

Chapter 2: File System

Operating system

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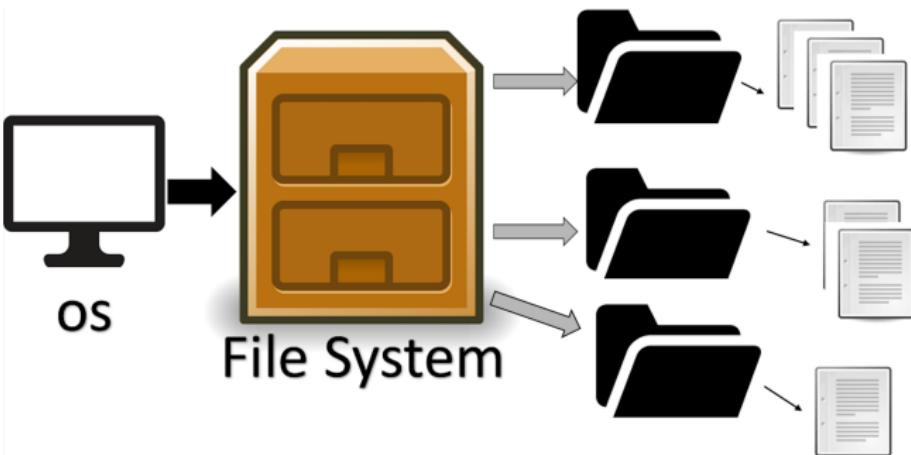
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- ▶ *File is defined as a collection of related information, which is named and stored in external memory.*



Hình 2: Files system

- ▶ *File attribute:* to manages files based on content, OS also defines attributes, properties (thuộc tính, tính chất).

Definitions (cont.)

► File attributes:

- File name
- File type
- File volume
- File creator, owner
- File access permission
- Thời gian tạo file, sửa file, truy cập lần cuối File created, edit time, last edited time
- File location

Definitions (cont.)

The image shows two side-by-side Windows file properties dialog boxes for a PDF file named "1. Giáo trình Hệ điều hành - GS. Tù Minh Phương.pdf".

Left Dialog (General Tab):

- Type of file: Foxit Reader PDF Document (.pdf)
- Opens with: Foxit Reader 9.7 (button to Change...)
- Location: H:\2022\OneDrive - CMC Technology & Solution\PTIT\Hệ điều hành\1. Giáo trình Hệ điều hành - GS. Tù Minh Phương.pdf
- Size: 4.08 MB (4,285,404 bytes)
- Size on disk: 4.08 MB (4,288,512 bytes)
- Created: Friday, August 12, 2022, 7:40:19 PM
- Modified: Friday, August 12, 2022, 7:41:39 PM
- Accessed: Today, September 5, 2022, 8:56:18 AM
- Attributes: Read-only Hidden Advanced...
- Security: This file came from another computer and might be blocked to help protect this computer. Unblock

Right Dialog (Details Tab):

Property	Value
Name	1. Giáo trình Hệ điều hành - GS. Tù Minh Phương.pdf
Type	Foxit Reader PDF Document
Folder path	H:\2022\OneDrive - CMC Technology & Solution\PTIT\Hệ điều hành
Size	4.08 MB
Date created	8/12/2022 7:40 PM
Date modified	8/12/2022 7:41 PM
Attributes	AL
Owner	DESKTOP-VLKIE33\Dinh Xuan Truong
Computer	DESKTOP-VLKIE33 (this PC)

Hình 3: File attributes

► File name:

- Identify files.
- Most used information when users work with files.
- Rules of file names:

Hệ điều hành	Độ dài tối đa	Phân biệt chữ hoa, chữ thường	Cho phép sử dụng dấu cách	Các ký tự cấm
MS-DOS	8 cho tên file 3 cho mở rộng	không	không	Bắt đầu bằng chữ cái hoặc số Không được chứa các ký tự / \ : ; = , ^ ? @
Windows NT FAT	255 ký tự cho cả tên file và đường dẫn	không	có	Bắt đầu bằng chữ cái hoặc số Không được chứa các ký tự / \ : ; = , ^ ? @
Windows NT NTFS	255	không	có	Không được chứa các ký tự / <> * :
Linux (EXT3)	256	Có	có (nếu tên file chứa trong ngoặc kép)	Không được chứa các ký tự ! @ # \$ % ^ & * () [] { } ‘ “ / \ : ; <> ‘

Hình 4: Rule of file name

- ▶ Information inside files could be different.
- ▶ Some files have unstructured information: text file. Structured files such as: database file, file excel.
File structure is also different and depends on the information of files
- ▶ OS need to know and support file structures?
- ▶ Support file structure at OS level:
 - Advantages:
 - ▶ File operations will be easier for application programmers.
 - ▶ OS can control file operations.
 - Disadvantages:
 - ▶ Size up the system volume/
 - ▶ Reduce the flexibility of system.
- ▶ In reality, OS consider files as collection of unstructured byte.

Definitions (cont.)

Files system



- ▶ Most of OS do not support and manage structured file.
- ▶ The file structure is managed by the application program and users.
- ▶ In UNIX, DOS, WINDOWS, files are considered as collection of bytes.
- ▶ Application programs will create and manage their own file structures.
For instance: *The graphical program saves the file as an unzipped binary, the data management system program creates a file that includes logs.*

Access Methods

- ▶ To read/write files, OS must specify how to access the file contents. Each OS supports one or more different access ways.
- ▶ **Sequential access:**
 - Information is read/write by byte/logic from the file beginning.
 - Use pointer to allocate the current position in files.
 - After one read/write operation, the pointer position will increase one to next position.
 - This type of access is suitable for files stored on magnetic tape. Information is written or read in the direction of the tape rotation.

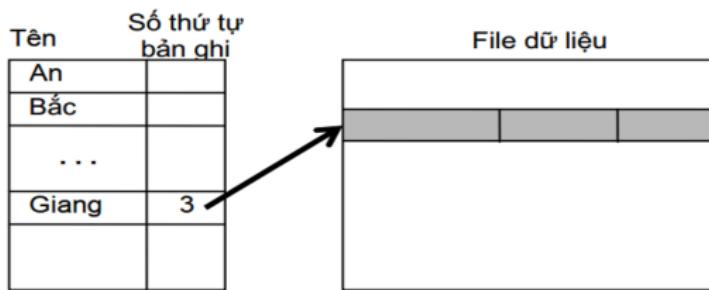
► Direct access:

- File is considered as numbered blocks/logs.
- Blocks can be accessed by arbitrary order.
- For instance: it can read 50th block, then 13th and 101th.
- Direct access is based on disk access characteristics, which allows accessing to any block.
- File is allocated at different blocks in disk, which allows non-sequential access.

Access Methods (cont.)

▶ Index-based access:

- Allows access to logs in the file, not by the number or position of log, but by the corresponding key to that log.
- File has one private index: includes keys and pointer to logs in files.
- Access: find corresponding key in index list, then pointer identify logs and access directly to it.



Hình 5: Index-based access

File operations

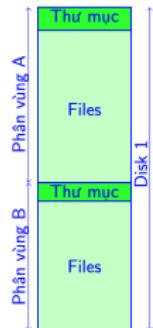
- ▶ OS regulate operations that users and applications can work with files.
- ▶ Most used operations are:
 - **Create file:** create empty file; File is allocated the space with attributes such as created time, name, user.
 - **Delete file:**
 - ▶ Free up the space that file takes in the disk.
 - ▶ Free up the file in folder.
 - ▶ Free up the space can simply mark as free space.
 - **Open file:**
 - ▶ Before read/write file.
 - ▶ Read file attributes in the disks to speed up the next read/write operation.
 - **Close file:**
 - ▶ Delete file information in the memory table to give a space for coming file.

- ▶ Many OS restrict the number of opened files at the same time, so close the accessed file is important.
- **Write to file:**
 - ▶ Data is written at the current position in file.
 - ▶ If the current position is at the end of file, information is added and the file volume increase.
 - ▶ If the current position is not at the end, information will be overwritten.
- **Read file** Information at current position will be read.
- **seek** Identify the current file position.
- **Read file attributes:** Some application need to read the file attributes such as access permission for security purpose.
- **Change file attributes:** Reset some file attributes.
- **Delete file content:** Delete file contend, release the space volume that file occupies, but keep file attributes except length.

File operations (cont.)

- **Lock file:** When many processes change file content, it may result in unexpected results, so OS allow locking file. When a process opens file, it can request to lock file and do not allow other processes access, read or write that file.

- ▶ The number of files stored in the disks is huge => need to organize files for easy management and access.
- ▶ Disk is assigned into partition/volume (logic disk).
 - * Disk is assign into:
Partitions, Minidisks, Volumes.
 - * Each partition is separated storage area. It can have OSs.

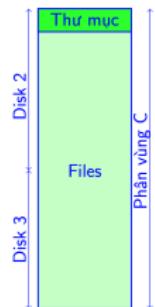


Folder (cont.)

Folder Definition

- ▶ Combine some disks into a big logic disk.

- * Users only care about file and folder logic.
- * They do not care about the disk partition management.



- ▶ To manage files in disk logic, file information is stored in folder.
- ▶ **Folder** is formed from *entries* and each entry is one file.
- ▶ *Entry* include file information: name, capacity, location, file type or pointer of storage information.
- ▶ Folder as a table, each row is an entry. Finding necessary row based on file name. Folder allow mapping file name to that row.
- ▶ Storage methods:

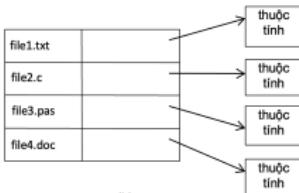
Folder (cont.)

Folder Definition

- All file properties are stored in folder. File contain content only => volume of entries, folder is big.
- A part of properties is stored with file content. Folder only store necessary information for finding file location => volume is decreased

file1.txt	Thuộc tính
file2.c	Thuộc tính
file3.pas	Thuộc tính
file4.doc	Thuộc tính

(a)



(b)

Hình 6: File properties storage a) With folder b) With file

► Open file:

- OS find in folder/entry mapping to file name.
- Read properties and location of file in table containing opened files.
- If entry mapping to another file structure of file properties, this structure will be written in the table.

► File searching: folder structure allow searching with file name.

► File create: create new entry and add in folder.

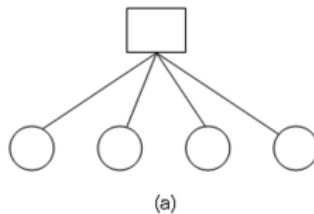
► File delete: information of file and entry will be deleted from folder.

► Folder list: list files and information of that entry.

► Change name: only work with folder, not file content.

► One level folder:

- Most simplest
- Only one folder and all files are stored in this folder.
- It is difficult to choose file name.
- It is difficult to search file.

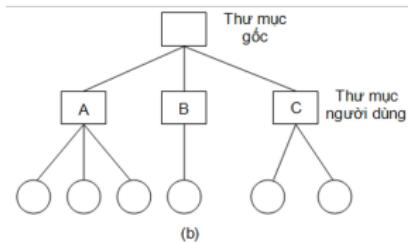


 = Thư mục  = File

Hình 7: One level folder structure

► Two level folder:

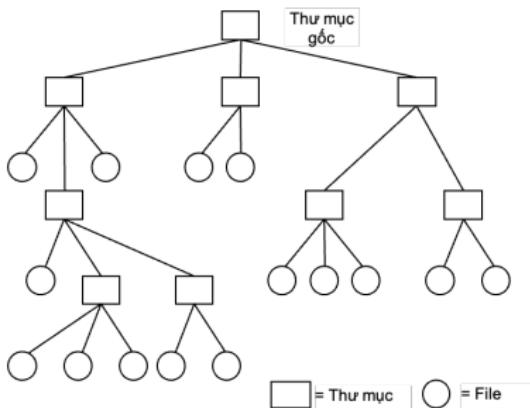
- Assign each user their own folder(UFD: User File Directory) containing their files.
- When user access file, file will be search in their name folder.
- User can name files with same name.
- Isolate users. Files that share with many users => copy to all user folders => waste of resource.



Hình 8: Two level folder structure

► Tree structure folder:

- Folder can contain other smaller folder and files.
- Folder structure is shown as tree structure: branch is folder and leaf is file.

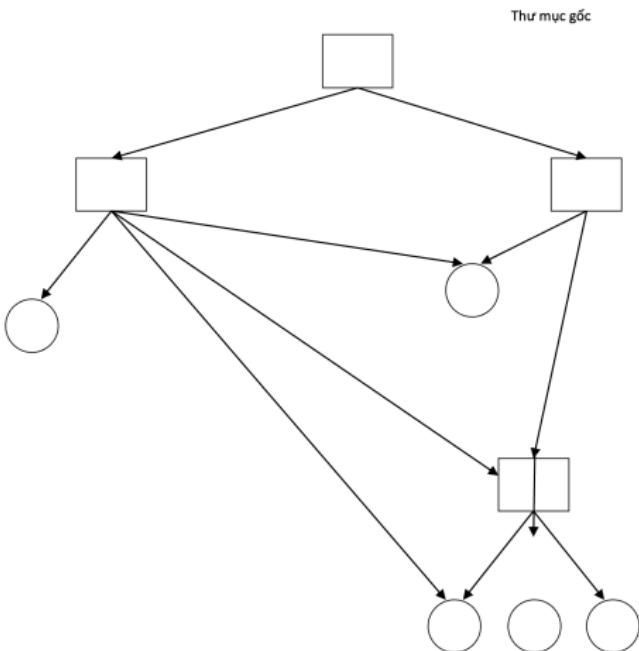


Hình 9: Tree structure folder

► Tree structure folder:

- Distinguish file entry and small folder entry: add special bit in entry
 - ▶ 1: folder entry
 - ▶ 0: file entry
- Each time, user work with current directory
- Organize tree structure folder for each disk:
 - ▶ In file systems like FAT, DOS, tree folder is structured for disk. Folder system is forest, each tree in one disk.
 - ▶ Linux: whole system contain one tree.

► Acyclic graph:



- Files and folder can be at different folders.

- This is a non-cyclic graph, and a extension of tree structure.
- Tree: leaf and branch may belong to other branches.
- Deployment:
 - ▶ Use Sử dụng liên kết: con trỏ tới thư mục hoặc file khác
 - ▶ Create the copies of shared files and store in different folder => ensure the synthesis and consistency => avoid cross back-up, store one file many times.
- Flexible but complicated

- ▶ Describe file location in folder
- ▶ Absolute directory:
 - Directory from root folder, to intermediate folder, file.
For ex: C: -> bc -> bin -> bc.exe
- ▶ Relative Directory:
 - From the current folder Tính từ thư mục hiện thời
 - Add 2 special entries in folder: "." represents current folder, và ".." for upper folder.

► List:

- Organize folder as the list of entries.
- Search entries by scanning the list
- Add new file in folder:
 - ▶ Scan folder to check the existing of file name
 - ▶ New entry is added at the end of the list or one cell in the table
- Open, delete file
- Search in the list (danh sách chậm)
- Store folder in the memory

► Binary tree:

- Increase searching speed thanks to structured data.
- NTFS file system of WinNT

► hash table:

- Use hash function to find location of entry in folder by file name.
- Quick searching time
- Hash function depends on the size of hash table => fixed hash table size.

► Folder structure of DOS:

- Each logic disk has its own folder, starting from ROOT folder.
- ROOT folder is placed at the beginning of disk, right after BOOT sector and FAT table.
- ROOT folder contains files and other child folders.
- Child folder can have files and other lower level folders.
- Organize by table: each entry is one row in table and has fixed size of 32 bytes.

8	3	1	10	2	2	2	4
Tên file			Phần dự phòng			Độ dài	

Diagram illustrating the structure of a DOS file entry table row:

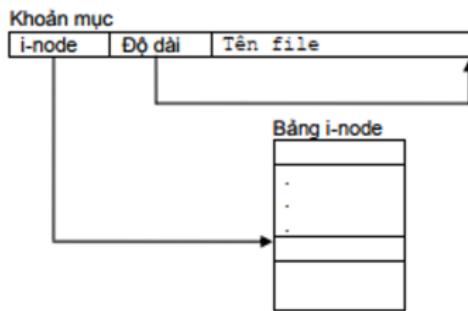
- Column 1: Tên file (File name) - 8 bytes
- Column 2: Phân mở rộng tên file (File extension) - 3 bytes
- Column 3: Thuộc tính (File attributes) - 1 byte
- Column 4: Ngày tạo file (File creation date) - 10 bytes
- Column 5: Thời gian tạo file (File creation time) - 2 bytes
- Column 6: Số thứ tự cluster đầu (First cluster number) - 2 bytes
- Column 7: Độ dài (Length) - 2 bytes
- Column 8: Phản ứng phòng (Reserve space) - 4 bytes

Annotations in Vietnamese:

- Phản mở rộng tên file (File extension)
- Thuộc tính (File attributes)
- Ngày tạo file (File creation date)
- Thời gian tạo file (File creation time)
- Số thứ tự cluster đầu (First cluster number)

► Folder structure of Linux:

- Folder system Ext2 in Linux is simple.
- Entry has file name and I-node address.
- Other information of file properties and location of data block are stored in I-node, not in folder.
- Entry size depends on length of file name.
- The headers of entry has information of entry size.



Conclusions

Chapter 2

- ▶ Definitions
- ▶ File access methods
- ▶ File operations
- ▶ Folder

Next

- ▶ Cấp phát không gian cho file
- ▶ Quản lý không gian trống trên đĩa
- ▶ Độ tin cậy của hệ thống file
- ▶ File system security
- ▶ File system FAT