

IT 609

Network and System Administration

Storage and RAID

Tuesday September 07, 2021

Section Overview

- Syllabus Updated (slightly)
- Calendar Updated
- Storage Basics
- Enterprise Storage
- RAID

Storage

Storage Basics

Plug it in!

Technologies

Magnetic

Hard disk drives



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Tape



"LTO2-cart-purple" by Austinmurphy at en.wikipedia. Licensed under CC BY-SA 3.0 via Commons - <https://commons.wikimedia.org/wiki/File:LTO2-cart-purple.jpg#/media/File:LTO2-cart-purple.jpg>

"LTO2-cart-wo-top-shell" by Austinmurphy at en.wikipedia. Licensed under CC BY-SA 3.0 via Commons - <https://commons.wikimedia.org/wiki/File:LTO2-cart-wo-top-shell.jpg#/media/File:LTO2-cart-wo-top-shell.jpg>

Technologies

Optical

CD/CD-R/CD-RW (670 - 700 M)

DVD/DVD-R/DVD-RAM (4.7 G)

Dual-layer DVD (8.5 G)

BluRay (25 G)



Technologies

Solid State

NAND-based Flash Memory

Multiple form factors



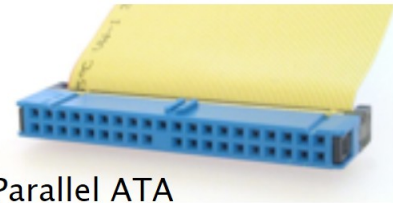
"Mtron SSD" by 76coolio at the English language Wikipedia. Licensed under CC BY-SA 3.0 via Commons - https://commons.wikimedia.org/wiki/File:Mtron_SSD.jpg#/media/File:Mtron_SSD.jpg

Interfaces - Internal

ATA - Advanced Technology Attachment

Previously known as IDE

Parallel - traditional version



Parallel ATA

Serial (SATA) - newer, faster, smaller cables



Serial ATA

Interfaces - Internal

SCSI - Small Computer Systems Interface

Up to 16 devices per bus



Parallel SCSI

SAS - Serial Attached SCSI

Supports both SAS and SATA



Serial SCSI

Interfaces - Internal Comparison

	ATA (Parallel)	SCSI	Serial ATA	SAS
Speed	100 MB/sec, 133 MB/sec	160 MB/sec, 320 MB/sec	300 MB/sec, 600 MB/sec	600 MB/sec, 1.2 GB/sec
Devices per Bus	2	7 or 15	1	1
Scalability	None	None	Up to 15 devices	Up to 16,000 devices
Costs	\$0.24/GB (2008)	\$1.1-2.0/GB (2008)	\$0.05-0.30/GB	\$0.07-0.50/GB

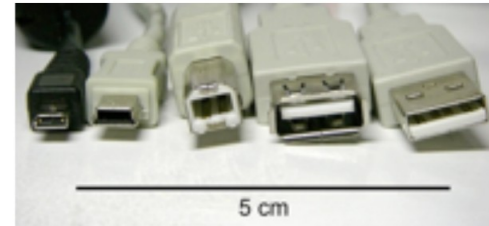
Interfaces - External

USB - Universal Serial Bus

Multi-purpose and ubiquitous

USB 2.0

USB 3.0



USB

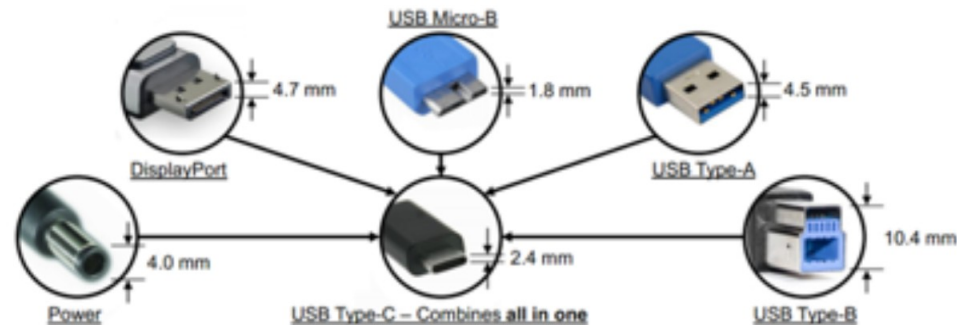
USB Type-C

USB 3.0 speeds

New, small connector

Multi-function

DisplayPort



<http://www.cypress.com/products/usb-type-c-and-power-delivery>

Interfaces - External

Firewire (iLink) (IEEE 1394)

Replacement for SCSI for external devices

Was entrenched in digital video



Firewire 400



Firewire 800

Fibre Channel

2, 4, 8, & 16 Gb/sec

Often used in Storage Area Networks



Fibre Channel – SPF

Thunderbolt

10 Gb/sec, bi-directional

PCIe plus DisplayPort



Thunderbolt

Interfaces - External Comparison

	USB 2.0	USB 3.0	Firewire 800	Fibre Channel	Thunderbolt
Bandwidth	480 Mbps	4.8 Gbps	800 Mbps	2, 4, 8, 16 Gbps	10 Gbps
Real Speed	40 MB/sec	100 MB/sec	98 MB/sec	200-1600 MB/sec	900 MB/sec
Devices per Bus	127	127	63	126 (16,777,216 w/ switches)	7
Power Provided	2.5 W	4.5 W	15 W	No	10 W

Enterprise Level

Enterprise Storage

Where to keep your stuff!

Tape

Sequential access

Still common for backups

Linear Tape-Open (LTO) is the most common format today

LTO-6 2.5 TB per cartridge

LTO-7 9.0 TB

LTO-8 12.0 TB



Flash versus Hard Disk Drive

No moving parts

Silent

Lighter

Lower power

Lower heat

Faster reads

Higher IOPS

Wears out

Larger capacity

Much cheaper

\$0.04/GB vs \$0.12/GB

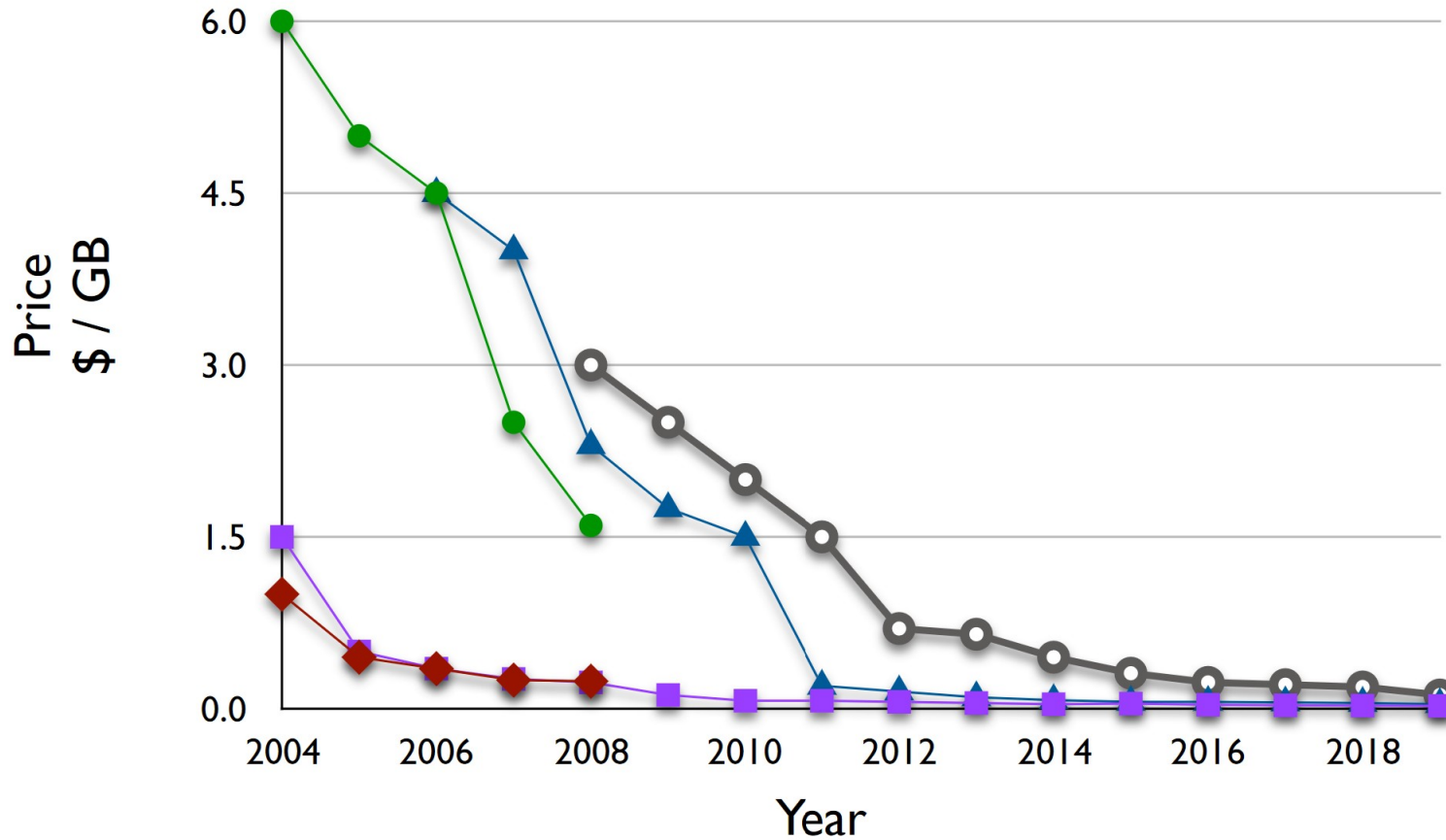
Faster writes (maybe)

Does not degrade with
each write/erase
operation

Easier to securely erase

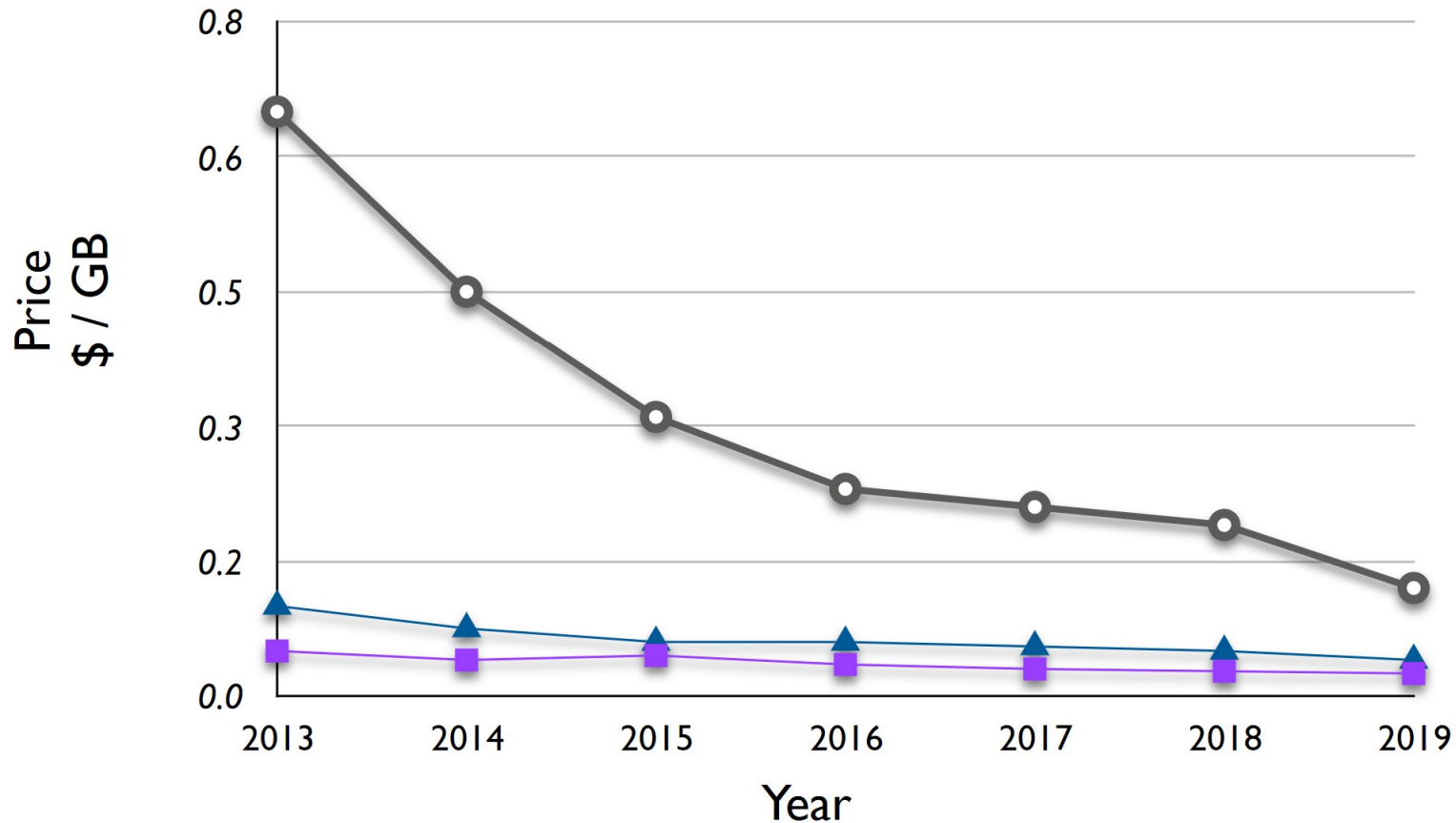
Price Comparison

◆ Parallel ATA ■ Serial ATA ● SCSI ▲ SAS ○ SATA Flash



Price Comparison

◆ Parallel ATA ■ Serial ATA ● SCSI ▲ SAS ○ SATA Flash



Options

- Direct Attached Storage (DAS) - Simplest
 - Independent Storage per Server
- Network Attached Storage (NAS)
 - File level centralized storage
 - Server mounts the file system
- Storage Area Network (SAN)
 - Block level centralized storage
 - Server sees SAN volume like DAS
- Object Storage

NAS

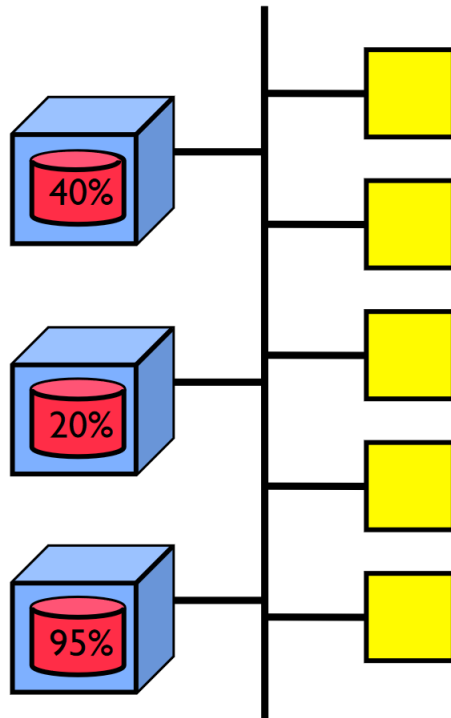
- An integrated device containing hard drives (with or without RAID), an embedded OS (often Linux), and network interface.
- Plug and Play Network storage.
- Managed via a Web Browser interface
- May support a wide range of protocols (SMB, AFP, NFS, FTP, WebDAV, etc.)
- Can allocate chunks of storage to a server or application without SAN complexity.

SAN

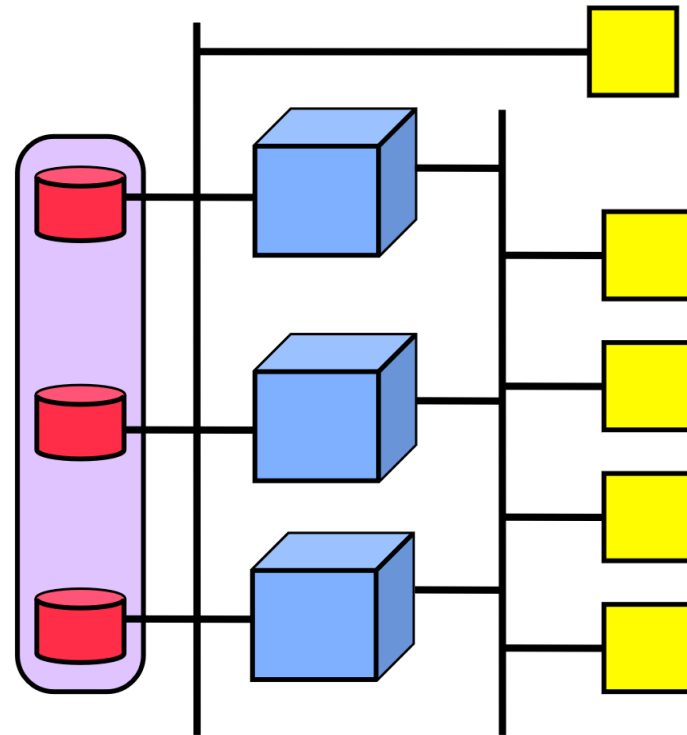
- Separate the storage problem from the processing problem.
- Provides flexibility and expandability
- Can decrease redundant, isolated, and underutilized pools of storage
- Requires a dedicated high speed interface to the storage Network
 - Fibre Channel
 - Gigabit Ethernet (iSCSI)

SAN

■ Client ■ Server ■ Disk

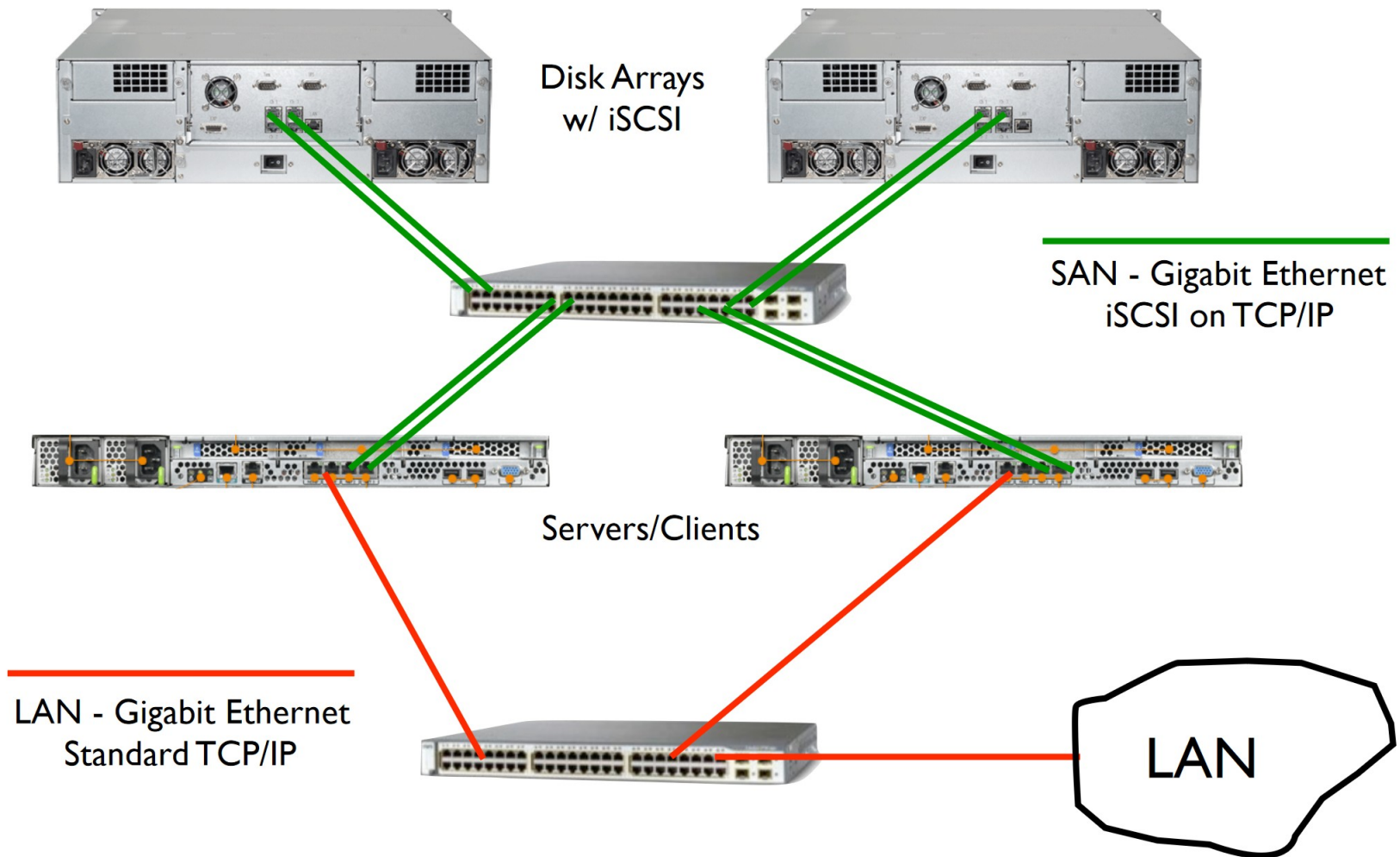


Servers with
Integral Storage



Storage Area Network
with Servers

SAN iSCSI



Object Storage

- Objects, not files are stored
 - Chunk of data plus Metadata
 - Very good for unstructured data
- “Cloud” Service
- Data Protection, not using RAID
 - Replication
 - Erasure coding (n chunks + m extras yields surviving m failures)
- Cheap and Deep

RAID Storage

A dark, textured background resembling a chalkboard. The word "RAID" is written in large, white, sans-serif capital letters in the center. Below it, the sentence "Keeping your stuff safe (hopefully)!" is written in a smaller, white, sans-serif font.

RAID

Keeping your stuff safe (hopefully)!

Acronym

- Redundant
- Array (of)
- Inexpensive/Independent
- Disk

RAID Within the Computer

- Multiple drives within the computer's case
- Hardware Controller
 - Better performance and more capabilities
 - Costs extra
 - Some chipsets or motherboards have integrated RAID controllers
- Software Drivers
 - Built-in to OS X, Windows, Linux
 - Generally limited to simple RAID designs

Stand-alone RAID

- Either for desktop or server/SAN use
- Can be costly
- SCSI, Firewire, USB, or Fiber Channel
- Handles RAID functions internal to device
- Redundant controllers, interfaces, etc.



Definitions

Striping - data striping is the technique of segmenting logically sequential data, such as a file, so that consecutive segments are stored on different physical storage devices.

Definitions

Mirroring - the replication of logical disk volumes onto separate physical hard disks in real time to ensure continuous availability.

Definitions

Parity - If a drive in the array fails, remaining data on the other drives can be combined with the parity data (using the Boolean XOR function) to reconstruct the missing data.

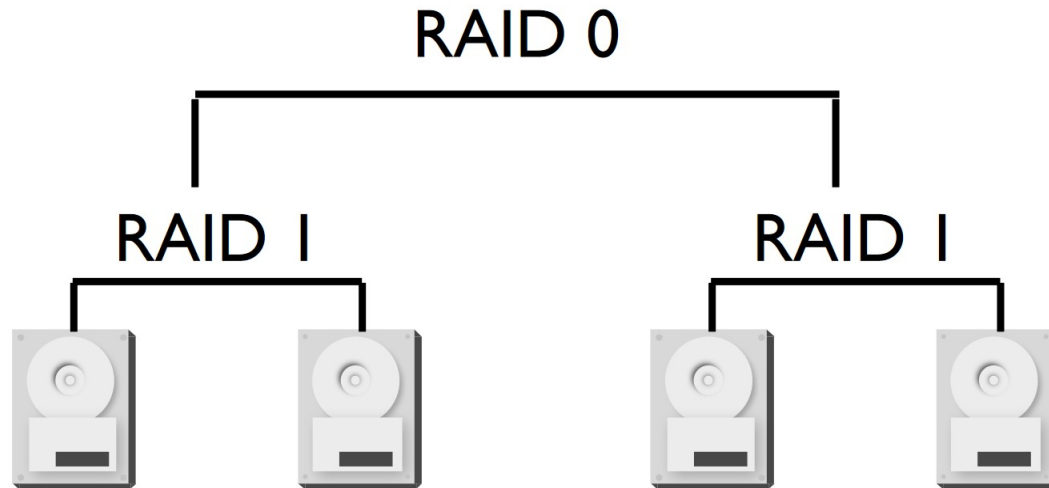
RAID Levels

- **JBOD** = Just a Bunch Of Disks
- **RAID 0** - Striping
- **RAID 1** - Mirroring
- **RAID 2** - Hamming code, special hardware
- **RAID 3** - Striped bits, dedicated parity disk
- **RAID 4** - Striped blocks, dedicated parity disk
- **RAID 5** - Striped blocks with striped parity
- **RAID 6** - Striped blocks with striped parity x 2

Levels Compared

RAID	Redundant?	Disks Needed	+/-
0	No	2 or more	Speed
1	Yes	Pairs	Protection, but high overhead
5	Yes	3 or more	Good balance of speed and protection
6	Yes	4 or more	Added protection, but slower

Combinations



Stripe across mirrors
RAID 1+0 (or 10)

Combinations

- Many possible configurations
 - Raid 5 + 0 (50)
 - Raid 6 + 0 (60)
- Also, multiple levels
 - Raid 10 + 0 (100)

RAID \neq Backups

- It provides Uptime and Recoverability from failure
- It is not a backup mechanism (even if there is redundancy in the data kept).
- Software Drivers
 - Built-in to OS X, Windows, Linux
 - Generally limited to simple RAID designs

Homework Assignment

- Get on to Discord
- Get on to myCourses