Dell™ PowerEdge™ M820 server

Delivered 19.3% more Oracle® Database 12*c* performance in half the space, saving up to 42.1%

Offers key reliability, availability, and serviceability features to keep workloads running

versus HP ProLiant BL680c G7

There is much to consider when selecting servers for your datacenter. That you want high workload performance is a given, but it's also critical that your server incorporates reliability, availability, and serviceability (RAS) features to keep mission-critical workloads running. From a business standpoint, you want to make the most of your space and keep costs down by choosing a high-density server solution. Not all servers are built to address these concerns simultaneously, so finding one that does is key.

In the Principled Technologies test labs, we looked at what the following two servers had to offer: a Dell PowerEdge M820 blade running Intel® Xeon® processors E5-4600 v2, and an HP ProLiant BL680c G7 with Intel Xeon processors E7-4800.

We found that the single-width Dell PowerEdge M820 had 19.3 percent better Oracle Database 12*c* performance than the double-width HP ProLiant BL680c G7 and consumed just half the blade chassis space. This means that you could fit 19.3 percent more performance in half the space or 2.38 times the performance in the same space with the Dell PowerEdge M820 due to its denser form factor. This can reduce your data center costs dramatically—by as much as 42.1 percent. When comparing RAS features, we found that the Dell PowerEdge M820 also incorporates most of the RAS features that the Intel Xeon E7 family provides, making it a good balance of performance, density, and high availability.

THE VALUE OF DENSITY WITH DELL POWEREDGE M820

Dense solutions enable you to get the most out of your resources. By fitting as much processing power as possible in the least amount of space, you can:

- reduce management overhead
- lower power and cooling costs
- save physical space and related rental costs
- reduce infrastructure costs such as chassis and cabling
- reduce software licensing costs

Blade servers are the go-to form factor to increase density without sacrificing performance or RAS features. Why not make the most of your density solution by selecting a blade that does more work in half the space? In this study, we explore the value the single-height Dell PowerEdge M820 blade powered by Intel Xeon processors E5-4600 v2 can provide your business.

For information about the server and our benchmark, see Appendix A. See Appendix B for detailed system configuration information and Appendix C for our step-by-step testing procedure.

MORE THAN DOUBLE YOUR PERFORMANCE PER U

Figure 1 shows the head-to-head relative performance results of our database tests, where we tested one server against the other. As the chart shows, the Dell PowerEdge M820 had 19.3 percent better Oracle Database 12*c* performance than the HP ProLiant BL680c G7.

Figure 1: The Dell PowerEdge M820 delivered 19.3 percent more transactions per second than the HP ProLiant BL680c G7, and fit into half the space.

Database performance

Relative performance

	Dell PowerEdge M820	HP ProLiant BL680c G7
	1.19	1
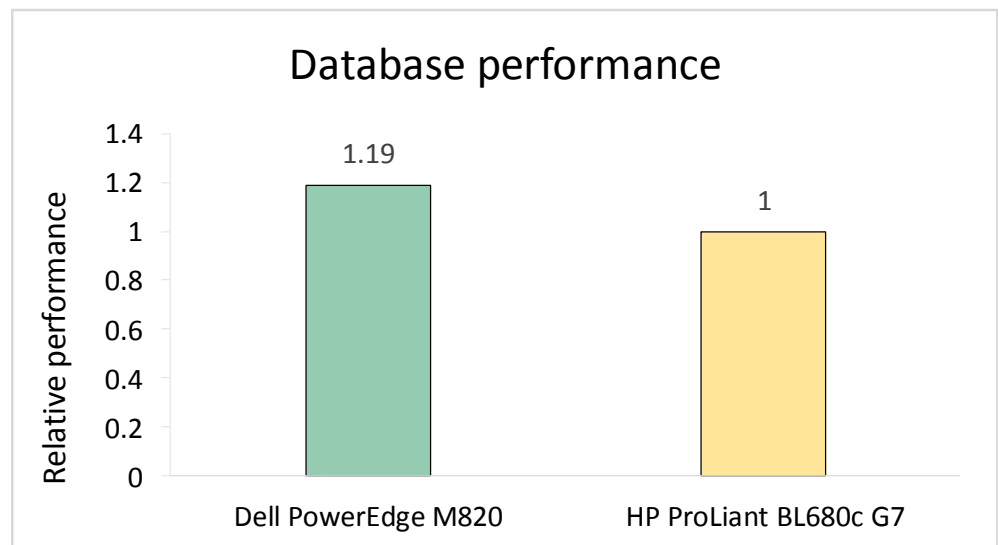
The compact form factor of the Dell PowerEdge M820 means that you can 19.3 percent more performance in half the space with the Dell PowerEdge M820, as Figure 1

shows. This means that the Dell PowerEdge M820 delivered 2.38 times more database performance per U than the HP server did, making it the clear winner in density (see Figure 2). This increase in performance per U means that the Dell PowerEdge M820 would allow you to make better use of your chassis, racks, and physical data center space to help your bottom line.

Figure 2: The Dell PowerEdge M820 delivered 2.38 times more database performance per U in our tests.
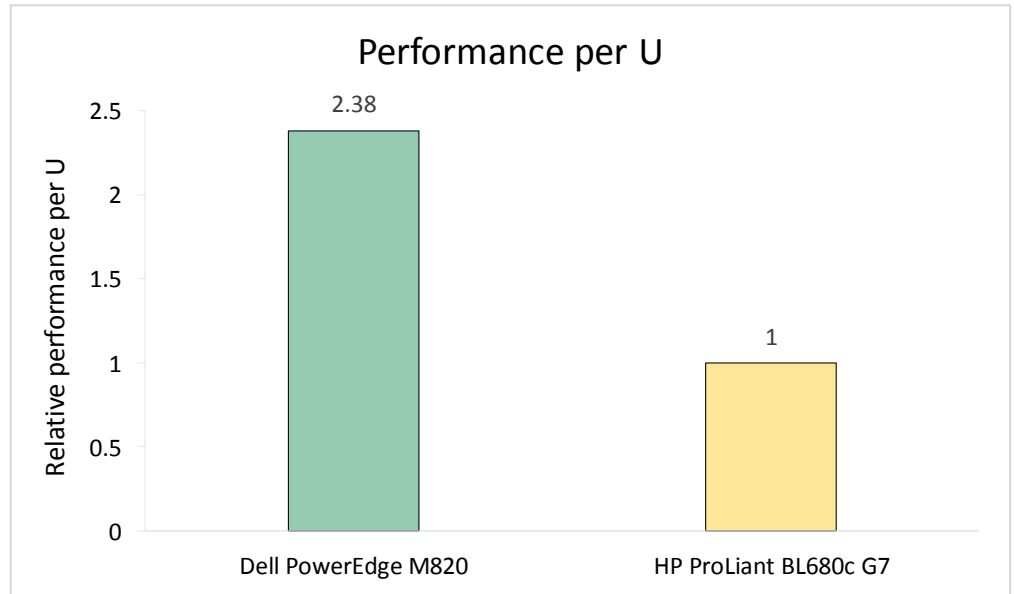
Extrapolated to a full chassis of Dell servers, it would take 10 HP servers and three HP enclosures to equal the performance of just a single Dell blade enclosure with eight Dell PowerEdge M820 servers. The Dell PowerEdge M820 also lets you get more out of your converged infrastructure and licensed cores for Oracle, as we discuss below.

EXPLORING THE COST BENEFITS OF THE DENSER DELL POWEREDGE M820

When you break down the costs of the two servers, the value that the density of the Dell PowerEdge M820 provides rapidly becomes clear. Because the Dell PowerEdge M820 can do more work in half the space as the HP ProLiant BL680c G7, your organization can save on the cost of enclosures, rack costs, port costs, and networking costs, so by choosing the denser PowerEdge M820, you can have a positive effect on your IT budget. Please note that we tested solutions with one server and one storage array, but if you extrapolate and if your applications scale linearly, these are the savings along the lines of what you could expect. We chose the 16- vs. 20-server comparison as a point of fairness, because that is the first server count at which both solutions have equivalent performance and fill chassis completely.

Figures 3 and 4 compare the costs of performance-equivalent configurations of Dell PowerEdge M820 and HP ProLiant BL680c G7 servers running Oracle Database 12*c*.

As Figure 3 shows, a Dell PowerEdge M820 solution with 16 blade servers and two chassis costs up to 42.1 percent less than the equivalent HP ProLiant BL680c G7 solution, which requires 20 servers and 5 chassis.

Cost of performance-equivalent solutions

Dell PowerEdge M820 solution: $612,487.04
HP ProLiant BL680c G7 solution: $1,057,075.12

(US Dollars: axis from $0 to $1,200,000)
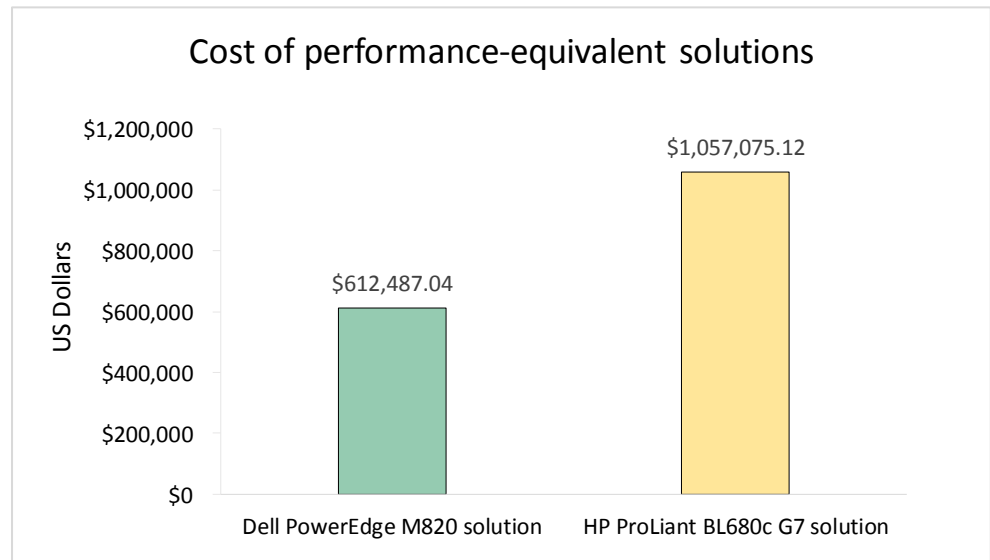
The denser, converged infrastructure approach of the Dell PowerEdge M820 means it can save you in a number of areas, including:

- **Hardware costs.** The PowerEdge M820 outperforms the ProLiant BL680c G7, so you can purchase fewer servers, chassis, switches, and more to get the same amount of work. In our comparison, the HP ProLiant BL680c G7 requires four extra servers, three extra chassis, and six additional switches to get the same performance as the Dell PowerEdge M820 solution.
- **Data center space costs.** The Dell PowerEdge M820 solution is denser than the HP ProLiant BL680c G7 solution. This means that it takes up less space, which lets you save on cost per square foot for the solutions. In our comparison, you could save up to 60 percent in data center space costs alone.
- **Energy costs.** The less hardware you have, the less you have to power. This can result in dramatic savings in power and cooling. We estimate that the Dell PowerEdge M820 solution could save up to 74 percent in energy costs over the HP ProLiant BL680c G7 solution.[1]
- **Rack costs.** The Dell PowerEdge M820 takes up 60 percent less rack space than the HP ProLiant BL680c G7 solution.

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[1] We did not measure power, but instead used vendor-provided power calculators to estimate power usage for our analysis. See Appendix D for details.

- **Port costs.** Because the HP ProLiant BL680c G7 solution requires more switches than the Dell PowerEdge M820 solution, it also has significantly higher port costs.[2]

Figure 4 presents a summary of the costs we incorporated in our analysis. See Appendix D for a complete breakdown of our cost analysis and the assumptions we made about the two solutions.

Summary	Dell PowerEdge M820 solution	HP ProLiant BL680c G7 solution
Number of servers	16	20
Hardware (rack, switch, enclosure, servers)	$546,327.04	$813,062.40
Data center space	$6,510.00	$16,275.00
Energy costs	$56,478.42	$219,808.76
Rack costs	$1,500.00	$3,750.00
Port costs	$1,671.58	$4,178.96
Total	$612,487.04	$1,057,075.12
Savings	**$444,588.08**	
Percentage savings	**42.06%**	

Figure 4: Cost analysis summary.

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[2] Please note that though we did not test with two switches per enclosure, a real-world company would include a second switch in each chassis for redundancy. We have included the cost of redundant switches in our analysis.

DON'T FORGET THE RAS

The Dell PowerEdge M820 is powered by Intel Xeon processors E5-4600 v2, which have a number of key RAS features to keep workloads running in a highly dense form factor.

If density is not your top priority, the Dell PowerEdge R920 rack server features all the RAS capabilities of the Intel Xeon E7 v2 processor family for maximum protection. See www.dell.com/us/business/p/poweredge-r920/pd for details.

For maximum RAS
We've also put the Intel Xeon processor E7 v2-based Dell PowerEdge R920 to the test in our labs.

To learn more about what it can offer, see our reports at www.principledtechnologies.com/Dell/R920_Oracle12c_PBD_0314.pdf and www.principledtechnologies.com/Dell/R920_Oracle_NVME_SSD_0314.pdf.

The Dell PowerEdge M820 offers many reliability, availability, and serviceability features in the Intel Xeon processor E5-4600 v2 chipset to keep your workloads running. The Intel Xeon processor E5-4600 v2 is the density-optimized four-socket solution from Intel. The Intel Xeon processor E7 family offers more RAS features than the E5 v2 family for customers with maximum high availability concerns, but requires a larger form factor to utilize the processing resources. While some organizations may require the additional RAS of the Intel Xeon E7 processor family, many organizations may be better served by the balance of density, performance, and high availability that Intel Xeon E5-4600 v2 processors provide. In this section, we detail the RAS features that the dense PowerEdge M820 utilizes and compare them to those of the Intel Xeon processor E7 chipset. If your organization requires the highest level of RAS features, Dell offers the PowerEdge R920 rack server with Intel Xeon E7 family processors.

The Dell PowerEdge M820 is equipped to handle many common errors that can bring a system down. It utilizes the following important RAS features to increase workload uptime:

- **Single Device Data Correction (SDDC)**, which allows for recovery from single-chip memory failure
- **Failed DIMM identification/isolation**, which alerts administrators to a specific failing DIMM channel pair for easy replacement
- **Memory sparing**, which moves excessive correctable errors to a spare area to prevent failure
- **Demand and patrol scrubbing**, which searches for correctable errors proactively and writes corrected data back to the memory
- **Memory thermal throttling**, which prevents DIMMs from overheating and failing
- **Memory mirroring intra-socket**, which keeps a copy of memory contents in case of failure
- **Memory address parity protection**, which detects transient errors on the address lines of the DDR channel

Figure 5 shows the number of important memory RAS features that the Intel Xeon E7 and E5 v2 processor families share.

RAS feature commonality
Data protection
Memory address parity protection
Advanced error-correcting (ECC) memory
Error containment
Error-handling architecture
Machine Check Architecture (MCA)

RAS feature commonality
Corrected Machine Check Interrupt (CMCI)
PCI Express® Advanced Error Reporting (AER)
Server management support
Failed/failing DIMM identification
Predictive failure analysis (PFA) support
In-field diagnosability

Figure 5: RAS features present in both the Intel Xeon E5 v2 and E7 processor families.

While the Intel Xeon E7 processor family incorporates a number of additional RAS features, including Double-chip spare (DDC +1), Intel SMI Clock, and Lane failover, the Intel Xeon E5-4650 v2-powered Dell PowerEdge M820 offers RAS at a level that many organizations find suit their needs.

CONCLUSION

Finding a server that can deliver the right balance of high workload performance, density, and RAS features can help you meet both infrastructure and business goals at the same time.

In our tests, the single-width Dell PowerEdge M820 blade delivered 19.3 percent better Oracle Database 12*c* performance than the HP ProLiant BL680c G7 in half the space, meaning it could deliver 2.38 times more transactions per U. The value of the denser Dell PowerEdge M820 was clear in our cost analysis of the two systems. Because the Dell PowerEdge M820 takes up less space, you need fewer enclosures, less rack space, and can save on port costs. In our sample comparison of two performance-equivalent solutions, we found that the Dell PowerEdge M820 solution could save up to 42.1 percent compared to an HP ProLiant BL680c G7 solution. That's money that you can use to buy even more servers for greater performance or to innovate elsewhere. We also found that the Dell PowerEdge M820 took high availability into account by utilizing key RAS features to help increase your workload uptime.

If you're looking for a dense blade solution to lower costs with the power to handle your important workloads and keep them running, our study shows that the Dell PowerEdge M820 blade addresses all those concerns.

APPENDIX A – ABOUT THE COMPONENTS

About the Dell PowerEdge M820

The Dell PowerEdge M820 is a scalable, full-height blade server powered by eight-core Intel Xeon processor E5-4600 v2-series units in a four-socket configuration with the power needed to drive the most computation-intensive applications. The PowerEdge M820 supports up to 1.5TB of DDR3 RAM across 48 slots, providing both capacity and bandwidth to maximize throughput and reduce storage I/O. It has multiple hot-plug storage options including SAS, SSD, and Express Flash PCIe® SSDs. Along with other blade servers in the PowerEdge line, the PowerEdge M820 fits right in with the power-efficient Dell PowerEdge M1000e Blade Enclosure.

For more information about the Dell PowerEdge M820, see www.dell.com/us/enterprise/p/poweredge-m820/pd.

About HammerDB

HammerDB is an open-source benchmark tool that tests the database performance of many leading databases, including Oracle Database, Microsoft® SQL Server®, PostgreSQL®, MySQL™, and more. The benchmark includes two built-in workloads derived from industry-standard benchmarks: a transactional (TPC-C-like) workload and a data warehouse (TPC-H-like) workload. For this study, we used the transactional workload. Our tests were not official TPC results and are not comparable in any manner. For more information about HammerDB, visit hammerora.sourceforge.net.

APPENDIX B – SYSTEM CONFIGURATION INFORMATION

Figure 6 provides detailed configuration information for the test systems.

System	Dell PowerEdge M820	HP ProLiant BL680c G7
Enclosure		
Model	Dell PowerEdge M1000e	HP BladeSystem c7000
Power subsystem		
Vendor	Dell	HP 2400W HE PSU
Wattage	2700 W	2400 W
Number	6	6
First I/O module		
Vendor and model	Dell PowerConnect M8024-k	HP VC Flex-10 enet
Type	10Gbs, SFP+	10Gbs, SFP+
Number	1	1
Second I/O module		
Vendor and model	Dell GBE Pass-Through	HP 1Gb Ethernet Pass-Thru
Type	1Gbs, RJ45	1Gbs, RJ45
Number	2	2
General		
Number of processor packages	4	4
Number of cores per processor	10	10
Number of hardware threads per core	2	2
System power management policy	Default	Default
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	E5-4650 v2	E7-4870
Socket type	2011LGA	2011LGA
Core frequency (GHz)	2.40	2.40
L1 cache	32 KB (per core)	32 KB (per core)
L2 cache	256 KB (per core)	256 KB (per core)
L3 cache	25 MB	30 MB
Platform		
Vendor and model number	Dell PowerEdge M820	HP ProLiant BL680c G7
Motherboard model number	OR58H9	OX437F
BIOS name and version	2.0.25	I25 07.01.2013
BIOS settings	Default	Default
Memory module(s)		
Total RAM in system (GB)	256	256
Vendor and model number	Samsung M393B2G70BH0-YH9	Samsung M393B5673FH0-CH9
Type	PC3-10600R	PC3-10600R
Speed (MHz)	1,333	1,333

System	Dell PowerEdge M820	HP ProLiant BL680c G7
Speed running in the system (MHz)	1,333	1,333
Timing/Latency (tCL-tRCD-tRP-tRASmin)	9-9-9-24	9-9-9-24
Size (GB)	16	16
Number of RAM module(s)	16	16
Chip organization	Double-sided	Double-sided
Rank	Dual	Dual
Operating system		
Name	Oracle VM Server	Oracle VM Server
Build number	3.3.1	3.3.1
File system	ext4	ext4
Kernel	3.8.13-26.4.2el6uek.x86_64	3.8.13-26.4.2el6uek.x86_64
Language	English	English
Graphics		
Vendor and model number	Matrox® G200eR2	AMD®/ATI™ ES1000
Graphics memory (MB)	16	32
RAID controller		
Vendor and model number	Dell PERC H710 Mini	HP Smart Array P410i
Firmware version	21.3.0-0009	6.40
Cache size (MB)	512	1024
Hard drives		
Vendor and model number	Seagate® ST973452SS	HP DH0072FAQRD
Number of drives	4	4
Size (GB)	73	73
RPM	15k	15k
Type	SAS	SAS
Ethernet adapters		
First network adapter		
Vendor and model number	Intel X520-k	HP NC553i Emulex
Type	PCIe	PCIe
Driver	Ixgbe 3.18.7	be2n2t 4.9.224.0u
Second network adapter		
Vendor and model number	Broadcom® BCM57810	HP NC542m Mellanox
Type	Mezzanine	Mezzanine
Driver	1.78.80 (Dec 2013)	mlx4_en v2.1.8 (May 8 2014)
USB ports		
Number	3 external, 1 internal	2 external, 1 internal
Type	2.0	2.0

Figure 6: System configuration information for the test systems.

Figure 7 details the configuration of the storage array we used in our tests.

Storage array	
Storage Array Model	Dell EqualLogic™ PS6210X
Firmware	7.0.5
Language	English
Storage array disks	
SSD type	
Vendor and model number	SanDisk® LB406M
Capacity (GB)	400
Quantity	7
HDD type	
Vendor and model number	Seagate ST9600205SS
Cache Size (MB)	16
RPM	10k
Capacity (GB)	600
Quantity	18

Figure 7: Storage configuration information.

APPENDIX C – HOW WE TESTED

Overview of our configuration

We configured each blade server with the Oracle virtual machine server environment, using iSCSI storage for the VMs' disks. We connected each blade chassis to the iSCSI storage array via one 10GbE network connection and to the VM and management networks through two 1GbE connections.

We created four VMs on each blade. Each VM had 50GB of RAM and five vCPUs, and ran Oracle Linux® 6 Update 5 with the UEK kernel as well as Oracle Database 12*c* R1 with ASM disk-volume management as an application.

Configuring the Oracle Virtual Machine environment

Each blade server had its BIOS set to its default values.

Installing Oracle VM Server 3.3.1

1. Boot the Oracle VM Server install disk.
2. At the Oracle VM boot options screen, click Enter.
3. Select Skip to skip the media check and continue to the installer.
4. At the Welcome to Oracle VM Server screen, click OK.
5. At the Language Selection screen, select English, and click OK.
6. At the Keyboard Selection screen, select US, and click OK.
7. Accept the Oracle VM Server license.
8. At the drive re-initialization warning screen, click Re-initialize all.
9. At the Partitioning Type screen, select replace existing Linux system, select the root device, and click OK.
10. At the Writing storage configuration to disk screen, click Write changes to disk.
11. At the Boot Loader Configuration screen, select the desired drive for the boot loader, and click OK.
12. At the Oracle VM Management Interface screen, select the desired management Ethernet port, and click OK.
13. At the IPv4 Configuration screen, select Manual address configuration, enter the management interface's IP address and network prefix, and click OK.
14. At the Miscellaneous Network Settings screen, enter the IP addresses for the Gateway and Primary DNS, and click OK.
15. At the Hostname Configuration screen, select manually, enter the server's hostname for the server, and click OK.
16. At the Time Zone Selection screen, select the desired time zone, and click OK.
17. At the Oracle VM Agent password screen, enter and confirm the desired password, and click OK.
18. At the Root Password screen, enter and confirm the desired root password, and click OK.
19. At the Installation to begin screen, click OK.
20. Once the installation has completed, click Reboot.
21. Log on to the server as root and update the software:

```
yum update
```

Installing Oracle VM Manager 3.3.1

We first installed the Oracle Linux 6 Update 5, 64-bit, on the auxiliary server and performed the following post-configuration tasks:

1. Disable firewall services:

```
service iptables stop;  chkconfig iptables off
service ip6tables stop; chkconfig ip6tables off
```

2. Disable SELinux by modifying the file /etc/selinux/config by changing the line `SELINUX=enabled` to `SELINUX=disabled`.

3. Modify the file /etc/hosts to include the IP addresses and hostnames of the VM servers and VM (yet to be created).

4. Copy the OVMM installation ISO and OVM VNC console package to the auxiliary server.

5. Log in as the root user.

6. Mount the OracleVM Manager installation IOS locally:

```
mount -o loop ovmm-3.3.1-installer-OracleLinux-b1065.iso /mnt
```

7. Log in as the root user, and run the preparatory script:

```
/mnt/createOracle.sh
```

8. Run the installer:

```
/mnt/runInstaller
```

9. On the select an installation type screen, enter `1`.

10. When prompted, enter the password for the application's accounts.

11. When prompted, enter the management server's hostname.

12. When prompted to start the installation, enter `1`.

13. When the installation completes, remove the temporary directory and unmounts the installation ISO.

```
rm –rf /tmp/ovm_config*
umount /mnt
```

14. Install the Oracle VNC console:

```
yum localinstall ovmcore-console-1.0-36.el6.noarch
```

Configuring the Oracle VM environment in Oracle VM Manager Web-console

1. Log on to the Oracle VM Manager Web-console from a client system; that is, in a Web browser, open a URL similar to this: https://<name of the OVMM server>:7002/ovm/console/faces/login.jspx

2. Select the Servers and VMs tab.

3. Click the Discover Servers button to begin the discovery wizard.

4. Leave the Oracle VM Agent Port at the default setting of 8899.

5. Enter a password for the Oracle VM Agent.

6. Enter the IP address for the new Oracle VM Server, and click OK.

7. After the server is added, go back to the Servers and VMs tab, and click Create Virtual NICs.

8. Click Auto Fill to automatically fill in the initial MAC address, select the number of virtual NICs to create, click Create, and click OK.

9. On the Servers and VMs tab, click Create Server Pool.

10. Enter a name and virtual IP address for the server pool.

11. Uncheck the box for Clustered Server Pool, and click Next.

12. On the Add Servers screen, select the newly added Oracle VM Server, click the right arrow to add it, and click Finish.

13. Once the Create Server Pool task completes, select the Repositories tab.

14. To begin adding storage repositories, click the + button.

15. Enter a name for the first repository.

16. Select Physical Disk, select the new server pool, and click the magnifying glass.

17. Select the desired physical disk from the list, and click OK.

18. Click Next.

19. Select the Oracle VM Server, add it to the list of servers to present the repository to, and click Finish.

20. Complete steps 14 through 19 for each physical disk RAID group: OS, Log, and Data.

21. For our testing, we also set up local repositories to store the Oracle Linux 6 Update 5 ISO and VM backups.

Creating VMs for Oracle Linux 6 and Oracle Database 12*c*

We installed Oracle Linux 6 Update 5 on each VM with additional configurations as specified below.

Creating the first virtual machine

1. On the Servers and VMs tab, click the Create Virtual Machine button.

2. Select Create a new VM, and click Next.

3. Select the new Oracle VM Server.

4. Select the OS repository to store the VM files.

5. Enter a name for the new VM.

6. Select Oracle Linux 6 for the Operating System.

7. For the Domain Type, select Xen HVM, PV drivers.

8. For Max Memory and Memory, enter 50000.

9. For Max Processors and Processors, enter 5.

10. Click Next.

11. On the Set up Networks, select an unassigned VNIC on the desired test network, and click Add VNIC.

12. Click Next.

13. For Slot 0, select CD/DVD.

14. Click the magnifying glass, and select the Oracle Linux 6 Update 5 ISO uploaded on the NFS, and click OK.

15. For Slot 1, select Physical Disk.

16. Click the magnifying glass, and select an OS physical disk.

17. Repeat steps 15 and 16 for one Log and one Data physical disk.

18. Click Next.

19. Add Disk and CDROM to the boot options list.

20. Click Finish.

21. Once Oracle Linux 6 Update 5 is installed, shut down the VM, change Slot 0 to empty, and edit the VM type to Xen PVM for the best performance. PVM natively does not allow boot from CDROM.

Virtual Machines: Oracle Linux 6 Update 5 and Oracle Database 12*c*

We configured each VM with one virtual disk on our OS repository running Oracle Linux 6 Update 5 with Oracle Database 12*c*, four virtual disks on our log repository presented to Oracle ASM for redo logs, and four virtual disks on our data repository presented to Oracle ASM for database data files. Below are the detailed steps we used to configure the software.

Installing Oracle Linux 6 Update 5

1. Configure the first VM to boot to the Oracle Linux 6 Update 5 ISO, and power it on.
2. Click the console button for the VM in the Oracle VM management console from a client with VNC Viewer installed.
3. Once the install screen loads, select Install or upgrade an existing system.
4. If you are unsure of the fidelity of the installation disk, select OK to test the installation media; otherwise, select Skip.
5. In the opening splash screen, select Next.
6. Choose the language you wish to use, and click Next.
7. Select the keyboard layout, and click Next.
8. Select Basic Storage Devices, and click Next.
9. Select Fresh Installation, and click Next.
10. Insert the hostname, and select Configure Network.
11. In the Network Connections menu, configure network connections.
10. After configuring the network connections, click Close.
11. Click Next.
12. Select the nearest city in your time zone, and click Next.
13. Enter the root password, and click Next.
14. Select Use All Space, and click Next.
15. Select the appropriate Data Store Device and select where the Bootloader will go.
16. Modify the Swap file to 20GB.
17. When the installation prompts you to confirm that you are writing changes to the disk, select Write changes to disk.
18. Select Software Basic Server, and click Next. Oracle Linux installation begins.
19. When the installation completes, select Reboot to restart the VM.

Initial configuration tasks

Complete the following steps to provide the functionality that Oracle Database requires. We performed all of these tasks as root.

1. Disable firewall services. In the command line (as root), type:
   ```
   service iptables stop;  chkconfig iptables off
   service ip6tables stop; chkconfig ip6tables off
   ```
2. Disable SELinux by modifying the file /etc/selinux/config by changing the line `SELINUX=enabled` to `SELINUX=disabled`.
3. Modify /etc/hosts to include the IP address of the VM and the hostname.
4. Install 12*c* RPM packages, install package dependencies, and modify kernel parameters:
   ```
   yum -y install oracle-rdbms-server-12cR1-preinstall
   ```

---

5. Install the following prerequisite package for Oracle ASM support:
    ```
    yum install oracleasm-support
    ```
6. Create the oracle groups, assign them to the oracle user and set its password:
    ```
    groupadd -g 1003 oper
    groupadd -g 1004 asmadmin
    groupadd -g 1005 asmdba
    groupadd -g 1006 asmoper
    usermod -G dba,oper,asmadmin,asmdba,asmoper oracle
    passwd oracle
    ```
7. Create the standard Oracle directory structure:
    ```
    mkdir -p /u01/app/oracle/product/12.1.0/grid
    mkdir -p /u01/app/oracle/product/12.1.0/dbhome_1
    chown -R oracle:oinstall /u01
    chmod -R 775 /u01
    ```
8. Modify the bash profiles for the oracle and grid environments. Append the following three sets of bash commands to the files /home/oracle/.bash_profile, /home/oracle/data_env and /home/oracle/grid_env:

    ```
    cat >> / home/oracle/.bash_profile << _EOF_1
    # Oracle settings for the database environment
    export TMP=/tmp
    export TMPDIR=$TMP
    export ORACLE_BASE=/u01/app/oracle
    export GRID_HOME=$ORACLE_BASE/product/12.1.0/grid
    export DATA_HOME=$ORACLE_BASE/product/12.1.0/dbhome_1
    export ORACLE_HOME=$DATA_HOME
    export ORACLE_SID=orcl
    export BASE_PATH=/usr/sbin:$PATH
    export PATH=$ORACLE_HOME/bin:$BASE_PATH
    export LD_LIBRARY_PATH=$ORACLE_HOME/lib:/lib:/usr/lib
    # Two shortcuts for switching between database and grid environments.
    alias grid_env='. /home/oracle/grid_env'
    alias data_env='. /home/oracle/data_env'
    _EOF_1

    cat > / home/oracle/data_env << _EOF_2
    # switch to Oracle database environment
    export ORACLE_SID=orcl
    export ORACLE_HOME=$DATA_HOME
    export PATH=$ORACLE_HOME/bin:$BASE_PATH
    export LD_LIBRARY_PATH=$ORACLE_HOME/lib:/lib:/usr/lib
    _EOF_2

    cat > / home/oracle/grid_env << _EOF_3
    # switch to Oracle grid environment
    export ORACLE_SID=+ASM
    export ORACLE_HOME=$GRID_HOME
    export PATH=$ORACLE_HOME/bin:$BASE_PATH
    export LD_LIBRARY_PATH=$ORACLE_HOME/lib:/lib:/usr/lib
    ```

```
  _EOF_3
```

9. Create disk partitions for ASM using parted:
```
for disk in d e; do
  parted /dev/xvd${disk} mklabel gpt
  parted /dev/xvd${disk} mkpart primary "1 -1"
done
```

10. Configure ASM and load its modules:
```
oracleasm configure -e -s y -u oracle -g asmadmin
oracleasm init
```

11. Add physical LUNs as ASM disks:
```
oracleleasm createdisk DISK1 /dev/xvdd1
oracleleasm createdisk LOG1  /dev/xvde1
```

Installing Oracle Grid Infrastructure 12*c*

1. Log in as the oracle user.
2. Unzip linuxamd64_12c_grid_1of2.zip and linuxamd64_12c_grid_2of2.zip.
3. Open a terminal to the unzipped database directory.
4. Set the Oracle grid environment.
5. To start the installer, type `./runInstaller`
6. At the software Updates screen, select Skip updates.
7. In the Select Installation Option screen, select Install and Configure Grid Infrastructure for a Standalone Server, and click Next.
8. Choose the language, and click Next.
9. In the Create ASM Disk Group screen, choose the Disk Group Name, and change redundancy to External.
10. Select the four ASM disks that you are planning to use for the database, and click Next.
11. In the Specify ASM Password screen, write the passwords for the ASM users, and click Next.
12. Leave the default Operating System Groups, and click Next.
13. Leave the default installation, and click Next.
14. Leave the default inventory location, and click Next.
15. Under Root script execution, select Automatically run configuration scripts and enter root credentials.
16. In the Prerequisite Checks screen, make sure that there are no errors.
17. In the Summary screen, verify that everything is correct, and click Finish to install Oracle Grid Infrastructure.
18. At one point during the installation, the installation prompts you to execute two configuration scripts as root. Follow the instructions to run the scripts.
19. At the Finish screen, click Close.
20. In preparation for the database installation, create an ASM disk-group, named REDO, for the database redo logs:
```
asmca -silent -createDiskGroup -sysAsmPassword Password1 \
    -asmsnmpPassword Password1 -diskGroupName REDO -disk \
    '/dev/oracleasm/disks/LOG1' -redundancy EXTERNAL
```

Installing Oracle Database 12*c*

1. Log in as the oracle user.

---

2. Unzip linuxamd64_12c_database_1_of_2.zip and linuxamd64_12c_database_2_of_2.zip.
3. To start the installer, type `./runInstaller`
4. In the Configure Security Updates screen, uncheck I wish to receive security updates via My Oracle Support, and click Next.
5. If you receive a warning about the email address not being specified, click Yes to continue.
6. At the Software Updates screen, select Skip Software Updates and click Next.
7. In the Select Installation Option screen, select Install database software only, and click Next.
8. Select Single instance database installation, and click Next.
9. Select the language, and click Next.
10. In the Select Database Edition screen, select Enterprise Edition, and click Next.
11. In the Specify Installation Location screen, accept the defaults, and click Next.
12. At the operating System groups screen select the appropriate groups and click Next.
13. At the summary screen click Install.

Installing and configuring the Oracle database
1. Log in as the oracle user.
2. Enter `dbca` and press Enter to open the Database configuration assistant.
3. At the Database Operation screen, select Create Database, and click Next.
4. Under Creation Mode, select Advanced Mode, and click Next.
5. At the Select Template screen, select General Purpose or Transaction Processing. Click Next.
6. Enter a Global database name and the appropriate SID.
7. At the Management Options screen, select Configure Enterprise Manager (EM) Database Express. Click Next.
8. At the Database Credentials screen, select Use the Same Administrative Password for All Accounts. Enter a password, and click Next.
9. At the Network Configuration screen, click Next.
10. At the Storage Configuration screen select Automatic Storage Management, and select `+DATA` as the Database File Location, and /backup as the Fast Recovery Area with a 150GB Fast Recover Area size.
11. At the Database Options screen click Next.
12. At the Initialization Parameters screen, click Next.
13. At the Creation Options, select Create Database, and click Next.
14. At the summary screen, click Finish.
15. Close the Database Configuration Assistant.

    We then configured our database with a custom spfile. For details on the specific Oracle database configuration, see Appendix D.

Creating redo logs
1. Log in to sqlplus and create two log groups with 250GB files on +LOG:
   ```
   sqlplus / as sysdba
   ALTER DATABASE ADD LOGFILE GROUP 10 ('+LOG/ORCL/ONLINELOG/log1.rdo')size 19g;
   ALTER DATABASE ADD LOGFILE GROUP 11 ('+LOG/ORCL/ONLINELOG/log2.rdo')size 19g;
   ```
2. Remove the three default redo log groups.

Setting up the HammerDB client

We used a dual-processor auxiliary server running Oracle Linux 6 Update 5, 64-bit, for the HammerDB client. We installed the operating system, following the instructions in section Installing Oracle Linux 6 Update. We then installed the HammerDB client software.

Installing HammerDB

We downloaded HammerDB 2.16 64-bit from the following location: hammerora.sourceforge.net. We installed HammerDB according to the installation guide (hammerora.sourceforge.net/hammerdb_install_guide.pdf), including the installation of one additional software package: libXScrnSaver-devel.

Installing Oracle Client libraries for HammerDB

1. Copy the Oracle 12*c* database client software, linuxamd64_12102_client.zip, to the auxiliary server.
2. Extract the archives contents to directory/client:

```
mkdir /client
cd /client
unzip ~/linuxamd64_12102_client.zip
chmod –R a+rX /client
```

3. Log on to the server as the oracle user.
4. Launch the Oracle Client Installer:

```
/client/runInstaller
```

5. In Select Installation Type, select Administrator (1.8 GB) as the installation type, and click Next.
6. In Software Updates, select Skip software updates, and click Next.
7. In Select Product Languages, select English and click the right-pointing arrow located between the two selection panels to add English to the Selected languages panel. Click Next.
8. In Specify Installation Location, accept the default locations provided, and click Next.
9. In Create Inventory, accept the defaults, and click Next.
10. In Summary, review the information, and click Install to begin installation.
11. In Install Product, follow the instructions to execute the scripts. Click OK when the scripts have completed.
12. In Finish, click Close to exit the installer.

Configuring the database

We used the TPC-C build schema build options for Oracle inside HammerDB to build the database. We set the following options in the build schema:

```
Oracle Service Name = R920_IP_addres/orcl
System user = system
System User Password = Password1
TPC-C User = tpcc
TPC-C User Password = tpcc
TPC-C Default Tablespace = tpcc
Order Line Tablespace = tpcc_ol
TPC-C Temporary Tablespace = temp
TimesTen Database Commatible = unchecked
Partition Order Line Table = checked
Number of Warehouses = 5000
Virtual Users to Build Schema = 60
```

```
Use PL/SQL Server Side Load = unchecked
Server Side Log Directory = /tmp
```

Running HammerDB

We ran HammerDB by filling in the appropriate information for the driver options. We tested with a 5-minute ramp up time and 5-minute test duration. We used 101 virtual users with 500-ms user delay and repeat delay. We used rman to back up the database and restore between runs.

APPENDIX D – COST ANALYSIS

Figure 8 breaks down the costs for two performance-equivalent solutions. Based on the assumptions in this table, we estimate that the Dell PowerEdge M820 solution can save up to 42.1 percent over the HP ProLiant BL680c G7 solution.

Dell PowerEdge M820 solution		HP ProLiant BL680c G7 solution	
Configuration size			
Number of servers	16	Number of servers	20
Number of servers per enclosure	8	Number of servers per enclosure	4
Number of enclosures	2	Number of enclosures	5
Enclosure size in U	10	Enclosure size in U	10
Solution size in U	20	Solution size in U	50
Ports per enclosure	2	Ports per enclosure	2
Cores per server (four 10-core processors per server)	40	Cores per server	40
Solution rack costs			
Number of racks per solution (40 available U per rack)	0.5	Number of racks per solution (40 available U per rack)	1.25
Cost per rack	$3,000.00	Cost per rack	$3,000.00
Total cost for racks for solution	$1,500.00	Total cost for racks for solution	$3,750.00
Individual networking switch			
Dell Networking S50V Switch with 48 Force10, Cable, 10GBASE-CX4, 3 Meters (with 3-year ProSupport included)	$20,059.00	Assume same switch for both	$20,059.00
Ports per switch	48.00		48.00
Cost per port	$417.90		$417.90
Switch cost per enclosure	$835.79		$835.79
Total switch cost for solution	$1,671.58		$4,178.96
Individual enclosures			
Dell PowerEdge M1000e Blade Server Enclosure with 1x Dell PowerConnect M8024 Managed Switches with Basic Support	$16,829.84	HP BladeSystem C7000 with 1X HP VC Flex-10	$32,538.00
ProSupport Plus for Dell PowerEdge M1000 Blade Server Enclosure with 1x Dell PowerConnect M8024 Managed Switches	$3,610.36	HP 3y 4h 24x7 c7000 ProCare Service for chassis and 3 year 24/7 blade switch hardware support	$6,276.00
Hardware and support subtotal	$20,440.20	Hardware and support subtotal	$38,814.00

Dell PowerEdge M820 solution			HP ProLiant BL680c G7 solution		
Energy costs					
Watts per fully loaded enclosure		4989.00	Watts per fully loaded enclosure		3293.00
Energy costs for power and cooling		$7,799.01	Energy costs for power and cooling		$5,147.75
Total costs per enclosure		$28,239.21	Total costs per enclosure		$43,961.75
Total cost for enclosures for solution		$56,478.42	Total cost for enclosures for solution		$219,808.76
Individual servers					
Dell PowerEdge M820		$30,739.84	HP ProLiant BL680c G7 Server Blade		$37,557.12
Dell ProSupport Plus: 3 Year Mission Critical 4 hour Onsite Service		$3,405.60	HP 3 year 4 hour 24x7 ProCare Service		$3,096.00
Server hardware subtotal		$34,145.44	Server subtotal		$40,653.12
Total cost for server hardware and hardware support for solution		$546,327.04	Total cost for servers for solution		$813,062.40
Total hardware costs for solution		$605,977.04	Total hardware costs for solution		$1,040,800.12
Data center space costs					
Data center space costs (3 year cost)		$6,510.00	Data center space costs (3 year cost)		$16,275.00
Solution totals					
Total cost for performance-comparable configurations		$612,487.04	Total cost		$1,057,075.12
Savings		**$444,588.08**			
Percentage savings		**42.06%**			

Figure 8: Cost breakdown for our solution cost analysis.

Server costs

We took the prices for the hardware from the Dell and HP Web sites on August 5, 2014. Prices do not include tax or shipping.

Energy costs

We did not measure power in our tests, and base our energy usage estimates on the power calculators that the vendors provide on their Web sites. We used these tools to determine what the hardware energy usage would be as configured for our tests. From these estimates, we assume that the Dell server uses 4,539 watts at 80 percent active/20 percent idle and the HP server uses 2,941 watts at 80 percent active/20 percent idle.

Figure 9 details our energy cost assumptions, which are the average kWh for the year ending in May 2014.[3]

Energy cost assumptions	
Cost per kWh	0.1049
Hours per year (average)	8,766
Data Center PUE	1.7

Figure 9: Energy cost assumptions.

Data center space costs

For data center costs, we assume $310 per year per square foot, with each rack using 14 square feet of floor space and having 40 useable rack space units. Figure 10 shows our assumptions for data center costs.

Data center cost assumptions	
Cost per square foot	$310.00
Usable U per rack	40
Number square feet per rack	14
Years	3
Three year cost per rack unit	$325.50

Figure 10: Data center space cost assumptions.

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[3] www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_3

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