



IT organizations appreciate the simplicity of file-level access provided by network attached storage (NAS), as well as the speed of block-level storage area network (SAN) systems. Unified storage systems enable further consolidation of storage deployments, helping reduce or eliminate islands of storage that were siloed for different workload or protocol needs. However, IT managers are finding that NAS, SAN, and unified storage products based on traditional architectures may become bottlenecks as they try to accommodate the surge of rapidly growing business data volumes. Traditional systems can scale up by adding disk capacity—but when the limits of a storage enclosure are reached, organizations must invest in a unit with controllers that are more powerful than those in the original enclosure.

Many IT organizations are now turning to scale-out storage approaches to help them expand seamlessly and avoid forklift upgrades or complex migration projects.<sup>1</sup> Dell EqualLogic scale-out storage, based on a virtualized peer storage architecture, enables IT departments to add storage easily when needed. In its unified platform, the EqualLogic line provides scale-out capabilities not only for block storage, but also for NAS file services. To quantify how EqualLogic unified storage delivers incremental performance increases as resources are added, Dell performed a series of benchmark tests under several operational use case scenarios.

### Performance scaling in a Linux environment

Organizations running Linux® OS-based databases need storage systems that can handle the high random I/O workloads of online transaction processing (OLTP) applications. To validate the performance scalability of EqualLogic SAN arrays in this

<sup>1</sup> For more information on the Dell EqualLogic scale-out architecture, see "Taking a scale-out approach to unified block and file storage," by Scott Sinclair, Arun Rajan, and John Mannix, in *Dell Power Solutions*, 2011 Issue 3, [content.dell.com/us/en/enterprise/d/business-solutions-power-en/Documents-ps3q11-20110186-rajan.pdf.aspx](http://content.dell.com/us/en/enterprise/d/business-solutions-power-en/Documents-ps3q11-20110186-rajan.pdf.aspx).

# Validating scale-out storage performance for block and file I/O

By Dylan Locsin, Jeff Junker, Arun Rajan, and Ananda Sankaran

A scale-out storage architecture helps organizations deal with demands for growing data capacity and access. Dell engineers put Dell™ EqualLogic™ scale-out storage through its paces to demonstrate its scalability in both file and block I/O scenarios.

## Next-generation virtualized storage

For efficient operation, highly virtualized data centers require storage that supports seamless movement and protection of virtual machines, applications, and data. Dell EqualLogic PS6100 Series arrays are designed to provide midsize organizations with highly scalable storage that automatically manages data in a redesigned, compact form factor.

[dell.com/PSseries](http://dell.com/PSseries)

scenario, Dell engineers ran tests using a typical deployed infrastructure in June 2011.

The test environment included two Dell PowerEdge™ R710 servers running Red Hat® Enterprise Linux 5.5. The Flexible I/O (FIO) benchmarking tool was used to generate the test workload, which had an 80 percent/20 percent read/write ratio. This FIO workload was run against one, two, and three Dell EqualLogic PS6100XV Internet SCSI (iSCSI) SAN arrays.

Testing showed essentially linear growth in I/Os per second (IOPS). The set of two arrays achieved approximately twice the IOPS as the baseline single-array test case, and the set of three arrays achieved approximately three times the IOPS as the baseline (see Figure 1). The results demonstrate the ability of the EqualLogic architecture to scale performance in proportion to the number of arrays added to a group.

### Scalability of physical file services

The Dell EqualLogic line delivers a scale-out unified storage architecture by adding the EqualLogic FS7500 scale-out NAS appliance to an EqualLogic PS Series SAN. Block and file data are stored on back-end EqualLogic PS Series arrays, which also provide iSCSI access to volumes. The EqualLogic FS7500 provides file services through Common Internet File System (CIFS) and Network File System (NFS) protocols.

From March through August 2011, Dell engineers studied the performance scalability of EqualLogic storage providing file services.<sup>2</sup> The test methodology comprised two parts:

- Creation of NFS exports or CIFS file shares on the EqualLogic FS7500
- Simulation of NFS or CIFS file operations from test clients to record system response times

The Dell team based the use case for the simulations on end-user access of file shares and created file data to simulate the workload. In one test scenario, NFS and CIFS simulations were run on an EqualLogic unified storage system comprising an EqualLogic FS7500 scale-out NAS

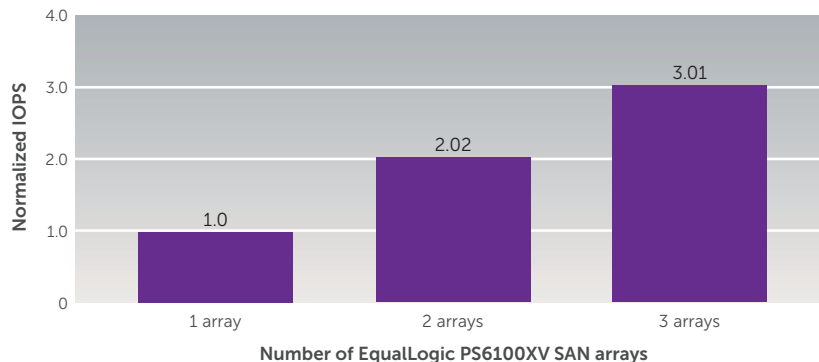


Figure 1. Throughput of EqualLogic PS6100XV arrays in Linux FIO benchmark tests

and EqualLogic PS6000XV SAN arrays with Serial Attached SCSI (SAS) drives at RAID-10. With two NAS appliances and four SAN arrays, the EqualLogic system delivered almost twice the performance for NFS operations (93 percent increase) and more than twice the performance for CIFS operations (168 percent increase), compared to one NAS appliance and two SAN arrays.

Another test scenario involved running the simulations on the EqualLogic FS7500 and EqualLogic PS6000E arrays with Serial ATA (SATA) drives at RAID-50. With two NAS appliances and four SAN arrays, the EqualLogic system provided more than twice the performance for NFS operations (110 percent increase) and CIFS operations (122 percent increase), compared to one NAS system and two SAN arrays.

The results of both tests indicate that by adding NAS controller resources and back-end SAN arrays, an EqualLogic unified storage system can scale out performance and help maximize system throughput and performance. Testing also showed that for very high file I/O needs, administrators should use two EqualLogic FS7500 appliances when four or more EqualLogic PS Series arrays are used to host the NAS reserve.

### Storage performance in a virtualized workload environment

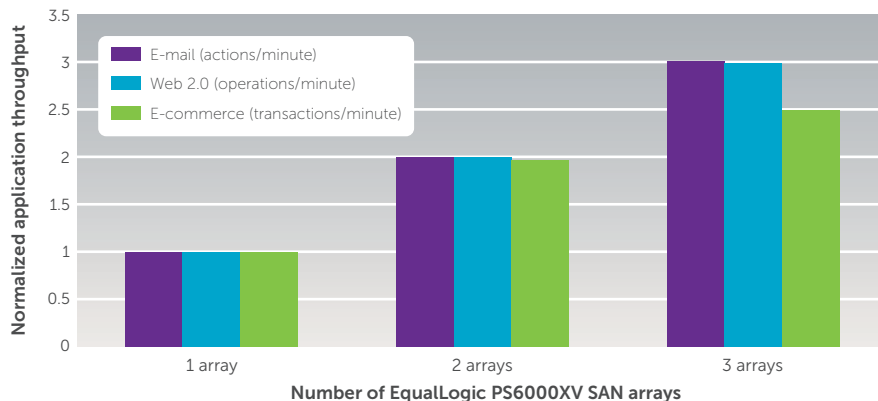
The iSCSI block storage protocol enables excellent performance for VMware® virtualization environments, as does the NFS protocol, which

### Dive deeper

The Dell EqualLogic FS7500 appliance adds scale-out unified NAS capabilities to EqualLogic PS Series iSCSI SANs, enabling management of iSCSI, CIFS, and NFS access from a single console. Learn how to integrate the EqualLogic FS7500 into an existing EqualLogic SAN to achieve optimum storage performance.

[dellstorage.com/FS7500IntegrationWP](http://dellstorage.com/FS7500IntegrationWP)

<sup>2</sup> For more information on the test configurations, results, and best practices, see "Scalability and deployment best practices for the Dell EqualLogic FS7500 NAS system as a file share solution," by Ananda Sankaran and Arun Rajan, August 2011, [dellstorage.com/FS7500BestPracticesWP](http://dellstorage.com/FS7500BestPracticesWP).



**Figure 2.** Performance of multiple virtual workloads in a VMware environment using an EqualLogic FS7500 scale-out NAS over NFS

some organizations prefer for the benefits of managing virtual machines in a file system. The EqualLogic unified storage system with the EqualLogic FS7500 scale-out NAS allows organizations to use both storage-access methods in a single platform.

To investigate the performance scalability of the unified EqualLogic platform to meet demanding I/O needs in a consolidated virtual environment, from May through August 2011 Dell engineers designed and ran tests with multiple simultaneous application workloads within a VMware infrastructure.<sup>3</sup>

The engineers deployed two VMware ESXi host servers with sufficient processor, memory, and network resources to avoid any host-layer bottlenecks and an EqualLogic unified storage system comprising the EqualLogic FS7500 scale-out NAS and EqualLogic PS6000XV arrays operating under a single group address. Three shared data stores using NFS exports from the EqualLogic FS7500 were configured on the ESXi servers. Second and third EqualLogic PS6000XV arrays were added to the pool one at a time to test performance scalability. For each storage configuration, engineers increased the applications' workloads and noted the application transaction throughputs while maintaining an acceptable application quality of service (QoS).

The tests used a mix of three application workloads:

- Mail server operations using Microsoft® Exchange Server, emulating 1,000 users with heavy-usage profiles and a fixed mailbox size
- Social networking Web site operations using Web 2.0–based applications defined by the Olio testing toolkit, fixed at 400 concurrent users
- E-commerce transactional operations using the open source Dell DVD Store database test suite and MySQL databases

The height of each bar in Figure 2 shows the normalized application throughput in a VMware environment using NFS. These results show that the EqualLogic unified scale-out system achieved a near-linear increase in application transaction performance within a VMware environment by increasing the number of back-end SAN arrays.

### Simple, effective scaling for optimum performance

Through comprehensive testing of EqualLogic scale-out storage under different block and file I/O scenarios, Dell demonstrated that the storage enables performance to be scaled incrementally

simply by adding units. Because of the many variables involved, specific performance results will vary based on an organization's IT infrastructure configurations, but in general, EqualLogic storage is designed to scale in both capacity and performance. Adding EqualLogic PS Series SAN arrays to the infrastructure helps scale capacity. To boost performance, administrators can add an EqualLogic FS7500 appliance to increase the number of NAS controllers and EqualLogic PS Series arrays to increase the number of drives servicing a workload.

By deploying the EqualLogic FS7500 scale-out NAS in new or existing storage infrastructures, organizations can realize the scalability benefits of unified block and file storage while avoiding the challenges of managing separate storage architectures. **PS**

### Authors

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### Learn more

Dell EqualLogic storage:  
[equallogic.com](http://equallogic.com)

Dell EqualLogic Host Integration Tools (HIT) for Linux technical report:  
[dellstorage.com/HitLinuxTR](http://dellstorage.com/HitLinuxTR)

<sup>3</sup> For more information on the test configurations and results, see "Dell EqualLogic FS7500—Unified block and file storage for virtual workloads," August 2011, [dellstorage.com/FS7500VMwareWP](http://dellstorage.com/FS7500VMwareWP).