The science behind the report:

Process data analytics queries faster with new Microsoft Azure Lsv3-series VMs featuring 3rd Gen 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 Process data analytics queries faster with new Microsoft Azure Lsv3-series VMs featuring 3rd Gen Intel Xeon Scalable processors.

We concluded our hands-on testing on June 1, 2022. 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 May 13, 2022 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 testing with 8-vCPU VMs.

Time to analyze a 1TB database (seconds)	L8s	L8s_v3	Lsv3-series advantage
1 stream	8,990	3,591	2.50x
7 streams	50,975	18,709	2.72x

Table 2: Results of our testing with 16-vCPU VMs.

Time to analyze a 1TB database (seconds)	L16s	L16s_v3	Lsv3-series advantage
1 stream	4,708	1,938	2.42x
7 streams	22,262	8,515	2.61x

Table 3: Results of our testing with 32-vCPU VMs.

Time to analyze a 1TB database (seconds)	L32s	L32s_v3	Lsv3-series advantage
1 stream	917	438	2.09x
7 streams	4,814	2,360	2.03x

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System configuration information

Table 4: Detailed information on the Microsoft Azure Lsv1-series VMs we tested.

System configuration information	L8s	L16s	L32s
Tested by	Principled Technologies	Principled Technologies	Principled Technologies
Test date	05/24/2022	05/25/2022	06/01/2022
CSP / Region	Microsoft Azure / East US 2	Microsoft Azure / East US 2	Microsoft Azure / East US 2
Workload & version	HammerDB v4.4 TPROC-H	HammerDB v4.4 TPROC-H	HammerDB v4.4 TPROC-H
Workload-specific parameters	CCI, MAXDOP 8, Lock Pages in Memory, 90% Reserved SQL Memory, TempDB on temp storage, 1000scale database, 1 and 7 user streams	CCI, MAXDOP 16, Lock Pages in Memory, 90% Reserved SQL Memory, TempDB on temp storage, 1000scale database, 1 and 7 user streams	CCI, MAXDOP 32, Lock Pages in Memory, 90% Reserved SQL Memory, TempDB on temp storage, 1000scale database, 1 and 7 user streams
Iterations and result choice	3 runs, median	3 runs, median	3 runs, median
Server platform	L8s	L16s	L32s
BIOS name and version	Microsoft Corporation Hyper-V UEFI Release v4.1, 7/22/2021	Microsoft Corporation Hyper-V UEFI Release v4.1, 7/22/2021	Microsoft Corporation Hyper-V UEFI Release v4.1, 7/22/2021
Operating system name and version/build number	Microsoft Windows Server 2022 Datacenter 10.0.20348 / Build 20348	Microsoft Windows Server 2022 Datacenter 10.0.20348 / Build 20348	Microsoft Windows Server 2022 Datacenter 10.0.20348 / Build 20348
Date of last OS updates/ patches applied	05/13/2022	05/13/2022	05/13/2022
Processor			
Number of processors	1	1	2
Vendor and model	Intel® Xeon® CPU E5-2698B v3	Intel Xeon CPU E5-2698B v3	Intel Xeon CPU E5-2698B v3
Core count (per processor)	16	16	16
Core frequency (GHz)	2.00	2.00	2.00
Stepping	2	2	2
Hyper-threading	No	No	No
Turbo?	Yes	Yes	Yes
Number of vCPUs per VM	8	16	32
Memory module(s)			
Total memory in system (GB)	64	128	256
NVMe™ memory present?	No	No	No
Total memory (DDR+NVMe RAM) (GB)	64	128	256
General HW			
Storage: NW or Direct Att / Instance	Network Att	Network Att	Network Att

System configuration information	L8s	L16s	L32s
Local storage			
OS			
Number of drives	1	1	1
Drive size (GB)	126	126	126
Drive information	Standard SSD	Standard SSD	Standard SSD
Temporary drive			
Number of drives	1	1	1
Drive size (GB)	1,388	2,807	5,630
Data drive			
Number of drives	2	3	6
Drive size (TB)	2	2	2
Drive information	Premium, 7,500 IOPS per drive	Premium, 7,500 IOPS per drive	Premium, 7500 IOPS per drive
Maximum uncached disk throughput per VM			
IOPS	10,000	20,000	40,000
MBps	250	500	1,000
Network adapter			
Vendor and model	Microsoft Hyper-V Network Adapter	Microsoft Hyper-V Network Adapter	Microsoft Hyper-V Network Adapter
Number and type of ports	1x 40Gb	1x 40Gb	1x 40Gb

Table 5: Detailed information on the Microsoft Azure Lsv3-series VMs we tested.

System configuration information	L8s_v3	L16s_v3	L32s_v3
Tested by	Principled Technologies	Principled Technologies	Principled Technologies
Test date	05/25/2022	05/25/2022	05/25/2022
CSP / Region	Microsoft Azure / South Central US	Microsoft Azure / South Central US	Microsoft Azure / South Central US
Workload & version	HammerDB v4.4 TPROC-H	HammerDB v4.4 TPROC-H	HammerDB v4.4 TPROC-H
Workload-specific parameters	CCI, MAXDOP 8, Lock Pages in Memory, 90% Reserved SQL Memory, TempDB on temp storage, 1000scale database, 1 and 7 user streams	CCI, MAXDOP 16, Lock Pages in Memory, 90% Reserved SQL Memory, TempDB on temp storage, 1000scale database, 1 and 7 user streams	CCI, MAXDOP 32, Lock Pages in Memory, 90% Reserved SQL Memory, TempDB on temp storage, 1000scale database, 1 and 7 user streams
Iterations and result choice	3 runs, median	3 runs, median	3 runs, median
Server platform	L8s_v3	L16s_v3	L32s_v3
BIOS name and version	Microsoft Corporation Hyper-V UEFI Release v4.1, 7/22/2021	Microsoft Corporation Hyper-V UEFI Release v4.1, 7/22/2021	Microsoft Corporation Hyper-V UEFI Release v4.1, 7/22/2021
Operating system name and version/build number	Microsoft Windows Server 2022 Datacenter 10.0.20348 / Build 20348	Microsoft Windows Server 2022 Datacenter 10.0.20348 / Build 20348	Microsoft Windows Server 2022 Datacenter 10.0.20348 / Build 20348
Date of last OS updates/ patches applied	05/13/2022	05/13/2022	05/13/2022

System configuration information	L8s_v3	L16s_v3	L32s_v3
Processor			
Number of processors	1	1	1
Vendor and model	Intel Xeon Platinum 8370C	Intel Xeon Platinum 8370C	Intel Xeon Platinum 8370C
Core count (per processor)	32	32	32
Core frequency (GHz)	2.80	2.80	2.80
Stepping	6	6	6
Hyper-threading	Yes	Yes	Yes
Turbo?	Yes	Yes	Yes
Number of vCPUs per VM	8	16	32
Memory module(s)			
Total memory in system (GB)	64	128	256
NVMe™ memory present?	No	No	No
Total memory (DDR+NVMe RAM) (GB)	64	128	256
General HW			
Storage: NW or Direct Att / Instance	Direct Att	Direct Att	Direct Att
Local storage			
OS			
Number of drives	1	1	1
Drive size (GB)	126	126	126
Drive information	Standard SSD	Standard SSD	SSD
Temporary drive			
Number of drives	1	1	1
Drive size (GB)	80	160	320
Data drive			
Number of drives	1	2	4
Drive size (TB)	1.92	1.92	1.92
Drive information	NVMe, 400,000 read IOPS per drive	NVMe, 400,000 read IOPS per drive	NVMe, 400,000 read IOPS per drive
Network adapter			
Vendor and model	Microsoft Hyper-V Network Adapter	Microsoft Hyper-V Network Adapter	Microsoft Hyper-V Network Adapter
Number and type of ports	1x 100Gb	1x 100Gb	1x 100Gb

How we tested

Testing overview

We tested Microsoft Azure VM instances featuring 3rd Gen Intel Xeon Scalable processors and compared them to VM instances featuring older Intel Xeon processors. We ran the TPROC-H workload from HammerDB on Microsoft SQL Server 2019 to show the time to complete savings for analytic databases that customers can expect to see using VM instances with newer processors vs. older ones.

Creating the Windows Server 2019 baseline image

Creating the baseline image VM

1. Log into the Azure Portal, and navigate to the Virtual Machines service.
2. Click Add to open the Add VM wizard.
3. On the Basics tab, set the following:

    a. From the drop-down menu, choose your Subscription.
    b. From the drop-down menu, choose your Resource group.
    c. Name the Virtual Machine.
    d. From the drop-down menu, choose your Region.
    e. Leave the Availability options set to No infrastructure redundancy required.
    f. From the Image drop-down menu, choose Choose Windows Server 2022 Datacenter.
    g. Leave Azure Spot instance set to No.
    h. Select the instance size you wish to use. We used Standard B4ms to create the baseline image.
    i. Choose a new Username and Password for the Administrator account.
    j. Leave Public inbound ports set to Allow selected ports.
    k. For Select inbound ports, choose SSH (22).

4. On the Disks tab, set the following:

    a. For the OS disk type, choose Standard HDD from the drop-down menu.
    b. Leave the default Encryption type.

5. On the Networking tab, set the following:

    a. From the drop-down menu, choose your Virtual network.
    b. To create a new Public IP, choose Create new.
    c. Leave the rest of the settings at defaults.

6. On the Management tab, set the following:

    a. From the drop-down menu, choose your Diagnostics storage account.
    b. Leave the rest set to defaults.

7. On the Advanced tab, leave all defaults.
8. On the Tags tab, add any tags you wish to use.
9. On the Review + create tab, review your settings, and click Create.

Configuring Microsoft Windows Server Datacenter 2022

1. Open Server Manager, and click Local Server.
2. Disable IE Enhanced Security Configuration.
3. Change the time zone to your local time zone.
4. Change the name of your server, and when prompted, reboot.
5. Open Server Manager again, and click Local Server.
6. Click to run updates.
7. Run updates, rebooting when prompted, until the server shows no new updates to install.

Installing SQL Server 2019 Enterprise

1. Download or copy the ISO to the server, and unzip it.
2. Double-click the Setup application.
3. Click Installation→New SQL Server Standalone installation or add features to an existing installation.
4. Choose the trial version, and click Next.
5. Check the box to accept the license terms and privacy statement, and click Next.
6. Check the Use Microsoft Update to check for updates (recommended) box, and click Next.
7. On the Install Rules page, click Next.
8. Check the boxes for the following features, and click Next:

   a. Database Engine Services
   b. Full-Test and Semantic Extractions for Search
   c. Client Tools Connectivity
   d. Client Tools Backwards Compatibility

9. Leave the Default instance, and click Next.
10. Leave the default Service Accounts, and click Next.
11. On the Server Configuration tab, choose Mixed Mode, and enter and confirm a Password for the SQL Server system administrator (SA) account.
12. Click Add Current User to Specify the SQL Server administrators.
13. Click Next.
14. Once you've passed the rule check, click Next.
15. Click Install.
16. When the installation is finished, go back to the SQL Server Installation Center, and click Install SQL Server Management Tools.
17. Download the SSMS file, and install with defaults.
18. When prompted, reboot the server.
19. To ensure there aren't any new updates for SQL, run Windows Update one more time. Make sure Windows Updates are set to get updates for other Microsoft products.
20. After you've installed all available updates, to disable Windows Update service, click the Start button, type `services`, and from the Services list, disable the Windows Update service.

Locking pages in memory

1. Click Start, and type `Local Security Policy`. When the program pops up in the search, open it.
2. Expand Local Policies, and click on User Rights Assignment.
3. In the pane on the right, scroll down, and double-click Lock pages in memory.
4. Click Add User or Group, type `NT Service\MSSQLSERVER`, and click OK.
5. To close the Properties window, click OK, and close the Local Security Policy window.

Installing HammerDB 4.4

1. Download HammerDB from the following URL: https://hammerdb.com/download.html.
2. Double-click the .exe file, choose English, and click OK.
3. Click Yes.
4. Click Next.
5. Chose a destination location, and click Next.
6. Click Next.
7. Click Finish.

Creating a snapshot of your baseline VM

1. In the Azure portal, navigate to the Snapshots service.
2. To open the Snapshot wizard, click Add.
3. On the Basics tab, set the following:

    a. From the drop-down menu, choose your Subscription.
    b. From the drop-down menu, choose your Resource group.
    c. Enter a name for your snapshot.
    d. From the drop-down menu, choose your Region.
    e. Select Full - make a complete read-only copy of the selected disk for the Snapshot type.
    f. Choose the OS disk from your baseline VM.
    g. For the Storage type, choose Standard HDD.

4. On the Encryption tab, leave all defaults.
5. On the Tags tab, add any tags you wish to use.
6. On the Review + create tab, review your settings, and click Create.

Creating your image with the baseline snapshot

To create an image, you must first have a Shared Image Gallery. The steps below walk through creating the gallery and images. Once you have created your gallery, you will not need to do so again to add new images.

1. In the Azure portal, navigate to the Shared image galleries service.
2. To open the Add gallery wizard, click Add.
3. On the Basics tab, set the following:

    a. From the drop-down menu, choose your Subscription.
    b. From the drop-down menu, choose your Resource.
    c. Name your gallery.
    d. From the drop-down menu, choose your Region.
    e. Optionally, enter a Description.

4. On the Tags tab, add any tags you wish to use.
5. On the Review + create tab, review your settings, and click Create.
6. Click on your new image gallery, and click Add new image definition to open the wizard.
7. On the Basics tab, set the following:

    a. Set the Operating System to Windows.
    b. Set the VM generation to Gen 2.
    c. Set the Operation system state to Specialized.
    d. Enter whatever you wish for the Publisher, Offer, and SKU entries.

8. Skip the Version tab.
9. Skip the Publishing options tab.
10. On the Tags tab, add any tags you wish to use.
11. On the Review + create tab, review your settings, and click Create.
12. Click on the image definition you've created, and click Add version to open the wizard.
13. On the Basics tab, set the following:

    a. Enter a version number, such as 1.0.0.
    b. Choose the OS disk snapshot of the baseline VM you created from the drop-down menu.
    c. Leave the rest as defaults.

14. On the Encryption tab, leave defaults.
15. On the Tags tab, add any tags you wish to use.
16. On the Review + create tab, review your settings, and click Create.

Creating the VMs for testing

In this section, we list the steps required to create a VM from the image we created previously. For our testing, we used the East US 2 Region for the Ls-series VMs, and South Central US for the Lsv3-series VMs. In these steps, we assume that a snapshot disk containing the TPROC-H database backup file already exists. See Tables 4 and 5 for the list of VM specifications we used. Follow the steps six times using the proper specifications for the VM you wish to create.

1. Open the Azure Portal, and navigate to the Share image galleries service.
2. Click the Shared image gallery you created.
3. Navigate to the image version you created (it should be something like 1.0.0), and click Create VM.
4. On the Basics tab, set the following:
   a. From the drop-down menu, choose your Subscription.
   b. From the drop-down menu, choose your Resource group.
   c. Enter a Virtual machine name.
   d. Choose Availability Zone, and set the Zone you desire.
   e. Select the instance size you want.
   f. Leave the rest as defaults.
5. On the Disks tab, set the following:
   a. Change the OS disk type to Standard SSD.
   b. Click Create and attach a new disk.
   c. Choose a name for the disk.
   d. Under Source type, select Snapshot.
   e. Under Snapshot, select the snapshot of your disk with the database backup.
   f. Choose the correct size, and click OK.
   g. If you're using Lsv3-series VMs, skip to the next section. For the Ls-series VMs, click Create and attach a new disk.
   h. Choose a name for the disk.
   i. Leave the Source Type as None (empty disk).
   j. Choose your desired size and tier. We used 2GB Premium SSDs.
   k. Click OK.
   l. Repeat steps g through j for any additional data disks needed for the Ls series VMs.
6. Skip the Networking, Management, and Advanced tabs.
7. On the Tags tab, assign any tags you wish to use.
8. On the Review + create tab, review your settings, and click Create.
9. Once the VM creation is finished, click Go to resource (or navigate to the virtual machine service, and click on the new VM).
10. Click Connect→RDP, and download the RDP file.
11. Double-click the RDP file, and log in with the user and password you set.

Configuring the VMs under test

In this section, we list the various Windows and SQL settings that we changed and the steps to do so. To see the exact settings for each VM, please refer to Tables 4 and 5.

Striping and formatting the data disks

1. Open PowerShell as an Administrator.
2. To pool, partition, and format the data disks as a single striped volume, run the following commands:

```
$PhysicalDisks = Get-PhysicalDisk | Where-Object {$_.CanPool -eq $true}
New-StoragePool -FriendlyName "DataFiles" -StorageSubsystemFriendlyName "Windows Storage*" '
-PhysicalDisks $PhysicalDisks | New-VirtualDisk -FriendlyName "Datafiles" '
-Interleave 65536 -NumberOfColumns $PhysicalDisks.Count -ResiliencySettingName simple '
-UseMaximumSize |Initialize-Disk -PartitionStyle GPT -PassThru |New-Partition -AssignDriveLetter '
-UseMaximumSize |Format-Volume -FileSystem NTFS -NewFileSystemLabel "DataDisks" '
-AllocationUnitSize 65536 -Confirm:$false
```

Setting the SQL memory reserve and max degree of parallelism (MAXDOP)

1. Open the SQL Server Management Studio.
2. Right-click the SQL Instance, and click Properties.
3. Click Advanced node, scroll down to the Max Degree of Parallelism, change the value, and click OK.
4. Right-click the SQL Instance, and go to Memory.
5. Set the Max Memory to 90% of the total memory in the system, click OK, and close the Properties window.
6. Right-click the SQL Instance, and restart the service. When prompted, click Yes.

Configuring the tempdb database

1. Open the SQL Server Management Studio.
2. Expand Databases and System databases, and right-click tempdb.
3. Add files and change the starting size as necessary. For the 8-vCPU VMs, we created eight 5GB data files and one 1GB log file; for the 16-vCPU and 32-vCPU VMs, we created eight 10GB data files and one 1GB log file.
4. Right-click the SQL Instance, and restart the service. When prompted, click Yes.
5. To move the tempdb to the database drive, open a new Query, and run the following, modified for the number of tempdb files your system has:

```
USE [master]
GO
ALTER DATABASE tempdb MODIFY FILE ( NAME = tempdev , FILENAME = 'D:\TempDB\tempdb.mdf' )
GO
ALTER DATABASE tempdb MODIFY FILE ( NAME = temp2 , FILENAME = 'D:\TempDB\tempdb_mssql_2.ndf' )
GO
ALTER DATABASE tempdb MODIFY FILE ( NAME = temp3 , FILENAME = 'D:\TempDB\tempdb_mssql_3.ndf' )
GO
ALTER DATABASE tempdb MODIFY FILE ( NAME = temp4 , FILENAME = 'D:\TempDB\tempdb_mssql_4.ndf' )
GO
ALTER DATABASE tempdb MODIFY FILE ( NAME = temp5 , FILENAME = 'D:\TempDB\tempdb_mssql_5.ndf' )
GO
ALTER DATABASE tempdb MODIFY FILE ( NAME = temp6 , FILENAME = 'D:\TempDB\tempdb_mssql_6.ndf' )
GO
ALTER DATABASE tempdb MODIFY FILE ( NAME = temp7 , FILENAME = 'D:\TempDB\tempdb_mssql_7.ndf' )
GO
ALTER DATABASE tempdb MODIFY FILE ( NAME = temp8 , FILENAME = 'D:\TempDB\tempdb_mssql_8.ndf' )
GO
ALTER DATABASE tempdb MODIFY FILE ( NAME = templog , FILENAME = 'D:\TempDB\templog.ldf' )
GO
```

6. Right-click the SQL Instance, and restart the service. When prompted, click Yes.

Running the tests

In this section, we list the steps to run the HammerDB TPROC-H test on the VMs under test. For the multiuser test (i.e., throughput test), we followed TPC-H recommendations for the 1,000-scale database we were testing, which is a user count of 7.

1. On the VM under test, restore the database so that the database and log files reside on the data disk.
2. Verify you've correctly configured your SQL settings and tempdb according to the instructions above and the instance on which you're running.
3. Open HammerDB.
4. Select Options→Benchmark.
5. Choose MSSQL Server and TPROC-H.
6. Expand SQL Server→TPROC-H→Driver Script.
7. Double-click Options, change the driver to ODBC Driver 17 for SQL Server, set MAXDOP to match SQL, enter the correct SQL Administrator credentials, and type the name of your TPROC-H database.
8. Click OK.
9. Expand Virtual User, and double-click Options.
10. Choose 1 user.
11. Check the boxes for Show Output, Log Output to Temp, and Use Unique Log Name.
12. Click OK.
13. Double-click Create users.
14. To capture performance metrics on the system, set Performance monitor (Perfmon) to record CPU, Memory, and drive usage information. Start Perfmon.
15. To begin the run, click Start.
16. When the run finishes, stop Perfmon, and save the HammerDB results file and Perfmon output.
17. Stop the HammerDB user.
18. Double-click User options, and set the number of users to the appropriate count for the multi-stream test.
19. Double-click Create users.
20. To capture performance metrics on the system, set Performance monitor (Perfmon) to record CPU, Memory, and drive usage information. Start Perfmon.
21. To begin the run, in HammerDB, click Start.
22. When the run finishes, stop Perfmon, and save the HammerDB results file and Perfmon output.
23. Reboot the VM.
24. Repeat the test two more times for a total of three runs at each user count, and record the median run.

Read the report at https://facts.pt/bG3rLqj ▶

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