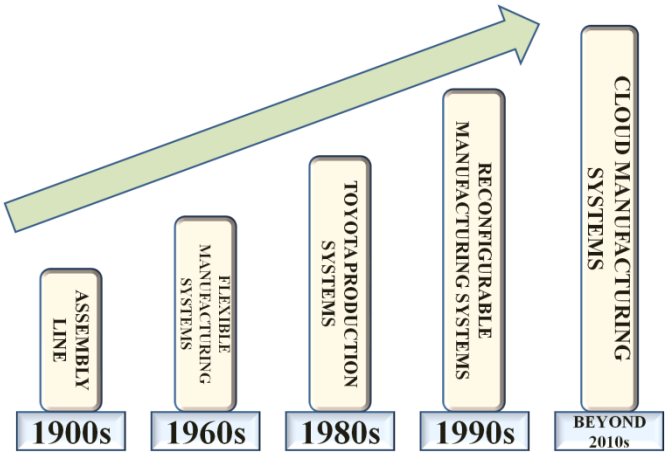

Figure 1 A history of manufacturing systems development

The concept of Cloud manufacturing was initially explained by the scholar Bohuli [3] in 2010 in one of his papers. It gave an initial outlook to the Cloud manufacturing (CM) concept and many supporting papers were published.

In 2010 European Commission initiated the FP7 program named Manucloud. Its objective was to investigate, develop and evaluate a suitable IT infrastructure to provide better support for on-demand manufacturing scenarios. In this path, ManuCloud seeks to implement the vision of a cloud-like architecture concept. It provides the users the necessary capability to utilize the manufacturing capabilities of configurable, virtualized production networks, based on cloud-enabled, federated factories, supported by a set of software-as-a-service applications. ManuCloud is part of the EU FP7 program [4].

2. Cloud computing

Dynamic resource sharing, on-demand resource provisioning, virtualization are the key building entities of cloud computing. “Everything is a service” when it comes to the cloud. The concept of cloud computing was initially introduced by John McCarthy. However, the term “cloud” came into prominence when large enterprises began to use the Virtual Private Network (VPN). The concept of VPN uprooted the point-to-point data circuit technology. We can say VPN is the beginning factor of cloud computing [5, 6].

Customers do not have to pay for infrastructure, installation, manpower, etc. to handle these activities including maintenance. The recent trend in IT envisages, moving the computing and data from desktop to large data centers.

In 2006 Amazon web services (Amazon EC2) were launched giving the world a new revolution of resource sharing concept. The open-source platform Eucalyptus which is used to create Amazon configured cloud technology paved a new way for the development of cloud networks on large scale.

2.1 Services provided by Cloud Computing for CM

"Everything is a Service" (XaaS) is the key motto of cloud computing. It is the core enabling technology of CM. The cloud computing technology is provided as services for the user in the following three models:-

1. *Software as a Service* (SaaS). The application software is offered as a service. Here the application runs on a cloud platform. It doesn't require installing on client's computers; examples are Gmail, Facebook, etc.
2. *Platform as a Service* (PaaS). The platform is provided as a service here. This enables the development and deployment of software without buying hardware and software layers for it; examples are Google App Engine
3. *Infrastructure as a Service* (IaaS). The storage and computing capabilities are made as a service; examples are GoGrid, Rackspace servers

Rather than IT services, CM is mostly concentrated in the areas of manufacturing resources and its allied services. So we can derive a new set of cloud computing models for CM utilizing SaaS, IaaS, PaaS including the following models [7]:

1. *Production as a Service (PROaaS) – The production activities of a product and its abilities are provided as a service.*
2. *Design as a Service (DaaS) – The design resource and ability is provided as a service.*
3. *Testing as a Service (TaaS) – The testing resource and ability are provided as a resource.*
4. *Simulation as a service (SIMaaS) – The simulation resource and ability is provided as a service.*
5. *Management as a Service (MANaaS) – Managerial resource and ability are provided as a service*

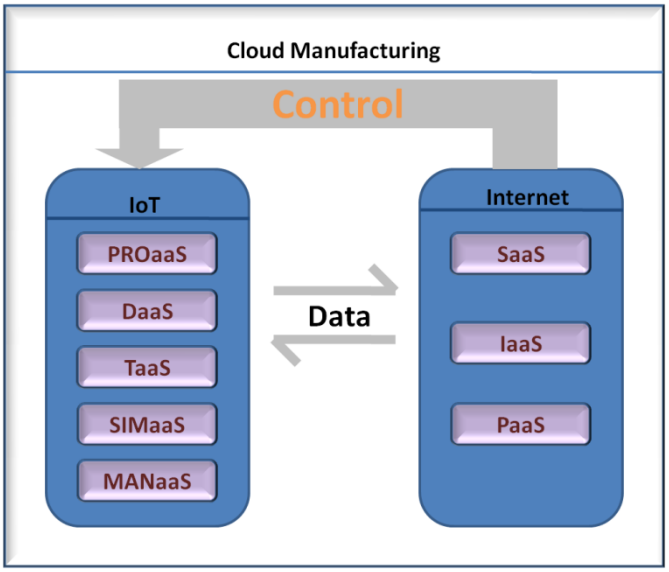

Figure 2. Relationship between cloud computing and CM

3. Cloud Manufacturing

Cloud manufacturing is a new service-oriented networked manufacturing system [8]. This manufacturing vision is introduced to provide the on-demand architecture with flexibility and reliability based on cloud computing.

Cloud manufacturing provides a flexible and adaptive infrastructure for industries to share and use various manufacturing resources or services on-demand under the dynamic, complicated and large-scale business environment. Cloud manufacturing mixes network-based manufacturing, service technology with cloud computing, IOT [9], and other advanced technology to achieve all kinds of manufacturing resources, centralized management, and intelligent business.

CM centralizes intelligent management to supply low-cost, global service to cloud customers, and its main clients are small or medium enterprises.

3.1 Layers of Cloud Manufacturing

Layers [10] of a CM consist of cloud consumers, Cloud providers, Cloud brokers, and the Cloud carrier. Cloud provider is the core player in the CM. A Cloud broker acts like a middle person between the consumer and the service provider.

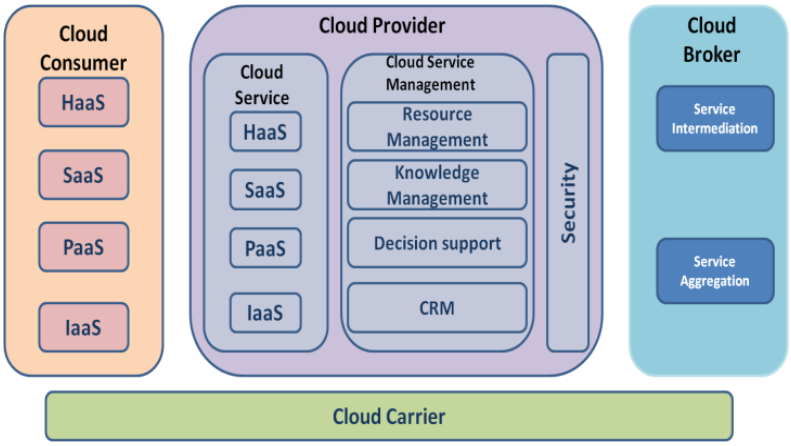

Figure 3. Layers of Cloud Manufacturing

3.2 The flow of Production Service in Cloud Manufacturing System

The flow of production service in a cloud manufacturing system is carried out in basically seven steps:

a) Client defining the needs
b) Registering with Cloud Agent
c) Raw material (RM) searching & Remote procurement
d) Plant identification
e) Transfer of RM
f) Manufacturing of Product
g) Transportation of product to the client

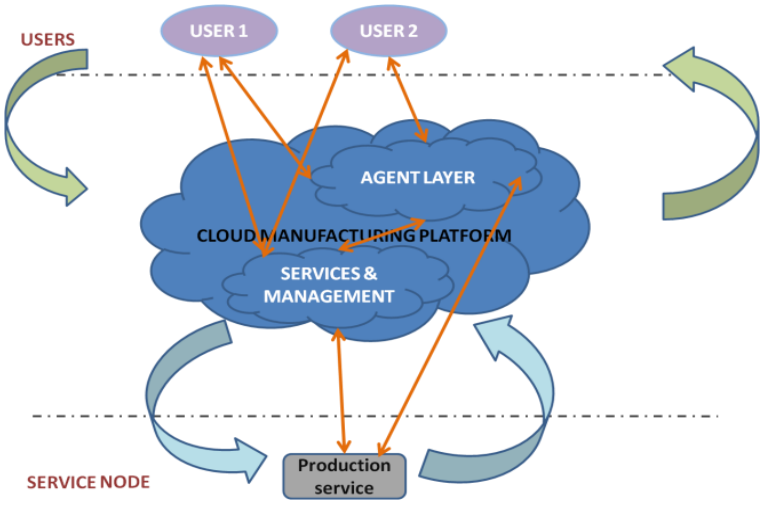

Figure 4. Production Service model of Cloud Manufacturing

3.3 The client initiates the production process by defining his needs

The client plans his product or production process which needs to be outsourced into the central network. Pricing, product specification, and designs are documented in a standard format (Standard cloud format).

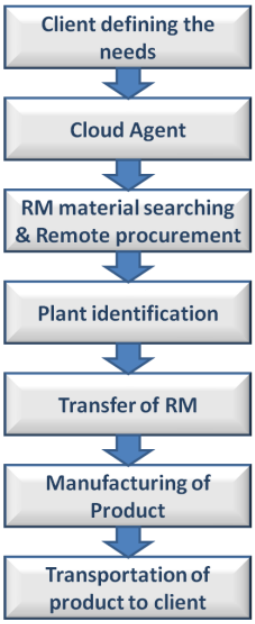

Figure 5. Flow of production service in CM

3.4 Registering with cloud agent

The agents in the cloud are the major controllers in the cloud manufacturing system. Agents are equipped with intelligent data warehousing systems for the storage of information regarding plants and supporting services.

3.5 Raw material searching and remote procurement

The RM suitable for the production process (as specified in the documentation) is searched by the agent. The suitable RM providers are shortlisted. The suitable providers are screened with strict specification checking. The selected RM is temporarily procured to the deploying unit.

3.6 Plant identification by an agent in association with the client

The plant which is suitable for the manufacturing of the client's design is identified. Database with the agent is utilized for this purpose. The intelligent computer systems will compare the plants available and the documentation provided by the client to identify suitable, cost-effective, time-bound, and complete plants.

3.7 Transfer of RM to plant

The procured RM at the RM provider is temporarily stocked at their warehouse. The agent will transfer this RM to the plant warehouse unit using their logistics techniques.

3.8 Manufacturing of product

When the RM arrives at the plant, quality testing is carried out. This item helps the plant to deliver quality outputs. The qualified and accepted RM is utilized for production.

3.9 Transportation of product to client specified destination by the agent.

The finished products are kept in the temporary inventory of the plant. It is transported to the specified location as per the delivery schedule.

4. The layout of a Production Service in Cloud Manufacturing System

In a production service Cloud Manufacturing system, the SME users are the service requestors. The requested service is available to the agent cloud through a common public platform. The agent cloud analyses the request, decomposes, schedule, and do some fault tolerance in the data.

The agent cloud is frequently linked with the RM provider cloud and the plant cloud. Agent cloud acts as a moderator between the requestor and utility provider. The plant cloud is connected to each production plant in the CM system. This is achieved using an interface. Plant private network is the controller grid of the machining center and equipment connected to it. The commands for these machines are generated in the plant server. The command for the machines is extracted /created from the documentation provided by the agent cloud.

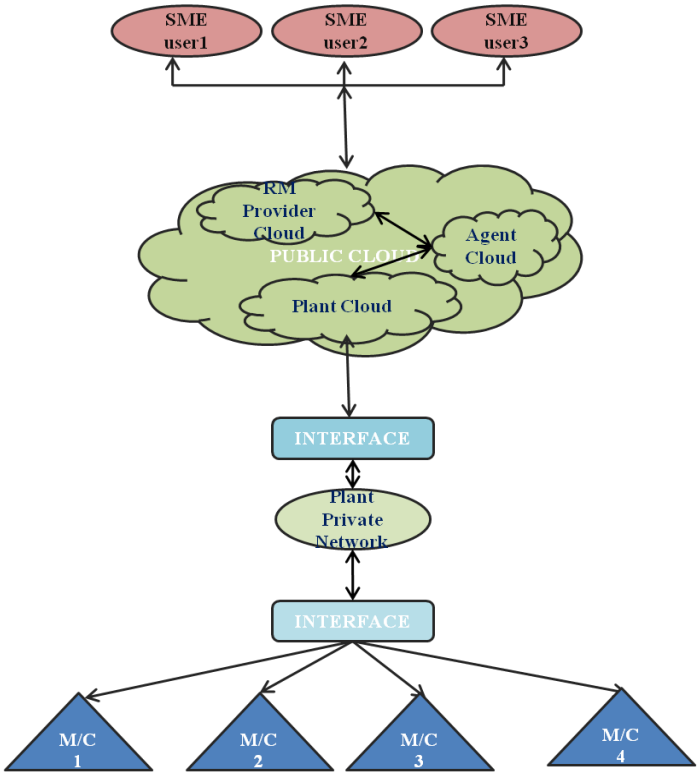

Figure 6. Layout of Production Service CM system

5. Security Enhancement in Cloud Network for Enterprises

The major barrier in cloud technology implementation is the lack of sufficient security in the cloud network [11]. Lack of appropriate security technologies resisted the growth of cloud systems. As cloud computing is the enabling technology of CM, the security barrier retarded its growth. By 2011 various technologies with wide acceptance began to catch the IT market.

The past barriers are given below:

- *Lack of traceability*
- *Lack of intelligent monitoring*
- *Lack of standard encryption techniques*

The emergence and usage of security technologies like AES 256 bit encryption, FIPS 140-2 make the cloud functionality of enterprises real. Examples are PerspecSys, CipherCloud.
The solutions for the past barriers can be categorized as:

- *Traceability*

The traceability of cloud applications can help enterprises in tracing their data and how they are used in the enterprise. By this technology, we can discover who is accessing and updating records from various locations. Example- AppProtex Discover

- *Activity monitoring*

Monitoring of cloud systems represents operational, legal, or compliance-related risk to the enterprise. This helps in auditing and external compliance-related tasks. Example- AppProtex Analyze

- *Cloud encryption gateways*

The Encryption methods use a cipher algorithm for the mathematical transformation of data. These encrypted data can be reverted to the original value using a key. Tokenization replaces a sensitive data field and replaces with a surrogate value for security purposes. These two technologies (encryption and tokenization) can be effectively used and enabled as cloud encryption gateways. This makes the IN and OUT data secure. Examples are AppProtex Protect, CipherCloud.

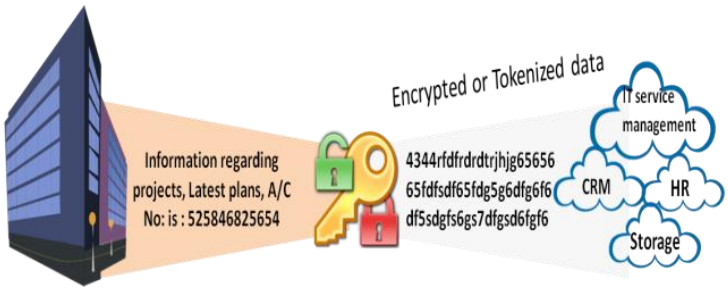

Figure 7. Encryption/decryption of enterprise data

6. Conclusion

Cloud Manufacturing offers a processing infrastructure for colossally collaborative manufacturing with agility, adaptability, and cost-effectiveness. Currently, the enterprise informational integration is not perfect, as it hinders the application of the cloud-manufacturing process to some extent. The emergence of cloud computing provides a new way to complete the mission of networked manufacturing. In contrast to the conventional networked manufacturing approach, the cloud manufacturing vision introduced in this paper promises flexibility, elasticity, and adaptability through the on-demand provisioning of manufacturing resources as a utility by blending the principles of cloud computing.

7. Acknowledgment

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