Technical Research Report

PROWESS

Do More with Less in the Enterprise

Testing by Prowess Consulting demonstrates that the Dell™ PowerStore™ 1200T can help enterprises reduce drive energy use by up to 41 percent.

Executive Summary

Data is the new gold. And businesses understand the value. They invest in the right IT infrastructure to run high-speed analytics on database workloads and search for trends, patterns, and correlations within their datasets. Insights from their analyses inform decisions that can lead to increased sales, more satisfied customers, and improved operations.

At the same time that IT leaders help their companies' analysts mine data on high-performance infrastructure, they are asked to reduce costs and work toward sustainability goals. One approach is to look for cost- and energy-efficient infrastructure components.

To explore options for IT organizations, Prowess Consulting tested two NVM Express® (NVMe®) all-flash platforms and measured both storage and energy efficiency. We tested the Dell™ PowerStore™ 1200T and a second, similar storage platform from Vendor A.[1] Both storage platforms guarantee a data reduction ratio (DRR) of 4:1 for block workloads.[2,3]

Prowess Consulting used Vdbench, an industry-standard storage benchmarking tool, to simulate a dataset with a 2:1 compression ratio and a 2:1 deduplication ratio. Using this dataset, we observed that the PowerStore 1200T demonstrated a significantly higher DRR of 4.8:1, compared to the Vendor A storage platform, which measured a DRR of 2.8:1. With higher data efficiency, the PowerStore 1200T can help enterprises reduce the number of NVMe solid-state drives (SSDs) needed for a given workload, leading to reduced infrastructure footprint and lower overall costs. Requiring fewer drives also means that less energy will be used, which can help enterprises meet their sustainability goals. In fact, in this specific testing scenario, the PowerStore 1200T used 41 percent less energy than the competitive platform.

Data-Storage Efficiency Benefits

Manufacturers of all-flash storage platforms have responded to customer needs for lower price points by applying data-efficiency technologies. They use data services, such as compression and deduplication, to help reduce the amount of physical storage that is needed to save a given dataset. Though these approaches have been used for years, increasing storage efficiency to lower costs is even more critical in today's uncertain business environment.

Reducing the required storage space lets organizations deploy fewer drives, which leads to a reduction in power and cooling needs. It also reduces the physical footprint of the solution, which can lead to savings in floor space and rack space. These benefits help reduce the total cost of ownership (TCO) of storage and help enterprises meet sustainability goals.

Data Reduction Guarantee

For the platforms tested, both Dell Technologies and Vendor A offer a 4:1 DRR guarantee.[2,3] This means that for block workloads, Dell Technologies and Vendor A both guarantee a logical storage capacity of at least four times the usable physical capacity of the purchased configuration.

How We Tested

We configured both the PowerStore 1200T and the Vendor A platforms with the maximum number of internal drives supported in the base enclosure. No externally connected shelves were used. (For complete details, refer to Test Methodology in the Appendix.)

We began our test setup by creating twelve 1 TB volumes on each array and then mapping these volumes to our servers through Fibre Channel connections. We tuned the storage and hosts according to each storage vendor's published best practices. We ran our data reduction validation three times and chose the median result for this report.

For testing purposes, we used a 12 TB dataset to ensure a manageable test time. However, because the DRR is not impacted by the quantity or size of the NVMe drives used, the same data reduction results can be extrapolated over larger datasets.

Ease of Use

We observed that the PowerStore 1200T user interface (UI) was more intuitive and easier to use than the Vendor A platform UI. For example, the PowerStore 1200T offers a single page for volume management, whereas the competitive platform requires the user to switch back and forth between two pages. Figure 1 shows capacity information displayed with PowerStore 1200T; note that ratios are clearly illustrated and data savings are pre-calculated. In contrast, the Vendor A UI did not clearly display information like storage utilization.

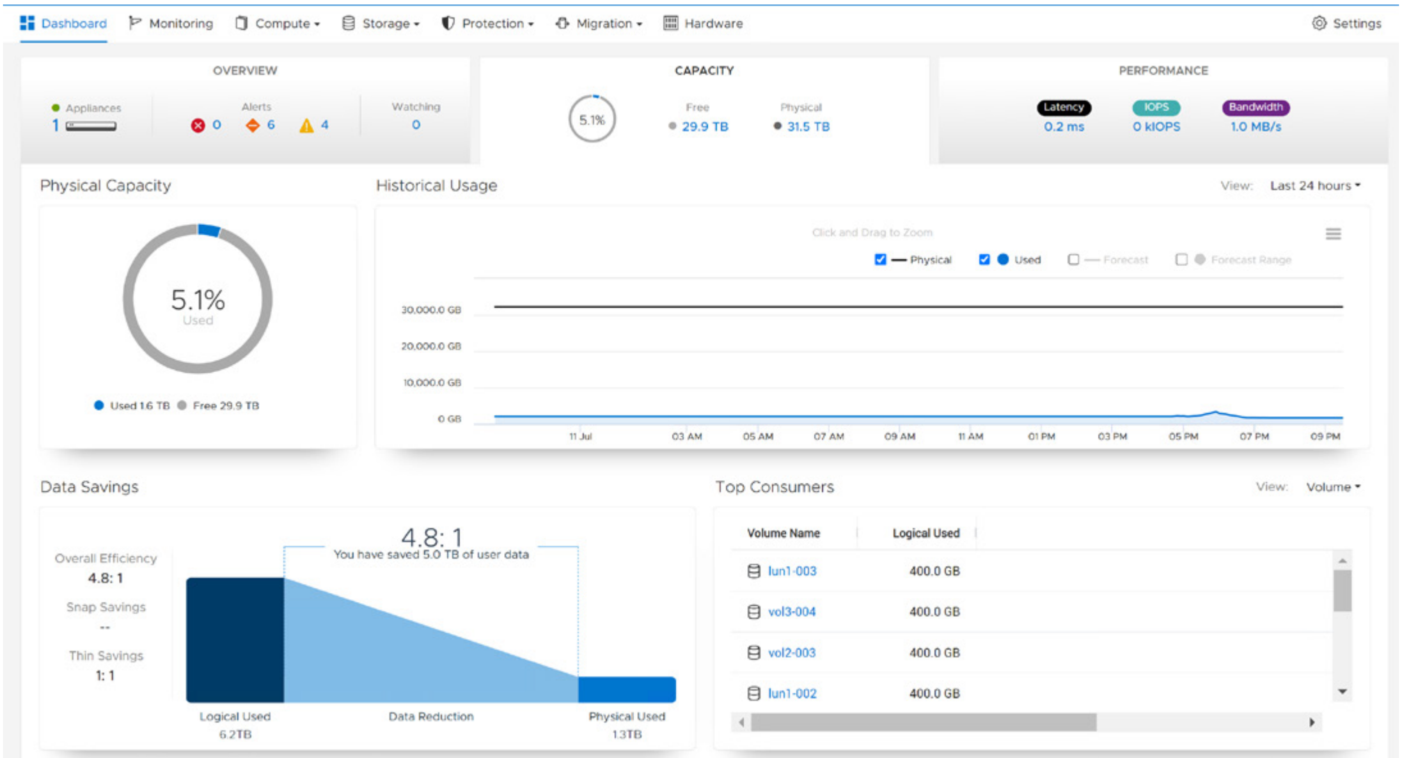

Figure 1 | The Dell™ PowerStore™ 1200T UI is intuitive and easy to use

Calculating DRRs

We started the test with each array containing empty volumes. Using the Vdbench tool, we simulated data migration into the arrays. The 12 TB dataset, which Vdbench created, had a 256 KB input/output (I/O) size, a 2:1 compression ratio, a 2:1 deduplication ratio, and a single thread per volume. We collected capacity and data reduction information before and after each iteration to assess the data reduction capabilities of both storage arrays.

The PowerStore 1200T demonstrated a DRR of 4.8:1, while the Vendor A storage platform demonstrated a DRR of 2.8:1 (see Figure 2). The PowerStore 1200T exceeded the 4:1 guarantee, while the Vendor A platform did not meet the guarantee. See the Appendix for details on the test procedure and test configurations.

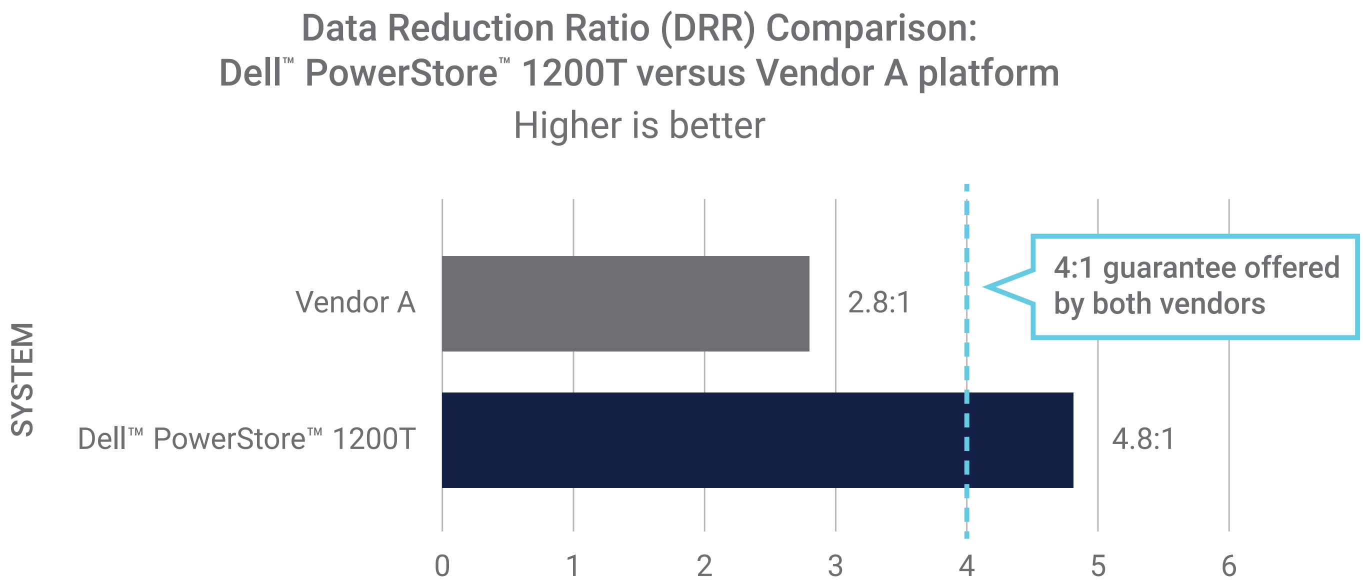

Figure 2 | DRR comparison

System Comparisons

Prowess Consulting computed how many fewer drives would be needed in the PowerStore 1200T to store the same amount of application data as in the Vendor A platform (for details, see System Comparison Calculations in the Appendix.)

In the test configuration, the PowerStore 1200T used 23 drives,[4] whereas the Vendor A system used 24 drives. The total usable capacity of the PowerStore 1200T system was 31.5 TiB, and the total usable capacity of the Vendor A system was 32.5 TiB. Usable capacity is less than raw capacity because some storage space is needed for metadata, RAID, and other system overhead. We read the usable capacity from each system's graphical user interface (GUI).

We took usable capacity and each system's DRR and computed effective capacity. Table 1 illustrates our calculations. The effective capacity of the PowerStore 1200T was 151.2 TiB, whereas the effective capacity of the Vendor A platform was 91.0 TiB; the effective capacity of the PowerStore 1200T was 66 percent higher.

Table 1 | Effective capacity calculated from total capacity

Unit Under Test	A. Drive Quantity	B. Drive Size (TB)	C. Raw Capacity (TB) A * B	D. Usable Capacity (TiB) Reported by Storage Platform	E. DRR Multiplier	F. Effective Capacity (TiB) D * E
Dell™ PowerStore™ 1200T	23	1.92	44	31.5	4.8	151.2
Vendor A platform	24	1.92	46	32.5	2.8	91.0

The relationships between effective capacity, DRR, and usable capacity for each system are illustrated in Figure 3 and Figure 4.

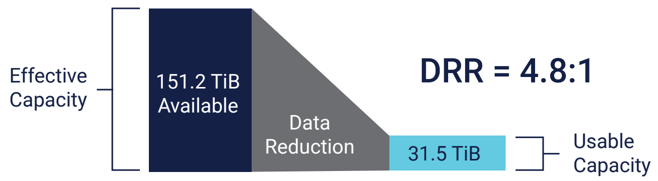

Figure 3 | Dell™ PowerStore™ 1200T data reduction

Figure 4 | Vendor A platform data reduction

To get an idea of how the superior DRR of the PowerStore 1200T would benefit an enterprise, we calculated what the raw capacity of the PowerStore 1200T would need to be to deliver the same effective capacity as the Vendor A platform—91 TB (see Table 2). We then translated this into the equivalent number of drives.

First, we calculated the usable capacity of the PowerStore 1200T by taking the Vendor A platform's effective capacity of 91 TiB and dividing that by the PowerStore 1200T platform's DRR. We then multiplied the usable capacity by the PowerStore 1200T platform's ratio of drive quantity (23 drives) to usable capacity (31.5 TiB), shown in Table 1. Multiplying 19 times (23/31.5) yields 14 equivalent drives. Thus, we would need 14 NVMe SSDs in the PowerStore 1200T to provide the same effective capacity as the Vendor A platform (see Table 2).

Table 2 | Calculating the equivalent Dell™ PowerStore™ 1200T drives to provide an effective capacity of 91 TiB

Unit Under Test	A. Effective Capacity	B. DRR	C. Usable Capacity A/B	D. Multiplier	E. Equivalent Drives C * D
Dell™ PowerStore™ 1200T	91 TiB	4.8	19	(23 drives/31.5 TiB)	14
Vendor A platform	91 TiB	2.8	32.5	–	24

Comparing 14 PowerStore 1200T drives to 24 Vendor A drives (see Table 2) reveals that the PowerStore 1200T requires 41 percent fewer drives to store this dataset.

Sustainability Goals

Sustainability is becoming a key strategy for businesses as environmental issues intensify and energy costs rise. Data reduction technologies can help reduce the amount of physical data storage space required, thus reducing the amount of power and cooling used. We examined energy savings as part of our research.

Platform Comparisons

Each active NVMe SSD uses 20 watts. Based on the scenario analyzed earlier in this report, the 14 drives of the PowerStore 1200T use 280 watts, whereas the Vendor A platform's 24 drives use 480 watts (see Table 3).

Table 3 | Power consumption for each platform

Unit Under Test	Power per Drive (watts)	Number of Drives	Total Power (watts)
Dell™ PowerStore™ 1200T	20	14	280
Vendor A platform	20	24	480

Comparing 480 watts to 280 watts tells us that the PowerStore 1200T used 200 fewer watts or 41 percent less energy than the Vendor A platform (see Figure 5). As fewer drives are used, we anticipate the need for less rack space and less cooling.

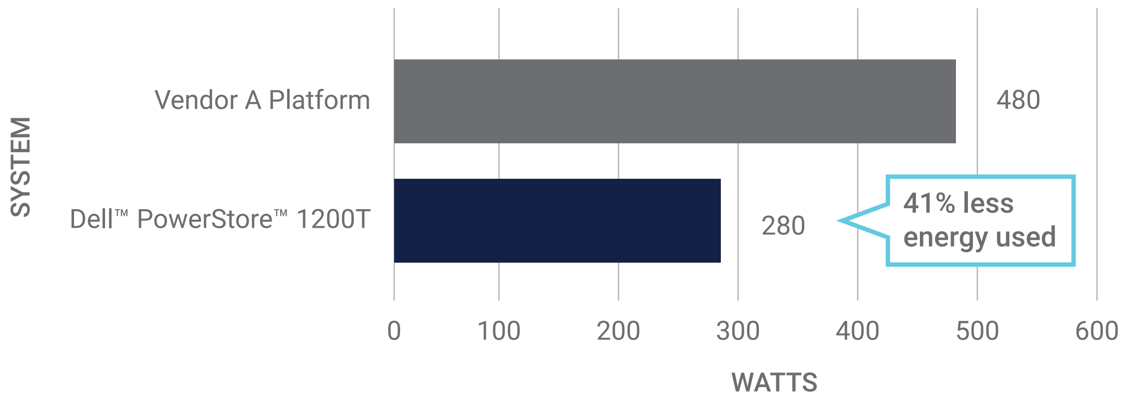

Figure 5 | Drive energy used per system (in watts)

These savings are linear with dataset scale. As datasets grow and more drives are added, the PowerStore 1200T offers significant power-consumption savings. At a usable capacity of 128 TiB, for example, the PowerStore 1200T saves 800 watts, as compared to the Vendor A platform.

Table 5 | Power-consumption savings with scale

Usable Capacity (TiB)	Number of Vendor A Drives	Number of Dell™ PowerStore™ 1200T Drives Required for the Same Effective Capacity	Vendor A Power Consumption (watts)	PowerStore Power Consumption (watts)	PowerStore 1200T Power Savings
32	24	14	480	280	200
64	48	28	960	560	400
96	72	42	1,440	840	600
128	96	56	1,920	1,120	800

Scalability

The PowerStore 1200T is highly scalable with flexibility, whereas the Vendor A platform is not. For example, the PowerStore 1200T system offers the ability to scale storage capacity in increments as small as one drive. An enterprise can add two, three, or four drives without worrying about expanding with a bundle of drives that result in overprovisioning of storage. This allows enterprises to purchase only the amount of storage needed for a given workload, minimizing storage costs. Given its lower DRR, single-drive scaling is an area of opportunity for Vendor A.

Reduced Total Cost of Ownership (TCO)

Because fewer PowerStore 1200T drives are needed to provide the same effective capacity as compared to the Vendor A platform, enterprises can reduce total hardware and software infrastructure costs. This can help to reduce TCO.

Summary of Research Results

Our research results are summarized below for easy reference.

4.8:1 DRR	41% less energy	Intuitive, easy to use	One-drive scaling	Lower overall TCO

- The PowerStore 1200T data efficiency was superior to that of the Vendor A platform using the simulated dataset. The PowerStore DRR measured 4.8:1, whereas the Vendor A platform DRR measured 2.8:1.
- The PowerStore 1200T used 41 percent less energy than the Vendor A platform in this test configuration with this dataset. These savings apply linearly as more drives are added.
- We observed that the PowerStore 1200T UI was more intuitive and easier to use than the Vendor A system UI.
- The PowerStore 1200T offers the ability to scale the number of drives purchased in increments as small as one drive. This allows enterprises to purchase just the amount of storage needed for a given workload and to minimize storage costs. Vendor A does not offer this capability.
- The ability of the PowerStore 1200T to use fewer drives for a given dataset, which reduces software and hardware costs, can result in lower overall TCO.

Conclusion

Enterprises need high-speed storage to support modern business initiatives. At the same time, they are under pressure to cut costs and use less energy. To explore options for businesses, Prowess Consulting evaluated the data- and energy-efficiency of the Dell PowerStore 1200T and the Vendor A platform. Both manufacturers guarantee a 4:1 DRR for block workloads. In our testing, the PowerStore 1200T DRR measured 4.8:1, exceeding its guarantee, whereas the Vendor A platform DRR fell short of its guarantee, measuring only 2.8:1. In the test scenario, the PowerStore 1200T used 41 percent less energy than the Vendor A platform. Based on these findings, we conclude that the PowerStore 1200T can help enterprises get the value they need from their data while reducing costs and energy use in an easy-to-manage, scalable platform.

Appendix

This section contains system comparison calculations, storage platform test configurations, the test methodology, and the Vdbench configuration file.

System Comparison Calculations

Table A1 | Comparing total capacity and effective capacity

Unit Under Test	Drive Quantity	Drive Size (TB)	Total Capacity (TiB)	Effective Capacity (TiB)	DRR
Dell™ PowerStore™ 1200T	23	1.92	31.5	151.2	4.8
Vendor A platform	24	1.92	32.5	91.0	2.8

Effective Capacity Calculations

We computed the effective capacity of the Vendor A platform using total capacity and DRR:

32.5 TiB * 2.8 = 91.0 TiB

We computed the effective capacity of the PowerStore 1200T using total capacity and DRR:

31.5 TiB * 4.8 = 151.2 TiB

Usable Capacity Calculation

To compare the two systems, we used the 4.8:1 DRR to compute what the usable capacity of the PowerStore 1200T would be if 91 TiB were its effective capacity:

91.0 TiB/4.8 = 19 TiB

Number of PowerStore 1200T Drives Required

Given a usable capacity of 19 TiB, we used a proportional calculation to determine the number of PowerStore 1200T drives required. If it previously took 23 PowerStore 1200T drives to get 31.5 TiB of total usable capacity, we can compute the number of drives needed for 19 TiB by multiplying:

(23 drives/31.5 TiB) * (19.0 TiB) = 14 drives

Storage Platform Testing Configurations

Table A2 | Testing virtual machine (VM) description and storage platforms under test configuration

Component	Testing VM	Dell™ PowerStore™ 1200T	Vendor A Platform
CPU Clock Rate	Not applicable (N/A)	2.4 GHz	2.4 GHz
Cores/Threads per CPU	N/A	10/20	12/24
Cores/Threads Total	N/A	20/40	24/48
Drive 01	Thin-provisioning lazy zeroed 500 GB	NVMe® NVRAM	–
Drive 01 Count	1	2	–
Drive 02	1 TB RMD LUN	NVMe® SSD	NVMe® SSD
Drive 02 Count	12	23	24
Memory	VMware® memory	–	–
Number of Memory DIMMs	N/A	12	12
Operating System (OS)	Oracle® Linux®	Dell™ PowerStore™ OS	Storage OS
OS Version	8	3.2.0.1 release, build 1860013, 2022-11-12 01:56:53, retail	Vendor A platform release X.X.X. 2023 release
OS Kernel	5.4.17-2102.201.3.el8uek.x86_64	–	–

Test Methodology

Prowess Consulting used the following methodology for our testing. During our testing, both the Dell PowerStore 1200T and the Vendor A system were in an offsite lab. We performed all tests remotely.

Configuring and Loading the Dell PowerStore 1200T Storage Platform

1. Sign in to the Dell PowerStore Manager GUI.
    a. Under the **Storage** tab, select **Volumes** from the drop-down menu.
    b. Click **Create**.
    c. In the **Create Volumes** pop-up, provide the following configuration:
        i. **Name (or Prefix): vol1**
        ii. **Description:** (leave blank)
        iii. **Category: Other**
        iv. **Application:** (leave blank)
        v. **Quantity: 6**
        vi. **Size: 1TB**
        vii. **Additional Volume Group: None Selected**
        viii. **Volume Protection Policy: None**
        ix. **Volume Performance Policy: Medium**
    d. At the bottom-right in the window, click **Next**.
    e. On the **Host Mappings** page, select the IP address of the host for the testing VM, and then click **Next**..
    f. On the **Summary** page, click **Create**.
2. Repeat step 1 to create an additional six volumes.
3. Sign in to the VMware vSphere® client for the testing VMware environment.
    a. On the **Datastores** page for the VM host selected in step 1, click **Rescan Storage**.
    b. Select the test VM, click **Actions**, and then click **Edit Settings**.
        i. In the **Edit Settings** page, select the **Add New Device** drop-down menu in the top right.
        ii. Under **Disks, Drives and Storage**, click **RDM Disk**.
        iii. On the **Select Target LUN** page, select one of the LUNs from the PowerStore 1200T.
        iv. Repeat this process for all 12 LUNs.
    c. Click **OK** to apply the new settings.
    d. Click **Actions**, and then click **Power on the Guest OS** of the testing VM.
4. Use Secure Shell (SSH) to access the testing VM.
    a. Navigate to the directory with Vdbench data, and then run the following command:

```
./vdbench -f test12.vdb -o test1-out
```

    b. Wait for Vdbench to complete.
5. After the Vdbench test is complete, wait three hours (maximum) for the deduplication process to finish.
6. Sign in to the PowerStore Manager GUI.
    a. On the **Dashboard** page, record:
        i. The **Overall Efficiency** ratio
        ii. The **Snap Savings** ratio
        iii. The **Thin Savings** ratio
        iv. The **Combined Ratio** at the top of the chart
        v. **Total Data Savings**
7. Sign in to the vSphere client for the testing VMware environment.
    a. Select the test VM, click **Actions**, and then click **Power Off the Guest OS**.
    b. Select the test VM, click **Actions**, and then click **Edit Settings**.
        i. In the **Edit Settings** pop-up window, expand the section labeled **Hard Disks**.
            1. For the first LUN from the PowerStore 1200T, select the **Cross/Close** icon next to the disk.
                a. Select the **Delete files from Datastore** check box.
            2. Repeat 12 times for each LUN.
            3. Click **OK**.

8. Sign in to the PowerStore Power Manager GUI.
    a. Click the **Storage** tab, and then select **Volumes** from the drop-down menu.
    b. Select the check box below the **Create** button to select all created LUNs.
    c. On the **Provision** drop-down menu, click **Unmap**.
    d. On the **Unmap Hosts** page, select the check box next to the **Testing VM Host's** name.
        i. Click **Apply**.
    e. On the **Volumes** page, select the **More Actions** drop-down menu.
        i. Click **Delete**.
        ii. On the **Delete Volumes** pop-up, click **Delete**.
9. Repeat steps 1–8 three times to complete validation.

Configuring and Loading the Vendor A Platform

1. Sign in to the Vendor A Platform Storage OS System Manager GUI.
    a. From the left-side menu, select **LUNs**.
    b. From the **LUNs** page, click **Add**.
    c. On the **Add LUNs page**, provide the following configuration information:
        i. **Name: vol1**
        ii. **Number of LUNs: 6**
        iii. **Capacity per LUN: 1 TiB**
        iv. **Host Operating System: VMware**
        v. **LUN format: VMware**
        vi. **Initiator Group**: Select the testing VM host from the drop-down menu
    d. Click **Save**.
2. Once the LUNs have been added, repeat steps 1c–d to create a second set of LUNs.
3. Sign in to the vSphere client for the testing VMware environment.
    a. On the **Datastores** page for the VM host selected in step 1, click **Rescan Storage**.
    b. Select the test VM, click **Actions**, and then click **Edit Settings**.
        i. On the **Edit Settings** page, select the **Add New Device** drop-down menu in the top right.
        ii. Under **Disks, Drives and Storage**, click **RDM Disk**.
        iii. On the **Select Target LUN** page, select one of the LUNs from the Vendor A platform.
        iv. Repeat this process for all 12 LUNs.
    c. Click **OK** to apply the new settings.
    d. Click **Actions**, and then click **Power on the Guest OS**.
4. Use SSH to access the **Testing VM**.
    a. Navigate to the directory containing the Vdbench tool data, and then run the following command:

```
./vdbench -f test12.vdb -o test1-out
```

    b. Wait for the Vdbench test to complete.
    c. After the Vdbench test is complete, wait three hours for the deduplication process to finish.
    d. Sign in to the **Storage OS System Manager** GUI.
    e. On the **Dashboard**, in the **Capacity** box, click the image for the capacity usage.
    f. In the **Cluster Capacity** pop-up window, record the following data:
        i. **Logical Used Data Size**
        ii. **Physical Used Data Size**
5. Sign in to the vSphere client for the testing VMware environment.
    a. Select the testing VM, click **Actions**, and then click **Power Off the Guest OS**.
    b. Select the testing VM, click **Actions**, and then click **Edit Settings**.
        i. In the **Edit Settings** pop-up window, expand the section labeled **Hard Disks**.
            1. For the first LUN from the Vendor A platform, select the **Cross/Close** icon next to the disk.
                a. Select the **Delete files from Datastore** check box.
            2. Repeat 12 times for each LUN.
            3. Click **OK**.

6. Sign in to the storage OS system manager GUI.
    a. On the **Dashboard**, in the **Capacity** box, click the image for the capacity usage.
    b. In the **Cluster Capacity** pop-up window, record the following data:
        i. **Logical Used Data Size**
        ii. **Physical Used Data Size**
7. Sign in to the vSphere client for the testing VMware environment.
    a. Select the testing VM, click **Actions**, and then click **Power Off the Guest OS**.
    b. Select the testing VM, click **Actions**, and then click **Edit Settings**.
        i. In the **Edit Settings** pop-up window, expand the section labeled **Hard Disks**.
            1. For the first LUN from the Vendor A platform, select the **Cross/Close** icon next to the disk.
                a. Select the **Delete files from Datastore** check box.
            2. Repeat 12 times for each LUN.
            3. Click **OK**.
8. Sign in to the Vendor A System Manager GUI.
    a. On the **Volumes** page, select the check boxes next to both created volumes.
        i. Click **Delete**.
    b. On the **Delete Volumes** page, select all check boxes, and then click **Delete**.
        i. Allow the **Volumes** page to update.
    c. On the updated page, click **More**, and then navigate to the **Deleted Volumes** page.
    d. On the **Deleted Volumes** page, select both volumes, and then click **Purge**.
        i. On the **Purge Volumes** page, confirm by clicking **Purge**.
9. Repeat steps 1– 8 three times to complete the testing.

Vdbench Configuration File

```
Test Settings

test12.vdb
compratio=2
dedupratio=2
dedupunit=4096

hd=default,shell=ssh,user=root,jvms=1
hd=hd5,system=PM_005

sd=default,openflags=o_direct
sd=sd1,hd=hd5,lun=/dev/sdb
sd=sd2,hd=hd5,lun=/dev/sdc
sd=sd3,hd=hd5,lun=/dev/sdd
sd=sd4,hd=hd5,lun=/dev/sde
sd=sd5,hd=hd5,lun=/dev/sdf
sd=sd6,hd=hd5,lun=/dev/sdg
sd=sd7,hd=hd5,lun=/dev/sdh
sd=sd8,hd=hd5,lun=/dev/sdi
sd=sd9,hd=hd5,lun=/dev/sdj
sd=sd10,hd=hd5,lun=/dev/sdk
sd=sd11,hd=hd5,lun=/dev/sdl
sd=sd12,hd=hd5,lun=/dev/sdm

wd=default,sd=*
wd=wd_prefill,sd=sd*,xfersize=256k,seekpct=eof,rdpct=0

rd=default
rd=rd_prefill,wd=wd_prefill,elapsed=20h,interval=10,iorate=max,forthreads=(1)
```

[1] Prowess Consulting did not have permission to use the commercial name of Vendor A for this paper.

[2] Dell Technologies. "Dell Technologies All-Flash Data Reduction Guarantee Terms and Conditions." May 2022. www.delltechnologies.com/asset/en-us/products/storage/legal-pricing/future-proof-dr-guarantee-tc.pdf. Storage data reduction guarantees: Requires customer signature and purchase of Dell ProSupport™ Plus or ProSupport with Mission Critical. Applicable products include all-flash storage products only. For more information, see www.dell.com/en-uk/dt/storage/data-storage.htm.

[3] Vendor A 4:1 DRR guarantee for NVMe, 2023.

[4] The Dell™ PowerStore™ 1200T platform in our testing had a total of 25 drives. Two of these were used for the PowerStore 1200T that has two drives that are used as NVRAM. For specifications, see: Dell Technologies. "Dell PowerStore Hardware Information Guide for PowerStore 1000, 1200, 3000, 3200, 5000, 5200, 7000, 9000, and 9200." Accessed June 2023. www.dell.com/support/manuals/en-us/powerstore-emp-partner/pwrstr-hwg/base-enclosure-component-overview?guid=guid-7914a554-6943-402e-bd38-3e893163657e&lang=en-us.

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