



Education

# **Solid State Storage TCO Calculator**

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## ➤ **Solid State Storage: TCO Calculator**

- ◆ The presentation will introduce the Total Cost of Ownership (TCO) Calculator that the SNIA Solid State Storage Initiative has developed to assist end users in assessing appropriate TCO-based HDD disk replacement deployment.
- ◆ The tutorial will review the structure of the SSSI TCO Calculator and demonstrate several use cases to estimate TCO impact and benefits.

- TCO Overview
- Introduction to SSS TCO Calculator
- How to use the calculator
- SSD Calculator Examples
- Summary
- Questions/Answers

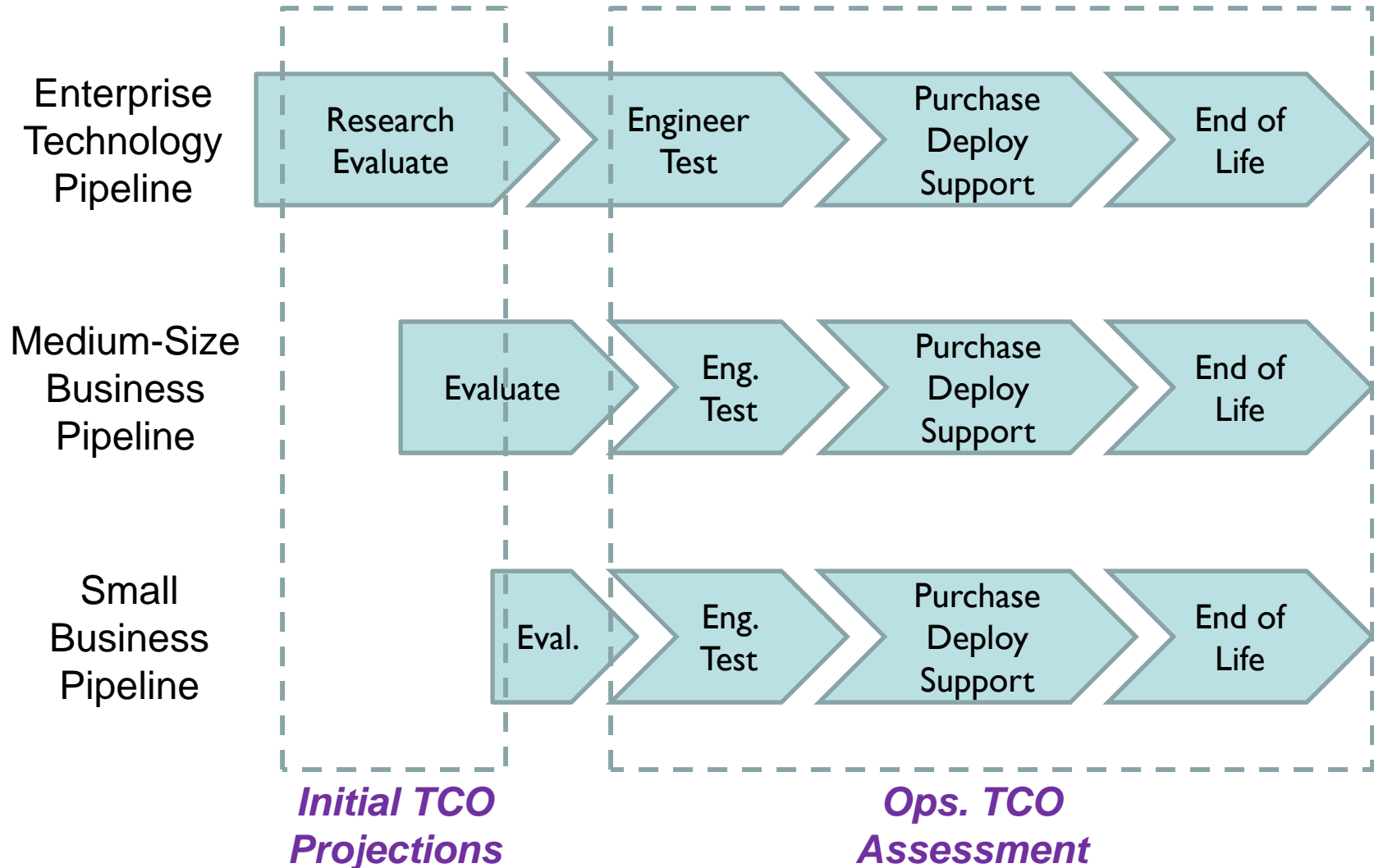
# Persistent Storage Attributes/Usage **SNIA**



- **Data Placement - by performance and access requirements**
- **Costs - relative and variable based on placement and services**
- **Goal - meet customer requirements at lowest possible TCO**

- Used for comparative analysis of optional solutions from a cost/benefit perspective or for assessing cost of storage/services deployed.
  - ◆ Question: What will/does storage cost over the full term of its service life?
- All costs need be considered
  - ◆ Need to understand TCO assumptions and formulas
- Cost is offset by benefits expressed in dollars
  - ◆ Hard Value – Can be quantitatively measured in \$\$
  - ◆ Soft Value – Qualitative value to which \$\$ may be assigned (e.g., user productivity, increased revenue, etc.)

# Typical IT Process



- Parameters that users will need to perform a TCO comparison between HDDs and SSDs
  - ◆ # HDDs currently in use
  - ◆ RPM/Drive Capacity/Interface
  - ◆ Power consumed per drive
  - ◆ Total capacity required by an application
  - ◆ Application I/O characterization
    - > read/write data access percentage
    - > random/sequential access pattern
    - > average i/o block size
  - ◆ RAID configuration being used
  - ◆ Cost of maintenance and repairs

## ➤ Input

- ◆ User Environment Data
- ◆ Assumptions
- ◆ Performance Data/Specifications

## ➤ Output

- ◆ TCO Impact (may increase or decrease)
- ◆ Performance Benefit

# TCO Calc. Steps - Application Entry

Enter data in each of the white fields. This sets up the parameters for an application-based storage setup. Fill out questions 1 thru 15 to see how Solid State Storage will affect your application. Note: The calculator is populated with sample data from SSDs and HDDs.

1	What is the I/O transfer size in KB?	4K
2	Which of the following most closely characterizes your application's I/O?	65/35
<b>For questions 3 - 11, input information about your current Hard Drive configuration.</b>		
3	Select your current HDD size	2.5 Inch
4	Select your HDD storage interface	SAS
5	Select your current HDD RPM	15K rpm
6	Select your current HDD per unit raw capacity	73 GB
7	How many <i>Hard Drives</i> do you currently have in the application?	12
8	What percentage of your Hard Drive capacity is <i>consumed</i> ?	70%
9	What RAID configuration do you <i>currently</i> use?	RAID 10
10	Do you <i>currently</i> purchase maintenance plans for your hard drives?	yes
11	How many <i>instances (or systems)</i> of the above configuration do you have?	1
<b>For questions 12 - 15, Please choose your solid state solution</b>		
12	Choose a SSS solution	Sample 128GB SLC
13	What <i>RAID</i> configuration will you use for your SSS?	RAID 5
14	Will you purchase maintenance plans for your SSS?	yes
<b>Recommended minimum number of Solid State Storage devices based on responses for questions 1 - 11.</b>		3

# TCO Calc. Steps - Examine Assumptions

Use the "Application Input" tab to understand and change the application assumptions.  
Use the "SSS Input" and "HDD Input" tabs to change the data for your specific storage.

<b>Datacenter and Storage Environment Assumptions</b>		
	<b>Model Assumptions</b>	<b>Default</b>
Storage service life/refresh cycle in years	<b>4</b>	4
2.5 inch drives per enclosure	<b>25</b>	25
3.5 inch drives per enclosure	<b>12</b>	12
Disk Array enclosures	<b>\$ 3,250</b>	\$ 3,250
Empty enclosure power draw at full load	<b>100</b>	100
Number of watts to cool 1 watt	<b>1.2</b>	1.2
Power cost per kwh for your region	<b>\$ 0.158</b>	\$ 0.158
Per failure IT Labor Cost at \$40 an hour	<b>\$ 320</b>	\$ 320
Maintenance cost as a % of drive cost	<b>17%</b>	17%

# TCO Calc. Steps - Compare Solutions

Add additional SSS options to find the best solution for you.

	Solid State Options	Capacity	Cost per Drive	Watts at full load
SSD Default	<i>Sample 128GB SLC</i>	128	\$ 1,280	2.0
Option 2	Brand X - 64GB SLC	64	\$ 600	1.2
Option 3	Brand Y - 32GB SLC	32	\$ 35	1.0
Option 4				

Maintenance **17.0%** Percentage adder to total SSS bill of materials, if selected in calculator

Per Drive RAID Perf. Efficiency\* Default

No RAID	100%	100%
RAID 0	75%	75%
RAID 1	50%	50%
RAID 5	45%	45%
RAID 6	25%	25%
RAID 10	50%	50%

\*Performance efficiency will improve with the number of drives  
This is a 6 drive efficiency

Update with your measurements or vendor provided information.

Input Single Drive Random Performance (No RAID)								
Sample 128GB SSD	Random Read/Write	100/0	95/5	65/35	50/50	35/65	5/95	0/100
	.5KB	12,045	11,808	6,002	4,845	4,829	4,366	4,299
	4K	5,771	5,535	4,372	3,740	3,295	3,018	2,920
	8K	4,633	4,469	3,600	3,065	2,822	2,633	2,522
	16K	3,597	3,504	2,837	2,557	2,387	2,198	2,168
	32K	2,696	2,591	2,255	2,231	2,121	1,989	1,833
	64K	1,961	1,898	1,531	1,411	1,268	1,038	971
	128K	1,288	1,224	932	820	725	551	532
	1,024K	156	147	109	95	79	74	73
	32,768K	5	5	4	4	4	4	4

# TCO Calc. Steps - Evaluate Opportunities

Adjust inputs for alternative scenarios and use the results header to see the immediate affect. Toggle between SSS options (Question 12) to find the best solution for your application in terms of TCO and IOPS gain. Details below line 34 on this sheet (on next slide).

TCO Impact	I/O Performance Improvement	IOPS Gain	Reduction in power	Previous HDD Total	Total SSDs	Total HDD Consumed	Total Usable SSS Capacity
\$547	290%	9,756	95.5%	12	3	307 GB	384 GB

*It's not just about the \$\$*

*Performance Benefits*

*Power Reduction*

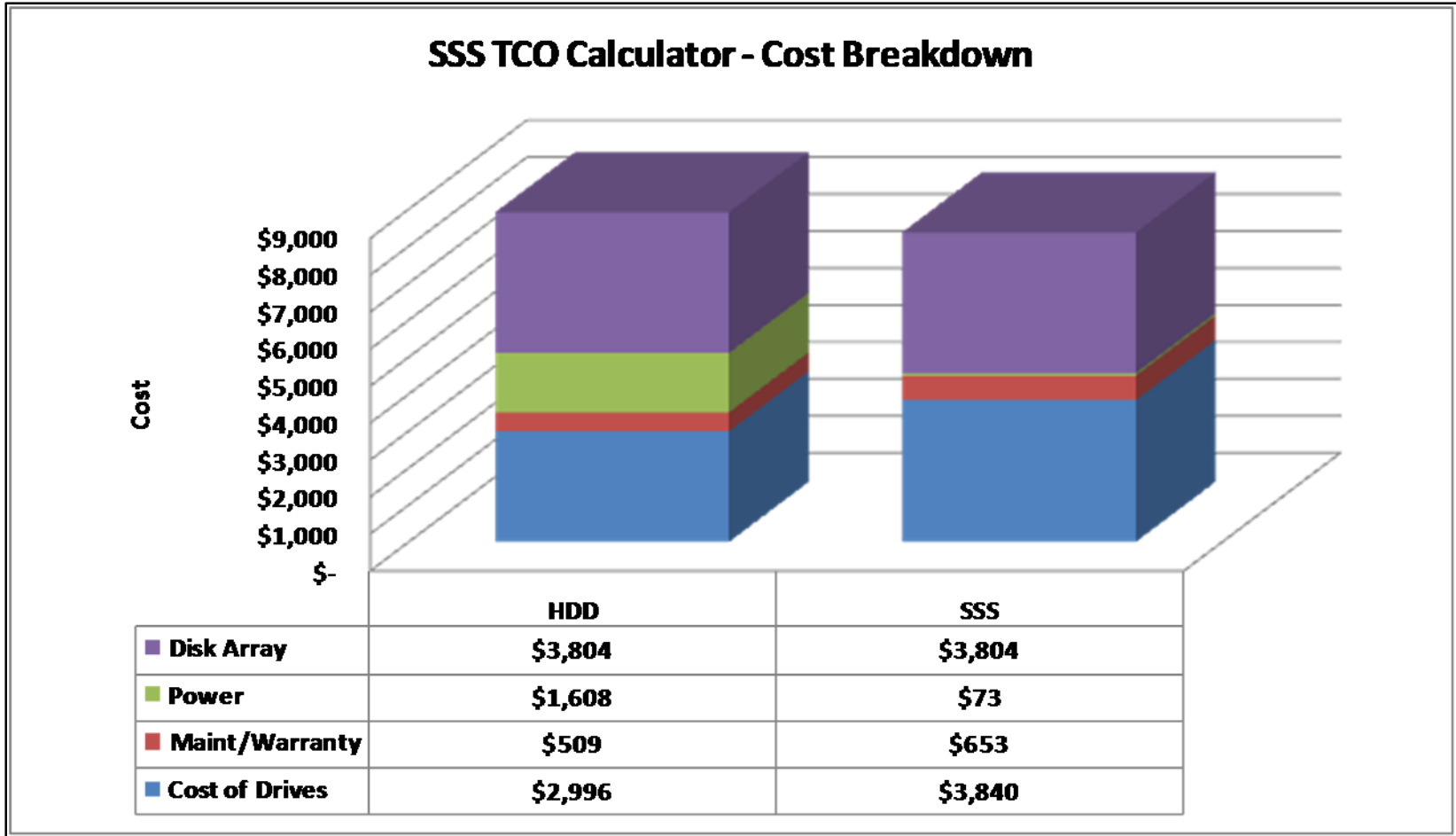
*Space Reduction*

# TCO Calc. Steps - Review Details/Select or Deselect Options

## TCO Results

<input checked="" type="checkbox"/>	<b>HDD Power Cost</b> HDD Power Cost HDD Cooling Cost Total HDD Energy Cost	Lifetime Cost \$ 731 \$ 877 \$ 1,608	<input checked="" type="checkbox"/>	<b>SSD Power Cost</b> SSD Power Cost SSD Cooling Cost	Lifetime Cost \$ 33 \$ 40 \$ 73 \$ <b>1,535</b> <i>Power Savings</i>
<input checked="" type="checkbox"/>	<b>Disk Array</b> HDD Cost of Enclosures HDD Enclosure Energy Draw Total HDD Enclosure Cost	Lifetime Cost \$ 3,250 \$ 554 \$ 3,804	<input checked="" type="checkbox"/>	<b>Disk Array</b> SSD Cost of Enclosures SSD Enclosure Energy Draw Total SSD Enclosure Cost	Lifetime Cost \$ 3,250 \$ 554 \$ 3,804 \$ - <i>Space Savings</i>
<input checked="" type="checkbox"/>	<b>Drive and Maintenance</b> HDD Cost Maintenance/Warranty Cost	Lifetime Cost \$ 2,996 \$ 509 \$ 3,505	<input checked="" type="checkbox"/>	<b>Drive and Maintenance</b> SSD Cost Maintenance/Warrant	Lifetime Cost \$ 3,840 \$ 653 \$ 4,493
	<b>HDD Total Cost of Ownership</b> Upfront Cost Per Year Cost Total usable capacity	\$ <b>8,917</b> \$ 7,309 \$ 402 307		<b>SSD Total Cost of</b> Upfront Cost Per Year Cost Total usable capacity	\$ <b>8,370</b> \$ 8,296 \$ 18 307
				<b>SSD Value for</b> Disk I/O Improvement Total capacity Reduction in Power	\$ <b>547</b> 290.38% 384 GB 95.5% Fewer Watts

# TCO Calc. Steps - Review TCO Breakdown Chart



# A Few Examples

# Use Case #1 - 400GB High Perf. 95% Read

- |   |   |      |
|---|---|------|
| 1 | What is the I/O transfer size in KB?                                      | 4K   |
| 2 | Which of the following most closely characterizes your application's I/O? | 95/5 |

***For questions 3 - 11, input information about your current Hard Drive configuration.***

- |    |  |          |
|----|--|----------|
| 3  | Select your current HDD size   | 2.5 Inch |
| 4  | Select your HDD storage interface  | SAS      |
| 5  | Select your current HDD RPM  | 15K rpm  |
| 6  | Select your current HDD per unit raw capacity                            | 73 GB    |
| 7  | How many <b>Hard Drives</b> do you currently have in the application?    | 12       |
| 8  | What percentage of your Hard Drive capacity is <b>consumed</b> ?         | 70%      |
| 9  | What RAID configuration do you <b>currently</b> use?                     | 10       |
| 10 | Do you <b>currently</b> purchase maintenance plans for your hard drives? | yes      |
| 11 | How many <b>instances</b> of the above configuration do you have?        | 1        |

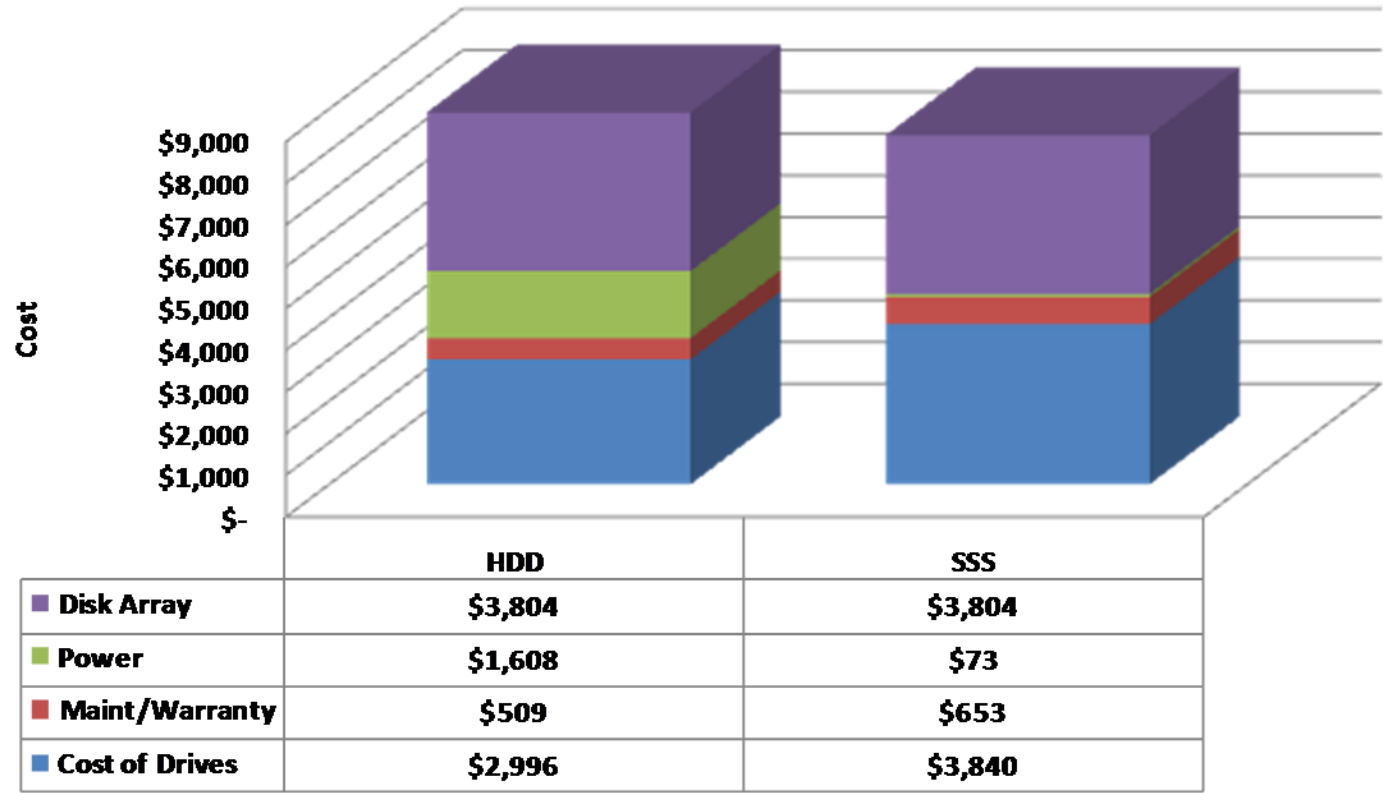
***For questions 12 - 15, Please choose your solid state solution***

- |    |   |            |
|----|---|------------|
| 12 | Choose a SSS solution                                     | Sample SSD |
| 13 | What <b>RAID</b> configuration will you use for your SSS? | 5          |
| 14 | How many SSS drives do you want for your application?     | 3          |
| 15 | Will you purchase maintenance plans for your SSS?         | yes        |

# Use Case #1 Results – Slightly Positive TCO Impact

TCO Impact	I/O Performance Improvement	IOPS Gain	Reduction in power	Previous HDD Total	Total SSDs	Total HDD Consumed	Total Usable SSS Capacity
\$547	290%	9,756	95.5%	12	3	307 GB	384 GB

**SSS TCO Calculator - Cost Breakdown**



From 15KRPM HDDs (\$3.42/GB) RAID-10 to 128GB SSDs (\$10/GB) RAID-5

# Use Case #2 - 400GB Medium Perf. 65% Read

- |   |   |       |
|---|---|-------|
| 1 | What is the I/O transfer size in KB?                                      | 4K    |
| 2 | Which of the following most closely characterizes your application's I/O? | 65/35 |

**For questions 3 - 11, input information about your current Hard Drive configuration.**

- |    |  |          |
|----|--|----------|
| 3  | Select your current HDD size   | 2.5 Inch |
| 4  | Select your HDD storage interface  | SAS      |
| 5  | Select your current HDD RPM  | 10K rpm  |
| 6  | Select your current HDD per unit raw capacity                                  | 146 GB   |
| 7  | How many <b>Hard Drives</b> do you currently have in the application?          | 6        |
| 8  | What percentage of your Hard Drive capacity is <b>consumed</b> ?               | 70%      |
| 9  | What RAID configuration do you <b>currently</b> use?                           | RAID 5   |
| 10 | Do you <b>currently</b> purchase maintenance plans for your hard drives?       | yes      |
| 11 | How many <b>instances (or systems)</b> of the above configuration do you have? | 1        |

**For questions 12 - 15, Please choose your solid state solution**

- |    |   |                  |
|----|---|------------------|
| 12 | Choose a SSS solution                                     | Sample 128GB SLC |
| 13 | What <b>RAID</b> configuration will you use for your SSS? | RAID 5           |
| 14 | Will you purchase maintenance plans for your SSS?         | yes              |

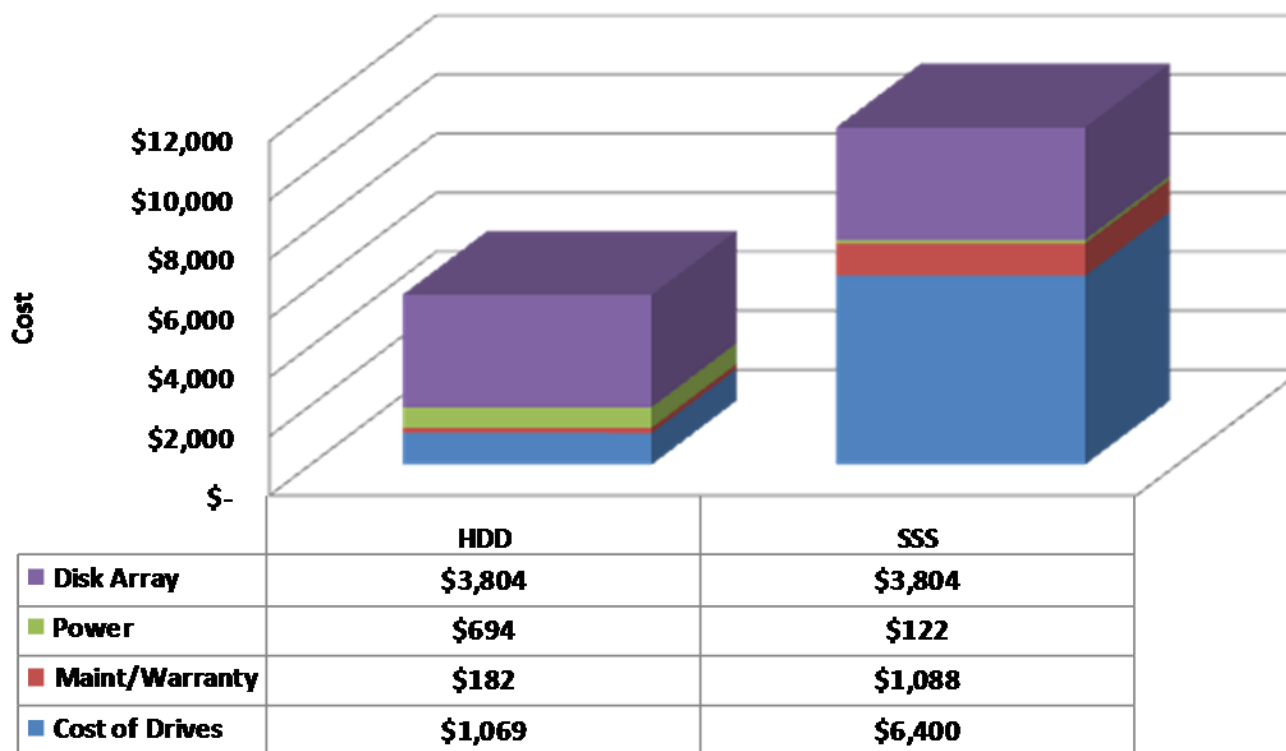
**Recommended minimum number of Solid State Storage devices based on responses for questions 1 - 11.**

**5**

# Use Case #2 Results – Negative TCO Impact

TCO Impact	I/O Performance Improvement	IOPS Gain	Reduction in power	Previous HDD Total	Total SSDs	Total HDD Consumed	Total Usable SSS Capacity
(\$5,665)	2631%	21,059	82.5%	6	5	491 GB	640 GB

**SSS TCO Calculator - Cost Breakdown**



**From 10KRPM HDDs (\$1.22/GB) RAID-5 to 128GB SSDs (\$10/GB) RAID-5**

# Use Case #3 - 300GB “Caching Disk” 65% Read

- |   |   |       |
|---|---|-------|
| 1 | What is the I/O transfer size in KB?                                      | 4K    |
| 2 | Which of the following most closely characterizes your application's I/O? | 65/35 |

**For questions 3 - 11, input information about your current Hard Drive configuration.**

- |    |  |          |
|----|--|----------|
| 3  | Select your current HDD size   | 2.5 Inch |
| 4  | Select your HDD storage interface  | SAS      |
| 5  | Select your current HDD RPM  | 15K rpm  |
| 6  | Select your current HDD per unit raw capacity                                  | 73 GB    |
| 7  | How many <b>Hard Drives</b> do you currently have in the application?          | 16       |
| 8  | What percentage of your Hard Drive capacity is <b>consumed</b> ?               | 50%      |
| 9  | What RAID configuration do you <b>currently</b> use?                           | RAID 10  |
| 10 | Do you <b>currently</b> purchase maintenance plans for your hard drives?       | yes      |
| 11 | How many <b>instances (or systems)</b> of the above configuration do you have? | 1        |

**For questions 12 - 15, Please choose your solid state solution**

- |    |   |                  |
|----|---|------------------|
| 12 | Choose a SSS solution                                     | Sample 128GB SLC |
| 13 | What <b>RAID</b> configuration will you use for your SSS? | RAID 5           |
| 14 | Will you purchase maintenance plans for your SSS?         | yes              |

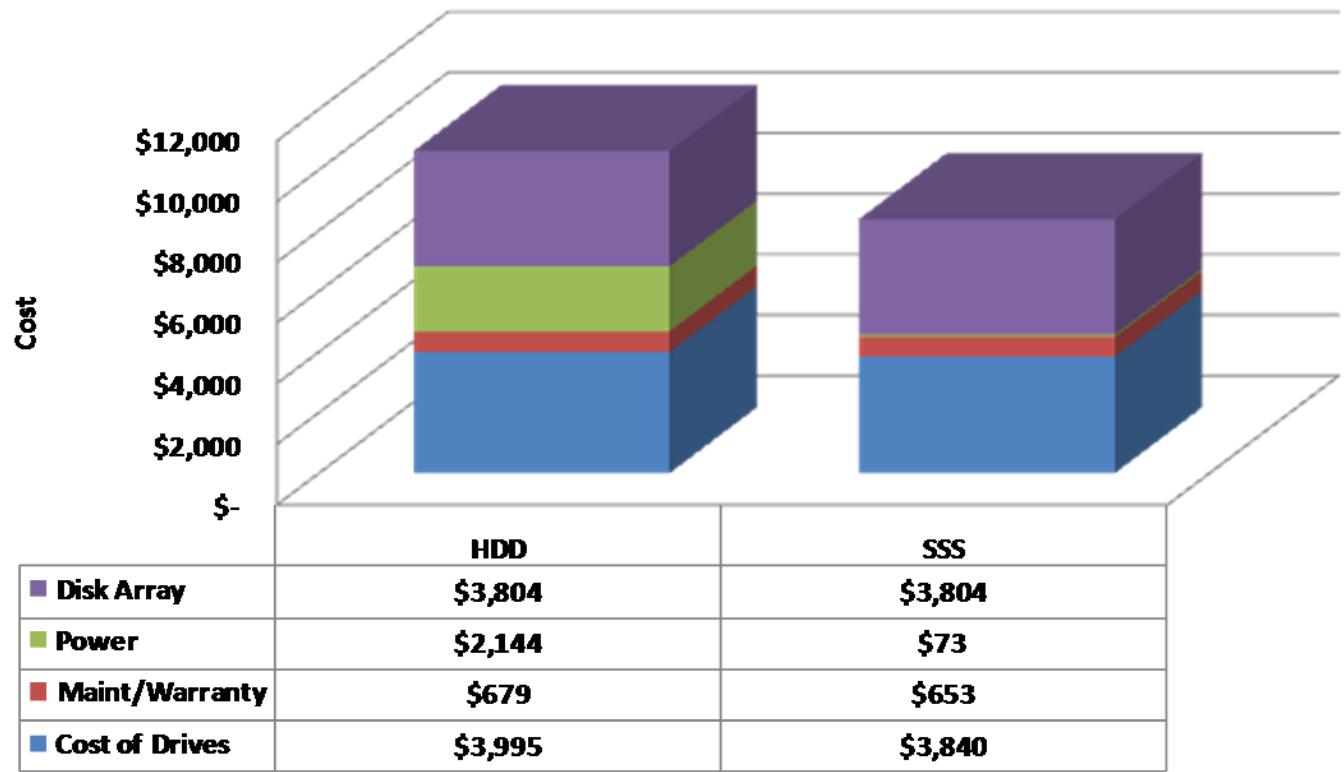
**Recommended minimum number of Solid State Storage devices based on responses for questions 1 - 11.**

3

# Use Case #3 Results – Very Positive TCO Impact

<b>TCO Impact</b>	<b>I/O Performance Improvement</b>	<b>IOPS Gain</b>	<b>Reduction in power</b>	<b>Previous HDD Total</b>	<b>Total SSDs</b>	<b>Total HDD Consumed</b>	<b>Total Usable SSS Capacity</b>
\$2,251	193%	8,636	96.6%	16	3	292 GB	384 GB

**SSS TCO Calculator - Cost Breakdown**



**From 15KRPM HDDs (\$3.42/GB) RAID-10 to 128GB SSDs (\$10/GB) RAID-5**

# Summary

- **Based on our sample numbers and assumptions used:**
  - ◆ TCO may justify SSD replacement of HDDs in some cases
    - > Use of SSDs for higher performance “caching devices” makes sense
    - > SSDs for medium/low I/O performance applications would be wasteful
  - ◆ SSD pricing will limit usage/deployment
    - > SSD prices need to decrease for broader adoption
    - > Enterprise MLC SSDs will lower cost/GB
    - > But ... HDD prices are also dropping
- All SSD benefits must be considered
  - ◆ Performance gains ... convert to \$\$ if possible
  - ◆ Power/Space ... host/rack/data center capacities
- All SSDs are not created equal
- Use your data and the SSS TCO Calculator to project SSS value/benefits for your environment and application

# Questions?

***Thank you for attending this session!***

Visit the SSSI Hands-on Lab!

Get a feel for SSS technologies in action and get additional hands-on training with the SSS TCO Calculator

Download the SSS Calculator at: [link](#)

- Please send any questions or comments on this presentation to SNIA: [tracksolidstate@snia.org](mailto:tracksolidstate@snia.org)

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**- SNIA Education Committee**

**Terry Yoshii  
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