White Paper

EMC PERFORMANCE OPTIMIZATION FOR MICROSOFT FAST SEARCH SERVER 2010 FOR SHAREPOINT

EMC Symmetrix VMAX, EMC FAST VP, Microsoft Hyper-V

- Optimize scalability and performance of FAST Search Server 2010 for SharePoint
- Validate virtualization of FAST Search infrastructure
- Scale-out architecture for enterprise configurations

EMC Solutions Group

This white paper describes the architecture of an enterprise-scale SharePoint collaboration farm with file share content and rich search capabilities provided by Microsoft FAST Search 2010 on EMC® Symmetrix® VMAX™ storage with EMC FAST VP enabled. Data protection is provided by EMC Replication Manager with replication and recoverability of the SharePoint content, the file share, and the FAST Search index.

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Executive summary

Business case

Microsoft FAST Search Server 2010 for SharePoint offers a new choice for large-scale companies whose business relies heavily on a high- performance search engine. Combining the power of FAST Search with the simplicity of SharePoint, Microsoft FAST Search Server 2010 for SharePoint delivers an exceptional intranet and people-search experience as well as a platform for building custom search-driven applications.

The deployment of FAST Search Server 2010 for SharePoint requires careful planning and an understanding of both SharePoint and FAST Search server workloads with regard to CPU, memory, network, and disk I/O requirements. Implementing this solution normally requires an extensive consulting engagement. This solution offers valuable guidance to the implementation team.

Customers often request virtualization of a FAST Search server farm, but because of the nature of search platforms, customers often assume that server virtualization on a SAN is not a good fit for such a high-demand platform as FAST Search.

Solution overview

This solution demonstrates the use EMC® Symmetrix® VMAX™ with Fully Automated Storage Tiering for Virtualized Pools (EMC FAST VP) technology to deploy an enterprise-class Microsoft FAST Search server farm. The solution demonstrates methods for moving from a physical to virtual FAST Search infrastructure.

This solution has two main objectives:

- Deploying a FAST Search server farm on physical servers.
- Virtualizing the FAST Search server farm with Windows Server 2008 R2 and Hyper-V.

This solution differentiates EMC from other storage and infrastructure vendors by providing guidance about enterprise-class storage and server requirements. This solution is designed for both physical and virtualized deployments of the FAST Search server environments.

In this solution, the EMC Symmetrix VMAX auto tiering technology provides sufficient support for both the storage I/O demands of a FAST Search server and a SharePoint farm. The virtualization of both the SharePoint farm and FAST Search server provides all the benefits of virtualization without sacrificing the performance of either the SharePoint farm or the FAST Search server.

Rapid local protection is achieved with EMC Symmetrix TimeFinder/Snap managed by EMC Replication Manager for FAST Search file systems and databases.

We achieved tremendous I/O requirements of this solution through a Brocade 8G Fibre Channel SAN for storage connectivity. Brocade 8G FC Host Bus Adapters (HBAs) and the DCX-4S backbone provided fully provisioned 8G FC connectivity between servers and the high performance EMC Symmetrix VMAX storage array.

"We" in this section as well as the remaining sections in this paper includes a team of EMC and partner solutions engineers who designed, built, and validated the solution presented in this document.

Key results

This solution demonstrates the following results:

- **Scalability**
  - EMC built an enterprise-scale SharePoint content farm with a unique data set for FAST Search indexing and searching. The farm consisted of 4 TB of SharePoint corpus (content) and a 5 TB file share indexed by a Microsoft Fast Search 2010 for SharePoint farm.
  - EMC Symmetrix VMAX can scale to accommodate FAST Search with low disk pool utilization while providing sufficient support for a 9 TB FAST Search server farm operation (crawl and mixed work load).
  - With EMC Symmetrix virtual provisioning, a Symmetrix VMAX storage platform can scale to accommodate Hyper-V for FAST Search server consolidation by providing on-demand storage space.
- **Performance**
  - All performance testing results for FAST Search were well within the ideal latency time (less than 1 second) as described by Microsoft. The FAST farm can serve 20 QPS with 0.07 seconds latency.
  - EMC auto tiering technology with Flash drives improved the query performance by 20 percent.
- **Server virtualization**
  - The virtualized FAST Search server farm provided search results similar to the physical FAST Search server environment while using less physical servers and CPUs.
  - The full crawl rate is about 50 percent slower than that in the physical FAST Search server environment because of a Hyper-V CPU constraint in the virtual environment.
- **User experience**
  - The FAST Search user experience in both the physical and virtualized FAST Search server farms was very similar. The search latency time was less than 0.5 seconds in both environments.

- **Protection**
  - EMC performed replication under a normal user load.
  - For a 4 TB SharePoint farm, replication completed in less than 15 minutes.
  - For a 5 TB file share, replication completed in about 2 minutes
  - For the entire FAST Search server farm, replication took about 8 minutes.
  - Replication for both the SharePoint and FAST Search server farms finished without any interruption or visible performance degradation.
  - It took 85 minutes to restore the SharePoint farm content of 5 TB.
  - It took less than 15 minutes to restore the entire FAST Search index. The search resumed after only a very short period of incremental crawl.

Introduction

Purpose

This white paper describes a large-scale solution that includes a content-centric environment with SharePoint managing its file shares and Microsoft FAST Search indexing and searching its content.

EMC built this architecture on an EMC Symmetrix VMAX storage system with the auto tiering technology enabled. With a virtualized SharePoint farm, the FAST Search servers are first deployed on physical servers and are then moved to a virtualized environment.

By focusing on scalability testing of Microsoft FAST Search, this white paper provides guidance for sizing and storage profiling of both the SharePoint farm and the FAST Search server farm and assesses the impact of FAST Search on overall SharePoint performance. This white paper also validates EMC Replication Manager-based backup of the entire SharePoint and the FAST Search server farms as well as the restoration of the SharePoint content and the FAST Search server farm.

Scope

This white paper:

- Describes the solution architecture of FAST Search servers deployed on both physical servers and a virtualized SharePoint farm with Microsoft Hyper-V enabled.
- Validates the architecture and methodology against the solution objectives and service-level agreement (SLA) goals.
- Proves that customers can virtualize FAST Search servers with acceptable crawl performance and comparable query performance while reducing host servers and decreasing maintenance costs and, adding server-level resiliency with a Hyper-V cluster.
- Demonstrates the value of the auto tiering technology, which automates the storage tiering and improves search performance.
- Profiles the impact of local replication by using Replication Manager and TimeFinder/Snap jobs to provide protection for both SharePoint and FAST Search server farms.

Audience

This white paper is intended for Microsoft SharePoint 2010 database administrators and storage architects involved in planning, architecting, or administering an environment with EMC Symmetrix VMAX as the storage platform and Brocade as the 8G FC SAN infrastructure. The paper is also intended for individuals planning to implement replication solutions.

Terminology

Table 1 describes some terminology that appears in this paper.

Table 1. Terminology

Term	Definition
Microsoft SharePoint 2010	SharePoint 2010 provides a broad, central application platform for common enterprise Web requirements. SharePoint's multi-purpose design allows you to manage and provision intranet portals, extranets, websites, documents and files, collaboration spaces, social tools, enterprise searches, business intelligence, process integration, system integration, workflow automation, and core infrastructure for third-party solutions.
Microsoft FAST Search Server 2010 for SharePoint	A new Microsoft product based on the FAST search technology. It combines the FAST high-end search capabilities with the SharePoint. FAST Search can connect to dozens of different systems, parse hundreds of different types of files, and provide airtight security and access control.
EMC Symmetrix VMAX	EMC Symmetrix VMAX with Enginuity™ version 5875 incorporates a new, highly scalable Virtualized Matrix Architecture™ that enables VMAX arrays to grow seamlessly and cost-effectively from an entry-level configuration into the world's largest storage system.
Microsoft Hyper-V	Microsoft Hyper-V in Windows Server 2008 and Windows Server 2008 R2 enables you to create a virtualized server computing environment. Hyper-V provides the software infrastructure and basic management tools that you can use to create and manage a virtualized server computing environment.
EMC Symmetrix FAST VP	Builds on and extends the capabilities of virtualized provisioning to provide a new form of FAST for Symmetrix at a sub-LUN level. EMC FAST VP can automatically plan and implement non-disruptive changes to storage allocations and optimize the use of a storage configuration composed of different drive technologies.
EMC Replication Manager	Manages EMC point-in-time replication through a centralized management console. Replication Manager coordinates the entire data replication process—from discovery and configuration to the management of multiple application consistent disk-based replicas.

Technology overview

Introduction

This solution includes the following components:

- **Microsoft FAST Search Server 2010 for SharePoint**

  Offers a new choice in enterprise search

- **Microsoft Hyper-V**

  Virtualizes server computing environment

- **EMC Symmetrix VMAX storage**

  Offers storage with high performance, scalability, and security

- **EMC Symmetrix FAST VP**

  Enables automatic storage tiering

- **EMC Replication Manager**

  Backs up and restores entire environment with minimal performance impact

Microsoft FAST Search Server 2010 for SharePoint

Microsoft FAST Search Server 2010 for SharePoint provides significant enhancements for enterprise search capabilities.

You can use FAST Search Server 2010 for SharePoint to resolve several search problems. It provides enhanced general productivity searches and also improves high-value search applications. High-value search applications drive measurable returns on investment (ROI) by helping a specific set of people obtain the most from a specific set of information. Common examples include product support applications, research portals, and customer record locators.

Microsoft Hyper-V

Microsoft Hyper-V on Windows Server 2008 R2 enables you to create a virtualized server computing environment. Hyper-V provides a software infrastructure and basic management tools that you can use to create and manage a virtualized server computing environment. You can use this virtualized environment to address business goals aimed at improving efficiency and reducing costs.

EMC Symmetrix VMAX

With the strategy of building simple, intelligent, and modular storage, EMC Symmetrix VMAX with Enginuity™ version 5875 incorporates a new, highly scalable Virtualized Matrix Architecture™ that enables Symmetrix VMAX arrays to grow seamlessly and cost-effectively from an entry-level configuration into the world's largest storage system. Symmetrix VMAX offers more efficiency, scalability, and security.

EMC Symmetrix FAST VP

Fully Automated Storage Tiering for Virtualized Pools (EMC FAST VP) builds on and extends the capabilities of virtualized provisioning to provide a new form of FAST for Symmetrix at the sub-LUN level. It automatically implements non-disruptive changes to storage allocations and optimizes the use of a storage configuration composed of different drive technologies. These optimizations take full advantage of the fast response time of Flash drives and provide the most cost-effective use of a mixed drive type configuration while providing the best performance.

EMC Replication Manager

EMC Replication Manager manages point-in-time replication through a centralized management console. Replication Manager coordinates the entire data replication process—from discovery and configuration to the management of multiple application-consistent, disk-based replicas. With Replication Manager, you can put the right data can in the right place at the right time—on demand or based on schedules and policies that you can easily define. This application-centric product provides simplified replica management with application consistency.

Brocade 8G FC SAN Infrastructure

Brocade 8G Fibre Channel Host Bus Adapters provide the highest performance storage I/O for Microsoft SharePoint and FAST Search servers. In conjunction with Brocade's full 8G FC line rate performance DCX backbones, we can attained the best FAST Search performance numbers.

SharePoint and FAST Search server role overview

Introduction

FAST Search Server 2010 for SharePoint builds on SharePoint Server 2010, and significantly enhances the enterprise search capabilities. The server role of the SharePoint 2010 farm contains the traditional SharePoint 2010 server roles as well as the new search service application server roles specifically for FAST Search connectors. The FAST Search server includes many processes and components. This architecture is derived from FAST Enterprise Search Platform (ESP), which provides enterprise-level scalability.

SharePoint server roles

The SharePoint 2010 farm configuration contains the following components:

- SharePoint central and site administration server
- SharePoint Web front-end server
- SQL Server 2008 R2 database server
- FAST Search Content Search Service Application (SSA) server
- FAST Search Query SSA server

The following are the functions of these servers:

SharePoint administration server

The solution deployed the SharePoint administration server on a Windows Server 2008 R2 virtual machine using a Windows Server 2008 R2 Hyper-V host. The Internet Information Service (IIS) had its own application pool that was separate from other services.

SharePoint Web front-end server

The solution deployed Web front-end servers on a Windows Server 2008 R2 virtual machine using a Windows Server 2008 R2 Hyper-V host with the following specifications:

- IIS provides Web content to SharePoint clients
- IIS Web garden threads use the default value 1 for optional performance and ease of management
- IIS logging is disabled to limit the unnecessary growth of log files and to optimize performance

Database server

The solution deployed the resource-intensive database servers on a Windows Server 2008 R2 virtual machine using a Windows Server 2008 R2 Hyper-V host with the following specifications:

- SQL Server 2008 R2 Enterprise application servers
- Database and log LUNs attached through pass-through LUNs.

FAST Search content SSA server

This solution deployed the FAST Search content SSA server on a Windows Server 2008 R2 virtual machine using a Windows Server 2008 R2 hyper-V host with the following specifications:

- The FAST content SSA enables retrieving (crawling) content for indexing from content repositories
- The content SSA represents the default indexing connector for the FAST Search Server 2010 for the SharePoint deployment
- Secure Sockets Layer (SSL) communication is enabled between the SharePoint server and the FAST Search server farms
- A dedicated LUN is attached as the pass-through LUN to store the content index files from the crawling operation

FAST Search query SSA server

This solution deployed the FAST query SSA on a Windows Server 2008 R2 virtual machine using a Windows Server 2008 R2 Hyper-V host. This server provided the query-side integration between the FAST Search Server 2010 for SharePoint farm and the parent SharePoint farm. It served as a gateway between a local or remote Web front-end server and the FAST Search Server 2010 for SharePoint farm.

EMC validation team installed and deployed the FAST Search query SSA on a SharePoint application server within the SharePoint server farm. The FAST Search query SSA contained query and crawl components for the people search function. A dedicated LUN was attached as the pass-through LUN for the query and crawl components.

FAST Search server roles

The Microsoft FAST Search Server 2010 for SharePoint farm topology contains various components that can be scaled out on multiple servers for performance and fault-tolerance purposes. The section briefly introduces the FAST Search server roles and the content flow.

Item processing component

The item processing component receives items to be indexed from indexing connectors and processes the items according to the given configuration. The item processing component then sends the processed items to the indexing service.

Content distributor

The content distributor communicates with the indexing connectors and organizes the feeding of documents from indexing connectors to the indexing service. You can set up a primary and a backup content distributor for fault-tolerance.

Web link analysis (Web analyzer)

Use the Web analyzer to analyze the search click-through logs and hyperlink structures. Both contribute to better-ranked search results.

Items that show many clicks in the search click-through log are popular and therefore receive better ranking scores than less-viewed items. Items to which many other

items are linked are also perceived to be more relevant for the user and therefore receive better rank scores.

The Web analyzer improves search relevancy by:

- Analyzing the link graph
- Adding anchor texts and a query independent rank boost based on link cardinality to the items in the index

Anchor texts describe the items they refer to and can improve recall and relevancy when a query term matches the anchor text. Items to which many links point are ranked higher.

The Web analyzer may scale out to many nodes to reduce the total time that is needed for the analysis. To do this, add dedicated lookup database components and link the processing components that are used during the link analysis.

Search cluster

The search cluster provides the main topology for indexing and query matching. These components require their own scaling models by using a matrix of servers in a row and column configuration.

Indexing

The indexing component creates inverted indexes, based on the items that it receives. The indexing component sends these inverted indexes to the query matching component for later use during query evaluation.

The indexing service consists of two components, the indexing dispatcher component and the indexing component. If the indexing service is deployed on multiple nodes, instances of these components are also deployed on multiple nodes.

Query processing

The query processing component performs pre-processing of the queries and post-processing of the results. Query processing includes query language parsing, linguistic processing, and item-level security processing. Result processing includes merging the results from multiple index columns, formatting the query hit list, formatting the query refinement data, and removing duplicates.

Content flow in a FAST Search server farm

The content flow in the FAST Search farm is as follows:

1. Item processing extracts searchable content from retrieved documents and processes the items based on the written language.
2. The indexing component converts the searchable content into inverted indexes that are, in turn, used by the query matching.
3. Query processing processes user queries by performing query transformations, such as synonym expansion, before matching the actual query against the index.

4. Query matching uses the search indexes to return items that match a user query. The items are returned in a query hit list that is sorted by the relevancy to the specified query.

Figure 1 demonstrates the detailed content flow and the internal content flow in FAST Search farm.

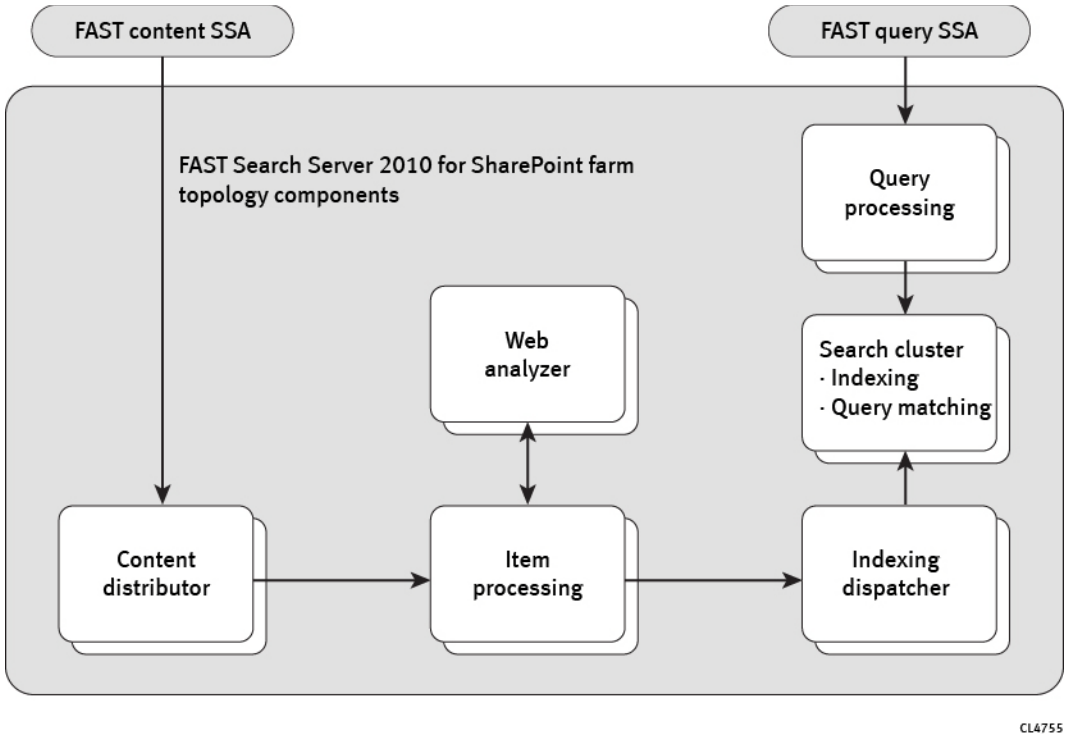


Figure 1. FAST Search for SharePoint farm topology and work flow

Solution architectures

Solution profile

The validation team tested this solution reflected in the configuration profile shown in Table 2.

The searchable content contained 4 TB of the SharePoint content. The SharePoint content was stored in 20 content databases, each of which was up to 200 GB. A 5 TB file share was stored on one of the SharePoint application servers.

Table 2. Environment profile

Item		Value
Content type		doc, docx, pdf, xls, xlsx, ppt, pptx, txt
Average content size		1.65 MB
Total data		4 TB (not externalized)
Document size range		20 KB - 50 MB
Total site count		200
Content database size (each)		Up to 200 GB
Total site collections		20
Sites for each site collection		10
Total user count		22,000
User concurrency		10 %
Total data		9 TB
Data size	SharePoint content	4 TB
	File Share	5 TB
Number of documents	SharePoint content	2,000,000
	File share	3,000,000
SharePoint–usage profiles (percentages for browse/search/modify)		80/10/10 70/5/25 50/20/30

Server architecture design overview

The solution contains the following two architectures:

- Physical FAST Search servers with virtualized SharePoint 2010 farm
- Virtualized FAST Search servers with virtualized SharePoint 2010 farm

For purposes of clarity, EMC refers to the configuration with the physical FAST Search server farm as the physical architecture and the configuration with the virtualized FAST Search server farm as the virtualized architecture in this document.

Physical FAST Search design

The five physical FAST Search servers had the following components:

- Two index and search servers
- Two document processors and content distributors
- One FAST Search administration server

Virtualized FAST Search design

The virtualized FAST Search design had the following differences in contrast with the physical FAST Search servers:

- The virtual design used two physical servers as Hyper-V hosts to replace the five physical servers
- The virtual design deployed five virtualized FAST Search servers for the same server performance as the physical FAST Search server farm

Physical FAST Search server solution architecture

The physical architecture of a FAST Search server farm demonstrated the typical deployment of a FAST Search server configuration.

The validated solution was a SharePoint 2010 farm using EMC Symmetrix VMAX with Hyper-V virtualization. The FAST Search servers were deployed on five physical hosts; the content SSA and query SSA were deployed on the SharePoint farm.

The SharePoint farm consisted of the following components:

- Three physical hosts with Hyper-V enabled
- All SharePoint servers are virtualized on the Hyper-V hosts
  - One Admin server
  - One Application server
  - Four Web front-end servers
  - Two SQL Servers

SharePoint native enterprise search was disabled and the content SSA and query SSA were deployed for feeding content and delivering queries to the FAST Search server farm.

The content SSA crawled content and fed it into the back end of FAST Search Server 2010 for SharePoint. The FAST Search query SSA provided query results from all content sources, which included the file share content and the SharePoint content in this solution.

The five physical hosts for the FAST Search server farm included:

- Two document processing servers, each with 12 document processors. One document processing server (with the primary Web analyzer) serves as content distributor and the other (with the secondary Web analyzer) serves as indexing dispatcher.
- Two index and search servers, each with six document processors.
- One FAST administration server with 18 document processors.

The query SSA and content SSA servers for the FAST Search server farm deployed as virtual machines on the SharePoint farm Hyper-V hosts.

Figure 2 depicts the overall architecture of the validated solution environment for the physical FAST Search server farm.

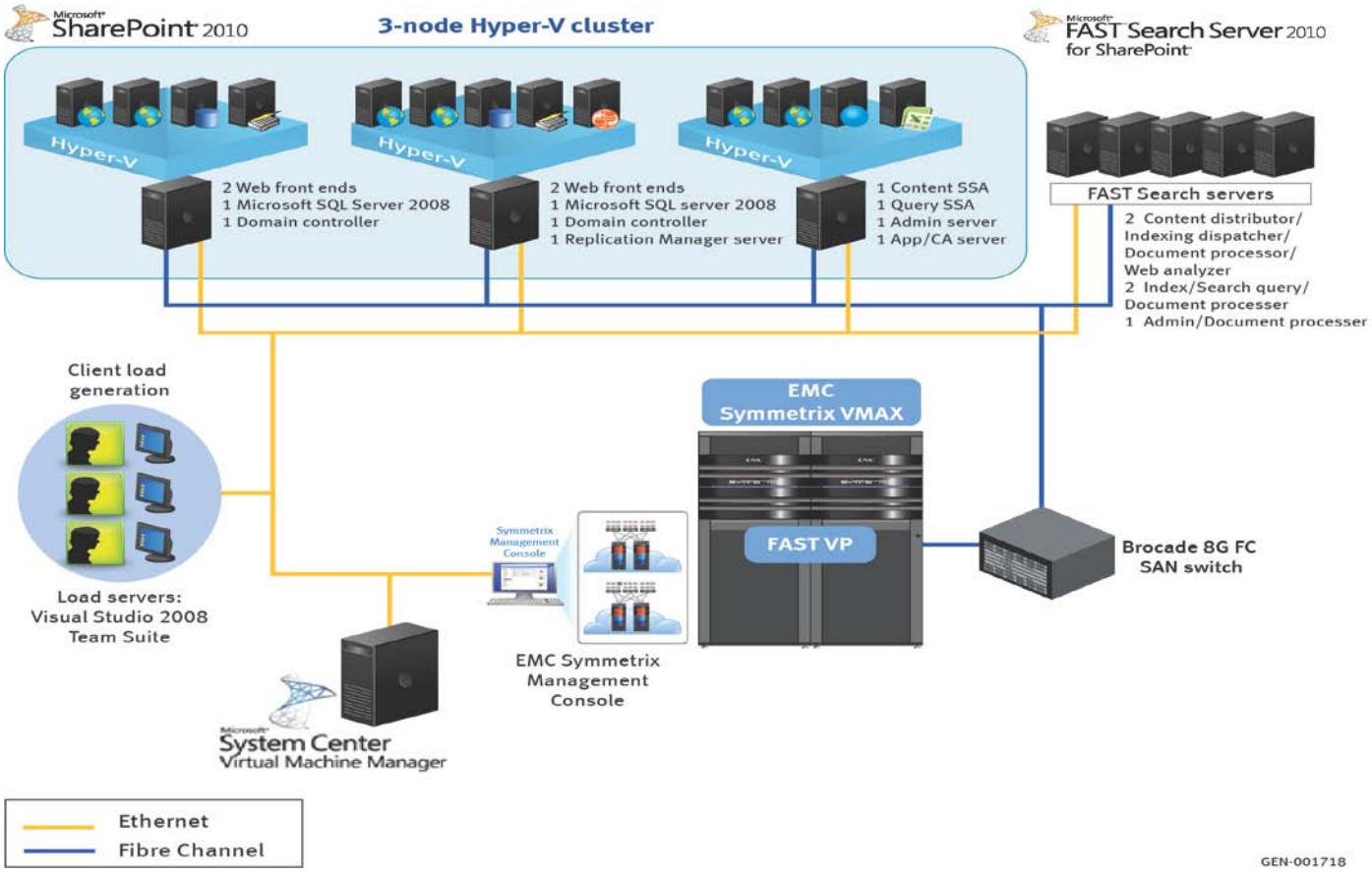


Figure 2. Physical FAST Search servers with a virtualized SharePoint farm

Physical FAST Search server deployment

Figure 3 shows the deployment architecture of a physical FAST Search server farm. For the actual deployment.xml content, refer to the Deployment file in the physical FAST Search farm section.

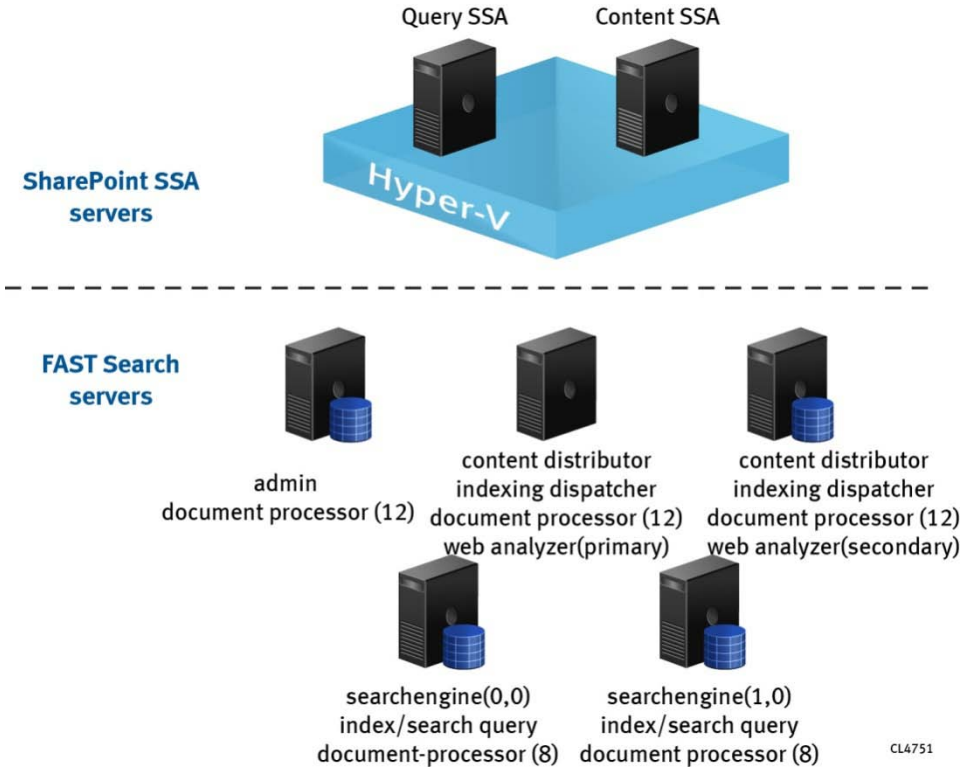


Figure 3. Physical FAST Search server farm configuration

Virtualized FAST Search solution architecture

Before migrating the FAST Search servers into the virtualized environment, the solution team considered the following factors:

- **The CPU number limitation of the guest virtual machine**

  The CPU number of the Windows 2008 R2 Hyper-V virtual machine is limited to four. EMC suggests that you set the CPU number for each virtual machine to four to get the best indexing and query performance in the virtualized environment.

- **FAST Search server license cost**

  The FAST Search license is based on the number of FAST Search servers. Adding more servers means a higher cost. You should consider a similar number of FAST Search servers when moving from a physical to a virtualized environment with a FAST Search server farm.

The virtualized architecture of the FAST Search server farm demonstrated a virtualized FAST Search server configuration.

The configuration of the FAST Search server farm is as follows:

- The two physical hosts with Hyper-V enabled include:
  - Two document processing virtual machines, each with eight document processors (the Hyper-V virtual machine has a limit of four processors; virtual machines cannot scale to more than four document processors).
  - Two index and search virtual machines.
  - One FAST administration virtual machine, with six document processors and a primary Web analyzer.
- The solution team deployed the query SSA and content SSA servers for the FAST Search server farm as virtual machines on the SharePoint farm Hyper-V hosts.

Figure 4 depicts the overall architecture of the validated solution environment for the virtualized FAST Search server farm.

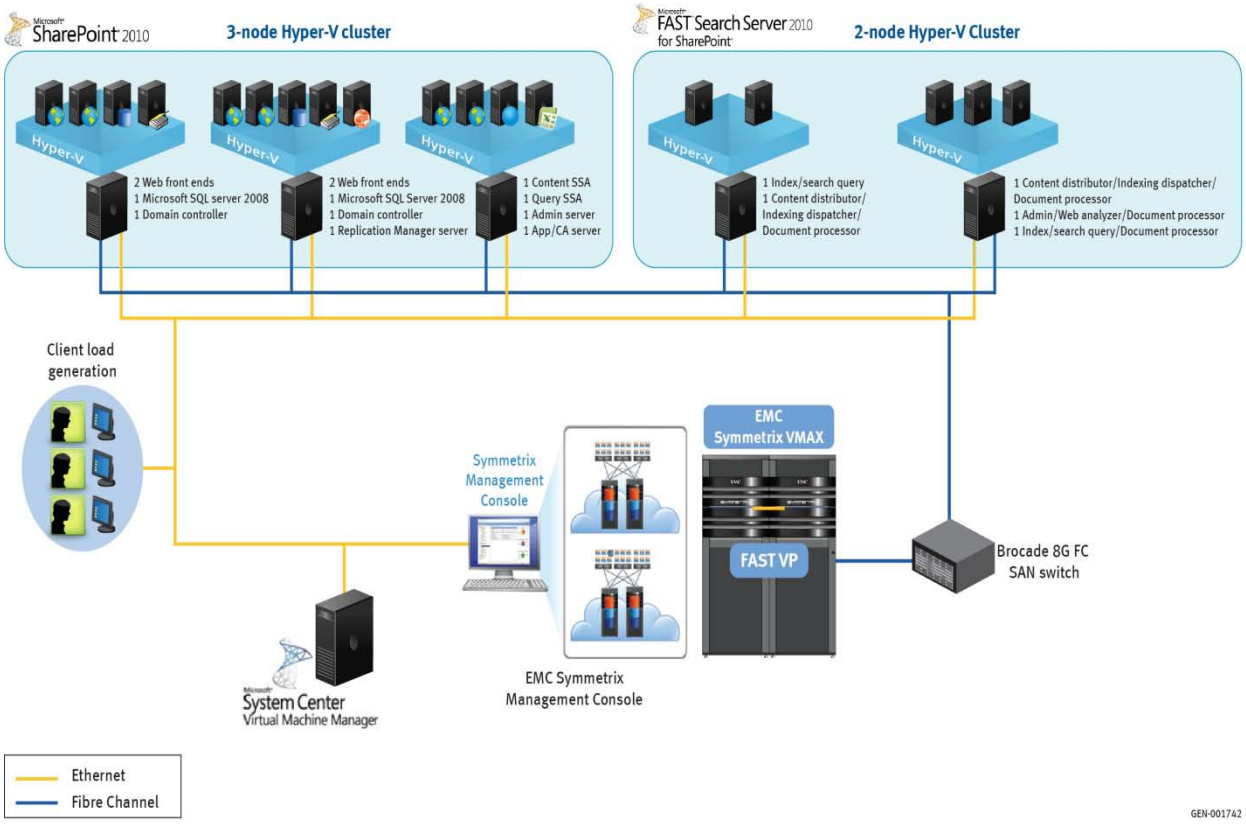


Figure 4. Virtualized FAST Search servers with a virtualized SharePoint farm

Virtualized FAST Search server deployment

Figure 5 shows the deployment architecture of the FAST Search server for a virtualized FAST Search server farm. For the actual deployment.xml content, refer to the Deployment file in the virtualized FAST server Search farm section.

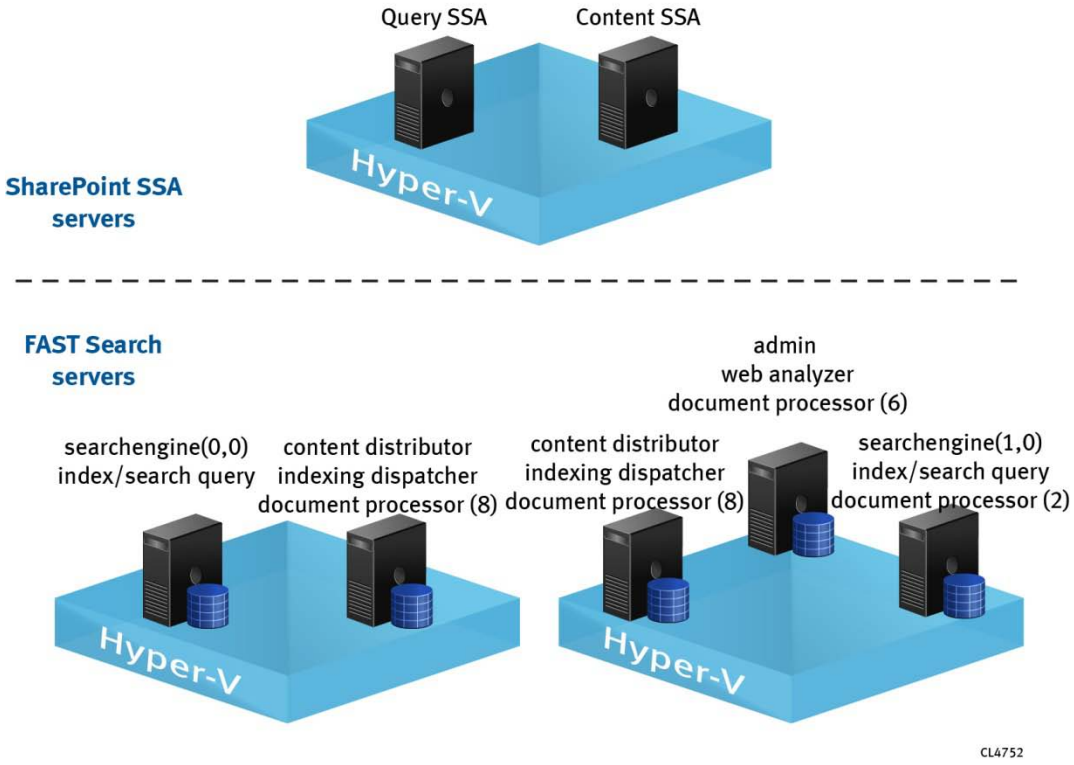


Figure 5. Virtualized FAST Search server farm configuration

Hardware resources

Table 3 shows the hardware resources for both physical and virtualized architectures.

Table 3. Hardware resources

Equipment			Quantity	Configuration
Symmetrix VMAX			1	Four engines 32 front-end directors 32 back-end directors 942 disks of the following types: 200 GB Flash drives, 600 GB 10,000 rpm Fibre Channel (FC), 450 GB 15,000 rpm FC, 1 TB 7,200 rpm SATA Cache: 248 GB
SharePoint Servers	Hyper-V hosts		3	Four sockets, quad cores, 128 GB memory
	Virtual machines		12	Two SQL Servers–4 vCPUs/32 GB Four WFEs–4 vCPUs/6 GB Two DCs–2 vCPUs/4 GB One APP/CA–2 vCPUs/4 GB One query SSA–4 vCPUs/8 GB One content SSA–4 vCPUs/8 GB One Replication Manager server virtual machine–2 vCPUs/4 GB
FAST Search servers	Physical		5	Two sockets, six cores, 48 GB Two indexing/search services One FAST administrator Two document processors with Web analyzers Two Brocade 825 dual port 8G FC HBAs
	Virtualized	Hyper-V hosts	2	Two sockets, six cores, 48 GB Two Brocade 825 dual port 8G FC HBAs
		Virtual machines	5	Two indexing/search services–4 vCPUs/16 GB One FAST administrator with Web analyzer and document processor–4 vCPUs/16 GB Two document processors–4 vCPUs/8 GB
Fibre Channel (FC) switches			2	Brocade DCX four-slot 8G FC backbones (minimum of 24 ports)
Network switches			1	1 GB IP switch (24 ports)
Systems center virtual machine manager (SCVMM)			1	Quad core/8 GB

Software resources

Table 4 lists the details of the software resources for both physical and virtualized architectures.

Table 4. Software resources

Title		Quantity	Version
Microsoft Windows Server (Hyper-V)	In the SharePoint farm	3	2008 R2
	In the FAST Search farm (for virtualized FAST Search farm only)	2	
Microsoft Windows Server		22	2008 R2
Microsoft SQL Server		2	2008 R2
Microsoft FAST Search server		5	2010 SP1
Microsoft SharePoint		8	2010 SP1
EMC Replication Manager		1	5.4
EMC PowerPath®		11	5.5
EMC Solution Enabler		12	7.3
EMC Symmetrix Management Console		1	7.2
KnowledgeLake Virtualized Studio Team System (VSTS) test code		1	1.3

Solution design and considerations

Microsoft SharePoint 2010 farm design

Overview

In SharePoint 2010, the crawl servers indexed the content of the SharePoint farm, then populated the crawl and property stored on the SQL database server and added content index files on the query server.

The SharePoint server farm hosted the query interfaces and content collection (crawling) interfaces for the search solution. FAST Search provided the back-end indexing and query matching capabilities and the administration of these features.

With FAST Search configured, the SharePoint native enterprise search was disabled and the SharePoint native crawl server and query server were replaced with the FAST Search content SSA connector and the FAST Search query SSA. This allowed the FAST Search servers to crawl and index all of the SharePoint content, providing query capabilities for the SharePoint farm.

In this test environment, 20 content databases on two SQL Server instances were populated with over 2,200,000 documents, which added up to 4 TB of data. The file share with over 3,000,000 documents occupied another 5 TB of data.

Considerations

SharePoint farm was designed for optimizing performance, reducing bottlenecks, and easing manageability.

The SharePoint 2010 farm consisted of:

- A Web application created by using the enterprise portal collaboration template.
- Sixteen enterprise document center site collections created on 16 content databases on two SQL Server hosts.
- Two SharePoint crawl servers.
- Four SharePoint query servers.
- Four SharePoint Web front-end servers.

When designing servers in a SharePoint farm for FAST Search servers, consider the following:

- Two crawlers: Each node pushes content into the FAST Search server. In most cases, a content SSA was hosted in a SharePoint 2010 farm. Two nodes were designed to push as much content as possible.
- Content SSA: Only one content SSA can be leveraged. In the current FAST Search edition, you cannot have multiple content SSAs.
- Query SSA: Only one query SSA can be leveraged. It is possible to scale out the components of that single query SSA to provide fault tolerance and higher query rates.

Database design

The sequence of building a SQL Server environment for SharePoint 2010 required three database subsets in the following order:

1. SQL system databases created during installation (master, model, msdb, and tempdb)
2. SharePoint databases systematically created from the deployment of SharePoint farms (SharePoint administration, configdb, crawl store, Windows SharePoint Services (WSS), and the content database)
3. SharePoint content databases populated by adding the user content documents in the SharePoint farm

The content database designed met the following requirements:

- The solution must support a content database of up to 250 GB capacity or 2,000 document items
- The solution must support over 2,000,000 documents, each with 4 TB data. The SharePoint farm is designed to have 20 content databases for 20 sites and 200 sub-sites
- One 250 GB pass-through LUN is configured for each content database and one 50 GB LUN is configured for each content database log

Microsoft Hyper-V cluster and virtual machine design for virtualized SharePoint 2010

When the solution team completed the SharePoint farm server LUN design and disk calculations, the team was able to calculate the virtual machine and Hyper-V requirements. Guidelines for SharePoint memory configurations are provided at Microsoft TechNet.

Based on the requirements, the SharePoint server virtual machines must support CPU utilization of less than 80 percent.

Based on Microsoft guidelines and vendor server specifications, the solution team determined the CPU and memory requirements for each virtual machine role.

The team provisioned a 120 GB virtual hard disk (VHD) volume for the SharePoint server operating system and used pass-through disks for the database and log volumes.

Table 5 details the configuration of the virtual machine CPU and memory.

Table 5. Detailed virtual machine design for the SharePoint farm

Virtual machine name	Number of servers	Number of vCPUs	Memory (GB)
Web front-end server	4	4	4
Admin server	1	2	4
SQL Server	2	4	16
FAST Search content SSA server	1	4	8
FAST Search query SSA server	1	4	8

Table 6 shows the Hyper-V server configuration for the SharePoint farm.

Table 6. Hyper-V server configuration for the SharePoint farm

Item	Description
Number of Hyper-V Servers	Three
CPU	Four sockets, six cores
Memory	128 GB
CPU number per server	24
Number of HBA per server	Two dual-port Brocade 825 8G FC HBAs

Physical FAST Search Server 2010 for SharePoint farm design

FAST Search Server 2010 for SharePoint provides an enterprise search infrastructure for the SharePoint server farm. It provides the back-end indexing and query matching capabilities and the administration of these features.

The FAST content SSA is the default indexing connector. It retrieves content from various content sources, such as SharePoint content repositories and the file server.

The physical FAST Search environment had five servers with a total of 60 CPUs, which provided the ability to maximize the document processors for indexing. This environment deployed a total of 52 document processors.

This environment deployed five FAST Search servers, each with the following server roles:

FAST Search admin server role

The FAST Search administration server was installed on a Windows Server 2008 R2 physical host. The administration server provided both the administrative function and the document processor function (12 document processors).

FAST Search content distributor server role

Two FAST Search content distributor servers were installed on Windows Server 2008 R2 physical host. These servers provided the following server roles:

- Content distributor
- Indexing-dispatcher
- Web analyzer (one as the primary, the other as the secondary)
- Document-processor (12 document processors for each server)

FAST Search indexing server role

Two FAST Search indexing servers were installed on a Windows Server 2008 R2 physical host. One of the indexing servers acted as the primary server and the other acted as the secondary server, which made a one-column, two-row index. Each server had eight document processors.

Virtualized FAST Search Server 2010 for SharePoint farm design

The design for a SharePoint farm in a virtualized environment was the same as in a physical environment. The validation team consolidated the FAST Search server farm into two Hyper-V servers; but the five FAST Search servers (virtual machine) remained the same. We reduced the number of document processors to 24 because of the CPU number limitation of Hyper-V virtual machines.

To preserve CPU power for document processing in the virtualized environment, the Web analyzer redundancy was not deployed and the server roles were also shifted among servers.

This environment deployed five FAST Search server virtual machines, each with the following server roles:

FAST Search administration server role

The FAST Search administration server was installed on the Windows Server 2008 R2 virtual machine of the Windows Server 2008 R2 Hyper-V host. The administration server had the following server roles:

- Administration
- Document processor (with a number of six)
- Web analyzer

FAST Search content distributor server role

Two FAST Search content distributor servers were installed on the Windows Server 2008 R2 virtual machine of the Windows Server 2008 R2 Hyper-V host. These servers provided the following server roles:

- Content distributor
- Indexing dispatcher
- Document processor (eight document processors for each server)

FAST Search indexing server role

Two FAST Search indexing servers were installed on the Windows Server 2008 R2 virtual machine of the Windows Server 2008 R2 Hyper-V host. One of the indexing servers acted as the primary server and the other acted as the secondary server, which made a one-column, two-row index. A backup indexing server also provided document-processing services (two document processors).

Test methodology design and data preparation

Preparing random data

The data in the content database and the file share were files downloaded from various sources. Each document generated hundreds of unique documents by inserting a keyword and timestamp into the original document. By changing the document name for the generated file to include the timestamp, we ensured that the documents in the test environment were unique. We used the keywords and timestamps in the search test to ensure the uniqueness of the search results.

Configuring the SharePoint farm for FAST Search

Follow these steps to configure the SharePoint farm to make it suitable for the FAST Search server:

1. Disable SharePoint native enterprise search
2. Remove the existing SharePoint SSAs if already created
3. Configure the FAST Search content SSA in the SharePoint farm
4. Install the FAST Search certificate on FAST Search servers
5. Configure the FAST Search query SSA
6. Change the default application proxy group for the SharePoint portal so that it is associated only with the FAST Search query application that is created
7. Install the certificate on the FAST administration server

Data distribution

In this environment, two different content sources were created: A 5 TB file share and 4 TB of content managed through SharePoint content databases.

- File share: The 5 TB file share was created on the SharePoint application server with a LUN of 5 TB.
- SharePoint content: The 4 TB of content for the SharePoint server was distributed across two SQL Servers, each with 10 databases. The file types were typical Microsoft Office files, including .doc, docx, xls, xlsx, ppt, pptx, Adobe Acrobat PDF file, and text file.

Table 7 presents the content load profile used during the solution validation.

Table 7. Content load profile

Item	Value
Content type	doc, docx, pdf, xls, xlsx, ppt, pptx, txt
Number of SharePoint items	2,190,954

Item	Value
Average SharePoint content size	1.82 MB
Number of file share items	3,124,223
Average file share content size	1.60 MB
Average content size for all content	1.65 MB

VSTS test client and test mechanism

The validation team used Microsoft Visual Studio Team System (VSTS) to simulate the SharePoint load and a client load emulation tool to ensure that the SharePoint farm operates at the optimal performance level.

The validation team built the testing environment with a VSTS team test rig with one controller and four agents.

Throughput is the number of operations (browse/search/modify) that a SharePoint farm can perform each second. Ideally, the number of operations that SharePoint requests per second is lower than the number targeted for a given level of performance. If the number of operations that SharePoint requests exceeds the target number, user actions and other operations take longer to complete.

Throughput is measured by request per second (RPS). You can convert RPS measurements to the total number of users by using a model of typical end-user behavior. Like many human behaviors, there is a broad range for typical behavior. The user model for the SharePoint environment has the following two variables:

- **Concurrency**: The percentage of users that are actively using the system.
- **Request rate**: The average number of requests per hour that an active user generates.

Request per hour (RPH) is the average user requests in an hour to calculate how long it takes to deliver a page back to the client. Use the following calculation to estimate the throughput for typical load:

$$\text{Throughput} = \frac{(\text{number of users}) \times (\text{percentage of active users})}{\text{request rate}}$$

For example, for 1,000 users, the following values result:

Simultaneous users = 1000 × 10% = 100

Estimated requests per user per hour = 36 = 1 request per user per 100 seconds

Throughput = simultaneous users/request rate = 100/100 = 1 RPS

Therefore, 1 RPS can support up to 1,000 users, each making 36 requests per hour. Table 8 describes throughput targets for four levels of user load.

Table 8. Throughput targets for user load

User load	Request rate	Supported users
Light	20 requests per hour. An active user generates a request every 180 seconds.	Each response per second of throughput supports 180 simultaneous users and 1,800 total users.
Typical	36 requests per hour. An active user generates a request every 100 seconds.	Each response per second of throughput supports 100 simultaneous users and 1,000 total users.
Heavy	60 requests per hour. An active user generates a request every 60 seconds.	Each response per second of throughput supports 60 simultaneous users and 600 total users.
Extreme	120 requests per hour. An active user generates a request every 30 seconds.	Each response per second of throughput supports 30 simultaneous users and 300 total users.

In this use case, all users adhered to a Microsoft typical user profile, which specified 36 requests per hour. In a typical user profile, the average user decision-making time for browsing, searching, or modifying data on a SharePoint server was eliminated. Every user request completed from start to finish without a pause, which generated a continuous workload on the system.

The VSTS testing includes the following key scenarios:

- Browse: The user selected a random URL from a previously viewed page. If a previously viewed page did not include any links, the tool used the default top level URL.
- Search: When a user navigated to the Search page and executed a search, a specific URL accepted the query string parameter. This query string parameter was randomly picked from a data set that was in memory on the load agent machine.
- Modify: A user randomly selected a URL from a data set randomly sampled from the content database on the load agent machine. The code retrieved the document and its metadata (basically a browser-like operation where properties of a document were viewed). The code updated a property and saved it back to SharePoint (a document update operation).

On a SharePoint server, the validation team:

- Updated binary and metadata content in the content database on the SQL Server.
- Wrote an entry to the change log in the Search database.
- Synchronized the SharePoint properties with the property values stored inside the actual document itself. A subsequent content download or upload operation occurred in the content database.

A change log entry resulted in the asynchronous crawling of the document led to further action against the search database as well as a download operation from the content database.

The test client used VSTS to test FAST Search Server 2010 for SharePoint performance. The test application simulated the operations of the SharePoint farm access.

During validation, a Microsoft heavy user load profile determined the maximum user count that the Microsoft SharePoint 2010 server farm could sustain while ensuring that the average response time remained within acceptable limits. Microsoft standards state that a heavy user performs 60 requests per hour.

Microsoft recommends that the response time from the Web front-end is categorized in the following way:

- **Slow (3-5 seconds)**: User response time is acceptable at this rate.
- **Recommended (1-2 seconds)**: This is the average user response time target.
- **Fast (less than 1 second)**: This is for organizations whose businesses demand speed.

You can find other relevant information on this topic at Microsoft TechNet.

User load profile

The validation team used a common mix of user profiles to emulate different types of business organizations. For example, some organizations were browse intensive, while others were search-intensive, modify-intensive, or both.

Table 9 shows the times for the browse, search, and modify operations of various user profiles.

Table 9. Times of browse, search, and modify operations

User profile	Browse/Search/Modify
1	80/10/10
2	70/20/10
3	50/30/20

The validation team ran all tests from a load controller host that spread the load evenly across each of the four load agent hosts. The load controller host also collected performance metrics for analysis from all of the load agents and hosts in the farm.

SharePoint response time requirement

The validation team conducted the tests based on the user response time requirement for Microsoft SharePoint 2010 for different user operations. To be considered as a well-performing SharePoint environment, all operations (browse/search/modify) are required to take less than 3 seconds.

Table 10 lists the required response time for Microsoft SharePoint 2010 user operations.

Table 10. Required response time

Test type	Details	Required response time
Browse	User browse	Less than 3 seconds
Search	Unique value search	Less than 3 seconds
Modify	Browse and metadata modify	Less than 3 seconds

Storage design

Overview

Storage design contains:

- SharePoint storage design
- FAST Search storage design
- Symmetrix auto tiering (FAST VP) design
- Replication Manager snapshot storage design

SharePoint storage design

The storage for the SharePoint farm typically requires middle to low IOPS on both the content database and the search components. The SharePoint storage design for this solution is as follows:

- Disk group design
  - Sixteen 600 GB 10,000 rpm Fibre Channel (FC) disks were used for the SharePoint boot and the operating system LUN.
  - Sixteen 450 GB 15,000 rpm FC disks were used for the SQL Server tempdb/log, SharePoint property database, configuration database, and crawl database.
  - Forty 2 TB 7,200 rpm SATA disks were used for the SharePoint content database (4 TB in total) and file share (5 TB in total).
- Virtualized provisioning pool design
  - The RAID type for the SATA and FC pool was RAID 1.
  - All disk groups used virtualized thin provisioning.
  - Concatenated meta devices were used.
- Virtual machine disk type design
  - The virtual machine boot and operating system LUN used the VHD disk type.
  - The EMC validation team added all other devices to virtual machines by using the pass-through LUN.
- LUN design

- The validation team designed appropriate LUNs to satisfy the various SharePoint component size requirements. Table 11 shows the LUN design for SharePoint.

Table 11. LUN design for SharePoint

LUN usage	Disk group	Disk type	RAID type	Capacity (GB)	Number of LUNs	Description
SQL Server 1	Disk group A	16 x 450 GB 15,000 rpm FC disks	RAID 1	100	4	tempdb
			RAID 1	100	1	tempdb log
			RAID 1	2	2	Mount point
			RAID 1	25	1	Property database and log Search Admin database and log
			RAID 1	40	1	SharePoint configuration databases and logs
			RAID 1	250	1	Crawl database LUN
			RAID 1	50	1	Crawl database log
	Disk group B	40 x2 TB 7,200 rpm SATA disks	RAID 1	250	10	Content databases
			RAID 1	30	10	Content databases log
SQL Server 2	Disk group A	40 x 2 TB 7,200 rpm SATA disks	RAID 1	100	4	tempdb
			RAID 1	100	1	tempdb log
			RAID 1	2	2	Mount point
	Disk group B	16 x 450 GB 15,000 rpm FC disks	RAID 1	250	10	Content databases
			RAID 1	30	10	Content databases log

FAST Search storage design

According to Microsoft, when using SAN storage instead of local disks for FAST Search servers, you should use the following estimation:

- 2,000 to 3,000 I/O operations per second (IOPS)
- 50 KB to 100 KB average block size
- Less than 10 milliseconds average read latency

The actual workload might require much less IOPS. Fewer SAN LUNs can serve a large data set crawl and query under heavy user load.

The FAST Search storage design for this solution is as follows.

Disk group design

For FAST Search storage, the validation team tested two different configurations

- FC-only storage without the auto tiering technology
  - One hundred and six 450 GB 15,000 rpm FC disks were used for FAST Search
- Flash, FC, and SATA disks with the auto tiering technology
  - Four 200 GB Flash disks
  - Forty-eight 450 GB 15,000 rpm FC disks
  - Sixteen 2 TB 7,200 rpm SATA disks

Virtualized thin provisioning pool design

The virtualized thin provisioning pool design is as follows:

- The RAID type for SATA and FC pool is RAID 1
- All disk groups use virtualized thin provisioning
- Concatenated meta devices are used

FAST Search volume design

The FAST Search index in this solution consisted of one column and two rows; the LUN size was 2 TB for each index LUN.

LUNs were designed to satisfy the different FAST Search component size and I/O requirements. Table 12 shows the LUN design for FAST Search volumes.

Table 12. LUN design for FAST Search

LUN usage	Disk type		RAID type	Capacity (GB)	Number of LUNs
	Without auto tiering	With auto tiering			
FAST index 01 (FiXML/index primary)	**Disk group C:** 106 x 450 GB 15,000 rpm FC disks	**Disk group D:** 48 x 450 GB 15,000 rpm FC disks; **Disk group E:** 4 x 200 GB Flash disks; **Disk group F:** 16 x 2 TB 7,200 rpm SATA disks	RAID 1	2000	1
FAST index 02 (FiXML/index backup)			RAID 1	2000	1
Index dispatcher/Content distributor			RAID 1	500	2
Administrator/Web analyzer (in a virtualized FAST Search server farm)			RAID 1	80	1

Symmetrix auto tiering technology design

Symmetrix auto tiering technology provides an easy way to utilize the storage service specializations of an array configuration with a mixture of drive types. It offers a simple and cost-effective way to provide optimal performance of a given mixed configuration by automatically tiering storage to the changing application needs. We chose the tiers for this solution for FAST Search volumes and set the policies to allow data movement between the tiers to optimize performance.

The solution used the following the auto tiering policy:

- Flash: 20 percent
- Fibre Channel: 30 percent
- SATA: 50 percent

Refer to Table 12 for details of the LUN design.

FAST Search virtual machine storage design

In the virtualized FAST Search environment:

- We used Virtual hard disk (VHD) for all virtual machine boot and operating system LUNs.
- We added all other devices to virtual machines by using the pass-through LUN.

Replication Manager snapshot storage design

TimeFinder/Snaps use space-saving pointer-based snapshots called virtualized devices (VDEVs). The Replication Manager-engaged TimeFinder/Snap storage design for this solution is as follows:

- Disk group design:
  - Twelve 450 GB 15,000 rpm FC disks were used for the save pool LUN
- Save pool design:
  - Set the RAID type for the save device pool as RAID 1
  - Configure TimeFinder/Snap save devices for the default save pool

Replication Manager design considerations

The following are some considerations for designing Replication Manager-enabled snaps or clones for SharePoint farm and FAST Search volumes.

General SharePoint configuration for Replication Manager

SharePoint search indexes and search databases must be located on separate LUNs from the content database and logs. At least one SharePoint host must have the Windows SharePoint services VSS writer enabled. The SharePoint farm account must have local administrative rights on the SharePoint writer host. For more information, see the reference document *EMC Replication Manager 5.4.0 Product Guide.*

Allocating the same LUN size for snap/clone LUNs

This ensures that the Replication Manager-managed storage pool matches the source production LUNs with the snap or clone LUN. Each snap or clone LUN must match the

size of the source LUN. If the production LUN is a meta LUN, the meta member size of the snap or clone should also be identical to the source LUN.

Disabling SCSI filtering for parent partition in Hyper-V

To ensure that the SharePoint LUN and FAST volume can be backed up using TimeFinder/Snap, install EMC solutions enabler on the servers as a prerequisite. Exclude the SharePoint component and FAST Search volumes from the Replication Manager installation binary LUN. Also, disable SCSI filtering (See Additional information).

Installing FAST Search Server on a separate device

To separate I/O from the FAST Search operation and to make replication and restore easier, it is recommended to install FAST Search server on a device separate from the operating system.

Moving SharePoint component to a separate device

EMC suggests that you install SharePoint on a device separate from the operating system.

By default, the crawler component, the administration component, the index component, and the crawler/index database are created in the SQL Server installation directory. Move these databases to a separate, dedicated LUN to ensure good performance and easy replication and restore.

You can modify the index location on the SharePoint Search service application topology modification page. You can modify the SSA administration component by using the following PowerShell script:

```
Set-SPEnterpriseSearchAdministrationComponent
```

Refer to Move Admin component for Search service application for more information. You can also find more details at Microsoft TechNet.

Restoring Microsoft SharePoint 2010 and FAST Search volumes

The following are some considerations for restoring SharePoint 2010:

- The SharePoint service VSS writer must be running
- Do not schedule a search crawl during the period of the restore
- SQL Server instances involved with the restore must be started and operational
- The Windows SharePoint services timers on all SharePoint hosts must be stopped and do not restart the service until after the restore is complete

Note You should back up the crawl store database, FAST administration database, Web analyzer data should with the FAST index at the same time to ensure consistency. You can back up the databases only when the crawl operation is paused or stopped and the content SSA is paused. You should restore these databases to the same point in time to make sure consistency with restored indexes.

The following is the prerequisite for restoring FAST Search volumes:

1. Stop all FAST Search services on the FAST Search servers. You can use the following command to list FAST Search services:

   ```
   nctrl status
   ```

2. Use the following command to stop FAST Search services:

   ```
   nctrl stop servicename (ie nctrl stop indexer)
   ```

Testing and validation methodology

Overview

The testing and validation of this solution contains two phases.

- Phase one validated the FAST Search server farm in the physical environment. It confirmed that the storage area network (SAN) storage has enough performance capacity to support 9 TB of content with FAST Search Server 2010 for the SharePoint farm. By tuning the FAST Search server, services can achieve better crawl and search performance.
- Phase two virtualized the FAST Search server farm. It validates that the same SAN storage configuration can support virtualized a FAST Search server farm with reasonable crawl and search performance. This phase also tested the local protection of both the SharePoint farm and the virtualized FAST Search server farm.

FAST Search raw I/O subsystem performance validation

This test validated that the disk subsystem that serviced I/O-intensive activity on the FAST Search servers can support the FAST Search requirements for the index/query LUN. As recommended by Microsoft, the solution tested different I/O sizes to validate that the I/O subsystem can sustain enough IOPS for different I/O patterns.

The validation team used IOmeter to test the raw I/O performance with the following settings:

- Each server had eight active workers to issue 1 KB, 32 KB, and 100 KB of I/O
- 1 TB of data was generated to eliminate the cache effect on each server

IOmeter test methodology

The I/O subsystem test used IOmeter as the testing tool. IOmeter is an I/O subsystem measurement and characterization tool for single and clustered systems. For detailed information, refer to the IOmeter website.

After installing IOmeter, the first step is to generate a suitable test file. Considering that EMC Symmetrix VMAX has 248 GB of mirrored cache, to pass most of the IOPS through to the back-end disks, four test files of 1 TB each are generated on the FAST Search index servers.

Table 13 shows the minimum number of IOPS recommended by Microsoft for a FAST Search server I/O subsystem. Refer to the Microsoft TechNet website for more information.

Table 13. Microsoft FAST Search servers I/O subsystem recommendation

Disk layout	1 KB read (IOPS)	32 KB read (IOPS)	32 KB write (IOPS)	100 MB read	100 MB write
Microsoft recommended minimum	2,000	1,800	900	500	250

Phase one: Validating the FAST Search server farm in the physical environment

In the first phase, the EMC validation team built and tested the physical FAST Search server farm using the following methods:

Measuring performance during a full crawl

This test measured the performance of FAST Search servers, SharePoint servers, and EMC Symmetrix VMAX during a full crawl of a 4 TB SharePoint content database and a 5 TB file share. We gathered the following performance counters to measure the FAST Search full crawl performance:

- **Full crawl rate**: Items crawled per minute and crawl throughput per minute
- **I/O subsystem**: Average IOPS, latency of the front-end hosts/virtual machines of the FAST Search servers and SharePoint servers, and back-end Symmetrix VMAX
- **CPU utilization**: CPU utilization of the front-end hosts/virtual machines of the FAST Search servers and SharePoint servers

Using VSTS to measure performance

This test measured the performance of FAST Search servers, SharePoint servers, and Symmetrix VMAX after the environment is fully indexed. The performance of three VSTS profiles (percentages for browse/search/modify) is 80/10/10, 70/20/10, and 50/30/20.

Besides the performance counters gathered in full crawl, the team gathered FAST Search query server performance to measure query performance.

Phase two: Validating the FAST Search server farm in the virtualized environment

In the second phase, the validation team consolidated the physical FAST Search server farm into a two-node Hyper-V cluster with virtual machines for FAST Search servers.

The shift from a physical FAST Search Server for SharePoint 2010 environment to a virtualized computing infrastructure made the management and deployment of FAST Search servers much easier while maintaining comparable search performance. With Symmetrix VMAX and auto tiering, virtualized FAST Search Server 2010 for SharePoint can have the expected crawl performance and can maintain similar search performance as physical FAST Search servers.

In this phase, the validation team built and tested virtualized FAST Search server farm using the following methodologies:

Measuring performance during a full crawl

This test measured the performance of FAST Search servers, SharePoint servers, and Symmetrix VMAX during a full crawl of a 4 TB SharePoint content database and a 5 TB file share.

We gathered the following performance counters to measure the FAST Search full crawl performance:

- **Full crawl rate**: The items crawled per minute and crawl throughput per minute
- **I/O subsystem**: Average IOPS, latency of the front-end hosts/virtual machines of the FAST Search servers and SharePoint servers, and back-end Symmetrix VMAX

- **CPU utilization**: Front-end hosts/virtual machines of the FAST Search servers and SharePoint servers

Using VSTS to measure the performance

After fully indexing the environment, the team measured the performance against three VSTS profiles including 80/10/10, 70/20/10, and 50/30/20 (percentages for browse/search/modify). These performance results are comparable with those from the physical environment.

In addition to the full crawl, the team measured the query performance for FAST Search query server performance.

Symmetrix auto tiering impact on SharePoint performance

You can enable the Symmetrix auto tiering technology to improve the handling of peak system load conditions. After enabling auto tiering, the validation team measured the performance for FAST Search servers, SharePoint servers and Hyper-V hosts, and Symmetrix VMAX storage to see the benefit of automatically tiering the storage workload for the entire environment.

EMC Replication Manager-engaged test methodology

Replication Manager job impact on FAST Search

To configure Replication Manager-engaged TimeFinder/Snap for the SharePoint and FAST Search server farms, you must configure the Replication Manager jobs. In the solution, we configured three Replication Manager application sets. We created Replication Manager jobs to replicate the file share, SharePoint, and FAST Search indexes. We created Replication Manager jobs for the five FAST Search volumes, the 5 TB file share, and the SharePoint 2010 farm components.

Figure 6 shows configured application sets and jobs .

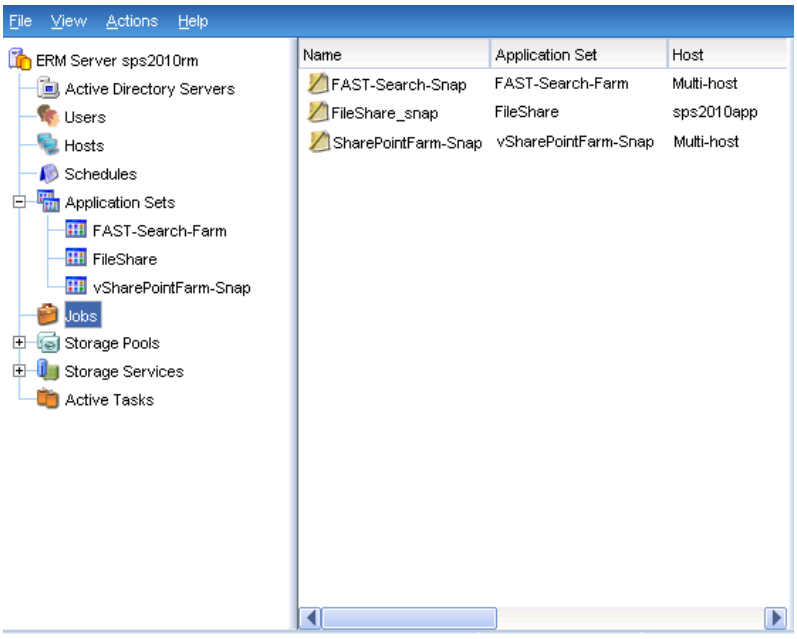


Figure 6. Application sets and jobs

The replication details of each Replication Manager job are as follows:

- SharePoint job:
  - 4 TB SharePoint content
  - SharePoint farm configuration databases
  - SharePoint farm components, including administrator, crawl, and index
  - FAST Search administration database
- Database file share job:
  - 5 TB file share
- FAST Search index job
  - 4 TB FAST Search indexing
  - FAST Search configuration LUNs

The TimeFinder snapshot job was configured to run against a normal SharePoint test load in 80/10/10 (percentages for browse/search/modify) and the impact of the replication job was measured.

Using Replication Manager to restore FAST Search Server 2010 for SharePoint

By leveraging EMC Symmetrix TimeFinder technology, EMC Replication Manager managed the recovery of both the SharePoint content databases and the FAST Search server data with recovery best practices. Because EMC Replication Manager version 5.4 supports only SharePoint content database restore, we restored the following components to test the disaster recovery performance of the SharePoint farm and FAST Search volumes:

- 4 TB SharePoint content database
- 5 TB file share
- 5 TB FAST Search indexes, and configuration LUNs
- FAST Search administration database

To validate that the SharePoint and FAST Search farms are working normally after being restored, the validation team performed the following tests in the Replication Manager-engaged SharePoint and FAST Search server farms:

- Deleted one or multiple items from the SharePoint farm, restored the corresponding database, and then verified that the items are restored.
- Performed an incremental crawl after restoring the FAST Search volumes and validate that the incremental crawl works normally.
- Measured performance impact, perform a VSTS test with a user load profile of 80/10/10 (percentages for browse/search/modify) after restoring the FAST Search volumes.

Test results

Overview

FAST Search for SharePoint provides several new features and enhancements, such as extreme scale search, thumbnails and previews, and extensive search platform. You can obtain detailed information from the Microsoft SharePoint website. This solution focuses on the crawl and query performance of the FAST Search Server 2010 for SharePoint system.

The solution proved that EMC Symmetrix VMAX storage arrays can fully support FAST Search Server 2010 for SharePoint in both physical and virtualized environments. This solution also proved that a FAST Search server farm can be virtualized while keeping search performance comparable with a physical FAST Search server farm. In addition, the solution proved that the Replication Manager-engaged TimeFinder/Snap feature can provide an efficient backup and restore method for the SharePoint and FAST Search server farms.

Crawl performance in physical and virtualized FAST Search farms

When compared with the physical FAST Search server farm, the crawl rate of a virtualized FAST Search server farm was acceptable with the Hyper-V CPU constraint.

Table 14 shows the full crawl rate for both physical and virtualized FAST Search environments.

Table 14. Comparison of full crawl rates

Environment	Physical CPUs	Configured CPUs	Document processors	Full crawl rate (items/minute)	
				SharePoint content	File share
Physical FAST Search server farm	60[1]	60	52	1513	1667
Virtualized FAST Search server farm	24	20	24	770	978

Both physical and virtualized FAST Search Server environments had acceptable performance for the index full crawl on the SharePoint content and file share.

The virtualized environment full crawl rate had the expected drop from the physical FAST Search environment, mostly because the Hyper-V virtual machine had a CPU number limitation of four. Only one-third of the CPU processing power in the physical environment was available in the virtualized environment. As a result, we put only about half of the document processors into the virtualized environment, with the crawl rate dropped to about 50 to 60 percent of the rate in the physical environment. The CPU number limitation for each core is expected to be resolved in a later Hyper-V release. With that, the full crawl rate is expected to improve in a virtualized Microsoft Hyper-V environment.

[1] Hyper-threading was turned off.

Table 15 shows the total number of IOPS for various server types. The total IOPS for full crawl was less than 2,000.

Table 15. Comparison of total IOPS

Server type	Average read size (KB)	Average write size (KB)	Total number of IOPS
SQL Server	26	24	1,434
FAST index	275	605	485
FAST servers	13	26	

Because the Symmetrix VMAX storage design leveraged virtual provisioning technology, the thin devices (provisioned for the hosts or the virtualized disks of the virtual machines) were evenly spread across the disk adapters and drives. The wide stripe technology spread the workload evenly on the back-end disks, which efficiently handled the massive and random IO in parallel.

Table 16 shows the VSTS profile test results for both the physical and virtualized FAST Search environments.

Table 16. Comparison of VSTS profile test results

Environment	Profile (browse/search/modify)	Average response time (seconds)			Queries per second	Total number of FAST IOPS
		Browse	Search	modify		
Physical	80/10/10	0.94	0.60	2.43	7.1	550
Virtualized	80/10/10	0.95	0.47	2.83	8.5	550

Key results for the virtualized FAST Search environment include the following:

- The FAST Search crawl rate was 80 GB/hour with two Hyper-V servers, five virtual machines, 20 CPUs, and 24 document processors.
- The search response time in the virtualized environment was similar to the response time in the physical environment (less than 1 second).
- The number of physical servers was reduced by 60 percent, from five to two.
- The FAST Search servers remained the same as in the physical environment.
- The number of document processors was reduced by approximately 58 percent, from 52 to 22, mainly because of the Hyper-V vCPU constraint (four vCPUs for each virtual machine).
- The full crawl performance was reduced by about 40 percent because of the reduced number of document processors.
- The search test results for the virtualized FAST farm test were slightly better than the results in the physical environment. The modify operation was slightly longer. The browse operation results were the same as the results in the physical environment.

Raw I/O performance of FAST Search disk subsystem

FAST Search server makes extensive use of the storage subsystem. Testing the raw I/O performance of the index/query disks can be an early indication of performance capacity.

Table 17 shows the IOmeter test results. The index servers had enough performance capacity to support the I/O subsystem of the FAST Search servers.

Table 17. IOmeter test results

Fast index servers	1KB 100% read (IOPS)	32KB 100% read (IOPS)	32 KB 67% read (MB/s)	100 KB 67% read average response time (ms)
fastidx01	3,433	2,996	136	9
fastidx02	3,590	2,951	39.5	9
Total/Average	7,023	5,947	175.5	9

Performance test results for the physical FAST Search environment

The following is a summary of test results for the FAST Search server farm in the physical environment:

- From a storage perspective, the disks and thin pools performed well. During the full crawl testing, the disk pool had an average of 60 percent utilization, with an 80 percent maximum. Total number of disk IOPS averaged 3,500 on the Symmetrix VMAX back end for full crawls and was approximately 1,900 for the query testing.
- The FAST Search crawl rate was 150 GB/hour with five servers, 60 available CPUs, and 52 document processors.
- The search response time was less than 1 second, supporting more than 22,000 users with 10 percent concurrent access.

Crawl test overview for the physical environment

The validation team performed full crawl tests for both of the 5 TB file share and 4 TB SharePoint content. We reset and cleared the indexes before starting the full crawl tests.

The crawl rate for the file share was slightly higher than the crawl rate for the SharePoint content database. The full crawl rate of the SharePoint content database was 1,516 items per minute, while the full crawl rate of the file share was 1,668 items per minute.

In both cases, the average number of IOPS for SharePoint was not very high. In the full crawl of the file share, the total number of back-end IOPS for both the SharePoint and FAST Search server farms was only 2,200 (about 10 percent of the number of IOPS for the FAST Search server farm). In the SharePoint content database full crawl, the total number of back-end IOPS was 3,340 (about one sixth of the number of IOPS from the FAST Search server farm).

The average CPU usage was approximately 40 to 50 percent for the servers in this environment during the full crawl testing.

Overall, the physical environment performed well with no connectivity or storage bottlenecks detected.

Full crawl performance for SharePoint content in the physical environment

The full crawl rate for the SharePoint content was 1,516 items per minute. The whole farm full crawl completed in about 1 day (24 hours and 15 minutes). Table 18 shows the results of the full crawl of the SharePoint content.

Table 18. Full crawl of SharePoint content results

Duration (hh:mm:ss)	Items crawled	Crawl rate (items/min)	Crawl rate (MB/min)	Crawl type
24:15:00	2,190,954	1,516	2,111	Full

Figure 7 shows the full crawl performance for the SharePoint content in the physical environment. The crawl rate of smaller documents was higher with the peak reaching 8,000 items per minute. The crawl rate of larger documents was lower, which was 1,516 items per minute or 2,111 MB per minute on average.

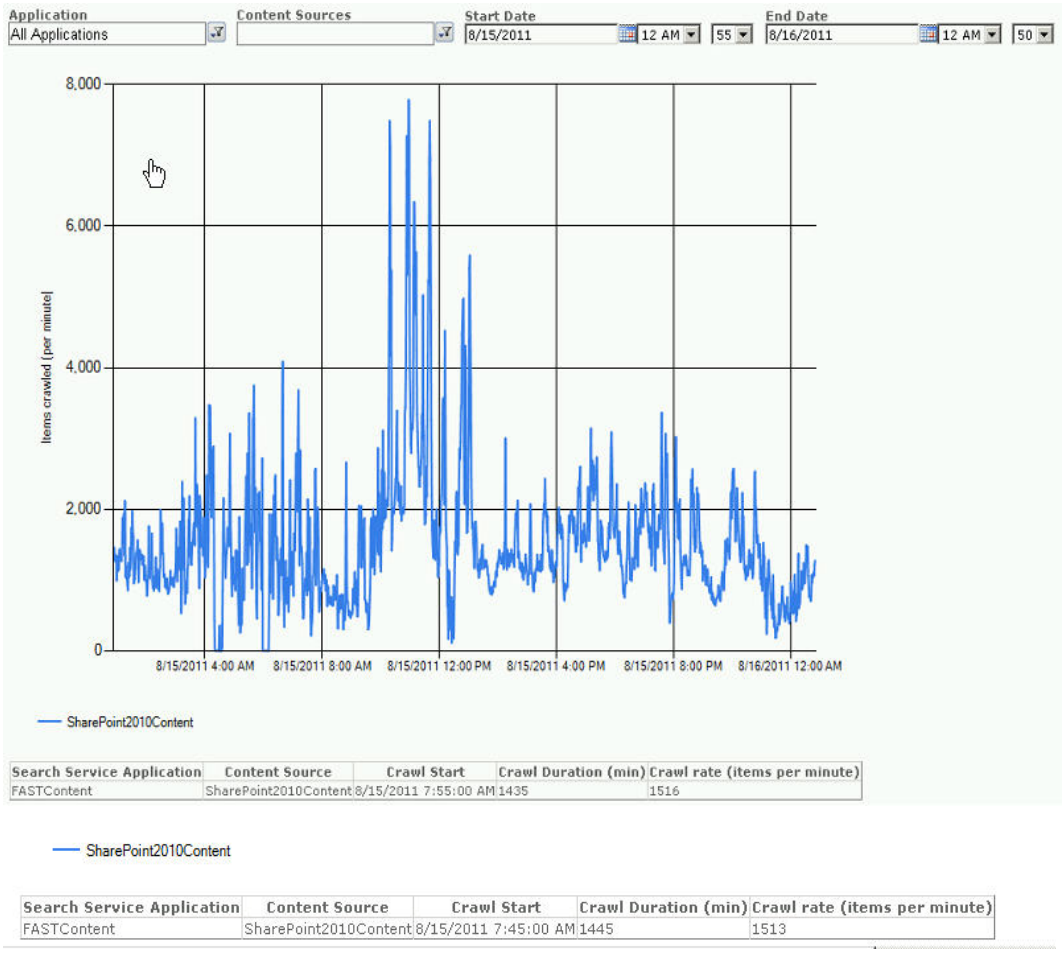


Figure 7. Full crawl performance for SharePoint content in a physical environment

SharePoint and FAST Search IOPS distribution during a full crawl

The number of IOPS during the full crawl of the SharePoint content was not as high as expected. The average total number of IOPS for the SharePoint farm (mainly the SharePoint content database, crawl database, and property databases) was 1,434 with peaks up to 4,749.

Average CPU usage for both the SharePoint farm and the FAST search farm was below 50 percent with the SharePoint farm below 30 percent. There were 60 CPUs and 42 document processors available in the physical FAST Server environment.

Table 19 shows the average and maximum number of IOPS for both the FAST Search servers and the SharePoint servers.

Table 19. Average and maximum IOPS for FAST Search and SharePoint servers

Item	FAST Search servers	SharePoint servers
Average total IOPS	485	1,434
Maximum total IOPS	1,809	4,749
Average CPU usage	41%	26%
Available CPUs in the farm	60	N/A
Document processors	42	N/A

Table 20 shows the expected number of IOPS and the actual peak number of IOPS for the FAST Search servers.

Table 20. Expected and actual peak IOPS for the FAST Search servers

Item	Estimated IOPS	Actual peak IOPS
FAST primary index volume	2,000	1,809
FAST backup index volume	2,000	334
Admin/document processor	2,000	224
Content distributor/indexing dispatcher/ web analyzer/document processor	2,000	373
Content distributor/indexing dispatcher/ web analyzer/document processor	2,000	379

Table 21 shows the FAST Search index volume I/O characteristics and read/write ratio during the full crawl.

Table 21. FAST Search index volume I/O characteristics and read/write ratio

Server role	Average IOPS	IOPS (maximum)	Read I/O size	Write I/O size	Read : Write
Primary	345	1,809	275 KB	605 KB	3:1
Secondary	47	334	45 KB	664 KB	1:50

Figure 8 shows the distribution of IOPS between the SharePoint and FAST Search server farms. The SharePoint farm generated about five-sixths of the number of IOPS for the whole environment, while the FAST Search server farm generated only one-sixth of the number of IOPS. The backup index (secondary index) server generated a very low number of IOPS with a very large I/O size.

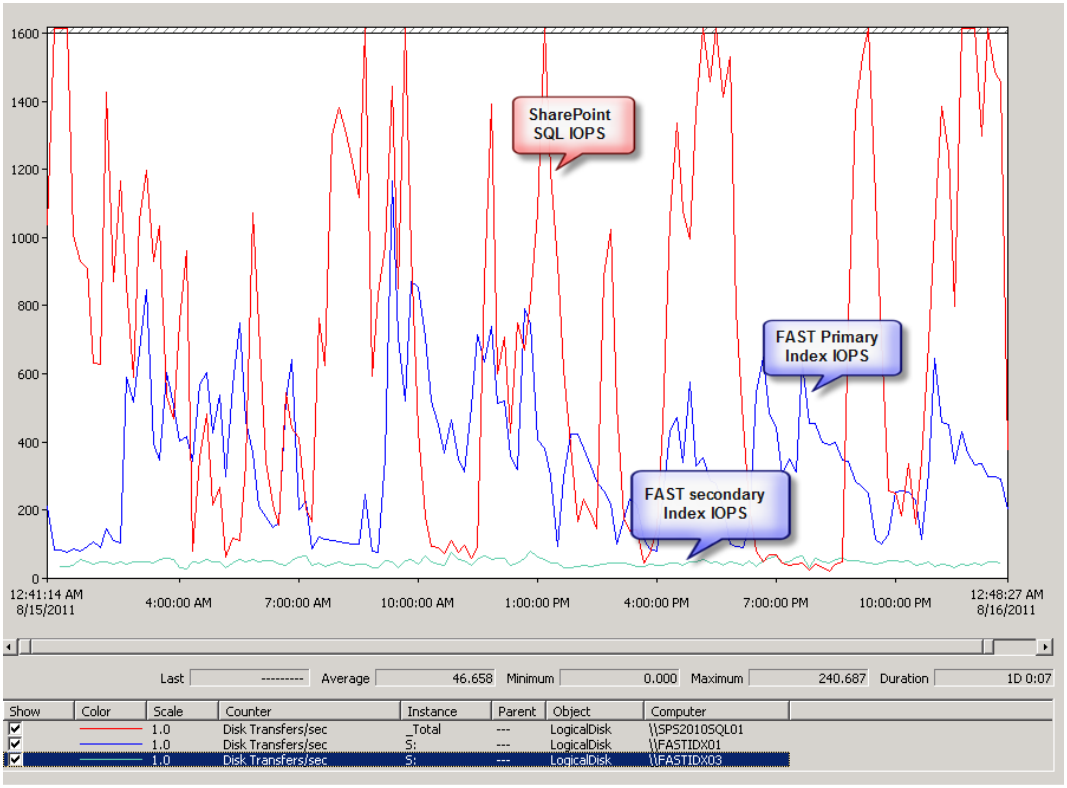


Figure 8. SharePoint and FAST Search IOPS distribution during a full crawl

Back-end storage Symmetrix VMAX performance

During the full crawl of SharePoint content database, both the SharePoint farm and FAST Search server farm performed well with no visible pressure. The following are the performance details:

- The total number of IOPS on the back end was 2,500 to 4,500. Figure 9 and Table 21 have more details.
- Disks and thin pools performed well. The disk utilization of SharePoint and FAST Search volumes was less than 50 percent as shown in Table 22.

As shown in Figure 9, the total number of IOPS for the content database full crawl in the physical environment was as high as 4,730 with an average of 3,340. The throughput was 210 MB per second.

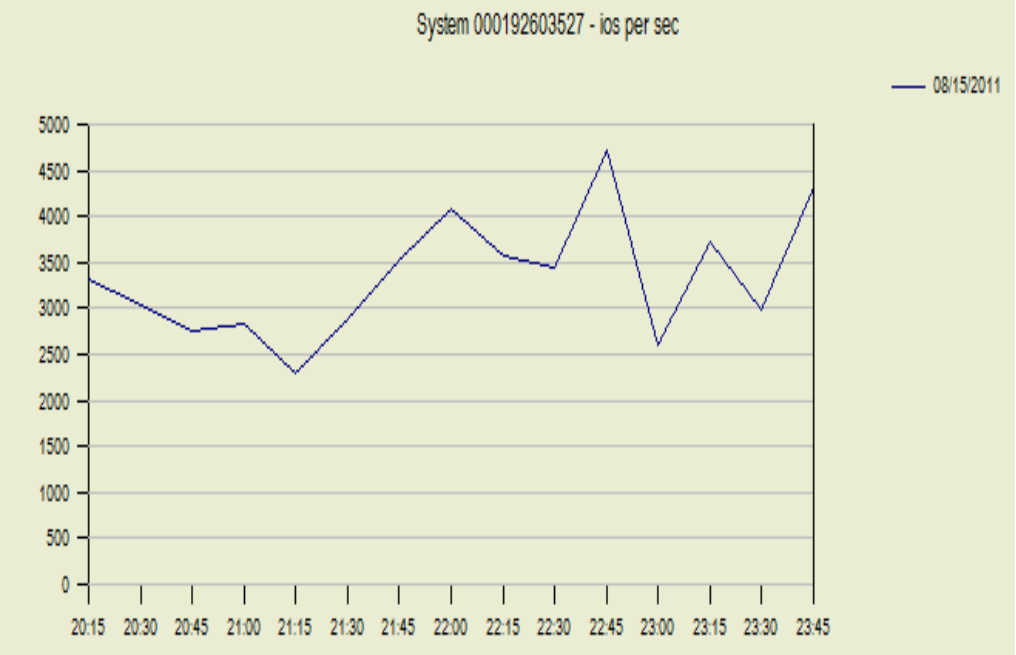


Figure 9. Total back-end IOPS for both SharePoint and FAST Search farms

Table 22 shows the average and maximum number of IOPS and throughput from the Symmetrix VMAX storage array for the SharePoint content database full crawl in the physical environment.

Table 22. IOPS and throughput for the SharePoint content database full crawl

Item	Average	Maximum
IOPS	3,340	4,730
Throughput (MB)	210	275

Table 23 shows the disk group utilization in the SharePoint content full crawl.

Table 23. Disk group utilization for the SharePoint content full crawl

Disk group utilization	Percentage
SharePoint farm	3%–5%
FAST index volumes	10%–47%

As a result of the lower IOPS on the hosts during the full crawl, the disk group utilization was very low for the content database full crawl.

Full crawl performance for the file share in the physical environment

As shown in Table 24, the full crawl rate for the file share was 1,668 items per minute, which was slightly higher than the full crawl rate for the content database. The whole farm full crawl completed in about 1.5 days (35 hours and 15 minutes).

Table 24. Full crawl result for file share

Duration (hh:mm:ss)	Items crawled	Crawl rate (items/min)	Crawl rate (MB/min)	Crawl type
35:15:00	3,124,223	1,668	2602	Full

Figure 10 shows the file share full crawl performance. The crawl rate for the smaller documents was higher with the peak reaching 27,900 items per minute. The crawl rate for the larger documents was lower, which averaged 1,668 items (2,602 MB) per minutes.

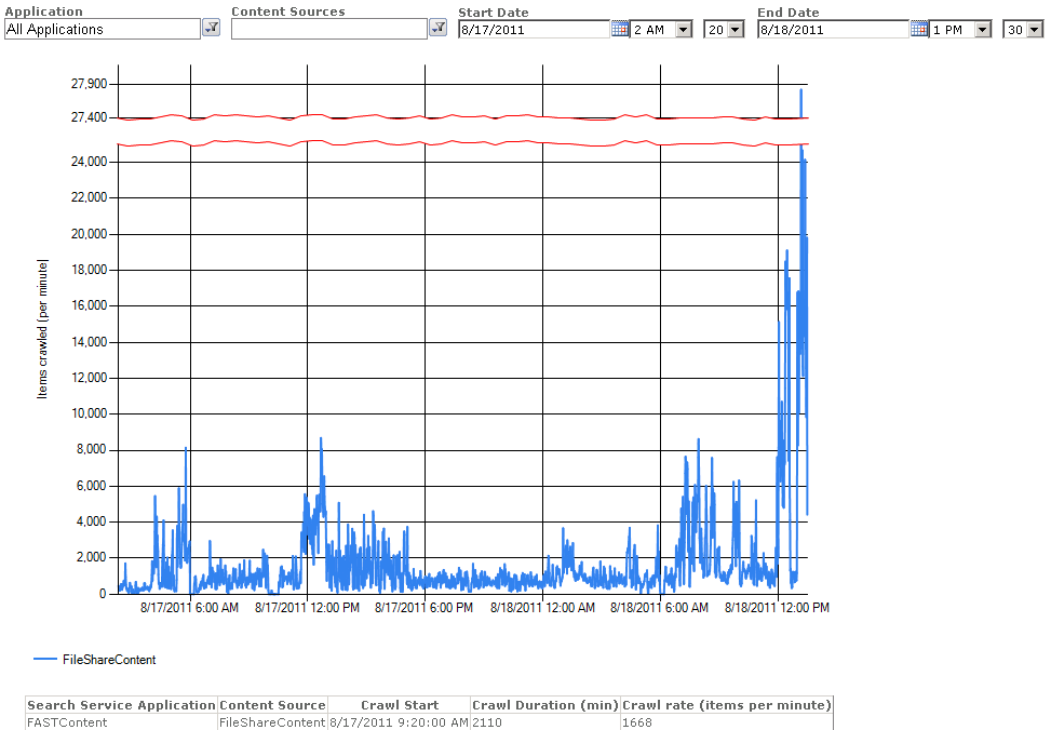


Figure 10. Full crawl performance for the file share

The number of IOPS for both FAST Search servers and SharePoint servers was much lower than the number of IOPS for the full crawl of SharePoint content database. Most of the I/O was for the file share LUNs. The average CPU usage was under 50 percent. Table 25 provides the details.

Table 25. IOPS and CPU usage of file share full crawl on FAST Search servers and SharePoint servers

Item	FAST Search servers	SharePoint servers
Average total IOPS	208	339
Maximum total IOPS	1,706	930
Average CPU usage	45%	34%
Available CPUs in the farm	60	N/A

Item	FAST Search servers	SharePoint servers
Document processors	42	N/A

Table 26 shows the expected number of IOPS and the actual peak number of IOPS for the FAST Search servers.

Table 26. Expected and actual peak IOPS for the FAST Search servers

Item	Estimated IOPS	Actual peak IOPS
FAST primary index volume	2,000	1,706
FAST backup index volume	2,000	186[2]
Admin/document processor	2,000	350
Content distributor/indexing dispatcher/ web analyzer/document processor	2,000	153
Content distributor/indexing dispatcher/ web analyzer/document processor	2,000	167

Table 27 shows the FAST Search index volume I/O characteristics and read/write ratio during the full crawl.

Table 27. FAST Search index volume I/O characteristics and read/write ratio

Server role	Average IOPS	IOPS (maximum)	Read I/O size	Write I/O size	Read : Write
Primary	284	1,706	313 KB	617 KB	5:2
Secondary	45	186	18 KB	756 KB	1:25

Figure 11 shows the distribution of IOPS between the file share volume and the FAST Search server farm. The average number of IOPS was around 430 on the file share and 550 on the primary index server. The backup index (secondary index) server had very low number of IOPS with a very large I/O size.

[2]When the primary server failed, the backup index server took over the primary server role and consumed the same level of IOPS as the primary server.

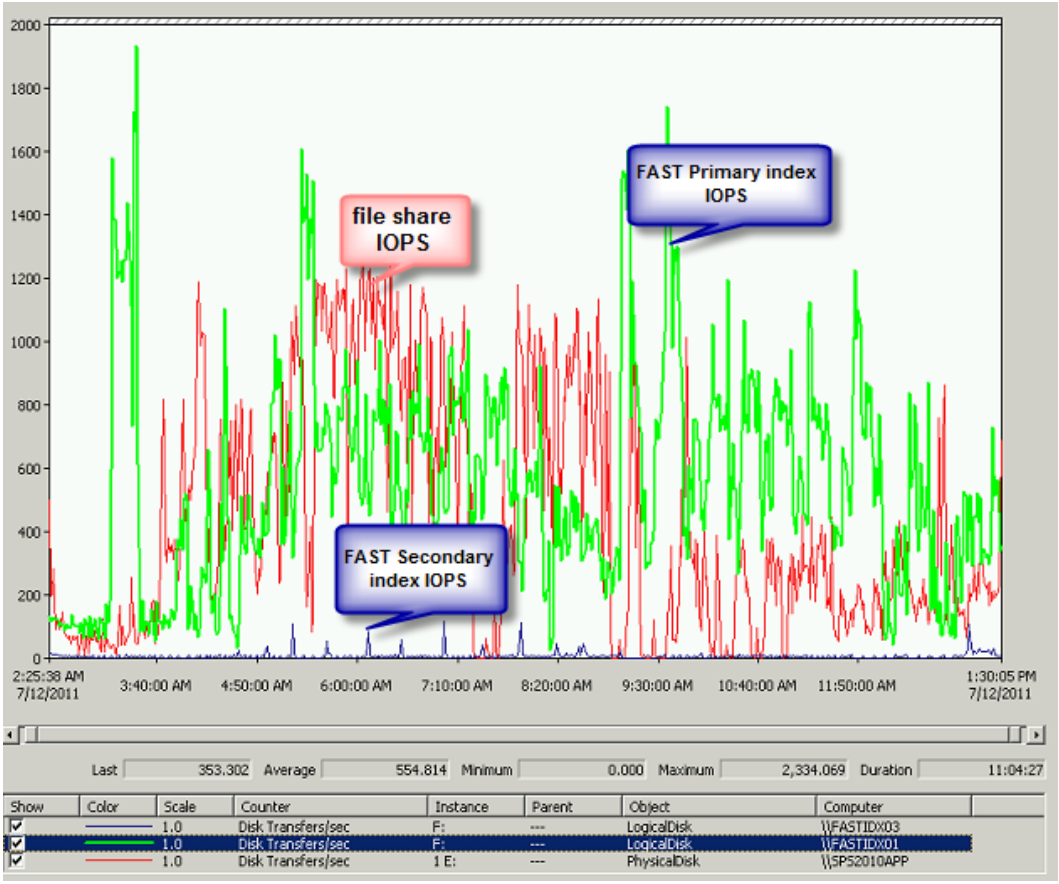


Figure 11. IOPS between the file share volume and the FAST Search server farm

Back-end storage Symmetrix VMAX performance

During the full crawl of the file share, both the SharePoint farm and the FAST Search server farm performed well, with no visible pressure. The following are the performance details:

- The total number of IOPS range on the back end was 1,400 to 2,880. The average IOPS for the content database full crawl in the physical environment was 2,200. The throughput was 234 MB per second on average. Figure 12 shows more details.
- Disks and thin pools performed well. Disk utilization of SharePoint and FAST Search volumes was less than 55 percent.

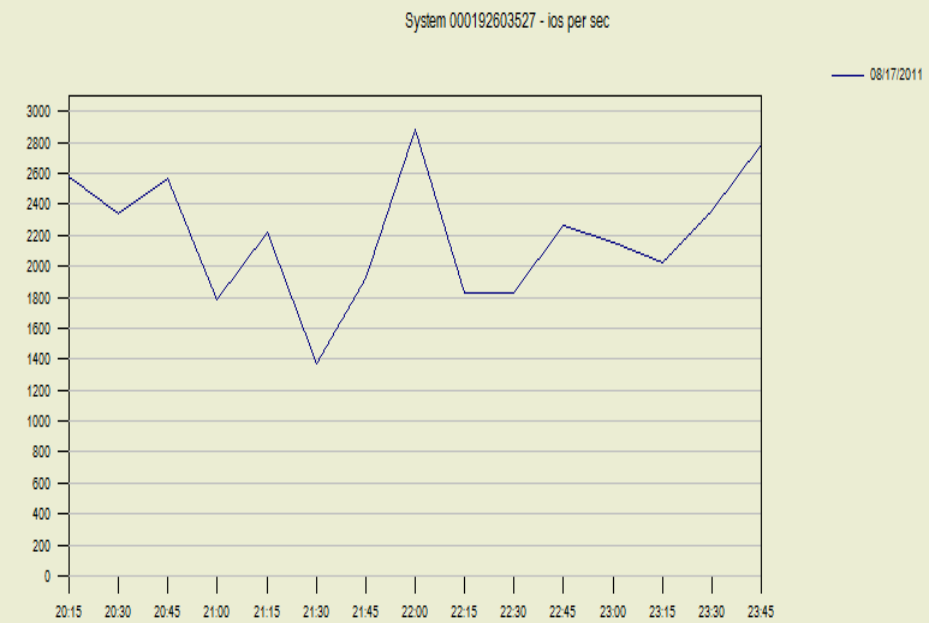


Figure 12. Back-end Symmetrix VMAX performance for a file share full crawl

Table 28 shows the disk group utilization for the SharePoint farm and FAST search farm.

Table 28. Disk group utilization during file share full crawl

Disk group utilization	Percentage
SharePoint volumes	5%–25%
FAST index volumes	20%–55%

Table 29 shows the total number of IOPS and throughput on the Symmetrix VMAX back end for the file share full crawl in the physical environment.

Table 29. Total IOPS and throughput during file share full crawl

Item	Average	Maximum
Total IOPS	2,200	2,880
Throughput (MB)	234	322

VSTS performance test against the physical FAST Search servers

Three different profiles (browse/search/modify) were tested against the indexed SharePoint content and file share. The search response time was under 1 second for all profiles, with seven to 17 queries per second for different profiles as shown in Table 30.

Table 30. VSTS performance test on physical FAST Search servers

Profile (browse/search/modify)	Requests per second	Average response time (second)			Queries per second
		Browse	Search	Modify	
80/10/10	35.7	0.94	0.60	2.43	7.1
70/20/10	36.5	0.93	0.63	2.14	9.5
50/30/20	38.0	0.90	0.83	2.26	16.7

As shown in Figure 13, the VSTS test (browse/search/modify) started at 6:00 and completed at 7:00. The one-hour workload generated less than 2,000 IOPS on the back end.

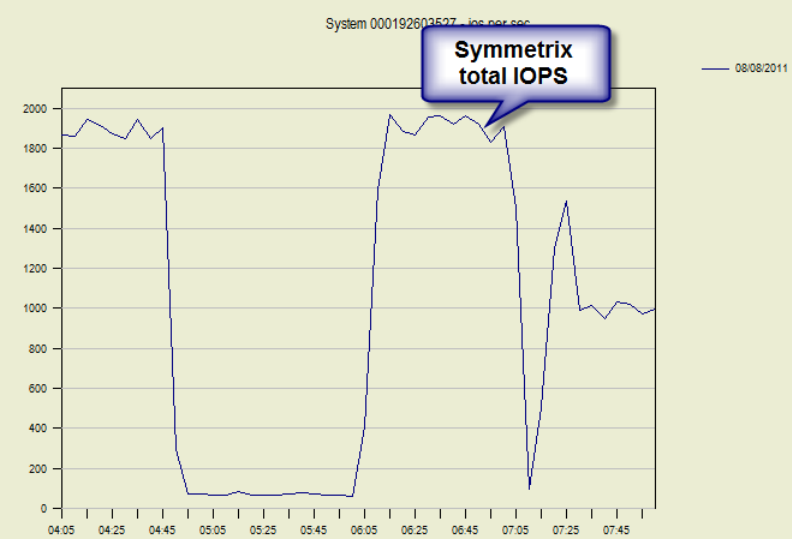


Figure 13. Symmetrix total IOPS

As shown in Figure 14, the number of IOPS for the two FAs for the FAST Search server was about 550 during the one-hour VSTS (browse/search/modify) test.

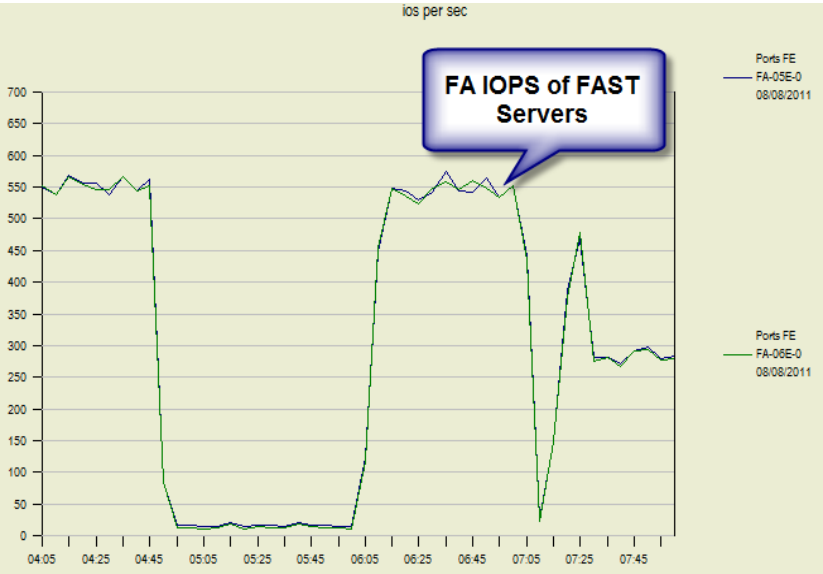


Figure 14. Symmetrix VMAX FA IOPS of FAST Search servers

Table 31 shows the maximum number of IOPS of the Symmetrix VMAX back end during the 80/10/10 (percentages for browse/search/modify) profile. The maximum number of IOPS was under 2,000 during the test period.

Table 31. Maximum IOPS of Symmetrix VMAX back end

Symmetrix VMAX back-end IOPS during 80/10/10 (browse/search/modify) profile	Maximum IOPS
Total SharePoint and FAST Search servers	1,900
FAST Search servers only	550

Performance test results for the virtualized environment

The test results for the FAST Search server farm in the virtualized (Hyper-V-enabled) environment include the following:

- The storage performance of the virtualized environment was similar to the storage performance of the physical environment.
- The FAST Search crawl rate was 80 GB/hour with three Hyper-V servers, five virtual machines, 20 CPUs, and 24 document processors.
- The search response time for the virtualized environment was the same as the search response time for the physical environment (less than 1 second).

The shift from a physical FAST Search Server for SharePoint 2010 environment to a virtualized computing infrastructure made it easier to manage and deploy the FAST Search servers while maintaining comparable search performance. With Symmetrix VMAX and the auto tiering technology, virtualized FAST Search Server 2010 for SharePoint produced the expected crawl performance and maintained search performance similar to the physical FAST servers.

The number of document processors in the FAST Search server farm can impose a major impact on the crawl performance. The SharePoint performance test results were closely related to the number of Web front-end servers in the SharePoint farm. Compared with the physical FAST Search server environment, in the virtualized FAST Search environment:

- The number of physical servers was reduced by 60 percent, from five to two.
- The number of FAST Search servers remained the same as in the physical environment.
- The number of document processors was reduced by approximately 58 percent, from 52 to 24, mainly because of the Hyper-V vCPU constraint (four vCPUs for each virtual machine).
- The full crawl performance was reduced by about 40 percent.
- The browse/search/modify test results were similar to the the results in the physical environment.

Crawl test overview for the virtualized environment

The SharePoint content database full crawl in the virtualized environment took about 2 days to finish. The crawl rate was half of what was observed in the physical FAST Search environment. The CPU usage, however, increased from 40 percent to 80 percent, indicating that the CPU is the bottleneck for the full crawl in this environment.

The test included 20 CPUs in the virtualized environment and 60 CPUs in the physical environment. This constraint caused the number of document processors to be reduced from 42 to 24 This was just over half the number in the physical environment. The performance impact on the virtualized environment was almost linear. The crawl rate was reduced by 50 percent compared to the physical environment.

Full crawl for SharePoint content performance in the virtualized environment

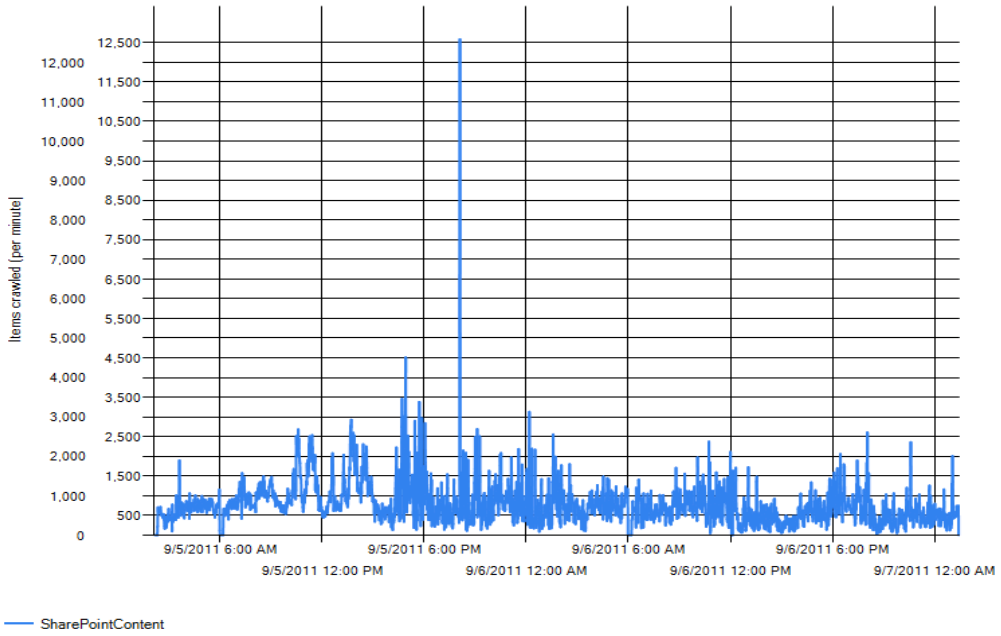
The SharePoint content full crawl rate was 770 items per minute. The full crawl of the entire farm completed in about 2 days (47 hours and 47 minutes).

Table 32 shows the full crawl performance of the SharePoint content.

Table 32. Full crawl performance of the SharePoint content

Duration (hh:mm:ss)	Items crawled	Crawl rate (items/min)	Crawl rate (MB/min)	Crawl type
47:47:00	2,190,954	770	1395	Full

Figure 15 shows the full crawl performance for the SharePoint content. The crawl rate for smaller documents was higher, with the peak reaching 12,500 items per minute. The crawl rate for larger documents was lower, at 770 items per minute or 1,395 MB per minute on average.



Search Service Application	Content Source	Crawl Start	Crawl Duration (min)	Crawl rate (items per minute)
vFASTContent	SharePointContent	9/5/2011 9:20:00 AM	2824	770

Figure 15. Full crawl performance of the SharePoint content

Table 33 shows the number of IOPS and the CPU usage of the SharePoint content full crawl for both the FAST Search and SharePoint servers.

Table 33. IOPS and CPU usage of the SharePoint content full crawl

Item	FAST Search servers	SharePoint servers
Average total IOPS	675	900
Maximum total IOPS	13,346	4,257
Average CPU usage	74%	45%
Available CPUs in the farm	20	N/A
Document processors	24	N/A

Table 34 shows the expected number of IOPS and the actual peak number of IOPS for the FAST Search servers.

Table 34. Expected and actual peak IOPS for the FAST Search servers

Item	Estimated IOPS	Actual peak IOPS
FAST primary index volume	2,000	6,592
FAST backup index volume	2,000	1,3346
Admin/document processor	2,000	2,334
Content distributor/indexing dispatcher/ web analyzer/document processor	2,000	959
Content distributor/indexing dispatcher/ web analyzer/document processor	2,000	1,527

Table 35 shows the FAST Search index volume I/O characteristics and read/write ratio during the full crawl.

Table 35. FAST Search index volume I/O characteristics and read/write ratio

Server role	Average IOPS	IOPS (maximum)	Read I/O size	Write I/O size	Read : Write
Primary	483	6,592	184 KB	345 KB	3:1
Secondary	103	13,346	42 KB	582 KB	1:5

Back-end Symmetrix VMAX storage performance

During the full crawl of the SharePoint content in the virtualized FAST Search environment, both the SharePoint and the FAST Search server farms performed well, with no visible pressure. The following are the performance details:

- The total number of IOPS on the back end was between 2,500 and 4,300.
- The disks and thin pools performed well. Disk utilization for SharePoint and FAST Search volumes was less than 50 percent.

Figure 16 shows the storage back-end performance of the SharePoint content full crawl in the virtualized FAST Search environment. The maximum number of IOPS was always below 4,300, with an average number of IOPS approximately 3,500, which was close to what we observed in the physical environment. This indicated that the storage back-end performance was the same in both physical and virtualized environments. CPU constraint caused the difference in overall crawl performance.

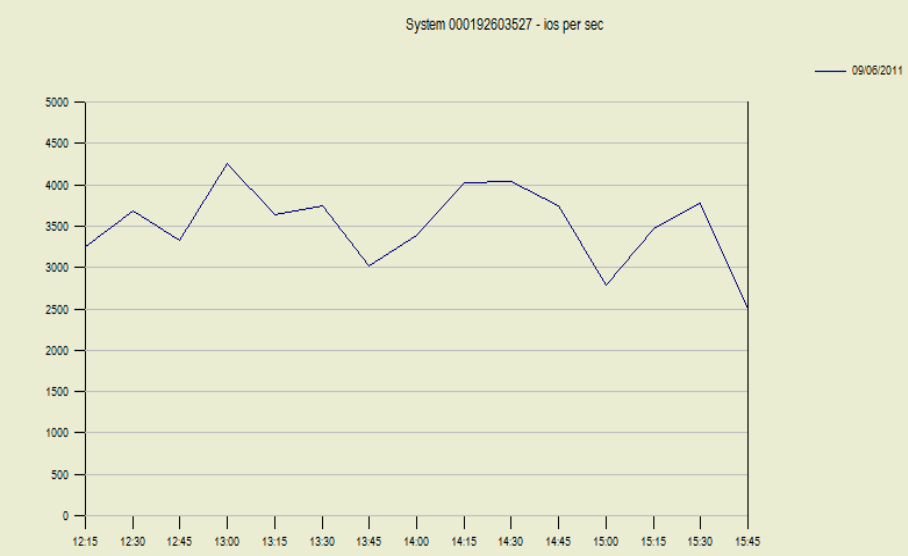


Figure 16. Storage back-end performance for the SharePoint content full crawl

As shown in Table 36, the average and maximum number of IOPS and throughput on the storage back end during the SharePoint content full crawl in a virtualized FAST Search server farm was very close to what was observed for the physical FAST Search server farm.

Table 36. IOPS and throughput on the storage back end during the SharePoint content full crawl

Item	Average	Maximum
IOPS	3,500	4,300
Throughput (MB)	217	300

Disk group utilization during the SharePoint content full crawl in the virtualized FAST Search server farm was also very close to what we observed for the physical FAST Search servers, as shown in Table 37.

Table 37. Disk group utilization during SharePoint content full crawl

Disk group utilization	Percentage
Content DB	20%–30%
FAST index volumes	30%–50%

File share full crawl performance in the virtualized environment

For the file share full crawl, the virtualized environment took about 2.5 days. The crawl rate was half of what was observed in the physical FAST Search environment. The CPU usage, however, increased from approximately 40 percent to 80 percent, indicating that the CPU is the bottleneck for the full crawl in this environment.

There were 20 CPUs available in the virtualized environment, while there were 60 in the physical environment. This constraint causes the number of document processors to be reduced from 42 to 24. This is just over half the number of processors in the

physical environment. The performance impact from the CPU resource constraint for the virtualized environment was almost linear. The crawl rate dropped by about 50 percent compared to the physical environment.

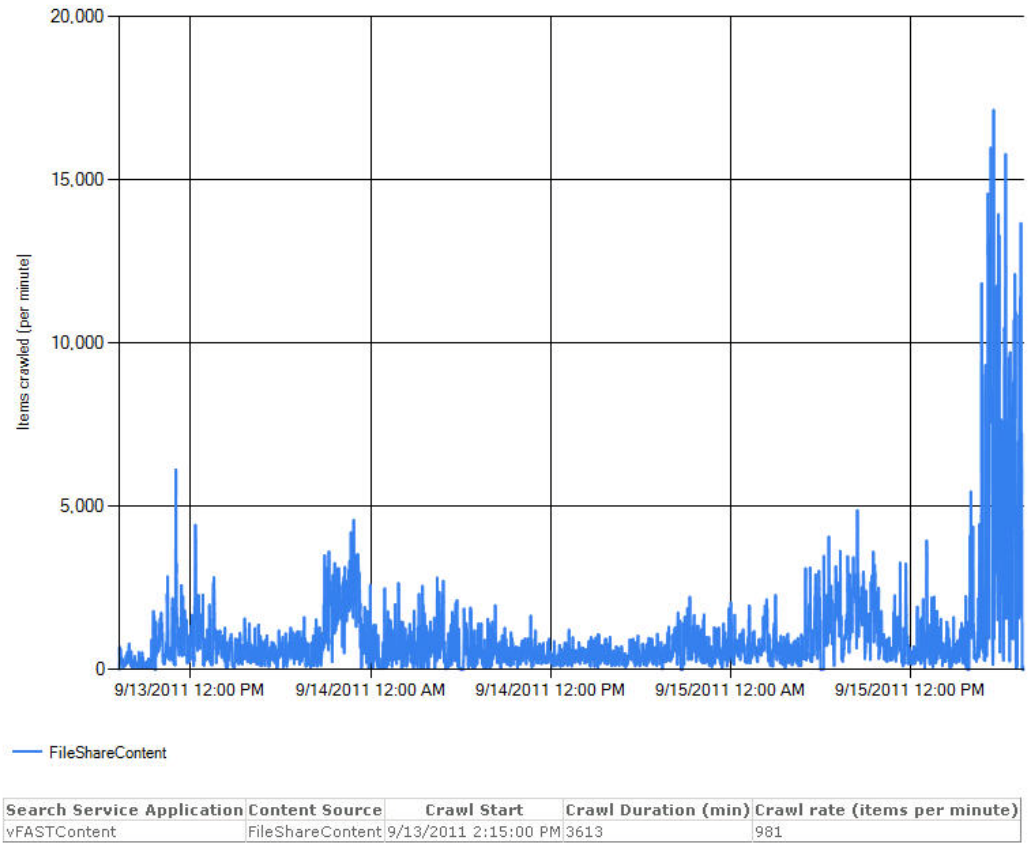
Table 38 shows the full crawl performance of the file share in the virtualized FAST Search environment. The full crawl rate of the file share was 978 items per minute, which was slightly higher than the rate for the content database. The whole farm full crawl completed in about 2.5 days (60 hours and 14 minutes).

Table 38. File share full crawl results

Duration (hh:mm:ss)	Items crawled	Crawl rate (items/min)	Crawl rate (MB/min)	Crawl type
60:14:32	3,124,223	978	1,383	Full

As shown in Figure 17, in the virtualized environment:

- The crawl rate for the file share was faster than the rate for the content database.
- The crawl rate, as in the physical environment, was largely related to the peak file size while processing the smaller files. The crawl rate of smaller documents was higher with the peak reaching 18,000 items per minute.
- The crawl rate averaged 981 items (1,383 MB) per minute.
- The full crawl was slower in the virtualized environment than in the physical environment, but the performance was still reasonable.



Search Service Application	Content Source	Crawl Start	Crawl Duration (min)	Crawl rate (items per minute)
vFASTContent	FileShareContent	9/13/2011 2:15:00 PM	3613	981

Figure 17. Full crawl performance of the file share content

Table 39 shows the number of IOPS and CPU usage of the file share full crawl on the FAST Search and SharePoint servers in the virtualized environment.

Table 39. IOPS and CPU usage of the file share full crawl

Item	FAST Search servers	SharePoint servers
Average Total IOPS	384	193
Maximum Total IOPS	7,869	1,263
Average CPU usage	83%	15%
Available CPUs in Farm	20	N/A
Document Processors	24	N/A

Table 40 shows the expected number of IOPS and the actual peak number of IOPS for the FAST Search servers.

Table 40. Expected and actual peak IOPS for the FAST Search servers

Item	Estimated IOPS	Actual peak IOPS
FAST primary index volume	2,000	7,869
FAST backup index volume	2,000	8,704
Admin/document processor	2,000	2,030
Content distributor/indexing dispatcher/ web analyzer/document processor	2,000	1,414
Content distributor/indexing dispatcher/ web analyzer/document processor	2,000	2,014

Table 41 shows the FAST Search index volume I/O characteristics and read/write ratio during the full crawl.

Table 41. FAST Search index volume I/O characteristics and read/write ratio

Server role	Average IOPS	IOPS (maximum)	Read I/O size	Write I/O size	Read : Write
Primary	463	7,869	186 KB	373 KB	3:1
Secondary	29	8,704	36 KB	560 KB	1:2

Back-end Symmetrix VMAX storage performance

The following are the test results of Symmetrix VMAX back-end storage performance:

- The total number of IOPS on the back end was between 1,800 and 3,500 (as shown in Figure 18).
- The average number of IOPS for the content database full crawl in the virtualized environment was 2,820. The throughput was 224 MB per second on average. Figure 18 and Table 42 have more details.
- Disk utilization of SharePoint and FAST Search volumes was less than 43 percent. Table 43 shows the disk group utilization.

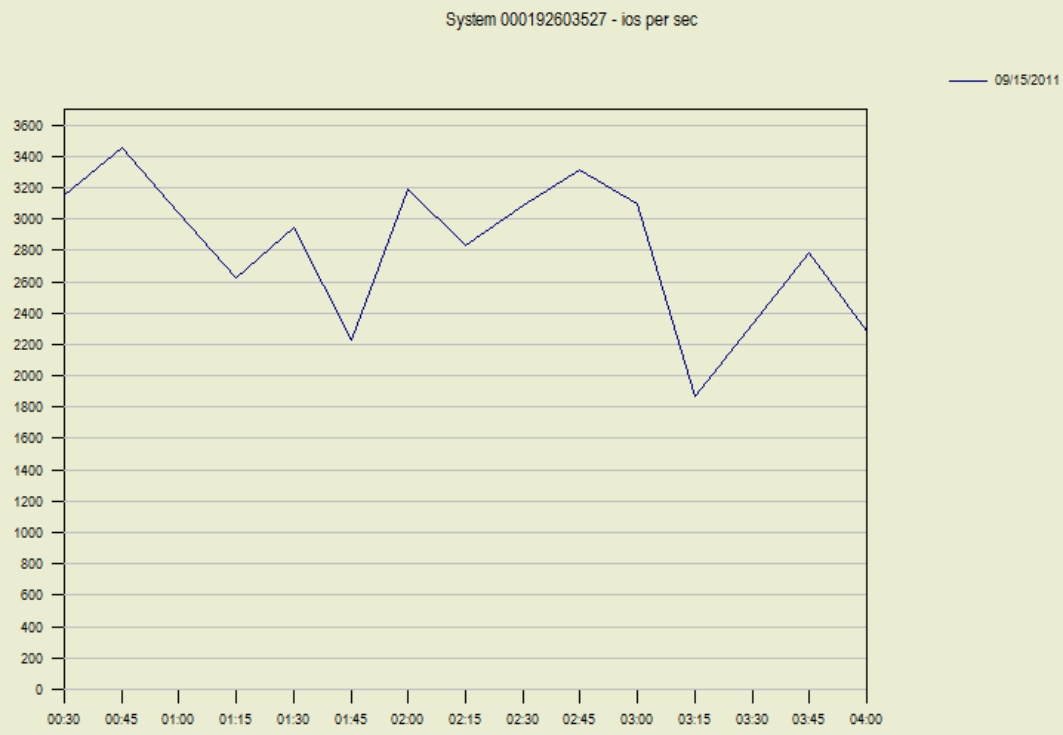


Figure 18. Back-end Symmetrix VMAX performance for the file share full crawl

Table 42. Total IOPS and throughput on the Symmetrix VMAX back end for the file share full crawl in the virtualized environment

Item	Average	Maximum
Total IOPS	2,820	3,460
Throughput (MB)	224	278

Disk group utilization for the SharePoint farm and FAST search farm is shown in Table 43.

Table 43. Disk group utilization during the file share full crawl

Disk group utilization	Percentage
SharePoint volumes	10%–25%
FAST index volumes	20%–43%

VSTS performance test against the virtualized FAST Search servers

The EMC validation team tested three different profiles (browse/search/modify) against the indexed SharePoint content and the file share. The search response time was under 1 second with eight to 13 queries per second for the different profiles. As shown in Table 44, the average search response time was slightly better than in the physical FAST Search environment (search performance for the two environments was almost the same).

Table 44. VSTS performance test against the virtualized FAST Search servers

Profile (percentages for browse/search/modify)	Requests per second	Average response time (second)			Queries per second
		Browse	Search	Modify	
80/10/10	38.2	0.95	0.47	2.83	8.5
70/20/10	41.6	0.90	0.55	2.50	14.4
50/30/20	38.5	0.88	0.67	2.08	12.9

The tests depicted in Figure 19 and Figure 20 were based on the 80/10/10 profile (percentages for browse/search/modify). The VSTS test (browse/search/modify) started at 7:15 and finished at 8:15, with a one-hour test duration. The total Symmetrix VMAX back-end number of IOPS was approximately 2,800, with 25 percent from the FAST Search servers.

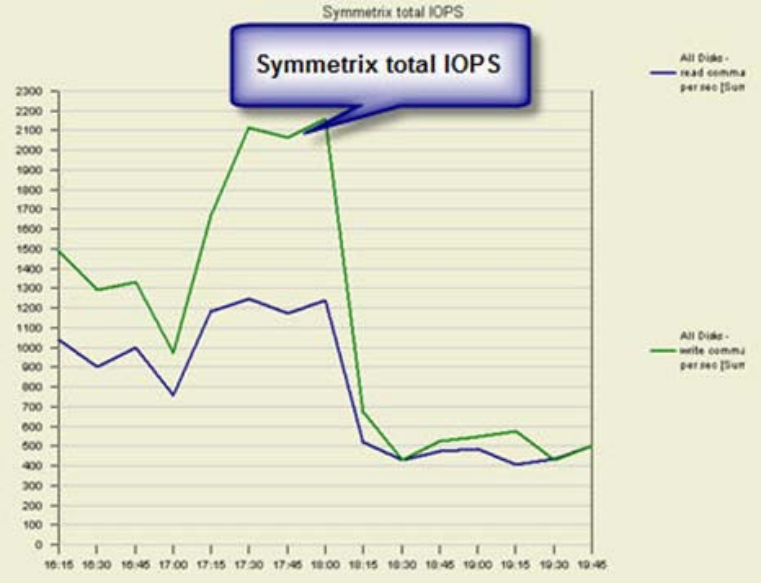


Figure 19. Symmetrix VMAX total IOPS

Figure 20. IOPS of FAST Search servers

Table 45 shows the Symmetrix VMAX back-end number of IOPS with an 80/10/10 (percentages for browse/search/modify) profile.

Table 45. IOPS of the back-end Symmetrix VMAX storage

Symmetrix VMAX back-end IOPS with 80/10/10 (browse/search/modify) profile	Maximum IOPS
Total SharePoint and FAST Search servers	3,400
FAST Search servers only	850

Pure (100 percent) search or query test results for the virtualized environment

The validation team conducted two different tests for pure search or query:

- The VSTS test: VSTS had three tiers including client, agent, and server. It measured the response of the user operations (browse/search/modify).
- The sbench test: The sbench tool was installed on the FAST servers. It issued queries to the FAST Search server farm directly, and measured the query latency without interfering with the SharePoint farm. Refer to the Search Technology website for more information about sbench.

Table 46 and Table 47 show the pure search or query test results for the virtualized FAST Search environment. With only one column in the FAST Search configuration, 25 queries per second (QPS) were supported with a response time of less than 2 seconds.

Table 46. VSTS test results for the virtualized FAST Search environment

Number of queries per second	Response time(seconds)

Number of queries per second	Response time(seconds)
25	1.67

Table 47. sbench test results for the virtualized FAST Search environment

Tested item	Value
Observed query rate (mean)	5
Search latency	0.05784
Maximum latency	0.4210
Observed query rate (mean)	19.86
Search latency	0.06956
Maximum latency	1.735

Auto tiering performance impact

With a profile of 80/10/10 (percentages for browse/search/modify), the search test ran in three tiered virtual pools with auto tiering enabled. Figure 21 shows the auto tiering movement results after 16 hours of VSTS testing. After enabling auto tiering, approximately 1.3 percent of data was promoted to the Flash tier; 4.3 percent of data was demoted to the SATA tier, and 94.6 percent of data resided on the FC tier.

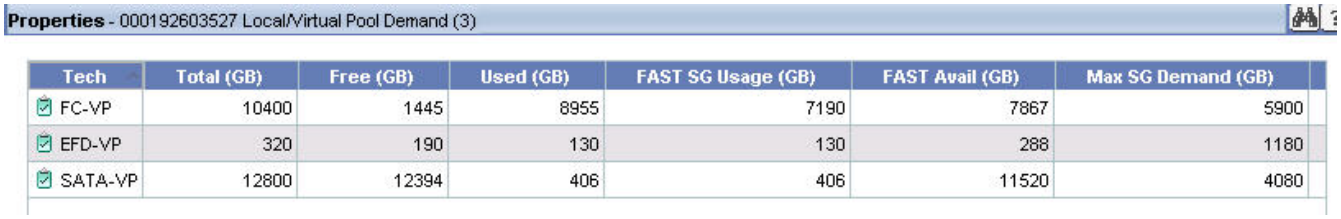


Figure 21. virtual pool usage in the virtualized FAST Search environment

Performance improved about 20 percent with auto tiering enabled for the profile of 80/10/10 (percentages for browse/search/modify) as shown in Table 48.

Table 48. QPS result with profile of 80/10/10 (browse/search/modify)

Symmetrix auto tiering used? (Yes /No)	Queries per second (QPS)
No	7.1
Yes	8.5

Replication Manager-engaged backup and restore for FAST Search Server 2010 for SharePoint

EMC Replication Manager-engaged snapshot backup

An EMC Replication Manager-engaged snapshot for the whole SharePoint farm (including the content database) took only 11 minutes to complete. The snapshot included five servers.

Table 49 shows that the file share snapshot completed in less than 2 minutes, which is quite fast. The FAST Search server farm backup took about 8 minutes across three servers.

Table 49. Snapshot backup with EMC Replication Manager

Item	Total size	Backup duration (hh:mm:ss)
SharePoint farm backup	4 TB	0:11:33
File share backup	5 TB	0:01:53
FAST Search server farm backup	5 TB	0:07:50

EMC Replication Manager-engaged snapshot restore and recovery

Restoring a single SharePoint database took only a few minutes to process. Restoring all 20 SharePoint databases across two SQL Server database servers took about 1.5 hours, most of which was spent recovering the databases (log replay).

As shown in Table 50, restoring a 5 TB file share took only about 2 minutes, the FAST Search farm restore took about 13 minutes, and the FAST Search server farm restore took less than 15 minutes.

Table 50. Snapshot restore and recovery with EMC Replication Manager

Item	Total size	Restore duration (hh:mm:ss)
SharePoint content databases restore	4 TB	1:24:33[3]
File share restore	5 TB	0:01:53
FAST Search server farm restore	5 TB	0:12:49

[3] Database recovery time was included.

Conclusion

Summary

EMC Symmetrix VMAX was highly scalable and easily capable of accommodating the storage performance and capacity requirements of Microsoft FAST Search Server 2010 for SharePoint. VMAX can fully support a FAST Search server farm in either a physical or virtualized environment.

Full crawl performance

Performance for the index full crawl of the SharePoint content and file share source was acceptable in both physical and virtualized FAST Search server environments. In comparison with a physical FAST Search server farm, the total number of CPUs for the virtualized FAST Search server farm was reduced by 67 percent (from 60 to 20); the number of document processors was reduced by 43 percent (from 42 to 24).

The crawl rate of a virtualized FAST Search server farm was acceptable, even considering the vCPU constraint imposed by Hyper-V virtualization technology:

- Based on crawl bandwidth per hour, EMC's full crawl test against a 5 TB file share using physical FAST Search servers completed in 35 hours and 15 minutes. On virtualized FAST Search servers, the test took 60 hours and 15 minutes.

  In contrast, based on the same unit of measure (crawl bandwidth per hour), Microsoft's full crawl test against a 5 TB file share using physical FAST Search servers took more than 46 hours. For more information about the full crawl test conducted by Microsoft, refer to Microsoft TechNet.

- Based on crawl bandwidth per hour, EMC's full crawl test against 4 TB of SharePoint content using physical FAST Search servers completed in 24 hours and 15 minutes. On virtualized FAST Search servers, the test took 47 hours and 15 minutes.

  Based on the same unit of measure (crawl bandwidth per hour), Microsoft's results for a comparable test were similar to EMC's. For more information about Microsoft's full crawl test against 4 TB of SharePoint content using physical FAST Search servers, refer to Microsoft TechNet.

Query performance and EMC auto tiering benefit

The solution demonstrated a high performing FAST Search query service:

- With a 50/20/30 (percentages for browse/search/modify) profile, a mixed workload with 30 percent queries can achieve 16.7 queries per second (QPS) in the physical FAST Search server farm.
- 14.4 QPS can be processed in the virtualized FAST Search server farm while supporting 22,000 users with 10 percent concurrent access.
- A pure search test achieved 20 QPS while keeping the mean query latency less than 0.07 seconds. In Microsoft's test results on Microsoft TechNet, the latency is more than 0.5 seconds when serving 20 QPS.

Before enabling Symmetrix auto tiering, 100 percent of the FAST Search volumes resided in the FC virtual disk pool. After enabling auto tiering, the automation of storage tiering improved search performance by 20 percent.

Environment protection

Both the FAST Search server farm and the SharePoint farm can be fully protected by Replication Manager:

- Completing a local replication of more than 9 TB of SharePoint content and FAST Search index took less than 22 minutes
- Recovering a FAST Search server farm with more than 5 TB of data took less than 15 minutes

Findings

The key findings of this proven solution testing are as follows:

- EMC Symmetrix VMAX can fully support FAST Search Server 2010 for SharePoint in both physical and virtualized environments.
- The migration of FAST Search servers to a virtualized environment reduced the number of physical host servers by 60 percent (from five to two). This also leveraged all of the management advantages of a virtualized environment while achieving query performance comparable to a physical environment and acceptable crawl performance compared to Microsoft's published test results. (In contrast to a physical environment, the crawl operation in a virtualized environment takes an additional 23 hours and 32 minutes for SharePoint content and an additional 25 hours for the file share.)
- Symmetrix auto tiering improved the query performance of FAST Search by 20 percent while reducing the total cost of ownership.
- EMC Replication Manager ensured environment protection. The SharePoint content and FAST Search server farm can be replicated and recovered with minimal impact on end users.

References

White papers

For additional information, see the white papers listed below (available on emc.com and EMC Powerlink):

- *Reduce Costs and Optimize Microsoft Server Performance in Virtualized Environments with EMC Symmetrix VMAX*
- *FAST VP for EMC Symmetrix VMAX–Theory and Best Practices for Planning and Performance*
- *EMC Symmetrix with Microsoft Hyper-V Virtualization*

Reference architecture

For additional information about this white paper, refer to the following reference architecture (available on emc.com and EMC Powerlink):

- *EMC Performance Optimization for Microsoft FAST Search Server 2010 for SharePoint–EMC Symmetrix VMAX, FAST VP, Microsoft Hyper-V*

Product documentation

For additional FAST Search information, refer to:

- *FAST Search Server 2010 for SharePoint Capacity Planning* (http://www.microsoft.com/download/en/default.aspx)
- *Deployment Guide for FAST Search Server 2010 for SharePoint* (http://www.microsoft.com/download/en/default.aspx)
- *FAST Search Server 2010 for SharePoint on TechNet (http://technet.microsoft.com/en-us/enterprisesearch/default)*

Other documentation

For additional information on SharePoint and EMC Replication Manager, refer to:

- *Capacity Planning and Sizing for Microsoft SharePoint Products and Technologies* (http://technet.microsoft.com/en-us/enterprisesearch/default)
- *EMC Replication Manager 5.4.0 Product Guide*

Additional information

Deployment file in the physical FAST Search server farm

The following is the deployment.xml file used to set the server role in the physical FAST Search server farm.

```
<host name="fastadm.sps2010.com">
     <admin />
     <query />
     <document-processor processes="12" />
</host>
<host name="fastidx01.sps2010.com">
     <content-distributor />
     <indexing-dispatcher />
     <document-processor processes="12" />
     <searchengine row="0" column="0" />
</host>
<host name="fastidx01.sps2010.com">
      <content-distributor />
      <indexing-dispatcher />
      <document-processor processes="12" />
      <searchengine row="1" column="0" />
</host>
<host name="fastdpd01.sps2010.com">
      <document-processor processes="12" />
      <webanalyzer server="true" lookup-db="true" link-
processing="true" max-targets="2" redundant-lookup="true" />
      </host>
<host name="fastdpd02.sps2010.com">
                  <document-processor processes="12" />
                  <webanalyzer server="false" lookup-db="true"
link-processing="true" max-targets="2" redundant-lookup="false" />
      </host>
<searchcluster>
      <row id="0" index="primary" search="true" />
      <row id="1" index="secondary" search="true" />
</searchcluster>
```

Deployment file in the virtualized FAST Search server farm

The following is the deployment.xml file used to set the server role in the virtualized FAST Search server farm.

```
<host name="vadmin. sps2010.com">
            <admin />
            <query />
            <document-processor processes="6" />
      </host>
      <host name="vidx01.sps2010.com">
            <content-distributor />
            <indexing-dispatcher />
            <searchengine row="0" column="0" />
      </host>
      <host name="vidx02.sps2010.com">
            <content-distributor />
            <indexing-dispatcher />
           <document-processor processes="2" />
            <searchengine row="1" column="0" />
```

```
            <webanalyzer server="true" lookup-db="true" link-
processing="true" max-targets="4" redundant-lookup="false"/>
      </host>
      <host name="vcdp01.sps2010.com">
            <document-processor processes="8" />
      </host>
      <host name="vcdp02.sps2010.com">
            <document-processor processes="8" />
      </host>
      <searchcluster>
            <row id="0" index="primary" search="true" />
            <row id="1" index="secondary" search="true" />
      </searchcluster>
```

Recommendations of FAST Search and SharePoint farm settings

The following settings are recommended by Microsoft for better crawl performance.

1. Change SharePoint crawler registry in the following registry directory:

HKLM\SOFTWARE\Microsoft\Office Server\14.0\Search\Global\Gathering Manager

- FilterProcessMemoryQuota (default to 100 MB)
  - Change to 200 MB
- DedicatedFilterProcessMemoryQuota (default to 100 MB)
  - Change to 200 MB
- FolderHighPriority (default to 50)
  - Change to 500

2. Turn off TCP/IP Chimney. Refer to Microsoft Support for more information
3. Apply hot fix KB976462
4. Document processors can be adjusted at run time

Disable SCSI filtering

In this solution, EMC Solutions Enabler is installed in the virtual machine hosted by Hyper-V with pass-through storage devices. EMC supports the installation of EMC Solutions Enabler with a child virtual machine with pass-through storage devices only when the parent partitions are running Windows Server 2008 R2, and when the appropriate settings for the virtual machine have been made.

EMC Solutions Enabler implements the usage of the extended SCSI commands, which are by default filtered by the parent partition. A bypass of the filtering is provided with Windows Server 2008 R2 Hyper-V. To disable the filtering of SCSI commands, the administrator can execute the following PowerShell script on the Hyper-V parent partition on the Hyper-V hosts of SharePoint in the physical FAST Search server environment, and Hyper-V hosts of SharePoint and FAST Search in the virtualized FAST Search environment.

```
//  PowerShell Script:  Set_SCCI_Passthrough.ps1
$Target = $args[0]
$VSManagementService=gwmi MSVM_VirtualSystemManagementService -
namespace "root\virtualization"
foreach($Child in Get-WmiObject -Namespace root\virtualization
Msvm_ComputerSystem -Filter "ElementName='$Target'")
```

```
{
$VMData=Get-WmiObject -Namespace root\virtualization -Query
"Associators of {$Child} Where
ResultClass=Msvm_VirtualSystemGlobalSettingData
AssocClass=Msvm_ElementSettingData"
$VMData.AllowFullSCSICommandSet=$true
$VSManagementService.ModifyVirtualSystem($Child,$VMData.PSBase.Get
Text(1))|out-null
}
```

The usage of the script under PowerShell execution environment is as follows.

```
.\Set_SCCI_Passthrough.ps1 ManagedVirtualMachineName
```

The script below can be used to check the current value of the SCSI filtering. It is necessary to provide the name of the virtual machine target to be reported on.

```
// PowerShell Script:  Get_SCCI_Passthrough.ps1
$Target=$args[0]
foreach ($Child in Get-WmiObject -Namespace root\virtualization
Msvm_ComputerSystem -Filter "ElementName='$Target'")
{
$VMData=Get-WmiObject -Namespace root\virtualization -Query
"Associators of {$Child}
Where ResultClass=Msvm_VirtualSystemGlobalSettingData
AssocClass=Msvm_ElementSettingData"
Write-host "VirtualMachine:"$VMData.ElementName
Write-Host
"CurrentlyByPassingSCSIFiltering:"$VMData.AllowFullSCSICommandSet

}
```

Move administrative component for Search Service Application

The usage of the script under the PowerShell execution environment is as follows:

```
.\Get_SCCI_Passthrough.ps1 ManagedVirtualMachineName
```

The following example uses Set-SPEnterpriseSearchAdministrationComponent to move the administrative component for FAST Query SSA to the location *R:\crawladmin* on the server *SharePointServerName*

```
// PowerShell Script:  moveAdminComp.ps1
PS C:\> $searchapp = Get-SPEnterpriseSearchServiceApplication
"FAST Query SSA"
PS C:\> $admin = Get-SPEnterpriseSearchAdministrationComponent -
SearchApplication $searchapp
PS C:\> $admin | Set-SPEnterpriseSearchAdministrationComponent -
SearchServiceIntance SharePointServerName -Force -StoragePath
R:\crawladmin
```

Note For more information about the PowerShell comlet, refer to Microsoft TechNet.