Introduction to Linux: **Overview**

Philipp Fruck & Pius Walter

Introduction

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- Studied CS back in 2019
- First Linux lecture in 2025
  - We still update/rework the lecture every year
  - We need your feedback!

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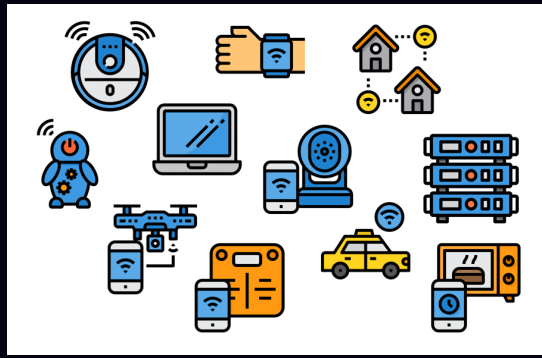
Quickly introduce yourself:

- Who are you?
- Which operating systems did you use previously
  - Windows, macOS, Linux? Or only mobile devices?

Organizational

- 11 lectures, each 1.5 hours
- Mostly hands-on
  - You'll need your own Linux system
- Introduction into Linux system components
  - Installation
  - Basic & advanced terminal commands
  - Building applications and containers
- Practical lab work submissions

What is Linux?



Icons by flaticon.com

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https://img.devrant.com/devrant/ran
1578772_VbG6J.jpg

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  - Open source compiler (gcc), system library (glibc) and coreutils
  - But: Lacking a kernel

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- Could run programs originally developed for Unix
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When we say "Linux", we are referring to an entire operating system

- There are opinions that a Linux based system should be called "GNU/Linux"
- Nowadays: Memes about "systemd/Linux"

Advantages of Linux

- Runs (almost) everywhere
  - From low-power to high performance computing (https://top500.org)
- Open Source
  - All source code is publicly available
  - Can be analyzed and modified to your liking
  - Great for academia
- Customizable/Configurable
- Free of charge*

Components of a Linux system

Component	Example	Description
Bootloader	grub, systemd-boot	Starts the system
Kernel	Linux	Interfaces with hardware
Init System	systemd / openrc	Starts and manages system services
Display Server	X11, Wayland	Renders the graphical user interface (GUI)
Display Manager	GDM, LightDM	Graphical login screen
Desktop Environment	Gnome, KDE, XFCE	Defines how your GUI looks and behaves
GUI toolkit/framework	GTK, QT, Electron	Allows building GUI apps with different look and feel
Security Framework	SELinux, AppArmor	Optional, enhanced security regulation

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Most distros do not ship/configure a security framework by default

- AppArmor is shipped/enabled by default on Debian/Ubuntu
- SELinux is shipped/enabled by default on the RedHat distro family (including Fedora)
- SUSE provides configuration for both AppArmor and SELinux

Linux Desktop Environments

A **Desktop Environment (DE)** defines the look & feel of your Linux system

Includes: panels/menus, settings, file manager, system tools

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Desktop Environment	Characteristics	Target audience
GNOME	Modern, minimal, keyboard-friendly	Users who like a clean workflow
KDE Plasma	Highly customizable, Windows-like, many settings	Power users, tinkerers
COSMIC	Gnome-inspired, written in Rust, supports tiling	Power users who like simplicity
XFCE	Lightweight, classic interface	Older hardware, performance-focused
LXQt / LXDE	Extremely lightweight	Very resource-constrained systems
Cinnamon	Traditional desktop (Windows-like)	Linux Mint users, beginners
MATE	Fork of old GNOME 2, lightweight	Users who want a stable, classic desktop
Budgie	Modern, elegant, GNOME-based	Users who like simplicity + polish
Pantheon	macOS-like, minimalistic	Users who like macOS feel (elementary OS)

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> Choice of DE = personal preference -> try several to find your favorite!

> DE is **not tied to the distro** -> you can install others later

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  - Distros support various release cycles and models
- Distros are opinionated
  - Software selection based on certain preferences
  - Some distros only ship open source software components (Debian, Fedora)
  - Some distros compile everything from source (Gentoo)
  - Different out-of-the-box security configuration (SELinux, AppArmor, Firewall frontends)
  - Different package managers and package formats
  - Desktop vs Server focus
  - etc ...

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A couple to point out:

- **Slackware** is one of the oldest distros, but nowadays almost obsolete
- **Debian** is a very stable (mostly server) distro which focuses on free software (community driven)
- **Ubuntu** is a newcomer friendly distro based on **Debian**, owned by Canonical
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- **Gentoo** is a source based distro -> software is compiled locally
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- **Fedora** is a community driven distro that focuses on modern software and security
- **RedHat** and **SUSE** offer *Enterprise Linux* (paid)
  - **Alma** and **Rocky** are community editions of **RedHat Enterprise Linux** (RHEL)
  - **SUSE Linux Enterprise Server** (SLES) has free community editions **Leap** and **Tumbleweed**
  - **Fedora** used as **RHEL** upstream -> Community + RedHat driven
  - **Ubuntu LTS** is considered *Enterprise Linux* as well

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- **Kali**/**Parrot OS** are targeted towards pentesting/security auditing (no daily-driving)
- **Alpine** is a minimal Linux distro focusing on minimal overhead (e.g., resource-constraint hardware/containers)

Which Linux Distros are there?



Linux distro release cycles

Distro	Release model	Cadence & support lifecycle
Slackware	Fixed / irregular	No fixed cadence; long-lived releases
Debian	Fixed	~2 yr; ~5 yr support
Ubuntu	Fixed	Each April and October; 9 mo support
Ubuntu LTS	Fixed	~2 yr; ~5 yr support (10 yr when paid)
Linux Mint	Fixed	~2 yr; follows Ubuntu LTS
Fedora	Fixed	~6 mo; ~1 yr support
Arch Linux	Rolling	Continuous; no fixed lifecycle
Gentoo	Rolling	Continuous; no fixed lifecycle
NixOS	Fixed / rolling channels	~6 mo; stable channels maintained
RHEL	Fixed / enterprise	Major ~3–4 yr; 10 yr lifecycle (multiple minor versions)
SUSE SLES	Fixed	Major ~3 yr; minor ~1 yr; ~5 yr support (LTS extends further)
SUSE Leap	Fixed	~2 yr; ~2 yr support
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> No, this will not be an exam question ;)

Installing Software

Windows

Traditional

- `.exe` or `.msi` as **installer**
  - Manually downloaded from some website
- Contains required application files or downloads them from the internet
- Each application ships all dependencies by itself -> no sharing

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- Shared libraries are packaged as dependencies
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  - Upside: Much more space efficient
  - Downside: More complicated packaging, "dependency hell"

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Modern

- AppImage: Self-contained binary (no package manager)
- Snap: Package manager for self-contained applications (GUI + CLI), proprietary store operated by Canonical
- Flatpak: Package manager (decentralized) for sandboxed, self-contained GUI applications
- Toolpak: Supposed to be flatpak for CLI

Package Managers

A **package manager**

- installs, updates, and removes software
- keeps track of dependencies (e.g., libraries required by applications)

Different distros use different package managers and package formats:

Distro Family / Type	Package Manager	Package Format
Debian / Ubuntu	`apt` / `dpkg`	`.deb`
Fedora / RHEL	`dnf` / `yum`	`.rpm`
Arch Linux	`pacman`	`.pkg.tar.zst`
Alpine Linux	`apk`	`.apk`
NixOS	`nix`	store paths
Universal formats	`flatpak`, `snap`, `appimage`	portable

> Some systems (e.g., rpm-ostree, transactional-update) are immutable - changes apply atomically after reboot.

> Most package managers can update the entire system with a single command!

Linux file system explained

In Windows, different disk partitions have different letters.

In Linux, there is the file system tree. Directories in the tree are separated via `/`.

Each disk can be *mounted* at any path in the tree.

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Some directories are **virtual**

- e.g. (`/proc`, `/sys`)
- these directories exist only in memory and are not stored on the disk

Linux file system explained

```
/
├── bin -> usr/bin      # Essential user commands (ls, cp, mv)
├── boot                # Bootloader files (kernel, initramfs)
├── dev                 # Device files (e.g. /dev/sda, /dev/tty)
├── etc                 # System configuration files
├── home                # User home directories (/home/alice)
├── lib -> usr/lib      # Shared libraries for essential programs
├── lib64 -> usr/lib64  # 64-bit libraries
├── media               # Auto-mounted removable media (legacy)
├── mnt                 # Temporary mount points (manual)
├── opt                 # Optional / 3rd-party software
├── proc                # Virtual filesystem with process info
├── root                # Home directory for root user
├── run                 # Volatile runtime data (since last boot)
├── sbin -> usr/sbin    # System binaries (fsck, ip, systemctl)
├── srv                 # Data served by the system (web, ftp)
├── sys                 # Virtual filesystem for hardware devices
├── tmp                 # Temporary files (auto-cleared)
├── usr                 # User programs, libraries, docs
└── var                 # Variable data (logs, cache, spool)
```

Binaries & Their Locations

Directory	Purpose
/bin	Essential user commands needed for booting and repairing the system (e.g., `ls`, `cp`, `mv`).
/sbin	Essential system binaries for booting and administration (e.g., `fsck`, `ip`, `mount`).
/usr/bin	Most user applications (non-essential, e.g., `vim`, `git`, `python`).
/usr/sbin	Admin and system tools that are not essential for booting (e.g., `sshd`, `apachectl`).
/usr/local/bin	Locally installed user applications (not managed by package manager).
/usr/local/sbin	Locally installed system admin tools (manual builds, custom scripts).
/home/<user>/.local/bin/	User-specific binaries installed via `pip`, `cargo`, `npm` etc. - only available to that user.
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All standard directories are described in the file system hierarchy manual page - run `man hier` to read it.

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  - Printers: Try to use AirPrint (driverless)

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- Tools to check drivers:
  - `lspci`, `lsusb` -> list devices
  - `lsmod` -> list kernel modules (drivers)
  - `dmesg` -> check system log for driver messages
  - More on that in the later lectures

How do I install my own distro?

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Installation

- Boot from your USB stick (use UEFI if possible)
- Fedora will boot into a live system, from where you can start the graphical installation
  1. Select the system language and keyboard layout
  2. Define the installation destination (the disk where you want Fedora installed). You can choose to use the entire disk or share it with an existing operating system (dual boot)
  3. Configure storage encryption (recommended for notebooks and portable devices for better security)
  4. Review your configuration and install Fedora Workstation

Thank you!

Thank you for your attention!

Don't forget the feedback in Moodle please!