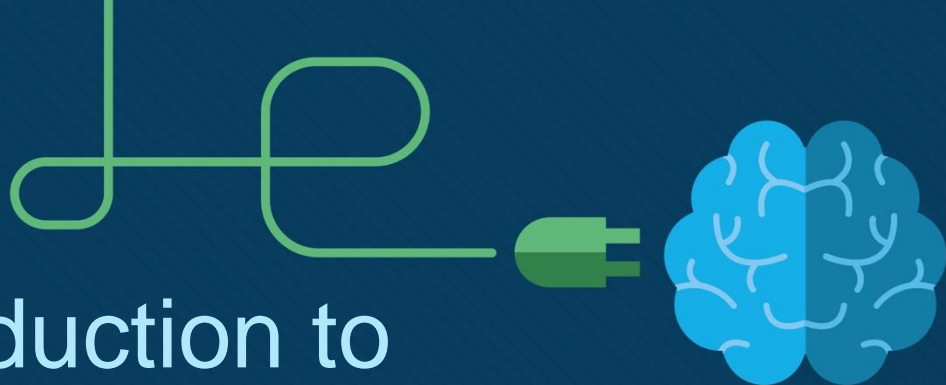# Chapter 1: Introduction to Personal Computer Hardware

Instructor Materials

IT Essentials 7.0

MUNI PED

**Katedra technické a informační výchovy**

# 1.1 Personal Computer

# Electrical Safety

- Electrical devices have certain power requirements.

- AC adapters are manufactured for specific laptops.

  - Exchanging AC adapters with a different type of laptop or device may cause damage to both the AC adapter and the laptop.

- Some printer parts, such as power supplies, contain high voltage. Check the printer manual for the location of high-voltage components.

**Follow electrical safety guidelines to prevent electrical fires, injuries, and fatalities.**

# ESD

- Electrostatic discharge (ESD) can occur when there is a buildup of an electric charge that exists on a surface which comes into contact with another differently charged surface.

- ESD can cause damage to computer equipment if not discharged properly.

- At least 3,000 volts of static electricity must build up before a person can feel ESD.

**Follow these recommendations to help prevent ESD damage**:

- Keep all components in antistatic bags until you are ready to install them.
- Use grounded mats on workbenches.
- Use grounded floor mats in work areas.
- Use antistatic wrist straps when working inside computers.
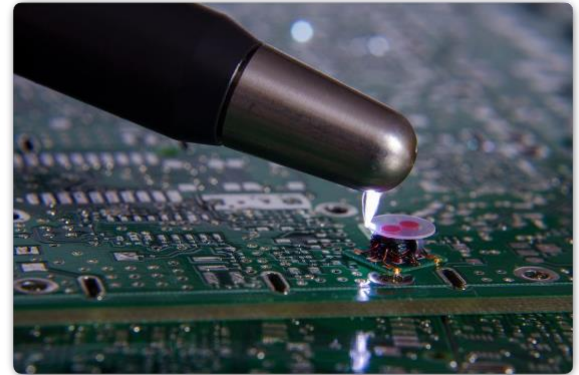
# 1.2 PC Components

# Cases

- The case houses the internal components such as the power supply, motherboard, central processing unit (CPU), memory, disk drives, and assorted adapter cards.

- The term **form factor** refers to the physical design and look of a case. Common desktop computers are available in form factors including:

  - Horizontal case
  - Full-Size Tower
  - Compact Tower
  - All-in-one

**Many case manufacturers may have their own naming conventions, including super tower, full tower, mid tower, mini tower, cube case, and more.**



| Cases | Horizontal case | Full-Size Tower | Compact Tower | All-in-one |

# Power Supplies

- Computers use a power supply to convert AC power into a lower voltage DC power required by internal components.

- Desktop computer power supply form factors include:

    - **Advanced Technology (AT)** – original power supply for legacy computer systems

    - **AT Extended (ATX)** – updated version of the AT

    - **ATX12V** – the most common power supply on the market today

    - **EPS12V** – originally designed for network servers but is now commonly used in high-end desktop models.

# Connectors



- A power supply includes several different connectors. They are used to power various internal components such as the motherboard and disk drives.

- Some examples are:
  - 20-pin or 24-pin slotted connector
  - SATA keyed connector
  - Molex keyed connector
  - Berg keyed connector
  - 4-pin to 8-pin auxiliary power connector
  - 6/8-pin PCIe power connector

# Power Supply Voltage

- The different connectors in a power supply also provide different voltages.

- The most common voltages supplied are 3.3 volts, 5 volts, and 12 volts.

- The 3.3 volt and 5 volt supplies are typically used by digital circuits, while the 12 volt supply is used to run motors in disk drives and fans.

  - Power supplies can also be single rail, dual rail, or multi rail.

  - A rail is the printed circuit board (PCB) inside the power supply to which the external cables are connected.

    **A computer can tolerate slight fluctuations in power, but a significant deviation can cause the power supply to fail.**
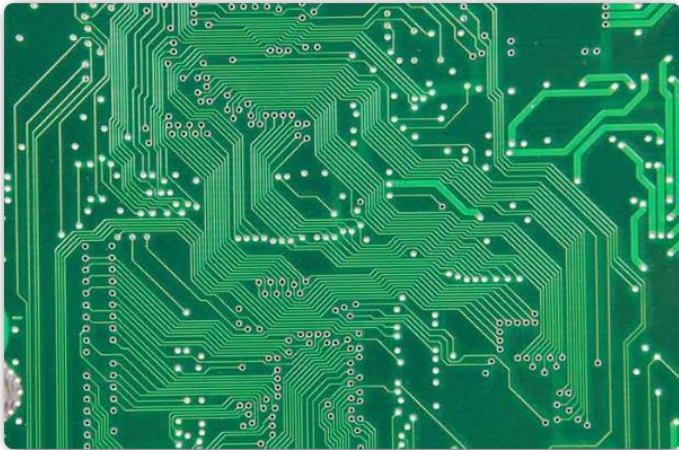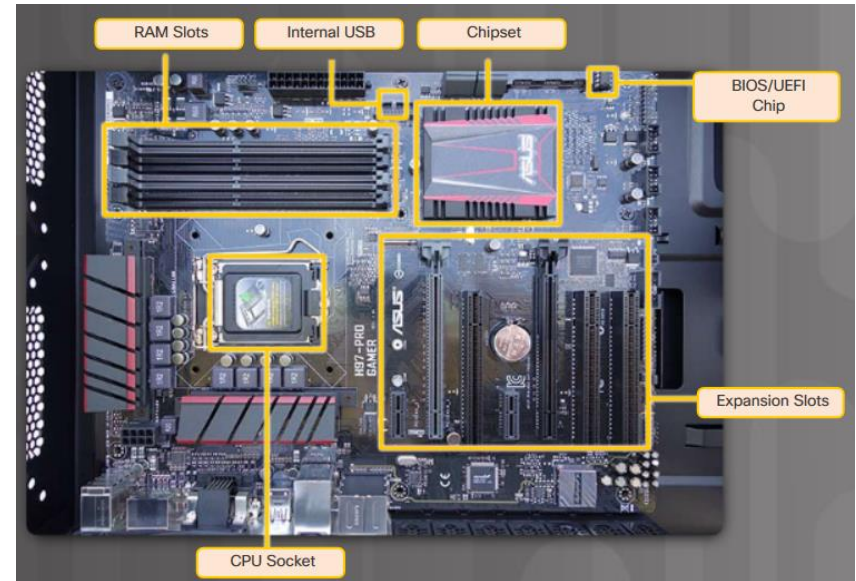
# Motherboards



- The motherboard is the backbone of the computer.

- It is a printed circuit board (PCB) that contains buses, or electrical pathways, that interconnect electronic components.

- These components may be soldered directly to the motherboard, or added using sockets, expansion slots, and ports.
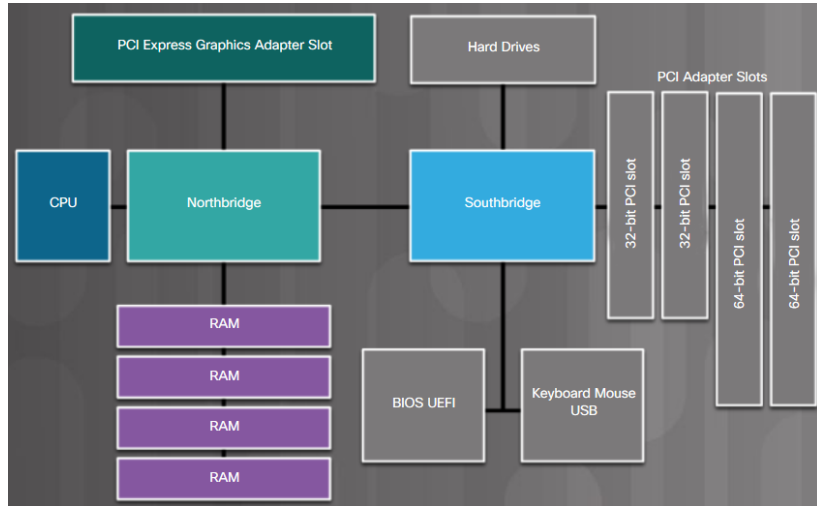
# Motherboard Components

- Major components on a motherboard include:

  - Central Processing Unit (CPU)

  - Random Access Memory (RAM)

  - Expansion slots

  - Chipset

  - Basic input/output system (BIOS) chip and Unified Extensible Firmware Interface (UEFI) chip

  - SATA connectors

  - Internal USB connector

# Motherboard Chipset



- **Chipset** consists of the integrated circuits on the motherboard that control how system hardware interacts with the CPU and motherboard.

- Most chipsets consist of the following two types:

  - **Northbridge** – Controls high speed access to the RAM and video card.
  - **Southbridge** – Allows the CPU to communicate with slower speed devices including hard drives, Universal Serial Bus (USB) ports, and expansion slots.

# Motherboard Form Factors

- The form factor of motherboards pertains to the size and shape of the board.

- There are three common motherboard form factors: **Advanced Technology eXtended** (ATX), **Micro-ATX**, and **ITX**.

| Form Factor | Description |
|---|---|
| ATX | • Advanced Technology eXtended<br>• Most popular form factor<br>• 12 in X 9.6 in (30.5 cm X 24.4 cm) |
| Micro-ATX | • Smaller footprint than the ATX<br>• Popular in desktop and small form factor computers<br>• 9.6 in X 9.6 in (24.4 cm X 24.4 cm) |
| Mini-ITX | • Designed for small devices such as thin clients and set-top boxes<br>• 6.7in X 6.7 in (17cm X 17 cm) |
| ITX | • Comparable form factor to Micro-ATX<br>• 8.5 in X 7.5 in (21.5 cm X 19.1 cm) |

**The choice of motherboard form factor determines how individual components attach to it, the type of power supply required, and the shape of the computer case.**

# What is CPU?

- The central processing unit (CPU) is responsible for interpreting and executing commands.

- The CPU is a small microchip that resides within a CPU package.

- The CPU socket is the connection between the motherboard and the processor.

- Modern CPU sockets and processor packages are built in following architectures:

  - **Pin Grid Array (PGA)** - the pins are on the underside of the processor package and is inserted into the motherboard CPU socket.

  - **Land Grid Array (LGA)** - the pins are in the socket instead of on the processor.
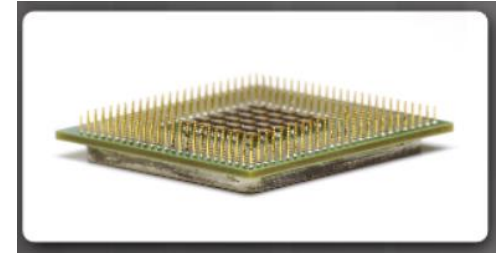
# Cooling Systems

- Computer components perform better when kept cool.

- Computers are kept cool using active and passive cooling solutions.

- Active solutions require power while passive solutions do not.

- Passive solutions for cooling usually involve reducing the speed at which a component is operating or adding heat sinks to computer chips.

- A case fan is considered as active cooling.

Heat Sink (Passive Cooling)

Case Fan (Active Cooling)

# Types of Memory

- A computer might use different types of memory chips.

- All memory chips store data in the form of bytes.

  - A byte is a block of eight bits stored as either 0 or 1 in the memory chip.

- **Read-Only Memory** (ROM) – such as ROM chip.

- **Random Access Memory** (RAM) is the temporary working storage for data and programs that are being accessed by the CPU. RAM is volatile memory.

- Adding more RAM in a computer enhances the system performance. However, the maximum amount of RAM that can be installed is limited by the motherboard.
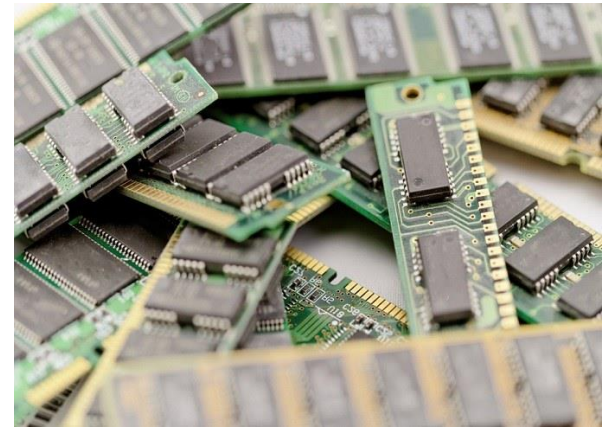
# Types of ROM

- Types of Read-only Memory (ROM) include:

  - ROM chips.

  - PROM chips.

  - EPROM chips

  - EEPROM chips.
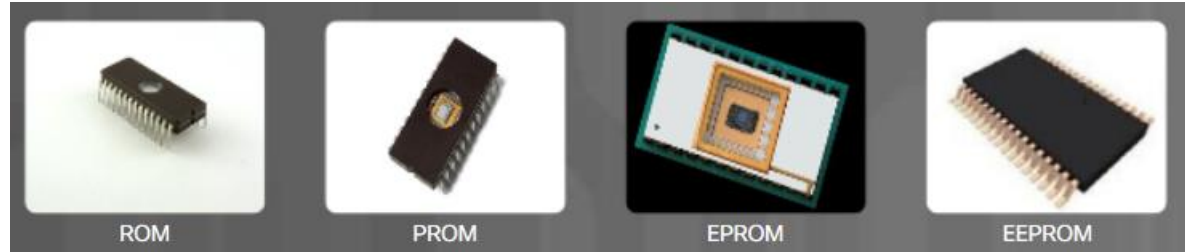
# Types of RAM

- Types of Random Access Memory (RAM) include:

  - Dynamic RAM (DRAM)

  - Static RAM (SRAM)

  - Synchronous Dynamic RAM (SDRAM)

  - Double Data Rate Synchronous Dynamic RAM (DDR SDRAM)

  - DDR2 Synchronous Dynamic RAM (DDR2 SDRAM)

  - DDR3 Synchronous Dynamic RAM (DDR3 SDRAM)

  - DDR4 Synchronous Dynamic RAM (DDR4 SDRAM)

  - GDDR Synchronous Dynamic RAM (GDDR SDRAM)

# Memory Modules

- Memory chips are soldered to a circuit board to create a memory module which is placed into a memory slot on the motherboard.

- Different types of memory modules include: **DIP**, **SIMM**, **DIMM memory**, and **SODIMM**.

- The speed of memory has a direct impact on how much data a processor can process in a given period of time.

- The fastest memory is typically static RAM (SRAM) which is used as cache memory



| DIP | SIMM | DIMM Memory | SODIMM |

# Memory Modules (Cont.)

- The speed of memory has a direct impact on how much data a processor can process in a given period of time.

- The fastest memory is typically static RAM (SRAM) which is used as cache memory for storing the most recently used data and instructions by the CPU.

  - The three most common types of cache memory are:

    - L1 cache – integrated into the CPU

    - L2 cache – was original mounted on the motherboard, but now integrated into the CPU

    - L3 cache – used some high-end workstations and server CPUs
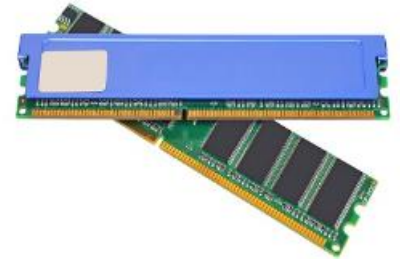
# Memory Modules (Cont.)

- Memory errors occur when the data is not stored correctly in the memory chips. The computer uses different methods to detect and correct data errors in memory.

  - Different types of error checking methods include:

    - **Nonparity** – Nonparity memory does not check errors in memory.

    - **Parity** – Parity memory contains 8 bits for data and 1 bit for error checking.

    - **ECC** – Error Correction Code memory can detect multiple bit errors in memory and correct single bit errors in memory

# Adapter Cards

- Adapter cards increase the functionality of a computer by adding controllers for specific devices or by replacing malfunctioning ports.

  - Common adapter cards include:

    - Sound adapter

    - Network Interface Card (NIC)

    - Wireless NIC

    - Video adapter or display adapter

    - Capture card

    - TV tuner card

    - Universal Serial Bus (USB) controller card

    - eSATA card



Sound Adapter

NIC

eSATA card

Video Adapter
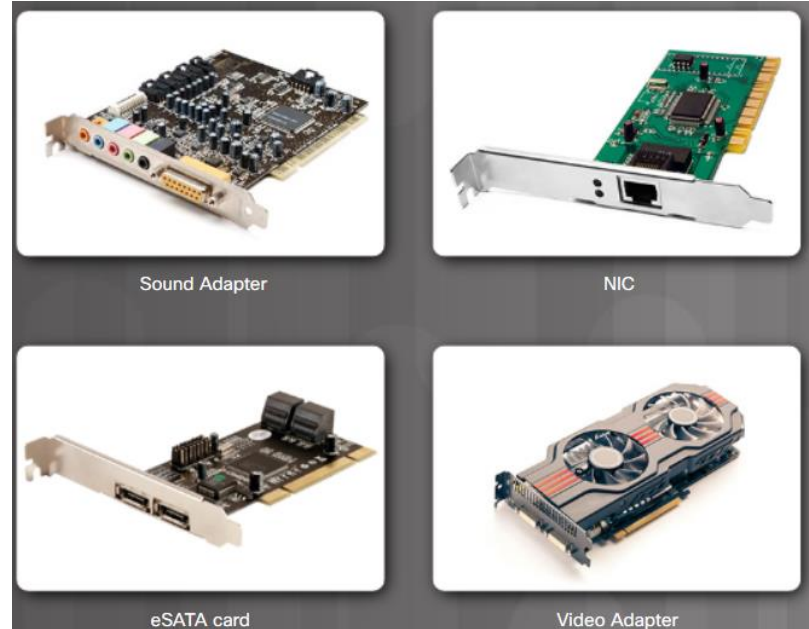
# Adapter Cards (Cont.)

- Computers have expansion slots on the motherboard to install adapter cards.

- The type of adapter card connector must match the expansion slot.

  - Common expansion slots include:

    - Peripheral Component Interconnect (PCI)

    - Mini-PCI

    - PCI eXtended (PCI-X)

    - PCI Express (PCIe)

    - Riser card

    - Accelerated Graphics Port (AGP)

# Types of Storage Devices

- Data drives provide non-volatile storage of data.

- Some drives have fixed media, and other drives have removable media.



Hard Disk Drive

Optical Drive

Solid State Drive

Tape Drive

- Data storage devices can be classified according to the media on which the data is stored:

  - Magnetic – like hard disk drive and tape drive

  - Solid state – like solid state drive

  - Optical – like CD and DVD

# Storage Device Interfaces

- Storage devices inside a computer connect to the motherboard using Serial AT Attachment (SATA) connections. The legacy interface is Parallel ATA (EIDE).

- The interface standards define the way that data is transferred, the transfer rates, and physical characteristics of the cables and connectors.

- There are three main versions of the SATA standard: SATA 1, SATA 2, and SATA 3.

- The cables and connectors are the same, but the data transfer speeds are different.

| ATA | Parallel (PATA) | IDE | 8.3 Mb/s |
|-----|-----------------|------|----------|
|     |                 | EIDE | 16.6 Mb/s |
|     | Serial (SATA)   | SATA 1 | 1.5 Gb/s |
|     |                 | SATA 2 | 3.0 Gb/s |
|     |                 | SATA 3 | 6.0 Gb/s |

# Magnetic Media Storage

- This type of storage represents binary values as magnetized or non-magnetized physical areas of magnetic media.

- Common types of magnetic media storage drives:

  - Hard Disk Drive (HDD) – the traditional magnetic disk devices with storage capacity ranging from gigabytes (GBs) to terabytes (TBs).

  - Tape Drive – most often used for archiving data.

    - Tape drives use a magnetic read/write head and removable tape cartridge.

    - Common tape storage capacities vary between a few GBs to many TBs.



3.5 inch          2.5 inch          1.8 inch

# Semiconductor Storage

- Solid-state drives (SSD) store data as electrical charges in semiconductor flash memory. This makes SSDs much faster than magnetic HDDs.

- SSDs have no moving parts, make no noise, are more energy efficient, and produce less heat than HDDs.

- SSDs come in three form factors:

  - Disc drive form factor – similar to an HDD

  - Expansion cards – plugs directly into the motherboard and mounts in the computer case like other expansion cards

  - mSata or M.2 modules – these packages may use a special socket. **M.2** is a standard for computer expansion cards.



SSD Form Factors

SSD 2.5" drive

SSD M2 drive

SSD adapter card
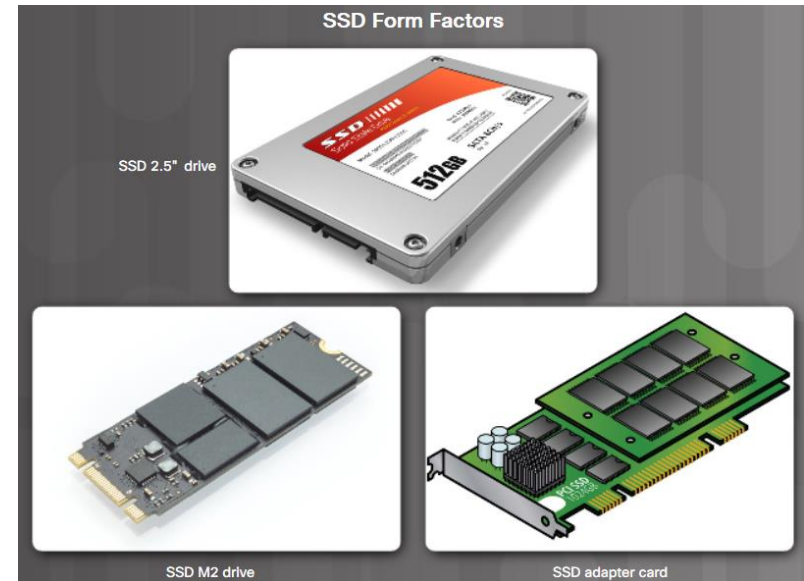
# Semiconductor Storage (Cont.)

- The Non-Volatile Memory Express (**NVMe**) specification was developed specifically to allow computers to take greater advantage of the features of SSDs by providing a standard interface between SSDs, the PCIe bus, and operating systems.

- NVMe allows compliant SSD drives to attach to the PCIe bus without requiring special drivers.

- Solid State Hybrid Drives (**SSHD**s) are a compromise between a magnetic HDD and an SSD.

  - They are faster than an HDD but less expensive than an SSD.

  - They combine a magnetic HDD with onboard flash memory serving as a non-volatile cache.

# Types of Optical Storage Devices

- Optical drives are removable media storage devices that use lasers to read and write data on optical media.

- They were developed to overcome the storage capacity limitations of removable magnetic media such as floppy discs.

  - There are three types of optical drives:
    - Compact Disc (CD) - audio and data
    - Digital Versatile Disc (DVD) - digital video and data
    - Blu-ray Disc (BD) - HD digital video and data

# Types of Optical Storage Devices (Cont.)

- CD, DVD, and BD media can be pre-recorded (read only), recordable (write once), or re-recordable (read and write multiple times).

- DVD and BD media can also be single layer (SL) or dual layer (DL). Dual layer media roughly doubles the capacity of a single disc.

| Optical Media | Description | Storage Capacity |
|---|---|---|
| CD-ROM | CD read-only memory media that is pre-recorded | 700 MB |
| CD-R | CD recordable media that can be recorded one time | |
| CD-RW | CD rewritable media that can be recorded, erased, and re-recorded | |
| DVD-ROM | DVD read-only memory media that is pre-recorded | 4.7 GB (Single-Layer) 8.5 GB (Dual-Layer) |
| DVD-RAM | DVD rewritable media that can be recorded, erased, and re-recorded | |
| DVD+/-R | DVD recordable media that can be recorded one time | |
| DVD+/-RW | DVD rewritable media that can be recorded, erased, and re-recorded | |
| BD-ROM | Blu-ray read-only media that is pre-recorded with movies, games, or software | 25 GB (Single-Layer) 50 GB (Dual-Layer) |
| BD-R | Blu-ray recordable media that can be recorded one time | |
| BD-RE | Blu-ray rewritable media that can be recorded, erased, and re-recorded | |

# Video Ports and Cables

- A video port connects a monitor to a computer using a cable.

- Video ports and monitor cables transfer analog signals, digital signals, or both.

  - Video ports and cables include:
    - Digital Visual Interface (DVI)
    - DisplayPort
    - High-Definition Multimedia Interface (HDMI)
    - Thunderbolt 1 or 2
    - Thunderbolt 3
    - Video Graphics Array (VGA)
    - Radio Corporation of America (RCA)

# Other Ports and Cables

- Input/output (I/O) ports on a computer connect peripheral devices, such as printers, scanners, and portable drives.

  - A computer may have other ports:

    - Personal System 2 (PS/2)

    - Audio and game port

    - Network

    - Serial AT Attachment (SATA)

    - Integrated Drive Electronics (IDE)

    - The Universal Serial Bus (USB)



PS/2    Audio and Gameport    Network



SATA    IDE    USB

# Adapters and Converters

- There are many connection standards in use today. These components are called adapters and converters:

  - **Converter** – performing the same function as an adapter but also translates the signals from one technology to the other.

  - **Adapter** – physically connecting one technology to another

    - Example of adapters include:

      - DVI to VGA Adapter

      - USB to Ethernet adapter

      - USB to PS/2 adapter

      - DVI to HDMI adapter

      - Molex to SATA adapter

      - HDMI to VGA converter



DVI to VGA adapter    USB to Ethernet converter    USB to PS/2 adapter

DVI to HDMI adapter    Molex to SATA adapter    HDMI to VGA converter
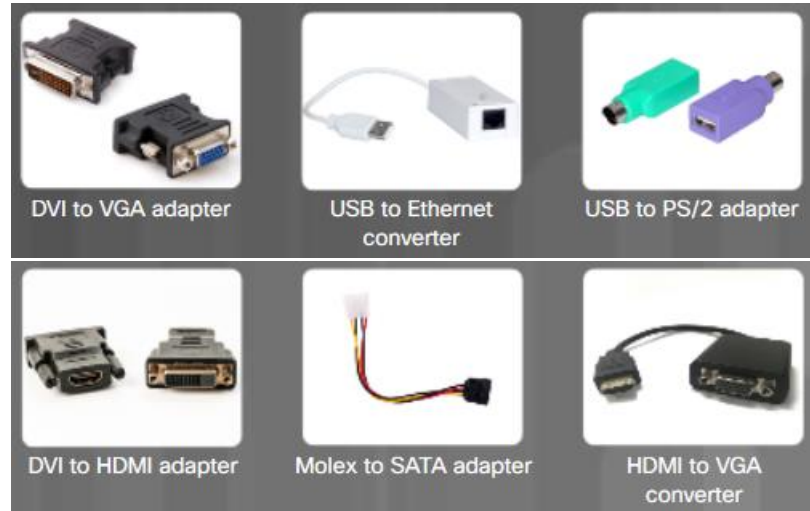
# The Original Input Devices

- Input devices all the user to communicate with a computer.

- Some of the first input devices include:

  - Keyboard and Mouse – these are the two most commonly used input devices
  - ADF / Flatbed Scanner – these devices digitize an image or document
  - Joystick and Gamepad – these devices are used for playing games
  - KVM Switch – a hardware device that can be used to control more than one computer while using a single keyboard, monitor, and mouse



Keyboard and Mouse        ADF / Flatbed Scanner        Joystick and Gamepad        KVM Switch
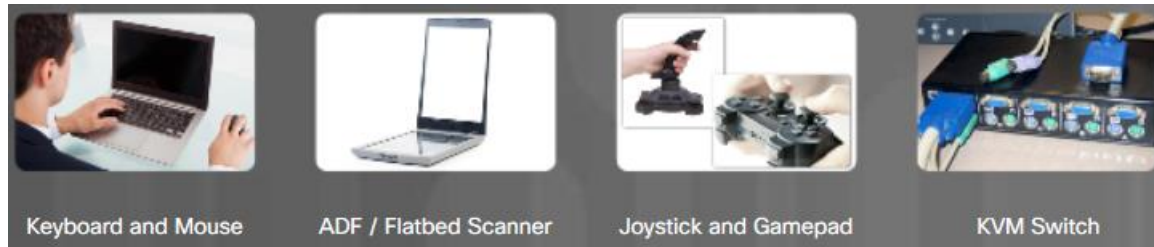
# New Input Devices

- Some new input devices include touch screen, stylus, magnetic strip reader, and barcode scanner:

  - **Touch screen** – input devices with touch or pressure sensitive screens

  - **Stylus** – a type of digitizer that allows a designer or artist to create artwork by using a pen-like tool

  - **Magnetic strip reader** – a device that reads information magnetically encoded on the back of plastic cards

  - **Barcode scanner** – a device that reads the information contained in the barcodes affixed to products



Touch screen     Stylus     Magnetic Stripe Reader     Barcode Scanner

# More New Input Devices

- A few newer input devices:

  - **Digital camera** – devices that capture digital images and videos

  - **Webcams** – video cameras that can be integrated into a computer

  - **Signature pad** – a device that electronically captures a person's signature

  - **Smart card reader** – a device used on a computer to authenticate the user. A smart card may be the size of a credit card with an embedded microprocessor that is typically under a gold contact pad on one side of the card.

  - **Microphone** – a device that allows a user to speak into a computer and have their voice digitized



| Digital Camera | Webcam | Signature Pad | Smart Card Reader | Microphone |

# Most Recent Input Devices

- The newest input devices include NFC devices and terminals, facial recognition scanners, fingerprint scanners, voice recognition scanners, and virtual reality headsets:

  - **NFC devices and terminals** – Near Field Communication (NFC) tap to pay devices

  - **Facial recognition scanners** – devices identifying a user based on unique facial features

  - **Fingerprint scanners** – devices identifying a user based on unique fingerprint

  - **Voice recognition scanners** – devices identifying a user based on unique voice

  - **Virtual reality headset** – used with computer games, simulators, and training applications with virtual reality functionalities.



| NFC Devices and Terminals | Facial Recognition Scanners | Fingerprint Scanners | Voice Recognition Scanners | Virtual Reality Headset |

# What are Output Devices?

- An output device takes binary information from the computer and converts it into a form that is easily understood by the user.

- Examples of output devices include monitors, projectors, VR headsets, printers, speakers, and headphones.


VR Headset


Printer


Monitor


Projector


Speakers


Headphones

cisco

# Monitors and Projectors

- Most monitors use one of three types of technology:

  - Liquid crystal display (LCD)

  - Light-emitting diode (LED)

  - Organic LED (OLED)



Monitor     Projector

- Most video projectors use LCD or DLP technology.

  - DLP stands for Digital Light Processing

  - Different projectors have different numbers of lumens, which affects the level of brightness of the projected image.

# VR and AR Headsets

- **Virtual Reality (VR)** uses computer technology to create a simulated, three-dimensional environment.

- A VR headset completely encases the upper portion of users' faces, not allowing in any ambient light from their surroundings.

- **Augmented Reality (AR)** uses similar technology but superimposes images and audio over the real world in real time.

- AR can provide users with immediate access to information about their real surroundings.

- An AR headset usually does not close off ambient light to users, allowing them to see their real life surroundings.



VR Headset

AR Headset
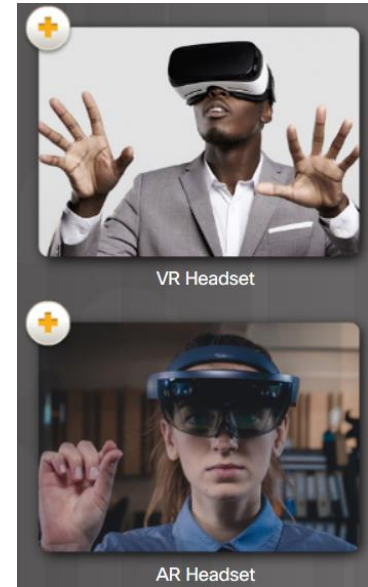
# Printers

- Printers are output devices that create hard copies of files.

- A hard copy might be a on a sheet of paper. It could also be a plastic form created from a 3D printer.

- Different types of printers:

  - Inkjet, impact, thermal, laser, and 3D printers

  - Printers use wired or wireless connections

  - All printers require printing material (such as ink, toner, liquid plastic, etc.)

  - Printers use a driver to communicate with OS
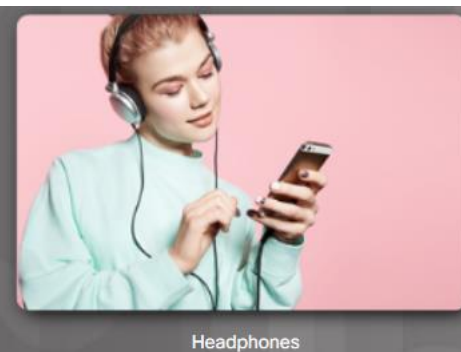


Inkjet Printer
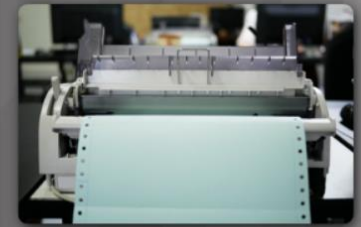
Impact Printer
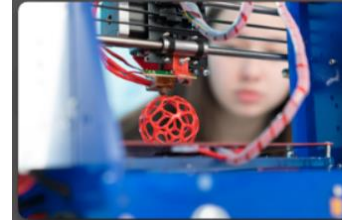
3D Printer

Thermal Printer

# Speakers and Headphones



Speakers

Headphones

- **Speakers** are a type of auditory output device.

-  Most computers and mobile devices have audio support either integrated into the motherboard or on an adapter card.

- **Headphones**, earbuds, and the earphones found in headsets are all auditory output devices.

- These may be wired or wireless. Some are Wi-Fi or Bluetooth-enabled.