Emerald™ Storage Taxonomy

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SNIA Emerald™ Training

SNIA Emerald Power Efficiency Measurement Specification, for use in EPA ENERGY STAR®

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SNIA™ Green Storage Initiative

SNIA Emerald™

Why have a storage taxonomy

- Need a taxonomy (product category and classification) to enable fair comparisons among similar storage products
  - e.g. disk, tape, solid state
- Similar green metrics may apply to all product categories, but different values establish best-in-class
  - Best in class online system and the best removable media system
- Unique considerations apply to special categories
  - e.g. disk, tape
- Clear taxonomy will simplify comparisons and aid regulatory efforts

SNIA Taxonomy v.s. Marketing Taxonomy

- Why did we not use the marketing terms like consumer, entry level, midrange, enterprise
  - Focus on what the storage system purpose is and associated power requirements to accomplish its task
  - Need a Taxonomy that would cover across multiple storage system
    - Disk and Tape marketing terms did not correlate easily
  - Taxonomy based on technology that would effect power consumption
  - Enough precision

Category Marketing	**Online** (see 5.3)	**Near Online** (see 5.4)	**Removable Media Library** (see 5.5)	**Virtual Media Library** (see 5.6)	**Adjunct Product** (see 5.7)	**Interconnect Element** (see 5.8)
Consumer/ Component	Online 1	Near Online 1	Removable 1	Virtual 1	Not defined in this specification	Not defined in this specification
Low-end	Online 2	Near Online 2	Removable 2	Virtual 2		
Mid-range	Online 3	Near Online 3	Removable 3	Virtual 3		
	Online 4					
High-end	Online 5	Near Online 5	Removable 5	Virtual 5		
Mainframe	Online 6	Near Online 6	Removable 6	Virtual 6		

Data Center Storage Taxonomy Categories (Block Storage)

- Categories
  - Online
  - Near Online
  - Removable Media Library (RML)
  - Virtual Media Library (VML)
  - Adjunct Product
  - Interconnect Element

Attribute	Category					
	Online	Near Online	Removable Media Library	Virtual Media Library	Adjunct Product	Interconnect Element
Access Pattern	Random/ Sequential	Random/ Sequential	Sequential	Sequential		
MaxTTFD (t)	t < 80 ms	t > 80 ms	t > 80 ms t < 5 min	t < 80 ms	t < 80 ms	t < 80 ms
User Accessible Data	Required	Required	Required	Required	Prohibited	Prohibited

Storage Category Breakdown

- Access pattern
  - Random – Any I/O load whose consecutively issued read and/or write request do not specify adjacently located data (SNIA Dictionary)
  - Sequential – An I/O load consisting of consecutively issued read or write requests to adjacently located data (SNIA Dictionary)
    - Online and Near-online systems can accommodate both I/O loads
    - RML and VML can only accommodate sequential easily
- Max Time To First Data
  - Time it takes to start to receiving data from a storage system to satisfy a read request
    - Online and VML systems less than 80ms
    - Near online, RML systems greater than 80ms
- User Accessible Data
  - Has to store data on the storage system

Online Storage

- Online Storage Systems
  - Storage systems on the Storage Area Network provide quick access to data
  - Support random access – look up account data
  - Support sequential access – stream video
  - Generally Disk systems
    - Solid state is moving into market

Near Online Storage

- Near Online Storage Systems
  - Storage systems on the Storage Area Network which may have a long access time to data
    - Wait for hard drives to spin up before accessing data
  - Support random access – look account data
  - Support sequential access – stream video
  - Generally Disk systems

Removable Media Library

- Removable Media Storage Systems
  - Storage systems on the Storage Area Network which may have a long access time to data
    - Wait for a tape cartridge to be loaded
  - Support sequential access – data backup, archiving, video streaming
  - Generally tape or optical libraries

Virtual Media Library

- Fast response to sequential request
  - Emulate a tape system with disk
  - Used to speed up backup operations

Non Supported Categories

- Adjunct product
  - A defined category in the specification but no measurement of power efficiency specified
  - These products support storage systems in a single purpose but do not actually store any user data on them
    - Virtualization, deduplication, NAS gateways
    - Outside the block storage system

- Interconnect element
  - Products that interconnect storage devices and host
    - Switches, extenders

Storage Taxonomy Classifications

- Each of the four defined Categories are broken down to six or less classifications
  - This breaks up each category to compare functional and size like systems
  - Covers the range from consumer/component to high-end/mainframe
  - No classifications defined for adjunct product or interconnect element

Category Level	**Online** (see 5.3)	**Near Online** (see 5.4)	**Removable Media Library** (see 5.5)	**Virtual Media Library** (see 5.6)	**Adjunct Product** (see 5.7)	**Interconnect Element** (see 5.8)
Consumer/ Component	Online 1	Near Online 1	Removable 1	Virtual 1	Not defined in this specification	Not defined in this specification
Low-end	Online 2	Near Online 2	Removable 2	Virtual 2		
Mid-range	Online 3	Near Online 3	Removable 3	Virtual 3		
	Online 4					
High-end	Online 5	Near Online 5	Removable 5	Virtual 5		
Mainframe	Online 6	Near Online 6	Removable 6	Virtual 6		

Classification of Online Systems

- Online Classification
  - Online 1
  - Online 2
  - Online 3
  - Online 4
  - Online 5
  - Online 6

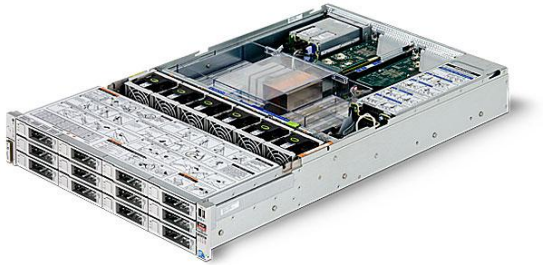
Attribute	Classification					
	Online 1	Online 2	Online 3	Online 4	Online 5	Online 6
Access Pattern	Random/ Sequential	Random/ Sequential	Random/ Sequential	Random/ Sequential	Random/ Sequential	Random/ Sequential
MaxTTFD (t)	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms
User-Accessible Data	Required	Required	Required	Required	Required	Required
Connectivity	Not specified	Connected to single or multiple hosts	Network-connected	Network-connected	Network-connected	Network-connected
Consumer/ Component	Yes	No	No	No	No	No
Integrated Storage Controller	Optional	Optional	Required	Required	Required	Required
Storage Protection	Optional	Optional	Required	Required	Required	Required
No SPOF	Optional	Optional	Optional	Required	Required	Required
Non-Disruptive Serviceability	Optional	Optional	Optional	Optional	Required	Required
FBA/CKD Support	Optional	Optional	Optional	Optional	Optional	Required
Maximum Supported Configuration	≥1	≥ 4	≥ 12	> 100	>400	>400

Online Classification Breakdown

- First thee access pattern, max time to first data, and user accessible data defined in the category section
- Connectivity
  - Connected by USB cable or connected to a single host or connected through a SAN
- Consumer component
  - Used by consumers or data centers
- Integrated storage controller
  - A controller to which storage devices are attached (SNIA Dictionary)
- Storage protection
  - A combination of hardware and software that assures that all IO operations will be preserved in the event of power loss or storage device failure
- No single point of failure
  - Assurance that if one component or path in a system fails data is accessible
- Non-disruptive serviceability
  - Continued availability to data during breaks/fixes, code patches, software/firmware upgrades, configuration changes, data migrations and system expansion (performance is not guaranteed)
- FBA/CKD support
  - Models of disk storage used in mainframe architecture
- Maximum supported configuration
  - The maximum number of disk a system can support
    - System has to support more disk than what is listed in the table

Online Classification Breakdown Continued

- Start small with online 1 and work up to large storage system with online 6
  - Online 1 system small consumer products
  - Online 2 system small storage system
    - Generally JBOD
    - For Energy Star needs to have a RAID controller



  - Online 3 system
    - Integrated control and needs to have some storage protection
  - Online 4 system
    - Larger storage systems that require no SPOF
  - Online 5 system
    - Very large high end systems that require non-disruptive serviceability
  - Online 6 system
    - Very large mainframe systems

The Other Category Classification

- No Classification 4
  - Near-online, removable media libraries, virtual media library
  - Done to keep the 1 through 6 span for all categories
- Near online uses the same attributes of online
  - The number of supported devices is adjusted
- Removable media libraries
  - Defines Online 1 as a component – an individual drive
  - Has an robotics attribute which means the storage system has to have a robot which loads the storage media to the drives
- Virtual media library
  - Uses a subset of the online attributes

Taxonomy Living Document

- As much as I would like it Storage is changing
  - Impact of Sold State Disk/Storage
  - Scale up – Scale Out
- Addition of Categories
  - Fill out adjunct product
  - File/NAS
  - Sold State

Near Online Classifications

Attribute	Classification					
	Near Online 1	Near Online 2	Near Online 3	Near Online 4	Near Online 5	Near Online 6
Access Pattern	Random/ Sequential	Random/ Sequential	Random/ Sequential		Random/ Sequential	Random/ Sequential
MaxTTFD (t)	t > 80 ms	t > 80 ms	t > 80 ms		t > 80 ms	t > 80 ms
User-accessible Data	Required	Required	Required		Required	Required
Connectivity	Not specified	Network connected	Network connected		Network connected	Network connected
Consumer/ Component	Yes	No	No		No	No
Integrated Storage Controller	Optional	Optional	Required		Required	Required
Storage Protection	Optional	Optional	Required		Required	Required
No SPOF	Optional	Optional	Optional		Optional	Required
Non-Disruptive Serviceability	Optional	Optional	Optional		Optional	Required
FBA/CKD Support	Optional	Optional	Optional		Optional	Optional
Maximum Supported Configuration	≥ 1	≥ 4	≥ 12		> 100	> 1000

Removable Media Library Classifications

Attribute	Classification					
	Removable 1	**Removable 2**	**Removable 3**	**Removable 4**	**Removable 5**	**Removable 6**
Access Pattern	Sequential	Sequential	Sequential		Sequential	Sequential
MaxTTFD (t)	80ms < t < 5m	80ms < t < 5m	80ms < t < 5m		80ms < t < 5m	80ms < t < 5m
User-Accessible Data	Required	Required	Required		Required	Required
Robotics	Prohibited	Required	Required		Required	Required
No SPOF	Optional	Optional	Optional		Optional	Required
Non-disruptive Serviceability	Optional	Optional	Optional		Optional	Required
Maximum Supported Drive Count	Not specified	4	≥ 5		≥ 25	≥ 25

Virtual Media Library Classifications

Attribute	Classification					
	Virtual 1	**Virtual 2**	**Virtual 3**	**Virtual 4**	**Virtual 5**	**Virtual 6**
Access Pattern	Sequential	Sequential	Sequential		Sequential	Sequential
MaxTTFD (t)	t < 80 ms	t < 80 ms	t < 80 ms		t < 80 ms	t < 80 ms
User-accessible Data	Required	Required	Required		Required	Required
Storage Protection	Optional	Optional	Required		Required	Required
No SPOF	Optional	Optional	Optional		Optional	Required
Non-Disruptive Serviceability	Optional	Optional	Optional		Optional	Required
Maximum Supported Configuration	12	>12	> 48		> 96	> 96