Behind the Report:

A Comparative Study of Enterprise Storage Platforms—Performance, Snapshots, Data Reduction, and Usability

Summary

The following test methodology outlines the steps that Prowess Consulting used to test the performance, snapshot, data-reduction, and ease-of-use capabilities of the Dell PowerStore™ 500T and IBM FlashSystem® 5300 storage solutions utilizing Vdbench on VMware ESXi™ Linux® virtual machines (VMs). For each storage platform, we used a single storage array with dual nodes. For the client side, we used one command VM and eight test VMs (two VMs per ESXi server). **Note**: The command VM needs access to the **Vdbench and snapshot files**.

For this testing, the Prowess Consulting engineers performed the following actions in an offsite lab:

1. Created logical unit numbers (LUNs) on the Dell PowerStore and IBM FlashSystem storage systems and exposed the LUNs to the VMware ESXi host.
   a. Measured the number of clicks needed to create the LUNs on each platform.
2. Added the LUNs as raw device mappings to eight total VMware Linux VMs exclusive to each storage platform.
3. Used Vdbench, an application that simulates a controlled input/output (I/O) load, to generate data on the LUNs.
4. Used Vdbench to generate I/O load and create 10 snapshots for each platform.
   a. Measured the latency impact of this commonly used data-protection task on I/O operations per second (IOPS) performance on each platform.
   b. Measured the storage efficiency using a data-reduction report or pool-properties view on each storage platform.
5. Used Vdbench to generate I/O load.
   a. Measured the performance of small write workloads, such as those used in transactional databases.

Hypothesis and Results

To assess the business value of an enterprise storage solution, customers need to consider multiple factors in addition to upfront costs. We hypothesized that certain key performance indicators (KPIs)—such as performance, latency impact on snapshot creation, data reduction, and usability—could give customers a more accurate picture of a storage solution's value to their business.

Our test results revealed that the Dell PowerStore 500T storage solution showed significantly better KPIs than the IBM FlashSystem 5300 storage solution. We also analyzed how these results can help customers decide what solution is best for their needs.

Compared to the IBM FlashSystem 5300 storage solution, the Dell PowerStore 500T platform:

- Achieves up to 52x lower latency during snapshot creation
- Provides up to 2.3x higher data reduction ratio (DRR)
- Delivers up to 1.66x the write performance
- Uses up to 2.3x fewer steps to provision volumes

Test Configurations

Table 1 shows the system configurations used for testing.

Table 1 | Storage platform configurations

Component	Testing VM	Dell PowerStore™ 500T	IBM FlashSystem® 5300
Number of CPUs	6 virtual CPUs	1 per node, 2 nodes per storage system	1 per node, 2 nodes per storage system
Total Cores		24	24
CPU Clock Rate		2.2 GHz	2.0 GHz
Storage Controller 1: Number of Drives	1 (operating system [OS])		
Storage Controller 2: Number of Drives	2 (test volumes)	12 x 3.8 TB NVM Express® (NVMe®) triple-level cell (TLC) solid-state drive (SSD)	12 x 4.8 TB 2.5-inch IBM FlashCore® Module (FCM) field-replaceable unit (FRU)
Memory	24 GB	96 GB per node	128 GB per node
Number of DIMMs		6 x 16 GB per node	
OS	Red Hat® Enterprise Linux®		
OS Version	8.3		
OS Kernel	5.4.17-2102.201.3.el8uek.x86_64		

Test Procedures

All testing was performed remotely, accessing the Dell PowerStore 500T and IBM FlashSystem 5300 systems in an offsite lab. This section contains step-by-step procedures for configuring and testing each platform.

Configuring and Testing the Dell PowerStore 500T Storage Platform

1. Sign in to the Dell PowerStore Manager graphical user interface (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 details:
      i. **Name (or Prefix): vol1**
      ii. **Description**: Leave blank.
      iii. **Category: Other**
      iv. **Application**: Leave blank.
      v. **Quantity: 16**
      vi. **Size: 100 GB**
      vii. **Additional Volume Group: vg1**
      viii. **Volume Protection Policy: None**
      ix. **Volume Performance Policy: Medium**
   d. At the bottom-right of the window, click **Next**.
   e. On the **Host Mappings** page, select all host for the ESXi hosts, and then click **Next**.
   f. On the **Summary** page, click **Create**.
2. Sign in to the VMware vSphere® client for the VMware testing environment.
   a. On the **Configure** page, in the **Storage Adapters** view, for each of the ESXi hosts 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 at 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 platform.
      iv. Repeat steps 2.b.ii. and 2.b.iii., adding a second 100 GB LUN to the VM.
   c. Click **OK** to apply the new settings.
   d. Repeat steps 2.b. and 2.c. for each VM.

3. Use Secure Shell (SSH) to access the command VM:
   a. Navigate to the directory with Vdbench data, and then run the following command to fill the volume with data that can be compressed at a 2:1 ratio:

```
./vdbench -f fill16.vdb -o test1-out
```

   b. Wait for Vdbench to complete.
   c. Wait an additional 30 minutes.
4. Sign in to the PowerStore Manager GUI.
   a. On the **Dashboard > Hardware** page, click the appliance name and record:
      i. The **Overall Efficiency** ratio
      ii. The **Snap Savings** ratio
      iii. The **Thin Savings** ratio
      iv. The **Overall DRR** at the top of the chart
      v. The **Savings of** value
      vi. **Logical Used**
      vii. **Physical Used**
5. Use SSH to open two terminals for accessing the command VM:
   a. In the first terminal window:
      i. Navigate to the Vdbench directory.
      ii. Prepare to run the following command, which will generate a workload of 50:50 read/write data:

```
./vdbench -f testsnap.vdb -o runID
```

   b. In the second terminal window:
      i. Navigate to the directory containing the snaptest file.
      ii. Prepare to run the following command, which will trigger a snapshot every hour for 10 hours, with a 10-hour snapshot expiration time:

```
./snaptest > snapshotting-runID
```

   c. In quick succession, run the commands prepared in both terminal windows.
   d. Wait 10 hours while the snapshots are taken.
   e. Wait an additional 10 hours while the snapshots expire.
   f. Wait an additional four hours for the system to settle.
   g. Record the data from **runID/totals.html** and **runID/flatfile.html**.
6. Sign in to the PowerStore Manager GUI.
   a. On the **Dashboard > Hardware** page, click the appliance name and record:
      i. The **Overall Efficiency** ratio
      ii. The **Snap Savings** ratio
      iii. The **Thin Savings** ratio
      iv. The **Overall DRR** at the top of the chart
      v. The **Savings of** value
      vi. **Logical Used**
      vii. **Physical Used**
7. Use SSH to access the command VM:
   a. Navigate to the directory with Vdbench data, and then run the following command:

```
./vdbench -f performancetest.vdb -o perf-runID
```

   b. Wait for Vdbench to complete.
   c. Record the data from **perf-runID/totals.html** and **perf-runID/flatfile.html**.
8. Sign in to the vSphere client for the VMware testing environment.
   a. Select the first test VM, click **Actions**, and then click **Edit Settings**.
   b. For the first LUN from the PowerStore platform, select the **ellipsis** icon next to the disk, and then select **Remove device and data**.
   c. For the second LUN from the PowerStore platform, select the **ellipsis** icon next to the disk, and then select **Remove device and data**.
   d. Click **OK**.
   e. Repeat steps 8.a.–8.d. for each test VM.

9. Sign in to the PowerStore Manager GUI.
    a. Click the **Storage** tab, and then select **Volume Group** from the drop-down menu.
    b. Select the **vg1** volume group and then the **members** card.
    c. Select all volumes.
    d. From the **More Actions** drop-down, select **Remove**.
    e. Click the **Storage** tab, and then select **Volumes** from the drop-down menu.
    f. Select the checkbox below the **Create** button to select all created LUNs.
    g. From the **Provision** drop-down menu, click **Unmap**.
    h. On the **Unmap Hosts** page, select the checkbox next to all of the **ESXi Host** names, and then click **Apply**.
    i. On the **Volumes** page, select the **More Actions** drop-down menu, and then click **Delete**.
        i. At the **Delete Volumes** pop-up, select **Skip Recycle Bin and Permanently Delete**, and then click **Delete**.
    j. Wait at least 30 minutes before taking any further actions with the platform.

Configuring and Testing the IBM FlashSystem® 5300 Platform

1. Sign in to the IBM FlashSystem platform's storage OS using the system manager GUI.
    a. From the left-side menu, select **Pools > Pools**.
        i. From the **Pools** page, click **Create > Create Pool**.
        ii. On the **Create Pool** page, provide the following configuration information:
            1. **Name: Pool0**
            2. Select the **Data Reduction** checkbox.
            3. If selecting an existing provisioning policy, select it from the drop-down at this point.
            4. Click **Create**.
            5. After pool creation completes, click **Close**.
        iii. Select the freshly created pool, and then click **Actions > Add Storage**.
            1. Confirm the default selections of **Drive Class** and **Number of Drives** are correct.
            2. Click **Add Storage**.
            3. When storage addition completes, click **Close**.
    b. From the left-hand menu, select **Volumes > Volumes**.
    c. On the **Volumes** page, select **Create Volumes**, and then specify:
        i. **Volume Group: vg1**
        ii. **Pool: Pool0**
    d. Click **Define Volume Properties**, and then set:
        i. **Name: vol1**
        ii. **Quantity: 16**
        iii. **Capacity: 100 GB**
    e. Click **Save**.
    f. Click **Create and map**.
    g. After the **Create Volumes** process completes, click **Continue**.
    h. Select all hosts to be mapped, and then click **Create Mapping**.
        i. If a "Volumes mapped to multiple hosts must coordinate access" warning appears, click **Yes**.
    i. After the mapping process completes, click **Close**.
2. Sign in to the VMware vSphere client for the VMware testing environment.
    a. On the **Configure** page, in the **Storage Adapters** view, for each of the VM hosts 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 at 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 IBM FlashSystem platform.
        iv. Repeat steps 2.b.ii. and 2.b.iii., adding a second 100 GB LUN to the VM.
    c. Click **OK** to apply the new settings.
    d. Repeat steps 2.b. and 2.c. for each test VM.
3. Use SSH to access the command VM:
    a. Navigate to the directory with Vdbench data, and then run the following command:

```
./vdbench -f fill16.vdb -o test1-out
```

    b. Wait for Vdbench to complete.
    c. Wait an additional 30 minutes.

4. Sign in to the IBM FlashSystem platform's storage OS using the system manager GUI.
   a. On the **Pools > Pools** page, select **Actions > Properties**, and then record:
      i. **Usable Capacity**
      ii. **Capacity Details**
      iii. **Thin Provisioning Savings**
      iv. **Compression Savings**
      v. **Drive Compression Savings**
      vi. **Deduplication Savings**
      vii. **Drive Compression Savings**
      viii. **Total Savings**
5. Use SSH to open two terminals for accessing the command VM:
   a. In the first terminal window:
      i. Navigate to the Vdbench directory.
      ii. Prepare to run the following command:

```
./vdbench -f testsnap.vdb -o runID
```

   b. In the second terminal window:
      i. Navigate to the directory containing the snaptest file.
      ii. Prepare to run the following command:

```
./snaptest > snapshotting-runID
```

   c. In quick succession, run the commands prepared in both terminal windows.
   d. Wait 10 hours while the snapshots are taken.
   e. Wait an additional 10 hours while the snapshots expire.
   f. Wait an additional four hours for the system to settle.
   g. Record the data from **runID/totals.html** and **runID/flatfile.html**.
6. Sign in to the IBM FlashSystem platform's storage OS using the system manager GUI.
   a. On the **Pools > Pools** page, select **Actions > Properties**, and then record:
      i. **Usable Capacity**
      ii. **Capacity Details**
      iii. **Thin Provisioning Savings**
      iv. **Compression Savings**
      v. **Drive Compression Savings**
      vi. **Deduplication Savings**
      vii. **Drive Compression Savings**
      viii. **Total Savings**
7. Use SSH to access the command VM:
   a. Navigate to the directory with Vdbench data, and then run the following command:

```
./vdbench -f performancetest.vdb -o perf-runID
```

   b. Wait for Vdbench to complete.
   c. Record the data from **perf-runID/totals.html** and **perf-runID/flatfile.html**.
8. Sign in to the vSphere client for the VMware testing environment.
   a. Select the first test VM, click **Actions**, and then click **Edit Settings**.
   b. For the first LUN from the IBM FlashSystem platform, select the **ellipsis** icon next to the disk, and then select **Remove device and data**.
   c. For the second LUN from the IBM FlashSystem platform, select the **ellipsis** icon next to the disk, and then select **Remove device and data**.
   d. Click **OK**.
   e. Repeat steps 8.a.–8.d. for each test VM.
9. Sign in to the IBM FlashSystem platform's storage OS using the system manager GUI.
   a. Select **Volumes > Volumes** from the left-hand menu.
   b. Select all volumes.
      i. Click **Actions > Remove private mappings**.
         1. Enter the number of mappings to be removed: **64**.
         2. Click **Remove**.
         3. After the progress window disappears, click **Close**.

ii. Select **Actions > Delete**.
    1. Enter volumes to be removed: **16**.
    2. Click **Delete**.
    3. After the progress window disappears, click **Close**.

c. Select **Pools > Pools** from the left-hand menu.
d. Select **Pool0**, and then click **Actions > Delete**.
    i. Press **Delete** at the confirmation window.
    ii. After the progress window disappears, click **Close**.

Vdbench and Snapshot Files

The following sections provide the details of the Vdbench configuration files utilized during our testing, in addition to the scripts used to initiate the platform snapshots.

Vdbench Configuration 1 fill16.vdb

We used the first Vdbench configuration file to generate disk usage on 16 devices, setting the compression ratio to 2.5 and the deduplication ratio to 2. This same file is used with both platforms.

```
compratio=2.5
dedupratio=2
dedupunit=4k
dedupsets=5%
messagescan=no
hd=default,shell=ssh,user=root
hd=hd1,system=PM_001
hd=hd2,system=PM_002
hd=hd3,system=PM_003
hd=hd4,system=PM_004
hd=hd5,system=PM_005
hd=hd6,system=PM_006
hd=hd7,system=PM_007
hd=hd8,system=PM_008
sd=default,openflags=directio
sd=sd1,hd=hd1,lun=/dev/sdc
sd=sd2,hd=hd1,lun=/dev/sdb
sd=sd3,hd=hd2,lun=/dev/sdc
sd=sd4,hd=hd2,lun=/dev/sdb
sd=sd5,hd=hd3,lun=/dev/sdc
sd=sd6,hd=hd3,lun=/dev/sdb
sd=sd7,hd=hd4,lun=/dev/sdc
sd=sd8,hd=hd4,lun=/dev/sdb
sd=sd9,hd=hd5,lun=/dev/sdc
sd=sd10,hd=hd5,lun=/dev/sdb
sd=sd11,hd=hd6,lun=/dev/sdc
sd=sd12,hd=hd6,lun=/dev/sdb
sd=sd13,hd=hd7,lun=/dev/sdc
sd=sd14,hd=hd7,lun=/dev/sdb
sd=sd15,hd=hd8,lun=/dev/sdc
sd=sd16,hd=hd8,lun=/dev/sdb
wd=default,sd=*
wd=wd_256k,sd=sd*,xfersize=256k,seekpct=eof
rd=default
rd=read4k_test,wd=wd_256k,iorate=max,interval=10,forrdpct=(0),elapsed=10h,forthreads=(1)
```

Vdbench Configuration 2 testsnap.vdb

We used the second Vdbench configuration file to generate load on 16 devices, with a 50/50 mix of read and write actions at an 8K block size, setting the compression ratio to 2.5 and the deduplication ratio to 2. This file is used with both platforms, in conjunction with their respective snapshot initiator scripts.

```
compratio=2.5
dedupratio=2
dedupunit=4k
dedupsets=5%
messagescan=no
hd=default,shell=ssh,user=root
hd=hd1,system=PM_001
hd=hd2,system=PM_002
hd=hd3,system=PM_003
hd=hd4,system=PM_004
hd=hd5,system=PM_005
hd=hd6,system=PM_006
hd=hd7,system=PM_007
hd=hd8,system=PM_008
sd=default,openflags=o_direct,size=100G
sd=sd1,hd=hd1,lun=/dev/sdb
sd=sd2,hd=hd1,lun=/dev/sdc
sd=sd17,hd=hd2,lun=/dev/sdb
sd=sd18,hd=hd2,lun=/dev/sdc
sd=sd33,hd=hd3,lun=/dev/sdb
sd=sd34,hd=hd3,lun=/dev/sdc
sd=sd49,hd=hd4,lun=/dev/sdb
sd=sd50,hd=hd4,lun=/dev/sdc
sd=sd65,hd=hd5,lun=/dev/sdb
sd=sd66,hd=hd5,lun=/dev/sdc
sd=sd81,hd=hd6,lun=/dev/sdb
sd=sd82,hd=hd6,lun=/dev/sdc
sd=sd97,hd=hd7,lun=/dev/sdb
sd=sd98,hd=hd7,lun=/dev/sdc
sd=sd113,hd=hd8,lun=/dev/sdb
sd=sd114,hd=hd8,lun=/dev/sdc
wd=default,sd=*
wd=wd_8k,sd=sd*,xfersize=8k,seekpct=100
rd=default
rd=mix8k_test,wd=wd_8k,iorate=50000,warmup=30,interval=30,forrdpct=(50),elapsed=10h,forthreads=(32)
```

Vdbench Configuration 3 performancetest.vdb

We used the third Vdbench configuration file to generate 4K and 8K block-sized write workloads, setting the compression ratio to 2.5 and the deduplication ratio to 2. This file is used with both platforms.

```
compratio=2.5
dedupratio=2
dedupunit=4k
dedupsets=5%
messagescan=no
hd=default,shell=ssh,master=192.168.2.200,user=root
hd=hd1,system=PS_001
hd=hd2,system=PS_002
hd=hd3,system=PS_003
hd=hd4,system=PS_004
hd=hd5,system=PS_005
hd=hd6,system=PS_006
hd=hd7,system=PS_007
```

```
hd=hd8,system=PS_008
sd=default,openflags=o_direct,size=100G
sd=sd1,hd=hd1,lun=/dev/sdb
sd=sd2,hd=hd1,lun=/dev/sdc
sd=sd17,hd=hd2,lun=/dev/sdb
sd=sd18,hd=hd2,lun=/dev/sdc
sd=sd33,hd=hd3,lun=/dev/sdb
sd=sd34,hd=hd3,lun=/dev/sdc
sd=sd49,hd=hd4,lun=/dev/sdb
sd=sd50,hd=hd4,lun=/dev/sdc
sd=sd65,hd=hd5,lun=/dev/sdb
sd=sd66,hd=hd5,lun=/dev/sdc
sd=sd81,hd=hd6,lun=/dev/sdb
sd=sd82,hd=hd6,lun=/dev/sdc
sd=sd97,hd=hd7,lun=/dev/sdb
sd=sd98,hd=hd7,lun=/dev/sdc
sd=sd113,hd=hd8,lun=/dev/sdb
sd=sd114,hd=hd8,lun=/dev/sdc
wd=default,sd=*
wd=wd_4k,sd=sd*,xfersize=4k,seekpct=100
wd=seq_4k,sd=sd*,xfersize=4k,seekpct=0
wd=wd_8k,sd=sd*,xfersize=8k,seekpct=100
wd=wd_32k,sd=sd*,xfersize=32k,seekpct=100
wd=wd_256k,sd=sd*,xfersize=256k,seekpct=100
wd=seq_256k,sd=sd*,xfersize=256k,seekpct=0
rd=default
rd=write4k_test,wd=wd_4k,iorate=max,warmup=30,interval=1,forrdpct=(0),elapsed=5m,forthreads=(8)
rd=write8k_test,wd=wd_8k,iorate=max,warmup=30,interval=1,forrdpct=(0),elapsed=5m,forthreads=(8)
```

PowerStore Snapshot Initiation Script snaptest.sh

This file is specific to the PowerStore test configuration. It is used to generate 10 snapshots over the course of 10 hours, with each snapshot having a 10-hour expiration. Replace ***PASSWORD_HERE*** with the system password, and set the host IP in the **REMOTE_HOST=""** line.

```
#!/bin/bash
# volume group name
VG_NAME="vg1"
# Number of repetitions
REPEAT_COUNT=10
# Remote server credentials
REMOTE_USER="admin"
REMOTE_HOST=""
# Step 1: Wait for 10 minutes
echo "Waiting for 10 minutes..."
sleep 600  # 600 seconds = 10 minutes
# Main loop to repeat n times
for ((i=1; i<=REPEAT_COUNT; i++))
do
  echo "Iteration $i"
  # Step 2: Create the snapshot on the remote system
  echo "Creating snapshot for volume group: $VG_NAME on remote server $REMOTE_HOST"
  SNAPSHOT_NAME="${VG_NAME}_snapshot_$i"
EXPIRE_DATE=$(date -u -d "+600 minute" +"%Y-%m-%dT%H:%M:%SZ")
  pstcli -d $REMOTE_HOST -u admin -p PASSWORD_HERE volume_group -name $VG_NAME snapshot -name $SNAPSHOT_
NAME -expiration_timestamp $EXPIRE_DATE
```

```
  echo “Waiting for 60 minutes...”
  sleep 3600  # 3600 seconds = 10 minutes
done
echo “Snapshot creation completed.”
```

IBM FlashSystem Snapshot Initiation Script snaptest.sh

This file is specific to the IBM FlashSystem test configuration. It is used to generate 10 snapshots over the course of 10 hours, with each snapshot having a 10-hour expiration. Replace both instances of ***PASSWORD_HERE*** with the system password, and set the host IP in the **REMOTE_HOST=””** line.

```
#!/bin/bash
# IBM FlashSystem volume group name
VG_NAME=”vg1”
# Number of repetitions
REPEAT_COUNT=10
# Number of times to print saving
iterations=50
# Remote server credentials
REMOTE_USER=”superuser”
REMOTE_HOST=””
#print saving
print_saving() {
   echo “Current saving”
   date
   sshpass -p ‘PASSWORD_HERE’ ssh $REMOTE_USER@$REMOTE_HOST “lsmdiskgrp -delim :” | awk -F: ‘{print
$32,$33,$35,$36}’
}
  # Step 1: Wait for 10 minutes
  echo “Waiting for 10 minutes...”
  sleep 600  # 600 seconds = 10 minutes
# Create 10 snapshots
for ((i=1; i<=REPEAT_COUNT; i++))
do
  echo “Iteration $i”
  print_saving
  # Step 2: Create the snapshot on the remote system
  echo “Creating snapshot for volume group: $VG_NAME on remote server $REMOTE_HOST”
  SNAPSHOT_NAME=”${VG_NAME}_snapshot_$i”
  sshpass -p ‘PASSWORD_HERE’ ssh $REMOTE_USER@$REMOTE_HOST “addsnapshot -name $SNAPSHOT_NAME -volumegroup
$VG_NAME -retentionminutes 600”
  print_saving
  # Step 3: Wait for 60 minutes
  echo “Waiting for 60 minutes...”
  sleep 3600  # 3600 seconds = 60 minutes
  print_saving
done
echo “Snapshot creation completed.”
#echo “Saving after testing”
for ((i=1;i<=iterations;i++))
do
echo “Running iteration $i every 15 min”
   print_saving
   sleep 900
done
echo “all iterations completed”
```

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