Computer Systems and Software

Motherboard, CPU, RAM, Storage, Peripherals

Firmware, System, Server-Side, Applications

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Computer Systems

Components and Functionality

What is a computer system?

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- **Computer system**: An integrated setup of hardware and software components
- Enables **efficient data input, processing, and output**
- Comprises **interconnected devices** for task execution
- Streamlines **human-computer interaction** for effective computing operations
- **Key elements**:
  - **Hardware**: Memory, input/output devices, storage devices, CPU
  - **Software**: Operating systems, programs, drivers

Evolution

- **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



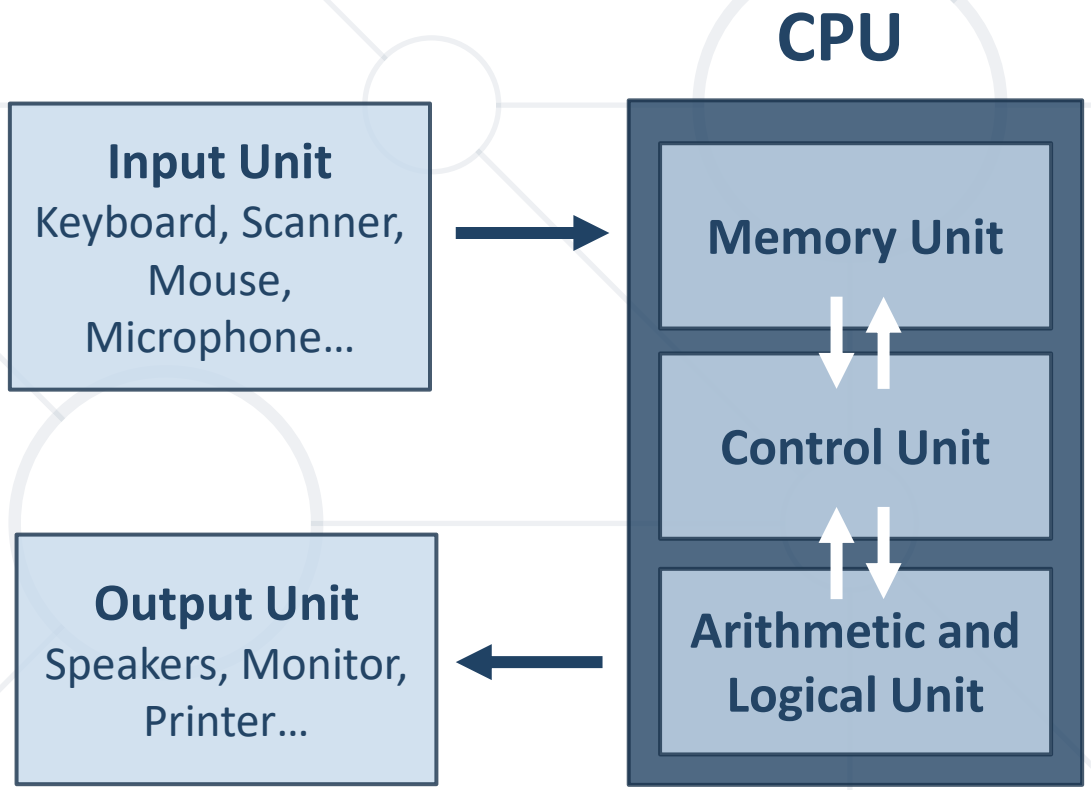



Computer Hardware

Motherboard, CPU, Memory, Storage, Peripherals

Basic Structure

- **Hardware** refers to the **physical components** of a computer
- Central Processing Unit (**CPU**)
  - All **data processing operations**
  - Controls the **operation**
- **Input devices**
  - Enter data
- **Output devices**
  - Get information



Computer System Hardware

CPU

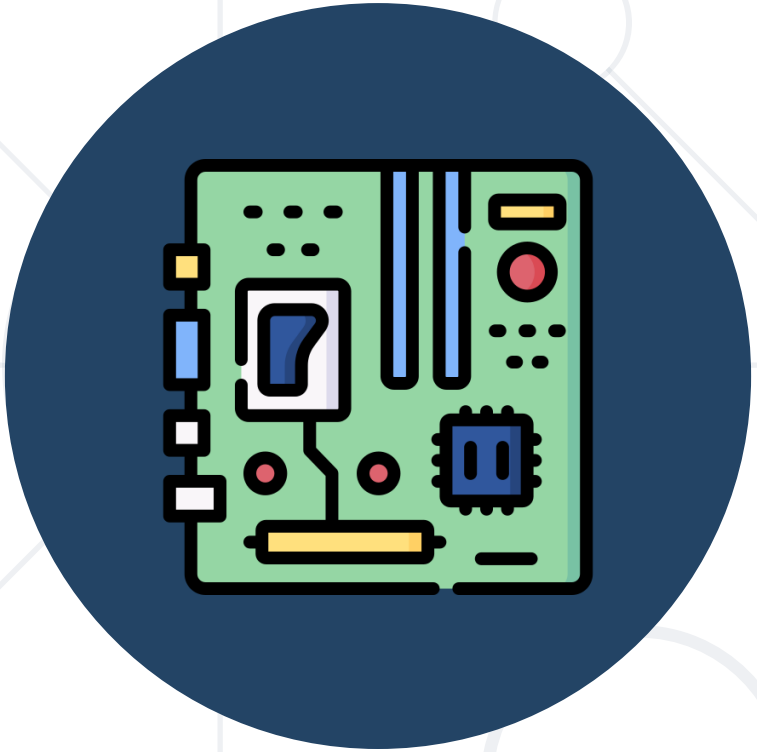
Disk Controller

USB Controller

Graphics Adapter

System Bus

Memory



Motherboard

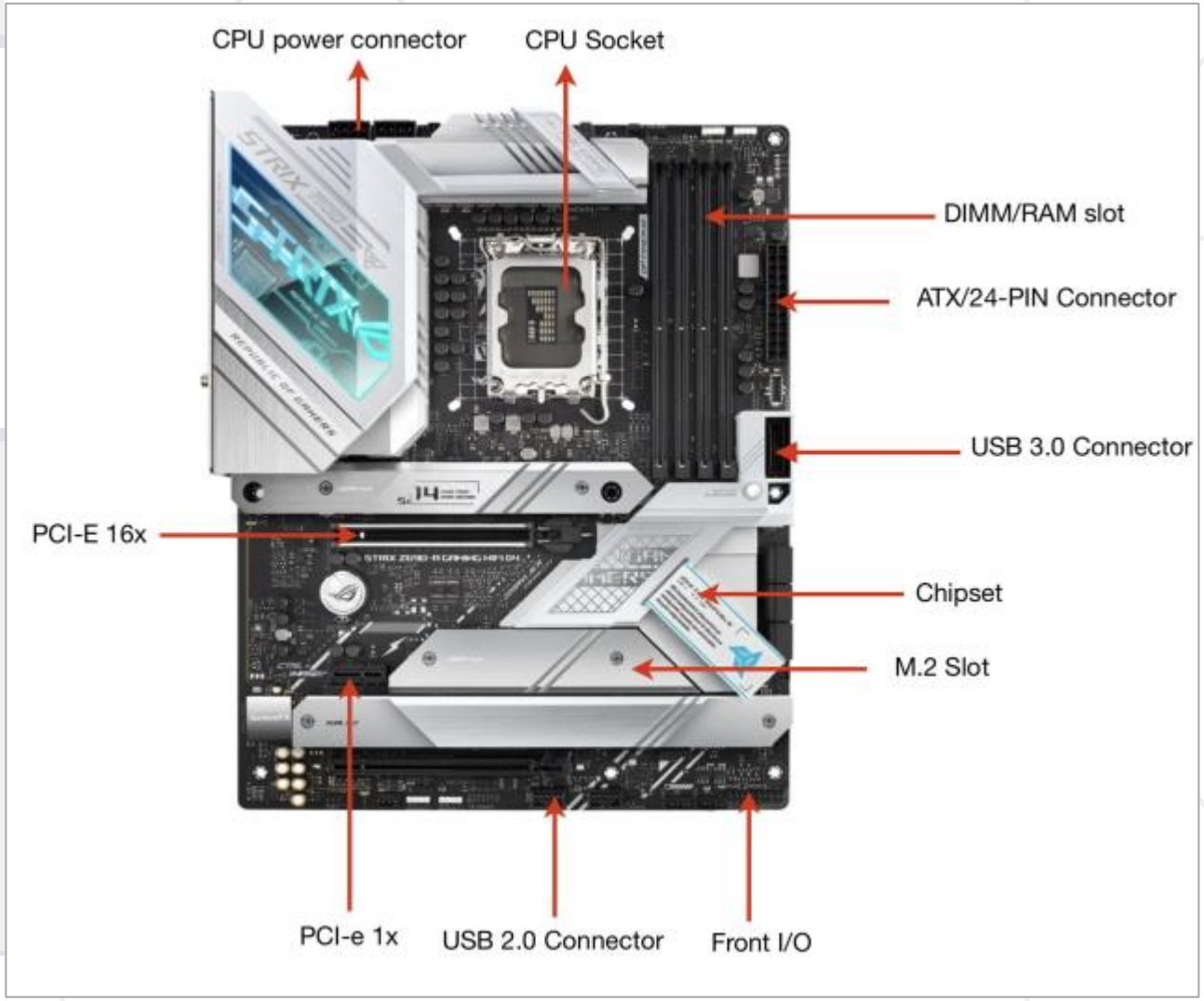
Backbone of a Computer System

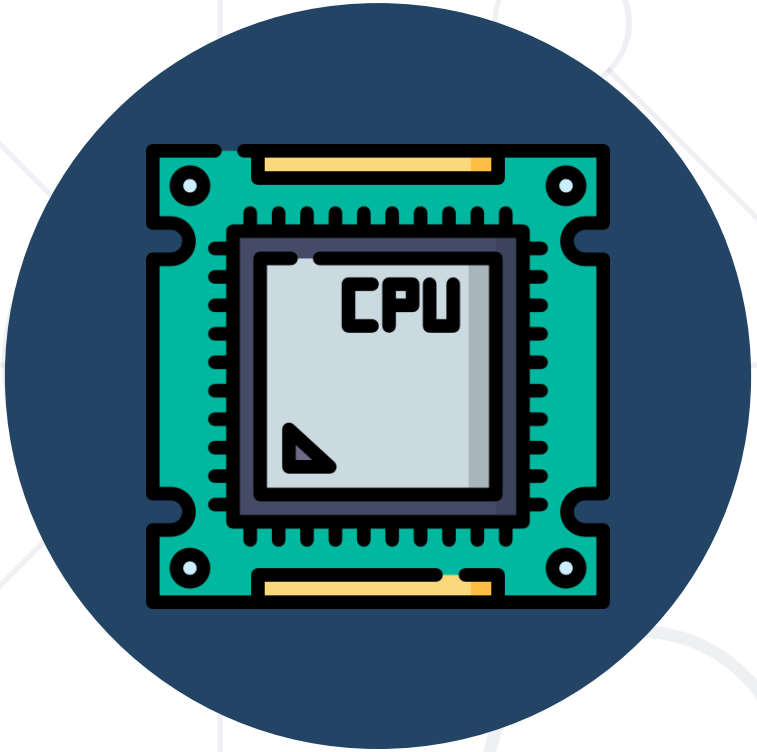
What is a Motherboard?

- Central Hub for **Hardware Connectivity**
  - Motherboards **enable communication** between all computer **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 Headers
- Bluetooth Module





CPU

Central Processing Unit

What is CPU?

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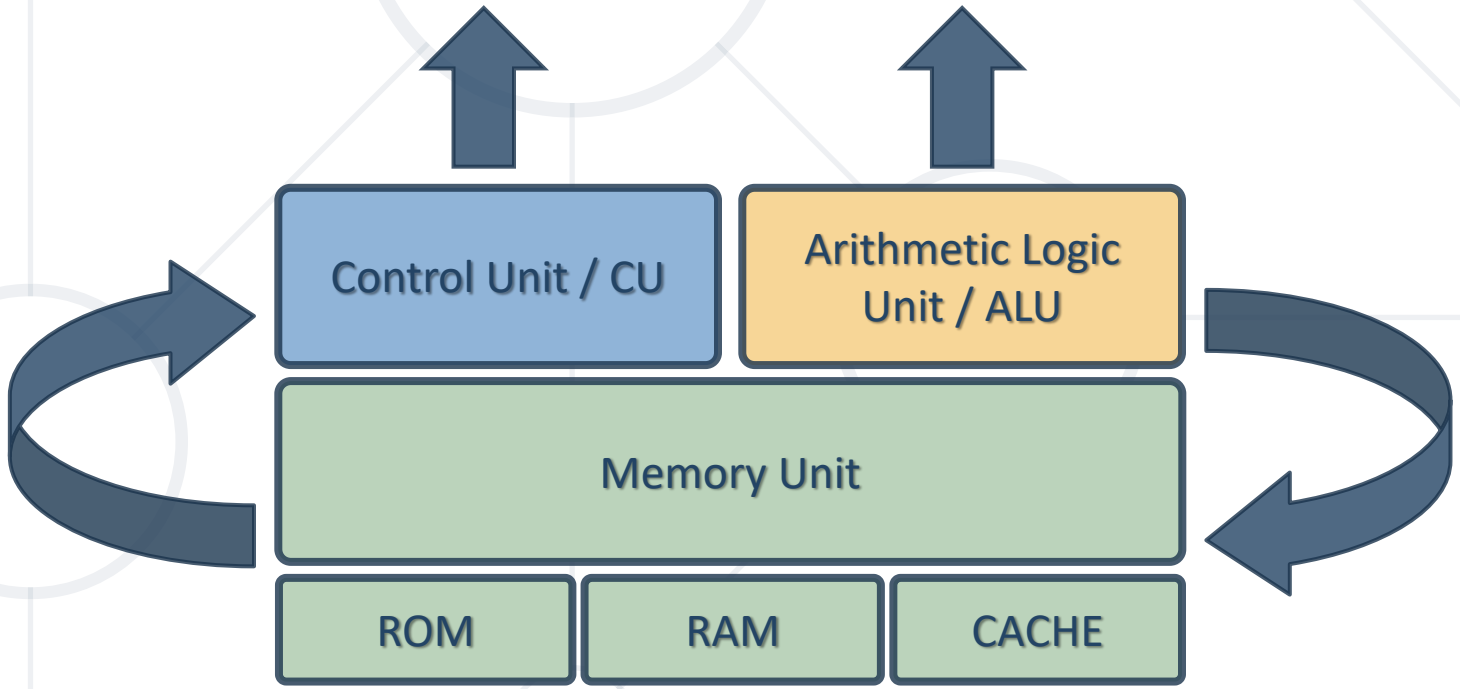
- **CPU** - The Brain of the Computer
  - Executes **calculations**, **actions**, and **runs programs**
  - Provides **processing power** and **instruction control**
- Three **Core Components**
  - **Control Unit** (CU)
    - **Manages instruction flow** and **coordinates** hardware functions
  - **Arithmetic and Logical Unit** (ALU)
    - Performs **arithmetic** and **logic operations**
  - **Memory Unit**
    - **Stores** data, programs, and information

CPU Parts Workflow

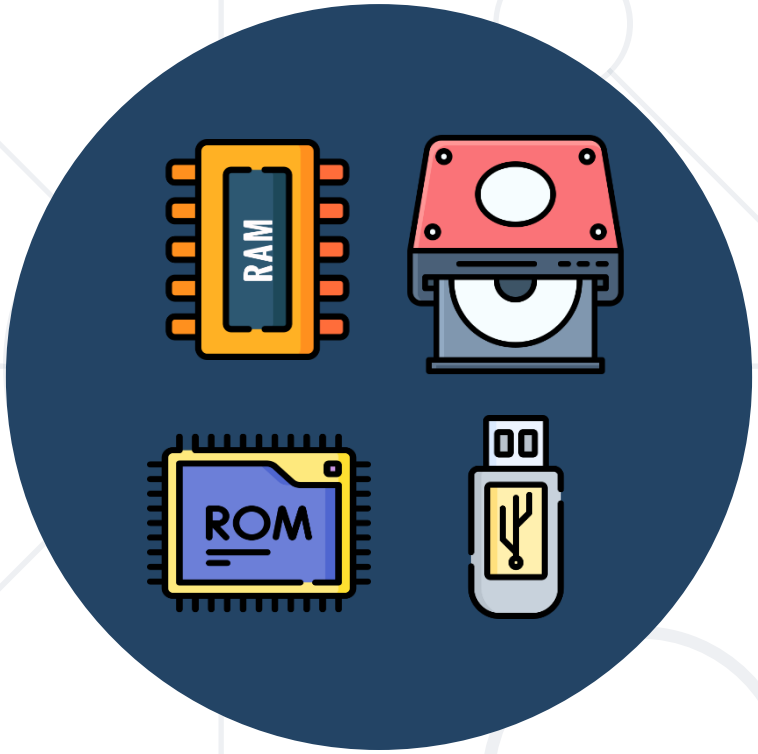
Step 2: Decode instructions into commands

Step 3: Execute commands

Step 1: Fetch instructions from memory



Step 4: Store results in memory



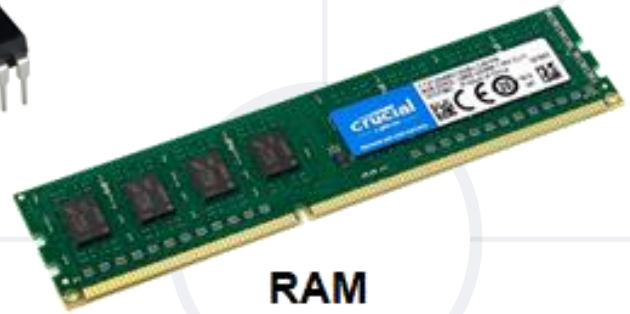
Memory and Storage

Storing Information in a Computer

Types of Memory

- **Primary memory**
  - **RAM** – stores the data that the CPU requires during the **execution of a program**
  - **ROM** – stores **crucial information for the system** to operate, like the essential program for the computer boot

ROM



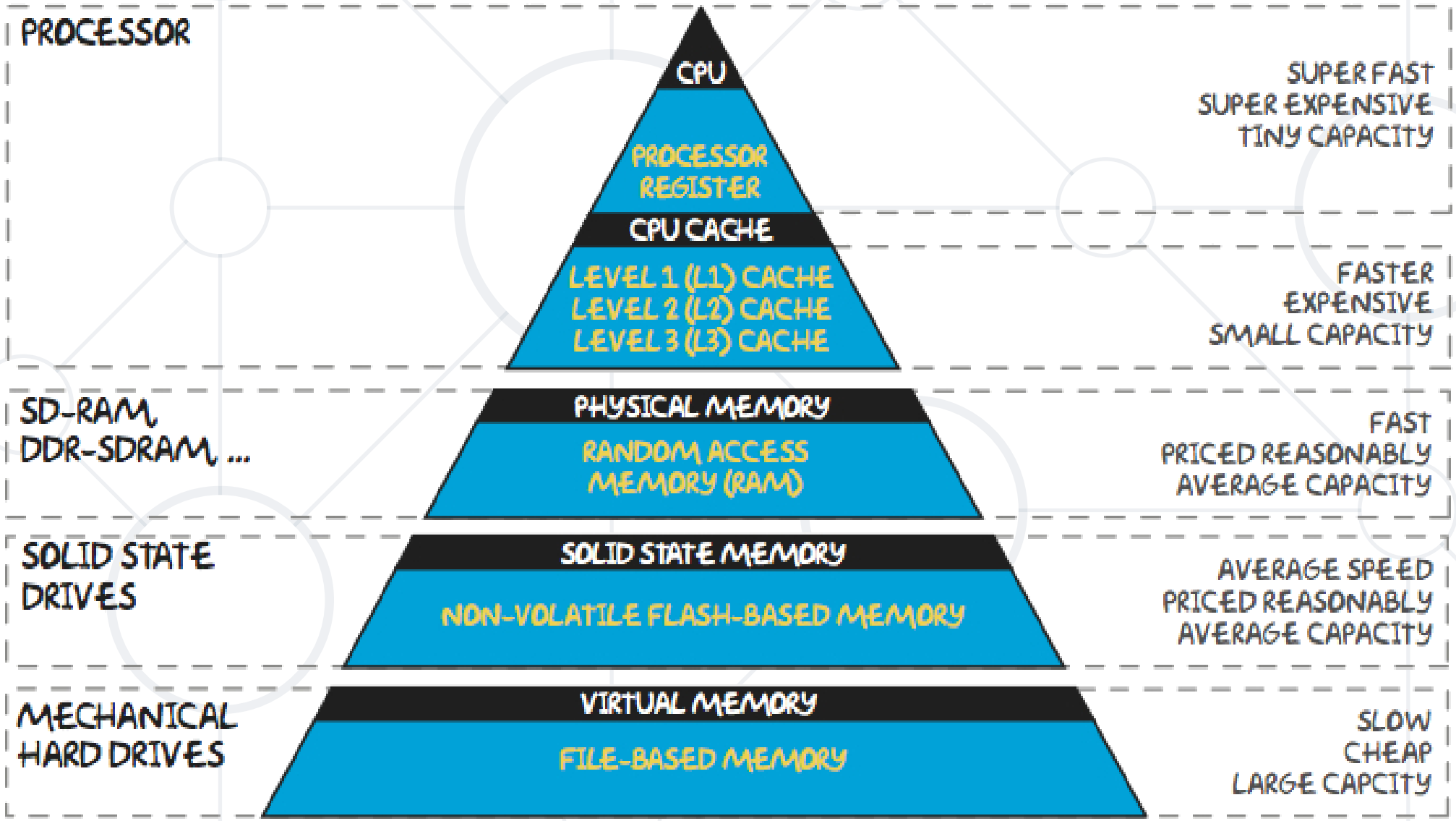
RAM

- **Secondary memory**
  - Not accessed directly by the processor
  - Examples: Hard Drive, SSD, Flash, Optical Drive, USD Drive

FLASH

- **Cache memory**
  - Part of the CPU: temporarily stores **frequently used instructions and data** for quicker access

Memory Hierarchy



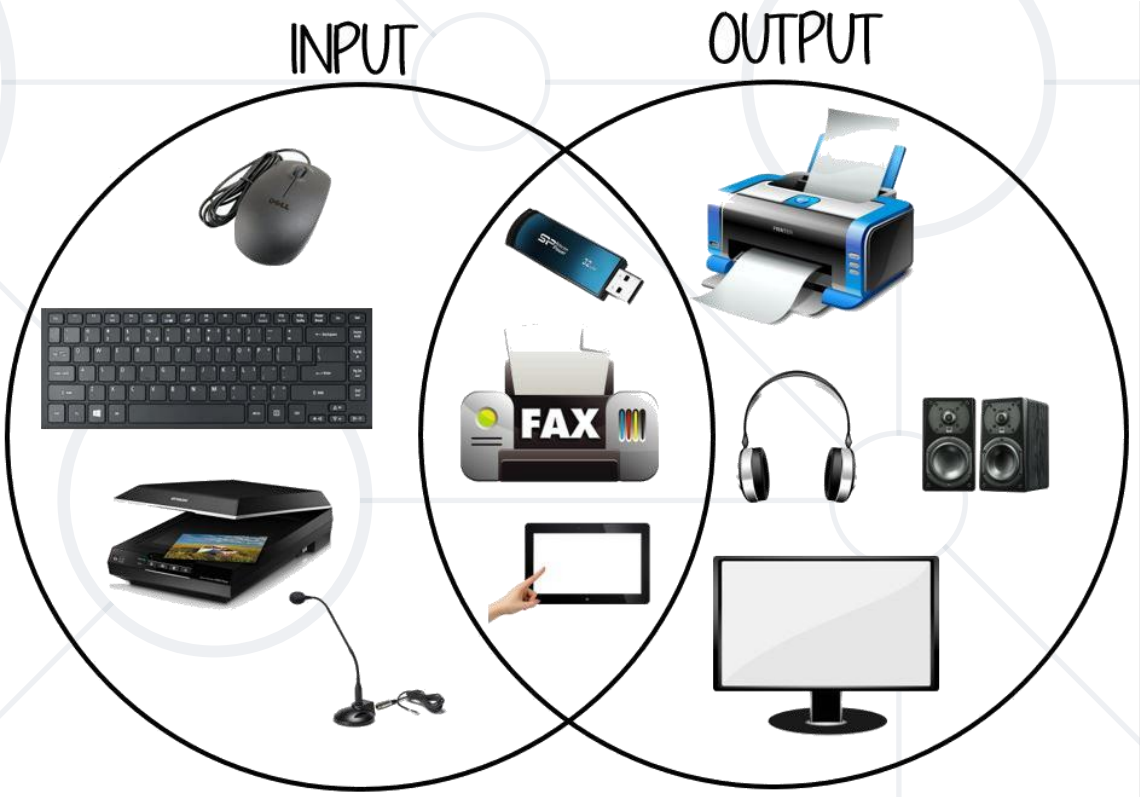
Peripheral Devices

Expanding Functionality

What is a Peripheral Device?

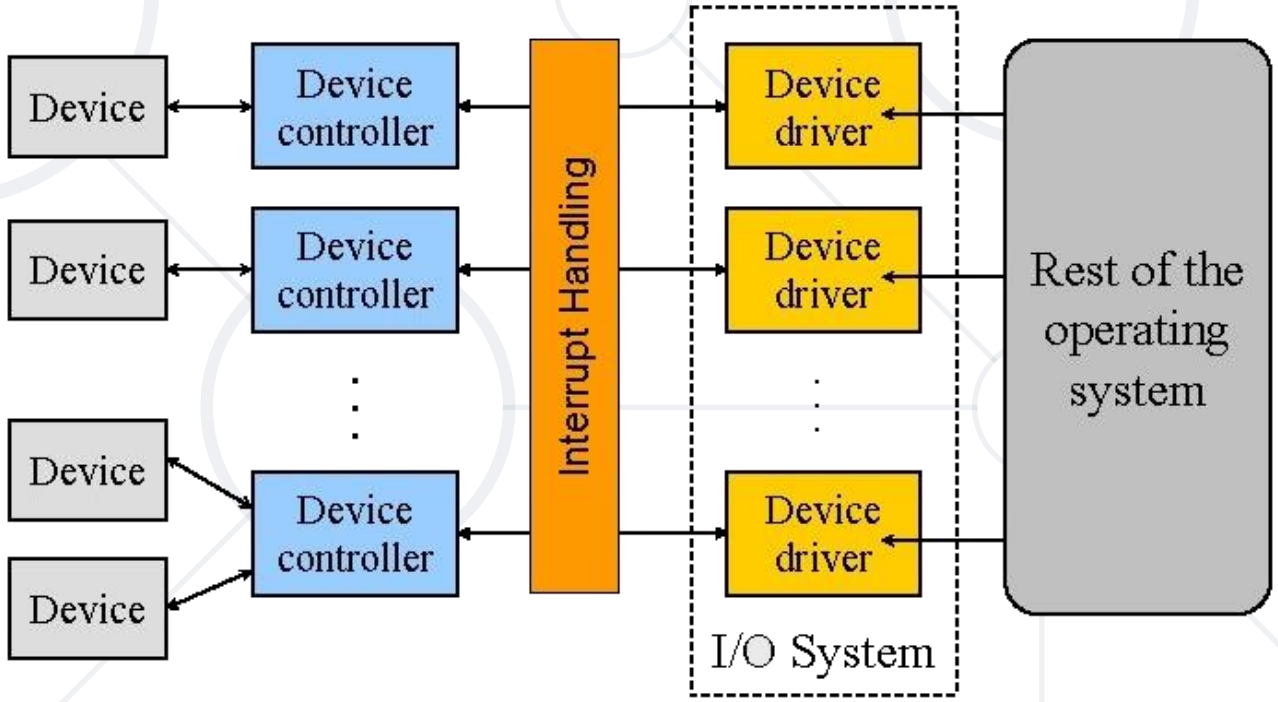
- **Any connected device** that provides a computer with **additional functionality**

- **Three main categories**:
  - **Input devices** → **send data** to the computer
  - **Output devices** → **receive data** from the computer
  - **Input/output** (**storage**) devices



Peripheral Devices Control

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



Computer Software

Firmware, System, Server-Side, Applications

Overview of Computer Software

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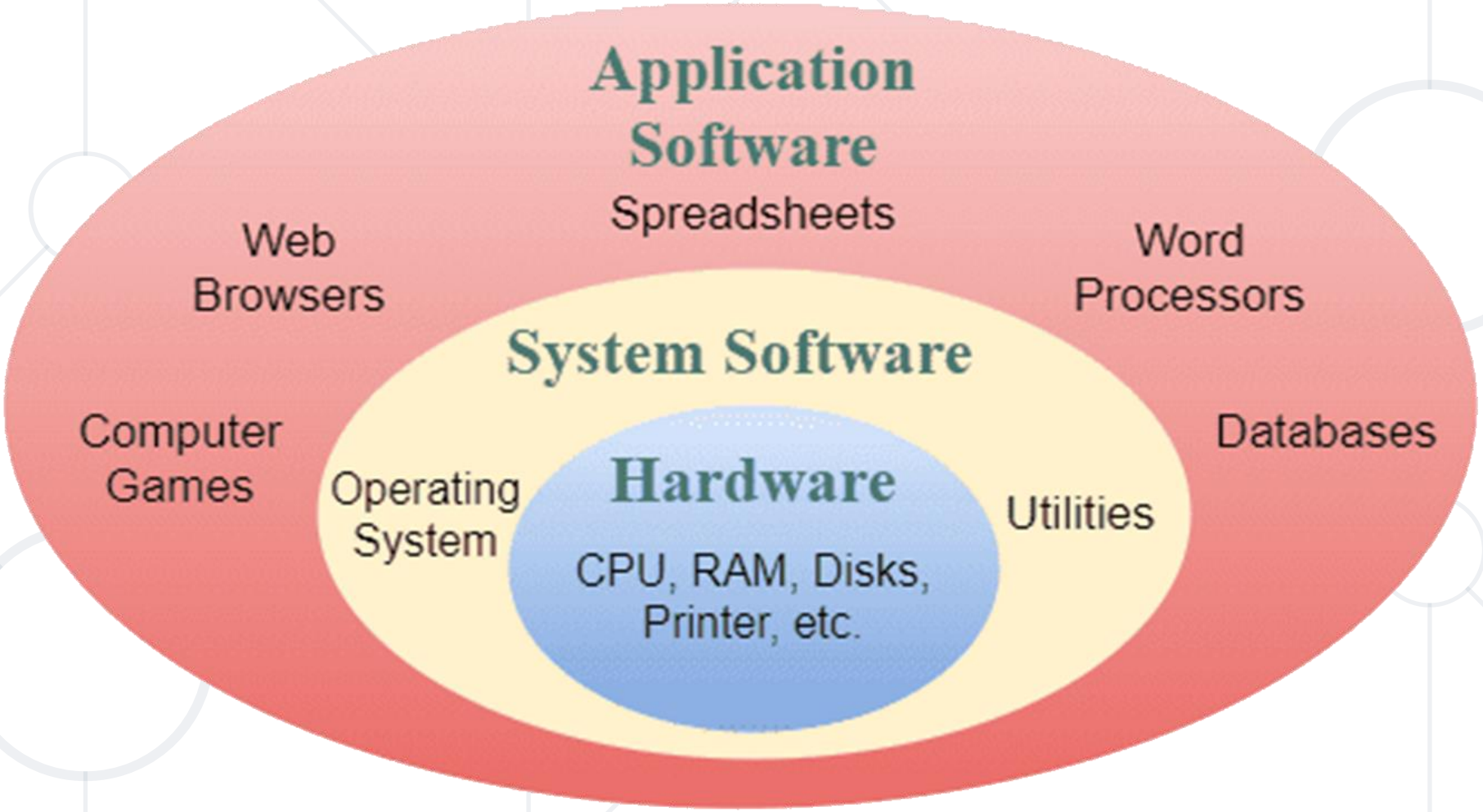
- Software **Defined**
  - Computer programs, instructions, and data that enable a computer system to **perform specific tasks**
- **Role** of Software:
  - **Interacts** with and **manages computer hardware**
  - Provides a **user-friendly interface** for interacting with the computer system

Computer System



Layers of Functionality and Interaction

- **Firmware**
  - Low-level software, **bridges** hardware and software
- **System Software**
  - **Manages and controls hardware**, platform for application software
- **Server-Side Software**
  - Runs on remote servers, processing requests and delivering data
- **Application Software**
  - Designed to help users **perform specific tasks**, including web apps, desktop apps, and mobile apps

Firmware

Bridge between Hardware and Software

What is 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
- **Functions** of Firmware
  - Hardware **initialization** during the boot process
  - **Management** of low-level hardware operations (e.g., device **initialization**, hardware **diagnostics**, and system **booting**)

Various Devices and Use Cases

- **Examples** of Firmware Applications
  - BIOS/UEFI in computers
  - Firmware in routers and modems
  - 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

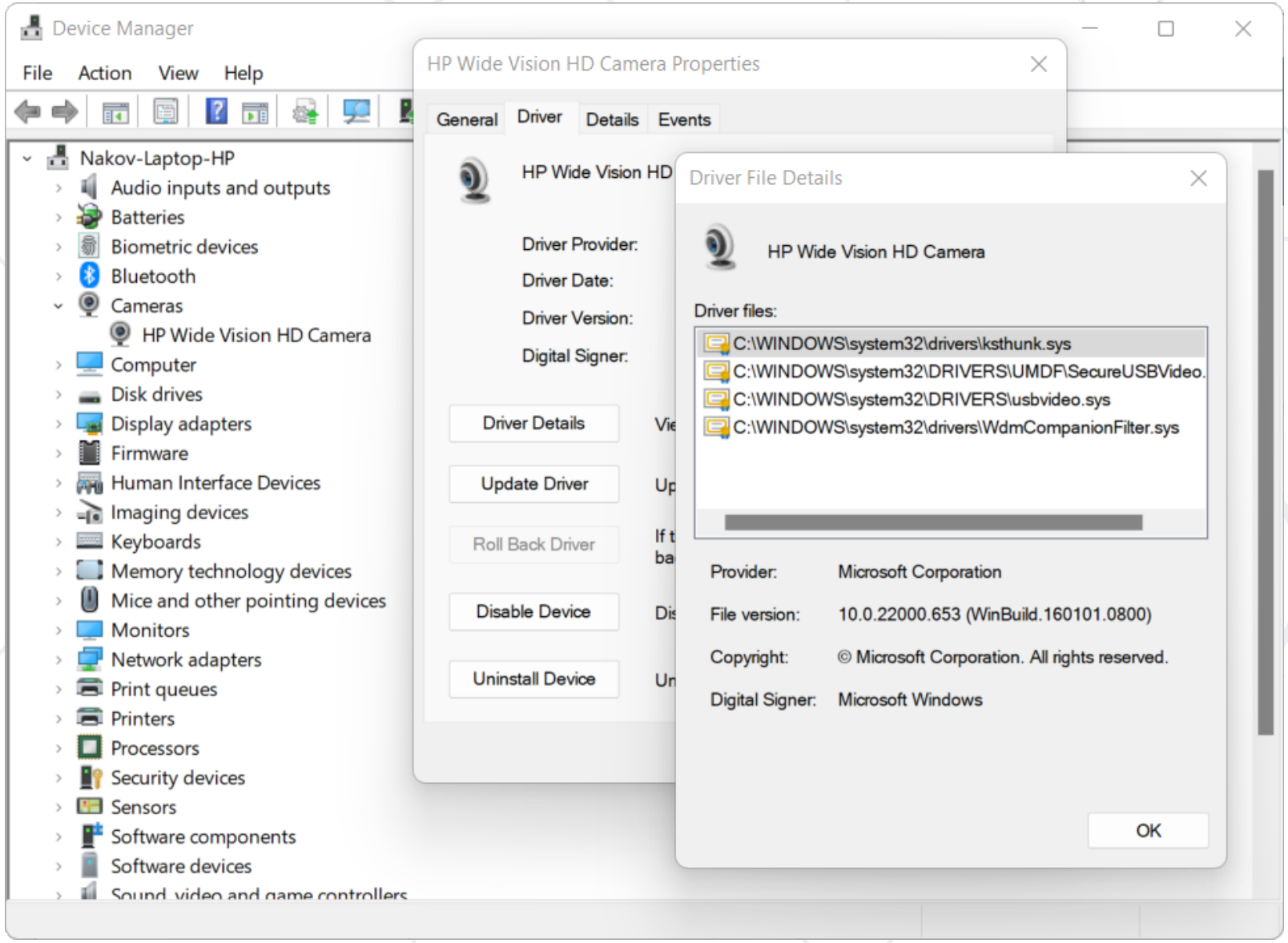
What is System Software?

- Software designed to **manage** and **control** computer **hardware**, providing a **platform** for **application software**
- **Key Components** of System Software
  - **Operating systems** (e.g., Windows, macOS, Linux)
  - **Device drivers** (software that enables communication between hardware and operating system)
  - **System utilities** (tools for system maintenance and optimization)

Operating Systems

- Windows, macOS, Linux, Android, iOS
- Manage hardware and software resources
- Provide **user interface**
- Enable **application execution**
- **Facilitate** file and memory management
- **Security** and **access control**
- System **updates** and **maintenance**

Device Drivers



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

System Utilities

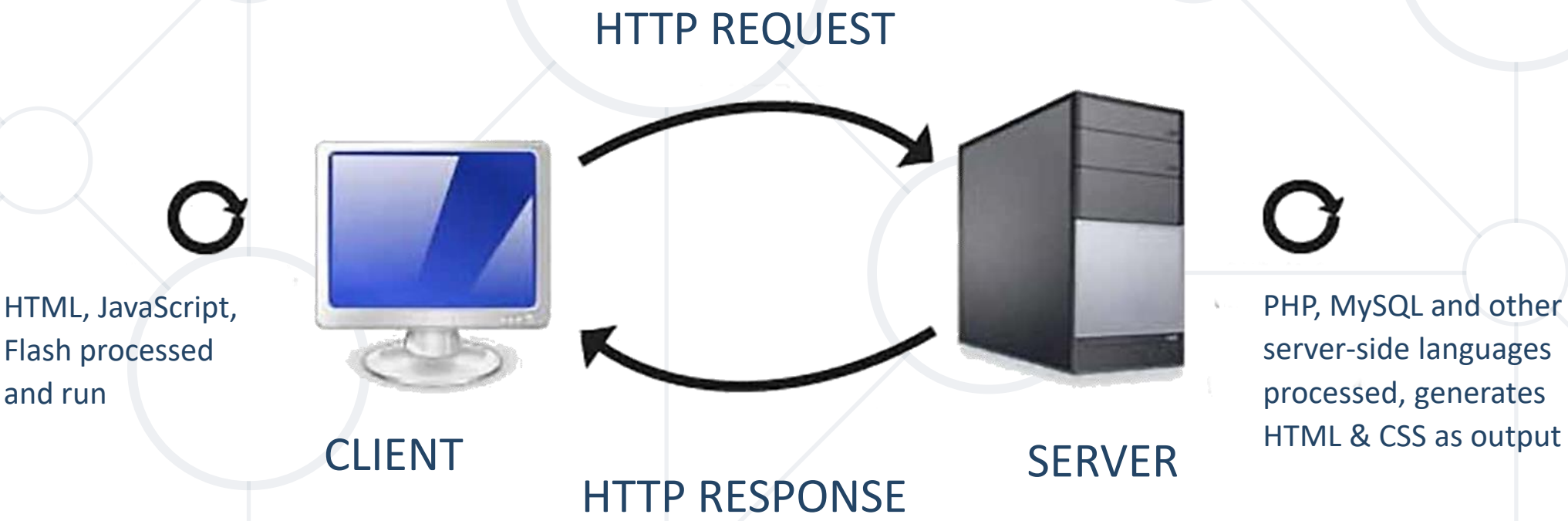
- Tools that help **maintain** and **optimize** a computer system
  - Disk **cleanup** and **defragmentation** (CCleaner)
  - **Antivirus** and **malware** protection (Norton AntiVirus)
  - System **backup** and **recovery** (Macrium Reflect)
  - Performance **monitoring** and **diagnostics** (Windows Task Manager)
  - Software **updates** and **patches** (Windows Update)

Server-Side Software

Facilitating Backend Operations and Web Services

What is Server-Side Software?

- Software that runs on a remote server, processing requests and delivering data to client devices.



Server-Side Software Examples

- **Common Types** of Server-Side Software
  - **Web** servers (e.g., Apache, Nginx)
  - **Database** servers (e.g., MySQL, PostgreSQL)
  - **Application** Servers (Tomcat, Node.js)
  - **Mail** Servers (Microsoft Exchange Server, Postfix)
  - **File** Servers (Windows File Server, Samba)
  - **Proxy** Servers (Squid, HAProxy)

Server-Side vs. GUI

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- **Server-side** Software:
  - **Executes** on a **web server**, rather than on the user's device
  - Handles **data processing, storage, and retrieval**
  - Powers web applications and APIs
  - Requires **efficient resource management** for optimal performance
- Graphical User Interface **(GUI)-based Applications**:
  - **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

Diverse Solutions

What is Application Software?

- Software designed to help users perform **specific tasks**, catered to **individual needs** and **preferences**
- Key Components of Application Software
  - **Productivity** tools (Microsoft Office, Google Workspace)
  - **Multimedia** software (Adobe Photoshop, VLC Media Player)
  - **Communication** apps (Zoom, WhatsApp)
  - **Web browsers** (Google Chrome, Mozilla Firefox)
  - **Games** (Fortnite, League of Legends)

Web applications

- What are **Web Apps**?
  - Accessed through a **web browser** with an **active internet** connection
  - **Platform-independent**
    - Accessible on any device with a web browser
  - **Automatic updates**
    - No need for manual installation or updating

Web applications (2)

- **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

Testing Challenges for Web Apps

- **Compatibility:** If the app works consistently across **different browsers**
- **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, browser capabilities, and server load → Testing for **scalability** and **load capacity**
- **Usability:** Testing for **accessibility**, **intuitive use** on different devices, and ease of **navigation**

Trello Project Management Web App

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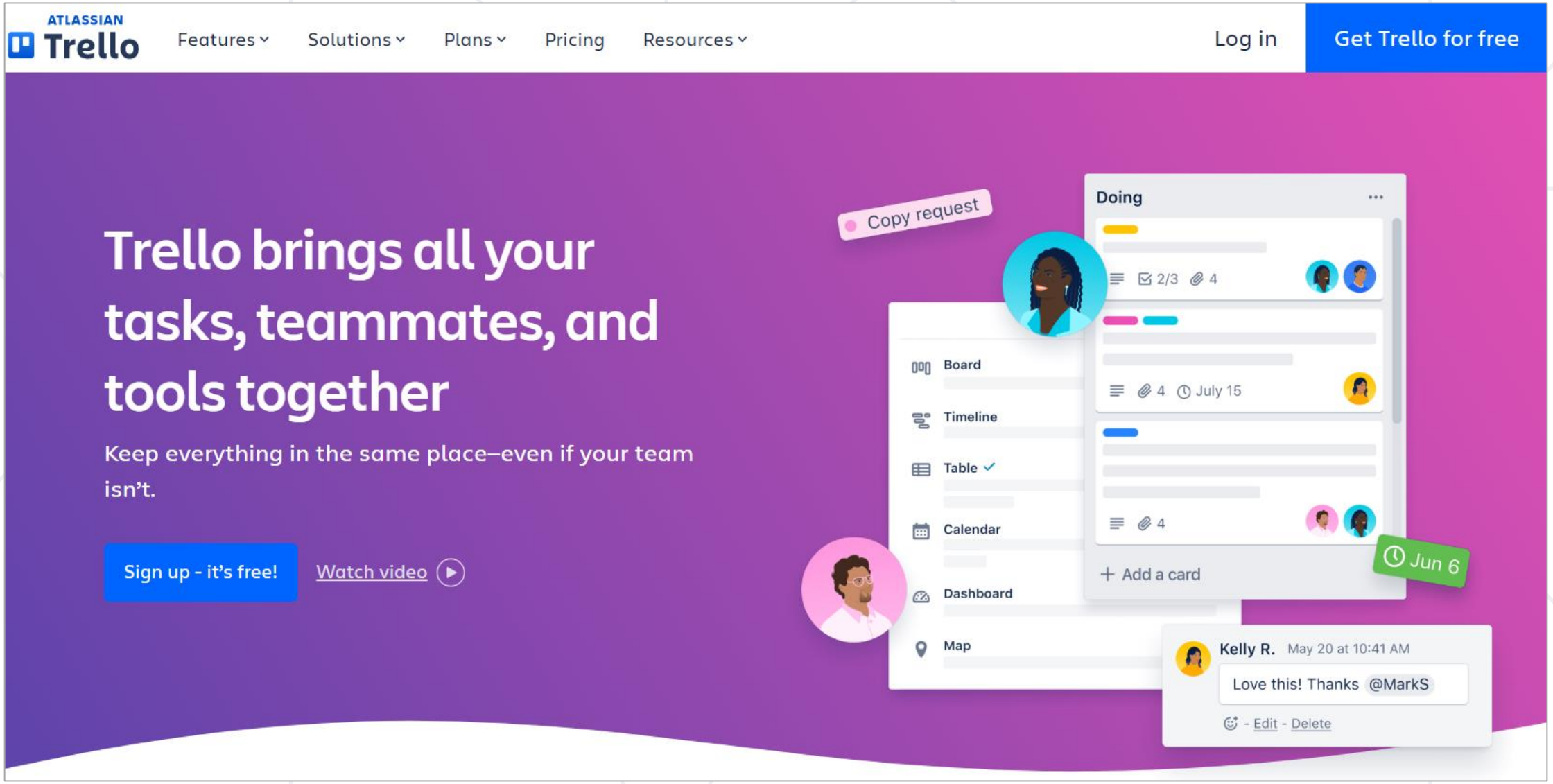
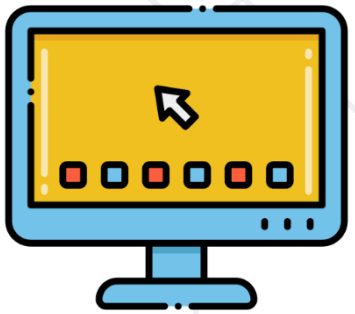


Desktop applications

- What are **Desktop Apps**?
  - **Installed** and **run locally** on a user's computer
  - **Offline access**
    - Can be used without an internet connection
  - **Robust features**
    - Often more feature-rich than web apps



Desktop applications (2)

- **Benefits** of **Desktop Apps**
  - **Performance**: Faster processing and response time, as tasks are executed locally
  - **Security**: Reduced risk of data breaches compared to web apps
  - **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

Testing Challenges for Desktop Apps

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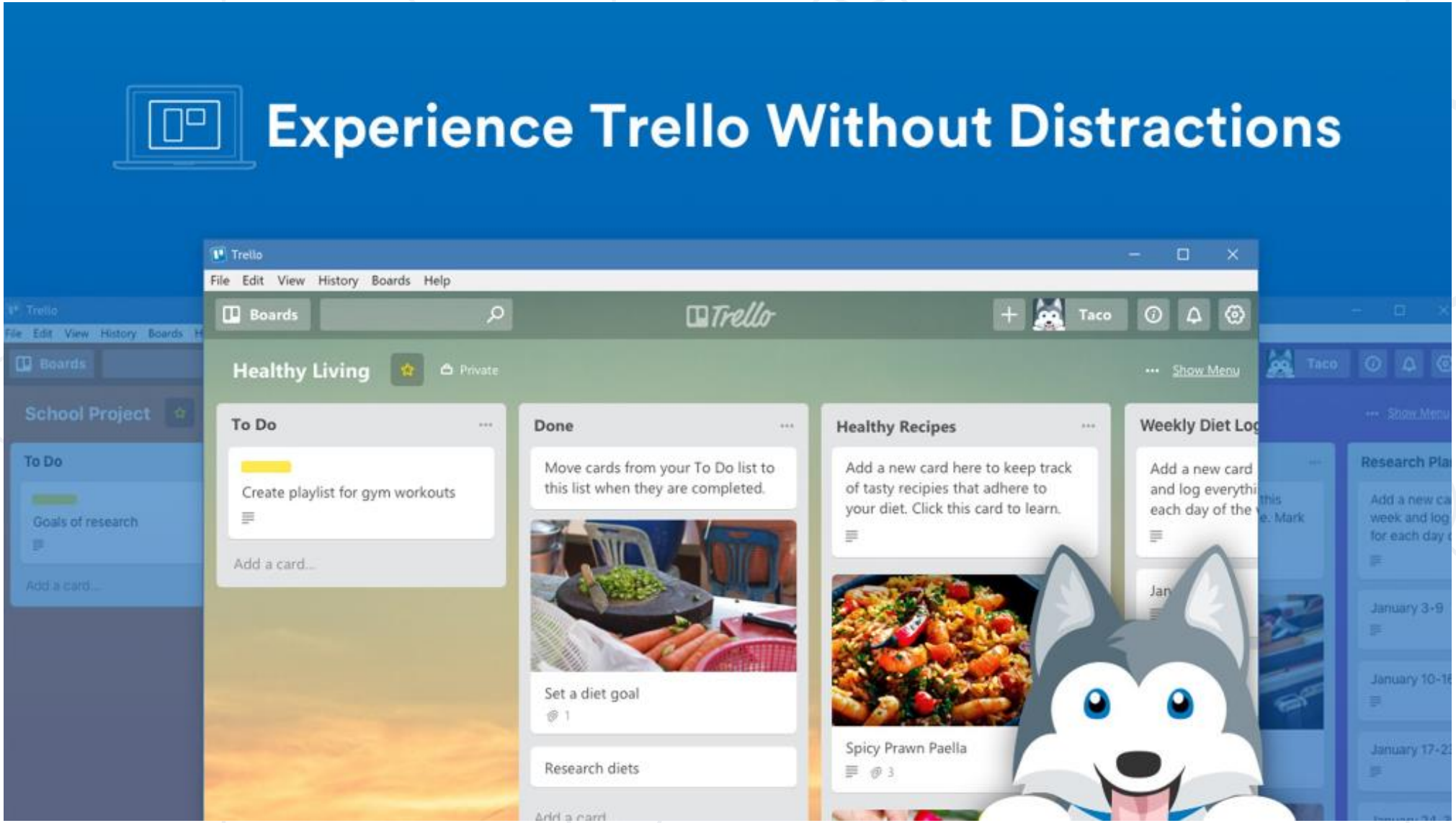
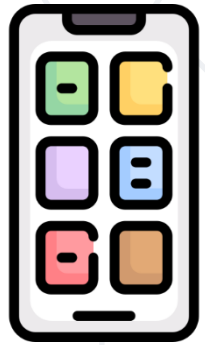
- **Installation\Uninstallation** including any **dependencies** or **prerequisites**
- **Performance Testing on Different Hardware Configurations** - **processors**, **memory**, and **graphic cards**
- **Compatibility Testing** for **different operating systems** and their **different versions**
- **Error Messages Testing** - **informative** and **helpful** for users
- **Integration Testing** with **other desktop applications**

Trello Project Management Desktop App



Mobile applications

- 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



Mobile applications (2)

- **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 operating system 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**

Trello Project Management Mobile App

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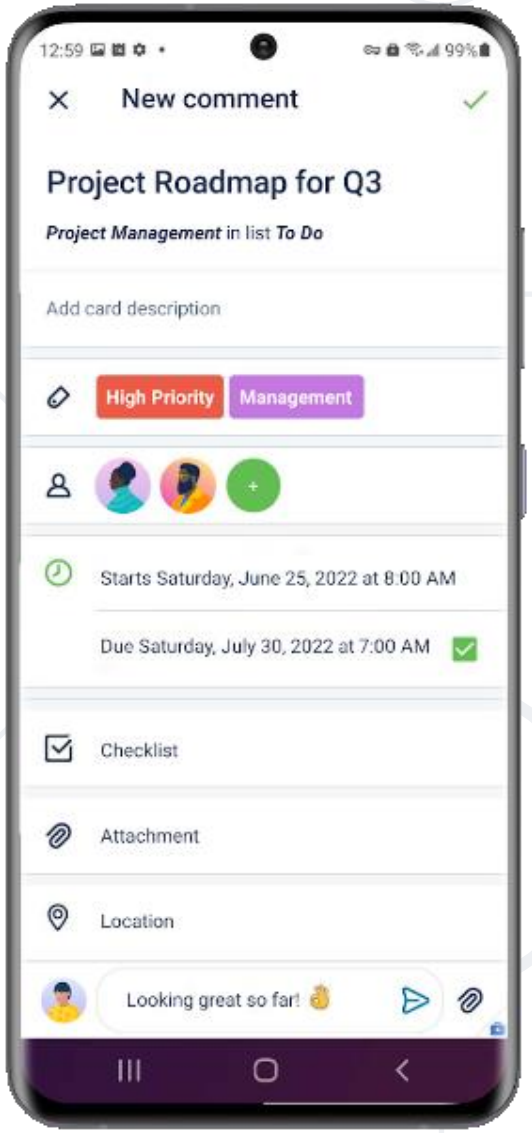
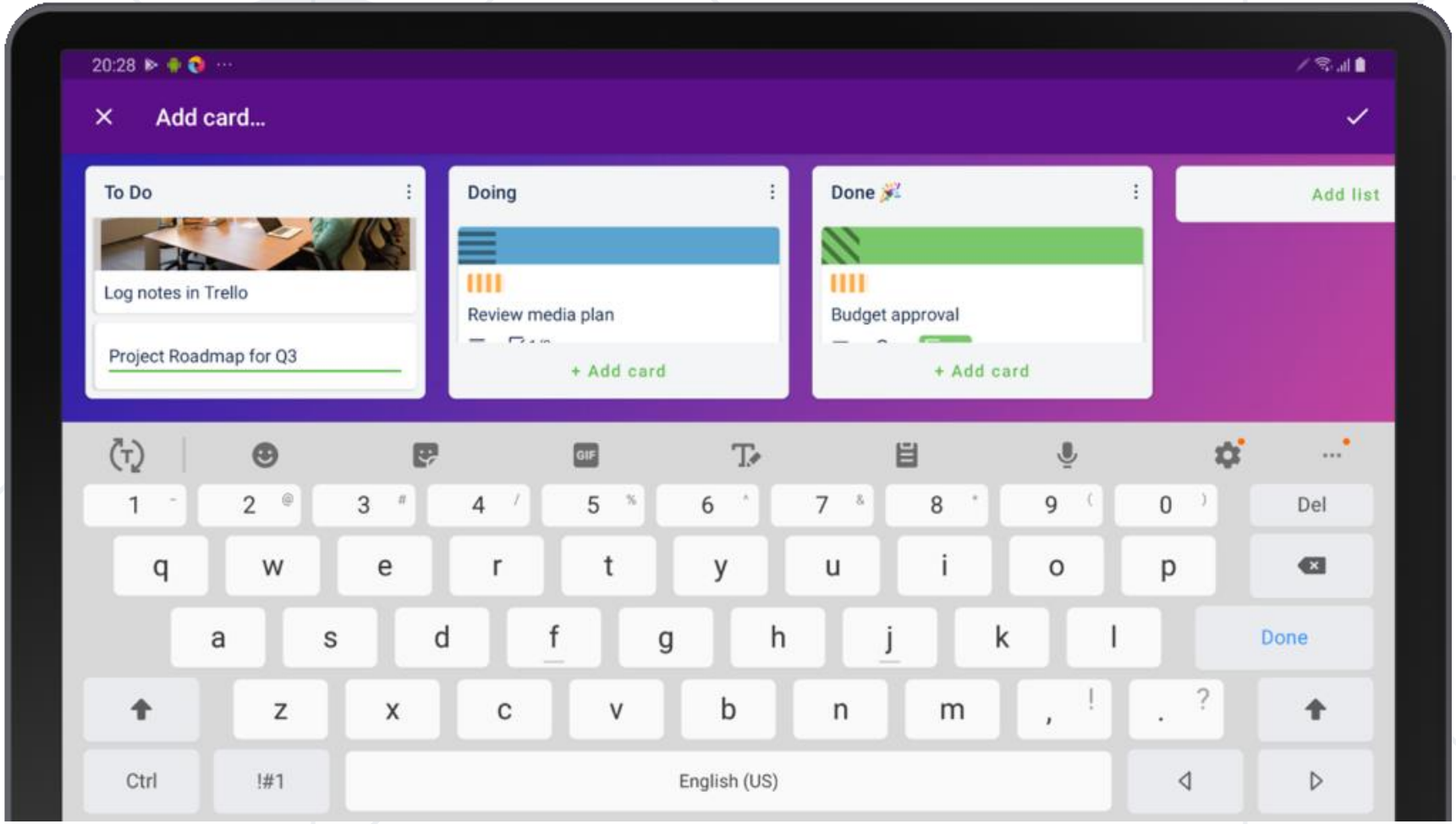
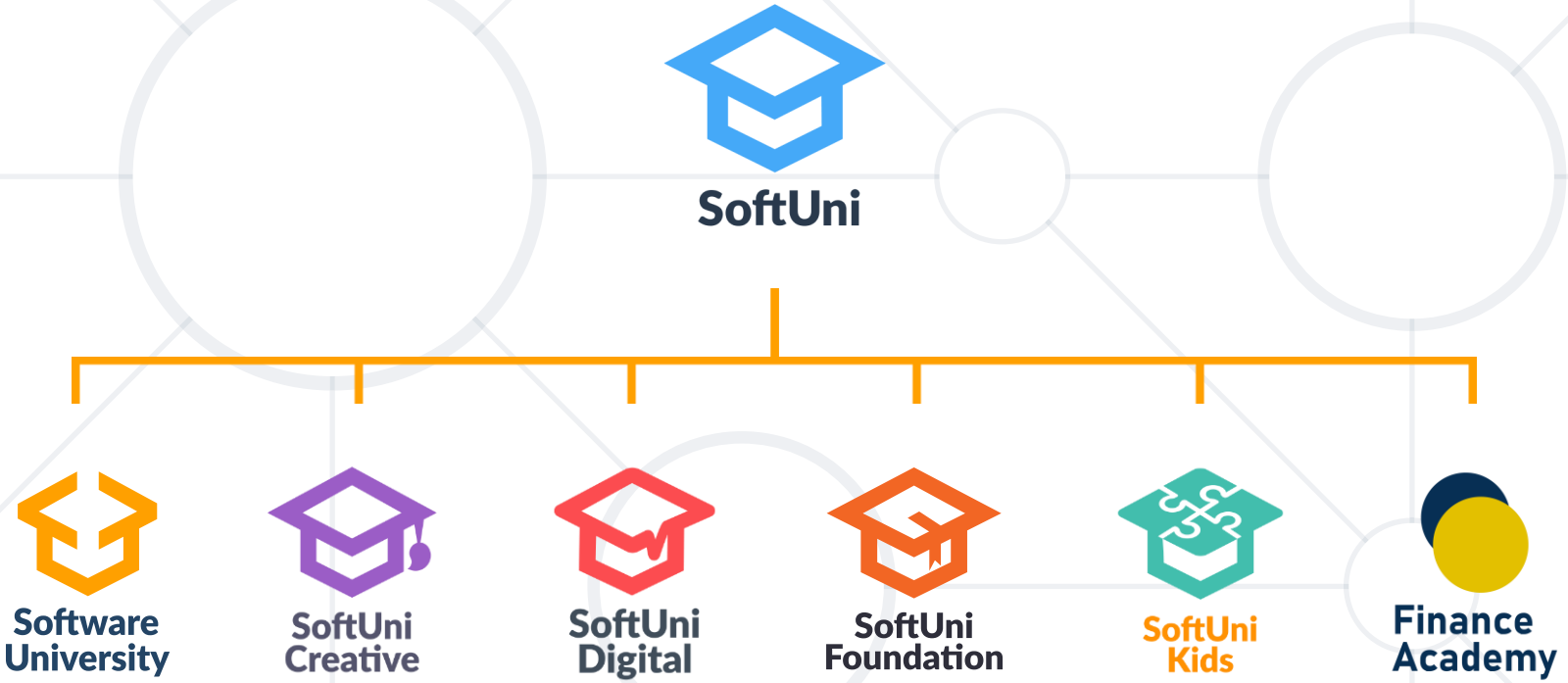




Summary

- **Hardware** is the **physical part**, whereas **software** is a **set of instructions** for the computer
- Main computer parts are the **CPU**, **input,** and **output devices**
- **Motherboard** ties all components together
- **Software** - **interacts with and manages** computer hardware
  - **Firmware**, **System** Software, **Server-side** Software vs GUI**,** **Application** Software, **Web** Apps, **Desktop** Apps, **Mobile** Apps

Questions?



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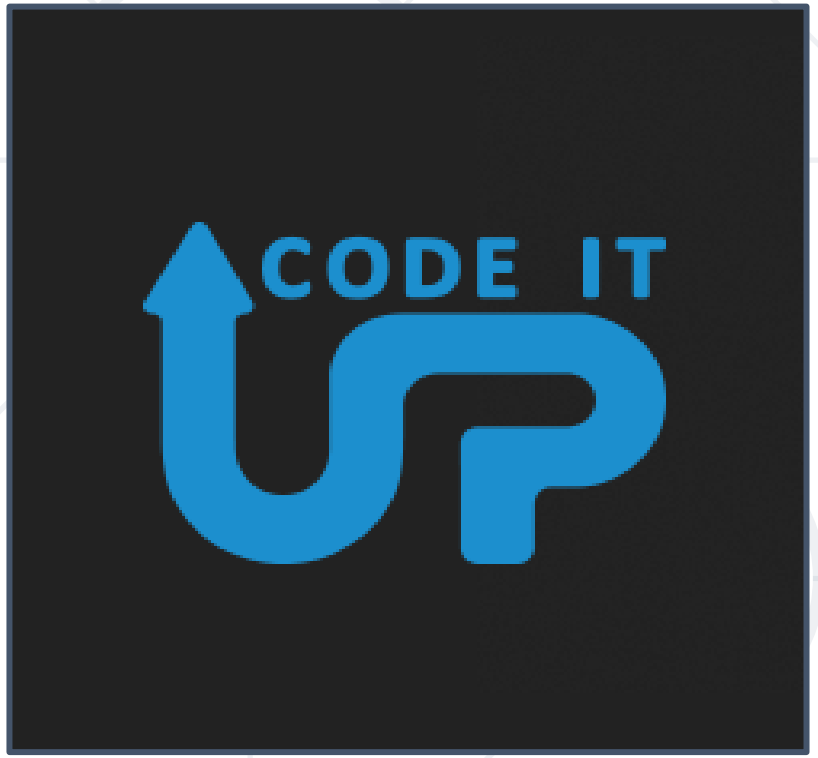

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