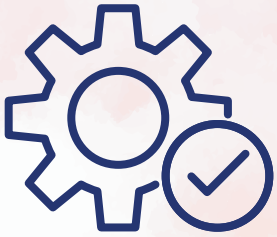

Process more SQL Server transactions

up to 2.7X the new orders per minute (NOPM)*

Faster response times during a SQL Server workload

67% lower average latency for new order transactions*

Lower cost for transactional database performance

Up to 68% lower price per performance*

*EBS gp3-backed EC2 r5b.16xlarge instance vs. an Azure E64ds_v4 VM with one ultra disk volume

Get higher transaction throughput and better price/performance with an Amazon EC2 r5b.16xlarge instance backed by EBS gp3 storage

In addition, the EBS gp3-backed EC2 r5b.16xlarge instance delivered a lower average transaction latency to offer more consistent transactional database performance than two Microsoft Azure E64ds_v4 VM configurations

A public cloud solution that can process more database transactions, with the additional ability to scale up to meet peak usage windows on demand, could mean more ecommerce orders and potentially more revenue. Organizations must also consider cost and value as well as performance consistency as they aim to save money and adhere to strict service level agreements (SLAs).

We ran an online transaction processing (OLTP) workload for Microsoft SQL Server 2019 Enterprise edition on a Amazon EC2 r5b.16xlarge instance with gp3 volumes and on Microsoft Azure E64ds_v4 VMs in two storage configurations, one with striped Premium SSD volumes and one with a single ultra disk volume. We made the EC2 R5b instance and Azure VM configurations as comparable as possible in computing and memory (page 2 provides the full details). The EC2 R5b instance processed more SQL Server transactions than either Azure VM configuration, including 2.7 times the new orders per minute (NOPM) of the Azure VM with ultra disk storage. In addition to more revenue from ecommerce applications, higher transactional throughput could support more users for an enterprise resource planning (ERP) application or reduce costs due to consolidated workloads.

Based on the better transactional database performance we saw in testing and its pricing, the EC2 R5b configuration can offer a better price-per-performance value than the Azure VM backed by either Premium SSD volumes or an ultra disk volume. Using the performance from our testing, we found that an organization with the on-demand, license-included EBS gp3-backed EC2 r5b.16xlarge instance could pay less monthly than with either Azure E64ds_v4 VM configuration. Compared to the on-demand, license-included Azure VM we tested with 12 Premium SSD volumes, the monthly cost per 1K NOPM for the EC2 configuration was 49 percent lower. In addition, the monthly cost per 1K NOPM for our EC2 configuration was 68 percent lower than the price-per-performance cost of the on-demand, license-included Azure VM with an ultra disk volume. Organizations deploying on-demand SQL Server workloads could better control their IT budgets with a lower monthly expense.

What we tested

To demonstrate the performance differences between the Amazon EBS gp3-backed EC2 r5b.16xlarge instances and the Azure Premium SSD and ultra disk-backed E64ds_v4 VMs, we ran the TPROC-C OLTP workload from HammerDB v4.2. An Intel® Xeon® Platinum 8259CL processor with a base core frequency of 2.50 GHz powered the EC2 r5b.16xlarge instances, and an Intel Xeon Platinum 8272CL processor with a base core frequency of 2.60 GHz powered the Azure E64ds_v4 VMs. In addition to having 2nd Generation Intel Xeon Scalable processors, the EC2 instance and both Azure VMs had the same number of vCPUs (64) and comparable on-demand hourly pricing. The EC2 instance had 512 GB of memory, and the Azure E64ds VMs had 504 GB.

The EC2 r5b.16xlarge instance has an input/output operations per second (IOPS) limit that is more than double that of the E64ds_v4 VM. According to Amazon, the EC2 r5b.16xlarge instance backed by EBS gp3 storage can support 173,333 IOPS,[1] and Microsoft claims the E64ds_v4 VM can support 80K IOPS uncached (the maximum for all generally available Azure VMs). Premium SSDs can operate in cached or uncached modes.[2] For our Premium SSD configuration, we enabled read caching to enhance transactional performance. Ultra disks support only un-cached reads and writes.[3]

The EC2 r5b.16xlarge instance has a throughput limit of 5,000 MBps. The Azure E64ds_v4 VM has a throughput limit of 1,200 MBps.

Table 1: Configuration details for the instances and storage we tested.

Test parameter	Amazon Elastic Compute Cloud (EC2)	Microsoft Azure	Microsoft Azure
Region	us-east-1c	US east zone 3	US east zone 3
Instance or VM type	r5b.16xlarge	E64ds_v4	E64ds_v4
CPU vCores	64	64	64
RAM (GB)	512	504	504
Storage type	gp3	P40 (data), P60 (log)	ultra disk
Storage capacity per volume	500 GB	2 TB	4 TB
Total storage capacity (TB)	5	22	4
Disk configuration	Data/log: 10 x 500 GB, simple stripe	Data: 11 x 2,000 GB, striped Log: 1 x 8,192 GB	Data/log: 1 x 4,000 GB
Max instance or VM IOPS / throughput	173,333 / 5,000 MBps	80,000 / 1,200 MBps	80,000 / 1,200 MBps
Configured volume IOPS / throughput	16,000 / 500 MBps	Data: 7,500 / 250 MBps Log: 16,000 / 500 MBps	80,000 / 250 MBps
Total max storage IOPS / throughput (all volumes)	160,000 / 5,000 MBps	Data: 82,500 / 2,750 MBps Log: 16,000 / 500 MBps	80,000 / 1,200 MBps
Max cache IOPS / throughput	N/A	615,000 / 3,872 MBps	N/A
Used cache?	N/A	Yes (read)	No

The EC2 instance and Azure VMs ran Microsoft Windows Server 2019 Datacenter Edition, version 10.0.17763 (Build 17763), and used Microsoft SQL Server 2019 (KB4577194) for the database.

For all three configurations, we wanted to max out the instance-level IOPS limits while providing at least 4 TB of storage. In some cases, we needed to over-provision the storage capacity to reach the required performance. For example, the P40 configuration had 17 more TB of storage than the other configurations because the Azure Premium Managed Disks have a preset capacity and IOPS-per-volume limit. However, each configuration used the same amount of storage (3.2 TB) for the database files. The 80K IOPS from the ultra disk volume was the maximum supported IOPS of the Azure VM we chose.

We believe these facts support our decision to compare the SQL Server NOPM performance in HammerDB of the EC2 r5b.16xlarge instance and the Azure E64ds v4 VM in both configurations. We intended to represent how a real-world customer might want to select comparable instances based on compute, while configuring respective storage options for best-possible IOPS and throughput to achieve optimal database performance. In addition, we chose the TPROC-C workload from HammerDB because it is a publicly available, non-proprietary tool for general use, and users can replicate common database usage scenarios to evaluate and validate performance without favoring a particular solution.

Process more SQL Server 2019 transactions with Amazon EBS gp3-backed EC2 r5b.16xlarge instances

Figure 1 shows the median NOPM for the three configurations we tested. The EBS gp3-backed EC2 R5b instance handled 1.7 times the NOPM of the P40-backed VM and 2.7 times the NOPM of the ultra disk-backed VM. Note that the P40-backed configuration used the VM's cache, but the cache was not available for the ultra disk configuration. Doing more work with the same number of instances, or the same amount of work with fewer instances, could translate to savings for your organization.

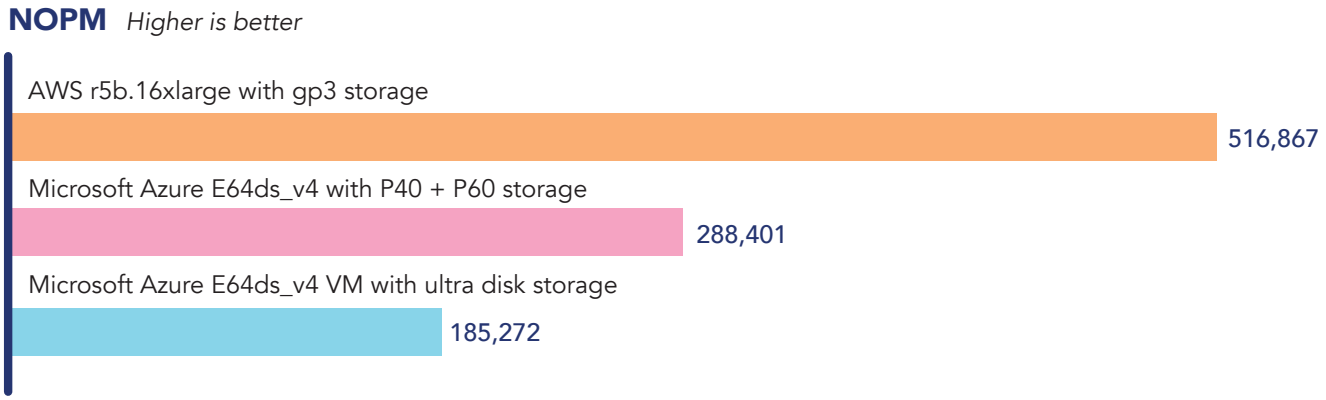

Figure 1: The NOPM that each configuration delivered while running an OLTP workload. Larger is better. Source: Principled Technologies.

Lower average latency with the Amazon EBS gp3-backed EC2 r5b.16xlarge instance during a transactional SQL Server workload

Figure 2 shows the average response times of the three configurations for new order transactions from the OLTP workload. The EBS gp3-backed EC2 R5b instance delivered 47 and 67 percent shorter new order transaction response times than the P40 and ultra disk-backed Azure VMs, respectively.

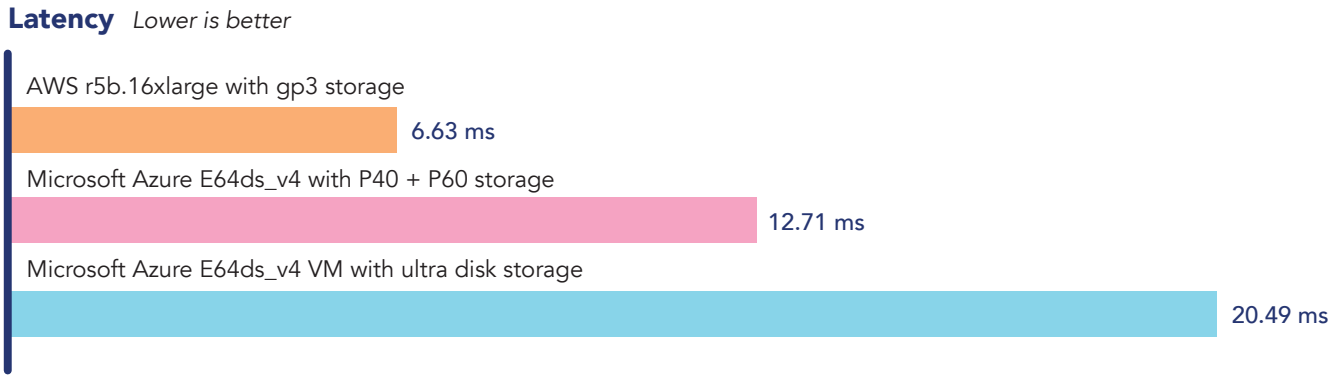

Figure 2: The response time, in milliseconds, that each configuration supported while processing new orders during an OLTP workload. Smaller is better. Source: Principled Technologies.

About EBS gp3 storage

According to Amazon, general-purpose SSD-based EBS gp3 storage can provide "SSD volumes that offer balanced cost and performance for majority of your workloads," and allow customers to "scale IOPS (input/output operations per second) and throughput without needing to provision additional block storage capacity" so they pay for only the storage they need.[4] Applications that require high performance, such as those that use MySQL, Cassandra, virtual desktops, and Hadoop analytics, could benefit from gp3 storage performance and cost. To learn more about gp3 volumes, visit https://aws.amazon.com/ebs/general-purpose/.

Spend less each month to run OLTP workloads on EBS gp3-backed EC2 R5b instances

Table 2 presents a price-per-performance scenario for the on-demand, license-included EC2 instance and the Azure VM we tested. The instance and VMs ran in the eastern US region data centers on September 24, 27, and 29, 2021, and October 6, 2021.[5,6,7] We compiled the on-demand costs of both solutions for a full 720-hour month to provide a worst-case cost comparison.[8,9,10] Expenses vary depending on the plan an organization chooses, which would include using the cloud for short-term performance bursts or needing longer-term options (e.g., one year, three years). Using the performance numbers from our testing in a 720-hour usage scenario, the monthly price per 1K NOPM from the EBS gp3-backed instance was USD$46.50, which was $45.44 and $102.11 lower than the monthly prices per 1K NOPM from the Azure VMs. An organization choosing the EBS gp3-backed EC2 R5b instance we tested could pay 49 or 68 percent less than if they chose the Azure VM with P40 or ultra disk volumes, respectively.

Table 2: Pricing for the EC2 instance, Azure VMs, and their respective storage. Source: Principled Technologies.

Test scenario	Parameter	EC2 r5b.16xlarge instance + gp3 volumes	Azure E64ds_v4 + P40 volumes	Azure E64ds_v4 + ultra disk volume
720-hr.usage scenario	Monthly on-demand price (USD)	$24,032.64	$26,513.02	$27,531.75
	Performance (NOPM)	516,876	288,401	185,272
	Price/performance (Monthly $/1K NOPM)	$46.50	$91.93	$148.60

Figure 3 shows the monthly price per 1K NOPM for the three configurations we tested in a 720-hour usage scenario.

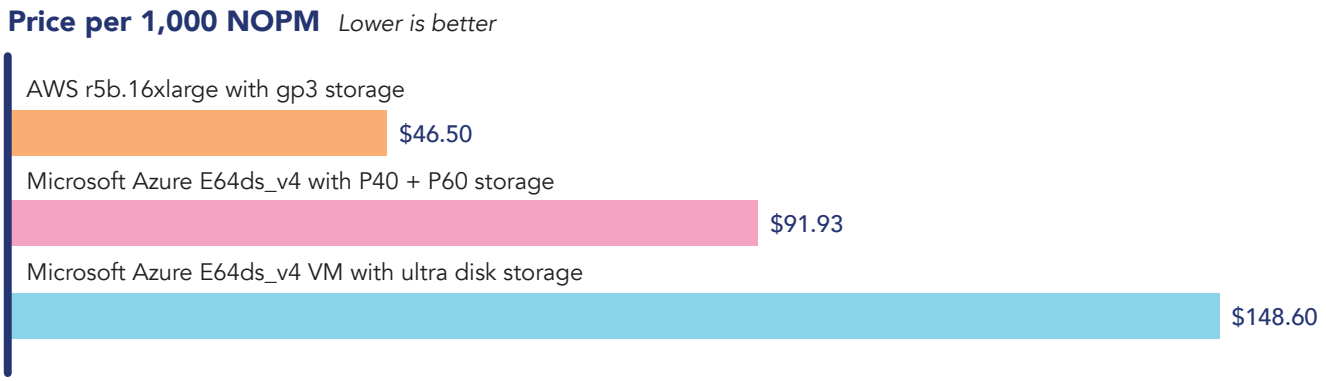

Figure 3: The monthly price per 1K NOPM each configuration could provide in a 720-hour usage scenario. Smaller is better. Source: Principled Technologies.

Why NOPM?

New orders per minute (NOPM) is a metric for OLTP workloads that shows only the number of new order transactions completed in one minute as part of a serialized business workload. HammerDB claims that because NOPM is "independent of any particular database implementation [it] is the recommended primary metric to use."[11]

Conclusion

Public cloud service providers offer numerous public options. Some aim to minimize cost and some aim to deliver strong, reliable performance. We found that EBS gp3 storage for EC2 R5b instances could offer a balance of both. In our tests, the EC2 solution supported more transactional database performance in NOPM than that of a Microsoft Azure E64ds_v4 VM with P40 or ultra disk volumes (1.7 and 2.7 times the NOPM, respectively). The EC2 R5b instance also delivered shorter response times and had a lower price-per-performance cost than the competing Azure VM in either storage configuration, costing up to 68 percent less.

1. Amazon, "Amazon EBS–optimized instances," accessed October 1, 2021, https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/ebs-optimized.html.
2. Microsoft, "Edv4 and Edsv4-series," accessed October 1, 2021, https://docs.microsoft.com/en-us/azure/virtual-machines/edv4-edsv4-series.
3. Microsoft, "Using Azure ultra disks," accessed October 4, 2021, https://docs.microsoft.com/en-us/azure/virtual-machines/disks-enable-ultra-ssd?tabs=azure-portal.
4. Amazon, "Amazon EBS General Purpose Volumes," accessed November 18, 2021, https://aws.amazon.com/blogs/aws/new-amazon-ebs-gp3-volume-lets-you-provision-performance-separate-from-capacity-and-offers-20-lower-price/.
5. Amazon, "Amazon EC2 On-Demand Pricing," accessed October 13, 2021, https://aws.amazon.com/ec2/pricing/on-demand/.
6. "Amazon EC2 On-Demand Pricing," accessed October 13, 2021.
7. Microsoft, "Windows Virtual Machines Pricing," accessed October 13, 2021, https://azure.microsoft.com/en-us/pricing/details/virtual-machines/windows/.
8. Instance pricing from both CSPs did not include operating system or SQL Server costs. To include those, we used each CSP's pricing calculator.
9. Amazon, "AWS Pricing Calculator," accessed October 13, 2021, https://calculator.aws/#/.
10. Microsoft, "Pricing calculator," accessed October 13, 2021, https://azure.microsoft.com/en-us/pricing/calculator/.
11. HammerDB, "Comparing HammerDB results," accessed October 1, 2021, https://www.hammerdb.com/docs/ch03s04.html.

Read the science behind this report at http://facts.pt/on7aNR3►

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