



Assessing performance in HP LeftHand SANs

HP LeftHand Starter, Virtualization, and Multi-Site SANs deliver reliable, scalable, and predictable performance

White paper

Introduction	2
The advantages of HP LeftHand SANs	2
Building robust storage clusters	3
An overview of each SAN	3
Technical specifications	4
Performance tuning tips	4
Network best practices	4
Disk formatting best practices	4
Storage node configuration best practices	4
Real-world application benchmarks	5
Performance test environment for realistic application benchmarks	5
Maximum performance metrics (cache hit performance)	5
Benchmark values	5
Microsoft SQLIOStress	6
Microsoft Exchange Jetstress	6
File copy using Robust File Copy	6
IOmeter	6
HP LeftHand Starter SAN performance results (SATA)	7
HP LeftHand Starter SAN performance results (SAS)	10
HP LeftHand Virtualization SAN performance results	13
HP LeftHand Multi-Site SAN performance results	16
Conclusion	19
For more information	19

Introduction

Organizations today need to manage a staggering amount of data. In many businesses, data volumes are growing by more than 100 percent per year. Data is the lifeblood of business. Consequently, reliable data protection and effective disaster recovery are among the most important challenges facing organizations today.

Equally important is the ability to keep data online and continuously available. Continuous availability is usually accomplished through the use of redundant server and storage components, such as clustered application servers and storage area networks (SAN). SANs capable of high availability (HA) eliminate single points of failure and help ensure that resources are online and available to any server, regardless of their location on the network.

For many enterprise production and virtualization environments, disaster-recovery capabilities are no longer a luxury; they're a necessity. SANs help organizations address the need for efficient remote replication—in direct contrast to the difficult-to-manage, haphazard silos of information that are often created by direct attached storage.

Using server virtualization, organizations can pool and share technology resources so that supply meets demand—and they can then use these resources to host and scale applications instantaneously. The SAN can bring corresponding flexibility to storage, enabling organizations to decouple the scaling of servers from storage and draw on a pool of storage that can be shared by the entire server infrastructure.

The advantages of HP LeftHand SANs

HP LeftHand P4000 SAN solutions deliver enterprise functionality that enhances virtual environments, simplifies management, and reduces costs. Easy to deploy, scale, and maintain, HP P4000 SANs help ensure that crucial business data remains available. Their innovative approach to storage provides unique double-fault protection across the entire SAN, reducing vulnerability without driving up costs as traditional SANs can.

HP LeftHand SANs run HP SAN/iQ[®] Software—which delivers enterprise-class SAN functionality—on reliable, cost-effective HP servers. When these industry-standard systems, equipped with high-performance disk drives, processing elements, cache, and controllers, are used for HP LeftHand SANs, the resulting storage cluster can scale to higher performance levels and reliability than many purpose-built storage devices.

Because HP LeftHand SANs are based on iSCSI (SCSI over standard IP) protocols, you can use the standard iSCSI drivers that accompany server operating systems to access virtualized storage in a cluster, over standard IP networks. Built with superior architecture, HP LeftHand SANs are substantially more scalable, available, reliable, and high-performing than competing iSCSI SAN products.

HP LeftHand SANs use *true clustering*, which means that the entire SAN responds to a single IP address—and that every storage system in the cluster participates equally in sharing both the workload and the cluster's storage capacity. True clustering allows organizations to treat a cluster as a single entity whose resources can be scaled and configured as needed. Doing so delivers the unique combination of performance and reliability that each application in a data center requires.

The range of HP LeftHand SANs includes:

- **HP LeftHand Starter SAN (SATA and SAS)**—Ideal for consolidating storage for Windows[®] or Linux servers, this SAN delivers all the features required to simplify storage—and to get you up and running quickly and cost-effectively.

- **HP LeftHand Virtualization SAN**—Ideal for virtualized environments, the HP P4500 SAS Virtualization SAN provides optimized shared storage enabling cost-effective high availability, scalable performance, and non-disruptive configuration changes.
- **HP LeftHand Multi-Site SAN**—Ideal for meeting high-availability needs, this robust, scalable, and highly available SAN storage solution can span multiple locations while still being managed as a single storage pool.

This white paper provides an overview of the performance characteristics that applications can expect with the HP LeftHand Starter, Virtualization, and Multi-Site SANs.

Building robust storage clusters

The architecture of HP LeftHand SAN allows you to add any number of expansion nodes to increase the size of the SAN. Increasing the number of expansion or storage nodes used in a SAN increases its total number of disks, processors, controllers, and network connections and adds cache—so performance scales along with capacity.

In addition, HP SAN/iQ Software's network RAID functionality dynamically load-balances data across the nodes in the SAN and eliminates bottlenecks as the SAN or cluster grows. Network RAID can dramatically increase data availability, because it leads to the striping and mirroring of data across multiple storage nodes. The disks, processors, controllers, network connections, and cache in the HP LeftHand Starter, Virtualization, and Multi-Site SANs were selected to maximize throughput, input/output operations per second (IOPS), and scalability.

An overview of each SAN

The HP LeftHand Starter SAN (SATA and SAS) lets you start small and keep your SAN system simple as you grow. The most scalable entry-level SAN available today, this is the perfect SAN for consolidating Windows® or Linux server storage. Buy only what you need today, knowing that your storage network can be scaled non-disruptively meet future performance and capacity needs.

The HP LeftHand Multi-Site SAN provides cost-effective, reliable, always-on data availability. This SAN comes complete with everything you need to deploy fully functional storage systems in two separate locations and manage them as a single SAN. Multi-site deployment provides protection against individual storage nodes going offline and keeps your data continuously available, even during complete failure of a rack, a building, or an entire site. The Multi-Site SAN is ideal for rolling out a highly available, virtualized IT infrastructure. Non-disruptive performance scalability helps you avoid bottlenecks and expensive controller upgrades. And a single, simple management interface for the two distinct sites allows configuration changes on the fly, with no downtime.

To extend the HP LeftHand Multi-Site SAN's high-availability capabilities to remote and branch offices, you can implement the Remote Office Solution Pack. This solution pack is certified with VMware Site Recovery Manager to deliver efficient, affordable SAN replication without requiring the purchase of additional hardware.

HP LeftHand Virtualization SAN provides enterprise-class reliability, high availability, and performance. Built on industry-standard Intel® chipsets, this SAN utilizes serial attached SCSI (SAS) drives to maximize performance and minimize response time in virtualized environments. The solution starts at 10.8 terabytes (TB) of raw storage, but can be easily expanded simply by adding Virtualization SAN Expansion Nodes.

All four HP LeftHand SANs include integrated replication capabilities, thin provisioning, and snapshots to simplify SAN management as the environment becomes more complex.

Technical specifications

	HP LeftHand Starter SAN (SATA)	HP LeftHand Starter SAN (SAS)	HP LeftHand Virtualization SAN	HP LeftHand Multi-Site SAN
Disk drives	16 SATA drives	16 SAS drives	24 (15k rpm SAS)	48 (15k rpm SAS)
Storage capacity/expandability	9 TB/108 TB	4.8 TB/96 TB	10.8 TB/216 TB	21.6 TB/432 TB
Storage controllers	Dual active/active load-balanced controllers	Dual active/active load-balanced controllers	Dual active/active load-balanced controllers	Dual active/active load-balanced controllers (per site)
Memory and cache	5 GB	5 GB	5 GB	10 GB
Network ports	Four 1Gb Ethernet	Four 1Gb Ethernet	Four 1Gb Ethernet	Eight 1Gb Ethernet
Power and cooling	Redundant	Redundant	Redundant	Redundant
Support, training, and installation	<ul style="list-style-type: none">• 3 years basic support• Remote installation assistance• SAN/iQ Software training	<ul style="list-style-type: none">• 3 years basic support• Remote installation assistance• SAN/iQ Software training	<ul style="list-style-type: none">• 3 years basic support• Remote installation assistance• SAN/iQ Software training	<ul style="list-style-type: none">• 3 years basic support• Remote installation assistance• SAN/iQ Software training

Performance tuning tips

Performance can be negatively impacted if the SAN is not configured properly. The following guidelines will help maximize the performance of the HP LeftHand SANs.

Network best practices

- Use Gigabit Ethernet switching infrastructure.
- Dedicate a separate IP subnet/VLAN to your HP LeftHand SAN.
- Use a secondary Gigabit Ethernet network interface card in servers attached to the Ethernet storage subnet for high availability and performance.
- If possible, attach all modules and application servers in the SAN to dual Gigabit switches for the storage networking for redundancy reasons—and make sure that the interconnect between the two switches is fast enough to handle any I/O requirements.
- Make sure that all switch ports and Ethernet adapters in the SAN are configured to run at full duplex Gigabit speeds.

Disk formatting best practices

- Use the default block size or allocation unit size except when a particular application specifies a different size. Microsoft® Exchange should be on volumes formatted with a block size of 4096 bytes.
- Create partitions starting at sector 128 to align the offset to 64 KB using Diskpar or Diskpart.

Storage node configuration best practices

- Bond networks interfaces for network redundancy and more bandwidth using adaptive load balancing (ALB).
- Use RAID level 5 or 10 for disk redundancy within storage modules.

- Enable SAN/iQ iSCSI load balancing for servers.
- Install the DSM software driver on your Windows servers to enable fault-tolerant paths to the SAN modules and increase available bandwidth for the SAN, boosting performance.

Real-world application benchmarks

Performance test environment for realistic application benchmarks

Performance data was gathered using enterprise-class servers with the following attributes:

- 2.8 GHz dual-core Intel Xeon® processor
- 4 GB RAM
- Dual Gigabit Ethernet network adapters (bonded using balance ALB)
- All equipment connected to the same Gigabit Ethernet switch

The HP LeftHand SAN configurations comprised a dedicated group of P4000 SANs whose features included the following:

- A single management group with a single cluster, including all storage modules
- Storage modules that were configured in RAID 5, with volumes further protected by SAN/iQ network RAID level 2 (two-way replication)
- iSCSI sessions that were load-balanced across the clusters using SAN/iQ iSCSI load balancing

The HP LeftHand SAN is designed to work on your existing Ethernet infrastructure. Separating the storage network from your corporate network is recommended in order to boost the solution's overall performance. For purposes of performance testing, the SAN network was isolated to a single broadcast domain (subnet) and had dedicated network interface cards for the storage traffic. A single 24-port Gigabit switch was used for all tests.

All disk volumes were configured using the Microsoft iSCSI Software Initiator Version 2.0.8. Volumes were mounted using the Windows Logical Disk Manager and formatted with NTFS using the default allocation unit size.

Maximum performance metrics (cache hit performance)

The maximum performance metrics data is used to show maximum performance limits of the SAN in an optimal scenario. While these numbers are often used as a basis of comparison between different storage vendors, they aren't representative of the workload typically found in production environments. The type of workload run against the SAN can dramatically affect performance numbers. The maximum performance metrics should be used for comparison against other SAN vendors rather than as a guideline for your specific needs. When sizing for your specific environment, HP advises using a benchmark that closely resembles your own data requirements.

Benchmark values

All of the following benchmarks were designed to help characterize the actual performance users can expect in similar production environments. Each benchmark measures different storage characteristics. Standard Microsoft SQL Server and Exchange benchmarks illustrate the expected performance in those application environments. The simple file copy benchmarks show throughput in megabytes per second (MB/s). The IOMeter benchmarks simulate IOPS (input/output operations per second) and throughput.

Microsoft SQLIOStress

The SQLIOStress utility was written and is maintained by the Microsoft SQL Server Escalation staff. Designed to help detect possible I/O path problems that would lead to Microsoft SQL Server data corruption or loss, it emulates various SQL Server database versions and types and reports on some basic benchmarks. It runs a minimum of five iterations. Only the third and fourth iterations should be used to compare performance, according to the SQLIOStress tool documentation; for purposes of this document, only the fourth iteration was used. The SQLIOStress test runs from only a single host and typically becomes CPU bound. The tool is not capable of scaling at the same rate as the SAN. Some scaling is achieved on a single host due to the lower latency in the SAN.

Best practice: Keep the data files and logs for SQL Server databases on separate volumes.

Microsoft Exchange Jetstress

The Jetstress tool allows administrators to verify the performance and stability of the disk subsystem before putting their Exchange server into a production environment. The tool reports back to the administrator with an HTML document that contains results and a PASS or FAIL for the overall test. A disk subsystem's PASS or FAIL is based strictly on whether specific test results do or do not fall within limits specified by Microsoft. Disk latency is the primary metric used by Jetstress for PASS/FAIL criteria. The values to pass are *log avg. disk sec/write*, *database page fault stalls*, and *database avg. disk sec/read*. Log average latency should be below 10 ms, database page fault stalls should always be 0, and database average read latency should be less than 20 ms. The HP LeftHand SAN uses an automated command-line version of Jetstress that increases threads until the test no longer passes and then records the IOPS of the last run that passed. The highest IOPS achieved while still passing is the value reported in this paper.

Best practice: Keep the e-mail database files and log files on separate volumes.

File copy using Robust File Copy

The file copy test is a straightforward Windows file copy. Using `robocopy.exe`, a file copy of one hundred 100 MB-sized files is done from direct attached storage (DAS) in the server to a volume on the SAN. For this test, a simple measurement of megabytes per second (MB/s) is taken. Robocopy (Robust File Copy) is included in the Windows resource kit. Individual file copy speeds are limited by the nature of low queue depth disk operations, but the architecture of an HP LeftHand SAN solution is capable of handling multiple file copy jobs simultaneously without degrading performance.

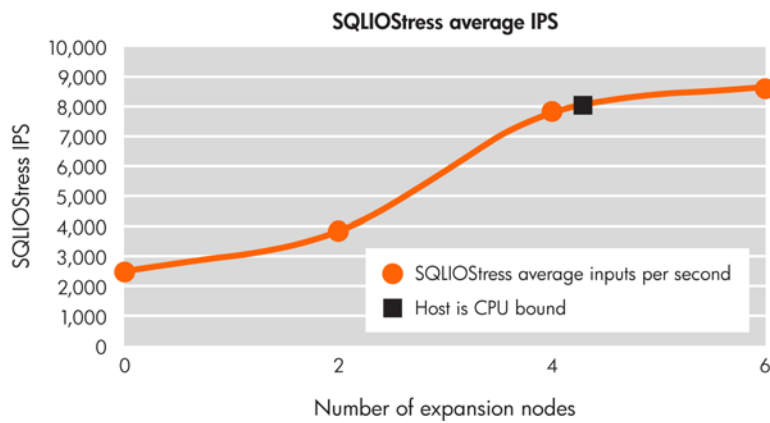
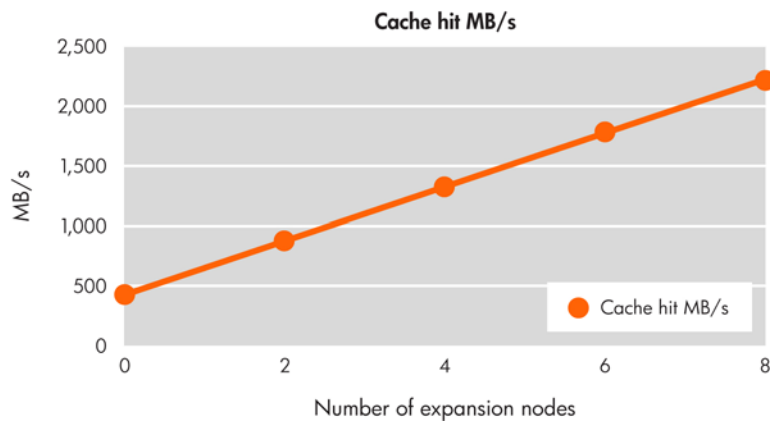
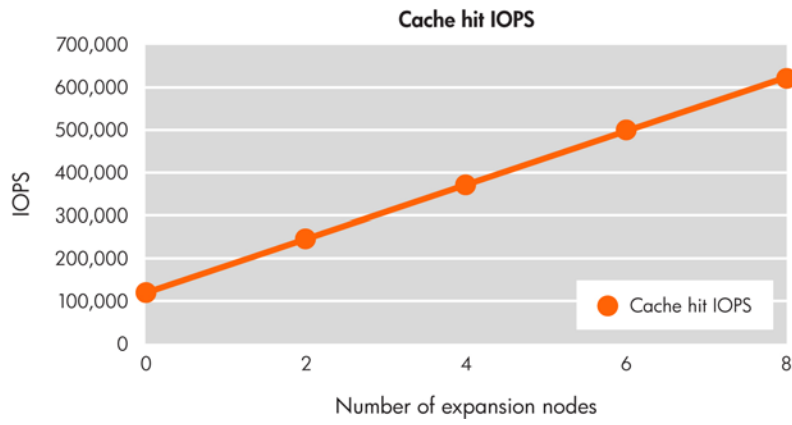
Best practices: When copying from DAS to the HP LeftHand iSCSI SAN, remember that the file copy cannot go any faster than the DAS disk. Make sure that the disk on which the source files reside is the fastest disk available to you—otherwise, file copy speed may be limited. Running multiple file copies at a time will increase aggregate performance.

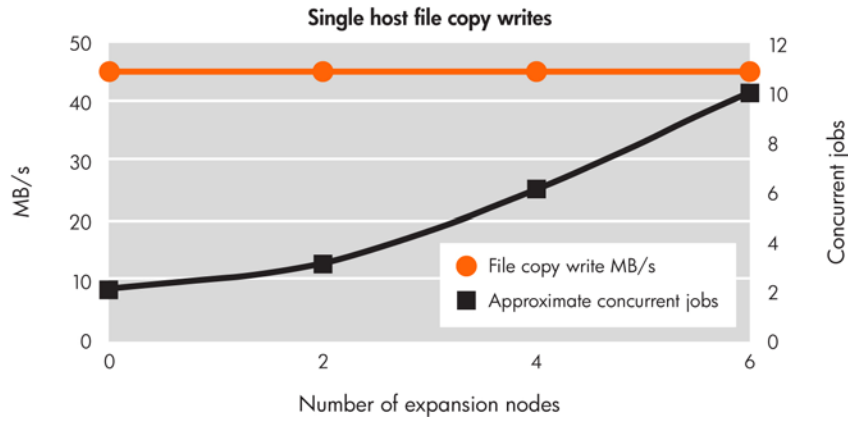
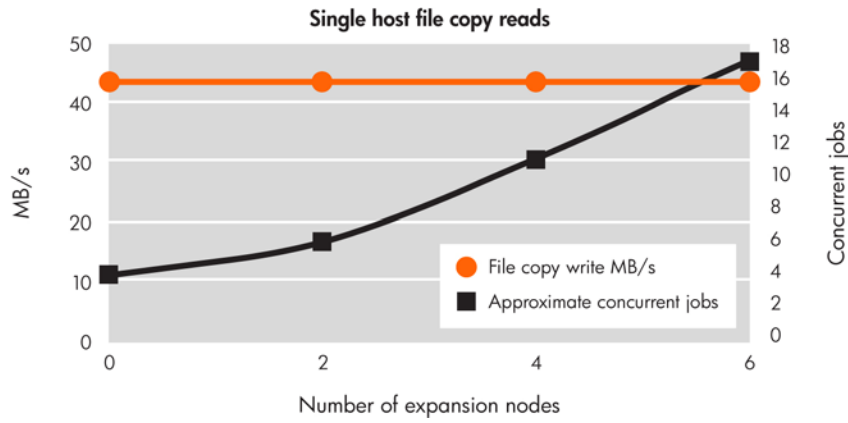
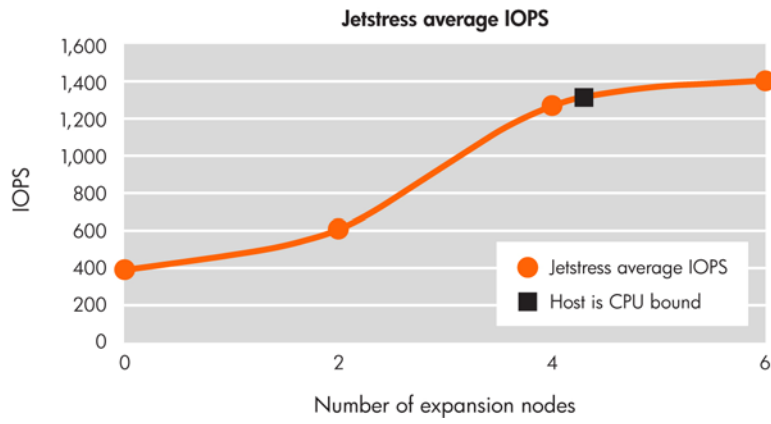
IOmeter

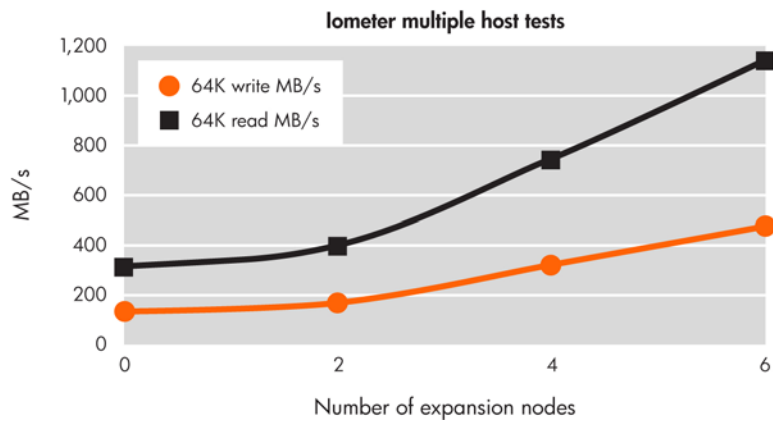
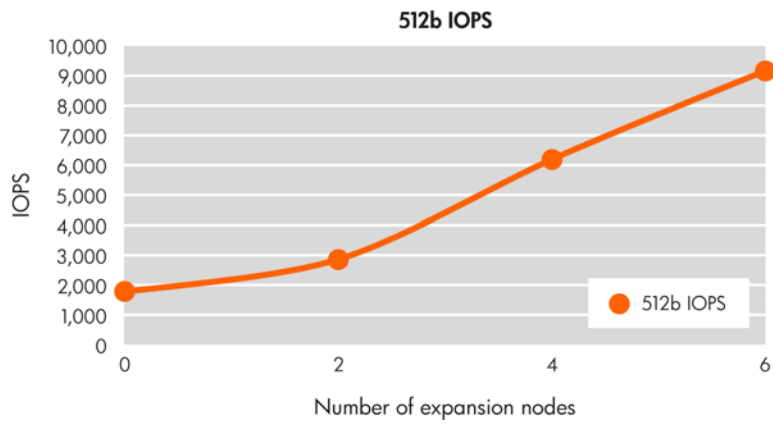
IOmeter is an I/O subsystem measurement and characterization tool. IOmeter is a good tool for simulating loads of different I/O sizes to demonstrate a system's IOPS and throughput capabilities. These configurations are designed to show typical speeds as opposed to the maximum values.

Best practices: Run IOmeter against raw disks to avoid file system cache interference.

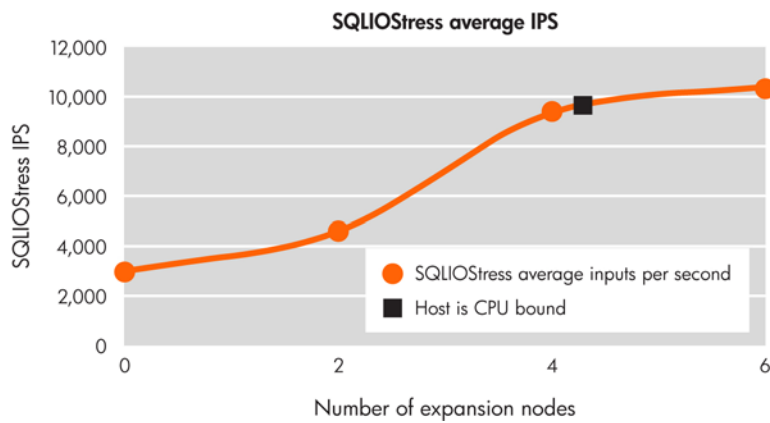
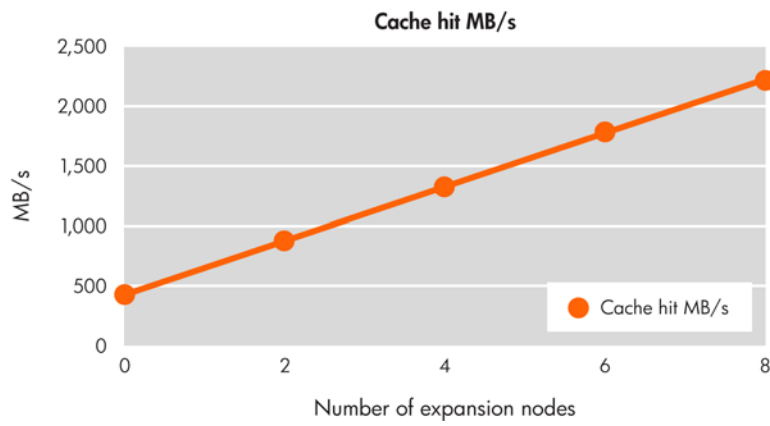
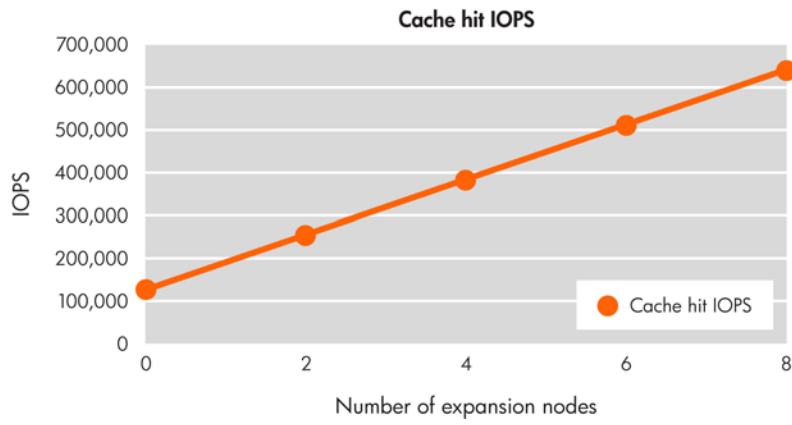
HP LeftHand Starter SAN performance results (SATA)

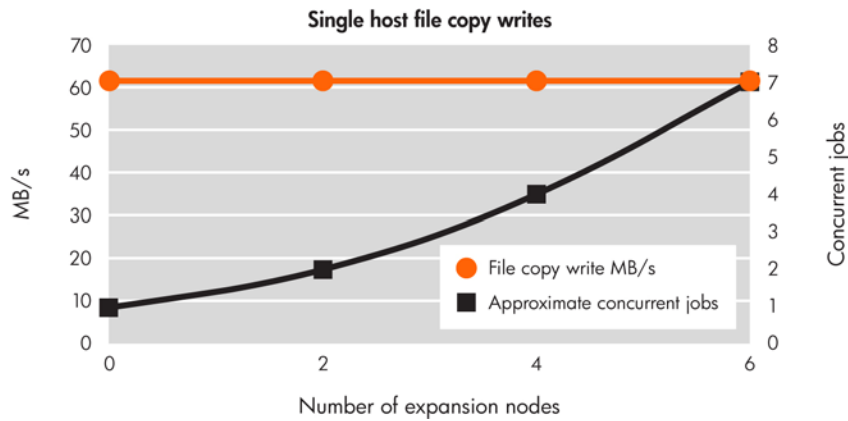
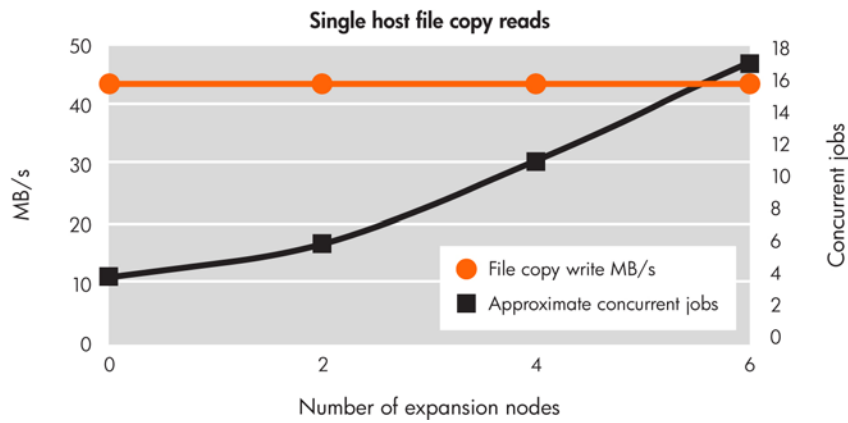
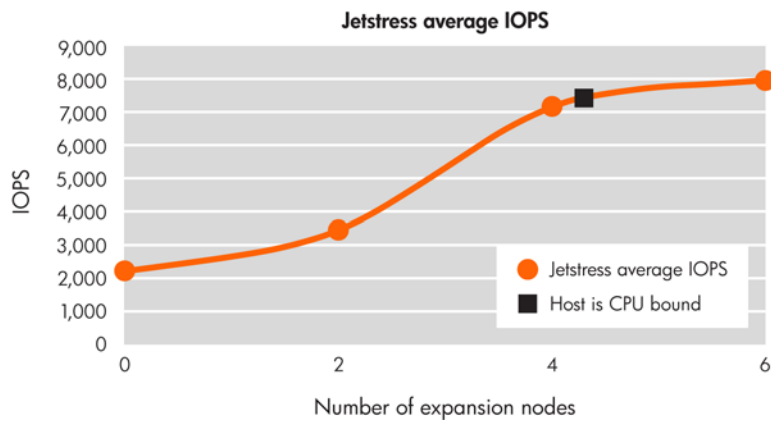


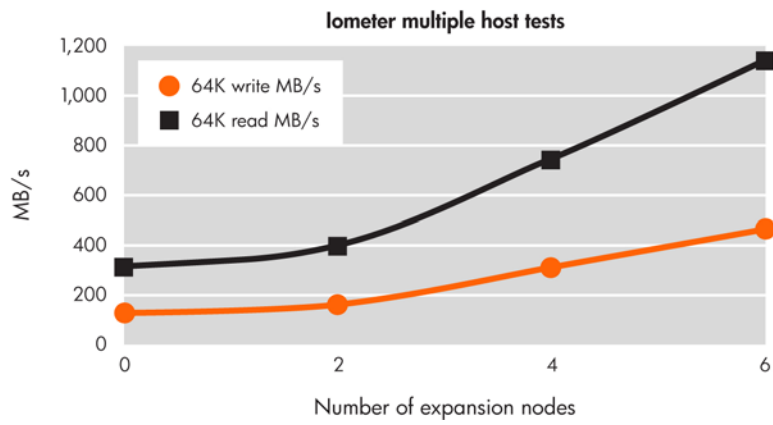
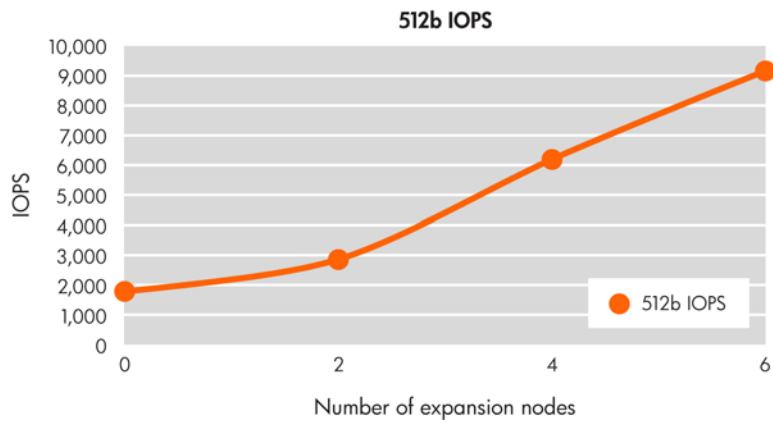




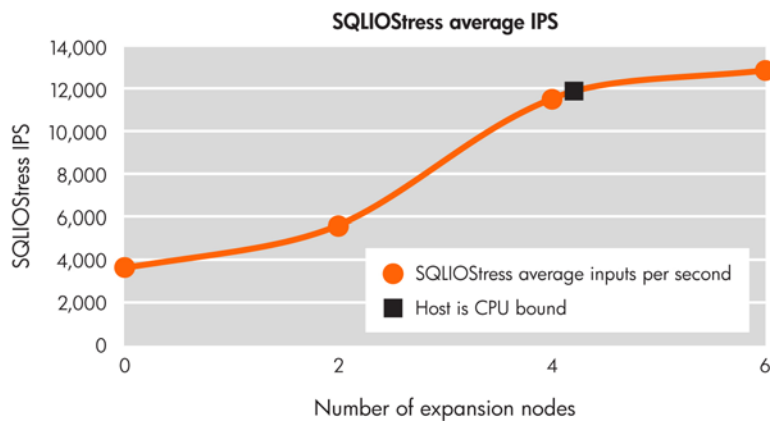
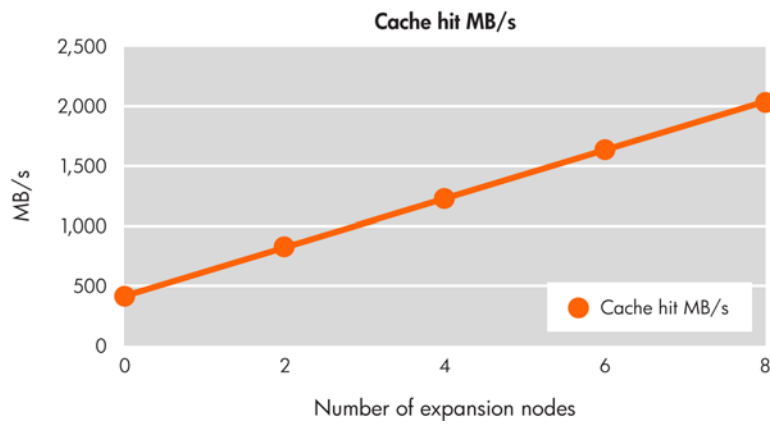
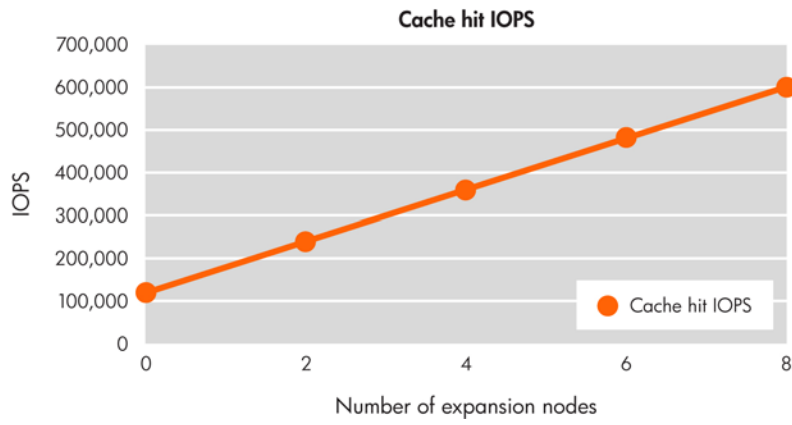
HP LeftHand Starter SAN performance results (SAS)

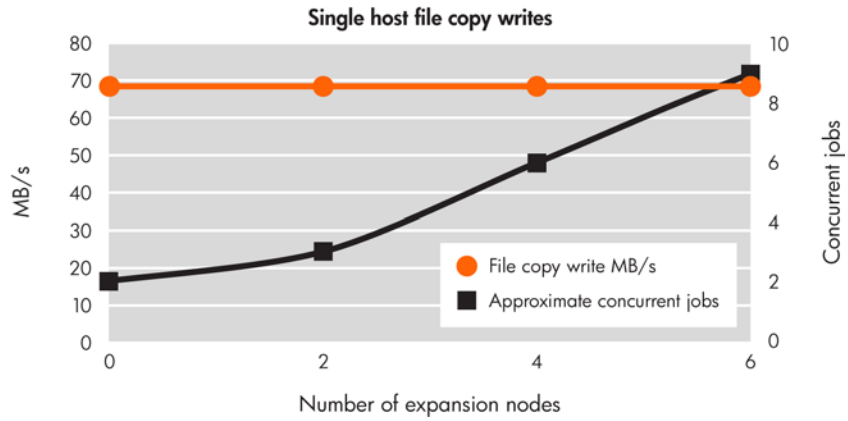
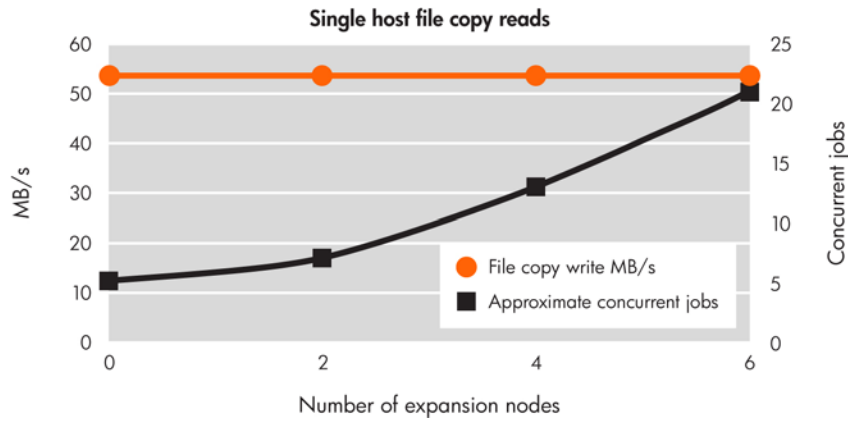
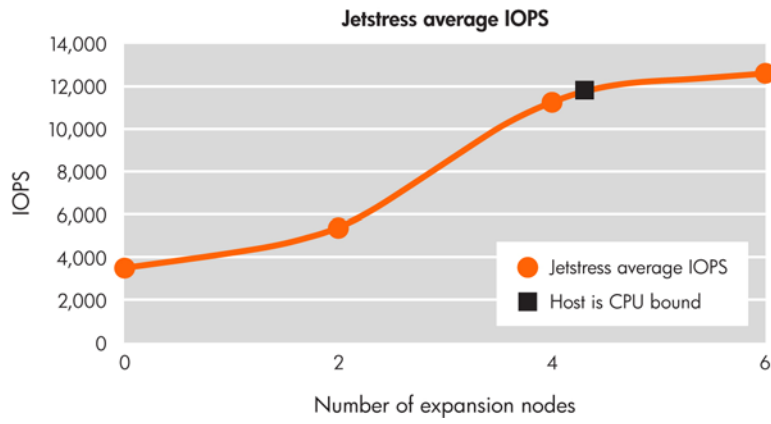


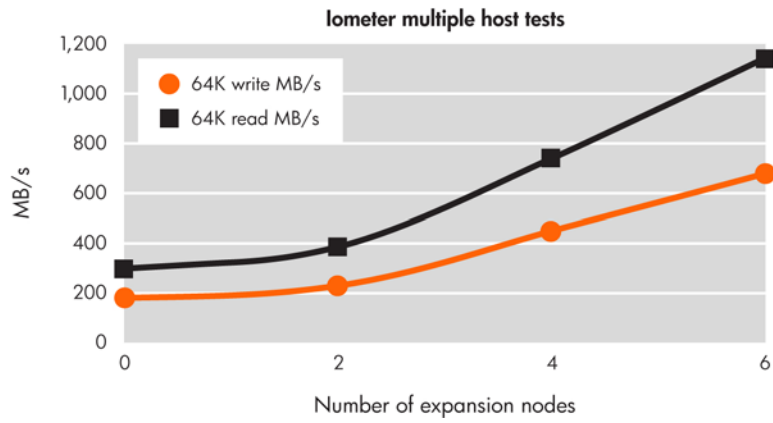
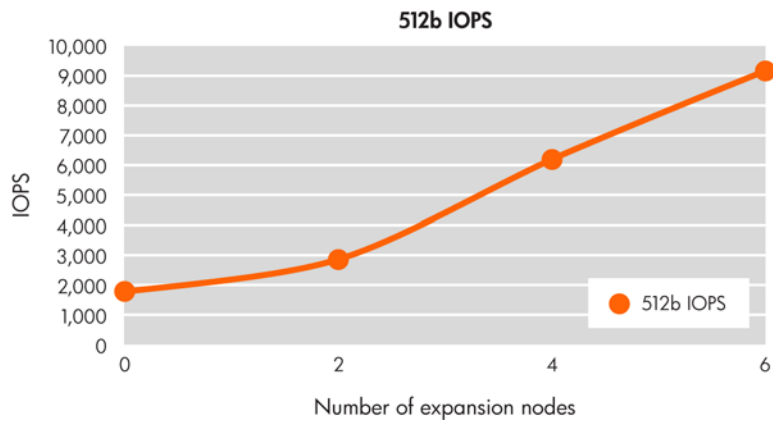




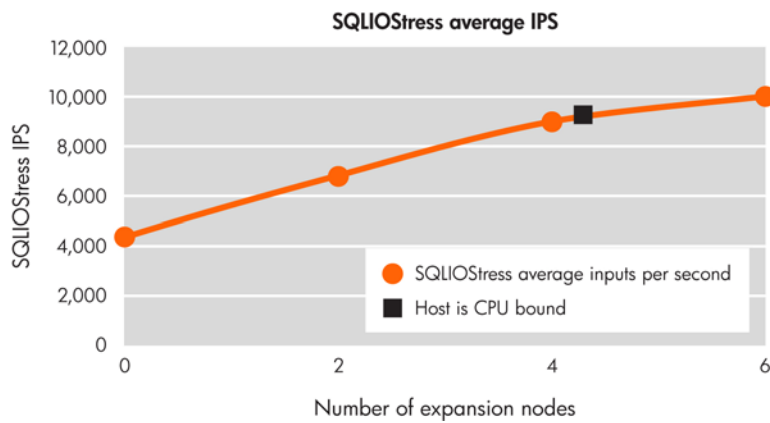
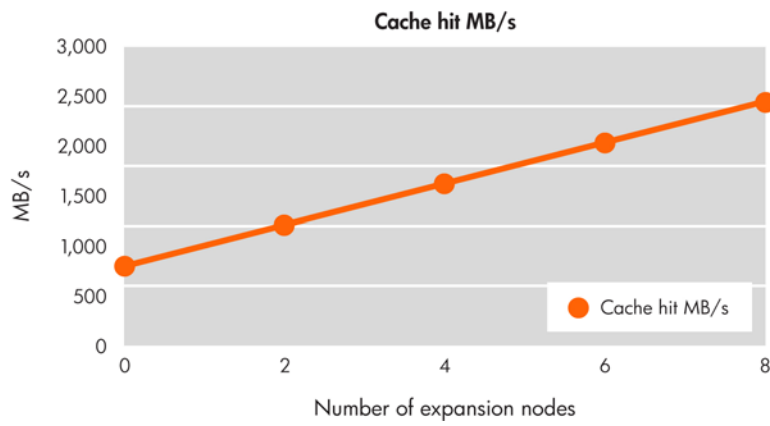
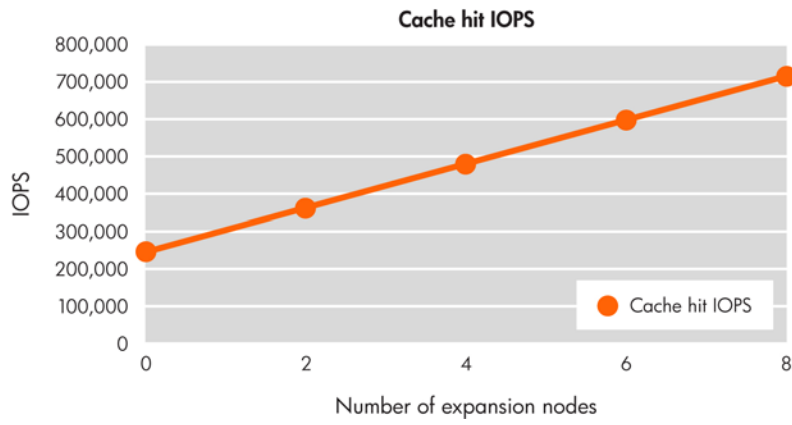
HP LeftHand Virtualization SAN performance results

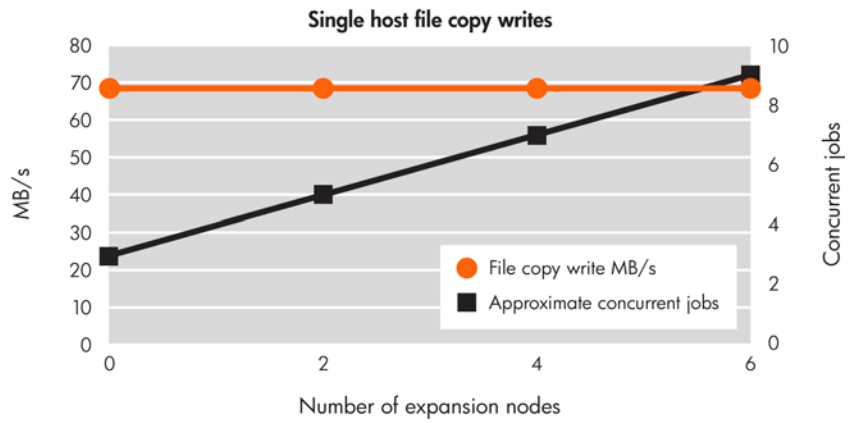
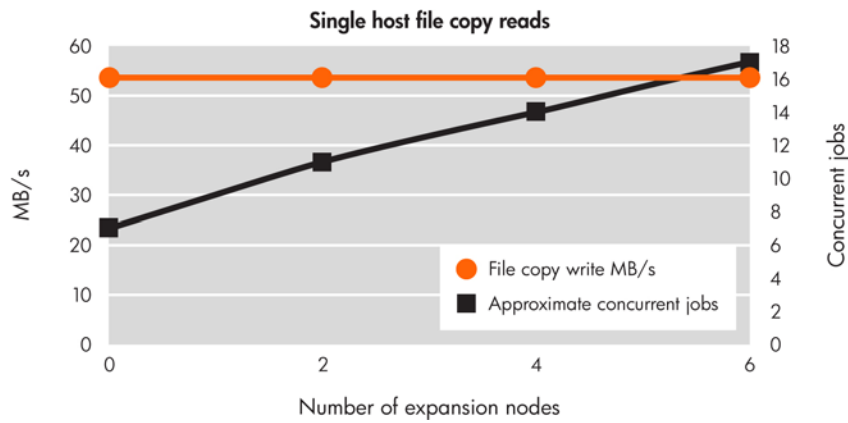
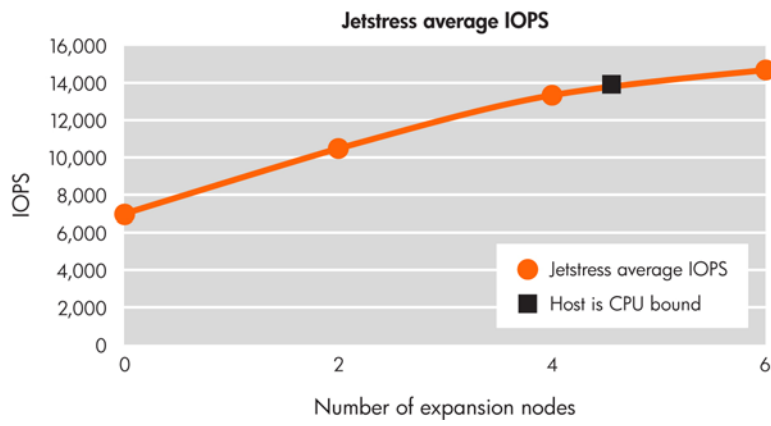


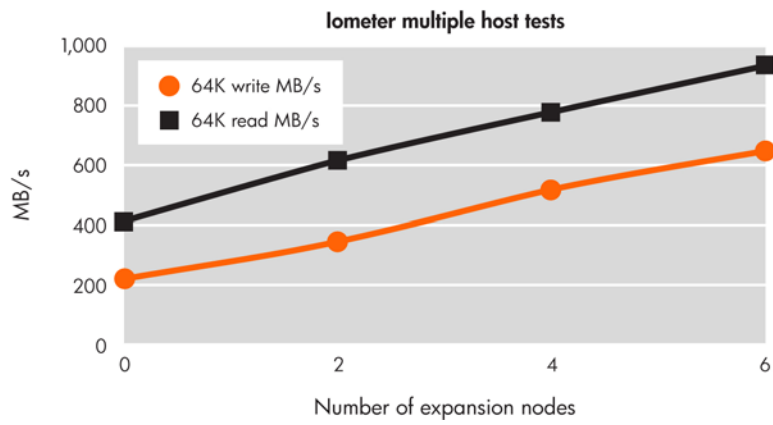
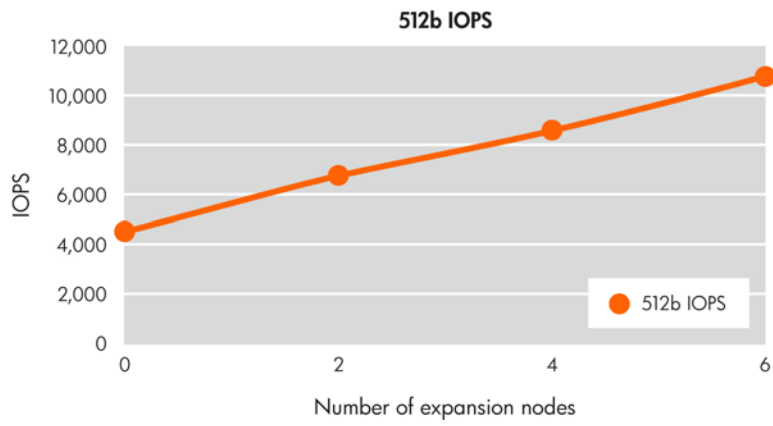




HP LeftHand Multi-Site SAN performance results







Conclusion

The HP LeftHand Starter, Virtualization, and Multi-Site SANs deliver reliable, scalable, and predictable performance for virtualization as well as for enterprise production environments that require extreme availability and data protection. Storage clustering allows the resources of multiple storage arrays to be aggregated together with HP LeftHand SANs into a robust, high-performance storage cluster. The flexibility and power of HP LeftHand iSCSI SAN storage clustering enables you to meet virtually any performance and/or capacity need.

For more information

For more information, visit: www.hp.com/go/p4000

Technology for better business outcomes

© Copyright 2009 Hewlett-Packard Development Company, L.P. The information contained herein is subject to change without notice. The only warranties for HP products and services are set forth in the express warranty statements accompanying such products and services. Nothing herein should be construed as constituting an additional warranty. HP shall not be liable for technical or editorial errors or omissions contained herein.

Microsoft and Windows are U.S. registered trademarks of Microsoft Corporation. Intel and Xeon are trademarks of Intel Corporation in the United States and other countries.

4AA2-5248ENW, April 2009

