interopLab

Bloombase StoreSafe – Interoperability and Exit Form: IBM Security Key Lifecycle Manager (SKLM)

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Document No.: Bloombase InteropLab - Interoperability and Certification – Interoperability and Exit Form - IBM SKLM - v0.95.doc

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1. Document Revision History

Revision	Date	Revised By	Comments
0.9	2017-1-3	Calvin Susanto, Bloombase	Initial draft for partner review
0.91	2017-1-13	Calvin Susanto, Bloombase	Interoperability test results documented
0.92	2017-1-16	Calvin Susanto, Bloombase	Interoperability test configuration documented
0.93	2017-1-16	Calvin Susanto, Bloombase	KMIP details documented
0.94	2017-1-16	Calvin Susanto,	Format changes

		Bloombase	
0.95	2017-1-16	Calvin Susanto, Bloombase	Format changes

2. Introduction

The Bloombase StoreSafe– Interoperability and Exit Form: IBM SKLM documents the evaluation of the Bloombase solution with IBM Security Key Lifecycle Manager (SKLM) for data-at-rest encryption.

This Exit Form is meant to augment an existing Use Cases and Certification document (UCC) between Bloombase and IBM. The use cases documented in the UCC document are captured here in Pass/Fail test scenarios.

All test scenarios must pass for the solution to be certified.

3. Certification Details

Partner Company Name: IBM

Usage Details: The IBM SKLM will be used as the OASIS KMIP-compliant key manager with Bloombase StoreSafe for encryption of data-at-rest of unified storage systems and services.

Testing Date: January 9, 2017

Bloombase Representative(s): Michael Brew, Calvin Susanto

Partner Representative(s): Rinkesh Bansal, Mahesh Paradkar

3.1 Products Tested

Item	Version	Details
IBM SKLM	2.7	OASIS KMIP-compliant key manager
Bloombase StoreSafe	3.5	Data-at-rest encryption security software appliance for NAS, SAN, object stores and cloud storage service endpoints

3.2 KMIP Features Supported

Item	Details
KMIP Specification	• 1.0 • 1.1
Transport Protocol	• TLS 1.0 • TLS 1.1 • TLS 1.2
Authentication Mechanism	X.509 certificate
KMIP Operations	• Locate • Get • Get Attributes • Get Attribute List • Add Attribute • Modify Attribute • Delete Attribute

KMIP Objects	• Certificate • Public Key • Private Key • Symmetric Key

4. Certification Test Cases and Results

#	Test Case	Required Result	Pass | Fail	Test Case Number	Notes
1	Documentation: Documents to cover deployment and use of Bloombase-IBM solution				
2	Interoperability Testing			6	
	Key Management			6.1	

	Key generation at IBM SKLM	Key generated	Pass	6.1.1
	Key access at IBM SKLM	Key retrieved	Pass	6.1.2
	Key access at IBM SKLM replication model clone node	Key retrieved	Pass	6.1.3
	CIFS Data Encryption and Decryption			6.2
	SMB authentication at CIFS secure storage	Login success	Pass	6.2.1
	List CIFS secure storage	List of shares returned	Pass	6.2.2
	Connect and access CIFS secure storage	Share connected	Pass	6.2.3
	Mount CIFS secure storage	Share mounted	Pass	6.2.4
	Write to CIFS secure storage	File written to share	Pass	6.2.5
	Read from CIFS secure storage	File read from share	Pass	6.2.6

	Delete from CIFS secure storage	File deleted from share	Pass	6.2.7
	NFS Data Encryption and Decryption			6.3
	Network access control at NFS secure storage	Access success	Pass	6.3.1
	List NFS secure storage	List of shares returned	Pass	6.3.2
	Connect and access NFS secure storage	Share connected	Pass	6.3.3
	Mount NFS secure storage	Share mounted	Pass	6.3.4
	Write to NFS secure storage	File written to share	Pass	6.3.5
	Read from NFS secure storage	File read from share	Pass	6.3.6
	Delete from NFS secure storage	File deleted from share	Pass	6.3.7
	iSCSI Data Encryption and Decryption			6.4
	Discover iSCSI secure storage	iSCSI disk discovered	Pass	6.4.1

	Connect to iSCSI secure storage	Disk connected	Pass	6.4.2
	Dump in iSCSI secure storage raw device	Data written to disk	Pass	6.4.3
	Dump out iSCSI secure storage raw device	Data read from disk	Pass	6.4.4
	Create filesystem on iSCSI secure storage	Filesystem created on disk	Pass	6.4.5
	Write to filesystem on iSCSI secure storage	File written to filesystem	Pass	6.4.6
	Read from filesystem on iSCSI secure storage	File read from filesystem	Pass	6.4.7
	Delete from filesystem on iSCSI secure storage	File deleted from filesystem	Pass	6.4.8
	FCP Data Encryption and Decryption			6.5
	Initialize FCP	Disk initialized	Pass	6.5.1

	secure storage disk			
	Dump in FCP secure storage raw device	Data written to disk	Pass	6.5.2
	Dump out FCP secure storage raw device	Data read from disk	Pass	6.5.3
	Create filesystem on FCP secure storage	Filesystem created	Pass	6.5.4
	Write to filesystem on FCP secure storage	File written to filesystem	Pass	6.5.5
	Read from filesystem on FCP secure storage	File read from filesystem	Pass	6.5.6
	Delete from filesystem on FCP secure storage	File deleted from filesystem	Pass	6.5.7
3	Final Results		Pass	

5. Test Environment Setup

5.1 IBM SKLM Configuration

IBM SKLM Web Management Console

For this interoperability test, the test SKLM is provided by IBM test team and is hosted at IBM SoftLayer cloud infrastructure.

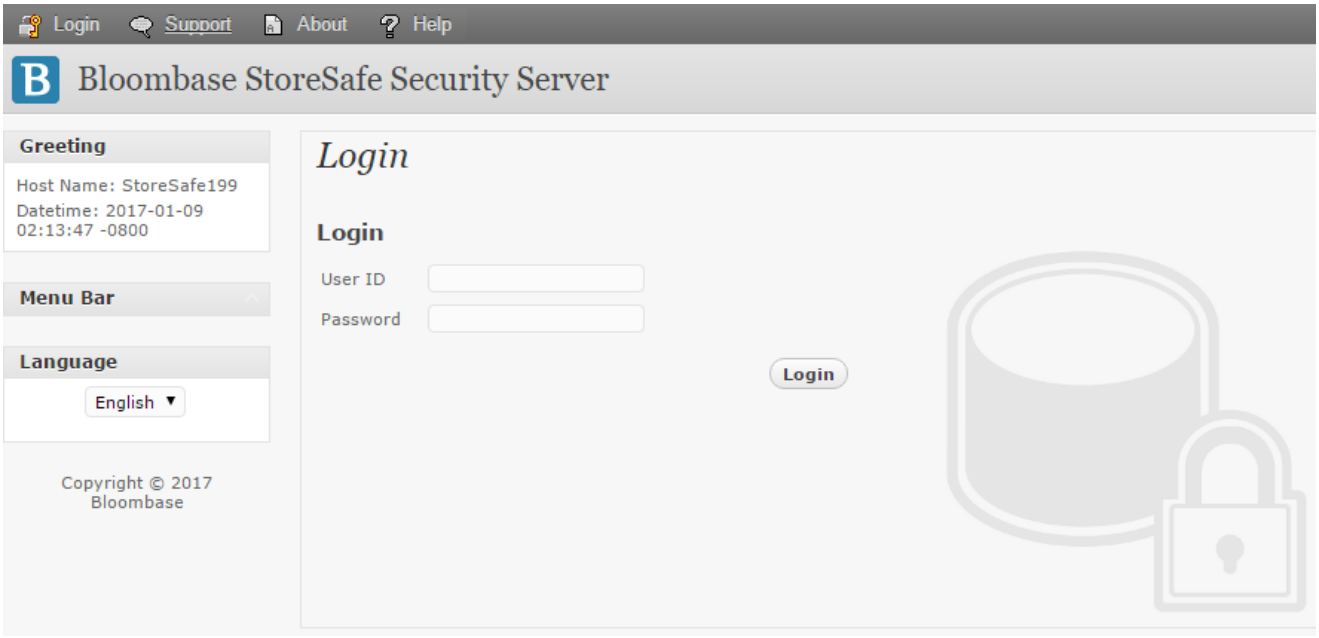
Bloombase StoreSafe client certificate is trusted by this Stand-Alone IBM SKLM with IP address `173.193.147.234` and port `5696`.

The exact same SKLM is used to test the interoperability between Bloombase StoreSafe and IBM SKLM high availability cluster.

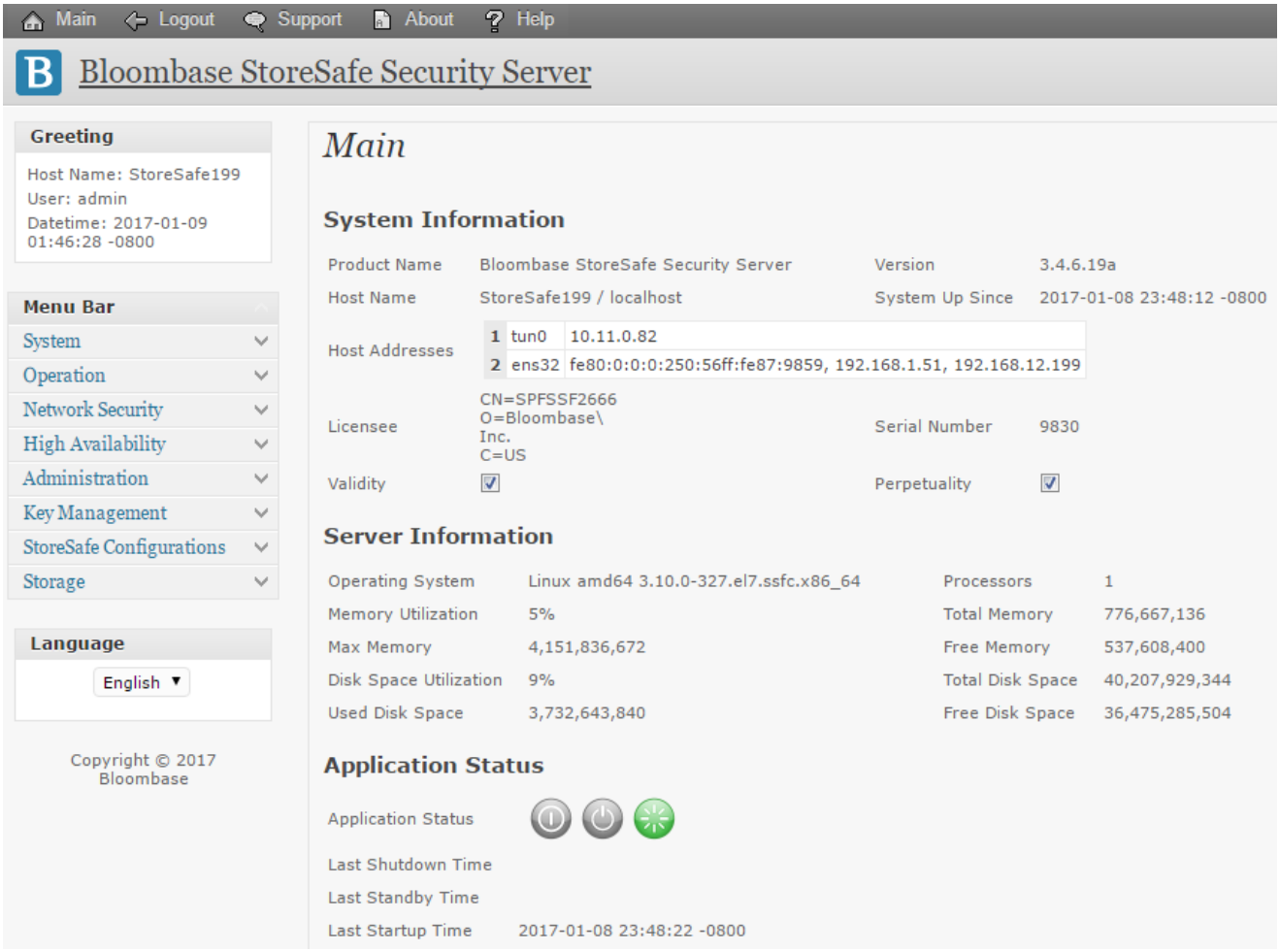
IBM test team has provided both “Master” and “Clone” SKLM server instances for the testing.

5.2 Bloombase StoreSafe Configuration

Bloombase StoreSafe Web Administration Console can be accessed using web browser at https://‹StoreSafe_IP›:8443. For this test, Bloombase StoreSafe with `192.168.12.199` as IP address is used and can be accessed at `https://192.168.12.199:8443`. Bloombase StoreSafe web management console login page will prompt and request for login credentials.

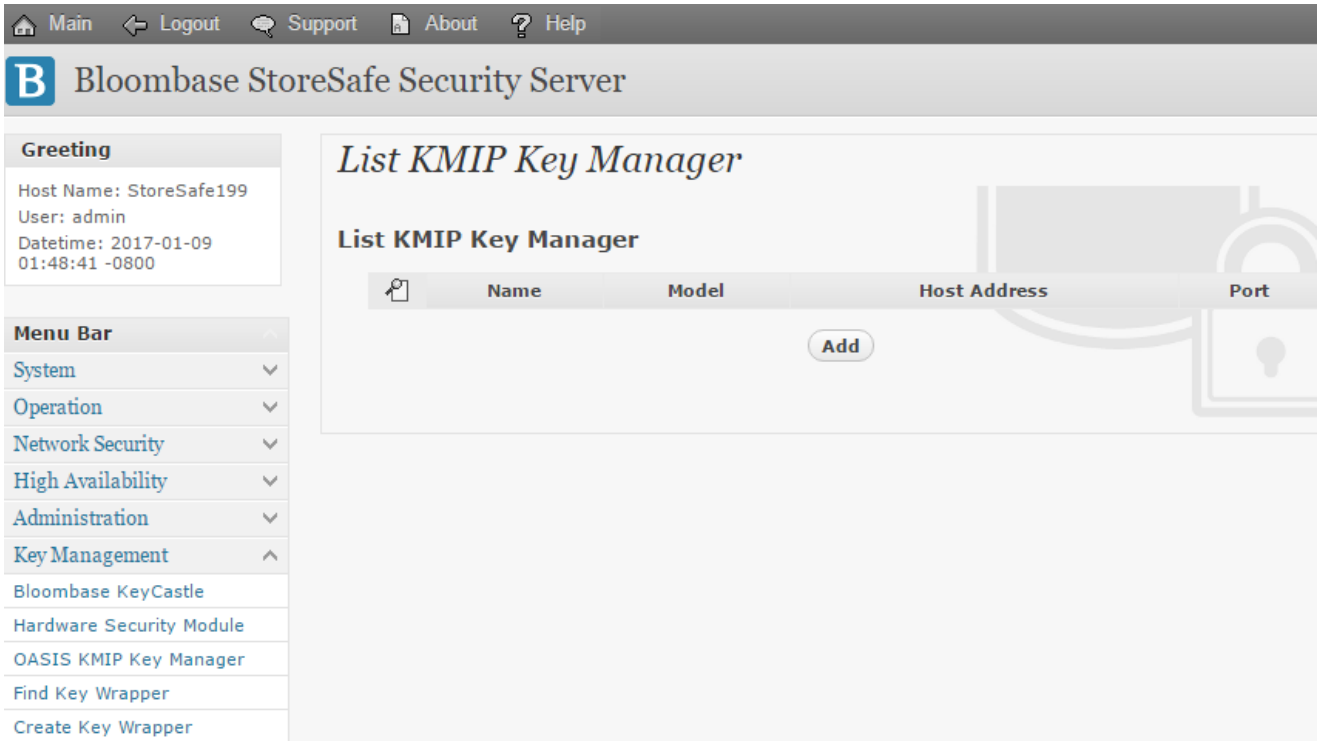


After login, the Main dashboard page of Bloombase StoreSafe web management console will display all system and server necessary information.

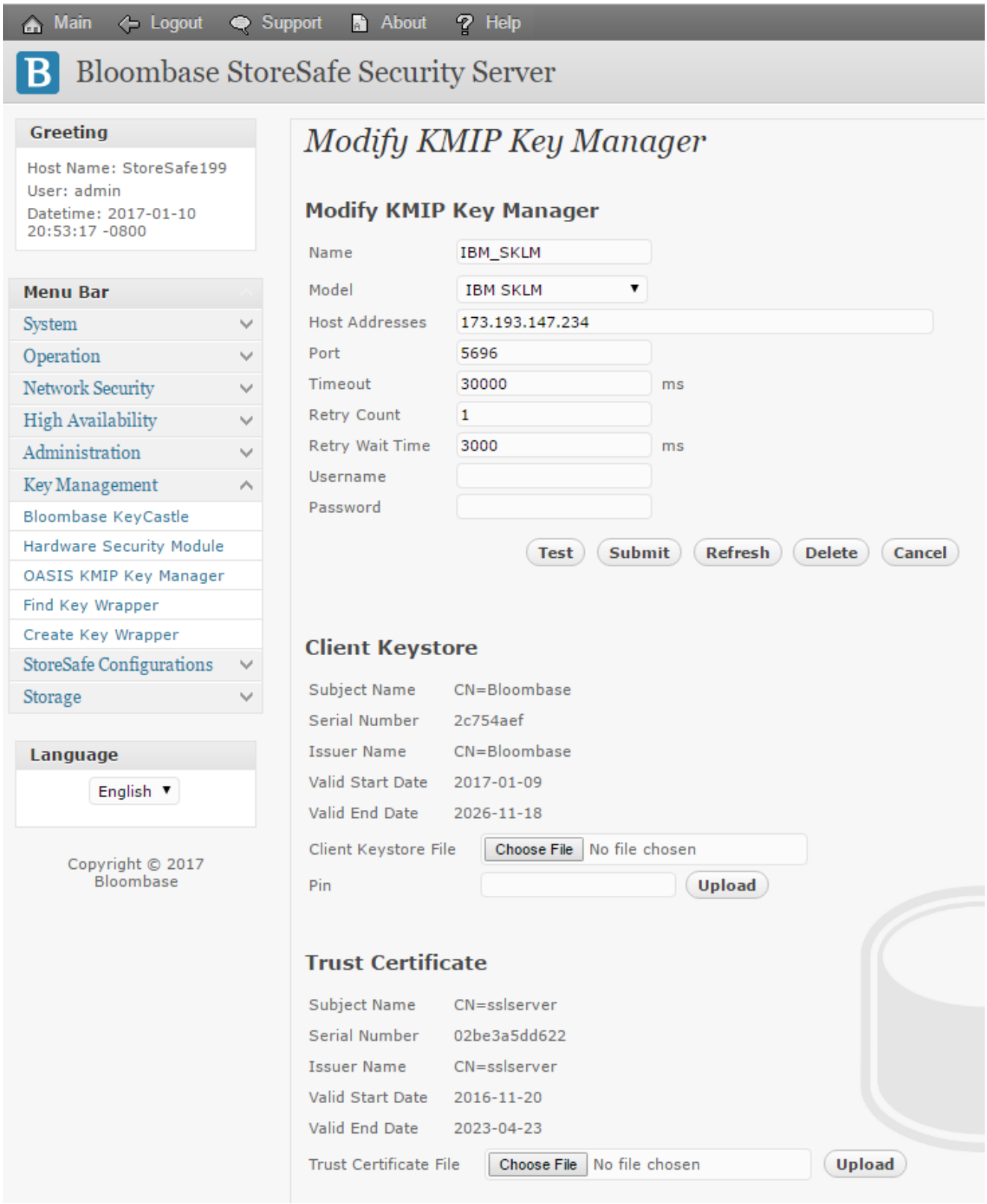


Setting up Integration with KMIP Key Manager – IBM SKLM

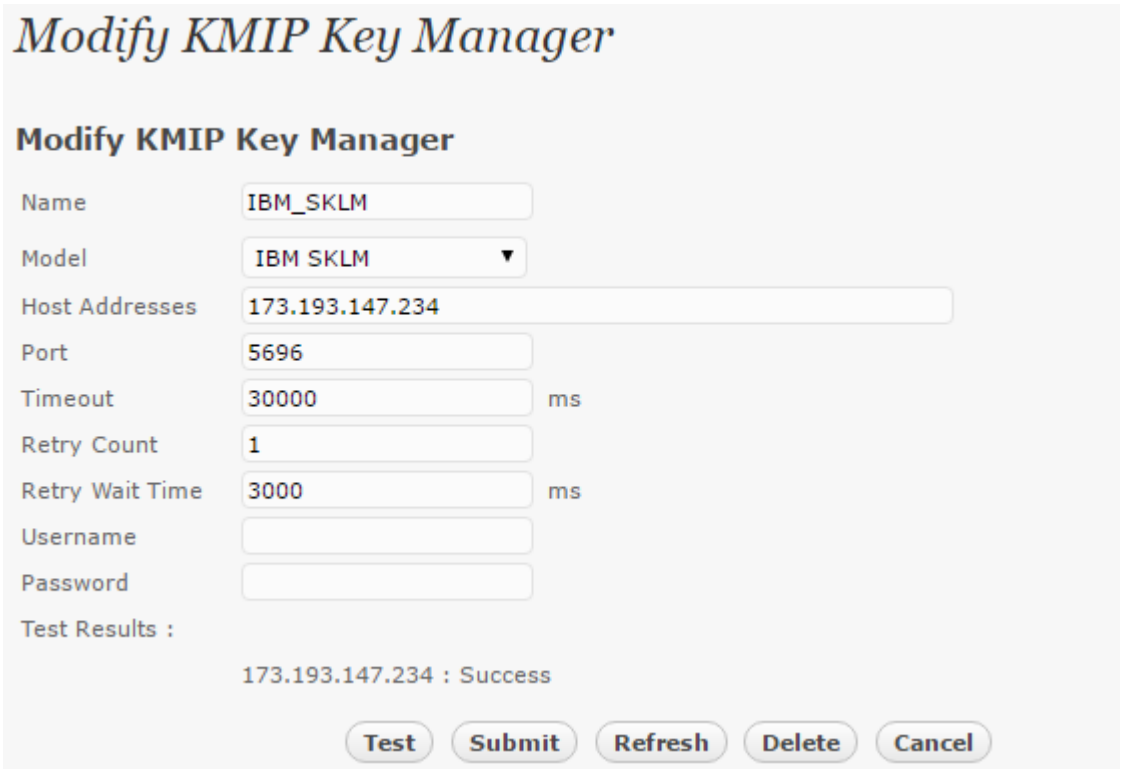
In this interoperability test effort, Bloombase StoreSafe serves as the client of IBM SKLM for encryption key access to deliver data-at-rest encryption services. To enable the built-in Bloombase KeyCastle to utilize the key in the network attached IBM SKLM, KMIP service configuration has to be setup. KMIP service configuration can be accessed from Bloombase StoreSafe web management console, under Menu Bar -› Key Management -› OASIS KMIP Key Manager.



Push “Add” button in order to create a new KMIP trust. Choose “IBM SKLM” model and input IBM SKLM details including IP address and port. For this test, IBM SKLM has been configured to provide KMIP service using IP address `173.193.147.234`. IBM SKLM service is trusted by adding the IBM SKLM server certificate to Bloombase StoreSafe’s trust KMIP Server Keystore and Bloombase StoreSafe client key-pair is generated and uploaded to KMIP Client Keystore.


Main
Logout
Support
About
Help
Bloombase StoreSafe Security Server
Greeting
Host Name: StoreSafe199
User: admin
Datetime: 2017-01-10 20:53:17 -0800
Menu Bar
System
Operation
Network Security
High Availability
Administration
Key Management
Bloombase KeyCastle
Hardware Security Module
OASIS KMIP Key Manager
Find Key Wrapper
Create Key Wrapper
StoreSafe Configurations
Storage
Language
English
Copyright © 2017 Bloombase
Modify KMIP Key Manager
Modify KMIP Key Manager
Name IBM_SKLM
Model IBM SKLM
Host Addresses 173.193.147.234
Port 5696
Timeout 30000 ms
Retry Count 1
Retry Wait Time 3000 ms
Username
Password
Test
Submit
Refresh
Delete
Cancel
Client Keystore
Subject Name CN=Bloombase
Serial Number 2c754aef
Issuer Name CN=Bloombase
Valid Start Date 2017-01-09
Valid End Date 2026-11-18
Client Keystore File Choose File No file chosen
Pin
Upload
Trust Certificate
Subject Name CN=sslserver
Serial Number 02be3a5dd622
Issuer Name CN=sslserver
Valid Start Date 2016-11-20
Valid End Date 2023-04-23
Trust Certificate File Choose File No file chosen
Upload

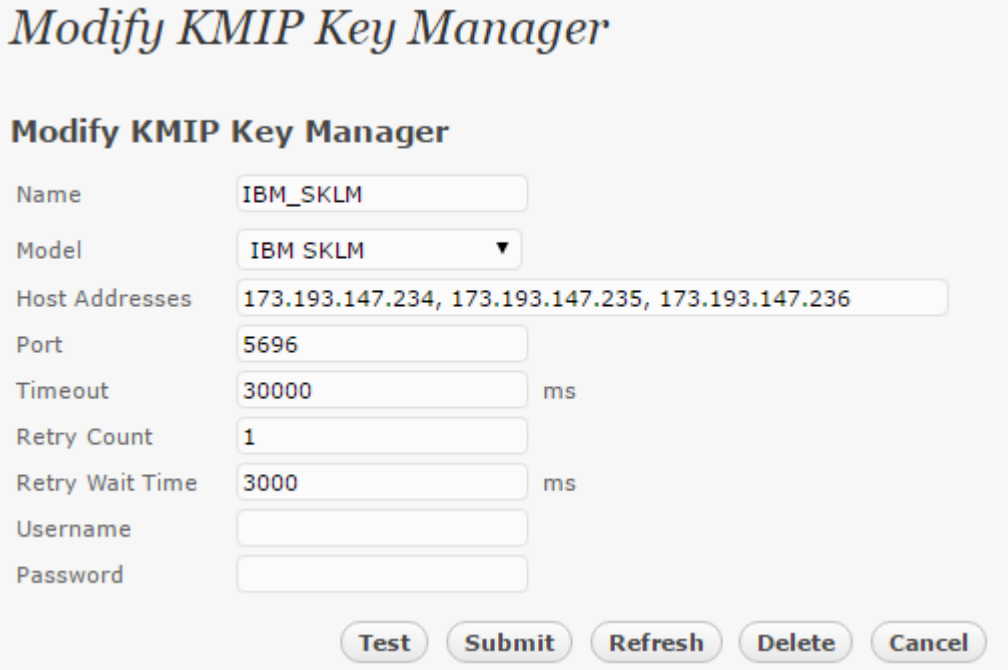
After configuration is complete, push “Test” button to check whether Bloombase StoreSafe and IBM SKLM communication is established. When “Test” button is pushed, IBM SKLM will authenticate Bloombase StoreSafe and Bloombase StoreSafe will send a query to IBM SKLM. If connection test between client-server returns “Success”, IBM SKLM is ready to use as Key Manager for Bloombase StoreSafe.



Push “Submit” button to save the configuration and the configured KMIP server can be viewed under Menu Bar -› Key Management -› OASIS KMIP Key Manager -› Find.

KMIP Key Manager High Availability Clustering Configuration

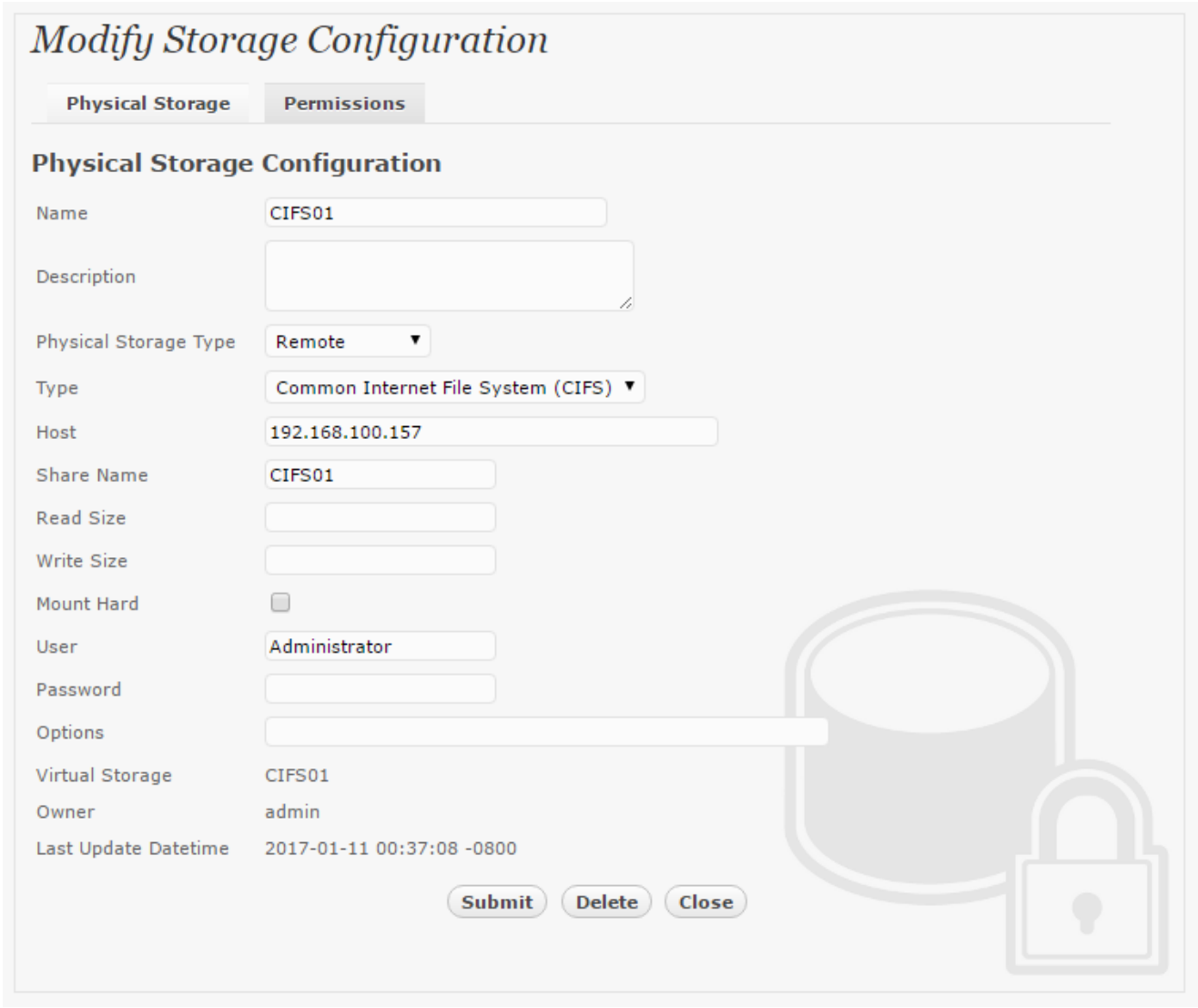
Considering IBM SKLM high availability clustering with replication, Bloombase StoreSafe also supports multi-server KMIP configuration. This can be used when there are more than 1 SKLM configured for high availability purpose. In below image, we assume there are three SKLM server; 1 master (`173.193.147.234`) and 2 clones (`173.193.147.235` and `173.193.147.236`). Bloombase StoreSafe will try to communicate with the 1st IP which is master (`173.193.147.234`). If it is failed it will try the next IP which is the 1st clone (`173.193.147.235`). If it happens both master and 1st clone are unable to be reached, the 2nd clone (`173.193.147.236`) will take over.



CIFS Secure Storage Configuration

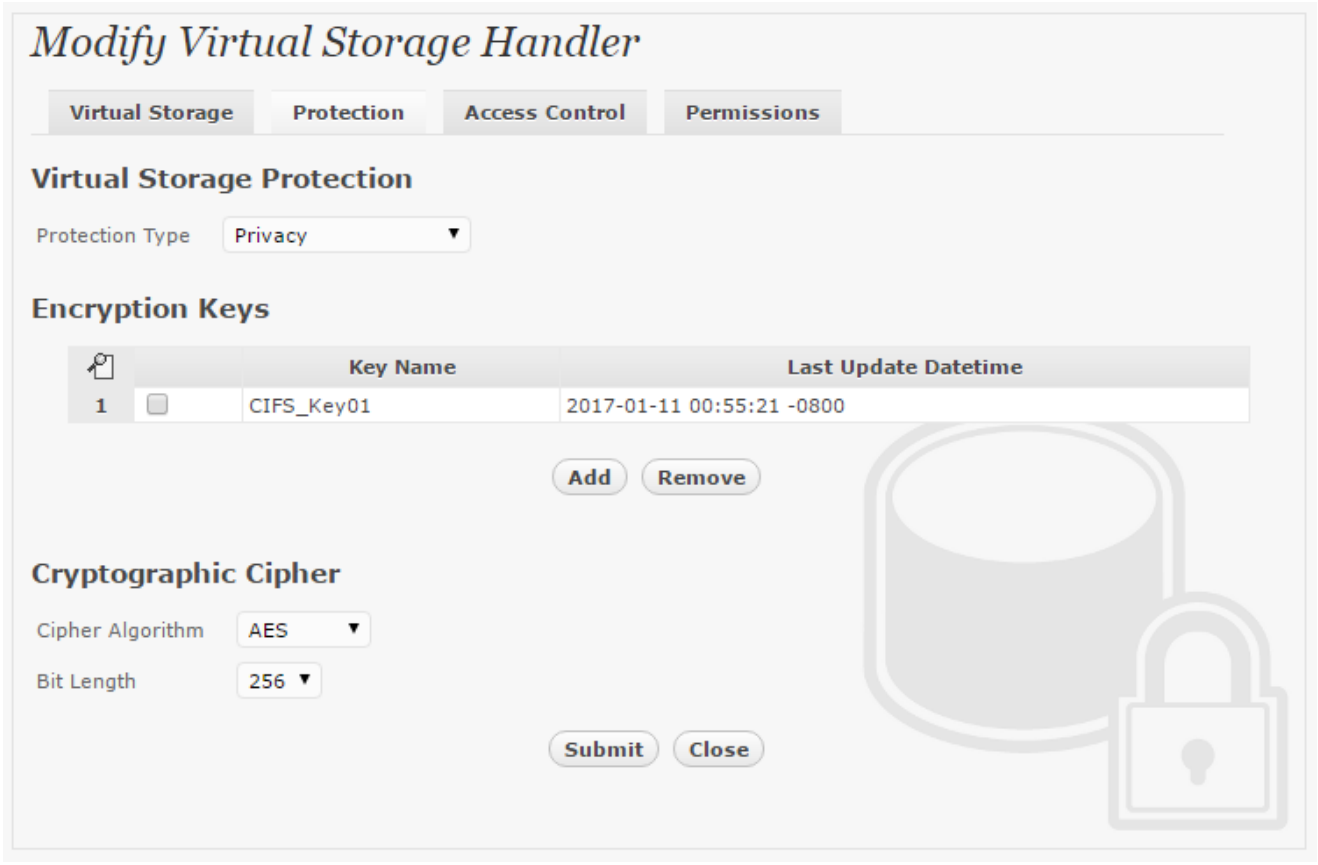
Physical storage namely '`CIFS01`' is configured to be secured by Bloombase StoreSafe using encryption. Backend Physical Storage can be configured under Menu Bar -› Storage -› Physical Storage.

CIFS backend storage is provisioned by Windows Server 2012 (`192.168.100.157`) with share, namely `CIFS01`.



Bloombase StoreSafe CIFS secure storage, named CIFS01, is configured to secure "CIFS01" backend physical storage.

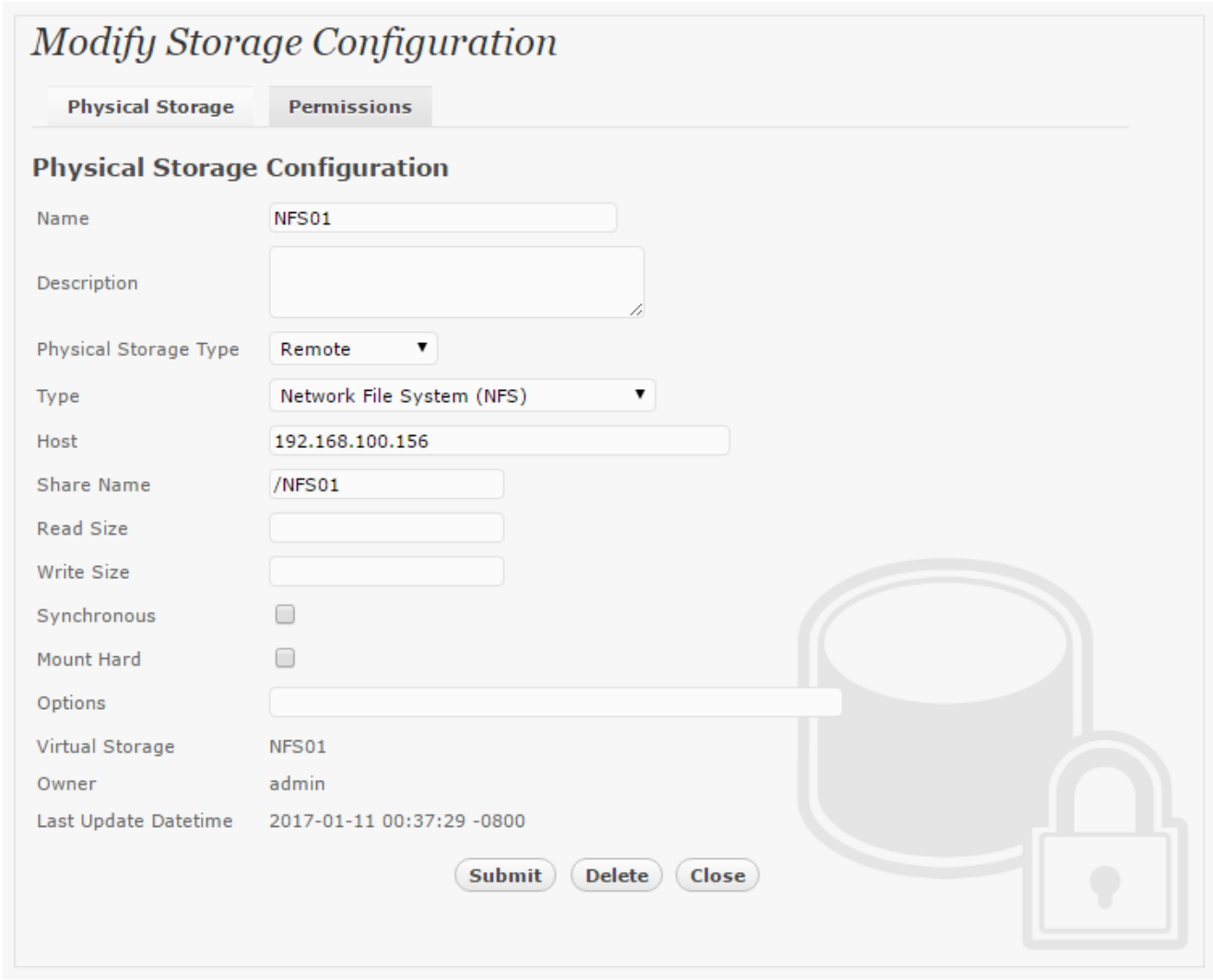
Files under Bloombase StoreSafe CIFS secure storage is encrypted using key `CIFS_Key01` that has been created and managed at IBM SKLM.



NFS Secure Storage Configuration

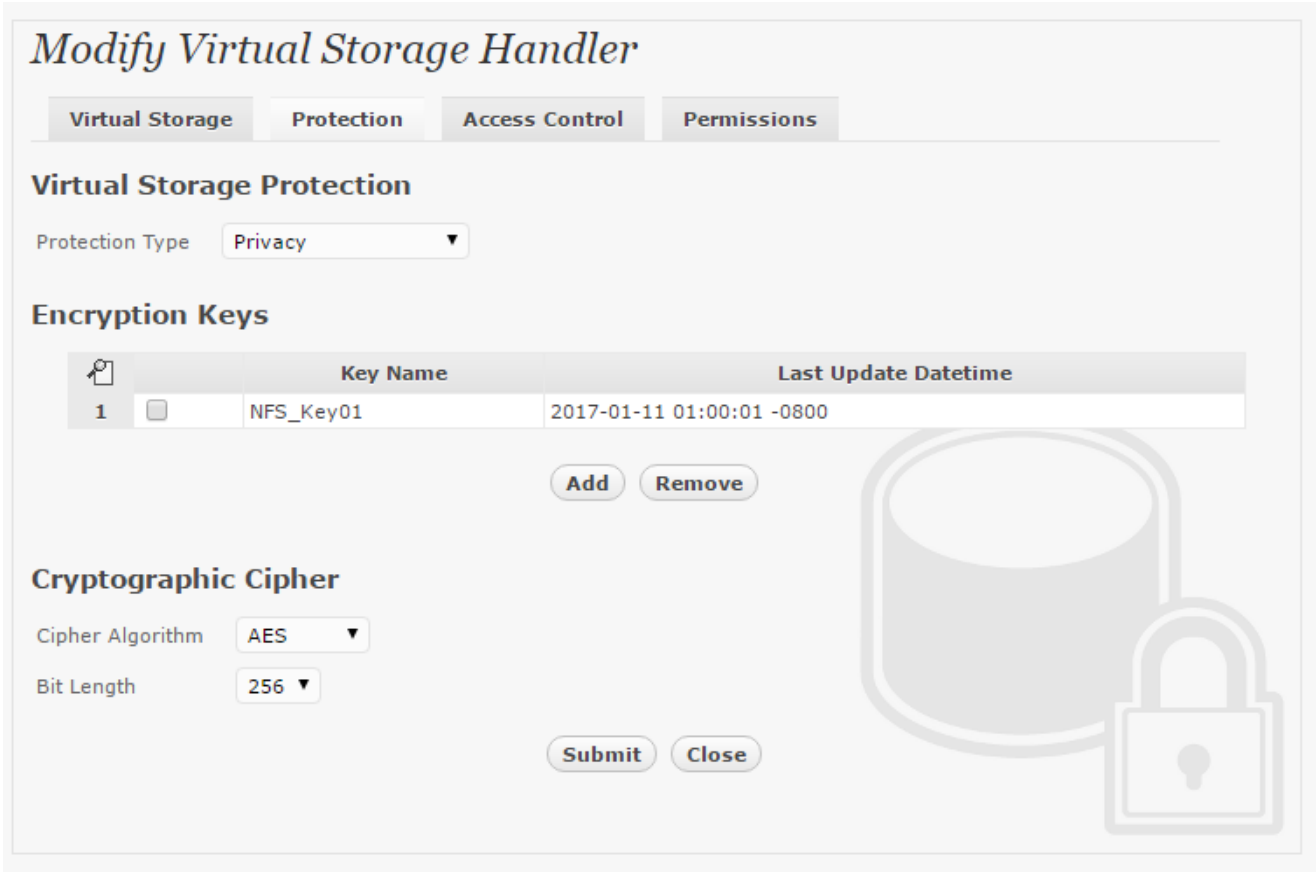
Physical storage namely '`NFS01`' is configured to be secured by Bloombase StoreSafe using encryption. Backend Physical Storage can be configured under Menu Bar -› Storage -› Physical Storage.

NFS backend storage is provisioned by CentOS 7 (`192.168.100.156`) with share name `/NFS01`.



Bloombase StoreSafe NFS secure storage, named `NFS01`, is provisioned to secure "`NFS01`" backend physical storage.

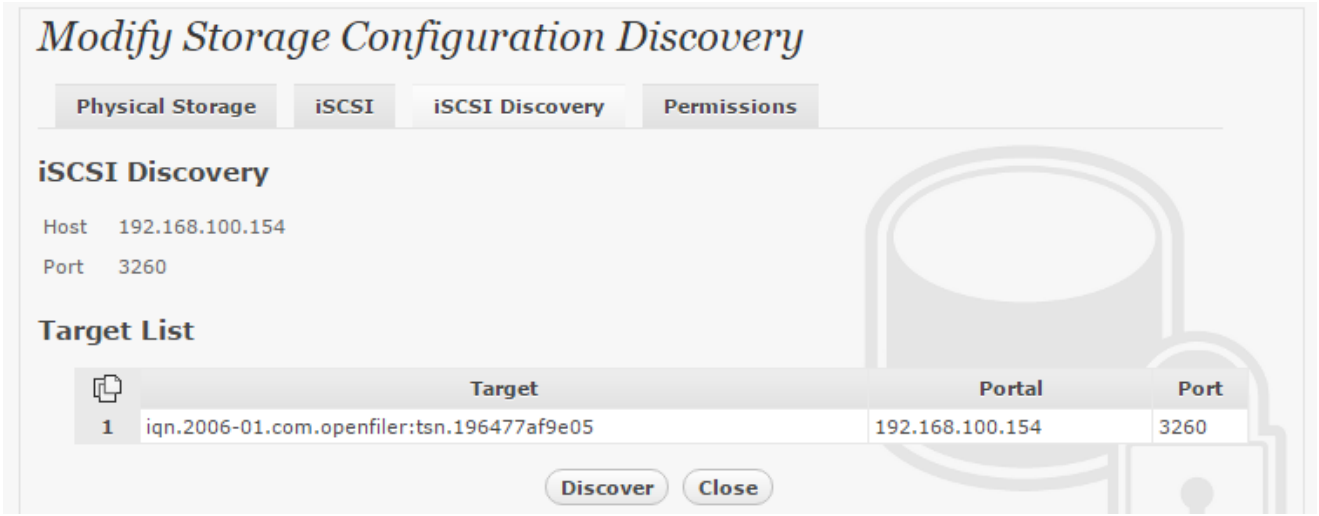
Files under Bloombase StoreSafe NFS secure storage is encrypted using key `NFS_Key01` that has been created and managed at IBM SKLM.

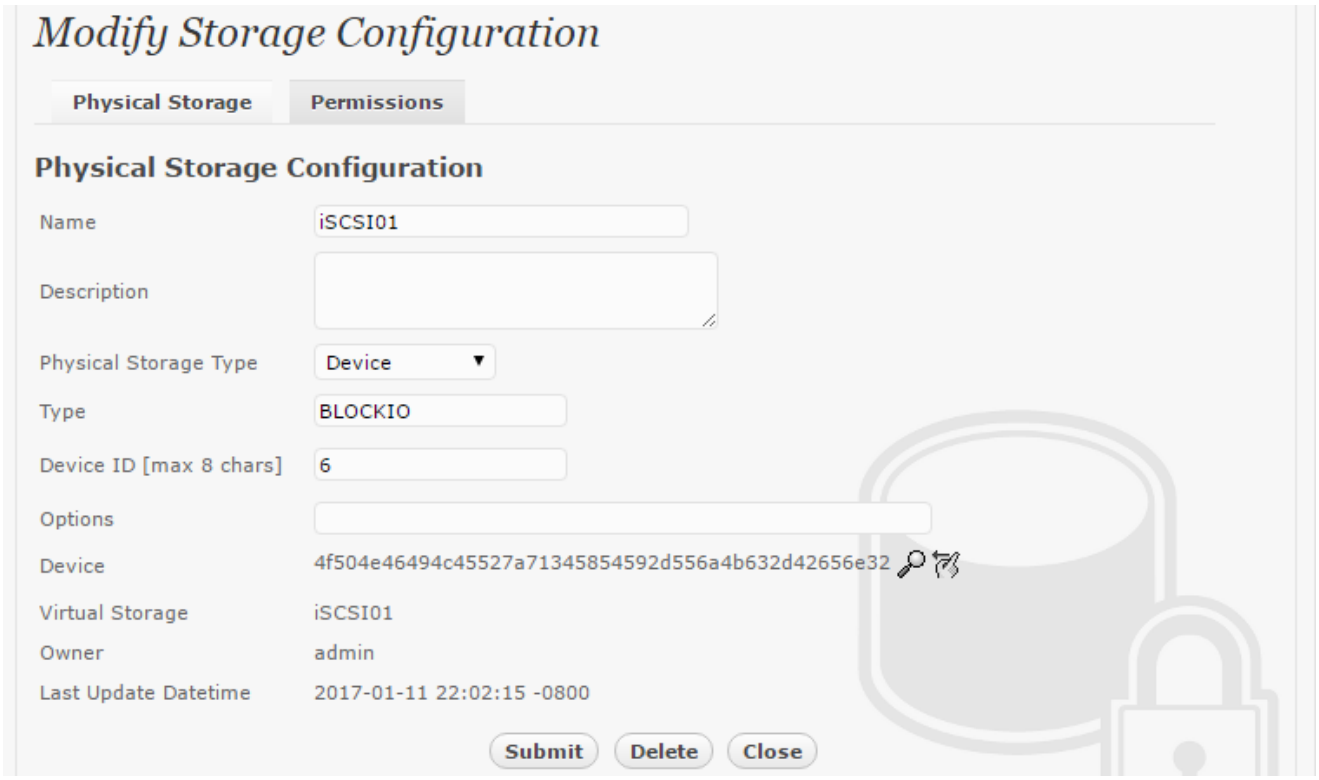


iSCSI Secure Storage Configuration

Physical storage namely '`iSCSI01`' is configured to be secured by Bloombase StoreSafe using encryption. Backend Physical Storage can be configured under Menu Bar -> Storage -> Physical Storage.

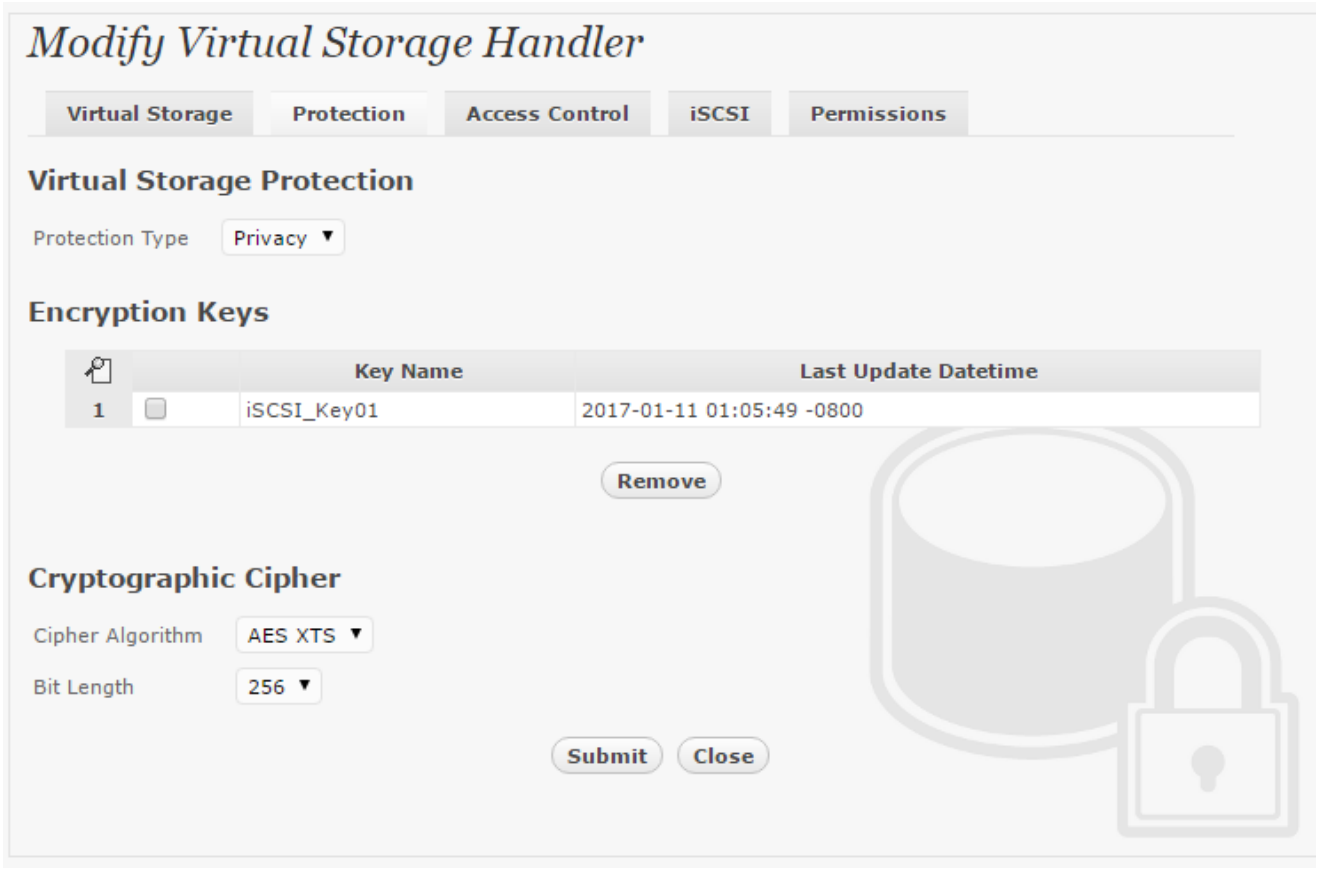
iSCSI backend storage is provisioned by OpenFiler (`192.168.100.154`). To configure the backend iSCSI storage to be encrypted, discover the iSCSI target at OpenFiler and configure the iSCSI backend storage.





Bloombase StoreSafe iSCSI secure storage, named `iSCSI01`, is provisioned to secure "`iSCSI01`" backend physical storage.

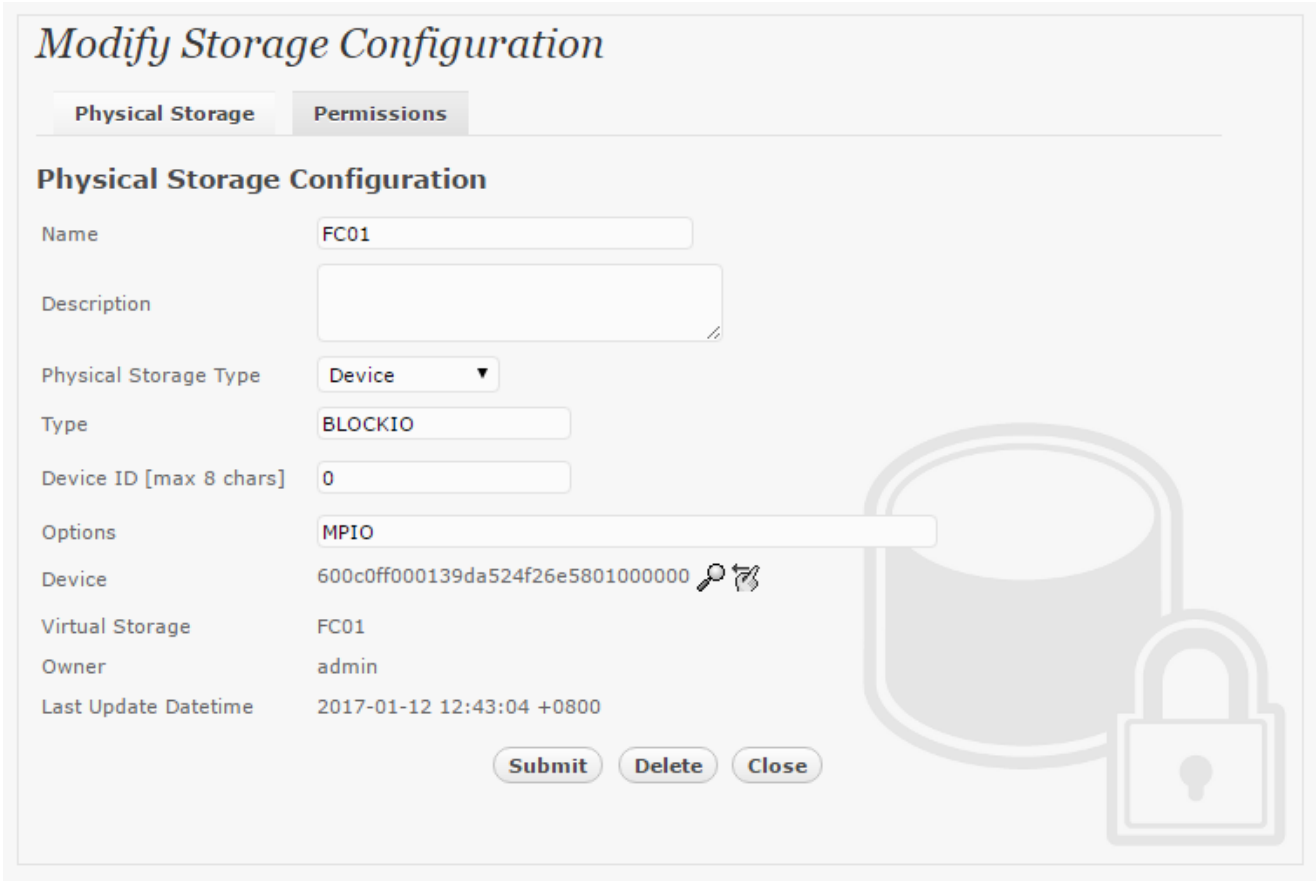
Disk contents inside Bloombase StoreSafe iSCSI secure storage is protected using key `iSCSI_Key01` that has been created and managed at IBM SKLM.



FCP Secure Storage Configuration

Physical storage namely '`FC01`' is configured to be secured by Bloombase StoreSafe using encryption. Backend Physical Storage can be configured under Menu Bar -› Storage -› Physical Storage.

FCP backend storage configuration is provisioned by SAN Storage (`192.168.100.140`).



Bloombase StoreSafe FCP secure storage, named `FC01`, is configured to secure "`FC01`" backend physical storage.

Disk contents inside Bloombase StoreSafe FCP secure storage is protected using key `FC_Key01` that has been created and managed at IBM SKLM.

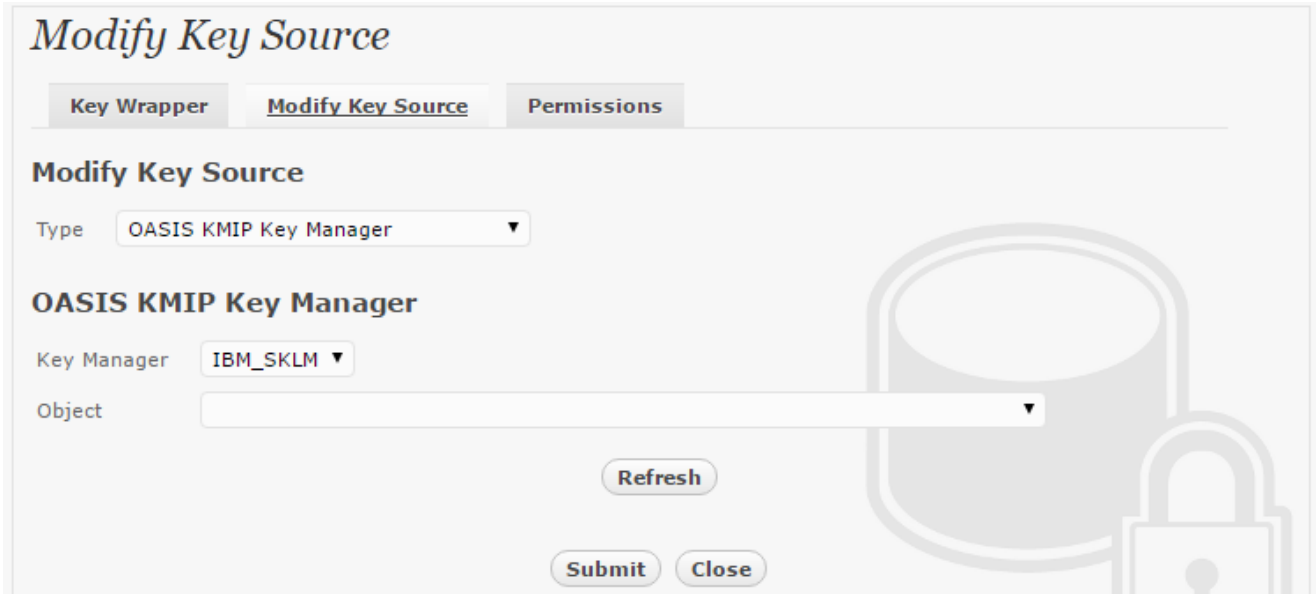
6. Interoperability Test Cases

6.1 Test Cases for Key Generation

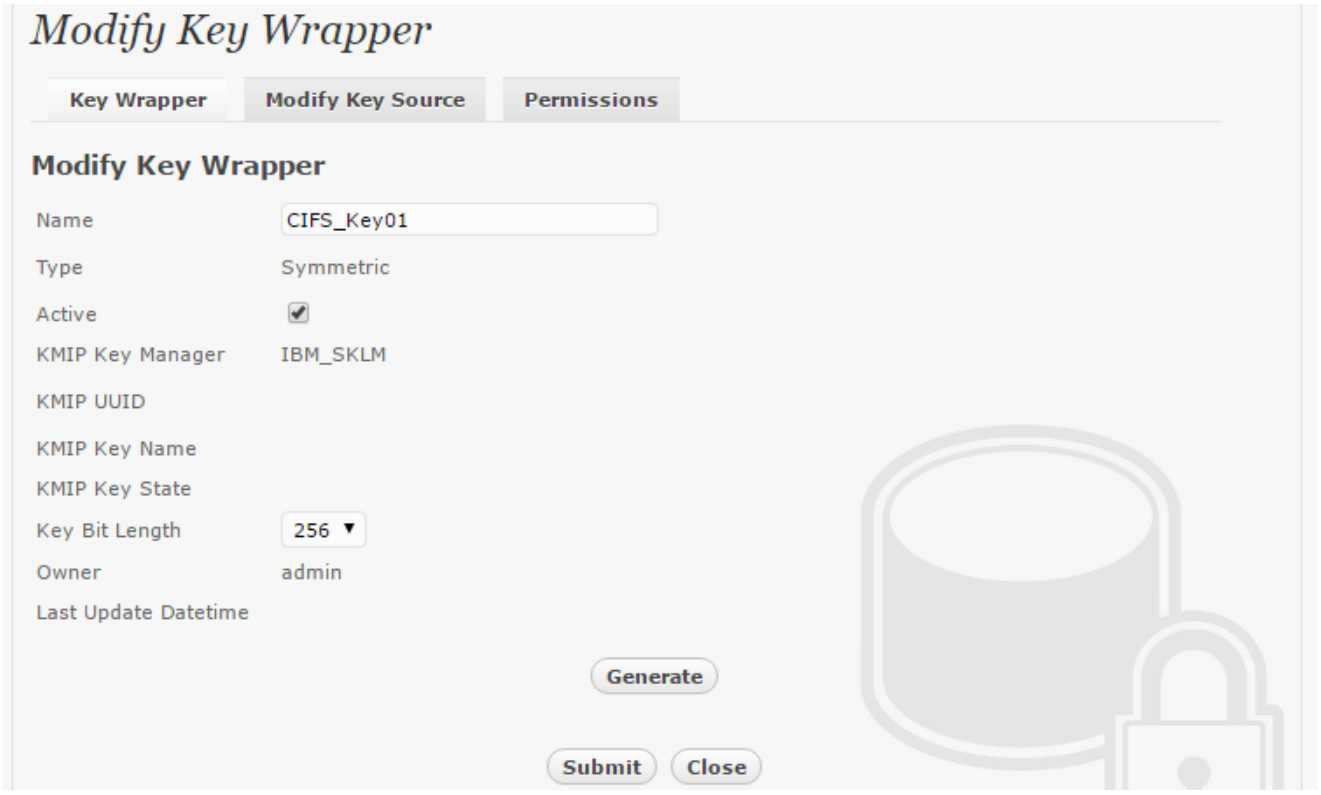
6.1.1 Key Generation at IBM SKLM

Login to the Bloombase StoreSafe web management console and expand the “Key Management” menu. Launch “Create Key Wrapper” tool and change to “Modify Key Source” tab. Select Key Source Type as “OASIS KMIP Key Manager” and configured Key Manager “`IBM_SKLM`”.

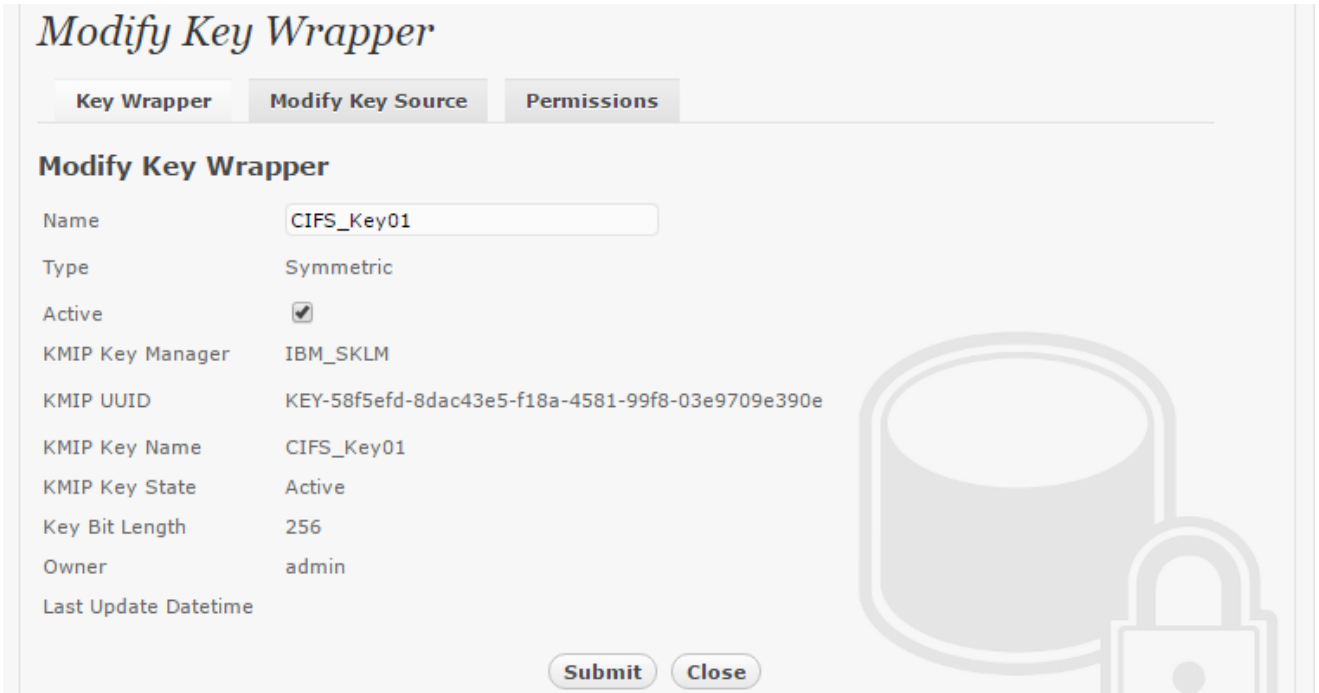
When “`IBM_SKLM`” is chosen, Bloombase StoreSafe will send several KMIP operations to list all keys stored in IBM SKLM; including Get & Get Attributes.



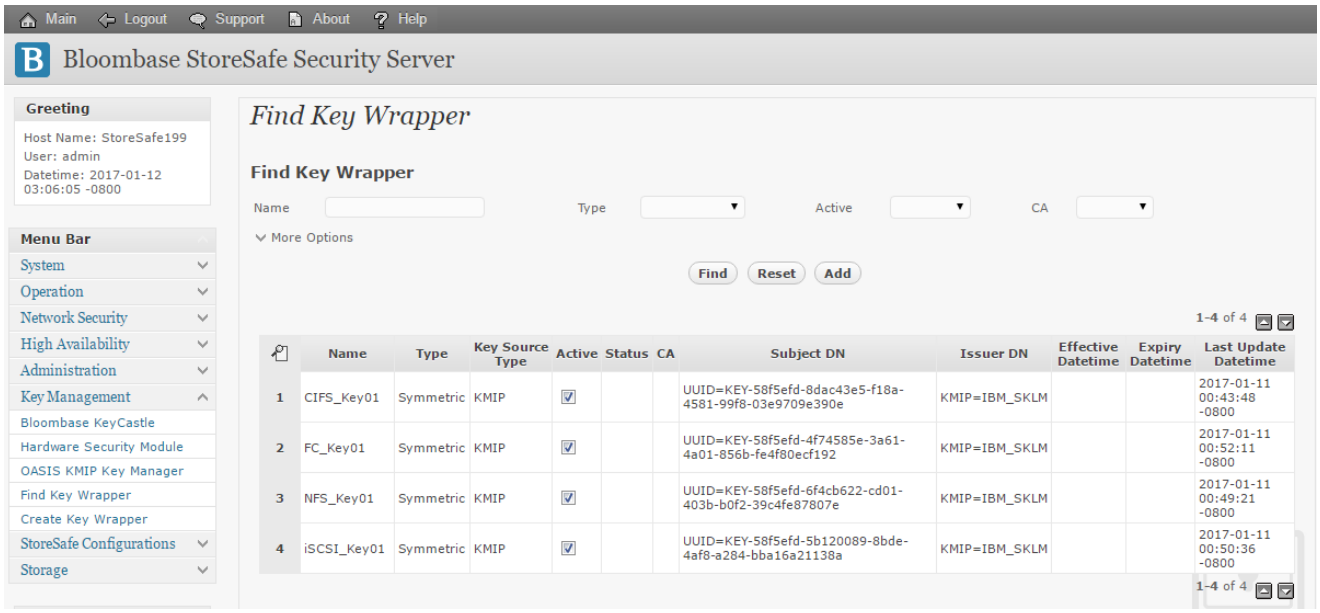
Leave the Object as blank and change to “Key Wrapper”. Input key name and push “Generate” button to generate KMIP key object at the configured IBM SKLM cluster. When “Generate” button is pushed, Bloombase StoreSafe will send several KMIP operations required for key generation; including Create, Get, Register, Add Attributes, Get Attributes, Destroy, and Activate.



Push “Submit” button to store the key created by Bloombase StoreSafe in IBM SKLM.

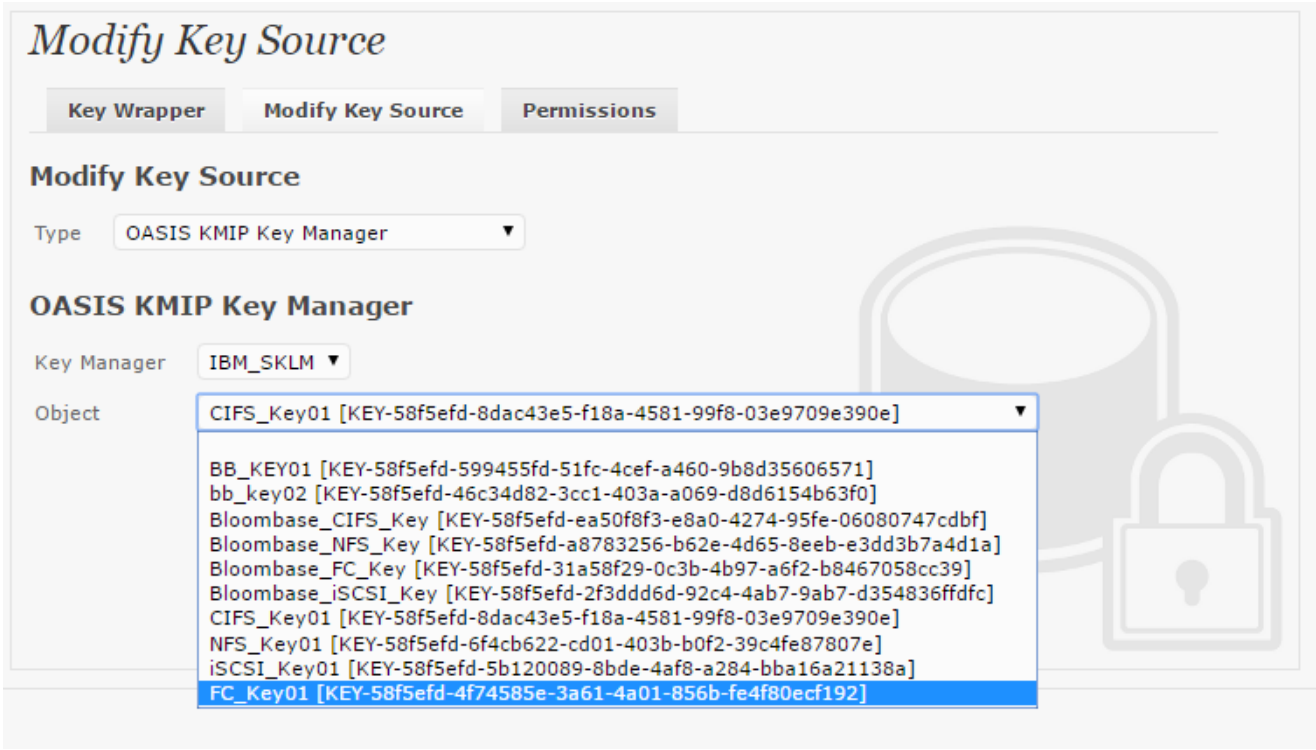


Push “Find” button to list all keys that are ready to use to provide data at-rest encryption. In this test effort, four different symmetric keys (`CIFS_Key01`, `NFS_Key01`, `iSCSI_Key01`, `FC_Key01`) are generated by Bloombase StoreSafe and stored in IBM SKLM.

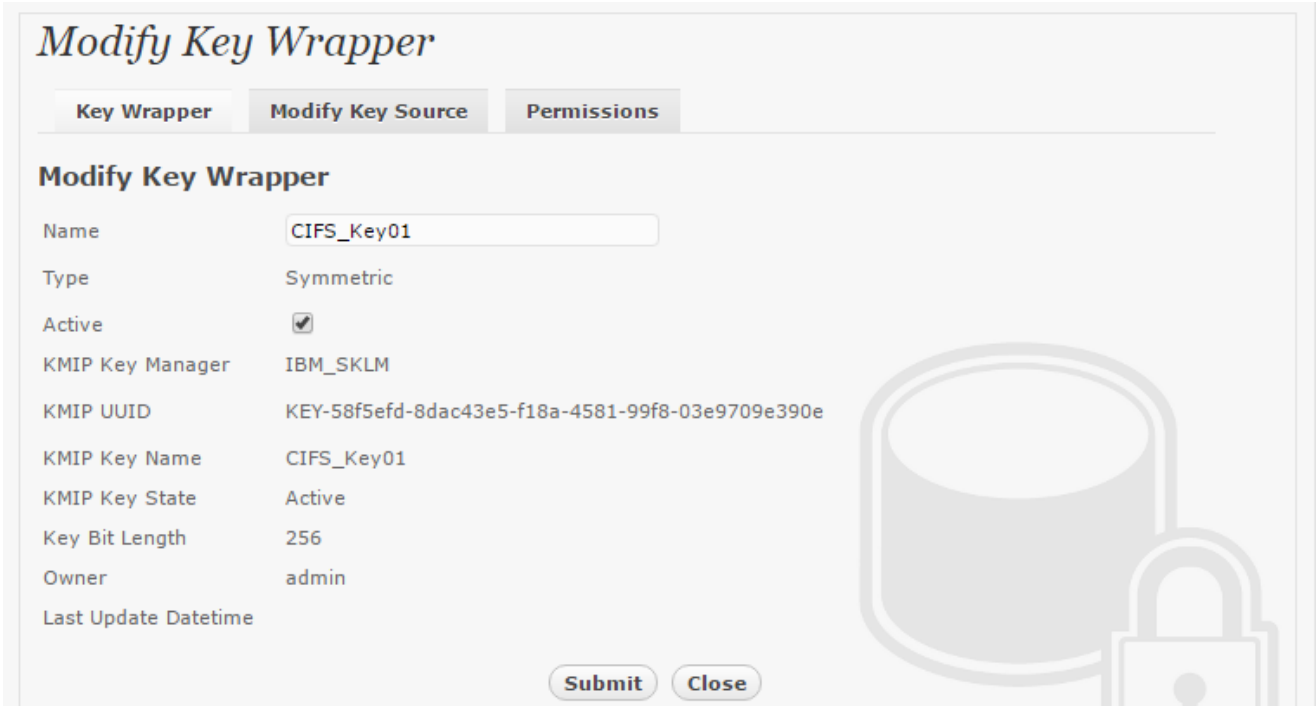


6.1.2 Key Access at IBM SKLM

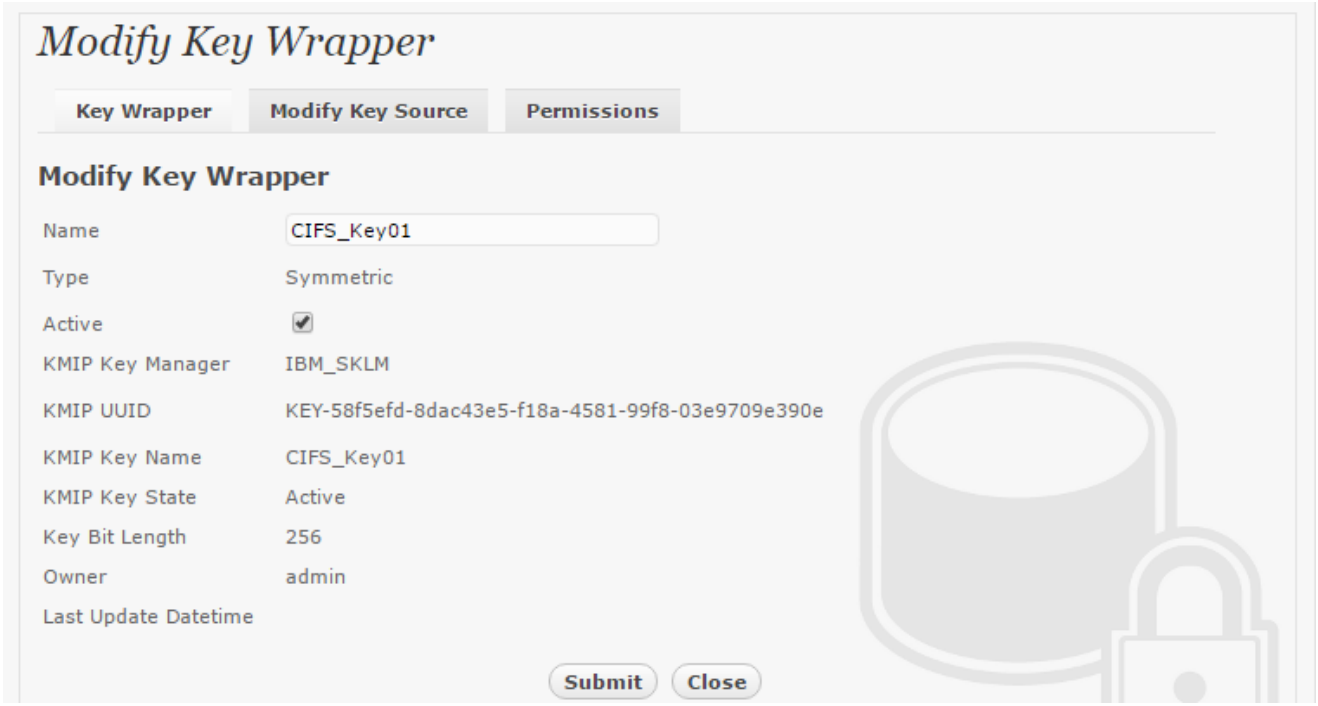
Login to the Bloombase StoreSafe web management console and expand the “Key Management” menu. Launch “Create Key Wrapper” tool and change to “Modify Key Source” tab. Select Key Source Type as “OASIS KMIP Key Manager” and configured Key Manager “`IBM_SKLM`”. Under object, list of all keys that are stored in IBM SKLM can be found. Choose the key that will be provisioned to Bloombase StoreSafe.



Change to “Key Wrapper” tab after choosing the key, key information will be shown.



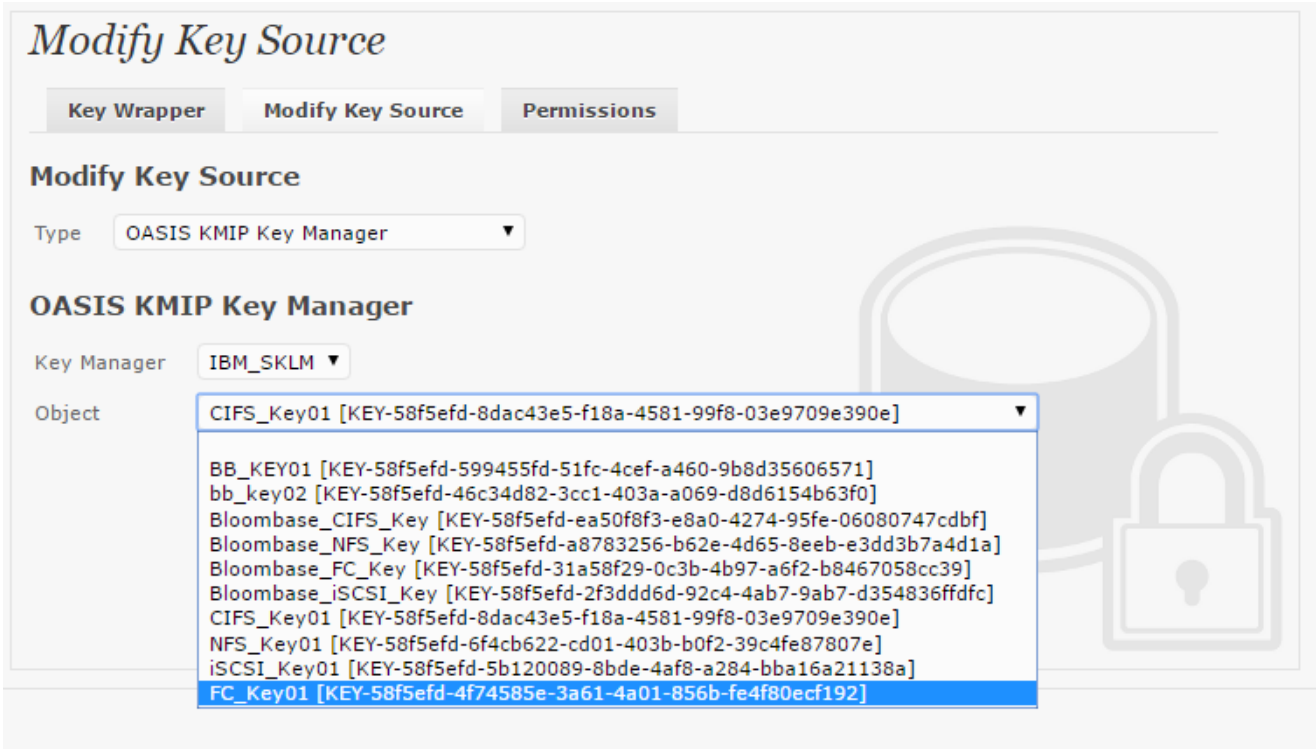
Push “Submit” button to complete the linkage of key from IBM_SKLM.



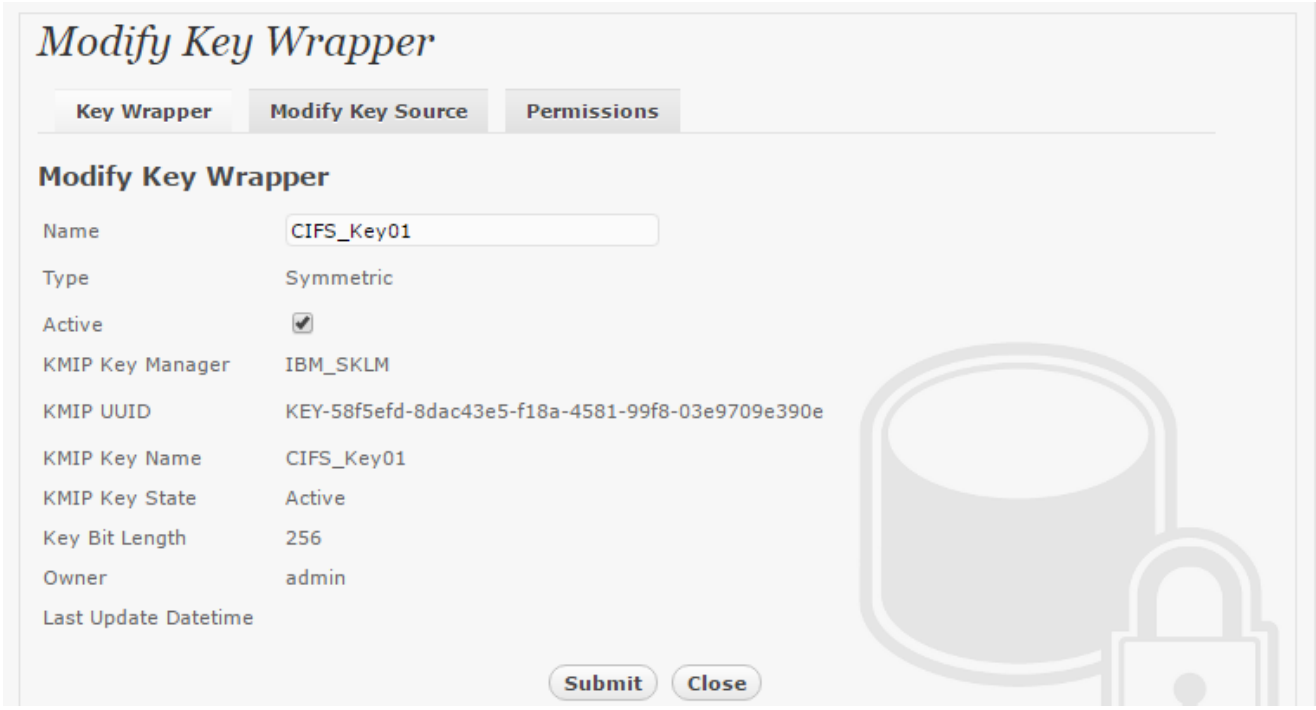
6.1.3 Key Access at IBM SKLM Replication Model Clone Node

Interoperability test between Bloombase StoreSafe and IBM SKLM HA is done by configuring IBM SKLM as Clone. Clone SKLM is limited to read only operation in which key generation is forbidden. In this test, Bloombase StoreSafe will get the key stored in IBM SKLM “Clone” which will be used to encrypt and un-encrypt data.

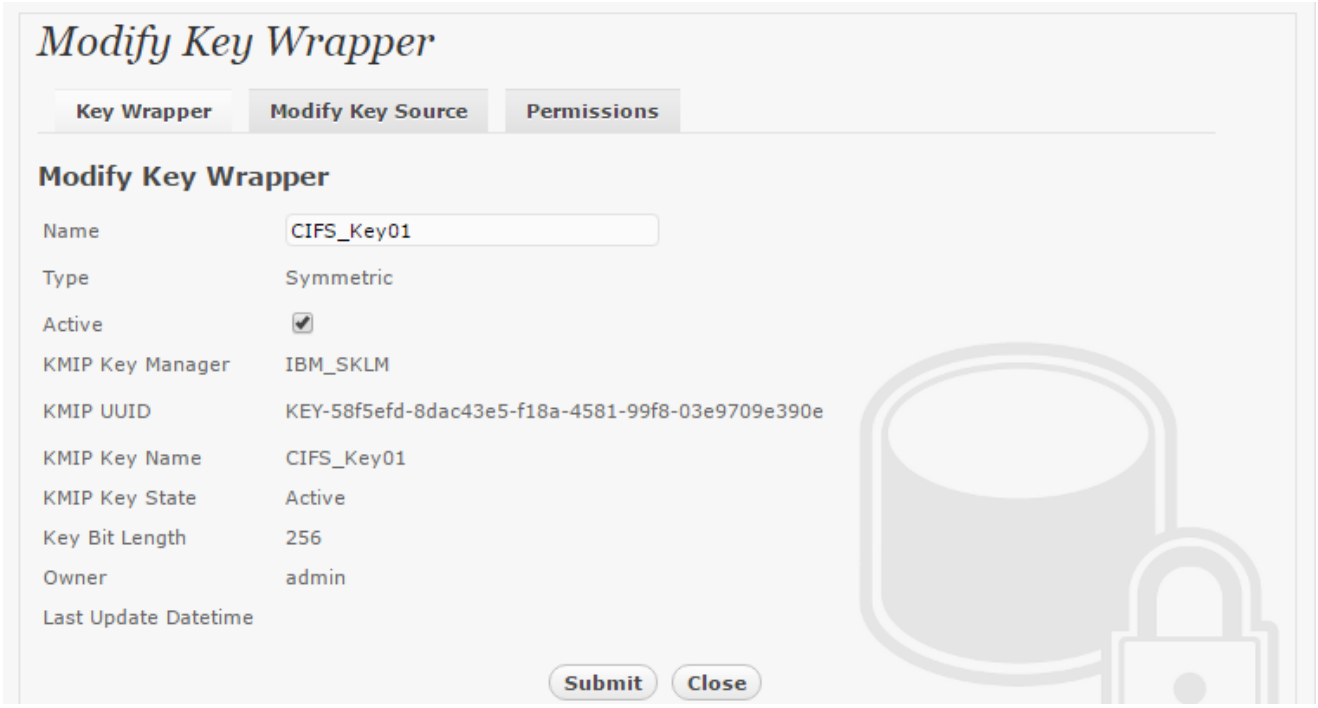
Login to the Bloombase StoreSafe web management console and expand the “Key Management” menu. Launch “Create Key Wrapper” tool and change to “Modify Key Source” tab. Select Key Source Type as “OASIS KMIP Key Manager” and configured Key Manager “`IBM_SKLM`”. Under object, list of all keys that are stored in IBM SKLM can be found. Choose the key that will be provisioned to Bloombase StoreSafe.



Change to “Key Wrapper” tab after choosing the key, key information will be shown.



Push “Submit” button to complete the linkage of key from `IBM_SKLM`.

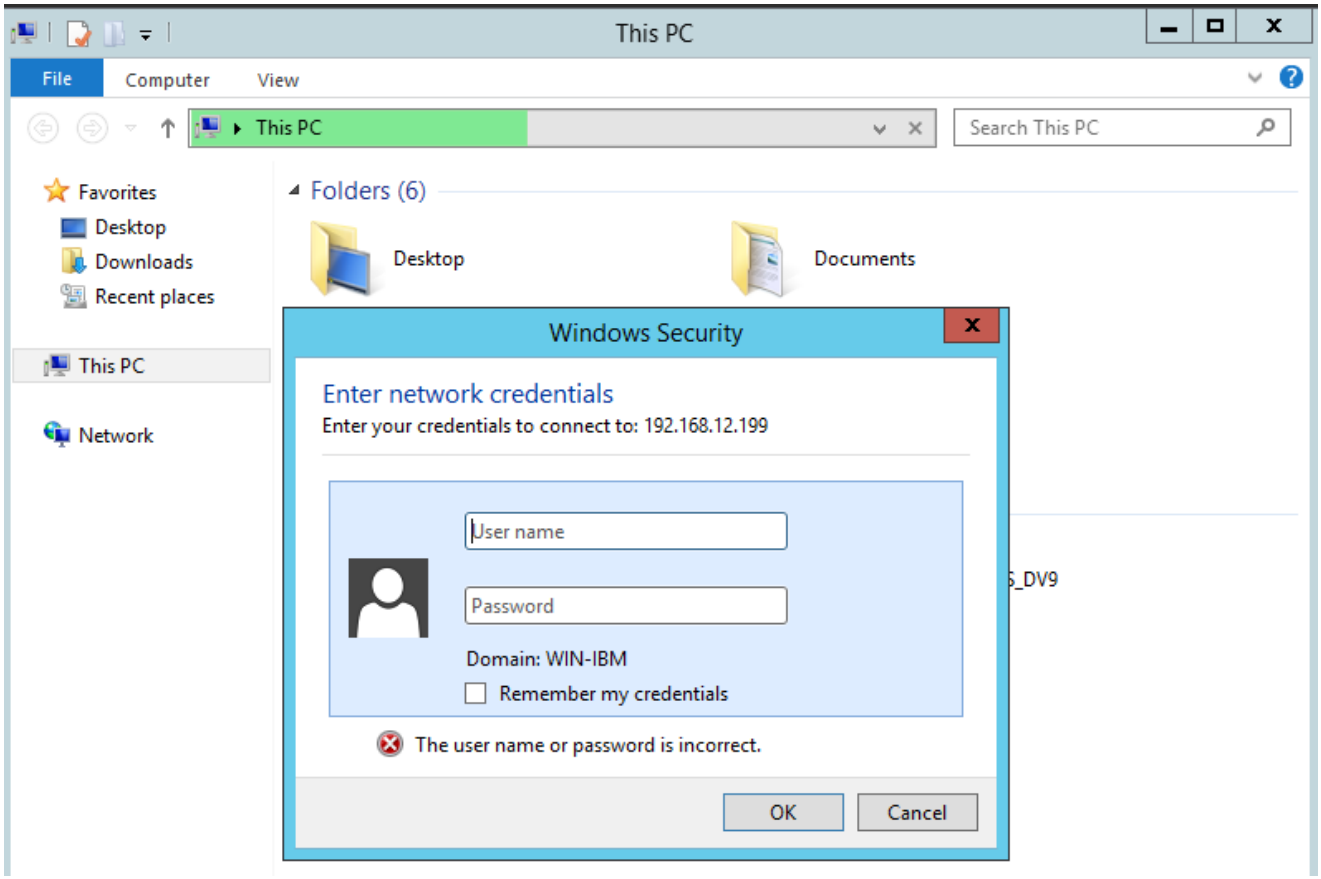


Interoperability test between Bloombase StoreSafe and “Clone” in IBM SKLM replication model maintain the “read-only” characteristics of “Clone” in IBM SKLM replication model. As a client, Bloombase StoreSafe is able to get and use the key which is stored in IBM SKLM to encrypt and un-encrypt data, but will not be able to make changes to existing objects in the clone IBM SKLM.

6.2 Test Cases for CIFS Data Encryption and Decryption

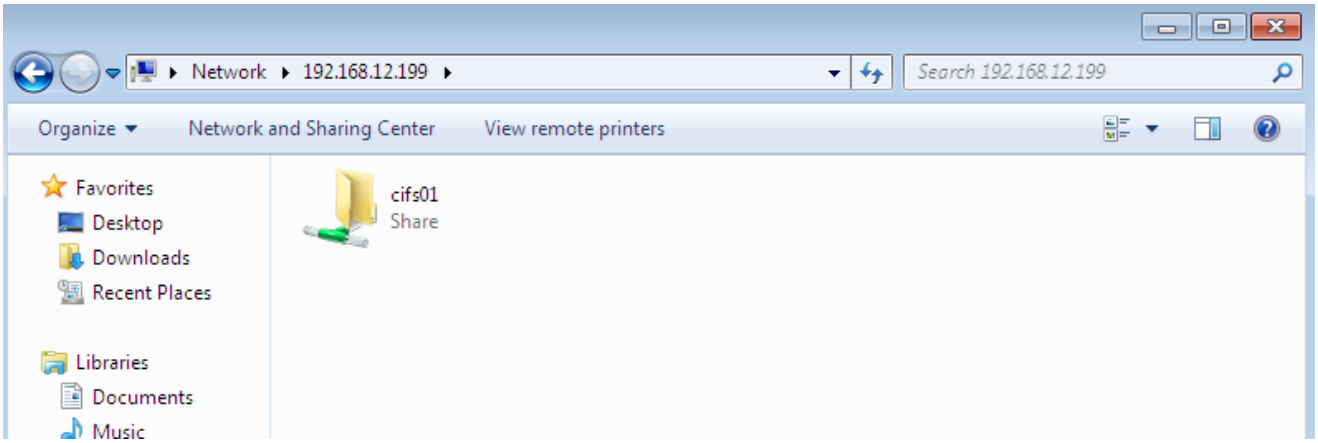
6.2.1 SMB Authentication at CIFS Secure Storage

Login to the CIFS secure storage delivered by Bloombase StoreSafe by accessing `\\192.168.12.199` using Windows File Explorer on Microsoft Windows 7 Client. A dialog box will be displayed and prompts for credentials for user authentication.



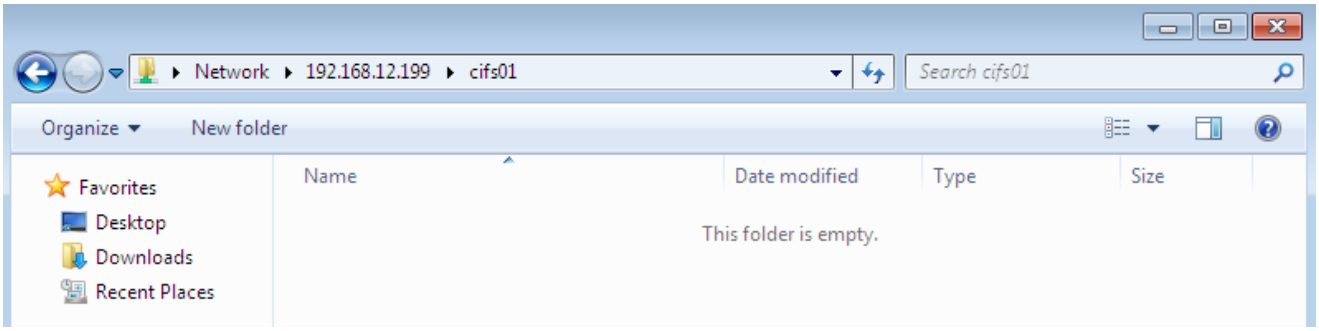
6.2.2 List CIFS Secure Storage

Once user successfully signs on to Bloombase StoreSafe as an authorized SMB user, the available Bloombase StoreSafe CIFS secure storage will be listed.



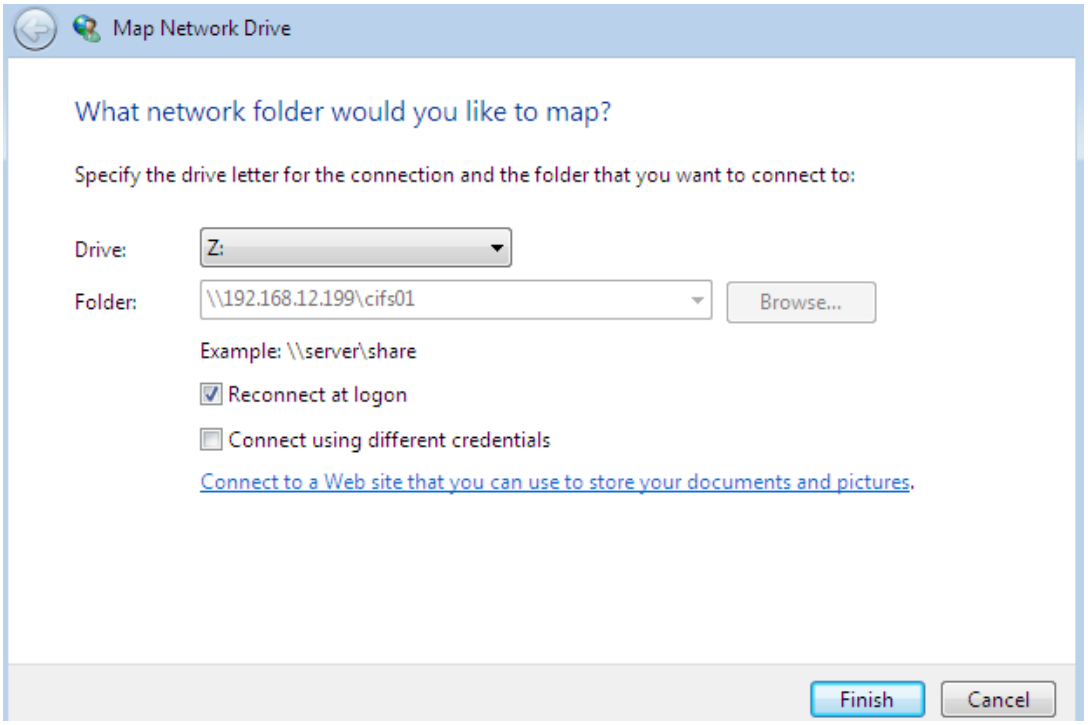
6.2.3 Connect and Access CIFS Secure Storage

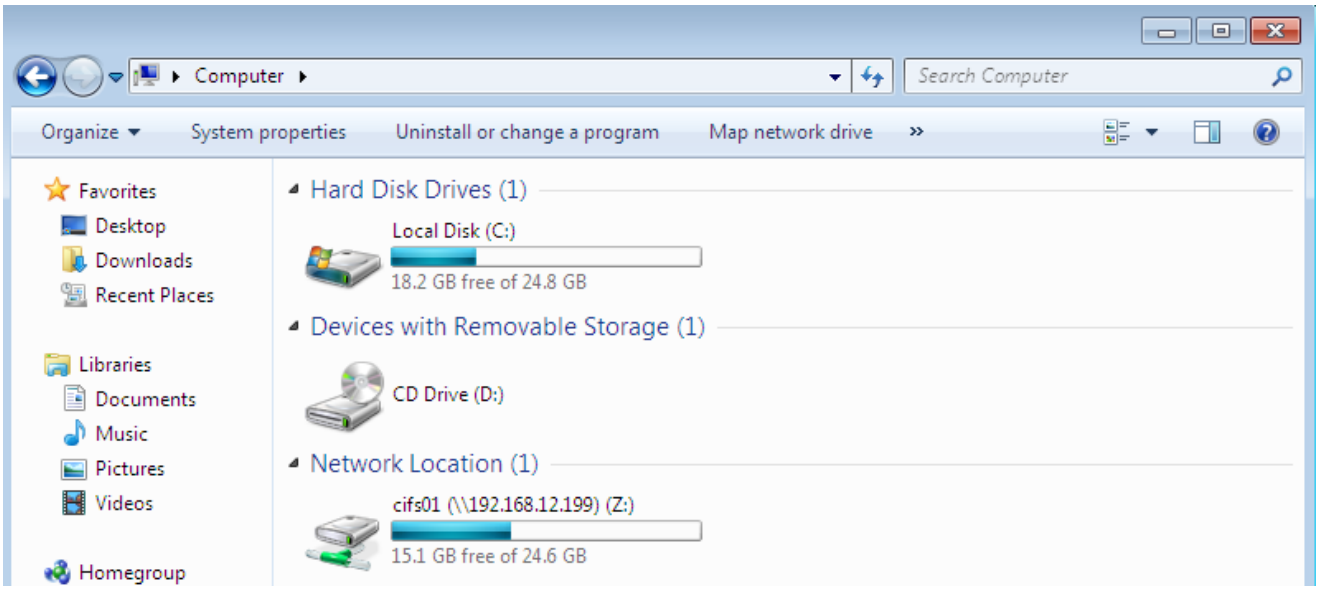
Authorized SMB user is able to list and access contents inside Bloombase StoreSafe CIFS secure storage.



6.2.4 Mount CIFS Secure Storage

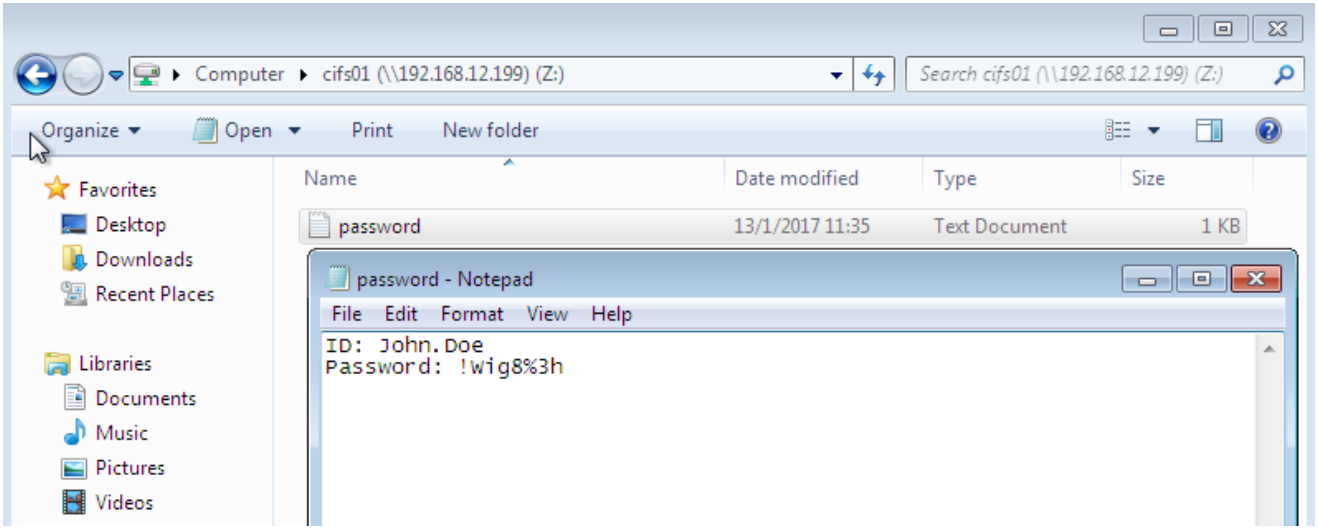
Mount Bloombase StoreSafe CIFS secure storage by using File Explorer, Map Network Drive wizard will be shown as it is supposed to be mounting any normal network storage. Choose drive letter and push “Finish” button, Bloombase StoreSafe CIFS secure storage has been successfully mapped as a network drive.



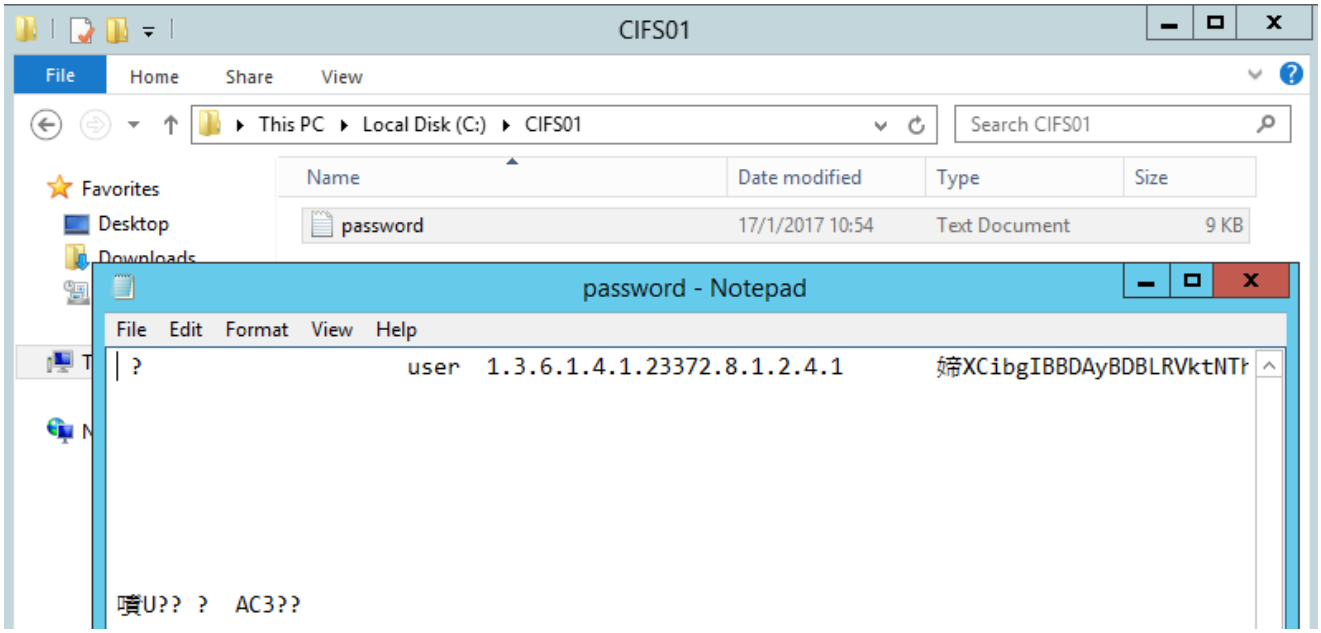


6.2.5 Write to CIFS Secure Storage

Create a new text document, named "`password.txt`", inside Bloombase StoreSafe CIFS secure storage.



Once the file is saved, it is encrypted on the fly and stored physically at backend storage in natural ciphertext format. File is encrypted by key `CIFS_Key01` that has been created and managed at IBM SKLM.



6.2.6 Read from CIFS Secure Storage

Read the newly created file in Bloombase StoreSafe CIFS secure storage, cipher-text file is retrieved physically from backend storage and un-encrypted on the fly. File is successfully presented and read as virtual clear-text data. File is un-encrypted using key `CIFS_Key01` that has been created and managed at IBM SKLM.

```
Z:\>type password.txt
ID: John.Doe
Password: !Wig8%3h
```

6.2.7 Delete from CIFS Secure Storage

Deleting file from Bloombase StoreSafe CIFS secure storage as if normal virtual-plain file. Delete file on Bloombase StoreSafe CIFS secure storage will automatically delete file at backend storage.

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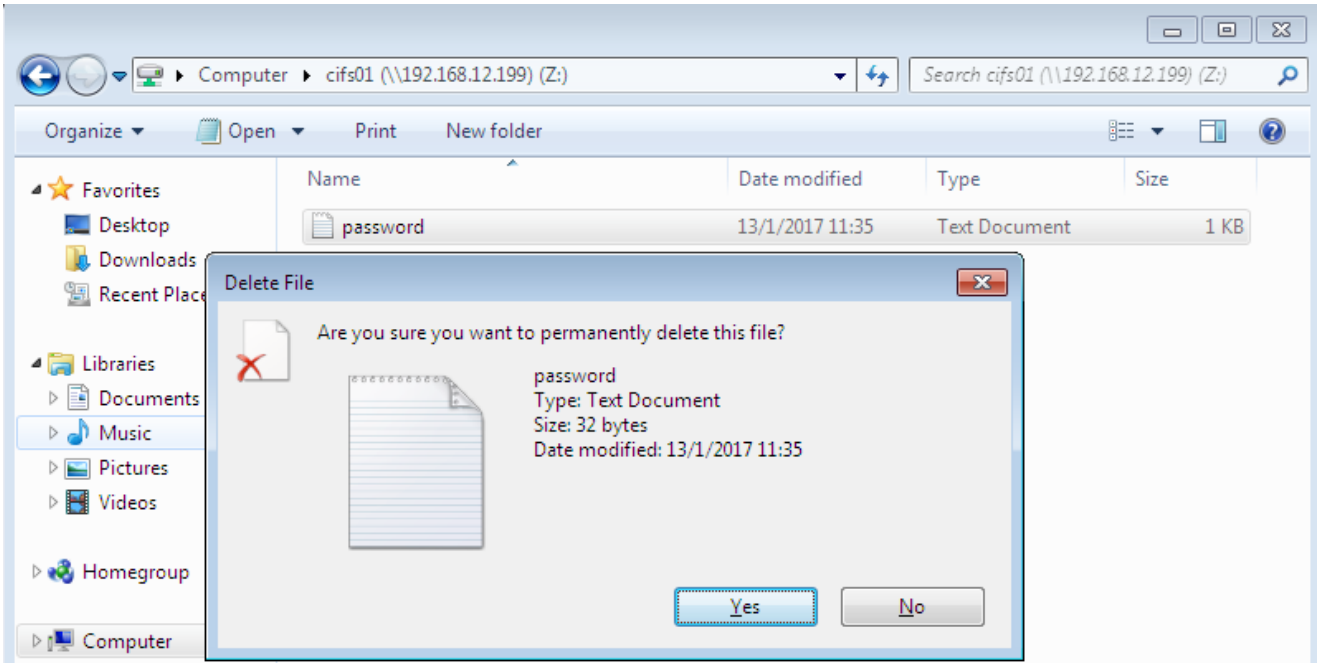
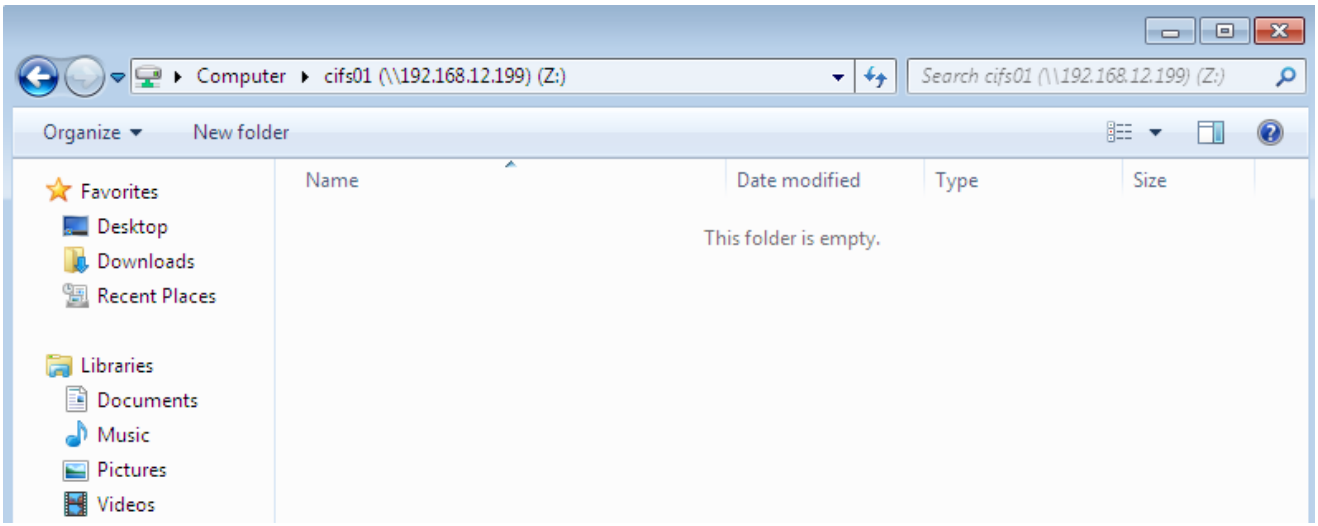




6.3 Test Cases for NFS Data Encryption and Decryption

6.3.1 Network Access Control at NFS Secure Storage

Mount Bloombase StoreSafe NFS secure storage on CentOS 7 client. Authorized client is able to access Bloombase StoreSafe NFS secure storage without returning any access denied error message.

```
[root@localhost ~]# mount -t nfs 192.168.12.199:/NFS01 /mnt/NFS01
[root@localhost ~]#
```

6.3.2 List NFS Secure Storage

List all contents of the mount point which mounted to Bloombase StoreSafe NFS secure storage.

```
[root@localhost ~]# ls -l /mnt/NFS01
total 0
```

6.3.3 Connect and Access NFS Secure Storage

Authorized client is able to access Bloombase StoreSafe NFS secure storage without returning any access denied or error message.

```
[root@localhost ~]# mount | grep NFS01
192.168.12.199:/NFS01 on /mnt/NFS01 type nfs (rw,relatime,vers=3,rsize=65536,wsize=65536,namlen=255,hard,proto=t
cp,timeo=600,retrans=2,sec=sys,mountaddr=192.168.12.199,mountvers=3,mountport=20048,mountproto=udp,local_lock=no
ne,addr=192.168.12.199)
[root@localhost ~]# cd /mnt/NFS01/
[root@localhost NFS01]#
```

6.3.4 Mount NFS Secure Storage

Client host with authorized IP address is able to get Bloombase StoreSafe NFS secure storage mounted as a mount point which operates almost like a filesystem.

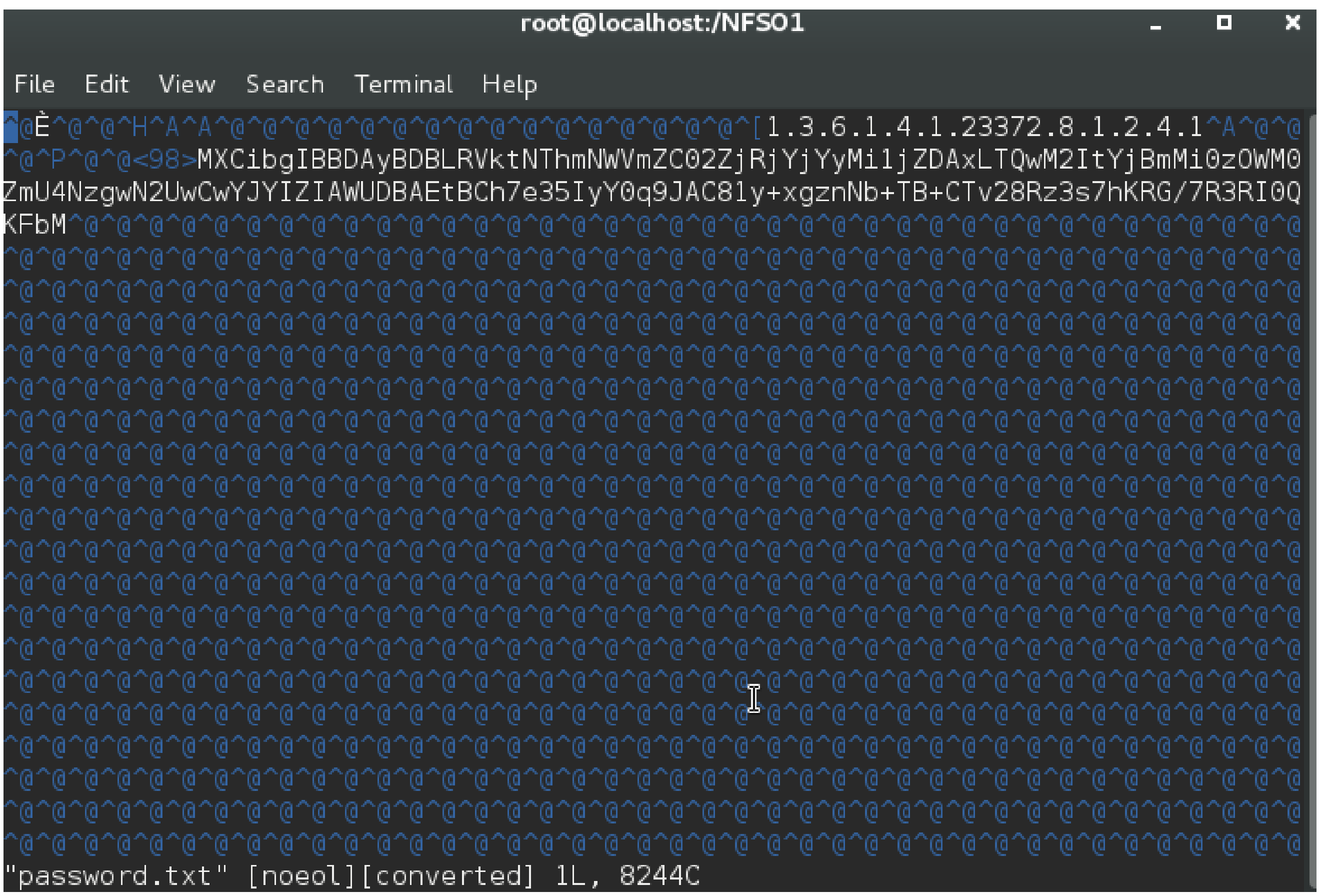
```
[root@localhost ~]# mount -t nfs 192.168.12.199:/NFS01 /mnt/NFS01
[root@localhost ~]# mount | grep NFS01
192.168.12.199:/NFS01 on /mnt/NFS01 type nfs (rw,relatime,vers=3,rsize=65536,wsize=65536,namlen=255,hard,proto=t
cp,timeo=600,retrans=2,sec=sys,mountaddr=192.168.12.199,mountvers=3,mountport=20048,mountproto=udp,local_lock=no
ne,addr=192.168.12.199)
```

6.3.5 Write to NFS Secure Storage

Create a new text document, named "`password.txt`", in the mount-point referencing Bloombase StoreSafe NFS secure storage.

```
[root@localhost ~]# echo "John.Doe u&G43tg%" > /mnt/NFS01/password.txt
[root@localhost ~]# ls /mnt/NFS01/password.txt
/mnt/NFS01/password.txt
```

File is encrypted on the fly and stored physically at the backend storage. File is encrypted using key `NFS_Key01` that has been created and managed at IBM SKLM.



6.3.6 Read from NFS Secure Storage

Read the newly created file from mount-point referencing to Bloombase StoreSafe NFS secure storage, cipher-text file is retrieved physically from backend storage and un-encrypted on the fly. File is successfully presented and read as virtual clear-text data. File is un-encrypted using key `NFS_Key01` that has been created and managed at IBM SKLM.

```
[root@localhost ~]# cat /mnt/NFS01/password.txt
John.Doe u&G43tg%
```

6.3.7 Delete from NFS Secure Storage

Delete file from mount-point referencing to Bloombase StoreSafe NFS secure storage as if normal virtual-plain file. Deleting file from mount-point referencing to Bloombase StoreSafe NFS secure storage will automatically delete file at backend storage.

```
[root@localhost ~]# rm /mnt/NFS01/password.txt
rm: remove regular file '/mnt/NFS01/password.txt'? y
[root@localhost ~]# ls -l /mnt/NFS01/
total 0
```

6.4 Test Cases for iSCSI Data Encryption and Decryption

6.4.1 Discover iSCSI Secure Storage

Discover Bloombase StoreSafe iSCSI secure storage on CentOS 7 with authorized IP network address returns discovery and listing of Bloombase StoreSafe iSCSI secure storage.

```
[root@localhost ~]# iscsiadm -m discovery -tst -p 192.168.12.199:3260
192.168.12.199:3260,1 iSCSI01
```

6.4.2 Connect to iSCSI Secure Storage

Authorized client is able to connect and access Bloombase StoreSafe iSCSI secure storage without any permission denied error message.

```
[root@localhost ~]# iscsiadm -m node -p 192.168.12.199:3260 -T iSCSI01 --login
Logging in to [iface: default, target: iSCSI01, portal: 192.168.12.199,3260] (multiple)
Login to [iface: default, target: iSCSI01, portal: 192.168.12.199,3260] successful.
```

6.4.3 Dump in iSCSI Secure Storage Raw Device

Write and dump in contents to Bloombase StoreSafe iSCSI secure storage as raw device which gets encrypted and persisted physically at backend storage.

```
[root@localhost dev]# dd if=/dev/zero of=/dev/sdd bs=4k count=2
2+0 records in
2+0 records out
8192 bytes (8.2 kB) copied, 0.00936727 s, 875 kB/s
```

Backend volume is encrypted by using key `iSCSI_Key01` that has been created and managed at IBM SKLM.

```
00000a00  29 bd 7d b6 7c ba 11 f6  69 62 f2 2d 40 1a 07 4a  |).}.|...ib.-@..J|
00000a10  bb 4e 72 0d c6 33 ef 02  8b 1b 3d 64 77 66 57 a5  |.Nr..3....=dwfW.|
00000a20  65 d5 44 cb 2e 2f cf 6a  53 a0 23 8d 70 b9 28 f3  |e.D../.jS.#.p.(.|
00000a30  40 10 d6 46 4a df 6d 56  44 f3 f1 83 b1 c1 67 68  |@..FJ.mVD.....gh|
00000a40  02 54 a5 e1 89 b7 02 ad  c5 30 26 ea fe 40 e7 04  |.T.......0&..@..|
00000a50  7e 2c f4 f9 a4 2f 8a 97  56 ac c0 26 90 6a 39 a5  |~,.../..V..&.j9.|
00000a60  13 ff 87 ca 06 51 be c5  5f f0 d1 a8 99 8c 08 a1  |.....Q.._.......|
00000a70  ce 76 71 cd 76 d6 7f 44  7b 43 3c 98 77 58 13 93  |.vq.v..D{C<.wX..|
00000a80  4d 09 7e f0 cb ae d4 32  cd 49 df 89 7a 0e 45 5e  |M.~....2.I..z.E^|
00000a90  b0 e7 d8 07 4f 9c 86 8f  12 32 0f 3c 10 95 9e a7  |....O....2.<....|
00000aa0  28 13 3c 6c e4 d2 e1 4a  60 6c a7 86 3a 8b ba a1  |(.<l...J`l..:...|
00000ab0  1f a6 1c fc 02 d9 72 8a  af db 1a d3 a2 1c e3 17  |......r.........|
00000ac0  33 35 eb 81 59 31 7c 5a  7b 48 e8 f4 7d a7 ca 4a  |35..Y1|Z{H..}..J|
00000ad0  02 1a d9 09 58 f5 75 a9  2f 55 3f f5 b5 b2 86 13  |....X.u./U?.....|
00000ae0  ac 3f 39 e4 db 12 d6 b0  28 32 29 cd 04 f2 9f 9f  |.?9.....(2).....|
00000af0  b0 88 01 21 2b da 39 c2  8c de 76 12 4b d8 ce 93  |...!+.9...v.K...|
00000b00  3c 7d e4 d5 bc 1d 9c 9c  5d 65 e1 54 e9 2a e1 e2  |<}......]e.T.*..|
```

6.4.4 Dump out iSCSI Secure Storage Raw Device

Dump out contents from Bloombase StoreSafe iSCSI secure storage as raw storage device which gets un-encrypted on the fly and retrieved physically from backend storage.

```
[root@localhost dev]# dd if=/dev/sdd of=/var/tmp/images.tar.gz bs=4k count=2
2+0 records in
2+0 records out
8192 bytes (8.2 kB) copied, 0.501861 s, 16.3 kB/s
```

6.4.5 Create Filesystem on iSCSI Secure Storage

Create partition on mounted Bloombase StoreSafe iSCSI secure storage and create filesystem.

```
[root@localhost dev]# fdisk /dev/sdd
Welcome to fdisk (util-linux 2.23.2).

Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

Device does not contain a recognized partition table
Building a new DOS disklabel with disk identifier 0xaf93092a.

Command (m for help): n
Partition type:
   p   primary (0 primary, 0 extended, 4 free)
   e   extended
Select (default p): p
Partition number (1-4, default 1): 1
First sector (2048-108003327, default 2048):
Using default value 2048
Last sector, +sectors or +size{K,M,G} (2048-108003327, default 108003327):
Using default value 108003327
Partition 1 of type Linux and of size 51.5 GiB is set

Command (m for help): w
The partition table has been altered!

Calling ioctl() to re-read partition table.
Syncing disks.
```

```
[root@localhost dev]# mkfs.ext3 /dev/sdd1
mke2fs 1.42.9 (28-Dec-2013)
Filesystem label=
OS type: Linux
Block size=4096 (log=2)
Fragment size=4096 (log=2)
Stride=0 blocks, Stripe width=128 blocks
3375104 inodes, 13500160 blocks
675008 blocks (5.00%) reserved for the super user
First data block=0
Maximum filesystem blocks=4294967296
412 block groups
32768 blocks per group, 32768 fragments per group
8192 inodes per group
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632, 2654208,
        4096000, 7962624, 11239424

Allocating group tables: done
Writing inode tables: done
Creating journal (32768 blocks): done
Writing superblocks and filesystem accounting information: done
```

6.4.6 Write to Filesystem on iSCSI Secure Storage

Create a new text document, named `password.txt`, in the mount-point referencing Bloombase StoreSafe iSCSI secure storage. File is encrypted on the fly and stored physically at the backend storage. File is encrypted using key `iSCSI_Key01` that has been created and managed at IBM SKLM.

```
[root@localhost ~]# echo "John.Doe u&G43tg%" > /mnt/iSCSI01/password.txt
[root@localhost ~]# ls /mnt/iSCSI01/password.txt
/mnt/iSCSI01/password.txt
```

6.4.7 Read from Filesystem on iSCSI Secure Storage

Read the newly created file from mount-point referencing to Bloombase StoreSafe iSCSI secure storage, cipher-text file is retrieved physically from backend storage and un-encrypted on the fly. File is successfully presented and read as virtual clear-text data. File is un-encrypted using key `iSCSI_Key01` that has been created and managed at IBM SKLM.

```
[root@localhost ~]# cat /mnt/iSCSI01/password.txt
John.Doe u&G43tg%
```


6.4.8 Delete from Filesystem on iSCSI Secure Storage

Delete file from mount-point referencing to Bloombase StoreSafe iSCSI secure storage as if normal virtual-plain file. Deleting file from mount-point referencing to Bloombase StoreSafe iSCSI secure storage will automatically delete file at backend storage.

```
[root@localhost ~]# rm /mnt/iSCSI01/password.txt
rm: remove regular file '/mnt/iSCSI01/password.txt'? y
[root@localhost ~]# ls -l /mnt/iSCSI01
total 16
drwx------. 2 root root 16384 Jan 12 16:55 lost+found
```

6.5 Test Cases for FCP Data Encryption and Decryption

6.5.1 Initialize FCP Secure Storage Disk

Client with authorized HBA WWNs and proper SAN switch zoning will be able to access Bloombase StoreSafe FCP secure storage as a disk and initialize the disk.

```
Disk /dev/sde: 50.0 GB, 49999970304 bytes, 97656192 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 4096 bytes / 524288 bytes
Disk label type: dos
Disk identifier: 0xa22ec068
```

6.5.2 Dump in FCP Secure Storage Raw Device

Write and dump in contents to Bloombase StoreSafe FCP secure storage as raw device which gets encrypted and persisted physically at backend storage.

```
[root@bb008 dev]# dd if=/dev/zero of=/dev/sde bs=4k count=2
2+0 records in
2+0 records out
8192 bytes (8.2 kB) copied, 0.000276755 s, 29.6 MB/s
```

Backend volume is encrypted by using key `FC_Key01` that has been created and managed at IBM SKLM.

```
000075e0  0c 00 cf 68 3e 81 48 46  09 18 86 a5 22 1f 39 52  |...h>.HF....".9R|
000075f0  14 d2 a4 cd 4a 29 a5 e2  1a 58 11 8f b3 c6 d4 10  |....J)...X......|
00007600  2f ee f6 4a 90 c5 10 aa  4b 8d b5 67 7a de bb 15  |/..J....K..gz...|
00007610  6d 67 4b e8 6f af 9b 40  17 57 b8 f0 ef 42 37 f2  |mgK.o..@.W...B7.|
00007620  9c 0e 75 34 95 f6 72 d3  10 88 8e f8 a1 96 3f 57  |..u4..r.......?W|
00007630  34 f1 d3 96 d6 c5 93 34  49 50 51 0f 6c 3e 22 82  |4.......4IPQ.l>".|
00007640  25 dd 29 ba ff ff 64 39  40 14 9a ed aa 8f ef 38  |%.)...d9@......8|
00007650  4f fe 01 2a 78 e8 79 b0  95 7f fd 53 bd 6c aa 36  |O..*x.y....S.l.6|
00007660  bd c9 26 56 bf a3 15 11  24 da b8 fa b9 2e 77 f0  |..&V....$.....w.|
00007670  3e f5 f4 87 75 c0 12 a4  16 de 7e 96 51 fc 08 49  |>...u.....~.Q..I|
00007680  2b 2c bb 87 bf f2 5c b3  04 d8 b0 fd fa d5 f7 ae  |+,....\.........|
00007690  ff a0 af 0f d2 72 f8 24  92 75 bb 1c d1 21 b8 41  |.....r.$.u...!.A|
000076a0  ce 61 0c b3 34 e3 e4 5a  d1 9c b4 f5 bd 6a 1b 6e  |.a..4..Z.....j.n|
000076b0  21 d9 f9 cc d1 35 17 55  1a 25 19 02 79 3a 95 27  |!....5.U.%..y:.'|
000076c0  f3 8b 93 94 c5 d1 27 0b  4e 67 d5 5e 30 88 e5 51  |......'.Ng.^0..Q|
000076d0  a1 a4 2d fb 15 a8 eb b5  59 85 ac 6c aa dd 8a b6  |..-.....Y..l....|
000076e0  52 38 92 5e 57 0b 16 16  68 2e 72 44 c5 a9 0a 3d  |R8.^W...h.rD...=|
000076f0  4c 68 0e a3 dc af 65 b1  5d 26 fa 91 74 b1 69 da  |Lh....e.]&..t.i.|
00007700  c8 c0 2a 7f 4b f2 66 a2  59 fb 4b 50 e2 3f be 0e  |..*.K.f.Y.KP.?..|
00007710  ab 9b 4f 9a 7e 8d 7e 91  f0 48 bb b4 1a 79 5c 62  |..O.~.~..H...y\b|
00007720  1a 33 c3 15 3c 9b 9b 79  0f 59 48 19 2c 77 61 30  |.3..<..y.YH.,wa0|
00007730  50 b4 36 97 e7 f0 74 d9  ca 90 d9 41 68 84 2e df  |P.6...t....Ah...|
00007740  30 05 a8 9e 1d 20 38 64  9b d7 b3 3e 71 f7 aa 4d  |0.... 8d...>q..M|
00007750  14 70 67 bf 16 e7 8c b6  81 ee b2 ec aa 0b f3 3d  |.pg............=|
```

6.5.3 Dump out FCP Secure Storage Raw Device

Dump out contents from Bloombase StoreSafe FCP secure storage as raw storage device which gets un-encrypted on the fly and retrieved physically from backend storage.

```
[root@bb008 /]# dd if=/dev/sde of=/var/tmp/image.tar.gz bs=4k count=2
2+0 records in
2+0 records out
8192 bytes (8.2 kB) copied, 0.00133511 s, 6.1 MB/s
```

6.5.4 Create Filesystem on FCP Secure Storage

Create partition on mounted Bloombase StoreSafe FCP secure storage and create filesystem.


```
[root@bb008 /]# fdisk /dev/sde
Welcome to fdisk (util-linux 2.23.2).

Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

Device does not contain a recognized partition table
Building a new DOS disklabel with disk identifier 0xec140678.

Command (m for help): n
Partition type:
   p   primary (0 primary, 0 extended, 4 free)
   e   extended
Select (default p): p
Partition number (1-4, default 1):
First sector (2048-97656191, default 2048):
Using default value 2048
Last sector, +sectors or +size{K,M,G} (2048-97656191, default 97656191):
Using default value 97656191
Partition 1 of type Linux and of size 46.6 GiB is set

Command (m for help): w
The partition table has been altered!

Calling ioctl() to re-read partition table.
Syncing disks.
```

```
[root@bb008 /]# mkfs.ext3 /dev/sde1
mke2fs 1.42.9 (28-Dec-2013)
Filesystem label=
OS type: Linux
Block size=4096 (log=2)
Fragment size=4096 (log=2)
Stride=0 blocks, Stripe width=128 blocks
3055616 inodes, 12206768 blocks
610338 blocks (5.00%) reserved for the super user
First data block=0
Maximum filesystem blocks=4294967296
373 block groups
32768 blocks per group, 32768 fragments per group
8192 inodes per group
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632, 2654208,
        4096000, 7962624, 11239424

Allocating group tables: done
Writing inode tables: done
Creating journal (32768 blocks): done
Writing superblocks and filesystem accounting information: done
```

6.5.5 Write to Filesystem on FCP Secure Storage

Create a new text document, named `password.txt`, in the mount-point referencing Bloombase StoreSafe FCP secure storage. File is encrypted on the fly and stored physically at the backend storage. File is encrypted using key `FC_Key01` that has been created and managed at IBM SKLM.

```
[root@bb008 /]# mkdir /mnt/FC01
[root@bb008 /]# mount /dev/sde1 /mnt/FC01
[root@bb008 /]# mount | grep FC01
/dev/sde1 on /mnt/FC01 type ext3 (rw,relatime,errors=continue,user_xattr,barrier=1,data=ordered)
[root@bb008 /]# echo "John.Doe I43%t^r2" > /mnt/FC01/password.txt
[root@bb008 /]# ls -l /mnt/FC01/password.txt
-rw-r--r-- 1 root root 18 Jan 12 16:08 /mnt/FC01/password.txt
```

6.5.6 Read from Filesystem on FCP Secure Storage

Read the newly created file from mount-point referencing Bloombase StoreSafe FCP secure storage, cipher-text file is retrieved physically from backend storage and un-encrypted on the fly. File is

successfully presented and read as virtual clear-text data. File is un-encrypted using key `FC_Key01` that has been created and managed at IBM SKLM.

```
[root@bb008 /]# cat /mnt/FC01/password.txt
John.Doe I43%t^r2
```

6.5.7 Delete from Filesystem on FCP Secure Storage

Delete file from mount-point referencing Bloombase StoreSafe FCP secure storage as if normal virtual-plain file. Deleting file from mount-point referencing Bloombase StoreSafe FCP secure storage will automatically delete file at backend storage.

```
[root@bb008 /]# rm /mnt/FC01/password.txt
rm: remove regular file '/mnt/FC01/password.txt'? y
[root@bb008 /]# ls -l /mnt/FC01/
total 16
drwx------ 2 root root 16384 Jan 12 16:06 lost+found
```


7. Interoperability and Certification Confirmation

By completing this Exit Form, IBM confirms that Bloombase StoreSafe will be validated by the typical QA process employed by IBM solution testing procedure and that issues found with the solution will be reported to Bloombase.

8. References

Bloombase StoreSafe, http://www.bloombase.com/products/storesafe/

IBM Security Key Lifecycle Manager, http://www-03.ibm.com/software/products/en/key-lifecycle-manager

IBM SoftLayer, http://www.softlayer.com/

IBM Bluemix, https://www.ibm.com/cloud-computing/bluemix/

Brocade 300 SAN Switch, http://www.brocade.com/en/products-services/storage-networking/fibre-channel/300-switch.html

HPE 1920-48G Ethernet Switch, https://www.hpe.com/us/en/product-catalog/networking/networking-switches/pip.switches.7399514.html

QLogic QLE2672, http://www.qlogic.com/Products/adapters/Pages/FibreChannelAdapters.aspx

Red Hat Enterprise Linux, http://www.redhat.com/en/technologies/linux-platforms/enterprise-linux