Let's hear it for the latest in PCIe SSDs – A Panel

Moderator: Eden Kim, Calypso Systems, Inc.

Panelists: Swapna Yasurapu, HGST
Jim Pappas, Intel
Jon Tanguy, Micron
Keun-Soo Jo, Samsung
Rob Callaghan, Sandisk
Marty Czekalski, Seagate
Cameron Brett, Toshiba

Agenda

- Opening Remarks:
  - **Eden Kim**, Calypso — *Overview – August 2014 Performance Comparison by Storage Class*

- Panelist Remarks:
  - **Cameron Brett**, Toshiba — *PCIe SSDs – More Performance Options for the Enterprise*
  - **Keun-soo Jo**, Samsung — *PCIe Express & NVM Express for PCIe Solid State Storage*
  - **Jon Tanguay**, Micron — *PCIe SSD – Growth with Partners*
  - **Rob Callaghan**, Sandisk — *Flash on the Memory Bus – ULLtraDIMM SSD*
  - **Marty Czekalski**, Seagate — *Key Value: Solid State Storage – the Next Frontier*
  - **Swapna Yasarapu**, HGST — *Different Strokes: Application Aware SSD Performance*
  - **Jim Pappas,** Intel — *Low Queue Depth IOPS*

- Questions to Individual Panelists
- Questions to Panel at large
- Questions from Audience

Note: Please pass written questions to the Moderator during the presentations for the Q & A

Moderator Biography:

Eden Kim, CEO Calypso Systems, Inc.

www.calypsotesters.com

Eden is CEO of Calypso Systems, Inc. – the manufacturer of the Calypso SSD Reference Test Platform (RTP). Calypso provides Industry standard SSD test equipment, test services and advanced SSD Data Analytics. The Calypso RTP is the tester of record for the SNIA SSS PTS.

Eden is Chair of the SNIA Solid State Storage Initiative PCIe SSD Committee and the TechDev committee and a member of the SNIA SSSI Governing Board. The PCIe SSD Committee holds once per month open calls where guest speakers present topics of interest. The TechDev committee investigates new Solid State Storage technologies, products and services and qualifies hardware for the SNIA PTS Reference Test Platform.

Eden is also Chair of the SNIA Solid State Storage Technical Working Group (TWG) which has published Solid State Storage Performance Test Specifications for both client and enterprise SSD test. The PTS provides a standardized methodology, test suites and reporting format for the comparative performance testing of solid state storage devices at the Block IO level.

Eden has published numerous white papers and articles on Solid State Storage, SSD test practices, the SNIA SSS TWG PTS, PCIe SSDs, SSD Synthetic Workloads and more.

Mr. Kim moderates a continuing series SSD related panels of experts at industry trade shows such as Flash Memory Summit, Storage Developers Conference and SNIA Annual Members Meeting. Mr. Kim also speaks at trade shows and gives presentations on various aspects of SSD testing and performance.

Flash Memory SUMMIT

Moderator Remarks
August 2014 - SSD Performance Comparison by Storage Class

August 2014 Summary Performance Comparison by Storage Class

Storage Class				IOPS FOB PTS WSAT - T4Q32	IOPS Steady State PTS IOPS - T2Q16 / T4Q32			Bandwidth PTS Throughput - T1Q32		Response Time PTS Latency - T1Q1	
	Category	Device Type	Capacity	RND 4KiB 100% W	RND 4KiB 100% W	RND 4KiB 65:35 RW	RND 4KiB 100% R	SEQ 1024KiB 100% W	SEQ 1024KiB 100% R	RND 4KiB 100% W Ave	RND 4KiB 100% W Max
	HDD & SSHD										
1	SSHD	7,200 RPM 2.5" SATA Hybrid	500 GB	134	134	131	148	107 MB/s	103 MB/s	18.54 mSec	40.63 mSec
2	SAS HDD	15,000 RPM 3.5" SAS HDD	80 GB	350	340	398	401	84 MB/s	90 MB/s	55.39 mSec	97.28 mSec
	CLIENT SSDs										
3	mSATA	mSATA 1.8" MLC	128 GB	45,743	1,359	1,926	36,517	187 MB/s	533 MB/s	0.74 mSec	543.41 mSec
4	M.2 x2	M.2 x2 2280 MLC	512 GB	61,506	4,185	9,532	71,282	455 MB/s	535 MB/s	0.29 mSec	24.99 mSec
5	SATA Client	SATAIII 2.5" MLC	200 GB	54,788	33,583	50,708	63,640	367 MB/s	480 MB/s	0.06 mSec	11.95 mSec
	ENTERPRISE SSDs										
6	SATA 6Gb/s	SATA 6Gb/s 2.5" eMLC	800 GB	57,422	39,561	46,072	70,604	454 MB/s	504 MB/s	0.05 mSec	0.22 mSec
7	SAS 12Gb/s	SAS 12Gb/s 2.5" MLC	800 GB	97,950	41,516	72,342	145,407	448 MB/s	973 MB/s	0.05 mSec	11.84 mSec
8	SFF 8639	SFF 8639 4 lane 2.5" MLC	700 GB	149,512	44,872	166,002	397,564	564 MB/s	1,698 MB/s	0.01 mSec	0.38 mSec
9	PCIe 8 Lane	PCIe 8 Lane Edge Card MLC	1400 GB	159,926	87,419	236,227	742,674	614 MB/s	2,673 MB/s	0.01 mSec	0.56 mSec

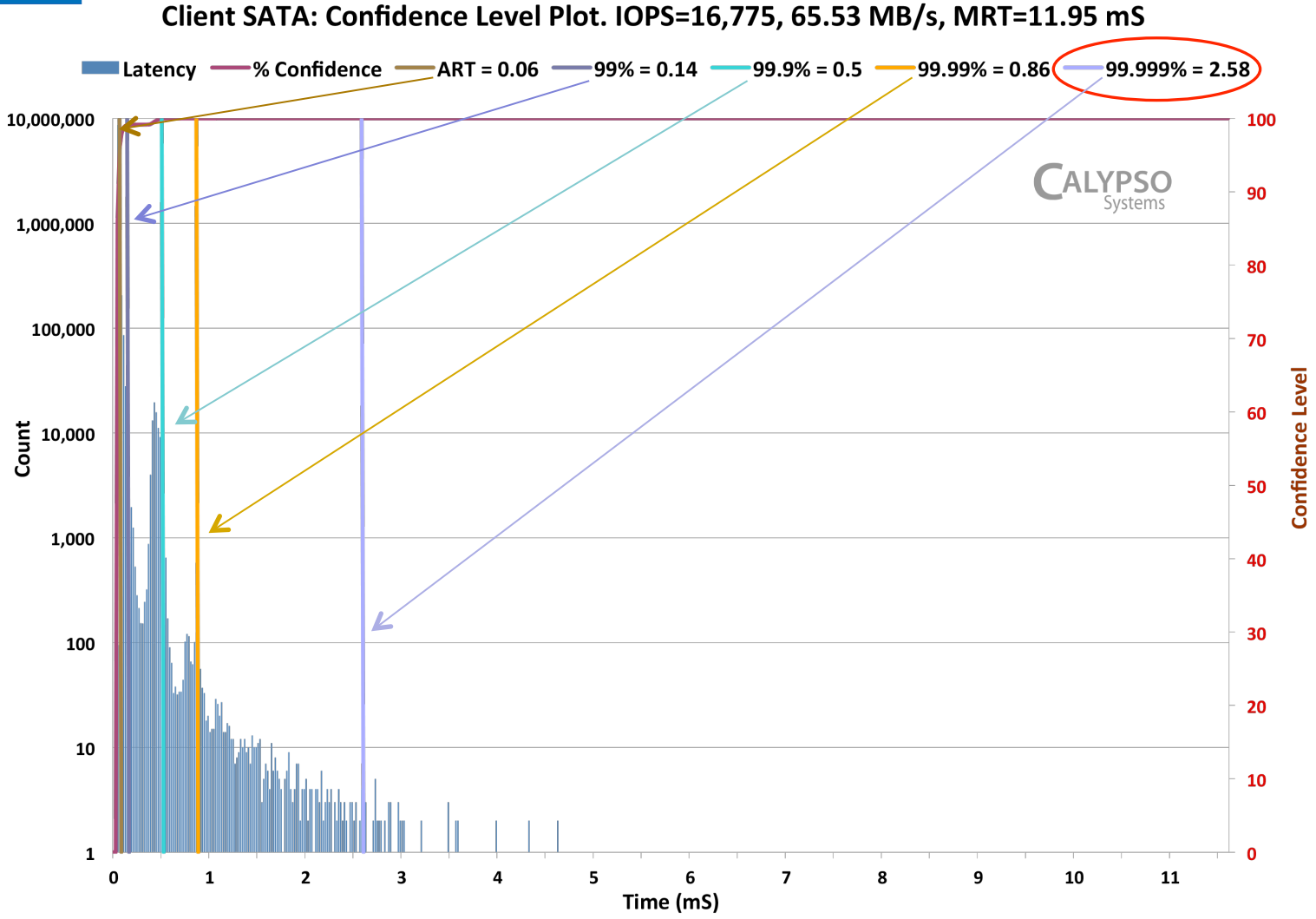
All measurements taken on the RTP 3.0 CTS 6.5 Reference Test Platform pursuant to the SNIA PTS-E 1.1.
NOTE: Thread and Queue settings for PTS IOPS are T2Q16 for HDD/SSHD & Client SSDs and T4Q32 for Enterprise SSDs.

CALYPSO Systems

Note: Performance generally improves as SSD designs advance. SSDs are optimizing IOPS performance for anticipated workloads.
Bandwidth increases with lanes & lane speed (see 12Gb/s SAS and SFF 8639). Response Time AVE & MAX levels should be viewed in context of RT Histogram distributions.

PTS Latency Test Histogram for RND 4K RW0 at T1Q1

How long does it take for 99.999% of total IOs to occur?

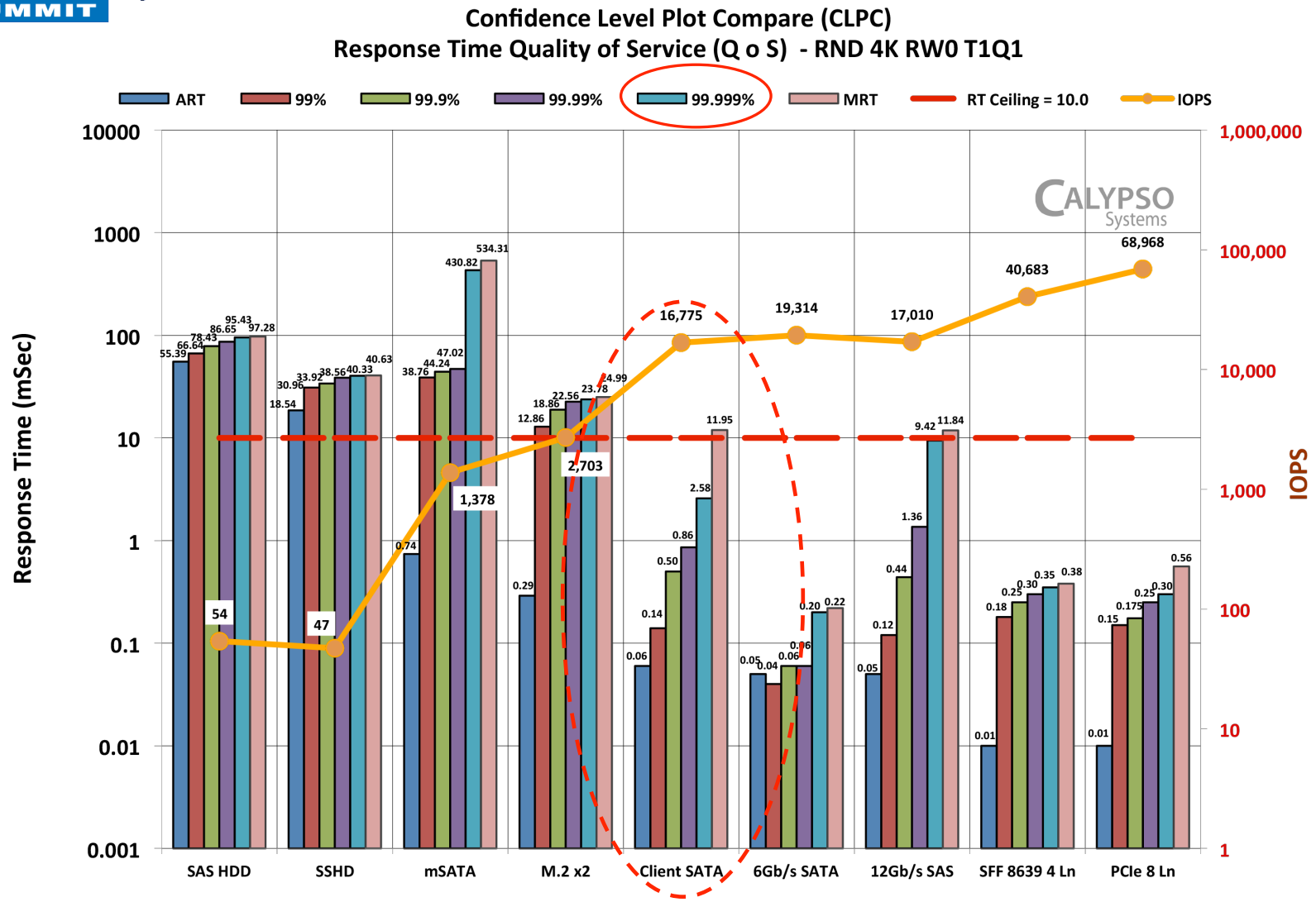


Note: Response Times Histograms show the distribution & frequency of all of the IO response times during the measurement period. In addition to Average and Maximum Response Times, levels are shown for 99%, 99.9%, 99.99% and 99.999% IO completion (or number of "9's" Confidence Level – aka "Quality of Service" or "QoS").

All testing conducted by Calypso on the RTP/CTS pursuant to the SNIA Solid State Storage Performance Test Specification-E v 1.1
For more details, go to www.calypsotesters.com/news

Comparing PTS Latency Test Response Time Histograms

Bars = Response Time Levels; Yellow line = IOPS at T1Q1



Note: RT Histograms for each device are compared above with RT Bars for ART, MRT and RT Confidence % levels. Dotted red line shows the Client SSD from the previous slide. Response Times & IOPS measured during the PTS Latency test (at T1Q1) and differ from Response Times & IOPS measured during the PTS IOPS test (at T2Q16 or T4Q32)

Notes on Performance Comparison by Storage Class Chart for August 2014

- M.2 x2, 12 Gb/s SAS & 4 lane PCIe SFF 8639 SSD are added to Aug 2014 Chart
- NVDIMM SSDs not yet tested to SNIA PTS
- Class performance overlap in certain metrics
- SSD devices can be optimized for a particular workload
- IOPS are generally easier, RND 4K RW0 IOPS are often optimized
- Bandwidth increases with lane count and bus speed
- Response times decrease as performance designs advance
- Response time Confidence Levels provide more context than just ART/MRT
- Performance should be viewed relative to specific workloads

All testing conducted by Calypso on the RTP/CTS pursuant to the SNIA Solid State Storage Performance Test Specification-E v 1.1
For more details, go to www.calypsotesters.com/news

Panelist Biography:

Cameron Brett, Dir SSD Product Marketing, TAEC

www.toshiba.com/taec/

Cameron Brett is Director SSD Product Marketing at Toshiba America Electronic Components' Storage Products Business Unit. He is responsible for defining and marketing Toshiba's SSDs, including SATA, SAS, and PCIe product lines. He has focused on bringing new generations of storage technology to market and working with OEM, datacenter and channel customers.

A 20-year veteran of the storage industry, he has previous product marketing/management experience with PMC-Sierra, Adaptec, QLogic, and Broadcom. He serves on the Board of Directors for the SCSI Trade Association (STA) and holds a BS in Computer Science from Monmouth University and an MBA from Santa Clara University

Panel Topic: **PCIe SSDs – More Performance Options for the Enterprise**

PCIe SSDs – More Performance Options for the Enterprise

New form factors and performance make PCIe an innovative storage interface

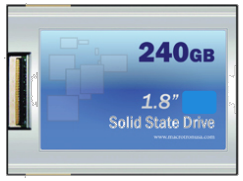
Cameron T Brett

Director, SSD Product Marketing, Toshiba

SSD Form Factors by Interface

3.5” LFF

2.5” SFF



1.8” SFF

M.2

22 x 80 x 2.3mmH/Single
22 x 80 x 3.5mmH/Double
22 x 110mm 3.5mmH/Double

BGA-SSD

16x 20x 2.2mmH

Add In Card

FHFL/FHHL/HHHL

mSATA

30 x 50.95 x 3.95mmH

SAS

SATA

PCI Express

PCIe SSD Product Segmentation *(as of 2014)*

Class	Endurance (DWPD)	Form factor	Capacities in 2015	Power	Performance
High Performance (add-in card)	x10	HHHL (x8) FHHL(x8/x16) FHFL(x16)	3.2TB 6.4TB 10TB	25W – 50W	<PCIe x16 <PCIex8
	x5				
	x1 – x3				
Mid Range Performance (SAS class)	X10	2.5” (x4,15mm)	400GB - 2TB	9W – 25W	600-800K IOPS
	X3	2.5” (x4,15mm)	400GB - 4TB		
	x1	2.5” (x4,15mm)	400GB – 8TB		
Value Performance (SATA class)	x5 (needed?)	2.5” (x4, 7mm)	400GB – 2TB	6W – 12W	150-300K IOPS
	X3	M.2 (22110) 2.5” (x2,x4, 7mm)	400GB – 1TB 400GB – 4TB	6W – 9W	150-200K IOPS
	<x1	M.2 (22110) 2.5” (x2,x4)	400GB – 1TB 400GB – 8TB		
Client / Boot	<x1	M.2 (2280) BGA (x2,x4)	60GB - 512GB	<1W-6W	<80K IOPS
Cold/Cool/HiCap	<x1	3.5” (x4)	20TB-40TB	<1W idle 6W active	25K IOPS

PCIe Segmentation Differentiators

- High performance add-in card
  - x8 or x16 PCIe lanes – widest path for performance; 1M+ IOPS
- Mid-range performance (SAS class)
  - 4K RR performance 150K-200K IOPS today → 600-800K for PCIe
  - Higher MTBF, endurance and performance than SATA-class
    - Performance = x4 PCIe saturation
  - Management “knobs” for OP/capacity
  - Power “knobs” for performance
  - Protection Information (various lengths)
  - End to end error correction
- Value performance (SATA class)
  - 4K RR performance 75K IOPS today → 100K/200K/300K
  - SATA-like pricing
  - Minimal management knobs
- Cold/Cool/Hi-cap
  - Latency benefit – microseconds response time vs. seconds for HDD spin up
  - HDD replacement / Lower TCO than HDD
  - <1W when idle, low power when active, short duration peak power

Panelist Biography:

Keun-soo Jo, Snr Mgr Memory Product Planning, Samsung

www.samsung.com

Keun-Soo Jo has experience in memory technologies and has been with Samsung for over 12 years. He has been responsible for SSD Product Planning in Samsung Electronics Co. Ltd. in Korea and currently the Senior Manager of Samsung Semiconductor Inc. in San Jose with same responsibility.

Mr. Jo has various experience covering areas of System Software, DRAM and Flash engineering within Samsung. As a Memory Product Planning Engineer he was Samsung's representative for the NAND flash Toggle DDR standardization in JEDEC, NVM Express WG, SATA-IO and many other Standard organizations

He started as System software engineer developing Memory test and instrument atomization software and from 2005 to 2007 his responsibility expanded to Sever System Memory applications. He is also an inventor of numerous granted and pending memory related patents.

Panel Topic: **PCIe Express & NVM Express for PCIe Solid State Storage**

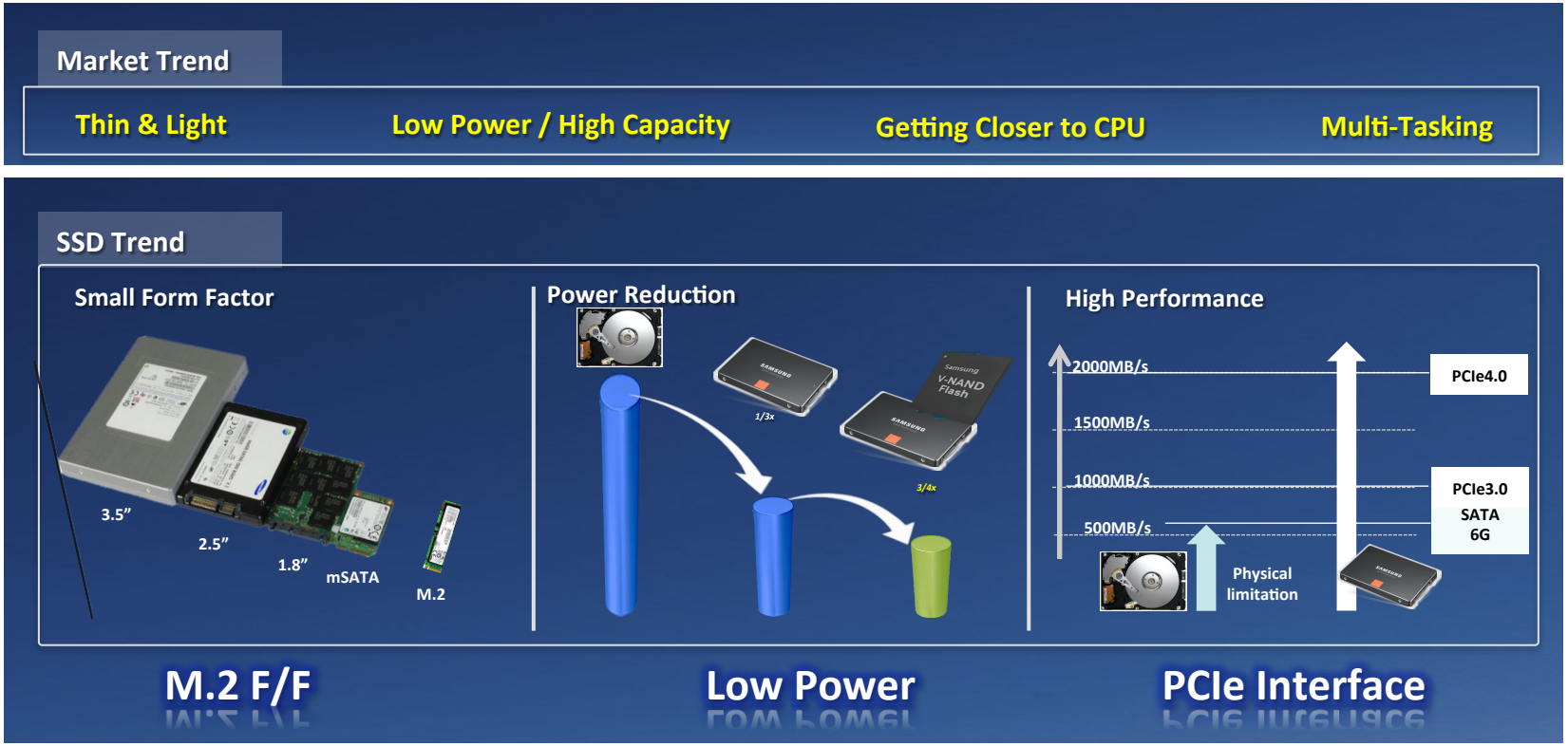
NVM Express™ Panel Discussion

KeunSoo Jo
Senior Manager
Samsung

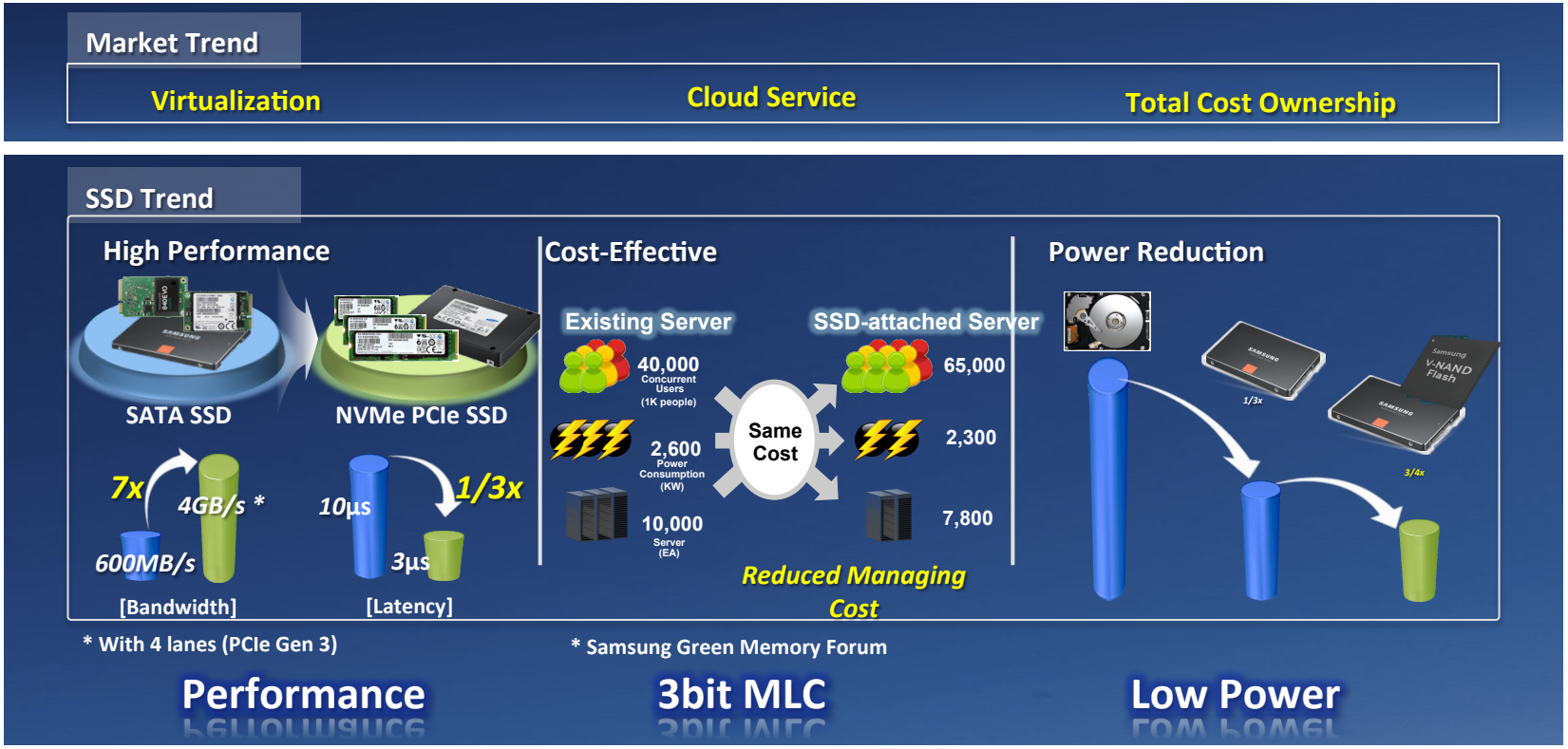
Statement of Position

- PCI Express Interface provides optimized solution for NAND Flash memory as storage interface
- NVM Express provides far beyond legacy PCIe SSD Application

PC SSD with Ultra Low Power SSD



Data Center SSD with Minimized TCO



NVM Express Throughout Applications

*Autonomous Power State Transition

Panelist Biography:

Jon Tanguy, Snr Technical Marketing Engineer, Micron

www.micron.com

Jon is a Sr. Technical Marketing Engineer in Micron's Storage Business Unit, which includes SSD and NAND Flash organizations, serving in this capacity for the past five years. Jon facilitates new product integration and customer qualifications for notebook and desktop applications, as well as SSD in the data center, as well as responsibility for technical documentation. Jon plays a key role in product planning and development, with an eye toward market requirements.

Jon has more than 20 years of experience in the data storage industry, working with both magnetic media and solid state technologies.

Jon earned his Bachelor of Science degree in Electrical and Computer Engineering from the University of Colorado at Boulder

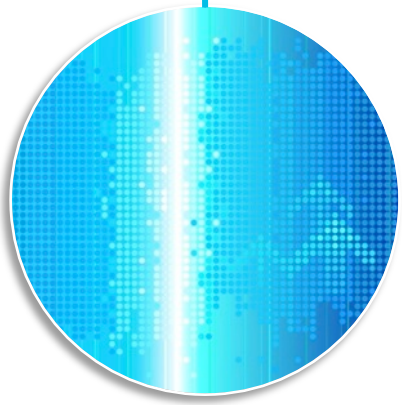
Panel Topic: PCIe SSD – Growth with Partners

PCIe SSD – Growth and Partnership

PCIe Market Growth

Cloud

Big Data



Networking

… and now, Mobile Computing

Case Study: Dstillery
World-leader In On-line Targeted Advertising

"We bought a lot of SAS hard disk drives but kept hitting performance bottlenecks. We had to find a solution to scale quickly without buying hundreds of additional servers."

Choosing Micron Because Of Our Understanding Of Costs And Requirements

Tiers of Flash solutions

- Inexpensive SATA boot SSDs
- Mainstream SATA enterprise SSDs; balancing application requirements and SSD cost.
- The final piece: Enterprise PCIe SSD

Sheer speed of PCIe SSDs enables scale without adding more HDDs or servers

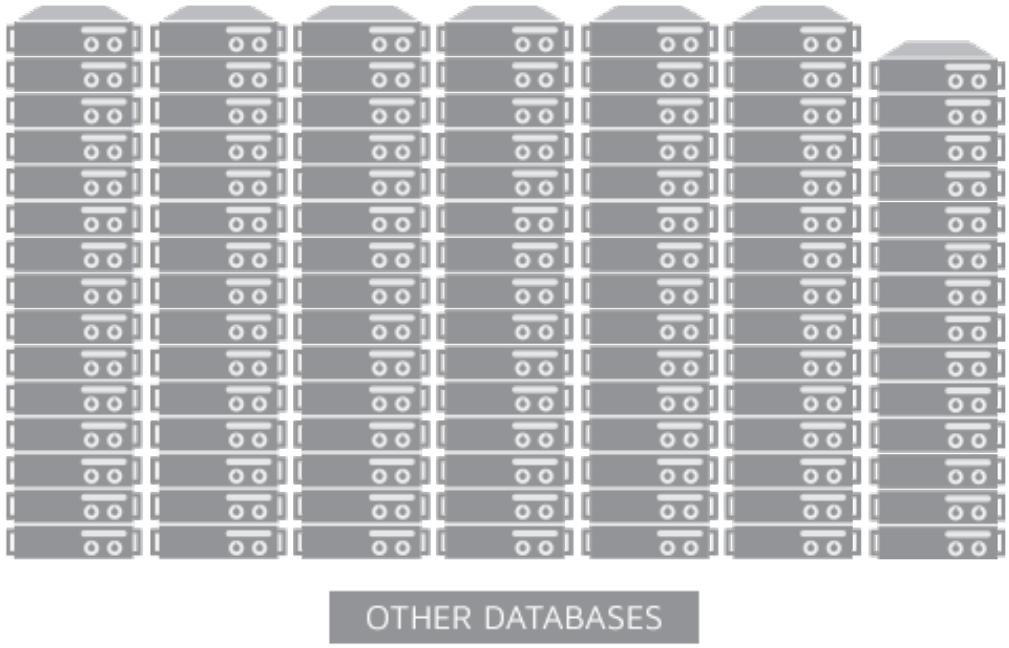
Staying with SAS HDDs required scale-up to 4X the server count, with the additional hosting space and power fees

Case Study: Aerospike
Creating The World's Largest Video Advertising Network

500K IOPS

With Full-Failover

Solution: Micron PCIe SSDs



104 Servers
DRAM Only

8 Servers
SSD & DRAM

PCIe: Coming to a notebook near you

SSD Proliferate to unique, SSD-only platforms

Resolves performance extensibility issues with SATA SSD

- Leaps past 550 MB/s ceiling of 6.0 Gbps SATA

Enables 2- or 4-lane transfer speeds 900 MB/s (read) & 800 MB/s (write) for first generation (x2) drives

- Significantly faster in the x4 options to come

Proliferation of M.2 form-factors enables tremendous flexibility for system designers

- Balancing larger storage scale with ultra thin and light computing in Notebooks and Professional Tablets.


Micron®
Focused on Memory | Engineered for your Innovation

Panelist Biography:

Rob Callaghan, Enterprise Product Marketing, SanDisk

www.sandisk.com

Rob Callaghan brings over 20 years of experience in enterprise storage product marketing.

At SanDisk, Rob drives outbound marketing efforts for SanDisk's ULLtraDIMM and PCIe Enterprise Storage products and solutions.

Most recently, Rob was the manager of product and marketing in the Datacenter Solutions Group at LSI Corporation. Before joining LSI, Callaghan held product and marketing management position at Quantum Corporation, Nortel, 3COM and Adaptec. He is an accomplished speaker, presenting at many industry events, including Storage Networking World and EMC World, and he is actively involved with SNIA in the Solid State Storage Initiative. He is the former Chair for the SNIA Storage Management Forum.

Rob holds a bachelor's degree in Business Information Systems from California State University East Bay and an MBA from Santa Clara University.

Panel Topic: Flash on the Memory Bus – ULLtraDIMM SSD

Forward-Looking Statements

During our meeting today we will make forward-looking statements.

Any statement that refers to expectations, projections or other characterizations of future events or circumstances is a forward-looking statement, including those relating to market position, market growth, product sales, industry trends, supply chain, future memory technology, production capacity, production costs, technology transitions and future products. This presentation also contains forward-looking statements attributed to third parties, which reflect their projections as of the date of issuance.

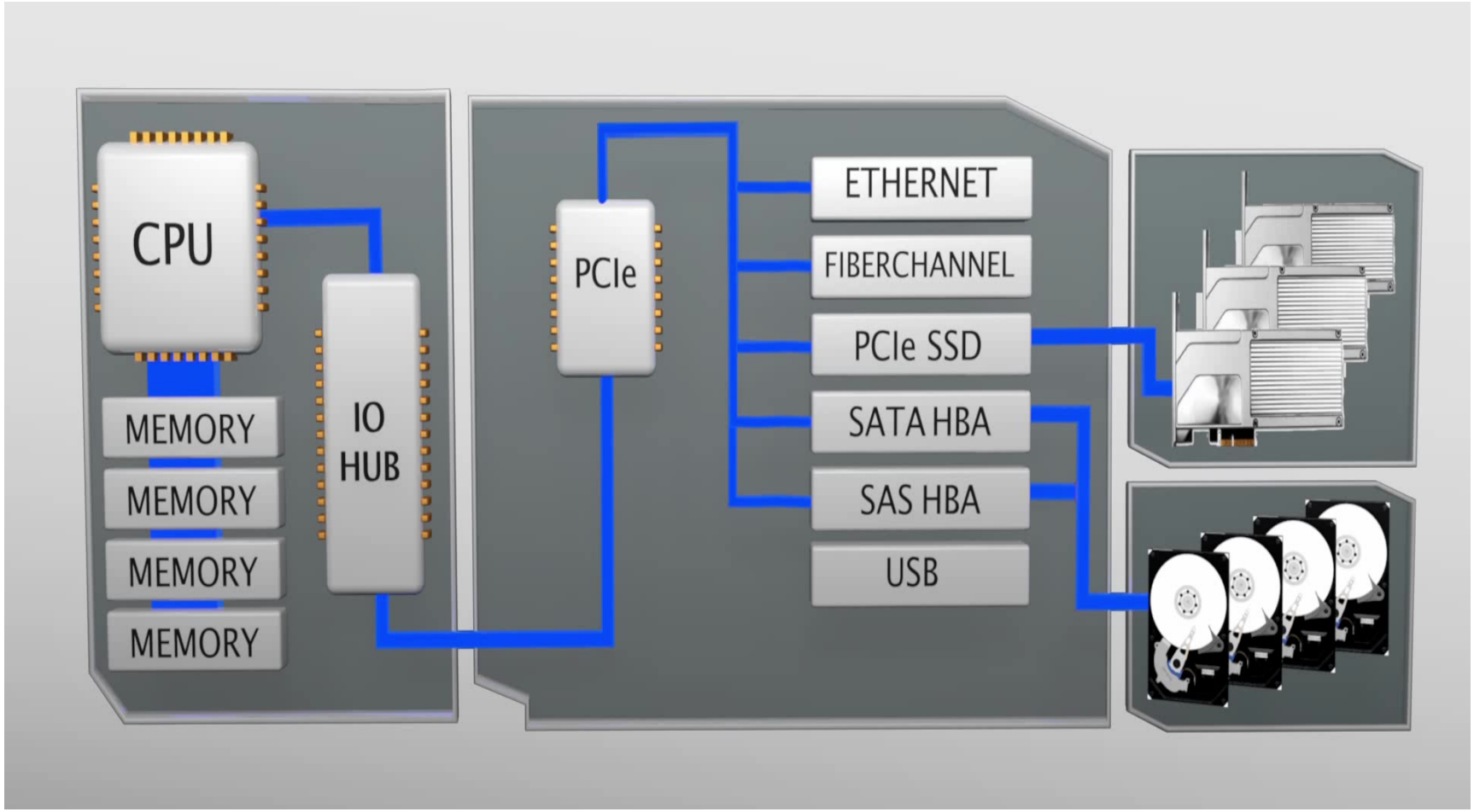
Actual results may differ materially from those expressed in these forward-looking statements due to a number of risks and uncertainties, including the factors detailed under the caption “Risk Factors” and elsewhere in the documents we file from time to time with the SEC, including our annual and quarterly reports.

We undertake no obligation to update these forward-looking statements, which speak only as of the date hereof or as of the date of issuance by a third party, as the case may be.

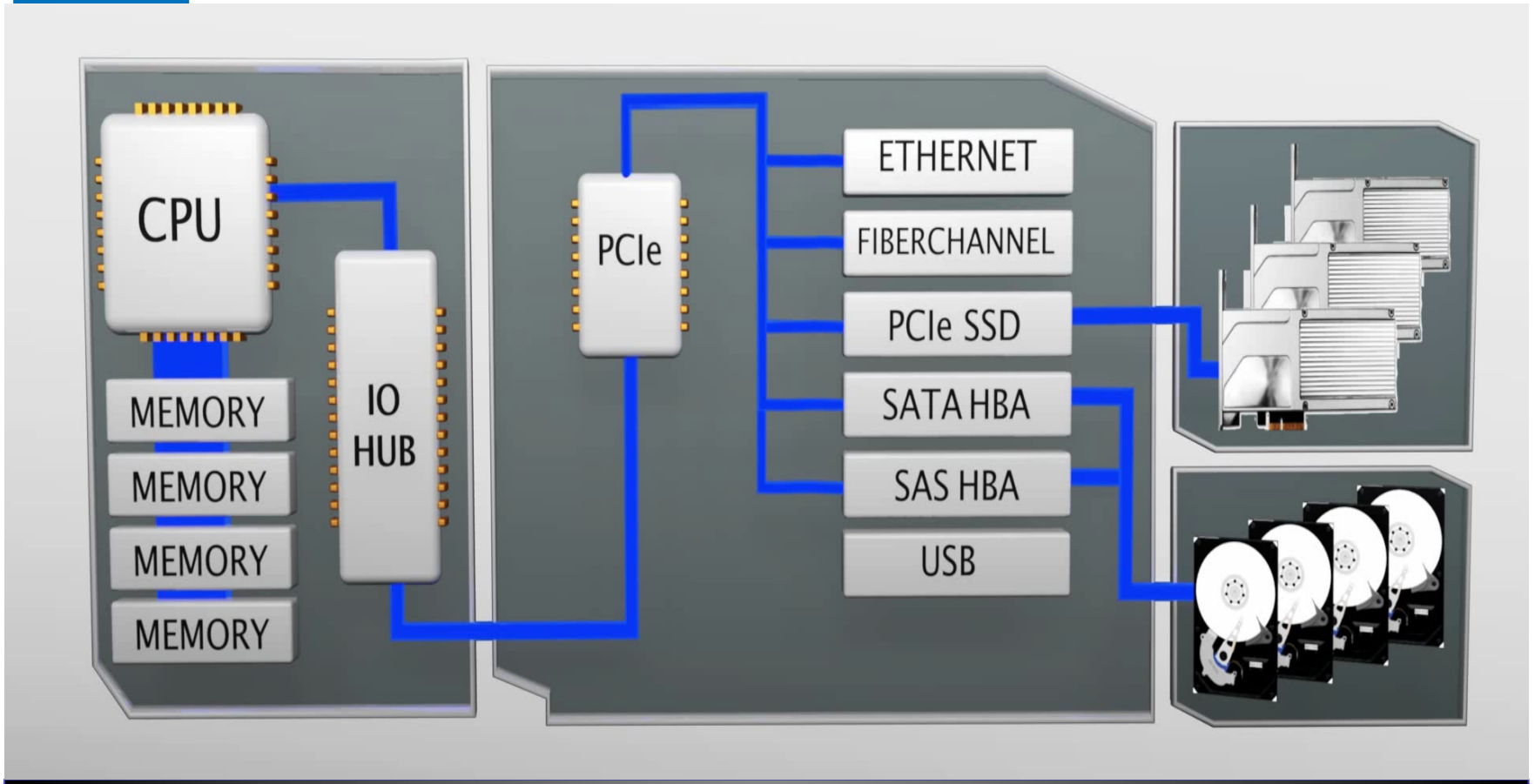
Customer Pain Points

- Enterprise-class SSD solution to accelerate key financial, transactional and database workloads.
- Flash storage solutions that would fit in rack, multi-node and blade based server architectures.
- Easily scale capacity but not pay a response time penalty. (More capacity = higher latency).
- Deterministic latency to allow applications to run more efficiently.

The I/O Bottleneck



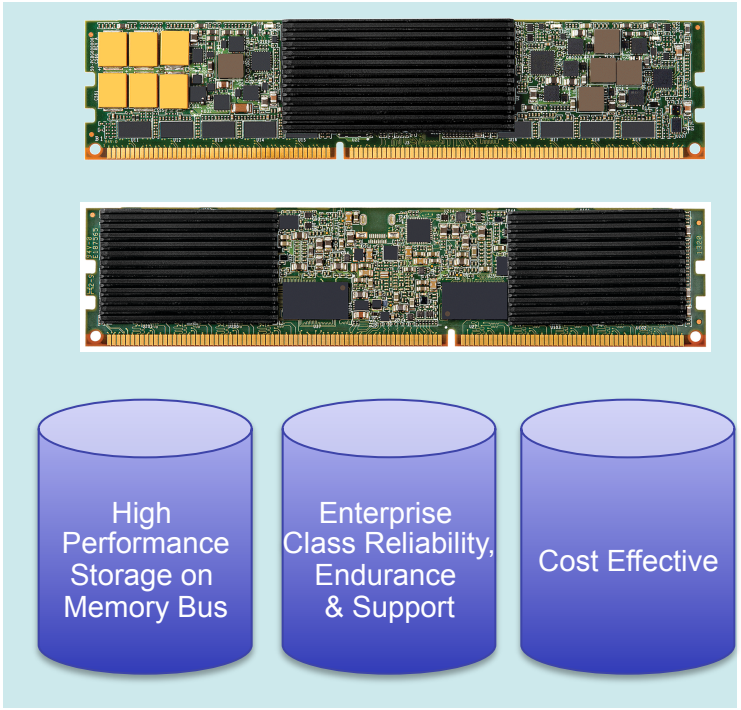
Connecting Flash to the Memory Bus



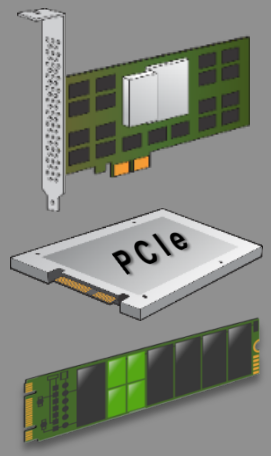
Connecting Flash to the Memory Bus eliminates contention and latency on the I/O hub

Summary – Flash DIMM Enters the Marketplace

- Enterprise-class SSD solution that connects to the Memory Bus.
- Designed for both rack and blade based server architectures.
- Easily Scales using DIMM slots.
- Enables applications to be streamlined for improved performance.



SSD Form Factors by Interface type

SATA	SAS	PCIe	DDR
Tier 2	Tier 1, 2	Tier 0, 1	Tier 0, 1
			

Panelist Biography:

Marty Czekalski, Emerging Architecture & Ecosystem Development, Sandisk , Seagate - www.seagate.com

Marty Czekalski brings over thirty years of senior engineering management experience in advanced architecture development for Storage and IO subsystem design, ASIC, and Solid State Storage Systems.

He is currently Sr. Staff Program Manager within Seagate's Emerging Business Organization.

Previous industry experience includes engineering management roles at Maxtor, Quantum and Digital Equipment Corporation.

Mr. Czekalski has participates in multiple interface standards committees and industry storage groups. He was a founding member of the Serial Attached SCSI Working Group during that lead to the development of Serial Attached SCSI. He currently serves as President and member of the Board of Directors of the SCSI Trade Association. Mr. Czekalski is also an active member of T10, SNIA, PCI-SIG and JEDEC.

Mr. Czekalski earned his MS degree in Electrical Engineering from the University of Maryland, and his BE degree in Electrical Engineering from the Stevens Institute of Technology.

Panel Topic: **Key Value: Solid State Storage – the Next Frontier**

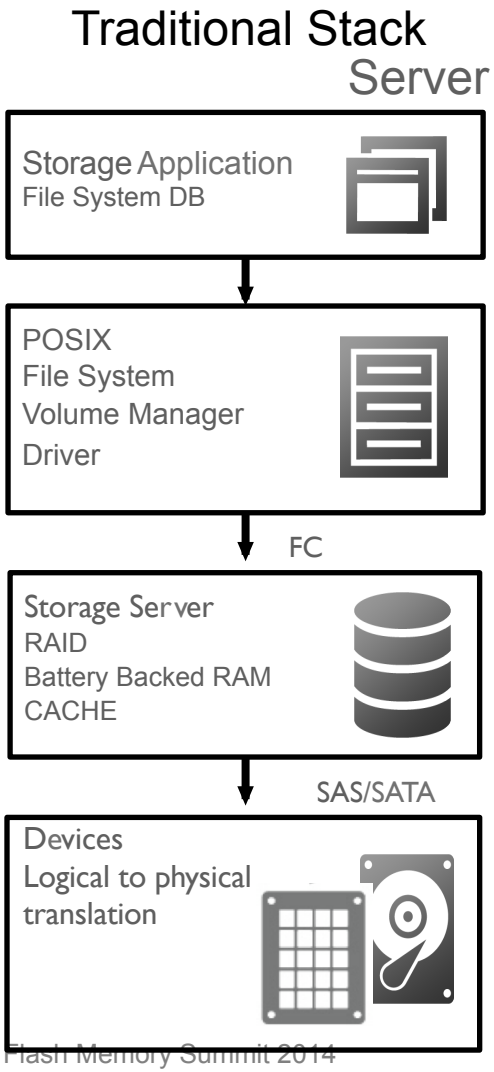
Key Value Solid State Storage:

The Next Frontier

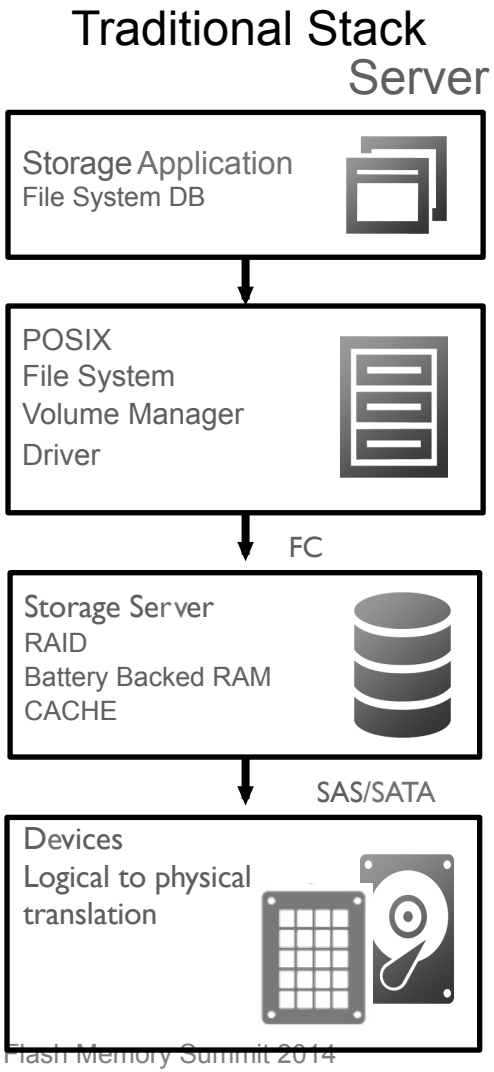
Marty Czekalski

Seagate Technology

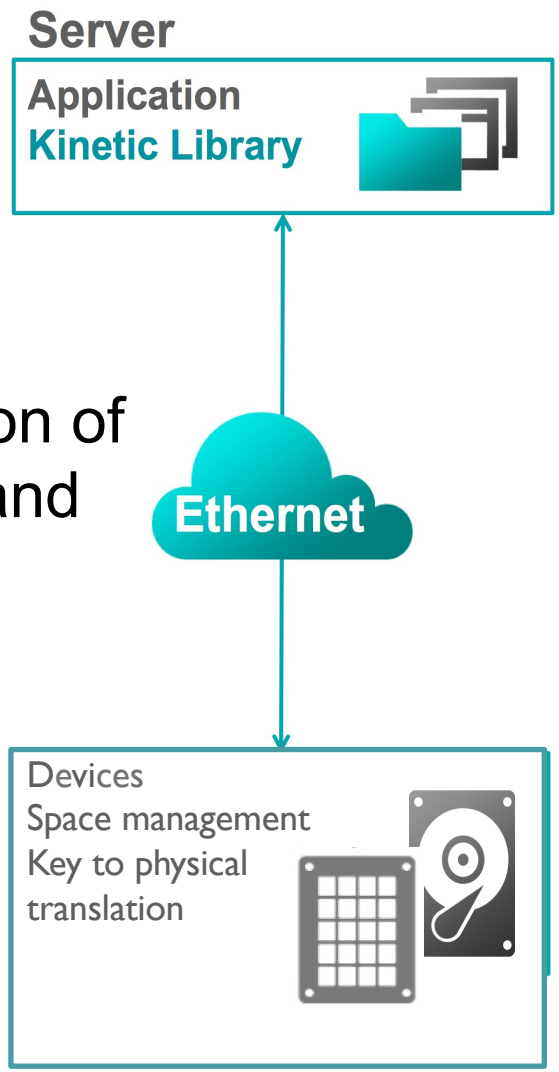
Key Value Concept



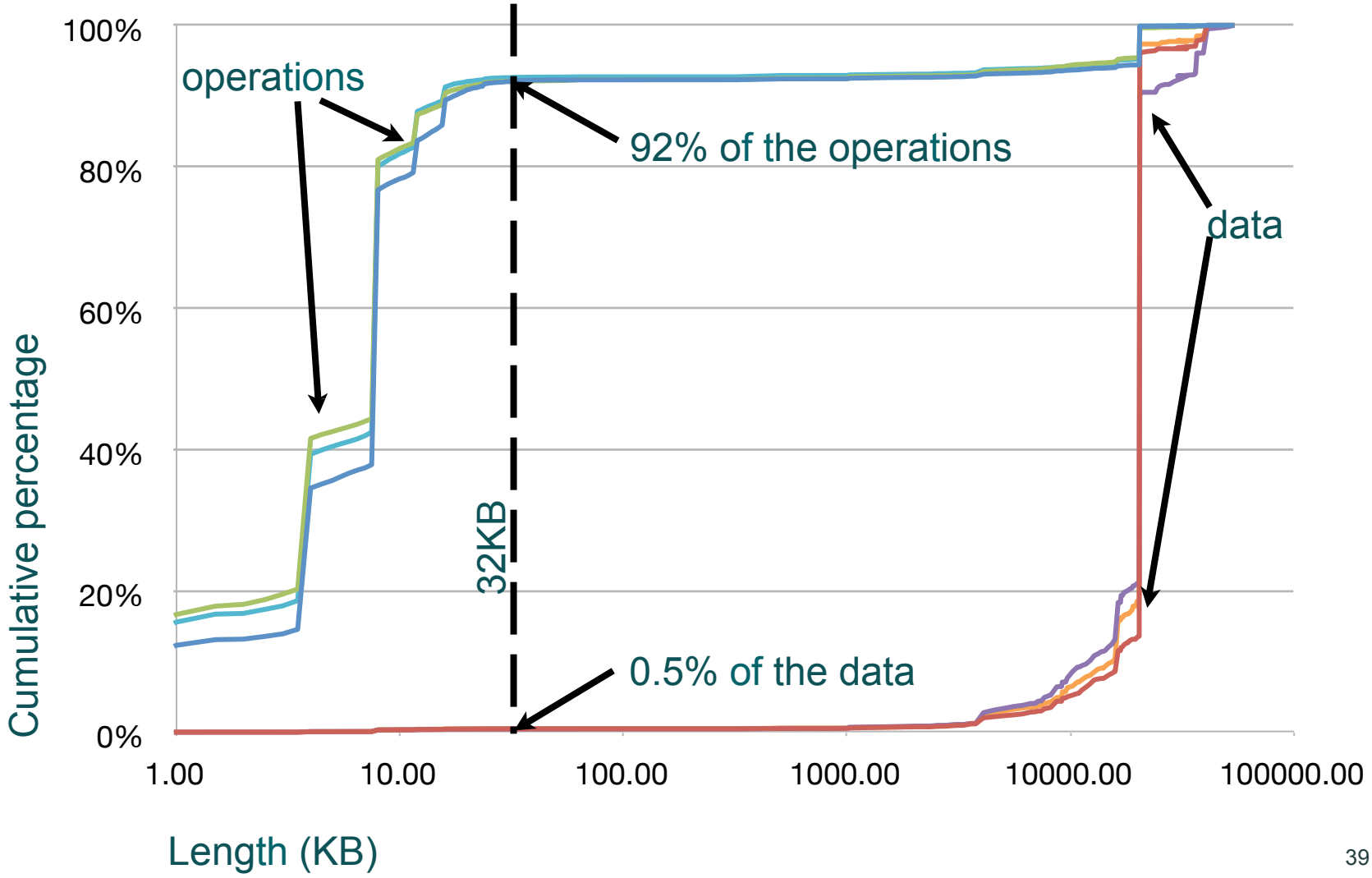
Key Value Concept



Dramatic reduction of metadata traffic and accesses

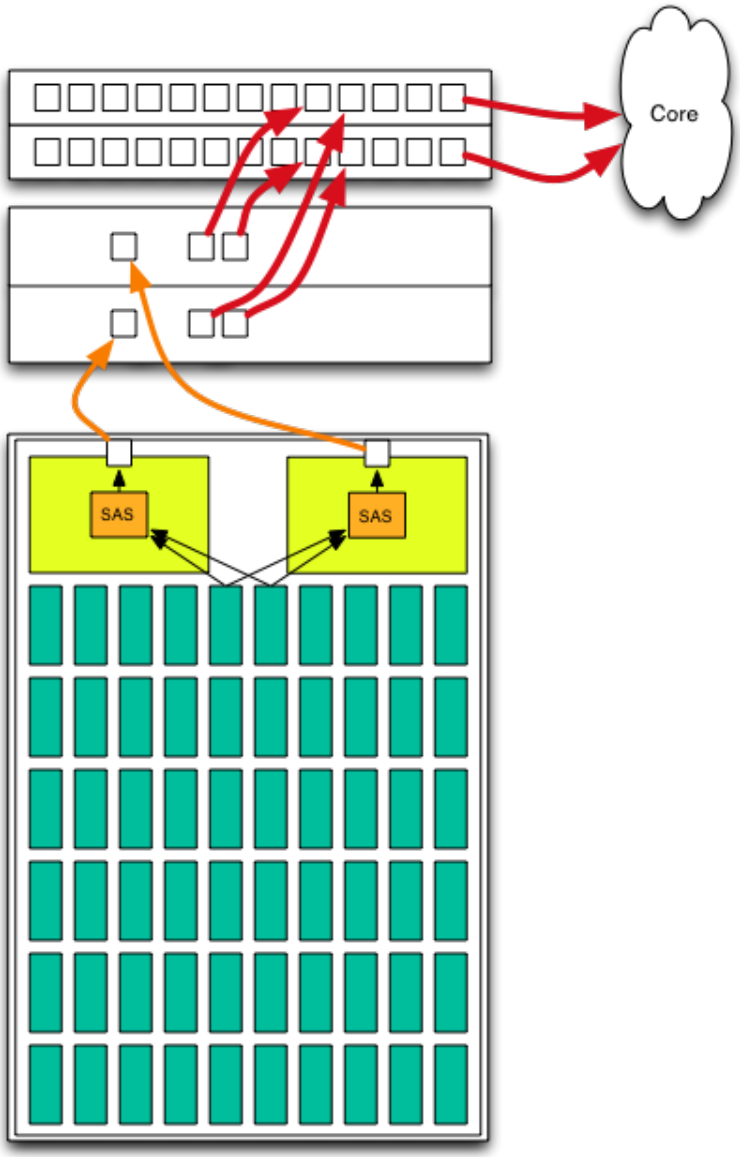


Cumulative operations ordered by length



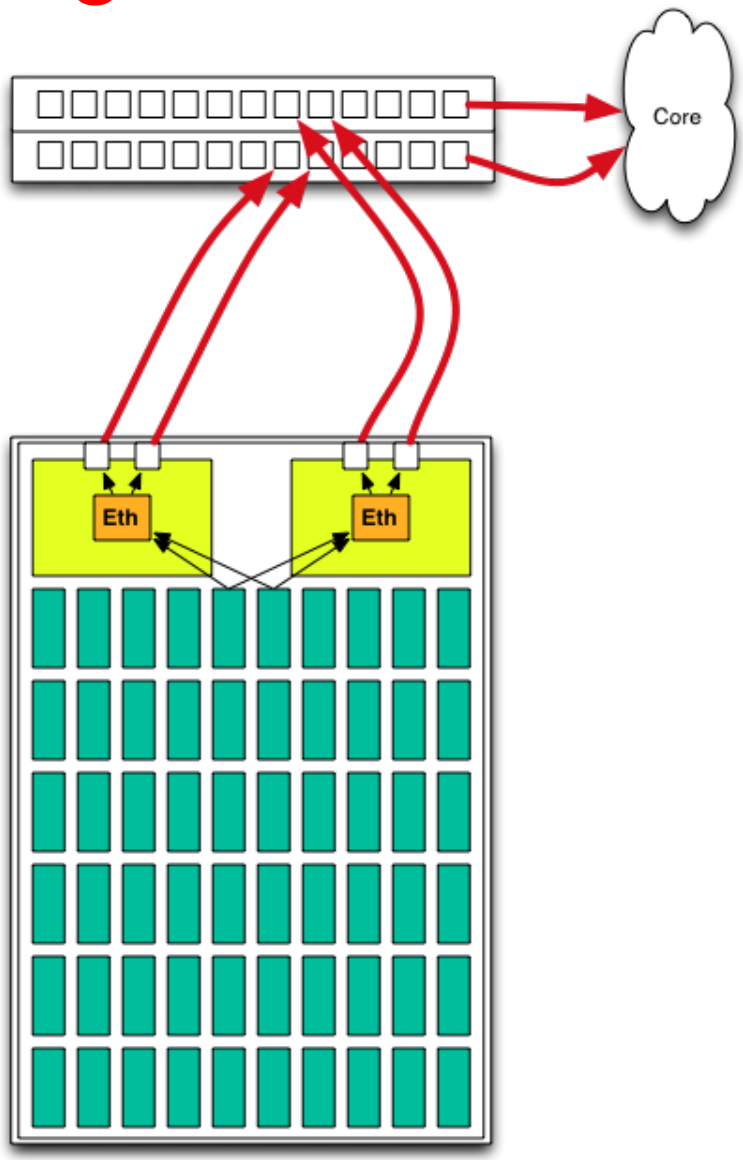
Typical HA High Density KV Store

- Storage Server Node
  - Common in hyper-scale deployments (e.g. CEPH, HDFS, Swift, etc)
- Intel server (KV function)
  - Double Socket
  - 48GB Ram
- Storage tray
  - Connected to the server



Low cost HA Configuration

- Each drive talks to both switches
- Each switch has multiple Ethernet ports
- KV Tray talks directly to ToR
- No servers



Converging Technologies

- Scale out architectures becoming more widely deployed – not just the big guys anymore
- Advancements in Ethernet
  - 40Gb/s and 100Gb/s, Silicon Photonics, RDMA
  - New switch architectures
  - Latency reduction (us) 100's ⇨10's ⇨1's
- Continued increases in compute and storage density

Opportunities

- Optimize the KV database and FTL
  - Elimination of OS stack and file systems overhead
  - Interface is media agnostic allowing for optimization to media characteristics
  - Use the log structure of the media to provide a more natural storage systems
  - Reduced write amplification
- Operations are inherently atomic
- TCO reduction by eliminating storage node servers
  - Capital, power, space, maintenance

Challenges

- Throw out existing device performance concepts and metrics (~~IOPs~~)
- New performance metrics – more file system like
  - KVOPs per GB
  - Full vs empty
  - Key and Value sizes
  - Characteristics of content

Panelist Biography:

Swapna Yasuparu, Dir SSD Product Marketing, HGST

www.hgst.com

As director of SSD Product Marketing at HGST, Swapna Yasarapu is charged with delivering the next-generation SSDs products. This includes assessing emerging technologies, defining requirements for new products, and aligning customers and industry partners with HGST's product and technology strategy.

With a Master's in Electrical Engineering from University of California and a MBA from Anderson School of Management, University of California, Swapna blends her hi -tech industry knowledge with marketing and strategy to bring enterprise-class products to market.

Swapna has over 15 years of in depth experience in hi-tech storage networks with responsibilities spanning from ASIC development, product development to managing hardware and software storage products through concept and development to production.

Panel Topic: **Different Strokes: Application Aware SSD Performance**

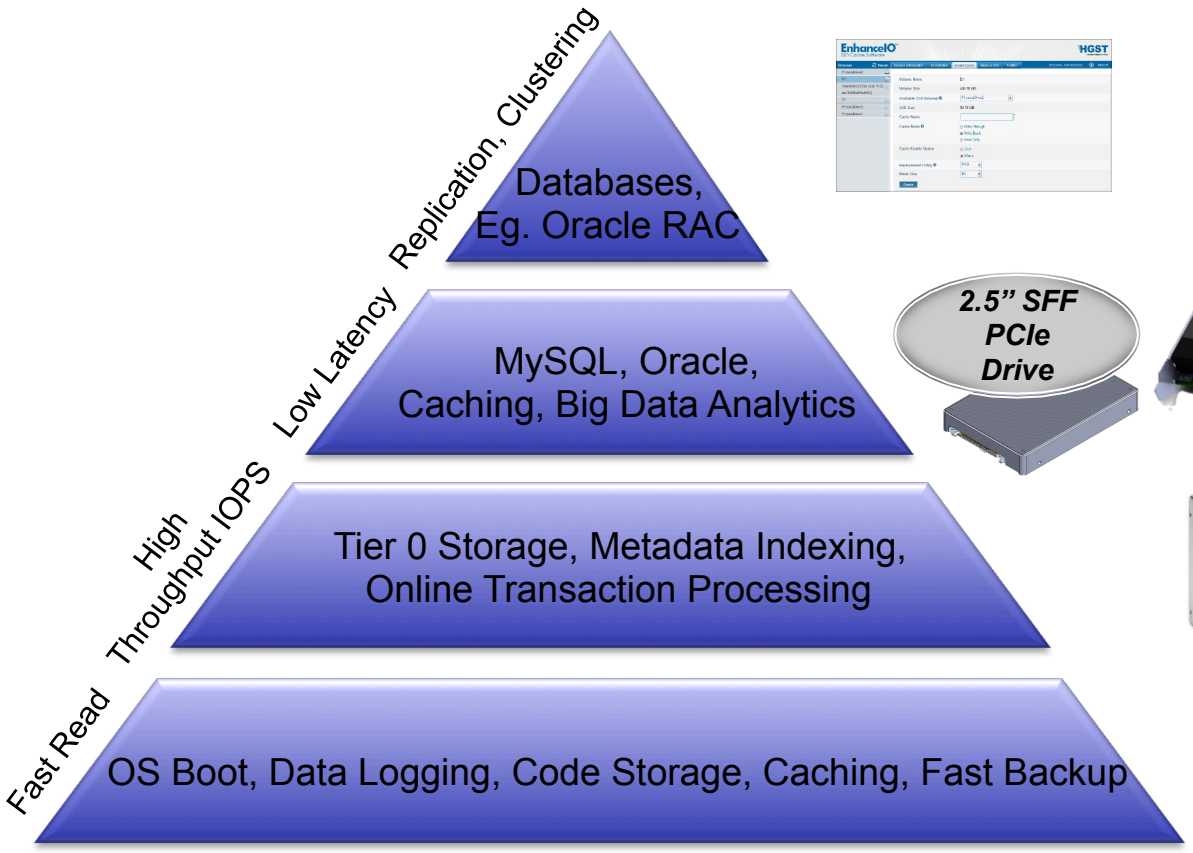
Different Strokes: Application Aware SSD Performance

Swapna Yasarapu

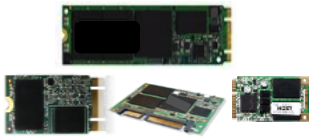
Director, SSD Product Marketing

HGST
a Western Digital company

One Size doesn't Fit All



Flash Aware Server Side Caching & Clustering software



Need to comprehensively address choke points to benefit from SSD performance

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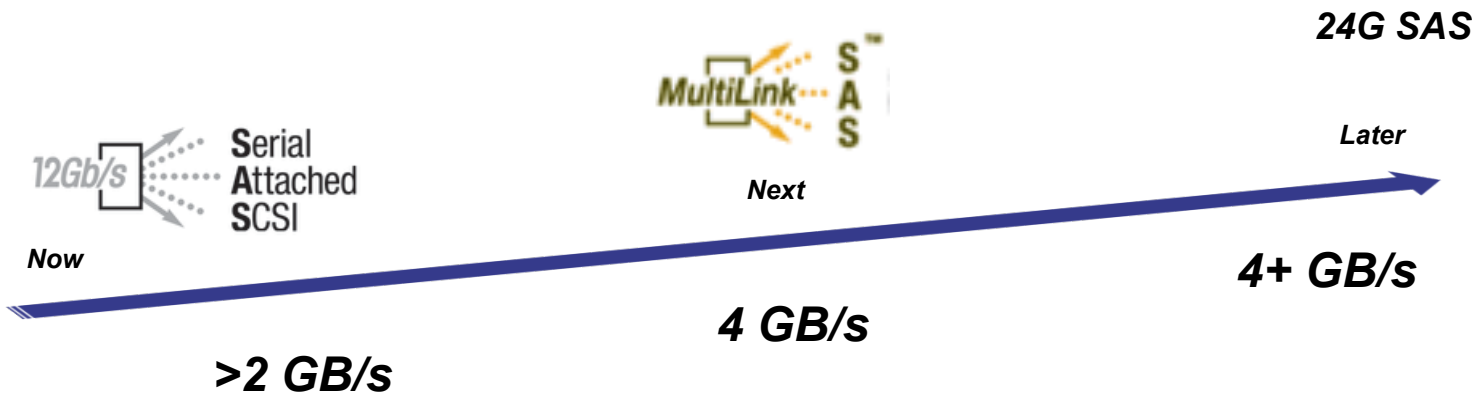
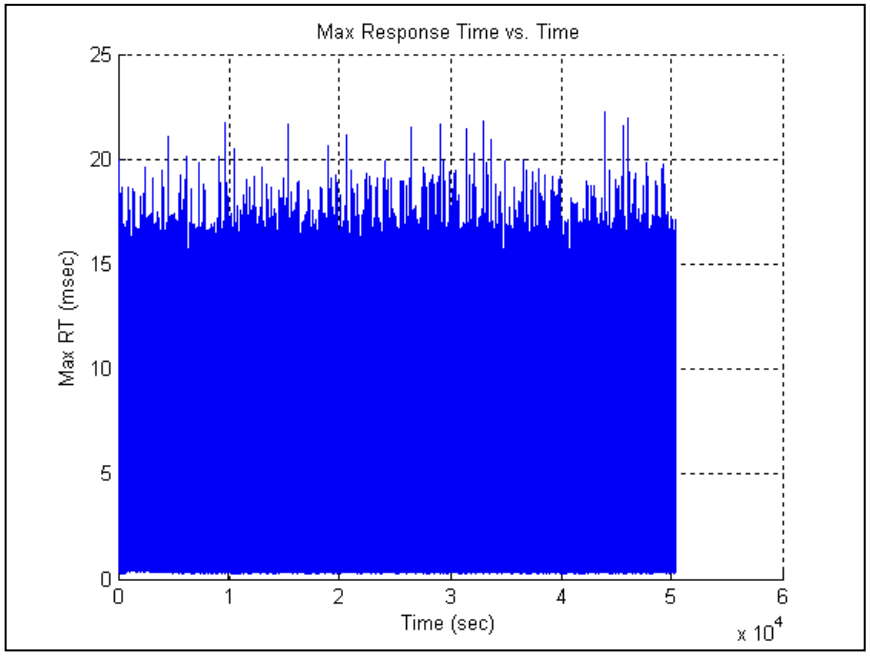
Innovating on throughput/ IO Performance

- Speeding up I/O Interfaces
- Scale performance to match scaling capacity
- Drive Efficiency in IOPs/GB

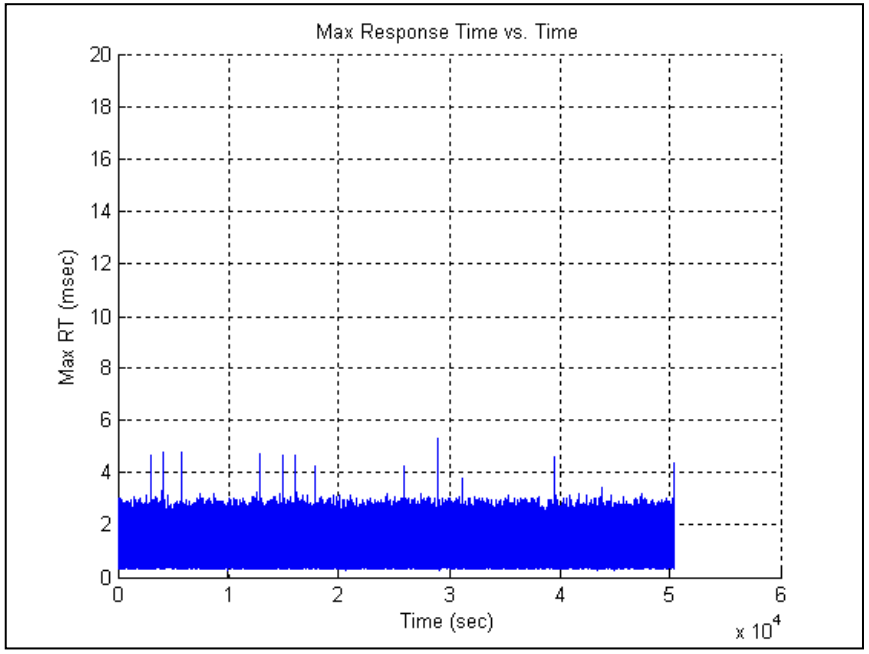


Delivering on Quality of Service (QoS)

- The last I/O counts
- Latency consistency is the key



High Latency Spikes causing application slow down



Consistent Latency profile – enabled consistent logging => Faster Application run time

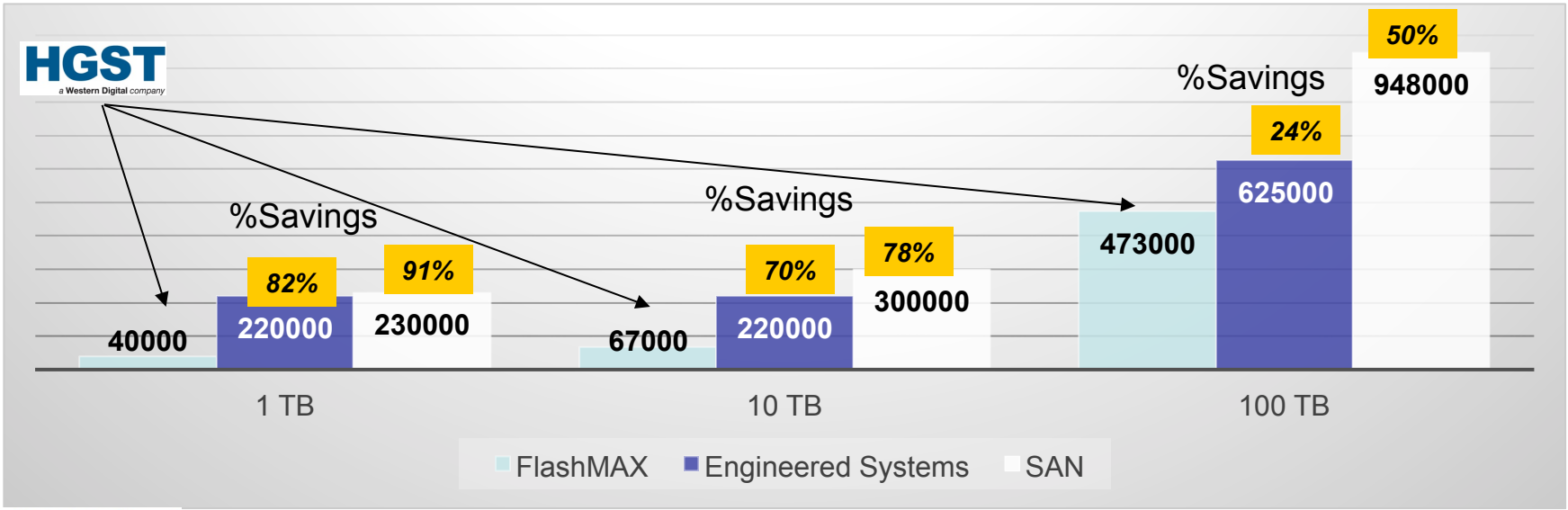
Key Takeaways

- Application needs drive performance requirements
- To unlock the SSD performance – need to eliminate choke points along the stack
  - Speed up IO interface
    - 12G SAS -> Multilink SAS -> 24G SAS
    - PCIe Generational speed up
  - Deliver on consistent latency profile
  - Make applications flash aware

Backup

Tie it all together with Flash Aware Clustered Software Solution

- ✓ Consistently high all-flash performance with node redundancy and high availability
- ✓ Deliver Scalable Infrastructure
  - ✓ Up to 72 TB of flash in a standard x86 server
- ✓ At a fraction of current SAN deployment cost



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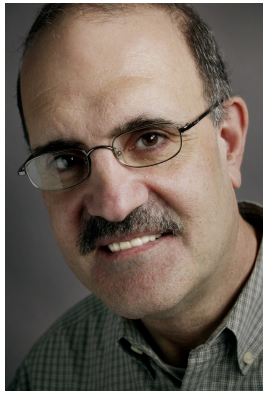
Panelist Biography:

Jim Pappas, Director of Technology Initiatives Data Center Group, Intel
www.intel.com



Jim Pappas is the Director of Technology Initiatives in Intel's Data Center Group. In this role, Jim is responsible to establish broad industry ecosystems that comply with new technologies in the areas of Enterprise I/O, Energy Efficient Computing, and Solid State Storage. Jim has founded, or served on several organizations in these areas including: PCI Special Interest Group, Storage Networking Industry Association (SNIA), InfiniBand Trade Association (IBTA), Open Fabrics Alliance (OFA), The Green Grid, and several emerging initiatives in his newest focus area of Solid State Storage.

Mr. Pappas has previously been the Director of Technology Initiatives in Intel's Desktop Products Group, and successfully led technologies such as AGP Graphics, DVD, IEEE 1394, Instantly Available PC, PCI, USB, and other advanced technologies for the Desktop PC.

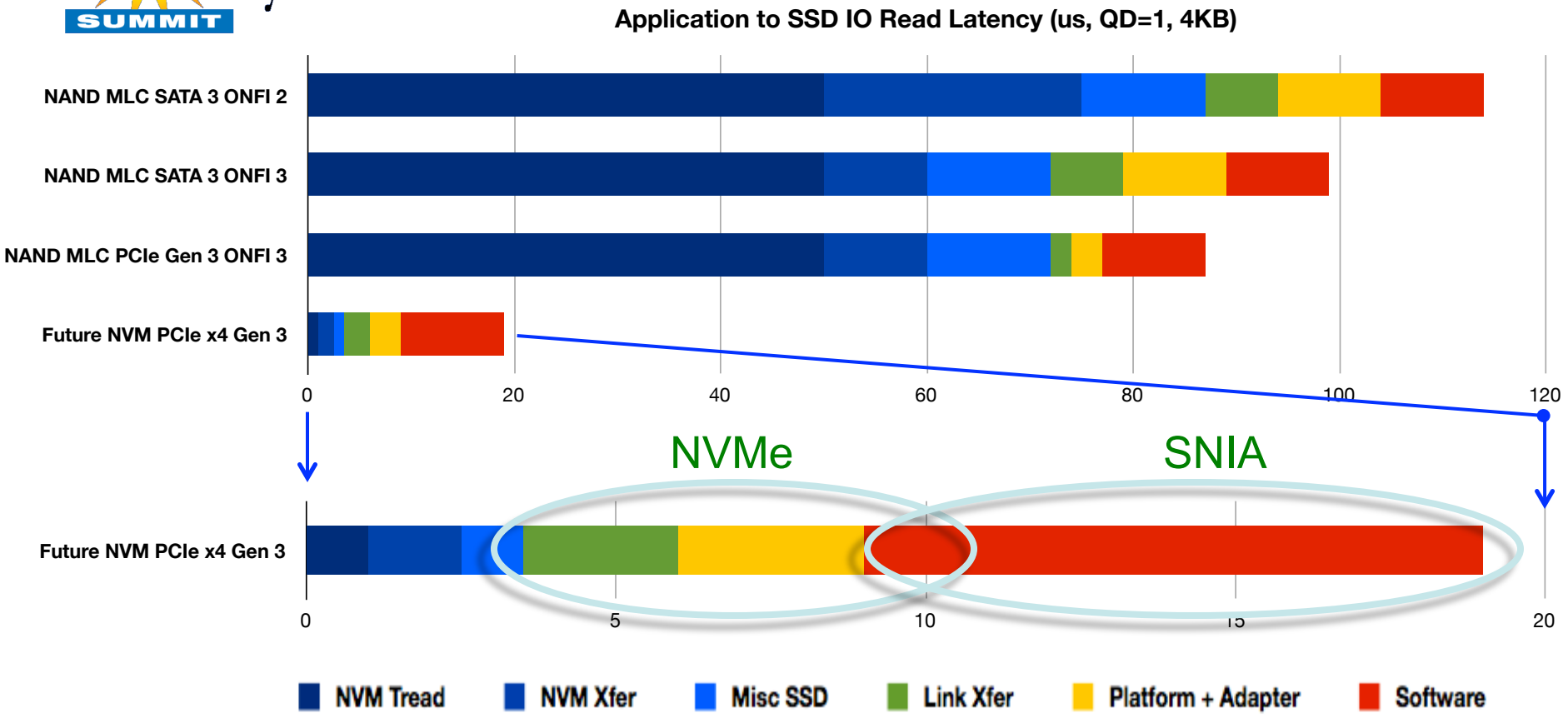
Mr. Pappas has over 30 years of experience in the computer industry. He has been granted eight U.S. patents in the areas of computer graphics and microprocessor technologies. He has spoken at dozens of major industry events and holds a B.S.E.E. from the University of Massachusetts, Amherst, Massachusetts.

Panel Topic: Low Queue Depth IOPS

Low Queue Depth IOPs

Jim Pappas
jim@intel.com

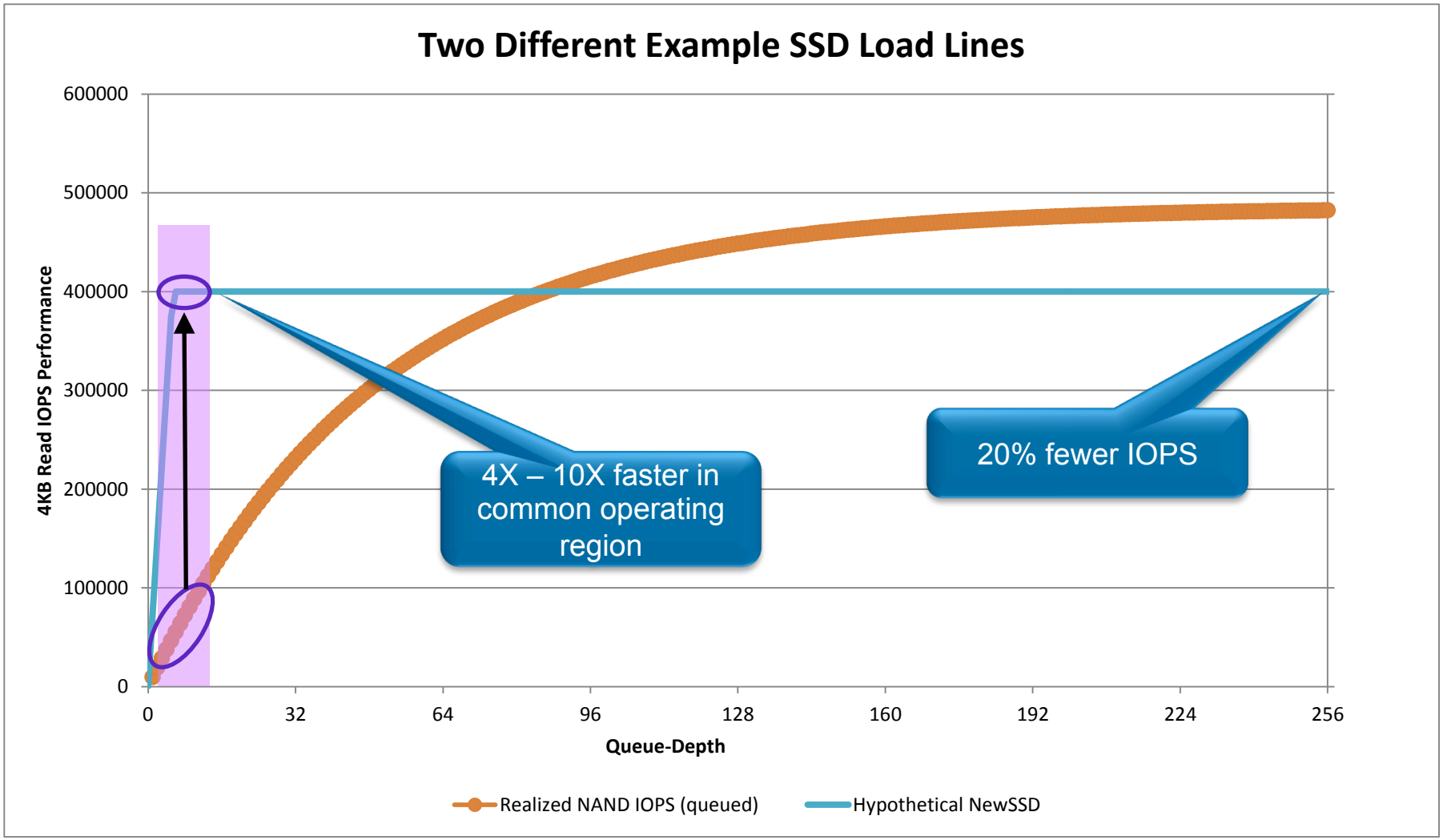
Opportunities with Next Generation NVM



NVM Express: Optimized platform storage interconnect & driver

SNIA NVM Programming TWG: Optimized system & application software

Comparison – which is the “better” SSD?



Conclusion: A New Metric for Measuring SSDs is Needed

Questions?

Jim Pappas
jim@intel.com

Panel Question & Answer Session
General Questions for Panelists

1. What are the key movers that are driving the rapid growth of solid state storage?
2. What are the key technologies that will create separation in the marketplace?
3. What problems are today's advanced SSD products solving?
4. Where/how do you see the major SSD categories affecting the marketplace?
5. What is the single most important influence that will shape SSD markets?
6. How does your product/technology solve a key market demand?
7. What does the SSD landscape look like in 10 years? 20 years?

Panelists Questions – please add a few questions either on your presentation or targeted at someone else's presentation

From Brett Cameron:

Q1. Why does PCIe offer so many more variations for the enterprise over SAS or SATA?

Q2. Will PCIe replace SAS or SATA in the long term?

From Jim Pappas:

Q1: You say that new metrics for measuring SSD performance will become necessary once we have SSDs created with "new media". Do you have an opinion on which organization should be driving that effort?

Q2: Do we really need new tools and benchmarks to measure "new media"… Or is it a re-focus of how we use existing tools and benchmarks?

From Swapna Yasurapu:

Q1. Myth vs. reality: What are the most common myths regarding SSD performance? Your thoughts on what is really important?

Q2. Where do you see the adoption of PCIe SSDs occurring? Is it cannibalistic to SATA / SAS SSD adoption?

From Marty Czekalski:

Q-JP - If what really matters is single queue depth latencies, why is the industry obsessed with high IOP numbers at max queue depths?

From Rob Callaghan:

1. How is this different than NVDIMM
2. Why is this the FlashDIMM architecture beneficial to applications
3. How is this different than NVMe solutions

For Marty:

1. Is this Software or an architecture
2. Can you explain share some applications that benefit from this?
3. Is this a transparent architecture or do applications have to be modified to use it.
4. Can you explain how the Low Cost HA configuration works given connect to a server like the first one?

From Jon Tanguy:

Q1: Jon, what is the most important factor your partners use in choosing a storage architecture?

Q2: Samsung. What challenges are seen in deploying M.2 SSDs in data center computing?

From Keun-soo Jo:

Q1.

Q2.