CRITICAL I/O WHITE PAPER

Replacing Legacy Fibre Channel Storage

Integrated Chassis FC Solutions: StoreBox and StoreRack
VPX Blade FC Solutions: StoreEngine and StorePak

Abstract

Data storage has become a critical function within many military systems. For many years, Fibre Channel connected storage, either configured as RAID or JBOD, has been the de-facto standard for high performance storage applications. Recent advances in SSD storage and associated controllers make it possible to replace or upgrade these legacy Fibre Channel connected storage systems, maintaining full compatibility while simultaneously providing a significant boost in storage capacity and performance.

Replacing Legacy Fibre Channel Storage

Data storage has become a critical function within many military systems. For many years, Fibre Channel connected storage, either configured as RAID or JBOD, has been the de-facto standard for high performance military storage applications. Recent advances in SSD storage and associated controllers make it possible to replace or upgrade these legacy Fibre Channel connected storage systems, maintaining full compatibility while simultaneously providing a significant boost in storage capacity and performance.

Critical I/O provides several options for the replacement of legacy Fibre Channel storage:

- **StoreBox-FC** – Rugged conduction cooled, fully integrated Fibre Channel Storage
- **StoreRack-FC** – Air-cooled rack mount, fully integrated Fibre Channel Storage
- **StoreEngine** and **StorePak** - VPX storage blades hosted in a customer provided chassis

All three of the above hardware options implement the identical Fibre Channel storage architecture, use identical storage management firmware, and implement the exact same Fibre Channel storage feature set. The only difference between the three options is in the physical chassis level packaging.

Considerations in Legacy Fibre Channel Storage Replacement

In considering the replacement of an existing legacy Fibre Channel storage system, there may be two different goals. The first (and possibly only) goal may be to (as seamlessly as possible) replace the storage system, maintaining full compatibility with the legacy system. The second goal may be to expand the storage capacity and/or performance of the legacy storage system. These two goals may impose different requirements on the replacement system. If the primary goal is a seamless replacement, then the replacement system should exactly emulate the legacy system with respect RAID levels/capacities (for RAID replacement), number of drives (and capacities) that are exposed (for JBOD replacement), and the performance level of the legacy system (IOPS, read rate, write rate).

RAID Levels/Capacity

The key elements include support for all common RAID levels (0/1/5/6/10), as well as support for an arbitrarily large number of RAID volumes. Each RAID volume may be of a different RAID level and capacity.

JBOD Drive Emulation

JBOD Drive Emulation is the ability to efficiently emulate any number of JBOD drives, regardless of the number of actual physical SSDs that are present in the replacement system. Drive virtualization features allow any number “M” of logical virtual drives of any desired capacity to be “virtualized” from any number “N” actual physical SSDs.

Performance Throttling

Precise emulation of a legacy system requires that the replacement system match the performance level of the legacy system in terms of read rates, write rates, rebuild rates (for RAID 1/5/6/10) and IOPs. Normally a SSD based replacement system will be much faster than a legacy hard drive based storage system. And while it is impossible to exactly match all aspects of performance, the use of performance throttling features can “slow” the SSD based system to approximate the same performance levels as the legacy system.

Interface Architecture

Interface architecture characteristics include the Fibre Channel rate (1, 2, 4, or 8 Gbps) as well as the interface redundancy model. Supported redundancy models include dual port active, active/passive, and standby failover models.

Upgrades in Capacity and/or Performance

Replacing a legacy system provides a clear opportunity to upgrade storage system performance and/or capacity. In particular, replacing a hard drive based legacy system with a SSD based system offers a potential for significant increase in read/write rates, and an even more dramatic increase in the IOPs rate. Critical I/O's Fibre Channel storage solutions are scalable in both capacity and performance, allowing the replacement storage system to scale should system needs evolve.

Critical I/O Fibre Channel Storage Building Blocks – *Boxes and Blades*

Critical I/O is a leading supplier of ultra-high-performance SSD based storage solutions for the military embedded market. And Critical I/O is also *the* leading supplier of Fibre Channel interface technology for this market. Combined, these two technologies provide the core of a high performance Fibre Channel storage solution.

Critical I/O provides fully pre-configured chassis level Fibre Channel storage systems including **StoreBox** and **StoreRack** products. Critical I/O also provides blade level Fibre Channel storage blocks, including **StoreEngine** and **StorePak** blade level products. Combined with these hardware components, Critical I/O provides comprehensive storage firmware which implements a full Fibre Channel storage/management feature set.

StoreBox and StoreRack integrated Fibre Channel storage products internally use the StoreEngine and StorePak blades and StoreEngine storage firmware. Thus a StoreBox Fibre Channel RAID/JBOD is functionally equivalent to one implemented using StoreEngine and StorePak blade level building blocks installed in a customer supplied chassis.

A blade level Fibre Channel storage solution can be implemented in as little as a single 3U VPX card comprising a StoreEngine with dual Fibre Channel interfaces and 6TB of on-board SSD storage. Or at the other extreme, a 6U VPX rack based system with multiple StorePaks can provide up to 60TB of SSD storage.

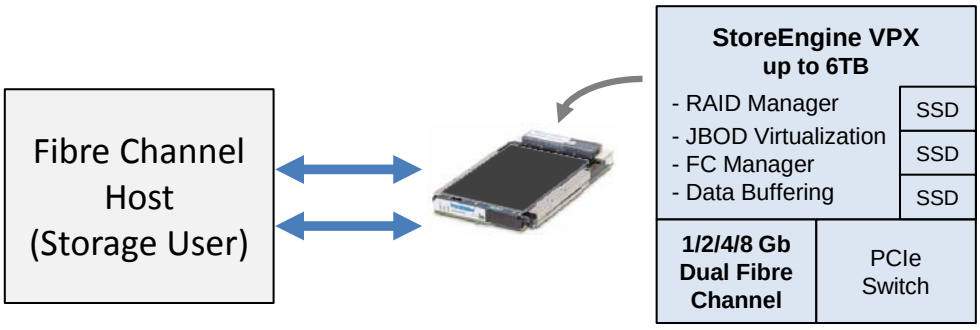

Figure 1: Minimal Fibre Channel SSD storage system - A single 3U VPX blade.

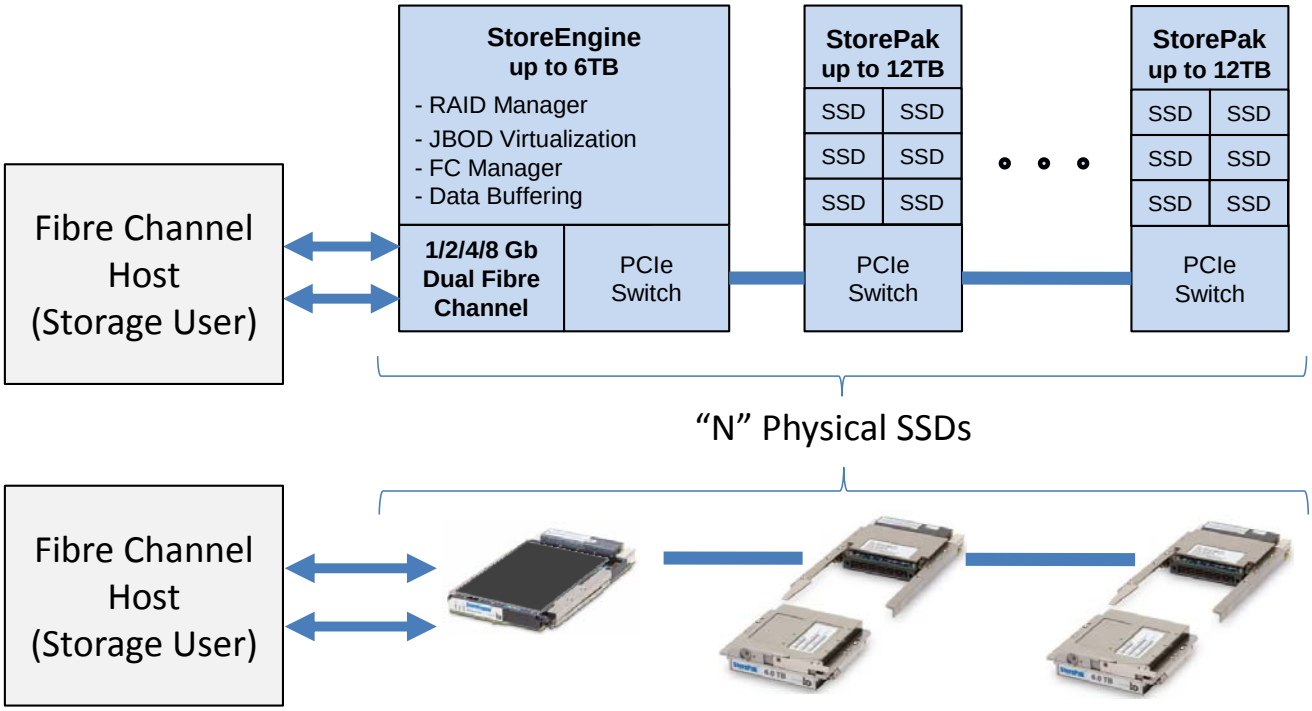

Figure 2: A larger blade based Fibre Channel SSD Storage system – Three 3U VPX slots.

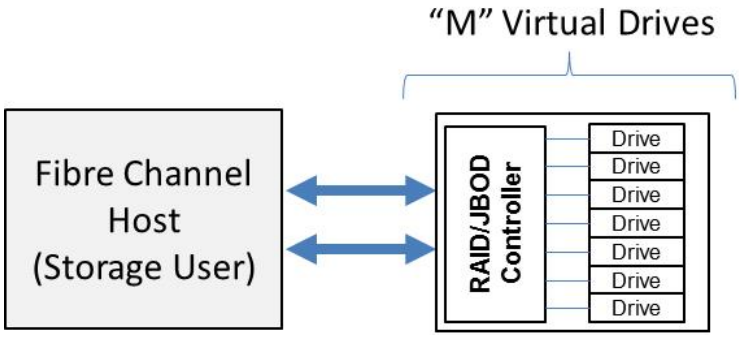

Figure 3: Host "drive virtualization" view of Figure 2 system. N physical SSDs emulating M virtual drives

StoreBox and StoreRack – Fully Integrated Fibre Channel Storage Systems

The **StoreBox-FC** Fibre Channel storage system consists of a ultra-compact conduction cooled chassis with dual optical Fibre Channel host interfaces, as well as dual 1GbE control/management interfaces. **StoreBox-FC** can provide up to 18TB of solid state storage in the compact conduction cooled chassis. **StoreRack-FC** is an air-cooled rack mount chassis that can provide up to 60TB of solid state storage, with dual or quad Fiber Channel host interfaces. Multiple configurations are available for both StoreBox and StoreRack with various storage capacities, performance capabilities, and I/O interface options. For both StoreBox, and Store Rack, multiple StorePak storage modules can be seamlessly added for increased storage capacity.

Internally, both StoreBox and StoreRack use Critical I/O's StoreEngine and StorePak boards, and flexible storage management firmware functionality to provide a dual channel full line rate Fibre Channel storage system. This provides a capability to support multiple Fibre Channel hosts, with aggregate data rates of up to 1.6 GB/s.

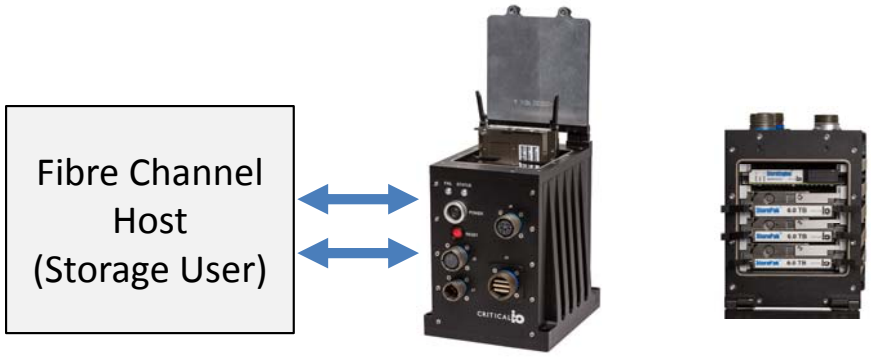

Figure 4. StoreBox-FC Provides up to 18TB of Fibre Channel SSD storage within a 6"x7"x8" envelope

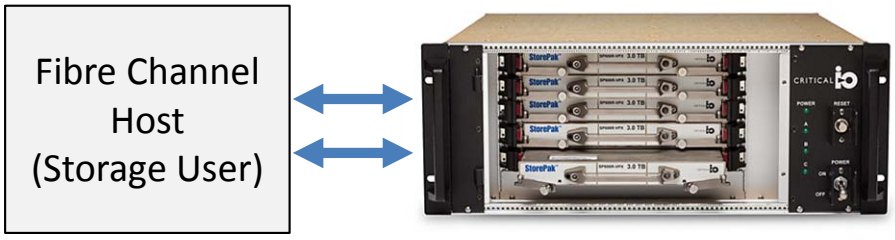

Figure 5. StoreRack-FC Provides up to 60TB of Fibre Channel SSD Storage

StoreEngine and StorePak – VPX Blade Level Storage Hardware Building Blocks

StoreEngine and **StorePak** are flexible storage building blocks that can be used to implement a wide range of data storage systems within the customers own chassis. In some cases, this may provide a possibility of completely eliminating a chassis in the legacy system.

StoreEngine is an ultra-high performance VPX storage controller blade that hosts up to 6 TB of non-removable on-board SSD storage as well as supporting a dual 1/2/4/8 Gb Fibre Channel interface (3U), or quad interface (6U). In addition to supporting Fibre Channel storage, StoreEngine can also, if desired, simultaneously provide high performance recording functionality as well as providing NAS file sharing functionality (like a NFS/CIFS file server).

StorePak is a VPX storage expansion blade that can host up to 12 TB (6U) or 6TB (3U) of easily hot swappable SSD storage per blade. Together, StoreEngine and StorePak provide unmatched storage capability, ultra high performance and high capacity within a small size, weight, and power (SWaP) footprint.

Figure 6. StoreEngine and StorePak blades. 3U or 6U VPX, air-cooled or conduction-cooled.

Both StoreEngine and StorePak provide rich backplane PCIe connectivity, with up to eight x4 PCIe backplane ports per VPX board for interconnections between StoreEngines and StorePaks. Both boards feature PCIe switches which are fully partitionable, providing greatly increased system architecture options.

Critical I/O Fibre Channel Storage Features

RAID Level Options

StoreEngine storage can be configured to operate as either RAID levels 0/1/5/6/10. All RAID modes aggregate storage into one or more RAID pools. Multiple RAIDs may be created and each RAID may be of a different capacity and RAID level.

Drive Virtualization

The Drive virtualization feature allows the emulation any number "M" of logical virtual drives of any desired capacity. The emulated drives are virtualized (created) from the physical SSDs, regardless of the number of actual physical SSDs that are present in the replacement system.

Encryption

An option is provided to encrypt all data as it is written to disk using AES-256 Self Encrypting SSDs (SEDs). An encryption manager utility is provided to assist in management of encryption keys.

Secure Erase

A SSD Secure Erase operation may be invoked via the web management interface. Secure Erase fully erases all data on the SSDs, restoring the SSD to an unused condition. Note that a Secure Erase operation can take several seconds to perform.

Quick Config

Quick Config provides a set of pre-defined storage system configurations that can, with a single mouse click, fully configure the storage system to one of several commonly used configurations.

Configuration Snapshots

Users can create and store "configuration snapshots". These configuration snapshots can be reapplied with a mouse click to restore the storage system to a known configuration. These configuration snapshots can also be transported to other systems, allowing users an easy way to "clone" configurations onto additional storage systems.

StorePak Hot-Swap

All of the Fiber Channel storage architectures discussed in this paper leverage StorePak removable SSD storage modules. StorePak modules are easily removed, and can be hot-swapped. A hot swap utility is provided to coordinate the Fibre Channel host activity with the StorePak hot swap mechanisms.

Storage System Management

A web based management utility is provided to configure the Fibre Channel storage system. Configuration options include Fibre Channel host configuration and LUN masking, RAID configuration, and virtual drive configuration. Features are also included to enable monitoring of the health of the storage system, RAIDs, and SSDs.

Other management methods may also be used, including in-band management methods and out-of-band management methods such as remote control client/server control or management protocols such as SNMP. Out-of-band methods use an auxiliary Ethernet connection to the storage system.

Summary

Recent generation SSD storage and associated controllers and management firmware make it possible to replace or upgrade legacy Fibre Channel connected storage systems, maintaining full compatibility while simultaneously providing a significant boost in storage capacity and performance. If the primary goal is a seamless replacement of a legacy system, the replacement system should exactly emulate the legacy system with respect RAID levels/capacities (for RAID replacement), number of drives (and capacities) that are exposed (for JBOD replacement), and the performance level of the legacy system (IOPS, read rate, write rate).

Critical I/O provides both fully pre-configured chassis level Fibre Channel storage systems including **StoreBox** and **StoreRack** products, as well as blade level Fibre Channel storage building blocks, including **StoreEngine** and **StorePak** which can be hosted in the customer's own chassis. Both of these hardware options implement the identical Fibre Channel storage architecture, use identical storage management firmware, and implement the exact same Fibre Channel storage feature set.