Achieving Consistent Low Latency with All-Flash Arrays

Brian McKean

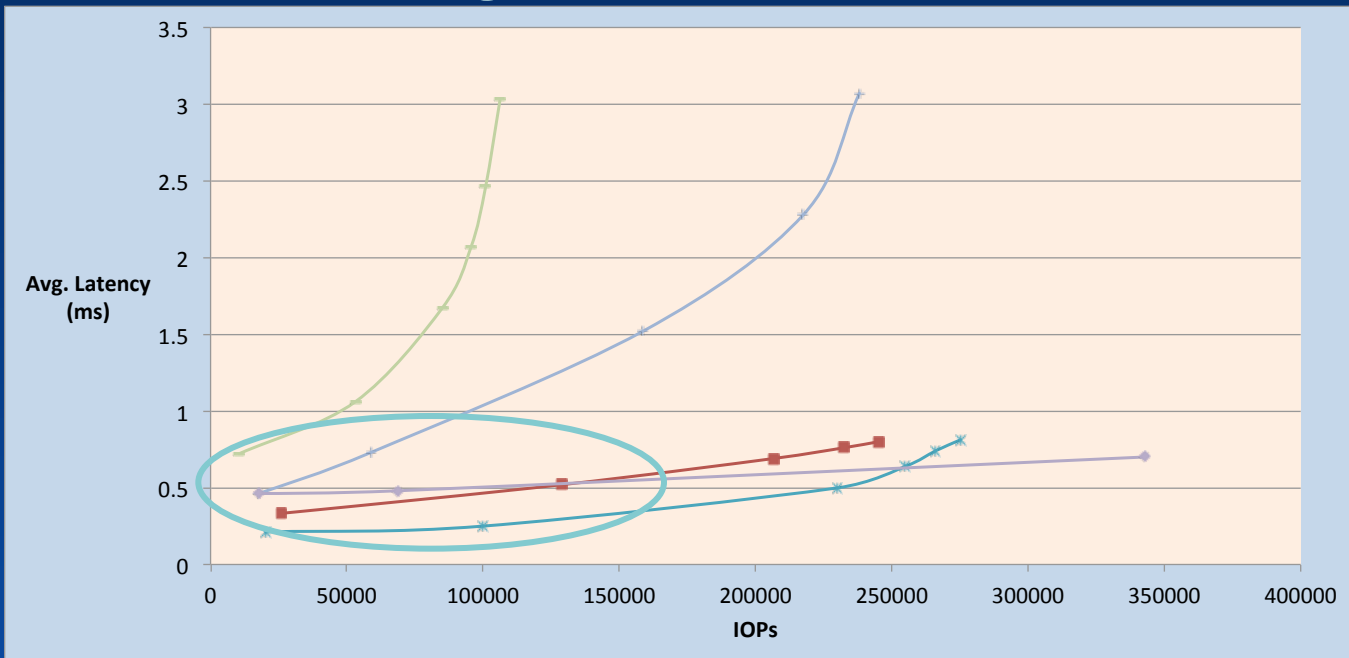## Netapp

E-Series Flash Architect

Two worlds for Latency

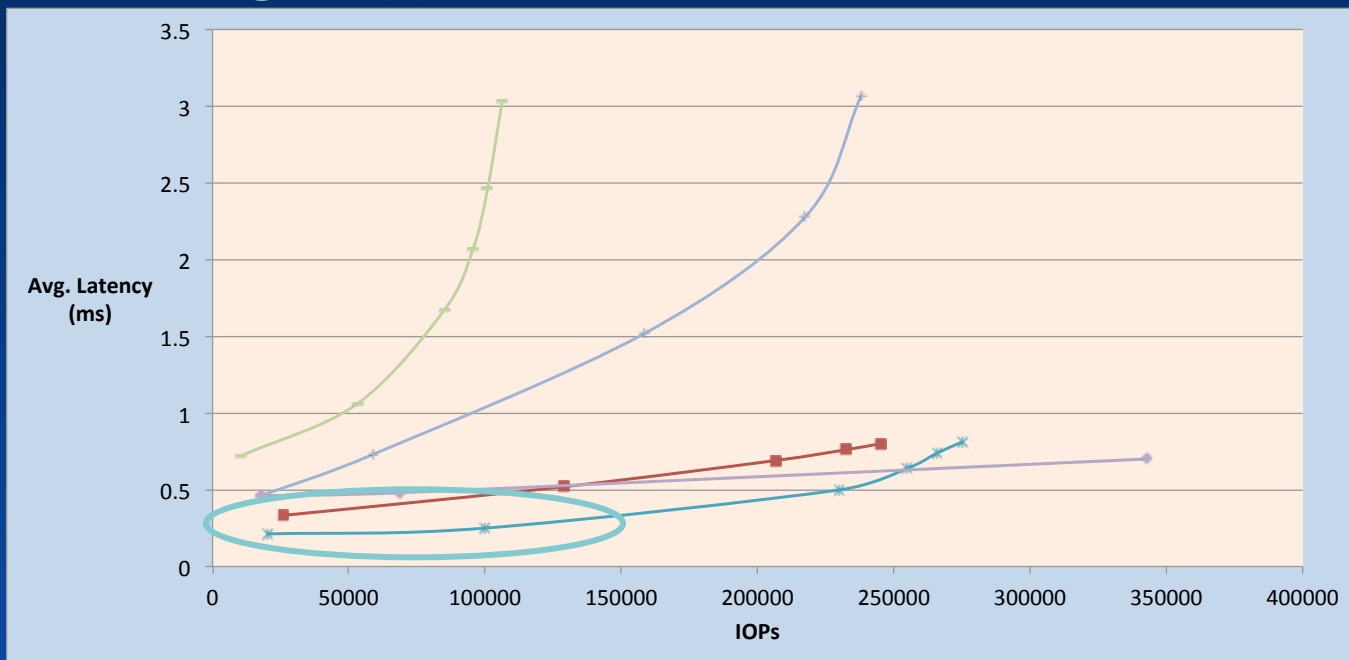|	Dedicated Application Hardware	Shared Storage
Average Latency	<0.5 ms	<1 ms
Latency Sensitivity	Very Sensitive to spikes	Less sensitive to spikes
Feature use	Light	Heavy
Key Metric	$/IOP	$/GB Effective

Latency

Share Storage Feature Rich

IOP = 8K Block, 40/60 R/W, 80% Random

Latency

Single Application – Dedicated Hardware

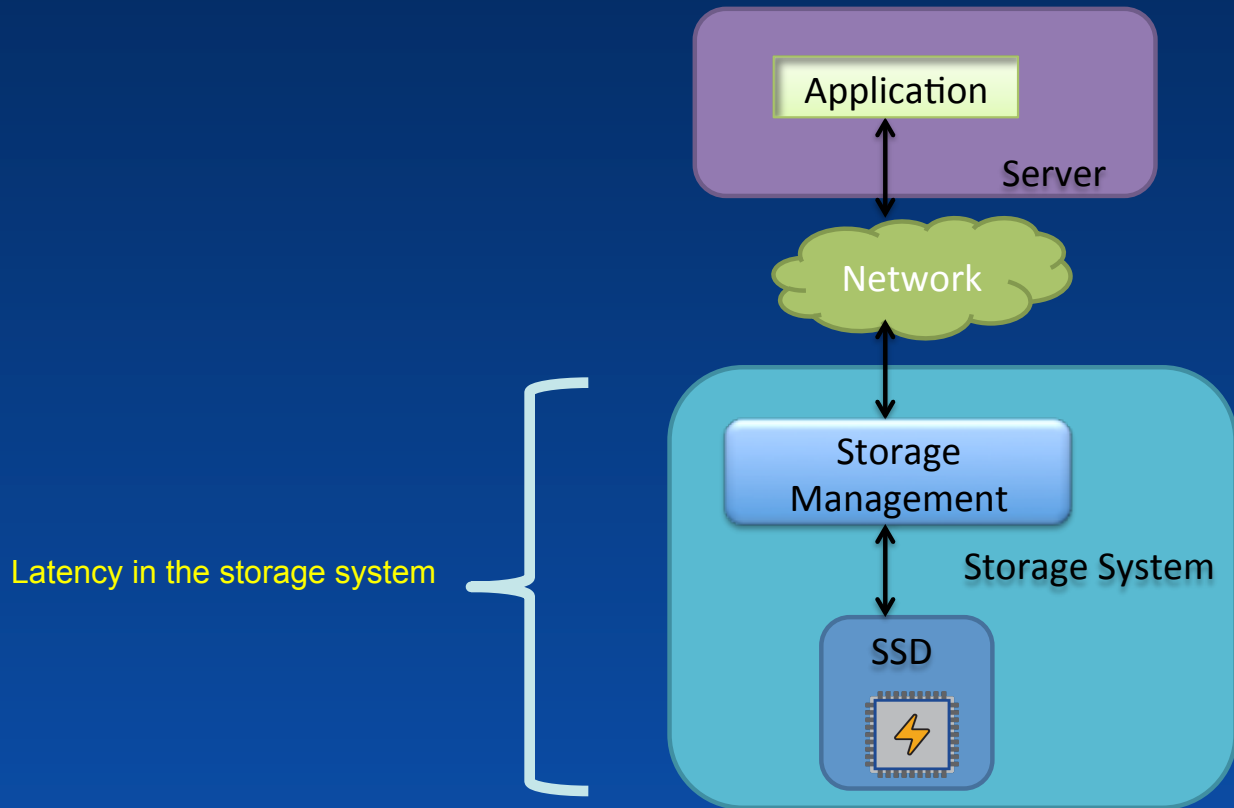IOP = 8K Block, 40/60 R/W, 80% Random

How do we keep latency low in All Flash Arrays?

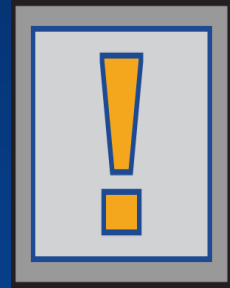| Function	Size	Time
Erase	256 KB	2 ms
Write	4 KB	200 usec
Read	4 KB	50 usec

We want to keep read and write to near flash speeds
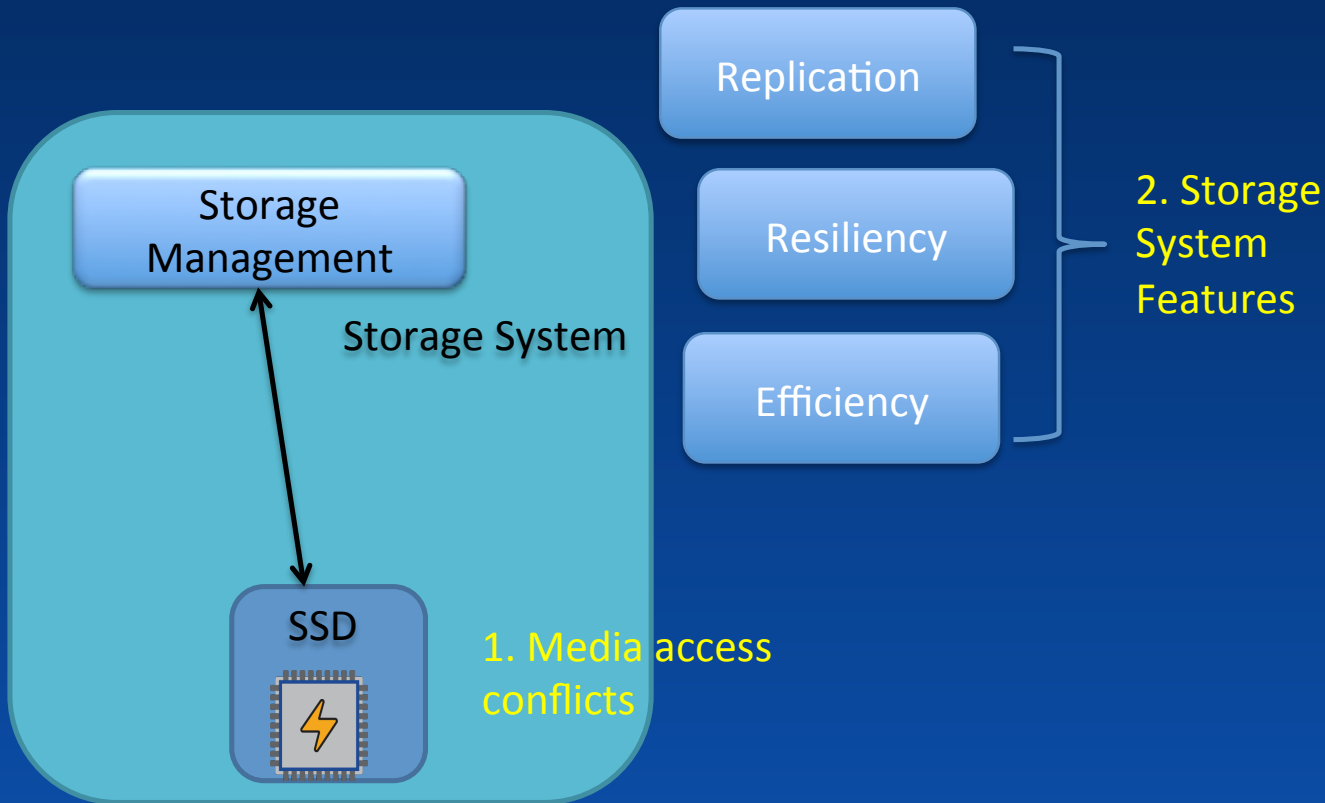
Storage Stack

What gets in the way of low latency?

1. Conflict with Flash media operations
   - Read/write waiting for for a 2 ms erase
2. Complexity of Storage Management Features
   - Layers of indirection & mapping
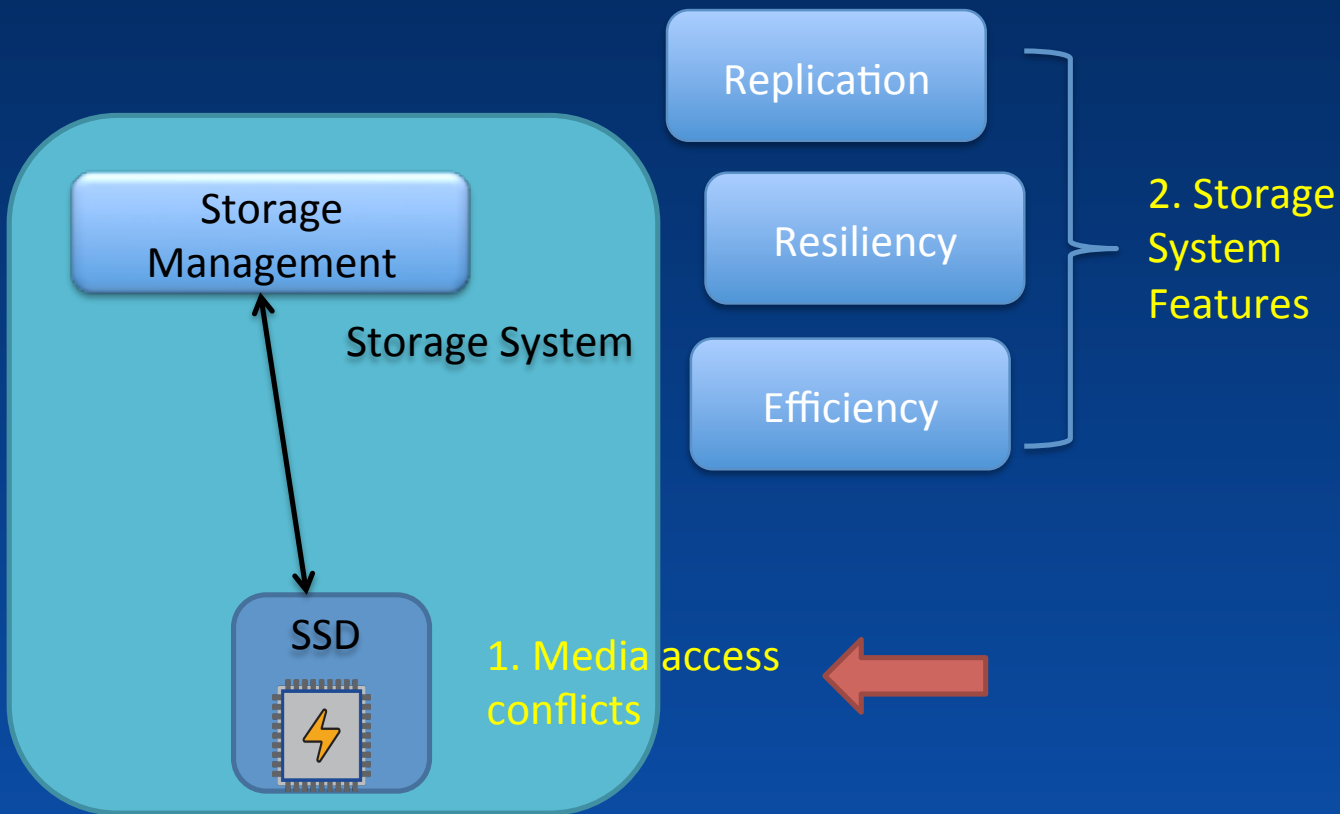   - Multiple media accesses

What gets in the way of low latency?

Storage Management

Storage System

SSD

Replication

Resiliency

Efficiency

2. Storage System Features

1. Media access conflicts

What gets in the way of low latency?

Replication

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Storage Management

Storage System

SSD

1. Media access conflicts
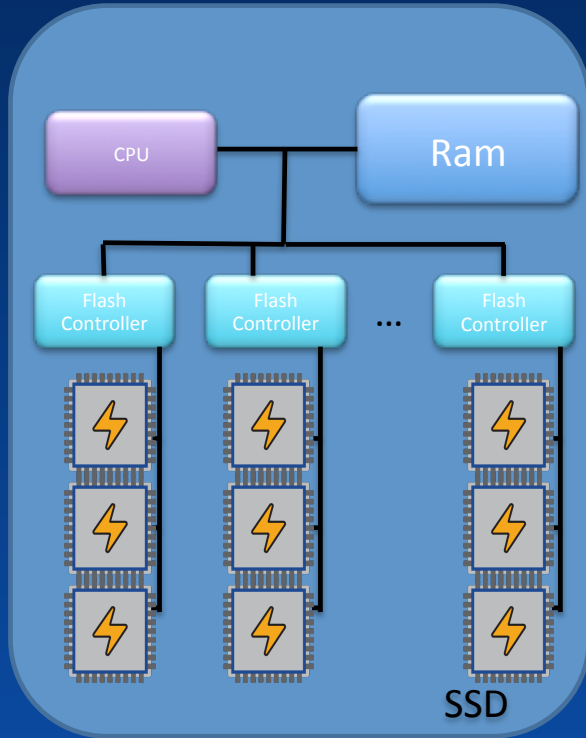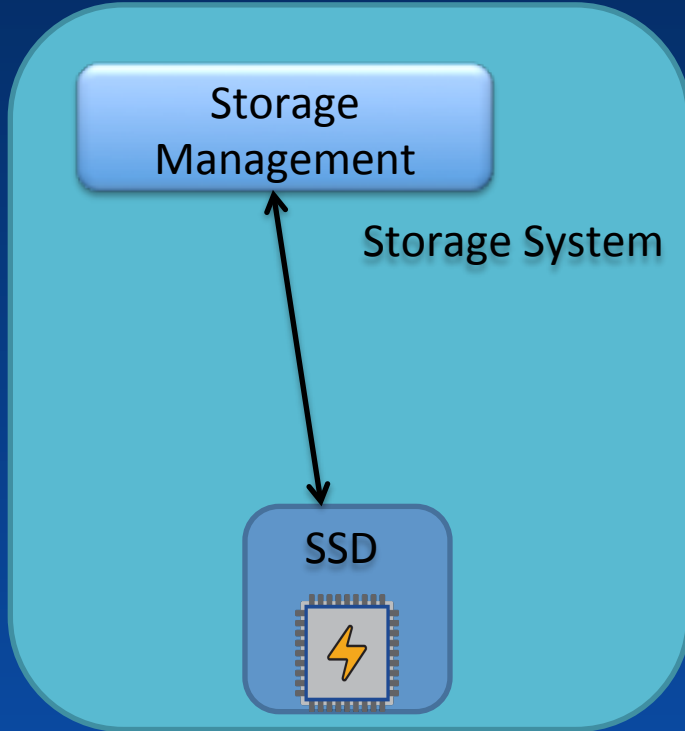
Handling Media Access Conflicts

Within Device
1. Flash lanes and flash controllers
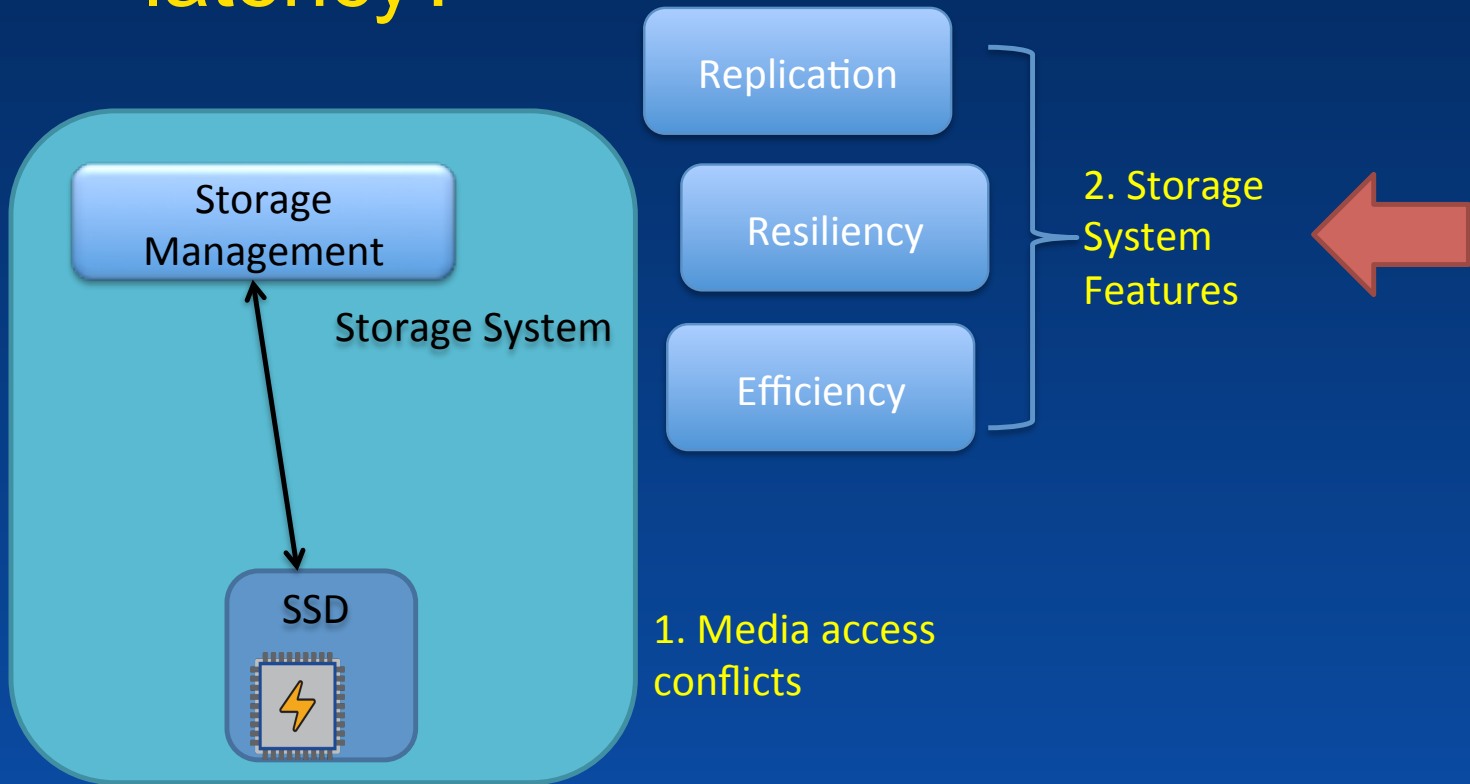2. CPU / RAM
3. Over provisioning flash capacity

Storage Management

Storage System

SSD

SSD & Storage System Together
1. Sequential write patterns
2. Access other devices
3. SCSI Stream commands

What gets in the way of low latency?

Storage System

Storage Management

SSD

Replication

Resiliency

Efficiency

2. Storage System Features

1. Media access conflicts

Handling Latency from Storage System features

- Replication
  - Snapshots
  - Clones

- Latency mitigation
  - Built into architecture
  - Hardware Assist
    - More cores
    - More DRAM
  - Higher performing SSD

Handling Latency from Storage System features

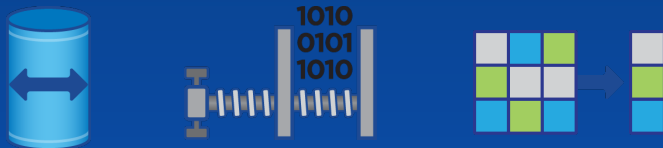- Resiliency
  - Erasure codes / RAID
  - Replication

- Latency mitigation
  - Hardware Assist
    - More cores
    - Specialized HW
  - NV Mirror
  - Higher performing SSD
  - RAID Level choice
  - Full stripe writes

Handling Latency from Storage System features

- Efficiency
  - Thin provisioning
  - Compression
  - De-duplication

- Latency mitigation
  - Built into architecture
  - IHardware Assist
    - More cores
    - More RAM
    - Specialized HW
  - Higher performance SSD
  - Fewer IO to SSD from efficiency

NetApp EF-Series Latency Optimization

Storage System Features

Resiliency

- SANtricity OS
- Custom drivers
- Streamlined IO Path
- Direct mapped
- Mirrored NVRAM
- Hardware assist for erasure coding

HA PAIR

Media Access Conflicts

SSD Selection & Qualification
- Over provisioning
- Flash lanes / device
- CPU/RAM

Top 5 SPC-1 Price-Performance
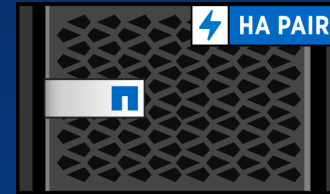#1 SPC-1 LRT

All Flash FAS Latency Optimization

Storage System Features

- Replication
- Resiliency
- Efficiency

- Data ONTAP OS
- Features Built into the Architecture
- Cores & DRAM, Mirrored NVRAM
- Flash Optimized Read IO Path
- Efficient Sequential Write Streams

HA PAIR

Media Access Conflicts

SSD Selection & Qualification
- Less Over provisioning
- Flash lanes / device
- CPU/RAM

Top 5 SPC-1 Performance

Summary

- Multiple approaches to developing an architecture for low latency

- No single feature is key for low latency

- Look for features and performance to fit your application needs