Logical Partitioning Feature of CB Series Xeon Servers Suitable for Robust and Reliable Cloud

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OVERVIEW: LPAR is Hitachi's own server virtualization feature for Hitachi Compute Blade servers. LPAR stands for logical partitioning used by mission-critical systems such as mainframes and offers excellent performance, including reliability, stability, and maintaining virtual server separation. The implementation of logical partitioning on Xeon[*1] *servers significantly expands the scope for applying virtualization in private clouds because it means that virtualization of mission-critical systems can be used even on Xeon servers. Hitachi is currently developing new solutions that improve ease-of-operation and simplify installation, and the number of sites using LPAR for cloud is increasing. LPAR is already a proven virtualization feature and Hitachi intends to continue with development to make further improvements in performance and reliability.*

INTRODUCTION

HITACHI aims to create new value through its next generation of IT (information technology) platforms and virtualization is a key technology for implementing the infrastructure clouds that will support this endeavor. Within this, Hitachi Compute Blade (CB) logical partitioning feature (LPAR) provides a server virtualization feature critical to data processing.

This article describes the characteristics of the LPAR, a server virtualization feature that enhances the virtualization environment for CB servers, along with examples of its use.

HITACHI COMPUTE BLADE LPAR FEATURES

Support for Logical Partitioning on Xeon Servers

LPAR is a server virtualization feature used for logical partitioning on mainframes and commercial UNIX[*2] servers. An advantage of logical partitioning is that, compared to the VM (virtual machine) method, it is easier to configure systems with higher reliability and performance. However, very few virtualization products support the use of logical partitioning on Xeon processors and other Xeon servers (see Table 1).

Virtualization based on logical partitioning has been widely used for mission-critical applications in the past and, unlike virtualization software from other vendors, Hitachi's LPAR feature also extends this capability to Xeon servers. Advanced hardware support is required to implement logical partitioning and therefore it is very helpful that Hitachi is also a server vendor. LPAR can be used on the CB2000 and CB320 servers in the CB series.

Resource Sharing for Cloud

Under logical partitioning control, abstraction of hardware resources such as CPUs (central processing

TABLE 1. Characteristics of Server Virtualization Features (Software) from Different Vendors
Logical partitioning is already used for mission-critical applications on mainframes, commercial UNIX servers, and other similar computer systems. Hitachi Compute Blade LPAR is a distinctive virtualization method that allows logical partitioning to be used for mission-critical applications on Xeon servers.

Category	Xeon servers			Commercial UNIX servers		Mainframe
Vendor	Hitachi (LPAR)	Vendor A	Vendor B	Vendor C	Vendor D	Hitachi
Guest OS	Windows[*1], Linux[*2]	Windows, Linux	Windows, Linux	Vendor C UNIX, Linux	Vendor D UNIX	VOS3
Type	LPAR	VM	VM	LPAR	LPAR	LPAR
Vendor type	Server vendor	Software vendor	Software vendor	Server vendor	Server vendor	Server vendor

OS: operating system LPAR: logical partitioning VOS3: Virtual-storage Operating System 3 VM: virtual machine
*1 Windows is a registered trademark of Microsoft Corporation in the United States and other countries.
*2 Linux is the registered trademark of Linus Torvalds in the U.S. and other countries.

*1 Xeon is a trademark of Intel Corporation in the U.S. and/or other countries.

*2 UNIX is a registered trademark of The Open Group.

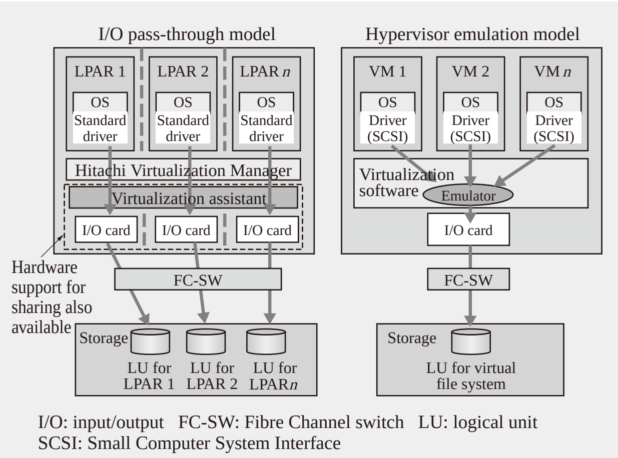

Fig. 1—I/O Architecture for Logical Partitioning and VM Methods.
Because logical partitioning uses a pass-through model, which allows the guest OS to access I/O cards directly, the OS can make full use of hardware functions. VM, on the other hand, has excellent configuration flexibility because it uses an emulator to deal with hardware differences.

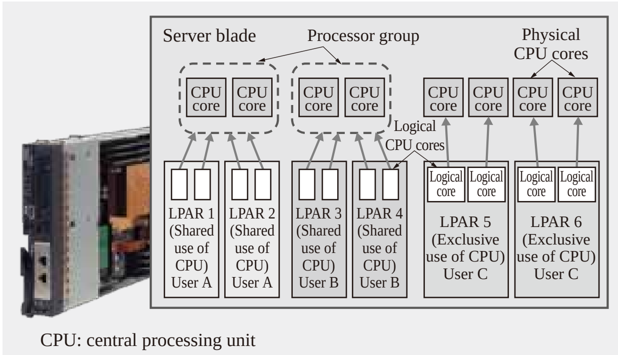

Fig. 2—Processor Group Feature for Preventing Users from Impacting Each Other.
In addition to using exclusive mode to keep users discrete (user C), the LPAR feature can also configure the use of processor groups for flexible sharing within a user's own department while maintaining discreteness from other departments (users A and B share two cores, which are split between them).

units), memory, and I/O (input/output) is kept to a minimum so that the guest OS (operating system) can have full control of hardware operation. This gives access to the advanced functions of external hardware.

In terms of their I/O control architectures, logical partitioning uses an I/O pass-through model, whereas VM uses a hypervisor emulation model (see Fig. 1).

The former is suitable for cloud applications because it not only allows the guest OS to have access to hardware functions such as Hitachi's ShadowImage function for copying supplementary volumes on storage devices, it also assumes a multi-tenant environment, making the logical partitions more independent and reducing interference between them.

LPAR FUNCTIONS FOR RELIABLE OPERATION

Preventing Impact on Systems Belonging to Other Companies or Departments

Because cloud-based systems share particular hardware resources between different companies or departments, there is a risk that one of the virtual servers may use a large proportion of a hardware resource due, for example, to an application program bug or unanticipated surge in system workload, and that this will impact the other virtual servers.

LPAR is equipped with a dedicated CPU feature, provides flexible resource allocation within a user's own department, and supports a processor group feature that allows systems to be configured in such a way that different departments cannot affect one another (see Fig. 2).

Use of Cloud for Heavily Loaded Systems

To allow for the case in which a mission-critical system with a heavy workload is migrated from a commercial UNIX machine to a Xeon server, a dedicated I/O structure was provided in which high-throughput I/O processing is entirely separated into different logical partitions. Doing so allows even mission-critical systems that handle heavily loaded to be migrated to the cloud.

Many past projects involving Xeon server integration dealt with systems with comparatively light workloads, which meant sharing I/O cards caused few performance bottlenecks. However, as some mission-critical systems have a heavy I/O load, a dedicated I/O function that allows I/O cards to use particular logical partitions exclusively was provided.

Non-stop Operation through Hardware Failures

An issue when using server virtualization is that, if a server hardware failure occurs, all of the virtual servers on that machine halt and the resulting service disruption has a major impact.

Because the LPAR feature is implemented in the firmware level, it has superb hardware control and can be used to implement cloud platforms with a high level of fault tolerance. On the high-performance CB2000 server blades, in particular, the operation can be controlled such that, when a hardware failure occurs that only impacts specific logical partitions,

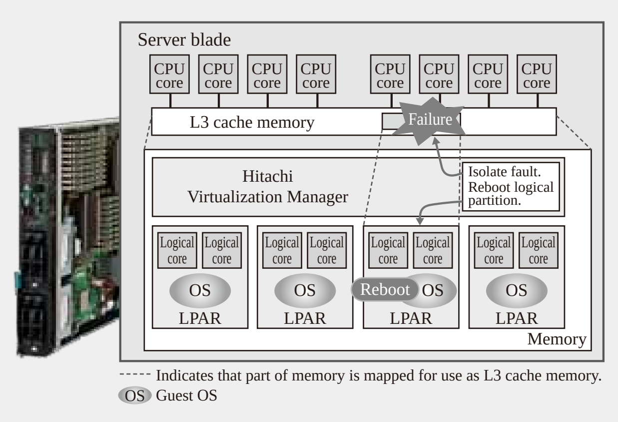

Fig. 3—High Level of Fault Tolerance Allowing Operation to Continue as much as Possible after Hardware Failure.
When a cache memory failure occurs, only the logical partitions that were using that cache memory are halted. The other logical partitions continue to run. The halted logical partitions are rebooted, fallback of the failed cache memory is performed, and operation resumes.

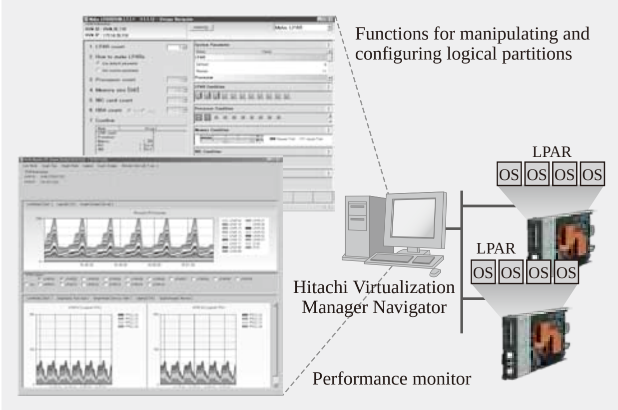

Fig. 4—Administration of Virtualization Environment Using Hitachi Virtualization Manager Navigator.
The LPAR feature is used to administer the virtualization environment. It includes a performance monitor and functions for manipulating and configuring logical partitions.

fallback of only those logical partitions are performed so that other logical partitions can continue to run (see Fig. 3). LPAR also includes a fault early warning or processor core swapping function that can avoid making a failure persistent by detecting advance indications of potential faults.

LPAR ADMINISTRATION

Administering LPAR across Entire Data Center

In addition to LPAR, a private cloud may also incorporate other systems configured on physical server(s) or VM-based virtualization software. Server management software is available for centralized administration of servers in data centers that contain a diverse mix of such systems.

Logical partitions can be managed in the same way as physical servers, and even if there is a mix of physical and virtual, a failed server blade can be switched to a spare using the N+1 cold standby feature supported by server management software. The system disk backup and restore functions are also supported for logical partitions defined by LPAR, just as if they were physical servers.

Administering LPAR System Environments

If a problem specific to the LPAR environment is found on a system managed by server management software, the Hitachi Virtualization Manager Navigator utility for obtaining detailed information on LPAR can be used to evaluate the situation and start work on resolving the problem. Hitachi Virtualization Manager Navigator is installed in and run from an administration PC (personal computer) and includes a performance monitor and configuration viewer, as well as logical partition migration and logical partition operation and setup functions (see Fig. 4).

The performance monitor displays parameters such as logical CPU utilization or NIC (network interface card) performance for each logical partition and for the entire blade. This data is recorded on an administration server where it is available for analysis, and it can also be used to produce reports on cloud operation, including converting the data to CSV (comma separated value) format, and classifying or totaling it as required for a particular site.

The configuration viewer collects and displays LPAR configuration information for each blade. Because manual administration carries a risk of error, a machine-based data collection function provides accurate and efficient configuration management for the cloud.

Power Saving Operation and Balancing of Performance and Workload

Over time, the workload on a system can vary widely (increase or decrease) from what was estimated in the initial design and it becomes apparent that the workload on some systems is only high at specific times of the year, such as once each quarter. At such times, the administrators may decide they want to reduce power consumption by consolidating all of the logical partitions with a low workload on a specific server blade so that the power to the freed-up blades can be turned off. Alternatively, they may want to free

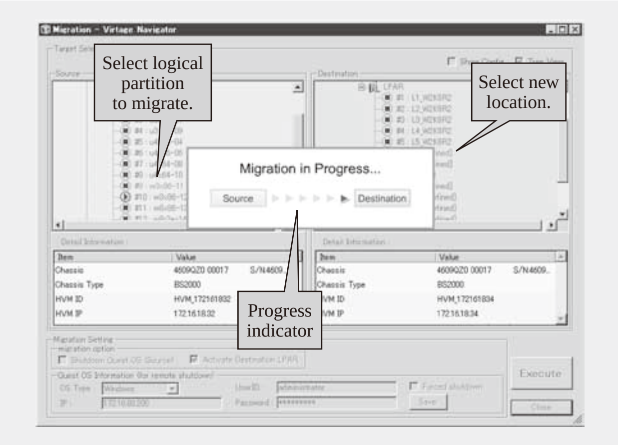

Fig. 5—Using Hitachi Virtualization Manager Navigator to Migrate a Logical Partition.
Select the logical partition to migrate from the pane on the left, select an unused logical partition number in the pane on the right, and then click the Execute button.

up server blades to allow periodic maintenance. In either case, making it easy to shift logical partitions to different blades improves operational efficiency.

LPAR provides a function for migrating (shifting) logical partitions that involves rebooting the guest OS (see Fig. 5).

The ability for the guest OS to access the hardware directly is a feature of LPAR and logical partitions can be migrated to a different server blade in a way that retains this capacity. One way that this capability might be used for cloud operation would be to shift logical partitions around each month to make time for scheduled shutdowns.

Configuring Backup Operation

While special precautions are required when performing a disk backup on a VM system, logical partitioning allows the backup of the guest OS in a virtual environment to be done in the same way as for a physical server. In particular, when using FC (Fibre Channel) to back up a shared storage device without going via the LAN (local area network) (a “LAN-free backup”), the logical partitions are treated as physical servers and the system is configured in the same way as in a non-virtualization environment. This makes the configuration design easier than when using VM.

Also, the backup server itself is a prime target for virtualization because it is used when the workload on the system being backed up is light. However, backup software vendors typically dislike configurations in which the input and output to the backup device is virtualized, and many do not support VM-based virtualization of the backup server. On the other hand, because the I/O operation under LPAR is the same as for a physical server, a number of vendors support logical-partitioning-based virtualization of the backup server. In other words, LPAR makes it possible to configure a backup server efficiently without having to allocate an extra physical server to this role.

CASE STUDIES

LPAR has already been installed at a large number of sites, particularly for systems that require a high degree of stability. The following case studies highlight sites that use the cloud concept.

(1) Marubeni Corporation

This project used the LPAR feature to configure a private cloud within the company, which was used to consolidate various departmental systems. The project’s successes included significant savings on server maintenance costs, installation footprint, and power consumption[(1)].

(2) Kitakyushu City

A local government cloud system was configured using the LPAR feature and various business applications were consolidated onto the virtualized system platform[(2)]. In addition to cutting costs by reducing use of physical resources, operational efficiency was also improved by designing an optimum server environment based on the actual application workload pattern.

CONCLUSIONS

This article has described the characteristics of LPAR, a server virtualization feature that enhances the virtualization environment for CB servers, along with examples of its use.

The LPAR feature is a distinctive virtualization product in the Xeon server sector and uses logical partitioning to implement virtualization, a technique that provides stable performance, reliability, and a high level of server independence. These characteristics are needed for robust and highly reliable cloud computing. LPAR also provides the operational functions required for cloud administration.

For the future, in terms of factors such as performance and reliability, Hitachi intends to maintain the use of hardware-based logical partitioning for virtualization while working on the development of functions, such as those that help minimize the frequency of service outages experienced by end users, and functions for ease of operation that are useful on VM systems.

REFERENCES

(1) "Special Report: Making Rigorous Use of IT Resources—Creation of Private Cloud by Marubeni Corporation (a Trading Company)," Hitachi Hyoron **92**, pp. 640–644 (Sep. 2010) in Japanese.
(2) Solutions for Local Government, "Case Study: Kitakyushu City, Fukuoka Prefecture, Turnkey Provision of Next-generation System Platform Using Highly Reliable Virtualization Technology as a Precursor to a Local Government Cloud," http://www.hitachi.co.jp/Div/jkk/jichitai/casestudy/kitakyushu/ in Japanese.
(3) H. Fujii et al., "Platform Technologies for Enterprise Information Systems Utilizing Cloud Computing," Hitachi Hyoron **91**, pp. 586–591 (Jul. 2009) in Japanese.
(4) H. Ueno et al., "'Virtage' for 'BladeSymphony,' a Server Virtualization Feature which Improves Server Management Efficiency," Hitachi Hyoron **89**, pp. 562–567 (Jul. 2007) in Japanese.
(5) H. Ueno, "Use of Hitachi's Virtage for Server Virtualization," 2011 Virtualization Compendium, pp. 168–178, Nikkei Business Publications, Inc. (Oct. 2010) in Japanese.
(6) H. Ueno et al., "Virtage: Hitachi's Virtualization Technology," Proceedings of GPC'09, IEEE-CS (May 2009).
(7) Virtage, BladeSymphony Integrated Service Platform, http://www.hitachi.co.jp/virtage in Japanese.

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