Resource Management

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IT systems have expanded along with the development and diffusion of Web-based systems. The demand for IT-based business solutions has increased throughout the business world. To meet the increasing customer demand and the need to cut operating expenses, Fujitsu Systemwalker Resource Coordinator (hereafter Resource Coordinator) offers a comprehensive software solution designed to help companies increase their productivity and efficiently manage resources such as servers, storage, networks, and software products in an entire platform. Also, Resource Coordinator supports stable, reliable operation and reduces the load on system administrators when they determine the causes and possible solutions to problems. Furthermore, Resource Coordinator provides system-wide autonomous control systems and an automatic recovery function and ensures reduced Total Cost of Ownership (TCO). This paper outlines the Resource Coordinator development policy, a broad array of advanced technologies, and our efforts to provide our customers with systems based on TRIOLE, Fujitsu's IT infrastructure platform concept.

1. Introduction

The number and scale of IT-based systems is increasing, and they are becoming more and more common in everyday life. For example, the following IT-based services are globally prevalent:

1) Automated Teller Machine (ATM) services of banks and convenience stores
2) Online tracking systems for home delivery services
3) Mail access and Internet connection services for cellular phones.

These important IT systems must provide around-the-clock services. If ongoing operations are disrupted for prolonged periods due to breakdowns, failures, errors, or malfunctions, business opportunities will be missed and serious social problems may even occur. As IT systems have grown in size, system configurations have become more complicated, resulting in an increased burden on system administrators. In fact, system configurations have become so complicated that system management is almost reaching the limits of human resources. For example, when a disk drive failure occurs, system administrators often cannot detect which application is affected. In the worst-case scenario, such a failure might make it necessary to stop the entire system for an extended period for troubleshooting. A crucial issue, therefore, is how to ensure the continuous availability of services. Also, the amount of downtime scheduled for system maintenance and upgrading should be minimized. In today's global information society, 24-hour operation is not only more common, but also more critical.

2. Fujitsu's development concept

2.1 Autonomous control systems

Fujitsu has developed and assisted in the development of specialized fault-tolerant systems based on the TRIOLE[1] core technology elements of autonomy, virtualization, and integration. This Fujitsu IT infrastructure enables system-wide application development and offers more reliable system operation and low overall Total Cost of Ownership (TCO) when considering installation, operation, downtime, and maintenance. These benefits are realized through the following features of our autonomous control systems:[2]

1) Configuration and reconfiguration of a system during installation, expansion, and changes to the resource configuration.
2) Failure prediction and quick recovery
3) Load balancing and prediction of performance degradation
4) Protection against illegal access

Using these systems, enterprises can maximize their use of IT resources, maintain service availability, and protect businesses from risks by managing system redundancy.

2.2 Systemwalker Resource Coordinator

To provide an autonomous control system, we must secure high reliability throughout a system's complete life cycle, from installation to maintenance and troubleshooting. For this purpose, Systemwalker Resource Coordinator (hereafter Resource Coordinator) for resource management and Systemwalker Service Quality Coordinator[3] for service management ensure not only high reliability and scalability, but also system optimization.

The following features are the foundations of the Resource Coordinator integrated management solutions and ensure simple management tasks throughout a system's life cycle, for example, installation and configuration in the building phase, patch application in the maintenance phase, and early failure detection in the troubleshooting phase:

1) Operation time is reduced and faulty operation is prevented during resource configuration changes.
2) When a failure occurs, the range of its effects and the cause of the problem can be determined.
3) Automatic system recovery is enabled in the event of a failure.
4) The workload on system administrators is reduced.
5) The scheduled downtime for system maintenance and upgrading is minimized

The Windows versions of Resource Coordinator[4] enable integrated management of blade servers. Versions for the Solaris Operating Environment (hereafter Solaris OE) enable integrated management of Solaris servers.

We will now discuss the Resource Coordinator features for Solaris OE.

3. Management design

3.1 Management image

Figure 1 shows how the servers and storage system are configured. For the server farm where the agent software of Resource Coordinator is installed, the management server centrally manages multiple nodes so system administrators can check the system configuration on the management client connected to the management server.

3.2 Management server

A management server is used to centrally manage multiple nodes. The manager software of Resource Coordinator should be installed on the management server.

3.3 Managed server nodes

Server nodes are managed by the management server. They notify the management server of the node states.

The agent software on the managed server nodes detects system failures, collects resource information about, for example, the logical resource configuration and storage system
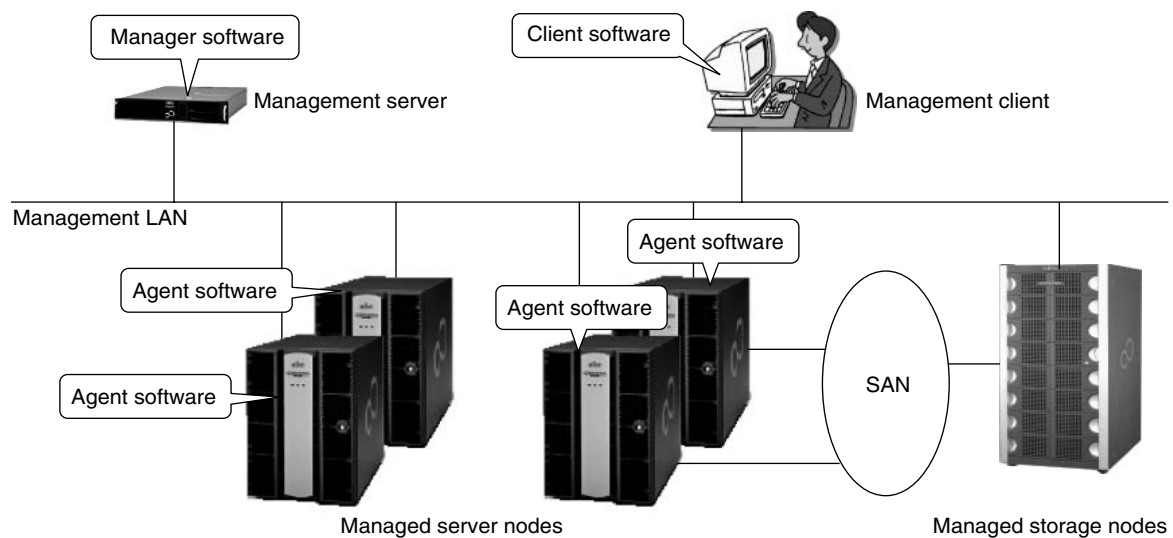
Figure 1
Management configuration with Systemwalker Resource Coordinator.

resources, and then reports the information to the management server.

3.4 Management client

A management client is connected to the management server to show the configuration and state of each managed node on the GUI display. It also manages the OS console of each managed node. The client software of Resource Coordinator should be installed on the management client.

3.5 Systemwalker Centric Manager

As shown in **Figure 2**, Resource Coordinator can provide lifecycle management of IT resources by coordinating with Systemwalker Centric Manager. This coordination enables system administrators to monitor the entire system and detect failures on the server farm resource management screen.

4. Feature description
4.1 Visualization of component failures and range of their effects

Normally, a system consists of multiple servers and storages. If system administrators monitor the entire system using multiple prod-ucts, each of which has its own type of management software, it will take them a long time to investigate problems, resulting in operational mistakes.

Resource Coordinator is seamlessly combined with server and storage management software. It notifies system administrators of failure events. The system administrators then call the hardware management functions of Resource Coordinator so they can determine the applications and components that the failures will affect and take effective corrective action for the failures.

As shown in **Figure 3**, Resource Coordinator closely coordinates with the server resource manager and the storage resource manager to monitor system failures and the configuration information of all managed resources. It also cooperates with the cluster manager to display the cluster service configuration and the cluster service status on the Resource Coordinator management screen and show the resources in which cluster service failures occur on the cluster manager screen.

Also, the combination of Resource Coordinator and Systemwalker Centric Manager enables quick detection of faults throughout the entire system.
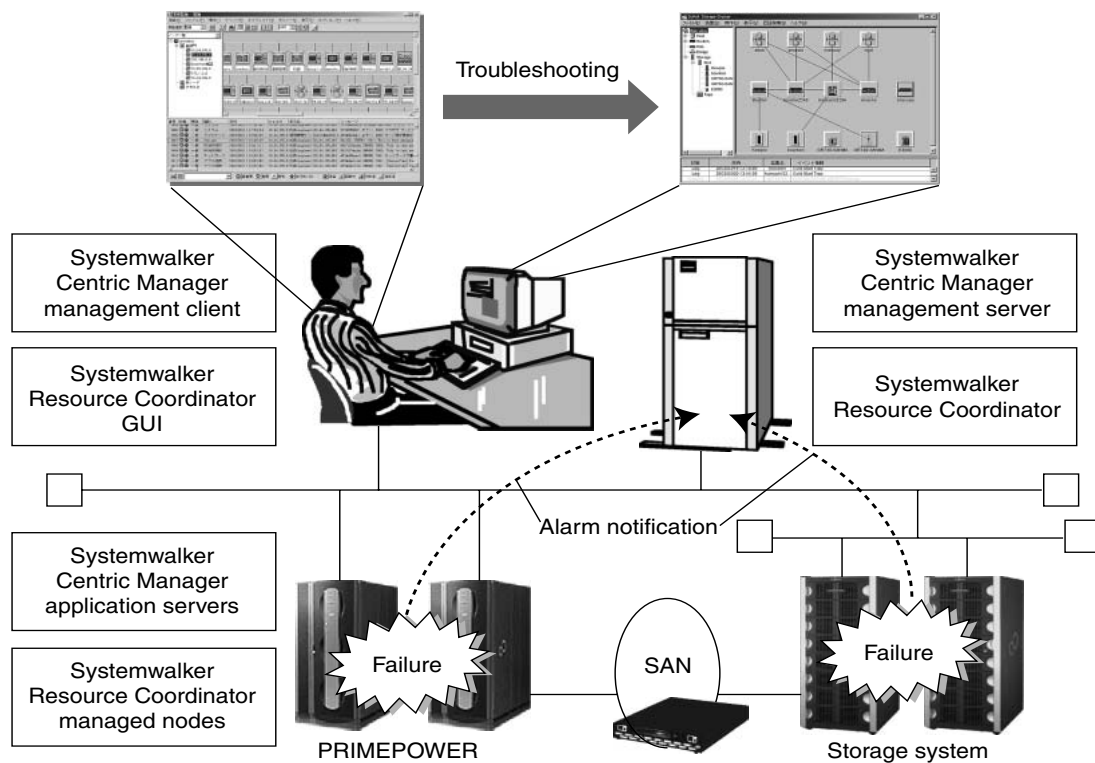
Figure 2
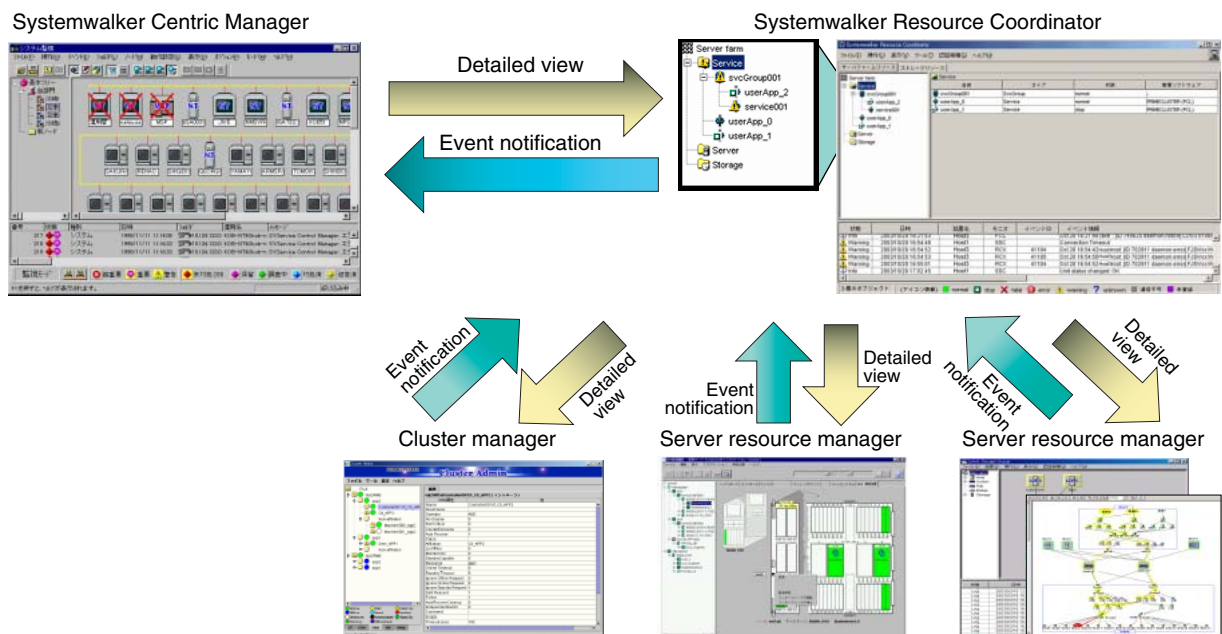Coordination with Systemwalker Centric Manager.

Figure 3
Visualization of component failures and range of their effects.

4.2 Early cause detection

Resource Coordinator monitors the entire system, which consists of service layers such as application servers and database servers, and performs integrated management of the system state and configuration. When Resource Coordinator detects a failure, it checks the system configuration information to identify the cause and the services affected by the failure. System administrators can identify the cause of a failure by monitoring the cluster service, server, and storage states displayed on the Resource Coordinator management screen.

For example, Resource Coordinator cooperates with the PRIMEPOWER (a Fujitsu UNIX server) server manager to detect the cause of a failure using a logical tree, physical tree, and rack view (**Figure 4**).

The functions and throughputs of storage system hardware and related software have been enhanced, creating a need for technologies that can manage storage resources. As shown in **Figure 5**, even in a large-scale storage system environment, Resource Coordinator can quickly detect a storage resource failure by monitoring the storage resources and resource configuration and

then determine the extent of its effects by precisely managing the relationships between the full range of components, from disk drives to databases.

When a network failure causes an application error or slowdown, the cause of the problem is hard to detect because the failure does not appear on the server log. As shown in **Figure 6**, the possible causes can be narrowed down by detecting abnormal behavior and transmission retries in the network and by checking response delays on each server node.

4.3 Efficient construction and server deployment

When system administrators deploy servers as they install and configure OSs and applications, it normally takes a couple of days to construct a system.

Resource Coordinator simplifies installation and configuration of OSs, drivers, and middleware. By installing Unified Installer on the management server, those products can be installed on multiple application servers simultaneously from an installation server.

This results in less work, quicker work completion, and the elimination of operational
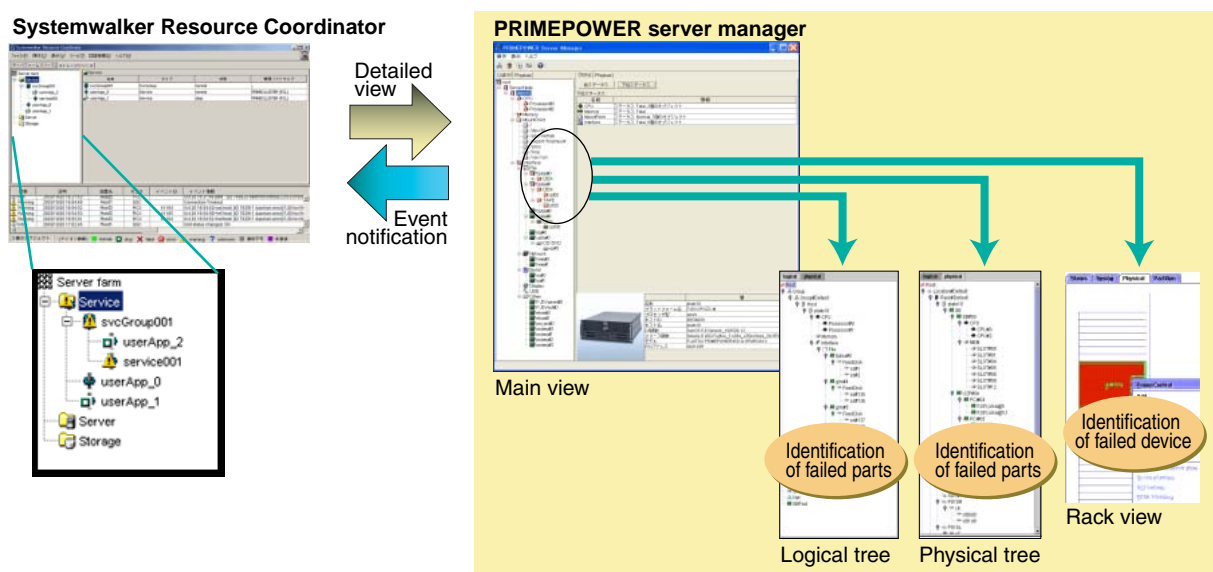

Figure 4
Early detection of server failures.

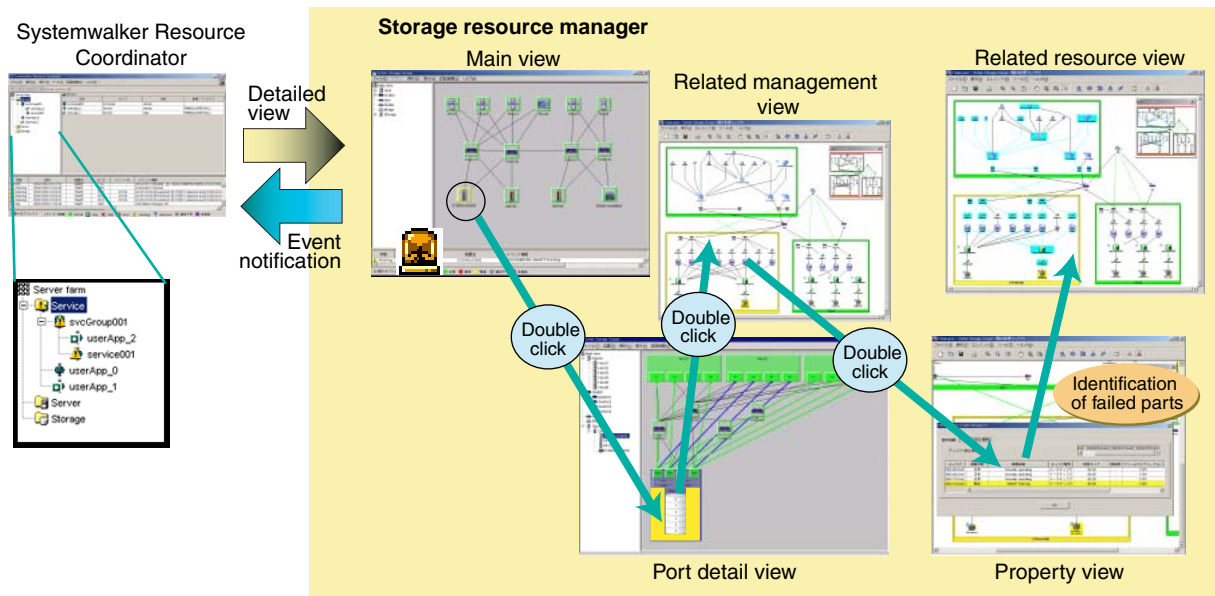FUJITSU Sci. Tech. J., **40**,1,(June 2004)

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Figure 5
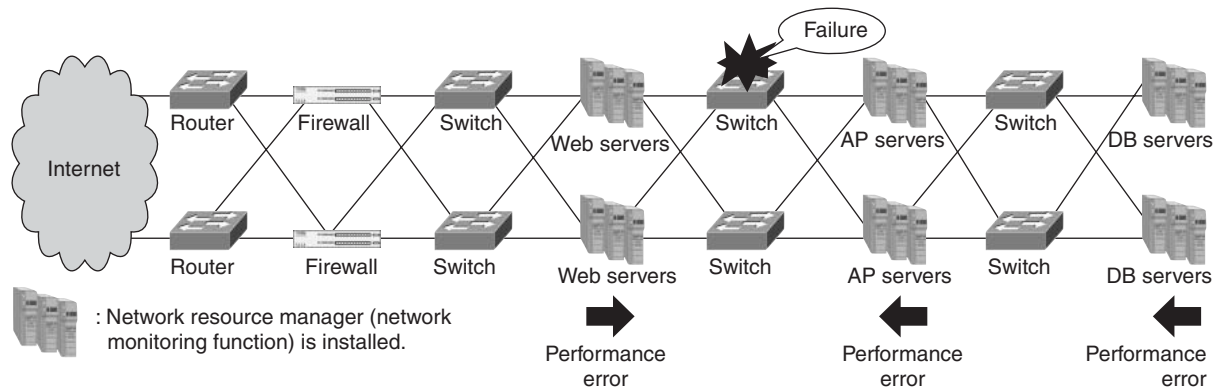Early detection of storage failures.

Figure 6
How to narrow down possible network failures.

mistakes. Unified Installer also supports simple and easy installation on a cluster system with multiple nodes (**Figure 7**).

The features of Unified Installer are as follows:

1) Hardware verification

A temporary OS is booted by a network boot. Then, internal disk drivers and Redundant Arrays of Independent (Inexpensive) Disks (RAID) devices are checked with the temporary OS and configuration files are set.

2) Integrated installation on multiple servers

An OS and software can be automatically installed on multiple application servers simultaneously from an installation server. System administrators only need to specify the products and parameters, and then installation is done automatically.

3) Integrated configuration

After software installation, a system environment is automatically configured based on an environment that has been preconfigured with a script.

4) Flash archive coordination

The configured server environment can be backed up in a file. Then, the disk image is ar-
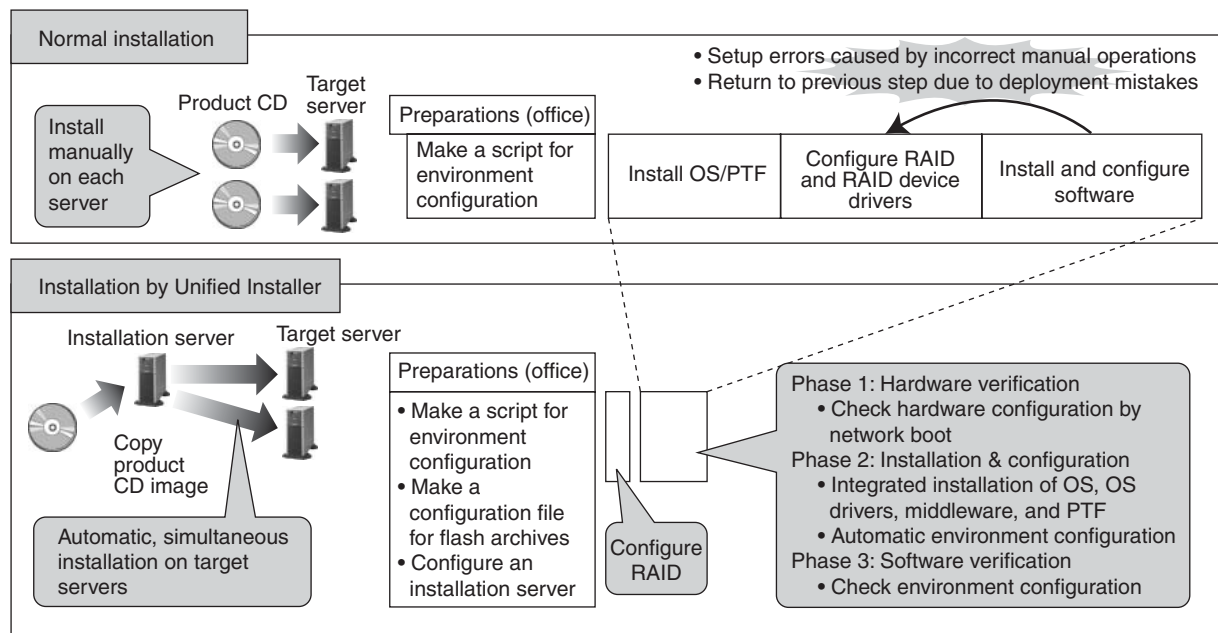
Figure 7
Efficient server installation and configuration.

chived and transmitted to managed servers in Solaris 9 OE.

5) Verification of software installation and environment configuration

System administrators can easily verify whether the server environment is correctly configured by checking the installation logs created by Resource Coordinator.

4.4 Maintenance

Resource Coordinator is also used for system maintenance tasks such as patch application and disk configuration.

1) Efficient patch application

Recently, more and more security patches are being applied to combat the increasing number of computer viruses.

Resource Coordinator supports maintenance tasks such as configuration changes of the system volumes and patch application on snapshot volumes (proxy volumes). These tasks are completed after the system is rebooted from snapshot disks. The system is down only during reboot (**Figure 8**).

When combined with Fujitsu's volume manager software, PRIMECLUSTER GDS (Global Disk Services), Resource Coordinator ensures that system disks are highly available by mirroring them. Furthermore, it supports online backup using PRIMECLUSTER GDS Snapshot.

2) Virtual volume function

When the disk volume layout is changed for I/O performance tuning or during a shift to a redundant configuration, business applications normally need to be stopped during data backup and restoration. Also, the settings of middleware and applications that recognize the disk names need to be changed.

As shown in **Figure 9**, Resource Coordinator supports simplified management of disk devices using the virtual volume function, regardless of the physical configuration of the disk devices.

This function creates virtual disks. System administrators can assign arbitrary names to the virtual disks. Even if the physical disk configuration is changed, the virtual disk names remain the same, so applications are not affected by such a change.
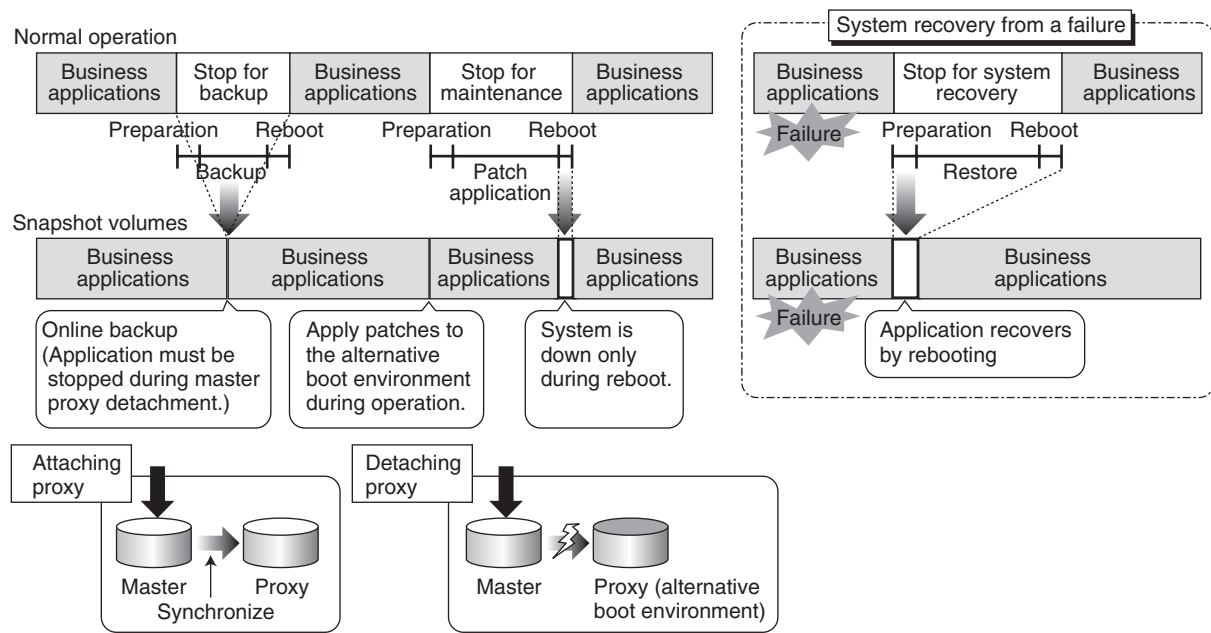
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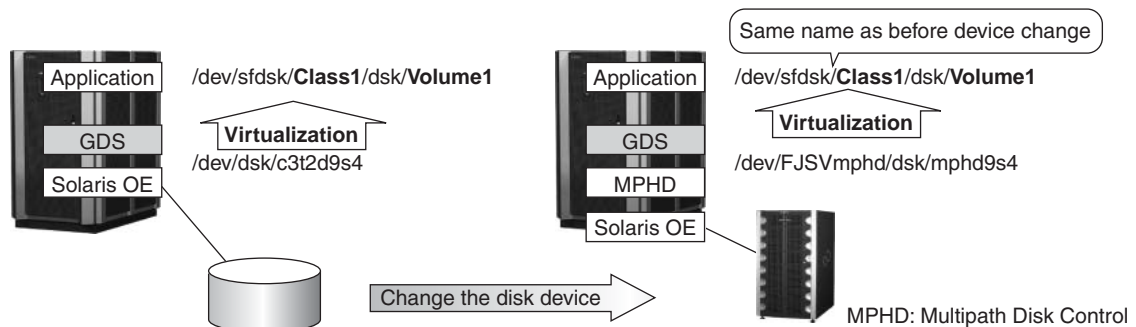
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Figure 8
Efficient patch application.

Figure 9
Virtual volume function.

4.5 Quick recovery

Fujitsu offers highly reliable, online backup and automated recovery services that ensure fast and accurate restoration so system administrators can reduce waste and downtime and also improve productivity.

1)   Online backup of system volumes

When system administrators back up data and system volumes, ongoing operations have to be stopped. However, when PRIMECLUSTER GDS Snapshot is used, systems remain highly available. Its online data backup and quick restore functions significantly reduce the time required to replicate and back up data so it stays consistent. The system downtime for backup can be minimized by rebooting the system from backup disks.

2)   Automatic recovery

For systems with storages and multiple servers such as application servers and database servers, a local problem can affect the whole system. For example, when a DB server in a cluster configuration fails, the DB server is failed-over by the cluster function. However, the AP server does not detect the DB server failover until the connection timeout. This may slow down busi-

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ness application performance and cause errors.

As shown in **Figure 10**, Resource Coordinator can report a failover from a DB server to an AP server using the event delivery function between service layers. The applications are quickly restarted when the AP server detects the DB server failover using the event delivery function.

3) Integrated management of OS consoles

Resource Coordinator enables integrated management of the OS consoles of multiple server nodes by displaying data, for example, various

types of messages, on the OS console. System administrators can perform software maintenance tasks such as installations, patch applications, and system reboots and resets. As shown in **Figure 11**, the OS consoles of multiple server nodes can be displayed on a management client. System administrators can execute a command simultaneously for these server nodes.

5. Conclusion
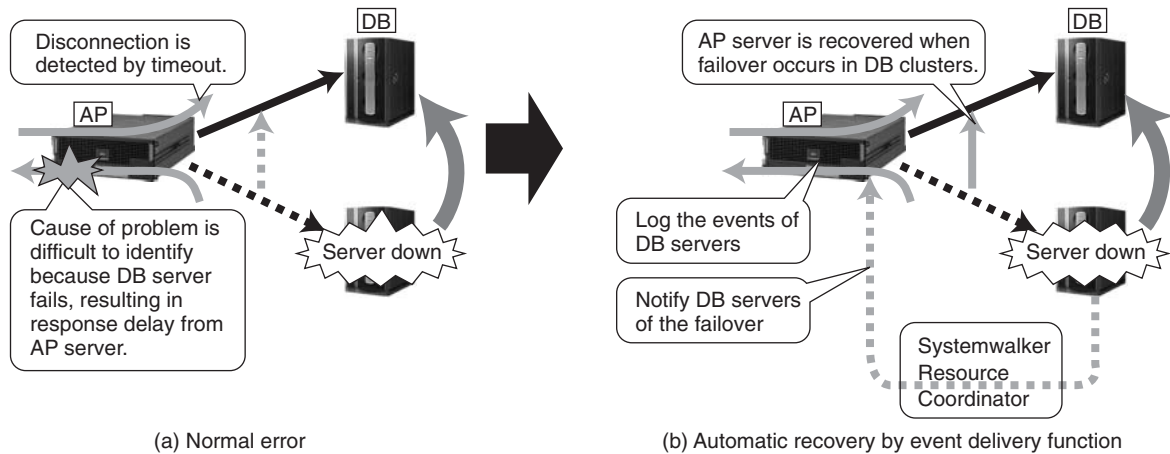
Resource Coordinator is a comprehensive IT

Figure 10
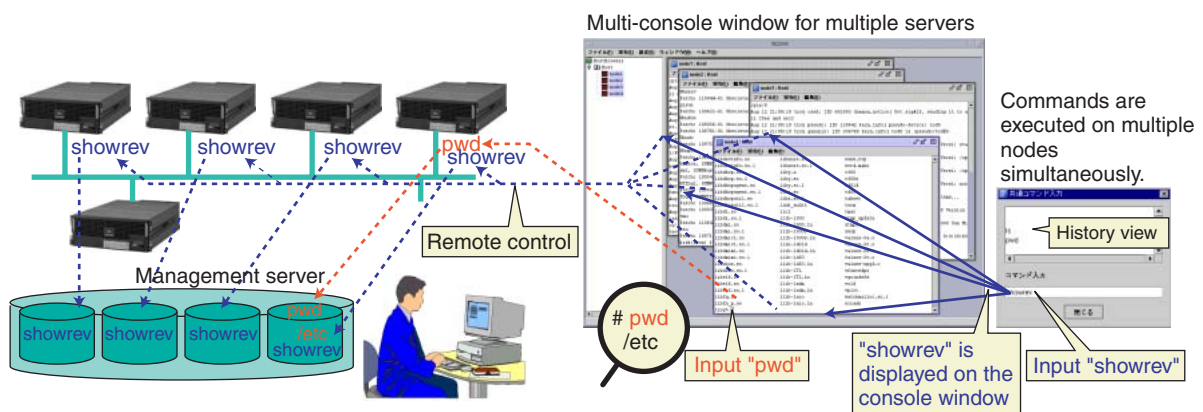Automatic recovery by event delivery function between AP and DB servers.

Figure 11
Server operation from a management client.

system management software uniquely designed as a comprehensive solution based on the core TRIOLE technology elements of autonomy, virtualization, and integration. Resource Coordinator provides a range of solutions that can be tailored to meet individual customer requirements for enhanced productivity, scalability, reliability, high availability, and cost reduction. The technology for the autonomous control systems Fujitsu is developing helps customers make the most effective use of system resources such as servers, storage devices, and networks and ensures flexible configurations, quick recovery, and optimization. In short, it ensures efficient use of resources in accordance with the intended purpose.

Fujitsu is dedicated to developing the funda-

mental technologies needed to build Grid systems. Our goal is to make Resource Coordinator the infrastructure for Grid systems so that servers and storages can fully use the computing capabilities of the infrastructure and resource management can be integrated.

References

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