High Performance RAID With Universal High-Performance Interconnect (UHI™)

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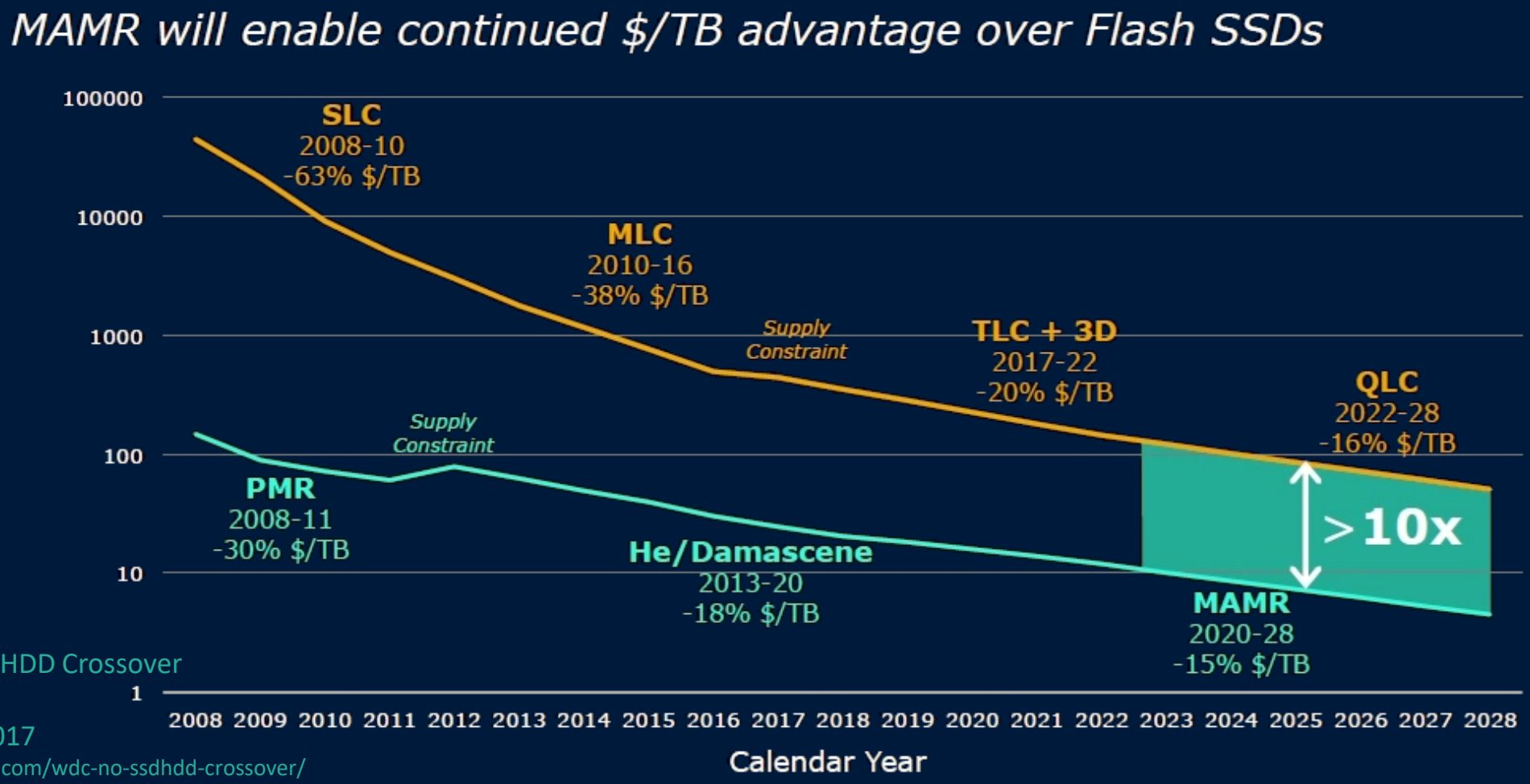
Abstract

Even with today's increasing storage density in SSDs, large density HDDs are still roughly an order of magnitude lower in terms of purchase cost in $/TB. We propose a high-performance RAID solution using a novel approach that employs NCQ and smart caching to order and minimize the number of transactions that are sent to the HDD, thus optimizing throughput and lowering average latency. A "server on a chip" incorporating RAID controllers provides processing and connectivity to memory and provides high bandwidth and low latency connectivity across Universal High-Performance Interconnect (UHI™) ports

Outline

- Market: Why HDD?
- UHI™ (Universal High-Performance Interconnect)
- Server-on-a-Chip
- HRAM™ (Heterogeneous RAM)
- System Architecture: Heterogeneous Accelerated Compute
- HDD Mass Storage System

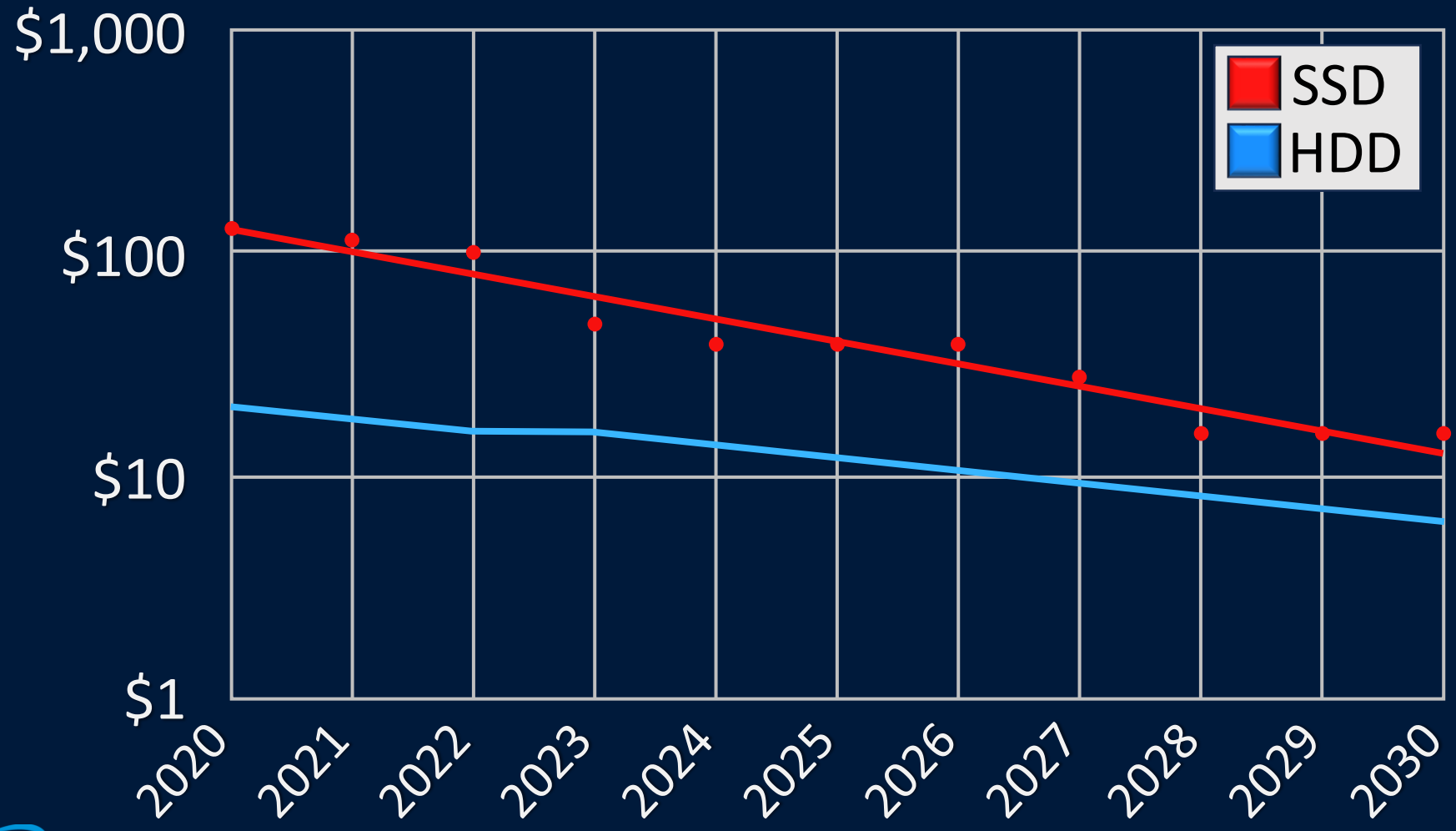
HDD vs. SSD $/TB 2017 Projection



WDC: No SSD/HDD Crossover
Jim Handy
October 17, 2017
https://thessdguy.com/wdc-no-ssdhdd-crossover/

Western Digital

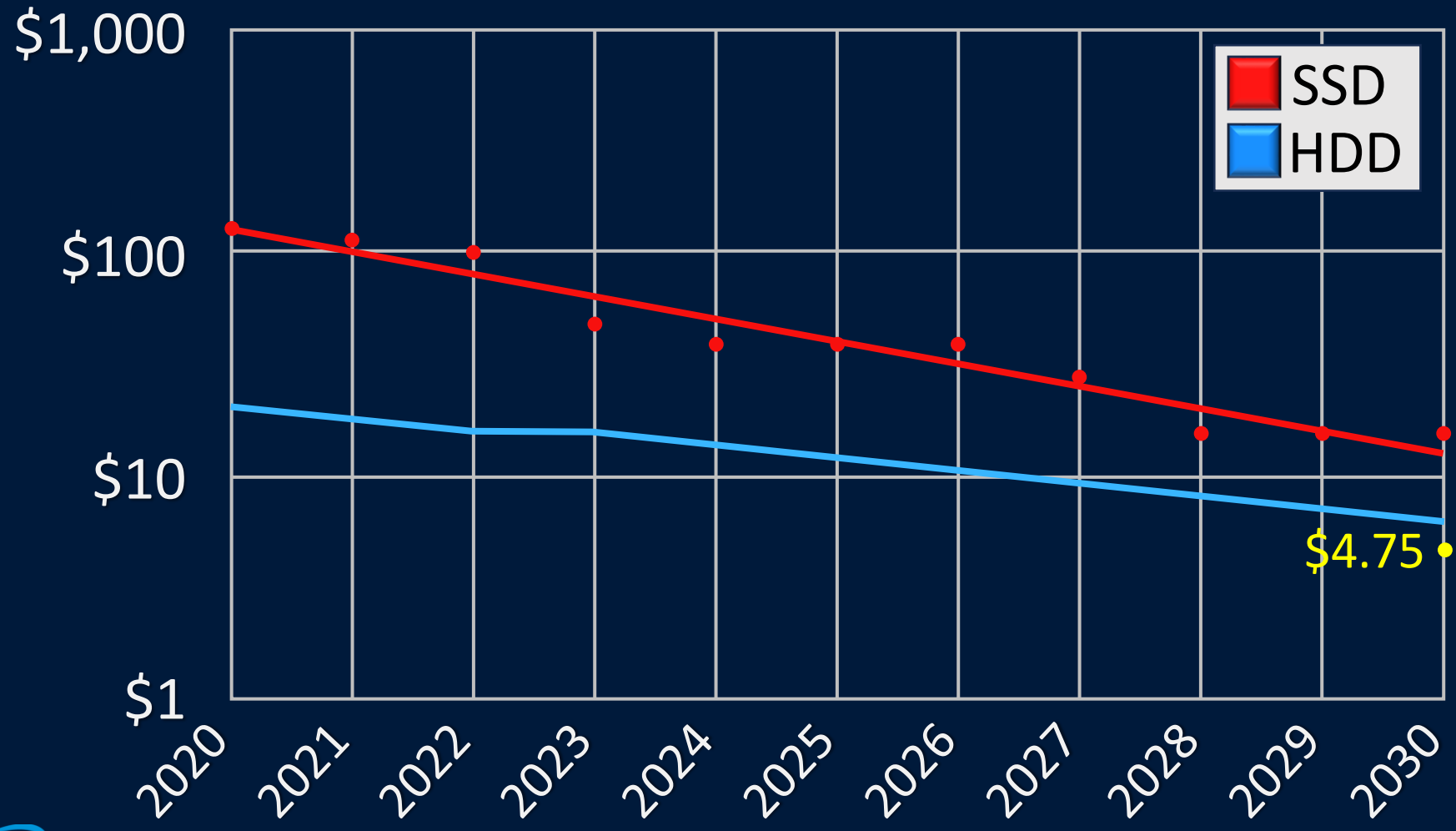
HDD vs. SSD $/TB 2025 Projection



Source: Jim Handy
Objective Analysis

Source: Tom Coughlin
Coughlin Associates

HDD vs. SSD $/TB 2025 Projection



Source: Jim Handy
Objective Analysis

Source: Tom Coughlin
Coughlin Associates

Prices Aren’t Always Monotonically Decreasing

1Q25–4Q25 NAND Flash Price Projections

	1Q25E	2Q25F	3Q25F	4Q25F
Blended NAND Flash	down 13~18%	down 0~5%	up 10~15%	up 8~13%

Source: TrendForce, Feb. 2025

TRENDFORCE

Supplier Production Cuts and AI Demand Expected to Drive NAND Flash Price Recovery in 2H25
by TheLostSwede
Feb 17th, 2025
https://www.techpowerup.com/332663/supplier-production-cuts-and-ai-demand-expected-to-drive-nand-flash-price-recovery-in-2h25

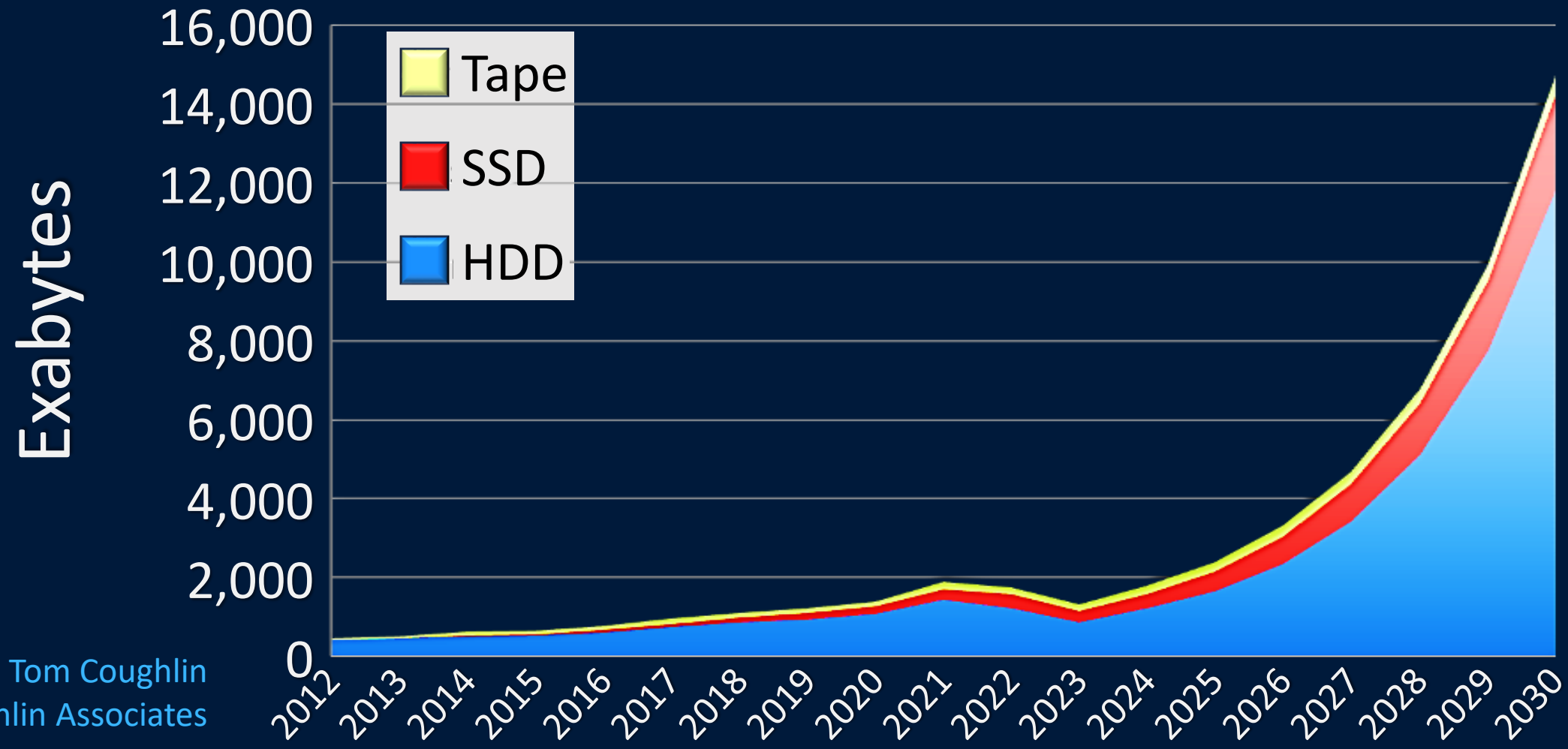
30+ TB HDDs Are Here Now

Seagate CEO Hints at 150TB HDDs*

- Seagate's, CEO Dr. Mosley and CTO Dr. Morris shared HDD roadmap
- 150TB hard drives, groundbreaking 15TB platters, (>= 2035)
- Seagate's Heat-Assisted Magnetic Recording, deployed in Mozaic

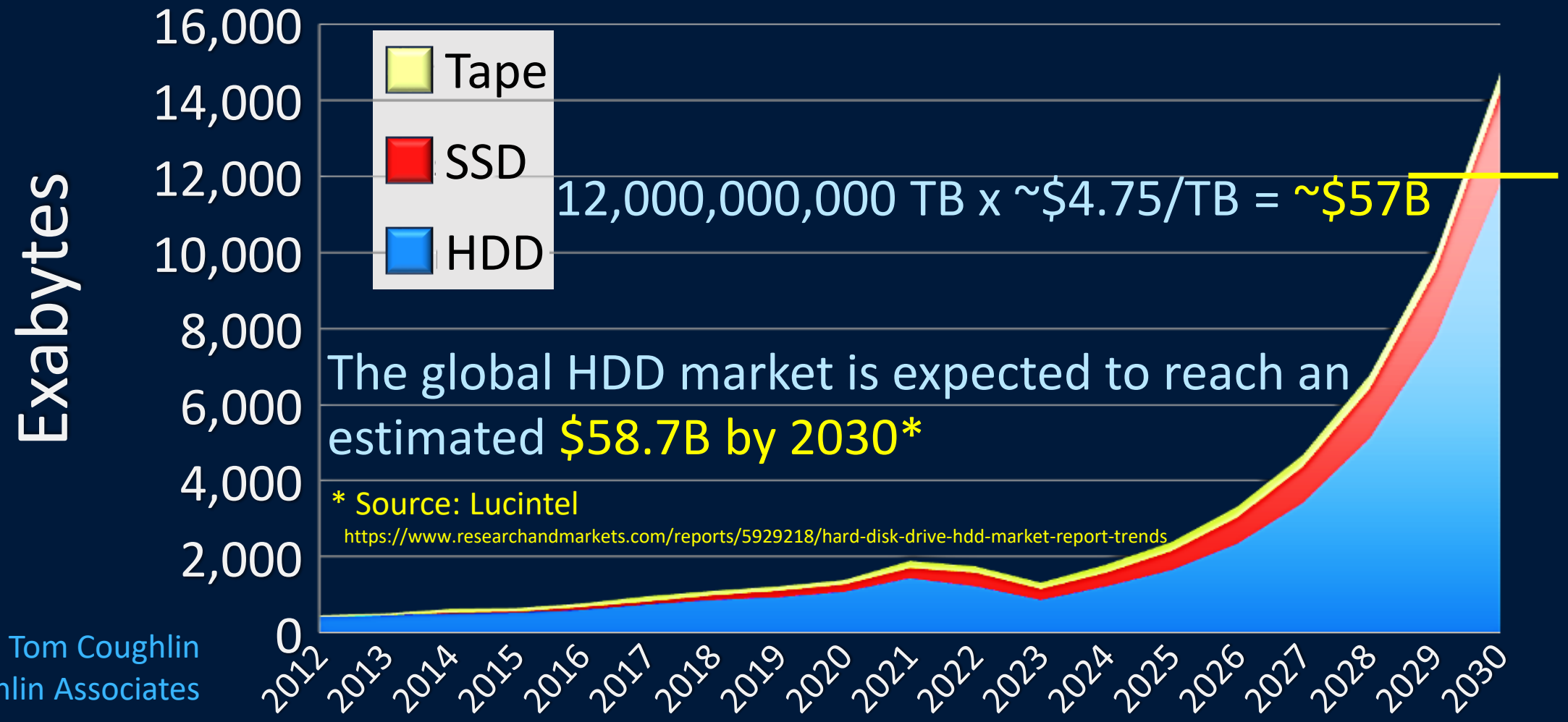
* Seagate CEO hints at 150TB hard drives thanks to novel 15TB platters, but notes it won't happen for another decade
By Efosa Udinmwen
June 1, 2025
https://www.techradar.com/pro/seagate-ceo-hints-at-150tb-hard-drives-thanks-to-novel-15tb-platters-but-that-wont-happen-for-another-decade

Projected & Shipped Capacity in Exabytes



Source: Tom Coughlin
Coughlin Associates

Projected & Shipped Capacity in Exabytes



Source: Tom Coughlin
Coughlin Associates

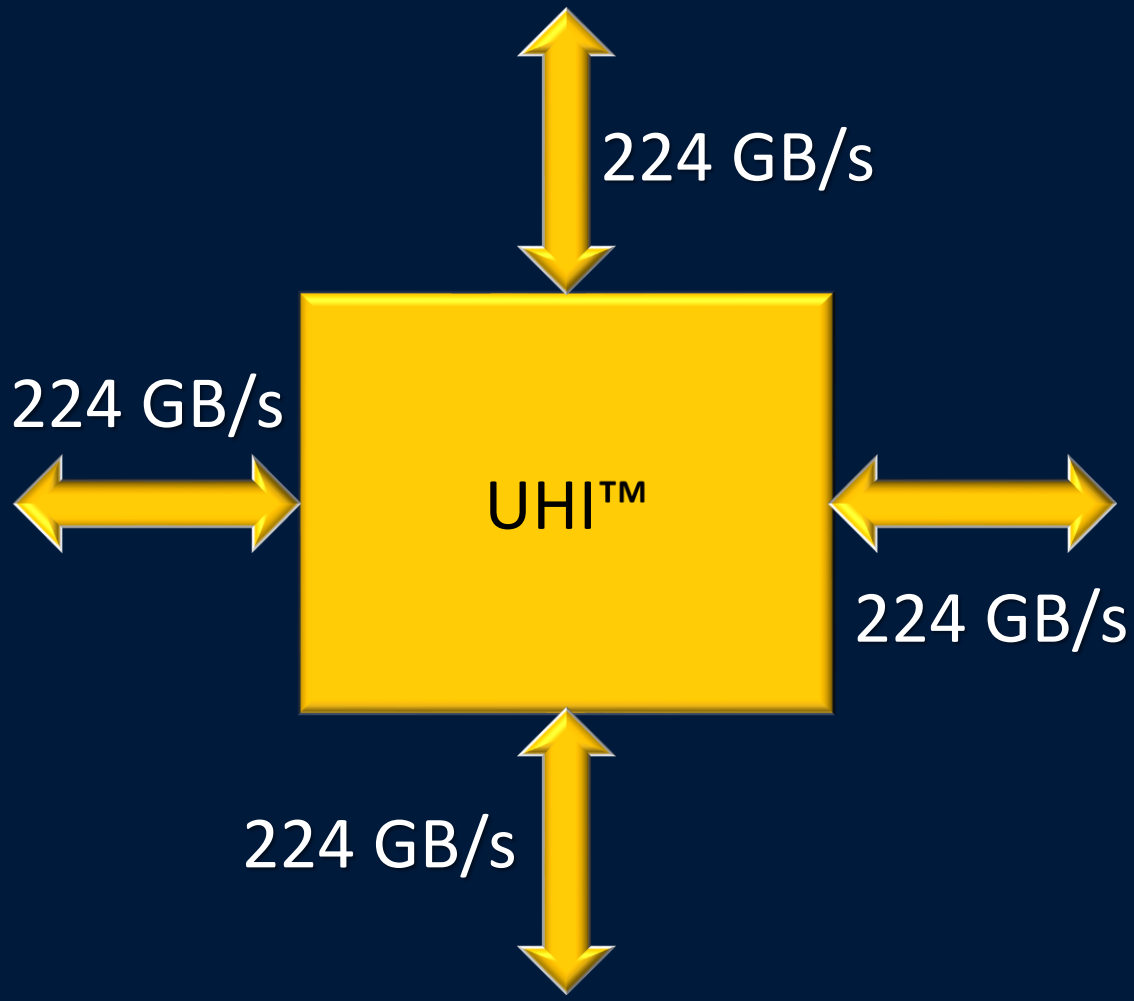
SSDs Unlikely to Completely Replace HDDs*

1) HDDs: Stable & reliable long-term storage
2) HDDs: Much less expensive option for storing massive data
3) HDDs: Excellent choice for infrequently accessed data
4) HDDs: Performance optimized with SSDs in hybrid systems
5) HDDs: Play an important role in the data storage hierarchy

* SSDs Unlikely to Completely Replace Hard Drives
Posted by T.J. Burlee
May 09, 2025
https://www.securedatarecovery.com/blog/will-ssds-replace-hard-drives

Universal High-Perf Interconnect (UHI™)

- 112G SerDes
  - PHYs
- 1 Port = 16 Lanes
  - 224 GB/s (bi-directional)
  - 64 + 4 pins (68 pins)
- 4 Ports / Chiplet
  - 896 GB/s (bi-directional)
- FEC, Encoders/Decoders
- ~30 W

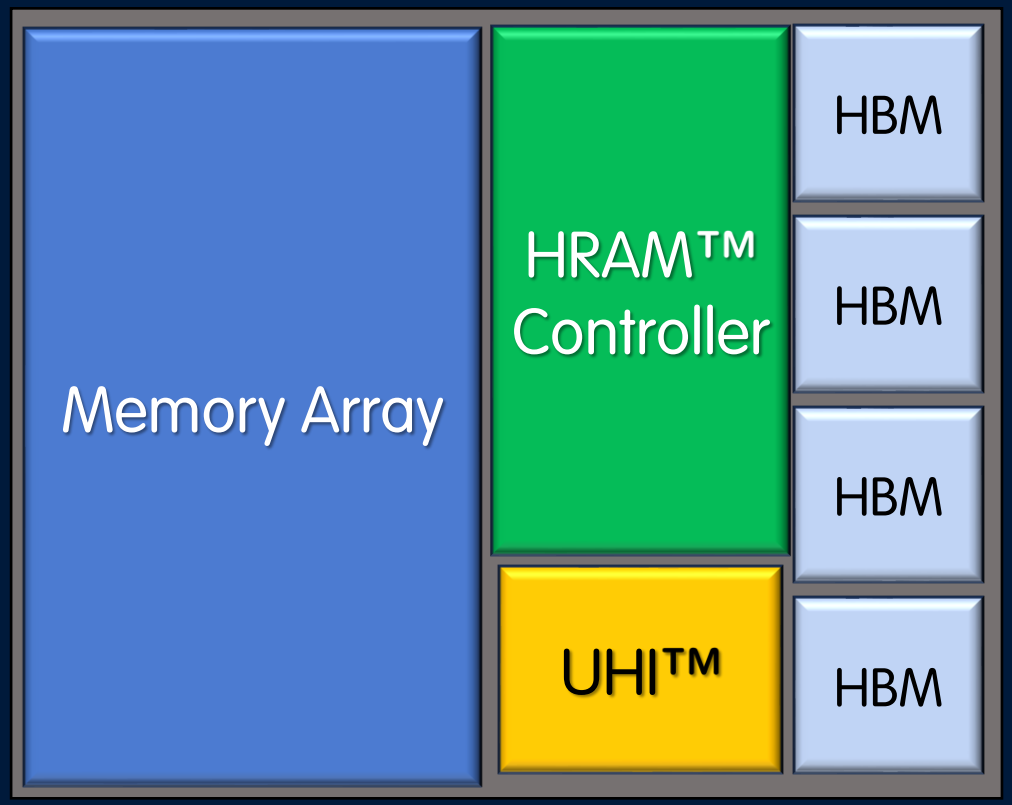


Server on a Chip Package

- Server-on-a-Chip
  - RISC-V Cores
    - 64 Application
    - 8 Interface (NIC)
    - 8 HDD (RAID)
  - Secure Boot, SPI, Key Vault
- UHI™ Chiplet
- I/O Mixed-Signal Analog Chiplet
  - SAS-4, PCIe, DDR, USB, HBM

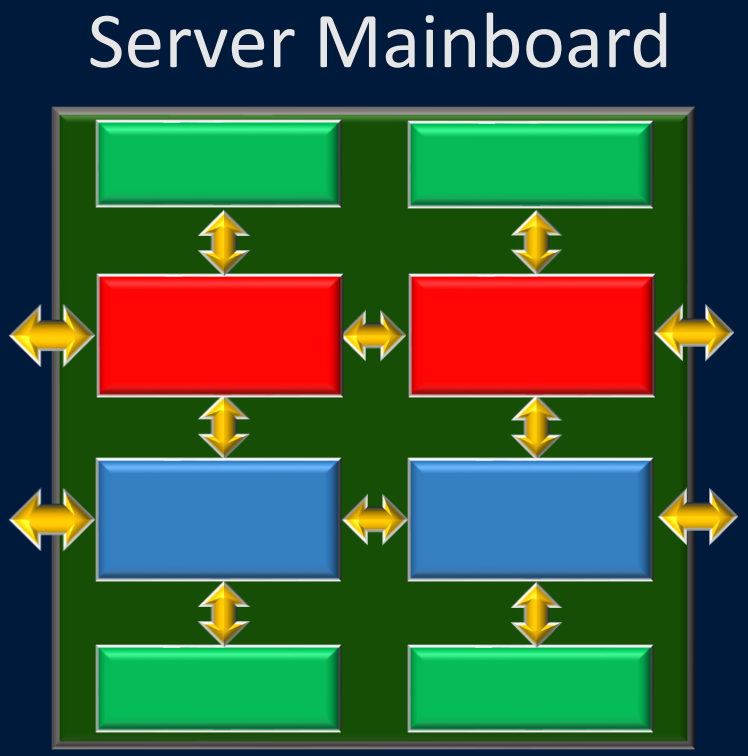
Heterogeneous RAM (HRAM™)

- UHI™
- Memory
- HBM
- Smart Controllers
  - Coherency
  - Security

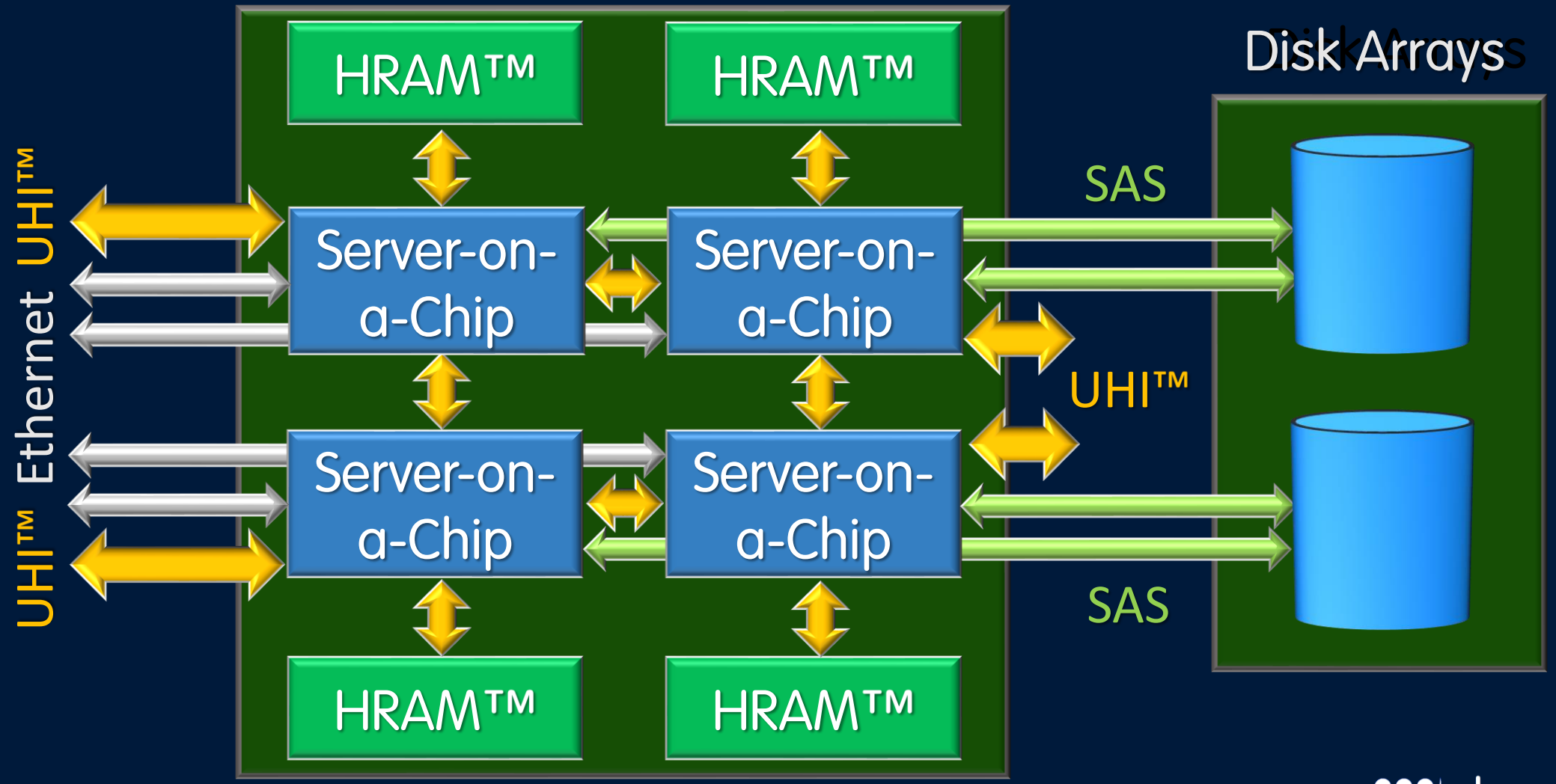


Heterogeneous Accelerated Compute

- UHI™ Fabric to Connect Blocks
- Server-on-a-Chip (Legacy Support Server)
- HRAM™ (Smart Memory)
- Application Specific Accelerators
  - AI, HPC
  - Database
  - Edge Proxying

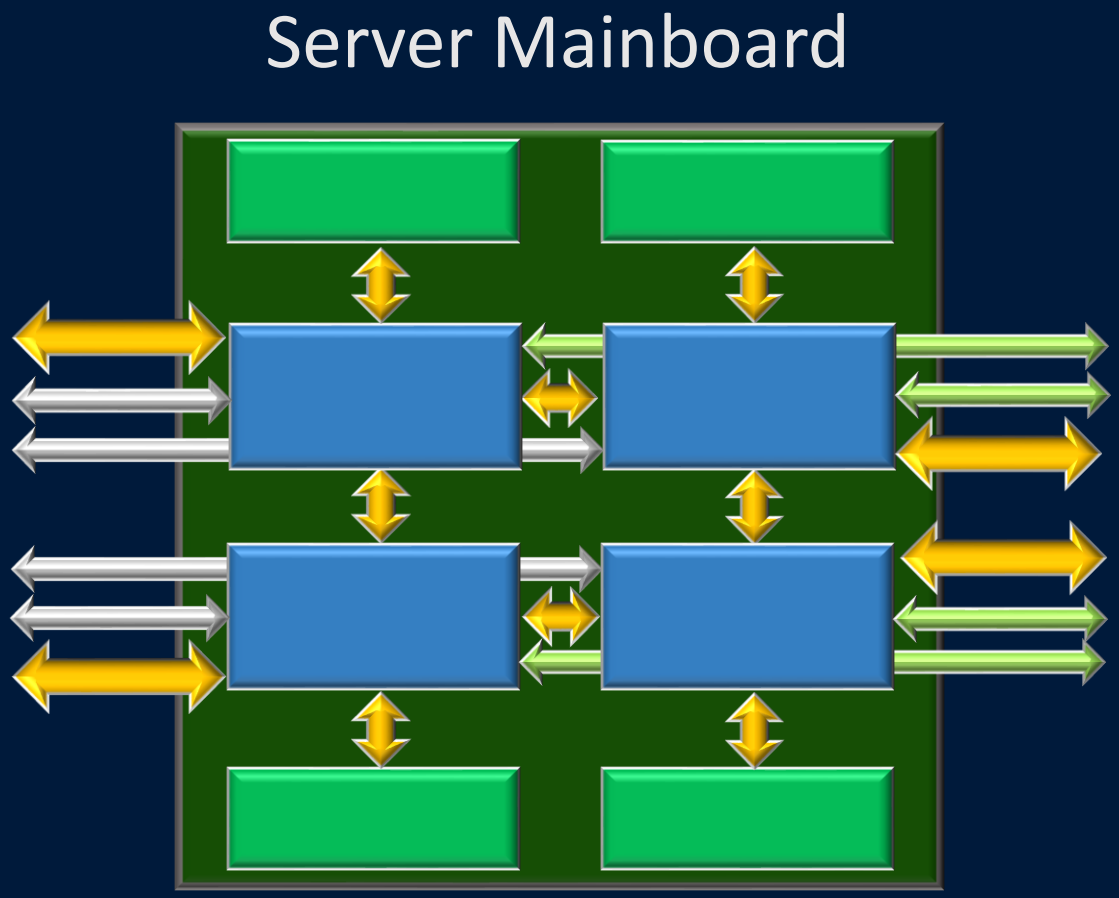


MP Server Storage Appliance



External I/O

- UHI™
  - 4 x 16 x 112 Gb/s (7,168 Gb/s)
- Ethernet
  - 4 x 2 x 100 Gbe (800 Gb/s)
- SAS-4
  - 4 x 16 x 24 Gb/s (1,536 Gb/s)



HDD Support & Performance

- RAID Support
  - 0, 1, 5, 6, 10, 50, 60
- NCQ
- Smart Caching
- Hardware Accelerated
  - Security
  - Encryption & Decryption
  - Rebuilds

Summary

- HDDs Have a Long Viable Roadmap
- Novel Heterogenous Accelerated Compute Architecture
- Universal High-Performance Interconnect (UHI™)
- Fast & Efficient Mass Storage Capabilities
- Architecture Has Broader Applications
  - Accelerated AI & HPC
  - Network Edge Proxying
  - Database
  - SSD and Hybrid Arrays

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- Tom Coughlin, Coughlin Associates

Thanks!