CS343: Operating System

File System and Device Driver

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Outline

- Mass Storage
  - Disk Structure
  - Disk Arm Scheduling
  - Disk Management
  - RAID Structure
- FS Basic
- FS Implementation
- I/O subsystem
- Device Drivers

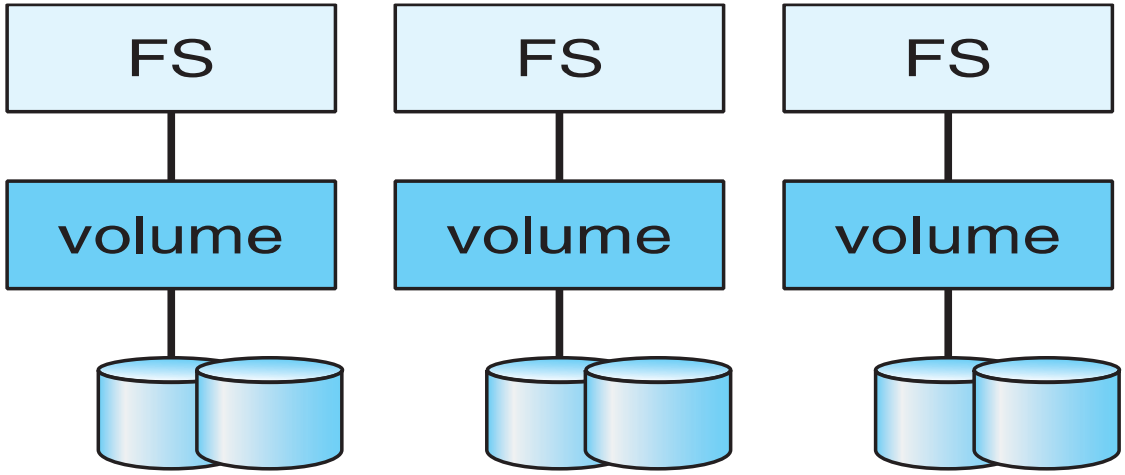
Other Features

- Regardless of where RAID implemented, other useful features can be added
- **Snapshot** is a view of file system before a set of changes take place (i.e. at a point in time)
- Replication is automatic duplication of writes between separate sites
  - For redundancy and disaster recovery
  - Can be synchronous or asynchronous
- Hot spare disk is unused, automatically used by RAID production if a disk fails to replace the failed disk and rebuild the RAID set if possible
  - Decreases mean time to repair

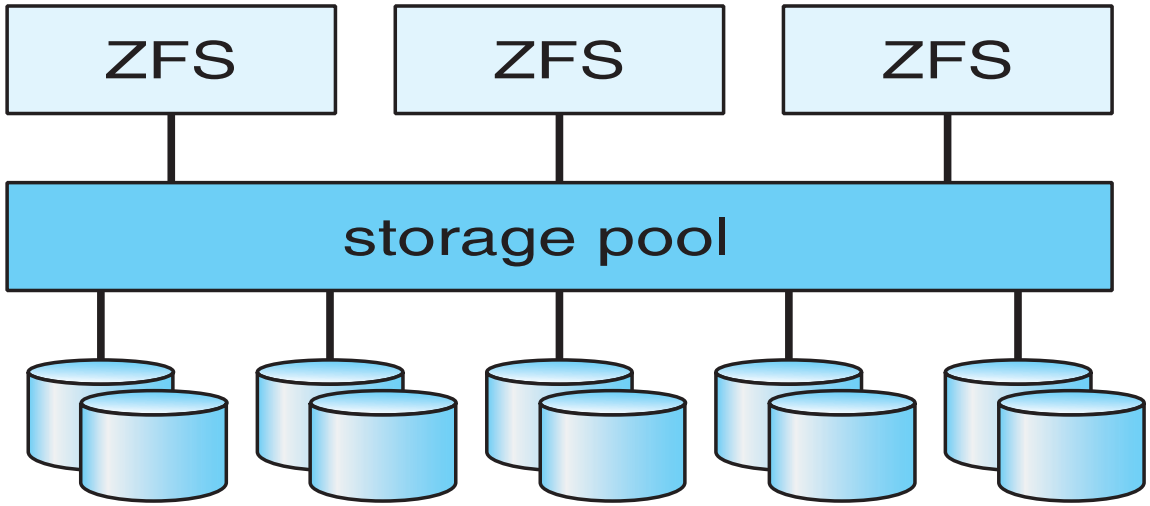
Extensions

- RAID alone does not prevent or detect data corruption or other errors, just disk failures
- Solaris ZFS adds **checksums** of all data and metadata
- Checksums kept with pointer to object, to detect if object is the right one and whether it changed
- Can detect and correct data and metadata corruption
- ZFS also removes volumes, partitions
  - Disks allocated in **pools**
  - Filesystems with a pool share that pool, use and release space like **`malloc()`** and **`free()`** memory allocate / release calls

Traditional and Pooled Storage



(a) Traditional volumes and file systems.



(b) ZFS and pooled storage.

File System: Introduction

File-System Interface

- File Concept
- Access Methods
- Disk and Directory Structure
- File-System Mounting
- File Sharing
- Protection

File Concept

- Contiguous logical address space
- Types:
  - Data : numeric, character, binary
  - Program
- Contents defined by file's creator
  - Many types
  - Consider **text file, source file, executable file, RTF, HTML**

FILE : Command in Linux

$ file a.out

a.out: ELF 32-bit LSB executable, Intel 80386, version 1 (SYSV), dynamically linked (uses shared libs), for GNU/Linux 2.6.32, not stripped

$ file test.c

test.c: ASCII text

$file CS341.pdf

CS341.pdf: PDF document, version 1.4

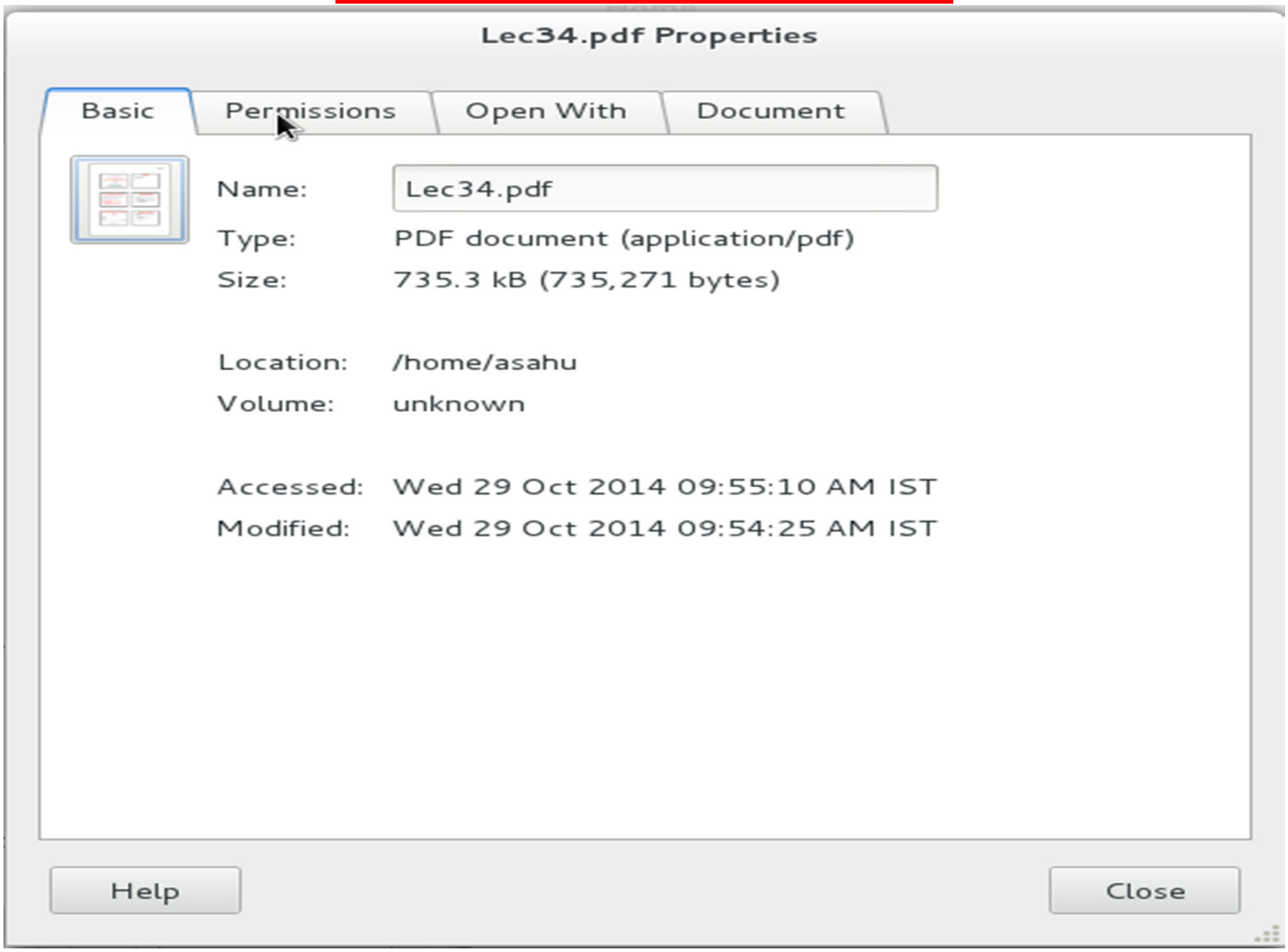
$file /dev/sda1

/dev/sda1: block special

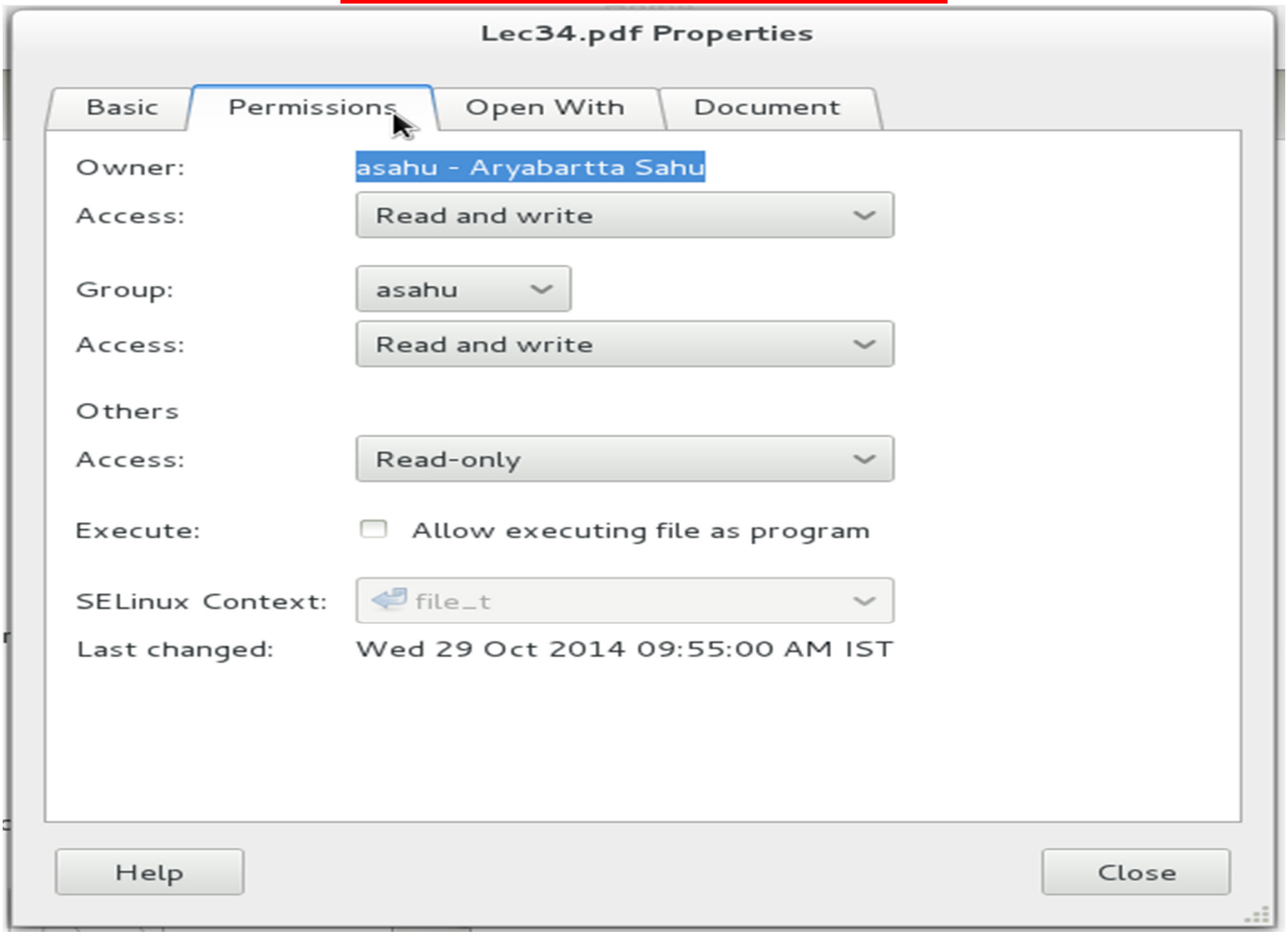
$file /dev/tty1

/dev/tty1: character special

File info : Graphical



File info : Graphical



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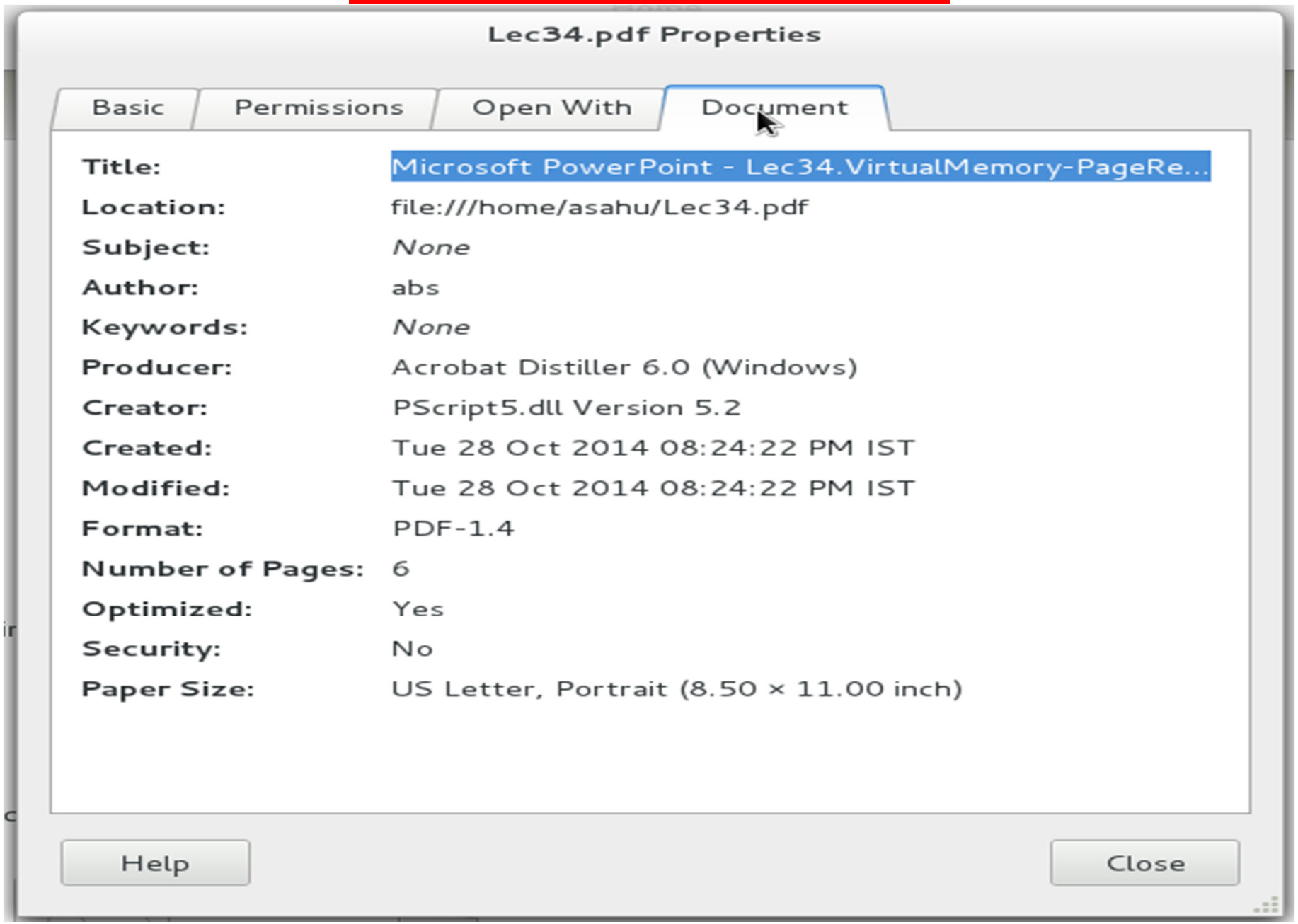


File Attributes

- **Name** – only information kept in human-readable form
- **Identifier** – unique tag (number) identifies file within file system
- **Type** – needed for systems that support different types
- **Location** – pointer to file location on device
- **Size** – current file size
- **Protection** – controls who can do reading, writing, executing

File Attributes

- **Time, date, and user identification** – data for protection, security, and usage monitoring
- Information about files are kept in the directory structure, which is maintained on the disk
- Many variations, including extended file attributes such as file checksum
- Information kept in the directory structure

File Operations

- File is an **abstract data type**
- **Create**
- **Write –** at **write pointer** location
- **Read –** at **read pointer** location
- **Reposition within file - seek**
- **Delete**
- **Truncate**

File Operations

- ***Open(F_i)***
  - Search the directory structure on disk for entry ***F_i***,
  - And move the content of entry to memory
- ***Close (F_i)***
  - Move the content of entry ***F_i*** in memory to directory structure on disk

Open Files

- Several pieces of data are needed to manage open files:
  - **Open-file table**: tracks open files
  - File pointer: pointer to last read/write location, per process that has the file open
  - **File-open count**: counter of number of times a file is open – to allow removal of data from open-file table when last processes closes it
  - Disk location of the file: cache of data access information
  - Access rights: per-process access mode information

Open File Locking

- Provided by some operating systems and file systems
  - Similar to reader-writer locks
  - **Shared lock** similar to reader lock – several processes can acquire concurrently
  - **Exclusive lock** similar to writer lock
- Mediates access to a file
- Mandatory or advisory:
  - **Mandatory** – access is denied depending on locks held and requested
  - **Advisory** – processes can find status of locks and decide what to do

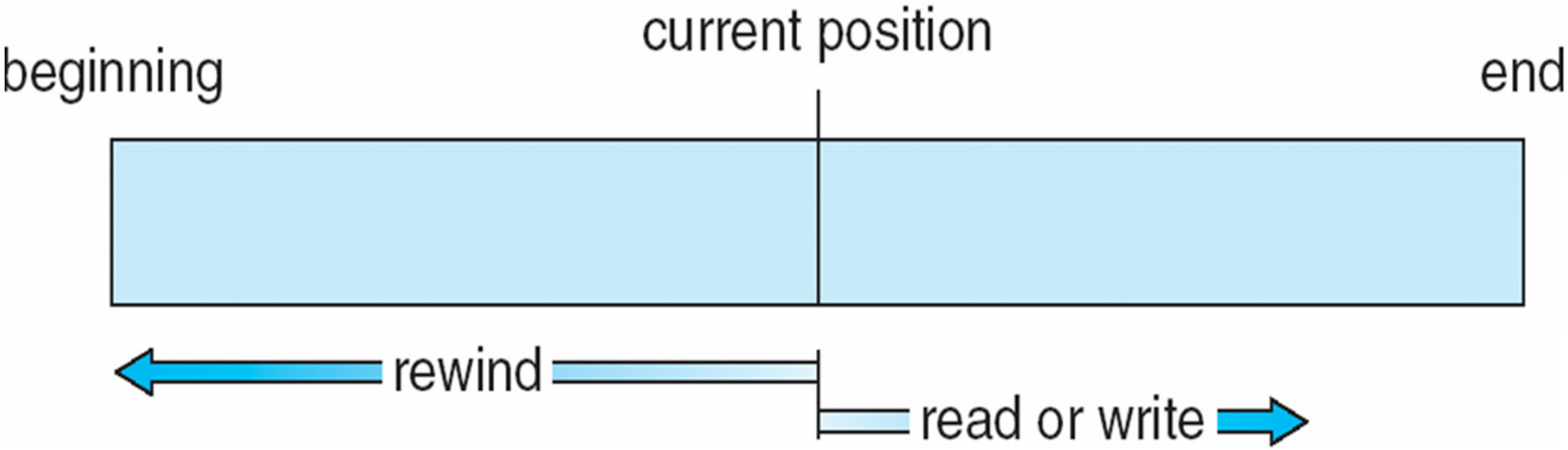
File Types – Name, Extension

- Executable : exe, com, bin
- Object : obj, o
- Source code : c, cc, cpp, pas, java , for
- Batch : bat, sh
- Text : txt,
- Word Processor : doc, rtf, odt, ods
- Library : a, lib, dll, so
- Print or view : ps, pdf, jpg
- Archive : tgz, zip, arc, tar
- Multimedia : mpeg, mov, mp3, avi

File Structure

- None - sequence of words, bytes
- Simple record structure
  - Lines, Fixed length, Variable length
- Complex Structures
  - Formatted document
  - Relocatable load file
- Can simulate last two with first method by inserting appropriate control characters
- Who decides:
  - Operating system and Program

Sequential-access File



Access Methods

- **Sequential Access**

```
read next
write next
reset
```

- **Direct Access –** file is fixed length logical records

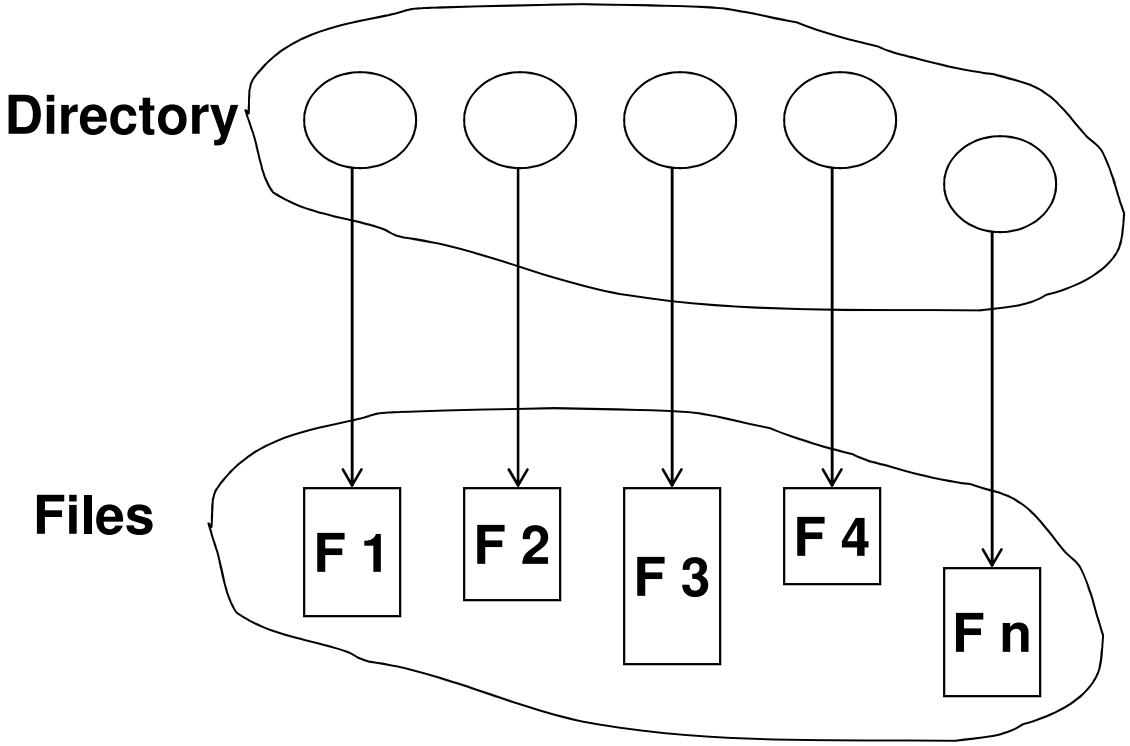
```
read n
write n
```

n = relative block number

Mostly used Data bases

Directory Structure

- A collection of nodes containing information about all files



Both the directory structure and the files reside on disk

Operations Performed on Directory

- Search for a file
- Create a file
- Delete a file
- List a directory
- Rename a file
- Traverse the file system

Directory Organization

- Efficiency – locating a file quickly
- Naming – convenient to users
  - Two users can have same name for different files
  - The same file can have several different names
- Grouping
  - logical grouping of files by properties
    (e.g., all Java programs, all games, …)