



Education

Scale-Out Storage

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➤ Scale-Out Storage

- ◆ This is an overview of scale-out storage systems and their underlying file system technologies - primarily focused on network-attached storage systems. In this presentation, scale-out will be defined in contrast with scale-up storage systems, the market, user, and technology needs driving a new class of storage systems will be explained, as well as a survey of open-source and commercial implementations available today.

Refer to Other Tutorials



Check out SNIA Tutorial:
Storage Tiering and the
Impact of Flash on File Systems



Check out SNIA Tutorial:
The File Systems Evolution



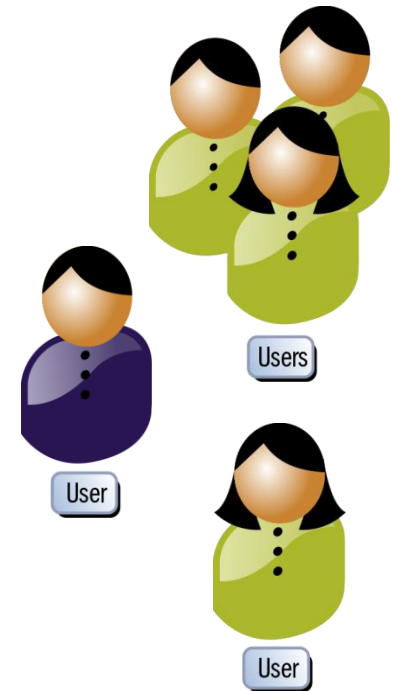
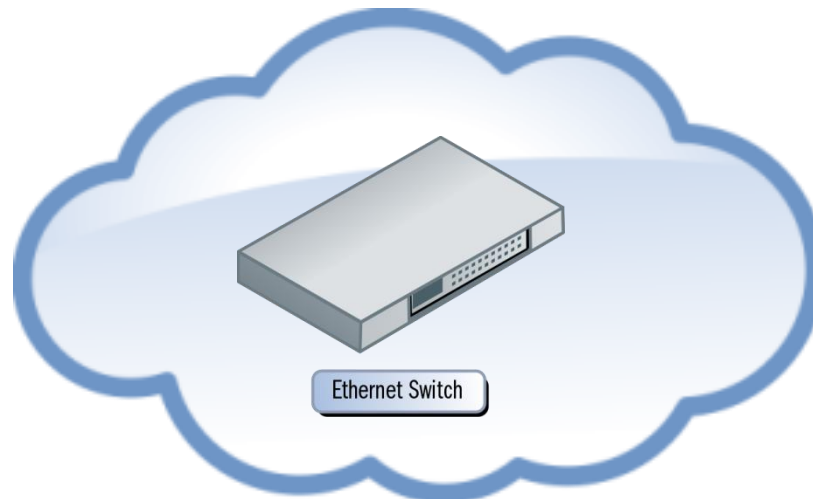
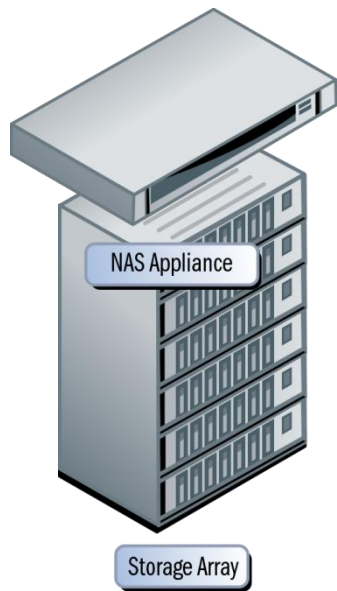
Check out SNIA Tutorial:
Aspects of Deduplication



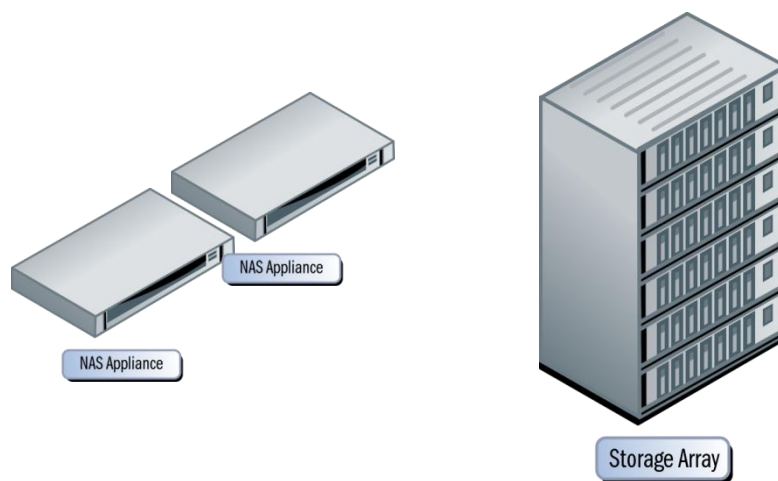
Check out SNIA Tutorial:
File Systems for Object Storage
Devices

Network-Attached Storage

- Simplicity – No Client Configuration Required
- Network Transparency – Standard Protocols
- NAS Server is typically called a **Head**
- NAS Servers typically deployed as a **Pair**

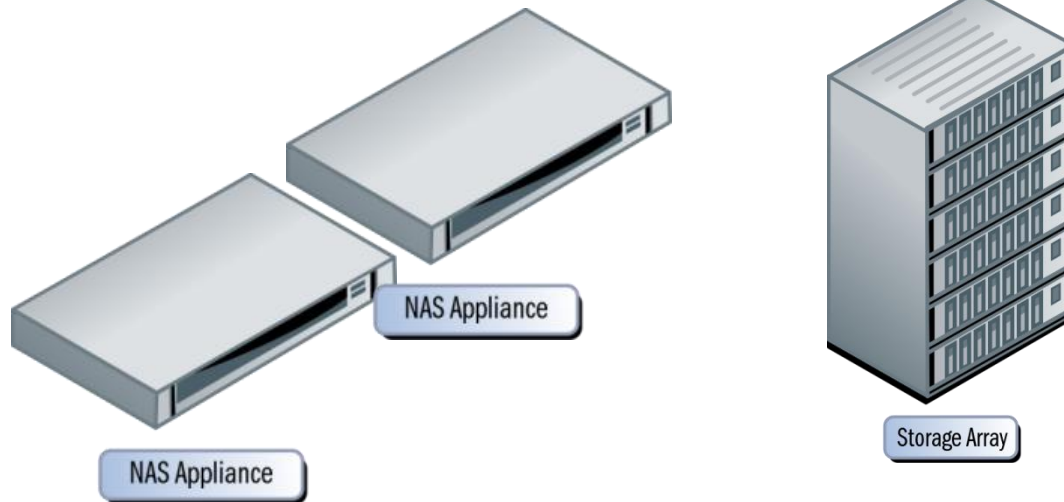


- Deploy More Powerful NAS Pairs
- Storage Can Be Retained and Expanded
- Volume Performance Limited to Single NAS Head



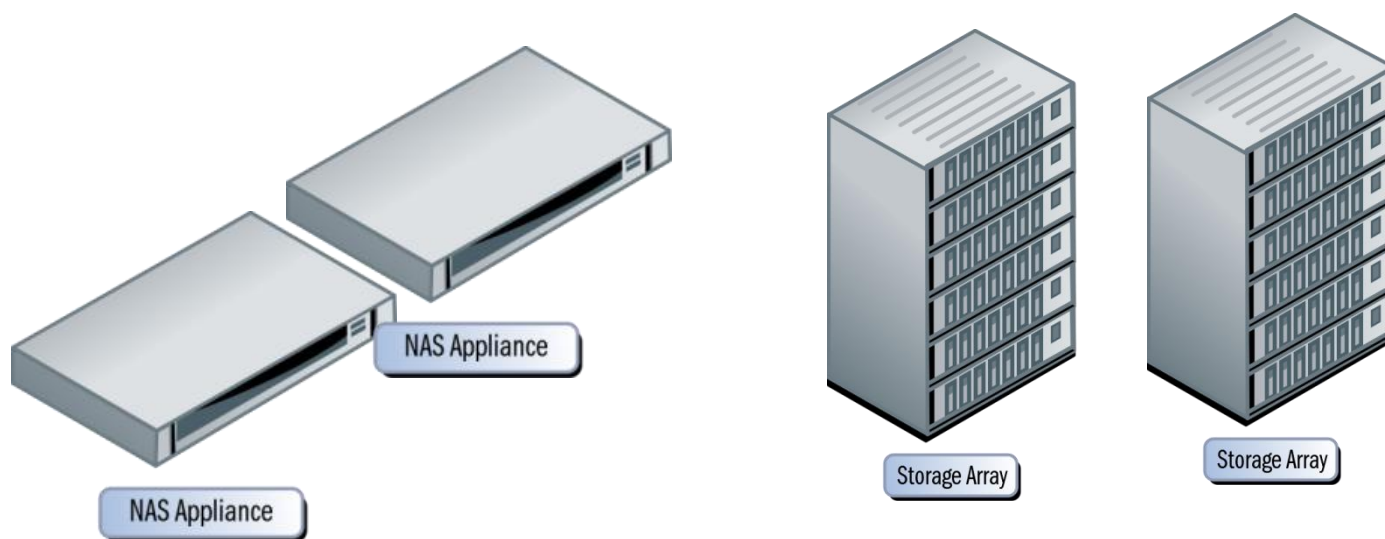
“Scale-Up”

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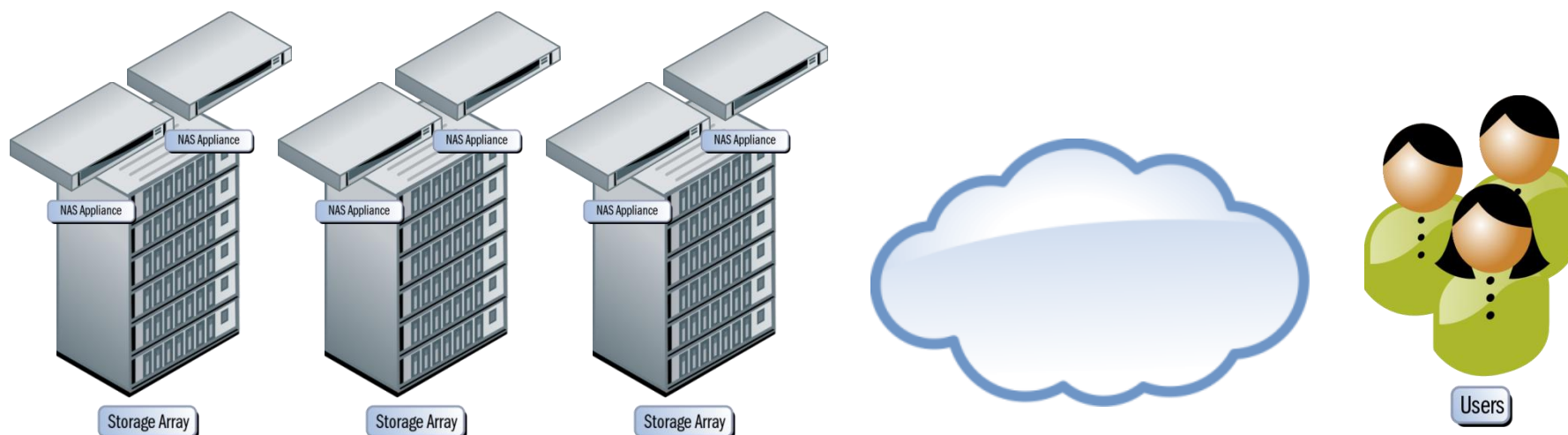
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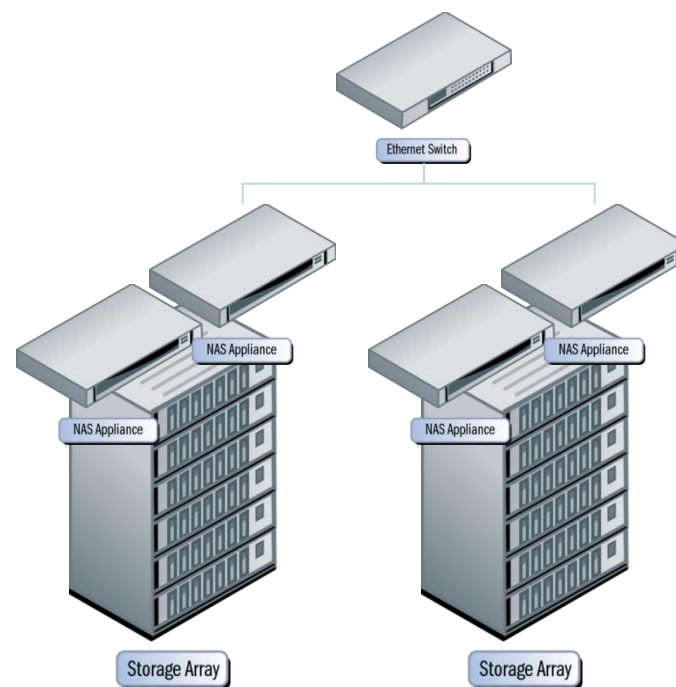
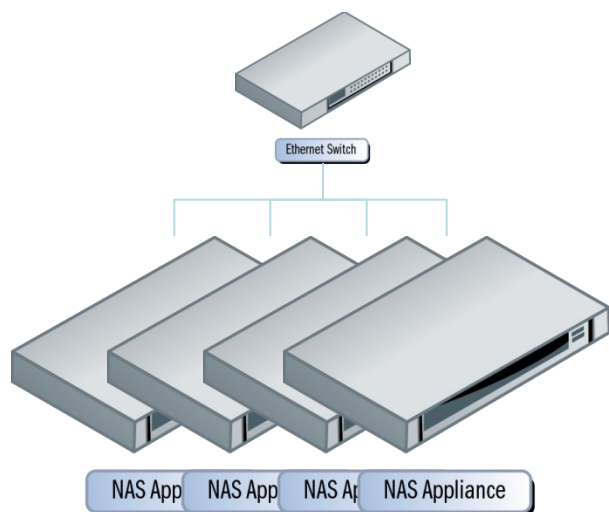


Horizontal Scaling

- Deploy Additional NAS Pairs
- Break Workflow Between NAS Pairs
- Duplicate Data Between NAS Pairs
- No Coupling Between NAS Pairs



- Distributed/Aggregated System
- Tight Coupling Between NAS Servers
- NAS Servers Referred to as **Nodes**



➤ Deployment/Capital Costs

- ◆ Storage Needs Difficult to Size Initially
- ◆ Difficult to Fully Utilize All Resources

➤ Management

- ◆ Horizontal Scaling Increases Management Complexity

➤ Performance

- ◆ Systems Cannot be Scaled-Up Effectively
- ◆ Workflows Cannot be Segmented

➤ Reliability

- ◆ Redundancy Typically Limited to 2-way

- Distributed System
 - ◆ Degree of Coupling Varies

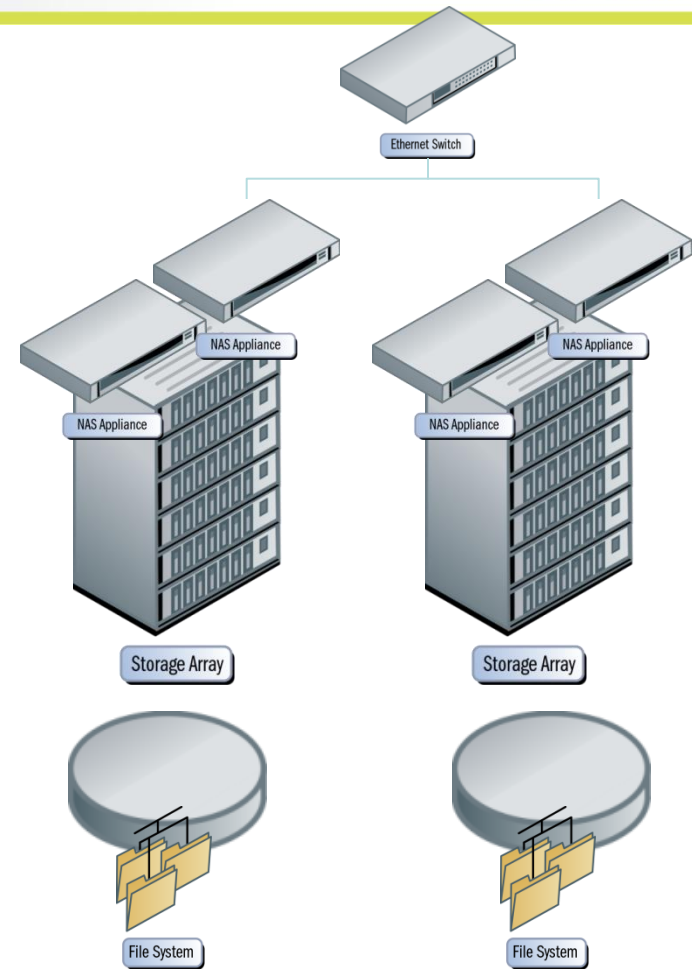
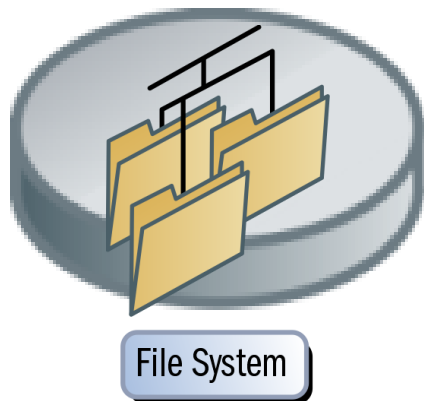
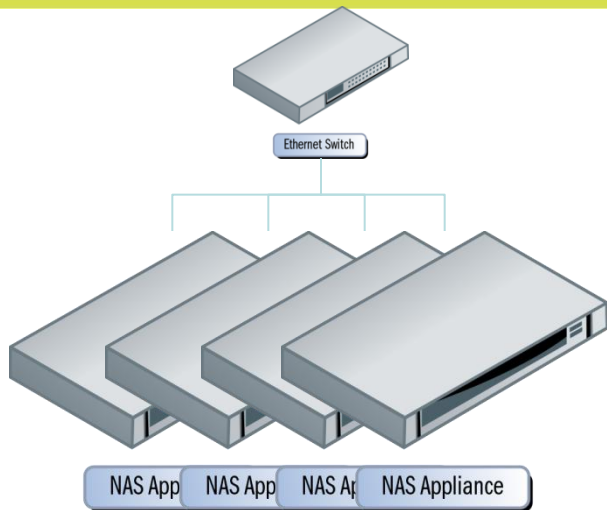
- Single Namespace
- High Availability and Data Protection
- Management Simplicity
- Investment Protection
- Ease of Scale

- Architecture choices drive many details!

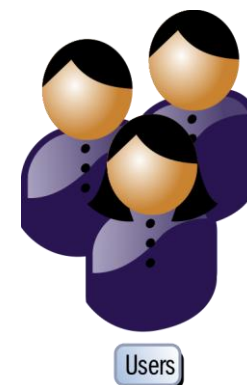
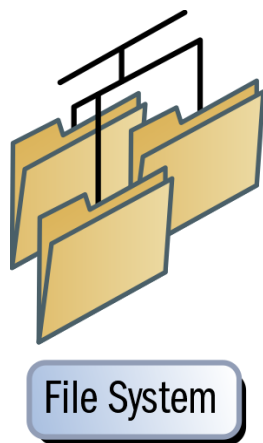
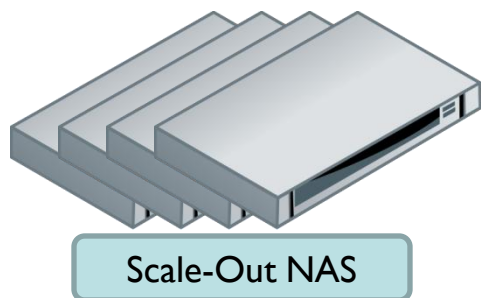
Scale-Out: Volumes

- **Single Namespace Presentation to Clients**
 - ◆ No Client Software Required For Presentation
 - ◆ No Client Setup Required for Presentation
- **Scale-Out Volume**
 - ◆ Single Volume
 - ◆ Multiple Volumes
- **Storage Efficiency**
- **Locking Semantics**
- **Multi-Protocol Semantics**

Scale-Out: Namespace/Volume

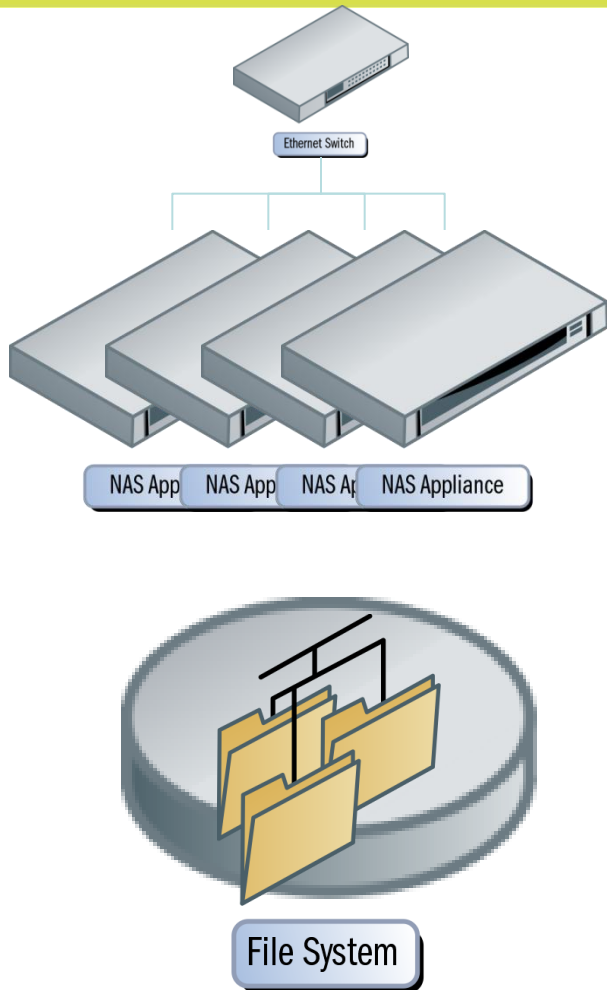


Scale-Out: Namespace

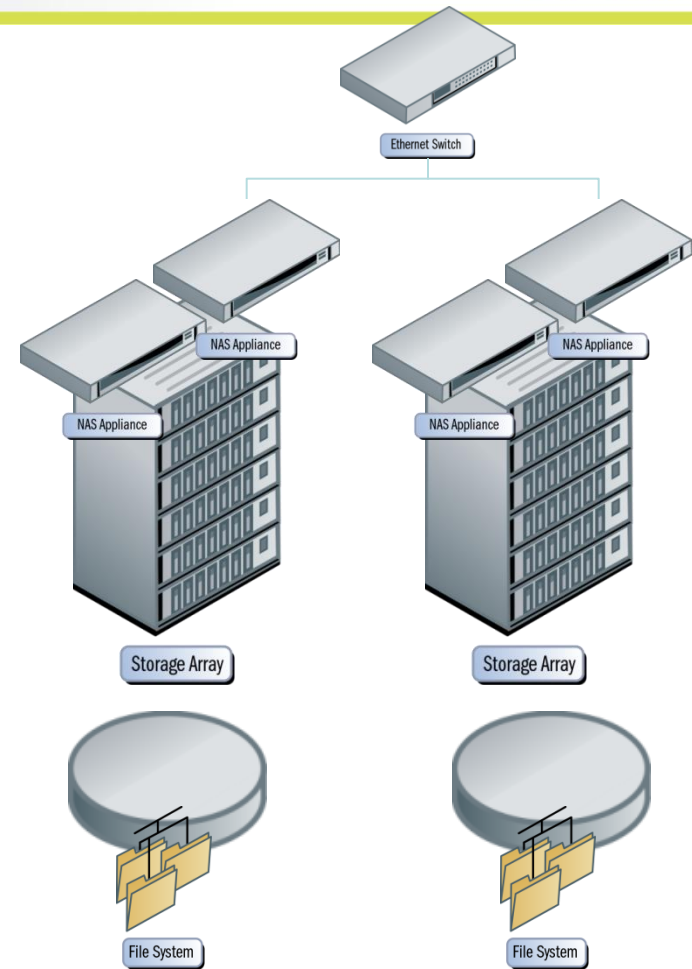


- Must Sustain Both Node Failures and Drive Failures
- Distributed Data Protection
 - ◆ Mirror Blocks Between Nodes for Redundancy
 - ◆ Generate FEC Blocks and Distribute Between Nodes
- Conventional HW/SW RAID Techniques
 - ◆ Use RAID techniques within Node
 - ◆ Node typically looks like a NAS Pair
- Data Protection Granularity
 - ◆ File-Level – different files can have different protections
 - ◆ Block-Level – protection is dictated at volume level

Scale-Out: Data Protection

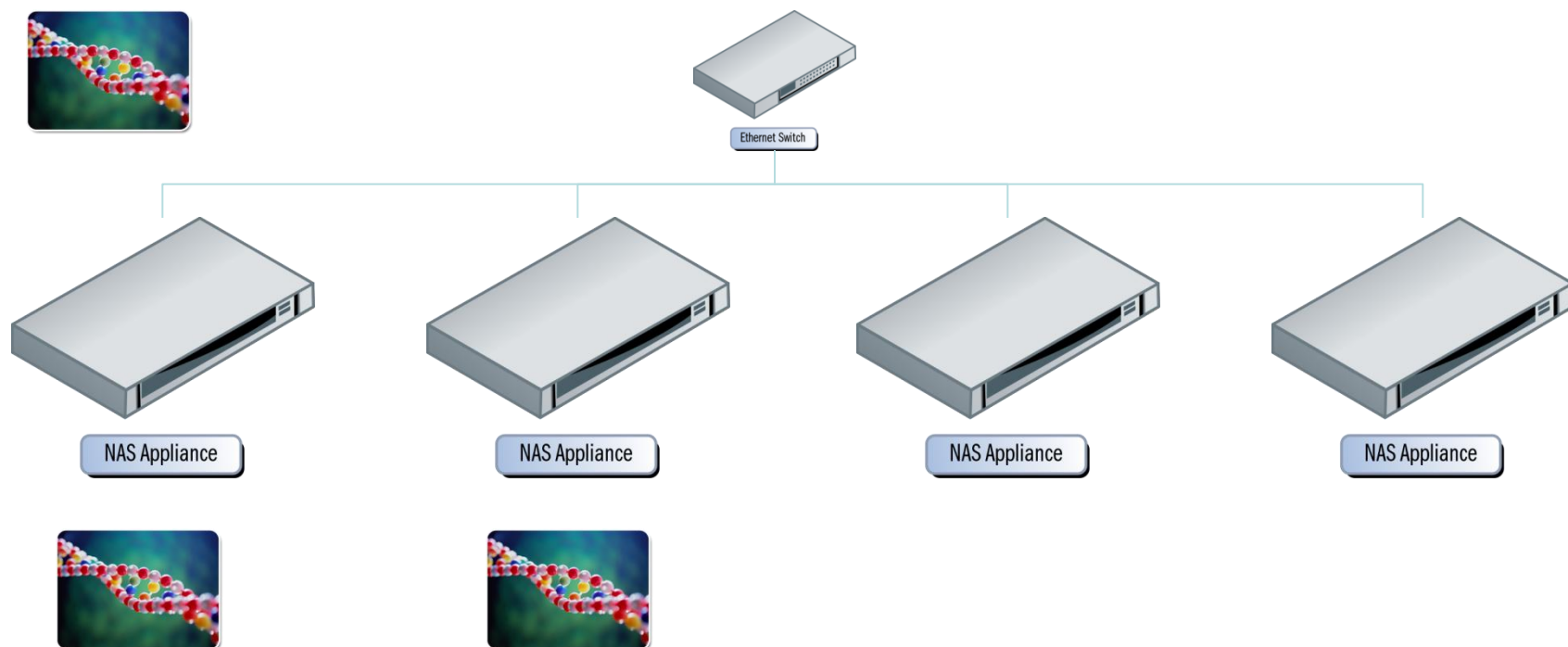


Distributed Protection



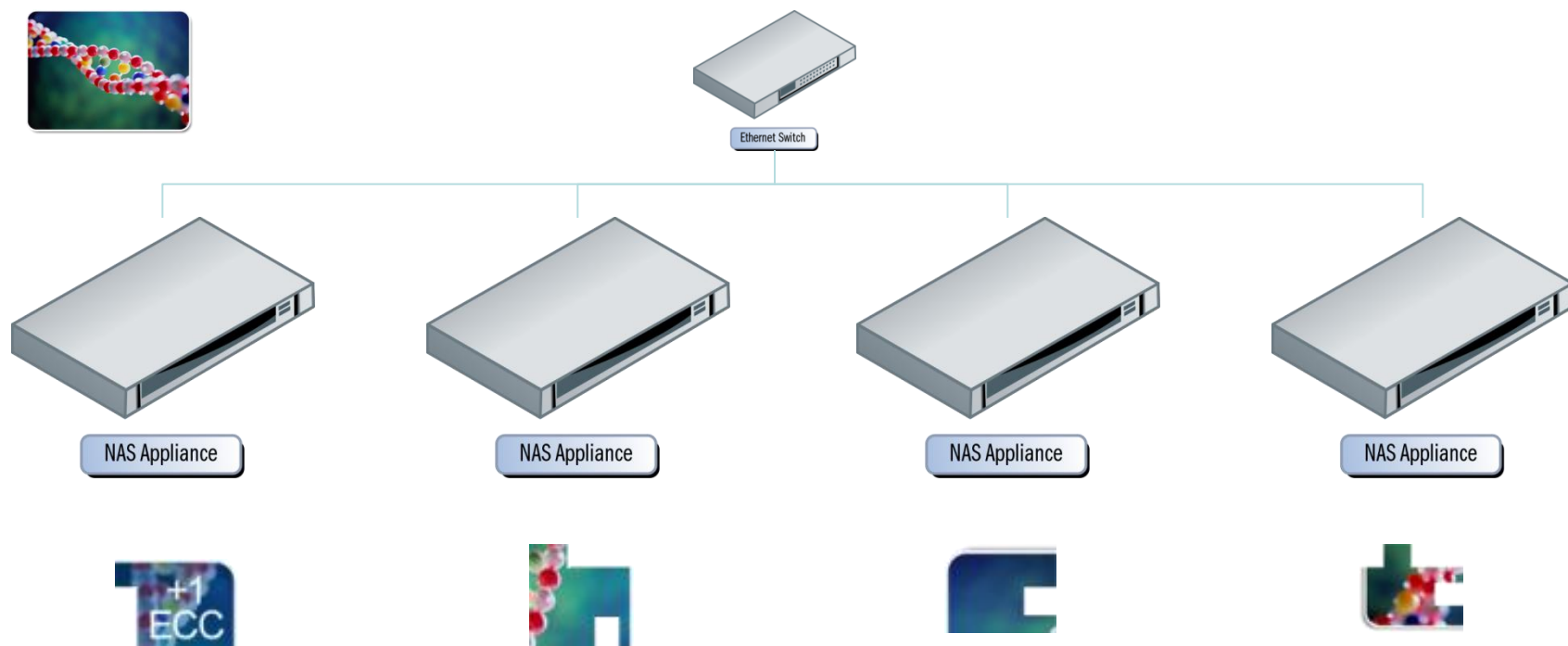
Conventional Protection

Scale-Out: Data Protection



Mirror Blocks Between Nodes for Redundancy

Scale-Out: Data Protection



Stripe files with FEC (forward-error-correction) protection

- **All-In Appliance Based Architectures**
 - ◆ Disk, CPU and Memory Fully Contained Nodes
 - ◆ Expand By Adding Appliances
 - ◆ Near-Commodity and Custom Chassis
- **Traditional Head/Shelf Appliance Architecture**
 - ◆ Paired NAS Head + Disk Shelves
 - ◆ Expand By Adding Pairs and/or Shelves
 - ◆ Near-Commodity and Custom Chassis
- **DIY/BYO**
 - ◆ Commodity Server + Disk Shelves
 - ◆ Highly Flexible Arrangements

- Distributed Systems Require Fast-Interconnects
 - ◆ High Throughput
 - ◆ Low-Latency
- Interconnect Typically Private, Self-Managed

- Infiniband
- 10GbE
- Myrinet

➤ System Software

- ◆ Identical Software Versions
- ◆ In-Family Software Versions
- ◆ Out-of-Family Software Versions

➤ Protocol/Data Servers

- ◆ Split Data/Meta-Data Nodes
- ◆ Data/Meta-Data Pod w/ Accessibility
- ◆ Distributed Data/Meta-Data

➤ NFS/CIFS/iSCSI (all)

- ◆ Can be balanced using Round-Robin, DNS Delegation
- ◆ MPIO/iSCSI Specific Drivers

➤ Client-Side Drivers (optional)

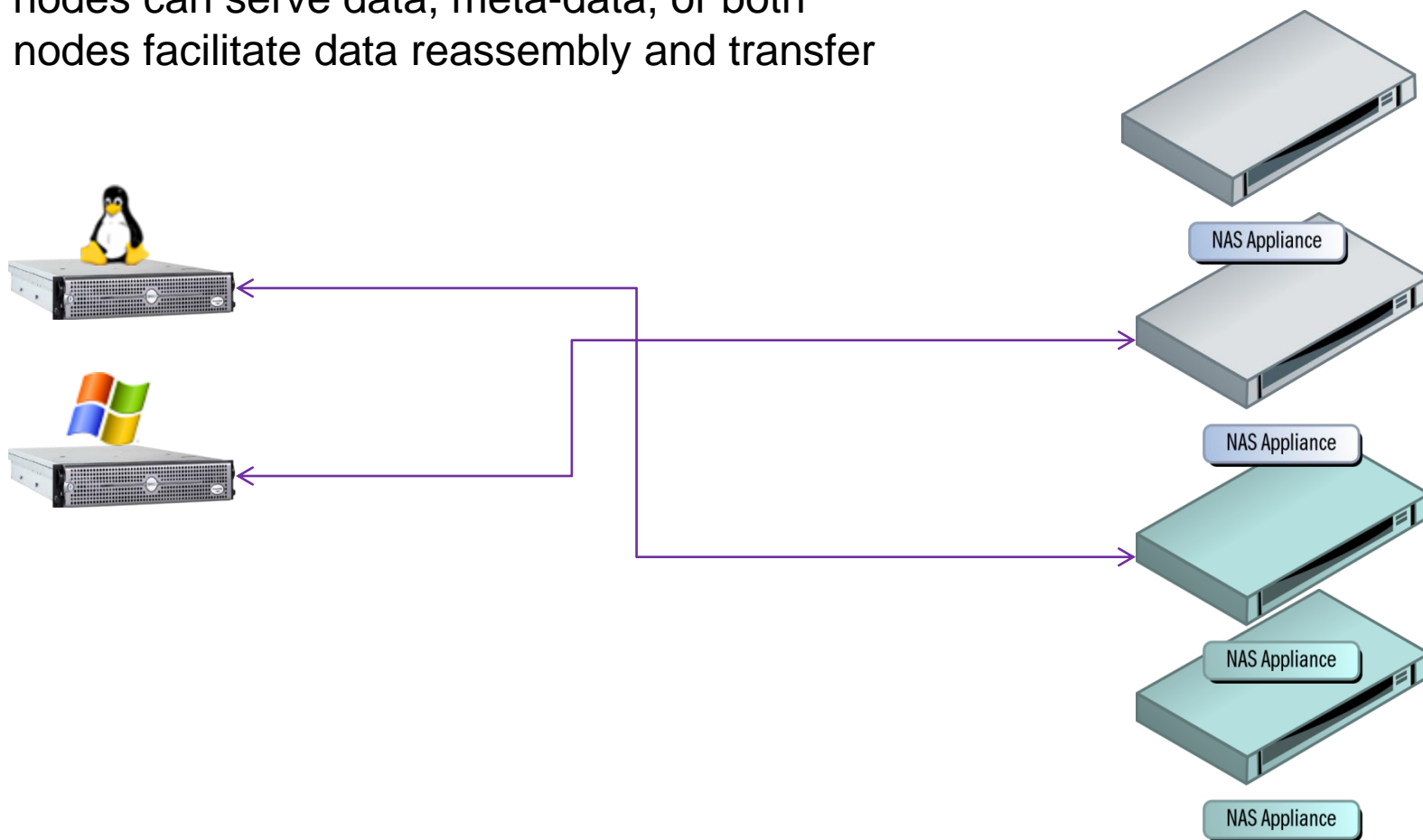
- ◆ Performance Benefits
- ◆ Load-balancing

➤ Customer-Aligned Clients (optional)

- ◆ Manually Align Client to Data

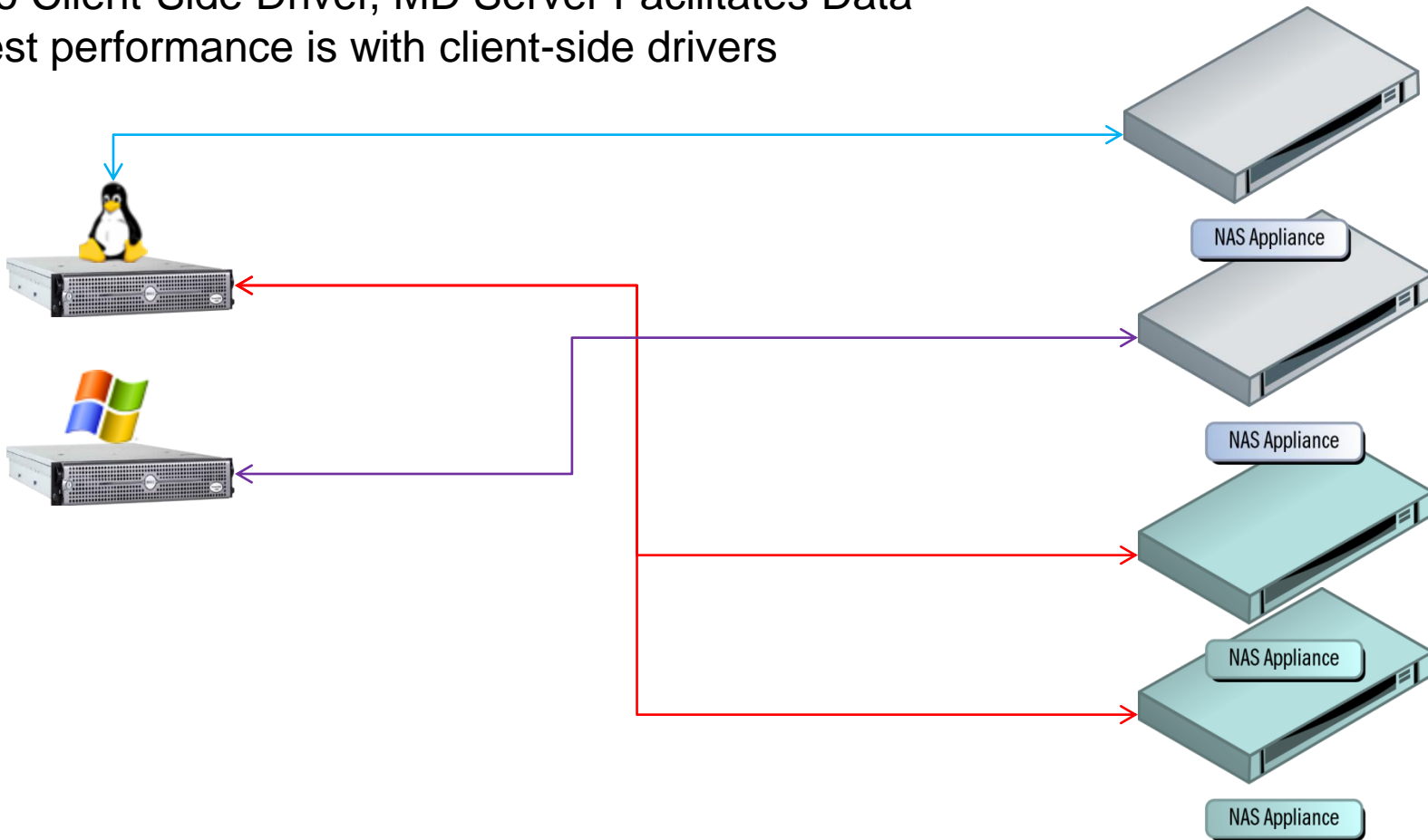
Scale-Out: Shared Data/MD Node

Data is striped across nodes
All nodes can serve data, meta-data, or both
All nodes facilitate data reassembly and transfer



Scale-Out: Dedicated MD Servers

Client-Side Drivers Split Data and Meta-Data Streams
w/o Client-Side Driver, MD Server Facilitates Data
Best performance is with client-side drivers

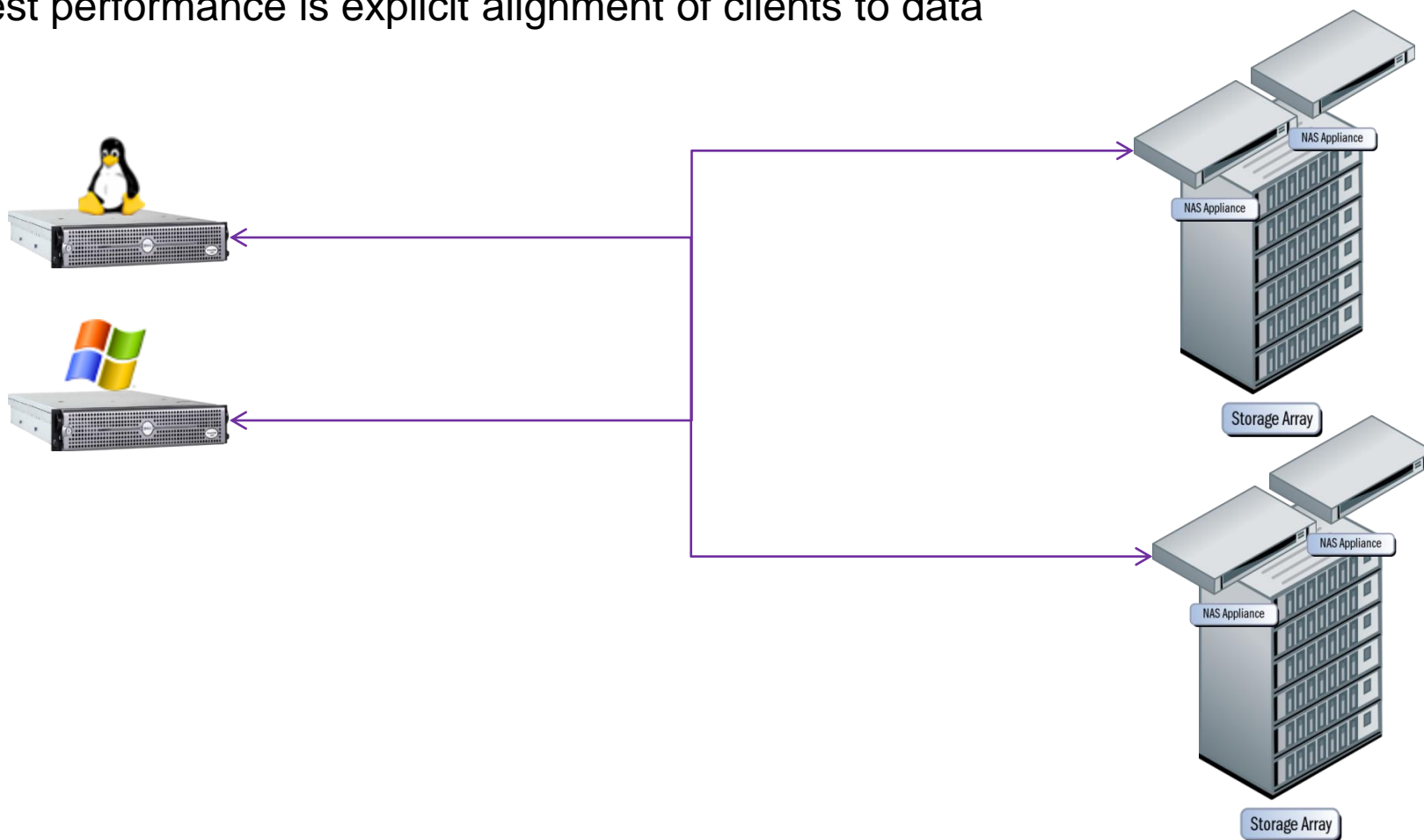


Scale-Out: Explicit Alignment

All nodes can service data/meta-data

Data not striped across nodes

Best performance is explicit alignment of clients to data



➤ Cache Semantics

- ◆ Globally Accessible Caches
- ◆ Node-Local Caching
- ◆ Block-Indexed Caches
- ◆ File-Indexed Caches
- ◆ Double-Caching

➤ Throughput and I/O Characteristics

- ◆ Large-Block I/O (throughput)
- ◆ Small-Block I/O
- ◆ Transactional/Latency-Sensitive I/O

- Dependency on Volume Configuration

- Managing a Single System
- Managing Multiple Systems within a Single System

- Life Cycle
 - ◆ Initial Configuration
 - ◆ Node Failure/Replacement
 - ◆ Storage Expansion
 - ◆ Node Addition

- Please send any questions or comments on this presentation to SNIA: trackfilemgmt@snia.org

**Many thanks to the following individuals
for their contributions to this tutorial.**

- SNIA Education Committee

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