Linux Crash course*

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1. Basics

Linux operation system (OS) is represented as a complex *filesystem*. All programs (e.g., /bin/cat), devices be it character (or stream-oriented) /dev/tty1 or block (random access) /dev/sda are represented as points of filesystem. The one major exception here is the *Network interfaces*. The filesystem one of the central parts of Linux, it is the first thing should be studied, however, understanding its structure is not difficult. First-of-all, the filesystem consists of tree hierarchy of files (leaves) and directories (internal nodes, or leaves).

Command	Description
<filename></filename>	A file is a named block of data in a filesystem. It always is presented as a part of some directory.
<directory></directory>	Is a virtual structure (file container), which other directories and files belong to. A set of directories form
	a parent-child relation based tree (directory-directory, directory-file).
filesystem	All files and directories form a filesystem.
1	Root directory of the filesystem – main directory for which all directories of filesystems are subdirectories
	and sub-subdirectories, etc. (or in other words children and descendants by parent-child relation).
pwd	Shows set of directories in parent-child relation from root directory (\prime) to the current directory.
•	Alias for current directory.
••	Alias for parent directory.
~	Home directory of current user.

Structure of file system:

/	Beginning (starting) point of a filesystem, root directory.
/boot	Contains kernel image file and modules, loaded during start up.
/home	Home folders for all users.
/sbin	Admin program and programs for privileged users.
/dev	Device files (character devices, block devices), e.g. terminal(tty), hard drive (hda, sda), cd-rom (sd).
/etc	Configuration files.
/bin	User programs and utilities.
/lib	Important shared libraries and kernel modules.
/mnt, /media	Directories for temporary mounting filesystems of external harddrives, usb, etc.
/opt	Optional packages, applications.
/proc	System files.
/proc/net	Network protocols status.
/proc/modules	Modules loaded currently.
/tmp	Temporary files.
/usr	User/system program, libraries and utilities.
/usr/bin	User program and utilities.
/usr/lib	Libraries for programs and programming languages, desktops.
/usr/local	Directory for applications installed locally (by user).
/usr/share	Architecture independent data, common for different systems, e.g. man pages.
/var	Variable files, user-specific.
/root	Home directory for root user.

2. Access rights/permissions

File permissions are divided into three categories by the user groups:

^{*}See http://www.comptechdoc.org/os/linux/usersguide/ are of many sources for deeper study.

- (a) Access rights for the owner (the one who created file).
- (b) Access rights for the group (which the file belongs to).
- (c) Access rights for other users.

and three symbols used to define access rights:

Char	Effects for files	Effects for directories
r	File can be read.	Directory can be viewed (list of files and subdirectories).
W	File can be changed.	Content of the directory can be changed (new files, delete files).
x	File can be executed.	Directory can be accessed.

(a) **r** for reading access. For files content can be read, for directories the listing of the directory can be obtained.

Normally permissions are written as 9 symbols: the first 3 symbols for the access rights of owner, the second – for the group, and the last – for other users (not the owner, not the group members).

For example: **rwxrwxrwx** full access for everyone or **rw-r-xr-** read/write access for owner, read and execute for the group and only read for others.

The most privileged user is **root**.

3. Types of files and directories¹.

These can be found by usage of a command ls -l (or ls -lah) the first symbol of each raw, which is explained later.

Char	Description	Example
-	Regular file	-rw-rr group user foo.txt
d	Directory	drwxr-xr-x group user tinyos
с	Character Device	crw-rw root root usbmon0
b	Block Device	brw-rw root disk sda
S	Local Domain Socket	srw-rw-rw- root log
р	Named Pipe	prw-rr- group user my_pipe
1	Symbolic Link	lrwxrwxrwx group user ns -> ns-allinone-3.12.1/ns-3.12.1

4. Console/shell.

Though Linux has X Window System (GNOME, KDE are based on it), the console (terminal) is still major part of Linux user interaction. The terminal system is core part of Linux, before loading X Window system the terminals are loaded and used (terminal is the first to boot, X Windows boots later, if at all).

X Window System is divided onto two parts, the first one is X Server part which reproduces graphics, takes input, etc, and the second one is the set of working programs which when needed ask X Server to display the user interfaces (client-server architecture is used). Inside X Window system X terminal (xterm), GNOME console, KDE's konsole emulates terminals in X Window systems and are essential parts of those. Thus, X Window System (X11) can be viewed as some kind of addition to terminals, though as it was said previously the copies or terminal emulators were implemented in X Window system, to support multiple terminals in one environment with graphical enhancements. The study and possibility to use consoles/terminals at full power is core to understanding Linux. Here, we will concentrate on commands used in terminals instead of X11 interfaces, although some functions and programs will need X11 in order to run, e.g., gnuplot, xfig.

5. File system usage, control and navigation

Command	Description	
ls	List files in current directory (if directory is specified explicitly then in the specified directory).	
	Options: "1" – list in rows with additional info, "a" – all, including hidden/functional (e.g., .bashrc), "h"	
	– human readable output.	
ad	Change current directory to a given one. The directory where to change can be given related to current	
ca	directory, or related to globally known directories (e.g., \sim or /).	
mkdir	Create a directory with a given name.	
rmdir	Remove directory(ies) with a given name.	
ср	Copy file(s) from source to destination.	
mv	Move file(s) from source to destination.	
rm	Remove files (with -rf option removes also directories, -r for recursion, -f for "forcing").	
rename	Renames multiple files (command mv can be used to rename one file).	
touch	Create files if it does not exist, changes timestamps otherwise.	
df	Shows filesystem disk usage. Option: -h produce human readble answer.	
du	Estimates file space usage. Option: -h produce human readble answer.	

¹http://bashshell.net/file-permissions-and-attributes/understanding-linux-file-types/

6. Restrictions

Command	Description
chmod	Change file mode bit. Permissions bits as discussed above. E.g., chmod 755 test.txt sets full access
	for the owner, and limited access to group and others.
chown	Change owner of files/directories. Rule 755 corresponds to binary 111.101.101 which in turn corresponds
	rwx.r-x.r-x as above.
chgrp	Change group owner of files/directories.
sudo	Do command as a substituted user (without specified username, treated to do as a root). What does
	sudo -s -H do?

7. File management tools

Command	Description
find	Search for files. E.g., findname "test.txt" search file "test.txt" starting from current directory
	recursively (by default).
awk	Pattern scanning program.
sed	Stream editor for filtering program.
cat	Concatenate files and print.
head	Output first parts of file.
tail	Output last parts of file.
tr	Translate or delete characters.
expand	Convert tabs to spaces.

8. File editors and viewers

Command	Description
emacs	Emacs file editor (also xemacs available for x windows system).
vi	VI editor for programmers.
more	Display text file on a screen. Basic viewer.
less	Display text file on a screen (with forward and backward navigation).
nano	Basic text editor with additional functionality, such as Alt+G - goto line command, etc.
gedit	Text editor for gnome desktop. With additional plug-ins it has highlighting for programming, script
	writing and so on.

9. $Shells^2$

Type echo **\$SHELL** to see what shell your are using, in this course we consider only **bash**.

Command	Description
bash	GNU Bourne-Again SHell.
csh	C shell.
ksh	Korn shell.
tcsh	TENEX C shell.
zsh	Z shell.

10. *Remote tools*

Command	Description
ssh	OpenSSH SSH client (secure remote login program). Allow all the shell functionality on the remote
	machine as for local user.
svn	Subversion command line client tool.
screen	Screen manager with terminal emulator.

11. Tricks and special commands

Command	Description
/.bashrc	The first file to be executed when starting bash shell.
g	Alias can be put in /.bashrc. Put line alias g='gnome-open' for GNOME user interface (generally,
	it can be alias g='xdg-open' for any X user interface: Gnome, KDE, xfce, etc) and you will be able
	to open files/directories from console using GNOME interface, as if you called those files directly in user
	interface. For example, "g ." opens current directory in file system navigator.

12. Processes control programs

²Comparisons in http://www.faqs.org/faqs/unix-faq/shell/shell-differences/ http://www.hep.phy.cam.ac.uk/lhcb/LHCbSoftTraining/documents/ShellChoice.pdf

Command	Description
ps	Show list of current processes running. Use ps - e for all processes running.
kill	Send close signal to a process, e.g. kill 123.
killall	Kill processes by name, e.g. killall emacs.
top/htop	Interactively shows current processes running, and CPU/memory usage, with additional possibility to
	search, kill processes.

13. Common command options in Linux.

Note: Use of one dash ("-") goes with single letter versions of options and the use of double dash ("--") goes with many-symbol, word versions of options. Many options has both versions of options e.g., "-v" and "--version" are the same options.

Command	Description
help	Information on command usage and options.
-1	List.
-R	Recursive.
-h	Human readable (say sizes not only in bytes, but also in megabytes, gigabytes). Example: "df -h", "1s -1h". In other cases it can be treated as short version of "help" option. Example: "nano -v".

14. Other commands, not listed in any command sets

Command	Description	
locate	Search for a file in known places (beforehand collected databases).	
who	Shows who is logged in to current machine.	
whoami	Print username by which you logged in.	
whereis	Locate the binary, source, and manual page files for a command.	
wget	Network downloader.	
man	An interface to the on-line reference manuals.	
ln	Makes links (hard, soft links) between files and directories.	
>	Write to file (output stream) and associate it with STDOUT.	
<	Open file (input stream) for reading and associate with STDIN.	
2>&1	Send STDERR to the same place that STDOUT is going to.	
>>	Append to file (output stream).	
1	Pipelines. E.g., echo "Hello" if read var1; then echo \$var1, world\!; fi;	
diff	Compare files (directories as a set of files) by line.	
patch	Apply patch (a diff file, previous result of comparison) to given original version of file.	
export	Prints (modifies) environment variables and variables associated to user.	

Notice piping usage: combination more +10 filename | head -n10 prints file filename starting from line 10 upto line 19 (10 lines).

More complete command list can be found in http://www.mediacollege.com/linux/command/linux-command.html or http://www.pixelbeat.org/cmdline.html, or simply call man <command> in order to see system manual on the command.

Additional information: Hot keys for terminals (working on konsole, minor changes possible on different consoles.

Key	Description
Ctrl+C	Kill current process in terminal.
Ctrl+Z	Stop process and return to terminal input line. After stopping process command bg sends process to background (it will continue to run while the terminal is free for new commands) and command fg sends process to foreground (the process is returned to run and occupy terminal).
Ctrl+D	Log out from the current terminal.
Ctrl+A or Home	Move cursor to beginning of input line.
Ctrl+E or End	(Move cursor to end of input line.
Tab	List available commands from typed letters (Ex: type iw and click tab, output = iwconfig iwevent iwgetid iwlist iwpriv iwspy)
Ctrl+U	Delete current line
Ctrl+K	Delete current line from cursor
Ctrl+W	Delete word before cursor in terminal
Arrows up / down	Browse command history
Ctrl+R	History search. Finds the last command matching the letters you type. Repeating hotkey Ctrl+R again search the next matching command, etc.
Shift+PageUp / PageDown	Scroll terminal output
Ctrl+L	Clears terminal output
Shift+insert	Paste
Mouse selection	In X selection of mouse (left button + hold while moving) copy the selected area in special buffer.
Mouse middle button	Paste selection from special buffer to the place where is the mouse cursor.