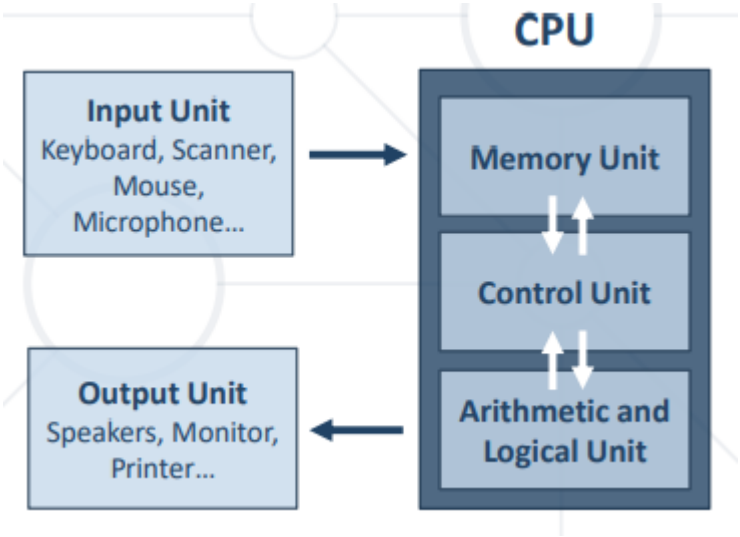
Software Technologies Fundamentals

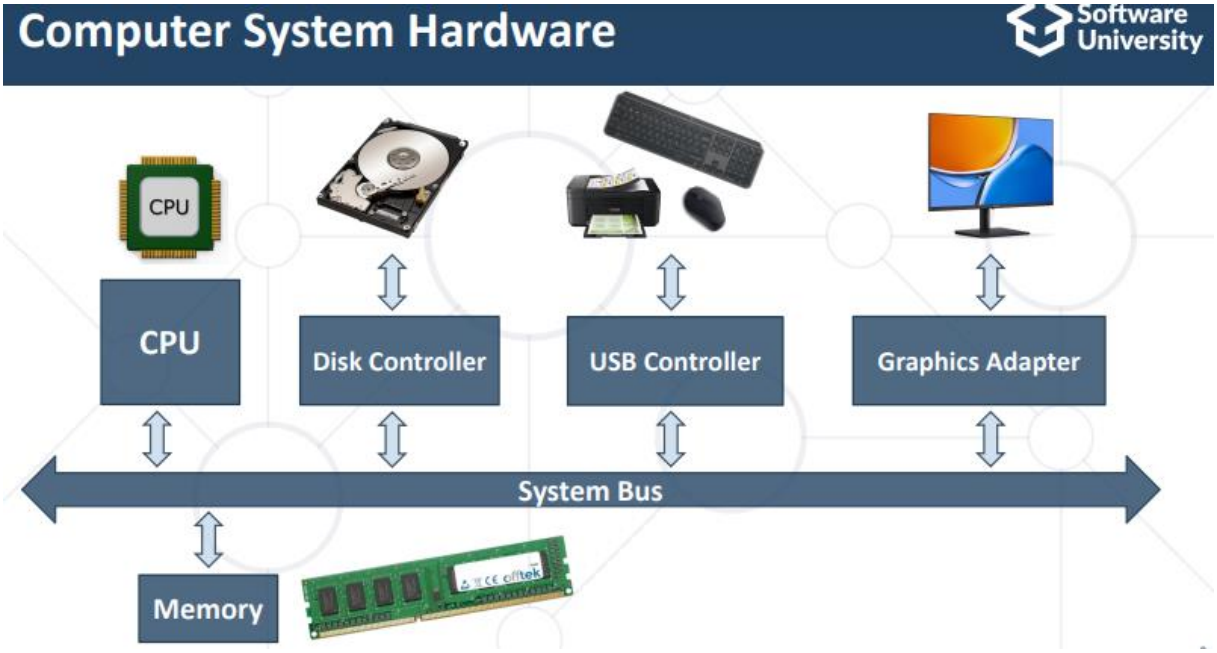
Computer Systems and Software

Hardware: Motherboard, CPU, RAM, Storage, Peripherals
Software: Firmware, System, Server-Side, Applications

▪ **Computer system**: an integrated bundle of hardware and software components, e. g. smartphone, POS terminal, laptop
▪ Enables efficient data input, processing, and output
▪ Comprises interconnected software and hardware components
▪ Human-computer interaction for the end-users / APIs for machine-to-machine interaction
▪ **Key elements:**
  ▪ Hardware: RAM, input/output devices, storage devices, CPU
  ▪ Software: operating systems, drivers, apps, games

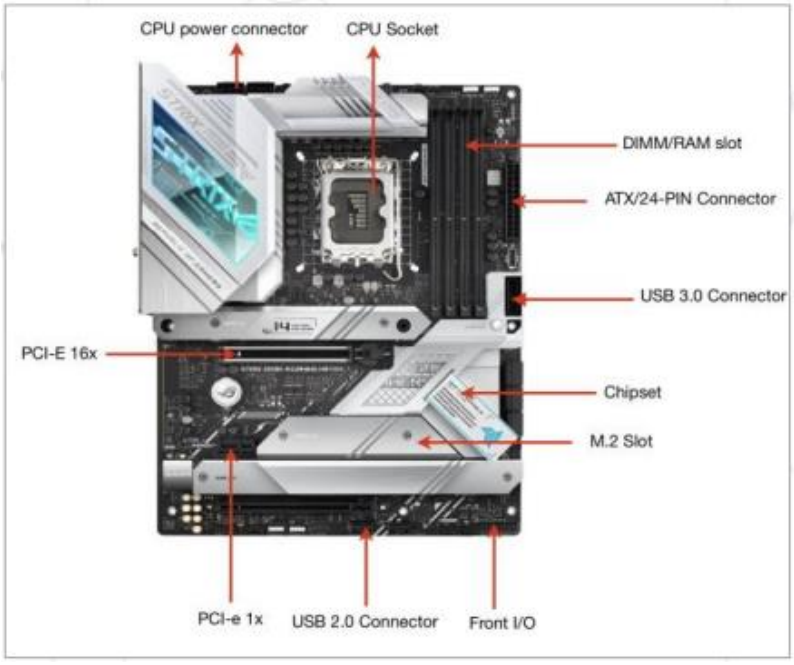
▪ **Early computing**: mechanical and electromechanical devices (e.g., Abacus, Babbage's Analytical Engine, ENIAC)
▪ **Advancements in technology**: transistors, integrated circuits, microprocessors (e.g., mainframe computers, minicomputers, personal computers)
▪ **Modern era**: pervasive computing, IoT, cloud computing, edge computing, rise of AI and machine learning
Computer Hardware - Motherboard, CPU, Memory, Storage, Peripherals
▪ Hardware refers to the physical components of a computer
▪ Central Processing Unit (CPU) – microprocessor
▪ Executes the code (programs)
▪ All data processing operations
▪ Input devices ▪ Enter data
▪ Output devices ▪ Get information



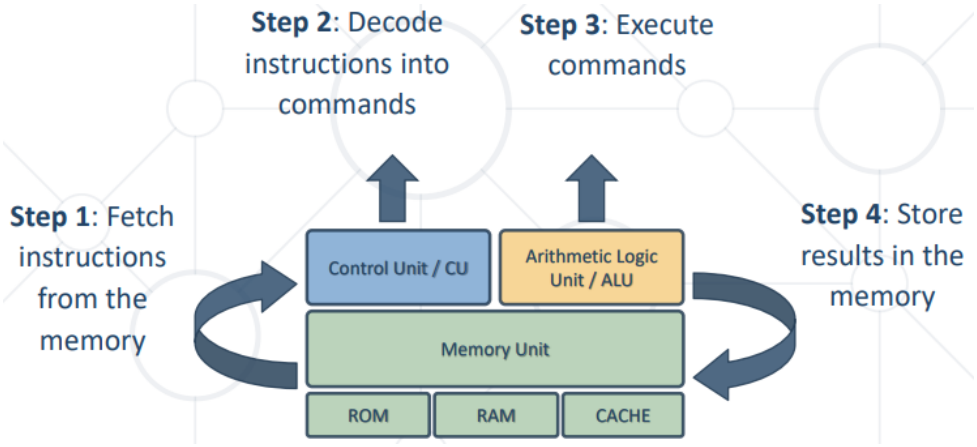


- **Motherboard** == central hub for hardware connectivity
  - Communication between all hardware components
- Compatibility considerations
  - Each motherboard is designed to work with specific types of processors and memory
- Expansion slots for enhanced functionality
  - Video cards for improved graphics performance
  - Sound cards for enhanced audio capabilities
  - Network cards for better internet connectivity

Motherboard Components ▪ CPU socket ▪ RAM slots ▪ Power connectors ▪ Chipset ▪ Expansion slots ▪ SATA connectors ▪ USB connectors ▪ Bluetooth module



▪ **CPU – the brain of the computer**
  ▪ Executes calculations, actions, and runs programs
  ▪ Provides processing power and instruction control
▪ Three core components
  ▪ **Control Unit (CU)** ▪ Manages instruction flow and coordinates hardware functions
  ▪ **Arithmetic and Logical Unit (ALU)** ▪ Performs arithmetic and logic operations
  ▪ **Memory Unit (MU)** ▪ Stores data, programs, and information



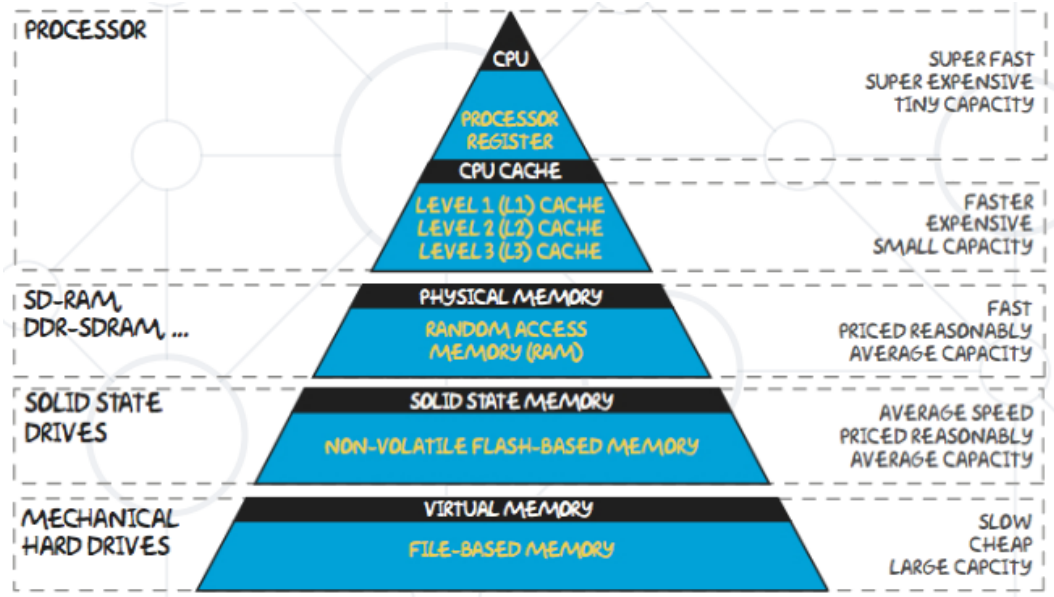
Memory and Storage - Storing Information in a Computer

▪ **Primary memory**
  ▪ RAM – read / write: stores data, required by the CPU during the execution of a program
  ▪ ROM – read-only: stores crucial data for the system to operate, like the essential program for the computer boot

▪ **Secondary memory**
  ▪ Not accessed directly by the processor
  ▪ Examples: hard drive, SSD, flash, optical drive, USB drive

▪ **Cache memory**

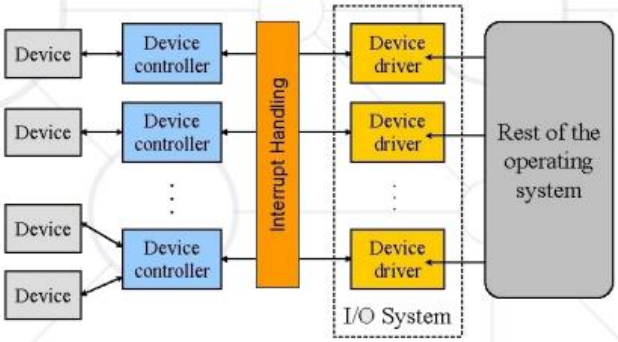
▪ Part of the CPU, very fast: temporarily stores frequently used instructions and data to speed-up access

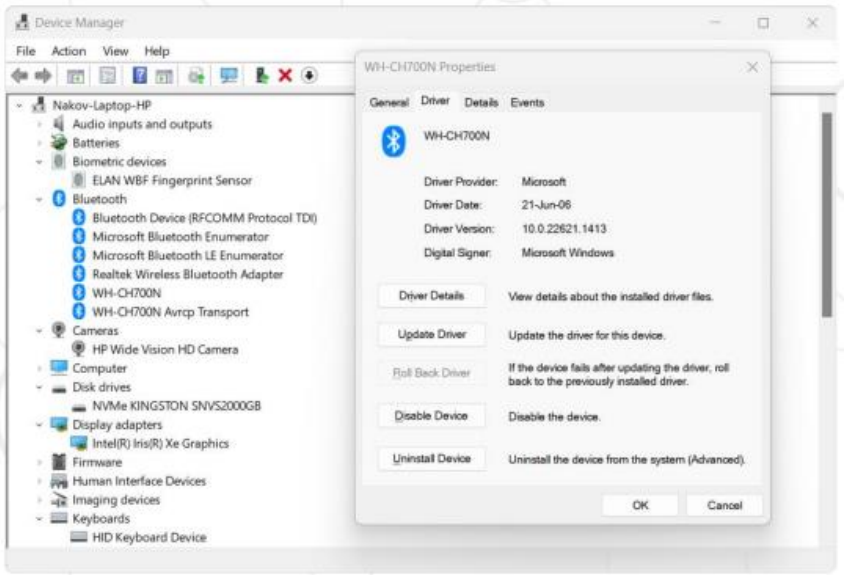


Peripheral Devices - Expanding Computer's Functionality

- Any connected device that expands computer's capabilities with additional functionality
- Three main categories:
  - **Input devices** → read data, e.g. keyboard, mouse, microphone
  - **Output devices** → write data, e. g. speakers, printer, monitor
  - **Input/output devices** → mixed, network card, hard drive, touchscreen monitor

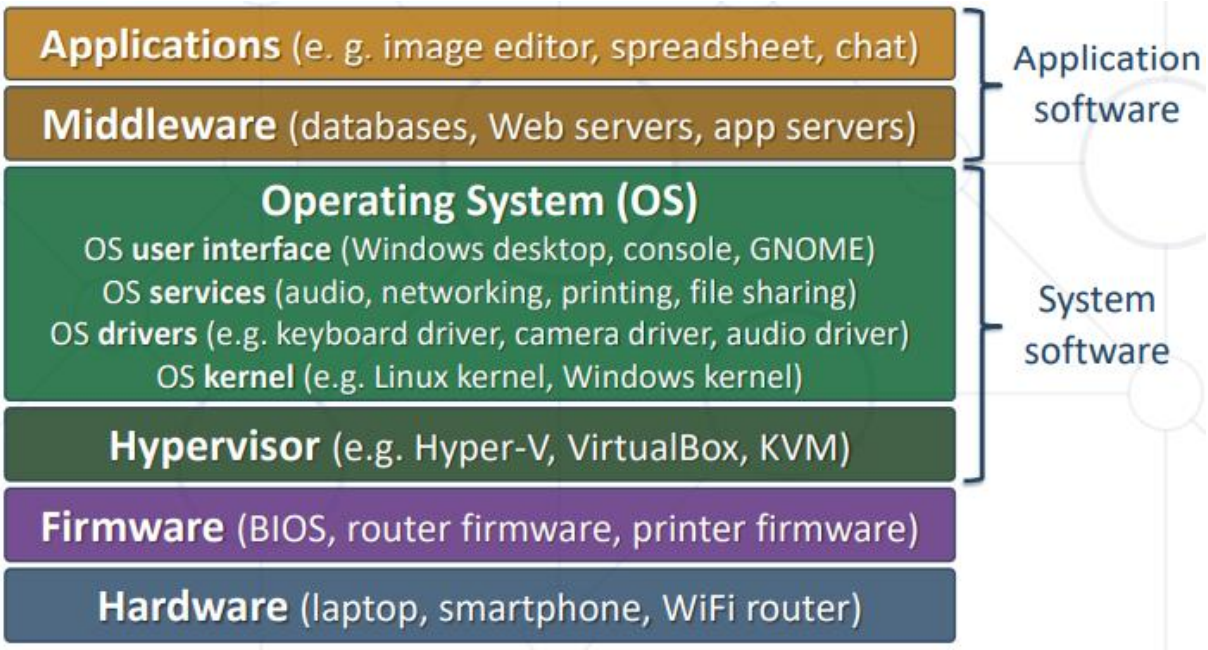
- **Device controller**
  - A physical device for connection between a peripheral device and the computer
  - E. g. USB controller
- **Device driver**
  - System software, which enables the communication and data transfer between devices and the system





Computer Software - Firmware, System Software, Applications

- Computer software – definition
  - Computer programs, instructions, and data that enable a computer system to perform specific tasks
- **Types of software**:
  - Application software: help the business to run, e.g. email software, spreadsheets, word processing, CRM systems, …
  - System software: interacts with and manages the hardware
- Standalone apps vs. software systems (client + server)



Layers of Software

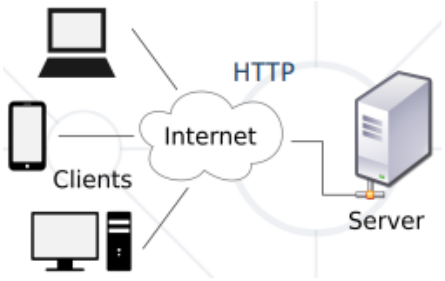
- **Firmware and embedded software**
  - Low-level software used to operate a hardware device
- **System software**
  - Manages and controls hardware, platform for applications
  - Operating systems (OS) – Windows, Linux, macOS, Android
  - Hypervisors – runs virtual machines (VMs) in the host OS
- **Application software**
  - Business applications, office apps, multimedia, communication
  - Several types: Web apps, desktop apps, mobile apps

Software Systems

- **Standalone apps**
  - Run locally, store their data locally, do not need Internet
  - Examples: Windows Calculator, Windows Explorer, Minesweeper
- **Software systems**
  - Consists of several components (e. g. client + server)
  - Example: mail server (remote) + mail client app (local)

- **Cloud apps:** hold all user data in the cloud + local client
  - Example: Google Docs, Discord, Trello, Canva

- Front-end and back-end separate the modern apps into client-side (UI) and server-side (data) components
- **Front-end** == client-side components (Desktop / mobile app / Web browser)
  - Implement the user interface (UI)
- **Back-end** == server-side components (data and business logic APIs)
  - Implements data storage and processing Front-End and Back-End
- **HTTP connects frontend with back-end**



Firmware - Bridge between Hardware and Software
- **Firmware** == permanent, low-level software, embedded in a device's read-only memory (ROM)
  - Controls device's basic functions and provides a stable foundation for higher-level software
  - Example: WiFi router's firmware, coffee machine firmware
- **Functions of firmware**
  - Hardware initialization during the boot process
  - Management of low-level hardware operations (e. g. device initialization, hardware diagnostics, and system booting)
- Examples of firmware applications
  - BIOS / UEFI in laptops and desktop computers
  - Firmware in routers, printers, scanners
  - Embedded systems, such as IoT devices
- Firmware updates
  - Most devices allow firmware updates to improve functionality or fix issues
  - Can be critical for security and performance

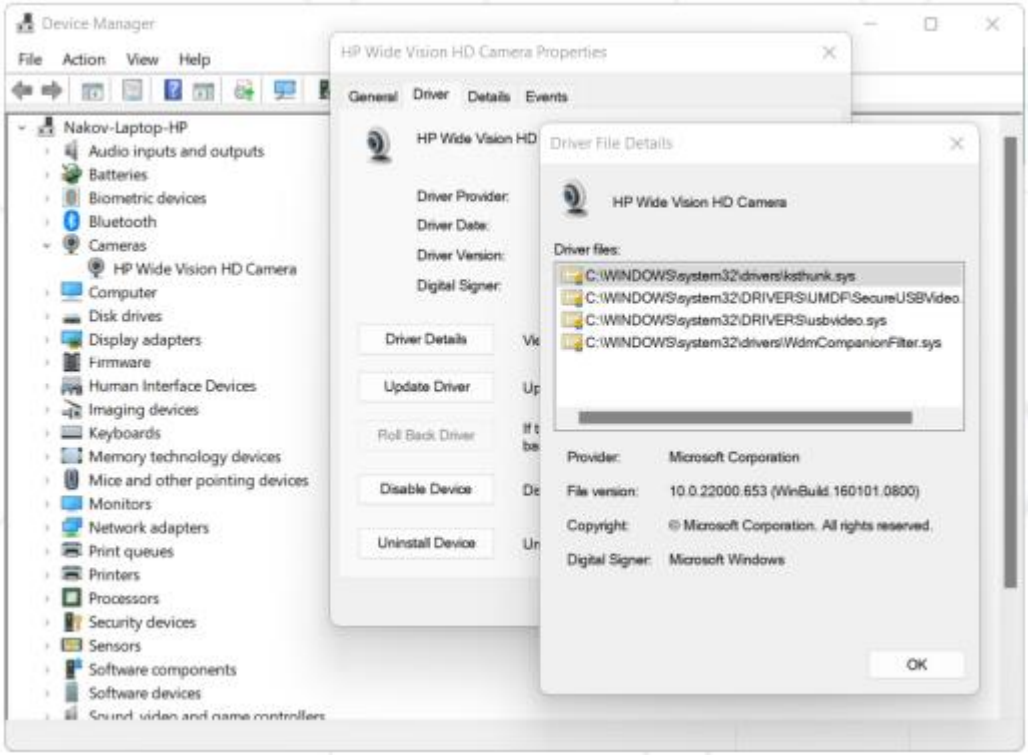
System Software - Foundation for Application Software
- Software designed to manage and control computer hardware, providing a platform for application software
- Examples of system software
  - **Hypervisors** – runs virtual machines (VMs) in the host OS
  - **Operating systems (OS)** – Windows, macOS, Linux, Android
  - **Device drivers** – software that enables communication between hardware and operating system), e. g. mouse driver
  - **System utilities** – tools for system maintenance and optimization, e. g. anti-virus, task manager, print spooler

Operating Systems

- Windows, macOS, Linux, Android, iOS
- Manage the hardware and software resources
- Manage processes (concurrently running apps)
- Distribute the system resources between all processes
- Manage file system and memory (RAM)
- Manage users, security and access control
- System updates and maintenance

Device Drivers

- In Windows, the "Device Manager" lists all devices, drivers, etc.



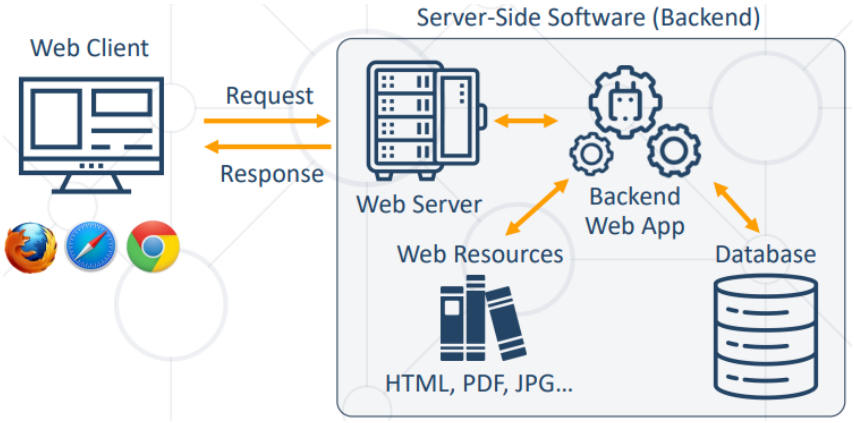
System Utilities

- Tools that help maintain and optimize a computer system
  - Antivirus and malware protection (e.g. Winows Defender)
  - System backup and recovery (e. g. Macrium Reflect)
  - Disk cleanup and defragmentation (e. g. CCleaner)
  - Performance monitoring and diagnostics (Task Manager)
  - Software updates and patches (e. g. Windows Update)
  - System hardware information (e. g. CPU-Z)
  - System logs viewer (e. g. Windows Events Viewer)

Server-Side Software (Backend) - Facilitating Backend Operations and Web Services

- Server-side software (backend software) runs on a remote server, processes requests and delivers data to client devices

- Common types of **server-side software**
  - Web servers (e. g. Apache, Nginx, IIS)
  - Database servers (e. g. MySQL, PostgreSQL, MongoDB)
  - Application servers / runtimes (e. g. Tomcat, Node.js, .NET Core)
  - Mail servers (e. g. Microsoft Exchange Server, Postfix)
  - File servers (e. g. Windows File Server, Samba)
  - Authentication servers (e. g. FreeIPA, Active Directory)



- **Server-side software (backend software):**
  - Executes on a remote server, rather than on the user's device
  - Handles data processing, storage, and retrieval
  - Powers Web applications, backend APIs, cloud services, etc.
  - Requires efficient resource management for optimal performance
- **Graphical User Interface (GUI) / front-end apps:**
  - Executes on the user's device (desktop, mobile, or Web)
  - Providing seamless and visually appealing user experience
  - Can be Web apps, desktop apps, or mobile apps

Application Software - Apps for the End Users

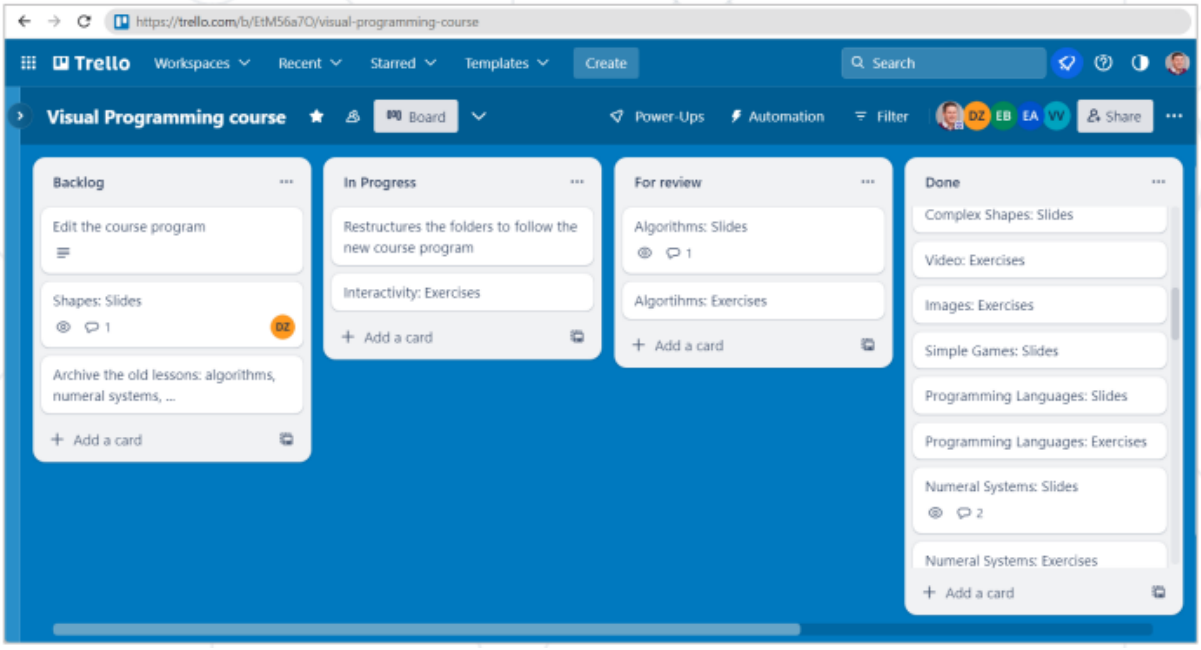
- Application software is designed for users to perform specific business tasks, catered to their individual needs
- **Examples of application software**
  - Productivity tools (Microsoft Office, Google Workspace)
  - Multimedia software (Adobe Photoshop, VLC Media Player)
  - Communication apps (Zoom, WhatsApp, MS Teams)
  - Web browsers (Google Chrome, Mozilla Firefox, Safari)
  - Games (Fortnite, League of Legends)

Web Apps - Applications, Accessed from the Web Browser

- What are Web apps?
  - Accessed through a Web browser with an active Internet connection
  - **Platform-independent**
    - Accessible on any device with a Web browser
    - Desktop/mobile Web browsers
  - **Automatic updates (always up-to-date)**
    - No need for manual installation or updating

- **Benefits of Web apps**
  - Scalability: easily accommodate a growing user base
  - Centralized data storage: simplifies data management and backup
  - Lower device requirements: minimal hardware needed (processing is done on the server-side)
  - Easier collaboration: real-time collaboration
  - Cross-platform compatibility: works across various operating systems and devices

- **Compatibility:** if the app works consistently across different Web browsers and different screen sizes (responsive design)
- **Usability:** testing for accessibility, intuitive use on different devices, and ease of navigation
- **Network conditions:** Web apps rely on an active internet connection→ testing under different network conditions
- **Security:** Web apps deal with sensitive data → testing for vulnerabilities such as XSS attacks and SQL injection
- **Performance:** performance can be affected by network speed / server load / browser capabilities → testing for scalability / load capacity

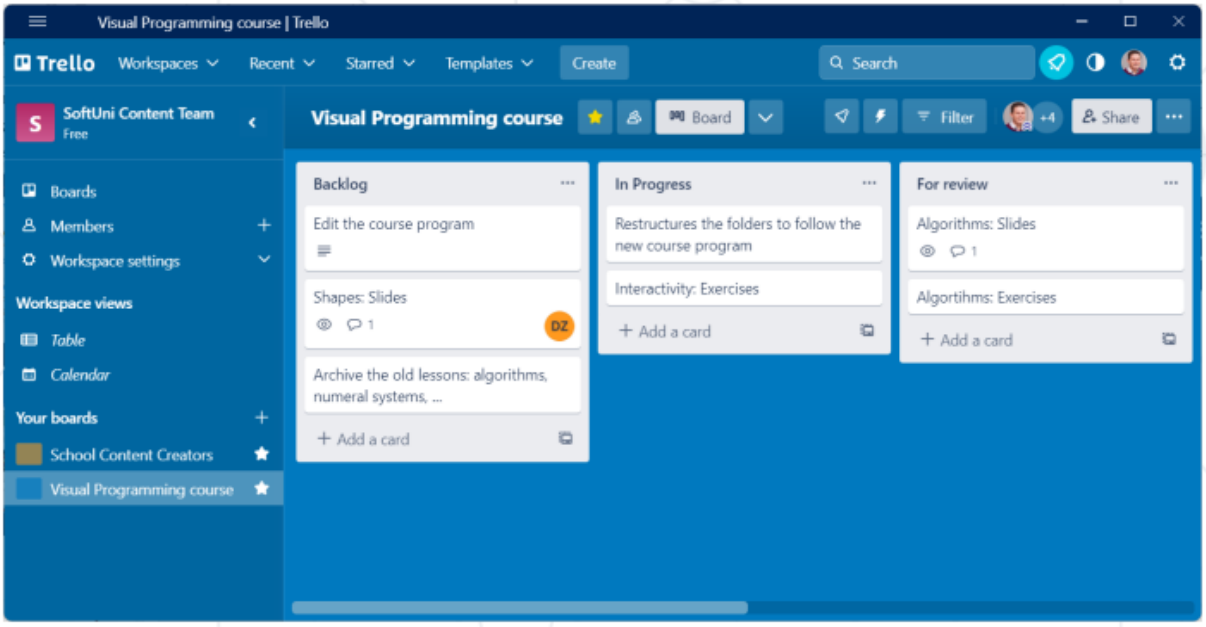


Desktop Apps - Applications Running Locally on Your Laptop

- What are desktop apps?
  - **Installed and run locally on a user's computer**
    - Store their data locally or remotely (depends)
  - **Offline access**
    - Can be used without an Internet connection
  - **More features**
    - Often more feature-rich than Web apps
    - Better integrated with the host OS

▪ Benefits of desktop apps
  ▪ **Performance:** faster processing and response time, as tasks are executed locally
  ▪ **Customization:** easily tailored to individual user preferences and needs
  ▪ **Integration:** compatible with other locally installed software and hardware
  ▪ **Cost-effective:** one-time purchase or licensing fees, instead of recurring subscription costs (depends)

▪ Installation / uninstallation including any dependencies or prerequisites
▪ Performance testing on different hardware configurations – processors, memory, and graphic cards
▪ Compatibility testing for different operating systems and their different versions
▪ User interface testing: desktop apps often have complex UI that need to be thoroughly tested
▪ Integration testing with other desktop applications



Mobile Apps - Applications Running Locally on Mobile Device
▪ What are mobile apps?
  ▪ Designed specifically for smartphones and tablets
  ▪ Accessible through dedicated app stores (e.g., Google Play, Apple App Store)
  ▪ Optimized for touchscreen interfaces and mobile device features (adaptable UI design for different screen sizes)
  ▪ Can work offline, online or mixed
▪ **Benefits of mobile apps**
  ▪ **Portability:** access apps and data on-the-go, anytime, anywhere
  ▪ **Push notifications:** real-time updates and alerts for improved user engagement
  ▪ **Device-specific features:** leverage device capabilities like GPS, camera, and sensors
  ▪ **Offline functionality**: some apps can operate without an Internet connection
  ▪ **Streamlined user experience:** tailored for smaller screens and touch-based interactions

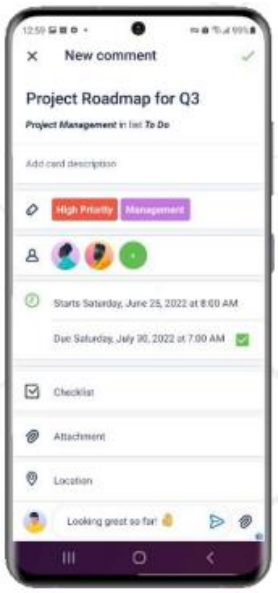
Testing Challenges for Mobile Apps

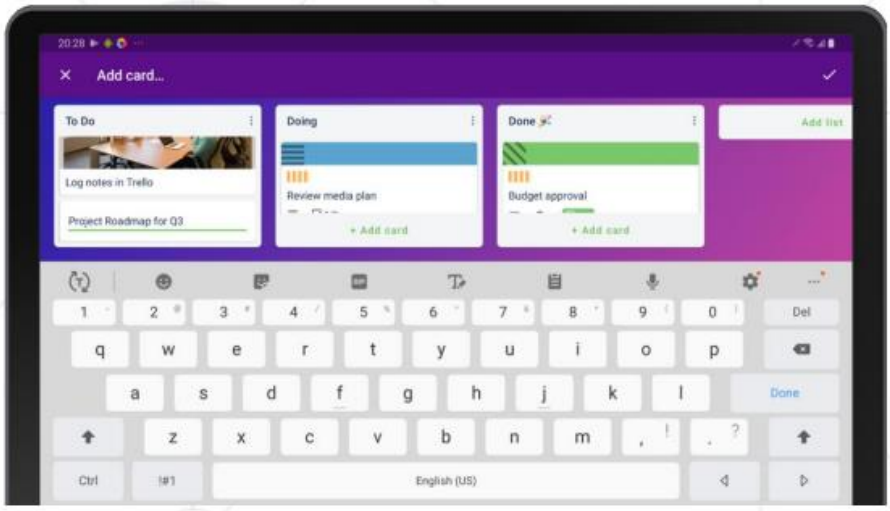
▪ **Compatibility** across different devices and OS versions is crucial for mobile apps (many different devices and versions in use)

▪ **User interface testing** – design and layout has significant impact on the user's experience on a smaller screen

▪ **Performance testing** – performance may be affected by limited processing power and memory on the user's device

▪ **Battery life testing** – to ensure that the app does not significantly drain the user's device battery





Summary

▪ **Hardware** is the physical part, whereas software is a set of instructions for the computer

  ▪ Main computer parts are the motherboard (ties together all components), CPU (code execution), input / output devices

▪ **Software** – programs, running in the computer

  ▪ Firmware and system software (OS, hypervisors)

  ▪ Server-side software (back-end) vs. GUI / front-end apps

  ▪ Application software (end-user apps): Web apps, desktop apps, mobile apps

  ▪ Software systems (client + server) and cloud apps

Operating Systems

OS Overview, Linux Shell, VM and Containers

Operating Systems (OS) – Overview - OS Purpose and Structure

▪ The **operating system (OS)** manages applications (processes), users, file system and resources in a device

▪ The OS is loaded into a device through a process called booting

▪ OS enables applications to interact with the device's hardware and software resources

▪ Applications make requests for services through a defined interface called an application program interface (API)

▪ At least one OS must be installed in a device to run basic programs, e. g. Web browser, file explorer, video player

OS Main Functions

▪ **Booting** – turning on the device and loading the OS

▪ **App loading and execution** – load and run programs (processes, apps), start / view / pause / terminate apps

▪ **Process management** – allocates resources to OS processes, share data between processes, protects, and synchronizes them

▪ **Memory management** – controls and coordinates the memory allocation for the applications running in the OS

▪ **Disk management** – manages storage (hard drives, SSD disks, optical disk drives, flash drives) and file systems

▪ **Device controlling** – controls the access to physical devices (like disk drives, CD/DVDs, USBs) and virtual devices (like random)

▪ **Networking** – communication over the network and Internet

▪ **Printing controlling** – takes control of printers connected and manages the printing process

▪ **User interface (UI)** – provides UI for the users to interact with the computer by commands or visual UI elements

▪ **Data security** – isolate apps, users and files to keep data secure (e. g. using file system / resource permissions)

▪ **Kernel** == core component of the OS

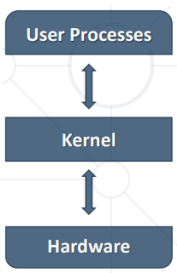
▪ **The OS "heart"** – bridges hardware and software components

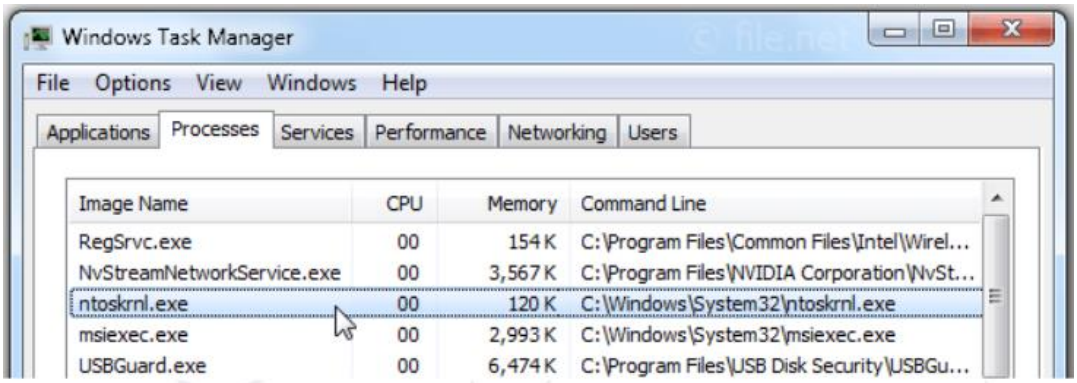
▪ Facilitates communication between different system components

▪ Provides complete control over the system

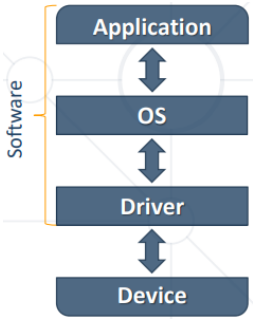
▪ Always stays resident in memory

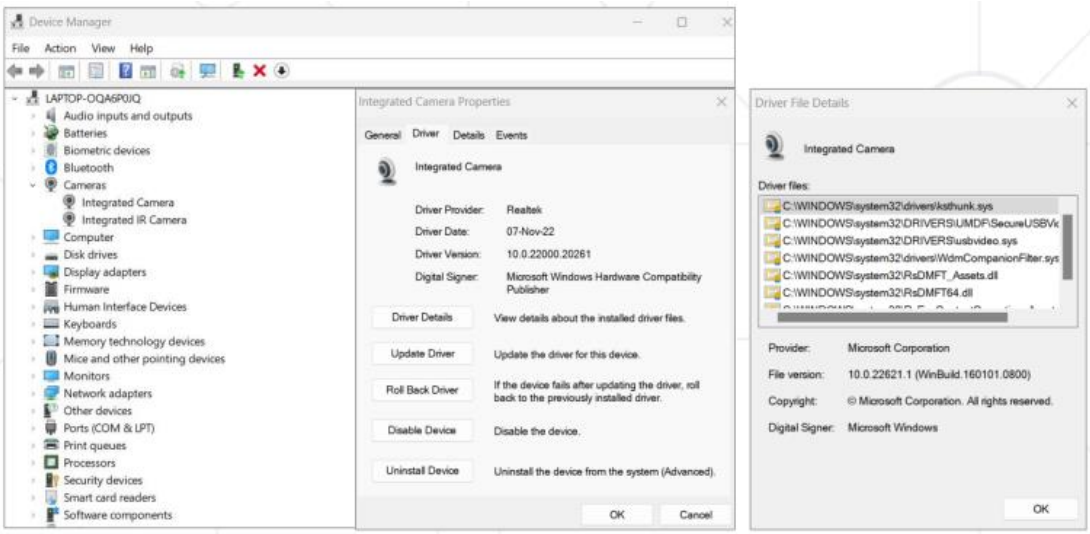
▪ Essential for running any operating system





- **Drivers** == set of system programs that enable hardware components to function
- Drivers connect the OS and devices
  - Enable hardware components or peripherals to operate properly
- Drivers are low-level software programs without a user interface (UI)
- All hardware components require a driver (e. g. disk drives, printers, keyboards)



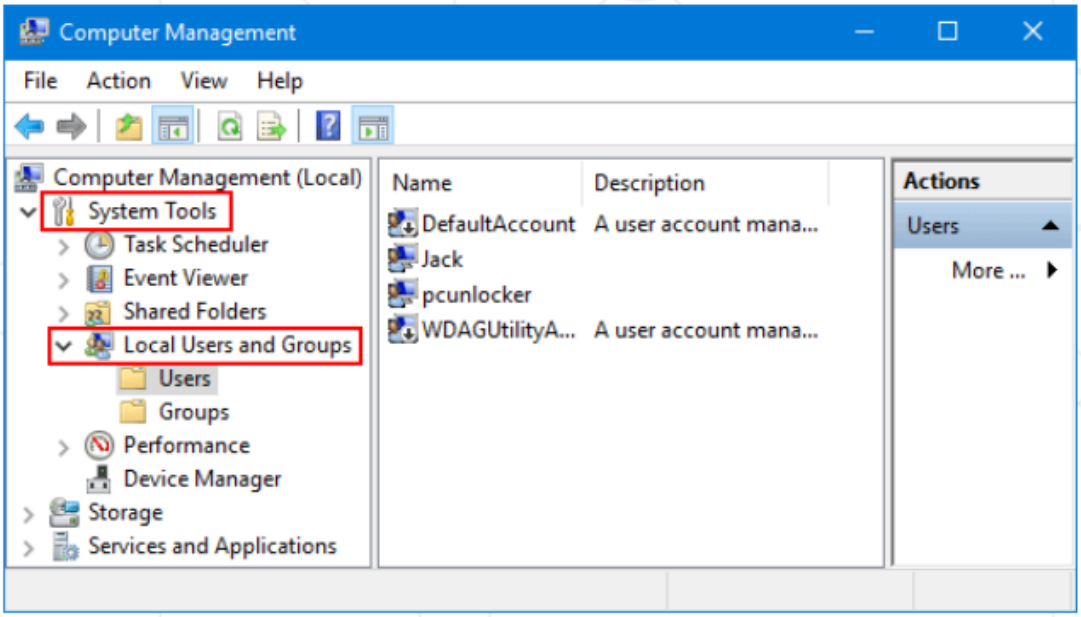


- **Shell** == user interface (UI) to the OS
  - Outermost layer of the operating system, located between the kernel and the apps
  - Provides a UI and tools to control processes, files, installed software, users, etc.
- Two types of shells:
  - **Command-line (CLI) shells** – require knowledge of commands, syntax, and concepts about the shell-specific scripting language (e. g. bash)
  - **Graphical (GUI) shells** – intuitive, easy to use (e. g. Windows Desktop)
- Most GUI-enabled OS provide also CLI shells for advanced users

Users in Operating Systems

- **Users in the OS** == individuals or entities who interact with the system by logging in and performing tasks
- A user often has a user account and is identified to the system by a username
- Users may have privileges over processes, folders and files, devices, services, network and other resources
    - Users are typically isolated from each other
- OS can be single-user (e. g. DOS) or multi-user (e. g. Linux, macOS, Windows)

- **User accounts** allow access to a system's resources
- Authentication is the process of verifying a user's identity
    - Through credentials (like passwords / keys)
- Authorization determines what resources a user can access based on their authenticated identity
- User accounts in the OS are important for accounting, security, logging, and resource management



Authentication vs. Authorization

- **Authentication** verifies the identity of a user or service
- **Authentication** answers the question:
    - Who are you?
- **Authorization** determines the user's access rights
- **Authorization** answers the question:
    - What are you allowed to do?

User Permissions

- OS controls the use of system and network resources
    - Through authentication and authorization
    - Based on user permissions over resources (e. g. file permissions)
- The OS determines if an authenticated user has the correct permissions to access a resource
    - Using built-in authorization and access control technologies

User Roles (Groups)

▪ User roles (groups) are permission sets that control access to resources (files, folders, processes, services)

▪ Simplify permission assignments, e. g. in a hosting company, all customers may use the group "web"

▪ Each user account may have multiple roles

▪ Examples of user roles **in MS Windows**: Administrator, User, Power User, Guest

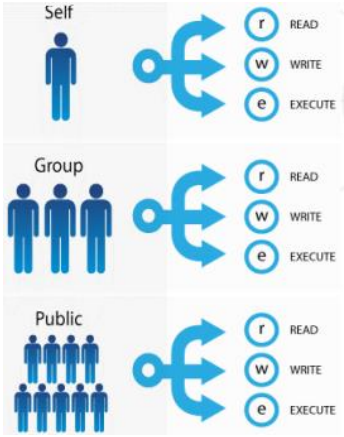
▪ Examples of user groups **in Linux**: root, user, nobody

Access Permissions in OS

▪ **Access permissions** determine a user's ability to perform a specific action, or access a feature or object

▪ Set access permissions to specify which users, groups, or roles can access your content

▪ The most common permissions are read, write and execute



Processes in OS

▪ A process is a program in action (a running app)

▪ Consume CPU time, RAM memory, file handles and other OS resources

▪ It's the basic unit of work in the operating system

▪ Unlike files, which are passive, processes are an active entity

▪ For example, when you open a browser to search the web, that's a process

Task Managers

▪ In OS, a task manager is a system monitoring app

▪ View processes, users, consumed resources, etc.

▪ View RAM, CPU, GPU, disk, network load

▪ Start / terminate (kill) processes

▪ Examples:

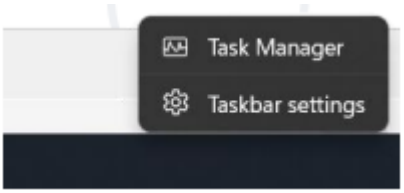
▪ Windows Task Manager in MS Windows ▪ top and htop in Linux ▪ Activity Monitor in macOS

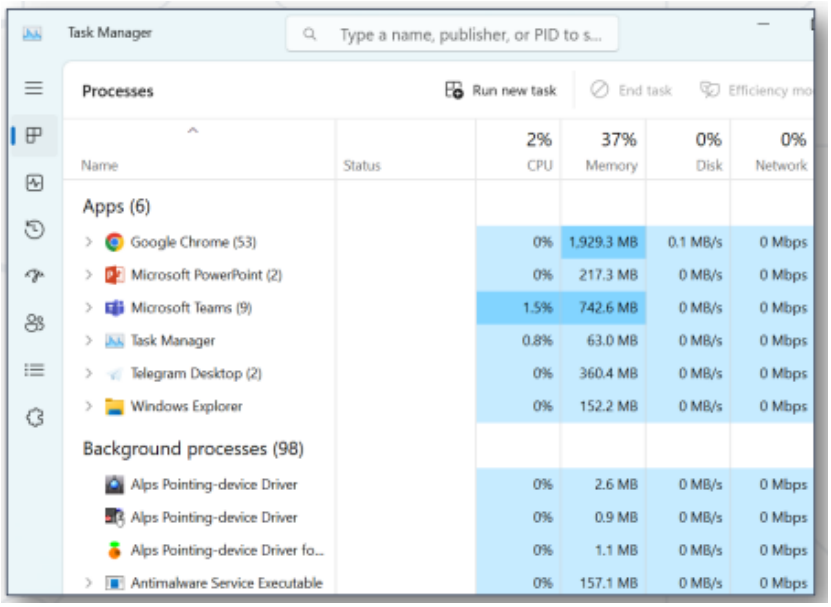
Windows Task Manager

▪ Open the Task Manager in MS Windows:

▪ [Ctrl + Alt + Delete] → select [Task Manager] from the menu

▪ Right click on the task bar → [Task Manager]





Popular Operating Systems - Windows, Linux, macOS, Android, iOS

Most Popular Operating Systems

- Five major operating system:
- Microsoft Windows ▪ Apple macOS ▪ Google's Android OS ▪ Apple iOS ▪ Linux (open source)

Microsoft Windows

- Proprietary OS, developed by Microsoft
- One of the most popular OS
  - Typically preinstalled on new PC
- Several versions: Windows 95 / 98 / Vista, Windows 7 / 8 / 10 / 11
  - Has been around since the 1980s
- Easy-to-use, intuitive GUI shell
  - Many apps and games

Apple macOS

- Apple and Macintosh computers run on macOS and OS X
  - Proprietary OS developed by Apple
- macOS is a Unix-based OS
  - Released over 20 years ago
- In 2020, Apple began transitioning to its own 64-bit ARM-based Apple M CPU
  - Apple M1 / M2 CPU: powerful and silent

Android OS

- Mobile OS, designed for touchscreen mobile devices
- Based on a modified version of the Linux kernel and other open-source software
- Core OS is called Android Open-Source Project (AOSP)
  - Free and open-source software
  - Developed and maintained by Google
- Many distributions (by Samsung, Xiaomi)

Apple iOS

- Mobile OS, developed by Apple
  - Exclusively for its hardware devices: iPhone, iPad and iPod Touch
- Closed ecosystem, dominated by Apple
- iOS UI uses multi-touch gestures: swipe, tap, pinch, and reverse pinch
- iOS runs on Apple hardware only
  - Might run on PC emulators, but is illegal

Linux

- Linux is Free and open-source family of operating systems
- Linux's popularity comes from its ease of customization and open license
- Offers CLI shell and many GUI desktops
- Many distributions: Ubuntu, CentOS, Debian, Mint, openSUSE, Alpine, …
- It offers a variety of options for those who understand how to use it

Virtual Machines & Containers - Remote Instances & Emulators

Virtual Machines (VM)

- A virtual machine (VM) is a software-based computer resource, used to run an OS inside another OS
- Digital version of a physical computer that can run programs and OS, store data, connect to networks, and other computing functions
- **Virtualization** == running a virtual machine (VM) / virtual environment inside a physical hardware system
  - E. g. run Android VM or Linux inside a Windows host
  - Storage, networking, desktops can also be virtual

Containers and Docker

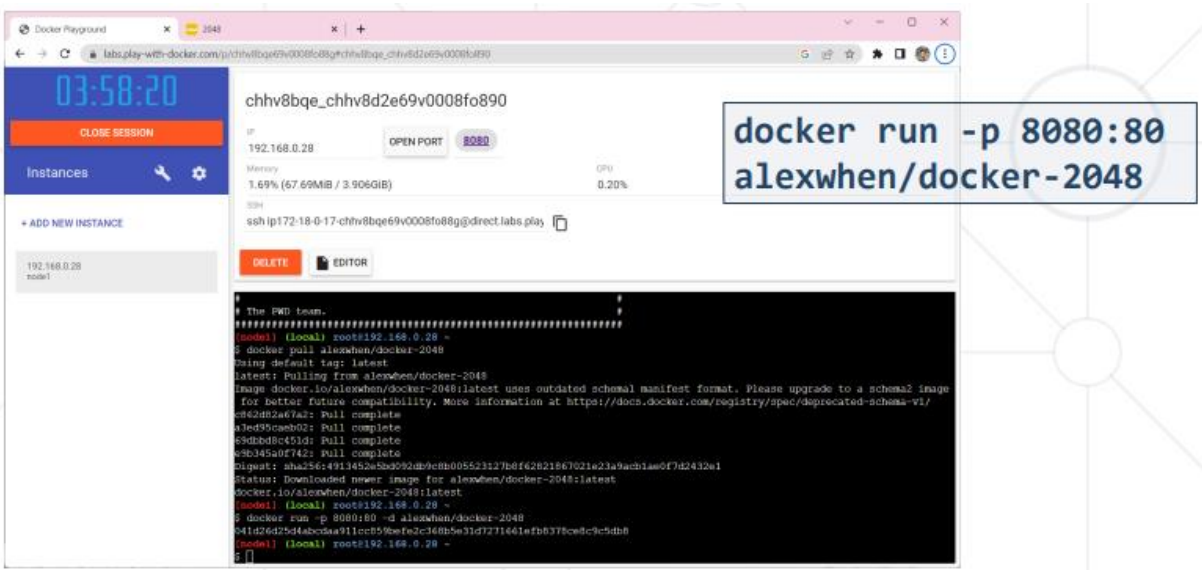
- **Container image** == software, packaged with its dependencies, designed to run in a virtual environment (like Docker)
  - E. g. WordPress instance (Linux + PHP + Apache + WordPress)
  - Simplified installation, configuration and deployment
  - **Lightweight** – containers use shared OS kernel with the host
- Docker is the most popular containerization platform
  - Runs containers from local image or downloaded from the Docker Hub online repository
  - Open-source, runs on Linux, Windows, Mac

Docker Containers

- A Docker container image is a lightweight, standalone executable package of software
  - Contains everything needed to run an app: code, runtime, libraries, tools, and settings
- **Container** == running Docker image
  - App, running inside the Docker Engine
- Containers provide fast and simple way to run apps, without installing them on the host OS
- Containers are isolated from the host and other containers → security

Remote VM Instances and Docker Playground

- Containers allow for customizable and replicable instances of an application
- Without interfering with anything else on a user's system (no conflicts)
- Docker Playground is an interactive and fun way to learn Docker
- Provides free Linux + Docker VMs
- Accessible for 4 hours, for learning
- https://labs.play-with-docker.com

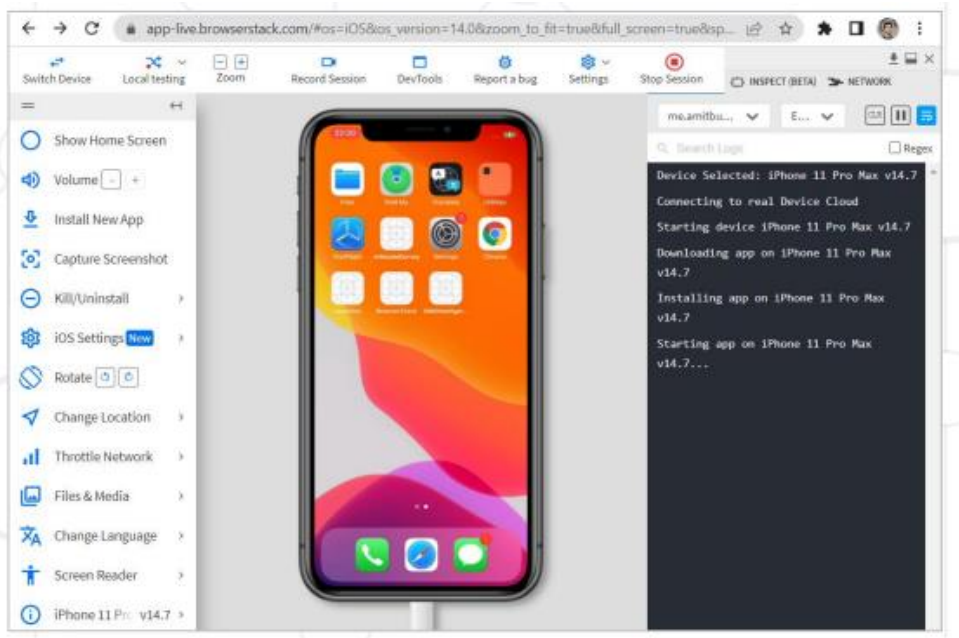


Device Emulators

- **Device emulators** run Android / iOS / other OS in a virtual machines (VM) and simulate device functions (e. g. rotation)
- BlueStacks, LDPlayer, Android Emulator - run Android apps in Windows and simulate mobile devices

BrowserStack – App & Browser Testing

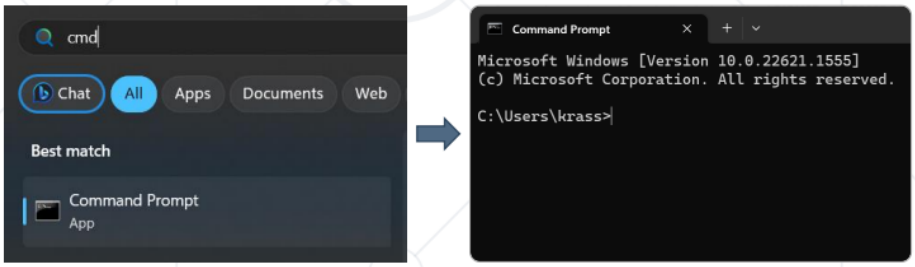
- **BrowserStack** – manual and automated online mobile testing for Web sites and mobile apps
- Test on remote physical devices: iPhone, iPad, Samsung, Xiaomi, Google smartphones / tablets
- Modern devices, modern Web browsers
- Android, iOS, Windows, macOS
- **BrowserStack Live** offers 3000+ devicebrowser-OS combinations for testing



Shell & Shell Commands - Shell Command Execution on Linux and Windows

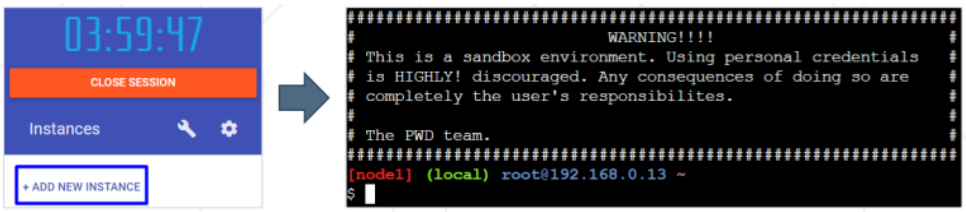
Opening the CLI Shell in MS Windows

1. Click [Start] -> [Run] or press [Windows + R] key
2. Type "cmd"
3. Click on [Command Prompt]



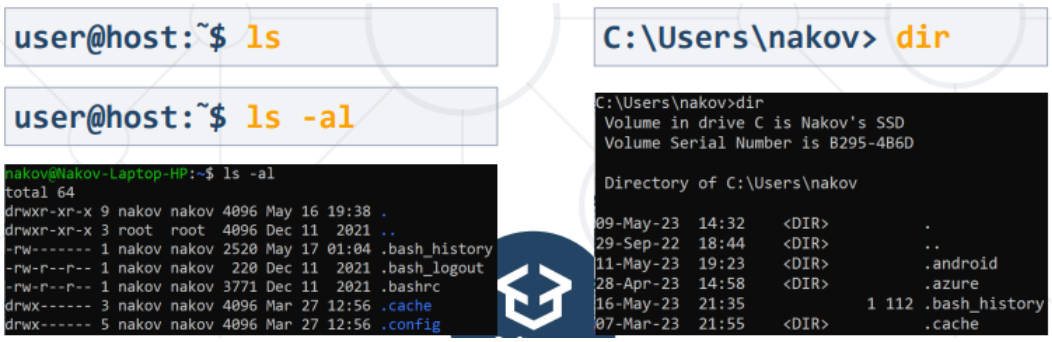
Linux Shell in Docker Playground

- Starting a Docker Playground session
  - Open Docker Playground, register and log in
  - Press [Start] and add a new instance
  - Now you have a Linux VM + Docker environment to experiment with



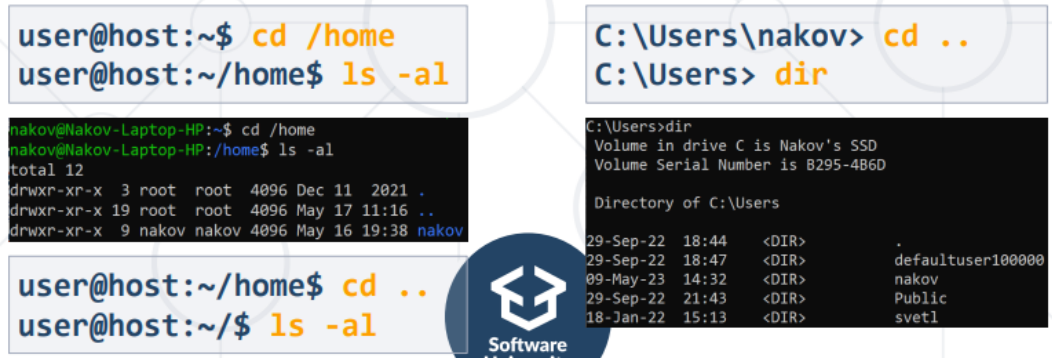
Commands: ls & dir

- ls list files and directories in Linux / UNIX / macOS
- dir lists the files and folders in Windows



Commands: cd

- cd changes the current working directory in Linux
- cd works the same way in Windows

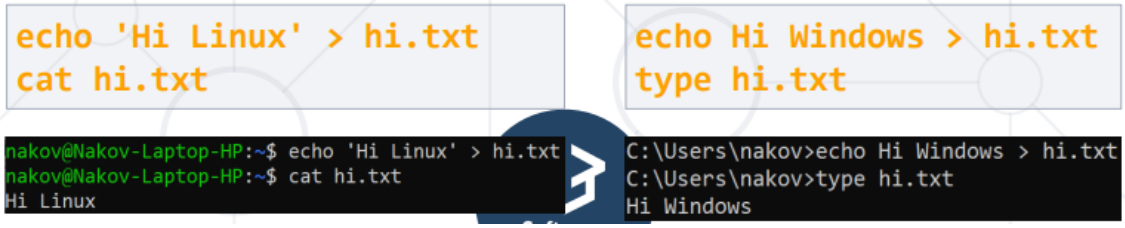


Commands: pwd / cd

- pwd prints the current working directory in Linux
- cd works the same way in Windows

Commands: echo and cat / echo and type

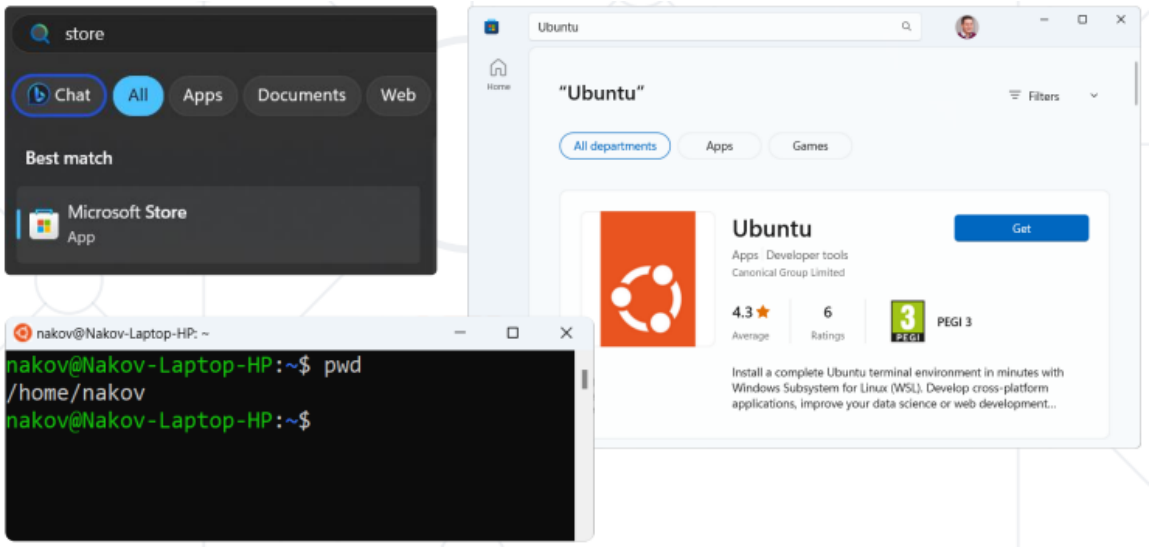
- echo '...' > filename prints a text to a file in Linux
- cat displays the content of given file
- echo ... > filename prints a text to a file in Windows
- type displays the content of given file



Can I Run Linux Commands on Windows PC?

- You can run Linux in Windows through a virtual machine
  - E. g. Ubuntu Linux in Virtual Box
- You can run Linux in Windows Subsystem for Linux (WSL)

Install WSL and Ubuntu Linux in Windows 11



Summary

- Operating Systems (OS) manage processes, users, files and other resources
- OS Examples: Windows, macOS, Linux, Android, iOS
- Virtual machine (VM) == OS inside another OS
- Container == app image, running in Docker
- Shell commands == execute commands from the console (Linux / Windows shell)

Network Fundamentals

OSI Model, MAC Address, IP Address, TCP and Ports

Network Protocol - a set of rules that determine how data is transmitted between different devices on the same network

▪ enable standardized communication between devices / programs

▪ Typically, one party sends a request (command / question / other) and receives a response from the other party

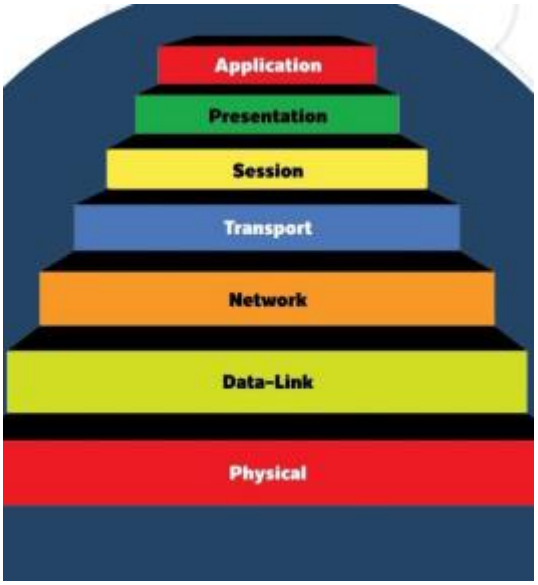
▪ Network protocols govern aspects of data transmission, addressing, routing, flow-control, and error handling

Network Layering Models

- Layers organize networking into a structured framework
- Facilitate the understanding, design, and management of complex networks
- Simplifies network communication and troubleshooting

Examples : OSI model (7 layers) and TCP (4 layers)

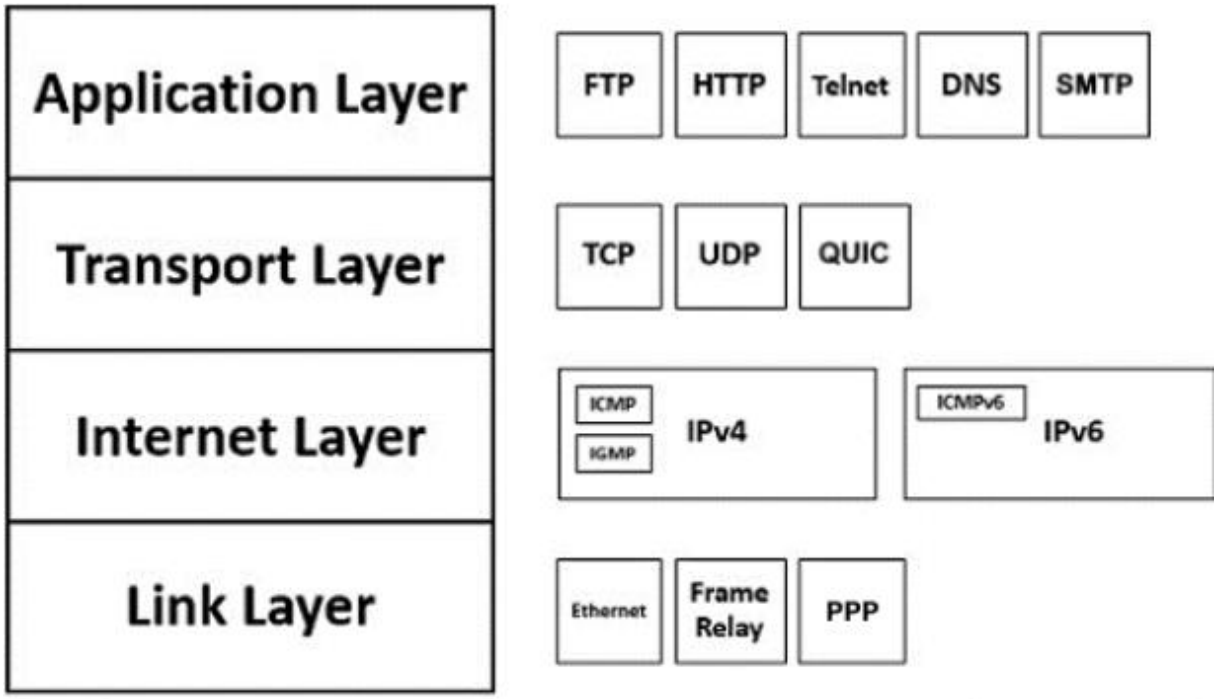
OSI Model



▪ **OSI Model** – consists of 7 layers each layer stacks on the previous and adds functionality to the data transmitted

1. **Physical Layer** - cables and radio.
   - Converts digital data into electrical impulses, radio signals, or optical signals for transmission. Devices : hubs, repeaters, antennas
2. **Data Link Layer** – MAC address, frames.
   - Manages data transmission, error detection / correction
   - Devices: switches, bridges, network interface cards (NICs)
3. **Network Laye**r - hosts and IP address, packets.
   - Packet routing: host → router → router → … → end host,
   - Devices : routers, layer 3 switches
4. **Transport Layer** – ports.
   - Error checking, flow control, congestion control, multiplexing
5. **Session Layer**
   - dialog control, token management, synchronization
6. **Presentation Layer** - data formats
   - data representation, encryption, decryption, compression, decompression
7. **Application Layer** – applications
   - Networking for applications, e. g. Web browsers use DNS, HTTP and HTTPS to open a Web site
   - Protocols - **HTTP, HTTPs, FTP, SMTP, IMAP, DNS**

TCP Model



TCP/IP Layers

1. **Link layer** – Combines the functionalities of OSI Physical and Data Link layers
2. **Internet Layer** - Corresponds to the OSI Network Layer
3. **Transport Layer** - Closely resembles the OSI Transport Layer
4. **Application Layer** - Merges the functionalities of OSI Session, Presentation, and Application layers

MAC, IP, Netmask, Gateway

Media Access Control (MAC) Address

- MAC address is a unique hardware identifier assigned to network interface cards (NICs)
- Format: 48-bit (6 hex numbers), e. g. 9c-93-4e-3f-14-f7

Internet Protocol (IP) Address

- IP address == 32-bit identifier (e. g. 192.168.0.61) assigned to devices in a network for addressing and routing purposes
- Netmask (e. g. 255.255.255.0) is a 32-bit number, used to masks out the network part of an IP address
- Gateway (e. g. 192.168.0.1) is the router IP used to access Internet
- IPv6 address == 128-bit address for the modern Internet

Ports

1. Ports Overview - Numerical identifiers used to distinguish specific processes or services running on a device within a network

- Facilitate end-to-end communication between applications on different devices

2. Types of Ports

- **TCP ports** - Used for connection-oriented communication, ensuring reliability and data integrity

- UDP ports - Used for connectionless communication, providing faster data transmission with minimal overhead

3. Port Numbers - Used to identify a network service

Networking: Summary

- Communication in Internet uses networking protocols
- IP: host-to-host communication in local networks and Internet
- TCP: implements reliable transport of data streams; uses ports to distinguish connections
- UDP: transports single packets, connectionless, faster, has no error checking; uses ports to distinguish connections
- DNS: maps hosts to IP addresses (e. g. softuni.org → 172.67.168.4)
- HTTP: request-response text-based protocol for the Web

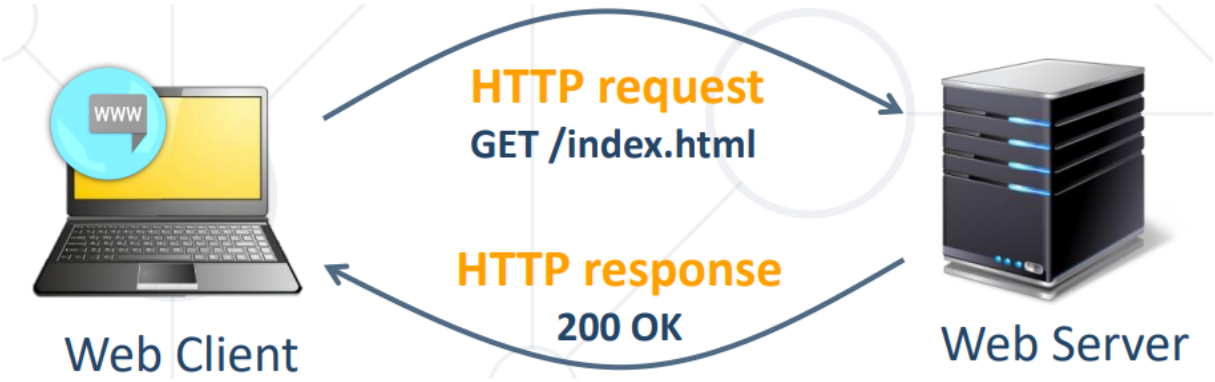
Web Fundamentals

1. **Domain Name System (DNS)**
   - A hierarchical, distributed system (part of Internet) that translates domain names into IP addresses
   - Facilitates the resolution of human-readable domain names to machine-readable IP addresses
2. **Domain name**
   - a unique, human-readable name for Internet host / machine / web site
   - Simplify navigation to websites, easier to remember and share
3. **Uniform Resource Locator (URL)**
   - a unique address pointing to a website, a web page, or a document on the Internet
4. **WWW (World Wide Web)**
   - A global, interconnected system of documents, images, and other resources, accessed through the Internet using Web browsers

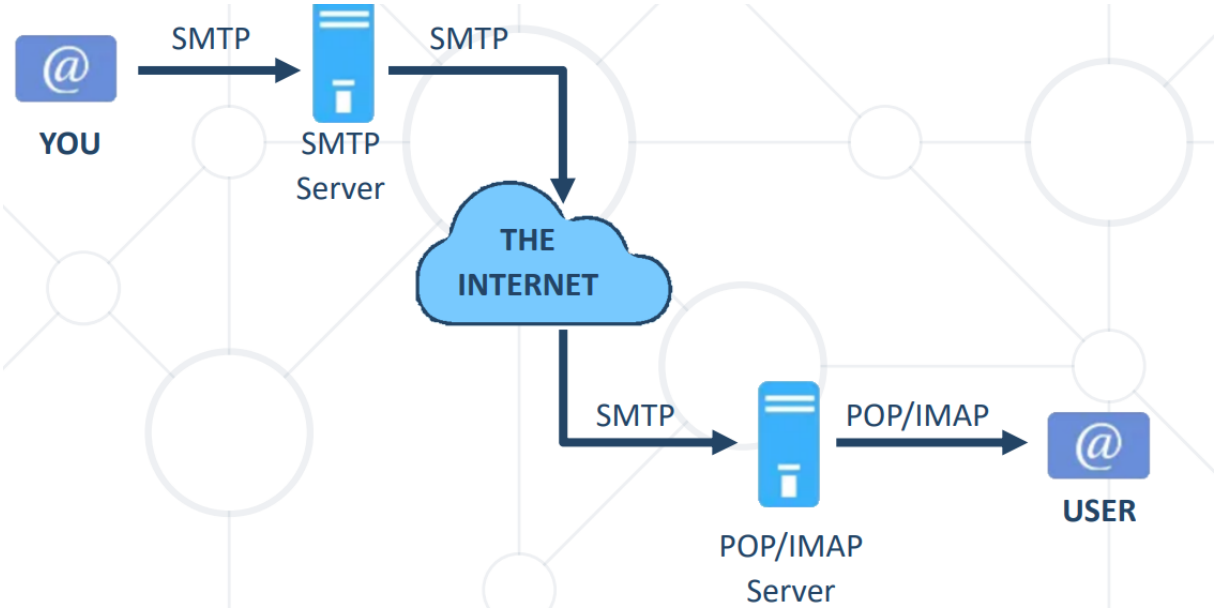
HTTP Protocol

HyperText Transfer Protocol (HTTP)

- Text-based client-server protocol for the Internet
- For transferring Web resources (HTML files, images, styles, etc.)
- Request-response based



Email Protocols: SMTP and IMAP



SMTP Protocol (Simple Mail Transfer Protocol)

- Send / receive email messages between mail servers

IMAP (Internet Message Access Protocol)

- Retrieve email messages from server mailbox
- Allows management of email messages on the server from different devices (sync and delete)
- More popular and flexible

POP (Post Office Protocol)

- Once downloaded to a client, the message is removed from the server (download and delete)
- Difficult to access email messages from different devices or locations