CS305
Computer Architecture

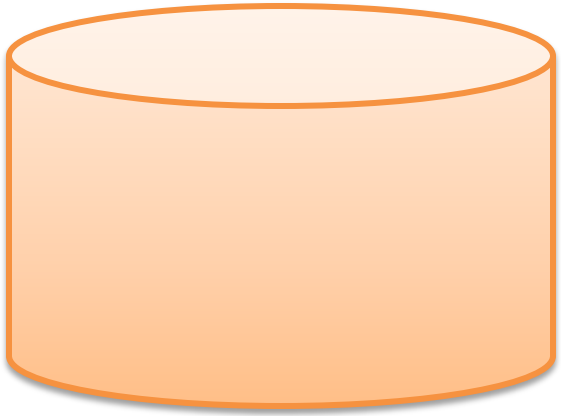
Magnetic Hard Disk Technology

Bhaskaran Raman
Room 406, KR Building
Department of CSE, IIT Bombay

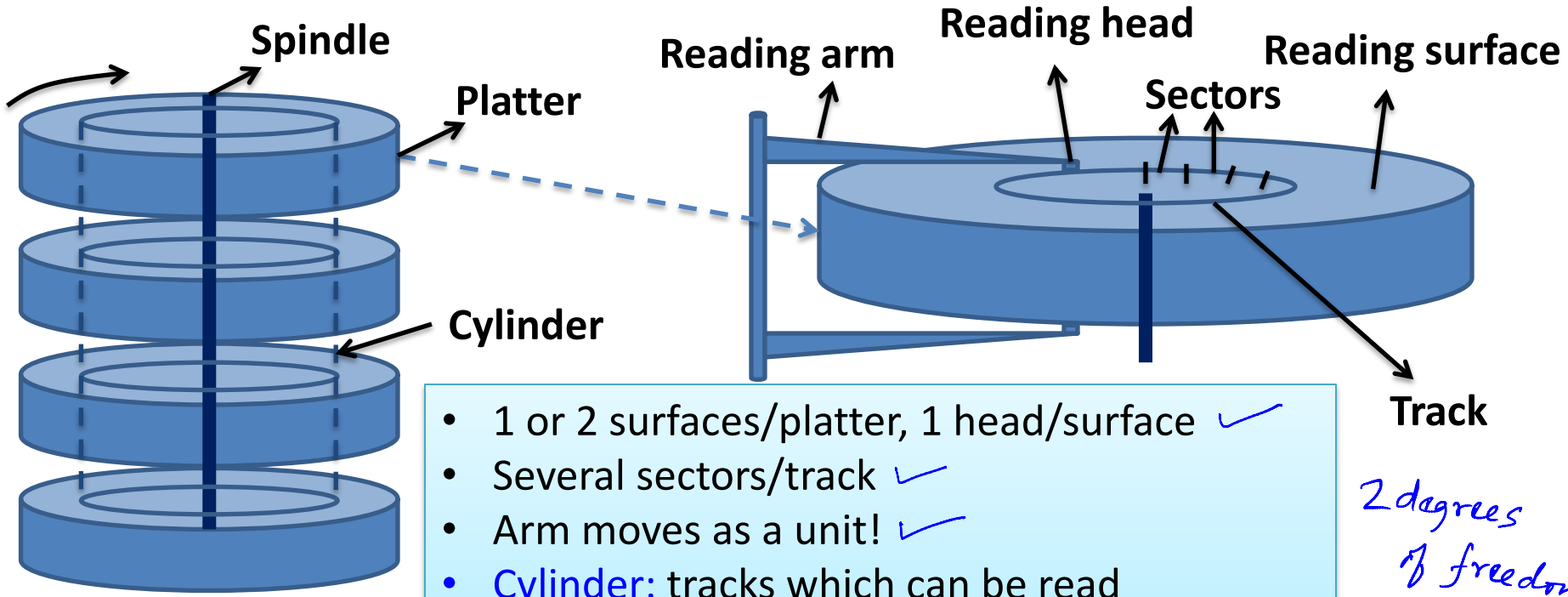
http://www.cse.iitb.ac.in/~br

Magnetic Hard Disks

- Very successful technology
- Price/byte hard to beat!
- Tape drive is better:
  - But poor random access
  - Good only for backup
- Negatives:
  - Latency is high
  - Fault tolerance issues
  - Power consumption: spinning



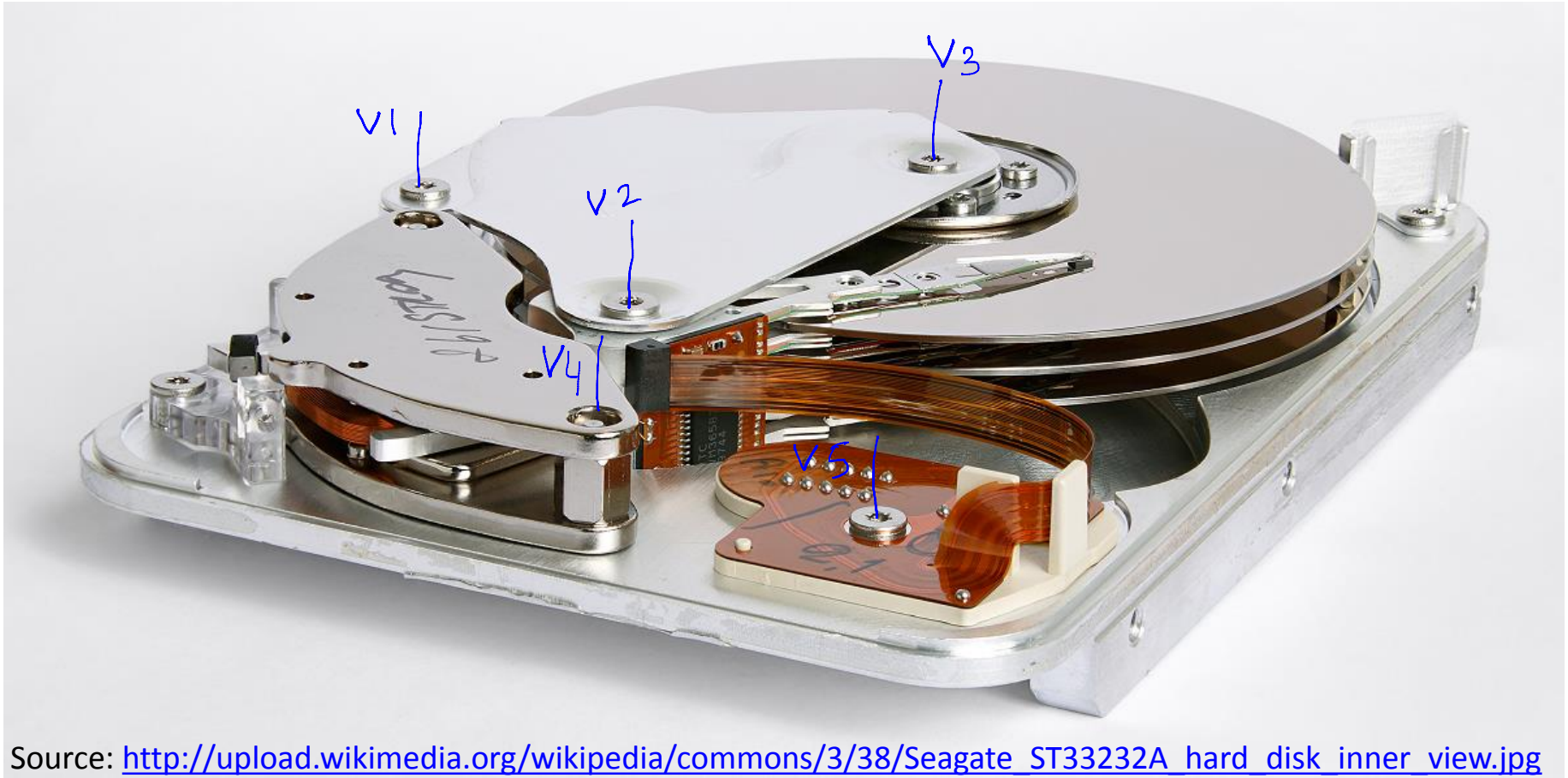
Parts of a Hard Disk



- 1 or 2 surfaces/platter, 1 head/surface
- Several sectors/track
- Arm moves as a unit!
- Cylinder: tracks which can be read simultaneously without moving the arm
- Arm only moves from one track to another: different sectors read through rotation

2 degrees of freedom

A Real Hard Disk: Seagate



Source: http://upload.wikimedia.org/wikipedia/commons/3/38/Seagate_ST33232A_hard_disk_inner_view.jpg

Some Typical Numbers

- Number of bytes/sector: 512-4096
- Number of sectors/track: a few tens to a few hundred
  - Can be variable
- Number of platters: 1-6
- Surfaces/platter: 1 or 2
- Heads/surface = 1
- Tracks/surface = a few 100 thousands
- Rotation speed (RPM): a few thousands – 10,000

Steps in Reading/Writing

Unit of reading/writing = 1 sector

- Seek to the correct cylinder: seek time
- Wait for correct sector to come under reading head: rotation time
- Actual data read/write: transfer time
- Controller overhead: typically quite small

A Numeric Example

Hard disk with rotational speed = 12000 RPM
Seek time = 4ms
Controller overhead = 0.1ms
Transfer rate = 20,000 KB/sec
Average time to read a sector (1KB) of data?

Average rotational delay = 0.5 x (time-for-1-rotation) = 2.5ms
Transfer time = 0.05ms
Total time = (4 + 2.5 + 0.05 + 0.1) ms = 6.65ms

CHS Addressing, LBA

- CHS: Cylinder, Head, Sector
  - First move the arm to the correct cylinder
  - Then choose the correct head
  - Then wait for the right sector to come under that head
- LBA: Logical Block Address, starting from 0
- Given

  c = cylinder number, h = head number, s = sector number

  $LBA = (c \times N_{heads/cyl} + h) \times N_{sectors/track} + (s - 1)$
- Caveat: sector numbering starts from 1 in CHS notation

$c = LBA / N_{sec/cyl}$ $h = (LBA \,\%\, N_{sec/cyl}) / N_{heads/cyl}$

$s = (LBA \,\%\, N_{sec/cyl}) \,\%\, N_{heads/cyl} + 1$

Role of Hard Disk Controller

- Provides an interface of LBA to the processor
  - OS further provides abstraction of file system
- Schedules requests to minimize arm movement
- Disk request scheduling algorithms
  - FIFO: bad
  - Shortest seek time first: may cause starvation
  - Elevator algorithm: move arm in order of increasing cylinder number, then decreasing cylinder number

0..99

c=0

initial head posn
12, 10, 18, 9, 25

order of serving:
10, 12, 18, 25, 9

Summary

- Hard disk: very successful technology
  - Survived through several eras of processors, memory systems!
- Steps: move to correct cylinder, choose head, wait for sector to rotate under head
- Mechanical movements
  - Primary cause of disadvantages: latency, power consumption, failures