File Systems

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Outline

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Concept of File

A file is a named collection of related information that is recorded on secondary storage [1].

[1] By the way, what is a variable in your program?

File Attributes

- Name, identifier, type, location, size, time stamp, etc., e.g.,
- In UNIX/Linux,
  - man 2 stat
  - man 1 stat

File Operations

- Creating a file.
- Opening a file.
- Writing a file.
- Reading a file.
- Repositioning within a file.
- Truncating a file.
- A few UNIX/Linux system calls,
  - `open`, `close`, `write`, `read`, `lseek`, `truncate`, `flock`, `chmod`, and `chown`
- Sequential vs. direct access

File Types

Explore the `file` command in UNIX/Linux,

- man 1 file

Concept of Directory

- The directory is a special type of file that stores a symbol table for the translatation of file names to their file control blocks.
- A file control block (FCB) contains information about the file, including ownership, permissions, and location of the file contents
- In UNIX/Linux, a FCB is an `inode`. See also,
  - `man 7 inode`
  - `man 2 stat`
  - `man 2 statx`
  - `man 1 stat`

Directory Operations

- Search for a file.
- Create a file.
- Delete a file.
- List a directory.
- Rename a file.
- Traverse the file system.
- In UNIX/Linux, see system calls,
  - `unlink`, `rmdir`, `mkdir`, `getdents`
  - In particular, see the example code in `getdents(2)` via `man 2 getdents`

Directory Structure

- Single-level directory
- Two-level directory
- Tree-structured directories
- Acyclic-graph directories
- General graph directory

Path name and Graph-structured directories

A file path is the path of a graph traveral in a graph-structured directories.
A path name is a notion of such a path.

- Absolute path name
- Relative path name

Types of File Access

- Read. Read from the file.
- Write. Write or rewrite the file.
- Execute. Load the file into memory and execute it.
- Append. Write new information at the end of the file.
- Delete. Delete the file and free its space for possible reuse.
- List. List the name and attributes of the file.
- Attribute change. Changing the attributes of the file.

Access Control

- Identity dependent access is to associate with each file and directory an access-control list (ACL) specifying user names and the types of access allowed for each user.
- In UNIX/Linux, we have the following to condense ACLs.
  - Owner. The user who created the file is the owner.
  - Group. A set of users who are sharing the file and need similar access is a group, or work group.
  - Other. All other users in the system.

Memory Mapped Files

Leveraging on virtual memory, we can access file via routine memory access, e.g.,

- In UNIX, via system call `mmap`
- In Windows, via Windows API `CreateFileMapping`, `CreateViewOfFile`.