

Chapter 11: File-System Interface

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

File Concept

- Contiguous logical address space
- Types:
 - ◆ Data
 - ✓ numeric
 - ✓ character
 - ✓ binary
 - ◆ Program

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
 - ◆ Program

File Attributes

- **Name** – only information kept in human-readable form.
- **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.
- **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.

File Operations

- Create
- Write
- Read
- Reposition within file – file seek
- Delete
- Truncate
- 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.

File Types – Name, Extension

file type	usual extension	function
executable	exe, com, bin or none	read to run machine-language program
object	obj, o	compiled, machine language, not linked
source code	c, cc, java, pas, asm, a	source code in various languages
batch	bat, sh	commands to the command interpreter
text	txt, doc	textual data, documents
word processor	wp, tex, rrf, doc	various word-processor formats
library	lib, a, so, dll, mpeg, mov, rm	libraries of routines for programmers
print or view	arc, zip, tar	ASCII or binary file in a format for printing or viewing
archive	arc, zip, tar	related files grouped into one file, sometimes compressed, for archiving or storage
multimedia	mpeg, mov, rm	binary file containing audio or A/V information

Access Methods

■ Sequential Access

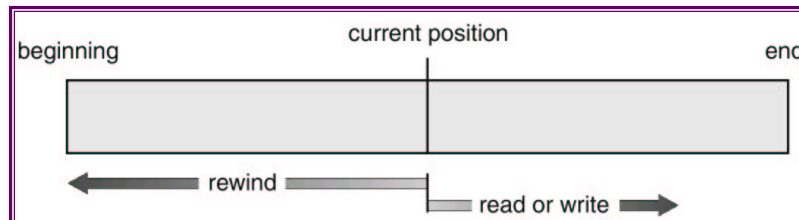
read next
write next
reset
no read after last write
(rewrite)

■ Direct Access

read n
write n
position to n
read next
write next
rewrite n

n = relative block number

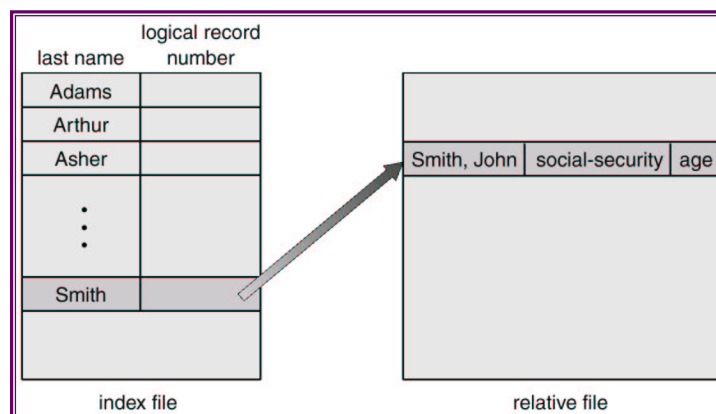
Sequential-access File



Simulation of Sequential Access on a Direct-access File

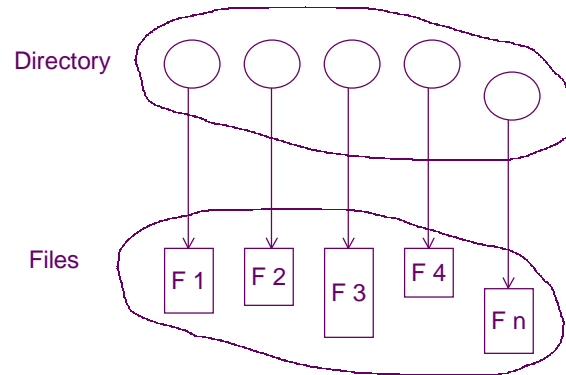
sequential access	implementation for direct access
<i>reset</i>	<i>cp = 0;</i>
<i>read next</i>	<i>read cp;</i> <i>cp = cp+1;</i>
<i>write next</i>	<i>write cp;</i> <i>cp = cp+1;</i>

Example of Index and Relative Files



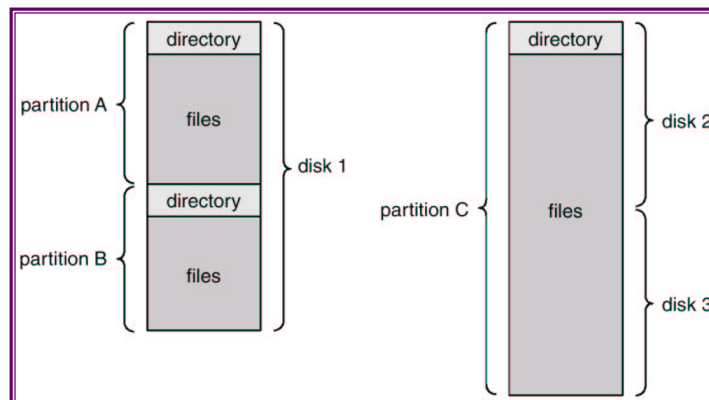
Directory Structure

- A collection of nodes containing information about all files.



Both the directory structure and the files reside on disk.
Backups of these two structures are kept on tapes.

A Typical File-system Organization



Information in a Device Directory

- Name
- Type
- Address
- Current length
- Maximum length
- Date last accessed (for archival)
- Date last updated (for dump)
- Owner ID (who pays)
- Protection information (discuss later)

Operations Performed on Directory

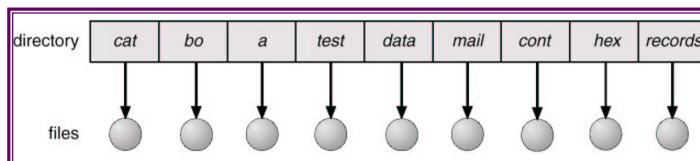
- Search for a file
- Create a file
- Delete a file
- List a directory
- Rename a file
- Traverse the file system

Organize the Directory (Logically) to Obtain

- **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, ...)

Single-Level Directory

- A single directory for all users.

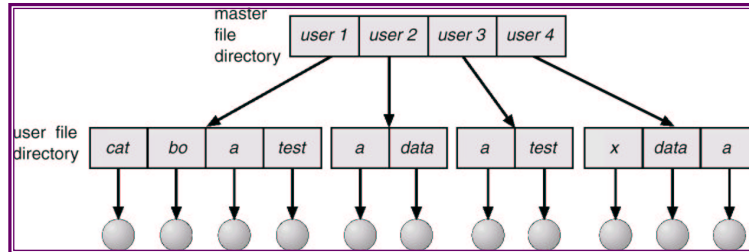


Naming problem

Grouping problem

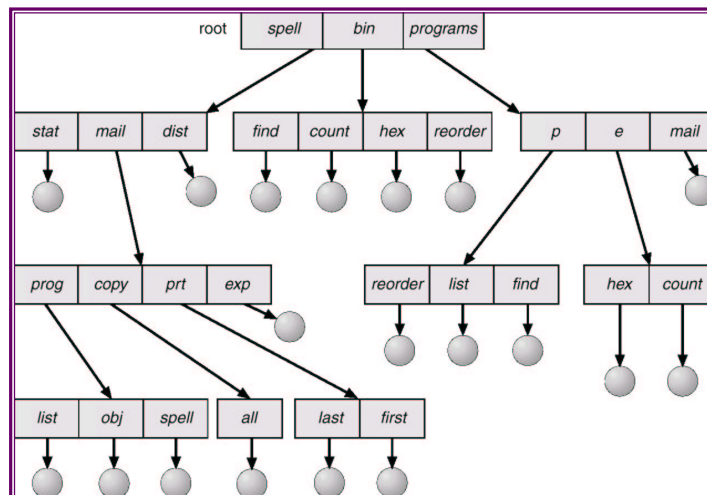
Two-Level Directory

- Separate directory for each user.



- Path name
- Can have the same file name for different user
- Efficient searching
- No grouping capability

Tree-Structured Directories

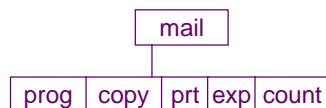


Tree-Structured Directories (Cont.)

- Efficient searching
- Grouping Capability
- Current directory (working directory)
 - ◆ `cd /spell/mail/prog`
 - ◆ `type list`

Tree-Structured Directories (Cont.)

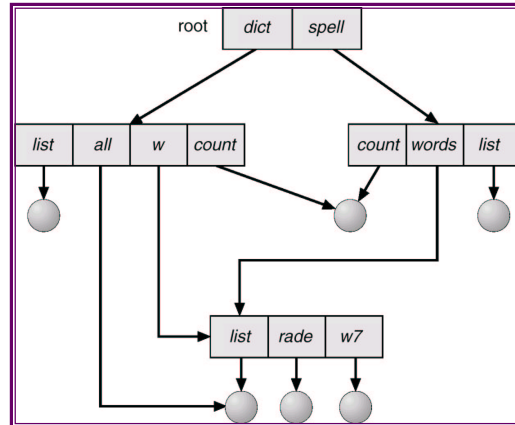
- **Absolute** or **relative** path name
- Creating a new file is done in current directory.
- Delete a file
 - `rm <file-name>`
- Creating a new subdirectory is done in current directory.
 - `mkdir <dir-name>`
 - Example: if in current directory `/mail`
 - `mkdir count`



Deleting "mail" ⇒ deleting the entire subtree rooted by "mail".

Acyclic-Graph Directories

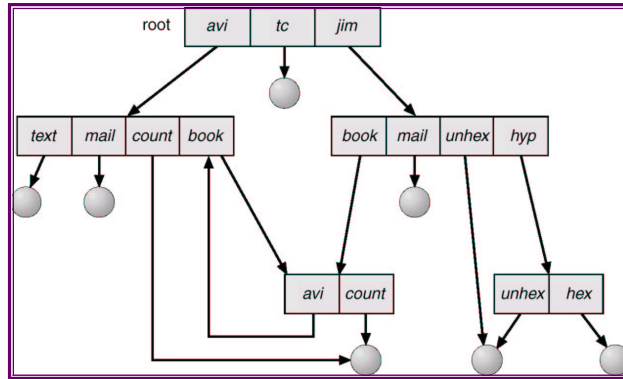
- Have shared subdirectories and files.



Acyclic-Graph Directories (Cont.)

- Two different names (aliasing)
- If *dict* deletes *list* \Rightarrow dangling pointer.
Solutions:
 - ◆ Backpointers, so we can delete all pointers.
Variable size records a problem.
 - ◆ Backpointers using a daisy chain organization.
 - ◆ Entry-hold-count solution.

General Graph Directory



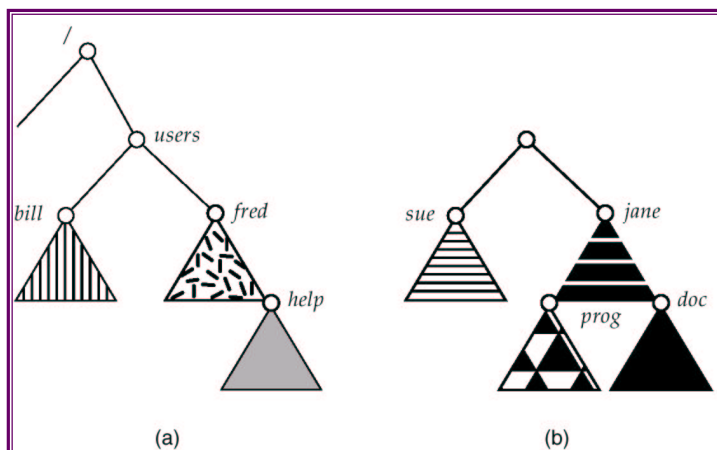
General Graph Directory (Cont.)

- How do we guarantee no cycles?
 - ◆ Allow only links to file not subdirectories.
 - ◆ Garbage collection.
 - ◆ Every time a new link is added use a cycle detection algorithm to determine whether it is OK.

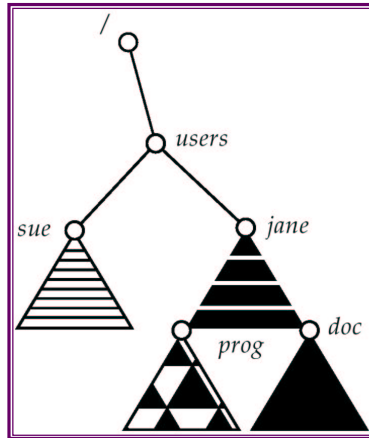
File System Mounting

- A file system must be **mounted** before it can be accessed.
- An unmounted file system is mounted at a **mount point**.

(a) Existing. (b) Unmounted Partition



Mount Point



File Sharing

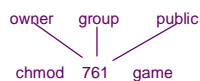
- Sharing of files on multi-user systems is desirable.
- Sharing may be done through a *protection* scheme.
- On distributed systems, files may be shared across a network.
- Network File System (NFS) is a common distributed file-sharing method.

Protection

- File owner/creator should be able to control:
 - ◆ what can be done
 - ◆ by whom
- Types of access
 - ◆ Read
 - ◆ Write
 - ◆ Execute
 - ◆ Append
 - ◆ Delete
 - ◆ List

Access Lists and Groups

- Mode of access: read, write, execute
 - Three classes of users
- | | | | |
|-------------------------|---|---|---------------------|
| a) owner access | 7 | ⇒ | RWX
1 1 1
RWX |
| b) group access | 6 | ⇒ | 1 1 0
RWX |
| c) public access | 1 | ⇒ | 0 0 1 |
- Ask manager to create a group (unique name), say G, and add some users to the group.
 - For a particular file (say *game*) or subdirectory, define an appropriate access.



Attach a group to a file

```
chgrp G game
```