

Chapter 11: File-System Interface

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

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File Concept

Contiguous logical address space

- Types:
 - Data
 - numeric
 - character
 - binary
 - Program

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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

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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.

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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.

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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, rtf, 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

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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

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Sequential-access File

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Simulation of Sequential Access on a Direct-access File

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

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Example of Index and Relative Files

logical record	
last name	number
Adams	
Arthur	
Asher	
⋮	
⋮	
Smith	

index file

Smith, John	social-security	age
-------------	-----------------	-----

relative file

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Directory Structure

A collection of nodes containing information about all files.

Directory

Files

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

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A Typical File-system Organization

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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)

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Operations Performed on Directory

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

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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,)

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Single-Level Directory

- A single directory for all users.

Naming problem

Grouping problem

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Two-Level Directory

Separate directory for each user.

Path name

Can have the same file name for different user

Efficient searching

No grouping capability

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Tree-Structured Directories

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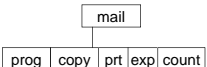
Tree-Structured Directories (Cont.)

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

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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`

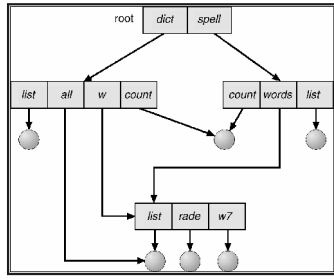


Deleting `mail` ⇒ deleting the entire subtree rooted by `mail`.

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Acyclic-Graph Directories

Have shared subdirectories and files.



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Acyclic-Graph Directories (Cont.)

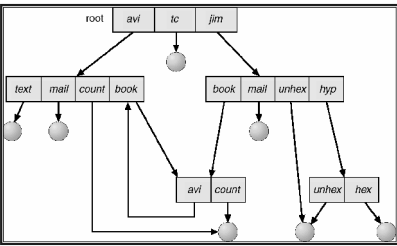
- Two different names (aliasing)
- If `dict` deletes `list` ⇒ dangling pointer.

Solutions:

- Backpointers, so we can delete all pointers.
- Variable size records a problem.
- Backpointers using a daisy chain organization.
- Entry-hold-count solution.

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General Graph Directory



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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.

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File System Mounting

A file system must be **mounted** before it can be accessed.

A unmounted file system (i.e. Fig. 11-11(b)) is mounted at a **mount point**.

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(a) Existing. (b) Unmounted Partition

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Mount Point

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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.

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Protection

File owner/creator should be able to control:

- what can be done
- by whom

Types of access

- Read
- Write
- Execute
- Append
- Delete
- List

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Access Lists and Groups

Mode of access: read, write, execute

Three classes of users

			RWX
a) owner access	7	⇒	1 1 1
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.

```

owner  group  public
 |      |      |
chmod 761  game

```

Attach a group to a file

```

chgrp G game

```

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