



Optimizing the Data Center with an End to End Solutions Approach

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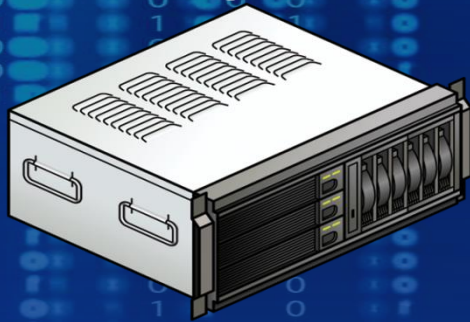
The Data Center

An Ecosystem

aka... Solution

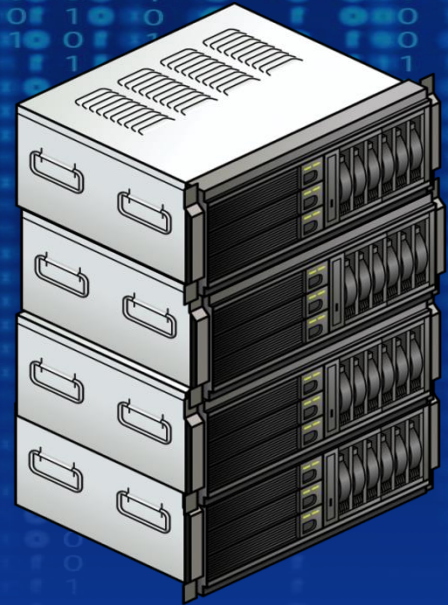
There are lots of ways to build a solution

Storage and compute together
in a single unit

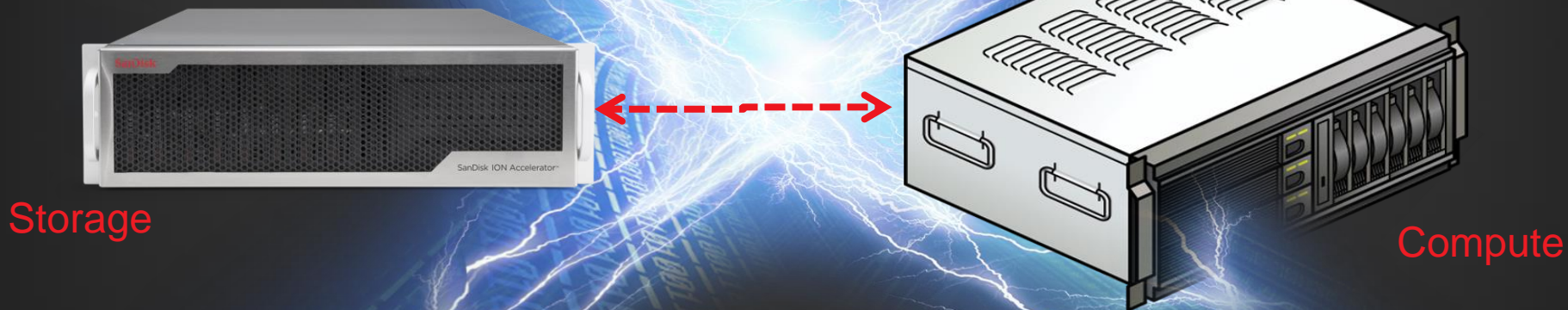


or

Lots of units operating
in a cluster or “Cloud”



Resource Pooling:



Storage and Compute still work together but physically separate

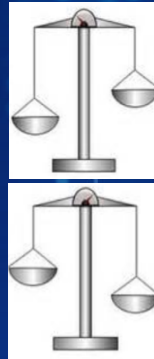
What do these examples have in common?

**It doesn't matter the configuration,
a change in one aspect of the solution
can affect the final capability of the entire solution**

Example:

**It doesn't matter how fast the CPU is if
the storage can't provide data fast enough**

**It doesn't matter how fast the storage is if
the CPU can't process the data**

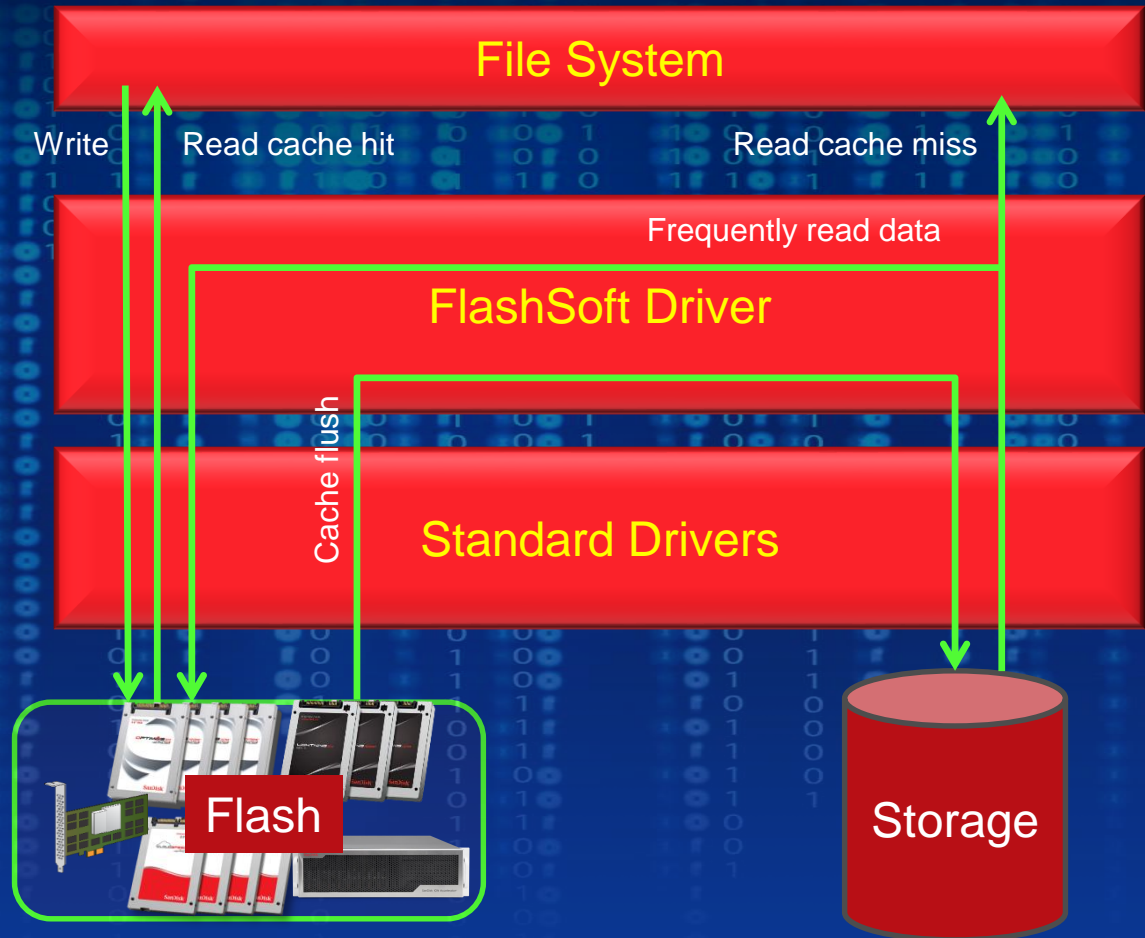


Balance the variables to get the best result!

Lets look at putting pieces in place that allow for the best final result. Examine how small changes affect the solution

Caching Solutions

Sure, they accelerate but what else do they do?

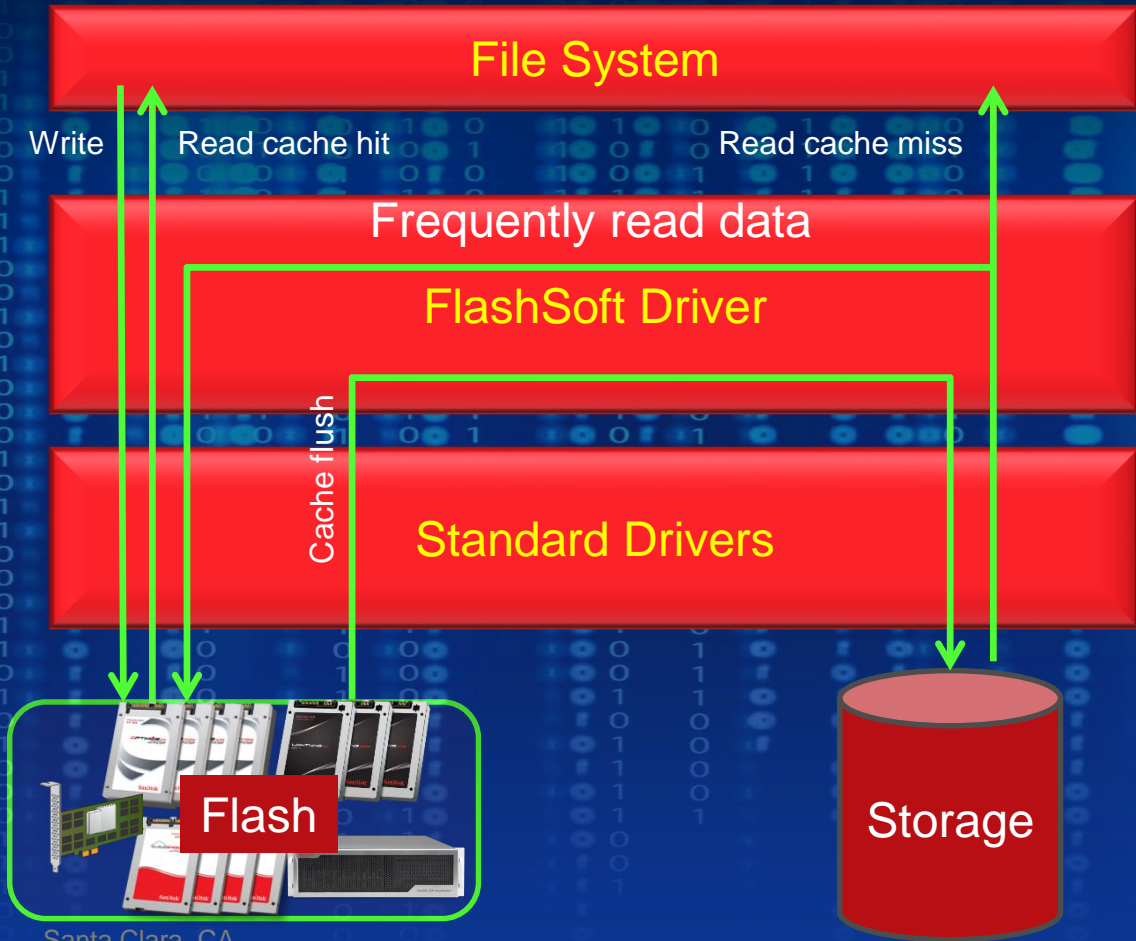


Cache hits allow:

- Faster system performance
- Relieves performance pressure on HDDs

Affect on the solution:

- Short stroked HDD sets can be reduced
- Type of HDD used can be changed (10k versus 15k)
- HDD RAID type may change allowing more capacity RAID 10 or 6 to RAID 5 etc..





What else can we do?

Let's consolidate some Hardware!

Having the individual hardware pieces ... not enough to fully realize the opportunities

- Fundamental shift in thinking is occurring
 - Flash used for applications that require high performance but ...
 - What about moderate performance scenarios?
 - HDDs will work, but can we do better?
 - Flash has powerful affects on other solution components
 - Don't limit your thinking to widget purchases

Solution cost and specifications are the focus, as opposed to any single device specifications

A photograph of a dense forest with tall, thin trees and a lush green undergrowth. The scene is captured from a low angle, looking down a path or clearing. The lighting is soft, suggesting a misty or overcast day.

Let's look at the forest instead of a single tree

HDD limitations lead to costly, complicated software, and additional hardware

- Inefficient short-stroked solutions
- DRAM used to hide slowness of HDDs
- Small capacity points needed for performance density (IOPs/GB)
- Algorithms and HW adders used to hide HDD slowness
- In Summary...

Flash solutions allow the removal of costly HDD constructs!

There's another way...

- Solid State Devices aren't just for performance
- Capacity/performance/cost characteristics of SSDs now allow cost-effective HDD replacement
- Cost per GB of individual devices are in some cases now less expensive than HDDs
- Ex. Capacity density of Optimus MAX 4 TB drive allows for consolidating 300 GB 15k HDDS by up to 13 to 1
 - Reduces infrastructure burden (housing/powering)
 - Cost to both acquire and operate a solution can be lower

Lets look at a real world example and put the pieces together using real list pricing!

We can assume any discounts would be applied evenly at a solutions sale level

Enterprise Solid State Devices are now lower cost per GB than high end 15K HDDs

- Optimus MAX (public list price) \$6,999*

– \$1.82/GB



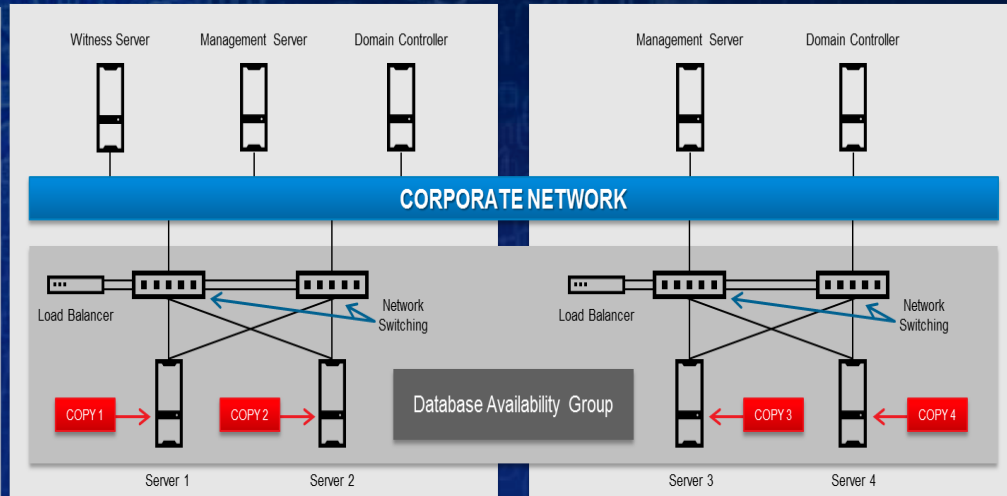
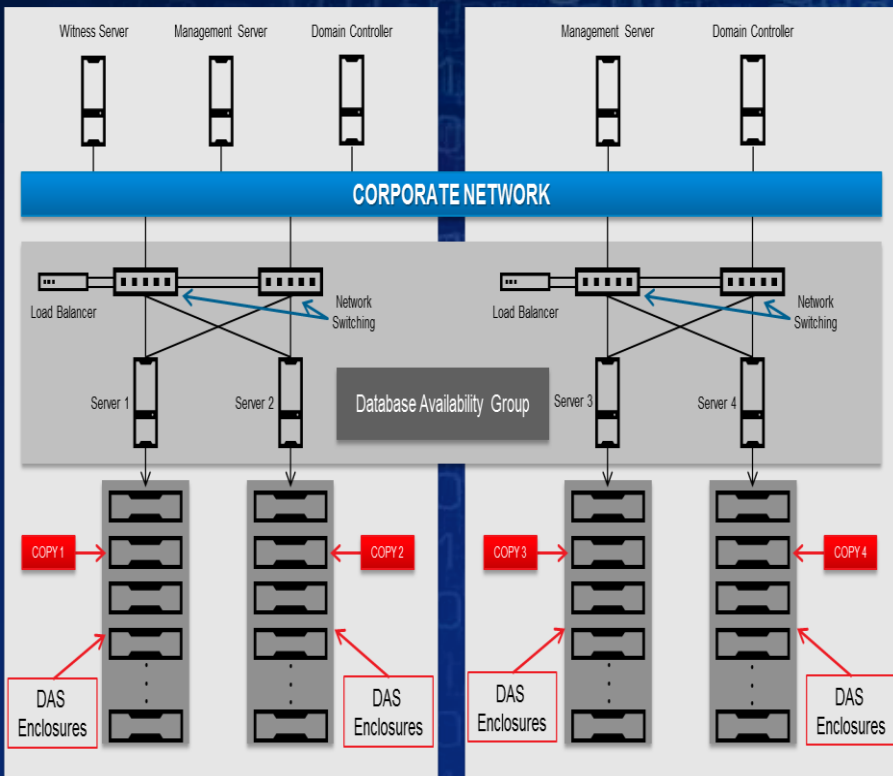
- 300 GB 15k RPM SAS HDD (public list price) \$669*

– \$2.23/GB

*Public list prices subject to change. SanDisk Corporation has no control or responsibility for list pricing

Historic First!!!

DAS enclosure count can be greatly reduced!

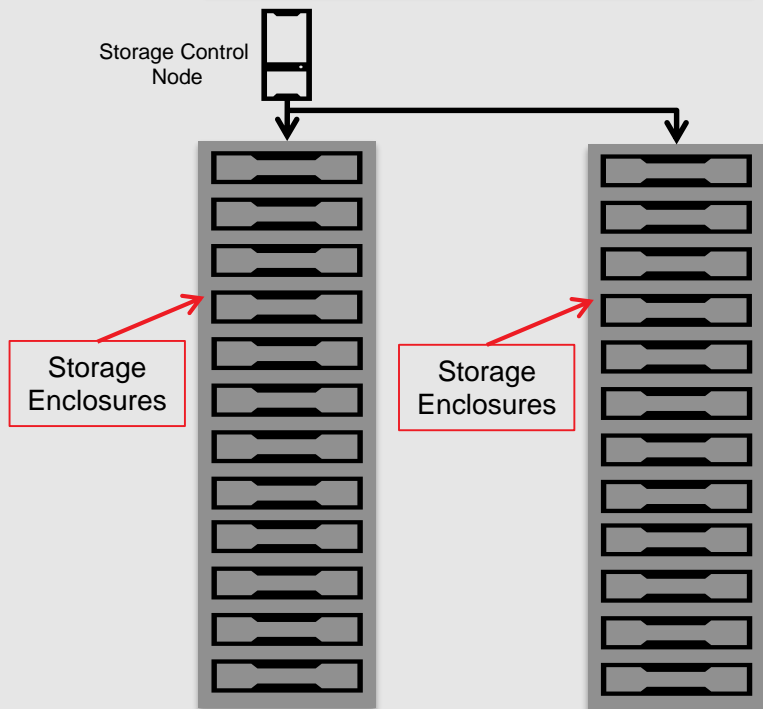


**SSD based solution with no need for DAS enclosures.
Over 90% reduction in rack space by removing need for DAS enclosures!
Up to 12 DAS enclosures per Server can be consolidated into the server! ***

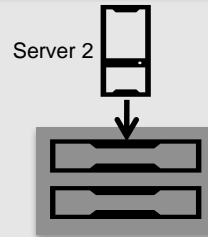
*Example and statement assumes 300 GB 15k SAS drives in enclosures and servers that can hold (24) 2.5 inch drives

Storage enclosure count can be greatly reduced!

HDD Storage Solution



SSD Storage Solution



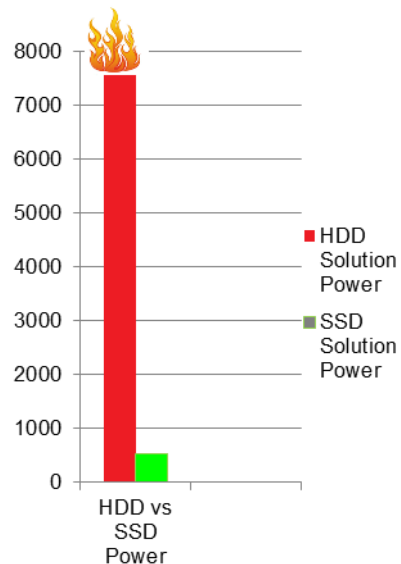
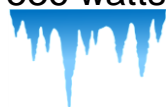
- 2 Storage Enclosures vs. 24
 - Over 90% HW footprint reduction
 - Value can be priceless in space constricted areas
- 48 SSDs vs 576 HDDs
 - Over 93% power reduction **
- \$344k vs \$481k List pricing *
 - 28% less cost to buy SSD solution
- 110 TB capacity vs 103 TB capacity
 - More usable capacity for smaller purchase price

What does the power savings look like?

- Lets set some power cost and power consumption points so we know where the numbers came from
 - 15.8 cents per KWh (averaging higher and lower cost power states.. Larger Hyperscale customers would likely pay a little less pay less of course)
 - 9 watts per HDD, 7 watts per SSD, 100 watts per enclosure for fans and circuitry etc...

- HDD solution would cost about \$10,500 per year at a continuous 7,580 watts
 - 16,676 watts at \$20,500 per year including 1.2x cooling factor

- SSD solution would cost about \$750 per year at a continuous 536 watts
 - Almost \$10,000 dollar savings per year!
 - Savings doubles to over **\$20,000** if you consider 1.2x cooling factor



Great examples, but what if we can't reach maximum consolidation?

What if we can't get 24 enclosures worth of HDD performance out of 2 enclosures?

Let's take a look!

- 8 Storage Enclosures vs. 24
 - 67% HW footprint reduction
 - Value can be priceless in space constricted areas
- \$367k vs \$481k List pricing *
 - Over 23% cost reduction to buy SSD solution
- 48 SSDs vs 576 HDDs
 - Over 85% power reduction **
- 110 TB capacity vs 103 TB capacity

Points to Ponder...

The great value propositions described previously hasn't even mentioned the following yet!

Performance margin of

SSDs vs HDD allow for configuration changes

- RAID array types in servers are frequently dictated by either capacity or performance sensitivity
 - RAID 10 for performance sensitivity
 - RAID 5 for capacity sensitivity
 - RAID 6 to limit exposure in critical mode



Performance versus Capacity

Ex. If forced to use RAID 10 to get HDD performance, SSDs can provide similar performance with RAID 5 or RAID 6, thus saving usable capacity

Performance margin of SSDs allow for smooth RAID recovery

- HDDs usually have no margin for rebuilding arrays in critical mode
 - No performance to spare so application suffers during rebuilds
- SSD performance margin can provide needed application performance while rebuilding a critical array transparently in parallel

Any other efficiency tips for the Data Center?

- In high growth areas where resources needed per server may change over time we can benefit by resource pooling
 - Removing the need to build half empty chassis
 - Add resources as needed
 - Remove the situation where you have to replace an out of date server but the storage/DRAM or CPU components are still good
 - HW breakdown is time consuming
 - Ex. Not enough CPU capabilities but flash devices in the box are still great

Database Acceleration with Pooled Resources

Ex. ION Accelerator Appliance



Target Customer

Oracle RAC and Microsoft SQL Server users

- CIO/CTO
- Application Architect
- Oracle or SQL Server DBA
- Storage Administrator

Value Proposition

- **High performance:** 1.7 Million random IOPS, 56 microsecond latency & 23GB/s bandwidth for transactional and sequential workloads
- **Efficient Density:** Scalable storage of up to 32TB ioMemory capacity in 1U – 4U rack space
- **Flexible:** Support for multiple applications, deployment models & storage interfaces
- **Simplicity:** Deploy, configure and manage with ease
- **Durability:** Enterprise Flash with proven x86 servers

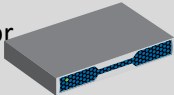
ION Deployment Scenarios

Flash as External Storage

Applications



Accelerate temp files or complete database



ION | DATA ACCELERATOR™

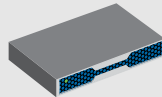
Provide flash memory to every server

Flash as External Shared Cache

Applications

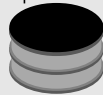


Shared Cache



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Existing storage



Add flash as cache seamlessly to servers

High Availability Flash for Clusters

Clustered Servers



In Memory Database



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Introduce flash benefits to HA configurations

ION servicing 32 SAP HANA Nodes



SAP® Certified
Hardware for SAP HANA®

- TDI certified
- 2-4X scalability
- 2x more HANA nodes than the closest competitor

Extremely dense flash enclosures (Big Data workloads)

Ex. InfiniFlash JBOF or Flash Appliance

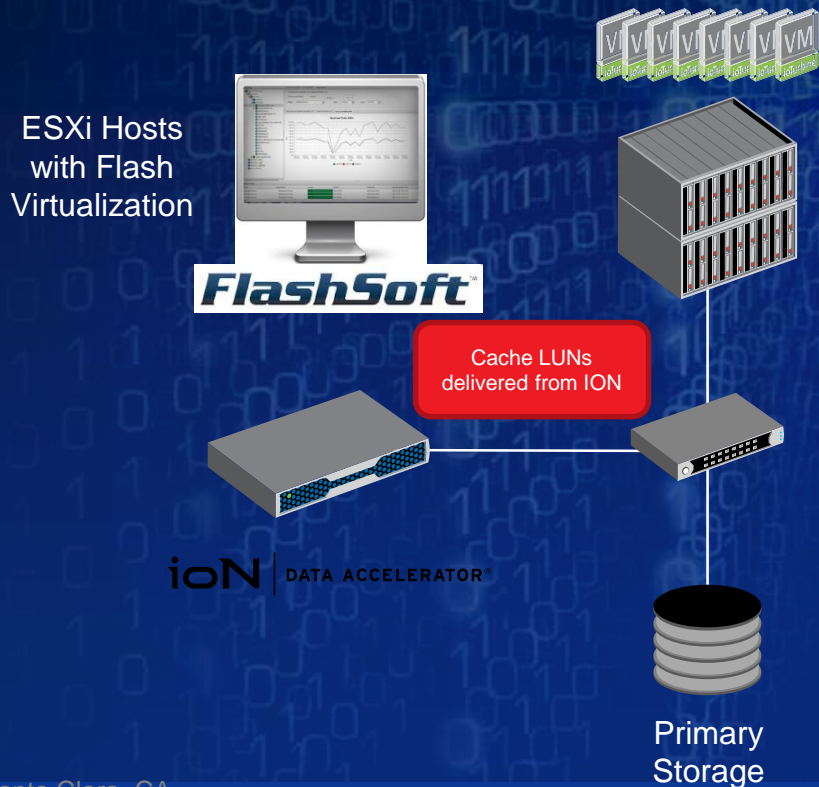


InfiniFlash™ IF100 and IF500

- High Density JBOF Storage appliance
- 512TB 3U, 780K IOPS, SAS
- Compelling TCO with Space and Energy savings
- Enabling a new breed of Applications and Service

- Scale-out All-Flash appliance
- InfiniFlash OS
 - Scale-out Flash optimized software
 - Unified Block, Object and File
 - Enterprise-class and Web-Scale features including snapshots, replication, thin provisioning

Mix all these variables for more benefits



- Scalability for virtual machine deployments
- Shared flash caching
- Ideal for blade server deployments
- Increase workload size, performance and VM density (~3x)
- Accelerate without the need for sidecar or mezzanine slot usage (denser solution)
- Extend server choice by removing need for DAS cache
- Server consolidation leads to SW license consolidation



Thank you!

Questions?

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See these solutions in action @
Booth #207

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