White Paper

5th Gen Intel® Xeon® Scalable Processors / Intel® Xeon® 6 Processors
NTT DATA Group Corporation

NTT DATA Group Accelerates Sustainability Management Initiatives by Validating the Power Efficiency of Intel® Xeon® Processors for Enterprise Applications

NTT DATA Group has been committed to advancing sustainability as part of its commitment to a greener society. The group tested the power efficiency on 5th Gen Intel® Xeon® Scalable processors and Intel® Xeon® 6 processors with E-cores using Java-based web applications. The results show that both provide benefits in power efficiency and performance per watt.

NTT DATA Group Corporation

Established: May 23, 1988

Business description: Systems integration, network system services, IT consulting and solutions

Capital: 142,520 million yen

Head office: Toyosu Center Building, 3-3-3 Toyosu, Koto-ku, Tokyo

https://www.nttdata.com/global/en/

Yasumasa Suenaga

IOWN Promotion Office, Innovation Technology Department,

Technology Innovation Division, NTT DATA Group Corporation

NTT DATA Group sustainability management

NTT DATA Group transitioned to a holding company structure under the name of NTT DATA Group Corporation in 2023. Currently, NTT DATA Japan manages the domestic (Japanese) business, while NTT DATA, Inc. operates globally.

The company's medium-term business plan (FY2022-2025) is focused on sustainability management, aiming to achieve a more sustainable society together with their customers by connecting diverse people through technologies. NTT DATA Group's sustainability management takes a long-term outlook titled, "Realizing a Sustainable Future."

This involves three core concepts: regenerating ecosystems to preserve Earth's environment for the future; clients' business growth supporting a sustainable society; and inclusive societies aimed at healthy and peaceful lives for all. Each of these tenets focuses on materiality (importance) as NTT DATA Group strives to contribute to SDGs.

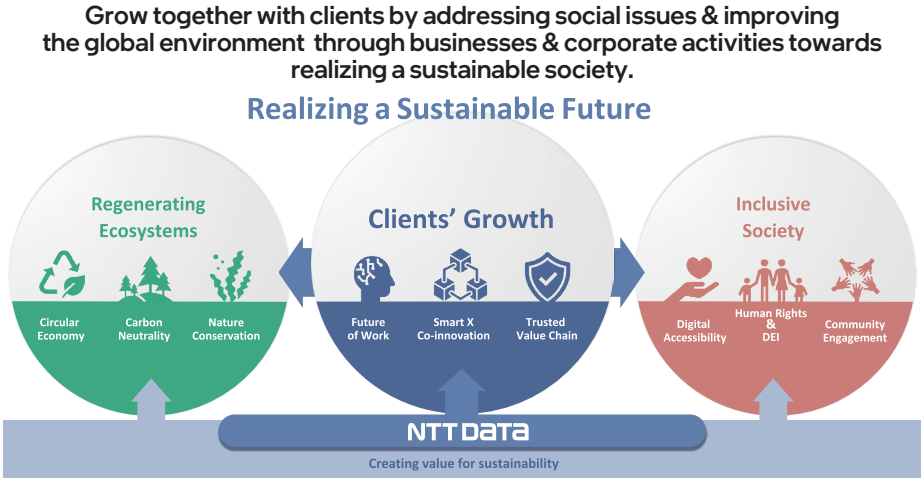


Figure 1. NTT DATA Group sustainability management

One initiative is "Carbon Neutrality," where NTT DATA Group focuses on social and customers' innovation for decarbonization to help resolve climate change issues. In 2023, the company formulated NTT DATA NET-ZERO Vision 2040 in response to the rising demand for net-zero greenhouse gas initiatives worldwide and their structural shift towards expanded business growth. This policy aims to achieve net-zero greenhouse gas emissions across the supply chain by 2040.

"In our roadmap, we aim to achieve net-zero direct and indirect emissions (Scope 1 and 2) within our own operations by 2030 for data centers and by 2035 for the entire company, including offices," says Suenaga. "We plan to achieve net-zero across the supply chain (Scope 1, 2 and 3) by 2040 through working together with our customers and suppliers."

Global IT systems and decarbonization

Meanwhile, global IT systems are another story. CO2 emissions are increasing, with estimates suggesting that power consumption in the IT sector will account for 20% of the world's total by 2030. The rapid adoption of generative AI in recent years has led to a significant increase in power consumption in data centers, and projections expect it to grow at an even faster pace. Focusing solely on the software within the broader IT field, CO2 emissions are estimated to be around 4-5% of the world's total, equivalent to those from railways, shipping, and aviation combined, according to some research reports.

"With this in mind, the latest report by the IT research firm Gartner identifies green IT as a key element of IT governance for CIOs, making it an issue that business leaders cannot ignore," says Suenaga.

The components for greening IT and the current measures

The sources of greenhouse gas emissions are found across many aspects of IT systems, including end-user devices, data centers, cloud, software, IT services, and communications. Each element requires different measures. Most reduction measures target hardware, data centers, and cloud, while those in the software domain remains behind. A research indicates that the software domain contributes about 18% to emissions, similar to data centers. Greening measures such as optimized implementation, low power frameworks, and environmentally conscious tuning are considered promising.

NTT DATA Group's initiatives for greener software

In response to these global trends, NTT DATA Group has been working on greening software including activities with the Green Software Foundation (GSF). GSF is a global non-profit organization established in May 2021 under the Linux Foundation. In addition to major global IT vendors such as Intel and Microsoft, its members include companies and organizations from financial and insurance industries, education sectors, and government agencies around the world. Aiming to help achieve the Paris Agreement's goal for 45% lower greenhouse gas emissions in the ICT sector by 2030, the foundation's mission is to develop and promote the necessary standards, tools, and best practices to reduce CO2 emissions from software.

NTT DATA Group is a steering member of GSF and contributes to many endeavors, from organizational management and specification definition to open source development. In September 2024, the Sustainable IT Impact Awards—presented by SustainableIT.org, a non-profit organization led by technology executives to promote global sustainability—recognized the company as a leader in IT sustainability.

Additionally, NTT DATA Group's independent R&D on green IT has developed a processing platform to consolidate data centers across multiple regions, which dynamically selects and uses the region with the lowest CO2 emissions, based on visualizing energy consumption and CO2 emissions of applications through a dashboard. To make effective use of hardware, the company is conducting research to maximize operational efficiency of software from a perspective of energy savings and building knowledge on utilizing energy-efficient hardware.

Suenaga explains, "To supplement these activities, we decided to validate the effectiveness of OPM 2.0—the power-saving mode of 5th Gen Intel® Xeon® Scalable processors—and the utility of E-cores, the technology in Intel® Xeon® 6 processors which prioritizes energy efficiency."

Validating the power-saving features of Intel® Xeon® processors

To validate the effectiveness of OPM 2.0 and the utility of E-cores, NTT DATA Group conducted a test using Java-based web applications commonly selected in the enterprise field. See the detailed results in the following sections. The key is that this test assessed the overall power consumption of the system, not just for CPU alone.

"Considering the goal of net-zero CO2 emissions in data centers under the NTT DATA NET-ZERO Vision 2040 and the provision of sustainable IT systems to our customers, we needed to target power consumption across all hardware components required to run software, such as the system board and cooling fans, not only the CPU," says Suenaga. "We therefore decided to validate power-saving effects on the entire server using Java-based web applications, which are often selected in systems we provide to our customers."

- **As the sources of GHG emission in IT vary widely, each requires different measures**
- **Most current measures are focused on hardware, data centers, and cloud, while those for software left behind**
- **On the other hand, the software field is responsible for about 20 percent of emissions, making it a promising area for reductions**

End-user devices	Establishing user device and green procurement policies; promotion of recycling
Data centers	Introduction of renewable energy, optimized air conditioning controls, next-gen cooling technology, optimized equipment, facilitating more use of LED lighting
Cloud	Migration to cloud services, prioritizing data centers powered by renewable energy
Software	Optimized implementations, introduction of low-power frameworks, environmentally-conscious tuning. > Not yet matured. Future expansion expected.
IT services	-
Communications	IOWN, optimizing communication equipment, more efficient network traffic control

Figure 2. The components for greening IT and the current measures

(1) 5th Gen Intel® Xeon® Scalable processor: OPM 2.0 effectiveness

- CPU: Intel® Xeon® Platinum 8558P processor
- Measured the power consumption and performance per watt with switching OPM 2.0 enabled and disabled
- Compared the all CPU cores utilization between highly loaded (around 90%) and lower loaded (around 40%) scenarios to see the effectiveness and potential side effects of OPM 2.0

(2) Intel® Xeon® 6 processor: E-cores utility

- CPU: Intel® Xeon® 6746E processor
- Measured the power consumption and performance per watt on 5th Gen Intel® Xeon® Scalable processor and Intel® Xeon® 6 processor with E-cores
- Compared the all CPU cores utilization between highly loaded (around 90%) and lower loaded (around 40%) scenarios to see the effectiveness and potential side effects of E-cores

*Processors selected from SKUs recommended by Intel as replacements.

Test procedures and results

Validation processes

- The test uses Airline Ticket Reservation System (ATRS), an application built with Macchinetta, a framework for enterprise application in the NTT Group. The power of the entire server chassis consumed when placing high load on a REST interface for seat availability searches is measured.
- The application and database are in an integrated configuration.
- To distribute load evenly across all cores, four instances, each composing a set of database and application, are created. Using the Linux **taskset** command, each instance is deployed to each physical core.
- Power consumption data is captured via Simple Network Management Protocol (SNMP) from the socket to which the test server is connected through a power distribution unit (PDU).

OPM 2.0 (Optimized Power Mode)

OPM, Intel's proprietary power-optimized operating mode, first appeared in 4th Gen Intel® Xeon® Scalable processors. Intel introduced OPM 2.0 in 5th Gen Intel® Xeon® Scalable processors for enhanced power optimization. The mode uses multiple methods, such as dropping uncore clock frequency based on workload, to reduce power consumption outside the core and achieve better performance per watt. 5th Gen Intel® Xeon® Scalable processors with OPM 2.0 enabled can lower package power consumption in a two-socket configuration by 66W to 110W at load levels of 30-40%.

E-cores and P-cores

Since the release of 12th Gen Intel® Core™ processors in 2021, Intel's PC processors have adopted a hybrid architecture with two types of cores: performance-oriented P-cores and energy-efficient E-cores. Server processors only used performance-oriented P-cores up to 4th and 5th Gen Intel® Xeon® Scalable processors. Starting with Intel® Xeon® 6 processors, Intel has featured both existing P-core SKUs and new SKUs with E-cores in its lineup. P-cores are optimized to handle single-threaded tasks for performance. E-cores feature a higher performance-per-watt, performance density, and lower power consumption.

In terms of workloads, P-cores are ideal for compute-intensive tasks like HPC and AI, as well as applications requiring single-core performance. E-cores are suitable for web services that require relatively less performance per core and microservices that combine multiple services to build a single application.

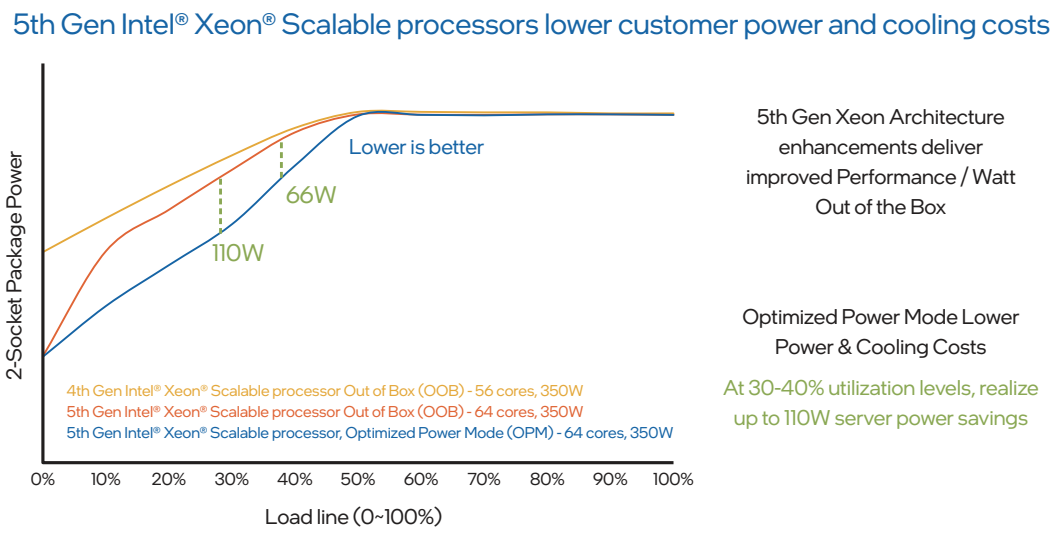


Figure 3. 4th and 5th Gen Intel® Xeon® Scalable processors: Higher efficiency at lower server utilization

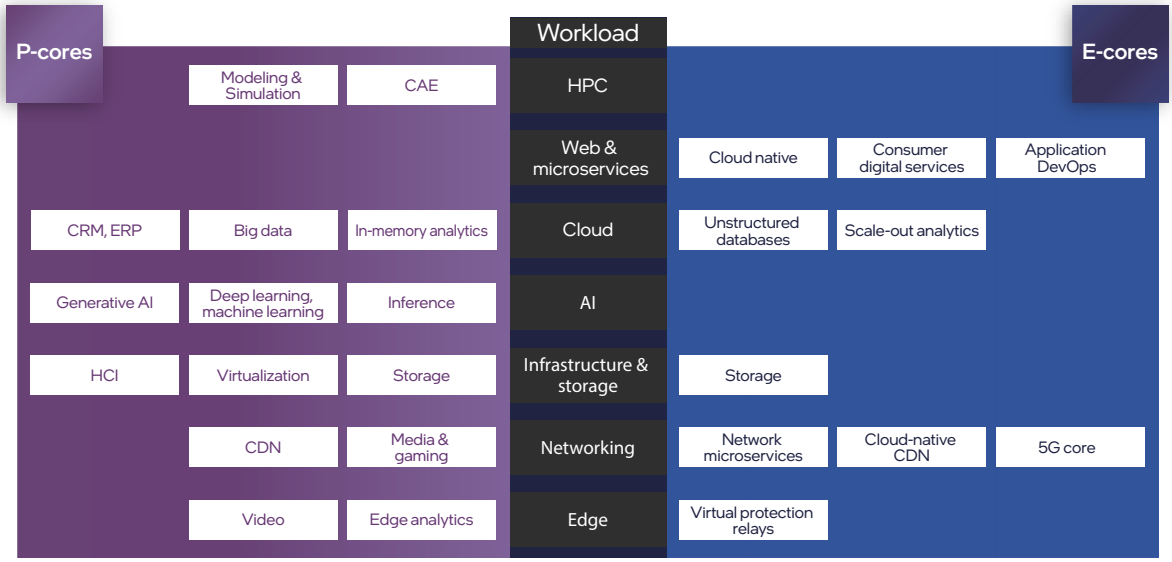


Figure 4. Addressing unique workload requirements

Test schedule

- July to August 2024: Test environment prepared, tuning configurations to measure the performance
- August to September 2024: Actual validation conducted

Measurement process

Measured power and performance-per-watt under varying loads in two configurations: on a 5th Gen Intel® Xeon® Scalable processor (switching OPM enabled or disabled) and an Intel® Xeon® 6 processor (with E-cores, OPM-equivalent functions enabled). Each configuration measured three times, taking the average value as its result.

Results

(1) 5th Gen Intel® Xeon® Scalable processor: OPM 2.0 effectiveness

Under high-load (at 90% CPU utilization) conditions, no significant difference is found in power consumption between OPM 2.0 enabled or disabled. Under low-load (at 40% CPU utilization) conditions, enabling OPM 2.0 lowered power consumption by around 7% compared to disabled, from 362.7W to 337.6W—a reduction of 25.1W.

While performance-per-watt showed no difference between OPM 2.0 enabled or disabled at higher loads, the result confirmed an improvement of about 8% at 40% loads.

(2) Intel® Xeon® 6 processor: E-cores utility

When comparing 5th Gen Intel® Xeon® Scalable processor (OPM enabled) and Intel® Xeon® 6 processor (with E-cores), tests confirmed that the latter one consumed less power under both high-load (at 90% CPU utilization) and low-load (at 40% CPU utilization) conditions. The results show around 41% lower power at high loads and 51% lower power at low loads, a reduction in power consumption on chassis of 167W and 171W respectively.

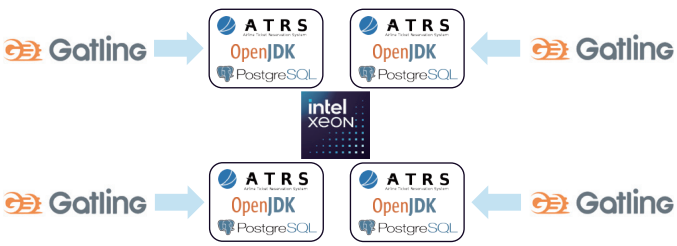


Figure 5. Validation process

Performance per watt increased by around 69% under high loads and by 89% under low loads, showing significant improvements in both conditions.

Insights and conclusion

(1) 5th Gen Intel® Xeon® Scalable processor: OPM 2.0 effectiveness

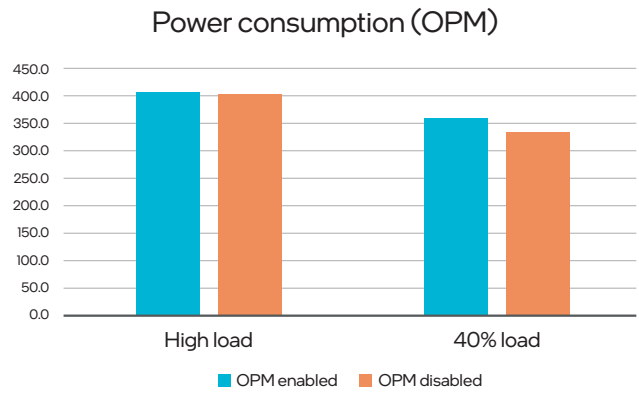
This test confirmed that enabling OPM 2.0 resulted in a reduction in power consumption under low loads in Java-based web application workload.

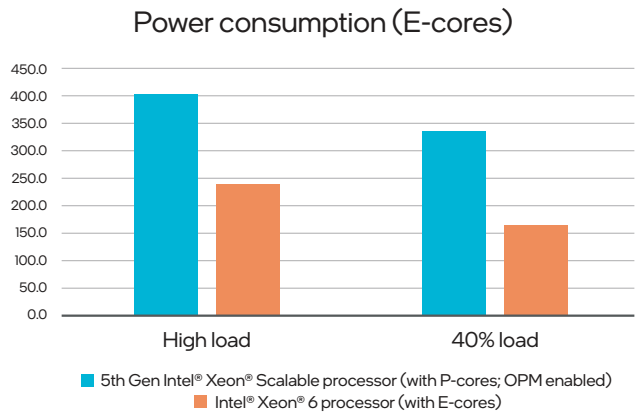
"Although the reduction is about 7%, I think that an absolute decrease of 25W is a significant impact," says Suenaga. "For applications running 24/7, even a decrease of 25W per hour would add up to considerable energy savings over time. And the fact that we validated the effect on the entire system, not just the CPU alone, is a meaningful outcome. Enabling OPM has no impact on peak performance in this kind of workload, which is also a positive finding."

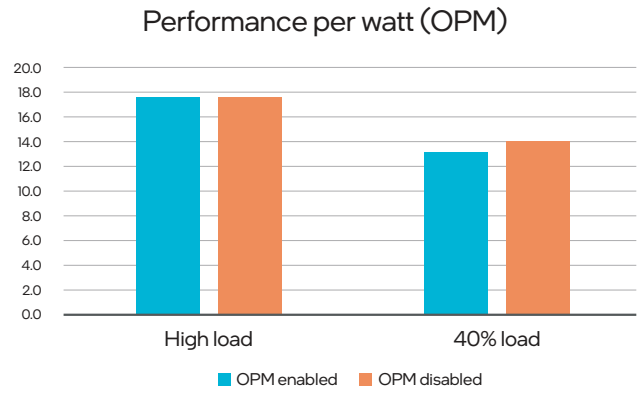
(2) Intel® Xeon® 6 processor: E-cores utility

Intel® Xeon® 6 processor with E-cores showed significant power savings and improved performance per watt in both high- and low-load scenarios compared to 5th Gen Intel® Xeon® Scalable processor. In use cases where system power consumption is the primary focus rather than single-core performance, using Intel® Xeon® 6 processors with E-cores can reduce operational power consumption without sacrificing application performance.

Suenaga continued, "Our initial assumption was that power savings with Intel® Xeon® 6 processor (with E-cores) might come at the expense of performance. However, contrary to our expectations, it consumed less power without affecting performance at all. Nearly doubled power efficiency for web applications compared to 5th Gen Intel® Xeon® Scalable processor with P-cores is a substantial impact."







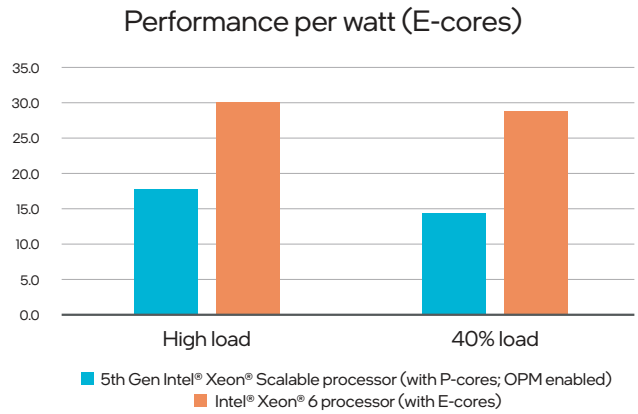


Figure 6. Test results (1)

Figure 7. Test results (2)

Summary and future prospects

This test demonstrated that enabling OPM 2.0 or using Intel® Xeon® 6 processors with E-cores for the development of Java web applications, NTT DATA Group's principal area, contributes to reducing greenhouse gas emissions and supports sustainable initiatives. Going forward, the company will apply these benefits to real-world web application development projects.

"I believe Intel® Xeon® 6 processor with E-cores is fully adequate for developing web applications designed with sustainability in mind," says Suenaga. "We will use Intel® Xeon® Scalable processors with P-cores for workload requiring single-core performance, and further efficiency is expected with OPM 2.0 enabled. In the future, we plan to propose Intel® Xeon® 6 processor with E-cores to our customers for projects emphasizing power savings to achieve net-zero greenhouse gas emissions as set forth in NTT DATA NET-ZERO Vision 2040."

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