State of the Art Performance in Flash Storage Arrays

Steve Cooper – CEO
One Stop Systems
State of the Art – 2016

- Highest performance
  - Significant improvements versus 2015
- Highest capacity and density
  - About the same as 2015
Two Types of Flash Arrays

- Direct Attached – JBOF
  - Communicates to host server(s)
    - PCIe over cable interface
  - Host server provides NAS functions and interfaces

- All-in-one – NAS
  - Communicates to other user computers
    - Ethernet and/or Infiniband interfaces
  - All-in-one package containing server motherboard and flash array
Direct Attached vs All-in-One

- **Direct Attached**
  - Simpler – extension of server slots
  - More flexible, pick any server, any S/W
  - Server can run application S/W
  - Server and flash de-coupled

- **All-in-one – NAS**
  - More complete, ready to run
  - Pre-configured hardware and S/W
    - Factory optimized
  - Less flexible, all-in-one packaging
Keys to High Performance

- High performance cards
  - NVMe protocol
  - RAID flash cards together

- PCIe interfaces
  - PCIe Gen 3
  - X8 from each flash card
  - x16 to host

- Avoid conversions, compression or anything else that slows down transfers
Performance Saturation Issues

- PCIe interfaces
- Conversions to other interfaces
- Host server architecture
**PCIe Performance**

- PCIe
  - PCIe varieties
    - Flash cards – Gen 3 x8
      - Cards utilize 15-50% of bandwidth
    - Link to host – Gen 3 x16
      - Saturates with 4-8 cards
  - Multiple PCIe interfaces extend performance

![Diagram of PCIe Performance](image-url)
PCIe to Host Performance

Host Server

PCIe Switch

Flash Cards

Flash Array

PCIe Gen 3 x16
Conversions

- PCIe interfaces are the standard
  - Flash controllers have PCIe interfaces
  - CPU components have PCIe interfaces

- Conversions to other interfaces
  - SAS, Infiniband, etc. conversions add latency
  - And these interfaces are slower
**Host Server**

- **Host server speed and configuration**
  - Speed of CPUs and memory
  - Left side, right side of dual CPU systems
    - Don’t cross over, avoid QPI bus traffic
    - Physically understand slot configuration
    - Map CPU cores appropriately
  - Map memory appropriately
- **Network adapter slot location**
Examples

High Performance Flash Array

- Direct Attach Array
- Holds 32 PCIe flash cards
  - Up to 200TB per system
  - Gen 3 x8 cards
  - 4 PCIe Gen 3 x16 interfaces to host servers
- 8 cards per PCIe link in four canisters
  - Cards in a canister RAIDed together
  - Canister performance of 14GB/s, 3M IOPS

**Total performance**
- 56GB/s transfer rate
- 12M IOPS
Examples
All-in-One Flash Array

- All-in-One Flash Array
- Holds 32 PCIe flash cards
  - Up to 200TB per system
  - Gen 3 x8 cards
  - PCIe Gen 3 x16 internal interfaces
- Four 100Gb Infiniband EDR interfaces
- **Total performance over Infiniband**
  - 40GB/s transfer rate
  - 10M IOPS
Summary
Flash Array State of the Art

- Direct Attached
  - 56GB/s transfers
  - 13M IOPS

- All-in-One
  - 40GB/s transfers
  - 10M IOPS