

Introduction to GNU/Linux

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The GNU/Linux operating system (History)

■ Linux

```
Path: gmdzi!unido!fauern!ira.uka.de!sol.ctr.columbia.edu!zaphod.mps.ohio-state.edu!wupost!uunet!mcsun!ne
From: torva...@klaava.Helsinki.FI (Linus Benedict Torvalds)
Newsgroups: comp.os.minix
Subject: What would you like to see most in minix?
Summary: small poll for my new operating system
Keywords: 386, preferences
Date: 25 Aug 91 20:57:08 GMT
Organization: University of Helsinki
```

Hello everybody out there using minix -

■ GNU (GNU's Not Unix)

```
From: CSvax:pur-ee:inuxc!ixn5c!ihnp4!houxm!mhuxi!eagle!mit-vax!mit-eddie!RMS@MIT-OZ
From: RMS@MIT-OZ@mit-eddie
Newsgroups: net.unix-wizards,net.usoft
Subject: new Unix implementation
Date: Tue, 27-Sep-83 12:35:59 EST
Organization: MIT AI Lab, Cambridge, MA
```

Free Unix!

The GNU/Linux operating system (Today)

Linux market share¹

- 1.5% Personal computers
- 35% Servers
- 53% Smart devices
- 97% Supercomputers

¹Source: Wikipedia



(a) Full Ubuntu installation on a dedicated partition



(b) Open Virtualization Archive with
ROS Indigo on Ubuntu 14.04.3 LTS

- nothing to be afraid of :)
- Gnome "desktop manager"
- Dash menu (equivalent of Start in Windows)
- Web browsing: Firefox
- File browsing: Nautilus
- Text editor: Gedit
- Installing software: Ubuntu Software Center

Exercise: Using Nautilus

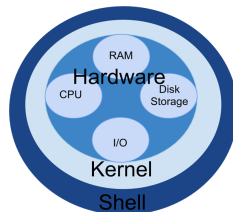
Using the Nautilus file browser, create a folder named pzros in your home folder.

Power users use the shell (a.k.a command line)

Why use the shell, when we have icons, windows and mice?

- faster
- complex operations via chaining
- batch operations
- in some cases, it's *the only option*

We'll be using the **bash** shell.



A note on notation

- \$ sign signifies a regular user prompt
- # sign signifies a superuser prompt
- Text in "monospace" font is to be entered literally, e.g.

```
user@host:~$ mkdir /tmp/test
```

- Pair of matching less/greater than signs (<>) denotes a "variable":

```
$ cd /home/<username>
```

- Pair of matching brackets denote an optional entry:

```
$ ls [-l]
```

Files and directories (1)

- Where are we?

```
user@host:~$ pwd
```

- What's inside?

```
user@host:~$ ls
```

- Additional options

```
user@host:~$ ls -la
```

- How to move/navigate?

```
user@host:~$ cd pzros
```

- Creating a directory

```
user@host:~/pzros$ mkdir tmp
```

- Creating a file

```
user@host:~/pzros$ gedit README.pzros &
```


Files and directories (2)

(Very) useful tips

- Tab completion
- Command history

- How to list file contents?

```
user@host:~/pzros$ less README.pzros
```

- Copying a file

```
user@host:~/pzros$ cp README.pzros tmp/
```

- How to delete a file?

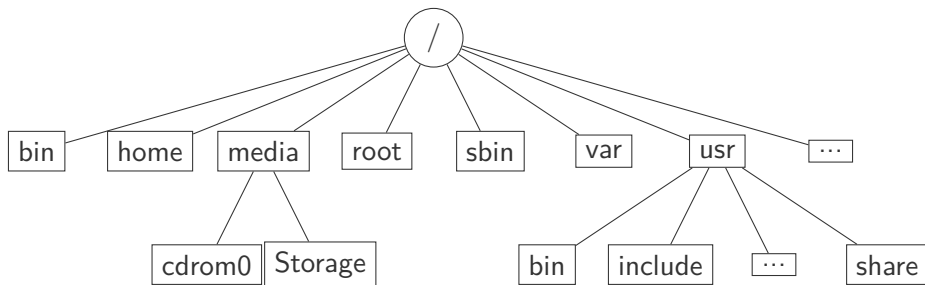
```
user@host:~/pzros$ rm tmp/README.pzros
```

Tip

Type *q* to get out of interactive programs like *less*.

Filesystem Hierarchy Standard

```
user@host:~/pzros$ ls -la /
```



<http://www.pathname.com/fhs/>

Exercise: Removable media

Insert a USB stick into your computer. List its contents in the terminal.
Don't forget to eject the USB device before removing it!

Filesystem permissions

- List contents of the root² user home directory

```
$ ls /root
ls: cannot open directory /root: Permission denied
...
```

- Every file/directory has permissions

```
$ ls -ld /root
drwxr-xr-x 34 root root 4096 2012-09-21 17:00 /root
```

set for three roles: owner, group and all others.

- Tools that manipulate ownership and permissions: `chown`, `chgrp` and `chmod`.

²This is where the term "to root" an Android device comes from

Superuser (root)

- Login disabled for root
- Multiple users can be designated as superusers using sudo³
- Executing a command with superuser privileges

```
user@host:~$ sudo ls /root
```

- Gaining a root shell

```
user@host:~$ sudo -i
root@host:~# gedit message.txt &
root@host:~# cp message.txt ~user
```

³Through the "User Accounts" GUI tool, or by editing (`/etc/sudoers`)

Command chaining and I/O redirection

- Pass a long output of a command to less using pipe |

```
$ ls -la /usr/lib | less
```

- Redirect the output of a command to a file

```
$ echo "Robots rule" > out.txt
```

```
$ cat out.txt
```

```
$ echo "Neces razbojnice\!" > out.txt
```

```
$ ls -la /usr/lib >> out.txt
```

stdin, stdout (1) and stderr (2) streams.

Getting help

- Almost all programs/commands have built-in help

```
$ ls --help
```

- For in-depth help use info...

```
$ info mkdir
```

- ...or man pages.

```
$ man mkdir
```

Exercise: mkdir and ls options

- ❶ Create a nested folder tmp2/tmp3/tmp4 inside of your pzros folder, using only one command (hint: check the options of the 'mkdir' command).
- ❷ Inside of the tmp4 folder, create a text file containing a list of all files from the /usr/include folder, ordered by timestamp.

Searching for files

- Searching for files

```
$ find /home -name README.txt
```

- Indexed searching with *locate*

```
$ locate stdio.h
```

- Find out which executable is run when a command is invoked

```
$ which info  
/usr/bin/info
```

Searching inside files

- The *grep* command

```
$ grep <PATTERN> [FILE]
```

- Search for a string in a file

```
$ grep printf /usr/include/stdio.h
```

```
$ grep printf /usr/include/*.h
```

- *grep* can be very useful when combined with other commands using |

```
$ ls /usr/lib | grep python
```


Exercise: locate

How many `stdio.h` files are there on your system. (Hint: use the `locate` command with an additional argument)

Exercise: grep

List all directories within the `/usr/lib` directory that have `rxwxr-xr-x` permissions. Store this list to a text file. (Hint: Pass the output of `ls` to `grep`).

Advanced Packaging Tool (apt)

- Library with various front-ends:
 - Ubuntu Software Center
 - apt-get
- Software repositories in `/etc/apt/sources.list.d`
- Packages are signed and have extensive metadata
- Information is **cached**
- Updating the cache

```
$ sudo apt-get update
```

- Searching the cache

```
$ apt-cache search console | grep -i drop-down
```

- Installing software

```
$ apt-get install guake  
$ sudo !!
```

- List installed packages

```
$ dpkg-query -l
```

- Find a package owning file

```
$ dpkg-query -S stdio.h
```

- List all files from a package

```
$ dpkg-query -L guake
```

Environment variables

Variables that affect the behavior of your system and processes.

- List all environment variables

```
$ env
```

- See the contents of a specific variable

```
$ echo $SHELL
```

- Set an environment variable

```
$ [export] PATH=$HOME/scripts:$PATH
```

Environment variables required in every shell session should be exported in `/.bashrc`

Process management (1)

- Suspending an app with Ctrl+Z

```
$ gedit
```

- Moving an app to background

```
$ ^Z
```

```
$ jobs
```

```
$ bg %1
```

- Killing an app

```
$ kill [-9] %1
```

or Ctrl+C while the app is in the foreground.

- Starting an app in background

```
$ gedit &
```

- Bringing an app to foreground

```
$ fg %1
```

Process management (2)

- List all processes

```
$ ps [aux]
```

- Monitor processes

```
$ top
```

- Kill a process by PID

```
$ kill -9 <PID>
```

- A fancy kill using pgrep and **backquote expansion**

```
$ kill -9 `pgrep gedit`
```

Preparation

Install the ROS **Indigo** distribution (Desktop-Full variant), by following the official instructions from the ROS Wiki. (If ROS is already installed on your machine, you do not need to reinstall, simply skip this assignment.)

Assignments

- 1 What is the location of the program that gets executed with the `roscore` command?
- 2 Determine the sizes of the largest and smallest files located in the same folder as `roscore`. Report the sizes in human-readable format (K, MB etc.). (Hint: use options of the `ls` command to sort the files by size.)

Assignments (continued)

- ③ Find all files inside `/opt/ros/indigo` which are **executable** and whose name begins with `rqt_`. Store the output in a file named `3.txt` (Hint: use the `find` command with additional options).
- ④ In order to determine which Python programs depend on the **tf** coordinate transform library, find all files inside `/opt/ros/indigo` that contain the string `import tf`. Store the output in a file named `4.txt` (Hint: use the `grep` command with additional option for recursive searching).

Summary

- Navigating the filesystem
- Creating files and folders
- Searching for things
- Process management
- Installing packages

- Basic Use of Linux Operating System at UniZg FER
- Linux tutorial at University of Surrey
- Introduction to Linux edX online course
- Linux System Administration at Rutgers University
- Rute User's Tutorial and Exposition - free Linux usage and administration handbook (somewhat outdated)
- Ubuntu documentation (official and community wiki)
- Ask Ubuntu (part of StackExchange network)