VIDEO SURVEILLANCE WITH SURVEILLUS VMS AND EMC ISILON STORAGE ARRAYS

- Successfully configure all solution components
- Use VMS at the required bandwidth for NAS storage
- Meet the bandwidth demands of a 2,200 camera casino deployment

Abstract

Surveillus VMS provides the high availability video infrastructure required by casinos and performs exceptionally well when writing and reading video files using EMC® Isilon® NAS storage clusters. This white paper describes how the EMC Solutions Group Physical Security team tested and validated the way Surveillus VMS integrates with EMC Isilon storage to create an ideal solution for casino deployment.

EMC Solutions Group

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Executive summary

Solution Overview
This solution positions EMC® Isilon® X200 NAS storage arrays with Surveillus Networks LLC’s Surveillus Video Management System (VMS) for a 2,200-camera casino-capable deployment. The EMC Global Solutions Physical Security team built and tested this solution and determined whether:

- Surveillus VMS can write and review video at the required bandwidth using NAS storage.
- Surveillus VSR or the EMC Isilon storage array requires modifications or configuration changes for a successful implementation.

Our tests confirmed that Surveillus VMS provides the high availability infrastructure required by casinos that performs exceptionally well when writing to an EMC Isilon storage cluster. This white paper explains the details of these findings.

Business case
Like many VMS applications in the industry, Surveillus had only been implemented for writing video to block level storage. These tests determined that:

- Surveillus can write to EMC Isilon storage using file-based network attached storage (NAS)
- The Surveillus VMS application meets the bandwidth demands of a 2,200-camera casino deployment.

Key results / recommendations
The total required bandwidth for the 2,200 cameras in the casino environment was approximately 8,896 Mb/s. You can spread this bandwidth across 40 Isilon X200 series storage nodes resulting in a 222.4 Mb/s (27.8 MB/s) per node average bandwidth requirement.

Our tests were successful at 50 MB/s, exceeding the 27.8 MB/s goal.

There are several Isilon configuration settings required for an implementation to be successful. This document describes those settings.

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1 The use of “our” and “we” in this section as well as the remaining sections in this paper includes a team of EMC and partner solutions (Surveillus Networks LLC) engineers who designed, built, and validated the solution presented in this document.
Introduction

Overview
This paper includes the following sections:

- Configuring Surveillus VMS for the Isilon X200
- Test result summary, configuration, and test details
- VMware® ESX®/ESXi™ implementation

Purpose
The purpose of this document is to provide information related to testing Surveillus VMS with an Isilon X200 NAS storage array and the required configuration for Surveillus and the Isilon X200 storage array.

Scope
The scope of this document is to provide guidance for installing Surveillus VMS with EMC Isilon NAS storage arrays.

Audience
This document is for EMC internal employees who may be implementing video surveillance using Surveillus VMS and EMC Isilon storage.

Terminology
This paper includes the following terminology.

Table 1. Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site</td>
<td>The Primary server defines a site. If two or more Primary servers are required for the implementation, then that implementation has two or more sites.</td>
</tr>
<tr>
<td>Storage Unit</td>
<td>Surveillus Linux application with the primary purpose of ingesting video from several cameras and writing video-to-video storage (Isilon X200)</td>
</tr>
<tr>
<td>Primary server</td>
<td>Surveillus Windows application providing management of several Storage Units. Many Primary servers can exist in an implementation.</td>
</tr>
<tr>
<td>Secondary server</td>
<td>Provides a backup mechanism to the Primary server</td>
</tr>
<tr>
<td>Video server or video simulator</td>
<td>Servers used to replicate video allowing a few video feeds the ability to create many video feeds for testing purposes</td>
</tr>
</tbody>
</table>
Configuring Surveillus for the Isilon X200

The EMC Global Solutions Physical Security team worked with Surveillus engineering to successfully test a 2,200-camera installation.

We booted the ESXi hosts from the local host RAID 1 storage and the virtual machines from VMware data stores defined on the EMC Physical Security lab’s EMC VNX5300™. We used VMware data stores for all Storage Units, the Primary server, and the Secondary server.

As illustrated in Figure 1:

- This solution uses a five-node Isilon X200 cluster.
- Each of the four NICs per node connects to a 1 GBE switch.
- Four Storage Units run as virtual machines on a single ESXi 4.1 host and connect through a 10 GbE link to a Cisco Nexus switch.
- Four Video Servers are positioned with a Primary server and Secondary server on a second ESXi 4.1 host.
- Each set of components connects to different physical switches to provide realistic IP traffic paths.
- Jumbo frames have an end-to-end maximum transmission unit (MTU) of 9,000 bytes.

![EMC Physical Security Lab configuration](image-url)

**Figure 1.** EMC Physical Security Lab configuration
With four video servers active, a video server simulates 37 or 38 cameras. When we forced a Storage Unit to fail, the cameras that were active on the failed Storage Unit quickly rebalanced across the remaining three Storage Units, correctly balancing 50 cameras among the remaining three Storage Units.

Each Surveillus Storage Unit wrote to a different NIC on the same Isilon X200 node.
Test result summary, configuration, and test details

Test result summary

Surveillus VMS performed well when writing to Isilon storage using NFS4. To test the configuration, the validation team:

- Removed disks
- Removed an Isilon X200 node from the cluster
- Added an Isilon X200 node to the cluster

Table 2 summarizes the tests performed on this solution.

<table>
<thead>
<tr>
<th>Test</th>
<th>Number of NICs</th>
<th>Maximum bandwidth</th>
<th>Maximum streams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max cameras</td>
<td>1</td>
<td>20 MB/s = 160 Mb/s</td>
<td>58</td>
</tr>
<tr>
<td>Throughput</td>
<td>4</td>
<td>40 MB/s = 320 Mb/s</td>
<td>120</td>
</tr>
<tr>
<td>Rebuild disk</td>
<td>4</td>
<td>40 MB/s = 320 Mb/s</td>
<td>120</td>
</tr>
<tr>
<td>Remove node</td>
<td>4</td>
<td>40 MB/s = 320 Mb/s</td>
<td>120</td>
</tr>
<tr>
<td>Add node</td>
<td>4</td>
<td>40 MB/s = 320 Mb/s</td>
<td>120</td>
</tr>
</tbody>
</table>

Configuration

A successful implementation is based on correctly configuring all components. The Surveillus Storage Units are based on Red Hat's Fedora Linux operating system, which by default uses NFS version 3. We modified this value to NFS version 4 to get storage extents greater than 2 TB. The following sections outline the primary Isilon and Surveillus Storage Unit configuration requirements. In these tests, only the Storage Units write to the Isilon X200.

VMware data stores

The validation team used an EMC VMX5300 storage array for all VMware data stores. The VMware data stores contain the boot images for the Linux Surveillus Storage Unit servers as well as the Microsoft Windows 7 workstations used for the Primary and Secondary servers.

Isilon X200

Because the Isilon system presents a single, large storage space to many systems, we configured SmartQuota so that each Storage Unit sees only its own allocation.

It is important to determine the correct values for each quota allocation. The total quota allocations should not exceed 100 percent minus at least “one-node” of storage to avoid any chance of suddenly reaching 100 percent utilization.
The solution validation team used the following procedure to configure the SmartQuota.

1. Set the SmartQuota as a “Hard threshold” and do not include usage for snapshots, as illustrated Figure 2.

2. Valid NFS settings include NFS version 3 (the default) or NFS version 4. NFS version 3 restricts storage extents to 2 TB. In this solution, we used NFS version 3 with 16 extents of 2 TB each. NFS v4 seemed overly complex and difficult to configure properly — due in part because it requires matching users/groups, in the domain. If you are using NFS version 4, enable it using the NFSv4 support settings as shown in Figure 3:
3. For each NFS share, set permissions to **Enable write access**, as shown in Figure 4.

![Figure 4. Enabling write access permissions](image)

4. If you are implementing NFS version 3, skip this step. In the NFS per share advanced settings, enable **Readdirplus enable** and **Return 32-bit file ids** and set them both to **yes**, as shown in Figure 5.

![Figure 5. Enabling Readdirplus and Return 32 bit file IDs](image)

5. In the **I/O Optimization Settings** window, we configured **Random** as the Data access pattern, as shown in Figure 6. However, you can use **Concurrent** in place of Random as an alternative.

![Figure 6. Setting the data access pattern](image)
6. Specify the UNIX permission for **Read**, **Write**, and **Execute** as illustrated in Figure 7.

| UNIX Permissions |
|------------------|------------------|------------------|------------------|
| User:            | Guest            |                   |                   |
| Group:           | Guests           |                   |                   |
| Permissions:     | Type             | Read             | Write            | Execute          |
| User            | ✓                | ✓                | ✓                | ✓                |
| Group           | ✓                | ✓                | ✓                | ✓                |
| Other           | ✓                | ✓                | ✓                | ✓                |

**Figure 7. Setting the UNIX permissions**

**Surveillus**

Surveillus supports the Ethernet NIC as *eth0, eth1, etc* (after modifying the Fedora persistence table). The Surveillus Storage Unit software will detect the active NIC and use it, whether it is eth0, eth1, etc.

**VMware**

Verify that the Ethernet interfaces are listed as E1000.

**Test details**

Using a five-node Isilon X200 storage array, we conducted several tests that focused on the aggregate bandwidth through a single node. The physical setup for these tests is described in the section entitled **Configuring Surveillus for the Isilon X2007 on page 7**.

We initiated various recovery tasks to determine how they affect the aggregate storage array throughput.

**Test 1 — Maximizing one NIC**

This first test determined the maximum number of cameras (streams) that a Surveillus/Isilon NIC pairing can accommodate, with the following results:

- A single NIC can accommodate 58 cameras attached to a single Surveillus Storage Unit.
- The maximum throughput for this configuration is 20 MB/s (160 Mb/s).

**Test 2 — Establishing a baseline**

We used four Storage Units in the remaining tests and connected each Storage Unit to a different Ethernet NIC on a single Isilon node. The aggregate camera count was 150 with an average bandwidth of 47 MB/s (376 Mb/s). This averaged 94 Mb/s per Storage Unit.

We produced the video by staggering the video start times. This generated a realistic random effect to the bandwidth as illustrated in the bandwidth graph shown in Figure 8.
Figure 8.  **Bandwidth**

PU utilization on the Isilon X200 was light during normal operation with no background tasks active as displayed in Figure 9.

![Figure 9. PU utilization](image)

**Test 3 — Rebuilding a disk**

In Test 3, we removed a single disk from the storage array and then formatted the removed disk and added it back to the array.

The throughput test was identical to that of Test 2 above. There was additional CPU overhead on the Isilon, which remained under 50 percent utilization.

The duration of rebuilding a disk takes up to 8 hours. We observed no performance degradation during this test.

**Test 4 — Removing a node**

In Test 4, we removed a single disk from the storage array. We then formatted the removed disk and added it back to the array.

The throughput test was identical to that of Test 2. There was some additional CPU overhead on the Isilon, which remained under 50 percent utilization.

Removing a node takes up to 12 hours. We observed no performance degradation during this test.

**Test 5 — Adding a node**

In Test 5, we removed a single disk from the storage array, then formatted the removed disk and added it back to the array.

The throughput test was identical to that of Test 2. There was some additional CPU overhead on the Isilon, which remained under 50 percent utilization.

Adding the node took only a few minutes as the disks were rebalanced. We observed no performance degradation during this test.
Surveillus Storage Unit implementation

Overview
VMware ESX/ESXi provides a platform that enables multiple Surveillus Storage Units to exist on a single physical host. In the EMC Physical Security lab, we booted VMware guests (for example, Storage Units) from the data store either on the local physical host or on a fiber-attached EMC VNX storage array. The solution boots VMware guests from the Isilon storage array.

This sections outlines configuration best practices for implementing a Surveillus Storage Unit.

Key objective
The key objective is to provide information related to a successful implementation of a Surveillus Storage Unit when installed for use with an EMC Isilon storage array. We also include VMware-specific configuration changes that you can use if you wish to use the Isilon as the boot data store.

Implementation
This section describes how to configure the VMware ESXi 4.1 and virtual machines.

VMware data store
You can place the data store from which a Storage Unit boots on the:
- ESX/ESXi physical host’s disk
- Fibre Channel attached storage array
- iSCSI attached storage
- NAS attached to the Isilon storage arrays

This requires no configuration changes.

NIC bonding
As a best practice, in a virtual environment, you must disable bonding in Surveillus.
### VMware ESX/ESXi and EMC Isilon SmartConnect

#### Overview
VMware ESX/ESXi provides a platform that allows Surveillus Primary servers, Secondary servers, and Storage Units to co-exist on the same physical servers.

When deploying a Surveillus VMware environment, make sure to correctly distribute the virtual machines across multiple VMware hosts.

**Note:** As tested, Fedora was the Linux distribution used for implementing the Surveillus Storage Units. Fedora is not a VMware supported OS.

#### Key objective
The objective of these tests is to reduce recovery times by reducing the Primary and Secondary server loads in the event of a physical server failure. We installed each site's Primary and Secondary servers on different physical servers. We then striped the site's Storage Units across all the physical servers.

#### VMware Distributed Resource Scheduler
The validation team used VMware Distributed Resource Scheduler (DRS) to install the Primary servers, associated Secondary servers, and Storage Units onto the VMware cluster.

EMC recommends that within a VMware DRS configuration, you should implement an Anti-Affinity rule in which a Primary server and its associated Secondary server cannot exist on the same physical host. This rule ensures that if the physical host fails, either the Primary server or Secondary server continues to run.

If you are not implementing the solution using DRS for VM guest placement, consider carefully the following sections.

#### EMC Isilon SmartConnect
To further increase the reliability and performance provided by the Surveillus architecture and augmented using VMware DRS, and to reduce system management overhead, the validation team implemented EMC Isilon SmartConnect™.

SmartConnect is a licensable software module of Isilon's OneFS® operating system that optimizes performance and availability by enabling intelligent client connection load balancing and failover support.

We connected the Surveillus Primary servers, Secondary servers, and Storage Units to the EMC Isilon array using a single virtual host name. SmartConnect load-balanced the connections across the EMC Isilon X200 storage nodes, greatly reducing the overhead associated with implementing the Surveillus solution.

EMC Isilon SmartConnect makes implementation easier by automating failover and failback and rebalancing the client connections across the cluster in the event of a failure. With the Surveillus high availability architecture, VMware DRS, and EMC Isilon SmartConnect, the solution, as implemented in our 2,200-camera environment, is very resilient.

#### Goal of striped Surveillus virtual machines
Striking, as discussed in the Implementation section on page 16 below, is intended to enhance availability. The goal is to reduce recovery times by distributing recovery over many sites in the event of a catastrophic failure of a physical host.
You can stripe Storage Units across all ESX/ESXi physical hosts, as illustrated in Figure 10 below. An alternative, in larger installations, with five or more ESX/ESXi hosts, is to stripe the Storage Units across all ESX/ESXi hosts except for the host with the associated Primary server (not illustrated).

**Implementation**

To stripe Surveillus virtual machines:

1. Stripe the Primary servers (PS) across the various ESX/ESXi hosts, and
   - Avoid placing two Primary servers on the same physical host.
   - Do not place a site’s Secondary server (SS) on the same physical host as its associated Primary server.

2. Stripe the Storage Units (SU) across all ESX/ESXi hosts.

In Figure 10, the number following the dash indicates the site. The number following the decimal point indicates a unique SU associated with the site. For example, PS-1 and SS-1 are the Primary and Secondary servers defining Site-1. SU-1.1 and SU-1.2 are two of the Storage Units associated with Site-1.

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**Figure 10.** Striping Surveillus virtual machines
Conclusion

Summary

Using the configuration parameters outlined in this document, our tests show that we can safely achieve up to 40 MB/s spread over the four NICs on an Isilon X200.

As required for this solution, in our lab environment we were able to achieve 40 MB/s, or 320 Mb/s with up to 120 cameras writing to each Isilon X200 node.

A single Isilon X200 NIC should not exceed a load of 20 MB/s, 160 Mb/s, or 58 cameras (streams).

The Surveillus high availability architecture, coupled with VMware DRS and EMC Isilon SmartConnect, provide a very resilient solution.

Findings

Table 3 summarizes the key points that this solution addresses.

<table>
<thead>
<tr>
<th>Key point</th>
<th>Solution objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Save per node limit</td>
<td>40 MB/s (320 Mb/s)</td>
</tr>
<tr>
<td></td>
<td>120 cameras</td>
</tr>
<tr>
<td>Tested maximum</td>
<td>50 MB/s</td>
</tr>
<tr>
<td>Reduced recovery times</td>
<td>Striping PS, SS, and SU over many ESX/ESXi hosts. Use VMware DRS or manual striping.</td>
</tr>
</tbody>
</table>

References

White papers

For additional information, see the white papers listed below.

- *SmartConnect – Optimize Scale-out Storage Performance and Availability*
- *EMC Isilon OneFS Operating System*