



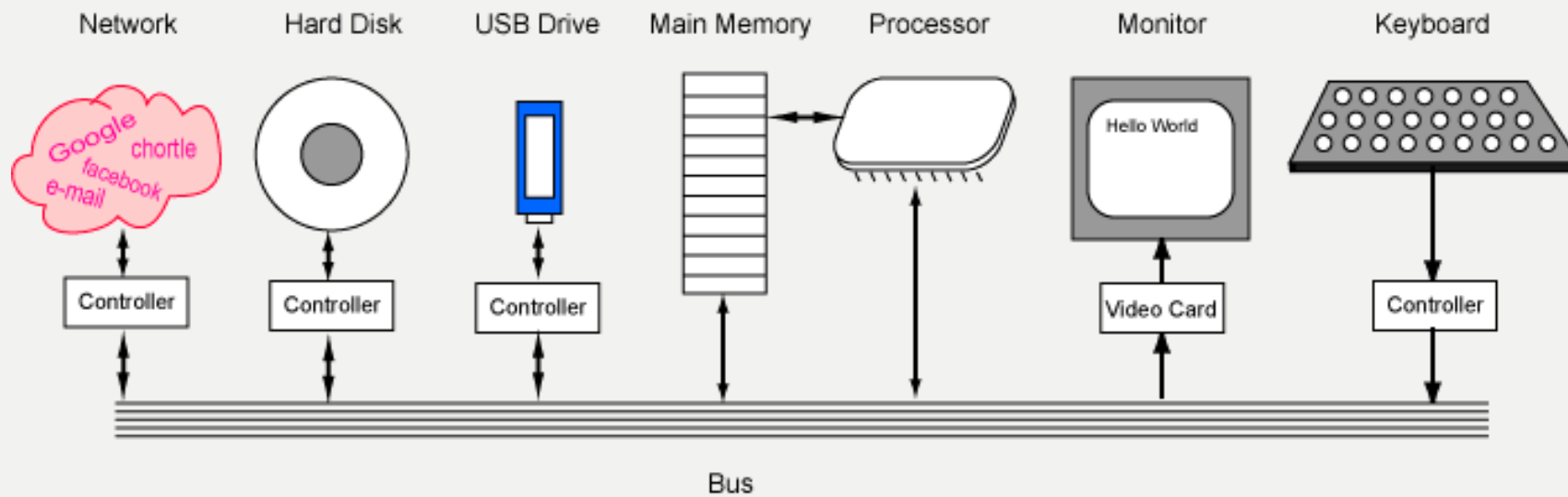
# Hardware & Software



# Hardware components

- Processor
- Main memory
- Secondary memory
- Input devices
- Output devices

# Hardware components



Main Components of a Computer System

# Memory

- The processor performs all the fundamental computation of the computer system. Other components contribute to the computation by doing such things as **storing data or moving data into and out** of the processor.
- A processor chip has **relatively little memory**. It has only enough memory to hold a few instructions of a program and the data they process.
- Complete programs and data sets are held in memory external to the processor. This memory is of two fundamental types: main memory, and secondary memory.
- Main memory is sometimes called **volatile** because it loses its information when power is removed.
- Secondary memory is usually **non-volatile** because it retains its information when power is removed.

# Memory

- **Main memory:**
  - closely connected to the processor.
  - stored data are quickly and easily changed.
  - holds the programs and data that the processor is actively working with.
  - interacts with the processor millions of times per second.
  - needs constant electric power to keep its information.
- **Secondary memory:**
  - connected to main memory through the bus and a controller.
  - stored data are easily changed, but changes are slow compared to main memory.
  - used for long-term storage of programs and data.
  - before data and programs can be used, they must be copied from secondary memory into main memory.
  - does not need electric power to keep its information.

# Main Memory

- Main memory is where programs and data are kept when the processor is actively using them. When programs and data become active, they are copied from secondary memory into main memory where the processor can interact with them. A copy remains in secondary memory.
- Main memory is intimately connected to the processor, so moving instructions and data into and out of the processor is very fast.
- Main memory is sometimes called **RAM**. RAM stands for **Random Access Memory**. "Random" means that the memory cells can be accessed in any order. However, properly speaking, "RAM" means the type of silicon chip used to implement main memory.
- Nothing permanent is kept in main memory. Sometimes data are placed in main memory for just a few seconds, only as long as they are needed by the processor

# Secondary Memory

- Secondary memory is where programs and data are kept on a long-term basis.
  - The hard disk has enormous storage capacity compared to main memory.
  - The hard disk is used for long-term storage of programs and data.
  - Data and programs on the hard disk are organized into files.
  - A **file** is a collection of data on the disk that has a name.
- Large blocks of data are copied from disk into main memory. This operation is slow, but lots of data is copied. Then, while a program is running, the processor can quickly read and write small sections of that data in main memory. When it is done, a large block of data is written back to disk.
- Often, while the processor is computing with one block of data in main memory, the next block of data from disk is read into another section of main memory and made ready for the processor. One of the jobs of an operating system is to manage main storage and disks this way.





# Input and Output Devices

- Input and output devices allow the computer system to interact with the outside world by moving data *into* and *out of* the system. An *input device* is used to bring data into the system. Some input devices are:

Keyboard, Mouse, Microphone, Barcode reader, Graphics tablet

- An *output device* is used to send data out of the system. Some output devices are:

Monitor, Printer, Speaker

- A network interface acts as both input and output. Data flows from the network into the computer, and out of the computer into the network.

# I/O

- Input/output devices are usually called **I/O** devices. They are directly connected to an electronic module attached to the motherboard called a **device controller**. For example, the speakers of a multimedia computer system are directly connected to a device controller called an audio card, which in turn is plugged into a bus on the motherboard.
- With many recent computers, the functions of a device controller are integrated with the motherboard. Some motherboards have audio, graphics, and network controllers built in.
- Often secondary memory devices like the hard disk are called I/O devices (because they move data in and out of main memory). What counts as an I/O device depends on context. To a user, an I/O device is something outside of the computer case. To a programmer, anything outside of the processor and main memory is an I/O device. To an engineer working on the design of a processor everything outside of the processor is an I/O device.

# Software

- Computer software consists of both *programs* and *data*. Programs consist of instructions for the processor. Data can be any information that a program needs: character data, numerical data, image data, audio data, and countless other types. The distinction between programs and data is not as clear-cut as you might think, however.
- **Fundamental Idea:** Both programs and data are saved in computer memory in the same way. The electronics of computer memory (both main memory and secondary memory) make no distinction between programs and data.
- The insight that both programs and data can be saved using the same electronic methods is an important concept in computer science. Computer systems use memory for either programs or data, as needed.

# Operating Systems

- An operating system is a complex program that keeps the hardware and software components of a computer system coordinated and functioning. It is like the owner of a small shop, who keeps everything in order by attending to customers, accepting deliveries, stocking the shelves, doing the bookkeeping, and so on. The shopkeeper must promptly attend to tasks as they arise. Without the shopkeeper the shop could not function.
- Most computer systems can potentially run any of several operating systems. For example, most Intel-based computers can run either Linux or a Windows operating systems. Usually only one operating system is installed on a computer system, although some computers have several. In any case, only one operating system at a time can be in control of the computer system. The computer user makes a choice when the computer is turned on, and that operating system remains in control until the computer is turned off.

# Starting a Program

- The user asks to run an application. This is done by clicking on an icon, making a menu choice, or by other means.
- The OS determines the name of the application.
- The OS finds the files on the hard disk where the application and its data are stored.
- The OS finds an unused section of main memory that is large enough for the application.
- The OS makes a copy of the application and its data in that section of main memory.
- The software on the hard disk is unchanged; main memory holds a copy of what is on disk.
- The OS sets up resources for the application.
- Finally, the OS starts the application running.
- As the application runs, the OS is there in the background managing resources, doing input and output for the application, and keeping everything else running.