Redpaper

Ilya Krutov

IBM System x3750 M4: Consolidation Platform for Dual-Socket Server Workloads

Many companies implement a *scale-out* approach to build their computing environments using general-purpose dual-socket rack servers. Historically, this approach seemed to be the most efficient way to run business applications in terms of price/performance, energy efficiency, and floor space.

With the introduction of the IBM® System x3750 M4 server (x3750 M4), a 2U four-socket rack server built on the Intel Xeon processor E5-4600 product family, traditional two-socket server-based computing can be transformed into a more efficient environment. This transformation can help to achieve cost, energy, and space savings, while it provides flexible support for a majority of demanding, dynamic enterprise workloads.

This IBM Redpaper™ publication contains information about x3750 M4's *combined scale-up and scale-out approach* that redefines the economics of a traditional rack-server-based data center. This approach establishes a new path to additional cost savings:

- Hardware and software acquisition
- Annual maintenance
- Operational efficiency
- Management
- Data center floor space

This publication is intended for IT professionals who architect and design x86-based general-purpose or special-purpose solutions, such as databases, virtualization, enterprise applications, collaboration, email, streaming media, web, and cloud applications.

This paper covers the following topics:

Executive summary

Technology refresh cycles can significantly reduce data center costs by transforming the existing infrastructure into a more efficient environment. This can be achieved by lowering the number of servers, sockets, cores, infrastructure (network and power) components, and racks in the data center. Look for potential cost savings in the following areas:

- Server hardware. There are fewer servers to acquire, deploy, and manage.
- Networking infrastructure. There are fewer devices and ports to acquire and maintain.
- Software. Fewer sockets or cores result in lower software licensing costs.
- Operations. Fewer servers use less power and generate less heat.
- Management. Fewer servers require less effort to deploy and support.
- Floor space. Fewer racks occupy less data center space.

The IBM System x3750 M4 server, built on the Intel Xeon processor E5-4600 product family, delivers an extensive set of features to provide an optimal balance between performance, energy consumption, occupied space, acquisition costs, and management costs. This applies to a broad range of general-purpose or specialized workloads being deployed, moved, or consolidated from existing implementations.

This study examines the price/performance-optimized segment of the traditional dual-socket servers built on standard Intel Xeon processors. During our consolidation analysis, we evaluated potential cost savings driven by the x3750 M4-based four-socket infrastructure. We compared that to the traditional dual-socket systems optimized for price/performance, and observed the following results for x3750 M4:

- Acquisition costs. We found no significant advantage or disadvantage to a four-socket setup.
- Infrastructure costs. We realized more than 50 percent savings, because there are fewer devices and ports to acquire and manage.
- Management costs. We realized more than 50 percent savings, because there are fewer servers, network devices, and ports.
- Software licensing fees. We realized more than 10 percent savings on per-socket and per-core fees.
- Operational costs. We realized more than 20 percent savings because of lower power consumption and heat dissipation.
- Data center realty costs. We realized more than 30 percent savings, because fewer racks are required to hold the equipment.

In addition, having fewer components leads to a lower failure rate, which results in higher availability for the entire data center infrastructure.

The x3750 M4 server changes the economics of the traditional two-socket, rack-server-based data center. It makes the computing infrastructure environment more efficient in terms of cost, energy, and space-efficiency. It also provides flexible support for a majority of demanding, dynamic enterprise workloads.

IBM System x3750 M4 overview

IBM System x3750 M4 is a four-socket server featuring a streamlined design, which is optimized for price/performance, with excellent flexibility and expandability. Models of the x3750 M4 are powered with the Intel Xeon processor E5-4600 product family, with up to eight cores each, providing an entry-level, four-socket solution. The x3750 M4 server maximizes storage density, and provides flexible Peripheral Component Interconnect (PCI) and 10 Gb (gigabit) Ethernet networking options in a 2U form factor.

Figure 1 shows the IBM System x3750 M4.

Figure 1 The IBM System x3750 M4

The x3750 M4 server has exceptional memory performance that is achieved by supporting three-per-channel registered dual inline memory module (RDIMM) configurations at speeds up to 25 percent faster than the Intel specification. It achieves these results without sacrificing IBM reliability. Load-reduced DIMM (LR-DIMM) speeds are also 25 percent beyond the Intel specification for 1.35 V DIMMs. This speed improves performance and reduces overall system power.

System x3750 M4 offers a flexible, scalable design, and a simple upgrade path to 16 hard disk drives (HDDs) or 32 IBM eXFlash solid-state drives (SSDs), with up to eight PCI Express (PCIe) 3.0 slots and up to 1.5 TB (terabytes) of memory.

The flexible, embedded Ethernet solution provides two standard Gb Ethernet (GbE) onboard ports, and a dedicated 10 GbE slot that allows for a choice of either two copper or two fiber optic connections. Comprehensive systems management tools with the next-generation Integrated Management Module II (IMM2) make the solution easy to deploy, integrate, service, and manage.

System x3750 M4 blends outstanding flexibility and expandability. The x3750 M4 2 + 2 socket design enables pay-as-you-grow processing with the new Intel Xeon processor E5-4600 product family. It also provides memory scalability to help lower costs and manage growth. The 5 + 3 PCIe socket design enables you to pay for PCIe capabilities as needed.

IBM System x3750 M4 positioning

IBM System x3750 M4 was introduced to fill the demand for application workloads that require four-socket processor scalability, but that do not require advanced reliability, availability, and serviceability (RAS) and scalability features found in IBM eX5 enterprise servers. The major application classes that fit this definition include *general-purpose workloads* common for traditional dual-socket rack servers, and *high-performance computing*.

Table 1 compares key specifications of standard two-socket IBM System x3650 M4, four-socket x3750 M4, and up to eight-socket scalable IBM System x3850 X5 rack servers.

Table 1 Specification comparison: x3650 M4, x3750 M4, and x3850 X5

Component	x3650 M4	x3750 M4	x3850 X5[a]
Form factor	2U rack	2U rack	4U rack
Product family	Intel Xeon processor E5-2600	Intel Xeon processor E5-4600	Intel Xeon processor E7-8800
Maximum number of CPUs	2	4	4
DIMM slots	24	48	64 or 96[b]
Maximum memory capacity	768 GB	1.5 TB	2 TB or 3 TB[b]
Maximum memory speed	1,600 MHz	1,600 MHz	1,066 MHz
Memory speed at maximum capacity	1,066 MHz	1,333 MHz	1,066 MHz
2.5-inch HDDs and SSDs	16	16	8
1.8-inch SSDs (IBM eXFlash)	32	32	16
Maximum PCIe slot I/O bandwidth	47.3 gigabytes per second (GBps)	63 GBps	32 GBps
RAS features	Standard	Standard	Advanced
Vertical scalability	None	2 + 2 socket plus memory	Scalable to 8-way, additional memory scalability with MAX5

a. The numbers shown for the x3850 X5 are for the four-way server. For the eight-way system, they must be multiplied by two.
b. Ninety-six DIMM slots and 3 TB of memory are available with an optional MAX5 memory expansion unit.

From the specification point of view, x3750 M4 fits right in the middle between x3650 M4 and x3850 X5, providing affordable performance scalability and standard RAS features. At the same time, compared to x3650 M4, x3750 M4 has a dense 2U package with up to 25 percent higher memory speed, and 33 - 50 percent higher I/O bandwidth. This makes the x3750 M4 a good choice for consolidating general-purpose workloads that are typically deployed on dual-socket servers.

Because of its unique capabilities, x3750 M4 can provide better value than traditional two-socket rack-based environments:

- Reduce the number of servers required to deploy the specific workload
- Reduce the number of infrastructure components:
  - Network adapters
  - Interconnect links
  - Switch ports
  - Power outlets
- Lower costs:
  - Capital expenses
  - Software licensing fees
  - Operational expenses
  - Management expenses
- Maintain required performance levels

To illustrate the potential benefits of the x3750 M4 servers, we provide information about general-purpose workload consolidation. This is the most common scenario in which you can expect to see additional cost savings. We also consider the sources of these savings.

General-purpose workload consolidation scenario

In this scenario, we operate a data center that consists of 100 dual-socket Intel Xeon processor 5600 product-family-based servers. Using dual-port adapters, the servers are connected to a GbE local area network (LAN) and 4 Gb Fibre Channel storage area network (SAN) infrastructure. The servers support a wide range of general-purpose and specialized workloads, such as databases, email, collaboration, web, enterprise applications, and streaming media.

The existing environment is shown in Figure 2.

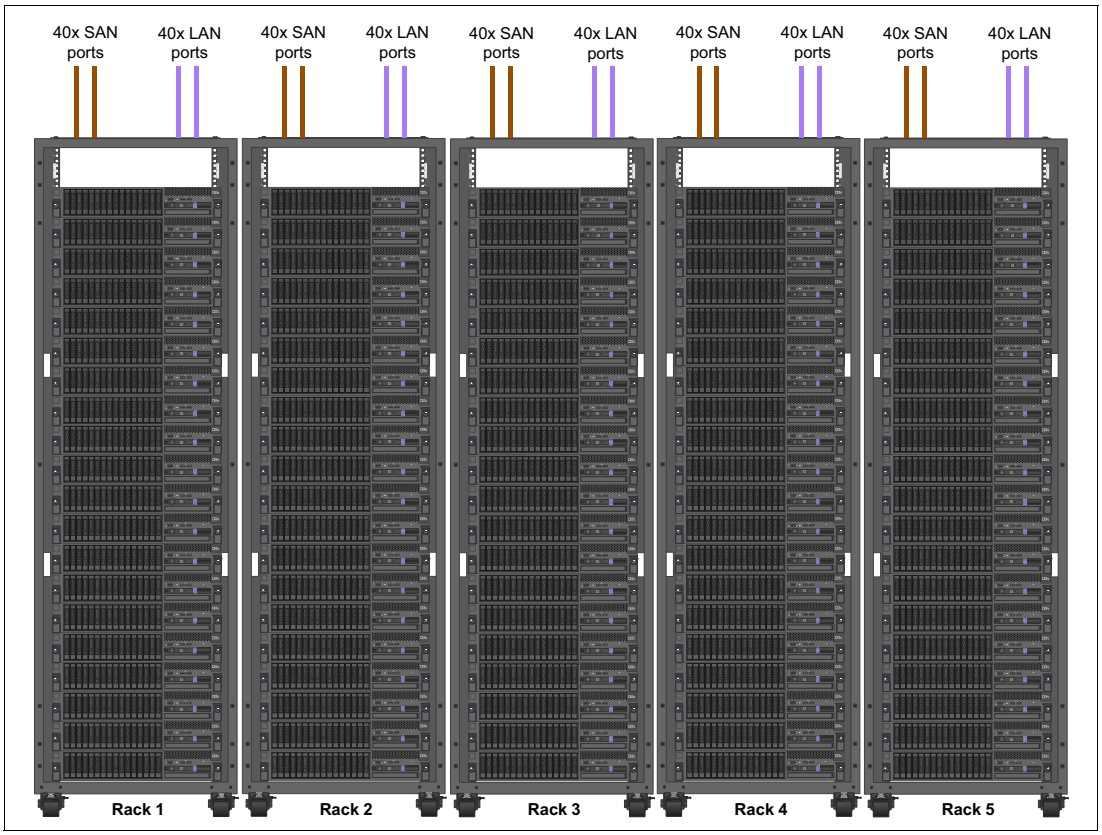

Figure 2 Existing data center environment

The servers are more than three years old, and we plan to perform a technology refresh cycle to replace these servers with the newer virtualized servers. We will also upgrade LAN and SAN infrastructure to meet growing I/O demand. We consider a traditional rack server-based approach, and are evaluating two solutions:

- Two-socket to two-socket (Intel Xeon processor E5-2600 product family) technology refresh
- Two-socket to four-socket (Intel Xeon processor E5-4600 product family) technology refresh

We established the following evaluation criteria to decide what approach to follow (fewer devices and lower costs are better):

- Hardware acquisition costs that are based on the number of servers, network devices, ports, power connectors, and outlets
- Software licensing fees that are based on the number of sockets or cores in a server, depending on the software licensing model:
  - Per-socket licensing, such as Microsoft Windows Server family and VMware vSphere offerings
  - Per-core licensing, such as Oracle or IBM DB2® databases
- Operational costs that are based on power and cooling requirements

- Management costs that are based on the number of servers, network device ports, power connectors, and power outlets
- Floor space (realty) costs that are based on the number of racks in which the server and networking hardware are installed

The purpose of our technology refresh is to drive overall costs down by lowering the number of servers, sockets, cores, network components, power infrastructure components, and racks:

- Server hardware. There are fewer servers to acquire, deploy, and manage.
- Networking infrastructure. There are fewer devices and ports to acquire and maintain.
- Software. Fewer sockets or cores result in lower software licensing costs.
- Operations. Fewer servers use less power and generate less heat.
- Management. Fewer servers require less effort to deploy and support.
- Floor space. Fewer racks occupy less data center space.

Our existing rack server environment is represented by traditional dual-socket servers built on Intel Xeon E5620 processors that are optimized for price/performance. The proposed dual-socket server solution is based on Intel Xeon processor E5-2620 product-family-based 2U rack servers, again optimized for cost and performance.

For the four-socket solution, we consider x3750 M4 servers running the Intel Xeon processor E5-4610 product family. We use SPECint_rate2006 results to estimate the consolidated computing performance of the entire data center to compare different approaches.

Table 2 summarizes key specifications of the servers being evaluated in this scenario.

Table 2 Server specifications

Feature	2S server (E5620)	2S server (E5-2620)	x3750 M4 (E5-4610)
SPECint_rate2006	223[a]	393[b]	885[c]
Sockets	2	2	4
Cores	8	12	24
Memory	64 GB (8x 8 GB)	256 GB (16x 16 GB)	512 GB (32x 16 GB)
Internal storage	2x 73 GB	2x 300 GB	2x 300 GB
LAN ports	2x 1 GbE	2x 10 GbE	2x 10 GbE
SAN ports	2x 4 Gb FC	2x 8 Gb FC	2x 16 Gb FC
Power connectors	2	2	2
Input power[d]	315 W	472 W	842 W
Heat [d]	1,076 British thermal units (BTU)/hour	1,613 BTU/hour	2,873 BTU/hour

a. The dual-socket x3650 M3 (Intel Xeon E5620) SPECint_rate2006 result, found at: http://www.spec.org/cpu2006/results

b. The dual-socket x3650 M4 (Intel Xeon processor E5-2620 product family) SPECint_rate2006 result, found at: http://www.spec.org/cpu2006/results

c. The four-socket x3750 M4 (Intel Xeon processor E5-4610 product family) SPECint_rate2006 result, found at: http://www.spec.org/cpu2006/results

d. Estimated data obtained for two-socket x3650 M3 (E5620), two-socket x3650 M4 (E5-2620), and four-socket x3750 M4 (E5-4610) servers from the IBM Power Configurator tool, found at: http://www.ibm.com/systems/bladecenter/resources/powerconfig.html

For the purpose of this comparison, we calculate estimated cost savings from moving to a new two-socket or four-socket platform based on certain criteria:

- The total number of:
  - Servers
  - Sockets
  - Cores
  - Network ports
  - Power connectors
- Input power
- Heat dissipation

Consideration: Depending on the specific Intel Xeon processor (E5-2600 or E5-4600 product family) selected for the consolidation comparison, the reduction in the number of servers, sockets, and cores will vary. Therefore, cost savings will vary as well. In this study, we consider consolidating the dual-socket Intel Xeon processor E5-2620-based servers that belong to the mainstream price/performance-optimized segment.

If the Intel Xeon processor E5-2603 or Intel Xeon processor E5-2609 product-family-based servers (entry-level cost-optimized segment) were used instead, the x3750 M4 advantages would be much greater, because of the further reduction in the number of servers. For more information, see the *IBM System x3750 M4 Total Cost of Ownership Case Study*: https://www.ibm.com/services/forms/signup.do?source=stg-web&S_PKG=500026817

Two-socket to two-socket technology refresh

First, examine the two-socket to two-socket technology refresh solution. The calculated results are shown in Table 3.

Table 3 Workload consolidation: Two-socket to two-socket technology refresh

Feature	2S server (E5620)	2S server (E5-2620)	Percent reduction
Number of servers	100	57	43
Total cores	800	684	15
Total sockets	200	114	43
Total rack space	200 U	114 U	43
Number of 42U racks	5	3	40
Total input power	31.5 kW	26.9 kW	15
Total heat dissipation	107.6 kBTU/hour	91.9 kBTU/hour	15
Total LAN ports	200	114	43
Total SAN ports	200	114	43
Total power outlets	200	114	43

Moving from the existing two-socket servers to the newer dual-socket servers can help drive the following savings:

- Management costs. We realized more than 40 percent savings, because there are fewer servers, network devices, and ports.
- Software licensing fees. We realized more than 40 percent savings for per-socket licensing, and up to 15 percent for per-core licensing.

- Operational costs. We achieved up to 15 percent savings because of lower power consumption and heat dissipation.
- Data center floor space costs. We achieved up to 40 percent savings, because fewer racks are required to hold the equipment.

The proposed two-socket server technology refresh solution is shown in Figure 3.

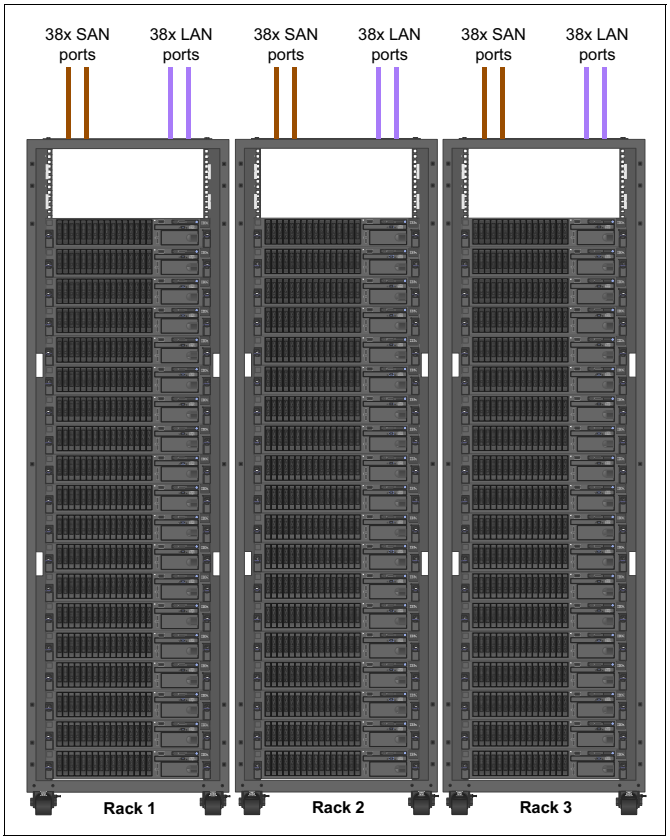

Figure 3 Proposed two-socket server technology-refresh solution

Two-socket to four-socket technology refresh

The calculations for the two-socket to four-socket technology-refresh solution are shown in Table 4.

Table 4 Workload consolidation: Two-socket to four-socket technology refresh

Feature	2S server (E5620)	4S x3750 M4 (E5-4610)	Percent reduction
Number of servers	100	25	75
Total cores	800	600	25
Total sockets	200	100	50
Rack space	200 U	50 U	75
Number of racks	5	2	60
Input power	31.5 kW	21 kW	33
Heat dissipation	107.6 kBTU/hour	71.8 kBTU/hour	33
Total LAN ports	200	50	75

Feature	2S server (E5620)	4S x3750 M4 (E5-4610)	Percent reduction
Total SAN ports	200	50	75
Total power outlets	200	50	75

Moving from dual-socket servers to newer four-socket x3750 M4 servers can help drive the following savings:

- Management costs. We achieved up to 75 percent savings, because there are fewer servers, network devices, and ports.
- Software licensing fees. We realized more than 50 percent savings for a per-socket software licensing model, or up to 25 percent for per-core licensing.
- Operational costs. We realized more than 30 percent savings because of lower power consumption and heat dissipation.
- Data center floor space costs. We achieved up to 60 percent savings, because fewer racks are required to hold the equipment.

The resulting infrastructure is shown in Figure 4.

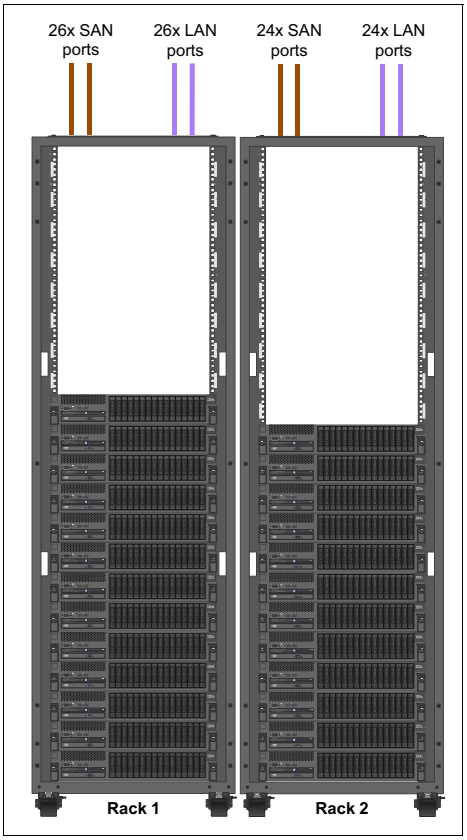

Figure 4 Two-socket to four-socket technology refresh

Two-socket versus four-socket technology refresh

We compared two-socket to two-socket and two-socket to four-socket approaches to identify potential advantages of four-socket x3750 M4 servers. The comparison is shown in Table 5.

Table 5 Workload consolidation: Two-socket versus four-socket

Feature	2S server (E5-2620)	4S x3750 M4 (E5-4610)	Percent 4S advantage
Number of servers	57	25	56
Total cores	684	600	12
Total sockets	114	100	12
Rack space	114 U	50 U	56
Number of racks	3	2	33
Acquisition cost	Comparable	Comparable	No significant advantage or disadvantage
Power consumption	26.9 kW	21 kW	22
Heat dissipation	91.9 kBTU/hour	71.8 kBTU/hour	22
Total LAN ports	114	50	56
Total SAN ports	114	50	56
Total power outlets	114	50	56

Based on the numbers shown in Table 5, we observed the following potential savings in our scenario, moving from the traditional two-socket Intel Xeon processor E5-2600 product-family-based servers to the four-socket x3750 M4 platform:

- Server hardware acquisition costs. We found no significant advantage or disadvantage between the dual-socket and four-socket servers described in the scenario.
- Networking and power infrastructure acquisition costs. We realized more than 50 percent savings, because there are fewer devices and ports to acquire and manage.
- Management costs. We realized more than 50 percent savings, because there are fewer servers, network devices, and ports.
- Software licensing fees. We realized more than 10 percent savings for per-socket and per-core software licensing models.
- Operational costs. We realized more than 20 percent savings because of lower power consumption and heat dissipation.
- Data center floor space costs. We realized more than 30 percent savings, because fewer racks are required to hold the equipment.

In addition, having fewer components means a lower failure rate and, therefore, higher availability for the entire data center infrastructure.

Conclusion

The IBM System x3750 M4 is designed to minimize cost, maximize 2U density, and simplify deployment of a wide range of general-purpose and specialized workloads. It matches the performance and capacity of processors, memory, I/O, and storage subsystems. It also reduces overall power consumption and provides efficient cooling for a dense computing environment.

The IBM System x3750 M4 includes these key features:

- The outstanding RDIMM and LR-DIMM memory performance of the x3750 M4 is achieved by supporting three-DIMMs-per-channel configurations at speeds up to 25 percent faster than the Intel specification, without sacrificing reliability.
- The x3750 M4's 2 + 2 processor socket design enables pay-as-you-grow processing, memory, and I/O scalability with the Intel Xeon processor E5-4600 product family. This enables you to lower acquisition costs and manage growth.
- The use of IBM eXFlash 1.8-inch SSDs instead of, or along with, traditional spinning drives (HDDs), can dramatically improve I/O performance and save energy.
- RAS features enable easier support and maintenance.

Our consolidation evaluation and analysis focused on x3750 M4-based infrastructure cost savings compared to dual-socket systems, and observed the following results:

- Acquisition costs. We found no significant advantage or disadvantage between price/performance-optimized dual-socket and four-socket Intel Xeon processor E5 family-based servers.
- Infrastructure costs. We realized more than 50 percent savings, because there are fewer devices and ports to acquire and manage.
- Management costs. We realized more than 50 percent savings because of fewer servers, network devices, and ports.
- Software licensing fees. We realized more than 10 percent savings on per-socket and per-core fees.
- Operational costs. We realized more than 20 percent savings because of lower power consumption and heat dissipation.
- Data center realty costs. We realized more than 30 percent savings, because fewer racks are required to hold the equipment.

In addition, having fewer components produces a lower failure rate and, therefore, higher availability for the entire data center infrastructure.

IBM System x3750 M4 changes the economics of the traditional two-socket, rack-server-based data center, and transforms its computing infrastructure. This transformation can help to achieve cost, energy, and space savings, while it provides flexible support for a majority of demanding, dynamic enterprise workloads.

Appendix: IBM System x3750 M4 product details

Table 6 lists the standard specifications of the x3750 M4.

Table 6 Standard specifications of the x3750 M4

Components	Specification
Form factor	2U rack
Processor	Up to four Intel Xeon processor E5-4600 product family processors, each with eight cores (up to 2.7 GHz), six cores (up to 2.9 GHz), or four cores (up to 2.0 GHz). Two processor sockets on the system board and two processors on the processor and memory expansion tray (standard on most models). Two QPI links up to 8.0 GTps each. Up to 1600 MHz memory speed. Up to 20 MB L3 cache per processor.
Chipset	Intel C600 series
Memory	Up to 48 DIMM sockets (12 DIMMs per processor). RDIMMs and LR-DIMMs (Load Reduced DIMMs) are supported, but memory types cannot be intermixed. The memory speed is up to 1600 MHz. There are 24 DIMM sockets on the system board. There are an additional 24 DIMM sockets on the processor and memory expansion tray (standard on most models).
Memory maximums	With RDIMMs: Up to 768 GB with 48x 16 GB RDIMMs and four processors. With LR-DIMMs: Up to 1.5 TB with 48x 32 GB LR-DIMMs and four processors.
Memory protection	ECC, Chipkill (for x4-based memory DIMMs), memory mirroring, and memory sparing.
Disk drive bays	Up to 16 2.5-inch hot-swap SAS/SATA bays, or up to 32 1.8-inch hot-swap solid-state drive (SSD) eXFlash bays. Drive bays can be in any combination of four 2.5-inch drives or eight 1.8-inch eXFlash SSD drives.
Maximum internal storage	Up to 14.4 TB with 900 GB 2.5-inch SAS HDDs, up to 16 TB with 1 TB 2.5-inch NL SAS/SATA HDDs, or up to 16 TB with 512 GB Enterprise Value SSDs, or up to 12.8 TB with 400 GB Enterprise SSDs. An intermix of SAS/SATA is supported.
RAID support	RAID 0, 1, 10 with integrated ServeRAID M5110e with LSI SAS2208 6 Gbps RAID on Chip (ROC) controller. Optional upgrades to RAID 5 and 50 are available (zero-cache is 512 MB and battery-backed cache is 512 MB or 1 GB flash-backed cache). There is an optional upgrade to RAID 6 and 60 for a 512 MB or 1 GB cache.
Optical drive bays	There is one bay for an optional multi-burner drive.
Tape drive bays	None internal. Use a supported external tape drive.
Network interfaces	Emulex BE3 controller with two standard integrated Gigabit Ethernet 1000BASE-T ports (RJ-45), and two optional 10 Gb ports through an adapter in a dedicated slot. The 10 GbE options are 10Base-T dual port (copper) or SFP+ dual port (fiber).
PCI Expansion slots	Up to eight slots, five on the system board, three on an optional riser card. The slots are as follows: ► Slot 1: PCIe 3.0 x8; full-height, half-length (optional with riser card, requires CPU 2) ► Slot 2: PCIe 3.0 x8; full-height, half-length (optional with riser card, requires CPU 2) ► Slot 3: PCIe 3.0 x8; full-height, half-length (optional with riser card, requires CPU 2) ► Slot 4: PCIe 3.0 x8; low profile (requires CPU 2) ► Slot 5: PCIe 3.0 x8; low profile (requires CPU 2) ► Slot 6: PCIe 3.0 x8; low profile ► Slot 7: PCIe 3.0 x8; low profile ► Slot 8: PCIe 3.0 x8; low profile Slots 1, 2, and 3 are physically x16 slots.

Components	Specification
Ports	Front: Two USB 2.0 ports and one DB-15 video port. Rear: Two USB 2.0 ports, one DB-15 video port, one DB-9 serial port, one RJ-45 systems management port, two RJ-45 1 GbE network ports, and two optional RJ-45 or SFP+ 10 GbE network ports. Internal: Two internal USB ports (for the embedded hypervisor).
Cooling	IBM Calibrated Vectored Cooling™ with up to six N+N redundant hot swap fans (all six standard). Each fan has two rotors.
Power supply	Up to two hot-swap redundant 1400 W AC power supplies (80 PLUS Platinum certification). 900 W power supplies are also available through CTO or Special Bid. A second power supply requires that the processor expansion tray or the power interposer card be installed.
Video	Matrox G200eR2 with 16 MB memory integrated into the IMM2. Maximum resolution is 1600x1200 at 75 Hz with 16 M colors.
Hot-swap parts	Hard drives, power supplies, and fans.
Systems management	UEFI, IBM Integrated Management Module II (IMM2), Predictive Failure Analysis, Light Path Diagnostics, Automatic Server Restart, IBM Systems Director and Active Energy Manager, and the IBM ServerGuide. IMM Advanced Upgrade software features for remote presence are standard with the x3750 M4.
Security features	Power-on password, administrator's password, Trusted Platform Module (TPM).
Operating systems supported	Microsoft Windows Server 2008 R2 and 2008, Microsoft Windows Server 2012, Red Hat Enterprise Linux 5 and 6, SUSE Linux Enterprise Server 10 and 11, VMware ESX 4.1 and VMware ESXi 4.1 embedded hypervisor, and VMware vSphere 5.
Limited warranty	Three-year customer-replaceable unit and onsite limited warranty with 9x5 next business day (NBD).
Service and support	Optional service upgrades are available through IBM ServicePac® offerings: Four-hour or two-hour response time, eight-hour fix time, one-year or two-year warranty extension, and remote technical support for IBM hardware and some IBM and third-party applications.
Dimensions	Height: 86 mm (3.4 in.), width: 445 mm (17.5 in.), depth: 746 mm (29.4 in.)
Weight	Minimum configuration: 25 kg (55 lb.), maximum: 30 kg (65 lb.)

Figure 5 shows a block diagram of the x3750 M4 system.

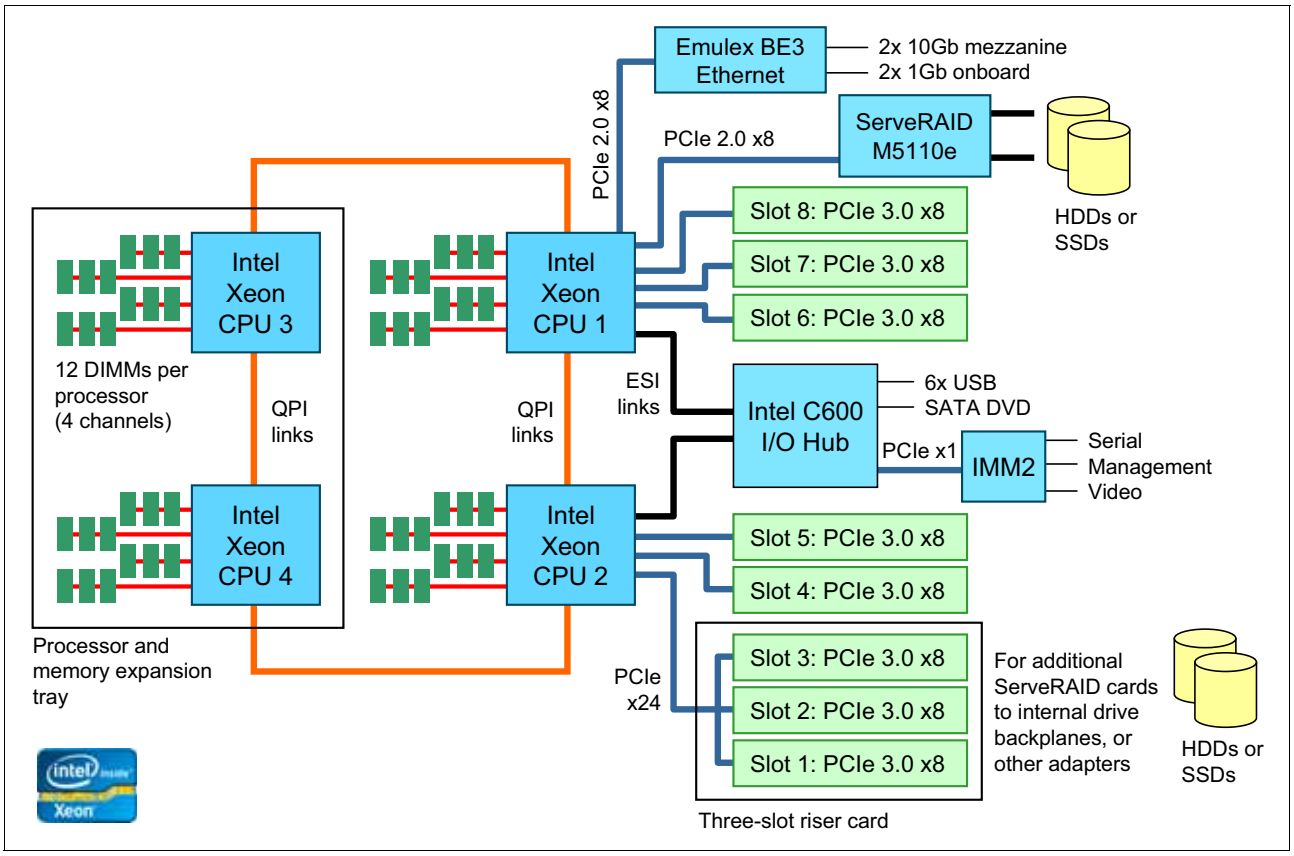

Figure 5 Block diagram of the IBM System x3750 M4

The following technology advances make the x3750 M4 uniquely positioned for two-socket workload consolidation:

- Memory speeds that are up to 25 percent higher than those found in Intel's specification
- IBM eXFlash SSD-based local storage
- Pay-as-you-grow 2 + 2 design approach to scale processor, memory, and I/O subsystems
- Dense 2U energy-efficient package
- Proven, standard IBM server RAS features

Memory speeds

One of the key features of the IBM System x3750 M4 is the potential to support memory speeds above the Intel specification. Specifically, in three-DIMMs-per-channel configurations, the following maximum memory speeds are possible:

- Up to 1,333 MHz for RDIMMs operating at 1.5 V, which is 25 percent more than the Intel specification establishes
- Up to 1,333 MHz for LR-DIMMs operating at either 1.5 V or 1.35 V, which is 25 percent more than the Intel specification establishes

This feature is the result of the IBM design approach:

- The x3750 M4 memory busses are shorter than those required by the Intel specification. The result is a memory bus with less signal loss as the memory data makes its way from the processors to the DIMMs. The shorter bus with less loss results in faster speeds.

- When running at the higher speeds, IBM thoroughly tests each and every DIMM we support. Each DIMM is taken through margin analysis in which the voltages, timings, and temperatures of the memory bus are varied to ensure that it still meets Intel's specification.
- The processors are kept centered in relation to memory. The shorter routes are achieved by centrally locating the processor within the width of the DIMM.

IBM eXFlash

IBM eXFlash technology is a server-based, high-performance internal storage solution that is based on SSDs and performance-optimized RAID controllers. A single eXFlash unit accommodates up to eight hot-swap SSDs, and can be connected to a single performance-optimized controller.

Each eXFlash unit occupies four 2.5-inch SAS HDD bays. You can install up to four eXFlash units in a single x3750 M4 for up to thirty-two 1.8-inch SSDs (eight SSDs per eXFlash unit).

A single IBM eXFlash unit has the following characteristics:

- Up to eight 1.8-inch hot-swap, front-accessible SSDs
- More than 200,000 random read/write, input/output operations per second (IOPS) in RAID-5 storage
- Up to 3.2 TB of available storage space with S3700 400 GB 1.8-inch MLC Enterprise SSDs

In theory, the random I/O performance of a single eXFlash unit combined with the IBM SATA Enterprise SSDs configured in a RAID 5 array is equivalent to the storage system consisting of more than 1,000 traditional spinning HDDs. Besides HDDs themselves, building such a massive, I/O-intensive, high-performance storage system requires external deployment with many additional infrastructure components, including host bus adapters (HBAs), switches, storage controllers, disk expansion enclosures, and cables.

Consequently, this leads to more capital expenses, floor space, electrical power requirements, and operational and support costs. Because eXFlash is an internal server storage, it does not require all of these components, and helps to eliminate additional expenses and environmental requirements.

In summary, an IBM eXFlash solution can provide the following significant benefits:

- Lower implementation cost of high-performance, I/O-intensive storage systems
- Improved cost-per-IOPS ratio
- Higher performance of I/O-intensive applications, such as databases, with up to ten times shorter response time
- Savings in power and cooling produced by a high performance-per-watt ratio
- Savings in floor space produced by an extreme performance-per-U ratio
- Simplified management and maintenance produced by internal, server-based configurations (requires no external power and information infrastructure)

In addition to its superior performance, eXFlash offers superior uptime, with three times the reliability of mechanical disk drives. SSDs have no moving parts to fail. They use enterprise wear-leveling to extend their use even longer. All of the operating systems that are listed in IBM ServerProven® for the x3750 M4 are supported for use with eXFlash.

Pay-as-you-grow scalability

The IBM System x3750 M4 server design uses a 2 + 2 scalability approach. You can start from a dual-socket configuration with 24 DIMM slots and five PCIe 3.0 slots. When needed, you can upgrade the existing configuration by adding the processor and memory expansion tray, which provides two additional processor sockets and 24 DIMM slots.

This totals four processors and up to 1.5 TB of memory, with 32 GB LR-DIMMs that all run at up to 1,333 MHz. You can also scale the I/O subsystem by adding three more PCIe 3.0 slots.

There are other performance and scalability features:

- The Intel Xeon processor E5-4600 product family improves productivity by offering superior system performance, with four-socket core processors and up to 2.7 GHz core speeds (eight-core processors), up to 20 MB of L3 cache, and up to two 8-GTps (gigatransfers per-second) QPI links.
- Up to four processors, 32 cores, and 64 threads with Intel Hyper-Threading Technology combine to maximize the concurrent execution of multithreaded applications.
- Intelligent and adaptive system performance with Intel Turbo Boost Technology 2.0 allows processor cores to run at maximum speeds during peak workloads by temporarily going beyond processor Thermal Design Power (TDP).
- Intel Advanced Vector Extensions (AVX) can improve floating-point performance for compute-intensive technical and scientific applications.
- Up to 16 HDDs or 32 eXFlash SSDs, together with an optical drive, provide a flexible and scalable all-in-one platform to meet your increasing demands.
- The server has two integrated and two optional 10 GbE ports that do not use PCIe slots.
- The server offers PCI Express 3.0 I/O expansion capabilities that improve the theoretical maximum bandwidth by almost 100 percent compared to the previous generation of PCI Express 2.0. That is, with PCI Express, you get 8 GTps per link using 128b/130b encoding, compared to 5 GTps per link using 8b/10b encoding.
- With Intel Integrated I/O Technology, the PCI Express 3.0 controller is integrated into the Intel Xeon processor E5 family. This integration reduces I/O latency and increases overall system performance.

Energy efficiency

The x3750 M4 offers the following energy-efficiency features to save energy, reduce operational costs, increase energy availability, and contribute to a green environment:

- Energy-efficient system board components help lower operational costs.
- The 900 W and 1400 W AC power supplies with 80 PLUS Platinum certification at high voltage AC are highly efficient.
- The Intel Xeon processor E5-4600 product family offers balanced performance and energy use with built-in Intel TurboBoost 2.0 and Intel Intelligent Power Capability technologies.
- Low-voltage 1.35 V Double Data Rate (DDR3) memory DIMMs use 19 percent less energy than 1.5 V DDR3 RDIMMs.
- SSDs use as much as 80 percent less power than traditional, spinning 2.5-inch HDDs.
- The server uses hexagonal ventilation holes, which are a part of IBM Calibrated Vectored Cooling technology. Hexagonal holes can be grouped more densely than round holes, providing more efficient airflow through the system.
- IBM Systems Director Active Energy Manager™ provides advanced data center power notification and management to help lower heat output and reduce cooling needs.

RAS features

The x3750 M4 provides many features to simplify serviceability and increase system uptime:

- The server offers Chipkill, memory mirroring, and memory rank sparing for redundancy in the event of a memory failure.
- The server provides restart recovery for any failed processor. In the event of a failure of processor 1, the server connects the south bridge to processor 2 for restart.
- The server has up to two redundant hot-swap power supplies, and up to six hot-swap dual-rotor N+N redundant fans, to provide availability for business-critical applications.
- The power source-independent light path diagnostics panel and individual light path LEDs lead the technician to failed (or failing) components, which simplifies servicing, speeds up problem resolution, and helps improve system availability.
- Predictive Failure Analysis (PFA) detects when system components operate outside of standard thresholds, and generates proactive alerts in advance of a possible failure, increasing uptime. These components support PFA:
  - Memory
  - SAS and SATA HDDs
  - Fans
  - Voltage reduction devices (VRDs)
  - Power supplies
- SSDs offer more reliability than traditional, mechanical HDDs for greater uptime.
- The built-in IMM2 continuously monitors system parameters, triggers alerts, and runs recovery actions in case of failures, minimizing downtime.
- Built-in diagnostics, using Dynamic Systems Analysis (DSA) Preboot, speed up troubleshooting tasks to reduce service time.
- A three-year customer-replaceable unit and onsite limited warranty, with 9x5 NBD support, is available. Optional service upgrades are available.

For more information, see *IBM System x3750 M4 Implementation Guide*, REDP-4874.

Related publications

For more information, see the following publications:

- *IBM System x3750 M4 Implementation Guide*, REDP-4874

  http://www.redbooks.ibm.com/abstracts/redp4874.html
- *Positioning IBM System x3750 M4 for High Performance Computing Workloads*, REDP-4890

  http://www.redbooks.ibm.com/abstracts/redp4890.html
- *IBM System x3750 M4*, TIPS0881

  http://www.redbooks.ibm.com/abstracts/redp0881.html
- *IBM System x3750 M4 Total Cost of Ownership Case Study*

  https://www.ibm.com/services/forms/signup.do?source=stg-web&S_PKG=500026817

Author

This paper was produced by a team of specialists from around the world working at the International Technical Support Organization, Raleigh Center.

Ilya Krutov is a Project Leader at the ITSO Center in Raleigh, and has been with IBM since 1998. Before he joined the ITSO, Ilya served in IBM as a Run Rate Team Leader, Portfolio Manager, Brand Manager, Technical Sales Specialist, and Certified Instructor. Ilya has expertise in IBM System x®, IBM BladeCenter®, and IBM Flex System™ products; server operating systems; and networking solutions. He has authored over 130 books, papers, Product Guides, and Solution Guides. He has a Bachelor's degree in Computer Engineering from the Moscow Engineering and Physics Institute.

Thanks to the following people for their contributions to this project:

Kevin Barnes, Tamikia Barrow, Mary Comianos, Shari Deiana, Cheryl Gera, Russell Kliegel, Linda Robinson, and David Watts
International Technical Support Organization, Raleigh Center

Randall Lundin
IBM

Now you can become a published author, too!

Here's an opportunity to spotlight your skills, grow your career, and become a published author—all at the same time! Join an ITSO residency project and help write a book in your area of expertise, while honing your experience using leading-edge technologies. Your efforts will help to increase product acceptance and customer satisfaction, as you expand your network of technical contacts and relationships. Residencies run from two to six weeks in length, and you can participate either in person or as a remote resident working from your home base.

Obtain more information about the residency program, browse the residency index, and apply online at:

ibm.com/redbooks/residencies.html

Stay connected to IBM Redbooks

- Find us on Facebook:

  http://www.facebook.com/IBMRedbooks

- Follow us on Twitter:

  http://twitter.com/ibmredbooks

- Look for us on LinkedIn:

  http://www.linkedin.com/groups?home=&gid=2130806

- Explore new IBM Redbooks® publications, residencies, and workshops with the IBM Redbooks weekly newsletter:

  https://www.redbooks.ibm.com/Redbooks.nsf/subscribe?OpenForm

- Stay current on recent Redbooks publications with RSS Feeds:

  http://www.redbooks.ibm.com/rss.html

Notices

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not grant you any license to these patents. You can send license inquiries, in writing, to:
IBM Director of Licensing, IBM Corporation, North Castle Drive, Armonk, NY 10504-1785 U.S.A.

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM websites are provided for convenience only and do not in any manner serve as an endorsement of those websites. The materials at those websites are not part of the materials for this IBM product and use of those websites is at your own risk.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Any performance data contained herein was determined in a controlled environment. Therefore, the results obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurements may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

COPYRIGHT LICENSE:

This information contains sample application programs in source language, which illustrate programming techniques on various operating platforms. You may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs.

This document, REDP-5025-00, was created or updated on July 11, 2013.

Send us your comments in one of the following ways:
- Use the online **Contact us** review Redbooks form found at:
  ibm.com/redbooks
- Send your comments in an email to:
  redbooks@us.ibm.com
- Mail your comments to:
  IBM Corporation, International Technical Support Organization
  Dept. HYTD Mail Station P099
  2455 South Road
  Poughkeepsie, NY 12601-5400 U.S.A.

Trademarks