CRITICAL I/O WHITE PAPER

SATA vs. PCIe Connected Storage for VPX systems

Abstract

Both PCIe and SATA are interconnect methods that can be used to connect multi-SSD storage blades to one or more host processor boards or other data sources in VPX systems. PCIe connectivity provides more performance, scalability, and flexibility. SATA connectivity provides a cost effective option for more moderate performance systems. Critical I/O's StorePak and SataPak VPX storage blades provide versatile PCIe and SATA connected storage, respectively, for both 3U and 6U VPX systems.

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SATA vs. PCIe Connected Storage for VPX systems

There are two main options for connecting high capacity SSD storage blades in VPX systems: SATA and PCI Express. While both methods accomplish the basic goal of providing host access to storage, they differ significantly in the connection methods, performance, storage aggregation efficiency, and scalability.

Both of these interconnect methods can be used to connect multi-SSD storage blades to one or more host processor boards or other data sources in VPX systems. Critical I/O's VPX SSD storage blades support both connection options. StorePak and SataPak provide versatile PCIe and SATA connected storage, respectively. StorePak and SataPak support both 3U and 6U VPX systems, with both air and conduction cooled versions.

Both StorePak and SataPak are comprised of a removable SSD storage module combined with a fixed VPX carrier base unit. The fixed base unit is plugged into a VPX slot and secured. The removable storage module may then easily be removed, replaced, or even hot-swapped while the fixed base unit remains in place. StorePak and SataPak both support up to 100,000 removal/insertion cycles.

StorePak provides extremely high-performance PCIe connected storage. It has an on-board multi-port PCIe switch connected a high-performance SATA controller that can aggregate the performance of up to six SATA SSDs which are hosted in a removable, hot-swappable storage module. A single StorePak supports storage capacities of up to 6 TB, with aggregated PCIe storage performance of up to 2.5 GB/s to a single host.

SataPak provides SATA connected SSD storage. It has six SATA SSDs, which are also hosted in a removable hot-swappable storage module. SataPak also supports storage capacities of up to 6 TB, and individual SATA port storage performance of up to 250 MB/s. Aggregate storage performance using all six ports is up to 1.5 GB/s using host based aggregation.

Figure 1. StorePak and SataPak both combine a removable SSD storage module with a fixed carrier base module

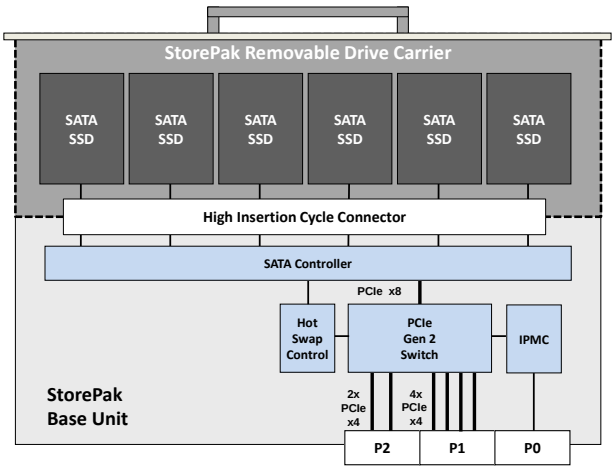

Figure 2. StorePak 6u VPX

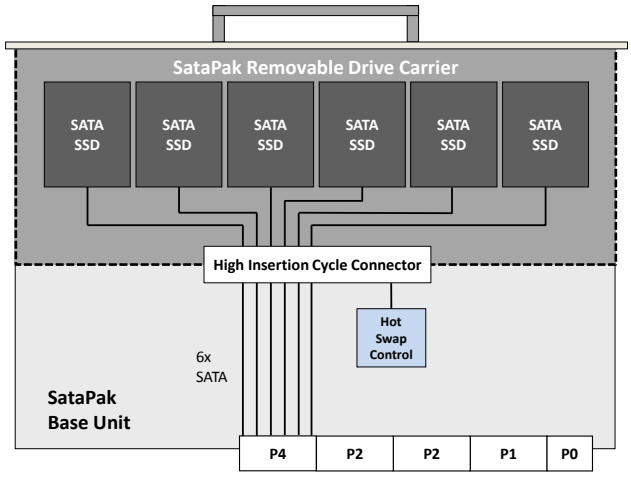

Figure 3. SataPak 6u VPX

The table below compares the attributes and capabilities of the StorePak and SataPak storage blades.

	StorePak	SataPak
Target Applications	**High performance and PCIe based scalability make StorePak ideal for high performance storage and data recording applications**	**Point to point SATA connectivity makes SataPak a cost effective solution for moderate performance DAS storage applications**
Capacity (single blade)	**Up to 6 TB**	**1-6 individual SSDs of up to 1 TB each**
Performance (single blade)	**Up to 2.5 GBytes/sec**	**Up to 250 Mbytes/sec for each SSD**
Host Interface	**PCIe (switched or point to point)**	**Individual SATA connections to each SSD**
Optional Interfaces (with StoreEngine, RTMs)	**1/10 Gb Ethernet, Fibre Channel**	**None**
Scalability	**Highly scalable**	**None**
RAID 0, 1	**Hardware based**	**Host (software) based**
Drive Aggregation	**Hardware based**	**Host (software) based**
Data Recording Mode	**Yes** (with StoreEngine)	**No**
File Serving (NAS)	**Yes** (with StoreEngine)	**No**
Removable Drive Module	**Yes**	**Yes**

SataPak - SATA Connected SSD Storage Blade

For systems with moderate storage capacity and performance requirements, SATA connection may be simpler and may also be lower cost. A prerequisite is that host processor boards must implement on-board SATA interfaces, and must present these interfaces for backplane connection. Backplane connections to storage blades may be via backplane traces (generally used in the case of custom backplanes) or via wafer cable connection systems such as those offered by Meritec and others.

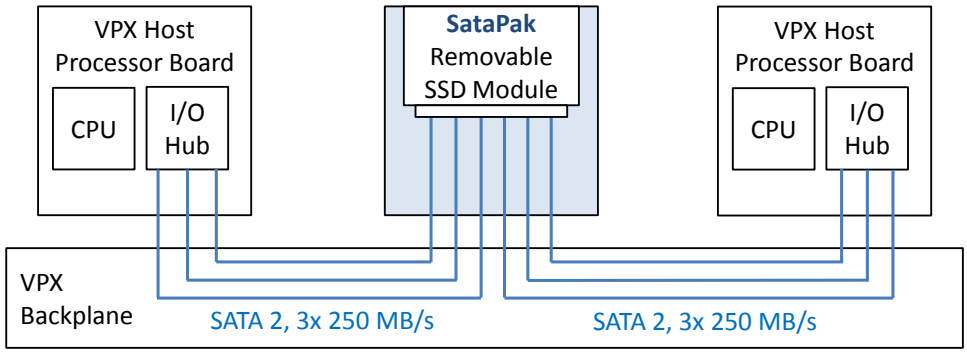

Figure 4. SataPak SATA host connectivity

A SATA connected storage blade presents individual SATA SSD port to the backplane and host processor, and thus presents individual drive images to the host system. This has the disadvantage of requiring that any storage aggregation (i.e. RAID) be performed in software on the host processor boards. But it has the advantage the SSDs on the storage blade may easily be allocated to multiple host board as shown in Figure 4. In this example, a six SSD SATA storage blade is used to provide three SSDs each to two separate processor boards.

VPX Storage Slot profiles have been introduced to standardize the SATA backplane connections of SATA storage blades. Host processor boards' backplane SATA connections tend to be non-standardized, however, so many systems using SATA connected storage will tend to used custom backplanes or cable connection systems mentioned above.

A disadvantage of SATA connected storage is that it relies on host based RAID/aggregation of the multiple SSDs that are presented to the host. This places an additional performance burden on the host, and may limit performance and capacity as well. The number of SSDs (and thus the aggregate performance) that may be utilized by single host is limited to the SATA connections of the host, which is typically in the range of one to four connections. In addition, chipset based SATA ports are often not able to sustain deterministic line-rate performance. It also may not be possible (due to backplane connectors and traces) to operate SSDs at SATA 3 rates of 6 Gbps, instead defaulting to the slower SATA 2 rates of 3 Gbps.

StorePak - PCIe Connected SSD Storage Blade

PCIe connected storage offers support for systems with higher storage capacity and performance requirements. A prerequisite is that all host processor boards (or other data source devices) must implement PCIe backplane interfaces. Backplane "Fat-Pipe" PCIe connectivity is a very common feature on processor boards today, as well as on certain other types of VPX payload and peripheral boards.

The StorePak PCIe connected storage blade can be configured to utilize internal RAID, and can thus present a single drive image to host boards, if desired. This has the advantage that storage aggregation (i.e. RAID) does not need to be performed in software on the host processor boards

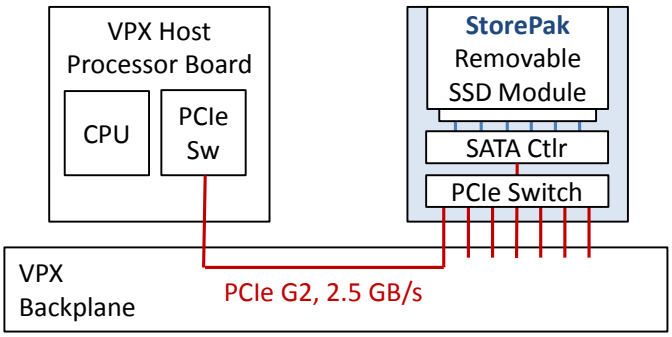

Figure 5. StorePak PCIe host connectivity

VPX PCIe storage blades may be designed to conform to VPX payload slot, peripheral slot, or switch slot profiles. The host processor boards' backplane PCIe connections use well defined VPX Fatpipe connections which are supported by many backplane designs, using both mesh and switched topologies.

Because PCIe connected storage includes internal RAID/aggregation of the multiple SSDS, it removes this additional performance burden on the host, as well as the resulting limitations on performance and capacity. The number of SSDs that may be utilized by single host is no longer limited to the SATA connections of the host. PCIe connected storage blades isolate SSD SATA connections from the backplane, and thus also have the ability to utilize the full bandwidth of current generation SATA 3 SSDs.

A further capacity and performance advantage of PCIe connected storage is the ability to aggregate the performance and capacity of multiple storage blades though additional PCIe connections, as shown in figure 6.

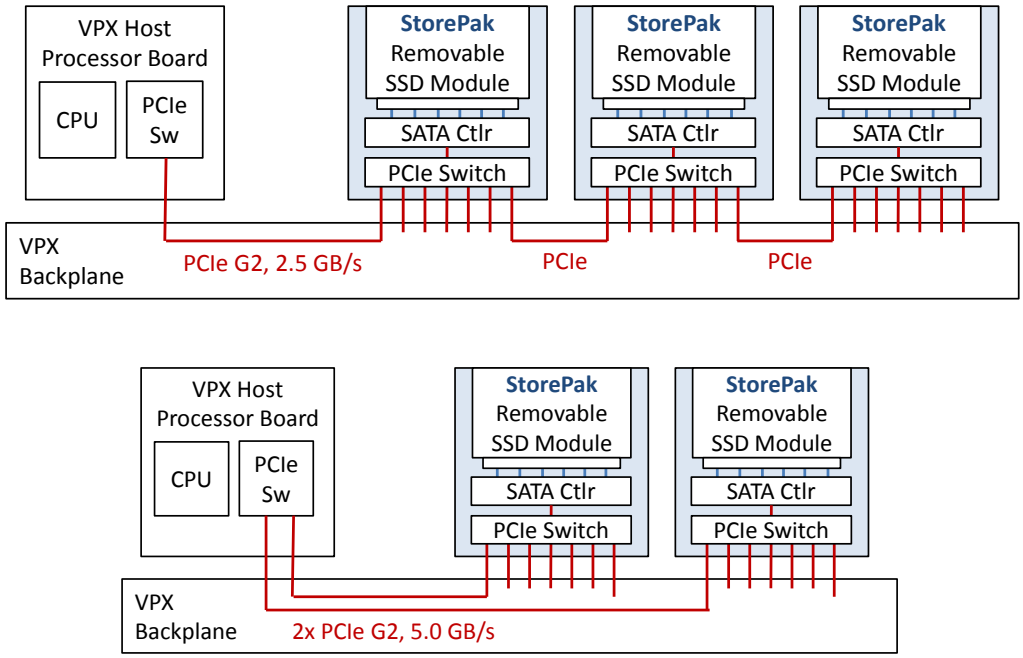

Figure 6. Two examples of storage scalability with StorePak

StorePak's PCIe connectivity also supports multi-mode storage operation when used in conjunction with a StoreEngine storage management blade. The configuration shown in figure 7 simultaneously supports direct DAS access over PCIe or FIbre Channel, NAS file sharing access over 1/10GbE, and high speed recording access to shared StorePak storage. Additional interface options are also available with this configuration, with support for 1/10 Gb Ethernet and Fibre Channel in addition to PCIe.

The combination of StoreEngine's built-in recording software and StorePak also form a versatile, very high performance data recorder which can scale to support multi-GB/s recording bandwidths and multi-TB capacity Figure 8 shows a typical PCIe recording architecture where two channels of data are recorded directly from PCIe data sources.

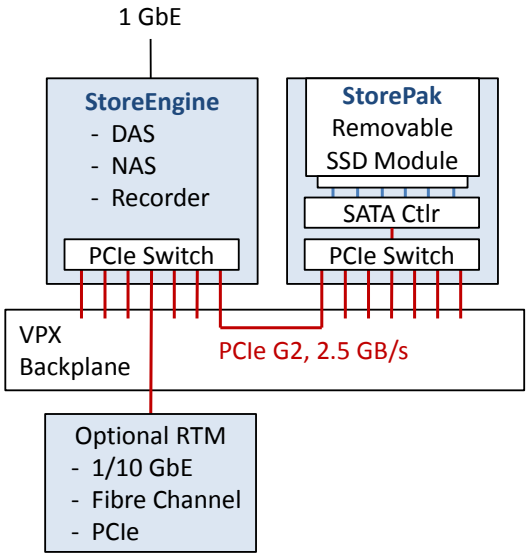

Figure 7. StorePak combined with StoreEngine

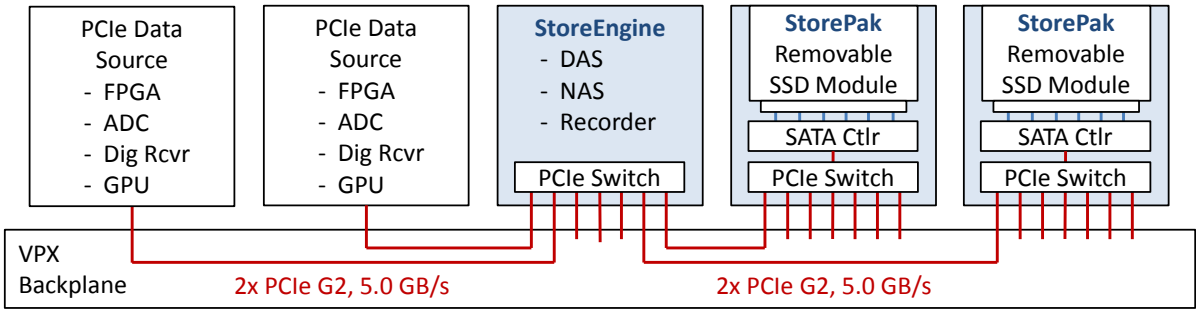

Figure 8. StoreEngine/StorePak PCIe Data Recorder example

Summary

PCI Express and SATA are both viable storage connectivity options for VPX systems. SATA host connectivity offers the advantages of simplicity and lower cost, but with reduced performance, capacity, and scalability. PCI Express provides a more versatile storage architecture that is highly scalable and configurable in terms of performance, capacity, interfaces options, and features. SATA and PCIe storage connectivity options are supported by Critical I/O's SataPak and StorePak storage blades, respectively.