

Performance Benefits of OpenVMS V8.4 Running on BL8x0c i2 Server Blades

**A detailed review of performance features
and test results for OpenVMS V8.4.**

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Table of Contents

Executive Summary

Introduction

Information Sources

Performance-Related Improvements in BL8x0c i2

Performance-Related Improvements in OpenVMS V8.4

Application Performance Tests

Conclusion

Executive Summary

In 2010 HP® introduced three new server blades and an update to OpenVMS® that will extend the life of the OpenVMS environment for many years. The BL8x0c i2 server blades use quad-core Intel® Itanium® 9300 processors. OpenVMS V8.4 offers improved performance designed for these new BL8x0c i2 server blades. This paper provides detailed analyses of the performance advantages of OpenVMS V8.4 running on BL8x0c i2 server blades. Data for this paper comes from HP and Intel product data sheets and published HP presentations that include performance test data.

HP's new BL8x0c i2 server blades include many performance-enhancing features. First, the processors are quad-core with Hyper-Threading versus dual core. Second, memory is improved with 8x more memory capacity, faster DDR3 memory, and 6x the memory bandwidth versus older Integrity blades. Other performance-related improvements result in higher bandwidth between the processors and IO, and improved cache efficiency and scalability.

The new server blades were tested using integer and floating point tests. Integer math provides a good indication of 'raw' CPU throughput while floating point math is a better indicator of how a CPU will perform running real-world applications. In both tests, the new servers' test scores were more than double those of older Integrity servers. Much of this is due to the new servers' quad-core processors. Other hardware enhancements further boost performance. *On a per core basis*, the high end Intel 9300 processor scored 15-17% higher than Intel Dual Core Itanium processors.

OpenVMS V8.4 includes many performance enhancements designed for the BL8x0c i2 server blades. The following types of workloads run faster on OpenVMS V8.4 (percentage improvement): Shadow BitMap Updating (400%), Very High Usage of mem(str)cmp() (350%), Shadow READ (300%), Maximized Usage of Lock Manager Resources (200%), Heavy AST Queuing (50%), Exception Handling (50%), Large number of Image Activation (45%), and High Speed USB Boot (25%). BACKUP is also improved in OpenVMS V8.4 with support for volumes up to 2TB and the ability to generate compressed savesets. Finally, an increase in MBC count of RMS enables high IO utilization.

The new server blades were compared to older Integrity servers using four specific application tests. All servers were running OpenVMS V8.4. In the Apache test, the BL860c i2 provides 95% better bandwidth and throughput than the BL860c. In the Rdb test, the BL890c i2 performed double the number of transactions per second as the rx8640. In the Java Test the maximum throughput of the BL860c i2 is up to 10.4x the AlphaServer ES45 on a per processor (socket) basis while the BL870c i2 is up to 1.8x faster than the rx6600. Finally, the BL890c i2 server blade consistently shows 3x performance advantage over the rx7640 in the Oracle 10gR2 tests. Based on this data, BL8x0c i2 server blades running OpenVMS V8.4 offer significantly better performance than older OpenVMS environments.

Highlights

Many companies rely on OpenVMS environments for their business critical applications.

In 2010 HP introduced new Integrity blades and an updated version of OpenVMS.

This paper focuses on the advantages of running OpenVMS V8.4 on BL8x0c i2 server blades.

Introduction

OpenVMS, introduced over thirty years ago, has grown to become a leading environment for business-critical applications. HP had two major product introductions in 2010 that will extend the life of the OpenVMS environment for many years. First, HP introduced new server blades based on the Intel Itanium 9300 processor series. The three new Integrity i2 blades include the Integrity BL860c i2, BL870c i2, and the BL890c i2. These new blades offer approximately twice the performance of the previous blade models with the same number of sockets. Second, HP introduced OpenVMS V8.4 which offers improved performance when running on HP's new Integrity i2 server blades. Some new features that enhance performance include improvements to Write BitMap Shadow Driver, memcmp/strcmp routines, Shadow Read, Dedicated CPU Lock Manager, AST Queuing, Exception Handling, and Image Activation. OpenVMS V8.4 also includes new support for Integrity RAD (Resource Affinity Domains), High Speed USB Boot, and AVIO (Accelerated Virtual I/O) for Integrity Virtual Machine. Applications that run on any OpenVMS version will also run on OpenVMS V8.4 due to binary compatibility of applications. Another paper by TechWise Research provides detailed analyses of the financial benefits for OpenVMS users to upgrade to these new BL8x0c i2 server blades running OpenVMS V8.4. That September 2010 paper is entitled ***Total Cost of Upgrading HP OpenVMS Environments to HP Integrity i2 Server Blades***. This paper focuses on the performance advantages of HP's new blade servers and OpenVMS V8.4.

Note: The performance test data in this white paper are from engineering test environments provided by HP. These environments do not represent any specific customer workload. Each company may see different results depending on configuration and workload (e.g., your mileage may vary).

Information Sources

TechWise Research utilized two sources of publically available information for this paper. The first includes published product specifications and data sheets from HP and Intel. The second includes published reports and performance test results that may be found on HP's website. One report is a presentation given at HP's 2010 Tech Forum entitled ***OpenVMS V8.4 on Tukwila Quad Core***. Another report is a December 2010 presentation entitled ***OpenVMS V8.4 Performance on New i2 Server***. Both of these presentations include data from performance tests conducted by HP.

Performance-Related Improvements in BL8x0c i2

Below is a summary of the BL8x0c i2 server blades' product specifications:

Highlights

The new BL8x0c i2 server blades include many performance-enhancing features. The processors are improved from dual-core to quad-core and they support Hyper-Threading.

Memory is improved from DDR2 to DDR3. Memory capacity is expanded 8x while memory bandwidth is improved 6x.

Introducing New Integrity Server Blades			
BL860c i2, BL870c i2 and BL890c i2			
	BL860c i2	BL870c i2	BL890c i2
Processor	Intel® Itanium® processor 9300 series (quad-core and dual-core)		
Processors/Cores	Up to 2 Processors/8 cores Up to 2 Processors/4 cores	Up to 4 Processors/16 cores	Up to 8 Processors/32 cores
Chipset	Intel Boxboro Chipset (I/O Hub)		
Memory Industry Std. DDR3 technology	24 DIMM Slots Max:192GB (w/8GB) Max:384GB (w/16GB)	48 DIMM Slots Max:384GB (w/8GB) Max:768GB (w/16GB)	96 DIMM Slots Max:768GB (w/8GB) Max:1.5TB (w/16GB)
Internal Storage	2 Hot-Plug SFF SAS HDDs HW RAID 0/1 controller (standard)	4 Hot-Plug SFF SAS HDDs HW RAID 0/1 controller (standard)	8 Hot-Plug SFF SAS HDDs HW RAID 0/1 controller (standard)
Networking (integrated)	4 x 10 GbE (Flex10) NICs	8 x 10 GbE (Flex10) NICs	16 x 10 GbE (Flex10) NICs
Mezzanine Slots	3 PCIe slots	6 PCIe slots	12 PCIe slots
Management	Integrity Integrated-Lights Out 3 (iLO 3) Advanced Pack (standard)		
Density	8 server blades in c7000 4 server blades in c3000	4 server blades in c7000 2 server blades in c3000	2 server blades in c7000 1 server blade in c3000

HP's new BL8x0c i2 server blades include many performance-enhancing features. The most obvious feature is the Itanium 9300 Series processor. These new quad-core processors offer double the number of cores, and higher frequency range, as compared to previous generation Itanium 9100 series processors. In addition, Intel's Hyper-Threading Technology enables each of these cores to handle two active software threads. The result is a processor that offers enhanced thread level parallelism.

HP's new BL8x0c i2 server blades also have several performance-enhancing features related to memory. First, these blades support much larger memory configurations than older blades. For example, the BL860c i2 supports up to 384GB of memory compared to 48GB for the BL860c. Additionally, the BL870c i2 supports 768GB compared to 96GB for the BL870c. The new blades also use faster DDR3 memory compared to DDR2 memory for the older blades. In addition to improved memory capacity and speed, the new servers also have up to six times more memory bandwidth. This improvement is due to Intel's new Scalable Memory Interconnect (SMI) and the presence of two integrated memory controllers within each processor (socket).

Two examples of additional performance-related improvements include Intel's QuickPath Interconnect technology that provides higher bandwidth between processors and IO and Directory-Based Cache Coherency which improves cache efficiency and scalability. There is high speed PCIe Gen 2 device support included in these blades. To maximize the network utilization, these blades support high bandwidth Flex-10 capable network devices. Detailed technical discussions of these features are beyond this paper's scope. The next section includes performance data that quantifies the benefits of these hardware features.

Highlights

The Integer Rating Test results for the new BL8x0c i2 server blades are more than double those of older Integrity servers.

Most of the difference is because the server blades use quad-core processors.

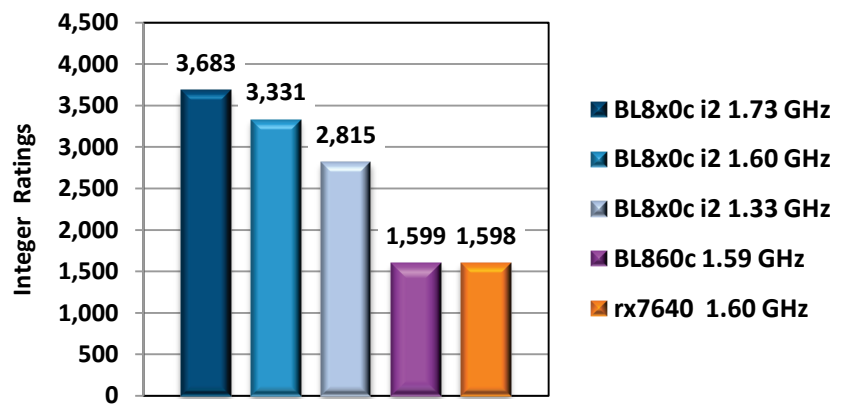
On a per core basis, the 1.73 GHz BL860c i2 is 15% faster for integer work than its predecessor BL860c.

CPU Performance

Integer Rating Test

Two of the fundamental tests used to compare platforms include the Integer and Floating Point tests. The Integer Rating Test aims to measure how fast a CPU can perform mathematical operations involving integers (whole numbers with no fractional part). This is a basic operation in all computer software and provides a good indication of 'raw' CPU throughput. Integer Rating Test scores count only the number of program iteration completions per second, allowing individual machines to perform this calculation in a machine-specific way. The chart below compares the DMIPS scores of the three new Itanium 9300 processors with two older Itanium processors.

**Integer Ratings - Dhrystone DMIPS
Per Processor (Socket)**



Source: HP

The above chart shows that the new servers are significantly faster in this basic performance metric. The most telling comparison is between the three servers that have processors with virtually identical clock speeds. The BL860c 1.59 GHz with 9MB cache and the rx7640 1.60 GHz with 12MB cache have virtually identical scores near 1,600 rating. The new BL8x0c i2 1.60 GHz with 6MB cache is more than twice as fast with a score of over 3,300 rating. Most, but not all, of this performance advantage is due to the fact that the new blades use quad-core processors compared to the dual-core processors used in the old blades. The 1.60 GHz quad-core BL860c i2 is 4% faster than the 1.60 GHz dual-core BL860c *on a per core basis*. Each core in the BL860c i2 1.73 GHz server blade is 15% faster for integer work than each core in the BL860c.

Highlights

The Floating Point Test results for the new BL8x0c i2 server blades are more than double those of older Integrity servers.

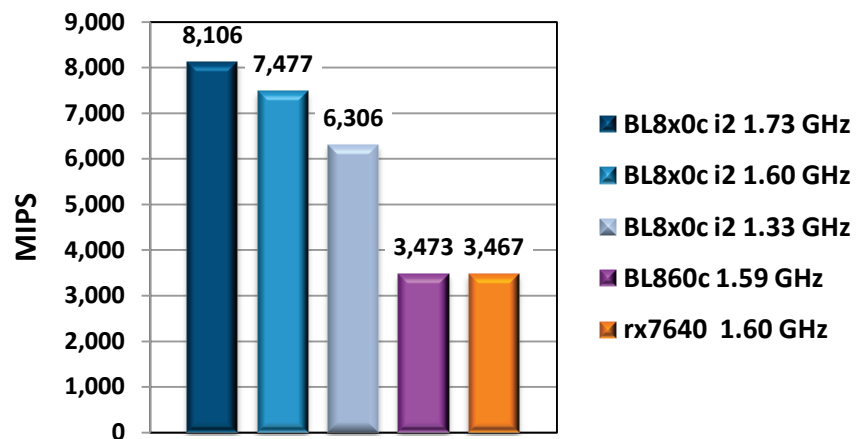
Much of this difference is also because the new processors are quad core versus dual core.

Some of this advantage is due to new high precision floating point architecture. On a per core basis, the 1.73 GHz BL860c i2 is 17% faster on floating-point than its high-end predecessor in the BL860c.

Floating Point Test

As useful as the Integer Test is to compare systems, intense computations typically involve rational numbers. A rational number is any number that can be made by dividing one integer by another. In performance tests, rational numbers are usually referred to as floating point numbers (e.g., any number with a fractional part such as 16.194). Floating point numbers are handled quite differently in the CPU compared to Integer numbers. For this reason, the floating point test is usually a better indicator to compare how different CPUs will perform running real-world applications. The following chart compares the performance of the same five processors in terms of Million Instructions per Second (MIPS). As before, higher numbers are better.

**Floating Point Rating
Per Processor (Socket)**



Source: HP

Similar to the Integer test results, the above results are on a per processor (socket) basis. Much of the superior performance of the new BL8x0c i2 server blades is because these servers use quad-core processors. The Itanium 9300 series processors also have new high precision floating architecture. Thanks to this new architecture, each core of the BL860c i2 1.73 GHz server blade is 17% faster on floating point than each core of the older BL860c server blade. On a per processor (socket) basis, the BL860c i2 1.73 GHz server blade is 133% faster in floating point than the previous BL860c server. This means the new servers will have a faster response to complex operations. Scientific, Automation, and Robotic applications are examples of applications that should benefit.

The previous two charts illustrate the performance advantages of the new BL8x0c i2 server blades that were introduced last year. HP also introduced an update to OpenVMS in 2010. The next few pages discuss the performance advantages of OpenVMS V8.4 over OpenVMS V8.3-1H1.

Performance-Related Improvements in OpenVMS V8.4

Below is a list of some of the improvements in OpenVMS V8.4 designed to enhance performance when running on HP BL8x0c i2 server blades.

Highlights

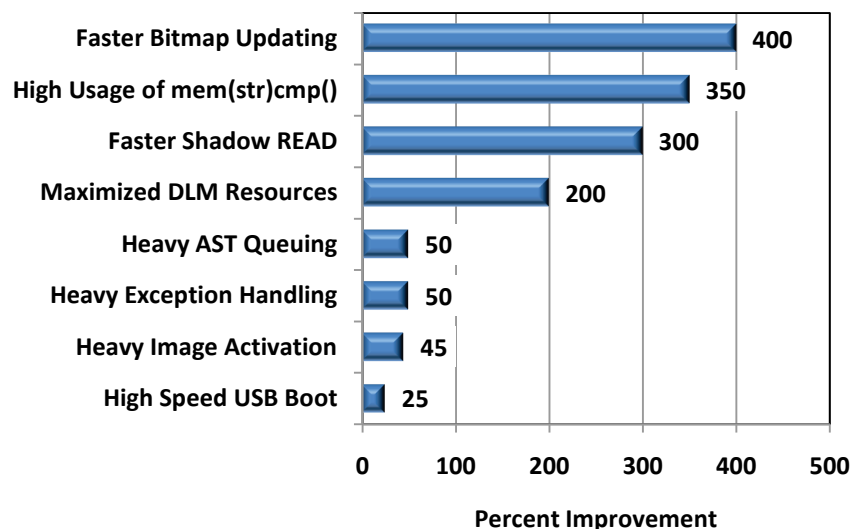
OpenVMS V8.4 includes many improvements that enhance performance when running on BL8x0c i2 server blades.

Several types of workloads improved by 200% or more compared to OpenVMS V8.3-1H1

- **Write BitMap (WBM) Shadow Driver:** SetBit Messages were changed from synchronous to asynchronous. The number of SetBit messages is also reduced by a factor of 10 for sequential I/O operations.
- **Memory/Strcmp Optimizations:** Added Memory/strcmp routine optimizations to take advantage of Itanium architecture on Integrity servers. This reduces compute time for memcmp/strcmp routines.
- **Shadow READ:** Increased the maximum number of shadow set members from three to six. Also improved utilization of controller read-ahead cache and added faster access to read-only data.
- **Dedicated CPU Lock Manager (DLM):** New pre-fetch instructions on the LCKRQ buffer and ability of DLM to operate on more than a single LCKRQ packet per acquire of the LCKMGR spinlock. This benefits applications like relational databases.
- **AST Queuing:** Deferred SCHED Asynchronous System Trap (AST) Queuing enhancements that address high contention on processing resources.
- **Exception Handling:** Multiple optimizations to exception handling increase the performance of applications that use this feature.
- **Image Activation:** Changes were made to optimize the spin lock contention by reducing I-cache flushes. These changes impact performance of applications that do many image activations.
- **High Speed USB Boot** - OpenVMS V8.4 adds support for this.

The chart below quantifies on a percentage basis the impact these changes have on performance when compared to OpenVMS V8.3-1H1.

OpenVMS V8.4 Performance Results



Source: HP

Highlights

OpenVMS V8.4 includes two key improvements to the Shadow feature - support for up to six members and Shadow Split Read LBN.

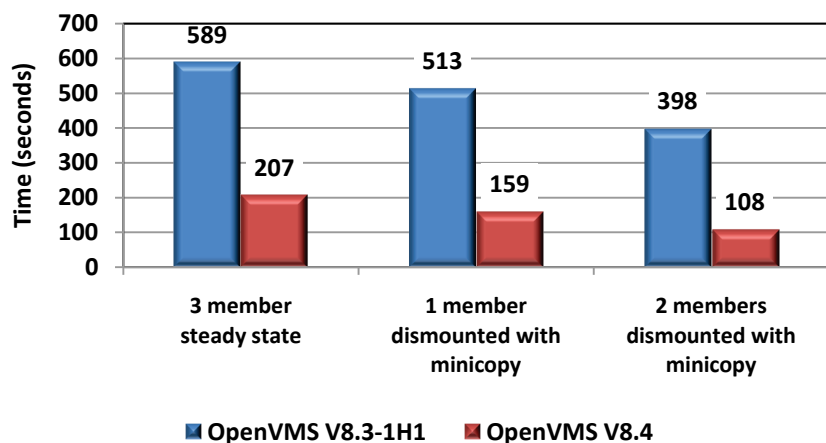
MiniCopy and MiniMerge are 3-4x faster, depending on the number of dismounted members.

Data access is 2-3x faster with six members, depending on the number of GB.

Several performance features and enhancements were added in the SHADOW feature of OpenVMS V8.4. The following chart illustrates the performance gains in MiniCopy and MiniMerge. This test involved a three node Integrity cluster with EVA8100 storage systems. Each node was located 10 kilometers apart. The system is tested in steady state with all three members as well as with one or two members dismounted. The test used a COPY command to read and write files from the shadow device. The total time to complete the whole operation was compared against each scenario mentioned below in graphs with V8.4 and V8.3-1H1. The results show that OpenVMS V8.4 provides 3-4x faster results than OpenVMS V8.3-1H1.

MiniCopy and MiniMerge Performance

(Less is Better)

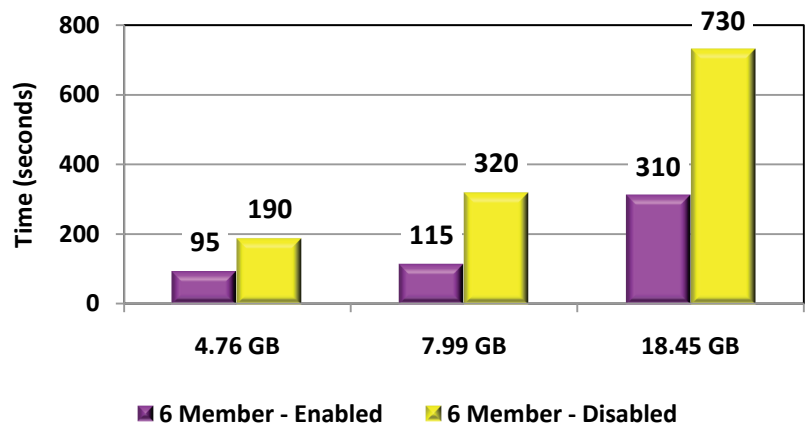


Source: HP

The following chart illustrates the impact of utilizing OpenVMS V8.4's ability to support six members and the Shadow Split Read LBN feature. Data access is 2-3x faster with six members, depending on the number of GB.

Shadow Split Read LBN

(Less is Better)



Source: HP

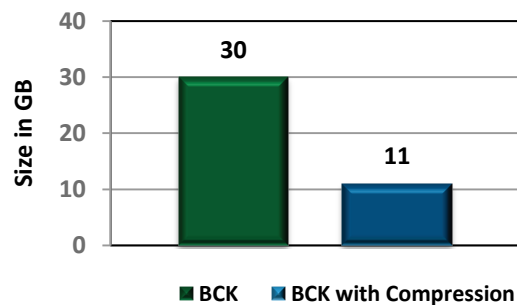
Highlights

OpenVMS V8.4 also includes two key improvements to BACKUP - support for volumes up to 2TB and ability to generate compressed savesets.

In one test image size was compressed by 272%. The amount of compression will depend on the type of data.

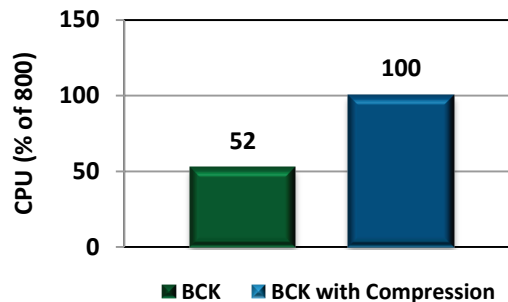
Finally, OpenVMS V8.4 includes several enhancements regarding backup. First, the maximum volume size supported increased from 1TB to 2TB. Second, BACKUP can now generate compressed savesets to disk or tape. Adding support for compression results in lower storage requirements for savesets, faster restoration of savesets, and overall improved performance. The charts below illustrate the impact data compression has when backing up a 30GB file to a LTO4 drive. The image size was compressed by 272% and the CPU usage doubled. Note, the amount of compression will vary depending on the type of data being compressed.

Size of Saveset
(Less is Better)



Source: HP

CPU Usage



Source: HP

A complete list of OpenVMS V8.4 enhancements may be found on HP's website at: http://h71000.www7.hp.com/openvms/v84_features.html. Companies currently running OpenVMS V8.3 should note that applications that run on OpenVMS V8.3 will also run on OpenVMS V8.4 due to binary compatibility of applications.

Application Performance Tests

Much of data presented so far is abstract in nature. As important as integer and floating point operations are, servers are not used to run benchmark tests. In the final section of this paper, we will present performance test results with four different real-world applications: Apache, Rdb, Java, and Oracle 10gR2.

Highlights

In terms of Apache, the BL860c i2 provides a 95% improvement in the number of requests per second compared to the BL860c.

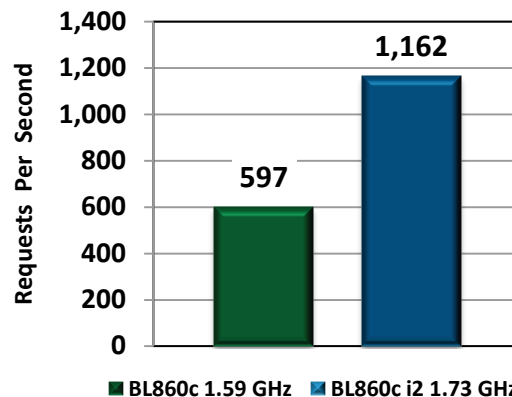
Apache clients should see a significant benefit in systems that include Flex-10 Capable VC Blade modules

Apache

ApacheBench(ab) is a tool for benchmarking Apache Hypertext Transfer Protocol (HTTP) servers. It shows how many requests per second the server is capable of serving. In this particular test, the client system was used to simulate a high number of simultaneous requests to Apache Servers running on BL860c and BL860c i2 blades, respectively. Both of these blades were connected across 1Gb Ethernet infrastructure. The per processor (socket) performance is depicted in the chart below. Apache clients should see a significant benefit in systems that include Flex-10 Capable VC Blade modules.

Apache Throughput Test

(More is better)



Source: HP

The above chart shows that the throughput (requests per second) increased by 95% with the new BL860c i2. This test was run on OpenVMS V8.4 using Apache 2.0.52. The new BL860c i2 was configured with a 1.73 GHz quad-core processor while the older BL860c was configured with a 1.59 GHz dual-core processor.

Highlights

In an Rdb test, the BL890c i2 performed double the number of transactions per second as the rx8640.

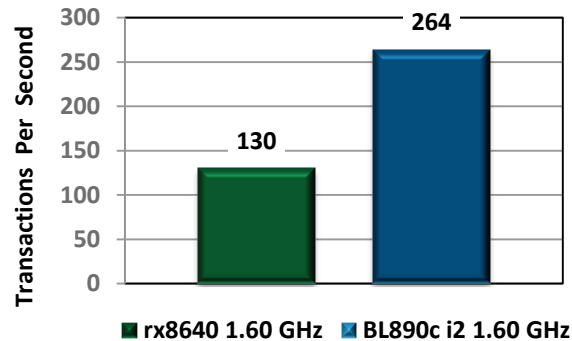
Similarly, the BL890c i2 can complete a transaction in half the times as an rx8640. In both tests Rdb utilized the hyper-threading built into BL8x0c i2 server blades.

Rdb

According to JCC Consulting, many factors influence the performance of an Rdb database including query execution times, update speed, concurrency issues, numbers of indexes, physical health and quality of storage areas, and system I/O performance. Rdb performance tests were run on the new BL890c i2 configured with one 1.60 GHz quad-core processor and 120GB of RAM and the rx8640 configured with one 1.60 GHz dual-core processor and 28GB RAM. Three versions of the T7.2-500 Rdb environment were tested including Oracle Rdb, SQL, and Rdb/Dispatch. The test runs a load with 100 jobs of 100000 txns/job. The DB was on single local disk to measure the within box performance. In this test, Rdb took advantage of hyper-threading on i2 servers. The chart below shows that the BL890c i2 has double the number of transactions per second as the rx8640.

Rdb Transactions per Second

(More is better)

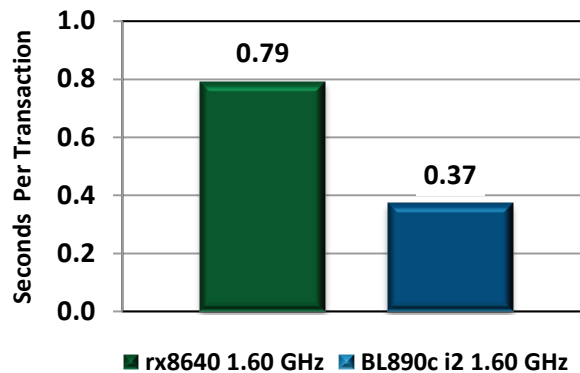


Source: HP

Similarly, the next chart illustrates that the BL890c i2 can complete a transaction in half the times as an rx8640. In both of these tests, Rdb took advantage of the hyper-threading built into BL8x0c i2 server blades.

Rdb Time per Transaction

(Less is better)



Source: HP

Highlights

Java Workloads are high CPU and Memory intensive.

Java tests can be analyzed in terms of maximum throughput or throughput at a set number of threads.

On a per processor (socket) basis, the maximum throughput of the BL860c i2 is up to 10.4x the AlphaServer ES45.

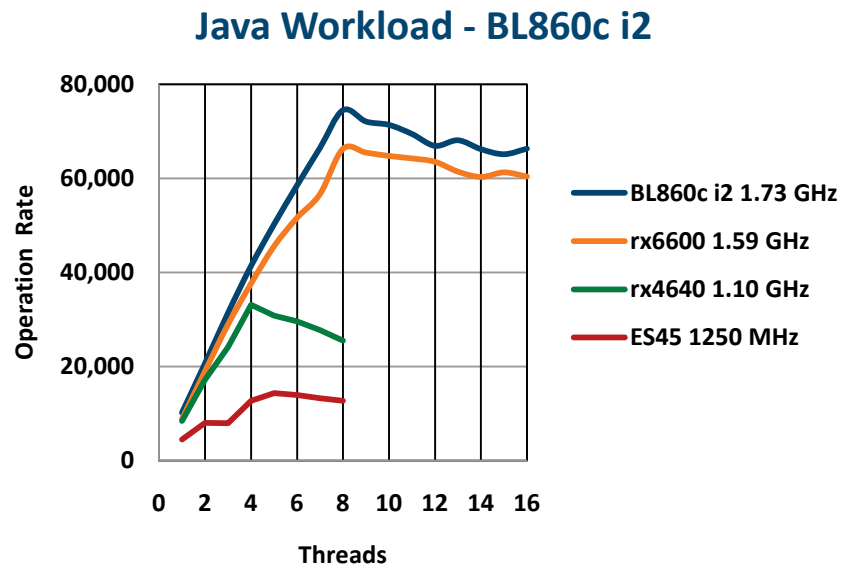
At 8 threads, the BL860c i2 is up to 11.7x the AlphaServer ES45 and up to 2.2x the rx6600.

Java

Java Workloads are high CPU and Memory intensive. The BL860c i2 was compared to three older systems. The system configurations for these four servers, all running OpenVMS V8.4, are as follows:

- BL860c i2 1.73 GHz / 6MB (2 chips / 8 cores)
- Integrity rx6600 1.59 GHz / 12MB (4 chips / 8 cores)
- Integrity rx4640 1.10 GHz / 4MB (2 chips / 4 cores)
- AlphaServer ES45 1250 MHz (4 chips / 4 cores)

The tests were run in default configurations with hyper-threading disabled. The Java Test creates threads up to twice the number of cores on a system. The 4-core ES45 and rx4640 have data up to 8 threads while the 8-core rx6600 and BL860c i2 data up to 16 threads. Test results are summarized in the chart below:



Source: HP

One way to interpret the above data is to compare each system's maximum throughput. Using the ES45 as the base, the rx4640, rx6600, and BL860c i2 servers' maximum throughput is up to 2.3x, 4.6x, and 5.2x of the AlphaServer ES45, respectively. On a per processor (socket) basis, the maximum throughput of the BL860c i2 is up to 10.4x the AlphaServer ES45.

The BL860c i2 and rx6600 both reach maximum throughput at 8 threads. The rx4640 and ES45, on the other hand, reach maximum throughput at 4 and 5 threads, respectively. Another way to interpret the data is to compare all four systems on a per processor (socket) basis at 8 threads. Using this approach, the BL860c i2's performance is up to 2.2x the rx6600, 2.9x the rx4640, and 11.7x the ES45.

Performance Benefits of OpenVMS v8.4 on BL8x0c i2

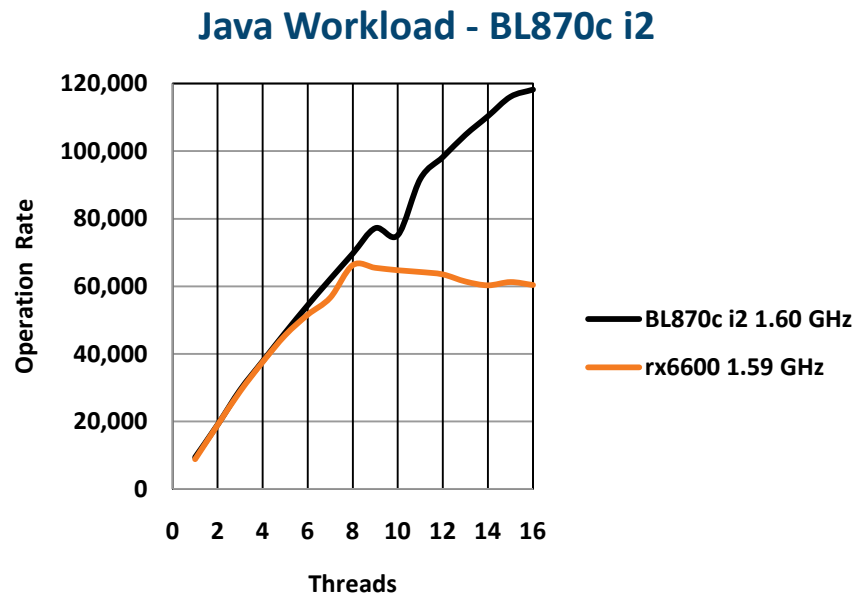
The BL870c i2 was also compared to an Integrity rx6600. The configurations for these two servers, both running OpenVMS V8.4, are as follows:

- BL870c i2 1.60 GHz / 6MB (4 chips / 16 cores)
- Integrity rx6600 1.59 GHz / 12MB (4 chips / 8 cores)

Highlights

On a per processor (socket) basis, the maximum throughput of the BL870c i2 is up to 1.8x the rx6600.

At 16 threads, the BL870c i2 is up to 2.0x the rx6600.



Source: HP

In terms of maximum throughput, the BL870c i2 servers' maximum throughput is up to 1.8x of the Integrity rx6600. Since both servers have four processors (sockets), the ratio is the same on a per processor (socket) basis.

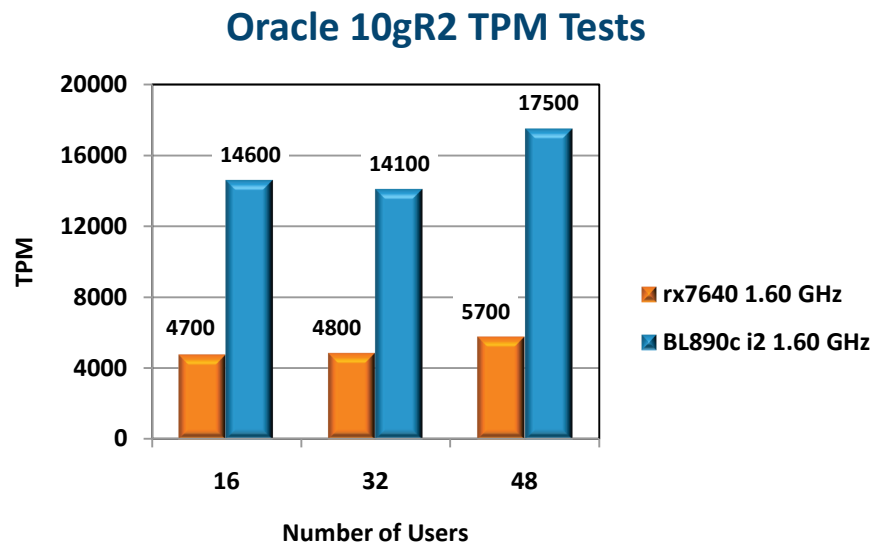
The rx6600 reaches maximum throughput at 8 threads while the BL870c i2 maximum throughput is at 16 or more threads. Comparing the two systems at 16 threads, the BL870c i2's performance is up to 2.0x the rx6600.

Highlights

The BL890c i2 server blade consistently shows up to 3x performance advantage over the rx7640 in the Oracle 10gR2 tests.

Oracle 10gR2

The final application-specific test analyzed is for Oracle 10gR2. This test compares the performance of an rx7640 and BL890c i2. The rx7640 has eight dual-core 1.60 GHz processor and 72GB of memory. The BL890c i2 has eight quad-core 1.60 GHz processor and 256GB of memory. Both servers have Oracle installed on local disk with the database files distributed over nearly 6 EVA 8100 disks. Both also have MostlyNuma RAD configured and HT disabled. Oracle was run in Shared Server Mode with 16, 32, and 48 users. The chart below summarizes the findings in transactions per minute.



Source: HP

The BL890c i2 server blade consistently shows 3x performance advantage over the rx7640 for the same numbers of users. Oracle took advantage of larger and faster shared memory allocation with optimized SGA as compared to the rx7640. The new blade architecture with performance benefits in BL890c i2 is an added advantage in driving the performance to same user load and CPU utilizations as rx7640.

Conclusion

This paper compares the performance of HP BL8x0c i2 server blades running OpenVMS V8.4 and older HP Integrity / AlphaServers running OpenVMS V8.3. Introduced in 2010, BL8x0c i2 server blades have many performance-enhancing features including quad-core Intel Itanium 9300 processors, 8x more memory capacity, faster DDR3 memory, faster PCIe bus, faster Memory and IO connectivity, higher scale out and scale within options with Blade Links and Flex-10 Technology, and 6x the memory bandwidth. The new server blades were tested using the Integer and Floating Point tests. In both tests, the new servers' test scores were more than double those of older Integrity servers with same number of processors (sockets). OpenVMS V8.4, also introduced in 2010, includes many enhancements that improve performance of various types of workloads when running on BL8x0c i2. The paper describes these enhancements and their impact on the performance. On a percentage basis, improvements ranged from 25% to 400%.



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All of the above results are, however, somewhat abstract. Companies evaluating a potential upgrade to BL8x0c i2 running OpenVMS V8.4 are more interested in real-world application performance. Four applications were tested using OpenVMS V8.4. The new BL8x0c i2 server blades provide 95% better throughput with Apache, double the number of transactions per second with Rdb, up to 10.4x per processor (socket) better performance than AlphaServer ES45 with Java Workloads, and up to 3x better performance running Oracle 10gR2. In addition, the BL870c i2 is up to 1.8x faster per processor (socket) with Java workloads than the rx6600.

From a TCO perspective, it usually makes sense to upgrade older OpenVMS environments to BL8x0c i2 running OpenVMS V8.4. A September 2010 TechWise paper entitled ***Total Cost of Upgrading HP OpenVMS Environments to HP Integrity i2 Server Blades*** shows that these upgrades typically pay for themselves in a year. This paper shows the upgrade also makes good sense from a performance perspective. Performance gains are so great that it may be possible to consolidate multiple older OpenVMS systems into fewer BL8x0c i2 server blades running OpenVMS V8.4.

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