Objectives

• Learn the approach to
  • Connecting devices
  • Connecting processors and memory
• Explore current examples of connectors
Reference

- https://www.youtube.com/watch?v=Gk2y3ndkl54
- Various Wikipedia articles

Internal Bus

• Allows CPU components to communicate

Usually not visible to the user of the device
The Bus

• The system shares data with other system components by way of a data bus

PCI bus slots provide attachment for expansion cards

Increasingly integrated into motherboards or by USB devices

The bus connecting the CPU and memory is called the system bus

Bus Types

• Internal / expansion bus
• Data movement
  • Serial – Bits move in sequence over a single wire pair
  • Parallel – bits move in parallel over several sets of wires
• Hot-swappable ports can be connected while equipment is running (similar to plug and play)

Expansion bus connects the system with external devices

Speed and bandwidth are factors in separation of internal and external buses
Bus Components

• Buses usually consist of
  • data lines - convey bits from one device to another
  • control lines - determine the direction of data flow and when each device can access the bus
  • address lines - determine the location of the source or destination of the data

Distinction between a bus and a network is not exact

Port

• Computer port - a physical interface between a computer and other computers or devices
• Specialized outlet on a piece of equipment to which a plug or cable connects
Color Coding

- Manufacturers standard colors
- Not uniformly implemented
- Examples
  - Orange, purple, or grey: Keyboard PS/2
  - Green: Mouse PS/2
  - Blue or magenta: Parallel printer DB-25
  - Amber: Serial DB-25 or DB-9
  - Pastel pink: Microphone 1/8" stereo (TRS) minijack
  - Pastel green: Speaker 1/8" stereo (TRS) minijack

Parallel Ports

- IEEE 1284
- Also referred to as a printer port
- Used for connecting peripheral devices
- Increasingly being replaced by USB (less physical space for multi-pin parallel)
- Newer versions reach 2 MBs
RS-232

- Serial connector
- Now outdated
- Used to connect to printers, mice, data storage, and other peripheral devices
- Replaced by USB
- Connectors for legacy devices

Example - USB

- Universal Serial Bus
- Current (but fading) generation – USB 2.0 (2000)
- Connection between devices and a host
- Also provides power

- Highlights
  - 5 meter max cable length
  - 5 volt DC power
  - 1-bit serial
  - 480 Mbps maximum bandwidth per controller
  - Controller directed (no requests from devices)
USB Connectors

- A, B, micro

USB 3.0

- Higher gross transfer rate (5 Gbs compared to 480Mbs))
- Device initiated communications
- Products became available during 2010
- Backwards compatible (including plugs and cables) to USB 2.0

New USB Type-C plug is reversible

MacBook Air and MacBook Pro available with USB 3.0

USB 3.1 beginning to become available at 10Gbs

Contents of a Blu-Ray disk can be transferred over USB 3.1 in 38 seconds
Lightning

- Apple
- Connects Apple mobile devices (iPhones, iPads, iPods, etc.) to host computers

FireWire

- IEEE 1394
- High speed serial bus
- Developed by Apple
- 400-3200Mbps
Thunderbolt

- Replacement for FireWire on Apple devices (e.g. disk)
- Intel proprietary standard
- Used for the connection of external peripheral devices
- Versions:
  - 1 – 10 Gbs
  - 2 – 20 Gbs
  - 3 – 40 Gbs
- Up to
  - 40 times faster than USB 2 and 25 times faster than FireWire 800

Audio / Video

- Analog or digital
- Video, audio, or both
- Examples
  - VGA (Video Graphics Array)
    - Analog RGB video signals
    - Multiple resolutions
    - Not hot pluggable
  - DVI (Digital Video Interface)
    - Supports analog and digital
    - Hot pluggable
    - Multi resolutions
    - 7.92 Gbs
## HDMI

- High Definition Multimedia Interface
- Up to 18Gbs
- Digital audio/video interface
- Multiple resolutions
- Hot pluggable
- Variety of connectors
- Variety of formats

Might be replaced by USB3.1 (capable of 4K video)

## Power Connectors

- Fixed vs detachable leads
- Standard
  - Friction attachment
  - Optional retainer
- MagSafe
  - Magnetically attached
  - Introduced by Apple
  - Tripping over the cord is less of a problem
  - Version 2 fits slimmer models (e.g., MacBook Air)
Audio Connectors

- Analog interface
- Terms
  - phone jack
  - audio jack
  - jack plug
  - stereo plug
  - mini-stereo
  - mini jack
  - headphone jack
  - microphone jack

Connector Adapters

- Convert one format to another
- Examples
  - HDMI to Thunderbolt
  - Lightning to USB
Internal Connectors

- SATA
  - Bus interface that connects a host bus adapter to mass storage devices (e.g., hard disks)
  - Up to 6Gbs
- PCI
  - Serial expansion bus

Did You Satisfy the Objectives?

- Learn the approach to
  - Connecting devices
  - Connecting processors and memory
- Explore current examples of connectors