Graid Technology Inc.

SupremeRAID™ overview for DISA

DEFENSE INFORMATION SYSTEMS AGENCY
The IT Combat Support Agency

EMERGING TECHNOLOGY DIRECTORATE (EM) TECHNICAL EXCHANGE MEETING

PRESENTED BY:

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Senior Director of OEM and Channel Business Development

GRAIDTECH.COM

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Agenda

- The RAID Bottleneck Challenge
- Our Innovative Solution
- Future Proof Your Environment
- Competitive Comparison
- CSFC Solution
- SupremeRAID™ Use Cases
- About Graid Technology Inc.
- Partners
- Nvme-oF Extra Slides

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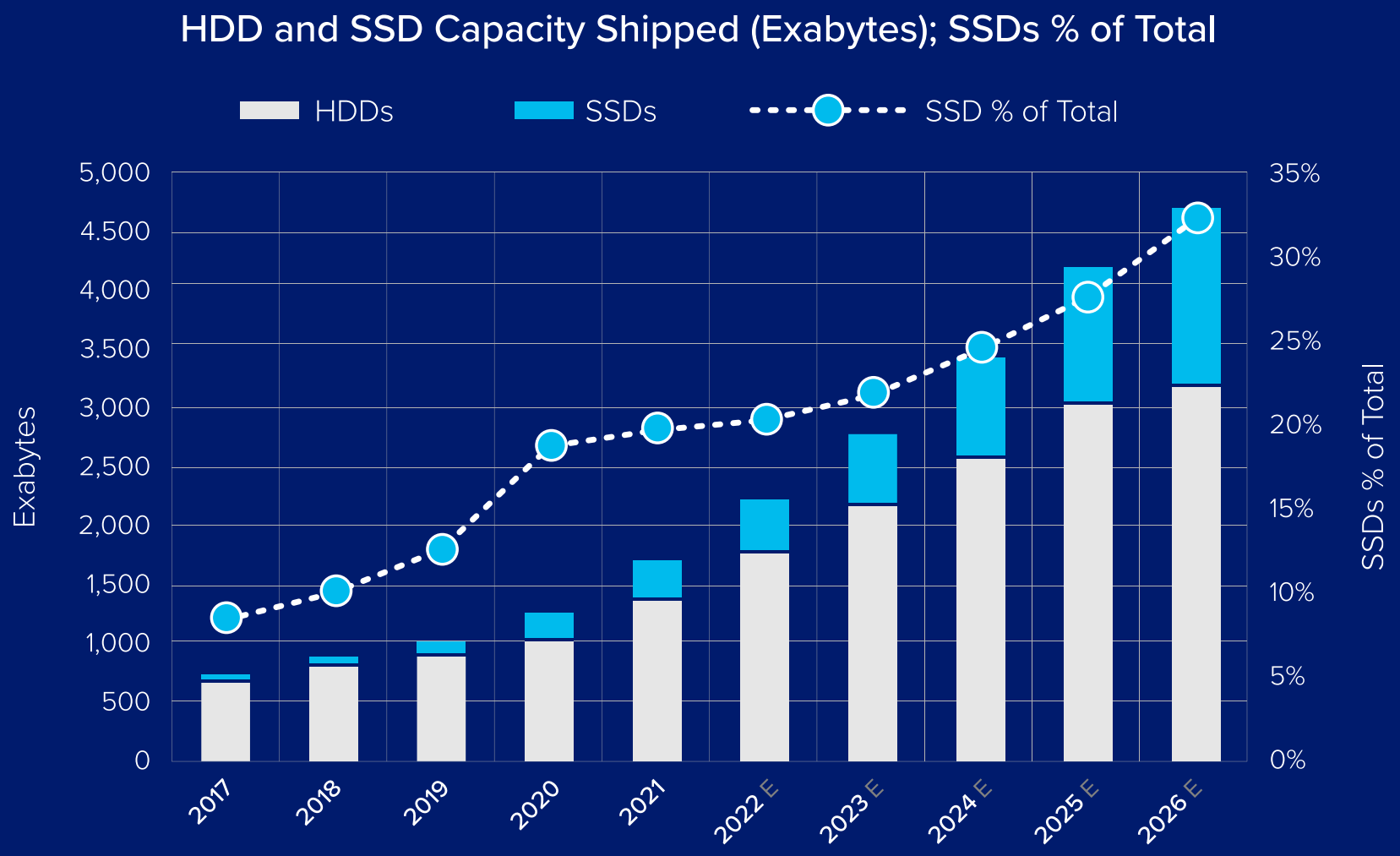
SupremeRAID™
The RAID Bottleneck Challenge

A Decade of Change in the Storage Market

- Storage systems are becoming increasingly software-defined
- Commodity hardware prevents vendor lock-in
- SSDs are replacing HDD as the storage medium of choice for the enterprise as they deliver lower TCO with improved scalability and flexibility
- Gartner analysts predict enterprise SSDs will be 32% of overall HDD/SSD capacity shipped by 2026 (vs ~20% share in 2021)



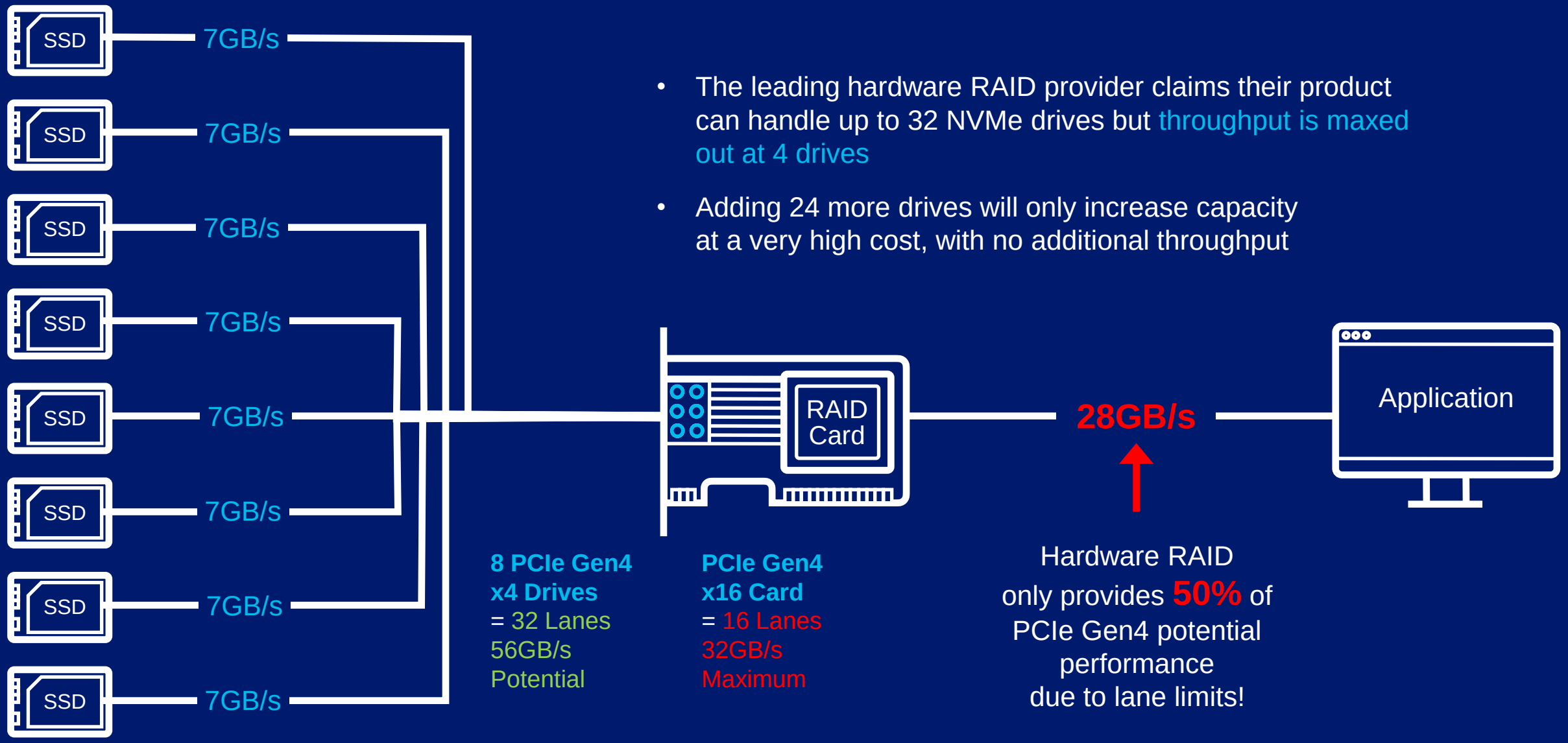
Source: Gartner; Wells Fargo Securities, LLC; Blocks & Files

The Challenge

Traditional RAID is a bottleneck

- Flash storage performance is evolving too fast to be fully utilized by existing storage architectures
- Software-based RAID competes with other applications for CPU power, slowing the whole system down
- Advances in NVMe technology are moving so fast that ASIC-based RAID can’t deliver the full performance capability of the SSDs
- **With these performance numbers, there is little to no ROI on investment in NVMe SSDs**

Hardware RAID Presents A Bottleneck



- The leading hardware RAID provider claims their product can handle up to 32 NVMe drives but throughput is maxed out at 4 drives
- Adding 24 more drives will only increase capacity at a very high cost, with no additional throughput

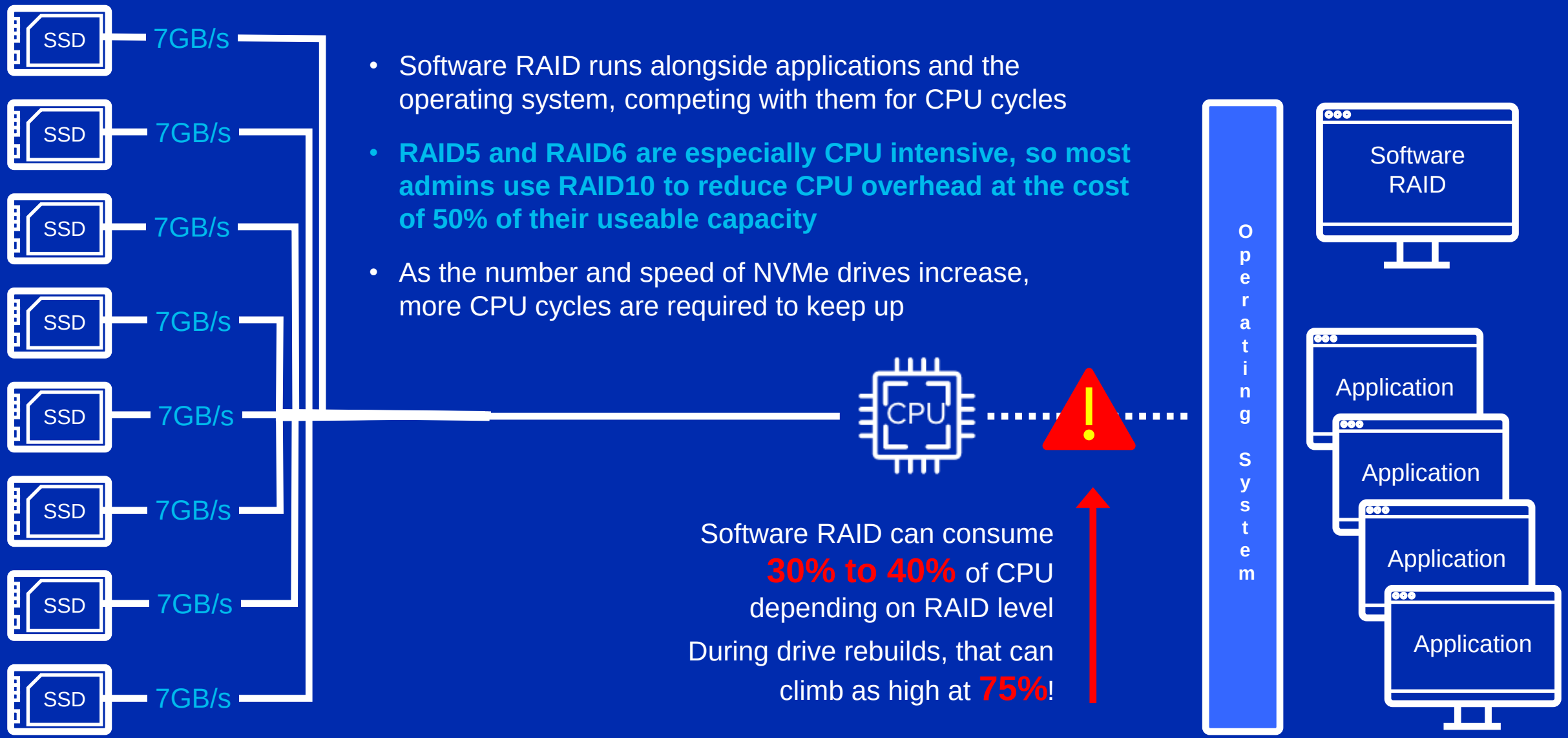
8 PCIe Gen4 x4 Drives
= 32 Lanes
56GB/s
Potential

PCIe Gen4 x16 Card
= 16 Lanes
32GB/s
Maximum

Hardware RAID only provides **50%** of PCIe Gen4 potential performance due to lane limits!

Based on Broadcom MegaRAID 9670W-16i

Software RAID Competes with Applications for CPU Cycles



- Software RAID runs alongside applications and the operating system, competing with them for CPU cycles
- **RAID5 and RAID6 are especially CPU intensive, so most admins use RAID10 to reduce CPU overhead at the cost of 50% of their useable capacity**
- As the number and speed of NVMe drives increase, more CPU cycles are required to keep up

Software RAID can consume **30% to 40%** of CPU depending on RAID level

During drive rebuilds, that can climb as high at **75%**!

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SupremeRAID™
Our Innovative Solution

The Solution: SupremeRAID™

Solve the IOPS Bottleneck

Process every IO with minimal CPU involvement

Solve the Throughput Bottleneck

RAID computation is out of the data path, resulting in up to **28M IOPS and 260GB/s throughput**

Achieve Unprecedented Performance & Increased Scalability

SupremeRAID™ removes the traditional RAID bottleneck to deliver maximum SSD performance, comprehensive data protection, and unmatched flexibility

INTRODUCING

SupremeRAID™ | The world's first NVMe and NVMeoF RAID card to unlock the full potential of your SSD performance

SupremeRAID™ SR-1010

SupremeRAID™ SR-1000

Our Innovative Technology

How SupremeRAID™ Works

- SupremeRAID™ is a software defined solution on GPU designed to deliver **maximum SSD performance without consuming CPU cycles**
- Out of path RAID protection technology means data travels directly from CPU to storage without passing through the SupremeRAID™ card

Unprecedented Performance Results

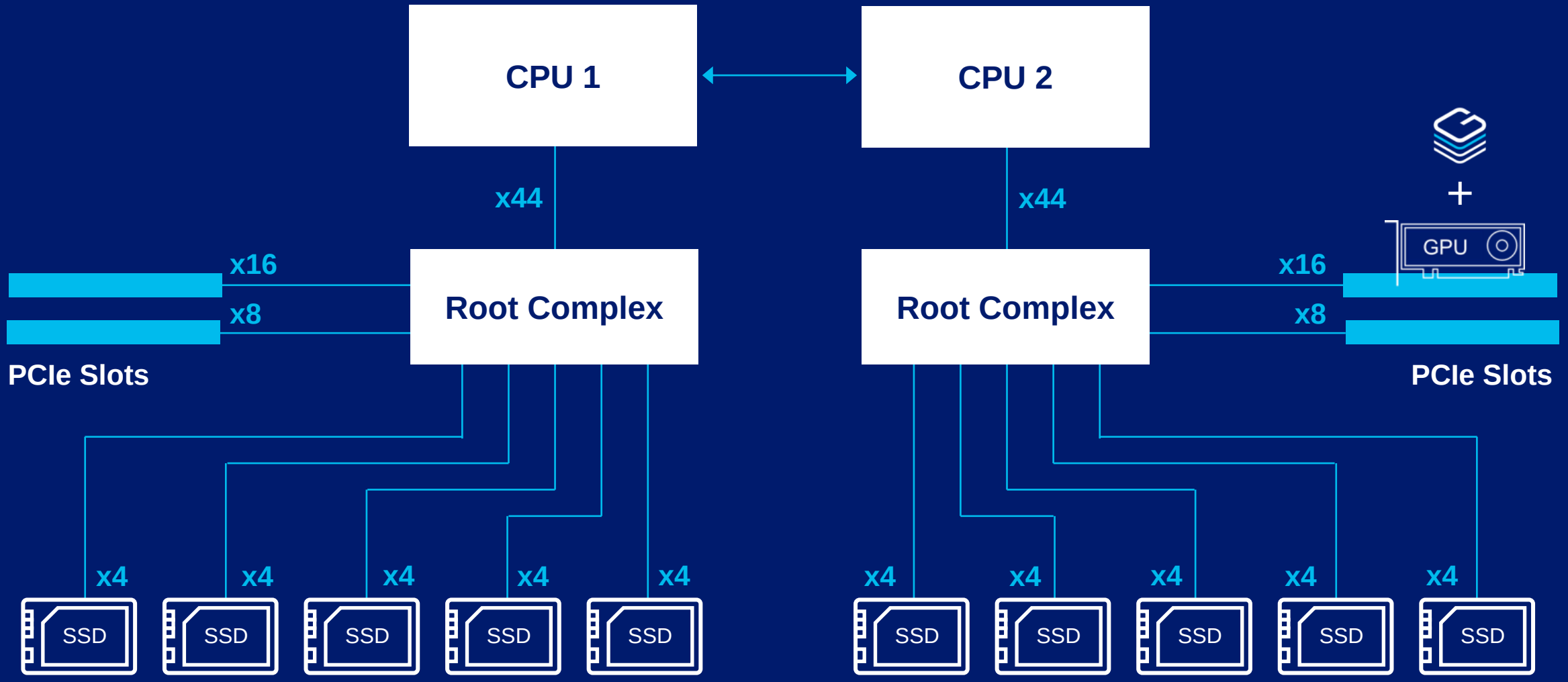
- SupremeRAID™ SR-1010 delivers **28M IOPS and 260 GB/s throughput**

  Based on Linux RAID5 with AMD EPYC 9654 96-Core Processor x 2 and KIOXIA CM7 x 24

- SupremeRAID™ SR-1000 delivers **16M IOPS and 220 GB/s throughput**

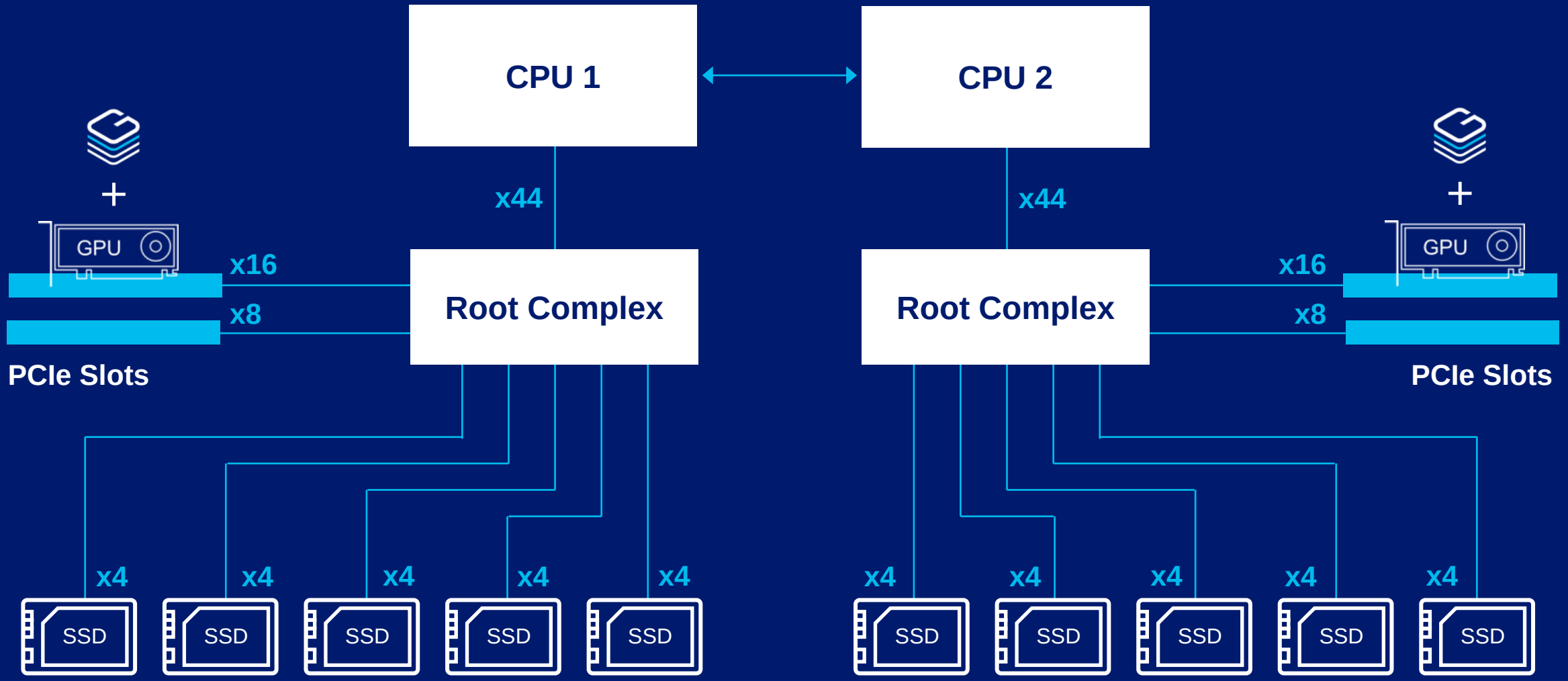
  Based on RAID5 with Intel® Xeon® Platinum 8468H CPU 48-Core with 2.1GHz x 2 and Samsung PM9A3 3.84TB x 32

How SupremeRAID™ Fits



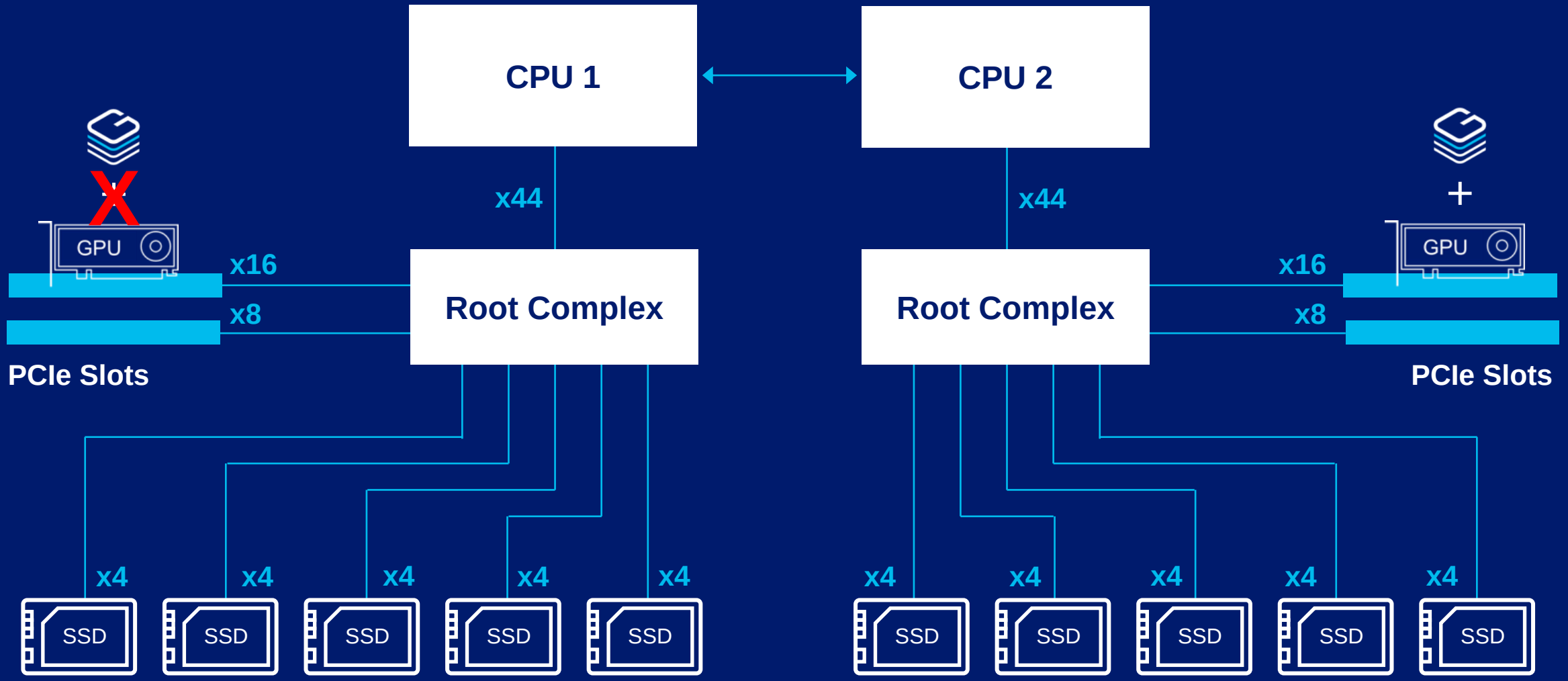
Manage up to 32 drives

Optional HA Configuration



Up to 16 drives managed by each controller

Active/Passive Failover



If 1 Controller fails, the remaining Controller will assume management of all disks (Up to 32)

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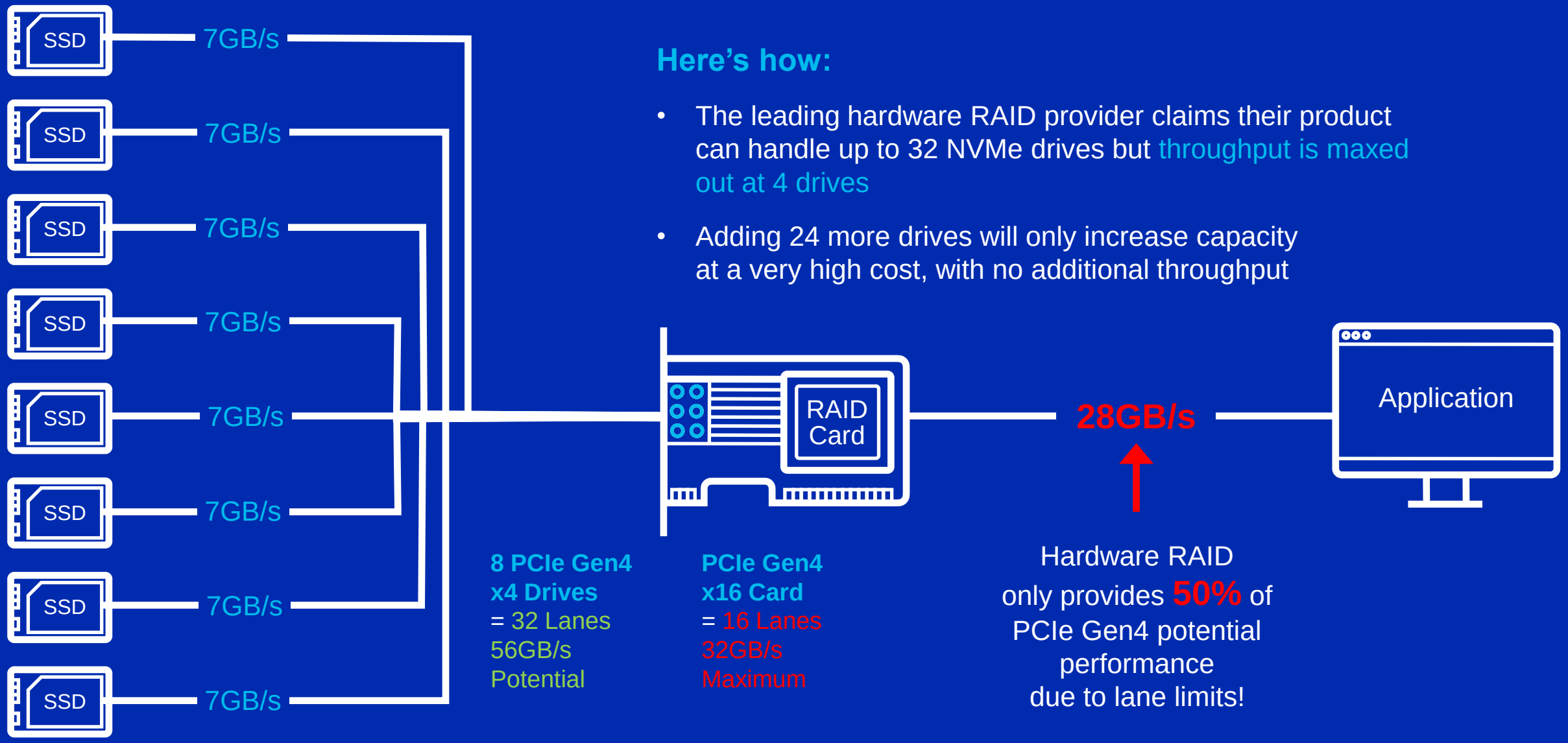
SupremeRAID™
Future Proof
Your Environment

Hardware RAID for PCIe Gen4 Presents A Bottleneck



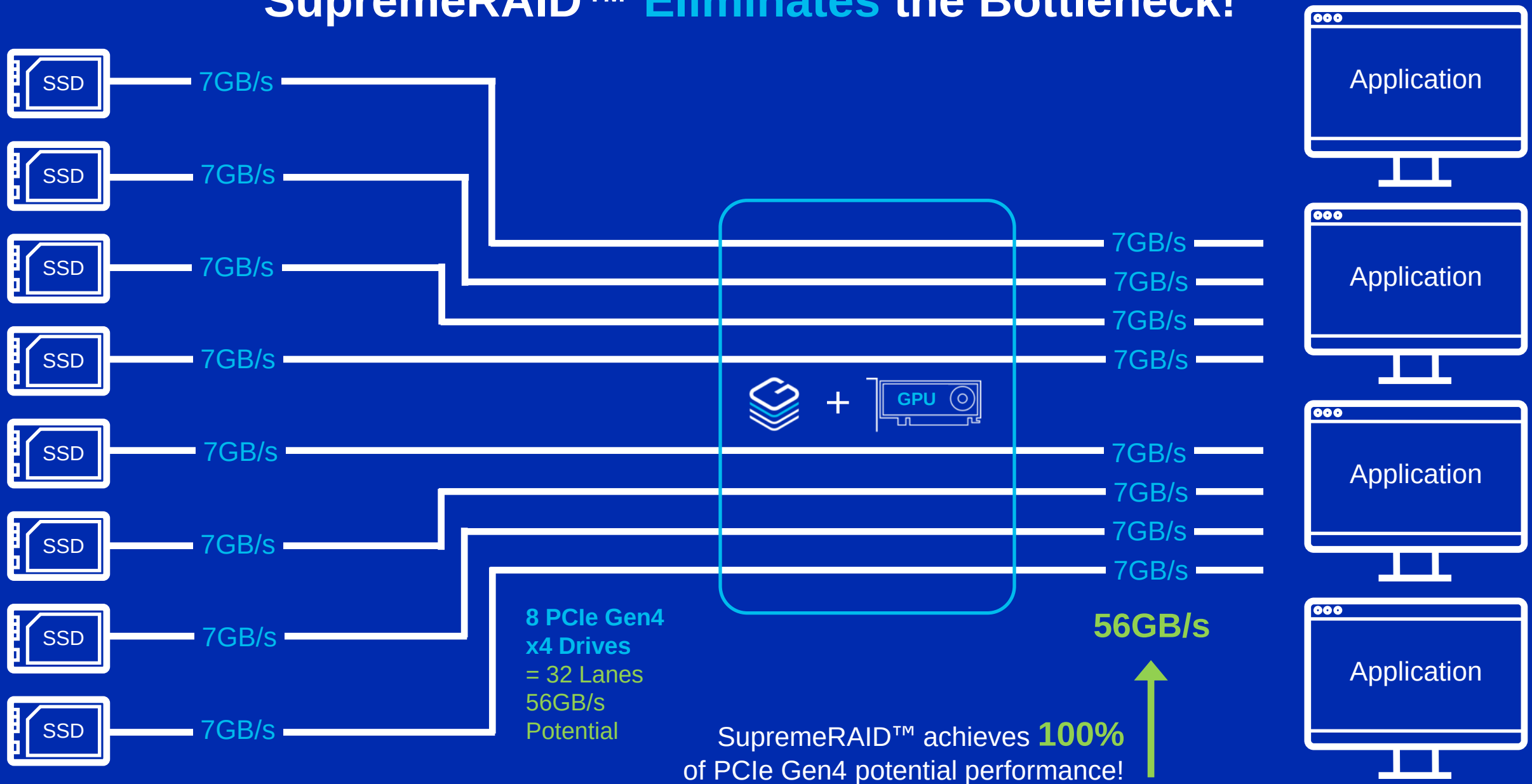
Here's how:

- The leading hardware RAID provider claims their product can handle up to 32 NVMe drives but throughput is maxed out at 4 drives
- Adding 24 more drives will only increase capacity at a very high cost, with no additional throughput

Hardware RAID only provides **50%** of PCIe Gen4 potential performance due to lane limits!

Based on Broadcom MegaRAID 9670W-16i

SupremeRAID™ Eliminates the Bottleneck!

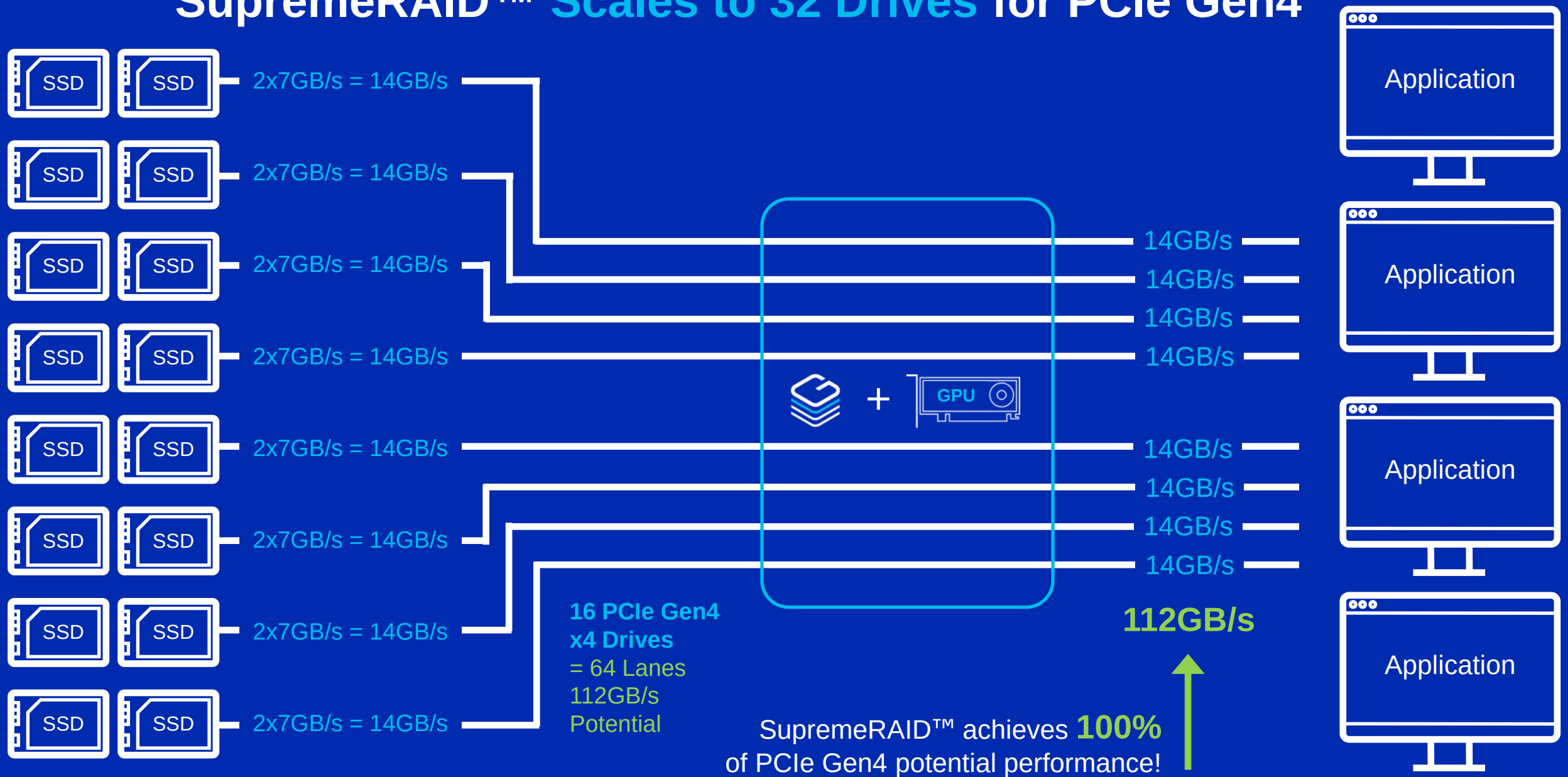


8 PCIe Gen4 x4 Drives
= 32 Lanes
56GB/s
Potential

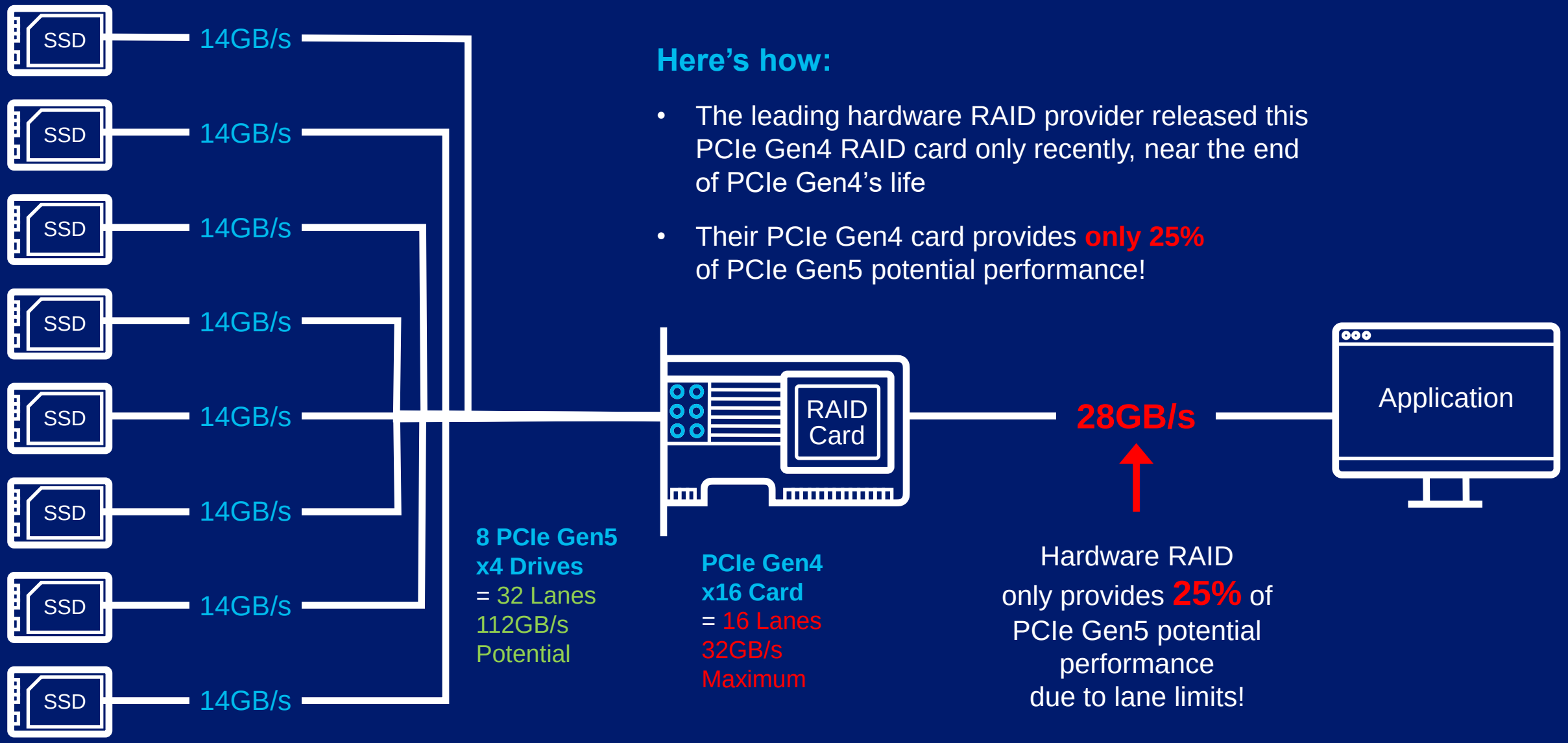
56GB/s

SupremeRAID™ achieves **100%**
of PCIe Gen4 potential performance!

SupremeRAID™ Scales to 32 Drives for PCIe Gen4



Hardware RAID for PCIe Gen5 Is Even Worse…

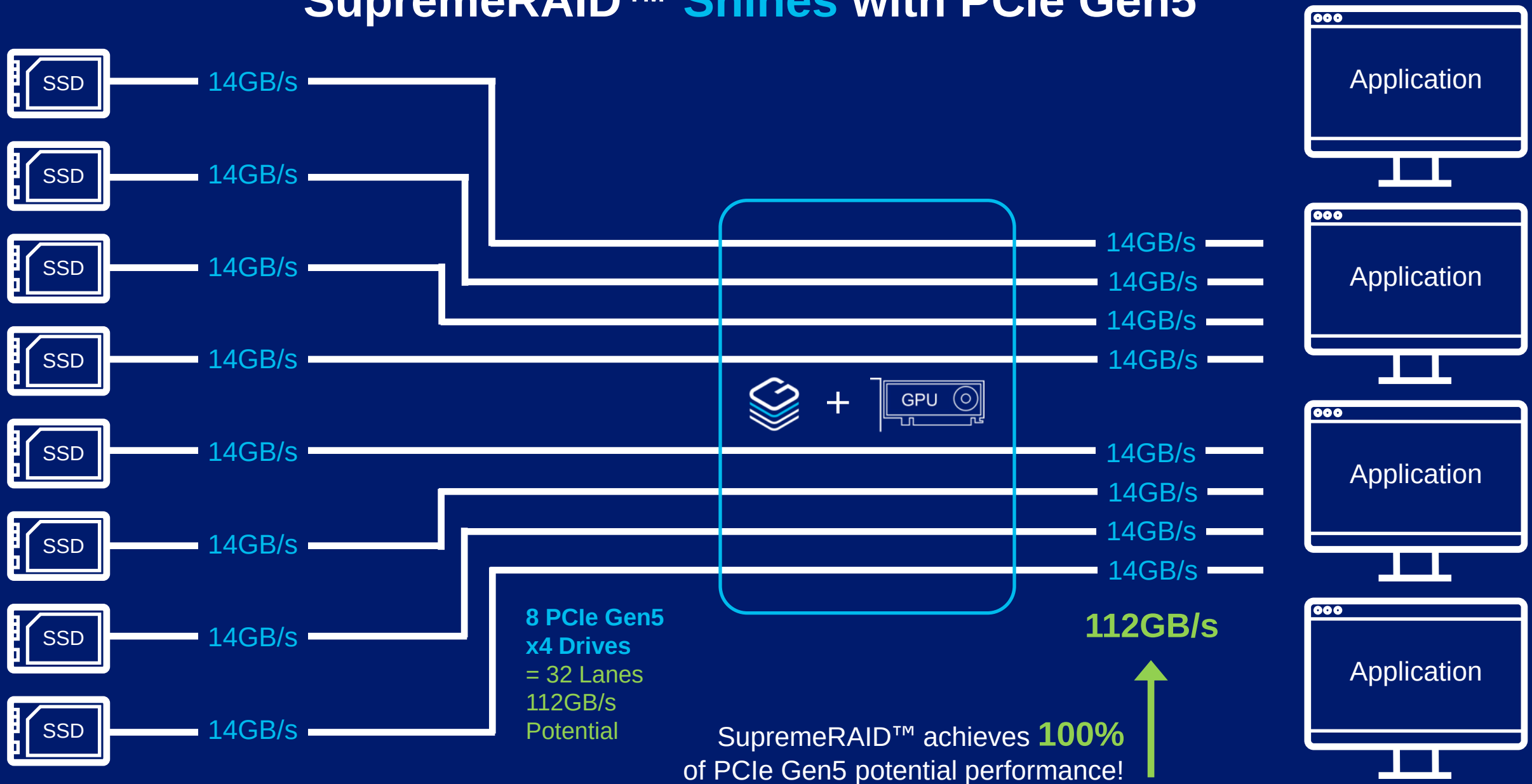


Here's how:

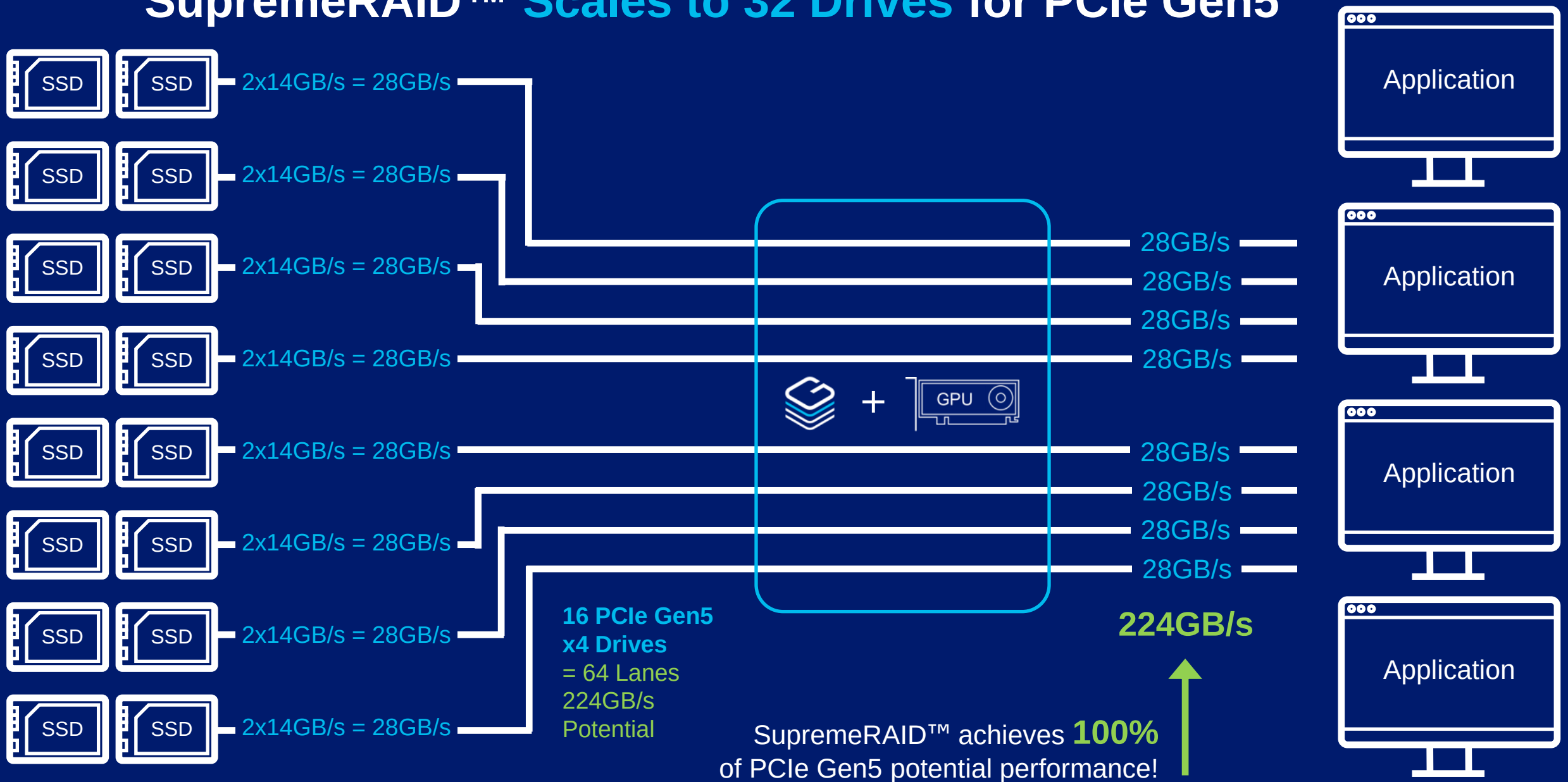
- The leading hardware RAID provider released this PCIe Gen4 RAID card only recently, near the end of PCIe Gen4's life
- Their PCIe Gen4 card provides **only 25%** of PCIe Gen5 potential performance!

Based on Broadcom MegaRAID 9670W-16i

SupremeRAID™ Shines with PCIe Gen5



SupremeRAID™ Scales to 32 Drives for PCIe Gen5



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SupremeRAID™
Competitive Comparison

Hardware RAID Doesn't Deliver

Broadcom MegaRAID 9670W-16i

- Designed for HDDs (based in ASICs)
- Delivers **only 600-800K IOPS** when used for NVMe SSDs
- Only supports 8 direct-wired NVMe SSDs per card
- Limited PCIe Uplink (x16 PCIe lanes)
  only 50% of the lanes needed for 8 drives
- Fixed amount of RAID processing
- SCSi-based RAID stack
- Claims to handle up to 32 NVMe drives
  yet throughput is maxed out at 4 drives
- Delivers **only 50%** of PCIe Gen4 potential performance and **only 25%** of PCIe Gen5 potential performance due to lane limits!

8 PCIe **Gen4**	PCIe **Gen4**
x4 Drives	x16 RAID Card
32 Lanes	**16** Lanes
56 GB/s Potential	**32** GB/s Maximum

= only **50%** of PCIe Gen4 potential performance due to lane limits!

8 PCIe **Gen5**	PCIe **Gen5**
x4 Drives	x16 RAID Card
64 Lanes	**16** Lanes
112 GB/s Potential	**32** GB/s Maximum

= only **25%** of PCIe Gen5 potential performance due to lane limits!

Comparison SupremeRAID™ SR-1010 PCIe Gen 3, 4 & 5

		SupremeRAID™ SR-1010	Software RAID	Hardware RAID
Performance (RAID 5)	4K Random Read	**28 M IOPS**	~2 M IOPS	6.9 M IOPS
	4K Random Write	**2 M IOPS**	200 K IOPS	651 K IOPS
	1M Sequential Read	**260 GB/s Throughput**	~9 GB/s Throughput	28.2 GB/s Throughput
	1M Sequential Write	**100 GB/s Throughput**	2 GB/s Throughput	10.4 GB/s Throughput
	4K Random Read in Rebuild	**5.5 M IOPS**	Unknown	1 M IOPS
	4K Random Write in Rebuild	**1.1 M IOPS**	Unknown	548 K IOPS
CPU Utilization		**None**	High	None
Data Protection		**RAID 0, 1, 5, 6, 10**	RAID 0, 1, 5, 10	RAID 0, 1, 5, 6
NVMeoF Support		**Yes**	Yes	No
Flexibility		**High**	Limited by CPU	None
Maximum Number of SSD Supported		**32**	32	8

Comparison SupremeRAID™ SR-1000 PCIe Gen 3, 4 & 5

		SupremeRAID™ SR-1000	Software RAID	Hardware RAID
Performance (RAID 5)	4K Random Read	**16 M IOPS**	~2 M IOPS	6.9 M IOPS
	4K Random Write	**820 K IOPS**	200 K IOPS	651 K IOPS
	1M Sequential Read	**220 GB/s Throughput**	~9 GB/s Throughput	28.2 GB/s Throughput
	1M Sequential Write	**90 GB/s Throughput**	2 GB/s Throughput	10.4 GB/s Throughput
	4K Random Read in Rebuild	**3 M IOPS**	Unknown	1 M IOPS
	4K Random Write in Rebuild	**600 K IOPS**	Unknown	548 K IOPS
CPU Utilization		**None**	High	None
Data Protection		**RAID 0, 1, 5, 6, 10**	RAID 0, 1, 5, 10	RAID 0, 1, 5, 6
NVMeoF Support		**Yes**	Yes	No
Flexibility		**High**	Limited by CPU	None
Maximum Number of SSD Supported		**32**	32	8

Maximum SSD Support Comparison

Broadcom

- Broadcom comes with 16 lanes directly connected to SSD
  - Each NVMe SSD occupies 4 lanes
  - Supports only 8 SSD direct connections to RAID card
- System design requires an extra PCIe switch in order to work around the number of SSDs supported
  - PCIe switch aggregates SSD lanes into 16 lanes to connect to RAID card
  - **32 SSD at 4 lanes requires 128 lanes, but bandwidth is limited to 16 lanes**

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- SSDs connect directly to PCIe bus
- SupremeRAID™ is a PCIe device connected to PCIe bus
  - Leverages our patent-pending technology for RAID protection off the data path
- No extra PCIe switch is needed, **SupremeRAID™ supports the maximum number of SSDs allowed by your system**
- SupremeRAID™ removes all throughput bottlenecks

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SupremeRAID™
CSFC Solution

CipherDriveOne SupremeRAID™CSfC Solution

CSfC Listed

Software

CipherDriveOne Plus

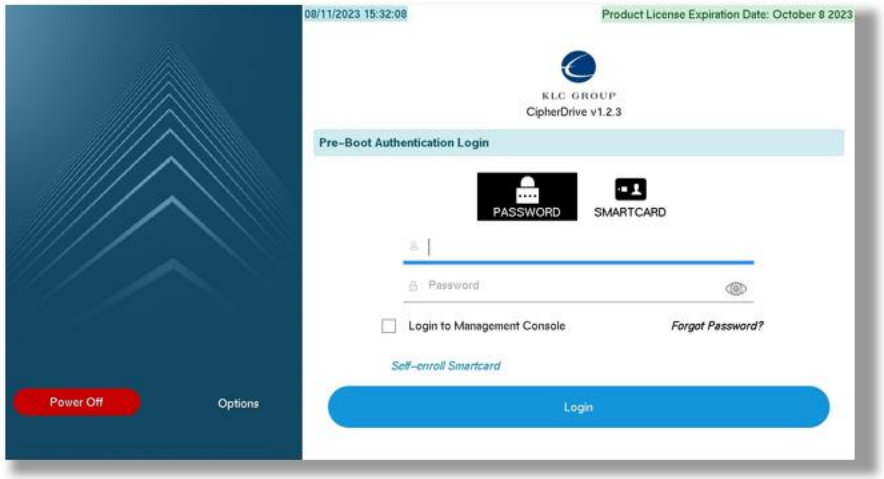
Hardware

Graid Technology Inc
SupremeRAID™
NVMe RAID

CSfC Listed SSD

CipherDriveOne Plus

CSfC Listed



- Pre-boot authentication for multi-disk
- User/pass, smart card(2FA), MFA
- OS Agnostic

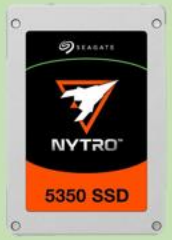
- FIPS 140-2, AES-256 Encryption
- Common Criteria, NSA CSfC listed
- DAR CP – Hardware Full Disk Encryption – Authentication Acquisition (AA)

CSfC: One Layer DAR + RAID

CSfC Listed

CipherDriveOne
+ Plus + Stealth

+



Seagate Nytro 5350

+

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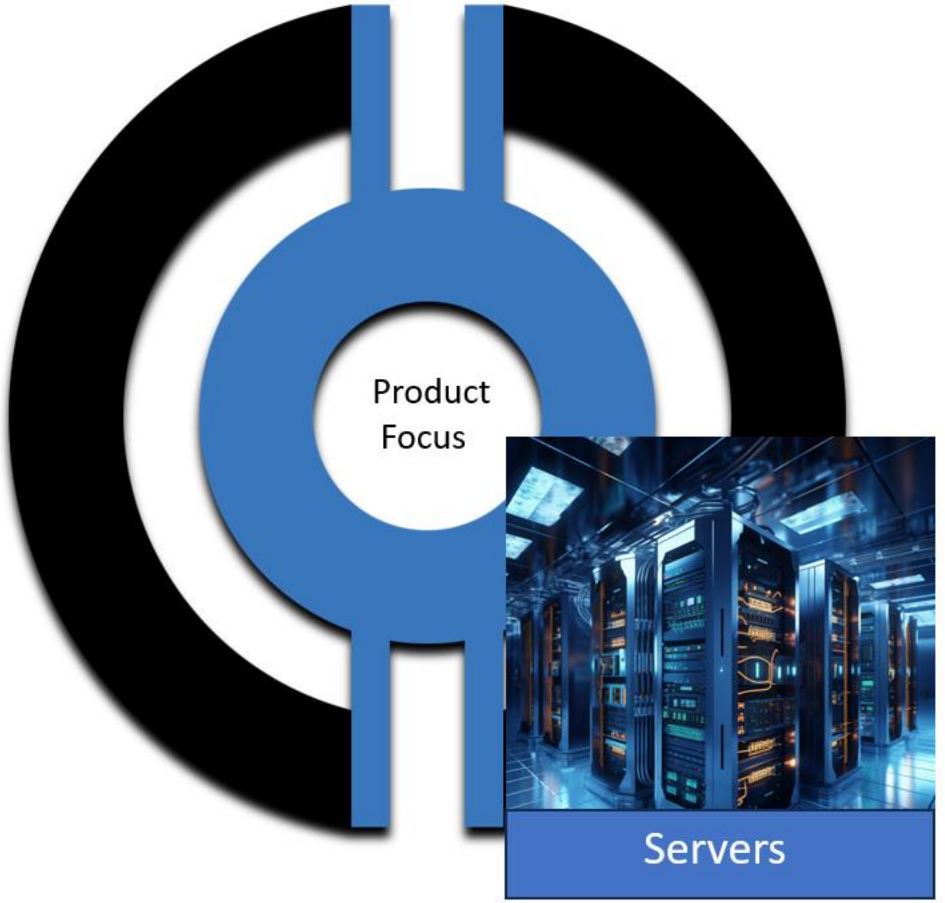
SupremeRAID™
- 1U
- 2U

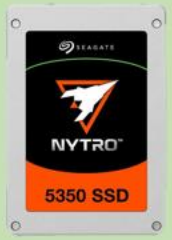


How it works

CSfC Listed

CipherDriveOne
+ Plus + Stealth

+



Seagate Nytro 5350

+

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SupremeRAID™
- 1U
- 2U

1. The server powers up.
2. CipherDriveOne Plus authenticates the user
3. CipherDriveOne passes the decryption keys to the Seagate SSDs, and the drives are unlocked.
4. The operating system boots and loads the SupremeRAID™ Drivers.
5. SupremeRAID™ high-speed NVMe RAID is active.
6. Seagate SSDs perform AES 256-bit encryption of all data presented to the SSD.

SupremeRAID™
Innovation, Performance, & Value

Flexible & Future Ready

Unmatched flexibility with features like new O/S support, compression, encryption, thin provisioning, or boot drive protection easily added with software releases

Plug & Play

Out of the box, into the future: effortless installation, no cabling or motherboard re-layout required

Highly Scalable

Easily manage 32 direct attached NVMe SSDs; extend data protection without sacrificing performance with Software Composable Infrastructure

World Record Performance

Unprecedented NVMe/NVMeoF performance up to 28M IOPS and 260GB/s throughput with a single SupremeRAID™ card delivers the full value of your server investment

Liberate CPU Resources

Offload your entire RAID computation to SupremeRAID™ to free-up precious CPU computing resources for 5G, AI and AIoT applications

Easy to Use

SupremeRAID™ doesn't rely on memory caching technology to improve performance, eliminating the need for battery backup modules

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SupremeRAID™
Use Cases

AI Training & Machine Learning

“AI Training requires reading large amounts of data, a procedure that can take more than 12 hours with traditional solutions. **Combining SupremeRAID™ and NFS over RDMA reduced the procedure to 2 hours—a huge productivity improvement.”**

— AI Director of a well-known Health Research Department Institution

4K Video Surveillance

“To capture a car race with 4K video quality from different cameras requires more than 10GB/s write throughput.

SupremeRAID™ is the only RAID solution to deliver this kind of performance with RAID5 data protection.”

— IT Director, Global Media Company

Automotive, Aviation & Drone

“When recording large amounts of high-definition video in a limited environment, a RAID1 solution might be able to keep up with the speed but it’s not cost efficient. SupremeRAID™ delivers RAID5/6 that matches the performance of RAID1, expanding available space from 50% to 80+%. **Not only is it good for cost savings but also makes a lot of things possible in this limited environment.”**

— Solution Architect, North American -based Aviation Company

High Performance Computing

“Scale-out/parallel file systems such as Spectrum Scale, Lustre, and BeeGFS still rely on traditional hardware or software RAID for drive level protection within storage nodes.

SupremeRAID™ unlocks even more performance and maximize usable capacity for HPC workloads.”

— HPC Solution Architect, North America-based Tier-one Server Manufacturer

Emergency Healthcare

"In situations where fast access to data without bottlenecks is critical to life and death, **SupremeRAID™ consistently delivers crucial patient data** to the healthcare providers that need it the most."

— Database Architect,
Nationally-recognized
Level 1 Trauma Medical Center

Healthcare Databases

"Healthcare organizations face multiple challenges in storing and maintaining increasingly large volumes of patient data.

SupremeRAID™ solved our need for flexible, scalable infrastructure capable of processing and protecting massive volumes of data on demand, **while also lowering our overall maintenance costs."**

— IT Director, Globally-recognized
Medical Research Facility

Local Databases

"Current hardware RAID is obviously not the solution for local databases due to its latency and performance limitation for NVMe SSDs.

SupremeRAID™ provides unbeatable performance and latency for databases to realize the full benefits of NVMe SSDs."

— Solution Architect,
Tier-one IT Company

SAN/NAS Storage Systems

"While most of the all-flash array vendors in the market only deliver up to 1.5M IOPS, Graid Technology Inc. makes **28M IOPS possible with a single SupremeRAID™ card."**

— R&D Director,
SAN Storage Company

Microscopy Instruments

“Data transfer between a Windows client, which manages the operation of the microscopy system, and the Linux compute nodes presented a significant bottleneck. However, SupremeRAID™ delivered line saturating performance, improving the efficiency of the workflow and overall value of this new design approach. **The improved sustained write performance of 100GB/s, especially in RAID5, is especially important to us.”**

— Director of Core Analysis, Tier 1 Research Hospital

Triple the Lifespan of Servers

Server manufacturing represents 15–30% of each machine’s carbon impact. Reusing existing machines reduces e-waste—the fastest-growing waste category today—and lowers greenhouse gas emissions. The problem is older servers have the highest failure rates.

One of the main issues comes from older RAID controllers: they have batteries, which increase failure rates. **By retrofitting older servers with SupremeRAID™ and newer NVMe SSDs, the performance and reliability of these older machines can be massively improved, thus extending their use life as well as reducing cost, emissions, and e-waste.**

— Datacenter Decommissioning Expert

Graid Technology Inc.

About
Graid Technology Inc.

Graid Technology Inc.

The New Standard in Enterprise Data Protection & Performance

We've developed the world's first NVMe and NVMeoF RAID card to unlock the full potential of your SSD performance.

Our extraordinary software plus hardware solution is the most powerful and flexible NVMe SSD RAID in the world.

HQ in Silicon Valley

R&D center in Taipei, Taiwan

Global Network of Partners, OEMs, Distributors & Resellers

Leadership

Our dedicated team of experts bring decades of experience in the SDS, ASIC and storage industries

Leander Yu

Co-Founder & CEO

Santa Clara, CA

Dr. Henry Chang

CTO

Taipei, Taiwan

David Tseng

Chief Architect

Taipei, Taiwan

Tom Paquette

SVP & General Manager, Americas and EMEA

Bonita Springs, FL

National Taiwan University

BIGTERA

TREND MICRO

ddn

IBM

SUPERMICRO

Partners, OEMs & Distributors

Resellers

SupremeRAID™ Competitive Advantages

Industry Leadership

Led by a dedicated team of experts with decades of experience in the SDS, ASIC and storage industries

Disruptive Innovation

Award-winning NVMe / NVMeoF performance via RAID without compromising data security or business continuity

Strategic Partnerships

Strong strategic partnerships with well known OEMs, distributors, resellers, and technology providers across the globe

Global Footprint

Immediate distribution to the greater global market (NA / EMEA / APAC); delivering well ahead of our competitors

Proven Performance

Extensive testing with documented record-breaking performance stats for both SupremeRAID™ SR-1000 and SR-1010

Graid Technology Inc.

Questions?

Thank You

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Name, Title

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GRAIDTECH.COM

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SupremeRAID™ with NVME-oF

NVMe over Fabrics (NVMe-oF) and SupremeRAID™

What is NVMe over Fabrics (NVMe-oF)?

NVMe-oF is NVMe Flash extended across a network; the “fabrics” part is the storage network that connects the host server to the flash array.

NVMe-oF supports existing network protocols such as Fibre Channel, iWARP, RoCE (RDMA over Converged Ethernet), Infiniband, and TCP

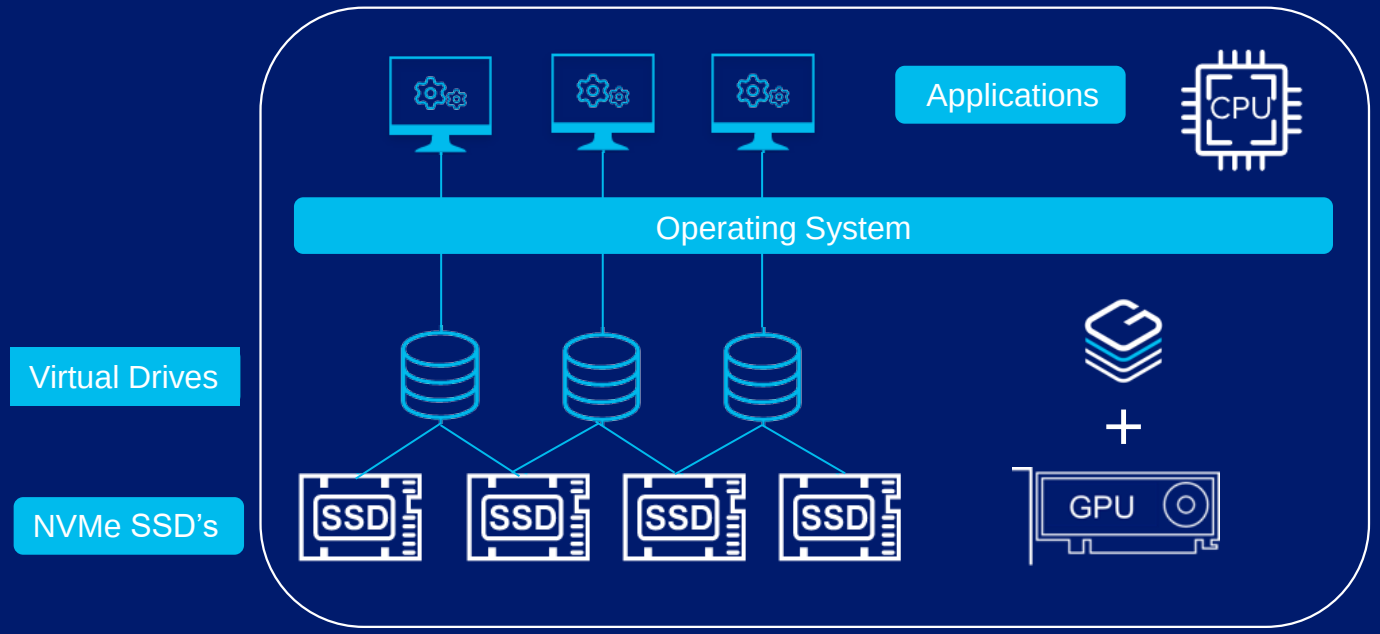
NVMe-oF benefits include:

- High performance
- Low latency
- Scalability

Where does SupremeRAID™ fit in NVMe-oF?

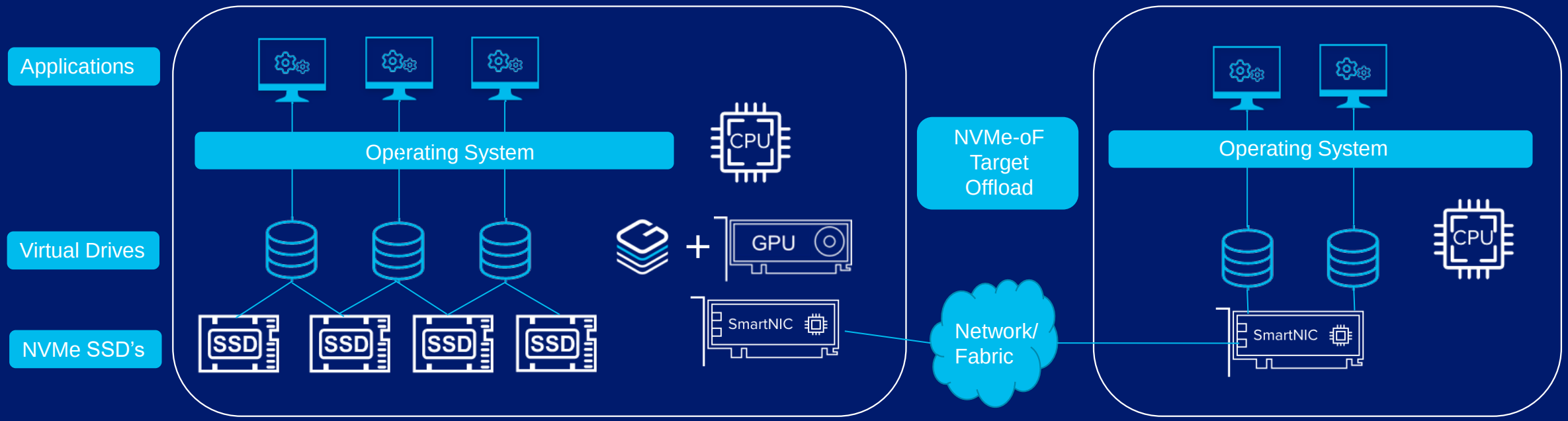
- The NVMe-oF Specification has no provision for Data protection
- SupremeRAID™ can provide all levels of RAID protection across NVMe-oF
- SupremeRAID™ outperforms traditional software by offloading RAID operations to a GPU
- SupremeRAID™ can act as either an NVMe-oF Target or NVMe-oF Initiator

Traditional Single Server with Internal NVMe/RAID



- SupremeRAID™ implements a virtual NVMe controller in the OS and leverages the computing power of of an Nvidia GPU
- SupremeRAID™ software on the Nvidia GPU offloads all RAID commands and parity calculations from the CPU
- SupremeRAID™ leverages its patent-pending technology to perform RAID protection out-of-path delivering 100% of the SSDs throughput

SupremeRAID™ as NVMe-oF Target

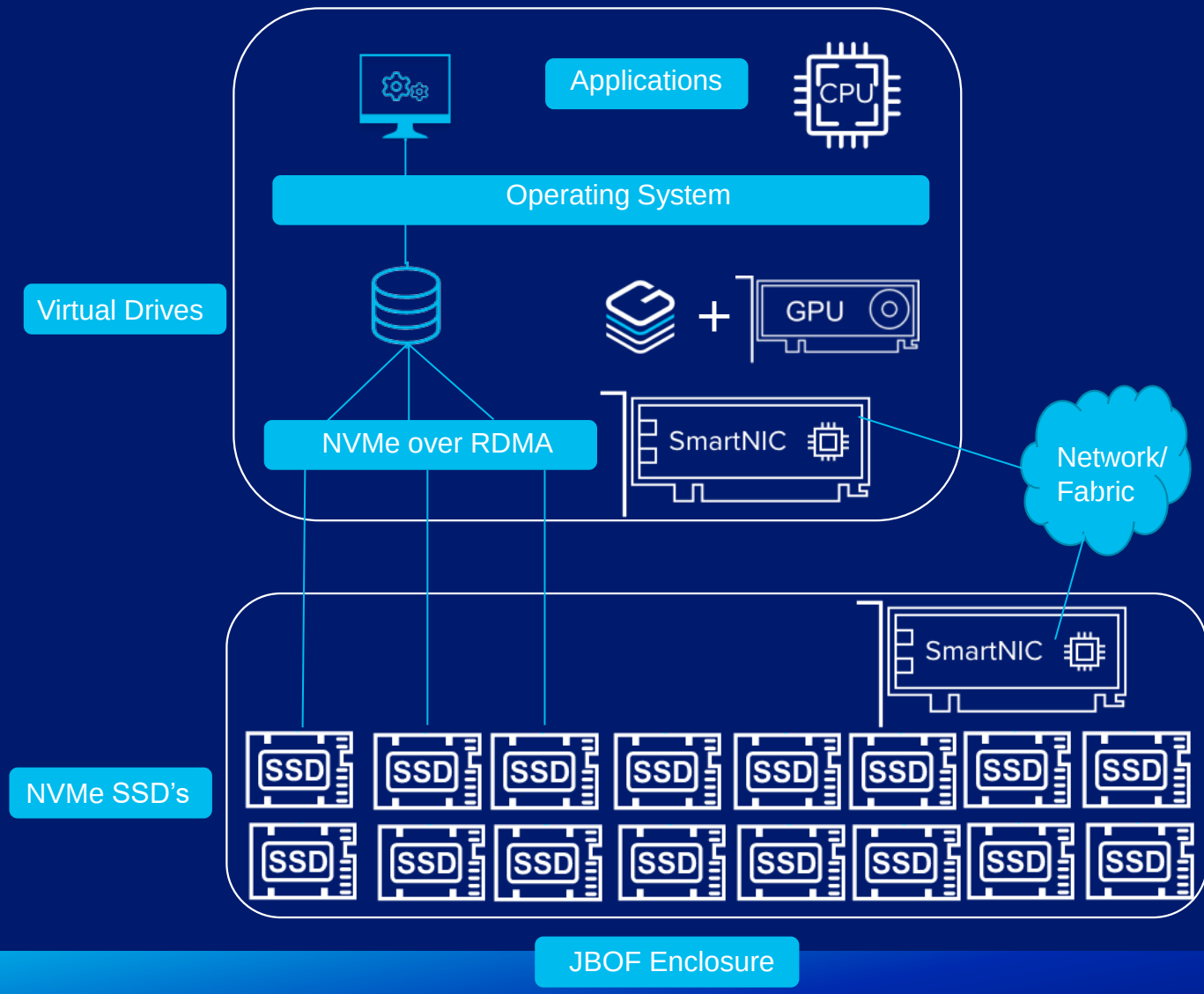


On the target side, SupremeRAID™ can compose local SSDs into a RAID volume, and share the RAID volume via the SmartNIC's target offload function

On the initiator side, the SmartNIC can directly attach the composed RAID volume and provide it to applications.

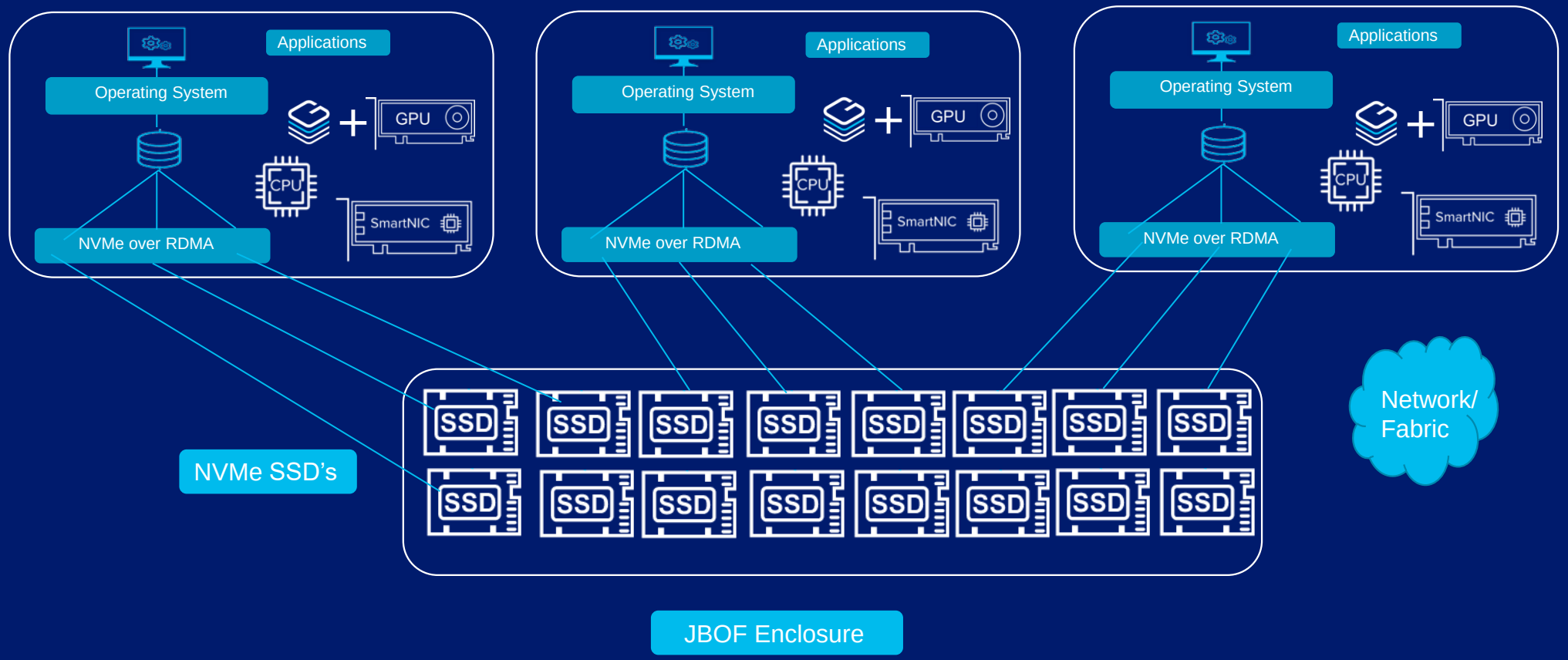
No CPU involved in the data path

SupremeRAID™ as NVMe-oF Initiator



- On the initiator side, the JBOF/SmartNIC can directly attach the RAW NVMe drives to the host
- Using RDMA, SupremeRAID™ combines the drives into a RAID set and protected virtual disks can be presented to the host OS
- No CPU involved in the data path

SupremeRAID™ as NVMe-oF Initiator with Multiple Hosts



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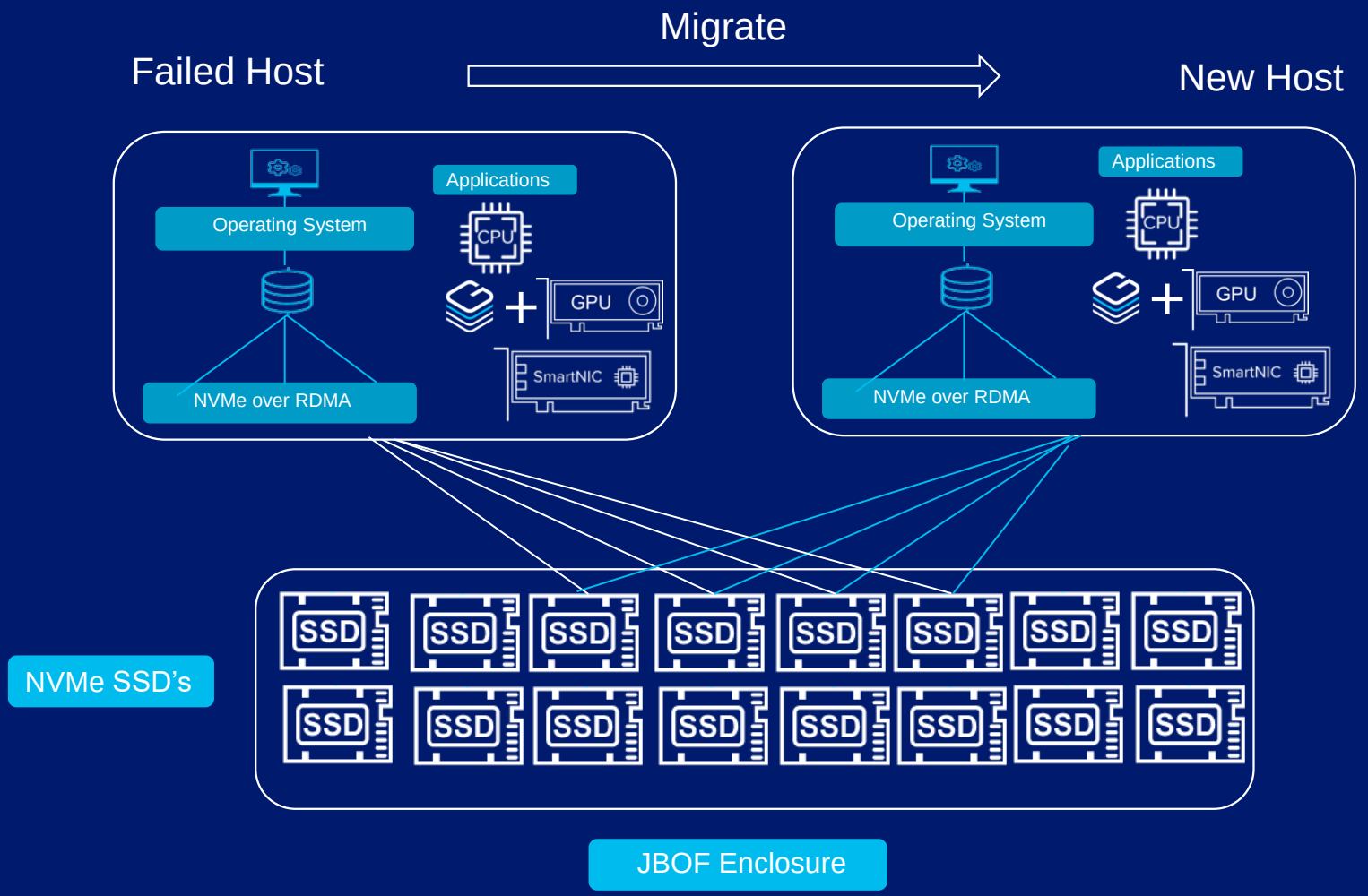
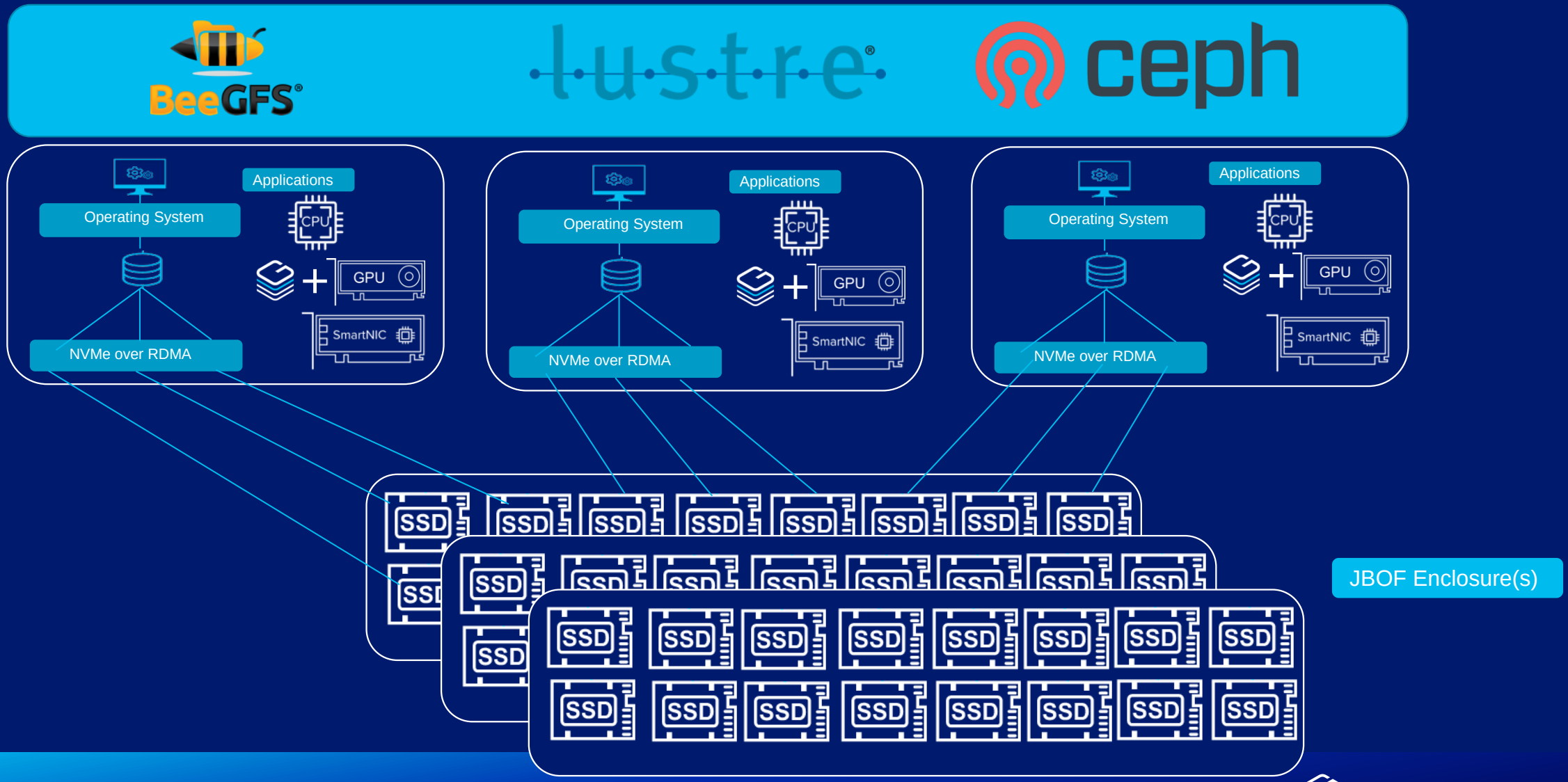
SupremeRAID™ with NVMeoF Use Cases

High Availability

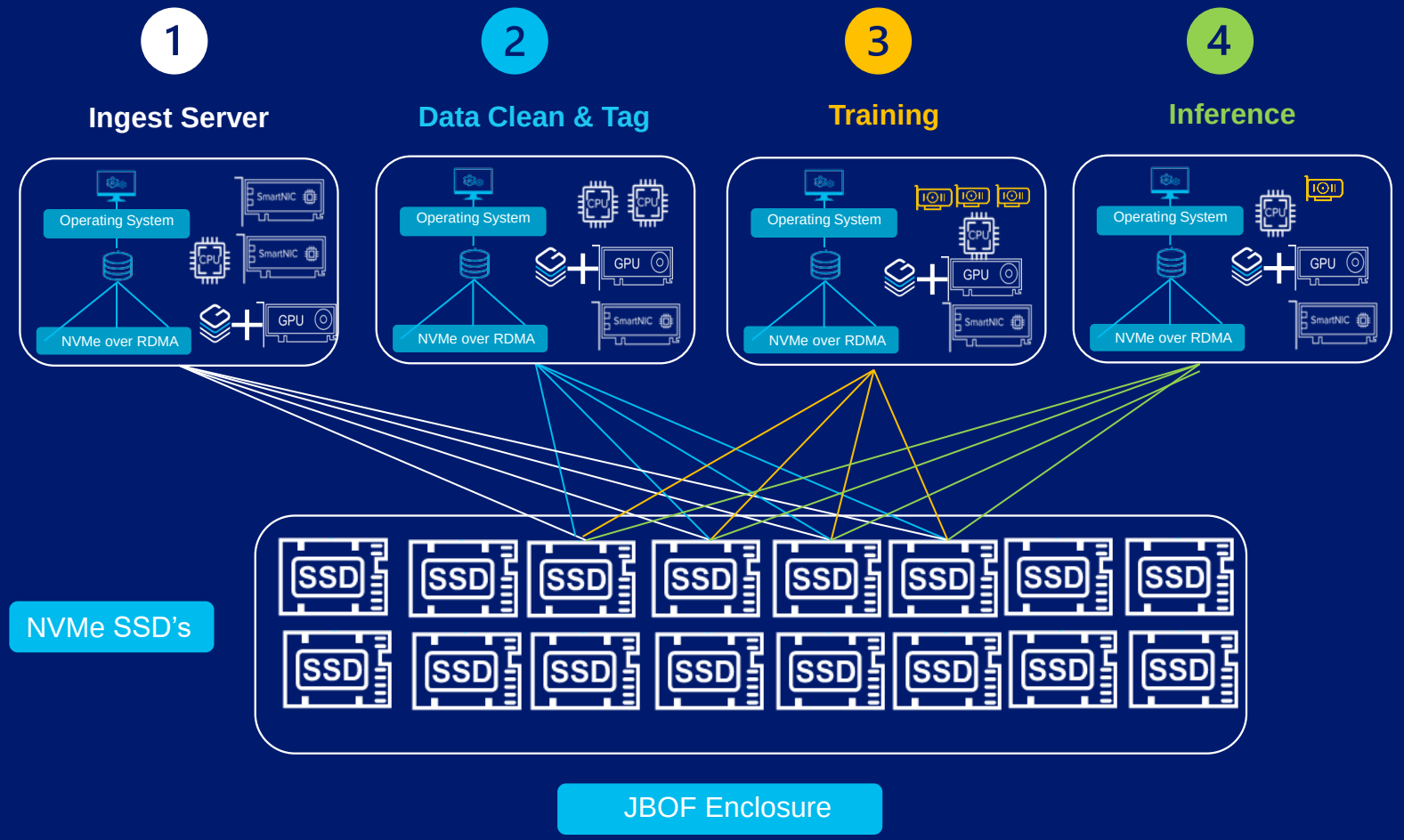


- Compose your system according to demand
- Easily replace a failed remote SSD
- Quickly migrate RAID groups and applications from the failed host to the new host manually
- Support for Active-Standby (on the roadmap)

HPC – Parallel File Systems



Enable AI/ML Workflows



Compose storage to each stage of the AI workflow:

1. Ingest is typically more Network heavy
2. Data Clean and Tag is CPU Intensive
3. Training is GPU Heavy
4. Inference requires single GPU