

Intelligent Architecture for the Data-Driven Business

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Solid State Performance Comparisons: SSD Cache Performance

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This presentation is available at http://www.demartek.com/Demartek_Presenting_SNWUSA_2013-10.html



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Demartek – About Us Solid-state Technology Overview SSD: Primary Storage vs. Caching Locations for SSD Caching Cache-friendly workloads **SSD** Performance Results – Demartek Lab References



About Demartek

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Solid State Technology Overview

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- Presents memory technology, such as DRAM or NAND flash, as storage media and appears as a disk drive to the operating system in most cases
 - Some motherboards allow dedicated SSD to act as a cache or other functions
- Some SSDs use DRAM and NAND flash together
- Very fast, no moving parts (no "seek time")
- Variety of form factors
- Prices dropping

Capacities doubling almost yearly

SSD: Primary Storage vs. Caching

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SSDs as primary storage

- Data is stored permanently on the SSDs
- Could be part of a tiering solution
- Only the applications whose data is stored on the SSDs are accelerated
- SSDs as a cache
 - Data (a copy) is stored temporarily on the SSDs
 - Accelerates reads (usually) and writes (sometimes)
 - Can potentially accelerate multiple applications at the same time

Both can be used (for different data)

SSD Caching Basics – 1

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Caching controller or software identifies any frequently accessed data ("hot data") and automatically moves a copy of the hot data to the solid-state media

SSD impact

- Multiple applications can benefit from the SSD cache simultaneously
- Performance improves over time, as cache is populated with data, known as cache "warm-up" or "ramp-up"

SSD Caching Basics – 2

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Data that can be cached:

- Reads only ("write-through" cache)
- Reads and writes ("write-back" cache)
 - Write-back cache takes more work to guarantee cache coherency

Overall HDD I/O load is reduced – Fewer I/O requests are seen by the back-end HDDs

SSD Caching Components

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Hardware

- PCIe NAND flash cards
- Drive form-factor SSDs (SATA or SAS interface)
- DIMM socket NAND flash solutions
- NAND flash mounted on motherboard

Software

- Provided by independent software groups
- Provided by the hardware vendor



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SSD Caching Architecture

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SSD caching can be deployed:

- Server-side
- In the network
- In the storage system

We have seen increased performance benefits by combining server-side with the others, in many cases

SSD Caching Workloads

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Caching Algorithms

- Prefer random I/O, small to moderate block sizes
- Some allow adjustments to cache block sizes, etc.

Cache Friendly Workloads

- Hot spots with repeated access
- OLTP databases
- Database indexes



- File system table of contents (MFT, inodes, etc.)
- Cache Un-friendly Workloads
 - Data that is accessed approximately evenly and is larger than the cache

Server-side SSD

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Advantages

– Closest to host CPU and applications

Disadvantages

- Difficult to share across servers, such as clusters, but this is changing
- Device types
 - Motherboard cache device
 - Caching storage/RAID controller
 - Installed SSD drives
 - Installed PCIe cards
 - DIMM socket NAND flash solutions



SSD In the Network

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Advantages

- Little or no change to servers or applications
- Can be shared across servers (clusters) or applications

Disadvantages

- Possibly new equipment added to the network
 - Possibly change target names for NAS or SAN targets from servers
 - Shared cache HBAs require installation into servers

Device Types

- NAS accelerator appliances file workloads
- SAN accelerator appliances block workloads
- FC HBA with shared cache across SAN fabric

SSD In the Storage System

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Advantages

- Cache implementations require no changes to application
- SSD cache can be shared across servers and apps

Disadvantages

Some storage system SSD caches only accelerate reads

Device Types

- SSD drives acting as a cache in the storage subsystem
- PCIe SSD cards acting as cache in controller

Server-side Read SSD Cache Read/Write "Flip" Effect on Back-end Storage Array

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Read/Write "Flip" effect of server-side SSD read cache on back-end storage array



SSD Cache Performance Examples

Reports available in the Demartek SSD Zone

Cache: SQL Server Database OLTP Workload

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Example 1: Server-side PCIe SSD cache connected to large FC SAN storage array

Cache – Reads per Second Cache – Seconds per Read (Physical Disk) (Physical Disk) 80,000 0.012 Demartek 70,000 Latency (seconds) 0.010 60,000 0.008 50,000 0.006 40,000 30,000 0.004 20,000 0.002 **Demartek** 10,000 0.000 0 - 00:00:0 0:10:00 1:00:00 1:10:00 1:20:00 1:30:00 1:40:00 1:50:00 2:00:00 0:20:00 0:30:00 0:40:00 0:50:00 2:10:00 0:00:00:0 0:30:00 0:40:00 0:50:00 1:00:00 1:10:00 1:20:00 1:30:00 2:00:00 0:10:00 0:20:00 1:40:00 1:50:00 2:10:00

Elapsed Time (hh:mm:ss)

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Example 1: Server-side PCIe SSD cache connected to large FC SAN storage array

Elapsed Time (hh:mm:ss)

Database Performance - PCIe SSD Cache 26,000 per Second ∞ Demartek' 24,000 22,000 20,000 **8**x 18,000 **Server Transactions** 7x 16,000 14,000 12,000 10,000 **4**x 8,000 6,000 4,000 SQL 2,000 0 0:00:00 1:00:00 2:00:00 3:00:00 4:00:00 7:00:00 5:00:00 6:00:00 Elapsed Time (H:MM:SS) Baseline (40 HDD) Cache 240GB Cache 480GB -Cache 480GB Steady State

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Example 2: Server-side PCIe SSD cache connected to medium FC SAN storage array **Database size: 1TB** Server: 2x Intel Xeon E5-2690, 2.9 GHz

Web Page Hit Rate - RAID Controller SSD Cache 180 160 166.40 140 7.2 x HDD Pages Per Second 120 HDD only 100 1 SSD 80 83.00 2 SSD 60 3.6 x HDD 40 20 23.10 0 0 10 20 30 40 50 60 70 80 90 **Elapsed Time in Minutes**

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Example 3: Internal RAID Controller with SSD cache and HDDs in a JBOD Web server data size: 40GB SSD: 32GB Server: 2x Intel Xeon E5345, 2.33 GHz

Demartek References

Demartek SSD Zone

<u>www.demartek.com/SSD</u>

Demartek SSD Deployment Guide

<u>www.demartek.com/Demartek_SSD_Deployment_Guide.html</u>

Demartek Commentary – Horses, Buggies & SSDs

www.demartek.com/Demartek_Horses_Buggies_SSDs_Commentary.html

Demartek Storage Interface Comparison

<u>www.demartek.com/Demartek_Interface_Comparison.html</u>

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Thank You!

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*also on the back of Dennis' business card

