Energy-saving Measures in Fujitsu's Network Products

● Shoji Temma

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Many data center operators are dealing with power-related problems these days. Indeed, all data centers in the Tokyo metropolitan area are reportedly facing a power shortage. Network equipment is not immune to this problem. This paper presents the current state of Fujitsu's SR-S series of switches and IPCOM EX series of network servers and describes a new approach to improving energy efficiency in switches by applying function integration with a high energy-saving effect, as already applied in the IPCOM EX series. It then describes Fujitsu's approach to the flow of cooling air in racks at data centers dominated by rack-mounted servers and introduces an approach toward even greater energy efficiency for the future.

1. Introduction

Many data center operators are now dealing with power-related problems. This is because the power consumed by all hardware in a data center—including servers and other devices, air conditioning equipment cooling those devices, and uninterruptible power supply (UPS) equipment supporting devices and air conditioning—is continually increasing. We have calculated that all data centers in the Tokyo metropolitan area are facing a power shortage (**Figure 1**).

Network equipment is not exempt from this problem. Indeed, the power consumed by network equipment in information technology (IT) systems is said to be increasing noticeably according to forecasts like the ones below.[note)]

- About 13 times 2006 levels by 2025 (103.3 billion kWh/year): Ministry of Economy, Trade and Industry (METI) estimates.
- About 600 times 2001 levels by 2020 (447.8 billion kWh/year): Ministry of Education, Culture, Sports, Science and Technology (MEXT) estimates.

note) Japan's total power consumption: about 970 billion kWh/year (2006).

Under these dire circumstances, Fujitsu is working to implement energy-saving measures in its network products. This paper begins by introducing the current state of Fujitsu's routers, switches, and other network products and energy-saving measures implemented in those products. It then describes an energy-saving approach to IT systems and future directions in this area.

2. Current state of Fujitsu's network products

2.1 Switch products (SR-S series)

2.1.1 Legislation

In accordance with discussions held in the Routers, etc. Evaluation Standard Subcommittee of the Energy Efficiency Standards Subcommittee with regards to energy problems in routers and switches in Japan, plans were made to add fiscal-year targets and energy efficiency standards for layer-2 (L2) switches by government ordinance and to enact these changes into law in 2011. A

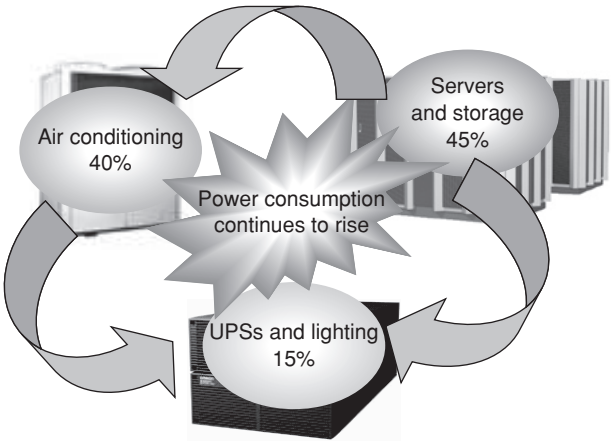

Figure 1
Breakdown of power consumption in a data center. The increases in servers and storage cause an increase in cooling equipment, which in turn causes an increase in the power infrastructure, such as UPSs.

brief chronology of L2 switch legislation in Japan is given below.

- 2002: Energy Efficiency Standards Subcommittee of the Advisory Committee for Natural Resources and Energy established.
- 2005–present: Proposal for energy-saving standards in routers and switches studied in Router & Switch Technology Committee of Communications and Information Network Association of Japan (CIAJ).
- July 2005: Routers, etc. Evaluation Standard Subcommittee of the Energy Efficiency Standards Subcommittee of the Advisory Committee for Natural Resources and Energy established.
- January to March 2008: Approval obtained at Evaluation Standard Subcommittee. Request for public comments initiated.
- 2008 (planned): L2 switches to be added as designated devices in Energy Saving Law by government ordinance.
- May 2011 (estimate): Application of energy efficiency standards to manufacturing and import of L2 switches to begin.

The current state of Fujitsu switch products (SR-S/SH series) with respect to standard values is shown in **Figure 2**. Current Fujitsu products

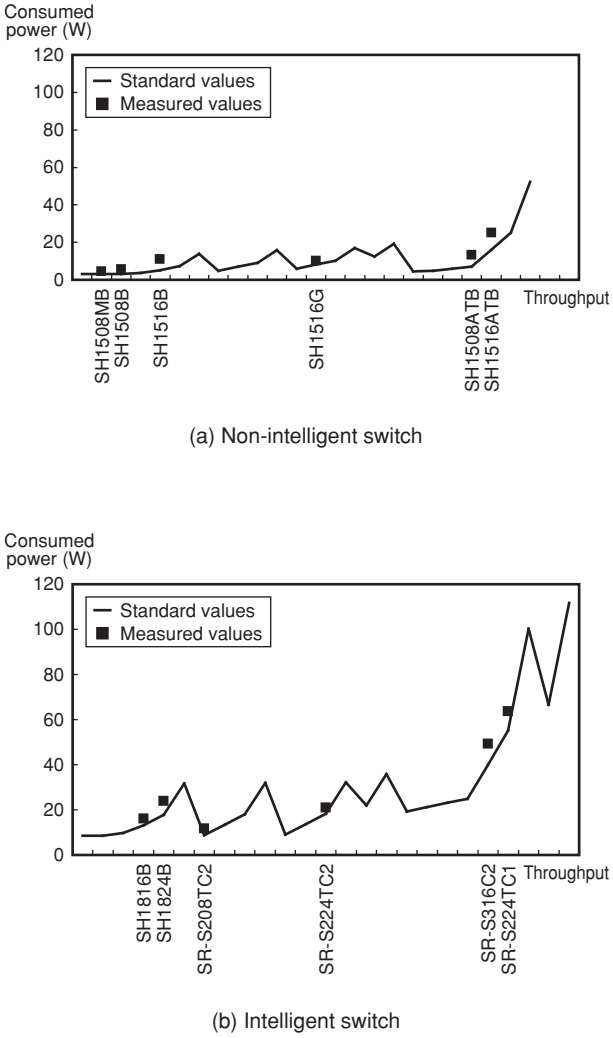

Figure 2
Measured and standard values of power consumption.

have not yet achieved the standard values, and efforts toward energy efficiency are now being made to meet those values by 2011, the year scheduled for these energy efficiency standards being made into law.

2.1.2 Approach toward energy efficiency

The following three techniques have been deemed effective as a result of investigating ways of making current products more energy efficient.

1) Replace high-power-consumption components with low-power-consumption ones: When the power consumed by measuring

Table 1
Power consumption and target values of current switch products.

Product name	No. of ports		Measured power consumption (W)	Target power consumption (W)	Target reduction
	100 M	1 G			
SR-S324TC1		24	63.6	55.1	13.4%
SR-S316C2		16	49.2	40.0	18.7%
SR-S224TC2	24	2	20.9	18.2	12.9%
SR-S208TC2	8	1	11.7	8.8	24.8%
SH1824B	24		20.0	17.9	10.5%
SH1816B	16		14.6	13.2	9.6%
SH1516G	16	2	10.2	8.1	20.6%
SH1516B	16		11.1	5.2	53.2%
SH1508B	8		5.7	3.0	47.4%
SH1508MB	8		4.6	3.0	34.8%
SR-S224PS1	24	4	59.8	63.2	–

100 M: 100 Mb/s
1 G: 1 Gb/s

individual components inside equipment was measured, it was found that cooling fans alone were responsible for about 10% of equipment power consumption.

2) Reduce power supplied to non-operating elements: A box-type switch is a device with few discrete components, so there are few internal elements that are not operating during normal operation. However, when the way in which these devices are used was observed, it was noticed that the number of ports to which no cables are attached was higher than expected. It was consequently found that equipment power consumption could be reduced by halting the supply of power to the interface circuits of those unused ports.

3) Increase the number of ports in equipment: Increasing the number of ports provided by individual pieces of equipment can reduce the total power requirements of a system by making it possible to achieve a system that had been using two pieces of equipment with only one piece of equipment.

In addition to the above, Fujitsu is reviewing the power consumed by each and every component—the basis of energy efficiency—while also reviewing circuit configurations with the aim of achieving the targets listed in **Table 1** by 2011.

2.2 NETWORK SERVER IPCOM EX series

Products in the IPCOM EX series act as appliances between an IT system and the network. They are based on the concept of "integration" to provide the various functions needed to connect the IT system to the network. From a functional viewpoint, the purpose of integration is twofold: simplify design and deployment and simplify operation and troubleshooting. From an environmental viewpoint, its purpose is to achieve a significant reduction in power consumption (**Figure 3**).[1)]

The IPCOM S series (announced in 2004) was the first to embrace the basic concept of integration, and the total power consumption of the IPCOM S2200 network server was 1400 W compared with total power consumption of 1900 W for the sum of individual functional devices (26% reduction). Furthermore, the total power consumption of the IPCOM EX2000IN (announced in 2007) was 157 W compared with 1270 W for the sum of the individual functional devices,

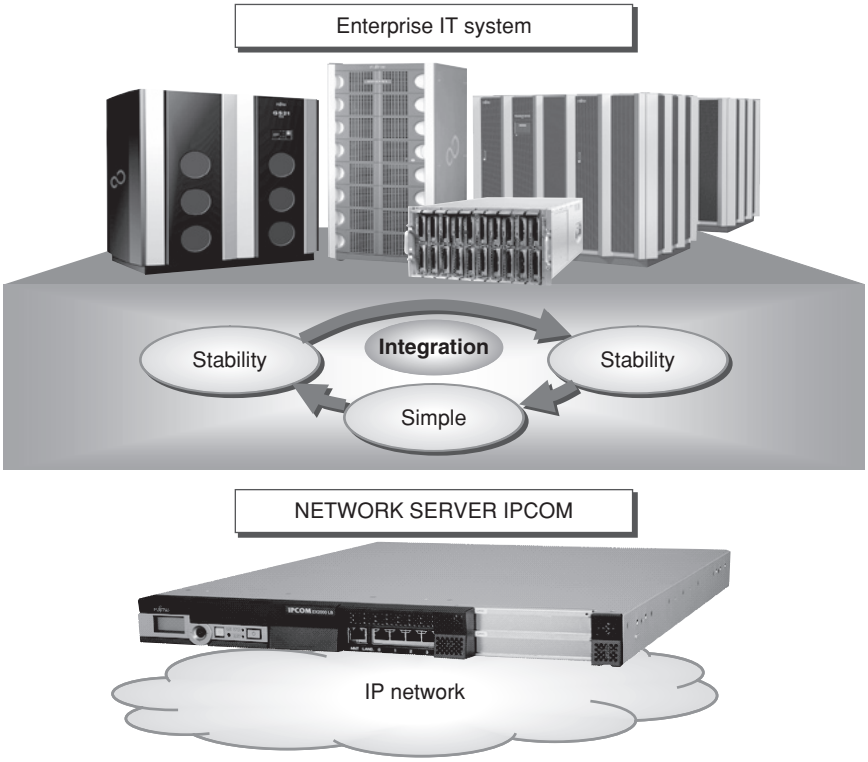

Figure 3
Integration—basic concept of IPCOM.

making for a reduction of 88%. The concept of integration can also save space in addition to energy. The required rack space can be reduced to 1/8 that when combining individual functional devices (**Figure 4**).

The IPCOM EX series also considers the need to reuse resources and has been designed to enable a resource-reuse rate of 93–95%.

3. New approach to energy efficiency

As described above, the basic idea behind reducing power consumption in each piece of equipment is to reduce power consumption in each constituent component and obtain a cumulative energy-saving effect. But one might wonder whether this kind of effort focusing on individual components alone is sufficient. In an IT system, partial optimization by itself cannot achieve total optimization, and likewise, in the area of energy efficiency, reducing power on only a device-by-device basis cannot achieve total optimization with respect to energy efficiency of an entire data center.

Focusing on data centers, where designers come face to face with energy problems, we discuss the following two points affecting total optimization considering that data centers accommodate a large number of devices in racks at a high density: reducing the number of devices and improving the cooling efficiency of rack-mounted devices.

1) Reducing the number of devices

A model of the network-device arrangement in a data center is shown in **Figure 5**. IPCOM integrates vertically distributed functions, so it consumes only 1/8 the power that conventional devices in combination would, making for a significant power-reduction effect.

However, to further reduce the number of devices, we can consider reducing the number of identical devices that are geographically distrib-

Device	Power	Rack-mount size
Router	50 W	1 U
Switch	40 W	1 U
Firewall	120 W	1 U
Switch	40 W	1 U
Server load distribution	280 W	2 U
Anti-virus	370 W	1 U
URL filter	370 W	1 U
Total	1270 W	8 U

Energy-saving/space-saving effect by integration

1. Energy-saving effect
   1270 W ⇒ 157 W ⋯ 1/8
2. Space-saving effect
   8 U ⇒ 1 U ⋯ 1/8

Device	Power	Rack-mount size
NETWORK SERVER IPCOM EX2000IN	157 W	1 U
Total	157 W	1 U

Figure 4
Energy and space saving by integration with the IPCOM EX2000IN.

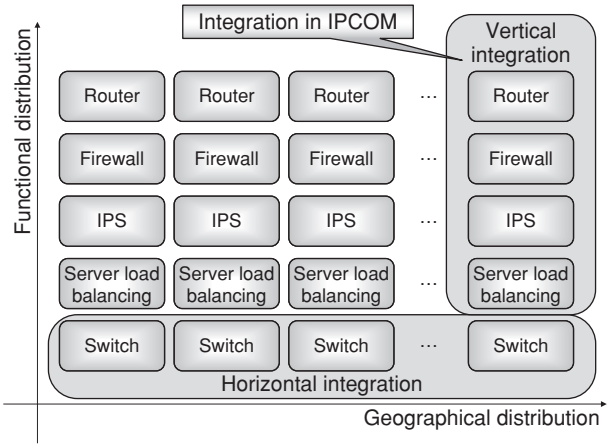

Figure 5
Arrangement of network devices in a data center.

uted through the use of horizontal integration. An example of horizontal integration is shown in **Figure 6**. Here, two geographically distributed switches are accommodated in one switch and each virtual local area network processed by those switches is allocated to a virtual switch to be independently processed. Horizontally integrating multiple switches on the basis of this concept of a virtual switch reduces the number of physical devices, thereby reducing the total power consumption of the data center. In addition to reducing the number of physical devices, horizontal integration can improve the utilization rate of a switch's ports and thereby reduce wasted power consumption due to unused ports. If you check the ports of any switch, you will probably find several unused ones. Even these unused ports consume power.

2) Improving cooling efficiency of rack-mounted devices

The cooling air flow in general switches is shown in **Figure 7**. A server mounted in a rack is cooled by air flowing from the front to the back of the rack. This holds true for chassis-type switch products, but for box-type switches that are now widely used cooling air flows crosswise with respect to that of servers. Consequently, when the rack's door is closed, the cooling air flow of servers interferes with that of switches inside the rack, resulting in a drop in cooling efficiency and the need for more air conditioning equipment. By aligning the cooling air flow between servers and switches, we can suppress excess power consumption.

Horizontal integration and cooling air flow alignment as described above are challenges that have arisen as switch speeds increase. In response to these new challenges, Fujitsu plans to provide a new product lineup oriented to data centers separate from the existing SR-S series of switches.

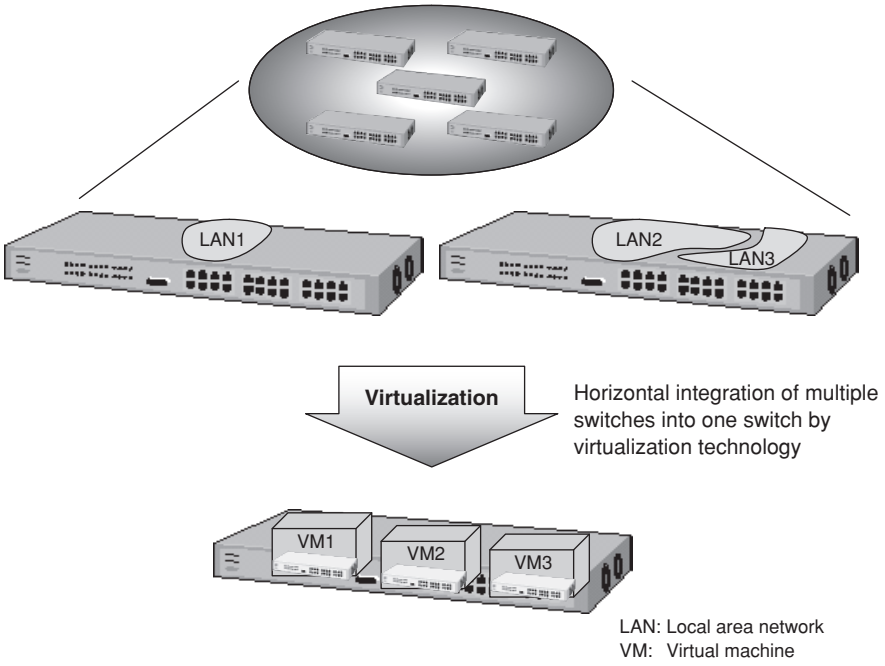

Figure 6
Horizontal integration of switches by virtualization technology.

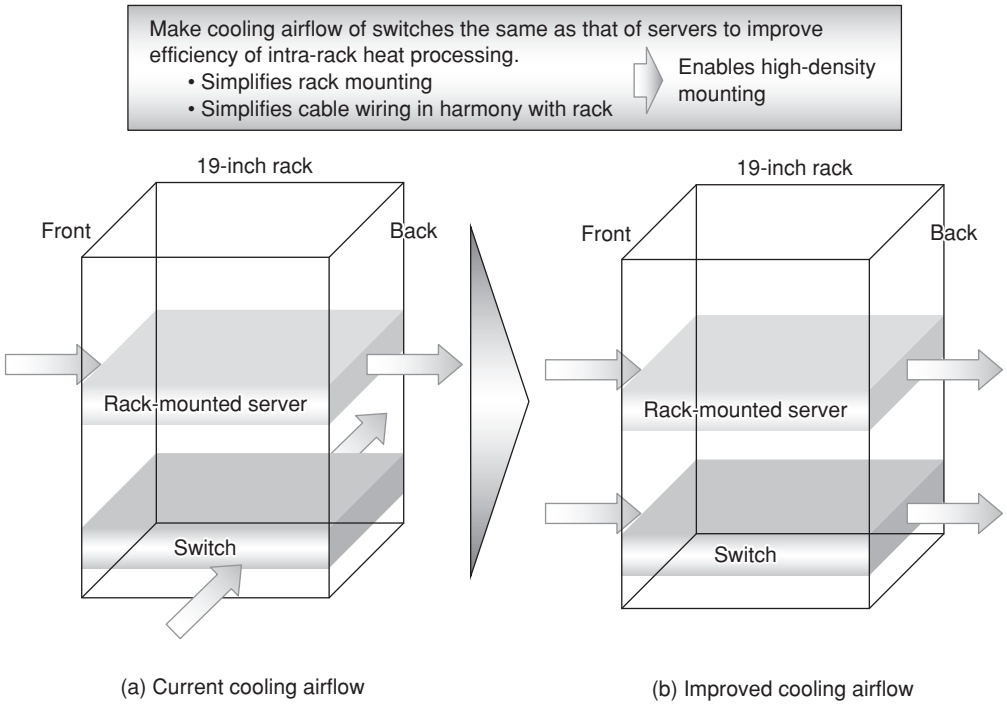

Figure 7
Improved cooling efficiency by aligning cooling airflow.

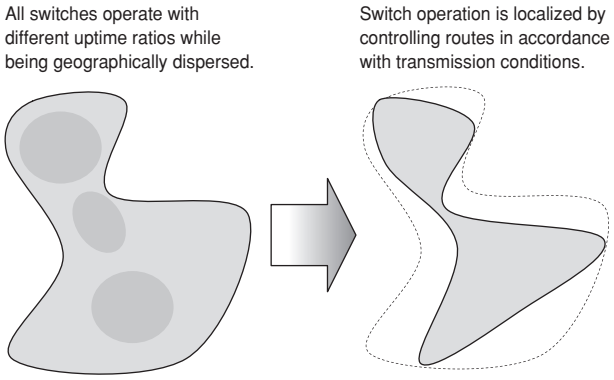

Figure 8
Approach to greater energy efficiency.

4. Toward greater energy efficiency

A network is constructed by interconnecting many switches. Although their operating conditions differ widely, all switches—whether they are performing communications or not—are in an operating mode (i.e., consuming power). We think that if we controlled the route of flowing packets in accordance with transmission conditions, we could localize communications and create switches that are not handling communications (**Figure 8**). Putting such switches into a sleep state could minimize the power that they consume and reduce overall network power consumption. Fujitsu Laboratories is beginning research on total optimization that spans an even broader range in the manner described above.

5. Conclusion

This paper presented Fujitsu's approach to saving energy in network products. From here on, network bit rates will increase from the current 10 Gb/s to 40 and 100 Gb/s. With existing technology, the amount of power consumed by network products can only be expected to rise as bit rates increase. Using the new approach presented here to achieve energy savings in network products, Fujitsu intends to pursue energy efficiency while pursuing higher bit rates.

Reference

1) S. Temma: IPCOM EX Series for Realizing Network Stability and Safety. *Fujitsu Sci. Tech. J.,* Vol. 44, No. 1, pp. 35–45 (January 2008).

Shoji Temma
Fujitsu Ltd.
Mr. Temma received the B.S. and M.S. degrees in Computer System Engineering from Hiroshima University, Hiroshima, Japan in 1981 and 1983, respectively. He joined Fujitsu Ltd., Kawasaki, Japan in 1983, where he has been engaged in research and development of communication processors for mainframes. Since 2001, he has also been engaged in R&D of IPCOM.