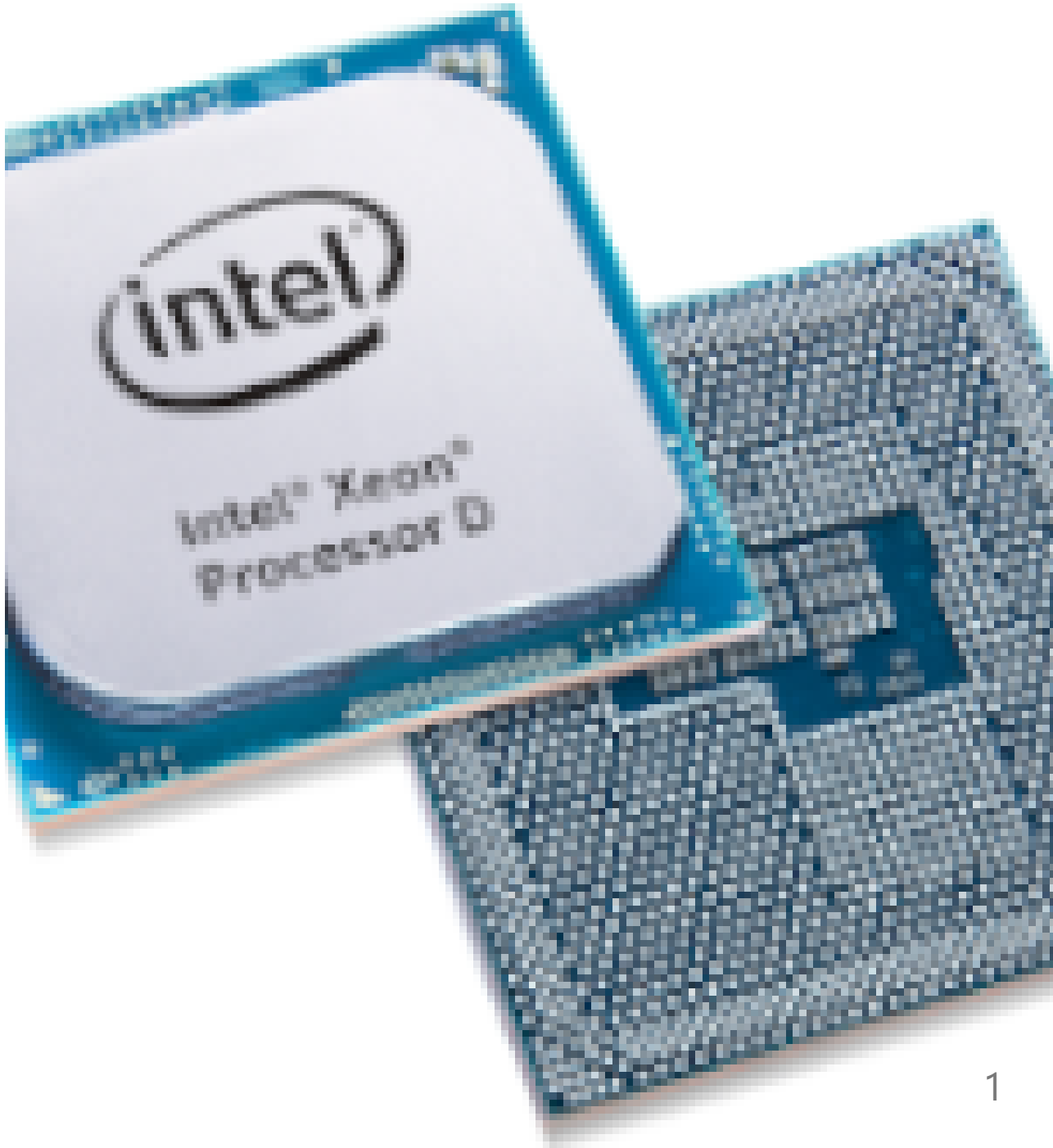
GCSE

Systems Architecture



Contents

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Software

What is a Computer System?

- A computer system includes both hardware and software.
- **Hardware**: Physical components you can touch.
- **Software**: Programs and instructions that run on hardware.

Elements of a Computer System

- **Input**: Devices like keyboard, mouse.
- **Process**: The computer processes input.
- **Output**: Devices like screen, printer.

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Hardware

- **CPU**: Central Processing Unit.
- **Memory (RAM)**: Temporary data storage.
- **Storage Devices**: Hard drives, SSDs.
- **Input Devices**: Keyboard, mouse, microphone.
- **Output Devices**: Screen, printer, speakers.

Software

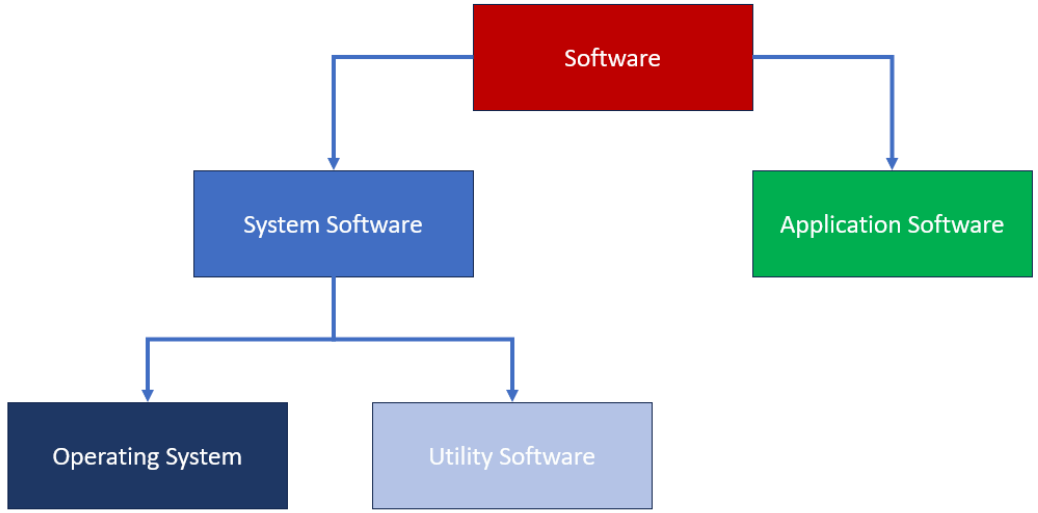
- **Operating Systems**: Manage hardware, e.g., Windows, macOS.
- **Application Software**: Programs for user tasks, e.g., word processors.
- **System Software**: Manages hardware and software interactions.

Types of Software

- **Application Software**: For end-user tasks.
- **System Software**: Manages computer operations.

System Software

- Operating Systems
- Device Drivers
- Utility Software



Application Software

- **Word Processors**: e.g., Microsoft Word, Google Docs.
- **Web Browsers**: e.g., Chrome, Firefox.
- **Media Players**: e.g., VLC, iTunes.
- **Graphic Design Software**: e.g., Photoshop, GIMP.

System Software

- **Operating Systems**: e.g., Windows, macOS, Linux.
  - Manage hardware resources.
  - Provide user interfaces.
- **Device Drivers**: Allow OS to communicate with hardware.
- **Utilities**: Tools for system management.
  - e.g., disk cleanup, antivirus.

Role of an Operating System

- **Manage Resources**: CPU, memory, I/O devices.
- **Provide a User Interface**: GUI and CLI.
- **Hardware Abstraction**: Simplifies hardware interaction.
- **Security**: Protects system and data.

Management of Resources

- **Processor Management**: Allocates CPU time.
- **Memory Management**: Manages RAM and virtual memory.
- **I/O Management**: Handles communication with devices.
- **Application Management**: Coordinates software execution.

User Interface

- **Graphical User Interface (GUI)**: Icons, windows, menus.
- **Command Line Interface (CLI)**: Text-based commands.
- **Accessibility Features**: Screen readers, magnification.

Utility Software

- **Disk Cleanup**: Frees up disk space.
- **Antivirus**: Detects and removes malware.
- **Backup and Recovery**: Safeguards data.
- **Disk Defragmenters**: Improves performance.
- **System Monitoring Tools**: Monitors system performance.

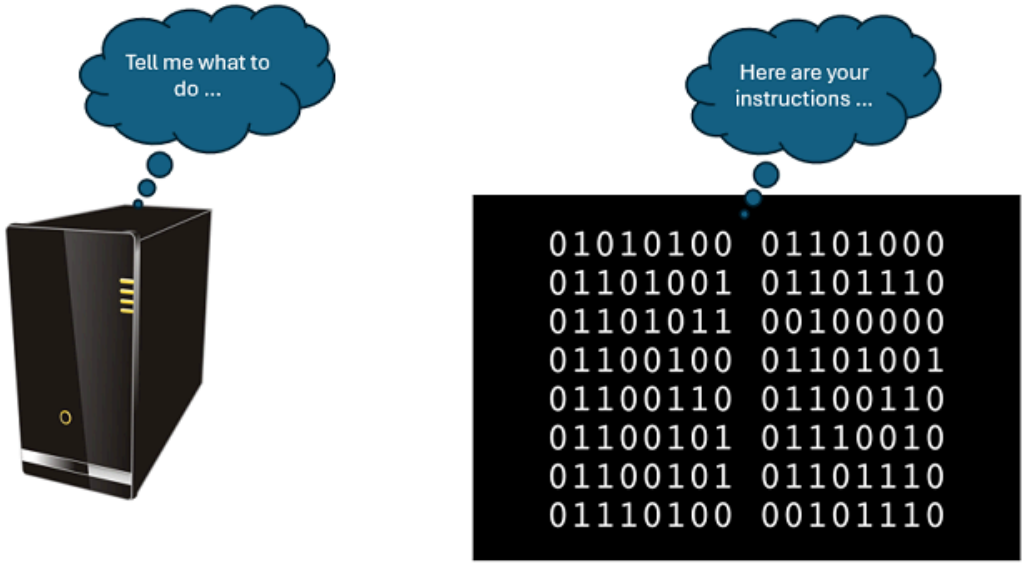
Programming Languages

Objectives

- Define a programming language and its role in software development.
- Differentiate between low-level and high-level programming languages.
- Compare high-level and low-level programming languages.
- Define machine code and assembly language as low-level languages.
- Describe the role of programming translators (assembler, compiler, interpreter).

What is a Computer Program?

- A set of instructions compiled together to perform specific tasks.
- Machine code: Binary numbers (0s and 1s).
- Programming languages: Formal languages for writing instructions.



Low-Level Languages

Machine Code

- Native binary language of computers (0s and 1s).
- Difficult to write and error-prone.
- CPU-specific: Instructions vary between processors.

Assembly Language

- Uses mnemonics (e.g., `LDA #5`) to represent machine code instructions.
- Easier than binary but still processor-specific.
- Converted to machine code by an assembler.

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Assembly Language Example

```
.text
.global main

main:
        mov r0, #23
        and r1, r0, #1
        cmp r1, #1
        blt _isEven
_isOdd:
        mov r0, #1
        ldr r1, =oddStr
        mov r2, #15
        mov r7, #4
        svc 0
        b _exit
_isEven:
        mov r0, #1
        ldr r1, =evenStr
        mov r2, #15
        mov r7, #4
        svc 0
_exit:
        mov r0, #0
        mov r7, #1
        svc 0

.data
oddStr:   .asciz "Number is odd\n"
evenStr:  .asciz "Number is even\n"
```

High-Level Languages

- Closer to human language; easier to read, write, and understand.
- Independent of hardware; portable across different systems.
- Examples: Python, Ruby, JavaScript, C#, Java, Lua.

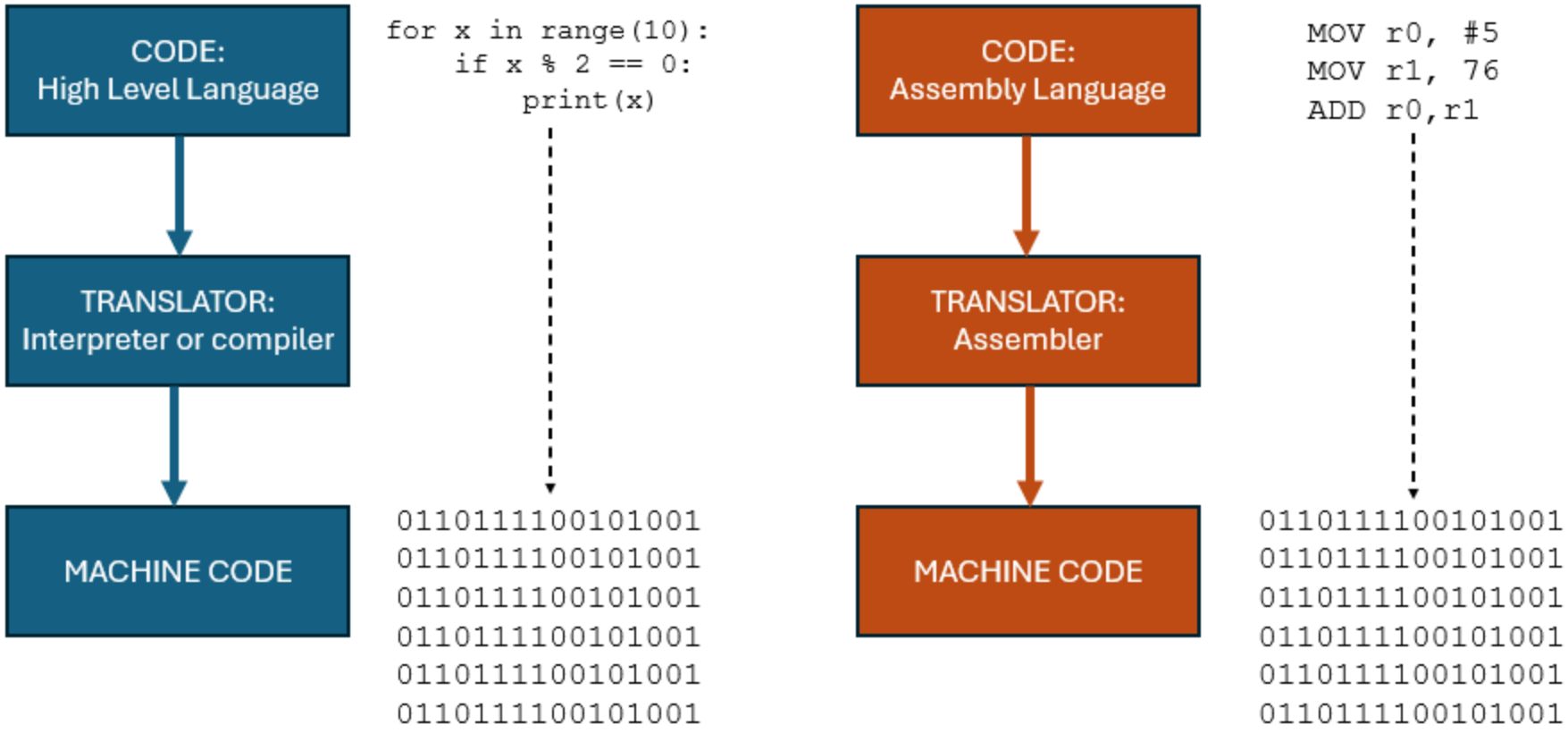
High-Level Language Example

```
def check_odd_or_even(value):
    if value % 2 == 0:
        return "Even"
    else:
        return "Odd"

# Example usage:
user_input = int(input("Enter a number: "))

result = check_odd_or_even(user_input)
print(f"The given number is {result}.")
```

High-Level vs Low-Level Languages

High-Level Language	Low-Level Language
Programmer friendly	Machine friendly
Easy to read and understand	Hard to read and understand
Easy to modify and change	Hard to make changes
Requires less code for the same task	Needs more code for simple tasks
Portable across systems	Non-portable
Needs a compiler or interpreter for translation	Needs an assembler for translation
Less memory efficient	More memory efficient
Slower execution	Faster execution

Program Translators



Interpreter

- Reads and executes code line by line.
- No separate compilation step.
- Examples: Python, JavaScript.
- Code must be interpreted on each execution.

Compiler

- Translates high-level code into machine code.
- Produces a standalone executable file.
- Requires separate compilation before execution.
- Examples: C, C++.

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Assembler

- Converts assembly code into machine code.
- One-to-one mapping from assembly to machine code.

Bytecode

- Intermediate code used for platform independence.
- Example: Java and Python.
- Compiled into bytecode, then interpreted by a virtual machine.

Java

- Compiled into bytecode (JVM).
- Platform-independent execution.

Python

- Compiled into bytecode (.pyc files).
- Executed by Python Virtual Machine (PVM).

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Inside the machine

Objectives

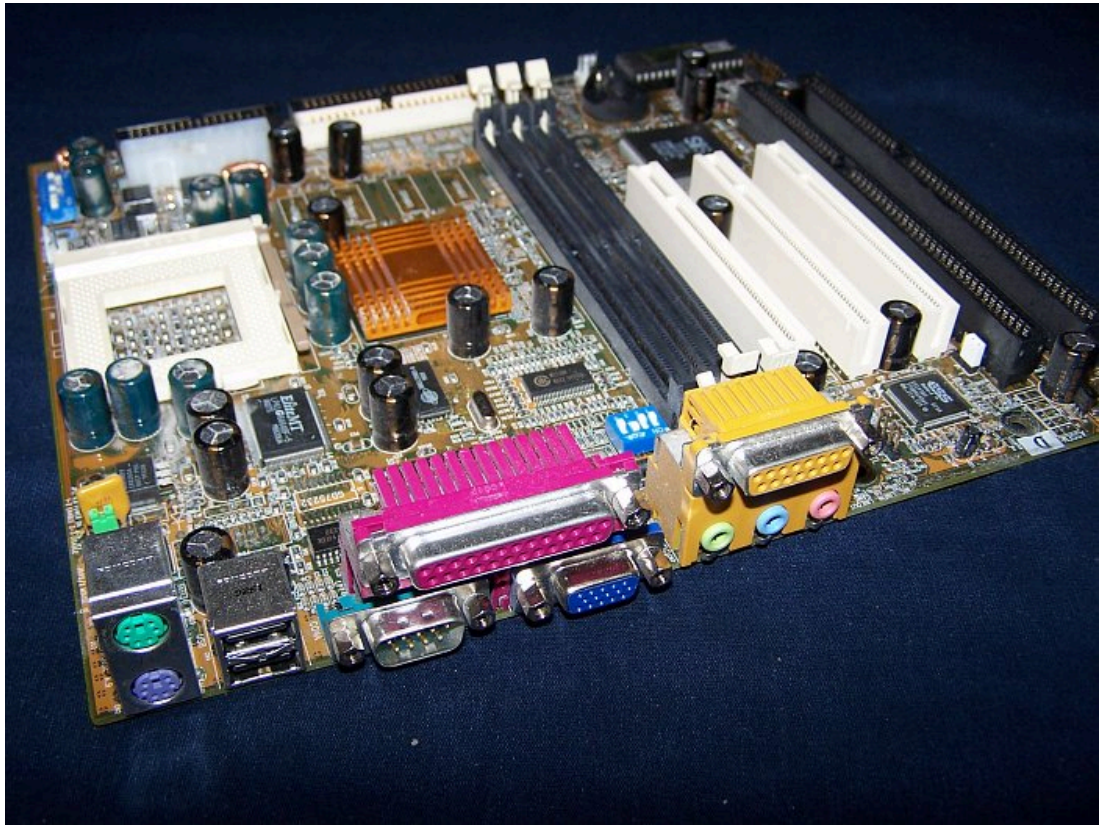
- Recognize and name key hardware components inside a computer system
- Understand their roles and interactions
- Troubleshoot hardware issues

Computer Components Overview

- **Motherboard**
- **Memory (RAM)**
- **CPU (Processor)**
- **Graphics Card**
- **Sound Card**
- **Network Card**
- **Secondary Storage**
- **Power Supply Unit**
- **Other Components**: Cables, fan, heatsink

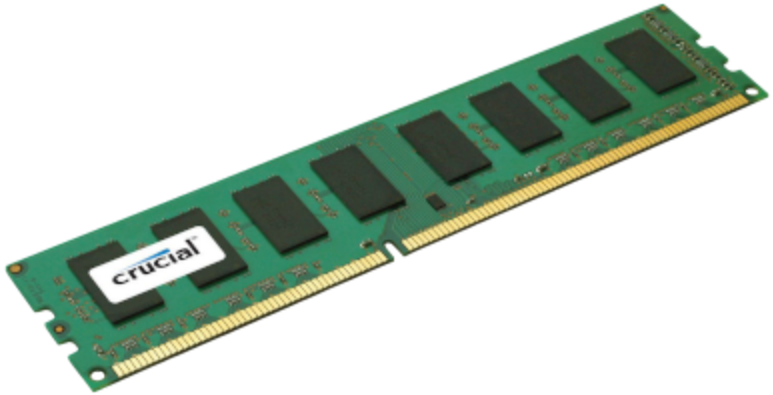
Motherboard

- CPU Socket
- Memory Slots
- Expansion Slots
- Chipset
- Storage Connectors
- Power Connectors
- I/O Ports
- BIOS/UEFI Chip
- CMOS Battery



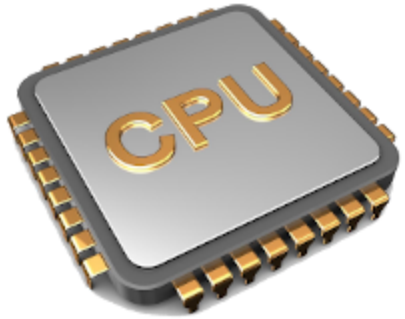
Main Memory (RAM)

- **Role**: Temporary storage for data actively used by CPU
- **Characteristics**:
  - Volatile (loses content when power off)
  - Provides fast access
  - Comes in sizes like 4GB, 8GB



Processor (CPU)

- **Role**: Executes instructions and performs calculations
- **Components**:
  - **ALU**: Performs arithmetic and logic operations
  - **Control Unit**: Manages CPU operations
  - **Clock**: Synchronizes operations
  - **Registers**: Fast storage within CPU

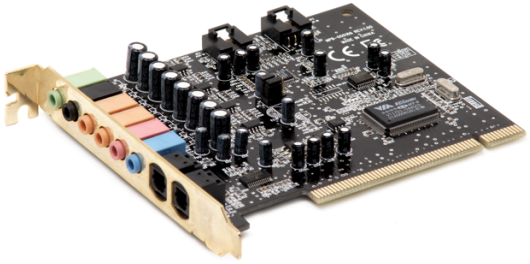


Graphics Card

- **Role**: Renders and displays visual information
- **Functions**:
  - Graphics rendering
  - 3D processing
  - Video playback
  - Parallel processing

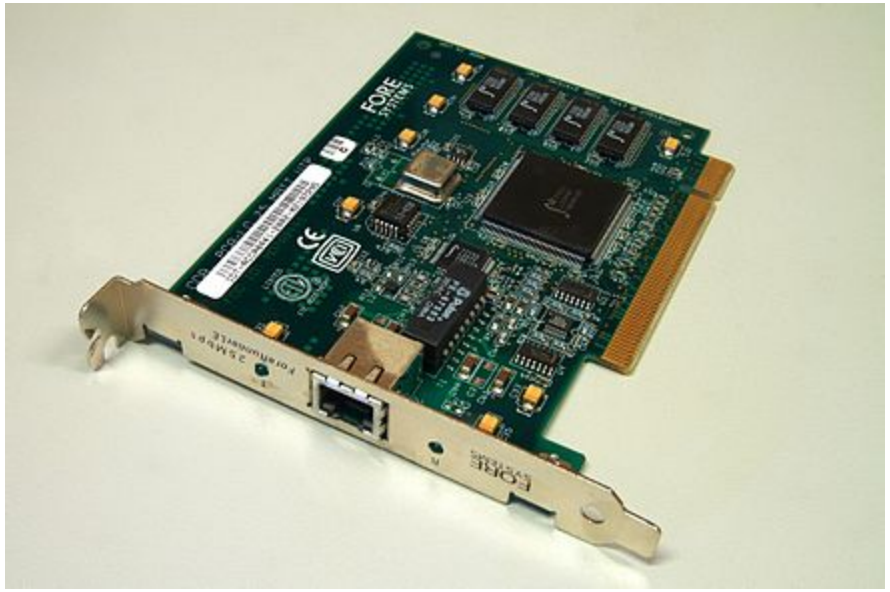
Sound Card

- **Role**: Processes and manages audio data
- **Functions**:
  - Audio playback
  - Sound quality enhancement
  - Surround sound support
  - Audio recording



Network Card

- **Role**: Connects computer to a network
- **Functions**:
  - Ethernet and/or wireless connectivity
  - Data transmission and reception
  - MAC Address and network protocols



Secondary Storage

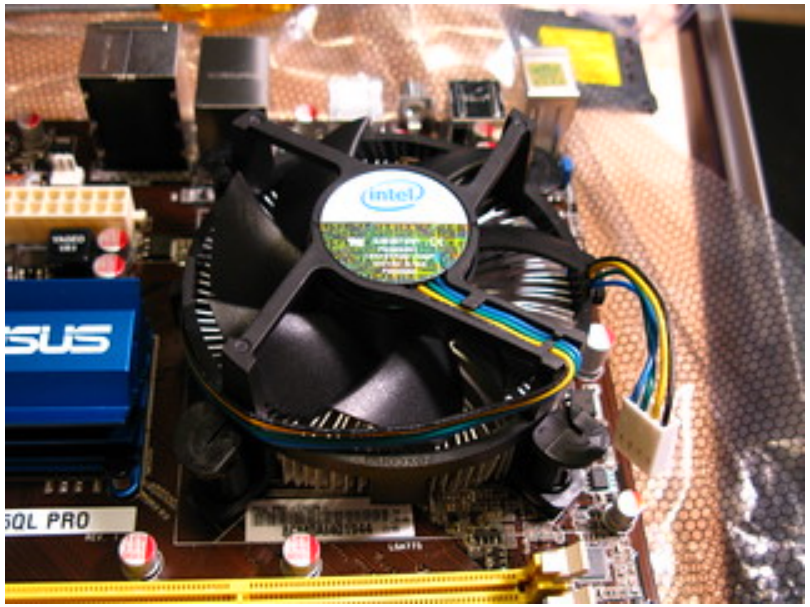
- **Role**: Long-term data storage
- **Types**:
  - **HDD**: Magnetic storage
  - **SSD**: Flash memory
  - **Optical Drives**: CD/DVD/Blu-ray
  - **USB Flash Drives and Memory Cards**

Power Supply Unit (PSU)

- **Role**: Provides power to the computer
- **Functions**:
  - Stabilizes power delivery
  - Protects against surges
  - Efficient power conversion
  - Regulates voltage and current

Heat Sink and Fan

- **Heat Sink**:
  - Absorbs and dissipates heat from CPU
  - Made of aluminum or copper
- **Fan**:
  - Enhances heat dissipation
  - Controlled based on CPU temperature



Memory

Secondary Storage

Systems Architecture