

# Computer Organization

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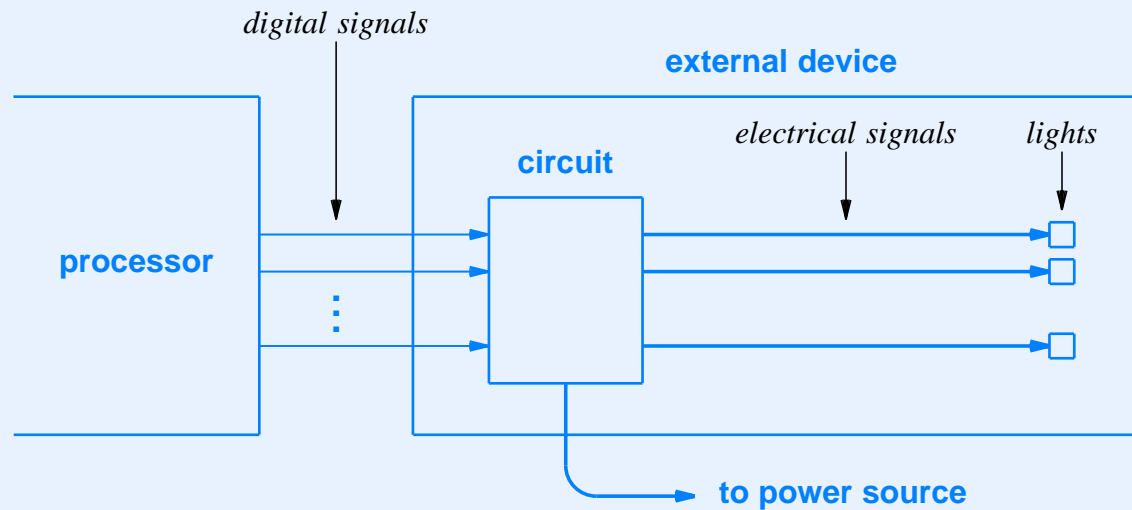
# **XIII**

## **Input / Output Concepts And Terminology**

# I/O Devices

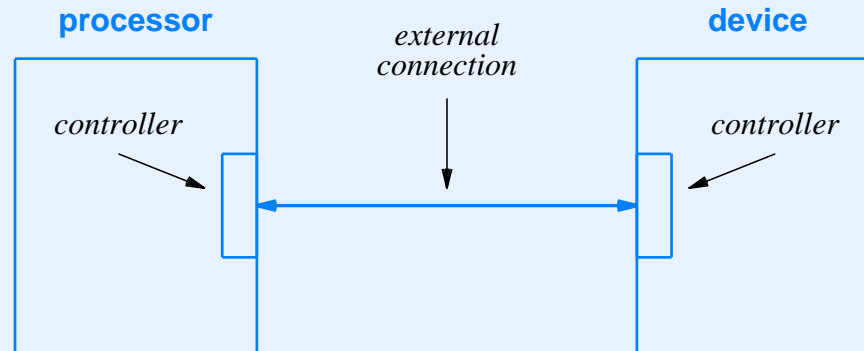
- Third major component of computer system
- Wide range of types
  - Keyboards
  - Mice
  - Monitors
  - Hard disks
  - Printers
  - Cameras
  - Audio speakers

# Illustration Of Early I/O Device



- Independent of processor
- Connected by digital signals

# Illustration Of Modern Interface Controller



- Needed at each end of physical connection
- Allows arbitrary voltage and signal on connection

# Two Types Of Interfaces

- Parallel interface
  - Composed of many wires
  - Each wire carries one bit at any time
  - *Width* is number of wires
- Serial interface
  - Single signal wire (also need ground)
  - Bits sent one-at-a-time
  - Slower than parallel interface

# Self-Clocking Data

- Ends of connection use separate clocks
- Transmission is *self-clocking* if signal encoded in such a way that receiver can determine boundary of bits

# Duplex Terminology

- Full-duplex
  - Simultaneous, bi-directional transfer
  - Example disk drive supports simultaneous *read* and *write*
- Half-duplex
  - Transfer in only one direction at a time
  - Interfaces must negotiate access before transmitting



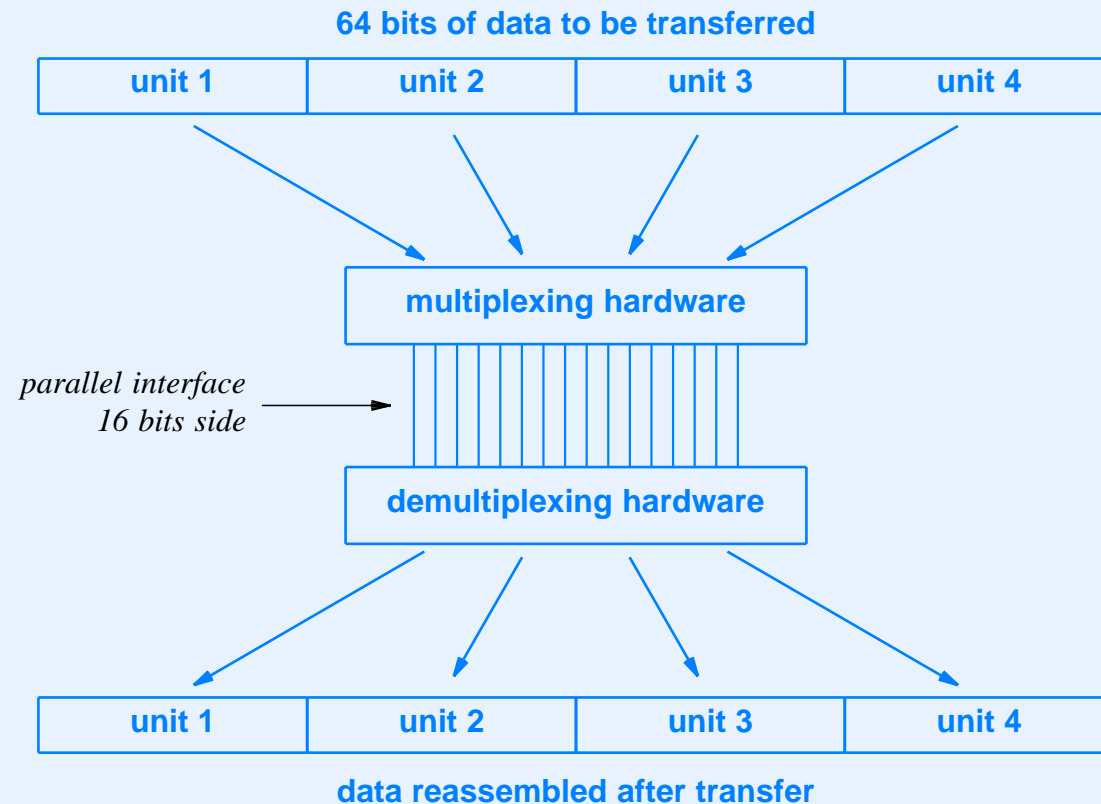
# Latency And Throughput

*The latency of an interface is a measure of the time required to perform a transfer, the throughput of an interface is a measure of the data that can be transferred per unit time.*

# Data Multiplexing

- Fundamental idea
- Arises from hardware limits on parallelism (pins or wires)
- Allows sharing
- Multiplexor
  - Accepts input from many sources
  - Sends small amount from one source before accepting another
- Demultiplexor
  - Receives transmission of pieces
  - Sends each piece to appropriate destination

# Illustration Of Multiplexing



- Sixty-four bits of data multiplexed over 16-bit path

# Multiplexing And I/O Interfaces

*Multiplexing is used to construct an I/O interface that can transfer arbitrary amounts of data over a fixed number of parallel wires. Multiplexing hardware divides the data into blocks, and transfers each block independently.*

# Multiple Devices Per External Interface

- Cannot afford separate interface per device
  - Too many wires
  - Not enough pins on processor chip
- We will see how sharing occurs

# Processor's View Of I/O

*A processor does not access external devices directly. Instead, the processor uses a programming interface to pass requests to an interface controller, which translates the requests into the appropriate external signals.*



**Questions?**