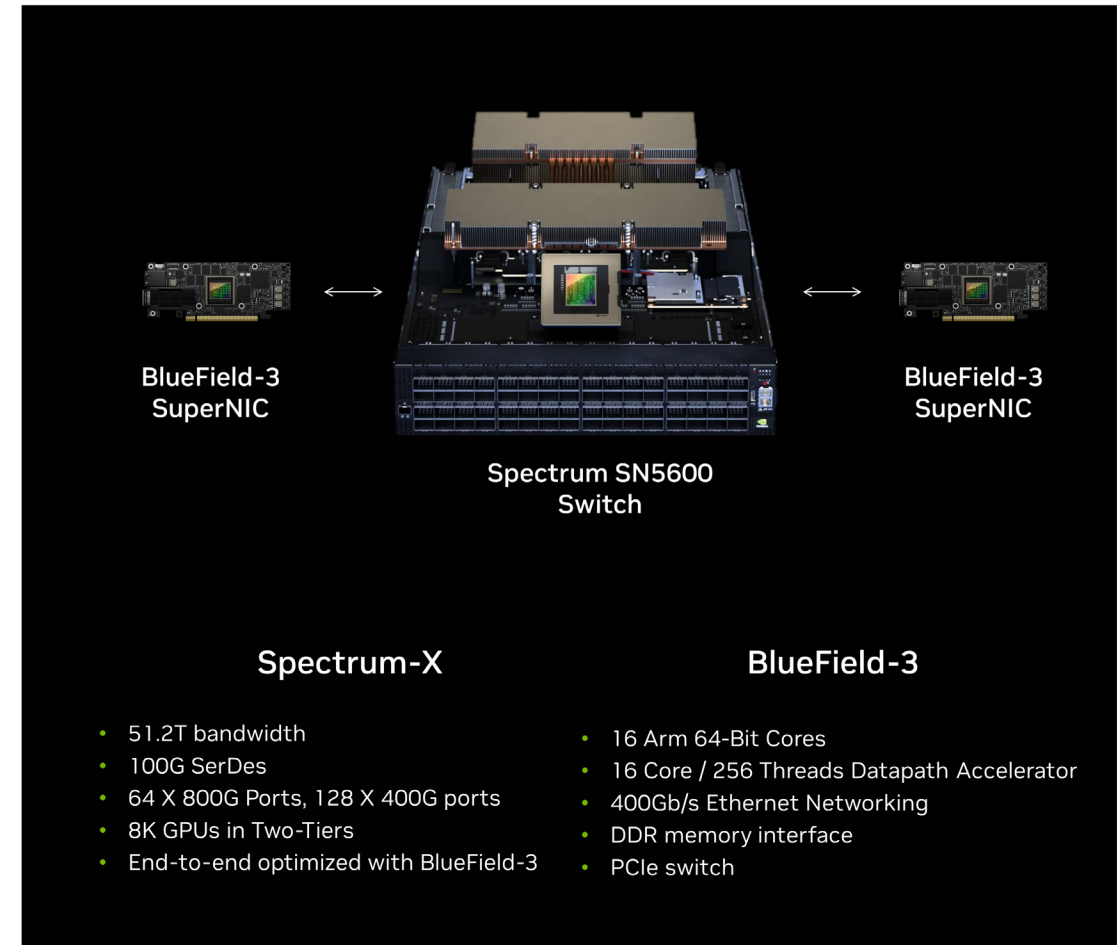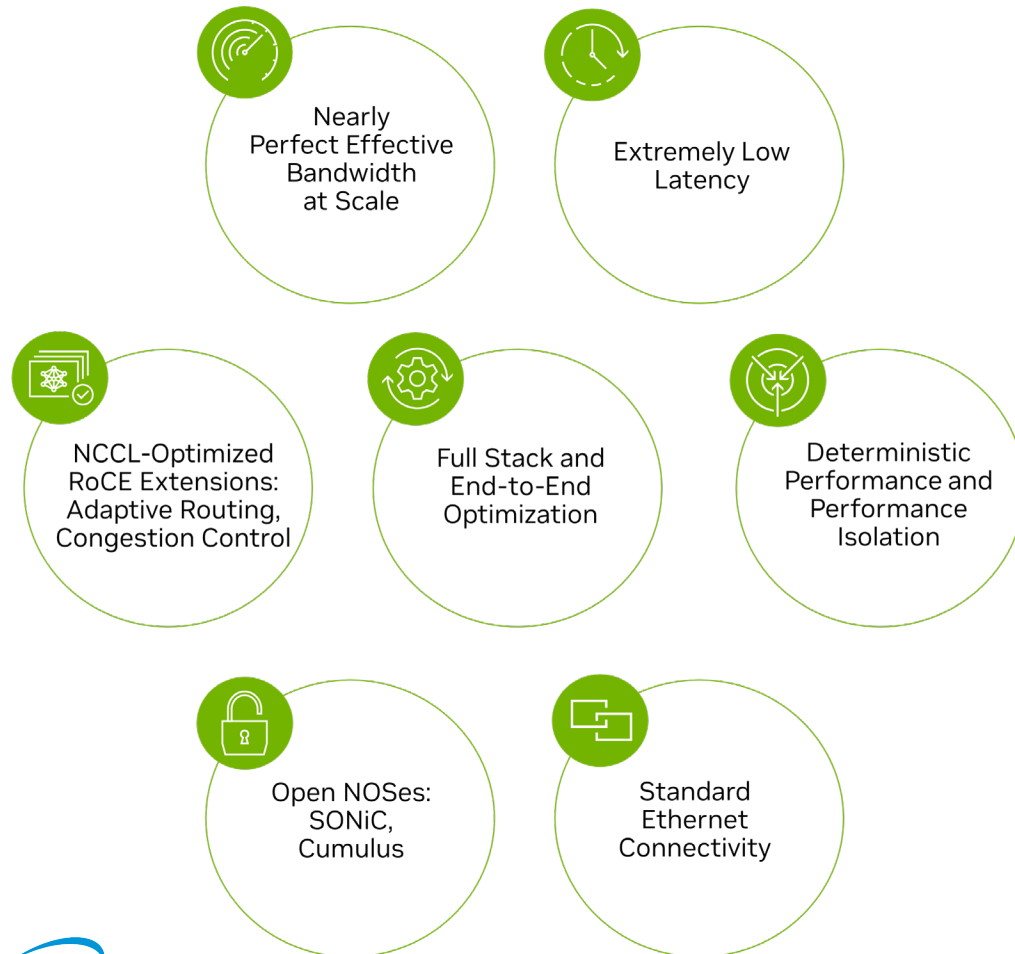# NVIDIA Spectrum-X Technology for AI Storage Fabrics

Reggie Reynolds

NVIDIA Spectrum-X: World's First Ethernet Platform for AI

Combining Specialized High-Performance Architecture with Standard Ethernet Connectivity

Nearly Perfect Effective Bandwidth at Scale

Extremely Low Latency

NCCL-Optimized RoCE Extensions: Adaptive Routing, Congestion Control

Full Stack and End-to-End Optimization

Deterministic Performance and Performance Isolation

Open NOSes: SONiC, Cumulus

Standard Ethernet Connectivity

BlueField-3 SuperNIC

Spectrum SN5600 Switch

BlueField-3 SuperNIC

Spectrum-X

- 51.2T bandwidth
- 100G SerDes
- 64 X 800G Ports, 128 X 400G ports
- 8K GPUs in Two-Tiers
- End-to-end optimized with BlueField-3

BlueField-3

- 16 Arm 64-Bit Cores
- 16 Core / 256 Threads Datapath Accelerator
- 400Gb/s Ethernet Networking
- DDR memory interface
- PCIe switch
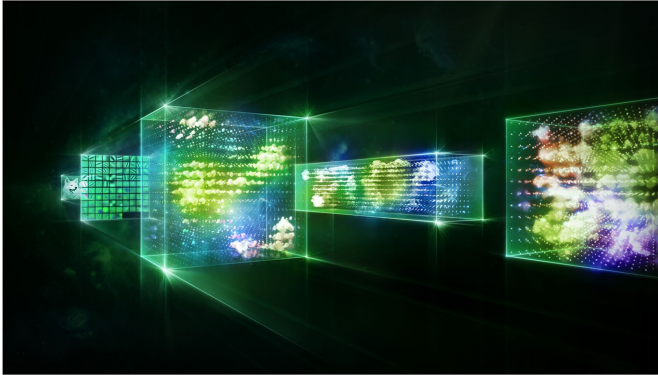
FMS
the Future of Memory and Storage

AI Storage Optimization Use Cases

Foundations to Build and Run Your AI Storage

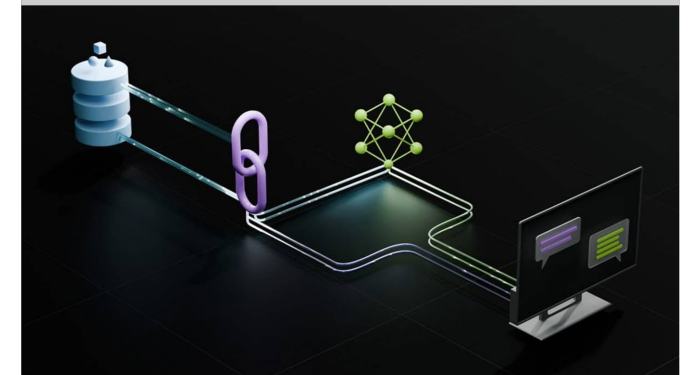## Storage Matters for High Performance AI Factories

Multi-modal Data Fetching

Checkpointing

Distributed Inference

Storage network performance is key to every stage of the AI model lifecycle

Data Ingest • Training • Fine Tuning • Inference

NVIDIA Spectrum-X Offers High Performance for Storage

Storage Ecosystem Partners Standardize on Spectrum-X Ethernet Technology

- Spectrum-X for storage workloads delivers up to:

48%

Higher storage
bandwidth per GPU

1.2X

Higher performance in
noisy neighbor scenarios

- Spectrum-X Ethernet is being adopted by key players in the high-performance storage ecosystem:
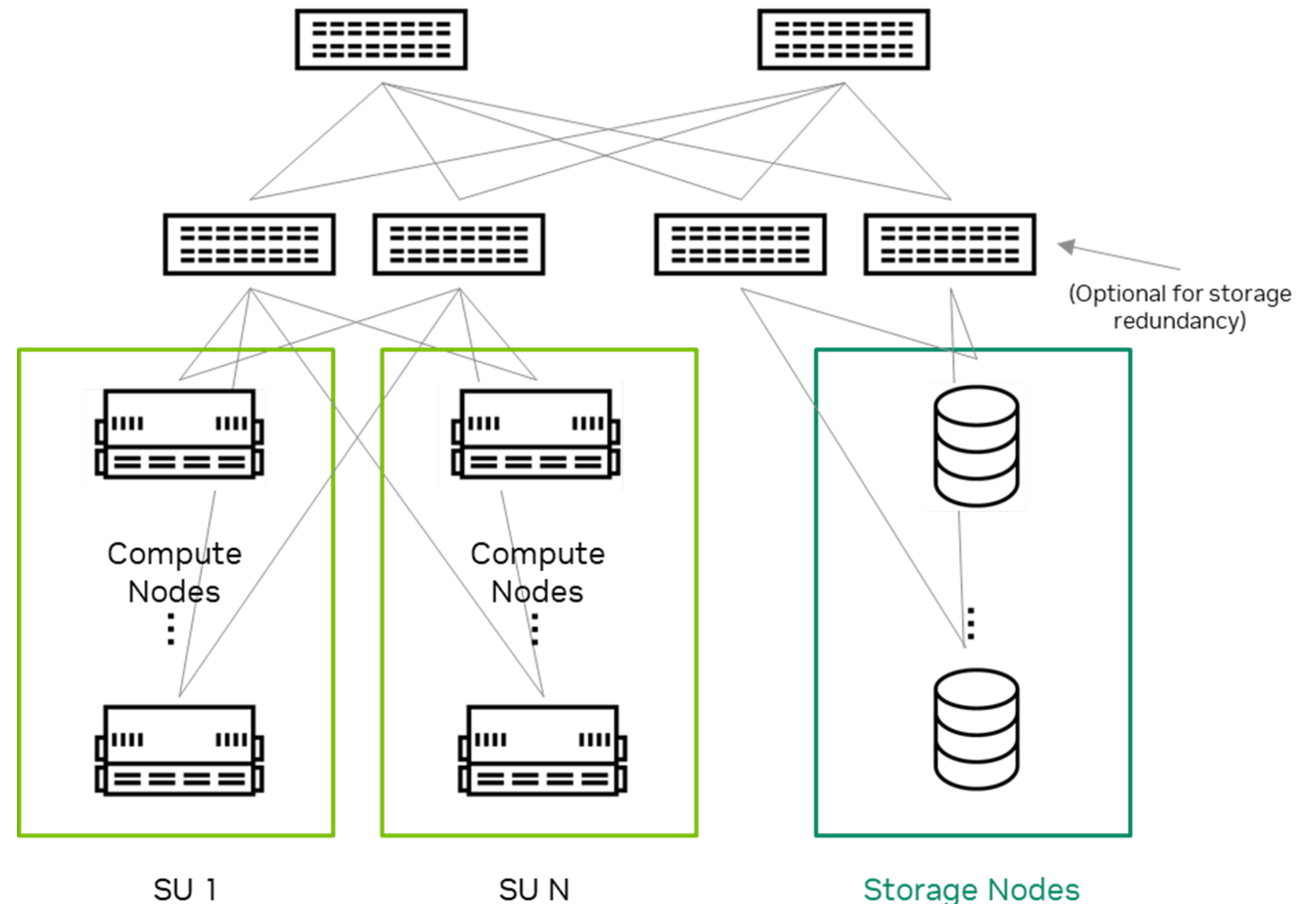
Improved Performance for the Data Storage Fabric

Leverage Adaptive Routing for Higher Effective Bandwidth

Storage operations such as checkpointing, data ingestion, model storage, retrieval, etc.
All generate elephant flows

Load balance with Spectrum-X adaptive routing for
50% higher effective bandwidth with perfect collision prevention

(Optional for storage redundancy)

Compute Nodes

Compute Nodes

SU 1

SU N

Storage Nodes

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Improved Performance for the Data Storage Fabric

Leverage Congestion Control for Performance Isolation

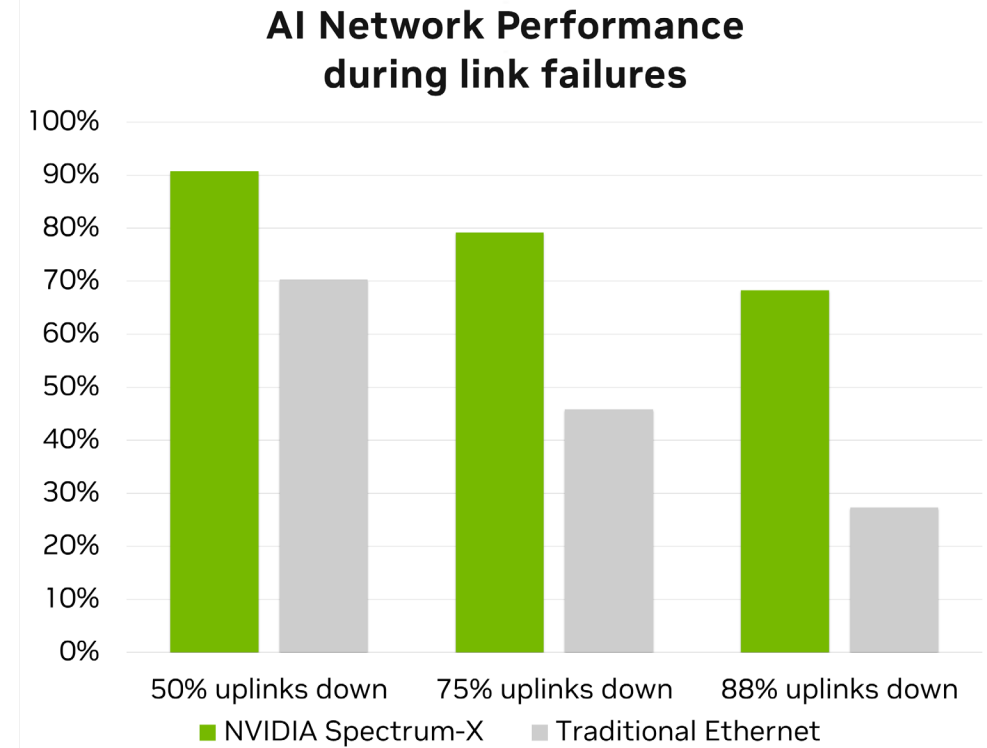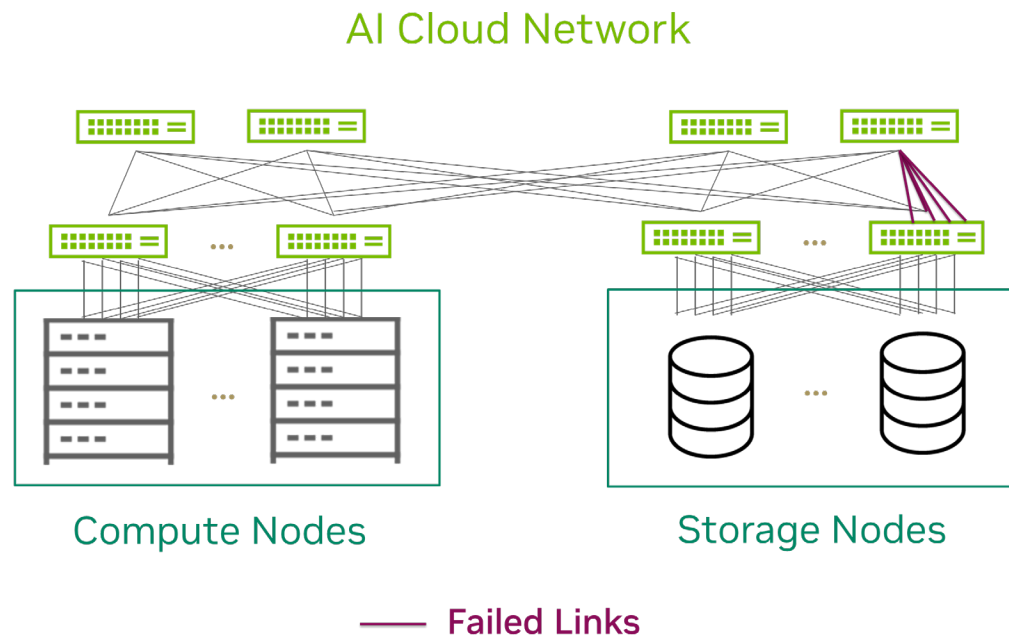Multiple clients read or write to a single storage server creates incast congestion

Spectrum-X congestion control avoids hotspots and provide performance isolation

(Optional for storage redundancy)

Compute Nodes

Compute Nodes

SU 1

SU N

Storage Nodes
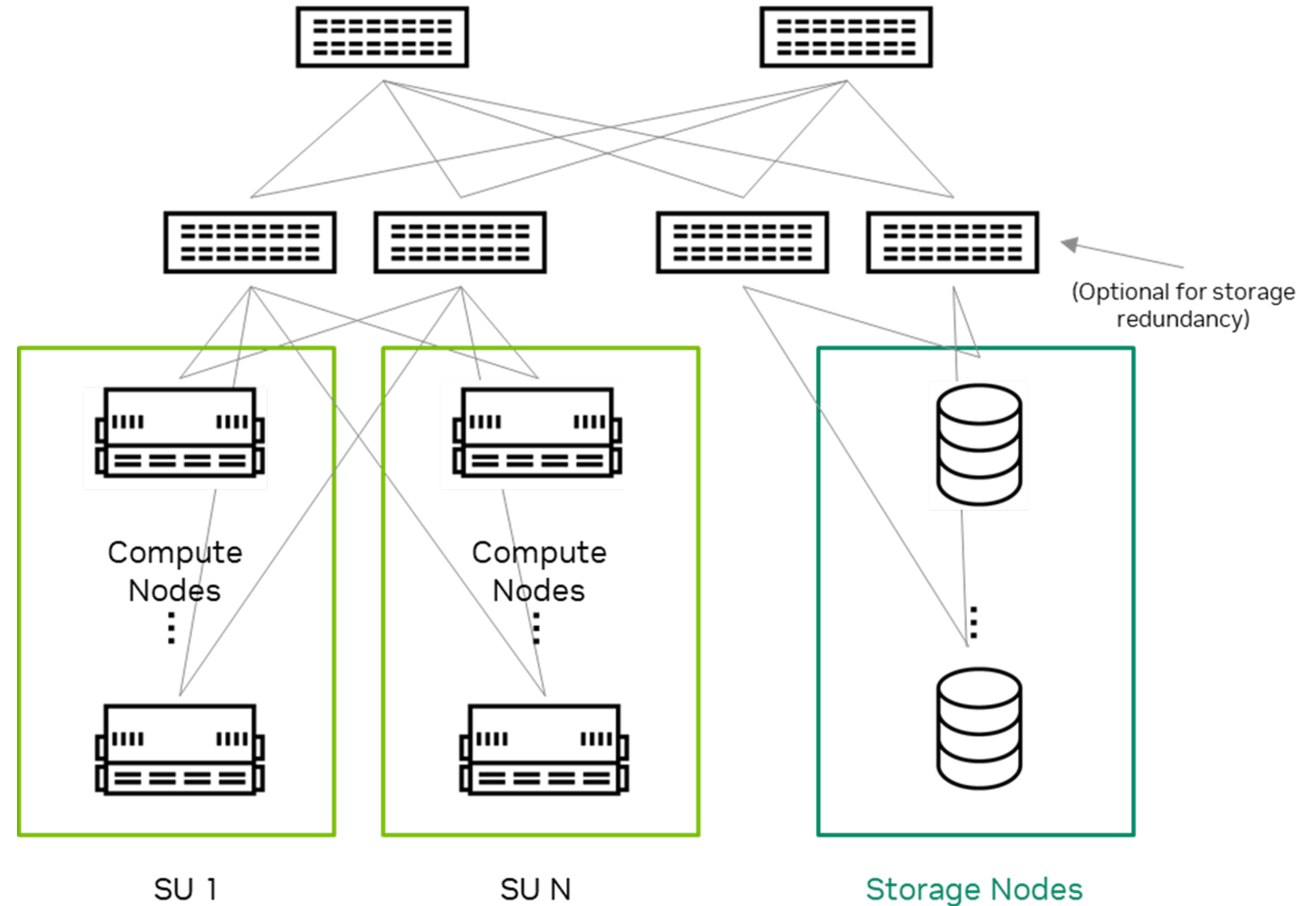
Resilient Adaptive Routing Performance

Link Failures on Traditional Ethernet Lead to Disproportionate Drop in AI Performance

AI Cloud Network

Compute Nodes

Storage Nodes

—— **Failed Links**

AI Network Performance during link failures

- 🟩 NVIDIA Spectrum-X
- ⬜ Traditional Ethernet

50% uplinks down · 75% uplinks down · 88% uplinks down

Spectrum-X utilizes global adaptive routing to rebalance flows and avoid failed paths

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Enhanced Visibility for AI Storage Fabrics

NetQ Accelerated Telemetry

Topology Validations – Reduce **Time To AI**

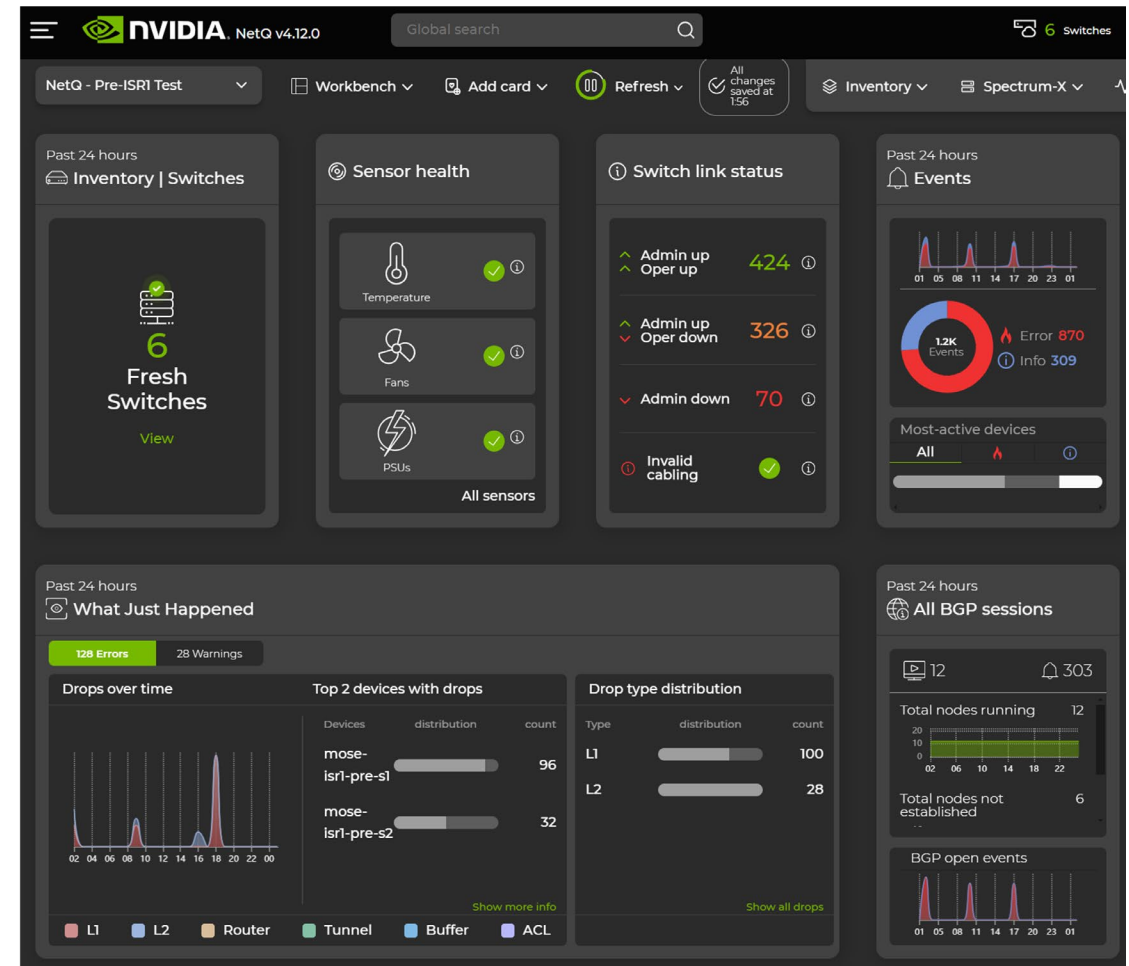AI Performance – Maximize Storage Utilization

Actionable Visibility – Reduce Time To Identify Issues

Link Health Monitoring – Detect Links Causing Issues

Hardware Monitoring – Identify Faulty Hardware

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Performance Benchmark Results and Partner Solutions

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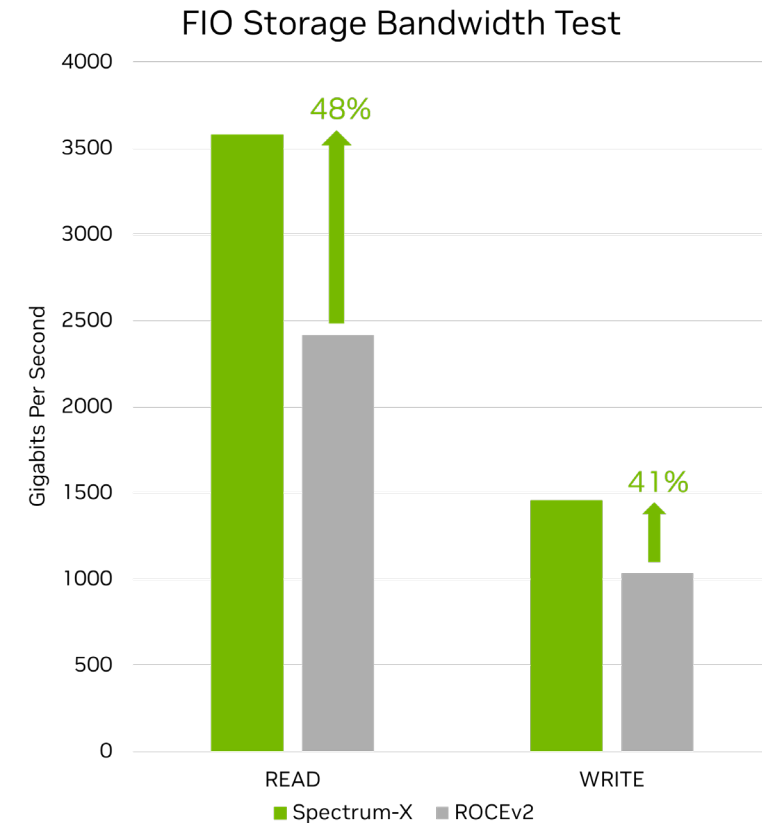# Spectrum-X Accelerates Israel-1 Storage
Storage IO performance at scale

- FIO Write Benchmark
  - Sends data from GPU nodes to Storage
  - Like saving Checkpoints during training
- FIO Read Benchmark
  - Sends data from Storage to GPU nodes
  - Like Inference or restoring checkpoints during training

NVIDIA Israel-1 AI Supercomputer
Validated / Optimized / Quantified

FIO Storage Bandwidth Test

- READ: Spectrum-X vs ROCEv2 — **48%**
- WRITE: Spectrum-X vs ROCEv2 — **41%**

Y-axis: Gigabits Per Second (0–4000)

Legend: ■ Spectrum-X ■ ROCEv2

Israel-1 Storage Test Results
300 GPUs across 4 SUs

Spectrum-X Accelerates GPFS

Up to 55% increased performance

- GPFS results:
  - Spectrum-X improved storage performance up to 55%
  - Bandwidth per port varied significantly with ROCEv2
  - Bandwidth per port was very consistent with Spectrum-X

- GPFS test setup:
  - 3 switches in a simplified leaf/spine topology
  - 8 servers in various storage client/target modes
  - 200GB and 1000GB files

- GPFS test topology:
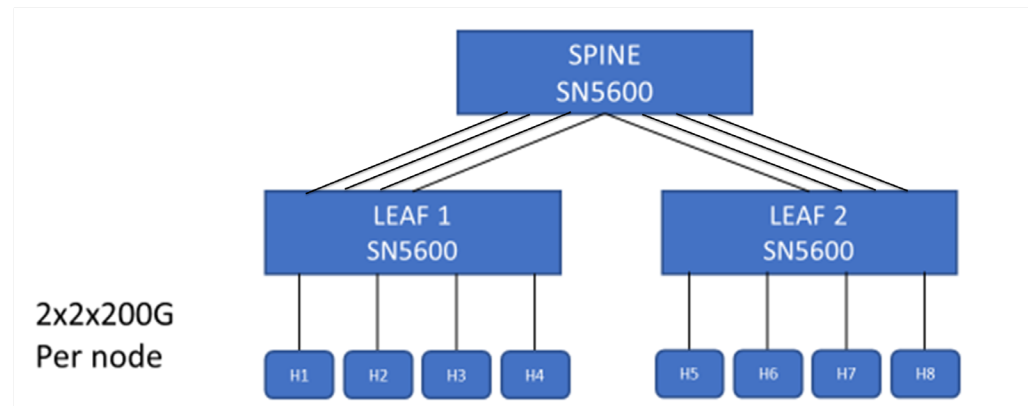
GPFS Write Performance
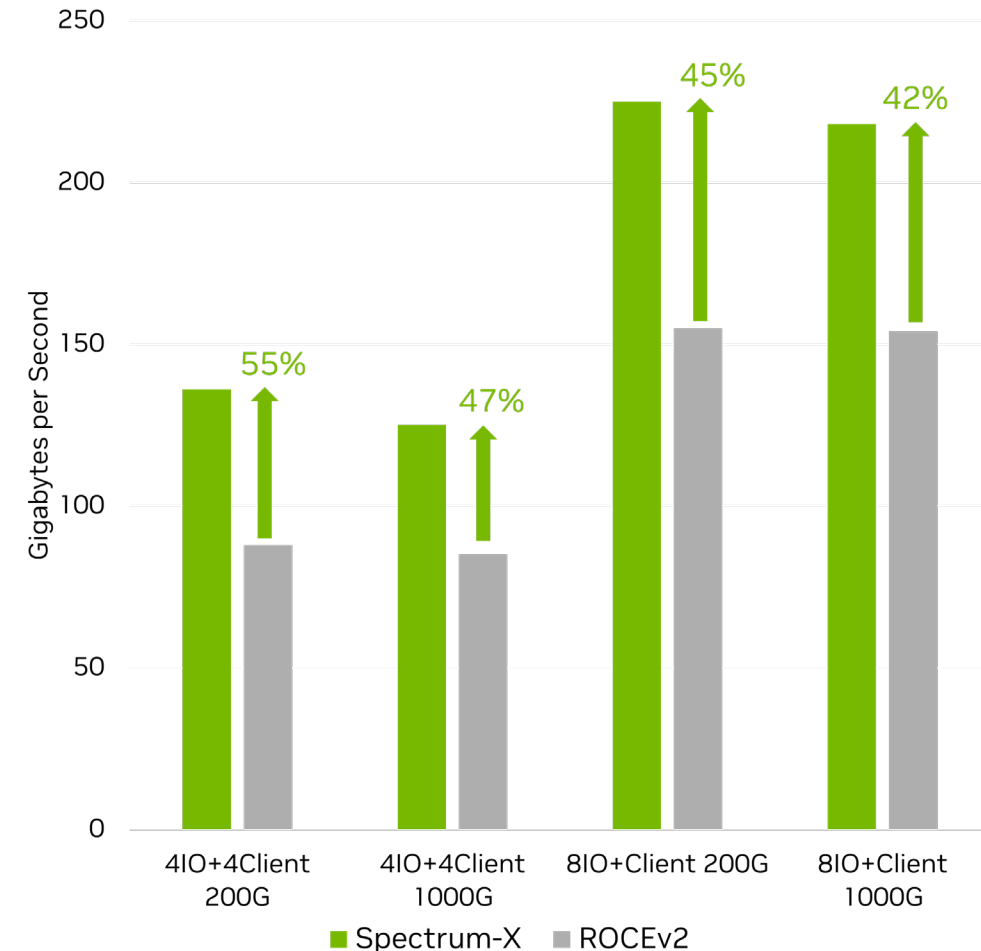
Benchmarks from NVIDIA Storage Partners

Summary of results from VAST, DDN, and Weka

- Significantly higher throughput

- Lower Latency

- Noisy Neighbor protection in the face of multiple workloads running simultaneously

- Higher Scalability

Resources

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Spectrum-X for Storage Resources

August 2025

NVIDIA Collateral:

- White paper

- Technical blog

- FAQ/positioning doc

- Spectrum-X Product Webpage

- NVShare

Partner Collateral:

- DDN white paper

- DDN blog

- VAST Data white paper

- VAST Data blog

- Weka blog

StorageReview

Enhancing AI Storage Fabrics with NVIDIA Spectrum-X

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Thank You!

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