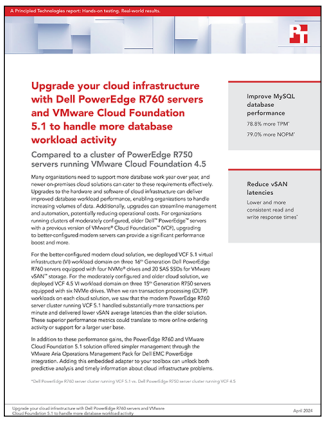

The science behind the report:

Upgrade your cloud infrastructure with Dell PowerEdge R760 servers and VMware Cloud Foundation 5.1 to handle more database workload activity

This document describes what we tested, how we tested, and what we found. To learn how these facts translate into real-world benefits, read the report Upgrade your cloud infrastructure with Dell PowerEdge R760 servers and VMware Cloud Foundation 5.1 to handle more database workload activity.

We concluded our hands-on testing on April 4, 2024. During testing, we determined the appropriate hardware and software configurations and applied updates as they became available. The results in this report reflect configurations that we finalized on January 16, 2024 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

To learn more about how we have calculated the wins in this report, go to http://facts.pt/calculating-and-highlighting-wins. Unless we state otherwise, we have followed the rules and principles we outline in that document.

Table 1: Results of our HammerDB TPROC-C benchmark testing. Simulation with 500 warehouses 64 virtual users, and 36 MySQL VMs with 10 vCPUs each.

	Dell™ PowerEdge™ R760 cluster running VCF 5.1	Dell PowerEdge R750 cluster running VCF 4.5
Transactions per minute (TPM)	1,042,535	582,836
New orders per minute (NOPM)	449,072	250,742

System configuration information

Table 2: Detailed information on the VCF management domain we used for testing.

System configuration information	Dell PowerEdge R750xs x4
BIOS name and version	
Non-default BIOS settings	Dell 1.12.1
Operating system name and version/build number	ESXi™ 8.0 Update 2 Build-22380479 (Dell customized)
Date of last OS updates/patches applied	01/16/24
Power management policy	Performance
Processor	
Number of processors	2
Vendor and model	Intel® Xeon® Gold 6336Y
Core count (per processor)	24
Core frequency (GHz)	2.40
Stepping	6
Memory module(s)	
Total memory in system (GB)	256
Number of memory modules	16
Vendor and model	Hynix HMA82GR7CJR8N-WM
Size (GB)	16
Type	PC4-23400
Speed (MHz)	2,933
Speed running in the server (MHz)	2,933
Storage controller	
Vendor and model	Dell PERC H755
Cache size (GB)	8
Firmware version	52.26.0-5179
Local storage (type A)	
Number of drives	8
Drive vendor and model	Seagate XS3840LE70134
Drive size (GB)	3,840
Drive information (speed, interface, type)	12GB SAS SSD
Network adapter	
Vendor and model	Broadcom BCM5720
Number and type of ports	2 x 25GbE
Driver version	22.71.11.13

System configuration information	Dell PowerEdge R750xs x4
Cooling fans	
Vendor and model	Dell
Number of cooling fans	5
Power supplies	
Vendor and model	Dell 07DWXYA01
Number of power supplies	2
Wattage of each (W)	1400

Table 3: Detailed configuration information for the three-node VCF clusters under test.

System configuration information	Dell PowerEdge R750 x3	Dell PowerEdge R760 x3
BIOS name and version		
Non-default BIOS settings	Dell 1.12.1	Dell 1.6.6
Operating system name and version/build number	ESXi 7.0 Update 3 Build-21930508 (Dell customized)	ESXi 8.0 Update 2 Build-22380479 (Dell customized)
Date of last OS updates/patches applied	01/16/24	01/16/24
Power management policy	Performance	Performance
Processor		
Number of processors	2	2
Vendor and model	Intel Xeon Gold 6330	Intel Xeon Gold 6430
Core count (per processor)	28	32
Core frequency (GHz)	2.00	2.10
Stepping	6	8
Memory module(s)		
Total memory in system (GB)	512	512
Number of memory modules	16	16
Vendor and model	Samsung M393A4K40EB3-CWE	Hynix HMCG88AEBRA115N
Size (GB)	16	32
Type	DDR4	PC5-38400
Speed (MHz)	3,200	4,800
Speed running in the server (MHz)	3,200	4,800
Storage controller		
Vendor and model	Dell HBA355i Front	Dell PERC H755
Cache size (GB)	8	8
Firmware version	24.15.14.00	52.26.0-5179

System configuration information	Dell PowerEdge R750 x3	Dell PowerEdge R760 x3
Local storage (type A)		
Number of drives	6	4
Drive vendor and model	KIOXIA PH-097GR0-TBPKK	KIOXIA PH-097GR0-TBPKK
Drive size (GB)	3,276	3,276
Drive information (speed, interface, type)	NVMe PCIe SSD	NVMe PCIe SSD
Local storage (type B)		
Number of drives	N/A	20
Drive vendor and model	N/A	Toshiba KRM6VVUG1T92
Drive size (GB)	N/A	1,920
Drive information (speed, interface, type)	N/A	12GB SAS SSD
Network adapter		
Vendor and model	Broadcom NetXtreme 57414	Broadcom BCM57404
Number and type of ports	2 x 25GbE	2 x 25GbE
Driver version	22.71.11.13	22.61.10.77
Cooling fans		
Vendor and model	Dell	Dell
Number of cooling fans	6	12
Power supplies		
Vendor and model	Dell 06C11WA02	Dell 0P56GHA00
Number of power supplies	2	2
Wattage of each (W)	1,400	2,800

How we tested

We deployed VMware Cloud Foundation (VCF) 5.1 management domain on four Dell PowerEdge R750xs servers. Each R750xs server had two BOSS drives for VMware ESXi 8.0.2 and eight SAS SSDs for VMware vSAN storage. We deployed a VI workload domain on the three Dell PowerEdge R760 servers. Each Dell PowerEdge R760 server had two BOSS drives for ESXi 8.0.2, and four NVMe drives and twenty SAS SSDs for vSAN storage.

We used the TPROC-C benchmark from the HammerDB suite to simulate a real-world online transaction processing (OLTP) database workload. We created a MySQL VM on the workload domain cluster with 10 vCPUs, 42 GB of memory, and 1 TB of storage from the VSAN datastore. We installed Ubuntu 22.04 and MySQL 8.0 on the MySQL VM. We then scaled up to 12 VMs on each Dell PowerEdge R760 server. We ran the HammerDB 4.9 TPROC-C workload with 500 warehouses and measured the TPM and NOPM metrics.

After we finished testing in the VCF 5.1 environment, we reimaged the four Dell PowerEdge R750xs servers with VMware ESXi 7.0.3 and deployed VCF 4.5 management domain on them. We then deployed a VI workload domain on the three Dell PowerEdge R750 servers. Each Dell PowerEdge R750 server had two BOSS drives for ESXi 7.0.3, and six NVMe drives for vSAN storage. We deployed an identical OLTP database workload on the Dell PowerEdge R750 servers with 12 MySQL VMs on each R750 server. Each MySQL VM had 10 vCPUs, 42GB of memory, and 1TB of vSAN storage. We ran the same HammerDB 4.9 TPROC-C workload with 500 warehouses and measured the TPM and NOPM metrics.

All the Dell PowerEdge servers in our testbed had two 25Gb Ethernet connections to a Dell S5248F switch. We also used a Dell PowerEdge R6625 server as an infrastructure server where we deployed the AD/DNS server, the Certificate Authority server, a jumpbox VM, and pfsense routers to manage the VLANs on the Dell S5248F switch.

Configuring the switch and networking

We created and configured the following VLANs for the VCF management domain on the Dell S5248F switch. We deployed a pfsense gateway on VLAN 1 and VLAN 200. The pfsense gateway also provided NAT and inter-vlan routing for these two VLANs.

Table 4: Switch and networking configuration information for the VCF management domain.

VLAN ID	Gateway	MTU	Description
1		9000	Management and VM network
20	192.168.20.1	9000	vSAN network
40	192.168.40.1	9000	vMotion Network
50	192.168.50.1	9000	NSX Host Overlay network
60	192.168.60.1	9000	NSX Edge TEP network
70	192.168.70.1	9000	NSX Edge Tier-0 uplink network
80	192.168.80.1	9000	NSX Edge 2nd Tier-0 uplink network
100	192.168.100.1	9000	NSX Management RegionA network
200		9000	NSX Management xRegion network

We created and configured the following VLANs for the VCF VI workload domain on the Dell S5248F switch. We deployed a pfsense gateway for VLAN 150 which provided DHCP service for the NSX Host Overlay network.

Table 5: Switch and networking configuration information for the VCF VI workload domain.

VLAN ID	Gateway	MTU	Description
1		9000	Management and VM network
120	192.168.120.1	9000	vSAN network
140	192.168.140.1	9000	vMotion network
150		9000	NSX Host Overlay network
160	192.168.160.1	9000	NSX Edge TEP network
170	192.168.170.1	9000	NSX Edge Tier-0 uplink network
180	192.168.180.1	9000	NSX Edge 2nd Tier-0 uplink network

Deploying the VCF management and workload domains

To deploy the management domain, VMware Aria Operations, and VI workload domain on the Dell PowerEdge servers, we followed the procedure in the VCF deployment guide: https://facts.pt/Hse6826.

Deploying the OLTP database workload

After we deployed the VI workload domain, we installed and configured MySQL 8.0 VMs on the workload domain cluster. We also Installed and configured client HammerDB VMs on an Infrastructure server.

Creating the base Ubuntu 22.04 VM

1. Connect and log into the vCenter in the Workload Domain.
2. Click the workload domain cluster, and click New VM.
3. Assign the VM the following properties:
    a. 16 vCPUs
    b. 64GB memory
    c. 2TB storage from the vSAN datastore.
    d. One network connection from the VM network portgroup
4. Click Finish.
5. Download and attach the Ubuntu 22.04 iso image to the base VM.
6. To install Ubuntu 22.04, power on the VM, and follow the on-screen instructions.

Installing MySQL 8.0 on the base VM

1. Via ssh, log into the Ubuntu 22.04 VM.
2. Update and upgrade Ubuntu 22.04:

```
sudo apt update
sudo apt upgrade
```

3. Install MySQL server:

```
sudo apt install mysql-server
```

4. In /etc/mysql/mysql.conf.d/mysqld.cnf, change the bind address to 0.0.0.0, and restart MySQL server:

```
sudo systemctl restart mysql.service
```

5. Set a password for the 'root' user:

```
sudo mysql
mysql> ALTER USER 'root'@'localhost' IDENTIFIED WITH mysql_native_password BY '<password>';
mysql> exit
```

6. Run the MySQL secure installation script. To finish the installation, follow the prompts:

```
sudo mysql_secure_installation
```

7. Create a tpcc user, and grant privileges:

```
mysql -u root -p
Enter password: <password>
mysql> create user '<tpcc user>'@'%' identified by '<password>';
mysql> create database tpcc;
mysql> grant all on *.* to '<tpcc user>'@'%';
mysql> exit
```

Creating and configuring the client VMs

We created the client VMs on a separate infrastructure server and connected them to the same VM network on the 25Gb switch. We used ESXi 8.0.2 for the infrastructure hypervisor and Ubuntu 22.04 for the Guest operation system.

1. Log into the client VM via ssh.
2. Install MySQL client library:

```
sudo apt-get install python3-dev default-libmysqlclient-dev build-essential pkg-config
sudo apt install python3-pip
pip install mysqlclient
sudo apt install mysql-client-core-8.0
```

3. Download and extract HammerDB 4.9:

```
wget https://github.com/TPC-Council/HammerDB/releases/download/v4.9/HammerDB-4.9-Linux.tar.gz
tar -xzvf HammerDB-4.9-Linux.tar.gz
```

Creating the TPROC-C database schema

1. SSH into the Ubuntu client VM, and navigate to the Hammerdb directory.
2. Create a mysql_tpcc_buildschema.tcl script file:

```
#!/bin/tclsh
puts "SETTING CONFIGURATION"
dbset db mysql
dbset bm TPC-C
diset connection mysql_host <mysql server IP>
diset connection mysql_port 3306
diset connection mysql_socket /tmp/mysql.sock
set vu 16
set warehouse 500
diset tpcc mysql_count_ware $warehouse
diset tpcc mysql_num_vu $vu
diset tpcc mysql_user <tpcc username>
diset tpcc mysql_pass <tpcc user password>
diset tpcc mysql_dbase tpcc
diset tpcc mysql_storage_engine innodb
diset tpcc mysql_partition true
puts "SCHEMA BUILD STARTED"
buildschema
puts "SCHEMA BUILD COMPLETED"
```

3. Build a TPCC database schema:

```
./hammerdbcli auto mysql_tpcc_buildschema.tcl
```

Running the HammerDB/OLTP tests

1. SSH into the Ubuntu client VM, and navigate to the hammerdb folder.
2. Create a mysql_tpcc_run.tcl file:

```
dbset db mysql
dbset bm TPC-C
diset connection mysql_host <mysql server IP>
diset connection mysql_port 3306
diset connection mysql_socket /tmp/mysql.sock
diset tpcc mysql_driver timed
diset tpcc mysql_rampup 5
diset tpcc mysql_duration 10
diset tpcc mysql_count_ware 500
diset tpcc mysql_user <tpcc username>
diset tpcc mysql_pass <tpcc user password>
diset tpcc tpcc_allwarehouse false
diset tpcc mysql_timeprofile true
loadscript
puts "TEST STARTED"
vuset vu 96
vuset logtotemp 1
vucreate
tcstart
tcstatus
set jobid [ vurun ]
vudestroy
tcstop
puts "TEST COMPLETE"
```

3. Run the test with 5 minutes warm-up time and 10 minutes run time:

```
./hammerdb_cli auto mysql_tpcc_run.tcl
```

4. To monitor performance of each host during the HammerDB runs, run the esxtop utility in batch mode, and output the data to CSV files:

```
esxtop -b -a -d 10 -n 94 > <output.csv>
```

5. Repeat step 3 for a total of three runs, and report the median results.

Read the report at https://facts.pt/1pJ4Dpb ▶

This project was commissioned by Dell Technologies.