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TECH NOTE

Configuring vCPU for Microsoft SQL Server Standard Edition

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Contents

1. Executive Summary

This document discusses product licensing limitations in Microsoft SQL Server Standard edition and important points to consider when you deploy SQL Server Standard edition in a virtual environment.

SQL Server Standard edition can use a maximum of 4 virtual CPUs (vCPU) or 24 cores. In a virtual environment, SQL Server maps each vCPU to a socket in a physical server. Therefore, it's essential to configure VMs that yield the best possible performance within the licensing limitations.

In this document, we don't recommend any specific vCPU-to-core ratio; however, depending on the application's SQL profile, your environment might benefit more from one configuration than from another. Therefore, we strongly recommend that you perform benchmark testing with your application before you set a specific vCPU-to-core ratio for SQL Server Standard edition deployments.

Document Version History

Version Number	Published	Notes
1.0	February 2023	Original publication.

2. Licensing Limits by SQL Server Edition

The following table outlines the current compute capacity limits by SQL Server edition as detailed in the Microsoft article Editions and supported features of SQL Server 2019. Refer to the Microsoft article Compute capacity limits by edition of SQL Server for more information on how capacity limits differ in physical and virtualized environments.

Table. Compute Capacity Limits per Single Instance by SQL Server Edition

SQL Server Edition	Maximum Compute Capacity per Single Instance (SQL Server Database Engine)
Enterprise	Operating system maximum
Developer	Operating system maximum
Standard	4 sockets or 24 cores (whichever is less)
Express	1 socket or 4 cores (whichever is less)

3. Nutanix vCPU Allocation Testing Environment

Nutanix tested vCPU allocation with the following software versions:

- SQL Server: Microsoft SQL Server 2019 RTM, 15.0.2000.5 (x64) Standard Edition (64-bit)
- Hypervisor: Nutanix AHV 5.20.3

> Note: Although we tested with a specific version of Nutanix AHV, we expect other versions and other hypervisors to demonstrate similar behavior.

4. vCPU Allocation Configuration Options

Option 1: System with 2 vCPU and 24 Cores per vCPU

In the first test configuration, we create a virtual server with 2 vCPU and 24 cores per vCPU.

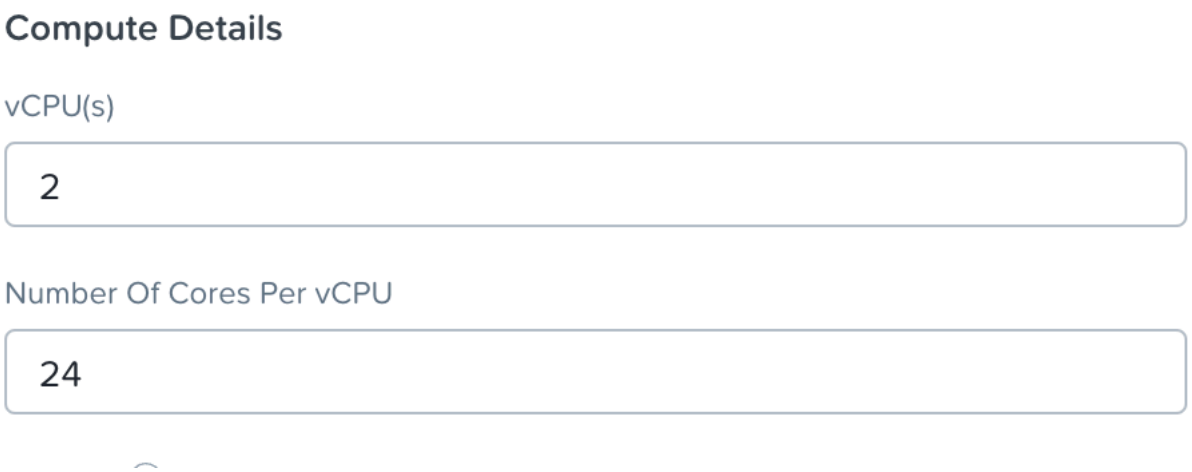


Figure 1: Option 1: Compute Details

We configure SQL Server CPU with automatic allocation.

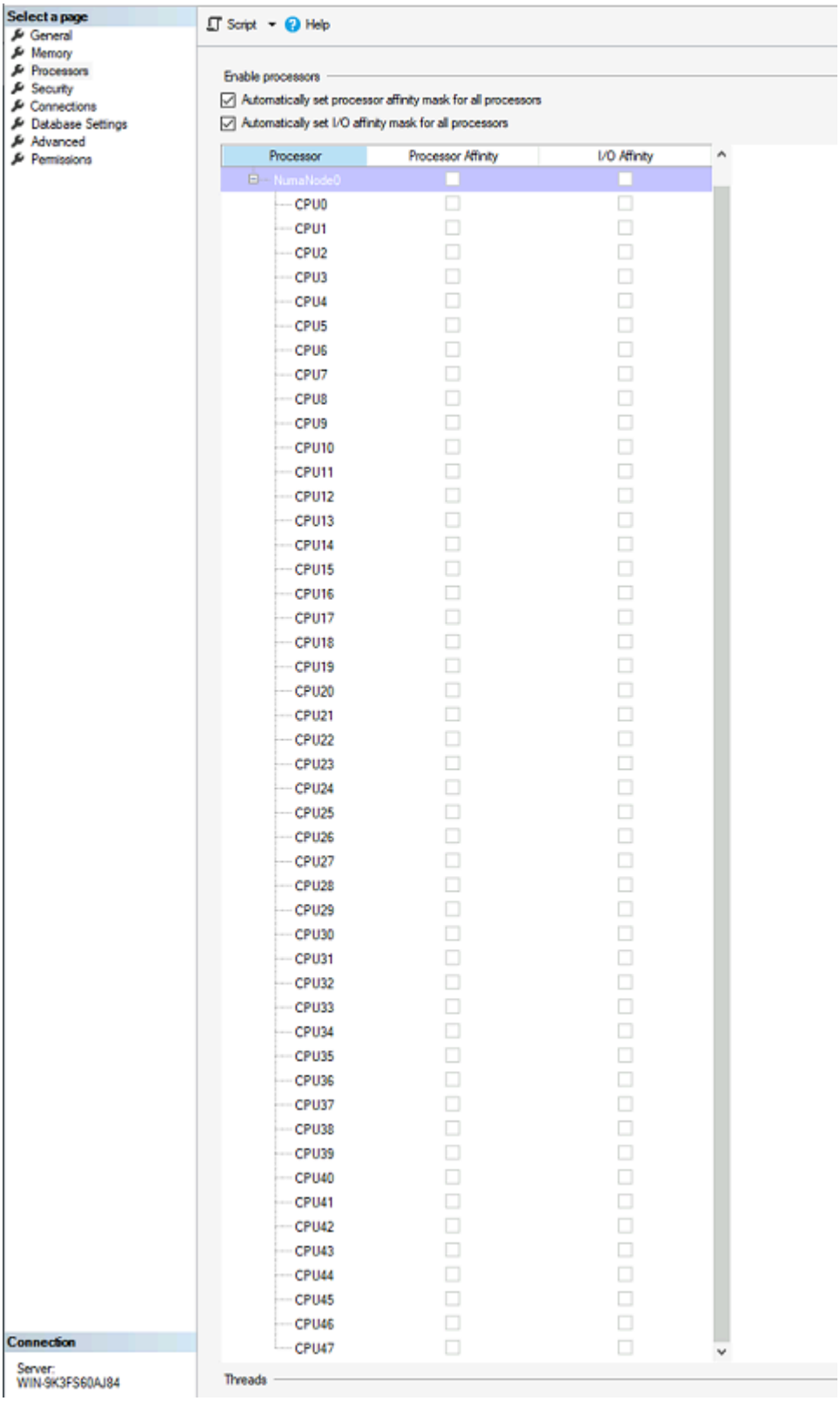
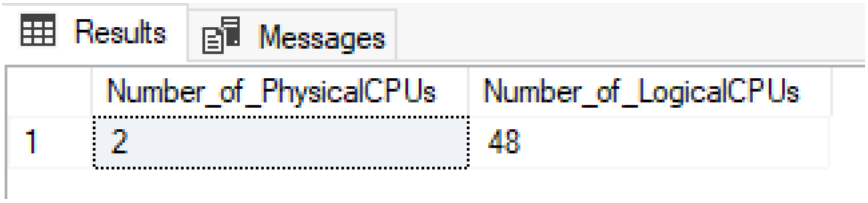


Figure 2: Option 1: CPU Automatic Allocation

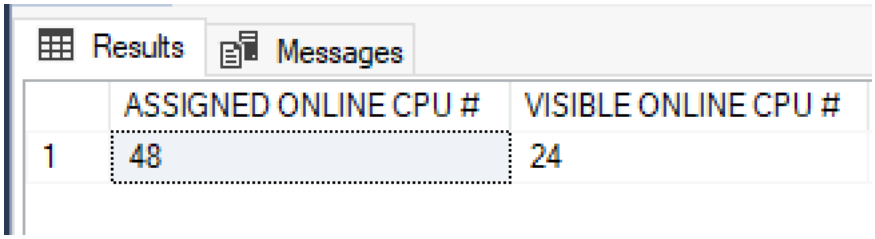
The following screenshot shows the number of physical and logical CPUs that the SQL Server operating system (OS) detects.


Results Messages

	Number_of_PhysicalCPUs	Number_of_LogicalCPUs
1	2	48

Figure 3: Option 1: Physical and Logical CPUs Detected

Although 48 cores are available to the database server (assigned online CPU), SQL Server can only use 24 cores (visible online CPU).


Results Messages

	ASSIGNED ONLINE CPU #	VISIBLE ONLINE CPU #
1	48	24

Figure 4: Option 1: Allocated vs. Usable CPU

When we query the dynamic management view for `dm_os_schedulers`, we can verify that only 24 cores are available and scheduled in SQL Server. With the licensing restrictions, SQL Server doesn't use the remaining 24 cores.


```
select  cpu_id, status from sys.dm_os_schedulers
where status = 'VISIBLE ONLINE'
```

100 %

Results | Messages

	cpu_id	status
1	0	VISIBLE ONLINE
2	1	VISIBLE ONLINE
3	2	VISIBLE ONLINE
4	3	VISIBLE ONLINE
5	4	VISIBLE ONLINE
6	5	VISIBLE ONLINE
7	6	VISIBLE ONLINE
8	7	VISIBLE ONLINE
9	8	VISIBLE ONLINE
10	9	VISIBLE ONLINE
11	10	VISIBLE ONLINE
12	11	VISIBLE ONLINE
13	12	VISIBLE ONLINE
14	13	VISIBLE ONLINE
15	14	VISIBLE ONLINE
16	15	VISIBLE ONLINE
17	16	VISIBLE ONLINE
18	17	VISIBLE ONLINE
19	18	VISIBLE ONLINE
20	19	VISIBLE ONLINE
21	20	VISIBLE ONLINE
22	21	VISIBLE ONLINE
23	22	VISIBLE ONLINE
24	23	VISIBLE ONLINE

Figure 5: Option 1: Scheduler Query Results

Option 2: System with 8 vCPU and 1 Core per vCPU

In the second test configuration, we create a virtual server with 8 vCPU and 1 core per vCPU.

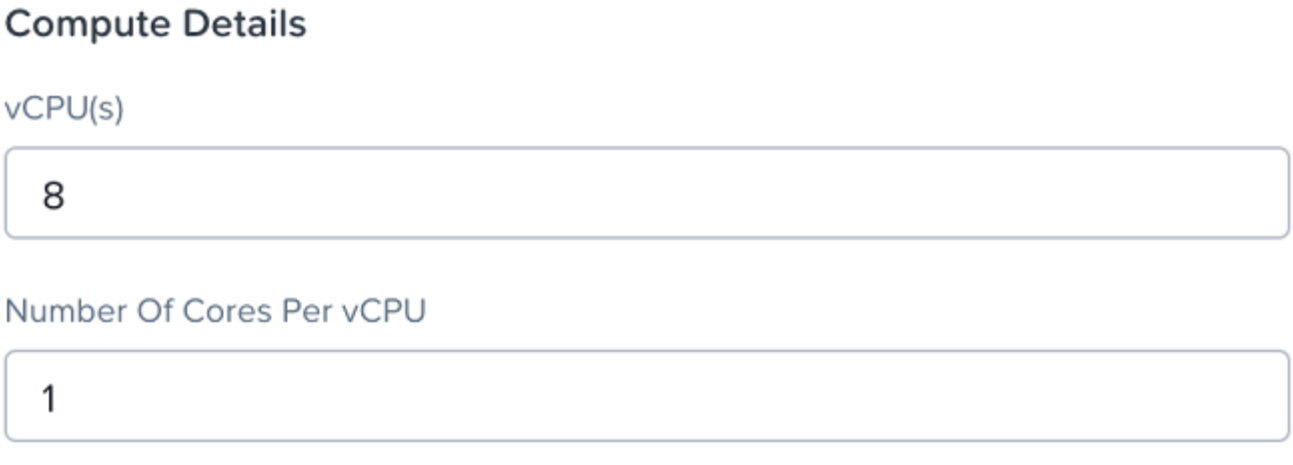


Figure 6: Option 2: Compute Details

We configure SQL Server CPU with automatic allocation.

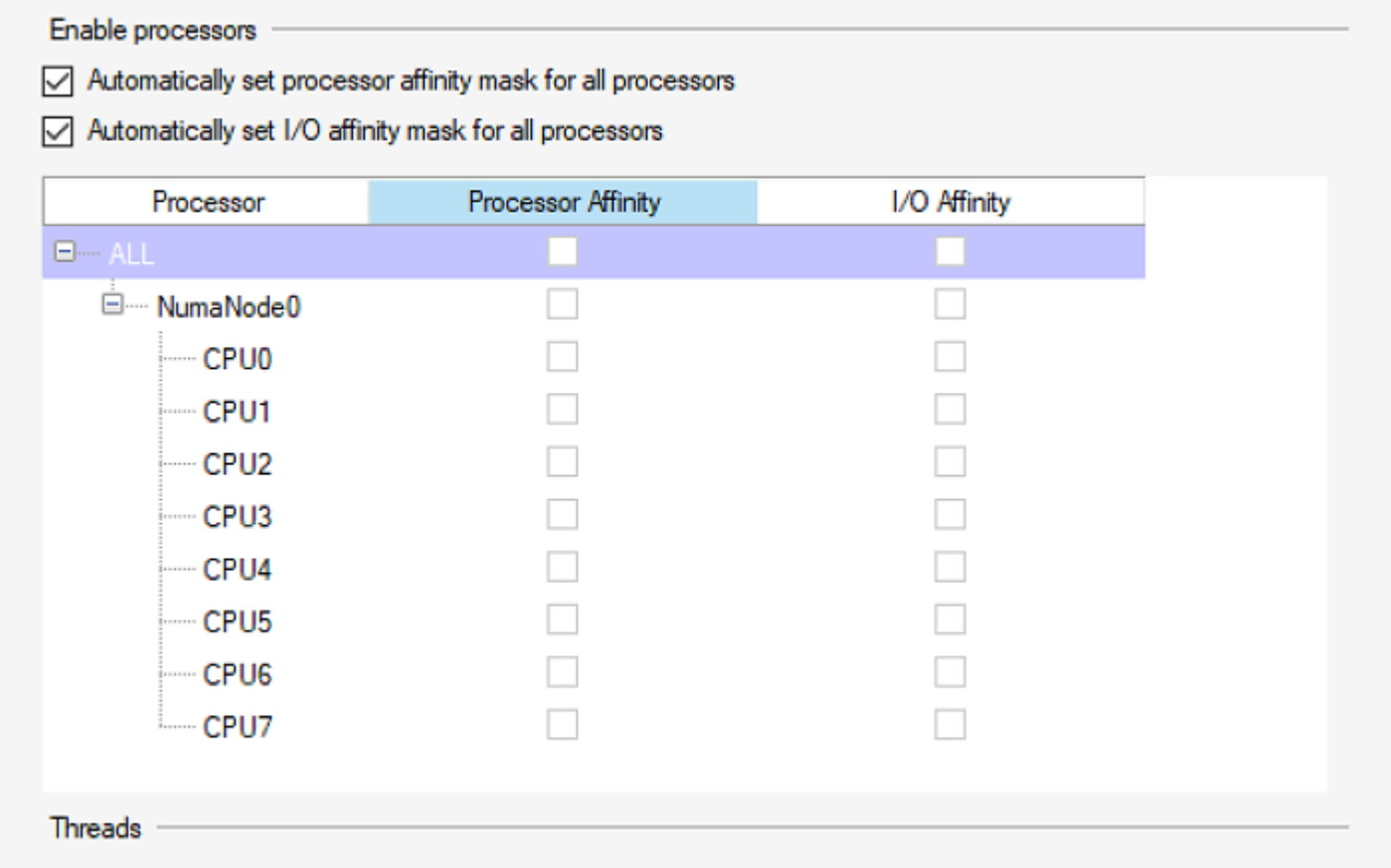


Figure 7: Option 2: CPU Automatic Allocation

Although the database server has 8 CPU allocated (assigned online), SQL Server can only use 4 CPU (visible online).

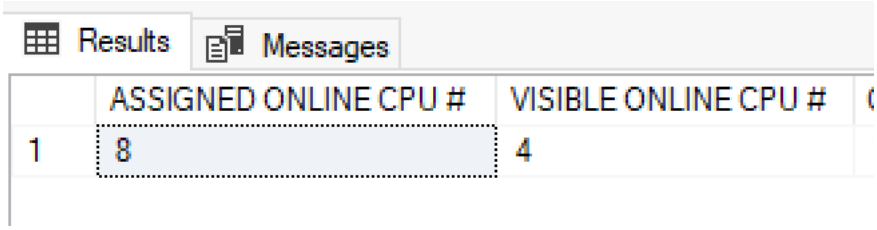


Figure 8: Option 2: Allocated vs. Usable Online CPU

When we query the dynamic management view for `dm_os_schedulers`, we can verify that only 4 vCPU are available and scheduled in SQL Server.

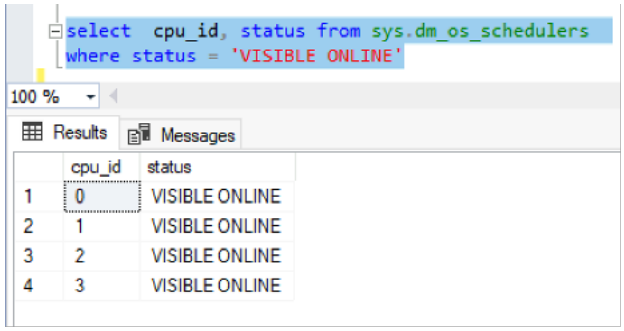


Figure 9: Option 2: Scheduler Query Results

SQL Server Standard edition is only licensed to use up to 4 vCPU. Because SQL Server in a virtual environment (in this case, AHV) maps each vCPU to a socket in a physical server, SQL Server Standard edition considers 8 vCPU to be over-allocation.

Option 3: System with 4 vCPU and 6 Cores per vCPU

In the third test configuration, we create a virtual server with 4 vCPU and 6 cores per vCPU.

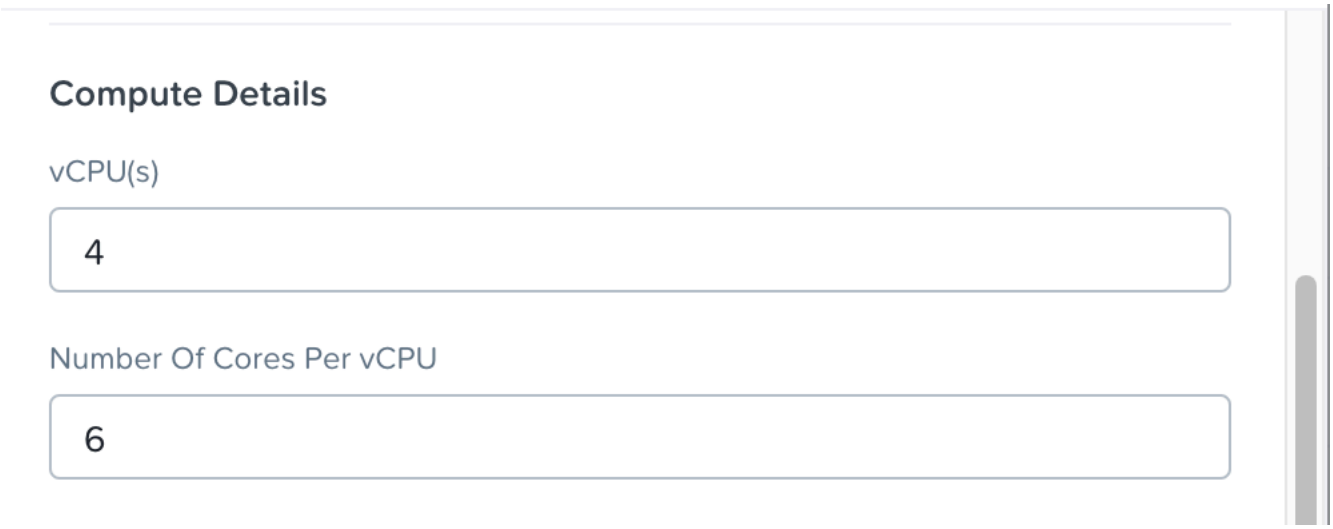


Figure 10: Option 3: Compute Details

We configure SQL Server CPU with automatic allocation.


```
select  cpu_id, status from sys.dm_os_schedulers
where status = 'VISIBLE ONLINE'
```

100 %

Results | Messages

	cpu_id	status
1	0	VISIBLE ONLINE
2	1	VISIBLE ONLINE
3	2	VISIBLE ONLINE
4	3	VISIBLE ONLINE
5	4	VISIBLE ONLINE
6	5	VISIBLE ONLINE
7	6	VISIBLE ONLINE
8	7	VISIBLE ONLINE
9	8	VISIBLE ONLINE
10	9	VISIBLE ONLINE
11	10	VISIBLE ONLINE
12	11	VISIBLE ONLINE
13	12	VISIBLE ONLINE
14	13	VISIBLE ONLINE
15	14	VISIBLE ONLINE
16	15	VISIBLE ONLINE
17	16	VISIBLE ONLINE
18	17	VISIBLE ONLINE
19	18	VISIBLE ONLINE
20	19	VISIBLE ONLINE
21	20	VISIBLE ONLINE
22	21	VISIBLE ONLINE
23	22	VISIBLE ONLINE
24	23	VISIBLE ONLINE

Figure 11: Option 3: CPU Automatic Allocation

The following screenshot shows the number of physical and logical CPUs that the SQL Server OS detects.

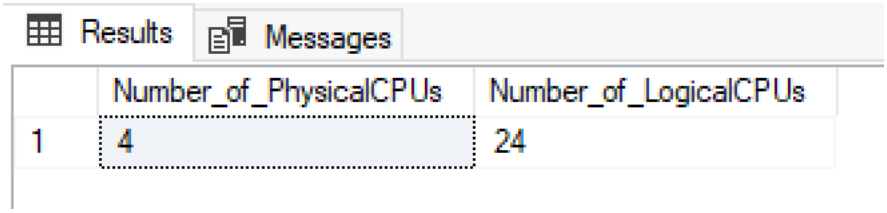


Figure 12: Option 3: Physical and Logical CPUs Detected

All allocated CPU resources (assigned online) are available and usable (visible online).

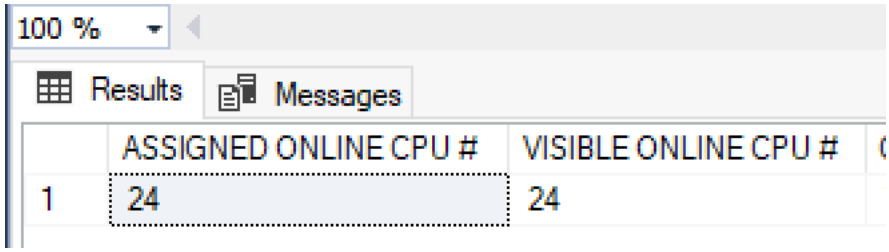


Figure 13: Option 3: Allocated vs. Usable Online CPU

When we query the dynamic management view for `dm_os_schedulers`, we can verify that all 24 cores are available and scheduled in SQL Server. SQL Server Standard edition consumes the allocated CPU resources in this configuration option.


```
select  cpu_id, status from sys.dm_os_schedulers
where status = 'VISIBLE ONLINE'
```

100 %

Results | Messages

	cpu_id	status
1	0	VISIBLE ONLINE
2	1	VISIBLE ONLINE
3	2	VISIBLE ONLINE
4	3	VISIBLE ONLINE
5	4	VISIBLE ONLINE
6	5	VISIBLE ONLINE
7	6	VISIBLE ONLINE
8	7	VISIBLE ONLINE
9	8	VISIBLE ONLINE
10	9	VISIBLE ONLINE
11	10	VISIBLE ONLINE
12	11	VISIBLE ONLINE
13	12	VISIBLE ONLINE
14	13	VISIBLE ONLINE
15	14	VISIBLE ONLINE
16	15	VISIBLE ONLINE
17	16	VISIBLE ONLINE
18	17	VISIBLE ONLINE
19	18	VISIBLE ONLINE
20	19	VISIBLE ONLINE
21	20	VISIBLE ONLINE
22	21	VISIBLE ONLINE
23	22	VISIBLE ONLINE
24	23	VISIBLE ONLINE

Figure 14: Option 3: Scheduler Query Results

5. Conclusion

When deploying SQL Server Standard edition in a virtual environment, consider the optimal vCPU-to-core ratio. SQL Server maps vCPU to physical sockets.

The following combinations of vCPU and cores per vCPU yield the best compute capacity in compliance with SQL Server Standard edition licensing limitations for systems in a virtual environment.

Table. vCPU-to-Core Configurations

vCPU Count	Number of Cores per vCPU	Total Cores
1	24	24
2	12	24
3	8	24
4	6	24

Depending on the host system's CPU configuration and the application workload, you might find a specific vCPU-to-core configuration that yields better performance. We strongly recommend that you conduct appropriate load testing to determine the optimal vCPU-to-core ratio for your workload in your environment.

About Nutanix

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