

CSIS 2260 Operating Systems

Introduction to Hardware

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Section: 010, 011, 012

Winter 2021

Schedule

- Blackboard Collaborate Ultra (Pacific Time)
 - Lecture: Fri 10:30 - 12:20 Online
 - Lab 010: Fri 12:30 - 14:20 Online
 - Lab 011: Thu 14:30 - 16:20 Online
 - Lab 012: Thu 16:30 - 18:20 Online
- Office Hour: Fri 14:30 - 15:30, by appointment
- We may use ZOOM in certain cases
- You need to attend the lecture and the lab of your section

Course Materials

- **Textbook (Required):** William Stallings, Operating Systems: Internals and Design Principles, 9th Ed, Pearson.
- **Reference (Not Required):** Mchoes, A. and Flynn, I. Understanding Operating Systems, 8th Ed, Cengage Learning
- **Hardware and Software supplies (Required):** A Windows 10 64-bit Desktop/Laptop with Quad-core CPU, at least 8 GB RAM and 100 GB free disk space, good and stable Internet connection, one MINIMUM 8 GB USB Flash Drive in good condition, Camera and Mic
- **Note: Mac computers of any model will NOT be supported for this course**

OPERATING SYSTEMS

Internals and Design Principles



WILLIAM STALLINGS

 Pearson

Ninth Edition

Evaluation

Assignments/labs	20%
Quizzes (2)	20%
Mid-Term Examination	30%
Final Examination	30%
Total	100%

- If the student completed less than 70% of the total evaluations available for this course, or missed more than 30% of the classes where the Course Outline specifies that attendance is a course requirement, he/she will be assigned an UN as the final grade
- To pass the course, the student must, in addition to receiving an overall course grade of 50%, also achieve a grade of at least 50% on the combined weighted examination components (including quizzes, tests, and exams)
 - For this course, the total value of examination components is $20\%+30\%+30\%=80\%$. Minimum 50% of the total is 40%. So, in order to pass you need a minimum of 50% overall course grade and an average minimum of 40% for the total of examination components

Evaluation

Assignments/labs	20%
Quizzes (2)	20%
Mid-Term Examination	30%
Final Examination	30%
Total	100%

- A final grade of C or higher is needed in order to take higher-level CSIS courses that require this course a prerequisite (e.g., CSIS 3155)
- Students are required to produce ID card during examinations
- Students will receive a UN as the final course grade for missing the FINAL examination

Important Issues

- Check blackboard and emails regularly, I post
 - Notes, labs, assignments, and announcements
- Class attendance is very important (check the course outline for policies)
 - A student missing more than 30% of classes will receive a UN as the final grade regardless of his/her performance in the course
 - Blackboard Collaborate Ultra keeps track of attendance
- Academic Dishonesty consequences
 - Zero tolerance for plagiarism and cheating
 - <https://www.douglascollege.ca/sites/default/files/docs/finance-dates-and-deadlines/Academic%20Integrity%20Policy%20w%20Flowchart.pdf>

Important Issues

- All activities, including lectures, labs, quizzes, and exams will be online until further notice
- Students are responsible for all the announcements made in the (online) classroom and lab concerning course information and schedule changes **WHETHER OR NOT** they are in attendance
- The Final Examination period is April 14-22. Please check the examination schedule as soon as it becomes available for potential scheduling conflicts. Do not make any travel arrangements within this exam period as the college will not change the exam date to accommodate your travel plans

Important Issues

- Unless otherwise communicated in the course outline or by the instructor, all labs/assignments must be completed **individually**
- All labs/assignments should be submitted using the Blackboard Community
- NO late labs/assignments will be accepted
- Missed quizzes/exams will not be made up
- Missing the final exam will automatically lead to a UN grade. Missing an exam without a medical excuse will result in a mark of ZERO
- Check Covid-19 Safety Guideline

Important Issues

- All academic related communication through emails must originate or destined from/to a valid @student.douglascollege.ca email address. Emails originated from a different email address will be disregarded
- Please include the following information in the email for efficient communication: course and section number, name, and student number; Emails without such information will be disregarded
- Expect one business day for email reply from instructor
 - Make an appointment for office hour for timely response

Tips for Doing Well

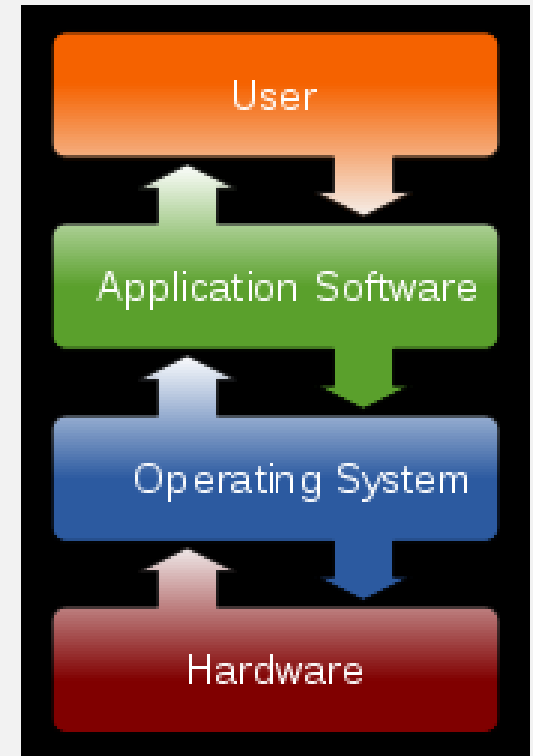
- Attend every class and take notes in lecture
- Read textbooks and supplementary materials
- Speak up and ask questions whenever you are confused, chances are, you are not the only one
- Do all assignments/labs and come to office hours for questions
- Use Google and YouTube to help understand concepts

Objectives

- Learn that a computer requires both hardware and software to work
- Learn about the many different hardware components inside of and connected to a computer

Hardware Needs Software to Work

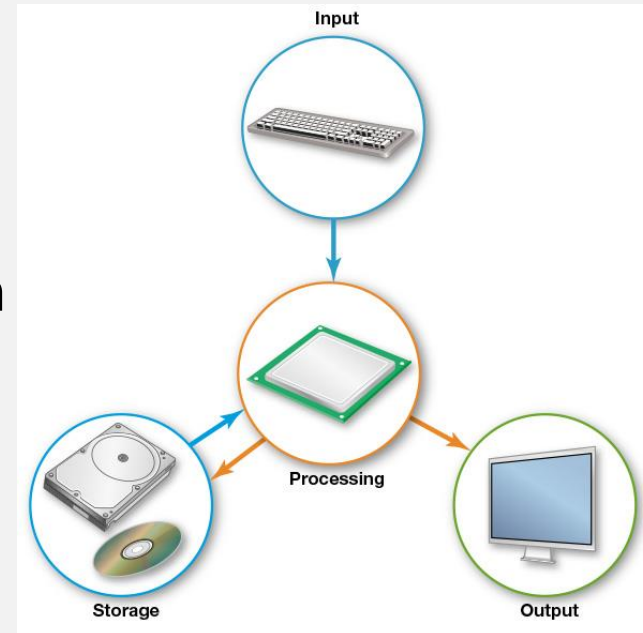
- Hardware
 - Computer's physical components
 - Monitor, keyboard, memory, hard drive
- Software
 - Instruction set
 - Directs hardware to accomplish a task
 - Uses hardware for four basic functions
 - Input, processing, storage, output
 - Systems software and application software
- Hardware components
 - Require an electrical system



<https://en.wikipedia.org/wiki/Software>

Understanding Your Computer

- Perform four major functions
 - Input: Gathers data, allows entering data
 - Process: Manipulates, calculates, or organizes data
 - Output: Displays data and information
 - Storage: Saves data and information



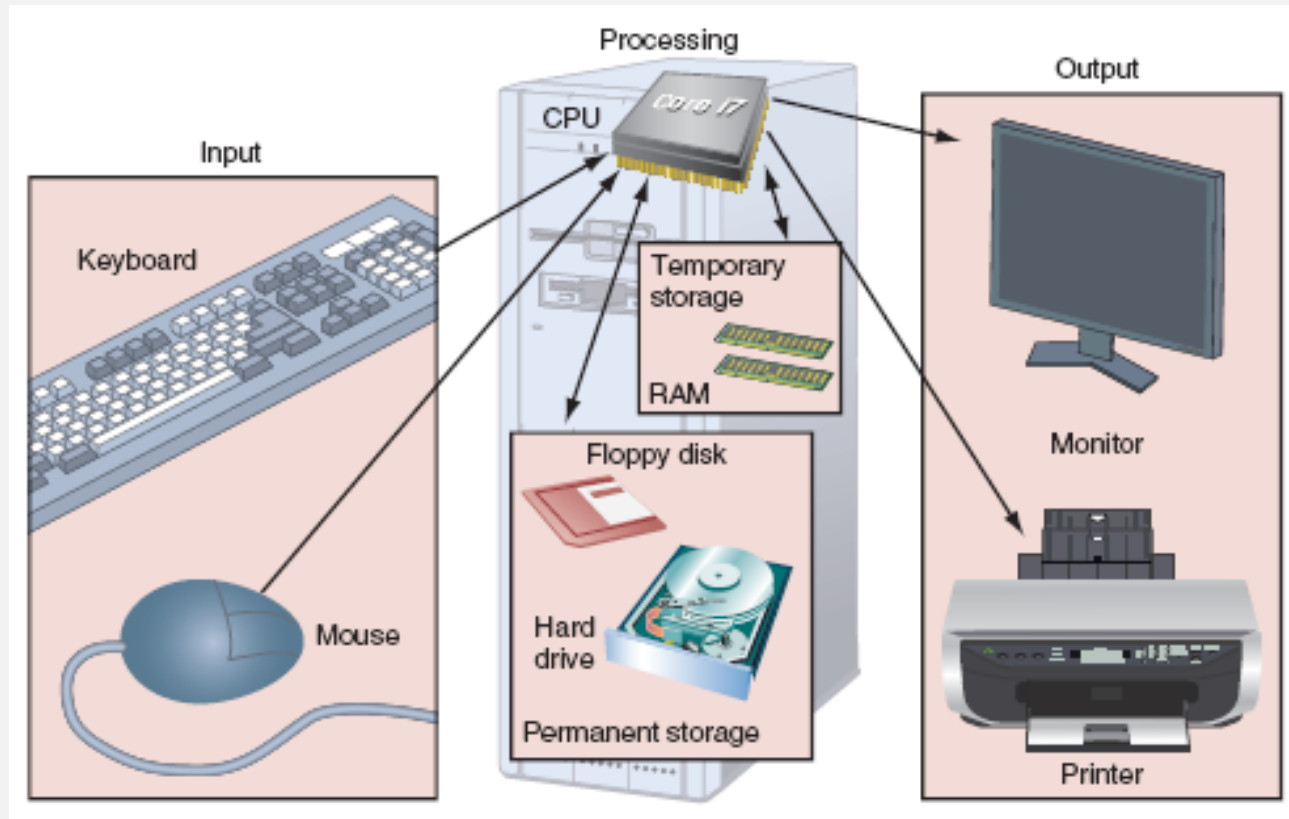


Figure 1-1 Computer activity consists of input, processing, storage, and output.
Courtesy: Course Technology/Cengage Learning

Hardware Needs Software to Work (cont'd.)

- User interaction with computer
 - User and software communicate with input/output devices
 - Hardware uses two states: on and off

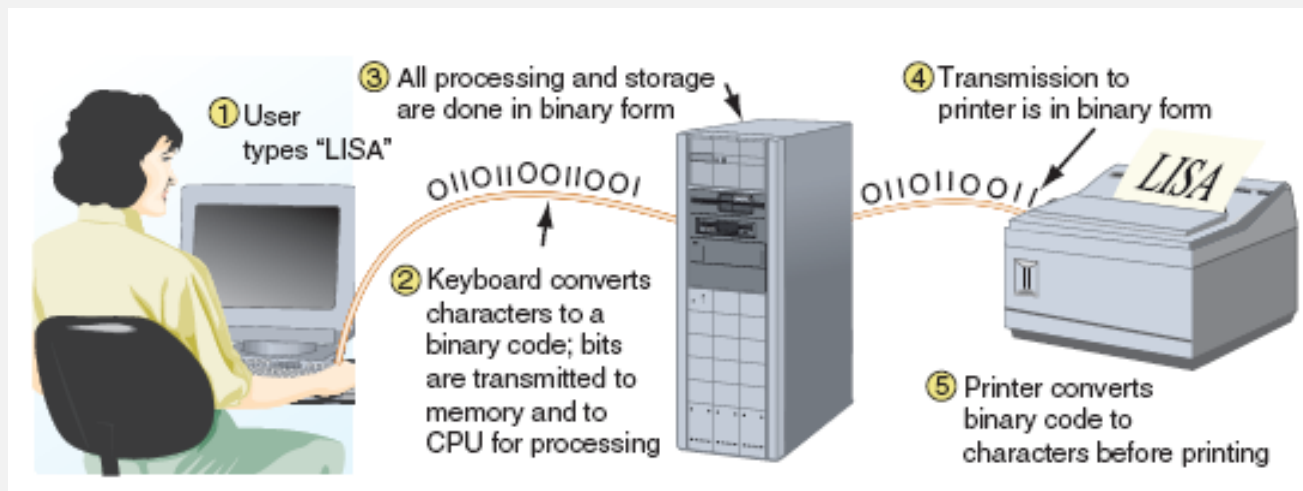










Figure 1-2 All communication, storage, and processing of data inside a computer are in binary form until presented as output to the user.
Courtesy: Course Technology/Cengage Learning

Hardware Needs Software to Work (cont'd.)

- Binary number system
 - Stores and reads two states
 - Zero or one
 - Bit: binary digit
 - Value of zero or one
 - Byte: eight bits
 - Used for counting, calculation, storage operations
- American Standard Code for Information Interchange (ASCII)
 - Each letter, number, and character is a string 0s and 1s
 - Originally uses 7 bits, extended to 8 bits later
 - Used for storing information

The number 25 stored as 8 bits using the binary number system:

25 = 0001 1001 =        

The letter A stored as 8 bits using ASCII code:




A = 0100 0001 =        

Figure 1-3 All letters and numbers are stored in a computer as a series of bits, each represented in the computer as on or off.
Courtesy: Course Technology/Cengage Learning

<https://www.rapidtables.com/code/text/ascii-table.html>

Further Reading

- How data is stored in computer memory
 - <https://www.log2base2.com/storage/how-data-is-stored-in-computer-memory.html>
- A Tutorial on Data Representation
 - <https://www3.ntu.edu.sg/home/ehchua/programming/java/datarepresentation.html>

Name	Abbreviation	Number of Bytes
Byte	B	1 byte
Kilobyte	KB	1,024 bytes (2^{10} bytes, 10^3 approx.)
Megabyte	MB	1,048,576 bytes (2^{20} bytes, 10^6 approx.)
Gigabyte	GB	1,073,741,824 bytes (2^{30} bytes, 10^9 approx.)
Terabyte	TB	1,099,511,627,776 bytes (2^{40} bytes, 10^{12} approx.)
Petabyte	PB	1,125,899,906,842,62 bytes (2^{50} bytes, 10^{15} approx.)
Exabyte	EB	1,152,921,504,606,846,976 bytes (2^{60} bytes, 10^{18} approx.)
Zettabyte	ZB	1,180,591,620,717,411,303,424 bytes (2^{70} bytes, 10^{21} approx.)

PC Hardware Components

- Input/output (I/O) devices: external to the case
- Processing, storage devices: internal to the case
- Central processing unit (CPU)
 - Also called: processor, microprocessor
 - Reads input, processes data, writes data to storage
- Elements required by I/O, storage devices
 - Method for CPU to communicate with the device
 - Software to instruct, control the device
 - Electricity to power the device
- <https://www.youtube.com/watch?v=yRmPTbGBqVI>

Hardware Used for Input and Output

- I/O device communication with computer components
 - Cabled using a port
 - Wireless (mouse, keyboard, printer, etc.)
- Primary input devices
 - Keyboard, mouse
- Primary output devices
 - Monitor: visually displays primary computer output
 - Printer: produces paper output (hard copy)

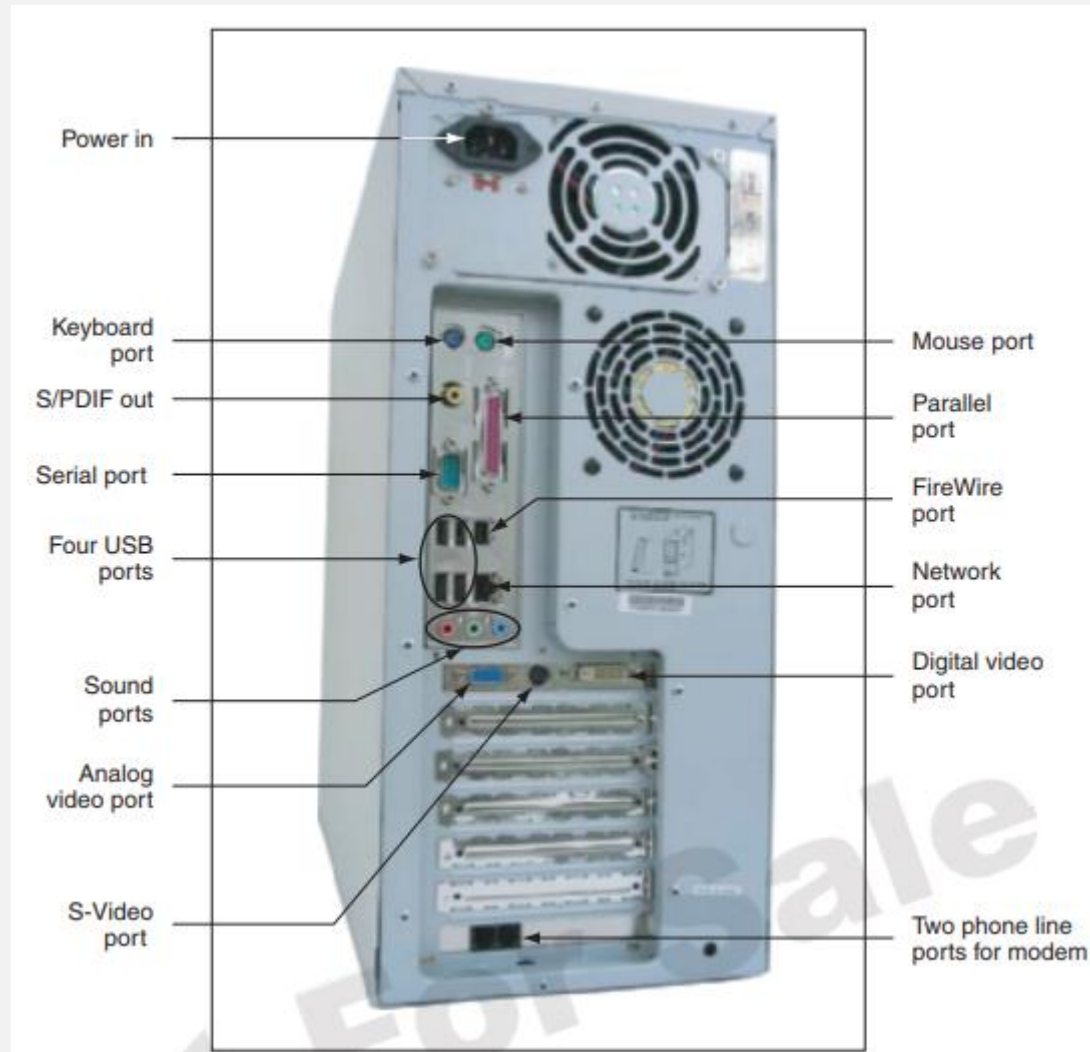


Figure 1-4 Input/output devices connect to the computer case by ports usually found on the back of the case.
Courtesy: Course Technology/Cengage Learning

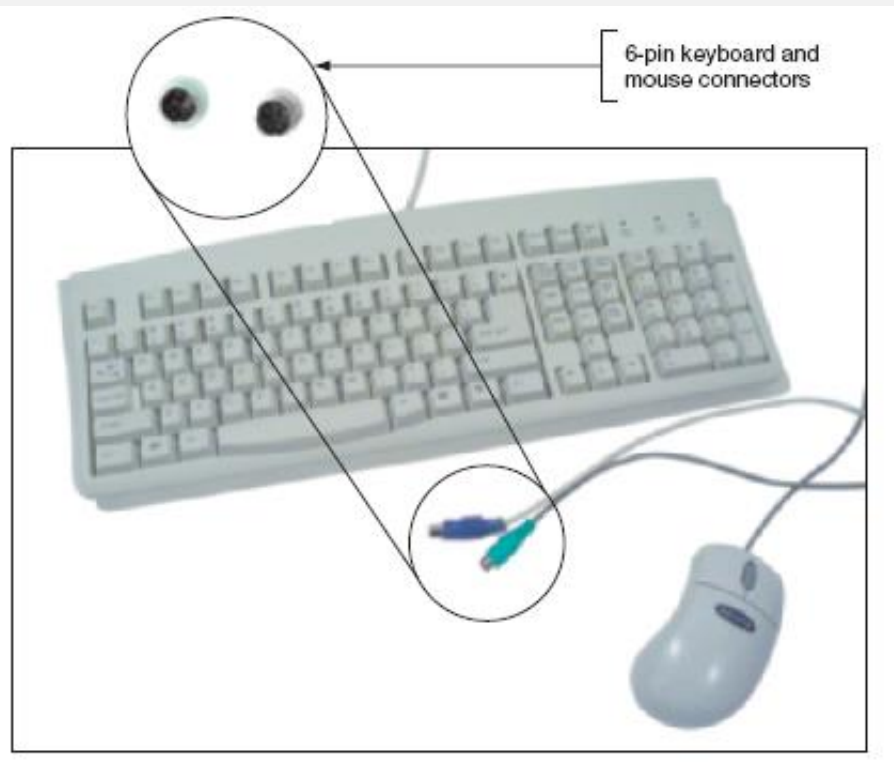


Figure 1-5 The keyboard and the mouse are the two most popular input devices. Courtesy: Course Technology/Cengage Learning

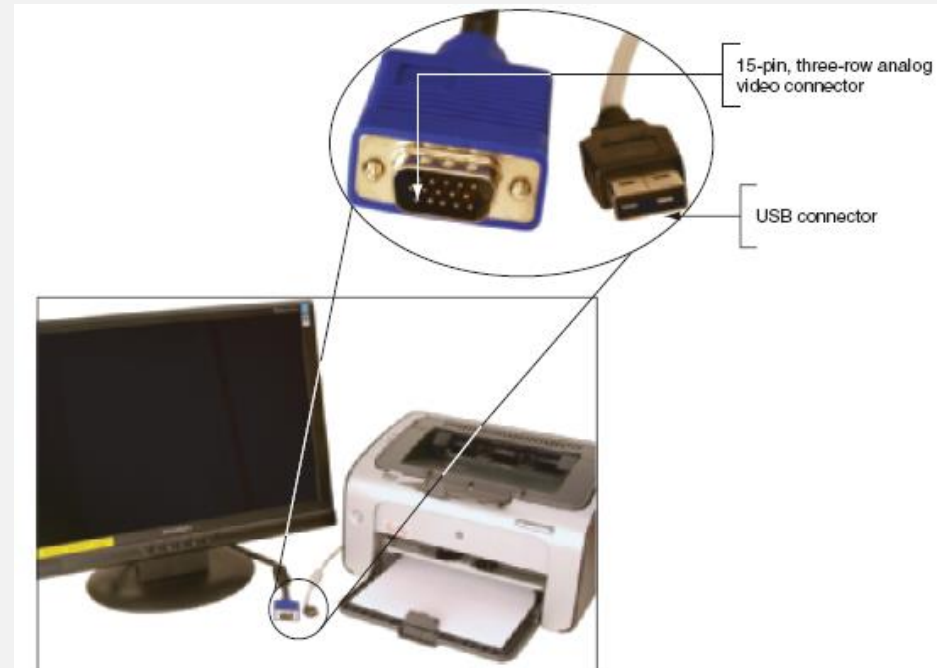


Figure 1-6 The two most popular output devices are the monitor and the printer. Courtesy: Course Technology/Cengage Learning

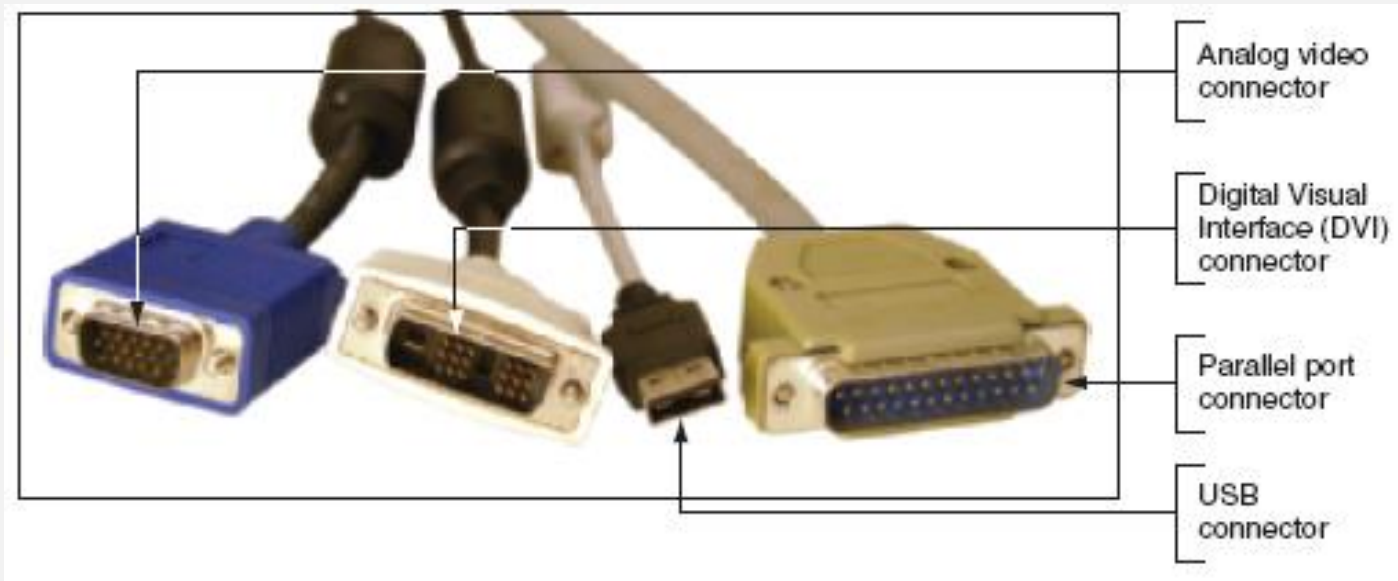
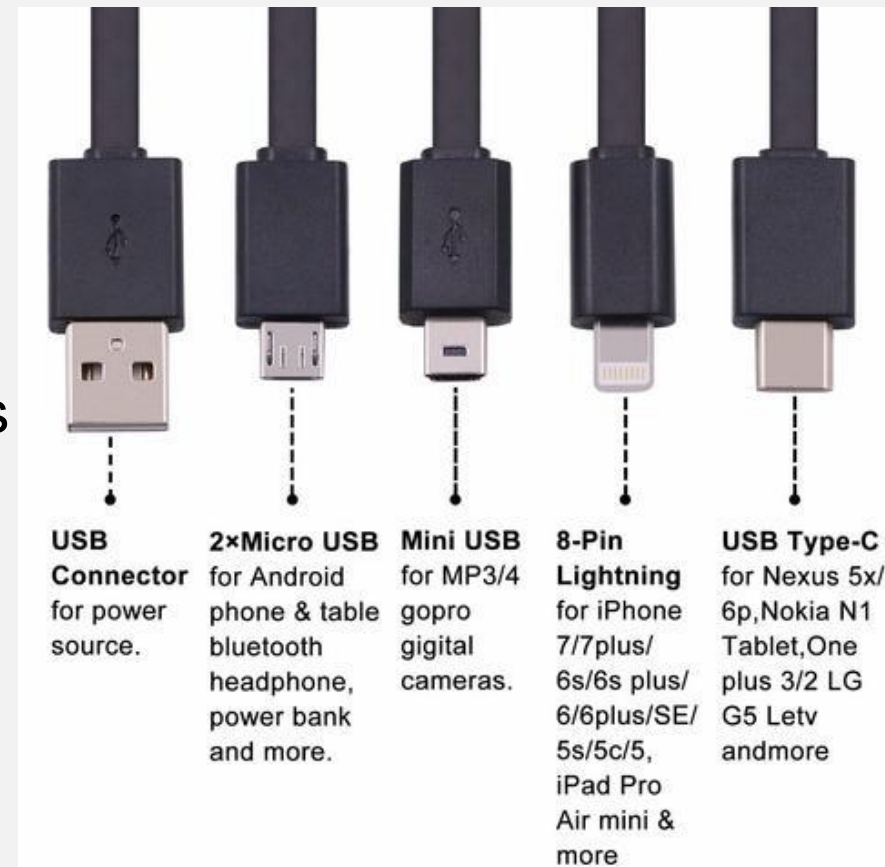


Figure 1-7 Two video connectors and two connectors used by a printer.
Courtesy: Course Technology/Cengage Learning

High-Speed and Data Transfer Ports

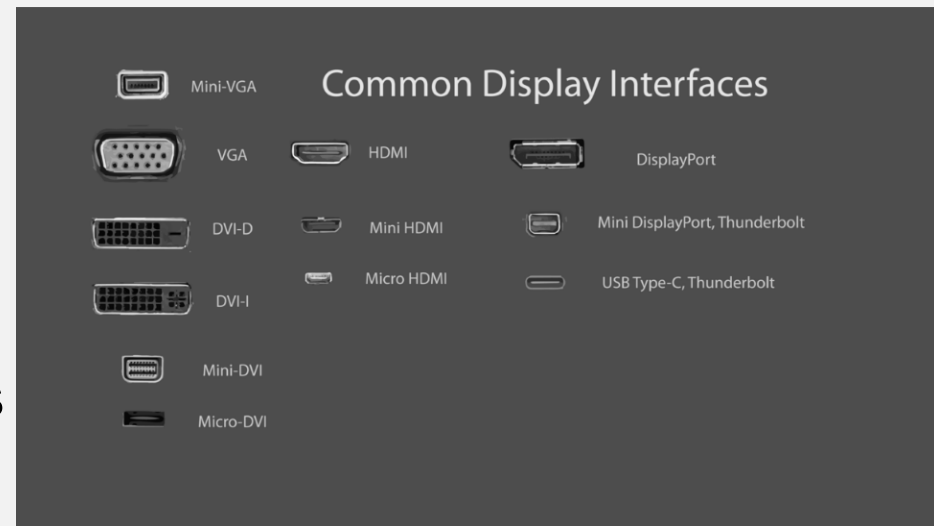
- Universal serial bus (USB)
- USB 2.0
 - Transfer speed: 480 Mbps
- New USB 3.1/3.2 standard port
 - Transfer speed of 10 or 20 Gbps
 - Charges devices faster than previous USB ports
- FireWire 800
 - Transfer speed up to 800 Mbps
- Thunderbolt
 - Transfer rate of 20 or 40 Gbps



<https://www.memorysuppliers.com/blogs/memory-suppliers-blog/guide-to-the-differences-between-mini-usb-micro-usb-and-usb-c>

Video ports

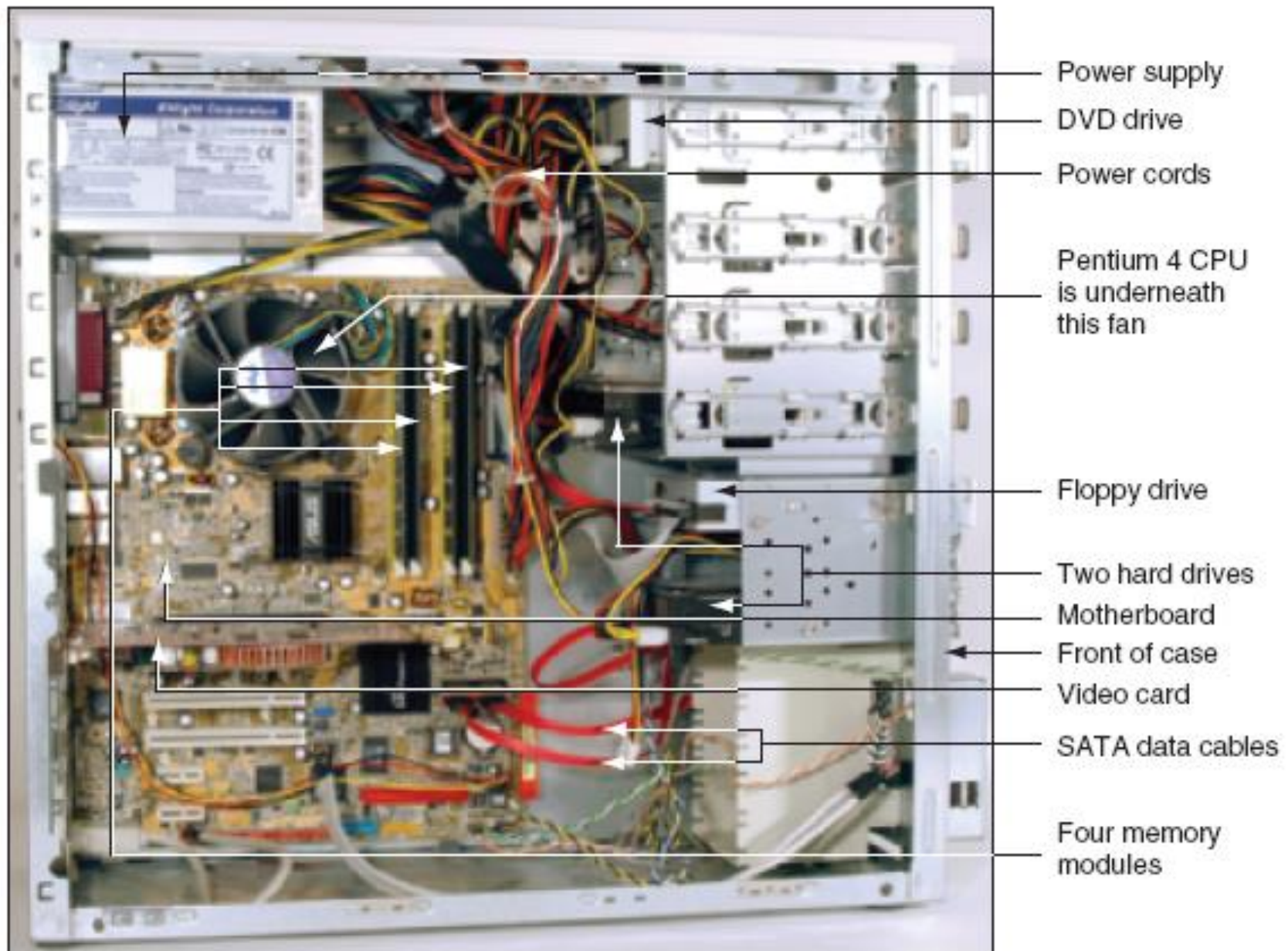
- Video ports
 - Connect monitors and multimedia devices
 - VGA - analog (Video Graphics Array)
 - DVI - digital visual interface
 - HDMI - high-definition multimedia interface. Allows both HD video and digital audio to be carried on one cable
 - DisplayPort



<https://www.weston-tech.com/blog/tech-tip-add-more-monitors-to-increase-desktop-real-estate-and-productivity/>

Hardware Inside the Computer Case

- Storage and processing occurs in the case
- Internal devices common to most computers
 - Motherboard holding CPU, memory, other parts
 - Hard drive, optical drive for permanent storage
 - Power supply with power cords supplying electricity
 - Adapter cards for internal and external communication
 - Cables to connect devices
- Adapter card installed in expansion slots
- Cable types
 - Data (communication) and power



The Motherboard

- Largest, most important circuit board
 - Main board or system board
 - Contains/holds the CPU, expansion slots, other devices
- Motherboard component categories
 - Processing, temporary storage, communication, power
- All devices communicate with CPU installed on the motherboard
- Peripheral device links to motherboard via cable
- Motherboard ports may be outside of the case
 - Keyboard, mouse, parallel, USB ports, sound ports

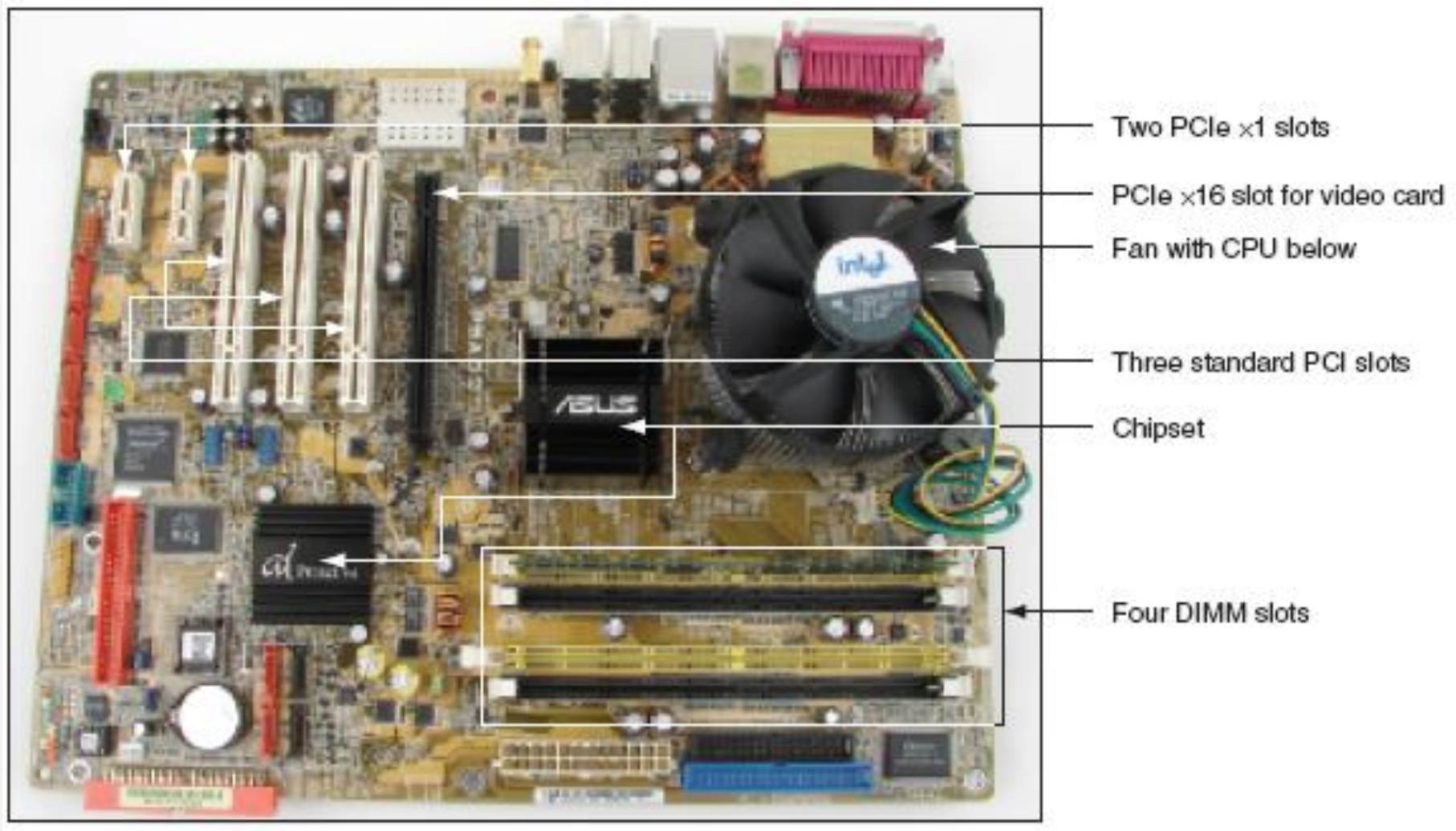


Figure 1-9 All hardware components are either located on the motherboard or directly or indirectly connected to it because they must all communicate with the CPU.

Courtesy: Course Technology/Cengage Learning

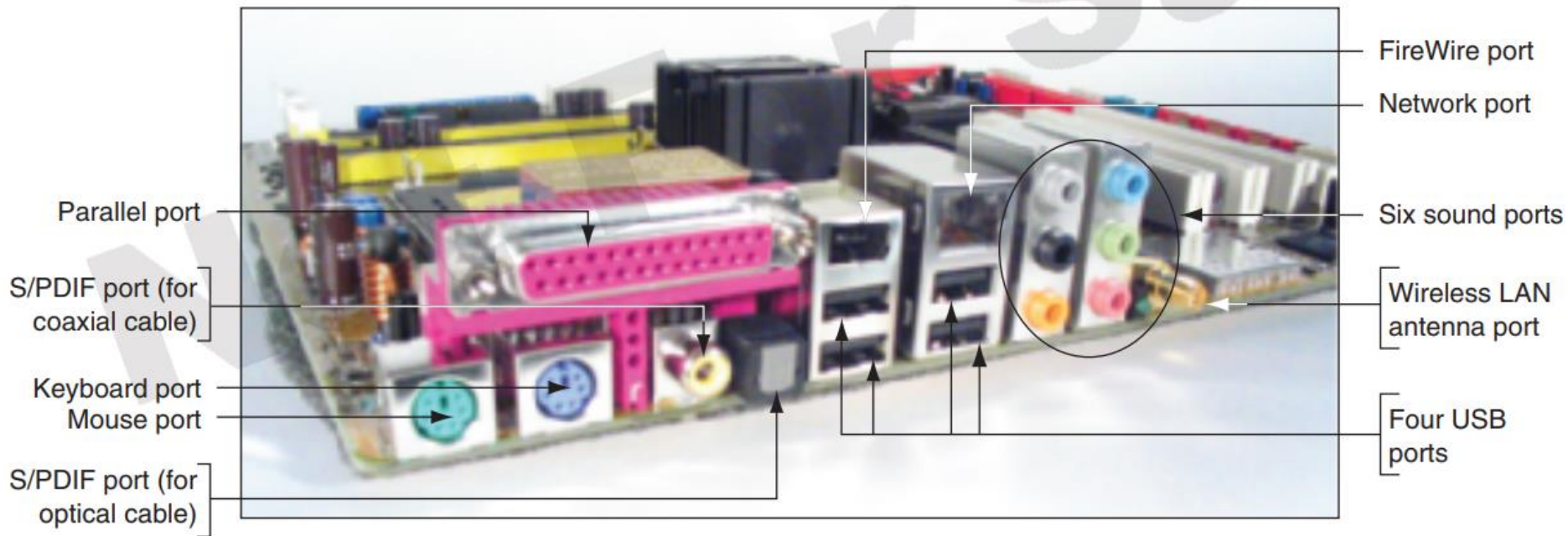


Figure 1-10 A motherboard provides ports for common I/O devices.
Courtesy: Course Technology/Cengage Learning

The Processor and the Chipset

- CPU
 - Chip inside the computer
 - Performs most data processing
- Chipset
 - Group of microchips on the motherboard controlling the flow of data and instructions to and from the processor
- Major CPU and chipsets companies
 - Intel, AMD, Qualcomm, Apple, Huawei, Samsung, TSM, etc.

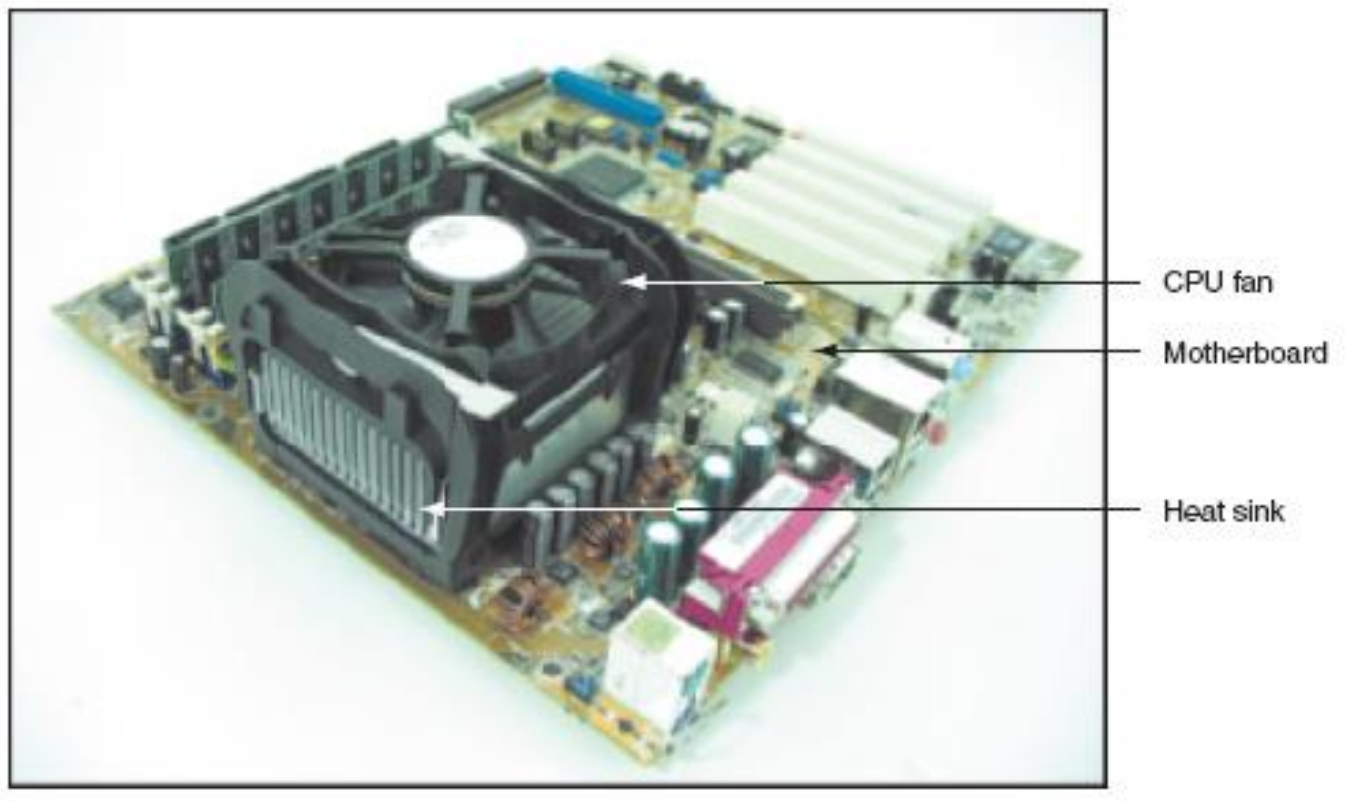


Figure 1-11 The processor is hidden underneath the fan and the heat sink, which keep it cool.

Courtesy: Course Technology/Cengage Learning

Storage Devices

- Primary storage (main memory)
 - Temporary (volatile) storage used by the processor
- Secondary storage (permanent storage/non-volatile)
 - Enables data to persist after machine turned off
 - Examples: hard drive, CD, DVD, USB drive

Primary Storage

- Provided by random access memory (RAM)
 - Located on motherboard, adapter cards
- RAM chips
 - Embedded on small board
 - Plugs into motherboard
 - Most common: dual inline memory module (DIMM)
 - Video memory: embedded on video card
- Volatile memory



Figure 1-13 A DIMM holds RAM and is mounted directly on a motherboard.

Courtesy: Course Technology/Cengage Learning

Secondary Storage

- Remote storage locations containing data and instructions
 - Cannot be directly processed by CPU
 - Permanent (nonvolatile)
- Hard drives
 - Main secondary computer storage device
 - Magnetic hard drives
 - Solid state drive (SSD)
 - Use non-volatile flash memory
 - Faster and more expensive



Figure 1-15 Hard drive with sealed cover removed.
Courtesy: Seagate Technologies LLC



Figure 1-16 Four SSD drives.
Courtesy: Course Technology/Cengage Learning

Secondary Storage (cont'd.)

- Hard drives (cont'd.)
 - ATA (Advanced Technology Attachment) standard
 - Specifies motherboard-hard drive interface
 - Types: serial ATA (SATA), parallel ATA (PATA)
 - Parallel ATA (PATA)
 - Two connectors on a motherboard for two data cables
 - Accommodates up to four IDE devices
 - Serial ATA (SATA) standard
 - Faster than PATA
 - External SATA (eSATA)
 - Usually two to eight SATA and eSATA connectors

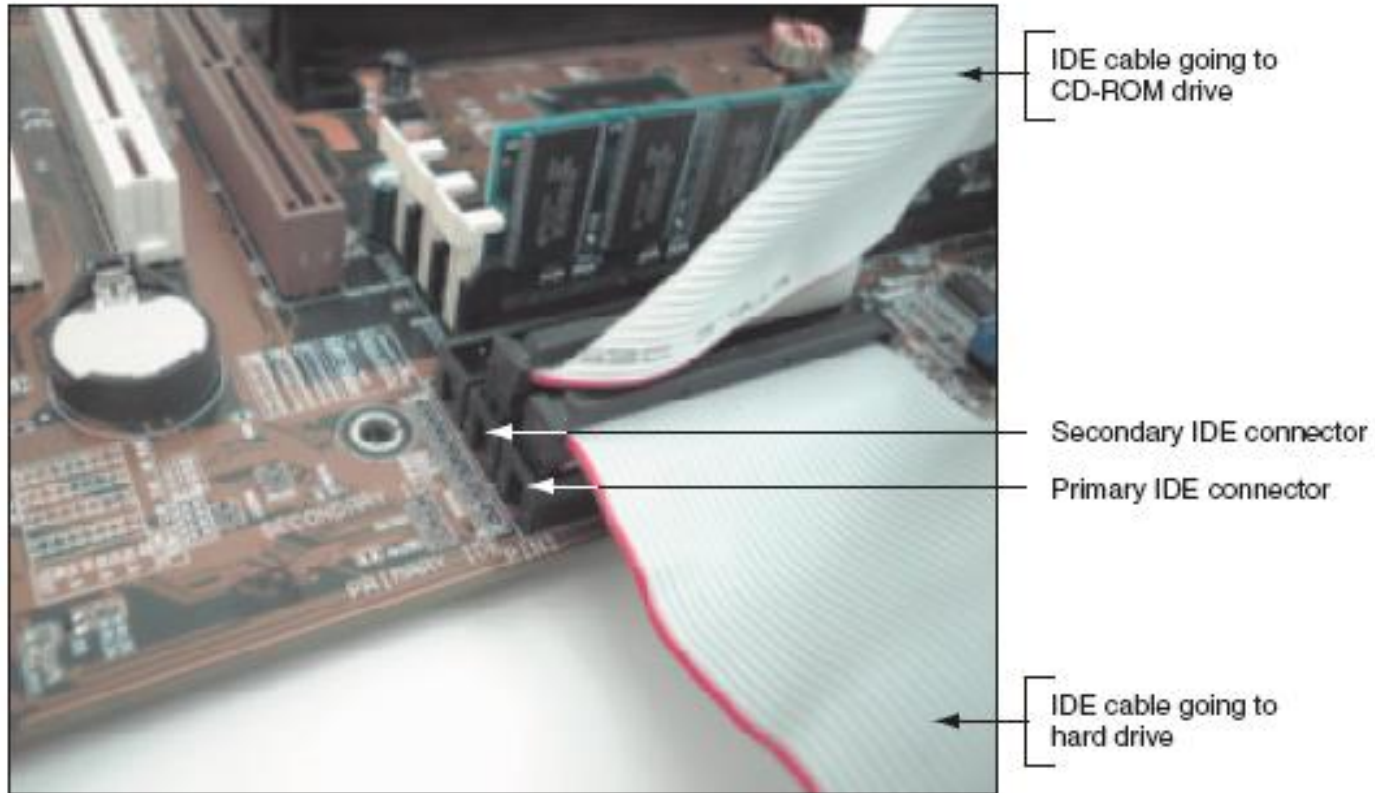


Figure 1-18 Using a parallel ATA interface, a motherboard has two IDE connectors, each of which can accommodate two devices; a hard drive usually connects to the motherboard using the primary IDE connector.
Courtesy: Course Technology/Cengage Learning

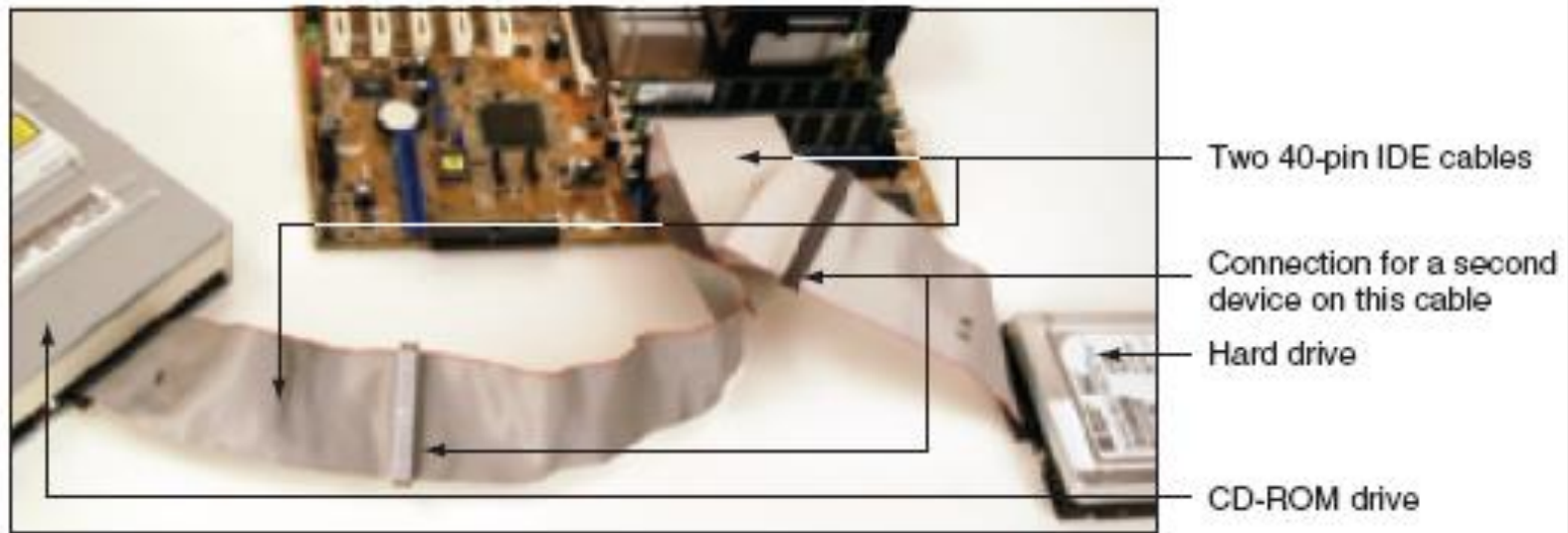


Figure 1-19 Two IDE devices connected to a motherboard using both IDE connections and two cables.

Courtesy: Course Technology/Cengage Learning



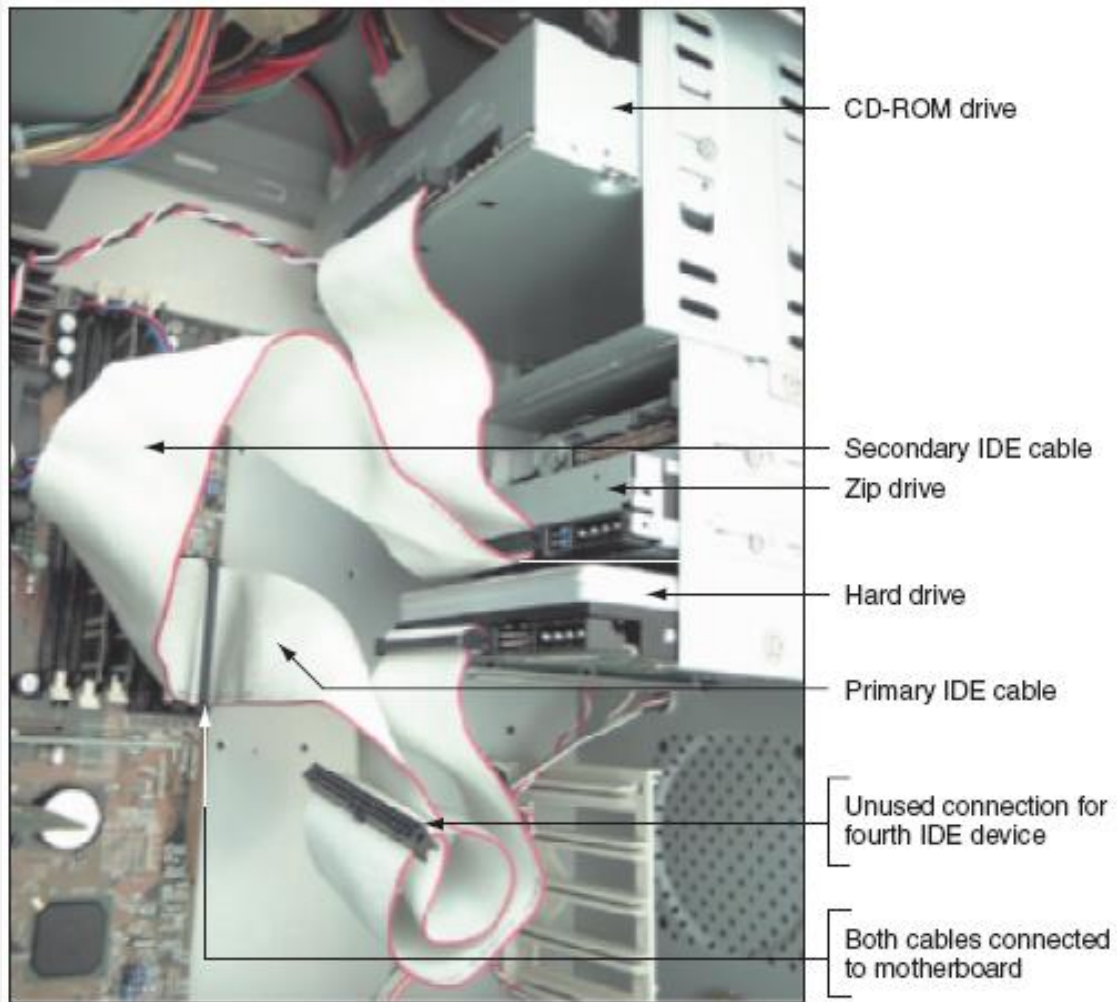


Figure 1-20 This system has a CD-ROM and a Zip drive sharing the secondary IDE cable and a hard drive using the primary IDE cable. Courtesy: Course Technology/Cengage Learning

Secondary Storage (cont'd.)

- Optical drives
 - RW can write to a disk
 - ROM (read-only memory) can only read a disc

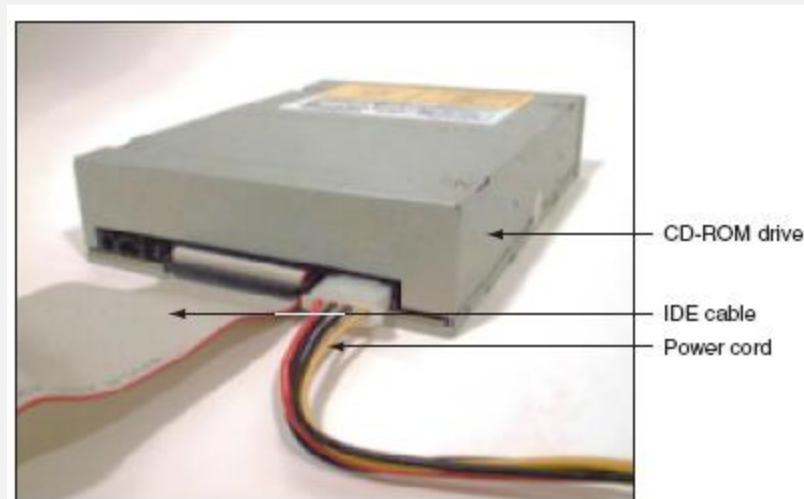


Figure 1-22 This CD drive is an EIDE (PATA) device and connects to the motherboard by way of an IDE data cable.

Courtesy: Course Technology/Cengage Learning

Secondary Storage (cont'd.)

- USB flash drives and memory cards
 - Popular, nonvolatile flash memory chips
 - Compact; easy to use; currently hold up to 64 GB of data

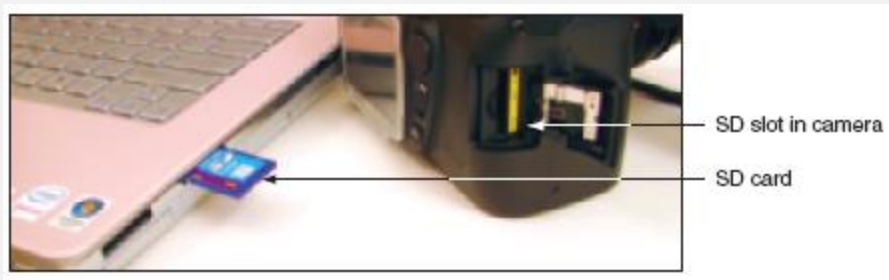


Figure 1-24 Most laptops have a memory card slot that can accommodate an SD card.

Courtesy: Course Technology/Cengage Learning



RAM vs. ROM

RAM

Random access memory

- Stores instructions and data
- Temporary (volatile) storage
- 1GB to 16 GB (can be larger for servers)
- To save data more permanently, save it to the hard drive or another permanent storage device

ROM

Read-only memory

- Stores startup instructions (BIOS)
- Permanent (nonvolatile) storage

Cache memory

- A type of RAM with higher access speed
- 512 KB to 8 MB
- Part of CPU

Motherboard Components Used For Communication Among Devices

- Traces
 - Fine lines on top and bottom of the motherboard's surface
- Bus
 - System of pathways used for communication, and the protocol and methods used for transmission
 - A protocol is a set of rules and standards that any two entities use for communication
- Data bus
 - Carries the data



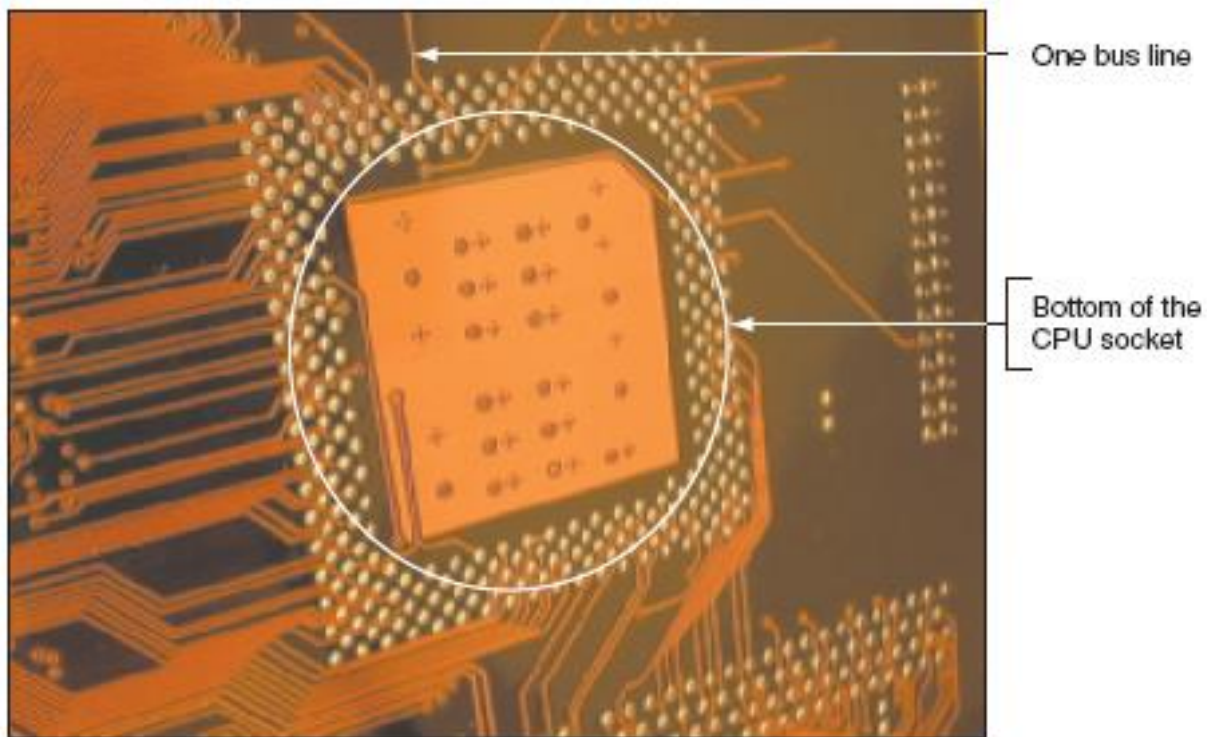


Figure 1-27 On the bottom of the motherboard, you can see bus lines terminating at the CPU socket.
Courtesy: Course Technology/Cengage Learning

Motherboard Components Used For Communication Among Devices (cont'd.)

- Binary data corresponds to voltage on the line
- Data bus sizes today
 - 16, 32, 64, 128, 256 bits wide
 - Some use error checking bit

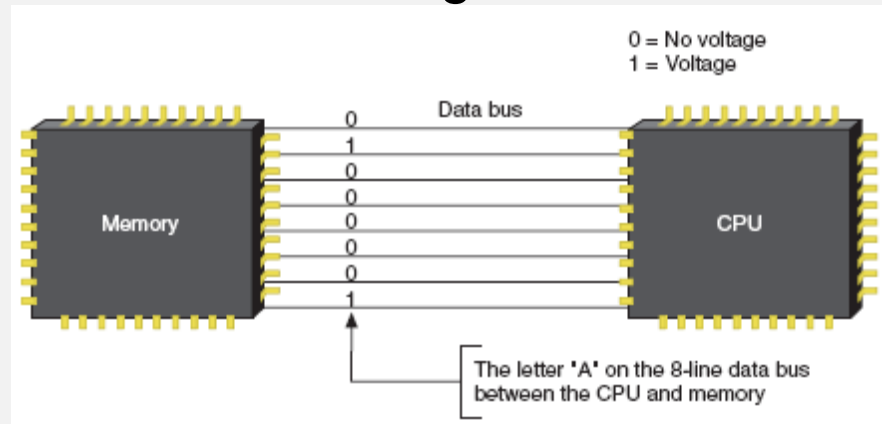


Figure 1-28 A data bus has traces or lines that carry voltage interpreted by the CPU and other devices as bits.

Courtesy: Course Technology/Cengage Learning

Motherboard Components Used For Communication Among Devices (cont'd.)

- Data path size
 - Width of a data bus
- Motherboard can have more than one bus
 - Main motherboard bus
 - Communicates with CPU, memory, chipset
 - Also called system bus, front side bus (FSB), memory bus, host bus, local bus, or external bus
- Buses for expansion slots:
 - PCI (Peripheral Component Interconnect)
 - AGP (Accelerated Graphics Port)

Find more buses at <https://www.techrepublic.com/article/understanding-your-motherboards-bus-system/>

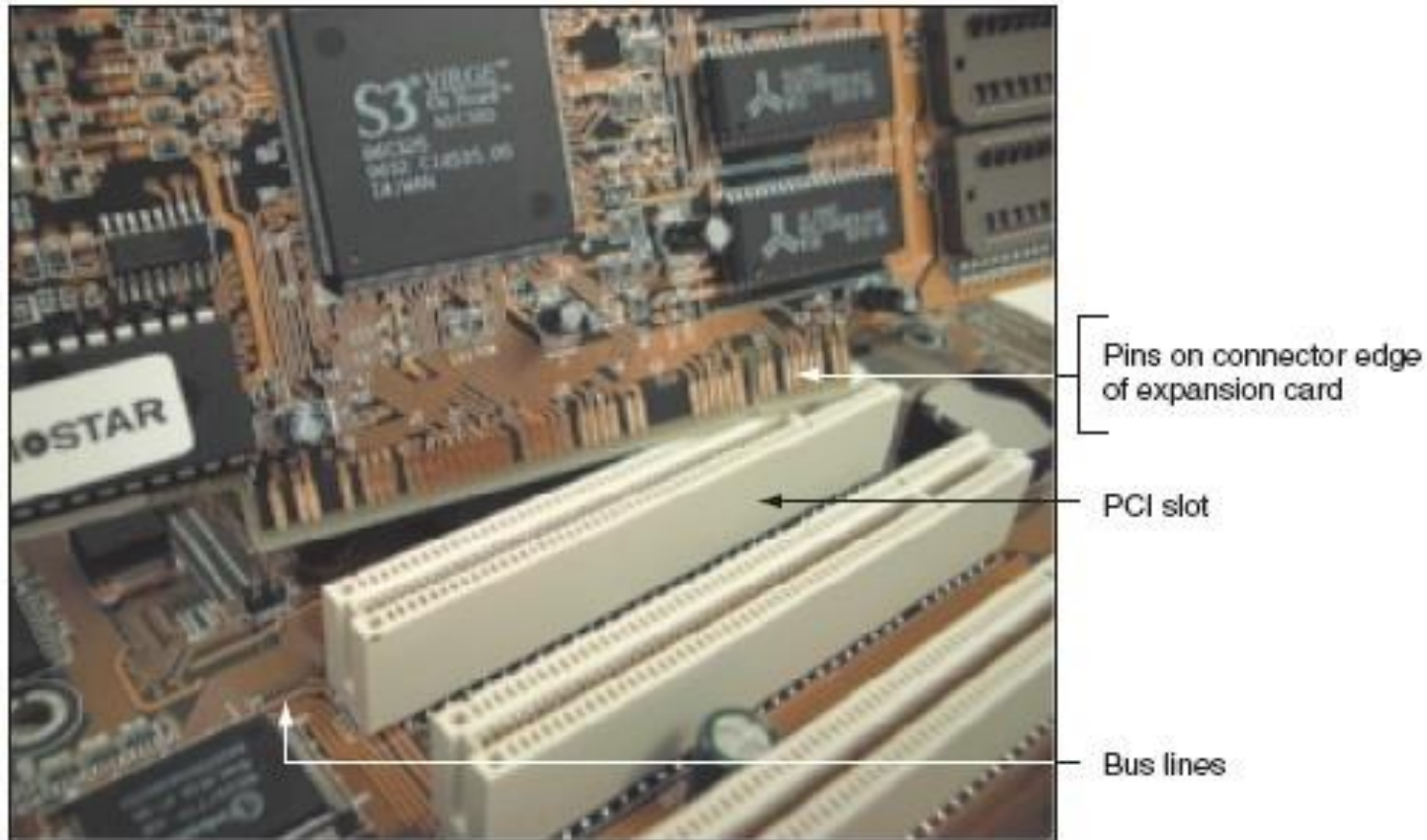


Figure 1-30 The lines of a bus terminate at an expansion slot where they connect to pins that connect to lines on the expansion card inserted in the slot.
Courtesy: Course Technology/Cengage Learning

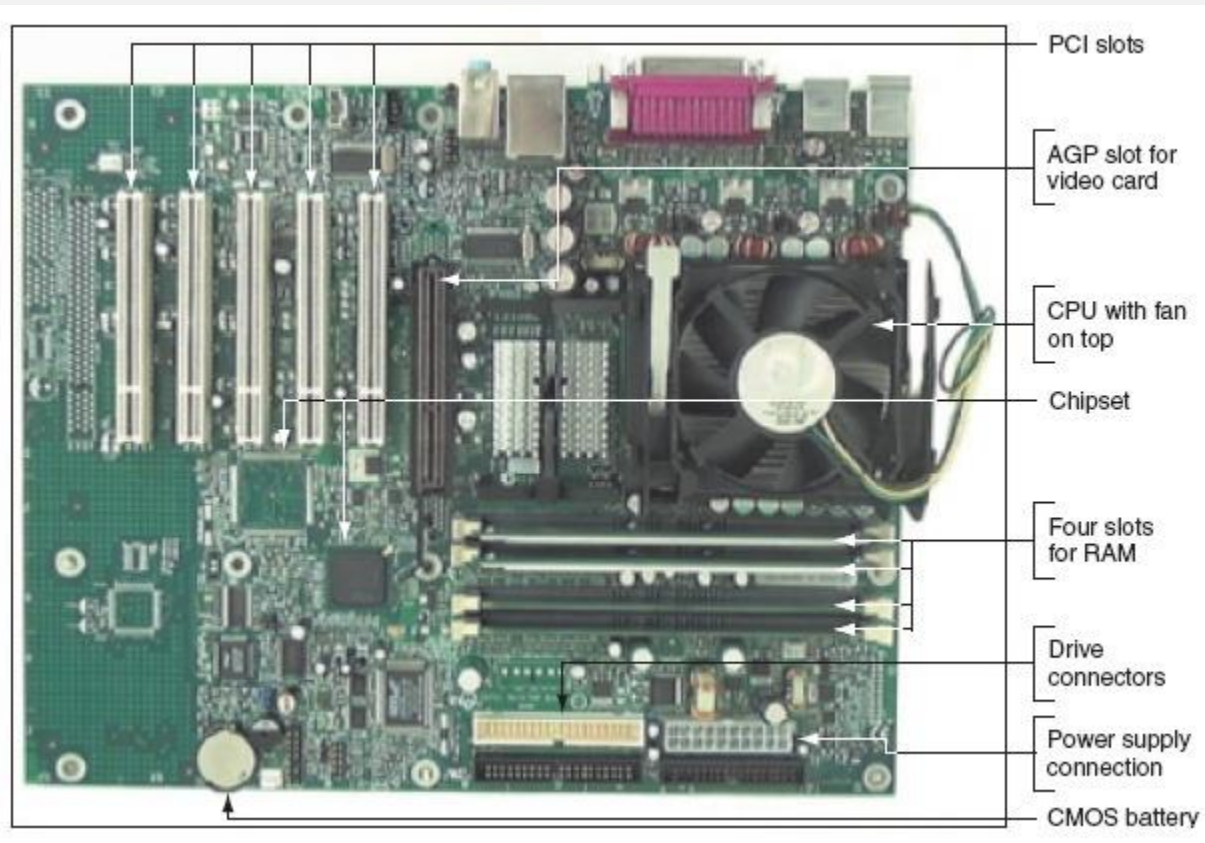


Figure 1-31 The one AGP slot used for a video card is set farther from the edge of the board than the PCI slots. Now replaced by PCI Express, officially abbreviated as PCIe or PCI-e.

Courtesy: Course Technology/Cengage Learning

PCI Express Example Connectors

x1

BANDWIDTH

Single direction: 2.5 Gbps/200 MBps
Dual Directions: 5 Gbps/400 MBps



x4

BANDWIDTH

Single direction: 10 Gbps/800 MBps
Dual Directions: 20 Gbps/1.6 GBps



x8

BANDWIDTH Single direction: 20 Gbps/1.6 GBps
Dual Directions: 40 Gbps/3.2 GBps



x16

BANDWIDTH Single direction: 40 Gbps/3.2 GBps
Dual Directions: 80 Gbps/6.4 GBps



Source: IBM

©2005 HowStuffWorks

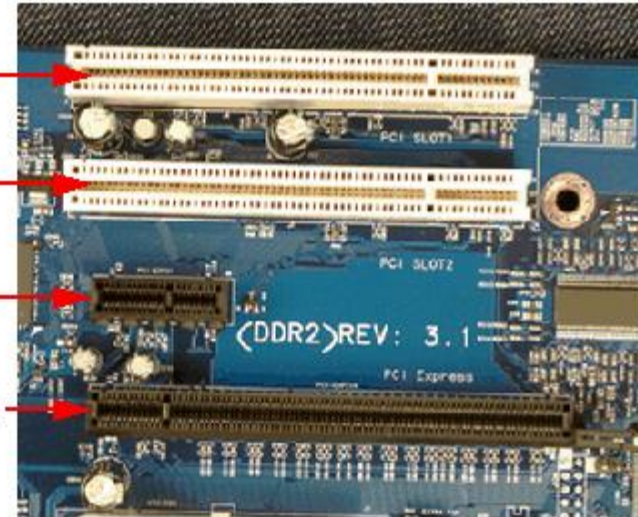
Slots:

PCI 2.0 32-bit

PCI 2.0 32-bit

PCI Express x1

PCI Express x16



<https://lenovopress.com/tips0456>

<https://www.brianjgraf.com/2013/06/06/nic-speeds/>

Motherboard Components Used For Communication Among Devices (cont'd.)

- System clock or system timer
 - Dedicated to timing motherboard chip activities
 - Quartz crystal generates oscillation
- Devices work according to beats (or cycles)
- Clock speed measured in hertz (cycles/second)
 - One megahertz (MHz): one million cycles per second
 - One gigahertz (GHz): one billion cycles per second
- Range of CPU speeds: 166 MHz to 4+ GHz
- FSB speeds can range from 66 MHz to over 800 MHz

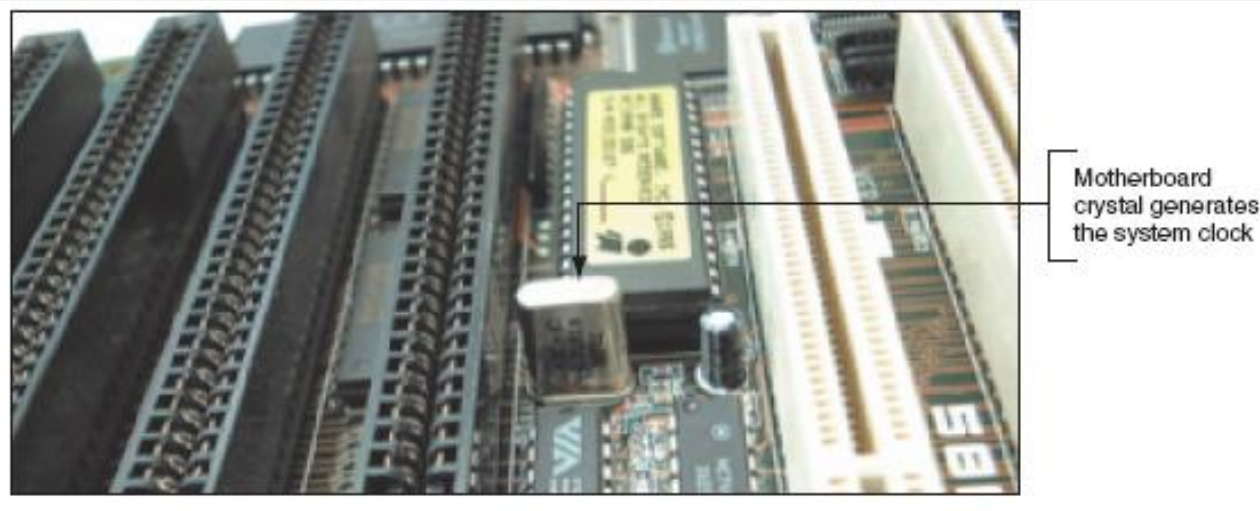


Figure 1-29 The system clock is a pulsating electrical signal sent out by this component that works much like a crystal in a wristwatch (one line, or circuit, on the motherboard bus is dedicated to carrying this pulse).

Courtesy: Course Technology/Cengage Learning

Expansion Cards

- Some names for circuits mounted in expansion slots
 - Circuit cards, adapter boards, expansion cards, cards
- Cards that connect the CPU to an external device
 - Video: provides a port for the monitor
 - Sound: provides ports for speakers and microphones
 - Network: provides a port for a network cable
 - Modem: provides ports for phone lines
- Determine a card's function by identifying its port

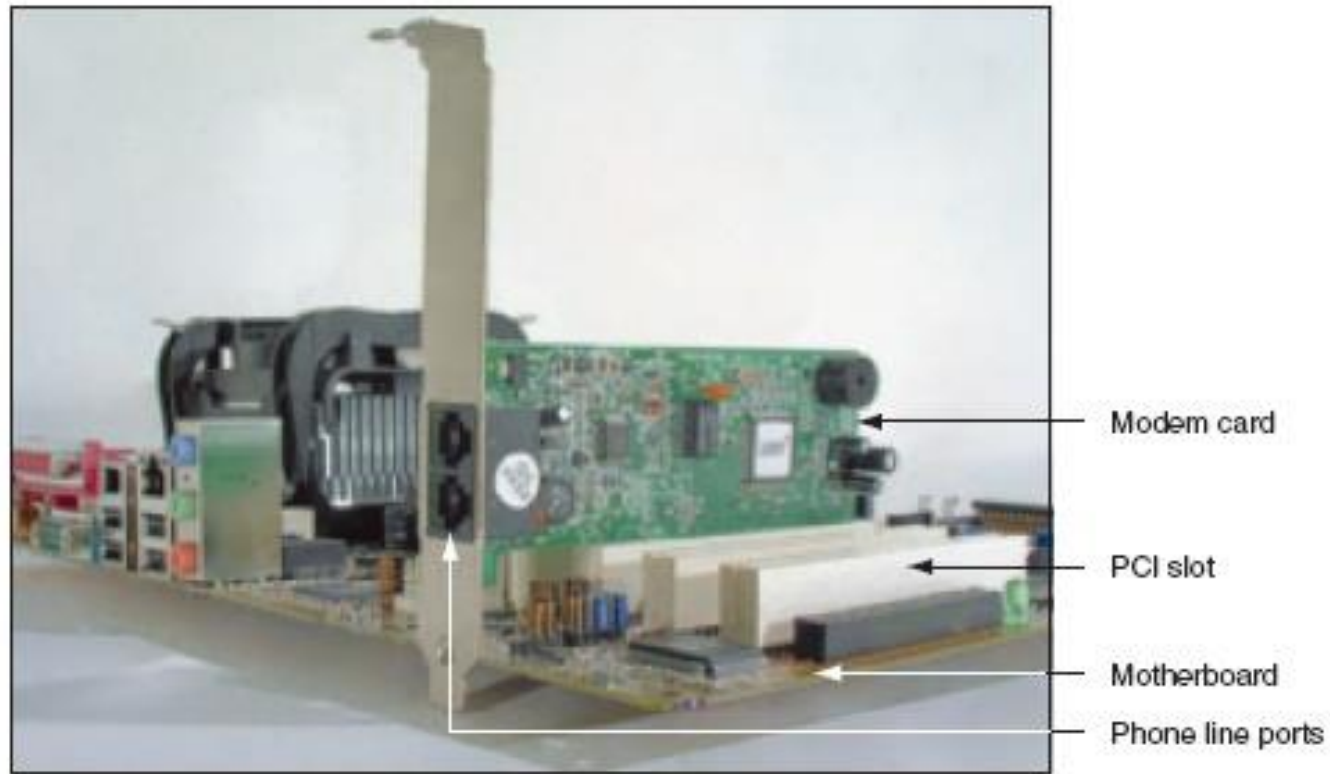


Figure 1-32 This adapter card is a modem card and is mounted in a PCI slot on the motherboard.
Courtesy: Course Technology/Cengage Learning

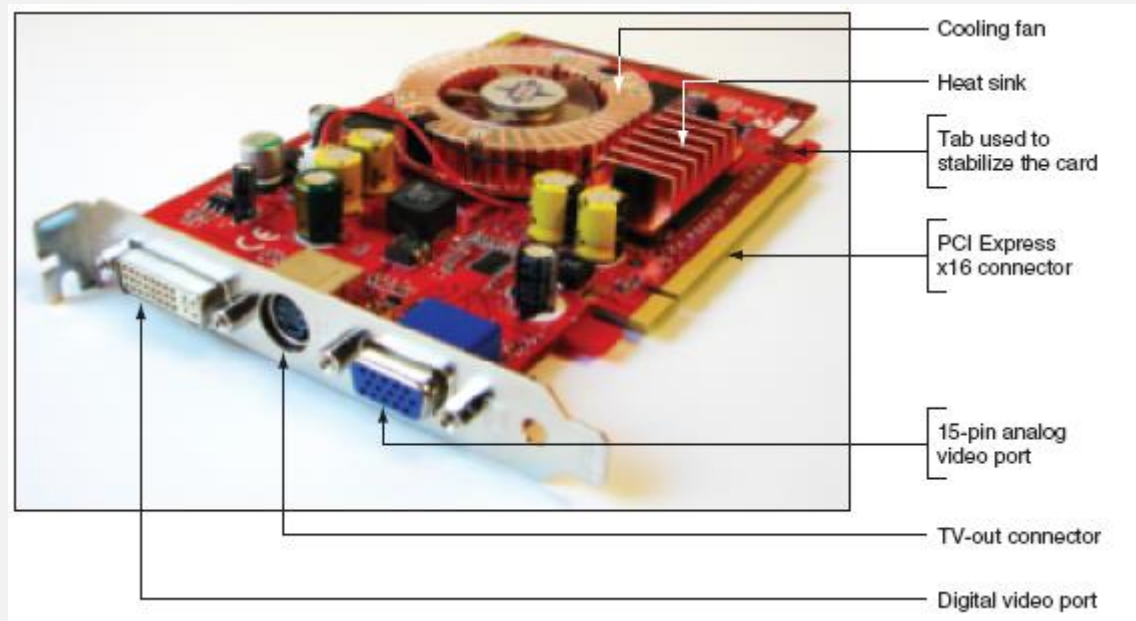
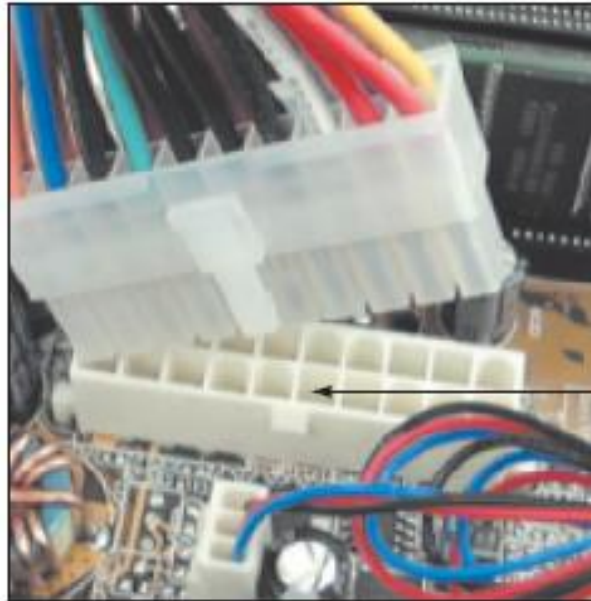


Figure 1-34 The easiest way to identify this video card is to look at the ports on the end of the card.
Courtesy: Course Technology/Cengage Learning

The Electrical System

- Power supply
 - Most important electrical component
 - Converts AC voltage external source to DC voltage
 - Reduces voltage from 110-120 volts to 12 volts or less
 - Runs a fan to cool the inside of the computer case
- Temperatures $> 185^{\circ}\text{ F}$ (85° C) can cause component failure
- Motherboard has 1 or 2 connections to power supply



P1 power connector
on a motherboard

Figure 1-36 The motherboard receives its power from the power supply by way of a 20 or 24-pin connector called the P1 connector
Courtesy: Course Technology/Cengage Learning

Instructions Stored on the Motherboard and Other Boards

- BIOS (basic input/output system)
 - Data and instructions stored on ROM chips
 - ROM BIOS chips: type of firmware, software embedded into hardware
 - The first program that runs every time you turn on your computer
- Three purposes served by motherboard ROM BIOS
 - System BIOS: manages simple devices
 - Startup BIOS: starts the computer
 - BIOS/CMOS setup: changes motherboard settings
- CMOS RAM: includes date, time, port configurations (volatile)
- Flash ROM
 - ROM chips that can be overwritten

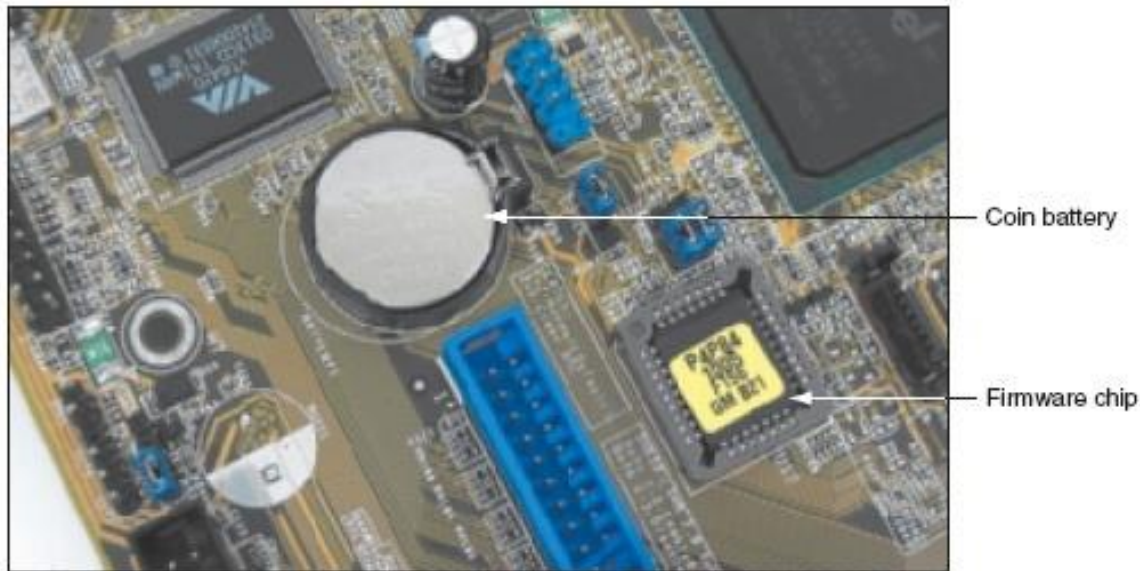


Figure 1-37 This firmware chip contains flash ROM and CMOS RAM; CMOS RAM is powered by the coin battery located near the chip.
Courtesy: Course Technology/Cengage Learning

Summary

- A computer comprises hardware and software
- Main functions
 - Input, output, processing, storage
- Data stored in a binary format (one or zero, on or off)
- Input/output devices
 - Keyboard, mouse, printer, monitor
- Motherboard (system board)

Summary (cont'd.)

- Primary storage (RAM): volatile
- Secondary storage: nonvolatile
- Parallel and serial ATA standards
 - Enable secondary storage devices to interface with the motherboard
- Computer bus
 - System of communication pathways, protocols
- ROM BIOS
 - Helps start PCs; manages simple devices; changes some motherboard settings
- <https://www.youtube.com/watch?v=ExxFxD4OSZ0>