Fujitsu Server PRIMERGY
Performance Report
PRIMERGY RX2450 M1

This document provides an overview of benchmarks executed on the Fujitsu Server PRIMERGY RX2450 M1.

Explaines PRIMERGY RX2450 M1 performance data in comparison to other PRIMERGY models. In addition to the benchmark results, the explanation for each benchmark and benchmark environment are also included.

Version
1.3 2023-10-03

Contents

Technical data

PRIMERGY RX2450 M1

In this document, the power of 10 (example: 1 GB = 10^9 bytes) is used to indicate the capacity of the internal storage, and the power of 2 (example: 1 GB = 2^{30} bytes) is used to indicate the capacity of the cache or memory module. Any other exceptional notation will be specified separately.

Model	PRIMERGY RX2450 M1
Form factor	Rack server
Number of sockets	2
Number of processors orderable	2
Processor type	AMD EPYC 7002 / 7003 Series Processors
Number of memory slots	32
Maximum memory configuration	2,048GB (3200 RDIMM) / 4,096GB (3200 LRDIMM)
Onboard HDD controller	SATA Controller embedded on CPU
Max. number of internal hard disks	24 x SATA HDD / SAS HDD / SATA SSD / SAS SSD / PCIe SSD
PCI slots	4 x PCI-Express 4.0(x16)

Processor Model	Number of cores	Number of threads	Cache [MB]	Rated frequency [GHz]	Maximum turbo frequency [GHz]	Maximum memory frequency [MHz]	TDP [W]
AMD EPYC 7002 Series Processors							
EPYC 7H12	64	128	256	2.60	3.30	3,200	280
EPYC 7F72	24	48	192	3.20	3.70	3,200	240
EPYC 7F52	16	32	256	3.50	3.90	3,200	240
EPYC 7F32	8	16	128	3.70	3.90	3,200	180
EPYC 7742	64	128	256	2.25	3.40	3,200	225
EPYC 7702	64	128	256	2.00	3.35	3,200	200
EPYC 7642	48	96	256	2.30	3.30	3,200	225
EPYC 7552	48	96	192	2.20	3.30	3,200	200
EPYC 7502	32	64	128	2.50	3.35	3,200	180
EPYC 7452	32	64	128	2.35	3.35	3,200	155
EPYC 7402	24	48	128	2.80	3.35	3,200	180
EPYC 7352	24	48	128	2.30	3.20	3,200	155
EPYC 7302	16	32	128	3.00	3.30	3,200	155
EPYC 7282	16	32	64	2.80	3.20	3,200	120
EPYC 7262	8	16	128	3.20	3.40	3,200	155
EPYC 7252	8	16	64	3.10	3.20	3,200	120
AMD EPYC 7003 Series Processors							
EPYC 7763	64	128	256	2.45	3.50	3,200	280
EPYC 7643	48	96	256	2.30	3.60	3,200	225
EPYC 75F3	32	64	256	2.95	4.00	3,200	280
EPYC 7513	32	64	128	2.60	3.65	3,200	200
EPYC 7453	28	56	64	2.75	3.45	3,200	225
EPYC 74F3	24	48	256	3.20	4.00	3,200	240
EPYC 7443	24	48	128	2.85	4.00	3,200	200
EPYC 7343	16	32	128	3.20	3.90	3,200	190
EPYC 72F3	8	16	256	3.70	4.10	3,200	180

All of AMD EPYC 7002 / 7003 Series processors that can be ordered with the PRIMERGY RX2450 M1 support AMD Turbo Core Technology. This technology allows you to operate the processor with higher frequencies than the rated frequency. The maximum frequency that can actually be achieved depends on the type of applications and the processing load.

The turbo functionality can be set in the BIOS option. Generally, Fujitsu generally recommends leaving the [Core Performance Boost] option set at the standard setting of [Auto], as performance is substantially increased by the higher frequencies. However, the higher frequencies depend on the operating conditions mentioned above and is not always guaranteed. If you need stable performance or want to reduce power consumption, it may be beneficial to set [Core Performance Boost] to disable to disable Turbo function.

Memory modules							
Type	Capacity [GB]	Number of ranks	Bit width of the memory chips	Frequency [MHz]	Load reduced	Registered	ECC
16 GB (1x16 GB) 1Rx4 DDR4-3200 RDIMM	16	1	4	3,200		✓	✓
16 GB (1x16 GB) 2Rx8 DDR4-3200 RDIMM	16	2	8	3,200		✓	✓
32 GB (1x32 GB) 1Rx4 DDR4-3200 RDIMM	32	1	4	3,200		✓	✓
64 GB (1x64 GB) 2Rx4 DDR4-3200 RDIMM	64	2	4	3,200		✓	✓
64 GB (1x64 GB) 4Rx4 DDR4-3200 LRDIMM	64	4	4	3,200	✓	✓	✓

Power supplies	Maximum number
Standard PSU 1600W	2

Includes components that will be supported after the system release. Also, some components may not be available in all countries or sales regions.

Detailed technical information is available in the data sheet PRIMERGY RX2450 M1.

SPEC CPU2017

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." They 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	Arithmetic	Compiler optimization	Measurement result	
SPECspeed2017_int_peak	10	Integer	Aggressive (peak)	Speed	Performance
SPECspeed2017_int_energy_peak					Power efficiency
SPECspeed2017_int_peak	10		Conservative (base)		Performance
SPECspeed2017_int_energy_peak					Power efficiency
SPECspeed2017_int_peak	10		Aggressive (peak)	Throughput	Performance
SPECspeed2017_int_energy_peak					Power efficiency
SPECspeed2017_int_peak	10		Conservative (base)		Performance
SPECspeed2017_int_energy_peak					Power efficiency
SPECspeed2017_int_peak	10	Floating point	Aggressive (peak)	Speed	Performance
SPECspeed2017_int_energy_peak					Power efficiency
SPECspeed2017_int_peak	10		Conservative (base)		Performance
SPECspeed2017_int_energy_peak					Power efficiency
SPECspeed2017_int_peak	13		Aggressive (peak)	Throughput	Performance
SPECspeed2017_int_energy_peak					Power efficiency
SPECspeed2017_int_peak	13		Conservative (base)		Performance
SPECspeed2017_int_energy_peak					Power efficiency

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. For example, value "1" was defined for the SPECspeed2017_int_base, SPECrate2017_int_base, SPECspeed2017_fp_base, and SPECrate2017_fp_base results of the reference system. 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

about 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 Fujitsu for publication at SPEC. This is why the SPEC web pages do not have every result. As Fujitsu archives the log files for all measurements, it is possible to prove the correct implementation of the measurements at any time.

Benchmark environment

System Under Test (SUT)	
Hardware	
• Model	PRIMERGY RX2450 M1
• Processor	2 x AMD EPYC 7002 / 7003 Series Processors
• Memory	32 x 64GB (1x64GB) 2Rx4 PC4-3200AA-L
Software	
• BIOS settings	• Determinism Slider = Power · L1 Stream HW Prefetcher = Enabled[*1] · L2 Stream HW Prefetcher = Enabled[*2] · NUMA nodes per socket = NPS4[*3] • SVM Mode = Disabled · DRAM Scrub Time = Disabled[*4] · ACPI SRAT L3 Cache As NUMA Domain = Enabled[*4] • APBDIS = 1[*4] · Fix SOC P-state = P0[*4] · EDC = 300[*4] • EDC Platform = 300[*4] · xGMI Link Ma Speed = 18Gbps[*4] "cTDP" and "Package Power Limit" were set: 280: EPYC 7763, EPYC 75F3, EPYC 7H12 240: EPYC 7643, EPYC 7543, EPYC 74F3, EPYC 7F72, EPYC 7F52, EPYC 7742, EPYC 7642 200: EPYC 7513, EPYC 7443, EPYC 7343, EPYC 72F3, EPYC 7F32, EPYC 7702, EPYC 7552, EPYC 7502, EPYC 7402 180: EPYC 7452, EPYC 7352, EPYC 7302, EPYC 7262 150: EPYC 7282, EPYC 7252 SPECrate2017_int_base: • IOMMU = Enabled[*4] SPECrate2017_fp_base: · SMT Control = Disabled[*5] • IOMMU = Disabled[*4] [*1] EPYC 7H12, EPYC 7742, EPYC 7702: Disabled [*2] EPYC 7H12, EPYC 7742, EPYC 7702, EPYC 7763, EPYC 7513: Disabled [*3] EPYC 7F72: NPS2 [*4] EPYC 7003 Series Processors [*5] EPYC 7763, EPYC 7513, EPYC 7H12, EPYC 7742, EPYC 7702
• Operating system	SUSE Linux Enterprise Server 15 SP2 5.3.18-22-default
• Compiler	AMD EPYC 7002 Processor series: C/C++/Fortran: Version 2.0.0 of AOCC AMD EPYC 7003 Processor series: C/C++/Fortran: Version 3.0.0 of AOCC

Benchmark results

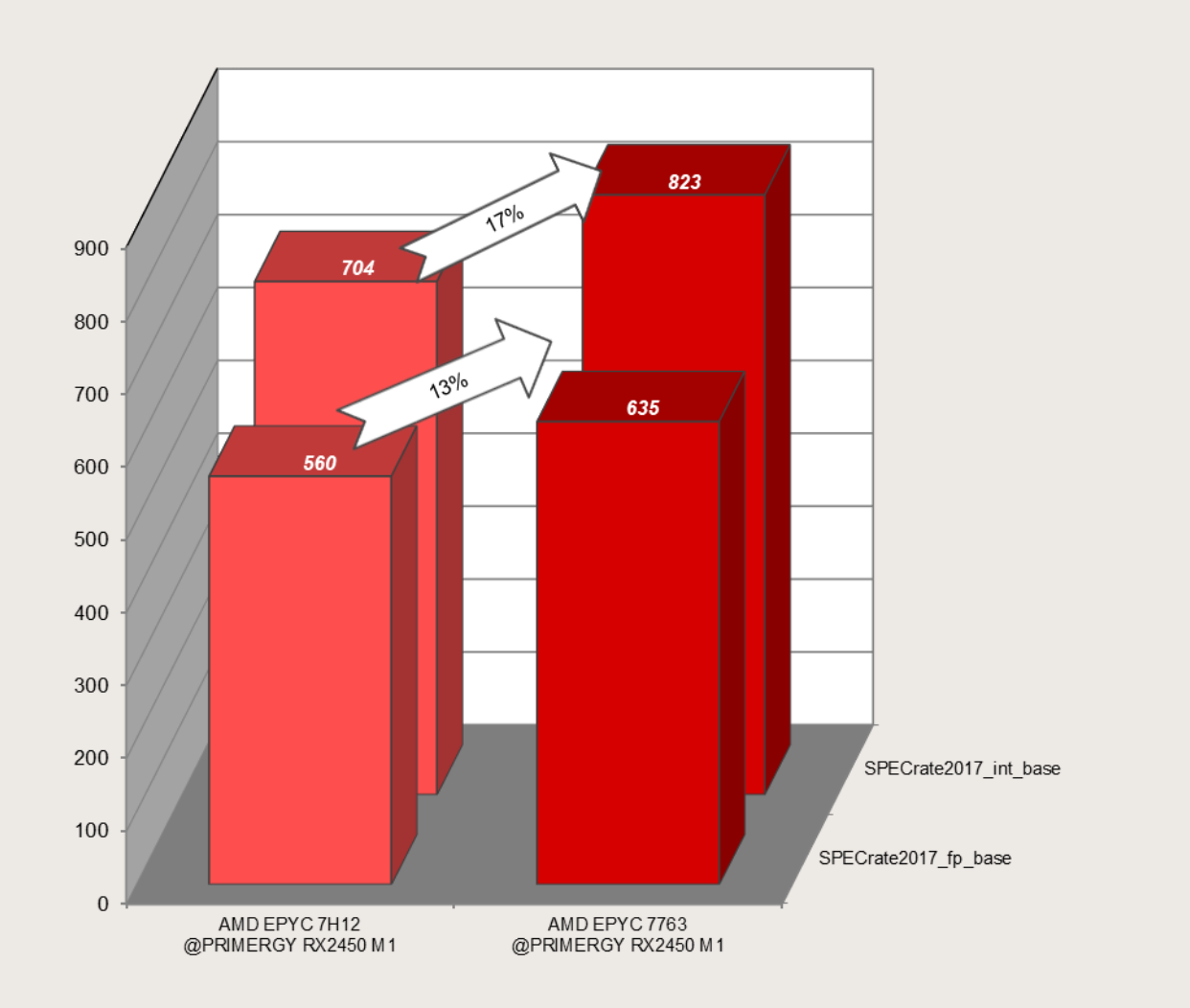
For processors, the benchmark results depend primarily on the size of the processor cache, the support for Hyper-Threading, the number of processor cores, and the processor frequency. In the case of processors with Turbo mode, the number of cores which are loaded by the benchmark determines the maximum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

Results with "est." are estimated values.

Processor model	Number of cores	Cache [MB]	Rated frequency [GHz]	Maximum memory frequency [MHz]	Number of processors	SPECrate2017 int_base	SPECrate2017 fp_base
AMD EPYC 7002 Series Processors							
EPYC 7H12	64	256	2.60	3,200	2	**706**	**540**
EPYC 7F72	24	192	3.20	3,200	2	**378**	**391**
EPYC 7F52	16	256	3.50	3,200	2	**293**	**346**
EPYC 7F32	8	128	3.70	3,200	2	**151**	**203**
EPYC 7742	64	256	2.25	3,200	2	**679**	**524**
EPYC 7702	64	256	2.00	3,200	2	**625**	**491**
EPYC 7642	48	256	2.30	3,200	2	**576**	**468**
EPYC 7552	48	192	2.20	3,200	2	**537**	**428**
EPYC 7502	32	128	2.50	3,200	2	**423**	**373**
EPYC 7452	32	128	2.35	3,200	2	**418**	**363**
EPYC 7402	24	128	2.80	3,200	2	**350**	**344**
EPYC 7352	24	128	2.30	3,200	2	**335**	**333**
EPYC 7302	16	128	3.00	3,200	2	**244**	**286**
EPYC 7282	16	64	2.80	3,200	2	**216**	**203**
EPYC 7262	8	128	3.20	3,200	2	**134**	**182**
EPYC 7252	8	64	3.10	3,200	2	**119**	**150**
AMD EPYC 7003 Series Processors							
EPYC 7763	64	128	2.45	3,200	2	**823**	**635**
EPYC 7643	48	96	2.30	3,200	2	**649**	**546**
EPYC 75F3	32	64	2.95	3,200	2	**572**	**529**
EPYC 7513	32	64	2.60	3,200	2	**485**	**435**
EPYC 7453	28	56	2.75	3,200	2	**434**	**395**
EPYC 74F3	24	48	3.20	3,200	2	**453**	**461**
EPYC 7443	24	48	2.85	3,200	2	**424**	**412**
EPYC 7343	16	32	3.20	3,200	2	**319**	**359**
EPYC 72F3	8	16	3.70	3,200	2	**185**	**246**

EPYC 7763, which is the highest performance model in EPCY 7003 series processors, scored 17% higher on SPECrate2017_int_base and 13% higher on SPECrate2017_fp_base than EPC 7H12, which is the highest performance model in EPCY 7002 series processors.

SPECrate2017: Comparison of AMD EPYC 7763 and AMD EPYC 7H12



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. This provides optimal load distribution for the available processor cores.

In the STREAM benchmark, a data area consisting of 8-byte elements is continuously copied to four operation types. Arithmetic operations are also performed on operation types other than COPY.

Arithmetics type	Arithmetics	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.

In this chapter, throughputs are indicated as a power of 10. (1 GB/s = 10^9 Byte/s)

Benchmark environment

System Under Test (SUT)	
Hardware	
• Model	PRIMERGY RX2450 M1
• Processor	2 x AMD EPYC 7002 / 7003 Series Processors
• Memory	32 x 64GB (1x64GB) 2Rx4 PC4-3200AA-L
Software	
• BIOS settings	• Determinism Slider = Performance • NUMA nodes per socket = NPS4 · L1 Stream HW Prefetcher = Enabled[*1] · L2 Stream HW Prefetcher = Enabled[*1] · SMT Control = Disabled[*2] • SVM Mode = Disabled • DRAM scrub time = disabled · ACPI SRAT L3 Cache As NUMA Domain = Enabled[*2] · APBDIS = 1[*2] · Fix SOC P-state = P0[*2] • EDC = 300[*2] · EDC Platform = 300[*2] • “cTDP” and “Package Power Limit” were set: 280: EPYC 7763, EPYC 75F3, EPYC 7H12 240: EPYC 7643, EPYC 7543, EPYC 74F3, EPYC 7F72, EPYC 7F52, EPYC 7742, EPYC 7642 200: EPYC 7513, EPYC 7443, EPYC 7343, EPYC 72F3, EPYC 7F32, EPYC 7702, EPYC 7552, EPYC 7502, EPYC 7402 180: EPYC 7452, EPYC 7352, EPYC 7302, EPYC 7262 150: EPYC 7282, EPYC 7252 [*1] EPYC 7003 Series Processors: Disabled [*2] EPYC 7003 Series Processors
• Operating system	SUSE Linux Enterprise Server 15 SP2 5.3.18-22-default

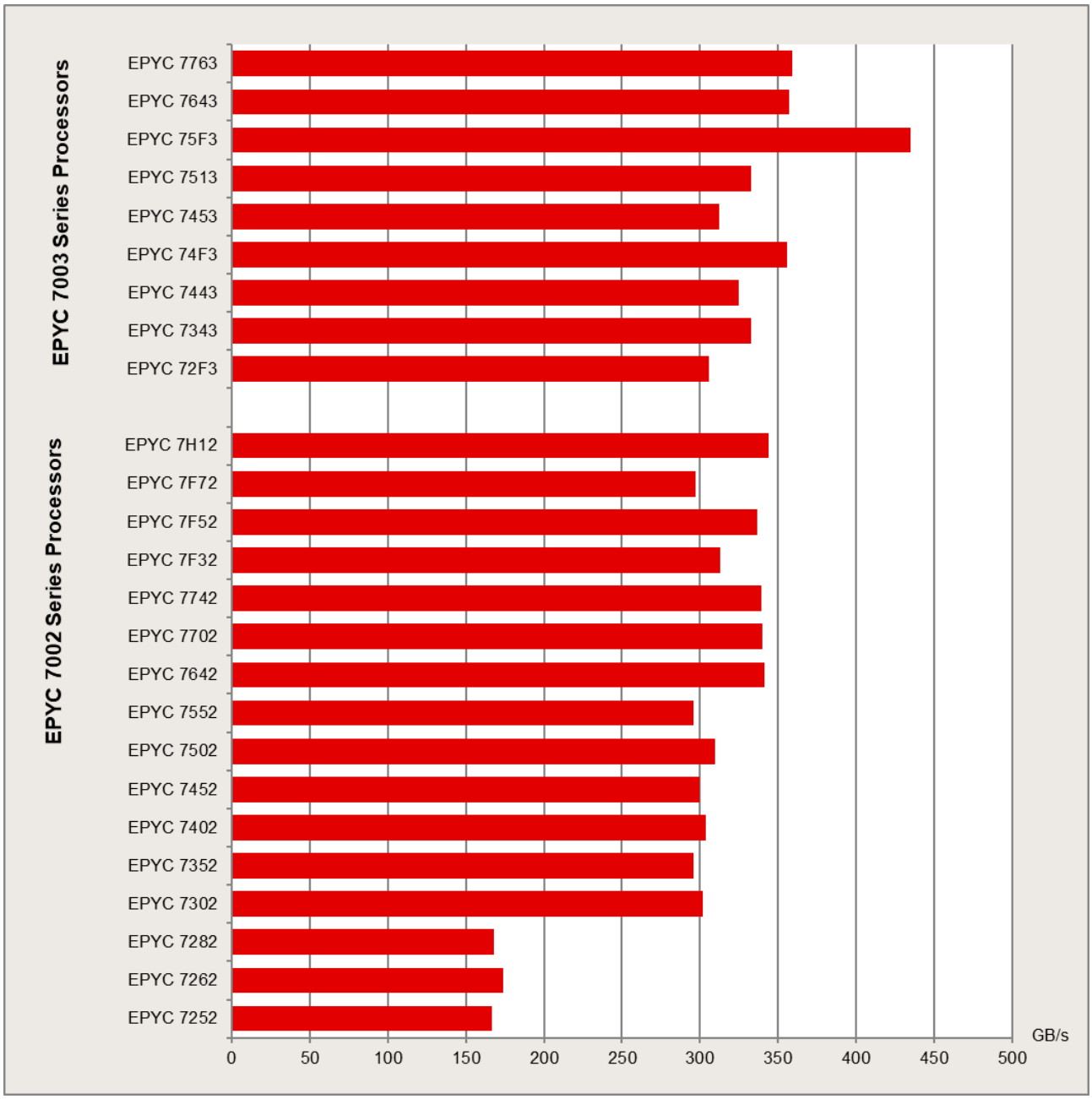
Benchmark results

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

Processor model	Memory frequency [MHz]	Maximum memory bandwidth [GB/s]	Number of cores	Rated frequency [GHz]	Number of processors	TRIAD [GB/s]
AMD EPYC 7002 Series Processors						
EPYC 7H12	3,200	204.8	64	2.60	2	**344**
EPYC 7F72	3,200	204.8	24	3.20	2	**297**
EPYC 7F52	3,200	204.8	16	3.50	2	**337**
EPYC 7F32	3,200	204.8	8	3.70	2	**313**
EPYC 7742	3,200	204.8	64	2.25	2	**339**
EPYC 7702	3,200	204.8	64	2.00	2	**340**
EPYC 7642	3,200	204.8	48	2.30	2	**341**
EPYC 7552	3,200	204.8	48	2.20	2	**296**
EPYC 7502	3,200	204.8	32	2.50	2	**310**
EPYC 7452	3,200	204.8	32	2.35	2	**300**
EPYC 7402	3,200	204.8	24	2.80	2	**304**
EPYC 7352	3,200	204.8	24	2.30	2	**296**
EPYC 7302	3,200	204.8	16	3.00	2	**302**
EPYC 7282	3,200	85.3[*1]	16	2.80	2	**168**
EPYC 7262	3,200	204.8	8	3.20	2	314 est.
EPYC 7252	3,200	85.3[*1]	8	3.10	2	**167**
AMD EPYC 7003 Series Processors						
EPYC 7763	3,200	204.8	64	2.45	2	**359**
EPYC 7643	3,200	204.8	48	2.30	2	**357**
EPYC 75F3	3,200	204.8	32	2.95	2	**435**
EPYC 7513	3,200	204.8	32	2.60	2	**333**
EPYC 7453	3,200	204.8	28	3.20	2	**312**
EPYC 74F3	3,200	204.8	24	3.20	2	**356**
EPYC 7443	3,200	204.8	24	2.85	2	**325**
EPYC 7343	3,200	204.8	16	2.75	2	**333**
EPYC 72F3	3,200	204.8	8	3.70	2	**306**

*1: Since EPYC 7282 and EPYC 7252 are optimized for four memory channels and a memory frequency of 2667 MHz, the maximum memory bandwidth is different from other processors.

STREAM TRIAD: Comparison of AMD EPYC 7003 Series Processors and AMD EPYC 7002 Series Processors



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. The description can be found in the following document.

http://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 x 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 x n matrix the number of arithmetic operations required for the solution is $2/3n^3 + 2n^2$. Thus, the choice of n determines the duration of the measurement. In other words, if n is doubled, the measurement time will be approximately eight times longer. The size of n also has an influence on the measurement result itself. As n increases, the measured value asymptotically approaches its 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. he 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: 1 billion floating point operations/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
x Number of processor cores of the computer
x 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 http://www.top500.org/. This requires using an HPL-based LINPACK version (see http://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 http://software.intel.com/en-us/articles/intel-math-kernel-library-linpack-download/.

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

Benchmark environment

System Under Test (SUT)	
Hardware	
• Model	PRIMERGY RX2450 M1
• Processor	2 x AMD EPYC 7002 / 7003 Series Processors
• Memory	32 x 64GB (1x64GB) 2Rx4 PC4-3200AA-L
Software	
• BIOS settings	• Determinism Slider = Performance • NUMA nodes per socket = NPS4 • L1 Stream HW Prefetcher = Enabled • L2 Stream HW Prefetcher = Enabled • SVM Mode = Disabled • DRAM scrub time = disabled • SMT Control = Disabled*1 • ACPI SRAT L3 Cache As NUMA Domain = Enabled*1 • APBDIS = 1*1 • Fix SOC P-state = P0*1 • IOMMU = Enabled*1 • EDC = 300*1 • EDC Platform = 300*1 “cTDP” and “Package Power Limit” were set: 280: EPYC 7763, EPYC 75F3, EPYC 7H12 240: EPYC 7643, EPYC 7543, EPYC 74F3, EPYC 7F72, EPYC 7F52, EPYC 7742, EPYC 7642 200: EPYC 7513, EPYC 7443, EPYC 7343, EPYC 72F3, EPYC 7F32, EPYC 7702, EPYC 7552, EPYC 7502, EPYC 7402 180: EPYC 7452, EPYC 7352, EPYC 7302, EPYC 7262 150: EPYC 7282, EPYC 7252 *1 AMD EPYC 7003 Series Processors
• Operating system	Ubuntu 20.04 5.0.0-13-generic

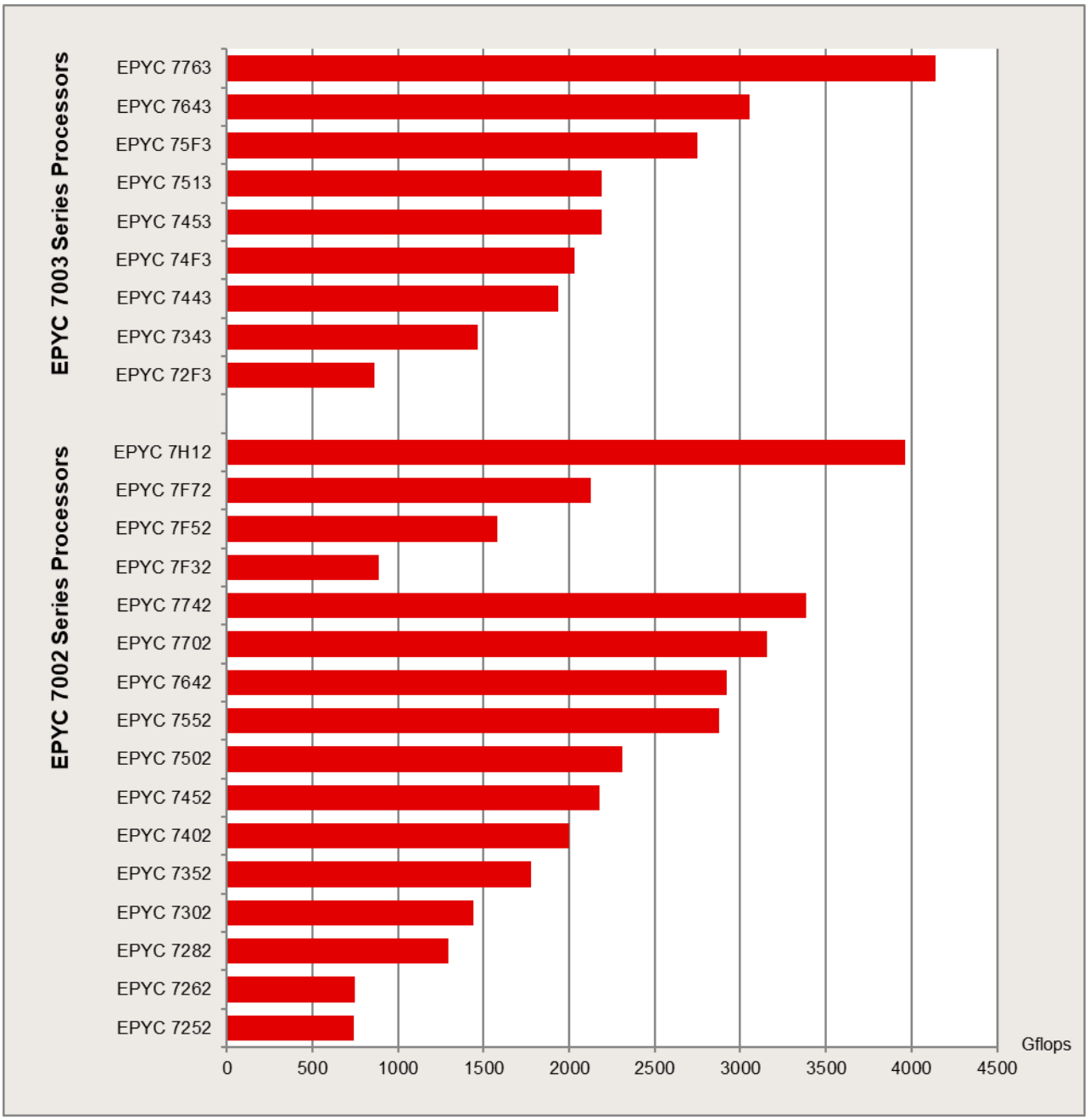
Some components may not be available in all countries or sales regions.

Benchmark results

Processor model	Numbers of cores	Rated frequency [GHz]	Number of processors	Rpeak [GFlops]	Rmax [GFlops]	Efficiency [%]
AMD EPYC 7002 Series Processors						
EPYC 7H12	64	2.60	2	5,325	**3,964**	74.4
EPYC 7F72	24	3.20	2	2,458	**2,129**	86.6
EPYC 7F52	16	3.50	2	1,792	**1,579**	88.1
EPYC 7F32	8	3.70	2	947	**890**	94.0
EPYC 7742	64	2.25	2	4,608	**3,385**	73.5
EPYC 7702	64	2.00	2	4,096	**3,155**	77.0
EPYC 7642	48	2.30	2	3,533	**2,921**	82.7
EPYC 7552	48	2.20	2	3,379	**2,878**	85.2
EPYC 7502	32	2.50	2	2,560	**2,314**	90.4
EPYC 7452	32	2.35	2	2,406	**2,178**	90.5
EPYC 7402	24	2.80	2	2,150	**1,999**	93.0
EPYC 7352	24	2.30	2	1,766	**1,777**	100.6
EPYC 7302	16	3.00	2	1,536	**1,442**	93.9
EPYC 7282	16	2.80	2	1,434	**1,297**	90.5
EPYC 7262	8	3.20	2	819	**748**	91.3
EPYC 7252	8	3.10	2	794	**743**	93.6
AMD EPYC 7003 Series Processors						
EPYC 7763	64	2.45	2	5,018	**4,140**	82.5
EPYC 7643	48	2.30	2	3,533	**3,053**	86.4
EPYC 75F3	32	2.95	2	3,021	**2,747**	90.9
EPYC 7513	32	2.60	2	2,662	**2,193**	82.4
EPYC 7453	28	3.20	2	2,867	**2,187**	76.3
EPYC 74F3	24	3.20	2	2,458	**2,030**	82.6
EPYC 7443	24	2.85	2	2,189	**1,934**	88.4
EPYC 7343	16	2.75	2	1,408	**1,467**	104.2
EPYC 72F3	8	3.70	2	947	**863**	91.1

Rpeak values in the table above were calculated by the base frequency of each processor. Since we enabled Turbo mode in the measurements, the average Turbo frequency exceeded the base frequency for some processors.

LINPACK: Comparison of AMD EPYC 7003 Series Processors and AMD EPYC 7002 Series Processors



SAP Sales and Distribution (SD) Standard Application Benchmark

Description of the benchmark

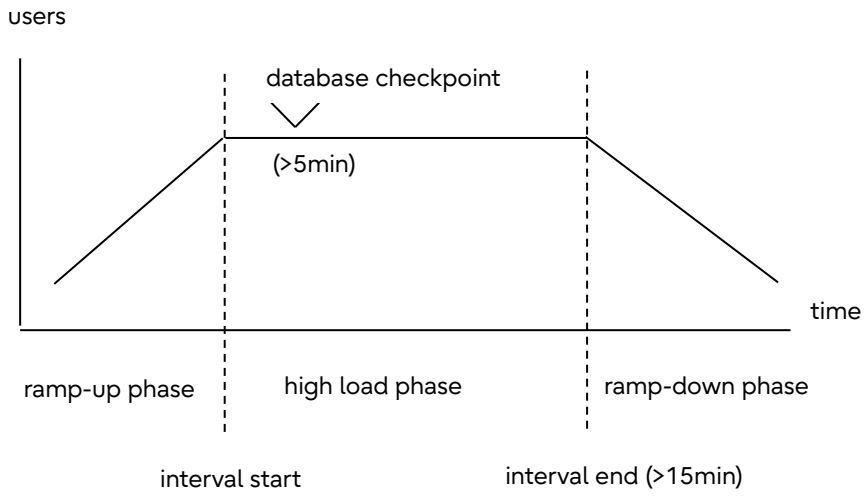
Since 1993 the SAP Standard Application Benchmarks have been developed by SAP in order to verify the performance, stability and scaling of a SAP application system and to provide information for configuring, sizing and for platform comparison. By far the most popular benchmarks from the many available are the SAP SD benchmark and the BW Edition for SAP HANA benchmark (see corresponding section).

The Sales and Distribution benchmark is one of the most CPU consuming benchmarks available and has become a de-facto standard for SAP's platform partners and in the ERP (Enterprise Resource Planning) environment.

During the benchmark a defined sequence of business transactions are run through as shown in the table below. The Sales and Distribution (SD) benchmark covers a sell-from-stock scenario (including a customer order creation, the corresponding delivery with subsequent goods movement and creation of the invoice) and consists of the following SAP transactions:

Create an order with five line items (SAP transaction VA01)
Create a delivery for this order (SAP transaction VL01N)
Display the customer order (SAP transaction VA03)
Change the delivery (SAP transaction VL02N) and post goods issue
List 40 orders for one sold-to party (SAP transaction VA05)
Create an invoice (SAP transaction VF01)

Each of the simulated users repeats this series of transactions from the start to the end of a benchmark run. The think time between two user actions is 10 seconds. During the so-called ramp-up phase the number of concurrently working users is increased until the expected limit is reached. When all users are active, the test interval starts. This performance level must be maintained for at least 15 minutes (benchmark rule). After at least 5 minutes of the high load phase one or more database checkpoints must be enforced (i.e. all log file data is flushed back to the database within the high load phase) or the amount of created dirty blocks must be written to disk for at least 5 minutes to stress the I/O subsystem in a realistic way (benchmark rule). At the end of the high load phase users are gradually taken off the system until none is active. When the test concludes, all relevant data (some are gathered with a SAP developed Operating System monitor) are then transferred to the presentation server for further evaluation.



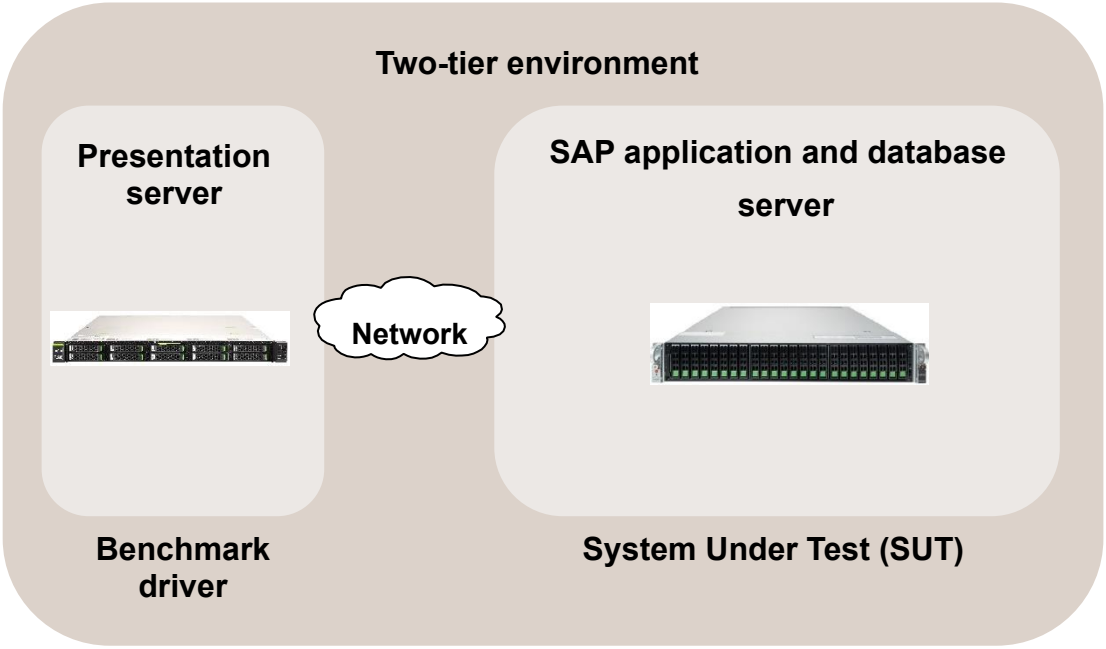
A benchmark can only be certified if the average dialog response time is less than 1 second. Certified and published SAP SD Benchmarks are published on SAP's benchmark site here.

Benchmark environment

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 SD benchmark users are simulated by the the presentation server aka benchmark driver.

The SAP SD Benchmarks for PRIMERGY RX2450 M1 were performed on a two-tier configuration.



Two SAP SD Benchmarks were conducted. One with AMD EPYC 7H12 (AMD Rome) and one with AMD EPYC 7763 (AMD Milan).

System Under Test (SUT)	
Hardware	
• Model	PRIMERGY RX2450 M1
• Processor	2 x AMD EPYC 7H12 2 x AMD EPYC 7763
• Memory	32 x 64 GB 2Rx4 DDR4-3200 R ECC
• Network interface	1 Gbit LAN
• Disk subsystem	PRIMERGY PRIMERGY RX2450 M1: 1 x Internal SSD SATA 480GB 1 x NVMe Intel P4510-1TB 1 x NVMe Intel P4510-2TB
Software	
• Operating system	Windows Server 2019
• Database	Microsoft SQL Server 2017
• SAP Business Suite Software	SAP enhancement package 5 for SAP ERP 6.0

System Under Test (SUT)	
Hardware	
• Model	PRIMERGY RX2530 M1
• Processor	2 x Intel Xeon E5-2699 v3
• Memory	236 GB
• Network interface	1 Gbit LAN
Software	
• Operating system	SUSE Linux Enterprise Server 12 SP2

Benchmark results

I) 2 x AMD EPYC 7H12 processor

Certification number 2021030	
• Number of SAP SD benchmark users	58,100
• Average dialog response time	0.98 seconds
• Throughput Fully processed order line items/hour Dialog steps/hour SAPS	 6,350,670 19,052,000 317,530
• Average database request time (dialog/update)	0.014 sec / 0.020 sec
• CPU utilization of central server	96%
• Operating system, central server	Windows Server 2019
• RDBMS	Microsoft SQL Server 2017
• SAP Business Suite software	SAP enhancement package 5 for SAP ERP 6.0
• Configuration Central Server	Fujitsu Server PRIMERGY PRIMERGY RX2450 M1, 2 processors / 128 cores / 256 threads, AMD EPYC 7H12, 2.60 GHz, 64 KB L1 cache and 512 KB L2 cache per core, 256 MB L3 cache per processor, 2,048 GB main memory

The SAP SD Benchmark certificate can be found here: Certificate 2021030

II) 2 x AMD EPYC 7763 processor

Certification number 2021071	
• Number of SAP SD benchmark users	61,000
• Average dialog response time	0.92 seconds
• Throughput Fully processed order line items/hour Dialog steps/hour SAPS	 6,702,000 20,106,000 335,100
• Average database request time (dialog/update)	0.015 sec / 0.026 sec
• CPU utilization of central server	95%
• Operating system, central server	Windows Server 2019
• RDBMS	Microsoft SQL Server 2017
• SAP Business Suite software	SAP enhancement package 5 for SAP ERP 6.0
• Configuration Central Server	Fujitsu Server PRIMERGY PRIMERGY RX2450 M1, 2 processors / 128 cores / 256 threads, AMD EPYC 7763, 2.45 GHz, 64 KB L1 cache and 512 KB L2 cache per core, 256 MB L3 cache per processor, 2,048 GB main memory

The SAP SD Benchmark certificate can be found here: Certificate 2021071

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

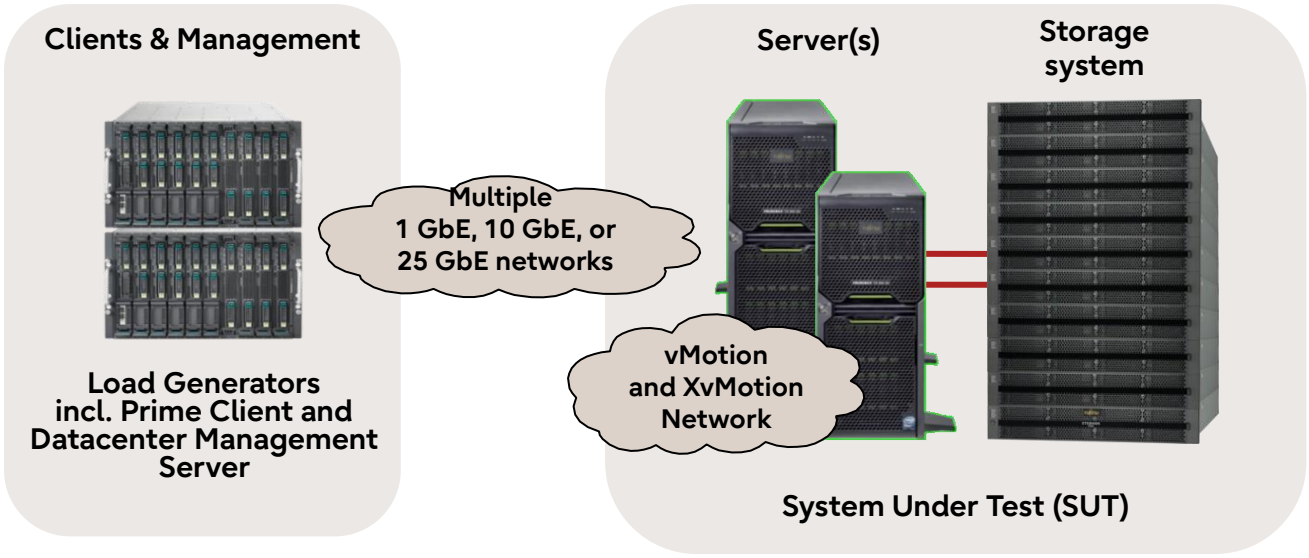
determined, which are the performance scores divided by the average power consumption in kilowatts (PPKW = performance per kilowatt (KW)).

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:



All the benchmark results were measured with the following environment:

System Under Test (SUT), at the measurement with EPYC 7763	
Hardware	
• Number of servers	2
• Model	PRIMERGY RX2450 M1
• Processor	2 × AMD EPYC 7763
• Memory	2048 GB: 32 × 64GB (1x64GB) 2Rx4 DDR4-3200 R ECC
• Network interface	2 × Mellanox MCX4121A-ACAT dual port 25Gb SFP28 PCIe Adapter 1 × Intel I350 1Gb dual port onboard
• Disk subsystem	2 × Emulex LPe35002 dual port 32Gb PCIe Adapter 4 × PRIMERGY RX2540 M4 configured as Fibre Channel target: 2 × Micron MTFDDAK480TDC SATA SSD (480 GB) 3 × Intel P4800X PCIe SSD (750 GB) 1 × Intel P4600 PCIe SSD (4 TB) 1 × PRIMERGY RX2540 M4 configured as Fibre Channel target: 1 × Micron MTFDDAK480TDC SATA SSD (480 GB) 3 × Intel P4800X PCIe SSD (750 GB) 1 × Intel P4600 PCIe SSD (2 TB) 3 × PRIMERGY RX2540 M5 configured as Fibre Channel target: 1 × Micron MTFDDAK480TDC SATA SSD (480 GB) 3 × Intel P4800X PCIe SSD (750 GB) 1 × Intel P4610 PCIe SSD (4 TB)
Software	
• BIOS	2.1.v2
• BIOS settings	See “Details”
• Operating system	VMware ESXi 7.0 U2a, Build 17867351
• Operating system settings	ESX settings: see “Details”

System Under Test (SUT), at the measurement with EPYC 7763	
Hardware	
• Number of servers	2
• Model	PRIMERGY RX2450 M1
• Processor	2 × AMD EPYC 7H12
• Memory	2048 GB: 32 × 64GB (1x64GB) 2Rx4 DDR4-3200 R ECC
• Network interface	2 × Mellanox MCX4121A-ACAT dual port 25Gb SFP28 PCIe Adapter 1 × Intel I350 1Gb dual port onboard
• Disk subsystem	2 × Emulex LPe35002 dual port 32Gb PCIe Adapter 4 × PRIMERGY RX2540 M4 configured as Fibre Channel target: 2 × Micron MTFDDAK480TDC SATA SSD (480 GB) 3 × Intel P4800X PCIe SSD (750 GB) 1 × Intel P4600 PCIe SSD (4 TB) 1 × PRIMERGY RX2540 M4 configured as Fibre Channel target: 1 × Micron MTFDDAK480TDC SATA SSD (480 GB) 3 × Intel P4800X PCIe SSD (750 GB) 1 × Intel P4600 PCIe SSD (2 TB) 3 × PRIMERGY RX2540 M5 configured as Fibre Channel target: 1 × Micron MTFDDAK480TDC SATA SSD (480 GB) 3 × Intel P4800X PCIe SSD (750 GB) 1 × Intel P4610 PCIe SSD (4 TB)
Software	
• BIOS	2.1.v2
• BIOS settings	See “Details”
• Operating system	VMware ESXi 7.0 U2a, Build 17867351
• Operating system settings	ESX settings: see “Details”

Detail	
See disclosure	https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/vmmark/2022-02-08-Fujitsu-RX2450M1.pdf https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/vmmark/2022-03-08-Fujitsu-PRIMERGY-RX2450M1.pdf

Datacenter Management Server (DMS)	
Hardware	
• Model	1 × PRIMERGY RX2540 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	Hypervisor: VMware ESXi 6.7 EP 02a Build 9214924

Datacenter Management Server (DMS) VM	
Hardware	
• Processor	4 x Logical CPU
• Memory	19 GB
• Network interface	1 x 1 Gbit/s LAN

Software	
• Operating system	VMware vCenter Server Appliance 7.0 U2 Build 17694817

Load generator	
Hardware	
• Model	6 x PRIMERGY RX2530 M2
• Processor	4 x PRIMERGY RX2530 M2 : 2 x Intel Xeon E5-2699 v4 2 x PRIMERGY RX2530 M2 : 2 x 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 EP 08 Build 13473784

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

Benchmark results

"Performance Only" measurement result (Feb 8, 2022)

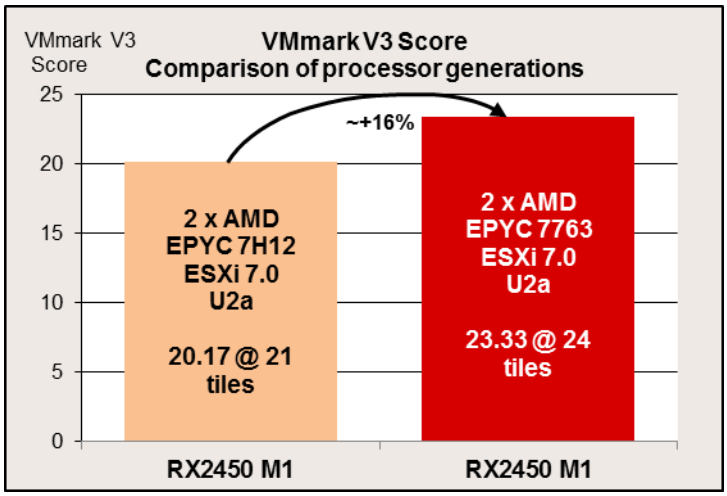
On February 8th, 2022 Fujitsu achieved with a PRIMERGY RX2450 M1 with two AMD EPYC 7763 processors and VMware ESXi 7.0 U2a a VMmark V3 score of "23.33@24 tile" in a system configuration with a total of 256 processor cores and when using two identical servers in the "System under Test" (SUT). With this result the PRIMERGY RX2450 M1 is in the official VMmark V3 "Performance Only" ranking the most powerful 2-socket server in a "Matched Pair" configuration consisting of two identical hosts (valid as of June 20th, 2022).

VMmark V3 Top 5 Scores (Performance Only, 2-socket servers, matched-pair configuration)			
Rank	**Server description**	**Score**	**Processor**
1	Fujitsu Server PRIMERGY RX2450 M1	23.33 @ 24 tiles	AMD EPYC 7763
2	Dell PowerEdge R7525	23.14 @ 24 tiles	AMD EPYC 7773X
3	Lenovo ThinkSystem SR665	21.58 @ 24 tiles	AMD EPYC 7763
4	Fujitsu Server PRIMERGY RX2450 M1	20.17 @ 21 tiles	AMD EPYC 7H12
5	Dell EMC PowerEdge R7525	20.04 @ 22 tiles	AMD EPYC 7763

All comparisons for the competitor products reflect the status of June 20th, 2022.

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 .

All VMs, their application data, the host operating system, and any additional data needed were stored on a powerful Fibre Channel disk subsystem. This disk subsystem used fast PCIe SSDs such as Intel Optane to improve the response time of storage media. The host-side network connectivity to the load generators and infrastructure load connectivity between hosts were implemented using 25GbE LAN ports.



The graph on the left compares the VMmark V3 score of the PRIMERGY RX2450 M1 with the 2nd generation EPYC processor to that with the 3rd generation EPYC processor. The 3rd generation EPYC 7763 processor achieved a 16% improvement in score compared to the 2nd generation EPYC 7H12 processor. This is due to the evolution of the micro-architecture of the EPYC processor.

Literature

PRIMERGY Servers

https://www.fujitsu.com/global/products/computing/servers/primergy/

PRIMERGY RX2450 M1

This Whitepaper

https://docs.ts.fujitsu.com/dl.aspx?id=1ed9e0c0-2ab1-4827-910f-a529797ef78f

https://docs.ts.fujitsu.com/dl.aspx?id=4e7fc710-9a5e-4582-92d1-5c9e27807152

Data sheet:

https://docs.ts.fujitsu.com/dl.aspx?id=bb8b1e2f-fa72-43ed-8f73-ab866ce170c7

PRIMERGY Performance

https://www.fujitsu.com/global/products/computing/servers/primergy/benchmarks/

SPEC CPU2017

https://www.spec.org/osg/cpu2017

Benchmark Overview SPECcpu2017

https://docs.ts.fujitsu.com/dl.aspx?id=20f1f4e2-5b3c-454a-947f-c169fca51eb1

STREAM

https://www.cs.virginia.edu/stream/

LINPACK

The LINPACK Benchmark: Past, Present, and Future

https://www.netlib.org/utk/people/JackDongarra/PAPERS/hplpaper.pdf

TOP500

https://www.top500.org/

HPL - A Portable Implementation of the High-Performance Linpack Benchmark for Distributed-Memory Computers

https://www.netlib.org/benchmark/hpl/

Intel Math Kernel Library – LINPACK Download

https://www.intel.com/content/www/us/en/developer/articles/technical/onemkl-benchmarks-suite.html

SAP SD / BWH

https://www.sap.com/benchmark

Benchmark results

SAP SD: https://www.sap.com/dmc/exp/2018-benchmark-directory/#/sd

Benchmark overview

SAP SD: http://docs.ts.fujitsu.com/dl.aspx?id=0a1e69a6-e366-4fd1-a1a6-0dd93148ea10

VMmark V3

https://www.vmware.com/products/vmmark.html

Benchmark Overview VMmark V3

https://docs.ts.fujitsu.com/dl.aspx?id=e6f9973c-90d6-47c6-b317-e388a978bfb7

Document change history

Version	Date	Description
1.3	2023-10-03	Update: • New Visual Identity format
1.2	2022-07-07	New: • VMmark V3 • Measure with AMD EPYC 7H12 and AMD EPYC 7763 Update: • Minor correction
1.1	2021-12-27	Update: • SPECcpu2017, STREAM, LINPACK Measured with AMD EPYC 7003 Series Processor • SAP SD • Measured with AMD EPYC 7H12 and AMD EPYC 7763
1.0	2021-06-17	New: • Technical data • SPECcpu2017, STREAM, LINPACK Measured with AMD EPYC 7002 Series Processor

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