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INTRODUCTION

1.1 DataCore Virtual SANs

This document describes how to use DataCore™ SANsymphony™-V software to create a high-performance and highly-available shared storage pool using the disks and flash storage on your application servers. This configuration is referred to as a virtual SAN. Virtual SANs address the requirements for fast and reliable access to storage across a cluster of servers without the need for a separate external SAN infrastructure.

A DataCore virtual SAN can leverage any combination of flash memory, solid state disks (SSD) and magnetic disks to provide persistent storage services as close to the application as possible without having to go out over the wire (network). Virtual disks provisioned from the virtual SAN can also be shared across a cluster of servers to support the dynamic migration and failover of applications between nodes (servers).

The ensuing technical overview covers the principal operational and deployment guidelines for implementing a SANsymphony-V virtual SAN from uninitialized storage devices. Note: Additional steps and precautions not covered here must be taken when storage contains active data to be migrated into the virtual SAN. It is assumed that the reader is familiar with the steps involved with installing SANsymphony-V. Installation guidelines can be found on the DataCore support website. You may also consult the online SANsymphony-V help web pages for additional information. Please refer to the References Section of this document for more details on specific considerations.

Ideal Use Cases for DataCore Virtual SANs

Consider the DataCore virtual SAN solution for:

**Latency-sensitive applications**
Speed up response and throughput by leveraging flash memory as persistent storage close to the applications and caching reads and writes from even faster server DRAM memory.

**Small Server Clusters in Remote Sites, Branch Offices and Small Computer Rooms**
Put the internal storage capacity of your servers to work as a shared resource while protecting your data against server outages simply by adding SANsymphony-V software.

**Virtual Desktop (VDI) Deployment**
Run more virtual desktops on each server and scale them out across more servers without the complexity or expense of an elaborate external SAN.
1.2 Terminology

<table>
<thead>
<tr>
<th>term</th>
<th>definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datastore</td>
<td>VMware ESXi container used for storing VMware virtual machine disk and configuration files.</td>
</tr>
<tr>
<td>Disk Pool</td>
<td>DataCore container used to pool various physical disk devices into a common management structure.</td>
</tr>
<tr>
<td>LUN</td>
<td>Logical Unit Number. Generally refers to a physical disk volume.</td>
</tr>
<tr>
<td>Root Partition</td>
<td>Refers to where the local Microsoft Windows installation is located. SANSymphony-V can exist in this partition with or without the presence of a hypervisor (such as Hyper-V).</td>
</tr>
<tr>
<td>RDM</td>
<td>VMware Raw Device Mapping.</td>
</tr>
<tr>
<td>Server Group</td>
<td>Refers to a DataCore logical group which contains all virtual SAN nodes under management.</td>
</tr>
<tr>
<td>Smart Deployment</td>
<td>The Smart Deployment Wizard is a tool provided by DataCore to assists administrators with the initial deployment of virtual SAN. This tool is not required to deploy virtual SAN.</td>
</tr>
<tr>
<td>Virtual Disk</td>
<td>DataCore disk object served to virtual SAN nodes.</td>
</tr>
<tr>
<td>VHD</td>
<td>Microsoft Hyper-V virtual disk file.</td>
</tr>
<tr>
<td>VMDK</td>
<td>VMware virtual disk file.</td>
</tr>
<tr>
<td>Virtual SAN Node</td>
<td>Refers to the physical server where DataCore SANSymphony-V is installed.</td>
</tr>
</tbody>
</table>

1.3 Virtual SAN Components and Features

1.3.1 Component Overview

Virtual SAN and Virtual SAN Nodes
A DataCore virtual SAN is comprised of two or more physical x86-64 servers with local storage, hosting applications. Up to a maximum of 64 servers may be configured within a centrally-managed group. Each server participating in the virtual SAN must run a properly licensed instance of SANSymphony-V. These physical servers are also referred to as virtual SAN nodes (or simply nodes). Generally each node contributes storage to the group’s shared pool. You may also configure SANSymphony-V nodes that do not contribute storage to the pool but only host applications that access storage from the pool.

Virtual SAN Storage Devices
Uninitialized block storage devices attached to a node (with the exception of its boot drive) can be included in the virtual SAN. Any combination of flash memory, SSD and magnetic disks may be used. Removable USB devices are not supported since they cannot be relied upon to be present.
SANsymphony-V Deployment Options
There are 3 ways to configure the SANsymphony-V software on the application servers depending on the operating system or server hypervisor controlling the physical machine.

1. **Physical Windows Server (no server hypervisor installed)**
   SANsymphony-V runs directly on top of the Windows Server operating system. All local block storage devices that are not initialized are automatically detected as suitable for the pool. An application such as Microsoft Exchange or SQL may be installed alongside SANsymphony-V. Microsoft Failover Cluster or other clustering technology can be used to provide application failover between servers.

   **NOTE:** If Microsoft Clustering is deployed, the volumes that are participating within the cluster must be presented using iSCSI, otherwise cluster validation will fail.

2. **Windows Server with Hyper-V**
   SANsymphony-V runs in the root partition (also referred to as the parent partition) on top of the Windows Server operating system. All local block storage devices that are not initialized are automatically detected as suitable for the pool. The Microsoft Hyper-V hypervisor role is installed alongside SANsymphony-V.

3. **VMware ESXi and other non-Windows based hypervisors**
   SANsymphony-V runs within a dedicated Windows Server virtual machine. The administrator can choose to:
   - Assign uninitialized storage devices from the server hypervisor to the SANsymphony-V virtual machine as raw storage devices (RDMs in ESXi).\(^1\)
   - Present VMDK virtual disks that reside on VMFS datastores to the SANsymphony-V virtual machine.
   - Use DirectPath to map the storage controller (RAID or PCIe flash device) directly to the SANsymphony-V virtual machine.\(^2\)

   **NOTICES:**
   \(^1\)All local disk-RDM mapping files being presented to the SANsymphony-V virtual machine must reside on the node’s local datastore (not within a virtual volume presented from SANsymphony-V). The presentation of raw storage devices (RDM) is preferred, but may not always be available based on hypervisor and/or local RAID controller capabilities. If RDM is not an option, consider using VMDK virtual disks or DirectPath.

   \(^2\)Do not use DirectPath with the controller in charge of handling the ESXi installation partition and/or physical disks.

   Check the References section of this guide for more information related to mapping raw storage to the SANsymphony-V virtual machine.
1.3.2 Features Overview

Enterprise SAN Features

SANsymphony-V provides the following enterprise storage features:

- Automated Storage Tiering
- Advanced Site Recovery *
- Analysis and Reporting
- Asynchronous Replication *
- Channel Load Balancing
- Continuous Data Protection (CDP) *
- Fibre Channel support *
- High-Speed Caching
- iSCSI support
- NAS/SAN (Unified Storage)
- Snapshot
- Storage Migration and Pass-through Disks
- Storage Pooling
- Synchronous Mirroring
- Thin Provisioning

(*) Optional Features

Virtual SAN Licensing

A SANsymphony-V license is required per node. Licenses are based on the amount of physical storage the node contributes to the shared pool. Some features are separately priced. Please refer to a DataCore authorized representative for more information regarding licensing and pricing.

Disk Pools

In SANsymphony-V, storage devices are organized into disk pools. You may create multiple disk pools within a virtual SAN node to distinguish how each resource pool will be used. For example, one would create a production disk pool and a test disk pool to separate which storage will be allocated to production and what devices are best suited for testing.

Auto-tiering within Disk Pools

Members of a disk pool may have differences in performance characteristics. SANsymphony-V uses sub-LUN automated storage tiering to dynamically match the best device to a given workload based on how frequently blocks of storage are accessed. This ensures that hotter-data resides on faster disk and cooler-data resides on slower disk within the pool.
**Virtual Disks**

Thin-provisioned virtual disks created from a node’s disk pool can be shared with other nodes in the virtual SAN. They appear as well-behaved logical drives to the operating systems or hypervisors that they are explicitly served to.

**High-Speed Cache**

Each virtual SAN node requires some amount of RAM to be used as high-speed cache. The amount of RAM allocated can be modified as necessary, but generally a minimum of 4GB or 10% (whichever is higher) of the hosts’ total available RAM is recommended for use as high-speed cache.

The purpose of the high-speed cache is to serve as a speed-matching buffer for writes and a large cache for reads. The result is conservatively a 3-5x performance increase over the native performance of magnetic disks. The use of RAM as read-write cache provides a significant performance advantage over virtual SAN products that only use slower flash memory as a read cache device.

**Synchronous Mirroring for High Availability**

SANsymphony-V provides continuous access to the shared storage pools even when a virtual SAN node is out of service. Critical data is synchronously mirrored between pairs of virtual SAN nodes to achieve high-availability. RAID protection within each node provides additional safeguards against component-level failures.
1.4 Architectural Overview

This document will cover the most common virtual SAN deployments recommended for SANsymphony-V. It will outline some of the major considerations for each component in a virtual SAN to put into perspective the versatility of the SANsymphony-V platform.

1.4.1 How the virtual SAN Works

The diagram below shows an example of a virtual SAN. SANsymphony-V (in red) is running in a dedicated virtual machine (VM) on each node alongside VMs hosting applications.

In the diagram above, the left two nodes are responsible for sharing a highly-available virtual disk with the other nodes that make up the group of servers. Each node pools its local flash and magnetic storage devices. Virtual disks are created from these pools and are synchronously mirrored between the two nodes. They are presented as multi-path disk devices over the network/fabric. The virtual disks may be sized as needed. Oversubscribing the storage is allowed since the virtual disks are thin provisioned to minimize actual capacity consumption.

The two left nodes, as well as any of the other virtual SAN nodes in the virtual SAN, can access the virtual disk over the network/fabric. Each node’s corresponding hypervisor recognizes the virtual disk as an available disk device.

In this same way, other nodes can contribute to the overall capacity of the shared storage pool. Each node adds more storage, processing, network and I/O power to the group.
1.4.2 Storage Considerations

Local Storage Device Configuration
SANsymphony-V leverages block storage connected to each virtual SAN node. The following considerations will enhance the performance and resiliency of the group.

Use RAID for local fault tolerance
While presenting individual non-RAID disks to SANsymphony-V is fully supported, it is recommended to use some level of RAID protection within each virtual SAN node to minimize the impact of inevitable drive failures. This can be accomplished in two ways:

1. Hardware RAID controller within each virtual SAN node
2. Disk pool mirroring provided by SANsymphony-V

The left node in the diagram above shows four disks (in green) configured in a RAID-5 group by the local hardware RAID controller. These appear as one large capacity drive to SANsymphony-V.

The middle node shows four disks (yellow and blue) presented individually to SANsymphony-V. Disk pool mirroring has been enabled for those four disks.
The screenshot above displays a disk pool created in SANsymphony-V on one of the virtual SAN nodes (SSV-VSA01) using four flash disks and a SAS disk. The flash disks have been mirrored and classified as Tier 1 (fastest) and the SAS disk as Tier 2. Up to 15 tiers are supported.

Please consult the Best Practice Guide on the DataCore support site for more important information regarding disk pool performance considerations.

**Use Synchronous Mirroring for High-Availability**

In addition to the component-level resiliency provided by local RAID, SANsymphony-V synchronously mirrors virtual disks across nodes. A virtual disk may be mirrored between two nodes. This provides data-level redundancy, resulting in a true high-availability solution across the virtual SAN. Should a node fail, or be taken out of service for maintenance, the other node in the group holding an identical copy of the critical data automatically handles all subsequent requests.

**NOTE:** When deploying virtual SAN within a VMware ESXi metro-cluster configuration (where there is significant distance, up to 100km, between virtual SAN nodes), use only virtual disks served on VMFS 5 datastores.
Within a server group, some or all of the Virtual SAN nodes can participate in synchronous mirroring operations (in pairs).

For example, a virtual disk on node #1 can be mirrored to node #2. At the same time, another virtual disk on node #1 can be mirrored to node #3. Node #1 can also have virtual disks that have no mirror. Additionally, once a mirror is established for a virtual disk, it is very simple to reassign which nodes are providing the mirror and this can be accomplished non-disruptively.

1.4.3 Networking Considerations

Local Network Device Configuration
In Virtual SAN environments that leverage iSCSI for storage services, it is recommended that the front-end and mirror paths use separate and dedicated physical network paths to avoid channel contention or saturation.

Supported Network and Fabric Types
Virtual SAN supports 1Gb, 10Gb, 40Gb, and 56Gb Ethernet networks for iSCSI traffic and 4Gb, 8Gb, and 16Gb for Fibre Channel fabrics. Please consult the Qualified Hardware Components FAQ located on the DataCore support site for additional detail regarding support for various hardware, network and fabric components.

Network Redundancy
The level of network redundancy is an important consideration (i.e. multiple NICs/HBAs and switches) and will depend on the IT budget and the type of applications that are running within the environment. It is recommended to have a sensible amount of redundancy to prevent interruption in service due to hardware failures.
For example, with a single initiator/target network, a failure in the LAN would prevent all the virtual SAN nodes from accessing their data in the shared storage pool. Using multiple network uplinks connected to multiple switches will increase the resiliency of the group against failure.

**Network Isolation**
Isolating front-end (initiator/target) paths, mirror path, and management path on a per-host basis is highly recommended. Optimally, this would imply that each traffic type is dedicated on its own virtual switch with its own dedicated network uplink within its own dedicated broadcast domain (or VLAN, if connected to a switch that is VLAN capable). This will ensure that no one traffic type will interfere with another.

**iSCSI Network Tuning Considerations**
There are several network tuning parameters which may result in better overall storage performance.

The following network tuning parameters are intended for each virtual SAN node in the group.

- Adjust the MaxInitiators registry setting to match the number of initiators in the server group. For example, if you have 16 physical hosts participating in the server group, set MaxInitiators to 16. This will require a reboot of each virtual SAN node to take effect.

In most cases, the following key will need to be created:

```
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsIs\Parameters
DWORD-32 bit Value: MaxInitiators = xx  (xx equal to the number of hosts)
```
For each NIC used with SANsymphony-V providing storage services to the virtual SAN (either as a front-end target port, backend initiator port, or mirror port), disable the power saving features within the power management properties section:

![Power Management Configuration](image)

### 1.4.4 Virtual SAN Node CPU Configuration

#### CPU Configuration with Root Partition Instances

Within root partition instances, the maximum number of CPUs available to SANsymphony-V depends on how many CPU sockets and how many cores per socket are available. For example, a server with two physical CPU sockets with eight cores per socket would have a total of 16 cores. SANsymphony-V would leverage up to ten cores for worker threads.

#### CPU Configuration with Virtual Machine Instances

Within virtual machine instances, the maximum number of CPUs available to the system depends on how many CPUs have been configured for use with the virtual machine instance. For example, a virtual machine with two virtual sockets and four cores would have a total of eight cores. SANsymphony-V would leverage up to seven cores for worker threads.

Since the virtual machine is subject to resource scheduling by the hypervisor, it is recommended that the CPU reservation be set to the maximum for the virtual machine to guarantee the full use of the CPUs that are allocated to SANsymphony-V.

### CPU Tuning Considerations

On the host server running SANsymphony-V, it is recommended to have:

- Hyper-Threading enabled if applicable (configured in the BIOS)
- BIOS settings set to High Performance
- Power settings for Windows Server set to High Performance
1.4.5 Virtual SAN Node Memory Configuration

Memory Configuration with Root Partition Instances
Within root partition instances, SANsymphony-V will by default take between 50-65% of the total amount of available physical memory resources. Since SANsymphony-V is running in the root, it has visibility to all available physical RAM installed in the system. It is recommended that this value be lowered to 10% (or to 4GB, whichever is larger) to free up RAM for the virtual machines controlled by the root hypervisor.

Memory Configuration with Virtual Machine Instances
Within virtual machine instances, SANsymphony-V will by default take between 50-65% of the total amount of assigned virtual machine memory resources. Since SANsymphony-V is running within a virtual machine, it has visibility to only the amount of RAM allocated to the virtual machine by the administrator. In this case, it is recommended to increase the SANsymphony-V cache allocation to 80%, and ensure that the amount of RAM assigned to the virtual machine is approximately 10% of the hosts’ physical RAM capacity (or 4GB, whichever is larger).

1.4.6 Virtual SAN Node Hypervisor Configuration

Hypervisor Configuration with Root Partition Instances
Since SANsymphony-V is executing in the root partition as a peer to the hypervisor, there are no changes that need to be made at the hypervisor level to accommodate SANsymphony-V.

Hypervisor Configuration with Virtual Machine Instances
Since SANsymphony-V is executing in a virtual machine under control of a hypervisor, there are some changes that are recommended at the hypervisor level to ensure proper functioning of the SANsymphony-V instance:

- Ensure that the SANsymphony-V instance is not a candidate for live-migration or similar hot-move functionality within the hypervisor cluster.
- Ensure that the host where SANsymphony-V is running does not participate in any power management functions within the hypervisor cluster.
- Ensure that the SANsymphony-V instance is not participating in high-availability functionality within the hypervisor cluster.
VMware ESXi 5.5 Configuration with Virtual Machine Instances
When running SANsymphony-V within a virtual machine under control of VMware ESXi 5.5, the following modifications are recommended:

- **Disk Max I/O Size**
  - From within the ESX Configuration Tab under Advanced Settings, change and/or verify the following value is set:
    - Disk.DiskMaxIOSize = 512
  - No reboot required

- **Reduce Idle-Wakeup Latencies**
  - VM Settings → Options tab → Latency Sensitivity → High
  - Must be done from within the VMware web management interface
  - Also requires that a CPU reservation be set. It is recommended to set the CPU reservation to maximum for each virtual SAN node.

**Windows Instance Where SANsymphony-V is Running**
The following settings are intended for the Windows operation system where SANsymphony-V is installed:

- **Power Settings**
  - Ensure that the Windows power setting is set to High Performance. This is applicable to both deployment models (root partition and VM).

- **Hotfixes**
  - Ensure that all required hotfixes are installed. See Important Windows Hotfixes in the references section of this document.
1.4.7 Virtual SAN Node Assignment

Prior to serving virtual volumes to the Virtual SAN nodes within the cluster, you must assign the SANsymphony-V instance to its corresponding Virtual SAN node. This is done by first defining the cluster’s Virtual SAN nodes within the SANsymphony-V management interface as shown below:

![Virtual SAN Nodes Interface](image)

Once the Virtual SAN nodes have been defined, click on the SANsymphony-V server listed in the DataCore Servers window (usually located on the left side of the interface). Click on Settings and expand the General Settings section.

![DataCore Server Interface](image)

You will now see an option for the Hypervisor Host. This is where you designate which Virtual SAN node the SANsymphony-V virtual machine instance is running on.

Now that the Virtual SAN node has been assigned as shown above, click the Apply button below to commit the changes. You must do this for each SANsymphony-V virtual machine-Virtual SAN node pair in the cluster.
Once this procedure has been completed for all Virtual SAN nodes in the cluster, you can proceed with mapping virtual volumes to those nodes.

1.5 Conclusion

Using DataCore SANsymphony-V software to create a virtual SAN is an extremely flexible enterprise storage services deployment model. This deployment model delivers a highly-consolidated server and storage environment that yields increased application performance, high availability, and lower total cost of ownership.

1.6 Additional Resources

There are many excellent resources to assist with the deployment of DataCore SANsymphony-V in virtual SAN as well as physical SAN environments. These resources can be found at the DataCore support website, at:

- Main Support Page
- Best Practices Guide
- Online Help
- FAQ Page

Most support resources require a support account. This can be easily done by visiting the support registration link, at:

- Support Registration
1.7 References

Best Practices for Performance Tuning of Latency-Sensitive Workloads in vSphere VMs

Deploying Extremely Latency-Sensitive Applications in VMware vSphere 5.5

VMware Raw Device Mapping for local storage

Modifying the MaxInitiators Registry Value
http://datacore.custhelp.com/app/answers/detail/a_id/1235/kw/maxinitiators

DataCore Qualified Hardware Components
http://datacore.custhelp.com/app/answers/detail/a_id/283

Important Windows Hotfixes (bottom of page)
http://datacore.com/products/technical-information/SANsymphony-V-Prerequisites.aspx