

Bloombase

StoreSafe

Integration Guide

Utimaco ESKM

utimaco[®]

Imprint

Copyright 2020	Utimaco IS GmbH Germanusstr. 4 D-52080 Aachen Germany
Phone	AMERICAS +1-844-UTIMACO (+1 844-884-6226) EMEA +49 800-627-3081 APAC +81 800-919-1301
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e-mail	support@utimaco.com
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1 Purpose and Scope

This document describes the steps necessary to integrate Utimaco ESKM with Bloombase StoreSafe to deliver agentless, transparent encryption security of traditional storage systems and next-generation storage services for mission-critical applications. Specifically, we cover the following areas:

- Install and configure Bloombase StoreSafe software appliance
- Integrate Bloombase StoreSafe with Utimaco ESKM
- Integrate Microsoft Windows 11 and Ubuntu 22.04 LTS client systems with Bloombase StoreSafe and Utimaco ESKM data-at-rest encryption security solution for Microsoft Windows Server 2025 and Rocky Linux 9 storage backends to demonstrate how high-bandwidth, agentless, application-transparent data encryption could be achieved for multiple network storage protocols namely SMB, NFS, iSCSI and NVMe/TCP.

2 Assumptions

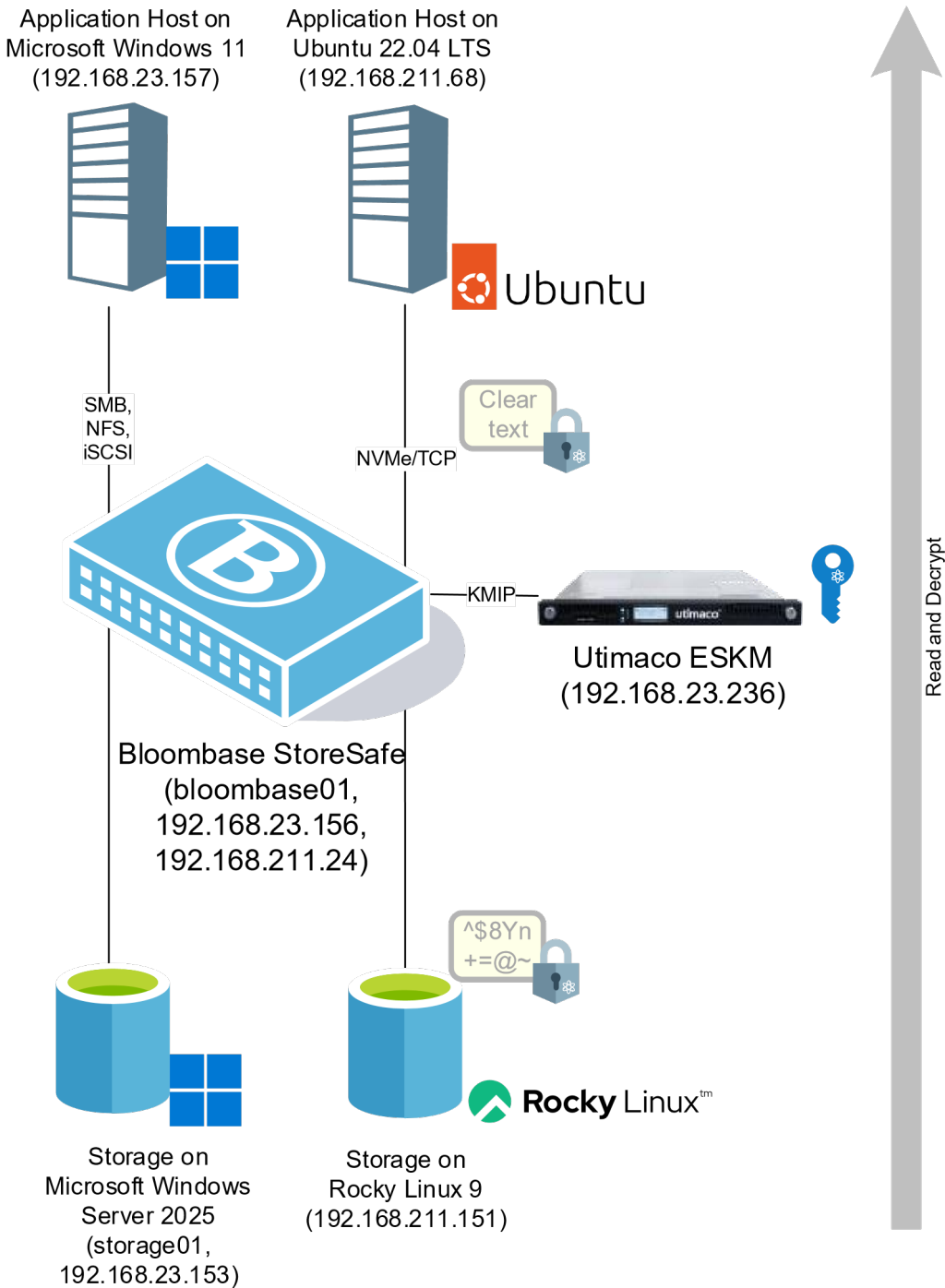
This document describes the integration of Utimaco ESKM with Bloombase StoreSafe. It is assumed that you are familiar with operation of Utimaco ESKM, storage systems, and major operating systems including Linux, Microsoft Windows, IBM AIX, HP-UX and Oracle Sun Solaris. It is also assumed that you possess basic UNIX administration skills. The examples provided may require modifications before they are run under your version of operating system.

As Utimaco ESKM is third party option to Bloombase StoreSafe data at-rest encryption security solution, you are recommended to refer to installation and configuration guides of specific model of Utimaco ESKM for your actual use cases. We assume you have basic knowledge of storage networking and information cryptography. For specific technical product information of Bloombase StoreSafe, please refer to our website at <https://www.bloombase.com> and Bloombase SupPortal <https://supportal.bloombase.com>.

3 Infrastructure

3.1 Setup

The integration discussed in this guide is based on the system block diagram below:



3.2 Storage Encryption

Storage Encryption	Bloombase StoreSafe Intelligent Storage Firewall Software
Server	VMware ESXi 6.5
Processor	4x Virtual CPU (vCPU)
Memory	8GB
Network Interface Card	NVIDIA ConnectX-5

3.3 Key Management System

Key Management System	Utimaco Enterprise Secure Key Manager (ESKM) v8.52.1
-----------------------	--

3.4 Storage Systems

Storage Systems	Microsoft Storage Server on Microsoft Windows Server 2025	NVMe over Fabrics (NVMe-oF) storage services on Rocky Linux 9
-----------------	---	---

3.5 Storage Hosts

Client Hosts	Microsoft Windows 11	Ubuntu 22.04 LTS
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3.6 Networking

Ethernet Switch	Celestica Seastone DX010 32-port 100GbE ONIE Switch
Network Interface Card	NVIDIA ConnectX-5
Cables	NVIDIA/Mellanox 100GbE QSFP28 DAC Cables

4 Configuration Overview

4.1 Utimaco Enterprise Secure Key Manager (ESKM)

Utimaco Enterprise Security Key Manager (ESKM) is installed and configured as a network attached virtual appliance with IP address 192.168.23.236 assigned.

Enterprise Secure Key Manager



Home ◆ Security ◆ Device Help ◆ Log Out

Device Configuration

- ▶ KMS Server
- ▶ KMIP Server
- ◆ REST Server
- ◆ Cluster
- ◆ Date & Time
- ▶ Network
- ◆ Kerberos
- ◆ HSM Integration
- ▶ SNMP
- ▶ Administrators

Device / System Information & Upgrade

System Information

Device Information Help ?

Product: Enterprise Secure Key Manager L1
Unit ID: UTI-ESKM-SN
Hardware Platform: VMware Virtual Platform
Software Version: 8.52.1 (vESKM 8.52)
Software Install Date: Fri Jun 21 14:55:37 PDT 2024

veskm
Logged in as admin

Utimaco ESKM can be managed remotely via web-based management console. Take note of the KMIP Server configuration.

Device Configuration

- ▶ KMS Server
- ▼ KMP Server
 - KMP Server
 - Interoperability
 - Health Check
 - REST Server
 - Cluster
 - Date & Time
 - ▶ Network
 - Kerberos
 - HSM Integration
 - ▶ SNMP
 - ▶ Administrators

Logs & Statistics

- ▶ Log Configuration
- ▶ Log Viewer
- ▶ Statistics

Maintenance

- ▶ Backup & Restore
- Services
- System Information & Upgrade
- Network Diagnostics

Device / [KMP Server](#) / KMP Server

veskm
Logged in as admin

KMIP Server Configuration

KMIP Server Settings

Help ?

IP:	[All]
Port:	5696
Server Certificate:	ESKMServerCert
Local CA Certificate for Certify/Re-certify:	ACME ESKM CA
Connection Timeout (sec):	360
Default number of items returned in Locate:	100
Maximum number of items returned in Locate:	1000

Edit

KMIP Server Authentication Settings

Help ?

Client Certificate Authentication:	enable
Trusted CA List Profile:	Default

Edit

4.1.1 KMIP Client

For the purpose of this interoperability testing, user “bloombase01” is provisioned and assigned for the Bloombase StoreSafe software appliance instance.

X.509 key pair “CN=bloombase01” is created and assigned as the KMIP client authentication for the user.

Enterprise Secure Key Manager



Home • Security • Device

Help • Log Out

- Keys & KMIP Objects**
 - Keys
 - KMIP Objects
 - Cloud Integration
 - Authorization Policies

- Users & Groups**
 - Local Users & Groups
 - Local Users
 - Local Groups
 - LDAP

- Certificates & CAs**
 - Certificates
 - Trusted CA Lists
 - Local CAs
 - Known CAs

- Advanced Security**
 - High Security
 - SSL Options
 - SSH Options
 - FIPS Status Server

Security / Local Users & Groups / Local Users

veskm
Logged in as admin

User and Group Configuration

Properties Memberships Interoperability Custom Attributes

Selected Local User

Help ?

Username:	bloombase01
Password:	*****
License Type:	KMIP
User Administration Permission:	<input checked="" type="checkbox"/>
Change Password Permission:	<input checked="" type="checkbox"/>
Enable KMIP:	<input checked="" type="checkbox"/>
Default KMIP Object Group:	default object group
Client Certificate:	emailAddress: Common Name: bloombase01 Not Valid Before: Aug 4 08:47:21 2024 GMT Not Valid After: Aug 2 08:47:21 2034 GMT
Date Created:	2024-08-05 01:50:01
Date Last Modified:	2024-08-05 01:50:01
Last Access Time:	2024-08-05 02:01:05

KMIP Client Certificate Contents:

```
-----BEGIN CERTIFICATE-----
MIIDjzCCAnegAwIBAgIBATANBgkqhkiG9w0BAQsFADCbnTElMAkGA1UEBhMCVVMx
EzARBgNVBAgTCkNhbg1mb3JuaWExEzARBgNVBAcTC1BzZWZzYW50b24xDTALBgNV
BAoTBFEFTUUXHTAbBgNVBAstFE1uZm9ybWw0aW9uIFN1Y3VyaXR5MRUwEwYDVQDD
EwxBQ01FIEVTS00gQ0ExHzAdBgkqhkiG9w0BCQEWEG1uZm9zZWNAWYWNtZS5jb20w
HhcNMjQwODAwMDg0NzIxWWhcNMzQwODAwMDg0NzIxWjAwMRQwEgYDVQDDAtibG9v
bWJhc2UwMTCCAS1wDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBALkhL/K9qc9E
-----END CERTIFICATE-----
```

The KMIP client certificate must be signed by the Utimaco ESKM CA.

Enterprise Secure Key Manager

Home • Security • Device

Help • Log Out

Keys & KMIP Objects

- ▶ Keys
- ▶ KMIP Objects
- ◆ Cloud Integration
- ◆ Authorization Policies

Users & Groups

- ▶ Local Users & Groups
- ▶ LDAP

Certificates & CAs

- ◆ Certificates
- ◆ Trusted CA Lists
- ◆ Local CAs
- ◆ Known CAs

Advanced Security

- ◆ High Security
- ▶ SSL Options
- ◆ SSH Options
- ◆ FIPS Status Server

Security / Local CAs

veskm
Logged in as admin

Certificate and CA Configuration

Sign Certificate Request

Help ?

Sign with Certificate Authority: ACME ESKM CA (maximum 3649 days) ▾

Certificate Purpose:

Server

Client

Server and Client

Certificate Duration (days): 3649

Certificate Request:

Sign Request Back

The KMIP configuration, client and CA certificate are added to the Bloombase StoreSafe web management console.

4.1.2 Ethernet Switch Configuration

Celestica Seastone DX010 32-port 100GbE ONIE switch has been used in this integration testing.



Ports 24 and 28 of the 100Gb Ethernet switch are connected to the NVIDIA ConnectX-5 NICs via DAC cables as shown in the SONiC console below.

```
Linux sonic 5.10.0-8-2-amd64 #1 SMP Debian 5.10.46-4 (2021-08-03) x86_64
You are on

SONiC
-----
-- Software for Open Networking in the Cloud --

Unauthorized access and/or use are prohibited.
All access and/or use are subject to monitoring.
```

```
admin@sonic:~$ sudo config vlan add 210
admin@sonic:~$ sudo config vlan member add -u 210 Ethernet24
admin@sonic:~$ sudo config vlan member add -u 210 Ethernet28
```

```
admin@sonic:~$ show vlan brief
```

VLAN ID	IP Address	Ports	Port Tagging	Proxy ARP	DHCP Helper Address
210		Ethernet24	untagged	disabled	
		Ethernet28	untagged		

```
admin@sonic:~$ show interfaces status
```

Interface	Lanes	Speed	MTU	FEC	Alias	Vlan	Oper	Admin	Type	Asym PFC
Ethernet0	65,66,67,68	100G	9100	rs	Eth1	trunk	down	up	N/A	N/A
Ethernet4	69,70,71,72	100G	9100	rs	Eth2	trunk	up	up	QSFP28 or later	N/A
Ethernet8	73,74,75,76	100G	9100	N/A	Eth3	trunk	down	up	N/A	N/A
Ethernet12	77,78,79,80	100G	9100	rs	Eth4	trunk	up	up	QSFP28 or later	N/A
Ethernet16	33,34,35,36	100G	9100	rs	Eth5	trunk	down	up	QSFP28 or later	N/A
Ethernet20	37,38,39,40	100G	9100	N/A	Eth6	trunk	down	up	N/A	N/A
Ethernet24	41,42,43,44	100G	9100	N/A	Eth7	trunk	up	up	QSFP28 or later	N/A
Ethernet28	45,46,47,48	100G	9100	N/A	Eth8	trunk	up	up	QSFP28 or later	N/A

```
Ethernet24: SFP EEPROM detected
  Application Advertisement: N/A
  Connector: No separable connector
  Encoding: Unspecified
  Extended Identifier: Power Class 1(1.5W max)
  Extended RateSelect Compliance: QSFP+ Rate Select Version 1
  Identifier: QSFP28 or later
  Length Cable Assembly(m): 2
  Nominal Bit Rate(100Mbs): 255
  Specification compliance:
    Extended Specification compliance: 10GBASE-CR4, 25GBASE-CR CA-25G-L or 50GBASE-CR2
with RS
  Vendor Date Code(YYYY-MM-DD Lot): 2021-12-06
  Vendor Name: FS
  Vendor OUI: 00-02-c9
  Vendor PN: Q28-PC02
  Vendor Rev: A2
  Vendor SN: G2140009608-2
```

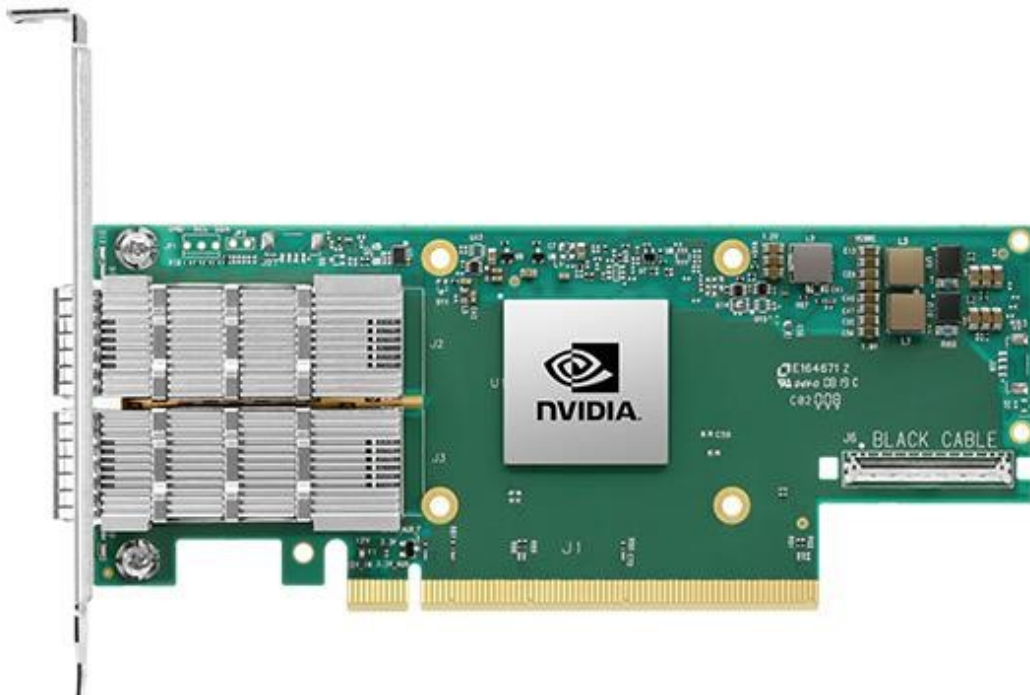
4.1.3 Direct Attach Copper (DAC) Cable

NVIDIA/Mellanox 100GbE QSFP28 DAC cables have been used in this interoperability testing.



4.1.4 Network Interface Card (NIC)

NVIDIA ConnectX-5 NIC has been used in this integration testing.



Install and configure NVIDIA ConnectX-5 NIC using the install image or the driver available from your distribution's repo.

```
user@ubuntu67:~$ lspci |grep mellanox -i  
0b:00.0 Ethernet controller: Mellanox Technologies MT27800 Family [ConnectX-5 Virtual Function]
```

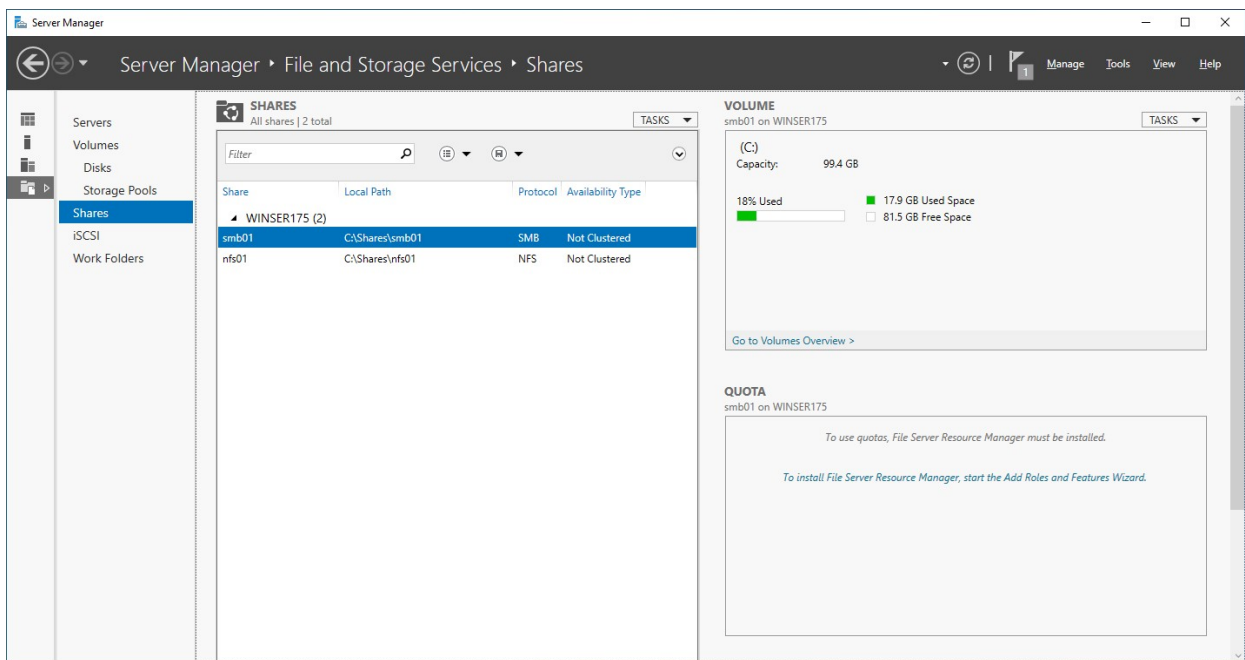
```
user@ubuntu67:~$ ibstat  
CA 'mlx5_0'  
  CA type: MT4120  
  Number of ports: 1  
  Firmware version: 16.35.2000  
  Hardware version: 0  
  Node GUID: 0x000c29fffe1dfb26  
  System image GUID: 0xb8cef60300f2cc66  
  Port 1:  
    State: Active  
    Physical state: LinkUp  
    Rate: 100  
    Base lid: 0  
    LMC: 0  
    SM lid: 0  
    Capability mask: 0x00010000  
    Port GUID: 0x020c29fffe1dfb26  
    Link layer: Ethernet
```

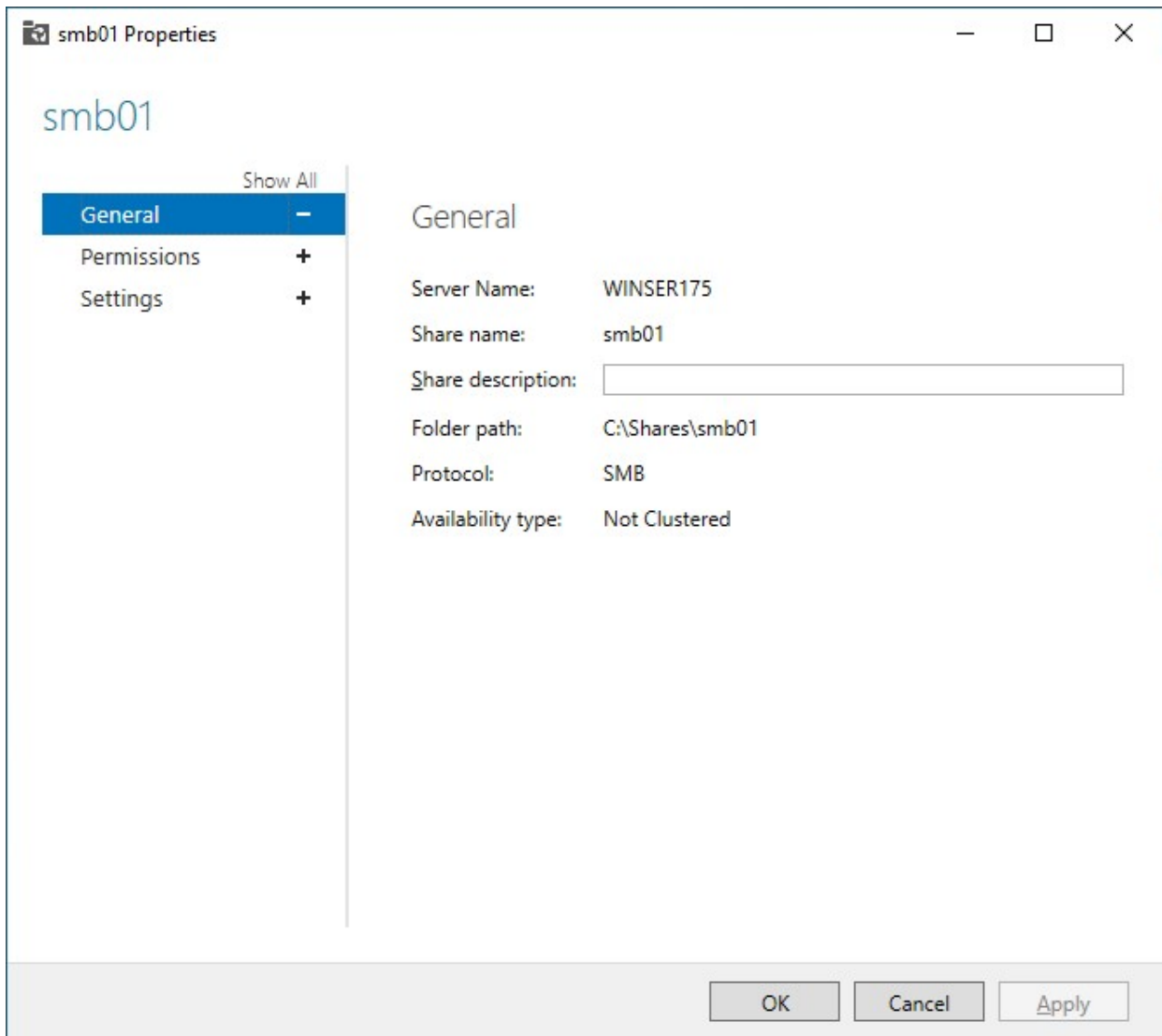
4.2 Microsoft Storage Server on Microsoft Windows Server 2025 Storage Backends

Microsoft Storage Server on Microsoft Windows Server 2025 running on VMware ESXi is used in this interoperability test which is able to provide storage services over network storage protocols including iSCSI, NFS, SMB, CIFS, REST, etc.

Microsoft Windows Server 2025 is deployed as a virtual appliance (VA) on VMware ESXi.

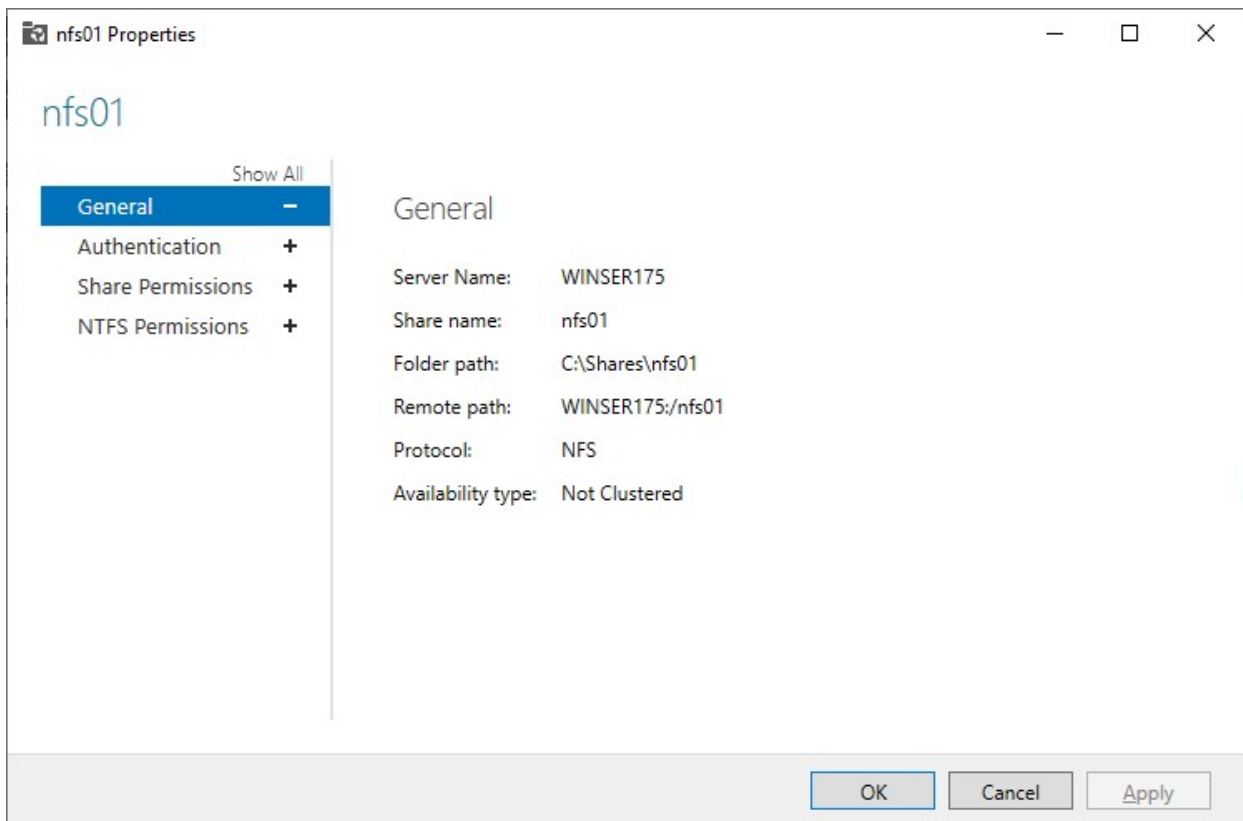
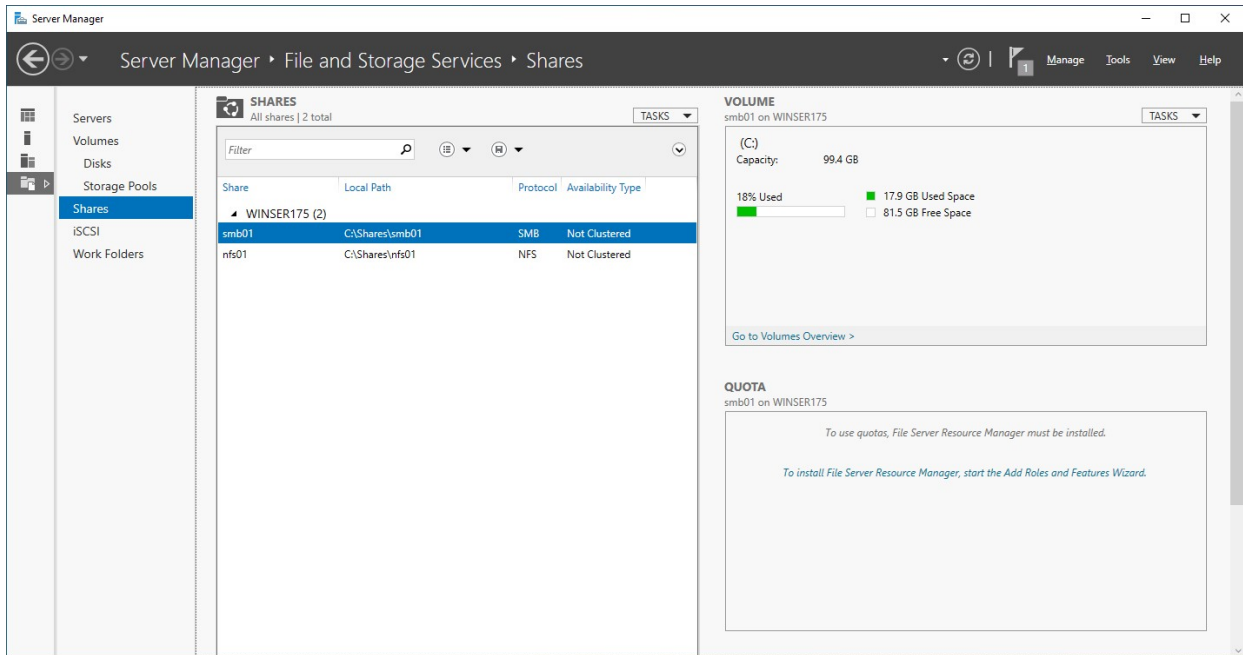
4.2.1 SMB Services Configuration





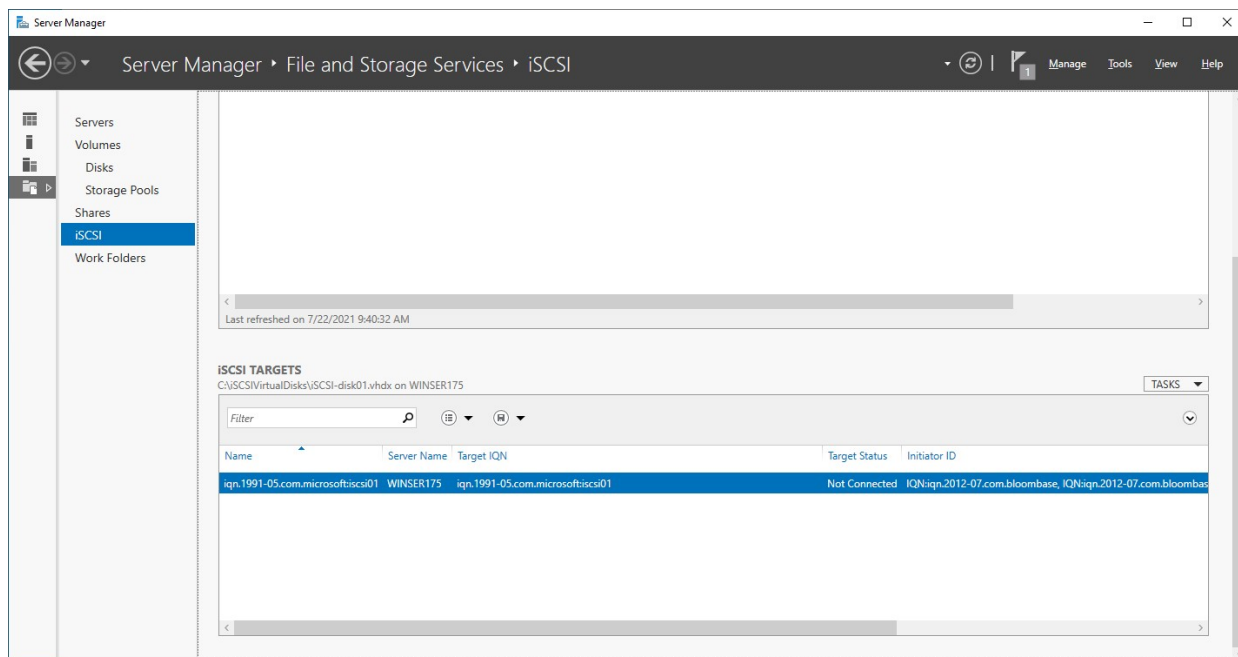
Microsoft Windows Server 2025 File Management is configured to provide the SMB share backend storage to client system users.

4.2.2 NFS Services Configuration



NFS storage service is provisioned on Microsoft Windows Server 2025 to be used in this integration testing.

4.2.3 iSCSI Services Configuration



iSCSI storage service is also provisioned on Microsoft Windows Server 2025 to be used in this integration testing.

4.3 NVMe over Fabrics (NVMe-oF) Storage Target on Rocky Linux 9 Storage Target

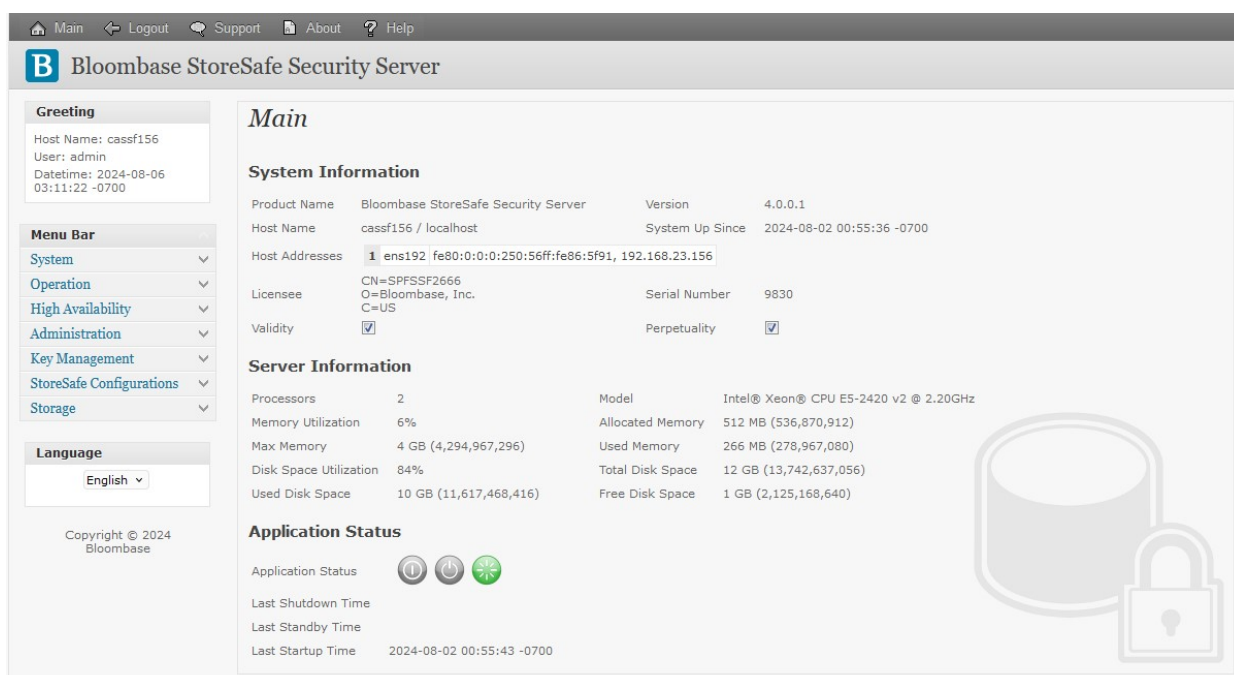
Linux NVMe-oF target software is used to be the storage backend secured by Bloombase StoreSafe Intelligent Storage Firewall.

```
[root@carockyj151 ~]# nvmetcli
>> ls
o- /
o- hosts ..... [..]
l o- nqn.2014-08.org.nvmexpress:uuid:4af97520-1bfe-4c8d-9069-5fb9ab632709 ..... [..]
o- ports ..... [..]
l o- 1 ..... [trtype=tcp, traddr=192.168.211.151, trsvcid=4420, inline_data_size=16384]
l o- ana_groups ..... [..]
l l o- 1 ..... [state=optimized]
l o- referrals ..... [..]
l o- subsystems ..... [..]
l l o- nqn.2014-08.org.nvmexpress:NUMF:uuid:7079993e-7413-4338-9b9b-a3af82259b18 ..... [..]
l o- 2 ..... [trtype=rdma, traddr=192.168.211.151, trsvcid=4420, inline_data_size=4096]
l o- ana_groups ..... [..]
l l o- 1 ..... [state=optimized]
l o- referrals ..... [..]
l o- subsystems ..... [..]
l o- nqn.2014-08.org.nvmexpress:NUMF:uuid:7079993e-7413-4338-9b9b-a3af82259b18 ..... [..]
o- subsystems ..... [..]
o- nqn.2014-08.org.nvmexpress:NUMF:uuid:7079993e-7413-4338-9b9b-a3af82259b18 [version=1.3, allow_any=0, serial=cdbf55fefeea52243d3]
o- allowed_hosts ..... [..]
o- namespaces ..... [..]
o- 1 ..... [path=/dev/nullb0, uuid=e581a156-7460-45e2-b6ae-0457e0762342, grpId=1, disabled]
```

4.4 Bloombase StoreSafe Intelligent Storage Firewall

Bloombase StoreSafe delivers unified data at-rest encryption security of files, block devices, objects, sequential storages, etc. In this interoperability test, both file-based and block-based encryption security services are validated against Bloombase StoreSafe with keys managed at Utimaco ESKM.

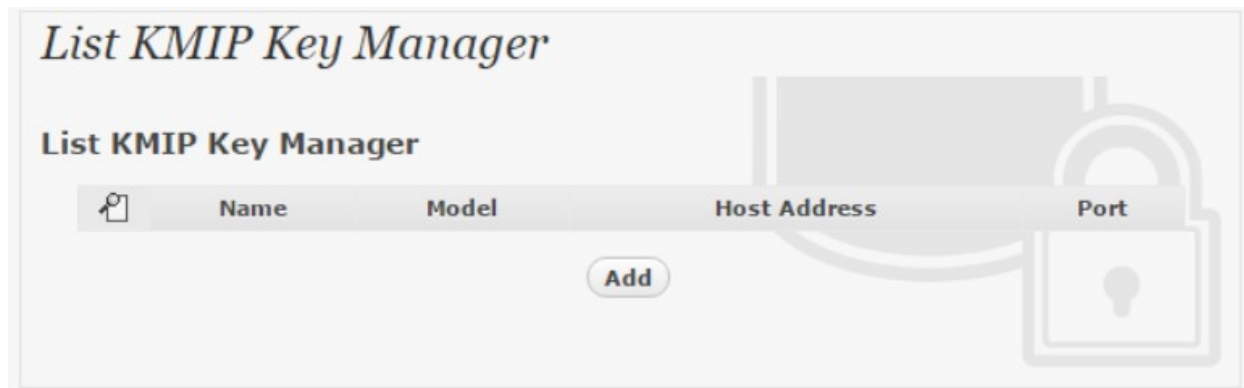
Bloombase StoreSafe Intelligent Storage Firewall software appliance is deployed as a virtual appliance (VA).



4.4.1 Utimaco Enterprise Secure Key Manager (ESKM) and Bloombase StoreSafe Integration

Bloombase supports Utimaco ESKM out of the box due to the fact that both products support OASIS Key Management Interoperability Protocol (KMIP).

To enable the built-in Bloombase KeyCastle to utilize keys managed in the network attached Utimaco ESKM, the KMIP service configuration at Bloombase web management console has to be set up. This is done by clicking "OASIS KMIP Key Manager" under "Key Management".



Input a name for the configuration, and select Model as

Utimaco ESKM

Input also the host address and port to access the Utimaco ESKM, and import the signed X.509 key pair as "Client Keystore", the certificate of the local root CA on Utimaco ESKM as "Trust Certificate".

Modify KMIP Key Manager

Modify KMIP Key Manager

Name	<input type="text" value="eskm01"/>
Model	<input type="text" value="Utimaco ESKM"/> ▼
Host Addresses	<input type="text" value="192.168.23.236"/>
Port	<input type="text" value="5696"/>
Timeout	<input type="text" value="30000"/> ms
Retry Count	<input type="text" value="1"/>
Retry Wait Time	<input type="text" value="3000"/> ms
Username	<input type="text" value="bloombase01"/>
Password	<input type="password"/>

Client Keystore

Subject Name	CN=bloombase01
Serial Number	01
Issuer Name	EMAILADDRESS=infosec@acme.com CN=ACME ESKM CA OU=Information Security O=ACME L=Pleasanton ST=California C=US
Certificate	
Valid Start Date	2024-08-04
Valid End Date	2034-08-02

Client Key/ Certificate	<input type="button" value="Browse..."/> No file selected.
Pin	<input type="text"/> <input type="button" value="Upload"/>

Trust Certificate

Subject Name	EMAILADDRESS=infosec@acme.com CN=ACME ESKM CA OU=Information Security O=ACME L=Pleasanton ST=California C=US
Serial Number	00
Issuer Name	EMAILADDRESS=infosec@acme.com CN=ACME ESKM CA OU=Information Security O=ACME L=Pleasanton ST=California C=US
Valid Start Date	2024-08-04
Valid End Date	2034-08-03

Trust Certificate File No file selected.



X.509 key pair CN=bloombase01 is generated and signed by the root CA in the Utimaco ESKM, and assigned as the client authentication key pair for Bloombase StoreSafe.

Modify KMIP Key Manager

Modify KMIP Key Manager

Name	<input type="text" value="eskm01"/>
Model	<input type="text" value="Utimaco ESKM"/>
Host Addresses	<input type="text" value="192.168.23.236"/>
Port	<input type="text" value="5696"/>
Timeout	<input type="text" value="30000"/> ms
Retry Count	<input type="text" value="1"/>
Retry Wait Time	<input type="text" value="3000"/> ms
Username	<input type="text" value="bloombase01"/>
Password	<input type="password"/>
Test Results :	192.168.23.236 : Success Vendor ID : Utimaco Inc.

Click 'Submit' to commit the configuration. If the certificates are setup properly, "test results" of the KMIP Key Manager would return "Success".

4.4.2 Encryption Key Provisioning

To generate key in attached Utimaco ESKM, select Key Source Type as

OASIS KMIP Key Manager

and the assigned Key Manager label, in this case

eskm01

Select "Add Key" and "generate" to create a new key on the key manager.

Modify Key Wrapper

Key Wrapper | **Permissions**

Modify Key Wrapper

Name:

Key Source: OASIS KMIP Key Manager

Type: Symmetric

Active:

KMIP Key Manager: eskm01

KMIP UUID:

KMIP Key Name:

KMIP Key State:

Key Bit Length:

Owner:

Last Update Datetime:

Or if key already exists, simply choose from the dropdown box.

Modify Key Wrapper

Key Wrapper | **Permissions**

Modify Key Wrapper

Key Source:

Key Manager:

Object:

Ensure you import a key from the key manager before you submit the key wrapper.

Find Key Wrapper

Find Key Wrapper

Name Type **Symmetric** Active CA

▼ More Options

Find **Reset** **Add**

1-1 of 1

Name	Type	Key Source Type	Active	Status	CA	Subject DN	Issuer DN	Effective Datetime	Expiry Datetime	Last Update Datetime
1 eskmkey01	Symmetric	OASIS KMIP Key Manager	<input checked="" type="checkbox"/>			UUID=30b314ce-0ca8-4fcd-b3b7-1c0e3258fda8	KMIP=eskm01			2024-08-04 19:01:07 -0700

1-1 of 1

The new key can be found on the ESKM management console.

[Security](#) / [KMIP Objects](#) / [KMIP Objects](#)

veskm
Logged in as **admin**

KMIP Object Configuration

KMIP Objects

[Help ?](#)

Query: **[All KMIP Keys]** **Run Query**

Items per page: **10** **Submit**

▲ UUID	Object Name	Owner	Object Type	State	Creation Date	FIPS Security Level
<input checked="" type="radio"/> 30b314ce-0ca8-4fcd-b3b7-1c0e3258fda8	eskmkey01	bloombase01	SymmetricKey	Active	2024-08-05 09:01:02	1
<input type="radio"/> c0323e68-cbfc-4d57-ac6a-07099284749d	-	bloombase01	SymmetricKey	Destroyed	2024-08-05 09:01:03	1
<input type="radio"/> ba1ef8e1-4047-4ea1-b7ee-cbb36ae006d3	-	bloombase01	SymmetricKey	Active	2024-08-05 09:01:03	1
<input type="radio"/> 6c307f35-f964-44f1-b18f-59711242e167	-	bloombase01	SymmetricKey	Destroyed	2024-08-05 09:01:03	1
<input type="radio"/> 348965b2-c596-42b6-a9ae-1f90fd66f624	-	bloombase01	SymmetricKey	Active	2024-08-05 09:01:04	1

1 - 5 of 5

Delete **Properties** **Purge Destroyed Objects**

4.4.3 Bloombase StoreSafe Data-at-Rest Encryption for SMB Configuration

Physical storage namely

smb01


is configured to be secured by Bloombase StoreSafe using encryption.

Modify Storage Configuration

Physical Storage | Permissions

Physical Storage Configuration

Name	<input type="text" value="smb01"/>
Description	<input type="text"/>
Physical Storage Type	Remote ▾
Type	Common Internet File System (CIFS) ▾
Host	<input type="text" value="storage01"/>
Share Name	<input type="text" value="smb01"/>
Read Size	<input type="text" value="65536"/> bytes
Write Size	<input type="text" value="65536"/> bytes
Mount Hard	<input type="checkbox"/>
User	<input type="text" value="user01"/>
Password	<input type="text"/>
Options	<input type="text"/>
Virtual Storage	smb01
Owner	admin
Last Update Datetime	2021-07-22 08:32:00 -0700



Virtual storage namely

smb01

of type

File

is created to virtualize physical storage

smb01

for application transparent encryption protection over network file protocols including CIFS.

Modify Virtual Storage

Virtual Storage
Protection
Access Control
Permissions

Modify Virtual Storage

Name	<input type="text" value="smb01"/>
Status	<input checked="" type="checkbox"/>
Description	<input type="text"/>
Active	<input checked="" type="checkbox"/>
Mode	File
Protocol	SMB
Owner	admin
Last Update Datetime	2021-07-22 04:33:45 -0700

Settings

Offline Setting Disabled

Physical Storage

Storage	smb01
Description	
Physical Storage Type	Remote
Type	cifs
Host	storage01
Share	smb01

Submit
Delete
Status
Close

Protection type is specified as

Privacy

and secure the Microsoft Storage Server storage backend using

AES 256-bit

encryption and encryption key

eskmkey01

managed at Utimaco ESKM.

Modify Virtual Storage Handler

Virtual Storage
Protection
Access Control
Permissions

Virtual Storage Protection

Protection Type Privacy

Encryption Keys

		Key Name	Last Update Datetime
1	<input type="checkbox"/>	eskmkey01	

Add Remove

Header

Protected

Cryptographic Cipher

Cipher Algorithm AES

Bit Length 256

CTR Mode

Submit Close

SMB/CIFS storage protocol relies mainly on user-password authentication for access control. In this test, the Bloombase StoreSafe secure storage resource

`smb01`

is provisioned for user

`user01`

with Microsoft Active Directory integration for user-password authentication and single sign-on.

Modify Virtual Storage Access Control

Virtual Storage | Protection | **Access Control** | Permissions

User Access Control

Warning: Deny access will override allow access

Everybody Read Write
 Deny Read Deny Write

User Repository: Local

	User	Access Control List	Deny Access Control List	Warning	Last Update Datetime
1	<input type="checkbox"/> user01	<input checked="" type="checkbox"/> Read <input checked="" type="checkbox"/> Write	<input type="checkbox"/> Deny Read <input type="checkbox"/> Deny Write		2021-07-22 04:33:45 -0700

4.4.4 Bloombase StoreSafe Data-at-Rest Encryption for NFS Configuration

Physical storage namely

nfs01

is configured to be secured by Bloombase StoreSafe using encryption.

Modify Storage Configuration

Physical Storage | **Permissions**

Physical Storage Configuration

Name	<input type="text" value="nfs01"/>
Description	<input type="text"/>
Physical Storage Type	<input type="text" value="Remote"/>
Type	<input type="text" value="Network File System (NFS)"/>
Host	<input type="text" value="storage01"/>
Share Name	<input type="text" value="nfs01"/>
Read Size	<input type="text" value="65536"/> bytes
Write Size	<input type="text" value="65536"/> bytes
Synchronous	<input type="checkbox"/>
Mount Hard	<input type="checkbox"/>
Options	<input type="text" value="vers=4.1"/>
Virtual Storage	nfs01
Owner	admin
Last Update Datetime	2021-07-23 04:47:41 -0700



Virtual storage namely

`nfs01`

of type

`File`

is created to virtualize physical storage

`nfs01`

for application transparent encryption protection over network file protocols including NFS.

Modify Virtual Storage

Virtual Storage | Protection | Access Control | Permissions

Modify Virtual Storage

Name:

Status:

Description:

Active:

Mode: File

Protocol: NFS

Owner: admin

Last Update Datetime: 2021-07-22 09:55:37 -0700

Settings

Offline Setting: ▼

Physical Storage

Storage: 🔍 🗑️


Description:

Physical Storage Type: Remote

Type: nfs

Host: storage01

Share: nfs01



Protection type is specified as

Privacy

and secure the Microsoft Storage Server storage backend using

AES 256-bit

encryption and encryption key

eskmkey01

managed at Utimaco ESKM.

Modify Virtual Storage Handler

Virtual Storage Protection Access Control Permissions

Virtual Storage Protection

Protection Type

Encryption Keys

	Key Name	Last Update Datetime
1 <input type="checkbox"/>	eskmkey01	

Header


Protected

Cryptographic Cipher

Cipher Algorithm

Bit Length

CTR Mode



NFS storage protocol relies mainly on UID/GID and networking for access control. In this test, the Bloombase StoreSafe secure storage resource

nfs01

is provisioned for client IP

192.168.23.157

Modify Virtual Storage Access Control

Virtual Storage | Protection | **Access Control** | Permissions

User Access Control
 Everybody Read Write

NFS File System Object Attributes
 Root Squash
 Weak Cache Consistency
 Default User Identifier
 Default Group Identifier
 Default Mode

Host Access Control

	Host	Access Control List	Security	Warning	Last Update Datetime
1	<input type="text" value="192.168.23.157"/>	<input checked="" type="checkbox"/> Read <input checked="" type="checkbox"/> Write	sys	<input type="text"/>	2024-08-01 02:30:50 -0700

Subnet Access Control

Subnet	Access Control List	Security	Warning	Last Update Datetime

4.4.5 Bloombase StoreSafe Data-at-Rest Encryption for iSCSI Configuration

Physical storage namely



```
iscsi01
```


is configured to be secured by Bloombase StoreSafe using encryption.

Modify Storage Configuration

Physical Storage | **Permissions**

Physical Storage Configuration

Name	<input type="text" value="iscsi01"/>
Description	<input type="text"/>
Physical Storage Type	<input type="text" value="Device"/>
Block I/O	<input checked="" type="checkbox"/>
Multipath	<input type="checkbox"/>
Device ID [max 8 chars]	<input type="text" value="11"/>
Options	<input type="text"/>
Device	60003ff44dc75adc919e979aaaf58040  
Virtual Storage	iqn.2012-07.com.bloombase:iscsi01
Owner	admin
Last Update Datetime	2021-07-23 11:53:49 -0700



Virtual storage namely

`iqn.2012-07.com.bloombase:iscsi01`

of type

`iSCSI`

is created to virtualize physical storage

`iscsi01`

for application transparent encryption protection over network file protocols including iSCSI.

Modify Virtual Storage

[Virtual Storage](#) | [Protection](#) | [Access Control](#) | [iSCSI](#) | [Permissions](#)

Modify Virtual Storage

Name:

Status:

Description:

Active:

Mode: iSCSI

Tape Library:

ATS:

Cluster:

Vendor:

Model:

Revision:

Owner: admin

Last Update Datetime: 2021-07-23 11:54:59 -0700

Physical Storage

	Storage	Description	Device
1	<input type="checkbox"/> iscsi01		60003ff44dc75adc919e979aaaf58040

Protection type is specified as

`Privacy`

and secure the Microsoft Storage Server storage backend using

`AES XTS 256-bit`

encryption and encryption key

`eskmkey01`

managed at Utimaco ESKM.

Modify Virtual Storage Handler

Virtual Storage Protection Access Control iSCSI Permissions

Virtual Storage Protection

Protection Type

Encryption Keys

	Key Name	Last Update Datetime
1 <input type="checkbox"/>	eskmkey01	

Cryptographic Cipher

Cipher Algorithm

Bit Length

iSCSI storage protocol relies mainly on CHAP, IQN, and networking for access control. In this test, the Bloombase StoreSafe secure storage resource

```
iqn.2012-07.com.bloombase:iscsi01
```

is provisioned for initiator

```
iqn.1991-05.com.microsoft:windows11
```

Modify Virtual Storage Access Control

Virtual Storage | Protection | Access Control | iSCSI | Permissions

Allowed Portal

Portal IP

Add Remove

Incoming Users

User	Warning	Last Update Datetime

Add Remove

Initiators

Initiator	Alias	Warning	Last Update Datetime
1 <input type="checkbox"/> iqn.1991-05.com.microsoft:windows11			2021-07-23 12:19:08 -0700

Add Remove

▼ List Initiators

Refresh Alias Submit Close

4.4.6 Bloombase StoreSafe Data-at-Rest Encryption for NVMe/TCP Configuration

Physical storage with Intel Solid State Drive DC P3600 Series PCIe NVMe SSDs is configured to be secured by Bloombase StoreSafe Intelligent Storage Firewall.

Modify Storage Configuration

Physical Storage

Permissions

Physical Storage Configuration

Name	<input type="text" value="nvme01"/>
Description	<input type="text"/>
Physical Storage Type	<input type="text" value="Block"/>
Device ID	<input type="text" value="1816d452-ac0d-49c2-9de0-d378f0cff5d6"/>
Options	<input type="text"/>
Device	d9395873-b937-4139-8911-07c347c447c0  
Virtual Storage	nqn.2022-06.io.storesafe:nvme01
Owner	admin
Last Update Datetime	2022-10-04 12:16:40 -0700

Virtual storage with “NVMe” mode is created to secure the just configured physical storage.

Modify Virtual Storage

- Virtual Storage
- Protection
- Access Control
- Permissions

Modify Virtual Storage

Name

Status

Description

Active

Mode NVMe

Model

Serial Number

Owner admin

Last Update Datetime 2022-10-05 10:03:21 -0700

Physical Storage

		Storage	Description	Device
1	<input type="checkbox"/>	nvme01		d9395873-b937-4139-8911-07c347c447c0

Select "Privacy" for protection type and select the encryption key. Choose the cipher algorithm and bit length.

Modify Virtual Storage Handler

Virtual Storage | Protection | Access Control | Permissions

Virtual Storage Protection

Protection Type: Privacy

Encryption Keys

	Key Name	Last Update Datetime
1	eskmkey01	

Remove

Cryptographic Cipher

Cipher Algorithm: AES XTS
Bit Length: 256

Submit Close

Add clients' NVMe Qualified Name (NQN) that can access Bloombase StoreSafe virtual storage.

Modify Virtual Storage Access Control

Virtual Storage | Protection | Access Control | Permissions

Initiators

	Initiator	Alias	Warning	Last Update Datetime
1	nqn.2014-08.org.nvmexpress:uuid:cf2eae42-6537-4891-85c2-77bbff4598b8			2022-06-03 14:50:03 -0700
2	nqn.2014-08.org.nvmexpress:uuid:98c22f42-0694-af6d-1b5b-6d7b4ea9944d			2022-07-13 12:20:18 -0700

Start Bloombase StoreSafe virtual storage.

Virtual Storage Status

Virtual Storage

Name nqn.2022-06.io.storesafe:nvme01
 Status
 Active
 Type NVMe

Physical Storage

Name nvme01
 Type Unknown

Active Share Status

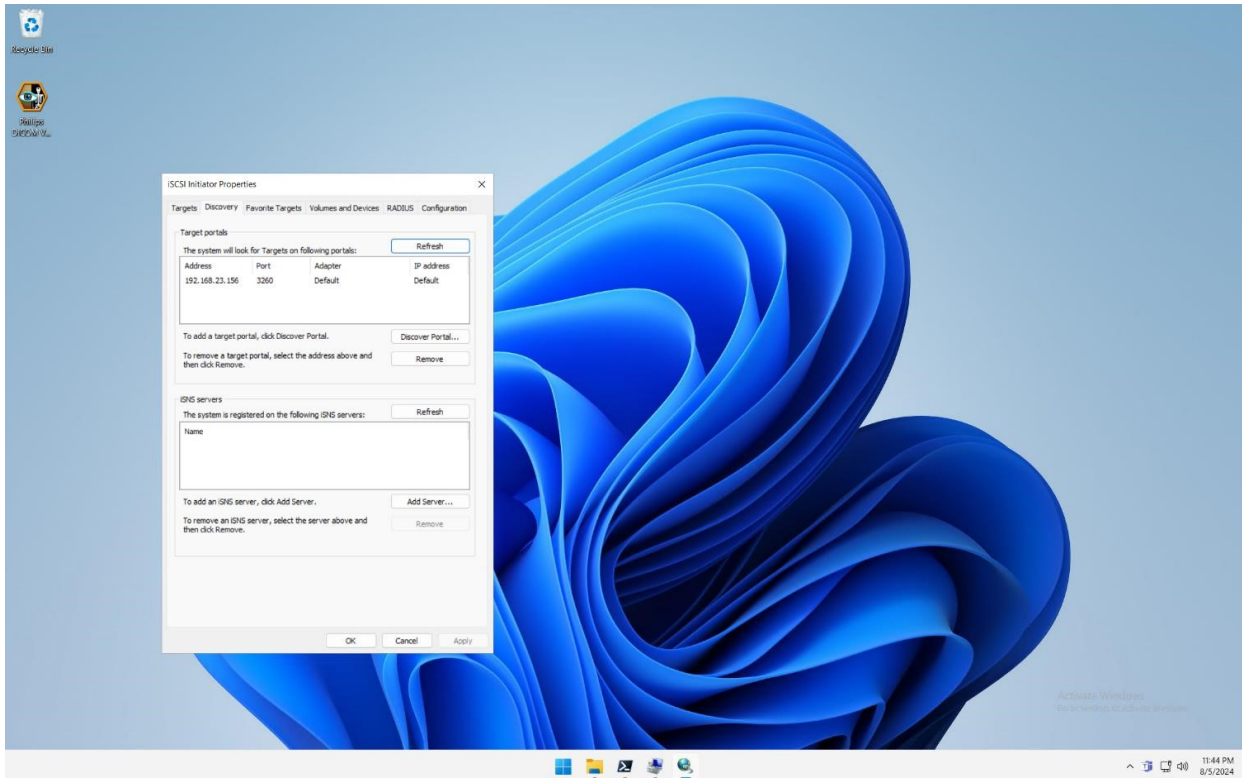
Share Name nqn.2022-06.io.storesafe:nvme01
 Storage Type Unknown
 Storage Path Target : nqn.2022-06.io.storesafe:nvme01
 LUN 1:[_SS_nvme33n1__];
 Sessions 2

[Refresh](#) [Stop](#) [Start](#) [Close](#)

4.5 Storage Clients

4.5.1 Microsoft Windows 11

Client host running Microsoft Windows 11 is used to access Bloombase StoreSafe Intelligent Storage Firewall virtual storage.



4.5.2 Ubuntu 22.04 LTS

Client host running Ubuntu 22.04 LTS is used to access Bloombase StoreSafe Intelligent Storage Firewall virtual storage.

```
user@ubuntu68:~$ lsb_release -a
No LSB modules are available.
Distributor ID: Ubuntu
Description:    Ubuntu 22.04.2 LTS
Release:       22.04
Codename:      jammy
```

The client will need nvme initiator software installed.

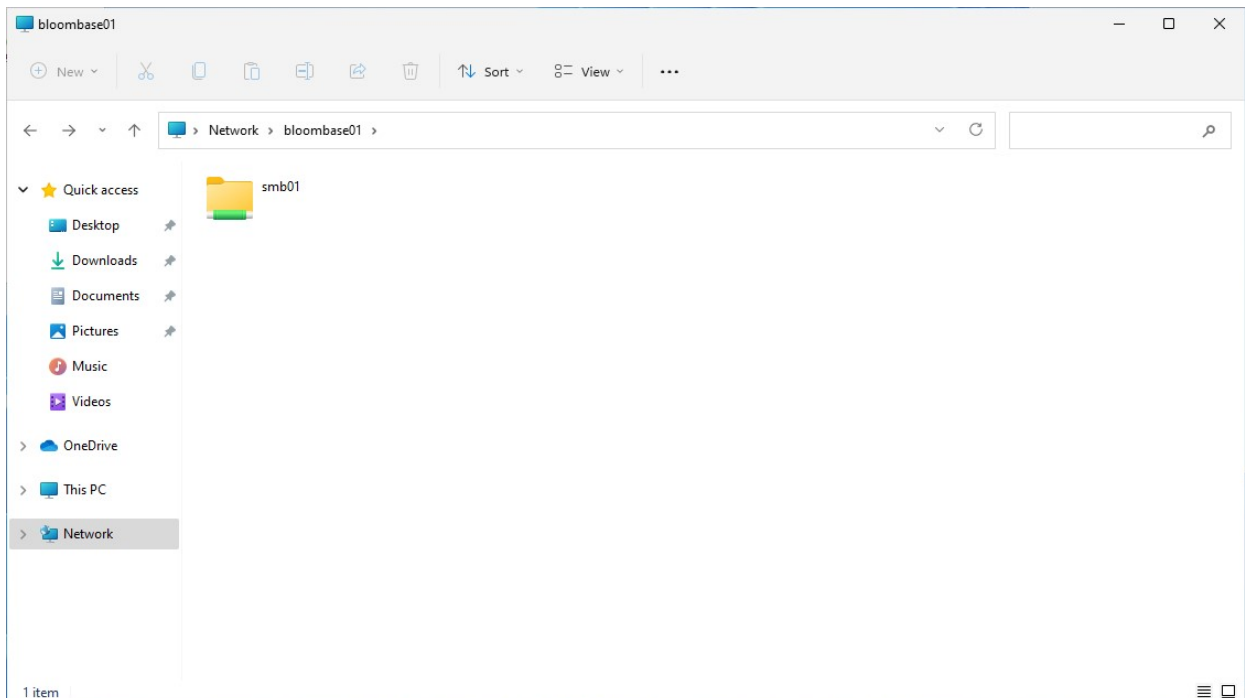
```
user@ubuntu68:~$ nvme --version  
nvme version 1.16
```

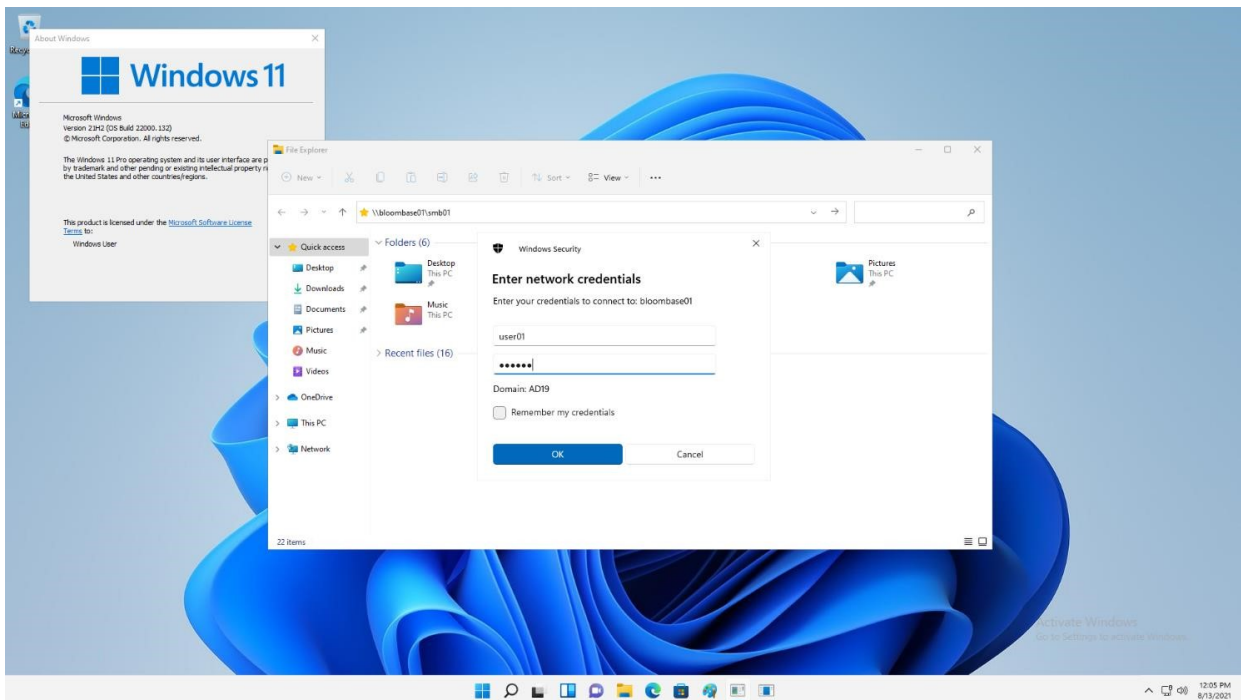
5 Test Cases

5.1 Tests for Data-at-Rest Encryption over SMB

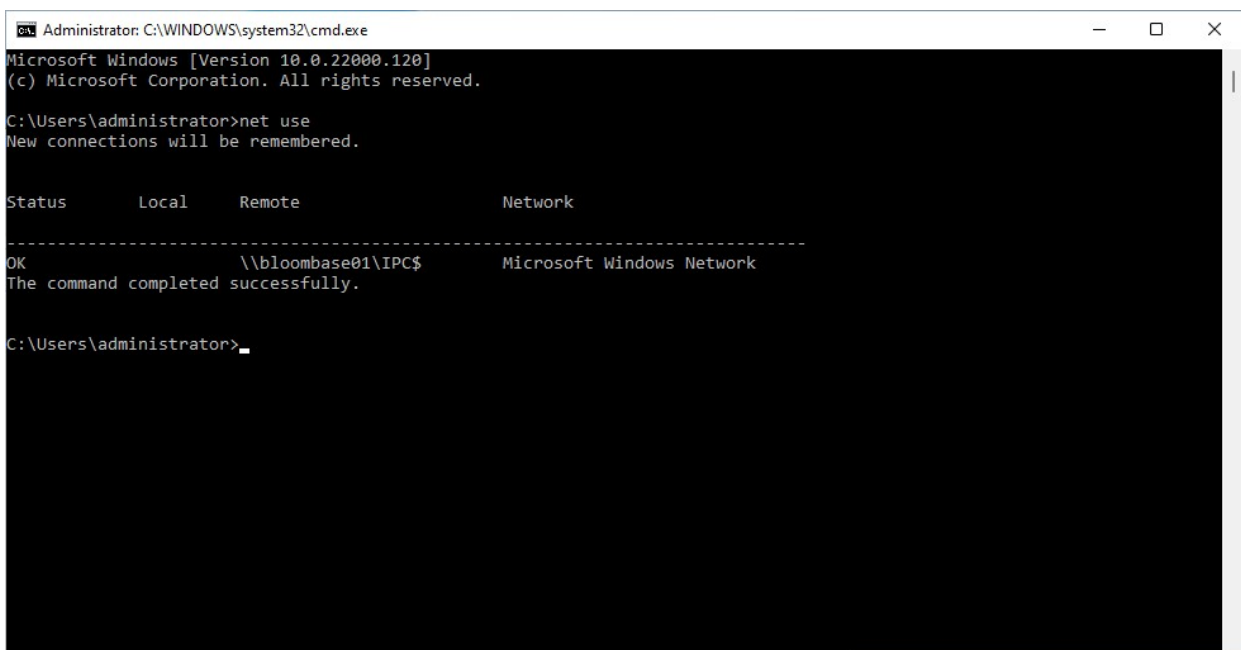
SMB shares are an example from the many protocols Bloombase StoreSafe supports for encryption. A share from a Windows Server 2025 system that is accessible by domain users is created to act as backend storage. Bloombase

StoreSafe creates a virtual encrypted share on its own hostname path that is accessed from a client software system.

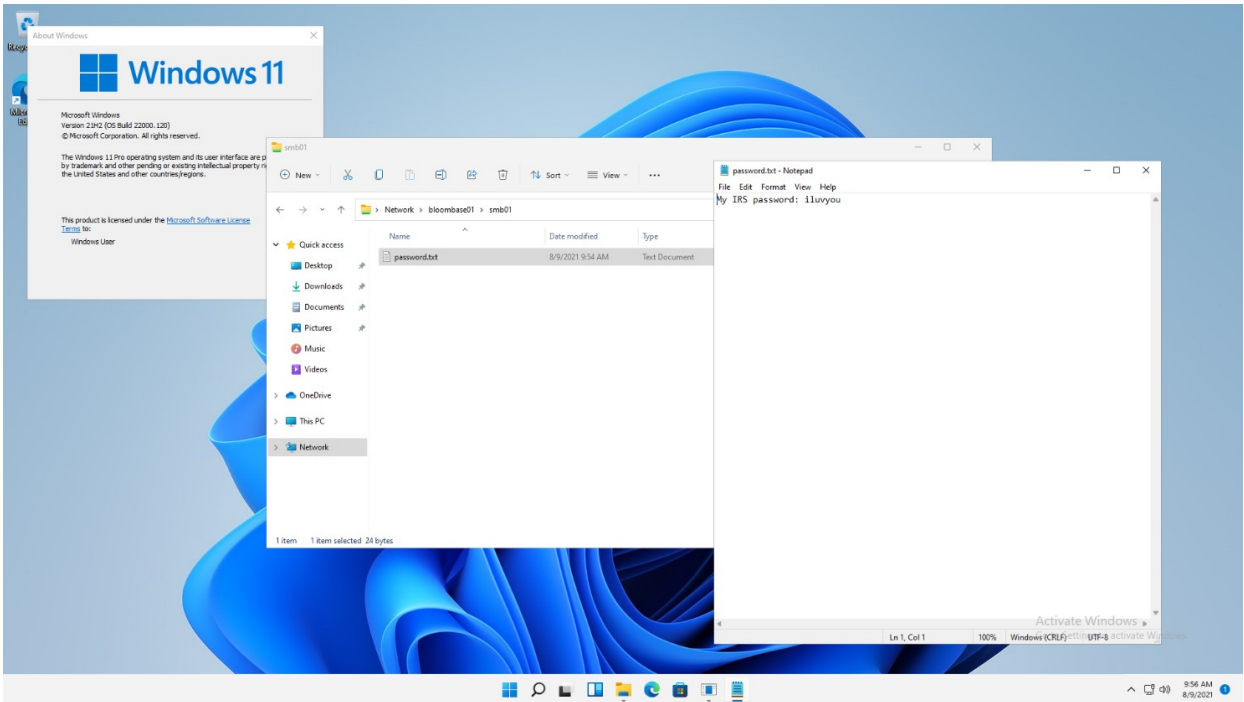




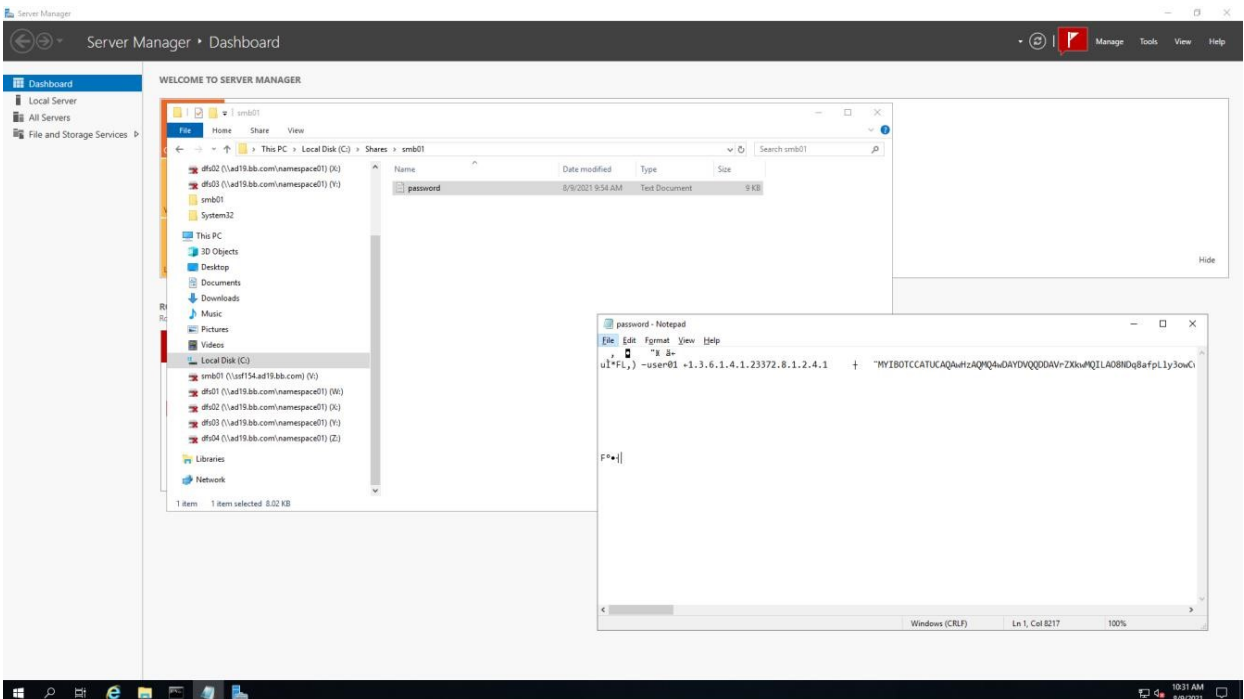
Microsoft Windows 11 clients can use the included network share on file manager to access the SMB share presented by Bloombase StoreSafe Intelligent Storage Firewall. Data owners can alternatively use the Net Use command to specify additional mounting options.



On the demo virtual encrypted SMB share, a sample plaintext file is created by the client and saved. The file is transparently encrypted by the Bloombase StoreSafe encryption engine and stored on the Windows Server 2025 backend share.

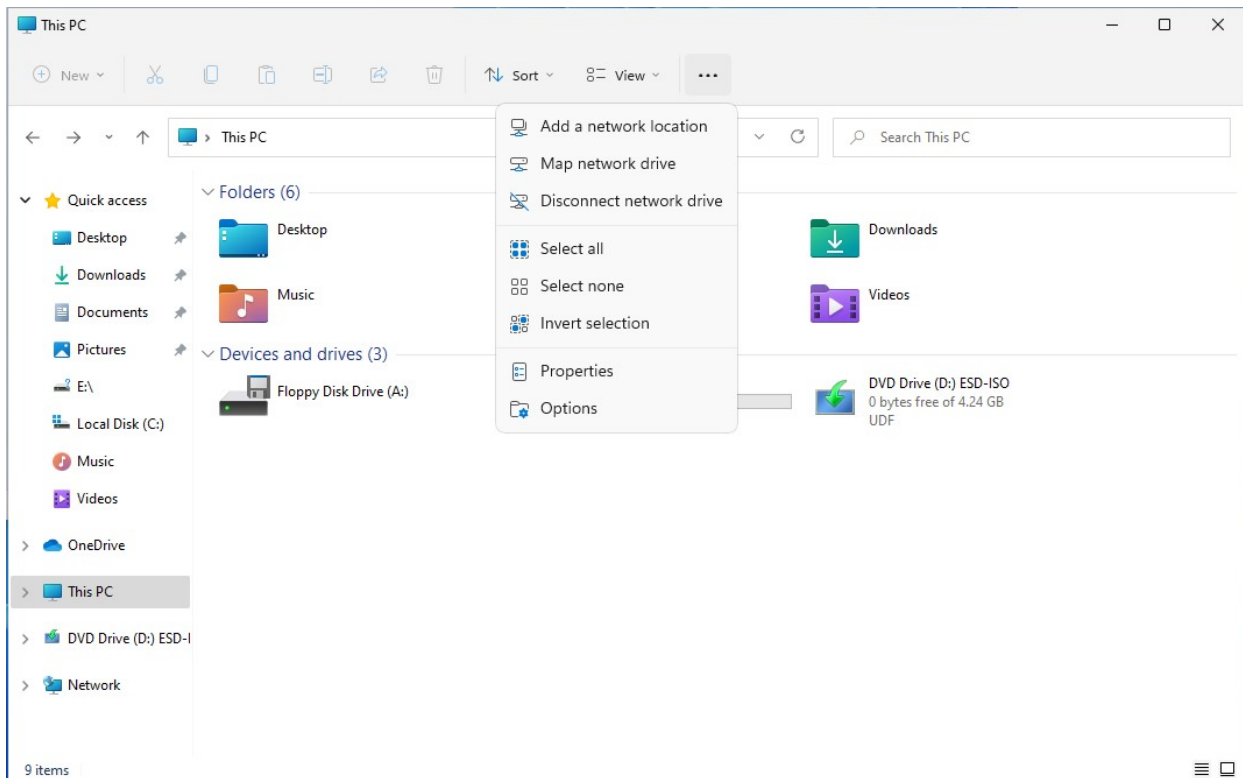


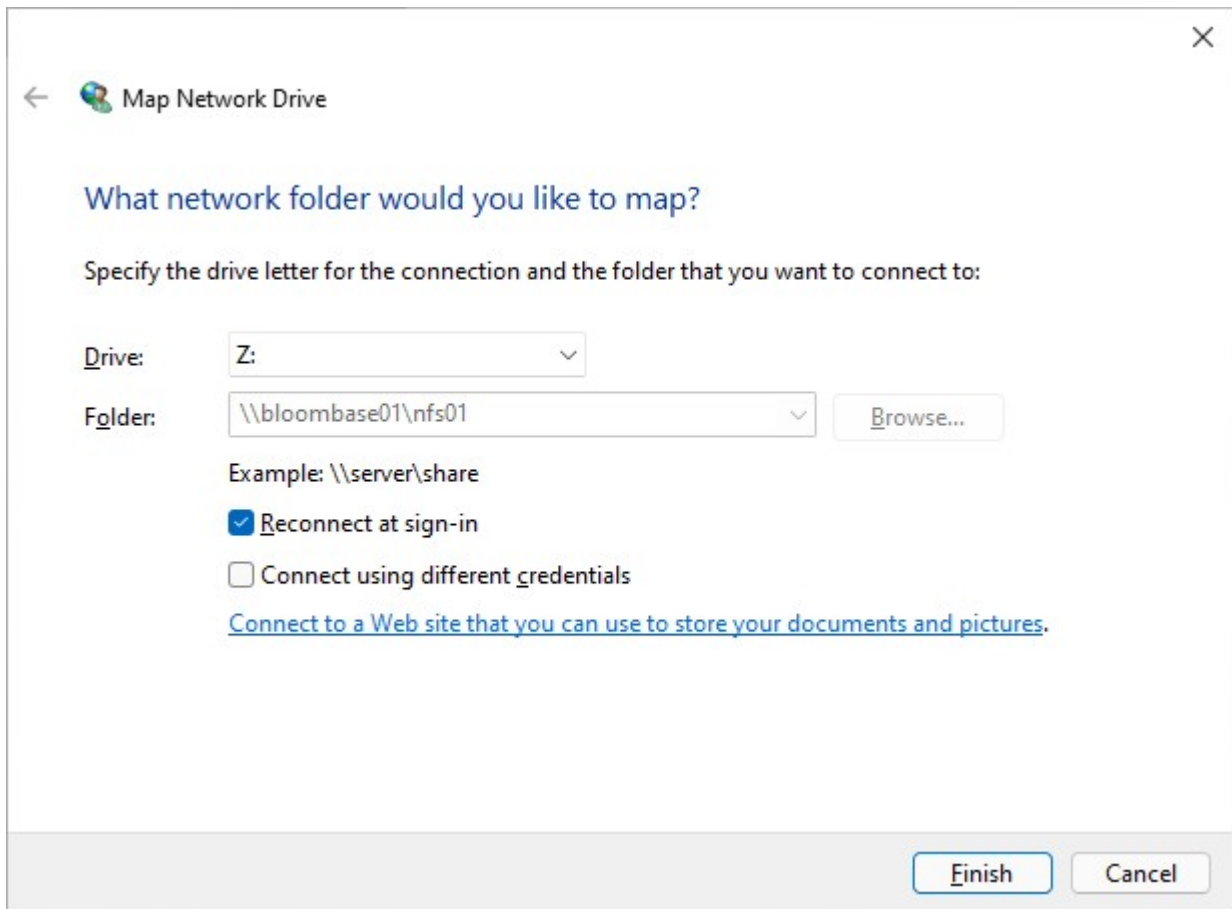
If the application data is attempted to be accessed directly on the backend without going through the Bloombase StoreSafe encryption engine, only ciphertext can be read as expected.



5.2 Tests for Data-at-Rest Encryption over NFS

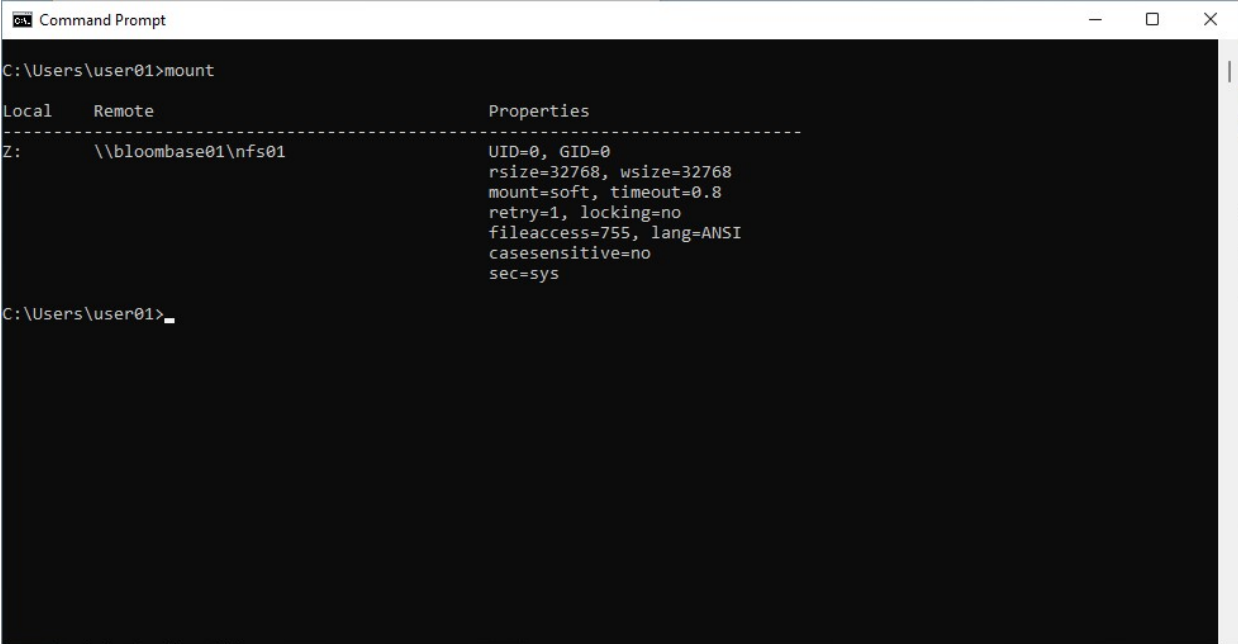
NFS shares are an example from the many protocols Bloombase StoreSafe supports for encryption. A share from a Windows Server 2025 system that is accessible by configure clients is created to act as backend storage. Bloombase StoreSafe creates a virtual encrypted share on its own hostname path that is accessed from a client software system.





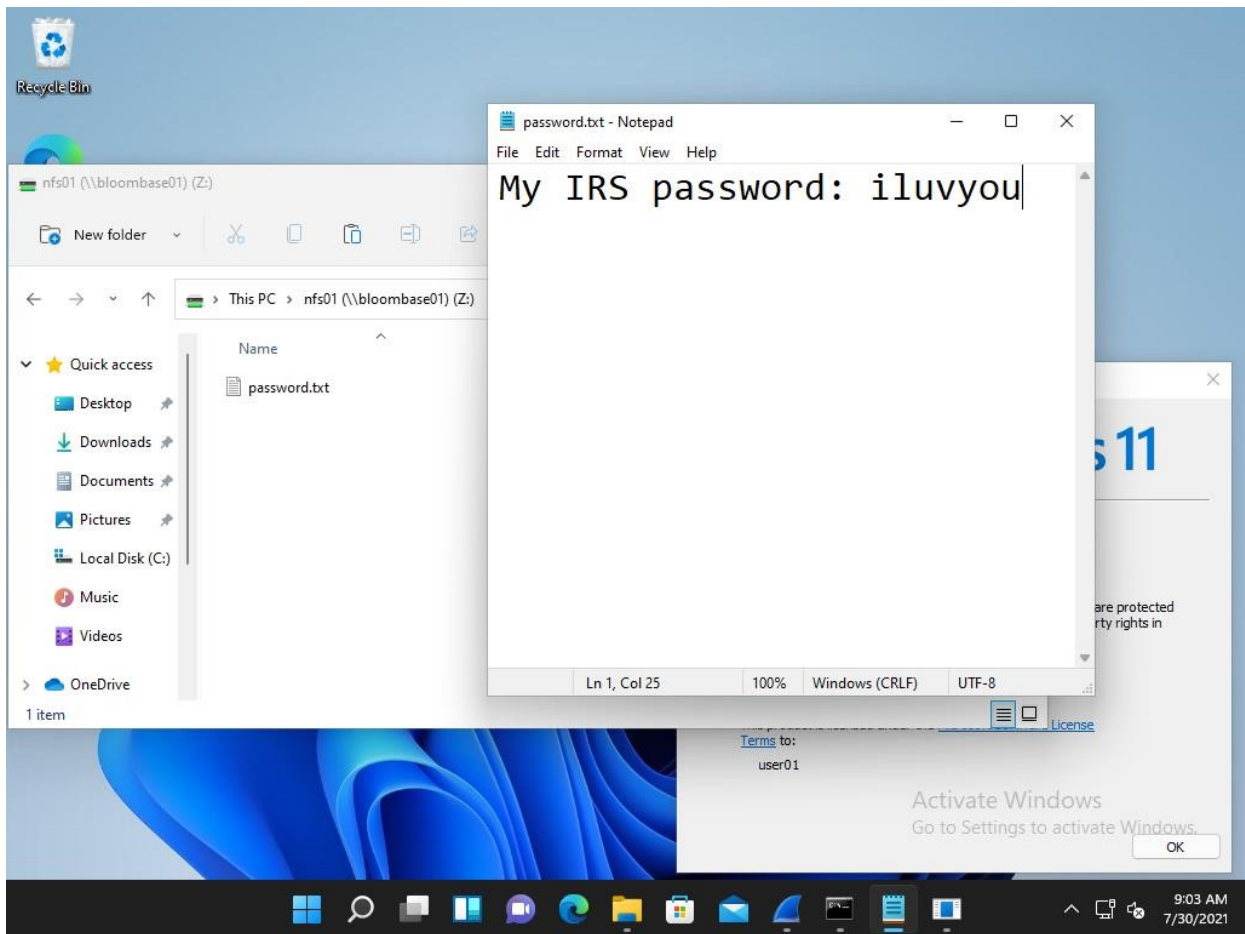
Microsoft Windows 11 clients can use the included map network drive option to add the NFS share presented by

Bloombase StoreSafe Intelligent Storage Firewall with a drive letter. Data owners can alternatively use the mount command to specify additional mounting options.

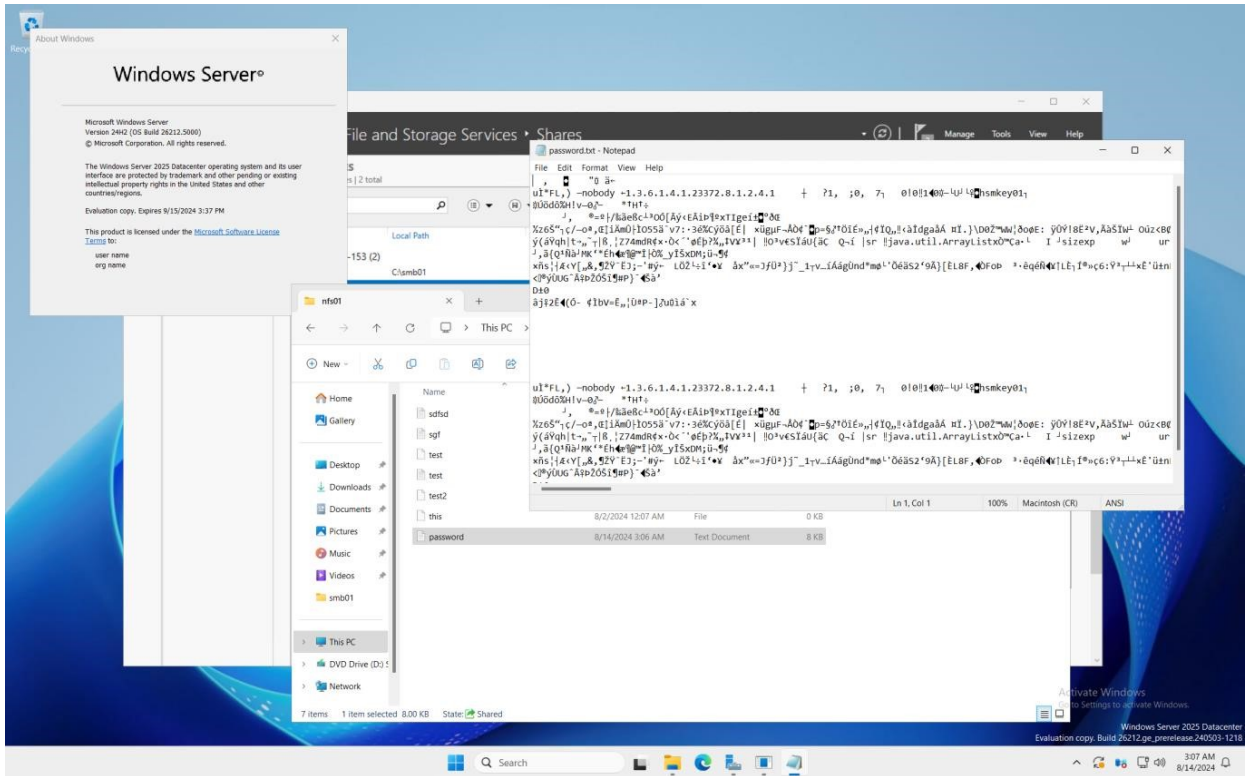


```
Command Prompt
C:\Users\user01>mount
Local      Remote
-----
Z:         \\bloombase01\nfs01
          UID=0, GID=0
          rsize=32768, wsize=32768
          mount=soft, timeout=0.8
          retry=1, locking=no
          fileaccess=755, lang=ANSI
          casesensitive=no
          sec=sys
C:\Users\user01>
```

On the demo virtual encrypted NFS share, a sample plaintext file is created by the client and saved. The file is transparently encrypted by the Bloombase StoreSafe encryption engine and stored on the Microsoft Windows Server 2025 backend share.

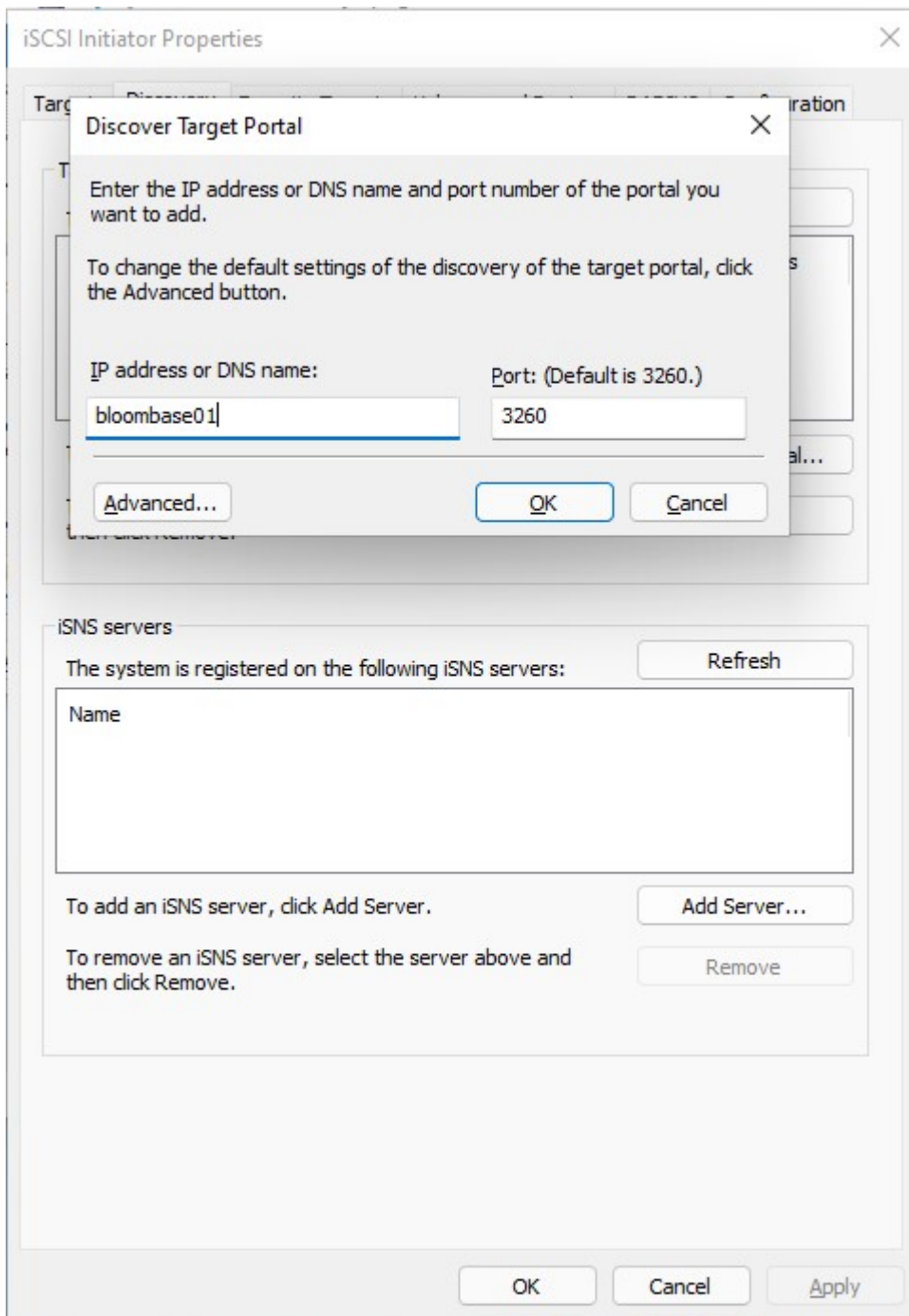


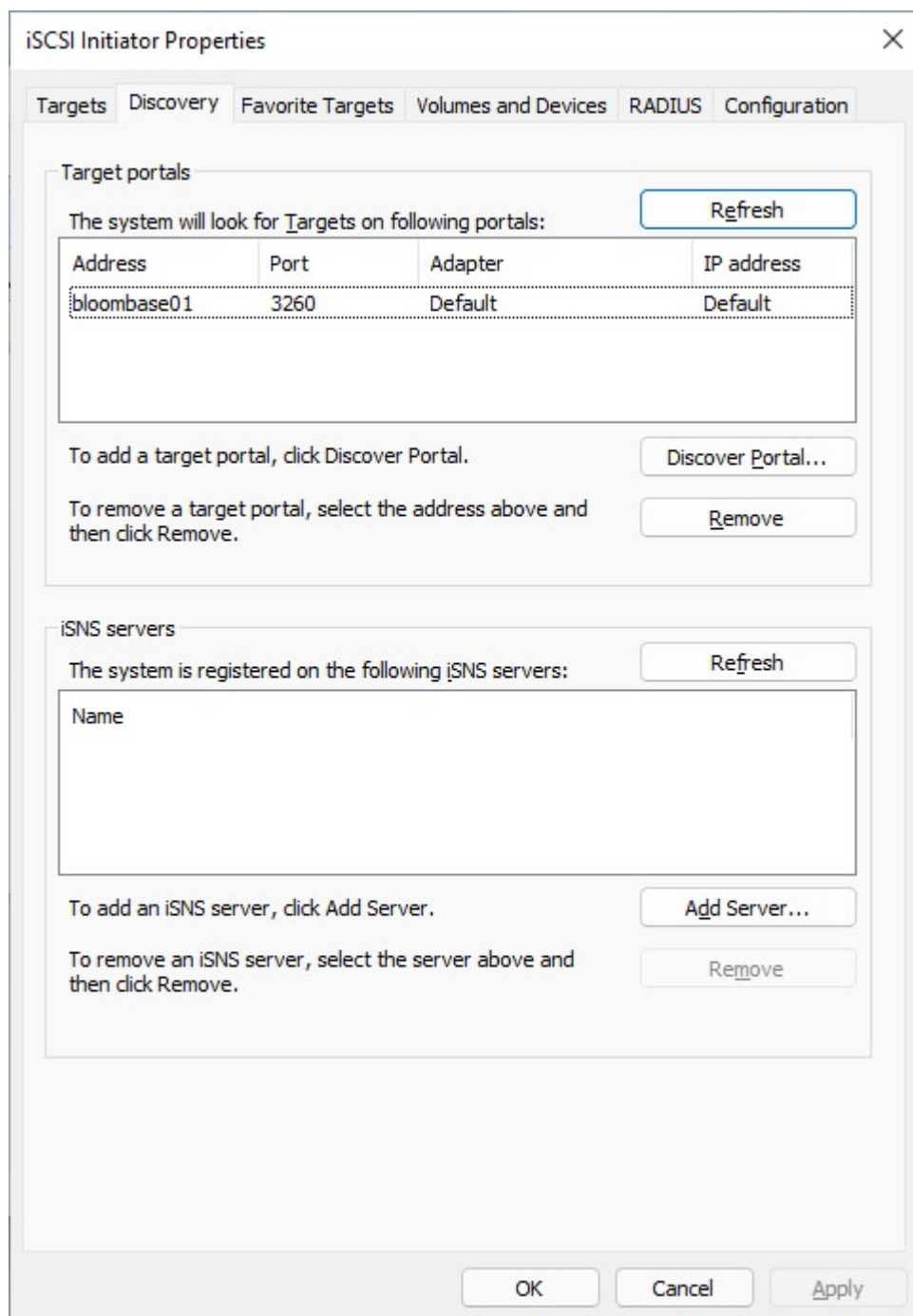
If the application data is attempted to be accessed directly on the backend without going through the Bloombase StoreSafe encryption engine, only ciphertext can be read as expected.



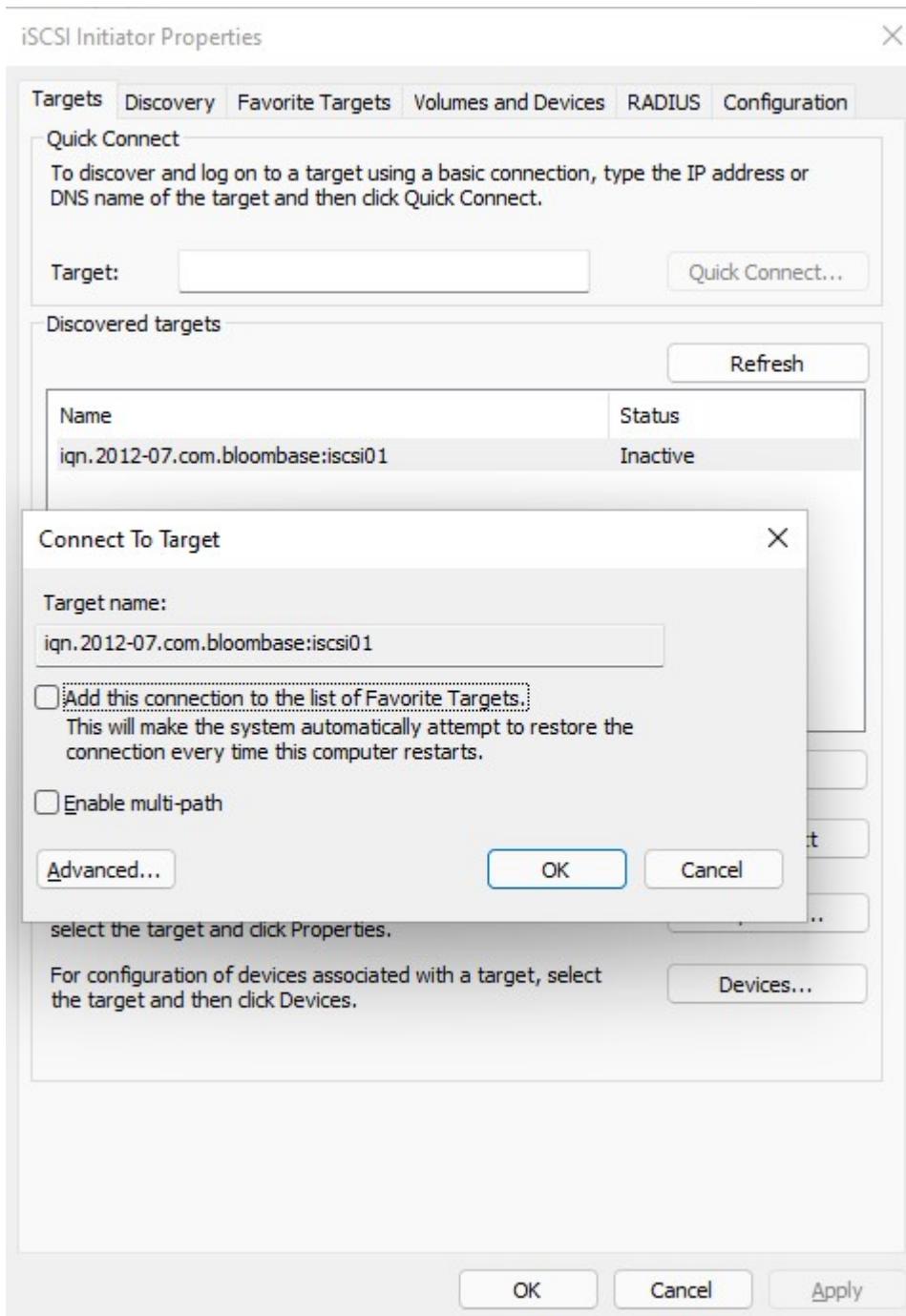
5.3 Tests for Data-at-Rest Encryption over iSCSI

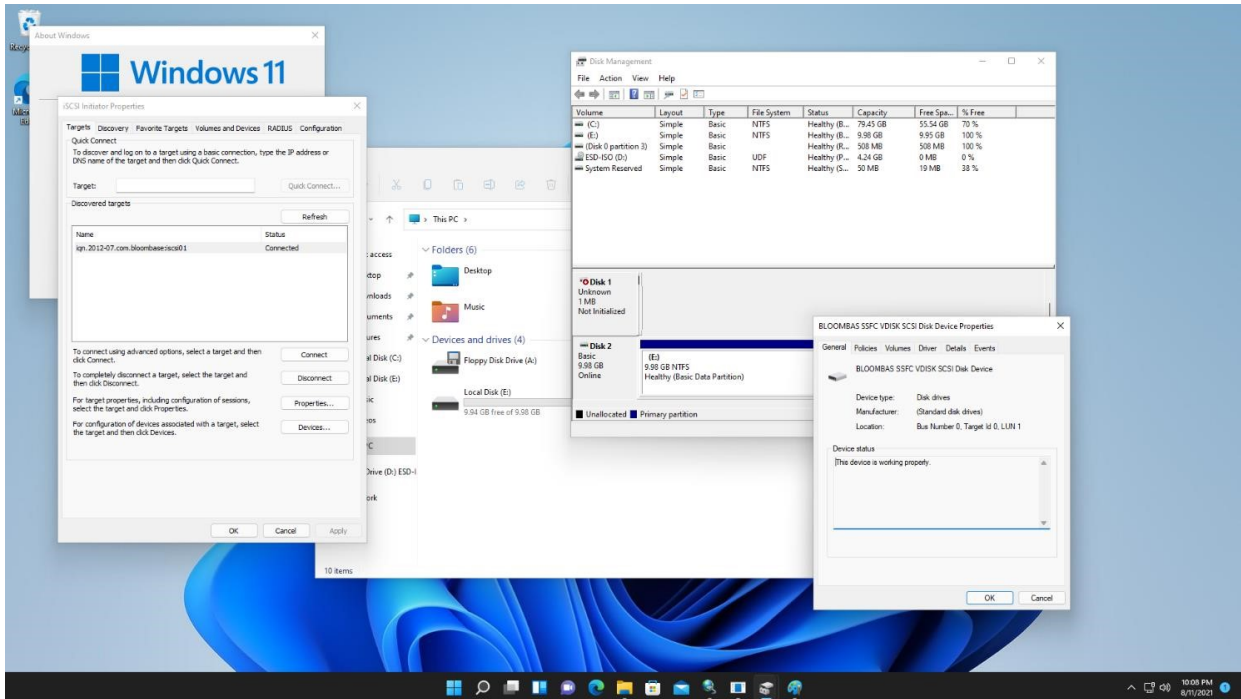
iSCSI targets are an example from the many protocols Bloomberg StoreSafe supports for encryption. A target from a Microsoft Windows Server 2025 system that is accessible by configure clients is created to act as backend storage. Bloomberg StoreSafe creates a virtual encrypted share on its own hostname path that is accessed from a client software system.



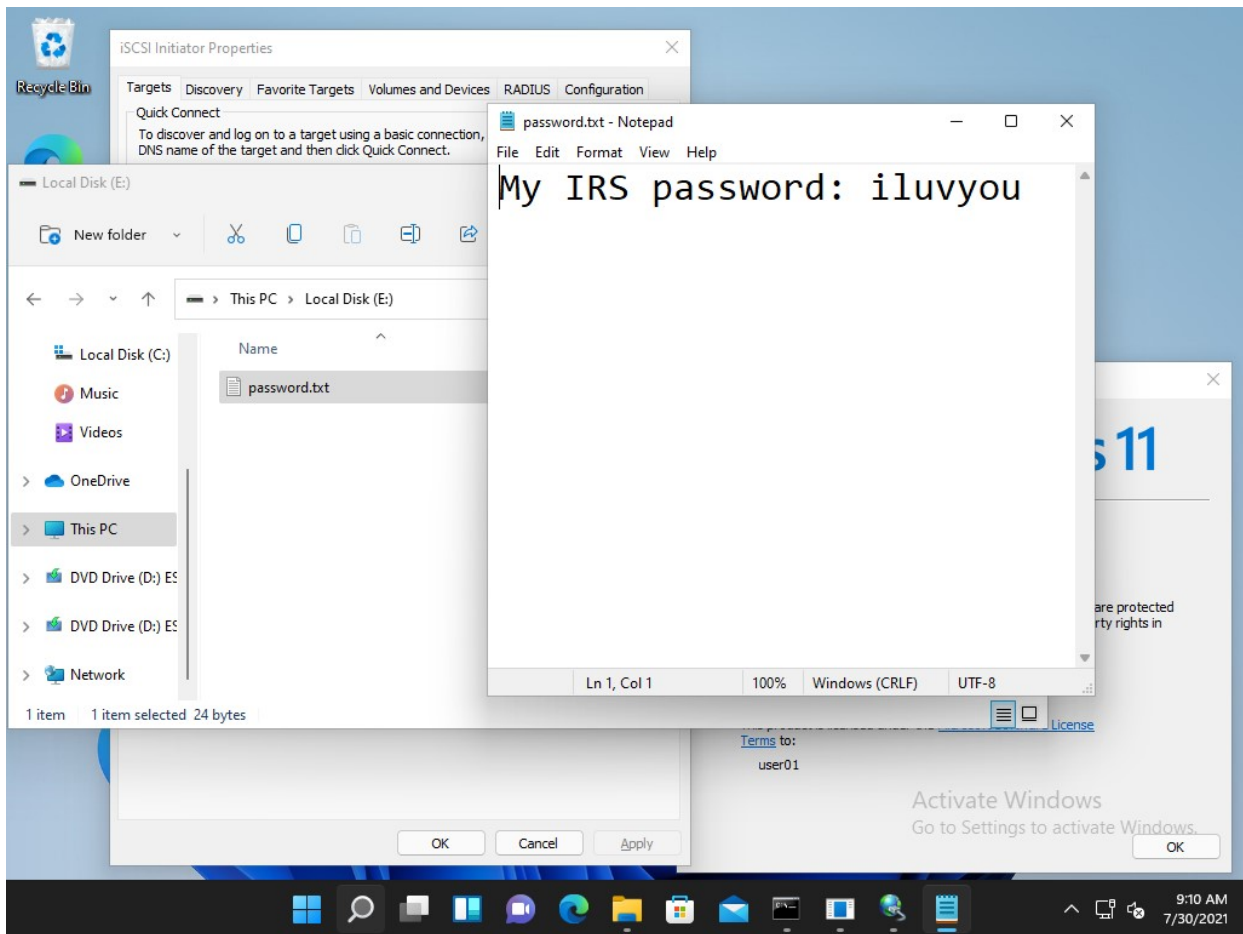


Microsoft Windows 11 clients can attach the virtual encrypted share with the default iSCSI initiator tool. Add the hostname and port to the discover tab, then connect to the iSCSI storage target presented by Bloombase StoreSafe Intelligent Storage Firewall. To access the Bloombase StoreSafe iSCSI disk, make sure the client IQN is added to the Bloombase StoreSafe configuration. The disk will be mounted to the system and it can be formatted with a filesystem.





On the demo virtual encrypted iSCSI target, a sample plaintext file is created by the client and saved. The file is transparently encrypted by the Bloombase StoreSafe encryption engine and stored on the Microsoft Windows Server 2025 storage backend.



If the application data is attempted to be accessed directly on the backend without going through the Bloombase StoreSafe encryption engine, only ciphertext can be read as expected.

```
Administrator: Command Prompt
C:\Users\administrator.AD19\Downloads>hexdump.exe \iscsiVirtualDisks\iscsi-disk01.vhdx
00000000: 76 68 64 78 66 69 6C 65 - 4D 00 69 00 63 00 72 00 |vhdxfileM i c r|
00000010: 6F 00 73 00 6F 00 66 00 - 74 00 20 00 57 00 69 00 |o s o f t W i|
00000020: 6E 00 64 00 6F 00 77 00 - 73 00 20 00 31 00 30 00 |n d o w s 1 0|
00000030: 2E 00 30 00 2E 00 32 00 - 30 00 33 00 34 00 38 00 |. 0 . 2 0 3 4 8|
00000040: 2E 00 30 00 00 00 00 00 - 00 00 00 00 00 00 00 00 |. 0|
00000050: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 00 |
*
00010000: 68 65 61 64 2A 71 DB FD - 0C 00 00 00 00 00 00 00 |head*q|
00010010: 41 5E F1 A0 04 CF 84 4A - AA 33 4E 98 5B 15 1C A8 |A^ J 3N [|
00010020: E7 E7 62 3E 18 A0 5B 40 - 9D 0A F9 B6 F2 9F FD ED |b> [ @|
00010030: 3A E1 8B AB F1 CE FD 48 - A6 66 B3 85 27 CD 36 7E | : H f ' 6~|
00010040: 00 00 01 00 00 00 10 00 - 00 00 10 00 00 00 00 00 |
00010050: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 00 |
*
00020000: 68 65 61 64 5D ED 23 7F - 0D 00 00 00 00 00 00 00 |head] #|
00020010: 41 5E F1 A0 04 CF 84 4A - AA 33 4E 98 5B 15 1C A8 |A^ J 3N [|
00020020: E7 E7 62 3E 18 A0 5B 40 - 9D 0A F9 B6 F2 9F FD ED |b> [ @|
00020030: 3A E1 8B AB F1 CE FD 48 - A6 66 B3 85 27 CD 36 7E | : H f ' 6~|
00020040: 00 00 01 00 00 00 10 00 - 00 00 10 00 00 00 00 00 |
00020050: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 00 |
*
00030000: 72 65 67 69 AE 8C 6B C6 - 02 00 00 00 00 00 00 00 |regi k|
00030010: 66 77 C2 2D 23 F6 00 42 - 9D 64 11 5E 0B FD 4A 08 |fw -# B d ^ J|
00030020: 00 00 30 00 00 00 00 00 - 00 00 10 00 01 00 00 00 |
00030030: 06 A2 7C 8B 90 47 9A 4B - B8 FE 57 5F 05 0F 88 6E | | G K W_ n|
00030040: 00 00 20 00 00 00 00 00 - 00 00 10 00 01 00 00 00 |
00030050: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 00 |
*
```

```
Administrator: Command Prompt
01418fd0: 1E 18 73 08 4E FA 13 3D - 95 59 BA D0 22 2B 8A EC | s N = Y "+|
01418fe0: FB 9C 8E 09 AA 4D B0 B6 - CF BE 6B D5 D2 77 87 30 | M k w 0|
01418ff0: 43 93 80 6C 4A 79 19 F3 - A4 4F 35 E4 AE D0 E3 6E |C lJy; O5 n|
01419000: 4F 30 96 7C 32 4A 3B F1 - 58 F3 B8 E4 63 05 B4 26 |00 |2J; X c &|
01419010: 50 8C 42 75 B6 B5 DA 98 - BE 57 3C 14 C6 C1 F1 DE |P Bu W<|
01419020: 1D 67 64 87 B7 AC A9 07 - 1F 1E EF DB 78 37 7F 98 |gd x7|
01419030: 2F 3B 4B 1C 8E 67 7C 37 - 1B 0B C5 7A 9C 87 E4 47 |/;K g|7 z G|
01419040: B0 E1 63 90 84 91 24 F5 - 8C 42 42 5F A1 8D B6 FF |c $ BB_|
01419050: 8F F2 3D 10 E1 33 5F EB - EC E3 44 E9 19 32 E4 7A | = 3_ D_ 2 z|
01419060: FC DC 3D 63 4A 47 22 71 - D6 C4 F4 47 31 EE B2 2E | =cJG"q G1 .|
01419070: 95 93 FF 79 A1 8F 16 AD - 65 B1 A8 FB 81 D1 7A C2 |y e z|
01419080: 7E 79 83 AD F9 91 49 34 - 78 C2 7C 38 A2 27 8F B7 |~y I4x |8 '|
01419090: 62 77 72 97 DA 1B 58 92 - E8 90 A5 54 69 73 32 A8 |bwr X Tis2|
014190a0: 5E 45 35 02 EC 83 A0 86 - 93 F3 47 08 00 23 A6 F7 |^E5 G #|
014190b0: EA F3 8C 4F 97 FA F3 18 - 39 EC A3 1A 7D 95 C5 49 | 0 9 } I|
014190c0: B4 CE 1E 93 D1 E6 3F 82 - 1C 5D 05 D7 50 9A 2C 9B | ? ] P ,|
014190d0: 6F F8 4F 59 3E 36 82 98 - 14 6D A3 D7 7A 33 92 91 |o OY>6 m z3|
014190e0: 1D 63 8D 22 10 07 3B E9 - F6 72 1D 43 C2 47 5E 0D |c " ; r C G^|
014190f0: 77 3F E2 CA 65 BB C6 47 - 43 76 E7 EB 69 77 16 C2 |w? e Gcv iw|
01419100: 66 30 1E 2D BD 3D FB A6 - 22 5B 19 5E D4 42 E1 F2 |f0 - = "[ ^ B|
01419110: BD FC 54 CB A1 04 0B 21 - 81 35 7C 93 33 8E B4 7F | T ! 5| 3|
01419120: 0D E5 5F 59 2C 93 99 3E - B2 42 C4 21 2B 29 2B 56 | _Y, > B !+)+V|
01419130: C7 CB CD AC 14 81 4B C7 - 4D 59 64 47 BD EB 32 09 | K MYdG 2|
01419140: 39 35 48 BD 4A 59 DF 4C - 83 C9 22 F4 F5 1D DE A5 |95H JY L "|
01419150: 26 35 95 61 E1 39 7C A1 - 68 4A 47 D2 EA 89 EC B5 |&5 a 9| hJG|
01419160: 40 A9 C7 3C 57 70 17 96 - 92 E4 67 93 BD 8E 6C 20 |@ <Wp g 1|
^C
C:\Users\administrator.AD19\Downloads>hexdump.exe \iscsiVirtualDisks\iscsi-disk01.vhdx | Findstr password
C:\Users\administrator.AD19\Downloads>
```

5.4 Tests for Data-at-Rest Encryption over NVMe/TCP

Client that has appropriate access can discover Bloombase StoreSafe Intelligent Storage Firewall virtual storage over NVMe/TCP protocol.

```
[root@bb027 ~]# nvme discover -t tcp -a 192.168.211.24 -s 4420 -q nqn.2014-08.org.nvmeexpress:uuid:cf2eae42-6537-4891-85c2-77bbff4598b8
```

```
trtype: tcp
adrfam: ipv4
subtype: nvme subsystem
treq: not required
portid: 1
trsvcid: 4420
subnqn: nqn.2022-06.io.storesafe:nvme01
traddr: 192.168.211.24
sectype: none
```

Connect client to Bloombase StoreSafe Intelligent Storage Firewall NVMe/TCP virtual storage.

```
[root@bb027 ~]# nvme connect -t tcp -a 192.168.211.24 -s 4420 -q nqn.2014-08.org.nvmexpress:uuid:cf2eae42-6537-4891-85c2-77bbff4598b8 -n nqn.2022-06.io.storesafe:nvme01
```

Ensure that Bloombase StoreSafe Intelligent Storage Firewall virtual storage is attached to the client after successful discovery and connection.

```
[root@bb027 ~]# lsblk
NAME        MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
sda          8:0    0  1.8T  0 disk
├─sda1       8:1    0   600M  0 part /boot/efi
├─sda2       8:2    0    1G    0 part /boot
└─sda3       8:3    0  1.8T  0 part
   ├─r1-root 253:0    0    70G  0 lvm  /
   ├─r1-swap 253:1    0  15.7G  0 lvm  [SWAP]
   └─r1-home 253:2    0  1.8T  0 lvm  /home
nvme0n1     259:0    0  1.1T  0 disk
```

Format and mount Bloombase Storesafe Intelligent Storage Firewall NVMe/TCP virtual storage.

```
[root@bb027 ~]# mount /dev/nvme0n1 /nvme01
[root@bb027 ~]# mount | grep nvme01
/dev/nvme0n1 on /nvme01 type xfs (rw,relatime,seclabel,attr2,inode64,logbufs=8,logbsize=32k,noquota)
[root@bb027 ~]# cd /nvme01/
```

Sample plaintext files have been pre-added into Bloombase StoreSafe Intelligent Storage Firewall NVMe/TCP virtual storage.

```
[root@bb027 nvme01]# ls -l
total 261336
-rw-r--r--. 1 root root    3285 Aug 13  2021  0.seq
-rw-r--r--. 1 root root    3201 Aug 13  2021 100.seq
-rw-r--r--. 1 root root    3066 Aug 13  2021 101.seq
-rw-r--r--. 1 root root    3191 Aug 13  2021 102.seq
-rw-r--r--. 1 root root    3362 Aug 13  2021 103.seq
-rw-r--r--. 1 root root    3275 Aug 13  2021 104.seq
-rw-r--r--. 1 root root    3192 Aug 13  2021 105.seq
-rw-r--r--. 1 root root    3204 Aug 13  2021 106.seq
-rw-r--r--. 1 root root    3200 Aug 13  2021 107.seq
-rw-r--r--. 1 root root    3184 Aug 13  2021 108.seq
-rw-r--r--. 1 root root    3155 Aug 13  2021 109.seq
-rw-r--r--. 1 root root    2993 Aug 13  2021 10.seq
-rw-r--r--. 1 root root    3044 Aug 13  2021 110.seq
-rw-r--r--. 1 root root    3287 Aug 13  2021 111.seq
```

Trusted client is able to access and read the Bloombase StoreSafe encrypted files as if they are in clear-text.

```

/
LOCUS      AQ721632                506 bp    DNA        linear    GSS 09-MAY-2010
DEFINITION HS_5563_B1_B06 T7A RPCI-11 Human Male BAC Library Homo sapiens
            genomic clone Plate=1139 Col=11 Row=D, genomic survey sequence.
ACCESSION  AQ721632
VERSION    AQ721632.1
DBLINK     BioSample: SAMN00183116
KEYWORDS   GSS.
SOURCE     Homo sapiens (human)
  ORGANISM Homo sapiens
            Eukaryota; Metazoa; Chordata; Craniata; Vertebrata; Euteleostomi;
            Mammalia; Eutheria; Euarchontoglires; Primates; Haplorrhini;
            Catarrhini; Hominidae; Homo.
REFERENCE  1 (bases 1 to 506)
  AUTHORS  Mahairas,G.G., Wallace,J.C., Smith,K., Swartzell,S., Holzman,T.,
            Keller,A., Shaker,R., Furlong,J., Young,J., Zhao,S., Adams,M.D. and
            Hood,L.
  TITLE    Sequence-tagged connectors: A sequence approach to mapping and
            scanning the human genome
  JOURNAL  Proc. Natl. Acad. Sci. U.S.A. 96 (17), 9739-9744 (1999)
  PUBMED   10449764
COMMENT    Contact: Mahairas GG, Wallace JC, Hood L
            High Throughput Sequencing Center
            University of Washington
            401 Queen Anne Avenue North, Seattle, WA 98109, USA
            Tel: (206) 616-3618
            Fax: (206) 616-3887
            Email: jwallace@u.washington.edu
"100.seq" 60L, 3201C

```

Any file/data stored via Bloombase StoreSafe Intelligent Storage Firewall NVMe/TCP virtual storage is seamlessly encrypted at the storage with zero operational impact to end users, system administrators and software applications.

```

[root@bb024 ~]# hexdump -C /dev/nvme0n1
00391940 61 cd fa af e1 12 60 48 a0 b9 07 ee 96 c4 58 82 |a....`H.....X.|
00391950 b4 2a 9e 8c 44 ee 9e 93 22 d4 30 88 2e 1f 56 1a |.*..D..."0...V.|
00391960 4e 21 56 87 78 a6 3c 5c 1b dd 93 28 d3 a3 c7 fe |N!V.x.<\...{...|
00391970 02 c7 3f a3 51 2d 2b 7c 2b 32 aa 5a 21 55 06 53 |..?.Q-+|+2.Z!U.S|
00391980 b0 bf dd 43 32 a2 30 49 fc ce c7 e2 8a 51 fe 9d |..C2.OI.....`.|
00391990 1c af 55 9e 50 bc 4c a9 39 eb b0 96 bd d6 60 df |..U.P.L.9.....`.|
003919a0 ed 48 25 bf ae 11 93 90 96 bc 46 5f 6d 18 25 5c |.H%.....F m.%\|
003919b0 e9 ea 62 b0 dc a2 45 75 5c ca 0b 22 df 78 fd b3 |..b...Eu\".x..|
003919c0 05 19 15 26 0f 1c 70 f4 03 09 33 6d eb 67 e2 7e |...&..p...3m.g.~|
003919d0 8f 38 fe 6f 5f 99 b3 d3 4f bb 21 71 9e 6b 67 8a |.8.o_...O.!q.kg.|
003919e0 bb c9 d0 8f c2 10 99 13 fa a3 8d 65 34 36 d1 44 |.....e46.D|
003919f0 96 f0 3f 76 d4 a0 d4 6b 7b 77 c4 1f d8 db 2d db |..?v...k{w....-.|
00391a00 ab 5f 41 9a d4 bc 00 89 6d 3b bb 1f 10 e0 c4 cb |. _A.....m;.....|
00391a10 4d e0 a6 28 ab 3e e6 5a fa ad fe 20 9a 9d ca cd |M..(>.Z... ..|
00391a20 e4 b9 22 fa 61 4a 6e 7b c1 82 4c ad fe 3a 72 d1 |..".aJn{..L.:r.|
00391a30 16 81 a7 32 f6 8c ab 33 f4 ed a0 5d 78 75 d7 9b |...2...3...]xu..|
00391a40 fe f8 7a dc 39 9f 87 75 c4 cd f7 3c bd c2 43 7e |..z.9..u...<..C~|
00391a50 d8 a2 47 6f 98 ea da ed d5 a2 40 c7 44 94 03 df |..Go.....@.D...|

```

```

[root@bb024 ~]# hexdump -C /dev/nvme0n1 | grep SAMN00183116
[root@bb024 ~]#

```

Create a new file to be secured by Bloombase StoreSafe Intelligent Storage Firewall.

```

[root@bb027 nvme01]# vi password.txt

```

```
My IRS password: iloveyou
My Citibank password: qwertyuiop
```

Trusted client is able to access and write files into Bloombase StoreSafe Intelligent Storage Firewall as if they are plain-text files.

```
[root@bb027 nvme01]# ls -l | grep password.txt
-rw-r--r--. 1 root root      60 Oct  5 08:03 password.txt
```

```
[root@bb027 nvme01]# cat password.txt
My IRS password: iloveyou
My Citibank password: qwertyuiop
```

Any file/data stored via Bloombase StoreSafe Intelligent Storage Firewall virtual storage is seamlessly encrypted at the storage with zero operational impact to end users, system administrators and software applications.

```
[root@bb024 ~]# hexdump -C /dev/nvme0n1
```

```
00391940 61 cd fa af e1 12 60 48 a0 b9 07 ee 96 c4 58 82 |a....`H.....X.|
00391950 b4 2a 9e 8c 44 ee 9e 93 22 d4 30 88 2e 1f 56 1a |*..D...".0...V.|
00391960 4e 21 56 87 78 a6 3c 5c 1b dd 93 28 d3 a3 c7 fe |N!V.x.<\... (...|
00391970 02 c7 3f a3 51 2d 2b 7c 2b 32 aa 5a 21 55 06 53 |..?.Q-+|+2.Z!U.S|
00391980 b0 bf dd 43 32 a2 30 49 fc ce c7 e2 8a 51 fe 9d |...C2.0I....Q..|
00391990 1c af 55 9e 50 bc 4c a9 39 eb b0 96 bd d6 60 df |..U.P.L.9.....`.|
003919a0 ed 48 25 bf ae 11 93 90 96 bc 46 5f 6d 18 25 5c |.H%.....F.m.%\|
003919b0 e9 ea 62 b0 dc a2 45 75 5c ca 0b 22 df 78 fd b3 |..b...Eu\..".x..|
003919c0 05 19 15 26 0f 1c 70 f4 03 09 33 6d eb 67 e2 7e |...&..p...3m.g.~|
003919d0 8f 38 fe 6f 5f 99 b3 d3 4f bb 21 71 9e 6b 67 8a |.8.o_...O.!q.kg.|
003919e0 bb c9 d0 8f c2 10 99 13 fa a3 8d 65 34 36 d1 44 |.....e46.D|
003919f0 96 f0 3f 76 d4 a0 d4 6b 7b 77 c4 1f d8 db 2d db |..?v...k{w....-.|
00391a00 ab 5f 41 9a d4 bc 00 89 6d 3b bb 1f 10 e0 c4 cb |. _A.....m;.....|
00391a10 4d e0 a6 28 ab 3e e6 5a fa ad fe 20 9a 9d ca cd |M.. (>.Z... ....|
00391a20 e4 b9 22 fa 61 4a 6e 7b c1 82 4c ad fe 3a 72 d1 |..".aJn{..L.:r.|
00391a30 16 81 a7 32 f6 8c ab 33 f4 ed a0 5d 78 75 d7 9b |...2...3...]xu..|
00391a40 fe f8 7a dc 39 9f 87 75 c4 cd f7 3c bd c2 43 7e |..z.9..u...<..C~|
00391a50 d8 a2 47 6f 98 ea da ed d5 a2 40 c7 44 94 03 df |..Go.....@.D...|
```

```
[root@bb024 ~]# hexdump -C /dev/nvme0n1 | grep password
[root@bb024 ~]#
```

6 Conclusion

In this integration guide, we have shown how to set up Bloombase StoreSafe Intelligent Storage Firewall with Utimaco ESKM to deliver on-the-fly encryption of multiple storage protocols including SMB, NFS, iSCSI and NVMe/TCP. The end result is a high-bandwidth, application-transparent storage encryption solution with centralized key management that locks down sensitive crown-jewel data on disks and helps mitigate information exfiltration threats for mission-critical systems and data services.

As a summary,

- Utimaco ESKM 8.52.1

has been integrated with Bloombase StoreSafe Intelligent Storage Firewall to deliver encryption security of Microsoft Storage Server on Microsoft Windows Server 2025 over SMB/CIFS, NFS, iSCSI and Rocky Linux 9 via NVMe/TCP network storage protocols for software applications running on Microsoft Windows 11 and Ubuntu 22.04 LTS.

Bloombase Product	Client Systems	Storage Backends	Key Management System
Bloombase StoreSafe Intelligent Storage Firewall 4.0	<ul style="list-style-type: none"> ▪ Microsoft Windows 11 ▪ Ubuntu 22.04 LTS 	<ul style="list-style-type: none"> ▪ Microsoft Windows Server 2025 ▪ Rocky Linux 9 	Utimaco ESKM 8.52.1

7 Disclaimer

The integration procedures described in this paper were conducted in the Bloombase InteropLab. Bloombase has not tested this configuration with all the combinations of hardware and software options available. There may be significant difference in your configuration that will change the procedures necessary to accomplish the objectives outlined in this paper. If you find that any of these procedures do not work in your environment, please contact us immediately.

8 Acknowledgement

Bloombase InteropLab would like to thank Utimaco team for supporting the integration of Bloombase StoreSafe with Utimaco ESKM.

9 Reference

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