



# **Interoperability of Bloombase StoreSafe Security Server and Brocade SAN Switch for Transparent Storage Area Network (SAN) Encryption**

June, 2010



## **Executive Summary**

Brocade enterprise grade fiber channel storage area network (SAN) switches are validated by Bloombase's interopLab to run with Bloombase StoreSafe application-transparent storage area network (SAN) encryption server. This document describes the steps carried out to test interoperability of Brocade SAN switches with Bloombase StoreSafe Storage Encryption Server on OS running on x86-based appliances. Host systems on Microsoft Windows, Linux, Solaris, IBM AIX, VMware and Citrix XenServer are validated against Bloombase StoreSafe Storage Encryption appliances securing Dell EMC SAN storage sub-system with Brocade SAN switches as storage interconnects.

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# Purpose and Scope

This document describes the steps necessary to integrate Brocade SAN switches with Bloombase StoreSafe enterprise storage security server to secure sensitive corporate business data in a storage area network (SAN). Specifically, we cover the following topics:

- Preparing Bloombase StoreSafe Security appliance(s) with FC-HBA(s)
- Preparing SAN storage sub-system
- Interoperability testing on host systems including Red Hat Linux, Novell Linux, Microsoft Windows, IBM AIX, Solaris, VMware ESX and Citrix XenServer

# Assumptions

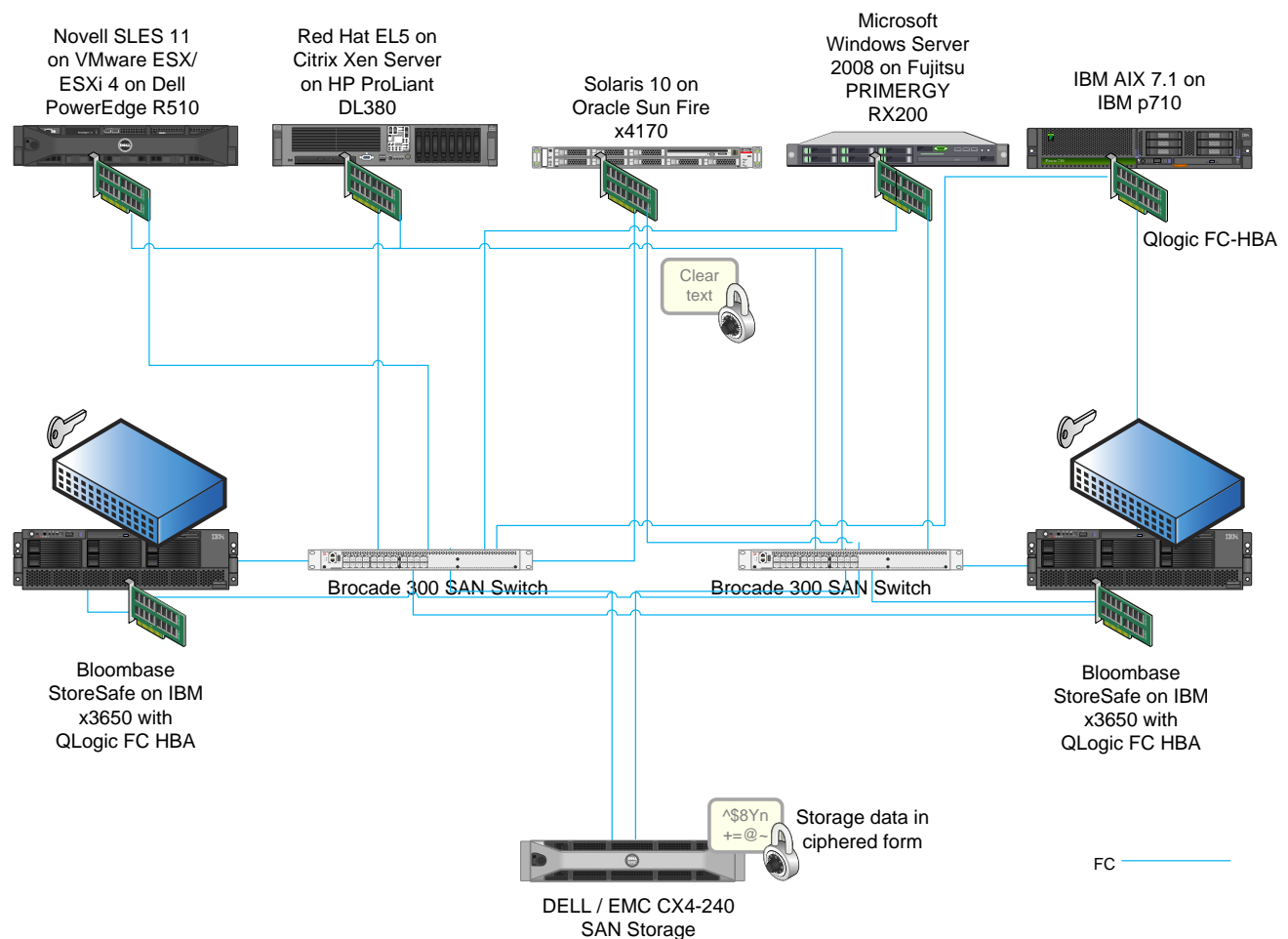
This document describes interoperability testing of Bloombase StoreSafe Security Server appliance on SAN storage sub-system with Brocade SAN switches as interconnects. Therefore, it is assumed that you are familiar with operation of storage systems and major operating systems including Linux, Windows, AIX, HP-UX and 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 UNIX.

As Brocade SAN switches are hardware option to Bloombase StoreSafe storage encryption system, you are recommended to refer to installation and configuration guides of specific model of Brocade SAN switch for the deployment you are going to test on. 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 <http://www.bloombase.com> or Bloombase SupPortal <http://supportal.bloombase.com>

# Infrastructure

## Setup

The validation testing environment is setup as in below figure



## Bloombase StoreSafe Storage Encryption Server Appliance

<b>Server</b>	IBM eServer xSeries x3650 M3
<b>Processors</b>	2 x Intel Xeon 5600-series quad-core 3.6 GHz
<b>Memory</b>	8 GB
<b>Operating System</b>	Bloombase OS 5.5 – Hardened and customized OS based on Linux kernel version 2.6.26 64-bit
<b>Storage Encryption Software</b>	Bloombase StoreSafe Security Server



## SAN Switch

<b>Model</b>	2 x Brocade 300 SAN Switch
<b>Link Speed</b>	8/4/2 Gbps auto-sensing

## Fiber Channel Host Bus Adapters

<b>Model</b>	QLogic QLE2562	QLogic QLE2462	QLogic QLA2342
<b>Speed</b>	8 Gbps	4 Gbps	2 Gbps
<b>Interface</b>	PCI-E	PCI-E	PCI-X

## Storage Area Network (SAN)

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

## Storage Hosts

<b>Model</b>	Dell PowerEdge R510	HP ProLiant DL380	Oracle Sun Fire x4170	Fujitsu PRIMERGY RX200	IBM p710
<b>Operating System</b>	Novell SLES 11 on VMware ESX/ESXi 4	Red Hat EL5 on Citrix XenServer	Solaris 10	Microsoft Windows Server 2008	IBM AIX 7.1
<b>Host Bus Adapter</b>	QLogic QLE2562	QLogic QLE2562	QLogic QLE2562	QLogic QLE2562	QLogic QLE2562

# Configuration Overview

## **SAN Fabric**

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

Zone Administration

Zoning Modes

Basic Zones

Traffic Isolation Zones

Basic Zones

Print Edit View Zoning Actions

New Resource View Refresh Enable Config Save Config Clear All

Alias Zone Zone Config

NameNew AliasDeleteRename

Member Selection List

Ports & Attached Devices(29 Members)

4(24 Ports)

4,0(U-Port,PID: 040000)

4,1(U-Port,PID: 040100)

4,2(U-Port,PID: 040200)

4,3(U-Port,PID: 040300)

4,4(U-Port,PID: 040400)

4,5(U-Port,PID: 040500)

4,6(U-Port,PID: 040600)

4,7(U-Port,PID: 040700)

4,8(U-Port,PID: 040800)

4,9(F-Port,PID: 040900)

4,10(F-Port,PID: 040a00)

4,11(F-Port,PID: 040b00)

4,12(U-Port,PID: 040c00)

4,13(U-Port,PID: 040d00)

4,14(U-Port,PID: 040e00)

4,15(U-Port,PID: 040f00)

4,16(U-Port,PID: 041000)

4,17(F-Port,PID: 041100)

4,18(F-Port,PID: 041200)

4,19(U-Port,PID: 041300)

4,20(U-Port,PID: 041400)

4,21(U-Port,PID: 041500)

4,22(U-Port,PID: 041600)

4,23(F-Port,PID: 041700)

Add Member >>

<< Remove Member

Add Other...

Alias Members

1 Member.

Network Portcard 50:01:43:80:04:25:17:90

Current View: Fabric View

Effective Zone Config: PRODUCTION

Loading information from Fabric... Done

Free Professional Management Tool

172.30.6.16

AD0

User: admin

Role: admin

# SAN Storage

The screenshot shows a configuration window for SAN Storage with the following sections:

- General Tab:**
  - Properties:** LUN Name: lun01, LUN ID: 01, Unique ID: 60:06:01:60:1E:80:29:00:E2:6C:53:C0:9B:8D:E0:11, Current State: Ready, Current State Details: (empty field).
  - Operation In Progress:** Operation: (empty field), Operation State: (empty field), Refresh button.
  - Storage Pool Properties:** Storage Pool: Pool 0, RAID Type: RAID5, Drive Type: FC, Available Capacity: 3.000 GB.
  - LUN Capacity:** User Capacity: 3602.381 GB, Consumed Capacity: 3672.224 GB.
  - Advanced:** Alignment Offset: 0.
  - Ownership:**
    - ☐ Auto Assignment Enabled
    - Current Owner: SP A, Allocation Owner: SP A
    - Default Owner:** ☒ SP A, ☐ SP B
- Buttons:** OK, Apply, Cancel, Help.

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

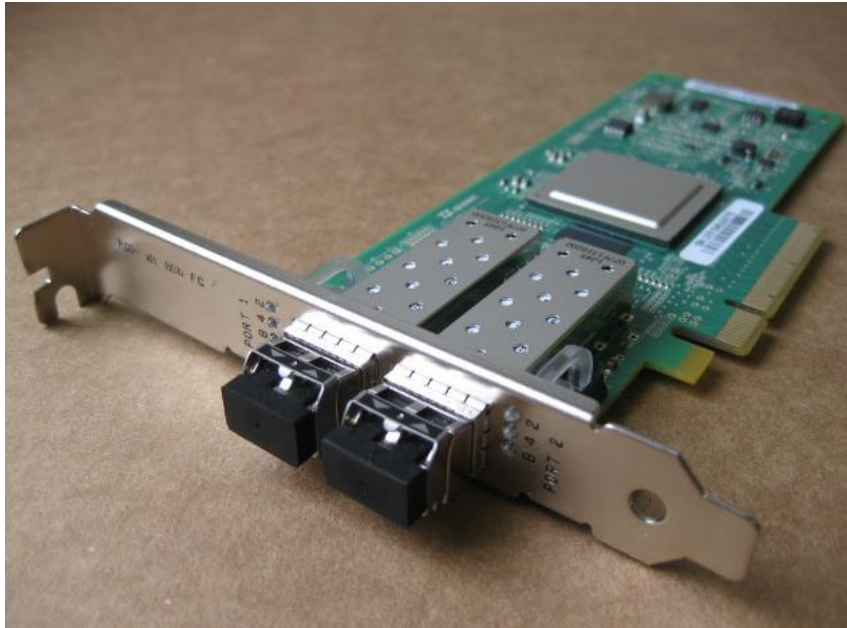
<b>Name</b>	lun01
<b>Capacity</b>	3 TB
<b>Redundancy</b>	RAID5

## QLogic FC-HBA

QLogic FC-HBAs

- QLogic QLE2562
- QLogic QLE2462
- QLogic QLA2362


are installed onto the x86-based appliance running Bloombase OS 5.5.



## Bloombase StoreSafe Security Server

StoreSafe supports both file-based and block-based on-the-fly storage encryption. In this interoperability test exercise, fiber channel SAN block-based encryption is validated against Brocade SAN switches.

[Main](#)
[Logout](#)
[Support](#)
[About](#)
[Help](#)


**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

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## Find Key Wrapper

**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

**Find** **Reset** **Add**

1-2 of 2

	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

1-2 of 2

## Encryption Key Configuration

Generate encryption key with name 'key' in 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" value=""/> 
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 followings.

### Configure StoreSafe SAN

**Configure StoreSafe SAN**

**Targets**

	Target
1	21:00:00:e0:8b:1f:03:7f
2	21:01:00:e0:8b:3f:03:7f

## Physical Storage Target Configuration

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

### List Storage Device

**List Physical Storage Device**

	Uuid	Type	Path	Size	Name
1	ATA_-KING-STON_-SSD-NOW_-30AM-10B5-M83Z	Single Path	5:0:0:0:	29313144	sda
2	4f50-4e46-494c-4500-6834-614a-7168-2d33-4e59-472d-4567-4e36	Single Path	8:0:0:0:	15695872	sdb
3	4f50-4e46-494c-4500-4564-4238-5274-2d53-6e46-472d-3630-4c48	Single Path	8:0:0:1:	10452992	sdc

Physical storage namely 'luno1' is configured to map to the storage device to be encrypted by 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.

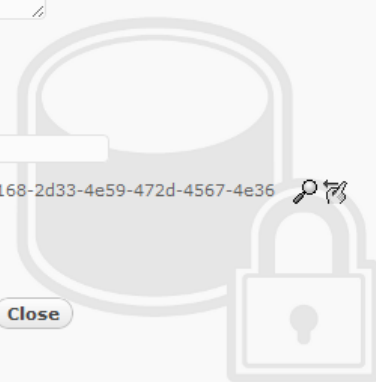


### Modify Storage Configuration

**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 'sano1' 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 'key'

### 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 mask 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	<div>10:00:00:00:c9:71:87:0c</div>	2011-02-15 11:45:58 +0800

Add

Remove

Submit

Close

# Validation Tests

## Test Scenarios

### Validation Matrix

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

Test Condition	Candidate
SAN Switch	<ul style="list-style-type: none"><li>• Brocade 300 SAN Switch</li></ul>
Storage System	<ul style="list-style-type: none"><li>• Dell / EMC CX4-240 SAN storage</li></ul>
HBA	<ul style="list-style-type: none"><li>• QLogic QLE2562</li><li>• QLogic QLE2462</li><li>• QLogic QLA2362</li></ul>

Storage Encryption Appliance	<ul style="list-style-type: none"> <li>• Bloombase StoreSafe Security Server on x86-based IBM x3650</li> </ul>
Host Server Hardware	<ul style="list-style-type: none"> <li>• Dell PowerEdge R510</li> <li>• HP ProLiant DL-380</li> <li>• Oracle Sun Fire x4170</li> <li>• Fujitsu PRIMERGY RX200</li> <li>• IBM p710</li> </ul>
Host Operating Systems	<ul style="list-style-type: none"> <li>• Microsoft Windows Server 2008</li> <li>• Red Hat EL 5</li> <li>• Novel SELS</li> <li>• Solaris 10</li> <li>• IBM AIX</li> <li>• VMware ESX/ESXi (hypervisor)</li> <li>• Citrix XenServer (hypervisor)</li> </ul>

---

## Raw Storage Device Tests

The following tests are carried out at storage host operating systems to access encrypted SAN storage by Bloombase StoreSafe appliances via Brocade SAN switches

Test	Description
Write disk with zeros	Write zeros into encrypted storage target via Bloombase 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 Bloombase 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 hosts to access encrypted SAN storage by Bloombase StoreSafe appliances via operating system file-systems with Brocade SAN switches as interconnects

- ext3 for Linux
- NTFS for Microsoft Windows
- JFS for IBM AIX
- UFS for Solaris

Test	Description
Directory creation	Platform equivalence of UNIX's mkdir
Directory rename	Platform equivalence of UNIX's mv
Directory removal	Platform equivalence of UNIX's rm
Directory move	Platform equivalence of UNIX's mv
File creation	Platform equivalence of UNIX's echo XXX ›
File rename	Platform equivalence of UNIX's mv
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"> <li>• Platform equivalence of UNIX's chmod</li> <li>• Valid for UNIX-based storage host systems only (Linux, AIX, HP-UX, Solaris)</li> </ul>
Softlink/Symbolic link removal	<ul style="list-style-type: none"> <li>• Platform equivalence of UNIX's rm</li> </ul>

	<ul style="list-style-type: none"> <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>

---

## 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 rotation	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
Database creation	✓	
Schema creation	✓	
Database record insert	✓	
Database record query	✓	
Database record update	✓	
Database record delete	✓	
Index creation	✓	
Tablespace alteration	✓	
Redo log creation	✓	
Redo log rotation	✓	
Archive log creation	✓	

# Conclusion

## Brocade SAN switches

- Brocade 300 SAN switch

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

Bloombase Product	Operating System	Brocade SAN Switches
Bloombase StoreSafe Security Server	Microsoft Windows Server 2008	Brocade 300 SAN switch
	Red Hat Enterprise Linux 5	Brocade 300 SAN switch
	Novel SELS 11	Brocade 300 SAN switch
	Solaris 10	Brocade 300 SAN switch
	IBM AIX 7	Brocade 300 SAN switch
	VMware ESX/ESXi 4 (hypervisor)	Brocade 300 SAN switch
	Citrix Xen Server (hypervisor)	Brocade 300 SAN switch

# 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 Microsoft Windows, <http://software.intel.com/en-us/articles/dd-for-windows/>
4. Oracle database server, <https://www.oracle.com/database>
5. Transaction Processing Performance Council, <http://www.tpc.org/tpcc/>
6. Brocade 300 SAN Switch, <http://www.brocade.com/products/all/switches/product-details/300-switch/index.page>