



Bloombase StoreSafe and IBM Guardium Key Lifecycle Manager Integration Guide for Data-at-Rest Encryption

November 2025

BLOOMBASE®

Executive Summary

IBM Guardium Key Lifecycle Manager (GKLM) has been validated by Bloombase InteropLab to run with Bloombase StoreSafe Intelligent Storage Firewall. This document describes the steps carried out to integrate IBM GKLM with Bloombase StoreSafe software appliance on Broadcom VMware ESXi to deliver high bandwidth transparent storage encryption on Terabit Ethernet for mission critical software applications. Client host systems Microsoft Windows 11 and Ubuntu 22.04 LTS have been tested with IBM GKLM and Bloombase StoreSafe storage firewall solution to secure Microsoft Storage Server 2025 and Rocky Linux 9 storage backends via storage networking protocols including SMB, NFS, iSCSI and NVMe/TCP.

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Purpose and Scope

This document describes the steps necessary to integrate IBM GKLM 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 IBM GKLM
- Integrate Microsoft Windows 11 and Ubuntu 22.04 LTS client systems with Bloombase StoreSafe and IBM GKLM 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.

Assumptions

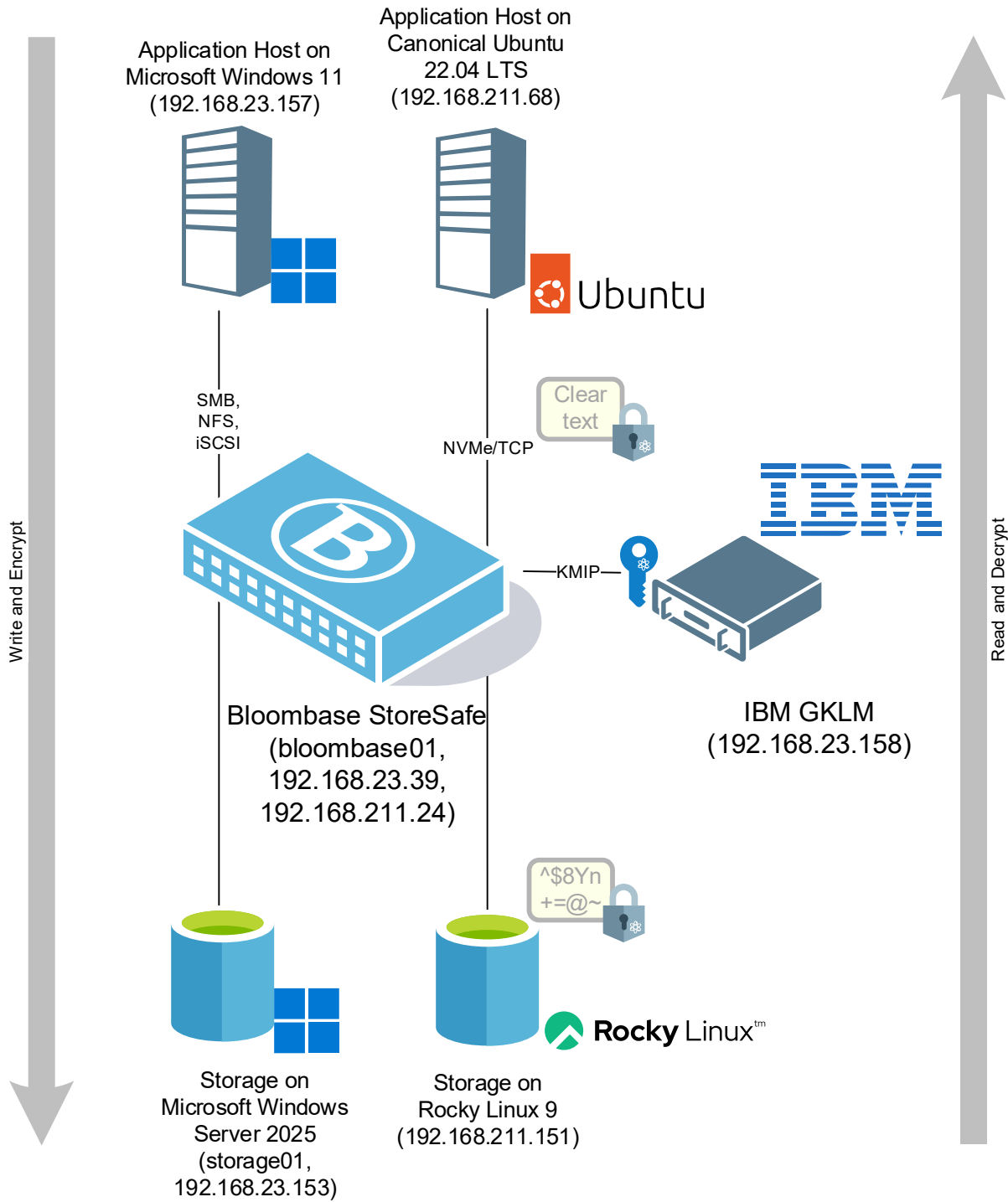
This document describes the integration of IBM GKLM with Bloombase StoreSafe. It is assumed that you are familiar with operation of IBM GKLM, storage systems, and major operating systems including Linux, Microsoft Windows, IBM AIX, HP-UX and Oracle Sun Solaris. It is also assumed that you possess basic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

As IBM GKLM 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 IBM GKLM 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>.

Infrastructure

Setup

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



Storage Encryption

Storage Encryption	Bloombase StoreSafe Intelligent Storage Firewall Software Appliance v4.0
Server	Broadcom VMware ESXi 6.5 on Dell PowerEdge T440 server
Processor	4x Virtual CPU (vCPU)
Memory	8GB
Network Interface Card	NVIDIA ConnectX-6

Key Management System

Key Management System	IBM Guardium Key Lifecycle Manager (GKLM) 5.0
------------------------------	-----------------------------------------------

Storage Systems

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

Client Hosts	Microsoft Windows 11	Ubuntu 22.04 LTS
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Networking

Ethernet Switch	Celestica Seastone DX010 32-port 100GbE ONIE Switch
Network Interface Card	NVIDIA ConnectX-6
Network Cables	NVIDIA/Mellanox 100GbE QSFP28 DAC Cables

Configuration Overview

IBM Guardium Key Lifecycle Manager (GKLM)

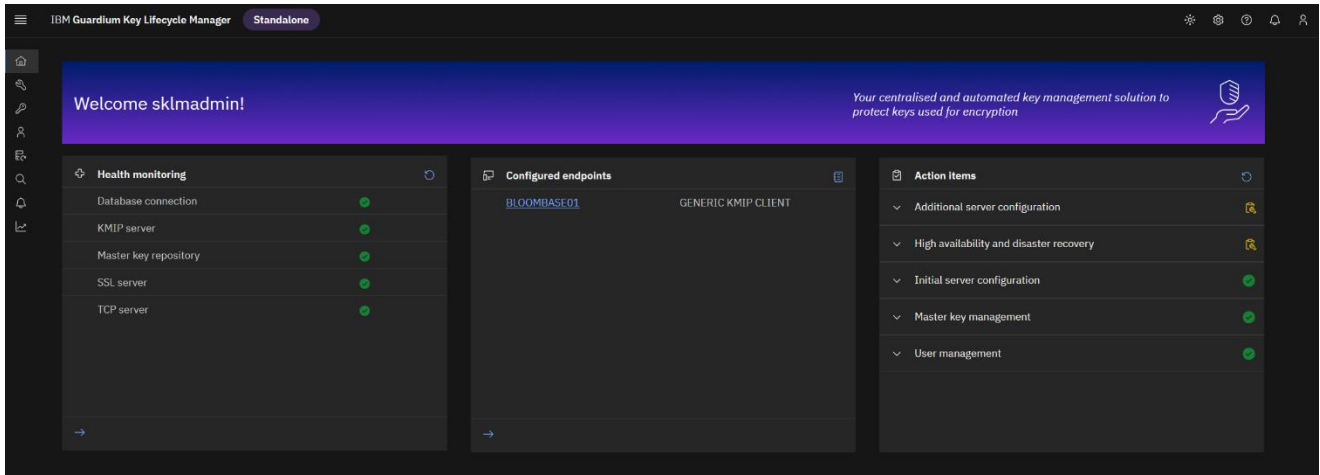
IBM Guardium Key Lifecycle Manager is an encryption key management tool that centralizes, simplifies and automates the key management process. It offers robust and security-rich key storage, key serving and key lifecycle management for encryption applications and solutions by using interoperability protocols, including KMIP.

The IBM GKLM can provide central management and secure storage of encryption keys used by Bloombase StoreSafe products. It provides intuitive web-based console, and APIs for managing of encryption keys.

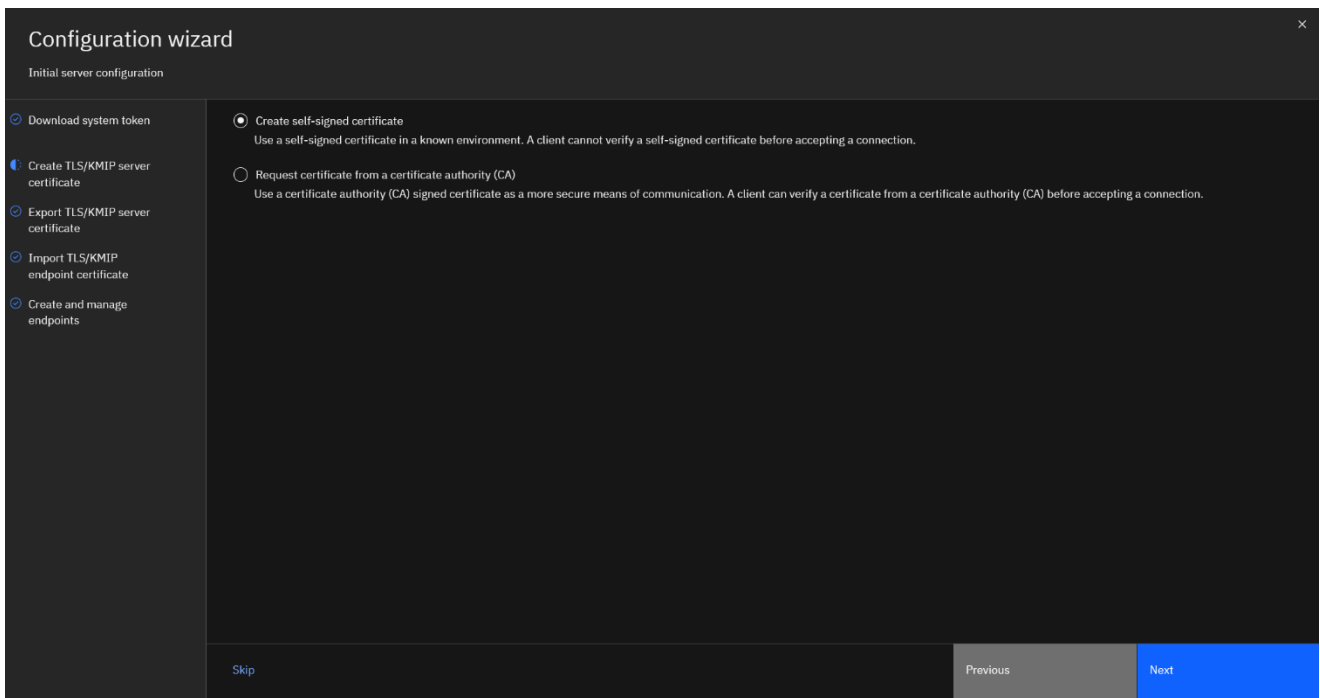
The KMIP services provided by IBM GKLM are used by Bloombase StoreSafe for encryption protection of data-at-rest use cases.

IBM GKLM Configurations

In this demo, an IBM Guardium Key Lifecycle Manager (GKLM) is installed and configured as a single node network attached virtual appliance with IP address 192.168.23.158 assigned.



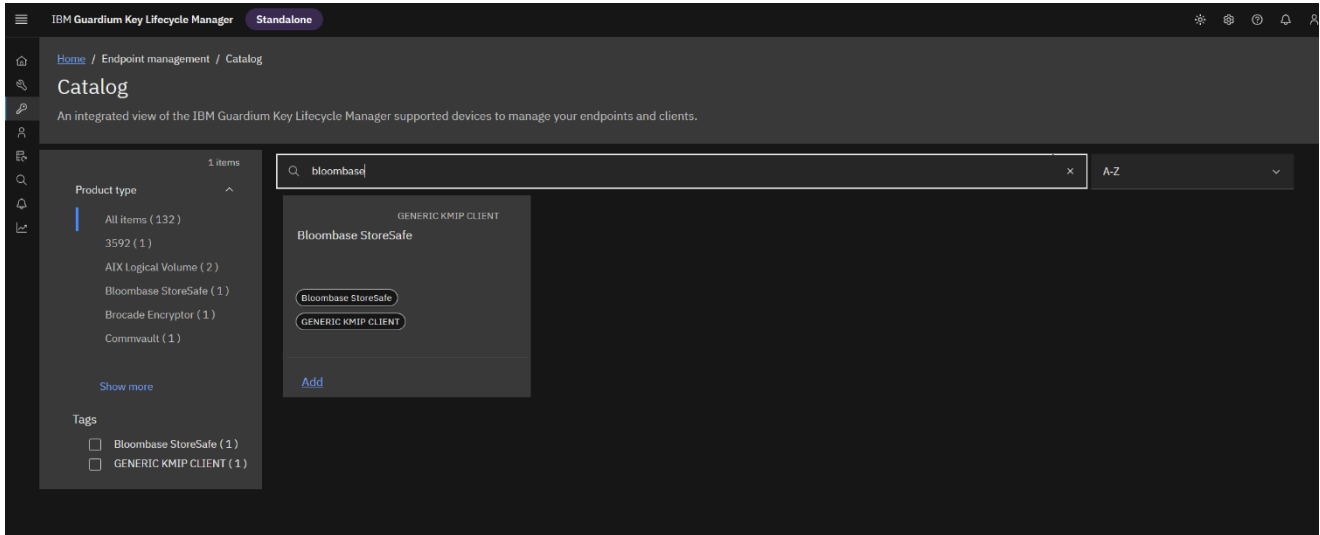
IBM GKLM can be managed remotely via web-based management console at port 9443. During initial server configuration, a KMIP certificate needs to be chosen. This certificate needs to be downloaded for use with the Bloombase StoreSafe client.



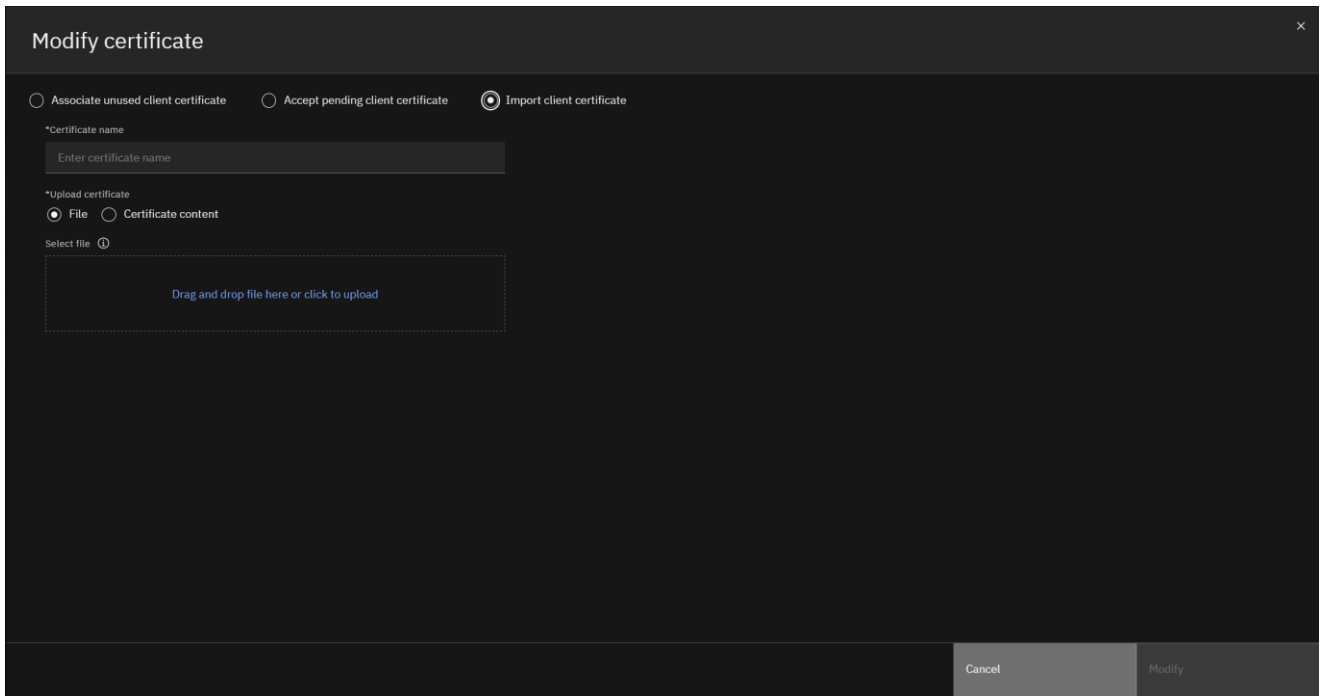
KMIP Client

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

A Bloombase StoreSafe profile can be found in the GKLM catalog.



The client certificate can either be uploaded manually or accepted after a connection attempt.



The KMIP client and GKLM certificate are later added to the Bloombase StoreSafe web management console.

Network Configuration

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-6 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: 100GBASE-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
```

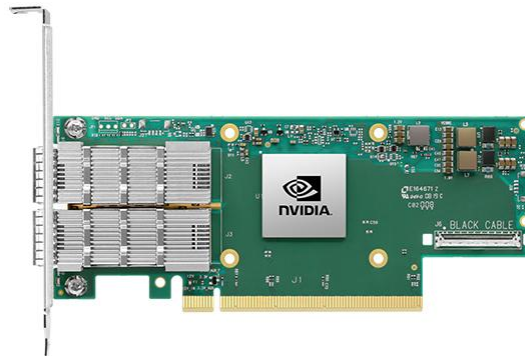
Direct Attach Copper (DAC) Cable

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



Network Interface Card (NIC)

NVIDIA ConnectX-6 NIC has been used in this integration testing.



Install and configure NVIDIA ConnectX-6 NIC using the install image or the driver available from your distribution's repo.

```
[root@rocky24 ~]# lspci |grep ConnectX
01:00.0 Ethernet controller: Mellanox Technologies MT42822 BlueField-2 integrated ConnectX-6 Dx network controller (rev 01)
01:00.1 Ethernet controller: Mellanox Technologies MT42822 BlueField-2 integrated ConnectX-6 Dx network controller (rev 01)
```

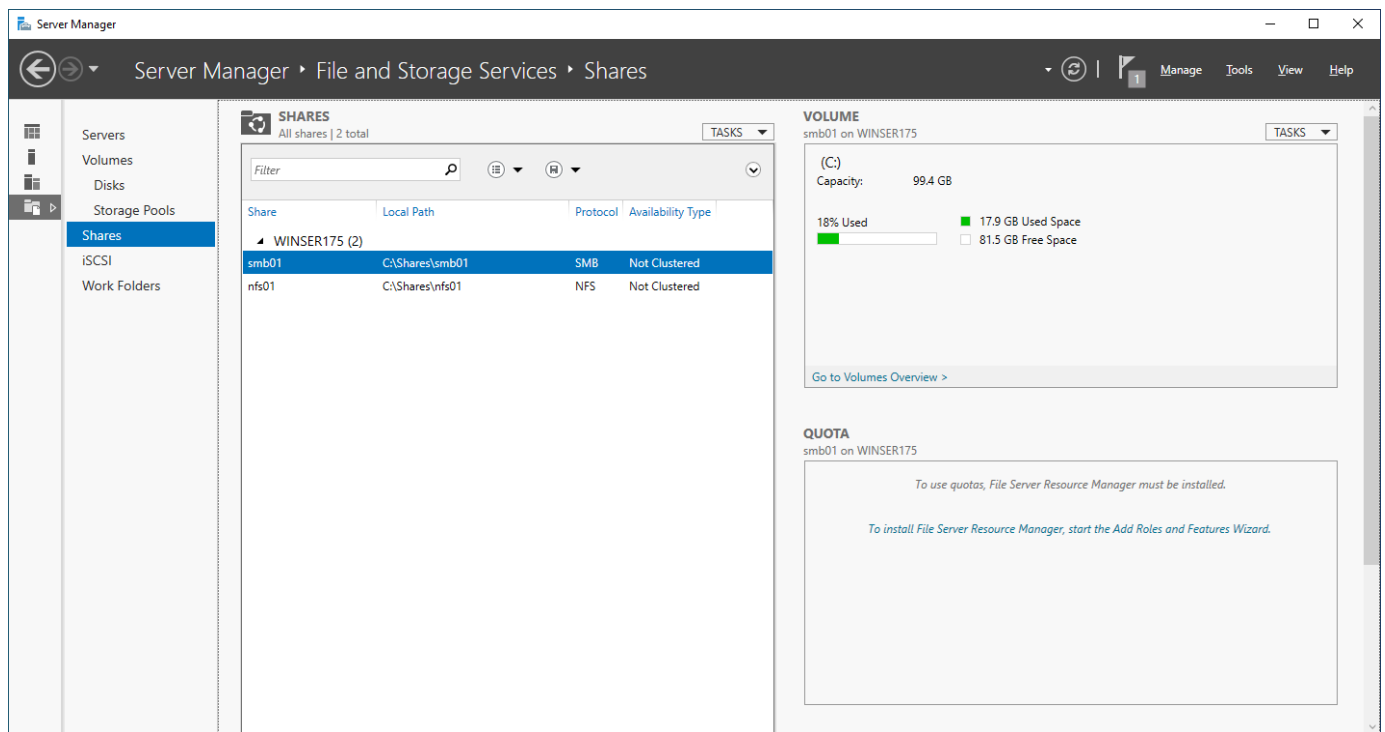
```
[root@rocky24 ~]# ibstat
CA 'mlx5_0'
  CA type: MT41686
  Number of ports: 1
  Firmware version: 24.39.2048
  Hardware version: 1
  Node GUID: 0xb8cef60300d214b2
  System image GUID: 0xb8cef60300d214b2
  Port 1:
    State: Active
    Physical state: LinkUp
    Rate: 40
    Base lid: 0
    LMC: 0
    SM lid: 0
    Capability mask: 0x00010000
    Port GUID: 0xbacef6fffed214b2
    Link layer: Ethernet
CA 'mlx5_1'
  CA type: MT41686
  Number of ports: 1
  Firmware version: 24.39.2048
  Hardware version: 1
  Node GUID: 0xb8cef60300d214b3
  System image GUID: 0xb8cef60300d214b2
  Port 1:
    State: Active
    Physical state: LinkUp
    Rate: 40
    Base lid: 0
    LMC: 0
    SM lid: 0
    Capability mask: 0x00010000
    Port GUID: 0xbacef6fffed214b3
    Link layer: Ethernet
```

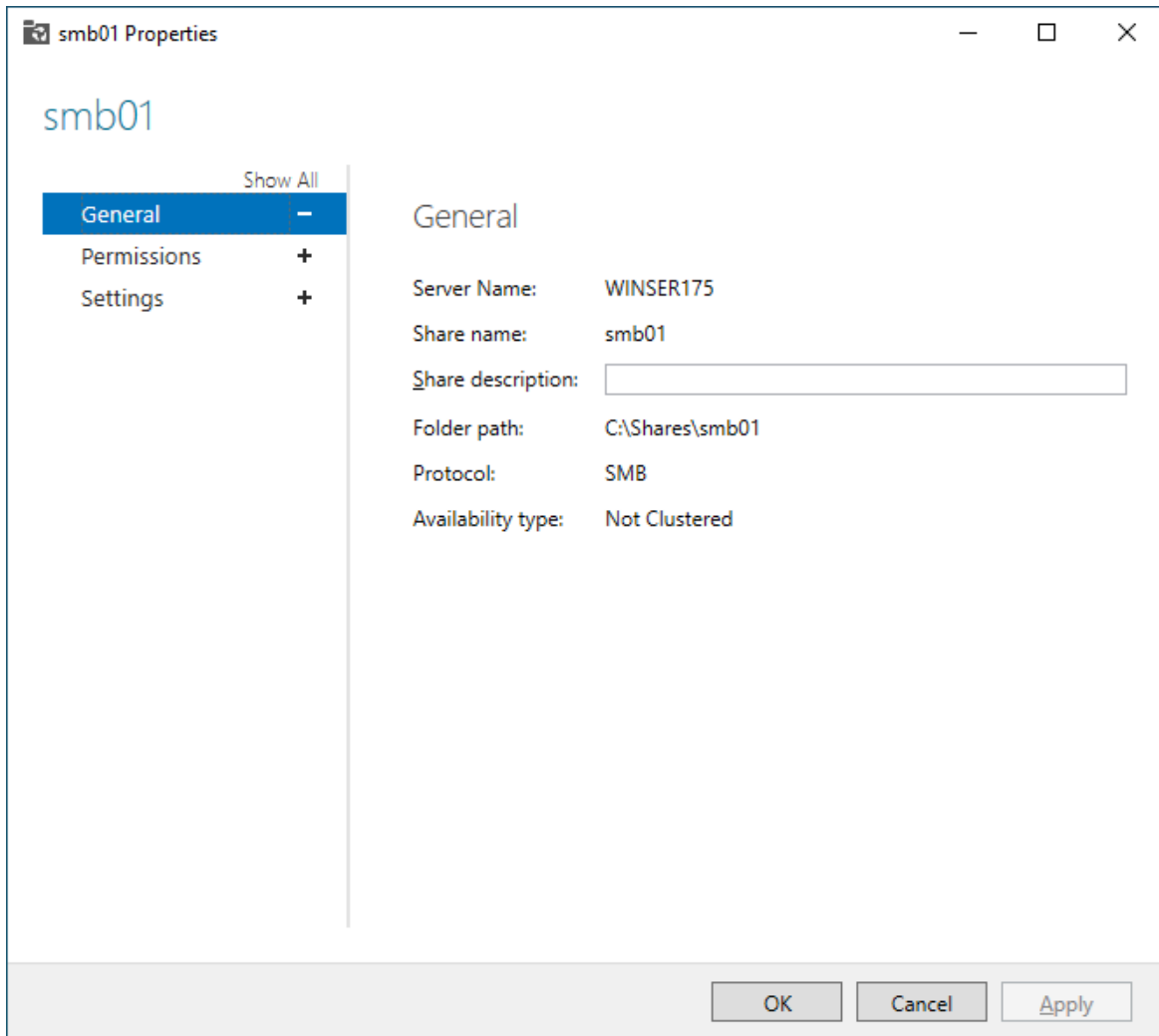

Microsoft Storage Server on Microsoft Windows Server 2025 Storage Backends

Microsoft Storage Server on Microsoft Windows Server 2025 running on Broadcom 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 Broadcom VMware ESXi.

SMB Services Configuration





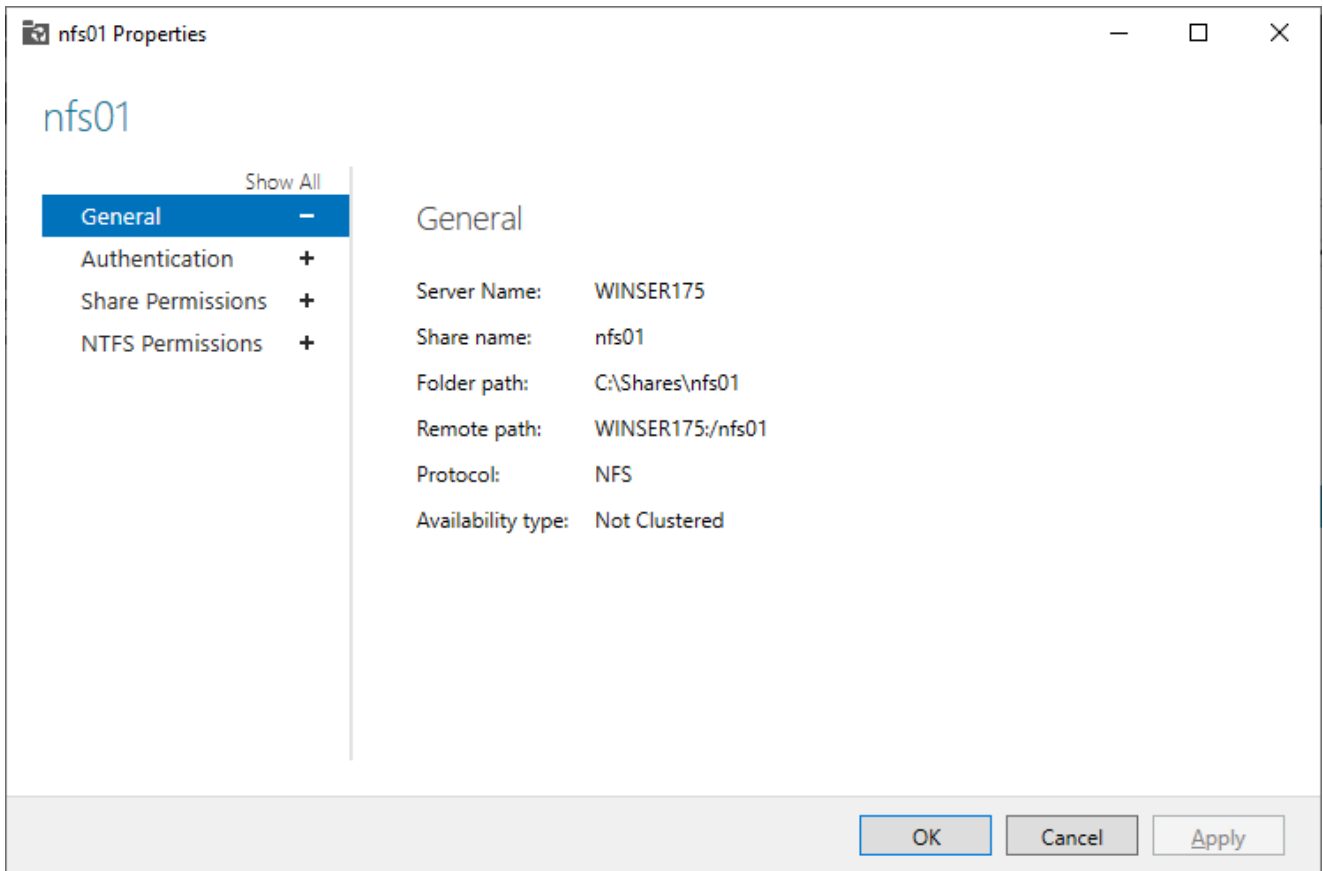
Microsoft Windows Server 2025 File Management is configured to provide the SMB share backend storage to client system users.

NFS Services Configuration

The screenshot displays the Windows Server Manager interface for configuring NFS services. The left-hand navigation pane shows the hierarchy: Servers > File and Storage Services > Shares. The main area is divided into three sections:

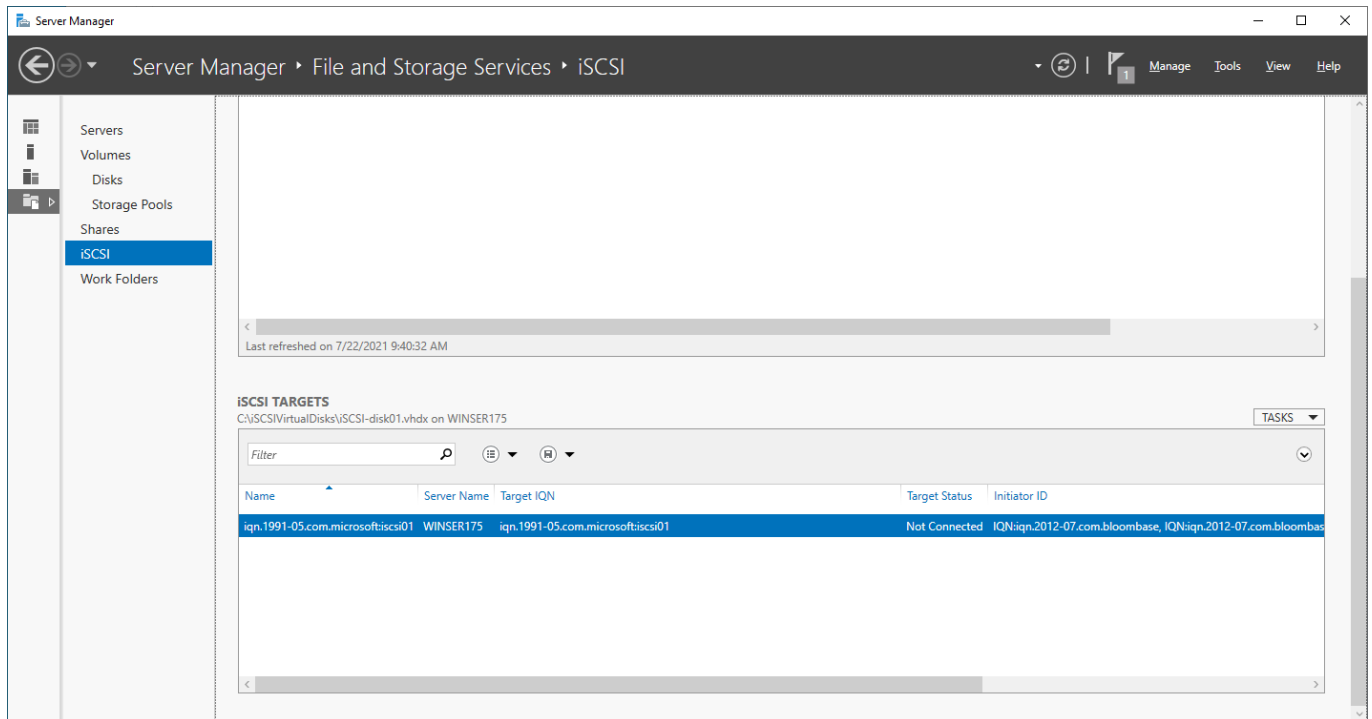
- SHARES**: A table listing shares on the server WINSER175. The table has columns for Share, Local Path, Protocol, and Availability Type. Two shares are listed: smb01 (SMB, Not Clustered) and nfs01 (NFS, Not Clustered).
- VOLUME**: A section for the smb01 share on WINSER175. It shows a capacity of 99.4 GB. A progress bar indicates that 18% of the space is used (17.9 GB), leaving 81.5 GB free.
- QUOTA**: A section for the smb01 share on WINSER175. It contains a message: "To use quotas, File Server Resource Manager must be installed. To install File Server Resource Manager, start the Add Roles and Features Wizard."

Share	Local Path	Protocol	Availability Type
WINSER175 (2)			
smb01	C:\Shares\smb01	SMB	Not Clustered
nfs01	C:\Shares\nfs01	NFS	Not Clustered



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

iSCSI Services Configuration



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

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@carocky151 ~]# nmctcli
/> ls
o- /
  o- hosts ..... [..]
  | o- nqn.2014-08.org.nvmexpress:uuid:4af97520-1bfe-4c8d-9069-5fb9ab632709 ..... [..]
  o- ports ..... [..]
  | o- 1 ..... [trtype=tcp, traddr=192.168.211.151, trsvcid=4420, inline_data_size=16384]
  | | o- ana_groups ..... [..]
  | | | o- 1 ..... [state-optimized]
  | | o- referrals ..... [..]
  | | o- subsystems ..... [..]
  | | o- nqn.2014-08.org.nvmexpress:NVMf:uuid:7079993e-7413-4338-9b9b-a3af82259b18 ..... [..]
  | o- 2 ..... [trtype=rdma, traddr=192.168.211.151, trsvcid=4420, inline_data_size=4096]
  | | o- ana_groups ..... [..]
  | | | o- 1 ..... [state-optimized]
  | | o- referrals ..... [..]
  | | o- subsystems ..... [..]
  | | o- nqn.2014-08.org.nvmexpress:NVMf:uuid:7079993e-7413-4338-9b9b-a3af82259b18 ..... [..]
o- subsystems ..... [..]
  o- nqn.2014-08.org.nvmexpress:NVMf:uuid:7079993e-7413-4338-9b9b-a3af82259b18 [version=1.3, allow_any=0, serial=cdbdf55fefeea52243d3]
  o- allowed_hosts ..... [..]
  o- namespaces ..... [..]
    o- 1 ..... [path=/dev/nullb0, uuid=e581a156-7460-45e2-b6ae-0457e0762342, grpuid=1, disabled]
```

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 IBM GKLM.

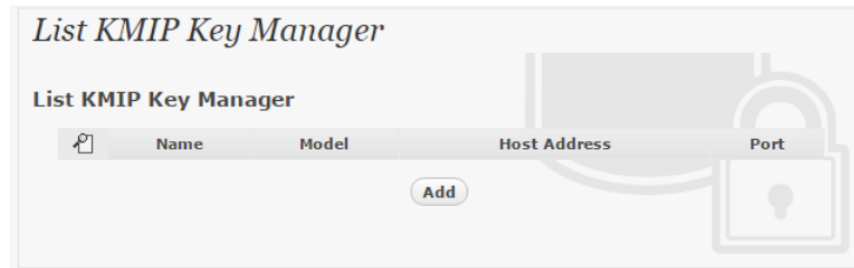
Bloombase StoreSafe Intelligent Storage Firewall software appliance is deployed as a virtual appliance (VA). Bloombase StoreSafe Web Administration Console in this example can be accessed using web browser at IP 192.168.23.39 and port 8443



IBM Guardium Key Lifecycle Manager (GKLM) and Bloomberg StoreSafe Integration

Bloomberg supports IBM GKLM out of the box due to both products' support of OASIS Key Management Interoperability Protocol (KMIP).

To enable the built-in Bloomberg KeyCastle to utilize keys managed in the network attached IBM GKLM, the KMIP service configuration at Bloomberg web management console must be set up. This is done by navigating to Menu Bar -> Key Management -> OASIS KMIP Key Manager.



Input a name for the configuration, and select Model as

IBM GKLM

Input the host address and port to access the IBM GKLM, import or create the "Client Keystore", and upload the server certificate on IBM GKLM as "Trust Certificate". Multiple comma-separated IP host addresses may be included if using a cluster.

Modify KMIP Key Manager

Modify KMIP Key Manager

Name

Model

Host Addresses

Port

Timeout ms

Retry Count

Retry Wait Time ms

Username

Password


Test Results :
192.168.23.158 : Success Vendor ID : SKLM 5.0.0.0 KMIP 2.0
BUILD 202412041550 KMIP_SSL_TIMEOUT 5

Client Keystore

Subject Name CN=SSF4004
O=Bloombase
ST=CA
C=US

Serial Number 00c2524b1bba314a7cf99e

Issuer Name CN=SSF4004
O=Bloombase
ST=CA
C=US

Certificate 

Valid Start Date 2025-11-05

Valid End Date 2030-11-05

Client Key/ Certificate No file selected.

Pin

Trust Certificate

Subject Name CN=IBM GKLM 5.0

Serial Number 1929dd9647fc

Issuer Name CN=IBM GKLM 5.0

Valid Start Date 2025-11-05

Valid End Date 2028-11-04

Trust Certificate File No file selected.

The client certificate CN=SSF4004 is generated and approved as the client authentication key pair for Bloombase StoreSafe on the GKLM interface.

Modify KMIP Key Manager

Modify KMIP Key Manager

Name	<input type="text" value="GKLM50"/>
Model	<input type="text" value="IBM GKLM"/>
Host Addresses	<input type="text" value="192.168.23.158"/>
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"/>
Password	<input type="text"/>
Test Results :	

192.168.23.158 : Success Vendor ID : SKLM 5.0.0.0 KMIP 2.0
BUILD 202412041550 KMIP_SSL_TIMEOUT 5

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

Encryption Key Provisioning

To generate key in attached IBM GKLM, select Key Source Type as

OASIS KMIP Key Manager

and the assigned Key Manager label, in this case

GKLM50


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

Modify Key Wrapper

Key Wrapper | **Permissions**

Modify Key Wrapper

Name	<input type="text" value="key01"/>
Key Source	OASIS KMIP Advanced management
Type	Asymmetric
Active	<input checked="" type="checkbox"/>
KMIP Key Manager	GKLM50
Algorithm	<input type="text" value="RSA"/>
Key Bit Length	<input type="text" value="2048"/>
Signature Algorithm	<input type="text" value="SHA256"/>
Key Usage	<input type="checkbox"/> Digital Signature
	<input type="checkbox"/> Non Repudiation
	<input type="checkbox"/> Key Encipherment
	<input type="checkbox"/> Data Encipherment
	<input type="checkbox"/> Key Agreement
	<input type="checkbox"/> Key Cert Sign
	<input type="checkbox"/> CRL Sign
	<input type="checkbox"/> Encipher Only
<input type="checkbox"/> Decipher Only	
Extended Key Usage	<input type="button" value="Add"/> <input type="button" value="Remove"/>
Owner	admin
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: OASIS KMIP Advanced management ▾

Key Manager: GKLM50 ▾

Object: ▾

Select Key
Add Key

Close



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

Find Key Wrapper

Find Key Wrapper

Name: Type: ▾ Active: 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	key01	Asymmetric	OASIS KMIP Advanced management	<input checked="" type="checkbox"/>			UUID=CERTIFICATE-d6362b1-199aafa3-6d2b-4328-9225-fb77d04d3444	KMIP=GKLM50			2025-11-12 01:10:18 -0800

1-1 of 1
▾
▾

The new key with matching UUID can be found on the IBM GKLM management console.

Certificate details ×

Alias	key01
Usage	BLOOMBASE01
Subject name	CN=key01
Issuer name	CN=key01

Validity

Valid from	-
Valid to	-
Validity	0 days

Cryptographic information

Algorithm	RSA
Key length	2048
Cryptographic params	-
Cryptographic usage mask	VERIFY ENCRYPT
Digital signature algorithm	SHA256_WITH_RSA_ENCRYPTION

System information

uuid	CERTIFICATE-d6362b1-199aafa3-6d2b-4328-9225-fb77d0...
Creation or import date	Nov 12, 2025, 05:10:56 PM Australian Western Standard Time (GMT+08:00)
Last changed date	Nov 12, 2025, 05:10:56 PM Australian Western Standard Time (GMT+08:00)

Close

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="password"/>
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 SMB.

Modify Virtual Storage

Virtual Storage | Protection | Access Control | Permissions

Modify Virtual Storage

Name	smb01
Status	<input checked="" type="checkbox"/>
Description	
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

key01

managed at IBM GKLM.

Modify Virtual Storage Handler

Virtual Storage Protection Access Control Permissions

Virtual Storage Protection
Protection Type: Privacy

Encryption Keys


	Key Name	Last Update Datetime
1	key01	

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 (MSAD) 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

More Options

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	Remote ▾
Type	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	nfs01
Status	<input checked="" type="checkbox"/>
Description	
Active	<input checked="" type="checkbox"/>
Mode	File
Protocol	NFS
Owner	admin
Last Update Datetime	2021-07-22 09:55:37 -0700


Settings

Offline Setting: Disabled

Physical Storage

Storage	nfs01
Description	
Physical Storage Type	Remote
Type	nfs
Host	storage01
Share	nfs01

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

key01

managed at IBM GKLM.

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"/>	key01	

Add **Remove**

Header

Protected


Cryptographic Cipher

Cipher Algorithm **AES**

Bit Length **256**

CTR Mode

Submit **Close**



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

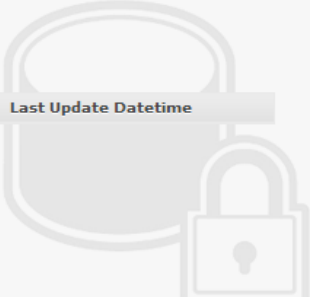
Host Access Control

	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
--------	---------------------	----------	---------	----------------------

▼ More Options



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	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

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

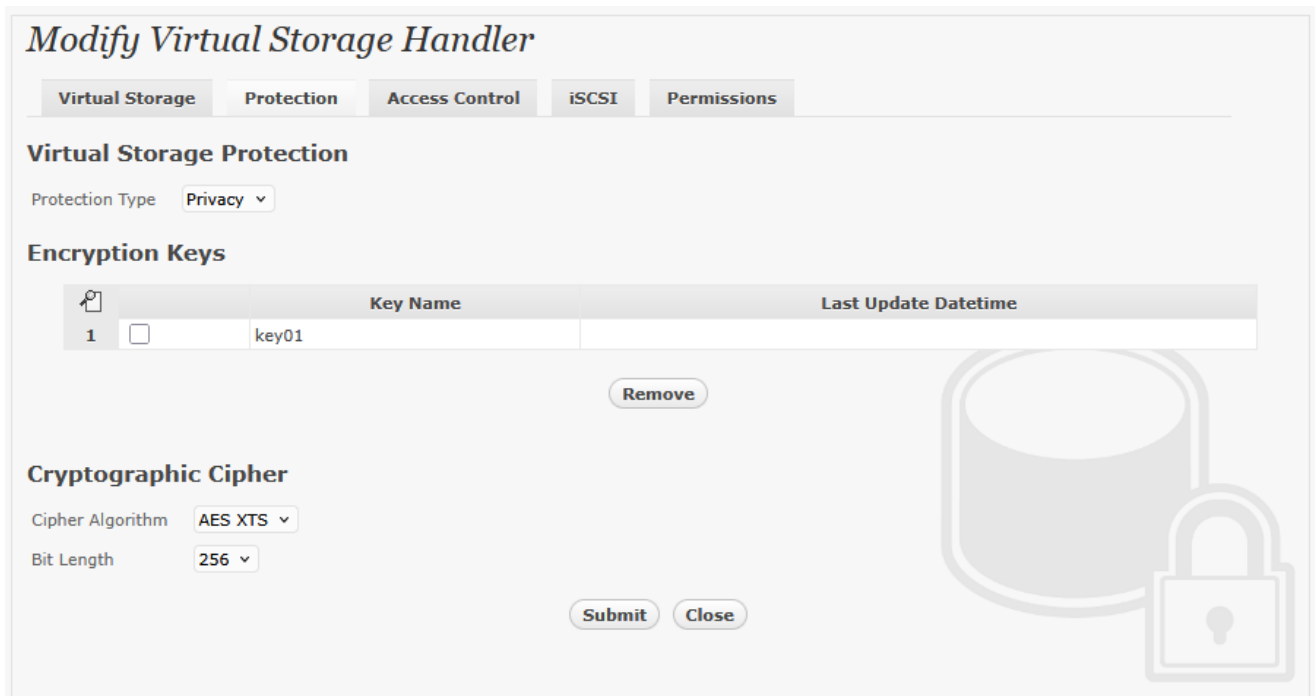
and secure the Microsoft Storage Server storage backend using

AES XTS 256-bit

encryption and encryption key

key01

managed at IBM GKLM.



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



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	<input type="checkbox"/>	key01	


[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	<input type="checkbox"/>	nqn.2014-08.org.nvmexpress:uuid:cf2eae42-6537-4891-85c2-77bbff4598b8			2022-06-03 14:50:03 -0700
2	<input type="checkbox"/>	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	<input checked="" type="checkbox"/>
Active	<input checked="" type="checkbox"/>
Type	NVMe

Physical Storage

Name	nvme01
Type	Unknown

Active Share Status

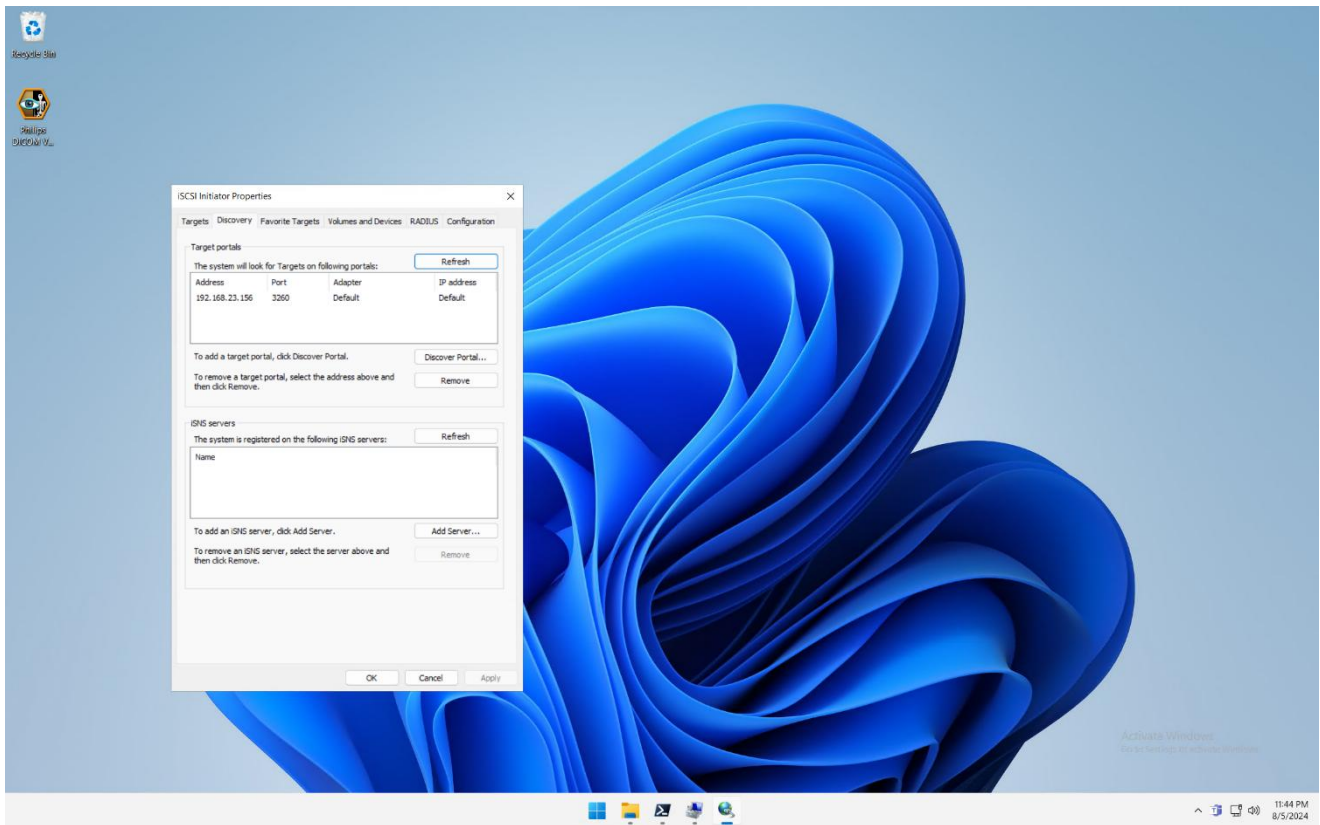
Share Name	nqn.2022-06.io.storesafe:nvme01
Storage Type	Unknown
Storage Path	Target : nqn.2022-06.io.storesafe:nvme01 LUN 1:[_SS_nvme33n1_];
Sessions	2 

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

Storage Clients

Microsoft Windows 11

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



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
```

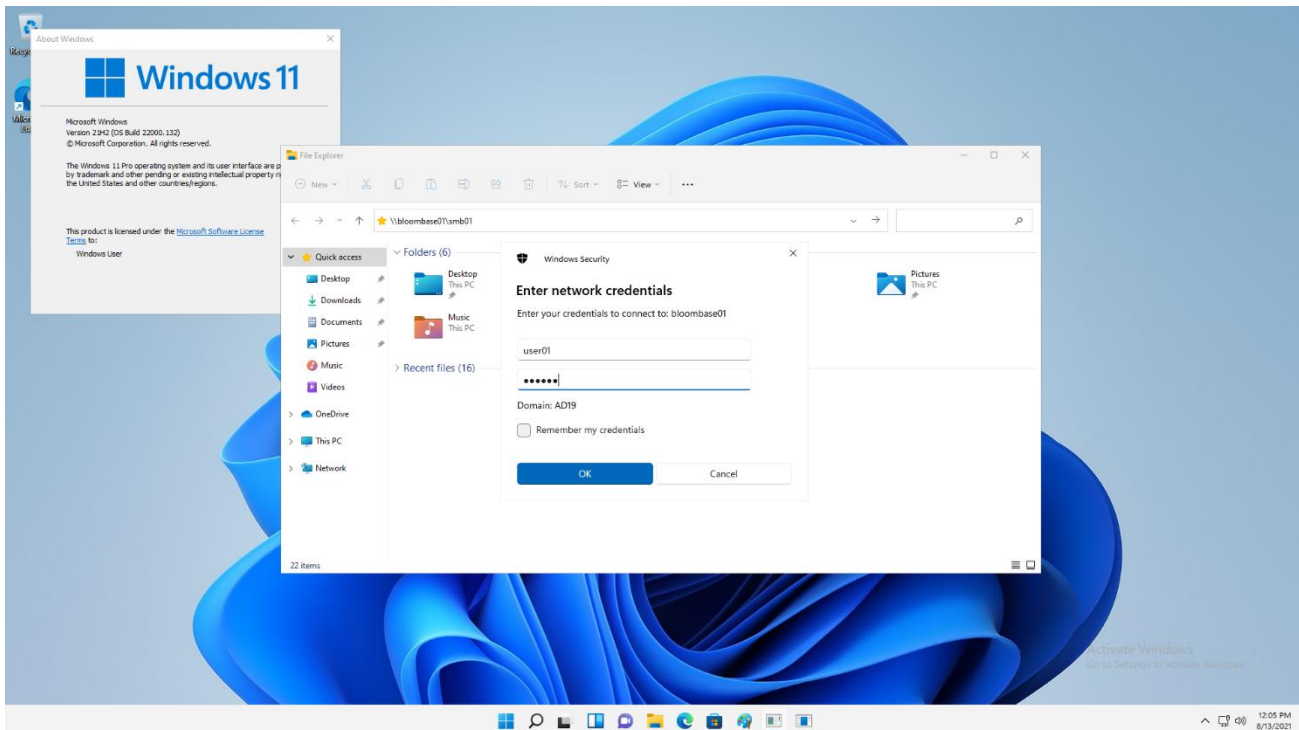
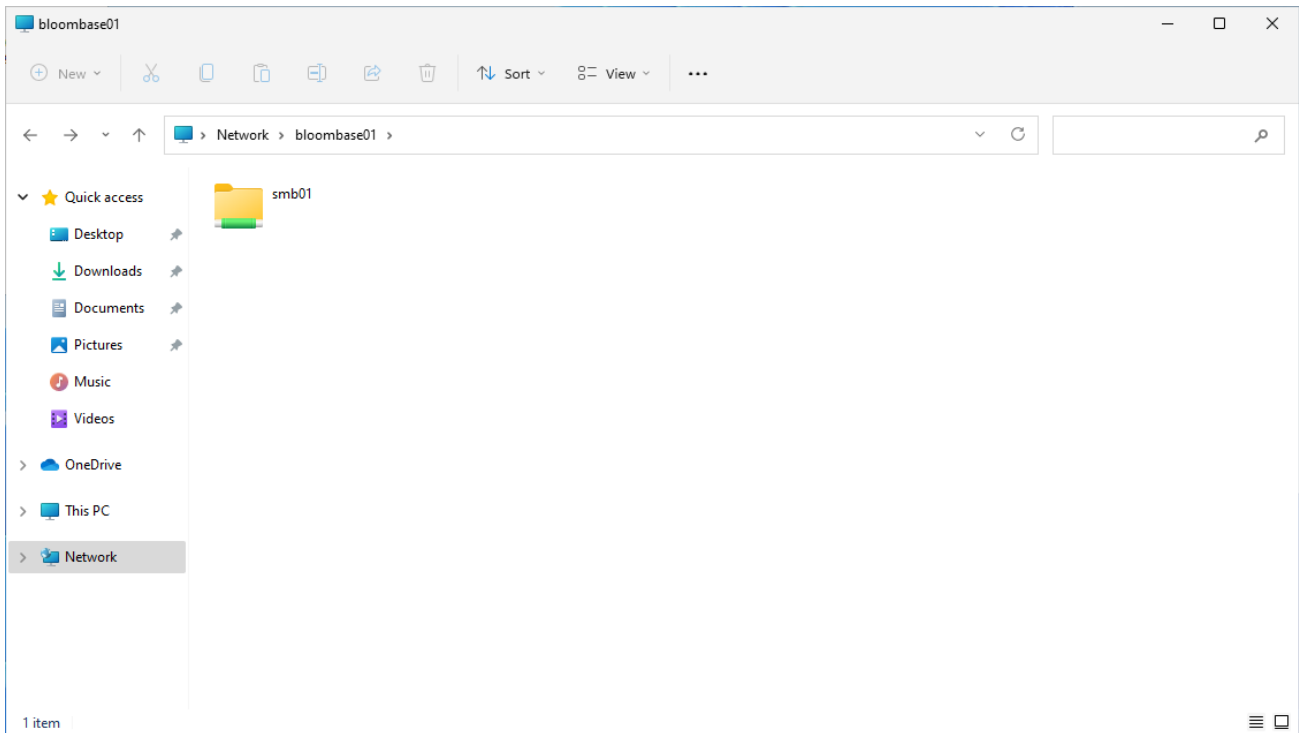
The client will need nvme initiator software installed.

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

Test Cases

Tests for Data-at-Rest Encryption over SMB

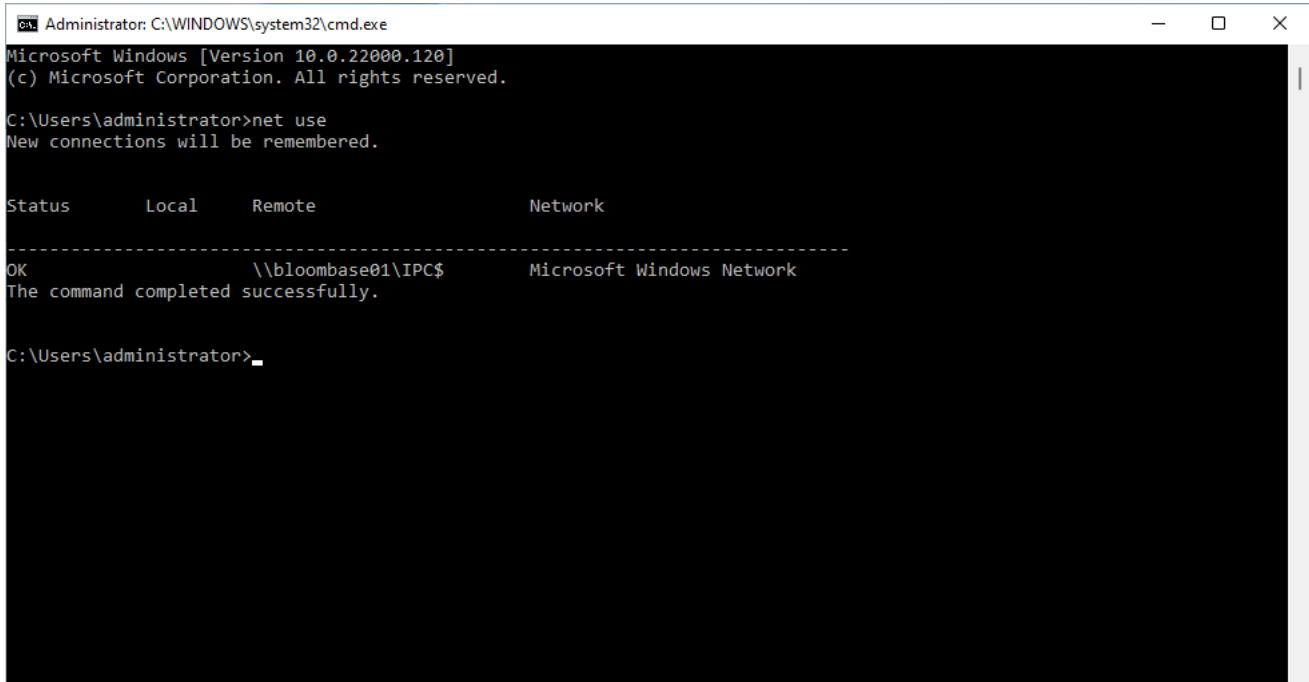
SMB shares are an example from the many protocols Bloombase StoreSafe supports for encryption. A share from a Windows Server 2025 system that is accessible by domain users is created to act as backend storage. Bloombase StoreSafe creates a virtual encrypted share on its own hostname path that is accessed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



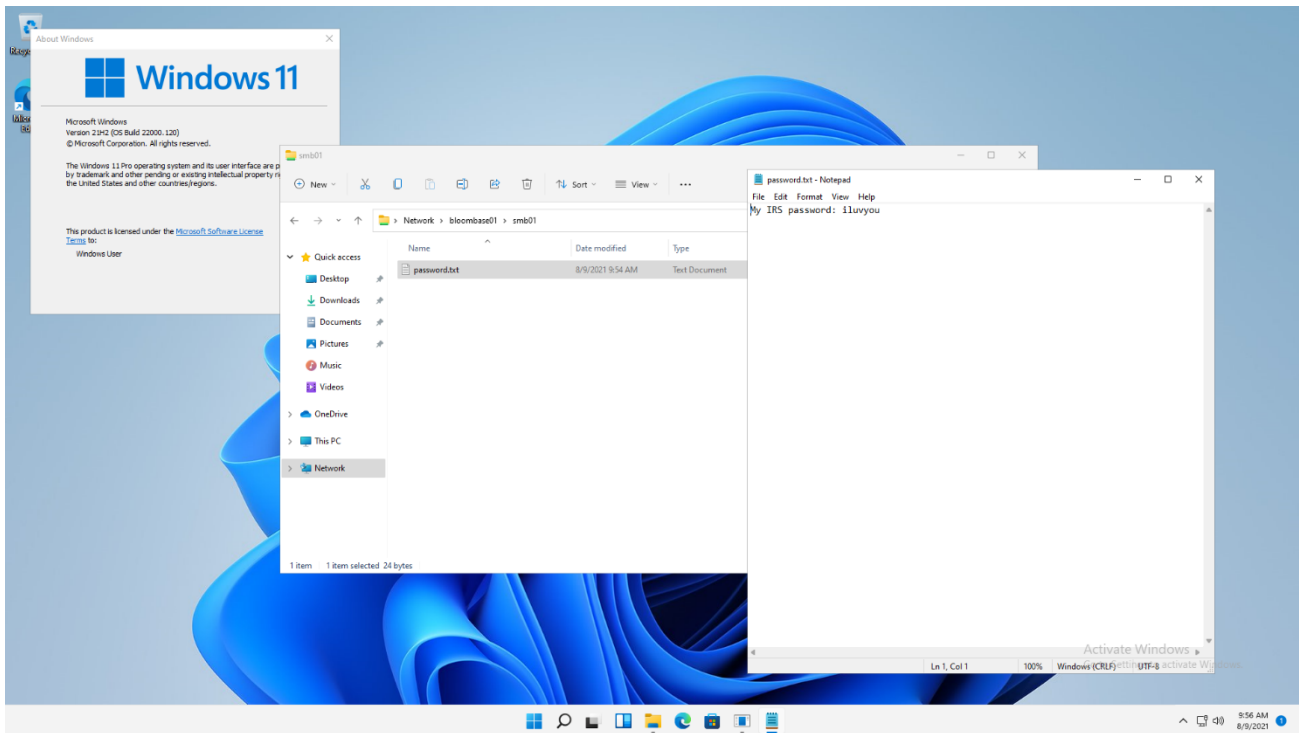
```
Administrator: C:\WINDOWS\system32\cmd.exe
Microsoft Windows [Version 10.0.22000.120]
(c) Microsoft Corporation. All rights reserved.

C:\Users\administrator>net use
New connections will be remembered.

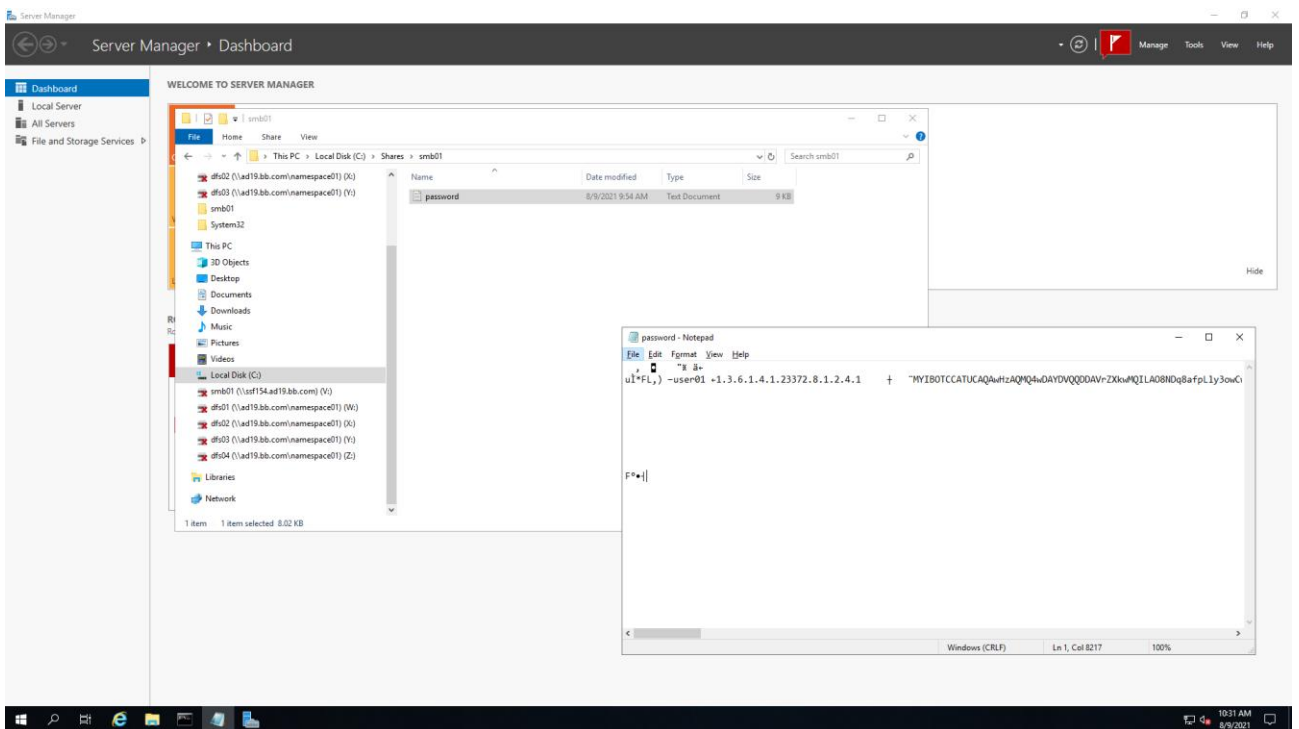
Status          Local          Remote          Network
-----
OK              \\bloombase01\IPC$  Microsoft Windows Network
The command completed successfully.

C:\Users\administrator>
```

On the 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 with encryption keys managed by IBM GKLm and stored on the Windows Server 2025 backend share.

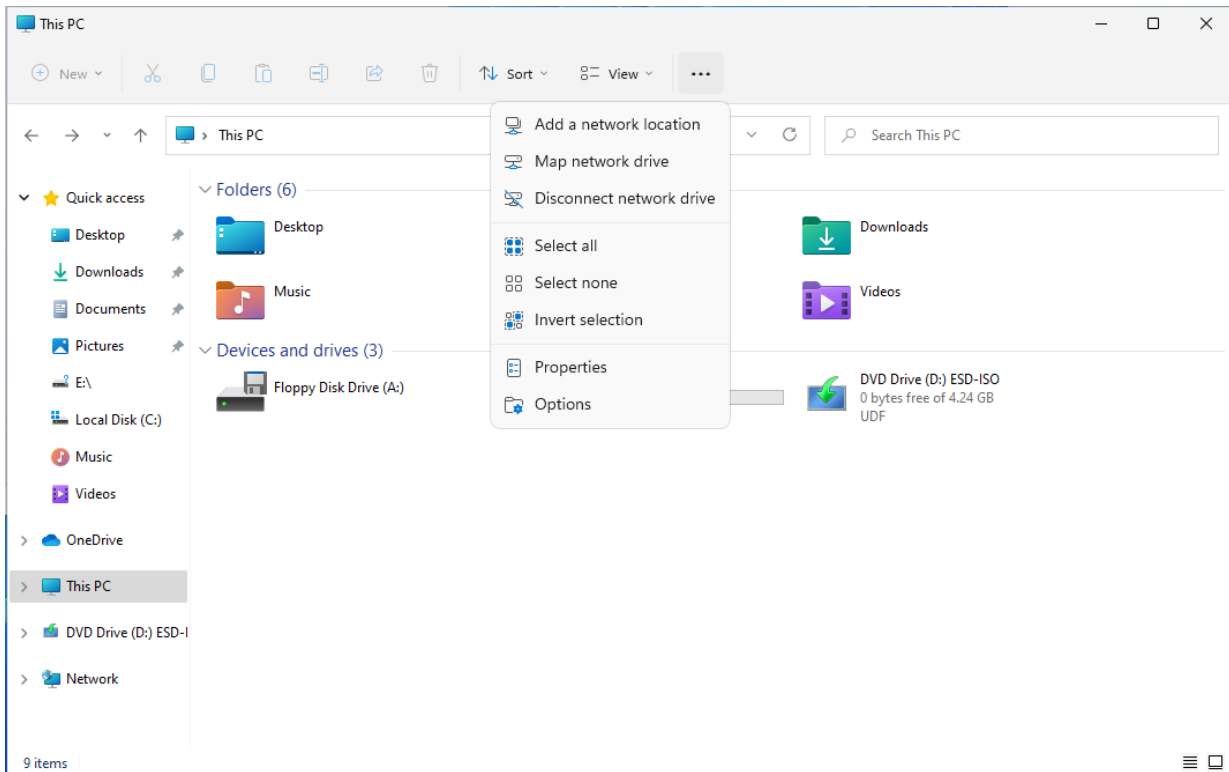


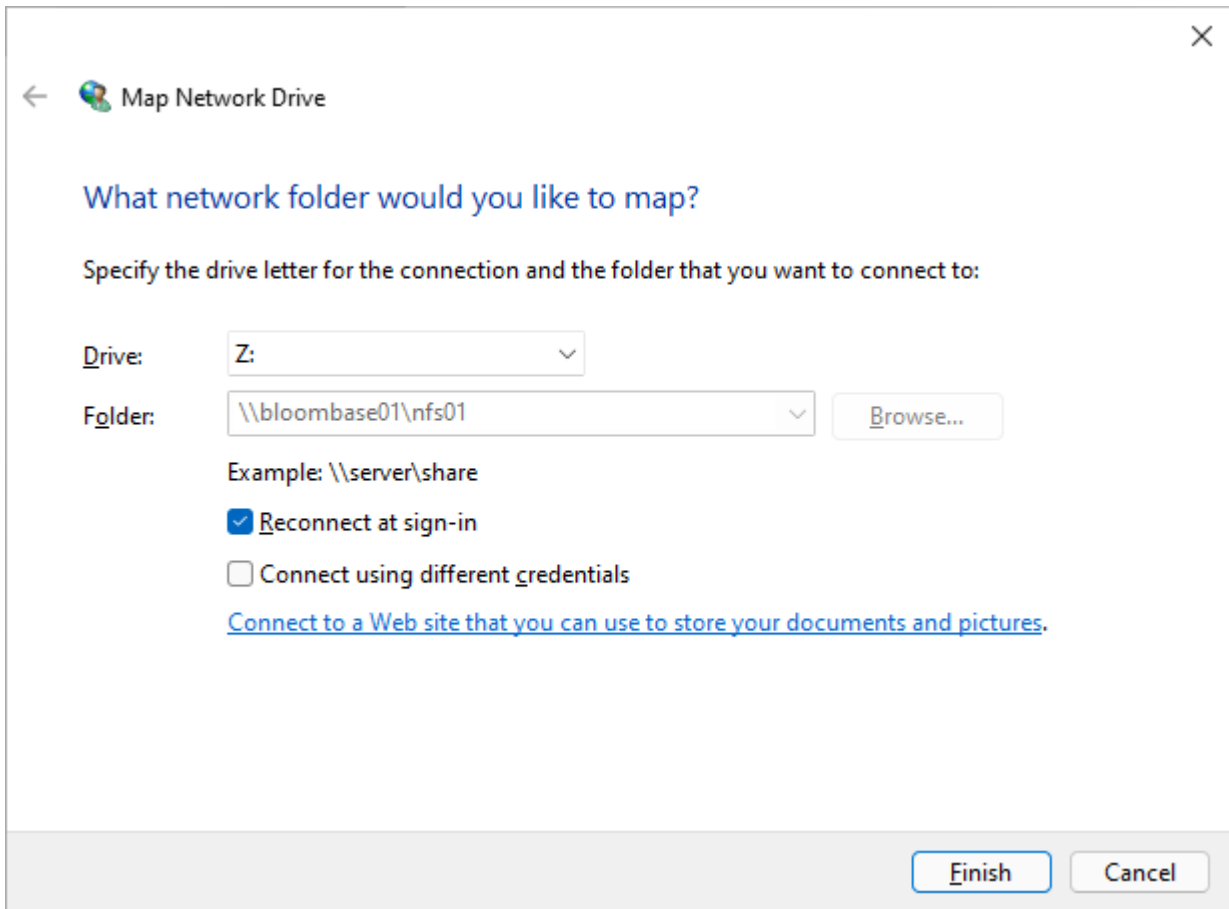
If the application data is attempted to be accessed directly on the backend without going through the Bloombase StoreSafe encryption engine, only ciphertext can be read as expected.



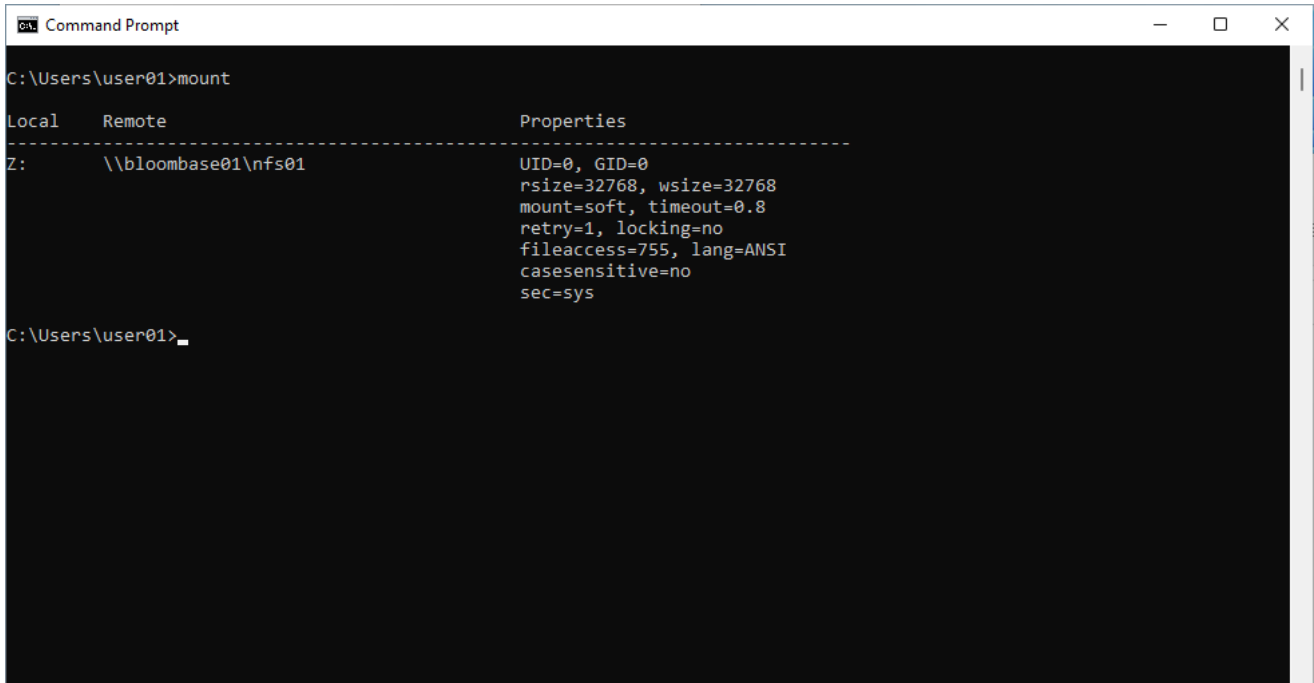
Tests for Data-at-Rest Encryption over NFS

NFS shares are an example from the many protocols Bloombase StoreSafe supports for encryption. A share from a Microsoft 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.



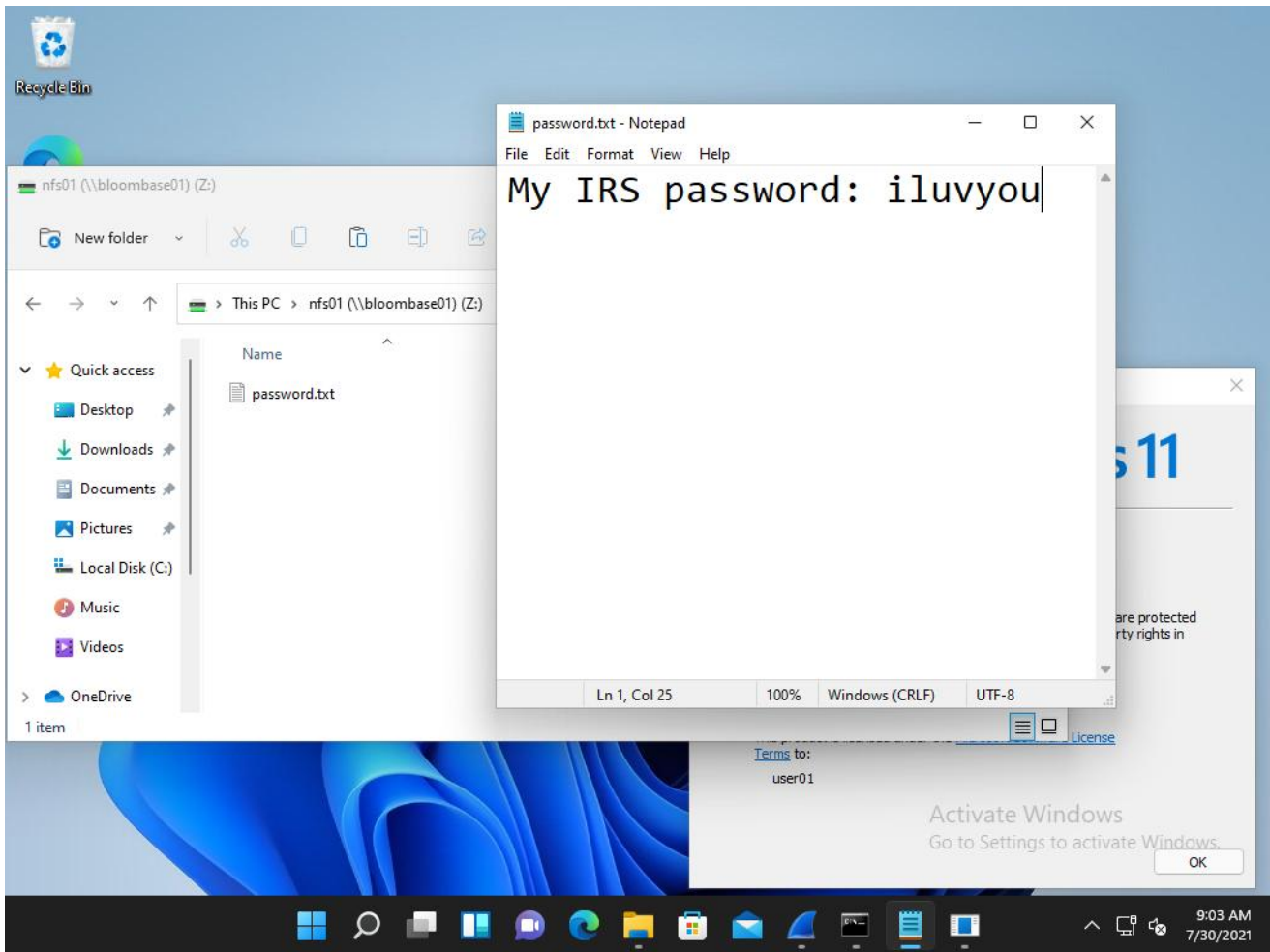


Microsoft Windows 11 clients can use the included map network drive option to add the NFS share presented by Bloombase StoreSafe Intelligent Storage Firewall with a drive letter. Data owners can alternatively use the mount command to specify additional mounting options.

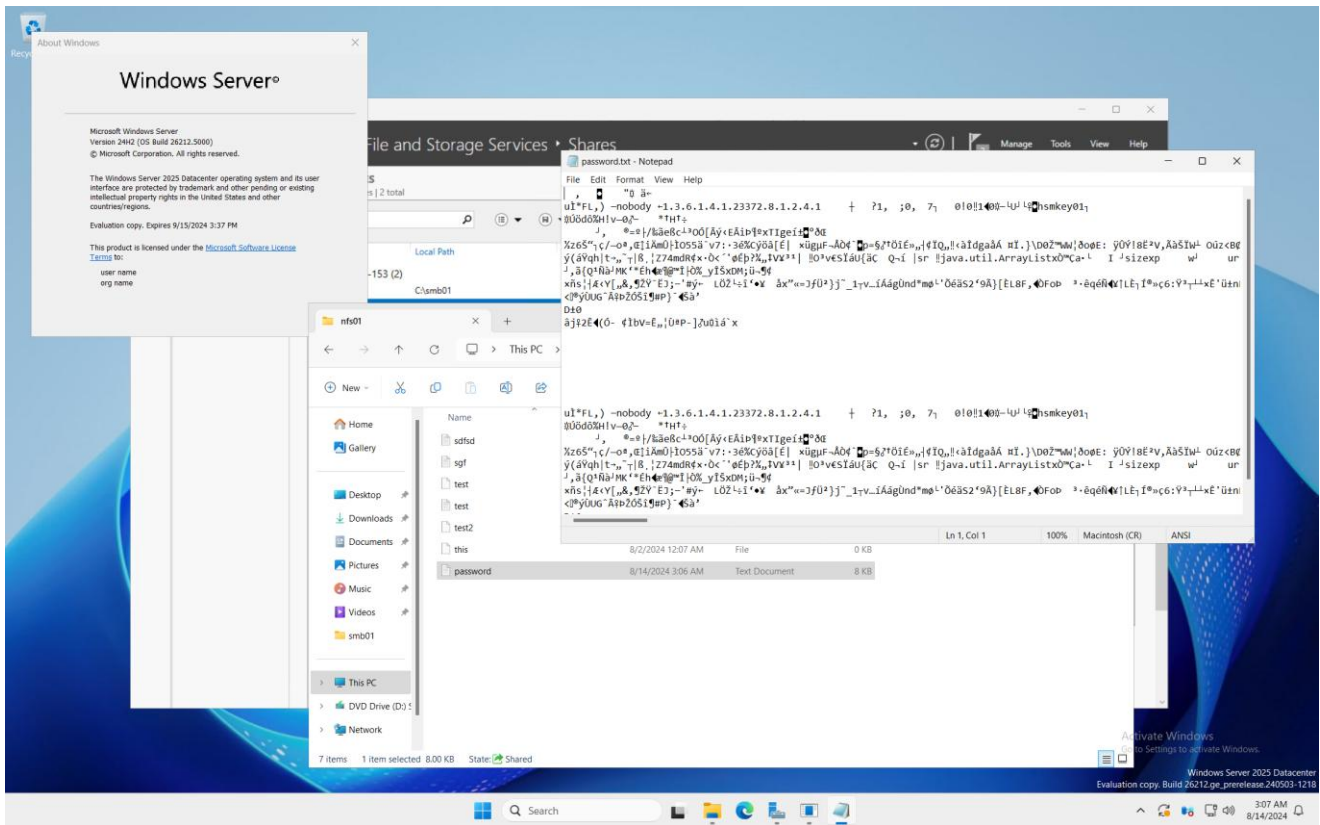


```
Command Prompt
C:\Users\user01>mount
Local      Remote      Properties
-----
Z:         \\bloombase01\nfs01  UID=0, GID=0
                                     rsize=32768, wsize=32768
                                     mount=soft, timeout=0.8
                                     retry=1, locking=no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

On the 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 with keys managed by IBM GKLM and stored on the Microsoft Windows Server 2025 backend share.

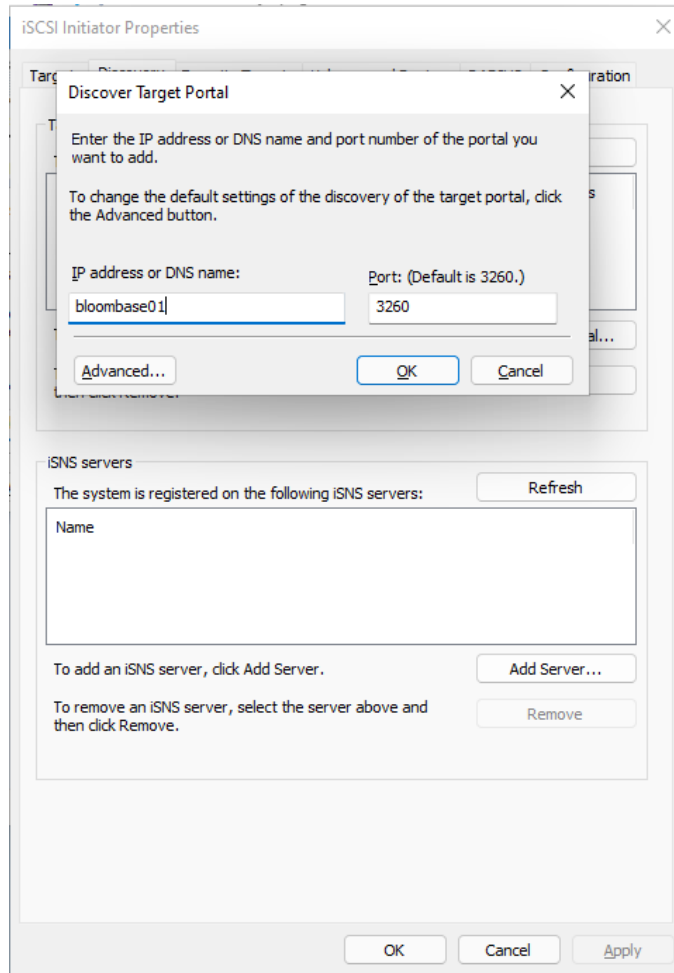


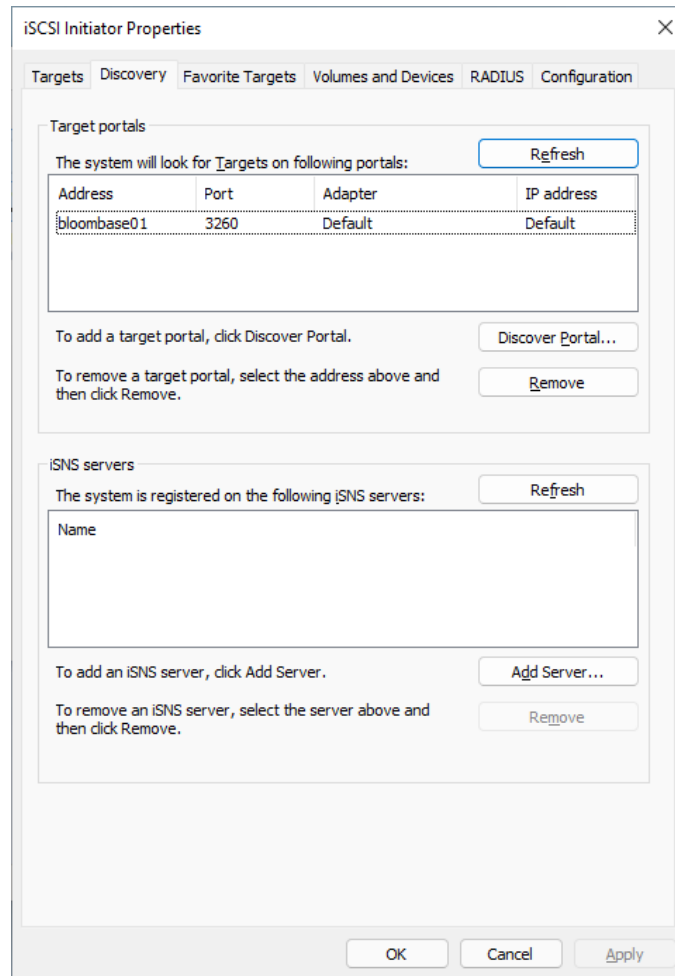
If the application data is attempted to be accessed directly on the backend without going through the Bloombase StoreSafe encryption engine, only ciphertext can be read as expected.



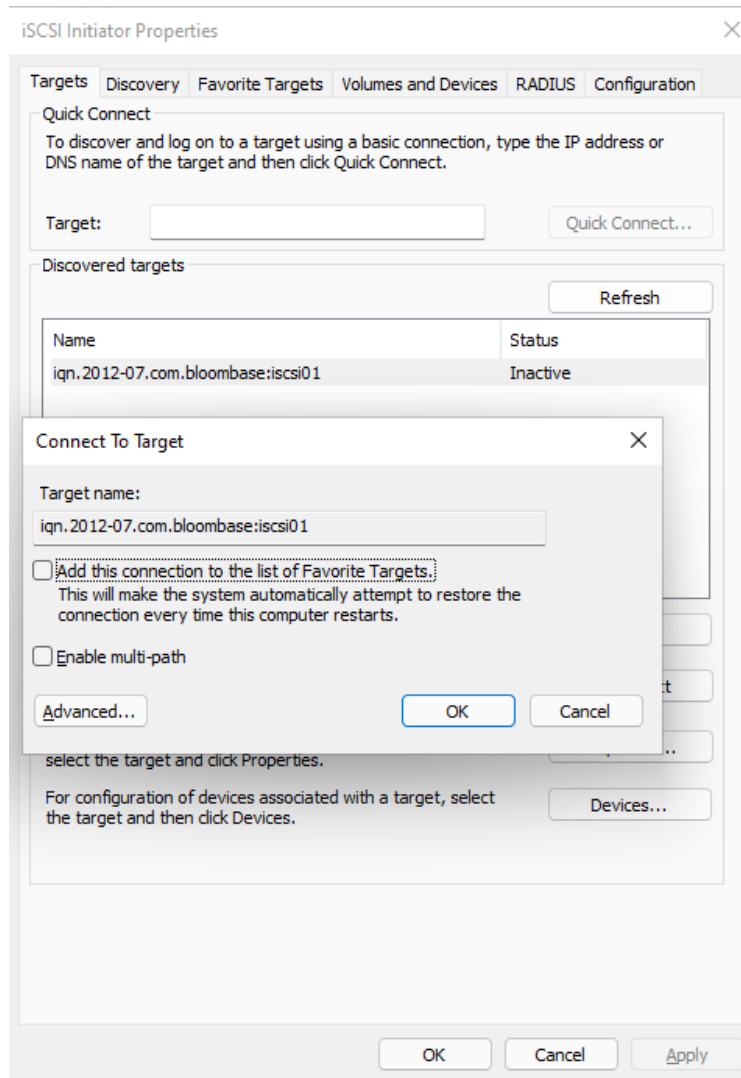
Tests for Data-at-Rest Encryption over iSCSI

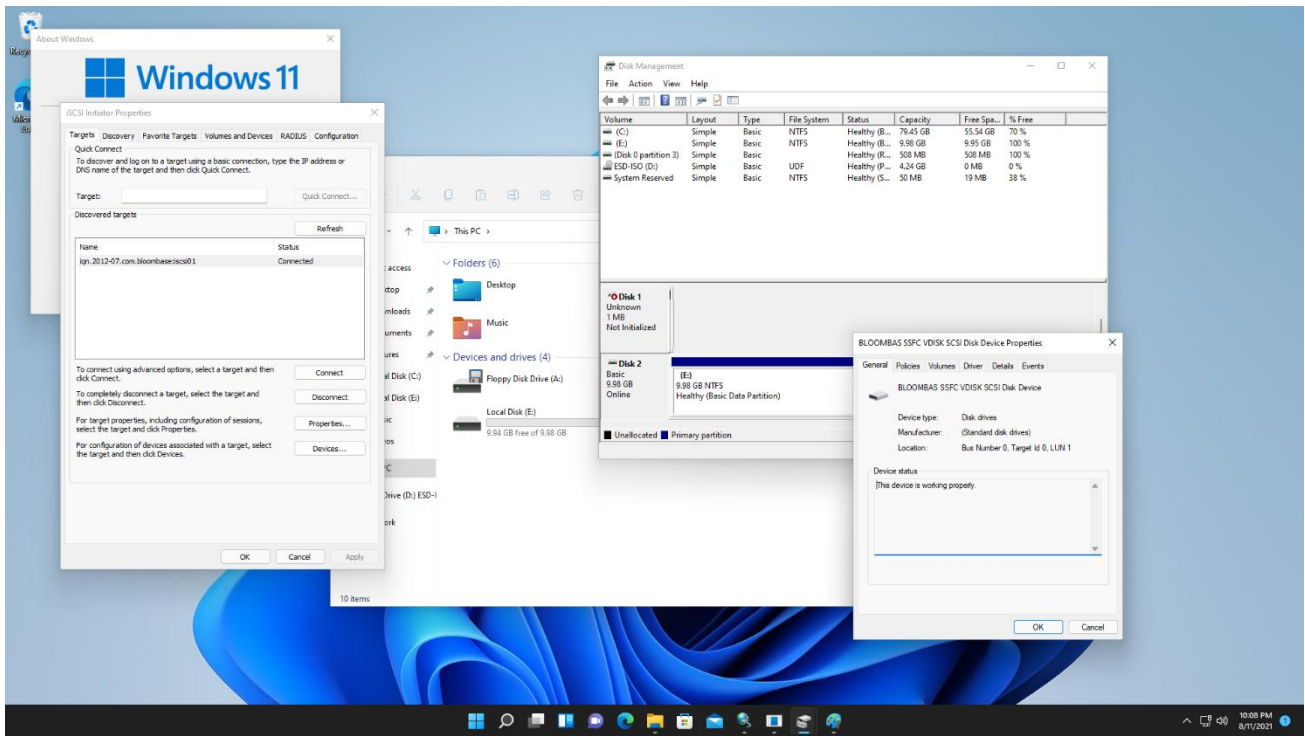
iSCSI targets are an example from the many protocols Bloombase StoreSafe supports for encryption. A target from a Microsoft Windows Server 2025 system that is accessible by configure clients is created to act as backend storage. Bloombase StoreSafe creates a virtual encrypted share on its own hostname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



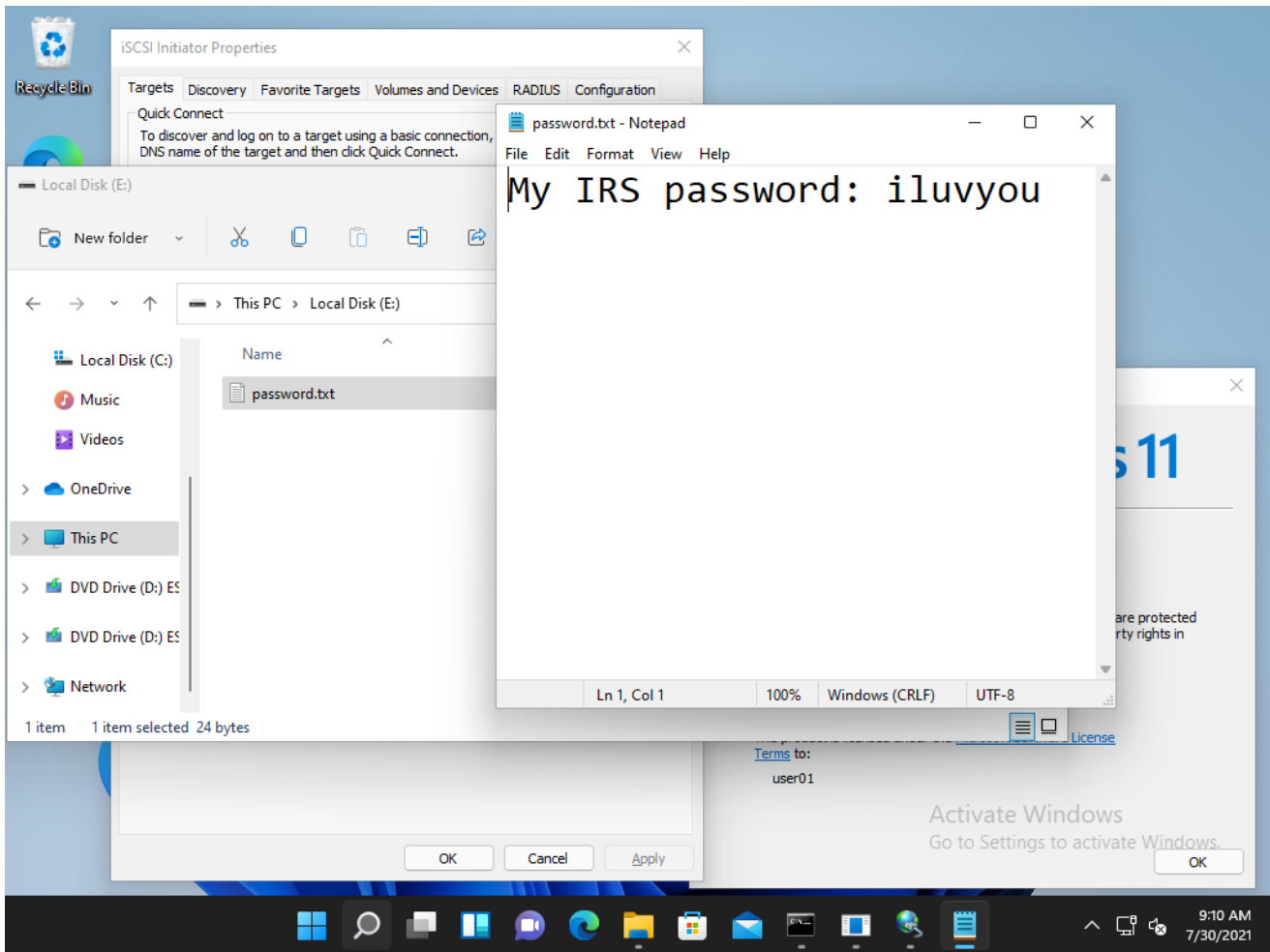


Microsoft Windows 11 clients can attach the virtual encrypted share with the default iSCSI initiator tool. Add the hostname and port to the discover tab, then connect to the iSCSI storage target presented by Bloombase StoreSafe Intelligent Storage Firewall. To access the Bloombase StoreSafe iSCSI disk,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





On the 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 with encryption keys managed by IBM GKM 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 9B 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 05 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 9B - BE 57 3C 14 C6 C1 F1 DE |P Bu Wc
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 |O 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 9B - 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 l
^C
C:\Users\administrator.AD19\Downloads>hexdump.exe \ISCSIVirtualDisks\iSCSI-disk01.vhdx | Findstr password
C:\Users\administrator.AD19\Downloads>
```

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.nvmexpress: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
├─rl-root   253:0    0    70G   0 lvm  /
├─rl-swap   253:1    0  15.7G  0 lvm  [SWAP]
├─rl-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 |...C2.0I.....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 SAMN00183116
[root@bb024 ~]# █

```

Create a new file to be secured by Bloomberg 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 Bloomberg 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 Bloomberg StoreSafe Intelligent Storage Firewall virtual storage with IBM GKLM centralize key management 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 ~]#
```


Conclusion

In this integration guide, we have shown how to set up Bloombase StoreSafe Intelligent Storage Firewall with IBM Guardium Key Lifecycle Manager (GKLM) 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,

- IBM Guardium Key Lifecycle Manager (GKLM) 5.0

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

- Microsoft Windows 11
- Ubuntu 22.04 LTS

- Microsoft Windows Server 2025
- Rocky Linux 9

IBM Guardium Key
Lifecycle Manager (GKLM)
5.0

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.

Acknowledgement

Bloombase InteropLab would like to thank IBM team for supporting the integration of Bloombase StoreSafe with IBM Guardium Key Lifecycle Manager (GKLM).

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15. Bloombase integration with IBM Security Key Lifecycle Manager, <https://www.ibm.com/support/pages/ibm-security-key-lifecycle-manager-videos-and-solutions#bloombase>