Chapter 8
Adding a Disk

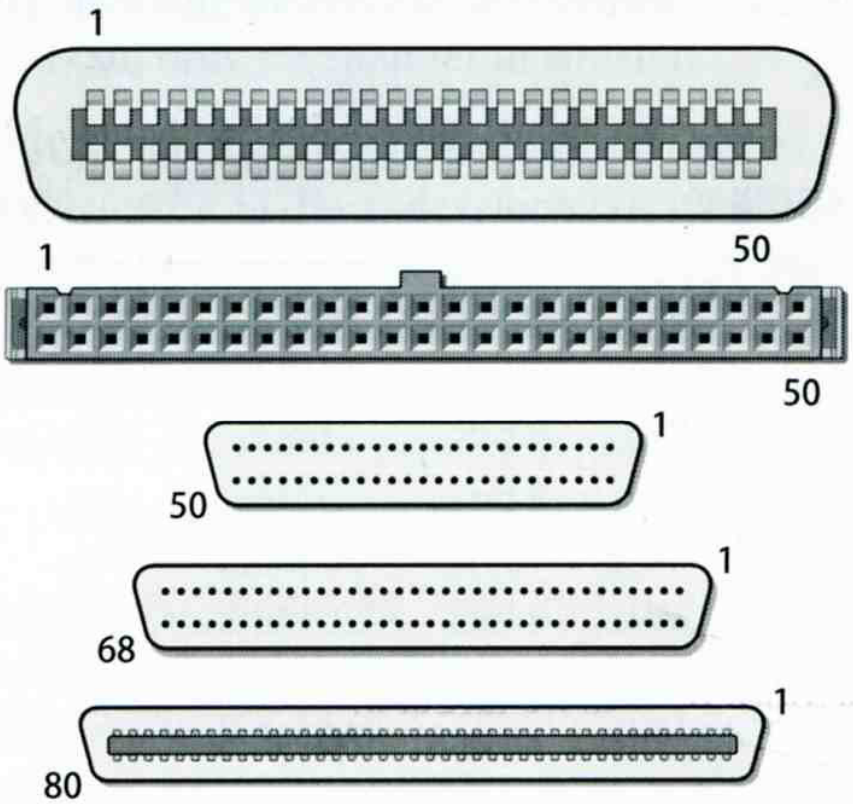
Disk Interface

- SCSI
  - Small Computer Systems Interface
  - High performance and reliability
- IDE
  - Integrated Drive Electronics
  - Low cost
  - Become acceptable for enterprise with the help of RAID technology
- USB
  - Universal Serial Bus
  - Convenient to use

Disk Interface – SCSI Interface Evolution

Version	Freq.	Width	Speed	Length	Diff.
SCSI-1	5MHz	8 bits	5MB/s	6m	25m
SCSI-2	5MHz	8 bits	5MB/s	6m	25m
SCSI-2 Fast	10MHz	8 bits	10MB/s	3m	25m
SCSI-2 Fast Wide	10MHz	16 bits	20MB/s	3m	25m
Ultra SCSI	20MHz	8 bits	20MB/s	1.5m	25m
Ultra Wide SCSI	20MHz	16 bits	40MB/s	1.5m	25m
Ultra2 SCSI	40MHz	16 bits	80MB/s	-	12m
Ultra160 SCSI	80MHz	16 bits	160MB/s	-	12m
Ultra320 SCSI	160MHz	16 bits	320MB/s	-	12m

Disk Interface – SCSI Interface Connector



Centronics
50 pins, SCSI-1/2, external

Ribbon connector (female)
50 pins, SCSI-1/2, internal

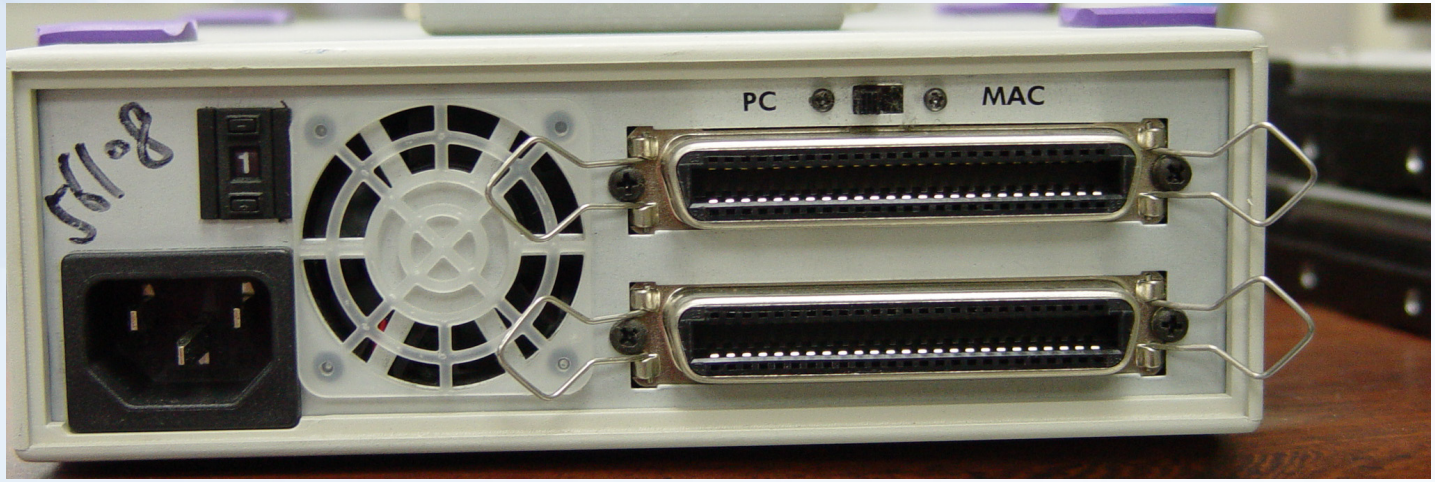
Mini-micro, aka HD50
50 pins, SCSI-2, external

Wide mini-micro, aka HD68
68 pins, SCSI-2/3, int/ext

SCA-2
80 pins, SCSI-3, internal

Disk Interface – SCSI Interface

- Daisy chain on SCSI bus
  - Most external devices have two SCSI ports
  - Terminator
- Each SCSI device has a SCSI ID

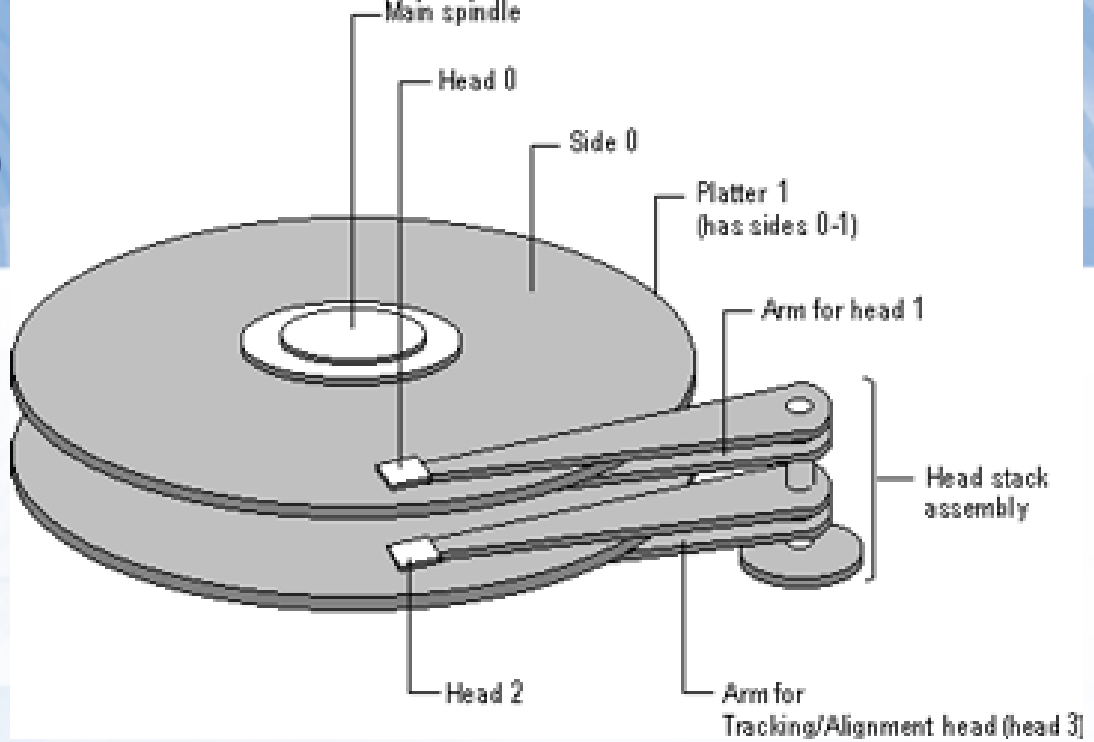


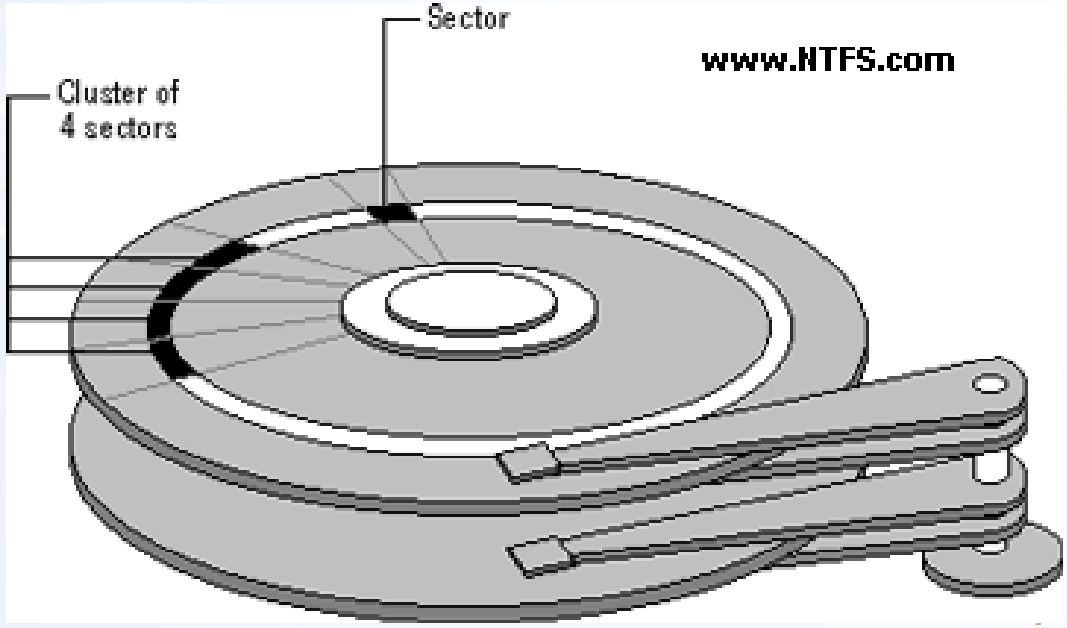
Disk Interface – IDE

- ATA (AT Attachment)
  - ATA2
    - **PIO, DMA**
    - **LBA (Logical Block Addressing)**
  - ATA3, Ultra DMA/33/66/100/133
  - ATAPI (ATA Packet Interface)
    - **CDROM, TAP**
  - Only one device can be active at a time
    - SCSI support overlapping commands, command queuing, scatter-gather I/O
  - Master-Slave
  - 40-pin ribbon cable

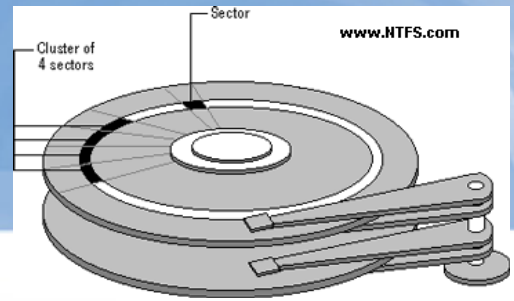
Disk Geometry (1)

- sector
  - Individual data block
- track
  - circle
- cylinder
  - circle on all platters
- Position
  - CHS
  - Cylinder, Head, Sector





Disk Geometry (2)



- 40G HD
  - 16384 cylinders, 80 heads
  - 63 sectors per track, 512 bytes per sector
  - 512 * 63 * 16384 * 80 = 42,278,584,320 bytes
  - 1KB = 1024 bytes
  - 1MB = 1024 KB = 1,048,576 bytes
  - 1GB = 1024 MB = 1,073,741,824 bytes
  - 42,278,584,320 / 1,073,741,824 ≒ 39.375 GB

Disk Installation Procedure (1)

- The procedure involves the following steps:
  - **Connecting the disk to the computer**
    - IDE: master/slave
    - SCSI: ID, terminator
    - power
  - **Creating device files**
    - /dev
    - /dev/MAKEDEV ad0
  - **Formatting the disk**
    - Low-level format
      - > Address information and timing marks on platters
      - > bad sectors
    - Manufacturer diagnostic utility

Disk Installation Procedure (2)

- **Partitioning and Labeling the disk**
  - Allow the disk to be treated as a group of independent data area
  - root, home, swap partitions
  - Suggestion:
    - > **/var, /tmp ➔ separate partition**
    - > Make a copy of root filesystem for emergency
- **Establishing logical volumes**
  - Combine multiple partitions into a logical volume
  - Software RAID technology
    - > **FreeBSD (Vinum)**
    - > **Linux (Linux LVM)**
    - > **Sun (Solstice Disk Suite)**

Disk Installation Procedure (3)

- **Creating UNIX filesystems within disk partitions**
  - Use "newfs" to install a filesystem for a partition
  - Filesystem components
    - > **A set of inode storage cells**
    - > **A set of data blocks**
    - > **A set of superblocks**
    - > **A map of the disk blocks in the filesystem**
    - > **A block usage summary**

Disk Installation Procedure (4)

- **Superblock contents**
  - > The length of a disk block
  - > Inode table's size and location
  - > Disk block map
  - > Usage information
  - > Other filesystem's parameters
- **sync system call**
  - > Flush the cashed superblocks in-memory copy to the permanent place in disk

Disk Installation Procedure (5)

- **Setting up automatic mounting**
  - mount
    - > **Bring the new partition to the filesystem tree**
    - > **mount point can be any directory**
    - > **% mount /dev/ad1s1e /home2**
  - Automount at boot time
    - > **/etc/fstab**
    - > **% mount –t cd9600 –o ro,noauto /dev/acd0c /cdrom**

```
tytsai@qkmj:/etc> less fstab
# Device          Mountpoint      FStype    Options       Dump    Pass#
/dev/ad0s1b       none            swap      sw            0       0
/dev/ad2s1b       none            swap      sw            0       0
/dev/ad0s1a       /               ufs       rw            1       1
/dev/acd0c        /cdrom          cd9660    ro,noauto     0       0
proc              /proc           procfs    rw            0       0
/dev/ad2s1a       /backup         ufs       rw,noauto     1       1
ccduty:/bsdhome   /bsdhome        nfs       rw,noauto     0       0
```

Disk Installation Procedure (6)

- **Setting up swapping on swap partitions**
  - swapon command

fsck – check and repair filesystem (1)

- System crash will cause
  - Inconsistency between memory image and disk contents
- fsck –p
  - Examine all local filesystem listed in /etc/fstab at boot time
  - Automatically correct the following damages:
    - **Unreferenced inodes**
    - **Inexplicably large link counts**
    - **Unused data blocks not recorded in block maps**
    - **Data blocks listed as free but used in file**
    - **Incorrect summary information in the superblock**

fsck – check and repair filesystem (2)

- Run fsck in manual to fix serious damages
  - Blocks claimed by more than one file
  - Blocks claimed outside the range of the filesystem
  - Link counts that are too small
  - Blocks that are not accounted for
  - Directories that refer to unallocated inodes
  - Other errors
- fsck will suggest you the action to perform
  - Delete, repair, …

Adding a disk to FreeBSD (1)

1. Check disk connection
   - Look system boot message

```
ad3: 16383MB <Virtual HD> [33288/16/63] at ata1-slave WDMA2
```

2. Use /stand/sysinstall to install the new HD
   - Configure → Fdisk → Label
   - Don't forget to "W" the actions
3. Make mount point and mount it
   - % mkdir /home2
   - % mount –t ufs /dev/ad3s1e /home2
   - % df
4. Edit /etc/fstab

Adding a disk to FreeBSD (2)

- If you forget to enable soft-update when you add the disk
  - % umount /home2
  - % tunefs –n enable /dev/ad3s1e
  - % mount –t ufs /dev/ad3s1e /home2
  - % mount

```
/dev/ad0s1a on / (ufs, local, soft-updates)
/dev/ad1s1e on /home (ufs, local, soft-updates)
procfs on /proc (procfs, local)
/dev/ad3s1e on /home2 (ufs, local, soft-updates)
```

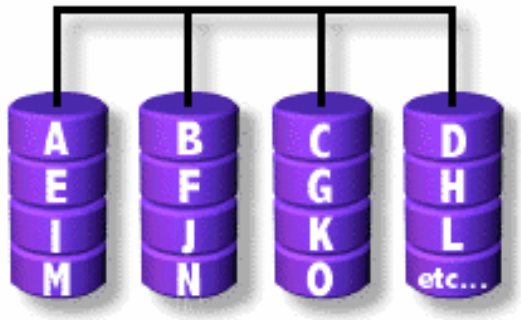
RAID (1)

- Redundant Array of Inexpensive Disks
  - A method to combine several physical hard drives into one logical unit
- Depending on the type of RAID, it has the following benefits:
  - Fault tolerance
  - Higher throughput
  - Real-time data recovery
- RAID 0, 1, 0+1, 5

RAID (2)

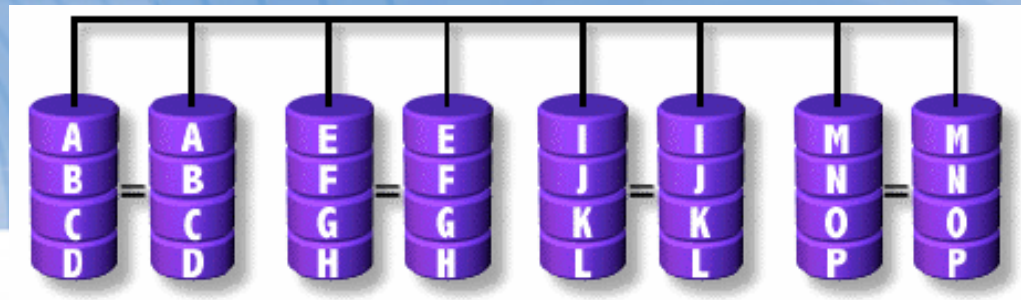
- Hardware RAID
  - There is a dedicate controller to take over the whole business
  - RAID Configuration Utility after BIOS
    - **Create RAID array, build Array**
- Software RAID
  - FreeBSD (Vinum)
  - Linux (Linux LVM)
  - Sun (Solstice Disk Suite)

RAID 0



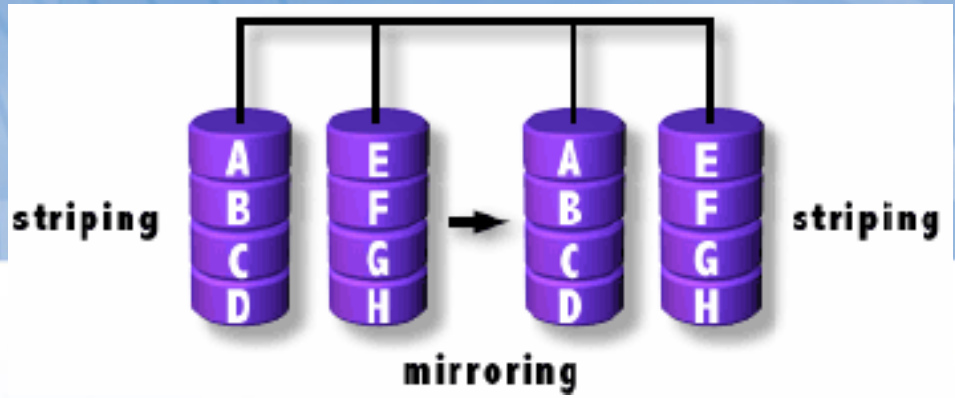
- Stripped data intro several disks
- Minimum number of drives: 2
- Advantage
  - Performance increase in proportional to n theoretically
  - Simple to implement
- Disadvantage
  - No fault tolerance
- Recommended applications
  - Non-critical data storage
  - Application requiring high bandwidth (such as video editing)

RAID 1



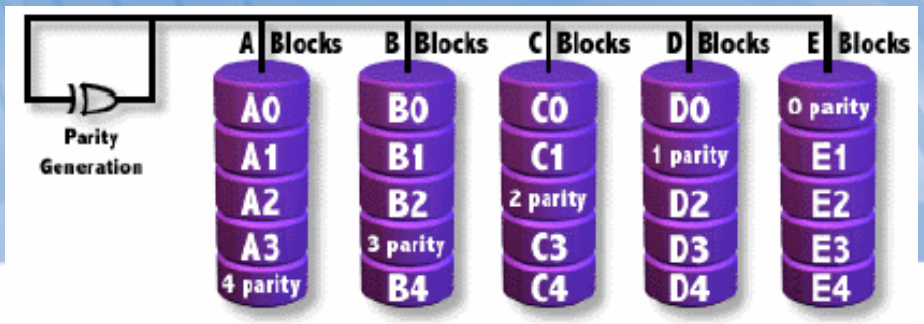
- Mirror data into several disks
- Minimum number of drives: 2
- Advantage
  - 100% redundancy of data
- Disadvantage
  - 100% storage overage
  - Moderately slower write performance
- Recommended application
  - Application requiring very high availability (such as home)

RAID 0+1



- Combine RAID 0 and RAID 1
- Minimum number of drives: 4

RAID 5



- Independent Disk with distributed parity blocks
- Minimum number of drives: 3
- Advantage
  - Highest read data rate
  - Medium write data rate
- Disadvantage
  - Disk failure has a medium impact on throughput
  - Complex controller design
  - When one disk failed, you have to rebuild the RAID array