# Dynamic Resource Management in Cloud Environment

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**Fujitsu has been providing ServerView Resource Orchestrator (ROR) since June 2010 as a software package for constructing and operating a private cloud within an enterprise. This software enables the user to construct a cloud infrastructure and a management environment, but in actual operation, it is still necessary to manage resources and set up a service environment based on them. Meanwhile, an increasing number of users wish to run quick trials of cloud computing in a simple and convenient environment. To meet their needs, Fujitsu has developed Cloud Infrastructure Management Software, which is a solution to be combined with ROR. This solution makes it easier to create a self-service portal and an environment for visualizing resource management. Further, to satisfy the needs of users who wish to perform critical, high-reliability tasks in a cloud environment, Fujitsu has made it possible to use a high-availability technology with ROR. In this paper, we introduce these solutions.**

## 1. Introduction

Fujitsu has been providing ServerView Resource Orchestrator (ROR) since June 2010 as a tool to create cloud infrastructure.[1)] However, because it is just an engine, it is still necessary to establish an environment suitable for services in actual operation such as setting up a self-service portal.[2)] While Fujitsu is providing the functions necessary to address this issue in combination with Systemwalker products, a considerable number of users wish to run quick trials without thinking about complicated issues, and many of them want to make a simple setup by using part of their existing resources.

In this paper, we will introduce Cloud Infrastructure Management Software (CIMS), which is a solution developed and offered to meet the above-mentioned needs. It allows administrators to easily construct and operate cloud infrastructure. Further, to meet the needs of users who wish to introduce critical, high-reliability systems with a cloud technology, we have made it possible to use a high-availability cluster technology with Red Hat Enterprise Linux (RHEL) Xen. We describe the details of this technology in this paper as well.

## 2. Virtualization and cloud

Currently in most companies, business systems are constructed individually by combining hardware such as servers, storage and networks with software such as OS's and middleware. Therefore, each business system needs to have a capacity sufficient to handle its peak use. This type of system is called a silo system in general. However, with silo systems there are surplus resources in periods other than peak times, and as a consequence overall resources have low availability. Further, it is difficult to change hardware once a system has been configured. This means it is difficult to flexibly deploy resources and have automated operation across the company while maintaining the silo system.

In recent years, virtualization technology has become more popular even for open systems, and silo systems now tend to be consolidated by arranging them in a virtualized way on common hardware. By virtualizing ICT resources, flexible deployment of resources becomes possible, which is something that could not been achieved with conventional silo systems. Through this improvement, a system can immediately deploy and operate the required resources only when necessary instead of individually preserving enough resources for the peak time. As a consequence, the net working rate of all hardware will increase and more efficient operation of resources will become possible.

Based on positively using virtualization technology to structure business systems, cloud computing offers an environment where administrators of each system can work efficiently. They need to pay attention only to the logical resources used by their own system, and without needing to consider the environment of hardware that is actually used.

To implement cloud computing, it must be possible to:[2)]

- Virtualize the physical resources owned and control them as a resource pool.
- Allocate resources from a resource pool if requested by users.
- Generate an environment where the user can actually use the allocate resources.
- Allow access from the networks specified by users.
- Conduct visualization to allow the operation status of the system to be understood.

Further, from the standpoint of an operation administrator it must also be possible to:

- Restrict access rights of users depending on the group or role of users.
- Isolate allocated resources between user groups or between organizations that share the resource pools.
- Add or remove actual resources depending on the surplus or deficit status of a resource pool.
- Charge a fee for using each system depending on the number of users and duration of use.

Fujitsu has realized these features by combining the following middleware products:[3)]

- Systemwalker Service Catalog Manager (CT-MGR)
- Systemwalker Software Configuration Manager (CF-MGR)
- Systemwalker Runbook Automation (RBA)
- ServerView Resource Orchestrator (ROR)

## 3. Offering of cloud infrastructure

Fujitsu has offered ROR with basic functions where resources of entire systems are classified and then pooled and the resources in each pool are allocated to each request without distinction.

Unlike a conventional virtual environment where only resources in servers are handled, the cloud environment needs to handle resources in wider fields including storage and networks. As these fields have been developed for a long time independently, they have their own administration systems. Therefore, ROR has adopted a structure that allows the conventional administration tools to be plugged in. If we at Fujitsu enhance ROR to support a new administration tool, we simply add a plug-in suitable for the tool, and the resources under the administration of the tool can be virtualized in cloud environments.

In ROR, the concept of a logical system is introduced; this system combines resources of virtualized servers, storages and networks and OS images to be introduced. It is called "L-Server." The concept of OS images includes not only the OS's but also everything running on the servers in the L-Server. This may include any common tools and middleware agents.

When a user tries to start up a new business system, the user should request ROR to assign an L-Server. While the user can specify individual specifications of L-Server at the requesting

assignment, it is also possible to construct a business system by selecting a template registered by the operation administrator in advance. Using this template offers the following advantages:

- Users can use a standardized system easily without needing to pay attention to the detailed specifications of L-Server.
- It is possible to standardize a data center as a whole by using such systems that are defined in advance based on the templates.

Because multiple templates are available to suit each application or scale, the operation administrators can prepare different types of templates that are suitable for their business. ROR can restrict pools and templates accessible to each user in order to accommodate multiple tenants.

## 4. Two types of demand

After releasing ROR, we received the two types of request shown below as feedback from users who were trying to construct a cloud:

1) Request for quick and simple installation of a cloud infrastructural environment

This means a function to construct a self-service portal in the user environment. This request was made because ROR has no customization feature on a Web that could serve as a basis for cloud operation, while ROR has only a basic function to create cloud infrastructure.

Further, when actually operating the system, it is necessary to control the overall environment, including physical resources, in addition to controlling the cloud. To construct a total operation environment, many users need information on the system's performance and on actual usage for billing purposes.

2) Request to perform critical, high-reliability tasks with cloud

Basically, virtual environments have evolved to date with the emphasis on the flexibility of system configuration rather than on high reliability. Because of this, there have not been many attempts to virtualize critical systems that need to be highly reliable. Nevertheless, there have been frequent requests for support for high-availability (HA) clusters in cloud environments, because many users need to avoid stopping systems whenever there are simple hardware failures in cloud environments.

To meet these requests, CIMS has been developed to meet the first request for quick and simple installation of a cloud infrastructure environment. At the same time, for the second request, functions of ROR were enhanced to allow users to perform critical, high-reliability tasks with cloud. The aim is to allow the platform deployed for ROR to be placed in the cluster environment. We will describe the details of these functions in the next section.

## 5. Concept and solution for CIMS

To meet the request for establishing an infrastructure for a cloud environment in a simple manner, we need something more than ROR. Because even though ROR offered the functions to construct infrastructure, we need to establish peripheral environments separately to actually operate the system. Particularly, in the case of a cloud, an administrator is connected with a user via networks, and needs to meet the requests from the user on an on-demand basis. Therefore, the setting up of a self-service portal site became an essential condition in addition to the construction of infrastructure for a cloud environment.

At the initial stage of ROR development, we thought that the functions of a self-service portal were strongly affected by the characteristics of the respective data center. Moreover, the application of ROR was envisaged based on the assumption that ROR should be based on the already existing operation environment in most cases. So, the functions related to a self-portal service were offered as a separate solution from ROR.[3] Nevertheless, with the progress of business, a significant amount of

demand was observed among users who wanted to run quick trials independently in a new and simple environment. In addition, many users wanted to construct a self-service portal that could address the deployment of cloud, while keeping the operations of individual servers for each department. Therefore, we needed to offer a function to construct an environment for cloud infrastructure and a function to set up a self-service portal at the same time.

Besides, because there was strong demand for an ability to understand the current status of the cloud infrastructure in conjunction with the physical resources, and a solution was necessary to visualize the whole system in a unified way. Although this request could be met by building additional functions for each user separately utilizing existing products, it was inefficient for each user. To solve this issue, we integrated a dashboard function in the ROR.[4)]

We consolidated ROR, the function to construct a self-service portal site, and the function to visualize the resource management via the dashboard. In this way, we offered a solution named "Cloud Infrastructure Management Software (CIMS)."[5)] This is a one-stop solution that enables both construction and operation of the environment for cloud infrastructure on an IaaS level. An example display of the CIMS dashboard is indicated in **Figure 1**. In addition, an example of a private cloud application using CIMS is indicated in **Figure 2**.

## 6. Performing high-reliability tasks in a cloud environment

Many users have expressed their needs to perform critical tasks, which need high reliability, in a cloud environment.

Because the individual system operates on each piece of hardware in the conventional silo-type system, any hardware trouble does not affect the area outside the individual system. On the other hand, in a cloud environment any problem with a single piece of hardware may spread across multiple business systems, since multiple systems are deployed as guests of VM on a common piece of hardware.

Basically, conventional measures for reliable systems have a mechanism against

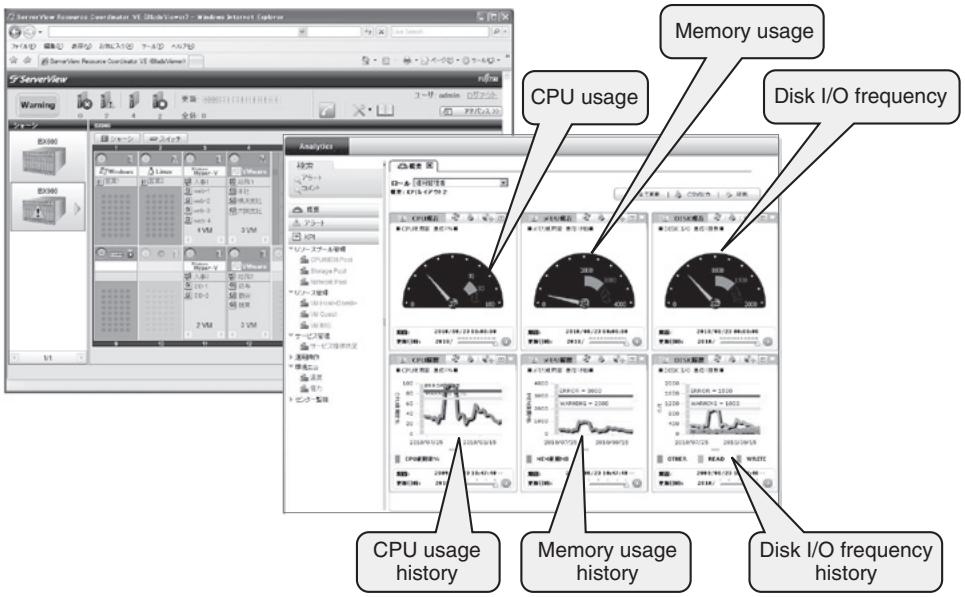


Figure 1
Sample display image of CIMS dashboard.

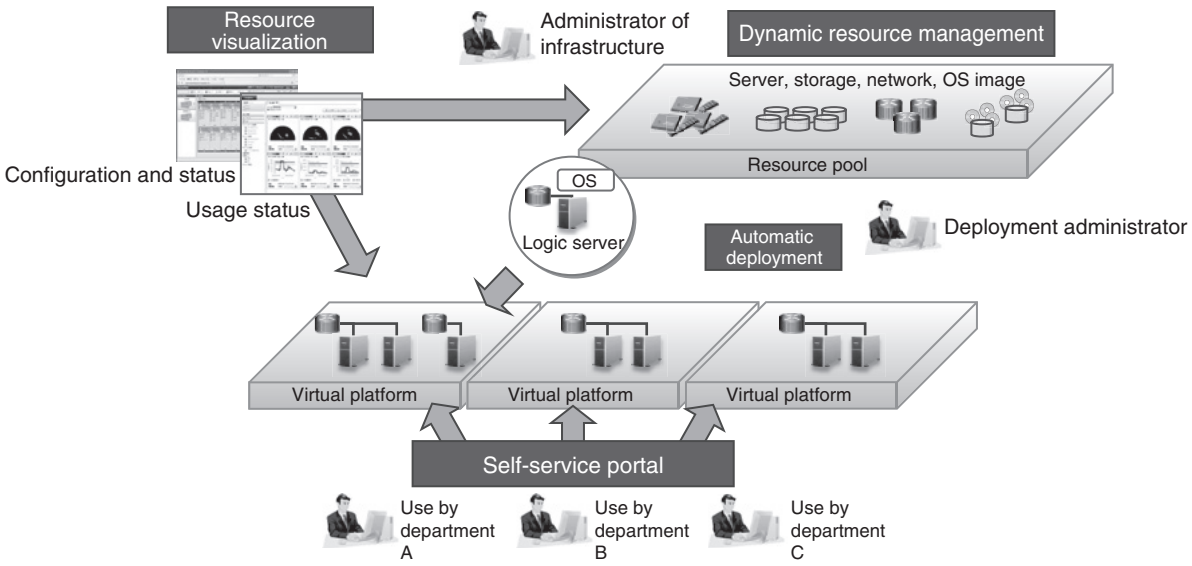


Figure 2
Usage pattern example of CIMS for private cloud service.

hardware troubles to ensure processing can be continued by bypassing the point of trouble using redundant resources. Meanwhile, in the virtual environment, a guest VM in operation can be transferred to another host without interrupting the operation. This feature is a means of offering high reliability in a cloud environment. The ROR incorporates these two functions (i.e. an HA mechanism to bypass the point of trouble, and live migration to transfer the guest VM to another host). But it should be noted that sufficient care is needed when using these functions because these mechanisms require certain conditions on physical allocation of resources for virtualized systems.

Details of these two mechanisms are as shown below:

1) HA mechanism

This is a mechanism to ensure the guest system is rebooted as a guest on a hypervisor of another piece of hardware in the event of a VM guest shutdown such as a crash. For this, a pair comprised of two VM guests is made basically. When a VM monitor mechanism (administration OS or administration manager) detects that one of these guests is shut down during its normal operation, another VM (i.e. a stand-by system) is started up to take over the business operations in progress. Because the stand-by system is not used in times of normality, it is an example of a cold stand-by environment.

2) Live migration

In the virtualized environment, hardware for the host in operation can be switched because its platform is separated from the physical resources. Transfer of a guest in operation to another piece of hardware without interruption is also possible. This mechanism is called a "live migration." The name of this kind of mechanism differs depending on the hypervisor of each piece of virtualization software. In Xen and Hyper-V, it is called "live migration," while it is called "vMotion" in VMware. Though their names are different, their actions are the same. Normally, this mechanism is used when you would like to shut down a physical server irrespective of the schedule of your business, such as when you conduct maintenance on the physical server.

By using the live migration, a guest can be transferred from the hypervisor on the hardware to be maintained to a different hypervisor not affected by hardware maintenance. In this way,

tasks can be continued without interruption.

3) Cluster

In the virtualized environment, hardware redundancy is exploited generally by using the HA mechanism or live migration explained in 1) and 2) in the previous section. ROR has supported these two mechanisms so far. The HA mechanism realizes a cold stand-by system, where the stand-by system is actuated only after detecting any system failure of the running system. If a further increase in reliability is requested, that is, shorter switching time, a switch based on hot stand-by is necessary even in the virtual environment. In this case, this stand-by system needs to be ready and waiting on a cluster system as it was in a real environment.

Even if redundancy of the server is exploited with cluster technology, the storage is still susceptible to a single point of failure (fragility caused by a lack of redundancy) because the storage remains as it is. To address this issue, we developed a new approach to achieve redundancy of the storage.

Fujitsu offers a high-reliability server named "PRIMEQUEST." Envisaging PRIMEQUEST users who want to maintain their system's current level of reliability even in a virtualized environment, we now support PRIMECLUSTER and Global Disk Services (GDS) with Xen, a virtualization function.

In the case of a cluster system, access to common data should be ensured within the range of switch. Therefore, the range of the resource group to which the storage for common data belong should be the same as the range of the cluster. For this reason, shared ranges for PRIMECLUSTER and those for GDS should be identical.

In the cluster system, the active system and the stand-by system monitor each other's heartbeat to realize a hot stand-by feature. In this mechanism, any system that shows no heartbeat for a certain period is regarded as being in "shutdown" mode. As a precondition of this mechanism, the I/O of Heartbeat should be completed within a specified period. However, in the virtualized environment, because the dispatcher overhead of a hypervisor, such as a switch between VM guests, may result in a delay, completion of I/O within a specified period is not guaranteed. To address this issue, we developed a new monitoring mechanism in this project as a countermeasure for such a delay. The concept of this mechanism is indicated in **Figure 3**.

Through positively using these technologies, we ensured the availability of the cluster system and the live migration in a virtualized environment. It allows users to construct a failure-resistant cloud.

## 7. Conclusion

With regard to the self-service portal, Fujitsu only offered a function to construct a cloud infrastructure and its control functions via ROR based on the assumption that most of our customers had already built their own self-service portal that suits their data center. However, as we observed unexpectedly high demand for constructing their cloud environment as a separate system from their existing environment, we offered a CIMS. With this, ROR integrates a function to create a self-service portal in a simple way, in addition to the visualization of resources. Normally, manufacturers tend to offer introductory tools with limited functions when they offer simplified product versions. On the other hand, we try to establish a one-stop tool that can both construct and control cloud infrastructure easily, rather than making a simplified version.

Further, to keep highly reliable operations in a virtualized environment, we constructed our conventional cluster environment also in a cloud environment. This is because we have many customers who would like to move their systems which have already been securely protected against hardware disturbance.

As for the requirements of users who want

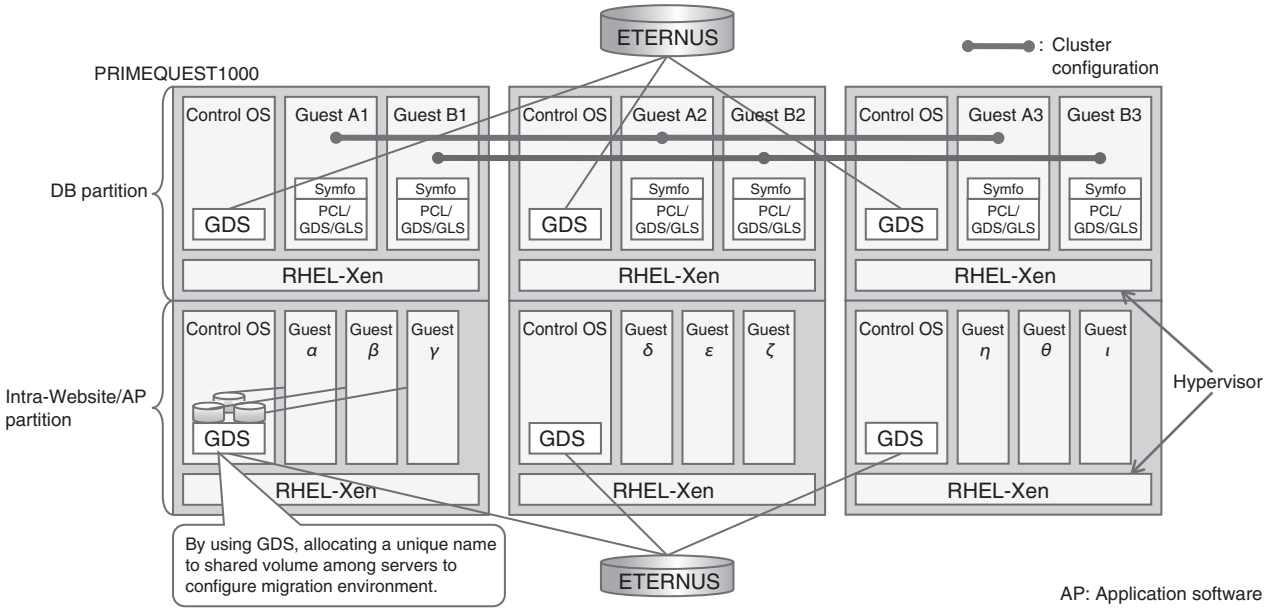


Figure 3
Supporting of PRIMECLUSTER on ROR for cloud environment.

to migrate their existing systems to a cloud environment without modification, we have a lot of issues. This is because virtualization technologies, the base of cloud computing, still do not support all of the technologies used on the conventional physical resources. This means, those users might require virtualization only for the number of systems existing in the actual environment, or they might require additional functions for cloud technology. Of course, it is difficult to meet all of these requirements, but we at Fujitsu will do everything we can. Our team is committed to achieving two goals for cloud environments: to construct an environment for systems to ensure easy and secure operation, and to maintain the high reliability nurtured in conventional environments.

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