

# Middleware for Supporting Private Clouds

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Cloud computing is attracting attention because it enables speedy construction of systems in response to rapidly changing business environments and helps reduce expanding information and communications technology (ICT) costs. There are two forms of cloud computing. One is a public cloud, where service providers provide their cloud services to a number of customers. The other is a private cloud, where a company's information system department provides company-specific cloud services to all sections of that company and its group companies. These two forms have a symbiotic relationship, and users can choose between them in accordance with their requirements for governance, security, reliability, and networks. Fujitsu is meeting various needs of customers by offering middleware products to construct a private cloud system in addition to providing public cloud services. In this paper, we introduce an outline of our middleware products that can reduce ICT costs and enable speedy construction of systems in a private cloud environment.

## 1. Introduction

A private cloud has several advantages: information and communications technology (ICT) resources are held in-house; governance, security, reliability, and networks can be matched to the customer's operations; it can be used as soon as the customer wants to use it; and it can be restored at any time. The implementation of one requires not only gathering together ICT resources but also developing a mechanism that can provide an automatic system that is easy for the user to apply and that does not impose a burden on the operations management department. It is also necessary to provide middleware and expand functions with respect to each of the infrastructure, middleware, and application layers.

In this paper, we discuss the issues related to each layer in the formation of a private cloud and outline the technology and middleware products that resolve these issues. Note that

this paper introduces the latest information on the development of Fujitsu's middleware and is based on the article "Middleware for Creating Private Clouds" that was published in the special July 2011 issue.<sup>1)</sup>

## 2. Fujitsu's middleware lineup

Fujitsu's middleware lineup is shown in **Figure 1**. The software packages that form the core of this lineup are Interstage and Systemwalker, which are foundation middleware, and ServerView, which is infrastructure-oriented middleware.

- 1) Interstage (service-oriented architecture [SOA] middleware)

This package supports the application and service management region and the information integration and utilization region. The core of Interstage is the Interstage Application Server, which forms a foundation for running Java in both the cloud system and on-premise

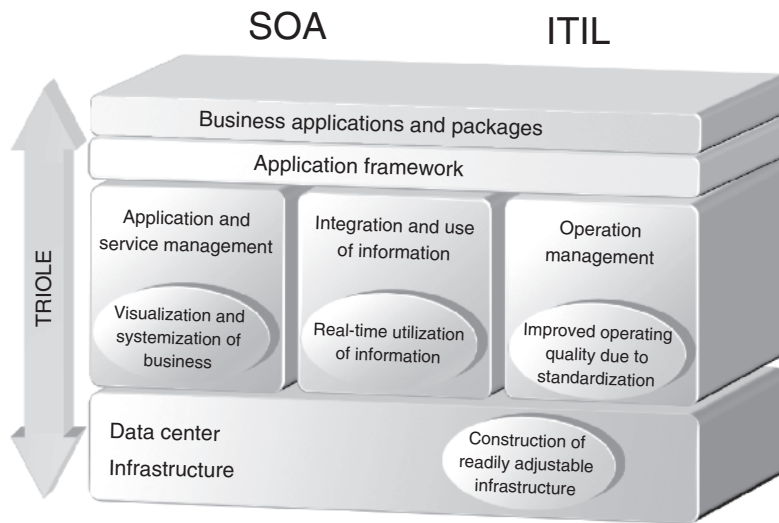


Figure 1  
Fujitsu's middleware lineup.

system environments, and a group of products that implements collaboration across the cloud system and the on-premise system through SOA technology (creating a hybrid cloud).

2) Systemwalker (Information Technology Infrastructure Library [ITIL] operations management)

This package uses ITIL technology and supports the operations management region. We provide the following products designed for private clouds:

- Systemwalker Software Configuration Manager V14g
- Systemwalker Service Catalog Manager V14g
- Systemwalker Runbook Automation V14g

We are also strengthening cloud-handling functions for certain existing products.

3) ServerView (infrastructure management)

This supports the data center and infrastructure regions. The ServerView Resource Orchestrator (dynamic resource manager), which manages virtual resources, provides a platform for private clouds.

As clouds become more widespread, functions that are compatible over the entire middleware lineup will become increasingly

important.

### 3. Fujitsu's approach to private clouds

At Fujitsu, we assume repeated steps of implementing standardization and automation while assessing the effects of the implementation, based on virtualization of the infrastructure, as an approach to the optimization of ICT systems created as "silos" (Figure 2).

The servers owned by a company are gathered together at a single location and virtualized, and business systems are consolidated. The specifications and configuration of the consolidated system are standardized in phases, and software installation, system construction tasks (such as defining the system settings), and operating tasks are automated. In addition, hardware resources, system resources, and business services are visualized. The users then apply for leases and identify their utilization situations. Operation managers consider the overall operating situation of the center and adjust resources flexibly to suit the operating conditions of the user's business.

This approach reduces the amount of manual work on both the users' side and the

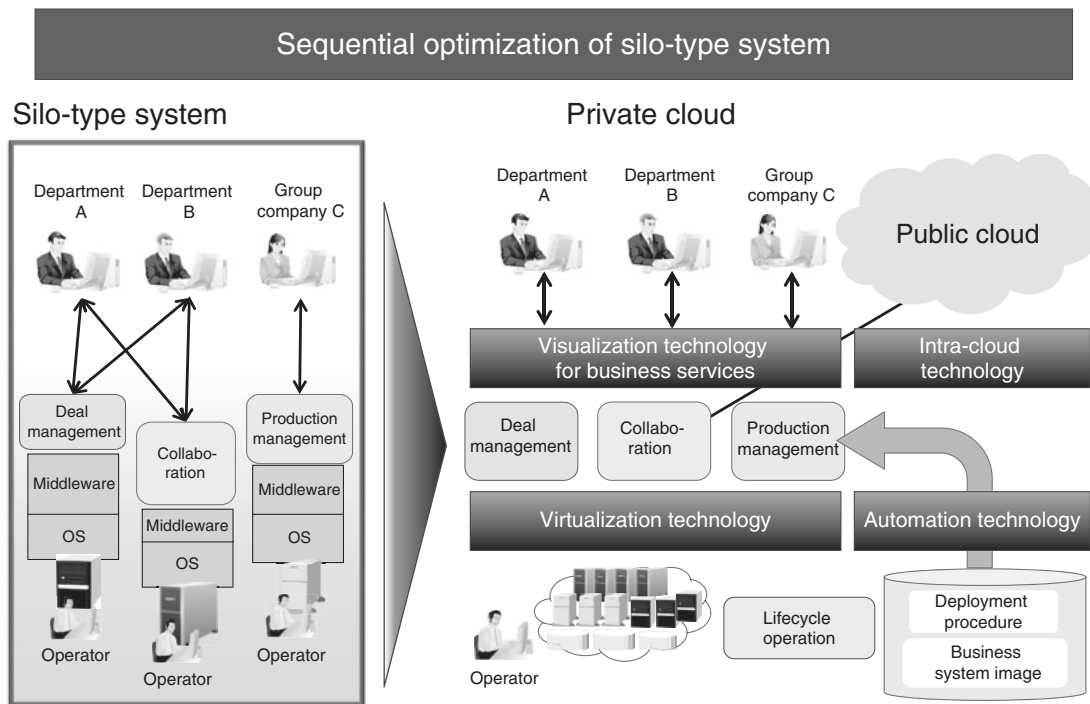


Figure 2  
Fujitsu's approach to private clouds.

operation managers' side and greatly shortens the time from service request to service provision. In addition, we implement a shift in operations from "owning" to "leasing for use," which is a characteristic feature of cloud systems. Part of the system can be located in a public cloud with access enabled to and from private clouds.

The middleware architecture necessary for private clouds is shown in **Figure 3**. The right-side frame shows the hierarchy of middleware such as that for application servers, which form the hardware on which applications and software packages run. This middleware provides an execution platform. The left-side frame shows the roles of cloud operations middleware, which manages and controls each of the layers on the right side.

#### 1) Dynamic resource management

This middleware is for the data center and infrastructure regions. It manages hardware resources consisting of servers, storage, and networks.

#### 2) Automatic deployment and automatic operation

This middleware is for the operations management region. It automates the deployment, setting, and operations of the complete software stack. It includes middleware that forms the execution platform.

#### 3) Visualization of business services

This middleware is for the application and service management region. It visualizes individual business service units, right down to applications and software packages.

#### 4) Development and execution software

This middleware is for the application and service management regions and information integration and utilization regions. It provides Java and COBOL execution environments and functions for cooperating with services and applications on public clouds.

We describe each of these middleware components in order below.

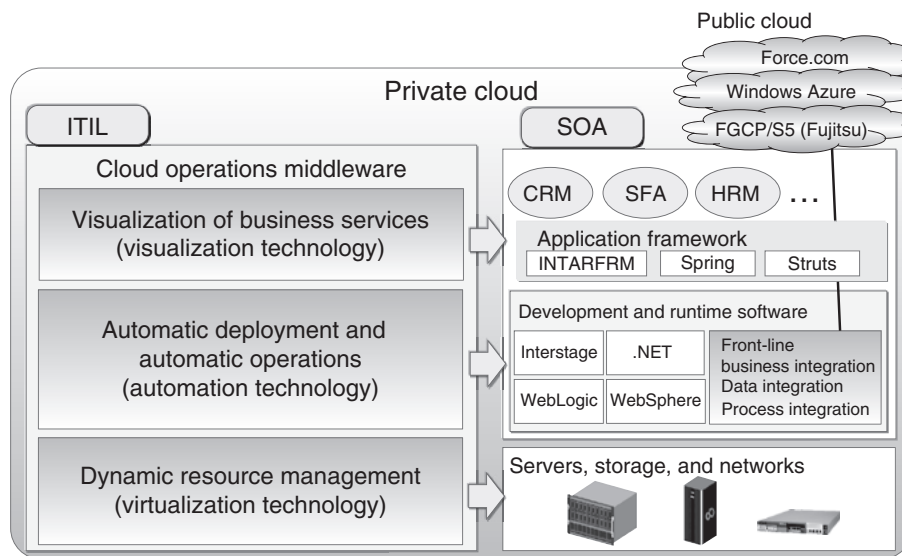


Figure 3  
Middleware architecture for private clouds.

#### 4. Dynamic resource management

The underlying foundation of private clouds is virtualization technology. In traditional system construction, a server that was barely large enough to satisfy the maximum data requirements of a business system was procured individually for each system. As a result, recent improvements in hardware performance have meant that a growing number of operating servers have a relatively low average CPU usage rate and disk usage rate. In addition, there are also servers that are installed permanently for development, maintenance and upgrades that are essentially only used for those activities, so their overall operating ratio is low.

Virtualization technology has made it possible for a number of independent virtual servers to run on a single physical server. This means that physical server resources can easily be shared by a number of different systems so that CPU and disk resources can be utilized more efficiently. On the other hand, there is a risk of either a shortage or surplus of resources due to the way in which systems are allocated to virtual servers. Operations management must

suitably control the way in which virtual servers are allocated to physical servers to ensure that resources are utilized efficiently. This resource management is a new management task created by virtualization.

To simplify this management task, we have ensured that the hardware resources of servers, storage, and networks are pooled and that only the necessary amounts of resources are allocated as required. This dynamic resource management function is provided by the ServerView Resource Orchestrator product.

In addition, it is necessary for operations management to always know the usage status of hardware resources and virtual resources and the availability of the resource pool, in order to control allocations appropriately. Visualization functions for these operations are provided by the Cloud Infrastructure Management Software and the Systemwalker Service Catalog Manager products.

#### 5. Automatic deployment

When pooled resources are allocated by dynamic resource management, allocating a single virtual server requires that the user

install middleware on that virtual server and set the middleware operating parameters. To reduce this user load, patterns are created beforehand, where each pattern consists of a configuration of servers, a network, and middleware necessary for executing an application, together with settings information for each component. This automatic deployment technology enables the user to automatically obtain a set of virtual servers with the necessary virtual images loaded, when the user requires it.

With automatic deployment, an operation manager decides on the specifications of the virtual server (such as the number of CPUs and the amount of memory) and the configuration of the operating system (OS) and middleware and constructs a virtual server image. These details are then recorded as a “template,” together with the parameters to be set. The user can always obtain the necessary virtual server suite automatically, whenever required, by simply selecting a template.

The automatic deployment function is provided by a product called Systemwalker Software Configuration Manager.

The following automatically deployed middleware products have proved themselves in practice:

- Application servers
  - Interstage Application Server
  - Oracle Weblogic Server
  - Websphere Application Server
- Databases
  - Symfoware Server
  - Oracle Database
  - SQL Server
- Open source software
  - Apache HTTP Server
  - Apache Tomcat

## 6. Automatic operation

Since a private cloud gathers together a large number of systems that were previously dispersed among various departments in a

company, operating loads that had been hidden become concentrated, and the load on operations management inevitably increases. It is thus necessary to provide a method of curbing the operating loads. Fujitsu therefore plans to standardize and automate system operations.

For example, if we consider the activation procedure, which is a basic operation of an ICT system, the flow is as follows:

- 1) Activate the virtual server
- 2) Activate the OS and middleware
- 3) Confirm the activation
- 4) Activate business applications
- 5) Confirm normal operation
- 6) Open to users

It is also necessary to take into account actions such as interrupting the subsequent operations if an abnormality is detected during operation and reporting to the appropriate personnel.

The automatic operations function defines a number of operations, such as 1) to 6) above, as a workflow and provides a function for running them automatically. This workflow includes the input of commands to the server and network equipment, confirmation of results, acknowledgment and confirmation requests to operations management, and functions for transmitting E-mail to appropriate personnel. Not only does this ensure that workloads become more efficient, it also makes it possible to prevent human error and to create a reliable operating record.

The automatic operating functions are provided by the Systemwalker Runbook Automation product.

## 7. Visualization of business services

If the setup is such that hardware resources are shared through virtualization and can be leased as the need arises, it is difficult to calculate the ICT infrastructure costs for each business system. This is because the procurement costs

of hardware such as servers and storage can no longer be allocated statically to specific business systems. For that reason, if a cloud is introduced, it is important to calculate expenses in accordance with the system resources used by each business system and to know how much the business system was used. We thus provide an accounting management function that produces resource usage and time-spent data by business system.

From the viewpoint of a user leasing resources and/or business systems, it is necessary to have a “service catalog” showing resource specifications and business systems availability and at what price. Such a catalog would function as a guide for customers wanting to use cloud resources. The Systemwalker Service Catalog Manager provides such a catalog. It lists the available services and system configurations, along with the price. Moreover, it has a self-management function for verifying and operating the services, a function for sending user requests for leasing services and restoring applications to the manager (or responsible person) of the user’s department for approval, and a metering (measuring) function for monitoring resource usage.

## 8. Development and execution software

In the development and execution of software running on a cloud, some cloud-aware functions are necessary. One function involves the automatic deployment described above. It is necessary to ensure that development and execution environments can be provided speedily when necessary. Another is a function that enables simple implementation of collaboration between a public cloud and a system that is on-premises.

In the switchover to a cloud environment, the front-line businesses should use public-cloud-based services while the other businesses should use on-premise systems. Therefore, the

on-premise business systems must be able to collaborate with the cloud-based services, such as by using a common customer master file.

To support such collaboration, we provide the following products in which three integration technologies (user interface integration, data integration, and process integration) are embedded:

- Interstage Information Integrator
- Interstage Interaction Manager
- Interstage Service Integrator
- Interstage Business Process Manager
- Interstage Business Process Manager Analytics

## 9. Case example

Three problems were encountered during Fujitsu’s middleware development: “rising server operating costs,” “insufficient or surplus server resources,” and “rising labor hours in development environment construction.” As a means of solving these problems, Fujitsu’s Numazu Software Development Cloud Center has been working to turn our software development environment into a cloud since 2008. We are now providing a service that automatically constructs and makes available development environments for 10 hubs and 4500 software developers in Japan and overseas (Figure 4). The cloud implemented by the Numazu Software Development Cloud Center also has a role of refining the cloud products and services we provide to customers. Creation of this cloud has solved the three problems above. Moreover, its use has speeded up development and has reduced the environmental load (a reduction of 13.7% in CO<sub>2</sub> emissions).

## 10. Conclusion

In this paper, we overviewed the middleware provided by Fujitsu for creating private clouds. As hardware becomes more concentrated, the sequence of processes of procurement, setting the middleware operating parameters, and running the system as well as calculating the cost burden,



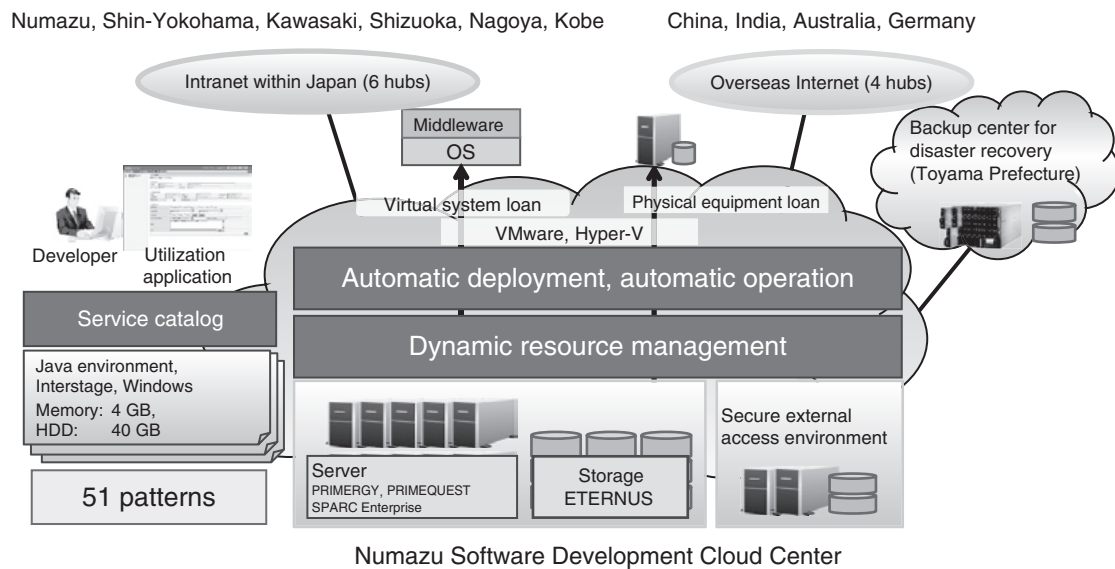


Figure 4  
Service provided by Numazu Software Development Cloud Center.

which were done piecemeal in the past, also become more concentrated, so greater efficiency can be expected from automated control and execution. In such an implementation, there is of course collaboration with the middleware on the management side but just as important is collaboration with the middleware on the side being managed (application development and execution environments).

In February 2011, we strengthened the functions of our middleware products. We improved their operability by adding a graphical user interface, making it possible to construct a private cloud by using screen operations similar to those of the Fujitsu Global Cloud Platform “FGCP/S5”<sup>note)</sup>, which is Fujitsu’s public cloud service. In addition, we have implemented an environment that enables the user to automatically deploy and immediately use a configured system, from installing the software to setting the operating parameters, even for a complicated business system with a three-level structure (Web server, application server, and database server).

note) Known outside Japan as the “Global Cloud Platform (GCP).”

Fujitsu provides middleware products for both the management side and the managed side. By making the most of the advanced features of our middleware products, we intend to contribute to the overall optimization of ICT systems through private clouds.

## References

- 1) H. Nagakura, et al.: Middleware for Creating Private Clouds. *Fujitsu Sci. Tech. J.*, Vol. 47, No. 3, pp. 263–269 (2011).



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