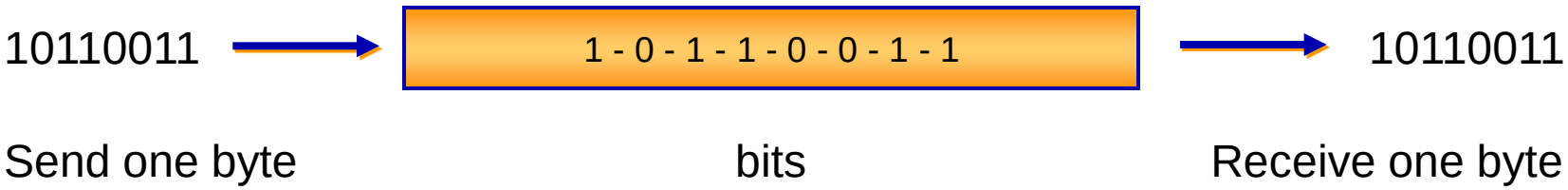
Input/Output Ports

IT Essentials Chapter 1

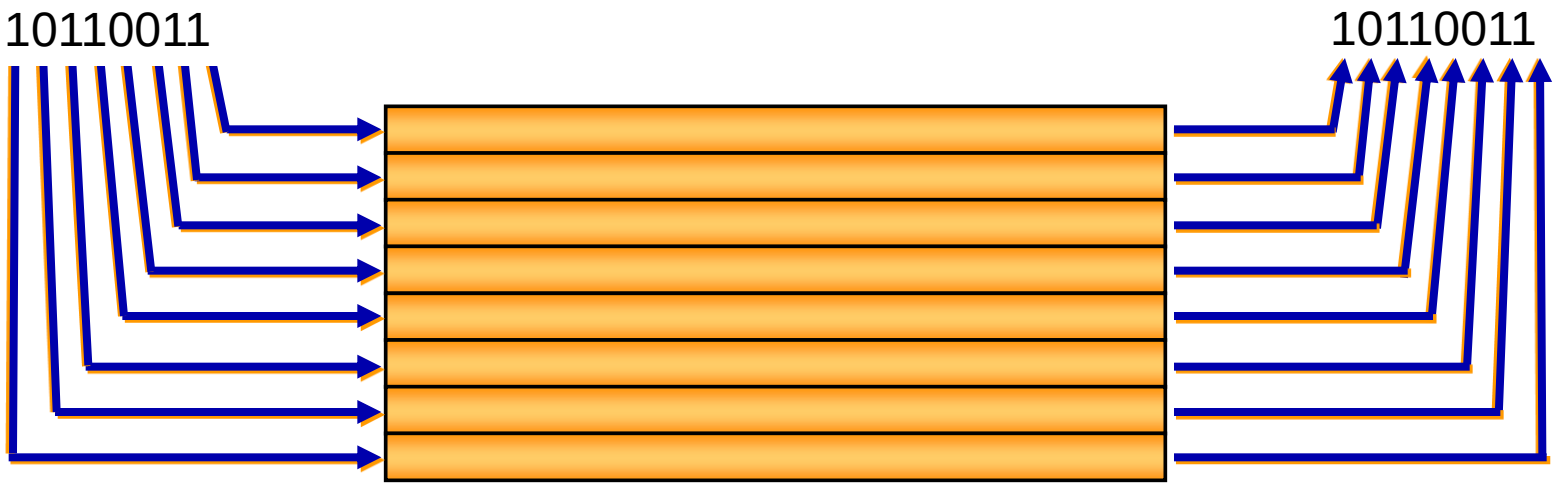
Device Connection

- All devices that connect outside of the computer must use a port to connect .
- Known as I/O ports (Input/Output).
- Bits can travel in serial or in parallel.

Serial Transmission Sends One Bit at a Time



Parallel Transmission Sends Several Bits at Once



Types of Ports

- Serial
- Parallel
- PS/2
- USB
- FireWire
- Inferred IR (not covered on exam)
- Bluetooth
- SCSI (discussed later)
- PCMCIA (discussed with laptops)

Serial Connectors

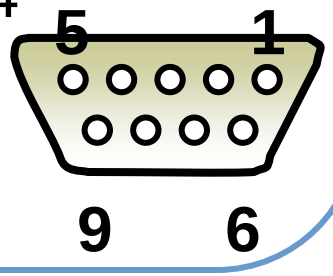
- Can use a DB-9 or DB-25 pin male connector
- Slowest ports
- Used for:
  - Mice
  - Keyboards
  - Modems

Serial Ports

- The name "serial" comes from the fact that a serial port "serializes" data. That is, it takes a byte of data and transmits the 8 bits in the byte one at a time. The advantage is that a serial port needs only one wire to transmit the 8 bits (while a parallel port needs 8). The disadvantage is that it takes 8 times longer to transmit the data than it would if there were 8 wires. Serial ports lower cable costs and make cables smaller.
- Before each byte of data, a serial port sends a start bit, which is a single bit with a value of 0. After each byte of data, it sends a stop bit to signal that the byte is complete. It may also send a parity bit.

Serial Ports

- Serial ports, also called **communication (COM) ports**, are **bi-directional**. Bi-directional communication allows each device to receive data as well as transmit it. Serial devices use different pins to receive and transmit data -- using the same pins would limit communication to **half-duplex**, meaning that information could only travel in one direction at a time. Using different pins allows for **full-duplex** communication, in which information can travel in both directions at once.
- Also called COM1, COM2, COM3, and COM4
- Can be referred to as a **RS-232 port**

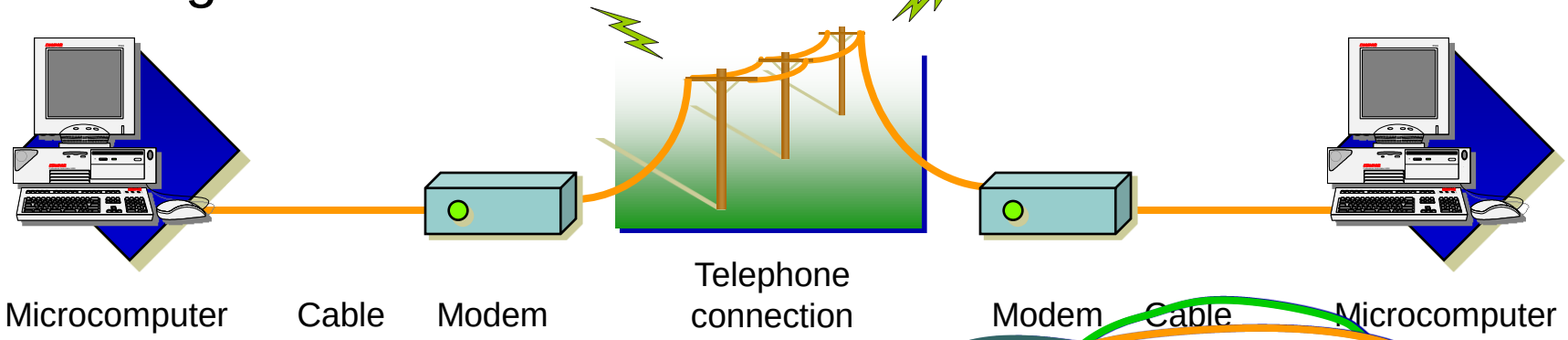


Serial Ports

- Serial ports rely on a special controller chip, the **Universal Asynchronous Receiver/Transmitter (UART)**, to function properly. The UART chip takes the parallel output of the computer's system bus and transforms it into serial form for transmission through the serial port. In order to function faster, most UART chips have a built-in buffer of anywhere from 16 to 64 kilobytes. This buffer allows the chip to cache data coming in from the system bus while it is processing data going out to the serial port. While most standard serial ports have a maximum transfer rate of 115 Kbps (kilobits per second), high speed serial ports, such as **Enhanced Serial Port (ESP)** and **Super Enhanced Serial Port (Super ESP)**, can reach data transfer rates of 460 Kbps.

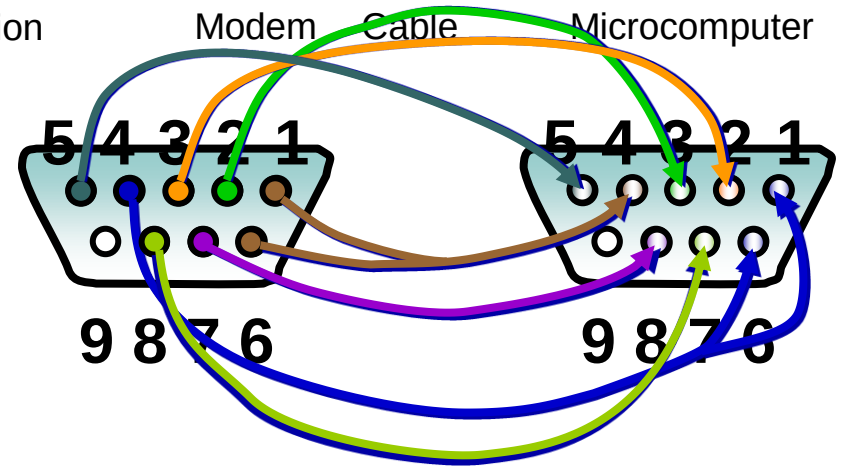
Serial Ports

Modems were commonly connected to Serial Ports on early computers. Modern computer modems connect using a RJ-11 connector to an internal modem.



Null Modem Pinouts

Early communication devices, like routers and switches, used a Null Modem cable to console into the device for programming.



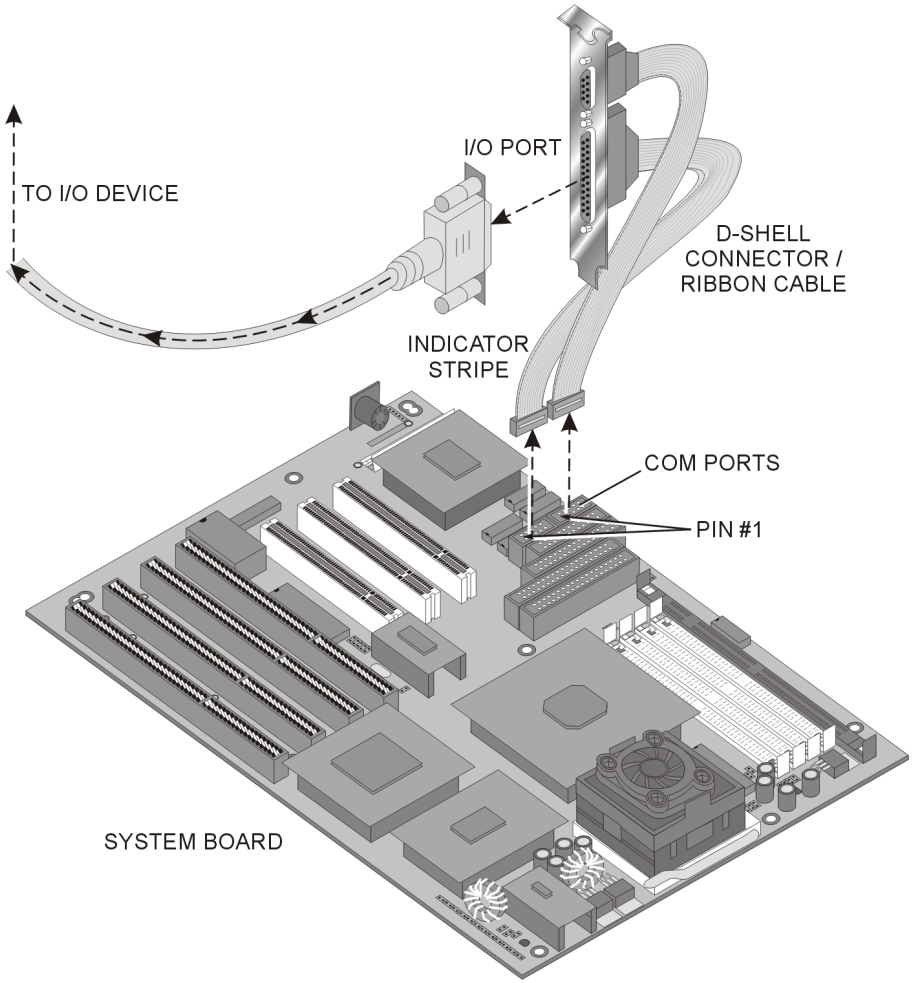
DIN-5 Keyboard Connector

- Older motherboards use a DIN-5 connector for the keyboard and a 9 pin serial connection for the mouse

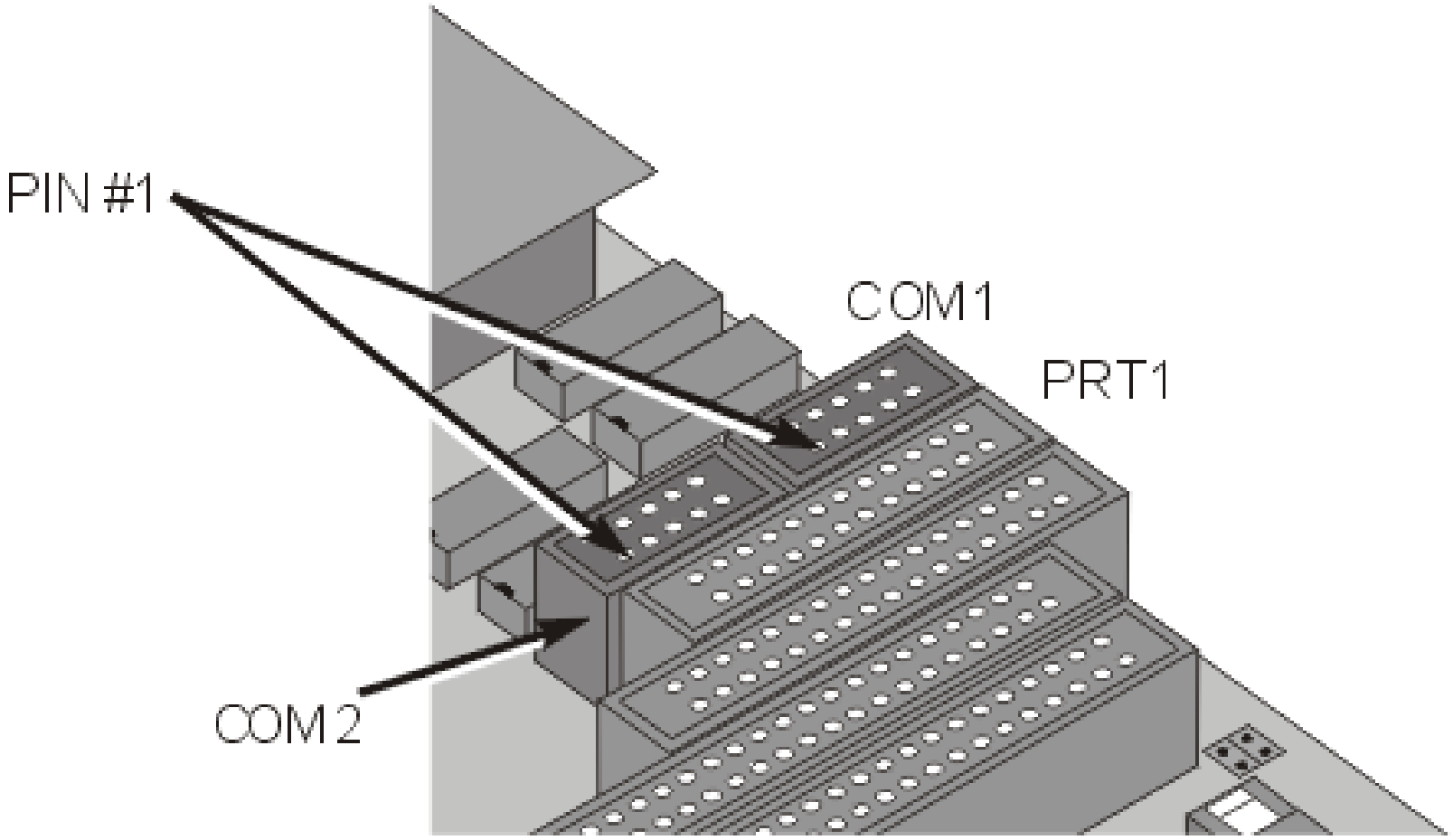
PS/2 and Keyboard Connectors

- PS/2 connectors are used for both mice and keyboard
- Also called 6-pin mini DIN
- Green for mouse
- Purple for keyboard
- Not interchangeable
- Standard for ATX boards

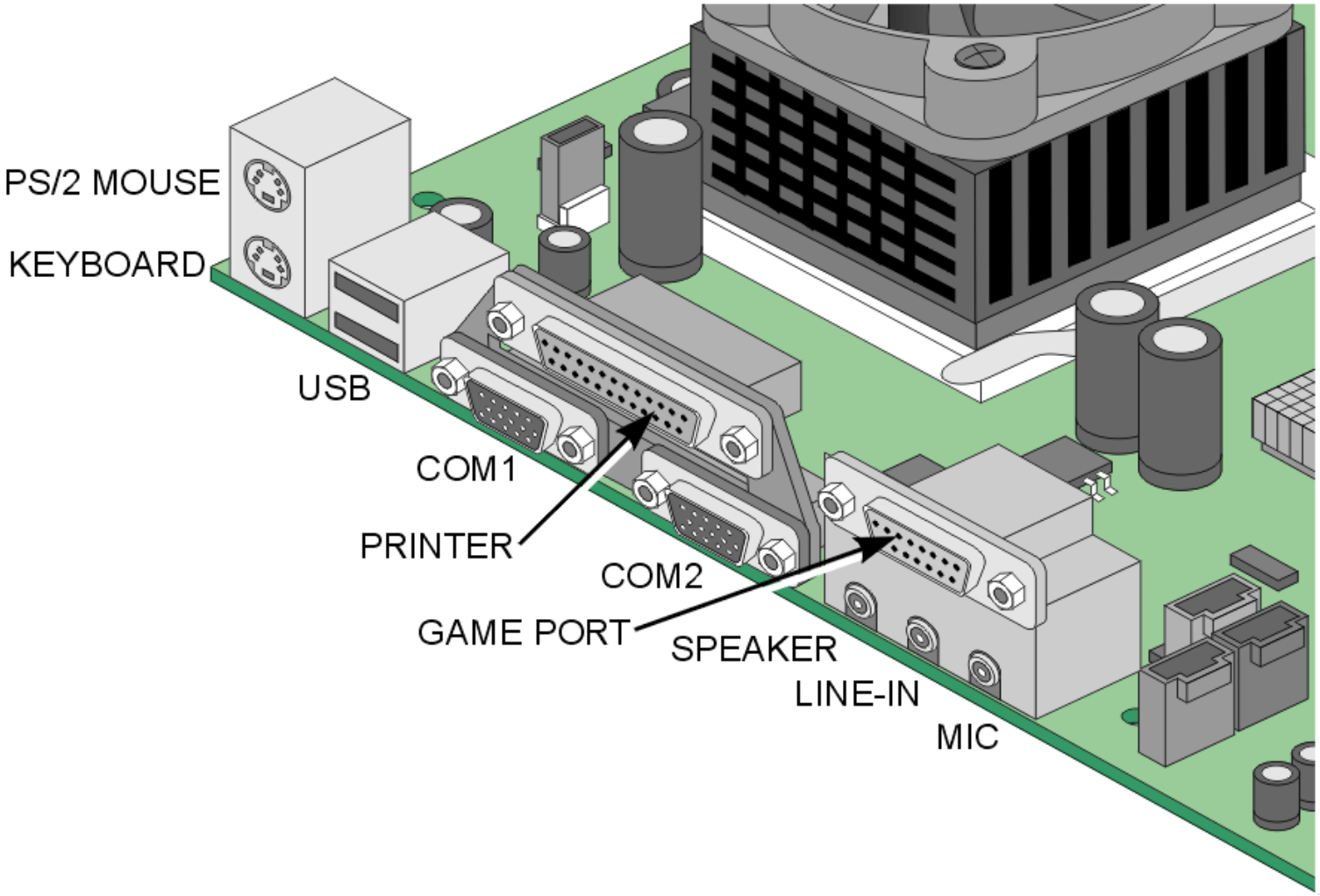
AT-Style Serial-Port Connections



AT-Style Serial-Port Connections

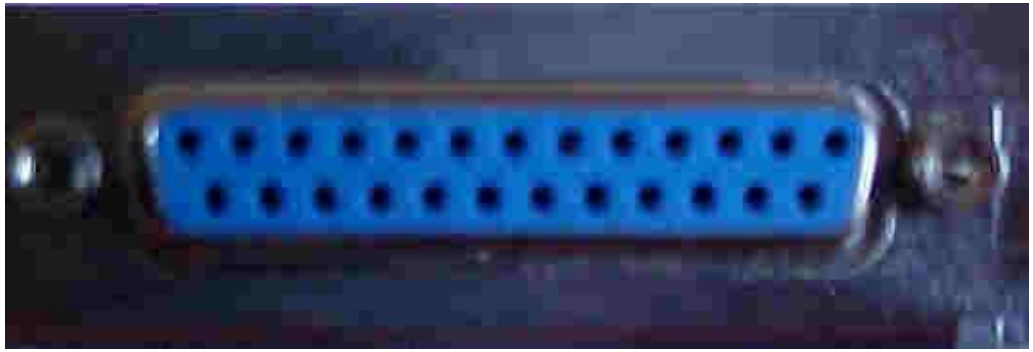


ATX System Board I/O Connections



Parallel Ports

- Uses a DB-25 pin female connector
- Data flows over 8 lines



- Used for:
  - Printers
  - Scanners
  - Portable drives

Parallel Ports

- When a PC sends data to a printer or other device using a parallel port, it sends 8 bits of data (1 byte) at a time. These 8 bits are transmitted **parallel** to each other, as opposed to the same eight bits being transmitted **serially** (all in a single row) through a serial port. The standard parallel port is capable of sending 50 to 100 kilobytes of data per second.
- Also called LPT1, LPT2, LPT3
- Bi-directional communication
- Transmission mode can be set in the BIOS
- Maximum cable length is 15 feet or 4.5 meters
- Can be referred to as a **IEEE-1284**

Parallel Ports

- Parallel ports were originally developed by IBM as a way to connect a printer to your PC. When IBM was in the process of designing the PC, the company wanted the computer to work with printers offered by **Centronics**, a top printer manufacturer at the time. IBM decided not to use the same port interface on the computer that Centronics used on the printer.
- Instead, IBM engineers coupled a 25-pin connector, **DB-25**, with a 36-pin Centronics connector to create a special cable to connect the printer to the computer. Other printer manufacturers ended up adopting the Centronics interface, making this strange hybrid cable the standard.

Parallel Ports

- When used to connect to a printer, it uses a 36 pin centronics connector at the printer end.

SPP/EPP/ECP Communications

- The original specification for parallel ports was unidirectional, meaning that data only traveled in one direction for each pin. With the introduction of the PS/2 in 1987, IBM offered a new **bidirectional** parallel port design. This mode is commonly known as **Standard Parallel Port** (SPP) and has completely replaced the original design. Bidirectional communication allows each device to receive data as well as transmit it. Many devices use the eight pins (2 through 9) originally designated for data. Using the same eight pins limits communication to **half-duplex**, meaning that information can only travel in one direction at a time. But pins 18 through 25, originally just used as grounds, can be used as data pins also. This allows for **full-duplex** (both directions at the same time) communication.

SPP/EPP/ECP Communications

- **Enhanced Parallel Port** (EPP) was created by Intel, Xircom and Zenith in 1991. EPP allows for much more data, 500 kilobytes to 2 megabytes, to be transferred each second. It was targeted specifically for non-printer devices that would attach to the parallel port, particularly storage devices that needed the highest possible transfer rate.
- Close on the heels of the introduction of EPP, Microsoft and Hewlett Packard jointly announced a specification called **Extended Capabilities Port** (ECP) in 1992. While EPP was geared toward other devices, ECP was designed to provide improved speed and functionality for printers.

SPP/EPP/ECP Communications

- In 1994, the IEEE 1284 standard was released. It included the two specifications for parallel port devices, EPP and ECP. In order for them to work, both the operating system and the device must support the required specification. This is seldom a problem today since most computers support SPP, ECP and EPP and will detect which mode needs to be used, depending on the attached device. If you need to manually select a mode, you can do so through the BIOS on most computers.

Universal Serial Bus (USB)

The Universal Serial Bus has the following features:

- **Host-based**, meaning that devices must connect to a computer in order to communicate.
- Up to **127 devices** can connect to the host, either directly or by way of USB hubs.
- Individual USB cables can run as long as 5 meters; with hubs, devices can be up to 30 meters (six cables' worth) away from the host.
- A USB cable has two wires for power (+5 volts and ground) and a twisted pair of wires to carry the data.
- On the power wires, the computer can supply up to 500 milliamps of power at 5 volts.

Universal Serial Bus (USB)

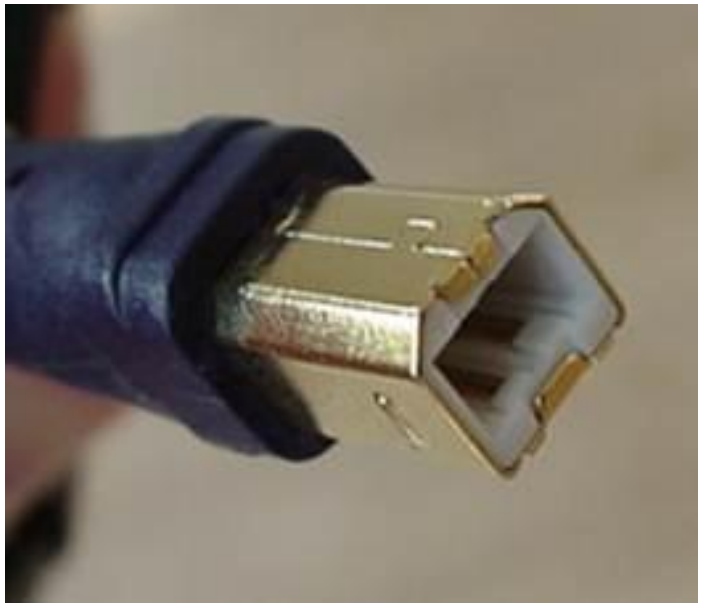
- Low-power devices (such as mice) can draw their power directly from the bus. High-power devices (such as printers) have their own power supplies and draw minimal power from the bus. Hubs can have their own power supplies to provide power to devices connected to the hub.
- USB devices are **hot-swappable**, meaning you can plug them into the bus and unplug them any time.
- Many USB devices can be put to **sleep** by the host computer when the computer enters a power-saving mode.
- Must have Windows 98, 2000, XP or Vista
- Not supported in Windows 95 or NT 4.0

Universal Serial Bus (USB)

- The goal of USB is to end all of these headaches. The Universal Serial Bus gives you a single, standardized, easy-to-use way to connect up to **127 devices** to a computer.
- The USB standard uses **"A" and "B" connectors** to avoid confusion:
- "**A**" connectors head "**upstream**" toward the computer.

Universal Serial Bus (USB)

- "**B**" connectors head "**downstream**" and connect to individual devices.
- By using different connectors on the upstream and downstream end, it is impossible to ever get confused -- if you connect any USB cable's "B" connector into a device, you know that it will work. Similarly, you can plug any "A" connector into any "A" socket and know that it will work.



USB Standards

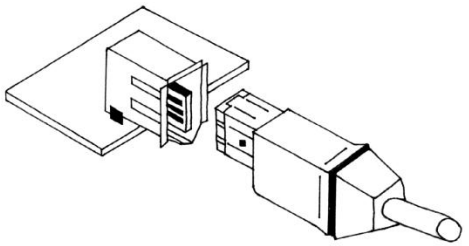
- USB 1.0 had a maximum bandwidth of 1.5 megabits per second.
- USB 1.1 (**Low-speed USB**) increased the maximum bandwidth to 12 megabits per second.
- USB 2.0 (**High-speed USB**) provides additional bandwidth for multimedia and storage applications and has a data transmission speed of 480 megabits per second (40 times faster than USB 1.1). To allow a smooth transition for both consumers and manufacturers, USB 2.0 has full forward and backward compatibility with original USB devices and works with cables and connectors made for original USB, too.
- USB 3.0 increased the maximum bandwidth to 4,800 megabits per second.

USB Cable Lengths

- Hi Powered devices – 5 meters max
  - Also called hi-speed
- Low Powered devices – 3 meters max
  - Also called low-speed
- Can be extended if you use a self-powered hub

FireWire

- Developed by Apple Computers in 1995
- Used for digital cameras, camcorders, and scanners
- Bi-directional communication
- Requires a special adapter card
- Common on new motherboards.
- FireWire is **peer-to-peer**, meaning that two FireWire cameras can talk to each other without going through a computer.
- Also called **IEEE-1394**

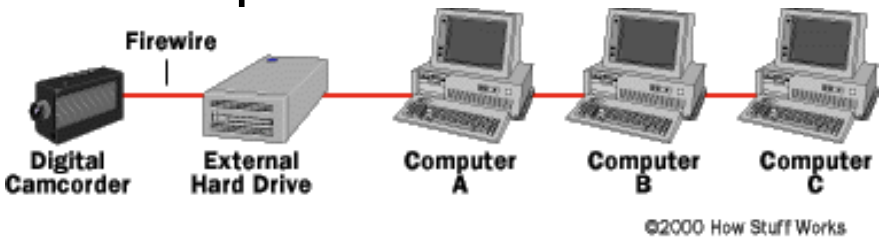


FireWire

- When the host computer powers up, it queries all of the devices connected to the bus and assigns each one an address, a process called **enumeration**. FireWire is **plug-and-play**, so if a new FireWire device is connected to a computer, the operating system auto-detects it and asks for the driver disk. If the device has already been installed, the computer activates it and starts talking to it. FireWire devices are **hot pluggable**, which means they can be connected and disconnected at any time, even with the power on.

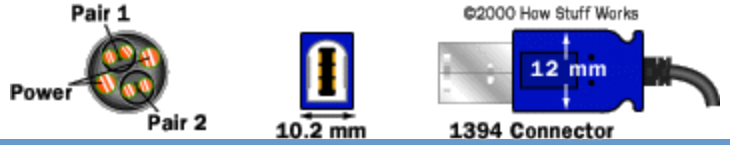
FireWire

- The bus ID and physical ID together comprise the 16-bit **node ID**, which allows for 64,000 nodes on a system. Individual FireWire cables can run as long as 4.5 meters. Data can be sent through up to 16 **hops** for a total maximum distance of 72 meters. Hops occur when devices are **daisy-chained** together. Look at the example below. The camcorder is connected to the external hard drive connected to Computer A. Computer A is connected to Computer B, which in turn is connected to Computer C. It takes four hops for Computer C to access the camera.



FireWire

- FireWire devices can be **powered or unpowered**. FireWire allows devices to draw their power from their connection. Two power conductors in the cable can supply power (8 to 40 volts, 1.5 amps maximum) from the computer to an unpowered device. Obviously, a high-power device like an external hard drive will have its own power supply, but low-power devices like digital still cameras can get their power from the bus in order to simplify them.
- Two or three twisted pair sets carry the data in a FireWire cable.
- Connectors types are either 4-pins or 6-pins.



FireWire

- An important element of FireWire is the support of **isochronous** devices. In isochronous mode, data streams between the device and the host in real-time with guaranteed bandwidth and no error correction. Essentially, this means that a device like a digital camcorder can request that the host computer allocate enough bandwidth for the camcorder to send uncompressed video in real-time to the computer. When the computer/camera FireWire connection enters isochronous mode, the camera can send the video in a steady flow to the computer without anything disrupting the process.

FireWire

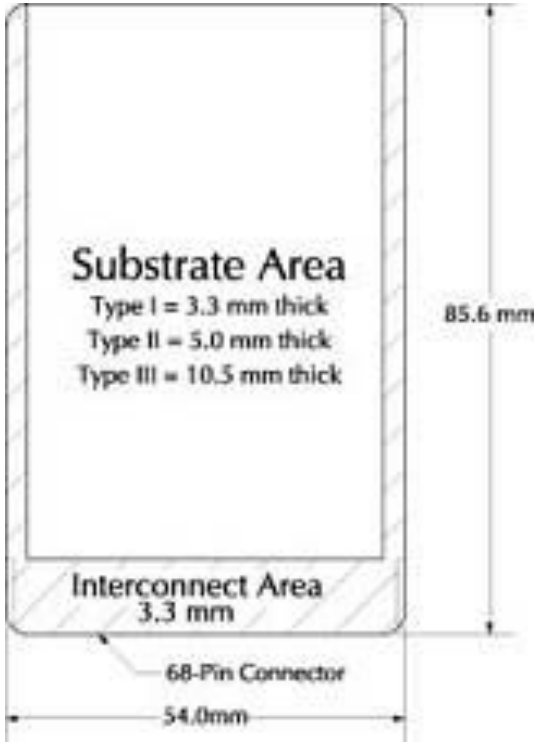
- Of course, FireWire had an answer to USB 2.0 in its IEEE 1394b, which will up the ante with transfer speeds starting at 800 Mbps.
- Now Firewire 3200 will reach an unbelievable 393 gigabits per second when the current copper FireWire cables are replaced with fiber optics.

PCMCIA

PCMCIA (Personal Computer Memory Card International Association) is an international standards body and trade association with over 200 member companies that was founded in 1989 to establish standards for Integrated Circuit cards and to promote interchangeability among mobile computers where ruggedness, low power, and small size were critical. As the needs of mobile computer users has changed, so has the PC Card Standard. By 1991, PCMCIA had defined an I/O interface for the same 68 pin connector initially used for memory cards.

PCMCIA

- Three types of cards:
  - Type 1
    - 3.3mm thick
    - Usually used for memory devices
  - Type 2
    - 5mm thick
    - Typically used for I/O devices such as data/fax modems, LANs, and mass storage devices.
  - Type 3
    - 10.5mm thick
    - Same as type 2 but need a thicker frame.



Bluetooth

- **Bluetooth** is an industrial specification for wireless personal area networks (PANs).
- Bluetooth provides a way to connect and exchange information between devices such as mobile phones, laptops, PCs, printers, digital cameras, and video game consoles over a secure, globally unlicensed short-range radio frequency.
- The Bluetooth specifications are developed and licensed by the Bluetooth Special Interest Group.
- Supported OS:
  - Windows XP Service Pack 2
  - Mac OS X v10.2

Bluetooth

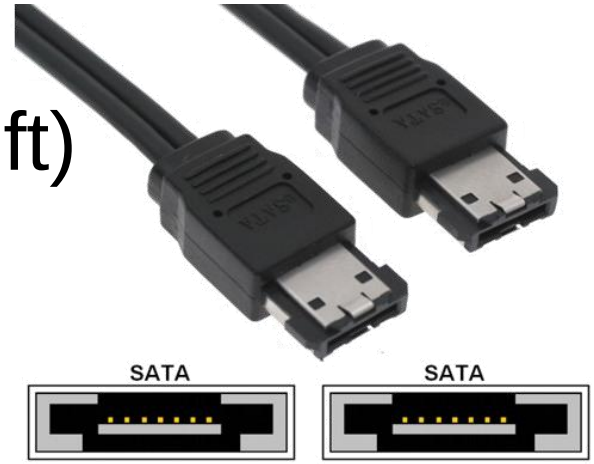
- Bluetooth is a radio standard and communications protocol primarily designed for low power consumption, with a short range based on low-cost transceiver microchips in each device.

Class 1	100 mW (20 dBm)	~100 meters
Class 2	2.5 mW (4 dBm)	~22 meters
Class 3	1 mW (0 dBm)	~6 meter

- Transmission speeds up to 721 Kbps in 1.1
- Up to 2.1 Mbps in 2.0
- Up to 480 Mbps in 3.0

eSATA

- External Serial AT Attachment port is the newest type.
- Cable length of 2 meters (6.6ft)
- Transfer speeds up to 3000 Megabits per second



Video Connectors

- VGA (analog) uses a 15 pin, 3 rows of 5, connectors

- DVI connector on a device is given one of three names, depending on which signals it implements:
  - **DVI-D** (digital only)
  - **DVI-A** (analog only)
  - **DVI-I** (integrated, digital & analog)

Light Peak

- **Light Peak** is a proprietary optical cable interface designed by Intel to connect devices in a peripheral bus. The technology has a high bandwidth at 10 Gbps, with the potential to scale to 100 Gbps by 2020.
- Currently in development, Light Peak is being developed as a single universal replacement for current buses such as SCSI, SATA, USB, FireWire, and PCI Express in an attempt to reduce the proliferation of ports on contemporary computers.
- Bus systems such as USB were developed for the same purpose, and successfully replaced a number of older technologies. However, increasing bandwidth demands have led to higher performance standards like eSATA and DisplayPort that cannot connect to USB and similar peripherals.

I/O Port Comparison

Name	Standard	Bus	Max Length	Transfer Speed	Power Provided	Devices per Channel
Serial	RS-232 DB9 male DB25 male	Serial	2 m	460 Kbps	No	1
Parallel	IEEE 1284 DB25 female	Parallel	4.5 m	2000 Mbps	No	1
USB	USB	Serial	3-5 m	480 Mbps	Yes	127
Firewire	IEEE1394 IEEE1394b	Serial	4.5 m	400 Mbps 800 Mbps	Yes	63
SATA	SATA	Serial	2 m	3000 Mbps	No	1
Bluetooth	IEEE 802.15	Wireless	6 m	480 Mbps	No	7
LightPeak	?	Serial	100 m	10-100 Gbps	No	?