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## Revisions

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 2013</td>
<td>Initial release</td>
</tr>
<tr>
<td>October 2013</td>
<td>Updated to include Windows Server 2012 R2 content</td>
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</table>

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Executive summary

This document provides an overview of Microsoft’s Offloaded Data Transfer (ODX), and its use with Dell Compellent Storage Center. When used with Storage Center 6.3, Windows Server 2012 and 2012 R2 ODX offloads data transfers to the SAN rather than the traditional server-based model, resulting in a 2-3x performance improvement and minimal server resource consumption.
1 ODX

1.1 Introduction to ODX

As data continues to grow, systems and storage administrators require a more efficient means of transferring the data. Traditional methods of data transfer through client-server or storage networks can be slow and consume precious server and network resources. Aiming to speed data transfer rates and reduce resource consumption, Microsoft developed Offloaded Data Transfer (ODX). Traditional copy operations use preserved buffer space on a server to read and write data. ODX uses a combination of offloaded reads and writes on the backend SAN and tokens representing data on the server. Data transfers are performed by the copy manager on SAN, removing the need for buffered copies on the server. By offloading data transfers to the SAN, ODX offers low CPU and memory consumption on the server, low network bandwidth utilization, and up to 3 times faster data transfer rates than the traditional, buffer based copy operation.

1.2 Windows Server 2012 and 2012 R2

Initially released in August of 2012, Windows Server 2012 offered significant improvements and new features over the prior release of Windows Server. Dubbed “the cloud OS” by Microsoft, Server 2012 was designed to be dynamic, scalable, resilient, and to be the core of the data center.

With a focus on offering an enterprise-class cloud platform, Windows Server 2012 R2 was released in October 2013. Server 2012 R2 added additional enhancements and features, including improvements to networking, storage, user experience, failover clustering, data deduplication, Hyper-V and more. For a complete listing of what’s new and changed in Windows Server 2012 R2, please refer to Microsoft TechNet.

1.3 Dell Compellent Storage Center 6.3

Storage Center 6.3 is Compellent’s most significant Storage Center array software release since the 6.0 introduction in January 2012. A no-charge upgrade for customers under a current support agreement, Storage Center 6.3 software provides enhanced scalability and performance for Dell Compellent SC8000 and Series 40 arrays, delivering up to 2 times system performance improvement on SC8000 when running enterprise applications.
2 ODX overview

ODX is enabled by default on Windows Server 2012 and 2012 R2 and Storage Center 6.3. ODX requires both the source and destination volumes be formatted with NTFS. ODX operations occur when transferring data on the same volume, or when transferring data between two different volumes.

Note: When transferring data between two volumes, ODX only works between volumes that are hosted on the same Storage Center (single or dual controller). Even if two volumes from different Storage Centers are mapped to the same server, data transfers will take place using the traditional buffered copy operation between the two volumes.

ODX operations can be initiated from a physical server or a virtual machine. The source and destination volumes can be physical disks, virtual hard disks (VHDs), or Server Message Block (SMB) shared disks (the share must be hosted on a volume located on the same Storage Center as the source/destination volume).

Within Hyper-V, ODX is used to speed up the virtualization platform layer. This allows Hyper-V to achieve native-like performance when virtual machines read and write to Storage Center. ODX also allows for rapid deployment of guests.

ODX operations on virtual machines (VMs) require the VMs be running Windows Server 2012, Windows Server 2012 R2 or Windows 8, and the VM’s virtual hard drive(s) be in the VHDX format. Transferring data between VMs require that both VMs virtual hard drives be housed on volumes hosted on the same Storage Center. VMs can use ODX to transfer data to other guests, physical pass-through volumes, virtual Fibre Channel volumes, and SMB shared disks.

2.1 ODX: how does it work?

As previously mentioned, ODX on Windows Server 2012 and 2012 R2 utilizes tokens sent to and received from Storage Center to transfer data. These tokens represent the initial offload read request, the data to be transferred, the destination, offload write request, and finally, the status of the transfer.

When a data transfer request is initiated from a Windows 2012 and 2012 R2 server, the following process occurs (please refer to Figure 2):

1. Windows sends a Populate token (offload read request) to Storage Center.
   a. This token is processed in 1GB increments, as long as the data is contiguous. For example, if a request is made for a 10.5 GB contiguous file, a total of 11 tokens will be sent to Storage Center.
   b. If multiple files are to be transferred, separate tokens are created for each file if the data is non-contiguous.
   c. Windows sends tokens for offload read requests sequentially. The current request must complete successfully before another request is sent.
2. Storage Center creates a token and sends a Good status back to Windows.
3. Windows sends a request for the representation of data (ROD) token to Storage Center.
4. Storage Center sends back a ROD token to Windows.
5. Windows sends a Write Using token (offload write request) to Storage Center.
   a. The Write Using token includes the ROD token, an offset into the token, the destination LBA and number of blocks.
   b. Write Using tokens are sent to Storage Center as 256MB requests.
6. Storage Center performs the copy of data.
7. Storage Center sends a Good status back to Windows.
   a. Steps 5-7 are repeated until the initial 1GB request is processed.
8. Steps 1-7 are repeated until all data has been transferred successfully.

If, at any point in the ODX transfer process an error occurs, Windows will revert to the standard copy operation to complete the transfer.

Additionally, ODX can be utilized when creating a fixed-size VHD. Without ODX enabled, Windows will explicitly zero-out all of the disk space that is being assigned to the new VHD file. Depending on the size of the VHD file, this can be a slow, time consuming process. With ODX enabled, Windows issues the Storage Center a Write Using token with a ROD token representing all zeros. For example, when creating a 50GB VHD file, Windows would issue the Write Using token command 200 times creating 256MB of zeros each time the command is issued, writing 50GB worth of zeros. This process takes seconds to complete. Windows reads the newly created VHD file as the full 50GB, but with thin provisioning on the Storage Center, the file is not consuming any actual space until data is written to it.
3 Windows Server 2012 R2 ODX lab validation

A test lab consisting of a Windows Server 2012 R2 host and Dell Compellent Storage Center 6.3 was configured to validate and gauge the efficiencies of ODX. The function of ODX is to offload common storage tasks to the array, freeing up host cycles of CPU, memory, storage bandwidth, and network bandwidth. Depending on the array’s workload, specific data transfer tasks could see a dramatic improvement in time to complete the task assigned.

The Dell Compellent Storage Center in this lab is a single pair of Series 40 Controllers with 48 146 GB 2.5 inch SAS drives (2 trays of 24 disks) making up Tier 1, and 12 2 TB 3.5 inch drives for Tier 3. The controllers communicate to the disk shelves via 6GB SAS.

The Dell Compellent array will create wide stripes of RAID10 and RAID5 over both trays of Tier 1, but because the size of the disks being utilized in Tier 3 exceed 1 TB, the Dell Compellent array defaults to dual redundancy using RAID6 instead of RAID5.

A single Dell R620 Server was utilized as the Windows Server 2012 R2 host for this test with a dual port QLogic Fibre Channel HBA providing the front end connectivity to the Dell Compellent Storage array. The Windows Server 2012 R2 host’s HBA was configured following Dell Compellent Best Practices for Storage Center connectivity.

3.1 Lab environment

All the tests were executed from the following hardware and software:

- Storage
  - Storage Center
    - Controllers: Dell Compellent SC8000
    - Firmware: 6.3.10.106.02
    - Tier 1 Disks: 48 – 146GB SAS 15k RPM (47 active, 1 hot spare)
    - Tier 2 Disks: 12 – 1.8 TB SAS 7k RPM (11 active, 1 hot spare)
    - Back End Connectivity: 8 Gbps Fibre Channel
- Server
  - Dell PowerEdge R620
    - Processors: 2 – Intel Xeon E5-2670 8 Core @ 2.60 GHz
    - Memory: 64 GB
    - LAN: 2 – Intel Gigabit 4P X540/I350
    - I/O card: QLogic QLE2562 Dual-port 8 Gbps Fibre Channel Card
      - All updates applied as of 10/18/2013
3.2 Test overview
The following tests were conducted on the test lab system to validate ODX performance in real world scenarios:

Large File Copy
- Copy a large file from one Dell Compellent volume to another – ODX Enabled / Disabled

Copy Multiple Files
- Copy multiple files from one Dell Compellent Volume to another – ODX Enabled / Disabled

Create a Large Fixed-Size Virtual Hard Disk
- Create a 100GB fixed-size VHD file on a Dell Compellent volume – ODX Enabled / Disabled

3.3 Test results
Large File Copy – copy a large file from one Dell Compellent volume to another – ODX Enabled / Disabled

Using Windows Explorer, a 16GB VHDX file was copied from one Dell Compellent volume to another. Baseline copy time was established with ODX disabled. ODX was then enabled and the copy performed again to capture any difference in performance.

The results of this test show that ODX can significantly decrease the amount of time needed to copy a large file. Using ODX showed a reduction of 143% in the time it takes to copy the file.

<table>
<thead>
<tr>
<th>Size of VHD file (GB)</th>
<th>ODX Enabled /sec</th>
<th>ODX Disabled /sec</th>
<th>%Time Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>40</td>
<td>97</td>
<td>143%</td>
</tr>
</tbody>
</table>
**Copy Multiple Small Files** - Copy multiple small files from one Dell Compellent Volume to another – ODX Enabled / Disabled

Using Windows Explorer, 1,435 files (1.28 GB total, average file size 91.34KB) were copied from one Dell Compellent volume to another. Baseline copy time was established with ODX enabled. ODX was then enabled and the copy performed again to capture any difference in performance.

The results of this test show ODX decreased the amount of time needed to copy multiple small files. Using ODX showed a reduction of 59.6% in the time it takes to copy the files.

### Table 2  Multiple small file copy testing results

<table>
<thead>
<tr>
<th>Number of Files/Total Size</th>
<th>ODX Enabled /sec</th>
<th>ODX Disabled /sec</th>
<th>%Time Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1435/1.28 GB</td>
<td>8.22</td>
<td>13.12</td>
<td>59.6%</td>
</tr>
</tbody>
</table>

**Figure 3  16GB VHDX file copy testing results**

- **16GB VHDX File Copy**
- **ODX Disabled** vs **ODX Enabled**

- **Seconds vs MB/s**
Create a Large Fixed-Size Virtual Hard Disk – Use Windows PowerShell to create a 100 GB fixed-size VHDX file on a Dell Compellent volume – ODX Enabled / Disabled

Using Windows PowerShell, a script was run to create a 100GB VHDX file on a Dell Compellent volume and report back the time in seconds the process took to complete. Baseline create time was established with ODX disabled. ODX was then enabled and the script re-run to capture any differences in performance.

The results of this test show ODX can reduce the time to create a fixed-size VHDX file to mere seconds. Using ODX showed a reduction of over 10,000% in the amount of time it takes to create the VHDX file.

Table 3  Time need to create a 100GB fixed-size VHDX file

<table>
<thead>
<tr>
<th>Size of VHD file (GB)</th>
<th>ODX Enabled /sec</th>
<th>ODX Disabled /sec</th>
<th>%Time Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>2.12</td>
<td>218.17</td>
<td>10000%</td>
</tr>
</tbody>
</table>
Figure 5  Time needed to create a 100GB fixed-size VHDX file
Conclusion
When used with Dell Compellent Storage Center 6.3, Windows Server 2012 and 2012 R2 ODX uses tokenized read and write operations to offload data transfers to Storage Center. By offloading data transfers to the SAN, ODX offers low CPU and memory consumption on the server, low network bandwidth utilization, and up to 3 times faster data transfer rates than the traditional, buffer-based copy operations. Creating large fixed-sized VHDs is virtually instantaneous, and facilitates deploying Hyper-V guests very quickly.
A Appendix

A.1 Recommended ODX Hotfix for Windows Server 2012

<table>
<thead>
<tr>
<th>KB Number</th>
<th>Title</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>KB2796995</td>
<td>A hotfix is available that corrects an issue with Offloaded Data Transfers failing on Windows Server 2012. This fix has been incorporated into Windows Server 2012 R2.</td>
<td><a href="http://support.microsoft.com/kb/2796995">http://support.microsoft.com/kb/2796995</a></td>
</tr>
</tbody>
</table>

A.2 Sample PowerShell commands used for testing

**Check ODX Status (return value 0 = ODX enabled, return value 1 = ODX disabled)**

Get-ItemProperty hklm:\system\currentcontrolset\control\filesystem -Name "FilterSupportedFeaturesMode"

**Disable ODX:**

Set-ItemProperty hklm:\system\currentcontrolset\control\filesystem -Name "FilterSupportedFeaturesMode" -Value 1

**Enable ODX:**

Set-ItemProperty hklm:\system\currentcontrolset\control\filesystem -Name "FilterSupportedFeaturesMode" -Value 0

**Create a 100GB VHDX file and report process run time (in seconds):**

$Destination = "G:\Test"

$CreateDiskTime = Measure-Command {New-VHD -Path "$Destination\Test_File.vhdx" -Fixed -SizeBytes 100GB}

$TotalTime = $CreateDiskTime.TotalSeconds

Write-Host $TotalTime
Additional resources

Support.dell.com is focused on meeting your needs with proven services and support.

DellTechCenter.com is an IT Community where you can connect with Dell Customers and Dell employees for the purpose of sharing knowledge, best practices, and information about Dell products and installations.

Recommended Dell Compellent publications on Knowledge Center: [http://kc.compellent.com](http://kc.compellent.com)

- Dell Compellent Storage Center Windows Server 2012 R2 Best Practices Guide
- Dell Compellent Storage Center Best Practices for Hyper-V

Recommended Microsoft publications: