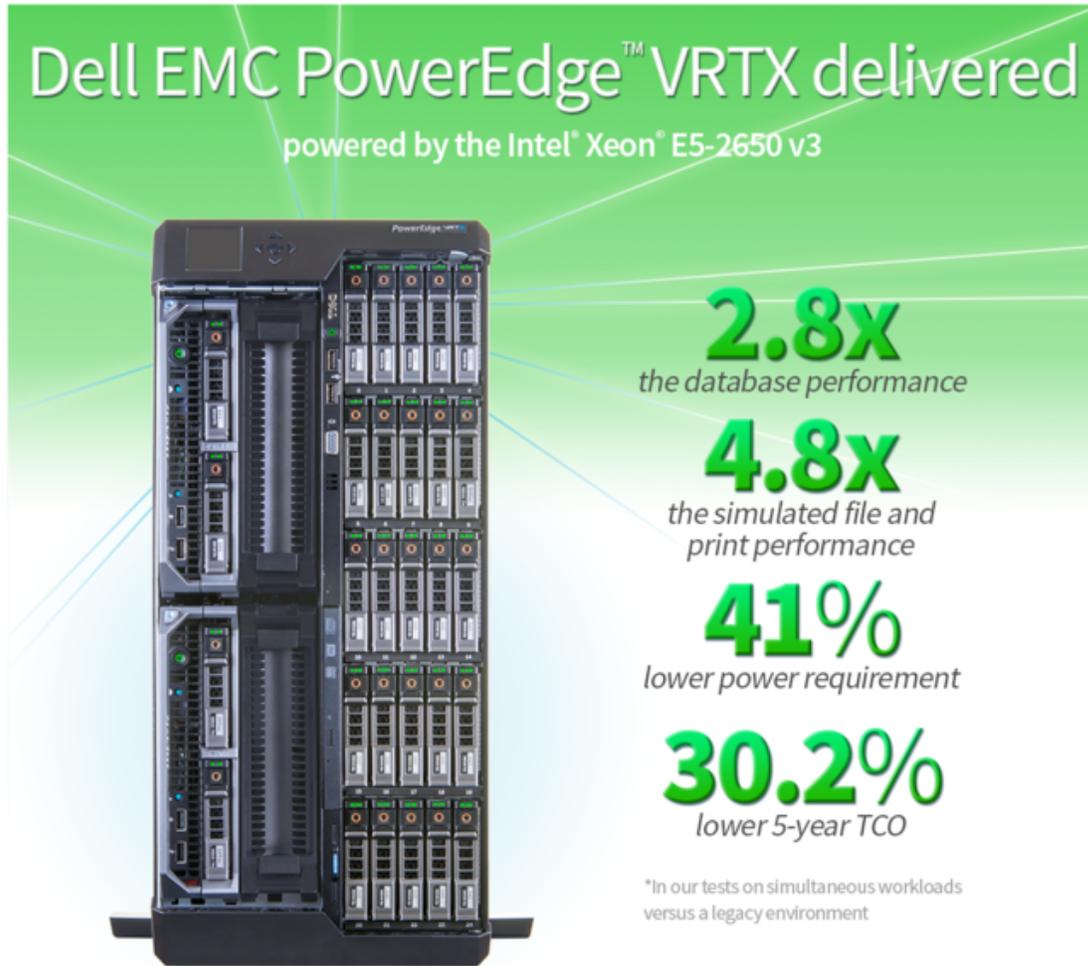# COMPARING PERFORMANCE AND COST: DELL EMC POWEREDGE VRTX WITH TWO DELL EMC POWEREDGE M630 SERVER NODES VS. A LEGACY SOLUTION

Dell EMC PowerEdge™ VRTX delivered
powered by the Intel® Xeon® E5-2650 v3

2.8x the database performance

4.8x the simulated file and print performance

41% lower power requirement

30.2% lower 5-year TCO

*In our tests on simultaneous workloads versus a legacy environment

Businesses using outdated servers for email, database, and file and print workloads stand to benefit greatly by replacing them. The Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 blade servers, both powered by the Intel Xeon processor E5-2650 v3, can provide the performance, scalability, and high availability your business needs to keep running and meet increased demand.

In the Principled Technologies labs, we simultaneously ran email, database, and simulated file and print workloads in a VMware® vSphere® ESXi™ virtual environment on the PowerEdge VRTX with two PowerEdge M630 server nodes configured in a high-availability (HA) cluster. The VRTX performed more simultaneous work while requiring less space and power, and provided a lower five-year TCO when compared with a legacy disparate hardware solution.[1] Combining servers, networking, and shared storage into an all-in-one solution, the PowerEdge VRTX can deliver big performance and savings.

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[1] In June 2013, Principled Technologies conducted testing comparing the performance of (1) the Dell PowerEdge VRTX with Dell PowerEdge M620 server nodes and (2) a legacy hardware solution. The results for the legacy solution that we cite in this report are from that earlier study. For more details, see the report for that study, available at www.principledtechnologies.com/Dell/VRTX_performance_TCO_0713.pdf.

GET BETTER PERFORMANCE WHILE USING LESS POWER

We compared performance, power consumption, space, and cost of running typical office applications (email, database, and file/print server) on the following solutions:

- **A Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes powered by the Intel Xeon processor E5-2650 v3**, running VMware vSphere 5.5 in a high-availability (HA) cluster configuration with four Microsoft® Windows Server® 2012 R2 virtual machines (VMs) – one running SQL Server® 2014, two running Exchange Server 2013, and one acting as a file/print server.
- **A legacy disparate hardware solution** consisting of three older HP tower servers, a NETGEAR® switch, and an HP storage appliance. The legacy tower servers ran bare metal instances of Windows Server 2012 with one running SQL Server 2012, one running Exchange Server 2010, and one running as a dedicated file/print server.

We ran three benchmarks simultaneously to stress the email, database, and file and print applications all at once. The performance of the legacy hardware solution we discuss in this report is from a June 2013 Principled Technologies study (available at www.principledtechnologies.com/Dell/VRTX_performance_TCO_0713.pdf).

When configuring the workloads for this study, we began by running workloads identical to the ones in the previous study, and found that the PowerEdge VRTX had an enormous amount of unused hardware capacity.

We then increased the load of each benchmark on the VRTX solution to reflect the business growth that would occur in a typical company over three years. Note that we did not increase the loads to a level that would push the VRTX to its limits. Rather, we attempted to represent realistic gradual growth a company would observe. Under the increased workload, the CPU utilization of the VRTX remained at levels that would allow for even greater workloads as the company experienced further growth in the future.

We also measured the power consumption of the PowerEdge VRTX and the legacy solution while idle and during the simultaneous workloads. For detailed configuration information about the solutions we tested, see Appendix A. For testing details, including the increased workload parameters we used, see Appendix B. For detailed test results, see Appendix C.

Comparing performance and cost: Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes vs. a legacy solution

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Dell EMC PowerEdge VRTX with the Intel Xeon processor E5-2650 v3 optimized application performance while reducing power consumption and providing headroom for future growth

Database performance

As Figure 1 shows, during our test running three workloads at the same time, the Dell EMC PowerEdge VRTX with two Intel Xeon processor E5-2650 v3-powered Dell EMC PowerEdge M630 server nodes achieved 2.9 times the database performance of the legacy disparate hardware solution. This means the VRTX solution would be able to produce at least 2.9 times as many database orders per minute. To simulate growth in the overall business and number of employees, we decreased the think time of our database benchmark on the M630s from the 300 milliseconds we ran on the legacy solution to 100 milliseconds; this shorter think time represents more activity and stress on the database.
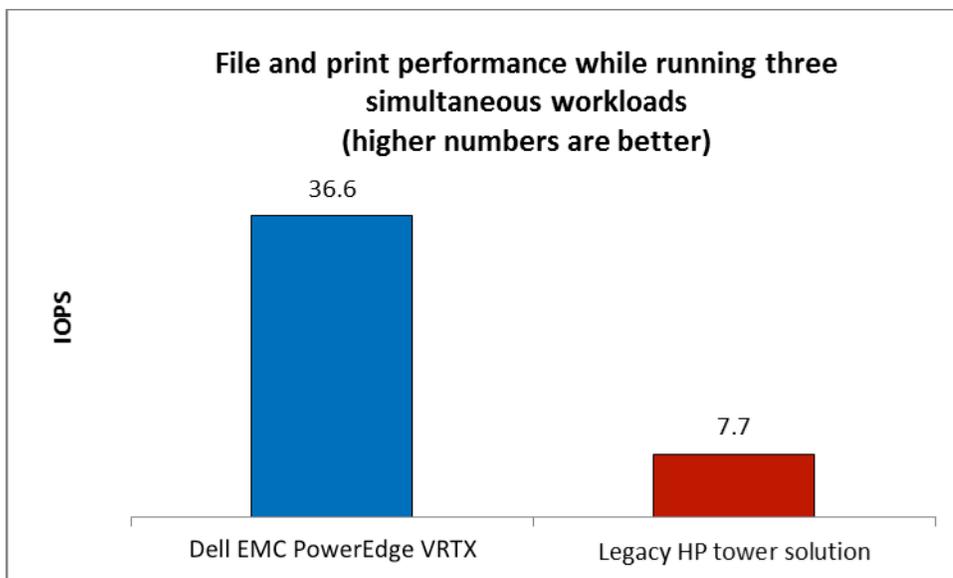
Figure 1: While running simultaneous email, database, and file and print workloads, the Dell EMC PowerEdge VRTX with two Intel processor-powered M630 server nodes supported more database workload than the legacy disparate hardware solution.

Database performance while running three simultaneous workloads
(higher numbers are better)
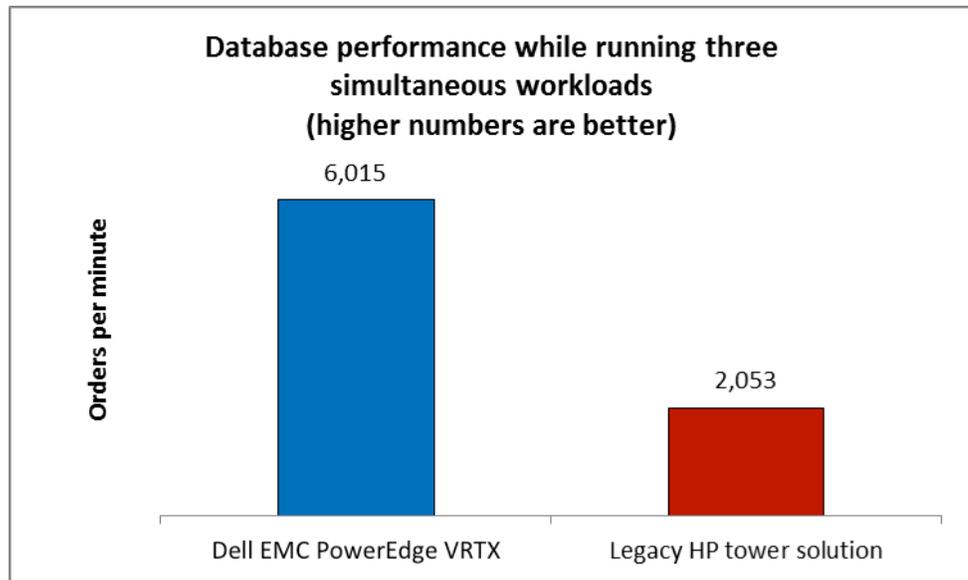
File and print performance

As Figure 2 shows, during our test running three workloads at the same time, the PowerEdge VRTX with two Intel Xeon processor E5-2650 v3-powered Dell EMC PowerEdge M630 server nodes achieved 4.8 times the simulated file and print performance of the legacy disparate hardware solution. Again, to show the impact of business growth, we increased the number of workers in our benchmark tool on the M630s to represent more simulated users accessing file and print capabilities.

Comparing performance and cost: Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes vs. a legacy solution

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Figure 2: While running
simultaneous email,
database, and file and print
workloads, the Dell EMC
PowerEdge VRTX with two
Intel processor-powered
M630 server nodes
supported more file and
print workload than the
legacy disparate hardware
solution.

File and print performance while running three simultaneous workloads (higher numbers are better)

36.6

7.7

IOPS

Dell EMC PowerEdge VRTX   Legacy HP tower solution

Exchange performance

Along with growing the workloads to compensate for business growth since the legacy systems testing, we upgraded from Exchange 2010 to Exchange 2013 and from Microsoft Load Generator 2010 to LoadGen 2013. We also increased the number of Exchange users from 500 to 750. Figure 3 shows our findings.

	Number of users supported	Latency in milliseconds
Dell EMC PowerEdge VRTX	750	1.8
Legacy disparate hardware solution	500	1.5

Figure 3: The Dell EMC PowerEdge VRTX reduced cabling complexity compared to the legacy disparate hardware solution.

While we can't directly compare the results from these two test scenarios due to the differences between the two versions of Exchange, we can look at the number of users and the latency, or response time, in milliseconds to learn about their relative performance. We found that latencies remained roughly even on the newer solution even with the increased number of users, and well within the average latency threshold of 50 milliseconds that Microsoft sets. This means that the VTRX solution can support one-and-a-half times as many email users while staying within an acceptable response time.

Power consumption

The compact Intel Xeon processor E5-2650 v3-powered Dell EMC PowerEdge M630 with Dell EMC PowerEdge VRTX not only supported more work than the legacy tower solution, it also used significantly less power while under heavier load thanks to Dell EMC's performance-per-watt system power management policy. As Figure 4 shows,

the M630 server nodes with VRTX used 41.5 percent less power while running our three simultaneous workloads than the legacy disparate hardware solution did. This reduced consumption can translate directly to savings.

Power consumption (lower is better)

Watts

Dell EMC PowerEdge VRTX: 396.8

Legacy HP tower solution: 678.7
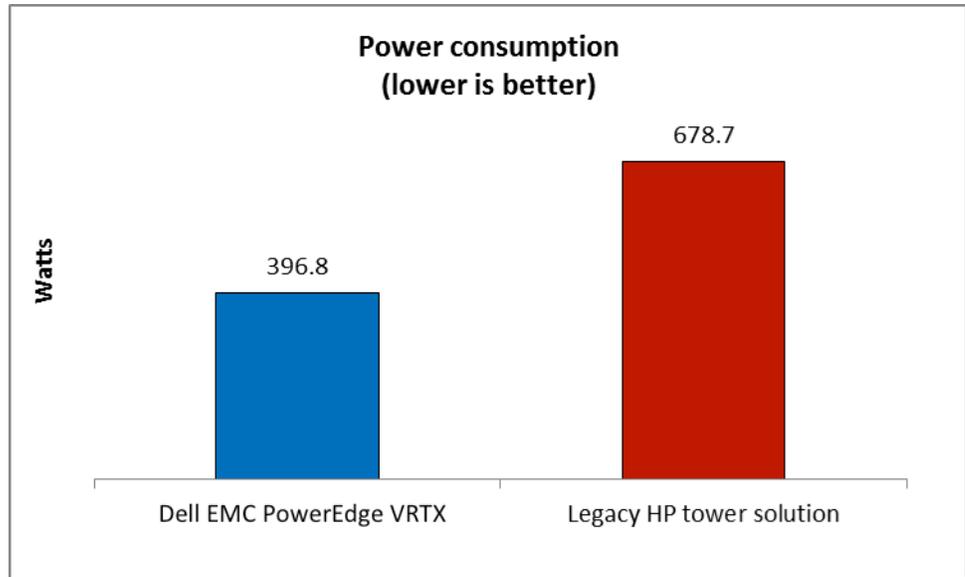
In our tests, we used a Dell EMC PowerEdge VRTX with only two servers compared to the three physical servers in the legacy hardware solution. Adding server nodes and more or faster drives to the shared storage may achieve greater performance gains, though the current configuration still had plenty of room for growth. Additionally, adding new application VMs to your VMware vSphere environment may give the Intel Xeon processor E5-2650 v3-powered VRTX solution scalability and room to grow as the demands of your business continue to increase. With a legacy disparate hardware solution, achieving similar results may require purchasing additional servers that take up more space and consume more power.

Reduced space and physical complexity

In addition to the extra space that legacy disparate hardware solutions encompass, they often have a great deal of complexity when it comes to hardware pieces and cabling. If your business' location has premium square footage value, accommodating your legacy solution can mean sacrificing precious space. The Dell EMC PowerEdge VRTX is a compact all-in-one-solution that fits easily under a desk and uses minimal cabling because the solution resides in one chassis.

Though the solution is unlikely to be in a server rack in a small or remote office, we looked at the rack-equivalent space each solution would occupy to make a universal size comparison. We found that the VRTX solution would fit into just 5U of rack-equivalent space – a 70.6 percent reduction in the space that the legacy solution would take up (a massive 17U).

Comparing performance and cost: Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes vs. a legacy solution

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For each U of rack-equivalent space, the Dell EMC PowerEdge VRTX with two Intel Xeon processor E5-2650 v3-powered Dell EMC PowerEdge M630 server nodes delivered a whopping 10 times the database performance, in orders per minute, than the legacy disparate hardware solution (see Figure 5).

Figure 5: The compact form factor of the Dell EMC PowerEdge VRTX means that, with two Intel processor-powered M630 server nodes, it packs more performance into less space than the legacy disparate hardware solution.
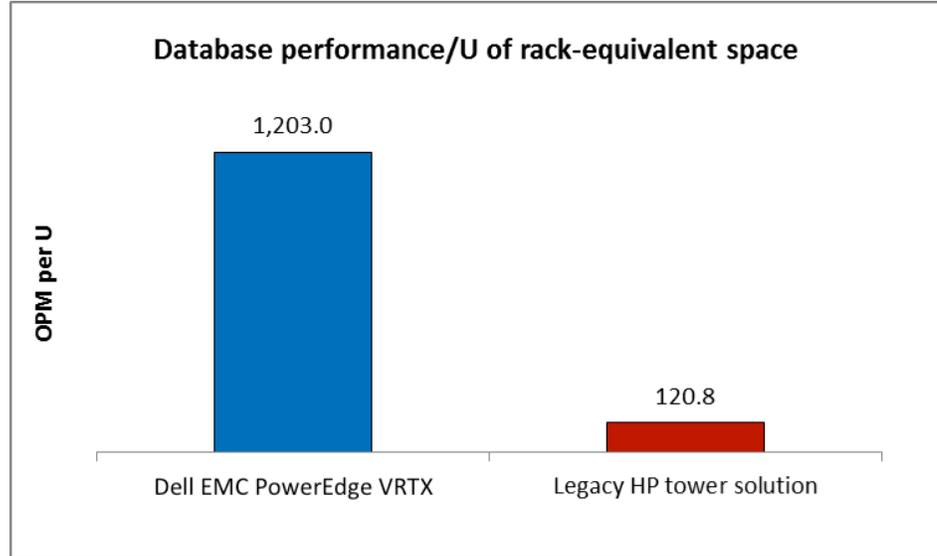
As Figure 6 shows, regardless of the server node configuration, the VRTX solution powered by the Intel Xeon processor E5 v3 family also used only 6 cables, 13 fewer than the legacy disparate hardware solution.

Dell EMC PowerEdge VRTX		
	Ethernet cables	**Power cables**
Total by type	2	4
Total cables		**6**
Legacy disparate hardware solution		
	Ethernet cables	**Power cables**
HP ProLiant ML310 G5	2	1
HP ProLiant ML370 G5	2	1
HP ProLiant ML110 G6	2	1
NETGEAR ProSAFE® Smart Switch	1	1
Storage	6	2
Total by type	13	6
Total cables		**19**

Figure 6: The Dell EMC PowerEdge VRTX reduced cabling complexity compared to the legacy disparate hardware solution.

Comparing performance and cost: Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes vs. a legacy solution

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Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes offered more performance per TCO dollar, lower five-year TCO, and a rapid ROI

While choosing to keep a legacy disparate hardware solution might seem convenient and cost-effective, we found that purchasing and running the Dell EMC PowerEdge VRTX with two Intel Xeon processor E5-2600 v3-powered Dell EMC PowerEdge M630 server nodes could deliver as much as a 30.2 percent lower five-year total cost of ownership (TCO) than continuing to use the legacy solution (see Figure 7).
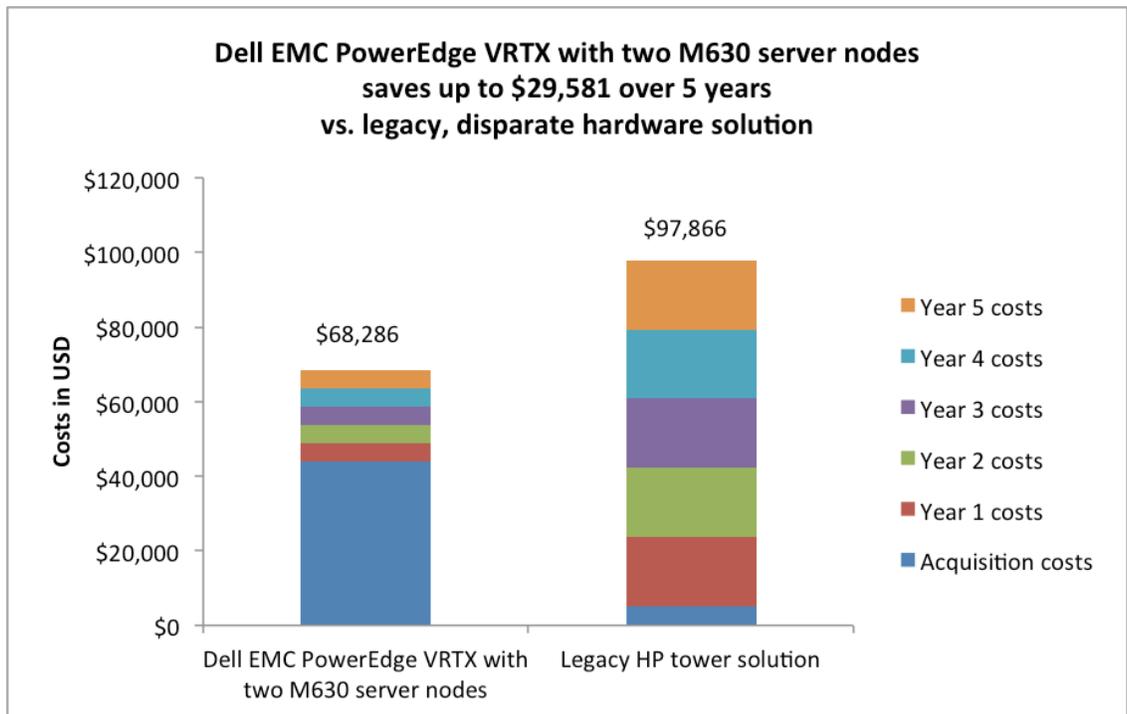
Figure 7: The Dell EMC PowerEdge VRTX with two M630 server nodes could deliver a 30.2 percent lower TCO over five years than continuing to use the legacy disparate hardware solution.

Savings in licensing, management, and support offset the larger acquisition costs of the PowerEdge VRTX with two Intel Xeon processor E5-2600 v3-powered M630 server nodes. After five years, the VRTX solution is $29,581 less expensive, saving 30.2 percent (see Figure 8).

	Dell EMC PowerEdge VRTX with two M630 server nodes	Legacy disparate hardware solution
Acquisition cost	$44,000	$5,102
Year 1 costs	$4,857	$18,553
Year 2 costs	$4,857	$18,553
Year 3 costs	$4,857	$18,553
Year 4 costs	$4,857	$18,553
Year 5 costs	$4,857	$18,553
Total	**$68,286**	**$97,866**

Figure 8: The Dell EMC PowerEdge VRTX with two M630 server nodes costs up to $29,581 less than the legacy solution after five years. (Totals may not sum due to rounding.)

Comparing performance and cost: Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes vs. a legacy solution

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With the PowerEdge VRTX with two Intel Xeon processor E5-2600 v3-powered M630 server nodes, we found that a business could achieve payback, or a return on investment (ROI), in as little as 35 months (see Figures 9 and 10).

Figure 9: The Dell EMC PowerEdge VRTX with two Intel processor-powered M630 server nodes can deliver payback in as little as 35 months.


Payback in 35 months for Dell EMC PowerEdge VRTX with two M630 server nodes vs. legacy, disparate hardware solution
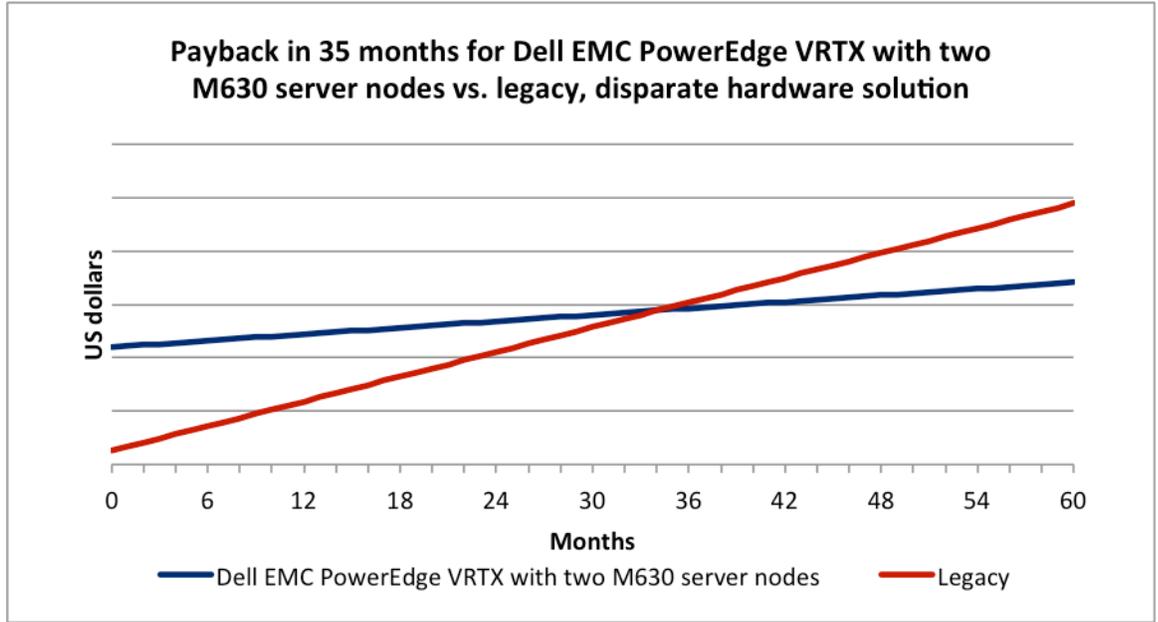
Payback category	Dell EMC PowerEdge VRTX with two M630 server nodes	Legacy disparate hardware solution	Difference
One-time initial investment	$44,000	$5,102	$38,898
Monthly cost	$405	$1,546	$1,141
Payback period			$38,898 ÷ $1,141 = **35 months**

Figure 10: The Dell EMC PowerEdge VRTX with two M630 server nodes can pay back your investment in 35 months, so by the 35th month, the return of investment is complete.

Using the calculations from our TCO analysis, we found that the PowerEdge VRTX with two Intel Xeon processor E5-2600 v3-powered PowerEdge M630 server nodes delivered 4.2 times as many database orders per minute per TCO dollar spent (see Figure 11).

Comparing performance and cost: Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes vs. a legacy solution

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Database performance/TCO dollar

0.09 — Dell EMC PowerEdge VRTX with two M630 server nodes

0.02 — Legacy HP tower solution

OPM per TCO dollar (higher is better)

Figure 11: The Dell EMC PowerEdge VRTX with two Intel processor-powered M630 server nodes delivered 4.2 times as many OPM per TCO dollar. Higher numbers are better.
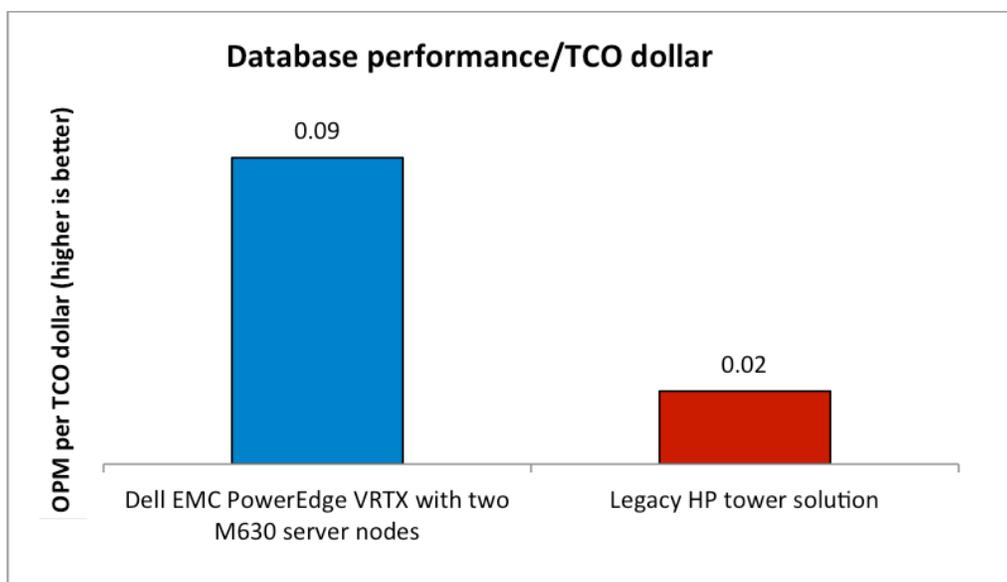
For complete details and assumptions of our TCO analysis, see Appendix D.

ALL-IN-ONE MODULAR INFRASTRUCTURE

The Dell EMC PowerEdge VRTX solution with M-series server nodes is an all-in-one solution designed to handle the performance needs of a small-to-medium business or remote office. Here, we provide information about each of the components we used as part of this solution.

About the Dell EMC PowerEdge VRTX

Dell EMC PowerEdge VRTX with 12 3.5-inch drives

Dell EMC PowerEdge VRTX with 25 2.5-inch drives

The Dell EMC PowerEdge VRTX is a compact, all-in-one solution in a 5U rack-able tower chassis. Designed to be quiet under normal operating conditions, the PowerEdge VRTX can be stowed under a desk in a small office without disrupting conversations. The four bays in the VRTX house a variety of different compute nodes, providing a space-saving alternative to four separate tower or rack servers. VRTX fans and blowers, based on Dell EMC Energy Smart Technologies, deliver low power consumption and use next-generation technologies to ensure they consume the least possible amount of fresh air to cool the enclosure.

In addition to accommodating office space, acoustics, thermal, and power considerations, the VRTX provides administrators with a unified interface, the Chassis Management Controller, for performing routine systems management tasks. Administrators can manage the VRTX locally or remotely from a centralized datacenter.

The VRTX chassis supports up to 120 TB of shared internal storage that is presentable as virtual drives to single or multiple compute nodes, and provides optional pass-through and eight PCIe® slots for additional device connectivity. The chassis-integrated storage can be configured with 25 bays for 2.5-inch drives, which we tested in this report, or with 12 bays for 3.5-inch drives. The VRTX integrated switch, which is

Comparing performance and cost: Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes vs. a legacy solution

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available as a 1GB or 10GB switch, contains multiple external network ports for easy expansion or integration into any computing environment. The VRTX is virtualization-ready and can enable a virtual desktop infrastructure for general-purpose computing in remote and branch offices.

For more information about the Dell EMC PowerEdge VRTX, visit http://www.dell.com/en-us/work/learn/modular-infrastructure.

About the Dell EMC PowerEdge M630 server nodes

According to Dell EMC, the PowerEdge M630 blade server "offers flexibility to optimize in-server storage and IO performance, allowing you to tailor your servers to your workloads today and adapt as your needs change over time."

The optional 12Gb PowerEdge RAID Controller (PERC) doubles the throughput and cache of previous generations and can dramatically boost IO for applications. The M630 supports up to four 1.8-inch SSDs or up to two 2.5-inch HDDs or Express Flash PCIe SSDs. Dell EMC Select Network Adapters offer quick access to the storage resources your server or cloud requires, via either NAS or SAN.

For more information about the Dell EMC PowerEdge M630 blade server, visit www.dell.com/us/business/p/poweredge-m630/pd.

About the Intel Xeon processor E5-2600 v3 product family

According to Intel, the Intel Xeon processor E5-2600 v3 product family "helps IT address the growing demands placed on infrastructure, from supporting business growth to enabling new services faster, delivering new applications in the enterprise, technical computing, communications, storage, and cloud." It also delivers benefits in performance, power efficiency, virtualization, and security.

The E5-2600 v3 product family has up to 50 percent more cores and cache than processors from the previous generation. Other features include the following:

- Intel Advanced Vector Extensions 2 (AVX2)
- Intel Quick Path Interconnect link
- Up to 18 cores and 36 threads per socket
- Up to 45 MB of last-level cache
- Next-generation DDR4 memory support
- Intel Integrated I/O providing up to 80 PCIe lanes per two-socket server
- Intel AES-NI data encryption/decryption

The Intel Xeon processor E5-2600 v3 product family also uses Intel Intelligent Power technology and Per-core P states to maximize energy efficiency.

Learn more at www.intel.com/content/www/us/en/processors/xeon/xeon-e5-brief.html.

WHAT WE TESTED

Database testing

To create our real-world ecommerce workload, we used the DVD Store Version 2.1 benchmarking tool. DS2 models an online DVD store, where customers log in, search for movies, and make purchases. DS2 reports these actions in orders per minute that the system could handle, to show what kind of performance customers could expect. The DS2 workload also performs other actions, such as adding new customers, to exercise the wide range of database functions you would need to run your ecommerce environment. For more details about the DS2 tool, see www.delltechcenter.com/page/DVD+Store.

File and print testing

To test the file and print capabilities of the solutions, we simulated workloads using the Iometer benchmark. Iometer measures IOPS on single and clustered systems. Iometer performs I/O operations to stress a system, and then records the performance of these I/O operations and the system stress they create. We used Iometer version 1.1 on each solution to simulate the same file and print workloads on the solutions. For more details about Iometer, see www.iometer.org.

Mail testing

To test the solutions' mail server performance, we used the Microsoft Load Generator 2013 (LoadGen) benchmark, performing tasks to simulate a heavy user generating mail activity. For our workloads, we used the following settings:

- Number of users: 750
- Mailbox Profile: 250MB
- Action Profile: Outlook_200

For more details about LoadGen, see www.microsoft.com/downloads/details.aspx?FamilyId=DDEC1642-F6E3-4D66-A82F-8D3062C6FA98&displaylang=en.

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IN CONCLUSION

Keeping a legacy disparate hardware solution instead of choosing the Dell EMC PowerEdge VRTX powered by the Intel Xeon processor E5-2600 v3 family may cost more than one would expect. We found that the VRTX with two Intel Xeon processor E5-2650 v3-powered Dell EMC PowerEdge M630 server nodes supported a heavier workload than a legacy disparate hardware solution across email, database, and file/print server simultaneous workloads while reducing power consumption by 41.5 percent.

The PowerEdge VRTX achieved these savings using 70.6 percent less rack-equivalent space than the legacy disparate hardware solution and with one-third as many cables, to reduce complexity and reduce the burden of space in small offices.

Finally, despite a larger initial investment, the PowerEdge VRTX with two Intel Xeon processor E5-2600 v3-powered PowerEdge M630 server nodes could actually lower the total cost of ownership over years as much as 30.2 percent, delivering a solid return on investment in less than three years.

As our test results show, investing in the Dell EMC PowerEdge VRTX solution powered by the Intel Xeon processor E5 v3 family could provide a compact solution to optimize application performance and reduce complexity at a lower lifetime cost than a legacy solution.

APPENDIX A – SYSTEM CONFIGURATION INFORMATION

In September 2016, Dell EMC rebranded the Dell PowerEdge VRTX and Dell PowerEdge M630 as the Dell EMC PowerEdge VRTX and Dell EMC PowerEdge M630. We completed our testing prior to that rebranding.

Figures 12 and 13 provide detailed configuration information for the test systems.

System	Dell PowerEdge VRTX solution
Enclosure	
Compute node enclosure	Dell PowerEdge VRTX
General dimensions of compute node enclosure	
Height (inches)	8
Width (inches)	19
Depth (inches)	29.5
U size in server rack equivalent (U)	5
Power supplies	
Total number	4
Vendor and model number	Dell 80 Plus Platinum E1100E-S0 (P/N 0YT39Y)
Wattage of each (W)	1,100
Cooling fans	
Total number	6
Vendor and model number	Delta Electronics, Inc.
Dimensions (h × w) of each	60 mm × 60 mm
Volts	12
Chassis RAID controller	
Vendor and model number	Dell SPERC8
Firmware version	23.11.46-0079
Cache size (GB)	1
Chassis shared hard drives	
Hard drive #1	
Vendor and model number	Dell ST300MM0006
Number of drives	10
Size (GB)	300
RPM	10k
Type	SAS 6.0 Gbps
Hard drive #2	
Vendor and model number	Dell C06VX
Number of drives	2
Size (TB)	400
RPM	SSD
Type	SAS 12.0 Gbps
Chassis USB ports	
Number	2
Type	2.0
Platform	
Vendor and model number	Dell PowerEdge M630

Comparing performance and cost: Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes vs. a legacy solution

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System	Dell PowerEdge VRTX solution
Motherboard model number	0JXJPT
Motherboard chipset	Intel C600
BIOS name and version	Dell BIOS 1.1.8
BIOS settings	Default
General	
Number of processor packages	2
Number of cores per processor	10
Number of hardware threads per core	2
System power management policy	Performance/watt
CPU	
Vendor	Intel
Name	Xeon E5-2650 v3
Stepping	M0
Socket type	Socket 2011-3 LGA
Core frequency (GHz)	2.30
L1 cache	32 KB (per core)
L2 cache	256 KB (per core)
L3 cache	25 MB (shared)
Memory modules (per node)	
Total RAM in system (GB)	64
Vendor and model number	Hynix Semiconductor M393A1G43DB0-CPB
Type	PC4-2133P
Speed (MHz)	2,133
Speed in the system currently running @ (MHz)	2,133
Timing/latency (tCL-tRCD-iRP-tRASmin)	13-13-13-33
Size (GB)	8
Number of RAM modules	8
Chip organization	Double-sided
Rank	Dual
RAID controller	
Vendor and model number	Dell PERC H730 Mini
Firmware version	25.2.1.0037
Cache size (GB)	1024 MB
Network adapter	
Vendor and model number	Broadcom® NetXtreme® II 10 Gb Ethernet BCM57810s
Type	Integrated
Number of Network Adapters	1
USB ports (per node)	
Number	2
Type	3.0

Figure 12: Detailed configuration information for the Dell PowerEdge VRTX solution.

Comparing performance and cost: Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes vs. a legacy solution

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Server	HP ProLiant ML110 G6	HP ProLiant ML310 G5	HP ProLiant ML370 G5
General dimensions of server			
Height (inches)	14.4	17.0	17.5
Width (inches)	6.9	7.9	8.6
Depth (inches)	16.8	24.0	28.5
U size in server rack equivalent (U)	4	5	5
Power supplies			
Total number	1	1	1
Vendor and model number	Delta Electronics® DPS300AB	Delta Electronics DPS-410DB	HP Switching Power Supply DPS-800GB A
Wattage of each (W)	300	410	850
Cooling fans			
Total number	1	1	3
Vendor and model number	HP 576930-001	HP 459188-001	Nidec Beta V35633-94
Dimensions (h × w) of each	92 mm × 25 mm	120 mm × 25 mm	130 mm × 125 mm
Volts	12	12	12
General			
Motherboard model number	576924-001	A61TR1	434719-001
Motherboard chipset	Intel 3400 Chipset	Intel 3210 Chipset	Intel C600
BIOS name and version	HP System BIOS - 0270126_TAN	ProLiant System BIOS - W05	ProLiant System BIOS P57
BIOS settings	Performance	Performance	Performance
Number of processor packages	1	1	2
Number of cores per processor	4	4	4
Number of hardware threads per core	2	1	1
System power management policy	Static High Performance	Static High Performance	Static High Performance
CPU			
Vendor	Intel	Intel	Intel
Name	Xeon X3460	Xeon X3370	Xeon E5450
Stepping	B1	E0	E0
Socket type	LGA 1156	LGA 775	LGA 771
Core frequency (GHz)	2.80	3.00	3.00
L1 cache	32 KB (per core)	32 KB (per core)	32 KB (per core)
L2 cache	256 KB (per core)	12 MB (shared)	12 MB (shared)
L3 cache (MB)	8	N/A	N/A
Memory modules			
Total RAM in system (GB)	4	4	8
Vendor and model number	Samsung® M391B5673EH1-CH9	Micron® MT18HTF25672AY-800E1	Samsung M395T5160QZ4

Comparing performance and cost: Dell EMC PowerEdge VRTX with two Dell EMC PowerEdge M630 server nodes vs. a legacy solution

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Server	HP ProLiant ML110 G6	HP ProLiant ML310 G5	HP ProLiant ML370 G5
Type	PC3-10600E DDR3	PC2-6400E DDR2	DDR2-5300F
Speed (MHz)	1,333	800	666
Speed in the system currently running @ (MHz)	1,333	800	666
Timing/latency (tCL-tRCD-iRP-tRASmin)	9-9-9-24	6-6-6-18	5-5-5-15
Size (GB)	2	2	4
Number of RAM modules	4	2	8
Chip organization	Double-Sided	Double-sided	Double-sided
RAID controller			
Vendor and model number	HP Smart Array B110i	HP Smart Array E200	HP Smart Array P400
Cache size (MB)	N/A	128	256
Hard drive #1			
Vendor and model number	Hitachi® HDS721032CLA362	HP DF0792A9844	HP EG0146FAWHU
Number of drives	1	2	2
Size (GB)	320	72	146
RPM	7.2K	15K	10K
Type	SATA	SAS	SAS
Hard drive #2			
Vendor and model number	N/A	ST500NM001	N/A
Number of drives	N/A	2	N/A
Size (GB)	N/A	500	N/A
RPM	N/A	7.2	N/A
Type	N/A	SAS	N/A
Network adapter			
Vendor and model number	Intel Pro/1000 PT Dual Port Server Adapter	Intel Pro/1000 PT Server Adapter	Intel Pro/1000 PT Dual Port Server Adapter
Type	PCIe	PCIe	PCIe
Number of ports	2	1	2
Network adapter 2			
Vendor and model number	HP NC 107i PCIe Gigabit	Intel Pro/1000 PT Server Adapter	N/A
Type	Integrated	PCIe	N/A
Number of ports	1	1	N/A
USB ports (per node)			
Number	6	2	4
Type	2.0	2.0	2.0

Figure 13: Detailed configuration information for the towers in the legacy hardware solution.

APPENDIX B – HOW WE TESTED

Our test scenario used two clustered PowerEdge M630s and a PowerEdge R710, which we used for our infrastructure server and to host client VMs. Figure 14 presents the virtual machines in our test environment.

VM name	vCPUs	Memory	Host for PowerEdge M630 tests	OS	OS drive	Additional drive
ExchangeCAS	8 sockets, each w/ 1 core	16 GB	M630 A	Windows Server 2012 R2 Standard	100 GB stored on VRTX HDDs	None
ExchangeMB	8 sockets, each w/ 1 core	16 GB	M630 A	Windows Server 2012 R2 Standard	100 GB stored on VRTX HDDs	750 GB, Thick Provisioned Eager Zeroed, Stored on VRTX HDDS
Iometer	4 sockets, each w/ 1 core	8 GB	M630 B	Windows Server 2012 R2 Standard	100 GB stored on VRTX HDDs	50 GB, Thick Provisioned Eager Zeroed, Stored on VRTX SSDs
SQL	8 sockets, each w/ 1 core	8 GB	M630 B	Windows Server 2012 R2 Standard	100 GB stored on VRTX HDDs	100 GB, Thick Provisioned Eager Zeroed, Stored on VRTX SSDs
DVD Store client	1 socket w/ 4 cores	8 GB	R710	Windows Server 2012 R2 Standard	100 GB stored on R710 HDDs	None
Exchange AD/DNS	1 socket w/ 1 core	8 GB	R710	Windows Server 2012 R2 Standard	100 GB stored on R710 HDDs	None
LoadGen client	1 socket w/ 4 cores	8 GB	R710	Windows Server 2008 R2 Enterprise	100 GB stored on R710 HDDs	None
NAT	1 socket w/ 4 cores	8 GB	R710	Windows Server 2012 R2 Standard	100 GB stored on R710 HDDs	None
VMware vCenter Server	2 sockets, each w/ 1 core	8 GB	R710	VMware vCenter Server Appliance 5.5	25 GB stored on R710 HDDs	100 GB, Thin Provisioned, Stored on the R710 disks

Figure 14: The virtual machines in our test environment.

We also followed the following guidelines:

1. All OS drives were thin provisioned.
2. All VMs hosted on the blade servers were stored on the VRTX storage.
3. All VMs hosted by the infrastructure server were stored on the infrastructure's drives.
4. On all servers, we installed all Windows updates available up to 05/15/2015.

In addition to its first drive, ExchangeMB had a 100 GB, Thick Provisioned Eager Zeroed drive stored on the OS storage volume used for storing backups.

Installing and configuring the infrastructure server

We configured a Dell PowerEdge R710 server with VMware vSphere (ESXi) 5.5.0 with Dell Drivers to host the Active Directory® VMs and the VMware vCenter VM.

Installing VMware vSphere 5.5 with Dell Drivers (ESXi) on the Dell PowerEdge R710

1. Insert the ESXi 5.5 disk, and select Boot from disk.
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 relevant volume to install ESXi 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 the password by entering it again. Press Enter to continue.
7. On the Confirm Install Screen, press F11 to install.
8. On the Installation complete screen, press Enter to reboot.

Configuring ESXi after installation

1. On the ESXi 5.5 screen, press F2, enter the root password, and press Enter.
2. On the System Customization screen, select Troubleshooting Options, and press Enter.
3. On the Troubleshooting Mode Options screen, select enable ESXi Shell, and press Enter.
4. Select Enable SSH, press Enter, and press Esc.
5. On the System Customization screen, select Configure Management Network.
6. On the Configure Management Network screen, select IPv4 Configuration.
7. On the IPv4 Configuration screen, select Set static IP; enter an IP address, subnet mask, and default gateway; and press Enter.
8. On the Configure Management Network screen, press Esc. When the installer asks if you want to apply the changes, press Y.
9. Log in as `root` with the vSphere client.
10. Select the Configuration tab, and click Networking.
11. Click Add Networking…
12. Create a virtual machine network called `PRIV-NET`, and select the adapter with access to the private test network.
13. Click OK.
14. Select the Configuration tab, and click DNS and routing.
15. Type a name, and select test.local for domain.

Setting up two VMs to host the Microsoft Windows® Active Directory server and the NAT server

1. In your web browser, connect to the vSphere server, and browse to the ESXi host hosting the management VMs (in our case, the PowerEdge R710).
2. Right-click the ESXi host, and choose New Virtual Machine.
3. On the Create New Virtual Machine window, select custom, and click Next.

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4. Assign a name to the virtual machine, and click Next.

5. Select the LUN for the storage, and click Next.

6. Select Virtual Machine Version 11, and click Next.

7. Choose Windows, select Microsoft Windows Server 2012, and click Next.

8. Choose the VM's virtual hardware options, and click Next (see each VM's section below for additional VM configuration data).

    •   Select one virtual processor socket, and one core per virtual socket.

    •   Select 4GB RAM.

    •   Select the NIC interface with access to the private test network.

    •   Leave the default option for SCSI controller.

9. Choose to create a new virtual disk, and click Next.

10. Make the OS virtual disk size 100 GB, choose thin provisioned, specify external storage, and click Next.

11. Keep the default virtual device node (0:0), and click Next.

12. Click Finish.

13. Right-click the VM, and select Edit Settings.

14. Click the Resources tab, and click Memory.

15. Select Reserve all guest memory, and click OK.

16. Connect the VM virtual CD-ROM to the Microsoft Windows Server 2012 R2 installation disk.

17. Start the VM.

Installing Microsoft Windows Server 2012 R2 Standard Edition

1. Connect the installation media and power on the VM.

2. When the option appears, press F11 to enter the Boot Manager.

3. Select the connected boot media, and press Enter.

4. Press any key when prompted to boot from DVD.

5. When the installation screen appears, click My language is English.

6. Leave language, time/currency format and input method as default, and click Next.

7. Click Install now.

8. When the Windows Setup window appears, click No thanks when prompted to go online to install updates.

9. Select Windows Server 2012 R2 Standard (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. Press Alt+A to open advanced partition options. Delete any partitions until there is only Drive 0 Unallocated Space.

13. Select Drive 0 Unallocated Space, and click Next, at which point Windows will begin installing, and will restart automatically after completing.

14. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.

15. Log in with the previously set up password.

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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 then click OK.
5. In the left pane, click Check for updates, and install all available updates.
6. Close the Windows Update window.

Configuring Windows Firewall

1. In Server Manager, click Tools→Windows Firewall with Advanced Security.
2. In the Overview section, click Windows Firewall Properties.
3. In the Domain Profile tab, for Firewall state, click Off.
4. In the Private Profile tab, for Firewall state, click Off.
5. In the Public Profile tab, for Firewall state, click Off.
6. Click OK.
7. Close the Windows Firewall Properties window.

Setting up Remote Desktop

1. In the Local Server tab of the Server Manager window, next to Remote Desktop, click Disabled.
2. In the System Properties window that appears, in the Remote Desktop section, select the Allow remote connections to this computer radio button, and click OK when the warning message appears.
3. Uncheck Allow connections only from computers running Remote Desktop with Network Level Authentication (recommended), and click OK.

Disabling IE Enhanced Security Configuration

1. In the Local Server tab of the Server Manager window, next to IE Enhanced Security Configuration, click On.
2. In the Internet Explorer Enhanced Security Configuration window, select the Off radio buttons for both Administrators and Users, and click OK.

Installing VMware Tools

1. Install VMware Tools. For more information, see
   kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=340.

Repeat the virtual machine, OS installation, and OS configuration described above to create a VM for the NAT server.

Installing Active Directory and DNS services

1. Power on the Active Directory VM.
2. On the Active Directory server, open Windows PowerShell®.
3. Run the following command: Install-WindowsFeature RSAT-ADDS
4. When the installation is finished, close PowerShell.
5. On the VM, open Server Manager.
6. On the Welcome screen, click 2, and click Add roles and features.
7. At the initial Before you begin screen, click Next three times.

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8. At the Server Roles screen, select Active Directory Domain Services.

9. On the pop-up window, click Add Features.

10. Click Next three times.

11. Verify the desired role is being installed, and click Install.

12. Once installation has finished, close the Add roles and features wizard.

13. In Server Manager, click the flag at the top, and select the Promote this server to a domain controller link.

14. Select Add a new forest, enter a root domain name of `test.local` and click Next.

15. On the Domain Controller Options screen, enter a password, and click Next.

16. On the DNS Options screen, click Next.

17. On the Additional Options screen, click Next.

18. On the Paths screen, click Next.

19. On the Review Options screen, click Next.

20. On the Prerequisites screen, verify all prerequisites have passed, and click Install.

21. Once Active Directory Domain Services finishes installing, click Finish, and restart the system.

Installing the NAT on the NAT server

Before installing the network address translation (NAT) service, you will need to plug a second network cable into the R710 server that has access to the internet and configure vSphere to make that connection available as a second NIC for the NAT VM.

1. On the NAT server, open the Add Roles and Feature Wizard.

2. On the Before you Being screen, click Next.

3. On the Installation Type screen, click Next.

4. On the Server Selection screen, click Next.

5. On the Server Roles screen, select Remote Access, and click Next.

6. On the Features screen, click Next.

7. On the Remote Access screen, click Next.

8. On the Role Services screen, select Routing, click Add Features on the popup, and click Next.

9. On The Web Server Role (IIS) screen, click Next.

10. On the Role Services screen, click Next.

11. On the Confirmation screen, click Install.

12. Once the installation is complete, click Close.

13. From Administrative Tools, open Routing and Remote Access…

14. In the left panel, right-click the target server and select Configure and Enable Routing and Remote Access.

15. In the Routing and Remote Access Server Setup Wizard, click Next.

16. On the Configuration screen, select Network Address Translation (NAT).

17. On the NAT Internet Connection screen, select the Ethernet port that will provide internet connection and click Next.

18. On the Completion screen, click Finish. When setting static IP address, the vCenter server's IP can now be used as the gateway on the isolated testing network.

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Configuring the VMware vSphere environment for the VRTX server nodes

Installing and configuring vCenter Server

1. In the vSphere client, select File, then Deploy OVF Template.
2. In the Deploy OVF Template window, click Browse, then browse to the location of the vCenter Server Appliance .ovf file, click Open, and click Next.
3. On the OVF Template Details screen, click Next.
4. In the Name and Location screen, enter `vCenter Server` for the name, and click Next.
5. In the Storage screen, select the appropriate datastore, and click Next.
6. In the Disk Format screen, select Thin Provision, and click Next.
7. In the Network Mapping screen, select the private test network.
8. In the Ready to Complete screen, check the Power on after deployment checkbox, and click Finish.
9. In the vSphere client, right-click the new vCenter, and select Open Console.
10. Note the instructions and the address to use for configuration.
11. Open a web browser to the address listed in the console.
12. Log in with `root` and the password `vmware`
13. In the vCenter Server Setup window, check the box to accept the license agreement, and click Next.
14. In the Configure Options screen, select the Configure with default settings, and click Next.
15. In the Review Configuration screen, click Start. Setup will complete, and a new database will be configured automatically. When it is finished, click Close.
16. Click the Admin Tab.
    a. In the current administrator password section, enter `vmware`
    b. Enter a new password into both password fields.

Configuring the VRTX shared storage

1. Open a web browser, and enter the address listed for the CMC IP on the front LCD display.
2. Log in with the appropriate credentials.
3. Expand Storage.
4. Click Storage.
5. Click the Setup tab.
    a. Under Assignment Mode, select the Multiple Assignment radio button, and click Apply.
    b. To confirm the Operation Successful message box, click OK.
6. Configure virtual disks:
    a. Click Storage→Virtual Disks.
    b. On the Virtual Disks tab, click Create.
        i. For Media Type, select HDD.
        ii. For Choose a virtual disk type, select RAID 10.
        iii. Select the 10 available 300 GB hard disk drives.
        iv. For the first volume (to be used for Microsoft Exchange), enter `850GB` and click Create Virtual Disk.
        v. To confirm the message box indicating Operation Successful, click OK.

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vi. Repeat steps i through iv for the next external volume (to be used for system operating systems), choosing `500GB`.

vii. For Media Type select SDD.

viii. For Choose a virtual disk type, select RAID 1.

ix. Select the two available 400 GB SSDs.

x. For the first volume (to be used for Microsoft SQL Server), enter `120GB` and click Create Virtual Disk.

xi. To confirm the message box indicating Operation Successful, click OK.

xii. Repeat steps ix through for the next external volume (to be used for Iometer), choosing `100GB`.

c. On the Virtual Disks tab, click Manage.

i. Select the Virtual Disks Action drop-down menu for Virtual Disk 0, and initialize the drives.

ii. Click Apply.

iii. To confirm the message box indicating Operation Successful, click OK.

iv. Repeat steps i through iii for the remaining virtual disks.

d. Allow shared LUN access to both compute nodes. On the Virtual Disks tab, click Assign.

i. Use the drop-down menu for all virtual disks and SLOT-01, and select Full Access.

ii. Use the drop-down menu for all virtual disks and SLOT-02, and select Full Access.

iii. Use the drop-down menu for all virtual disks and SLOT-03, and select Full Access.

iv. Use the drop-down menu for all virtual disks and SLOT-04, and select Full Access.

v. Click Apply.

vi. To confirm the Operation Successful message box, click OK.

Configuring the VMware vSphere environment for the VRTX server nodes

Configuring boot properties of the Dell PowerEdge M630 servers

1. Open a web browser, and enter the address listed for the CMC IP on the front LCD display.

2. Log in with the appropriate credentials.

3. Expand Server Overview, and select Slot-01.

4. Click the Setup Tab. Perform the following steps in the iDRAC settings:

   a. Check the Enable LAN checkbox.

   b. Check the Enable IPv4 checkbox.

   c. Check the DHCP checkbox.

   d. Check the IPMI Over LAN checkbox.

   e. Click Apply iDRAC Network Settings.

   f. To confirm changes to the iDRAC network settings, click OK.

5. Power on the server.

   a. Click the Power Tab.

   b. Select Power On Server.

   c. Click Apply.

   d. To confirm server control action, click OK.

   e. To confirm operation was successful, click OK.

6. Click the Properties tab.

7. Click Launch Remote Console.

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8. On new browser page, click Continue to website (not recommended) if prompted.
    a. If a message appears indicating a pop-up was blocked, select Always allow pop-ups from this site.
    b. Close the browser tab for the iDRAC.
    c. Click Launch Remote Console.
    d. If a message appears indicating the Web page wants to run an add-on called "Virtual Console from Dell Inc.," select Allow for all websites.
9. A new window appears showing the console for the server to configure. Select Power→Reset System.
10. Change the boot disk order in System Setup.
    a. When prompted during POST, press F2 to enter System Setup.
    b. Click System BIOS.
    c. Click Boot Settings.
    d. Click BIOS Boot Settings.
    e. Scroll down, and click Hard Disk Drive Sequence.
        i. Highlight the SD card or USB drive entry, and move it to the top using the + key.
        ii. Click OK.
    f. Click Back twice.
    g. Click Finish.
    h. Click Yes.
    i. Click Finish.
    j. Click OK. The system will restart.

Installing VMware vSphere 5.5 (ESXi) on the Dell PowerEdge M630 servers

1. Mount the ESXi 5.5 ISO via the iDRAC, and boot the M630 to that ISO.
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 an SD card or USB drive to install ESXi 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 the password by entering it again. Press Enter to continue.
7. On the Confirm Install Screen, press F11 to install.
8. On the Installation complete screen, press Enter to reboot.
9. Repeat for the additional PowerEdge M630.

Configuring VMware vSphere (ESXi) embedded on server nodes

1. Complete configuration of ESXi host:
    a. Press F2.
    b. Enter the root account password, and press Enter.
    c. Select Configure Management Network, and press Enter.
    d. Select Network Adapters.
    e. Select the adapter that connects your server to the private testing network.
    f. Press Esc.

g. To restart networking, press Y.

h. Select Troubleshooting Options.

    i. Select Enable ESXi shell, and press Enter.

    ii. Select Enable SSH, and press Enter.

    iii. Press Esc.

i. To log out, press Esc.

2. Repeat for the second PowerEdge M630.

Adding the server nodes to the vCenter Server

1. In a web browser, navigate to the vCenter IP, click Log in to vSphere Web Client, and log in using `root` and your password.

2. In the left panel, select vCenter, then Datacenters.

3. Right-click in the empty panel, and select New Datacenter.

4. In the New Datacenter window, give the Datacenter a name and click OK. We used `VRTX-01`

5. Select your test datacenter.

6. On the left panel, select Hosts, then click Add a host.

7. On the Name and Location screen, enter the IP address for the R710 client and click Next.

8. On the Connection settings screen, enter the User name and Password and click Next.

9. On the Host summary screen, click Next.

10. On the Assign license screen, click Next.

11. On the Lockdown mode screen, click Next.

12. On the VM location screen, click Next.

13. Repeat steps 7–11 for both PowerEdge M630s.

Configuring the external volumes

1. In the vSphere client, select the first host.

2. Click the Configuration tab.

3. Click Storage, and click Add Storage…

4. Choose Disk/LUN.

5. Select the disk, and click Next.

6. Accept the default of VMFS-5 for the file system.

7. Review the disk layout, and click Next.

8. Enter the datastore name, and click Next.

9. Accept the default of using maximum capacity, and click Next.

10. Click Finish.

11. Repeat for all volumes available through the Shared PERC 8 Mini.

12. Add shared storage on the second host:

    a. On the second host, click the Configuration tab.

    b. Click the Storage menu.

    c. The new storage should appear automatically. If no storage is listed, click Rescan All…

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d. Click OK to rescan all adapters. The shared storage will appear automatically with the name VRTX-shared-01 already configured.

Setting up a high-availability cluster

1. Right-click the VRTX-01 Datacenter.
2. Select New Cluster.
3. Name the cluster. For our testing, we used `VRTX-M630`
4. Check the Turn On vSphere HA checkbox, and click Next.
5. Accept all vSphere HA defaults, and click Next.
6. Accept Virtual Machine Options defaults, and click Next.
7. Accept VM Monitoring defaults, and click Next.
8. Accept VMware EVC defaults, and click Next.
9. Accept VM Swapfile Location defaults, and click Next.
10. To create the cluster, click Finish.
11. Click and drag each ESXi host into the cluster to populate it.

Creating the first VM

1. Using the vSphere client, connect to the vCenter Server.
2. Right-click the cluster, and choose New Virtual Machine.
3. On the Configuration screen, choose Custom, and click Next.
4. On the Name and Location screen, add a name, select the datacenter, and click Next.
5. On the specific Host screen, choose the first PowerEdge M630 blade and click Next.
6. On the Storage screen, select the OS datastore on the external storage, and click Next.
7. On the Virtual Machine Version screen, choose Virtual Machine Version 8, and click Next.
8. On the Guest Operating System screen, choose Windows, select Microsoft Windows Server 2012 R2 (64-bit), and click Next.
9. On the CPUs screen, choose 1 virtual socket, and 4 virtual processors per core, and click Next.
10. On the Memory screen, choose 8 GB RAM, and click Next.
11. On the Network screen, click 1 for the number of NICs, select the NIC connected to the isolated testing network, and click Next.
12. On the SCSI Controller screen, leave the default virtual storage controller, and click Next.
13. On the Select a Disk screen, choose to create a new virtual disk, and click Next.
14. On the Create a Disk screen, make the OS virtual disk size 100 GB, and choose thin provisioned.
15. On the Advanced Options screen, leave the default virtual device node (0:0), and click Next.
16. On the Ready to Complete screen, click Finish.
17. Right-click the VM, select Upgrade Virtual Hardware, and click Yes.
18. Start the VM.
19. Attach the Windows Server 2012 R2 ISO image to the VM, and install Windows Server 2012 R2 on your VM.

Installing the operating system on the VMs

Repeat the sections above regarding the initial creation of the virtual machines and installation of Windows Server 2012 R2 Standard.

Cloning the VM

1. Using the vSphere Client, right-click the first VM and select Template, then Clone to Template.
2. On the Name and Location screen, enter a Template Name.
3. On the Host / Cluster screen, select the management server.
4. On the Datastore screen, select a datastore, and click Next.
5. On the Ready to Complete screen, click Finish.

    The template created will be used to clone out the rest of the VMs.

Installing and configuring Microsoft Exchange Servers

We installed Microsoft Exchange 2013 SP3 CAS server and mailbox server on two VMs residing on the first Dell PowerEdge M630.

Configuring the Exchange 2013 VMs on the VRTX

After cloning, modify the Exchange 2013 VMs to contain the following settings:

- Memory: 16 GB
- Virtual Processors: 8
- Additional virtual disks for the mailbox server.
    - o 1 × 750GB virtual disk for mailbox storage (Thick-provisioned, eager-zeroed)
    - o 1 × 100GB virtual disk for log storage (Thick-provisioned, eager-zeroed)

After adding the drives from the vSphere client, configure additional drives in Windows using the following steps.

1. In the taskbar, click the Server Manager icon.
2. In the left pane, expand Storage, and click Disk Management.
3. Right-click the first volume, and choose Initialize Disk.
4. In the right pane, right-click the volume, and choose New Simple Volume…
5. At the welcome window, click Next.
6. At the Specify Volume Size window, leave the default selection, and click Next.
7. At the Assign Drive Letter or Path window, choose a drive letter, and click Next.
8. At the Format Partition window, choose NTFS, and click Next.
9. At the Completing the New Simple Volume Wizard window, click Finish.

Testing overview

We used the RAID 10 consisting of 300GB hard drives on the VRTX shared storage to store the Exchange mailbox. We added two virtual drives to the Exchange Mailbox: one for Exchange data and one for logs.

For our workloads, we used the following settings:

- Users: 750
- Mailbox Profile: 250MB mailboxes
- Action Profile: Outlook_200
- Client Type: Outlook 2007 Cached

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Configuring the Active Directory server

Installing the Active Directory Domain Services role

Before completing this step, you will need to apply a static IP address for the server. In our case, we used `192.168.1.10`.

1. Launch Server Manager, and select Add roles and features.
2. Click Next at the Add Roles and Features Wizard.
3. Select Role-based or feature-based installation, and click Next.
4. Select the AD server from the server pool, and click Next.
5. Select Active Directory Domain Services from the list of Roles, click the Add Features button to add features that are required by Active Directory Domain Services, and click Next.
6. Accept the defaults selected by setup at the Select Features screen, and click Next.
7. Click Next at the AD DS screen.
8. Select Restart the destination server automatically if required at the confirmation screen, and click Install.
9. Click the yellow warning triangle in the server manager window.
10. Click Promote this server to a domain controller.
11. Select Add a new forest, type in the Root domain name (`fqdn`), and click Next. For our testing, we used `test.local`
12. Type in and confirm the password, and click Next.
13. Click Next at the DNS Options screen.
14. Verify the NetBIOS name, and click Next.
15. Accept the default paths, and click Next.
16. Review the options, and click Next.
17. Verify the prerequisite check passes successfully, and click Install.

Preparing AD for Exchange

1. Create a reverse lookup zone:
   a. Click the start button, and type `DNS` in the search field.
   b. Open the DNS manager by clicking on it in the results field.
   c. Expand your Active Directory domain, and click on Reverse Lookup Zones.
   d. Click Action→New Zone.
   e. Click Next on the Welcome screen.
   f. Chose Primary Zone, and click Next.
   g. Leave default replication scope, and click Next.
   h. Choose IPv4, and click Next.
   i. Enter the IP address of your domain (`192.168.3` for our example).
   j. Choose Allow both nonsecure and secure dynamic updates, and click Next.
   k. Click Finish.

2. Insert the Exchange 2012 SP1 Installation ISO in the AD VM DVD drive.
3. In Windows Explorer, double-click the Exchange DVD icon.

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4. In the Exchange installation folder, hold down shift, and right-click.

5. Choose Open a command window here.

6. Run the following command: `Setup.exe /PrepareSchema /IAcceptExchangeServerLicenseTerms`

7. When the previous command completes, run the following command: `Setup.exe /PrepareAD /OrganizationName:"organization name" /IAcceptExchangeServerLicenseTerms`

8. Close the command window when the setup finishes.

Installing Active Directory Certificate Services

1. Launch Server Manager, and select Add roles and features.

2. Click Next at the Add Roles and Features Wizard.

3. Select Role-based or feature-based installation, and click Next.

4. Choose Active Directory Certificate Services.

5. Click Add Features, if prompted, to install any required features.

6. Click Next.

7. Click Next.

8. Click Next.

9. Choose Certificate Authority and Certification Authority Web Enrollment.

10. Click Add Features, if prompted, to install any required features.

11. Click Next.

12. Leave defaults, and click Next.

13. Click Install.

14. Click Close when the install finishes.

15. Click on the yellow warning symbol in the Server Manager, and click Configure Active Directory Certificate Services

16. Leave defaults, and click Next.

17. Check both Certification Authority and Certification Authority Web Enrollment, and click Next.

18. Choose Enterprise CA, and click Next.

19. Choose Root CA, and click Next.

20. Choose Create a new private key, and click Next.

21. Leave defaults, and click Next.

22. Leave defaults, and click Next.

23. Leave 5 years, and click Next.

24. Leave default locations, and click Next.

25. Click Configure.

26. Close when the configuration finishes.

27. Open Internet Explorer and navigate to `localhost/certsrv/Default.asp` to verify that the installation succeeded.

Installing Exchange Server 2013 SP1 Mailbox and Client Access Server roles

Using the template, clone two VMs: one for the Exchange Client Access Server, or CAS, and the other for the Exchange Mailbox Server. Edit the hardware settings in each. The Mailbox server should have eight vCPUs (eight virtual sockets each with one core) and 16 GB of memory. Using the Exchange datastore, add a 750 GB disk and a 100 GB disk to the Mailbox server for the Exchange mailbox and Exchange logs respectively. Set static IPs on both VMs and join the domain.

1. On the Exchange Mailbox Server, log into the server using domain administrator credentials.
2. Open Windows PowerShell and run the following command:

   ```
   Install-WindowsFeature AS-HTTP-Activation, Desktop-Experience, NET-
   Framework-45-Features, RPC-over-HTTP-proxy, RSAT-Clustering, RSAT-
   Clustering-CmdInterface, RSAT-Clustering-Mgmt, RSAT-Clustering-
   PowerShell, Web-Mgmt-Console, WAS-Process-Model, Web-Asp-Net45, Web-
   Basic-Auth, Web-Client-Auth, Web-Digest-Auth, Web-Dir-Browsing, Web-Dyn-
   Compression, Web-Http-Errors, Web-Http-Logging, Web-Http-Redirect, Web-
   Http-Tracing, Web-ISAPI-Ext, Web-ISAPI-Filter, Web-Lgcy-Mgmt-Console,
   Web-Metabase, Web-Mgmt-Console, Web-Mgmt-Service, Web-Net-Ext45, Web-
   Request-Monitor, Web-Server, Web-Stat-Compression, Web-Static-Content,
   Web-Windows-Auth, Web-WMI, Windows-Identity-Foundation
   ```

3. Restart the server.
4. Download the Microsoft Unified Communications Managed API 4.0, Core Runtime 64-bit (go.microsoft.com/fwlink/p/?linkId=258269).
5. Run UcmaRuntimeSetup.exe.
6. When the installation completes, click Finish.
7. Navigate to the location of the Exchange installation media, and double-click Setup.exe.
8. At the Check for Updates? screen, check the Connect to the Internet and check for updates checkbox, and click Next.
9. When the updates complete, click Next.
10. At the Introduction screen, click Next.
11. At the License Agreement screen, check the box to accept the terms, and click Next.
12. At the Recommended Settings screen, check the Don't use recommended settings checkbox, and click Next.
13. At the Server Role Selection, select Mailbox or Client Access role, and click Next.
14. At the Installation Space and Location screen, leave the default location for the installation, and click Next.
15. At the Malware Protection Settings, select Yes to disable, and click Next.
16. At the Readiness Checks screen, allow the verification to complete. If there are no failures, click Install.
17. When the installation completes, click Finish, and restart the server.
18. Repeat steps 1 –17 for the Exchange CAS server.

Configuring Exchange

1. On the CAS server, open the Exchange Admin Center by using a browser and navigating to

   ```
   https://localhost/ecp
   ```

2. Enter the domain administrator credentials, and click Sign in.
3. If prompted, select the language and time zone, and click Save.

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4. In the left pane, click Mail Flow, then click Send Connectors.
5. On the Send Connectors page, click the New icon.
6. In the New Send Connector wizard, specify SMTP as the name and select Internet as the type. Click Next.
7. In the Network settings screen, choose MX record associated with recipient domain, and click Next.
8. In the Address space screen, click the Add icon.
9. In the Add domain window, enter * in the Fully Qualified Domain Name (FQDN) field, and click Save.
10. Click Next.
11. In the Source Server screen, click the Add icon.
12. In the Select a Server window, select the mailbox server, click Add, and then click OK.
13. Click Finish.
14. In the left pane of the EAC, click servers, select the name of the CAS server, and click Edit.
15. Click Outlook Anywhere, and enter the appropriate FQDN of the Client Access Server for the external and internal hostname field. For example, `exchangeserver.test.local`
16. Choose NTLM as the authentication method, and click Save.
17. Click Virtual Directories, and then click the Configure external access domain icon.
18. In the Select the Client Access servers to use with the external URL window, click the Add icon.
19. Select the CAS server, and click Add. Click OK.
20. Type the FQDN of the CAS server in the Enter the domain, and click Save.
21. Log into the Active Directory server using administrator credentials, and complete the following steps:
    a. Open Server Manager, then click Tools→DNS.
    b. In DNS Manager, expand the Active Directory server name→Forward Lookup Zones→test.local in the left pane.
    c. In the right pane, verify or create the DNS records as presented in Figure 15.

Type	Host or child domain/alias name	FQDN	FQDN of mail server
Mail Exchanger (MX)	Leave blank	domain.com	casserver.domain.com
Alias (CNAME)	Autodiscover	Autodiscover.domain.com	casserver.domain.com
Alias (CNAME)	Owa	Owa.domain.com	casserver.domain.com

Figure 15: DNS records.

22. Log back into your CAS server.
23. In the Exchange Power Shell, run the following commands, replacing "$HostName" with the host name (not FQDN) of your CAS server.

```
Set-EcpVirtualDirectory "$HostName\ECP (Default Web Site)" -InternalUrl
((Get-EcpVirtualDirectory "$HostName\ECP (Default Web
Site)").ExternalUrl)

Set-WebServicesVirtualDirectory "$HostName\EWS (Default Web Site)" -
InternalUrl ((get-WebServicesVirtualDirectory "$HostName\EWS (Default Web
Site)").ExternalUrl)
```

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```
Set-ActiveSyncVirtualDirectory "$HostName\Microsoft-Server-ActiveSync
(Default Web Site)" -InternalUrl ((Get-ActiveSyncVirtualDirectory
"$HostName\Microsoft-Server-ActiveSync (Default Web Site)").ExternalUrl)

Set-OabVirtualDirectory "$HostName\OAB (Default Web Site)" -InternalUrl
((Get-OabVirtualDirectory "$HostName\OAB (Default Web
Site)").ExternalUrl)

Set-OwaVirtualDirectory "$HostName\OWA (Default Web Site)" -InternalUrl
((Get-OwaVirtualDirectory "$HostName\OWA (Default Web
Site)").ExternalUrl)

Set-PowerShellVirtualDirectory "$HostName\PowerShell (Default Web Site)"
-InternalUrl ((Get-PowerShellVirtualDirectory "$HostName\PowerShell
(Default Web Site)").ExternalUrl)

Get-OfflineAddressBook | Set-OfflineAddressBook -
GlobalWebDistributionEnabled $True -VirtualDirectories $Null
```

24. Create a folder at the root of C: on the CAS server, and share it to Everyone with read/write permissions.
25. Log back into the Exchange admin center, and navigate to Servers→certificates.
26. Choose the CAS server in the drop-down menu, and click the plus sign to create a new certificate.
27. Choose Create a request for a certificate from a certification authority, and click Next.
28. Name the certificate, and click Next.
29. Do not request a wildcard certificate, and click Next.
30. Click Browse, choose the CAS server, and click OK. Click Next.
31. Leave defaults, and click Next.
32. Leave defaults, and click Next.
33. Enter your organization information, and click Next.
34. Enter the path to the share you created on the CAS server, and click Finish. Example:
    `\\cas\share\myrequest.REQ`
35. Log into the AD server, and open Internet Explorer.
36. Browse to localhost/CertSrv
37. Click Request a certificate.
38. Choose advanced certificate request.
39. Choose Submit a certificate request by using a base-64-endcoded CMC…
40. Open Windows Explorer and navigate to the share folder on the CAS server where the certificate request is stored.
41. Open the certificate with notepad and copy the content between BEGIN NEW CERTIFICATE REQUEST and END NEW CERTIFICATE REQUEST.
42. Paste the copied content into the Saved Request window.
43. Choose Web Server in the Certificate Template drop-down menu, and click Submit.
44. Choose Base 64 encoded, and download the certificate.

45. Copy the new certificate into the share folder on the CAS server.

46. Log back into the CAS server and open the Exchange Admin Center.

47. Go to Servers→Certificates, and highlight the certificate you began before (should say Pending request in the status column).

48. Click Complete on the right side.

49. Type the path to the certificate, including the certificate name, and click OK. Example:
    `\\cas\share\certnew.CER`

50. Verify that the status has changed to Valid.

51. Edit the new entry, and click Edit.

52. Go to services and check SMTP and IIS, click Save.

53. Click Yes on the warning message.

54. Run the following steps on the CAS and AD servers.

    a. Click Start, and type `MMC`
    b. Click File→Add/Remove Snap-in
    c. Choose Certificates, and click Add.
    d. Choose Computer account, and click Next.
    e. Choose Local computer, and click Finish.
    f. Click OK.
    g. Expand Certificates→Trusted Root Certificate Authorities→Certificates
    h. Click Action→All Tasks→Import
    i. Click Next.
    j. Browse to the share folder on the CAS server, and choose the new certificate you created. Click Next.
    k. Leave defaults, and click Next.
    l. Click Finish.
    m. Click OK on the Import was successful message.

55. Log into the CAS server and open the Exchange admin center.

56. Navigate to Servers→Databases.

57. Restart the Microsoft Exchange Information Store service on the MB server.

58. Using the Edit button, disable the maintenance schedule and enable circular logging for each mailbox database.

59. Dismount and remount the databases.

60. Open the Exchange Management shell, and enter the following to move the paths of the default mailbox:

61. Move-Databasepath "DatabaseName" –EdbFilepath "E:\Newlocation\DBname.edb" –LogFolderpath "F:\Newlocation"

62. When prompted, type `A` and press Enter.

63. Open Exchange Management Shell, and enter the following:
    `Get-OutlookAnywhere |Set-OutlookAnywhere -ExternalHostname cas.domain.com -`
    `DefaultAuthenticationMethod NTLM -ExternalClientsRequireSsl $true`

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Installing and configuring the Exchange 2013 mail test clients and completing LoadGen configuration on the Exchange 2013

For our testing, we used one virtual client machine to run LoadGen 2013. To create the mail clients, we installed several software components. We followed this process for each installation:

Installing Windows Server 2008 R2 SP1 Enterprise Edition

1. Insert the installation DVD for Windows Server 2008 R2 SP1 Enterprise into the DVD drive.
2. At the Language Selection Screen, click Next.
3. Click Install Now.
4. Select Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
5. Click the I accept the license terms checkbox, and click Next.
6. Click Custom.
7. Click Next.
8. At the User's password must be changed before logging on warning screen, click OK.
9. Enter the desired password for the administrator in both fields, and click the arrow to continue.
10. At the Your password has been changed screen, click OK.
11. Click Start, type `change power-saving settings` and press Enter.
12. Click Change plan settings.
13. Change the Turn off the display drop-down menu to Never.
14. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization screens.

To set up this server, we had to install several additional software components. The following subsections detail the necessary installation processes.

Joining the domain

1. Set a static IP.
2. Select Start→Control Panel→Network Connections→Local Area Connection.
3. Click Properties.
4. Highlight Internet Protocol (TCP/IP), and click Properties.
5. Select the Use the following DNS server addresses radio button, and enter the IP of the DNS server in the Preferred DNS server field. Click OK.
6. Right-click My Computer, and select Properties.
7. Under the Computer Name tab, click Change.
8. In the Computer Name Changes screen, under the Member of section, select the Domain radial box, and type `test.local`
9. Select OK to start joining the domain.
10. When the screen appears asking for a person qualified on the domain, type `Administrator` as the username and `Password1` as the password.
11. At the Welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
12. At the System Properties screen, click OK.

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13. When a pop-up appears asking if you want to restart now, click Yes to restart your computer.

Installing Internet Information Services

1. Click Start→Administrative Tools→Server Manager.
2. On the left pane, click Roles.
3. Click Add Roles.
4. Click the Application Server checkbox.
5. When the Add features required for Application Server? screen appears, click Add Required Features.
6. Click Next.
7. Click Next.
8. At the Select Role Services page for Application Server, click the Web Server (IIS) Support checkbox.
9. Click Add Required Support Role Services.
10. Click Next.
11. Click Next.
12. At the Select Role Services page for Web Server (IIS), click IIS 6 Management Compatibility, ASP, and CGI checkboxes; and click Next.
13. Click Install.
14. Click Close.

Installing Load Generator

Download and install Load Generator 2013 using all defaults.

Importing the certificate and editing the hosts file

1. Click Start, and type MMC
2. Click File→Add/Remove Snap-in
3. Choose Certificates, and click Add.
4. Choose Computer account, and click Next.
5. Choose Local computer, and click Finish.
6. Click OK.
7. Expand Certificates→Trusted Root Certificate Authorities→Certificates.
8. Click Action→All Tasks→Import.
9. Click Next.
10. Browse to the share folder on the CAS server, and choose the new certificate you created. Click Next.
11. Leave defaults, and click Next.
12. Click Finish.
13. Click OK on the Import was successful message.
14. Open the Notepad program, and use File→Open to open the hosts file stored at
    C:\Windows\System32\drivers\etc
15. Add the IP and FQDN of the CAS server.
16. Save and close Notepad.

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Preparing Load Generator

1. Log into the mail client.
2. Select Start→All Programs→Microsoft Exchange→Exchange Load Generator 2013.
3. When the Load Generator screen appears, select Start a new test.
4. Select Create a new test configuration, and click Continue.
5. Change the total length of simulation to 1 hour.
6. In the Specify test settings screen, type `Password1` as the Directory Access Password and Mailbox Account Master Password, and click Continue with recipient management.
7. Create 750 users in the Mailbox Database, and click Continue.
8. To accept defaults for Advanced recipient settings, click Continue.
9. In the Specify test user groups screen, select the plus sign to add a user group.
10. Change the Client Type to Outlook 2007 Cached, the action profile to Outlook_200, and the Mailbox size to 250 MB, and click Continue.
11. In Remote configurations, check the checkbox to enable distributing the workload, enter the computer names of all of the test clients, and click Continue.
12. Click Save the configuration file as, and name it `testcfg.xml`
13. Click Start the initialization phase (recommended before running the test).
14. Once you have initialized the database, create a backup copy of the Exchange mailbox databases.

Installing and configuring Microsoft SQL Server 2014

We installed Microsoft SQL Server 2014 on a VM residing on the second Dell PowerEdge M630.

Configuring the SQL Server VM (VRTX only)

1. After cloning, modify the SQL VM to contain the following settings:
   - Memory: 16 GB
   - Virtual Processors: 8
   - Additional virtual disks:
     - 1 × 100GB virtual disks for SQL database and log data (Thick provisioned, eager-zeroed)

Installing SQL Server 2014

1. Open the console for the VM or connect to the VM with RDP.
2. Mount the installation ISO to the VM.
3. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2014 DVD, and double-click.
4. If the installer prompts you with a .NET installation prompt, click Yes to enable the .NET Framework Core role.
5. In the left pane, click Installation.
6. On the Product Key screen, enter a product key for standard, and click Next.
7. At the Setup Support Rules screen, wait for the rule check to complete. If there are no failures or relevant warnings, click OK.
8. Select the Specify a free edition and from the drop-down menu, select Evaluation. Click Next.
9. Click the checkbox to accept the license terms, and click Next.

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10. If no failures are displayed after the setup support files are installed, click Next.

11. At the Setup Role screen, choose SQL Server Feature Installation.

12. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, and Management Tools – Complete. Click Next.

13. At the Installation Rules screen, click Next after the check completes.

14. At the Instance configuration screen, leave the default selection of default instance, and click Next.

15. At the Disk Space Requirements screen, click Next.

16. At the Server Configuration screen, check that NT AUTHORITY\SYSTEM is selected for SQL Server Agent and SQL Server Database Engine. Click Next.

17. Assuming there are no failures, click Next.

18. At the Database Engine Configuration screen, select Mixed Mode.

19. Enter and confirm a password for the system administrator account.

20. Click Add Current user. This may take several seconds.

21. Click Next.

22. At the Error and usage reporting screen, click Next.

23. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.

24. At the Ready to Install screen, click Install.

25. After installation completes, click Close.

26. Create a SQL Server login for the ds2user (see the Configuring the database (Data generation overview) section for the specific script to use).

27. Copy the pre-created DVD Store backup to the specified backup volume.

28. Download and install any available updates for Microsoft SQL Server 2014. We installed SQL Server 2014 SP1 and CU5.

Configuring the database workload client

For our testing, we used a single client machine for the Microsoft SQL Server client. To create this client, we created a Windows Server 2013 R2 VM, assigned a static IP address, and installed .NET 3.5. We used this client to drive the DVD Store benchmark we ran against the SQL database.

Configuring the database

Data generation overview

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 10GB database size and the database platform on which we ran: Microsoft SQL Server. We ran the Install.pl script on a utility system running Linux. The database schema was also generated by the Install.pl script.

After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server 2014. We built the 10GB database in SQL Server 2014, and then performed a full backup, storing the backup file on the C: drive for quick access. We used that backup file to restore the server between test runs.

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The only modification we made to the schema creation scripts were the specified file sizes for our database. We explicitly set the file sizes higher than necessary to ensure that no file-growth activity would affect the outputs of the test. Besides this file size modification, the database schema was created and loaded according to the DVD Store documentation. Specifically, we followed the steps below:

1. We generated the data and created the database and file structure using database creation scripts in the DS2 download. We made size modifications specific to our 10GB database and the appropriate changes to drive letters.
2. We transferred the files from our Linux data generation system to a Windows system running SQL Server.
3. We created database tables, stored procedures, and objects using the provided DVD Store scripts.
4. We set the database recovery model to bulk-logged to prevent excess logging.
5. We loaded the data we generated into the database. For data loading, we used the import wizard in SQL Server Management Studio. Where necessary, we retained options from the original scripts, such as Enable Identity Insert.
6. We created indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
7. We updated statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
8. On the SQL Server instance, we created a ds2user SQL Server login using the following Transact SQL (TSQL) script:

```
USE [master]
GO
CREATE LOGIN [ds2user] WITH PASSWORD=N'',
        DEFAULT_DATABASE=[master],
        DEFAULT_LANGUAGE=[us_english],
        CHECK_EXPIRATION=OFF,
        CHECK_POLICY=OFF
GO
```

9. We set the database recovery model back to full.
10. We created the necessary full text index using SQL Server Management Studio.
11. We created a database user and mapped this user to the SQL Server login.
12. We then performed a full backup of the database. This backup allowed us to restore the databases to a pristine state relatively quickly between tests.

Figure 16 shows our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
primary	PRIMARY	3.25
cust1	DS_CUST_FG	5,767
cust2	DS_CUST_FG	5,767
ind1	DS_IND_FG	2,621

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Logical name	Filegroup	Initial size (MB)
ind2	DS_IND_FG	2,621
ds_misc	DS_MISC_FG	2,621
orders1	DS_ORDERS	2,621
orders2	DS_ORDERS	2,621
Log files		
ds_log	Not Applicable	20,480

Figure 16: Our initial file size modifications.

Installing and configuring Iometer

We installed Iometer using all defaults on a VM residing on the second Dell PowerEdge M630.

Configuring the Iometer VM (VRTX only)

After cloning, modify the Iometer VM to contain the following settings:

- o   Memory: 8 GB
- o   Virtual Processors: 4
- o   Additional virtual disks:
    - ▪   1 × 50GB virtual disk for Iometer target (Thick provisioned, eager-zeroed)

Installing and configuring Iometer on the VM

1. Download the Iometer 1.1 package for Windows from www.iometer.org/doc/downloads.html.
2. Double-click the installer, and click Run.
3. At the Welcome window, click Next.
4. At the License Agreement window, click I Agree.
5. At the Choose Components window, leave the defaults selected, and click Next.
6. At the Choose Install Location window, change the Destination Folder to C:\Iometer 1.1, and click Install.
7. When the installation completes, click Finish.
8. Copy the relevant access specification file to the VM.

Configuring the Iometer workloads (both legacy and VRTX)

We set up Iometer to deliver a light file/print server-like I/O load through the duration of the tests. Below we review the specific configuration of our Iometer workload.

Iometer workload specifications

- 50GB dataset, 1 Outstanding I/O per target (sectors)
- 512KB transfer request size
- 100ms transfer delay
- 1 Burst I/O
- 80% read, 100% random
- 45 minute run time
- 60 second ramp up time
- Cycling – normal

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Running the test

Test start and run times

We ran all workloads concurrently in order to start and record all performance counters for this report. The specific testing parameters we used for each benchmark are included in the setup sections, and specifics for launching these tests are described below.

About running the LoadGen test

To run the test, we installed the LoadGen client and server components and simulated 750 Exchange users targeting the Exchange VM using LoadGen's Exchange_200 Workload profile. We ran the LoadGen benchmark for 45 minutes, and beginning at the 15-minute mark, we used a 30-minute measurement window for performance monitoring.

For more details about LoadGen, see www.microsoft.com/download/en/details.aspx?displaylang=en&id=14060.

About running the DVD Store tests

We created a series of batch files, SQL scripts, and shell scripts to automate the complete test cycle. DVD Store outputs an orders-per-minute metric, which is a running average calculated through the test. In this report, we report the last OPM reported by each client/target pair.

Each complete test cycle consisted of the general steps listed below.

1. Clean up prior outputs from the target system and the client driver system.
2. Drop the database from the target.
3. Restore the database on the target.
4. Shut down the target.
5. Reboot the host and client system.
6. Wait for a ping response from the server under test (the hypervisor system), the client system, and the target.
7. Let the test server idle for 20 minutes.
8. Start the DVD Store driver on the client.

    We used the following DVD Store parameters for testing:

    ```
    ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=30 --
    n_threads=12 --db_size=10GB --think_time=0.1 --detailed_view=Y --
    warmup_time=15
    ```

About running the Iometer tests

1. Log into the Iometer machine.
2. Open the Iometer specification for the machine.
3. Click the start button.
4. After all access specifications finish running, remove the result files from the machine.

APPENDIX C – DETAILED TEST RESULTS

Figure 17 shows the results of our database, mail, and file and print testing as well as power data for the Dell PowerEdge VRTX with two Dell PowerEdge M630 server nodes. The median run was determined by OPM.

Dell PowerEdge VRTX with two Dell PowerEdge M630 server nodes	Run 1	Run 2	Run 3	Median run
Power				
Idle power (W)	373.6	375.0	375.1	375.0
Active power (W)	397.2	396.8	396.6	396.8
Database				
Orders per minute	6011	6015	6029	6015
Mail				
Average latency (ms)	1.9	1.8	1.9	1.8
File and print				
IOPS	36.5	36.6	36.6	36.6

Figure 17: Detailed run results for the Dell PowerEdge VRTX with two Dell PowerEdge M630 server nodes.

Figure 18 shows the results of our database, mail, and file and print testing as well as power data for the legacy disparate hardware solution we tested. The median run was determined by OPM.

Legacy, disparate hardware	Run 1	Run 2	Run 3	Median run
Power				
Idle power (W)	660.2	671.4	662.9	671.4
Active power (W)	679.7	678.7	678.1	678.7
Database				
Orders per minute	2,050	2,053	2,053	2,053
Mail				
Average latency (ms)	1.22	1.4	1.5	1.4
File and print				
IOPS	7.8	7.7	7.8	7.7

Figure 18: Detailed run results for the legacy disparate hardware solution from our testing.

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APPENDIX D – TCO CALCULATIONS

In this appendix, we estimate and compare five-year costs for the two solutions we tested in this report. Each solution supports one SQL Server 2014 Standard Edition instance, one Microsoft Exchange 2013 Standard Edition instance, and one instance for file/print – in three VMs on the Dell PowerEdge VRTX solution and on individual servers in the legacy solution.

- Dell PowerEdge VRTX – we include acquisition costs and annual costs to run the Dell PowerEdge VRTX solution we tested in this report.
- Legacy solution – we compared performance of the Dell PowerEdge VRTX to a set of three 4- to 5-year-old HP servers, a shared HP storage array, and a switch. We estimate costs for this solution.

Assumptions

General

- We use current U.S. dollars for all calculations.
- We assume all tasks are executed by a system administrator earning in salary and benefits the equivalent of $56.09 an hour.[2]
- For the Dell PowerEdge VRTX solution, we assume an existing VMware vCenter server that is not included in this cost analysis.
- We consider only the costs that are platform specific. We thus omit staff costs for tasks that would be common to the two solutions and would require same or similar effort and cost for the two solutions. These include the cost of setting up and maintaining the SQL Server and Exchange databases, updating the operating system versions, and updating the SQL server versions as updates become available over the five-year TCO timeframe.
- We include only server licensing in this model and omit client access license costs and other client licensing.
- For the legacy solution, we assume the business would repurpose legacy equipment from other uses, so would need to purchase software for both the legacy and VRTX solutions.
- We include software license costs with acquisition costs and software support costs with annual costs.
- We do not include data center costs such as space or build costs because we assume the company would install these solutions in the main office or a branch office, not in a centralized enterprise data center.

Acquisition costs

- Acquisition costs for both solutions include software licenses for Microsoft Windows Server, Microsoft SQL Server, and Microsoft Exchange Server. Costs for the Dell PowerEdge M630 servers also include VMware vSphere license costs.
- Acquisition costs for the Dell PowerEdge VRTX solution include hardware and five-year hardware support, software licenses, and setup costs.
- Acquisition costs for the Dell PowerEdge M630 servers include the 29 percent discount available for this server model in the Dell online store.

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[2] http://swz.salary.com/salarywizard/Systems-Administrator-II-Salary-Details.aspx?hdcbxbonuse=off&isshowpiechart=true&isshowjobchart=false&isshowsalarydetailcharts=false&isshownextsteps=false&isshowcompanyfct=false&isshowaboutyou=false

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Yearly costs

- Costs for both solutions include Microsoft Software Assurance costs, energy costs for power and cooling, and hardware management costs.
- We include costs to power and cool the solutions using power utilization measurements we made during testing. We estimate cooling costs equal to power costs.
- F or the legacy solution, we assume the business purchases post-warranty hardware support each year from the vendor for the servers and storage array. We include that in yearly costs, not acquisition costs.
- We also include estimates of the cost of additional downtime for the aging legacy servers. We estimate negligible downtime for VRTX and 10 hours per server per year for the older legacy servers. We estimate the cost of that downtime at $300 an hour assuming a number of users are affected each time one of the servers becomes unavailable.
- Costs for the Dell PowerEdge VRTX solution also include staff costs for the Dell PowerEdge VRTX solution to manage the VMware VSphere 5 virtualization.

Dell PowerEdge VRTX solution cost

Figure 19 shows the costs we calculated for the Dell PowerEdge VRTX solution.

Dell PowerEdge VRTX with two Dell PowerEdge M630 server nodes	Unit	Cost per unit	Quantity description	Quantity	Total cost
Acquisition costs					
Hardware					
Dell PowerEdge VRTX platform	Platform (after 29% discount)	$20,515	One VRTX including five-year support	1	$20,515
Dell PowerEdge M630 Blade Server	Node (after 29% discount)	$7,488	One node including five-year support	2	$14,977
Software licenses					
Windows Server 2012 R2 Standard Edition (processor + CAL licensing)	Each server with up to two processors. Up to two VMs per license.	$883	Two servers with two processors each (max two VMs per server)	2	$1,766
Microsoft SQL Server 2012 R2 Standard (server + CAL licensing)	One license per SQL VM	$898	One SQL Server VM per legacy SQL server we consolidate	1	$898
Microsoft Exchange Server 2013 Standard Edition (server + CAL licensing)	One license per Exchange VM	$708	Two Exchange VMs per legacy Exchange server we consolidate	2	$1,416
VMware vSphere 5 Standard for one processor	One per processor	$995	Number processors	4	$3,980
Setup	Cost per hour	$56	Number hours	8	$449
Total acquisition costs					**$44,000**

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Dell PowerEdge VRTX with two Dell PowerEdge M630 server nodes	Unit	Cost per unit	Quantity description	Quantity	Total cost
Annual costs					
Software support					
Windows Server 2012 Standard Edition (Software Assurance)	Each server with up to two processors	$221	Two servers with two processors each (max two VMs per server)	2	$442
Microsoft SQL Server 2012 Standard (Software Assurance)	One license per SQL VM	$225	One SQL Server VM per legacy SQL server we consolidate	1	$225
Microsoft Exchange Server 2013 (Software Assurance)	One server	$177	Two Exchange VMs per legacy Exchange server we consolidate	2	$354
VMware vSphere 5 Standard Basic support	One per processor per year	$273	Number processors	4	$1,092
Energy cost for power and cooling	Platform	$725	One VRTX	1	$725
Hardware management	Cost per hour	$56	Number hours	12	$673
VMware management	Cost per hour	$56	Number hours	24	$1,346
Total annual costs					**$4,857**
Average cost per month					**$405**

Figure 19: Cost analysis for the Dell PowerEdge VRTX with two Dell PowerEdge M630 server nodes. (Totals may not sum due to rounding.)

Legacy solution costs

Figure 20 shows the costs we calculated for the legacy solution.

Legacy costs	Unit	Cost per unit	Quantity description	Quantity	Total cost
Acquisition costs					
Software licenses					
Windows Server 2012 Standard Edition (processor licenses)	Each server with up to two processors. Up to two VMs per license.	$883	Three servers with one or two processors each	3	$2,649
Microsoft SQL Server 2012 Standard (processor licenses)	One server	$898	One server with SQL installed	1	$898
Microsoft Exchange Server 2013 Standard (server licenses)	One server	$658	One Server with Exchange	1	$658
Setup					
	Cost per hour	$56	Number hours	16	$897
Total acquisition costs					**$5,102**
Annual costs					

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Legacy costs	Unit	Cost per unit	Quantity description	Quantity	Total cost
Support					
Windows Server 2012 Standard Edition (Software Assurance)	Each server with up to two processors	$221	Three servers with one or two processors each	3	$663
Microsoft SQL Server 2012 Standard (Software Assurance)	One server	$165	One server with SQL installed	1	$165
Microsoft Exchange 2013 Standard (Software Assurance)	One server	$165	One server with Exchange	1	$165
Hardware support	HP extended support agreements for three servers and storage array with one-year terms	$3,091	One year	1	$3,091
Energy cost for power and cooling					
		$1,269	One year	1	$1,269
Hardware management					
	Per solution	$50	Estimate at two hours a month per server + one hour a month for storage array per year	84	$4,200
Downtime cost					
	Per hour downtime cost	$300	Each server down for multiple hours a year	30	$9,000
Legacy annual costs					**$18,553**
Average cost per month					**$1,546**

Figure 20: Cost analysis for the legacy solution. (Totals may not sum due to rounding.)

ABOUT PRINCIPLED TECHNOLOGIES

Principled Technologies®

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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.

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