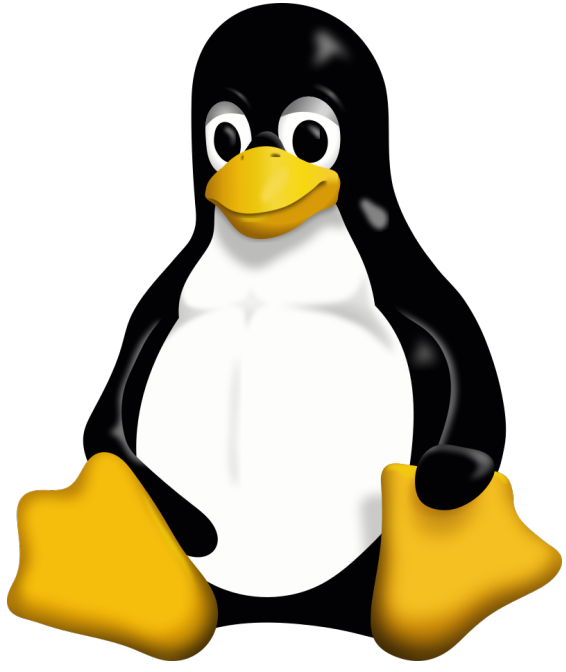
Linux – The Operating System of Freedom

Zoltán Szabó, Department of Statistics, LSE (May 23, 2023)



Contents

- A bit of Linux history.
- Linux distributions.
- Installation.
- Applications.
- Ricing and phones.

My journey

Win
start

My journey

$$\underbrace{\text{Win}}_{\text{start}} \rightarrow \overbrace{\text{'Unix'}}^{\text{school}}$$

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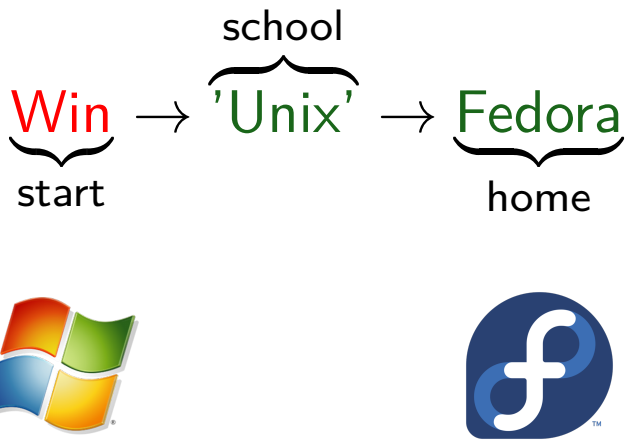

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My journey

Win (start) → 'Unix' (school) → Fedora (home) → Ubuntu (school), macOS (home) → CentOS (school) → Arch (home).






Some fun

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Newsgroups: comp.os.mimix
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One of the main secrets

free and open source $\Rightarrow$ knowledge sharing $\Rightarrow$ creativity can kick in $\Rightarrow$ versatility!

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- Late 1970s: companies started to spread proprietary software $\Rightarrow$

- GNU project = GNU is Not Unix:
  - Goal: write a UNIX-like operating system entirely of free software.
  - Users are legally free (GPL)

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1. to study,
2. to modify, and
3. to distribute the software.

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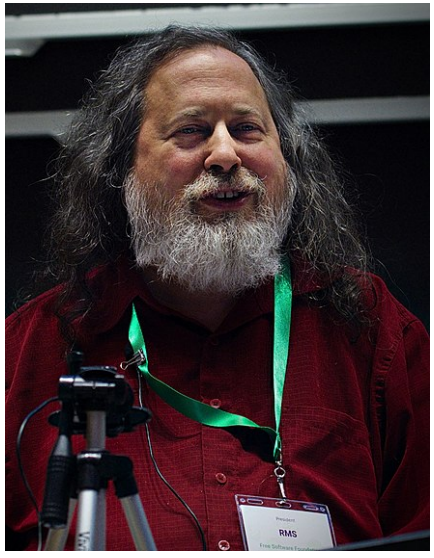
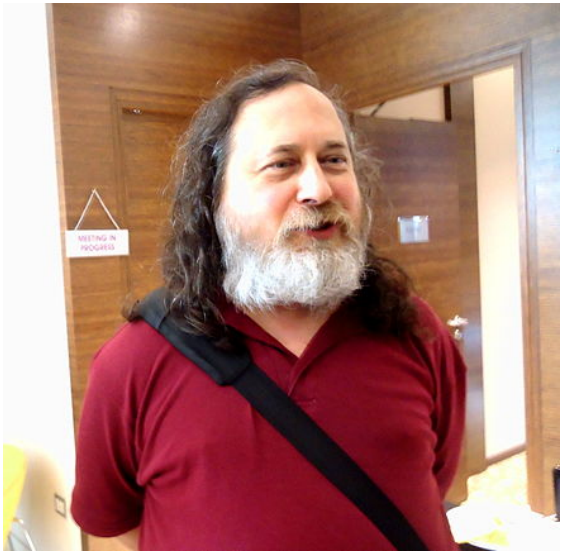
  - mass collaboration announced by Richard Stallman ('83; his website).

Richard (Matthew) Stallman: RMS – his hacker name;)





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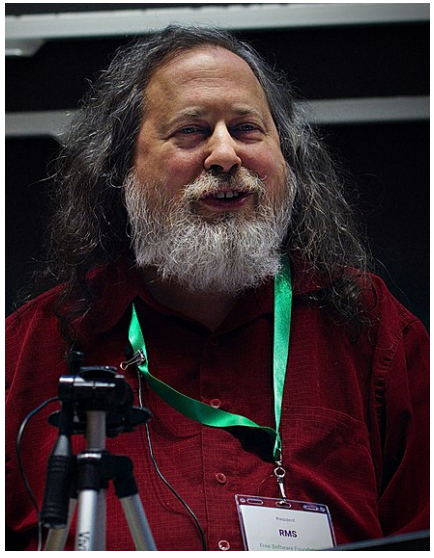
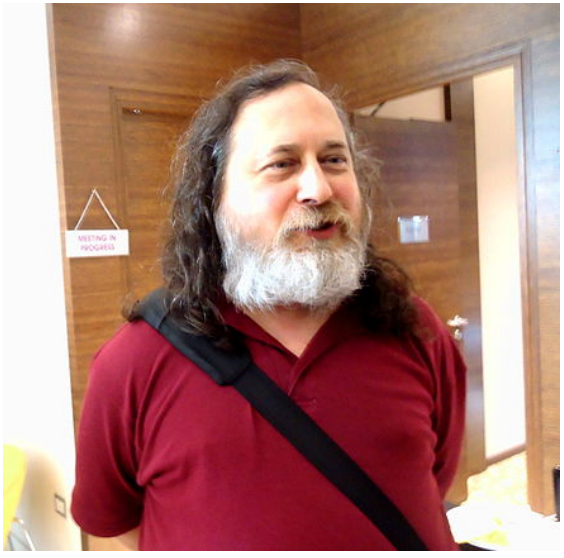


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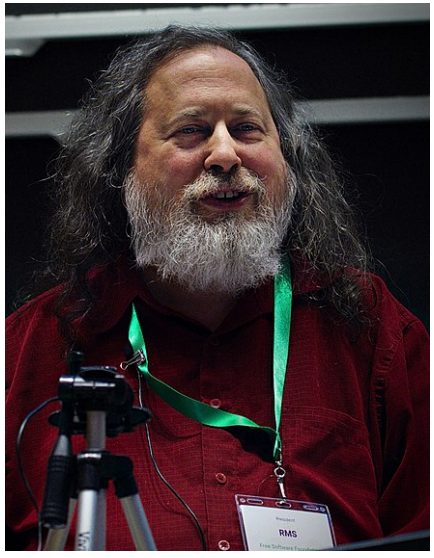
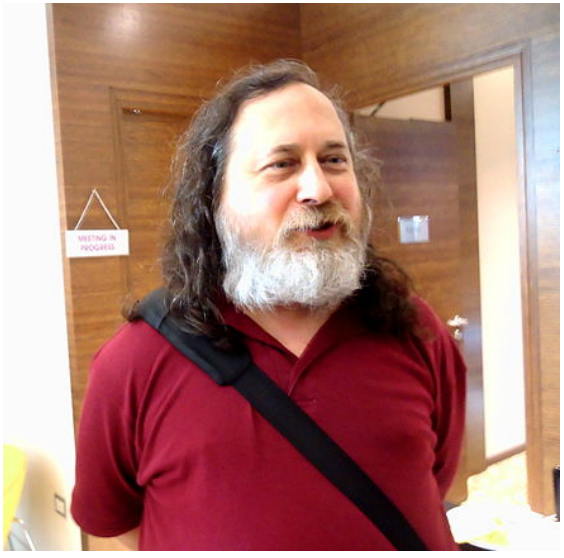


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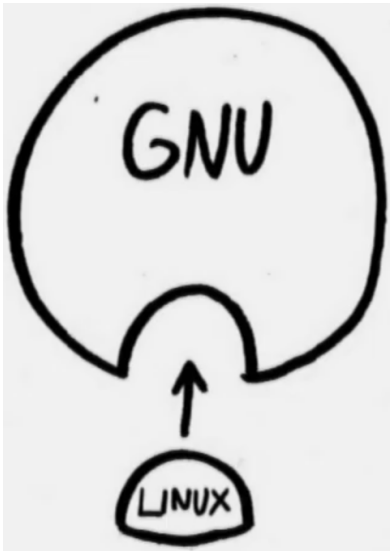
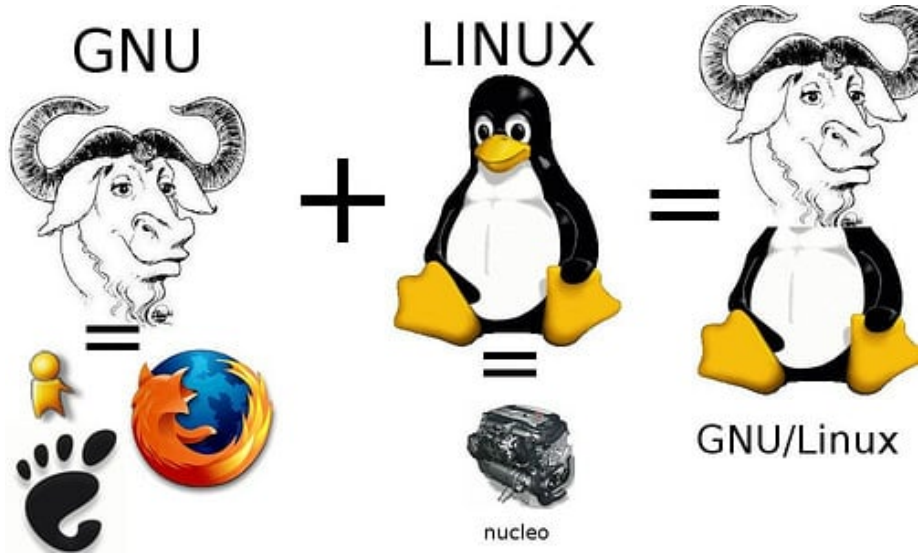
- Creator of GNU Emacs: 'text editor' (LISP interpreter).

GNU/Linux ('92-), shortly Linux



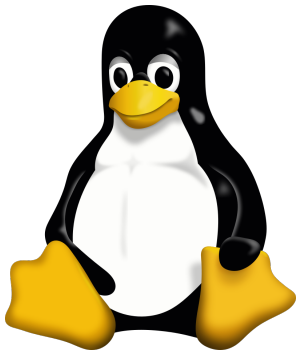


$\Rightarrow$

1. GNU utils: high-level utilities.
2. Kernel:
   - low-level 'stuff', written in C, GPLv2,
   - manages the CPU, memory, device drivers, file system, ...

Linus+

- Tux (the mascot of the Linux kernel) := Torvalds UniX.



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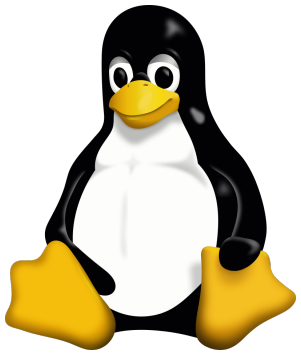

- Author of Git (GPLv2):
  - distributed version control system,
  - gold standard in collaborative coding efforts,
  - developed for the Linux kernel ('05),
  - # of lines in the code of Linux kernel: 30+ million.

Free vs open; O := Odysee

Free software (a.k.a. FOSS, libre software):

- goal: to respect user freedom and privacy.

to *not constrain* the user

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- free $\ni$ open-source, but
  - free $\neq$ open-source: text, vid[O],
  - open source code can 'spy' on you.

Free vs right to repair

- idea in 60s$_{\text{vid[O]}}$: \$12 $\ll$ \$1500 (MacBook Pro),
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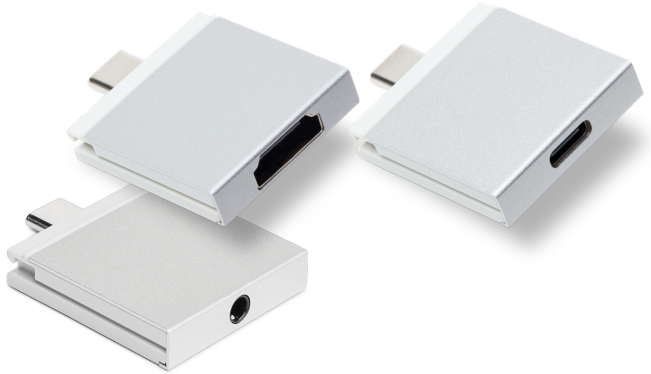
  - a laptop initiative: frame.work.



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- community-driven, versatile, transparent, secure & private, modular, resource-efficient, sustainable.

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  - standard for computing clusters (example: slurm).

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Various distros (tree):

- there have been $>$ 1000 distributions,
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- there have been $>$ 1000 distributions,
- currently (May 23, 2023): 274 distributions,
- but minor differences.

Primary choice to make

point release vs rolling release.

Point release model: Win

- Example:
  - Windows: 3.0, 3.1x, 95, 98, Me, NT, 2000, XP, Vista, 7, 8, 10, 11.

Point release model: Win, macOS

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- Properties:
  1. occasional big changes,
  2. end-of-life date!

Point release: Linux distributions



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- Fedora:
  - upstream source for Red Hat Enterprise Linux (developed by Red Hat),
  - released every 6 months.

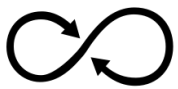
Rolling release: Linux distributions

- Arch Linux:

  - one-time installation with continuous upgrades,
  - lightweight and flexible,
  - follows the keep it simple (KISS) principle,
  - designed to teach its user.

Rolling release: Linux distributions

- other examples: openSUSE Tumbleweed, Gentoo.



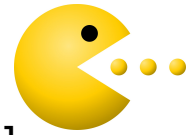
Tumbleweed

Point release vs rolling release

point	rolling	
	always up-to-date	+
	(new software features, bug fixes, security patches)	
	supports even very new hardware	+
	more secure	+
	no need to reinstall it	+
	requires semi-decent internet	−
	less suited for servers (where stability is max-ed)	−

My choice: Arch (released in 2002)

0. rolling release.
1. great package manager (pacman),
   - fast,
   - allows parallel downloading.



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   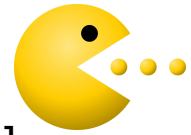

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   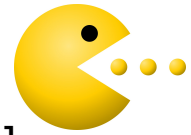

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   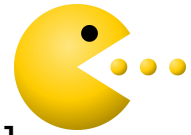

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   Both are searchable.

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4. Follow the instructions.

Downloading note

- .iso size:
  - 11 GB (MacOS Ventura) – for comparison.

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  - 5.2 GB (Windows 11) – for comparison.
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- .iso size:
  - 2.5 GB (Pop!_OS),
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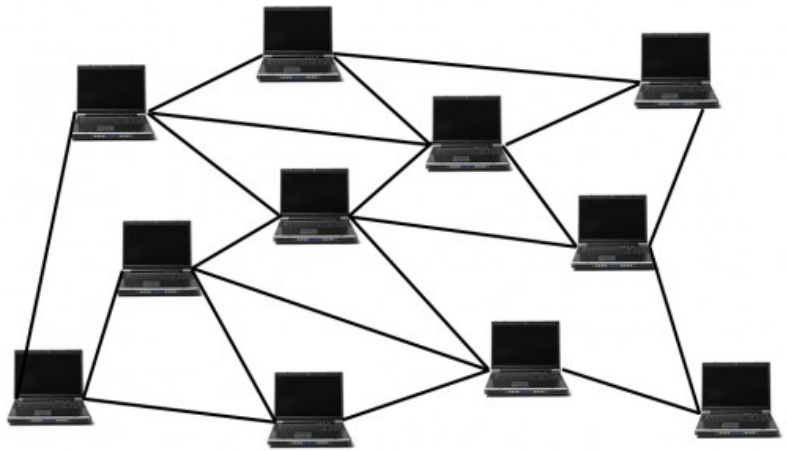
  - http; torrent: this can be faster ($\Leftarrow$ sharing).



Notes on the boot process — a 'bit' technical

1. system's firmware (such as BIOS/UEFI/Coreboot/Libreboot) $\xrightarrow{\text{starts}}$
2. bootloader (such as GRUB $\Leftarrow$ GNU; features & others) $\xrightarrow{\text{loads}}$
3. the kernel (your operating system).

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In practice:

- firmware:
  - probes for hardware, simple health checks,
  - it has a UI accessible with a magic key (Esc, F1/F2/...),
  - allows you to designate a boot device (USB/hard/CD/DVD drive, ...),
  - consults the GPT[†] partition table to identify the ESP[‡], and launches the target application (typically the bootloader).

[†]no chat 😉, [‡]EFI System Partition.

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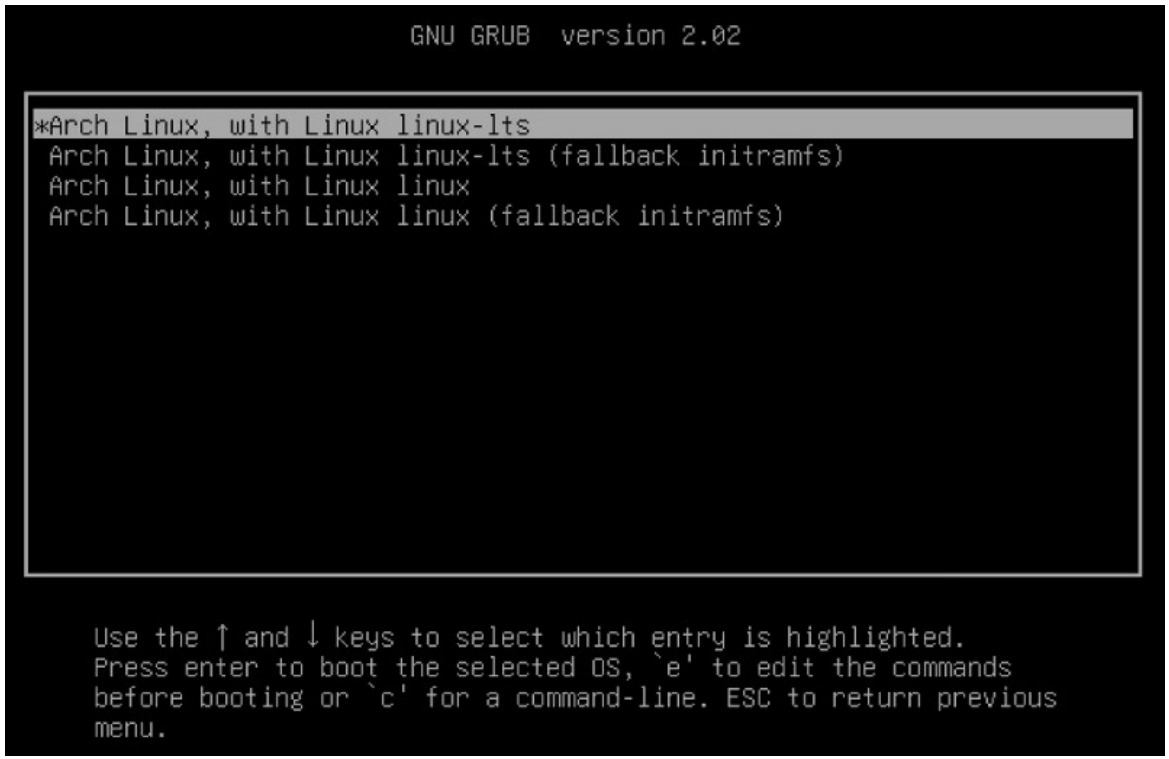
- bootloader:
  - gives a menu on which kernel / operating system to invoke.



Instructions: for Arch – scary;)

1. Step-by-step text guide (official one).
2. Video guide:
   - vid_1[O]: UEFI; check the YouTube comments as well!
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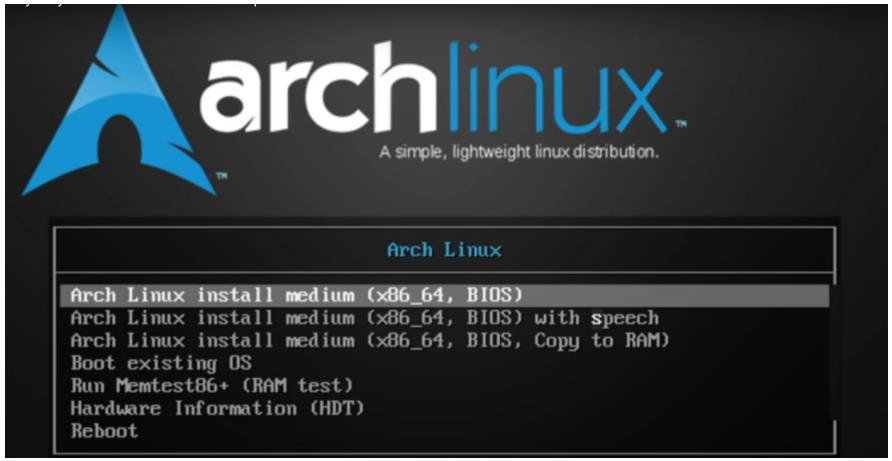
Definitions

- firmware: BIOS (very old machine), UEFI (semi-new computer).
- partition table: BIOS $\Rightarrow$ MBR (a.k.a. DOS, MS-DOS); UEFI $\Rightarrow$ GPT.
- LVM: adjustable layout, LUKS: encryption.
- LUKS: your data can't be read even if your laptop is stolen.

Instructions: BIOS or UEFI

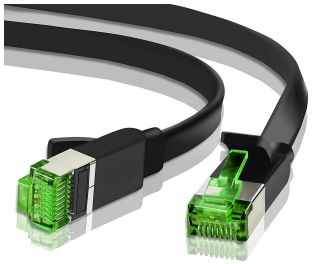
BIOS:



UEFI:

Installation hints

1. use ethernet: faster.



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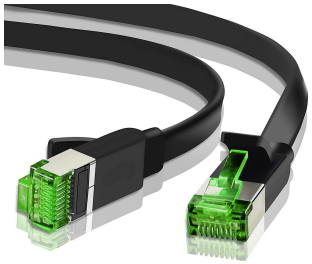
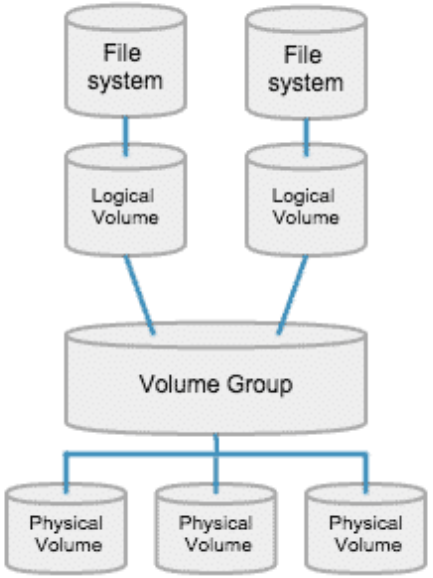


2. start simply: no encryption, no LVM.



Installation hints

2. start simply – elaborated (nerdness level dependent):
   1. Live media/USB/image (Fedora, Ubuntu):
      - .iso writing, hardware support check, quick look at the system ✓,
      - slower than SSD.

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†Start with a DE before a WM.

Installation hints – continued

3. partition formatting:
   - ext4: more settled – my choice,

   - btrfs:
     - modern alternative,
     - supports compression $\Rightarrow$ less space, increased storage lifespan,
     - copy-on-write $\Rightarrow$ consistency even in case of power loss,
     - snapshot feature,
     - limited LUKS support.

     $\Rightarrow$ It is worth keeping an eye on it!

Installation hints – continued

4. kernel (stable), LTS kernel (longterm) [others]:
   - stable: maintained until the next stable release,
   - LTS: maintained for a few extra years,
   - good to have both: flexibility.

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5. swap:
   - helps if RAM is exhausted (but slower, $\times 1000$!); size recommendations.
   - 2 types:
     1. swap partition: often preferred,
     2. swap file: easier to resize, but less tested.

Installation hints – continued

6. good boot time ($\sim$ 11s):
   - SSD matters: Samsung 970 EVO Plus $\leftarrow$ my choice (for laptop).

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7. Use a spare drive (to avoid the wrestling of the op. systems).

Installation hints – continued

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10. Post-installation:
    - think in terms of tasks not software, and use the native applications.
    - a weekly system update can be healthy.

Applications: categorized; some handy ones

Notations: M = '$\in$ main', A = '$\in$ AUR', W = web client, P = pip, ✓ = installed by default.

- Web & mail:
  - browser: firefox (M), tor-browser (A).
  - e-mail: ProtonMail (W), thunderbird (M).

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- Web & mail:
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- Media:
  - image viewer: feh (M), gthumb (M), geeqie (M).
  - image editor: gimp (M).
  - video player: mplayer (M), vlc (M), celluloid (M).
  - video editor: kdenlive (M).
  - video downloader: youtube-dl (M), yt-dlp (M).
  - spotify:
    - player: spotify (A),
    - downloader: spotdl (P).
  - audio editor: tenacity (A).

Applications+

- Text:
  - document viewer: xdvi (✓, $\in$ texlive), xpdf (M),
  - .pdf annotation: xournalpp (M),
  - text editing: texlive-most (LaTeX, group, M), kile (M) ($\approx$ WinEdt), vim (M), libreoffice-still (M), notepadqq (M).

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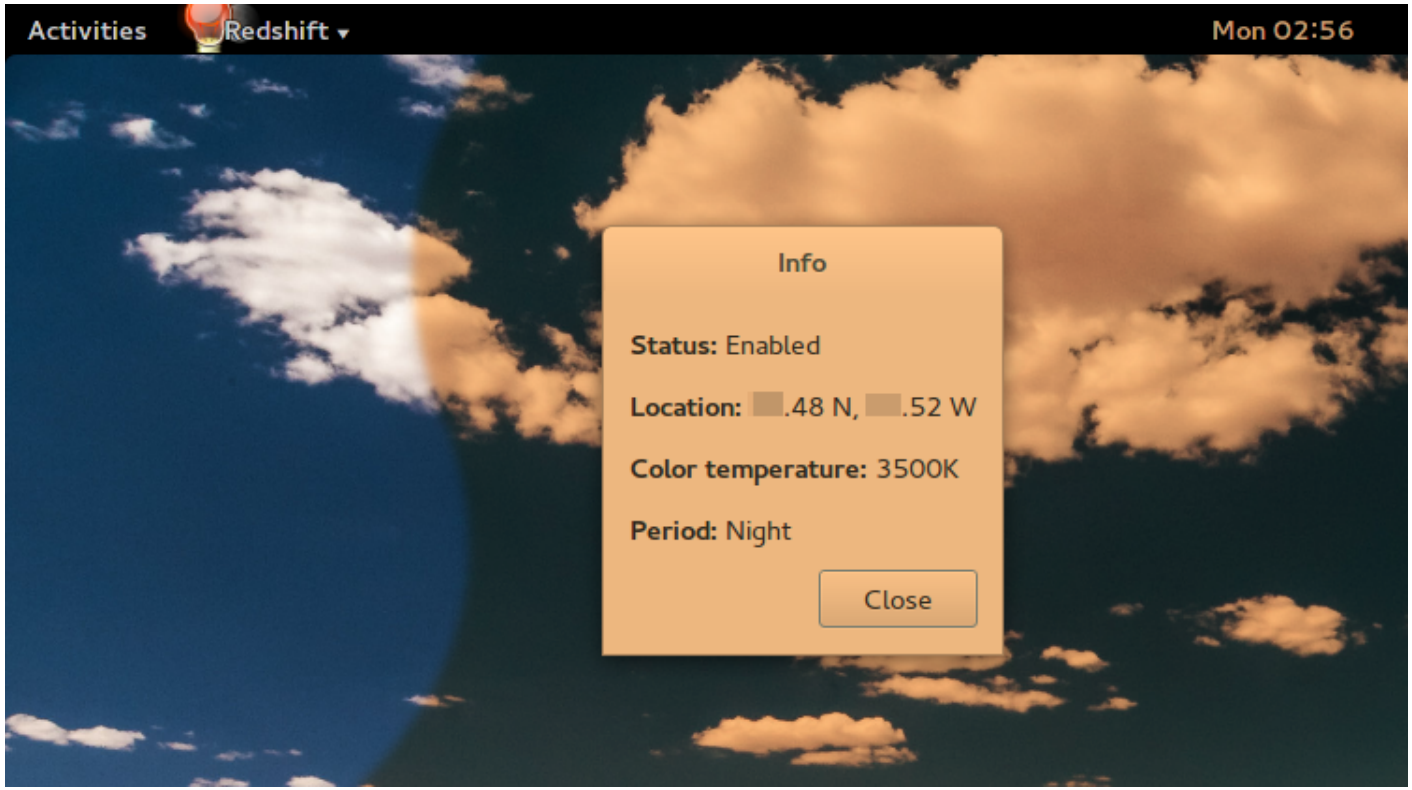
- Chat & collaboration:
  - chat: skypeforlinux-stable-bin (A), zoom (A), qtox (M),
  - version control: git (M),
  - calendar & reminder: remind (M).

Applications+

- eye protection: redshift (M),



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- firewall: ufw (M),
- desktop environment: gnome (M, group), qtile (M, WM).

Desktop environments (DE)

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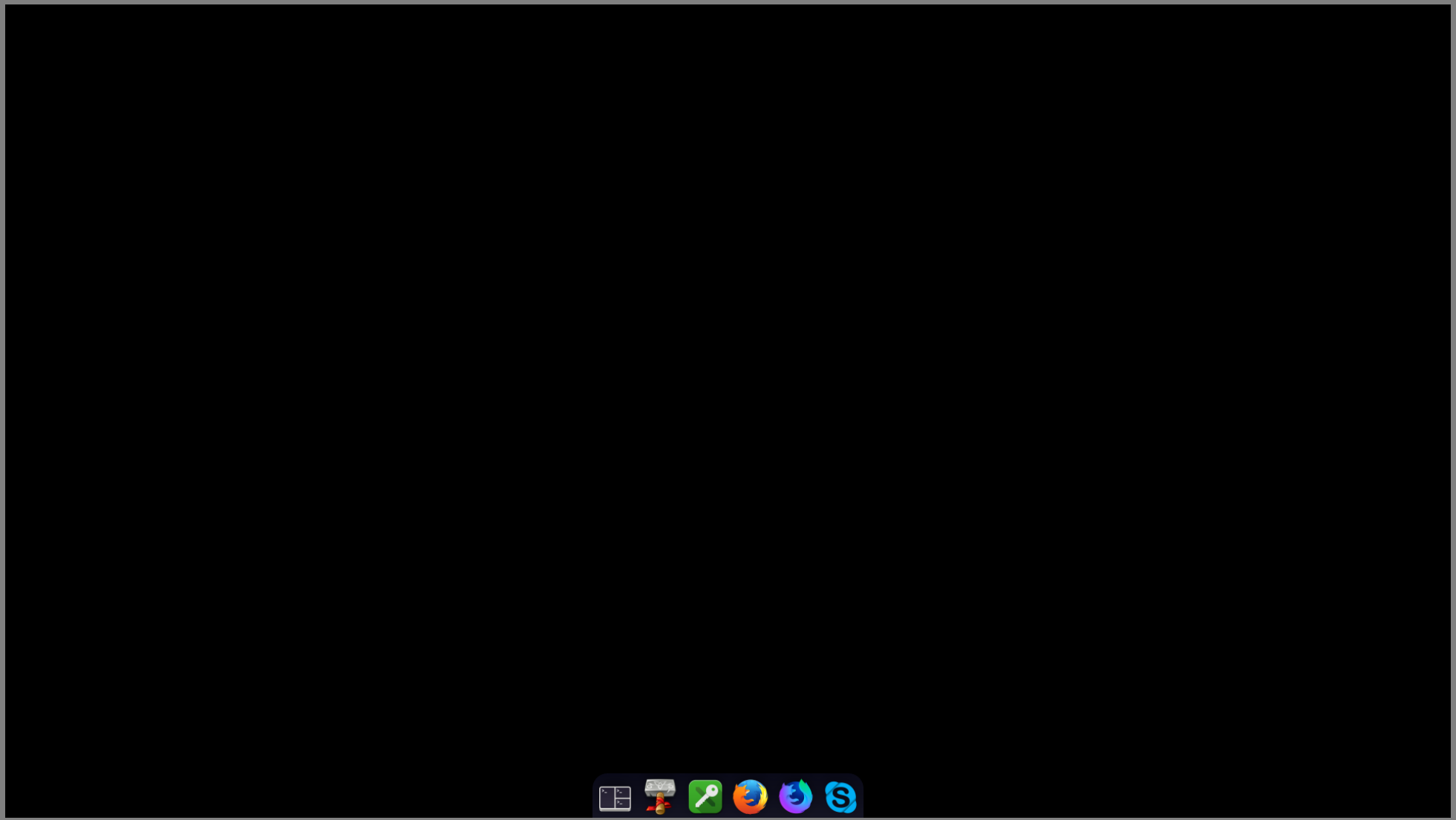
Examples follow

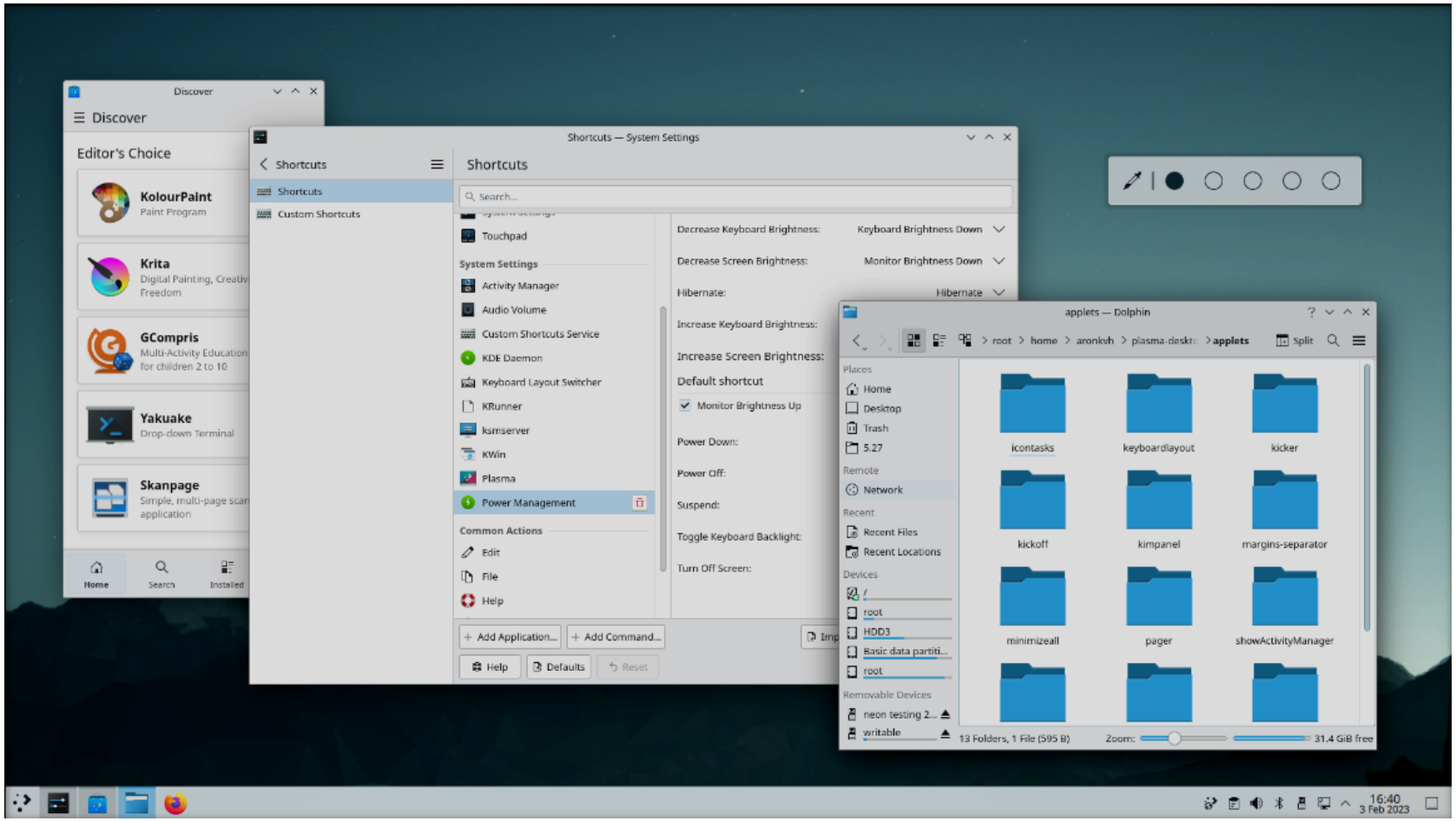
DE: GNOME


Activities
Mar 23 12:48
Type to search
GNOME
We promote software freedom

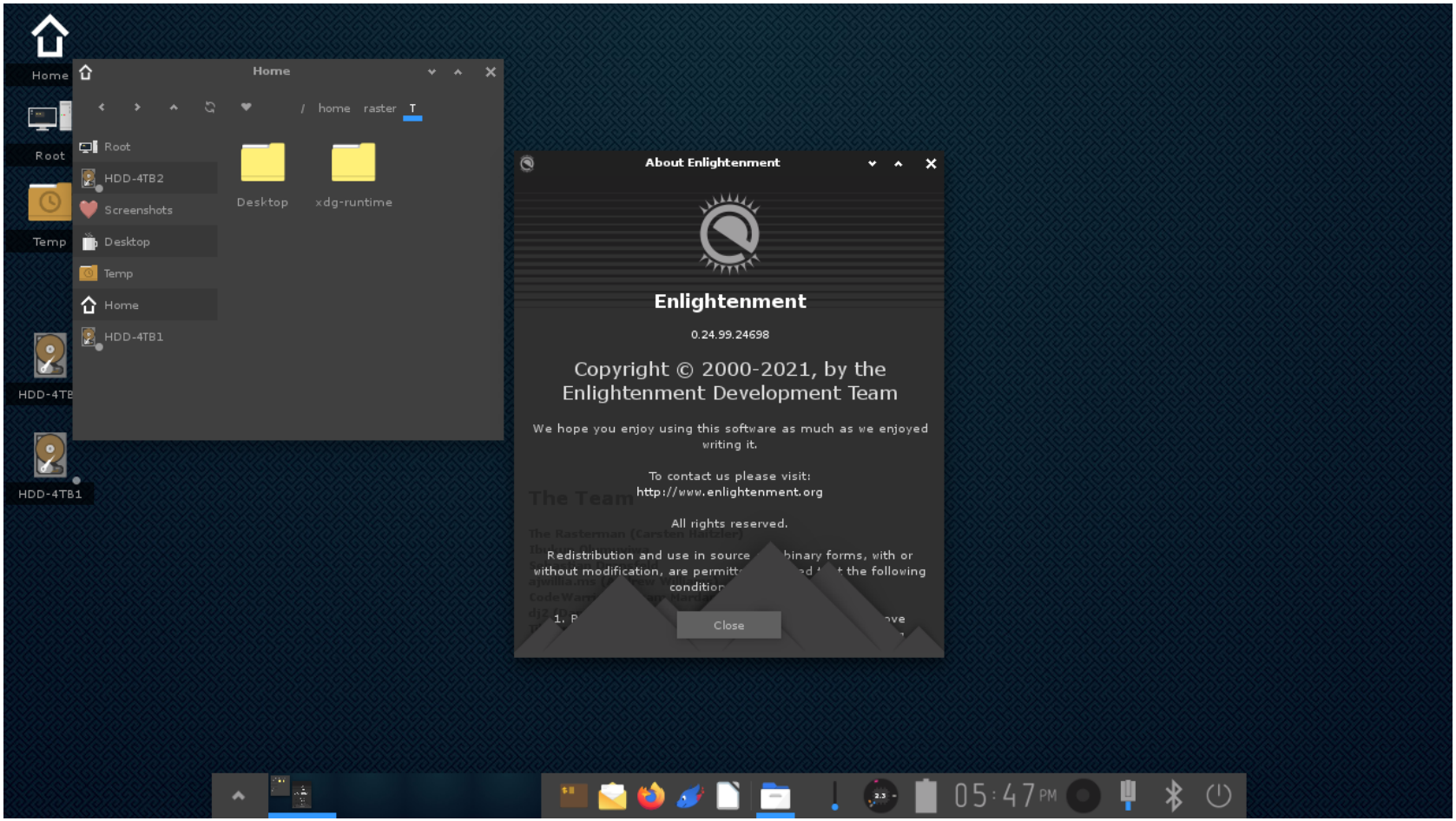
DE: GNOME – my desktop



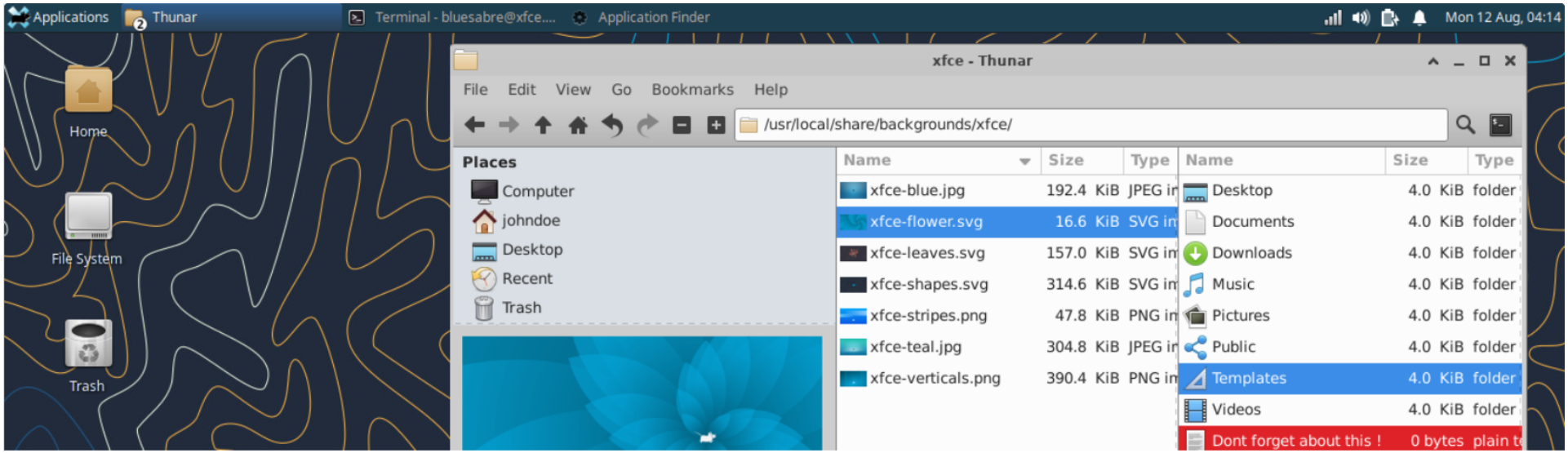
DE: KDE Plasma



DE: Enlightenment



DE: Xfce


Applications
Thunar
Terminal - bluesabre@xfce....
Application Finder
Mon 12 Aug, 04:14
Home
File System
Trash
xfce - Thunar
File Edit View Go Bookmarks Help
/usr/local/share/backgrounds/xfce/
Places
Computer
johndoe
Desktop
Recent
Trash
Name Size Type
xfce-blue.jpg 192.4 KiB JPEG in
xfce-flower.svg 16.6 KiB SVG in
xfce-leaves.svg 157.0 KiB SVG in
xfce-shapes.svg 314.6 KiB SVG in
xfce-stripes.png 47.8 KiB PNG in
xfce-teal.jpg 304.8 KiB JPEG in
xfce-verticals.png 390.4 KiB PNG in
Name Size Type
Desktop 4.0 KiB folder
Documents 4.0 KiB folder
Downloads 4.0 KiB folder
Music 4.0 KiB folder
Pictures 4.0 KiB folder
Public 4.0 KiB folder
Templates 4.0 KiB folder
Videos 4.0 KiB folder
Dont forget about this ! 0 bytes

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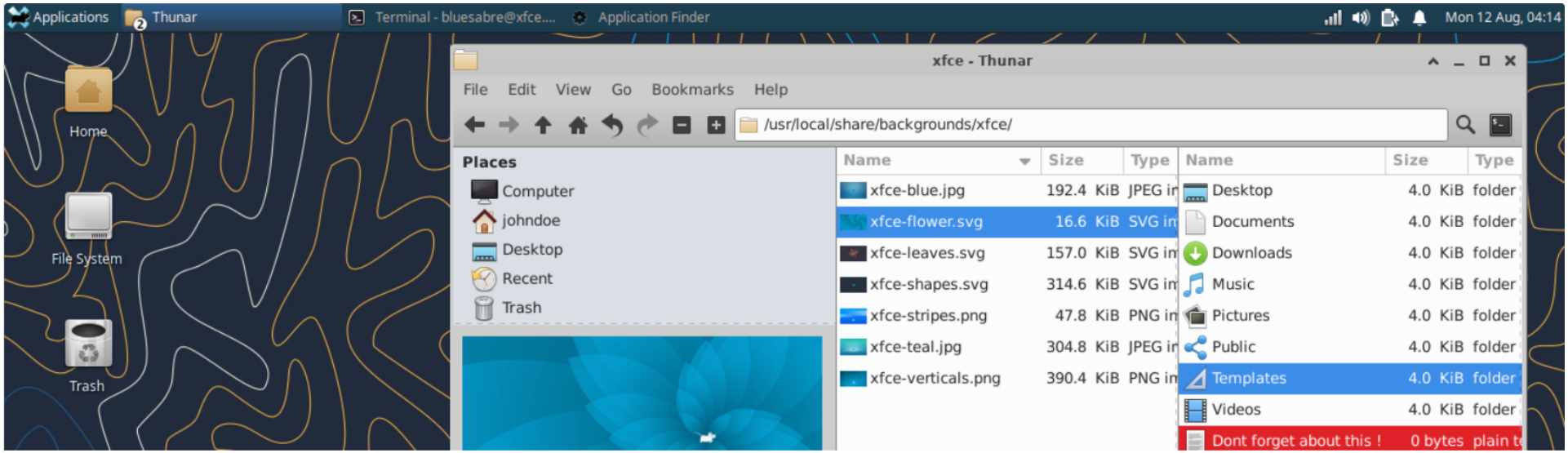

Extra DE inspiration

unixporn (screenshots).

Window managers (WM)

- It allows handling windows (open, close, min/max-ze, move, resize, . . .).
- It can be part of a DE or standalone.
- Idea: WMs can be even snappier than DEs.

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- Idea: WMs can be even snappier than DEs.
- 3 types:
  1. stacking (a.k.a. floating),
  2. tiling: non-overlapping windows,
  3. dynamic: allows switching between tiling and floating layout.

WM $\rightarrow$ DE

- Stacking:
  - Mutter $\rightarrow$ GNOME,
  - KWin $\rightarrow$ KDE,
  - Xfwm $\rightarrow$ Xfce,
  - Enlightenment $\rightarrow$ Enlightenment.

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Examples follow

WM: i3

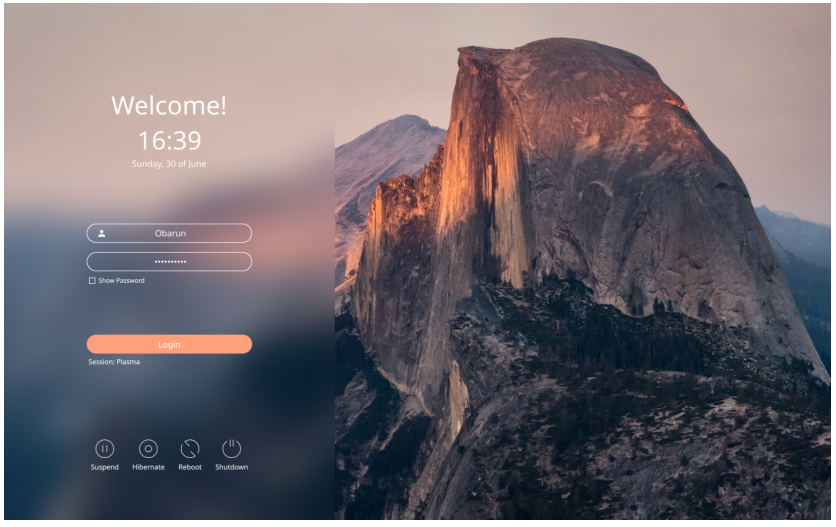

main.c (~/i3/src) - VIM
}
/* Set up i3 specific atoms like I3_SOCKET_PATH and I3_CONFIG_PATH */
x_set_i3_atoms();
struct ev_io *xcb_watcher = scalloc(sizeof(struct ev_io));
struct ev_io *xkb = scalloc(sizeof(struct ev_io));
struct ev_check *xcb_check = scalloc(sizeof(struct ev_check));
struct ev_prepare *xcb_prepare = scalloc(sizeof(struct ev_prepare));
ev_io_init(xcb_watcher, xcb_got_event, xcb_get_file_descriptor(conn), EV_READ);
ev_io_start(main_loop, xcb_watcher);
if (xkb_supported) {
ev_io_init(xkb, xkb_got_event, ConnectionNumber(xkbdpy), EV_READ);
ev_io_start(main_loop, xkb);
/* Flush the buffer so that libev can properly get new events */
XFlush(xkbdpy);
}
ev_check_init(xcb_check, xcb_check_cb);
ev_check_start(main_loop, xcb_check);
ev_prepare_init(xcb_prepare, xcb_prepare_cb);
ev_prepare_start(main_loop, xcb_prepare);
xcb_flush(conn);
manage_existing_windows(root);
if (!disable_signalhandler)
setup_signal_handler();
/* Ignore SIGPIPE to survive errors when an IPC client disconnects
* while we are sending him a message */
signal(SIGPIPE, SIG_IGN);
/* Autostarting exec-lines */
if (autostart) {
struct Autostart *exec;
TAILQ_FOREACH(exec, &autostarts, autostarts) {
LOG("auto-starting %s\n", exec->command);
start_application(exec->command);
}
}
/* Autostarting exec_always-lines */
struct Autostart *exec_always;
TAILQ_FOREACH(exec_always, &autostarts_always, autostarts_always) {
LOG("auto-starting (always!) %s\n", exec_always->command);
start_application(exec_always->command);
}
ev_loop(main_loop, 0);
src/main.c 464,9 99%
x200: mplayer S02/E05.avi
MPlayer
x200: git log
commit b87742172b3802badb615418f45d8556bfcf149b
Author: Michael Stapelberg <michael@stapelberg.de>
Date: Sun Jul 17 22:18:00 2011 +0200
Add missing function prototype for strndup on Darwin (Thanks Marcus)
commit 3da3a691063f7c4c7f09461bbe948fa48abeb5fd
Author: Michael Stapelberg <michael@stapelberg.de>
Date: Sun Jul 17 15:21:57 2011 +0200
i3-config-wizard: use fgetln on Darwin, use strndup from FreeBSD on Darwin (Thanks Mar
commit 02dfb8e891a759ed2152918778f6d0a928a71cac
Author: Michael Stapelberg <michael@stapelberg.de>
Date: Sun Jul 17 15:18:45 2011 +0200
use memmem and strndup from FreeBSD on Darwin (Thanks Marcus)
commit fc583adb9956ff95e9019bef8bb0e7c2e21d133b
Author: Michael Stapelberg <michael@stapelberg.de>
Date: Sun Jul 17 15:17:24 2011 +0200
makefile: link -liconv on Darwin (Thanks Marcus)
commit 7512f633a79b290f4e60287fb2b1cd689f025b42
Author: Michael Stapelberg <michael@stapelberg.de>
Date: Fri Jul 15 19:21:39 2011 +0200
:
1 2 3 4
2001:4d88:100e:23:21f:16ff:fe1a:f5b8 | 2,3 GB | DHCP: no | VPN: no | W: down | E: 192.168.1.42 (1000 Mbit/s) | BAT 74,15% [@] | 01% | 0,03 | 2011-07-22 15:02:32

WM: Qtile


monadtall
45.1%
739M/15419M
83.0°C
40G 10%
77%
?100%
1
14-11-2020 13:58
SUBSCRIBE

Login/display manager

- It gives graphical login – if you prefer not using/starting from tty:)
- Popular choices: (i) SDDM: tutorial[O] (further inspiration)



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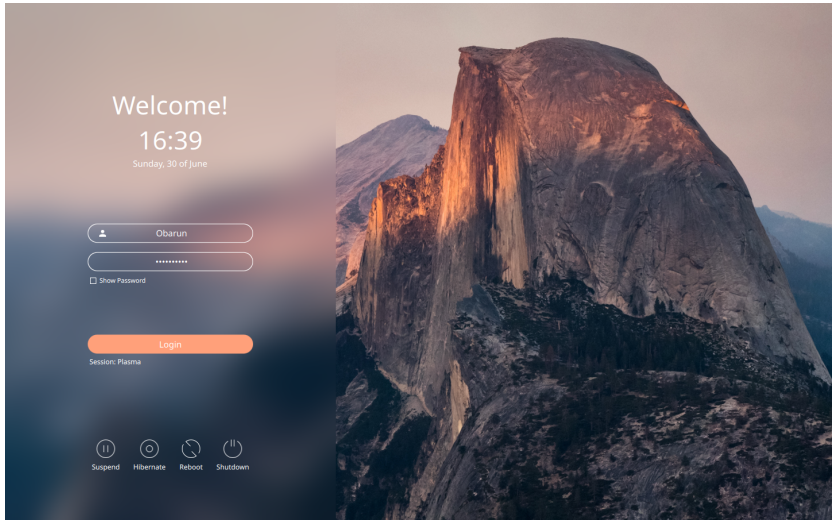

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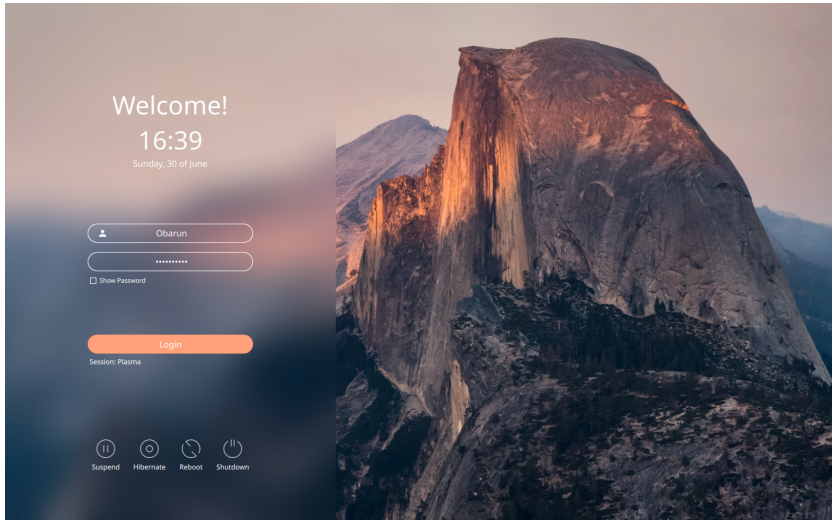

Terminal: used for instance @ Arch install

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- like Jupyter notebook,
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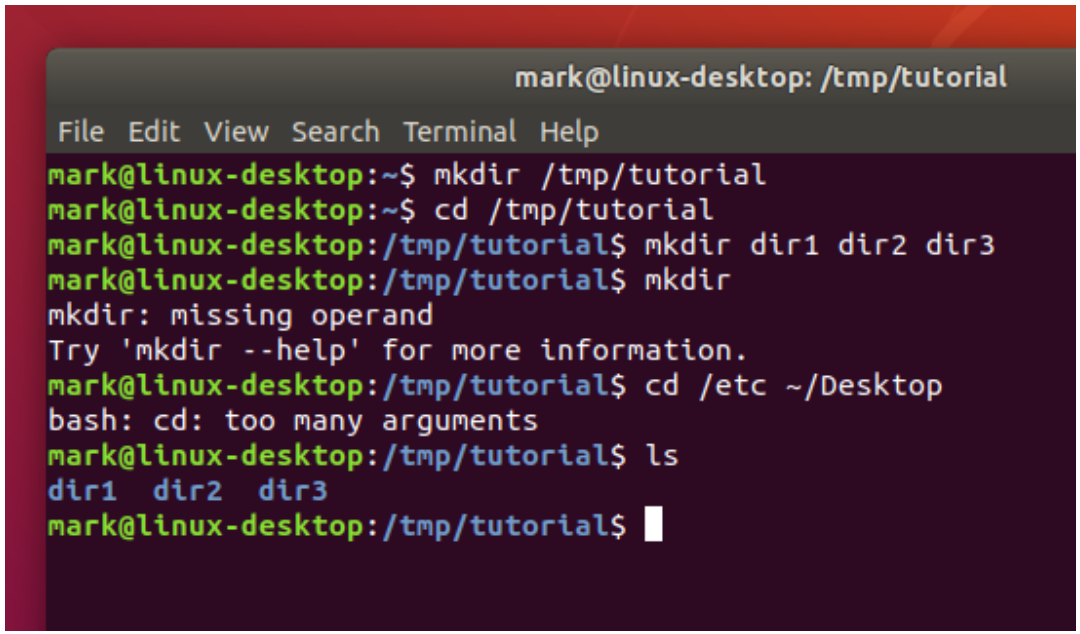

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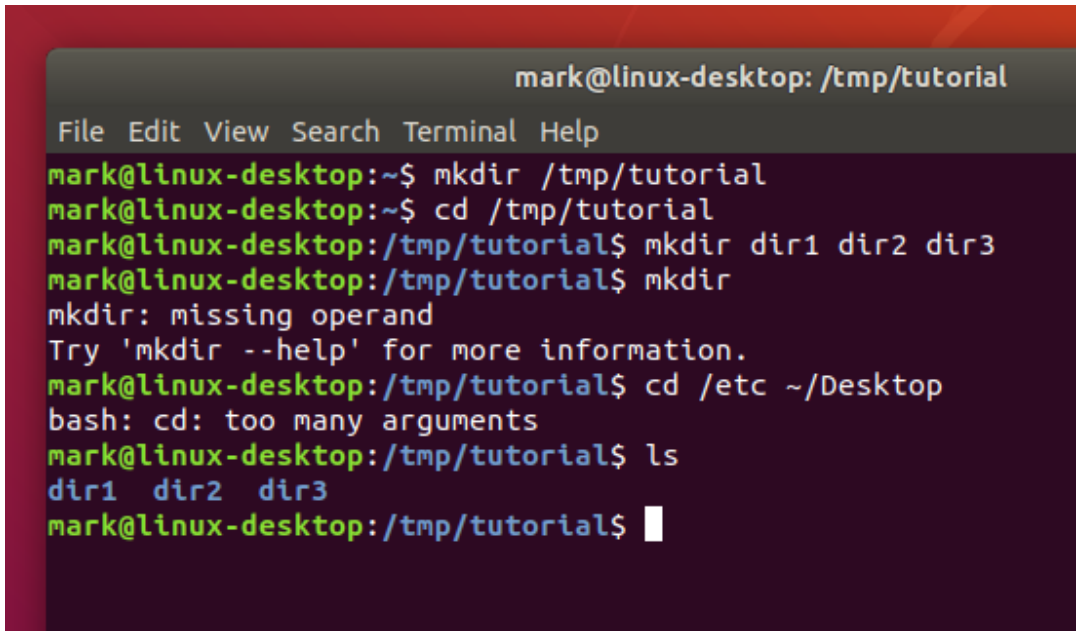

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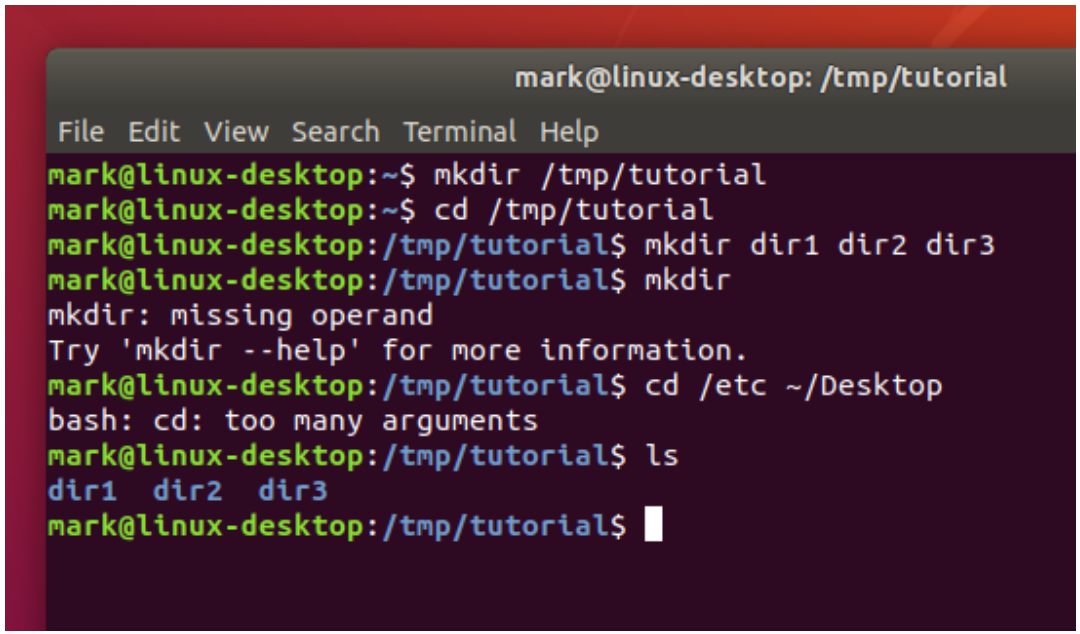

- Google Colab: `!shellcommand`,
- virtual console = text terminal + login prompt (ttyX = Ctrl+Alt+FX, X$\in$ [7]).

Command line (CLI) – continued

- Examples:
  - `$ cd` : change the current working directory,
  - `$ ls` : list directory content,
  - `$ pwd` : print the name of the current directory,
  - `$ cp` : copy files & directories,
  - `$ mv` : move or rename files and directories,
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  $\Rightarrow$
  - shell/bash scripting.
  - lot of automation possibilities.

Superb text editor: Vim

- modal editor $\xrightarrow{\text{change}}$ i = input mode, Esc = command mode,
- highly customizable & efficient,
- keyboard-driven, language-like.
  Example:

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h,j,k,l	:	arrows (left, down, up, right),

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Superb text editor: Vim

- modal editor $\xrightarrow{\text{change}}$ i = input mode, Esc = command mode,
- highly customizable & efficient,
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- cross-platform.

Vim – continued (free ⇒)

- integration to browser, Jupyter notebook, . . .
- evolution: vi → Vim → Neovim (community-developed),

- personal Wiki: vimwiki,
- tutorials: $ vimtutor and

Name	Vids
ThePrimeagen	link_1, link_2, link_3, link_4, link_5, link_6
Missing Semester	link[O]
DistroTube	link_1[O], link_2[O]
Ben Awad	link

Hint: How to ask on forums?

- Netiquette[O]; discussion $\rightarrow$ guide.
- DIY mentality:
  - the community is friendly and helps *if* you put in effort,
  - $\Rightarrow$ read & do your research first!

Odysee (with LBRY) / YouTube channels: good educators

Name	Odysee	YouTube	
DistroTube	link	link	
Learn Linux TV	–	link	
Eric Murphy	link	link	
Brodie Robertson	link	link	
EF - Linux Made Simple	link	link	(less active nowadays†)
OldTechBloke	link	link	(less active nowadays†)
Mental Outlaw	link	link	(Linux, privacy)
Luke Smith	link	link	(less active nowadays†)
VeronicaExplains	–	link	(less active†)
MobileTechReview	–	link	laptop & mobile reviews
Naomi Brockwell: NBTV	link	link	privacy
Louis Rossmann	link	link	right to repair

† but her/his past videos are nice.

Ricing: Conky

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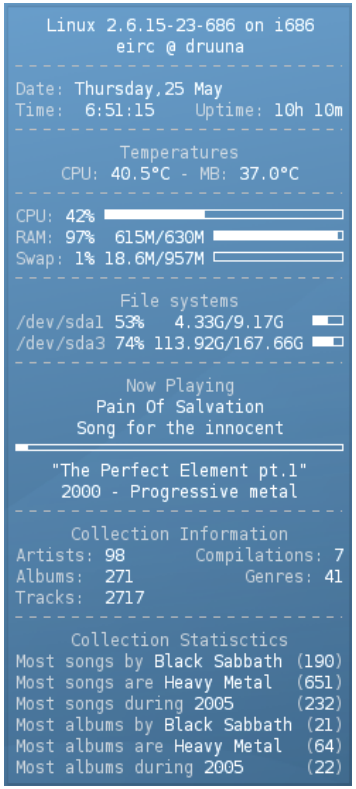
- Example (further inspiration):



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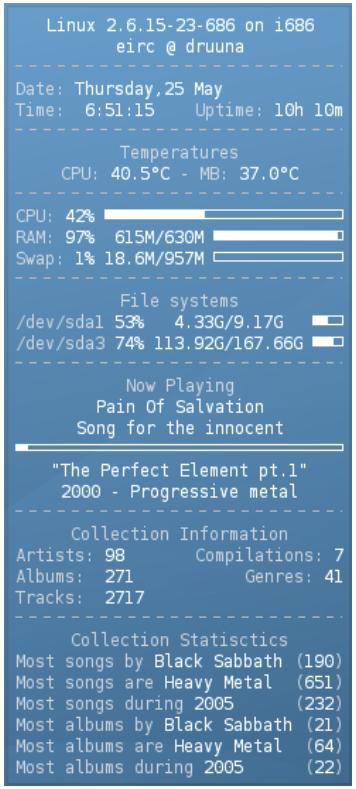

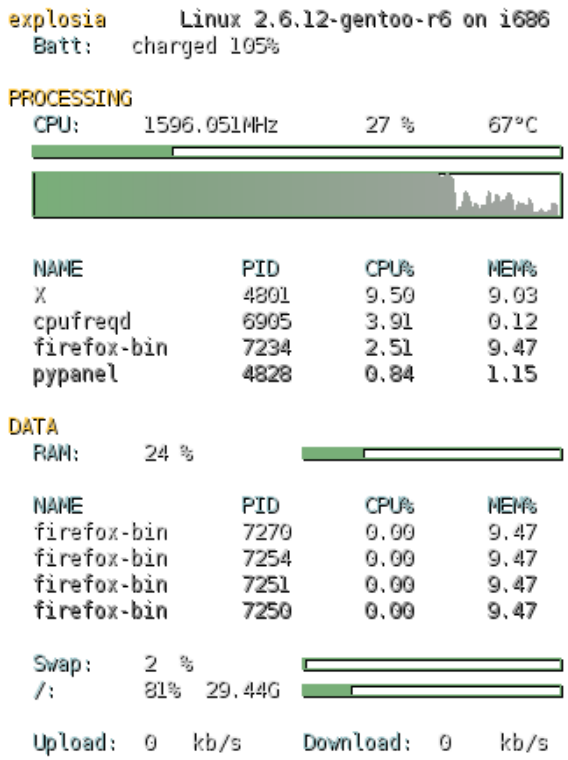

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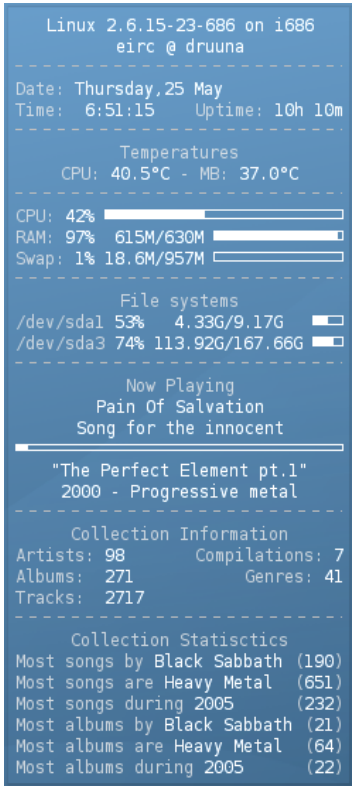

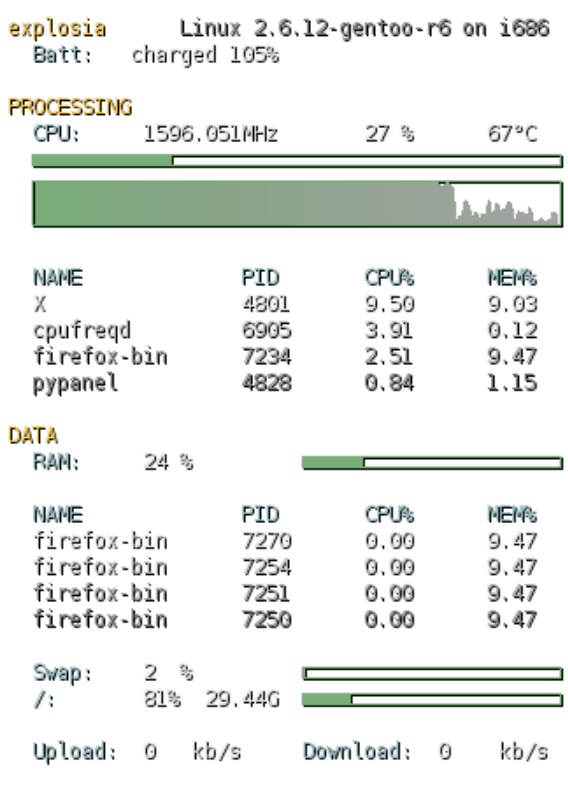

Ricing: Conky on desktop

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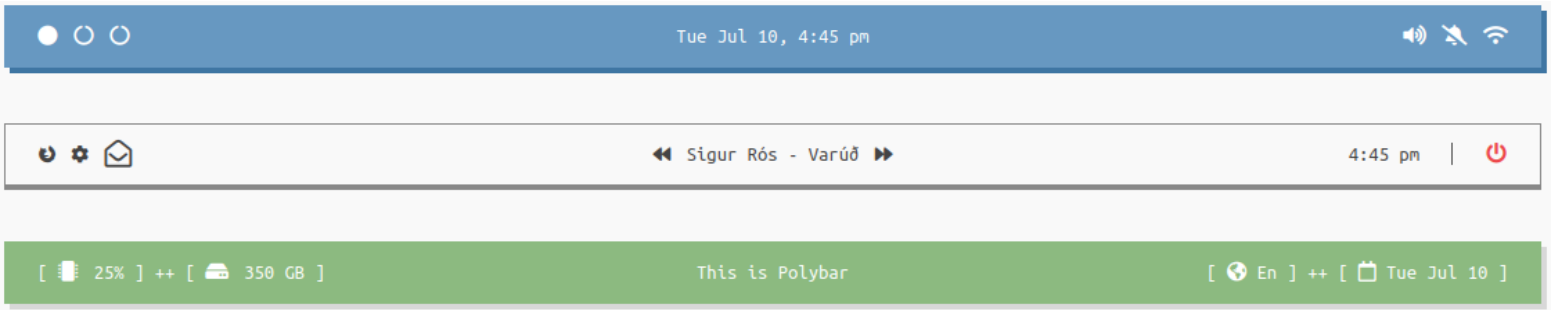
Ricing: Polybar ($link_1$, $link_2$)



- fast replacement of the status bar,
- date, time, keyboard layout, backlight, volume, MPD, network, CPU, ...

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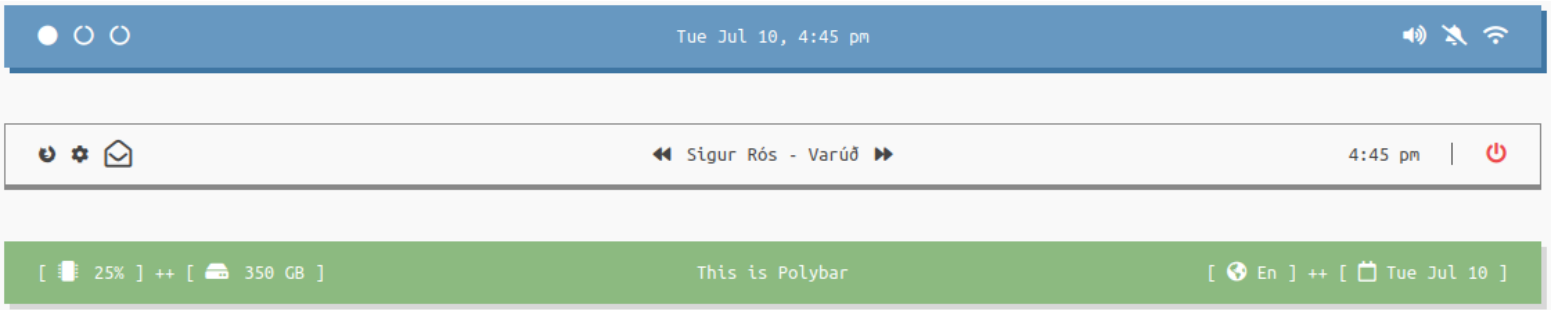

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Example follows.

Polybar example

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- They can
  - add effects like transparency, animations or blur,
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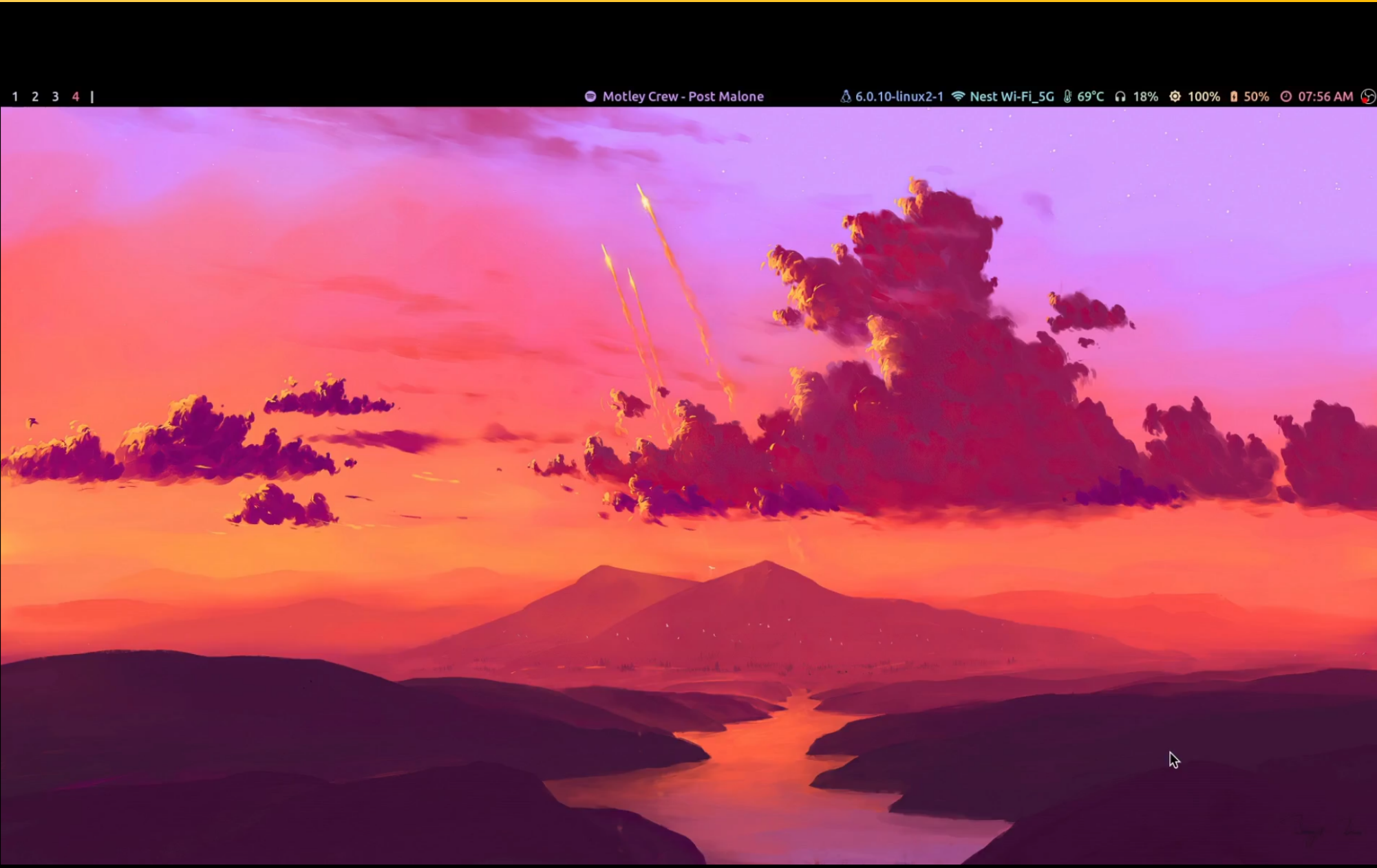
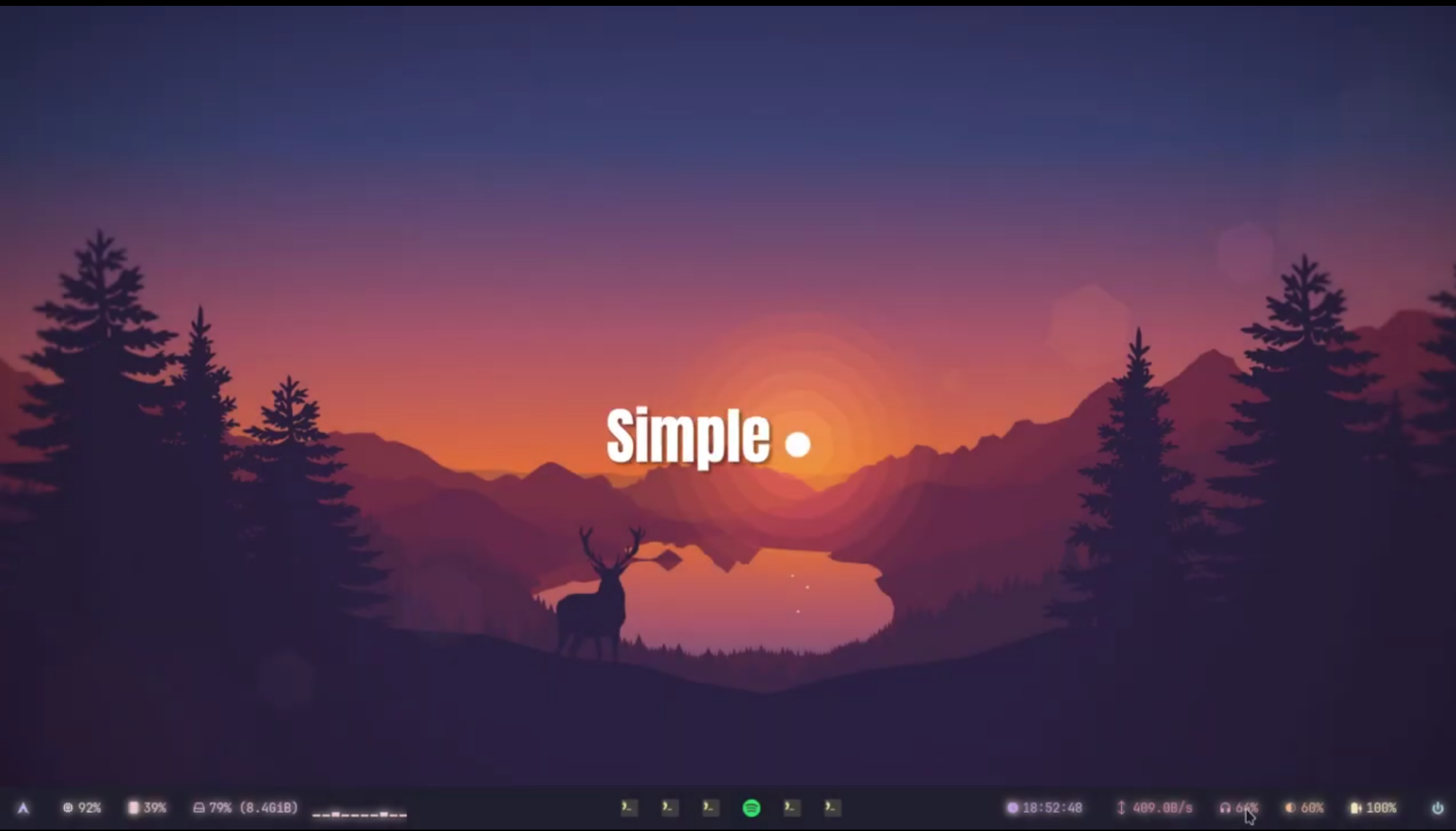
- For Hyprland: website, wiki; demo (screenshot):

Compositor: HyperInd$_{vid}$



Compositor: Wayfire[vid]



Linux phones (security & privacy; beta!)

1. Librem 5:
   - by Purism, running PureOS.

Linux phones

2. PinePhone, PinePhone Pro:
   - by Pine64,
   - PinePhone Pro: Wiki; various op. systems $\ni$ Arch;)
   - recipe: vid_1, vid_2, vid_3, vid_4, vid_5.

My choice (more stable and transparent communication)

Summary

- Linux history, user freedom

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Are you ready to own your computer