The science behind the report:

Serve more customers with the Dell EMC PowerEdge R740 and 2nd Generation Intel Xeon Scalable processors

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 Serve more customers with the Dell EMC PowerEdge R740 and 2nd Generation Intel Xeon Scalable processors.

We concluded our hands-on testing on May 8, 2019. 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 April 10, 2019 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

System configuration information

The table below presents detailed information on the systems we tested.

Server configuration information	Dell EMC™ PowerEdge™ R740	HPE ProLiant DL380 Gen9
BIOS name and version	2.1.6	2.62
Operating system name and version/build number	RHEL 7.6	RHEL 7.6
Date of last OS updates/patches applied	04/10/19	04/10/19
Power management policy	Performance	Performance
Processor		
Number of processors	2	2
Vendor and model	Intel® Xeon® Gold 6230	Intel Xeon E5-2667 v3
Core count (per processor)	20	8
Core frequency (GHz)	2.1	3.2
Stepping	1	R2

Server configuration information	Dell EMC™ PowerEdge™ R740	HPE ProLiant DL380 Gen9
Memory module(s)		
Total memory in system (GB)	256	256
Number of memory modules	16	8
Vendor and model	Samsung M393A4K40CB2-CTD	HPE SmartMemory 840758-091
Size (GB)	16	32
Type	DDR4 PC4-21300	DDR4 PC4-21300
Speed (MHz)	2,666	2,666
Speed running in the server (MHz)	2,666	2,133
Storage controller		
Vendor and model	Dell PERC H740P	HP Smart Array P440ar Controller
Cache size (GB)	8	2
Firmware version	50.5.0-1750	6.60
Local storage A		
Number of drives	2	N/A
Drive vendor and model	Dell Intel SSDSCKJB120G7R	N/A
Drive size (GB)	120	N/A
Drive information (speed, interface, type)	M.2 SSD	N/A
Local storage B		
Number of drives	8	8
Drive vendor and model	Intel D3-S4510	Intel S3700
Drive size (GB)	1,920	400
Drive information (speed, interface, type)	SSD, SATA	SSD, SATA
Network adapter		
Vendor and model	Intel 25GbE 2P XXV710	HPE Ethernet 1Gb 4-port 331i
Number and type of ports	2 x 25GbE	4 x 1GbE
Driver version	3.6.15	20.14.54
Cooling fans		
Vendor and model	Sunon VF60381B1	HP 777285-001
Number of cooling fans	6	6
Power supplies		
Vendor and model	Dell 450-AEBL	HP 720479-B21
Number of power supplies	2	2
Wattage of each (W)	1,100	800

How we tested

Installing Red Hat® Enterprise Linux® 7.6

1. Insert the Red Hat Enterprise Linux 7.6 installation media into the server, and boot to it.
2. Select Install or upgrade an existing system.
3. Choose the language you wish to use, and click Continue.
4. Select Installation Destination.
5. Select the desired disk for the OS.
6. Under Other Storage Options, select I will configure partitioning.
7. Click Done.
8. Select Click here to create them automatically.
9. Remove the /home partition.
10. Expand the swap partition to 20GB.
11. Assign all remaining free space to the / partition.
12. Click Done.
13. Click Accept Changes.
14. Select Kdump.
15. Uncheck Enable kdump, and click Done.
16. Select Network & Hostname.
17. Enter the desired hostname for the VM.
18. Turn on the desired network port, and click Configure.
19. On the General tab, select Automatically connect to this network when it is available.
20. On the IPv4 Settings tab, under Method, select Manual.
21. Under Addresses, click Add, and enter the desired static IP information for the server.
22. Enter the desired DNS information.
23. Click Save, and click Done.
24. Select Date & Time, and ensure you have set the correct date, time, and time zone.
25. To add your NTP server, click the cog next to the Network Time On/Off switch.
26. Add the IP address of your NTP server, and click +.
27. Uncheck all other NTP servers.
28. Click OK.
29. Click Done.
30. Click Begin Installation.
31. Select Root Password.
32. Enter the desired root password, and click Done.
33. When the installation completes, select Reboot to restart the server.

Configuring Red Hat Enterprise Linux 7.6 for Oracle

1. Log on to the server as root.
2. Disable the firewall:

```
systemctl stop firewalld
systemctl disable firewalld
```

3. Disable SELinux:

```
vi /etc/selinux/config
SELINUX=disabled=
```

4. Update RHEL 7.6:

```
yum update -y
```

5. Using yum, install the following prerequisite packages for Oracle Database:

```
yum install -y binutils.x86_64 compat-libstdc++-33 compat-libstdc++-33.i686 compat-libcap1.x86_64
gcc.x86_64 gcc-c++.x86_64 glibc.i686 glibc.x86_64 glibc-devel.i686 glibc-devel.x86_64 ksh libaio.i686
libaio.x86_64 libaio-devel.i686 libaio-devel.x86_64 libdmx libgcc.i686 libgcc.x86_64 libstdc++.i686
libstdc++.x86_64 libstdc++-devel.i686 libstdc++-devel.x86_64 libXi.i686 libXi.x86_64 libX11 libXau
libxcb libXext.i686 libXi libXmu libXt libXtst.i686 libXtst.x86_64 libXv libXxf86dga libXxf86misc
libXxf86vm make.x86_64 net-tools nfs-utils smartmontools sysstat.x86_64 unixODBC unixODBC-devel unzip
xhost xorg-x11-apps xorg-x11-utils xorg-x11-xauth zip zlib-devel zlib-devel.i686
```

6. Disable auditd:

```
systemctl disable auditd
```

7. Create Oracle users and groups by running these shell commands:

```
groupadd -g 54321 oinstall
groupadd -g 54322 dba
groupadd -g 54323 oper
groupadd -g 54324 backupdba
groupadd -g 54326 kmdba
groupadd -g 54325 dgdba
groupadd -g 54327 asmdba
groupadd -g 54328 asmoper
groupadd -g 54329 asmadmin

useradd --uid 54321 --gid oinstall --groups
dba,oper,backupdba,dgdba,kmdba,asmdba,asmoper,asmadmin oracle
```

8. Create passwords for the oracle account with passwd.

```
passwd oracle
```

9. Create the following directories, and assign the following permissions.

```
mkdir -p /u01/app/oracle/product/18.0.0.0/grid
mkdir -p /u01/app/oracle/product/18.0.0.0/dbhome_1
chown -R oracle:oinstall /u01
chmod -R 775 /u01/
```

10. On a separate computer, navigate to the RHEL Labs page for the RHEL Tuner for Oracle (https://access.redhat.com/labs/rheltfo/), and fill out the proper details for your system (we put the SGA as 300GB). Click the button to generate the script for your server.
    - Red Hat Enterprise Linux Version: Red Hat Enterprise Linux 7
    - Oracle Group Name/ID: 54321
    - System Global Area (SGA): 235 GB
    - Maximum number of open file descriptors: 65536 (Default)
11. Copy the RHEL Tuner script to your server.
12. On your server, accept all changes, and execute the RHEL Tuner.

```
sh rhel-config-for-oracle.sh
```

13. Append the following to the /etc/security/limits.conf:

```
oracle - nofile 65536
oracle - nproc 16384
oracle - stack 32768
oracle - memlock 134217728
soft memlock unlimited
hard memlock unlimited
```

14. Add the following lines to the .bash_profile for the oracle user:

```
export TMP=/tmp
export TMPDIR=$TMP
export ORACLE_HOSTNAME=<HOSTNAME>
export ORACLE_UNQNAME=orcl
export ORACLE_BASE=/u01/app/oracle
export GRID_HOME=/u01/app/18.0.0.0/grid
export DB_HOME=$ORACLE_BASE/product/18.0.0.0/db_1
export ORACLE_HOME=$DB_HOME
export ORACLE_SID=orcl
export ORACLE_TERM=xterm
export BASE_PATH=/usr/sbin:$PATH
export PATH=$ORACLE_HOME/bin:$BASE_PATH

export LD_LIBRARY_PATH=$ORACLE_HOME/lib:/lib:/usr/lib
export CLASSPATH=$ORACLE_HOME/JRE:$ORACLE_HOME/jlib:$ORACLE_HOME/rdbms/jlib

alias grid_env='. /home/oracle/grid_env'
alias db_env='.    /home/oracle/db_env'
```

15. Create the following files in the oracle user/s home folder.

```
>>>grid_env<<<
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
export CLASSPATH=$ORACLE_HOME/JRE:$ORACLE_HOME/jlib:$ORACLE_HOME/rdbms/jlib
>>>db_env<<<
export ORACLE_SID=orcl
export ORACLE_HOME=$DB_HOME
export PATH=$ORACLE_HOME/bin:$BASE_PATH
export LD_LIBRARY_PATH=$ORACLE_HOME/lib:/lib:/usr/lib
export CLASSPATH=$ORACLE_HOME/JRE:$ORACLE_HOME/jlib:$ORACLE_HOME/rdbms/jlib
```

16. Download and install OracleASM support and lib packages from here: https://access.redhat.com/solutions/315643.
17. Navigate to the directory where you downloaded the OracleASM packages, and install them:

```
yum localinstall -y oracleasm*
```

18. Create a partition on all disks using fdisk.
19. Edit /etc/sysconfig/oracleasm to contain the following:

```
# ORACLEASM_ENABLED: 'true' means to load the driver on boot.
ORACLEASM_ENABLED=true

# ORACLEASM_UID: Default UID owning the /dev/oracleasm mount point.
ORACLEASM_UID=oracle

# ORACLEASM_GID: Default GID owning the /dev/oracleasm mount point.
ORACLEASM_GID=oinstall

# ORACLEASM_SCANBOOT: 'true' means fix disk perms on boot
ORACLEASM_SCANBOOT=true

# ORACLEASM_USE_LOGICAL_BLOCK_SIZE: 'true' means use the logical block
# size reported by the underlying disk instead of the physical. The
# default is 'false' ORACLEASM_USE_LOGICAL_BLOCK_SIZE=false
```

20. Run the following command to initialize oracleasm:

```
oracleasm init
```

21. Run the following commands to configure all of the disks for Oracle ASM:

```
oracleasm createdisk DATA1 /dev/sdb1
oracleasm createdisk DATA2 /dev/sdc1
oracleasm createdisk DATA3 /dev/sdd1
oracleasm createdisk DATA4 /dev/sde1
oracleasm createdisk LOG1 /dev/sdf1
oracleasm createdisk LOG2 /dev/sdg1
```

Installing Oracle Grid Infrastructure 18*c*

1. Log in as the oracle user.
2. Unzip linuxx64_180000_grid_home.zip.
3. Open a terminal to the unzipped database directory.
4. To set the Oracle grid environment, type `grid_env`
5. To start the installation, type `/u01/app/oracle/product/18.0.0/grid/gridSetup.sh`
6. At the Select Installation Option screen, select Install and Configure Grid Infrastructure for a Standalone Server, and click Next.
7. Choose the language, and click Next.
8. At the Create ASM Disk Group screen, choose the Disk Group Name (DATA), and change redundancy to Normal.
9. Change the path to `/dev/oracleasm/disks` and select the DATA disks.
10. At the Specify ASM Password screen, choose Use same password for these accounts, write the passwords for the ASM users, and click Next.
11. At the Management Options screen, 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, leave the defaults, and click Next.
16. At the Prerequisite Checks screen, check for errors.
17. At 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. To run the ASM Configuration Assistant, type `asmca`
21. In the ASM Configuration Assistant, click Create.
22. In the Create Disk Group window, name the new disk group `LOG`, choose Normal Redundancy, and select the two LOG disks.
23. Click Advanced Options.
24. Set the database compatibility level to 18.0.0.0.0, and click OK.
25. Exit the ASM Configuration Assistant.

Installing Oracle Database 18*c*

1. Unzip LINUX.X64_180000_db_home.zip.
2. Open a terminal to the unzipped database directory.
3. To set the first Oracle database environment, type `db_env`
4. Run `/u01/app/oracle/product/18.0.0/dbhome_1/runInstaller`
5. Wait for the GUI installer to load.
6. On the Select Configuration Option, select Set Up Software Only, and click next.
7. On the Select Database Installation Option, select Single instance database installation, and click Next.
8. On the Select Database Edition, select Enterprise Edition, and click Next.
9. On the Specify Installation Location, leave the default Oracle base, and click Next.
10. On the Privileged Operating System groups, keep the default, and click Next.
11. On the Perform Prerequisite Checks, wait for the verification results, fix all errors, and click Next.
12. Review the Summary page, and click Install.
13. Once the Execute Configuration scripts prompt appears, ssh into the server as `root`, and run the following command: `/u01/app/oracle/product/18.0.0/dbhome_1/root.sh`
14. Return to the prompt, and click OK.
15. Once the installer completes, click Close.

Creating and configuring the database

1. Using SSH -X, log into the host.
2. To switch to the first database environment, type `db_env`
3. To open the Database configuration assistant, type `dbca`, and press Enter.
4. At the Database Operation screen, select Create Database, and click Next.
5. Under Creation Mode, select Advanced configuration, and click Next.
6. At the Database Deployment Type screen, select Data Warehouse, and click Next.
7. Enter a Global database name and the appropriate SID, and uncheck Create as Container database. Click Next.
8. At the storage option screen, select Use following for the database storage attributes.
9. In the drop-down menu, select Automatic Storage Management (ASM), select +DATA for the file location, and click Next.
10. At the Fast Recovery Option screen, check the box for Specify Fast Recovery Area.
11. In the drop-down menu, select ASM. For the Fast Recovery Area, select +DATA. For the size, enter 200GB.
12. At the Specify Network Configuration Details screen, select the listener, and click Next.
13. At the Specify Oracle Data Vault Config Option screen, leave the default options, and click Next.
14. At the Specify Configuration Options screen, leave the memory selections to defaults, and click Next.
15. At the Specify Management Options screen, select Configure Enterprise Manager (EM) Database Express, and click Next.
16. At the User Credentials screen, select Use the same administrative password for all accounts, enter and confirm the desired password, and click Next.
17. At the Creation Options screen, select Create Database, and click Next.
18. At the Summary screen, click Finish.
19. Close the Database Configuration Assistant.

Configuring Oracle tablespaces and redo log

Alter the tablespaces on both systems as shown below. To enter SQL prompt, type `sqlplus /` as sysdba.

```
ALTER DATABASE ADD LOGFILE GROUP 11 ( '/tmp/temp1.log' ) SIZE 50M;
ALTER DATABASE ADD LOGFILE GROUP 12 ( '/tmp/temp2.log' ) SIZE 50M;

ALTER SYSTEM SWITCH LOGFILE;
ALTER SYSTEM SWITCH LOGFILE;
ALTER SYSTEM CHECKPOINT;

ALTER DATABASE DROP LOGFILE GROUP 1;
ALTER DATABASE DROP LOGFILE GROUP 2;
ALTER DATABASE DROP LOGFILE GROUP 3;

ALTER SYSTEM SWITCH LOGFILE;
ALTER SYSTEM SWITCH LOGFILE;
ALTER SYSTEM CHECKPOINT;

alter system set "_disk_sector_size_override"=TRUE scope=both;

ALTER DATABASE ADD LOGFILE GROUP 1 ( '+LOG/redo01.log' ) SIZE 150G
BLOCKSIZE 4K;
ALTER DATABASE ADD LOGFILE GROUP 2 ( '+LOG/redo02.log' ) SIZE 150G
BLOCKSIZE 4K;

ALTER SYSTEM SWITCH LOGFILE;
ALTER SYSTEM SWITCH LOGFILE;
ALTER SYSTEM CHECKPOINT;

ALTER DATABASE DROP LOGFILE GROUP 11;
ALTER DATABASE DROP LOGFILE GROUP 12;

SHUTDOWN

STARTUP

HOST rm -f /tmp/temp*.log
```

```
CREATE BIGFILE TABLESPACE "TPCC"
DATAFILE '+DATA/ORCL/DATAFILE/tpcc.dbf' SIZE 200G AUTOEXTEND ON NEXT 1G
BLOCKSIZE 8K
EXTENT MANAGEMENT LOCAL AUTOALLOCATE
SEGMENT SPACE MANAGEMENT AUTO;

CREATE BIGFILE TABLESPACE "TPCC_OL"
DATAFILE '+DATA/ORCL/DATAFILE/tpcc_ol.dbf' SIZE 100G AUTOEXTEND ON NEXT 1G
BLOCKSIZE 16K
EXTENT MANAGEMENT LOCAL AUTOALLOCATE
SEGMENT SPACE MANAGEMENT AUTO;

ALTER DATABASE DATAFILE '+DATA/ORCL/DATAFILE/<UNDO FILE>' RESIZE 32760M;
```

Configuring the Oracle pfile

Alter the Oracle pfile as shown below. To make Oracle use it, enter the following, and restart Oracle:

```
CREATE SPFILE = '+DATA/ORCL/spfileorcl.ora' FROM PFILE='$ORACLE_HOME/pfile.ora'

_ash_enable=FALSE
_awr_restrict_mode=FALSE
_check_block_after_checksum=FALSE
_collect_undo_stats=FALSE
_db_block_check_objtyp=FALSE
_db_block_prefetch_limit=0
_disable_highres_ticks=TRUE
_first_spare_parameter=1
_numa_shift_enabled=FALSE
_resource_manager_always_off=TRUE
_trace_pool_size=0
_use_adaptive_log_file_sync=FALSE
_disable_logging=FALSE
_disable_selftune_checkpointing=TRUE
_disk_sector_size_override=TRUE
_enable_NUMA_interleave=TRUE
_enable_NUMA_support=TRUE
_fast_cursor_reexecute=TRUE
_in_memory_undo=TRUE
_kgl_hot_object_copies=8
aq_tm_processes=0
audit_trail=NONE
commit_logging=BATCH
commit_wait=NOWAIT
db_block_checking=false
db_block_checksum=false
db_block_size=8192
db_cache_size=175g
db_16k_cache_size=32212254720
db_create_file_dest='+DATA'
db_name='orcl'
db_recovery_file_dest='+DATA'
db_recovery_file_dest_size=200g
db_file_multiblock_read_count=4
db_writer_processes=4
diagnostic_dest='/u01/app/oracle'
disk_asynch_io=TRUE
dml_locks=500
fast_start_mttr_target=0
java_pool_size=6442450944
large_pool_size=6442450944
lock_sga=TRUE
log_buffer=1073709056
```

```
log_checkpoint_interval=0
log_checkpoint_timeout=0
log_checkpoints_to_alert=TRUE
open_cursors=2000
parallel_max_servers=0
parallel_min_servers=0
pga_aggregate_target=3589934592
pre_page_sga=FALSE
processes=1000
query_rewrite_enabled=FALSE
remote_login_passwordfile=EXCLUSIVE
replication_dependency_tracking=FALSE
result_cache_max_size=0
shared_pool_size=11811160064
statistics_level='BASIC'
timed_statistics=false
trace_enabled=FALSE
transactions=2000
transactions_per_rollback_segment=1
undo_management=AUTO
undo_retention=2
undo_tablespace=UNDOTBS1
use_large_pages=ONLY
_undo_autotune=FALSE
_db_writer_flush_imu=false
plsql_optimize_level=3
plsql_code_type="NATIVE"
*.compatible='18.0.0'
*.control_files='+DATA/ORCL/CONTROLFILE/current.262.1007103279','+DATA/ORCL/CONTROLFILE/
current.261.1007103279'
*.dispatchers='(PROTOCOL=TCP) (SERVICE=orclXDB)'
*.local_listener='LISTENER_ORCL'
```

Configuring the HammerDB client for Oracle Database

1. Create an Oracle user:

   ```
   useradd oracle
   ```

2. Assign the Oracle user a password:

   ```
   passwd oracle
   ```

3. Log in as the Oracle user.
4. Navigate to the folder with the client installer, and launch it.
5. In Select Installation Type, select Administrator (1.8 GB), and click Next.
6. In Specify Installation Location, accept the default locations provided, and click Next.
7. In Create Inventory, accept the defaults, and click Next.
8. In Summary, review the information, and click Install.
9. In Install Product, follow the instructions to execute the scripts. When the scripts have completed, click OK.
10. On the Finish screen, to exit the installer, click Close.
11. Append the following to ~/.bash_profile:

    ```
    export ORACLE_HOME=/home/oracle/app/oracle/product/12.1.0.2/client_1
    export LD_LIBRARY_PATH=$ORACLE_HOME/lib
    export ORACLE_LIBRARY=$ORACLE_HOME/lib/libclntsh.so
    export PATH=$ORACLE_HOME/bin:$PATH
    ```

Generating the HammerDB TPC-C-like 800 warehouse database

1. Log into the HammerDB client as the oracle user.
2. Navigate to the HammerDB directory.
3. Start the HammerDB cli:

```
./hammerdbcli
```

4. Set the following build parameters:

```
dbset db ora
dbset bm TPC-C
diset connection system_password <Password>
diset connection  instance <IP ADDRESS/orcl>
diset tpcc count_ware 800
diset tpcc num_vu 24
diset tpcc tpcc_def_tab tpcc
diset tpcc tpcc_ol_tab tpcc_ol
diset tpcc partition true
diset tpcc hash_clusters true
Build the schema:
buildschema
```

Running the test

We ran the test five times on each configuration and took the median run. We used RMAN to back up and restore the database in between runs.

1. Log into the HammerDB client as the oracle user.
2. Navigate to the HammerDBB directory.
3. Start the HammerDB cli:

```
./hammerdbcli
```

4. Set the following run parameters:

```
dbset db ora
dbset bm TPC-C
diset connection system_password <Password>
diset connection  instance <IP ADDRESS/orcl>
diset tpcc count_ware 800
diset tpcc total_iterations 1000000000
diset tpcc ora_driver timed
diset tpcc rampup 15
diset tpcc duration 30
diset tpcc timeprofile true
```

5. Reload the newly created script:

```
loadscript
```

6. Configure and create the virtual users:

```
vuset vu 85
vuset showoutput 1
vuset logtotemp 1
vuset unique 1
vucreate
```

7. Kick off the test:

```
vurun
```

8. When the test finishes, kill the virtual users:

```
vudestroy
```

Read the report at http://facts.pt/3z99w9i ▶

This project was commissioned by Dell EMC.

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