LARGE SCALE INFRASTRUCTURE

2110414 Large Scale Computing Systems
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Outline

- Overview

- Hardware Virtualization

- Storage Technology

3 Overview

Trends in IT Management

- ☐ Server performance and storage size grow very rapidly

- ☐ Equipment become much cheaper

- ☐ Some applications exhibit "seasonal" workload demands

- ☐ Lead to server and storage consolidation
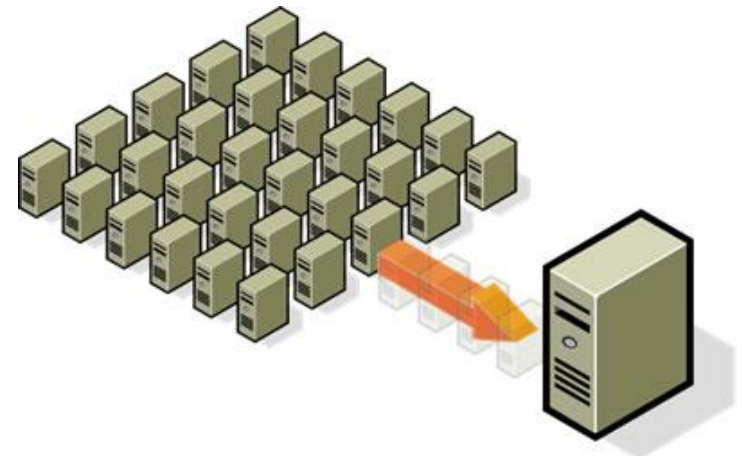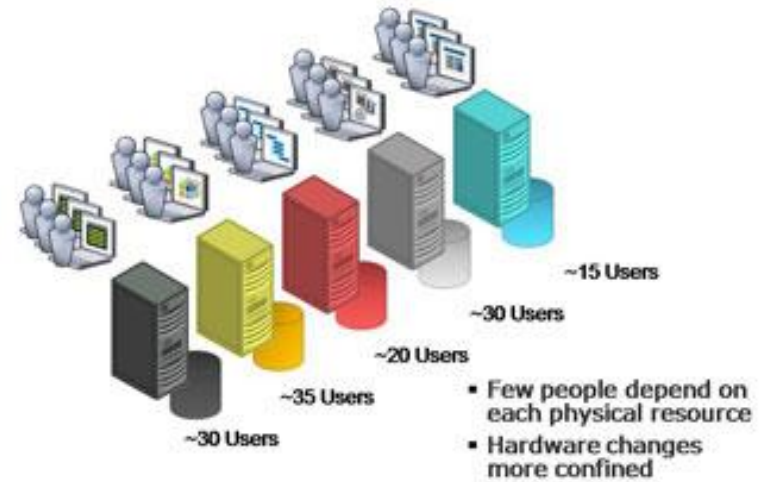
5 Hardware Virtualization

Adapted from

- P. Strassmann, " Introduction to Virtualization", George Mason University, 2008

- M. Behrens, "Virtualization Assessment"

Server Consolidation

- Old applications rely on many servers
  - High operation cost: maintenance, electricity, etc.
  - Heterogeneous environments
  - Difficult to migrate
- New servers are very powerful and under-utilized
  - Some resources remain idle
- Reduce costs by consolidating servers

~15 Users
~30 Users
~20 Users
~35 Users
~30 Users

- Few people depend on each physical resource
- Hardware changes more confined

Virtualization Concept

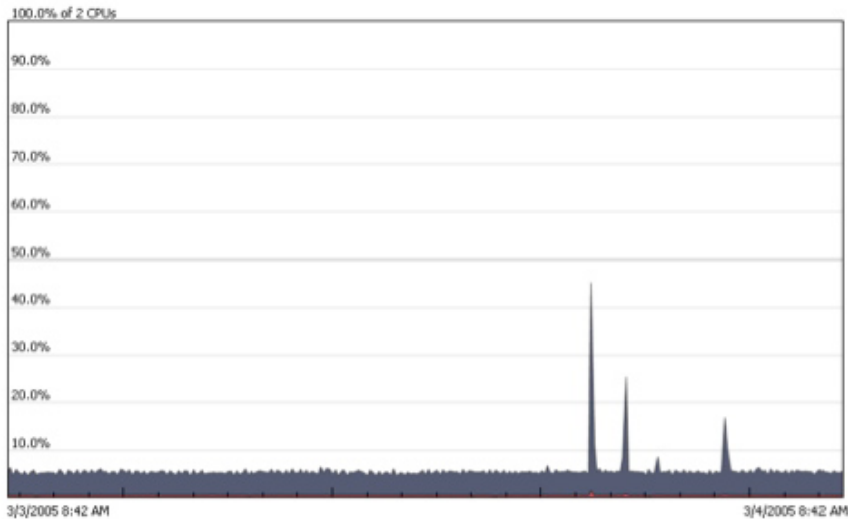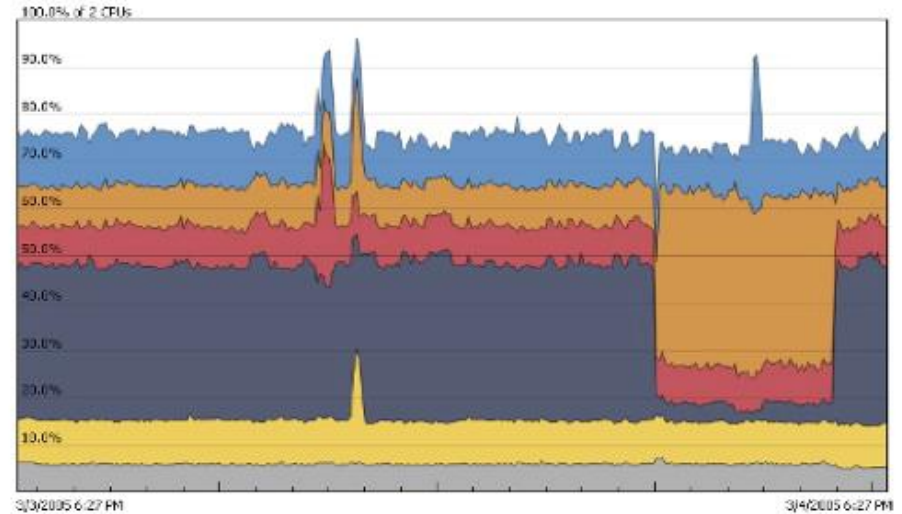2110414 - Large Scale Computing Systems

Capacity Utilization:
# Stand-Alone vs. Virtualization Servers

Dedicated Server

Virtualized Servers

Virtualization Approaches

- Hardware-assisted virtualization
  - Require hardware support e.g. CPU special instruction sets
  - Accelerated virtualization, hardware virtual machine, native virtualization
- Full Virtualization
  - Guest OS is unaware of being virtualized
  - Required a special software called "Hypervisor" or "Virtual Machine Monitor" to manage the virtualization
  - May or may not required hardware support

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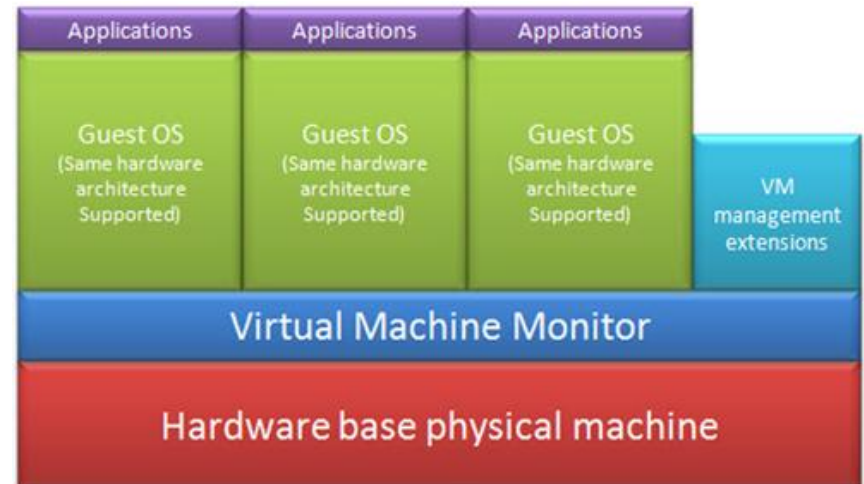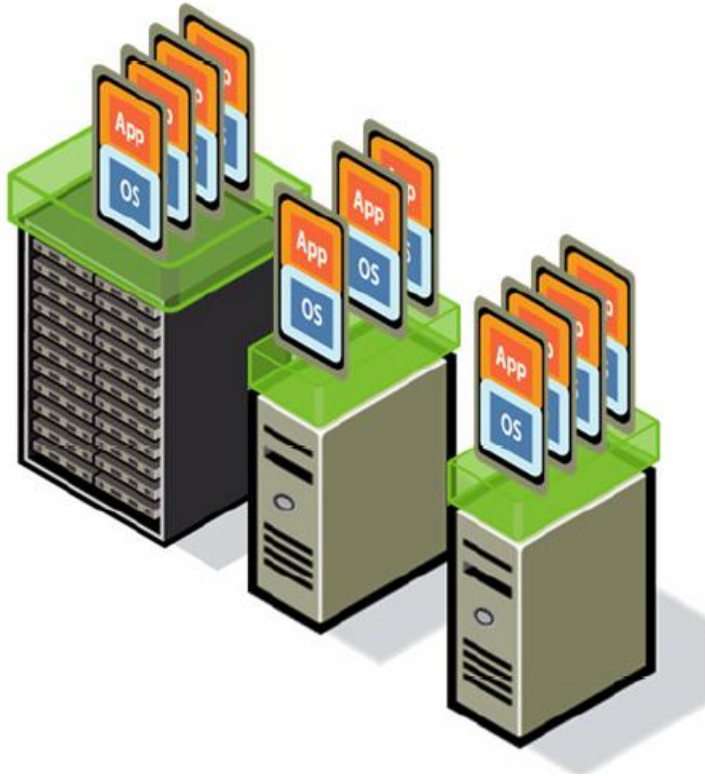
Virtualization Approaches

☐ ParaVirtualization

- ☐ Host OS (Hypervisor) provides a special Hypercall API to perform some functions for Guest OS

- ☐ Guest OS kernel must be modified to utilize these APIs

- ☐ Host OS cannot touch Guest OS directly
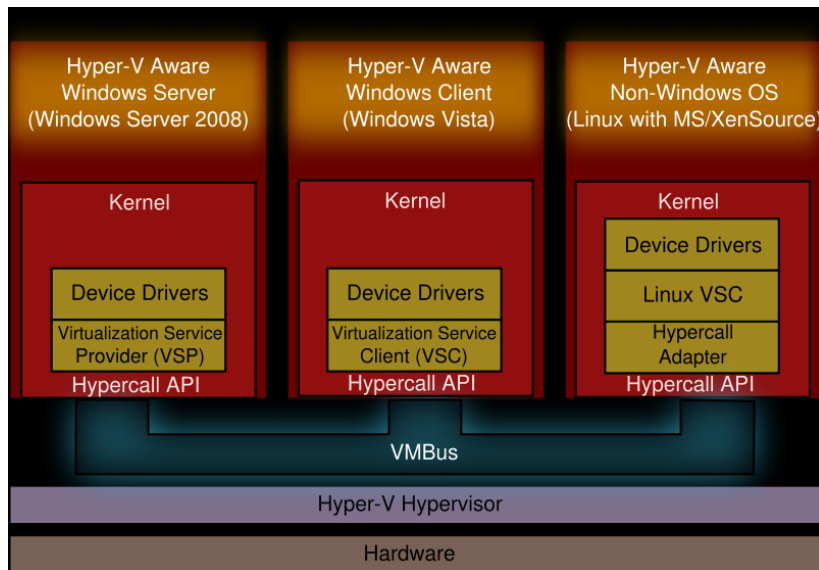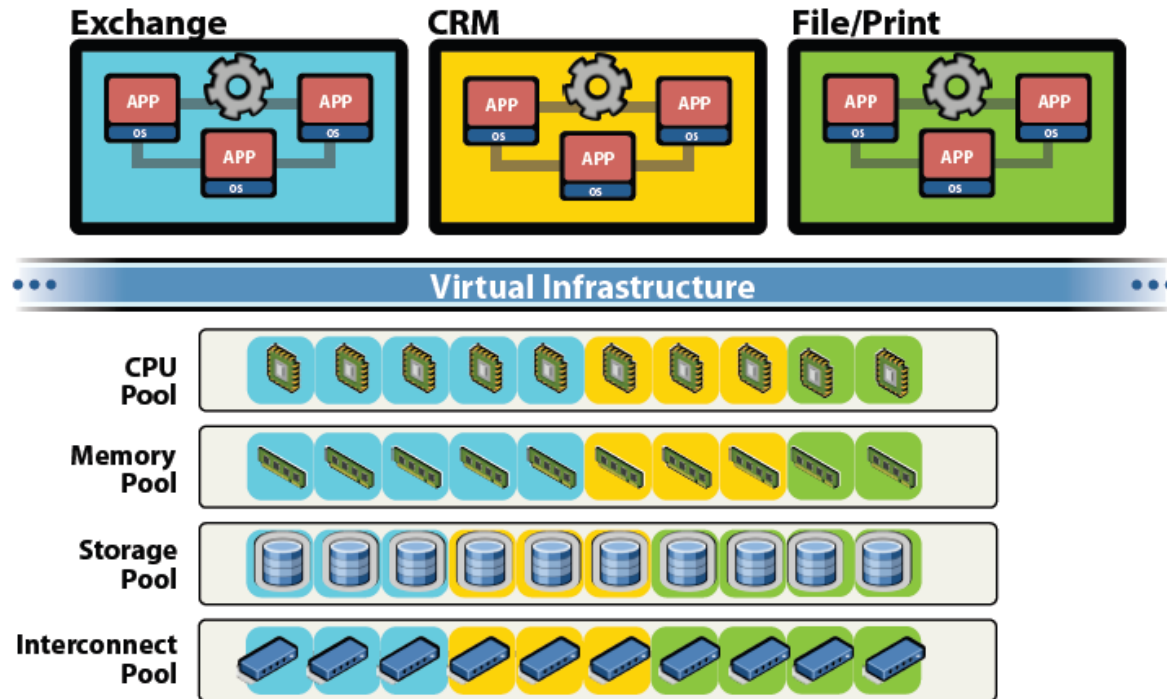
Benefits of Virtualization

☐ **Flexible Resource management**

- Server consolidation
- Dynamic resource sharing
- Reduce power consumption

☐ **Simplify maintenance**

- Zero downtime maintenance
- Live migration
- Patch management
- Efficient recovery

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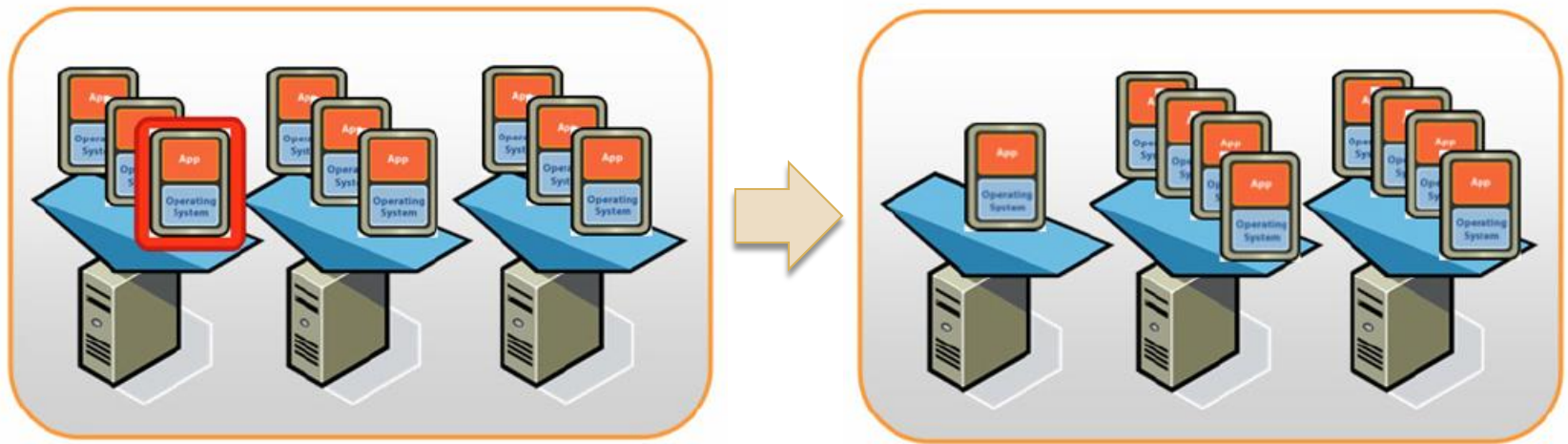
Resource Consolidation

- ☐ Reduce number of physical servers
- ☐ Decrease power consumptions
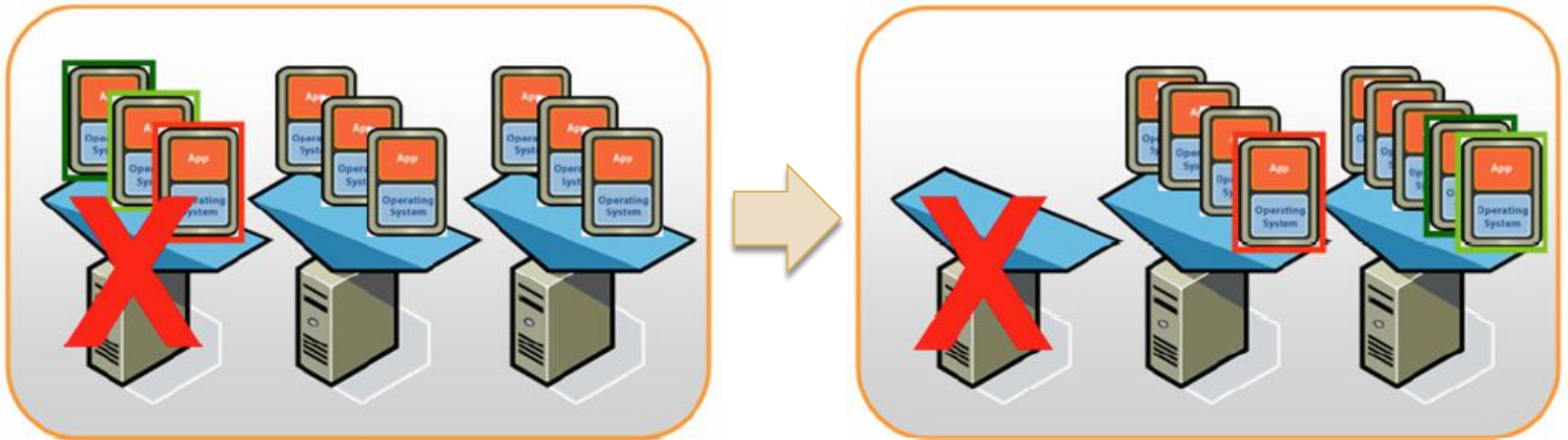- ☐ Resource pooling
- ☐ Flexible resource allocation

Flexible Resource Allocation

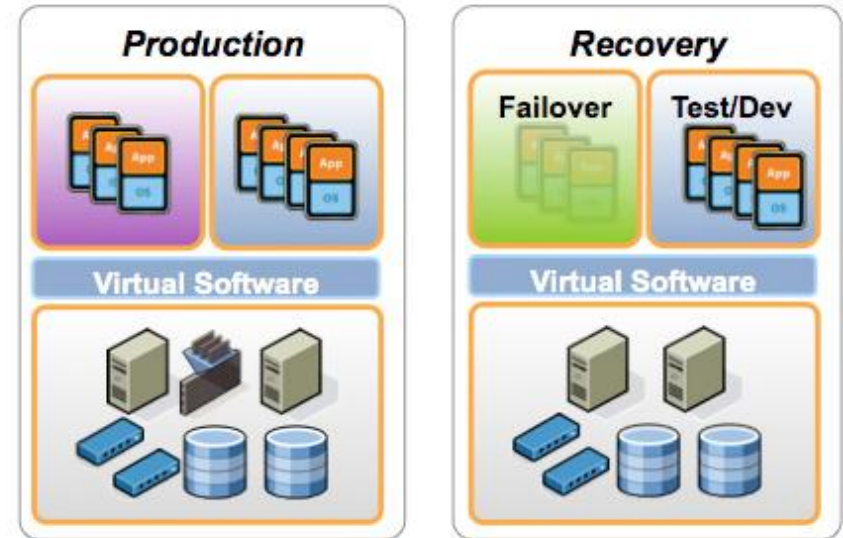2110414 - Large Scale Computing Systems

Cheaper Fail-Over

- Reduce the cost of dedicated fail-over servers
- Smooth transition when brining fail-over servers back

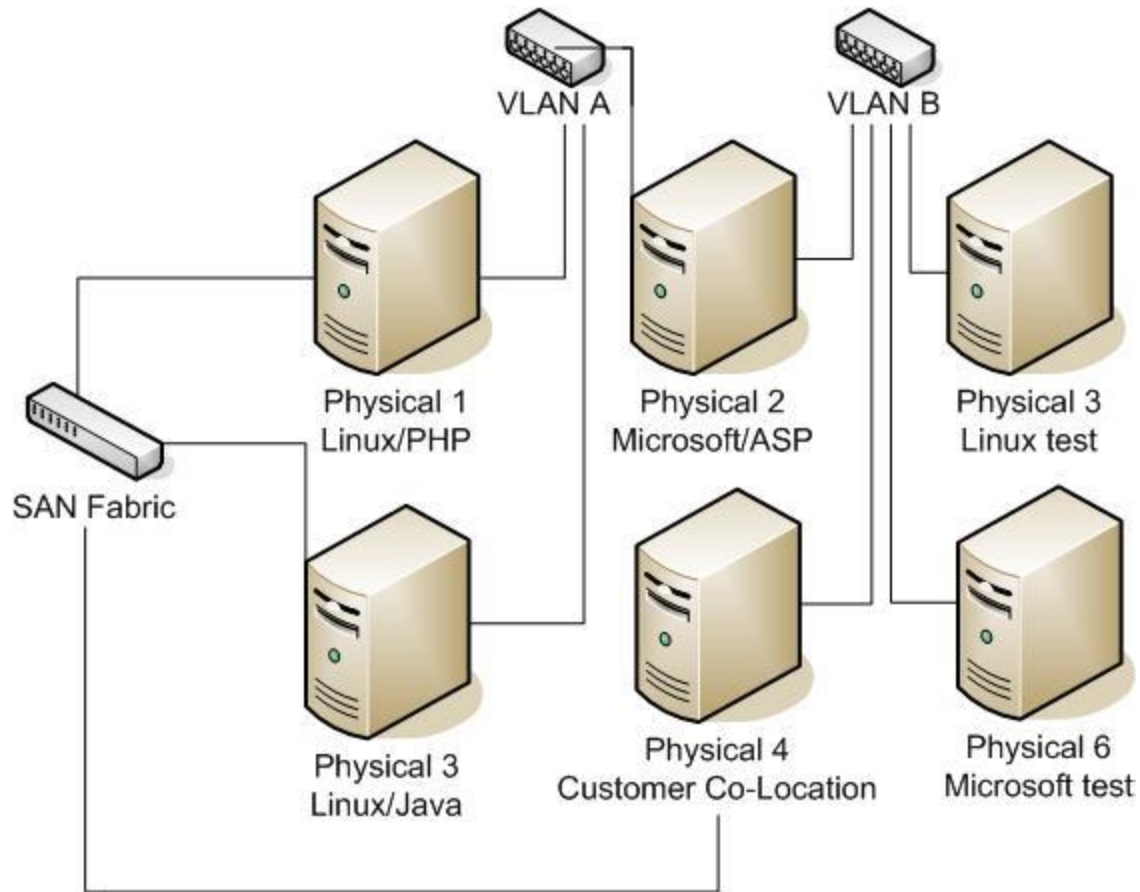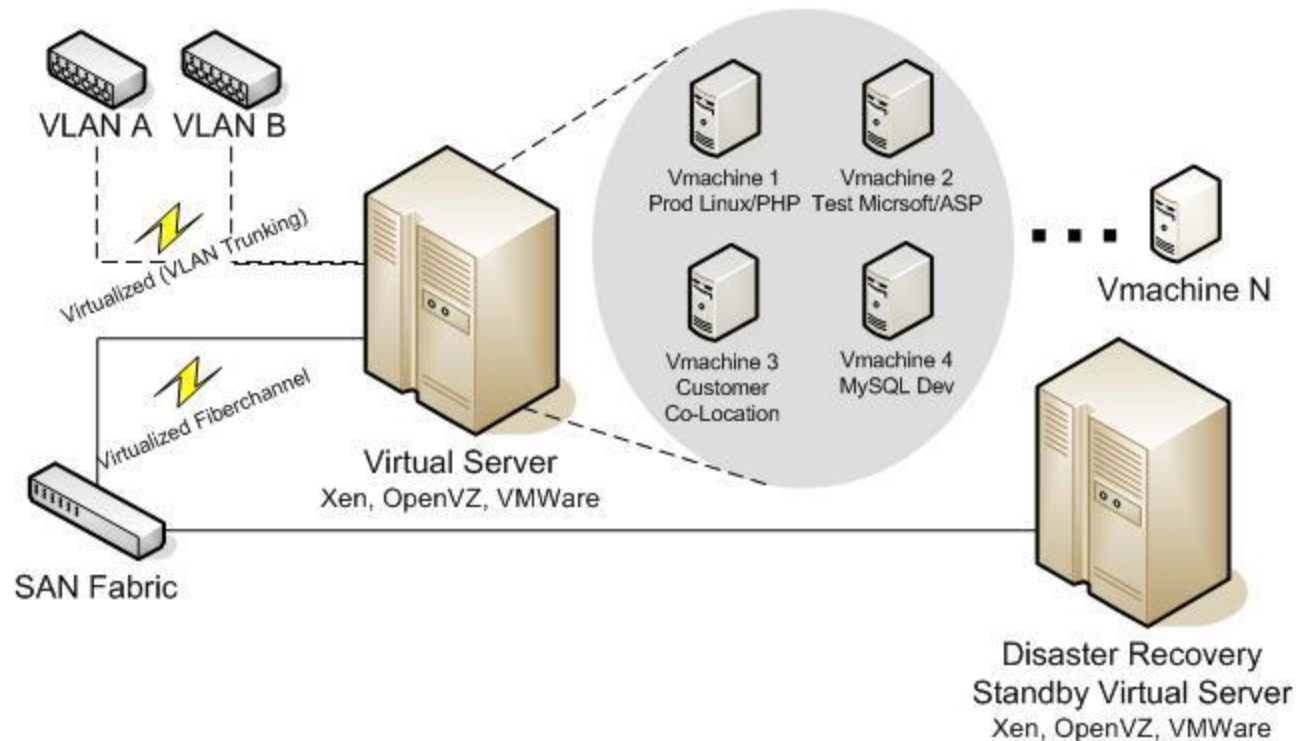# Efficient Recovery

- Recovery site concept
    - For disaster recovery
    - Cold site, warm site, hot site
    - Require duplicating infrastructure (e.g. servers, networks, etc.)
- Virtualization allows a new recovery model
    - Simplify and lower cost of recovery site
    - Leverage for other workloads e.g. for testing, for other apps, etc.

Current Architecture

Virtualized Architecture

VLAN A   VLAN B

Virtualized (VLAN Trunking)

Virtualized Fiberchannel

SAN Fabric

Virtual Server
Xen, OpenVZ, VMWare

Vmachine 1
Prod Linux/PHP

Vmachine 2
Test Micrsoft/ASP

Vmachine 3
Customer
Co-Location

Vmachine 4
MySQL Dev

Vmachine N

Disaster Recovery
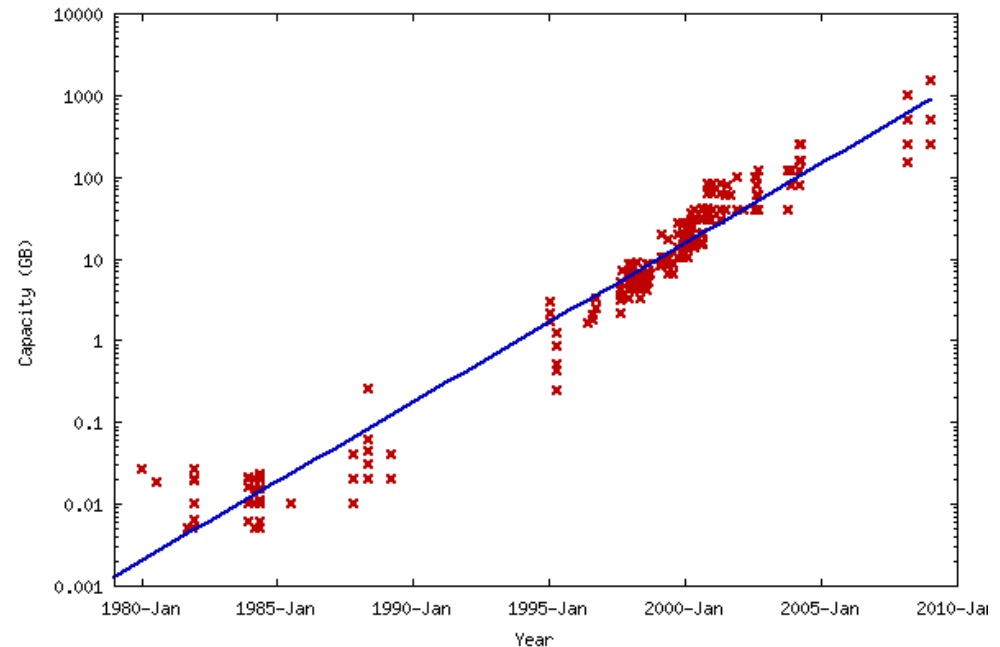Standby Virtual Server
Xen, OpenVZ, VMWare

18 | Storage Technology

Storage (Hard Disk Drive)

- Capacity
- Interface Technology
  - IDE (P-ATA) / SATA
  - SCSI / SAS
  - FC
- Performance
  - Seek Time
  - Data Transfer Rate (e.g. 15K RPM)

Network Attached Storage (NAS)

- File-level data storage
- Connecting directly to standard network
- Standard file-based protocols
  - NFS, CIFS, FTP, HTTP
  - UPnP, Rsync, …
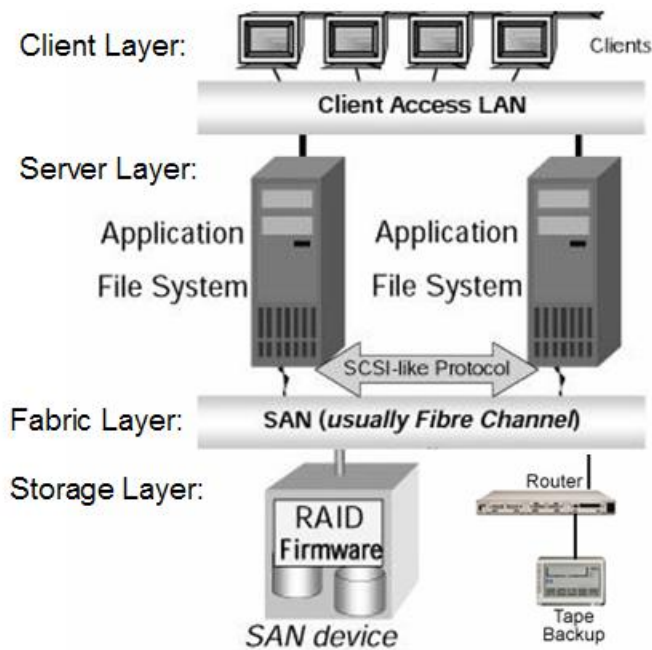- Pros: Simple to operate and maintain, Cheap
- Cons: Performance limitation

Storage Area Network (SAN)

□ Block-level data storage

□ Connect to "SAN" network

 ▫ Ethernet

 ▫ Fiber Channel

□ Storage protocols

 ▫ Fiber Channel Protocl (FCP)

 ▫ iSCSI

 ▫ Fiber Channel over Ethernet (FCoE)

□ Pros: High performance

□ Cons: Expensive, complex
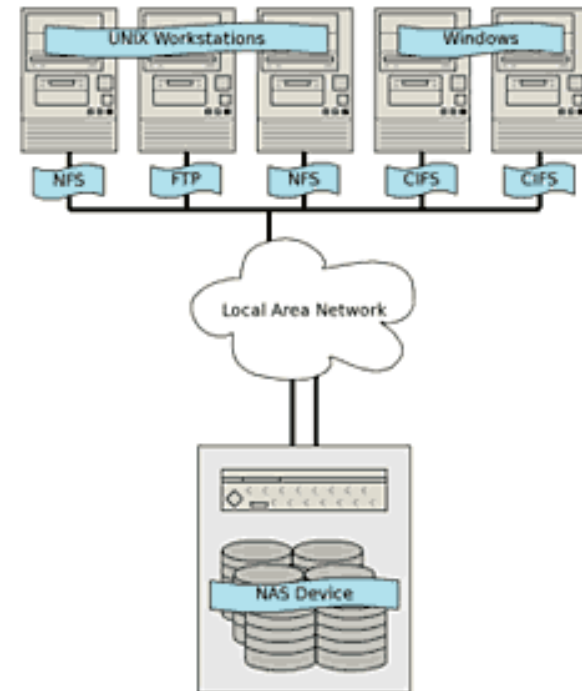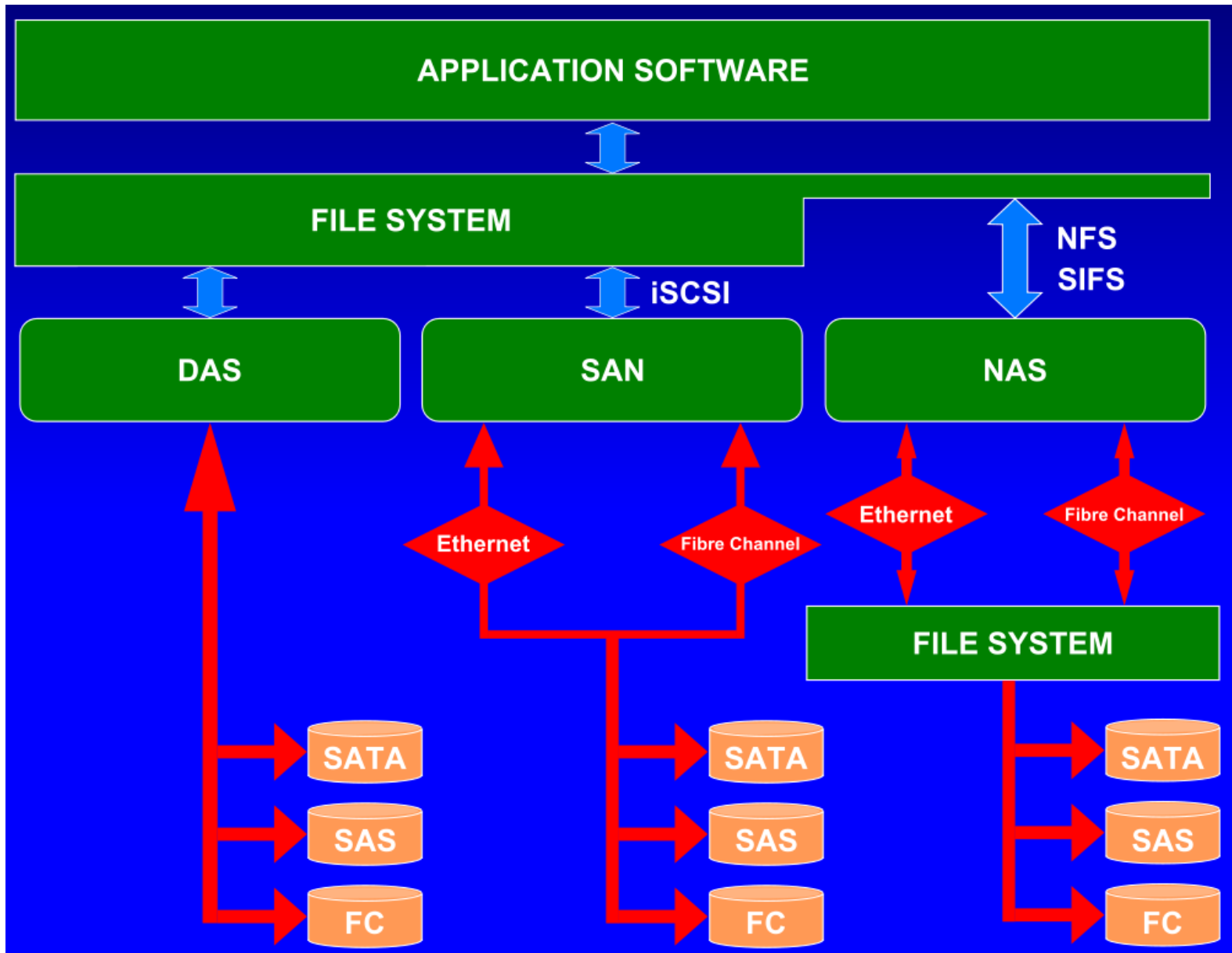
Storage Architecture: SAN vs. NAS
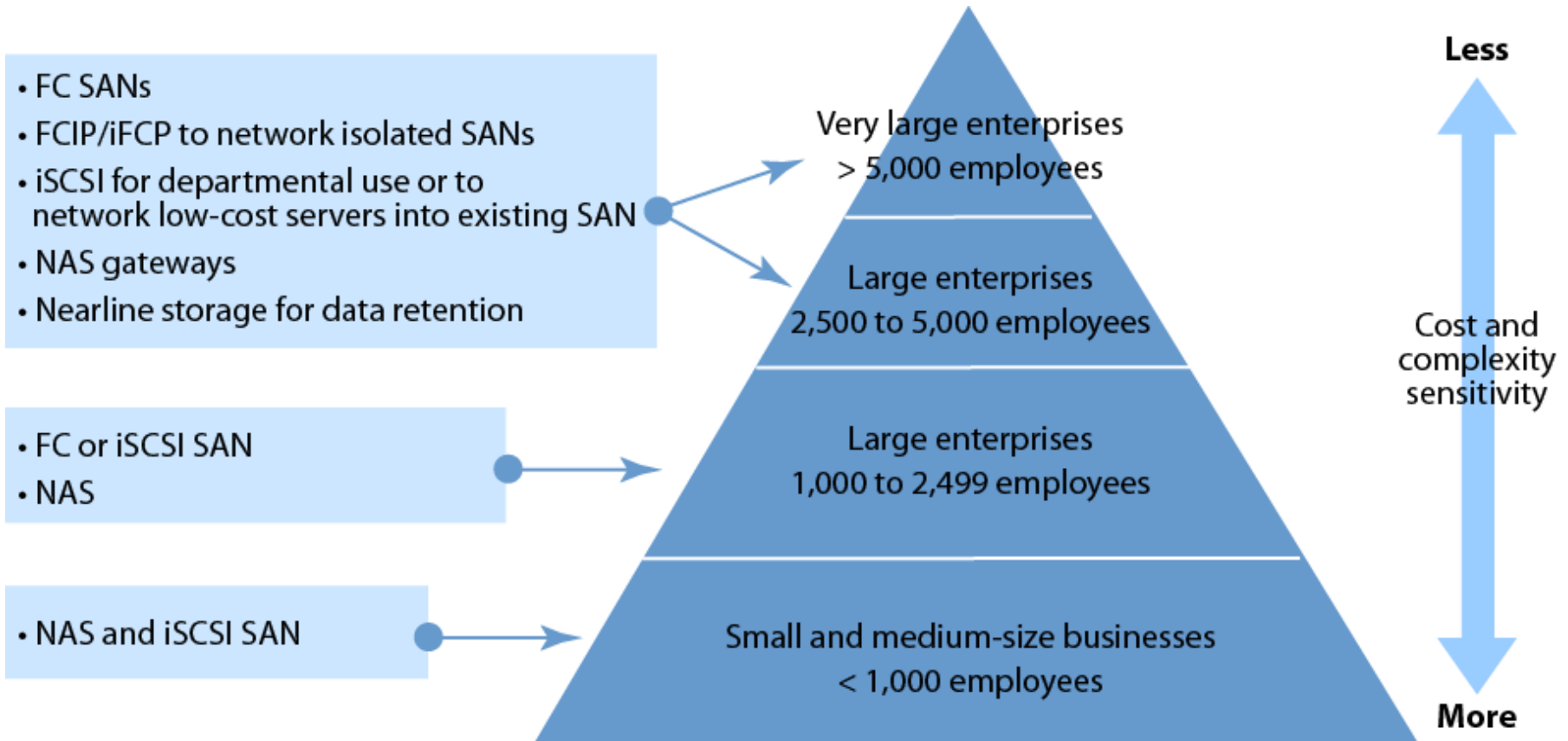
SAN: Storage Area Network	NAS: Network Attached Storage

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IP-based storage adoption trends

· FC SANs
· FCIP/iFCP to network isolated SANs
· iSCSI for departmental use or to
  network low-cost servers into existing SAN
· NAS gateways
· Nearline storage for data retention

· FC or iSCSI SAN
· NAS

· NAS and iSCSI SAN

Less

Very large enterprises
> 5,000 employees

Large enterprises
2,500 to 5,000 employees

Large enterprises
1,000 to 2,499 employees

Small and medium-size businesses
< 1,000 employees

Cost and
complexity
sensitivity

More

RAID

- Redundant Array of Inexpensive Disks
  - Achieve high levels of storage reliability
  - Using low-cost and less reliable PC-class disk-drive components
- Hot-Spare
  - A drive physically installed in the array which is inactive until an active drive fails
- Hot-Swapped
 - Ability to add/remove disks without shutting down the system

Popular RAID Level

□ RAID 0 – Striping

- ▪ improved performance
- ▪ additional storage
- ▪ no redundancy or fault tolerance
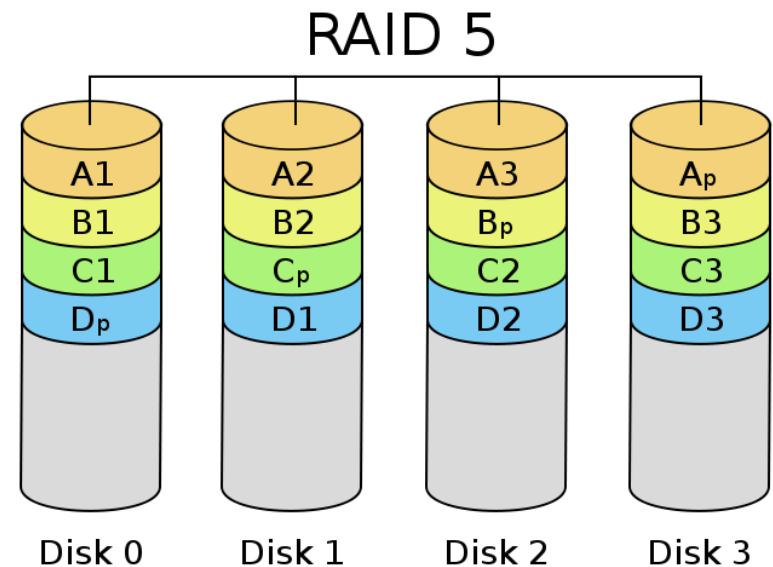- ▪ N storage capacity

RAID 0

Disk 0   Disk 1
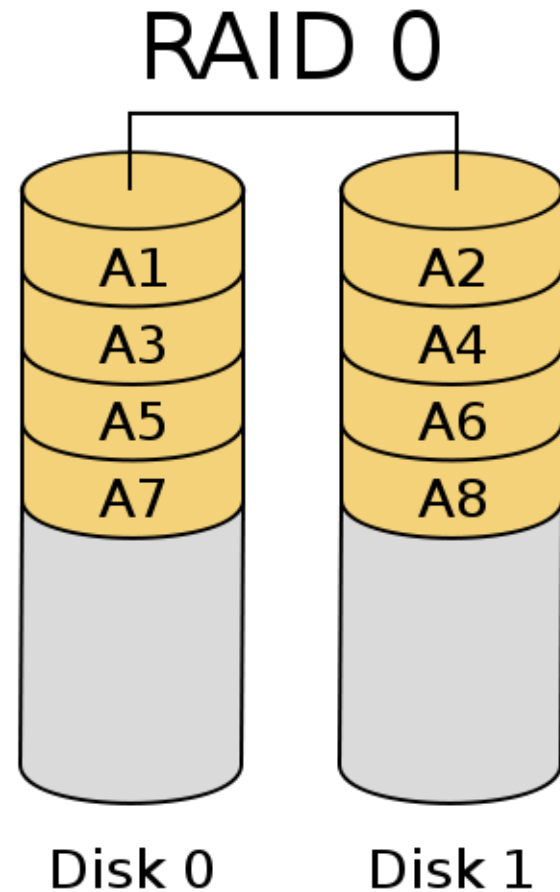
Popular RAID Level

- RAID 1 – Mirroring
  - Provides fault tolerance from disk errors
  - Up to one-disk failure
  - Increased read performance
  - Very small performance reduction when writing
  - 1 storage capacity

RAID 1

A1	A1
A2	A2
A3	A3
A4	A4

Disk 0   Disk 1
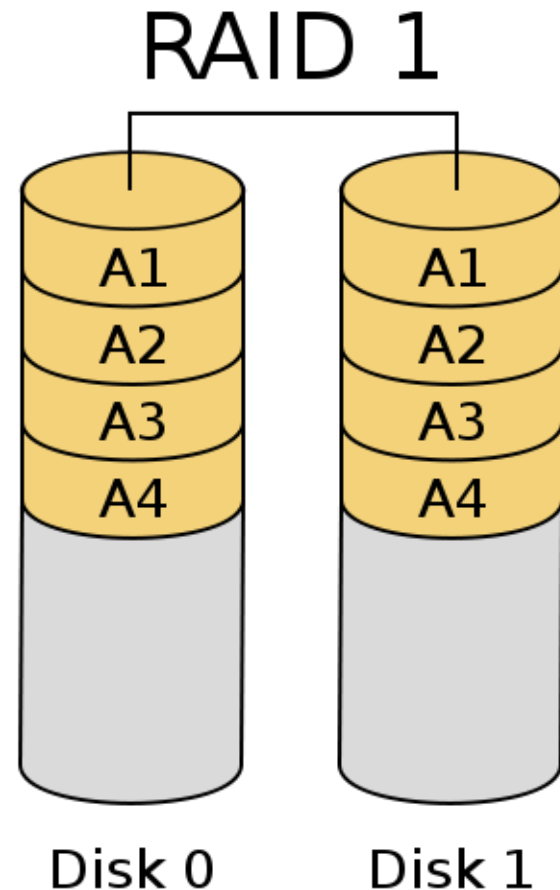
Popular RAID Level

- RAID 5 – Interleave Parity
  - Distributed data to all disks with one disk as a parity container
  - Good disk performance
  - Up to one-disk failure
  - N-1 storage capacity

RAID 5

A1 A2 A3 Ap
B1 B2 Bp B3
C1 Cp C2 C3
Dp D1 D2 D3

Disk 0   Disk 1   Disk 2   Disk 3

References

- P. Strassmann, " Introduction to Virtualization", http://www.strassmann.com/pubs/gmu/2008-10.pdf, George Mason University, 2008