# Results of PRIMERGY RX300 S7 on SAP® Server Power Standard Application Benchmark

Fujitsu PRIMERGY RX300 S7 demonstrates an impressive boost in energy efficiency using the Intel® Xeon® E5-2600 product family.

## Introduction

Today, energy efficiency is one of the decisive factors when selecting a server for SAP® applications. SAP has thus defined - in close cooperation with its partners - a benchmark that examines the energy-efficiency factor.
Back in 2011, Fujitsu was the first company to achieve results on the SAP server power standard application benchmark with the PRIMERGY RX300 S6[I]. In comparison with this previous benchmark, Fujitsu is now able to demonstrate – through new results achieved on the same benchmark – that the power consumption per SAPS decreased by as much as 43% with the new Fujitsu PRIMERGY RX300 S7 server generation featuring the Intel® Xeon® E5-2600 product family[II].

## Benchmark Parameters

In this paper, we discuss the following results achieved by Fujitsu on the SAP server power standard application benchmark that were certified on March 6, 2012:

| | |
|---|---|
| Power efficiency indicator – Server (watts/kSAPS) | 10.5 |
| Average throughput over all load levels | 15,480 |
| Minimum ambient temperature (°C) | 22.0 |
| SAP Business Suite software | SAP enhancement package 4 for SAP ERP 6.0 |
| RDBMS | Microsoft SQL Server 2008 Enterprise Edition |
| Operating system | Windows 2008 R2 Datacenter x64 |
| Central server | Fujitsu PRIMERGY RX300 S7<br>2 processors, 16 cores, 32 threads, Intel Xeon processor E5-2660,<br>2.2 GHz, 128 GB main memory, 450W Platinum PSU |

For further details, please refer to www.sap.com/benchmark: SAP certificate number 2012007

The key performance indicator of this benchmark is the value "watts per kilo SAPS" (watts/kSAPS). A smaller value therefore means less power consumption for a defined load and thus indicates greater energy efficiency. This benchmark saw consumption of an average of 10.5 watts in order to obtain a throughput of 1,000 SAPS.

## Pushing Energy Efficiency to New Limits

On February 14, 2011 the first results on the SAP server power standard application benchmark were certified, run on a PRIMERGY RX300 S6 with the Intel Xeon X5675 processor. The value reached at that time was 18.3 watts/kSAPS, which demonstrated impressively low power consumption in combination with high throughput. This excellent result has now been improved by another 43%.

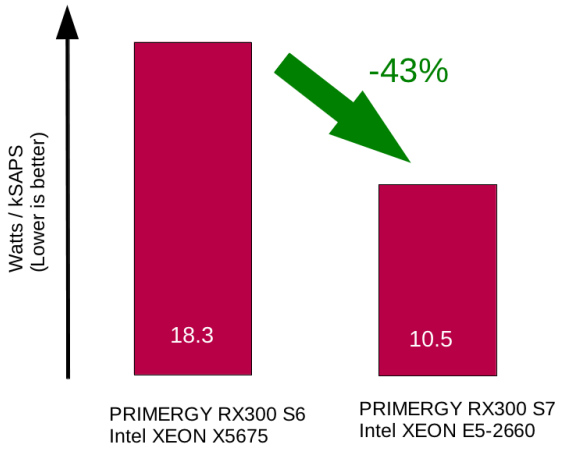
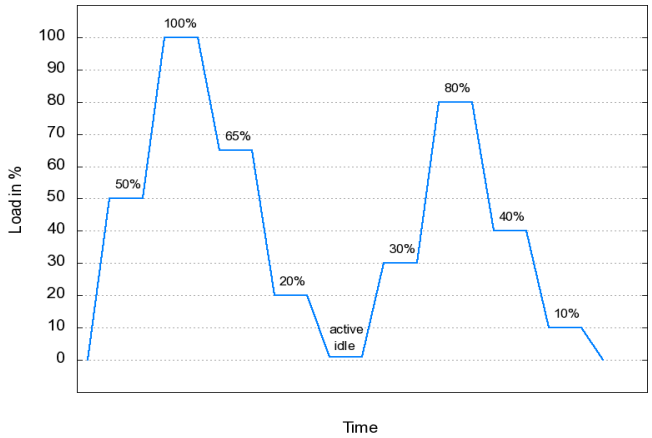



*Figure 1: The new server generation requires 43%less power per SAPS*

## Measurement Procedure

The SAP server power standard application benchmark executes different load levels to simulate the variation of server utilization over time. Throughput and electrical power consumption are determined in a defined series of measurements at nine load levels. The 100% value is defined in the preparatory work. This is the maximum number of SAP Sales and Distribution (SD) standard application benchmark users that can be operated on this system with a response time under one second - this benchmark had 6,150 SAP SD benchmark users as the 100% load. The actual benchmark has nine load levels run consecutively with the specified percentages of user numbers:




50%, 100%, 65%, 20%, active idle, 30%, 80%, 40%, 10%.
Active idle is the phase where a minimum of load runs on the system (one user on each instance of the SAP solution)

The individual phases run in an interconnected mode, i.e. as soon as the high load interval of one phase has ended, the next phase starts. You thus have an end-to-end measurement of about 4 hours in which the KPIs throughput (SAPS) and electrical power consumption (Watt) can be determined in the high-load phases of each load level.

*Figure 2: The SAP server power standard application benchmark varies the load on the system.*

## Measurement Values: Throughput and Power Consumption

The key metric 10.5 watts/kSAPS shows the average overall nine load levels. Having a look at each load level gives an insight on how the system consumes energy in relation to the delivered workload.

The following diagram shows the recorded electrical power consumption compared to the performance provided in SAPS. The graph shows this curve for the current benchmark run on the PRIMERGY RX300 S7 and compares this to the curve of the former benchmark that was run on the PRIMERGY RX300 S6:

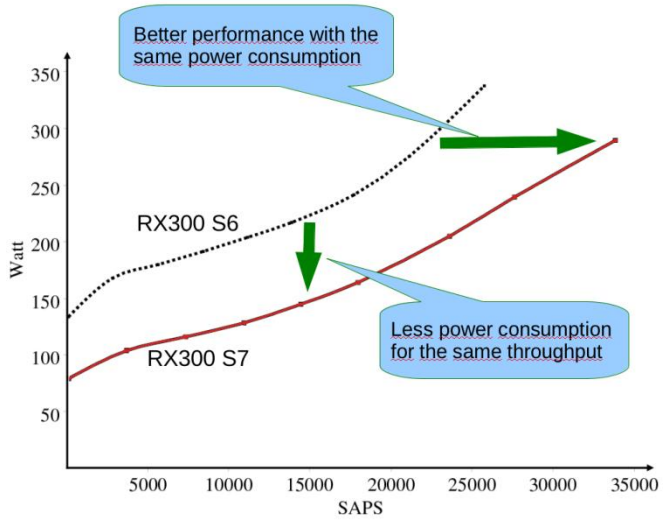



*Figure 3: Better power efficiency can be a result of higher performance or lower power consumption*

Figure 3 makes it very understandable that energy efficiency consists of two parts: Energy consumption and throughput.

- Efficiency increases if energy consumption decreases
- Efficiency increases if throughput increases.

In this benchmark, both improvements apply: The energy consumption is significantly better for all load levels than in the previous benchmark. On the other hand the average throughput has increased from 11,810 SAPS to 15,480 SAPS, thus giving more headroom for additional load.

## Efficiency

The Power Efficiency Indicator is an important indicator for this benchmark. It is specified in watts/kSAPS and the certified value 10.5 represents the average energy efficiency factor for all load levels. This indicator can of course be calculated for every load phase and gives an impression of how efficiency will develop when the system is utilized at a higher level.

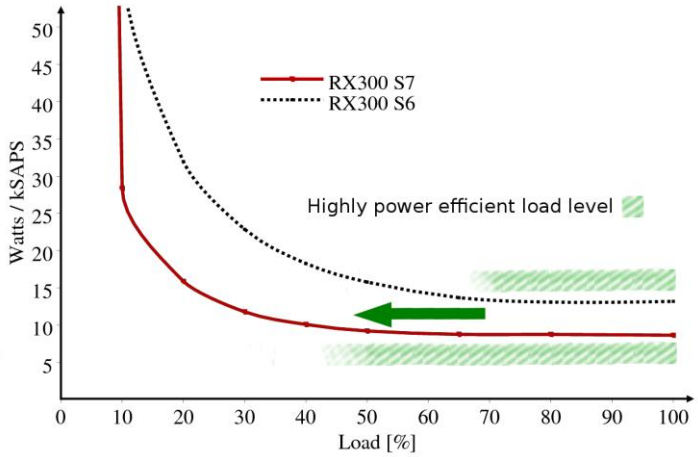



*Figure 4: The Power Efficiency Indicator has improved for all of the nine different load levels in the SAP server power standard application benchmark*

The X-axis indicates the load level as defined by the benchmark (percentage of maximum number of users that the system can sustain). Very low system utilization will always result in worse efficiency than high system utilization, regardless of the server generation. The best efficiency is reached when the system is fully utilized. Figure 4 shows that there is an area between the two extremes where the curve becomes quite flat at medium load, demonstrating that the server is already performing efficiently at these moderate load levels. Comparing the two curves, we can see that this flat area (indicating good efficiency) starts at a lower load level using the newer server generation. As it is unrealistic and, because of needed headroom for peak loads also not desirable, to drive a system at 100% load all the time, this load area of good efficiency is an important influencing factor for the overall efficiency of the system.

The PRIMERGY RX300 S7 has been consequently designed for energy efficiency in all load levels, thus widening the area of workload at which the system runs highly efficiently. However, energy-efficient servers alone cannot guarantee a highly energy-efficient operation of the entire system landscape in a datacenter. Smart management of the IT infrastructure is needed as well to distribute the load to the IT resources. Fujitsu offers for dynamic IT infrastructures for SAP solutions, which addresses this issue, e.g., FlexFrame for SAP solutions. The combination of efficient servers and a dynamic IT infrastructure solution will help to run SAP solutions in a more power-efficient manner.

## Server Configuration Optimized for Power Efficiency

Energy consumption does not play a role with systems run on other SAP standard application benchmarks. Those systems normally have very generous configurations in order to attain maximum performance. However, the SAP server power standard application benchmark balances the two "contradictory" targets of low energy consumption and high performance. As the design of PRIMERGY systems is already optimized for high energy efficiency levels (e.g., via energy-efficient power supply units and sophisticated power management tools), only a few changes are required for an efficiency optimized benchmark.

The main configuration facts for this benchmark are:

1. The use of Intel® Xeon® processor E5-2660, which is optimized for the best performance per watt ratio by balancing the thermal envelope of 95 W with high performance requirements.
2. Using efficient low-voltage DDR3 memory. The total amount of 128 GB main memory was configured as eight times 16 GB DIMMs.
3. The DIMMs support up to 1,600 MHz memory speed. In order to reduce the electric power consumption of the memory the speed was throttled to 1333 MHz in the BIOS.
4. The SAP server power standard application benchmark only measures the power consumption of the server without external storage. Therefore the benchmark configuration used external fiber channel storage connected with a dual port fiber channel controller. The database log and data files were on this storage device. The internal boot disk, which also contained all other software and database executables, page file, etc., is counted as part of the server and therefore included in the power measurement. This disk was a "250GB SATA BC" disk – a disk, especially designed as a low-power enterprise disk. The PRIMERGY RX300 S7 has an integrated raid controller on board, which was used to connect this disk.
5. Activation of the "Fujitsu enhanced power plan." A power plan is a collection of Windows settings that manages the power savings of the system. Windows 2008 R2 comes with some pre-defined power plans that cover typical system usage. The Fujitsu power plan comes with the Fujitsu ServerView Software and allows even more power saving with only little impact to the performance.
6. Usage of one 450W Platinum PSU with an efficiency of 94%. This is not a special configuration for this benchmark: All PRIMERGY RX300 S7 servers are equipped with Platinum level PSU.

The PRIMERGY RX300 S7 server is not only a highly efficient system, it also provides convincing performance, as demonstrated in the SAP SD standard application benchmark, which resulted in 7,570 SAP SD users (certification number: 2012008, March 2012)[iii]. To reach the highest performance level, the configuration for this benchmark slightly differed from the set-up used in the SAP server power standard application benchmark. Configuration differences:

1. Use of Intel E5-2690 processor
2. Run the memory at 1,600 MHz, 16 x 8GB DIMM

3. Activate the power plan "performance optimized"
4. Add a second 450W PSU

## A New Generation of Intel® Processor Architecture

The Intel® Xeon® processor E5-2600 product family comes with a wide range of built-in sensors for power consumption and temperature. This enables the processor to respond dynamically to the usage of the system and adapt to the current workload. Furthermore the sensors allow precise monitoring of the different parts and interaction with the operating system to implement advanced power schemes like the Fujitsu enhanced power plan. Apart from this, a lot of the sensors can be accessed by software and allow simple monitoring of the system under test. The following charts were generated using the Intel Performance Counter Monitor while the system was performing the SAP server power standard application benchmark (further information: http://software.intel.com/en-us/articles/intel-performance-counter-monitor/).

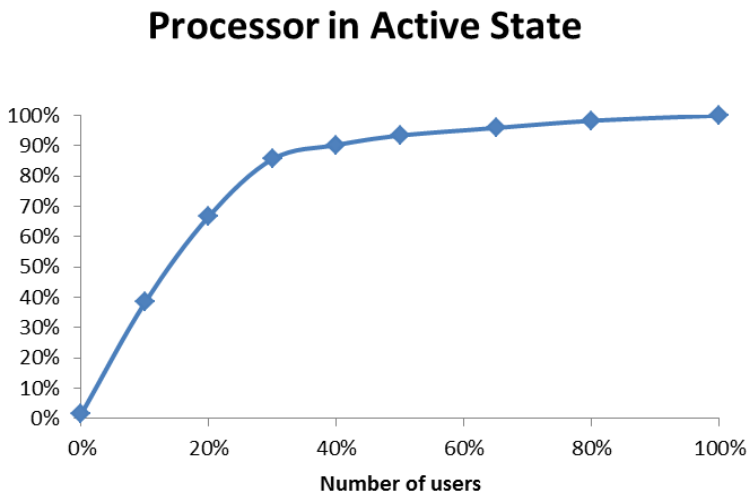




*Figure 5: Already at average load levels, the processor needs to go to active state C0 most of the time.*

Modern processors like the Intel® Xeon® processor E5-2660 implement power-saving techniques to disable parts of the processor when they are not used. These idle states when parts of a processor or the complete processor are switched off are called C states. For example, the core clock can be powered down and the different cache levels can be flushed. C0 is the operational state: The processor is active and doing some useful work. Figure 5 shows at what percentage the processor is in the C0 state depending on the load level. Interestingly, the processor is already in C0 state most of the time if only 30% of the maximum users are active. This can be explained, as the system runs distributed on all cores, thus keeping all cores busy most of the time. C states help to reduce the power consumption of the CPU when there is no useful work to be done.

Another way to reduce power consumption is the reduction in core frequency. This is realized by the so-called P states: When the system is only partly used, the operating system can reduce the core frequency. Figure 6 shows this mechanism in effect. For low utilization, a minimum core frequency of 1.2GHz guarantees a minimum response time when processing a dialog step.

When utilization rises, the frequency is increased in steps of 100MHz. The Intel® Turbo Boost Technology allows the Intel Xeon processor E5-2660 to increase its nominal frequency of 2.2GHz up to a maximum speed of 2.7GHz at the 100% load level. If only one or two cores were active, the maximum turbo speed would be even higher, but as the system utilizes all cores simultaneously, this effect cannot be observed in this benchmark.

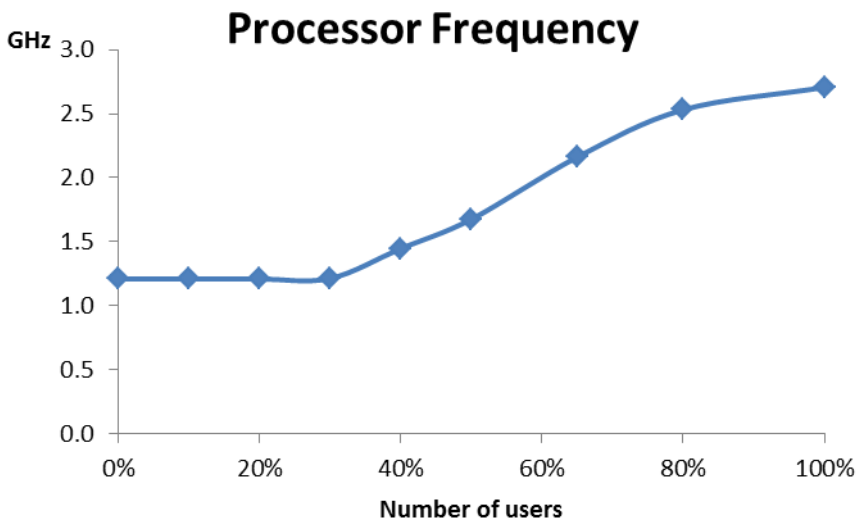



*Figure 6: The core frequency is reduced to save power at lower system utilization*

## Power Consumption and Thermal Headroom

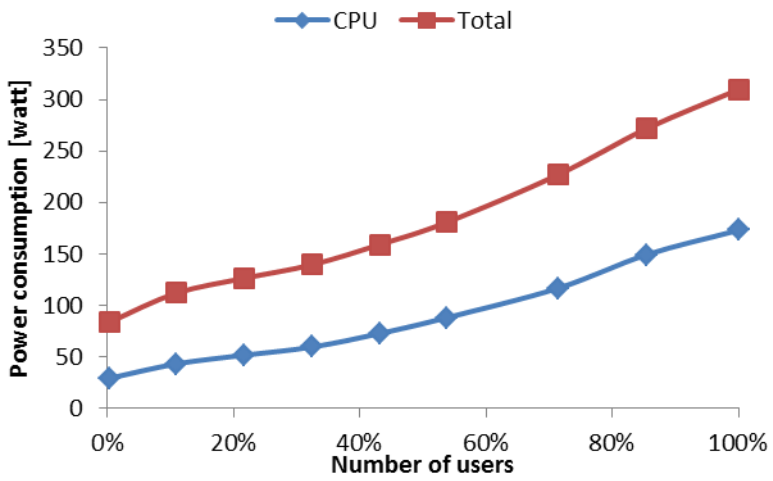



*Figure 7: Power consumption of the processor in comparison to the total system*

Figure 7 summarizes the power consumption of the CPU in comparison to the power consumption of the entire system. As the processor is still the server component that consumes most energy, the processor therefore has the highest potential to save energy with advanced power saving techniques.

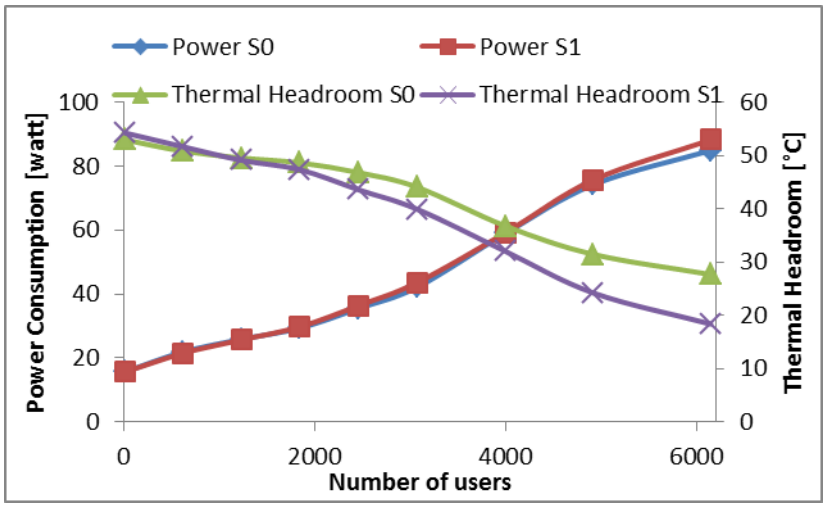



*Figure 8: With increasing number of users, the power consumption increases and the thermal headroom decreases.*

In Figure 8, the power consumption is graphed separately for each socket in comparison to the thermal headroom of the system. Since the distribution of database and application servers results in an imbalance of utilization, there is a slight variation between the two sockets of the systems. Cooling of the CPUs is one of the major issues in the design of a server. Fujitsu has invested a lot of research to optimize the air flow inside the server. For example, the cable-free board design together with a smart layout of the fan banks helps guarantee enough cooling for all critical components at a low fan speed, thus reducing the power consumption of the fans. The diagram shows the thermal headroom going down when the load increases – meaning the CPUs get hotter. But even at 100% load, the CPUs are still far from a critical temperature.

## Summary

The result of the Fujitsu PRIMERGY RX300 S7 server on the SAP server power standard application benchmark underlines that energy efficiency is not just a buzz word in the IT industry. It is taken seriously by Fujitsu and Intel, which is demonstrated by the next generation of Fujitsu PRIMERGY RX300 S7 servers featuring the Intel® Xeon® E5-2600 product family with an outstanding reduction of 43% for the power efficiency indicator in the SAP server power standard application benchmark. This impressive result was achieved on all load levels of the benchmark.

It could be reached by the combination of the latest Intel processor developments with smart server architectures and components from Fujitsu. Today, the server already runs power efficiently if the system utilization is as low as 30%, but can also take advantage of Intel Turbo Boost technology to drive the core frequency beyond the nominal frequency, while maintaining its power efficiency.

## Further Information on Energy Efficiency

### PRIMERGY Servers – Energy Efficient from the Start

PRIMERGY Servers are designed to meet state-of-the-art energy-saving requirements and standards. New power management functions as well as the new highly efficient PSUs help reduce energy costs significantly. In this way, power management has been further simplified and pre-defined energy profiles integrated:

- Performance mode: This profile makes it possible for the PRIMERGY Server to achieve maximum performance
- Minimum power mode: Ensures the lowest energy consumption so that enormous savings in times are achieved with low utilization.
- Low-noise mode: Reduces noise to a minimum and thus enables operation in an office environment

The new generation of PRIMERGY Dual Socket Servers are based on highly efficient power supply units with an efficiency degree of 94% (80+ Platinum), which enable cost-efficient operation of the PRIMERGY Servers. Further Information: http://new-primergy-2012.ts.fujitsu.com

### Dynamic Infrastructure Solutions – FlexFrame for SAP

Energy efficiency of each single server is an important prerequisite for the creation of a highly efficient environment. However, the smart orchestration of the entire SAP solution-based infrastructure can add further significant savings. FlexFrame for SAP is a pre-tested and integrated IT infrastructure solution supporting dynamic assignment of virtual and physical servers to SAP applications. With end-to-end management of cost-efficient industry standard servers, storage, networks and SAP applications, it is an ideal IT infrastructure for efficient, reliable and flexible operation of complete environments running SAP solutions.

For further information on efficiency increases with FlexFrame for SAP please listen to Thomas Schott, head of the corporate IT Service Center, Rehau AG + Co (Video Link: http://video.ts.fujitsu.com/default.aspx?movieID=173).

### Fujitsu SystemInspection Service for SAP Solutions

The optimal sizing of the entire SAP solution-based environment is also an important factor. The Fujitsu SystemInspection Service for SAP solutions also provides important information. This service was designed for two application areas:

- Analyze performance bottlenecks
- Forecasts for further operation as well as support for upgrade, migration and consolidation projects

The SystemInspection Service makes parameters, such as performance, utilization and response behavior, transparent. It detects existing and future bottlenecks and provides all the information required for optimized sizing recommendations as part of the upgrade and migration projects. Oversizing an IT scenario, which always means increased energy consumption, is now a thing of the past. Further information about the Fujitsu SystemInspection Service for SAP solutions can be found at: http://ts.fujitsu.com/sap.

### Fujitsu environment management

Fujitsu has been continuously investing in its environment protection programs since 1993. The protection of the environment and the further development of environmentally-compatible products which bring benefits to society, the economy and nature is part of our global management strategy. The Fujitsu group is committed to long-term development initiatives which reduce the environmental pressure caused by IT (OF IT), and uses IT to solve environmental problems (BY IT).

The environment management system ensures that a structured approach is used to achieve and measure sustainable targets. The Fujitsu Green Procurement Policy includes an obligation to "Green procurement" with our business partners. Fujitsu's Environmental Programs and Activities. Fujitsu is a member of the Green Grid, an IT consortium, whose aim is to reduce the total worldwide amount of energy consumption in data centers. Fujitsu is also a member of the Climate Savers Computing Initiative. This initiative unites industry, consumers and environment protection organizations in order to significantly improve the energy efficiency of computers and servers. As a member Fujitsu is obliged to develop and offer products that meet or even surpass energy standards. In 2005 Fujitsu joined the United Nations Global Compact, and has had Global ISO14001 certification since 2006 and is listed in the Dow Jones Sustainability Index.

### SAP and Sustainability

With more than 190,000 customers worldwide, SAP has a special responsibility for how much energy is consumed by its solutions. Therefore, SAP provides the following options for sustainable IT operations:

- Solutions and consulting services that help customers reduce their environmental footprint and at the same time increase the sustainability of their entire business processes.
- Energy-efficient software, for example through virtualization, efficient coding and recommendations for architecture and design.
- Collaboration with technology partners that offer infrastructures with the highest energy efficiency. SAP is working to optimize the hardware to make SAP solutions work as efficiently as possible.
- SAP has launched a benchmarking initiative on the way to defining a common method for measuring the energy consumption. The new SAP power standard application benchmarks expand the existing benchmark suite with a contemporary component measuring power consumption in the benchmark environment.

With the latest result achieved by Fujitsu on the SAP server power standard application benchmark, Fujitsu has achieved one more milestone for energy-efficient hardware. After having achieved the first certified results on the SAP server power standard application benchmark - a very good result of 18.3 watts/kSAPS – Fujitsu managed to cut power consumption nearly in half and has now achieved 10.5 watts/kSAPS. These results will pose a tough challenge for the competition to beat.

### Intel – Environmentally Friendly Production of Efficient Processors

The topic of environment protection is at the top of Intel's agenda. As early as 2008 Intel was supplying processors without using lead and halogen. Low pollutants and CO2 emissions and energy efficiency are the focus of Intel environment initiatives. By annually using more than 1.3 billion kilowatt hours of "green power" Intel itself has set a standard for using renewable energy sources. Intel is working closely with the US environment agency EPA on Energy Star® energy-saving guidelines and is also working with Microsoft, Fujitsu and other well-known companies on the Climate Savers Computing Initiative with the aim of saving energy and reducing emissions of greenhouse gases. The Intel® Xeon® processors automatically regulate their energy consumption according to performance and server workload. As the existing benchmark with the Intel® Xeon® E5-2600 processor shows, this results in a considerable reduction in energy costs and CO2 emissions in the data center.

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[i] Configuration and results of the Fujitsu PRIMERGY RX300 S6 on the two-tier SAP server power standard application benchmark: 2 processors, 12 cores, 24 threads; Intel Xeon X5675 processor; running SAP enhancement package 4 for the SAP ERP 6.0 application, SQL Server 2008, and Windows 2008 R2 Datacenter Edition. Achieved 18.3 watts/kSAPS. Certification number 2011008.

[ii] Configuration and results of the Fujitsu PRIMERGY RX300 S7 on the two-tier SAP SD standard application benchmark: 2 processors, 16 cores, 32 threads; Intel Xeon processor E5-2690; running SAP enhancement package 4 for SAP ERP 6.0, SQL Server 2008 and Windows 2008 R2 Enterprise Edition. Achieved 7,570 SAP SD benchmark users. Certification number 2012008.

For more details see: http://www.sap.com/benchmark

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