Micro-modular Server and Phase Change Cooling Mechanism Contributing to Data Center TCO Reduction

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Abstract

NEC has developed a "micro-modular server" featuring high integration and power saving and a "phase change cooling unit" featuring a local cooling technology that is able to provide natural cooling without using electrical power for the data centers. Of the various newly developed technologies packaged with these products, this paper focuses on the power saving, high density and operations management technologies that contribute to a reduction in the total cost of ownership (TCO) of data centers. Various innovative features of the products are also discussed.

Keywords

cloud, data center, server, network, phase change cooling, power saving, operation management.

1. Introduction

In consideration of the rapid shifting of ICT systems from the ownership type (on premise) to the utilization type (cloud), NEC has developed a micro-modular server and phase change cooling mechanism. The use of these technologies in the platforms of the cloud business carriers and corporate private cloud systems is assumed and the sale of solution type platforms incorporating these systems has already begun.

Up to 736 units of micro-modular servers can be mounted per rack in order to reduce the data center installation space to 20% and also to reduce the footprint cost significantly. On the other hand, the phase change cooling mechanism is capable of highly efficient local cooling and can reduce the cooling costs of data centers up to 30%. At NEC, we not only intend to reduce the power consumption of IT equipment but also propose optimization of the total cost of ownership (TCO) including those for the data center facilities.

2. Micro-modular Server

Since a data center installs a large number of servers, these servers are required to occupy a small footprint and to consume power optimally. We have therefore recently developed a micro-modular Server featuring both high integration and low power consumption for use in data centers (**Photo 1**).

Photo 1 The recently developed micro-modular server.

2.1 Latest Technologies Applied to the Micro-modular Server

(1) Power saving

By adopting the latest power-saving components including the C2000 series power-saving Intel Atom processor, the mSATA SSD and the 2.5-Gbps network by leading any other competitors, we have productized a Micro-modular Server that consumes only a quarter of the power required by the previous product[*1].

(2) High integration

By fully applying the cooling design technology to withstand the 40-degree environment that has been cultivated via our past researches, we have implemented an ultra-high-density design that makes it possible to mount up to 46 server modules in a 2U-size rack chassis. We have thus succeeded in achieving integration at the highest level, with the capability of mounting 16 chassis, including a total of 736 servers per 42U rack.

The weight per chassis has also been reduced to 34 kg for the largest configuration. This allows the servers to be installed on the floor of an ordinary data center with a load bearing of 500 kg/m² without adversely affecting the high-density features.

As a result, the footprint can be reduced to 1/5th that of the previous product, thereby contributing to the service cost efficiency by reducing the footprint, rack and wiring costs (**Fig. 1**).

(3) Improved management efficiency

A control chip is incorporated in each server module and two chassis management modules are additionally installed to manage the hardware resources in the chassis (server module, fan, power unit, etc.). This choice of design optimally provides high availability against faults and high server management efficiency for high-density servers.

Furthermore, the system operation management costs can be reduced when an optional Rack Management System appliance is operated simultaneously. It makes it possible to have an integrated control of multiple server modules and hardware resources mounted in the chassis.

2.2 Innovative Technologies Adopted for the Micro-modular Server

(1) Design balanced between network bandwidth and power saving

Each server module has two 2.5-Gbps Ethernet ports, each of which is connected to a couple of L2 network switch modules mounted in the chassis so that both reservation of bandwidth and network redundancy are achieved. Because each switch module uplinks data to the higher-level network at a total rate of 80 Gbps, which is calculated as 40 Gbps (10 Gbps x 4) x 2 ports, so the number of required ports is reduced.

In order to achieve high performances and to lead our competitors both in power saving and in high-speed networking, we adopted the 2.5-Gbps Ethernet in place of the 1-Gbps Ethernet that is commonly employed in the market or the 10-Gbps Ethernet that features a high speed but has a high power demand. The balance between power saving and high-speed networking enabled by this strategy distinguishes our servers from those of our competitors.

In consideration of the maintainability, server modules are installed via the cold swap system in order to enable replacement without stopping the other modules and to thus contribute to improving the efficiency of operations.

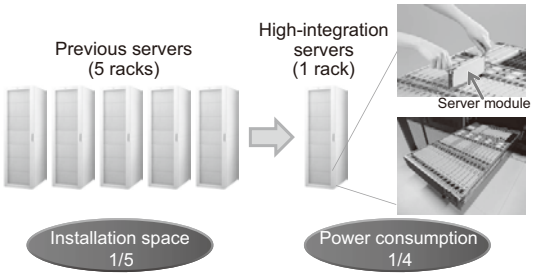


Fig. 1 High integration and low power consumption contributing to service cost reduction.

(2) High-density cooling design and maintainability considerations

While ordinary high-density servers enable the mounting of four servers in a 2U size rack, our cooling technology has made possible high-density packing of more than ten times the number of units, or of 46 server modules, in a 2U same size rack.

Thanks to a design emphasizing both high density and maintainability, individual server modules can be serviced or replaced by simply opening the top panel of the server cabinet.

3. Local Cooling Technology Featuring Natural Cooling without Using Electricity

3.1 Productization of a Phase Change Cooling Unit

The phase change cooling unit cools the heat exhausted from high-integration servers efficiently by using the mechanism by which a liquid draws heat when it gasifies (phase change cooling). After applications to supercomputers and high-end servers, we independently advanced this technology

[*1] Previous product: SIGMABLADE (Express5800/B120b-d)

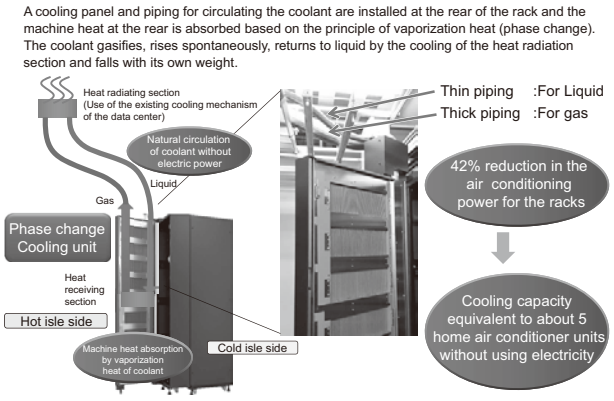


Fig. 2 Outline of a phase change cooling unit.

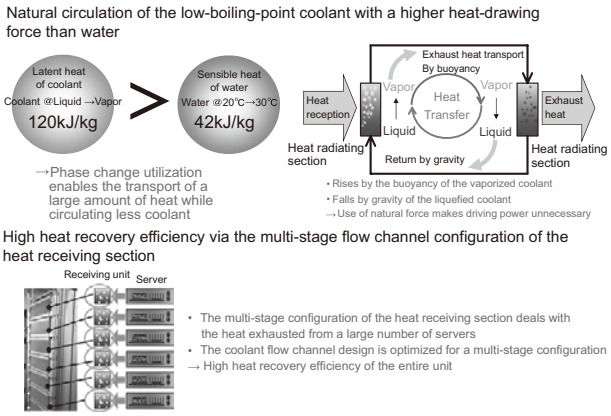


Fig. 3 Unique technologies of the phase change cooling unit.

for application to high-integration servers.

The unit is installed on the rear door of each server rack. When the coolant inside the unit receives the heat exhausted from the rear of the ICT equipment, it boils, evaporates and gasifies to cool the exhaust from the ICT equipment by absorbing the heat (**Fig. 2**).

The gasified coolant then moves to the ceiling section under its own buoyancy, it is liquefied by the cooling equipment in the ceiling section and returns to the heat receiving section through the piping in the phase change cooling unit via the gravity of the liquefied coolant. The returned coolant is used again in the next cooling.

The heat transfer and discarding cycle inside the phase change cooling unit does not need electrical power for driving the air conditioning fan or for recirculating the coolant.

3.2 Innovativeness and Uniqueness of the Phase Change Cooling Unit

This technology is an extension of the cooling technology of high power density ICT equipment. Unlike ordinary air conditioning systems, it employs a unique solution that functions efficiently in the temperature range required for ICT equipment cooling and it features a low environmental load (**Fig. 3**). Consequently, its safety is very high because it does not need a high-pressure vessel as is the case for ordinary air conditioning systems.

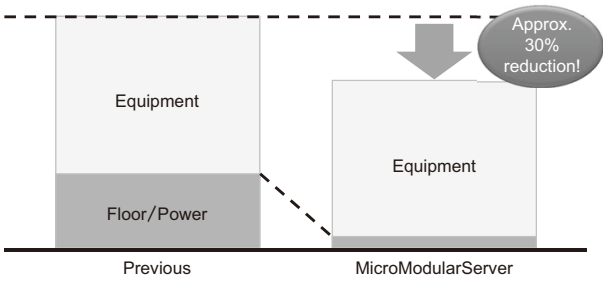
A high heat receiving performance (The capability of receiving 50% of the heat exhausted from 30 kW equipment) is achieved thanks to the multi-stage configuration of the heat receiving section and the structural device that optimizes the amount of coolant required by each stage of the heat receiving section. Moreover, the absence of need for mechanical or electrical control mechanisms implements high reliability and maintenance freedom.

4. Solution Type Platforms

We will provide service platforms utilizing micro-modular servers, phase change cooling units and advanced OSS (Open Source Software) sequentially for use in cloud services and big data analysis.

- **Hosting service platform “Cloud Platform for Dedicated Hosting”**[*2]
  The need for hosting services including those for the dedicated hosting service with which the server is not virtualized but a single server is leased (physical hosting). Since this kind of service cannot integrate servers by means of virtualization, a high-density, highly efficient platform is required.
  A solution platform based on micro-modular servers and phase change cooling can reduce the footprint/power costs to as low as 1/8th of the traditional physical hosting servers and can also reduce the total service costs by about 30% (**Fig. 4**).
- **Big data analysis service platform “Data Platform for Hadoop”**
  The micro-modular Server system features a large number of servers, a high-speed network (2.5 Gbps) and network switching capable of a high uplink speed of max. 160 Gbps. This design allows it to perform as an optimum platform for distributed processing environments such as big data analysis systems requiring multiple servers. It also features a high networking performance between servers, even in large-scale environments using several racks as well as in environments accommodated in a single 2U rack. We can combine such a platform with big data analysis platform software such as Hadoop or Spark and provide platform products capable of rapidly building high-speed analysis services.

[*2] The product name in Japan is the Cloud Platform Suite Data Center Package.



Calculated by NEC assuming cost structures of advanced hosting businesses,
Preconditions: Assuming a business deploying a hosting service of a 2,000-rack scale in the U.S.

Fig. 4 Facility cost reduction achieved by power-saving, high-integration platform.

5. Conclusion

In this paper, we have introduced our efforts aimed at power saving of solution type platforms based on our Micro-modular servers and phase change cooling mechanism together with details of their innovative features. Since the announcement in May 2014, the advanced functions and specifications of these packaged platform have been highly approved both inside and outside of Japan, as listed below. Many inquiries have been addressed to us from data center businesses worldwide and particularly from the U.S.

- Interop Tokyo 2014 “Best of Show Award”
  Grand Prix in Dace Center & Storage Category
- Datacenter Dynamics APAC Award
  “Innovation in IT Optimization”
- Nikkan Kogyo Shimbun Ltd.: 57th Ten Best New Products Award

At NEC, we are determined to develop the most advanced ICT and facility technologies by providing solution type platforms for our customers that are able to support the creation of new businesses. Moreover, we expect that our highly efficient solutions will contribute to supportive measures for the conservation of the global environment.

* Intel Atom is a trademark of Intel Corporation in the U.S. and other countries.

* Ethernet is a registered trademark of Fuji Xerox Co., Ltd.

* Hadoop and Spark are registered trademarks or trademarks of The Apache Software Foundation.

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