New Possibilities for Flash

Peter Kirkpatrick

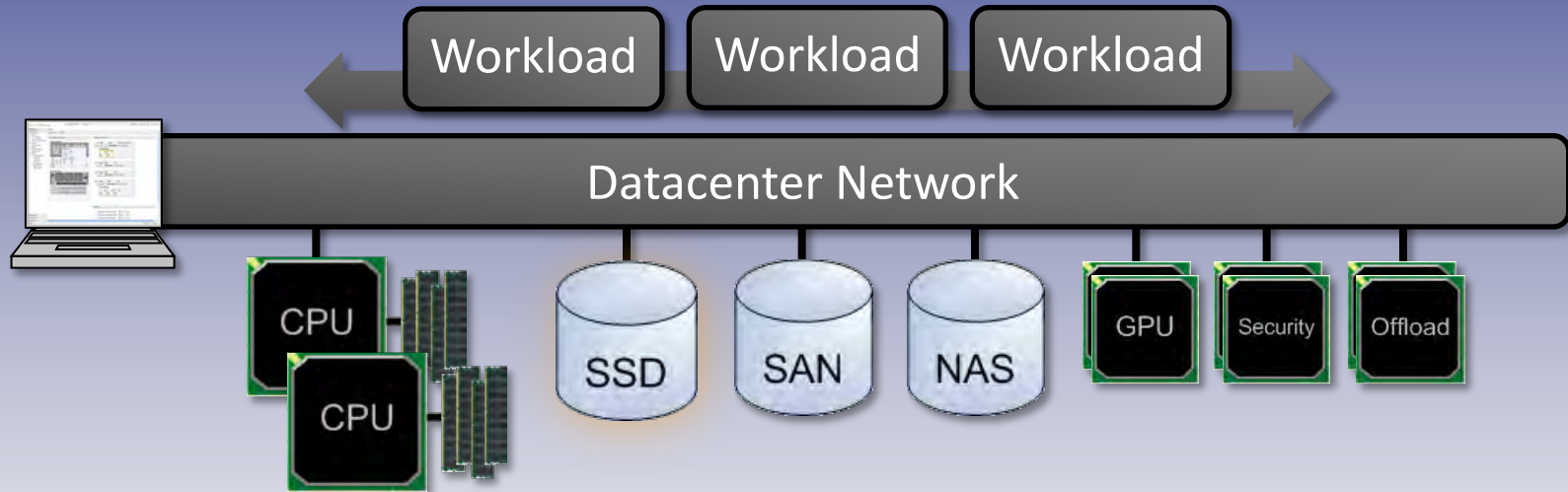Founder and Chief Architect, Aprius

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New Possibilities for Flash

- Recent advances in NAND flash and controllers have enabled very high performance, reliable Solid State Storage

- SSD "Disk Drive" form factor is an ideal level of integration

- To date, SSDs have mostly been used to replace HDDs in servers, storage area networks (SANs) and network attached storage (NAS)

- But the performance and economics of flash present a new architectural opportunity
    - Performance indicates that flash should be tightly coupled to CPU
    - Economics indicate that the flash resource should be shared
    - A new architecture is necessary to satisfy both requirements
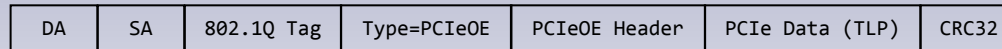
Network Based I/O Virtualization

Workload   Workload   Workload

Datacenter Network

CPU
CPU
SSD   SAN   NAS
GPU   Security   Offload

Driver 1
Virtualization
Consolidation and mobility
moving beyond CPU/RAM

Driver 2
Network Convergence
LAN/SAN leading the way
for other protocols

Driver 3
Dynamic Infrastructure
Shared resources, usage
driven by workload needs

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IOV System Architecture

Stateless Servers

Shared Resources (e.g. flash)

I/O Gateway

PCIe over
Ethernet

DA	SA	802.1Q Tag	Type=PCIeOE	PCIeOE Header	PCIe Data (TLP)	CRC32

Standard 802.1Q Frame   *PCIeOE*

Host Initiator
Extends host PCIe tree
Native driver model

PCIe Over Ethernet
Low latency, high bandwidth
Guaranteed delivery
Resource management
Standard 802.1Q frames

Target Resources
Shared PCIe resources
Software management

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Integration of Flash SSD

- **IOV-based Flash Array**
  - Built on I/O Gateway concept
  - Virtualized (SR-IOV) SAS/SATA Controllers
  - 2.5" Enterprise SSD Form Factor Drives
  - PCIe 2.0 and SAS/SATA 3G Generation

- **Host Performance**
  - 800 MB/s, 200k IOPS (10GbE)
  - 1600 MB/s, 400k IOPS (2x10GbE)

- **Array Performance**
  - 12.8 GB/s, >2M IOPS
  - Response time < 100us
  - 9.6 TB Capacity
  - 32 Hosts @ 10GbE

Benefits of IOV-Flash

- Consolidation of valuable resources
- High performance shared across many hosts
- Dynamic provisioning for efficiency
- DAS model using well known protocols
- Mix with other IOV (FC, Offload, GPU, …)
- New architectures become possible
  - Shared flash-based DAS
  - Fast shared storage tier
  - Caching for SAN

Summary
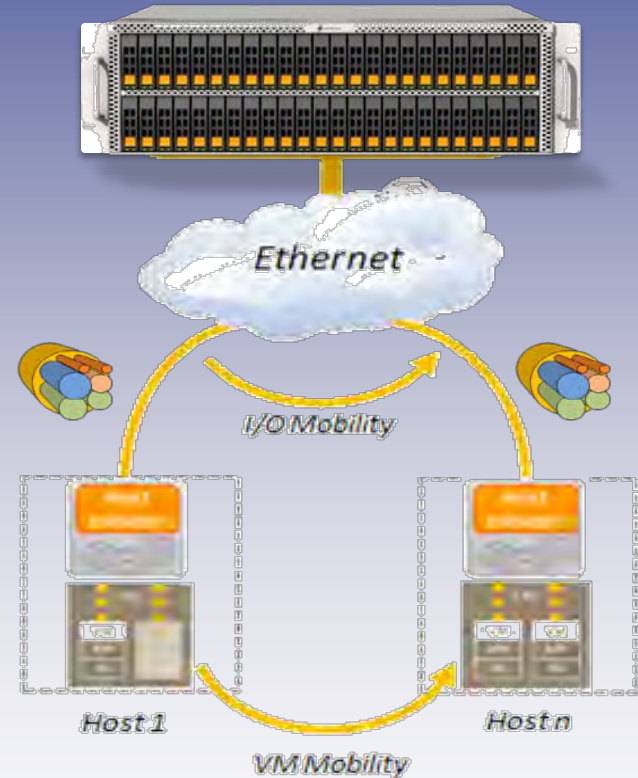
The maturation of flash technology is changing the way storage is viewed in the datacenter.

Network-based I/O virtualization is a key enabler for realizing the performance and economic potential of flash.

Together, these technologies enable a more efficient, dynamic datacenter architecture.

Thank You

- **Peter Kirkpatrick, Aprius Founder and Chief Architect**

  Peter is chief architect and founder of Aprius. He has broad experience in research and product development of high speed communication and computing systems. At Intel, he performed pathfinding work in server systems architecture utilizing advanced protocols, high bandwidth interconnects and adaptive electronics. At Intel and Lightlogic, he designed innovative 10Gb/s system interfaces for the enterprise networking market. Peter studied Computer Engineering at the University of Colorado in Boulder. He has been awarded 14 U.S. patents and published peer-reviewed papers in diverse fields. Contact Peter at (408) 524-3166 or peter.kirkpatrick@aprius.com.

- **About Aprius**

  Aprius is a venture-backed Silicon Valley company developing systems that provide virtualized I/O resources to groups of servers 'on-demand'. Aprius systems greatly simplify the use of I/O for servers, enabling connectivity to a wide range of resources while accelerating the provisioning, management and mobility of I/O resources. For additional information, Aprius may be contacted at info@aprius.com or www.aprius.com.