Lecture 19

Disk Storage Organization

Text: Chapter 16
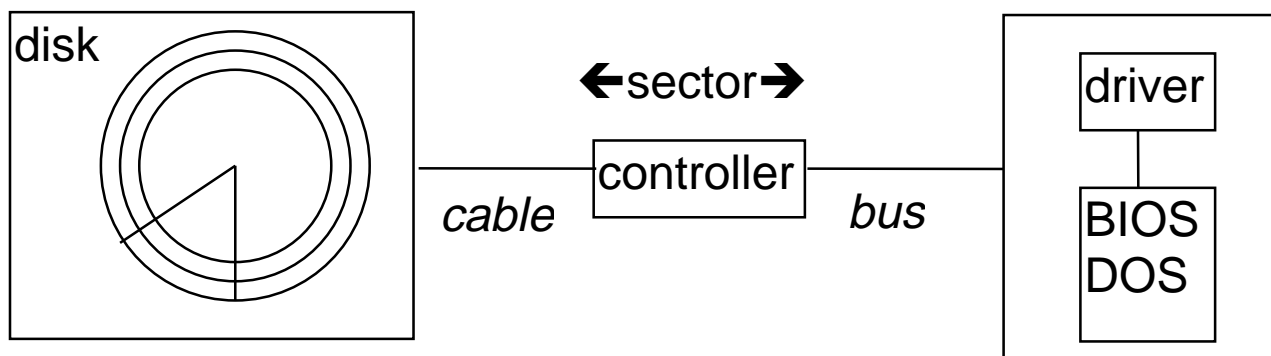
HARDWARE VIEW

Physical Device:

Track   A circle on the surface of the disk
Cylinder Tracks with the same radius on all surfaces
Sector   A portion of a track

Disk address:
- Cylinder/track/sector
- relative sector number

Read and Write operations are done on sectors only.

The size of a sector is usually a power of 2
   256, 512, 1024, 2048

Disk Capacity
3.5" 1.44 MB
- 80 tracks per side
- 18 sectors per track
- 512 bytes per sector
- 1 sector per cluster

OPERATING SYSTEM VIEW

To increase efficiency, the operating system may want to use storage units larger than sectors to store a file. The operating system can group several sectors into a cluster:

Cluster   A collection of sectors.
          For example, four sectors per cluster
          This is what the operating systems reads and
          writes to the disk.

| Sector | Sector | Sector | Sector |
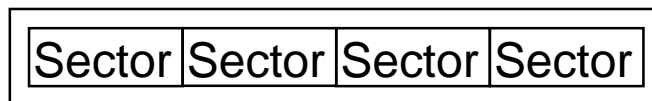
The operating system needs to account for all of the clusters, and to allow the user to name the file.

Directory   A place where the operating system keeps
            track of the names, extensions, sizes,
            protections and locations of files.

File Allocation Table
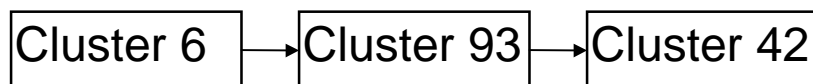   A file may be stored in one or more clusters.

Example:
```
    A 5,329-byte file stored on a disk which
    has 512-byte sectors by an OS which
    uses a cluster factor of 4 will need 3
    clusters:

    Cluster size = 4*512= 2,048
```

$$\left\lceil \frac{5,329}{2,048} \right\rceil = 3 \text{ clusters}$$

These clusters are not contiguous, so we could end up
with the following chain of clusters:

$$\boxed{\text{Cluster 6}} \longrightarrow \boxed{\text{Cluster 93}} \longrightarrow \boxed{\text{Cluster 42}}$$

The File Allocation Table will record which is the first,
second, third (and so forth) cluster for the file.

Reading from a file…

USERS usually want to read "lines" of a file. A line is terminated with a line feed or carriage return:

```
Mary had a little lamb↵
Whose fleece was white as snow.↵
And everywhere that Mary went,↵
The lamb was sure to go.↵
```

When this file is put into a sector, the sector is filled with characters (including the line feed):

sector

```
Mary had a little lamb↵Whose fleece was
```

```
white as snow. ↵And everywhere that Mary
```
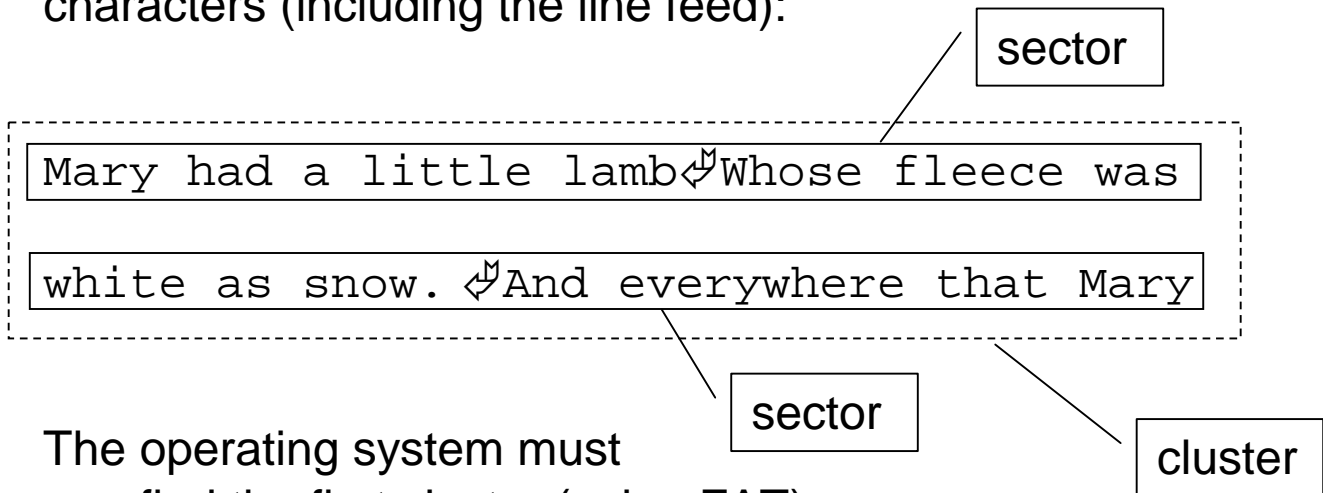
sector

cluster

The operating system must
- find the first cluster (using FAT)
- read characters out of the sector(s) until it finds a line feed.

DISK ORGANIZATION

System Area
Side 0, Track 0, Sector 1

- Boot record
- File Allocation Table (FAT)
- Directory

Data Area

- System files
  IO.SYS
  MSDOS.SYS

- User files

Example:

3.5" 1.44MB:
Boot sector: 0
FAT: sectors 1-18
Directory: sectors 19-32

Boot record

- At 00h, a jump to the bootstrap routine.
- DOS version
- bytes per sector
- sectors per cluster
- sectors per track
- number of surfaces
- volume label

etc.

File Allocation Table

- one entry for every cluster on the disk
- media descriptor (floppy disk/ hard disk)
- 12 or 16-bit FAT entries
- pointers to the clusters making up a file

Directory

- file name (8 bytes), or directory, deleted,…
- file extension (3 bytes)
- file attribute (1 byte)
    normal /read only/ hidden/ DOS
- time of day created or last updated (2 bytes)
- date when created or last updated (2 bytes)
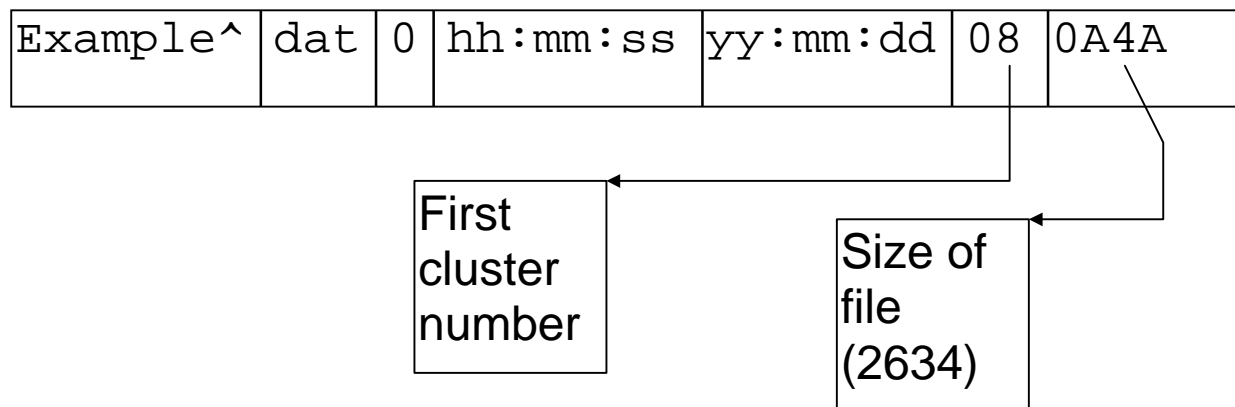- starting cluster number
- size of the file

EXAMPLE:

A 2,634-byte file called "example.dat" is stored on a 3.5"
1.44MB disk, using 512 bytes per sector and 1 sector per
cluster.

The file requires $\lceil 2634/512 \rceil = 6$ sectors.
Suppose the file occupies clusters 8, 5, 26, 24, 19 and 4.

Directory entry:

Example^	dat	0	hh:mm:ss	yy:mm:dd	08	0A4A

First cluster number

Size of file (2634)

FAT:

F0F	FFF	000	000	FFF	01A	000	000	005	000	000

Cluster:

0	1	2	3	4	5	6	7	8	9	10

000	004	000	000	000	00D	013	000	018	000	000

18	19	20	21	22	23	24	25	26	27	...

Exercises - Lecture 19

1. What is the raw (unformatted) capacity of each of the following disk drives?

	surfaces	tracks	sectors	sector size	capacity
a.	2	80	19	512	
b.	8	200	24	1024	
c.	4	400	34	1024	
d.	4	200	23	512	

2. How much disk space will be consumed by each of the following files, presuming a sector size of 512 bytes:

	File size	sectors per cluster	disk space
a.	19KB	1	
b.	19KB	2	
c.	19KB	4	
d.	19KB	8	
e.	2K	1	
f.	2K	2	
g.	2K	4	
h.	2K	8	

3. Suppose a new file called "TEST.DAT" which contains 8,152 bytes is being put on a disk which has a sector size of 512 bytes. DOS may select available clusters in the order 3, 7, 8, 2, 5, 4,9 (but may not need all of them), and uses a clustering factor of 4.

Fill in the proper numbers in the FAT and directory entry:

DIRECTORY

		0	hh:mm:ss	yy:mm:dd		

FAT

0	1	2	3	4	5	6	7	8	9	10