



Interoperability of Bloombase StoreSafe and ATTO Celerity Fibre-Channel Host Bus Adapter and ATTO FibreConnect Fibre-Channel Switch for Transparent Storage Area Network (SAN) Encryption

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BLOOMBASE[®]

ATTO

Executive Summary

ATTO Celerity fibre-channel host bus adapters (FC-HBA) and ATTO FibreConnect fibre-channel switch are validated by Bloombase interopLab to run with Bloombase StoreSafe non-disruptive, agentless, application-transparent storage area network (SAN) encryption server. This document describes the steps carried out to test interoperability of ATTO Celerity Fibre-Channel HBAs with Bloombase StoreSafe Storage Encryption Server on OS running on x86-based commodity server appliance. Host system of Red Hat Enterprise Linux (RHEL) 7 on HPE ProLiant DL380 Server with ATTO Celerity FC HBA is validated against Bloombase StoreSafe Storage Encryption appliance with Dell EMC SAN storage sub-system.

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The interoperability tests in this report are carried out at Bloombase interopLab with sponsor from ATTO Technology, Inc.

About ATTO Technology, Inc.

ATTO Technology, Inc., headquartered in Amherst, New York, is a global leader of storage connectivity and infrastructure solutions for data-intensive computing environments. It is our vision to provide a wide range of end-to-end solutions to help customers better store, manage and deliver their data. We believe that our company's experience in engineering advanced technology into real-world product solutions provides customers a unique competitive advantage. For more information, please refer to <http://www.atto.com/>

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Purpose and Scope

This document describes the steps necessary to test interoperability of ATTO Celerity FC HBA with Bloomberg StoreSafe enterprise storage software appliance to secure sensitive corporate business data in a storage area network (SAN) accessible by HPE ProLiant DL380 Server. Specifically, we cover the following topics:

- Preparing Bloomberg StoreSafe software appliance for encryption
- Preparing ATTO FibreConnect Fibre-Channel SAN Switch
- Preparing EMC SAN storage sub-system
- Interoperability testing on Red Hat Enterprise Linux (RHEL) 7 on HPE ProLiant DL380 Server host system with ATTO Celerity FC HBA

Assumptions

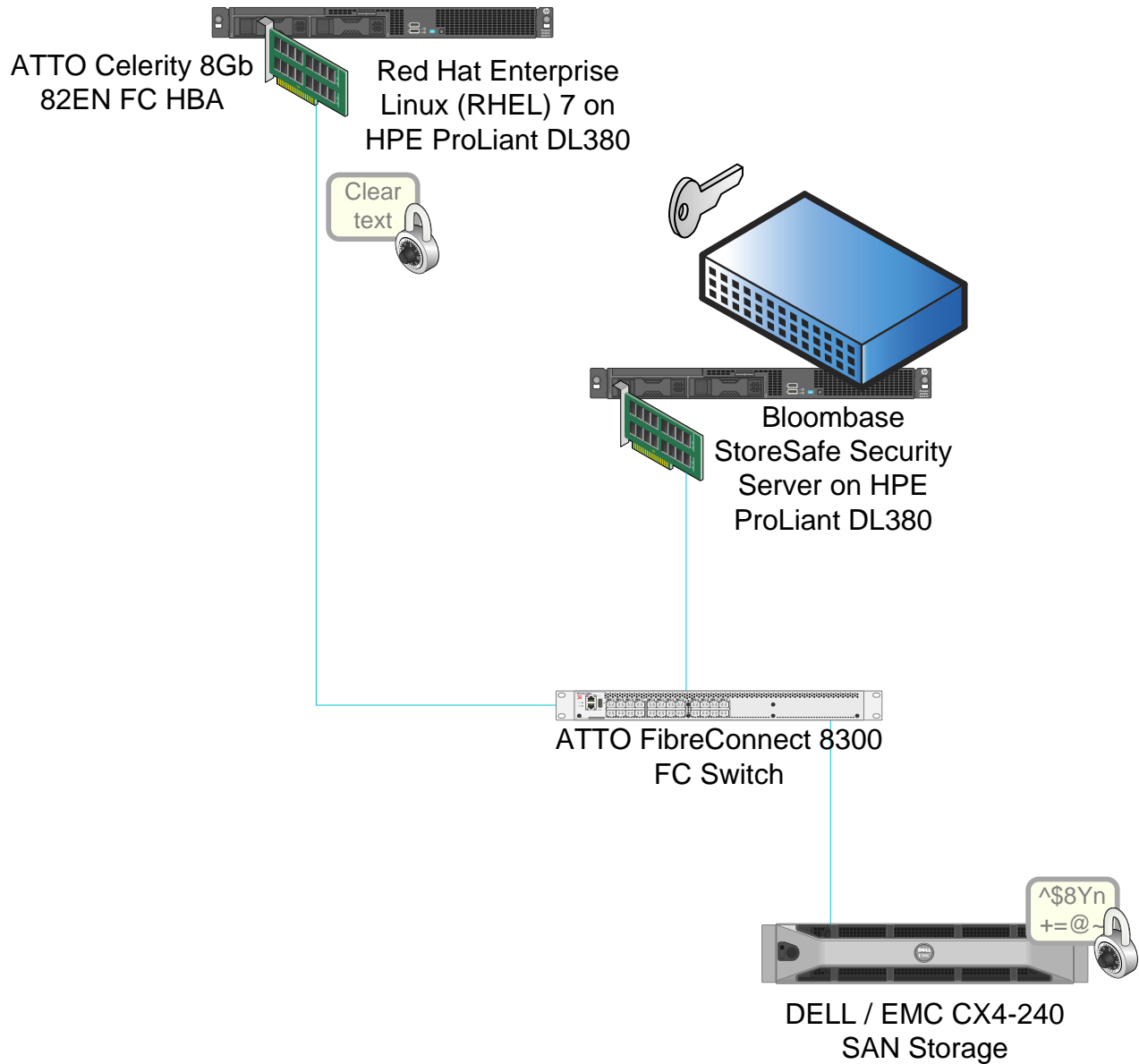
This document describes interoperability testing of ATTO Celerity FC HBA powered Red Hat Enterprise Linux (RHEL) 7 on HPE ProLiant DL380 Server with Bloomberg StoreSafe Software Appliance on SAN storage sub-system. It is assumed that you are familiar with operation of storage systems and major operating systems including UNIX. 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 Unix.

We assume you have basic knowledge of storage networking and information cryptography. For specific technical product information of Bloomberg StoreSafe, please refer to our website at <http://www.bloomberg.com> or Bloomberg SupPortal <http://supportal.bloomberg.com>

Infrastructure

Setup

The validation testing environment is setup as in below figure:



Bloombase StoreSafe Storage Software Encryption Server Appliance

Server	HPE ProLiant DL380 Server
Processors	2 x Intel Xeon E5-2640 series quad-core 2.6 GHz
Memory	16 GB
Storage Encryption Software	Bloombase StoreSafe Software Appliance v3.4

Storage Host

Model	HPE ProLiant DL380 Server
Operating System	Red Hat Enterprise Linux (RHEL) 7
Host Bus Adapter	ATTO Celerity 8Gb 82EN

Fibre-Channel Host Bus Adapter

Model	ATTO Celerity 8Gb 82EN
Speed	8 Gbps
Interface	PCI-E

SAN Switch

Model	ATTO FibreConnect 8000 Fibre-Channel Switch
Link Speed	8/4/2 Gbps auto-sensing

Storage Area Network (SAN)

SAN Storage	Dell / EMC CX4-240 SAN Storage
Link Speed	8/4/2 Gbps auto-sensing

Configuration Overview

ATTO Fibre-Channel Host Bus Adapter

ATTO FC-HBA

- ATTO Celebrity 8Gb 82EN

Is installed at HPE ProLiant DL380 Server running Red Hat Enterprise Linux (RHEL) 7.



Bloombase StoreSafe Software Appliance

StoreSafe supports both file-based and block-based on-the-fly storage encryption. In this interoperability testing, fibre-channel SAN block-based encryption is validated against ATTO Celerity FC-HBA.

Bloombase Spitfire StoreSafe Security Server

Greeting
 Host Name: storesafe02
 User: admin
 Datetime: 2011-02-18 14:23:55 +0800

Menu Bar

- System
- Operation
- Network Security
- High Availability
- Administration
- Key Management
- Spitfire KeyCastle
- Hardware Security Module
- Find Key Wrapper
- Create Key Wrapper
- Storage

Language
 English

Find Key Wrapper

Name: Active:

CA:

Subject DN: Issuer DN:

Serial Number: Issuer Serial Number:

Effective Date From: Effective Date To:

Expiry Date From: Expiry Date To:

	Name	Key Source Type	Active	CA	Subject DN	Issuer DN	Effective Datetime	Expiry Datetime	Last Update Datetime
1	kc-key01	Spitfire KeyCastle	<input checked="" type="checkbox"/>	<input type="checkbox"/>	CN=kc-key01	CN=kc-key01	2011-02-08 22:57:20 +0800	2021-02-05 22:57:20 +0800	2011-02-08 23:06:05 +0800
2	test	Local	<input checked="" type="checkbox"/>	<input type="checkbox"/>	CN=test	CN=test	2011-02-08 22:40:51 +0800	2021-02-05 22:40:51 +0800	2011-02-08 22:40:54 +0800



Encryption Key Configuration


Encryption key named 'key' is generated at bundled KeyCastle key life-cycle management tool

Modify Key Wrapper

Key Wrapper | **Upload Key Contents** | **Modify Key Source** | **CRLDP** | **OCSP** | **Permissions**

Modify Key Wrapper

Name	<input type="text" value="key"/>
Active	<input checked="" type="checkbox"/>
Exportable	<input type="checkbox"/>
CA	<input type="checkbox"/>
Subject DN	CN=key
Serial Number	695376542685815571917364
Issuer DN	CN=key
Certificate	<input checked="" type="checkbox"/> 
Public Key	<input checked="" type="checkbox"/>
Private Key	<input checked="" type="checkbox"/>
Key Bit Length	1024
Effective Datetime	2011-02-18 22:26:36 +0800
Expiry Datetime	2021-02-15 22:26:36 +0800
Revocation Check Method Type	<input type="text"/> 
Revoked	<input type="checkbox"/>
Key Usage	-
Extended Key Usage	
Owner	admin
Last Update Datetime	



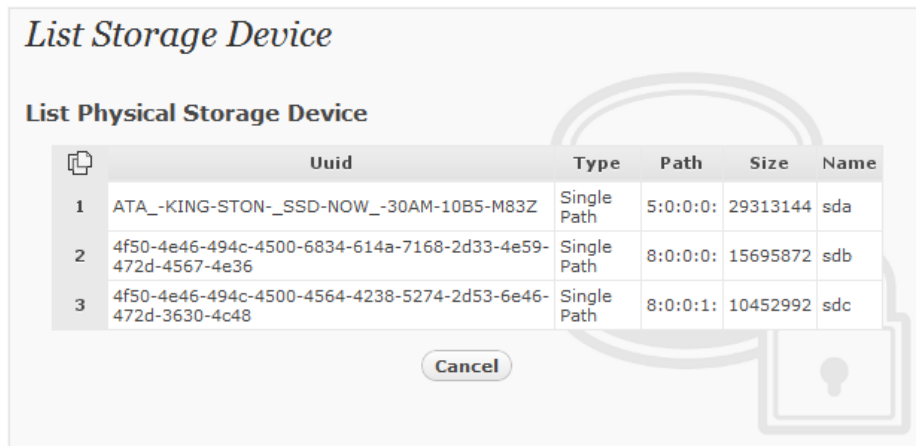
Virtual SAN Configuration

Bloombase StoreSafe block-based virtual storage and physical storage settings are configured as follows.



Physical Storage Target Configuration

After zoning and LUN mask are properly configured at SAN switches, StoreSafe is able to mount to LUNs of SAN storages and are shown on 'List Storage Device' tool



Physical storage target named 'lun01' is configured to map to the storage device to be secured by Bloombase StoreSafe encryption.

Bloombase StoreSafe secures SAN contents as virtual block devices. Volumes can be secured independently by specific cryptographic cipher, bit length, encryption key, etc.

Modify Storage Configuration

Physical Storage Permissions

Physical Storage Configuration

Name

Description

Physical Storage Type

Type

Options

Device 4f50-4e46-494c-4500-6834-614a-7168-2d33-4e59-472d-4567-4e36

Owner admin

Last Update Datetime 2011-02-18 18:06:54 +0800

Encrypted Virtual Storage Provisioning

Virtual storage named 'sano1' of type 'FC' is created to virtualize physical storage 'lun01' for transparent encryption protection over fibre-channel protocol. This virtual storage target acts as a virtual LUN which serves as storage proxy for storage host's transparent access.

Modify Virtual Storage

Virtual Storage | Protection | Access Control | Permissions

Modify Virtual Storage

Name:

Status:

Description:

Active:

Mode: ▼

Owner: admin

Last Update Datetime: 2011-02-19 02:46:25 +0800

Physical Storage

Storage: lun01  

Description:

Physical Storage Type: Device



Protection type is specified as 'Privacy' and the FC SAN LUN is secured using AES-XTS 256-bit encryption and encryption key 'key'.

Modify Virtual Storage Handler

Virtual Storage | Protection | Access Control | Permissions

Virtual Storage Protection

Protection Type: ▼

Encryption Keys

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

Cryptographic Cipher

Cipher Algorithm: ▼

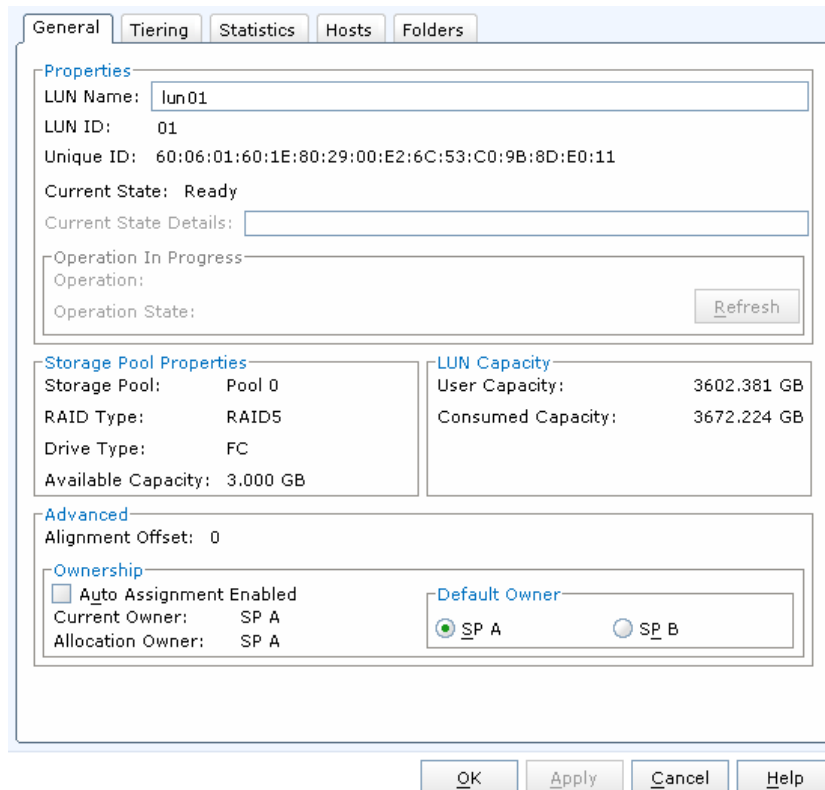
Bit Length: ▼



Fiber-channel protocol access control relies mainly on LUN mask for host based access control, the WWN of host HBA on 'Host' of 'Host Access Control' section is configured as follows such that storage host, in this case, HPE ProLiant DL380 Server with ATTO Celerity HBA, can read/write in non-disruptive way automating encryption and un-encryption for authorized applications.



SAN Storage

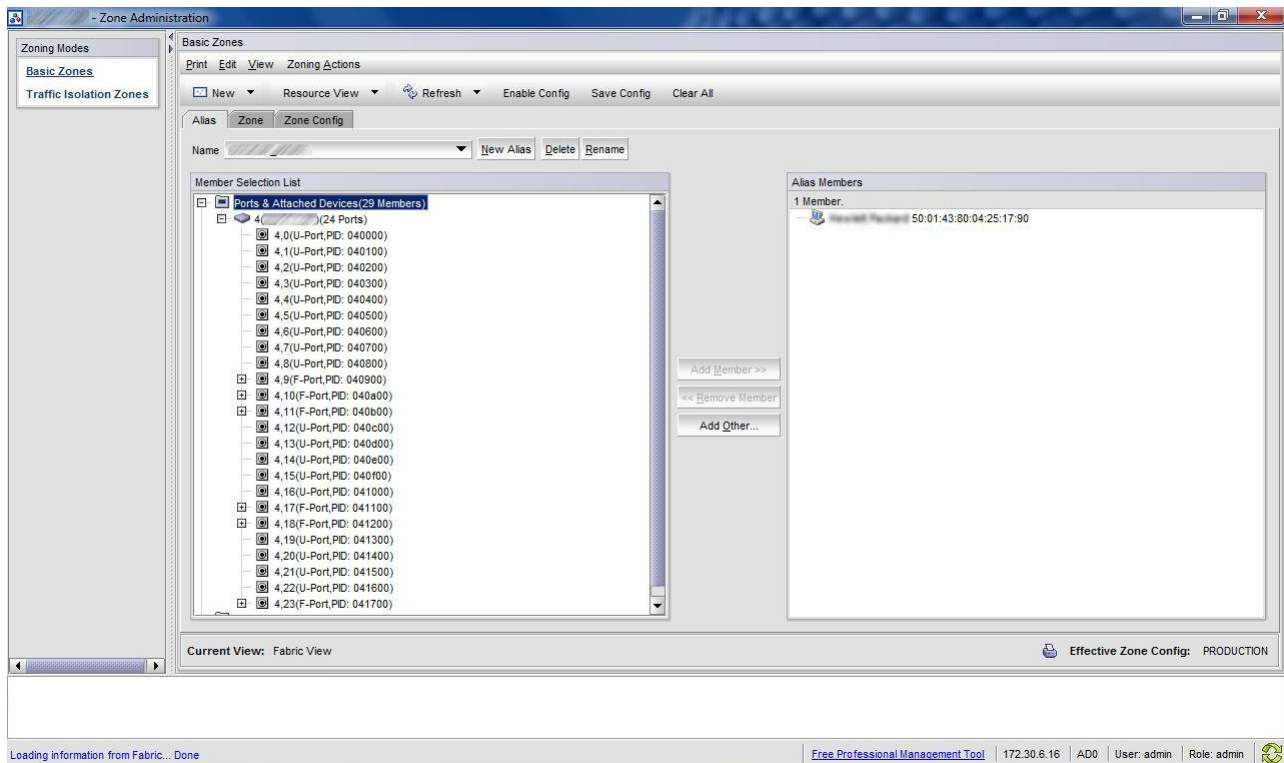


A LUN is created at Dell / EMC CX4 SAN with below parameters

Name	Lun01
Capacity	3 TB
Redundancy	RAIDS

SAN Fabric

The virtual disks on Dell / EMC SAN are exposed to Bloombase StoreSafe appliance for access.



Validation Tests

Test Scenarios

Validation Matrix

Validation tests span across models of ATTO Celerity FC-HBAs and SAN switches, Bloombase StoreSafe Security Server, appliance hardware platform, and host platform.

Test Condition	Candidate
FC-HBA	<ul style="list-style-type: none">● ATTO Celerity 8Gb 82EN
SAN Switch	<ul style="list-style-type: none">● ATTO FibreConnect 8300 Fibre-Channel Switch
Storage System	<ul style="list-style-type: none">● Dell / EMC CX4-240 SAN storage
Storage Encryption Appliance	<ul style="list-style-type: none">● Bloombase StoreSafe software appliance on x86-based HP ProLiant DL380
Host Server Hardware	<ul style="list-style-type: none">● HPE ProLiant DL380 Server

Host Operating Systems

- Red Hat Enterprise Linux (RHEL) 7

Raw Storage Device Tests

The following tests are carried out at storage host operating system with ATTO Celerity HBA to access encrypted SAN storage via Bloomberg StoreSafe appliances directly

Test	Description
Write disk with zeros	Write zeros into encrypted storage target via Bloomberg StoreSafe, platform equivalence of UNIX's <code>dd if=/dev/zero of=/dev/sda</code>
Read disk to null device	Read from encrypted storage target via Bloomberg StoreSafe, platform equivalence of UNIX's <code>dd if=/dev/sda of=/dev/null</code>
Wipe disk with random data	Write random zeros and ones into encrypted storage target, platform equivalence of UNIX's <code>dd if=/dev/urandom of=/dev/sda</code>

File System Tests

The following tests are carried out at storage host with ATTO Celerity HBA to access encrypted SAN storage via Bloomberg StoreSafe appliances via operating system file-systems

- HFS Plus

Test	Description
Directory creation	Platform equivalence of UNIX's <code>mkdir</code>
Directory rename	Platform equivalence of UNIX's <code>mv</code>
Directory removal	Platform equivalence of UNIX's <code>rm</code>
Directory move	Platform equivalence of UNIX's <code>mv</code>
File creation	Platform equivalence of UNIX's <code>echo XXX ></code>
File rename	Platform equivalence of UNIX's <code>mv</code>

File removal	Platform equivalence of UNIX's rm
File move	Platform equivalence of UNIX's mv
File append – by character	Platform equivalence of UNIX's echo XXX >>
File append – by block	Platform equivalence of UNIX's echo XXX >>
File parameters inquiry	Platform equivalence of UNIX's ls *X
File permission configurations	<ul style="list-style-type: none"> ● Platform equivalence of UNIX's chmod ● Valid for UNIX-based storage host systems only (Linux, AIX, HPUX, Solaris)
Softlink/Symbolic link removal	<ul style="list-style-type: none"> ● Platform equivalence of UNIX's rm ● Valid for UNIX-based storage host systems only (Linux, AIX, HPUX, Solaris)
Softlink/Symbolic link move	<ul style="list-style-type: none"> ● Platform equivalence of UNIX's mv ● Valid for UNIX-based storage host systems only (Linux, AIX, HPUX, Solaris)

Application Tests – Oracle Database Server

Test	Remarks
Database creation	Version equivalence of CREATE DATABASE
Schema creation	Version equivalence of CREATE TABLE
Database record insert	Version equivalence of INSERT INTO
Database record query	Version equivalence of SELECT * FROM
Database record update	Version equivalence of UPDATE
Database record delete	Version equivalence of DELETE FROM
Index creation	Version equivalence of CREATE INDEX
Tablespace alteration	Version equivalence of ALTER TABLESPACE
Redo log creation	Automated by Oracle data server, verify by examining Oracle system log

Redo log creation	Automated by Oracle data server, verify by examining Oracle system log
Archive log creation	Automated by Oracle data server, verify by examining Oracle system log

Result

Raw Storage Device Tests

Test	Validation Pass	Remarks
Write disk with zeros	✓	
Read disk to null device	✓	
Wipe disk with random data	✓	

File System Tests

Test	Validation Pass	Remarks
Directory creation	✓	
Directory rename	✓	
Directory removal	✓	
Directory move	✓	
File creation	✓	
File rename	✓	
File removal	✓	
File move	✓	
File append – by character	✓	
File append – by block	✓	
File parameters inquiry	✓	

File permission configurations	✓
Softlink/Symbolic link removal	✓
Softlink/Symbolic link move	✓

Application Tests – Oracle Database

Test	Validation Pass	Remarks
Initialize disk	✓	
Filesystem partition	✓	
Directory creation	✓	
Directory rename	✓	
Directory removal	✓	
Directory move	✓	
File creation	✓	
File rename	✓	
File removal	✓	
File move	✓	
File append – by character	✓	
File append – by block	✓	
File parameters inquiry	✓	
File permission configurations	✓	
Softlink/Symbolic link removal	✓	
Softlink/Symbolic link move	✓	

Conclusion

ATTO FC-HBAs

- ATTO Celerity 8Gb 82EN

and ATTO SAN switch

- ATTO FibreConnect 8300 Fibre-Channel switch

pass all Bloombase interopLab's interoperability tests with Bloombase StoreSafe enterprise storage encryption server

Bloombase Product	Operating System	ATTO FC-HBAs	SAN Switch
Bloombase StoreSafe Software Appliance	Red Hat Enterprise Linux (RHEL) 7	ATTO Celerity 8Gb 82EN	ATTO FibreConnect 8300 Fibre-Channel switch

Acknowledgement

We would like to thank ATTO Technology, Inc. for sponsoring and supporting the FC-HBA used in the tests of this technical report.

Disclaimer

The tests described in this paper were conducted in the Bloomberg InteropLab. Bloomberg has not tested this configuration with all the combinations of hardware and software options available. There may be significant differences 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.

Technical Reference

1. Bloombase StoreSafe Technical Specifications, <http://www.bloombase.com/content/8936QA88>
2. Bloombase StoreSafe Compatibility Matrix, <http://www.bloombase.com/content/e8Gzz281>
3. dd for Unix, [https://en.wikipedia.org/wiki/Dd_\(Unix\)](https://en.wikipedia.org/wiki/Dd_(Unix))
4. Oracle database server, <https://www.oracle.com/database/index.html>
5. Transaction Processing Performance Council, <http://www.tpc.org/tpcc/>
6. ATTO Celerity 8Gb 82EN FC HBA, <http://www.atto.com/products/product.php?scat=1&sku=CTFC-82EN-000>
7. ATTO FibreConnect 8300 Fibre-Channel Switch, <http://www.atto.com/products/family.php?id=13>