New Management Technologies for Blade Servers

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Blade servers make it possible to accommodate a large number of servers and switches in one chassis at high density. To operate a large number of servers in a highly reliable and cost effective way, the concept of provisioning is important. Provisioning means preparing bare-metal servers in a server pool that can be shared by several business systems in order to provide servers quickly. To realize provisioning, virtualization technologies such as configuration management, pool management, and automation are necessary.

This paper introduces the management technologies for efficiently and reliably operating blade servers that are provided by Systemwalker Resource Coordinator, Fujitsu's provisioning software product. It also introduces future technologies for performing autonomic provisioning in which an IT system reconstructs itself organically.

1. Introduction

1.1 Advantages of blade servers

Blade servers make it possible to accommodate a large number of servers and switches in one chassis at high density. The hardware unit containing a chassis is called a server blade, and the server blades are connected to switches called switch blades through a middle plane. Compared to traditional servers, blade servers have the following advantages:

1) More servers can be placed in each rack.
2) They can accommodate computing devices and network devices in one chassis.
3) Switches and servers do not need to be connected by cables.
4) Server blades and switch blades are hot-pluggable.
5) They can accommodate equipment called management blades that allow administrators to collectively manage the entire hardware, for example, server blades, switch blades, power units, and fans, in a chassis. Management blades provide the following management functions:

- Configuration management

Manages the configuration and state of the blades in a chassis and detects changes that occur in the blades.

- Fault management

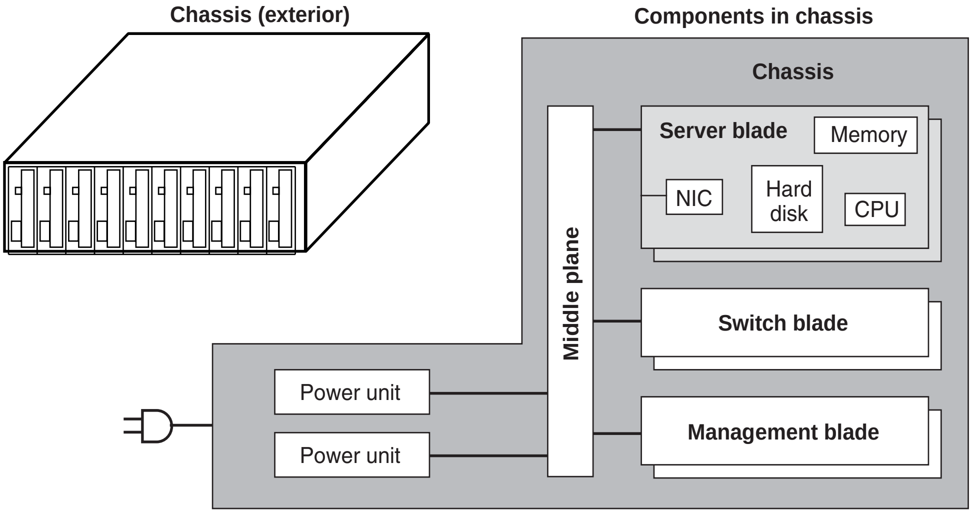
Detects faults occurring in server blades, switch blades, power units, and fans. This function also issues alarms to management tools using Simple Network Management Protocol (SNMP) traps.

- Power management

Performs on/off switching and rebooting of a chassis, server blades, and switch blades.

Figure 1 shows an example hardware configuration of a blade server.

Another feature of blade servers is they can be combined with various virtualization technologies. For instance, in a blade server, because a server can access only a fixed switch, Virtual Local Area Network (VLAN) can be used so multiple



CPU: Central processing unit NIC: Network interface card

Figure 1
Hardware configuration of blade server.

business systems can share a chassis. In addition, other virtualization technologies such as load balancing and storage virtualization can be used to apply blade servers to business systems.

1.2 Issues

Business systems that use blade servers have a large number of server blades, and when a large number are in use, it is important to ensure they do not degrade system reliability. Although many factors can degrade a system's reliability, the most important ones to consider are:

1) Hardware faults
2) Software faults
3) Insufficient resources to deal with unexpected load increases
4) Human error

Regarding factors 1) and 2), it is expensive to improve the quality of hardware and software. A blade server helps to reduce the service downtime, because new servers can be added and failed servers can be replaced without disconnecting and reconnecting the complicated network cables.

Regarding factor 3), it is difficult to accurately estimate system size in an open system. Moreover, in a Web system, it is difficult to accurately predict the amount of transactions. Therefore, it is necessary to build a system that includes an allowance for peak workloads. As a result, there are many resources that are usually not used and systems inevitably go down when the number of transactions exceeds the predicted level. On the other hand, the number of active servers in a blade computing system can easily be increased, so only the minimum number of servers need to be used in the initial installation and servers can easily be added when the system load increases.

Regarding factor 4), it is impossible to eliminate human error completely, but the risk of it occurring can be reduced by automating system operation as much as possible. However, in a traditional system, servers and networks are separated, so the system configuration strongly depends on human operation. With a blade computing system, networks and servers are consolidated in a single chassis, so it is easier to automate system operation and therefore minimize human error than in a traditional system.

1.3 Systems using blade servers

A high-availability and cost-effective system using blade servers is constructed as follows:

1) Bare-metal server blades are prepared for a

server pool that can be shared by several business systems.
2) If a fault occurs, the environment and settings are restored to another server blade in the server pool.
3) When a server resource shortage occurs in the load sharing server group because of a load increase, a server from the server pool is added to the load sharing server group. Then, the environment settings are restored to extend the load sharing server group.
4) When the fault is repaired or the system load returns to normal, the server that was replaced or added is returned to the server pool.

Figure 2 shows an image of a high-availability system using blade servers.

Provisioning provides a quick and flexible service by preparing IT resources in advance. It brings the following benefits to customers:
1) It enables customers to visualize the impact of physical faults on services and thereby reduce the time needed to recover from faults.
2) It quickly reconstructs a system when a fault occurs and therefore reduces system down-time.
3) It quickly adds servers when the system load increases and therefore reduces the amount of time the service level is degraded and makes it easier to use server resources more effectively.
4) By automating intervention tasks such as installation and maintenance, it reduces the risk of human error and makes operation more cost-effective.

In the next section, we describe the blade server management technology used to realize provisioning.

2. Blade server management

This section describes the blade server management technology implemented in Systemwalker Resource Coordinator, which is a management software offered by Fujitsu. The first version of this software focuses on blade servers,

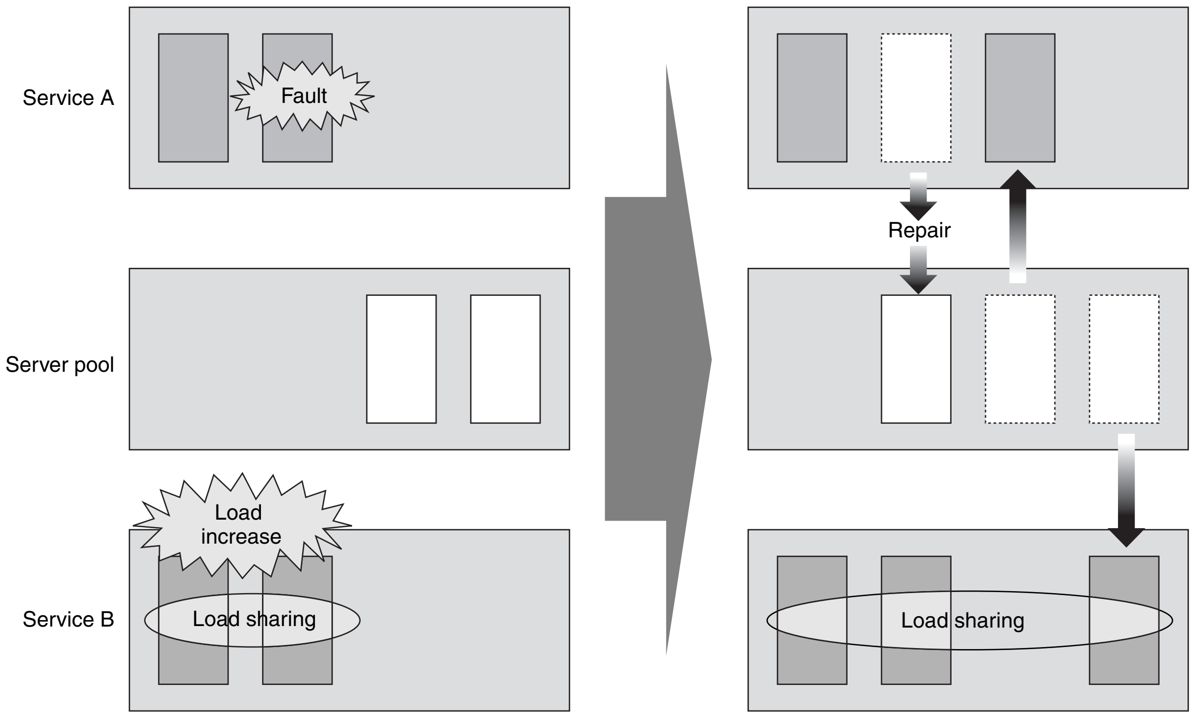


Figure 2
High-availability system using blade servers.

and we plan to make a future version that supports other IT resources.

2.1 Provisioning blade servers

To change an IT resource allocation dynamically, physical resources must be virtualized to operate resources logically. The following functions are needed to virtualize IT resources for blade server provisioning:

1) Configuration management

Manages the configurations of server blades and switch blades. This function also manages system images that can be cloned and the software operating on each server.

2) Pool management

Manages prepared servers as groups of servers that may or may not belong to a specific service. These groups, called server pools, are managed using the concept of a "service," which is a group of server blades used for a series of jobs. Pool management is described in Section 2.5.

Managing the physical features of each server is also important. When administrators select a server from a server pool, they need to know physical information about the server, for example, the number of CPUs, the CPU speeds, and the switch blade to which the server is connected.

3) Common interface

The interfaces for managing and controlling managed elements depend on the managed element types and the tools used to manage them. The common interface encapsulates these differences and must be pluggable so it can manage new elements.

4) Automation

Automates operations for setting up a server such as creating an Operating System (OS) environment, installing software, and setting a network environment (IP address, host name, VLAN ID, etc.).

5) Lifecycle management

Manages physical and logical configurations throughout a system's lifecycle. To dynamically reconstruct a server during system operation, the configurations must be managed throughout the system's lifecycle and not just in the installation phase.

6) Visualization

Displays the system configuration and status through a graphical user interface (GUI). This function helps system administrators to detect faults quickly and optimize the resource usage.

2.2 Architecture of blade server management

Figure 3 shows the architecture of blade server management for the provisioning implemented by Systemwalker Resource Coordinator. The architecture consists of the integrated management console, integrated manager, management framework, management components, configuration definition file, and configuration database. The management functions of the management components are described in the next section.

1) Management components

The management components control managed elements directly. Each management component manages a specific managed element in a specific operation phase using SNMP, telnet, and a proprietary protocol.

2) Management framework

The management framework virtualizes managed elements to manage and control blade servers. It stores configuration information collected by the management components and logical groups of the managed elements into the configuration database. It also provides a common interface to control managed elements via the management components. The interface provided by the management framework is described using XML (eXtensible Markup Language), because it makes it easy to extend the interface and compensates for differences when a new managed element type or a new management component is added. The management framework and management components can be installed on another computer, and they communicate using HTTP

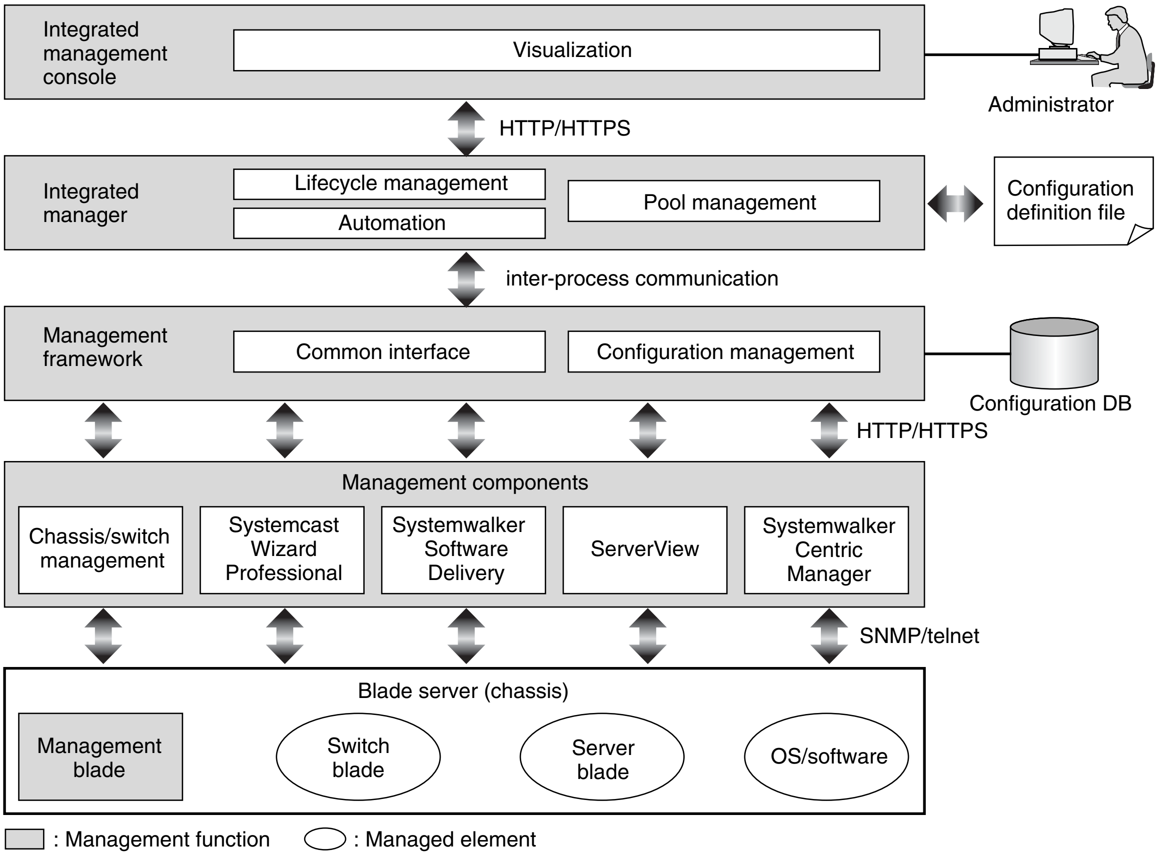


Figure 3
Blade server management architecture.

(HyperText Transfer Protocol) or HTTPS (HTTP over Secure Sockets Layer). Therefore, they can communicate securely through a firewall.

3) Integrated manager

The integrated manager automates provisioning tasks via the management framework. It decomposes a provisioning task into several instructions and controls the management components through the management framework interface. It controls the sequences of instructions, timing of operations, and error handling. Moreover, it correlates management tasks throughout the IT lifecycle, from installation to monitoring and maintenance. It also manages resource pools using logical groups stored by the management framework.

4) Integrated management console

The integrated management console displays the physical and logical configuration of the system on blade servers. An administrator can monitor and operate a system by using the GUI from a remote location throughout the system's lifecycle, from installation to monitoring and maintenance. Therefore, an administrator can detect faults and seamlessly reconstruct an environment on the server pool.

5) Configuration definition files

The configuration definition files describe the system configurations that the administrators intend to construct on the blade servers. The integrated manager can import these files and store them in the configuration database.

6) Configuration database

The configuration database stores the physical and logical configurations. It also stores relationship information to establish links between the management information of each management component.

2.3 Management components

The management components are implemented by the blade server hardware and the existing management software. **Table 1** shows the management functions required for provisioning on blade servers.

Systemwalker Resource Coordinator links and integrates the following management software as management components:

1) ServerView

ServerView is the server management software bundled with Fujitsu PRIMERGY servers.

2) SystemcastWizard Professional

SystemcastWizard Professional can install OS images remotely and clone them on other servers.

3) Systemwalker Software Delivery

Systemwalker Software Delivery offers distribution functions for software resources.

4) Systemwalker Centric Manager

Systemwalker Centric Manager offers monitoring functions for the OS and software in addition to the functions provided by Systemwalker Software Delivery.

Previously, administrators had to use the individual GUIs and commands of these components. But now, the integrated manager combines the complicated provisioning processes for these components into a single task.

2.4 Configuration management

The configuration management is a basic component of virtualization. Systemwalker Resource Coordinator manages blade servers using the resource model shown in **Table 2**.

Figure 4 shows the relationships among these groups and server blades.

Service A consists of two tiers: Web service A and the AP service. Each service is load-shared by using a load balancer. Web service A consists of three servers that have been created using system image Web image A. Web image A consists of two softwares: httpd and Servelt. Server08, which does not belong to any service, can be used as a pool server. For instance, when adding a server

Table 1
Management functions for provisioning on blade servers.

Phase	Managed element	Management function
Installation	Switch	VLAN setting
	Server	Boot
	OS	Cloning image and setting
	Software	Distribution and installation
Monitoring	Switch	Monitoring port status, faults, performance
	Server	Monitoring power status, faults, performance
	OS	Monitoring node status, faults, performance
	Software	Monitoring process status, faults, performance
Maintenance	Switch	Reset
	Server	Turning on/off
	OS	Applying patches and shutdown
	Software	Applying patches and start/stop

Table 2
Resource model.

Name	Meaning
Service	Group of server blades used for a series of jobs
Load sharing group	Group of server blades virtualized by a load balancer
System image	Group of software to be bound to the server blade
Software	Software function included in the system image

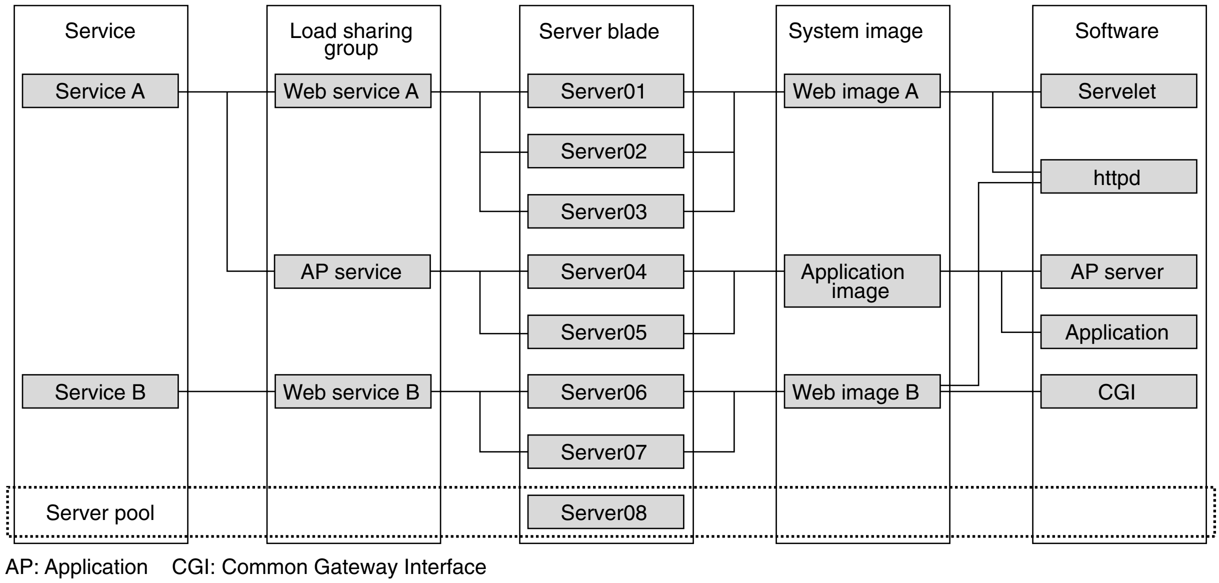


Figure 4
Relationships in resource model.

from the server pool to Web service A, Server08 is linked to Web image A and belongs to Web Service A. If a patch must be applied to software httpd, system images Web image A and Web image B must be updated; then, the load sharing groups Web service A and Web service B are affected by applying a patch.

Using this resource model, Systemwalker Resource Coordinator can correlate the configuration information managed by the management components; therefore, it can automate provisioning processes throughout the lifecycle. This resource model can be defined using the configuration definition files. Then, Systemwalker Resource Coordinator can import definition information that has been defined using another system design tool.

2.5 Pool management

To make a blade server system highly available and cost-effective, a server pool is needed. In Systemwalker Resource Coordinator, the following server pools can be used:

1) Bare-metal pools

Servers are not assigned system images and do not belong to any service.

2) Service-specific pools

Servers are not assigned system images but belong to a service. These servers are reserved for specific services.

3) Function-specific pools

Servers are assigned system images but do not belong to any service. These servers are set up in advance so they can be started quickly.

4) In service

Servers are assigned system images and belong to services. These servers work for specific services.

Figure 5 shows how server pools are managed.

The operations shown in Figure 5 do the following:

1) Put in

Arranges a server blade so it is used by a specific service.

2) Put out

Arranges a server blade so it can be used by any service.

3) Setup

Installs and sets up server blades and switches according to the logical definition.

Since Systemwalker Resource Coordinator

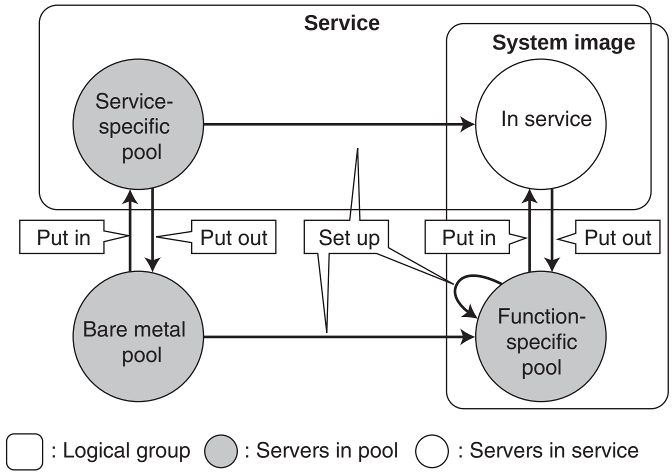


Figure 5
Pool management.

offers flexible pool management and simple operations, an administrator can quickly construct a server pool when a service degradation or stoppage occurs.

2.6 Usage example

This section describes how provisioning works in a scenario with Systemwalker Resource Coordinator.

[Scenario]

1) A hardware fault (e.g., a CPU error) has occurred on a server blade.
2) The administrators search for a suitable server from the server pool, then restore the server and network environments onto it from the bare-metal state.

Figure 6 shows how the management components work in the above scenario.

[Sequence]

1) ServerView detects a hardware fault on a server blade and reports it to the management framework.
2) The integrated manager and integrated management console report the warning to the administrator.
3) Using the integrated management console, the administrator isolates the server where the fault occurred and identifies which service and load sharing group the server belongs to.
4) The administrator selects a suitable server from the server pool. For instance, the administrator can easily select a server connected to the switch to which the failed server is connected. To help in this decision, the integrated management console displays the physical configuration of the blade server.
5) The administrator puts the server selected in 4) into the service group and load sharing group to which the failed server belonged.
6) The administrator assigns the system image registered in this service and sets up the added server blade using the integrated management console.
7) The integrated manager reports the addition of the server blade to the management components so it can be managed through the management framework.
8) The switch management agent is set to the VLAN ID defined for maintenance.
9) SystemcastWizard professional starts by using the PXE (Preboot eXecution Environment) and clones the master image defined in the system image. After cloning, SystemcastWizard professional sets an IP address and a host name.

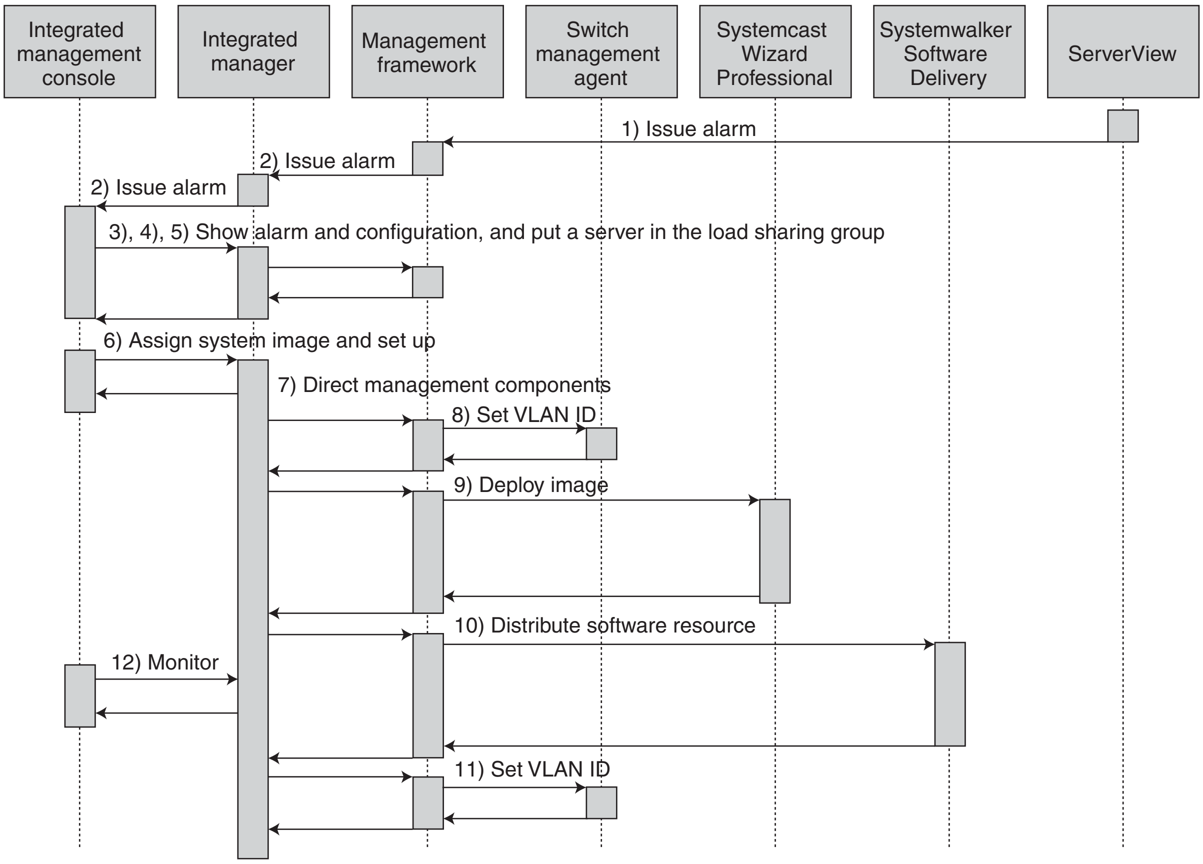


Figure 6
Sequence of usage example.

10) Systemwalker Software Delivery distributes the software resources defined in the software.
11) The switch management agent is set to the VLAN ID defined in the service for system operation.
12) The integrated manager monitors processes 8) to 11) and records the results in the log file.

2.7 Future developments

At present, an administrator must analyze the root cause and make decisions to take action before provisioning. However, if human intervention remains necessary, it is difficult to respond quickly to business demands, which change at dizzying speed. Moreover, it is difficult to take action in advance before a problem occurs.

In the future, systems themselves will perform analyses, make decisions autonomously based on business requirements, and reconstruct systems organically. The key technologies for achieving these functions are considered to be system composition and autonomic control.

1) System composition

Designs logical system layouts and generates suitable physical arrangements using resource management. Its goal is to design a system based on business requirements (e.g., reduced system cost) and a service level agreement (SLA) to provide, for example, a guaranteed maximum response time.

2) Autonomic control

Automates provisioning tasks when a problem occurs. It predicts the future service level from the viewpoint of business requirements (e.g., load increases in a specific period) and logs data of the past (e.g., the amount of resources used). If

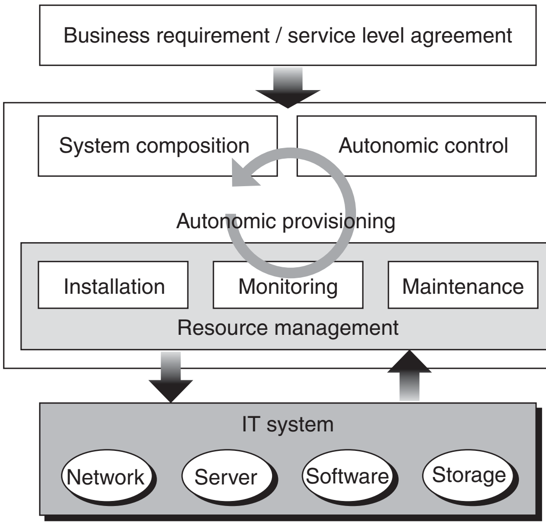


Figure 7
Autonomic provisioning.

it predicts an inability to satisfy the SLA, it automatically performs dynamic system reconstruction.

If the technologies and resource management described in this paper work together, autonomic provisioning can be realized. **Figure 7** shows the relationships among these components.

3. Conclusion

Blade servers can greatly improve the reliability of business systems. Provisioning realizes swift action and efficient resource utilization when faults and load increases occur.

In order to realize provisioning, resource management for configuration management, pool management, and automation is indispensable. Systemwalker Resource Coordinator offers provisioning solutions on blade servers. In the future, provisioning solutions will have extended support ranges and these new solutions will form the basis of autonomic provisioning.

Akira Tsuneya received the B.E. degree in Physics from Kyushu University, Fukuoka, Japan in 1988. He joined Fujitsu Ltd., Kawasaki, Japan in 1988, where he has been engaged in development of enterprise management software.