Education

Facing an SSS Decision?
SNIA Efforts to Evaluate SSS Performance

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Abstract

Solid state storage (SSS) technology offers a quantum leap in the performance of storage technology. However, a broad spectrum of products and architectures are flooding the marketplace, each with very different performance characteristics. Users have no consistent method of measuring or comparing the performance of vendor offerings. The SNIA SSS Technical Working Group established a Performance subcommittee to help the market with solutions for this problem.

Agenda

- Definitions
- SSS Performance Issues and Challenges
- Challenges in reporting SSS Performance
- Examples of these challenges
- SNIA SSS standardization efforts
- Coordination with other standards organizations
- Summary and conclusions

Definitions

Solid State Drive (SSS)

A nonvolatile storage medium that employs integrated circuits (RAM or flash memory) rather than rotating magnetic or optical media. It generally offers very high access performance compared to that of rotating magnetic disks, because it eliminates mechanical seek and rotation time. It includes all form factors, interfaces & technologies, including flash and RAM SSDs.

Solid State Drive (SSD)

A subset of SSS which uses the same interfaces and form factor as hard disk drives (HDDs)

This presentation is about NAND Flash SSS (including SSDs)

State of SSS Performance

- One of its biggest advantages
  - However, not fully understood
- SSS has different performance characteristics from spinning media
- New and evolving market
  - Diverse and rapidly evolving core technologies and architectures
  - Many new players in the market
- Challenging to compare performance between products from different vendors

Performance Issues & Challenges

- SSS Performance behaviors are quite different from HDDs
  - Reads are much faster than writes
  - SSS devices manage their own storage
    - Maintain virtual/physical LBA mapping
    - Do wear leveling and background garbage collection
    - Have reserve capacity used by the SSS controller, not visible to OS/user
  - Performance changes with use
    - Preconditioning can have a big impact on performance
- Needs to be characterized differently

SSS Performance Challenges

- Read IOPs vs. write IOPs
- Throughput vs. latency
- Large vs. small blocksizes
- Random vs. sequential
- Out of the box performance vs. pre-conditioned
- Performance predictability vs variability
- Read to write ratio variability

Challenges in SSS Performance

1. Substantial performance variation for different parameters (e.g. Block size, R/W mix)
2. Big performance differences for client vs. enterprise SSS
3. Performance variation with use
4. No standards on how to report performance
   - Metrics, methodology and state of device under test

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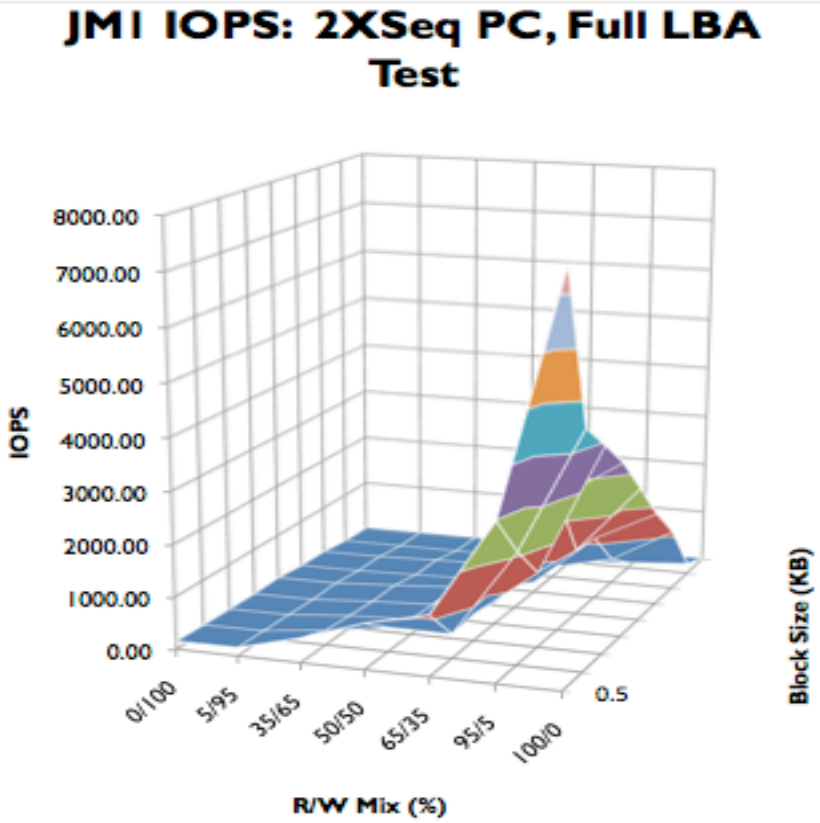
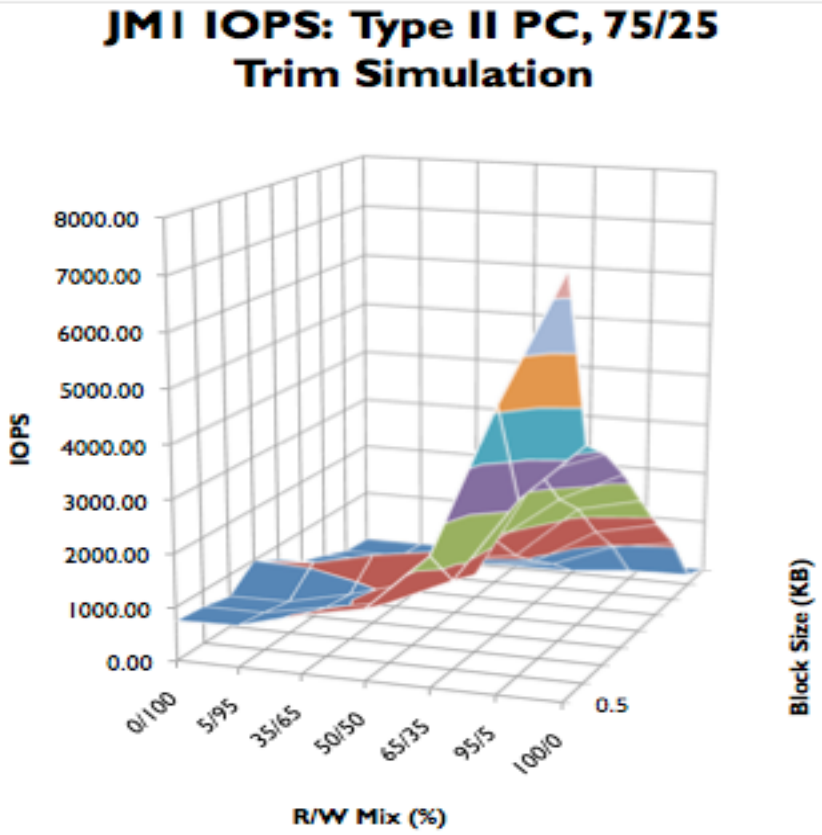
SSS performance parameters

Chart SSS IOPS Profiles*





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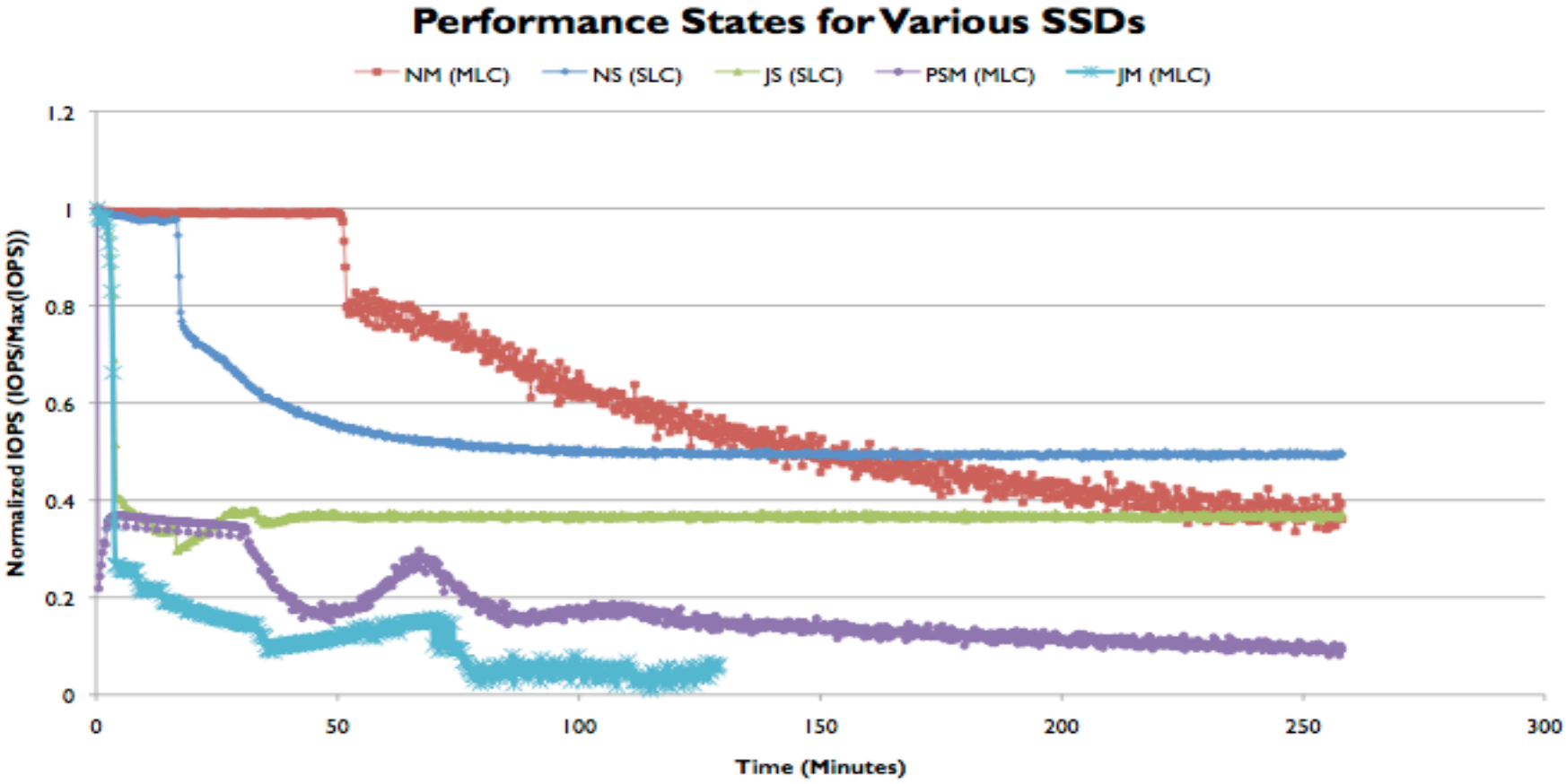
Enterprise vs. Client IOPS

Chart showing varying SSS performance*



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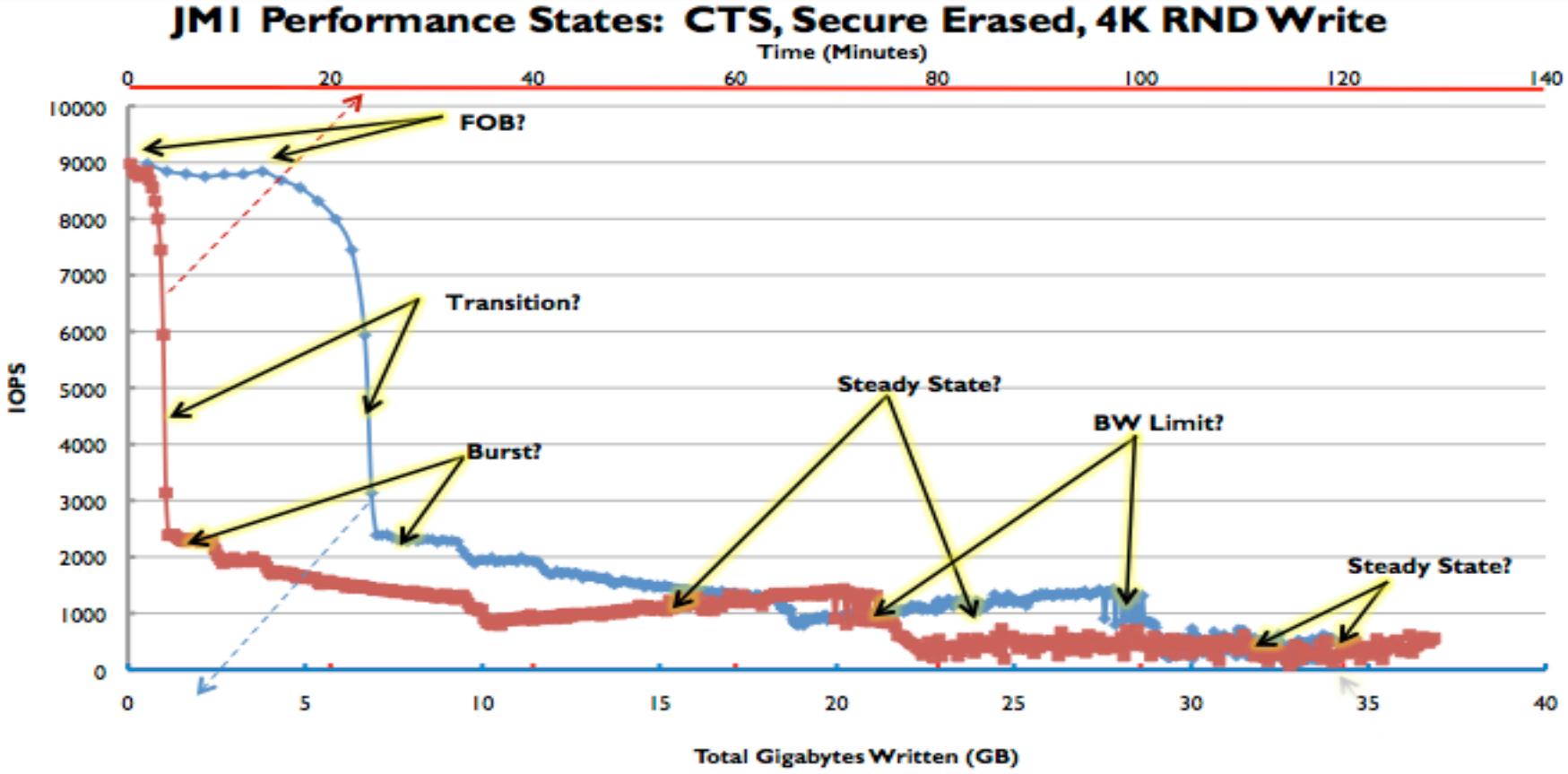
Effects of Preconditioning

Chart showing SSS preconditioning*



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Need for SSS Performance Stds

- What is needed:
  - Consistent metrics and parameters to quantify SSS performance
  - Consistent test methodology including
    - A standard for preconditioning the SSS
    - A standard for testing performance recovery in idle periods
  - Reference platform (common hardware/software environment)

Help On Its Way!

- SNIA SSS Technical Working Group (TWG) is working on addressing this need
  - Performance subcommittee established in Jan '09
  - Participation of a large number of companies in the SSS industry
    - SSS architecture experts
    - Performance analysis experts
  - Developing a standard performance test suite
  - First performance spec targeted to be released 4Q09

What Has Been Involved?

- Analyze and evaluate data from various companies
- Debate input and proposals from various participants
- Use combined wisdom to come up with draft spec
- Intense and thorough discussions of draft spec
- Validation by testing actual products to confirm the measurability and usefulness of each metric.
- Getting all participants to agree!

Not easy!

Example of Challenges

Different views of what's important

- Some companies wanted to discuss data availability performance and others just raw SSS performance
- Some wanted to discuss performance behind storage subsystems, some performance at the drive interface, others performance at the server level.

What Metrics Should Be Measured?

- IOPS?
  - I/Os per second
  - Shows the strength of SSS
  - Very suitable for OLTP and Database apps
- Latency?
  - Some apps sensitivity
  - Included in IOPS?
- Throughput/bandwidth?
  - More suitable for HDDs
  - Suitable for large sequential workloads

IOPS issues

- Provided by most vendors
- Are these burst or sustained?
- New SSS or used one?
- Block sizes?
- Read/write mix?
- Is it representative of
  - User environment?
  - User application mix?
- Can we interpolate?

Also …

- How was it measured?
- What was the configuration?
- Was it set up behind a controller? Which one?
- What O/S? Application?
- Is that number the user will encounter?
- Can there be other bottlenecks in the user environment?

Actual performance can be quite different due to other variables (H/W, S/W, O/S, apps)

Goals of Any Reference Platform

- **Repeatable** → common starting point; common procedures
- **Stable** → test at steady state
- **Applicable** → results relevant to user's environment
- **Comparable** → fair device-to-device comparisons
- **Practical** → completes within reasonable time, available at reasonable price
- **Accessible** → open spec.; 3rd party validation

IOPS Testing Methodology

How should IOPS be measured?

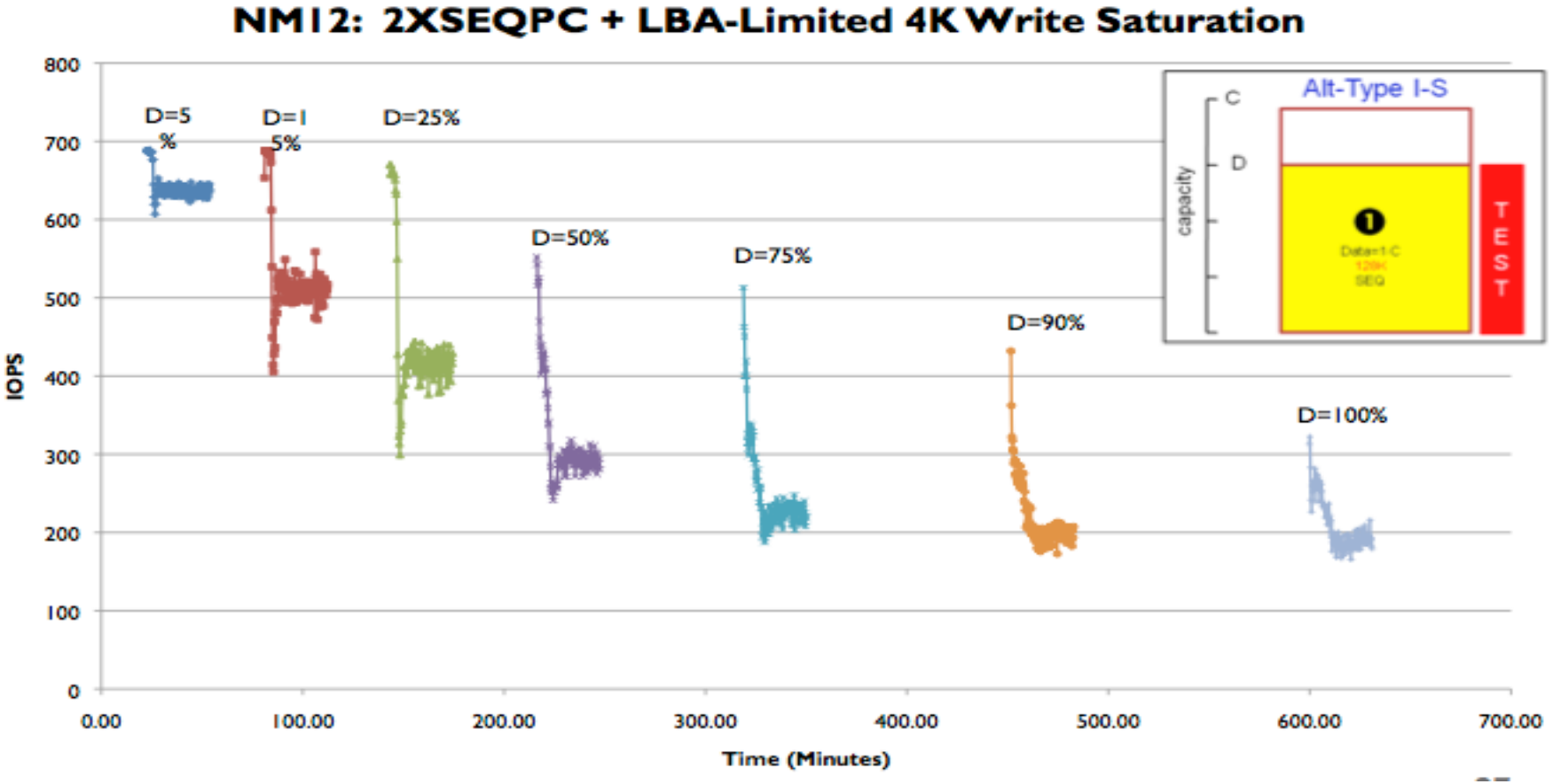
- Reference platform
- Test methodology
  - Independent test fixture, testing multiple samples of same drive at one time with uniform workload
- Preconditioning
  - Best guess is mixture of sequential (large block) and random (large block) writes sufficient to write the full drive capacity twice

Example: Idle Tests

- SSS housekeeping tasks are done in the background
- With no idle periods, background tasks accumulate
- Eventually, background tasks need to get done affecting performance
- Does the SSS performance recover in idle periods?
  - Some do … some don't
- Does it restore lost performance?
  - Total?
  - Partial?
  - None?

Idle Tests

Chart on SSS idle effect*



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Coordination

- SNIA SSS TWG is coordinating efforts with JEDEC, SSDA, IDEMA, T10, T13
  - Avoid duplication of efforts
    - Eg. Endurance, data retention are handled by JEDEC
  - Develop compatible standards
    - Eg. T13 Trim
  - Avoid developing conflicting standards

Summary

- SSS performance characterization has been challenging
- SNIA SSS TWG is working on defining a spec for SSS performance that is:
  - Consistent
  - Repeatable
  - Allows fair comparison between products

For participation and/or more information go to

www.snia.org/sssi

Summary

- SNIA SSS Performance spec
  - Will provide a performance spec document (Some description)
  - Will be available on the SNIA web site and various storage conferences and conventions
  - Expected to be available 4Q09
  - Will cover: metrics, parameters, test methodology, preconditioning and idle tests

Q&A / Feedback

- Please send any questions or comments on this presentation to SNIA: tracksolidstate@snia.org

Many thanks to the following individuals for their contributions to this tutorial.

- SNIA Education Committee

Khalid Amer	**Name of contributor here**
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Easen Ho	**Name of contributor here**