

White Paper

FUJITSU Server PRIMERGY

Performance Report PRIMERGY TX1320 M2

This document contains a summary of the benchmarks executed for the FUJITSU Server PRIMERGY TX1320 M2.

The PRIMERGY TX1320 M2 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
1.1
2016-02-29



Contents

Document history	2
Technical data	3
SPECcpu2006	5
SPECpower_ssj2008.....	8
Disk I/O: Performance of storage media	13
Disk I/O: Performance of RAID controllers	19
STREAM.....	27
Literature.....	29
Contact	29

Document history

Version 1.0 (2016-01-14)

New:

- Technical data
- SPECcpu2006
Measurements with Celeron G3900, Pentium G4400, Core i3-6100 and Intel® Xeon® Processor E3-1200 v5 Product Family
- SPECpower_ssj2008
Measurement with Xeon E3-1260L v5
- STREAM
Measurements with Celeron G3900, Pentium G4400, Core i3-6100 and Intel® Xeon® Processor E3-1200 v5 Product Family

Version 1.1 (2016-02-29)

New:

- Disk I/O: Performance of storage media
Results for 2.5" and 3.5" storage media
- Disk I/O: Performance of RAID controllers
Measurements with "LSI SW RAID on Intel C236 (Onboard SATA)", "PRAID CP400i", "PRAID EP400i" and "PRAID EP420i" controllers

Updated:

- Technical data
Xeon E3-1225 v5 added
- SPECcpu2006
Measurements with Xeon E3-1225 v5
- STREAM
Measurement with Xeon E3-1225 v5

Technical data

PRIMERGY TX1320 M2



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 TX1320 M2
Model versions	PY TX1320M2/LFF PY TX1320M2/SFF
Form factor	Tower server
Chipset	Intel® C236
Number of sockets	1
Processor type	Intel® Celeron® G3900 Intel® Pentium® G4400 Intel® Core™ i3-6100 Intel® Xeon® Processor E3-1200 v5 Product Family
Number of memory slots	4
Maximum memory configuration	64 GB
Onboard LAN controller	2 × 1 Gbit/s
Onboard HDD controller	Controller with RAID 0, RAID 1 or RAID 10 for up to 4 SATA HDDs
PCI slots	2 × PCI-Express 3.0 x8 1 × PCI-Express 3.0 x4 1 × PCI-Express 3.0 x1 (mech. x4)
Max. number of internal hard disks	PY TX1320M2/LFF: 2 PY TX1320M2/SFF: 6

Processors (since system release)							
Processor	Cores	Threads	Cache	Rated Frequency	Max. Turbo Frequency	Max. Memory Frequency	TDP
			[MB]	[Ghz]	[Ghz]	[MHz]	[Watt]
Celeron G3900	2	2	2	2.80	n/a	2133	51
Pentium G4400	2	2	3	3.30	n/a	2133	54
Core i3-6100	2	4	3	3.70	n/a	2133	51
Xeon E3-1220 v5	4	4	8	3.00	3.50	2133	80
Xeon E3-1225 v5	4	4	8	3.30	3.70	2133	80
Xeon E3-1240L v5	4	8	8	2.10	3.20	2133	25
Xeon E3-1260L v5	4	8	8	2.90	3.90	2133	45
Xeon E3-1230 v5	4	8	8	3.40	3.80	2133	80
Xeon E3-1240 v5	4	8	8	3.50	3.90	2133	80
Xeon E3-1270 v5	4	8	8	3.60	4.00	2133	80
Xeon E3-1280 v5	4	8	8	3.70	4.00	2133	80

All the processors of Intel® Xeon® Processor E3-1200 v5 Product Family that can be ordered with the PRIMERGY TX1320 M2 support Intel® Turbo Boost Technology 2.0. This technology allows you to operate the processor with higher frequencies than the nominal frequency. Listed in the processor table is "Max. Turbo Frequency" for the theoretical frequency maximum with only one active core per processor. The maximum frequency that can actually be achieved depends on the number of active cores, the current consumption, electrical power consumption and the temperature of the processor.

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

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

Memory modules (since system release)								
Memory module	Capacity [GB]	Ranks	Bit width of the memory chips	Frequency [MHz]	Low voltage	Load reduced	Registered	ECC
4GB (1x4GB) 1Rx8 DDR4-2133 U ECC	4	1	8	2133				✓
8GB (1x8GB) 2Rx8 DDR4-2133 U ECC	8	2	8	2133				✓
16GB (1x16GB) 2Rx8 DDR4-2133 U ECC	16	2	8	2133				✓

Power supplies (since system release)	Max. number
Standard PSU 250W	1

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

Detailed technical information is available in the [data sheet PRIMERGY TX1320 M2](#).

SPECcpu2006

Benchmark description

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

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

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

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

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

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

Benchmark environment

System Under Test (SUT)	
Hardware	
Model	PRIMERGY TX1330 M2
Processor	Celeron G3900 Pentium G4400 Core i3-6100 Intel® Xeon® Processor E3-1200 v5 Product Family
Memory	4 x 16GB (1x16GB) 2Rx8 DDR4-2133 U ECC
Software	
Operating system	SUSE Linux Enterprise Server 12 (x86_64)
Operating system settings	echo always > /sys/kernel/mm/transparent_hugepage/enabled
Compiler	C/C++: Version 16.0.0.101 of Intel C++ Studio XE for Linux Fortran: Version 16.0.0.101 of Intel Fortran Studio XE for Linux

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

Benchmark results

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

Processor	SPECint_base2006	SPECint2006	SPECint_rate_base2006	SPECint_rate2006
Celeron G3900	44.4	45.9	80.8	83.5
Pentium G4400	52.8	54.5	95.9	99.3
Core i3-6100	61.9	64.0	133	139
Xeon E3-1220 v5	65.0	67.2	196	202
Xeon E3-1225 v5	68.1	70.6	201	208
Xeon E3-1240L v5	59.7	61.6	198	206
Xeon E3-1260L v5	70.4	73.3	239	248
Xeon E3-1230 v5	69.5	71.8	244	254
Xeon E3-1240 v5	71.1	73.4	249	258
Xeon E3-1270 v5	72.7	75.3	253	262
Xeon E3-1280 v5	72.4	74.9	249	259

Processor	SPECfp_base2006	SPECfp2006	SPECfp_rate_base2006	SPECfp_rate2006
Celeron G3900	61.0	61.6	90.9	91.7
Pentium G4400	70.4	71.1	105	106
Core i3-6100	85.4	86.8	131	134
Xeon E3-1220 v5	90.5	92.4	174	177
Xeon E3-1225 v5	92.5	94.9	176	179
Xeon E3-1240L v5	84.1	86.2	164	168
Xeon E3-1260L v5	95.4	97.6	182	187
Xeon E3-1230 v5	95.1	97.1	188	192
Xeon E3-1240 v5	96.5	98.5	189	194
Xeon E3-1270 v5	98.2	100	191	196
Xeon E3-1280 v5	97.5	99.8	189	194

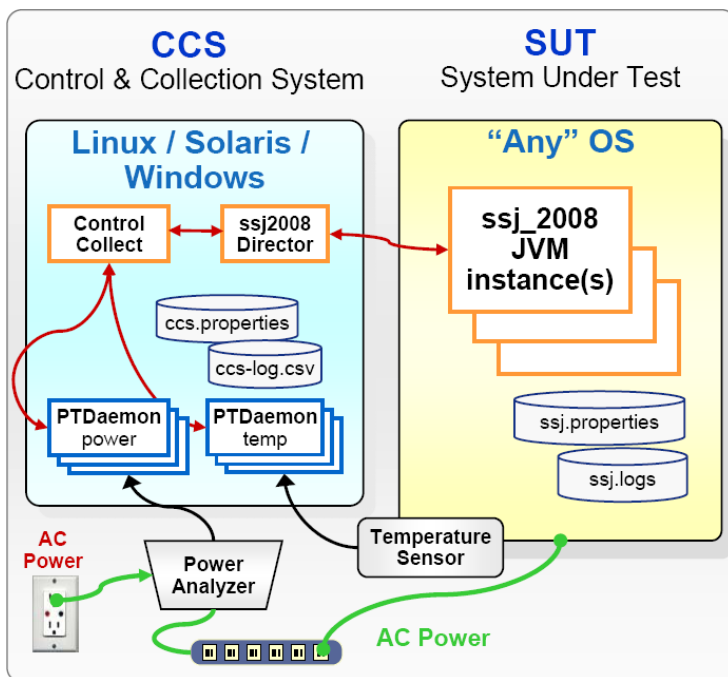
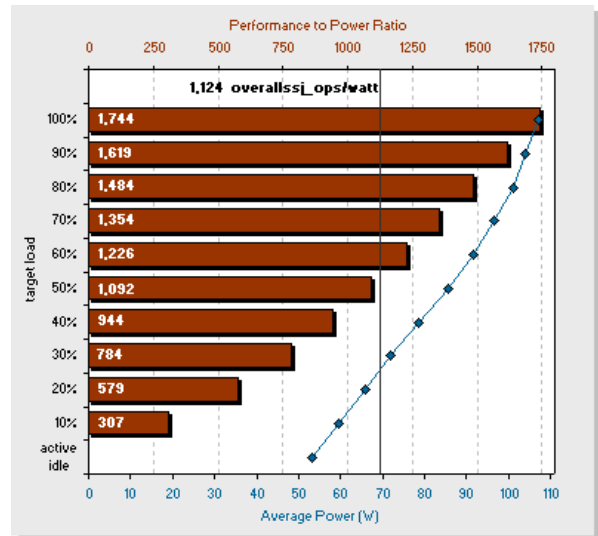
SPECpower_ssJ2008

Benchmark description

SPECpower_ssJ2008 is the first industry-standard SPEC benchmark that evaluates the power and performance characteristics of a server. With SPECpower_ssJ2008 SPEC has defined standards for server power measurements in the same way they have done for performance.

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

SPECpower_ssJ2008 reports power consumption for servers at different performance levels — from 100% to “active idle” in 10% segments — over a set period of time. The graduated workload recognizes the fact that processing loads and power consumption on servers vary substantially over the course of days or weeks. To compute a power-performance metric across all levels, measured transaction throughputs for each segment are added together and then divided by the sum of the average power consumed for each segment. The result is a figure of merit called “overall ssj_ops/watt”. This ratio provides information about the energy efficiency of the measured server. The defined measurement standard enables customers to compare it with other configurations and servers measured with SPECpower_ssJ2008. The diagram shows a typical graph of a SPECpower_ssJ2008 result.



The benchmark runs on a wide variety of operating systems and hardware architectures and does not require extensive client or storage infrastructure. The minimum equipment for SPEC-compliant testing is two networked computers, plus a power analyzer and a temperature sensor. One computer is the System Under Test (SUT) which runs one of the supported operating systems and the JVM. The JVM provides the environment required to run the SPECpower_ssJ2008 workload which is implemented in Java. The other computer is a “Control & Collection System” (CCS) which controls the operation of the benchmark and captures the power, performance and temperature readings for reporting. The diagram provides an overview of the basic structure of the benchmark configuration and the various components.

Benchmark environment

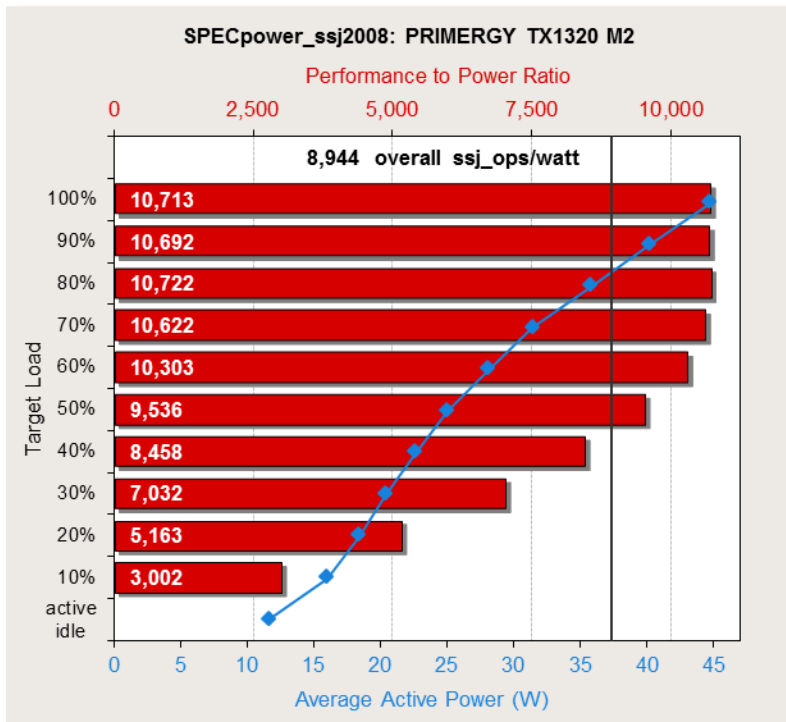
System Under Test (SUT)	
Hardware	
Model	PRIMERGY TX1320 M2
Model version	PY TX1320M2/LFF
Processor	Xeon E3-1260L v5
Memory	2 x 8GB (1x8GB) 2Rx8 DDR4-2133 U ECC
Network-Interface	Onboard LAN-Controller (1 port used)
Disk-Subsystem	Onboard HDD controller 1 x SSD SATA 6G 64GB DOM N H-P
Power Supply Unit	1 x Standard PSU 250W
Software	
BIOS	R1.3.0
BIOS settings	Hardware Prefetcher = Disabled Adjacent Cache Line Prefetch = Disabled DCU Streamer Prefetcher = Disabled ASPM Support = Auto Turbo Mode = Disabled DMI Control = Gen1 Intel Virtualization Technology = Disabled LAN 2 Controller = Disabled
Firmware	8.04A
Operating system	Microsoft Windows Server 2012 R2 Standard
Operating system settings	Using the local security settings console, "lock pages in memory" was enabled for the user running the benchmark. Power Management: Enabled ("Fujitsu Enhanced Power Settings" power plan) Set "Turn off hard disk after = 1 Minute" in OS. Benchmark was started via Windows Remote Desktop Connection. Each JVM instance was affinitized to two logical processors.
JVM	Oracle Java HotSpot(TM) 64-Bit Server VM (build 24.80-b11, mixed mode), version 1.7.0_80
JVM settings	start /AFFINITY [0x3,0xC,0x30,0xC0] -server -Xmn2300m -Xms2750m -Xmx2750m -XX:SurvivorRatio=60 -XX:TargetSurvivorRatio=90 -XX:AllocatePrefetchDistance=256 -XX:AllocatePrefetchLines=4 -XX:LoopUnrollLimit=45 -XX:InitialTenuringThreshold=12 -XX:MaxTenuringThreshold=15 -XX:ParallelGCThreads=2 -XX:InlineSmallCode=3900 -XX:MaxInlineSize=270 -XX:FreqInlineSize=2500 -XX:+AggressiveOpts -XX:+UseLargePages -XX:+UseParallelOldGC -XX:-UseAdaptiveSizePolicy

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

Benchmark results

The PRIMERGY TX1320 M2 achieved the following result:

SPECpower_ssj2008 = 8,944 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 8,944 overall ssj_ops/watt for the PRIMERGY TX1320 M2. 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.

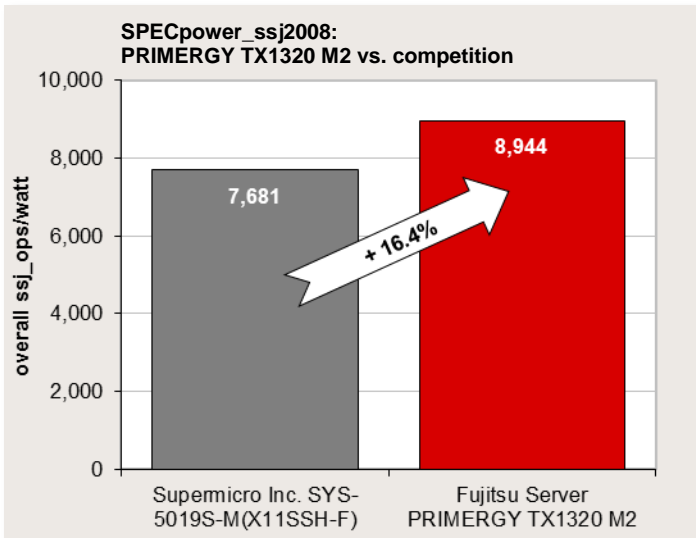
The following table shows the benchmark results for the throughput in ssj_ops, the power consumption in watts and the resulting energy efficiency for each load level.

Performance		Power	Energy Efficiency
Target Load	ssj_ops	Average Power (W)	ssj_ops/watt
100%	478,512	44.7	10,713
90%	429,767	40.2	10,692
80%	383,866	35.8	10,722
70%	333,825	31.4	10,622
60%	289,162	28.1	10,303
50%	238,762	25.0	9,536
40%	191,219	22.6	8,458
30%	143,580	20.4	7,032
20%	94,862	18.4	5,163
10%	48,106	16.0	3,002
Active Idle	0	11.6	0
$\sum \text{ssj_ops} / \sum \text{power} = 8,944$			



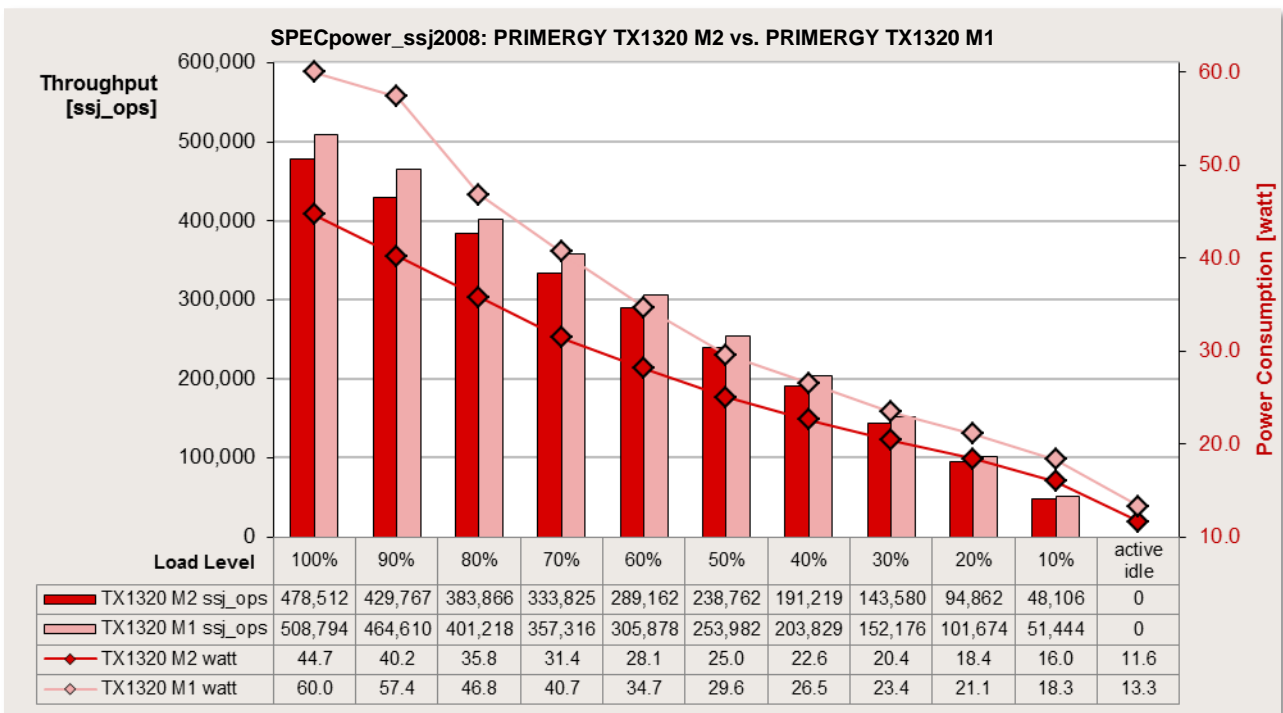
The PRIMERGY TX1320 M2 achieved a new class record with this result, thus surpassing the best result of the competition by 16.4% (date: November 25, 2015). Thus, the PRIMERGY TX1320 M2 proves itself to be the most energy-efficient 1-socket server in the world. For the latest SPECpower_ssj2008 benchmark results, visit:

http://www.spec.org/power_ssj2008/results.

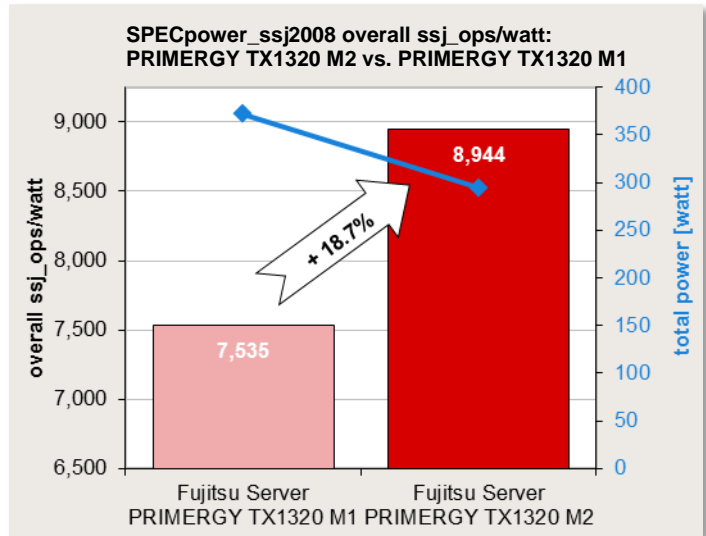


The comparison with the competition makes the advantage of the PRIMERGY TX1320 M2 in the field of energy efficiency evident. With 16.4% more energy efficiency than the best result of the competition in the class of 1-socket servers, the Supermicro Inc. SYS-5019S-M(X11SSH-F) server, the PRIMERGY TX1320 M2 is setting new standards.

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 TX1320 M2 compared to the predecessor PRIMERGY TX1320 M1.



Contrary to the predecessor system the PRIMERGY TX1320 M1, the PRIMERGY TX1320 M2 was on account of the better energy efficiency measured without Turbo mode. This explains the somewhat lower throughput of the PRIMERGY TX1320 M2 compared with the PRIMERGY TX1320 M1. However, the resulting significantly lower power consumption leads to an overall increase in the energy efficiency of the PRIMERGY TX1320 M2 by 18.7%.



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

<i>Data throughput [MB/s]</i>	$= \text{Transaction rate [IO/s]} \times \text{Block size [MB]}$
<i>Transaction rate [IO/s]</i>	$= \text{Data throughput [MB/s]} / \text{Block size [MB]}$

This section specifies capacities of storage media on a basis of 10 (1 TB = 10¹² bytes) while all other capacities, file sizes, block sizes and throughputs are specified on a basis of 2 (1 MB/s = 2²⁰ 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	
Model	PRIMERGY TX1320 M2
Controller	1 x PRAID CP400i
Storage media	For model version PY TX1320M2/LFF:
	HDD
	Seagate ST1000NM0033
	Seagate ST2000NM0024
	Seagate ST2000NM0033
	Seagate ST4000NM0033
	Seagate ST500DM002
	Western Digital WD1003FBYX
	Western Digital WD2000FYYZ
	Western Digital WD3000FYYZ
Western Digital WD4000FYYZ	
Western Digital WD5003ABYX	
For model version PY TX1320M2/SFF:	
SSD	HDD
Intel SSDSC2BB120G4C	HGST HUC101812CS4204
Intel SSDSC2BB240G4C	HGST HUC101812CSS204
Intel SSDSC2BB480G4C	HGST HUC101818CS4204
Intel SSDSC2BB800G4C	HGST HUC101890CS4204
	HGST HUC101890CSS204
	HGST HUC101830CSS204
	HGST HUC101860CS4204
	HGST HUC101860CSS204
	HGST HUC156030CSS204
	HGST HUC156045CSS204
	HGST HUC156060CSS204
	Seagate ST1000NX0313
	Seagate ST2000NX0253
	Seagate ST91000640NS
	Seagate ST9250610NS
	Seagate ST9500620NS
Software	
Operating system	Microsoft Windows Server 2012 Standard R2
Administration software	ServerView RAID Manager 6.2.1
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	The first 10% of the usable LBA area is used for sequential accesses; the next 25% for random accesses.
File system	raw

Total number of lometer workers	1
Alignment of lometer 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 for the models of the PRIMERGY TX1320 M2 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](#). The measurements were made using controllers which have their main features listed in the table below:

Storage medium	Controller name	Cache	Supported interfaces		RAID levels
SSD/HDD	PRAID CP400i	-	SATA 6G SAS 12G	PCIe 3.0 x8	0, 1, 1E, 10, 5, 50

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 used in the PRIMERGY TX1320 M2:

Storage medium type	Interface	Form factor
HDD	SATA 6G	2.5"
HDD	SATA 6G	3.5"
HDD	SAS 12G	2.5"
SSD	SATA 6G	2.5"

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 of the PRIMERGY TX1320 M2 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.

SSDs in comparison with the most powerful HDD

Random accesses (maximum performance values in IO/s):

PRIMERGY TX1320 M2 Model version PY TX1320M2/SFF					
Capacity [GB]	Storage device	Interface	Transactions [IO/s]		
			Database	Fileserver	Filecopy
800	Intel SSDSC2BB800G4C	SATA 6G	30495	3117	3960
600	HGST HUC156060CSS204 (HDD)	SAS 12G	768	653	670
480	Intel SSDSC2BB480G4C	SATA 6G	29575	4067	3521
240	Intel SSDSC2BB240G4C	SATA 6G	23354	2870	2432
120	Intel SSDSC2BB120G4C	SATA 6G	15950	2026	1554

Sequential accesses (maximum performance values in MB/s):

PRIMERGY TX1320 M2 Model version PY TX1320M2/SFF				
Capacity [GB]	Storage device	Interface	Throughput [MB/s]	
			Streaming	Restore
800	Intel SSDSC2BB800G4C	SATA 6G	478	437
600	HGST HUC156060CSS204 (HDD)	SAS 12G	237	237
480	Intel SSDSC2BB480G4C	SATA 6G	478	434
240	Intel SSDSC2BB240G4C	SATA 6G	478	267
120	Intel SSDSC2BB120G4C	SATA 6G	443	140

HDDs

Random accesses (maximum performance values in IO/s):

PRIMERGY TX1320 M2					
Model version PY TX1320M2/LFF					
Capacity [GB]	Storage device	Interface	Transactions [IO/s]		
			Database	Fileserver	Filecopy
4000	Seagate ST4000NM0033	SATA 6G	265	245	242
4000	Western Digital WD4000FYYZ	SATA 6G	187	176	187
3000	Western Digital WD3000FYYZ	SATA 6G	189	178	185
2000	Seagate ST2000NM0024	SATA 6G	311	286	295
2000	Seagate ST2000NM0033	SATA 6G	264	240	243
2000	Western Digital WD2000FYYZ	SATA 6G	191	177	185
1000	Seagate ST1000NM0033	SATA 6G	274	249	248
1000	Western Digital WD1003FBYX	SATA 6G	163	151	158
500	Seagate ST500DM002	SATA 6G	214	196	195
500	Western Digital WD5003ABYX	SATA 6G	199	182	191

PRIMERGY TX1320 M2					
Model version PY TX1320M2/SFF					
Capacity [GB]	Storage device	Interface	Transactions [IO/s]		
			Database	Fileserver	Filecopy
2000	Seagate ST2000NX0253	SATA 6G	329	285	290
1800	HGST HUC101818CS4204	SAS 12G	605	517	534
1200	HGST HUC101812CS4204	SAS 12G	651	533	543
1200	HGST HUC101812CSS204	SAS 12G	596	495	510
1000	Seagate ST1000NX0313	SATA 6G	328	281	290
1000	Seagate ST91000640NS	SATA 6G	302	258	243
900	HGST HUC101890CS4204	SAS 12G	651	533	545
900	HGST HUC101890CSS204	SAS 12G	639	539	552
600	HGST HUC156060CSS204	SAS 12G	768	653	670
600	HGST HUC101860CS4204	SAS 12G	678	558	567
600	HGST HUC101860CSS204	SAS 12G	632	535	545
500	Seagate ST9500620NS	SATA 6G	300	257	249
450	HGST HUC156045CSS204	SAS 12G	744	608	631
300	HGST HUC156030CSS204	SAS 12G	758	625	636
300	HGST HUC101830CSS204	SAS 12G	670	567	577
250	Seagate ST9250610NS	SATA 6G	310	262	259

Sequential accesses (maximum performance values in MB/s):

PRIMERGY TX1320 M2				
Model version PY TX1320M2/LFF				
Capacity [GB]	Storage device	Interface	Throughput [MB/s]	
			Streaming	Restore
4000	Seagate ST4000NM0033	SATA 6G	183	183
4000	Western Digital WD4000FYYZ	SATA 6G	162	161
3000	Western Digital WD3000FYYZ	SATA 6G	168	167
2000	Seagate ST2000NM0024	SATA 6G	204	204
2000	Seagate ST2000NM0033	SATA 6G	179	179
2000	Western Digital WD2000FYYZ	SATA 6G	157	157
1000	Seagate ST1000NM0033	SATA 6G	184	184
1000	Western Digital WD1003FBYX	SATA 6G	130	129
500	Seagate ST500DM002	SATA 6G	138	138
500	Western Digital WD5003ABYX	SATA 6G	130	127

PRIMERGY TX1320 M2				
Model version PY TX1320M2/SFF				
Capacity [GB]	Storage device	Interface	Throughput [MB/s]	
			Streaming	Restore
2000	Seagate ST2000NX0253	SATA 6G	133	134
1800	HGST HUC101818CS4204	SAS 12G	242	242
1200	HGST HUC101812CS4204	SAS 12G	238	238
1200	HGST HUC101812CSS204	SAS 12G	211	211
1000	Seagate ST1000NX0313	SATA 6G	131	131
1000	Seagate ST91000640NS	SATA 6G	108	108
900	HGST HUC101890CS4204	SAS 12G	233	233
900	HGST HUC101890CSS204	SAS 12G	212	211
600	HGST HUC156060CSS204	SAS 12G	237	237
600	HGST HUC101860CS4204	SAS 12G	230	230
600	HGST HUC101860CSS204	SAS 12G	210	210
500	Seagate ST9500620NS	SATA 6G	111	111
450	HGST HUC156045CSS204	SAS 12G	237	237
300	HGST HUC156030CSS204	SAS 12G	236	236
300	HGST HUC101830CSS204	SAS 12G	210	210
250	Seagate ST9250610NS	SATA 6G	113	112

Disk I/O: Performance of RAID controllers

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

<i>Data throughput [MB/s]</i>	$= \text{Transaction rate [IO/s]} \times \text{Block size [MB]}$
<i>Transaction rate [IO/s]</i>	$= \text{Data throughput [MB/s]} / \text{Block size [MB]}$

This section specifies capacities of storage media on a basis of 10 (1 TB = 10¹² bytes) while all other capacities, file sizes, block sizes and throughputs are specified on a basis of 2 (1 MB/s = 2²⁰ 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 chapter were determined using the hardware and software components listed below:

System Under Test (SUT)	
Hardware	
Controller	1 × "LSI SW RAID on Intel C236 (Onboard SATA)" Intel C236 PCH, Code name Sunrise Point Driver name: megasr1.sys, Driver version: 17.01.2015.0716 BIOS version: A.15.08211538R 1 × „PRAID CP400i“ 1 × „PRAID EP400i“ 1 × „PRAID EP420i“ Driver name: megasas2.sys, Driver version: 6.706.06 Firmware package: 24.7.0-0061
Drive	2 × 3.5" SATA HDD Seagate ST3000NM0033 6 × 2.5" SATA SSD Intel SSDSC2BB480G4C 4 × 2.5" SATA HDD Seagate ST91000640NS 6 × 2.5" SAS HDD HGST HUC156045CSS204
Software	
Operating system	Microsoft Windows Server 2012 Standard R2
Administration software	ServerView RAID Manager 6.2.1
Benchmark version	3.0
Stripe size	Controller default
Measuring tool	Iometer 1.1.0
Measurement area	The first 10% of the usable LBA area is used for sequential accesses; the next 25% for random accesses.
File system	raw
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 presented here are designed to help you choose the right solution from the various configuration options of the PRIMERGY TX1320 M2 in the light of disk-I/O performance. Various combinations of RAID controllers and storage media will be analyzed below. Information on the selection of storage media themselves is to be found in the section “Disk I/O: Performance of storage media”.

Hard disks

The hard disks are the first essential component. If there is a reference below to “hard disks”, this is meant as the generic term for HDDs (“hard disk drives”, in other words conventional hard disks) and SSDs (“solid state drives”, i.e. non-volatile electronic storage media).

Mixed drive configurations of SAS and SATA hard disks in one system are permitted, unless they are excluded in the configurator for special hard disk types.

More hard disks per system are possible as a result of using 2.5" hard disks instead of 3.5" hard disks. Consequently, the load that each individual hard disk has to overcome decreases and the maximum overall performance of the system increases.

More detailed performance statements about hard disk types are available in the section “Disk I/O: Performance of storage media” in this performance report.

Model versions

The maximum number of hard disks in the system depends on the system configuration. The following table lists the essential cases.

Form factor	Interface	Connection type	Number of PCIe controllers	Maximum number of hard disks
3.5"	SATA 6G	direct	0	2
2.5"	SATA 6G	direct	0	4
3.5"	SATA 6G, SAS 12G	direct	1	2
2.5"	SATA 6G, SAS 12G	direct	1	6

RAID controller

In addition to the hard disks the RAID controller is the second performance-determining key component. In the case of these controllers the “modular RAID” concept of the PRIMERGY servers offers a plethora of options to meet the various requirements of a wide range of different application scenarios.

The following table summarizes the most important features of the available RAID controllers of the PRIMERGY TX1320 M2. A short alias is specified here for each controller, which is used in the subsequent list of the performance values.

Controller name	Alias	Cache	Supported interfaces		In the system		FBU
					Max. # disks per controller	RAID levels	
LSI SW RAID on Intel C236 (Onboard SATA)	Sunrise Point	-	SATA 6G	-	4 × 2.5" 2 × 3.5"	0, 1, 10	-
PRAID CP400i	PRAID CP400i	-	SATA 6G SAS 12G	PCIe 3.0 x8	6 × 2.5" 2 × 3.5"	0, 1, 1E, 5, 10, 50	-
PRAID EP400i	PRAID EP400i	1 GB	SATA 6G SAS 12G	PCIe 3.0 x8	6 × 2.5" 2 × 3.5"	0, 1, 1E, 5, 6, 10, 50, 60	✓
PRAID EP420i	PRAID EP420i	2 GB	SATA 6G SAS 12G	PCIe 3.0 x8	6 × 2.5" 2 × 3.5"	0, 1, 1E, 5, 6, 10, 50, 60	✓

The onboard RAID controller is implemented in the chipset Intel C236 on the system board of the server and uses the CPU of the server for the RAID functionality. This controller is a simple solution that does not require a PCIe slot.

System-specific interfaces

The interfaces of a controller to the system board and to the hard disks have in each case specific limits for data throughput. These limits are listed in the following table. The minimum of these two values is a definite limit, which cannot be exceeded. This value is highlighted in bold in the following table.

Controller alias	Effective in the configuration				Connection via expander
	# Disk-side data channels	Limit for throughput of disk interface	# CPU-side data channels	Limit for throughput of CPU-side interface	
Sunrise Point	4 x SATA 6G	2060 MB/s	4 x DMI 3.0	3433 MB/s	-
PRAID CP400i	8 x SAS 12G	8240 MB/s	8 x PCIe 3.0	6761 MB/s	-
PRAID EP400i	8 x SAS 12G	8240 MB/s	8 x PCIe 3.0	6761 MB/s	-
PRAID EP420i	8 x SAS 12G	8240 MB/s	8 x PCIe 3.0	6761 MB/s	-

More details about the RAID controllers of the PRIMERGY systems are available in the white paper "[RAID Controller Performance](#)".

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.

In the case of controllers with a cache there are several parameters that can be set. The optimal settings can depend on the RAID level, the application scenario and the type of data medium. In the case of RAID levels 5 and 6 in particular (and the more complex RAID level combinations 50 and 60) it is obligatory to enable the controller cache for application scenarios with write share. If the controller cache is enabled, the data temporarily stored in the cache should be safeguarded against loss in case of power failure. Suitable accessories are available for this purpose (e.g. a FBU).

For the purpose of easy and reliable handling of the settings for RAID controllers and hard disks it is advisable to use the software "ServerView RAID Manager" 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.

More information about the setting options of the controller cache is available in the white paper "[RAID Controller Performance](#)".

Performance values

In general, disk-I/O performance of a RAID array depends on the type and number of hard disks, on the RAID level and on the RAID controller. If the limits of the [system-specific interfaces](#) are not exceeded, the statements on disk-I/O performance are therefore valid for all PRIMERGY systems. This is why all the performance statements of the document "[RAID Controller Performance](#)" also apply for the PRIMERGY TX1320 M2 if the configurations measured there are also supported by this system.

The performance values of the PRIMERGY TX1320 M2 are listed in table form below, specifically for different RAID levels, access types and block sizes. Substantially different configuration versions are dealt with separately. 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 has three implications: On the one hand hard disks with optimal performance were used (the components used are described in more detail in the subsection [Benchmark environment](#)). Furthermore, cache settings of controllers and hard disks, which are optimal for the respective access scenario and the RAID level, are used as a basis. And ultimately each value is the maximum value for the entire load intensity range (# 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.

2.5" - Random accesses (maximum performance values in IO/s):

PRIMERGY TX1320 M2 Model version PY TX1320M2/SFF							
Configuration version			RAID level	HDDs random 8 kB blocks 67% read [IO/s]	HDDs random 64 kB blocks 67% read [IO/s]	SSDs random 8 kB blocks 67% read [IO/s]	SSDs random 64 kB blocks 67% read [IO/s]
RAID Controller	Hard disk type	#Disks					
C236	ST91000640NS SATA HDD SSDSC2BB480G4C SATA SSD	2	1	380	332	27821	4667
		4	0	683	390	43486	9602
		4	10	562	323	37799	7645
PRAID CP400i	HUC156045CSS204 SAS HDD SSDSC2BB480G4C SATA SSD	2	1	1153	971	37739	4685
		6	10	3162	1641	103415	15269
		6	0	3728	1953	124627	20451
PRAID EP400i	HUC156045CSS204 SAS HDD SSDSC2BB480G4C SATA SSD	6	5	1863	939	29313	6667
		2	1	1590	888	38230	4953
		6	10	3557	2468	119902	15053
PRAID EP420i	HUC156045CSS204 SAS HDD SSDSC2BB480G4C SATA SSD	6	0	4091	2888	151055	20607
		6	5	2640	1410	47436	7192
		2	1	1544	994	38253	4813
PRAID EP420i	HUC156045CSS204 SAS HDD SSDSC2BB480G4C SATA SSD	6	10	3611	2475	119959	11329
		6	0	4163	2938	156514	19848
		6	5	2801	1583	51218	8531

(cursive: calculated)

2.5" - Sequential accesses (maximum performance values in MB/s):

PRIMERGY TX1320 M2 Model version PY TX1320M2/SFF							
Configuration version			RAID level	HDDs sequential 64 kB blocks 100% read [MB/s]	HDDs sequential 64 kB blocks 100% write [MB/s]	SSDs sequential 64 kB blocks 100% read [MB/s]	SSDs sequential 64 kB blocks 100% write [MB/s]
RAID Controller	Hard disk type	#Disks					
C236	ST91000640NS SATA HDD	2	1	113	108	711	417
	SSDSC2BB480G4C SATA SSD	4	0	427	423	1274	1528
		4	10	224	212	1003	776
PRAID CP400i	HUC156045CSS204 SAS HDD	2	1	327	230	914	397
	SSDSC2BB480G4C SATA SSD	6	10	828	689	2681	1177
		6	0	1383	1379	2685	2368
PRAID EP400i	HUC156045CSS204 SAS HDD	6	5	1158	1148	2680	1745
	SSDSC2BB480G4C SATA SSD	2	1	350	232	914	403
		6	10	898	710	2718	1042
PRAID EP420i	HUC156045CSS204 SAS HDD	6	0	1418	1421	2715	2087
	SSDSC2BB480G4C SATA SSD	6	5	1193	1184	2733	1816
		2	1	375	232	910	389
PRAID EP420i	HUC156045CSS204 SAS HDD	6	10	920	693	2766	1168
	SSDSC2BB480G4C SATA SSD	6	0	1425	1418	2763	2323
		6	5	1161	1169	2773	1960

(cursive: calculated)

3.5" - Random accesses (maximum performance values in IO/s):

PRIMERGY TX1320 M2 Model version PY TX1320M2/LFF								
Configuration version			RAID level	HDDs random 8 kB blocks 67% read [IO/s]	HDDs random 64 kB blocks 67% read [IO/s]	SSDs random 8 kB blocks 67% read [IO/s]	SSDs random 64 kB blocks 67% read [IO/s]	
RAID Controller	Hard disk type	#Disks						
C236	ST1000NM0033 SATA HDD	2	1	351	321	N/A	N/A	
PRAID CP400i	ST1000NM0033 SATA HDD	2	1	414	378	N/A	N/A	
PRAID EP400i	ST1000NM0033 SATA HDD	2	1	598	434	N/A	N/A	
PRAID EP420i	ST1000NM0033 SATA HDD	2	1	588	539	N/A	N/A	

(cursive: calculated)

3.5" - Sequential accesses (maximum performance values in MB/s):

PRIMERGY TX1320 M2 Model version PY TX1320M2/LFF								
Configuration version			RAID level	HDDs sequential 64 kB blocks 100% read [MB/s]	HDDs sequential 64 kB blocks 100% write [MB/s]	SSDs sequential 64 kB blocks 100% read [MB/s]	SSDs sequential 64 kB blocks 100% write [MB/s]	
RAID Controller	Hard disk type	#Disks						
C236	ST1000NM0033 SATA HDD	2	1	187	176	N/A	N/A	
PRAID CP400i	ST1000NM0033 SATA HDD	2	1	187	176	N/A	N/A	
PRAID EP400i	ST1000NM0033 SATA HDD	2	1	211	182	N/A	N/A	
PRAID EP420i	ST1000NM0033 SATA HDD	2	1	237	176	N/A	N/A	

(cursive: calculated)

Conclusion

At full configuration with powerful hard disks the PRIMERGY TX1320 M2 achieves a throughput of up to 2773 MB/s for sequential load profiles and a transaction rate of up to 156514 IO/s for typical, random application scenarios.

For best possible performance we recommend one of the plug-in PRAID controllers. To operate SSDs within the maximum performance range the PRAID CP400i is already suited for the simpler RAID levels 0, 1 and 10, and a PRAID controller with cache is to be preferred for RAID 5.

In the event of HDDs the controller cache for random load profiles with a significant write share has performance advantages for all RAID levels.

STREAM

Benchmark description

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

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

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

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

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

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

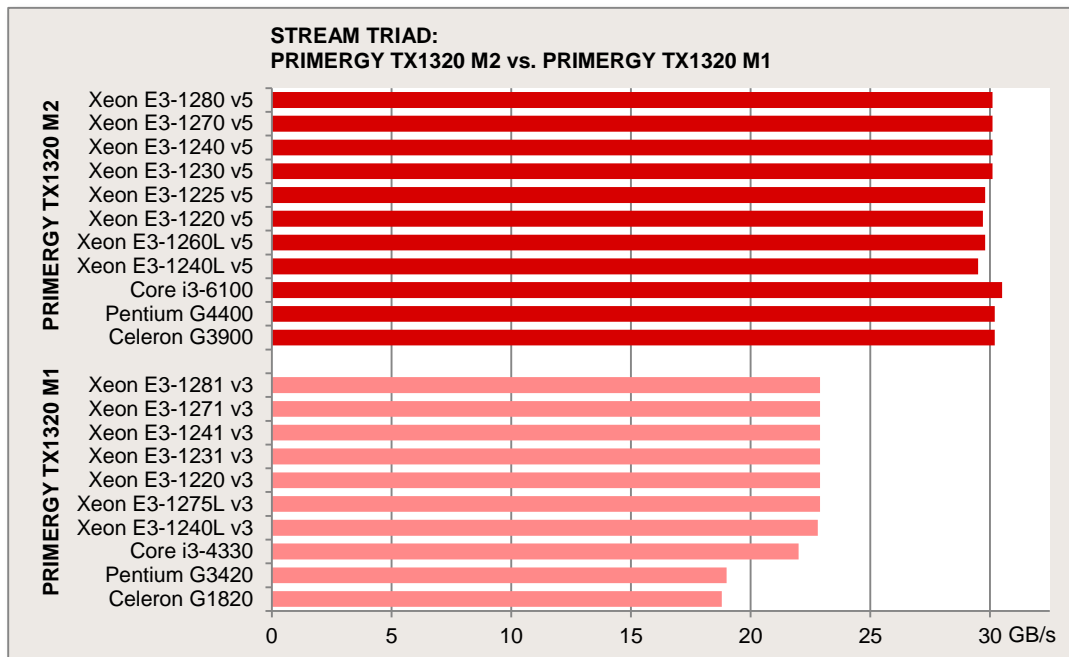
System Under Test (SUT)	
Hardware	
Model	PRIMERGY TX1320 M2
Processor	Celeron G3900 Pentium G4400 Core i3-6100 Intel® Xeon® Processor E3-1200 v5 Product Family
Memory	4 x 16GB (1x16GB) 2Rx8 DDR4-2133 U ECC
Software	
Operating system	SUSE Linux Enterprise Server 12 (x86_64)
Operating system settings	Transparent Huge Pages inactivated
Compiler	Intel C++ Composer XE 2015 for Linux
Benchmark	Stream.c Version 5.10

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

Benchmark results

Processor	Memory Frequency [MHz]	Max. Memory Bandwidth [GB/s]	Cores	Processor Frequency [GHz]	TRIAD [GB/s]
Celeron G3900	2133	34.1	2	2.80	30.2
Pentium G4400	2133	34.1	2	3.30	30.2
Core i3-6100	2133	34.1	2	3.70	30.5
Xeon E3-1240L v3	2133	34.1	4	2.10	29.5
Xeon E3-1260L v3	2133	34.1	4	2.90	29.8
Xeon E3-1220 v3	2133	34.1	4	3.00	29.7
Xeon E3-1225 v3	2133	34.1	4	3.30	29.8
Xeon E3-1230 v3	2133	34.1	4	3.40	30.1
Xeon E3-1240 v3	2133	34.1	4	3.50	30.1
Xeon E3-1270 v5	2133	34.1	4	3.60	30.1
Xeon E3-1280 v5	2133	34.1	4	3.70	30.1

The following diagram illustrates the throughput of the PRIMERGY TX1320 M2 in comparison to its predecessor, the PRIMERGY TX1320 M1.




Literature


PRIMERGY Servers


<http://primergy.com/>

PRIMERGY TX1320 M2

This White Paper:

 <http://docs.ts.fujitsu.com/dl.aspx?id=517aad33-78c4-4e1c-9a59-c30aa4a765af>

 <http://docs.ts.fujitsu.com/dl.aspx?id=d21c75e6-f493-4e16-9583-8ee02a585dc7>

 <http://docs.ts.fujitsu.com/dl.aspx?id=bdca5c63-c7cf-4ea8-a7da-5d64ba7d20de>

Data sheet

<http://docs.ts.fujitsu.com/dl.aspx?id=5612cc98-d6ad-42c2-8a6a-3ce94cb2d553>

PRIMERGY Performance

<http://www.fujitsu.com/fts/x86-server-benchmarks>

Performance of Server Components

<http://www.fujitsu.com/fts/products/computing/servers/mission-critical/benchmarks/x86-components.html>

RAID Controller Performance 2013

<http://docs.ts.fujitsu.com/dl.aspx?id=e2489893-cab7-44f6-bff2-7aeea97c5aef>

RAID Controller Performance 2016

<http://docs.ts.fujitsu.com/dl.aspx?id=9845be50-7d4f-4ef7-ac61-bbde399c1014>

Disk I/O: Performance of storage media and RAID controllers

Basics of Disk I/O Performance

<http://docs.ts.fujitsu.com/dl.aspx?id=65781a00-556f-4a98-90a7-7022feacc602>

Information about Iometer

<http://www.iometer.org>

SPECcpu2006

<http://www.spec.org/osg/cpu2006>

Benchmark overview SPECcpu2006

<http://docs.ts.fujitsu.com/dl.aspx?id=1a427c16-12bf-41b0-9ca3-4cc360ef14ce>

SPECpower_ssj2008

http://www.spec.org/power_ssj2008

Benchmark Overview SPECpower_ssj2008

<http://docs.ts.fujitsu.com/dl.aspx?id=166f8497-4bf0-4190-91a1-884b90850ee0>

STREAM

<http://www.cs.virginia.edu/stream/>

Contact

FUJITSU

Website: <http://www.fujitsu.com/>

PRIMERGY Product Marketing

<mailto:Primergy-PM@ts.fujitsu.com>

PRIMERGY Performance and Benchmarks

<mailto:primergy.benchmark@ts.fujitsu.com>

© Copyright 2016 Fujitsu Technology Solutions. Fujitsu and the Fujitsu logo are trademarks or registered trademarks of Fujitsu Limited in Japan and other countries. Other company, product and service names may be trademarks or registered trademarks of their respective owners. Technical data subject to modification and delivery subject to availability. Any liability that the data and illustrations are complete, actual or correct is excluded. Designations may be trademarks and/or copyrights of the respective manufacturer, the use of which by third parties for their own purposes may infringe the rights of such owner. For further information see <http://www.fujitsu.com/fts/resources/navigation/terms-of-use.html>

2016-02-29 WW EN