The science behind the report:

Process more read-heavy I/O with HPE ProLiant DL385 Gen10 Plus servers configured with KIOXIA value SAS and NVMe mainstream SSDs

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 more read-heavy I/O with HPE ProLiant DL385 Gen10 Plus servers configured with KIOXIA value SAS and NVMe mainstream SSDs.

We concluded our hands-on testing on May 21, 2021. 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 14, 2021 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.

To capture our data points, we created three custom, large-block, sequential read Vdbench workloads. We also used HCIBench as an automation tool to deploy test VMs, orchestrate input/output (I/O) workloads, and collect results. For each I/O profile, we configured the benchmark to calculate max performance, and then scaled I/O rate from 10 percent to 120 percent, capturing throughput, IOPS, and latency at each scale point. For our comparisons, we used the reported metrics at 100 percent I/O rate shown in tables 1 through 3. This I/O rate was the point where the benchmark determined an optimal balance between higher I/O performance without incurring extreme storage latencies.

Table 1: Throughput (MB per second), input/output operations per second (IOPS), and latency (ms) results for 100 percent max performance (per Vdbench IOrate).

I/O profile	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB KIOXIA CD6 Series NVMe SSDs	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB KIOXIA RM5 Series SAS SSDs	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB competitor SATA SSDs
Max throughput (MB per second)			
32K 100 percent reads, 100 percent sequential	5,269	4,319	2,693
64K 100 percent reads, 100 percent sequential	7,688	4,562	2,832
128K 100 percent reads, 100 percent sequential	10,366	4,566	2,776

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I/O profile	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB KIOXIA CD6 Series NVMe SSDs	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB KIOXIA RM5 Series SAS SSDs	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB competitor SATA SSDs
Input/output operations per second (IOPS)			
32K 100 percent reads, 100 percent sequential	168,609	138,215	86,165
64K 100 percent reads, 100 percent sequential	123,015	72,994	45,314
128K 100 percent reads, 100 percent sequential	82,928	36,526	22,211
Latency (ms)			
32K 100 percent reads, 100 percent sequential	1.05	1.19	1.18
64K 100 percent reads, 100 percent sequential	1.42	3.78	2.16
128K 100 percent reads, 100 percent sequential	13.88	13.27	3.51

Table 2: Hardware pricing information for our tested configurations and Vdbench IOPS per dollar for 100 percent max performance (per Vdbench IOrate).

	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB KIOXIA CD6 NVMe SSDs	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB KIOXIA RM5 SAS SSDs	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB competitor SATA SSDs
32K 100 percent reads, 100 percent sequential			
Total hardware cost of the solution	$196,446.03	$192,216.03	$191,406.03
IOPS	168,609	138,215	86,165
IOPS per dollar	**0.8582**	**0.7190**	**0.4501**
64K 100 percent reads, 100 percent sequential			
Total hardware cost of the solution	$196,446.03	$192,216.03	$191,406.03
IOPS	123,015	72,994	45,314
IOPS per dollar	**0.6262**	**0.3797**	**0.2367**
128K 100 percent reads, 100 percent sequential			
Total hardware cost of the solution	$196,446.03	$192,216.03	$191,406.03
IOPS	82,928	36,526	22,211
IOPS per dollar	**0.4221**	**0.1900**	**0.1160**

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System configuration information

Table 3: Detailed information on the servers we tested.

System configuration information	HPE ProLiant DL385 Gen10 Plus
BIOS name and version	2.42_01-23-2021
Operating system name and version/build number	VMware® ESXi™ 7.0.2 build-17630552
Date of last OS updates/patches applied	04/14/2021
Power management policy	OS Managed
Processor	
Number of processors	2
Vendor and model	AMD EPYC™ 7702
Core count (per processor)	64
Core frequency (GHz)	2.0
Stepping	B0
Memory module(s)	
Total memory in system (GB)	512
Number of memory modules	16
Vendor and model	Micron® MTA36ASF4G72PZ-3G2E7
Size (GB)	32
Type	PC4-25600
Speed (MHz)	3,200
Speed running in the server (MHz)	3,200
Storage controller	
Vendor and model	HPE Smart Array P408i-a SR Gen10
Cache size (GB)	2
Firmware version	2.65
Local storage (internal USB)	
Number of drives	1
Drive size (GB)	16
Drive information (speed, interface, type)	USB 2.0
Network adapter 1	
Vendor and model	HPE Ethernet 1Gb 4-port 331i Adapter
Number and type of ports	4 x 1GbE
Driver version	1.24.8

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System configuration information	HPE ProLiant DL385 Gen10 Plus
Network adapter 2	
Vendor and model	HPE Ethernet 100Gb 1-port QSFP28 MCX515A-CCAT Adapter
Number and type of ports	1 x 100GbE
Driver version	16.27.2008

Table 4: Detailed VMware vSAN™ storage configuration.

	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB KIOXIA CD6 Series NVMe SSDs	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB KIOXIA RM5 Series SAS SSDs	HPE ProLiant DL385 Gen10 Plus server with two 3.84TB competitor SATA SSDs
Number of vSAN nodes	3	3	3
vSAN disk groups per node	1	1	1
vSAN cache tier			
Number of drives per disk group	1	1	1
Drive vendor and model	KIOXIA KCM6XVUL800G	KIOXIA KCM6XVUL800G	KIOXIA KCM6XVUL800G
Drive size (GB)	800	800	800
Drive information (speed, interface, type)	NVMe PCIe Gen 4, SSD, 2.5	NVMe PCIe Gen 4, SSD, 2.5	NVMe PCIe Gen 4, SSD, 2.5
vSAN capacity tier			
Number of drives per disk group	2	2	2
Drive vendor and model	KIOXIA KCD6XLUL3T84	HPE VO003840RWUFB	HP VK003840GWSRV
Drive size (GB)	3,840	3,840	3,840
Drive information (speed, interface, type)	NVMe PCIe Gen 4, SSD, 2.5	12 Gbps, SAS, SSD, 2.5	6 Gbps, SATA, SSD, 2.5
Total number of drives per vSAN node	3	3	3

For vSAN traffic, we used a dedicated 100Gb network switch with a corresponding dedicated single-port 100Gb network adapter for each server and enabled jumbo frames by setting MTU to 9,000.

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How we tested

Installing VMware vSphere 7.0 Update 2

1. Download the image for VMware ESXi 7.0 Update 2.
2. Mount the image to the server.
3. Power on the server.
4. The system will boot to the mounted image and the Loading ESXi installer screen will appear. When prompted, press Enter to continue.
5. Press F11 to Accept the EULA and Continue.
6. Select the storage device to target for installation. We selected the internal SD card. To continue, press Enter.
7. To confirm the storage target, press Enter.
8. Select the keyboard layout, and press Enter.
9. Provide a root password and confirm it. To continue, press Enter.
10. Press F11 to Install.
11. Upon completion, press Enter to reboot the server.

Installing VMware vCenter Server Appliance 7.0 Update 2

1. Download the VMware vCenter® 7.0 Update 2 from the VMware support portal at https://my.vmware.com.
2. Mount the image on your local system, and navigate to the vcsa-ui-installer folder. Expand the folder for your OS, and if the installer does not automatically begin, launch it.
3. The vCenter Server® Installer wizard opens. Click Install.
4. To begin installation of the new vCenter server appliance Click Next.
5. Check the box to accept the license agreement, and click Next.
6. Enter the IP address of one of your newly deployed HPE ProLiant DL385 Gen10 Plus servers with ESXi 7.0 Update 2. Provide the root password, and click Next.
7. To accept the SHA1 thumbprint of the server's certificate, click Yes.
8. Accept the VM name, and provide and confirm the root password for the VCSA. Click Next.
9. Set the size for the environment you are deploying. We selected small. Click Next.
10. Select the datastore on which to install. Accept the datastore defaults, and click Next.
11. Enter the FQDN, IP address information, and DNS servers you want to use for the vCenter server appliance. Click Next.
12. To begin deployment, click Finish.
13. Once Stage 1 completes, click Close. To confirm, click Yes.
14. Open a browser window, and connect to https://[vcenter.FQDN:5480/.
15. On the Getting Started - vCenter Server page, click Set up.
16. Enter the root password, and click Log in.
17. Click Next.
18. Enable SSH access, and click Next.
19. To confirm the changes, click OK.
20. For the Single Sign-On domain name, enter `vsphere.local`. Enter a password for the administrator account, confirm it, and click Next.
21. Click Next.
22. Click Finish.

Creating a cluster in vSphere 7.0 Update 2

1. Open a browser, and enter the address of the vCenter server you deployed (https://[vcenter.FQDN]/ui).
2. In the left panel, select the vCenter server, right-click, and select New Datacenter.
3. Provide a name for the new datacenter, and click OK.
4. Select the datacenter you just created, right-click, and select New Cluster.
5. Give a name to the cluster, and enable vSphere DRS. Click OK.
6. Under Add hosts in the cluster configuration panel, click Add.
7. Check the box for Use the same credentials for all hosts. Enter the IP Address and root credentials for the first host, and enter the IP addresses of all remaining hosts. Click Next.
8. To select all hosts, check the box for Hostname/IP Address. Click Ok.
9. Click Next.
10. Click Finish.

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Configuring VMware vSAN on the cluster using Quickstart

1. In the Hosts and Clusters pane, select the newly created VMware vSAN cluster.
2. Click the Configure tab, and under Configuration, select Quickstart.
3. Under Cluster basics, click Edit.
4. Enable vSAN, and click OK.
5. Under Add Hosts, click Add.
6. Enter the IP and credentials for each of the hosts you wish to add to the cluster, and click Next.
7. Under Configure hosts, click Configure.
8. Under Physical adapters, click the dropdown next to the adapters you wish to use for vSAN traffic, and select DSwitch. Leave the Distributed switches and Port groups options as default. Click Next.
9. Enter the value of the VLAN you wish to use for vSAN.
10. If you wish, change IP type to static, and enter IPs for the hosts. Otherwise, leave IP type as DHCP. Click Next.
11. On the Advanced options page, click Next.
12. On the Claim disks page, select the disks which you wish to use for Capacity and Cache, and click Next.
13. Click Next, and click Finish.

Deploying the HCIBench controller VM

1. Log into vCenter server.
2. Right-click Datacenter.
3. Click Deploy OVF Template.
4. Select Local file, and click Browse.
5. Select HCIBench_2.5.3.ova, and click Open.
6. Click Next.
7. At the Select name and location screen, click Next.
8. Select the infrastructure host, and click Next.
9. At the Review details screen, click Next.
10. At the Accept license agreement screen, click Accept twice, and click Next.
11. At the Select storage screen, choose a datastore to host the appliance, and click Next.
12. At the Select network screen, select the VM and Management networks, and click Next.
13. At the Customize template screen, enter Network Settings and Root credentials, and click Next.
14. At the Ready to complete screen, click Finish.

Configuring HCIBench

1. Navigate to http://HCIBench_IP:8443/, and log in using root credentials.
2. Provide the following VMware vSphere® environment information:

   - vCenter hostname or IP
   - vCenter username and password
   - Datacenter name
   - Cluster name
   - Network name
   - Datastore name
   - Hosts
   - Host username and password

3. Under Upload the Vdbench File, click Choose File, and select the vdbench50407.zip file.
4. Select Open, and click Upload Vdbench.
5. Click Save Configuration.

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Deploying Vdbench guest VMs and running the test

We deployed 24 VMs with 10 data disks each, sized 10 GB. See the following section for detailed Vdbench parameter files.

1. Navigate to http://HCIBench_IP:8443/, and log in using root credentials.
2. Provide the following guest VM specifications:

    - VM name prefix
    - Number of VMs
    - Number of data disks
    - Size of data disks

3. Under Upload a Vdbench parameter file, click Choose File.
4. Select the appropriate parameter file, and click Open.
5. Click Upload Parameter File.
6. Under Select a Vdbench parameter file, click Refresh.
7. Select the appropriate parameter file, and click Save Configuration.
8. Click Test.

Vdbench parameter file

```
hd=default,jvms=8
sd=sd1,lun=/dev/sda,openflags=o_direct,hitarea=0,range=(0,100),threads=8
sd=sd2,lun=/dev/sdb,openflags=o_direct,hitarea=0,range=(0,100),threads=8
sd=sd3,lun=/dev/sdc,openflags=o_direct,hitarea=0,range=(0,100),threads=8
sd=sd4,lun=/dev/sdd,openflags=o_direct,hitarea=0,range=(0,100),threads=8
sd=sd5,lun=/dev/sde,openflags=o_direct,hitarea=0,range=(0,100),threads=8
sd=sd6,lun=/dev/sdf,openflags=o_direct,hitarea=0,range=(0,100),threads=8
sd=sd7,lun=/dev/sdg,openflags=o_direct,hitarea=0,range=(0,100),threads=8
sd=sd8,lun=/dev/sdh,openflags=o_direct,hitarea=0,range=(0,100),threads=8
sd=sd9,lun=/dev/sdg,openflags=o_direct,hitarea=0,range=(0,100),threads=8
sd=sd10,lun=/dev/sdh,openflags=o_direct,hitarea=0,range=(0,100),threads=8
* 32k workloads
wd=Read100Rand0_32k,sd=sd*,rdpct=100,seekpct=0,xfersize=32k
* 64k workloads
wd=Read100Rand0_64k,sd=sd*,rdpct=100,seekpct=0,xfersize=64k
* 128k workloads
wd=Read100Rand0_128k,sd=sd*,rdpct=100,seekpct=0,xfersize=128k
* RUN DEFAULTS
rd=default,curve=(10-120,10),iorate=curve,warmup=30,elapsed=120,iorate=curve
rd=wkd1_32k_Read100Rand0,wd=Read100Rand0_32k,sd=sd*
rd=wkd2_64k_Read100Rand0,wd=Read100Rand0_64k,sd=sd*
rd=wkd3_128k_Read100Rand0,wd=Read100Rand0_128k,sd=sd*
```

Read the report at http://facts.pt/y461pe7 ▶

This project was commissioned by KIOXIA.

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