Disks

Drive Specifics

	IBM 360KB floppy	WD 18GB HD
Cylinders	40	10601
Tracks per cylinder	2	12
Sectors per track	9	281 (average)
Sectors per disk	720	35742000
Bytes per sector	512	512
Capacity	360 KB	18.3 GB
Seek time (minimum)	6 ms	0.8 ms
Seek time (average)	77 ms	6.9 ms
Rotation time	200 ms	8.33 ms
Spinup time	250 ms	20 sec
Sector transfer time	22 ms	17 msec

Disk Zones

RAID

RAID 0
(Redundant Array of Inexpensive Disks

RAID 1
(Mirrored copies)

RAID 4
(Striped with parity)

RAID 5
(Parity rotates through disks)

CD-ROMs

Disk Sector

Preamble	Data	ECC

Sector Skew

Direction of disk rotation

Sector Interleaving

No interleaving   Skipping 1 sector   Skipping 2 sectors
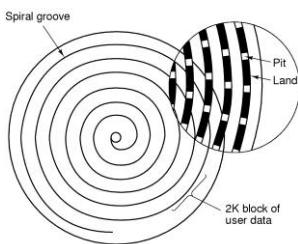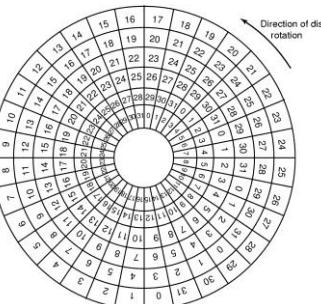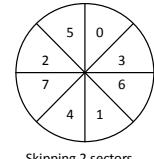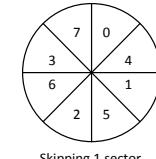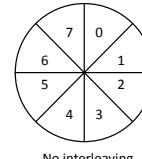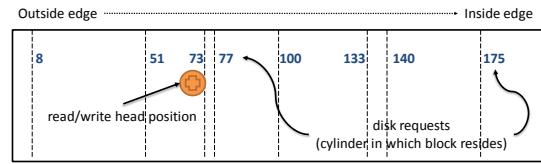
Disk Requests

- Seek time
- Rotational delay
- Actual transfer time

Disk Request Scheduling

Outside edge ⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱⸱ Inside edge

8   51   73   77   100   133   140   175

read/write head position

disk requests
(cylinder in which block resides)
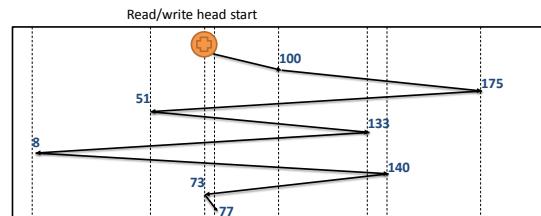
Disk seek algorithm examples assume a request queue & head position (disk has 200 cylinders)

Queue = 100, 175, 51, 133, 8, 140, 73, 77
Head position = 63

Seek Distance

Total distance travelled to service a set of disk requests
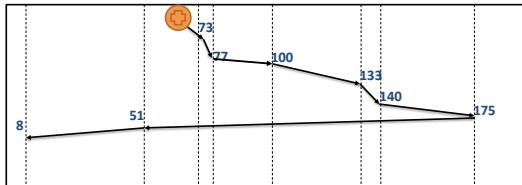
First-Come, First-Served (FCFS)

Read/write head start

100
175
51
133
8
140
73
77

Seek distance = (100-63) + (175-100) + (175-51) + (133-51) + (133-8) + (140-8) + (140-73) + (77-73) = **646 cylinders**

Shortest Seek Time First
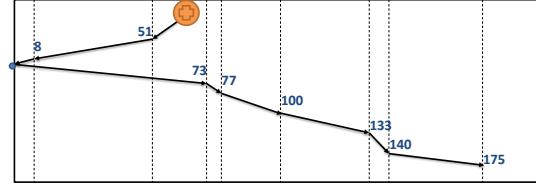
Read/write head start

Seek distance = 10 + 4 + 23 + 33 + 7 + 35 + 126 + 43 = **281 cylinders**

SCAN (Elevator Algorithm)
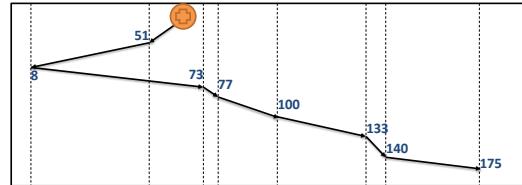
Read/write head start

Seek distance = 12 + 43 + 8 + 73 + 4 + 23 + 33 + 7 + 35 = **238 cylinders**

LOOK
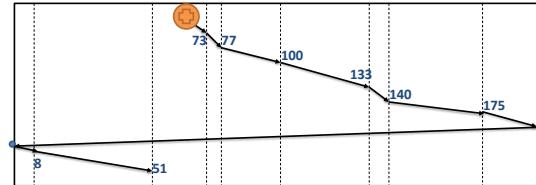
Read/write head start

Seek distance = 12 + 43 + 65 + 4 + 23 + 33 + 7 + 35 = **222 cylinders**

C-SCAN
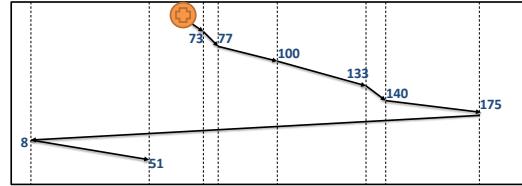
Read/write head start

Seek distance = 10 + 4 + 23 + 33 + 7 + 35 + 24 + 199 + 8 + 43 = **386 cylinders**
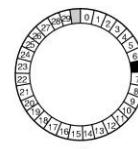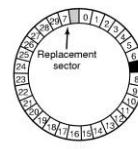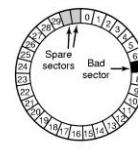
C-LOOK

Read/write head start
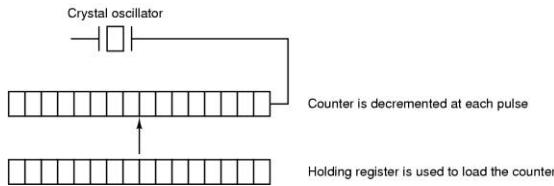
Seek distance = 10 + 4 + 23 + 33 + 7 + 35 + 167 + 43 = **322 cylinders**

Spare Sectors

Clocks

Crystal oscillator

Counter is decremented at each pulse

Holding register is used to load the counter

Time of Day

| 64 bits |
| Time of day in ticks |

(a)

| 32 bits |
| Time of day in seconds |

Number of ticks in current second

(b)

| 32 bits |
| Counter in ticks |

System boot time in seconds

(c)
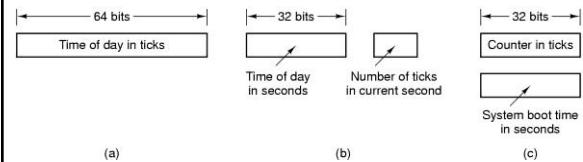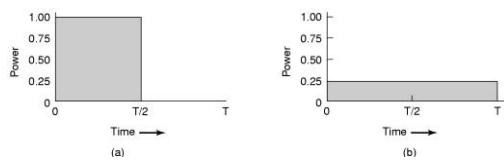
Soft Timers

Do we really need hardware timer interrupts for preemption?

Power Management

Device	Li et al. (1994)	Lorch and Smith (1998)
Display	68%	39%
CPU	12%	18%
Hard disk	20%	12%
Modem		6%
Sound		2%
Memory	0.5%	1%
Other		22%

CPU Power

Power — Time → (a)

Power — Time → (b)

$$\text{Power} \propto \text{Voltage}^2$$