File management and manipulation

Операционни системи, ФМИ, 2019/2020

Filesystem Hierarchy Standard

- Filesystem standard (FHS)
  - Guiding principles for each area of filesystem
  - Predictable location of files and directories
  - Provides uniformity across multiple Linux distributions
- The Linux Standards Base
  - Aims to allow Linux binaries to run unmodified on multiple Linux distributions
  - Specifies system and library interfaces and environment
  - Incorporates the FHS

Navigating the filesystem

- *absolute* vs. *relative* addressing
- changing and displaying directories (`cd`, `pwd`)
- `cd` (without parameters)
- `cd ~george`
- `cd ~`
- `cd -`
- `.` and `..`

Displaying directory contents

- *human-readable*
- `ls`
- `ls -a` - show all files (including *.hidden* files)
- `ls -l` - long listings
  - `ls -lh`
- `ls -d` - show directories, not contents
- `touch foo`
- `mkdir bar`

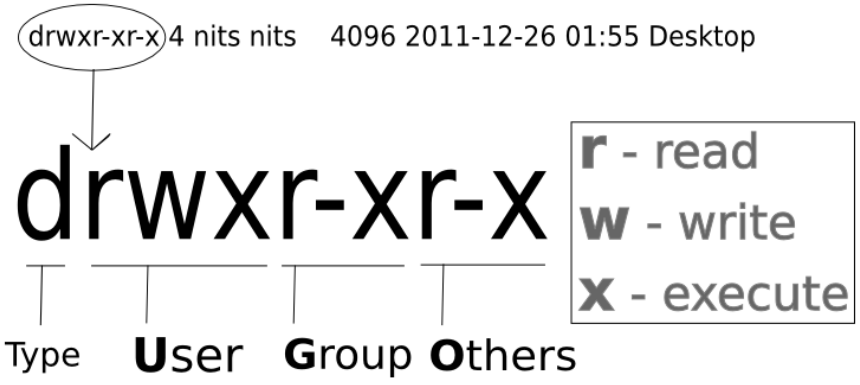
File {group,}ownership

- each file is owned by a specific UID and GID
- `chown` - change the user (UID) ownership
  - only root can change ownership to another user
  - `chown foo:bar`
- `chgrp` - modify just the group (GID) ownership
  - `chown :bar`
- newly created files will usually be given GID ownership based on the current active group of the person who creates the file

File permissions

- type of file
  - `-` - regular file
  - `b` - block special file
  - `c` - character special file
  - `d` - directory
  - `l` - symbolic link
  - `p` - FIFO (named pipe)
  - `s` - socket
- permision sets
  - user (owner)
  - group (group owner)
  - everyone else (other)
  - symbolic representation `rwxr-xr-x`
  - numeric representation 0755

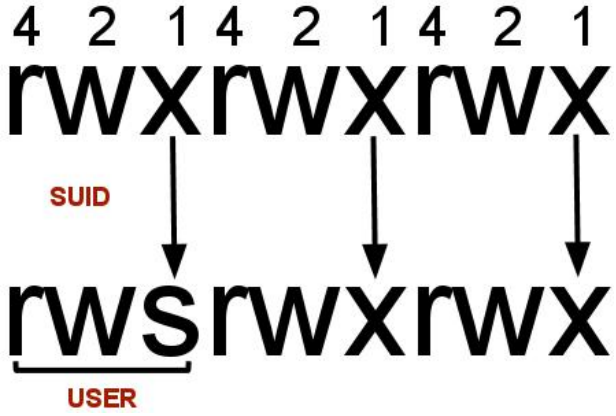
File permissions (cont.)



- `r - 100b - 4` - Read
- `w - 010b - 2` - Write
- `x - 001b - 1` - Execute
- `v`

Special permissions

- Set UID upon execution (SUID)
- Set GID upon execution (SGID)
- sticky bit
- different behavior for files and directories



Special permissions (cont.)

- SUID and SGID on files
  - an executable with the SUID bit set runs with the security context of the user who owns it, regardless of the executing user
  - SGID
- SGID on directories
  - files or sub-directories created within that directory inherit the group ownership of the SGID directory
- Sticky Bit on directories
  - normally in a directory that is world writable, users can delete each other's files. Setting the sticky bit overrides this behavior

Changing file permissions

- `chmod`
  - numeric notation `chmod 0664 foo.txt`
  - symbolic notation `chmod u=rw,g=rw,o=r foo.txt`
  - `+`, `-`, `=`
- `chmod -R`

umask

- Default permissions for newly created filesystem objects
  - files 666
  - directories 777
- `umask`
  - defines what permissions to **withhold** from the default permissions
  - display or change umask
  - usually set in the user or system shell dot files

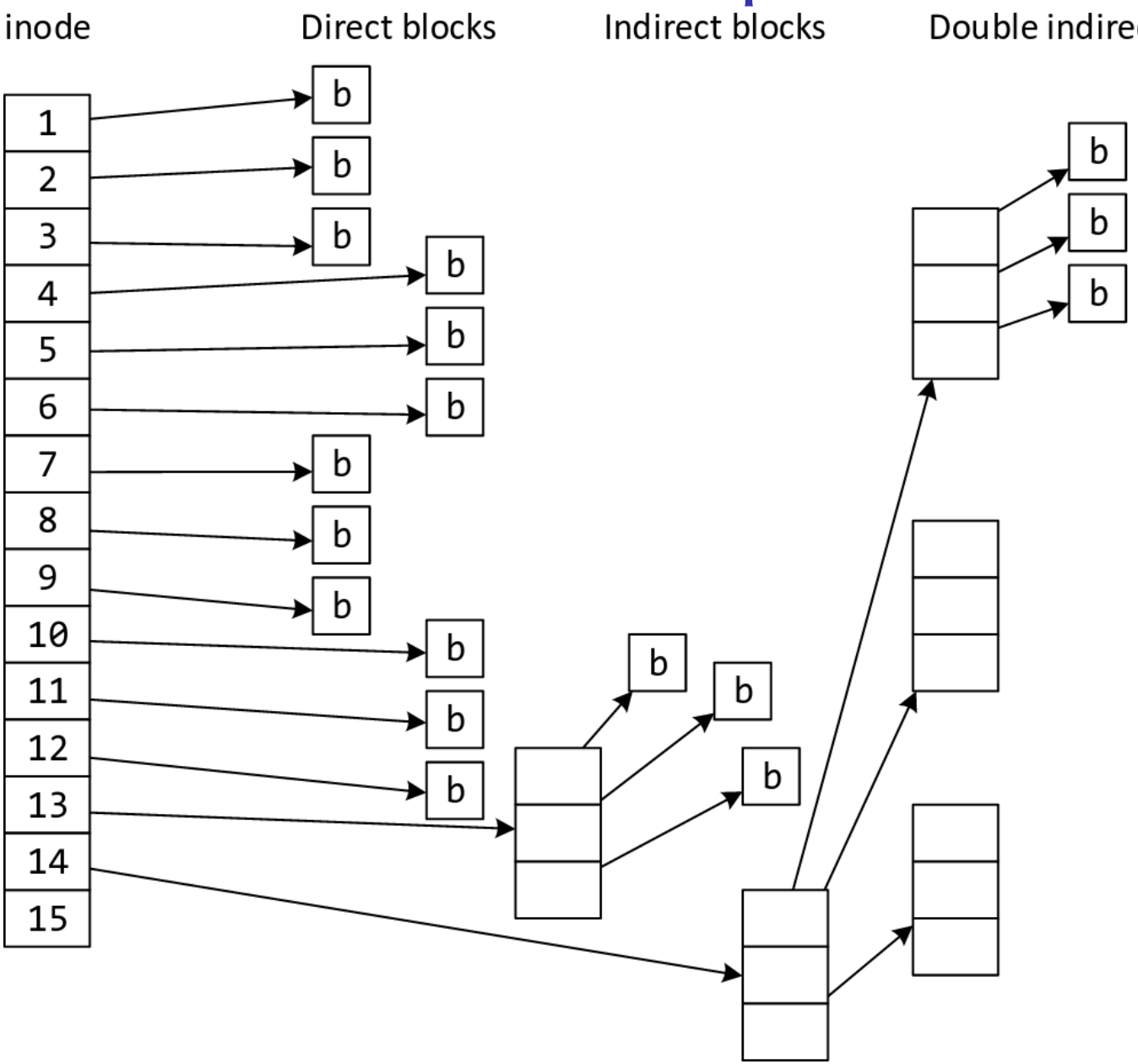
Directory and file manipulation

- `mkdir foo`
  - `mkdir -p foo/bar`
  - `mkdir -m`
- `rmdir`
- `cp`
- `mv`
- `rm`
- `touch` - mtime/atime

UNIX filesystem structure

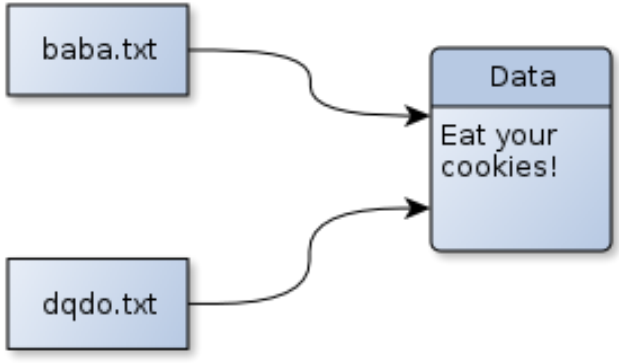
- blocks
- inodes
  - permissions
  - access time, modification time, inode change time
  - owner
  - group
  - size in bytes
  - occupied blocks
  - link count (names of the inode)
  - inode number
- directories (are files that) hold filenames and inodes
- superblock contains filesystem parameters (how many inodes, etc.)

inode pointer structure



Filesystem hard links

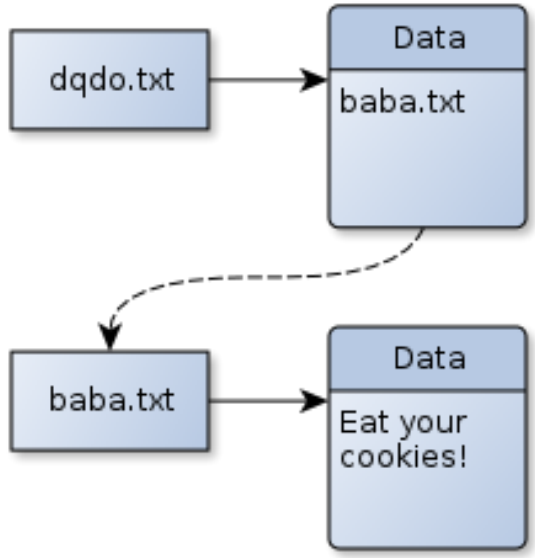
- a directory entry that references the same inode as another directory entry
  - can't span filesystems
  - can't create hard links to non-existent file
  - can't reference directories
  - do not occupy storage space (i.e. blocks)
  - `ln [option]... target link_name`



- `ls -i`

Filesystem symbolic links

- a file that references another file via path and name
  - can reference directories
  - can span filesystems
  - can reference non-existent files
  - `ln -s target link_name`
  - occupy space



- symlink / soft link

df, du, stat

- `df` Report disk space usage per filesystem
  - `-h` human readable output
  - `-i` list inode information instead of block usage
  - `-T` include filesystem type
  - `--si` use powers of 1000 instead of 1024
  - `-P` use the POSIX output format
- `du` Report disk usage per file and directory
  - `-h` human readable sizes
  - `-s` summarize, only display total for each argument
  - `-x` do not include files on a different filesystem
  - `--si` use powers of 1000 instead of 1024
- `stat` display file or file system status
  - `-L` follow links
  - `-c --format`

File extensions and content

- file extensions are just part of the file name
- some applications may care about extensions
- `file` - reports the type of file by examining the file contents
- `/usr/share/file/magic.mgc`

Displaying text files

- `cat` - concatenate files and print on the standard output
- `more`
- `less`
- `head`
- `tail`
  - `tail -f`
- `-n`

Displaying binary files

- displaying raw binary data may corrupt the display terminal
- `strings` - displays ASCII text inside binary files
- `xxd` - displays HEX and ASCII dump of file
- `clear`

xargs

- build and execute command lines from standard input
- `xargs [options] [command [initial-arguments]]`
- reads items from the standard input
  - delimited by blanks or newlines
- executes the command (`/bin/echo`)
  - one or more times
  - with any initial-arguments
  - followed by items read from standard input
- `-0, --null`
- `-I`
- `-n`

Searching the filesystem

- *machine-readable*
- `find [options] [starting-point] [expression]`
  - global/positional options
  - tests
  - operators
    - `-o`, `-a` (default)
  - actions
    - `-print` vs `-print0` vs `-printf`
    - `-ls`
    - `-exec`
- `find /foo -name bar -print`

Archiving & compressing

- archiving
  - `tar`
  - `cpio`
- compressing
  - `compress`
  - `gzip`
  - `bzip2`
  - `lzma`
  - `xz`

Archives with tar

- `tar`
  - manipulates `.tar` files (*tarballs*)
  - used for backup and transfer of files
  - creates, extracts or lists the contents of tarballs
  - `c`, `x`, `t`, `f`, `v`
  - traditional vs. UNIX-style vs. GNU-style usage
  - `tar cvf foo.tar ./foo/*`
  - GNU `tar` supports built-in compression methods
    - `-a, --auto-compress`
    - `-J, --xz`
- `.tar` (*tarball*)
  - records file and directory structure
  - includes metadata about the file: date, timestamps, ownership, permissions, etc.

XZ Utils

- `xz`
- `.xz`
- `unxz` / `xzcat` / `xz -d`
- compression format of choice