

# Enterprise Data Integrity and Increasing the Endurance of Your Solid-State Drive

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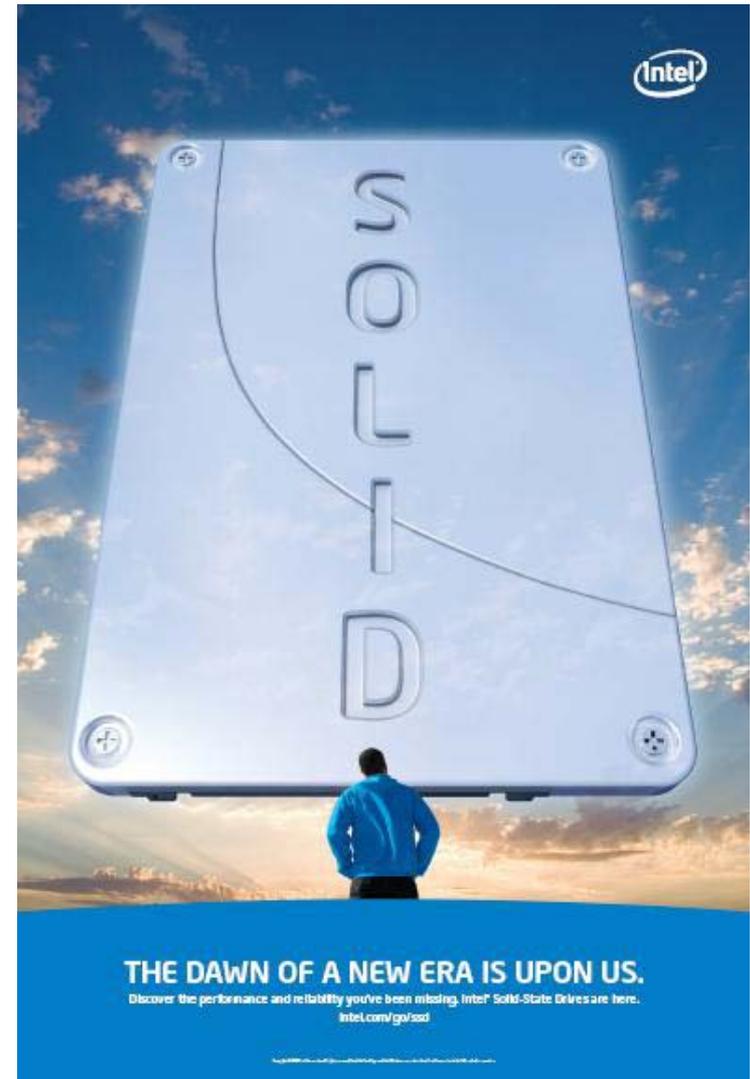
MEMS003

Sponsors of Tomorrow: 

# Agenda

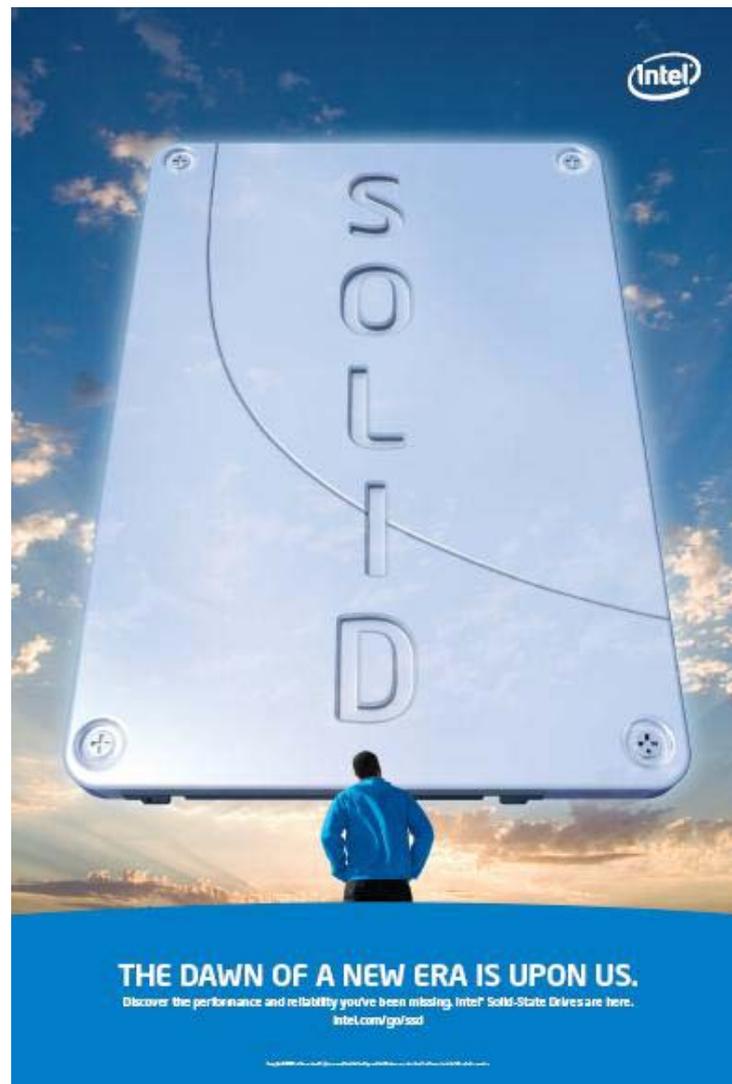
## Enterprise Endurance & Data Integrity

- What is SSD Endurance?
- Impacts on Endurance
- Validating SSD Endurance
- Enterprise Data Integrity Features – Hitachi SAS SSD Case Study



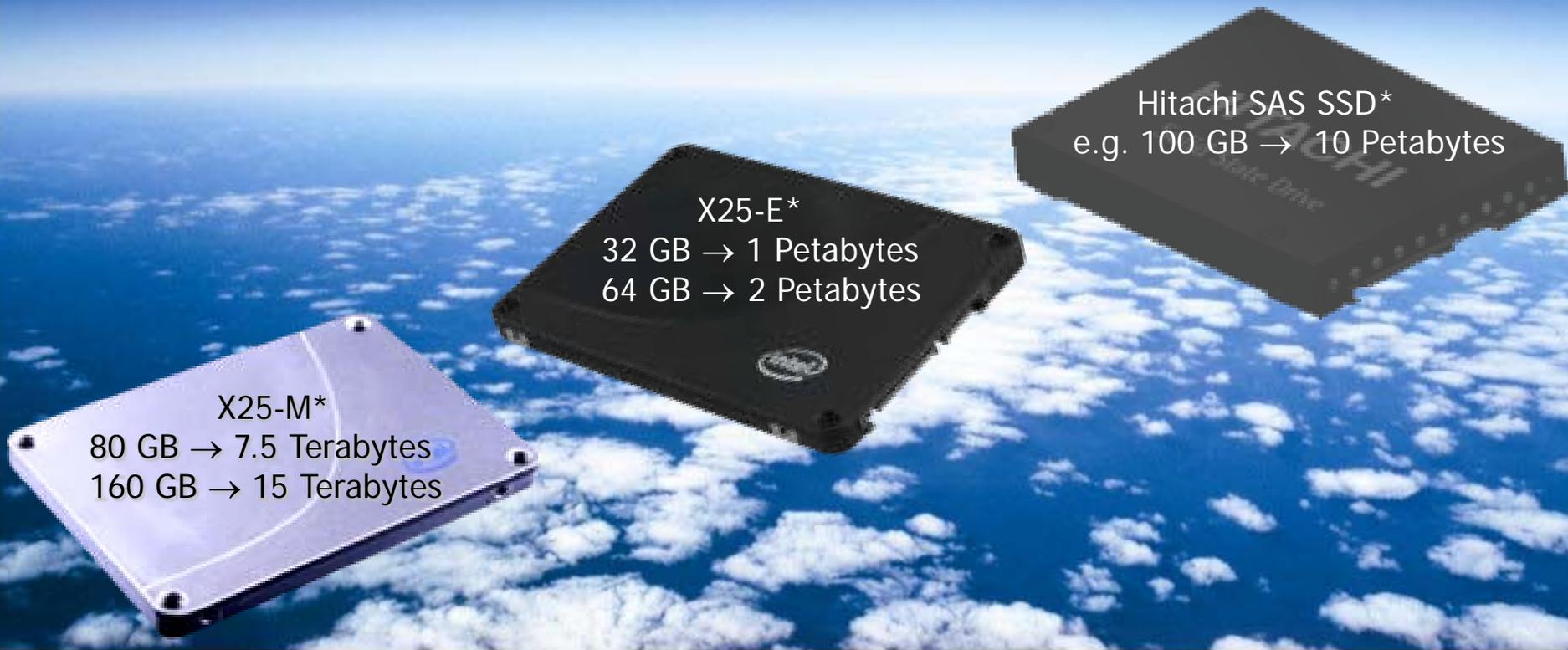
# Enterprise Endurance & Data Integrity

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# What is SSD Endurance?

- Enterprise SSD Endurance can be defined as the total amount of random host data which can be written within the life of the drive



\*Intel® X25-M Mainstream Solid-State Drive

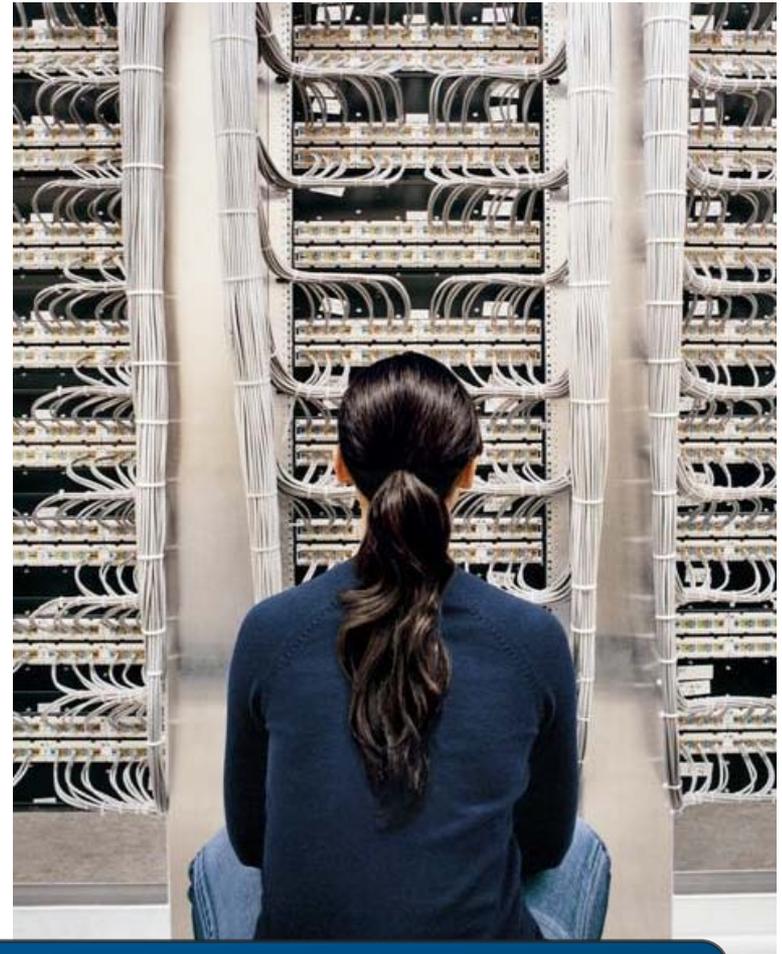
\*Intel® X25-E Extreme SATA Solid-State Drive

\*Other names and brands may be claimed as the property of others

4 Enterprise Endurance specified as 4K writes written randomly to all LBAs, queue depth 32, Write Cache enabled, Client Endurance not shown

# Why Endurance Matters with SSDs

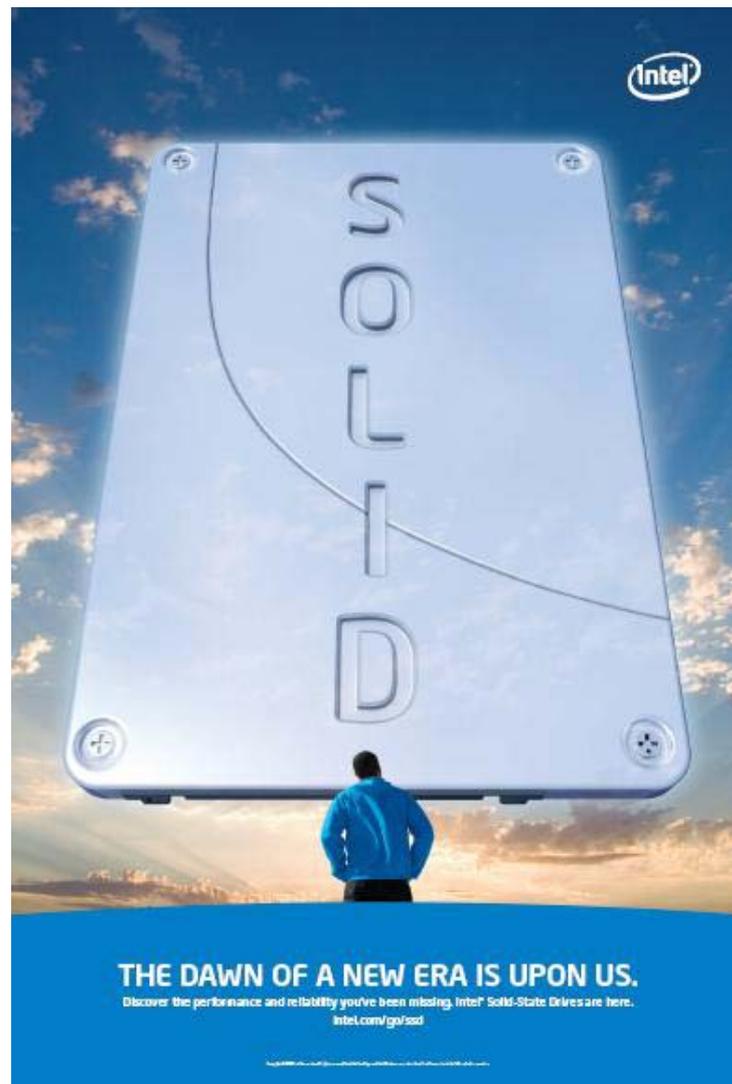
- Under demanding enterprise workloads, SSDs based on NAND flash can wear out
- There can be greater than 10X difference in endurance between SSD models in enterprise workloads
- To ensure the best SSD value, choose and configure the SSD to match the endurance needs of the application



***Understanding elements which impact SSD endurance enable ROI optimization***

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# What Impacts Endurance?

## NAND Technology

Block erase cycles (SLC vs MLC )

## Write Workload

Random vs Sequential

## Spare Area

Capacity reserve / work space

## Managed by:

### Firmware Algorithms

Efficiency of NAND writes (Write amplification) and wearleveling

## Delivers:

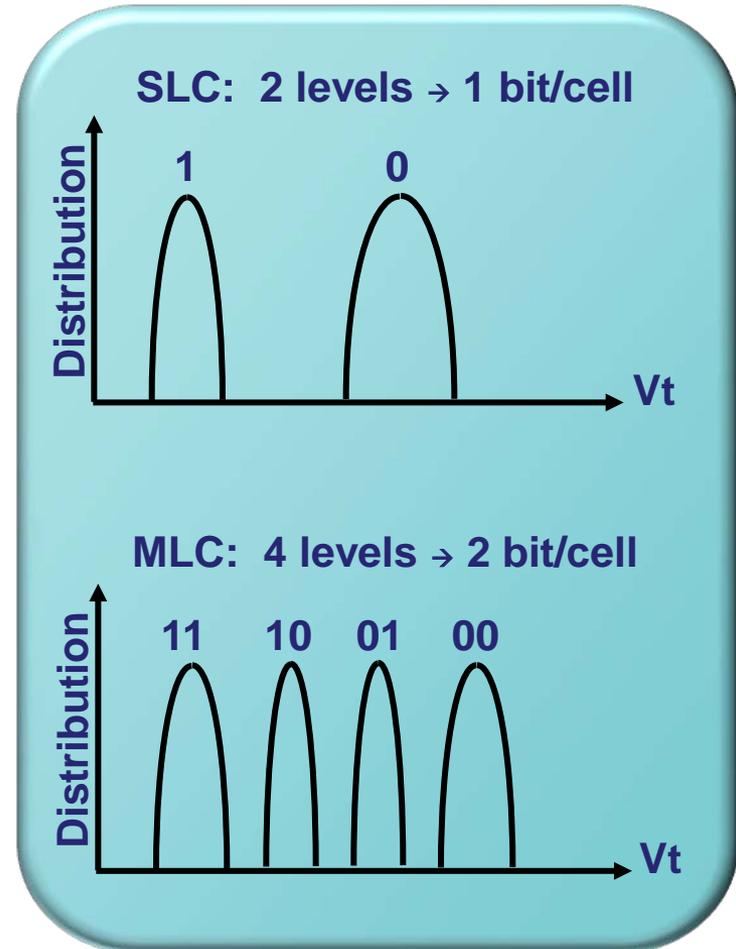
### Drive Endurance

Drive design and arch matters!

*Lower write amplification → Fewer NAND cycles → Faster write perf*  
*High Random Writes = Endurance Efficiency*

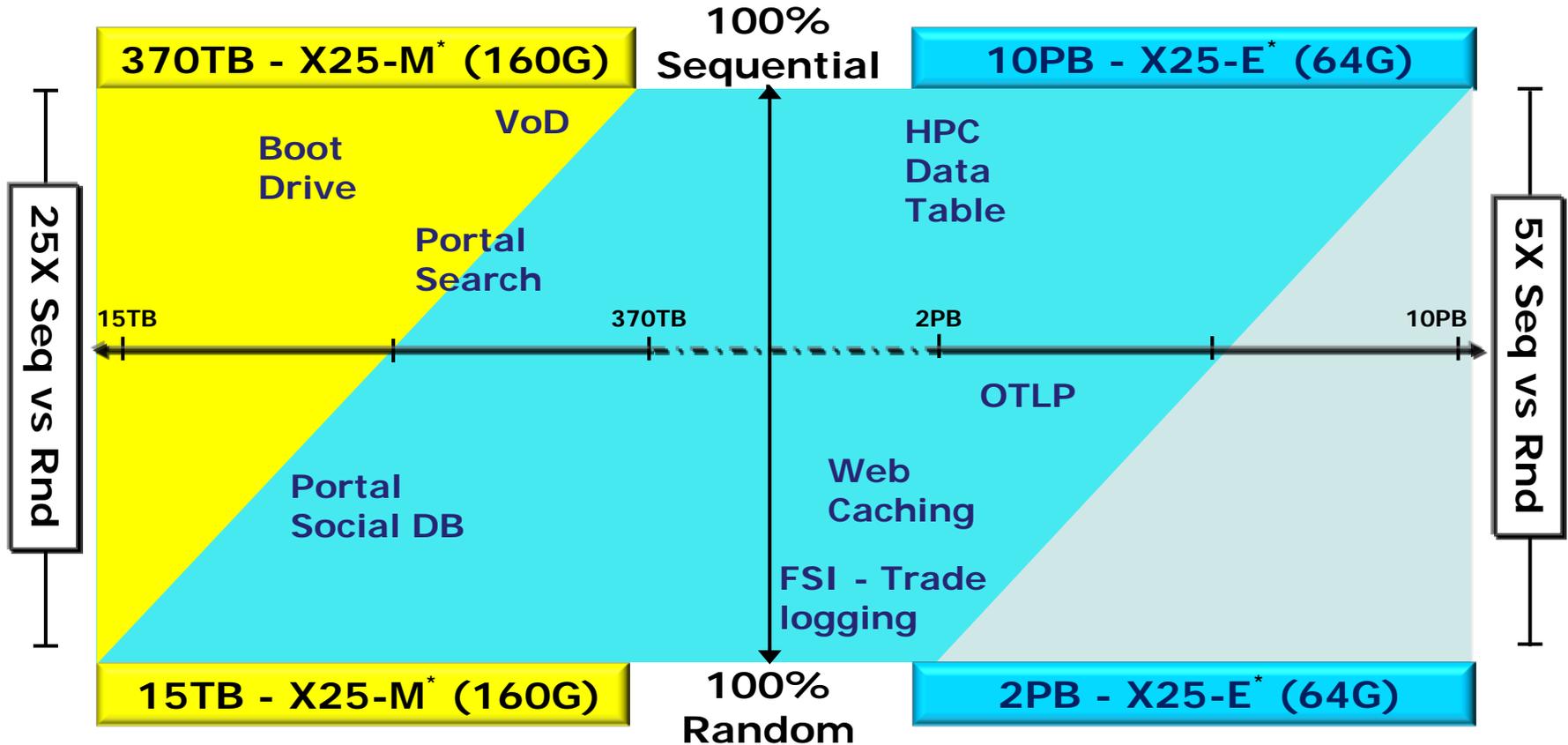
# NAND Technology Effects on Endurance

- SLC (Single Level Cell) NAND
  - Two electrical states
  - Larger electrical separation of states
  - Faster write performance
  - Enhanced data retention
  - 10X program / erase endurance
- MLC (Multi-Level Cell) NAND
  - Four electrical states
  - 2X the bit density per cell
  - Slower write performance
  - Greater ECC requirements
  - Compute application cost optimization



***MLC NAND offers 2X capacity  
at reduced endurance***

# Write Workload Affects Endurance



**Enterprise Endurance improves 5-25X for sequential workloads**

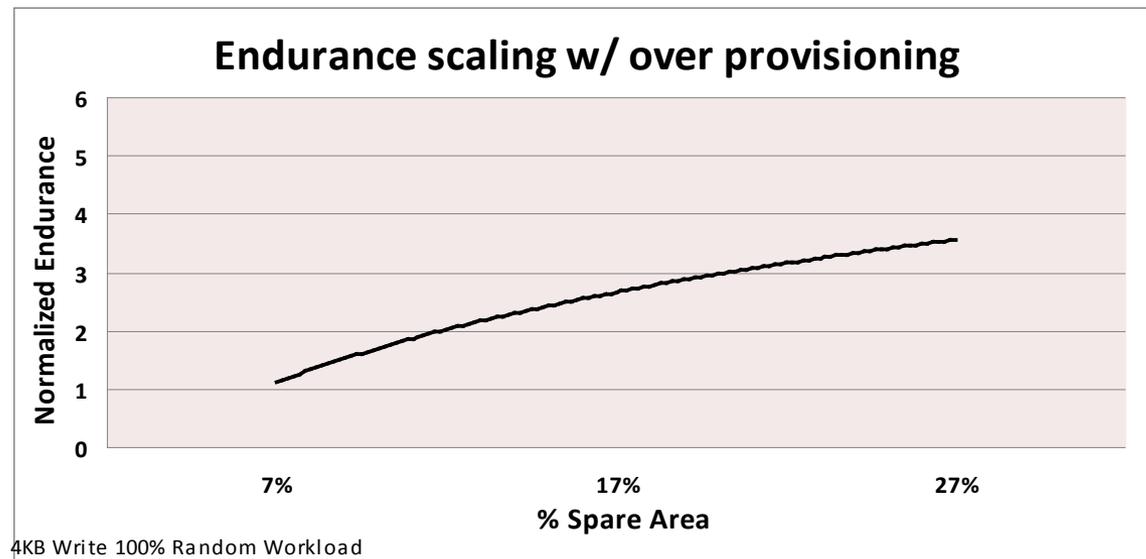
\*Intel® X25-M Mainstream Solid-State Drive

\*Intel® X25-E Extreme SATA Solid-State Drive

Note: Endurance shown assumes 100% of data locations written with 4k write transfer sizes

# Spare Area Affects Endurance

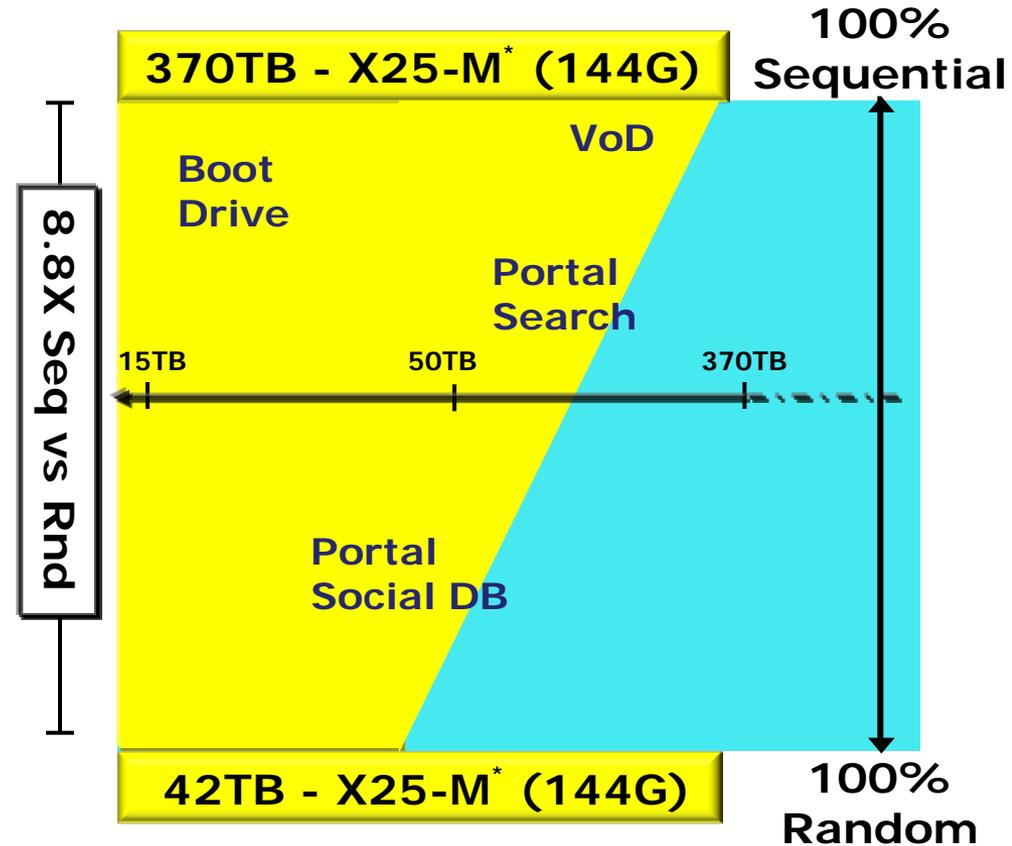
- Increasing spare area increases endurance
  - Spare area beyond 27% of native capacity has diminishing returns
- Adjust Intel® SSD spare area by limiting drive capacity
  - ATA8-ACS Host Protected Area feature set is used (SET MAX ADDRESS)
  - Use ATA8-ACS SECURITY ERASE UNIT prior to limiting capacity
  - Setting partition to smaller size after erase is an option (less robust)



***Intel SSD Technology allows adjusting capacity to provide up to 3.5X improvement in endurance***

# Case Study: 144 GB User Capacity

- User Capacity of 144 GB
  - Native 160 GB capacity reduced by 16 GB
  - Spare area increase to 17%
- 42 TB endurance capability!
  - Endurance increased by 27 TB
  - 2.8X improvement!
- Sequential write capability unchanged



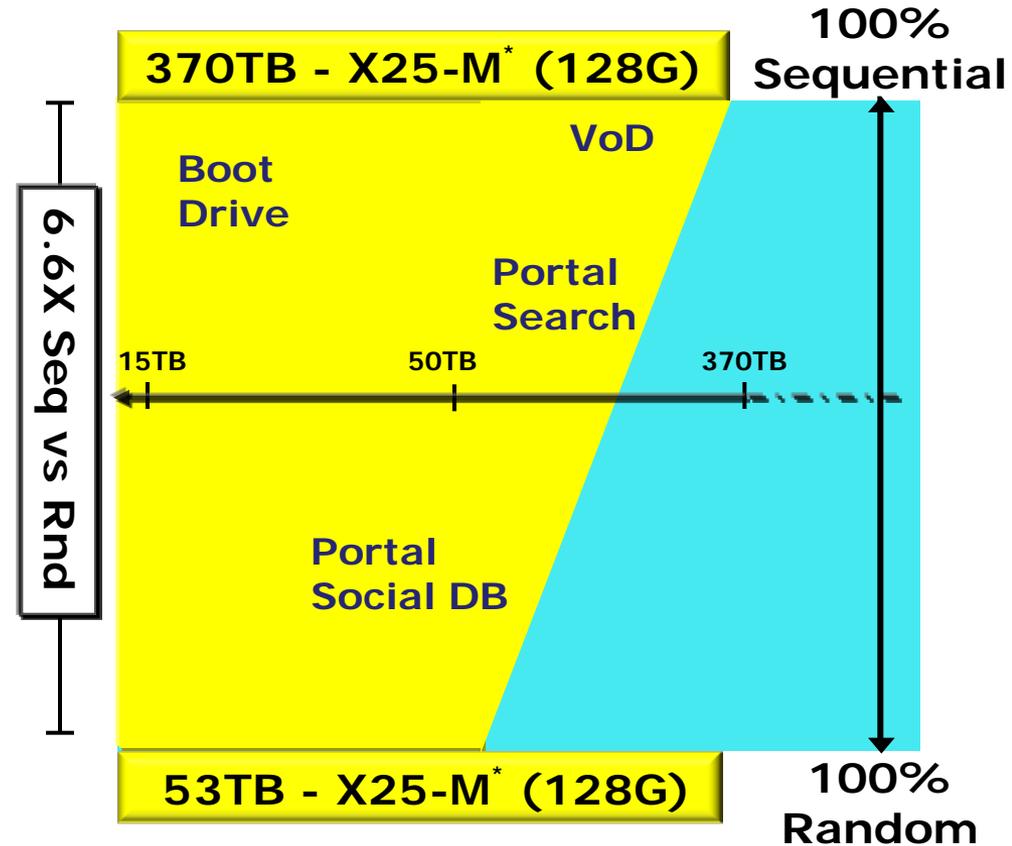
**10% capacity reduction provides 2.8X Enterprise Endurance gains!**

\*Intel® X25-M Mainstream Solid-State Drive

Note: Assumed that the drive is written to through 100% span with 100% 4k random or sequential write transfer sizes

# Case Study: 128 GB User Capacity

- User Capacity of 128 GB
  - Native 160 GB capacity reduced by 32 GB
  - Spare area increase to 27%
- 53 TB endurance capability!
  - Endurance increased by 38 TB
  - 3.5X improvement!
- Sequential write capability unchanged

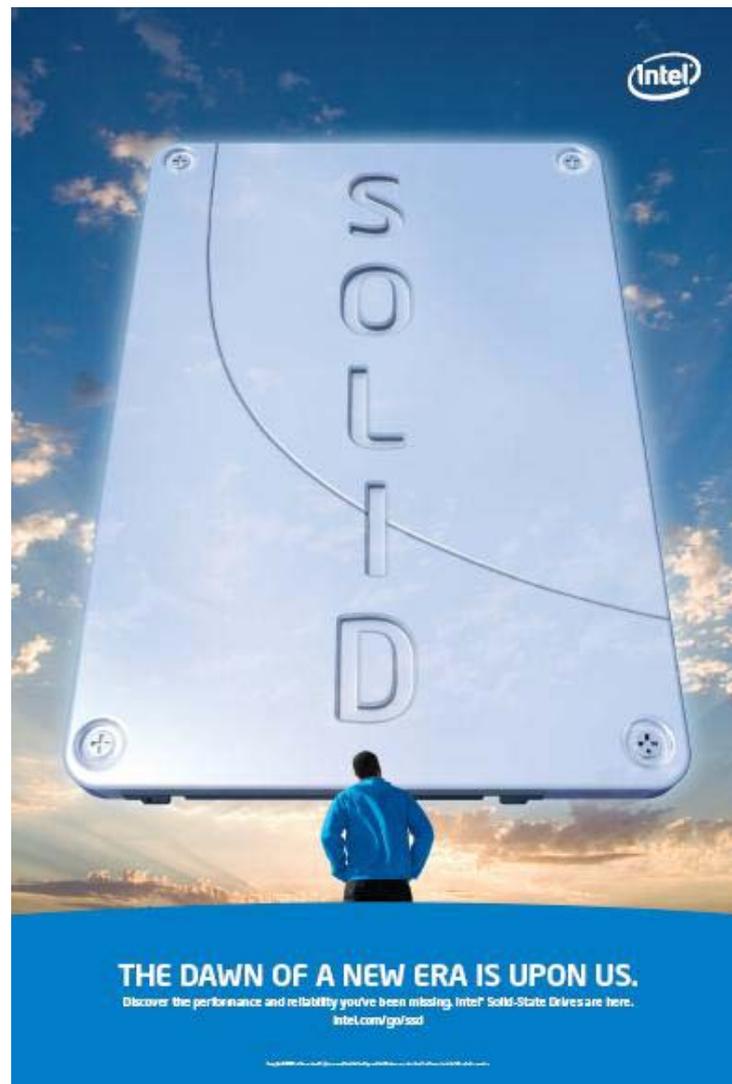


**Intel® X25-M\* SSDs allow users to configure endurance to meet application requirements**

\*Intel® X25-M Mainstream Solid-State Drive

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# Monitoring Intel® SSD Endurance

- Intel provides SMART attributes which allow monitoring of write usage and endurance

SMART Address	Attribute Name	Detailed Description
E1h	Host Writes	Number of Logical Block Addresses (LBAs/512 byte sectors) written by the host. Raw value field is increased by 1 for every 65,535 LBAs written by the host.
E9h	Media Wear Indicator	Value reports percentage of endurance remaining, decreasing from 100% with use. Value based on average NAND Program / Erase cycles consumed vs. capability

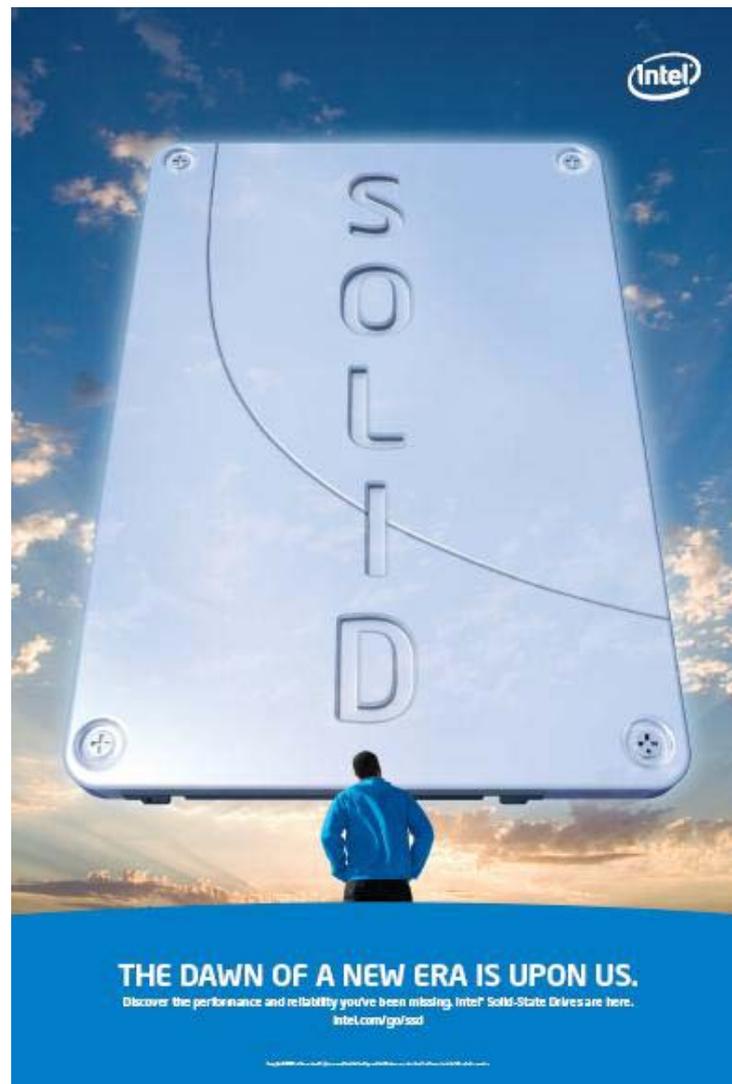
***Intel SMART attributes allow users to ensure the endurance capability meets the application need***

# Endurance Summary

- Enterprise SSD endurance defined
  - Enterprise SSD endurance is defined as drive write capability for small data transfers written randomly
- Extending the life of your SSD
  - Intel SSD endurance is managed by efficient firmware algorithms which minimize write amplification
  - NAND technology, write workload, and spare area impact endurance capability
  - Intel<sup>®</sup> Technology allows adjusting user capacity to increase endurance capability to meet application requirements
- Monitoring endurance
  - Intel SSDs provide SMART attributes for monitoring host activity and SSD wear

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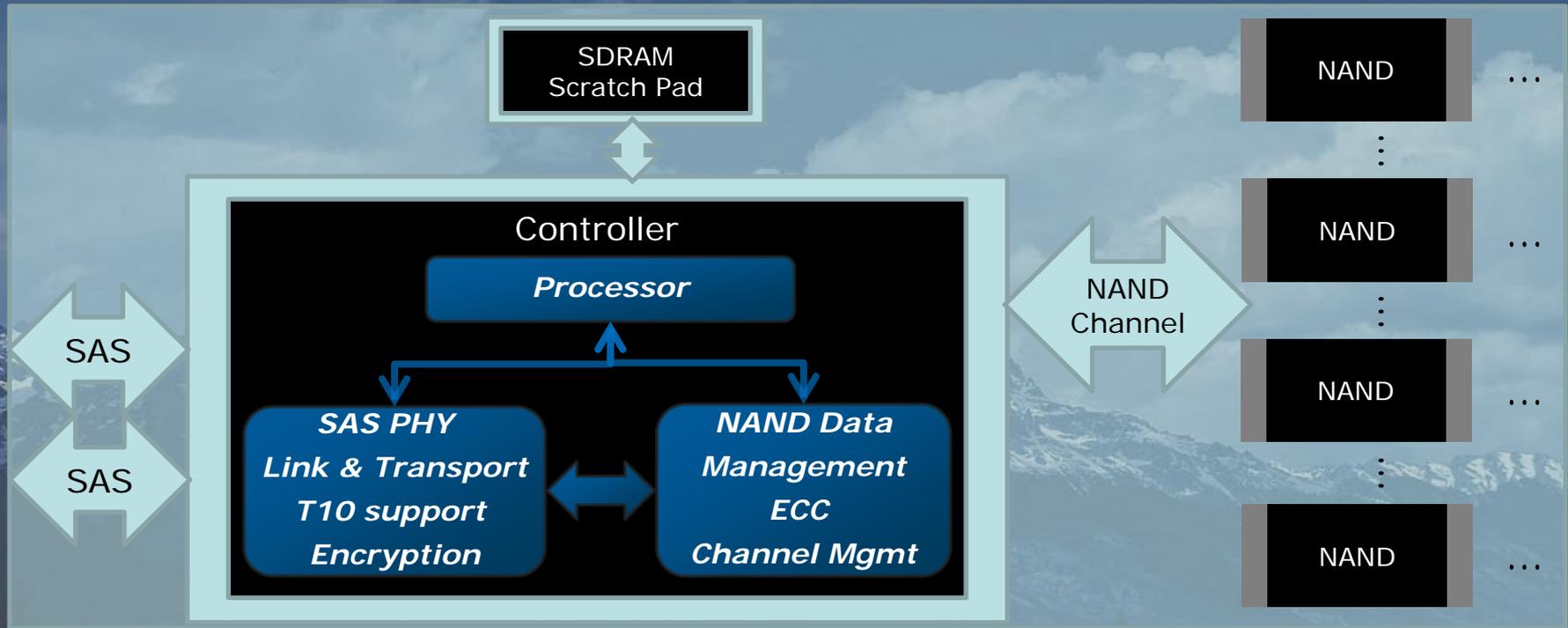
# Hitachi GST SAS SSD\*

Dual Port 6G SAS SSD  
Large capacities



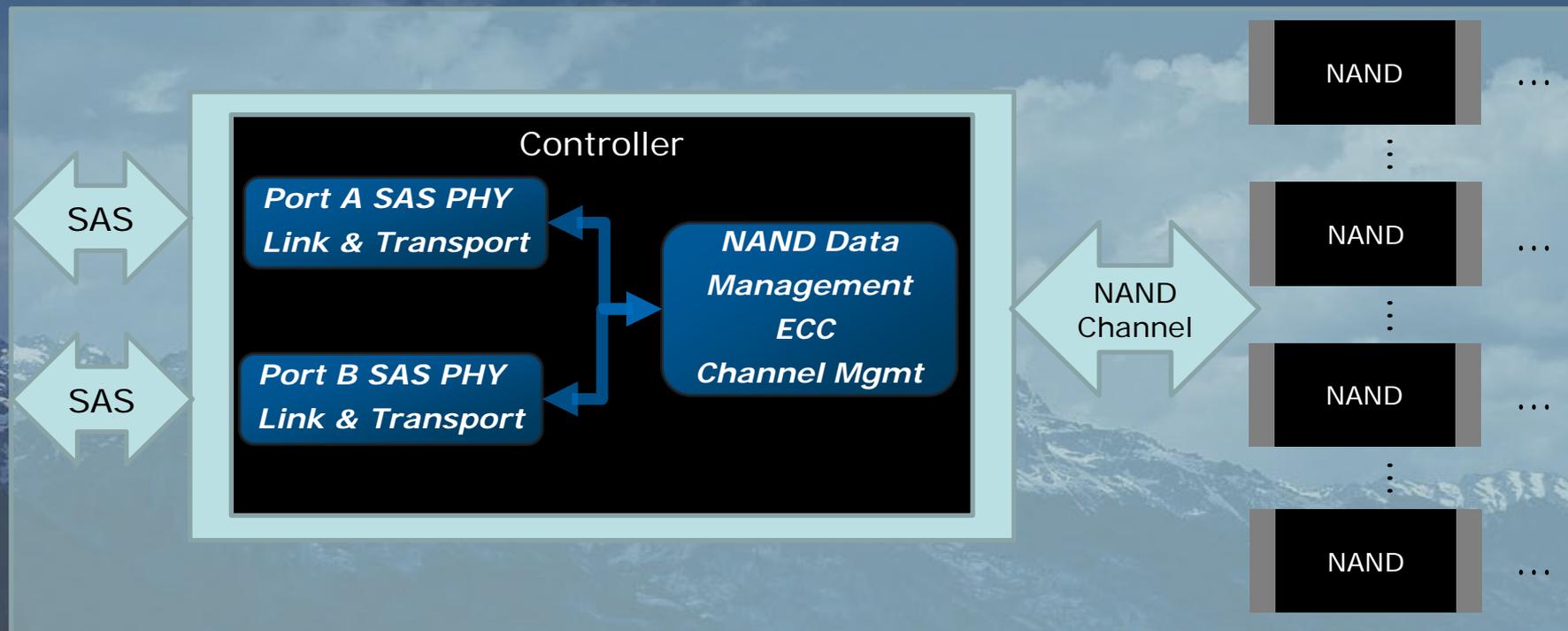
- **High performance with superior reliability**
  - SLC NAND capacity provisioned for high performance and data reliability
- **Marketed and sold by Hitachi GST for the Enterprise**
  - Joint Development between Hitachi GST and Intel
  - Integrating Hitachi GST's Enterprise HDD products and Intel's NAND and NAND management

# Hitachi GST SAS SSD



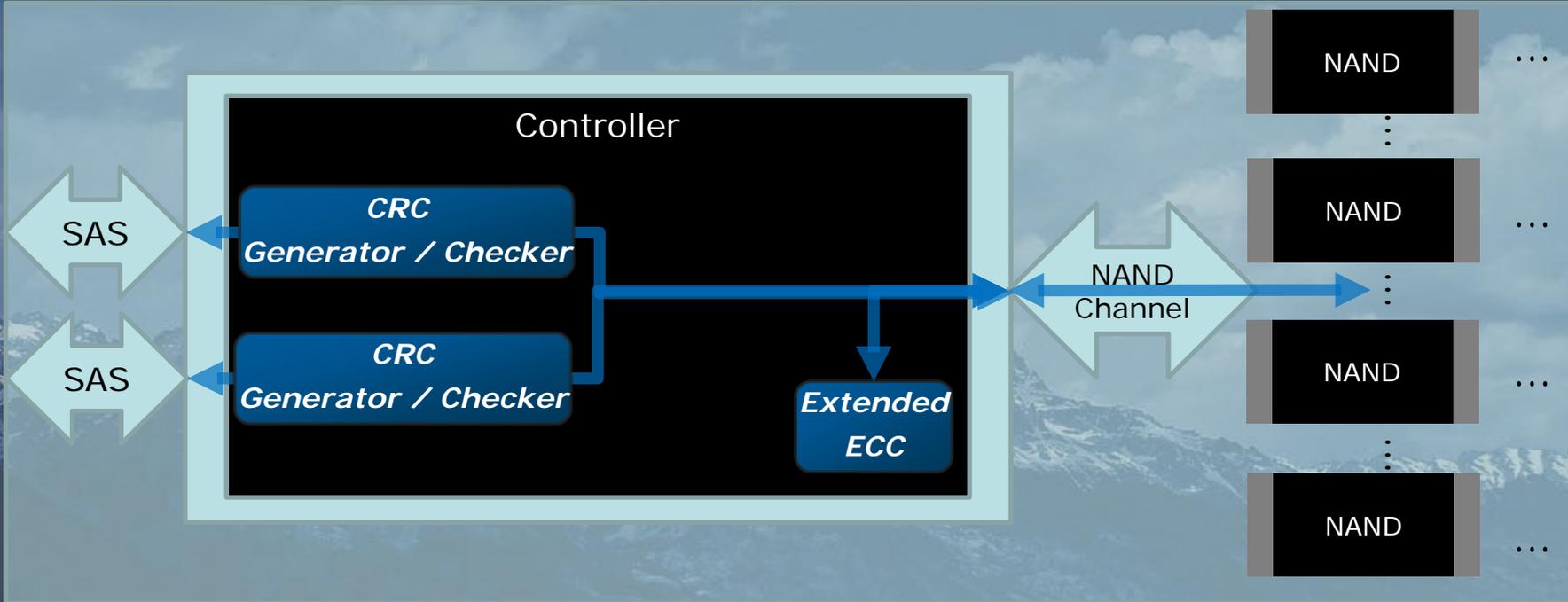
- High performance with superior reliability delivered by
  - Dual Port 6Gb SAS
  - T10 end to end data protection
  - Extended Data ECC
  - Power Loss detect and protect

# Dual Port 6Gb SAS



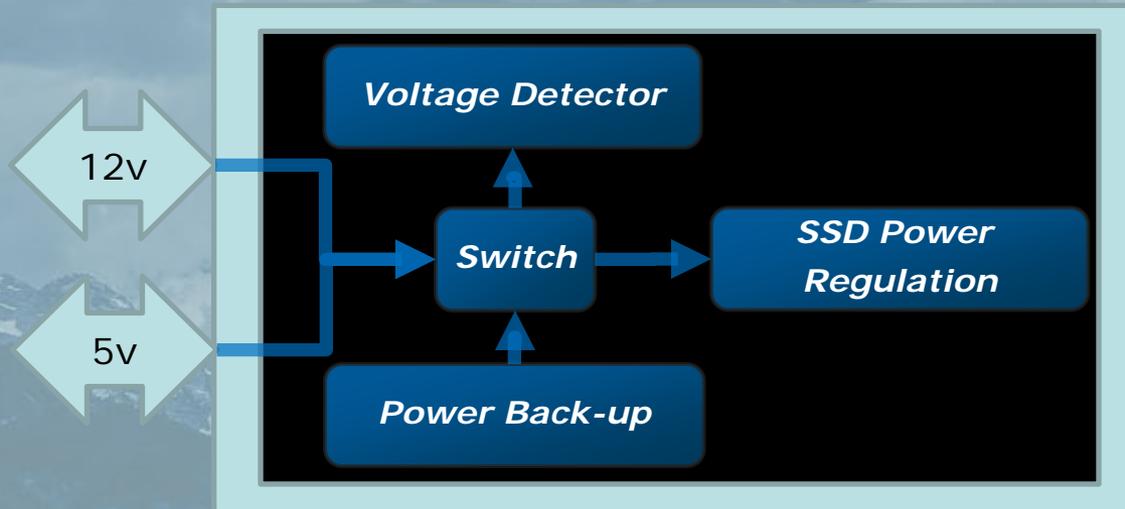
- Dual Port 6Gb SAS for performance and reliability
  - Two completely independent 6Gbps port controls for data transfers
  - Either port can be utilized as a “fail over” port to improve system level reliability in the event of a failed port or host channel

# End to End Data Protection & Extended ECC



- SSD CRC protects customer data path
  - CRC uniquely seeded and stored with customer data
  - Customer CRC accompanies data and stored to NAND
  - T10 end to end protection checking option
- Extended ECC increases data recovery capability
  - ECC written to NAND with customer data

# Power Loss Detect and Protect



- Power Loss Detect circuit monitors incoming power
- Detect circuit switches to Power back-up at low voltage detect
- SSD operates under back-up completing cached operations safely
- Allowance for hot unplug while writing

# Call to Action

- Intel® SSDs meet the challenging endurance requirements of enterprise workloads
  - Understand your application needs and choose the best Intel SSD to match
  - Adjust capacity as needed to stretch endurance and maximize ROI
  - Use SMART features to monitor SSD endurance
- Future SSD technologies enhance data integrity capability
  - Look for new Hitachi GST SAS SSDs\* based on Intel NAND technology

# Want More Info on SSDs?

- Attend or download these SSD-related sessions

## Tuesday, Sept 22<sup>nd</sup>

- EBLS001 - Extending Battery Life of Mobile PCs: An Overview

## Wednesday, Sept 23<sup>rd</sup>

- MEMS001 - Designing Solid-State Drives into Data Center Solutions
- MEMS002 - Understanding the Performance of Solid-State Drives in the Enterprise
- MEMS003 - Enterprise Data Integrity and  
Increasing the Endurance of Your Solid-State Drive
- MEMS004 - Future Solid-State Drive Innovations
- MEMQ002 - Open Q&A for SSD sessions

## Thursday, Sept 24<sup>th</sup>

- MPTS006 - Extreme Notebook Design: Architecting the Most Powerful Mobile Platforms for Gaming & Workstation Applications
- RESS006 - Differentiated Storage Services: Making the Most of Solid-State Drives
- STOS004 - Intel® Modular Server with Intel® Solid-State Drives

- Visit our Booth #532 on Level 1 of the Tech Showcase
  - SSD vs HDD comparisons, gaming demo and more!
- Visit us online at [www.intel.com/go/ssd](http://www.intel.com/go/ssd)
  - Product briefs, datasheets, whitepapers, videos, technical support

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The gross margin percentage could vary significantly from expectations based on changes in revenue levels; capacity utilization; start-up costs, including costs associated with the new 32nm process technology; variations in inventory valuation, including variations related to the timing of qualifying products for sale; excess or obsolete inventory; product mix and pricing; manufacturing yields; changes in unit costs; impairments of long-lived assets, including manufacturing, assembly/test and intangible assets; and the timing and execution of the manufacturing ramp and associated costs. Expenses, particularly certain marketing and compensation expenses, as well as restructuring and asset impairment charges, vary depending on the level of demand for Intel's products and the level of revenue and profits. 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