Microsoft® SharePoint®
Server 2010

Virtualized Small Farm - Performance Study

Dell™ | SharePoint Solutions
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November 2010
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Executive Summary

A Microsoft® SharePoint® Server 2010 farm hosts the core platform services and applications that provide many different functions for its users. A SharePoint 2010 farm deployment usually employs a multi-tier architecture. Understanding sizing of each of the tiers of a SharePoint farm requires a comprehensive study of the workload requirements and performance capabilities of each hardware component.

This white paper includes a comprehensive study, and describes how a virtualized SharePoint small farm built using Dell™ PowerEdge™ rack servers and Dell EqualLogic™ storage performed under load testing. This virtualized SharePoint Server 2010 small farm is deployed in multiple virtual machines hosted by PowerEdge R710 servers, and using Microsoft® Windows Server® 2008 R2 with Microsoft Hyper-V™, instead of a conventional solution deployment on physical servers.

It is a priority for Dell to provide accurate guidance to customers when recommending infrastructure elements of a SharePoint implementation. Through testing, we have provided guidelines on how to choose the best architecture to increase performance and help keep client response times under one second in SharePoint farms. Dell’s SharePoint engineering team developed a load generation framework to perform this load testing, so that we could share these results with our customers. This data is provided to help our customers understand the performance impact of SharePoint collaboration workload, and how to size and design the best farm architecture to support these workloads.

This paper provides detailed information on how the farm was configured, some of the factors considered while designing the farm, how Dell performs SharePoint load testing, and the performance metrics associated with various farm components. It also details information on how the recommended farm architectures could support more than 15,000 users with 10% concurrency or 1,500 concurrent users and achieve response times that are below one second.

In a similar white paper, SHAREPOINT SERVER 2010: SMALL FARM - PERFORMANCE STUDY, is available from www.dell.com/sharepoint. It describes how a SharePoint small server farm was built and configured on physical servers. The white paper also provides details the performance results of the physical server SharePoint small farm under the load test.

A companion paper, SHAREPOINT SERVER 2010: AN INTRODUCTION, is available from www.dell.com/sharepoint. It offers an overview of SharePoint Server 2010, and provides common concepts and definitions that form a good basis for understanding the reference architectures presented in this paper.

Another companion paper, SharePoint 2010: Designing and Implementing a Small Farm, is available from www.dell.com/SharePoint. This companion paper provides the reference architecture and infrastructure best practices for implementing a SharePoint 2010 small farm. These reference architectures formed the basis of the performance study described in this paper.
Introduction

Microsoft SharePoint Server 2010 builds on the capabilities that were offered in Microsoft Office SharePoint Server 2007 to provide a rich platform for collaboration, information sharing, and document management. SharePoint 2010 adds several new features, and introduces important architectural changes and product improvements.

Capacity planning for a SharePoint farm deployment requires a thorough study of the existing requirements and future growth. A SharePoint implementation can be used in several ways, including custom-developed applications. This introduces complexity while sizing the servers and storage for a SharePoint implementation.

There are six pillars\(^1\) that organizations can apply to create clarity around how SharePoint will be used. This performance study paper provides performance capacity details of a virtualized SharePoint 2010 small farm configured with PowerEdge rack servers and EqualLogic iSCSI storage in the context of SharePoint collaboration\(^2\).

SharePoint 2010 Farm topologies

A SharePoint server farm is a collection of servers that collectively provide the services required by a SharePoint deployment. Some of these services, or sets of services, comprise predefined roles, and must be configured within the solution. Other services and components are optional, but they provide additional features and functionality that are often desirable. These optional components may include service applications, such as managed metadata and Excel services. There are some constraints and best practices that help determine which components should be located on each server in the farm. Also, by considering how the components are distributed, the farm can be designed to more easily accommodate later growth.

The size and capacity of a SharePoint 2010 implementation can vary based on several factors, such as number of concurrent users, service applications in the farm, the expected uptime service-level agreement (SLA), etc. These factors dictate how many servers are needed in the SharePoint farm and how the overall farm architecture looks. Based on the these factors, SharePoint 2010 farm implementations can be classified as small farm, medium farm\(^3\) and a large farm\(^4\) deployments.

NOTE: In SharePoint Server 2010, components generally provide functionality for a given service application. As a result, this paper may use the terms “role” and “component” interchangeably. In this context, SharePoint roles refer to one or more components that provide a farm service, and should not be confused with Windows Server roles, which generally include one or more Windows services to provide operating system functionality.

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Small Farm Topology

A typical SharePoint small server farm consists of two tiers: Web front-end/application and database. Dedicated servers are used to host each tier to provide process isolation and to allow for future growth. A server farm deployment model helps ensure that the solution infrastructure is scalable, flexible, and resilient to hardware failures. To achieve these goals, a small farm implementation uses multiple servers at all tiers of the farm deployment. The farm model uses a dedicated database server, and generally distributes Web front-end server roles and application server roles across multiple hosts at the front-end tier. The study described in this paper used SharePoint 2010 small farm architecture to understand how several components of a farm perform when incrementing user loads.

Within the scope of this paper, a virtualized farm configuration was used to study the performance characteristics of SharePoint 2010 on Dell servers and storage. This virtualized configuration describes a SharePoint deployment on virtual machines using Microsoft Hyper-V virtualization. The following sections explain how the virtual farm was configured, and how it performed during the load test.

As shown in Figure 1 and Figure 2, the virtual farm configuration used in the performance study employed PowerEdge R710 rack servers and an EqualLogic PS6000XV storage array for the database backend. The following sections describe the server choice for each of the farm roles, and provide a technical overview of the servers/storage array used in this performance study.

Figure 1: Virtual Farm Configuration - Front View of the Farm

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5 SharePoint 2010 - Designing and implementing a small farm
The PowerEdge R710 server is a two-socket, 2U rack server with support for up to 192GB of physical RAM and the latest quad-core and six-core Intel® Xeon® processors. The R710 supports a maximum internal disk storage capacity of 4.8TB when using 8 x 0.6TB 10K RPM SAS 6Gbps drives in a RAID 0 configuration. It has four PCIe expansion slots that enable future hardware upgrades. In addition, the R710 has four internal LOM 1 GB NIC connections.

The Virtual Farm section describes the PowerEdge R710 hardware configuration and its sizing to implement the virtualization configuration for the SharePoint small server farm in more detail. It also explains why a PowerEdge R710 server is a suitable choice to implement this virtualization farm.

**EqualLogic PS6000XV Storage Array**

The EqualLogic PS6000XV is a virtualized iSCSI SAN that combines intelligence and automation with fault tolerance to provide simplified administration, enterprise performance and reliability, and seamless scalability.

A PS-Series array provides the following features:

- No-single-point-of-failure hardware
  - Redundant, hot-swappable hardware components (disks, control modules, fans, and power supplies)
  - Component failover and disk sparing occur automatically without user intervention or disrupting data availability
  - RAID technology provides data protection in each array
- High-performance control modules (the PS6000 control module has four 1 Gigabit Ethernet interfaces)
- Support for standard Gigabit Ethernet networks.
Virtual Farm Configuration

As a virtualization solution, Hyper-V allows users to take maximum advantage of server hardware by providing the capability to run multiple operating systems (on virtual machines) on a single physical server.

Hyper-V is implemented as a role in Windows Server 2008. There are many updates and functionality improvements in Windows Server 2008 R2. The Hyper-V hypervisor is the core component of Hyper-V, and is responsible for creating and managing isolated execution environments called partitions. The hardware requirement for Hyper-V is the virtualization extensions in the processors (Intel VT or AMD-V™). When the Hyper-V role is enabled in Windows Server 2008 and loaded for the first time, it creates a partition called root or parent partition. The virtual machines created on this hypervisor are referred as child partitions and the operating system installed within a virtual machine (VM) is commonly called guest operating system. Figure 3 shows a high-level architecture of Hyper-V in Windows Server 2008.

The root/parent partition has direct access, and controls all hardware devices such as network, storage, and memory allocation to the partitions. Unlike the parent partition, child partitions do not have access to physical hardware, but rather have virtualized devices. I/O requests from VMs are routed through the parent partition to the physical adapters on the system. Devices presented to the child partitions are either considered synthetic or emulated virtual devices. An emulated virtual device is a software implementation of a typical PCI-device, and requires additional processing power from a
host server. Synthetic virtual devices, which are also implemented in software, use the high-performance VMBus channel as the communication mechanism between partitions.

Hyper-V also includes an integration services which provides better integration between child and parent partitions, device drivers for synthetic devices, and other enhancements such as the Hyper-V Integration Services. The Hyper-V Integration Services automatically install after Windows Server 2008 R2 guest operating system installation completes.

Dell recommends a two-server solution using PowerEdge R710 servers for the virtualized environment in this SharePoint Small server farm. The solution also employs high-availability technology to ensure continuity of service. As mentioned earlier, this SharePoint 2010 small server farm consists of two tiers: Web front-end/Application (WFE/AP) and database server (DB). Deployment of server roles is on virtual machines instead of on physical servers as in physical server solution. VM nodes of WFE/AP and DB are installed across two physical R710 servers using Windows Server 2008 R2 with Hyper-V enabled. In addition, Microsoft SQL Server® 2008 R2 is deployed in an active/passive Microsoft failover cluster environment to provide high availability for the farm database content. Figure 1 provides a high-level view of the server roles in this virtualized configuration.

The two PowerEdge R710 servers are equipped with two 6-core 2.93GHz Intel Xeon X5670 processors, which can provide a total of 12 CPU cores per physical server (multi-threading was not enabled in this deployment). In this configuration, each VM is allocated four virtual processors (vProcs) and appropriate memory. This leaves adequate hardware resources for the host server to support the VMs and any Hypervisor and operating system overhead. Table 1 and Table 2 show the sizing for both physical and virtual servers to support the SharePoint small server farm.

Table 1: Physical server configuration details for a virtual farm

<table>
<thead>
<tr>
<th>Host Platform</th>
<th>Processor</th>
<th>RAM</th>
<th>Storage</th>
<th>Network</th>
<th>OS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x R710</td>
<td>2 x Six-Core 2.93GHz Intel Xeon X5670</td>
<td>48GB</td>
<td>Internal (SAS 15K)</td>
<td>12 x networks for WFE VM Public, DB VM Public/Farm, DB VM Private Cluster, and Host Management: 4 internal NIC ports and 2x(Quad-port Broadcom 5709 NIC)</td>
<td>Windows Server 2008 R2 Enterprise with Hyper-V Role Enabled (with MS hotfix KB974909)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 x 146 GB RAID 1 volumes</td>
<td>OS, VHD Volumes, and Index Pass-thru</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2: Virtual machine configuration details for a virtual farm

<table>
<thead>
<tr>
<th>Virtual Machine</th>
<th>Processor</th>
<th>RAM</th>
<th>Storage</th>
<th>Network</th>
<th>OS</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFE &amp; APP</td>
<td>4 vProc</td>
<td>8GB</td>
<td>OS Fixed VHD • Index Passthru Volume</td>
<td>1 Dedicated Virtual network: 4 port NIC teaming</td>
<td>Windows Server 2008 R2 Enterprise SharePoint 2010 Standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failover Cluster SQL Server DB</td>
<td>4 vProc</td>
<td>16GB</td>
<td>OS Fixed VHD • 4 LUNs for SQL Cluster DB using direct iSCSI Connections</td>
<td>1 Dedicated Virtual Connection for Cluster/Farm network: 4 port NIC teaming • 1 Dedicated Virtual Connection for Private Cluster Network • 2x Dedicated Virtual Network for iSCSI Connections</td>
<td>Windows Server 2008 R2 Enterprise SQL 2008 R2 Standard</td>
</tr>
</tbody>
</table>

NIC teaming was used for the farm network connections on WFE and SQL DB servers to provide sufficient network bandwidth for the farm networking. Two iSCSI connections were used to provide redundancy and load balancing to the back-end storage array. All virtual networks are implemented using isolated Dedicated Virtual Networks to ensure the isolation in the connectivity from each other, as well as from a VM to a parent operating system partition. These require two quad-port Broadcom 5709 NICs and four internal LOM NICs in a PowerEdge R710 server. Figure 4 provides details on how the virtual networks were implemented.
PowerEdge R710 consists of eight HDD bays which provide 4 x 146 GB RAID-1 volumes to host the two VMs. Three local volumes hosted the root operating system partition and two VHDs for WFE/APP and SQL Server DB nodes. The fourth volume was deployed as a pass-through drive for better performance of the farm’s indexing feature.

More importantly, EqualLogic iSCSI PS6000 storage is a suitable solution for this virtualized farm configuration. Hyper-V supports iSCSI connections initiated directly from within a guest operating system to an iSCSI storage array. This means that any iSCSI LUN that is provisioned directly to a guest operating system is not visible to the parent partition. In addition, this provides many advantages for the support of high-availability VMs, VM Quick Migration, and additional storage capacity for the server.

For additional information on Dell value propositions, guidance on best practices to implement Hyper-V in your environment, and other design considerations including networking, storage, and high availability solutions, see the References section of this paper.

**Farm architecture and configuration of farm roles**
The experimental farm has the physical architecture and configuration shown in Figure 1 and Figure 2, with two Web Front End/Application Servers (WFE/APP) and two database servers in a failover cluster. Because there is negligible requirement in processing power on an application server role in this...
SharePoint small farm, the application server role was enabled on the same server as the WFE. This farm was configured to use Windows authentication; therefore, all requests during the load test were authenticated requests.

The farm servers at all tiers used teamed network connections to provide load balancing and failover capabilities.

Table 3 lists the operating system and software editions used in the farm configurations. The rationale for choosing this matrix is explained in the later sections of this paper.

<table>
<thead>
<tr>
<th>Web front-ends</th>
<th>Database Servers</th>
</tr>
</thead>
<tbody>
<tr>
<td>SharePoint Server</td>
<td>SharePoint Server 2010 Standard Edition</td>
</tr>
<tr>
<td>Database Server</td>
<td>NA</td>
</tr>
</tbody>
</table>

Table 3: OS and Software Editions Used in This Study

NOTE: Step-by-step instructions for installing and configuring a SharePoint farm and any service applications used in this performance study are outside the scope of this paper. For more information and resources, refer to the References section of this paper.

Configuration of Web front-end servers
SharePoint 2010 farm design included two Web front-end servers. The software matrix for these web front-end servers is shown in Table 3. SharePoint 2010 Standard Edition was used as the performance study, included only out-of-the-box features of SharePoint, and was a collaboration workload only. As a part of the collaboration workload, only the search service application was deployed and no other service applications such as Excel and Visio.

All of the Web front-end servers were configured in a Network Load Balancing (NLB) cluster⁶. Using NLB, stateless applications like SharePoint Web front-end can be made scalable by adding additional servers when the load increases. Since, as mentioned earlier, the network connections were made redundant by using Broadcom NIC teaming, NLB has been configured to use multicast mode to avoid IP address conflicts⁷ in the farm.

HTTP request throttling
SharePoint 2010 offers resource throttling features that can be configured to help increase server performance and protect server resources during peak usage times. SharePoint 2010 has a default timer job that checks server resources compared to configured throttle levels. By default, server CPU, memory, request in queue, and request wait time are monitored. After three unsuccessful checks, the server enters a throttling period and will remain in this state until a successful check is completed. Requests that were generated prior to the server’s entering throttling mode will be completed. Any

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⁷ Using teaming adapters with network load balancing may cause network problems - [http://support.microsoft.com/kb/278431](http://support.microsoft.com/kb/278431)
new HTTP GET and Search Robot requests will generate a 503 error message, and will be logged in the event viewer.

The throttle settings can be modified to increase the overall load supported by the farm servers. However, this requires a complete study to determine accurate throttle setting recommendations for any given user load or requests per second. The default HTTP throttle monitor settings will prevent an extensive load testing to find out the “real” capacity of the farm servers. Hence, HTTP request throttling was turned off during the load testing of SharePoint.

**Search service application configuration**

SharePoint 2010 changed the search architecture, and introduced high availability at the application tier or crawler. The new search service application architecture in SharePoint 2010 includes greater redundancy. The new design provides flexibility and allows the query and crawler roles to be scaled-out separately on an as-needed basis. Search crawlers are now stateless; they do not store a copy of the index. However, the index does still propagate, and is stored locally on the query servers. Two application servers hosting the crawler role were used in this performance study.

The small farm configuration used the search service application configuration shown in Figure 5. The search crawler and query roles were hosted on both of the Web front-end servers to enable high availability and provide improved search performance. Both crawler roles were associated with the same crawl database, and were crawling the same content source. Two index partitions were created and for redundancy, a copy (or mirror) of the index partition was placed on each Web front-end. On both of the Web front-ends, a dedicated pass-through RAID 1 volume was used to store the index contents.

The search architecture shown in Figure 5 is a logical presentation of how SharePoint Search service was configured. This configuration provides complete redundancy for both search crawler and query roles.

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Network Configuration
For both the Web front-end and application servers and SQL Database Servers, teamed network connections were used in the SharePoint farm’s network. These teamed connections (shown in Figure 2) were configured to be in the smart load balancing mode (SLB), which supports both load balancing and failover.

Configuration of the database server
As shown in Figure 1 and Figure 2, this performance study paper deployed virtual machines hosted on a PowerEdge R710 server as the database servers in the virtualized farm configuration described earlier. Two database servers were deployed in a high-availability failover cluster, with redundant data paths at the database tier of the SharePoint farm.

A SharePoint farm’s performance depends on the performance of the database server and the database backend. Storage resource from the host server which is hosting the virtual machine are limited; therefore, the SQL instance was connected directly to an external EqualLogic iSCSI storage array. In this virtualized configuration of the SharePoint small farm, one EqualLogic PS6000XV storage array was used to provide sufficient storage capacity and I/O bandwidth to the SQL database contents. This array provides 16 x 300GB 15K RPM SAS drives configured in a RAID 10 for storing the SharePoint content.
By default, SQL Server uses all available physical memory, because it dynamically grows and shrinks the size of the buffer pool depending on the physical memory reported by the operating system. However, this behavior can be adjusted to limit the amount of physical memory used by SQL Server. Within the scope of this paper, SQL Server memory was limited to 80% of the actual physical memory available in the system. For example, on the virtual clustered SQL database server, out of 16GB of physical memory, 12.8GB was allocated to SQL Server.

**Database server network configuration**

Similar to the Web front-end and application tiers, the database tier also used teamed network connections for the farm network as shown in Figure 2. For the iSCSI storage network, two LOM connections were dedicated, and MPIO was configured to provide load balancing and failover capability.

**Performance Study of a Small Farm**

SharePoint 2010 is a versatile platform that can be used in a variety of ways. Some SharePoint workloads work almost out of the box, others require or allow significant customization, and still others are the result of completely custom applications. This flexibility results in many possible ways to use SharePoint, which makes it difficult to accurately size servers and storage for a SharePoint farm. Also, since there is no standard benchmark for sizing SharePoint workloads, it is important to provide accurate guidance to customers when recommending the infrastructure elements of a SharePoint implementation. These factors led to the development of the Dell SharePoint Load Generation framework used to perform load testing of a SharePoint farm.

**Dell SharePoint Load Generation framework**

An internally developed load generation framework had been used in understanding the performance characteristics of a SharePoint farm. This framework includes load testing of SharePoint out-of-the-box usage profiles, such as collaboration and publishing.

The Dell SharePoint load generation framework has two components: a content population tool and Microsoft Visual Studio® Team Suite (VSTS) Web test framework.

**Content population tool**

The content population tool is designed to prepare the SharePoint farm for load testing. This content population tool was designed to distribute the SharePoint content across multiple site collections.

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Figure 7: SharePoint Content Population Tool

The content population tool was developed to

- Create SharePoint Web applications
- Create site collections
- Add Web components to home pages
- Create document libraries
- Create SharePoint list items
- Upload documents/images, etc.

This utility is capable of populating hundreds of gigabytes of SharePoint content in a few hours. The size of the SharePoint content database — and other aspects such as number of site collections, etc. — vary based on the usage profile selection. A usage profile is a collection of use cases closely mapped to realistic SharePoint usage. To some extent, these usage profiles were mapped to SharePoint Capacity Planning Tool\(^\text{10}\) and other Microsoft recommendations. Although SharePoint Capacity Planning Tool was intended for MOSS 2007, there are several aspects of these recommendations\(^\text{11}\) that still apply to SharePoint 2010 out-of-the-box workloads. The content generated and uploaded by the content population tool serves as a baseline for SharePoint 2010 load testing using Visual Studio test framework.

VSTS load testing framework

Dell’s SharePoint load generation framework uses VSTS 2010 to perform load testing. Within VSTS, each load test directly maps to a SharePoint usage profile, and each usage profile defines a list of use cases and how many use cases are run per hour per connected user. Using VSTS 2010 helps to rapidly create use cases and parameterize those use cases. SharePoint load testing is performed using a test rig, as shown in Figure 8, of several physical test agents. The results are captured in to a SQL database on the test controller.


As mentioned earlier, the load test usage profiles were based on the SharePoint Capacity Planning Tool (SCP) and other Microsoft recommendations for SharePoint 2010. SCP defines several usage profiles for both collaboration and publishing workloads. These usage profiles are categorized as low, medium, and heavy-usage profiles. These categories define several aspects of a usage profile, such as how many requests are sent per hour per connected user, what use cases constitute a load test, and what percentage (test mix) of each use case is used within each load test.

Within the scope of this paper, a heavy collaboration usage profile was used. Table 4 shows the heavy collaboration test mix as suggested by SCP.

<table>
<thead>
<tr>
<th>SCP Usage Profiles</th>
<th>Heavy Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Page Access (%)</td>
<td>30</td>
</tr>
<tr>
<td>List Page Access (%)</td>
<td>20</td>
</tr>
<tr>
<td>Document/Picture Download (%)</td>
<td>15</td>
</tr>
<tr>
<td>Document/Picture Upload (%)</td>
<td>8</td>
</tr>
<tr>
<td>Search (%)</td>
<td>15</td>
</tr>
<tr>
<td>Total requests/hour/connected user</td>
<td>60</td>
</tr>
</tbody>
</table>

*Table 4: SCP usage profile definition*

As shown in Table 4, SCP defines only a high-level test mix for each usage profile. Table 5 shows a more granular translation of this heavy collaboration usage profile. Several use cases were mapped to each of the categories, and the number of use cases per hour per connected user was assigned.
<table>
<thead>
<tr>
<th>Heavy Collaboration Test Mix</th>
<th>Number of tests/hr/connected user</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Home Page Access</strong></td>
<td></td>
</tr>
<tr>
<td>Read Site Home Page</td>
<td>18</td>
</tr>
<tr>
<td><strong>List Page Access</strong></td>
<td></td>
</tr>
<tr>
<td>Read Survey</td>
<td>6</td>
</tr>
<tr>
<td>Read Lists</td>
<td>6</td>
</tr>
<tr>
<td><strong>Document/Picture Download</strong></td>
<td></td>
</tr>
<tr>
<td>Read Document Library</td>
<td>2</td>
</tr>
<tr>
<td>Read Home to Document Library</td>
<td>1</td>
</tr>
<tr>
<td>Read Wiki Page</td>
<td>2</td>
</tr>
<tr>
<td>Read Picture Library</td>
<td>1</td>
</tr>
<tr>
<td>Read Home to Wiki Page</td>
<td>2</td>
</tr>
<tr>
<td>Read Home to Picture Library</td>
<td>1</td>
</tr>
<tr>
<td><strong>Document/Picture Upload</strong></td>
<td></td>
</tr>
<tr>
<td>Create Wiki Page</td>
<td>3</td>
</tr>
<tr>
<td>Upload Document</td>
<td>2</td>
</tr>
<tr>
<td><strong>Search</strong></td>
<td></td>
</tr>
<tr>
<td>Search Site</td>
<td>10</td>
</tr>
<tr>
<td><strong>List Item Insertion/Deletion</strong></td>
<td></td>
</tr>
<tr>
<td>Respond to Survey</td>
<td>2</td>
</tr>
<tr>
<td>Reply to Discussion Topic</td>
<td>1</td>
</tr>
<tr>
<td>Edit Wiki Page</td>
<td>2</td>
</tr>
<tr>
<td>Comment home to blog post</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total tests/hour/connected user</strong></td>
<td>60</td>
</tr>
</tbody>
</table>

*Table 5: Dell’s Test mix for a heavy-collaboration profile*

It is important to note that Dell’s test mix shown in Table 5 is not a one-to-one mapping to SCP recommendations. For example, SCP defines total requests per hour per connected user. However, within Dell’s test mix for the heavy collaboration profile, this translates to more requests than 60 per hour, as the usage profile uses 60 tests per hour per connected user. Additionally, one test could mean more than one request. Hence, the results published in this paper may or may not map directly to SCP recommendations, and are specific to the workload mix defined in Table 5.

**Test methodology**

The intent of the experiments conducted as a part of this performance study was to understand the capacity of a small SharePoint farm as shown in Figure 1 and Figure 2, with the configuration described in Table 2. Several load test iterations were conducted with incrementing user load. For example, an initial user load of 250 virtual users was used, and the same had been incremented by 250 users until the farm resources reached an optimal level of utilization. The overall goal of the load test was to ensure that the processor utilization was below 60% and the average farm response time below one second.
The data set used to build the content database included several different types of files. This includes Microsoft Office documents, Adobe® PDF documents, and several image formats. Table 6 shows a distribution of file content sizes used in this performance study.

<table>
<thead>
<tr>
<th>Average File size</th>
<th>Number of files</th>
</tr>
</thead>
<tbody>
<tr>
<td>1KB to 500KB</td>
<td>34240</td>
</tr>
<tr>
<td>500KB to 1MB</td>
<td>5223</td>
</tr>
<tr>
<td>1MB to 10MB</td>
<td>13003</td>
</tr>
<tr>
<td>10MB to 70MB</td>
<td>125</td>
</tr>
</tbody>
</table>

Table 6: Data set

The aggregated SharePoint content database size was around 53GB. During the load test duration, this content database grew by almost 20%. This performance study involved load testing of out-of-the-box SharePoint deployment using a test mix shown in Table 5. A full content crawl was performed once at the beginning of the load tests. There were no subsequent crawls after load testing or during the load test duration.

The performance data shown in this paper was a result of load testing on the final configuration of a SharePoint farm as described in Table 2. The following sections of this paper described the performance data and how several components within the farm performed at incremental user loads.

Performance Results & Analysis

As a part of this performance study, several performance metrics were collected and analyzed. Based on the results, the farm configuration was adjusted to reach the final farm configuration shown in Figure 1 and Figure 2. This section describes the performance data metrics captured from the load test. As mentioned earlier, this study included only collaboration workload and the test mix shown in Table 5. Therefore, all results shown here are relative to the workload used and may differ with any other implementation outside of the test mix shown.

The following table shows, at a high level, how the SharePoint 2010 farm performed in terms of maximum concurrent user load achieved and requests per second.

<table>
<thead>
<tr>
<th>SharePoint 2010 Virtualized Small Farm</th>
<th>Max concurrent user load achieved</th>
<th>Requests per second\textsuperscript{12} at Max concurrent user load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1500</td>
<td>73.7/sec</td>
</tr>
</tbody>
</table>

Table 7: Farm Performance

The virtualized SharePoint small farm shown in Figure 1 could support up to 1,500 concurrent users with an average farm response time of 0.12 seconds at the maximum user load tested on the final

\textsuperscript{12} This number indicates the avg. requests per second generated during the load test duration and this is a VSTS reported metric
configuration. This indicates that the farm architecture used for this performance study could support faster\(^{13}\) sub-one-second farm response times, even at the maximum concurrent user load.

\[\text{Figure 9: Avg. Response time - Virtual Farm}\]

The average processor utilization on the Web front-end servers in this farm configuration was below 50%, even at the maximum user load. As expected because NLB was used at the Web front-end tier, all WFEs were more or less equally loaded.

In a heavily loaded scenario, even though the average processor utilization is below 50%, the SharePoint 2010 farm (Figure 1) may not support more users than what is shown in Table 7. This is mainly because of the ASP.NET and IIS request queue length limitations. The out-of-the-box IIS and ASP.NET queue length settings can be adjusted to go beyond the concurrent user load shown in this performance study paper. This, however, is outside the scope of this paper, and may require an in-depth study in itself.
The overall network utilization was well below 50% of the total available bandwidth, 4GB of a four-NIC teaming in this virtualized farm configuration. The following charts capture the network utilization at Web front-end and database tiers of the farm, and show the aggregated performance numbers of the teamed NICs used on all servers in the farm. The database network utilization numbers in the following chart are an aggregation utilization of all network channels used in MPIO.

In addition, performance results show that maximum memory utilization on the Web front-end servers at the maximum user load was within 50% of the available physical memory. This indicates that there is enough room for future growth, while providing high availability for all SharePoint roles hosted on Web front-end servers.

As shown in Figure 1 and Figure 6, one EqualLogic PS6000XV array was used, and four SQL server databases were placed on the iSCSI LUNs provisioned on this array. The following charts show how these iSCSI LUNs performed during the load test with incrementing user loads.

The I/O generated by the test mix shown in Table 5 was relatively small in size (~100KB), and was random I/O. This resulted in approximately 160 disk transfers per second$^{14}$ (see Figure 12) to the LUNs$^{15}$ provisioned on the EqualLogic iSCSI enclosure.

![Figure 12: Avg. Disk Transfers per Second](image)

With a 16-disk iSCSI backend, disk seconds per transfer was well below one second, and showed that the EqualLogic array was capable of handling a heavy collaboration workload of 1,500 concurrent users.

$^{14}$ Captured using Visual Studio
$^{15}$ Search DB is not included in the charts here as there was more or less no disk access during load test
Figure 13: Avg. Disk Second per Transfer

Figure 14 shows the average disk queue length for each iSCSI volume used to store the SharePoint 2010 databases.

The EqualLogic PS6000XV array with a 16-disk backend provided optimal performance for the SharePoint databases. All the performance metrics were seen to be well within the acceptable limits.

To thoroughly understand the system response of a Hyper-V host, each individual virtual machine, as well as the PowerEdge R710 server under heavy load, another experimental load test run was

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completed with the same test mix of a heavy-collaboration profile. User load was increased gradually to the maximum workload of 1,500 users. Figure 15 and Figure 16 show the processor utilization and the system’s memory availability of the Hyper-V hosts and virtual WFE & SQL database machines.

**Figure 15: Processor Utilization of Hyper-V Hosts & Virtual Machines**

Allocated with 4 virtual processors each VM, WFE1-VM/WFE2-VM and SQL database server SQL1-VM utilized almost 60% and 30% (at its maximum value) respectively of their processing power. The Hyper-V host, VM1-SP10, which hosted the WFE1-VM and the active cluster SQL machines, had a total of 7% in its processor utilization. Figure 17 is a zoom-in view of VM1-SP10’s processor utilization. On the other hand, the other Hyper-V host, VM2-SP10, utilized less processing power due to the containment of a passive cluster SQL machine.
Figure 16: Total Memory Availability of Hyper-V Hosts & Virtual Machines

The total memory availability of Hyper-V hosts and VMs are sufficient. There is enough available memory for each node to performance under a maximum workload.

Figure 17: Processor Utilization of a Hyper-V Host
As shown in Figure 17, the Hyper-V utilized a total 7% processor power at maximum with 1,500 user load. This shows that PowerEdge R710 server is a suitable choice to host Hyper-V virtual machine and it has sufficient available hardware resource for the SharePoint farm’s future growth. As mentioned in Table 2 VMs consumed eight virtual processors out of the total twelve physical cores of the Hyper-V host, a PowerEdge R710 server. Hyper-V virtual processor does not have one-to-one mapping with logical processor on a host server; Hyper-V hypervisor handles scheduling of virtual processors on any available logical processor.

Summary

A SharePoint 2010 farm consists of multiple servers, each of which is provisioned with different SharePoint components. A smaller SharePoint farm in general is a best choice for small and medium businesses with relatively lower concurrent user load. A small SharePoint farm employs a two-tier architecture with all SharePoint Web front-end and application roles hosted on the Web front-end servers, and, at the database tier, one or more SQL Servers in a failover cluster are used to enable high availability of SharePoint databases. The reference architecture used in this performance study enables high availability at all tiers of the farm, and provides complete search service application redundancy by hosting two crawlers and mirroring the index partitions.

SharePoint 2010 can be used in many different ways, and each implementation needs an in-depth study of requirements, such as expected user load, requests per second, and future growth. This performance study paper was intended to understand the performance capacity of a virtualized small SharePoint 2010 farm built on Windows Server 2008 Hyper-V R2, using PowerEdge rack servers and EqualLogic iSCSI storage. This study showed that the virtualized farm configuration could support approximately 15,000 users, with a minimum concurrency of 10 percent. Also, the average farm response time was well below one second. The EqualLogic PS6000XV array provided highly optimal performance for the SharePoint 2010 deployment used in this performance study.
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