

## Disk Hardware

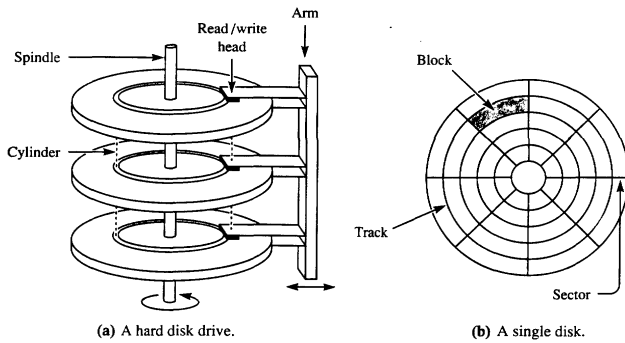


Diagram from *Computer Science*, Volume 2, J. Stanley Warford, Heath, 1991.

- Arm can move in and out
  - Read / write head can access a ring of data as the disk rotates
- Disk consists of one or more *platters*
  - Each platter is divided into rings of data, called *tracks*, and each track is divided into *sectors*
  - One particular platter, track, and sector is called a *block*

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## Disk Hardware (cont.)

- Typical disk today:
  - Total capacity = 4.2GB
  - 9 platters (18 surfaces)
  - 4096 tracks per surface
  - 32-64 sectors per track
  - 1K bytes per sector
- Trends in disk technology
  - Disks are getting smaller, for similar capacity
    - Faster data transfer, lighter weight
  - Disk are storing data more densely
    - Faster data transfer
    - Density improving faster than mechanical limitations (seek time, rotational delay)
  - Disks are getting cheaper (factor of 2 per year since 1991)

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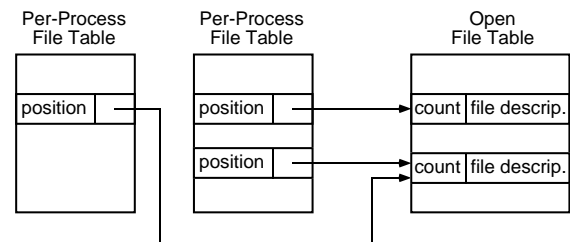
## Data Structures for Files

- Every file is described by a *file descriptor*, which may contain (varies with OS):
  - Type
  - Access permissions — read, write, etc.
  - Link count — number of directories that contain this file
  - Owner, group
  - Size
  - Access times — when created, last accessed, last modified
  - Blocks where file is located on disk
- Not included:
  - Name of file

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## OS Data Structures for Files

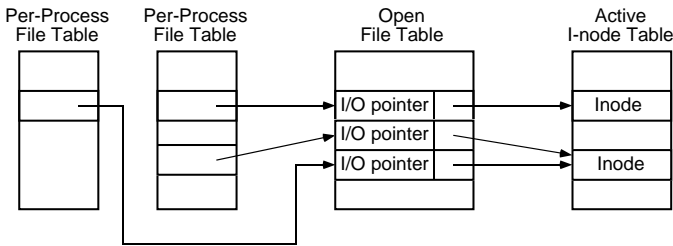


- *Open file table* (one, belongs to OS)
  - Lists all open files
  - Each entry contains:
    - A *file descriptor*
    - Open count — number of processes that have the file open
- *Per-process file table* (many)
  - List all open files for that process
  - Each entry contains:
    - Pointer to entry in open file table
    - Current position (offset) in file

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## UNIX Data Structures for Files



- **Active Inode table** (one, belongs to OS)
  - Lists all active *inodes* (file descriptors)
- **Open file table** (one, belongs to OS)
  - Each entry contains:
    - Pointer to entry in active inode table
    - Current position (offset) in file
- **Per-process file table** (many)
  - Each entry contains:
    - Pointer to entry in open file table

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## Disk Data Structures for Files

- The file descriptor information must also be stored on the disk, for persistence
  - Includes all the basic information listed on the previous slides
  - All *inodes* (file descriptors) are stored in a fixed-size array on the disk called the *ilist*
    - The size of the ilist array is determined when the disk is initialized
    - The index of a file descriptor in the array is called its *inode number*, or *inumber*
- File descriptors are stored:
  - Originally, together on the inner (or outer) track
  - Then, together on the middle track (why?)
  - Now: there are small file descriptor are spread out across the disk, so as to be closer to the file data

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## UNIX File System

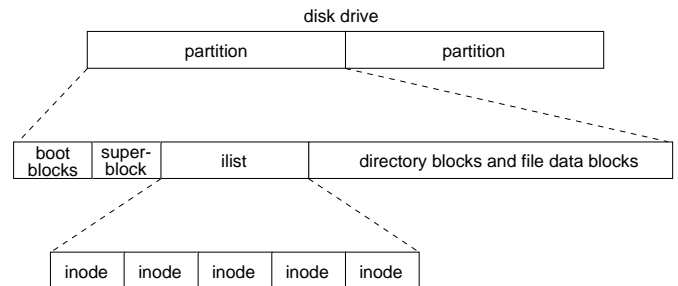
- A file descriptor (*inode*) represents a file
  - All *inodes* are stored on the disk in a fixed-size array called the *ilist*
    - The size of the ilist array is determined when the disk is initialized
    - The index of a file descriptor in the array is called its *inode number*, or *inumber*
  - Inodes for active files are also cached in memory in the *active inode table*
- A UNIX disk may be divided into *partitions*, each of which contains:
  - Blocks for storing directories and files
  - Blocks for storing the ilist
    - Inodes corresponding to files
    - Some special inodes
      - Boot block — code for booting the system
      - Super block — size of disk, number of free blocks, list of free blocks, size of ilist, number of free inodes in ilist, etc.

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## UNIX File System (cont.)

- High-level view:



- Low-level view:

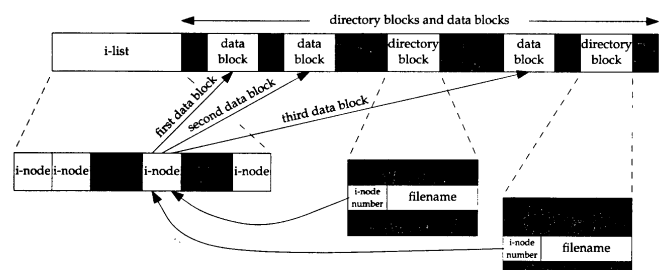


Diagram from *Advanced Programming in the UNIX Environment*, W. Richard Stevens, Addison Wesley, 1992.

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