A Framework of Performance Measurement Monitoring of Cloud Service Infrastructure System for Service Activation

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Abstract

Cloud computing is a computing paradigm of providing IT resources, such as infrastrcture, platform and application, in the form of service by using internet technology. In recent, cloud platform service is being used to establish the platform ecosystem of ICT service industry and ensure application agility. In spite of these trends, the market is not being actively revitalized due to sudden service interruption, users' concern for failure or lack of compatibility between cloud systems. This paper proposes a reliable cloud service for providing objective, quantitative and measureable performance results on cloud service. In particular, this paper will define the scope for measuring the system performance of VM for IaaS among various areas of cloud service, while focusing on the area of requirements to deduce performance measurement items.

Keywords: *Cloud Service, IaaS, Virtual Machine, Performance Measurement, Framework*

1. Introduction

Cloud computing, a computing paradigm for providing IT resources such as infrastructure, platform and application in the form of service using internet technology, is being used as a means of changing and innovating the lives of people and the business environment of companies by changing the existing IT service delivery method. In recent, cloud service provides continuous innovation and growth of ICT service industry, and ensures application agility in the new software convergence market [1].

In spite of the importance of cloud service, users are deeply concerned about sudden service interruption or failure because of the characteristic of users' data being stored and managed in the server of cloud service provider. In addition, there is a concern for confidential information being leaked resulting from storing data externally, as well as a concern for dependency resulting from lack of compatibility between cloud systems [2].

In terms of cloud service users' main reasons for using cloud environment, they included its advantages such as cost reduction, speed and ease of change through

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business process change and sharing service model as shown in Figure 1. On the other hand, in terms of their considerations before using cloud environment, it was found that they were still anxious about using cloud service for the reasons of loss of control, data loss and personal information protection risk and uncertainty in cloud environment as shown in Figure 2.
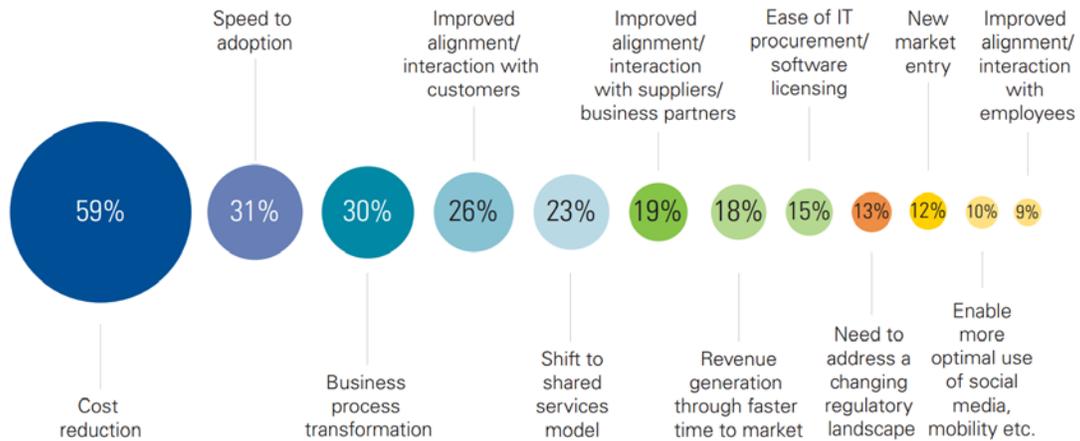
Figure 1. Main Reasons to Use Cloud Service [3]
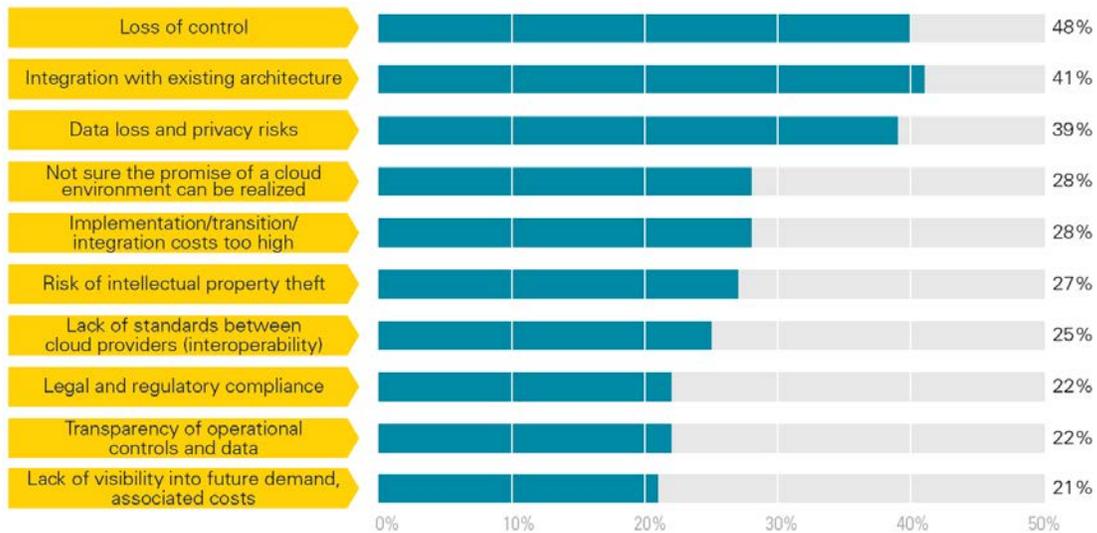
Figure 2. Top 10 Considerations for Adopting Cloud Service by Users [3]

This paper proposes a framework of cloud service performance measurement system to provide criteria for choosing cloud service with confidence according to needs by providing objective and quantitative comparison and evaluation results on cloud service as shown in Figure 3. In particular, this paper defines the scope of system performance measurement of virtual machine (VM) of infrastructure service (IaaS) among various areas of cloud service, and deduces performance measurement items by analyzing requirements. Based on this, this paper will develop a framework of performance measurement system of VM to provide assistances in the performance management of IaaS [4].
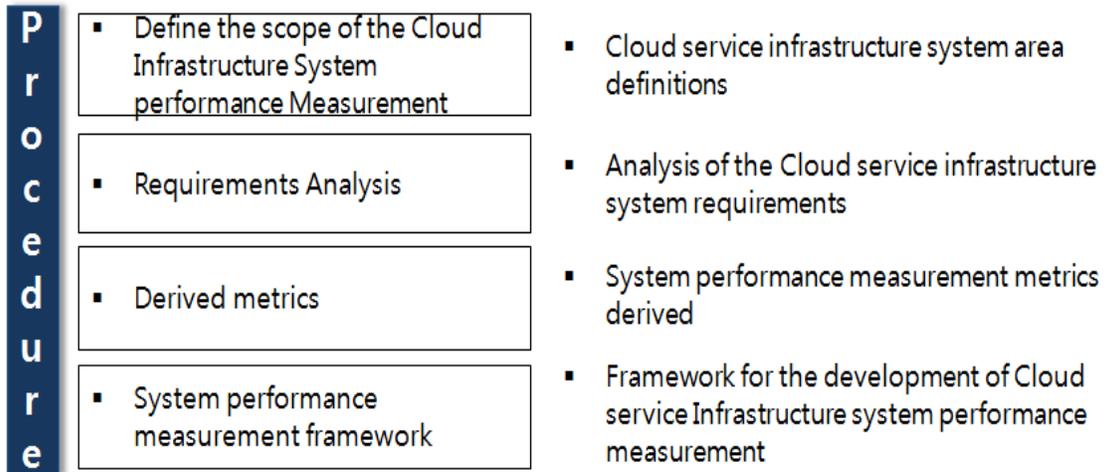
Figure 3. Purpose and Scope of the Study

2. Requirements Analysis Scope

IaaS as a cloud service is providing a service for easily and quickly creating, managing and monitoring server resources such as CPU, memory, disk, network and OS via internet browser, and hardware platform can be divided into several logical units that are respectively referred to as virtual machine (VM) [5].

VM refers to server resources such as CPU, memory and disk that are ready to be used through allocation or appropriate arrangement, and analyzes the requirements of measuring VM performance from the VM creation to extinction according to users' request in the virtualization area of cloud service infrastructure system as shown in Figure 4.
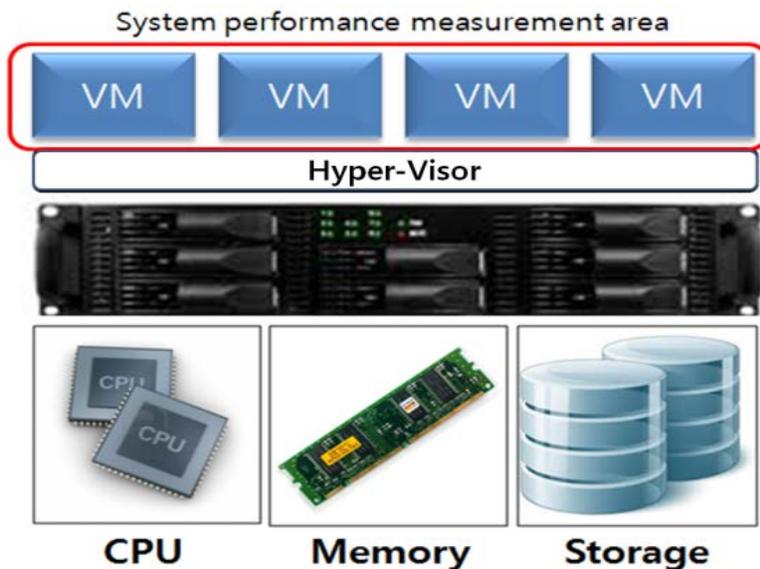
Figure 4. Performance Measurement Area of cloud service Infrastructure System

3. Requirements Deduction Procedure

For the purpose of deducing the performance quality requirements of VM from cloud service users' request, items through which performance can be measured are deduced through the research and analysis of cloud infrastructure service status (purpose of use, VM instance type, VM performance measurement & monitoring status) and existing IT infrastructure system performance (performance measurement type, system performance measurement items).

3.1. Purpose of Using Cloud Infrastructure Service

The main purpose of using cloud infrastructure service is to deduce quality requirements information that can be experienced by users when using VM and the biggest purpose of using cloud infrastructure service was found to be the ability to quickly provide ICT resources (server, storage, network, *etc*.) when needed by users. In terms of main reasons for using cloud infrastructure service, they were found to be the ability to quickly respond to changes in business situations such as reducing costs by minimizing the waste of server idle resources during the time when server is not used and allowing server resources to be used flexibly during peak time.

3.2. Cloud Infrastructure Service Status Research

For analyzing the main reasons for using cloud infrastructure service, the need for displaying VM performance quality information is reviewed by analyzing VM instance type and main information being provided. In addition, the required and optional items selected by a new service user to request VM when using cloud infrastructure service for the first time, as well as functions that are additionally provided by service provider are analyzed to deduced requirement items that need quality information display to system performance before selecting function. Furthermore, information that can be used as a reference for cloud service users when selecting VM was identified by analyzing VM performance measurement and monitoring status C744 analysis as a reference when deducing quality requirements. Table 1 shows the cloud infrastructure service required service optional items and Table 2 presents the cloud infrastructure service required additional service optional items.

Table 1. Cloud Infrastructure Service Required Service Optional Items

Classification	Check Item		Main Content
Sever Specification	Required	VM Instance	User selects the basic service specification of CPU (vCore), memory and disk of virtual machine (VM) suitable for service & development environment
	Required	Sever OS	After selecting basic VM Instance, select server operating system (OS) suitable for service & development environment
	Optional	DB	Select DB to run VM

	Optional	Public IP	For each service provider, 1 public IP is being provided for free. When needing additional public IP in addition to IP provided, service user requests it by checking required quantity
Basic Optional Service	Optional	Network	User estimates expected traffic usage (GB) for each service provided to request network usage
	Optional	Storage	When needing additional disk volume in addition to disk volume provided by VM Instance, users need to request their required disk volume
	Optional	Snapshot	[Concept] A function for storing the status of current VM disk volume and returning to the status at which snapshot has been stored whenever needed by user by supporting the creation of image and volume
	Optional	Image	[Concept] As a composition of snapshot as template, it is a service function enabling the creation of a new VM in the same status at which snapshot was created. The term template refers to a process of creating "snapshot" into "image"

Table 2. Cloud Infrastructure Service Required Additional Service Optional Items

Classification	Check Item		Main Content
Cloud Server Management	Optional	VPX (LB)	Support function for server resource load balancing service
	Optional	Monitoring	Support function for VM performance surveillance, server, WAS (web application server), DBMS error event management, access control and user management service
	Optional	Scale Up/Down	Support function for a service allowing product change without canceling VM being used
Security	Optional	Web firewall	Support function for user certification, access control, tracking, information leakage prevention
	Optional	RVM F/W	Support function for providing source IP & port based access control
	Optional	IPS (IDS)	Support function for external invasion detection and block

Optional	Server vaccine	Support function for virus, worm, spyware control
Optional	DB encryption	Support function for encryption solution service to reinforce the security of customer information, DB, etc.
Optional	VPN	Support function for a service allowing virtual connection from external network to internal network

3.3. Status of IaaS Monitoring Service Provision

For the purpose of deducing the requirements of IaaS system performance measurement, the status of providing VM performance measurement & monitoring information of commercially available IaaS services was analyzed. The research result revealed that in the case of providers providing monitoring function for cloud IaaS service, they are providing real-time information through respective performance & monitoring metrics based measurement and analysis solutions but information that can be referenced by users when selecting VM was not being provided in advance.

3.4. IT Infrastructure System Performance Measurement Type

Based on benchmarking of existing IT infrastructure system performance measure types, consideration items in advance for deducing VM performance quality requirements were reviewed. Based on the research, following requirements were deduced for system performance composition components as shown in Table 3 [6].

- Performance index value: response time, processing amount per hour, resource use amount, number of supportable maximum concurrent users
- Performance index progress (change) type: type of progress or change of performance index in various workload models and load amounts
- Breaking point: checks load amount at which system cannot process users' request
- Error symptom & cause: checks the symptom & cause of system not being able to process users' request
- Capacity expansion plan: checks components requiring tuning or expansion and its scale to satisfy defined performance goal in preparation for expected load amount increase

Table 3. IT Infrastructure System Performance Measurement Type [6]

Test Type	Objective	Main Content
Load Test	Checks whether system satisfies defined performance goal	Measures system's performance index (response time, processing amount per hour, resource use amount, etc.) in normal & peak load amounts
Stress Test	Checks whether system performs normal functions in overload situations	Evaluates whether synchronization, resource contention and memory leakage related issues occur in load amount exceeding peak

Capacity Test	Checks system capacity for the system to satisfy defined performance goal during expected user & data increase	Based on past performance measured values, estimates system resources and establishes expansion strategy to satisfy defined performance goal in increased load amounts

3.5. Analysis of Server System Performance Measurement Metrics

Server system performance measurement items are analyzed while deducing VM performance quality item requirements to reflect them in deducing performance measurement items and items for measuring server system performance include CPU, memory, disk, process, kernel, file system and network I/O as shown in Table 4.

Table 4. Server System Performance Measurement Metrics [7]

Classification	Measurement Metrics	Measuring Method
CPU	Total CPU use rate (%), system mode use rate (%), user mode use rate (%), run queue, pre queue, number of active processes, number of users	Real-time
Memory	Total memory use rate (%), system & buffer cache (%), page request rate (per sec.), page out rate (per sec.), swap out rate (per sec.), memory queue, swap space use rate (%), memory cache hit PCT(%)	Real-time
Disk	Peak disk, use rate (%), disk IO, busy (%), raw IO rate (per sec.), disk queue, number of disks	Real-time
Process	Process load, zombie process	Real-time
Kernel	Parameter set setup	Not real-time
File System	File system rate (per sec.), peak file system space use rate (%)	Real-time
Network I/O	Network packet rate (%), network collision rate (%), error rate (per sec.), network traffic	Real-time

4 Cloud System Dynamic Monitoring Metric Components & Requirements

4.1. VM system Dynamic Monitoring Metric Components

Requirements for measuring system performance are deduced by analyzing the essential/optional items that need to be selected, as well as additional functions provided to request VM of cloud infrastructure service [8].

Based on this, performance measurement items of cloud service infrastructure system can be deduced through existing IT infrastructure system performance analysis type and server

system performance measurement item analysis. Table 5 shows performance measurement items shows the performance of CPU, memory and disk.

Table 5. VM System Performance Measurement Metrics

Metrics	Measurement Content
CPU	Measure the processing speed of VM standard processor
Memory	Measure the processing speed of VM standard memory
Disk	Measure the I/O performance being transmitted to VM standard disk
Total Performance (single task)	Measure single task standard performance
Total Performance (multiple tasks)	Measure multiple tasks standard performance

4.2. Dynamic Monitoring System Function & Procedure

For the purpose of measuring the quality of quality infrastructure service, it requires the system functions of performance measurement target, performance measurement level gauge, data collection and information provision, as shown in Figure 5. The performance measurement target is IaaS target system establishing quality measurement information and the level of service and performance of the system is gauged. The performance measurement information of the system is stored into database to provide information based on collected quality data.

- Target system (target): as a target system for measuring cloud service performance, virtual server (VM) of commercial cloud infrastructure service is targeted

- Gauge system (gauge): cloud service performance is gauged through agent distribution and measuring tool execution to measure the cloud service performance of target system

- Collection system (collect): measurement data executed/gauged by agent distributed from target system is collected

- Information provision (web): collected performance measurement data is provided via web according to information display method
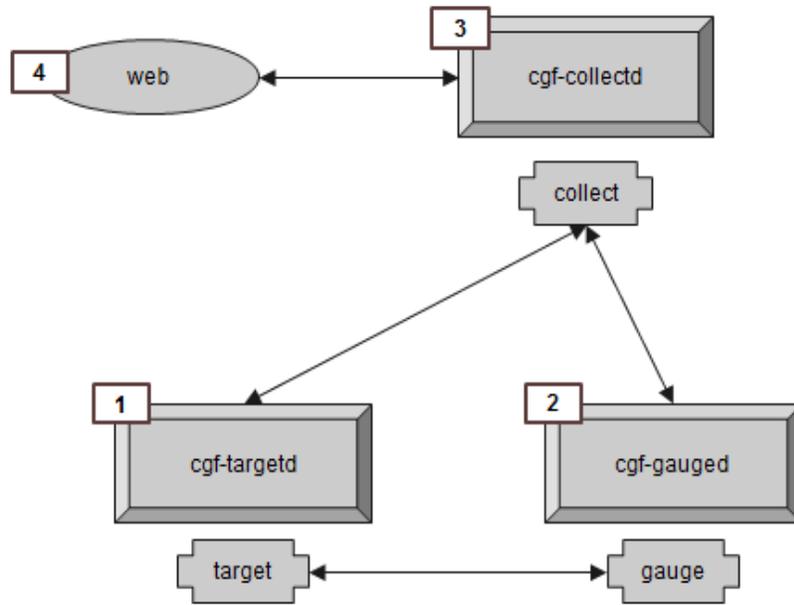
Figure 5. Dynamic Monitoring System Function and Procedure

4.3. Dynamic Monitoring System Design

The operating procedure of dynamic monitoring system to measure the performance of cloud infrastructure service VM is as shown in Figure 6.
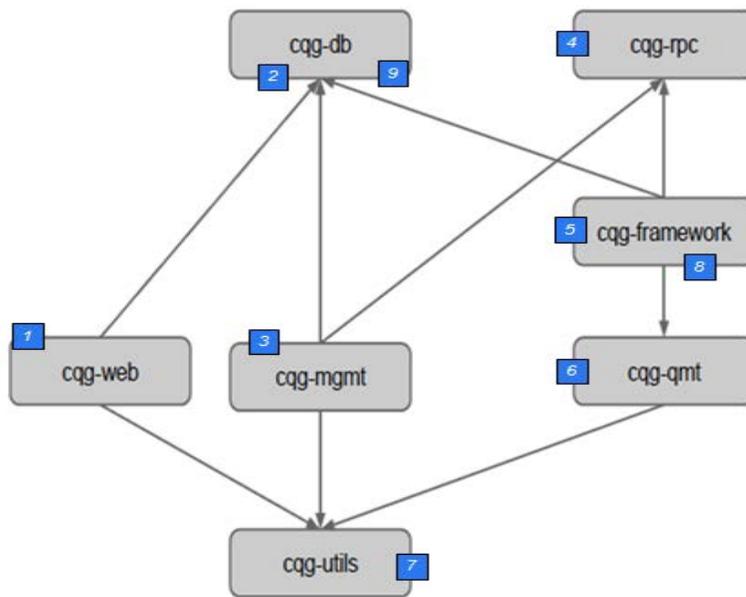
Figure 6. Performance Measurement Monitoring System Program Operating Procedure

Table 6 shows the main role of the each component of performance measurement monitoring system.

Table 6. Main Role of the each Component of Performance Measurement Monitoring System

Component	Main Role
cqg-db	Database management code
cqg-qmt	Performance measuring tool gauge, target agent code
cqg-rpc	Damon interface code
cqg-utils	Utility code for common function
cqg-framework	Collect, gauge, target damon code
cqg-mgmt	Periodic task (damon monitoring, report creation, DB backup) management code
cqg-web	Portal code

Main contents for each step of program operating procedure to measure the performance of cloud infrastructure service virtual server (VM) are as follow.

(1) Register performance measurement target node: provider & service name, IP information, port information, *etc*.
(2) Store registered target node information database
(3) Refer to registered target node information in management server
(4) Call procedure to measure performance
(5) Collection, gauge and target node task control performance through framework: manage automated task based on set value and schedule
(6) Collect performance measured data performed and measured from gauge node through agent distributed from gauge & target node
(7) Send data collected from target & gauge node to database server
(8) Store quality information data collected to database

4.4. Expandability of Dynamic Monitoring System

The proposed monitoring system has a tree structure of receiving performance measurement result values from cloud infrastructure service that are stored through collection node and analyzing/processing stored data values to provide information. The advantage of such tree structure is in its expandability. It can continuously expand performance measurement target within the scope of preventing load in processing data received from sub node by considering the performance of gauge node. In addition to monitoring the CPU, memory and disk of VM, it can also monitor network traffic, data up/download packet amount & speed, service availability, cloud service application (web hosting, portal service, DB, etc.) and cloud service security [9, 10].

5. Conclusion

This paper defined the scope for measuring the performance of cloud infrastructure service, and deduced according items of performance characteristics of VM to develop a framework for managing the performance of infrastructure system. In particular, the framework has been developed to quickly reflect market requirements in a form that

allows convenient addition/deletion of tools in a module form for responding to future cloud technology and service users' needs.

It is expected that the result of this paper will allow cloud service to be changed from the supplier-centered technology perspective to user-centered service perspective, and can be used as a framework for developing tools to manage the performance of cloud service infrastructure system.

This paper has some limitations. As this study was conducted for IaaS among various areas of cloud services, it would be necessary to expand the scope of study in the future to SaaS and PaaS. In addition, a more specific framework can be proposed for measuring the performance of cloud service by conducting a study for measuring the performance of network and storage according to the characteristics of IaaS.

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