



# SSDS-301-1: The Latest on Form Factors - A Panel Discussion

**Cameron Brett**, KIOXIA, Moderator

Panelists:

**Jonmichael Hands**, Chia Network; **Don Jeanette**, TRENDFOCUS;  
**Trent Johnson**, IBM; **Paul Kaler**, HPE; **Bill Lynn**, AMD



Thursday, August 10, 8:30 am Ballroom B

Learn more - [www.snia.org/fms](http://www.snia.org/fms)



**Flash Memory Summit**  
CONFERENCE & EXPOSITION

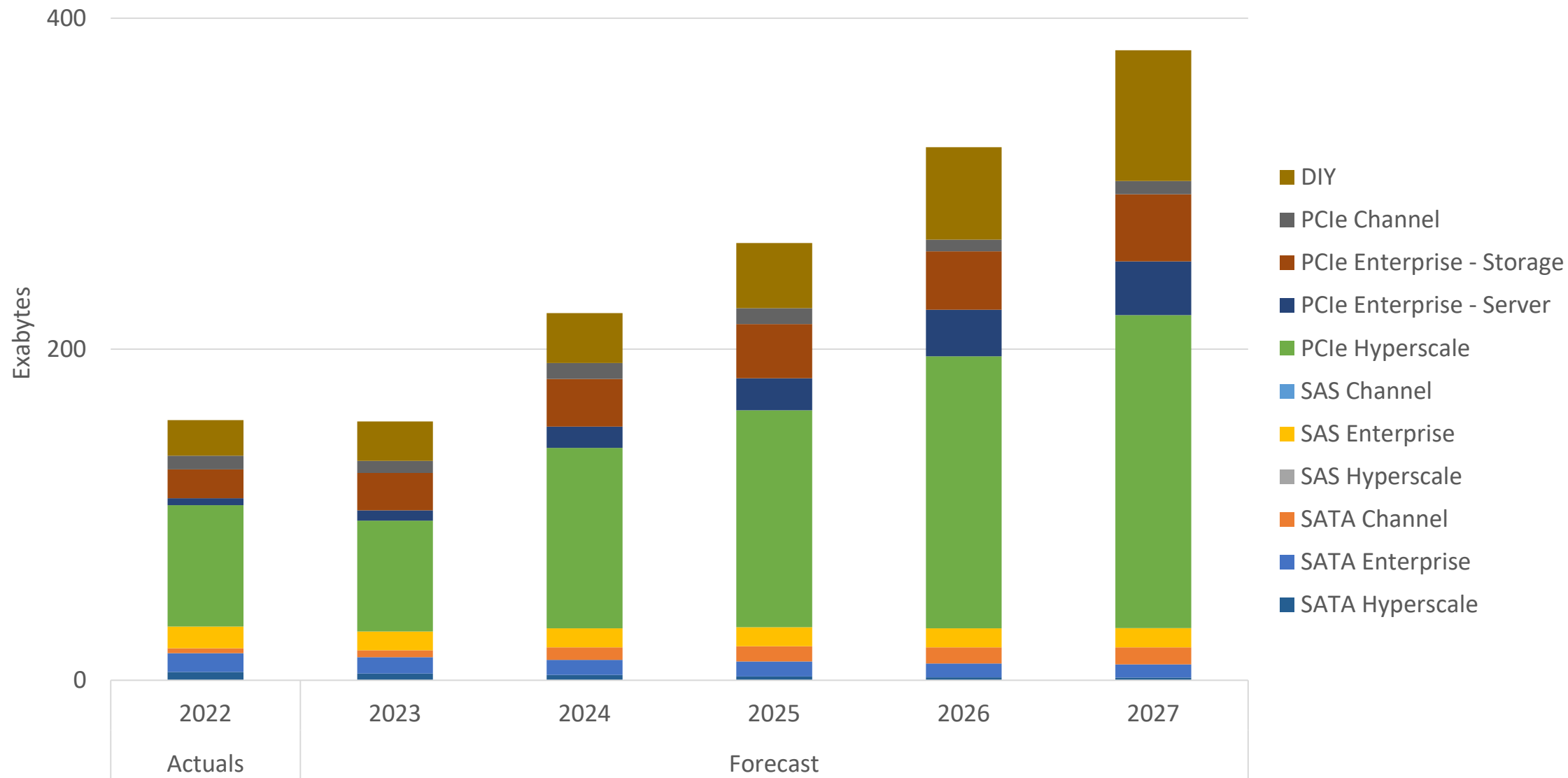
Santa Clara Convention Center  
**August 8-10, 2023**  
[FlashMemorySummit.com](http://FlashMemorySummit.com)

**ALL  
ABOUT  
MEMORY &  
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# Don Jeanette

## Trend Focus

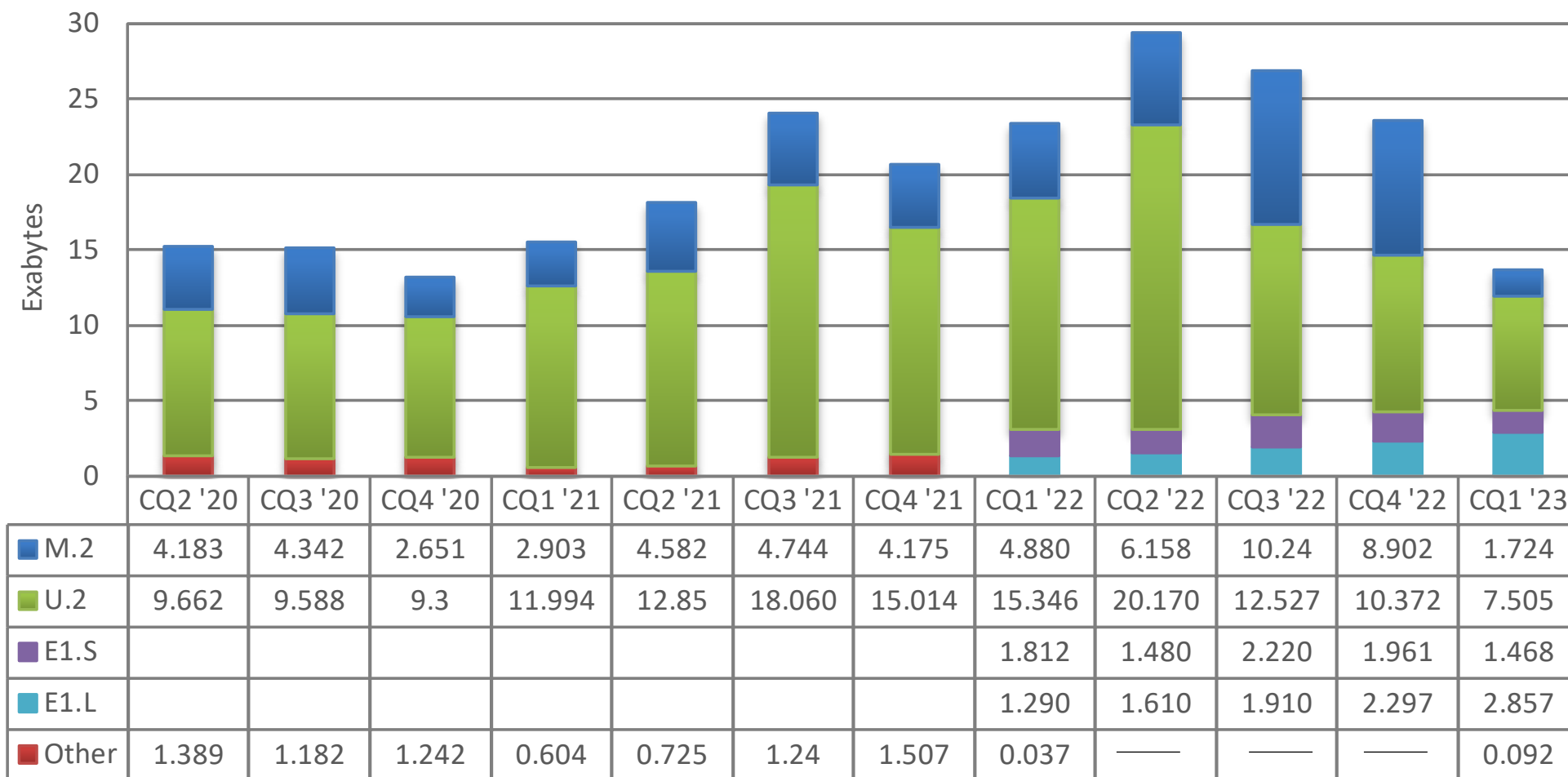
# eSSD Forecast: Exabytes by End Market



August 2023

# Historical Enterprise PCIe SSD

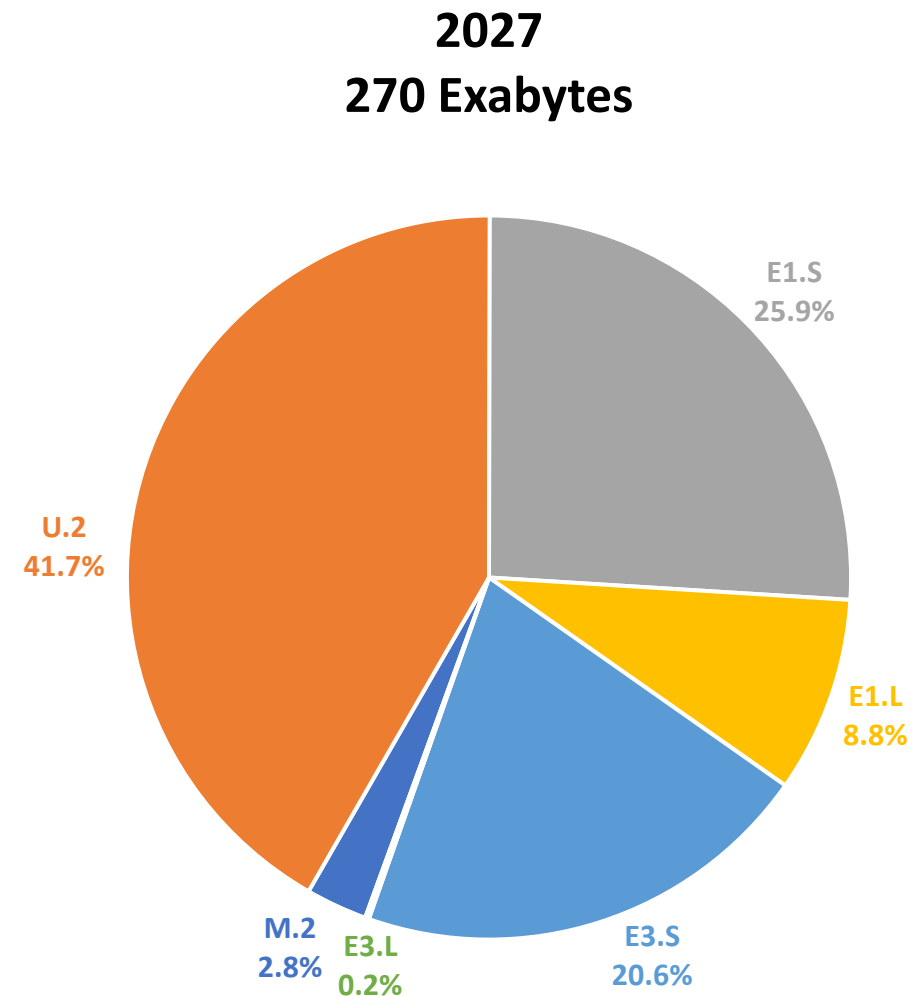
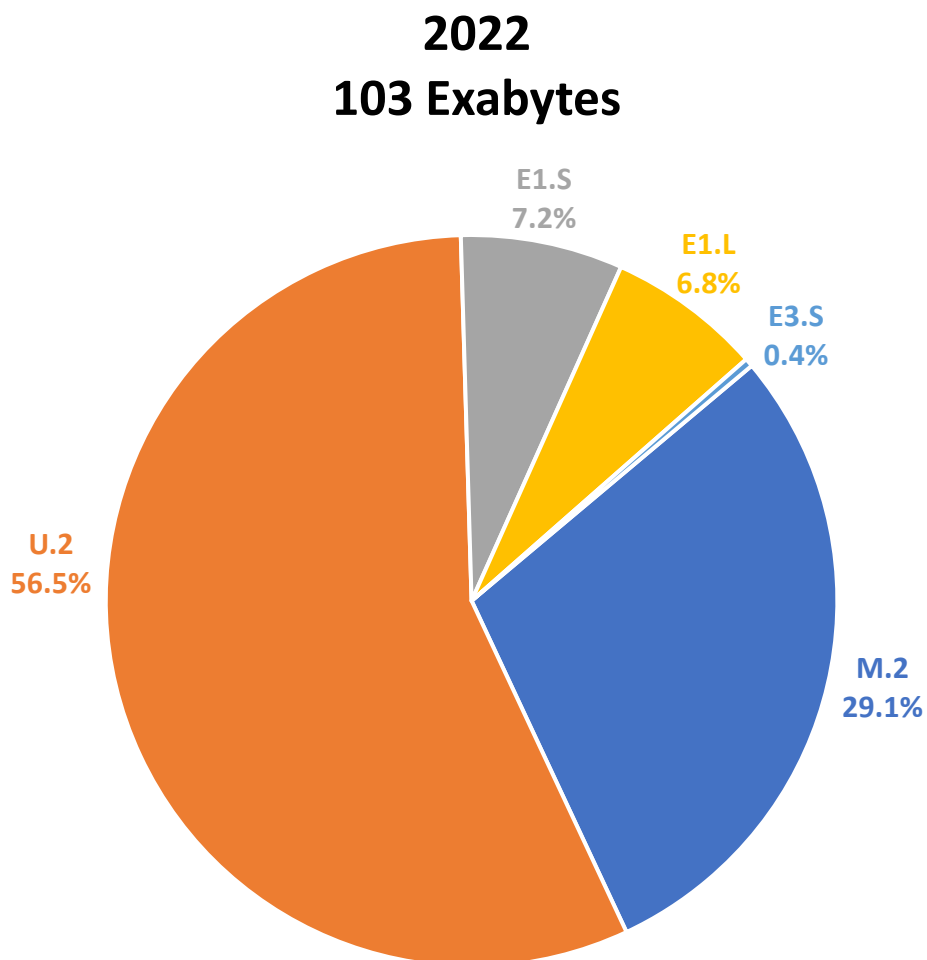
Exabytes By Form-Factor



\*Prior to CQ1 '22, the E1.S and E1.L form factors were included in the 'Other' category.

August 2023

# PCIe Exabytes by Form Factor



# Trent Johnson

IBM



# IBM Flash Systems



Flash Systems 9500



Flash Systems 7300



Flash Systems 5200



IBM FlashCore™ Module



NVMe SSD

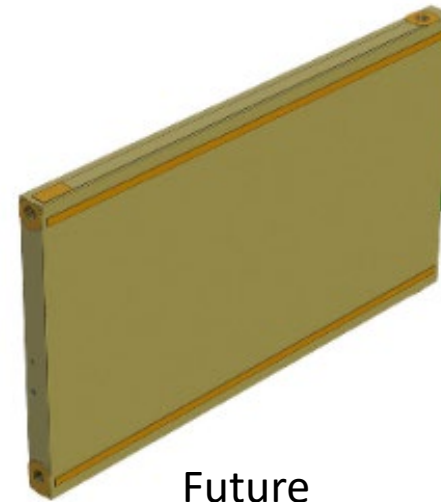
- Enterprise QLC storage
- Compression at speed
- Encryption at speed
- RAID assists

# Benefits of EDSFF for IBM Flash Systems

- Greater drive power envelope allows for more flexible design
- More efficient use of space allows greater enclosure density
- Fewer lane connections enabled by PCIe 5
- Increased switch bandwidth enabled by PCIe 5
- Simpler connector
- Slots are useful for more than just SSDs
- Increased adoption of E3 is driving volumes from U.2 to E3



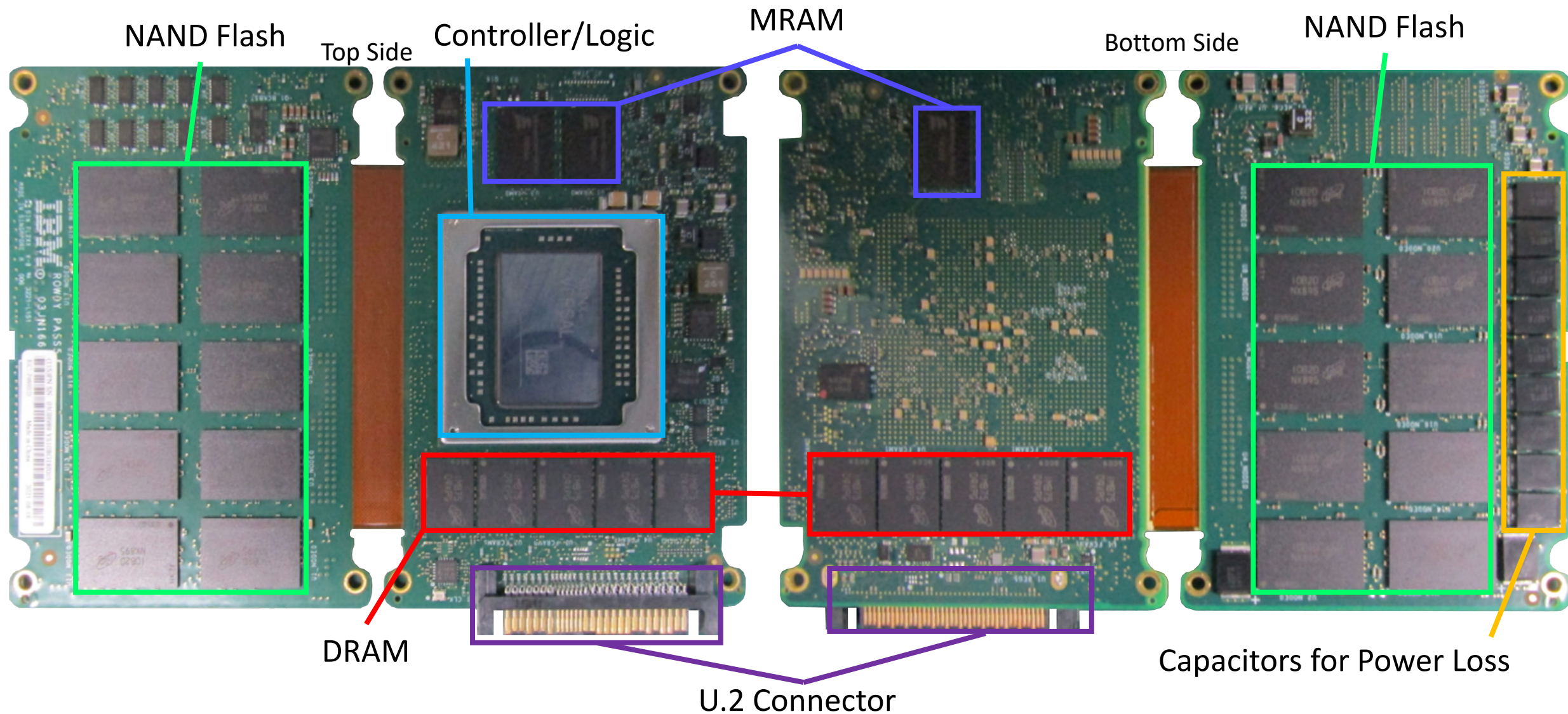
Today



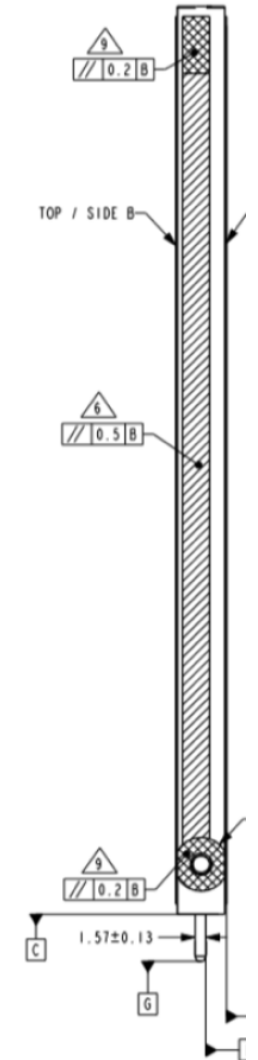
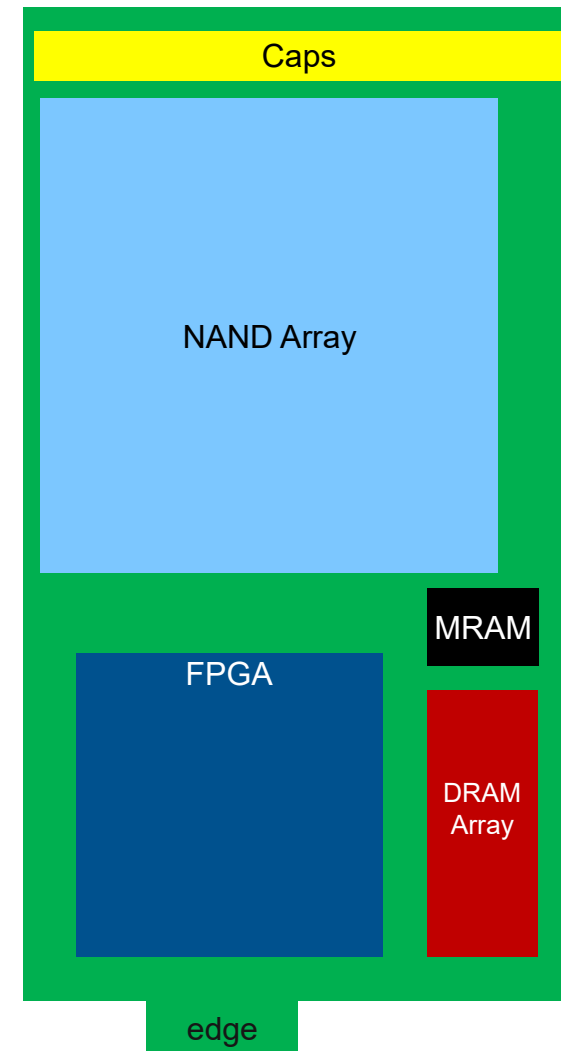
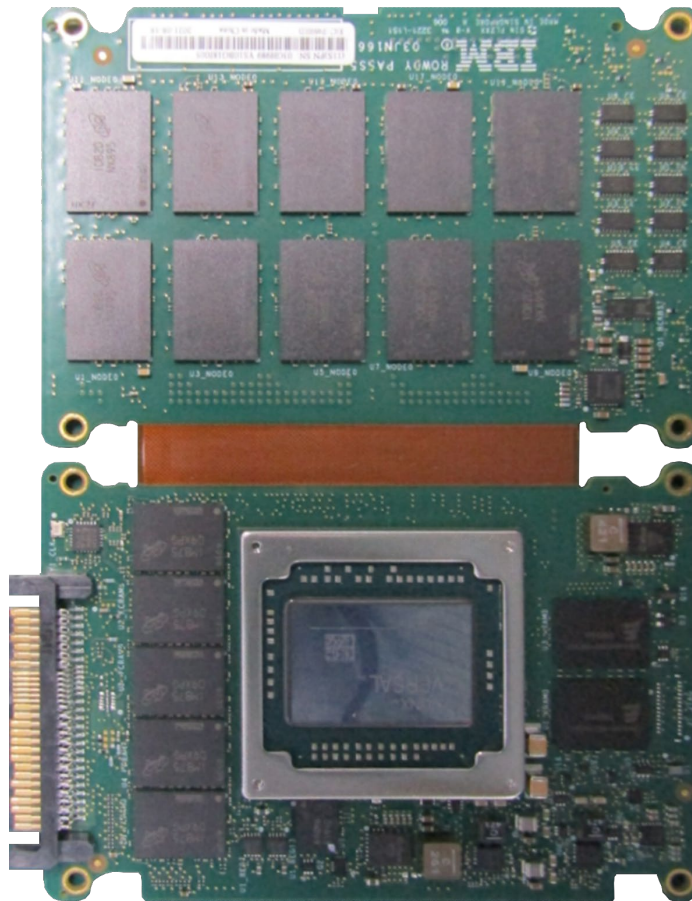
Future



# The Layout of Today's IBM FlashCore™ Module



# FlashCore™ Module E3.L Floor Planning Concept



# Paul Kaler

Hewlett Packard Enterprise

# HPE 1U ProLiant Server EDSFF E3.S Adoption

HPE ProLiant DL320 Gen11  
1U, 1P



Up to 8 EDSFF E3.S or 4 E3.S 2T NVMe PCIe Gen5 SSDs

Software Defined Compute, Data Collection and Management, Cold Storage workloads requiring a cost optimized, compact form factor

HPE ProLiant DL360 Gen11  
1U, 2P



Up to 20 EDSFF E3.S or 10 E3.S 2T NVMe PCIe Gen5 SSDs

Compute-dense solution for high-performance workloads such as VDI, EDA, CAD, or virtualization workloads that require increased compute density with built-in security and flexibility



# HPE 1U ProLiant Server EDSFF E3.S Adoption

HPE ProLiant DL325 Gen11  
1U, 1P



Up to 20 EDSFF E3.S or 10 E3.S 2T NVMe PCIe Gen5 SSDs

Software Defined Compute, Data Collection and Management, CDN, VDI, and Cold Storage workloads requiring a cost optimized, high density, compact form factor

HPE ProLiant DL365 Gen11  
1U, 2P



Up to 20 EDSFF E3.S or 10 E3.S 2T NVMe PCIe Gen5 SSDs

Compute-dense solution for high-performance workloads such as VDI, EDA, CAD, or virtualization workloads that require increased compute density with built-in security and flexibility

# HPE 2U ProLiant Server EDSFF E3.S Adoption

HPE ProLiant DL380 Gen11

2U, 2P



HPE ProLiant DL380a Gen11

2U, 2P



Up to 36 EDSFF E3.S or 18 E3.S 2T NVMe PCIe Gen5 SSDs

Up to 8 EDSFF E3.S or 4 E3.S 2T NVMe PCIe Gen5 SSDs

Performance, expandability, and scalability for diverse workloads and environments, e.g., Collaborative, CRM, SCM, ERM, Data & Analytics, AI, VDI, and Content Mgmt

4DW GPUs in a 2U2P ProLiant DL design for emerging AI workloads, e.g., AI Training & Inference, MCAD, HPC, and Engineering Apps



# HPE 2U ProLiant Server EDSFF E3.S Adoption

HPE ProLiant DL345 Gen11

2U, 1P



HPE ProLiant DL385 Gen11

2U, 2P



Up to 36 EDSFF E3.S or 18 E3.S 2T NVMe PCIe Gen5 SSDs

Data-intensive workloads such as software-defined storage, video transcoding, and virtualized apps

Up to 36 EDSFF E3.S or 18 E3.S 2T NVMe PCIe Gen5 SSDs

Compute and data storage demanding workloads requiring increased core count, and storage and I/O scalability, e.g., AI, ML, Big Data analytics

# HPE Alletra 4000 Storage Server EDSFF E3.S Adoption

## HPE Alletra 4110

1U, 2P all-NVMe data storage server



20 EDSFF E3.S NVMe PCIe Gen5 SSDs

For the most **performance-demanding** data storage-centric workloads:

- Data stores for machine learning
- Distributed and NoSQL databases
- High-performance Software-Defined Storage (SDS)
- Data-heavy hyperconverged infrastructure (HCI)

## HPE Alletra 4120

2U, 2P hybrid-NVMe data storage server



12 EDSFF E3.S NVMe PCIe Gen5 SSDs (rear mount)

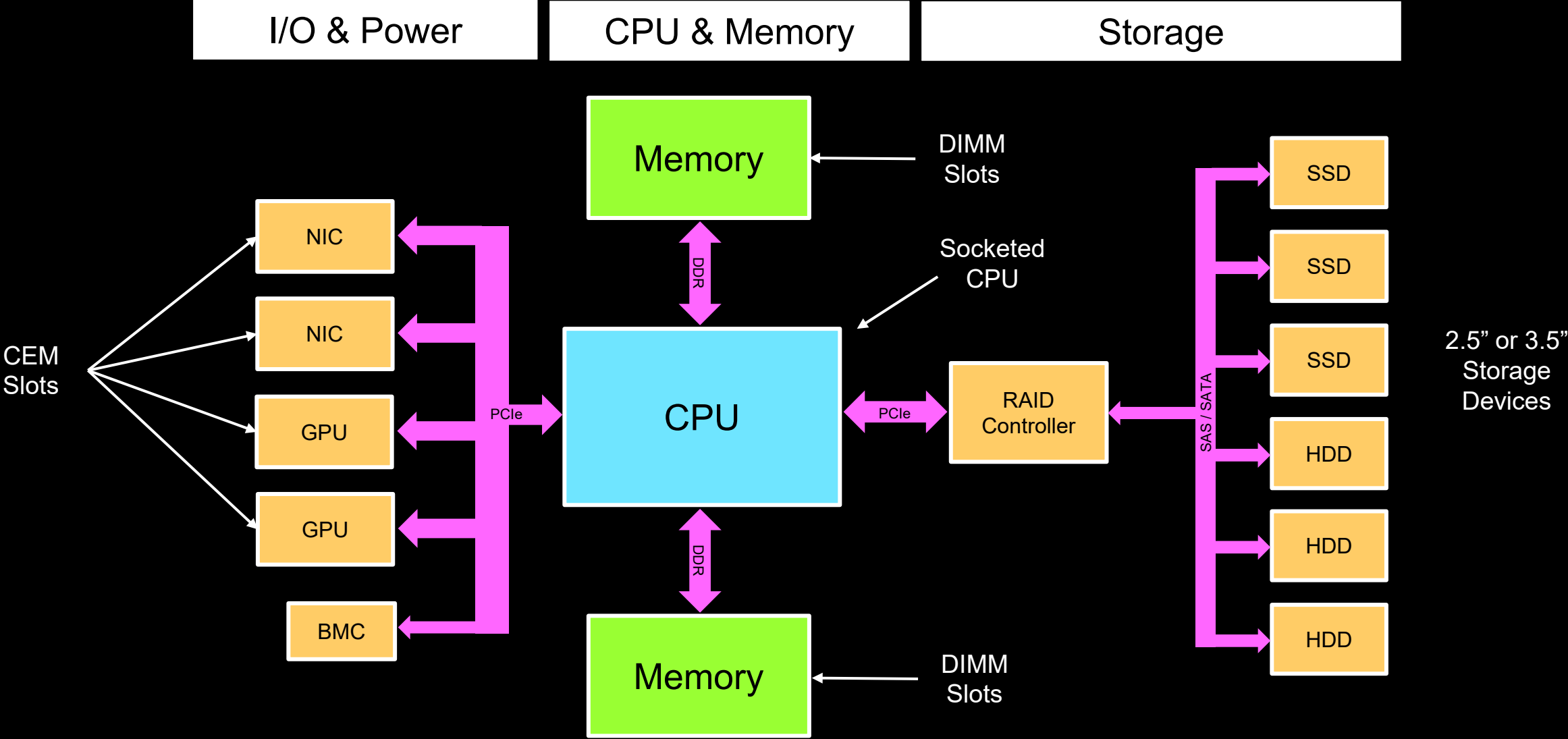
For the **broadest range of** data storage-centric workloads including:

- analytics data lakes
- general purpose Software-Defined Storage (SDS)
- converged data protection
- active archives
- and many more!

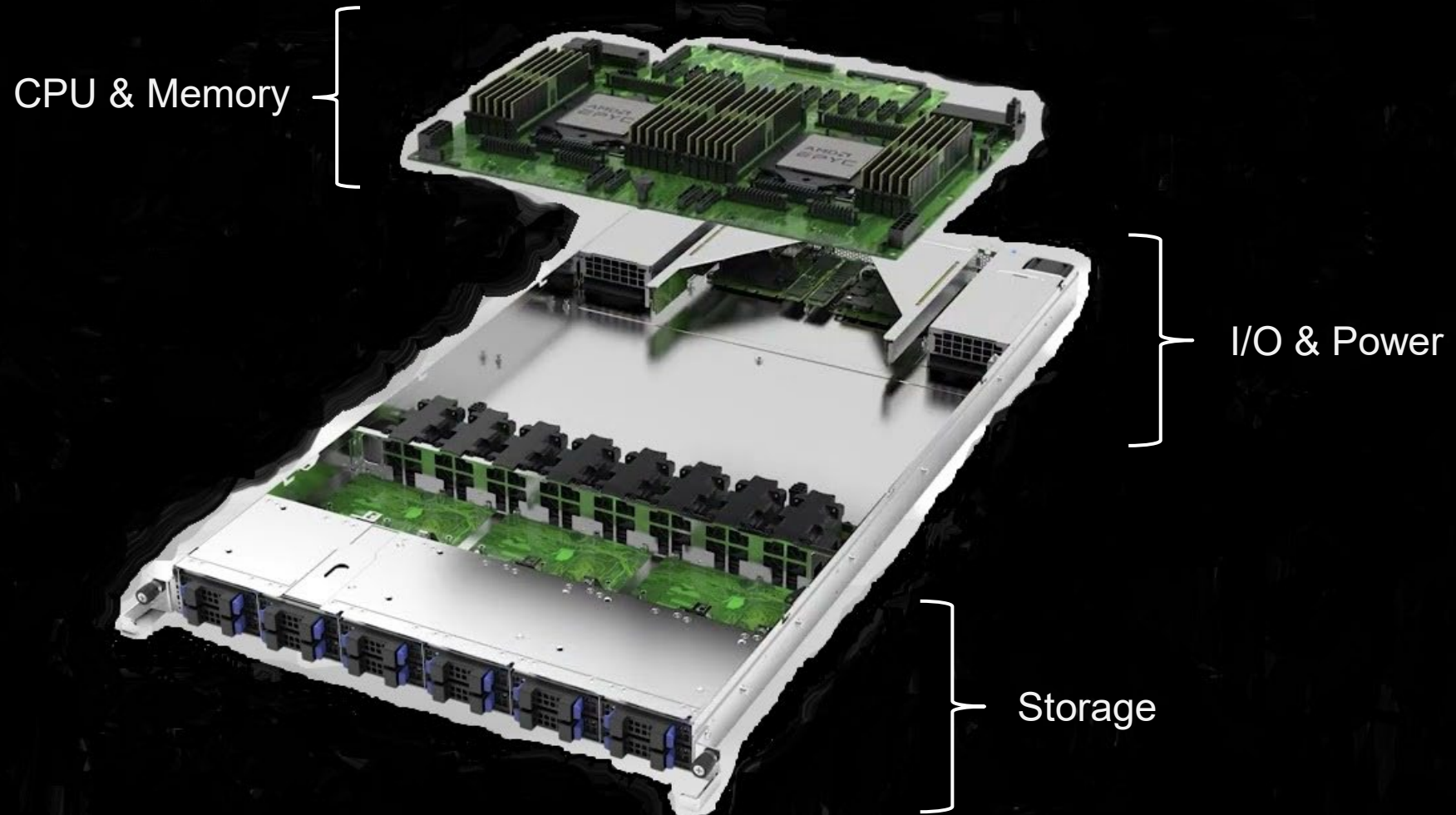
# Bill Lynn

AMD

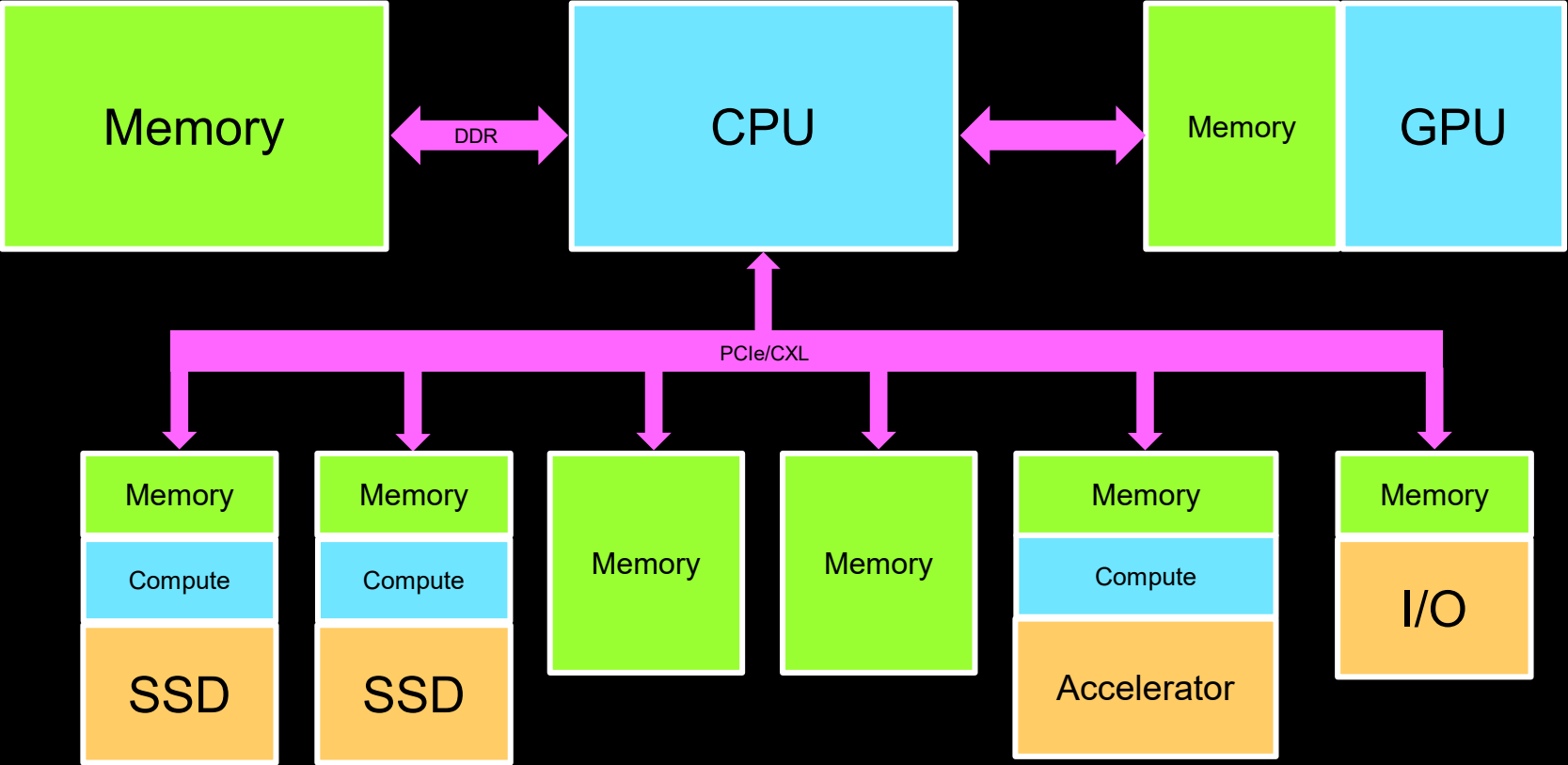
# Traditional Single Socket Server Architecture



# DC-MHS Implementation with full width HPM



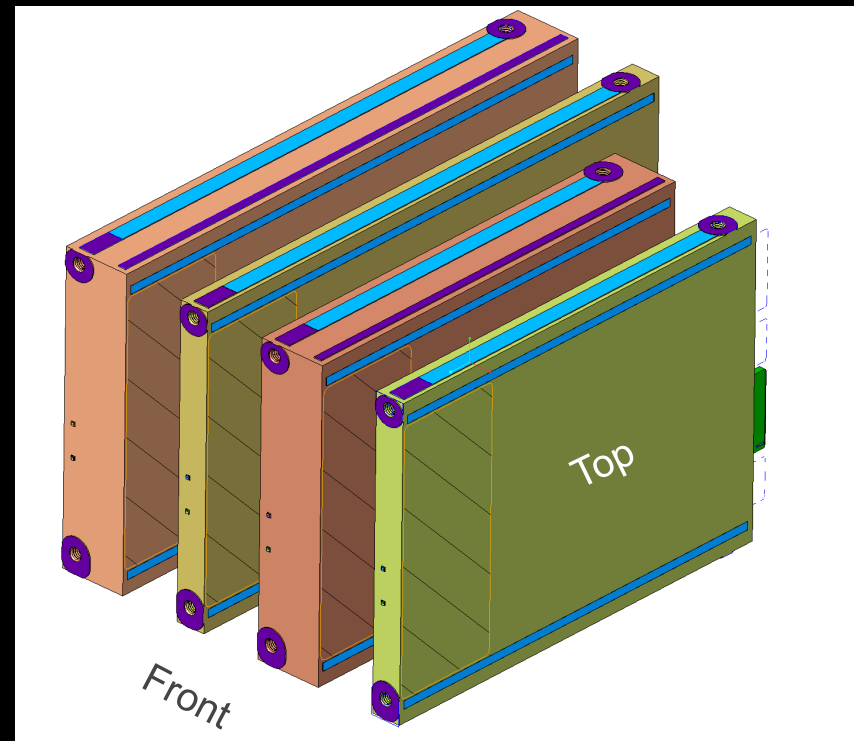
# Memory is Everywhere





# E3

- Family of four device form factors with a common width that vary in length and width.
- Primarily targeted as a replacement for 2.5" and 3.5" drive form factors.
- Based on the SFF-TA-1002 connector providing support for PCIe Gen 5 and Gen 6.
- Supports various PCIe link widths including x1, x2, x4, x8, and x16
- Expanded use cases include CXL memory, low end accelerators, and network adapters



| Device Variation | Width | Length   | Thickness | Power |
|------------------|-------|----------|-----------|-------|
| E3.S             | 76mm  | 112.75mm | 7.5mm     | 25W   |
| E3.S 2T          | 76mm  | 112.75mm | 16.8mm    | 40W   |
| E3.L             | 76mm  | 142.2mm  | 7.5mm     | 40W   |
| E3.L 2T          | 76mm  | 142.2mm  | 16.8mm    | 70W   |

# Jonmichael Hands

Chia Networks

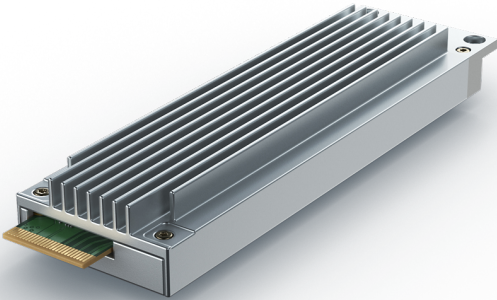
# SSD EDSFF Ecosystem – Drive Vendors



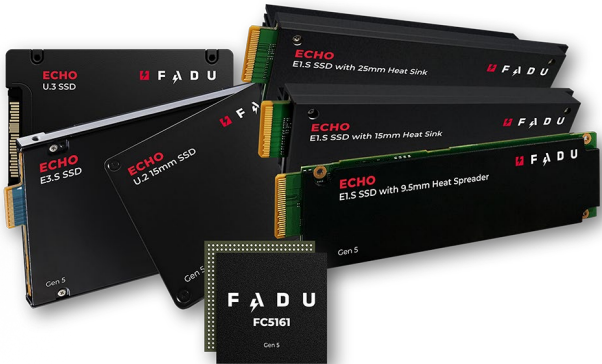
**KIOXIA**



**SAMSUNG**



 **SOLIDIGM™**



 **FADU**



 **SMART®**  
Modular Technologies



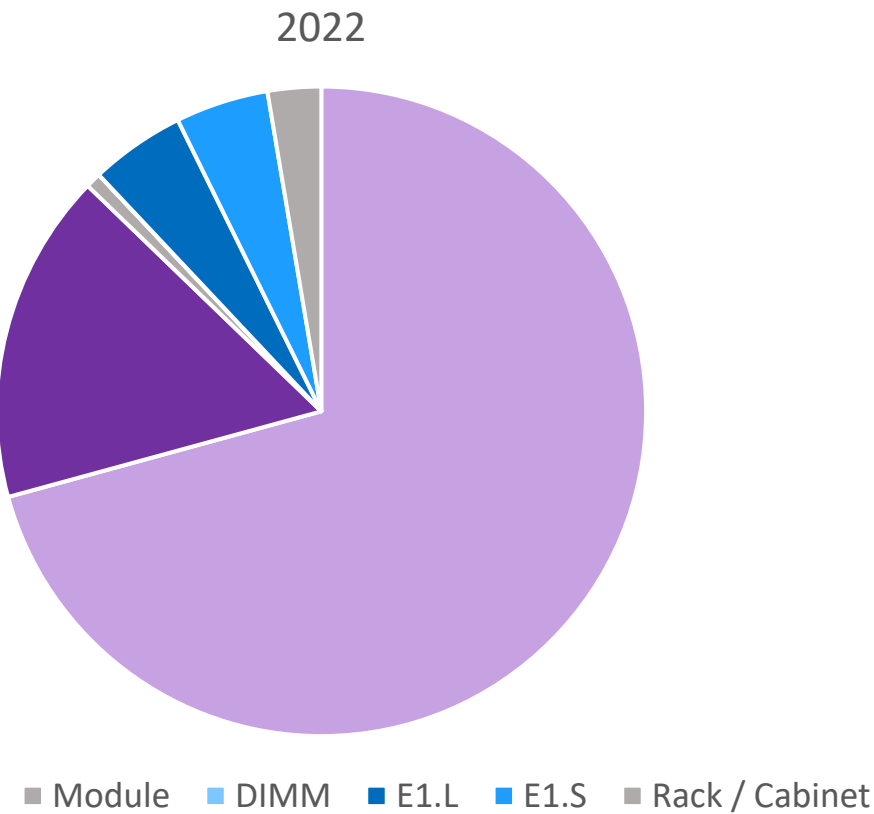
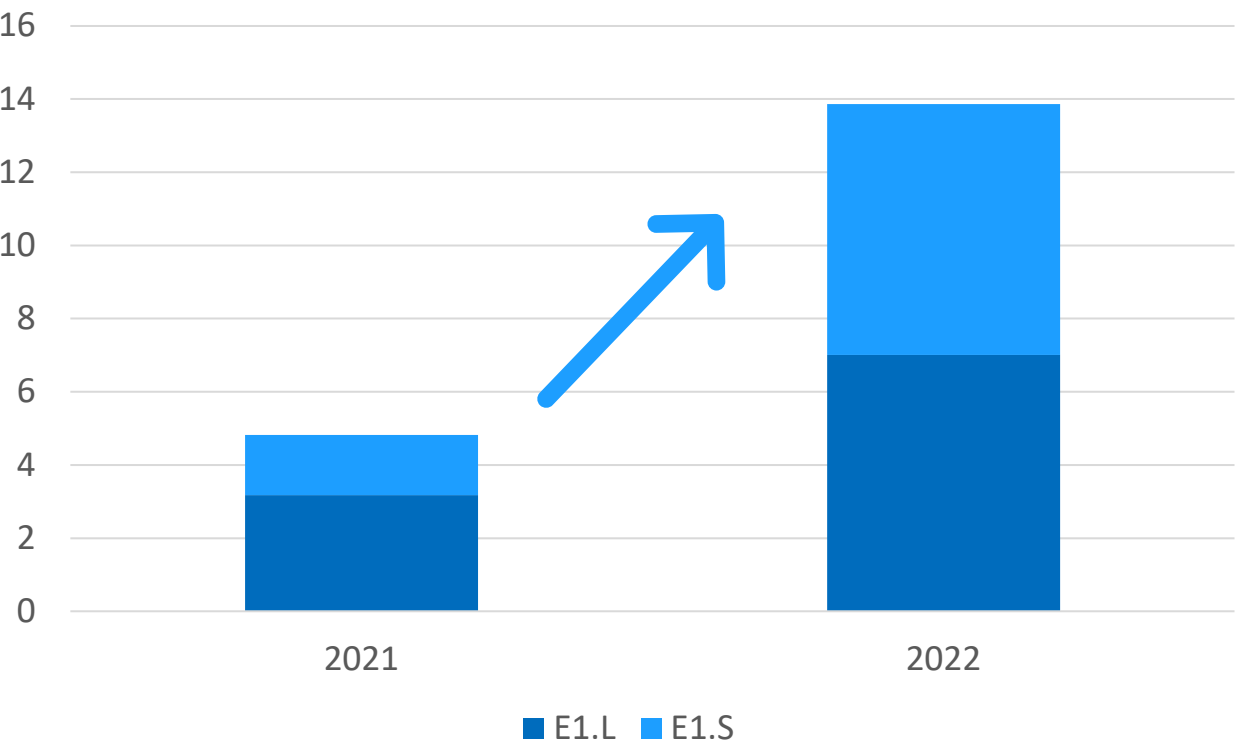
 **Micron®**



 **SK hynix**

# EDSFF Market Adoption

EDSFF Exabytes



Source: IDC Worldwide Quarterly SSD Shipment Results, CY 4Q22 Doc #US49401423, February 2023

# EDSFF Server and Storage



*Ssg-221E-NE324R*

*ASG-1115S-NE316R*



16x Hot-swap EDSFF E3.S (1T) NVMe slots, support E3.S (2T)

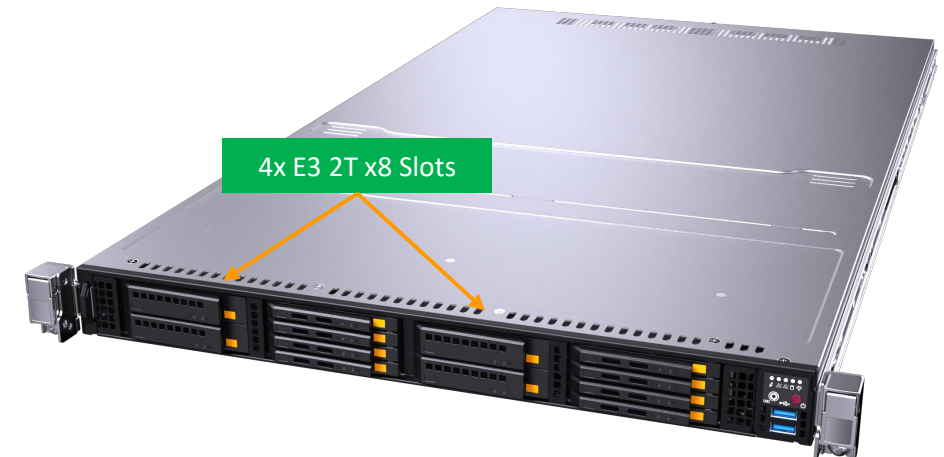


*Ssg-121E-NES24R – Available Now*



24x Hot-swap EDSFF short (E1.S) 9.5 or 15mm NVMe slots

*Ssg-121E-NE316R – Support E3.S 2T x8 (CXL) Devices*



# EDSFF Specification Update

- E3, SFF-TA-1008
  - 2.03: Support for 4C+ (OCP NIC), and 2x1C, added new use cases (CXL), label positioning, LED definition (power/activity & fault/identify)
  - 2.04: Clarify “sustained” max power
- SFF-TA-1009: 3.1.1
  - PCIe 6.0!!
  - USB 2.0 and NIC signals, LED stuff

## 8. PCIe Electrical Requirements

In general, EDSFF devices are expected to follow requirements as specified in both the *PCI Express Base Specification* and the *PCI Express Card Electromechanical Specification*. This chapter provides device requirements that deviate from the *PCI Express Card Electromechanical Specification*. For details on the connector electricals, please refer to *SFF-TA-1002 Card Edge multilane protocol agnostic connector specification*.

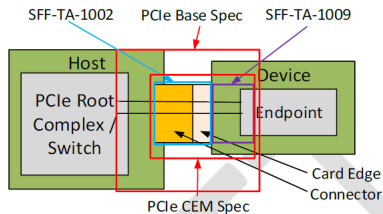


Figure 8-1. EDSFF Electrical Requirements Coverage

### 8.1 Signal Integrity Requirements

Table 8-1 summarizes the signal integrity requirements for the device. Additional explanation is provided in the subsequent sections. All measurements are referenced to an 85  $\Omega$  differential impedance.

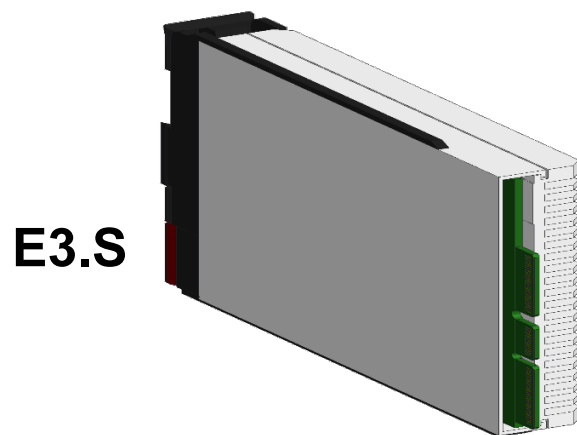
Table 8-1. Summary of Signal Integrity Requirements

| Line Rate                              | Insertion Loss (IL)   | Return Loss (RL)   | Power Sum Near End Crosstalk (PSNEXT) <sup>1</sup>                             | Power Sum Far End Crosstalk (PSFEXT) <sup>1</sup>                              |
|--|---|--|--|--|
| PCIe 4.0<br>(8-GHz-<br>NRZ/16.0 GT/s)  | -5.5 dB<br>(f = 0 to 8 GHz)   |  | $\leq -40$ dB (0 to 12 GHz)  | $\leq -40$ dB (0 to 8 GHz)<br>$\leq -48 + 1.0 * f$ dB<br>(f = 8 to 12 GHz)     |
| PCIe 5.0<br>(32.0 GT/s/16-<br>GHz-NRZ) | $\geq -0.2 - 0.425 * f$ dB<br>(f = 0 to 16 GHz)<br>$\geq 5 - 0.75 * f$ dB<br>(f = 16 to 24 GHz)   | $\leq -10$ dB (< 4 GHz)<br>$\leq -7$ dB (4 to 24 GHz)        | $\leq -45$ dB (0 to 16 GHz)<br>$\leq -55 + 0.625 * f$ dB<br>(f = 16 to 24 GHz) | $\leq -36$ dB (0 to 16 GHz)<br>$\leq -44 + 0.5 * f$ dB<br>(f = 16 to 24 GHz)   |
| PCIe 6.0<br>(64.0 GT/s)                | $\geq -1.5 - 0.28125 * f$ dB<br>(f = 0 to 16 GHz)<br>$\geq 6 - 0.75 * f$ dB<br>(f = 16 to 24 GHz) | $\leq -15$ dB (< 1.25 GHz)<br>$\leq -10$ dB (1.25 to 24 GHz) | $\leq -60$ dB (0 to 16 GHz)<br>$\leq -70 + 0.625 * f$ dB<br>(f = 16 to 24 GHz) | $\leq -50$ dB (0 to 16 GHz)<br>$\leq -60 + 0.625 * f$ dB<br>(f = 16 to 24 GHz) |



# CXL Memory Modules (CMMs) – new standard

- EDSFF form factors are also now leveraged for main memory expansion with CXL interface
- In fact, JEDEC has recently published the first CXL Memory Module Specification (CMM) with significant industry support: JESD317
- Standard CMM targets specified: E1.S x8, E3.S 2T x8, E3.S 1T



## JEDEC STANDARD

Compute Express Link (CXL™)  
Memory Module Reference Base  
Standard

JESD317

March 2023

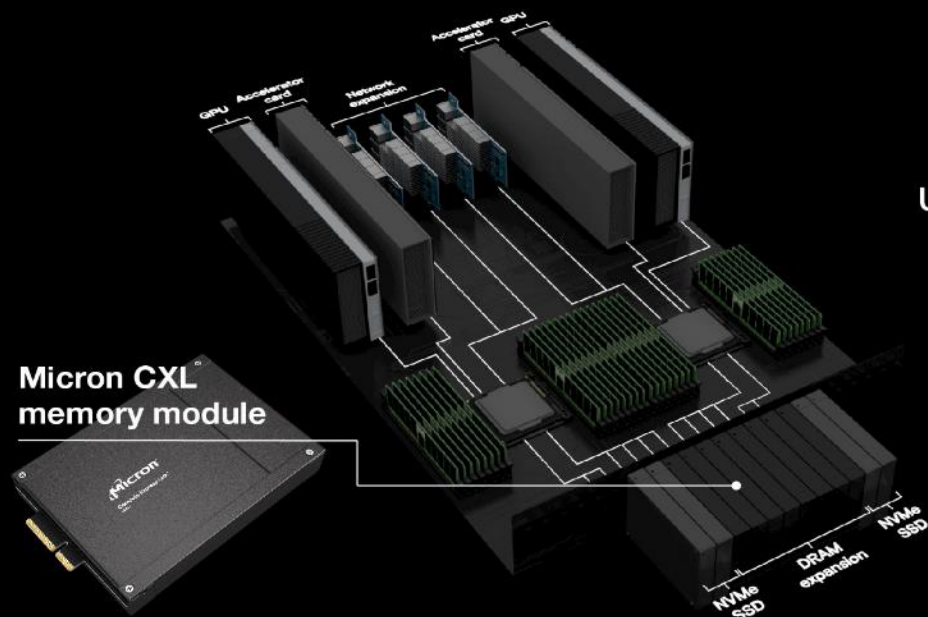
JEDEC SOLID STATE TECHNOLOGY ASSOCIATION



Specification available now for download: <https://www.jedec.org/system/files/docs/JESD317.pdf>

# CXL Memory Modules

- Enable memory expansion physically removed from CPU or even outside of host system
- Can leverage the same EDSFF slots for CXL in system as used for PCIe-attached NVMe drives



High memory bandwidth

Up to 790 GB/s total<sup>1</sup>

Low latency<sup>2</sup>

Ultrahigh memory capacity

Up to 3.2 TB total<sup>1</sup>

## Emerging data center application workloads

Micron CXL memory expansion is ideal for data-intensive applications



High-performance computing



In-memory database



Business analytics



Virtualized platforms

## Benefits of Micron CXL memory

### Increase performance

Achieve up to 40% faster execution time<sup>3</sup>

### Boost utilization

Balance memory bandwidth to CPU cores

### Optimize allocation

Scale up memory without overprovisioning

<sup>1</sup> Memory capacity and bandwidth values based on AMD's next-generation SP5 high-end platform that offers 1P and 2P support, 12-channel DDR5 memory and 64 CXL V1.1+ lanes

<sup>2</sup> Equivalent to single NUMA hop

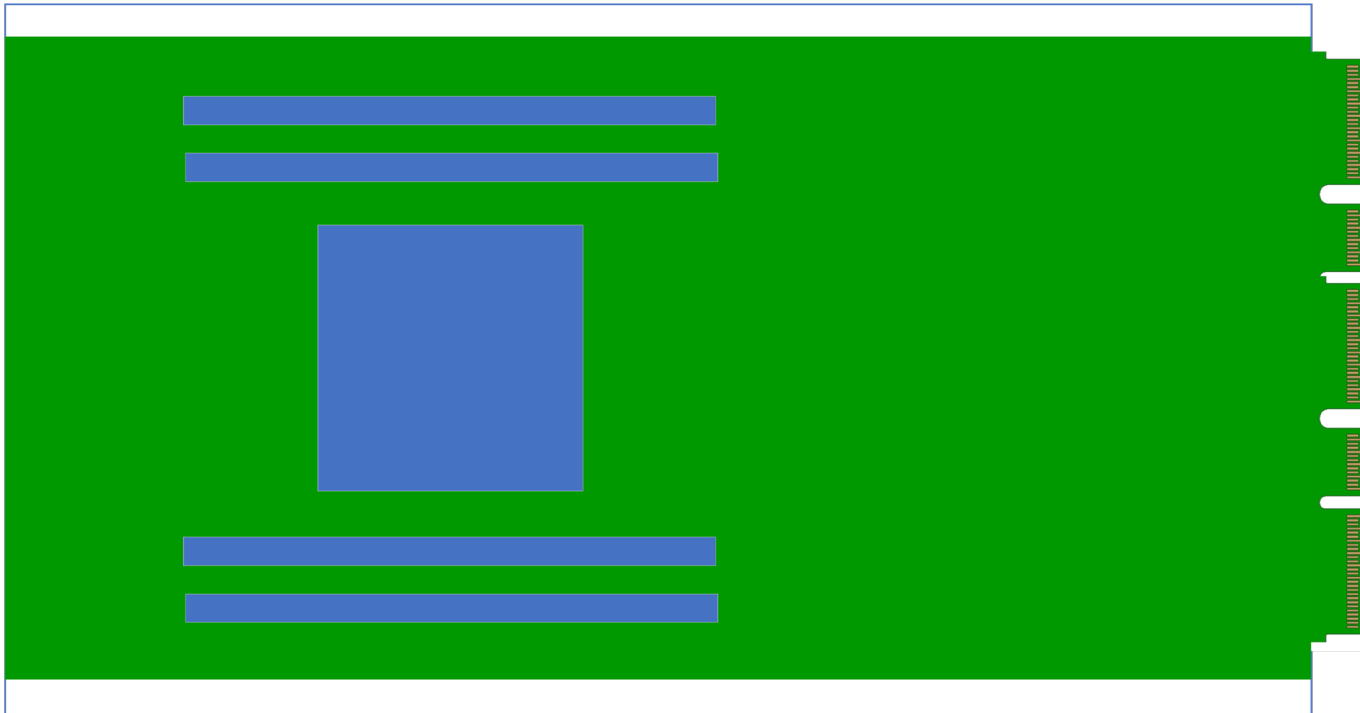
<sup>3</sup> Micron internal testing results based on CXL evaluation platform and emulation

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# EDSFF form factors and beyond

- The ecosystem for EDSFF has grown so significantly with E1 and E3 devices, further leverage is also being explored in industry.
- Most recent is work in SNIA SFF on new SFF-TA-1034 module: Pluggable Multi-purpose Module
- Could be leveraged for many different applications



- EDSFF-compatible connector
- Supports up to 32 lanes of PCIe/CXL
- High power support (400W+)

Targeting ~38-39mm height max  
and 16.8mm, fits in 1U rack space





# Thank You!



# SSDS-301-1: The Latest on Form Factors - A Panel Discussion

*Thursday, 8/10/23  
8:30am – 9:35am PT*

# Panelists and Discussion Topics

- General updates, use cases and product availability (65 minutes)
- Moderator – Cameron T Brett
- Panelists
  - Don Jeanette, VP, Trend Focus
  - Jonmichael Hands, VP of Storage, Chia Networks
  - Trent Johnson, SSD Hardware Architect, IBM
  - Paul Kaler, Future Storage Architect, HPE
  - Bill Lynn, AMD
- ~8 mins per panelist (3-4 slides), with 25 mins of topic discussion
- Interactive with questions from audience



# Narrative / Flow of Session / Slide Content (your own template)

- Cam welcomes and introduces the panelists
  - States the panelist will provide updates, insights and new product info
  - Interactive discussion, so questions can be asked during presentations
- Don provides the latest on SSD market data and growth of EDSFF
  - Comments on adoption and replacement of older technologies
- Trent Johnson – why did IBM choose to develop EDSFF SSDs?
  - What is IBM's product and use case?
- Paul Kaler – Newest platforms supporting EDSFF, E3 only?
  - Why the transition supporting PCIe 5.0 and beyond for EDSFF?
- Jonmichael – SSD, spec and use case updates (from last webinar)
- Bill Lynn – What is AMD doing with E3.S and CXL

# Panel Discussion Topics

- Question 1 – Geared to Don and market
  - How is the E3 and E1 adoption affecting
- Question 2 – Geared to Paul and Trent on OEM applications
  - Why E3 for server and storage use cases? And why tie it to PCIe 5.0
- Question 3 – Geared to JM on SSD trends
  - How is overall SSD adoption by vendors?
  - Cam can comment on KIOXIA SSDs
- Question 4 – Geared to Bill/CXL
  - What makes E3.S a good fit for CXL and what other devices are a good fit?
- Question 5 – What features/capabilities would you like to see come next for EDSFF?

# Panel Discussion Topics

- Add your own questions/topics you'd like me to ask