UNIX SYSTEMS PROGRAMMING

By

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Previous Class

- Basics of Files
- UNIX file system
- Inode
- Fields of Disk inode

Today's Agenda

- Fields of Disk inode continues
- Hard link
- Symbolic link
- Inode Table
- Conversion of a path name to an inode

Inode

- Inode stores the meta data of the file
- Fields of Disk inode
- **File owner identifier**:
- Individual, group, super user [Column 4 and 5 of ls –li]
- **File type**: File, directory, special file or FIFO (pipes)
- [first character of column 2 in ls –li]
- Hyphen (-) represents Regular File
- d represents Directory
- b represents Block Device Driver
- c represents Character Device Driver
- l represents Symbolic Link
- p represents Named Pipe [used for inter process comm.]
- s represents Unix Domain Socket

Inode

- Fields of Disk inode continues
- **File access permissions**
- Column 2 in ls –li
- r represents read permission
- w represents write permission
- x represents execute permission
- - represents the permission is not awarded
- 3 sets of permissions – Owner, Group and Others
- **File size**
- Column 6 in ls –li

Inode

- Fields of Disk inode continues
- **File access and modified times**
- Column 7 in **ls -li**
- Changing the content of a file automatically implies a change to the inode
- Changing the inode does not imply that the contents of the file change
- Changing the permissions affects only the inode change time
- See inode change time with **ls –lc** and data
- content change time by using **ls –lu**
- See **stat** command to display access time, modify time and change time

Inode

- Fields of Disk inode continues
- **Number of links to the file**
- Column 3 in ls -li
- Link count – The number of directories that contain an entry with this inode number
- When a new file is created, by default, the number of links will be 1
- When a new directory is created
- The link count of the parent directory will be incremented
- The link count of the newly created directory will be 2

Creating a link in UNIX

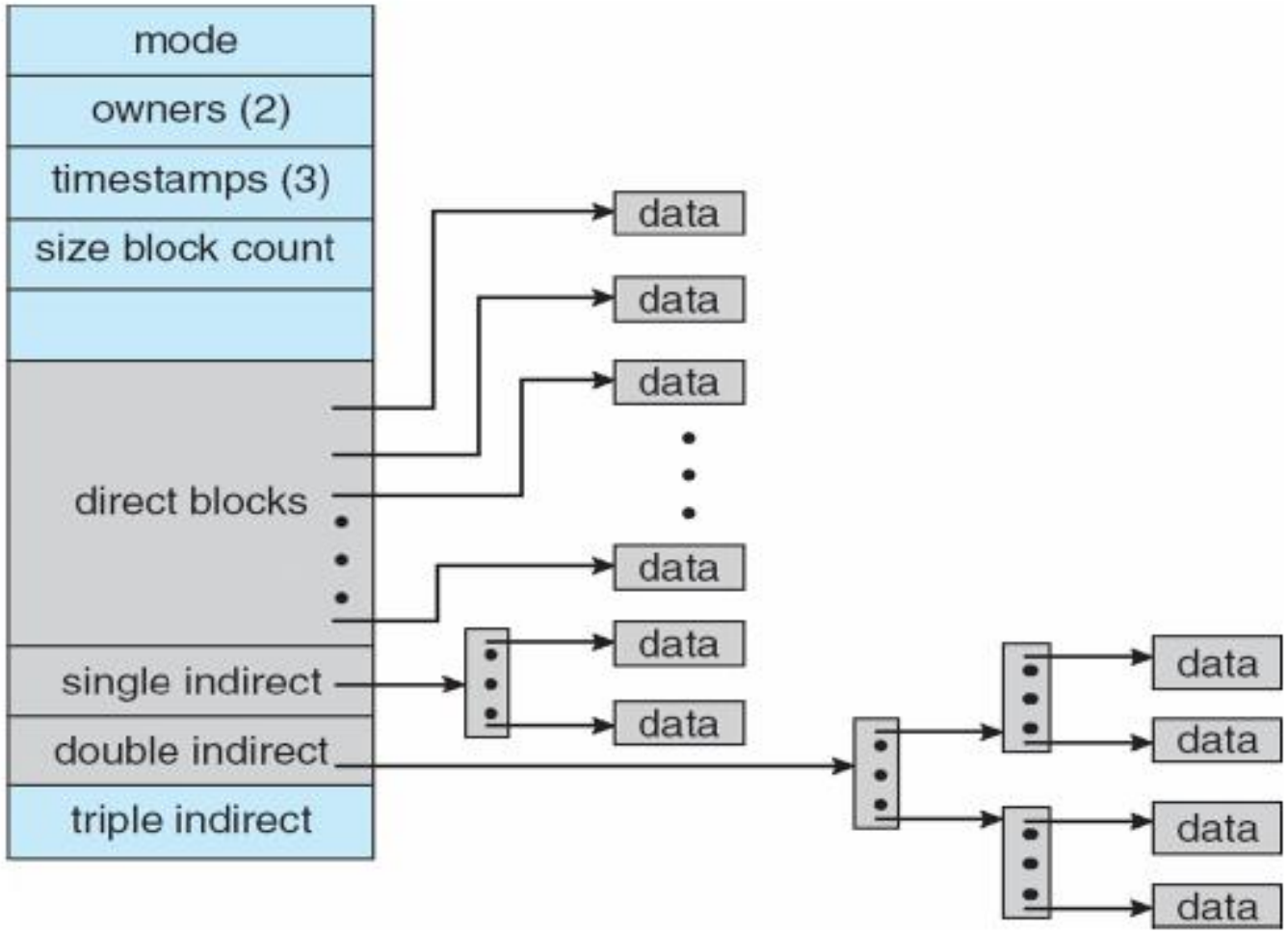
- How to create link?
- 2 types – hard link and symbolic link
- Hard link
- Can be created in UNIX by using ln command
- Syntax: ln <target> <link name>
- Example: ln file1.txt file1link
- Will increment the link count of file1.txt and set the link count of file1link same as file1.txt's link count.
- Two links [hard] to a file point to the same inode, hence will have same inode number
- You can remove a link using rm command.
- – Symbolic link
- Syntax: ln –s <target> <symlink name>

Inode

- Fields of Disk inode continues
- **Table of contents for the disk addresses of data in a file**
- 13 / 15 entries in inode table of contents
- 10 / 12 direct
- 1 single indirect
- 1 double indirect
- 1 triple indirect

UNIX (4K bytes per block)

UNIX (4K bytes per block)



Inode

- Block size is 4kb
- 10 direct entries
- So total size of a file that can be stored using direct entry of inode table is
- 10*4kb=40kb
- That is we can use 10 direct entries in the inode table to store a file having size < 40 kb
- If the file size is more than 40kb then we will use single indirection
- Single indirection
- Lets assume one entry is 4byte
- Total entries in single indirection will be 4K/4B=4096/4=1024 entries.
- Sigle indirect will store 1024*4K=1K*4K=1024*4096=4Mb size of file
- i.e using single indirect we can store upto 4 Mb size file
- Similarly in double indirect we can store upto 1K*1K*4K=4 GB size of file
- And for triple indirect we can access upto 1K*1K*1K*4K=4TB size of file
- Total size that can be represented by an inode is 40K+4MB+4GB+4TB

Inode

- Inode does not specify the path name(s) that access the file
- File names of all the sub-directories and files will be available as a part of the directory data block

Directories

- The first 2 bytes in each directory entry are the only connection between the name of a file and its contents
- UNIX system restrict component names to a maximum of 14 characters, and 2 byte inode number
- Size of one directory entry is 16 bytes
- Every directory contain file names dot and double dots with inode number of its directory and its parent directory respectively
- File name in a directory is called link
- Links a name in the directory hierarchy to the inode, hence to the data

Directories

- Same inode can appear in more than one directory
- Remove file (rm) does not remove inode. It removes directory entries or links
- When the link count becomes 0, the system removes inode, hence the file itself
- Access Permissions
- – Read -> allows a process to read the directory
- – Write -> allows process to create, remove directory entries
- – Execute -> allows process to search the directory for a file name

Conversion of a path name to an Inode

- Kernel converts path + filename to the file's inode
- Kernel parses the path name one component at a time
- All path name searches start from the current directory of the process unless the path name start with '/'(start from the root).
- The current directory inode number and Root inode number are available with the Kernel

Conversion of a path name to an Inode

- Examples
- 1. “/etc/passwd”
- 2. “exercises/SysPgm1/test1/mydetails.txt”
- where the current directory is “/home/SysPgm”

THANK YOU