



What has Changed?

***SNIA Emerald™ Power Efficiency
Measurement Specification V3.0.3 to V4.0.0***



SNIA Emerald™

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About the SNIA

The Storage Networking Industry Association is a not-for-profit global organization, made up of member companies spanning the global storage market. SNIA's mission is to lead the storage industry worldwide in developing and promoting standards, technologies, and educational services to empower organizations in the management of information. To this end, the SNIA is uniquely committed to delivering standards, education, and services that will propel open storage networking solutions into the broader market. For more information about SNIA, visit www.snia.org.

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SNIA's Green Storage Initiative (GSI) is focused on advancing energy efficiency and conservation for data center networked storage technologies in an effort to minimize the environmental impact of data storage operations. SNIA's Green Storage activities take place in two separate working bodies, the SNIA Green Storage Technical Working Group (TWG) and the Green Storage Initiative. The TWG is focused on developing repeatable and fair test methodologies and metrics for enterprise storage systems through which energy consumption and efficiency can be measured. The Green Storage Initiative is focused on creating and publicizing best practices to the industry for energy efficient storage networking, promoting storage-centric applications that reduce storage footprint and associated power requirements, and educating regulatory bodies and testing organizations to apply test methodologies and best practices.

About the SNIA Emerald™ Program

The SNIA Emerald™ Program is a vendor-neutral, public service to the storage industry, IT community, and regulatory body community that is sponsored and operated by the SNIA GSI. The program supports the use and evolution of the SNIA Emerald™ Power Efficiency Measurement Specification. The measurement procedure and test metrics are documented in the SNIA Emerald™ Power Efficiency Measurement Specification, which is developed, released, and maintained by the Green Storage TWG under the guidance of the GSI. GSI produces education programs and materials for testers to consistently and competently use the SNIA Emerald™ Power Efficiency Measurement Specification.

The EPA ENERGY STAR® Data Center Storage Program is based on the methodology defined in the Specification and offers another vehicle for publication of product test results created in accordance with the Specification. Some national regulatory bodies cross-reference the EPA ENERGY STAR Program for their needs, while other national regulatory bodies around the world are aware of the SNIA Emerald™ Specification and in the future, may base their programs on the methodology and metrics.

For more information about the SNIA Emerald™ Program, visit www.sniaemerald.com.

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The information contained in this publication is subject to change without notice. This guide represents a "best effort" attempt by the SNIA Green Storage Technical Working Group to provide guidance to those implementing the *SNIA Emerald™ Power Efficiency Measurement Specification*, and the guide may be updated or replaced at any time. The SNIA shall not be liable for errors contained herein.

Suggestions for revisions to this guide and questions concerning implementation of the *SNIA Emerald™ Power Efficiency Measurement Specification* can be directed (via email) to emerald@snia.org.

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I Introduction

This document describes the changes to *SNIA Emerald™ Power Efficiency Measurement Specification V3.0.3* to create *V4.0.0*.

Section 2 provides a summary of the changes made to the *SNIA Emerald™ Power Efficiency Measurement Specification V3.0.3* (referred to within this document as simply *Specification V3.0.3*), developed as part of the *SNIA Emerald™ Program*, which resulted in the *SNIA Emerald™ Power Efficiency Measurement Specification V4.0.0* (referred to within this document as simply *Specification V4.0.0*).

Specification V4.0.0 is a revision of *Specification V3.0.3* whose primary purpose is to extend the Storage Taxonomy to explicitly address storage systems based on Solid State Storage devices. There are also minor modifications to the COM testing requirements, I/O intensity during data migration phase of Block Access testing, and to the reporting requirements.

Any conflict between this document and *Specification V3.0.3* or *Specification V4.0.0* shall defer to the *Specifications*.

1.1 Audience

The target audience of this document includes organizations and individuals that are planning for or testing in accordance with *Specification V4.0.0* and are familiar with *Specification V3.0.3*. An organization or individual performing such testing is referred to as a test sponsor.

Test sponsors are urged to carefully read the *Specification V4.0.0* in order to become aware of all changes.

1.2 Impact

Test sponsors should not expect any difference in SUT metric results between *Specification V3.0.3* and *Specification V4.0.0*, given all other test conditions are the same (e.g., SUT configuration, initial conditions, test environment, benchmark driver type, revision, script parameters, etc.), and the more constrained COMs testing procedure of *Specification V4.0.0* was used.

1.3 References

Specification V3.0.3 and *Specification V4.0.0* are available through the SNIA Emerald™ website: www.sniaemerald.com/download/Spec_v3.0 and www.sniaemerald.com/download/Spec_v4.0.

Complete information for testing in accordance with the *SNIA Emerald™ Power Efficiency Measurement Specification* is available at: www.sniaemerald.com/download.

Training for testers and organizations using the *SNIA Emerald™ Power Efficiency Measurement Specification* is available at: www.sniaemerald.com/education/vendor-training.

2 Changes from Specification V3.0.3 to Specification V4.0.0

All references (to clauses, subclauses, figures, and tables) in this document pertain to *Specification V4.0.0* unless otherwise noted.

2.1 Brief Summary of Changes

The changes from *Specification V3.0.3* to *Specification V4.0.0* are primarily to revise the Storage Taxonomy to explicitly address storage systems based on Solid State Storage devices. This has resulted in an extended structure for the taxonomy and a major rewriting of the Taxonomy (Clause 5).

A test procedure was added for systems based on Solid State Storage devices that offer the same access methods as otherwise similar systems based on magnetic disk media. The test procedure is the same as that for systems based on magnetic disk media.

The Conditioning Test for Block Access testing was modified to be less constraining (see Subclause 2.6.2 of this document).

The COMs testing procedure was modified to be more constraining (see Subclauses 2.6.3 and 2.6.4 of this document).

Metrics and Disclosure Requirements were added for systems based on Solid State Storage devices. These are essentially same as those for systems based on magnetic disk media.

Disclosure Requirements regarding caches in storage controllers and storage media were expanded and additional requirements regarding storage media were added.

2.2 General Changes

Wording changes were made throughout the document to improve readability and clarity. Changes were made to reflect the changed nomenclature of the revised Storage Taxonomy. Defined terms, when available, are used more commonly and more appropriately throughout *Specification V4.0.0*. These, and numerous editorial changes, are not listed here.

2.3 Definitions, Symbols, Abbreviations, and Conventions (Clause 4)

2.3.1 Definitions (Subclause 4.2)

The following terms were added to the definitions:

- hybrid Solid State Storage and magnetic disk system
- hyper converged system
- JBOD
- non-volatile
- shelf
- Solid State Storage

The definitions of the following terms were substantively improved:

- cache



- formatted capacity
- hot band
- non-disruptive serviceability
- stable storage

2.3.2 Symbols and Abbreviated Terms (Subclause 4.3)

The following symbols and abbreviated terms were added:

- INCITS InterNational Committee for Information Technology Standards
- NVSS Non-Volatile Solid State
- OSD Object-Based Storage Device
- RAID Redundant Array of Independent Disks
- RVML Removable and Virtual Media Library
- USB Universal Serial Bus

2.4 Taxonomy (Clause 5)

2.4.1 General

Clause 5 Taxonomy was extensively revised in its entirety to explicitly include storage systems based on Solid State Storage while essentially preserving the previous taxonomy for other storage systems. To accomplish this, the structure of the taxonomy was extended with additional (third) level of Set. Solid State Storage based systems were placed in the NVSS (non-volatile solid state) Set as a pair of new Categories. Existing Online and Near-Online Categories were placed in the Disk Set. The existing Removable Media Library and Virtual Media Library Categories were placed in the RVML Set.

Within the Categories, the six existing Classification levels were preserved and a seventh Classification JBOD (level 1.5) was inserted between Consumer/Component (level 1) and Low-end (level 2)

Specification V4.0.0 Table 3 provides a graphical summary of the revised taxonomy were preserved. *Specification V3.0.3* Table 2 provides the corresponding summary for comparison.

In each the Classifications, the attribute “Connectivity” was changed to “Multi-host Shareability” to provide a more meaningful differentiator. The related entries in each of the Classification tables (Tables 4, 5, 7, 8, and 9) were changed/added accordingly.

In each the Classifications, the attribute “Maximum Supported Configuration” was renamed “System Capacity”.

2.4.2 Category Attributes (Subclause 5.3.2)

This subclause is the starting point for determining the taxonomy for a product.

This subclause shows the attributes that are the primary differentiators between taxonomy Sets and Categories. In addition to addressing the revised taxonomy and structure and the explicit addition of Solid State Storage-based systems, additional existing attributes were brought into this subclause for improved clarity and usability.

2.4.3 Taxonomy Classifications (Subclause 5.4)

This subclause was extended to be a more thorough exposition of taxonomy Classifications.

2.4.4 Disk Set Online Category (Subclause 5.5)

The Disk Set Online Category is the Online Category of *Specification V3.0.3* with the following changes:

1. Storage systems in this Category are based on magnetic disk media only. Hybrid systems (based on magnetic disk and Solid State Storage media) are now considered to be NVSS Set Disk Access Category.

2.4.5 Disk Set Near-Online Category (Subclause 5.6)

The Disk Set Near-Online Category is the Near-Online Category of *Specification V3.0.3* with the following changes:

1. The attribute “Media Type” was added.
2. Storage systems in this Category are based on magnetic disk media only. Hybrid systems (based on magnetic disk and Solid State Storage media) are now considered to be NVSS Set Disk Access Category.
3. The attribute “Access Paradigm” was added.

2.4.6 RVML Set Removable Media Library Category (Subclause 5.7)

The RVML Set Removable Media Library Category is the Removable Media Library Category of *Specification V3.0.3* with the following changes:

1. The attribute “Media Type” was added.
2. Storage systems in this Category are based only on magnetic tape and/or optical disk media. This clarifies what was previously implicitly understood.
3. The attribute “Access Paradigm” was added.
4. The attribute “System Capacity” for (previously “Maximum Supported Drive Count”) Classification Removable 2 was corrected to be ≤ 4 rather than exactly 4 drives.

2.4.7 RVML Set Virtual Media Library Category (Subclause 5.8)

The RVML Set Virtual Media Library Category is the Virtual Media Library Category of *Specification V3.0.3* with the following changes:

1. Storage systems in this Category are based only on magnetic disk and/or Solid State Storage media. This clarifies what was previously implicitly understood.
2. The attribute “Media Type” was added.
3. The attribute “Access Paradigm” was added.
4. The attribute “System Capacity” (previously “Maximum Supported Drive Count”) for Classification Virtual 1 was corrected to be ≤ 12 rather than exactly 12 drives.



2.4.8 NVSS Set Disk Access Category (Subclause 5.9)

This is a new Category that addresses systems based on a) Solid State Storage devices or b) a combination of Solid State Storage devices and magnetic disk media. The latter are often referred to as “hybrid” systems.

Systems in this Category offer a storage access paradigm, i.e., Block, File, and/or Object.

“All-Flash Arrays” are examples of products typically covered by this Category.

2.4.9 NVSS Set Memory Access Category (Subclause 5.10)

This is a new Category that addresses systems based on Solid State Storage devices. Systems in this Category offer a memory access paradigm, i.e., load and store.

This Category is presented for completeness, but no test methodology is defined.

2.4.10 Classification Attributes (Subclause 5.11)

This subclause was added to articulate the meaning of the attributes used in the taxonomy. This subclause is highly relevant to determining where a product fits in the taxonomy.

2.4.11 Taxonomy Rules (Subclause 5.12)

This subclause (based on Subclause 5.4 of *Specification V3.0.3*) has been reworded for strength and clarity.

2.5 Capacity Optimization (Clause 6)

Subclause 6.2 of *Specification V3.0.3* was removed as not necessary or appropriate to this clause.

2.6 Test Definition and Execution Rules (Clause 7)

To add a testing methodology for NVSS Set Disk Access Category systems, the wording of this clause was changed to that these systems are tested in the same manner as Disk Set Online Access Category systems.

2.6.1 Execution Overview (Subclause 7.1.1)

Table 10 was added. Table 10 provides an informative navigational guide that indicates which parts of the Clause are relevant for testing products in the various Sets and Categories.

2.6.2 Tiered Storage Configuration Data Migration Phase (Subclause 7.3.4.2.2)

The Conditioning Test for Block Access (Disk Set Online Category, Disk Set Near-Online Category, and NVSS Set Disk Access Category systems) testing was modified to reduce the minimum required IO intensity during the migration phase per the IO profile (Table 19) from 25 % to 5 %.

2.6.3 Requirements (for COMs tests) (Subclause 7.6.3)

Two paragraphs were added at the end of Subclause 7.6.3 to more precisely articulate how the COMs tests are to be performed.

2.6.4 Generating Data Sets (for COMs tests) (Subclause 7.6.4)

The COMs testing procedure requirements for generating test data sets and applying them to the product under test were narrowed to require that the COM Test Data Set Generator be used to directly generate the test data set on the product under test, eliminating the option of placing the COM Test Data Set Generator output somewhere and then copying the data set to the product under test.

This requirement is re-articulated in Subclauses 7.6.5.2, 7.6.5.3, 7.6.5.5, and 7.6.5.6.

2.6.5 Drive Counts (RVML Set Removable Media Library) Testing (Subclause 7.7)

Table 24 is updated to specify the required drive count during tests of Removable-5 and Removable-6 Classification systems.

2.6.6 RVML Set Virtual Media Library Category Testing – Pre-Fill (Subclause 7.8.1)

The requirement that pre-fill data must be random bytes was removed. The nature of the data pattern to be used is addressed by the required Vdbench script.

2.7 Metrics (Clause 8)

Metrics for NVSS Set Disk Access Category systems were added, which are the same as those for Disk Set Online Access Category and Disk Set Near-Online Access Category systems.

2.8 Disclosure Requirements (Clause 9)

Disclosure requirements for NVSS Set Disk Access Category systems were added, which are the same as those for Disk Set Online Access Category and Disk Set Near-Online Access Category systems.

2.8.1 Test Characterization (Subclause 9.4)

The taxonomy set of the product under test shall be disclosed.

2.8.2 Product Under Test Description – Storage Controllers (Subclause 9.5.2)

More detailed information on storage controller cache sizes is required to be disclosed:

- 5. Controller volatile cache size (GiB)
- 6. Controller non-volatile cache size (GiB)

2.8.3 Product Under Test Description – Storage Media (Subclause 9.5.5)

More detailed information on storage media cache sizes is required to be disclosed:

- 8. Media volatile cache size (MiB)
- 9. Media non-volatile cache size (MiB)

Additional information on storage media is required to be disclosed:

- 11. Media interface speed (Mb/s)
- 12. Does media contribute to formatted capacity? (Yes or No)



2.9 Bibliography

Reference links were updated.

Reference [3] for count-key-data was added.