



DEVELOPMENT OF CLOUD VIRTUALIZATION TECHNOLOGY AND ITS APPLICATION IN MANUFACTURING MANAGEMENT SYSTEM- A CASE STUDY

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ABSTRACT

The aim of this study is to propose a cloud virtualization technology infrastructure with an implementation of a case study. Applications of cloud computing in manufacturing and application of virtualization technology in the manufacturing literatures are reviewed in this paper. A manufacturing model is proposed based on cloud virtualization technology. An application scenario of the manufacturing management system based on cloud is developed and evaluated. This cloud-based manufacturing management system model to be proposed here includes infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS). This cloud-based manufacturing management system based on real manufacturing scenario is implemented. Three virtualization technologies are adopted to make the system maintained on different operating systems. For evaluation of the developed system, each verified user accessed the services with portable devices in various operating



systems. *The developed system was verified with various windows-based operating systems. The experimental results show the function of the developed system is workable.*

Keywords : Virtualization; Virtual machine; Virtual Application; Virtual USB Device; Cloud Manufacturing Management System;

INTRODUCTION

Traditionally, enterprises deploy own manufacturing management systems in almost every computers in their firm. Enterprises encountered two issues. First, when the systems need to be updated, IT staff should reinstall the latest version in all computers. Second, these systems are also limited to specific operating systems, which cause it difficult to deploy and manage. For example, every Windows-based computers need to be reinstalled the latest software version and cannot install Mac-based software. Therefore, this study develops virtual application to solve above problem. However, using virtual application can't access the USB device in some occasions. Take logistic inventory system as an example, staff usually uses RFID reader for cargo inventory. Normally, RFID readers are connected to computers through USB ports, which cause another issue that virtual applications on virtual machines cannot directly connected to local computer USB ports. An USB virtualization solution based on virtual technology is also proposed in this research to solve the issue.

LITERATURE REVIEW

Applications of cloud computing in logistics

In recent years, many scholars have proposed the cloud technology based on the innovative service model of logistics [2, 3]. Some studies are introduced the wireless radio frequency technology. For example, some researches applied RFID and Zigbee to develop logistic management systems [4, 5]. Its achievement is to make an automatic inventory and information access that can help the development of logistics cloud.

Zhiying Zhou et al. proposed a three-layer wisdom logistics model, including infrastructure layer, application layer, and service provider layer. In the infrastructure layer, there are hardware resources and software resources which support the platform. It is divided into public cloud and private cloud. Most of the low security data of small and medium-sized enterprises can be allocated in the public cloud by purchasing data warehouse storages. Therefore, it can avoid duplicate development and waste of resources. The application layer

is worked as software. In this layer, the users can design and operate cloud services. The service provider layer provides cloud computing on the basis of the new business model. The cloud software can be revised based on user demand [6]. According to the study, the cloud computing can be applied in the logistics system in real scenarios.

Shang-Liang Chen [7] et al. proposed the architecture of the logistics management system based on SaaS concept. As shown in Figure 1, the system is divided into four layers: physical resource layer, SaaS service pool layer, middleware layer and service-oriented architecture layer. The cloud architecture installs the functions of the service module, and the application can call service on the cloud to achieve the concept of computing cloud. It is necessary to install the application in local computer and cannot get the services in different devices. Therefore, this study improves the defects, extends the architecture, and develops the systems.

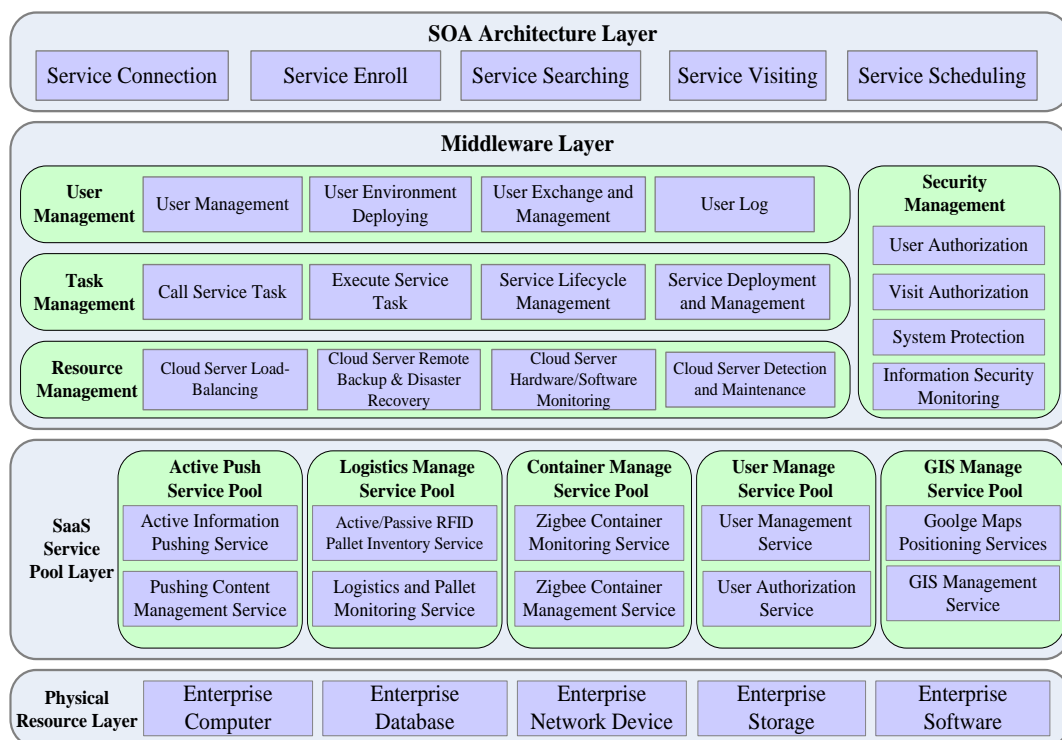


Figure 1. SaaS architecture of logistic management system [7]

Application of virtualization technology

Xing Wang [8] proposed the cloud-computing based logistic information network and offers a brand-new mode in hardware environment construction, software development, network platform management. It can reduce the investment of the initial stages of information technology for the small and medium-sized logistics enterprises. The logistics informatics network is divided into four layers: base layer, support layer, service layer and logistics information business layer. The first layer includes hardware facilities (telecommunication network, network equipment, computer hardware, logistics facilities) and logistics information standards (product electronic code, EDI standards). The second layer is support layer which is covering the entire supply chain. It includes database, certification, and data exchange. The third layer is the logistics information services layer including the operation of logistics information platform, the development platform and service Platform. The fourth layer is logistics information business layer. It is constituted by warehouse management system, transportation management system, customs system, and order management system. It is used to achieve high-level information processing and handling. According to the architecture, the system is extended and implemented in this study.

THREE-LAYER VIRTUALIZATION INFRASTRUCTURE

Architecture of Three-layer Virtualization Infrastructure

In this study, the architecture of virtualization is divided into three layers, Virtual Machine, Desktop Virtualization, Application Virtualization, and USB Device Virtualization, as shown in Figure 5, and explained as follows:

Layer 1, Virtual Machine (VM): hardware virtualization technology is applied to the cloud server. Several virtual machines are created for installing the different operation systems. For example, WIN XP, WIN 7, WIN 8, WIN Server and Linux, etc..

Layer 2, Desktop Virtualization (DV) and Application Virtualization (App-V): users can select the operating system to connect to the cloud server through various devices. For example, notebook, PC, and mobile device.

Layer 3, USB Device Virtualization (UDV): when USB device plugged in to the local computer, it will create a virtual com port to the virtual machine. Normally, remote services in virtual machines are unable to access local USB comports. Our UDV solutions provide users a way of accessing services in virtual machines and receiving/transmitting from local USB comports.

The three-layer virtualization technology is developed in this study. The end user device can connect to the cloud to use different operating system. The end user can use virtual application in different operating system.

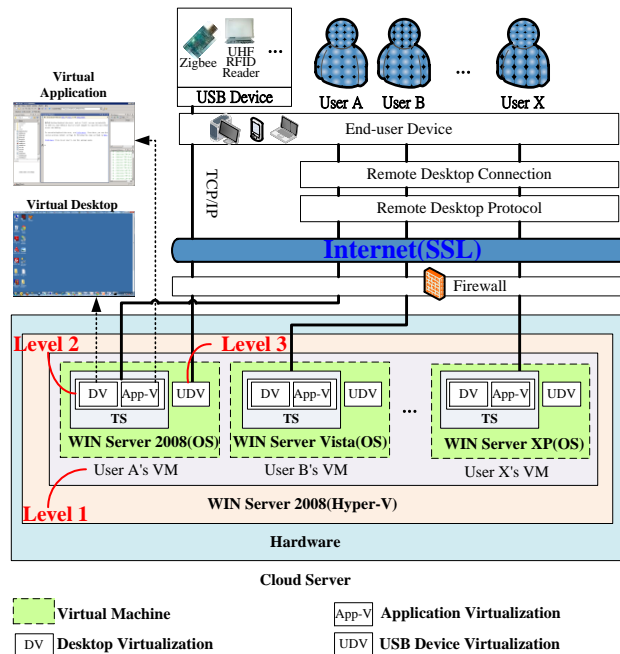


Figure 5. Architecture of 3-Layer Virtualization Infrastructure

Server virtualization

The Para Virtualization is adopted in this study. Hyper-V is adapted to construct virtual machines in the operating system of Windows Server 2008. Three physical machines are divided and virtualized to eleven virtual machines. Five of the virtual machines are used to construct virtual desktop. Four of the virtual machines are deployed the cloud service pool. One of the virtual machines is used as Active Directory (AD) server. Two of the virtual machines are cloud load balancing servers. All the virtual machines add into the same domain. In this case, AD services can manage the virtual machines and user identity verification. This study introduces “Integration Services” into virtualization of operating system. It makes different operating systems to communicate with the Hypervisor. Then, the virtual machines can connect to the hardware. For example, Network Interface Card (NIC) and Small Computer System Interface (SCSI).

Desktop and Application Virtualization

This study adopts Remote Desktop Protocol (RDP) to access virtual desktop [9]. Applications are installed in loud servers. And AD server will provide different software for different users based on limits of authority. A web interface is designed as a platform to provide virtual desktop service and virtual application service. The users can connect to the cloud web server to access the virtual services. It is convenient to use the applications in the local computers. The web interface includes the virtual application (Remote App) and virtual desktop (Remote Desktop). The web page is developed with ASP.NET and ActiveX to connect to the Terminal Service (TS) on the cloud. For information security, the application uses Active Directory (AD) to verify the user's identity and his authority for that application. When the users login to the web page of Remote App, it shows the applications available. The remote control function is designed to show the accessibility of disk drivers, printers, and clipboard software shown in Figure 6.

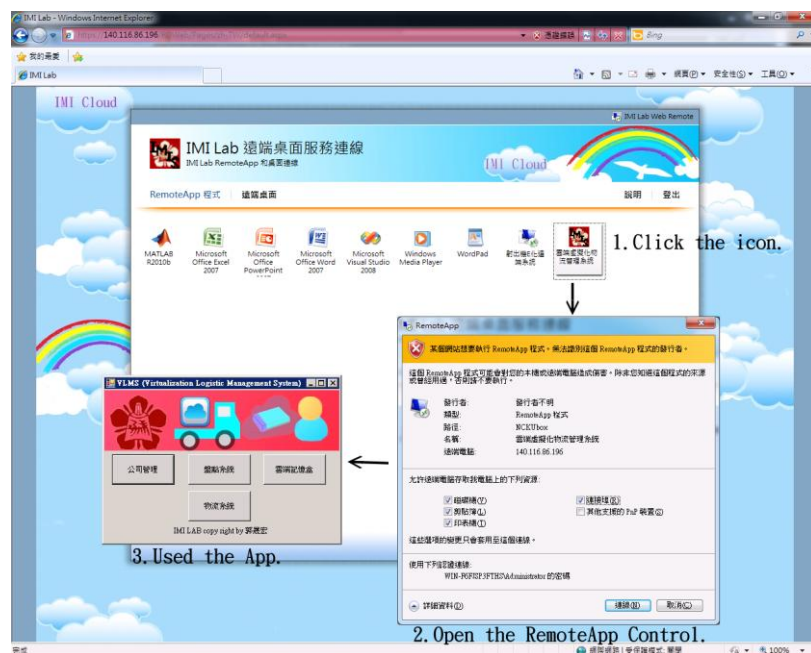


Figure 6. Virtual service (Through web browser)

USB device Virtualization

WIN Server 2008 virtualization services can access data through local USB devices. In pervious researches proposed by many researches, virtual machines are unable to access data from USB devices connected to computers. For solving the issue, this study design and implement an USB device transmission module, which can transfer data from USB devices

(connected with local computers) to virtual machines, named Virtual USB (V-USB). Both the local personal computer and the virtual machine should install this V-USB module which can access data of USB devices from the local part to the virtual machines through the TCP/IP connection, as shown in Figure 7.

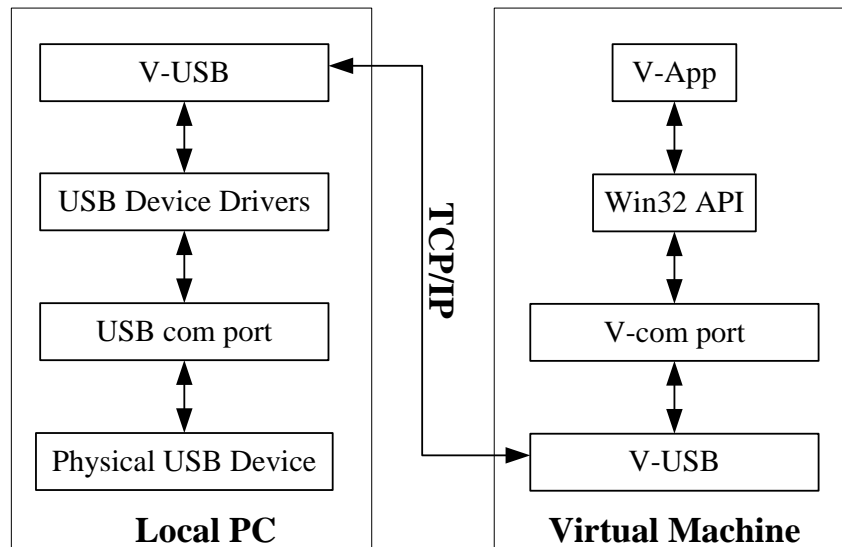


Figure 7. Architecture of virtual USB device

CASE STUDY

Implementation of CLMS based on 4-Layer Virtualization Model

The logistics cloud is proposed in this study and the virtualization technology makes the applications easier to manage and deploy in the cloud. The users can use different operation systems and get the latest cloud service with end-user devices.

1 Application scenario of CLMS

The cloud logistics management system can be applied in different factory. For example, a company divides into factory A, factory B ...factory N, as shown in Figure 2. The goods inventory of factory can connect to the virtual server on the cloud through the internet. When the staffs make an inventory, the system needs to connect the hardware devices. For example, UHF RFID Reader and Zigbee ,as shown in Figure 2. Therefore, the system uses the USB device virtualization to access the local USB device. Then the system can serve as a local application, and it can simply be used by any browsers through the internet. The cell phones send GPS signals to any readable device at all times. It aims to make the users can monitor the status of goods and vehicles with the end user device (For example, Table PC

and PDA) when transported.

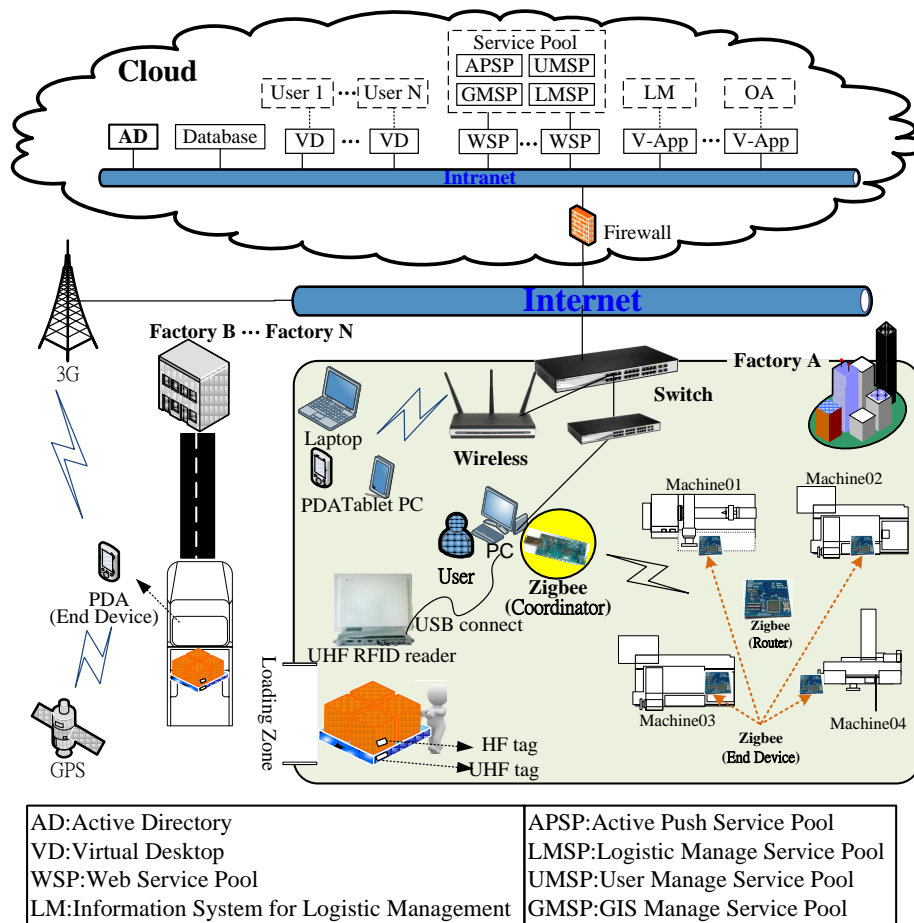


Figure 2. Application scenarios of CLMS

2 Model of CLMS

The six-layer logistics model of this study is shown in Figure 3. It includes Physical Resource Layer, Support Layer, Virtualization Layer, Information Layer, End Device layer, and USB Hardware Layer. The six-layer model is explained as follows:

1. Physical Resource Layer: physical hardware of the cloud includes server, network equipment and data storage, etc..
2. Support Layer: includes database, certification, data encryption, cloud service pool and data exchange, etc..
3. Virtualization Layer: implementation of cloud virtualization technology includes virtual machine, virtual desktop and virtual application, etc..
4. Information Layer: provides the related information of logistics management.

5. End Device layer: user devices. For example, PC, notebook, PDA or tablet computers, etc..
6. USB Hardware Layer: it contains all the user-side-connected devices. For example, RFID UHF or HF inventory equipment. And the cloud application can call the uses-side hardware devices based on USB device virtualization.

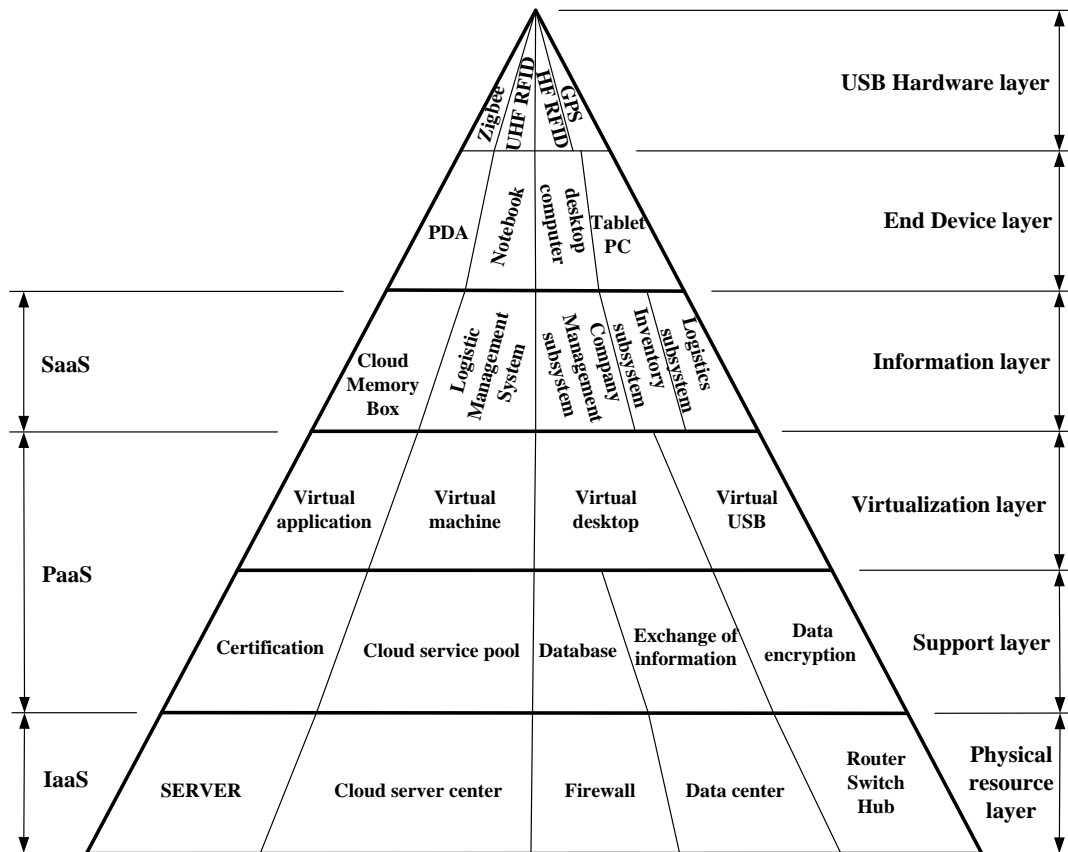


Figure 3. Model of CLMS

3 Architecture of CLMS

In the cloud architecture, the system of this study can be accessed in two ways:

1. Web Browser. For example, Internet Explorer.
2. Application. For example, Remote Desktop.

The above ways are accessed through the internet. The system architecture of this study is shown in Figure 4 and explained as follows:

1. Virtualization architecture: includes virtual operating system, virtual desktop, virtual application, and virtual USB.
 - (1) virtual operating system: WIN server 2008, WIN 7, and XP, etc..
 - (2) virtual desktop: open and perform the operating system through the internet.
 - (3) virtual application : includes cloud logistics management system, Microsoft Office, and MatLab 2010, etc..
 - (4) virtual USB: through the USB device virtualization the virtual application can access local USB devices.
 - (5)
2. Cloud load balancing: includes cloud load balancing monitoring platform, and cloud load balancing distribution platform.
3. Cloud service pool: provides active message delivery services, logistics management services to the cloud, login service, and GPS location services.
4. Virtualization Management System: responsible for the management server of the entire cloud. For example, add a server, add the VM, and install and release of the virtualization application, etc.
5. Cloud Logistic Management System: responsible for the management of the logistics information. For example, inventory of goods, cargo shipments, monitoring of cargo locations and other services.

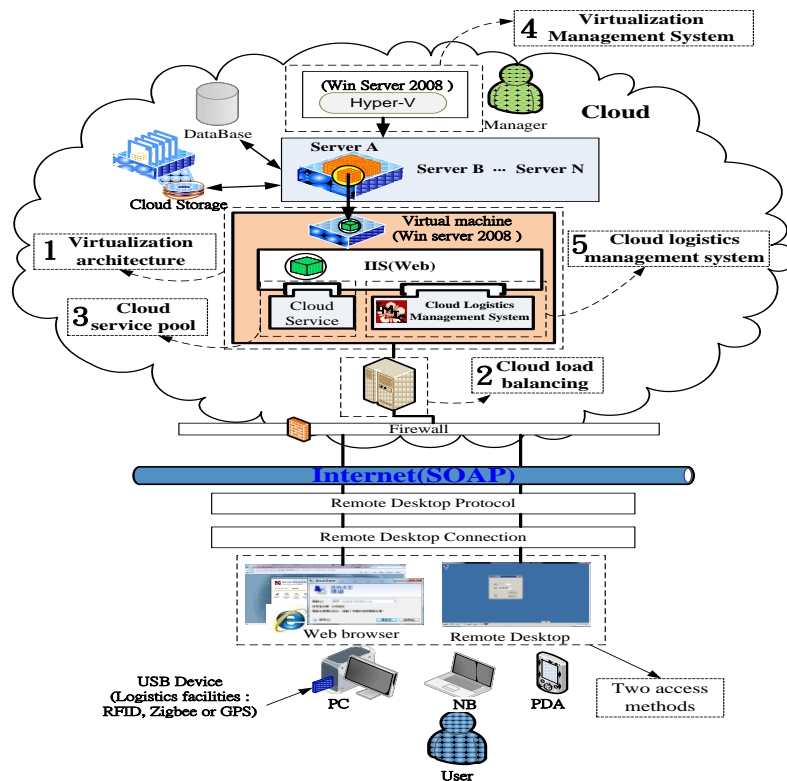


Figure 4. Architecture of CLMS

4 Implementation of CLMS

The cloud-based logistic management system in this research was implemented with a case study CLMS. CLMS has three major subsystems, including company management subsystem, inventory subsystem and logistics subsystem. The company management subsystem is to manage the basic information of the company. The inventory subsystem is to make an automatic inventory for the goods, establish the information of goods and access USB hardware device information. For example, UHF/HF RFID reader, Zigbee and GPS. The logistics subsystem is responsible for displaying the real-time information of goods outside. For example, the logistics subsystem uses the GPS positioning to track current positions of goods on vehicles equipped with GPS devices.

This study uses the Virtual USB to read the information of the local computer RFID UHF reader device within the inventory subsystem, as shown in Figure 8. COM9 is a virtual com port which redirecting local USB device (RFID UHF reader) on the cloud.

The data of this RFID system is received with four antennas signals. The information of the pallet will be sent into the system. For example, there are ten lamps placed in the pallets belongs to the TYC company, etc.

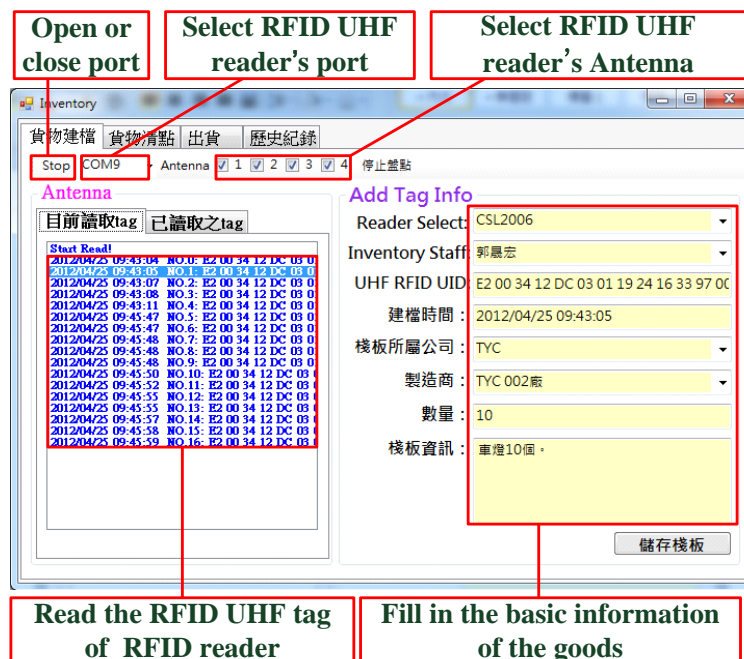


Figure 8. Inventory subsystem – Filling basic information of pallet

When new pallet information is created, the users can inventory the goods of the pallet. And the system will prompt the number of the goods. The users determine whether the information is correct or not and save it. In the shipping screen, the users can choose which pallets to ship, transmit, and display the goods.

The logistics subsystem can read the latitude and longitude of GPS and display the current location of users. It also shows the destination in the screen. The recipients need to sign the signature, and the system sends the E-mail or SMS to the customers. The customers will receive the mail to identify whether the signature and the goods are correct or not.

SYSTEM EVALUATION

Notebooks, tablet pc and mobile devices are tested with systems in this study. The specifications of hardware and software within system tests are shown in Table 1. The functions (includes virtual desktop, virtual application, and cloud logistic management system) are all tested with the system.

Table 1. Specifications of hardware and software within the system tests

Hardware Name	Hardware Type	Operating System
ASUS A42J	Notebook	WIN 7
SAMSUNG SGH-i908	mobile device	WIN mobile 6.1
Surface for Windows 8 Pro	tablet pc	WIN 8

The information of the testing systems is shown in Table 2. The tests are normal in the notebooks and tablet pc. The mobile device cannot connect to the RFID reader and Zigbee etc.. Therefore, the mobile device cannot support most of functions in the RDP and the function of virtual USB. But it can display the information for the managers to make decisions.

Table 2. Comparison of various system tests

		ASUS A42J (WIN 7)	SAMSUNG SGH-i908 (WIN mobile 6.1)	Surface for Windows 8 Pro (WIN 8)
Virtual desktop	WIN XP	✓	✓	✓
	WIN 7	✓	✓	✓
	WIN 8	✓	✓	✓
	WIN Server 2008	✓	✓	✓
	Linux	✓	✓	✓
Virtual application		✓	✗	✓
Cloud logistic management system		✓	✗	✓
Virtual desktop's	Application	✓	✓	✓
	Cloud logistic management system	✓	✓	✓
	Virtual USB	✓	✓	✓

CONCLUSIONS

In this paper, a cloud virtualization technology infrastructure is proposed with an implementation of a case study: cloud-based logistics management system (CLMS) based on real logistic scenario. Contributions of this research are listed as follows:

1. Applications of cloud computing in logistics and application of virtualization technology literatures are reviewed in this paper.
2. A logistics model is proposed based on cloud virtualization technology. A three-layer virtualization technology is designed with three main solutions for real logistic scenario. Cloud virtual machines can access local USB devices based on our solutions.
3. An application scenario of the logistics management system based on cloud is developed and evaluated.

The results show the system can manage and install the application on different operating systems. The developed system was verified with various windows-based operating systems. The experimental results show the function of the developed system is workable.



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