Computer Architecture and Organization

I / O Units

Lecture 7

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INPUT / OUTPUT DEVICE

- The computer system's I/O architecture is its interface to the outside world.
- The third key element of a computer system is a set of I/O modules

INPUT / OUTPUT DEVICE

❖why one does not connect peripherals directly to the system bus . **The reasons are as follows:**

1- There are a wide variety of peripherals with various methods of operation.

2- The data transfer rate of peripherals is often much slower than that of the memory or processor.

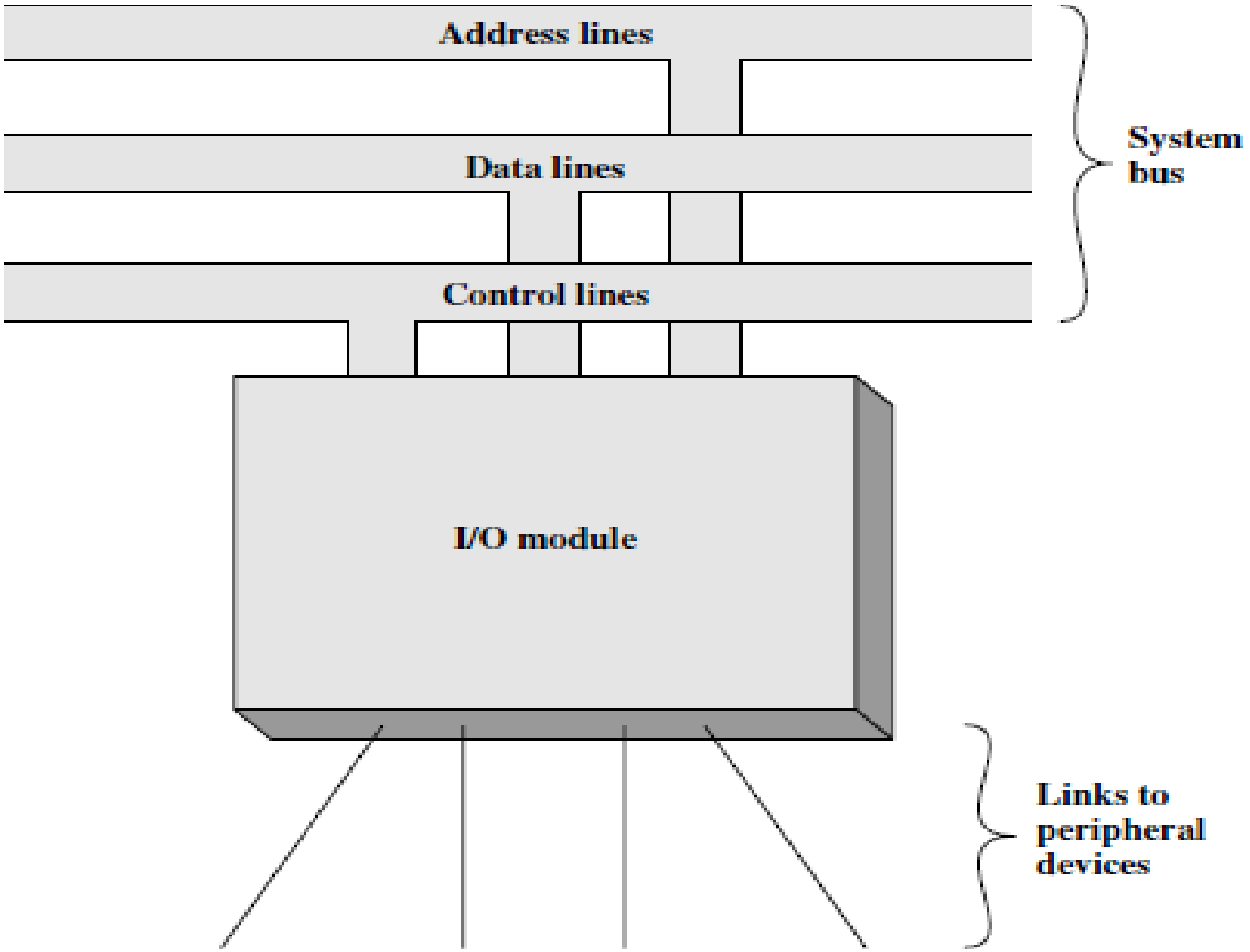
3- The data transfer rate of some peripherals is faster than that of the memory or processor.

4- Peripherals often use different data formats and word lengths than the computer to which they are attached.

INPUT / OUTPUT DEVICE

- Each module interfaces to the system bus or central switch and controls one or more peripheral devices.
- An **I/O** module is not simply a set of mechanical connectors that wire a device into the system bus.
- The **I/O** module contains logic for performing a communication function between the peripheral and the bus.

I/O Module


Address lines
Data lines
Control lines
System bus
I/O module
Links to peripheral devices

I/O Module

❖This module has **two major** functions :

1- Interface to the processor and memory via the system bus or central switch .

2- Interface to one or more peripheral devices by **tailored data links** (is the means of connecting one location to another for the purpose of transmitting and receiving digital information .

EXTERNAL DEVICES

- External device attaches to the computer by a link to an **I/O module** .
- The link is used to exchange control, status, and data between the I/O module and the external device.
- When external device connected to an I/O module is often referred to as a peripheral device or, simply, a peripheral.

EXTERNAL DEVICES

❖**Classify External Devices into Three Categories:**

1- Human readable: used to communicate with:

- the computer user .
- video display terminals (VDTs) .
- printer.
- keyboard .
- mouse

EXTERNAL DEVICES

2- Machine readable : used to communicate with :

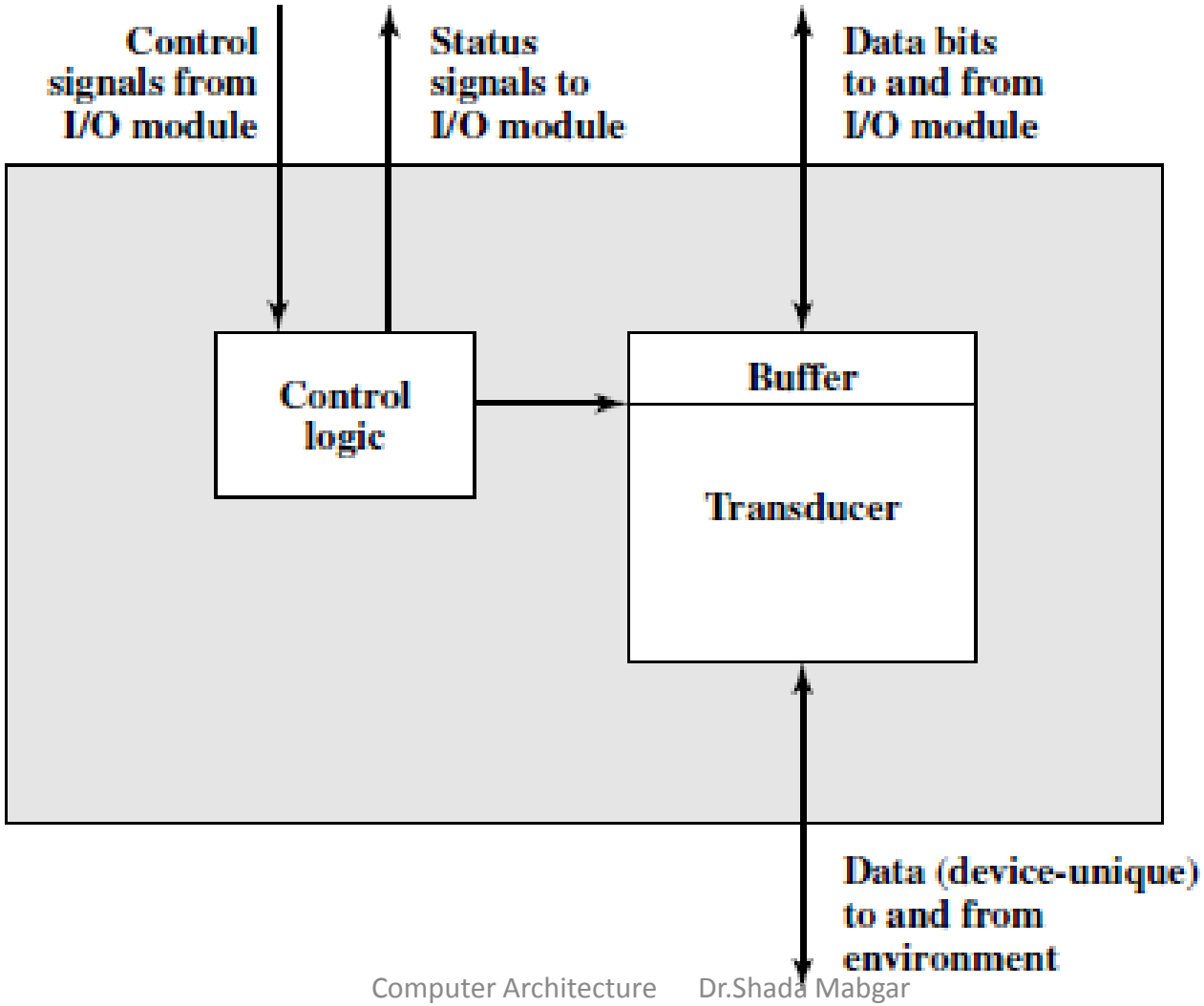
- electronic equipment
- magnetic disk and tape systems .

3- Communication :used to communicate with :

- remote device .
- modem .
- Network Interface Card .

EXTERNAL DEVICE

Block Diagram



EXTERNAL DEVICE
Block Diagram

- The interface to the I/O module is in the form of control, data, and status signals.
- Control signals determine the function that the device will perform- send data to the I/O module (INPUT or READ), accept data from the I/O module (OUTPUT or WRITE), report status, or perform some control function particular to the device (e.g., position a disk head).

EXTERNAL DEVICES
Block Diagram

- Data are in the form of a set of bits to be sent to or received from the I/O module.
- Status signals indicate the state of the device.

- Examples are READY/NOT-READY to show whether the device is ready for data transfer .

- Control logic associated with the device controls the device's operation in response to direction from the I/O module
- The transducer converts data from electrical to other forms of energy during output and from other forms to electrical during input.
- A buffer is associated with the transducer to temporarily hold data being transferred between the I/O module and the external environment- a buffer size of 8 to 16 bits is common.

EXTERNAL DEVICES

- The most common means of computer/user interaction is a keyboard/monitor .
- The user provides input through the keyboard.
- This input is then transmitted to the computer and may also be displayed on the monitor.
- The monitor displays data provided by the computer.
- The basic unit of exchange is the character.
- with each character is a code, typically 7 or 8 bits in length.
- used text code is the **International Reference Alphabet** (**IRA**). **The U.S. national version of IRA is referred to as the American Standard Code for Information Interchange (ASCII).**

EXTERNAL DEVICES

- Each character in this code is represented by a unique 7-bit binary code; thus, 128 different characters can be represented.
- Characters are of two types: **printable and control.**
- **Printable characters** are the alphabetic , numeric, and special characters that can be printed on paper or displayed on a screen.
- **Control characters** have to do with controlling the printing or displaying of characters;

EXTERNAL DEVICES

- For **keyboard input**, when the user depresses a key, this generates an electronic signal that is interpreted by the transducer in the keyboard and translated into the bit pattern of the corresponding **IRA code**. This bit pattern is then transmitted to the I/O module in the computer. At the computer, the text can be stored in the same IRA code.

EXTERNAL DEVICES

- On output, **IRA** code characters are transmitted to an external device from the I/O module . The transducer at the device interprets this code and sends the required electronic signals to the output device either to display the indicated character or perform the requested control function.

I/O MODULES
Module Function

- The major requirements for an I/O module fall into the following categories:

- Control and timing
- CPU communication
- Device communication
- Data buffering
- Error detection

- Any period of time, the processor may communicate with one or more external devices

I/O MODULES
Module Function

Control and Timing :

- coordinate the flow of traffic between internal resources and external devices.
- Example

- CPU inquires I/O module about device status

- I/O module returns the device status.

- If the device ready to transmit, CPU requests the transfer of data.

- I/O module gets data from the device .

- I/O module transfers data to CPU

I/O MODULES
Module Function

CPU communication

- **Command decoding**:

- I/O module accepts commands from the CPU sent as signals on the control bus . **For example, an I/O module for a disk drive might accept the following commands: READ SECTOR, WRITE SECTOR, SEEK track number, and SCAN record ID.**

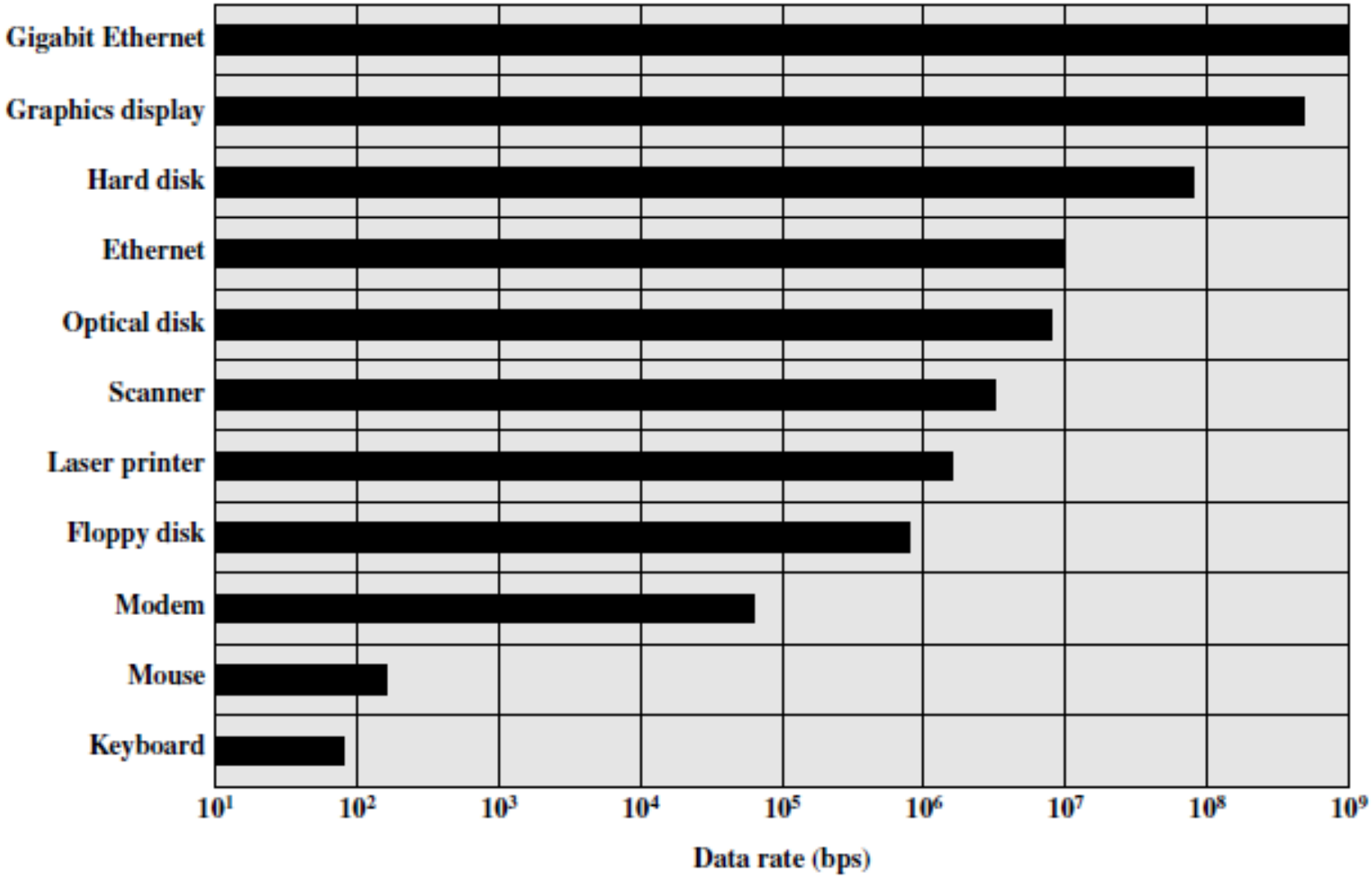
- **Data:** Data are exchanged between the processor and the I/O module over the data bus.

I/O MODULES
Module Function

- **Status reporting:** Because peripherals are so slow, it is important to know the status of the I/O module . ***For example, if an I/O module is asked to send data to the processor (read), it may not be ready to do so because it is still working on the previous I/O command. This fact can be reported with a status signal .Common status signals are BUSY and READY .***

4-Address recognition: each word of memory has an address, so does each I/O device.an I/O module must recognize one unique address for each peripheral it controls.

Typical I/O Data Rates



I/O MODULES
Module Function

Device communication

This communication involves :

- commands, status information, and data.

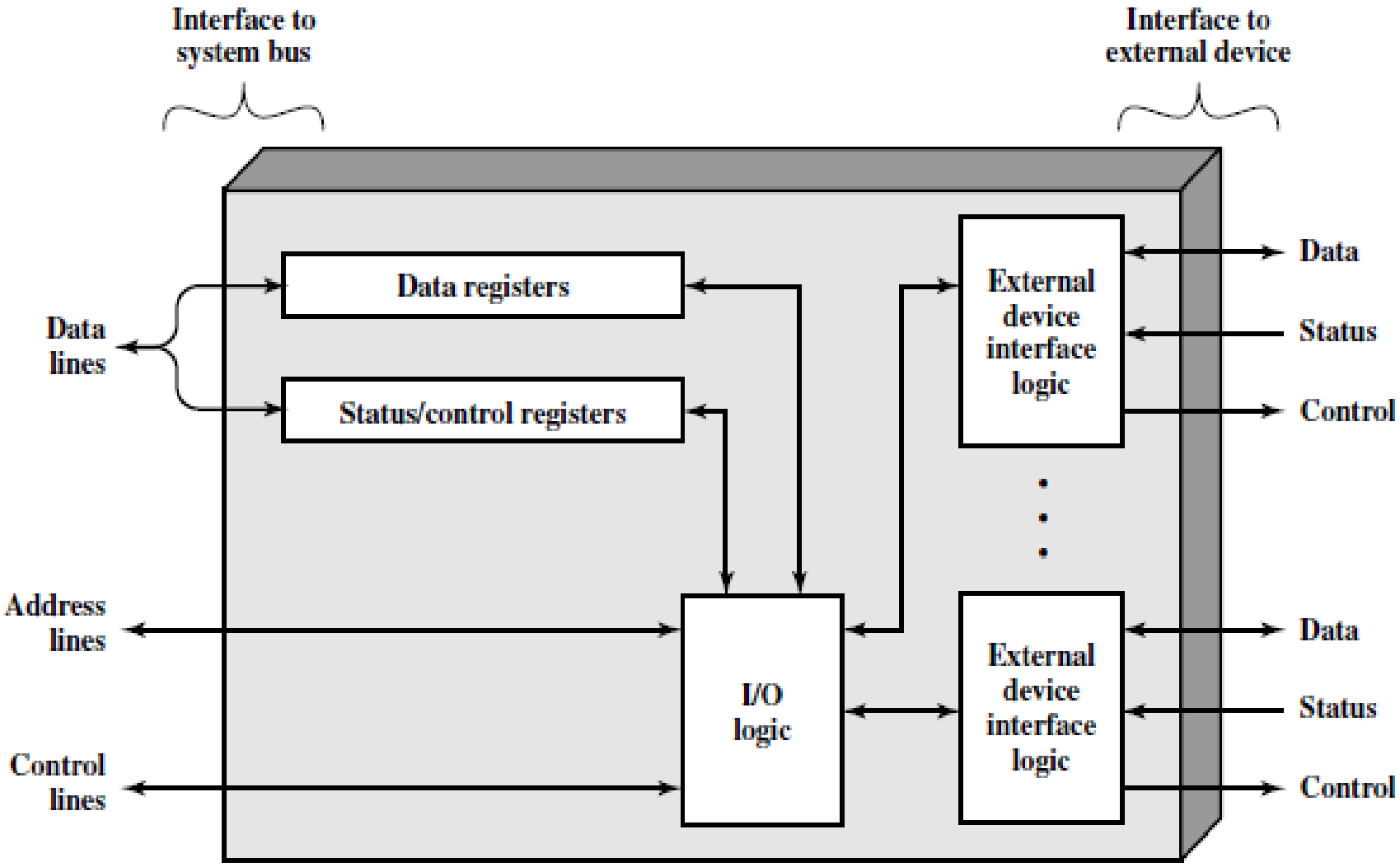
Data buffering

-Data coming from main memory are sent to an I/O module in a rapid burst

-Data are buffered in the I/O module and then sent to the peripheral device at its data rate.

Error detection - One class of errors includes mechanical and electrical errors reported by the device (e.g., paper jam, bad disk track).

I/O Module Structure
Block Diagram of an I/O Module



I/O Module Structure
Block Diagram of an I/O Module

- The module connects to the rest of the computer through a set of signal lines (e.g., system bus lines).
- Data transferred to and from the module are buffered in one or more data registers.
- There may also be one or more status registers that provide current status information. A status register may also function as a control register, to accept detailed control information from the processor .
- The I/O module contains logic specific to the interface with each device that it controls.

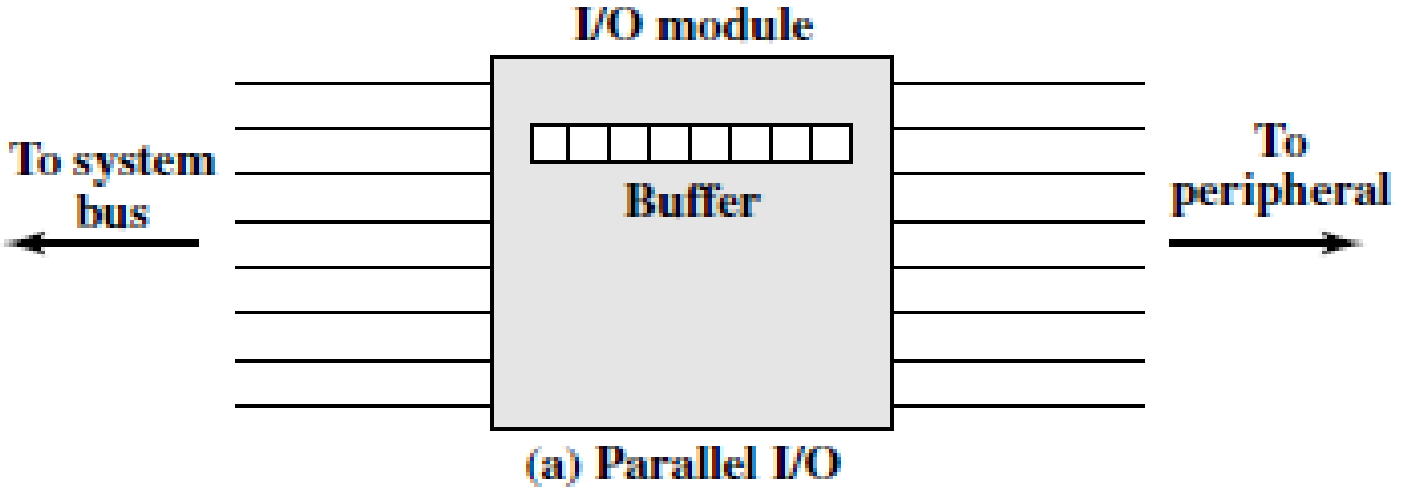
THE EXTERNAL INTERFACE

- One major characteristic of the interface is whether it is **serial or parallel .**
- **Parallel interface -** there are multiple lines connecting the I/O module and the peripheral, and multiple bits are transferred simultaneously , just as all of the bits of a word are transferred simultaneously over the data bus.
- **Serial interface**, there is only one line used to transmit data, and bits must be transmitted one at a time.

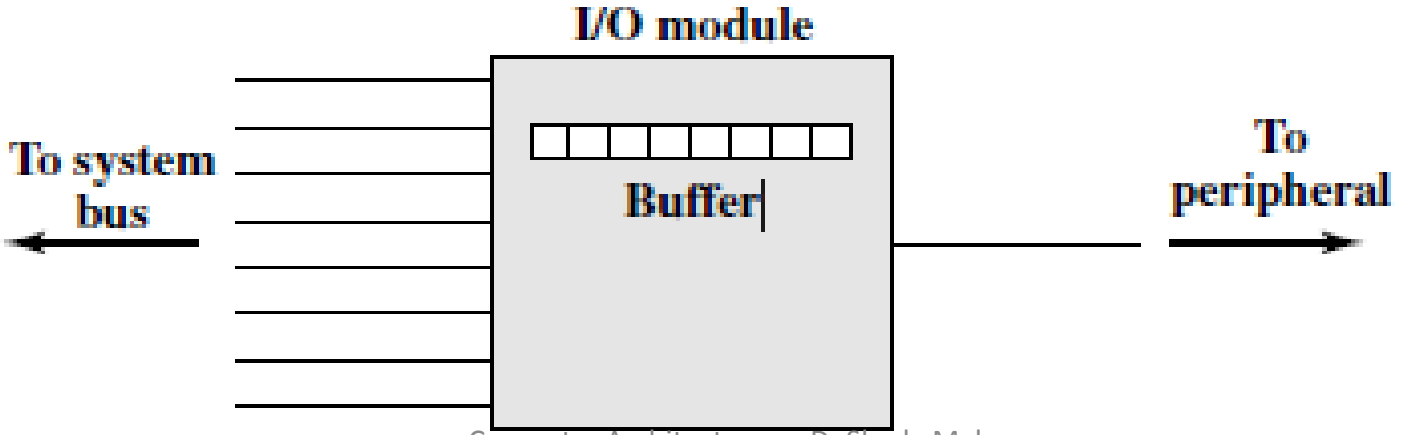
Types of Interfaces

- A **parallel** interface has traditionally been used for higher-speed peripherals-**tape and disk**.
- The **serial** interface has traditionally been used for **printers and terminals** .
- **I/O module** has an internal buffer compensate for the differences in speed between the system bus and external device

Types of Interfaces



(a) Parallel I/O



(b) Serial I/O