

## **SAS: Today's Fast and Flexible Storage Fabric**

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Secretary, SCSI Trade Association

Alliances Marketing Manager, Scalable Storage BU –  
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# About the Instructor

Jeremiah Tussey is the Alliance Marketing Manager for Microsemi's Enterprise Storage and Communications Group, managing vendor alliances for SATA, SAS, PCIe, and NVMe products, as well as CPU-Platform and Operating System ecosystem enablement.

He has over 18 years of experience in the storage industry, with focuses in Applications Engineering and Product Marketing for SCSI, SATA, PCIe, Fibre Channel, and Enclosure Management products.

Jeremiah is the current Secretary of the SCSI Trade Association and current Treasurer of the Serial ATA International Organization. He received his bachelor's in electrical engineering from the University of Colorado.

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# Abstract

- SAS is the backbone of nearly every enterprise storage deployment, rapidly evolving, adding new features and enhanced capabilities, and offering “no compromise” system performance. SAS not only excels as a device level interface, its versatility, reliability and scalability have made it the connectivity standard of choice for creating new enterprise storage architectures.
- This presentation covers the advantages of using SAS as a device interface and how its capabilities as a connectivity solution are changing the way data centers are being deployed. 12Gb/s SAS transfer rates, bandwidth aggregation, SAS fabrics (including switches) active connections, and multi-function connectors allow data center architects to create sustainable storage solutions that scale well into next-generation 24G SAS designs and beyond.

# Today's Takeaways

- Flexibility of SAS is Unparalleled

- Media flexibility
- Scalability
- System architectures

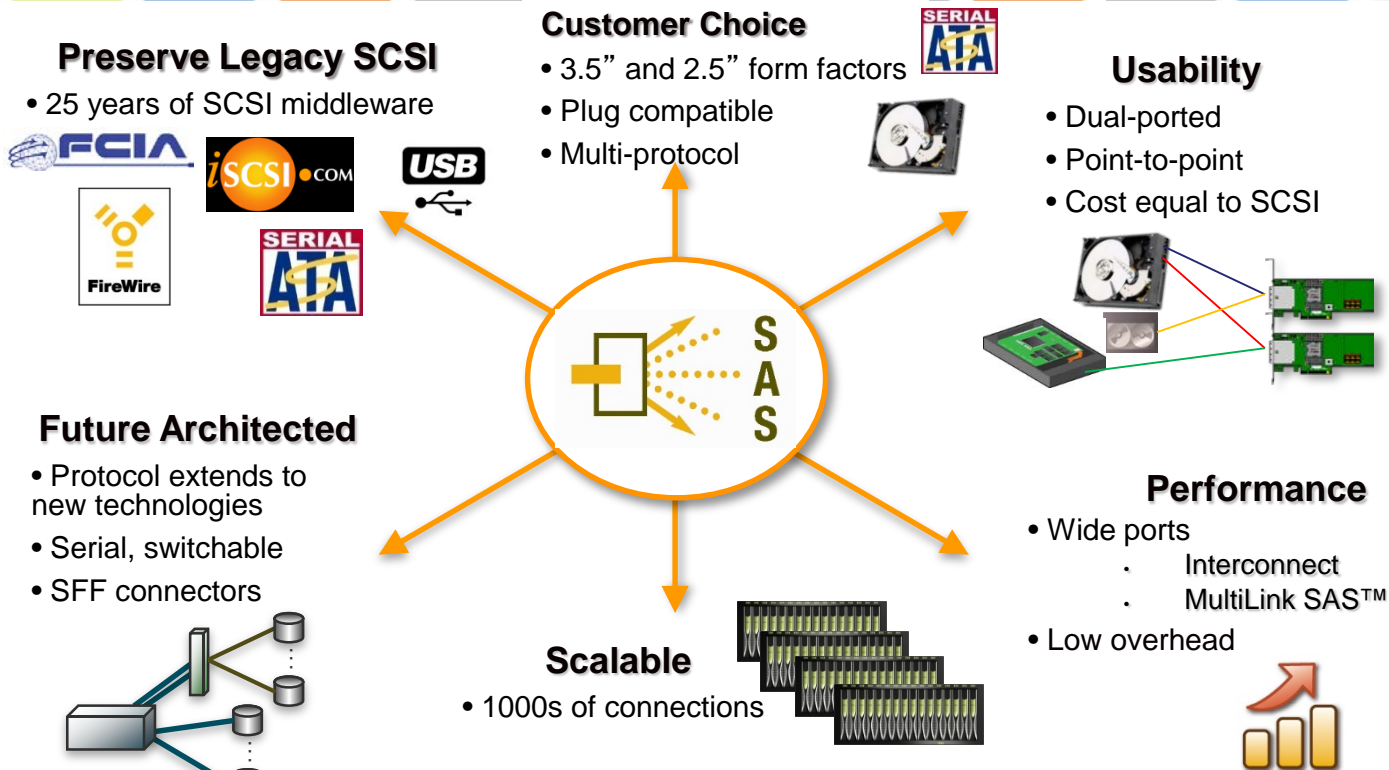


- SAS Technology Addresses a Very Large, Growing Market

- SAS Continues to Evolve through Innovation

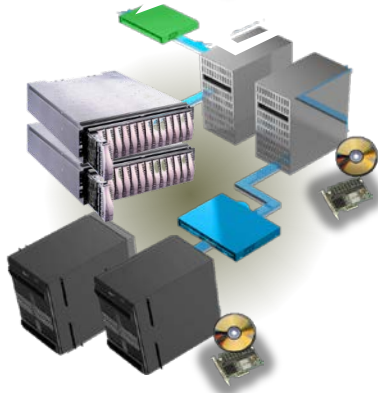
- Performance
- Features

# SAS – Preserving the Past, Creating the Future



# SAS & SATA Span the Storage Spectrum

## Direct Attach Storage



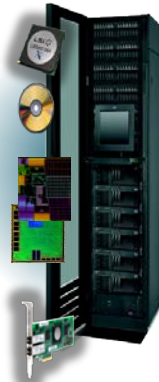
- Controllers/ROCs/HBAs
- Expanders
- SAS/SATA HDDs
- SAS/SATA SSDs

## SAS Fabrics



- Expanders
- SAS switches
- Bridges
- Port multiplexers

## External Storage



- Controllers/ROCs/HBAs
- Expanders
- SAS/SATA HDDs
- SAS/SATA SSDs
- SAS/SATA tape

## Media



- SAS HDDs
- SAS SSDs
- SATA HDDs
- SATA SSDs
- Near-line SAS HDDs
- SMR HDDs

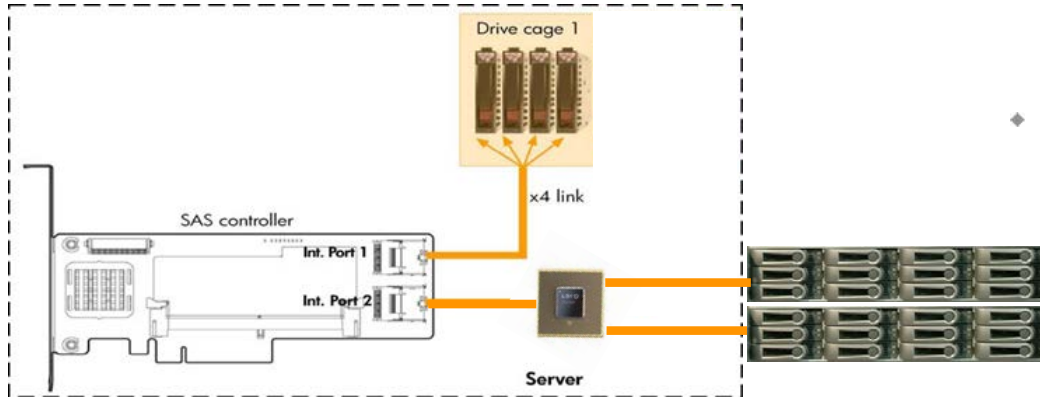
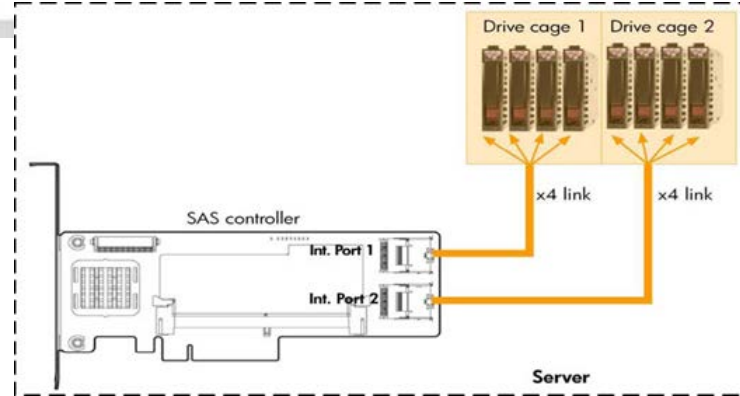
***SAS is the Predominant Enterprise Drive Interface***

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# Scalability in Server & Hyper-Converged Architectures

## Simple DAS

- ◆ High Performance
- ◆ Inexpensive
- ◆ Modular

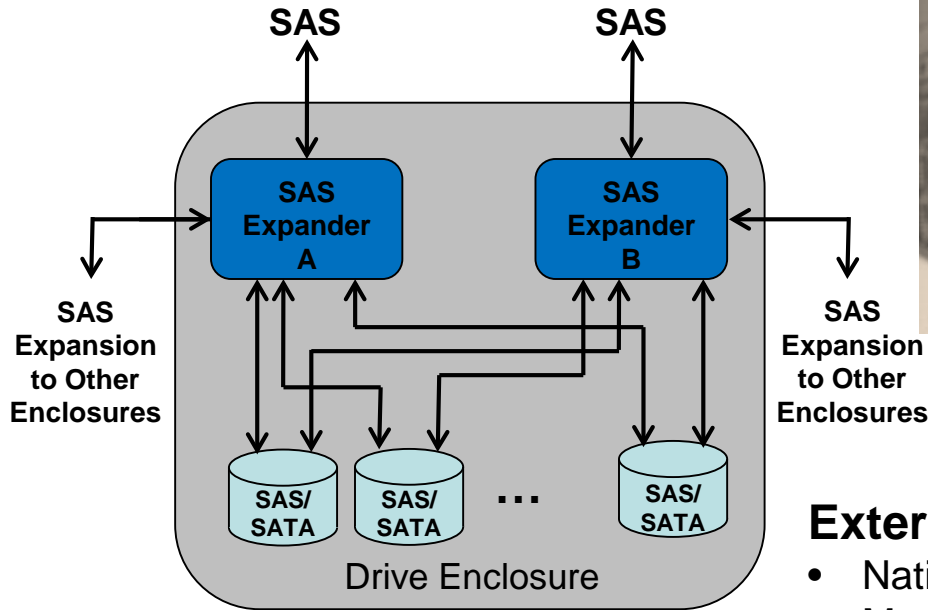


## Extended DAS

- ◆ Pay-as-you-grow
- ◆ High Capacity



# Scalability in External Storage Architectures



## External Storage:

- Native High-Availability
- Modular
- Simplified, Robust Cabling
- Scales to 1000s of Devices

# Protocols Compared

	<b>x1 24G SAS</b>	<b>x1 NVMe (Gen4)</b>	<b>x4 NVMe (Gen4)</b>
Performance (Bandwidth)	19.2 Gb/s	15.8 Gb/s	63.0 Gb/s
Performance (Read Latency*)	15.9us	15.7us	11.3us
Scalability	1000's of Devices	10's of Devices	10's of Devices
Power	9W	9W	25W
Flexibility	12G SAS HDD&SSD 6G SAS/SATA HDD&SSD	NVMe Gen4 SSDs, NVMe Gen3 SSDs	NVMe Gen4 SSDs, NVMe Gen3 SSDs
Manageability	SES-2, SMP	Unproven	Unproven
Availability	Native Dual Port	Unproven	Unproven
Channel Length	19" FR4, 6m Cu Cable, 300m AOC	4" FR4, 1m Cu Cable	4" FR4, 1m Cu Cable

\*Latency includes OS, driver, HBA (if required) and flight time, media access times not included

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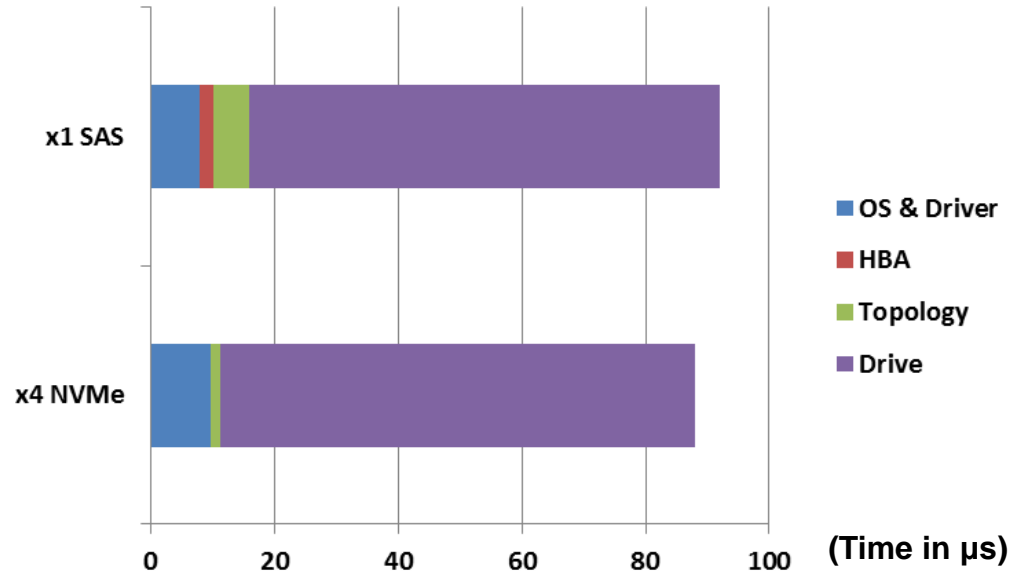
# Today's Bandwidth by the Numbers

	SATA	x1 PCIe	x1 12Gb/s SAS	x2 PCIe 3.0	x2 12Gb/s SAS MultiLink SAS™	x4 PCIe 3.0	x4 12Gb/s SAS MultiLink SAS™
No. of Links / Lanes	1	1	1	2	2	4	4
Transfer Rate per Link/Lane	6 Gb/s	8 Gb/s	12 Gb/s	8 Gb/s	12 Gb/s	8 Gb/s	12 Gb/s
Max Bandwidth	0.6 GB/s	2.0 GB/s	2.4 GB/s	4.0 GB/s	4.8 GB/s	8.0 GB/s	9.6 GB/s

**SAS Supplies 20% More bandwidth Per Lane**

# 4k Random Read Latency

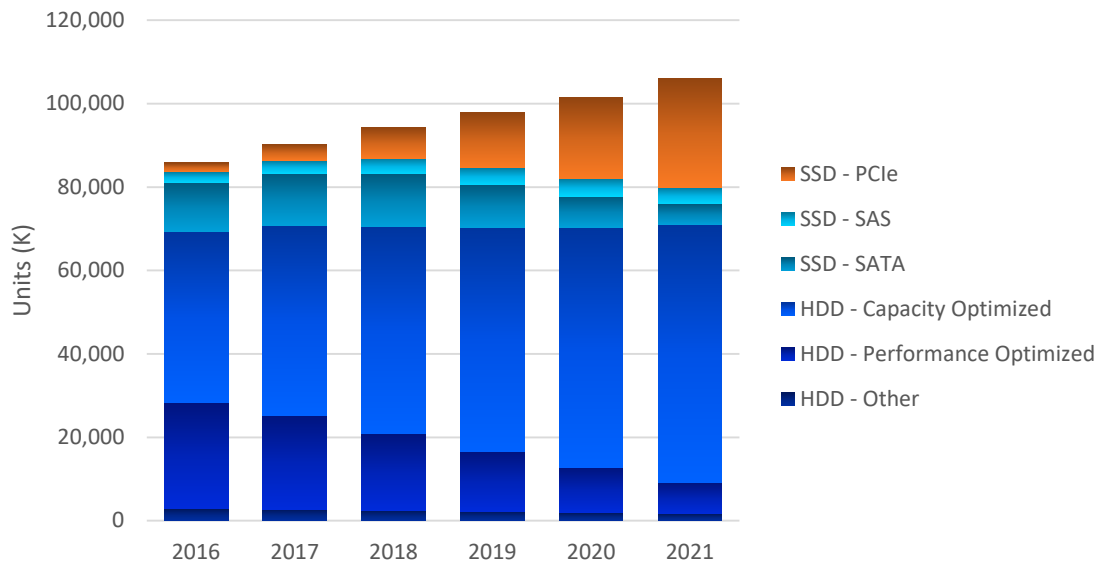
QD1



**Read Latencies Dominated by NAND Latencies (and will continue to increase)**

# Enterprise Unit Shipments

Worldwide Enterprise Shipments, 2016-2021

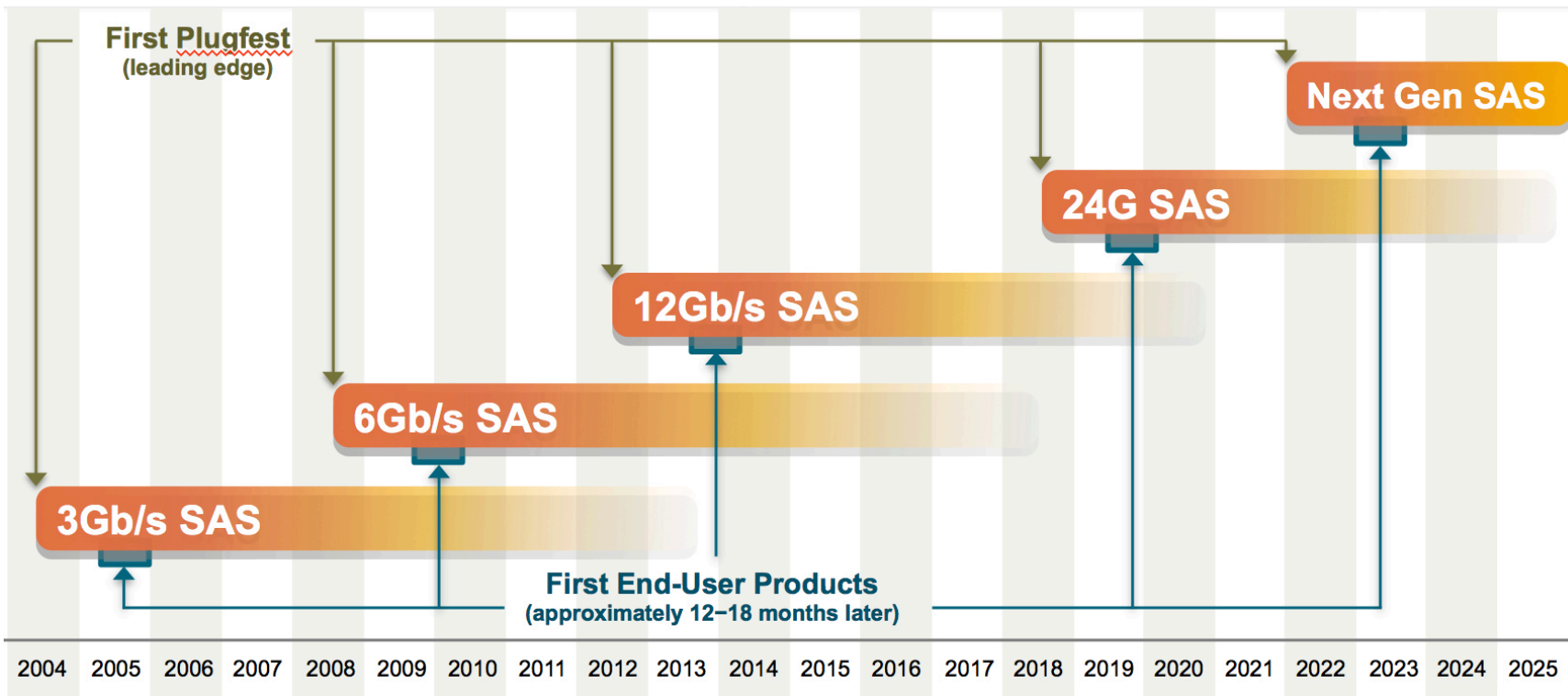


**>75% of All Enterprise Shipments through 2021  
Require SAS Infrastructure**

Source: IDC, May 2017

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# Technology Roadmap



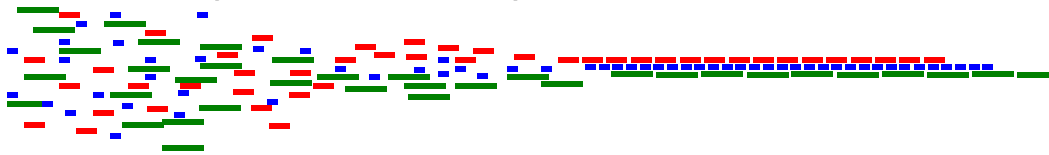
# Recent Innovations in SAS

- Storage Intelligence
- Persistent Connections
- Enhanced Power Control
- Shingled Magnetic Recording Support

**Recent SAS Innovations - the Focus  
of the May 2016 SAS Plugfest**

## ■ Streams

- Provides hints to SSD about data sets that have similar expected lifetimes
- Reduces intermixing of data from different applications, thus reducing fragmentation during garbage collection
- Improves performance
- Reduces write amplification and improves endurance

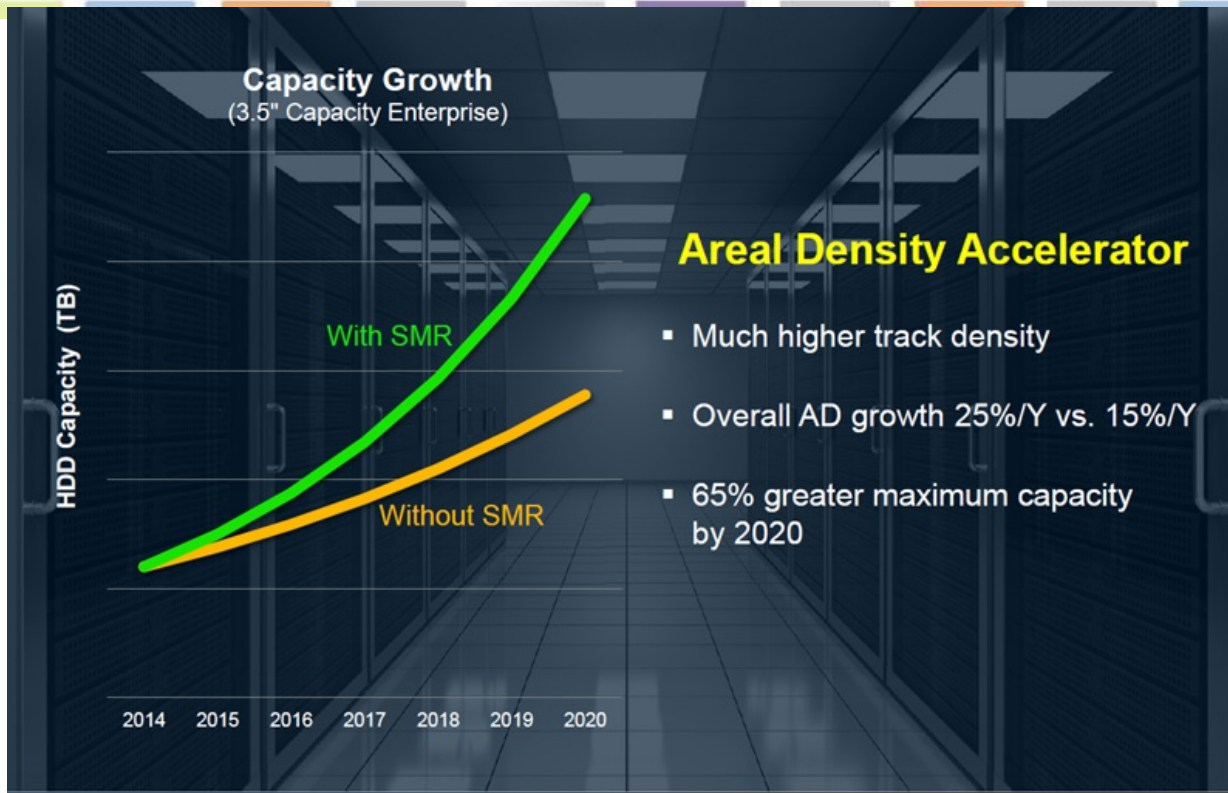


## ■ Background Activity Control

- Provides hints to SSD to optimize timing of background activities (e.g., garbage collection)
- Provides more consistent performance during peak activity times



# Why Shingled Magnetic Recording??





# 24G SAS Objectives

- Double the Effective Bandwidth of 12Gb/s SAS
- Backwards Compatibility
  - Support for two generations of backward compatibility
  - Leverage existing ecosystem (tools, test equipment)
- Preserve the Existing SAS Value Proposition
  - Reliability – Robust error handling
  - Scalability – Scalable to 1,000s of devices
  - Flexibility – SAS infrastructure supports SAS and SATA devices
  - Serviceability – Surprise add/remove media and cables
  - Manageability – Storage management built into the standard
- Align with Next-Generation Platform Launches



# Key Messages

- Flexibility of SAS is Unparalleled

- Media flexibility
- Scalability
- System architectures

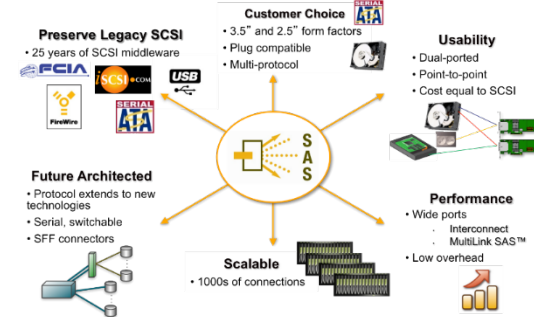
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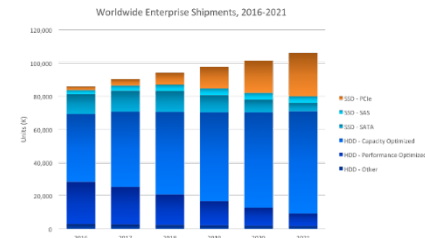
- Performance
- Features
- Advanced Roadmap



## SAS – Preserving the Past, Creating the Future



## Enterprise Unit Shipments



>75% of All Enterprise Shipments Through 2021 Require SAS Infrastructure

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The SNIA Education Committee thanks the following Individuals for their contributions to this Tutorial.

## Authorship History

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