DELL ACCELERATION APPLIANCE FOR DATABASES 2.0 AND MICROSOFT SQL SERVER 2014: A REFERENCE ARCHITECTURE

Deploying Microsoft® SQL Server® 2014 on Dell™ Acceleration Appliance for Databases 2.0

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INTRODUCTION

The Dell Acceleration Appliance for Databases (DAAD) is a storage solution that enables enterprises to boost database performance with minimal implementation time and IT labor. DAAD 2.0 was designed to help businesses that need to decrease database latencies, increase throughput, and improve overall performance without rebuilding or heavily modifying existing infrastructure.

Many of today's databases are stored on conventional spinning-disk storage arrays connected with Fibre Channel SANs. These solutions use slower storage technology, and they can often produce performance bottlenecks. As disk I/O operations queue up, compute resources on the database server become idle, which minimizes the potential improvements available with expanded compute capacity. In addition, expanding compute resources could lead to increased costs, as database licensing is calculated per CPU.

Increasing storage performance is a viable alternative to expanding the number of database nodes. Stronger storage performance can improve the utilization of available compute resources, reducing the need for additional hardware and potentially saving on software licensing costs.

Your business can use DAAD 2.0 to address database performance without rebuilding your existing infrastructure. DAAD 2.0 adds performance to application environments that may already deliver snapshots, compression, encryption, and other helpful storage features at the software level, such as those offered by database vendors. Rather than duplicating these functions at the storage level, the database-agnostic DAAD 2.0 provides straightforward block storage as a simple, high-performance alternative to complex storage solutions and appliances. This solution can offer improved database performance without requiring infrastructure build-outs, storage "rip and replace", or high-cost compute resources.

DELL ACCELERATION APPLIANCE FOR DATABASES 2.0

Figure 1: The DAAD 2.0 we used in our datacenter.

DAAD 2.0 hardware

DAAD 2.0 supports Fibre Channel, InfiniBand, and iSCSI for its storage network protocol. The solution we used for this guide, however, used only the Fibre Channel-enabled model. The DAAD 2.0 appliance is based on the 2U, high-performance Dell PowerEdge R730™ as a platform. Our highly-available model of the DAAD 2.0 included two Dell PowerEdge R730 servers, each of which included the following components:

- Two Intel® Xeon® processors E5-2667 v3 (8-core)
- 384GB DDR4 Memory
- Four Fusion-io® 6.4 TB MLC PCIe® SSDs
- One QLogic® 2662 Dual-port 16Gb Fibre Channel HBA
- One Mellanox® ConnectX®-3 InfiniBand Dual Port 40GbE
- Fusion-io ION Accelerator® software version 2.5.1

DAAD software

The backbone of DAAD 2.0 is the Fusion-io ION Accelerator software. This software, installed on the appliance itself, enables features such as the high-availability option, the three SAN connectivity options (16Gb Fibre Channel, 56Gb InfiniBand, and 40Gb iSCSI), and both command-line interface (CLI) and graphic user interface (GUI) management portals. The DAAD we used featured Fusion-io ION Accelerator version 2.5.1. Using the CLI or GUI enables IT staff to manage storage similarly to how they

would manage a traditional SAN—users can create LUNS, control the disk-allocation unit size, and use other options specific to SAN connectivity.

Figures 2 through 5 show the DAAD 2.0 GUI in use. For more information on Fusion-io ION Accelerator, see www.fusionio.com/products/ion-accelerator/.

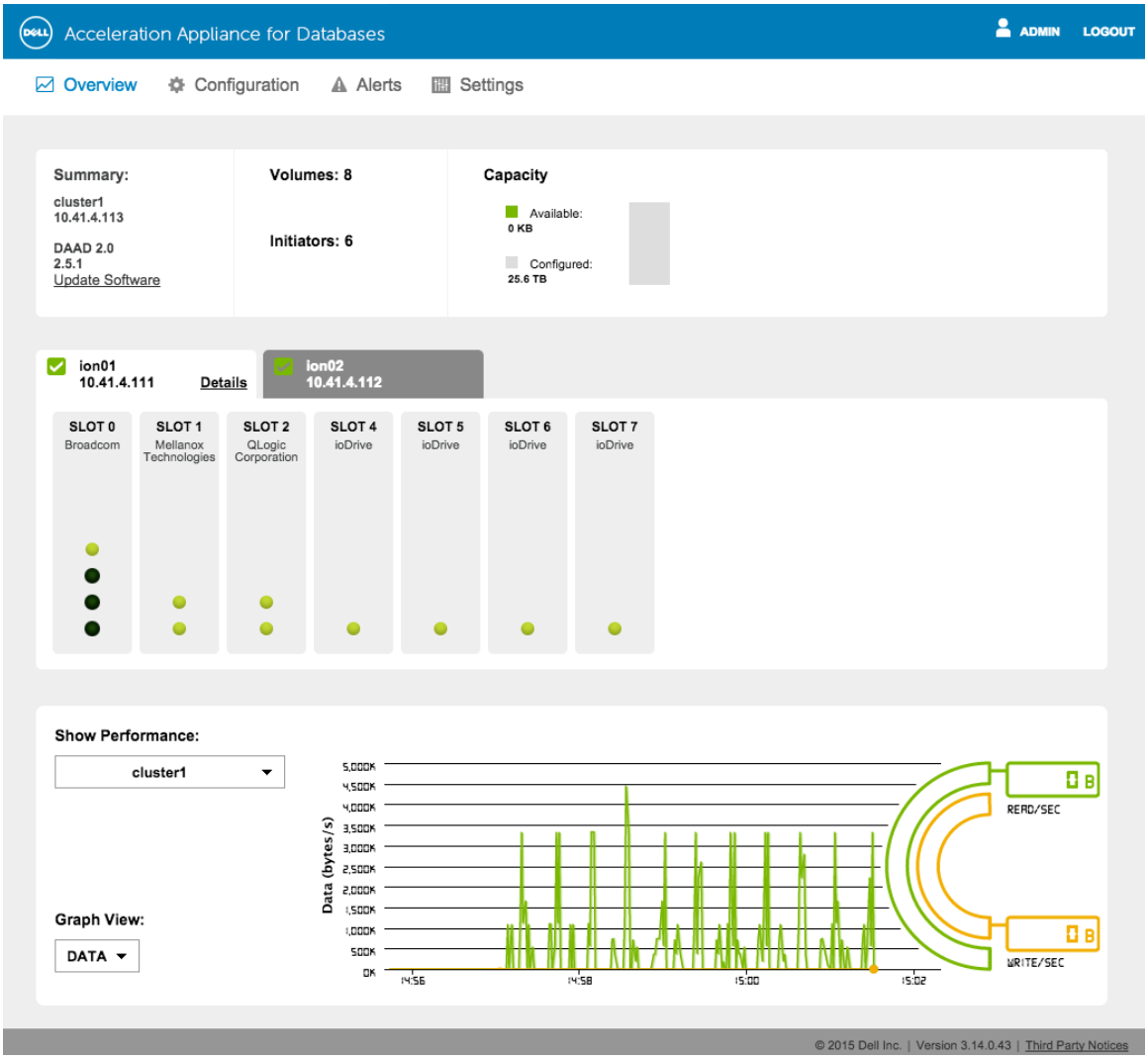

Figure 2: A sample of the DAAD 2.0 web GUI overview tab, with at-a-glance volume information, port connectivity, and live read/write performance monitoring.

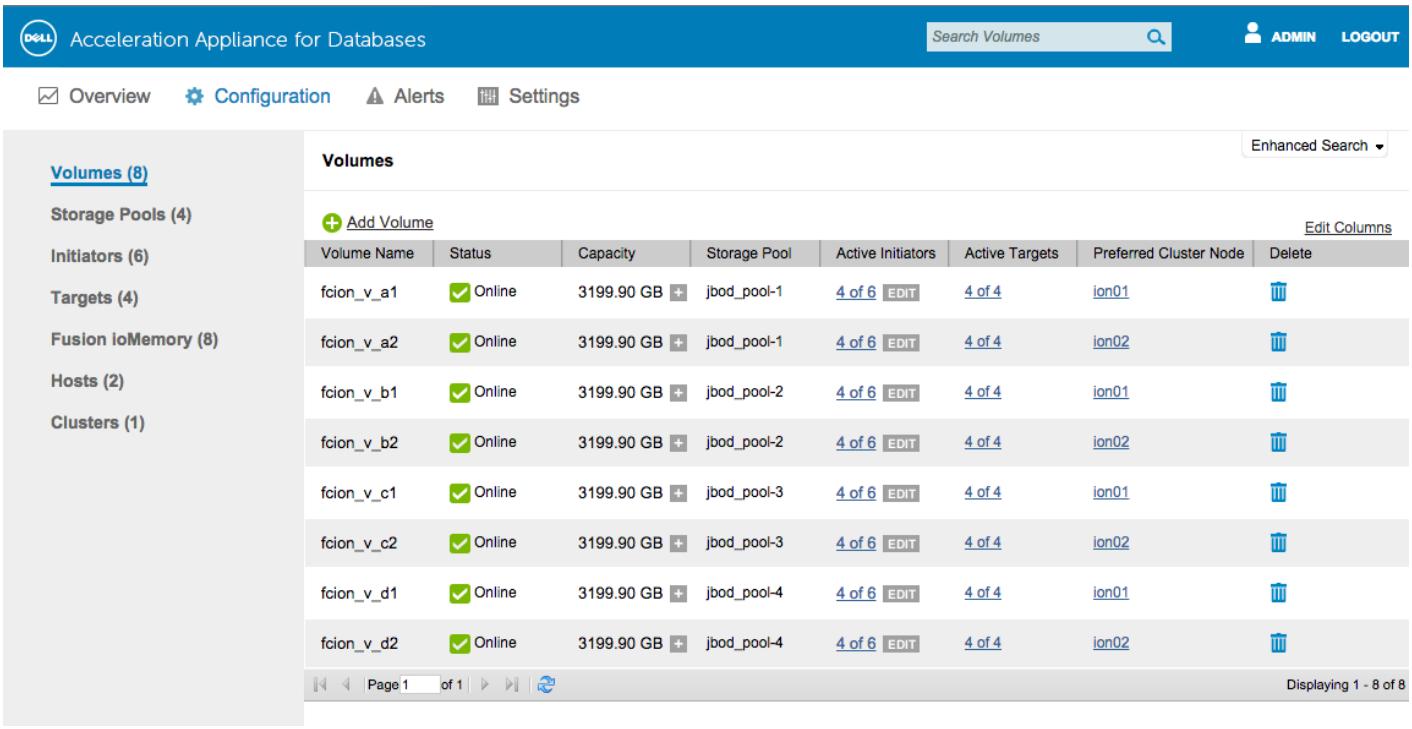

Figure 3: A sample volumes page, showing detailed information about the DAAD volumes, including capacity, initiator/target connections, and preferred cluster node.

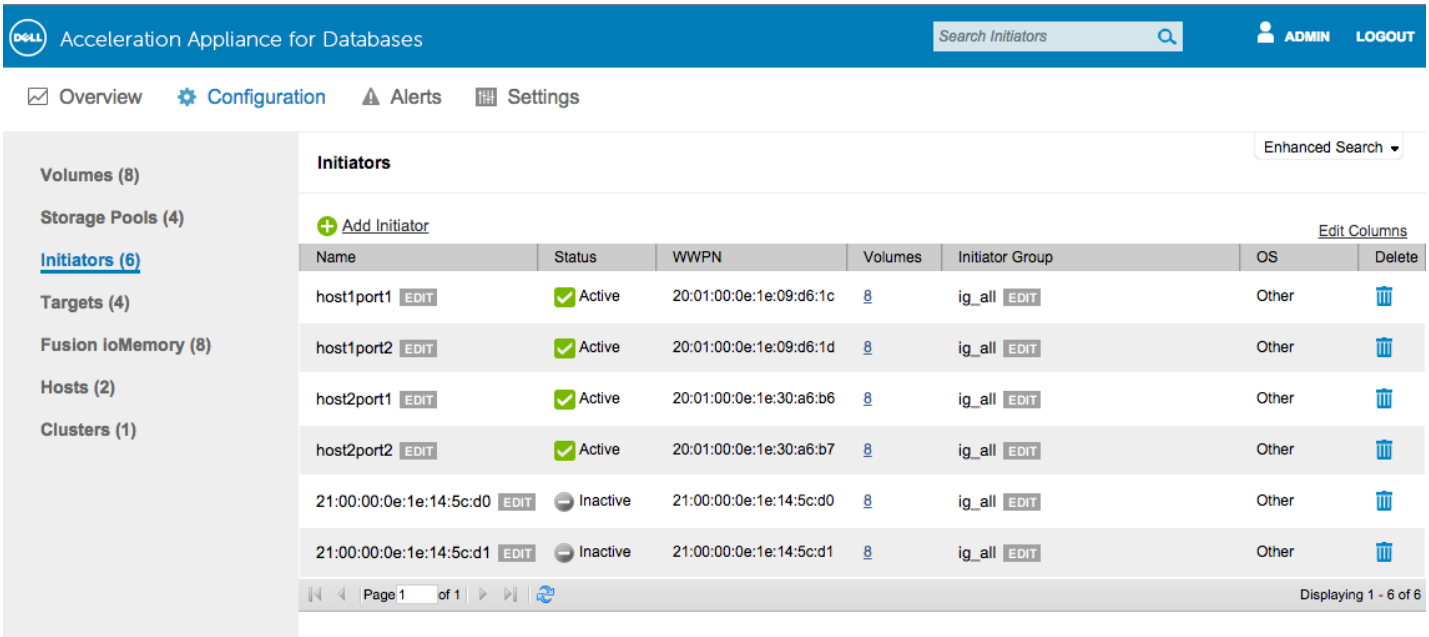

Figure 4: A sample initiators page, which can show automatically-discovered initiators in your SAN and which allows initiator group management, showing WWPN and volume information.

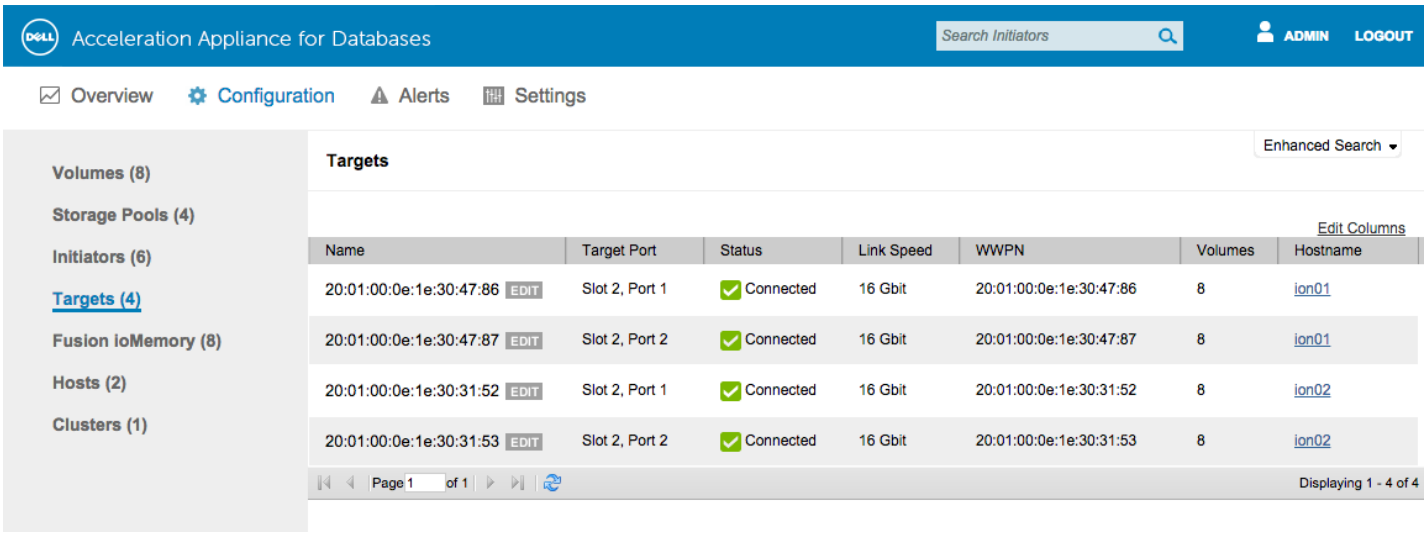

Figure 5: A sample of the targets page, showing fiber link speeds, WWPNs, and volume counts.

OUR SOLUTION OVERVIEW

This reference architecture is intended for a business with a VMware® vSphere® environment powering their database applications – specifically, a business whose current server and storage hardware might not be powerful enough to handle larger workloads. If your business wants to improve performance in Microsoft SQL Server 2014 without drastically revamping infrastructure, deploying the DAAD 2.0 to host database resources can be a simple solution. Specifically, we address the implementation of Microsoft SQL Server 2014 installed on virtualized Microsoft Windows Server® 2012 R2, using the High Availability Fibre Channel version of the DAAD 2.0 as persistent storage. Some parts of this architecture may apply to similar SANs based on the DAAD-compatible iSCSI and InfiniBand® protocols.

Prerequisites for this guide

This document assumes your business already has a local network and a VMware vSphere environment, including VMware vCenter Server™ (or VMware vCenter Server Appliance) installed for VMware ESXi management. In this guide, we add two new servers to that vCenter Server, create a vSphere cluster using them, and present them with the DAAD appliance's LUNs for use as VMFS datastores. This guide assumes you have a working knowledge of VMware vSphere and VMware vCenter Server and familiarity with essential concepts such as networking and Fibre Channel-based storage. Each environment's requirements are different, so rather than walk through every possible configuration for Microsoft SQL Server 2014 on Windows Server 2012 R2, we leave choices up to the administrator performing these setup tasks. Before proceeding

with this guide, ensure that you have racked the hardware and have the appropriate power sources available.

Hardware configuration

Our solution used a single DAAD 2.0 appliance in a highly available configuration, two Dell PowerEdge R730 servers in a VMware vSphere 5.5 cluster to host virtual machines (VMs), and assumed a pre-existing local network. The sample database VM we demonstrate used Windows Server 2012 R2 as the operating system and Microsoft SQL Server 2014 as the database management system. Figure 6 presents a configuration summary for the solution we configured and validated.

Solution	Dell PowerEdge R730 solution
Server	2 × Dell PowerEdge R730
Operating systems	VMware vSphere 5.5, Windows Server 2012 R2 Datacenter Edition
Database	Microsoft SQL Server 2014
Switches	1 × Brocade® 6505 24-port 16Gb Fibre Channel switch
Storage appliance	1 × HA 25.6 TB FC Dell Acceleration Appliance for Databases

Figure 6: Configuration summary for the solution we validated.

Figure 7 depicts a logical diagram of the solution. The DAAD had access to the local network for management purposes. We recommend using Dell iDRAC8 for the DAAD and for the Dell PowerEdge R730 database servers in order to make Out-of-Band (OOB) management possible. For more information on iDRAC, see www.dell.com/learn/us/en/555/solutions/integrated-dell-remote-access-controller-idrac .

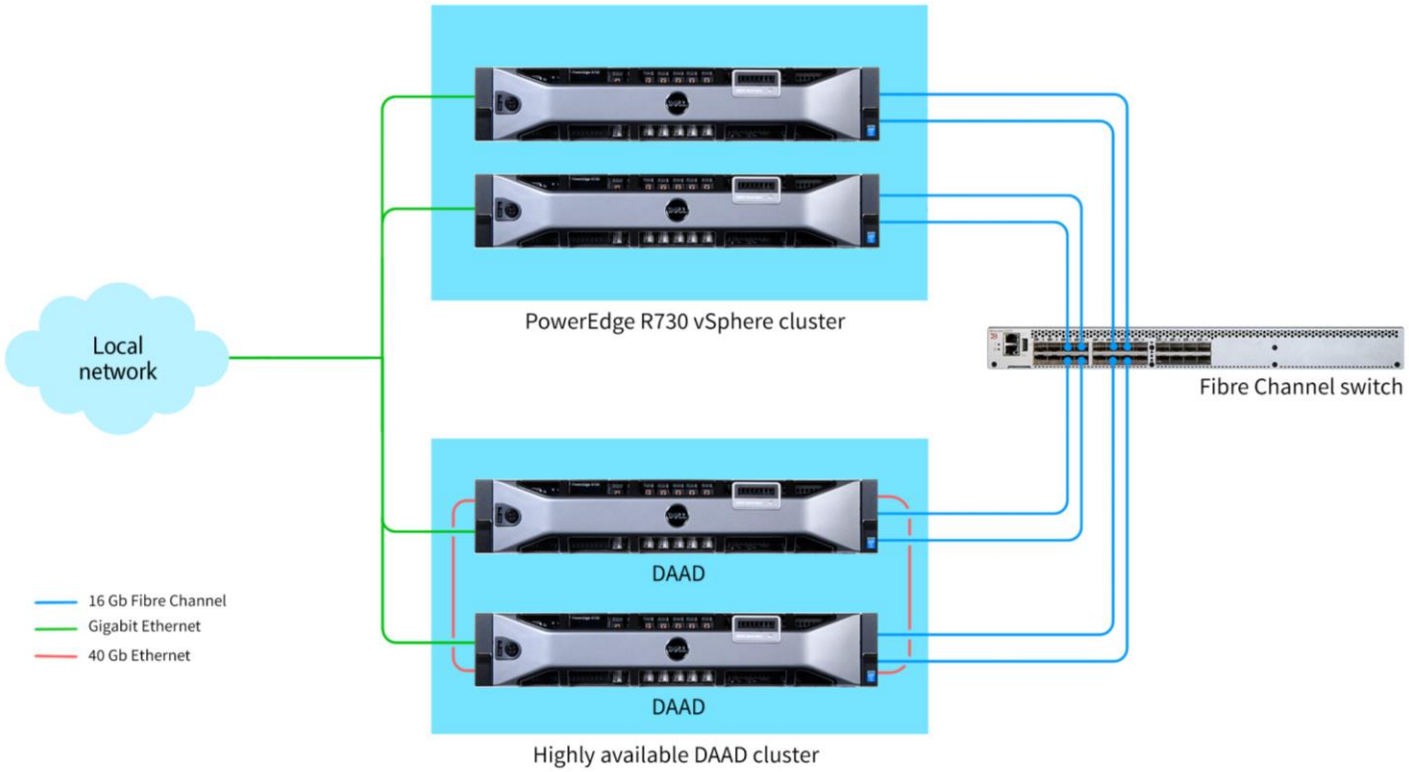

Figure 7: Our virtualized SQL Server 2014 environment, with storage powered by DAAD 2.0, for this reference architecture.

SAN and Ethernet network architecture

We connected our database servers to the local network using a standard 1GbE switch and used VMware vSphere virtual switch technology to connect our SQL VM to the local network. Depending on the requirements of your environment, your network architect may recommend additional physical connections, more appropriate bandwidth, or redundancy.

For our SAN configuration, the DAAD came pre-configured with Fibre Channel HBAs. We connected the Dell PowerEdge R730s' HBAs to the DAAD 2.0 storage via a 16Gb Brocade 6505 Fibre Channel switch. Your business can retain the capability to use the DAAD appliances in high-availability mode without reworking the SAN architecture, or you can expand the SAN to include additional DAADs, traditional spinning disks, or SSD storage.

The use of a Brocade 6505 16Gb Fibre Channel switch can make the SAN easily expandable so future storage and compute resources can attach to the switch. For this reference architecture, the database server contained the Dell-branded QLogic 2662 dual-port 16Gb Fibre Channel HBA. Any solution following this reference architecture

must contain at least one Fibre Channel HBA, and all components must be compatible with 16Gb Fibre Channel.

Database server

Figure 8: The model of Dell PowerEdge R730 we used for our hypervisor hosts.

We used two Dell PowerEdge R730 servers in a VMware vSphere cluster to host a database server VM. The latest generation of Dell servers feature numerous improvements, such as the transition to DDR4 memory, the Intel Xeon processor E5 v3 family, and more, which altogether can increase performance and make administration easier. The Dell PowerEdge R730 rack servers we tested had the following configuration (for a full list of hardware specifications, see Appendix B):

- Dual Intel Xeon processors E5-2650 v3 (10-core)
- 256GB of DDR4 ECC RAM
- iDRAC8 Enterprise for OOB remote management

CONSOLIDATION, UPGRADE, AND MIGRATION CONSIDERATIONS

Changes to database infrastructure are sometimes precipitated by the goal of improving database performance. This often involves a combination of database consolidation, software upgrades, and migration. Migrating legacy database applications to the latest software offerings and DAAD 2.0 technology while consolidating resources can provide performance benefits and potential long-term savings.

For example, in separate studies, we found that using DAAD 2.0 helped boost storage performance in our datacenter in several scenarios. In fact, we used the configuration outlined in this guide, featuring a Dell PowerEdge R730 VMware vSphere cluster, and found that virtualized SQL instances in the cluster powered by DAAD could handle over 80 times the database workload of a baremetal legacy HP server using

direct-attached storage.[1] For more details about the configuration we used, see Appendix A.

Considering the benefits of consolidation, upgrade, or migration

Specific server consolidation and database migration steps are outside the scope of this reference architecture. That said, the following considerations can benefit your organization in addition to improving database performance:

- Consolidating and upgrading the hardware stack of your organization can save money through lower licensing, power, and management costs, mostly due to simply having fewer servers. This can provide the potential for a quick return on investment for DAAD 2.0, as we show in a separate study.[2]
- Upgrading to new hardware can provide better power management, systems management resources, and BIOS features.
- Upgrading to new software can provide new ancillary benefits and features. For example, Microsoft SQL Server 2014 can provide databases with better data redundancy, protection, and availability than previous versions; enable cutting-edge in-memory data processing and analysis; and expand database reach to the public, private, and hybrid cloud with a number of hybrid cloud opportunities, including backup, high availability, and disaster recovery.

Considering your prior environment

If you are incorporating a database migration, physical server migration, or consolidation effort into your storage redesign efforts with DAAD 2.0, planning is key. This is especially true when transitioning into a virtualized environment. There are specific details related to each server or database, including the maintenance window for migrating the server or database to its new environment, the number of affected users, and the configuration tasks necessary to assimilate the databases into the consolidated environment. Information to gather prior to consolidation may include the following:

- Server OS version and patch level
- SQL Server version and patch level
- Number of logins on this SQL Server instance and their type (Windows or SQL Server authenticated logins)
- Current backup strategy and schedule for the databases on this server
- Replication, mirroring, or AlwaysON details for this SQL instance, if any
- Detailed information regarding permissions and roles

[1] www.principledtechnologies.com/Dell/DAAD_SQL_Server_2014_performance_0915.pdf
[2] Ibid.

- SQL Server Agent jobs on this SQL Server

In addition, after the databases have migrated to their new SQL Server instance, you must ensure that any system or application using the database has updated connection information. Addressing this concern can include modifying logins, permissions, applications, SQL Server Agent jobs, and third-party backup products to establish connections to the database within its new environment.

Considering VMware vSphere storage features

Because you are using vSphere for your hypervisor infrastructure and management, it may be useful to understand a few storage-related features that VMware offers. These features can help you enhance DAAD 2.0's utility and integration into your environment.

Storage I/O Control is a VMware vSphere feature that allows you to use priorities to configure rules that control I/O resources allocated to virtual machines. It also gives you the ability to monitor storage resource shares and limits. This means your VMware vSphere Storage I/O Control can work together with the high-performance DAAD and other slower storage hardware to properly allocate I/O as you see fit.

Storage vMotion® is a feature that makes it possible for virtual machines' disk files to migrate across storage arrays without downtime. This feature, used in conjunction with VMware Distributed Resource Scheduler (DRS) also proactively deals with storage bottlenecks by moving disk files to alternative LUNs when it can yield higher performance. This means when working with the high-performance DAAD coupled with VMware vSphere, the environment and you have plenty of options in the areas of performance and mobility.

CONFIGURING THE DAAD 2.0 SOLUTION

Cabling DAAD 2.0 and PowerEdge R730

To achieve redundancy for the power supplies of our DAAD 2.0 and R730s, we connected one PSU from each physical server to one circuit, and the other PSU from each server to another circuit. We configured the R730 server nodes of the DAAD with their 40Gb Mellanox PCIe cards in the topmost PCIe slot and the Fibre Channel HBA in the slot beneath. We used one-meter 40Gb QSFP cables for the Mellanox ports, with the first slot on the first node connecting to the first slot on the second node, and the second slot on the first node connecting to the second slot on the second node (see Figure 9). We connected Fibre Channel cables to both ports in each R730's Fibre Channel HBA and attached them to our Brocade 6505 switch.

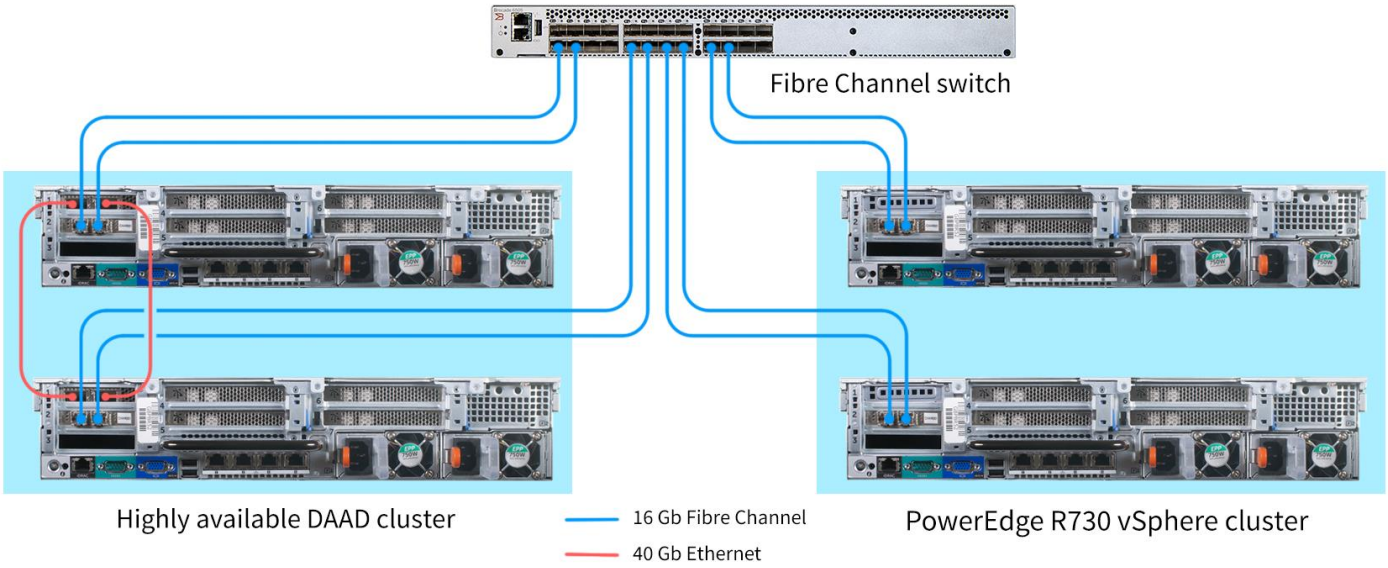

Figure 9: The back of the DAAD 2.0 connected to the other solution components.

Storage configuration

The optimal configuration of volumes on the DAAD 2.0 involves mirroring each volume across one PCIe SSD in each node of the DAAD 2.0 cluster. Using the command-line interface, we created eight equally sized volumes for the database files and logs, with each volume residing primarily on one node's PCIe SSD and redundantly on the other node's equivalent PCIe SSD, and alternated which node's cards were primary or redundant. We allocated four volumes for the SQL database files and four volumes for the log files, all of which we presented for use as datastores in vSphere. You may need to adjust the number and size of your volumes to fit your specific database requirements. For detailed steps, see Appendix C.

Note that as in prior versions, Microsoft SQL Server 2014 allows the user to configure the default storage location for databases and choose the location for individual databases. In this reference architecture, we stored all SQL Server 2014 database and log files on the DAAD 2.0 storage.

Setting up the DAAD volumes, initiator group, and LUNs

With storage resources from your DAAD 2.0, virtualizing your database servers can create a level of scalability unmatched by bare-metal database instances. However, your DAAD 2.0 must know which servers to present these resources to, and initiator groups handle this granting of access. If your business needs to add more nodes to your

vSphere cluster, you would need to add their initiators to the initiator group on the DAAD.

To set up the volumes, initiator group, and LUNs on DAAD 2.0 storage, follow the general steps below. For a specific walkthrough for each of these steps, see the Creating volumes and LUNs on the DAAD section in Appendix C.

1. Connect to the DAAD 2.0 nodes via SSH.
2. Create a direct access storage profile.
3. Create the required number of volumes—we used eight, each using half of a storage pool's available space.
4. Create an initiator group, providing the WWPNs of the hypervisor servers' Fibre Channel HBAs.
5. Create one LUN per volume, provide them to the new initiator group, and give each LUN all the space of their respective volumes.

INSTALLING AND CONFIGURING THE VMWARE VSPHERE HOSTS AND VMS

Hypervisor installation and configuration

There are many options for creating a virtual database server. If your business has a component or vendor preference different from what we used in our solution, consult the available documentation or best practices before setting up your database server, and then use the following sections of this document as a suggested guide.

The following steps describe how we configured our VMware vSphere servers, two Dell PowerEdge R730s, in a VMware vSphere 5.5 cluster. We then created a Windows Server 2012 R2 VM on which we installed and configured SQL Server 2014. In your case, you may instead have VMs that you are migrating or other applications to install.

Before beginning, we ensured that the Dell PowerEdge R730s were physically connected to the same SAN as the DAAD. For detailed instructions, see Appendix C.

1. Deploy the hypervisor
    a. Configure the RAID volumes on the server as needed.
    b. Deploy VMware ESXi via automated method, USB, or other media.
    c. Choose installation options that fit your environment's needs.
2. Configure the hosts in VMware vCenter Server
    a. Connect to your VMware vCenter Server using the vSphere web client, and connect to the new R730 hosts to the vCenter.
    b. Create a cluster consisting of the two new R730 hosts.
    c. Scan the hosts' storage adapters, and add the DAAD's eight LUNs to the cluster as datastores.
3. Create the first VM

a. Using vSphere vCenter, create a new VM with your desired settings, and allocate virtual hard disks residing on the DAAD 2.0 datastores for database storage.
b. For this VM, begin the installation of Windows®. When prompted, choose to install Windows Server 2012 R2 Datacenter Edition with GUI from the installation media.
c. Reboot this VM as necessary. Then, using Windows Update, apply all available updates.
d. Assign an appropriate host name to the VM.
e. Assign an appropriate IP address to the network adapter.
f. Proceed with application installation.

One of the key components for scalability in your solution is the number of VMs supported by your DAAD 2.0. When creating multiple VMS, keep in mind their anticipated resource use, uptime, and peak loads so as not to oversubscribe their hosts' compute resources or overburden the DAAD 2.0's storage capabilities.

Installing Microsoft SQL Server 2014

The following is a brief summary of the requirements for installing Microsoft SQL Server 2014. If you plan to use a different version of Microsoft SQL Server, requirements may differ slightly. Ensure that your solution meets the basic requirements before attempting any part of the installation and configuration process for SQL Server 2014 or your chosen DBMS.

For a complete list of hardware and software requirements and a list of supported operating systems for each SQL Server edition, see msdn.microsoft.com/en-us/library/ms143506.aspx.

Basic requirements that apply to all SQL Server installations:

- .NET Framework 3.5 SP1 and 4.0
- Windows PowerShell® 2.0
- Network Software (Shared memory, Named Pipes, TCP/IP, or VIA)
  - Shared memory and VIA are not supported on failover clusters, and VIA will be diminished in future versions of SQL Server.
- 6 GB of hard-disk space

Processor, memory, and OS requirements:

- Minimum 1 GB (512 MB for Express Editions); recommended 4 GB or more depending on database size (1 GB for Express Editions)
- Minimum 1.0 GHz for x86 processors or 1.4 GHz for x64 processors; recommended 2.0 GHz or faster

Microsoft SQL Server 2014 can be installed on most Microsoft Windows Server Core versions of Windows Server 2008 R2 SP1 and Windows Server 2012. Some features cannot be installed on Microsoft Windows Server Core versions and must be installed on a different machine. For a list of which features are supported, see msdn.microsoft.com/en-us/library/hh231669.aspx.

It is possible to install distinct versions of SQL Server on the same machine, but certain considerations apply. For a detailed list of these considerations, see msdn.microsoft.com/en-us/library/ms143694.aspx.

Other versions of Microsoft SQL Server may follow similar steps, but you should consult available documentation for differences if you choose to use a different version. Provide the database server VMs with the installation media for SQL Server 2014 before beginning.

1. Launch the Microsoft SQL Server 2014 installer.
2. Install features appropriate to your datacenter's needs, which typically include Database Engine Services, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, and Management Tools – Complete. Other SQL Server components, such as SQL Server Reporting Services and SQL Server Analysis Services, may apply but are outside the scope of this guide.
3. Configure the authentication for the system, using either Windows Authentication or Mixed; Mixed uses native SQL Server authentication.
4. Install SQL 2014.
5. For each additional database server VM, complete steps 1 through 4.

SUMMARY

As this guide has shown, installing and configuring a Microsoft Windows Server 2012 R2 with SQL Server 2014 powered by the Dell Acceleration Appliance for Databases is a straightforward procedure. A key benefit from implementing DAAD 2.0 into your infrastructure is the ability to accelerate workloads without a complete storage area network redesign. This can be ideal for businesses that have snapshot and deduplication features within their software stack or are looking to improve database performance without investing in large storage solutions that may contain features they do not need. Consider DAAD 2.0 for your business—a storage acceleration solution that requires only 4U of rack space and can potentially give your database workloads a boost.

APPENDIX A – ABOUT THE COMPONENTS

About the Dell Acceleration Appliance for Databases 2.0 hardware

The 2U Dell PowerEdge R730 rack servers used in the highly available DAAD configuration are each powered by two Intel Xeon processors E5-2667 v3, 384 GB of DDR4 RAM, and QLogic QLE2662 16Gb Fibre Channel HBAs, providing functional flexibility in the datacenter. Each server also includes four 6,400 GB SanDisk® SX300 Fusion ioMemory™ PCIe SSDs to reduce storage bottlenecks.

With redundant power supply units, hot-swappable hardware, and Dual SD™ card option for Failsafe Hypervisors, the Dell PowerEdge R730 supports hardware high availability. The PowerEdge R730 comes standard with iDRAC8 with Lifecycle Controller and Dell OpenManage™, which all work to streamline management. For more details on the Dell PowerEdge R730, visit www.dell.com/us/business/p/poweredge-r730/pd. For more details on the Intel Xeon processor E5-2600 v3 series, visit www.intel.com/content/dam/www/public/us/en/documents/product-briefs/xeon-e5-brief.pdf.

About Microsoft SQL Server 2014

This latest iteration of the Microsoft SQL Server family is a next-generation data platform that includes many new features oriented to enterprise users focused on transactional performance and speed, time-to-insight, business analytics, high availability, and integration of their data streams into public and private cloud environments. Microsoft highlights the following key features:

Support for in-memory OLTP via a memory and OLTP-optimized database engine integrated into the platform's data engine, plus enhancements to the in-memory column store already present in Microsoft SQL Server 2012.

Ease of integration with Microsoft Azure™, making SQL Server 2014 a platform for hybrid cloud, supporting scenarios such as cloud backup and cloud disaster recovery.

Better redundancy with AlwaysOn Availability Groups, allowing up to eight secondary replicas to be placed in different locations for high availability, read-access efficiency, and backup and data recovery.

For more information about Microsoft SQL Server 2014, visit www.microsoft.com/en-us/sqlserver/default.aspx.

About Microsoft Windows Server 2012 R2

Windows Server 2012 R2, the latest release of this server OS from Microsoft, is at the core of the Microsoft Cloud OS vision, offering vast computing resources at an enterprise scale to provide scale-up for large, mission-critical databases in both physical and virtual environments. To handle the largest database applications, it supports up to 2,048 logical processors per Hyper-V® host. In a virtual environment, it supports up to 64 virtual CPUs, up to 1 terabyte (TB) of memory, and up to 64 TB of virtual disk capability per Hyper-V VM. With Microsoft Windows Server 2012 R2, it is possible to have up to 64 nodes in a SQL Server cluster and up to 8,000 VMs within a Hyper-V cluster.

For more information, see www.microsoft.com/en-us/server-cloud/products/windows-server-2012-r2/.

APPENDIX B – DETAILED SYSTEM CONFIGURATION

Figure 10 presents the server configuration we used for this guide.

System	Dell PowerEdge R730	Dell Acceleration Appliance for Databases 2.0
Power supplies		
Total number	2	2
Vendor and model number	Dell 0G6W6KX02	Dell 0G6W6KX02
Wattage of each (W)	750	750
General		
Number of processor packages	2	2
Number of cores per processor	10	8
Number of hardware threads per core	2	2
System power management policy	Performance	Performance
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	E5-2650 v3	E5-2667 v3
Socket type	FCLGA2011-3	FCLGA2011-3
Core frequency (GHz)	2.3	3.2
Bus frequency	9.6 GT/s	9.6 GT/s
L1 cache	32 + 32 KB (per core)	32 + 32 KB (per core)
L2 cache	256 KB (per core)	256 KB (per core)
L3 cache	25 MB	20 MB
Platform		
Vendor and model number	Dell PowerEdge R730	Dell PowerEdge R730
Motherboard model number	0599V5	0599V5
BIOS name and version	1.2.10	1.1.4
BIOS settings	Defaults	Defaults
Memory module(s)		
Total RAM in system (GB)	256	384
Vendor and model number	Samsung® M386A4G40DM0-CPB	Hynix HMA42GR7MFR4N-TFT1
Type	PC4-17000	PC4-17000
Speed (MHz)	2,133	2,133
Speed running in the system (MHz)	2,133	2,133
Size (GB)	32	16
Number of RAM module(s)	8	24
Chip organization	Double-sided	Double-sided
Rank	2Rx4	2Rx4

System	Dell PowerEdge R730	Dell Acceleration Appliance for Databases 2.0
Operating system		
Name	VMware vSphere 5.5	ION Accelerator (SUSE® Linux® Enterprise Server)
Build number	2068190	2.5.1-413
File system	VMFS	btrfs
Kernel	5.5.0	3.0.101-0.15.1.6651.0.PTF-default (x86_64)
Language	English	English
RAID controller		
Vendor and model number	Dell PERC H730P Mini	Dell PERC H730P Mini
Firmware version	25.2.1.0037	25.2.1.0037
Cache size (GB)	2	2
RAID configuration	1 × RAID10	1 × RAID
Hard disk types		
Hard disks (OS)		
Vendor and model number	Dell ST300MM0006	Dell ST300MM0006
Number of disks	8	2
Size (GB)	300	300
RPM	10K	10K
Type	SAS	SAS
PCIe SSDs		
Vendor and model number		Fusion ioMemory SX300
Number of disks		4
Size (GB)		6,400
Type		PCIe
Ethernet adapters		
Vendor and model number	Intel 4-port Gigabit I350-t Network Daughter Card	Broadcom NetXtreme® BCM5720 Quad-port Gigabit
Firmware	7.10.18	7.10.18
Type	PCIe	PCIe
Fibre Channel adapters		
Vendor and model number	QLogic QLE2672 16Gb Fibre Channel Adapter	QLogic QLE2672 16Gb Fibre Channel adapter
Firmware	03.11.09	03.11.09
Type	PCIe	PCIe
USB ports		
Number	4	4
Type	USB 2.0	USB 2.0

Figure 10: System configuration information for the test systems.

APPENDIX C – SPECIFICS OF OUR SETUP

Prior to completing these steps, we assume that you have already racked your DAAD, R730 database servers, and fiber switch; provided power to the solution; and attached the components to your infrastructure network.

Creating volumes and LUNs on the DAAD 2.0

1. In a terminal, SSH into one of the DAAD 2.0 nodes with the admin credentials.
2. Enter the following commands to create mirrored volumes across the DAAD 2.0 nodes, an initiator group consisting of the WWPNs of the Fibre Channel ports on the database server, and eight LUNs to be presented to the database server:

```
profile:create direct
volume:create -n ion01 -n ion02 fcion_v_a1 50% jbod_pool-1
volume:create -n ion02 -n ion01 fcion_v_a2 100% jbod_pool-1
volume:create -n ion01 -n ion02 fcion_v_b1 50% jbod_pool-2
volume:create -n ion02 -n ion01 fcion_v_b2 100% jbod_pool-2
volume:create -n ion01 -n ion02 fcion_v_c1 50% jbod_pool-3
volume:create -n ion02 -n ion01 fcion_v_c2 100% jbod_pool-3
volume:create -n ion01 -n ion02 fcion_v_d1 50% jbod_pool-4
volume:create -n ion02 -n ion01 fcion_v_d2 100% jbod_pool-4
inigroup:create ig_all 20:01:00:0e:1e:09:d6:1c 20:01:00:0e:1e:09:d6:1d
   20:01:00:0e:1e:09:d6:2c 20:01:00:0e:1e:09:d6:2d
lun:create fcion_v_a1 ig_all -b 512 -a
lun:create fcion_v_a2 ig_all -b 512 -a
lun:create fcion_v_b1 ig_all -b 512 -a
lun:create fcion_v_b2 ig_all -b 512 -a
lun:create fcion_v_c1 ig_all -b 512 -a
lun:create fcion_v_c2 ig_all -b 512 -a
lun:create fcion_v_d1 ig_all -b 512 -a
lun:create fcion_v_d2 ig_all -b 512 -a
```

Installing VMware vSphere 5.5

We installed VMware vSphere 5.5 for each R730 server on local drives in a RAID 10 configuration.

1. Connect a USB DVD drive with the vSphere 5.5 installation disk or media, and boot the server.
2. On the Welcome screen, press Enter.
3. On the End User License Agreement (EULA) screen, press F11.
4. On the Select a Disk to Install or Upgrade Screen, select the virtual drive to install vSphere on, and press Enter.
5. On the Please Select a Keyboard Layout screen, press Enter.

6. On the Enter a Root Password Screen, assign a root password, and confirm it by entering it again. To continue, press Enter.
7. On the Confirm Install Screen, to install, press F11.
8. On the Installation complete screen, to reboot, press Enter.

Configuring your VMware vSphere hosts in VMware vCenter Server

We used an existing VMware vCenter Server to import our hosts, configure our storage, and create and manage our test VMs.

Creating a datacenter and cluster

1. In a web browser on a machine on the same subnet as the vCenter server, enter the vCenter server IP address in the address bar, and press Enter.
2. Enter the administrator credentials, and log into the vSphere Web Client.
3. In the left pane, navigate to the vCenter Server.
4. In the main pane, click to create a Datacenter.
5. Enter a name, and click OK.
6. In the main pane, click Add a host.
7. Enter the management IP address of the first R730, and click Next.
8. Enter the root credentials for the first R730, and click Next.
9. When prompted with a message about trusting the host, click Yes.
10. Click Next.
11. On the Assign License page, use the no license option for Evaluation Mode, and click Next.
12. Click Next.
13. On the VM Location page, select the appropriate datacenter, and click Next.
14. Click Finish.
15. In the left pane, navigate to the datacenter again, and repeat steps 6 through 14 for the second R730.
16. Navigate to the datacenter again, and click Create a cluster.
17. In the Hosts tab, right-click the first R730, and click Move To.
18. Choose the newly created cluster, and click OK.
19. Complete steps 17 and 18 for the second R730.

Configuring the host network adapters

1. In the left pane, navigate to the Hosts menu, and click the first R730 host.
2. In the Manage tab, select Networking.

3. Select Virtual switches, and click Add host networking.
4. In the menu that appears, select Virtual Machine Port Group for a Standard Switch, and click Next.
5. Select New standard switch, and click Next.
6. Select Active adapters, and click Add.
7. Select the network adapter to be associated with the private network virtual switch, and click OK.
8. Click Next.
9. Enter an appropriate network label, and be sure to use the same one for each host. We used `Private Network`.
10. Click Next.
11. At Ready to complete, click Finish.
12. Complete steps 1 through 11 for the second host.

Configuring the virtual storage adapters

1. In the left pane, navigate to the hosts menu, and click the cluster.
2. In the Related Objects tab, click Datastores.
3. Click Add new datastore.
4. When the pop-up appears, click Next.
5. Select VMFS, and click Next.
6. Select one of the R730 hosts, select one of the DAAD 2.0 LUNs, and enter a name for the datastore. We named our eight datastores `Data1`, `Data2`, `Data3`, `Data4`, `Logs1`, `Logs2`, `Logs3`, and `Logs4`.

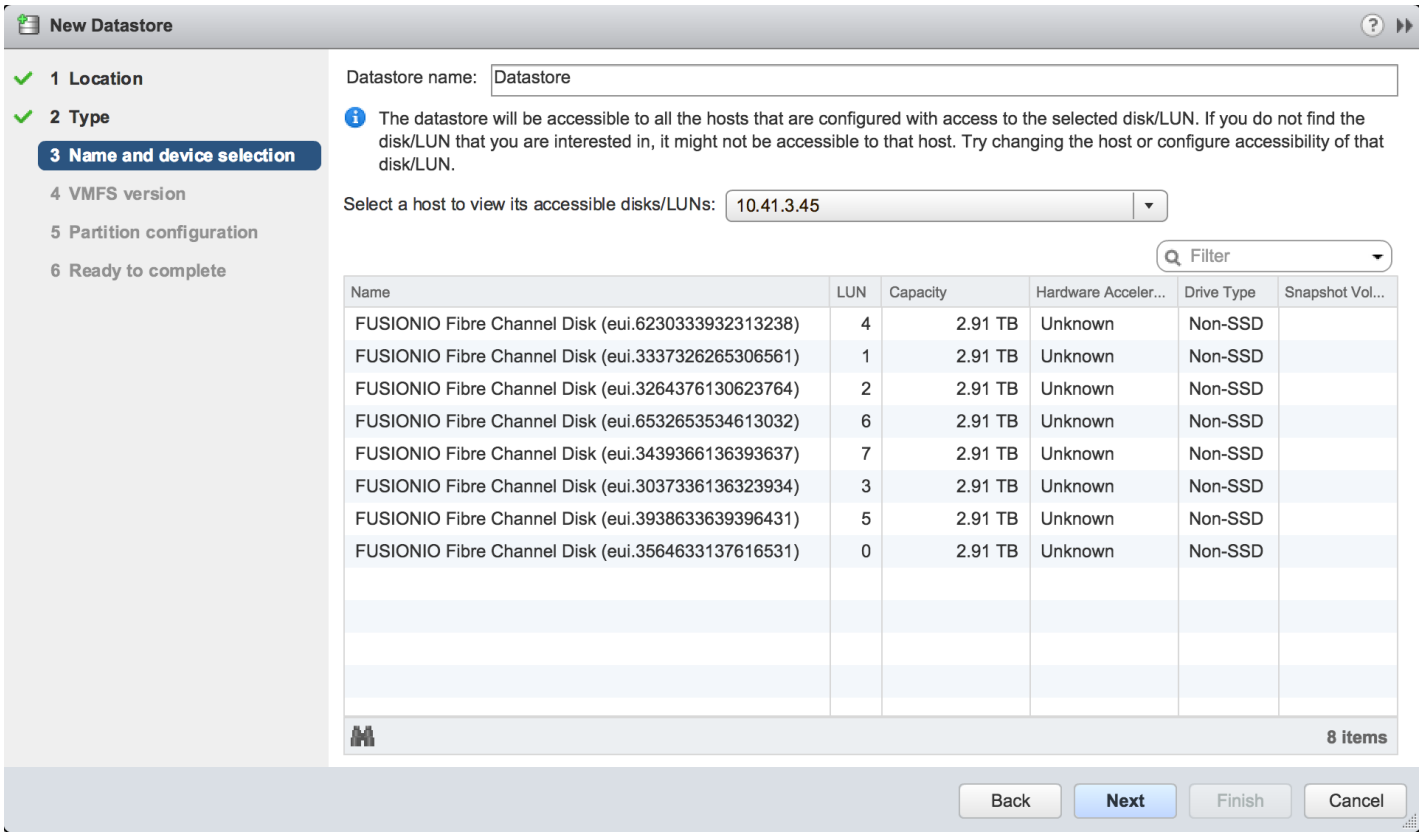

Figure 11: Discovering and adding the DAAD 2.0's LUNs to the vSphere cluster as datastores.

7. Click Next.
8. Select VMFS 5, and click Next.
9. Select Use all available partitions, and click Next.
10. Click Finish.
11. Complete steps 3 through 10 for the seven other DAAD 2.0 LUNs.

Creating VMs

1. Right-click the first R730 host, and choose New Virtual Machine.
2. Choose Create a new virtual machine, and click Next.
3. Enter a name for the virtual machine, and click Next.
4. Select the first R730 host as a compute resource, and click Next.
5. Select the local datastore, and click Next.
6. Select vSphere 5.5 and later, and click Next.
7. Choose the appropriate guest OS, and click Next.
8. Set the number of vCPUs and configure them as appropriate.
9. Expand the Memory section, and set the RAM amount as appropriate.

10. Select the new virtual hard disk, and make sure its location is the appropriate datastore.
11. Set the appropriate SCSI controller type.
12. Add a new Network Adapter, and provide it with the Private Network.
13. Change the New Network's Adapter Type to VMXNET3.
14. For additional virtual disks, select New SCSI Controller in the New device drop-down menu, and click Add.
15. Set the appropriate SCSI controller type. For our testing, we selected VMware Paravirtual.
16. In the New device drop-down menu, select New Hard Disk, and click Add.
17. Configure your virtual drive with the desired size, provisioning type, and location. For our testing, we set this virtual hard disk to have 250 GB of storage, its provisioning to be thick-provision eager-zeroed, and its location to be on the Data1 datastore.
18. Set its Virtual Device Node to be SCSI(1:0).
19. If needed, configure an additional virtual drive with the desired size, provisioning type, and location. For our testing, we set this virtual hard disk to have 100 GB of storage, its provisioning to be thick-provision eager-zeroed, and its location to be on the Logs1 datastore. We designated this virtual device node to be SCSI(1:1).
20. After creating the necessary virtual hard disks, click Next.
21. Review the configuration, and click Finish.
22. Start the VM.
23. Attach the OS installation media to the VM, and complete the installation process.

Installing Microsoft Windows Server 2012 R2 Standard Edition on the VM

1. Insert the installation USB drive into the rear USB 3.0 port, and restart the server.
2. When the option appears, to enter the Boot Manager, press F11.
3. Select BIOS Boot Menu.
4. Select the USB drive, and press Enter.
5. When prompted to boot from DVD, press any key.
6. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
7. Click Install now.
8. When the installation prompts you, enter the product key.
9. Select Windows Server 2012 Standard Edition (Server with a GUI), and click Next.
10. Check I accept the license terms, and click Next.
11. Click Custom: Install Windows only (advanced).

12. Select Drive 0 Unallocated Space, and click Next. At this point, Windows begins automatically, and restarts automatically after completing.
13. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
14. Log in with the password you set up previously.

Configuring Windows Update

1. In the left pane of the Server Manager window, click Local Server.
2. In the main frame, next to Windows Update, click Not configured.
3. In the Windows Update window, in the main pane, click Let me choose my settings.
4. Under Important updates, select Never check for updates (not recommended), and click OK.
5. In the left pane, click Check for updates, and install all available updates.
6. Close the Windows Update window.

Installing .NET Framework 3.5

1. Click Start→Server Manager→Manage→Add Roles and Features.
2. Select Role-based or feature-based installation, and click Next.
3. Select the local server under Server Pool, and click Next twice.
4. Under Features, select .NET Framework 3.5 Features, and click Next.
5. Click Install.
6. Click Close upon completion.
7. Reboot the server.

Configuring volumes in Windows Server 2012 R2

1. When the server has rebooted, press Windows + X, and click Disk Management.
2. Right-click the first unallocated disk, and click Online.
3. Right-click the same disk, and click Initialize Disk.
4. Click OK.
5. Right-click the right side of that disk's row, and click New Simple Volume.
6. Click Next.
7. Click Next.
8. Provide a drive letter, and click Next.
9. Provide a volume label, and click Next.
10. Click Finish.

11. Repeat steps 1-10 for the other disk.
12. Navigate to each volume, and in the root directory of each volume, create a folder called `sql`.

Installing and configuring SQL Server 2014

In some cases, you may want to customize your SQL Server 2014 installation to match your environment or requirements. We include the choices we made in our setup.

1. Log in to the database server VM with administrator credentials.
2. Insert the installation DVD for SQL Server 2014 into the server's DVD drive.
3. Attach the physical DVD drive to the VM.
4. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2014 DVD, and double-click.

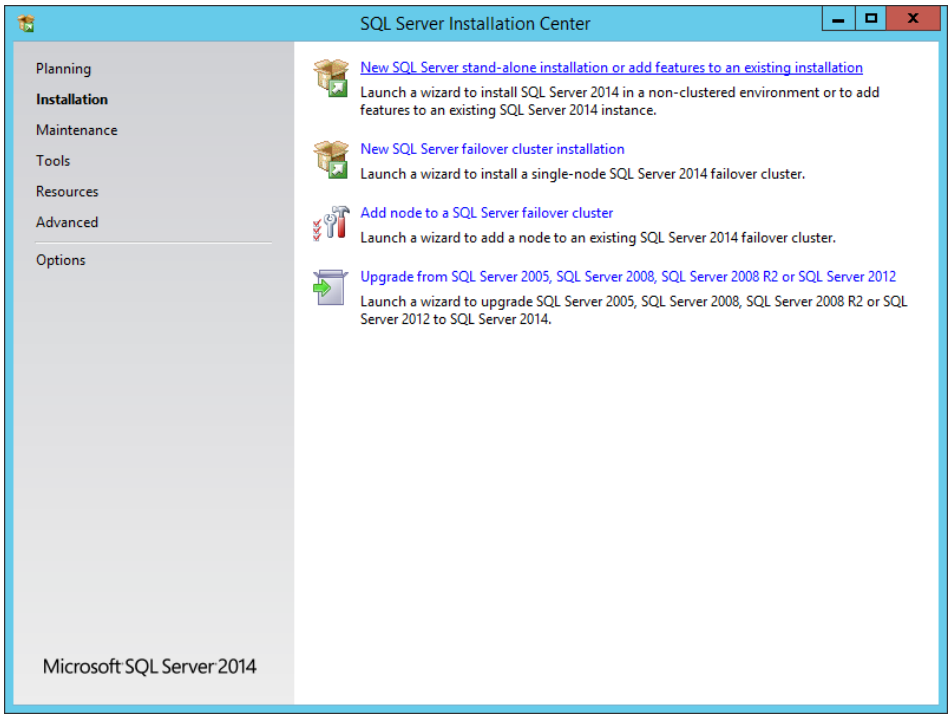

Figure 12: Microsoft SQL Server 2014 Installation Center.

5. If the installer prompts you with a .NET installation prompt, to enable the .NET Framework Core role, click Yes.
6. In the left pane, click Installation.
7. Click New installation or add features to an existing installation.
8. At the Setup Support Rules screen, wait for the check to complete. If there are no failures or relevant warnings, click OK.
9. Select the Evaluation edition, and click Next.

10. To accept the license terms, click the checkbox, and click Next.
11. To install the setup support files, click Install.
12. If there are no failures displayed, click Next. You may see a Computer domain controller warning and a Windows Firewall warning. For now, ignore these.
13. At the Setup Role screen, choose SQL Server Feature Installation.

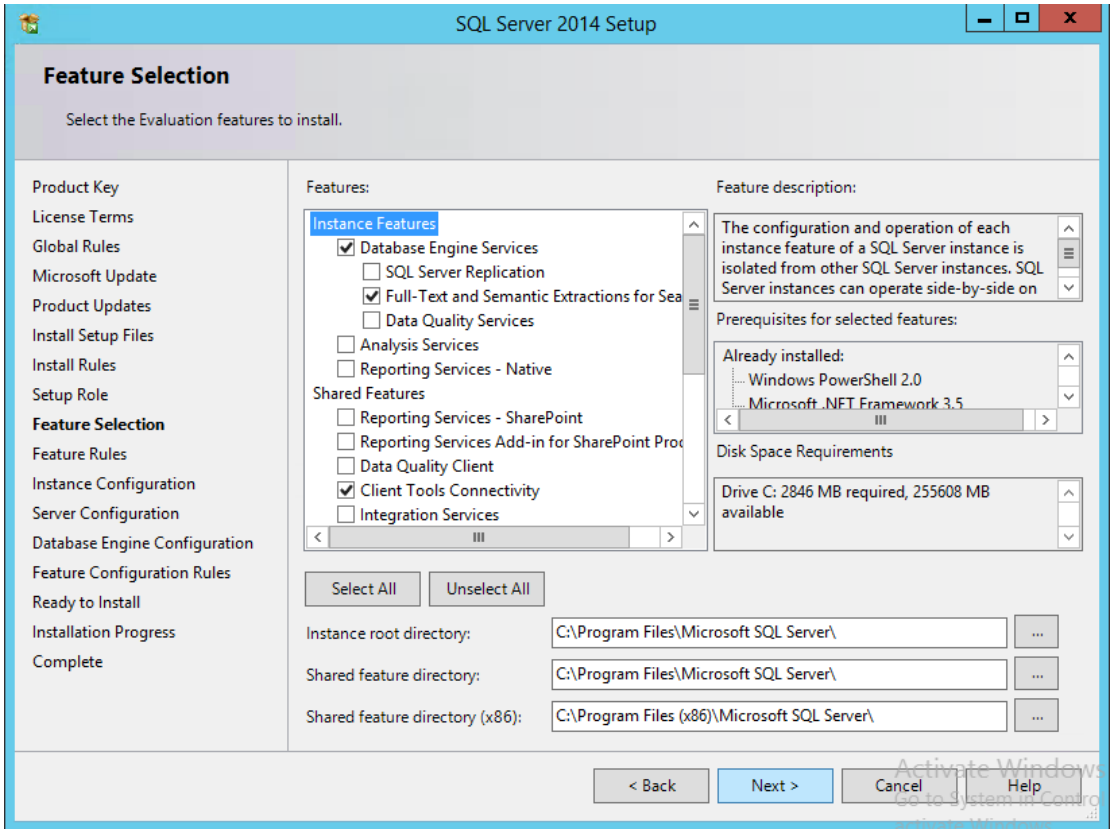

Figure 13: Microsoft SQL Server 2014 Feature Selection screen.

14. At the Feature Selection screen, select the features required by your organization. For this guide, we selected Database Engine Services, Full-Text Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, and Management Tools – Complete. Specify a directory (we kept defaults), and click Next.
15. At the Installation Rules screen, once the check completes, click Next.
16. At the Instance configuration screen, leave the default selection of default instance, and click Next.
17. At the Disk space requirements screen, click Next.

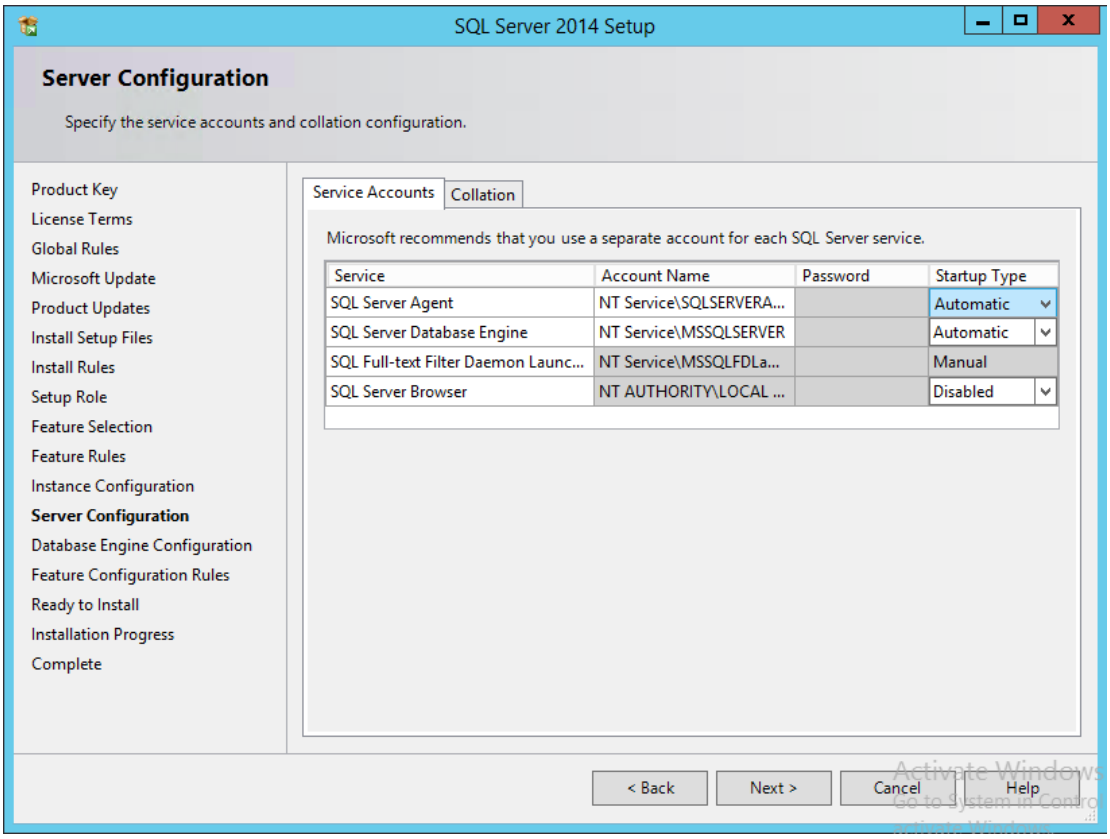

Figure 14: Microsoft SQL Server 2014 Server Configuration screen.

18. At the Server Configuration screen, choose the accounts to be used for each SQL Server component. For this guide, we set NT Service\SQLSERVERAGENT for SQL Server Agent, set NT Service\MSSQLSERVER for SQL Server Database Engine, and set the SQL Server Agent Startup Type to Automatic. For your environment, you may need to assign specific Active Directory users to these service accounts. Verify with your Active Directory administrator. Click Next.

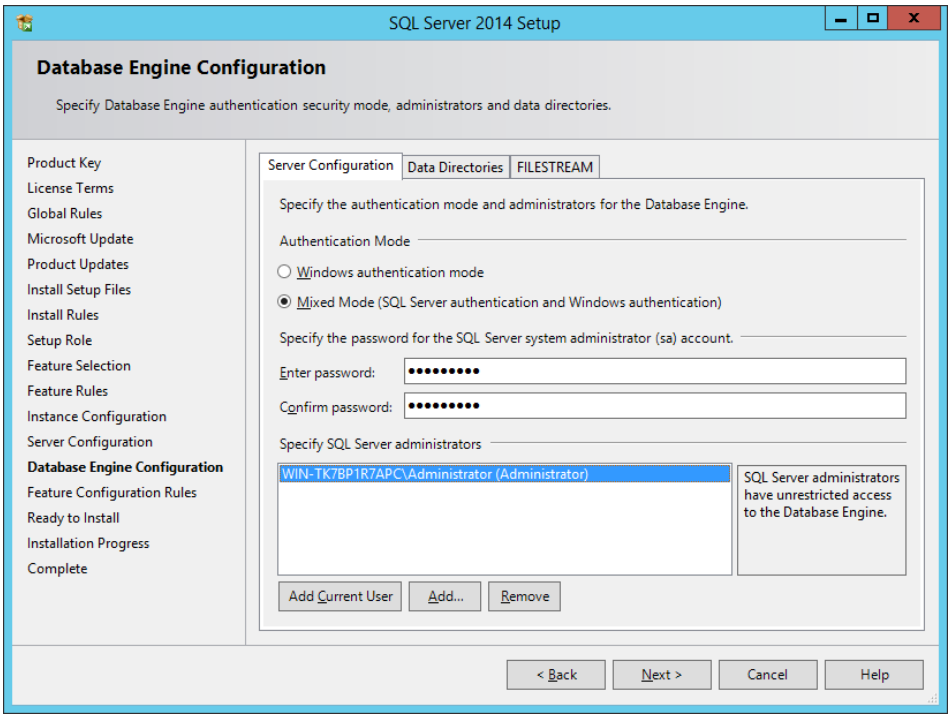

Figure 15: SQL Server 2014 Server Configuration tab.

19. At the Database Engine Configuration screen, there are three tabs that you must address:
    a. On the Server Configuration tab, select Windows Authentication mode or Mixed Mode. Add any necessary users, and if using Mixed Mode, provide a password for the sa account. For this guide, we selected Mixed Mode and added the current user (Windows Local Administrator).
    b. On the Data Directories tab, enter the directories for the SQL data and logs. For this guide, we used the DAAD 2.0's DATA and LOGS volumes' SQL folders created earlier.
    c. On the FILESTREAM tab, if appropriate for your organization, enable FILESTREAM. For this guide, we left FILESTREAM disabled.
20. Click Next.
21. At the Error and usage reporting screen, click Next.
22. At the Installation Configuration rules screen, check that there are no failures or relevant warnings, and click Next.
23. At the Ready to Install screen, click Install.
24. After installation completes, click Close.
25. Download and install the latest cumulative update packs available. As of the writing of this reference architecture, the latest available was Cumulative Update 16 for SQL Server 2014, which you can download at support.microsoft.com/en-us/kb/3052476.

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