File system and directory structure

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Agenda

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- Analyzing file properties
- File types
- Links
- Inodes
- Root directory structure

Introduction

- "On a UNIX (LINUX) system, **everything is a file; if something is not a file, it is a process**."
- No difference between a file and a directory, since a directory is just a file containing names of other files.
- Programs, services, texts, images, and so forth, are all files.
- Input and output devices, and generally all devices, are considered to be files, according to the system.

Analyzing file properties

- Output of “ls -l” command on a given file

  -rw-r--r-- 1 student student 12408 2010-25-03 18:44 file
- File type
- Permissions
- Number of hard links
- Owner/Group
- File size
- Last Modified time
- Name

File types

- Regular files (-)
  - e.g. text files, images, audio and video files, etc.
- Directories (d)
  - files that are lists of other files
- Character device file ©
  - relate to devices through which the system transmits data one character at a time
- Block device file (b)
  - correspond to devices through which the system moves data in the form of blocks

File types (cont.)

- Domain sockets (s)
  - a special file type, similar to TCP/IP sockets, providing inter-process networking protected by the file system's access control
- Named pipes (p)
  - act more or less like sockets and form a way for processes to communicate with each other, without using network socket semantics
- Symbolic links (l)
  - a system to make a file or directory visible in multiple parts of the system's file tree

Links

- There are two types of links
  - Soft links: these are like shortcuts pointing to a file or directory. One can create a soft link by executing the following command:
    ln -s <source> <link>
  - Hard links: these are synonyms for files. One can create a hard link by executing following command:
    ln <source> <link>

Inodes

- At the time a new file is created, it gets a free Inode. In that Inode is the following information:
  - Owner and group owner of the file
  - File type (regular, directory, ...)
  - Permissions on the file
  - Date and time of creation, last read and change
  - Date and time this information has been changed in the inode
  - Number of hard links to this file
  - File size
  - An address defining the actual location of the file data

Inodes (cont.)

- The only information not included in an inode, is the file name and directory. These are stored in the special directory files.
- Users can display inode numbers using the '-i' option to 'ls' command or with a 'stat' command.
- The inodes have their own separate space on the disk.

Root directory structure

- / - starting point of directory structure. Every other file and directory on the system is under the root directory
- **/boot** – the place where Linux keeps information that it needs when booting up, like kernel, boot loader, etc.
- **/etc** – the configuration files for the Linux system. Most of these files are text files and can be edited by hand.
  - **/etc/fstab** – contains descriptive information about the various file systems and their mount points
  - **/etc/passwd** – the file that contains various pieces of information for each user account. This is where the users are defined
  - **/etc/hosts** – mapping hostnames to IP addresses

Root directory structure (cont.)

- **/bin** – contains the most important programs that the system need to operate, such as shell, ls, grep, and other essential things.
- **/sbin** – most system administration programs. In many cases these programs must be run as a root user
- **/usr** – this directory contains user applications and a variety of other things for them, like their source codes, and pictures, docs or configuration files they use
  - **/usr/bin** – applications for the system users
  - **/usr/include** – header files for the C compiler
  - **/usr/doc** – documentation for the user applications
  - **/usr/share** – configuration files and graphics for many user apps

Root directory structure (cont.)

- **/lib** – shared libraries for the programs that are dynamically linked (similar to DLLs on Windows)
- **/home** – this is where users keep their personal files. Every user has their own directory under /home
- **/root** – superuser home directory
- **/var** – contains variable data that changes constantly when the system is running
  - **/var/log** – contains system log files
  - **/var/mail** – incoming and outgoing mail
  - **/var/spool** – files that are queued for some process, like printing
- **/tmp** – for the programs to write their temporary files

Root directory structure (cont.)

- **/dev** – the devices that are available to a system
  - **/dev/hda# /dev/hdb# -** IDE hard drives. Each partition is represented as a separate hard drive.
  - **/dev/sda# /dev/sdb#** - SCSI and SATA hard drives. USB stick drives are also shown as sda devices.
  - **/dev/fd0** - primary floppy drive
  - **/dev/cdrom /dev/dvd** – CD/DVD drive
  - **/dev/null** – Black hole. Anything send to this device will disappear
- **/proc** – virtual directory containing running processes, kernel configuration, etc.