White Paper
FUJITSU Server PRIMERGY
Performance Report PRIMERGY RX1330 M3

This document contains a summary of the benchmarks executed for the FUJITSU Server PRIMERGY RX1330 M3.

The PRIMERGY RX1330 M3 performance data are compared with the data of other PRIMERGY models and discussed. In addition to the benchmark results, an explanation has been included for each benchmark and for the benchmark environment.

Version
1.0
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Document history

Version 1.0 (2017-06-02)

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Technical data

PRIMERGY RX1330 M3

Decimal prefixes according to the SI standard are used for measurement units in this white paper (e.g. 1 GB = 10^9 bytes). In contrast, these prefixes should be interpreted as binary prefixes (e.g. 1 GB = 2^{30} bytes) for the capacities of caches and memory modules. Separate reference will be made to any further exceptions where applicable.

Model	PRIMERGY RX1330 M3
Model versions	PY RX1330M3/LFF/standard PSU PY RX1330M3/LFF/hot plug PSU/red. fans PY RX1330M3/SFF/standard PSU PY RX1330M3/SFF/hot plug PSU/red. fans PY RX1330M3/10xSFF/hot plug PSU/red.fans
Form factor	Rack server
Chipset	Intel® C236
Number of sockets	1
Processor type	Intel® Celeron® G3930 Intel® Pentium® G4560 Intel® Core™ i3-7100 Intel® Xeon® Processor E3-1200 v6 Product Family
Number of memory slots	4
Maximum memory configuration	64 GB
Onboard LAN controller	2 × 1 Gbit/s
Onboard HDD controller	Controller with RAID 0, RAID 1 or RAID 10 for up to 4 SATA HDDs
PCI slots	2 × PCI-Express 3.0 x8 1 × PCI-Express 2.0 x4 (mech. x8)
Max. number of internal hard disks	PY RX1330M3/LFF/standard PSU、 PY RX1330M3/LFF/hot plug PSU/red. fans： 4 PY RX1330M3/SFF/standard PSU、 PY RX1330M3/SFF/hot plug PSU/red. fans： 8 PY RX1330M3/10xSFF/hot plug PSU/red.fans：10

Processors (since system release)							
Processor	Cores	Threads	Cache [MB]	Rated Frequency [Ghz]	Max. Turbo Frequency [Ghz]	Max. Memory Frequency [MHz]	TDP [Watt]
Celeron G3930	2	2	2	2.90	n/a	2133	51
Pentium G4560	2	4	3	3.50	n/a	2400	54
Core i3-7100	2	4	3	3.90	n/a	2400	51
Xeon E3-1220 v6	4	4	8	3.00	3.50	2400	72
Xeon E3-1225 v6	4	4	8	3.30	3.70	2400	73
Xeon E3-1230 v6	4	8	8	3.50	3.90	2400	72
Xeon E3-1240 v6	4	8	8	3.70	4.10	2400	72
Xeon E3-1270 v6	4	8	8	3.80	4.20	2400	72
Xeon E3-1280 v6	4	8	8	3.90	4.20	2400	72

All the processors of Intel® Xeon® Processor E3-1200 v6 Product Family that can be ordered with the PRIMERGY RX1330 M3 support Intel® Turbo Boost Technology 2.0. This technology allows you to operate the processor with higher frequencies than the nominal frequency. Listed in the processor table is "Max. Turbo Frequency" for the theoretical frequency maximum with only one active core per processor. The maximum frequency that can actually be achieved depends on the number of active cores, the current consumption, electrical power consumption and the temperature of the processor.

As a matter of principle Intel does not guarantee that the maximum turbo frequency will be reached. This is related to manufacturing tolerances, which result in a variance regarding the performance of various examples of a processor model. The range of the variance covers the entire scope between the nominal frequency and the maximum turbo frequency.

The turbo functionality can be set via BIOS option. Fujitsu generally recommends leaving the "Turbo Mode" option set at the standard setting "Enabled", as performance is substantially increased by the higher frequencies. However, since the higher frequencies depend on general conditions and are not always guaranteed, it can be advantageous to disable the "Turbo Mode" option for application scenarios with intensive use of AVX instructions and a high number of instructions per clock unit, as well as for those that require constant performance or lower electrical power consumption.

Memory modules (since system release)								
Memory module	Capacity [GB]	Ranks	Bit width of the memory chips	Frequency [MHz]	Low voltage	Load reduced	Registered	ECC
4GB (1x4GB) 1Rx8 DDR4-2400 U ECC	4	1	8	2400				✓
8GB (1x8GB) 1Rx8 DDR4-2400 U ECC	8	1	8	2400				✓
16GB (1x16GB) 2Rx8 DDR4-2400 U ECC	16	2	8	2400				✓

Power supplies (since system release)	Max. number
Standard PSU 300W	1
Modular PSU 450W platinum hp	2

Some components may not be available in all countries or sales regions.
Detailed technical information is available in the data sheet PRIMERGY RX1330 M3.

SPECcpu2006

Benchmark description

SPECcpu2006 is a benchmark which measures the system efficiency with integer and floating-point operations. It consists of an integer test suite (SPECint2006) containing 12 applications and a floating-point test suite (SPECfp2006) containing 17 applications. Both test suites are extremely computing-intensive and concentrate on the CPU and the memory. Other components, such as Disk I/O and network, are not measured by this benchmark.

SPECcpu2006 is not tied to a special operating system. The benchmark is available as source code and is compiled before the actual measurement. The used compiler version and their optimization settings also affect the measurement result.

SPECcpu2006 contains two different performance measurement methods: the first method (SPECint2006 or SPECfp2006) determines the time which is required to process single task. The second method (SPECint_rate2006 or SPECfp_rate2006) determines the throughput, i.e. the number of tasks that can be handled in parallel. Both methods are also divided into two measurement runs, “base” and “peak” which differ in the use of compiler optimization. When publishing the results the base values are always used; the peak values are optional.

Benchmark	Arithmetics	Type	Compiler optimization	Measurement result	Application
SPECint2006	integer	peak	aggressive	Speed	single-threaded
SPECint_base2006	integer	base	conservative		
SPECint_rate2006	integer	peak	aggressive	Throughput	multi-threaded
SPECint_rate_base2006	integer	base	conservative		
SPECfp2006	floating point	peak	aggressive	Speed	single-threaded
SPECfp_base2006	floating point	base	conservative		
SPECfp_rate2006	floating point	peak	aggressive	Throughput	multi-threaded
SPECfp_rate_base2006	floating point	base	conservative		

The measurement results are the geometric average from normalized ratio values which have been determined for individual benchmarks. The geometric average - in contrast to the arithmetic average - means that there is a weighting in favour of the lower individual results. Normalized means that the measurement is how fast is the test system compared to a reference system. Value “1” was defined for the SPECint_base2006-, SPECint_rate_base2006, SPECfp_base2006 and SPECfp_rate_base2006 results of the reference system. For example, a SPECint_base2006 value of 2 means that the measuring system has handled this benchmark twice as fast as the reference system. A SPECfp_rate_base2006 value of 4 means that the measuring system has handled this benchmark some 4/[# base copies] times faster than the reference system. “# base copies” specify how many parallel instances of the benchmark have been executed.

Not every SPECcpu2006 measurement is submitted by us for publication at SPEC. This is why the SPEC web pages do not have every result. As we archive the log files for all measurements, we can prove the correct implementation of the measurements at any time.

Benchmark environment

System Under Test (SUT)	
Hardware	
Model	PRIMERGY RX1330 M3
Processor	Celeron G3930 Pentium G4560 Core i3-7100 Intel® Xeon® Processor E3-1200 v6 Product Family
Memory	16GB (1x16GB) 2Rx8 DDR4-2400 U ECC × 4
Software	
BIOS settings	SPECint2006/SPECint_base2006/SPECfp2006/SPECfp_base2006： Hyper-threading = Disabled
Operating system	SUSE Linux Enterprise Server 12 SP2 (x86_64)
Operating system settings	cpupower -c all frequency-set -g performance cpupower idle-set -d 2 cpupower idle-set -d 3 cpupower idle-set -d 4 echo always > /sys/kernel/mm/transparent_hugepage/enabled SPECint2006/SPECint_base2006/SPECfp2006/SPECfp_base2006： KMP_AFFINITY = "granularity=fine,scatter" OMP_NUM_THREADS = "4" SPECint_rate2006/SPECint_rate_base2006/SPECfp_rate2006/SPECfp_rate_base2006： echo 1 > /proc/sys/vm/drop_caches echo 1000000000 > /proc/sys/kernel/sched_min_granularity_ns echo 1500000000 > /proc/sys/kernel/sched_wakeup_granularity_ns
Compiler	C/C++: Version 17.0.0.098 of Intel C/C++ Compiler for Linux Fortran: Version 17.0.0.098 of Intel Fortran Compiler for Linux

Some components may not be available in all countries or sales regions.

Benchmark results

In terms of processors the benchmark result depends primarily on the size of the processor cache, the support for Hyper-Threading, the number of processor cores and on the processor frequency. In the case of processors with Turbo mode the number of cores, which are loaded by the benchmark, determines the maximum processor frequency that can be achieved. In the case of single-threaded benchmarks, which largely load one core only, the maximum processor frequency that can be achieved is higher than with multi-threaded benchmarks.

The results marked (est.) are estimates.

Processor	SPECint_base2006	SPECint2006	SPECint_rate_base2006	SPECint_rate2006
Celeron G3930			83.8(est.)	86.2(est.)
Pentium G4560			123(est.)	128(est.)
Core i3-7100			141(est.)	146(est.)
Xeon E3-1220 v6			**200**	**207**
Xeon E3-1225 v6			**209**	**217**
Xeon E3-1230 v6			**256**	**266**
Xeon E3-1240 v6			**265**	**276**
Xeon E3-1270 v6			**270**	**280**
Xeon E3-1280 v6	**74.5**	**77.0**	**271**	**280**

Processor	SPECfp_base2006	SPECfp2006	SPECfp_rate_base2006	SPECfp_rate2006
Celeron G3930	45.8(est.)	47.6(est.)	92.8(est.)	94.2(est.)
Pentium G4560	55.6(est.)	57.9(est.)	122(est.)	124(est.)
Core i3-7100	91.5(est.)	93.7(est.)	142(est.)	146(est.)
Xeon E3-1220 v6	**92.4**	**93.6**	**184**	**188**
Xeon E3-1225 v6	**95.9**	**97.0**	**189**	**193**
Xeon E3-1230 v6	**99.5**	**101**	**202**	**205**
Xeon E3-1240 v6	**102**	**103**	**205**	**210**
Xeon E3-1270 v6	**105**	**106**	**207**	**212**
Xeon E3-1280 v6	**104**	**106**	**207**	**212**

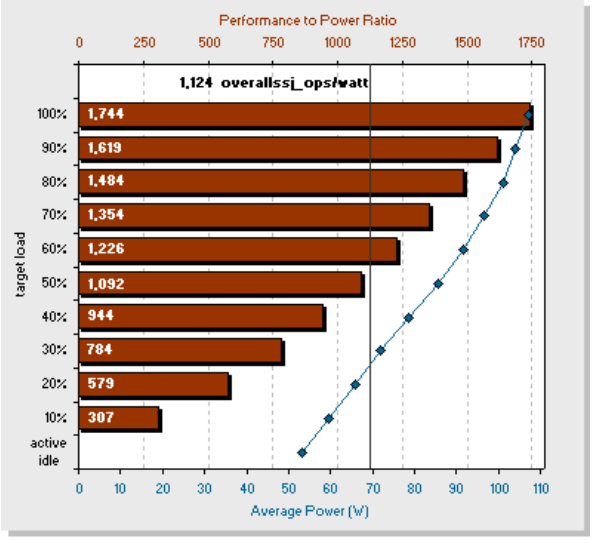
SPECpower_ssj2008

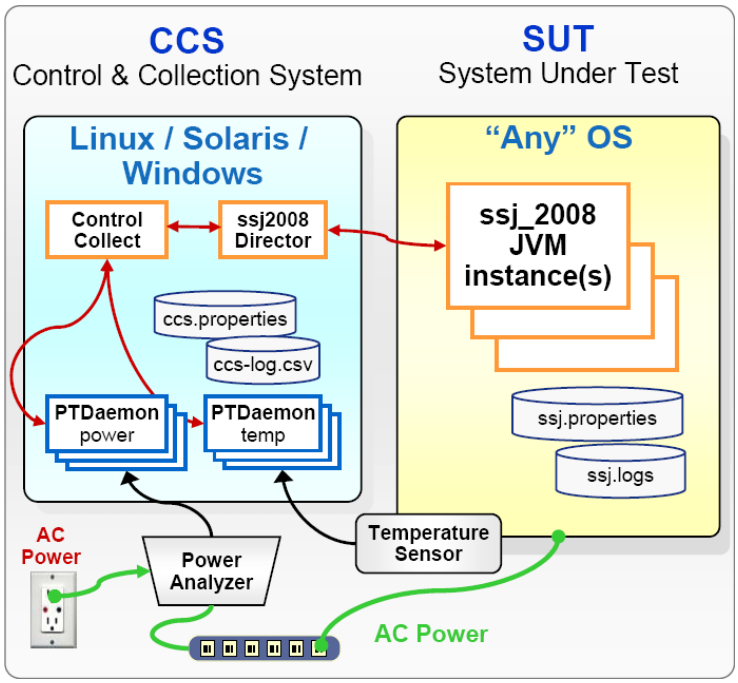
Benchmark description

SPECpower_ssj2008 is the first industry-standard SPEC benchmark that evaluates the power and performance characteristics of a server. With SPECpower_ssj2008 SPEC has defined standards for server power measurements in the same way they have done for performance.

The benchmark workload represents typical server-side Java business applications. The workload is scalable, multi-threaded, portable across a wide range of platforms and easy to run. The benchmark tests CPUs, caches, the memory hierarchy and scalability of symmetric multiprocessor systems (SMPs), as well as the implementation of Java Virtual Machine (JVM), Just In Time (JIT) compilers, garbage collection, threads and some aspects of the operating system.

SPECpower_ssj2008 reports power consumption for servers at different performance levels — from 100% to "active idle" in 10% segments — over a set period of time. The graduated workload recognizes the fact that processing loads and power consumption on servers vary substantially over the course of days or weeks. To compute a power-performance metric across all levels, measured transaction throughputs for each segment are added together and then divided by the sum of the average power consumed for each segment. The result is a figure of merit called "overall ssj_ops/watt". This ratio provides information about the energy efficiency of the measured server. The defined measurement standard enables customers to compare it with other configurations and servers measured with SPECpower_ssj2008. The diagram shows a typical graph of a SPECpower_ssj2008 result.





The benchmark runs on a wide variety of operating systems and hardware architectures and does not require extensive client or storage infrastructure. The minimum equipment for SPEC-compliant testing is two networked computers, plus a power analyzer and a temperature sensor. One computer is the System Under Test (SUT) which runs one of the supported operating systems and the JVM. The JVM provides the environment required to run the SPECpower_ssj2008 workload which is implemented in Java. The other computer is a "Control & Collection System" (CCS) which controls the operation of the benchmark and captures the power, performance and temperature readings for reporting. The diagram provides an overview of the basic structure of the benchmark configuration and the various components.

Benchmark environment

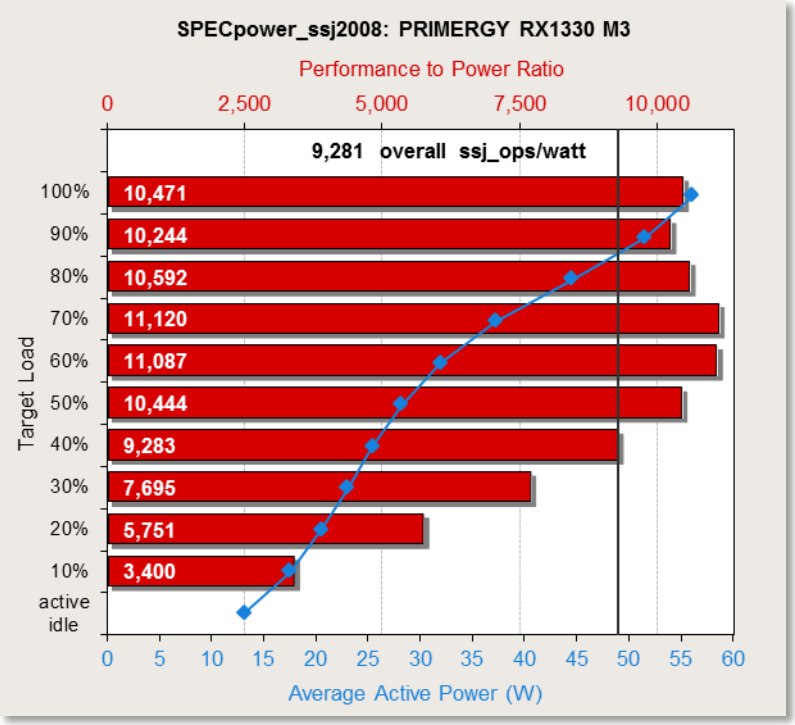
System Under Test (SUT)	
Hardware	
Model	PRIMERGY RX1330 M3
Model version	PY RX1330M3/LFF/standard PSU
Processor	Xeon E3-1230 v6
Memory	2 × 8GB (1x8GB) 2Rx8 DDR4-2400 U ECC
Network-Interface	Onboard LAN-Controller (2port used)
Disk-Subsystem	Onboard SATA controller 1 × SSD SATA 6G 64GB DOM N H-P
Power Supply Unit	1 × Standard PSU 300W
Software	
BIOS	R0.92.0
BIOS settings	Hardware Prefetcher = Disabled Adjacent Cache Line Prefetch = Disabled DCU Streamer Prefetcher = Disabled ASPM Support = Auto Turbo Mode = Disabled LAN Controller = LAN 1 Intel Virtualization Technology = Disabled SATA Port 1 = Disabled SATA Port 2 = Disabled SATA Port 3 = Disabled SATA Port 4 = Disabled SATA Port 5 = Disabled Serial Port = Disabled Management LAN = Disabled
Firmware	8.64F
Operating system	Microsoft Windows Server 2012 R2 Standard
Operating system settings	Using the local security settings console, “lock pages in memory” was enabled for the user running the benchmark. Power Management: Enabled (“Fujitsu Enhanced Power Settings” power plan) Set “Turn off hard disk after = 1 Minute” in OS. Benchmark was started via Windows Remote Desktop Connection. Each JVM instance was affinitized to two logical processors.
JVM	Oracle Java HotSpot(TM) 64-Bit Server VM (build 24.80-b11, mixed mode), version 1.7.0_80
JVM settings	-server -Xmn9500m -Xms11000m -Xmx11000m -XX:SurvivorRatio=1 -XX:TargetSurvivorRatio=99 -XX:AllocatePrefetchDistance=256 -XX:AllocatePrefetchLines=4 -XX:LoopUnrollLimit=45 -XX:InitialTenuringThreshold=12 -XX:MaxTenuringThreshold=15 -XX:ParallelGCThreads=2 -XX:InlineSmallCode=3900 -XX:MaxInlineSize=270 -XX:FreqInlineSize=2500 -XX:+AggressiveOpts -XX:+UseLargePages -XX:+UseParallelOldGC

Some components may not be available in all countries or sales regions.

Benchmark results

The PRIMERGY RX1330 M3 achieved the following result:

SPECpower_ssj2008 = 9,281 overall ssj_ops/watt

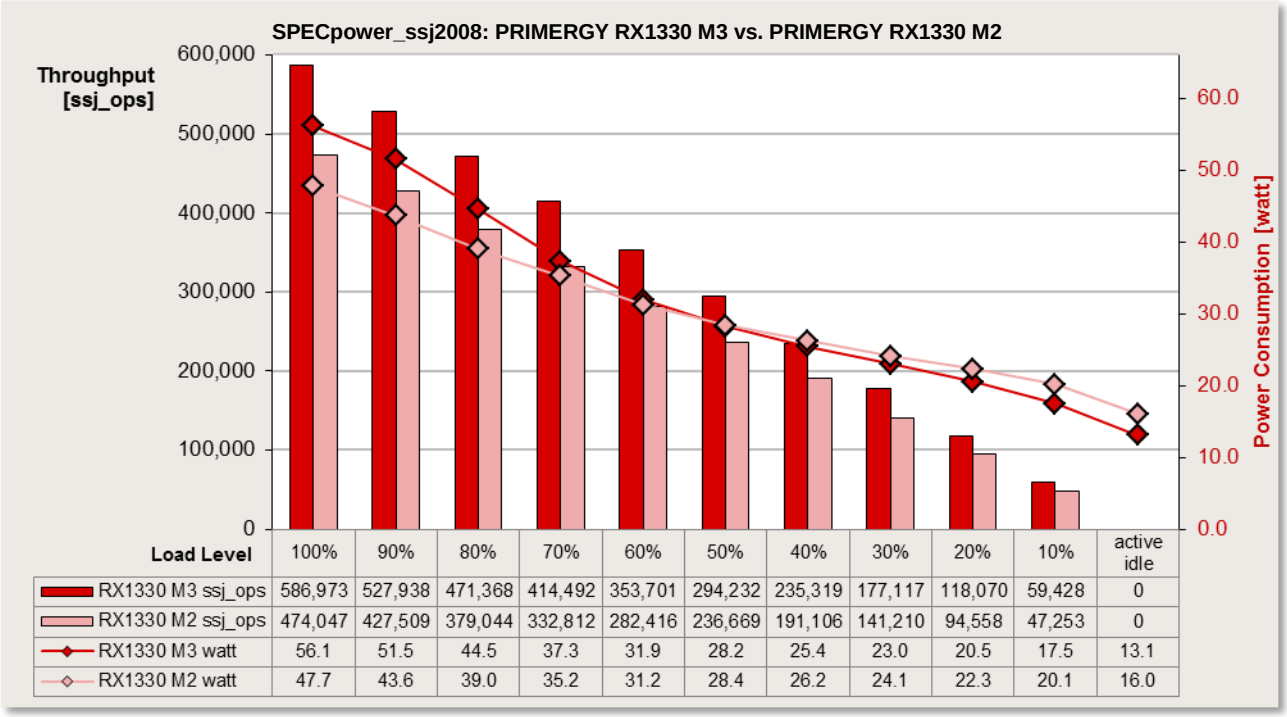


The adjoining diagram shows the result of the configuration described above. The red horizontal bars show the performance to power ratio in ssj_ops/watt (upper x-axis) for each target load level tagged on the y-axis of the diagram. The blue line shows the run of the curve for the average power consumption (bottom x-axis) at each target load level marked with a small rhomb. The black vertical line shows the benchmark result of 7,809 overall ssj_ops/watt for the PRIMERGY RX1330 M3. This is the quotient of the sum of the transaction throughputs for each load level and the sum of the average power consumed for each measurement interval.

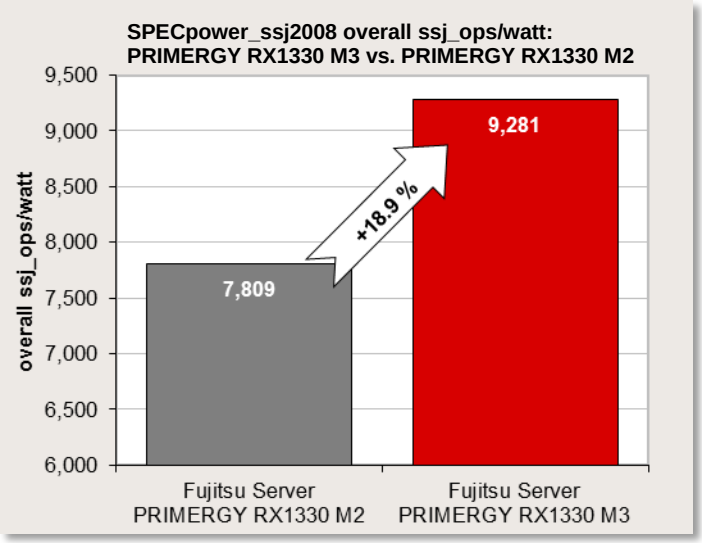
The following table shows the benchmark results for the throughput in ssj_ops, the power consumption in watts and the resulting energy efficiency for each load level.

Performance		Power	Energy Efficiency
Target Load	ssj_ops	Average Power (W)	ssj_ops/watt
100 %	586,973	56.1	10,471
90 %	527,938	51.5	10,244
80 %	471,368	44.5	10,592
70 %	414,492	37.3	11,120
60 %	353,701	31.9	11,087
50 %	294,232	28.2	10,444
40 %	235,319	25.4	9,283
30 %	177,117	23.0	7,695
20 %	118,070	20.5	5,751
10 %	59,428	17.5	3,400
Active Idle	0	13.1	0
		∑ssj_ops / ∑power = 9,281	

The following diagram shows for each load level the power consumption (on the right y-axis) and the throughput (on the left y-axis) of the PRIMERGY RX1330 M3 compared to the predecessor PRIMERGY RX1330 M2



Load Level	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	active idle
RX1330 M3 ssj_ops	586,973	527,938	471,368	414,492	353,701	294,232	235,319	177,117	118,070	59,428	0
RX1330 M2 ssj_ops	474,047	427,509	379,044	332,812	282,416	236,669	191,106	141,210	94,558	47,253	0
RX1330 M3 watt	56.1	51.5	44.5	37.3	31.9	28.2	25.4	23.0	20.5	17.5	13.1
RX1330 M2 watt	47.7	43.6	39.0	35.2	31.2	28.4	26.2	24.1	22.3	20.1	16.0



The comparison with PRIMERGY RX1330 M2 which has been the most energy efficient in the category of 1 socet rack server the advantage of the PRIMERGY TX1330 M3 in the field of energy efficiency evident.

Compared with RX1330 M2 of old system, RX1330 M3 achieves 18.9% superior energy efficiency.

VMmark V2

Benchmark description

VMmark V2 is a benchmark developed by VMware to compare server configurations with hypervisor solutions from VMware regarding their suitability for server consolidation. In addition to the software for load generation, the benchmark consists of a defined load profile and binding regulations. The benchmark results can be submitted to VMware and are published on their Internet site after a successful review process. After the discontinuation of the proven benchmark “VMmark V1” in October 2010, it has been succeeded by “VMmark V2”, which requires a cluster of at least two servers and covers data center functions, like Cloning and Deployment of virtual machines (VMs), Load Balancing, as well as the moving of VMs with vMotion and also Storage vMotion.

In addition to the “Performance Only” result, it is also possible from version 2.5 of VMmark to alternatively measure the electrical power consumption and publish it as a “Performance with Server Power” result (power consumption of server systems only) and/or “Performance with Server and Storage Power” result (power consumption of server systems and all storage components).

VMmark V2 is not a new benchmark in the actual sense. It is in fact a framework that consolidates already established benchmarks, as workloads in order to simulate the load of a virtualized consolidated server environment. Three proven benchmarks, which cover the application scenarios mail server, Web 2.0, and e-commerce were integrated in VMmark V2.

Application scenario	Load tool	# VMs
Mail server	LoadGen	1
Web 2.0	Olio client	2
E-commerce	DVD Store 2 client	4
Standby server	(IdleVMTest)	1

Each of the three application scenarios is assigned to a total of seven dedicated virtual machines. Then add to these an eighth VM called the “standby server”. These eight VMs form a “tile”. Because of the performance capability of the underlying server hardware, it is usually necessary to have started several identical tiles in parallel as part of a measurement in order to achieve a maximum overall performance.

A new feature of VMmark V2 is an infrastructure component, which is present once for every two hosts. It measures the efficiency levels of data center consolidation through VM Cloning and Deployment, vMotion and Storage vMotion. The Load Balancing capacity of the data center is also used (DRS, Distributed Resource Scheduler).

The result of VMmark V2 for test type „Performance Only“ is a number, known as a “score”, which provides information about the performance of the measured virtualization solution. The score reflects the maximum total consolidation benefit of all VMs for a server configuration with hypervisor and is used as a comparison criterion of various hardware platforms.

This score is determined from the individual results of the VMs and an infrastructure result. Each of the five VMmark V2 application or front-end VMs provides a specific benchmark result in the form of application-specific transaction rates for each VM. In order to derive a normalized score the individual benchmark results for one tile are put in relation to the respective results of a reference system. The resulting dimensionless performance values are then averaged geometrically and finally added up for all VMs. This value is included in the overall score with a weighting of 80%. The infrastructure workload is only present in the benchmark once for every two hosts; it determines 20% of the result. The number of transactions per hour and the average duration in seconds respectively are determined for the score of the infrastructure workload components.

In addition to the actual score, the number of VMmark V2 tiles is always specified with each VMmark V2 score. The result is thus as follows: “Score@Number of Tiles”, for example “4.20@5 tiles”.

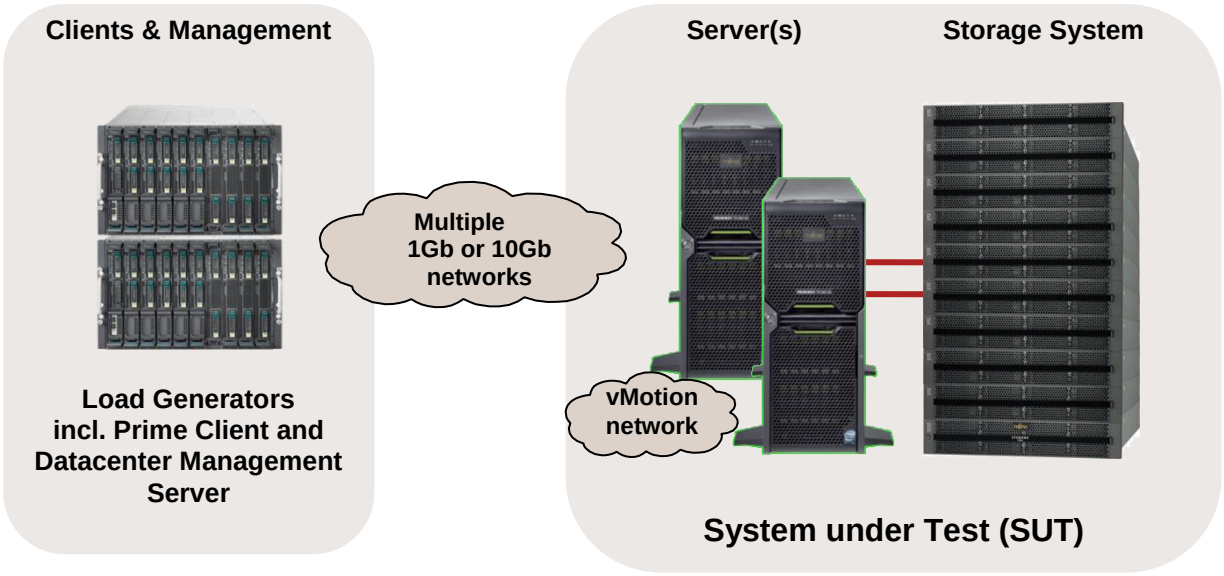
In the case of the two test types “Performance with Server Power” and “Performance with Server and Storage Power” a so-called “Server PPKW Score” and “Server and Storage PPKW Score” is determined, which is the performance score divided by the average power consumption in kilowatts (PPKW = performance per kilowatt (KW)).

The results of the three test types should not be compared with each other.

A detailed description of VMmark V2 is available in the document Benchmark Overview VMmark V2.

Benchmark environment

The measurement set-up is symbolically illustrated below:



System Under Test (SUT)	
Hardware	
Number of servers	3
Model	PRIMERGY RX1330 M3
Processor	3 × Xeon E3-1280 v6
Memory	64 GB: 4 × 16GB (1x16GB) 2Rx8 DDR4-2400 T ECC
Network interface	1 × Onboard Intel I210 Dual Port 1GbE Adapter 1 ×Intel I210 Single Port 1GbE Adapter
Disk subsystem	1 × Dual port FC Ctrl 8Gb/s 2 Chan QLE2562 MMF LC LP 1 × PRIMERGY RX300 S8 configured as Fibre Channel target: 4 × SAS-SSD (400 GB) 2 × Fusion-io ioDrive®2 PCIe-SSD (1.2 TB) RAID 0 with several LUNs Total: 2195 GB
Software	
BIOS	Version V5.0.0.11 R1.3.0
BIOS settings	See details
Operating system	VMware ESXi 6.0.0 U3 Build 5050593
Operating system settings	ESX settings: see details

Details	
See disclosure	http://www.vmware.com/a/assets/vmmark/pdf/2017-05-08-Fujitsu-RX1330M3.pdf

Datacenter Management Server (DMS)	
Hardware (Shared)	
Enclosure	PRIMERGY RX2540 M1
Network Switch	2 ×Fujitsu SR-X340TR1
Hardware	
Model	1 ×Fujitsu Server PRIMERGY RX2540 M1
Processor	2 ×Xeon E5-2697 v3
Memory	24 GB
Network interface	2 × 1 Gbit/s LAN
Software	
Operating system	VMware ESXi 6.0.0 Build 3620759
Datacenter Management Server (DMS) VM	
Hardware	
Processor	4 × logical CPU
Memory	10 GB
Network interface	2 × 1 Gbit/s LAN
Software	
Operating system	Microsoft Windows Server 2008 R2 Enterprise x64 Edition

Prime Client	
Hardware (Shared)	
Enclosure	PRIMERGY RX2540 M1
Network Switch	1 × Fujitsu SR-X340TR1
Hardware	
Model	1 × PRIMERGY RX2540 M1
Processor	2 × Xeon E5-2630 v3
Memory	128 GB
Network interface	4 × 1 Gbit/s LAN
Software	
Operating system	Microsoft Windows Server 2008 Enterprise x64 Edition SP2

Load generator	
Hardware	
Model	1 × PRIMERGY RX4770 M3 1 × PRIMERGY CX2540 M2
Processor	PRIMERGY RX4770 M3: 4 × Xeon E7-8880 v4 PRIMERGY CX2540 M2: 2 × Xeon E5-2687W v4
Memory	PRIMERGY RX4770 M3: 256GB PRIMERGY CX2540 M2: 256GB
Network interface	PRIMERGY RX4770 M3: 4 × 1 Gbit/s LAN PRIMERGY CX2540 M2: 4 × 1 Gbit/s LAN
Software	
Operating system	VMware ESX 6.0.0 U2 Build 3620759

Load generator VM (per tile 1 load generator VM)	
Hardware	
Processor	4 × logical CPU
Memory	4 GB
Network interface	1 × 1 Gbit/s LAN
Software	
Operating system	Microsoft Windows Server 2008 Enterprise x64 Edition SP2

Some components may not be available in all countries or sales regions.

Benchmark results

On May 8, 2017 Fujitsu achieved with a PRIMERGY RX1330 M3 with Xeon E3-1280 v6 processors and VMware ESXi 6.0.0 U1b a VMmark V2 score of “3.96@3 tiles” in a system configuration with a total of 3 × 4 processor cores and when using three identical servers in the “System under Test” (SUT). With this result the PRIMERGY RX1330 M3 is in the official VMmark V2 “Performance Only” ranking the most powerful 1-socket server (valid as of benchmark results publication date).

All comparisons for the competitor products reflect the status of 8th May 2017. The current VMmark V2 “Performance Only” results as well as the detailed results and configuration data are available at http://www.vmware.com/a/vmmark/.

The processors used, which with a good hypervisor setting could make optimal use of their processor features, were the essential prerequisites for achieving the PRIMERGY RX1330 M3 result. These features include Hyper-Threading. All this has a particularly positive effect during virtualization.

All VMs, their application data, the host operating system as well as additionally required data were on a powerful Fibre Channel disk subsystem. As far as possible, the configuration of the disk subsystem takes the specific requirements of the benchmark into account. The use of flash technology in the form of SAS SSDs and PCIe-SSDs in the powerful Fibre Channel disk subsystem resulted in further advantages in response times of the storage medium used.

The network connection to the load generators was implemented via 1Gb LAN ports. The infrastructure-workload connection between the hosts was by means of 1Gb LAN ports.

All the components used were optimally attuned to each other.

STREAM

Benchmark description

STREAM is a synthetic benchmark that has been used for many years to determine memory throughput and which was developed by John McCalpin during his professorship at the University of Delaware. Today STREAM is supported at the University of Virginia, where the source code can be downloaded in either Fortran or C. STREAM continues to play an important role in the HPC environment in particular. It is for example an integral part of the HPC Challenge benchmark suite.

The benchmark is designed in such a way that it can be used both on PCs and on server systems. The unit of measurement of the benchmark is GB/s, i.e. the number of gigabytes that can be read and written per second.

STREAM measures the memory throughput for sequential accesses. These can generally be performed more efficiently than accesses that are randomly distributed on the memory, because the processor caches are used for sequential access.

Before execution the source code is adapted to the environment to be measured. Therefore, the size of the data area must be at least 12 times larger than the total of all last-level processor caches so that these have as little influence as possible on the result. The OpenMP program library is used to enable selected parts of the program to be executed in parallel during the runtime of the benchmark, consequently achieving optimal load distribution to the available processor cores.

During implementation the defined data area, consisting of 8-byte elements, is successively copied to four types, and arithmetic calculations are also performed to some extent.

Type	Execution	Bytes per step	Floating-point calculation per step
COPY	a(i) = b(i)	16	0
SCALE	a(i) = q × b(i)	16	1
SUM	a(i) = b(i) + c(i)	24	1
TRIAD	a(i) = b(i) + q × c(i)	24	2

The throughput is output in GB/s for each type of calculation. The differences between the various values are usually only minor on modern systems. In general, only the determined TRIAD value is used as a comparison.

The measured results primarily depend on the clock frequency of the memory modules; the processors influence the arithmetic calculations.

This chapter specifies throughputs on a basis of 10 (1 GB/s = 10^9 Byte/s).

Benchmark environment

System Under Test (SUT)	
Hardware	
Model	PRIMERGY RX1330 M3
Processor	Celeron G3930 Pentium G4560 Core i3-7100 Intel® Xeon® Processor E3-1200 v6 Product Family
Memory	4 × 16GB (1x16GB) 2Rx8 DDR4-2400 U ECC
Software	
Operating system	SUSE Linux Enterprise Server 12 SP2 (x86_64)
Operating system settings	Transparent Huge Pages inactivated
Compiler	Version 17.0.0.098 of Intel C++ Compiler for Linux
Benchmark	Stream.c Version 5.10

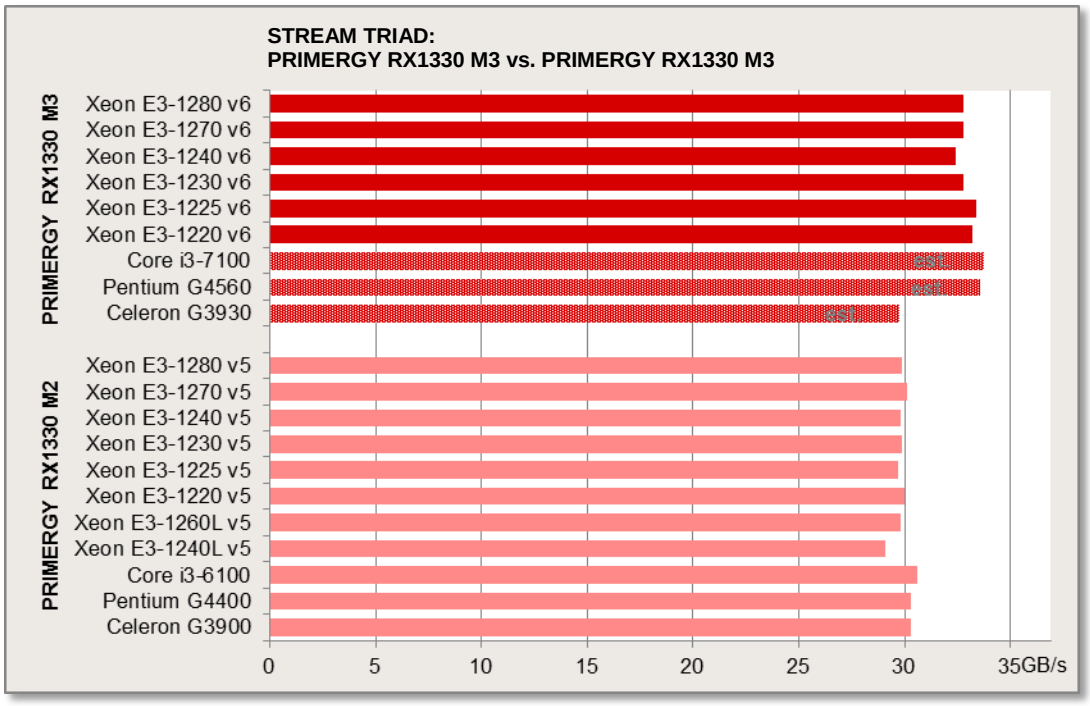
Some components may not be available in all countries or sales regions.

Benchmark results

The results marked (est.) are estimates.

Processor	Memory Frequency [MHz]	Max. Memory Bandwidth [GB/s]	Cores	Processor Frequency [GHz]	TRIAD [GB/s]
Celeron G3930	2133	34.1	2	2.90	29.8(est.)
Pentium G4560	2400	38.4	2	3.50	33.6(est.)
Core i3-7100	2400	38.4	2	3.90	33.8(est.)
Xeon E3-1220 v6	2400	38.4	4	3.00	**33.2**
Xeon E3-1225 v6	2400	38.4	4	3.30	**33.4**
Xeon E3-1230 v6	2400	38.4	4	3.50	**32.8**
Xeon E3-1240 v6	2400	38.4	4	3.70	**32.4**
Xeon E3-1270 v6	2400	38.4	4	3.80	**32.8**
Xeon E3-1280 v6	2400	38.4	4	3.90	**32.8**

The following diagram illustrates the throughput of the PRIMERGY RX1330 M3 in comparison to its predecessor, the PRIMERGY RX1330 M3.



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PRIMERGY RX1330 M3

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