



# Interoperability of Bloombase StoreSafe and ATTO Celerity 16G Fiber-Channel Host Bus Adapter (FC-HBA) for Transparent Data-at-Rest Encryption

April, 2017

The logo for Bloombase, consisting of the word "BLOOMBASE" in a bold, blue, sans-serif font with a registered trademark symbol.



## Executive Summary

ATTO carrier grade Celerity 16G Fiber Channel Host Bus Adapters (FC-HBA) are validated by Bloombase's interopLab to run with Bloombase StoreSafe to secure Hewlett Packard Enterprise (HPE) MSA P2000 Storage Area Network (SAN) by state-of-the-art encryption. This document describes the steps carried out to test interoperability of ATTO Celerity 16G FC-HBAs with Bloombase StoreSafe Storage Encryption Server running on Intel x86-based commercial-off-the-shelf (COTS) server appliances. Storage client running Red Hat Enterprise Linux (RHEL) 7 on HPE ProLiant DL20 Server with ATTO Celerity 16G FC-HBA is validated with Bloombase StoreSafe Storage Encryption Server securing HPE MSA P2000 FC-SAN.

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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 <https://www.atto.com>

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# Purpose and Scope

This document describes the steps necessary to integrate ATTO Celerity FC-162E 16G Fiber Channel Host Bus Adapters (FC-HBA) with HPE ProLiant DL20 commercial-off-the-shelf server as storage client and test with Bloomberg StoreSafe enterprise storage software appliance to secure sensitive business data managed at Hewlett Packard Enterprise (HPE) MSA P2000 Fiber Channel Storage Area Network (FC-SAN) via Fiber Channel Protocol (FCP). Specifically, we cover the following topics:

- Installing and configuring Bloomberg StoreSafe software appliance on HPE ProLiant DL20 server
- Provisioning storage volume at HPE MSA P2000 FC-SAN to be secured by Bloomberg StoreSafe
- Interoperability testing on client system with Red Hat Enterprise Linux (RHEL) 7 on HPE ProLiant DL20 server with ATTO Celerity FC-162E 16G FC-HBA

# Assumptions

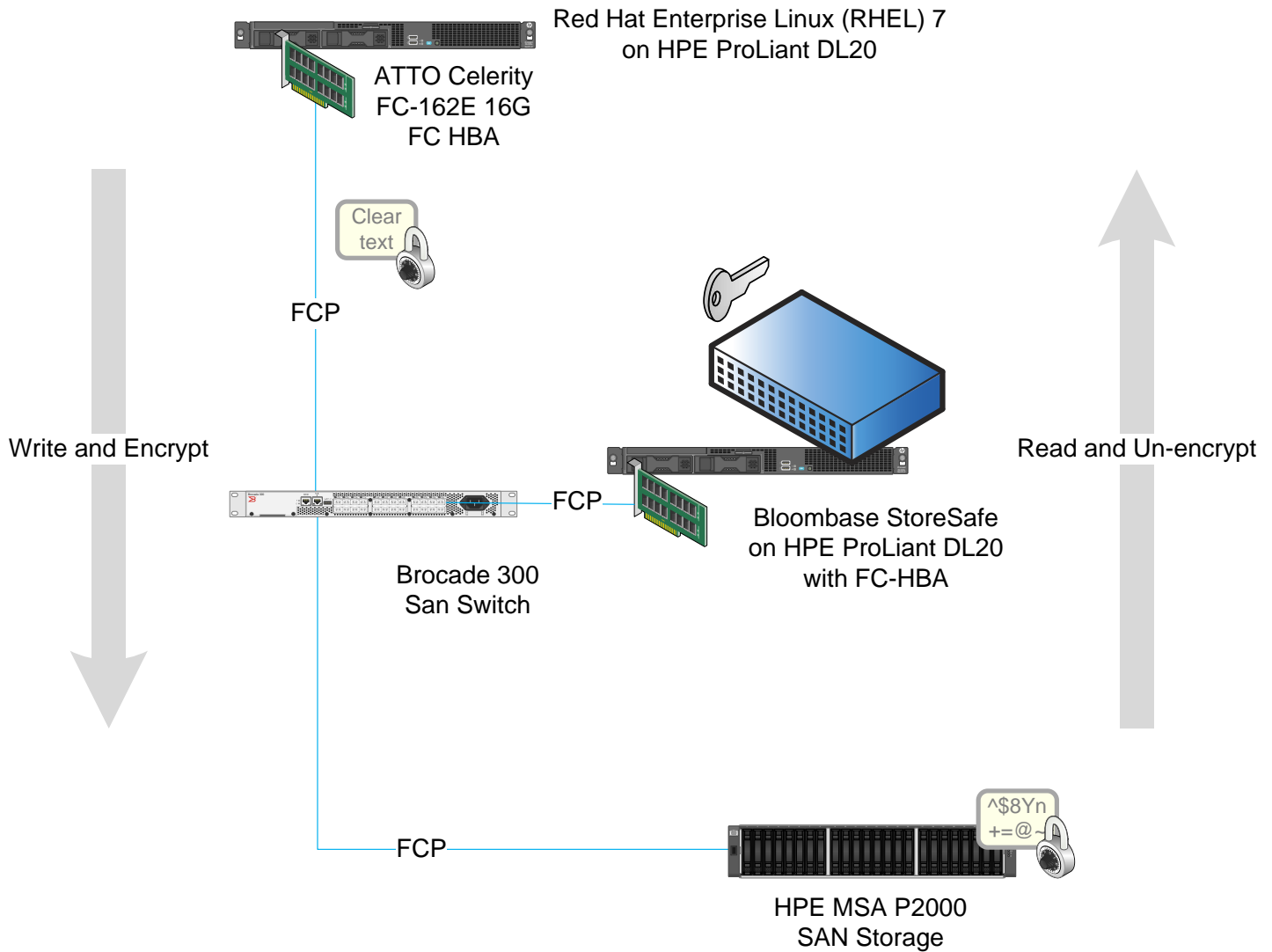
This document describes interoperability testing of ATTO Celerity FC-162E 16G FC-HBA with Bloomberg StoreSafe on HPE ProLiant DL20 Server for data-at-rest encryption. It is assumed that you are familiar with operation of storage systems and major operating systems including UNIX and/or Linux. It is also assumed that you possess basic UNIX administration skills. The examples provided may require modifications before they could be run under your version of UNIX.

You are recommended to refer to installation and configuration guides of specific model of ATTO Celerity FC-HBA for the client platform you are going to test on. 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 <https://www.bloomberg.com> or Bloomberg SupPortal <https://supportal.bloomberg.com>.

# Infrastructure

## Setup

The validation testing environment is set up as in below figure:



## Bloombase StoreSafe Storage Encryption Server

<b>Server</b>	HPE ProLiant DL20 Gen9 Server
<b>Processors</b>	1 x Intel Xeon E3-1240V5 series quad-core 8M cache 3.5 GHz
<b>Memory</b>	8 GB
<b>Storage Encryption Software</b>	Bloombase StoreSafe Software Appliance v3.4



## Storage Client

<b>Model</b>	HPE ProLiant DL20 Gen9 Server
<b>Operating System</b>	Red Hat Enterprise Linux (RHEL) 7
<b>Fiber Channel Host Bus Adapter</b>	ATTO Celerity FC-162E 16G FC-HBA

## Fiber Channel Storage Area Network (SAN)

<b>SAN Storage</b>	Hewlett Packard Enterprise (HPE) MSA P2000 SAN
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## SAN Switch

<b>SAN Switch</b>	Brocade 300 SAN Switch
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# Configuration Overview

## ATTO Celerity Fiber Channel Host Bus Adapter

ATTO FC-HBA

- ATTO Celerity FC-162E 16G FC-HBA

is installed at HPE ProLiant DL20 Server running Red Hat Enterprise Linux (RHEL) 7 as storage client to Bloombase StoreSafe.



## Interconnect

COMMSCOPE SYSTIMAX OM<sub>3</sub> 3-meter 50/150 micron multi-mode fiber-optic cables with LC-LC terminations are used in this interoperability testing.



# Bloombase StoreSafe Software Appliance

Bloombase StoreSafe supports file-based, share-based, block-based and object-based on-the-fly storage encryption. In this interoperability testing effort, SAN block-based encryption is provisioned to the client system with ATTO Celerity 16G FC-HBA installed.

**Bloombase 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

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## Encryption Key Configuration


Generate encryption key with name `key01` in bundled Bloombase 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" value=""/>
Revoked	<input type="checkbox"/>
Key Usage	-
Extended Key Usage	
Owner	admin
Last Update Datetime	



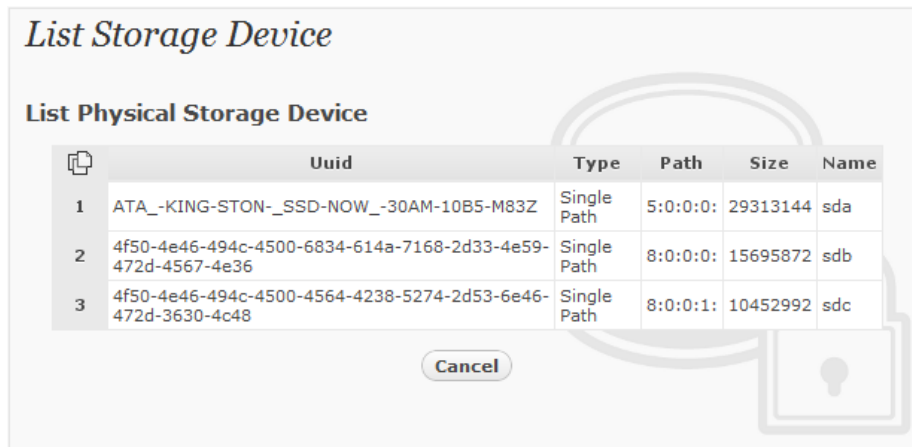
## Virtual Storage Configuration

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



## Physical Storage Target Configuration

Bloombase StoreSafe should be able to mount to LUNs of SAN storages and shows on 'List Storage Device' tool





Physical storage namely lun01 is configured to map to the storage device to be encrypted by Bloombase StoreSafe

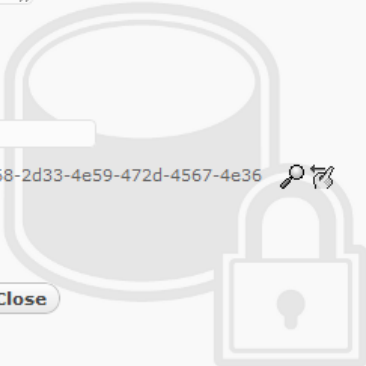
Bloombase StoreSafe secures SAN contents block by block. Volumes can be secured one by one by specific cryptographic cipher, bit length, encryption key, etc.

### Modify Storage Configuration

**Physical Storage** | **Permissions**

#### Physical Storage Configuration

Name	<input type="text" value="lun01"/>
Description	<input type="text"/>
Physical Storage Type	Device <input type="button" value="v"/>
Type	<input type="text" value="FC"/>
Options	<input type="text"/>
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 namely `lun01` of type `FC` is created to virtualize physical storage `lun01` for transparent encryption protection over FCP

### 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 secure the FC SAN LUN using AES-XTS 256-bit encryption with encryption key key01.



### Modify Virtual Storage Handler

Virtual Storage Protection Access Control Permissions

#### Virtual Storage Protection

Protection Type

#### Encryption Keys

	Key Name	Last Update Datetime
1	key	

#### Cryptographic Cipher

Cipher Algorithm

Bit Length

Fiber channel protocol access control relies mainly on LUN masking for host based access control, the WWN of host HBA on 'Host' of 'Host Access Control' section is configured as follows:

### Modify Virtual Storage Access Control

Virtual Storage Protection Access Control Permissions

#### Host Access Control

	Host	Last Update Datetime
1	10:00:00:00:c9:71:87:0c	2011-02-15 11:45:58 +0800

# Validation Tests

## Test Scenarios

### Validation Matrix

Validation tests span across models of ATTO Celerity 16G FC-HBAs, Bloomberg StoreSafe, server hardware platform, and client host platform.

Test Condition	Candidate
Fiber Channel Host Bus Adapter	ATTO Celerity FC-162 FC-HBA
Storage System	Hewlett Packard Enterprise (HPE) MSA P2000 SAN
SAN Switch	Brocade 300 SAN Switch
Storage Encryption	Bloomberg StoreSafe on x86-based HPE ProLiant DL20 Gen9 server
Client System	Red Hat Enterprise Linux (RHEL) 7 with ATTO Celerity FC-162 FC-HBA

## Raw Storage Device Tests

The following tests are carried out at storage host operating system with ATTO Celerity FC-162-FC-HBAs to access encrypted Hewlett Packard Enterprise (HPE) MSA P2000 FC-SAN storage through Bloomberg StoreSafe as a storage proxy.

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 installed with ATTO Celerity FC-162 16G FC-HBA to access encrypted Hewlett Packard Enterprise (HPE) MSA P2000 FC-SAN storage via Bloomberg StoreSafe as a bump-in-the-wire configuration delivering application-transparent encryption security.

- Ext3 for Linux

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 &gt;</code>
File rename	Platform equivalence of UNIX's <code>mv</code>
File removal	Platform equivalence of UNIX's <code>rm</code>
File move	Platform equivalence of UNIX's <code>mv</code>

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"> <li>● Platform equivalence of UNIX's chmod</li> <li>● Valid for UNIX-based storage host systems only (Linux, AIX, HPUX, Solaris)</li> </ul>
Softlink/Symbolic link removal	<ul style="list-style-type: none"> <li>● Platform equivalence of UNIX's rm</li> <li>● Valid for UNIX-based storage host systems only (Linux, AIX, HPUX, Solaris)</li> </ul>
Softlink/Symbolic link move	<ul style="list-style-type: none"> <li>● Platform equivalence of UNIX's mv</li> <li>● Valid for UNIX-based storage host systems only (Linux, AIX, HPUX, Solaris)</li> </ul>

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## Result

### Raw Storage Device Tests

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

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### 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	✓

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# Conclusion

ATTO Celerity 16G FC-HBAs

- ATTO Celerity FC-162 16G FC-HBAs

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

<b>Bloomberg Product</b>	<b>Storage System</b>	<b>SAN Switch</b>	<b>Fiber Channel Host Bus Adapter</b>
Bloomberg StoreSafe Software Appliance	Hewlett Packard Enterprise (HPE) MSA P2000 FC-SAN	Brocade 300 SAN Switch	ATTO Celerity FC-162 16G FC-HBA

# Acknowledgement

We would like to thank ATTO Technology, Inc. for sponsoring and supporting the 16G FC-HBAs used in the tests of this technical report.

# Disclaimer

The tests 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 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 FC-162 16G FC-HBA, <https://www.atto.com/products/fc-adapters/fibre-channel-hba/16gb/CTFC-162E-000>
7. Hewlett Packard Enterprise (HPE) MSA P2000 FC-SAN, <https://www.hpe.com/h20195/V2/Getdocument.aspx?docname=c04168365>
8. Brocade 300 SAN Switch, <http://www.brocade.com/en/products-services/storage-networking/fibre-channel/300-switch.html>