Introduction to the Linux OS

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Overview and Organization

Introduction to the Operation system Linux, focus on the command line, scripting, basic services and tools used in (not only) physics: tasks automation in data processing and modeling

Organization

- Graded Assessment (KZ): attendance to the lectures, worked out homeworks

Literature

- C. Herborth: Unix a Linux - Názorný průvodce, Computer Press, Praha, 2006
- D. J. Barrett: Linux - Kapesní přehled, Computer Press, Praha, 2006
- M. Sobell: Mistrovství v RedHat a Fedora Linux, Computer Press, Praha, 2006
- M. Sobell: Linux - praktický průvodce, Computer Press, Praha, 2002
- E. Siever: Linux v kostce, Computer Press, Praha, 1999
- Number of online sources...

Study materials and homeworks

- http://kfa.mff.cuni.cz/linux

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Syllabus

1. UNIX systems, history, installation, basic applications
2. Structure of the Linux OS, file systems, hierarchy of the file system
3. Command line, shells, remote access (ssh, ftp)
4. Processes and their administration, basic system commands, packages, printing
5. Users, file and directory permissions
6. Work with files and directories, file compression, links, partition
7. Text-file processing commands, redirection, pipeline
8. Regular expressions
9. Command line based text editors
10. User and system variables, output processing
11. Scripts: basic construction, conditionals, loops, functions, automation
12. Networking, server-client services: http, (s)ftp, scp, ssh, sshfs, nfs
13. Programming in Linux (examples of Fortran, C/C++, Python), version control systems, documents in Latex

Scripts: Basics

Sequence of commands can be put into script files.

- `#` are used for comments
- Special header "comment": `#!/usr/bin/zsh` instructs the script to be run by the `zsh` shell. Not only for shells, but also for interpreters like `python`
- `exit` [`number`] to quit script [and possibly return a *return code*]
  - Not needed at the very end of a script, it will end by itself
- `set -x` command inside a script instruct to show the commands being run by the script
- Two ways how to run a script:
  - *./script.sh*: starts a new shell and runs the script in it
  - *source ./script.sh* (or also `. ./script.sh`: runs the commands from the script one by one in the current shell → i.e. as if one would write them manually in the current terminal
  - PS: The *'./'* makes sure it runs `script.sh` in the current directory, and not somewhere from the `$PATH` paths

```
#!/bin/sh
echo $SHELL
sleep 0.5
```

Commands: User Information

- `login`: Login user to the session, normally not directly invoked
- `logout`: Logout user from the session
- `exit`: Exit from the terminal/shell/script
- `id` [user]: User and group id information about myself
- `groups` [user]: List groups user is in
- `whoami`: Return user-name
- `who`: Show who is logged in
- `w`: Show who is logged in and what is he/she doing
- `last`: Show list of last logged-in users
- `su/sudo`: Become superuser
  - `su -` to make sure superuser paths are set
  - `sudo -i` to start superuser shell

- `ls` [path/file]: List files/directories
  - `ls -1`: List one file/dir per line
  - `ls -l`: List full information:

```
-rw-r--r--  1 reznicek reznicek 15360 Oct 14 19:40 osnova_Uvod_do_Linuxu.doc
drwxr-xr-x 18 reznicek reznicek  4096 Jan 31 2019  skola
```

    - File type (file='-', dir='d', ...), access rights
    - Number of links (copies)
    - User name
    - Group name
    - Size in bytes
    - Date and time of last modification
    - File name
  - `ls -h`: Human readable file size
  - `ls -a`: List also hidden files and directories (`.*`)
  - `ls -d`: Show information about directory instead of listing its content
  - `ls -R`: List recursivelly also content of sub-directories
  - `ls -t`: Sort by modification time
  - `ls -r`: Reverse sort order (name, time)
- `stat file`: Disk-storage info about `file`
  - Physical place on disk
  - Creation, modification and access times

Commands: File / Directories

- `cd` [path]: Change directory
  - `cd ../`: Go one directory up
  - `cd ./`: Go to (stay in) current directory
  - `cd /`: Go to root (top filesystem) directory
  - `cd ~/`, `cd`: Go to home directory
  - `cd -`: Go to previous directory (back from last cd command)
  - Change directory *relatively* to the current dir or *absolutelly* specified path from the root dir
    - *relative* path example: `cd work/papers` or `cd ./work/papers`
    - *absolute* path example: `cd /home/username/work/papers`
- `pwd`: Print current directory
- `readlink -f file`: Print full path to the given `file`
- `cat file`: Dump content of `file` on the screen
- `less file`: Browse `file` content on the screen
  - Enhanced `more` command (also on Windows)
  - Search for content ('/' key)
- `touch file`: Update *modification time*
- `diff file1 file2`: Show difference between two files, GUI versions exist too (`meld`, `diffuse`)
- File and directory manipulations (see later lectures in details):
  - `cp`, `mv`, `rm`: copy, move/rename, remove files
  - `mkdir`, `rmdir`: create directory, remove (empty!) directory
- Terminal-based file browser: `mc`

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Work on Remote Machine via SSH

Secure Shell Connection, assuming the host PC is running `sshd` server (just install the ssh-server package...)

Client can:

- `ssh -Y username@hostname`
- Gains access to login shell on remote machine
- Can send graphical windows (e.g. xterm)
  - `-Y` allows to transfer graphics
- With sudo/su commands can manage the computer (including reboots, poweroff etc.)
- Configure automatic options for ssh via `$HOME/.ssh/config` file:

```
Host lxplus
  user reznicek
  Hostname lxplus.cern.ch
Host ipnp-stick
  User mlive
  Hostname 10.77.0.11
```

At MFF there is a faculty computing Linux cluster `chimera` for all faculty members:
https://www.mff.cuni.cz/en/hpc-cluster/general-information

Manipulation with users and groups

Users:

- Users stored in `/etc/passwd`

```
student:x:1001:1001:Student linuxu,T11,1234,5678,Poznamka:/home/student:/bin/bash
```

- `adduser`: add new user, copy `/etc/skel` content to the newly created home directory. Default options in `/etc/adduser.conf`
- `deluser`: remove user (home directory is kept by default)
- `usermod`: modifications to user settings (home dir, id, password-expiry, groups, shell, lock-password)
- `chfn`: changer user information (full name etc.)
- `passwd`: change user password
- `chsh`: change user shell

Groups:

- Groups stored in `/etc/group`
- `groupadd`: add new group
- `groupdel`: delete group
- `groupmod`: name, id
- `gpasswd`: groups can have passwords, administrators

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Change ownership of a file/dir

Users:

- `chown username:groupname file`: change user and group ownership of a file/dir
  - `chown -R`: recursively for all sub-directories
  - `chown --dereference`: for symbolic links "jump" to the real file the link is pointing to
- `chgrp groupname file`: changer group ownership of a file/dir
- Username change mostly only for superuser, user cannot "give" file to another user. But owner can modify group =¿ give file for r/w to other users via groups

Change read/write/execute/access rights to files/dir

```
meop35 exam # ls -lai
total 21
1433763 drwxr-xr-x  5 petr petr     288 Oct  9 11:59 .
   4350 drwxr-xr-x 11 petr users    976 Oct  9 11:57 ..
1434761 -rw-r--r--  1 petr petr   13643 Oct  8 21:37 FILESYSTE.win
1434763 lrwxrwxrwx  1 petr petr      11 Oct  9 11:59 core -> /proc/kcore
1434735 drwxr-xr-x  2 petr petr      48 Oct  9 11:57 doc
1434764 srwxrwxrwx  1 petr petr       0 Oct  9 11:59 gpmctl
1434757 drwxr-xr-x  2 petr petr      72 Oct  9 11:58 hudba
1434758 -rw-------  1 petr petr      31 Aug 21 13:52 hymna.mp3
1434756 drwxr-xr-x  2 petr petr      80 Oct  9 11:58 prednasky
1416878 crw-rw----  1 root tty   2, 190 Oct  9 11:59 ptyae
1434762 lrwxrwxrwx  1 petr petr       9 Oct  9 11:58 sym_link -> hymna.mp3
meop35 exam #
```

Command `chmod`

- `chown ugoa+/-rwxst file`
  - `u`: user rights
  - `g`: group rights
  - `o`: rights of others
  - `a`: rights of all (user, group, others), not specifying who defaults to "all"
  - `+`: add rights
  - `-`: remove rights
  - `r`: read rights
  - `w`: write/modify rights, for dirs only works when 'x' is set too
  - `x`: executable (file), directory enter and listing allowed (directories)
  - `s`: setuid bit, allows to run command with file-owner privilegies (`/etc/passwd`)
  - `t`: sticky bit for directory (o+t): everyone can create files, but files can be deleted only by the owners (Despite the "xw" rights for all in the directory - e.g. `/tmp`)

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1416878 crw-rw----  1 root tty   2, 190 Oct  9 11:59 ptyae
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meop35 exam #
```

Command `chmod`

- `chown 0644 file`
- Rights can be also defined by octal numbers:
  - 777 = (binary) 111 111 111 = rwx rwx rwx
- Default permissions driven by `umask` (022 = files ar 644, dirs are 755 =¿ i.e. it is subscracted from 666 and 777)
- Some filesystems support more advanced file-atributes (e.g. immutable, nodeletable, no copy, no write, ...) via commands `chattr` (and listing these attributes via `lstattr`)

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Users and Groups

Users and Groups:

- /etc/passwd: users configutation: home, shell, title, uid
- /etc/shadow: users password hash
- /etc/groups: groups

Superusers:

- su / sudo (-i)
- su needs further config to run graphical applications
- visudo
- separate home dir in /root