DapuStor x ATTO: Scalable NVMe Storage with Advanced PCIe Switch Technology

01 Overview

Non-Volatile Memory Express (NVMe) is a storage protocol purpose-built for solid-state drives (SSDs) connected via PCI Express (PCIe). NVMe SSDs offer significantly lower latency in the tens of microseconds and deliver gigabytes per second of sustained read and write throughput. A PCIe Switch can enable PCIe bifurcation, adding more PCIe lanes to the motherboard, so that more NVMe SSDs can be accommodated on the host with little performance overhead.

ATTO and DapuStor, leaders in PCIe switch and enterprise SSD technologies, have partnered to deliver a high-performance NVMe solution that boosts overall system efficiency.

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02 Benefits of the Joint Solution

1. Expanded PCIe Connectivity

   - Scale NVMe storage beyond native CPU PCIe lane limitations through integrated PCIe switching
   - Connect and manage more NVMe SSDs per host while maintaining full bandwidth and low-latency access
   - FPGA-based control intelligently orchestrates host-target device paths, optimizing efficiency and resource allocation in real-time

2. Optimized Throughput

   - Aggregate multiple PCIe lanes and balance traffic dynamically across NVMe devices for sustained throughput
   - Reduce contention and eliminate oversubscription by ensuring each SSD receives adequate bandwidth
   - Delivers multi-drive performance scaling that matches CPU-native NVMe without latency penalties

3. Seamless Integration

   - Appears as standard NVMe device to the host OS – no proprietary drivers or software layers required
   - Compatible with industry-standard RAID implementations both software-based and hardware RAID engines for high-availability configurations
   - Works within existing PCIe, NVMe, and UEFI frameworks, simplifying qualification and deployment

4. Intelligent Host and Target Management

   - FPGA logic on-board handles link initialization, path management, and error recovery – independent of host CPU resources
   - Enables multi-host sharing and drive pooling with deterministic latency and isolation between workloads
   - Supports adaptive performance tuning and real-time monitoring of device health

5. Infrastructure & Power Efficiency

- Reduces reliance on additional CPU sockets, chipsets, and memory channels by consolidating NVMe connectivity into a single adapter
- Lowers total power draw per terabyte of NVMe capacity by minimizing idle CPU and memory overhead
- Cuts rack-level power and cooling requirements, improving density and energy efficiency for high-performance environments.

03 Test Results

A system with one ATTO ExpressNVM S48F NVMe Switch Adapter and four NVMe SSDs (DapuStor PCIe Gen4 R5101 3.84TB) was tested for compatibility and performance.

The hardware, OS, and test tools are illustrated below.

Item	Description
CPU	Intel Xeon Silver 4410Y, 12 core
Memory	128GB, 2*32 GB, 4800MHz
Drive	DapuStor PCIe Gen4 R5101 3.84 TB NVMe SSD
OS	Rocky Linux 9.5 (Blue Onyx) kernel 5.14.0-503.40.1.el9_5.x86_64
PCIe Switch	ATTO ExpressNVM S48F Adapter
Server platform	Supermicro X13DEI (PCIe Gen 5 Platform)
Test Tool	fio-3.35

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The topology of the connection between the PCIe card and drives can be found from the lspci command.

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+-[0000:42]-+-00.0  Intel Corporation Ice Lake Memory Map/VT-d
|           +-00.1  Intel Corporation Ice Lake Mesh 2 PCIe
|           +-00.2  Intel Corporation Ice Lake RAS
|           +-00.4  Intel Corporation Device 0b23
|           \-01.0-[43-4c]--+-00.0-[44-4c]--+-00.0-[45]----00.0  ATTO Technology, Inc. Device 00c8
|                           |               +-01.0-[46]----00.0  DapuStor Corporation NVMe SSD Controller DP600
|                           |               +-02.0-[47]----00.0  DapuStor Corporation NVMe SSD Controller DP600
|                           |               +-03.0-[48]----00.0  ATTO Technology, Inc. Device 00c8
|                           |               +-04.0-[49]----00.0  ATTO Technology, Inc. Device 00c8
|                           |               +-05.0-[4a]----00.0  DapuStor Corporation NVMe SSD Controller DP600
|                           |               +-06.0-[4b]----00.0  DapuStor Corporation NVMe SSD Controller DP600
|                           |               \-07.0-[4c]----00.0  ATTO Technology, Inc. Device 00c8
|                           \-00.1  ATTO Technology, Inc. ExpressNVM PCIe Gen4 Switch
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The NVMe SSD drives can also be found using from NVMe list command.

Node	Model	Usage	FW Rev
/dev/nvme0n1	DAPUSTOR DPRD3104T0T603T8000	3.84 TB / 3.84 TB	FF002150
/dev/nvme1n1	DAPUSTOR DPRD3104T0T603T8000	3.84 TB / 3.84 TB	FF002150
/dev/nvme2n1	DAPUSTOR DPRD3104T0T603T8010	3.84 TB / 3.84 TB	FF002150
/dev/nvme3n1	DAPUSTOR DPRD3104T0T603T8010	3.84 TB / 3.84 TB	FF002150

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The combined performance of 4 NVMe SSDs, which are linked to an ATTO ExpressNVM S48F Adapter, and the performance of a single drive are both tested. We then calculate the ratio between the combined and the single drive performance to show how much the PCIe card is resistant to the link overhead.

	Single Drive Performance	Combined Performance - 4 Drives	Combined: Single Drive Performance Ratio
Seq. Read (GB/s)	6.6	26.3	4
Seq. Write (GB/s)	5.4	21.5	4
Rand. Read (KIOPS)	1570	3719	2.4
Rand. Write (KIOPS)	247	991	4

This test result demonstrates the capability of the joint solution to connect and manage multiple DapuStor NVMe SSDs via ATTO ExpressNVM S48F Adapter while minimizing the overhead on performance.

04 Solution Use Cases

Potential target applications for the solution include:

1. High-Performance Storage Arrays

- Build dense NVMe all-flash arrays by connecting multiple DapuStor NVMe SSDs behind an ATTO ExpressNVM adapter for maximizing performance and capacity.

2. Accelerate Data Processing & Analytics

- Deliver multi-million IOPS and extremely high throughput for applications such as OLTP databases, real-time analytics, AI-inferencing, and cloud-native storage workloads.

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3. Content Delivery, Rich-Media Editing & Streaming

- Ideal for video-on-demand (VOD), OTT platforms, and edge CDN nodes requiring consistent low latency and high throughput.

4. Transactional Databases & Financial Systems

- Optimized for MySQL, PostgreSQL, and Oracle—supporting high-frequency trading and real-time risk analysis.

About ATTO

Founded in 1988, ATTO Technology, Inc. is a global leader specializing in high-performance storage and network connectivity solutions for enterprise IT, data centres, and media workflows. Through close collaboration with industry partners, ATTO engineers innovative technologies that optimize end-to-end data delivery, networking, and storage management across the most demanding IT ecosystems - all while maximizing customer value.

About DapuStor

DapuStor Corporation, founded in April 2016, specializes in enterprise solid-state drives (SSDs), SoCs, and edge computing products. With a world-class R&D team of over 400 members, the company has comprehensive capabilities from chip design to mass production. DapuStor's products are widely used in servers, telecom operators, and data centers, empowering businesses worldwide to manage their data more efficiently.

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