William Stallings Computer Organization and Architecture

Chapter 5

Memori External

Jenis Memori External

- Magnetic Disk
  - RAID
  - Removable
- Optical
  - CD-ROM
  - CD-Writable (WORM)
  - CD-R/W
  - DVD
- Magnetic Tape

Magnetic Disk

- Metal atau plastic dilapisi dg material yg bersifat magnet (iron oxide)
- Jenis kemasan
  - Floppy
  - Winchester hard disk
  - Removable hard disk

Format dan Organisasi Data

- Lingkaran konsentris atau track
  - Ada Gap antar track
  - Gap sempit, kapasitas bertambah
  - Jumlah bit per track sama (kerapatan bervariasi)
  - Kecepatan putar tetap
- Track dibagi menjadi beberapa sector
- Ukuran minimum block adalah satu sector
- Satu block bisa berisi lebih dari satu sector

Fixed/Movable Head Disk

- Fixed head
  - Ada satu head (r/w) per track
  - Head diletakkan pada tangkai yg tetap
- Movable head
  - Hanya ada satu head per side
  - Diletakkan pada tangkai yg dpt bergerak

Removable / Nonremovable

- Removable disk
  - Dapat dilepas dari drive dan diganti dg disk lain
  - Memberikan kapasitas simpanan yg tak terbatas
  - Mudah melakukan transfer data antar sistem
- Nonremovable disk
  - Terpasanang permanen dalam drive

Floppy Disk

- 8”, 5.25”, 3.5”
- Kapasitas kecil
  - sampai 1.44Mbyte (ada yg 2.88M)
- Lambat
- Umum dipakai
- Murah

Winchester Hard Disk (1)

- Dikembangkan oleh IBM di Winchester (USA)
- Dikemas dalam satu unit
- Berisi satu cakram atau lebih
- Head sangat kecil
- Handal

Winchester Hard Disk (2)

- Umum digunakan
- Murah
- Sbg external storage yg sangat cepat
- Kapasitas semakin besar
  - Dalam orde GB

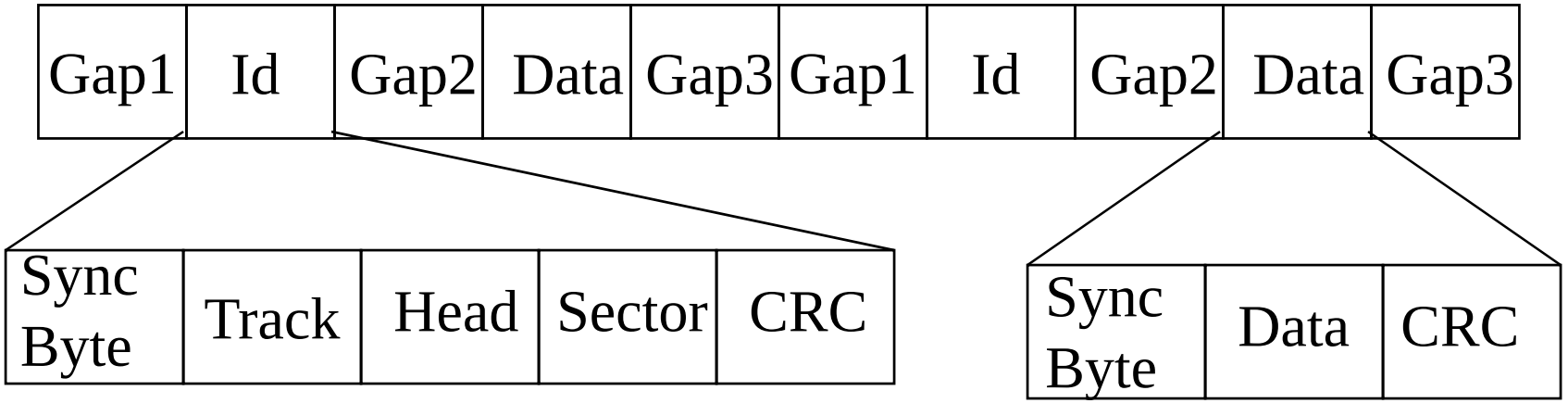
Removable Hard Disk

- ZIP
  - Murah
  - Banyak digunakan
  - 100MB
- JAZ
  - Mahal
  - 1G
- L-120 (a: drive)
  - Juga dpt untuk membaca 3.5” floppy

Pencarian Sector

- Harus dapat mengenali awal suatu track dan sector
- Format disk
  - Menambahkan informasi tambahan
  - Memberi tanda awal track dan sector

ST506 format (old!)



Karakteristik

- Fixed head atau movable head
- Removable disk atau fixed disk
- Single side atau double side
- Single platter atau multiple platter
- Mekanisme head
  - Contact (Floppy)
  - Fixed gap
  - Flying (Winchester)

Multiple Platter

- Satu head per side
- Semua head di-join dan di-align
- Track-track yg setiap platter membentuk cylinder
- Data dipecah berdasarkan cylinder
  - Mengurangi gerakan head
  - Meningkatkan kecepatan (transfer rate)

Kecepatan

- Seek time
  - gerakan head ke track yg dituju
- (Rotational) latency
  - Putar platter sampai posisi data dibawah head
- Access time = Seek + Latency
- Transfer rate

RAID

- Redundant Array of Independent Disks
- Redundant Array of Inexpensive Disks
- Ada 6 level
- Tidak berhirarki
- Sejumlah disks (fisik) yg dipandang sbg satu drive (logical) oleh Sistem Operasi
- Data tersebar diantara disk fisik

RAID 0

- No redundancy
- Data striped across all disks
- Round Robin striping
- Increase speed
  - Multiple data requests probably not on same disk
  - Disks seek in parallel
  - A set of data is likely to be striped across multiple disks

RAID 1

- Mirrored Disks
- Data is striped across disks
- 2 copies of each stripe on separate disks
- Read from either
- Write to both
- Recovery is simple
  - Swap faulty disk & re-mirror
  - No down time
- Expensive

RAID 2

- Disks are synchronized
- Very small stripes
  - Often single byte/word
- Error correction calculated across corresponding bits on disks
- Multiple parity disks store Hamming code error correction in corresponding positions
- Lots of redundancy
  - Expensive
  - Not used

RAID 3

- Similar to RAID 2
- Only one redundant disk, no matter how large the array
- Simple parity bit for each set of corresponding bits
- Data on failed drive can be reconstructed from surviving data and parity info
- Very high transfer rates

RAID 4

- Each disk operates independently
- Good for high I/O request rate
- Large stripes
- Bit by bit parity calculated across stripes on each disk
- Parity stored on parity disk

RAID 5

- Like RAID 4
- Parity striped across all disks
- Round robin allocation for parity stripe
- Avoids RAID 4 bottleneck at parity disk
- Commonly used in network servers

- N.B. DOES NOT MEAN 5 DISKS!!!!!

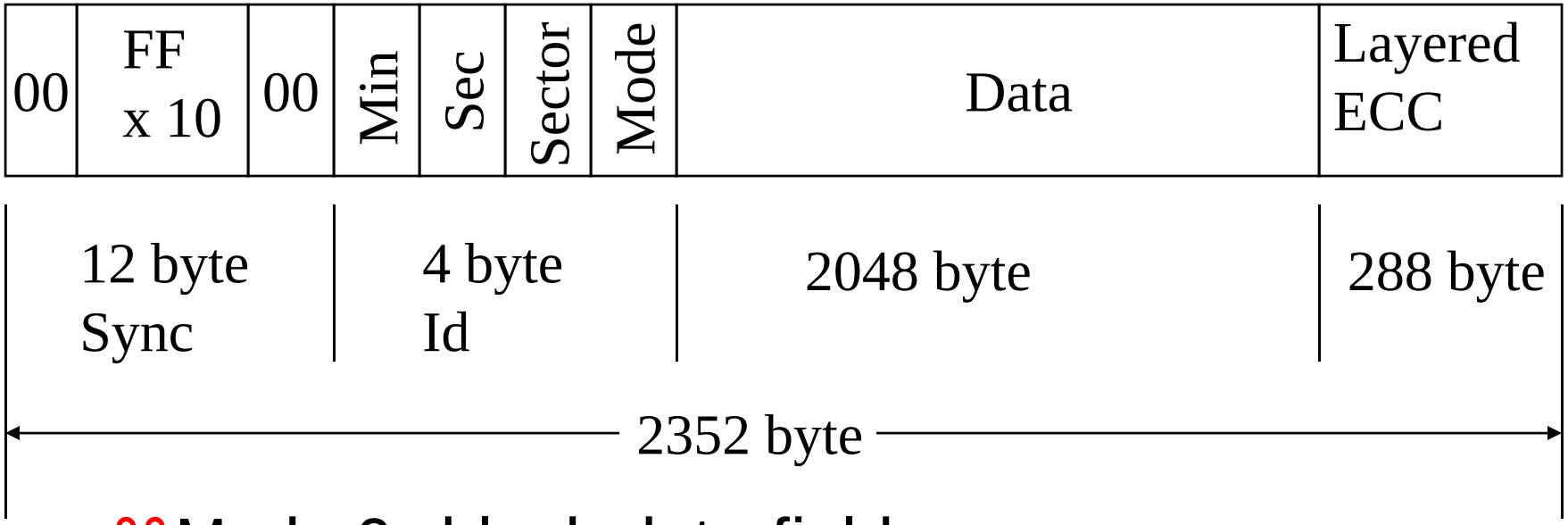
Optical Storage CD-ROM

- Originally for audio
- 650Mbytes giving over 70 minutes audio
- Polycarbonate coated with highly reflective coat, usually aluminum
- Data stored as pits
- Read by reflecting laser
- Constant packing density
- Constant linear velocity

CD-ROM Drive Speeds

- Audio is single speed
  - Constant linier velocity
  - 1.2 ms^{-1}
  - Track (spiral) is 5.27km long
  - Gives 4391 seconds = 73.2 minutes
- Other speeds are quoted as multiples
- e.g. 24x
- The quoted figure is the maximum the drive can achieve

CD-ROM Format



- Mode 0=blank data field
- Mode 1=2048 byte data+error correction
- Mode 2=2336 byte data

Random Access on CD-ROM

- Difficult
- Move head to rough position
- Set correct speed
- Read address
- Adjust to required location
- (Yawn!)

CD-ROM for & against

- Large capacity (?)
- Easy to mass produce
- Removable
- Robust

- Expensive for small runs
- Slow
- Read only

Other Optical Storage

- CD-Writable
  - WORM
  - Now affordable
  - Compatible with CD-ROM drives
- CD-RW
  - Erasable
  - Getting cheaper
  - Mostly CD-ROM drive compatible

DVD - what's in a name?

- Digital Video Disk
  - Used to indicate a player for movies
    - Only plays video disks
- Digital Versatile Disk
  - Used to indicate a computer drive
    - Will read computer disks and play video disks
- Dogs Veritable Dinner
- Officially - nothing!!!

DVD - technology

- Multi-layer
- Very high capacity (4.7G per layer)
- Full length movie on single disk
  - Using MPEG compression
- Finally standardized (honest!)
- Movies carry regional coding
- Players only play correct region films
- Can be “fixed”

DVD - Writable

- Loads of trouble with standards
- First generation DVD drives may not read first generation DVD-W disks
- First generation DVD drives may not read CD-RW disks
- Wait for it to settle down before buying!

Foreground Reading

- Check out optical disk storage options
- Check out Mini Disk

Magnetic Tape

- Serial access
- Slow
- Very cheap
- Backup and archive

Digital Audio Tape (DAT)

- Uses rotating head (like video)
- High capacity on small tape
  - 4Gbyte uncompressed
  - 8Gbyte compressed
- Backup of PC/network servers