

HP OSMS: MySQL Sizing Guide for HP ProLiant c-Class Blade Servers

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Introduction

HP Open Source Middleware Stacks (OSMS) offer building block applications, such as the Web Server; technical blueprints, and documents such as this MySQL Sizing Guide which describes the maximum MySQL workload that HP ProLiant c-Class Blade Servers are capable of supporting; and consulting services to speed the successful implementation of an open source strategy.

Executive Summary

The HP Open Source Integrated Portfolio (HP OSIP) comprises a range of products and services designed to verify that customers can successfully realize the cost and feature benefits of adopting open source software in their IT environments. HP Open Source foundation components include the base components of an open source-based ecosystem. HP servers and storage are validated to run the Linux operating system together with the supported commercial Linux distribution.

This results published in this document were achieved using the SysBench benchmark for each of the HP ProLiant c-Class Blade Servers. Various test configurations and test environments were used and documented to provide readers an opportunity to understand the testing methodology.

Intended Audience

The intended audience for this document is anyone who is interested in determining the number of database workload that can be supported on a given HP ProLiant c-Class Blade Server and details for deploying a hardware environment based on the database requirements of certain applications.

Scope and Purpose

This document presents the results of a series of benchmark tests performed using the SysBench software test suite. The tests were conducted running a MySQL database server to evaluate system performance when running a database under a heavy load. The following HP ProLiant servers were used in this test: BL460c, BL480c, BL465c, and BL685c. The benchmark data provided in this sizing guide can assist customers in determining which HP ProLiant c-Class Blade Server meets their MySQL database requirements along with how-to information for configuring the HP ProLiant c-Class Blade Server and storage in a specific production environment.

HP provides quality assurance from extensive integration testing with open source software and HP hardware so that you can confidently deploy the complete stack. Once you have completed a successful evaluation, you have the flexibility to “do it yourself” or get assistance from HP to incorporate open source stacks into your existing IT infrastructure.

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Typographic Conventions

This document uses the following typographic conventions.

Command	A command name or qualified command phrase.
ComputerOut	Text displayed by the computer.
Ctrl-x	A key sequence. A sequence such as Ctrl-x indicates that you must hold down the key labeled Ctrl while you press another key or button.
ENVIRONVAR	The name of an environment variable, for example, PATH.
[ERRORNAME]	The name of an error, usually returned in the <code>errno</code> variable.
Key	The name of a keyboard key. Return and Enter both refer to the same key.
Term	The defined use of an important word or phrase.
UserInput	Commands and other text that you type.
VARIABLE	The name of a placeholder in a command, function, or other syntax display that you replace with an actual value.
<code>\</code> (<i>continuation character</i>)	A backslash (<code>\</code>) at the end of a line of code (such as a command) indicates that the following line of code is contiguous, and you must not insert a line break. This convention facilitates the typesetting of long lines of code examples on a printed page. If you cut and paste sample code from this publication, ensure that you remove backslash characters at line endings.
...	The preceding element can be repeated an arbitrary number of times.
	Separates items in a list of choices.

Publishing History

The document publishing date and part number indicate the current edition of the document. The publishing date changes when a new edition is printed. Minor changes might be made without changing the publishing date. The document part number changes only when extensive changes are made. Document updates might be issued between editions to correct errors or document product changes. For the latest version of this document online, see the HP Technical Documentation website at:

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Benchmark Software

The SysBench test suite is an open source, cross-platform, multi-threaded benchmark tool for evaluating system performance when running a database under a heavy load. Depending on the options used, SysBench can be used to test the following system components:

- File I/O performance
- Scheduler performance
- Memory allocation and transfer speed
- POSIX threads implementation performance
- Database server performance (OLTP benchmark)

The results documented in this document were obtained using the SysBench test suite to generate results in an environment using the MySQL database server on ProLiant systems (x86_64) running RHEL. Table 1 lists the software versions used for the benchmark tests.

Table 1 Test Software Environment

Software	Website
SysBench version 0.4.8	http://sysbench.sourceforge.net/
Red Hat Enterprise Linux 5 AS Update 1 (RHEL5 AS u1)	N/A
MySQL database server version 5.0.46 (for an x86_64 system)	

This paper describes the results of overall database server performance based on the OLTP benchmark. Because this represents a transactional workload, the InnoDB storage engine was used for the MySQL database server. Four different servers from the HP ProLiant family were used for each of the OLTP tests. Each test was performed using read-only queries and then with read/write queries and a varied number of connections. Additionally, each of the tests were performed when the MySQL data files were located on the local attached storage (SAS), as well as Fibre Channel attached Storage Area Network (SAN) on an HP StorageWorks 1500 Modular Smart Array (MSA1500).

Hardware Test Environment

This benchmark was performed within an HP BladeSystem c-Class blade enclosure with enhanced backplane using C-GbE2 Network interconnect switches. Table 2 lists the specifications of the hardware test environment.

Table 2 Test Hardware Environment

Hardware	BL460c	BL465c	BL480c	BL685c
CPU	(2) Quad-Core Intel® Xeon® processor X5365 (3.0 GHz/4MB L2 cache per core)	(2) Dual-Core AMD Opteron™ processor 2218 (2.6 GHz/1MB L2 cache per core)	(2) Quad-Core Intel® Xeon® processor X5365 (3.0 GHz/4MB L2 cache per core)	(2) Dual-Core AMD Opteron processor Model 8218 (2.6 GHz/1MB L2 cache per core)
Memory	16GB (8x2GB PC2-5300 DDR2)	14GB (6x2GB+ 2x1GB PC2-5300 DDR2)	24GB (12x2GB PC2-5300 DDR2)	12GB (6x2GB PC2-5300 DDR2)
Disk Storage	2 x 73GB SAS Smart Array E200i controller with Battery Backed Write Cache (BBWC) and Fibre Channel attached MSA1500	2 x 73GB SAS Smart Array E200i controller with Battery Backed Write Cache (BBWC) and Fibre Channel attached MSA1500	4 x 73GB SAS Smart Array P400i controller with Battery Backed Write Cache (BBWC) and Fibre Channel attached MSA1500	2 x 73GB SAS Smart Array E200i controller with Battery Backed Write Cache (BBWC) and Fibre Channel attached MSA1500

Table 2 Test Hardware Environment (continued)

Hardware	BL460c	BL465c	BL480c	BL685c
File System Partitioning	(ext3 – no LVM): Disk0: /, /boot, swap Disk1: FC attach – 7 36GB disks 10k RPM, RAID 0	(ext3 – no LVM): Disk0: /, /boot, swap Disk1: FC attach – 7 36GB disks 10k RPM, RAID 0	(ext3 – no LVM): Disk0: /, /boot, swap Disk1: FC attach – 7 36GB disks 10k RPM, RAID 0	(ext3 – no LVM): Disk0: /, /boot, swap Disk1: FC attach – 7 36GB disks 10k RPM, RAID 0
Operating System	RHEL5 AS u1 SMP kernel (2.6.18-53.el5) with errata updates	RHEL5 AS u1 SMP kernel (2.6.18-53.el5) with errata updates	RHEL5 AS u1 SMP kernel (2.6.18-53.el5) with errata updates	RHEL5 AS u1 SMP kernel (2.6.18-53.el5) with errata updates

SysBench Configuration

The OLTP test mode emulates real database usage by issuing common SQL queries on typical table structures. SysBench populates the following table with `oltp-table-size` rows at the beginning of the test.

```
CREATE TABLE `sbtest` (
  `id` int(10) unsigned NOT NULL auto_increment,
  `k` int(10) unsigned NOT NULL default '0',
  `c` char(120) NOT NULL default '',
  `pad` char(60) NOT NULL default '',
  PRIMARY KEY (`id`),
  KEY `k` (`k`)
) ENGINE=InnoDB DEFAULT CHARSET=latin1
```

To test general purpose database performance, the *complex* test mode was used. The InnoDB storage engine supports ACID compliant transactions; therefore, the SysBench uses `BEGIN/COMMIT` statements around each of the transactions. Table 3 lists the SQL queries used in testing.

Table 3 SQL Queries

Type of Query	SQL Query Syntax
Point queries	<code>SELECT c FROM sbtest WHERE id=N</code>
Range queries	<code>SELECT c FROM sbtest WHERE id BETWEEN N and M</code>
Range SUM() queries	<code>SELECT SUM(c) FROM sbtest WHERE id BETWEEN N AND M</code>
Ordered range queries	<code>SELECT c FROM sbtest WHERE id BETWEEN N AND M ORDER BY c</code>
Distinct range queries	<code>SELECT DISTINCT c FROM sbtest WHERE id BETWEEN N AND M ORDER BY c</code>
Updates on indexed column	<code>UPDATE sbtest SET k=k+1 WHERE id=N</code>
Updates on non-index column	<code>UPDATE sbtest SET c=N WHERE id=N</code>
Delete queries	<code>DELETE FROM sbtest WHERE id=N</code>
Insert queries	<code>INSERT INTO sbtest VALUES (...)</code>

Table 4 lists the configuration options that were used for SysBench.

Table 4 SysBench Options

SysBench option	Value	Description
--test	oltp	OLTP emulates operations that a read database would perform. Other options are CPU, threads, mutex, memory, and fileio.
--oltp-table-size	1000000	Sets the number of rows in the test table.
--mysql-engine-trx	yes	Sets the value for whether the storage engine used is transactional.
--oltp-test-mode	complex	Determines how transactions are performed. Options are simple (very simple SELECTs), complex (transactional), and nontrx (non-transactional).
--oltp-read-only	on/off	Sets whether the UPDATE/DELETE/INSERT queries are used. Both cases were run for these tests.
--oltp-dist-type	special	Allows for the distribution of random numbers
--max-requests	0	Sets the total number of requests allowed. The value "0" indicates unlimited requests are allowed.
--num-threads	varied from 1 to 128	Sets the number of worker threads.
--init-rng	on	Initializes the random number generator.
--max-time	180	Sets the limit for total execution time in seconds.

MySQL Installation

The MySQL Certified Software, downloaded from the MySQL Network, provides the `mysql-enterprise-gpl-5.0.46-0.rhel5.x86_64.tar` file for RHEL5 on x86_64 servers. Table 5 lists the components contained in the tar file.

Table 5 MySQL Installation Packages

RPM Package	Description
<code>MySQL-server-enterprise-gpl-5.0.46-0.rhel5.x86_64.rpm</code>	MySQL database server (mysqld, etc)
<code>MySQL-client-enterprise-gpl-5.0.46-0.rhel5.x86_64.rpm</code>	MySQL client programs (mysql, mysqladmin, etc)
<code>MySQL-devel-enterprise-gpl-5.0.46-0.rhel5.x86_64.rpm</code>	MySQL header files and libraries (needed to build SysBench)

MySQL Configuration

The example configuration file (`my-large.cnf`) that is provided with the MySQL database server, was used as the basis of the `my.cnf` test file. Table 6 lists the changes that were made to the `mysqld` configuration.

Table 6 MySQL Test Configuration

mysqld Option	Value	Description
<code>max_connections</code>	1600	Maximum number of connections. The default is 100.
<code>max_connect_errors</code>	10	Number of interrupted connections from a host after which connections are blocked.
<code>table_cache</code>	2048	Number of open tables for all threads. The default is 512.
<code>sort_buffer_size</code>	512K	Buffer size for each thread that needs to sort results. Increase for faster ORDER BY and GROUP BY operations.
<code>binlog_cache_size</code>	1M	Size of cache to hold SQL statements for the binary log during a transaction. Increase for large, multiple-statement transactions.

Table 6 MySQL Test Configuration *(continued)*

mysqld Option	Value	Description
join_buffer_size	1M	Buffer size for joins that do not use indices and require a full table scan.
thread_cache_size	16	Number of server threads to cache for reuse.
thread_stack	192K	Per-thread stack size. The default is 192K.
query_cache_size	0	Amount of memory allocated for caching query results. The value "0" disables query cache.
ft_min_word_len	4	Minimum length of the word to be included in a full-text index.
tmp_table_size	64M	Maximum size of in-memory temp tables. Increase for GROUP BY.
innodb_data_file_path	ibdata1:100M\ :autoextend	Path to innodb data files and sizes. Increase size from 10MB to 100MB.
innodb_buffer_pool_size	1900M	Number of bytes of the memory buffer to cache data and indices.
innodb_additional_mem_pool_size	20M	Number of bytes of memory pool used to store the data dictionary information and data structures. The default is 1M.
innodb_log_file_size	900M	Size of each log file in log group. The default is 5MB.
innodb_flush_log_at_trx_commit	2	Determines how the log buffer is written to the disk. The value "2" means data is flushed on every commit, but no disk flush occurs. The default is 1.
innodb_locks_unsafe_for_binlog	1	Controls next-key locking in search and index scans. The default is 0 (disabled).
innodb_thread_concurrency	1000	Number of threads currently inside the innodb engine. The default varies with the MySQL version.
innodb_concurrency_tickets	500	Number of 'free tickets' to allow re-entry into the innodb engine.
InnoDB_log_buffer_size	8M	The size of buffer InnoDB used in the memory to write the log files. Ranges from 1MB to 8MB. Large log buffer saves disk I/O operations.
innodb_table_locks	0	Specifies whether InnoDB locks a table internally. The default is 1 (enabled).
innodb_support_xa	0	Specifies whether InnoDB supports XA transactions. The default is 1 (supported).
innodb_doublewrite	skip-innodb-doublewrite	InnoDB stores all data twice by default. Disable it by using the --skip-innodb-doublewrite parameter when starting the MySQL server.
innodb_checksums	skip-innodb-checksums	Checksum validation is used on all data pages by default. Disable it by using the --skip-innodb-checksums parameter when starting the MySQL server.

Benchmark Results

For each read-only or read/write test, SysBench was run with a varying number of thread connections to determine the maximum transactions per second (tps). The tests were conducted on both the internal storage with the battery backed write cache option (BBWC) and the Fibre Channel attached Storage Area Network.

Depending on whether the application requires many read/write queries, it may help to set the database connection pool to the number of processing cores. For read-only testing, all HP ProLiant c-Class Blade Servers in the test can still handle almost the same number of transactions even though the number of concurrent threads is double the number of processing cores. Therefore, more database connections than the number of processing cores for read-only applications can be used.



NOTE: For read/write testing, the maximum performance (shown in bold in the following result tables) was achieved when the number of concurrent threads was the same as the total number of processing cores in the system.

Interpreting the Data

The results of the testing are presented in the following sections and show the maximum number of tps that each of the systems can handle, depending on the number of threads. The precise database query load and mix of queries that an application generates vary greatly between applications. Another important consideration in the benchmark testing was how many concurrent connections the application had with the database server. The results in the data tables show that having more connections can negatively impact the throughput.

If an application requires 1200 read/write tps from 16 database connections, all of the HP ProLiant c-Class Blade Servers used in these tests are suitable because all of the test servers can handle at least 1245 tps. For read-only applications that require 2000 tps using eight database connections, both the HP ProLiant BL465c and BL685c servers, configured with 2 Dual-Core Opteron processors, are suitable having a capacity of 2500 tps. The ProLiant BL460c server and BL480c server, configured with 2 Quad-Core Xeon processors, can handle a maximum of 4500 read-only tps and 3000 read/write tps. For an application that requires more than 4500 read-only or more than 3000 read/write tps, consideration should be given to using MySQL Replication and spreading the load across multiple ProLiant servers.

HP ProLiant BL460c Server

The HP ProLiant BL460c server has features that are equal to standard 1U rack-mount servers. The two-processor, dual-core or quad-core ProLiant BL460c combines power-efficient compute power, and high density with expanded memory and I/O for maximum performance. The ProLiant c7000 enclosure supports up to 16 BL460c server blades, two more servers than the IBM BladeCenter, and each BL460c supports double the memory capacity of the HS21 server without an expansion blade. The ProLiant BL460c now comes with dual-core and quad-core Intel® Xeon® processors, DDR2 fully buffered DIMMs, Serial Attached SCSI (SAS) or Serial ATA (SATA), hard drives, and support of multi-function NICs and multiple I/O cards. The BL460c provides a performance system ideal for the full range of scale-out applications. In this small form factor, the BL460c includes more features to enable high-availability, such as hot plug hard drives, mirrored memory, online spare memory, memory interleaving, embedded RAID capability, and enhanced remote Lights-Out management. Table 7 provides the benchmark results that were obtained using a ProLiant BL460c server configured with two Quad-Core Intel® Xeon® processors running at 3.0GHz.



NOTE: Maximum performance appears in bold.

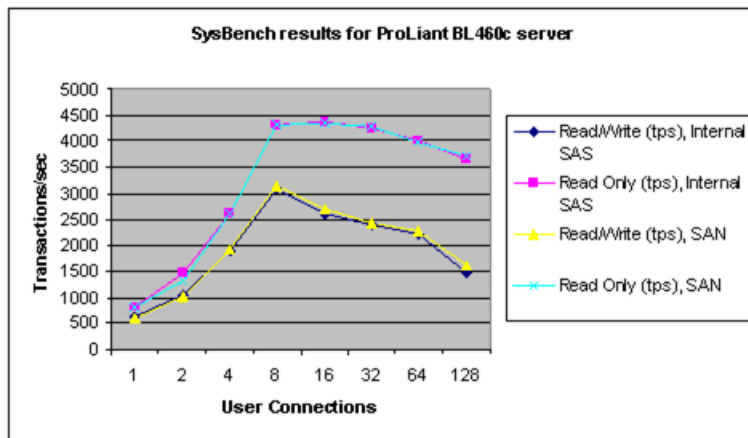
Table 7 SysBench Results for the HP ProLiant BL460c Server

Connections	Read/Write (tps) Internal SAS	Read Only (tps) Internal SAS	Read/Write (tps) Fibre Channel SAN	Read Only (tps) Fibre Channel SAN
1	624	794	610	809
2	1057	1454	1029	1330

Table 7 SysBench Results for the HP ProLiant BL460c Server (continued)

Connections	Read/Write (tps) Internal SAS	Read Only (tps) Internal SAS	Read/Write (tps) Fibre Channel SAN	Read Only (tps) Fibre Channel SAN
4	1893	2615	1910	2593
8	3088	4301	3145	4297
16	2604	4374	2690	4353
32	2382	4148	2423	4271
64	2220	4006	2271	3990
128	1478	3641	1626	3722

Figure 1 SysBench Results for the HP ProLiant BL460c Server



HP ProLiant BL465c Server

The HP ProLiant BL465c server is a two-way server blade designed for maximum compute density and power efficiencies. The small form factor accommodates two blades in each slot allowing for 16 servers in a standard 6u enclosure. Each CPU is a 95 Watt version of the Dual-Core AMD Opteron 2000 series processor, which gives the equivalent of four processing units per server. Up to 32GB of PC2-5300 DIMMs running at 667MHz is supported. Internal storage consists of two small form factor disk drives, either SAS or SATA attached to the integrated Smart Array E200i RAID controller with 64MB cache supporting RAID 0, 1. An optional StorageWorks SB40c storage blade provides connectivity to additional storage, supporting RAID 5, and ADG. The benchmark results in Table 8 were obtained with a ProLiant BL465c server configured with two Dual-Core Opteron processors running at 2.6 GHz.

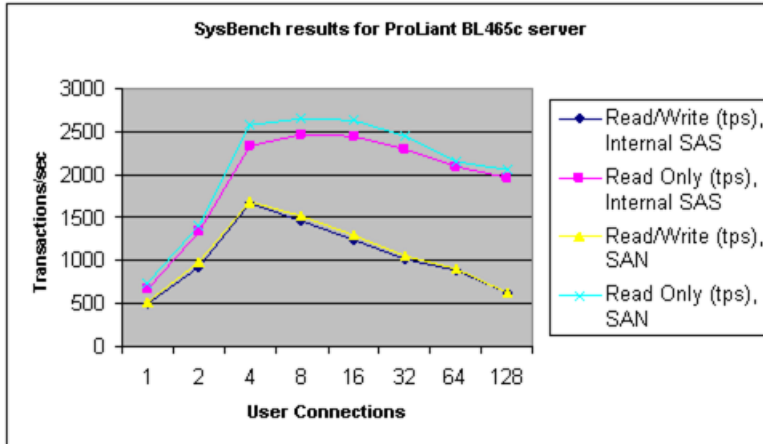
Table 8 SysBench Results for the HP ProLiant BL465c Server

Connections	Read/Write (tps), Internal SAS	Read Only (tps), Internal SAS	Read/Write (tps), Fibre Channel SAN	Read Only (tps), Fibre Channel SAN
1	497	664	514	746
2	931	1340	973	1415
4	1665	2341	1692	2568
8	1467	2455	1523	2640
16	1245	2437	1298	2621
32	1014	2302	1048	2445

Table 8 SysBench Results for the HP ProLiant BL465c Server (continued)

Connections	Read/Write (tps), Internal SAS	Read Only (tps), Internal SAS	Read/Write (tps), Fibre Channel SAN	Read Only (tps), Fibre Channel SAN
64	885	2097	911	2148
128	621	1962	630	2049

Figure 2 SysBench Results for the HP ProLiant BL465c Server



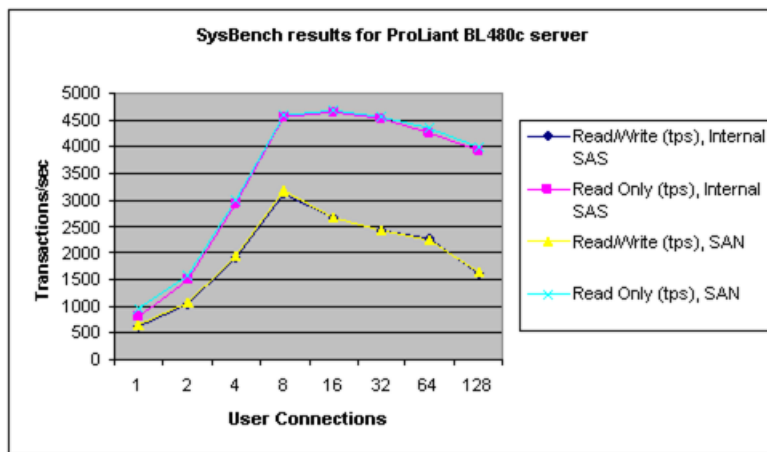
HP ProLiant BL480c Server

The HP ProLiant BL480c server is a 2-way server blade designed for maximum performance and scalability. The ProLiant BL480c server can support two Quad-Core Inter Xeon processors, which gives the equivalent of eight processing units per server. Up to 48GB (PC2-5300 DDR2, 667 MHz) of memory is supported. Each full-height blade has a Smart Array P400i Controller that supports four hot-swap SCSI disks in a RAID configuration. An optional dual-port Fiber Channel adapter provides connectivity to HP and third-party storage area networks (SANs). The benchmark results in Table 9 were obtained with a BL480c server configured with two Quad-Core Inter Xeon processors running at 3.0 GHz.

Table 9 SysBench Results for the HP ProLiant BL480c Server

Connections	Read/Write (tps), Internal SAS	Read Only (tps), Internal SAS	Read/Write (tps), Fibre Channel SAN	Read Only (tps), Fibre Channel SAN
1	628	817	650	944
2	1060	1494	1070	1573
4	1922	2939	1951	2987
8	3125	4544	3177	4588
16	2663	4635	2655	4682
32	2411	4533	2435	4551
64	2261	4260	2251	4333
128	1604	3926	1634	3986

Figure 3 SysBench Results for the HP ProLiant BL480c Server



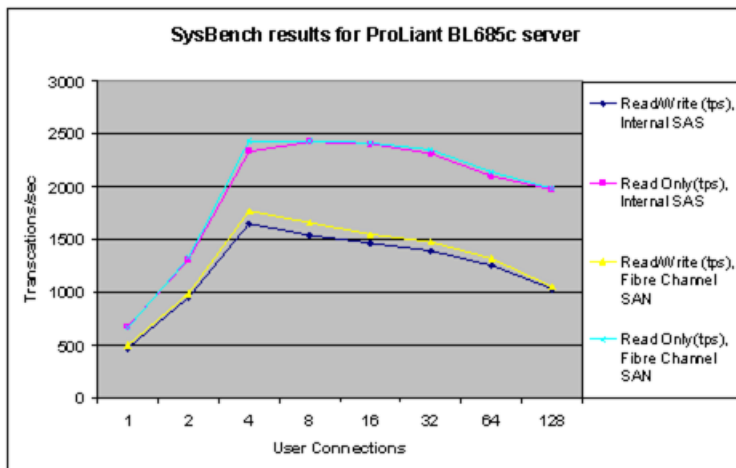
HP ProLiant BL685c Server

The HP ProLiant BL685c server blade delivers no-compromise performance and expansion in the densest four processor server blade form factor available. With up to four AMD Opteron™ 8000 Series processors, 64GB of DDR2 memory, two hot-plug Serial Attached SCSI (SAS) or Serial ATA (SATA) hard-drives, four embedded Gigabit NICs, and three I/O expansion slots, the HP ProLiant BL685c delivers the density you want with the performance you need to handle the most demanding enterprise class applications. Each blade server has a Smart Array E200i Controller that supports two hot-swap SCSI disks in a RAID configuration. Optional dual-port Fiber Channel adapter provides connectivity to HP and third-party storage area networks (SANs). The benchmark results are listed in Table 10, and were obtained using a ProLiant BL685c server configured with two Dual-Core Opteron processors running at 2.6 GHz.

Table 10 SysBench Results for the HP ProLiant BL685c Server

Connections	Read/Write (tps), Internal SAS	Read Only (tps), Internal SAS	Read/Write (tps), Fibre Channel SAN	Read Only (tps), Fibre Channel SAN
1	470	670	497	664
2	951	1307	984	1323
4	1650	2327	1770	2426
8	1540	2419	1655	2427
16	1463	2400	1548	2413
32	1385	2312	1468	2347
64	1247	2094	1319	2139
128	1034	1971	1050	1975

Figure 4 SysBench Results for the HP ProLiant BL685c Server

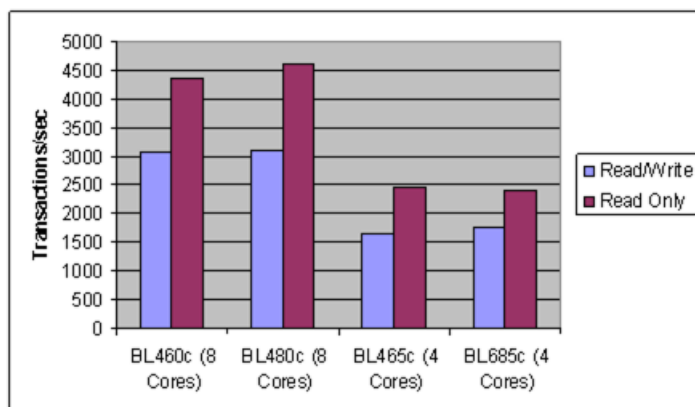


Summary

The results of the SysBench testing indicated that the HP ProLiant c-Class Blade Servers provide a solid platform for the MySQL database server. Along with the integrated Smart Array controller these servers provide the security of RAID storage to the host operating system and database files, while also offering excellent performance for many applications.

The results of the benchmarks tests are provided in Figure 5 and indicate that the HP ProLiant BL465c server is a good choice for an entry-level database server with scalability to SAN, as the size of the database grows. When higher performance levels are required from a single server, both the HP ProLiant BL460c and HP ProLiant BL480c servers (when configured with two Quad-Core processors) provided a good option for scalability.

Figure 5 Benchmark Test Results



The test results indicated that optimum price and performance could be achieved using a MySQL Replication configuration with a pair of HP ProLiant BL460c or BL480c servers with 8 cores in a high-availability cluster where HP ProLiant c-Class Blade Servers acted as the MySQL master database server. This, combined with a number of ProLiant BL465c servers acting as the MySQL slave database servers, provided a robust, scalable database environment within a single HP BladeSystem enclosure.

Resources

For additional information on the hardware and software used in the MySQL sizing tests, see the following websites:

HP and MySQL <http://h71028.www7.hp.com/enterprise/cache/77721-0-0-0-121.html>

MySQL <http://www.mysql.com>

HP BladeSystem <http://www.hp.com/go/bladeSystem/>

<http://h18004.www1.hp.com/products/blades/components/bladeservers.html>

HP ActiveAnswers for MySQL Database Server

<http://h71019.www7.hp.com/ActiveAnswers/cache/81882-0-0-0-121.html>

SysBench Benchmark Software <http://sysbench.sourceforge.net/>