Education

Storage Virtualization II

Effective use of Virtualization

- focusing on block virtualization -

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Agenda

- *Virtualization Checklist – Background info*
- Implementing Virtualization Step-by-Step
- Achieving .... Through Virtualization
  - Capacity
  - Performance
  - High Availability
- Storage Virtualization and the SNIA SMI-S
- Policy-based Service Level Management
- Q&A

Virtualization Checklist

- Before purchasing and implementing any product the user should be aware that Storage Virtualization is an enabling technology and is a part of the solution

- Storage Virtualization is a tool for the IT administrator to simplify the management of the storage resources and reduce the complexity of the overall IT infrastructure

What's the Problem

- Storage problems in specific areas, such as:
  - Capacity
  - Availability
  - Performance
  - Flexibility/Change of Attributes
  - Manageability
- Goals to achieve through adoption of virtualization
  - Align the storage infrastructure with the Business and IT Objectives of the end user
  - Measure with Service Level Agreements (SLAs)
    - internally and externally defined
  - Implement business plans such as D/R, B/C and strategic plans

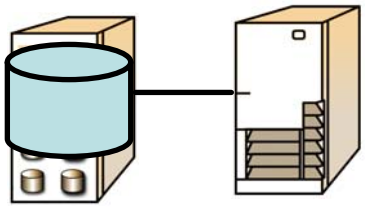
Implementing Storage Virtualization step-by-step

- Step 1: Starting from a DAS environment
- Step 2: Add SAN infrastructure
- Step 3: Add Virtualization infrastructure
  - Out-of-Band example
  - In-Band example
- Step 4: Move DAS volumes to SAN
- Step 5: Change Primary/Secondary relationship
- Step 6: Establish HA environment
- Step 7: Create and Use Single Storage Pool
- Step 8: Establish Load Balancing/Multi-pathing

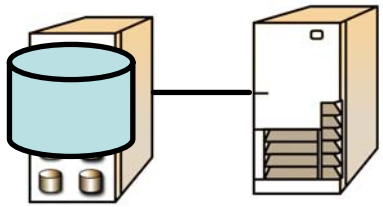
- *Sequence may change from project to project*

Implementing Storage Virtualization
1. Start - DAS environment

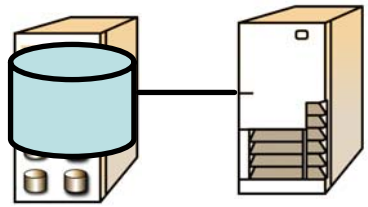
DAS = either internal or external storage devices



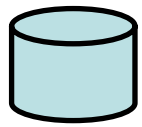
DAS



DAS

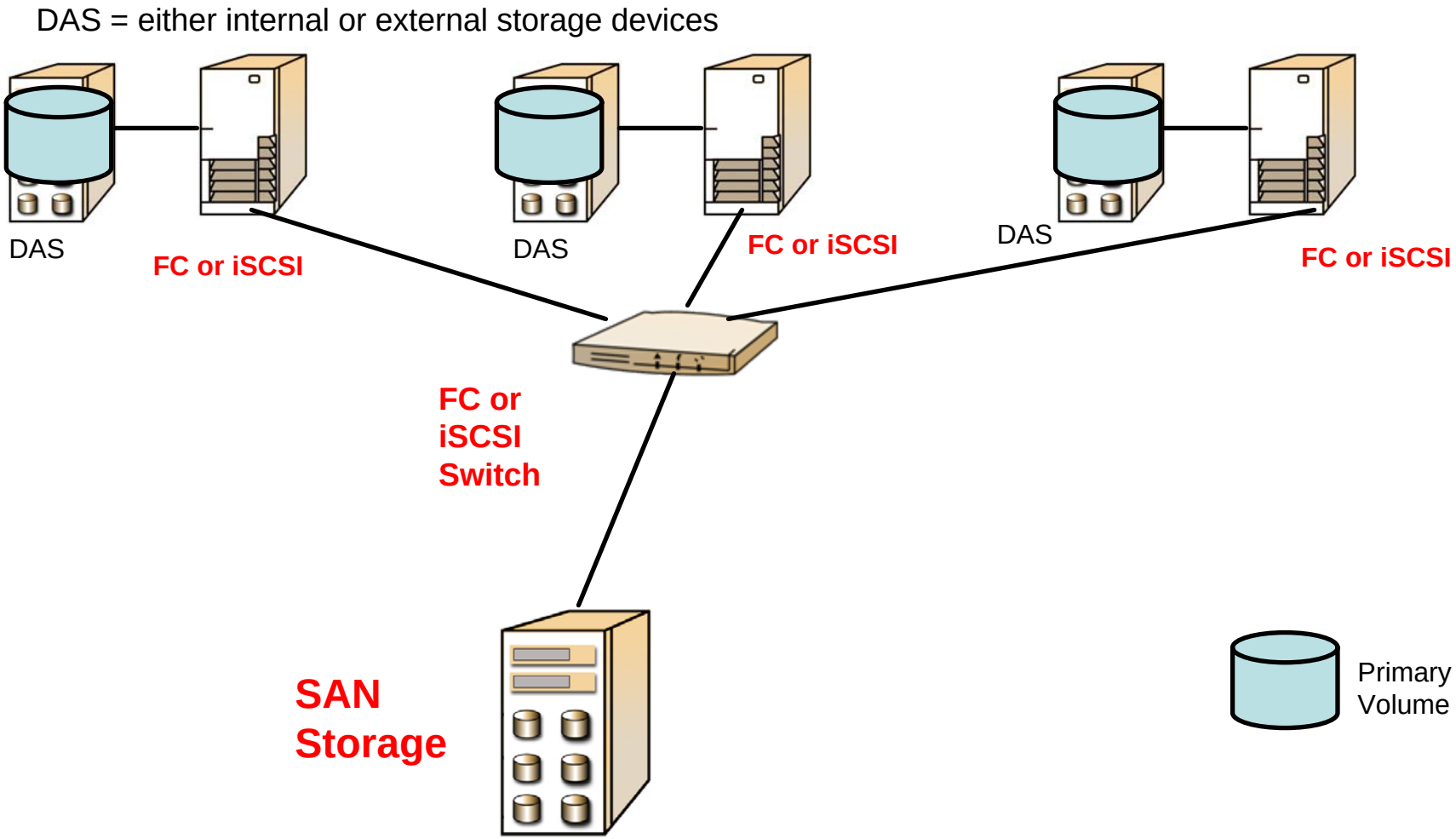


DAS

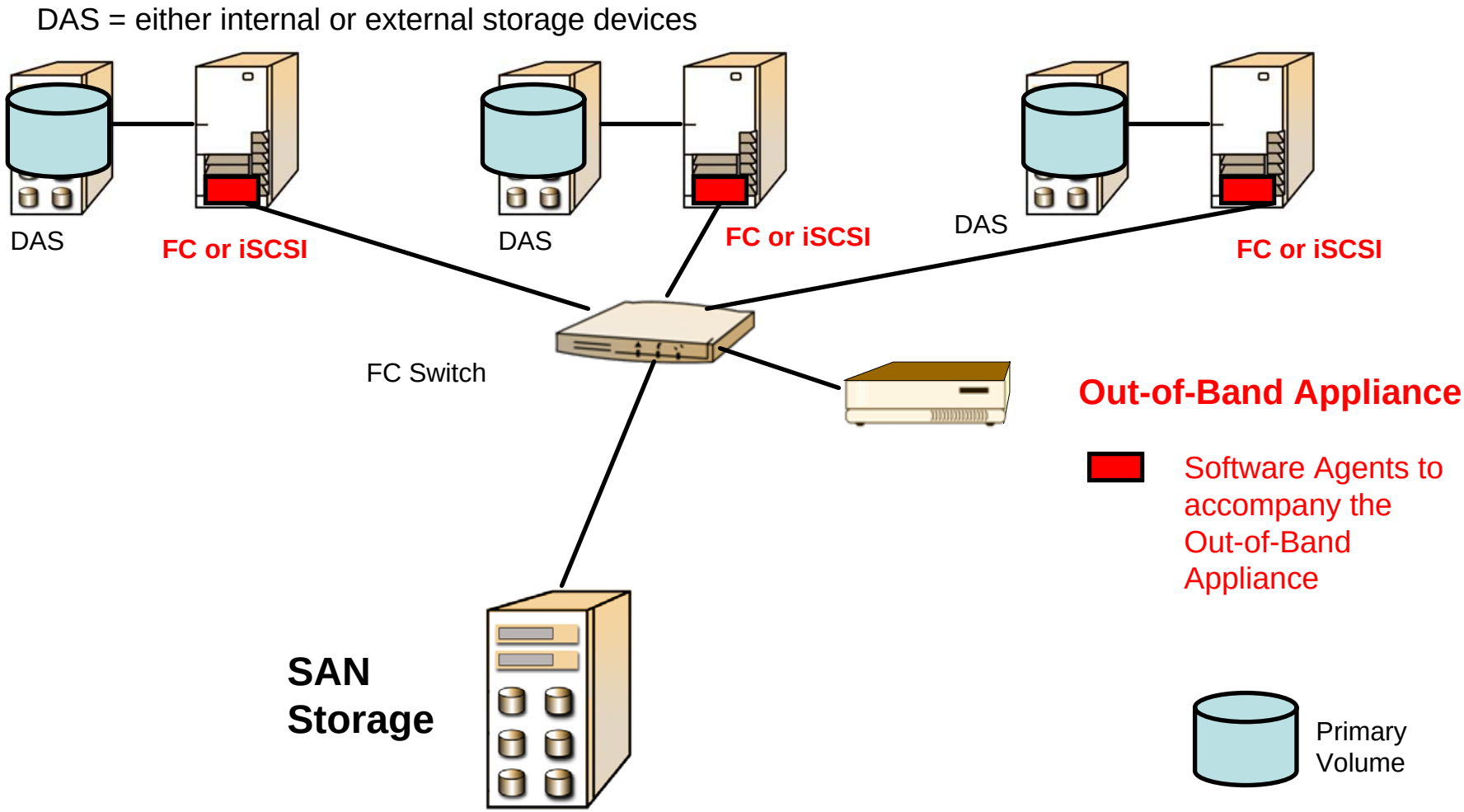


Primary Volume

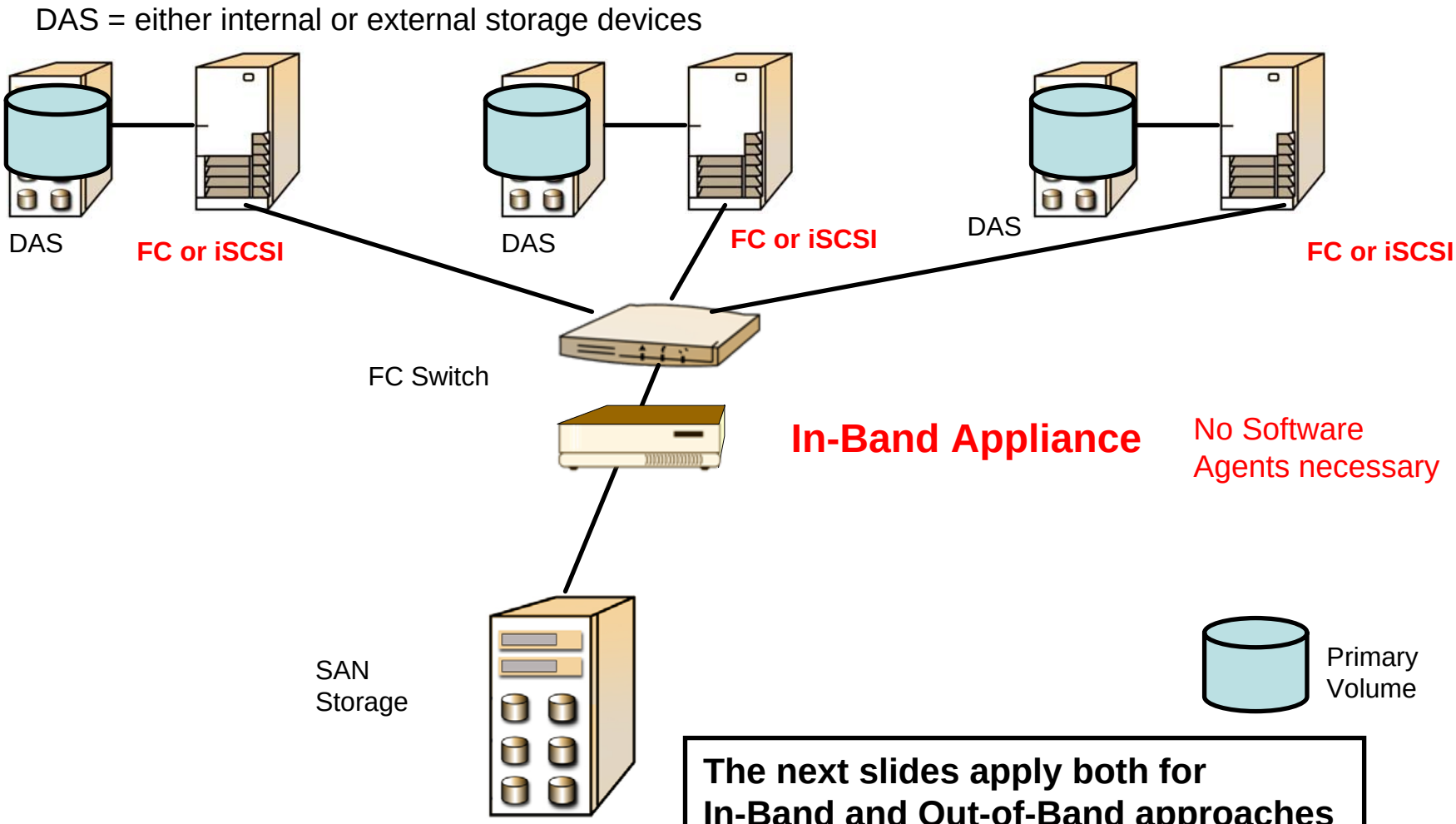
Implementing Storage Virtualization
2. Add SAN infrastructure



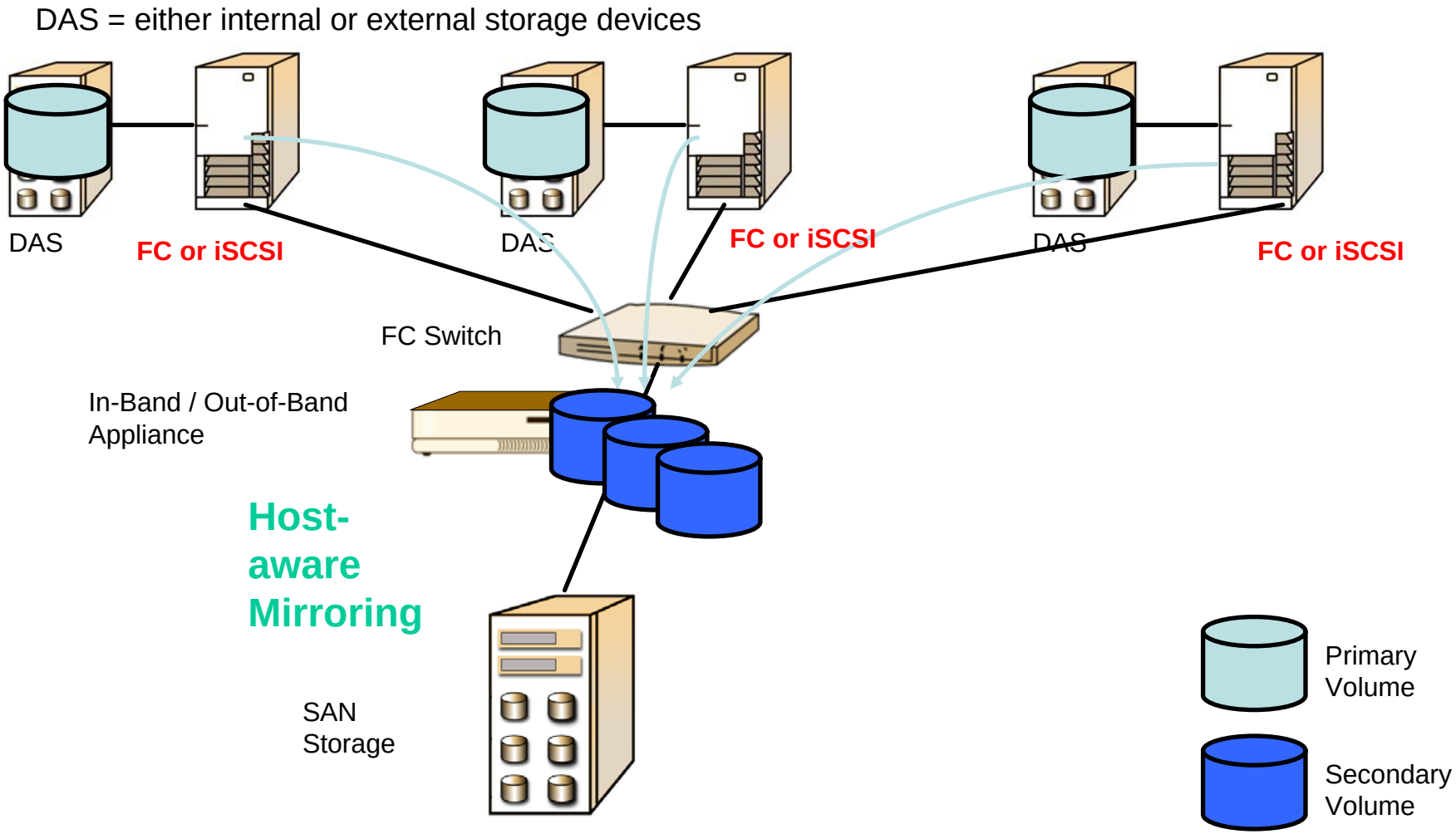
Implementing Storage Virtualization
3a. Add Virtualization - OOB



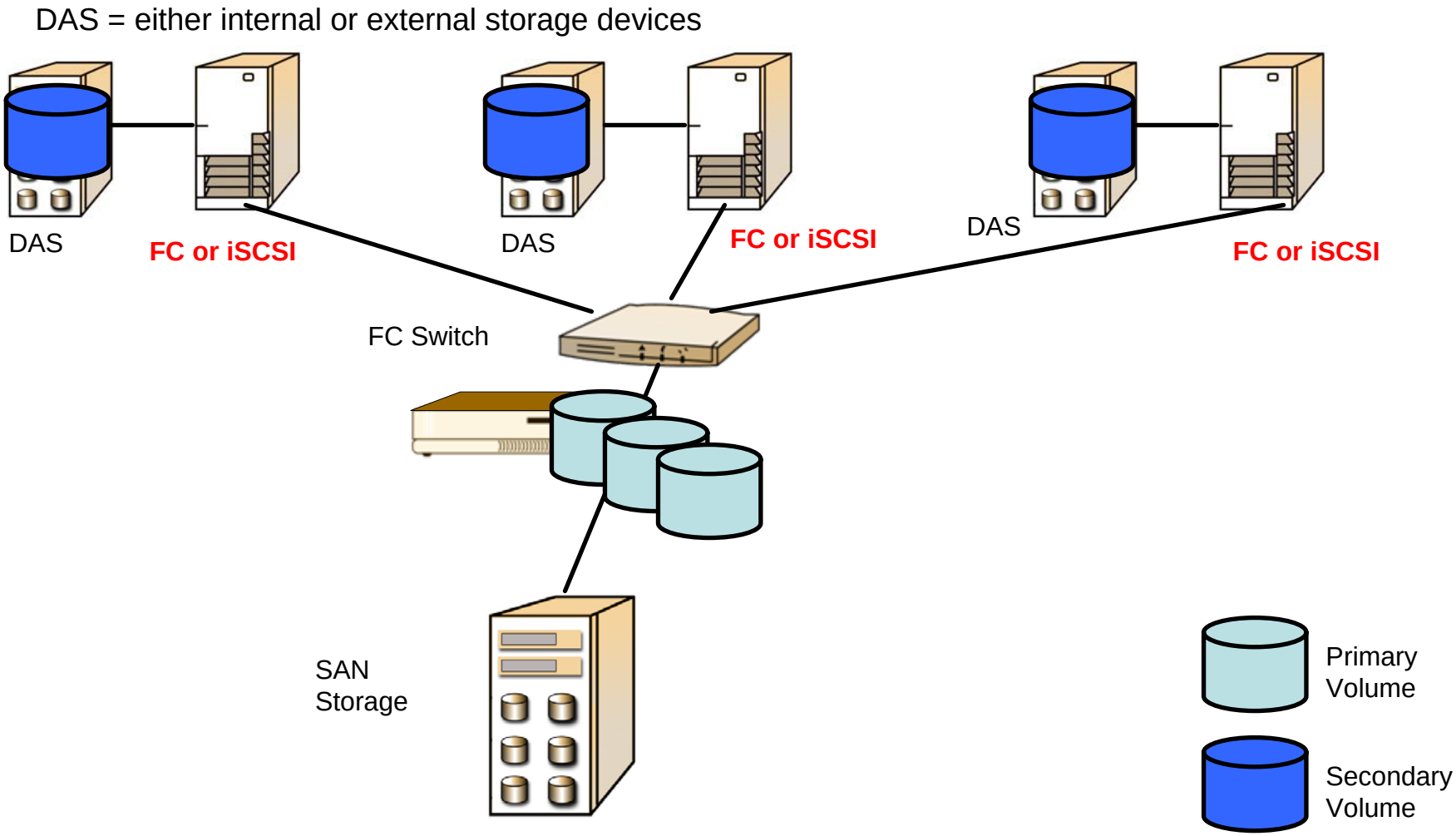
Implementing Storage Virtualization
3b. Add Virtualization – In-Band



Implementing Storage Virtualization
4. Move DAS Volumes to SAN

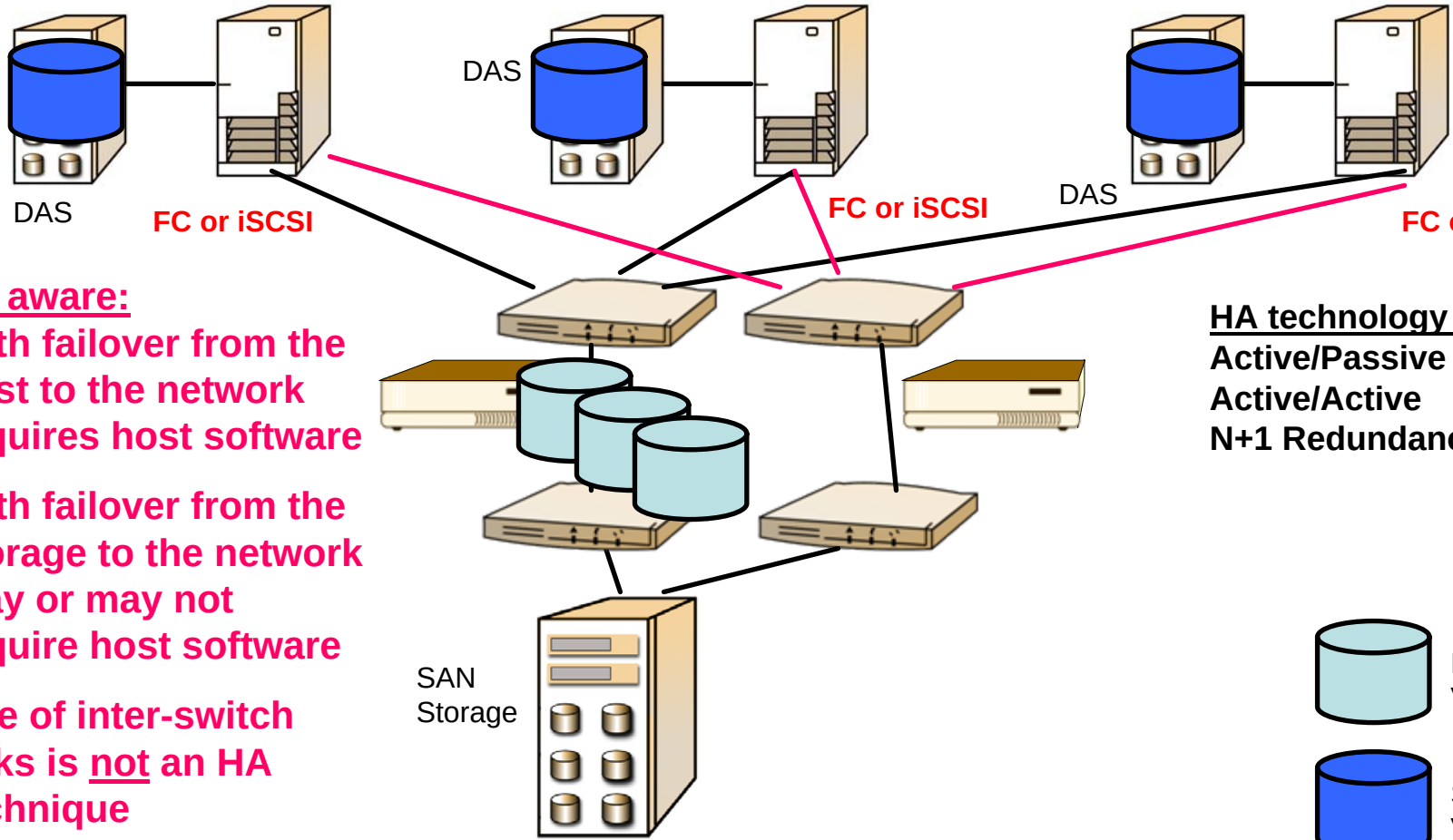


Implementing Storage Virtualization
5. Change Primary/Secondary



Implementing Storage Virtualization
6. Establish HA environment

DAS = either internal or external storage devices



Be aware:

Path failover from the host to the network requires host software

Path failover from the storage to the network may or may not require host software

Use of inter-switch links is not an HA technique

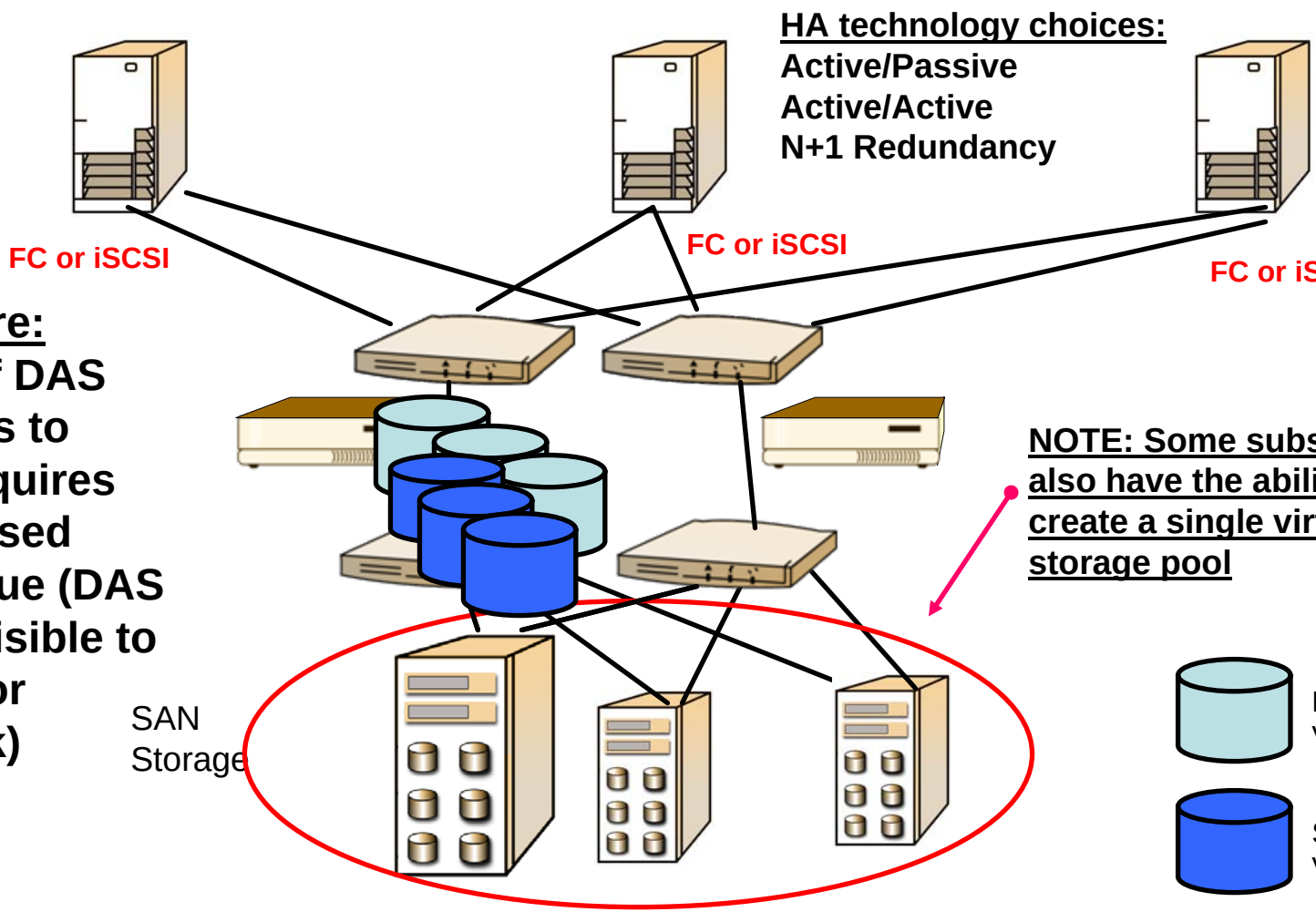
HA technology choices:

Active/Passive
Active/Active
N+1 Redundancy

Primary Volume

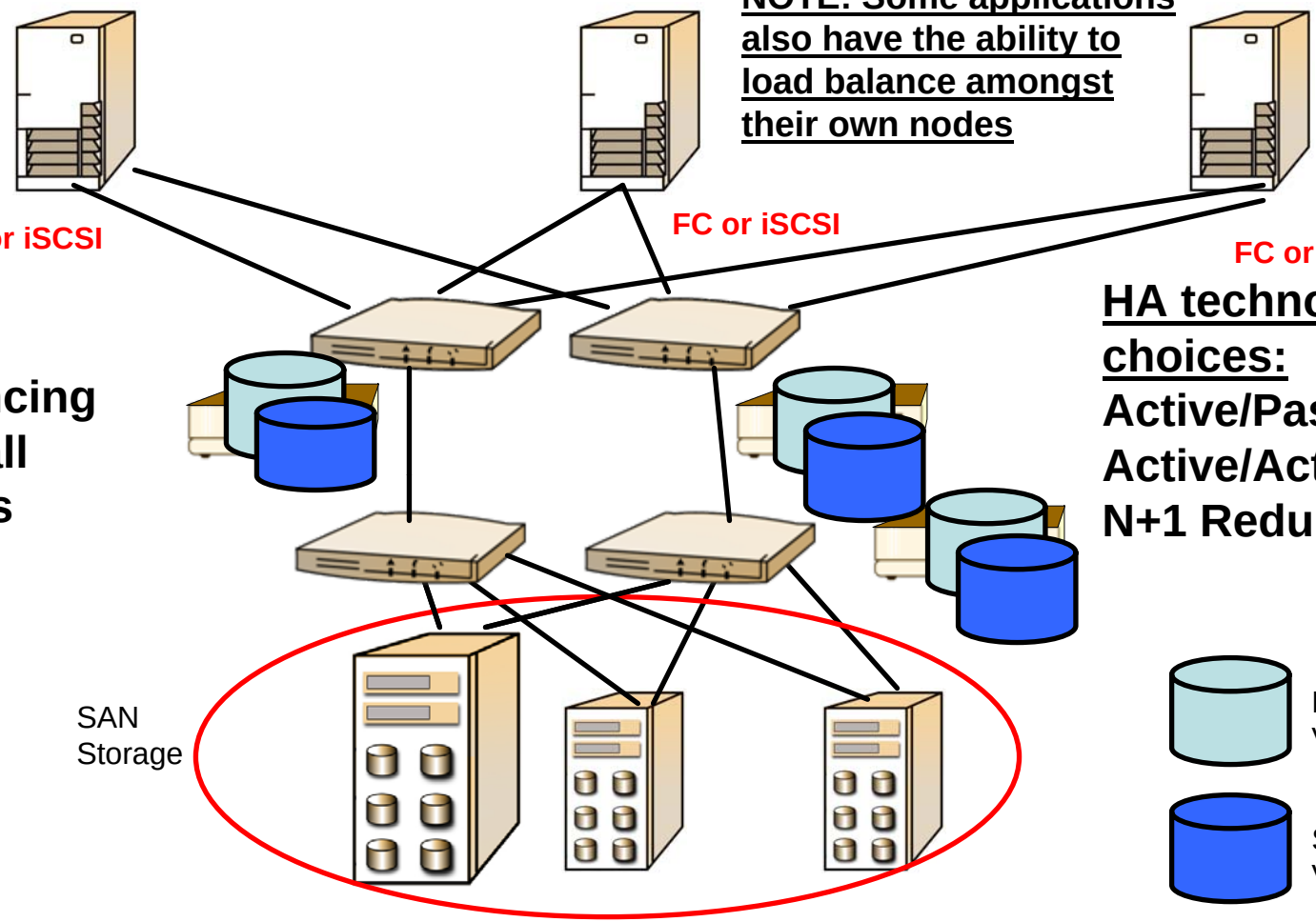
Secondary Volume

Implementing Storage Virtualization
7. Create Single Storage Pool



Be aware:
Copy of DAS volumes to SAN requires host-based technique (DAS is not visible to arrays or network)

Implementing Storage Virtualization
8. Load Balancing



Be aware:
Load balancing occurs at all three levels and may involve software

HA technology choices:
Active/Passive
Active/Active
N+1 Redundancy

Achieving High Availability **in a Virtual environment**

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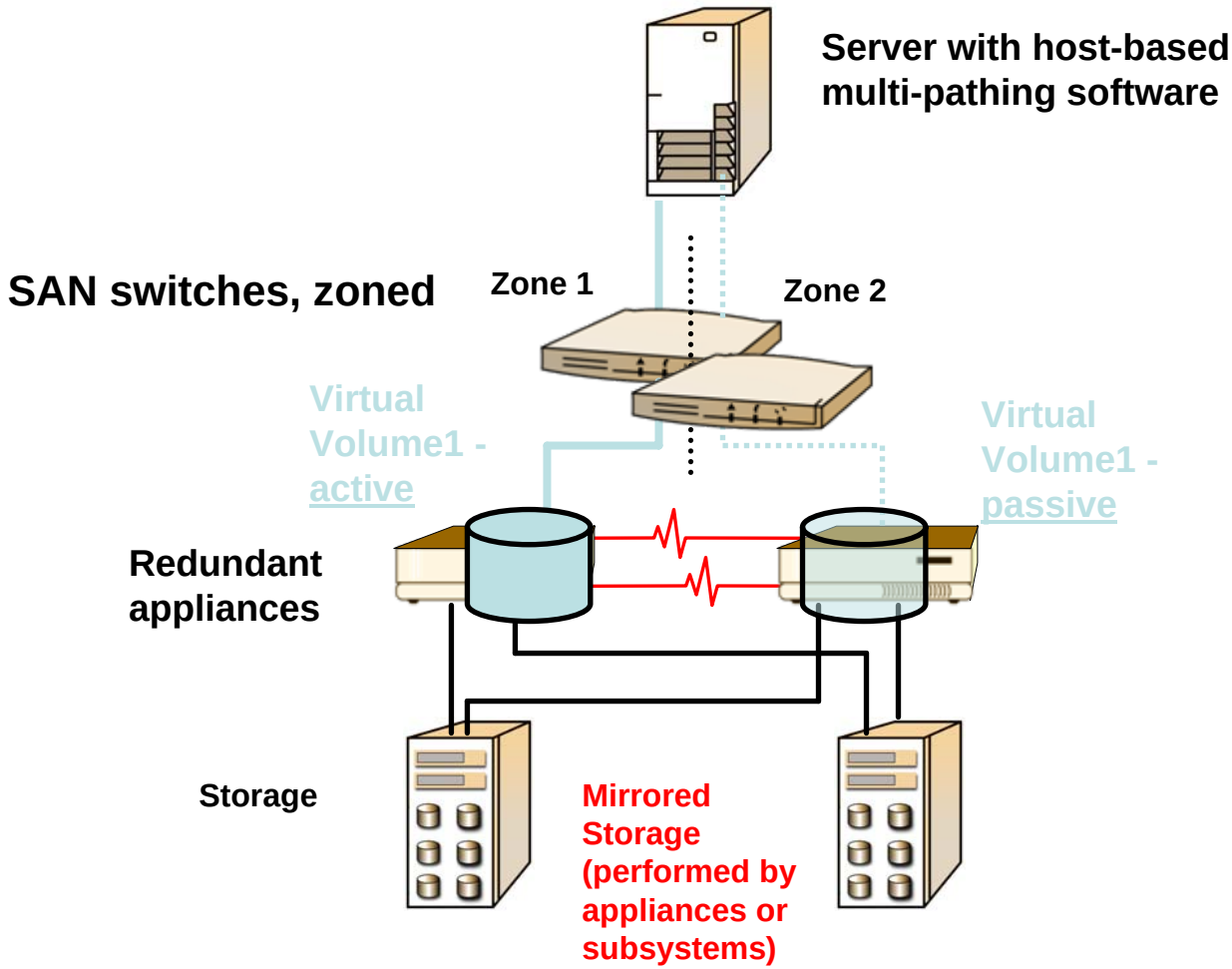
Network-based Virtualization

- Do not rely on only one network-based appliance or intelligent switch only
  - Same rule for in-band as for out-of-band
- There are different methods to protect the engines
  - Active / Passive
  - Active / Active
  - N+1 redundancy
  - N-way distributed clustering
- The technique used is vendor-specific

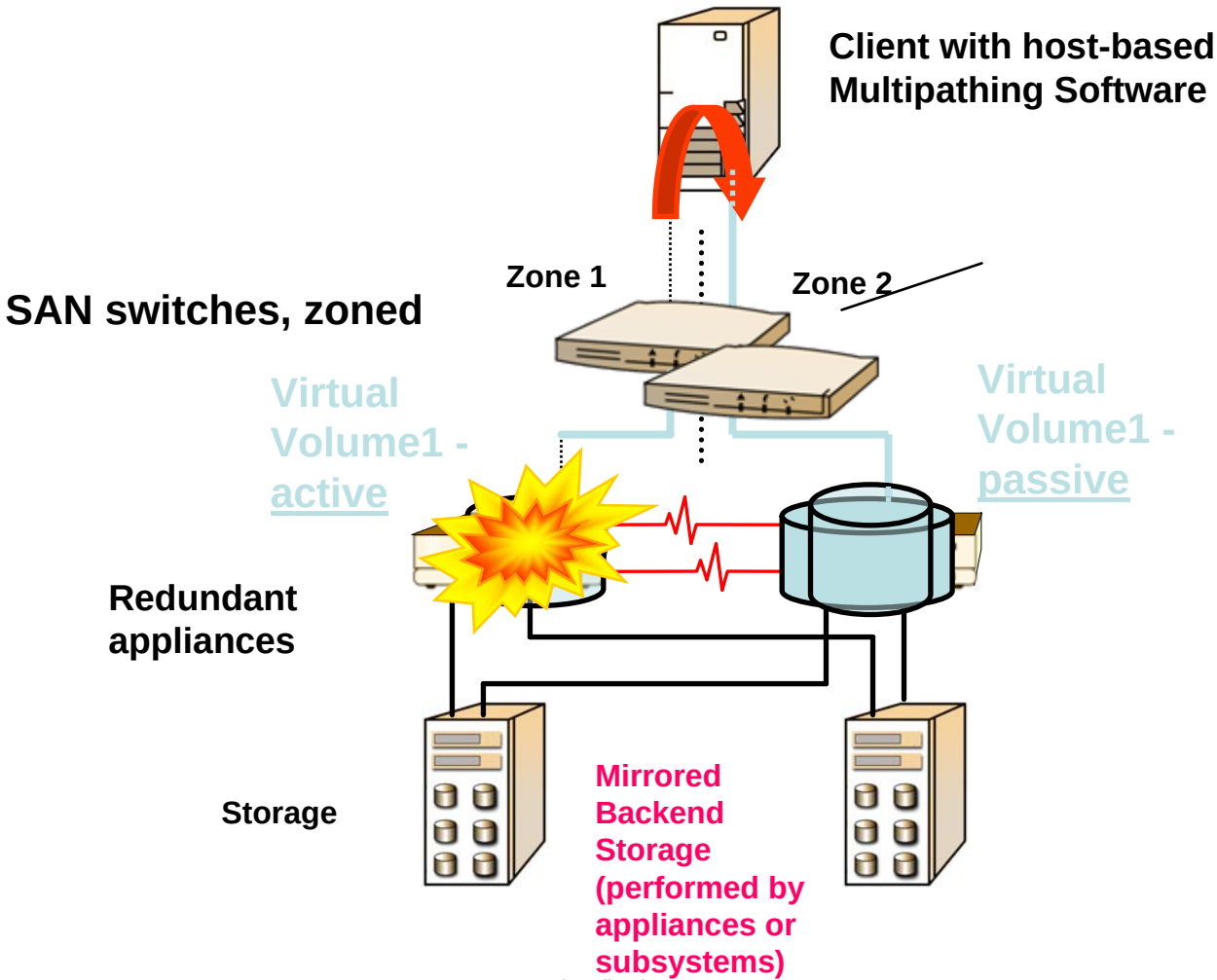
Achieving High Availability

Example: active/passive appliances or subsystems



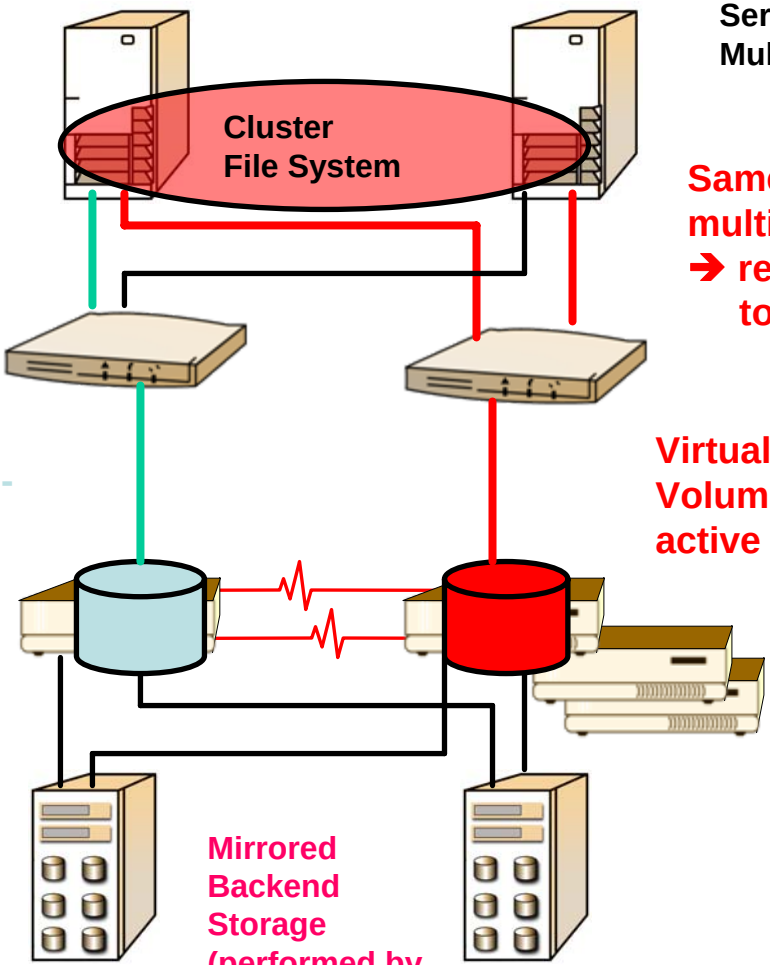
Achieving High Availability

Example: active/passive appliances or subsystems



Achieving High Availability

Example: Multiple access of same volume



Servers with host-based Multipathing Software

Same Volumes are accessed by multiple servers simultaneously
➔ requires Cluster File System to avoid data integrity problems

Virtual Volume1 - active

Virtual Volume2 - active

Redundant appliances

Expansion of the Redundancy to multiple appliances (N+1)

Storage

Mirrored Backend Storage (performed by appliances or subsystems)

Achieving High Availability

Example: active/active switch-based virtualization

Clients with host-based Multipathing Software

Cluster File System

Same Volume is accessed by multiple servers simultaneously
➔ requires Cluster File System to avoid data integrity problems

Virtual Volume 1 - active

Virtual Volume 2 - active

Switches with virtualization capability

Switches use some form of HA heartbeat mechanisms through OOB links – NOT inter-switch links

Storage

Mirrored Backend Storage (performed by switches or subsystems)

High Availability Considerations
for 'intelligent' switches

- To support high-availability configurations, virtual storage management must be distributed across two or more switches.
  - The switches present a virtual volume/LUN to the host(s) for a given LUN presented by the storage array(s) – and that LUN may be a virtual disk
  - Host-based multi-pathing software allows active-passive or active-active access to the virtual volumes presented to the host(s)
  - Allows hosts to access virtual volumes in the presence of a switch failure

Achieving High Availability

Example: Multiple servers access the same volume

Servers with host-based Failover Software (host-to-switch failover)

Same Volume is accessed by multiple servers simultaneously ➔ requires Cluster File System to avoid data integrity problems

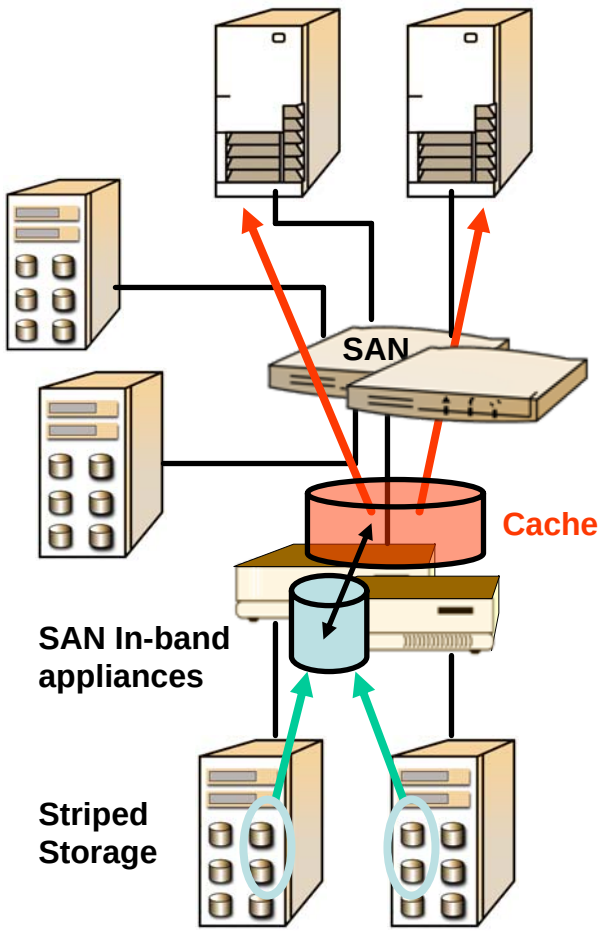
Out-of-Band Appliances

Achieving Performance in a Virtual environment

- Striping / Mirroring
  - Simultaneous reads and/or writes
- Load Sharing
- Load Balancing
- Off-loading host systems
- Caching (where possible)

Achieving Performance

Example: In-band appliance

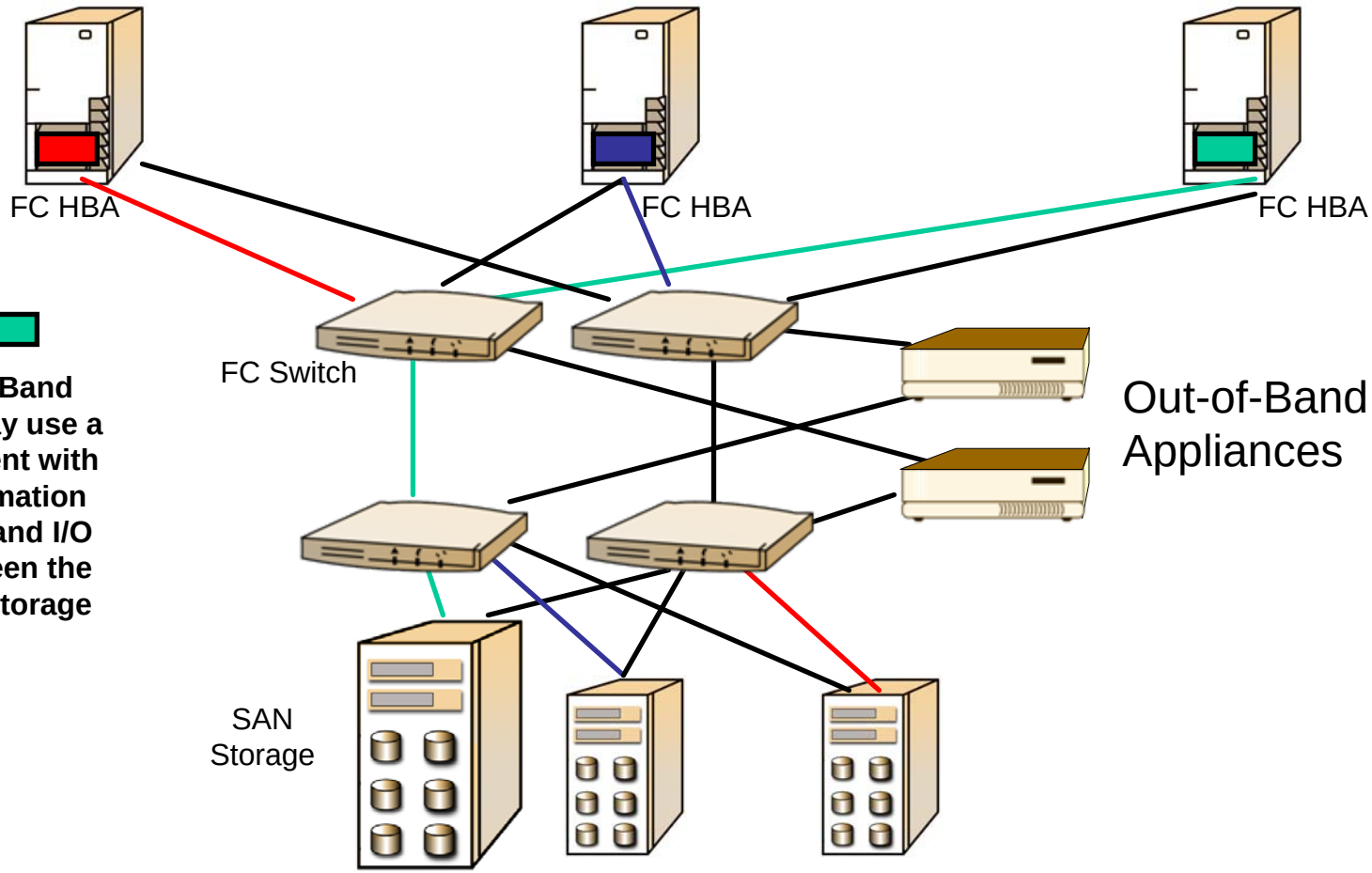


Performance Improvement:

1. Striping across multiple disk arrays
2. **Caching Technology in the In-Band SAN appliance**

Achieving Performance

Example: Out-of-Band appliance

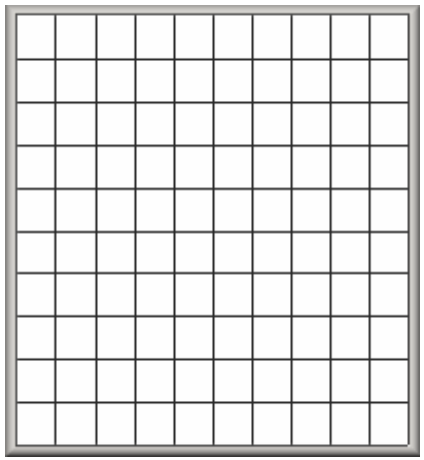


The Out-of-Band Appliance may use a Software Agent with the transformation information and I/O ocurrs between the Server and Storage

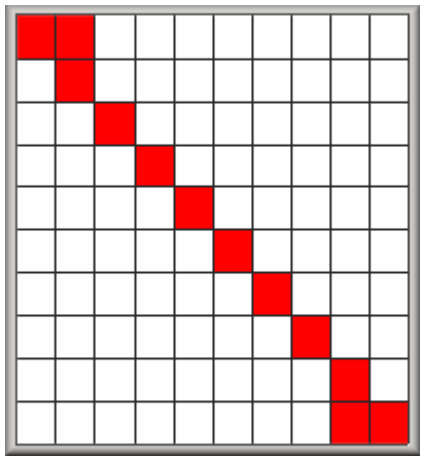
Achieving dynamic capacity improvements in a virtual environment

- Eliminate fixed-size LUNs
- Create dynamic virtual LUNs and expand the LUNs as necessary
  - Requires dynamic volume support on the host(s)
- Create large virtual LUNs and pools and assign backing (physical) storage to it as the host writes data (Sparse Allocation)
- Dynamic growth of Volumes and File Systems simultaneously

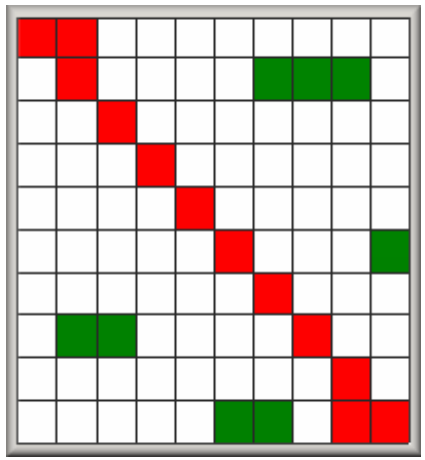
Sparse Allocation



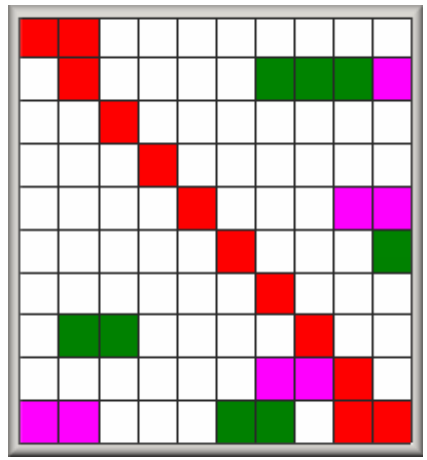
1. New Volume



2. Initial Filesystem allocation



3. Data Written



3. More Data Written

Unallocated Logical Block

Filesystem Metadata

Application Data

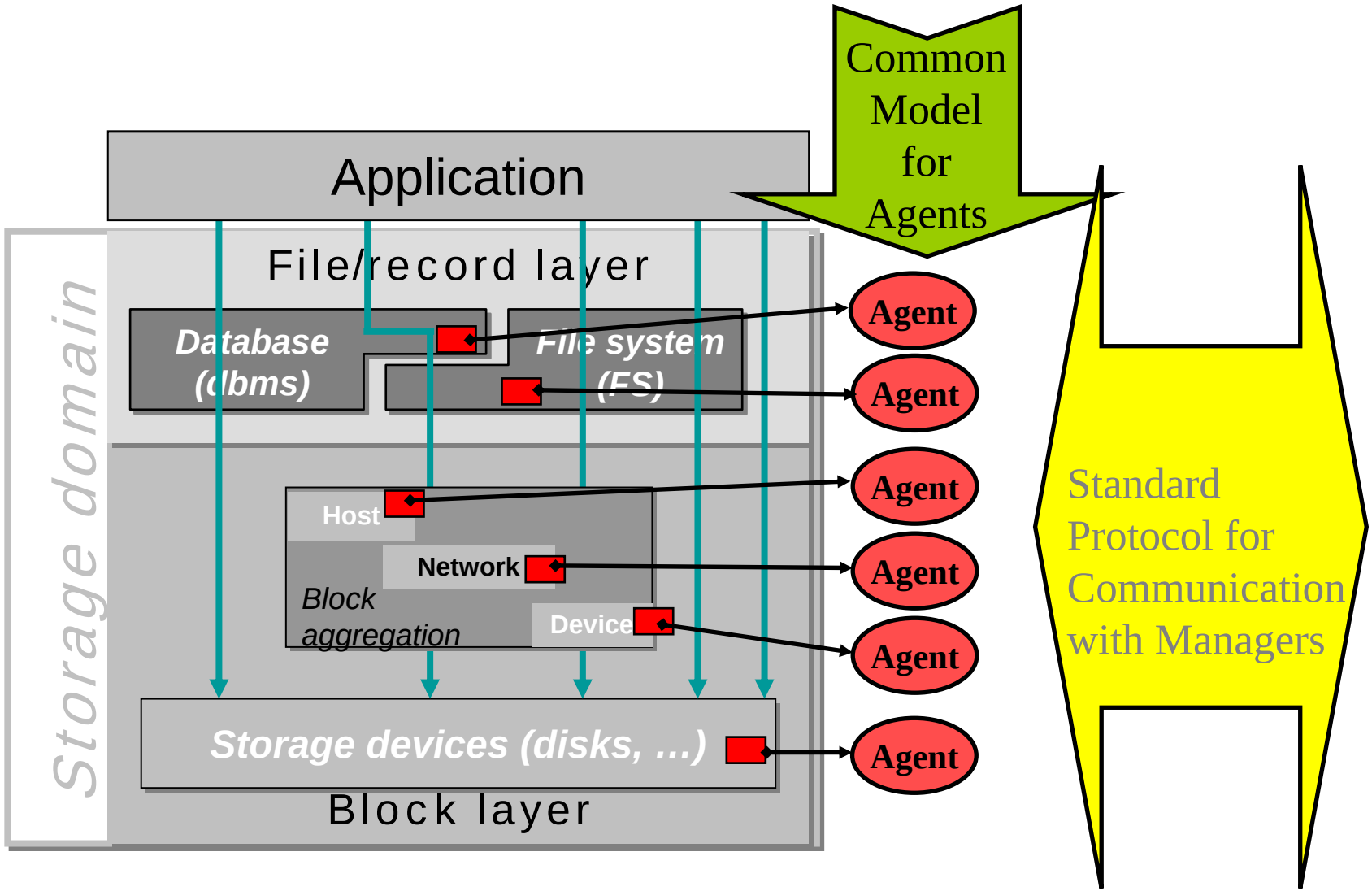
Storage Virtualization and SNIA's Storage Management Initiative (SMI)

The following material corresponds with the SNIA SMI-S 1.1.x

A Brief Introduction to SMI-S

- SNIA's strategic initiative to solve end-user operational challenges for Storage Management
  - Passive (Discovery and Monitoring)
  - Active (Storage Configuration; manually and policy-based)
- Based on Standards
  - WBEM (Web Based Enterprise Management)
  - CIM (Common Management Model)
- Includes Block Virtualization in its first version

Control Path in SNIA Shared Storage Model

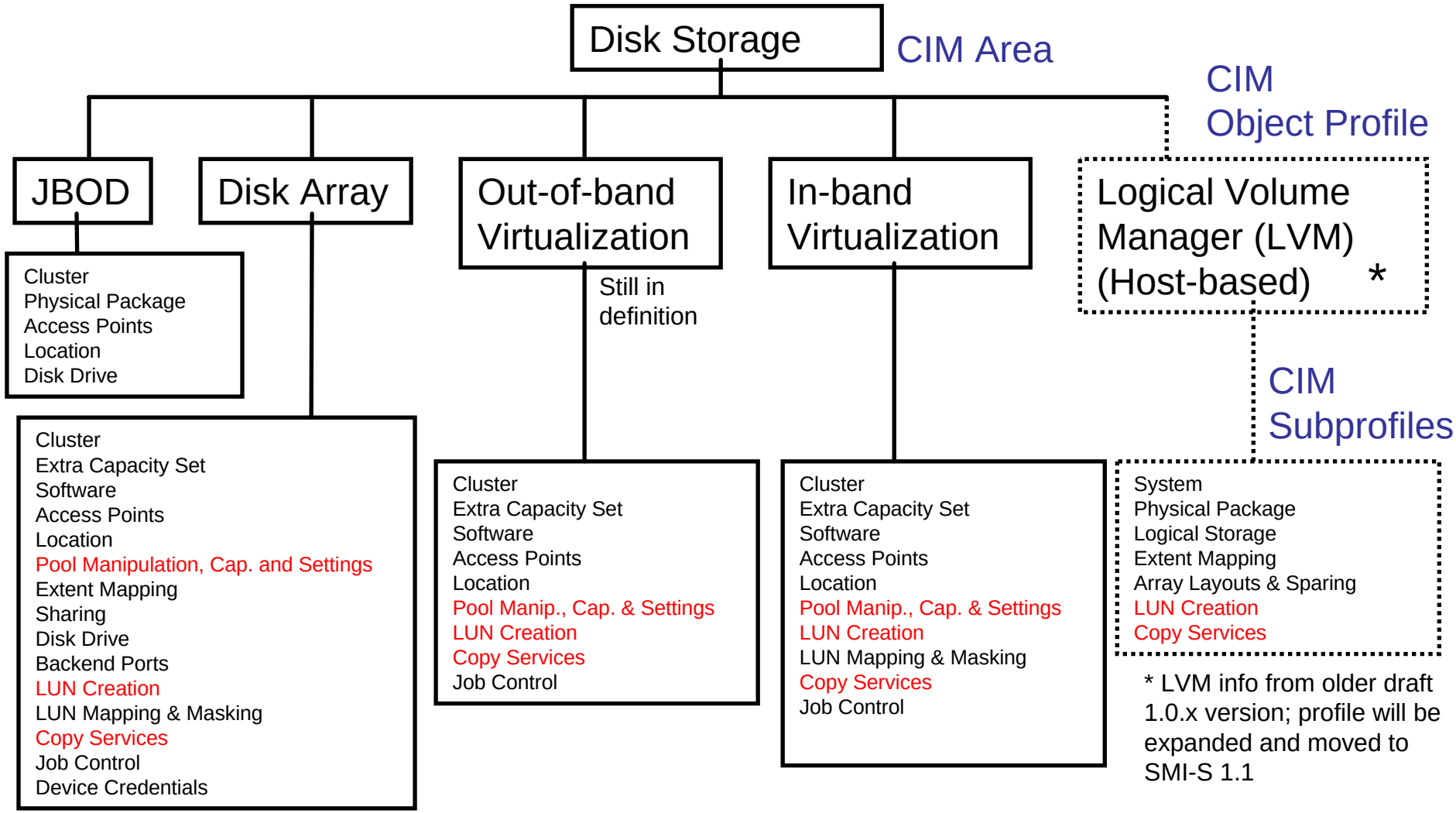


SMI-S V1.1.x Capabilities

1. Identify key resources in a SAN
2. Identify interconnects between key resources in a SAN
3. Receive asynchronous notification that the configuration in a SAN has changed
4. Identify the health of key resources in a SAN
5. Receive asynchronous notification that the health of a SAN has changed
6. Identify the available performance of interconnects in a SAN
7. Receive asynchronous notification that the performance of a SAN interconnect has changed
8. Identify the zones being forced in as SAN
9. Create/Delete and enable/disable zones in a SAN
10. Identify the storage volumes in a SAN
11. Create/delete/modify storage volumes in a SAN
12. Identify the connectivity and access rights to Storage Volumes in a SAN
13. Create/delete and enable/disable connectivity and access rights to Storage Volumes in a SAN
14. Allow a site to require the use of authenticated clients

Block Virtualization

SMI-S V1.1.x
Disk Storage in the SMI-S



SMI-S and Storage Virtualization

- SMI-S is not a virtualization of storage per se
- It is a “virtualization” of the management APIs for the different vendor’s components.
- The long term impact of SMI-S on virtualization products is profound!
  - Eliminates the need for proprietary APIs to perform common management tasks such as creating LUNs, manage snapshots or data replication
  - Avoids reverse engineering and its corresponding problems
- SNIA SMI-S V1.1.x already delivers standard interfaces that use virtualization technologies
- Will help to establish Policy-based Service Level Management and Automated Storage Resource Management (SRM)

Policy-based Service Level Management

What's the role of storage virtualization?

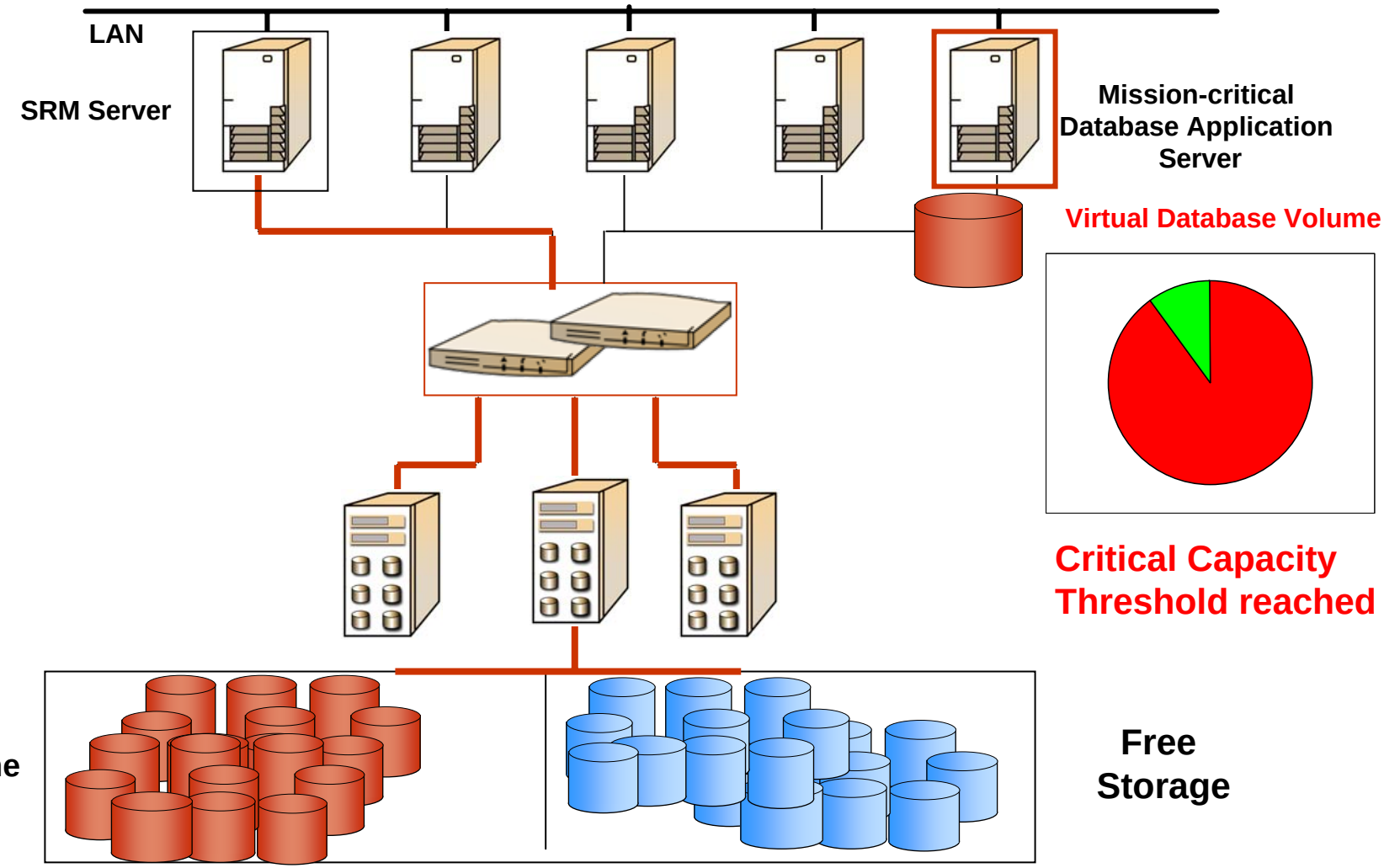
Policy-based Service Level Management

- Handles error-prone administrator tasks (such as storage provisioning) automatically
- Pre-defined rules (policies) must be set
- One critical Service Level Management outcome is efficient Storage Capacity Planning
  - Dynamic Provisioning
  - Automated Capacity Plan Execution

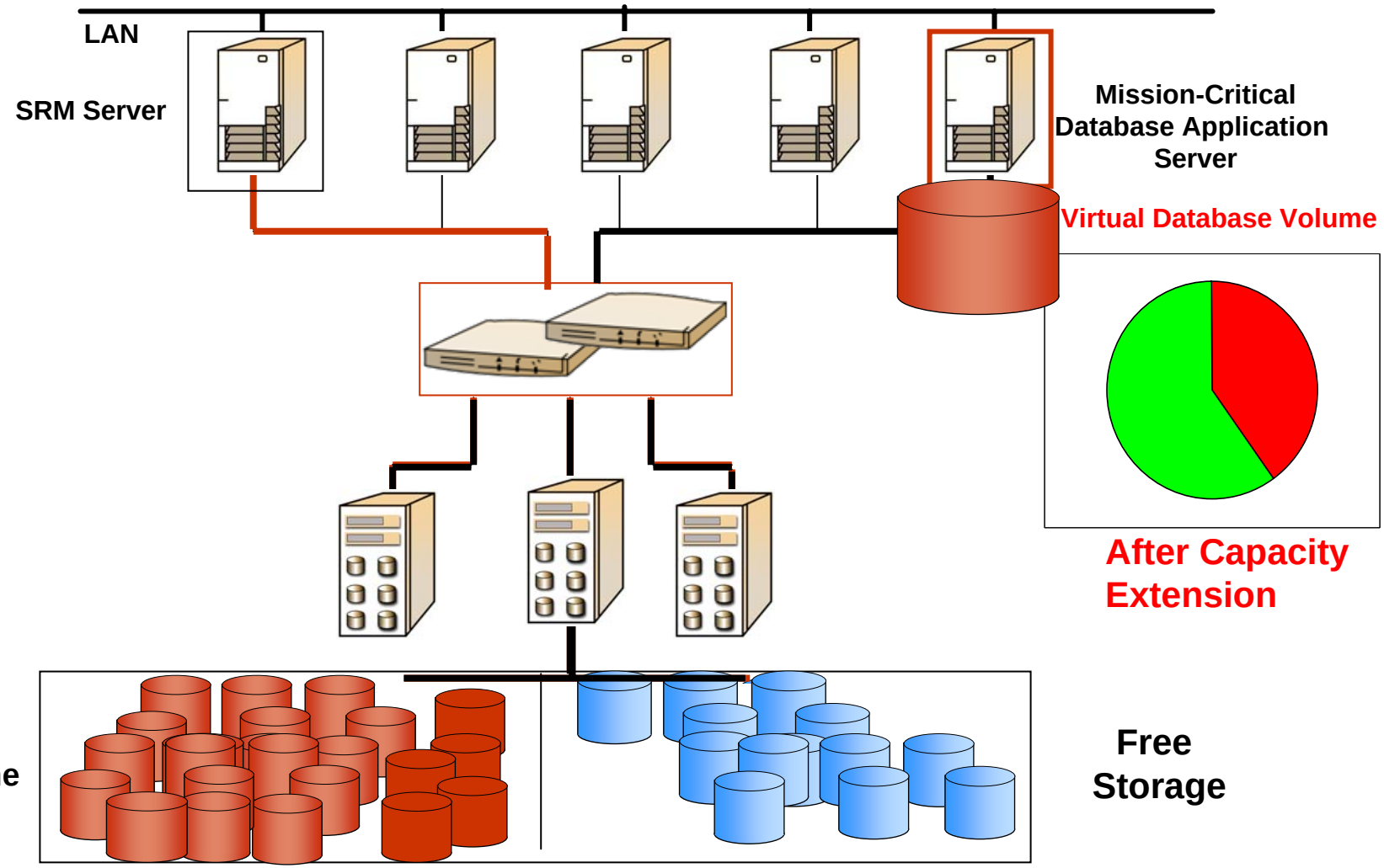
Storage Capacity Planning (Storage on Demand)

- **Monitoring of Storage Capacity**
  - Application-centric – but can be done in fabric or subsystem
- **Threshold Management**
  - Definition of rules: What to do, when, to whom…
- **Discover free capacity with desired storage attributes**
- **Assign new storage into the server zone(s)**
  - Switch zoning via vendor-specific APIs or SNIA SMI-S
- **Grant specific server(s) access to the storage**
  - LUN Masking via vendor-specific APIs or SNIA SMI-S
- **Map storage to the server volume(s) (Online !!)**
  - Resize / Re-layout the volume (vendor APIs or SNIA SMI-S)
- **Make larger volume aware to the application**
  - For example: - sparse allocation or
    - automatic, dynamic growth of file system

Policy-based Service Level Management - big picture (I)



Policy-based Service Level Management – big picture (II)



Storage Virtualization for Policy-based Service Level Management

- Policy-based Service Level Management must be performed (executed) without any user interaction
- Once new free storage capacity is discovered, the existing volumes must be resized online without any impact to the application
- Only Storage Virtualization techniques can assure these requirements – coupled with OS involvement

Q&A / Feedback

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

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

SNIA Education Committee

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