



Virtual Storage Tier and Beyond

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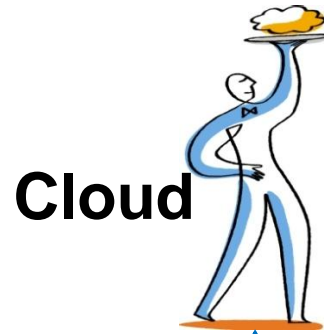
- Trends
 - Other Storage Trends and Flash
 - “5 Min” Rule
 - Issues for Flash
 - Dedupe and Flash
- Caching Architectural Choices
 - NetApp’s Criteria for Effective Tiering
 - Performance and Caching “Tiers”
 - Comparison of Cache Location Choices
 - Implication of Trends / Choices
- NetApp Virtual Storage Tier
 - Portfolio of Products
 - Performance Results
 - Flash in a Shared Virtual Infrastructure





Trends

Storage Trends and Flash



- Performance bursts
- QOS and Cache partitioning

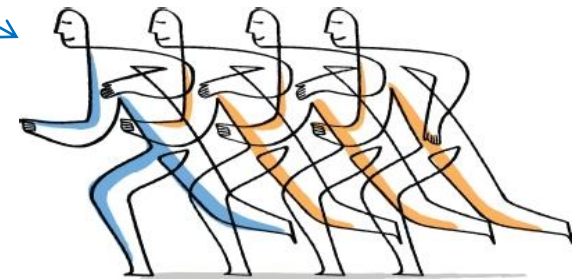
Flash

- Consolidate performance
- Need for shared cache



Big Data

Enabling new applications



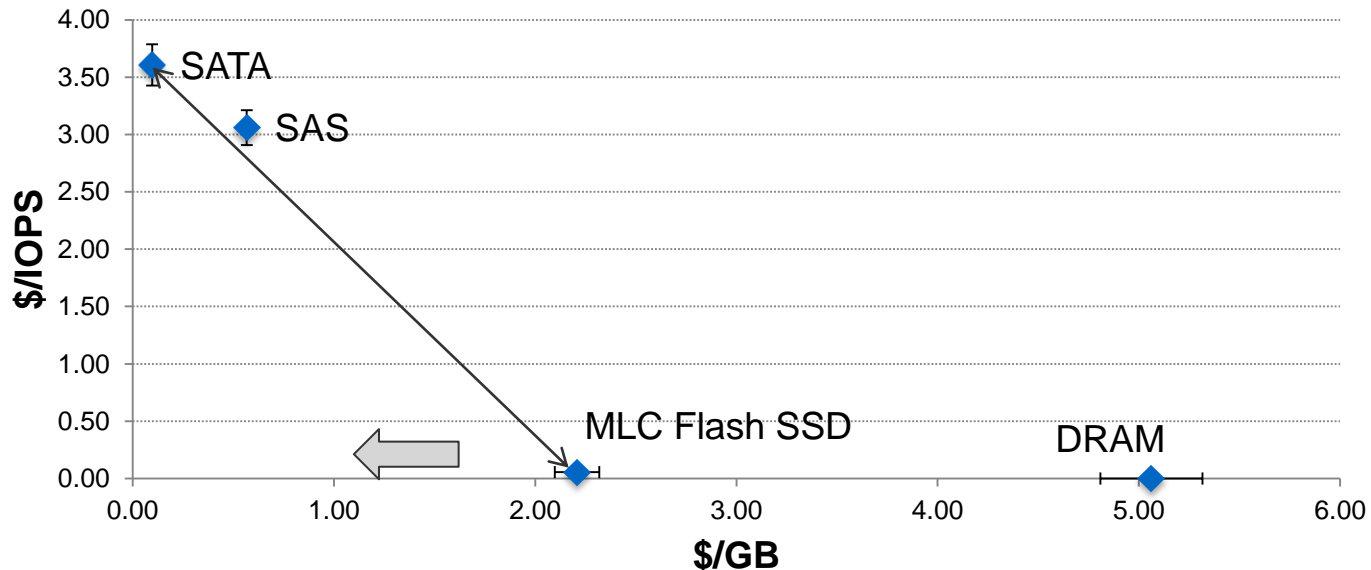
Virtualization

Flash Vs HDD

Gray's "5 min rule" becomes 30 hrs

- 16K random access re-reference interval < 30h
 - Use Flash instead of HDD
- For 2 MiB sequential, breakeven is 1/4 hour

\$/IOPS vs. \$/GB for IO Devices



Wear Life

- Cache is the worst case for wear life
- NetApp's Write-Anywhere layout minimizes write amplification

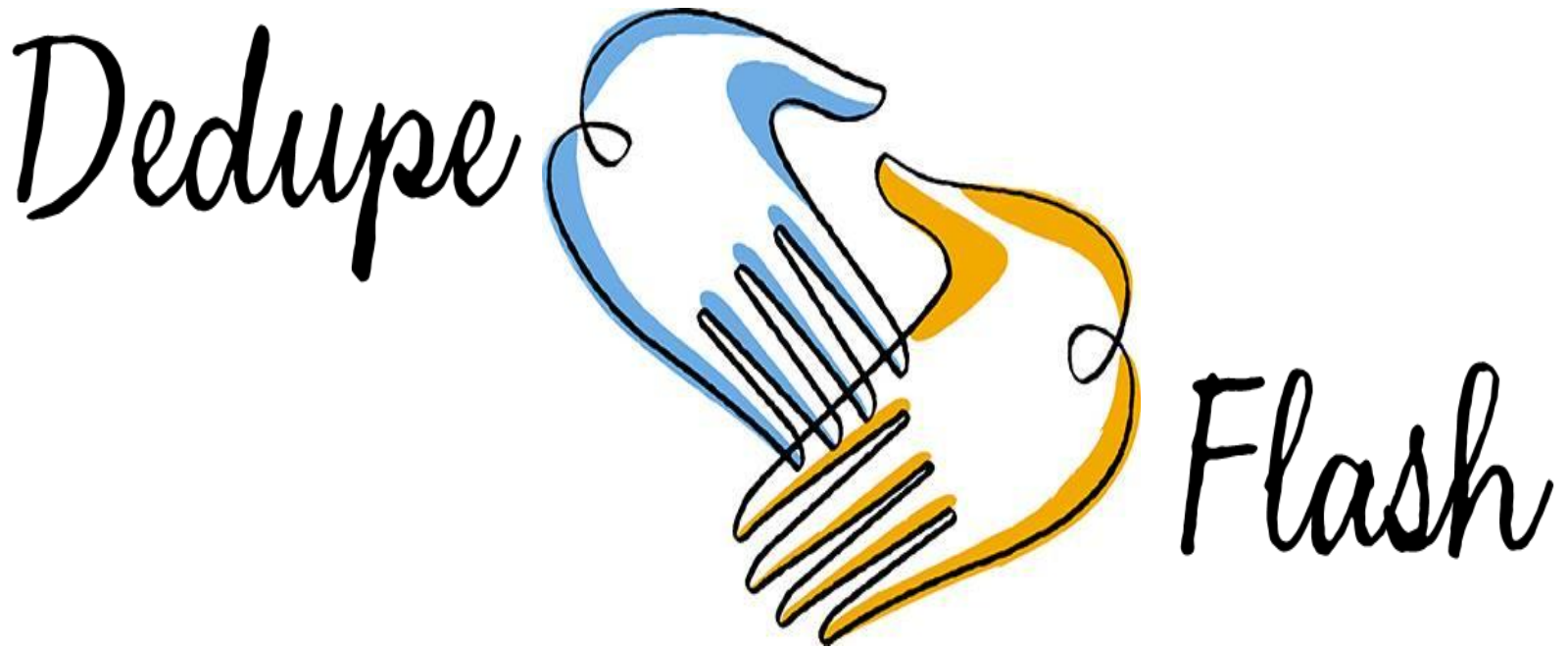
	SLC	eMLC	MLC	TLC
P/E Cycles (K)	100K	30K	5-10K	1-3K

■ Cost (\$/GB compared to SATA)

	RAM	SAS	SLC	eMLC	MLC
Cost compared to SATA	200x	6x	80x	40x	20x

■ Management Overhead

- Data Migration Or Caching



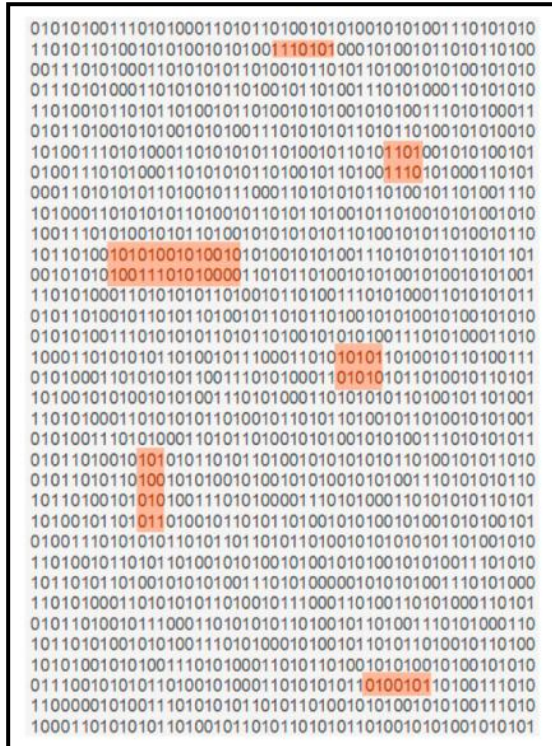


Caching Architecture Choices

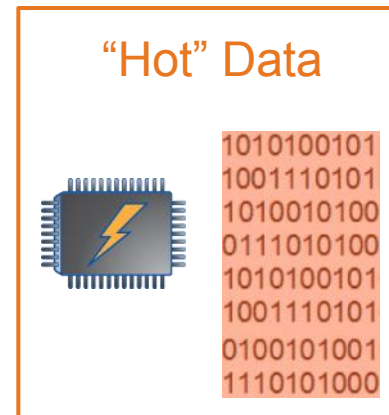
Storage Tiering

Opportunity For Optimization

Primary Storage Pool:
All data – hot and cold



Objective:
Intelligently
place “hot” data
on the highest
performing media



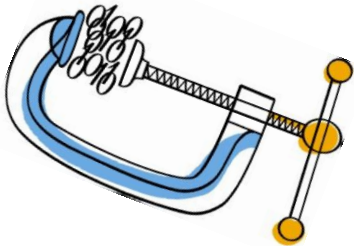
Data should be **fast** when **hot**, and **low cost** when it's **cold**

NetApp's Criteria for Effective Tiering



Simple

- Work out of the box with default settings
- Low management overhead



Efficient

- Use high cost media (Flash) efficiently
- Enable high capacity drives as primary tier

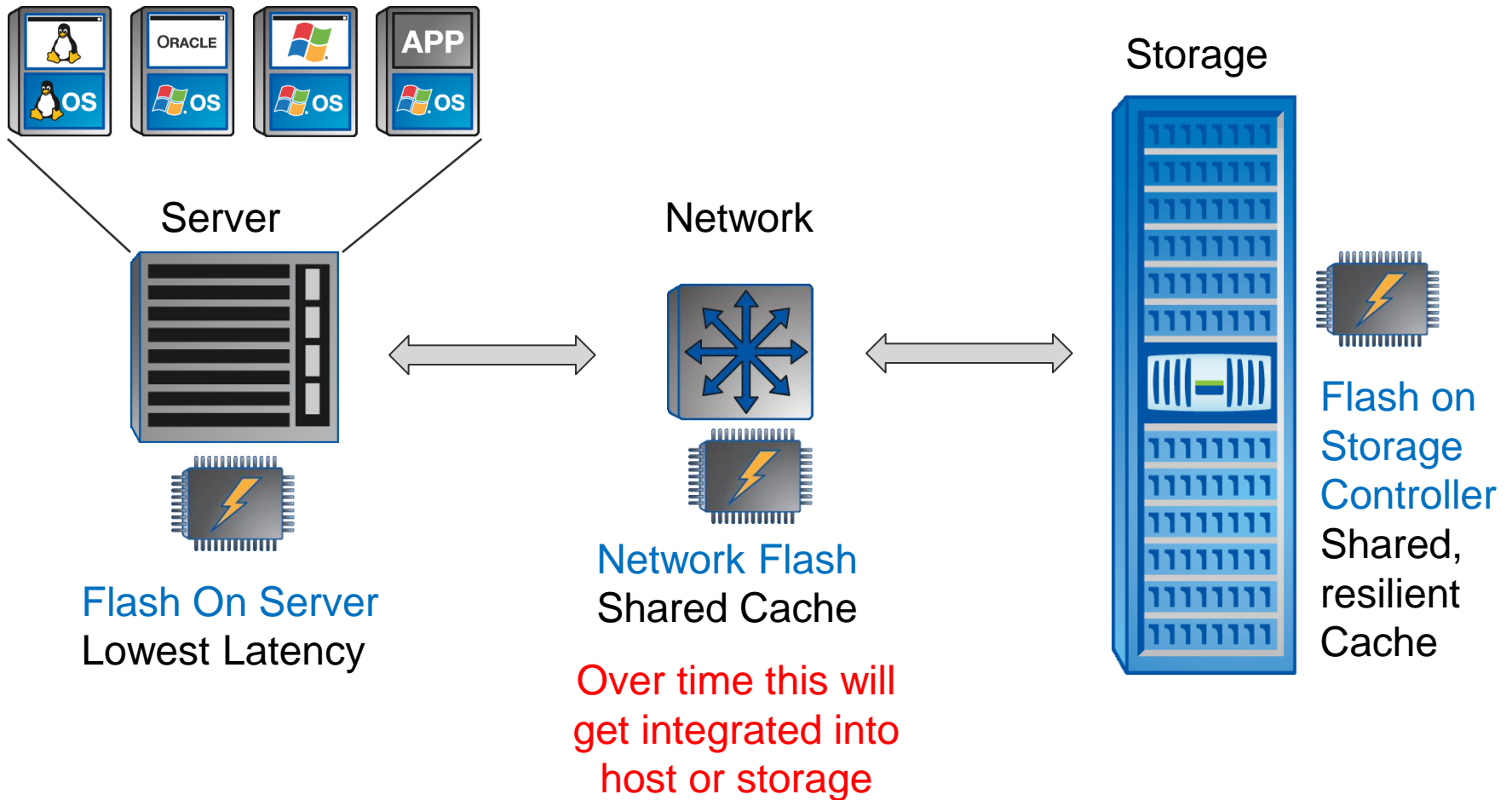


Real-Time

- Serve data when it's hot

Caching Architectures

Performance and Capacity “Tiers”



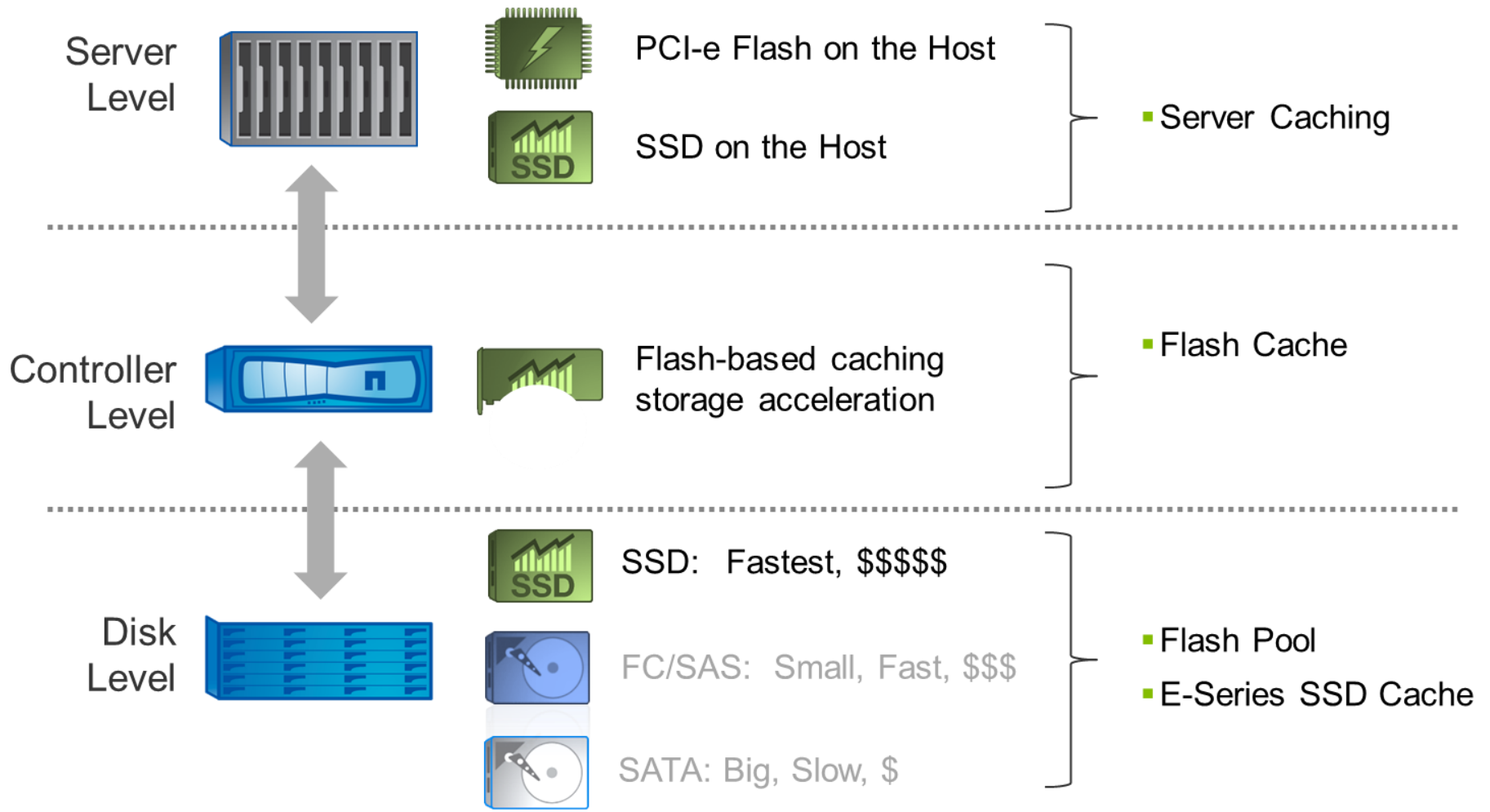
- Over time Networked cache will merge into the host or the backend controller
- Tiering architectures will evolve to 2-tier architectures
- Cache on the host and the cache on the controller will co-exist
- Emergence of the performance and capacity “tiers”
- Over time Flash will be replaced by other SCM alternatives

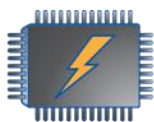


Virtual Storage Tier

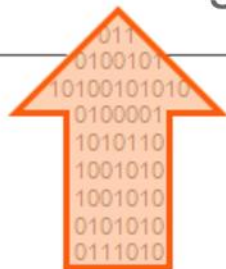
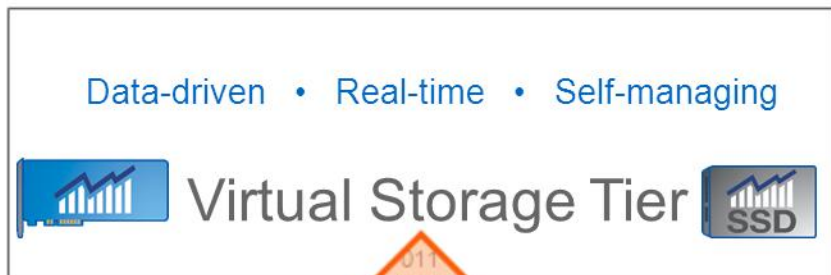
NetApp Flash as Cache Portfolio

Includes only caching options





FLASH



HDD Storage

- Efficient Use of Flash
- Simple to install
- Self Managing
- Non Disruptive Operations
- Caching vs. Data Migration
- Minimal HDD I/O's
- Highly Granular (4KB)
- Real Time Responsiveness

VST: Flash Cache (File Services)

Before:

FAS 6210 HA Pair with 144TB



240 SAS 600GB 10K RPM Disks

After:

FAS 6210 HA Pair with 168TB



168 1TB 7.2K
RPM SATA Disks



1TB Flash Cache

Cost/Efficiency Impact

- Entire workload moved from SAS to SATA (file services workload)
- 34.1% lower cost per TB
- 40.2 % lower \$/IOPS
- 40.5% less power

Flexibility Impact

- 16.7% more storage capacity
- 28.5% more IOPS
- 18.5% improvement in average response time

VST: Flash Pool (OLTP)

Before:

FAS 6210 HA Pair with 144TB



240 SAS 600GB 10K RPM Disks

After:

FAS 6210 HA Pair with 216TB



216 1TB 7.2K RPM SATA Disks



24 100GB SSDs

Cost/Efficiency Impact

- Entire workload moved from SAS to SATA (OLTP workload)
- 46.3% lower cost per TB
- 18% lower \$/IOPS
- 26.5% less power

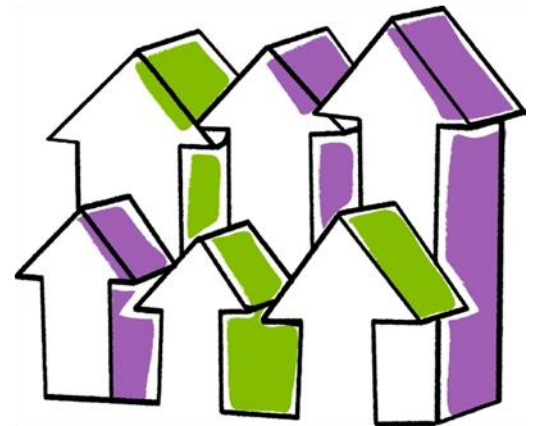
Flexibility Impact

- 50% more storage capacity
- Similar IOPS ($\pm 2\%$)
- Significant improvement in average response time

Where to use VST

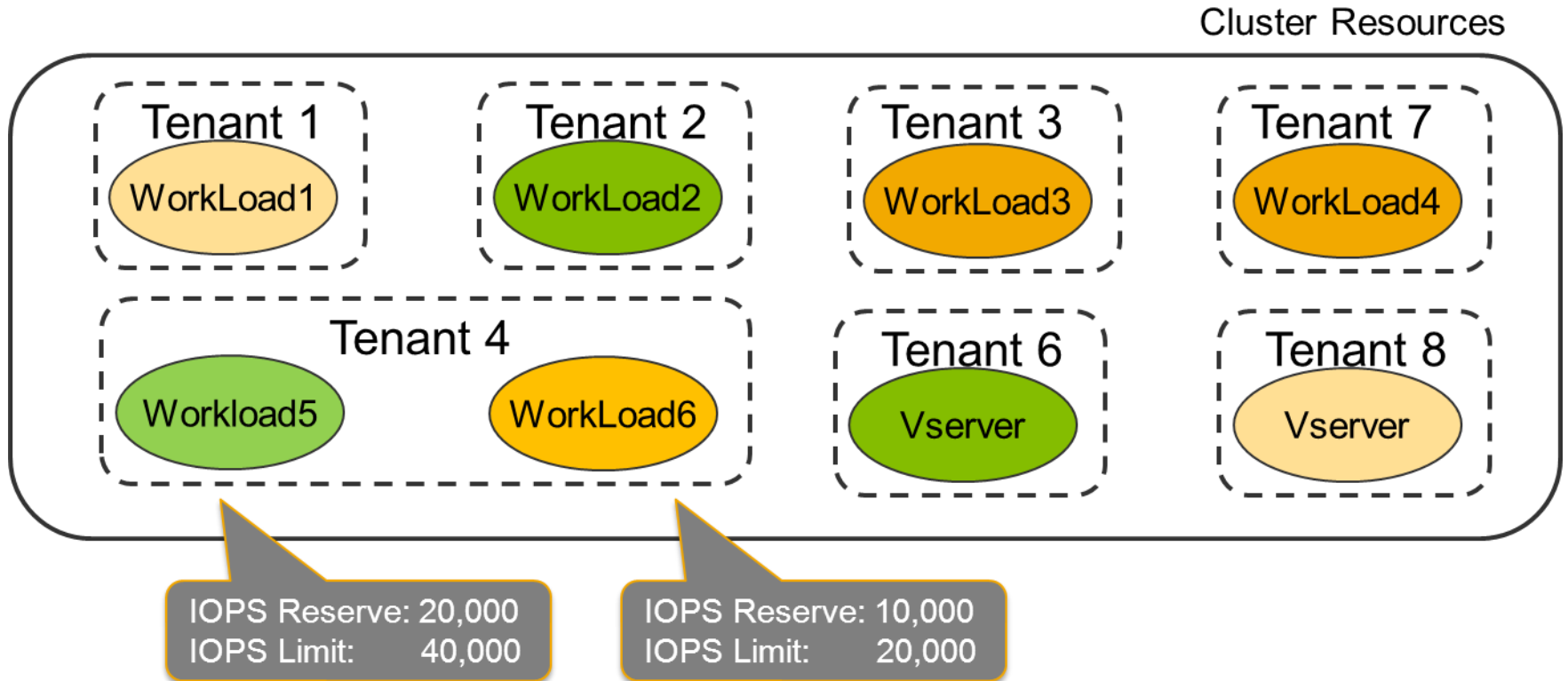
VST has been effective in these environments

- Databases
- File services
- VMware[®], Hyper-V,[™] and Citrix
- Microsoft[®] Exchange and SharePoint[®]
- Engineering and software development



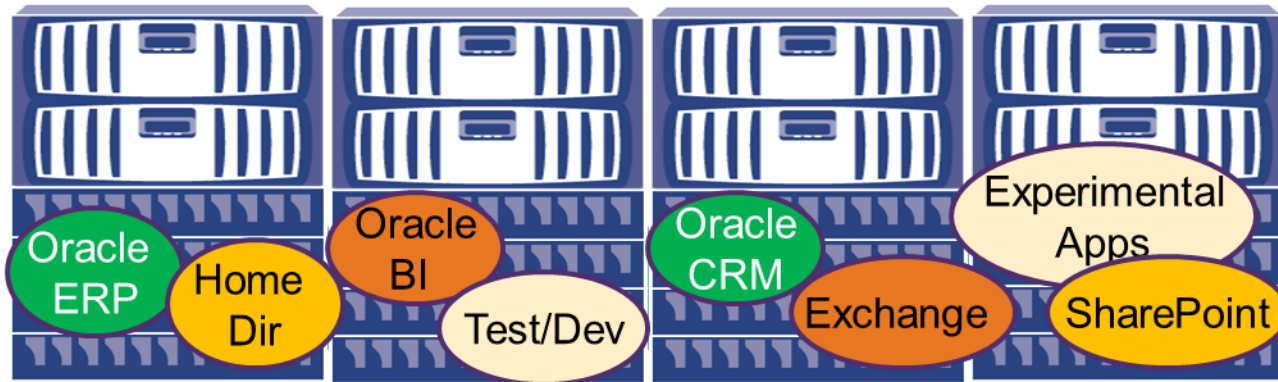
Shared Virtual Infrastructure

Logical View



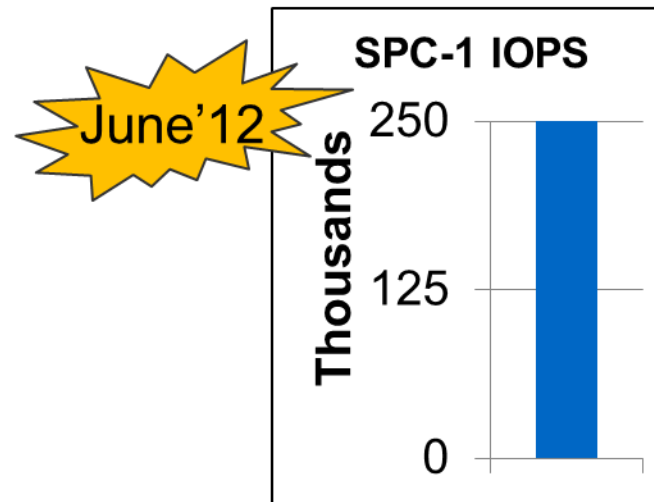
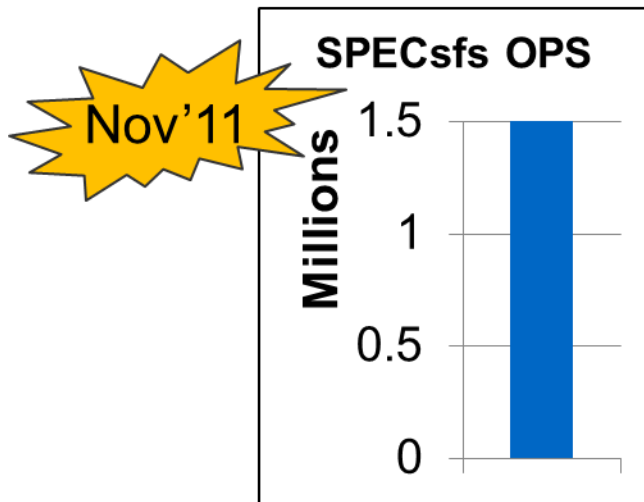
Shared Virtual Infrastructure

Physical View



- Automated provisioning via Service Catalogs
- Dynamic placement based on SLO
- **Intelligent cache partitioning**
- Non-disruptive operations
- Seamless scaling

NetApp Data ONTAP 8 and FAS Systems deliver scalability, efficiency, and non-disruptive operations



- Leading performance for NAS
- Scaling to 24 nodes
- Consistently fast response time

- High performance for SAN
- NetApp storage efficiency drives price/perf value (\$6.69/SPC-1 IOPS)
- Scaling to 6 nodes

Thank you

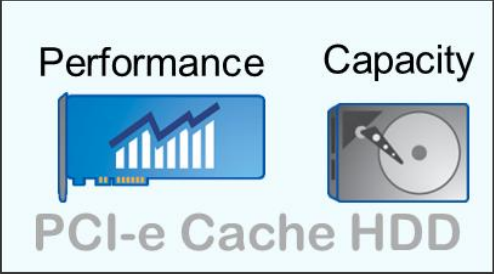
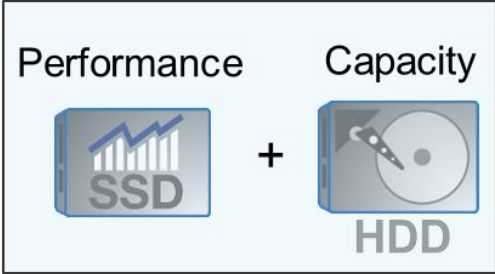


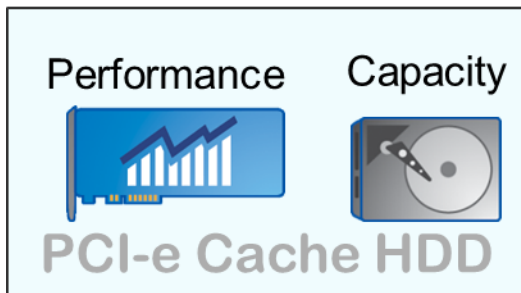
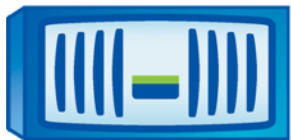
Q&A



NetApp Flash as Cache Offering

Today (Jul 2012)

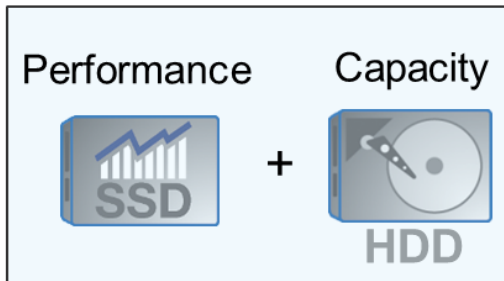
Flash Cache	Flash Pool
 <p>Performance Capacity PCI-e Cache HDD</p>	 <p>Performance Capacity SSD + HDD</p>
<ul style="list-style-type: none"> ■ What is it? <ul style="list-style-type: none"> – Controller based PCIe card – Plug and play 	<ul style="list-style-type: none"> ■ What is it? <ul style="list-style-type: none"> – Storage level RAID protected read & write cache
<ul style="list-style-type: none"> ■ What does it do? <ul style="list-style-type: none"> – Per controller cache – hot volumes on multiple aggrs – Caches random reads 	<ul style="list-style-type: none"> ■ What does it do? <ul style="list-style-type: none"> – Specific to aggregates – Caches random reads & writes – Cached data persistence through failovers



Flash Cache

*Standard with all
FAS/V 6240 and 6280
systems*

- Predictable Results
- Improves average latency for random reads
 - PCI-e Controller based Flash
- Increase I/O throughput
- Reduce costs by using fewer, less expensive disk drives
- No management required
- Effective for file services, tech apps, web apps



Flash Pool

- SSD-like performance for hot reads and writes data
 - Aggregate-level, read and write cache
- Enables capacity optimized HDDs as primary disk Tier
 - All Workloads
- Consistent performance during takeover and reboot events
- Works out of the box with default settings
- Effective for biz apps, OLTP, VDI