IN&OUT AG

Interoperability Test Report between Huawei Storage and ‘Veeam Backup and Replication V12’

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Preliminary Note

This report was created independently and neutrally by In&Out.

In&Out AG

In&Out AG from Zurich is supporting its customers as an independent and vendor-neutral consulting company in the areas of IT infrastructure and data centers for years. In&Out has proven years of experience in performance measurements and optimization and has developed the benchmark tool IOgen™.

Huawei

Founded in 1987, Huawei is a global leader in storage systems with 194,000 employees. Analysts rank Huawei as one of the leaders in storage systems.

Figure 1 - Gartner Magic Quadrant Primary Storage (2022), Source: Gartner

Veeam Backup & Replication V12

Veeam released on February 14, 2023, a new major release of their backup software suite Backup & Replication. This release allows backups directly to object storage, can create immutable and spaceless full backups. In this report we will test many of the new features in combination with the corresponding Huawei storage products and features

Huawei OceanStor Pacific Scale-Out Storage

Huawei OceanStor Pacific Scale-Out Storage systems are dedicated storage systems for unstructured data. The Huawei OceanStor Pacific series (formerly known as OceanStor 100D) is an intelligent Scale-Out Storage product with scale-out and supports the business needs of both today and tomorrow.

OceanStor Pacific series provides on-demand file, object, HDFS, and block storage for upper-layer applications by organizing local storage resources of each node with storage system software. It implements cost-effective storage for mass data, maximized efficiency for diversified data, and everlasting operations for online services. The OceanStor Pacific series is available with three characteristics: performance, balanced and archive models.

Huawei OceanProtect Backup Storage

Huawei OceanProtect Backup storage features rapid backup and rapid recovery, efficient reduction, and solid resilience, and helps to implement efficient backup and restoration and greatly reduce the TCO. It is widely used in government, financial, carrier, healthcare, and manufacturing industries. In addition, it offers easy-to-use management modes and convenient local/remote maintenance modes, significantly decreasing the management and maintenance costs.

Huawei OceanStor Hybrid Flash Storage

Huawei OceanStor Hybrid Flash storage systems offer comprehensive and superb solutions by using diverse efficiency boost mechanisms to provide industry-leading performance. Those solutions help customers maximize their return on investment (ROI) and meet the requirements of different application scenarios such as online transaction processing (OLTP), online analytical processing (OLAP), high-performance computing (HPC), server virtualization, and virtual desktop infrastructure (VDI).

Objective

To subject the new Veeam V12 Backup & Replication software in combination with suitable storage systems to an intensive test. In particular, the following points were to be tested:

I. Backup and restore functionality with NAS service and object service of Huawei storage.
II. Immutable backups using hardened repository which from Huawei storage.
III. Immutable backups with the WORM feature of Huawei OceanStor Pacific.

All tests were run with Veeam Backup & Replication software version 12.

Management Summary

We can summarize the results of our measurements and tests as follows:

I. The three tested Huawei storage systems which are OceanStor Hybrid Flash Storage, OceanProtect Backup Storage and OceanStor Pacific Scale-Out Storage can act as an NAS backup repository for Veeam V12.
II. The Huawei OceanStor Hybrid Flash storage system was tested with a hardened repository for Veeam. Here also every backup and restore scenario was handled as usual. But it was not possible to delete any backup data written to the storage system, even on the Linux command line.
III. The Huawei OceanStor Pacific Scale-Out Storage system was used as an S3 compatible backup repository. All backup and restore operations were handled as usual.
IV. The Huawei OceanStor Pacific Scale-Out Storage system was used as an S3 compatible and immutable backup repository (WORM functionality). Also, all backups and restores run as usual. On the other side we were not able to delete one backup bucket from the Veeam side and from within an S3 browser tool.

The stability and behavior of the systems were always flawless in the test. We did not notice any failures or inexplicable performance fluctuations. The operation of the storage system is familiar to experienced Huawei storage administrators and easy even for users who are not familiar with the system.

Test Setup

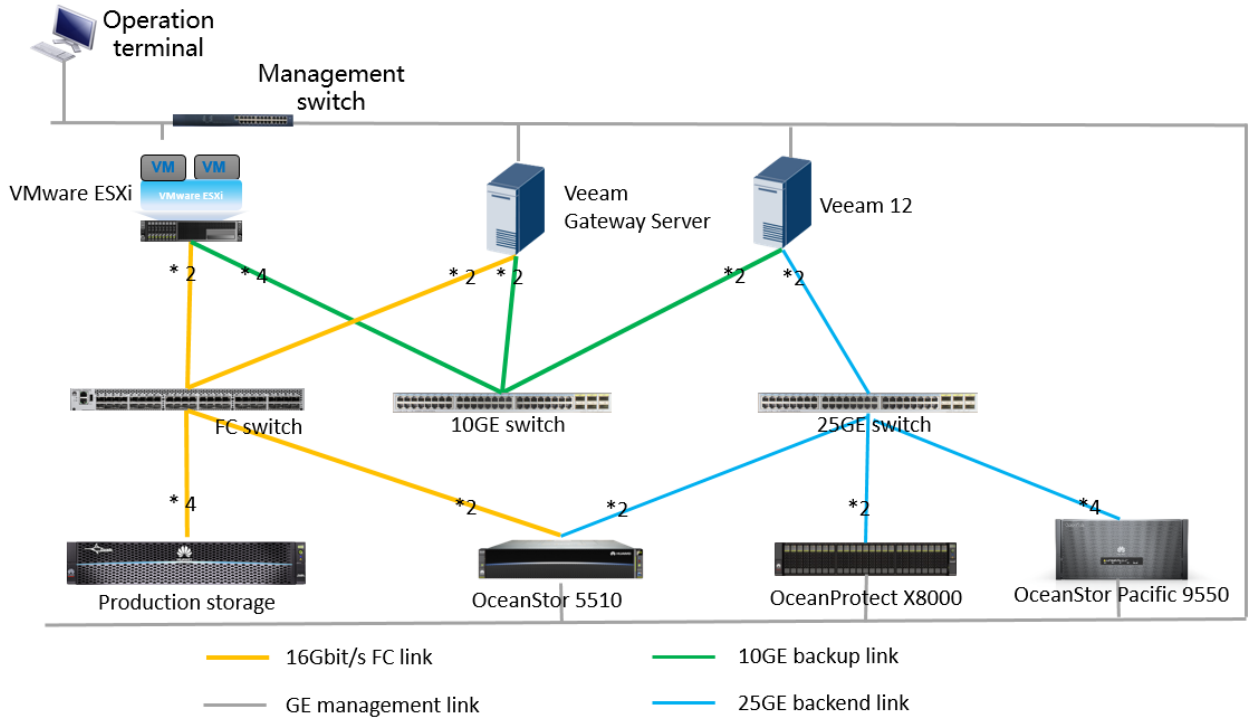


Figure 2 - Test setup (here using the example for Veeam)

Throughout the functional test one VM running on the VMware ESXi host, was backed up with several backup repositories which created with Huawei storage NAS service and Object service.

The VMware ESXi host is connected to the backup network with 4 network ports, each with 10 Gbit/sec (green in the Figure).

The backup server is connected to the storage switch via two 25 Gbit/sec connections each. The Huawei OceanStor 5510 and OceanProtect X8000 storage systems are connected by two 25Gbit/sec connections to the backup switch. The OceanStor Pacific has four 25Gbit/sec connections to the backup switch.

In detail, the following hardware was used for the test setup:

Device	Description	Quantity
ESXi	X86 server, CPU: 2 x Silver 4110, Storage: 2 x 16 Gbit/s FC-AL, Backup network: 4 x 10 Gbit/s	1
Backup server	X86 server, CPU: 2 x Gold 5120, backup network: 2 x 10 Gbit/s, backup storage: 2 x 25 Gbit/s	2
IP Switch	Huawei CE 6860 10GE Switch	1
IP Switch	Huawei CE 6863 25 GE Switch	1
FC Switch	Huawei SNS2248 16Gbps FC switch	1
Backup Storage	OceanProtect X8000 with two controllers, 20 x 7.68 TB SSD, 4 x 4-port 25GE Software version: 1.2.0	1
	OceanStor 5510 with two controllers, 3.84TB SSD*16， 2.4TB SAS *9, 2 x 4-port 25GE Software version: 6.1.5	1
	OceanStor Pacific 9550 with 4 nodes, 10TB NL_SAS * 144, 4 x 2-port 25GE Software version: 8.1.5	1

Table 1 - Hardware used

The following software products and versions were used:

Component	Description
CentOS Linux 7	Linux operating system, for clients
Windows Server	Veeam server, Version 2019
Veeam	Backup & Replication 12

Table 2 - Software used

Veeam Standard Backups and Restores

We tested all three Huawei storage as standard NAS protocol and S3 protocol:

I. OceanProtect X8000 with NAS share.

II. OceanStor 5510 with NAS share.

III. OceanStor Pacific 9550 with NAS share.

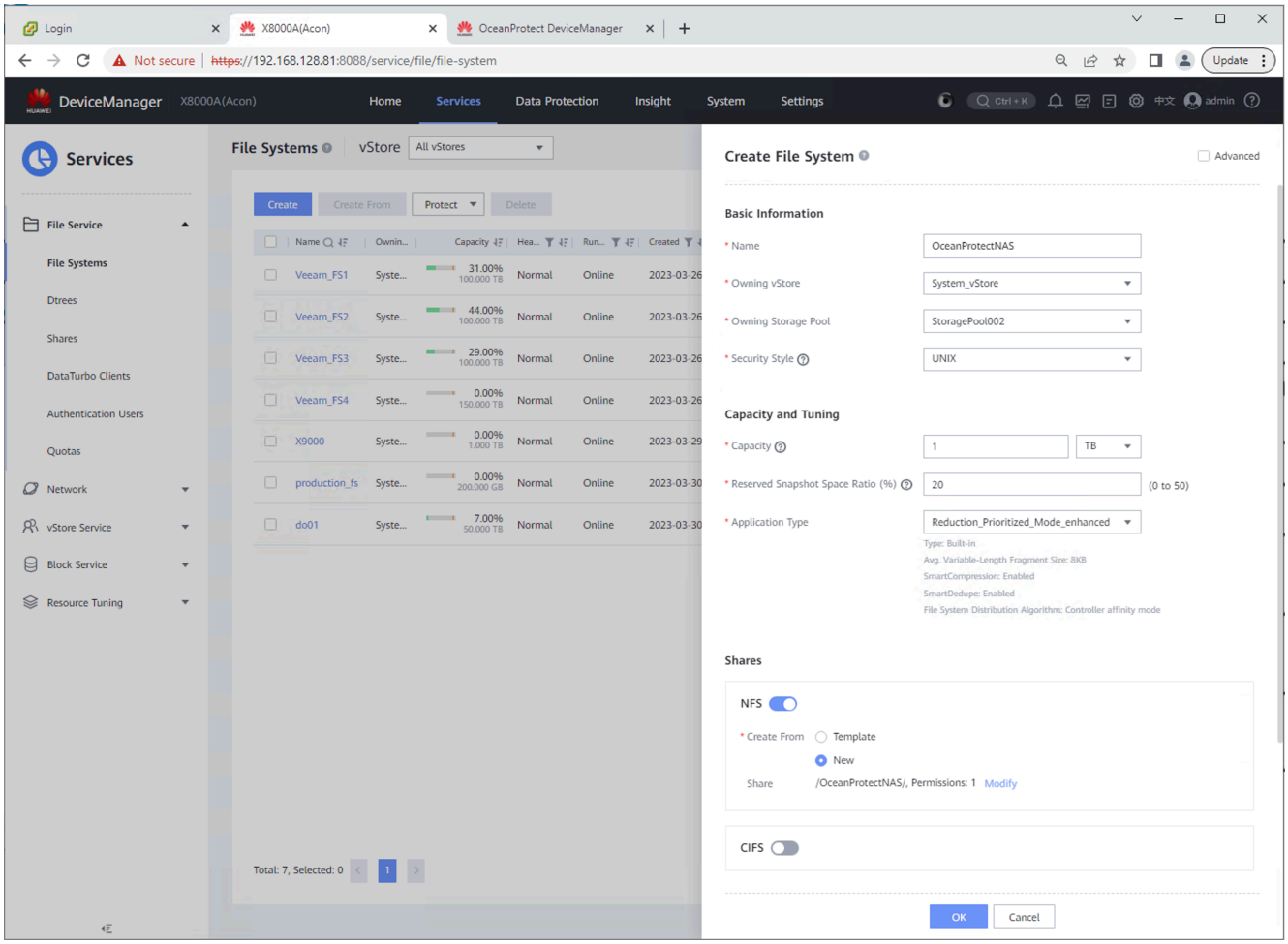
IV. OceanStor Pacific 9550 with Object service.

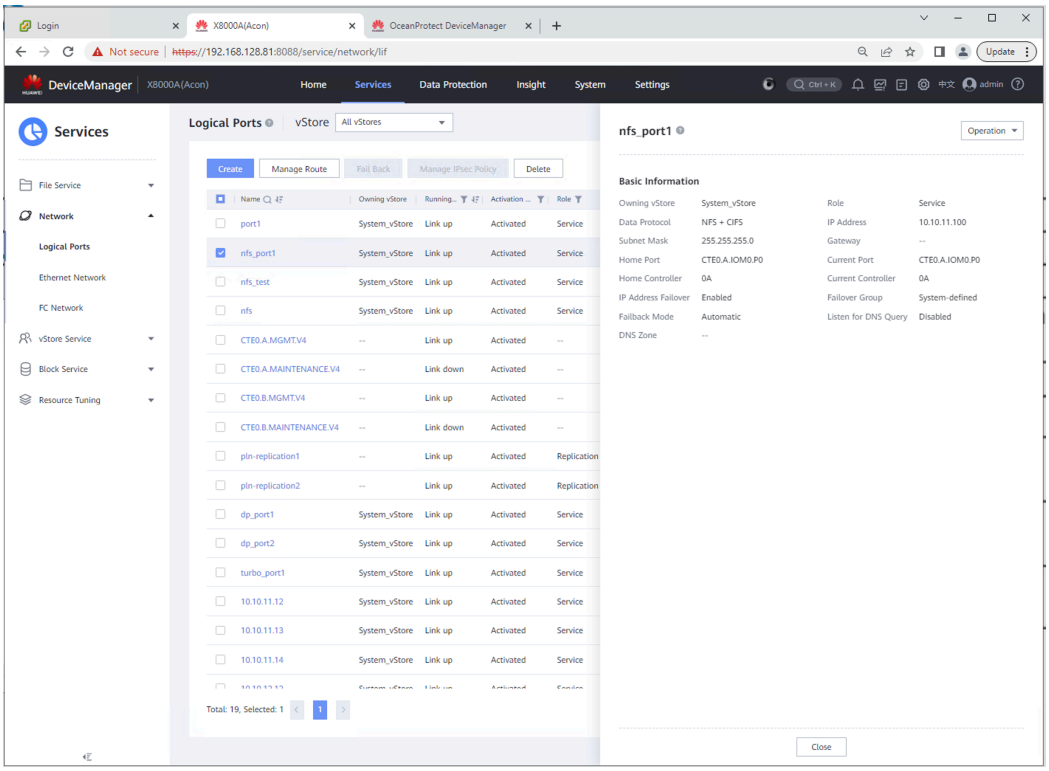
All three Huawei storage systems were able to successfully perform backups and restores of VMware VMs. They can store the backup data of whole VMs as full and incremental backups.

Veeam version 12 offers the feature to use an S3 or S3-compatible storage as backup storage. We tested this feature in combination with the OceanStor Pacific 9550. Also, more important than backups, all restores, whole VM and single file restores from full and incremental backups run successful with all three Huawei storage backup solutions.

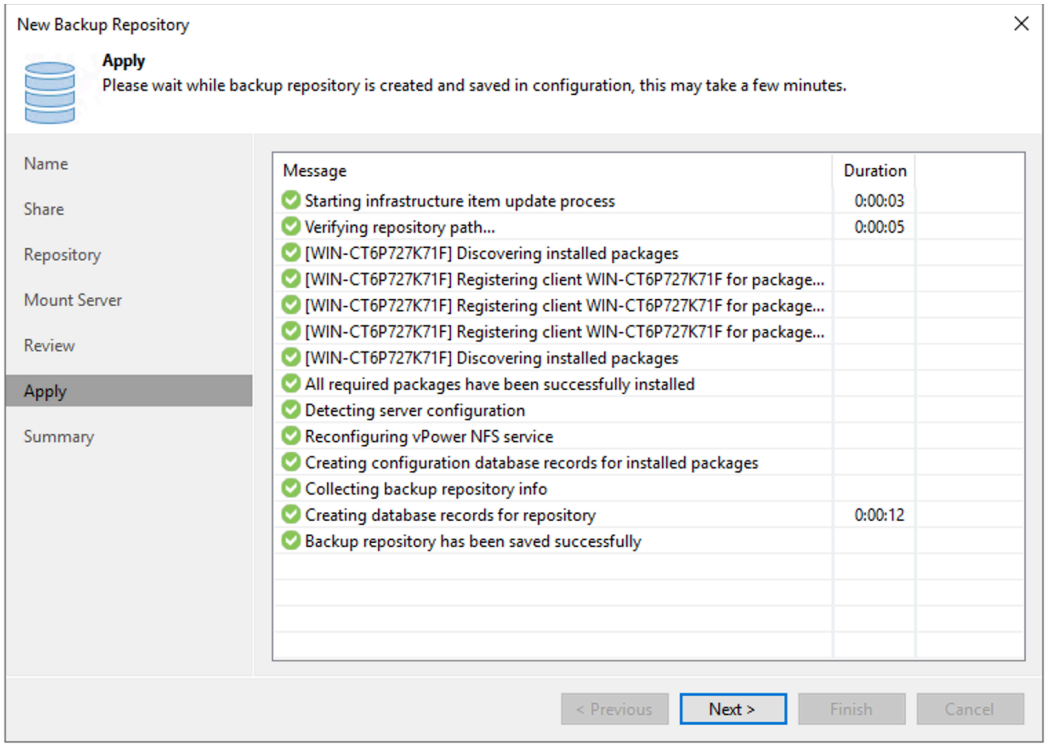
Test 1 OceanProtect NAS service as the Backup Repository

In the first test case we created one file system and one NFS share on the OceanProtect X8000.

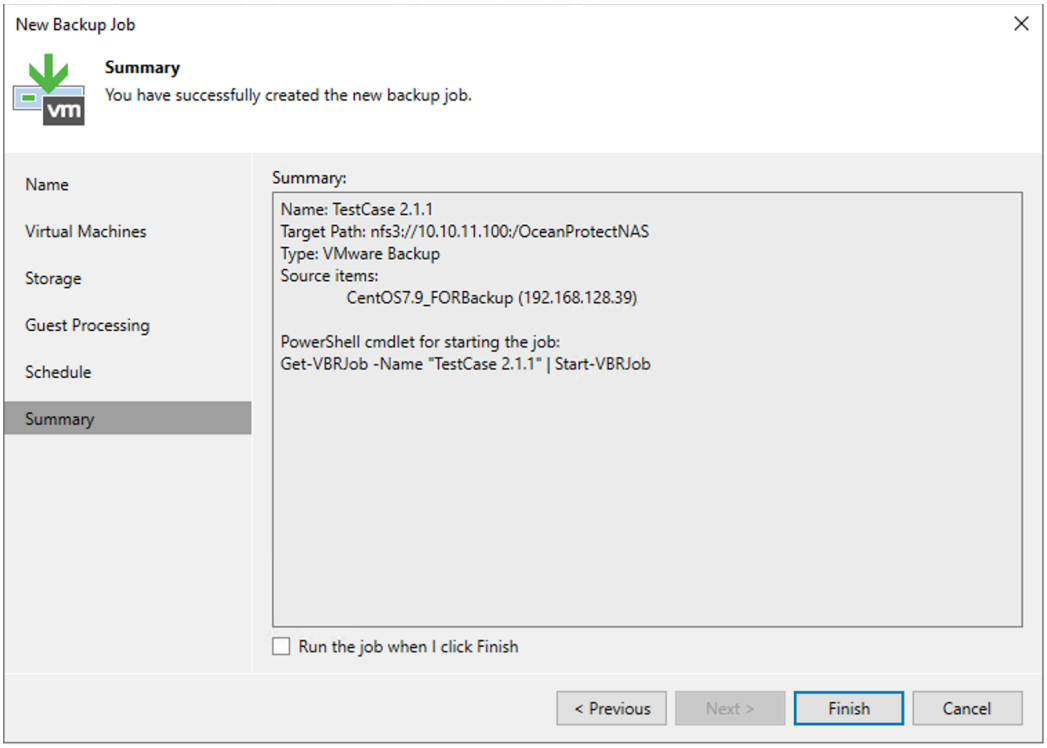




Then, create one repository based on the NFS share of OceanProtect X8000.

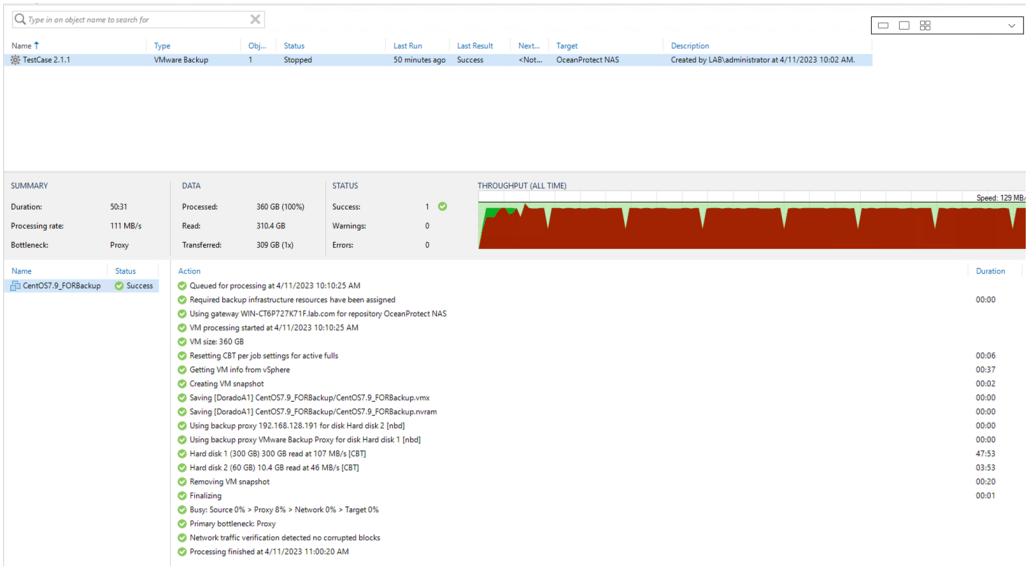


At last, create one new backup job for VM, the target path is the repository which created previous step.

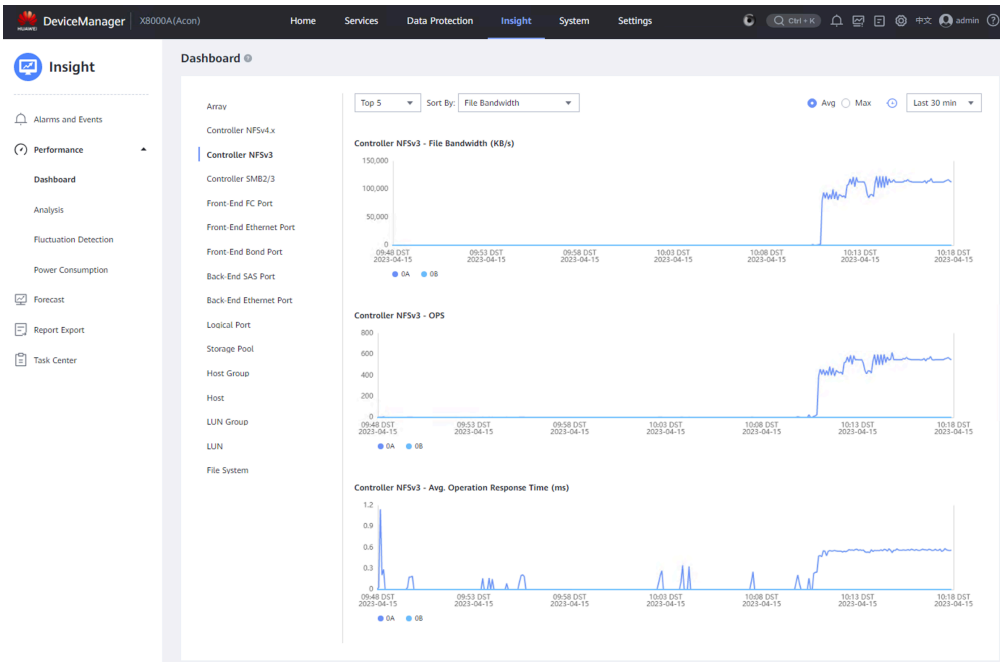


Test 1.1 Full backup

Start the new backup job and it executed successfully.



We can see, the performance metric OPS and bandwidth on OceanProtect have value and almost same with the Veeam 12.

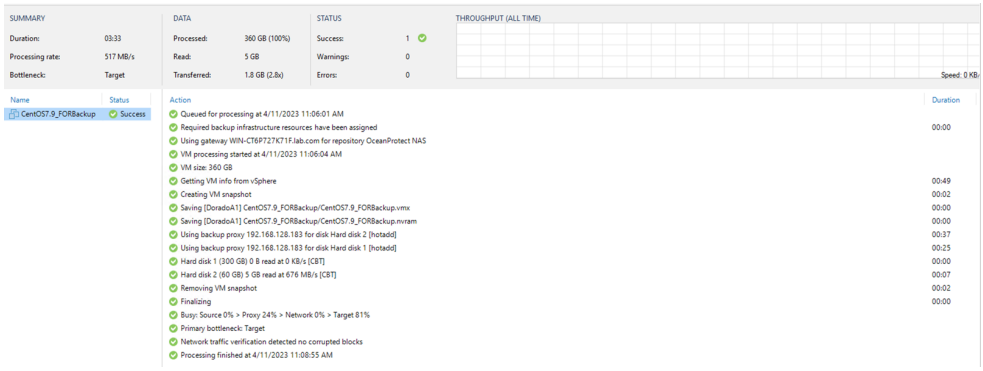


Test 1.2 Incremental backup

Next step, copy 5 files to the directory of VM to simulate the incremental date.

```
[root@host141 vdbench50407]# ll /fs1
total 8
-rwxrwxrwx. 1 root root  68 Apr 11 13:19 no_dismount.txt
drwxr-xr-x. 2 root root 116 Apr 11 13:20 vdb.1_1.dir
-rwxrwxrwx. 1 root root 176 Apr 11 13:20 vdb_control.file
[root@host141 vdbench50407]# ll /fs1/vdb.1_1.dir/
total 5242888
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0004.file
[root@host141 vdbench50407]#
```

Then start the incremental backup and it executed successfully too.

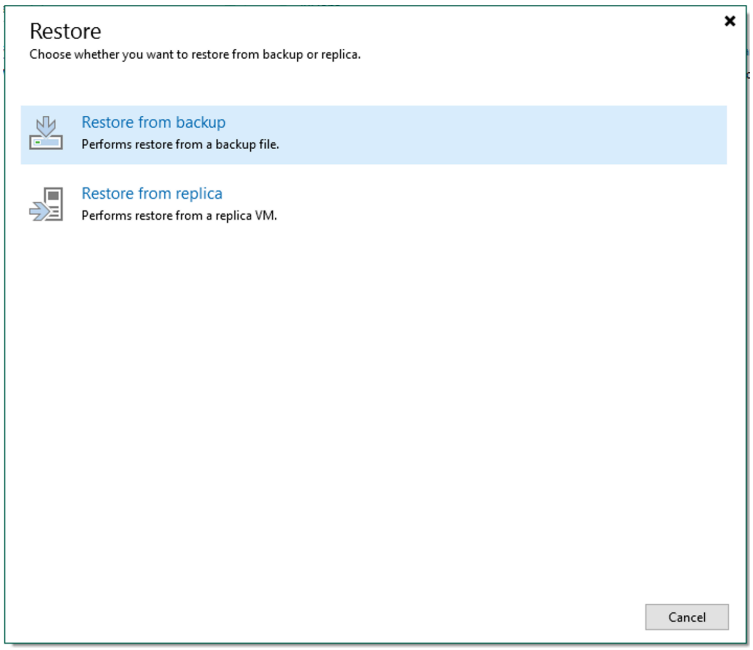


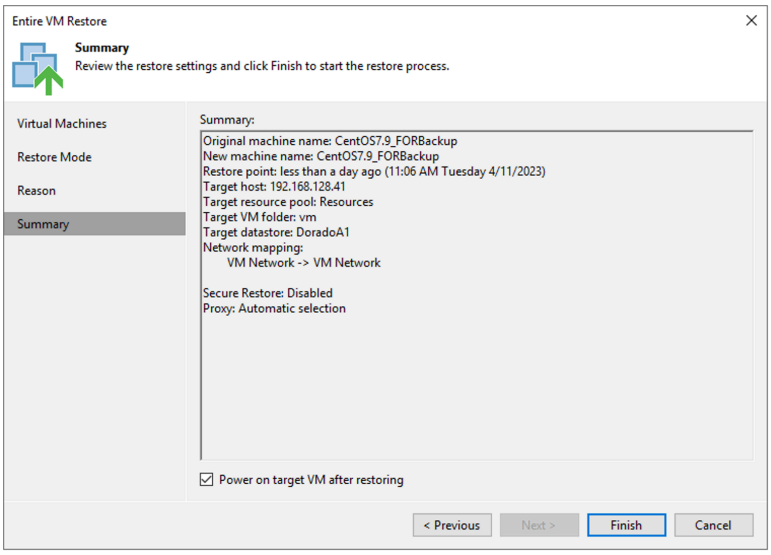
Test 1.3 Restore VM

Then we are trying to restore the VM from the backup data, so calculate the hash value of the 5 files and delete them.

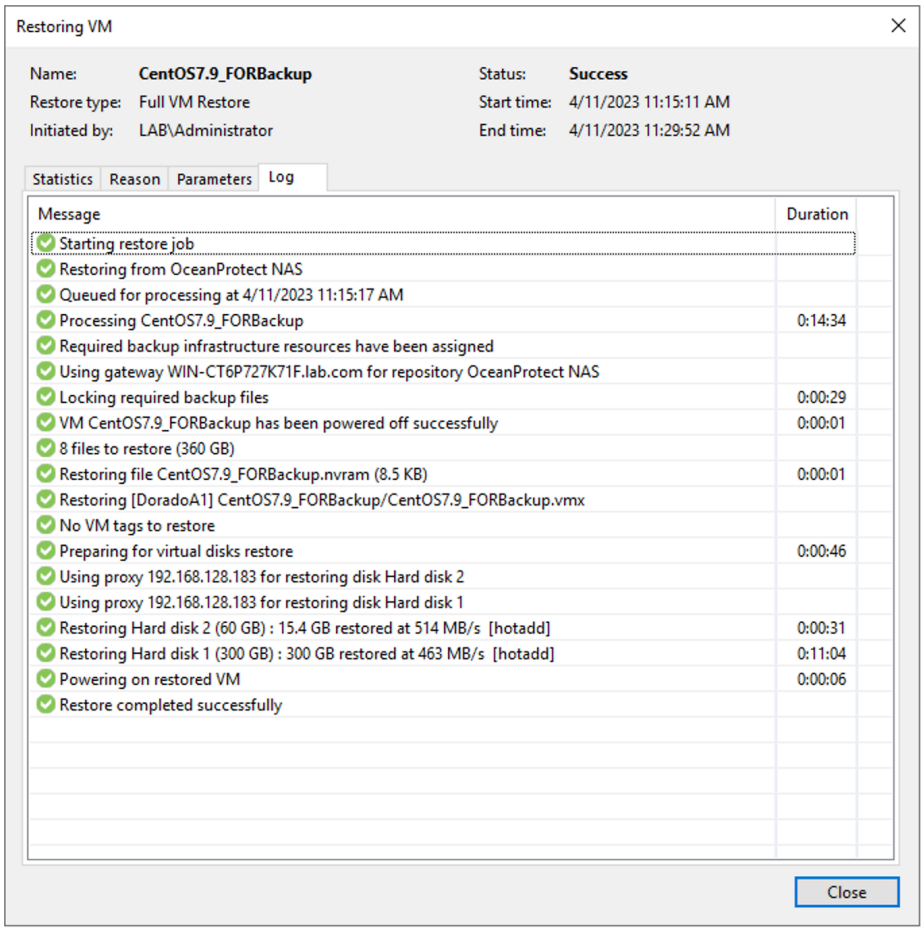
```
[root@host141 vdbench50407]# ll /fsl
total 8
-rwxrwxrwx. 1 root root  68 Apr 11 13:19 no_dismount.txt
drwxr-xr-x. 2 root root 116 Apr 11 13:20 vdb.1_1.dir
-rwxrwxrwx. 1 root root 176 Apr 11 13:20 vdb_control.file
[root@host141 vdbench50407]# ll /fsl/vdb.1_1.dir/
total 5242888
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0004.file
[root@host141 vdbench50407]# sha256sum /fsl/vdb.1_1.dir/*
4ff79455c48b7c43209086a5cb1907a564fd3a7e25c1299a9f2ad753164ee51a  /fsl/vdb.1_1.dir/vdb_f0000.file
cf0323c98f49874080a9b7e317d03ecbcbb773b14f29a4784e7bbad5a31867c1  /fsl/vdb.1_1.dir/vdb_f0001.file
779504eaf25e58810f7b1e60ac4ce44671505dcfd5a17f3cb3d5da8508264b2a  /fsl/vdb.1_1.dir/vdb_f0002.file
70860809b74f0f9e62f08cdca147c3f96da37871fc4815a84a794f6e2dc1604f  /fsl/vdb.1_1.dir/vdb_f0003.file
da398a1e8ad4c6fa400b8c020dd7e6dc345828c7fec36b830ddf23032eb6a51a  /fsl/vdb.1_1.dir/vdb_f0004.file
[root@host141 vdbench50407]#
[root@host141 vdbench50407]#
[root@host141 vdbench50407]# rm  /fsl/vdb.1_1.dir/*
rm: remove regular file '/fsl/vdb.1_1.dir/vdb_f0000.file'? z
rm: remove regular file '/fsl/vdb.1_1.dir/vdb_f0001.file'? y
rm: remove regular file '/fsl/vdb.1_1.dir/vdb_f0002.file'? y
rm: remove regular file '/fsl/vdb.1_1.dir/vdb_f0003.file'? y
rm: remove regular file '/fsl/vdb.1_1.dir/vdb_f0004.file'? y
[root@host141 vdbench50407]# rm  /fsl/vdb.1_1.dir/*
rm: remove regular file '/fsl/vdb.1_1.dir/vdb_f0000.file'? y
[root@host141 vdbench50407]# ll  /fsl/vdb.1_1.dir/*
ls: cannot access /fsl/vdb.1_1.dir/*: No such file or directory
[root@host141 vdbench50407]#
```

Start the restore from backup job after the files were deleted.





And the restore VM is completed and successes.



Check the hash value after the VM power on, and the value is the same with before for every file.

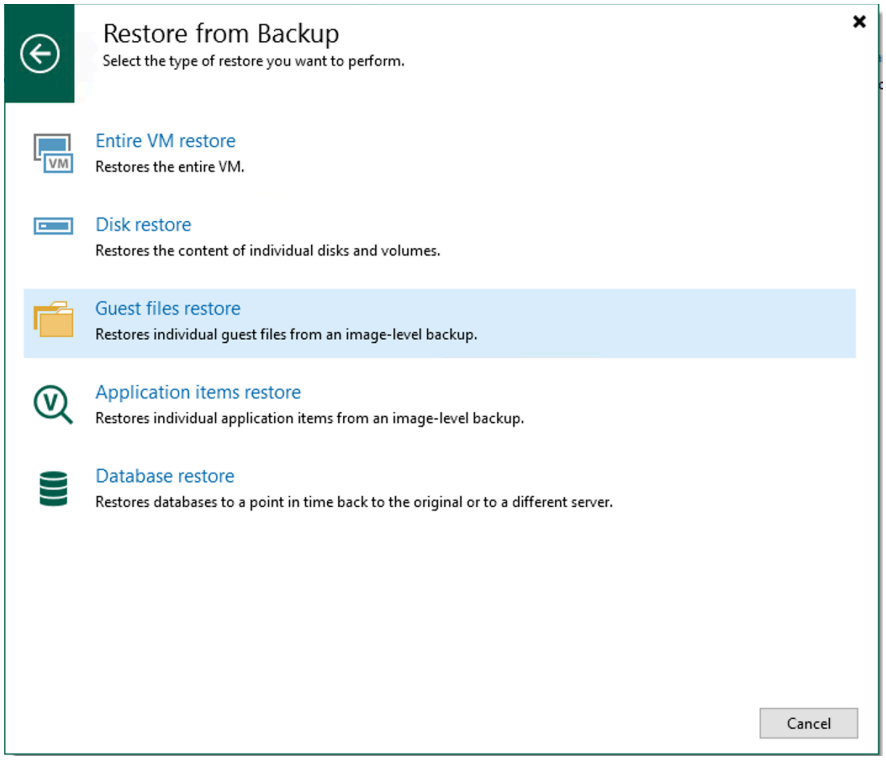
```
login as: root
root@192.168.128.141's password:
Access denied
root@192.168.128.141's password:
Last failed login: Tue Apr 11 13:47:38 CEST 2023 from 192.168.128.222 on ssh:notty
There was 1 failed login attempt since the last successful login.
Last login: Tue Apr 11 12:57:43 2023 from cell.lab.com
[root@host141 ~]# ll /fs1/vdb.1_1.dir/
total 5242888
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 vdb_f0004.file
[root@host141 ~]# sha256sum /fs1/vdb.1_1.dir/*
4ff79455c48b7c43209086a5cb1907a564fd3a7e25c1299a9f2ad753164ee51a  /fs1/vdb.1_1.dir/vdb_f0000.file
cf0323c98f49874080a9b7e317d03ecbcbb773b14f29a4784e7bbad5a31867c1  /fs1/vdb.1_1.dir/vdb_f0001.file
779504eaf25e58810f7b1e60ac4ce44671505dcfd5a17f3cb3d5da8508264b2a  /fs1/vdb.1_1.dir/vdb_f0002.file
70860809b74f0f9e62f08cdca147c3f96da37871fc4815a84a794f6e2dc1604f  /fs1/vdb.1_1.dir/vdb_f0003.file
da398a1e8ad4c6fa400b8c020dd7e6dc345828c7fec36b830ddf23032eb6a51a  /fs1/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
```

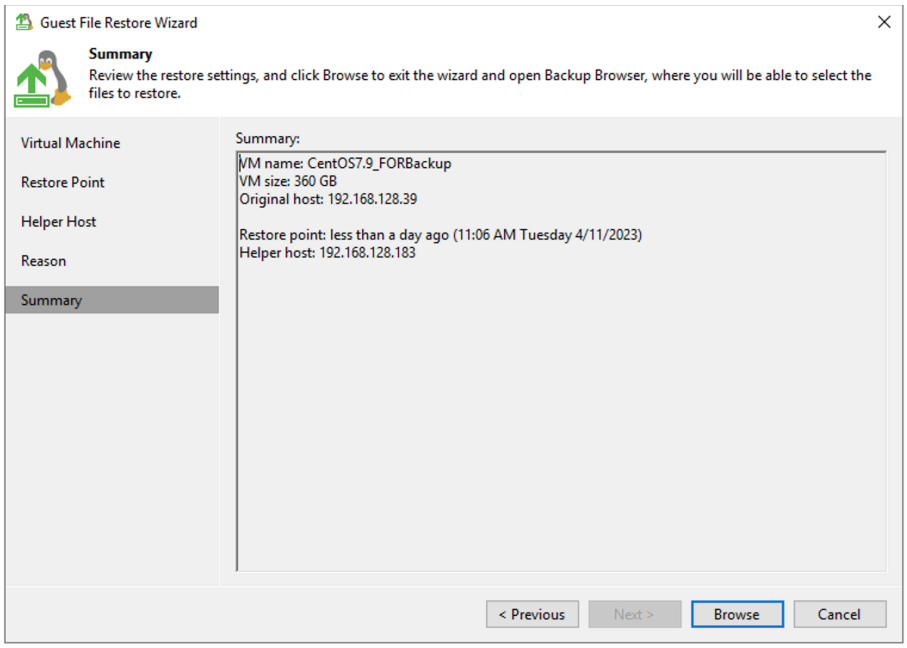
Test 1.4 Restore Guest-OS files

Then delete the files again, we are going to restore the files only.

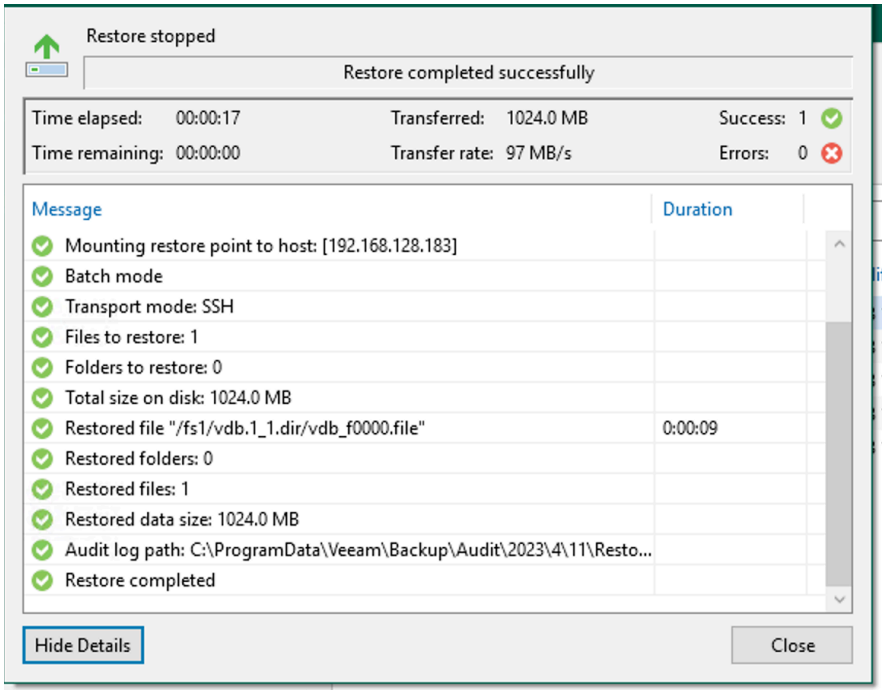
```
root@host141:~
[root@host141 ~]# sha256sum /fs1/vdb.1_1.dir/*
4ff79455c48b7c43209086a5cb1907a564fd3a7e25c1299a9f2ad753164ee51a  /fs1/vdb.1_1.dir/vdb_f0000.file
cf0323c98f49874080a9b7e317d03ecbcbb773b14f29a4784e7bbad5a31867c1  /fs1/vdb.1_1.dir/vdb_f0001.file
779504eaf25e58810f7b1e60ac4ce44671505dcfd5a17f3cb3d5da8508264b2a  /fs1/vdb.1_1.dir/vdb_f0002.file
70860809b74f0f9e62f08cdca147c3f96da37871fc4815a84a794f6e2dc1604f  /fs1/vdb.1_1.dir/vdb_f0003.file
da398a1e8ad4c6fa400b8c020dd7e6dc345828c7fec36b830ddf23032eb6a51a  /fs1/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# rm /fs1
fs1/   fs101/ fs102/
[root@host141 ~]# rm /fs1
fs1/   fs101/ fs102/
[root@host141 ~]# rm /fs1/vdb.1_1.dir/vdb_f0000.file
rm: remove regular file '/fs1/vdb.1_1.dir/vdb_f0000.file'? z
[root@host141 ~]# rm /fs1/vdb.1_1.dir/vdb_f0000.file
rm: remove regular file '/fs1/vdb.1_1.dir/vdb_f0000.file'? y
[root@host141 ~]#
[root@host141 ~]# ll /fs1/vdb.1_1.dir/vdb_f0000.file
ls: cannot access /fs1/vdb.1_1.dir/vdb_f0000.file: No such file or directory
[root@host141 ~]# ll /fs1/vdb.1_1.dir/*
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
```

Start the guest files restore job.

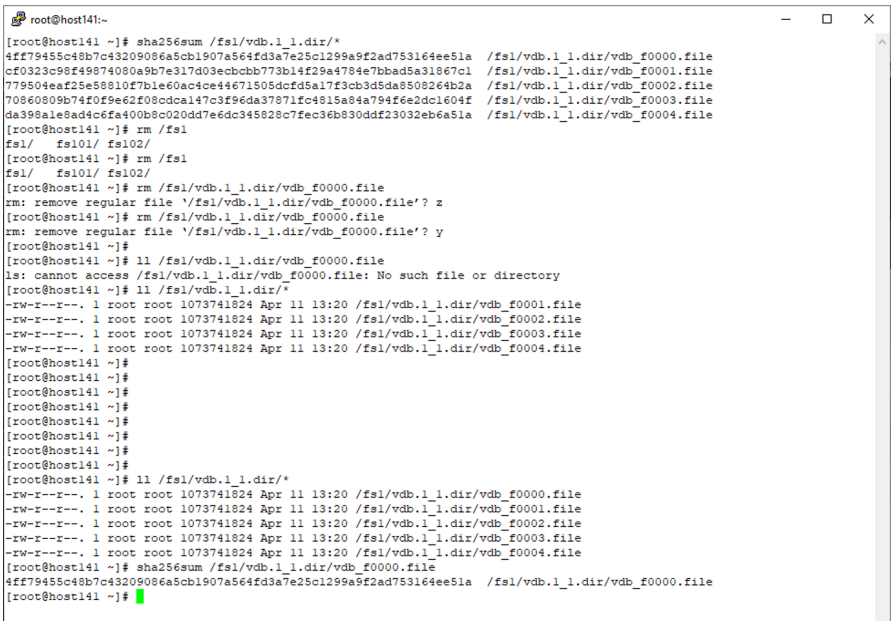




And the files are restore completed and successes.

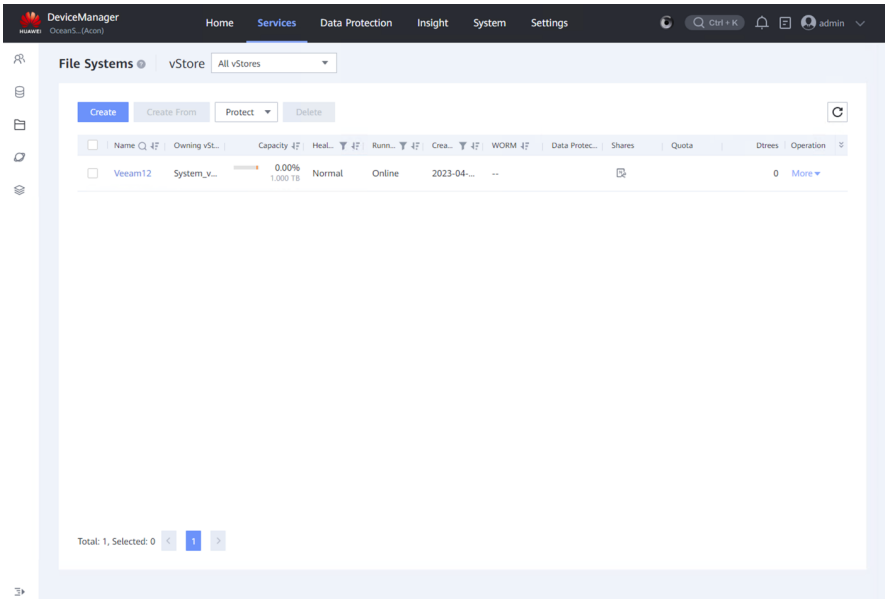


Check the hash value for each file, the value is the same with before.

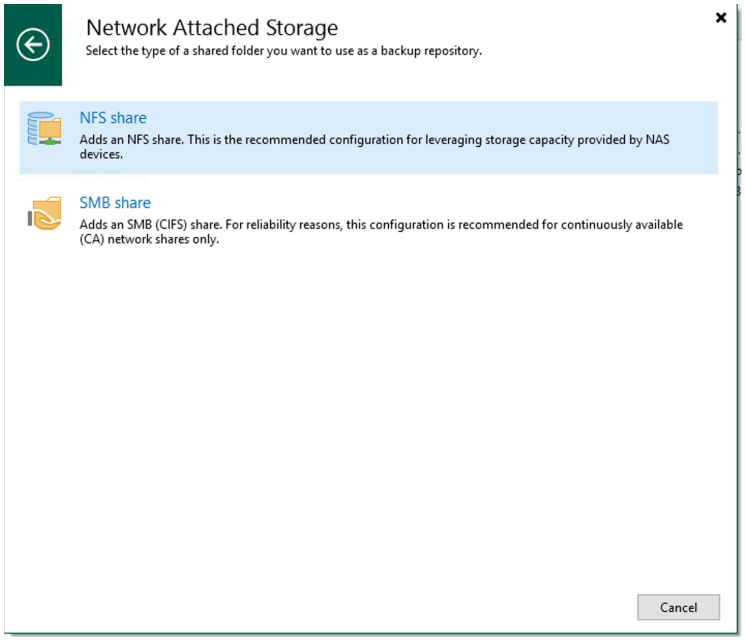

root@host141:~
[root@host141 ~]# sha256sum /fs1/vdb.1_1.dir/*
4ff79455c48b7c43209086a5cb1907a564fd3a7e25c1299a9f2ad753164ee51a /fs1/vdb.1_1.dir/vdb_f0000.file
cf0323c98f49874080a9b7e317d03ecbcbb773b14f29a4784e7bbad5a31867c1 /fs1/vdb.1_1.dir/vdb_f0001.file
779504eaf25e58810f7b1e60ac4ce44671505dcfd5a17f3cb3d5da8508264b2a /fs1/vdb.1_1.dir/vdb_f0002.file
70860809b74f0f9e62f08cdca147c3f96da37871fc4815a84a794f6e2dc1604f /fs1/vdb.1_1.dir/vdb_f0003.file
da398a1e8ad4c6fa400b8c020dd7e6dc345828c7fec36b830ddf23032eb6a51a /fs1/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# rm /fs1
fs1/   fs101/ fs102/
[root@host141 ~]# rm /fs1
fs1/   fs101/ fs102/
[root@host141 ~]# rm /fs1/vdb.1_1.dir/vdb_f0000.file
rm: remove regular file '/fs1/vdb.1_1.dir/vdb_f0000.file'? z
[root@host141 ~]# rm /fs1/vdb.1_1.dir/vdb_f0000.file
rm: remove regular file '/fs1/vdb.1_1.dir/vdb_f0000.file'? y
[root@host141 ~]#
[root@host141 ~]# ll /fs1/vdb.1_1.dir/vdb_f0000.file
ls: cannot access /fs1/vdb.1_1.dir/vdb_f0000.file: No such file or directory
[root@host141 ~]# ll /fs1/vdb.1_1.dir/*
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]# ll /fs1/vdb.1_1.dir/*
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 13:20 /fs1/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# sha256sum /fs1/vdb.1_1.dir/vdb_f0000.file
4ff79455c48b7c43209086a5cb1907a564fd3a7e25c1299a9f2ad753164ee51a /fs1/vdb.1_1.dir/vdb_f0000.file
[root@host141 ~]#

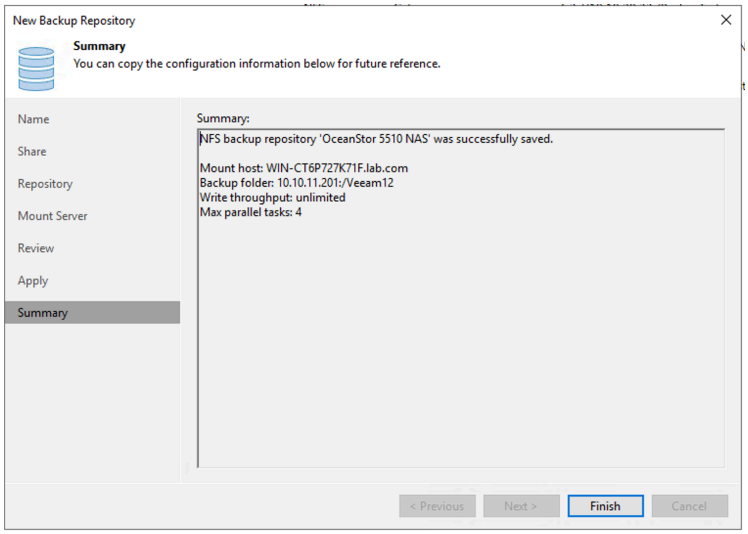
Test 2 OceanStor NAS service as the Backup Repository

Next case we created one file system and one NFS share on the OceanStor 5510.



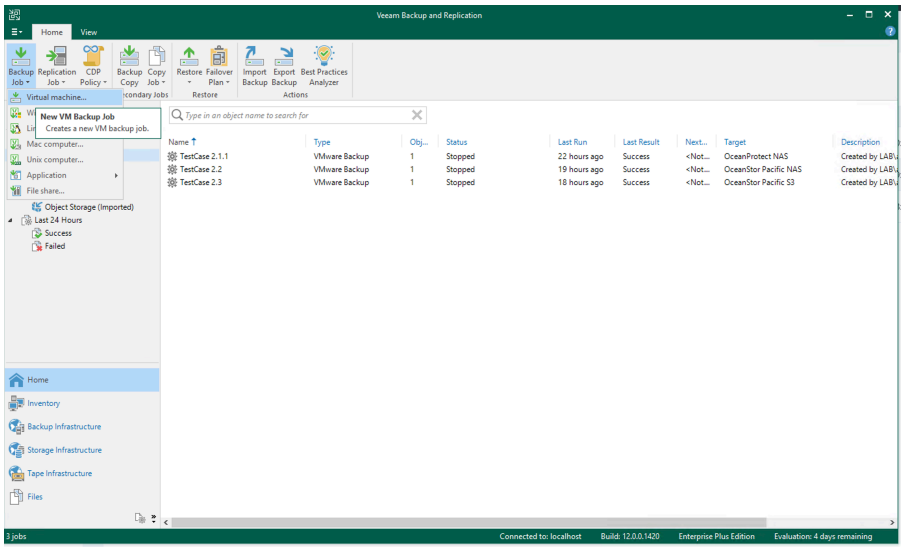
Then, create one repository based on the NFS share of OceanStor 5510.

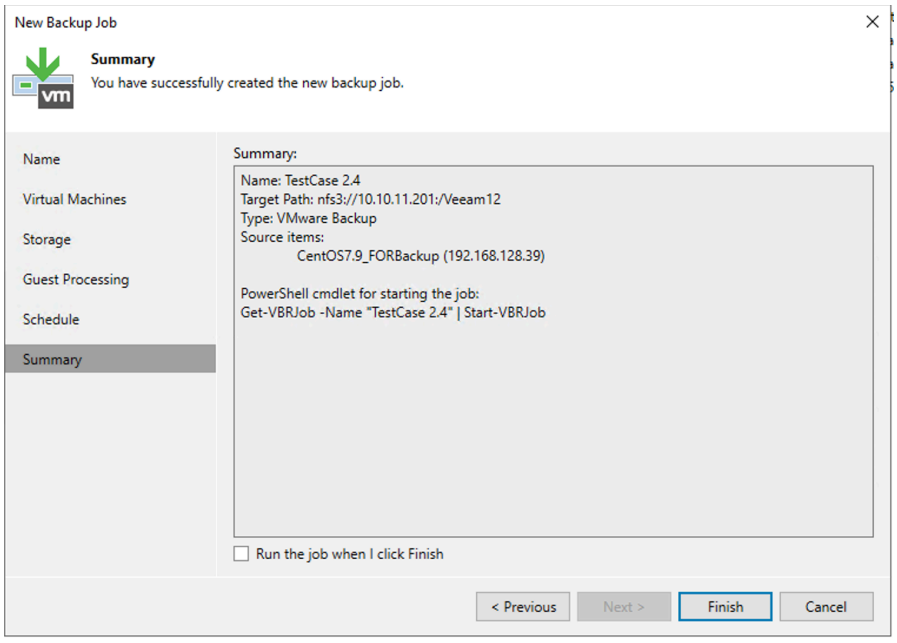


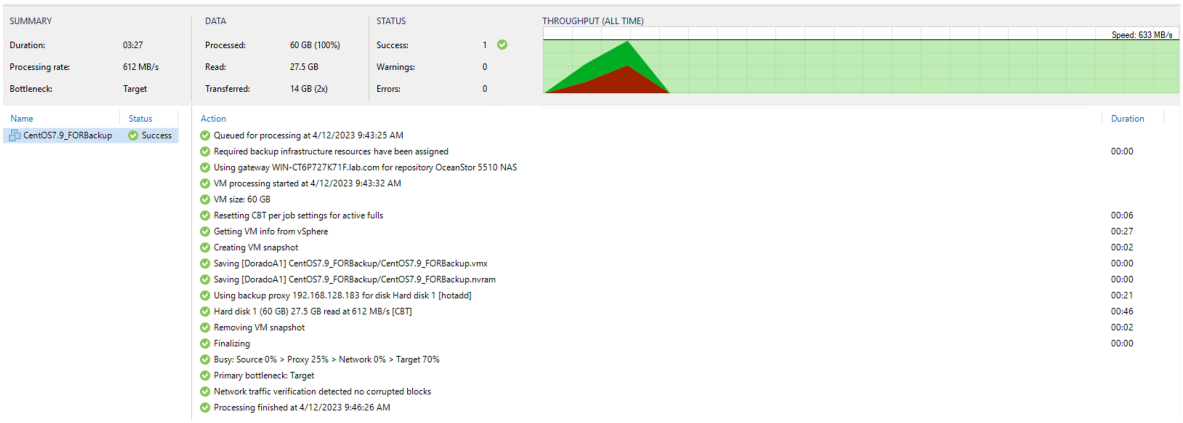


Test 2.1 Full backup

Start the new backup job and it executed successfully.





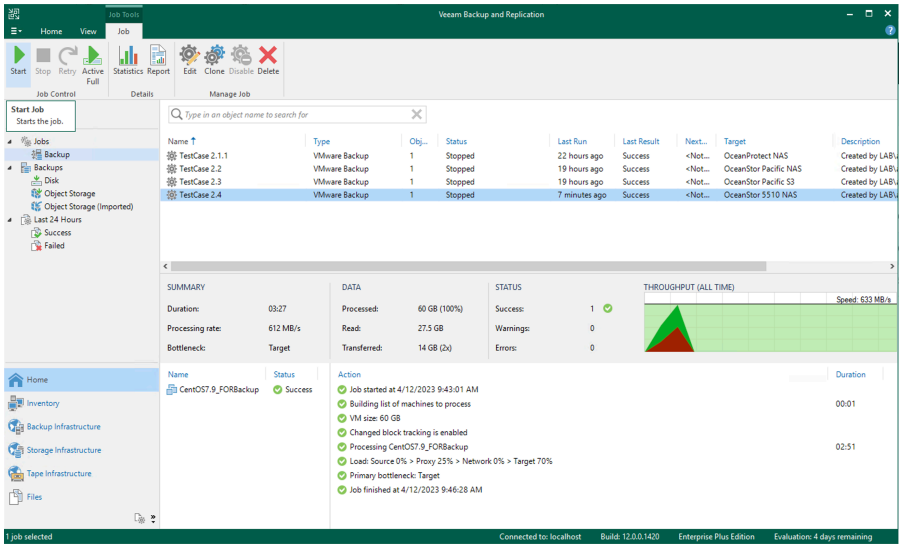


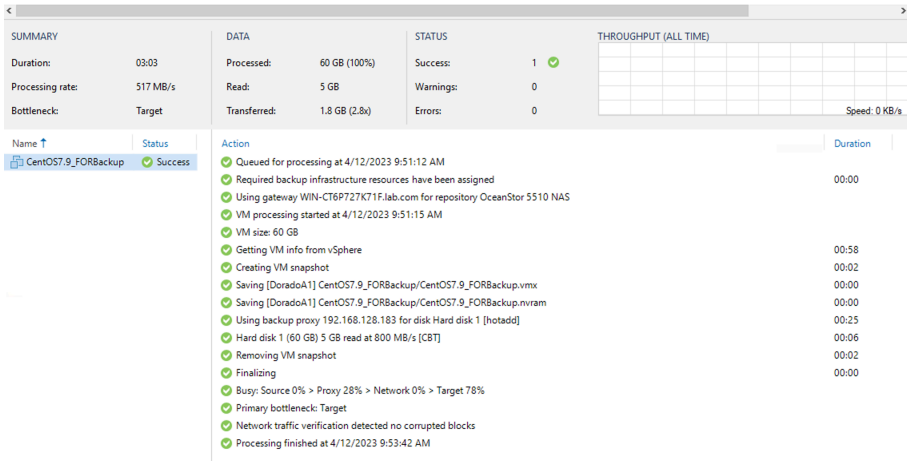
Test 2.2 Incremental backup

Then copy 5 files to the directory of VM.

```
12:05:33.708 Vdbench execution completed successfully. Output directory: /root/vdbench50407/output

[root@host141 vdbench50407]# ll /fs4/vdb
vdb.l_1.dir/      vdb_control.file
[root@host141 vdbench50407]# ll /fs4/vdb.l_1.dir/
total 5242900
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0004.file
[root@host141 vdbench50407]#
[root@host141 vdbench50407]# sha256sum /fs4/vdb.l_1.dir/*
dbfa6d9efde05d6057ed8e6598d0290dceac738810579bbb3203c16f0289718b  /fs4/vdb.l_1.dir/vdb_f0000.file
49bdd39199f331e1035f9159c4520e13502eelea133acb8d8a8088cf9a27b71b  /fs4/vdb.l_1.dir/vdb_f0001.file
13546807ea77699c66a7ae63ea600c3e26f4ef511435509198a8e45eae77c61e  /fs4/vdb.l_1.dir/vdb_f0002.file
e37712d39fb3a24fac01520ca33f6863c4898fb4f91ffc8532b42ba24f3d1407  /fs4/vdb.l_1.dir/vdb_f0003.file
172949d12e3c64c980808b6d246d0df3ba9a98da06ecb49ecab3511b1f2e5f13  /fs4/vdb.l_1.dir/vdb_f0004.file
[root@host141 vdbench50407]#
```

Then start the incremental backup and it executed successfully.



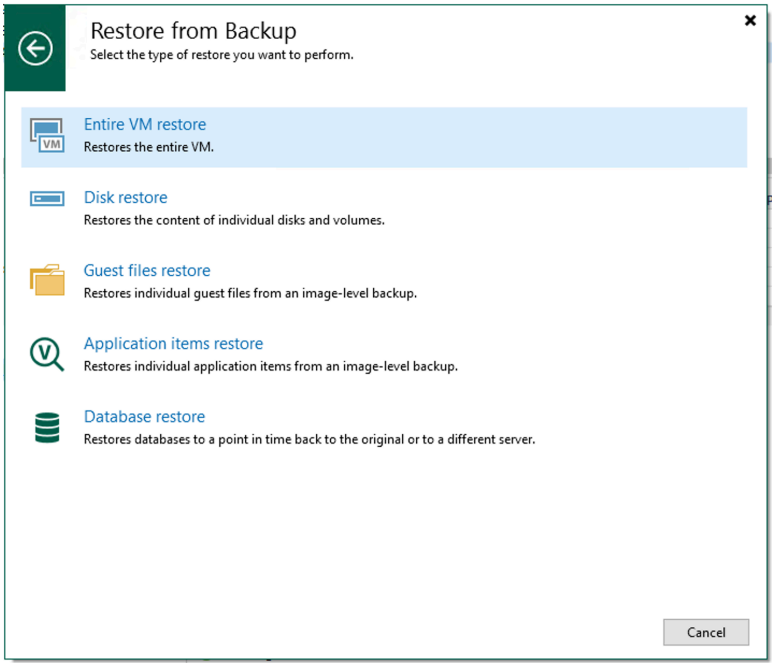


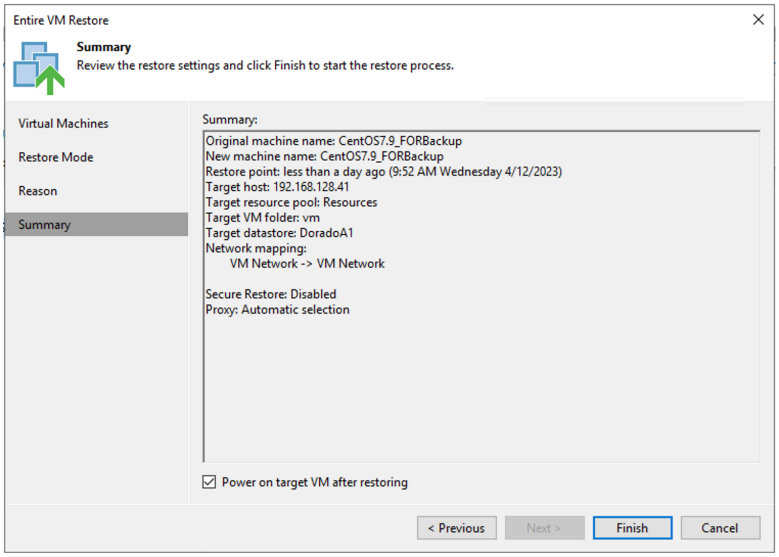
Test 2.3 Restore VM

Then we are trying to restore the VM from the backup data, so calculate the hash value of the 5 files and delete them.

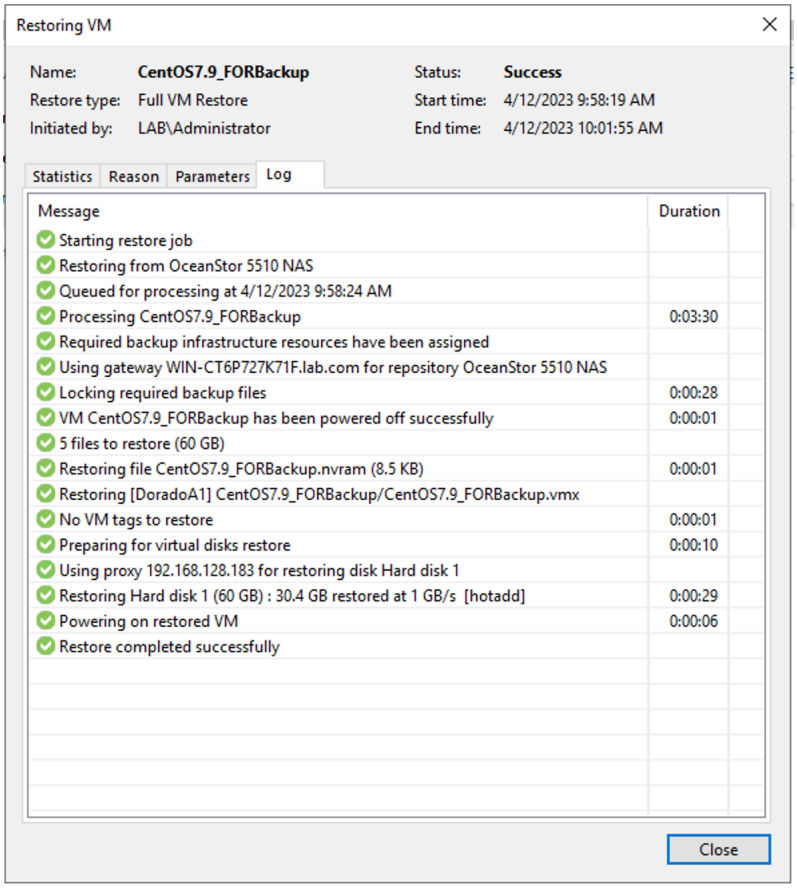
```
[root@host141 vdbench50407]# ll /fs4/vdb.1_1.dir/
total 5242900
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0004.file
[root@host141 vdbench50407]#
[root@host141 vdbench50407]# sha256sum /fs4/vdb.1_1.dir/*
dbfa6d9efde05d6057ed8e6598d0290dceac738810579bbb3203c16f0289718b  /fs4/vdb.1_1.dir/vdb_f0000.file
49bdd39199f331e1035f9159c4520e13502ee1ea133acb8d8a8088cf9a27b71b  /fs4/vdb.1_1.dir/vdb_f0001.file
13546807ea77699c66a7ae63ea600c3e26f4ef511435509198a8e45eae77c61e  /fs4/vdb.1_1.dir/vdb_f0002.file
e37712d39fb3a24fac01520ca33f6863c4898fb4f91ffc8532b42ba24f3d1407  /fs4/vdb.1_1.dir/vdb_f0003.file
172949d12e3c64c980808b6d246d0df3ba9a98da06ecb49ecab3511b1f2e5f13  /fs4/vdb.1_1.dir/vdb_f0004.file
[root@host141 vdbench50407]#
[root@host141 vdbench50407]#
[root@host141 vdbench50407]#
[root@host141 vdbench50407]#
[root@host141 vdbench50407]# rm /fs4/vdb.1_1.dir/*
rm: remove regular file '/fs4/vdb.1_1.dir/vdb_f0000.file'? y
rm: remove regular file '/fs4/vdb.1_1.dir/vdb_f0001.file'? y
rm: remove regular file '/fs4/vdb.1_1.dir/vdb_f0002.file'? y
rm: remove regular file '/fs4/vdb.1_1.dir/vdb_f0003.file'? y
rm: remove regular file '/fs4/vdb.1_1.dir/vdb_f0004.file'? y
[root@host141 vdbench50407]# ll /fs4/vdb.1_1.dir/
total 0
[root@host141 vdbench50407]#
```

Start the restore from backup job after the files were deleted.





The restore VM is completed and successes.



Check the hash value after the VM power on, and the value is the same with before for every file.

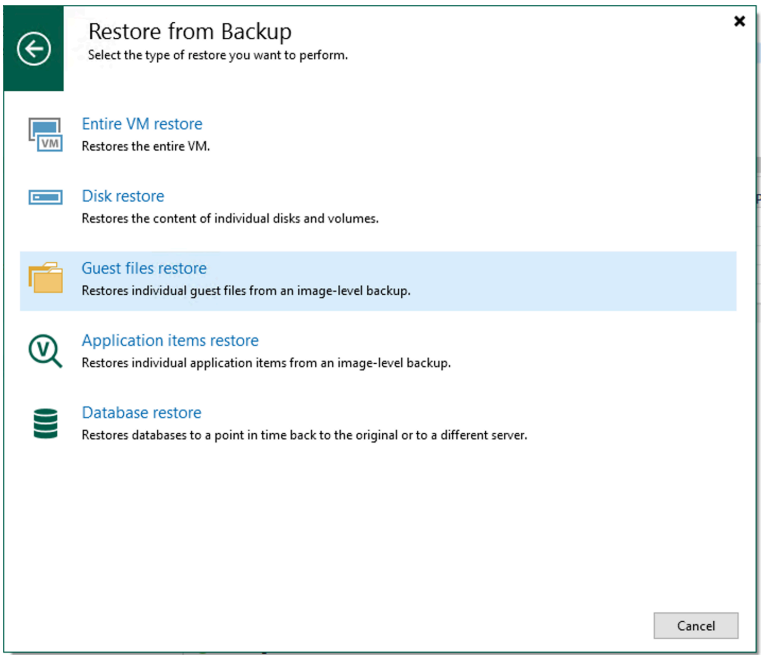
```
login as: root
root@192.168.128.141's password:
Last login: Wed Apr 12 11:34:56 2023 from win-ct6p727k71f.lab.com
[root@host141 ~]#  ll /fs4/vdb.1_1.dir/
total 5242900
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0004.file
[root@host141 ~]# sha256sum /fs4/vdb.1_1.dir/*
dbfa6d9efde05d6057ed8e6598d0290dceac738810579bbb3203c16f0289718b  /fs4/vdb.1_1.dir/vdb_f0000.file
49bdd39199f331e1035f9159c4520e13502eeleal33acb8d8a8088cf9a27b71b  /fs4/vdb.1_1.dir/vdb_f0001.file
13546807ea77699c66a7ae63ea600c3e26f4ef511435509198a8e45eae77c61e  /fs4/vdb.1_1.dir/vdb_f0002.file
e37712d39fb3a24fac01520ca33f6863c4898fb4f91ffc8532b42ba24f3d1407  /fs4/vdb.1_1.dir/vdb_f0003.file
172949d12e3c64c980808b6d246d0df3ba9a98da06ecb49ecab3511b1f2e5f13  /fs4/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
```

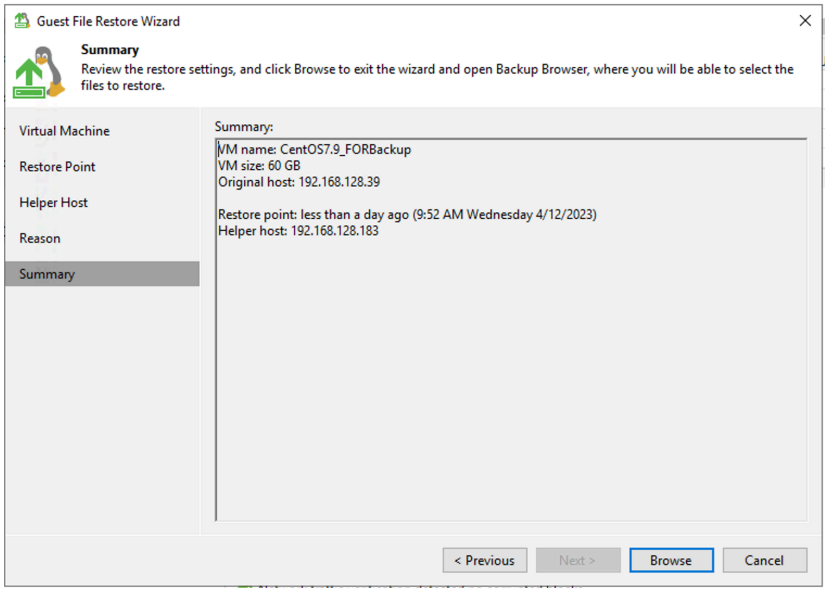
Test 2.4 Restore Guest-OS files

Then delete the files again, we are going to restore the files only.

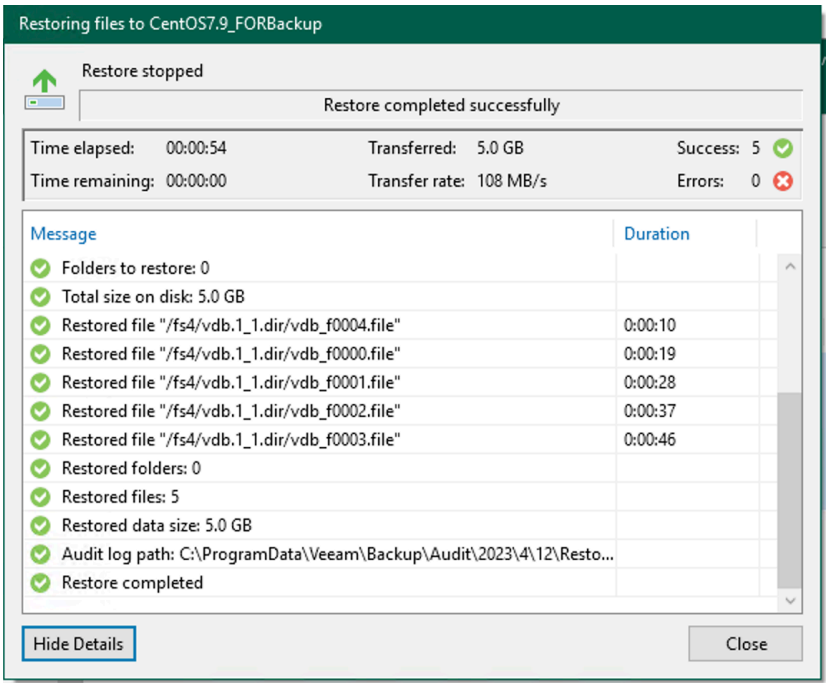
```
[root@host141 ~]#  ll /fs4/vdb.1_1.dir/
total 5242900
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0004.file
[root@host141 ~]# sha256sum /fs4/vdb.1_1.dir/*
dbfa6d9efde05d6057ed8e6598d0290dceac738810579bbb3203c16f0289718b  /fs4/vdb.1_1.dir/vdb_f0000.file
49bdd39199f331e1035f9159c4520e13502eeleal33acb8d8a8088cf9a27b71b  /fs4/vdb.1_1.dir/vdb_f0001.file
13546807ea77699c66a7ae63ea600c3e26f4ef511435509198a8e45eae77c61e  /fs4/vdb.1_1.dir/vdb_f0002.file
e37712d39fb3a24fac01520ca33f6863c4898fb4f91ffc8532b42ba24f3d1407  /fs4/vdb.1_1.dir/vdb_f0003.file
172949d12e3c64c980808b6d246d0df3ba9a98da06ecb49ecab3511b1f2e5f13  /fs4/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# rm /fs4/vdb.1_1.dir/*
rm: remove regular file '/fs4/vdb.1_1.dir/vdb_f0000.file'? y
rm: remove regular file '/fs4/vdb.1_1.dir/vdb_f0001.file'? y
rm: remove regular file '/fs4/vdb.1_1.dir/vdb_f0002.file'? y
rm: remove regular file '/fs4/vdb.1_1.dir/vdb_f0003.file'? y
rm: remove regular file '/fs4/vdb.1_1.dir/vdb_f0004.file'? y
[root@host141 ~]#  ll /fs4/vdb.1_1.dir/
total 0
[root@host141 ~]#
```

Start the guest files restore job.





And the files are restore completed and successes.

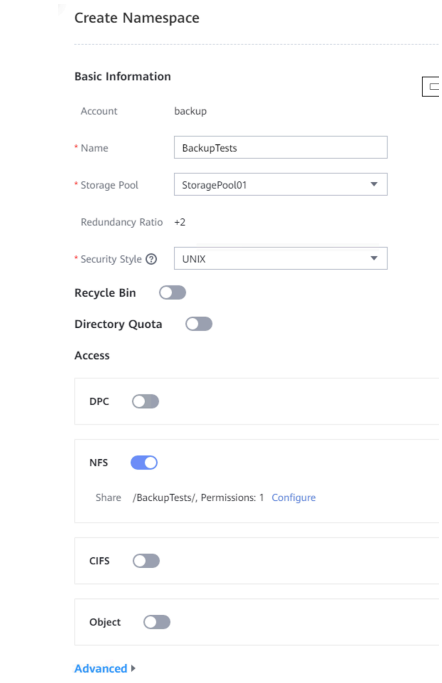


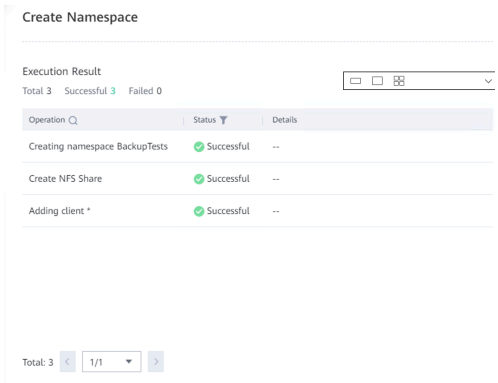
Check the hash value for each file, the value is the same with before.

```
[root@host141 ~]#  ll /fs4/vdb.1_1.dir/
total 5242880
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 12 12:05 vdb_f0004.file
[root@host141 ~]# sha256sum /fs4/vdb.1_1.dir/*
dbfa6d9efde05d6057ed8e6598d0290dceac738810579bbb3203c16f0289718b  /fs4/vdb.1_1.dir/vdb_f0000.file
49bdd39199f331e1035f9159c4520e13502eelea133acb8d8a8088cf9a27b71b  /fs4/vdb.1_1.dir/vdb_f0001.file
13546807ea77699c66a7ae63ea600c3e26f4ef511435509198a8e45eae77c61e  /fs4/vdb.1_1.dir/vdb_f0002.file
e37712d39fb3a24fac01520ca33f6863c4898fb4f91ffc8532b42ba24f3d1407  /fs4/vdb.1_1.dir/vdb_f0003.file
172949d12e3c64c980808b6d246d0df3ba9a98da06ecb49ecab3511b1f2e5f13  /fs4/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
```

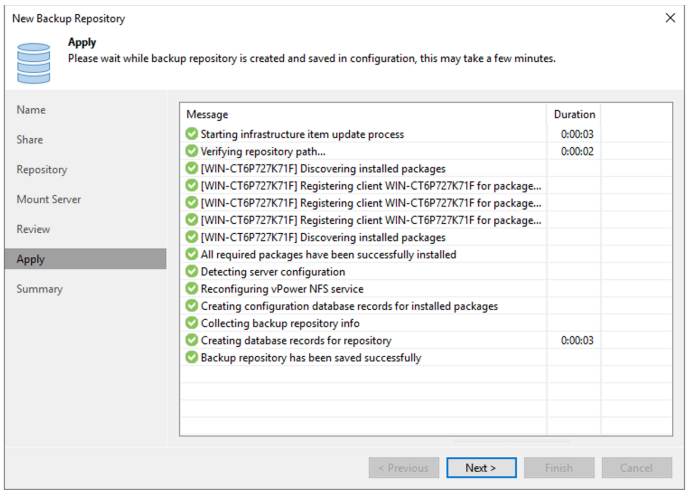
Test 3 OceanStor Pacific NAS service as the Backup Repository

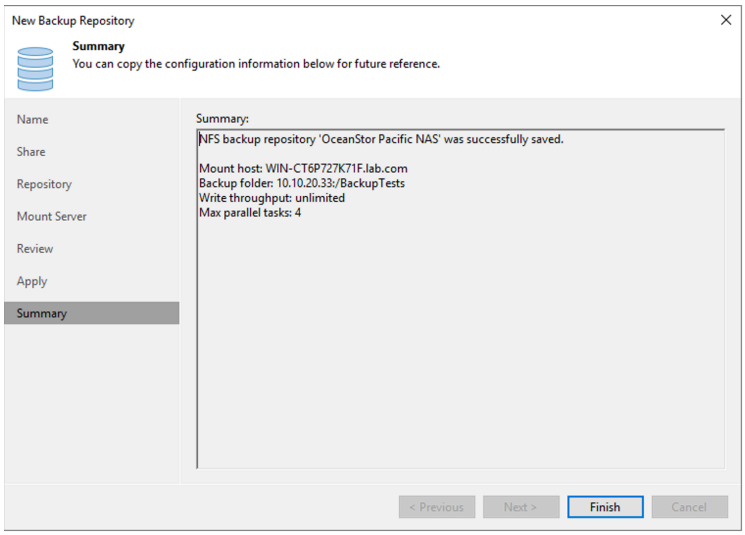
We created one namespace and enable NFS share on the OceanStor Pacific 9550.





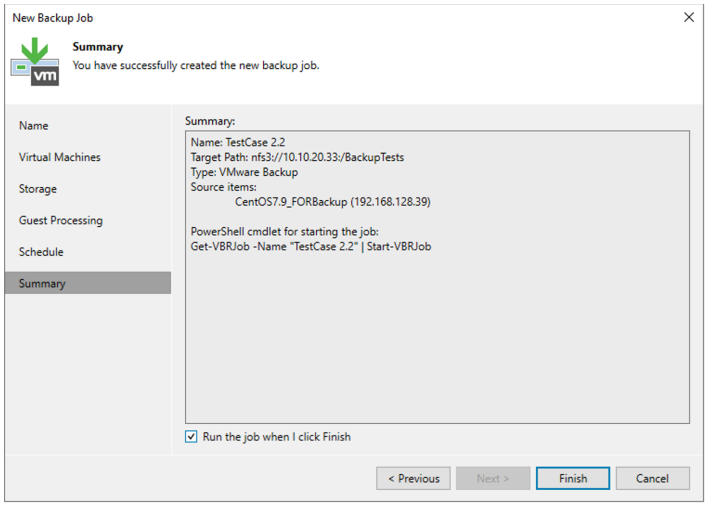
Then, create one repository based on the NFS share of OceanStor Pacific 9550.

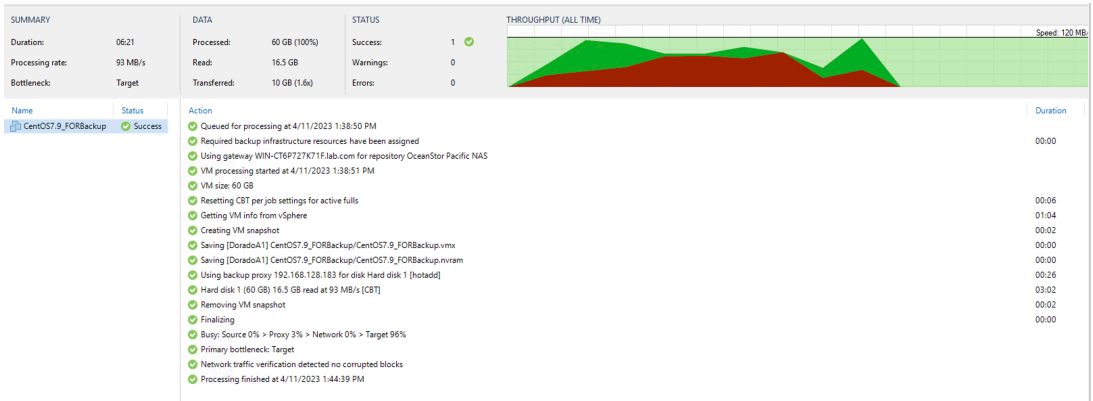




Test 3.1 Full backup

Start new backup job based on the repository from OceanStor Pacific 9550 and it executed successfully.



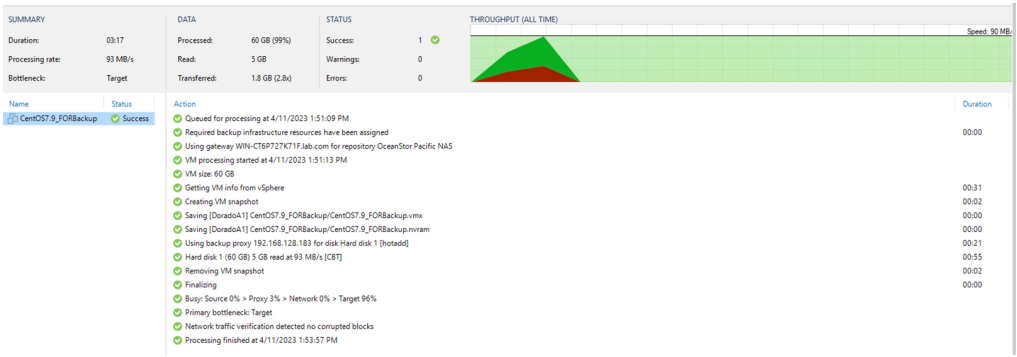


Test 3.2 Incremental backup

Next step, copy 5 files to the directory of VM to simulate the incremental date.

```
[root@host141 vdbench50407]# ll /fs2
total 8
-rwxrwxrwx. 1 root root  68 Apr 11 16:05 no_dismount.txt
drwxr-xr-x. 2 root root 116 Apr 11 16:06 vdb.1_1.dir
-rwxrwxrwx. 1 root root 175 Apr 11 16:06 vdb_control.file
[root@host141 vdbench50407]# sha256sum /fs2/vdb.1_1.dir/*
77d8d0a7d7c0ab66a7237a36160828441c126183a999c3ec60b1361b2be8906e  /fs2/vdb.1_1.dir/vdb_f0000.file
60c7e8acac4a011f2feae55992e9b353a82abe6752ddbfb8f8ce226068d6dd96  /fs2/vdb.1_1.dir/vdb_f0001.file
6f4892569165067dc73150780e6fe3700689b98f0b905b894c8bd01560fa1056  /fs2/vdb.1_1.dir/vdb_f0002.file
f9e52359e3882f1b05f6ce92181d5f9c0eb1f54c3ba5d7192e55792014c10be6  /fs2/vdb.1_1.dir/vdb_f0003.file
47d125178e5211147901490ac9e820698bc576de837ef44bf84bc41ad382b896  /fs2/vdb.1_1.dir/vdb_f0004.file
[root@host141 vdbench50407]#
```

Then start the incremental backup and it executed successfully too.

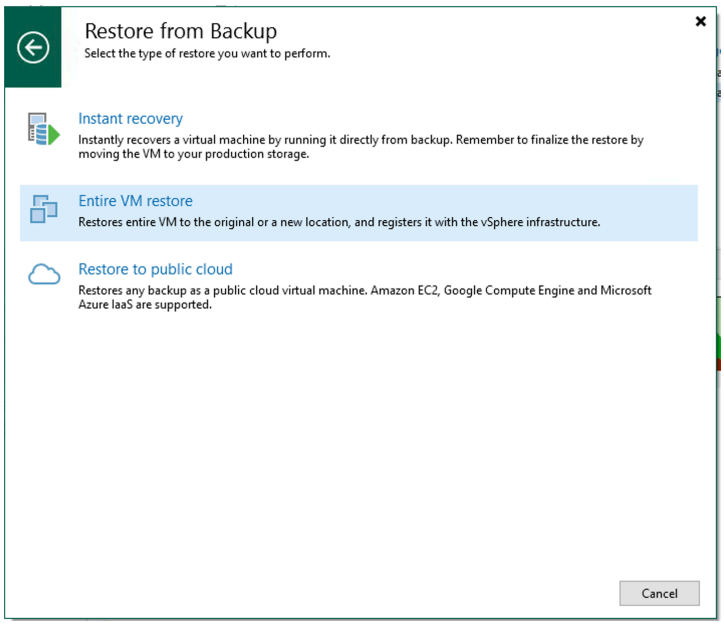


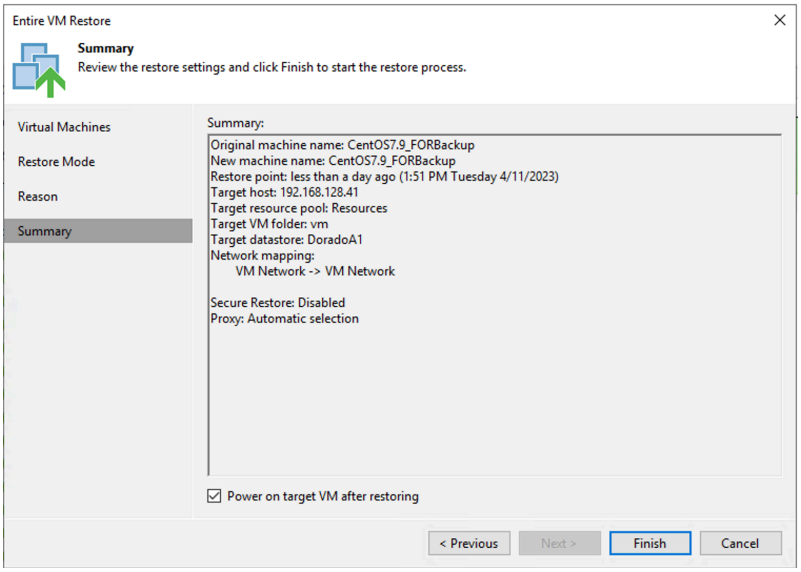
Test 3.3 Restore VM

Then delete the 5 files which copied in the VM.

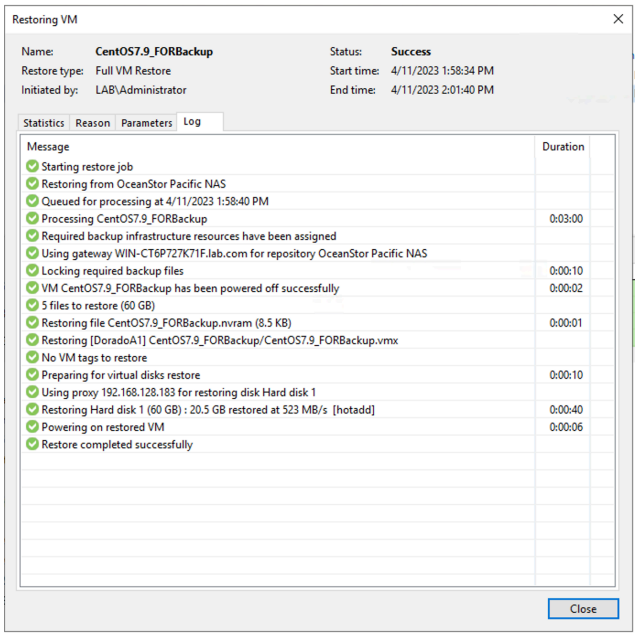
```
[root@host141 vdbench50407]# rm /fs2/vdb.1_1.dir/*
rm: remove regular file '/fs2/vdb.1_1.dir/vdb_f0000.file'? y
rm: remove regular file '/fs2/vdb.1_1.dir/vdb_f0001.file'? y
rm: remove regular file '/fs2/vdb.1_1.dir/vdb_f0002.file'? y
rm: remove regular file '/fs2/vdb.1_1.dir/vdb_f0003.file'? y
rm: remove regular file '/fs2/vdb.1_1.dir/vdb_f0004.file'? y
[root@host141 vdbench50407]#
[root@host141 vdbench50407]#
[root@host141 vdbench50407]# ll /fs2/vdb.1_1.dir/*
ls: cannot access /fs2/vdb.1_1.dir/*: No such file or directory
[root@host141 vdbench50407]#
```

Start the restore from backup job after the files were deleted.





The restore VM is completed and successes.



Check the files after the VM power on, all files are restored.

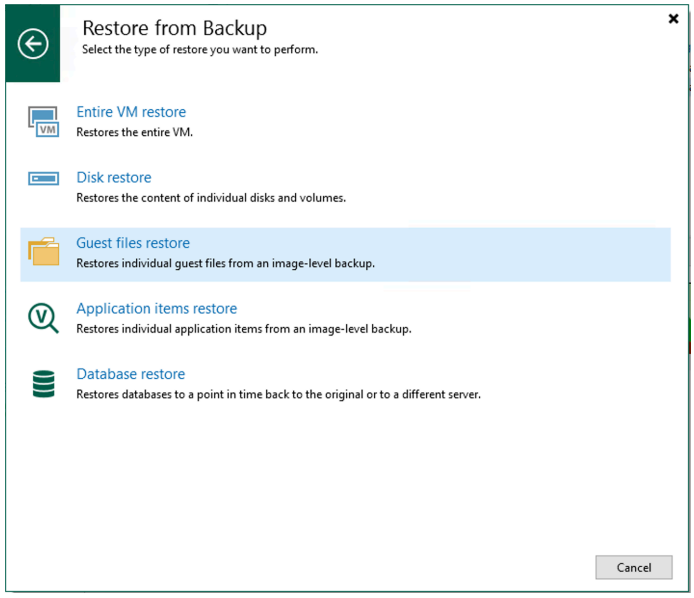
```
[root@host141 ~]#  ll /fs2/vdb.1_1.dir/*
-rw-r--r--. 1 root root 1073741824 Apr 11 16:06 /fs2/vdb.1_1.dir/vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 11 16:06 /fs2/vdb.1_1.dir/vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 16:06 /fs2/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 16:06 /fs2/vdb.1_1.dir/vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 16:06 /fs2/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# sha256sum /fs2/vdb.1_1.dir/*
77d8d0a7d7c0ab66a7237a3616082841c126183a999c3ec60b1361b2be8906e  /fs2/vdb.1_1.dir/vdb_f0000.file
60c7e8acac4a011f2feae55992e9b353a82abe6752ddbfb8f8ce226068d6dd96  /fs2/vdb.1_1.dir/vdb_f0001.file
6f4892569165067dc73150780e6fe3700689b98f0b905b894c8bd01560fa1056  /fs2/vdb.1_1.dir/vdb_f0002.file
f9e52359e3882f1b05f6ce92181d5f9c0eb1f54c3ba5d7192e55792014c10be6  /fs2/vdb.1_1.dir/vdb_f0003.file
47d125178e5211147901490ac9e820698bc576de837ef44bf84bc41ad382b896  /fs2/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
```

Test 3.4 Restore Guest-OS files

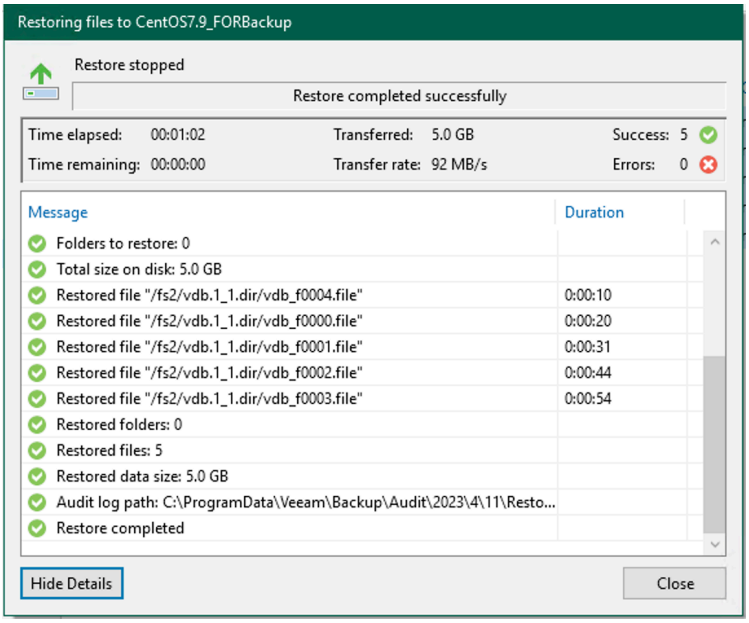
Then delete the files again, we are going to restore the files only.

```
[root@host141 ~]#
[root@host141 ~]# rm /fs2/vdb.1_1.dir/*
rm: remove regular file '/fs2/vdb.1_1.dir/vdb_f0000.file'? y
rm: remove regular file '/fs2/vdb.1_1.dir/vdb_f0001.file'? y
rm: remove regular file '/fs2/vdb.1_1.dir/vdb_f0002.file'? y
rm: remove regular file '/fs2/vdb.1_1.dir/vdb_f0003.file'? y
rm: remove regular file '/fs2/vdb.1_1.dir/vdb_f0004.file'? y
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]# ll /fs2/vdb.1_1.dir/*
ls: cannot access /fs2/vdb.1_1.dir/*: No such file or directory
[root@host141 ~]#
```

Start the guest files restore job.



And the files are restore completed and successes.

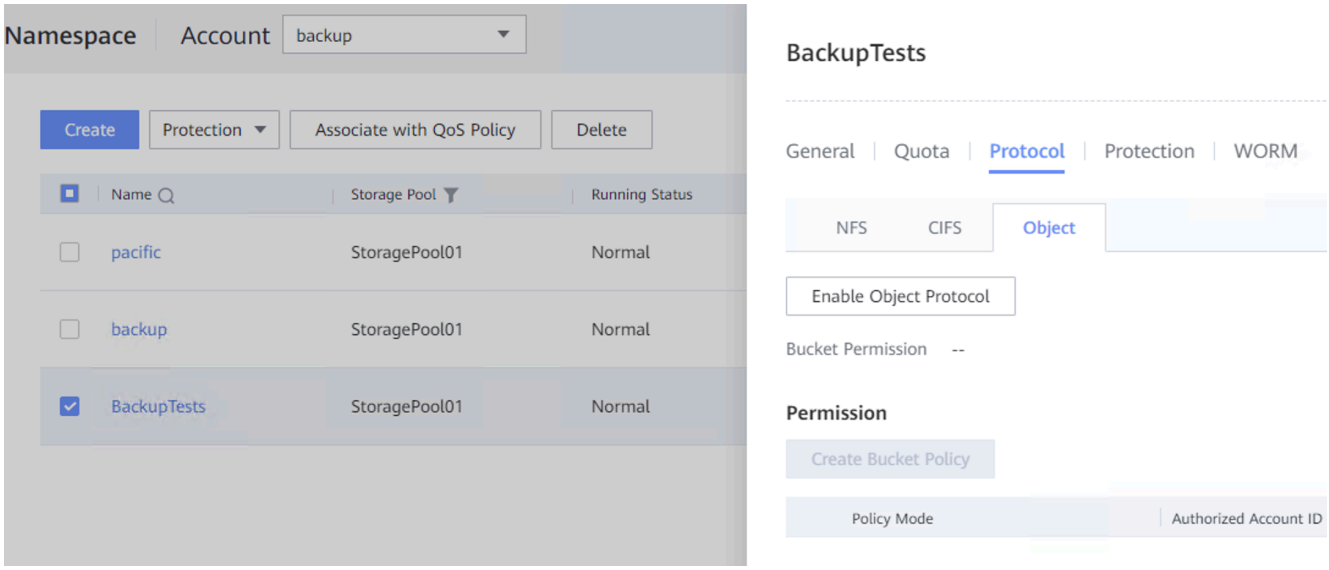


Check the files in the directory, every file is restored successfully.

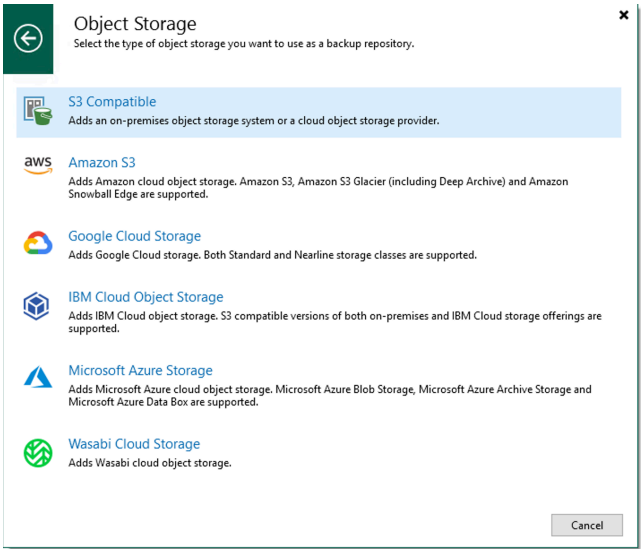
```
[root@host141 ~]# ll /fs2/vdb.1_1.dir/*
-rw-r--r--. 1 root root 1073741824 Apr 11 16:06 /fs2/vdb.1_1.dir/vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 11 16:06 /fs2/vdb.1_1.dir/vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 16:06 /fs2/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 16:06 /fs2/vdb.1_1.dir/vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 16:06 /fs2/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# sha256sum /fs2/vdb.1_1.dir/*
77d8d0a7d7c0ab66a7237a3616082844lcl26183a999c3ec60bl361b2be8906e  /fs2/vdb.1_1.dir/vdb_f0000.file
60c7e8acac4a011f2feae55992e9b353a82abe6752ddbfb8f8ce226068d6dd96  /fs2/vdb.1_1.dir/vdb_f0001.file
6f4892569165067dc73150780e6fe3700689b98f0b905b894c8bd01560fa1056  /fs2/vdb.1_1.dir/vdb_f0002.file
f9e52359e3882flb05f6ce92181d5f9c0eb1f54c3ba5d7192e55792014c10be6  /fs2/vdb.1_1.dir/vdb_f0003.file
47dl25178e5211147901490ac9e820698bc576de837ef44bf84bc41ad382b896  /fs2/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
```

Test 4 OceanStor Pacific Object service as the Backup Repository

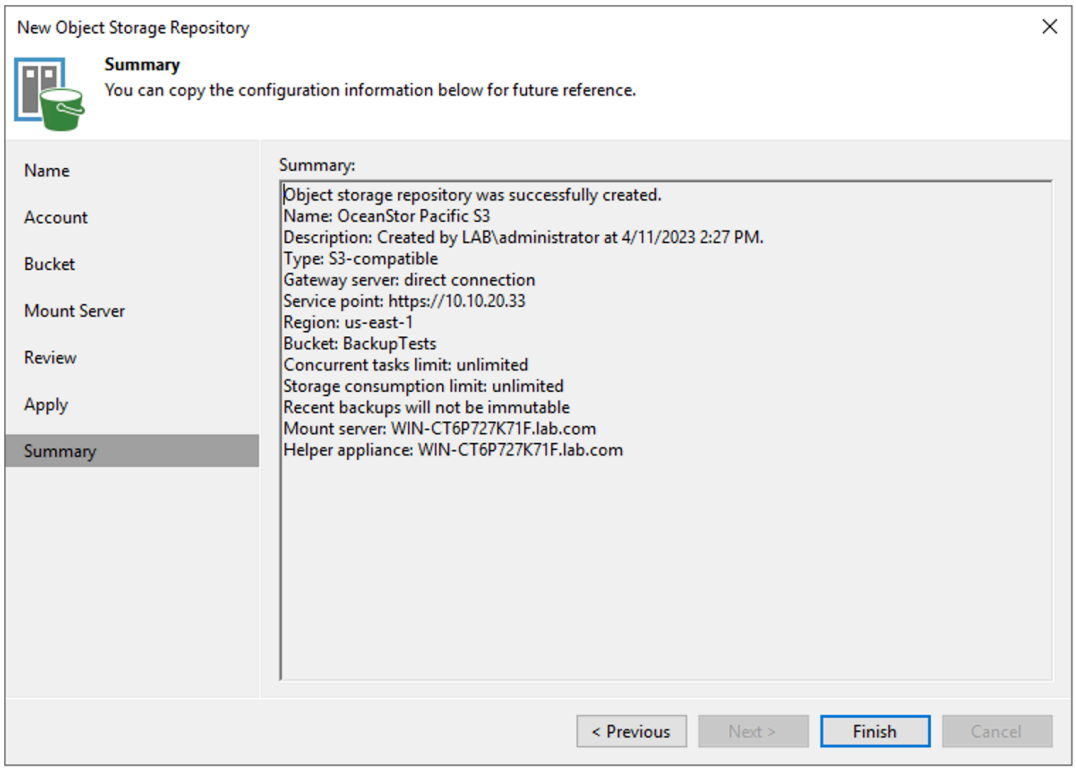
Enable the object protocol based on the namespace on OceanStor Pacific 9550:



The next step is to configure a new backup repository with S3 compatible type in Veeam 12 console:



It must be a S3 compatible storage type. We must declare the access and secret key, the bucket to be used and other information. In summary, the new definition looks like this:

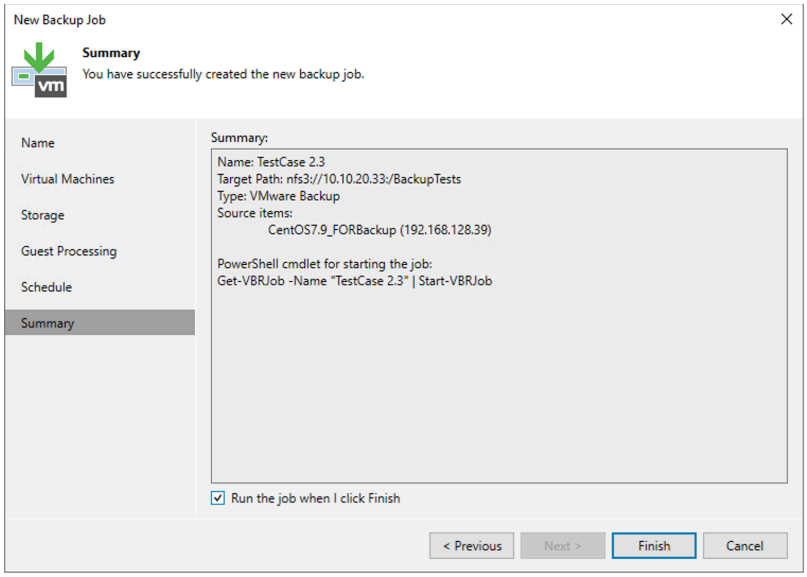


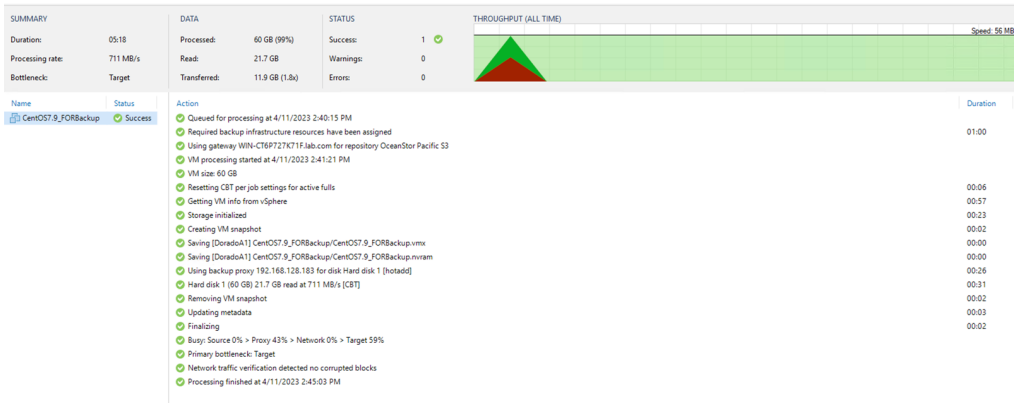
To test the functionality of this backup repository type we run full and incremental backups and full and incremental restore operations with the whole VM and single files.

Every test run without any issues and was executed successful.

Test 4.1 Full backup

Start new backup job based on the object repository from OceanStor Pacific 9550 and it executed successfully.



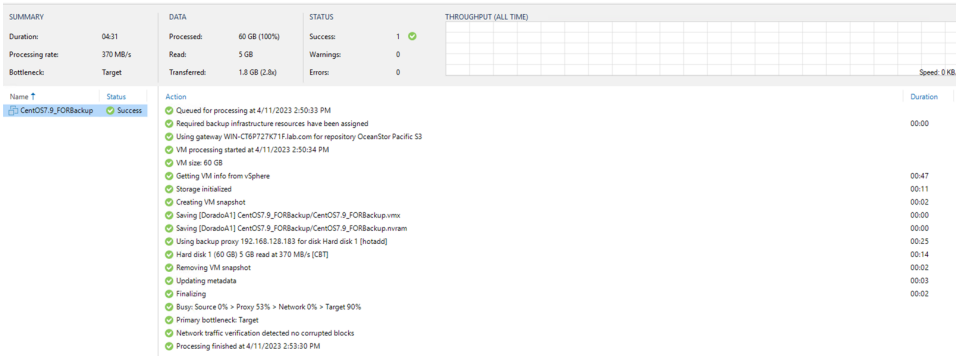


Test 4.2 Incremental backup

Next step, copy 5 files to the directory of VM to simulate the incremental date.

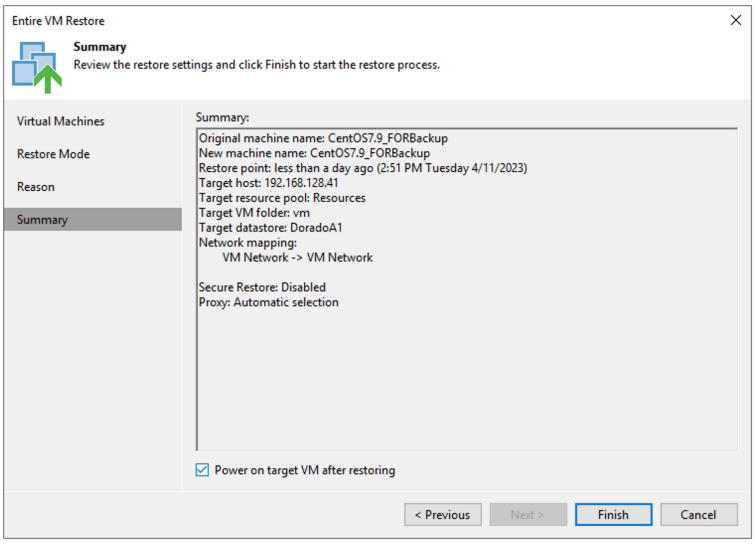
```
17:04:44.069 Vdbench execution completed successfully. Output directory: /root/vdbench50407/output

[root@host141 vdbench50407]# ll /fs3
total 8
-rwxrwxrwx. 1 root root  68 Apr 11 17:04 no_dismount.txt
drwxr-xr-x. 2 root root 116 Apr 11 17:04 vdb.1_1.dir
-rwxrwxrwx. 1 root root 175 Apr 11 17:04 vdb_control.file
[root@host141 vdbench50407]# ll /fs3/vdb.1_1.dir/
total 5242896
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 vdb_f0004.file
[root@host141 vdbench50407]# sha256sum /fs3/vdb.1_1.dir/*
06a39ba09bf89d603aac37643d7c0540b1670c62f040f39c37b034f316bb0d08  /fs3/vdb.1_1.dir/vdb_f0000.file
928b240f9106a9280473a0ed9dfc1cfa0ae15804444ae6a30bd99c335c1e07fc  /fs3/vdb.1_1.dir/vdb_f0001.file
f6ac7e57c9ba1e9c3677319fc9449403d91c2c0590b00523b20edb888e109276  /fs3/vdb.1_1.dir/vdb_f0002.file
8da790335c097149b9ec4b1122e0b6867f3891ee7f950ae56906196eada9d672  /fs3/vdb.1_1.dir/vdb_f0003.file
2b6f06d6ed4a3470a3ea771b42e9e251723de918954a327eb3a9f62d8f2622ee  /fs3/vdb.1_1.dir/vdb_f0004.file
[root@host141 vdbench50407]#
```

Then start the incremental backup and it executed successfully.

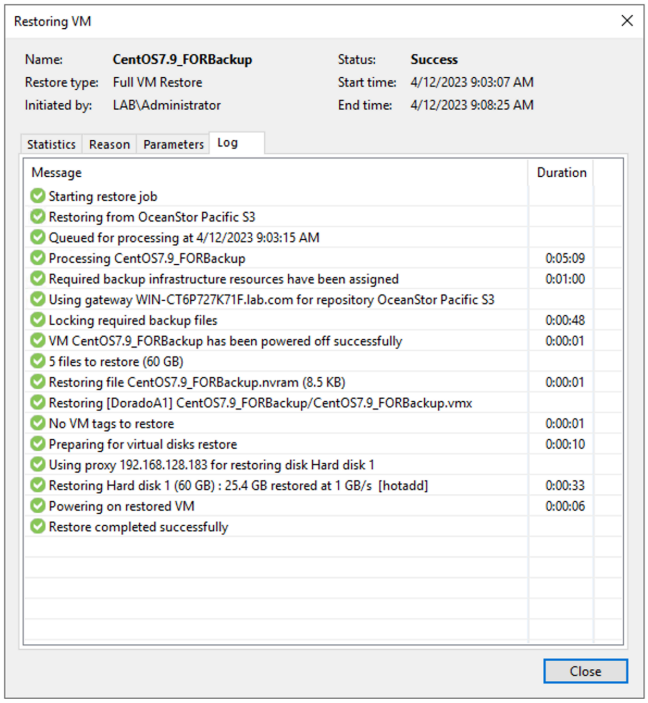


Test 4.3 Restore VM

Start the restore from backup job after the files were deleted in the VM.



The restore VM is completed and successes.



Check the hash value after the VM power on, and the value is the same with before for every file.

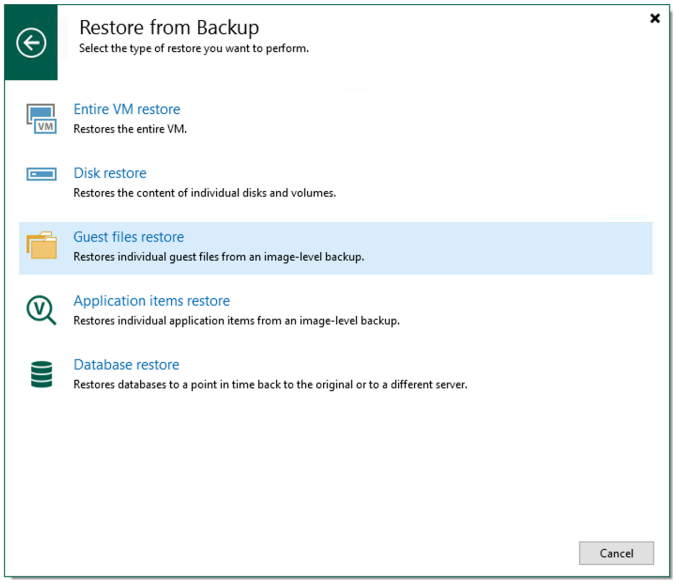
```
[root@host141 ~]# ll /fs3/vdb.1_1.dir/*
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 /fs3/vdb.1_1.dir/vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 /fs3/vdb.1_1.dir/vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 /fs3/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 /fs3/vdb.1_1.dir/vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 /fs3/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# sha256sum /fs3/vdb.1_1.dir/*
06a39ba09bf89d603aac37643d7c0540b1670c62f040f39c37b034f316bb0d08  /fs3/vdb.1_1.dir/vdb_f0000.file
928b240f9106a9280473a0ed9dfc1cfa0ae15804444ae6a30bd99c335c1e07fc  /fs3/vdb.1_1.dir/vdb_f0001.file
f6ac7e57c9bale9c3677319fc9449403d91c2c0590b00523b20edb888e109276  /fs3/vdb.1_1.dir/vdb_f0002.file
8da790335c097149b9ec4b1122e0b6867f3891ee7f950ae56906196eada9d672  /fs3/vdb.1_1.dir/vdb_f0003.file
2b6f06d6ed4a3470a3ea771b42e9e251723de918954a327eb3a9f62d8f2622ee  /fs3/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
```

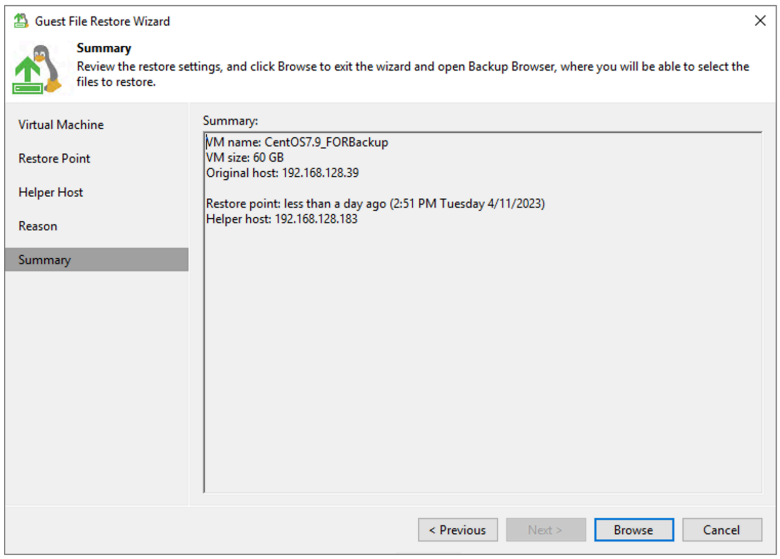
Test 4.4 Restore Guest-OS files

Then delete the files again, we are going to restore the files only.

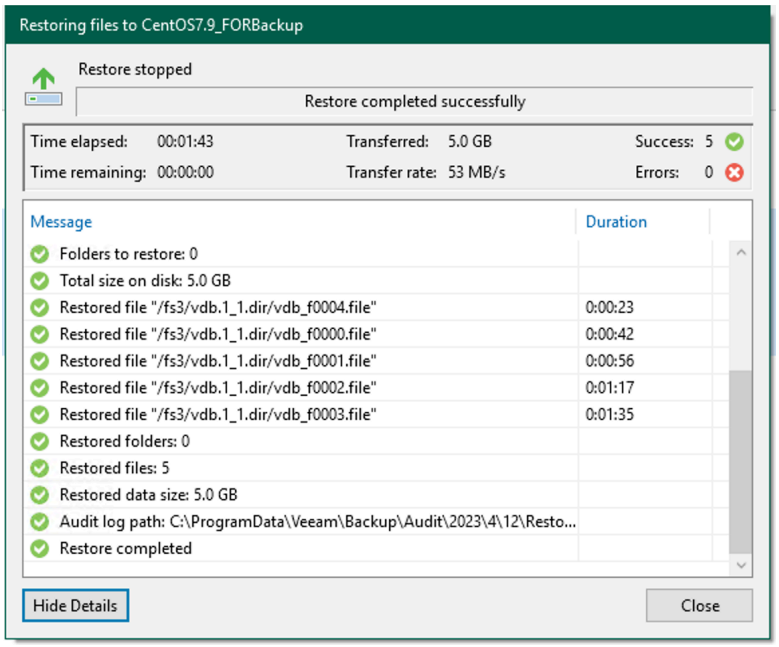
```
[root@host141 ~]# ll /fs3/vdb.1_1.dir/*
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 /fs3/vdb.1_1.dir/vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 /fs3/vdb.1_1.dir/vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 /fs3/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 /fs3/vdb.1_1.dir/vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 11 17:04 /fs3/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# sha256sum /fs3/vdb.1_1.dir/*
06a39ba09bf89d603aac37643d7c0540b1670c62f040f39c37b034f316bb0d08  /fs3/vdb.1_1.dir/vdb_f0000.file
928b240f9106a9280473a0ed9dfc1cfa0ae15804444ae6a30bd99c335c1e07fc  /fs3/vdb.1_1.dir/vdb_f0001.file
f6ac7e57c9bale9c3677319fc9449403d91c2c0590b00523b20edb888e109276  /fs3/vdb.1_1.dir/vdb_f0002.file
8da790335c097149b9ec4b1122e0b6867f3891ee7f950ae56906196eada9d672  /fs3/vdb.1_1.dir/vdb_f0003.file
2b6f06d6ed4a3470a3ea771b42e9e251723de918954a327eb3a9f62d8f2622ee  /fs3/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]# rm  /fs3/vdb.1_1.dir/*
rm: remove regular file '/fs3/vdb.1_1.dir/vdb_f0000.file'? y
rm: remove regular file '/fs3/vdb.1_1.dir/vdb_f0001.file'? y
rm: remove regular file '/fs3/vdb.1_1.dir/vdb_f0002.file'? y
rm: remove regular file '/fs3/vdb.1_1.dir/vdb_f0003.file'? y
rm: remove regular file '/fs3/vdb.1_1.dir/vdb_f0004.file'? y
[root@host141 ~]# ll /fs3/vdb.1_1.dir/*
ls: cannot access /fs3/vdb.1_1.dir/*: No such file or directory
[root@host141 ~]#
```

Start the guest files restore job.





And the files are restore completed and successes.


Restoring files to CentOS7.9_FORBackup
Restore stopped
Restore completed successfully
Time elapsed: 00:01:43
Transferred: 5.0 GB
Success: 5
Time remaining: 00:00:00
Transfer rate: 53 MB/s
Errors: 0
Message
Duration
Folders to restore: 0
Total size on disk: 5.0 GB
Restored file "/fs3/vdb.1_1.dir/vdb_f0004.file" 0:00:23
Restored file "/fs3/vdb.1_1.dir/vdb_f0000.file" 0:00:42
Restored file "/fs3/vdb.1_1.dir/vdb_f0001.file" 0:00:56
Restored file "/fs3/vdb.1_1.dir/vdb_f0002.file" 0:01:17
Restored file "/fs3/vdb.1_1.dir/vdb_f0003.file" 0:01:35
Restored folders: 0
Restored files: 5
Restored data size: 5.0 GB
Audit log path: C:\ProgramData\Veeam\Backup\Audit\2023\4\12\Resto...
Restore completed
Hide Details
Close

Veeam Special Backup and Restore Features

Veeam version 12 offers the immutable backup feature. Backups cannot be changed or deleted anymore, even from direct access on the storage layer. We tested this feature with OceanStor 5510 and OceanStor Pacific 9550.

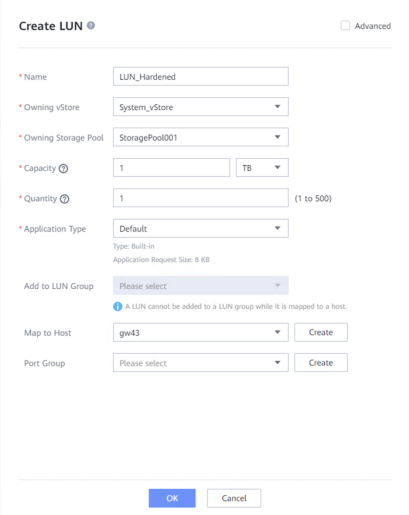
In this report we will focus on the special features of the storage systems and new features in Veeam 12:

I. OceanStor 5510 with FC block storage and hardened repository

II. OceanStor Pacific with immutable object storage

Test 5 OceanStor block service as hardened repository

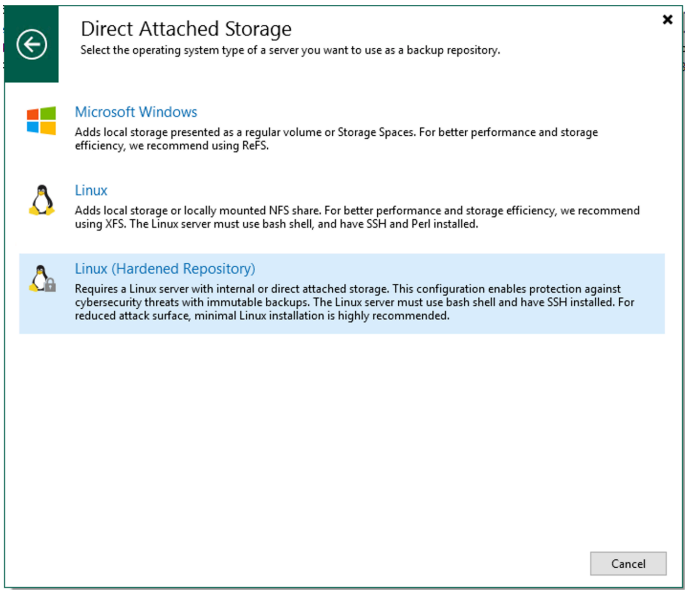
In this test case we created a normal LUN on the OceanStor 5510 storage system and made it visible to the backup server:



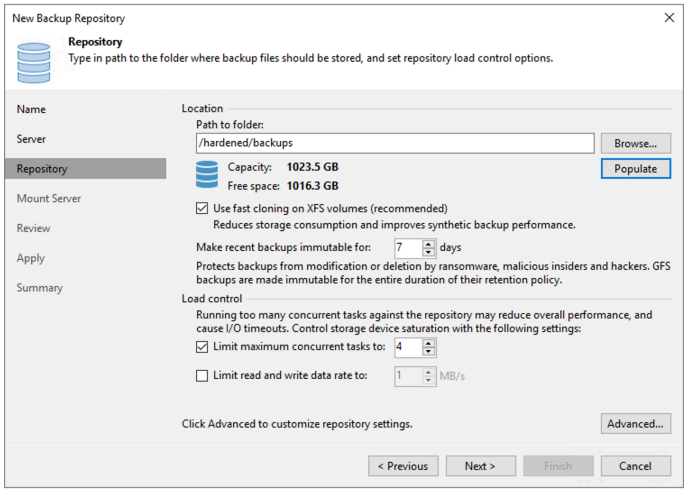
Then, created an XFS file system (because it is a Linux server) on it and mounted the filesystem:

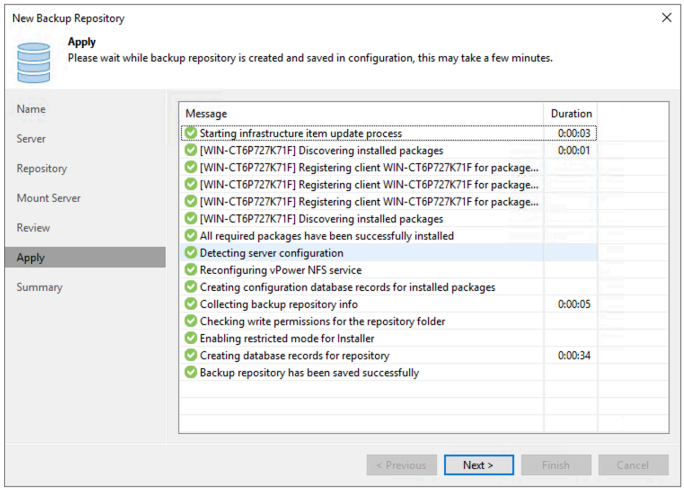
```
[root@gw43 ~]# lsscsi -i
[0:0:1:0]    enclosu HUAWEI   Expander 12Gx28  128   -          -
[0:2:0:0]    disk    AVAGO    AVAGO            4.66  /dev/sda   SAVAGO_AVAGO_00124fbd2b22157e2b950daa5b820300
[15:0:1:1]   disk    HUAWEI   XSG1             6000  -          -
[16:0:0:1]   disk    HUAWEI   XSG1             6000  -          -
[17:0:0:0]   cd/dvd  Virtual  DVD-ROM VM 1.1.0  225  /dev/sr0   Virtual_DVD-ROM_VM_1.1.0-0:0
[18:0:0:1]   disk    up       updisk           6000  /dev/sdb   Sup_updisk_2102354SEN10N91000030001
[root@gw43 ~]# lsblk -i
NAME        MAJ:MIN RM   SIZE RO TYPE MOUNTPOINT
sda           8:0    0 557.9G  0 disk
|-sda1        8:1    0   600M  0 part /boot/efi
|-sda2        8:2    0     1G  0 part /boot
`-sda3        8:3    0 556.3G  0 part
  |-cl-root 253:0    0    50G  0 lvm  /
  |-cl-swap 253:1    0     4G  0 lvm  [SWAP]
  `-cl-home 253:2    0 502.3G  0 lvm  /home
sdb           8:16   0     1T  0 disk
`-sdb1        8:17   0  1024G  0 part
sr0          11:0    1   7.7G  0 rom
up-0        252:0    0     1T  0 disk
up-1        252:1    0     1T  0 disk
[root@gw43 ~]# upadmin show vlun
------------------------------------------------------------------------------------------------------------------------------------------------------
-------
 Vlun ID  Disk      Name                 Lun WWN                          Status  Capacity  Ctrl(Own/Work)    Array Name     Dev Lun ID  No. of Paths(Available/Total)

    0     sdb   LUN_Hardened  63ca37e100e87434014c3ca500000001  Normal   1.00TB       --/--       OceanStor_5510      1                   2/2

------------------------------------------------------------------------------------------------------------------------------------------------------
-------
[root@gw43 ~]#
```

The next step is to create a new backup repository in Veeam, here as a direct attached storage repository with the type Linux (hardened Repository):



And enable fast cloning on XFS volumes.

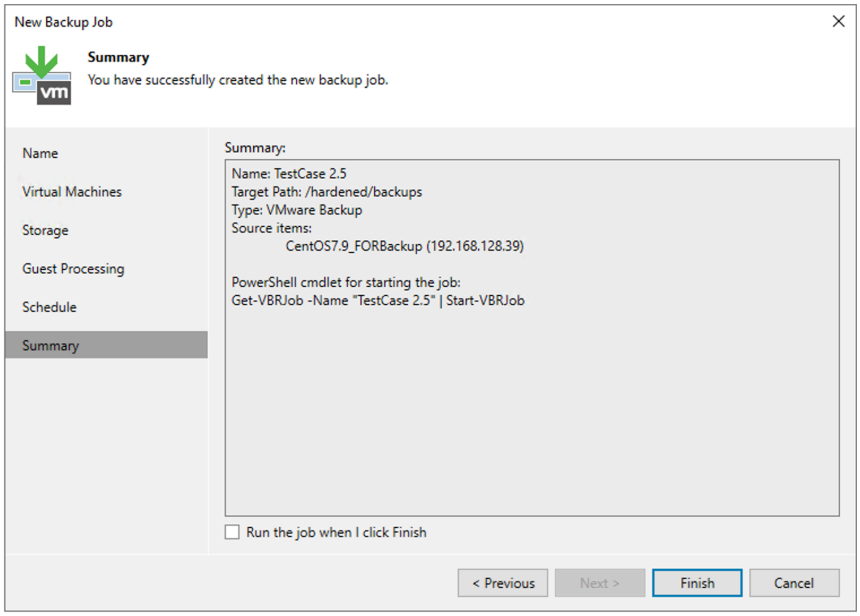


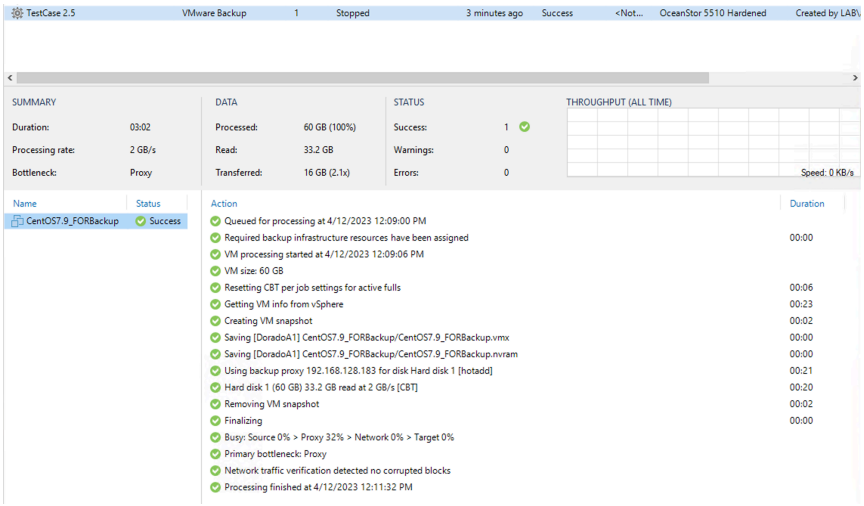


As the next step we execute a full and an incremental backup of one VM. Backing up some VMs and files is OK, but they are useless without corresponding restore functionality. Therefore, we tested the restores of the full VM and of single files, too. Everything went without any failures.

Test 5.1 Full backup

Start new backup job based on the hardened repository from OceanStor 5510 and it executed successfully.



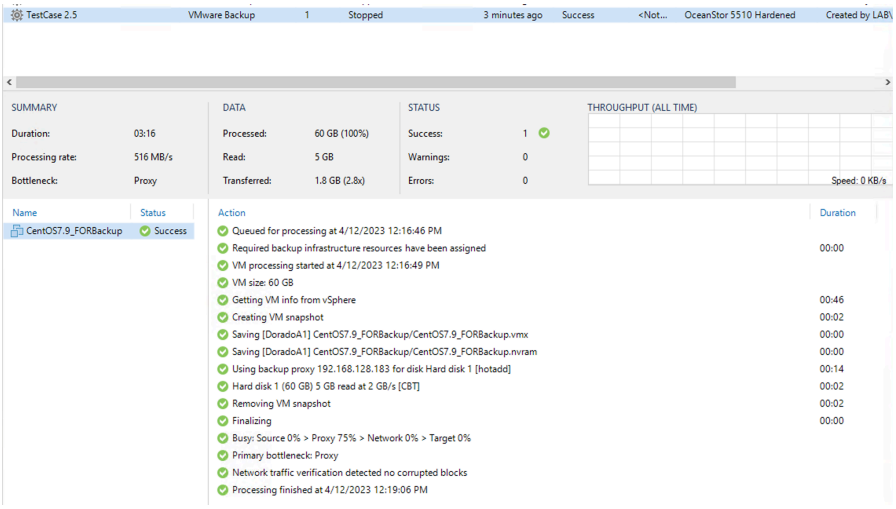


Test 5.2 Incremental backup

Next step, copy 5 files to the directory of VM to simulate the incremental date.

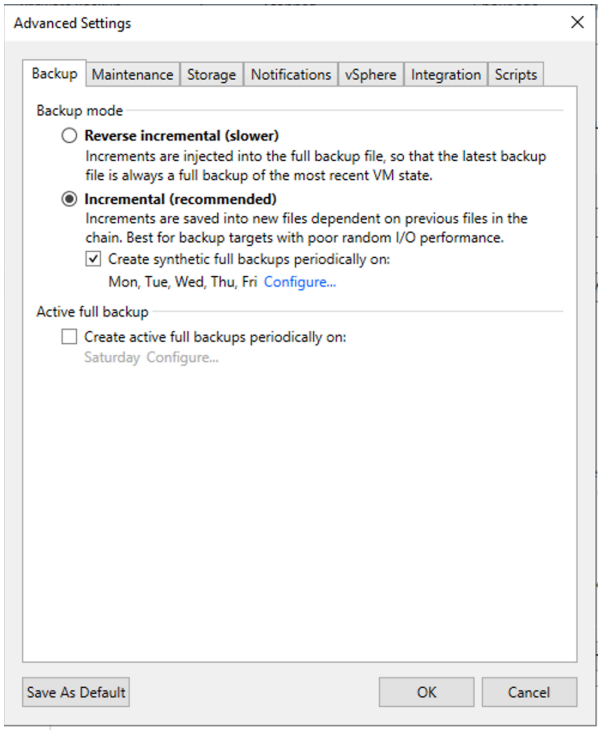
```
[root@host141 vdbench50407]# ll /home/fs5/
total 8
-rwxrwxrwx. 1 root root  68 Apr 12 14:31 no_dismount.txt
drwxr-xr-x. 2 root root 116 Apr 12 14:31 vdb.1_1.dir
-rwxrwxrwx. 1 root root 180 Apr 12 14:31 vdb_control.file
[root@host141 vdbench50407]# ll /home/fs5/vdb.1_1.dir/
total 5242896
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 vdb_f0004.file
[root@host141 vdbench50407]#
[root@host141 vdbench50407]# sha256sum /home/fs5/vdb.1_1.dir/*
6b1b1c8174c07c09613c1c2a5e85d46a10c633d4a1644880f5d40dbfa90f3291  /home/fs5/vdb.1_1.dir/vdb_f0000.file
62274b01d5539c5367823566069df08e2a93c547a33870410744d425a4c3882f  /home/fs5/vdb.1_1.dir/vdb_f0001.file
2fa0d64b51b2121a8e900cae0e1068f329cdce98b9155f0c13e3d8e0d814872d  /home/fs5/vdb.1_1.dir/vdb_f0002.file
5f4d4ee6e7cca54f03410122a36b67c9b9ff8d60834309bcccd84a3968328380  /home/fs5/vdb.1_1.dir/vdb_f0003.file
bc6e0a83abe99b5309810ca1c7a7804372236le25db387e50bbb9afe91cf6f9a  /home/fs5/vdb.1_1.dir/vdb_f0004.file
[root@host141 vdbench50407]#
```

Then start the incremental backup and it executed successfully.

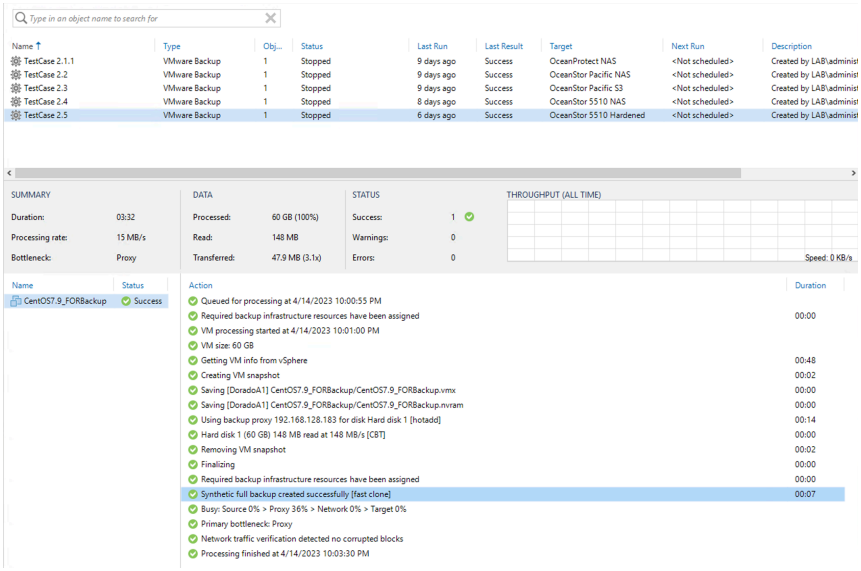


Test 5.3 Synthetic full backup

Check the advanced setting on backup job, the synthetic full backup is enabled.



Check the backup job, the synthetic full backup is executed automatically and successfully.



Test 5.4 Immutability of hardened repository

But here we have a hardened repository and we want to test if we can change the backup information directly from the filesystem of the Linux backup server:

```
[root@gw43 TestCase 2.5]# ll
total 18762112
-rw-r--r--. 1 user01 user01       17831 Apr 12 12:20 CentOS7.9_FORBackup_9E395.vbm
-rw-r--r--. 1 user01 user01 17264443392 Apr 12 12:12 CentOS7.9_FORBackup.vm-141D2023-04-12T120839_606A.vbk
-rw-r--r--. 1 user01 user01  1947938816 Apr 12 12:19 CentOS7.9_FORBackup.vm-141D2023-04-12T121558_146E.vib
[root@gw43 TestCase 2.5]#
[root@gw43 TestCase 2.5]#
[root@gw43 TestCase 2.5]#
[root@gw43 TestCase 2.5]#
[root@gw43 TestCase 2.5]# id
uid=0(root) gid=0(root) groups=0(root) context=unconfined_u:unconfined_r:unconfined_t:s0-s0:c0.c1023
[root@gw43 TestCase 2.5]# mv CentOS7.9_FORBackup.vm-141D2023-04-12T121558_146E.vib CentOS7.9_FORBackup.vm-141D2023-04-12T121558_146E.vib.bernd
mv: cannot move 'CentOS7.9_FORBackup.vm-141D2023-04-12T121558_146E.vib' to 'CentOS7.9_FORBackup.vm-141D2023-04-12T121558_146E.vib.bernd': Operation not per
mitted
[root@gw43 TestCase 2.5]# ls -ald
drwxr-xr-x. 2 user01 user01 186 Apr 12 13:24 .
[root@gw43 TestCase 2.5]# cd
[root@gw43 ~]# su -m user01
bash: /root/.bashrc: Permission denied
bash-4.4$
bash-4.4$
bash-4.4$
bash-4.4$
bash-4.4$ exit
[root@gw43 ~]# su - user01
[user01@gw43 ~]$ cd /hardened/backups/
[user01@gw43 backups]$ ll
total 0
drwxr-xr-x. 2 user01 user01 186 Apr 12 13:24 'TestCase 2.5'
[user01@gw43 backups]$ cd TestCase\ 2.5/
[user01@gw43 TestCase 2.5]$ ll
total 18762112
-rw-r--r--. 1 user01 user01       17831 Apr 12 12:20 CentOS7.9_FORBackup_9E395.vbm
-rw-r--r--. 1 user01 user01 17264443392 Apr 12 12:12 CentOS7.9_FORBackup.vm-141D2023-04-12T120839_606A.vbk
-rw-r--r--. 1 user01 user01  1947938816 Apr 12 12:19 CentOS7.9_FORBackup.vm-141D2023-04-12T121558_146E.vib
[user01@gw43 TestCase 2.5]$  mv CentOS7.9_FORBackup.vm-141D2023-04-12T121558_146E.vib CentOS7.9_FORBackup.vm-141D2023-04-12T121558_146E.vib.bernd
mv: cannot move 'CentOS7.9_FORBackup.vm-141D2023-04-12T121558_146E.vib' to 'CentOS7.9_FORBackup.vm-141D2023-04-12T121558_146E.vib.bernd': Operation not per
mitted
[user01@gw43 TestCase 2.5]$
```

As you can see in the screen shot, it was not possible to change or delete the backup pieces belonging to the backups of the VM. We can't do this with the root account or with the user who owns the files.

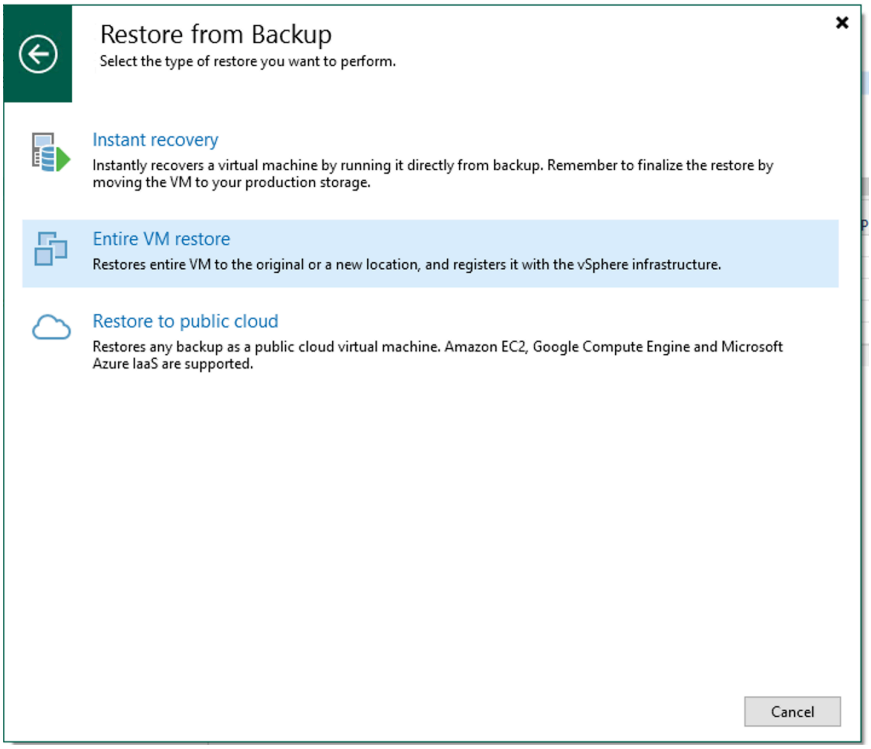
So, a hardened repository is immutable.

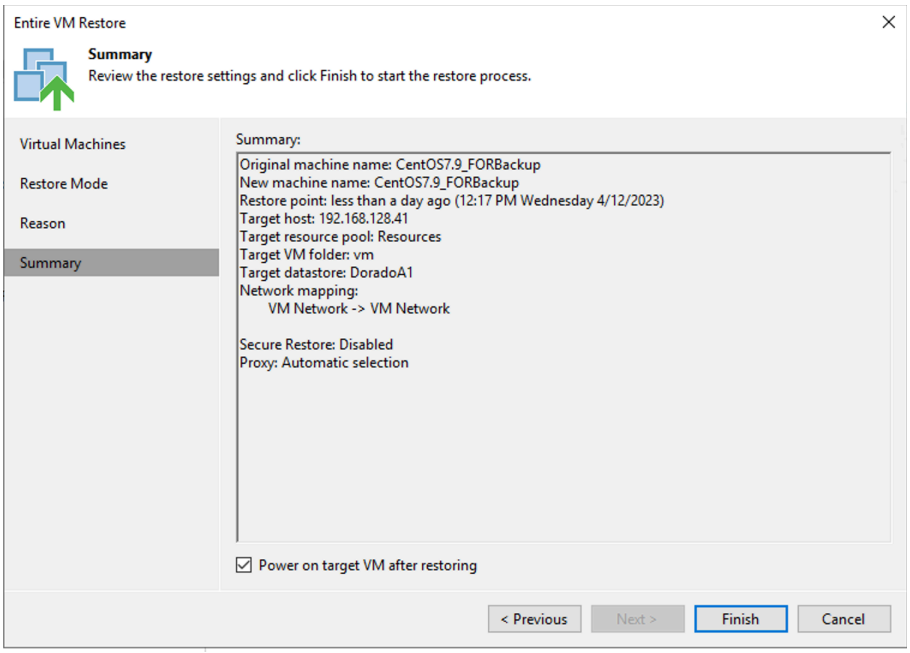
Test 5.5 Restore VM

Then delete the 5 files which copied in the VM.

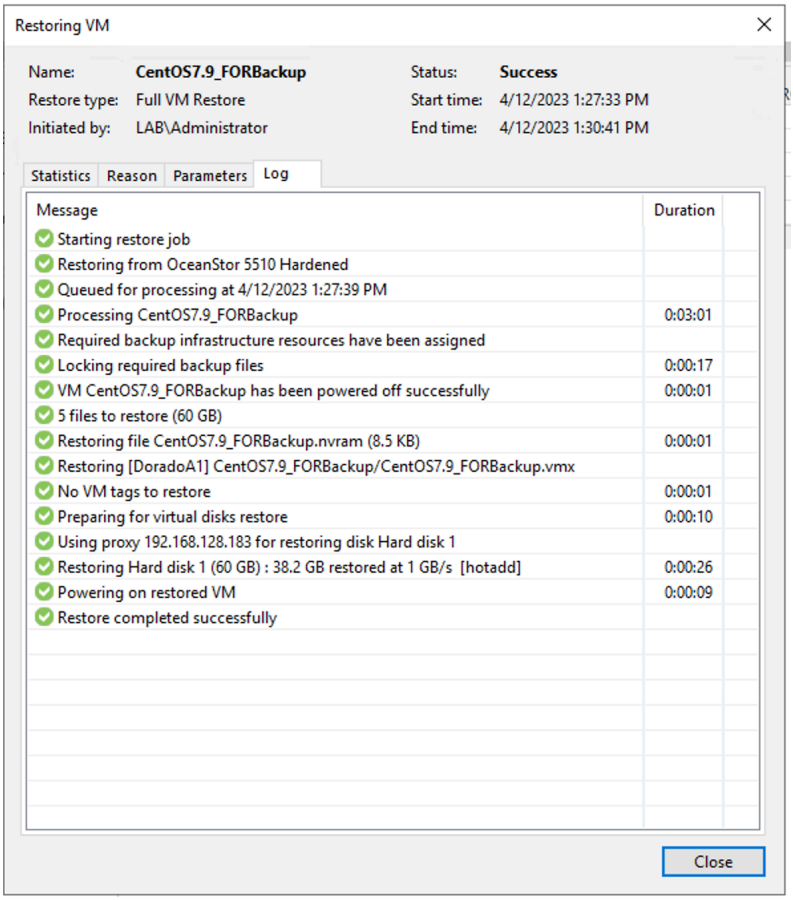
```
[root@host141 vdbench50407]# sha256sum /home/fs5/vdb.1_1.dir/*
6b1b1c8174c07c09613c1c2a5e85d46a10c633d4a1644880f5d40dbfa90f3291  /home/fs5/vdb.1_1.dir/vdb_f0000.file
62274b01d5539c5367823566069df08e2a93c547a33870410744d425a4c3882f  /home/fs5/vdb.1_1.dir/vdb_f0001.file
2fa0d64b51b2121a8e900cae0e1068f329cdce98b9155f0c13e3d8e0d814872d  /home/fs5/vdb.1_1.dir/vdb_f0002.file
5f4d4ee6e7cca54f03410122a36b67c9b9ff8d60834309bcccd84a3968328380  /home/fs5/vdb.1_1.dir/vdb_f0003.file
bc6e0a83abe99b5309810ca1c7a7804372236le25db387e50bbb9afe91cf6f9a  /home/fs5/vdb.1_1.dir/vdb_f0004.file
[root@host141 vdbench50407]# rm /home/fs5/vdb.1_1.dir/*
rm: remove regular file '/home/fs5/vdb.1_1.dir/vdb_f0000.file'? y
rm: remove regular file '/home/fs5/vdb.1_1.dir/vdb_f0001.file'? y
rm: remove regular file '/home/fs5/vdb.1_1.dir/vdb_f0002.file'? y
rm: remove regular file '/home/fs5/vdb.1_1.dir/vdb_f0003.file'? y
rm: remove regular file '/home/fs5/vdb.1_1.dir/vdb_f0004.file'? y
[root@host141 vdbench50407]# ll /home/fs5/vdb.1_1.dir/*
ls: cannot access /home/fs5/vdb.1_1.dir/*: No such file or directory
[root@host141 vdbench50407]#
```

Start the restore from backup job after the files were deleted in the VM.





The restore VM is completed and successes.



Check the hash value after the VM power on, and the value is the same with before for every file.

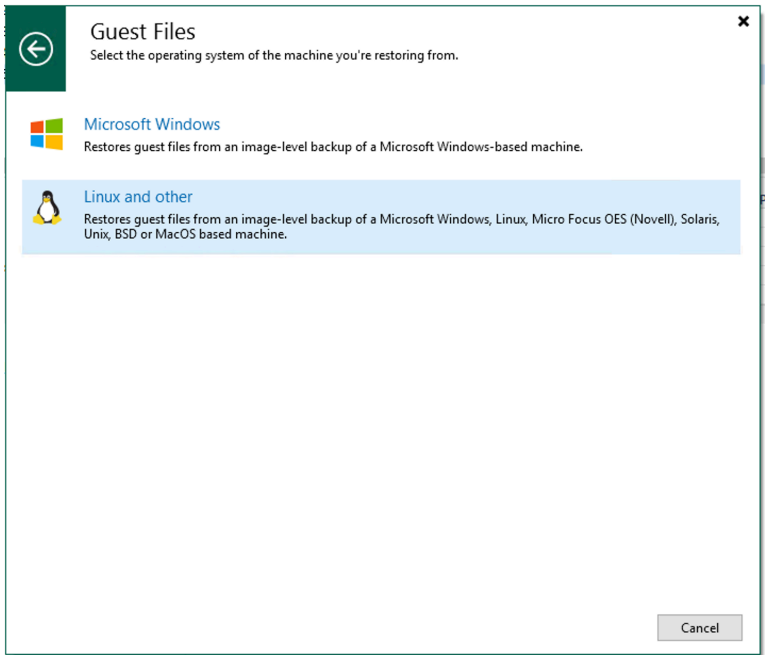
```
login as: root
root@192.168.128.141's password:
Last login: Wed Apr 12 12:27:24 2023 from win-ct6p727k71f.lab.com
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#  ll /home/fs5/vdb.1_1.dir/*
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# sha256sum /home/fs5/vdb.1_1.dir/*
6b1b1c8174c07c09613c1c2a5e85d46a10c633d4a1644880f5d40dbfa90f3291  /home/fs5/vdb.1_1.dir/vdb_f0000.file
62274b01d5539c5367823566069df08e2a93c547a33870410744d425a4c3882f  /home/fs5/vdb.1_1.dir/vdb_f0001.file
2fa0d64b51b2121a8e900cae0e1068f329cdce98b9155f0c13e3d8e0d814872d  /home/fs5/vdb.1_1.dir/vdb_f0002.file
5f4d4ee6e7cca54f03410122a36b67c9b9ff8d60834309bcccd84a3968328380  /home/fs5/vdb.1_1.dir/vdb_f0003.file
bc6e0a83abe99b5309810ca1c7a7804372236le25db387e50bbb9afe91cf6f9a  /home/fs5/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
```

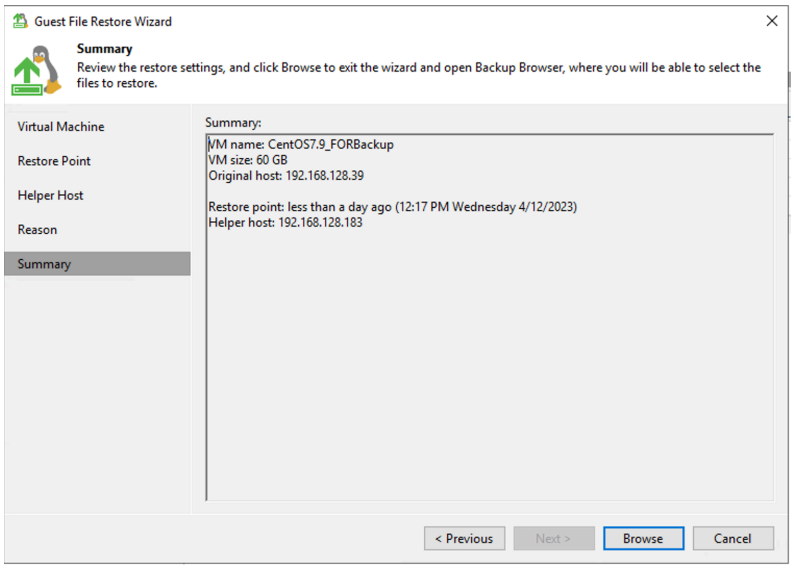
Test 5.6 Restore Guest-OS files

Then delete the files again, we are going to restore the files only.

```
root@host141:~
[root@host141 ~]#  ll /home/fs5/vdb.1_1.dir/*
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# sha256sum /home/fs5/vdb.1_1.dir/*
6b1b1c8174c07c09613c1c2a5e85d46a10c633d4a1644880f5d40dbfa90f3291  /home/fs5/vdb.1_1.dir/vdb_f0000.file
62274b01d5539c5367823566069df08e2a93c547a33870410744d425a4c3882f  /home/fs5/vdb.1_1.dir/vdb_f0001.file
2fa0d64b51b2121a8e900cae0e1068f329cdce98b9155f0c13e3d8e0d814872d  /home/fs5/vdb.1_1.dir/vdb_f0002.file
5f4d4ee6e7cca54f03410122a36b67c9b9ff8d60834309bcccd84a3968328380  /home/fs5/vdb.1_1.dir/vdb_f0003.file
bc6e0a83abe99b5309810ca1c7a7804372236le25db387e50bbb9afe91cf6f9a  /home/fs5/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# rm /home/fs5/vdb.1_1.dir/*
rm: remove regular file '/home/fs5/vdb.1_1.dir/vdb_f0000.file'? y
rm: remove regular file '/home/fs5/vdb.1_1.dir/vdb_f0001.file'? y
rm: remove regular file '/home/fs5/vdb.1_1.dir/vdb_f0002.file'? y
rm: remove regular file '/home/fs5/vdb.1_1.dir/vdb_f0003.file'? y
rm: remove regular file '/home/fs5/vdb.1_1.dir/vdb_f0004.file'? y
[root@host141 ~]#  ll /home/fs5/vdb.1_1.dir/*
ls: cannot access /home/fs5/vdb.1_1.dir/*: No such file or directory
[root@host141 ~]#
```

Start the guest files restore job.



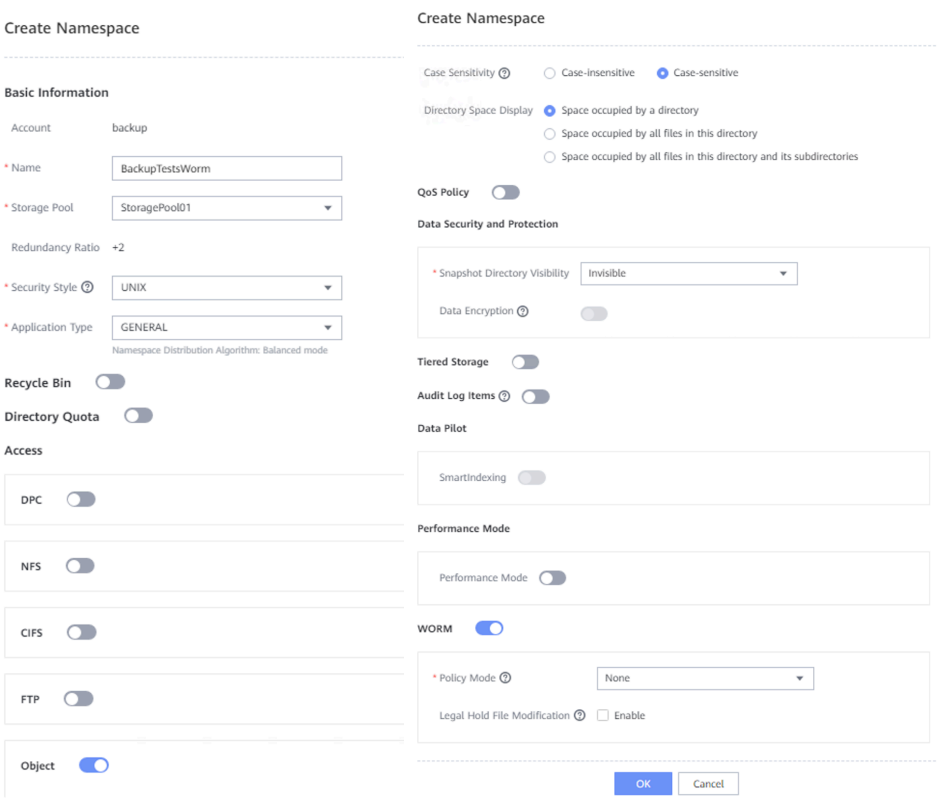


Check the files in the directory after the restore job finish, every file is restored successfully.

```
[root@host141 ~]#  ll /home/fs5/vdb.1_1.dir/*
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 12 14:31 /home/fs5/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]# sha256sum /home/fs5/vdb.1_1.dir/*
6b1b1c8174c07c09613c1c2a5e85d46a10c633d4a1644880f5d40dbfa90f3291  /home/fs5/vdb.1_1.dir/vdb_f0000.file
62274b01d5539c5367823566069df08e2a93c547a33870410744d425a4c3882f  /home/fs5/vdb.1_1.dir/vdb_f0001.file
2fa0d64b51b2121a8e900cae0e1068f329cdce98b9155f0c13e3d8e0d814872d  /home/fs5/vdb.1_1.dir/vdb_f0002.file
5f4d4ee6e7cca54f03410122a36b67c9b9ff8d60834309bcccd84a3968328380  /home/fs5/vdb.1_1.dir/vdb_f0003.file
bc6e0a83abe99b5309810ca1c7a78043722361e25db387e50bbb9afe91cf6f9a  /home/fs5/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
```

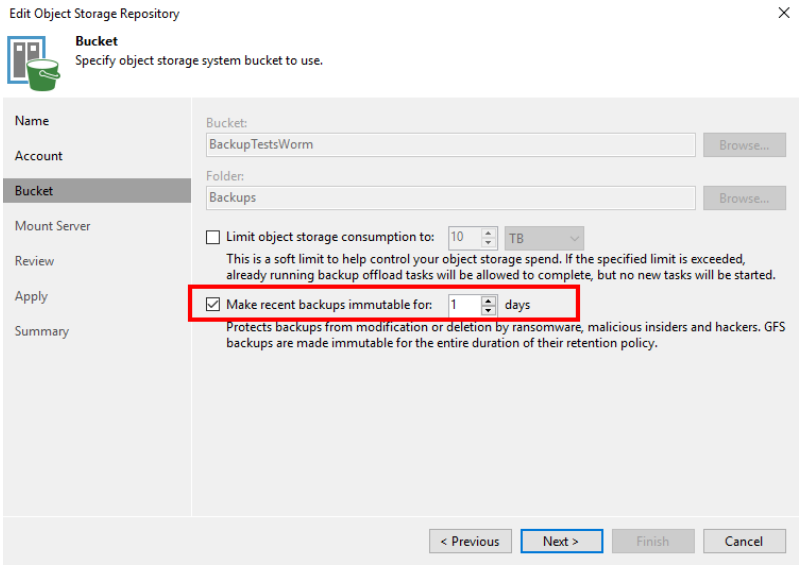
Test 6 OceanStor Pacific Object service with WORM as the Backup Repository

One namespace with WORM functionality on the OceanStor Pacific 9550 is created.



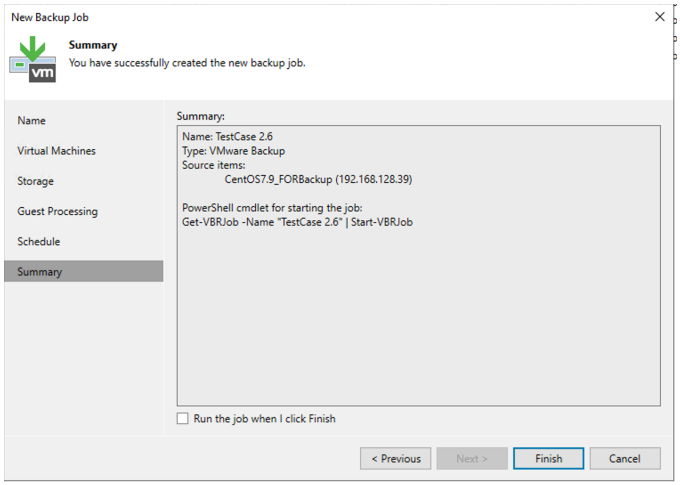
The above two screenshots show the creation of the same namespace. The WORM functionality is selected on the second picture in the lower part.

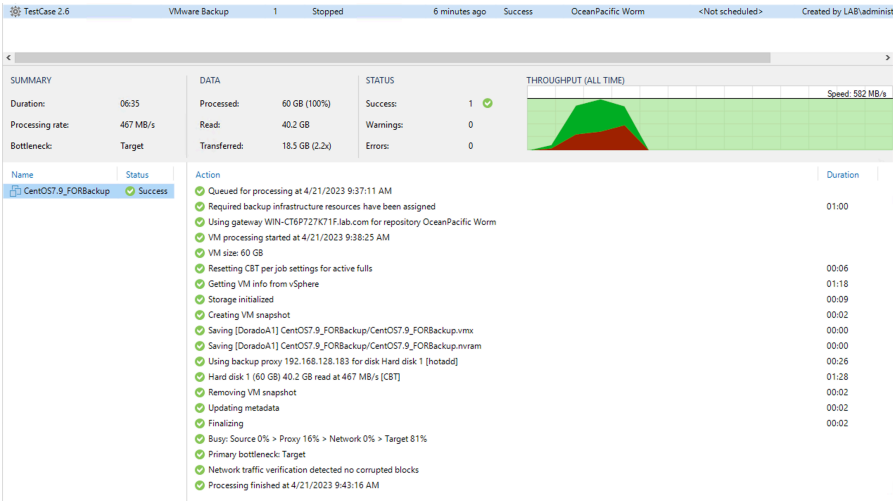
The next step is to create an S3 compatible backup repository, checked “make recent backups immutable for:” and set 1 day, then finish the creation of Object Storage Repository.



Test 6.1 Full backup

Start new backup job based on the object repository with immutable from OceanStor Pacific 9550 and it executed successfully.



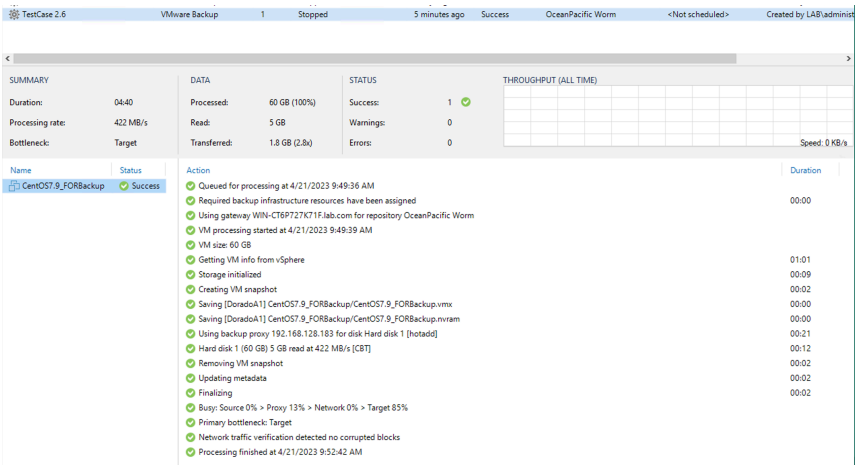


Test 6.2 Incremental backup

Next step, copy 5 files to the directory of VM to simulate the incremental date.

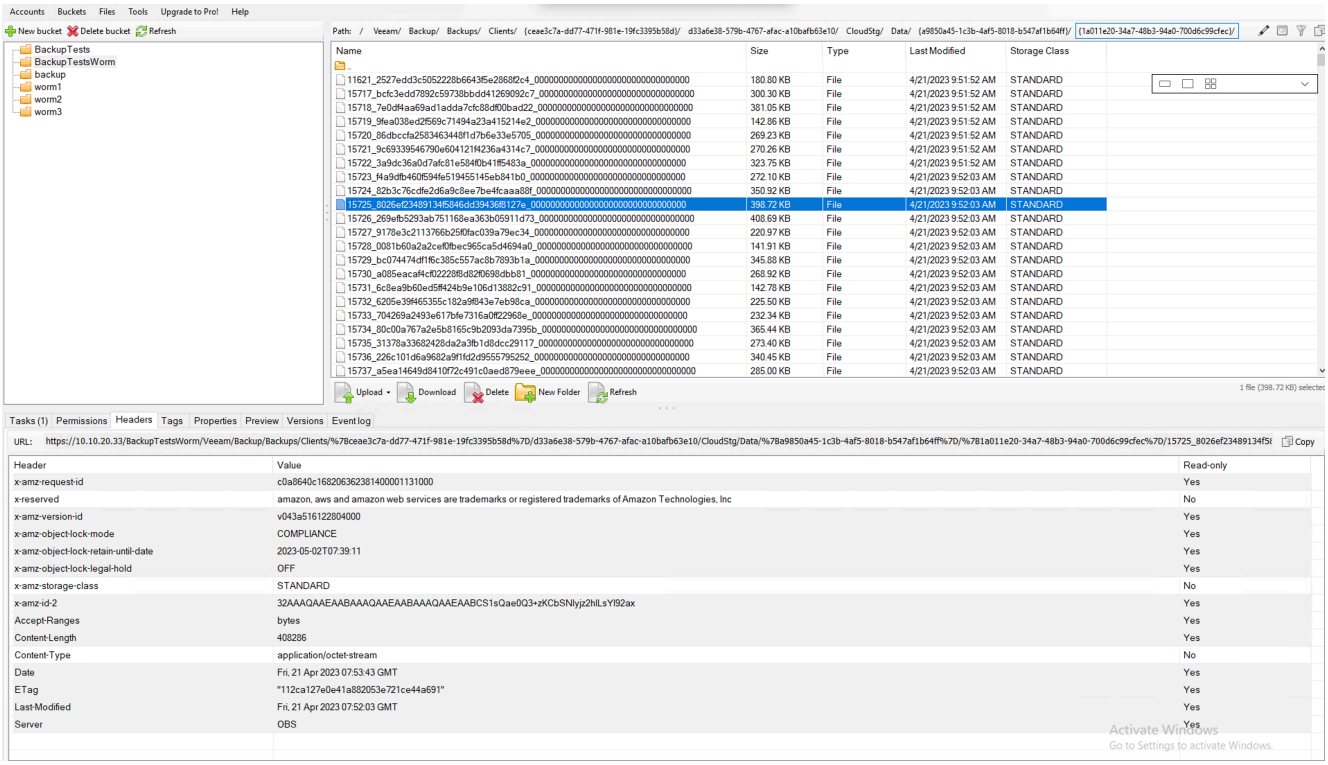
```
12:02:48.225
12:02:48.225 Miscellaneous statistics:
12:02:48.225 (These statistics do not include activity between the last reported interval and shutdown.)
12:02:48.225 WRITE_OPENS         Files opened for write activity:                 2          1/sec
12:02:48.225
12:02:48.939 Vdbench execution completed successfully. Output directory: /root/vdbench50407/output

[root@host141 vdbench50407]# cd /home/fs6
[root@host141 fs6]# ll
total 8
-rwxrwxrwx. 1 root root  68 Apr 21 12:02 no_dismount.txt
drwxr-xr-x. 2 root root 116 Apr 21 12:02 vdb.l_1.dir
-rwxrwxrwx. 1 root root 180 Apr 21 12:02 vdb_control.file
[root@host141 fs6]# cd vdb.l_1.dir/
[root@host141 vdb.l_1.dir]# ll
total 5242892
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0004.file
[root@host141 vdb.l_1.dir]# sha256sum vdb_f000*
51560a3cf06ede594e200a88290b40e060629d0fad2ea58c1b547c8b27174d02  vdb_f0000.file
1913dd70dae80da9b4e658630fc5586a6be39d3362076028773c4d61c6ad3d42  vdb_f0001.file
b7afd25882e02c55e6edd8195d96bc43e52a83ad42718b141aa73467f475c46b  vdb_f0002.file
b87f22b00103f07adc89c3919dd540232f137a8531dd4dad967dd9fe000f582d  vdb_f0003.file
ee7c7c40629e3cf6fde4e9262e05a0f098772c010c78ad96bd873a3d61de3cc7  vdb_f0004.file
[root@host141 vdb.l_1.dir]#
```

Then start the incremental backup and it executed successfully.

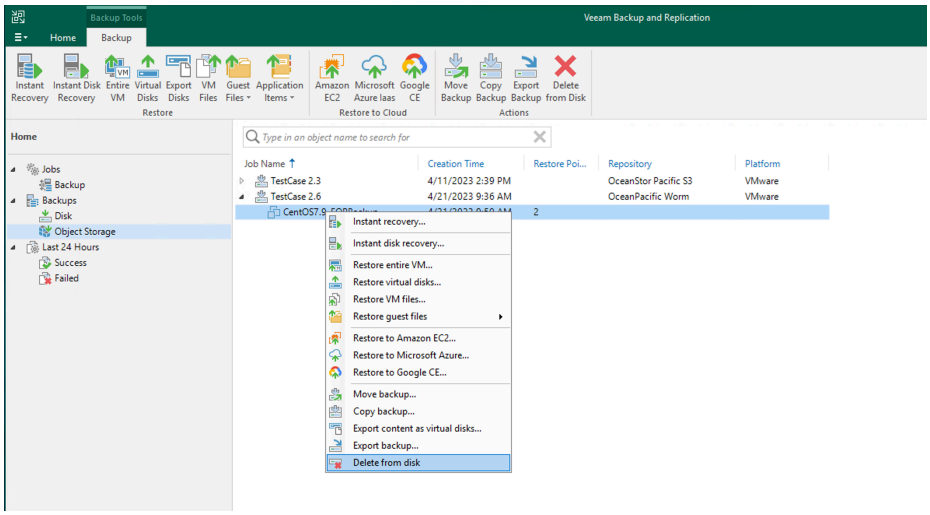


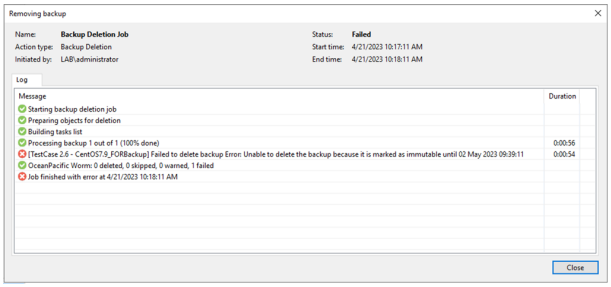
Test 6.3 Immutability of hardened repository

After successful backup and restore tests (as above, without any failures) we could see several buckets with the S3 Browser:



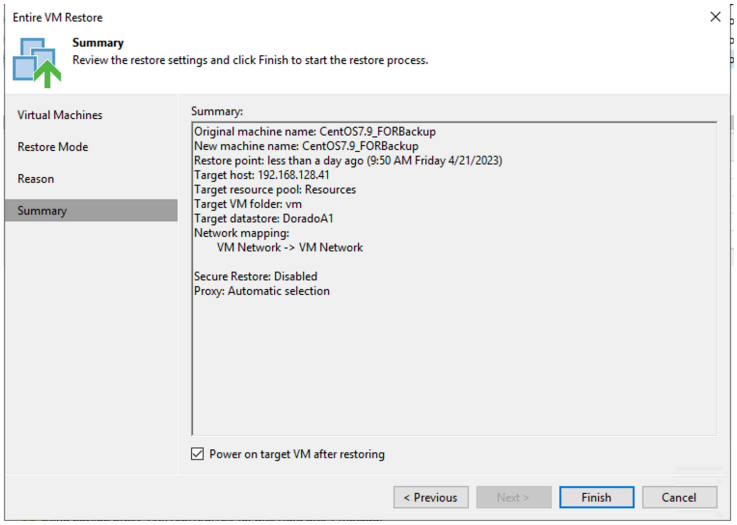
Now we tried to delete one of the backup pieces from within Veeam, the deletion is failed. Here the WORM functionality of OceanStor Pacific protected the backup files.



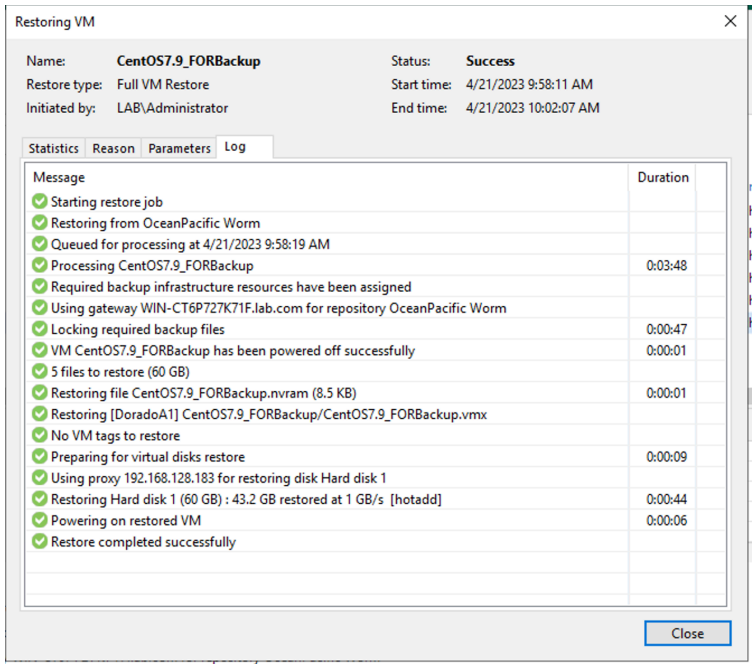


Test 6.5 Restore VM

Start the restore from backup job after the files were deleted in the VM.



The restore VM is completed and successes.



Check the hash value after the VM power on, and the value is the same with before for every file.

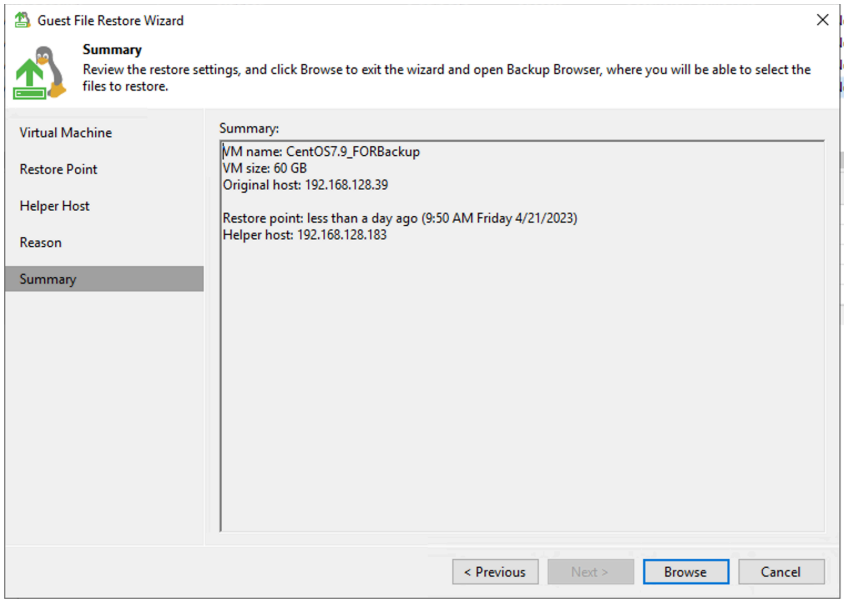
```
[root@host141 vdb.1_1.dir]# ll
total 5242892
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0004.file
[root@host141 vdb.1_1.dir]# sha256sum vdb_f000*
51560a3cf06ede594e200a88290b40e060629d0fad2ea58c1b547c8b27174d02  vdb_f0000.file
1913dd70dae80da9b4e658630fc5586a6be39d3362076028773c4d61c6ad3d42  vdb_f0001.file
b7afd25882e02c55e6edd8195d96bc43e52a83ad42718b141aa73467f475c46b  vdb_f0002.file
b87f22b00103f07adc89c3919dd540232f137a8531dd4dad967dd9fe000f582d  vdb_f0003.file
ee7c7c40629e3cf6fde4e9262e05a0f098772c010c78ad96bd873a3d61de3cc7  vdb_f0004.file
[root@host141 vdb.1_1.dir]#
[root@host141 vdb.1_1.dir]#
[root@host141 vdb.1_1.dir]# rm vdb_f000*
rm: remove regular file 'vdb_f0000.file'? y
rm: remove regular file 'vdb_f0001.file'? y
rm: remove regular file 'vdb_f0002.file'? y
rm: remove regular file 'vdb_f0003.file'? y
rm: remove regular file 'vdb_f0004.file'? y
[root@host141 vdb.1_1.dir]#
[root@host141 vdb.1_1.dir]# ll
total 0
[root@host141 vdb.1_1.dir]#
login as: root
root@192.168.128.141's password:
Last login: Thu Apr 20 16:55:04 2023 from win-ct6p727k71f.lab.com
[root@host141 ~]# uptime
 12:19:43 up 1 min,  1 user,  load average: 0.07, 0.03, 0.01
[root@host141 ~]# ll /home/
fs5/    fs6/    user01/
[root@host141 ~]# ll /home/fs6/vdb
vdb.1_1.dir/      vdb_control.file
[root@host141 ~]# ll /home/fs6/vdb.1_1.dir/
total 5242892
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0000.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0001.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0003.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 vdb_f0004.file
[root@host141 ~]# sha256sum /home/fs6/vdb.1_1.dir/*
51560a3cf06ede594e200a88290b40e060629d0fad2ea58c1b547c8b27174d02  /home/fs6/vdb.1_1.dir/vdb_f0000.file
1913dd70dae80da9b4e658630fc5586a6be39d3362076028773c4d61c6ad3d42  /home/fs6/vdb.1_1.dir/vdb_f0001.file
b7afd25882e02c55e6edd8195d96bc43e52a83ad42718b141aa73467f475c46b  /home/fs6/vdb.1_1.dir/vdb_f0002.file
b87f22b00103f07adc89c3919dd540232f137a8531dd4dad967dd9fe000f582d  /home/fs6/vdb.1_1.dir/vdb_f0003.file
ee7c7c40629e3cf6fde4e9262e05a0f098772c010c78ad96bd873a3d61de3cc7  /home/fs6/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
```

Test 6.6 Restore Guest-OS files

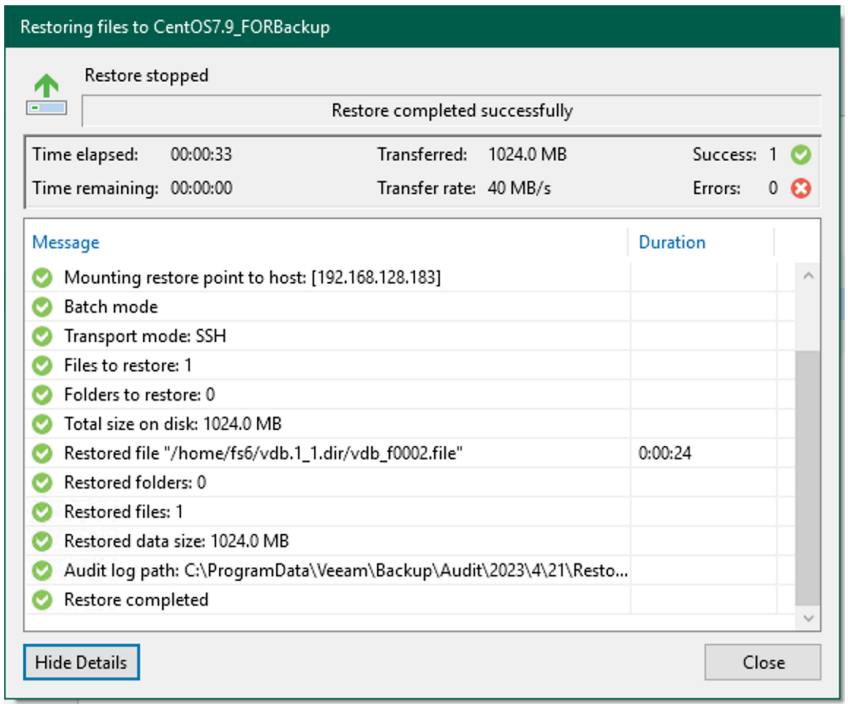
Then delete one file again, we are going to restore the files only.

```
[root@host141 ~]# sha256sum /home/fs6/vdb.1_1.dir/*
51560a3cf06ede594e200a88290b40e060629d0fad2ea58c1b547c8b27174d02  /home/fs6/vdb.1_1.dir/vdb_f0000.file
1913dd70dae80da9b4e658630fc5586a6be39d3362076028773c4d61c6ad3d42  /home/fs6/vdb.1_1.dir/vdb_f0001.file
b7afd25882e02c55e6edd8195d96bc43e52a83ad42718b141aa73467f475c46b  /home/fs6/vdb.1_1.dir/vdb_f0002.file
b87f22b00103f07adc89c3919dd540232f137a8531dd4dad967dd9fe000f582d  /home/fs6/vdb.1_1.dir/vdb_f0003.file
ee7c7c40629e3cf6fde4e9262e05a0f098772c010c78ad96bd873a3d61de3cc7  /home/fs6/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]# rm /home/fs6/vdb.1_1.dir//home/fs6/vdb.1_1.dir/vdb_f0002.file
rm: cannot remove '/home/fs6/vdb.1_1.dir//home/fs6/vdb.1_1.dir/vdb_f0002.file': No such file or directory
[root@host141 ~]#
[root@host141 ~]# rm /home/fs6/vdb.1_1.dir/vdb_f0002.file
rm: remove regular file '/home/fs6/vdb.1_1.dir/vdb_f0002.file'? z
[root@host141 ~]# rm /home/fs6/vdb.1_1.dir/vdb_f0002.file
rm: remove regular file '/home/fs6/vdb.1_1.dir/vdb_f0002.file'? y
[root@host141 ~]# ll /home/fs6/vdb.1_1.dir/vdb_f0002.file
ls: cannot access /home/fs6/vdb.1_1.dir/vdb_f0002.file: No such file or directory
[root@host141 ~]#
```

Start the guest files restore job.



And the files are restore completed and successes.



Check the file is restored to the directory successfully and the hash value is same with before.

```
[root@host141 ~]# sha256sum /home/fs6/vdb.1_1.dir/*
51560a3cf06ede594e200a88290b40e060629d0fad2ea58c1b547c8b27174d02  /home/fs6/vdb.1_1.dir/vdb_f0000.file
1913dd70dae80da9b4e658630fc5586a6be39d3362076028773c4d61c6ad3d42  /home/fs6/vdb.1_1.dir/vdb_f0001.file
b7afd25882e02c55e6edd8195d96bc43e52a83ad42718b141aa73467f475c46b  /home/fs6/vdb.1_1.dir/vdb_f0002.file
b87f22b00103f07adc89c3919dd540232f137a8531dd4dad967dd9fe000f582d  /home/fs6/vdb.1_1.dir/vdb_f0003.file
ee7c7c40629e3cf6fde4e9262e05a0f098772c010c78ad96bd873a3d61de3cc7  /home/fs6/vdb.1_1.dir/vdb_f0004.file
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]# rm /home/fs6/vdb.1_1.dir//home/fs6/vdb.1_1.dir/vdb_f0002.file
rm: cannot remove '/home/fs6/vdb.1_1.dir//home/fs6/vdb.1_1.dir/vdb_f0002.file': No such file or directory
[root@host141 ~]#
[root@host141 ~]# rm /home/fs6/vdb.1_1.dir/vdb_f0002.file
rm: remove regular file '/home/fs6/vdb.1_1.dir/vdb_f0002.file'? z
[root@host141 ~]# rm /home/fs6/vdb.1_1.dir/vdb_f0002.file
rm: remove regular file '/home/fs6/vdb.1_1.dir/vdb_f0002.file'? y
[root@host141 ~]# ll /home/fs6/vdb.1_1.dir/vdb_f0002.file
ls: cannot access /home/fs6/vdb.1_1.dir/vdb_f0002.file: No such file or directory
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]#
[root@host141 ~]# ll /home/fs6/vdb.1_1.dir/vdb_f0002.file
-rw-r--r--. 1 root root 1073741824 Apr 21 12:02 /home/fs6/vdb.1_1.dir/vdb_f0002.file
[root@host141 ~]# sha256sum /home/fs6/vdb.1_1.dir/vdb_f0002.file
b7afd25882e02c55e6edd8195d96bc43e52a83ad42718b141aa73467f475c46b  /home/fs6/vdb.1_1.dir/vdb_f0002.file
[root@host141 ~]#
```

Conclusion

We can summarize the results of our tests as follows:

I. In every tested backup repository configuration, all backup and restore operations worked as usual. We could not find any differences to normal standard repositories.

II. The hardened repository type worked perfectly. It was not possible to delete any data in the backup repository, even from the Linux command line as a super user (root) nor the owner of the files. Protection of the backup data is really given.

III. Also, the worm functionality (immutable) of the OceanStor Pacific Scale-Out Storage system works perfectly. It is not possible to delete any backup data, also in conjunction with the object storage functionality.

The stability and behavior of the systems was always flawless in the test. We did not notice any failures or inexplicable performance fluctuations. The operation of the Huawei Storage Systems is intuitive and easy even for beginners.

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Bernd Patolla studied computer science at the University of Passau and joined In&Out AG in 2005. Bernd Patolla is specialized in Oracle and PostgreSQL databases, Unix operating systems, backup environments and storage systems.

In&Out has many years of practical experience in architecture, conception, benchmarking and tuning of storage and system platforms, especially for core applications for banks and insurance companies.