Fujitsu’s PRIMERGY BX620 S4 Blade Server for Solving Server Consolidation Problems

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Based on a technical analysis of about 9000 business talks given by Fujitsu for customers, we found that amid the ongoing IT system optimization at enterprises, blade servers had become an increasingly important IT platform for optimizing infrastructure. We also discovered that about 80% of our customers had introduced blade servers in order to consolidate their own servers. The customers expect this consolidation of servers to provide management with a global understanding of their IT systems, reduce the heavy workload that server operation imposes on user departments, and curtail IT investment costs in information system departments. However, server consolidation also entails such problems as a more complex network design and increased workload on an information system department. Fujitsu fully understood these server consolidation problems based on extensive consultations on optimizing infrastructure conducted in the past. To solve these problems, Fujitsu developed and marketed the PRIMERGY BX620 S4 blade server. The PRIMERGY BX620 S4 offers superior IT system flexibility by expanding network functions, simplifies operation and management by utilizing virtualization technology, and also reduces power consumption. This paper describes the technologies that provide these advantages.

1. Introduction

Amid the ongoing IT system optimization at enterprises, the market for blade servers has significantly expanded. Given the need to consolidate servers in various enterprise departments, coupled with advances made in server virtualization technology, Fujitsu systematized TRIOLE BladeServer technology to provide the most advanced IT systems for customers, and has continued making combined hardware/software technical innovations, mainly based on technological advances in automatization, visualization, and server virtualization. These technologies are also expected to reduce IT maintenance costs in information system departments, enhance security among the various departments, and concentrate IT visualization and resources in original services (all of which are advantageous for management and service departments). Fujitsu’s application results suggest that consolidating 50 existing servers into 20 blade servers that adopt server virtualization technology could reduce the total cost of ownership (TCO) to about 55%.

Such server consolidation, however, entails the following three new problems:

1) Complicated network design

In a conventional blade server system, each server actually supports four ports as Gigabit Ethernet ports. Conversely, the new system employs a redundant LAN configuration where one LAN is shared by multiple services and thus necessitates a very complicated design using a tag virtual LAN (Tag VLAN) in considering interference with network performance.

2) Increased workload on administrators of...
information system departments

Changing the connection of blades to a Storage Area Network (SAN) accounts for about 50% of the total server consolidation work. Since changing the server settings entails changing the SAN-side settings as well, administrators must handle an increased workload.

3) Increased power consumption at datacenters

Conventional blade servers consume more power in proportion to performance. This increases the total power consumption at datacenters.

To address the problems above, Fujitsu attempted to enhance blade servers and server management software by developing and marketing the PRIMERGY BX620 S4 blade server. The PRIMERGY BX620 S4 offers improved operability and availability as expected in server consolidation, and reduces the customer’s TCO, including management cost and such running costs as that for power consumption.

This paper introduces the following advantages of the PRIMERGY BX620 S4:

1) Improved flexibility by extending network functions.
2) Improved operation management and service consistency facilitated by virtualization technology.
3) Reduced power consumption.

2. Improved flexibility by extending network functions

Adding and changing services in a consolidated server system poses the problem of complicated network design. To address this problem, we enhanced the network functions for the new system. The following describes the technology adopted by the PRIMERGY BX620 S4 to enhance network functions.

In describing the structure of a blade server, it mainly consists of server blades, an enclosure, and switch blades (Figure 1). The server blade contains a CPU, memory, hard disk drive, and I/O

| Enclosure contains a fan unit, PSU, switch blades, KVM, and management blades. |
| Switch blades (redundant configuration enabled) |
| Management blades (redundant configuration), KVM |
| PSU (redundant configuration enabled) |

Figure 1
Structure of blade server.
ports, and operates as a server. The enclosure is the chassis that houses the server blades, switch blades, power supply unit, cooling fan unit, and management blades for system management. These components inside the enclosure are interconnected by a cable-less design, via a mid-plane positioned at the center of the enclosure. The I/O ports of the server blades are connected via the switch blade to a network outside the enclosure.

These blade servers offer levels of serviceability, power consumption, operability, installation, and ease of adding servers that are superior to those of rack-mounted servers.

The PRIMERGY BX620 S4 is equipped with more server-blade I/O ports, enclosure transmission lines, and switch-blade I/O ports, so that one server blade can have up to ten I/O ports.

2.1 Enhancement of server blade I/O ports

One server blade can have up to ten I/O ports. Therefore, even when adopting the LAN redundant configuration, physically independent ports can be assigned to up to three different purposes or services. For example, when a blade server is used as an application server in a Web 3-layer model, two ports for the Gigabit Ethernet interface can be assigned to a Web server, database server, and management server, respectively. This prevents the sharing of multiple purposes and services on one LAN, as well as interference with performance and complicated network settings (Figure 2).

Adding a Gigabit Ethernet, 4-Gb/s fibre channel (FC), or 10-Gigabit Ethernet LAN (to be supported in the future) enables the addition of two ports, depending on the expansion board to be mounted on the server blade. This facilitates network and storage connection by using the SAN boot function.

2.2 Enhancement of the mid-plane inside the enclosure

The mid-plane inside the enclosure was improved to enhance transmission lines that connect the server blades to switch blades. Specifically, the number of transmission lines was increased based on the ports added. As a result, the bandwidth between the server blades and switch blades was widened up to 520 Gb/s, or about 4.3 times wider than the conventional one. This enables a flexible network configuration

![Figure 2](image.png)

**Figure 2** Example of enhanced network.
and assures a wider bandwidth for consolidating servers.

2.3 Enhancement of switch blades

More ports were added to the 1-Gb/s switch blade side. That is, the number of downlink ports was increased to 30, given the increased number of standard LAN ports for the server blade. The number of uplink ports was increased to 12 to assure the necessary bandwidth relative to downlink port enhancement. Moreover, the user interface of these switch blades and that of Fujitsu’s LAN switch “SR-S Series” (highly evaluated for its high reliability and security) were unified for easier operation.

3. Improved operation management and service consistency facilitated by virtualization technology

Connecting a blade server to SAN in a conventional configuration poses an operation problem, such as taking much time for the server administrator and SAN storage administrator to make arrangements at server maintenance or replacement. This problem was resolved by enhancing SAN connection virtualization technology that provides easier operation management, and improves service consistency. The following describes the conventional method and problems in interconnecting a blade server to SAN, and then describes the new technology — SAN connection virtualization technology.

3.1 Conventional method of interconnecting blade servers to SAN

A blade server is interconnected to the SAN environment via an FC expansion board and an FC switch blade. The FC expansion board can be mounted in the server blade; the FC switch blade can be mounted in the enclosure. The FC expansion board that can be mounted in each server blade has two FC interface ports. Up to two FC switch blades can be mounted per enclosure. The FC expansion board and FC switch blades configure a multi-path SAN connection environment. The blade server can be connected to a disk array unit by either of two methods: 1) directly connecting a disk array unit supporting SAN connection to the FC switch blade in the blade server, or 2) connecting the disk array unit via an external FC switch cascade-connected to the blade server.

Manually performing server maintenance or replacement in such a SAN connection environment entails many complicated operations, and minute mistakes could cause serious problems. To address such problems, we developed automatic operation management software known as “Systemwalker Resource Coordinator”. This product supports the SAN boot function and N:1 automatic recovery function. The SAN boot function executes system bootstrap operation from the SAN disk. The N:1 automatic recovery function recovers the system in case of server failure by automatically switching the faulty server blade to a standby server blade. These functions reduce administrator workload by shortening the system recovery time, and automating server maintenance and replacement.

3.2 Problem with the conventional interconnection method

The conventional interconnection method described above poses the problem of having to change the SAN-side settings at automatic recovery.

When SAN areas are assigned at blade server installation, the World Wide Name (WWN) — a fixed address set in the FC expansion board of the server blade — must also be set on the SAN side to establish a one-to-one relation between each server blade and each SAN-side volume. Therefore, when server conditions must be changed, the SAN-side settings must also be changed. Should the server for service A fail in the server N:1 automatic recovery configuration, for example, service A must be processed by the standby server. For this purpose, the address of
the standby server’s FC expansion board must
be recognized as the address of the server for
service A. Therefore, the address of the volume
corresponding to service A on the SAN side was
switched to the WWN of the standby server
(Figure 3).

In the example given of a user system, the
server administrator is different from the SAN
storage administrator. Therefore, when the
server administrator changes the server condi-
tions, the SAN storage administrator must also
change the SAN-storage setting conditions. This
increases workload on the server administrator
because it takes a considerable amount of time
to make arrangements with the SAN storage
administrator.

3.3 Method and advantages of
SAN connection virtualization

The PRIMERGY BX620 S4 can switch
server conditions without having to change
SAN-side settings because the interconnection
between blade servers and the SAN environ-
ment is virtualized. Specifically, the uniqueness
of each port of an FC expansion board mounted
in a server blade is assured, and virtual WWNs
that can be freely assigned to devices are written
to volatile RAM of the FC expansion board in
each server blade to enable recognition of those
virtual WWNs from the SAN side. We also devel-
oped operation management software known as
“Systemwalker Resource Coordinator Virtual
server Edition” to manage, automatically set,
and control the virtual WWN to be set in each
server blade.

The following describes the concrete opera-
tion of server switching by using the virtual
SAN connection. Figure 4 shows an example of
automatic server switching at error occurrence in
the current server used for service A. The current
server is automatically switched to the stand-
by server as follows: First, the current server is
stopped, then the virtual WWN assigned to that
server is set to the standby server, followed by
the standby server being restarted to complete
server switching.

Since the settings on the SAN side need
not be changed in this new system, no SAN-side
adjustments are required when switching
servers, even when the server administrator is
different from the SAN storage administrator.
Changing the server configuration in a conven-
tional system takes several hours to several days
because arrangements must be made between
the server administrator and SAN storage
administrator. In the new system, however, the
time needed to make a configuration change was
reduced to mere minutes.

WWN is saved on the FC expansion board
in the new system as follows: Each time a virtu-
al WWN is written to volatile RAM of the FC
expansion board, it can be recognized from the
SAN side, while retaining the WWN fixed for the
FC expansion board. When power is turned off,
the virtual WWN is cleared and only the fixed
address remains valid. Therefore, when a server
blade is pulled out from a blade system and
inserted into another blade system, the server
blade can be used without any trouble.

No special hardware is required to provide
SAN connection virtualization. In other words,
the FC expansion boards and FC switch blades
can be used without modification since both
conform to FC vendor specifications as the indus-
try standard. This improves compatibility with
the existing external SAN environment.

4. Reduced power consumption

In response to recent growing needs for
compliance, security to prevent illegal access
and information leaks, business continuity in
case of recovery from a disaster, and diversifica-
tion of risks, system installation sites have been
rapidly concentrated at datacenters. Datacenters
often adopt a rack-mounted type of system or a
blade-type system in considering system integra-
tion and collective settings.

In line with the growing concentration
note) WWN A and WWN B are fixed World Wide Names.

Figure 3
Conventional server switching method.

note) WWN v-a and WWN v-b are virtual World Wide Names.

Figure 4
Server switching method by SAN connection virtualization.
of equipment at datacenters, ways to reduce
datacenter running costs, such as expenses for
electricity, investments in air-conditioning equip-
ment, and management cost are attracting more
attention.

The increased power consumption of a
single server system is one of the main reasons
for greater attention being paid to reducing such
running costs. Server power consumption has
increased proportionally with higher levels of
server performance. For example, server power
consumption in 2006 was about 2.5 times as high
as that in 2002. This increased power consump-
tion also entails a higher power cost and greater
heat output, which makes the installation of
high-density equipment more difficult.

To solve these problems, the authors devel-
oped a blade server that consumes low power.

This blade server is the PRIMERGY BX620
S4\textsuperscript{2)} equipped with server blades containing
high-performance, low-voltage, quad-core, Intel
Xeon 5300-series processors and 2.5-inch, serial
attached, SCSI (SAS) hard disk drives.

At the stage of designing the server blade
motherboard for the PRIMERGY BX620 S4,
both electrical design and thermal design were
conducted by considering the low-voltage Xeon
processors in addition to regular Xeon proces-
sors. As a result, CPU power consumption was
reduced by a maximum of about 60% compared
with conventional processors of equivalent
performance (Figure 5). This reduces the power
cost by about 15,000 yen per server blade and
150,000 yen per enclosure when running the
system 24 hours a day, 365 days a year.

The hard-disk form factor was also changed
from 3.5 inches to 2.5 inches. Therefore, the
higher integration of LSI of the new hard disk
drive reduced the power consumption of electric
circuits to about half that of the 3.5-inch SAS
hard disk drive having equivalent capacity and
rotational frequency.

5. Conclusion

This paper introduced the new problems
posed by blade servers and the three technolo-
gies adopted to resolve these problems, based
on our extensive experience in server consolida-
tion. This paper mainly described new network
functions and virtualization technology. Recent
years have witnessed growing demands for lower
power consumption and less heat output at
datacenters, as well as for lighter, higher-density
equipment. To satisfy these demands, Fujitsu
will continue advancing power saving technology,
high-density packaging technology, and virtual-
ization technology based on the results of blade
server development, in order to develop the next
generation of superior servers.

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\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{power_consumption.png}
\caption{Comparison of power consumption among processors of
equivalent performance.}
\end{figure}
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