Technical Report

Dell Exchange 2013 Reference Architecture for 500 to 20,000 Microsoft Users
Reliable and affordable storage for your business

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1 Overview

Continuing Dell’s strategy of delivering additional value to IT system designers and Dell customers, we are excited to announce a new Dell Reference Architecture for Microsoft™ Exchange 2013. The objective of this document is to provide a comprehensive guide for the primary infrastructure components required to support 500 to 20,000 Exchange 2013 users.

Many reference architectures focus on a single design point for a fixed number of users. These architectures can be helpful, but often do not provide enough design information when a customer has multiple physical locations with different user populations. In these cases a customer needs help to understand the server and storage requirements for their specific set of user sites.

This document highlights Dell™ PowerEdge™ R720 servers with QLogic 16Gb Gen 5 Fibre Channel adapters, Brocade 16Gb Gen 5 6505 Fibre Channel switches and Dell MD3 PowerVault storage, and how they can be used to create an Exchange 2013 infrastructure requiring virtually no unscheduled drive maintenance in the primary storage system. The “worry-free” concept of this solution is based on the self-healing data protection capability of the Dell MD3 PowerVault storage using Dynamic Disk Pooling (DDP) technology to withstand multiple drive failures over time without requiring drive maintenance actions by the customer. This capability can be used to design system solutions that require no drive maintenance for multiple years, significantly lowering the operational and therefore total cost of system ownership. Dynamic Disk Pooling is a standard (no-cost) feature of the Dell MD3 PowerVault storage systems.
The primary benefits of DDP technology are:

• Significantly simpler storage management through the elimination of traditional RAID
• Improved data protection through self-healing DDP capability allowing for multiple drive failures over time without unscheduled drive maintenance
• Significantly reduces storage system performance impact following a drive or multiple drive failures
• Full utilization of all disks and elimination of idle spares management
• Simple, automated reconfiguring of DDP when drives are added or removed from the pool

In order to achieve the goal of the reference architecture many tests were run at various user mailbox counts to build a repeatable design model. This document describes a Jetstress simulation of a Microsoft® Exchange Server® 2013 environment. Jetstress is a tool provided by Microsoft that is designed to simulate an Exchange Server environment. With this tool, customers can simulate any number of users, specify a workload for those users and provide a storage limit. This tool generates a simulated workload, which provides results indicating how well customers’ storage environment configuration will handle the load.

2. Introduction

This report is focused on a Microsoft Exchange 2013 Server solution architecture for 500 to 20,000 users. The testing completed demonstrated the value of the Dell server/networking and storage system as affordable, scalable, high performance infrastructure. This solution is very affordable and enables performance levels that are normally reserved for more expensive systems.

This Dell reference architecture has been designed using these components:

• Dell PowerEdge R720 Servers running Windows Server 2012 R2
• Dell MD34 and MD38 PowerVault 16Gb storage using Dynamic Disk Pooling technology
• QLogic QLE2662 16Gb Gen 5 Fiber Channel Adapters
• Brocade 6505 16Gb Gen 5 SAN switches
• Dell Networking 5524 Network Switches
3 Infrastructure Components

3.1 Dell PowerEdge R720 Server

The Dell PowerEdge R720 Server offers the following features:

• Engineered with the right combination of features and performance scalability to handle tough workloads for both large and small data center environments
• Intended for demanding workloads, including private cloud, VDI, data warehouses, e-commerce, and HPC
• Comes with out-of-band management controller for immediate integration into existing management schemes

Dramatically boost application performance with the latest Intel® Xeon® processor E5-2697 v2 product family (recommended in this reference architecture) and up to 24 dual in-line memory modules (DIMMs). Built with 22-nanometer process technology and up to 12 cores per processor, it enables super-fast processing for compute-intensive tasks.

Enhance your data center performance with the balanced, scalable I/O capabilities of the PowerEdge R720 — including integrated PCI Express (PCIe) 3.0-capable expansion slots.

Tailor your network throughout to match your application needs with features that allow you to take full advantage of your additional I/O performance.

3.2 QLogic QLE2662 16Gb Gen 5 Fiber Channel Adapters

The QLogic Fibre Channel adapters have the following design characteristics:

• 16Gbps per port maximum throughput for high bandwidth (SAN) traffic
• Over 1.2 million IOPS reduces latency in high transaction intensive applications and virtualized environments
• Optimization for virtualized environments: with increasing numbers of VMs on virtualized servers it is essential that the I/O performance scales as the VM count grows and doesn’t become a bottleneck
• Decreased power and cooling costs by using the fewest PCI Express® lanes in PCIe® Gen 3 environments
• Overlapping protection domains (OPDs) to ensure a high level of reliability as data moves to and from the PCI bus and Fibre Channel network
• Complete investment protection for legacy 8Gb Fibre Channel infrastructure

Information on the Dell 16Gb Gen 5 FC adapter can be found at:


3.3 Brocade 6505 16Gb Gen 5 SAN switches

The Brocade 6505 SAN Switch has the following design features:

• Provides exceptional price/performance value, combining flexibility, simplicity, and enterprise-class functionality in a 24-port, 1U entry-level switch
• Enables fast, easy, and cost-effective scaling from 12 to 24 ports using Ports on Demand (PoD) capabilities
• Simplifies management through Brocade Fabric Vision technology, reducing operational costs and optimizing application performance
• Simplifies deployment and supports high-performance fabrics by using Brocade ClearLink Diagnostic Ports (D_Ports) to identify optic and cable issues
• Maximizes resiliency with non-disruptive software upgrades and an optional redundant power supply
• Simplifies deployment with the Brocade EZSwitchSetup wizard
• Simplifies server connectivity by deploying as a full-fabric switch or a Brocade Access Gateway
3.4 Dell MD3 PowerVault Storage

The Dell PowerVault MD3 storage systems are affordable, dedicated, high-availability (HA), shared-storage arrays designed to offer improved performance and capacity for storage consolidation and server virtualization, while delivering deployment flexibility and scalability. The MD3 PowerVault series has a high degree of flexibility for our customers, able to be configured to meet a wide variety of IT demands.

The MD3 arrays are available with the highly available dual, active/active controllers with 12Gb SAS and optional 16Gb Fibre Channel or 10Gb iSCSI host interfaces. They support hot-pluggable power supplies/cooling fans and any mixture of hard disk drives the customer may need. They provide the user with hot pluggable redundant controllers. The controllers have battery backed, mirrored cache so that in the rare instance of a controller failure, the surviving controller takes ownership of the failed controller’s disks and continues processing I/O without interruption. Features such as, active disk scrubbing, non-disruptive firmware upgrades and I/O multi-path capabilities ensure high availability of data and make the system suitable for latest, most demanding applications.

The latest generation MD3820f and MD3860f arrays, used in this reference architecture, come with both 12Gb SAS and 16Gb fibre channel host ports in a highly available dual, active/active controller array. MD3820f and MD3860f deliver 2x the performance* of the previous generation MD3 systems and are offered with 4GB or 8GB controller cache, providing a maximum of 16GB cache per array.

*Comparison with previous MD3 generation for large block sequential read

Dynamic Disk Pools Overview

Dynamic Disk Pools (DDP) offer a worry-free method for data protection and performance. DDP dynamically distributes data, spare capacity, and protection information across a pool of drives, differing from traditional RAID groups in terms of configuration. DDP uses a dynamic balancing algorithm that defines where data segments are placed. In case of drive failure, segments are recreated and dynamically rebalanced elsewhere with no user intervention. DDP looks essentially the same at the ‘virtual level’ as RAID, but differs from traditional RAID groups in the following aspects:

- DDP eliminates the need for hot-spare disks. Every disk is an active participant in the pool adding to overall performance.
- DDP eliminates the restriction around how many disks can be added or removed to/from a single pool (pool must have a minimum of 11 disks), thus eliminating the need to manage multiple pools. Volumes are created from the pool as they are created today in the traditional RAID pools.
- In a DDP, volume data is distributed across the entire disk pool in segments. Each volume includes some number of ‘virtual stripes’. This provides greater protection, enables the system to quickly rebuild a drive in the event of a failure, and allows faster expansion than traditional RAID systems.
- Greatly simplifies administration. There are no RAID levels to understand and manage, no idle spares to worry about, and capacity expansion or reduction is effortless.

Because of these differences, DDP offers ease of use and management advantages when compared to traditional RAID groups. In addition, greater performance is seen with applications or environments that have more random access patterns, such as Microsoft Exchange. This reference architecture design has leveraged the self-healing benefits of DDP and has enough built-in pool capacity to support two years of no unscheduled drive maintenance, greatly lowering TCO.
Jetstress testing provides the following benefits:

- Works with the Microsoft Exchange Server 2013 database engine to simulate the Exchange database and log disk input/output (I/O) load on the storage system.
- Verifies the performance and stability of the disk system prior to putting an Exchange 2013 server into production.
- Verifies disk performance by simulating Exchange disk I/O load. Jetstress simulates the Exchange database and log file loads produced by a specific number of users.
- Successful completion of the Jetstress disk performance and stress tests in a non-production environment, you will have verified that your Exchange 2013 disk subsystem is adequately sized for the user count and user profiles established.

## 4 Solution Description

### 4.1 Introduction to Jetstress

Jetstress is a tool for simulating Exchange Server database I/O load without requiring an Exchange Server to be installed. It is primarily used to validate storage physical deployments against the defined user population and profile targets.

To accurately simulate the complex Exchange Server database I/O pattern, Jetstress makes use of the same ESE.DLL that Exchange Server uses in production. Additionally, Jetstress uses the same version of the Extensible Storage Engine (ESE) files which production Exchange Server infrastructures are built.

The most important aspect of Jetstress testing is that it allows customers to see how the physically deployed storage infrastructure will behave, after a real Exchange Server workload is applied. Fundamentally, a successful Jetstress test validates that all of the storage and networking hardware and software components within the I/O stack, are working at a level that is sufficient to meet the predicted performance required by Exchange Server to operate successfully.

### 4.2 Design Considerations

Dell leveraged multiple Jetstress tests over a broad set of Exchange 2013 user scenarios to map the performance of the MD3820f and MD3860f systems with a single Dynamic Disk Pool. This mapping has enabled the delivery of a scalable reference design supporting many user deployment scenarios.

Given the near infinite number of possible architecture scenarios for organizations with 500 to 20,000 employees, this paper provides design guidance to enable the user to design systems in increments of 1000 users per site up to 20,000 users.

Mailbox databases and the data they contain are one of the most critical components of any Exchange organization. In Microsoft Exchange Server 2013, you can protect mailbox databases and the data they contain by configuring your mailbox databases for high availability and site resilience. Exchange 2013 reduces the cost and complexity of deploying a highly available and resilient messaging solution while providing higher levels of end-to-end availability and supporting large mailboxes. Building on the native replication capabilities and high availability architecture in Exchange 2010, Exchange 2013 enables customers of all sizes and in all segments to economically deploy a messaging continuity service in their organization.

The high availability and site resilience features used first introduced in Exchange 2010 are used in Exchange 2013 to create and maintain database copies. Exchange 2013 also leverages the concept of database mobility, which is Exchange-managed database-level failovers.

Database mobility disconnects databases from servers and adds support for up to 16 copies of a single database. It also provides a native experience for creating copies of a database.

Setting a database copy as the active mailbox database is known as a switchover. When a failure affecting a database or access to a database occurs and a new database becomes the active copy, this process is known as a failover. This process also refers to a server failure in which one or more servers bring online the databases previously online on the failed server. When either a switchover or failover occurs, other Exchange 2013 servers become aware of the switchover almost immediately and redirect client and messaging traffic to the new active database.

For example, if an active database in a DAG fails because of an underlying storage failure, Active Manager will automatically recover by failig over to a database copy on another Mailbox server in the DAG. In Exchange 2013, managed availability adds new
behaviors to recover from loss of protocol access to a database, including recycling application worker pools, restarting services and servers, and initiating database failovers.

This reference architecture provides a framework for deployments of 500-20,000 Exchange 2013 users located in a single region with two datacenters. Datacenter A is geographically located with the users and will house the active copies of the mailbox databases, Datacenter B is at a remote location and will serve as the backup and disaster recovery site. The users profile is set to send and receive 200 email messages per day at an average size of 75 KB. The DDP pool has been sized to support each user having a 2GB mailbox.

In scenarios where customers have multiple datacenters, the Exchange 2013 infrastructure can be deployed in one or distributed across two or more sites to provide site resiliency. Typically the service level agreement (SLA) will define the level of high availability and therefore the placement of the Exchange infrastructure. In smaller organizational, single-site, scenarios redundancy can occur in the same or different datacenters in the same building.

Dell recommends designing each server installation with the capability to power down a server for maintenance without affecting the Exchange 2013 user environment or experience and without switching to Exchange databases at a secondary datacenter. To do this a second database copy must be kept in the active datacenter and enough processing power must be designed into the infrastructure to support this design plan.

Exchange 2013 includes managed availability which is the integration of built-in, active monitoring within the high availability platform. With managed availability, the system can make a determination on when to fail over a database based on service health. Managed availability is an internal infrastructure that’s deployed on the Client Access and Mailbox server roles in Exchange 2013. Managed availability includes three main asynchronous components that are constantly doing work. The first component is the probe engine, which is responsible for taking measurements on the server and collecting data. The results of those measurements flow into the second component, the monitor. The monitor contains all of the business logic used by the system based on what is considered healthy on the data collected. Similar to a pattern recognition engine, the monitor looks for the various different patterns on all the collected measurements, and then it decides whether something is considered healthy. Finally, there is the responder engine, which is responsible for recovery actions. When something is unhealthy, the first action is to attempt to recover that component. This could include multi-stage recovery actions; for example, the first attempt may be to restart the application pool, the second may be to restart the service, the third attempt may be to restart the server, and the subsequent attempt may be to take the server offline so that it no longer accepts traffic. If the recovery actions are unsuccessful, the system escalates the issue to a human through event log notifications.
The key characteristics of mailbox database copies are:

- Up to 16 copies of an Exchange 2013 mailbox database can be created on multiple Mailbox servers, provided the servers are grouped into a database availability group (DAG), which is a boundary for continuous replication. Exchange 2013 mailbox databases can be replicated only to other Exchange 2013 Mailbox servers within a DAG. You can’t replicate a database outside of a DAG, nor can you replicate an Exchange 2013 mailbox database to a server running Exchange 2010 or earlier.

- All Mailbox servers in a DAG must be in the same Active Directory domain.

- Mailbox database copies support the concepts of replay lag time and truncation lag time. Appropriate planning must be performed before enabling these features.

- All database copies can be backed up using an Exchange-aware, Volume Shadow Copy Service (VSS)-based backup application.

- Database copies can be created only on Mailbox servers that don’t host the active copy of a database. You can’t create two copies of the same database on the same server.

- All copies of a database use the same path on each server containing a copy. The database and log file paths for a database copy on each Mailbox server must not conflict with any other database paths.

- Database copies can be created in the same or different Active Directory sites, and on the same or different network subnets.

- Database copies aren’t supported between Mailbox servers with round trip network latency greater than 500 milliseconds (ms).

To ensure a resilient infrastructure Dell recommends deploying a minimum of three high availability database copies and a lagged database. Two high availability database copies should be deployed in the active datacenter to permit servers to be taken down for servicing without moving users over to a passive datacenter. A third high availability database copy should be deployed in the passive datacenter to provide site resiliency. A lagged database copy will also be deployed in the passive datacenter to protect against logical corruption of the database.

### 4.3 Server Sizing

The Dell PowerEdge R720 server using an Intel Xeon E5-2697 v2 2.7 GHz processor and 256GB of physical memory is recommended for this reference architecture.

We understand customers may desire to use a different server configuration than what is recommended in this reference architecture. For sizing the servers required by Exchange 2013, Microsoft has created the Exchange 2013 Mailbox Server Role Requirements Calculator. The calculator is an excellent tool for estimating the number of processor cores and amount of memory required to support a desired workload.
4.4 Server Hardware Requirements

The number of servers required to support an Exchange 2013 infrastructure will vary depending on the chosen server configuration. Below is an example of the projected servers required to support the active and passive databases at two data centers based on the number of users.

<table>
<thead>
<tr>
<th>Number of Mailboxes Supported</th>
<th>Primary Active Datacenter Physical Servers</th>
<th>Secondary Passive Datacenter Physical Servers</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>1K</td>
<td>4</td>
<td>4</td>
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<tr>
<td>2K</td>
<td>4</td>
<td>4</td>
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<tr>
<td>3K</td>
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<td>4</td>
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<tr>
<td>4K</td>
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<td>4</td>
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<tr>
<td>5K</td>
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<td>4</td>
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<tr>
<td>6K</td>
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<td>7</td>
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<tr>
<td>7K</td>
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<td>8K</td>
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<td>9K</td>
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<td>10K</td>
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<td>11K</td>
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<td>7</td>
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<tr>
<td>12K</td>
<td>7</td>
<td>7</td>
</tr>
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<td>13K</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>14K</td>
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<td>15K</td>
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</tr>
<tr>
<td>20K</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

4.5 Storage Sizing

This reference architecture utilizes Dynamic Disk Pooling (DDP) technology offered on the Dell MD3 PowerVault Storage System. This greatly simplifies the storage setup because it eliminates RAID calculations and provides greater data protection and performance during the life cycle of the storage system. Storage sizing was determined for 500 to 20,000 mailbox scenarios in increments of 1000 mailboxes to provide easy setup guidelines.

To determine the number of disks required within each MD38 system multiple Jetstress ESRP test scenarios were performed to validate the expected performance characteristics of the system. The use cases all assumed 2Gb mailbox sizes with a single Dynamic Disk Pool using 900GB 10k 2.5” SAS HDDs supporting the I/O requirements of 1 active database and 2 high availability database copies. Capacity was calculated to support single set of database and log files, therefore depending on redundancy design and number of sites designs would require multiples of values in tables below. To take advantage of the self-healing characteristics of DDP, testing was completed on drive pools assuming an unusually high total failure rate of 5% over two years. A 5% drive failure rate assumption is about 42% more than would normally be expected in actual use. This was done to provide a high level of confidence to infrastructure administrators.
The table below shows the minimum number of drives required to permit no unscheduled drive maintenance for a period of two years:

<table>
<thead>
<tr>
<th>Number of Mailboxes Supported</th>
<th>Primary Active Datacenter Drives in DDP</th>
<th>Secondary Passive Datacenter Drives in DDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>1K</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>2K</td>
<td>18</td>
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<tr>
<td>3K</td>
<td>25</td>
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<td>4K</td>
<td>33</td>
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<td>10K</td>
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<td>11K</td>
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<tr>
<td>12K</td>
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<td>13K</td>
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<tr>
<td>20K</td>
<td>157</td>
<td>157</td>
</tr>
</tbody>
</table>

If system administrators do not wish to implement a system with the two-year additional level of drive maintenance protection they can reduce the drive counts above by 5%. User data will still be protected by the DDP during any drive failures and the system will notify the administrator when the pool requires additional capacity.

The 900GB 10k drives were selected for this architecture because they provide an optimal balance of price to performance with reasonable cost per unit of capacity. We understand system designers may wish to use other drive types and capacity points and have created a MD3 PowerVault Capacity Performance calculator. The MD3 PowerVault Capacity Performance Calculator is designed to calculate the number of drives required, the usable capacity performance (in IOPS and MB/s), the power (in watts and BTUs), the system size (in Us), and the part numbers of major items — all based upon the desired minimum usable capacity, RAID Level or DDP, and the select percentage read of the system. In addition, the latest calculator now includes two new selections to improve the accuracy of performance numbers: file transfer block size and cache memory (enabled or disabled).
4.6 Storage Hardware Requirements

The number of disks required at each site based on a single database has been defined below:

<table>
<thead>
<tr>
<th>Mailboxes</th>
<th>500</th>
<th>1k</th>
<th>2k</th>
<th>3k</th>
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<th>6k</th>
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OR

<table>
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<th>13k</th>
<th>14k</th>
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OR

<table>
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<th>18k</th>
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<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: If using a design point greater than 120 drives, a premium feature key for additional physical disk support must be purchased.

4.7 Storage Setup

In all testing and in this reference architecture the storage was and should be configured with a single Disk Pool. This varies from the typical Exchange Server configuration for traditional storage where most solutions will prescribe dedicating the log files to a dedicated RAID group, but makes installation much simpler.

Figure 1

Disk Pool setup

5 Conclusion

Hopefully the reference architecture provides designers and users valuable information for setting up a robust affordable Microsoft Exchange 2013 infrastructure.