



Dell EqualLogic Best Practices Series

Reference Architecture for a Virtualized SharePoint 2010 Document Management Solution

A Dell Technical White Paper

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Table of Contents

Acknowledgements.....	iii
Feedback.....	iii
Executive summary.....	iv
1 Introduction.....	5
1.1 Objective.....	5
2 Test methodology.....	7
2.1 Workload characterization.....	7
2.2 Content Repository – and Workload data generation.....	8
2.3 Load generation with Visual Studio and Visual Studio test controller and agents.....	9
3 Test configuration.....	10
3.1 SharePoint farm virtual machines.....	12
3.2 Virtual networking.....	12
3.3 SharePoint farm configuration.....	12
3.4 EqualLogic array.....	13
3.5 Network switches.....	13
3.6 Servers.....	13
3.7 EqualLogic HIT configuration.....	14
4 Test results.....	15
4.1 workload one – heavy upload environment.....	15
4.2 workload two – heavy browse environment.....	16
5 Conclusion.....	18
6 Best Practices.....	19
7 Appendix.....	20
7.1 Workload 1 – heavy upload environment with 10k SAS disks.....	20
Additional resources.....	22

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Feedback

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Executive summary

Microsoft® SharePoint® 2010 is a flexible and powerful document management and business collaboration application. Due to its breadth of features, configuring a SharePoint 2010 solution that can effectively meet an organization's needs can be a daunting task. This white paper focuses on the most often utilized document management features of SharePoint 2010, specifically, intranet browsing, file upload and download, and document search, in order to develop a reference architecture that meets the needs of a medium sized SharePoint Farm. These features represent a baseline for a SharePoint 2010 deployment and provide a starting point for further examination of advanced SharePoint capabilities.

EqualLogic arrays provide an excellent return on investment to customers who want to deploy a SharePoint 2010 document management solution with thousands of active users. Performance testing of a 15k RPM SAS system was initially conducted, however results demonstrated that more than 20,000 users could be supported based upon the criteria cited in this paper and that number of users falls outside of the scope of our target environment. Comprehensive performance testing of 10k RPM SAS and 7200 RPM NL-SASEqualLogic storage array models were subsequently conducted in order to determine the right solution for a SharePoint 2010 reference architecture for medium sized organizations.

Our study findings led to further evaluation of a single Dell™ EqualLogic™ PS6100E as the storage solution for a virtualized SharePoint 2010 medium farm deployment supporting a maximum of 5,000 active SharePoint users with 10% concurrency, represented by 500 concurrent users.¹ A cost optimized array like the EqualLogic PS6100E with large 7200 rpm NL-SAS disks provides high capacity storage for the customer looking to implement a SharePoint 2010 document management solution.

During testing, the EqualLogic PS6100E easily processed more than 1500 IOPS for 500 concurrent users and the average latency was still well below the 20 ms threshold expected from a storage system providing services to an application like SharePoint 2010.²

¹ 10% concurrency is the standard model used in Microsoft publications on SharePoint 2010 capacity planning. <http://www.microsoft.com/resources/documentation/wss/2/all/adminguide/en-us/stsb07.aspx>

² Microsoft "Storage and SQL Server capacity planning and configuration (SharePoint Server 2010)", <http://technet.microsoft.com/en-us/library/cc298801.aspx>

1 Introduction

SharePoint 2010 is a feature rich document management and business collaboration application which requires the deployment and configuration of numerous hardware and software systems. Document management is one of the primary business functions provided by SharePoint 2010. A document management system grants employees, business partners, and customers the potential to access a data repository for submitting, searching, retrieving, and modifying the documents stored in the system, as well as keeping track of document versions and providing workflow.

The core components of a document management system are:

- Document submission, including versioning and permission assignment
- Document retrieval, including modification and annotation
- Document browsing, including inline editing, calendar and blog features
- Document search, including filter and permission restrictive access

This white paper describes the results of performance tests for a virtualized SharePoint® 2010 document management solution on an EqualLogic PS6100E storage array. The primary audience for this paper is IT managers and technical decision makers interested in sizing and performance results for a cost effective SharePoint 2010 document management storage solution.

1.1 Objective

The objective of this paper is to characterize a SharePoint 2010 document management solution on EqualLogic storage and measure the impact to that storage system under varying simulated customer loads. Microsoft SharePoint best practices³ were used throughout this study with the exceptions noted below.⁴

By definition, a medium SharePoint 2010 farm design consists of multiple web, application, and database servers for load balancing and data redundancy.⁵ In small SharePoint 2010 farms the server components can be consolidated to one server for ease of management and cost. Conversely, in large SharePoint 2010 farms, the need for several higher performing components, including EqualLogic storage systems with 10K RPM, 15K RPM SAS, and SSD drives becomes a necessity.

Though the EqualLogic PS6100E is capable of input and output performance beyond that required to support 500 concurrent users, it can be considered a best practice to maintain this level of headroom for supporting additional users, SharePoint features, or unexpected performance conditions. This can lead to

³ Microsoft SharePoint 2010 best practices can be found at <http://technet.microsoft.com/en-us/library/cc850682.aspx>

⁴ SharePoint 2010 content databases were allowed to grow larger than 200GB, Microsoft's recommended limit, as backup and restore limitations were not a consideration for the testing. The Microsoft SQL Server 2008 R2 'maximum degree of parallelism' option was left on the default setting. The SQL server databases were limited to a single file. SQL database growth was left on the default auto-growth. A single database server was used for search functionality. *Changes to these settings are best evaluated for each production environment.*

⁵ Medium farm description, <http://technet.microsoft.com/en-us/library/ee667264.aspx>

the consideration of storage array scaling or to a tiering solution with a secondary array system and faster drives for data that is commonly accessed. *See the appendix for scaling results of an EqualLogic PS 6100X array.*

Test Goals

The immediate goal of the performance tests was to validate that an EqualLogic PS6100E could support 500 concurrent users accessing the system within the scope of the four primary features of a document management system. Within the scope of this goal 3 system performance thresholds were defined:

- Storage latency must remain below 20ms per I/O
- Web Server and SQL Server CPU utilization must remain below a 50% average to allow for scaling of more users and a faster EqualLogic array or a tiered array solution.
- TCP retransmits on the storage network must remain below 0.5%

2 Test methodology

In order to simulate 500 concurrent SharePoint users, Microsoft® Visual Studio® 2010 Ultimate along with the distributed test functionality of Visual Studio test controller and test agents were deployed and simulated user loads were generated to represent random access to the SharePoint 2010 farm. The primary goal of the test methodology was to represent random access to multiple SharePoint 2010 sites, files, and features.

2.1 Workload characterization

Two different potential customer workloads were tested with the SharePoint 2010 document management solution.

Workload 1:

The first workload was upload intensive representing an environment in which SharePoint 2010 users were responsible primarily for creating new files within the document management repository. This environment is representative of one where traditional pen and paper storage has been replaced with a digital solution.

Workload 2:

The second, and more common environment, is where users spend much of their time browsing existing documents, looking at their calendar, reading blogs and web pages, and lastly uploading, downloading, or searching for documents. Typically this type of load is not storage intensive, but can be server resource intensive. The EqualLogic PS6100E should easily support more than 500 concurrent users in this environment without latency or throughput issues.

Visual Studio workload mixes

Visual Studio 2010 Ultimate was used to capture actual SharePoint browsing, uploading, downloading, and search sessions. Then those recordings were used to generate a load representing 500 concurrent users accessing random SharePoint 2010 sites and files.

Table 1 below lists the two test mixes and the constants used throughout the testing procedure. This list gives customers the opportunity to determine which test case more closely matches their production environment.

Table 1: Test Mixes

	Workload 1 – Upload Heavy	Workload 2 – Browse Heavy
Browse	20%	40%
Upload	40%	20%
Download	20%	20%
Search	20%	20%

Visual Studio 2010 Test Constants

- Five second 'think times' between user tests, simulating time between clicks for users
- Three hour test duration
- Constant 500 total users
- No warm-up
- Visual Studio web test connection model – connections per user
- Percentage of new users: 100%
- Browser: 100% Internet Explorer® 8.0
- Network: 100% LAN
- Five second sample rate for performance counter data
- Visual Studio test iterations not used

Performance Monitoring Tools

During each test run, resource usage was captured by using Microsoft Windows 2008 Performance Monitor (Perfmon.exe), Dell™ EqualLogic™ SAN Headquarters (SAN HQ), and Visual Studio 2010 Ultimate in order to determine the load on the test farm. The following details were captured during each test.

- Vmware Host and Guest OS CPU and memory utilization
- Retransmits for all iSCSI connections
- Errors for all iSCSI connections
- Storage I/O Performance

Input/output operations per second is the most common metric of measuring overall performance of a storage system, but latency and the effect on response times for user applications are also important to monitor.

2.2 Content Repository – and Workload data generation

The workload that was simulated for the SharePoint 2010 environment consisted of multiple content databases, a central site collection, and numerous sites. Those sites were populated with data to represent a data migration from an existing file system to a SharePoint document management repository. Finally the files were read, downloaded, and searched. In addition, new files were added to the system. Details of this content generation are presented in the sections below.

Content generation with Visual Studio and Windows PowerShell®

Microsoft recommends a maximum content database size of 200 GB in order to easily facilitate backup and restore functions. Based upon system backup and restore capabilities, and the file sizes that will be stored in the document management solution, larger content databases can be used. Creating numerous content databases can create excessive administrative overhead and must be balanced with restore capabilities. Backing up the SharePoint configuration using the SharePoint Automatic Snapshot Management capabilities of EqualLogic can alleviate many of the performance issues commonly associated with this task, allowing the SharePoint administrator to be able to not only create larger content databases but to back them up more rapidly and efficiently.

Each content database below was implemented as a site collection with an associated business department: IT, Management, Sales, and Support respectively. These Site collections were created as SharePoint 2010 team sites and then each of them were subsequently populated with 10 sub sites associated to different organization teams within each of the business departments.

- Intranet, 100GB: <http://intranet.sis.local> – user home page
- IT, 800GB: <http://intranet.sis.local/sites/it> – IT document library
- Management, 800GB: <http://intranet.sis.local/sites/sales> – Management document library
- Sales, 800GB: <http://intranet.sis.local/sites/sales> – Sales document library
- Support, 800GB: <http://intranet.sis.local/sites/sales> – Support document library

Each business team site (40 in total across 4 departmental site collections) was then populated with data to simulate a conversion from their existing file system to a SharePoint 2010 document management solution. SharePoint provides PowerShell cmdlets, lightweight commands invoked within automation scripts provided at the command line, which allow the SharePoint administrator to script loading the system with preexisting data.

- Each site was populated with an initial load of 17.5 GB of data. (700 GB total)
- The initial data consisted of 50% 1 MB files, 30% 5 MB files, 15% 10 MB files, and 5% 20 MB files. In order to increase data utilization of the array Visual Studio upload tests were run until the SharePoint data set reached a size of 5TB.
- Then, to simulate a minimum array capacity utilization of 65%, each site and the crawl database was cloned twice on the array to represent snapshot data. In order to minimize variations in performance results during snapshot creation, clones were used instead of snapshots.

2.3 Load generation with Visual Studio and Visual Studio test controller and agents

These tests were based upon 500 concurrent users. Within a 10% concurrency model, 5,000 active users could be supported with 500 of them all using the system at one time. This is the model for SharePoint utilization that is used within Microsoft publications for planning and sizing Sharepoint deployments.⁶

In order to simulate 500 concurrent users of the SharePoint farm, it is necessary to create a distributed Visual Studio load solution. Visual Studio supports this functionality by offloading the load to a Visual Studio controller and load agents. Seven such agents were used to create the distributed load that represented the traffic from 500 users connecting to the SharePoint farm at all times.

A Visual Studio web test was used to manually capture the actual upload, download, search, and browse actions of users to a single site and a single file within that site. The resulting Visual Studio web test file was then modified so that each connection during the 3 hour load test would perform these actions randomly to one of the 40 SharePoint sites and choose a random file within that site.

⁶ Actual production environment baseline performance testing should be performed in order to determine the proper sizing of the SharePoint farm and underlying network and storage architecture.

3 Test configuration

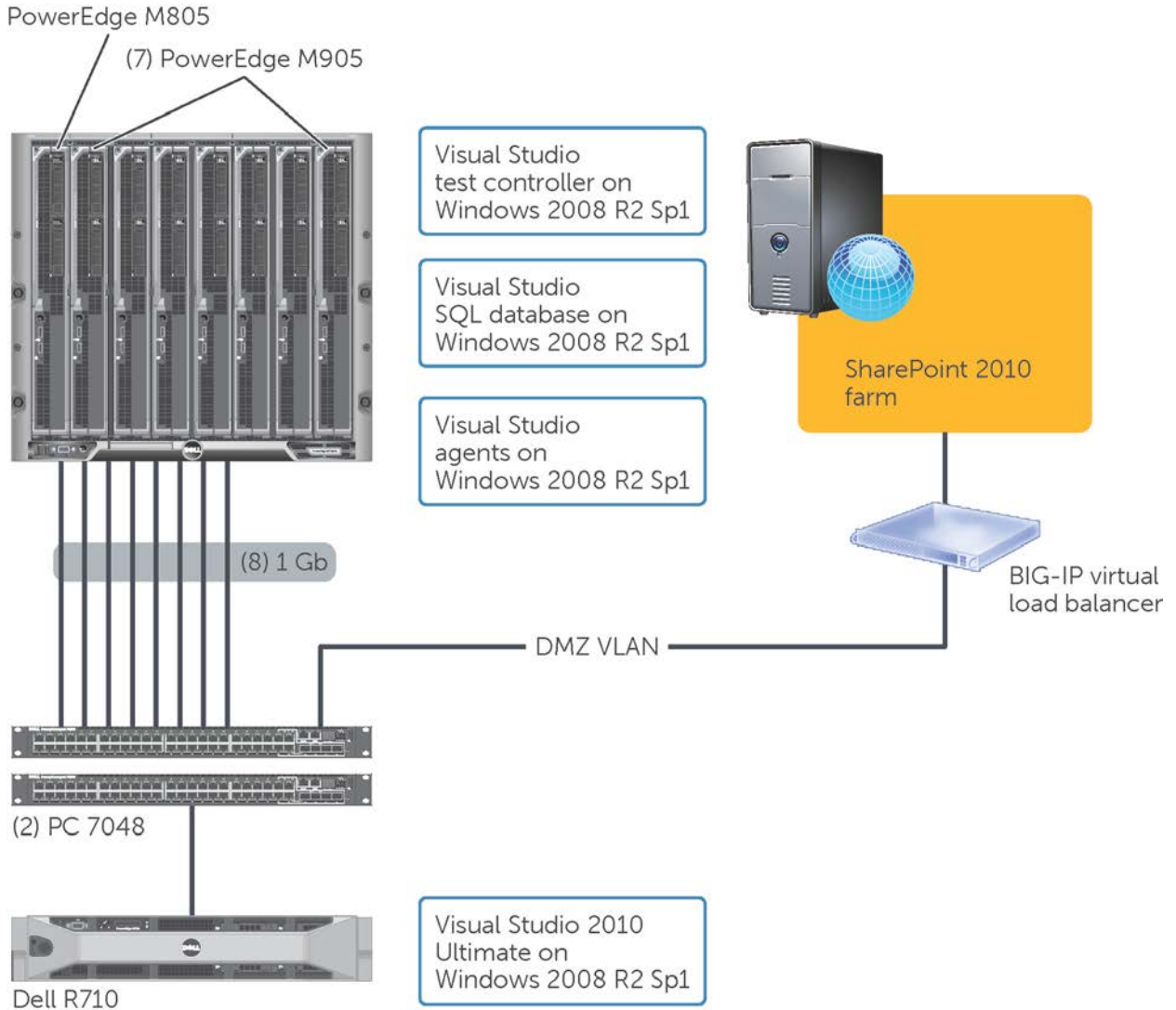


Figure 1 SharePoint 2010 – Visual Studio 2010 test environment diagram

Test Environment Components:

- Visual Studio 2010 Ultimate, PowerEdge R710
- Visual Studio SQL Server, Virtualized on Vmware ESXi 5, PowerEdge M805
- Visual Studio test controller, virtualized on Vmware ESXi 5, PowerEdge M805
- Visual Studio test agents x7, virtualized on Vmware ESXi 5, PowerEdge M905

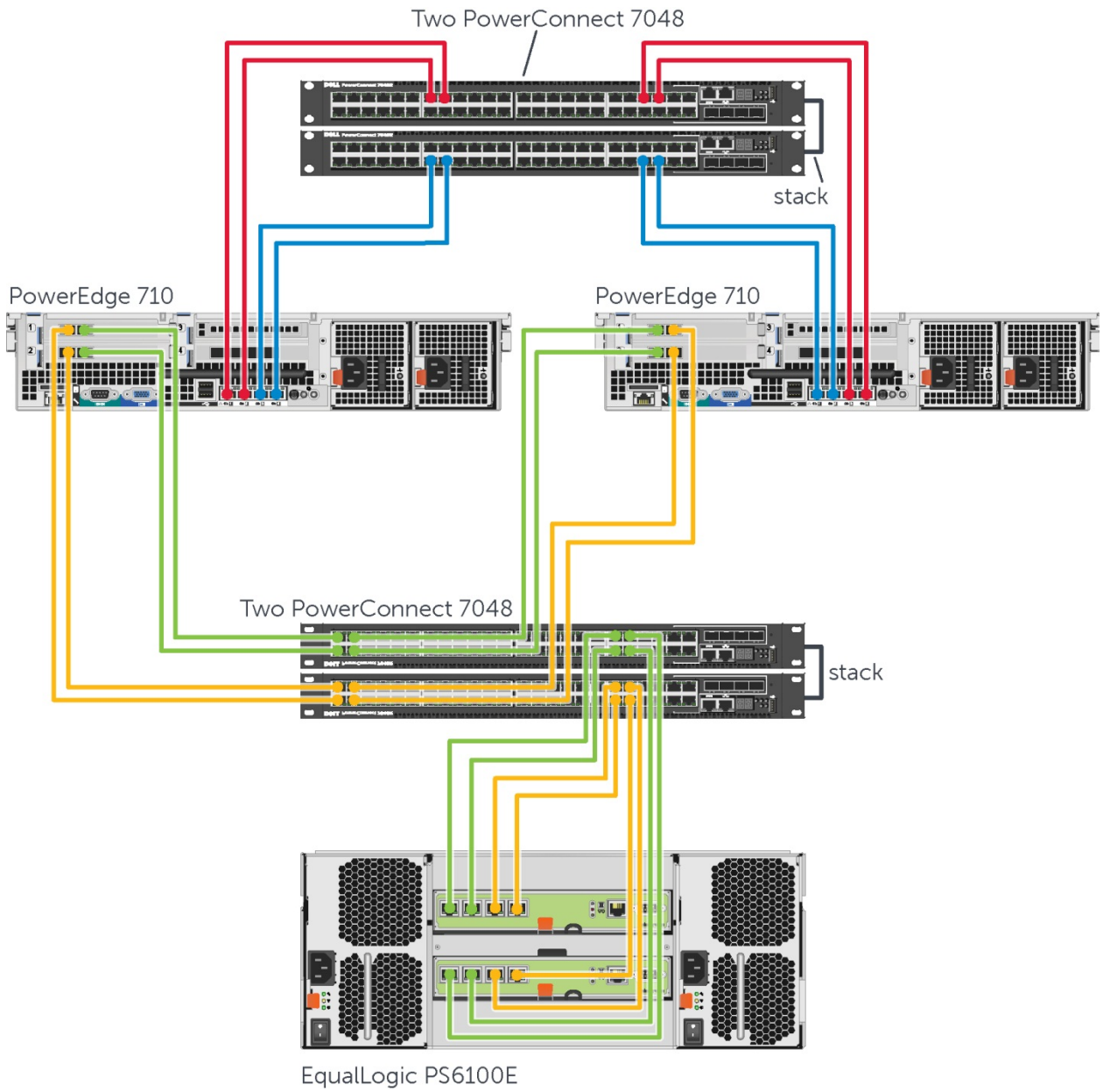


Figure 2 SharePoint 2010 Farm – storage connectivity

3.1 SharePoint farm virtual machines

Host	Name	Function	vCPUs	Memory
R610 #1	AD	Active Directory, DNS	1	4GB
R610 #1	EQLMan	EQL Manager console and SAN HQ	1	4GB
R610 #1	vCenter	Vmware vCenter	1	4GB
R610 #2	Web1	SharePoint WFE	4	8GB
R610 #2	App1	SharePoint central admin	4	8GB
R610 #3	Web2	SharePoint WFE	4	8GB
R610 #3	App2	SharePoint central admin	4	8GB
R610 #4	F5 BIG-IP	Web load balancing VM	2	4GB
R710 #1	SQL1	SQL 2008 – active cluster member	4	24GB
R710 #2	SQL2	SQL 2008 – inactive cluster member	4	24GB

3.2 Virtual networking

The following table lists the Vmware hosts, their virtual switches, the number of physical adapters connected to that virtual switch, and a description of the traffic on that virtual switch. VMXNET3 drivers were used for all virtualized network adapters.

Host	vSwitch0	vSwitch1	vSwitch2	vSwitch4
R610 #1	1 – Vmkernel Port	2 – Internal Net	2 – DMZ/Web	1 – iSCSI Net
R610 #2	1 – Vmkernel Port	2 – Internal Net	4 – DMZ/Web	2 – iSCSI Net 1 and 2
R610 #3	1 – Vmkernel Port	2 – Internal Net	4 – DMZ/Web	2 – iSCSI Net 1 and 2
R610 #4	1 – Vmkernel Port	2 – Internal Net	4 – DMZ/Web	2 – iSCSI Net 1 and 2
R710 #1	2 – Vmkernel Port	2 – Internal Net	2 – HeartBeat	2 – iSCSI Net 1 and 2
R710 #2	2 – Vmkernel Port	2 – Internal Net	2 – HeartBeat	2 – iSCSI Net 1 and 2

Vswitch0 – Vmware management only

Vswitch1 – Internal communications of all systems over the private 192.168.25.0/24 network

Vswitch2 – DMZ/Web communications on the 10.0.0.0/24 network (NAT behind load balancer)

Vswitch3 – iSCSI communications between SQL servers and EqualLogic array on the 172.16.25.0/24 network.

3.3 SharePoint farm configuration

SharePoint functions by server:

VM Name	Host	Function
App 1	R610 #2	Central administration
		Microsoft SharePoint Foundation Workflow Timer service
		Search query and site settings service (admin)
		SharePoint server search (crawl)
App 2	R610 #3	Central administration

Web1	R610 #2	Microsoft SharePoint Foundation Web Application
		Managed metadata web service
		Search query and site settings service (index + index mirror)
Web2	R610 #3	Microsoft SharePoint Foundation Web Application
		Search query and site settings service (index + index mirror)
		SharePoint server search (crawl)
SQL1	R710 #1	Microsoft SharePoint Foundation database
SQL2	R710 #2	Microsoft SharePoint Foundation database

3.4 EqualLogic array

EqualLogic PS6100E	
Storage array firmware	v5.2.2 on both controller modules
Disks (half full array)	12x 2TB, 7.2 k NL-SAS 3.5", 2 hot spares
Disks (full array)	24x 2TB, 7.2 k NL-SAS 3.5", 2 hot spares
Capacity	9.42 TB, 4 TB initial data population
RAID Configuration	RAID 10

3.5 Network switches

Dell PowerConnect 7048R, 4x Switches – 2 separate pairs stacked	
System boot image	4.2.0.4
Flow control	Enabled
MTU	9216
Spanning tree	Portfast enabled globally

3.6 Servers

Dell PowerEdge R610, 4 Servers	
Processors	2x Xeon X5690, 3.4 Ghz
Hyper threading	Enabled
BIOS version	6.0.7
Memory	24GB
Broadcom network adapter	1x Broadcom BCM5709 (Data connectivity)
Broadcom firmware	6.4.5 bc 5.2.3 NCSI 2.0.11
Intel network adapters	2x Intel 82576 (ISCSI connectivity)
Intel firmware	1.5-1
OS	Vmware ESXi 5.0 build 469512-standard (updated)

Dell PowerEdge R710, 2 Servers	
Processor sockets	2x Xeon E5520, 2.3 Ghz
Processor cores per socket	4
Hyper threading	Enabled
BIOS version	6.0.7
Memory	64GB physical
Network adapters	2x 4-port Broadcom BCM5709, 2x 2-port Broadcom BCM 5709
Network adapter firmware	6.4.5 bc 5.2.3 (NCSI 2.0.11 on 4 port adapters)
OS	Vmware ESXi 5.0 build 469512-standard (updated)

EqualLogic Host Integration Tools (HIT)	version 4.0
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3.7 EqualLogic HIT configuration

The EqualLogic HIT MPIO component provides for architecture aware iSCSI Multipath I/O (MPIO) connectivity between hosts and target arrays in order to optimize performance and availability. In the configuration used in the test SharePoint farm, all IP networks (except the iSCSI network) were removed from MPIO load balancing and all other configuration options were left on their original default setting. Reference <https://support.equallogic.com/WorkArea/DownloadAsset.aspx?id=10257> for more information.

4 Test results

The results in the tables below reveal the performance results of simulating 500 concurrent users with the two workloads described in section 2 above. The first workload simulates an environment where SharePoint users are focused on putting large numbers of documents into document libraries for archival purposes. The second workload shows a more balanced environment where SharePoint users primarily use the system to read existing articles, calendar entries, and documents.\

During the 3 hour tests, a 1 hour window was screen captured that represents the “peak condition” of storage array utilization, which is defined within this paper as the maximum number of IOPS generated during the load session.

4.1 workload one – heavy upload environment

Table 1 Heavy upload environment

Concurrent users tested	500
VS – requests per second	116
Storage IOPs at 500 users	1649
Write latency	1.9ms
Read latency	7.9ms
Web server CPUs	<4% (4 CPUs each)
Web server 2 CPUs**	<4% (4 CPUs)
Search – Query server CPUs	<1% (4 CPUs)
SQL server CPUs	43% (4 CPUs)
67.4% Writes	

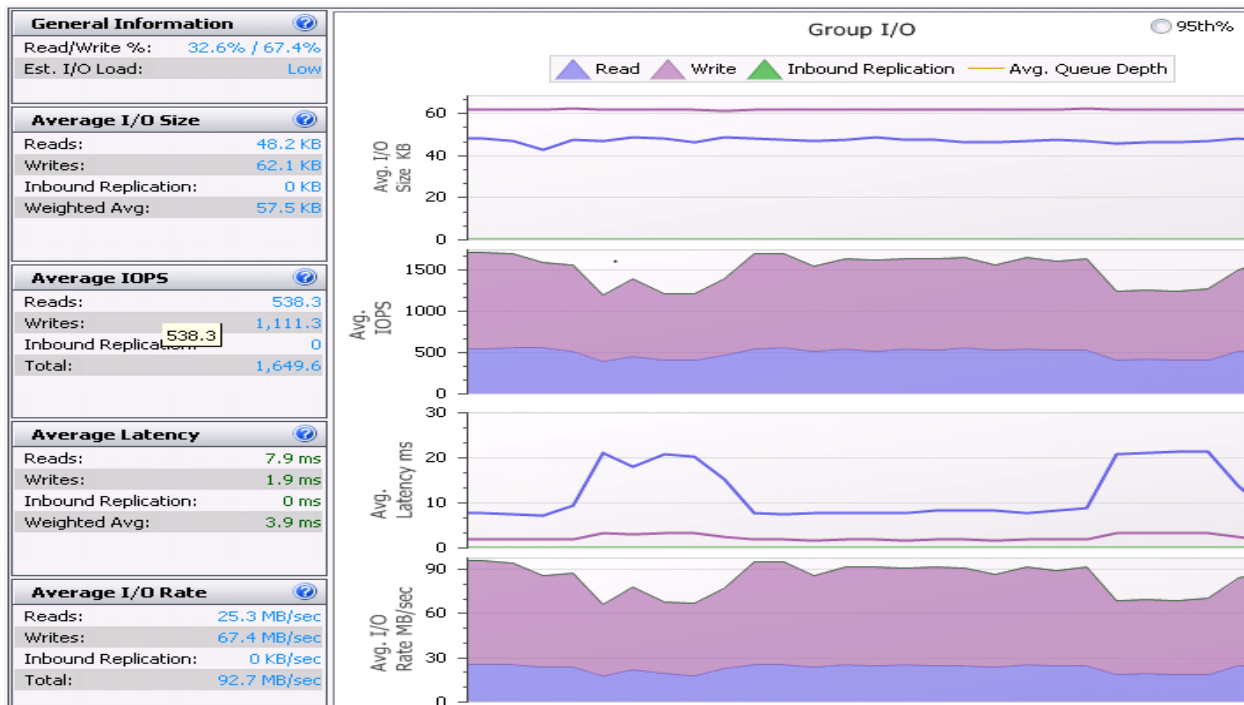


Figure 3 workload one: Heavy upload environment – I/O Live View session

Notice that the heavy upload workload consists of nearly 70% writes, yet read latency is higher. The reason for this is that host writes are acknowledged after caching them on the array controllers. The read latency is primarily due to the need for fetching data from the array disk drives as opposed to cache.

The average write IO size is nearly 64k implying that a Windows 2008 formatted volume that uses 64KB for NTFS allocation unit size would be a very efficient configuration for writes and nearly as efficient for the 48KB read IO seen here. The large block size can be also related to the file sizes that were used with the testing methodology. If you use smaller files, you should evaluate the IO size using SAN HQ and adjust accordingly.

4.2 workload two – heavy browse environment

Table 2 Heavy browse environment

Concurrent users tested	500
VS - requests per second	110
Storage IOPs at 1000 users	1223.7
Write latency	1.5ms
Read latency	8ms
Web server CPUs	<2% (4 CPUs each)
Web server 2 CPUs**	<2% (4 CPUs)
Search – Query server CPUs	<2% (4 CPUs)
SQL server CPUs	33% (4 CPUs)
63.9% Writes	

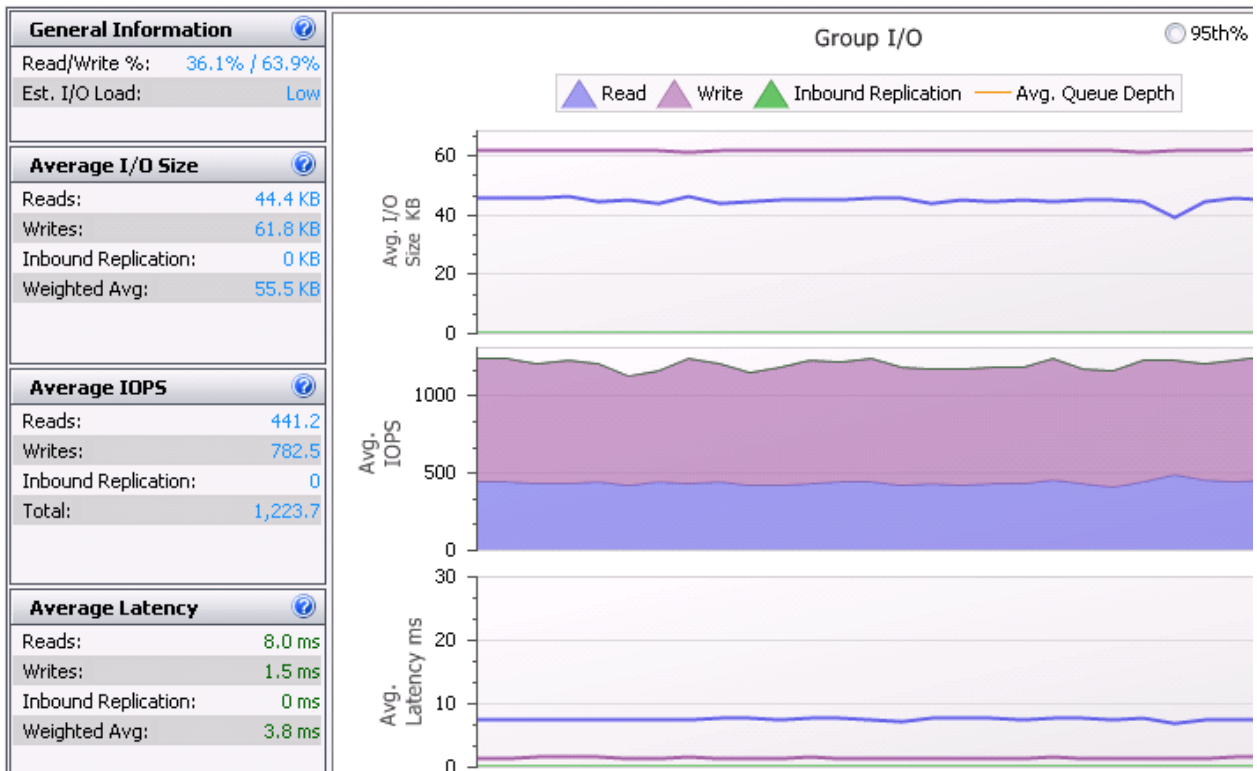


Figure 4 workload two: Heavy browse environment – I/O Live View session

The more read intensive heavy browse workload reveals an interesting anomaly where writes are a common occurrence, particularly writes to tempdb which can be seen in figure 5 below. With nearly as many writes as the heavy upload test, optimizing the RAID configuration for numerous random writes will increase performance for the document management solution.

The shift from 40% uploads in workload one to 20% uploads in workload two only reduced writes by 3.5%. Optimization of the tempdb files and their location is going to be very important to the success of the SharePoint deployment and should be considered high priority in a production environment.

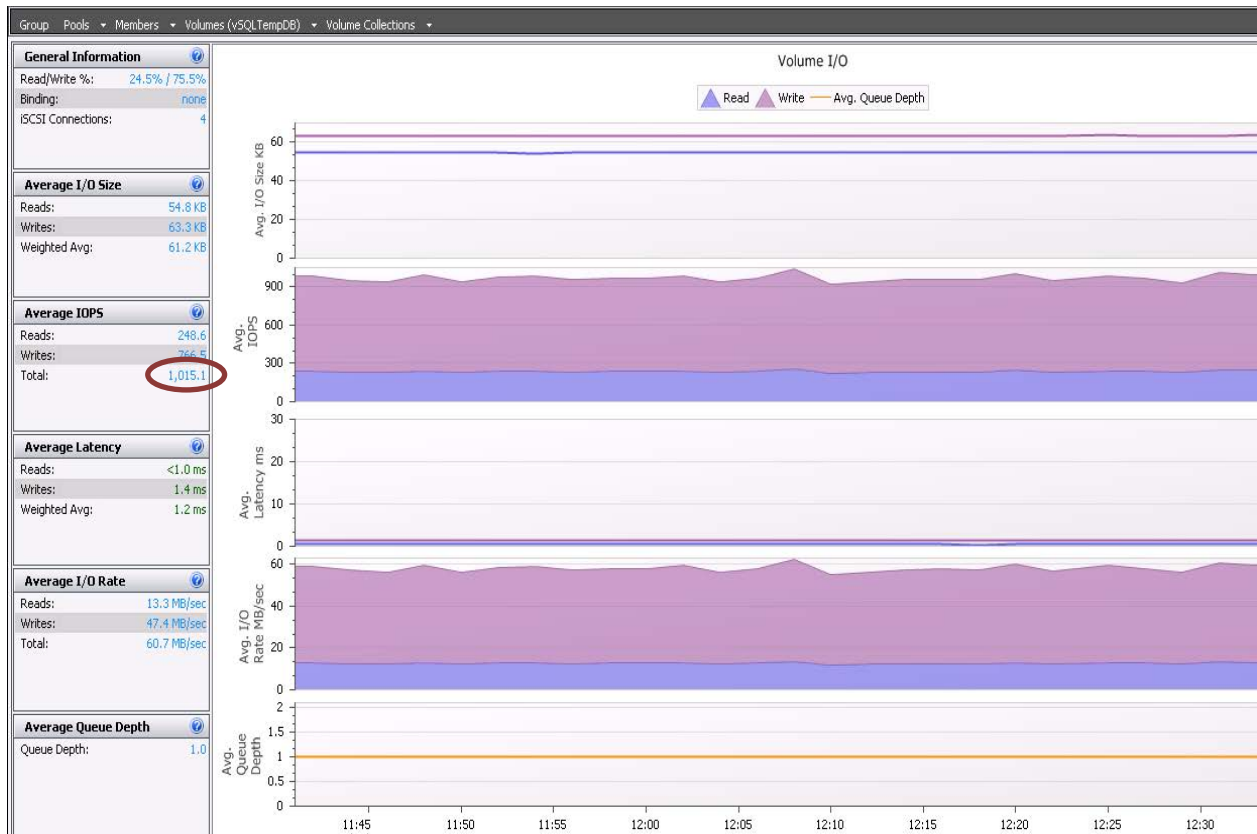


Figure 5 Use case two: Heavy browse environment with 12 disks – tempdb I/O view

This illustrates the importance of optimizing tempdb for the end-to-end performance of SharePoint 2010. More than 80% of all of the IO traffic was represented by just tempdb during this workload.

5 Conclusion

From the tests and data analysis in this white paper it can be concluded that:

- A single EqualLogic PS6100E array can easily and effectively support a virtualized SharePoint 2010 medium farm solution of up to 5,000 active SharePoint users utilizing a conservative 10% concurrency model, even beyond 65% array capacity utilization.
- Both use cases above can support more than 500 concurrent users. Beyond 500 users however, latency of the storage system and CPU utilization, particularly of the database servers, can begin to affect user response times. At this point scaling the solution becomes a valid consideration. See the appendix for testing of a scaled EqualLogic PS6100X array solution.
- Scaling to an faster more powerful EqualLogic storage array will allow you to support more users and more SharePoint features (*See the appendix for details*)
- Read latency can become a bottleneck for the storage system if lossless writes monopolize the storage array's assets. The user experience can be affected if administrators thusly allow users to write excessively large files or if heavy writes are the primary function of the document management system.

6 Best Practices

- Establish a performance baseline after configuring your primary SharePoint 2010 feature set. Then you will be able to see how much each additional feature or group of users you add after that point affects the system.
- Running a SharePoint 2010 farm on web front end servers and search query servers with just 2 CPUs provided plenty of processing power for 5000 active users. However the Database server CPU utilization needs to be monitored closely to make sure that scaling is not a requirement. As search services or crawl services become more utilized, those server's CPUs also need to be monitored closely.
- The search crawl function is schedulable and should be minimized during working hours or scheduled during low system utilization as it can put significant strain on all resources. Due to the ability to schedule this function around your user's heavy load periods, tests were not performed during crawling and as such performance numbers are not affected by this feature.
- The SQL TempDB database is heavily utilized by SharePoint 2010. Optimization of the size, location, and number of files used to implement this database can be critical to the success of the application and is something to be considered for any deployment.⁷

⁷ "Optimizing tempdb performance", [http://technet.microsoft.com/en-us/library/ms175527\(v=sql.105\).aspx](http://technet.microsoft.com/en-us/library/ms175527(v=sql.105).aspx) and "Best Practices for SQL 2008 in a SharePoint Server 2010 Farm" <http://technet.microsoft.com/en-us/library/hh292622.aspx>

7 Appendix

In order to provide valuable scaling performance results for the workloads above, the entire web farm, except the cloned data, was migrated to an EqualLogic PS6100X 10k SAS array. This array was above the 65% capacity with just the SharePoint data and it is implied that snapshots (simulated as clones) would be offloaded onto a second array system in order to optimize cost per capacity.

The tests were then run once more with 1000 concurrent users, or 10,000 active users based upon 10% concurrency. The results can be seen below. *The results of the 6100X are not meant to be used as a direct performance comparison to the 6100E results. The methodology used to write data to the drives, was different and the way the data was layed out on the disks was different.*

7.1 Workload 1 – heavy upload environment with 10k SAS disks

Table 3 Heavy upload environment with 24 SAS Disks

Concurrent users tested	1000
Storage IOPs at 1000 users	1941.5
Write latency	2.2ms
Read latency	16.6ms
Web server CPUs	<4% (4 CPUs each)
Web server 2 CPUs**	<4% (4 CPUs)
Search – Query server CPUs	<2% (4 CPUs)
SQL server CPUs	49% (4 CPUs)
67.7% Writes	

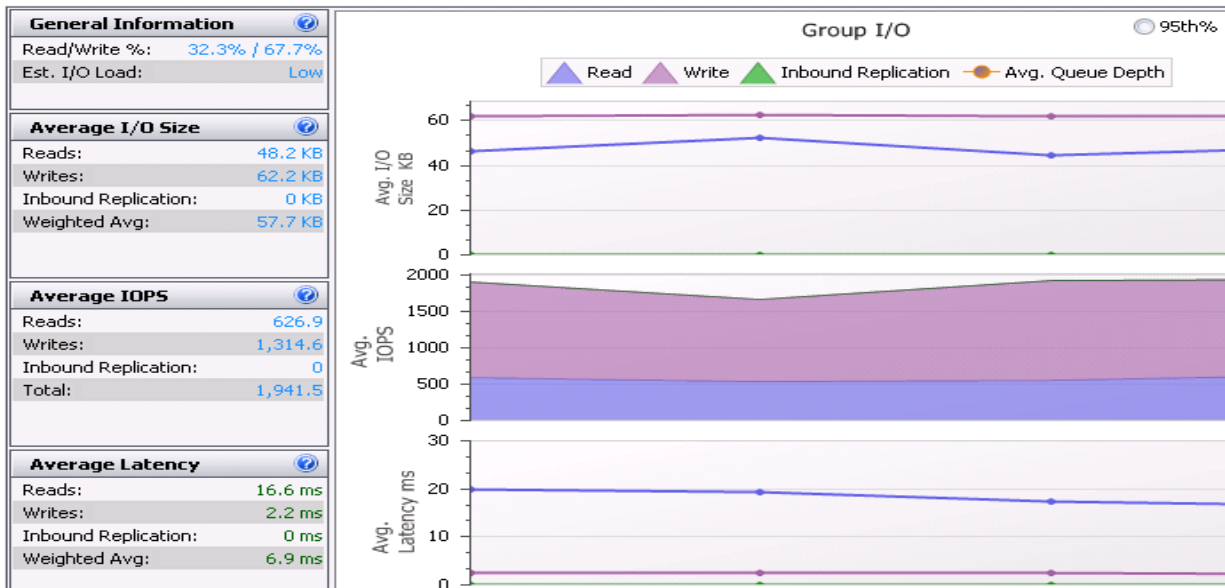


Figure 6

The EqualLogic PS 6100X is able to process the additional IOPS generated by twice as many users and still remain below the latency threshold of 20ms, even for this more specialized heavy upload test.

Table 4 Workload 2: heavy browse environment with 10k SAS disks Heavy browse environment with 24 SAS Disks

Concurrent users tested	1000
Storage IOPs at 1000 users	1774
Write latency	2.4ms
Read latency	12.2ms
Web server CPUs	<2% (4 CPUs each)
Web server 2 CPUs**	<2% (4 CPUs)
Search – Query server CPUs	<2% (4 CPUs)
SQL server CPUs	37% (4 CPUs)
64.7% Writes	

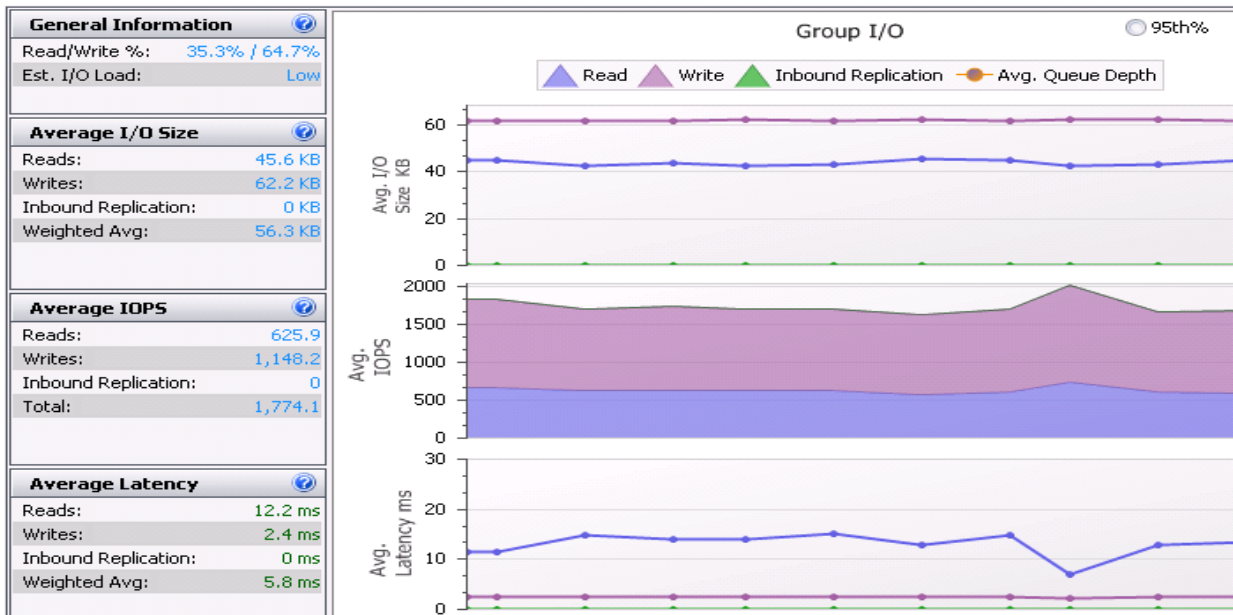


Figure 7

In the heavy browse environment, there is still plenty of room for additional features and functions for SharePoint before we reach our latency ceiling, or we could maintain just the document management features and scale up with more users.

Additional resources

Support.dell.com is focused on meeting your needs with proven services and support.

DellTechCenter.com is an IT Community where you can connect with Dell Customers and Dell employees for the purpose of sharing knowledge, best practices, and information about Dell products and your installations.

Referenced or recommended Dell publications:

- Dell EqualLogic Configuration Guide:
<http://en.community.dell.com/dell-groups/dtcmedia/m/mediagallery/19852516/download.aspx>.
- Dell EqualLogic HIT configuration:
<https://support.equallogic.com/WorkArea/DownloadAsset.aspx?id=10257>

For EqualLogic best practices white papers, reference architectures, and sizing guidelines for enterprise applications and SANs, refer to Storage Infrastructure and Solutions Team Publications at:

- <http://dell.to/sM4hJT>

Referenced Microsoft publications:

- Storage and SQL Server capacity planning and configuration (SharePoint Server 2010):
<http://technet.microsoft.com/en-us/library/cc298801>



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