The science behind the report:

Consolidate three legacy servers onto one Dell EMC PowerEdge R940 with 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 Consolidate three legacy servers onto one Dell EMC PowerEdge R940 with 2nd Generation Intel Xeon Scalable processors.

We concluded our hands-on testing on July 27, 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 July 22, 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™ R940	Dell PowerEdge R920
BIOS name and version	Dell 2.1.8	Dell 1.4.3
Non-default BIOS settings	None	None
Operating system name and version/build number	Windows Server® 2019 Datacenter Evaluation 10.0.17763.593	Windows Server 2019 Datacenter Evaluation 10.0.17763.593
Date of last OS updates/patches applied	6/29/2019	7/17/2019
Power management policy	Balanced	Balanced
Processor		
Number of processors	4	4
Vendor and model	Intel® Xeon® Gold 6240	Intel Xeon E7-4890 v2
Core count (per processor)	18	15
Core frequency (GHz)	2.60	2.80
Stepping	6	7

Server configuration information	Dell EMC™ PowerEdge™ R940	Dell PowerEdge R920
Memory module(s)		
Total memory in system (GB)	768	512
Number of memory modules	24	32
Vendor and model	Micron® 36ASF4G72PZ-2G9E2	Samsung® M393B2G70BH0-YK0
Size (GB)	32	16
Type	PC4-23400	PC3-10600R
Speed (MHz)	2,933	1,333
Speed running in the server (MHz)	2,933	1,333
Storage controller		
Vendor and model	1 x Dell PERC H740P	2 x Dell PERC H730P
Cache size (GB)	8 GB	2 GB
Firmware version	50.5.0-1750	25.5.5.0005
Driver version	7.705.13.00	6.604.06.00
HDD storage		
Number of drives	N/A	8 / 4
Drive vendor and model	N/A	Seagate® ST9300653SS / Seagate ST9900805SS
Drive size (GB)	N/A	300 / 900
Drive information (speed, interface, type)	N/A	15K SAS HDD / 10K SAS HDD
SATA SSD storage		
Number of drives	12	12
Drive vendor and model	Intel SSDSC2KB019T8R	Intel SSDSA2CW60
Drive size	1.92 TB	600 GB
Drive information (speed, interface, type)	6Gbps SATA SSD	3Gbps SATA SSD
NVMe SSD storage		
Number of drives	12	N/A
Drive vendor and model	Dell Express Flash NVMe™ P4610	N/A
Drive size (GB)	1.6	N/A
Drive information (speed, interface, type)	PCIe NVMe SSD	N/A
Network adapter		
Vendor and model	Intel 2P XXV710	Intel 2P XXV710
Number and type of ports	2 x 25Gb Ethernet	2 x 25Gb Ethernet
Driver version	1.10.128.0	1.10.128.0

Server configuration information	Dell EMC™ PowerEdge™ R940	Dell PowerEdge R920
Cooling fans		
Vendor and model	Tecra S9421	Dell P4HPY
Number of cooling fans	8	6
Power supplies		
Vendor and model	Dell 095HR5A04	Dell 0CC6WFX02
Number of power supplies	2	4
Wattage of each (W)	1,600	1,100

How we tested

Installing Windows Server 2019 Datacenter

Before installing the OS, we reset the BIOS settings on each server to their defaults, and created RAID groups according to the table below:

	Dell EMC PowerEdge R940	Dell PowerEdge R920
RAID1 Hypervisor	2x SATA SSD	2x SAS HDD
RAID10 Guest OS	4x SATA SSD	4x SAS HDD
RAID10 Guest Data	12x NVMe SSD	12x SATA SSD
RAID10 Guest Logs	6x SATA SSD	6x SAS HDD

1. Attach the Windows Server 2019 Datacenter installation media to the server, using the virtual optical drive or another method.
2. Boot the server to the installation media.
3. At the language selection screen, click Next.
4. Click Install Now.
5. Select Windows Server 2019 Datacenter Evaluation (Desktop Experience), and click Next.
6. Check the I accept the license terms checkbox, and click Next.
7. Click Custom: Install Windows only (advanced).
8. Select the RAID1 group created for the hypervisor install, and click Next.
9. Once the installation completes, enter a password for the Administrator user, and click Finish.
10. Disable the firewall, real-time protection, IE security, and run all Windows Updates. Set the time zone, and enable Remote Desktop access.
11. Using Disk Management, bring the RAID10 groups online and create NTFS volumes on each.
12. Using Server Manager, add the Hyper-V role, and restart the server.

Creating the base VM

1. Using the 25Gb network adapter, create a virtual switch.
2. Using Hyper-V Manager, create a new VM with the following options. Ensure that each VHD has its own SCSI controller and is placed into the appropriate RAID10 group.

   - Generation 2
   - 8 virtual CPU
   - 20GB virtual memory
   - 60GB VHD for Guest OS (dynamically expanding)
   - 100GB VHD for Oracle data (fixed size)
   - 40GB VHD for Oracle logs (fixed size)
   - 100GB VHD for database backup (dynamically expanding, placed on Guest Data RAID10)

3. Attach the 25Gb virtual switch to the VM.
4. Install Windows Server 2019 Datacenter onto the VM using the steps above, and create a user named `oracle` with administrator privileges.

Installing Oracle Database 19c

Perform the following steps on the base VM using the oracle user.

1. Download the Oracle Database 19c installation files for Windows, and extract the contents to a specific location such as `C:\oracle`. This directory will become the Oracle home for this configuration.
2. Run `setup.exe`.
3. Select the Create and configure a single database radio button and click Next.
4. Select the Server class radio button and click Next.
5. Select the Use Existing Windows User radio button, enter the oracle username and password, and click Next.
6. Enter the location of the extracted contents, such as `C:\oracle`, into the text box, and click Next.
7. At the Create Inventory screen, click Next.
8. Select the Data Warehousing radio button, and click Next.
9. Uncheck the Create as Container database radio button, and click Next.
10. Uncheck the Enable Automatic Memory Management checkbox, enter 16384MB for the target database memory, and click Next.
11. Select the File system radio button, enter the NTFS location on the Guest Data RAID10 group, and click Next.
12. At the Management Options screen, uncheck the Register with Enterprise Manager (EM) Cloud Control checkbox, and click Next.
13. At the Recovery Options screen, uncheck the Enable Recovery check box (we used the parameter file to later specify a recovery area), and click Next.
14. Select the Use the same password for all accounts radio button, enter a password, and click Next.
15. At the Operating System Groups screen, click Next.
16. Check the Automatically run configuration scripts checkbox, enter the Administrator password, and click Next.
17. Wait for the prerequisite checks to finish, and if there are no warnings, click Install.
18. At the configuration script pop-up question, click Yes.
19. When the installation completes, click Close.

Configuring Oracle Tablespaces and redo log

Alter the tablespaces on both systems as we show below. Open a command prompt and type `sqlplus / as sysdba` to enter the SQL prompt.

```
ALTER DATABASE ADD LOGFILE GROUP 11 ( C:\oracle\temp\temp1.log' ) SIZE 50M;
ALTER DATABASE ADD LOGFILE GROUP 12 ( C:\oracle\temp\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 ( F:\redo01.log' ) SIZE 15G
BLOCKSIZE 4K;
ALTER DATABASE ADD LOGFILE GROUP 2 ( F:\redo02.log' ) SIZE 15G
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 del C:\oracle\temp\temp*.log

CREATE BIGFILE TABLESPACE "TPCC"
DATAFILE 'D:\ORCL\DATAFILE\tpcc.dbf' SIZE 50G AUTOEXTEND ON NEXT 1G
BLOCKSIZE 8K
EXTENT MANAGEMENT LOCAL AUTOALLOCATE
SEGMENT SPACE MANAGEMENT AUTO;

CREATE BIGFILE TABLESPACE "TPCC_OL"
DATAFILE 'D:\ORCL\DATAFILE\tpcc_ol.dbf' SIZE 25G AUTOEXTEND ON NEXT 1G
BLOCKSIZE 16K
EXTENT MANAGEMENT LOCAL AUTOALLOCATE
SEGMENT SPACE MANAGEMENT AUTO;
```

Configuring the Oracle pfile

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

```
CREATE SPFILE = 'C:\oracle\database\spfileorcl.ora' FROM PFILE='C:\oracle\pfile.ora'

orcl.__inmemory_ext_roarea=0
orcl.__inmemory_ext_rwarea=0
orcl.__java_pool_size=0
orcl.__large_pool_size=67108864
orcl.__oracle_base='C:\oracle'
orcl.__pga_aggregate_target=4294967296
orcl.__sga_target=12884901888
orcl.__shared_io_pool_size=134217728
orcl.__shared_pool_size=1744830464
orcl.__streams_pool_size=0
orcl.__unified_pga_pool_size=0
*._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
*._db_writer_flush_imu=false
*._disable_highres_ticks=TRUE
*._disable_logging=FALSE
*._disable_selftune_checkpointing=TRUE
*._disk_sector_size_override=TRUE
*._enable_NUMA_interleave=TRUE
*._enable_NUMA_support=TRUE
*._fast_cursor_reexecute=TRUE
*._first_spare_parameter=1
*._in_memory_undo=TRUE
*._kgl_hot_object_copies=8
*._numa_shift_enabled=FALSE
*._resource_manager_always_off=TRUE
*._trace_pool_size=0
*._undo_autotune=FALSE
*._use_adaptive_log_file_sync='FALSE'
*.aq_tm_processes=0
*.audit_file_dest='C:\oracle\admin\orcl\adump'
*.audit_trail='NONE'
*.commit_logging='BATCH'
*.commit_wait='NOWAIT'
*.compatible='19.0.0'
*.control_files='E:\ORCL\control01.ctl','E:\ORCL\control02.ctl'
*.db_16k_cache_size=2g
*.db_block_checking='false'
```

```
*.db_block_checksum='false'
*.db_block_size=8192
*.db_cache_size=14g
*.db_file_multiblock_read_count=4
*.db_name='orcl'
*.db_recovery_file_dest_size=95g
*.db_recovery_file_dest='G:\backup'
*.db_writer_processes=4
*.diagnostic_dest='C:\oracle'
*.disk_asynch_io=TRUE
*.dispatchers='(PROTOCOL=TCP) (SERVICE=orclXDB)'
*.dml_locks=500
*.fast_start_mttr_target=0
*.local_listener='LISTENER_ORCL'
*.lock_sga=TRUE
*.log_buffer=1073709056
*.log_checkpoint_interval=0
*.log_checkpoint_timeout=0
*.log_checkpoints_to_alert=TRUE
*.nls_language='AMERICAN'
*.nls_territory='AMERICA'
*.open_cursors=2000
*.parallel_max_servers=0
*.parallel_min_servers=0
*.pga_aggregate_target=4096m
*.plsql_code_type='NATIVE'
*.plsql_optimize_level=3
*.pre_page_sga=FALSE
*.processes=1000
*.query_rewrite_enabled='FALSE'
*.remote_login_passwordfile='EXCLUSIVE'
*.replication_dependency_tracking=FALSE
*.result_cache_max_size=0
*.sga_target=12884901888
*.star_transformation_enabled='TRUE'
*.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'
```

Configuring the HammerDB client for Oracle Database

We used a separate server to host client VMs with HammerDB installed. We created one client VM per test VM. Install Windows Server 2016 Datacenter onto each client VM, and complete the steps below as user oracle with Administrator privileges.

1. Download the latest HammerDB distribution, and extract the contents.
2. Navigate to the folder with the client installer, and launch it.
3. In Select Installation Type, select Administrator (1.8 GB) as the installation type, and click Next.
4. In Specify Installation Location, accept default locations provided, and click Next.
5. In Create Inventory, accept the defaults, and click Next.
6. In Summary, review the information, and click Install to begin installation.
7. In Install Product, follow the instructions to execute the scripts. When the scripts complete, click OK.
8. On the Finish screen, click Close to exit the installer.
9. Download the Oracle Instant Client, and extract the contents.
10. Copy `C:\oracle\database\network\admin\sqlnet.ora` to the client VM.
11. Create the following environment variables on the client VM to point to oci.dll and sqlnet.ora. For example:

    ```
    ORACLE_LIBRARY = C:\instant_client_19_3\oci.dll
    TNS_ADMIN = C:\oracle\sqlnet.ora
    ```

Generating the HammerDB TPC-C 400 warehouse database

1. Log into the HammerDB client as the oracle user.
2. Navigate to the HammerDB directory.
3. Start the HammerDB CLI.
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 400
diset tpcc num_vu 12
diset tpcc tpcc_def_tab tpcc
diset tpcc tpcc_ol_tab tpcc_ol
diset tpcc partition true
diset tpcc hash_clusters true
```

5. Build the schema:

```
buildschema
```

Running the test

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

1. Log into the HammerDB client as the oracle user.
2. Navigate to the HammerDB directory.
3. Start the HammerDB CLI.
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 400
diset tpcc total_iterations 1000000000
diset tpcc ora_driver timed
diset tpcc rampup 10
diset tpcc duration 20
diset tpcc timeprofile true
```

5. Reload the newly created script:

```
loadscript
```

6. Configure and create the virtual users:

```
vuset vu 12
vuset showoutput 1
vuset logtotemp 1
vuset unique 1
vucreate
```

7. Kick off the test:

```
vurun
```

8. When the test is finished, kill the virtual users:

```
vudestroy
```

Read the report at http://facts.pt/fhvcwjm ▶

This project was commissioned by Dell EMC.

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