HIGH AVAILABILITY CONFIGURATION FOR A MULTIPLE REGION EMC® HEALTHCARE INTEGRATION PORTFOLIO (HIP) REGISTRY AND REPOSITORY

An Architectural Overview

EMC HIP, EMC xDB, EMC AutoStart™, Microsoft Windows 2008

- High Availability for EMC HIP and EMC xDB
- Automated Failover and Recovery
- Multiple Region Scalability

Abstract

This white paper describes a solution that offers high availability for the EMC HIP and EMC xDB document sharing product suite across multiple region architecture.

November 2013
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Executive Summary

This white paper provides a high availability (HA) architecture for the EMC Healthcare Integration Portfolio (HIP) Registry and Repository using EMC xDB, EMC AutoStart, VMware® vSphere®, Riverbed Stingray™ Traffic Manager, and Microsoft Windows Server.

The designed architecture provides:

- A disaster recovery procedure using EMC RecoverPoint® and VMware Site Recovery Manager™ (SRM)
- High availability for EMC xDB using EMC AutoStart
- Load balancing and high availability for EMC XDS Registry and Repository using Riverbed Stingray Traffic Manager
- Guidelines to build similar multiple region solutions

Business Case

The increasing volumes of medical data present challenges for the management of healthcare IT.

Healthcare IT management also faces the difficulties of integrating and easily sharing unstructured data with other patient data and presenting this data to the caregiver at the “point-of-decision-making” anywhere in the enterprise.

Sharing of highly available medical information between hospitals in a region is a new critical IT service that is being deployed by numerous healthcare organizations.

When the sharing requirement is across multiple regions, the level of complexity increases and the highly available IT service takes on greater significance.

Key Results and Recommendations

The architecture enables customers to:

- Share clinical documents across multiple regions
- Provide load balancing and high availability for multiple EMC XDS Registry and Repository servers using Riverbed Stingray Traffic Manager
- Achieve uninterrupted read-only access to clinical data in the event of a failure of the EMC xDB Master database
- Automate the failover of the EMC xDB Master and Replica servers to standby EMC xDB Master and Replica servers using EMC AutoStart
Introduction

Purpose
The purpose of this white paper is to document an architecture capable of supporting a highly available multiple region HIP deployment.

Scope
The scope of this white paper includes documenting the following:

- The HA configuration for a multiple region EMC HIP Registry/Repository solution
- The behavior of the EMC HIP components in the event of a component failure
- The benefits of using EMC AutoStart in the event of an EMC xDB Master/Replica failure

The scope of this white paper does not include documenting the following:

- High availability of EMC Documentum Content Server using EMC RecoverPoint and VMware SRM. This is outlined in the following paper:
  
  *EMC Medical Image Management with Document Sharing Solution (Enterprise) – Business Continuance*

Audience
This white paper is intended for EMC employees, partners, and customers, including IT planners, xDB server database administrators (DBAs), and EMC field personnel who are tasked with deploying such a solution in a customer environment. It is assumed that the reader is familiar with the various components of the solution.

Terminology
This white paper includes the terminology shown in Table 1.

Table 1. Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>DICOM</td>
<td>Digital Imaging and Communications in Medicine</td>
</tr>
<tr>
<td>HIP</td>
<td>Healthcare Integration Portfolio</td>
</tr>
<tr>
<td>HL7</td>
<td>Health Level 7</td>
</tr>
<tr>
<td>IHE</td>
<td>Integrating Healthcare Enterprise</td>
</tr>
<tr>
<td>PACS</td>
<td>Picture Archiving and Communication System</td>
</tr>
<tr>
<td>RIS</td>
<td>Radiology Information System</td>
</tr>
<tr>
<td>WDK</td>
<td>Web Development Kit</td>
</tr>
<tr>
<td>xDB</td>
<td>XML database</td>
</tr>
<tr>
<td>XDS</td>
<td>Cross-Enterprise Document Sharing</td>
</tr>
<tr>
<td>SRM</td>
<td>Site Recovery Manager</td>
</tr>
<tr>
<td>SRA</td>
<td>Storage Replication Adapter</td>
</tr>
</tbody>
</table>
Technology Overview

Overview
This section provides an overview of the primary technologies included in this solution:

- EMC HIP Components
- EMC Documentum
  - EMC Documentum Content Server
  - EMC Documentum Docbroker
- EMC xDB
- IHE XDS Toolkit
- EMC RecoverPoint
- EMC AutoStart
- VMware vSphere
- VMware vCenter SRM
  - Planned Migration
  - Automated Re-protection
  - Automated Failback
  - Enhanced Dependency Definition
- Riverbed Stingray Traffic Manager
  - Software Application
  - Stingray Traffic Manager Virtual Appliance

EMC HIP Components
The HIP XDS Registry is the directory or “white pages” for medical and administrative content that provides applications within the enterprise with the ability to discover and then access information. Based on the implementation of Integrating Healthcare Enterprise's (IHE) XDS Registry specifications, it provides a central catalog for documents that reside in a federated system of healthcare repositories, either heterogeneous or geographically distributed.

The HIP XDS Repository stores the document content for the patient's healthcare record where all patient-centric documents, images, and media are available via the XDS-specification for applications to consume. This applies even when the clinical, financial, and operational content was not created through the use of an XDS specification.

EMC Documentum
EMC Documentum provides a set of complementary capabilities to traditional RIS/PACS integrations. It allows documents, patient records, prescriptions, invoices, and other unstructured content to be easily accessed using a secure, virtual, and federated repository. Documentum also uses open standard message formats to reduce the expensive point-to-point integrations that are typically required.
EMC Documentum Content Server

EMC Documentum Content Server governs the Documentum content repository containing the data and metadata. Content Server delivers a set of content management services and a comprehensive infrastructure for all content applications. Capable of supporting multisite enterprise deployments, Content Server can manage HTML and XML formats, graphics, multimedia, other types of rich media, and traditional documents created with desktop applications.

EMC Documentum Docbroker

The Documentum DocBroker is a process that provides client sessions with connection information. To establish a connection, a client session must know where to find a server that accesses the requested content repository. When a client session is opened, the client contacts the DocBroker and requests the information it needs to connect with a server for the requested content repository.

EMC xDB

EMC xDB is used by the XDS Registry to store the registry metadata. EMC xDB is a native XML database. Its scalable architecture and complete support for the XQuery language enables any organization to warehouse content in an application-neutral format. These databases do not depend on a proprietary application for information retrieval.

Unlike relational databases, xDB enables you to easily modify content schemas to adapt to changing information requirements. It also supports queries against complex data structures that are not easily modeled in rows and columns. In addition, with its powerful and extensible development and runtime toolset, xDB is a powerful platform for the most complex and demanding content-centric applications.

IHE XDS Toolkit

The IHE XDS Toolkit is a Graphical User Interface (GUI) application that is installed into the webapps directory of a local servlet container, for example, Tomcat. You can use this toolkit to create XDS configuration actors and then execute XDS transactions against these actors. An actor contains a list of servers to use to validate the XDS transactions.

EMC RecoverPoint

EMC RecoverPoint and EMC RecoverPoint/SE are comprehensive data protection solutions for enterprise and commercial customers. RecoverPoint provides integrated continuous data protection (CDP) and continuous remote replication (CRR) to recover applications to any point in time.

RecoverPoint offers a comprehensive set of replication capabilities across heterogeneous storage systems to provide continuous data protection and remote replication for business continuity and disaster recovery.

EMC RecoverPoint Storage Replication Adapter for VMware vCenter Site Recovery Manager enables VMware vCenter SRM to implement disaster recovery using EMC RecoverPoint. RecoverPoint SRA supports VMware vCenter SRM functions, such as failing over and failing back, by using RecoverPoint as the replication engine.

EMC AutoStart

EMC AutoStart monitors and automates the restart process of your application and data services on an alternate server for UNIX, Linux, and Microsoft Windows environments. AutoStart also automates the failback of your services, applications,
and data—managing both failover directions and ensuring consistent and error-free business continuity.

**VMware vSphere**

VMware vSphere uses the power of virtualization to transform data centers into simplified cloud computing infrastructures and enables IT organizations to deliver flexible and reliable IT services. vSphere virtualizes and aggregates the underlying physical hardware resources across multiple systems and provides virtual resource pools to the data center.

As a cloud operating system, vSphere manages large infrastructure collections (such as CPUs, storage, and networking) as a seamless and dynamic operating environment. It also manages the complex operations of a data center.

**VMware vCenter SRM**

VMware vCenter Site Recovery Manager (SRM) enhances your ability to build, manage, and execute reliable disaster recovery plans for your virtual environment. With the release of version 5.0, VMware has expanded the capabilities of vCenter SRM to provide unprecedented levels of protection. New solutions are now possible through the addition of the capabilities discussed below.

**Planned Migration**

Planned migration is a workflow designed to deliver migration while minimizing the risk of data loss. Planned migration stops the workflow from continuing if it encounters an error. This functionality provides an opportunity to fix the problem, ensuring that systems are properly quiescent, and that all data changes replicate successfully.

**Automated Re-protection**

Re-protection is an extension to recovery plans for use only with array-based replication. Automated re-protect enables the environment at the recovery site to establish replication and protection of the environment back to the original protected site through a single click.

**Automated Failback**

Automated failback returns the entire environment to the originally protected primary site. This can only happen after re-protection ensures that data replicates to and synchronizes with the original primary site. Failback follows the same workflow used to migrate the environment to the protected site, which ensures that the critical systems encapsulated by the recovery plan return to their original environment. Automated failback, like re-protection, is only available for use with array-based replication protected virtual machines.

**Enhanced Dependency Definition**

Enhanced dependency includes the addition of five priority groups and the ability to set virtual machine dependencies within a priority group. You can define virtual machine dependencies to ensure that required systems are available before powering on dependent virtual machines. This enables highly organized workflow control, and ensures that required services are available before powering on the dependent virtual machines.
**Software Application**

You can install Riverbed Stingray Traffic Manager on any commodity hardware platform or as a virtual appliance on VMware. Traffic Manager is a software-based LH7 application delivery controller (ADC) designed to deliver a fast, high performance user experience. It provides reliable access to public websites and enterprise applications—whether they run in a public cloud, private cloud, or virtualized environment—while maximizing the efficiency and capacity of web and application servers.

**Stingray Traffic Manager Virtual Appliance**

Stingray Traffic Manager provides load balancing across multiple EMC HIP Registry/Repositories.
Architectural Overview

This white paper characterizes and validates high availability for a virtualized EMC xDB and XDS environment using Windows 2008 and EMC AutoStart, EMC RecoverPoint, and VMware SRM. VMware is used to provide the virtualization layer.

**Physical Environment**

Figure 1 shows the configuration of a multiple region physical environment. Central is the primary location for the region. This location is also protected against local site failure.

East and West act as the secondary locations in the region.

Testing was limited to the interaction of East with Central. In a production environment, the West location would be configured similar to East and would behave in the same manner.
Figure 1. Physical environment
Table 2, Table 3, and Table 4 show the hardware resources used during the testing of this solution.

**Table 2. Hardware resources – Central**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Quantity</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>2</td>
<td>128 GB memory servers with 2.27 GHz, 8C processors</td>
</tr>
<tr>
<td>VNX5500 storage array</td>
<td>1</td>
<td>FLARE™ Release 32</td>
</tr>
<tr>
<td>Fibre Channel (FC) switch</td>
<td>2</td>
<td>8 GB, 80 ports</td>
</tr>
<tr>
<td>Network switch</td>
<td>1</td>
<td>10 GB, 24 ports</td>
</tr>
<tr>
<td>RecoverPoint Appliances</td>
<td>2</td>
<td>Gen 4</td>
</tr>
</tbody>
</table>

**Table 3. Hardware resources – Central Disaster Recovery**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Quantity</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>2</td>
<td>128 GB memory servers with 2.27 GHz, 8C processors</td>
</tr>
<tr>
<td>VNX5500 storage array</td>
<td>1</td>
<td>FLARE™ Release 32</td>
</tr>
<tr>
<td>Fibre Channel (FC) switch</td>
<td>2</td>
<td>8 GB, 80 ports</td>
</tr>
<tr>
<td>Network switch</td>
<td>1</td>
<td>10 GB, 24 ports</td>
</tr>
<tr>
<td>RecoverPoint Appliances</td>
<td>2</td>
<td>Gen 4</td>
</tr>
</tbody>
</table>

**Table 4. Hardware resources – East**

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Quantity</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server</td>
<td>2</td>
<td>128 GB memory servers with 2.27 GHz, 8C processors</td>
</tr>
<tr>
<td>VNX5500 storage array</td>
<td>1</td>
<td>FLARE™ Release 32</td>
</tr>
<tr>
<td>Fibre Channel (FC) switch</td>
<td>2</td>
<td>8 GB, 80 ports</td>
</tr>
<tr>
<td>Network switch</td>
<td>1</td>
<td>10 GB, 24 ports</td>
</tr>
</tbody>
</table>
Table 5 shows the software resources used during the testing of this solution.

### Table 5. Software resources

<table>
<thead>
<tr>
<th>Software</th>
<th>Version</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMC VNX5500 VNX OE for Block</td>
<td></td>
<td>Operating environment for the block</td>
</tr>
<tr>
<td>VMware ESX</td>
<td>5.1</td>
<td>Server hypervisor</td>
</tr>
<tr>
<td>EMC PowerPath® Virtual Edition</td>
<td>5.7.02</td>
<td>Multipathing and load balancing for block access</td>
</tr>
<tr>
<td>VMware vCenter Server</td>
<td>5.1</td>
<td>vSphere Management Server</td>
</tr>
<tr>
<td>Microsoft Windows Server</td>
<td>2008 R2 SP1</td>
<td>Operating system for all virtual machines</td>
</tr>
<tr>
<td>EMC Documentum</td>
<td>7.0 Patch 9</td>
<td>Used for hosting Documentum Repositories</td>
</tr>
<tr>
<td>EMC xDB</td>
<td>10.3.0</td>
<td>Installed on Microsoft Windows. Includes xDB Master and xDB Replica</td>
</tr>
<tr>
<td>EMC HIP components</td>
<td>1.4.003</td>
<td>Installed on Microsoft Windows. Includes XDS Registry and Repository</td>
</tr>
<tr>
<td>EMC AutoStart</td>
<td>5.5</td>
<td>Software that monitors and automates the restart and failover processes of your applications</td>
</tr>
<tr>
<td>EMC RecoverPoint</td>
<td>3.5.1</td>
<td>Provides the disaster recovery solution for the storage and server environment.</td>
</tr>
<tr>
<td>VMware Site Recovery Manager</td>
<td>5.1</td>
<td>Controls the execution of reliable disaster recovery plans for the solutions' virtual environment</td>
</tr>
<tr>
<td>EMC Site Recovery Adapter</td>
<td>2.1</td>
<td>Supports SRM functions, by using RecoverPoint as the replication engine</td>
</tr>
<tr>
<td>IHE XDS Toolkit</td>
<td>2.1.40</td>
<td>Used this toolkit to execute XDS transactions</td>
</tr>
</tbody>
</table>
Virtual Configuration

ESX Configuration
The virtual infrastructure per site consisted of two servers to form a VMware ESX HA cluster with version 5.1 installed.

VMware Network
All virtual machines use VMXNET3 adapters. This included a 10 GbE backbone network connecting the physical ESX servers. A virtual distributed switch was created on the ESX cluster into which the 10 Gb ports were added.

Virtual Machine Resources and Software
Table 6 and Table 7 list the virtual resources allocated to each of the virtual machines and the software installed on each machine.

<table>
<thead>
<tr>
<th>Table 6. Virtual machine allocations for Central</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual machine</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
</tbody>
</table>
| Documentum Content Server and Docbroker | 2 | • Microsoft Windows Server 2008 R2 SP1  
• Apache Tomcat 7  
• Microsoft SQL Server 2012 Client  
• Java JDK 1.6.0_37  
• Documentum Content Server 7.0 containing:  
  ▪ XDS Repository  
  ▪ Content Storage Services enabled  
  ▪ Retention Policy Services enabled  
  ▪ Trusted Content Services enabled  
  ▪ Documentum Docbroker  
  ▪ HIP XDS Repository DCTM DAR file installed to XDS  
  ▪ VMware tools |
| XDS Registry | 2 | • Microsoft Windows Server 2008 R2 SP1  
• Java JDK 1.6.0_37  
• HIP Registry 1.4  
• Tomcat 7  
• VMware tools |
| XDS Repository | 2 | • Microsoft Windows Server 2008 R2 SP1  
• Java JDK 1.6.0_37  
• HIP Repository 1.4  
• Tomcat 7  
• VMware tools |
<table>
<thead>
<tr>
<th>Virtual machine</th>
<th>Quantity</th>
<th>Software</th>
</tr>
</thead>
</table>
| xDB Master server     | 2        | • Microsoft Windows Server 2008 R2 SP1  
                          • Java JDK 1.6.0_37  
                          • Documentum xDB 10.3  
                          • Tomcat 7  
                          • VMware tools  
                          • AutoStart agent |
| xDB Replica server    | 2        | • Microsoft Windows Server 2008 R2 SP1  
                          • Java JDK 1.6.0_37  
                          • Documentum xDB 10.3  
                          • Tomcat 7  
                          • VMware tools  
                          • AutoStart agent |
| EMC AutoStart console | 1        | • AutoStart console virtual machine                                      |
| Riverbed Stingray Traffic Manager | 2 | 9.1 |
| Microsoft SQL Server 2012 | 2 | • Microsoft Windows Server 2008 R2 SP1  
                          • Microsoft SQL Server 2012  
                          • VMware tools |
<table>
<thead>
<tr>
<th>Virtual machine</th>
<th>Quantity</th>
<th>Software</th>
</tr>
</thead>
</table>
| XDS Registry                  | 2        | • Microsoft Windows Server 2008 R2 SP1  
• Java JDK 1.6.0_37   
• HIP Registry 1.4  
• Tomcat 7  
• VMware tools |
| XDS Repository                | 2        | • Microsoft Windows Server 2008 R2 SP1  
• Java JDK 1.6.0_37   
• HIP Repository 1.4  
• Tomcat 7  
• VMware tools |
| xDB Replica Server            | 2        | • Microsoft Windows Server 2008 R2 SP1  
• Java JDK 1.6.0_37   
• Documentum xDB 10.3  
• Tomcat 7  
• VMware tools  
• AutoStart agent |
| Riverbed Stingray Traffic     | 2        | 9.1                                                                      |
| Manager                      |          |                                                                          |
| EMC AutoStart console         | 1        | • AutoStart console virtual machine                                      |
Figure 2 shows the virtualized layout of the solution.

Figure 2. Virtualized layout
Figure 3 shows the data flow (Register and Query) for a multiple region deployment.
Design Considerations

Introduction

Figure 2 is representative of a three-site deployment architecture.

The Central site was designated to act as the primary location. The SQL servers and the Documentum Content servers reside at this location. A Microsoft SQL cluster provides a highly available database system. The Documentum Content server uses this SQL cluster to store the Documentum XDS Repository. The HA design for these components is out of scope for this white paper.

EMC XDS Registry and Repository servers at the Central location facilitate:

- READ and WRITE requests at the primary location handled by the Central EMC XDS Registry and Repository servers.

EMC XDS Registry and Repository servers at the other locations facilitate:

- WRITE requests being routed to the EMC XDS Registry and Repository servers in Central.
- READ requests serviced by local EMC XDS Registry and Repository servers. This allows these locations within the region to service read requests in the event that the Central location becomes unavailable.

A Riverbed Stingray Traffic Manager cluster was configured at each location. This facilitated the load balancing of transactions across the XDS Registry and XDS Repository virtual machines.

AutoStart uses a DNS alias at all locations. At the Central location, the alias for the xDB Master server is XDBServer. At the East location, the alias for the xDB Replica server is EastXDBReplica.

The Central location uses a disaster recovery (DR) site to protect against a total site failure. EMC RecoverPoint and VMware Site Recovery Manager (SRM) are used to failover to the DR site in the event of a failure. The testing of total site failure is not included in the scope of this white paper.

Central Design Considerations

xDB Master

As part of the design for the xDB Master and the xDB Master standby servers, the VMFS datastores for the database and logs were shared. This enabled the standby server to seamlessly take over the function of the Master server in the event of a failure.

AutoStart

AutoStart manages the failover and restart processes of the xDB Master server. The AutoStart console was installed on its own virtual machine but it could also have been installed on any of the xDB virtual machines.

You should install a second AutoStart console virtual machine to the AutoStart domain. In the event of a failure on one AutoStart console virtual machine, you can still manage the domain.
The AutoStart agent was installed on all xDB virtual machines. Within AutoStart, two resource groups were configured, one for the xDB Master servers and one for the East xDB Replica servers.

**Note:** A resource group consists of settings that allow the xDB service to restart on the same server or fail over to another server.

One of the functions of AutoStart within this solution is to monitor the xDB service on the Master server. If this service fails, AutoStart restarts the service on that server. After three unsuccessful restart attempts, AutoStart automatically fails over to the standby Master server. The number of restart attempts is configurable within AutoStart.

If the server that the xDB service is running on fails, AutoStart automatically fails over the xDB service to the standby server.

**HIP (XDS Registry and Repository)**

As shown in Figure 2, dual XDS Registry and Repository servers were configured.

The Groovy SOAP route builder script, which is part of the HIP installation package, was customized on the East XDS Registry servers to reroute Provide and Register requests from the East location to the Central XDS Registry servers. It is configured within the registry.properties file on the East XDS Registry servers.

The XDS endpoint within the script needs to be modified as shown in the example below in Figure 4.

```groovy
from('xds-iti42:xds-iti42')
 .routeId('xds-iti42:xds-iti42')
 .choice()
 .when().constant(ITI42RequestValidatorEnabled).process(iti42RequestValidator())
 .end()
 .to('xds-iti42://Central_Stingray_Virtual_Servername:8080/hip-webapps-registry-1.4/xds-iti42')
 .process(iti42ResponseValidator())
```

*Figure 4. Modified entry in SOAP route builder script*
**xDB Replica**

As part of the design for the xDB Replica and xDB Replica Standby servers, the VMFS datastores for the database and logs were shared. The Replica receives its updates from the xDB Master server in Central. The Replica servers were configured with a unique replicator ID, as shown below in Figure 5.

![Figure 5. East Replica showing login screen](image-url)

**Figure 5. East Replica showing login screen**
Test Results

Overview

This chapter describes the behavior and observations at both the Central (Primary) and the East location during the XDS testing.

The XDS Toolkit was used as part of all testing that was executed in the environment. The XDS transaction flow is shown in Figure 6.

![XDS transaction flow](image)

Central Test Objectives

The objectives of the tests executed at the Central location were to validate the design of the environment and to prove that ProvideAndRegisterDocumentSet and RegistryStoredQuery transactions were handled as expected.

During the ingestion of clinical documents, failures were simulated within the environment. Individual component and total site failures were induced against the XDB, XDS Registry and Repository servers. The recovery process was observed and documented.

The following tests were performed at the Central location:

- Provide and Register Document Set to Central
- Registry Stored Query from Central
- Retrieve Document Set from Central
- Automated failover of xDB using EMC AutoStart
- Total site failover using EMC RecoverPoint and VMware SRM
Provide and Register Document Set Execution to Central

The open source XDS Toolkit was used to initiate a Provide and Register Document Set to the Central XDS Repository server. This completed successfully, validating the functionality of the configuration of the Central location, as shown in Figure 7.

The Central XDS Registry servers then route this to the xDB Master server by connecting to the XDB Server alias that has been created, as described in the Design Considerations section.

Figure 7. Provide and Register Document Set with all XDS Repository servers online

This test was repeated with one XDS Repository server shut down and the result was successful. This proves that the load balancing of the XDS Repository servers within the Stingray Traffic Manager is operating as designed.

Registry Stored Query Execution from Central

The XDS Toolkit was used to initiate a Registry Stored Query Execution from the Central location. This completed successfully, validating the functionality of the configuration of the Central location, as shown in Figure 8.
This test was repeated with one EMC XDS Registry server shut down and the result was successful. This proves that the load balancing of the EMC XDS Registry servers within the Stingray Traffic Manager is operating as designed.
Retrieve Document Set from Central

The XDS Toolkit was used to initiate a Retrieve Document Set to the EMC XDS Repository from the Central location. This completed successfully, validating the functionality of the configuration of the Central location, as shown in Figure 9.

![Retrieve Document](image)

**Figure 9. Repository retrieve**

This test was repeated with one Central XDS Repository server shut down and the result was successful. This proves that the load balancing of the XDS Repository servers within the Stingray traffic manager is operating as designed.
Automated Failover of xDB using EMC AutoStart

EMC AutoStart is designed as part of the solution to monitor the xDB configuration, as shown in Figure 2.

As proven in the Provide and Register Document Set to Central test described above, during normal operation, all Provide and Register and Query operations are serviced successfully using the xDB alias XDBServer.

The AutoStart resource group will assign this alias to either the xDB Master or xDB Standby, depending on which server is assigned as the owner of the resource group.

For the purpose of this test, the xDB Master server was failed. Consequently AutoStart relocated ownership of the resource group from the xDB Master to the xDB Standby.

Failover from the xDB Master to the xDB Standby takes approximately 30 seconds. During this time, any connection attempt will fail. Once the resource group is back online, all Provide and Register and Query operations will run successfully.

For further information on xDB failover using AutoStart, see the document below:

High Availability Configuration for Healthcare Integration Portfolio (Hip) Registry

Total Site Failover using EMC RecoverPoint and VMware SRM

A Disaster Recover site has also been created for protection against site failure at the Central location.

EMC RecoverPoint and VMware SRM provide the replication and recovery for the solution environment.

For test purposes, a total site failure was initiated by simultaneously failing both ESX servers in the cluster at the Central site. The disaster recovery plan was then initiated from within the Virtual Center at the DR site. The recovery plan completed successfully and all virtual machines were successfully failed over to the DR site allowing for the continuation of Provide and Register and Query operations.

Note: Executing a Provide and Register or Query operation while site failover is occurring will result in a connection error.

The use of SRM with RecoverPoint in this solution environment resulted in a recovery time of approximately 30 minutes after a site failure. Depending on site specifics, results may vary slightly.

For more information on the results of the failover of these products, please contact your local EMC representative to obtain access to the following document:

EMC Medical Image Management with Document Sharing Solution (Enterprise) – Business Continuance
The objectives of the tests executed at the East location were to validate the design of the environment and to prove that XDS ProvideAndRegisterDocumentSet and RegistryStoredQuery transactions were handled as expected.

During the ingestion of clinical documents, failures were simulated within the environment. Individual component failures were induced against the xDB, XDS Registry and Repository servers. The recovery process was observed and documented.

The following tests were performed at the East location:

- Provide and Register Document Set to East XDS Registry/Repository servers
- Registry Stored Query from East while Central XDS Registry servers are offline
- Retrieve Document Set from East when Central XDS Repository servers are offline

**Provide and Register Document Set to East**

The XDS Toolkit was used to initiate a Provide and Register Document Set to the East location. The East XDS Registry servers then routes this to the xDB Master server via the Central XDS Registry servers as configured in the Groovy SOAP route builder script. This completed successfully, validating the functionality of the configuration as shown in Figure 10.
This test was repeated with one East EMC XDS Repository server shut down and the result was successful. This proves that the load balancing of the EMC East XDS Repository servers within the Stingray Traffic Manager is operating as designed.
Registry Stored Query from East while Central XDS Registry Servers are Offline

The XDS Toolkit was used to initiate a Registry Stored Query operation from East when the Central XDS Registry servers were offline, as shown in Figure 11.

We repeated this test with one East XDS Registry server shut down and the result was successful. This proves that the load balancing of the East XDS Registry servers within the Stingray Traffic Manager is operating as designed.
Retrieve Document Set from East when Central XDS Repository Servers are Offline

The XDS Toolkit was used to initiate a Retrieve Document Set at the East location while the Central XDS Repository servers are offline. This completed successfully, validating the functionality of the configuration of the East location, as shown in Figure 12.

![Retrieve Document](Image)

**Figure 12. Retrieve Document Set from East**

We repeated this test with one East XDS Repository server shut down and the result was successful. This proves that the load balancing of the East XDS Repository servers within the Stingray Traffic Manager is operating as designed.
Conclusion

Summary

The High Availability Configuration for a Multiple Region Healthcare Integration Portfolio (HIP) Registry and Repository solution provides a medical document management environment that can capture clinical information from multiple locations.

The testing emulated a multiple region configuration consisting of a Primary (Central) and Secondary (East) location.

Findings

The test results demonstrate that this solution provides:

- High availability for EMC xDB using EMC AutoStart.
- High availability for EMC XDS Registry and XDS Repository using Riverbed Stingray Traffic Manager IP load balancing.
- The ability of a secondary location to service IHE transactions (RegistryStoredQuery) locally through the use of EMC xDB database replication.
- The ability of a secondary location to route IHE transactions (ProvideandRegisterDocumentSet) to the primary location through the use of a SOAP Route Groovy builder script customization.
References

For additional information, see EMC.com and the product documents listed below:

- Healthcare Solutions on EMC.com
- High Availability Configuration for Healthcare Integration Portfolio (Hip) Registry
- Choosing an xDB Configuration