White Paper
FUJITSU Server PRIMERGY
Performance Report PRIMERGY RX4770 M5

This document contains a summary of the benchmarks executed for the FUJITSU Server PRIMERGY RX4770 M5.

The PRIMERGY RX4770 M5 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
1.4
2021/07/28

Contents

Document history

Version 1.0 (2019/04/30)

New:

- Technical data
- SPECcpu2017
  Measurements with 2nd Generation Intel Xeon Processor Scalable Family
- SPECpower_ssj2008
  Measurements with Intel Xeon Platinum 8276L and Intel Xeon Platinum 8280L
- SPECjbb2015
  Measurement with Intel Xeon Platinum 8280L
- OLTP-2
  Calculated with 2nd Generation Intel Xeon Processor Scalable Family
- vServCon
  Measurements with 2nd Generation Intel Xeon Processor Scalable Family

Version 1.1 (2019/10/04)

New:

- SAP SD
  Certification number 2019033
- Disk I/O: Performance of storage media
  Results for 2.5" storage media
- VMmark V3
  “Performance Only” measurement with Intel Xeon Platinum 8280
- STREAM, LINPACK
  Measured with 2nd Generation Intel Xeon Processor Scalable Family

Updated:

- SPECcpu2017
  Measured additionally with 2nd Generation Intel Xeon Processor Scalable Family

Version 1.2 (2020/04/24)

Updated:

- Technical data
  Added 2nd Generation Intel Xeon Processor Scalable Family
- SPECcpu2017, OLTP-2 , vServCon, STREAM, LINPACK
  Measured or calculated additionally with 2nd Generation Intel Xeon Processor Scalable Family

Version 1.3 (2020/05/29)

Updated:

- Technical data, STREAM, LINPACK
  Fixed typo in processor specifications

Version 1.4 (2021/07/28)

Updated:

- Contact information and URLs
  Updated to the latest one
- Minor correction

Technical data

PRIMERGY RX4770 M5

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 RX4770 M5
Model versions	PY RX4770 M5 PY RX4770 M5 LC PY RX4770 M5 Performance
Form factor	Rack server
Chipset	Intel C624
Number of sockets	4
Number of processors orderable	PY RX4770 M5 : 2 or 4 PY RX4770 M5 LC : 4 PY RX4770 M5 Performance : 4
Processor type	2nd Generation Intel Xeon Scalable Processors Family
Number of memory slots	48 (12 per processor)
Maximum memory configuration	6,144 GB
Onboard HDD controller	Controller with RAID 0, RAID 1 or RAID 10 for up to 8 SATA HDDs
PCI slots	PY RX4770 M5 : 12 × PCI-Express 3.0 x16 PY RX4770 M5 LC : 12 × PCI-Express 3.0 x16 PY RX4770 M5 Performance : 8 × PCI-Express 3.0 x16
Max. number of internal hard disks	PY RX4770 M5 : 16 × 2.5" PY RX4770 M5 LC : 16 × 2.5" PY RX4770 M5 Performance : 8 × 2.5"

Processors (since system release)								
Processor	Cores	Threads	Cache [MB]	UPI Speed [GT/s]	Rated Frequency [Ghz]	Max. Turbo Frequency [Ghz]	Max. Memory Frequency [MHz]	TDP [Watt]
April 2019 released								
Xeon Platinum 8280L	28	56	38.5	10.4	2.7	4.0	2933	205
Xeon Platinum 8280M	28	56	38.5	10.4	2.7	4.0	2933	205
Xeon Platinum 8280	28	56	38.5	10.4	2.7	4.0	2933	205
Xeon Platinum 8276L	28	56	38.5	10.4	2.2	4.0	2933	165
Xeon Platinum 8276M	28	56	38.5	10.4	2.2	4.0	2933	165
Xeon Platinum 8276	28	56	38.5	10.4	2.2	4.0	2933	165
Xeon Platinum 8270	26	52	35.8	10.4	2.7	4.0	2933	205
Xeon Platinum 8268	24	48	35.8	10.4	2.9	3.9	2933	205
Xeon Platinum 8260L	24	48	35.8	10.4	2.4	3.9	2933	165
Xeon Platinum 8260M	24	48	35.8	10.4	2.4	3.9	2933	165
Xeon Platinum 8260Y	24	48	35.8	10.4	2.4	3.9	2933	165
	20	40						
	16	32						
Xeon Platinum 8260	24	48	35.8	10.4	2.4	3.9	2933	165
Xeon Platinum 8256	4	8	16.5	10.4	3.8	3.9	2933	105
Xeon Platinum 8253	16	32	22.0	10.4	2.2	3.0	2933	125
Xeon Gold 6262V	24	48	33.0	10.4	1.9	3.6	2933	135
Xeon Gold 6254	18	36	24.8	10.4	3.1	4.0	2933	200
Xeon Gold 6252	24	48	35.8	10.4	2.1	3.7	2933	150
Xeon Gold 6248	20	40	27.5	10.4	2.5	3.9	2933	150
Xeon Gold 6246	12	24	24.8	10.4	3.3	4.2	2933	165
Xeon Gold 6244	8	16	24.8	10.4	3.6	4.4	2933	150
Xeon Gold 6242	16	32	22.0	10.4	2.8	3.9	2933	150
Xeon Gold 6240L	18	36	24.8	10.4	2.6	3.9	2933	150
Xeon Gold 6240M	18	36	24.8	10.4	2.6	3.9	2933	150
Xeon Gold 6240Y	18	36	24.8	10.4	2.6	3.9	2933	150
	14	28						
	8	16						
Xeon Gold 6240	18	36	24.8	10.4	2.6	3.9	2933	150
Xeon Gold 6238M	22	44	30.3	10.4	2.1	3.7	2933	140
Xeon Gold 6238L	22	44	30.3	10.4	2.1	3.7	2933	140
Xeon Gold 6238	22	44	30.3	10.4	2.1	3.7	2933	140
Xeon Gold 6234	8	16	24.8	10.4	3.3	4.0	2933	130
Xeon Gold 6230	20	40	27.5	10.4	2.1	3.9	2933	125
Xeon Gold 6226	12	24	19.3	10.4	2.7	3.7	2933	125
Xeon Gold 6222V	20	40	27.5	10.4	1.8	3.6	2400	115
Xeon Gold 5222	4	8	16.5	10.4	3.8	3.9	2933	105
Xeon Gold 5220S	18	36	24.8	10.4	2.7	3.9	2666	125
Xeon Gold 5220	18	36	24.8	10.4	2.2	3.9	2666	125
Xeon Gold 5218B	16	32	22.0	10.4	2.3	3.9	2666	125

Xeon Gold 5218	16	32	22.0	10.4	2.3	3.9	2666	125
Xeon Gold 5217	8	16	11.0	10.4	3.0	3.7	2666	115
Xeon Gold 5215L	10	20	13.8	10.4	2.5	3.4	2666	85
Xeon Gold 5215M	10	20	13.8	10.4	2.5	3.4	2666	85
Xeon Gold 5215	10	20	13.8	10.4	2.5	3.4	2666	85

Model	PY RX4770 M5	PY RX4770 M5 LC	PY RX4770 M5 Performance
Supported CPU	Xeon Platinum 8276L Xeon Platinum 8276M Xeon Platinum 8276 Xeon Platinum 8260L Xeon Platinum 8260M Xeon Platinum 8260Y Xeon Platinum 8260 Xeon Platinum 8256 Xeon Platinum 8253 Xeon Gold 6262V Xeon Gold 6252 Xeon Gold 6248 Xeon Gold 6246 Xeon Gold 6244 Xeon Gold 6242 Xeon Gold 6240L Xeon Gold 6240M Xeon Gold 6240Y Xeon Gold 6240 Xeon Gold 6238M Xeon Gold 6238L Xeon Gold 6238 Xeon Gold 6234 Xeon Gold 6230 Xeon Gold 6226 Xeon Gold 6222V Xeon Gold 5222 Xeon Gold 5220S Xeon Gold 5220 Xeon Gold 5218B Xeon Gold 5218 Xeon Gold 5217 Xeon Gold 5215L Xeon Gold 5215M Xeon Gold 5215	Xeon Platinum 8280L Xeon Platinum 8280M Xeon Platinum 8280 Xeon Platinum 8276L Xeon Platinum 8276M Xeon Platinum 8276 Xeon Platinum 8270 Xeon Platinum 8268 Xeon Platinum 8260L Xeon Platinum 8260M Xeon Platinum 8260Y Xeon Platinum 8260 Xeon Platinum 8256 Xeon Platinum 8253 Xeon Gold 6262V Xeon Gold 6254 Xeon Gold 6252 Xeon Gold 6248 Xeon Gold 6246 Xeon Gold 6244 Xeon Gold 6242 Xeon Gold 6240L Xeon Gold 6240M Xeon Gold 6240Y Xeon Gold 6240 Xeon Gold 6238M Xeon Gold 6238L Xeon Gold 6238 Xeon Gold 6234 Xeon Gold 6230 Xeon Gold 6226 Xeon Gold 6222V Xeon Gold 5222 Xeon Gold 5220S Xeon Gold 5220 Xeon Gold 5218B Xeon Gold 5218 Xeon Gold 5217 Xeon Gold 5215L Xeon Gold 5215M Xeon Gold 5215	Xeon Platinum 8280L Xeon Platinum 8280M Xeon Platinum 8280 Xeon Platinum 8270 Xeon Platinum 8268 Xeon Gold 6254

All the processors that can be ordered with the PRIMERGY RX4770 M5 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 maximum frequency 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 can 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 of "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.

Suffix of Processor number shows additional feature of Xeon Processor.

The processors with M/L suffix support larger memory capacity of 2TB/socket(M-suffix) or 4.5TB/socket(L-suffix) whereas normal processors support 1TB/socket memory capacity.
The processors with S suffix are specifically designed to offer consistent performance for search workloads.
The processors with V suffix are specifically designed to help maximize $/VM
The processors with Y suffix support Intel Speed Select Technology. It enables to provide 3 distinct configurations(number of active cores and frequencies) which customer can choose in BIOS option.
Specifications of Xeon Gold 5218B and Xeon Gold 5218 including core count and frequencies are the same. The difference is minor electrical specifications only.

Suffix	Additional feature
M	Support up to 2TB/socket memory
L	Support up to 4.5TB/socket memory
S	Search Optimized
V	VM Density Optimized
Y	Speed Select

Memory modules (since system release)								
Memory module	Capacity [GB]	Ranks	Bit width of the memory chips	Frequency [MHz]	Load reduced	Registered	NVIDIMM	ECC
8 GB (1x8 GB) 1Rx8 DDR4-2933 R ECC	8	1	8	2933		✓		✓
16 GB (1x16 GB) 2Rx8 DDR4-2933 R ECC	16	2	8	2933		✓		✓
16 GB (1x16 GB) 1Rx4 DDR4-2933 R ECC	16	1	4	2933		✓		✓
32 GB (1x32 GB) 2Rx4 DDR4-2933 R ECC	32	2	4	2933		✓		✓
64 GB (1x64 GB) 2Rx4 DDR4-2933 R ECC	64	2	4	2933		✓		✓
64 GB (1x64 GB) 4Rx4 DDR4-2933 LR ECC	64	4	4	2933	✓	✓		✓
128 GB (1x128 GB) 4Rx4 DDR4-2933 LR ECC	128	4	4	2933	✓	✓		✓
128GB (1x128GB) DCPMM-2666	128			2666			✓	✓
256GB (1x256GB) DCPMM-2666	256			2666			✓	✓
512GB (1x512GB) DCPMM-2666	512			2666			✓	✓

Power supplies (since system release)	Max. number
Modular PSU 1600 W 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 RX4770 M5.

SPECcpu2017

Benchmark description

SPECcpu2017 is a benchmark which measures the system efficiency with integer and floating-point operations. It consists of an integer test suite (SPECrate 2017 Integer, SPECspeed 2017 Integer) containing 10 applications and a floating-point test suite (SPECrate 2017 Floating Point, SPECspeed 2017 Floating Point) containing 14 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.

SPECcpu2017 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.

SPECcpu2017 contains two different performance measurement methods: The first method (SPECspeed 2017 Integer or SPECspeed 2017 Floating Point) determines the time which is required to process a single task. The second method (SPECrate 2017 Integer or SPECrate 2017 Floating Point) 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 and the peak values are optional.

Benchmark	Number of single benchmarks	Arithmetics	Type	Compiler optimization	Measurement result
SPECspeed2017_int_peak	10	integer	peak	aggressive	Speed
SPECspeed2017_int_base	10	integer	base	conservative	
SPECrate2017_int_peak	10	integer	peak	aggressive	Throughput
SPECrate2017_int_ base	10	integer	base	conservative	
SPECspeed2017_fp_peak	10	floating point	peak	aggressive	Speed
SPECspeed2017_fp_base	10	floating point	base	conservative	
SPECrate2017_fp_peak	13	floating point	peak	aggressive	Throughput
SPECrate2017_fp_base	13	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 favor 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 SPECspeed2017_int_base, SPECrate2017_int_base, SPECspeed2017_fp_base, and SPECrate2017_fp_base results of the reference system. For example, a SPECspeed2017_int_base value of 2 means that the measuring system has handled this benchmark twice as fast as the reference system. A SPECrate2017_fp_base value of 4 means that the measuring system has handled this benchmark some 4/[# base copies] times faster than the reference system. “# base copies” specifies how many parallel instances of the benchmark have been executed.

Not every SPECcpu2017 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 RX4770 M5
Processor	2nd Generation Intel Xeon Scalable Processors Family
Memory	48 × 32 GB (1x32 GB) 2Rx4 PC4-2933Y-R
Software	
BIOS settings	SPECspeed2017_int: Patrol Scrub = Disabled Override OS Energy Performance = Enabled Energy Performance = Performance Fan Control = Full Sub NUMA Clustering = Disabled WR CRC feature Control = Disabled Hyper-Threading = Disabled SPECSpeed2017_fp: Adjacent Cache Line Prefetch = Disabled Energy Performance = Performance Fan Control = Full Hyper-Threading = Disabled Intel Virtualization Technology = Disabled Override OS Energy Performance = Enabled Patrol Scrub = Disabled Stale AtoS = Disabled Sub NUMA Clustering = Disabled WR CRC feature Control = Disabled SPECrate2017_int: DCU Streamer Prefetcher = Disabled Energy Performance = Performance Hardware Prefetcher = Disabled*1 HWPM = Native Mode with no legacy LLC Prefetcher = Disabled*2 Override OS Energy Performance = Enable Patrol Scrub = Disabled Sub Numa Clustering = Disabled*3 WR CRC feature Control = Disabled XPT Prefetch = Enable Fan Control = Ful SPECrate2017_fp: HWPM = Native Mode with no legacy Hyper Threading = Disabled*4 LLC Dead Line Alloc = Disabled*2 Local/Remote Threshold = Disable Patrol Scrub = Disabled Sub Numa Clustering = Disabled*3 Uncore Frequency Override = Power Balanced*1 WR CRC feature Control = Disabled Fan Control = Full *1: Xeon Platinum 8280L/8280M/8280, Xeon Platinum 8276L/8276M/8276, Xeon Platinum 8270, Xeon Platinum 8268, Xeon Platinum 8260L/8260M/8260 *2: except *1 *3: Xeon Bold 5217, Xeon Gold 5215 *4: Xeon Platinum 8280L/8280M/8280, Xeon Platinum 8276L/8276M/8276, Xeon Platinum 8270, Xeon Platinum 8268, Xeon Platinum 8260L/8260M/8260
Operating system	SPECspeed2017_int, SPECrate2017_int , SPECrate2017_fp: SUSE Linux Enterprise Server 15 4.12.14-25.28-default SPECspeed2017_fp: Red Hat Enterprise Linux Server release 7.6 3.10.0-957.el7.x86_64

Operating system settings	Stack size set to unlimited using "ulimit -s unlimited" SPECspeed2017_fp, SPECrate2017 Kernel Boot Parameter set with : nohz_full=1-X (X: logical core number -1) SPECrate2017_fp echo 10000000 > /proc/sys/kernel/sched_min_granularity_ns
Compiler	SPECspeed2017_int, SPECspeed2017_fp, SPECrate2017_int: CPU released in April 2019 C/C++: Version 19.0.1.144 of Intel C/C++ Compiler for Linux Fortran: Version 19.0.1.144 of Intel Fortran Compiler for Linux SPECrate2017_fp: CPU released in April 2019 C/C++: Version 19.0.0.117 of Intel C/C++ Compiler for Linux Fortran: Version 19.0.0.117 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 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.

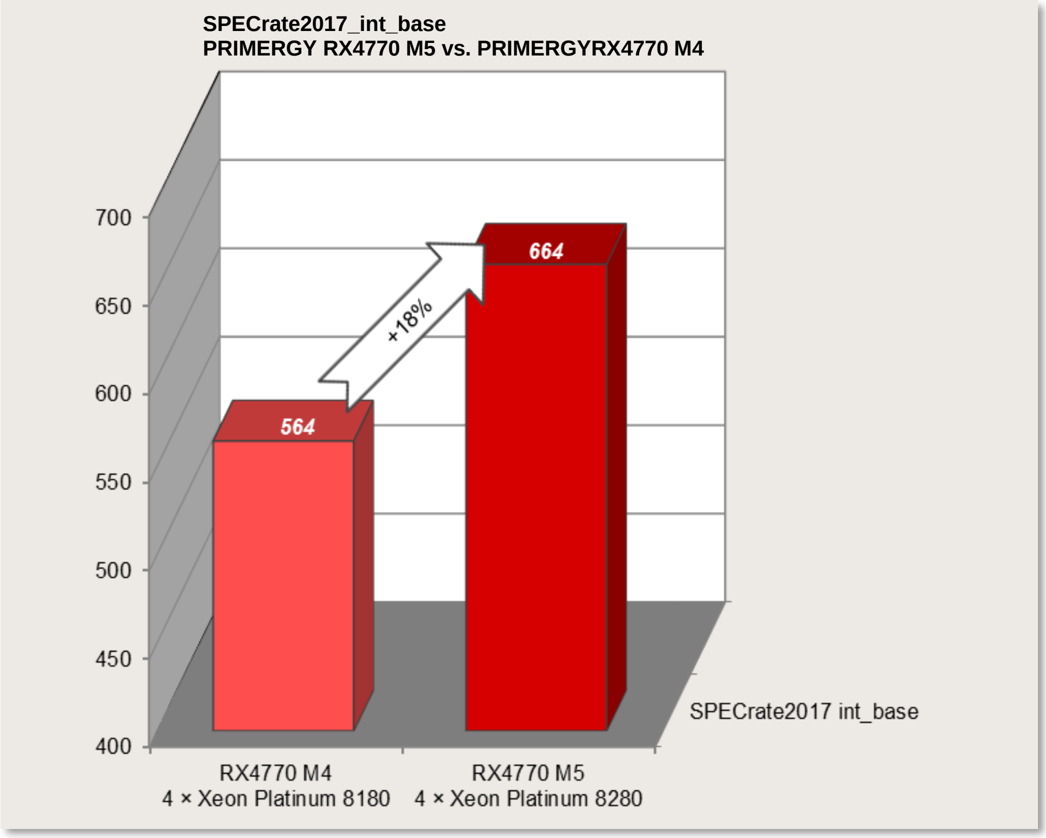
The result with "est." are the estimated values.

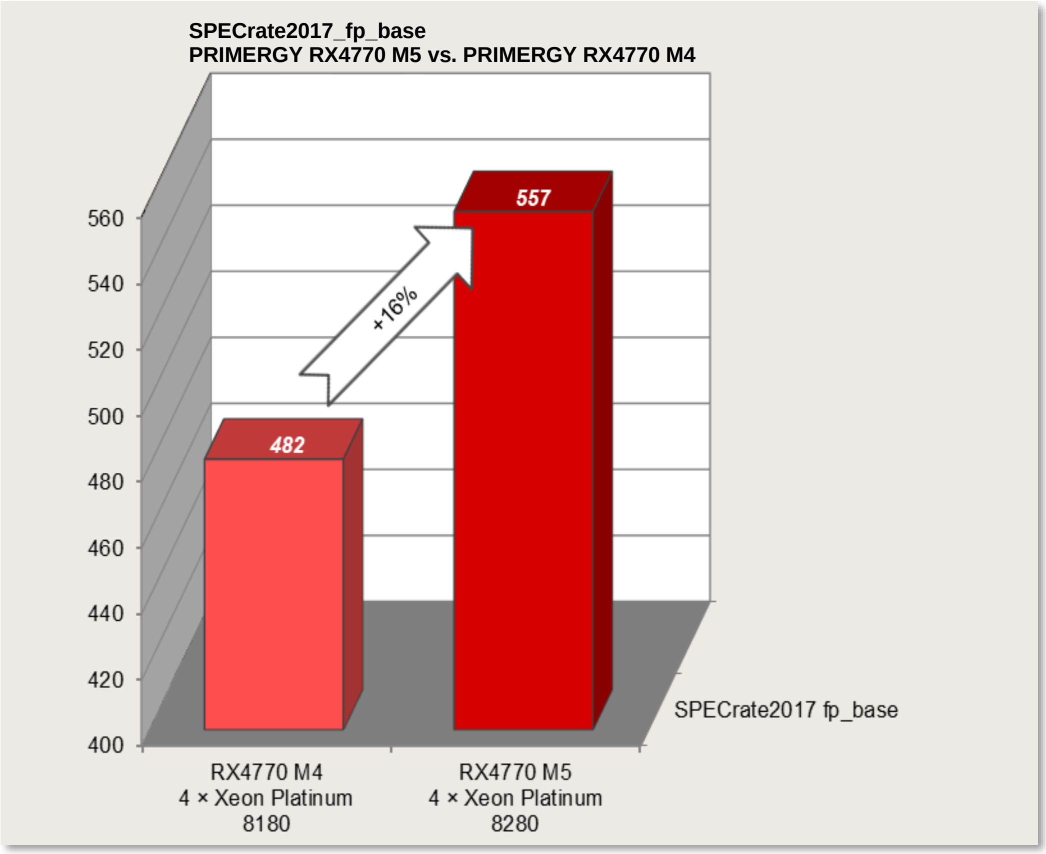
SPECrate2017				
Processor	**Cores**	**Number of Processors**	**SPECrate2017 int_base**	**SPECrate2017 fp_base**
April 2019 released				
Xeon Platinum 8280L	28	4	**664**	**557**
Xeon Platinum 8280M	28	4	664(est.)	557(est.)
Xeon Platinum 8280	28	4	664(est.)	557(est.)
Xeon Platinum 8276L	28	4	**584**	**516**
Xeon Platinum 8276M	28	4	584(est.)	516(est.)
Xeon Platinum 8276	28	4	584(est.)	516(est.)
Xeon Platinum 8270	26	4	**610**	**530**
Xeon Platinum 8268	24	4	**586**	**519**
Xeon Platinum 8260L	24	4	**536**	**488**
Xeon Platinum 8260M	24	4	536(est.)	488(est.)
Xeon Platinum 8260Y	24	4	**542**	**489**
	20	4	476(est.)	437(est.)
	16	4	409(est.)	399(est.)
Xeon Platinum 8260	24	4	536(est.)	488(est.)
Xeon Platinum 8256	4	4	**127**	**152**
Xeon Platinum 8253	16	4	**334**	**344**
Xeon Gold 6262V	24	4	**475**	**417**
Xeon Gold 6254	18	4	**500**	**452**
Xeon Gold 6252	24	4	**528**	**476**
Xeon Gold 6248	20	4	**479**	**444**
Xeon Gold 6246	12	4	**360**	**370**
Xeon Gold 6244	8	4	**264**	**293**
Xeon Gold 6242	16	4	**418**	**402**
Xeon Gold 6240L	18	4	442(est.)	418(est.)
Xeon Gold 6240M	18	4	442(est.)	418(est.)
Xeon Gold 6240Y	18	4	**438**	**416**
	14	4	373(est.)	376(est.)
	8	4	236(est.)	273(est.)
Xeon Gold 6240	18	4	**442**	**418**
Xeon Gold 6238L	22	4	484(est.)	448(est.)
Xeon Gold 6238M	22	4	484(est.)	448(est.)
Xeon Gold 6238	18	4	**484**	**448**
Xeon Gold 6234	22	4	**247**	**275**

Xeon Gold 6230	20	4	**433**	**412**
Xeon Gold 6226	12	4	**324**	**337**
Xeon Gold 6222V	20	4	**395**	**369**
Xeon Gold 5222	4	4	**127**	**151**
Xeon Gold 5220S	18	4	**397**	**383**
Xeon Gold 5220	18	4	**398**	**383**
Xeon Gold 5218B	16	4	364(est.)	358(est.)
Xeon Gold 5218	16	4	**364**	**358**
Xeon Gold 5217	8	4	**213**	**232**
Xeon Gold 5215L	10	4	232(est.)	251(est.)
Xeon Gold 5215M	10	4	232(est.)	251(est.)
Xeon Gold 5215	10	4	**232**	**251**

SPECspeed2017				
Processor	Cores	Number of Processors	SPECspeed2017 int_base	SPECspeed2017 fp_base
Xeon Platinum 8280	28	4		228(est.)
Xeon Gold 6244	8	4	**10.8**	

The following two diagrams illustrate the throughput of the PRIMERGY RX4770 M5 in comparison to its predecessor PRIMERGY RX4770 M4, in their respective most performant configuration.





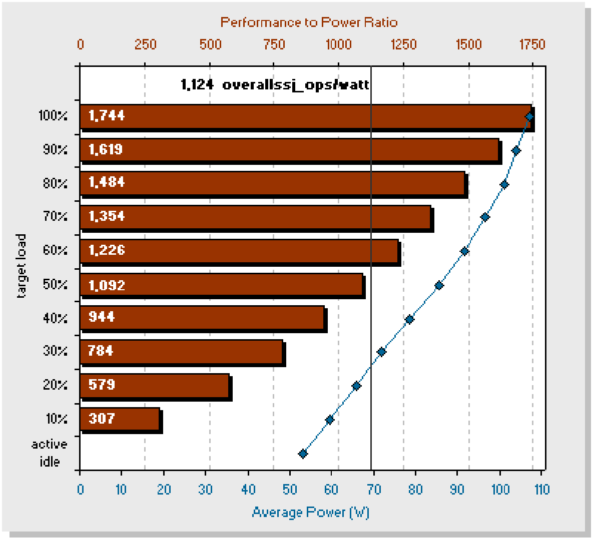
SPECpower_ssj2008

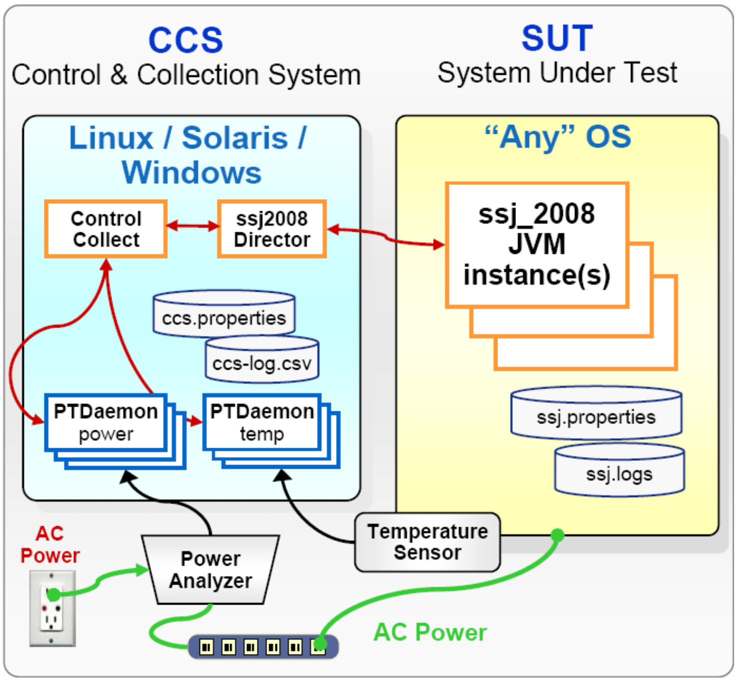
Benchmark description

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)	
For Windows OS measurement	
Hardware	
Model	PRIMERGY RX4770 M5
Processor	Intel Xeon Platinum 8276L
Memory	24 ×16 GB (1x16 GB) 2Rx8 PC4-2933 R ECC
Network interface	1 × PLAN EM 4 x 1Gb T OCP(Dynamic LOM), S26361-F3953-E401
Disk subsystem	1 × SSD M.2 240GB, S26361-F5706-E240
Power Supply Unit	1 × Modular PSU 1600 W platinum hp
Software	
BIOS	R1.8.0
BIOS settings	SATA Controller = Disabled. Serial Port = Disabled. Hardware Prefetcher = Disabled. Adjacent Cache Line Prefetch = Disabled. DCU Streamer Prefetcher = Disabled. Intel Virtualization Technology = Disabled. Turbo Mode = Disabled. Override OS Energy Performance = Enabled. Energy Performance = Energy Efficient. DDR Performance = Power balanced.(effective memory frequency = 2666 MHz) Autonomous C-state Support = Enabled. ASPM Support = Force L0s. UPI Link Frequency Select = 9.6GT/s. Uncore Frequency Override = Power balanced. IMC Interleaving = 1-way. HWPM = Disabled. USB Port Control = Enable internal ports only. Network Stack = Disabled. Link L0p Enable = Enabled. Link L1 Enable = Enabled.
Firmware	2.20c
Operating system	Microsoft Windows Server 2016 Standard
Operating system settings	Turn off hard disk after = 1 Minute. Turn off display after = 1 Minute. Minimum processor state = 0%. Maximum processor state = 100%. Disabled 3 NIC ports. Using the local security settings console, "lock pages in memory" was enabled for the user running the benchmark. Benchmark was started via Windows Remote Desktop Connection. <N/A>: The test sponsor attests, as of date of publication, that CVE-2017-5754 (Meltdown) is mitigated in the system as tested and documented. <Yes>: The test sponsor attests, as of date of publication, that CVE-2017-5753 (Spectre variant 1) is mitigated in the system as tested and documented. <Yes>: The test sponsor attests, as of date of publication, that CVE-2017-5715 (Spectre variant 2) is mitigated in the system as tested and documented.
JVM	Oracle Java HotSpot 64-Bit Server VM (build 24.80-b11, mixed mode), version 1.7.0_80

JVM settings	-server -Xmn1700m -Xms1950m -Xmx1950m -XX:SurvivorRatio=1 -XX:TargetSurvivorRatio=99 -XX:AllocatePrefetchDistance=256 -XX:AllocatePrefetchLines=4 -XX:ParallelGCThreads=2 -XX:InlineSmallCode=3900 -XX:MaxInlineSize=270 -XX:FreqInlineSize=2500 -XX:+UseLargePages -XX:+UseParallelOldGC -XX:AllocatePrefetchInstr=0 -XX:MinJumpTableSize=18 -XX:UseAVX=0
For Linux OS measurement	
Hardware	
Model	PRIMERGY RX4770 M5
Processor	Intel Xeon Platinum 8280L
Memory	24 ×16 GB (1x16 GB) 2Rx8 PC4-2933 R ECC
Network interface	1 × PLAN EM 4 x 1Gb T OCP(Dynamic LOM), S26361-F3953-E401
Disk subsystem	1 × SSD M.2 240GB, S26361-F5706-E240
Power Supply Unit	1 × Modular PSU 1600 W platinum hp
Software	
BIOS	R1.8.0
BIOS settings	SATA Controller = Disabled. Serial Port = Disabled. Hardware Prefetcher = Disabled. Adjacent Cache Line Prefetch = Disabled. DCU Streamer Prefetcher = Disabled. Intel Virtualization Technology = Disabled. Turbo Mode = Disabled. Override OS Energy Performance = Enabled. Energy Performance = Energy Efficient. DDR Performance = Power balanced.(effective memory frequency = 2666 MHz) Autonomous C-state Support = Enabled. ASPM Support = Force L0s. UPI Link Frequency Select = 9.6GT/s. Uncore Frequency Override = Power balanced. IMC Interleaving = 1-way. HWPM = Disabled. USB Port Control = Enable internal ports only. Network Stack = Disabled. Link L0p Enable = Enabled. Link L1 Enable = Enabled.
Firmware	2.20c
Operating system	SUSE Linux Enterprise Server 12 SP4 4.12.14-94.41-default

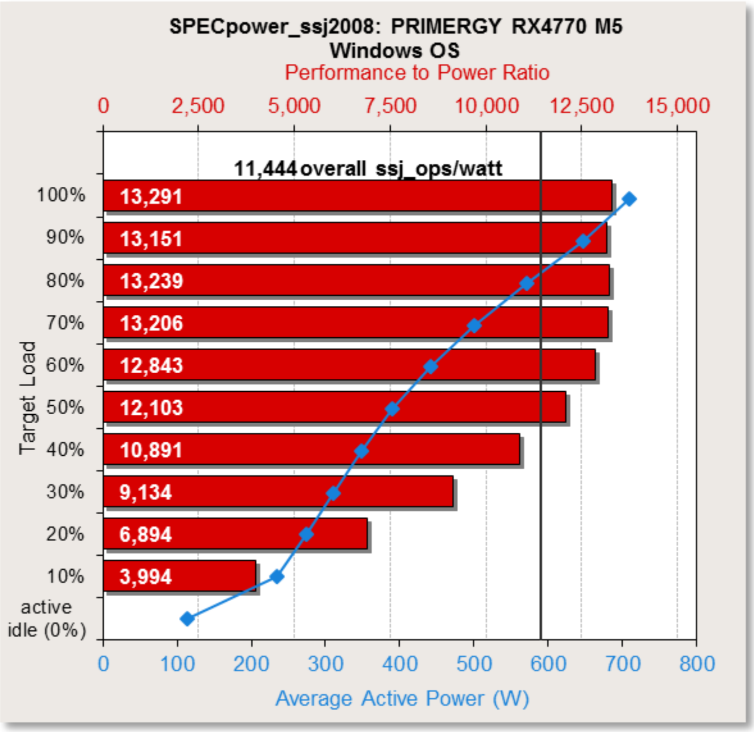
Operating system settings	kernal parameter:pcie_aspm=force pcie_aspm.policy=powersave intel_pstate=disable rcu_nocbs=1-223 nohz_full=1-223 isolcpus=1-223 modprobe cpufreq_conservative cpupower frequency-set --governor conservative echo -n 98 > /sys/devices/system/cpu/cpufreq/conservative/up_threshold echo -n 1 > /sys/devices/system/cpu/cpufreq/conservative/freq_step echo -n 1000000 > /sys/devices/system/cpu/cpufreq/conservative/sampling_rate echo -n 0 > /sys/devices/system/cpu/cpufreq/conservative/ignore_nice_load sysctl -w kernel.sched_migration_cost_ns=6000 echo -n 97 > /sys/devices/system/cpu/cpufreq/conservative/down_threshold echo -n 1 > /sys/devices/system/cpu/cpufreq/conservative/sampling_down_factor sysctl -w kernel.sched_min_granularity_ns=10000000 echo always > /sys/kernel/mm/transparent_hugepage/enabled powertop --auto-tune echo 0 > /proc/sys/kernel/nmi_watchdog cpupower frequency-set -u 2400MHz sysctl -w vm.swappiness=50 sysctl -w vm.laptop_mode=5 <Yes>: The test sponsor attests, as of date of publication, that CVE-2017-5754 (Meltdown) is mitigated in the system as tested and documented. <Yes>: The test sponsor attests, as of date of publication, that CVE-2017-5753 (Spectre variant 1) is mitigated in the system as tested and documented. <Yes>: The test sponsor attests, as of date of publication, that CVE-2017-5715 (Spectre variant 2) is mitigated in the system as tested and documented.
JVM	Oracle Java HotSpot 64-Bit Server VM (build 24.80-b11, mixed mode), version 1.7.0_80
JVM settings	-server -Xmn1700m -Xms1950m -Xmx1950m -XX:SurvivorRatio=1 -XX:TargetSurvivorRatio=99 -XX:AllocatePrefetchDistance=256 -XX:AllocatePrefetchLines=4 -XX:LoopUnrollLimit=45 -XX:InitialTenuringThreshold=12 -XX:MaxTenuringThreshold=15 -XX:ParallelGCThreads=8 -XX:InlineSmallCode=3900 -XX:MaxInlineSize=270 -XX:FreqInlineSize=2500 -XX:+AggressiveOpts -XX:+UseLargePages -XX:+UseParallelOldGC -XX:+UseHugeTLBFS -XX:+UseTransparentHugePages -XX:UseAVX=0

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

Benchmark results(Windows)

The PRIMERGY RX4770 M5 in Microsoft Windows Server 2016 Standard achieved the following result:

SPECpower_ssj2008 = 11,444 overall ssj_ops/watt



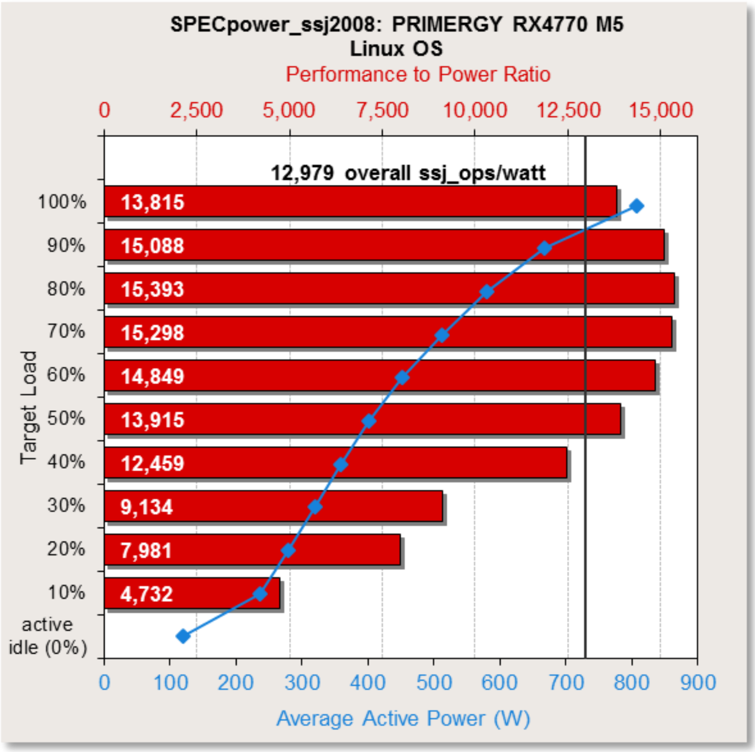
The adjoining diagram shows the result of the configuration described above. The red horizontal bars show the performance to power ratio in ssj_ops/watt (upper x-axis) for each target load level tagged on the y-axis of the diagram. The blue line shows the run of the curve for the average power consumption (bottom x-axis) at each target load level marked with a small rhomb. The black vertical line shows the benchmark result of 11,444 overall ssj_ops/watt for the PRIMERGYRX4770 M5. 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%	9,432,104	710	13,291
90%	8,512,403	647	13,151
80%	7,566,232	572	13,239
70%	6,622,170	501	13,206
60%	5,675,935	442	12,843
50%	4,725,788	390	12,103
40%	3,787,516	348	10,891
30%	2,836,687	311	9,134
20%	1,888,531	274	6,894
10%	940,508	235	3,994
Active Idle	0	113	0
∑ssj_ops / ∑power = 11,444			

Benchmark results(Linux)

The PRIMERGY RX4770 M5 in SUSE Linux Enterprise Server 12 SP4 achieved the following result:



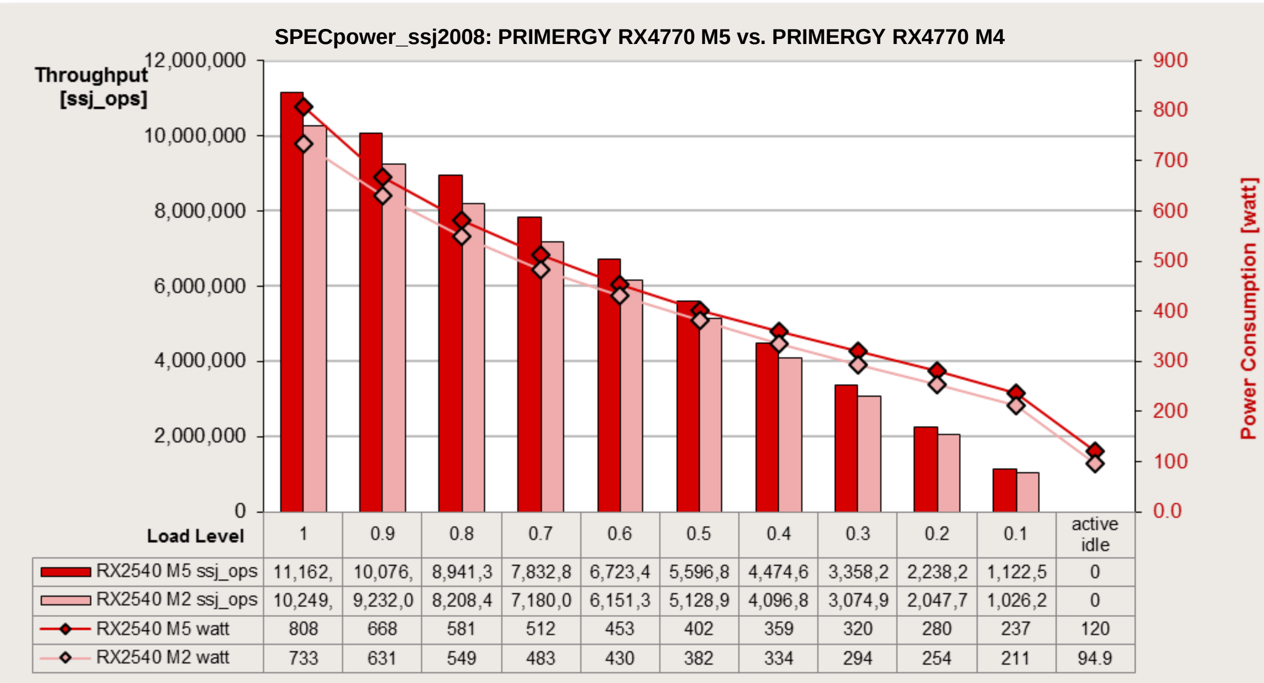
SPECpower_ssj2008 = 12,979 overall ssj_ops/watt

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 12,979 overall ssj_ops/watt for the PRIMERGYRX4770 M5. 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.

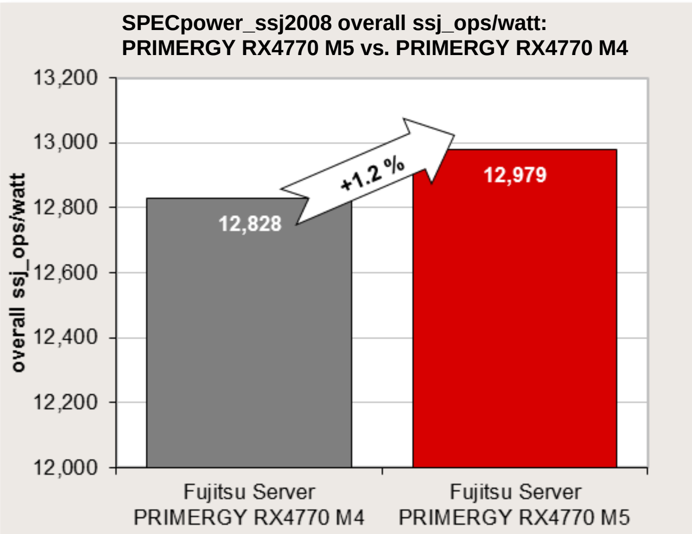
The following table shows the benchmark results for the throughput in ssj_ops, the power consumption in watts and the resulting energy efficiency for each load level.

Performance		**Power**	**Energy Efficiency**
Target Load	ssj_ops	Average Power (W)	ssj_ops/watt
100%	11,162,949	808	13,815
90%	10,076,651	668	15,088
80%	8,941,321	581	15,393
70%	7,832,822	512	15,298
60%	6,723,475	453	14,849
50%	5,596,891	402	13,915
40%	4,474,650	359	12,459
30%	3,358,285	320	9,134
20%	2,238,257	280	7,981
10%	1,122,533	237	4,732
Active Idle	0	120	0
			∑ssj_ops / ∑power = 12,979

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 RX4770 M5 compared to the predecessor PRIMERGY RX4770 M4.



Thanks to the latest Scalable Family processors, the PRIMERGY RX4770 M5 has a higher throughput. This results in an overall 1.2% increase in energy efficiency in the PRIMERGY RX4770 M5.



Difference of score by OS&JVM version

A score of SPECpower_ssj2008 differs about 10% in maximum caused by OS used in the system. OS has performance influence in itself. Thus depending on OS type, usable JVM versin is different. Currently combinations of Windows Server2012 R2&JVM7, Windows Server2016&JVM11 and Linux&JVM11 are used in Fujitsu and other vendor's submission results.
Under appropriate OS settings and JVM options, the score becomes high in order as Linux&JVM7≧ Windows Server2012 R2&JVM7>Windows Server2016&JVM11.
There is so few difference between Linux&JVM7 and Windows Server2012. On the other hand, a combination of Windows Server2016&JVM11's score is about 10% lower than the other two combination's score.
Under the rule of SPECpower_ssj2008, Windows Server2016, relatively new OS, is not allowed to measure with JVM7. Therefore it needs to use later JVM version. Alt-rt.jar , a module including in JVM7, is related to accelerate collection type HashMap. However, the module is deleted in JVM11. This is the main reason of SPECpower_ssj2008 score measured with JVM11 gets lower.

SPECjbb2015

Benchmark description

The SPECjbb2015 benchmark is the latest version of a series of Java benchmark following SPECjbb2000, SPECjbb2005 and SPECjbb2013. “jbb” stands for Java Business Benchmark. It evaluates the performance and the scalability of the Java business application environment.

The SPECjbb2015 is a benchmark modeled on the business activity of a world-wide supermarket company IT infrastructure. The company has some supermarket stores, headquarters which manage them and suppliers who replenishes the inventory. The following processing is exercised based on the requests from customers and company inside.

- POS (Point Of Sales) processing in supermarkets and online purchases
- Issuing and managing coupons and discounts and customer payments management
- Managing receipts, invoices and customer databases
- Interaction with suppliers for the replenishment of the inventory
- Data mining operations to identify sale patterns and to generate quarterly business reports

The SPECjbb2015 benchmark has a two performance metrics:

- max-jOPS : This is the maximum transaction rate that can be achieved while the system under test meets the benchmark constraints. That is, it is a metric of the maximum processing throughput of the system.
- critical-jOPS : This is the geometric mean of the maximum transaction rates that can be achieved while meeting the constraint on the response time of 10, 25, 50, 75 and 100 milliseconds. In other words, it is a metric of the maximum processing throughput of the system under response time constraint.

The SPECjbb2015 benchmark consists of the three components, Backends (BE) which contains the business logic and data, Transaction Injector (TxI) which issues transaction requests, and Controller (Ctr) which directs them. With the configuration of these components, the benchmark is divided into the following three categories:

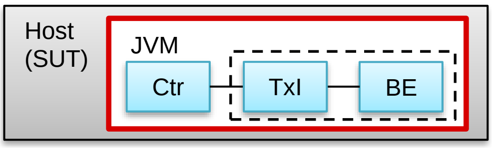
- SPECjbb2015 Composite

  All components run on one JVM running on one host.
- SPECjbb2015 MultiJVM

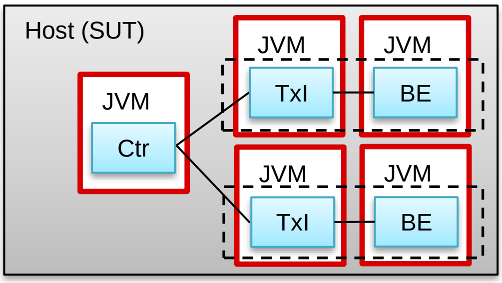
  All components are existed on one host, but each runs on a separate JVM.
- SPECjbb2015 Distributed

  Back-ends are existed on hosts separated from hosts on which the other components are running. Back-ends and the other components are connected by networks.

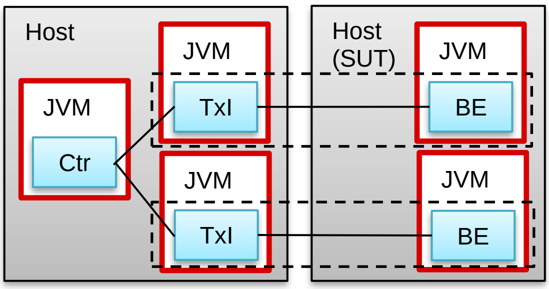
Results are not comparable to those in other categories.



(a) example of SPECjbb2015 Composite configuration



(b) example of SPECjbb2015 MultiJVM configuration



(c) example of SPECjbb2015 Distributed configuration

The result of the SPECjbb2015 benchmark reflects not only the performance of Java runtime environment (JRE) but the performance of the operating system and the hardware underneath it. For JRE, the factors like Java Virtual Machine (JVM), Just-in-time Compiler (JIT), garbage collection, user thread affect a performance score, and for hardware, the performance of processors, memory subsystem, and network has an impact on it. The SPECjbb2015 benchmark does not cover disk I/O performance.

The detailed specification of the benchmark can be found at https://www.spec.org/jbb2015/ .

Benchmark environment

PRIMERGY RX4770 M5 was configured for the SPECjbb2015 Composite benchmark measurement.

System Under Test (SUT)	
Hardware	
Model	PRIMERGY RX4770 M5
Processor	4 × Xeon Platinum 8280L
Memory	48 × 32 GB (1x32 GB) 2Rx4 DDR4-2933 R ECC
Network interface	1 Gbit/s LAN
Disk subsystem	Disk : 1 × M.2 SSD 240 GB
Software	
BIOS settings	Hardware Prefetcher set to Disabled Adjacent Cache Line Prefetch set to Disabled DCU Streamer Prefetcher set to Disabled Intel Virtualization Technology set to Disabled VT-d set to Disabled Override OS Energy Performance set to Enabled Energy Performance set to Performance Link Frequency Select set to 10.4GT/s Patrol Scrub set to Disable SNC set to Disabled Write CRC set to Disabled
Operating system	Red Hat Enterprise Linux 7.6 (kernel 3.10.0-957.el7.x86_64-default was applied)
Operating system settings	ulimit -n 1048576 ulimit -i unlimited ulimit -s unlimited ulimit -u unlimited ulimit -l unlimited ulimit -v unlimited ulimit -m unlimited cpupower -c all frequency-set -g performance echo 6000000 > /proc/sys/kernel/sched_min_granularity_ns echo 1000 > /proc/sys/kernel/sched_migration_cost_ns echo 990000 > /proc/sys/kernel/sched_rt_runtime_us echo 0 > /proc/sys/kernel/numa_balancing tuned-adm profile latency-performance Disable SELinux
JVM	Oracle Java SE 11.0.2

JVM settings	-server -Xms1380g -Xmx1380g -Xmn1350g -XX:SurvivorRatio=69 -XX:MaxTenuringThreshold=15 -XX:+UseLargePages -XX:LargePageSizeInBytes=2m -XX:+UseParallelOldGC -Xnoclassgc -XX:+AggressiveOpts -XX:+UseNUMA -XX:-UseBiasedLocking -XX:+AlwaysPreTouch -XX:-UseAdaptiveSizePolicy -XX:-UsePerfData -XX:TargetSurvivorRatio=90 -XX:ParallelGCThreads=224 -verbose:gc -XX:+PrintGCDetails -XX:+UseHugeTLBFS -XX:+UseTransparentHugePages -XX:+AggressiveHeap

SPECjbb2015 settings	specjbb.comm.connect.client.pool.size = 64;
	specjbb.comm.connect.timeouts.connect = 700000;
	specjbb.comm.connect.timeouts.read = 700000;
	specjbb.comm.connect.timeouts.write = 700000;
	specjbb.controller.rtcurve.warmup.step = 0.9;
	specjbb.customerDriver.threads = {probe=96, saturare=96};
	specjbb.forkjoin.workers = {Tier1=222, Tier2=1, Tier3=50};
	specjbb.mapreducer.pool.size = 256;

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

Benchmark results

"SPECjbb2015 Composite" measurement result (April 2, 2019)

259,141 SPECjbb2015-Composite max-jOPS

207,097 SPECjbb2015-Composite critical-jOPS

On April 2, 2019 PRIMERGY RX4770 M5 with two Intel Xeon Platinum 8280L processor achieved the scores of 207,097 SPECjbb2015-Composite critical-jOPS in Red Hat Enterprise Linux 7.6. With the result, it ranked first in the 4-socket server category for SPECjbb2015-Composite critical-jOPS.

The latest results of the SPECjbb2015 benchmark can be found at https://www.spec.org/jbb2015/results/ .

SAP SD

Benchmark description

The SAP application software consists of modules used to manage all standard business processes. These include modules for ERP (Enterprise Resource Planning), such as Assemble-to-Order (ATO), Financial Accounting (FI), Human Resources (HR), Materials Management (MM), Production Planning (PP), and Sales and Distribution (SD), as well as modules for SCM (Supply Chain Management), Retail, Banking, Utilities, BI (Business Intelligence), CRM (Customer Relation Management) or PLM (Product Lifecycle Management).

The application software is always based on a database so that a SAP configuration consists of the hardware, the software components operating system, the database, and the SAP software itself.

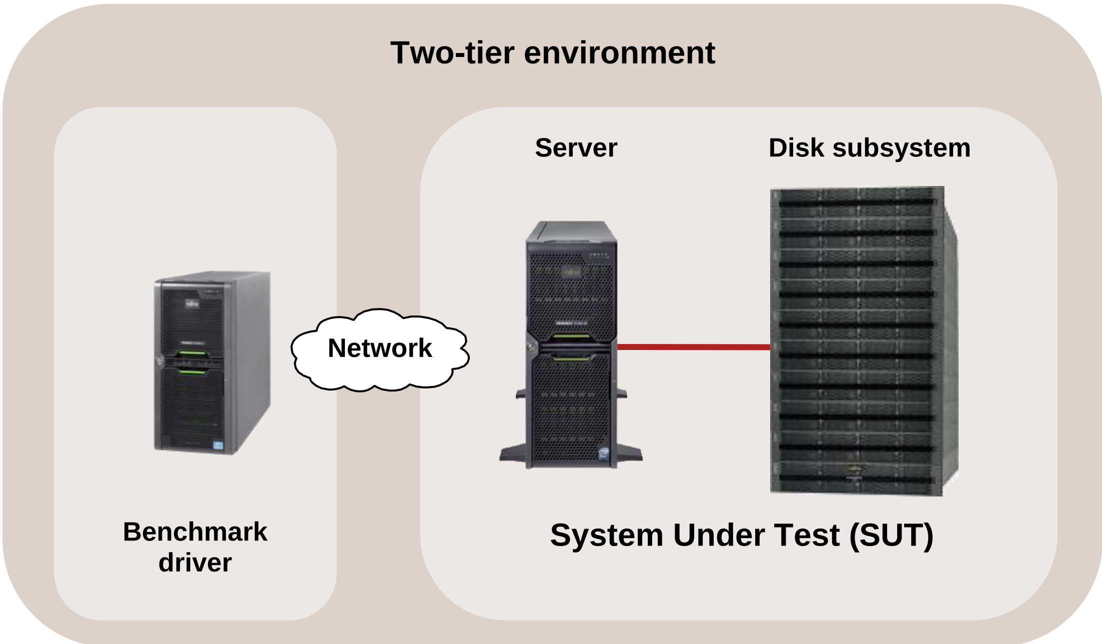
SAP AG has developed SAP Standard Application Benchmarks in order to verify the performance, stability and scaling of a SAP application system. The benchmarks, of which SD Benchmark is the most commonly used and most important, analyze the performance of the entire system and thus measure the quality of the integrated individual components.

The benchmark differentiates between a two-tier and a three-tier configuration. The two-tier configuration has the SAP application and database installed on one server. With a three-tier configuration the individual components of the SAP application can be distributed via several servers and an additional server handles the database.

The entire specification of the benchmark developed by SAP AG, Walldorf, Germany, can be found at: https://www.sap.com/benchmark.

Benchmark environment

The typical measurement set-up is illustrated below:



System Under Test (SUT)	
Hardware	
Model	PRIMERGY RX4770 M5
Processor	4 × Xeon Platinum 8280
Memory	48 × 32 GB (1x32 GB) 2Rx4 DDR4-2933 R ECC
Network interface	1 Gbit/s LAN
Disk subsystem	PRIMERGY RX4770 M5: 1 × HDD SAS 12 Gb/s 2.5" 15K 600 GB 1 × PCIe-SSD 750 GB
Software	
BIOS settings	Enable SNC
Operating system	Windows Server 2016
Database	Microsoft SQL Server 2012
SAP Business Suite Software	SAP enhancement package 5 for SAP ERP 6.0

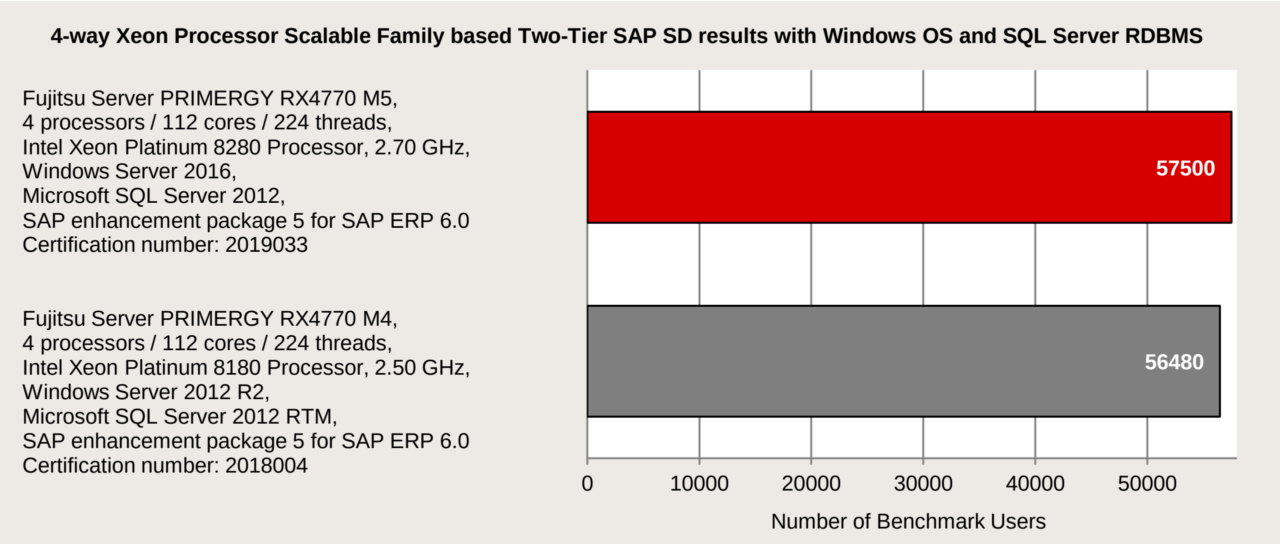
Benchmark driver	
Hardware	
Model	PRIMERGY RX2540 M2
Processor	2 × Xeon E5-2637 v4
Memory	256 GB
Network interface	1 Gbit/s LAN
Software	
Operating system	SUSE Linux Enterprise Server 12 SP2

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

Benchmark results

Certification number 2019033	
Number of SAP SD benchmark users	57,500
Average dialog response time	0.97 seconds
Throughput Fully processed order line items/hour Dialog steps/hour SAPS	 6,287,670 18,863,000 314,380
Average database request time (dialog/update)	0.010 sec / 0.021 sec
CPU utilization of central server	98%
Operating system, central server	Windows Server 2016
RDBMS	Microsoft SQL Server 2012
SAP Business Suite software	SAP enhancement package 5 for SAP ERP 6.0
Configuration Central Server	Fujitsu Server PRIMERGY RX4770 M5, 4 processors / 112 cores / 224 threads, Intel Xeon Platinum 8280 Processor, 2.70 GHz, 64 KB L1 cache per core and 1,024KB L2 cache per core, 38.5 MB L3 cache per socket, 1,536 GB main memory

The following chart shows a comparison of two-tier SAP SD Standard Application Benchmark results for 4-way Xeon Processor Scalable Family based servers with Windows OS and SQL Server database (as of June 18, 2019). The PRIMERGY RX4770 M5 outperforms its predecessor PRIMERGY RX4770 M4. The latest SAP SD 2-tier results can be found at https://www.sap.com/dmc/exp/2018-benchmark-directory/#/sd



Disk I/O: Performance of storage media

Benchmark description

Performance measurements of disk subsystems for PRIMERGY servers are used to assess their performance and enable a comparison of the different storage connections for PRIMERGY servers. As standard, these performance measurements are carried out with a defined measurement method, which models the accesses of real application scenarios on the basis of specifications.

The essential specifications are:

- Share of random accesses / sequential accesses
- Share of read / write access types
- Block size (kB)
- Number of parallel accesses (# of outstanding I/Os)

A given value combination of these specifications is known as “load profile”. The following five standard load profiles can be allocated to typical application scenarios:

Standard load profile	Access	Type of access		Block size [kB]	Application
		read	write		
File copy	random	50%	50%	64	Copying of files
File server	random	67%	33%	64	File server
Database	random	67%	33%	8	Database (data transfer) Mail server
Streaming	sequential	100%	0%	64	Database (log file), Data backup; Video streaming (partial)
Restore	sequential	0%	100%	64	Restoring of files

In order to model applications that access in parallel with a different load intensity the "# of Outstanding I/Os" is increased from 1 to 512 (in steps to the power of two).

The measurements of this document are based on these standard load profiles.

The main results of a measurement are:

- Throughput [MB/s] Throughput in megabytes per second
- Transactions [IO/s] Transaction rate in I/O operations per second
- Latency [ms] Average response time in ms

The data throughput has established itself as the normal measurement variable for sequential load profiles, whereas the measurement variable “transaction rate” is mostly used for random load profiles with their small block sizes. Data throughput and transaction rate are directly proportional to each other and can be transferred to each other according to the formula

Data throughput [MB/s]	*= Transaction rate [IO/s] × Block size [MB]*
Transaction rate [IO/s]	*= Data throughput [MB/s] / Block size [MB]*

This section specifies capacities of storage media on a basis of 10 (1 TB = 10^{12} bytes) while all other capacities, file sizes, block sizes and throughputs are specified on a basis of 2 (1 MB/s = 2^{20} bytes/s).

All the details of the measurement method and the basics of disk I/O performance are described in the white paper “Basics of Disk I/O Performance”.

Benchmark environment

All the measurement results discussed in this section apply for the hardware and software components listed below:

System Under Test (SUT)			
Hardware			
Controller: 1x PRAID CP400i			
	Storage media	Category	Drive Name
	HDD	SAS HDD(SAS 12Gbps, 10krpm)[512e]	AL15SEB06EQ *2 *3
		SAS HDD(SAS 12Gbps, 10krpm)[512n]	AL15SEB030N *2 *3
		SAS HDD(SAS 12Gbps, 15krpm)[512n]	ST300MP0006 *1 *3
		NL-SAS HDD (SAS 12Gbps, 7.2krpm)[512n]	ST1000NX0453 *1 *3
		BC-SATA HDD(SATA 6Gbps, 7.2krpm)[512e]	ST1000NX0313 *1 *3
		BC-SATA HDD(SATA 6Gbps, 7.2krpm)[512n]	ST2000NX0403 *1 *3
	SSD	SAS SSD(SAS 12Gbps, Write Intensive)	KPM51MUG400G *2 *3 KPM51MUG800G *2 *3 KPM51MUG1T60 *2 *3
		SAS SSD(SAS 12Gbps, Mixed Use)	WUSTR6440ASS204 *2 *3 WUSTR6480ASS204 *2 *3 WUSTR6416ASS204 *2 *3 WUSTR6432ASS204 *2 *3 WUSTR6464ASS204 *2 *3
		SAS SSD(SAS 12Gbps, Read Intensive)	WUSTR1548ASS204 *2 *3 WUSTR1596ASS204 *2 *3 WUSTR1519ASS204 *2 *3 WUSTR1538ASS204 *2 *3 WUSTR1576ASS204 *2 *3 WUSTR1515ASS204 *2 *3
		SATA SSD(SATA 6Gbps, Mixed Use)	MZ7KH240HAHQ *2 *3 MZ7KH480HAHQ *2 *3 MZ7KH960HAJR *2 *3 MZ7KH1T9HAJR *2 *3 MZ7KH3T8HALS *2 *3
		SATA SSD(SATA 6Gbps, Read Intensive)	MTFDDAK240TCB *2 *3 MTFDDAK480TDC *2 *3 MTFDDAK960TDC *2 *3 MTFDDAK1T9TDC *2 *3 MTFDDAK3T8TDC *2 *3 MTFDDAK7T6TDC *2 *3

Controller:	Integrated PCI Express controller CPU: 2x Intel Xeon Gold 5222 (3.80GHz)		
	Storage media	Category	Drive Name
	SSD	2.5 inch PCIe SSD(Write Intensive)	SSDPE21K750GA *2 *4
		2.5 inch PCIe SSD(Mixed Use)	SSDPE2KE016T8 *2 *4 SSDPE2KE032T8 *2 *4 SSDPE2KE064T8 *2 *4
	SSD	PCIe SSD (Write Intensive)	SSDPED1K375GA *2 *4 SSDPED1K750GA *2 *4

Controller:	Intel C620 Standard SATA AHCI controller		
	Storage media	Category	Drive Name
	SSD	M.2 Flash Module	MTFDDAV240TCB *2 *4 MTFDDAV480TCB *2 *4

*1) The operating system uses Microsoft Windows Server 2012 Standard R2.
*2) The operating system uses Microsoft Windows Server 2016 Standard.
*3) Measurement area is type 1.
*4) Measurement area is type 2.

Software		
Operating system		Microsoft Windows Server 2012 Standard R2 Microsoft Windows Server 2016 Standard
Benchmark version		3.0
RAID type		Logical drive of type RAID 0 consisting of 1 hard disk
Stripe size		Controller default (here 64 kB)
Measuring tool		Iometer 1.1.0
Measurement area	Type1	RAW file system is used. The first 10% of the usable LBA area is used for sequential accesses; the next 25% for random accesses.
	Type2	NTFS file system is used. The 32GB area is secured for the first of the target drive, and is used for sequential access and random access.
Total number of Iometer workers		1
Alignment of Iometer accesses		Aligned to whole multiples of 4096 bytes

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

Benchmark results

The results shown here are intended to help you select the appropriate storage media under the aspect of disk-I/O performance. For this purpose, a single storage medium was measured in the configuration specified in the subsection Benchmark environment.

Controller

The measurements were made using controllers in the table below.

Storage medium	Storage medium	Cache	Supported interfaces		RAID levels
			host	drive	
SSD/HDD	PRAID CP400i	-	PCIe 3.0 x8	SATA 6G SAS 12G	0, 1, 1E, 10, 5, 50
PCIe SSD	Integrated PCI Express controller	-	PCIe 3.0 x4		-
M.2 Flash	C620 Standard SATA AHCI controller	-	DMI 3.0 x4	SATA 6G	-

Storage media

When selecting the type and number of storage media you can move the weighting in the direction of storage capacity, performance, security or price. The following types of HDD and SSD storage media can be PRIMERGY servers:

Storage medium type	Interface	Form factor
HDD	SAS 12G	2.5 inch
	SATA 6G	2.5 inch
SSD	SAS 12G	2.5 inch
	SATA 6G	2.5 inch, or M.2
	PCIe 3.0	2.5 inch, or Add in card

HDDs and SSDs are operated via host bus adapters, usually RAID controllers, with a SATA or SAS interface. The interface of the RAID controller to the chipset of the systemboard is typically PCIe or, in the case of the integrated onboard controllers, an internal bus interface of the systemboard.

Of all the storage medium types SSDs offer by far the highest transaction rates for random load profiles as well as the shortest access times. In return, however, the price per gigabyte of storage capacity is substantially higher.

Cache settings

In most cases, the cache of HDDs has a great influence on disk-I/O performance. It is frequently regarded as a security problem in case of power failure and is thus switched off. On the other hand, it was integrated by hard disk manufacturers for the good reason of increasing the write performance. For performance reasons it is therefore advisable to enable the hard disk cache. To prevent data loss in case of power failure you are recommended to equip the system with a UPS.

For the purpose of easy and reliable handling of the settings for RAID controllers and hard disks it is advisable to use the RAID-Manager software “ServerView RAID” that is supplied for PRIMERGY servers. All the cache settings for controllers and hard disks can usually be made en bloc – specifically for the application – by using the pre-defined modi “Performance” or “Data Protection”. The “Performance” mode ensures the best possible performance settings for the majority of the application scenarios.

Performance values

The performance values are summarized in the following tables, in each case specifically for a single storage medium and with various access types and block sizes. The established measurement variables, as already mentioned in the subsection Benchmark description, are used here. Thus, transaction rate is specified for random accesses and data throughput for sequential accesses. To avoid any confusion among the measurement units the tables have been separated for the two access types.

The table cells contain the maximum achievable values. This means that each value is the maximum achievable value of the whole range of load intensities (# of Outstanding I/Os). In order to also visualize the numerical values each table cell is highlighted with a horizontal bar, the length of which is proportional to the numerical value in the table cell. All bars shown in the same scale of length have the same color. In other words, a visual comparison only makes sense for table cells with the same colored bars. Since the horizontal bars in the table cells depict the maximum achievable performance values, they are shown by the color getting lighter as you move from left to right. The light shade of color at the right end of the bar tells you that the value is a maximum value and can only be achieved under optimal prerequisites. The darker the shade becomes as you move to the left, the more frequently it will be possible to achieve the corresponding value in practice.

Storage media

HDDs

Random accesses (units: IO/s):

Capacity [GB]	Storage device	Inter face	Transactions [IO/s]		
			Database	Fileserver	filecopy
600	AL15SEB06EQ	SAS 12G	592	516	544
300	AL15SEB030N	SAS 12G	645	546	568
300	ST300MP0006	SAS 12G	768	662	472
1,000	ST1000NX0453	SAS 12G	371	321	306
1,000	ST1000NX0313	SATA 6G	324	281	288
2,000	ST2000NX0403	SATA 6G	326	286	294

Sequential accesses (units: MB/s):

Capacity [GB]	Storage device	Inter face	Throughput [MB/s]	
			Streaming	Restore
600	AL15SEB06EQ	SAS 12G	260	260
300	AL15SEB030N	SAS 12G	231	230
300	ST300MP0006	SAS 12G	304	304
1,000	ST1000NX0453	SAS 12G	137	137
1,000	ST1000NX0313	SATA 6G	131	131
2,000	ST2000NX0403	SATA 6G	133	133

SSDs

Random accesses (units: IO/s):

Capacity [GB]	Storage device	Inter face	Transactions [IO/s]		
			Database	Fileserver	filecopy
400	KPM51MUG400G	SAS 12G	84,469	13,329	13,677
800	KPM51MUG800G	SAS 12G	99,728	14,549	18,049
1,600	KPM51MUG1T60	SAS 12G	108,428	17,243	19,634
400	WUSTR6440ASS204	SAS 12G	83,427	14,459	13,924
800	WUSTR6480ASS204	SAS 12G	94,899	22,414	21,187
1,600	WUSTR6416ASS204	SAS 12G	97,107	24,053	22,802
3,200	WUSTR6432ASS204	SAS 12G	106,745	23,975	22,793
6,400	WUSTR6464ASS204	SAS 12G	111,695	23,911	22,639
480	WUSTR1548ASS204	SAS 12G	77,846	11,663	9,904
960	WUSTR1596ASS204	SAS 12G	88,384	18,834	16,636
1,920	WUSTR1519ASS204	SAS 12G	89,397	21,635	21,597
3,840	WUSTR1538ASS204	SAS 12G	99,644	23,727	22,831
7,680	WUSTR1576ASS204	SAS 12G	106,933	23,688	22,644
15,360	WUSTR1515ASS204	SAS 12G	107,687	23,590	22,686
240	MZ7KH240HAHQ	SATA 6G	49,159	7,313	7,431
480	MZ7KH480HAHQ	SATA 6G	50,558	7,774	7,810
960	MZ7KH960HAJR	SATA 6G	50,647	7,793	7,916
1,920	MZ7KH1T9HAJR	SATA 6G	50,702	8,040	7,960
3,840	MZ7KH3T8HALS	SATA 6G	50,766	8,039	7,936
240	MTFDDAK240TCB	SATA 6G	18,959	3,367	4,516
480	MTFDDAK480TDC	SATA 6G	24,710	3,799	5,006
960	MTFDDAK960TDC	SATA 6G	30,152	4,625	5,553
1,920	MTFDDAK1T9TDC	SATA 6G	37,234	5,606	5,566
3,840	MTFDDAK3T8TDC	SATA 6G	41,711	6,429	6,133
7,680	MTFDDAK7T6TDC	SATA 6G	40,683	6,874	6,672
750	SSDPE21K750GA	PCIe3 x4	214,231	37,611	36,957
1,600	SSDPE2KE016T8	PCIe3 x4	135,500	41,066	37,080
3,200	SSDPE2KE032T8	PCIe3 x4	136,782	48,210	45,348
6,400	SSDPE2KE064T8	PCIe3 x4	192,245	51,767	51,438
375	SSDPED1K375GA	PCIe3 x4	212,118	37,121	36,123
750	SSDPED1K750GA	PCIe3 x4	209,628	37,592	36,941
240	MTFDDAV240TCB	SATA 6G	19,773	3,844	4,968
480	MTFDDAV480TCB	SATA 6G	22,258	4,935	6,294

Sequential accesses (units: MB/s):

Capacity [GB]	Storage device	Inter face	Throughput [MB/s]	
			Streaming	Restore
400	KPM51MUG400G	SAS 12G	1,056	1,041
800	KPM51MUG800G	SAS 12G	1,056	1,042
1,600	KPM51MUG1T60	SAS 12G	1,057	1,042
400	WUSTR6440ASS204	SAS 12G	1,073	626
800	WUSTR6480ASS204	SAS 12G	1,073	1,008
1,600	WUSTR6416ASS204	SAS 12G	1,073	1,029
3,200	WUSTR6432ASS204	SAS 12G	1,073	1,030
6,400	WUSTR6464ASS204	SAS 12G	1,073	1,030
480	WUSTR1548ASS204	SAS 12G	1,055	554
960	WUSTR1596ASS204	SAS 12G	1,067	965
1,920	WUSTR1519ASS204	SAS 12G	1,073	1,030
3,840	WUSTR1538ASS204	SAS 12G	1,073	1,030
7,680	WUSTR1576ASS204	SAS 12G	1,073	1,030
15,360	WUSTR1515ASS204	SAS 12G	1,073	1,029
240	MZ7KH240HAHQ	SATA 6G	526	486
480	MZ7KH480HAHQ	SATA 6G	526	485
960	MZ7KH960HAJR	SATA 6G	525	485
1,920	MZ7KH1T9HAJR	SATA 6G	526	485
3,840	MZ7KH3T8HALS	SATA 6G	526	485
240	MTFDDAK240TCB	SATA 6G	487	258
480	MTFDDAK480TDC	SATA 6G	507	362
960	MTFDDAK960TDC	SATA 6G	507	440
1,920	MTFDDAK1T9TDC	SATA 6G	507	483
3,840	MTFDDAK3T8TDC	SATA 6G	504	481
7,680	MTFDDAK7T6TDC	SATA 6G	469	482
750	SSDPE21K750GA	PCIe3 x4	2,546	2,295
1,600	SSDPE2KE016T8	PCIe3 x4	3,213	1,917
3,200	SSDPE2KE032T8	PCIe3 x4	3,209	2,800
6,400	SSDPE2KE064T8	PCIe3 x4	3,205	3,048
375	SSDPED1K375GA	PCIe3 x4	2,460	2,197
750	SSDPED1K750GA	PCIe3 x4	2,546	2,296
240	MTFDDAV240TCB	SATA 6G	487	258
480	MTFDDAV480TCB	SATA 6G	509	403

OLTP-2

Benchmark description

OLTP stands for Online Transaction Processing. The OLTP-2 benchmark is based on the typical application scenario of a database solution. In OLTP-2 database access is simulated and the number of transactions achieved per second (tps) determined as the unit of measurement for the system.

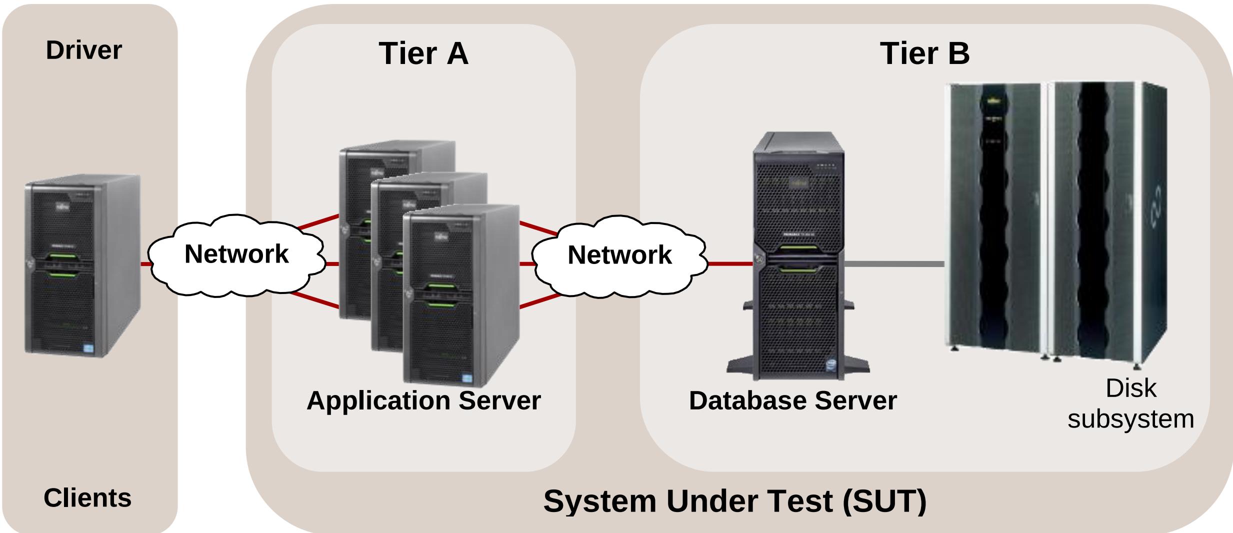
In contrast to benchmarks such as SPECint and TPC-E, which were standardized by independent bodies and for which adherence to the respective rules and regulations are monitored, OLTP-2 is an internal benchmark of Fujitsu. OLTP-2 is based on the well-known database benchmark TPC-E. OLTP-2 was designed in such a way that a wide range of configurations can be measured to present the scaling of a system with regard to the CPU and memory configuration.

Even if the two benchmarks OLTP-2 and TPC-E simulate similar application scenarios using the same load profiles, the results cannot be compared or even treated as equal, as the two benchmarks use different methods to simulate user load. OLTP-2 values are typically similar to TPC-E values. A direct comparison, or even referring to the OLTP-2 result as TPC-E, is not permitted, especially because there is no price-performance calculation.

Further information can be found in the document Benchmark Overview OLTP-2.

Benchmark environment

The typical measurement set-up is illustrated below:



All OLTP-2 results were Calculated based on the configuration of the next following pages of PRIMERGY RX4770 M5.

Database Server (Tier B)	
Hardware	
Model	PRIMERGY RX4770 M5
Processor	2nd Generation Intel Xeon Processor Scalable Family
Memory	2 processors: 24 × 64 GB (1x64 GB) 2Rx4 DDR4-2933 ECC 4 processors: 48 × 64 GB (1x64 GB) 2Rx4 DDR4-2933 ECC
Network interface	1 × Dual Port onboard LAN 10 Gb/s
Disk subsystem	RX4770 M5: Onboard RAID controller PRAID EP420i 2 × 300 GB 10k rpm SAS Drive, RAID 1 (OS), 6 × 1.6 TB SSD, RAID 10 (LOG) 4 × 1.6 TB SSD, RAID 10 (temp) 5 × PRAID EP540e 5 × JX40 S2: 14 × 1.6 TB SSD Drive each, RAID5 (data)
Software	
BIOS	Version R1.2.0
Operating system	Microsoft Windows Server 2016 Standard + KB4462928
Database	Microsoft SQL Server 2017 Enterprise + KB4341265

Application Server (Tier A)	
Hardware	
Model	1 × PRIMERGY RX2530 M4
Processor	2 × Xeon Platinum 8180
Memory	192 GB, 2666 MHz Registered ECC DDR4
Network interface	1 × Dual Port onboard LAN 10 Gb/s 1 × Dual Port LAN 1 Gb/s
Disk subsystem	2 × 300 GB 10k rpm SAS Drive
Software	
Operating system	Microsoft Windows Server 2016 Standard

Client	
Hardware	
Model	1 × PRIMERGY RX2530 M2
Processor	2 × Xeon E5-2667 v4
Memory	128 GB, 2400 MHz registered ECC DDR4
Network interface	1 × onboard Quad Port LAN 1 Gb/s
Disk subsystem	1 × 300 GB 10k rpm SAS Drive
Software	
Operating system	Microsoft Windows Server 2012 R2 Standard
Benchmark	OLTP-2 Software EGen version 1.14.0

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

Benchmark results

Database performance greatly depends on the configuration options with CPU, memory and on the connectivity of an adequate disk subsystem for the database. In the following scaling considerations for the processors we assume that both the memory and the disk subsystem has been adequately chosen and is not a bottleneck.

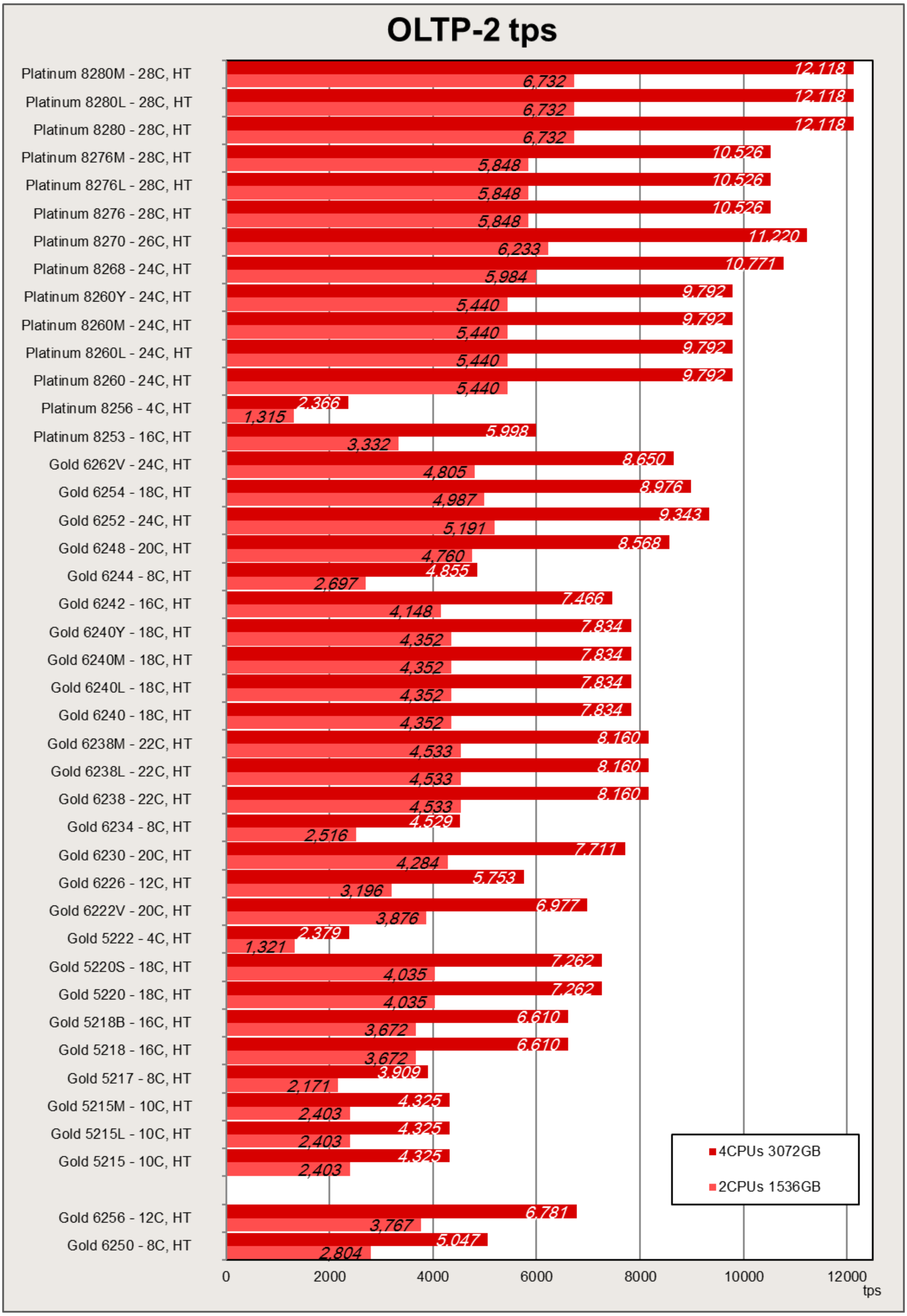
A guideline in the database environment for selecting main memory is that sufficient quantity is more important than the speed of the memory accesses. This why a configuration with a total memory of 3072 GB was considered for the measurements with four processors and a configuration with a total memory of 1536 GB for the measurements with two processors. Both memory configurations have memory access of 2933 MHz..

The result with "est." are the estimated values.

Processor	Cores	Threads	4CPU Score	2CPU Score
April 2019 released				
Xeon Platinum 8280L	28	56	12,118 (est.)	6,732 (est.)
Xeon Platinum 8280M	28	56	12,118 (est.)	6,732 (est.)
Xeon Platinum 8280	28	56	12,118 (est.)	6,732 (est.)
Xeon Platinum 8276L	28	56	10,526 (est.)	5,848 (est.)
Xeon Platinum 8276M	28	56	10,526 (est.)	5,848 (est.)
Xeon Platinum 8276	28	56	10,526 (est.)	5,848 (est.)
Xeon Platinum 8270	26	52	11,220 (est.)	6,233 (est.)
Xeon Platinum 8268	24	48	10,771 (est.)	5,984 (est.)
Xeon Platinum 8260L	24	48	9,792 (est.)	5,440 (est.)
Xeon Platinum 8260M	24	48	9,792 (est.)	5,440 (est.)
Xeon Platinum 8260Y	24	48	9,792 (est.)	5,440 (est.)
	20	40	8,521 (est.)	4,734 (est.)
	16	32	7,387 (est.)	4,104 (est.)
Xeon Platinum 8260	24	48	9,792 (est.)	5,440 (est.)
Xeon Platinum 8256	4	8	2,366 (est.)	1,315 (est.)
Xeon Platinum 8253	16	32	5,998 (est.)	3,332 (est.)
Xeon Gold 6262V	24	48	8,650 (est.)	4,805 (est.)
Xeon Gold 6254	18	36	8,976 (est.)	4,987 (est.)
Xeon Gold 6252	24	48	9,343 (est.)	5,191 (est.)
Xeon Gold 6248	20	40	8,568 (est.)	4,760 (est.)
Xeon Gold 6226	12	24	5,753 (est.)	3,196 (est.)
Xeon Gold 6244	8	16	4,855 (est.)	2,697 (est.)
Xeon Gold 6242	16	32	7,466 (est.)	4,148 (est.)
Xeon Gold 6240L	18	36	7,834 (est.)	4,352 (est.)
Xeon Gold 6240M	18	36	7,834 (est.)	4,352 (est.)
Xeon Gold 6240Y	18	36	7,834 (est.)	4,352 (est.)
	14	28	6,406 (est.)	3,559 (est.)
	8	16	4,004 (est.)	2,224 (est.)
Xeon Gold 6240	18	36	7,834 (est.)	4,352 (est.)
Xeon Gold 6238L	22	44	8,160 (est.)	4,533 (est.)
Xeon Gold 6238M	22	44	8,160 (est.)	4,533 (est.)
Xeon Gold 6238	22	44	8,160 (est.)	4,533 (est.)
Xeon Gold 6234	8	16	4,529 (est.)	2,516 (est.)
Xeon Gold 6230	20	40	7,711 (est.)	4,284 (est.)
Xeon Gold 6226	12	24	5,753 (est.)	3,196 (est.)

Xeon Gold 6222V	20	40	6,977 (est.)	3,876 (est.)
Xeon Gold 5222	4	8	2,379 (est.)	1,321 (est.)
Xeon Gold 5220S	18	36	7,262 (est.)	4,035 (est.)
Xeon Gold 5220	18	36	7,262 (est.)	4,035 (est.)
Xeon Gold 5218B	16	32	6,610 (est.)	3,672 (est.)
Xeon Gold 5218	16	32	6,610 (est.)	3,672 (est.)
Xeon Gold 5217	8	16	3,909 (est.)	2,171 (est.)
Xeon Gold 5215L	10	20	4,325 (est.)	2,403 (est.)
Xeon Gold 5215M	10	20	4,325 (est.)	2,403 (est.)
Xeon Gold 5215	10	20	4,325 (est.)	2,403 (est.)

The following diagram shows the OLTP-2 transaction rates that can be achieved with one and two processors of the Intel Xeon Processor Scalable Family.



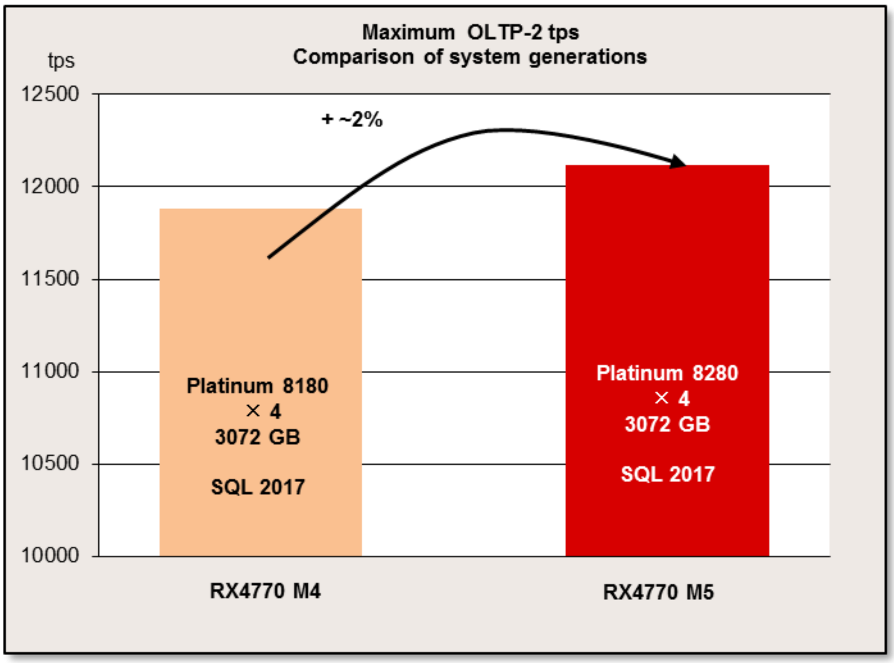
It is evident that a wide performance range is covered by the variety of released processors. If you compare the OLTP-2 value of the processor with the lowest performance (Xeon Platinum 8256) with the value of the processor with the highest performance (Xeon Platinum 8280), the result is an 5-fold increase in performance.

The features of the processors are summarized in the section “Technical data”.

The relatively large performance differences between the processors can be explained by their features. The values scale on the basis of the number of cores, the size of the L3 cache and the CPU clock frequency and as a result of the features of Hyper-Threading and turbo mode, which are available in most processor types. Furthermore, the data transfer rate between processors (“UPI Speed”) also determines the performance.

Within a group of processors with the same number of cores, scaling can be seen via the CPU clock frequency.

If you compare the maximum achievable OLTP-2 values of the current system generation with the values that were achieved on the predecessor systems, the result is an increase of about 2%.



vServCon

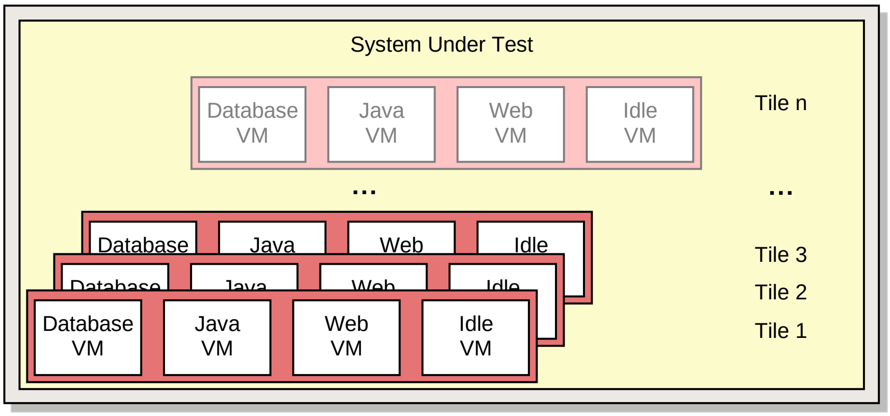
Benchmark description

vServCon is a benchmark used by Fujitsu to compare server configurations with hypervisor with regard to their suitability for server consolidation. This allows both the comparison of systems, processors and I/O technologies as well as the comparison of hypervisors, virtualization forms, and additional drivers for virtual machines.

vServCon is not a new benchmark in the true sense of the word. It is more a framework that combines already established benchmarks (or in modified form) as workloads in order to reproduce the load of a consolidated and virtualized server environment. Three proven benchmarks are used which cover the application scenarios database, application server, and web server.

Application scenario	Benchmark	No. of logical CPU cores	Memory
Database	Sysbench (adapted)	2	1.5 GB
Java application server	SPECjbb (adapted, with 50% - 60% load)	2	2 GB
Web server	WebBench	1	1.5 GB

Each of the three application scenarios is allocated to a dedicated virtual machine (VM). A fourth machine, the so-called idle VM, is added to these. These four VMs make up a “tile”. Depending on the performance capability of the underlying server hardware, you may as part of a measurement also have to start several identical tiles in parallel in order to achieve a maximum performance score.



Each of the three vServCon application scenarios provides a specific benchmark result in the form of application-specific transaction rates for the respective VM. In order to derive a normalized score, the individual benchmark result for one tile is put in relation to the respective result of a reference system. The resulting relative performance value is then suitably weighted and finally added up for all VMs and tiles. The outcome is a score for this tile number.

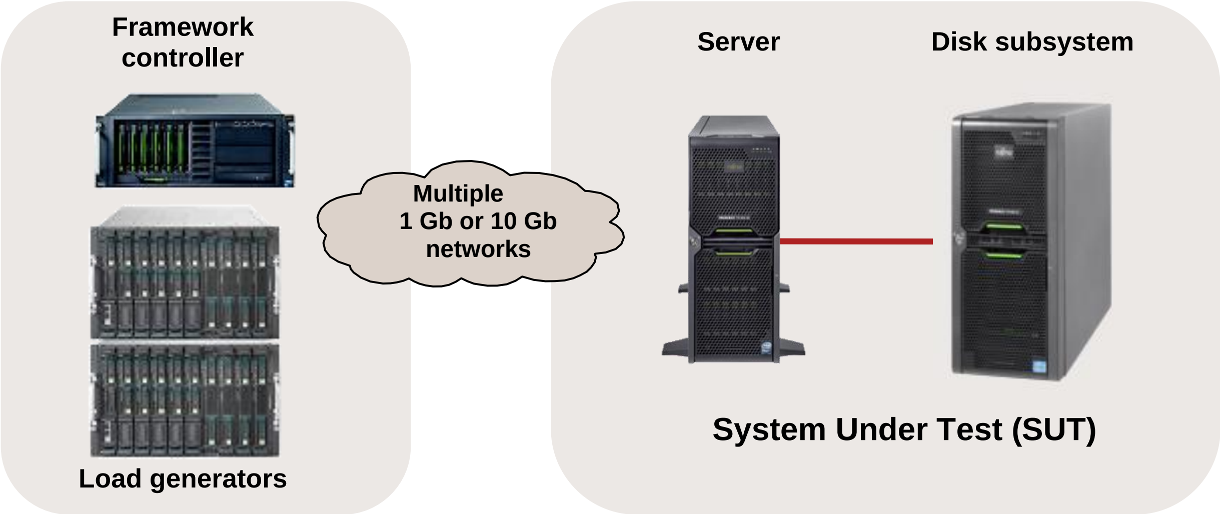
As a general rule, start with one tile, and this procedure is performed for an increasing number of tiles until no further significant increase in this vServCon score occurs. The final vServCon score is then the maximum of the vServCon scores for all tile numbers. This score thus reflects the maximum total throughput that can be achieved by running the mix defined in vServCon that consists of numerous VMs up to the possible full utilization of CPU resources. This is why the measurement environment for vServCon measurements is designed in such a way that only the CPU is the limiting factor and that no limitations occur as a result of other resources.

The progression of the vServCon scores for the tile numbers provides useful information about the scaling behavior of the “System under Test”.

A detailed description of vServCon is in the document: Benchmark Overview vServCon.

Benchmark environment

The typical measurement set-up is illustrated below:



System Under Test (SUT)	
Hardware	
Processor	4 × 2nd Generation Intel Xeon Scalable Processors Family
Memory	48 × 32 GB (1x32 GB) 2Rx4 DDR4-2933 R ECC
Network interface	2 × Intel Ethernet Controller X710 for 10GbE SFP+
Disk subsystem	1 ×dual-channel FC controller Emulex LPe160021 LINUX/LIO based flash storage system
Software	
Operating system	VMware ESXi 6.7 EP06 Build 11675023

Load generator (incl. Framework controller)	
Hardware (Shared)	
Enclosure	4 × PRIMERGY RX2530 M2
Hardware	
Processor	2 × XeonE5-2683 v4
Memory	128 GB
Network interface	3 × 1 Gbit LAN
Software	
Operating system	VMware ESXi 6.0.0 U2 Build 3620759

Load generator VM (on various servers)	
Hardware	
Processor	1 × logical CPU
Memory	4048 MB
Network interface	2 × 1 Gbit/s LAN
Software	
Operating system	Microsoft Windows Server 2008 Standard Edition 32 bit

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

Benchmark results

The PRIMERGY four-socket rack systems dealt with here are based on processors of the 2nd Generation Intel Xeon Scalable Processors Family . The features of the processors are summarized in the section “Technical data”.

The available processors of these systems with their results can be seen in the following table.

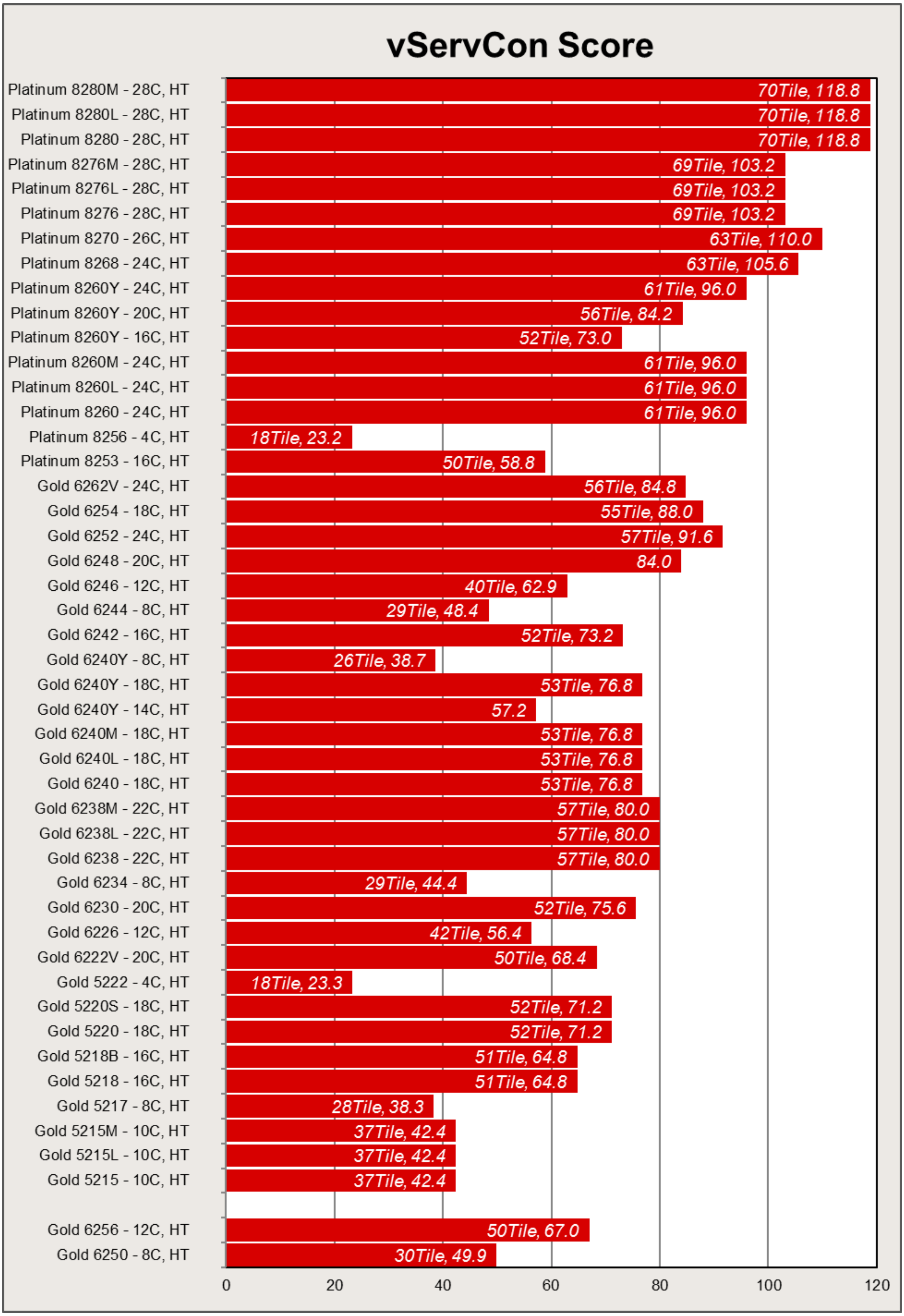
The result with "est." are the estimated values.

Processor	Cores	Threads	#Tiles	Score
April 2019 released				
Xeon Platinum 8280L	28	56	70 (est.)	118.8 (est.)
Xeon Platinum 8280M	28	56	70 (est.)	118.8 (est.)
Xeon Platinum 8280	28	56	70	118.8
Xeon Platinum 8276L	28	56	69 (est.)	103.2 (est.)
Xeon Platinum 8276M	28	56	69 (est.)	103.2 (est.)
Xeon Platinum 8276	28	56	69 (est.)	103.2 (est.)
Xeon Platinum 8270	26	52	63 (est.)	110.0 (est.)
Xeon Platinum 8268	24	48	63 (est.)	105.6 (est.)
Xeon Platinum 8260L	24	48	61 (est.)	96.0 (est.)
Xeon Platinum 8260M	24	48	61 (est.)	96.0 (est.)
Xeon Platinum 8260Y	24	48	61 (est.)	96.0 (est.)
	20	40	56 (est.)	84.2 (est.)
	16	32	52 (est.)	73.0 (est.)
Xeon Platinum 8260	24	48	61 (est.)	96.0 (est.)
Xeon Platinum 8256	4	8	18 (est.)	23.2 (est.)
Xeon Platinum 8253	16	32	50 (est.)	58.8 (est.)
Xeon Gold 6262V	24	48	56 (est.)	84.8 (est.)
Xeon Gold 6254	18	36	55 (est.)	88.0 (est.)
Xeon Gold 6252	24	48	57 (est.)	91.6 (est.)
Xeon Gold 6248	20	40	53 (est.)	84.0 (est.)
Xeon Gold 6246	12	24	40 (est.)	62.9 (est.)
Xeon Gold 6244	8	16	29	48.4
Xeon Gold 6242	16	32	52 (est.)	73.2 (est.)
Xeon Gold 6240L	18	36	53 (est.)	76.8 (est.)
Xeon Gold 6240M	18	36	53 (est.)	76.8 (est.)

Xeon Gold 6240Y	18	36	53 (est.)	76.8 (est.)
	14	28	46 (est.)	57.2 (est.)
	8	16	26 (est.)	38.7 (est.)
Xeon Gold 6240	18	36	53 (est.)	76.8 (est.)
Xeon Gold 6238L	22	44	57 (est.)	80.0 (est.)
Xeon Gold 6238M	22	44	57 (est.)	80.0 (est.)
Xeon Gold 6238	22	44	57 (est.)	80.0 (est.)
Xeon Gold 6234	8	16	29 (est.)	44.4 (est.)
Xeon Gold 6230	20	40	52 (est.)	75.6 (est.)
Xeon Gold 6226	12	24	42 (est.)	56.4 (est.)
Xeon Gold 6222V	20	40	50 (est.)	68.4 (est.)
Xeon Gold 5222	4	8	18 (est.)	23.3 (est.)
Xeon Gold 5220S	18	36	52 (est.)	71.2 (est.)
Xeon Gold 5220	18	36	52 (est.)	71.2 (est.)
Xeon Gold 5218B	16	32	51 (est.)	64.8 (est.)
Xeon Gold 5218	16	32	51 (est.)	64.8 (est.)
Xeon Gold 5217	8	16	28 (est.)	38.3 (est.)
Xeon Gold 5215L	10	20	37 (est.)	42.4 (est.)
Xeon Gold 5215M	10	20	37 (est.)	42.4 (est.)
Xeon Gold 5215	10	20	37 (est.)	42.4 (est.)

These PRIMERGY four-socket rack systems are very suitable for application virtualization owing to the progress made in processor technology. Compared with a system based on the previous processor generation, approximately 5.9% higher virtualization performance can be achieved (measured in vServCon score in their maximum configuration).

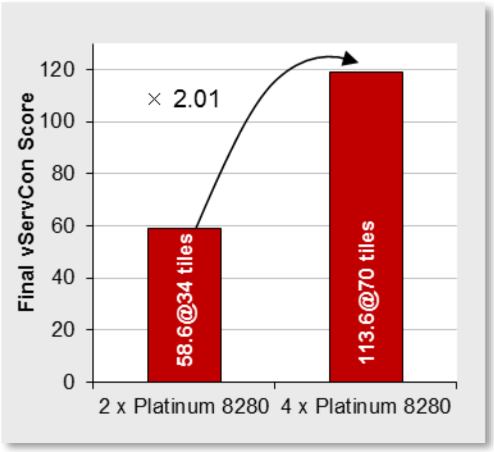
The following diagram compares the virtualization performance values that can be achieved with the processors reviewed here.



The relatively large performance differences between the processors can be explained by their features. The values scale on the basis of the number of cores, the size of the L3 cache and the CPU clock frequency and as a result of the features of Hyper-Threading and turbo mode, which are available in most processor types. Furthermore, the data transfer rate between processors ("UPI Speed") also determines performance.

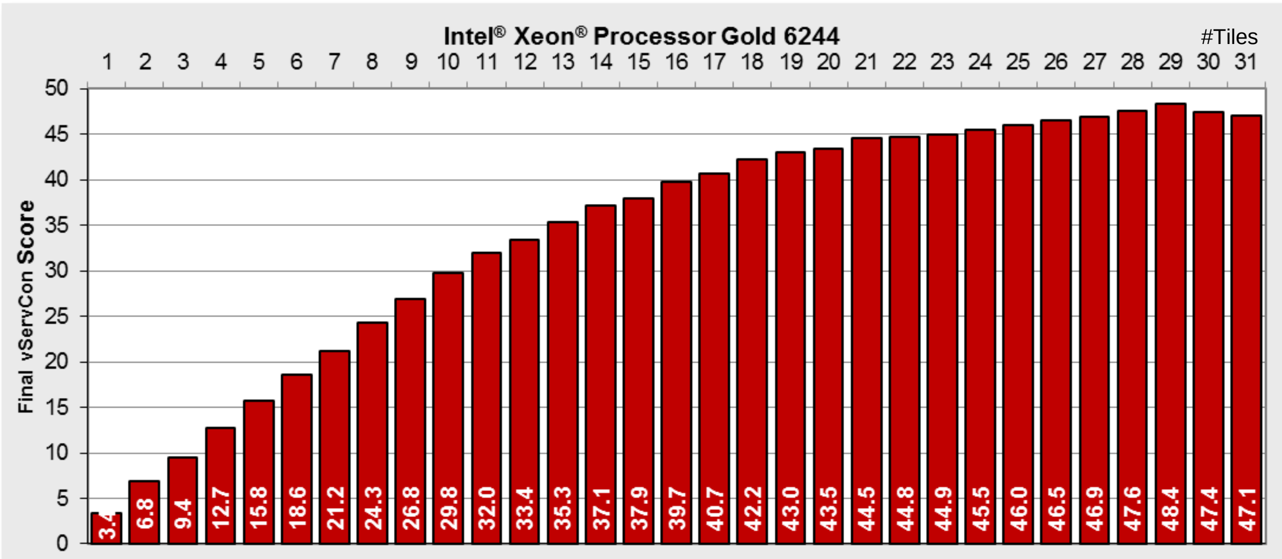
Within a group of processors with the same number of cores scaling can be seen via the CPU clock frequency.

As a matter of principle, the memory access speed also influences performance. A guideline in the virtualization environment for selecting main memory is that sufficient quantity is more important than the speed of the memory accesses. The vServCon scaling measurements presented here were all performed with a memory access speed – depending on the processor type – of at most 2933 MHz.



Until now, we have looked at the virtualization performance of a fully configured system. However, with a server with four sockets, the question also arises as to how good performance scaling is from two to four processors. The better the scaling, the lower the overhead usually caused by the shared use of resources within a server. The scaling factor also depends on the application. If the server is used as a virtualization platform for server consolidation, the system scales with a factor of 2.01. When operated with four processors, the system thus achieves twice the performance as with two processors, as is illustrated in this diagram using the processor version Xeon Platinum 8280 as an example.

The next diagram illustrates the virtualization performance for increasing numbers of VMs based on the Xeon Gold 6244 (8-Core) processors.

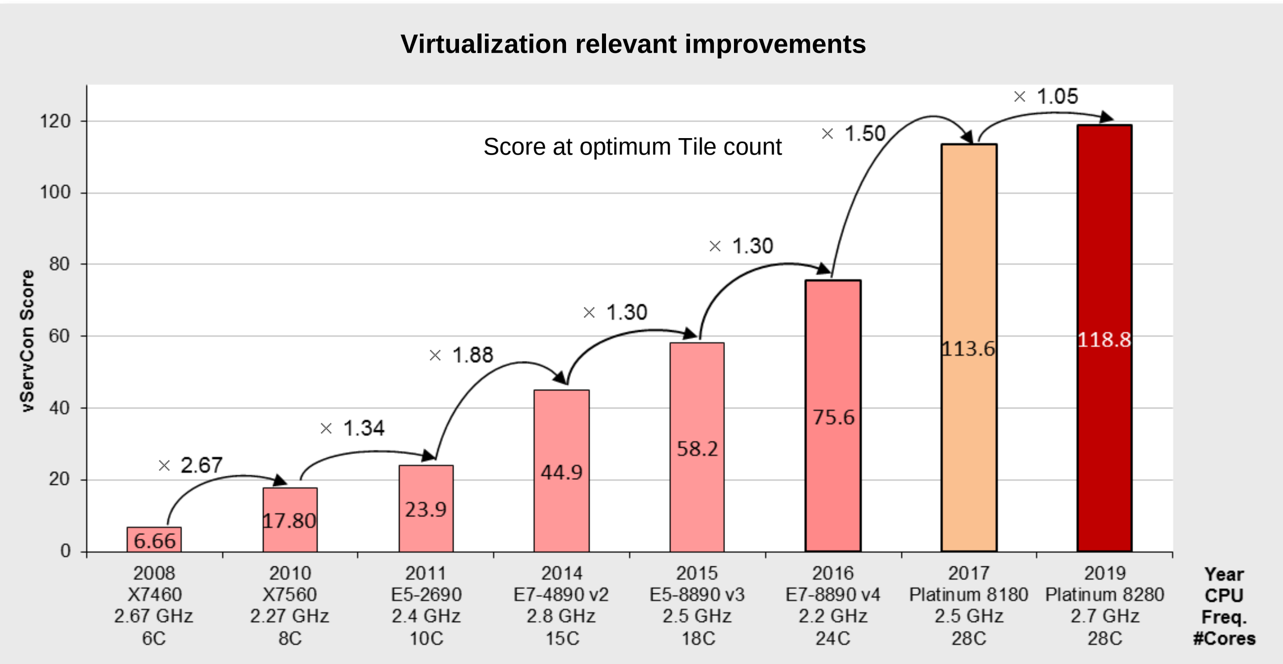


The previous diagram examined the total performance of all application VMs of a host. However, studying the performance from an individual application VM viewpoint is also interesting. This information is in the previous diagram. For example, the total optimum is reached in the above Xeon Gold 6244 situation with 87 application VMs (29 tiles, not including the idle VMs) The low load case is represented by three application VMs (one tile, not including the idle VM). Remember, the vServCon score for one tile is an average value across the three application scenarios in vServCon. This average performance of one tile drops when changing from the low load case to the total optimum of the vServCon score – from 3.4 to 48.4/29=1.7, i.e. to 50%. The individual types of application VMs can react very differently in the high load situation. It is thus clear that in a specific situation the performance requirements of an individual application must be balanced against the overall requirements regarding the numbers of VMs on a virtualization host.

The performance for an individual VM in low-load situations has only slightly increased for the processors compared here with the highest clock frequency per core. We must explicitly point out that the increased virtualization performance as seen in the score cannot be completely deemed as an improvement for one individual VM.

Performance increases in the virtualization environment since 2010 are mainly achieved by increases in the maximum number of VMs that can be operated.

	Best Maximum Performance CPU	vServCon Score max.
2008	X7460	6.66@ 6 tiles
2009	X7560	17.8@18 tiles
2011	E7-4870	23.9@24 tiles
2014	E7-4890 v2	44.9@28 tiles
2015	E7-8890 v3	58.2@34 tiles
2016	E7-8890 v4	75.6@44 tiles
2017	Platinum 8180	113.6@68tiles
2019	Platinum 8280	118.8@70tiles



VMmark V3

Benchmark description

VMmark V3 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 V2” in September 2017, it has been succeeded by “VMmark V3”. VMmark V2 required 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. VMmark V3 covers the moving of VMs with XvMotion in addition to VMmark V2 and changes application architecture to more scalable workloads.

In addition to the “Performance Only” result, 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 V3 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. Two proven benchmarks, which cover the application scenarios Scalable web system and E-commerce system were integrated in VMmark V3.

Application scenario	Load tool	# VMs
Scalable web system	Weathervane	14
E-commerce system	DVD Store 3 client	4
Standby system		1

Each of the three application scenarios is assigned to a total of 18 dedicated virtual machines. Then add to these an 19th VM called the “standby server”. These 19 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 V3 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, XvMotion and Storage vMotion. The Load Balancing capacity of the data center is also used (DRS, Distributed Resource Scheduler).

The result of VMmark V3 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 V3 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 result for each tile is 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 V3 tiles is always specified with each VMmark V3 score. The result is thus as follows: “Score@Number of Tiles”, for example “8.11@8 tiles”.

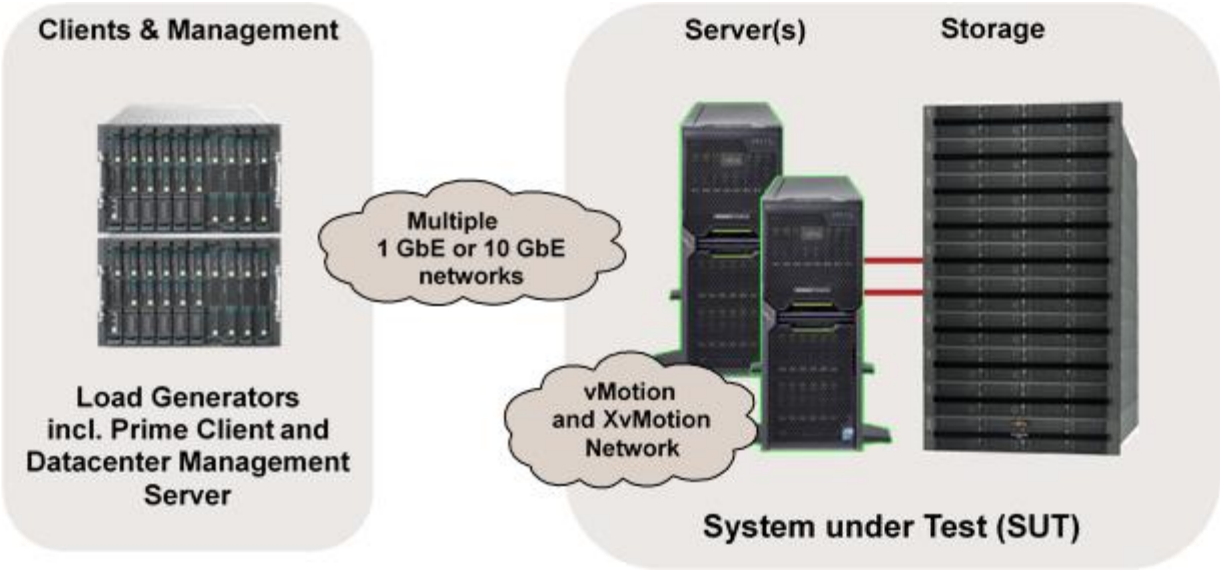
In the case of the two test types “Performance with Server Power” and “Performance with Server and Storage Power”, a so-called “Server PPKW Score” and “Server and Storage PPKW Score” are determined, which are the performance scores divided by the average power consumption in kilowatts (PPKW = performance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

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

A detailed description of VMmark V3 is available in the document Benchmark Overview VMmark V3.

Benchmark environment

The typical measurement set-up is illustrated below:



System Under Test (SUT)	
Hardware	
Number of servers	2
Model	PRIMERGY RX4770 M5
Processor	4 × Intel Xeon Platinum 8280
Memory	768 GB: 48 × 32 GB (1x32 GB) 2Rx4 DDR4-2933 R ECC
Network interface	2 × Intel Ethernet Controller X710 for 10GbE SFP+ 1 × Intel Ethernet Connection X722 for 1GbE
Disk subsystem	2 × Dual port PFC EP LPe31002 6 × PRIMERGY RX2540 M5 configured as Fibre Channel target 4 × PRIMERGY RX2540 M5: 2 × Micron MTFDDAK480 TDC SATA-SSD (480 GB) 3 × Intel P4800X 750GB PCIe SSD (750 GB) 1 × Intel P4600 4TB PCIe SSD (4 TB) SATA-SSD1, 2(RAID 1) 1 × PRIMERGY RX2540 M5: 1 × Micron MTFDDAK960 TDC SATA-SSD (960 GB) 2 × Intel P4800X 750GB PCIe SSD (750 GB) 2 × Intel P4600 2TB PCIe SSD (2 TB) 1 × PRIMERGY RX2540 M5: 1 × Micron MTFDDAK960 TDC SATA-SSD (960 GB) 4 × Intel P4800X 750GB PCIe SSD (750 GB)
Software	
BIOS	V5.0.0.14 R1.8.0 for D3753-C1x
BIOS settings	See details
Operating system	VMware ESXi 6.7 EP 08, Build 13473784
Operating system settings	ESX settings: see details

Details	
See disclosure	https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/vmmark/2019-08-27-Fujitsu-RX4770M5.pdf

Datacenter Management Server (DMS)	
Hardware	
Model	1 × PRIMERGY RX2530 M2
Processor	1 × Intel Xeon E5-2698 v4
Memory	64 GB
Network interface	1 × Emulex One Connect Oce14000 1 GbE Dual Port Adapter
Software	
Operating system	VMware ESXi 6.7 EP 02a Build 9214924
Datacenter Management Server (DMS) VM	
Hardware	
Processor	4 × logical CPU
Memory	16 GB
Network interface	1 × 1 Gbit/s LAN
Software	
Operating system	VMware vCenter Server Appliance 6.7.0d Build 9451876

Load generator	
Hardware	
Model	5 × PRIMERGY RX2530 M2
Processor	3 × Fujitsu PRIMERGY RX2530M2 2 × Intel Xeon E5-2699 v4 2 × Fujitsu PRIMERGY RX2530M2 2 × Intel Xeon E5-2699A v4
Memory	256 GB
Network interface	1 × Emulex One Connect Oce14000 1GbE Dual Port Adapter 1 × Emulex One Connect Oce14000 10GbE Dual Port Adapter
Software	
Operating system	VMware ESXi 6.7 U1 Build 10302608

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

Benchmark results

“Performance Only” measurement result (August 27 2019)

On August 27, 2019 Fujitsu achieved with a PRIMERGY RX4770 M5 with Xeon Platinum 8280 processors and VMware ESXi 6.7 EP 08 a VMmark V3 score of “17.23@18 tiles” in a system configuration with a total of 4 × 56 processor cores and when using two identical servers in the “System under Test” (SUT). With this result the PRIMERGY RX4770 M5 is in the official VMmark V3 “Performance Only” ranking the most powerful four-socket server in a “matched pair” configuration consisting of two identical hosts (valid as of benchmark results publication date).

All comparisons for the competitor products reflect the status of August 27, 2019. The current VMmark V3 “Performance Only” results as well as the detailed results and configuration data are available at https://www.vmware.com/products/vmmark/results3x.html .

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 RX4770 M5 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 and the infrastructure-workload connection between the hosts were implemented via 10GbE LAN ports.

All the components used were optimally attuned to each other.

VMmark is a product of VMware, Inc.

STREAM

Benchmark description

STREAM is a synthetic benchmark that has been used for many years to determine memory throughput and 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, it 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 RX4770 M5
Processor	2nd Generation Intel Xeon Scalable Processors Family
Memory	48 × 32 GB (1x32 GB) 2Rx4 PC4-2933Y-R
Software	
BIOS settings	IMC Interleaving = 1-way Override OS Energy Performance = Enabled Energy Performance = Performance HWPM Support = Disabled Intel Virtualization Technology = Disabled LLC Dead Line Alloc = Disabled Stale AtoS = Enabled
Operating system	SUSE Linux Enterprise Server 15
Operating system settings	Kernel Boot Parameter set with : nohz_full=1-X (X: logical core number -1) Transparent Huge Pages inactivated sched_cfs_bandwidth_slice_us = 50000 sched_latency_ns = 240000000 sched_migration_cost_ns = 5000000 sched_min_granularity_ns = 100000000 sched_wakeup_granularity_ns = 150000000 cpupower -c all frequency-set -g performance cpupower idle-set -d 1 cpupower idle-set -d 2 cpupower idle-set -d 3 echo 0 > /proc/sys/kernel/numa_balancing echo 1 > /proc/sys/vm/drop_caches ulimit -s unlimited
Compiler	CPU released in April 2019 C/C++: Version 2019.3.0.591499 of Intel C/C++ Compiler for Linux
Benchmark	STREAM Version 5.10

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

Benchmark results

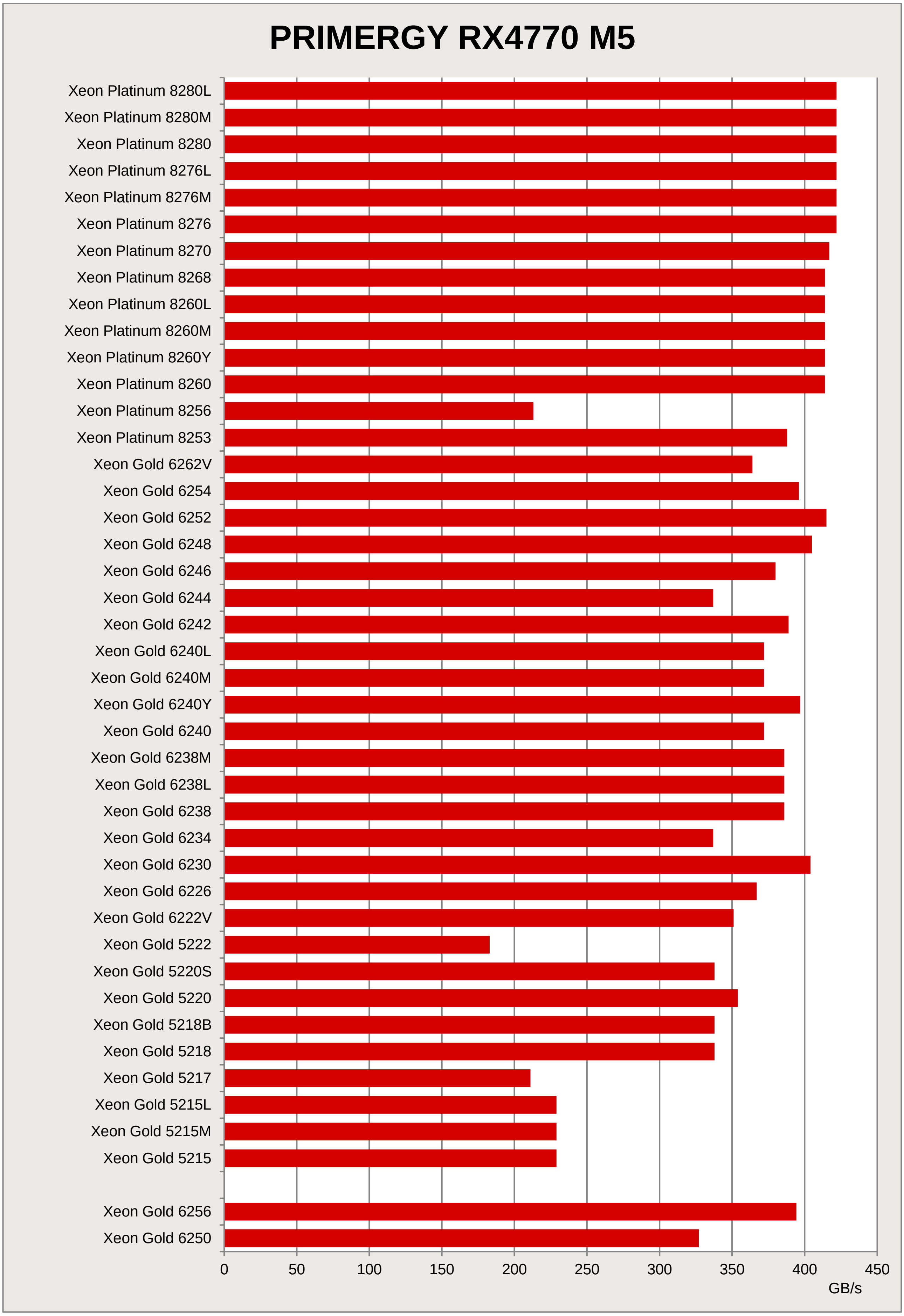
The result with "est." are the estimated values.

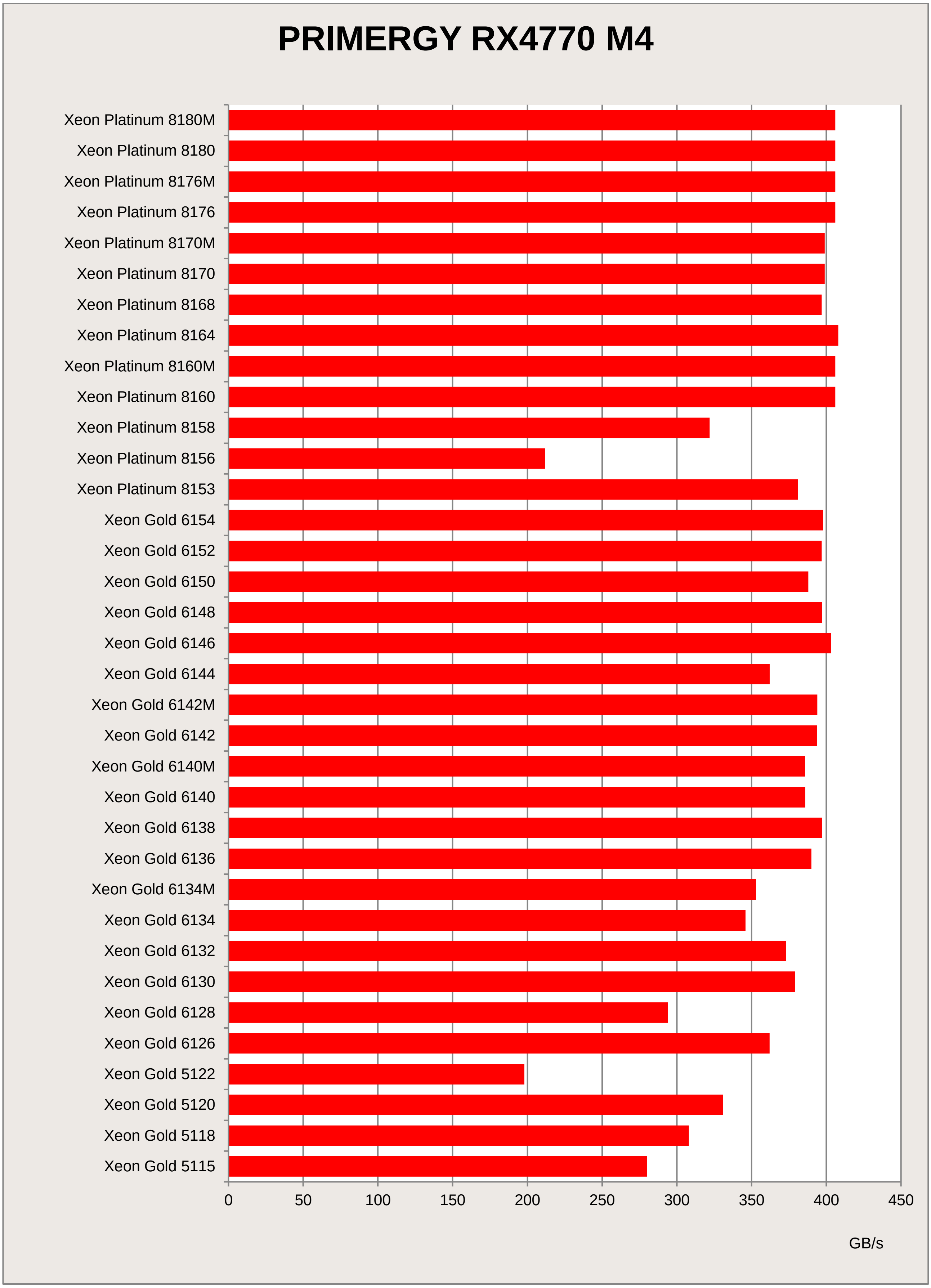
Processor	Memory Frequency [MHz]	Max. Memory Bandwidth *1 [GB/s]	Cores	Processor Frequency [GHz]	Number of Processors	TRIAD [GB/s]
April 2019 released						
Xeon Platinum 8280L	2933	140.8	28	2.7	4	**422**
Xeon Platinum 8280M	2933	140.8	28	2.7	4	422(est.)
Xeon Platinum 8280	2933	140.8	28	2.7	4	422(est.)
Xeon Platinum 8276L	2933	140.8	28	2.2	4	**422**
Xeon Platinum 8276M	2933	140.8	28	2.2	4	422(est.)
Xeon Platinum 8276	2933	140.8	28	2.2	4	422(est.)
Xeon Platinum 8270	2933	140.8	26	2.7	4	**417**
Xeon Platinum 8268	2933	140.8	24	2.9	4	**414**
Xeon Platinum 8260L	2933	140.8	24	2.4	4	**414**
Xeon Platinum 8260M	2933	140.8	24	2.4	4	414(est.)
Xeon Platinum 8260Y	2933	140.8	24	2.4	4	**414**
	2933	140.8	20	2.4	4	**397**
	2933	140.8	16	2.4	4	**392**
Xeon Platinum 8260	2933	140.8	24	2.4	4	414(est.)
Xeon Platinum 8256	2933	140.8	4	3.8	4	**213**
Xeon Platinum 8253	2933	140.8	16	2.2	4	**388**
Xeon Gold 6262V	2933	140.8	24	1.9	4	**364**
Xeon Gold 6254	2933	140.8	18	3.1	4	**396**
Xeon Gold 6252	2933	140.8	24	2.1	4	**415**
Xeon Gold 6248	2933	140.8	20	2.5	4	**405**
Xeon Gold 6246	2933	140.8	12	3.3	4	**380**
Xeon Gold 6244	2933	140.8	8	3.6	4	**337**
Xeon Gold 6242	2933	140.8	16	2.8	4	**389**
Xeon Gold 6240L	2933	140.8	18	2.6	4	372(est.)
Xeon Gold 6240M	2933	140.8	18	2.6	4	372(est.)
Xeon Gold 6240Y	2933	140.8	18	2.6	4	**397**
	2933	140.8	14	2.6	4	**382**
	2933	140.8	8	2.6	4	**339**
Xeon Gold 6240	2933	140.8	18	2.6	4	**372**
Xeon Gold 6238M	2933	140.8	22	2.1	4	386(est.)
Xeon Gold 6238L	2933	140.8	22	2.1	4	386(est.)
Xeon Gold 6238	2933	140.8	22	2.1	4	**386**
Xeon Gold 6234	2933	140.8	8	3.3	4	**337**
Xeon Gold 6230	2933	140.8	20	2.1	4	**404**
Xeon Gold 6226	2933	140.8	12	2.7	4	**367**
Xeon Gold 6222V	2400	140.8	20	1.8	4	**351**
Xeon Gold 5222	2933	140.8	4	3.8	4	**183**
Xeon Gold 5220S	2666	128.0	18	2.7	4	**338**

Xeon Gold 5220	2666	128.0	18	2.2	4	**353**
Xeon Gold 5218B	2666	128.0	16	2.3	4	338(est.)
Xeon Gold 5218	2666	128.0	16	2.3	4	**338**
Xeon Gold 5217	2666	128.0	8	3	4	**211**
Xeon Gold 5215L	2666	128.0	10	2.5	4	228(est.)
Xeon Gold 5215M	2666	128.0	10	2.5	4	228(est.)
Xeon Gold 5215	2666	128.0	10	2.5	4	**228**

*1: Value per Processor

The following diagram illustrates the throughput of the RX4770 M5 in comparison to its predecessor, the RX4770 M4


PRIMERGY RX4770 M5
Xeon Platinum 8280L
Xeon Platinum 8280M
Xeon Platinum 8280
Xeon Platinum 8276L
Xeon Platinum 8276M
Xeon Platinum 8276
Xeon Platinum 8270
Xeon Platinum 8268
Xeon Platinum 8260L
Xeon Platinum 8260M
Xeon Platinum 8260Y
Xeon Platinum 8260
Xeon Platinum 8256
Xeon Platinum 8253
Xeon Gold 6262V
Xeon Gold 6254
Xeon Gold 6252
Xeon Gold 6248
Xeon Gold 6246
Xeon Gold 6244
Xeon Gold 6242
Xeon Gold 6240L
Xeon Gold 6240M
Xeon Gold 6240Y
Xeon Gold 6240
Xeon Gold 6238M
Xeon Gold 6238L
Xeon Gold 6238
Xeon Gold 6234
Xeon Gold 6230
Xeon Gold 6226
Xeon Gold 6222V
Xeon Gold 5222
Xeon Gold 5220S
Xeon Gold 5220
Xeon Gold 5218B
Xeon Gold 5218
Xeon Gold 5217
Xeon Gold 5215L
Xeon Gold 5215M
Xeon Gold 5215
Xeon Gold 6256
Xeon Gold 6250
0
50
100
150
200
250
300
350
400
450
GB/s


PRIMERGY RX4770 M4
Xeon Platinum 8180M
Xeon Platinum 8180
Xeon Platinum 8176M
Xeon Platinum 8176
Xeon Platinum 8170M
Xeon Platinum 8170
Xeon Platinum 8168
Xeon Platinum 8164
Xeon Platinum 8160M
Xeon Platinum 8160
Xeon Platinum 8158
Xeon Platinum 8156
Xeon Platinum 8153
Xeon Gold 6154
Xeon Gold 6152
Xeon Gold 6150
Xeon Gold 6148
Xeon Gold 6146
Xeon Gold 6144
Xeon Gold 6142M
Xeon Gold 6142
Xeon Gold 6140M
Xeon Gold 6140
Xeon Gold 6138
Xeon Gold 6136
Xeon Gold 6134M
Xeon Gold 6134
Xeon Gold 6132
Xeon Gold 6130
Xeon Gold 6128
Xeon Gold 6126
Xeon Gold 5122
Xeon Gold 5120
Xeon Gold 5118
Xeon Gold 5115
0
50
100
150
200
250
300
350
400
450
GB/s

LINPACK

Benchmark description

LINPACK was developed in the 1970s by Jack Dongarra and some other people to show the performance of supercomputers. The benchmark consists of a collection of library functions for the analysis and solution of linear system of equations. A description can be found in the document https://www.netlib.org/utk/people/JackDongarra/PAPERS/hplpaper.pdf.

LINPACK can be used to measure the speed of computers when solving a linear equation system. For this purpose, an n × n matrix is set up and filled with random numbers between -2 and +2. The calculation is then performed via LU decomposition with partial pivoting.

A memory of $8n^2$ bytes is required for the matrix. In case of an n × n matrix the number of arithmetic operations required for the solution is $^2/_3 n^3 + 2n^2$. Thus, the choice of n determines the duration of the measurement: a doubling of n results in an approximately eight-fold increase in the duration of the measurement. The size of n also has an influence on the measurement result itself. As n increases, the measured value asymptotically approaches a limit. The size of the matrix is therefore usually adapted to the amount of memory available. Furthermore, the memory bandwidth of the system only plays a minor role for the measurement result, but a role that cannot be fully ignored. The processor performance is the decisive factor for the measurement result. Since the algorithm used permits parallel processing, in particular the number of processors used and their processor cores are - in addition to the clock rate - of outstanding significance.

LINPACK is used to measure how many floating point operations were carried out per second. The result is referred to as **Rmax** and specified in GFlops (Giga Floating Point Operations per Second).

An upper limit, referred to as **Rpeak**, for the speed of a computer can be calculated from the maximum number of floating point operations that its processor cores could theoretically carry out in one clock cycle.

Rpeak = Maximum number of floating point operations per clock cycle
× Number of processor cores of the computer
× Rated processor frequency [GHz]

LINPACK is classed as one of the leading benchmarks in the field of high performance computing (HPC). LINPACK is one of the seven benchmarks currently included in the HPC Challenge benchmark suite, which takes other performance aspects in the HPC environment into account.

Manufacturer-independent publication of LINPACK results is possible at https://www.top500.org/. The use of a LINPACK version based on HPL is prerequisite for this (see https://www.netlib.org/benchmark/hpl/).

Intel offers a highly optimized LINPACK version (shared memory version) for individual systems with Intel processors. Parallel processes communicate here via "shared memory", i.e. jointly used memory. Another version provided by Intel is based on HPL (High Performance Linpack). Intercommunication of the LINPACK processes here takes place via OpenMP and MPI (Message Passing Interface). This enables communication between the parallel processes - also from one computer to another. Both versions can be downloaded from https://software.intel.com/content/www/us/en/develop/articles/intel-mkl-benchmarks-suite.html

Manufacturer-specific LINPACK versions also come into play when graphics cards for General Purpose Computation on Graphics Processing Unit (GPGPU) are used. These are based on HPL and include extensions which are needed for communication with the graphics cards.

Benchmark environment

System Under Test (SUT)	
Hardware	
Model	PRIMERGY RX4770 M5
Processor	2nd Generation Intel Xeon Scalable Processors Family
Memory	48 × 32 GB (1x32 GB) 2Rx4 PC4-2933Y-R
Software	
BIOS settings	HyperThreading = Disabled Link Frequency Select = 10.4 GT/s HWPM Support = Disabled Intel Virtualization Technology = Disabled Sub NUMA Clustering = Disabled LLC Dead Line Alloc = Disabled Stale AtoS = Enabled Write CRC = Disabled Fan Control = Full
Operating system	SUSE Linux Enterprise Server 15
Operating system settings	Kernel Boot Parameter set with : nohz_full=1-X (X: logical core number -1) cpupower -c all frequency-set -g performance sched_min_granularity_ns = 100000000 sched_wakeup_granularity_ns = 150000000 run with avx512
Compiler	CPU released in April 2019 C/C++: Version 2019.3.0.591499 of Intel C/C++ Compiler for Linux
Benchmark	Intel Optimized MP LINPACK Benchmark for Clusters

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

Benchmark results

The result with "est." are the estimated values.

Processor	Cores	Processor Frequency [GHz]	Number of Processors	Rpeak [GFlops]	Rmax [GFlops]	Efficiency
April 2019 released						
Xeon Platinum 8280L	28	2.7	4	9,677	**7,028**	73%
Xeon Platinum 8280M	28	2.7	4	9,677	7,028(est.)	73%
Xeon Platinum 8280	28	2.7	4	9,677	7,028(est.)	73%
Xeon Platinum 8276L	28	2.2	4	7,885	**5,403**	69%
Xeon Platinum 8276M	28	2.2	4	7,885	5,403(est.)	69%
Xeon Platinum 8276	28	2.2	4	7,885	5,403(est.)	69%
Xeon Platinum 8270	26	2.7	4	8,986	**6,167**	69%
Xeon Platinum 8268	24	2.9	4	8,909	**6,070**	68%
Xeon Platinum 8260L	24	2.4	4	7,373	**5,230**	71%
Xeon Platinum 8260M	24	2.4	4	7,373	5,230(est.)	71%
Xeon Platinum 8260Y	24	2.4	4	7,373	**5,304**	72%
	20	2.4	4	6,144	**4,694**	76%
	16	2.4	4	4,915	**4,149**	84%
Xeon Platinum 8260	24	2.4	4	7,373	5,230(est.)	71%
Xeon Platinum 8256	4	3.8	4	1,946	**1,542**	79%
Xeon Platinum 8253	16	2.2	4	4,506	**3,145**	70%
Xeon Gold 6262V	24	1.9	4	5,837	**4,212**	72%
Xeon Gold 6254	18	3.1	4	7,142	**5,206**	73%
Xeon Gold 6252	24	2.1	4	6,451	**4,930**	76%
Xeon Gold 6248	20	2.5	4	6,400	**4,551**	71%
Xeon Gold 6246	12	3.3	4	5,069	**3,673**	72%
Xeon Gold 6244	8	3.6	4	3,686	**2,861**	78%
Xeon Gold 6242	16	2.8	4	5,734	**4,172**	73%
Xeon Gold 6240L	18	2.6	4	5,990	4,286(est.)	72%
Xeon Gold 6240M	18	2.6	4	5,990	4,286(est.)	72%
Xeon Gold 6240Y	18	2.6	4	5,990	**4,251**	71%
	14	2.6	4	4,659	**3,704**	80%
	8	2.6	4	2,662	**2,744**	103%
Xeon Gold 6240	18	2.6	4	5,990	**4,286**	72%
Xeon Gold 6238M	22	2.1	4	5,914	4,413(est.)	75%
Xeon Gold 6238L	22	2.1	4	5,914	4,413(est.)	75%
Xeon Gold 6238	22	2.1	4	5,914	**4,413**	75%
Xeon Gold 6234	8	3.3	4	3,379	**2,607**	77%
Xeon Gold 6230	20	2.1	4	5,376	**3,773**	70%
Xeon Gold 6226	12	2.7	4	4,147	**3,295**	79%
Xeon Gold 6222V	20	1.8	4	4,608	**3,623**	79%
Xeon Gold 5222	4	3.8	2	1,946	**1,539**	79%
Xeon Gold 5220S	18	2.7	2	3,110	**2,443**	79%
Xeon Gold 5220	18	2.2	2	2,534	**2,448**	97%

Xeon Gold 5218B	16	2.3	2	2,355	2,236(est.)	95%
Xeon Gold 5218	16	2.3	2	2,355	**2,236**	95%
Xeon Gold 5217	8	3	2	1,536	**1,434**	93%
Xeon Gold 5215L	10	2.5	2	1,600	1,468(est.)	92%
Xeon Gold 5215M	10	2.5	2	1,600	1,468(est.)	92%
Xeon Gold 5215	10	2.5	2	1,600	**1,468**	92%

Rpeak values in the table above were calculated by the base frequency of each processor. Since we enabled Turbo mode in measurements of *Rmax*, the average Turbo frequency exceeded the base frequency for some processors. That is the reason why *Efficiency* of some processors exceeds 100%.
As explained in the section "Technical Data", Intel generally does not guarantee that the maximum turbo frequency can be reached in the processor models due to manufacturing tolerances. A further restriction applies for workloads, such as those generated by LINPACK, with intensive use of AVX instructions and a high number of instructions per clock unit. Here the frequency of a core can also be limited if the upper limits of the processor for power consumption and temperature are reached before the upper limit for the current consumption. This can result in the achievement of a lower performance with turbo mode than without turbo mode. In such cases, you should disable the turbo functionality via BIOS option.

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