Chapter Four

Making Connections

Data Communications and Computer Networks: A Business User's Approach

Seventh Edition

After reading this chapter, you should be able to:

- *List* the four components of all interface standards
- *Discuss* the basic operations of the USB and EIA-232F interface standards
- *Cite* the advantages of FireWire, SCSI, iSCSI, InfiniBand, and Fibre Channel interface standards
- *Outline* the characteristics of asynchronous, synchronous, and isochronous data link interfaces

After reading this chapter, you should be able to (continued):

- *Recognize* the difference between half-duplex and full-duplex connections
- *Identify* the operating characteristics of terminal-to-mainframe connections and why they are unique compared to other types of computer connections

Introduction

- ***Connecting*** *peripheral devices* to a computer has, in the past, been a fairly challenging task
- Newer ***interfaces*** have made this task much easier
- Let's examine the interface *between a computer and a device*
  - This interface occurs primarily at the *physical layer*

Interfacing a Computer to Peripheral Devices

- The connection to a peripheral is often called the *interface*
- The process of providing all the proper interconnections between a computer and a peripheral is called *interfacing*

Characteristics of Interface Standards

- There are essentially **two types of standards**
  - **Official standards**
    - Created by standards-making organizations such as ITU (International Telecommunications Union), IEEE (Institute for Electrical and Electronics Engineers), (now defunct) EIA (Electronic Industries Association), ISO (International Organization for Standardization), and ANSI (American National Standards Institute)
  - **De facto standards**
    - Created by *other groups* that are not official standards but because of their widespread use, become "*almost*" standards

Characteristics of Interface Standards (continued)

- There are four *possible* components to an interface standard:
  - Electrical component: deals with voltages, line capacitance, and other electrical characteristics
  - Mechanical component: deals with items such as the connector or plug description
  - Functional component: describes the function of each pin or circuit that is used in a particular interface
  - Procedural component: describes how the particular circuits are used to perform an operation

Two Important Interface Standards

- In order to better understand the four components of an interface, let's examine **two interface standards**
  - **EIA-232F** – an older standard originally designed to connect a modem to a computer
  - **USB** (Universal Serial Bus) – a newer standard that is much more powerful than EIA-232F

An Early Standard: EIA-232F

- Originally named RS-232 but has gone through many revisions
- All four components are defined in the EIA-232F standard:
  - Electrical
  - Mechanical (DB-25 connector and DB-9 connector)
  - Functional
  - Procedural

An Early Standard: EIA-232F

- EIA-232F also used the definitions DTE and DCE
  - An example of a DTE, or *data terminating equipment*, is a computer
  - An example of a DCE, or *data circuit-terminating equipment*, is some form of modem

What is meant by ***duplexity***?

- EIA-232F defines a *full-duplex* connection. What does this mean?
- A *full-duplex* connection transmits data in both directions and at the same time
- A *half-duplex* connection transmits data in both directions but in only one direction at a time
- A *simplex* connection can transmit data in only one direction
- Can you think of a modern example of each?

Universal Serial Bus (USB)

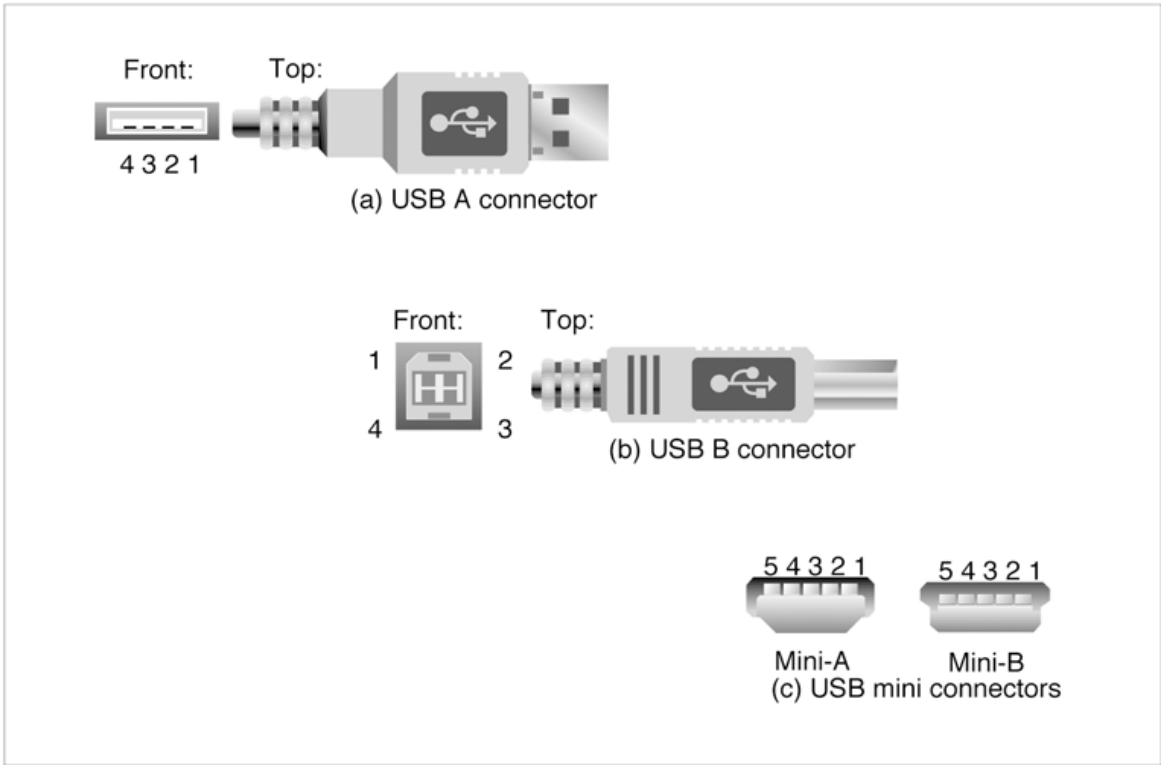
- The *USB interface* is a modern standard for interconnecting a wide range of peripheral devices to computers
- Supports plug and play
- Can daisy-chain multiple devices
- USB **2.0** can support **480** Mbps (USB **1.0** is only **12** Mbps)
- USB **3.0** can support **4.8** Gbps

Universal Serial Bus (USB) (continued)

- The USB interface defines all *four components*
- The *electrical component* defines two wires VBUS and Ground to carry a 5-volt signal, while the D+ and D- wires carry the data and signaling information
- The *mechanical component* precisely defines the size of four different connectors and uses only four wires (the metal shell counts as one more connector)

Universal Serial Bus (USB) (continued)

Figure 4-1
The four types of USB connectors



Universal Serial Bus (USB) (continued)

- The *functional* and *procedural* components are fairly complex but are based on the polled bus
- The computer takes turns asking each peripheral if it has anything to send
- More on polling near the end of this chapter

FireWire

- Low-cost digital interface
- Capable of supporting transfer speeds of up to 800 Mbps
- Hot pluggable
- Supports two types of data connections:
  - Asynchronous connection
  - Isochronous connection

Thunderbolt

- Digital interface currently found on ***Apple products***
- Capable of supporting transfer speeds of ***up to 10 Gbps***
- Uses same connector as existing Mini DisplayPort and similar protocol as PCI Express
- Can daisy-chain devices and may get even faster with later versions

SCSI and iSCSI

- SCSI (Small Computer System Interface)
  - A technique for interfacing a computer to high-speed devices such as hard disk drives, tape drives, CDs, and DVDs
  - Designed to support devices of a more permanent nature
    - SCSI is a systems interface
  - Need SCSI adapter
- iSCSI (Internet SCSI)
  - A technique for interfacing disk storage to a computer via the Internet

InfiniBand and Fibre Channel

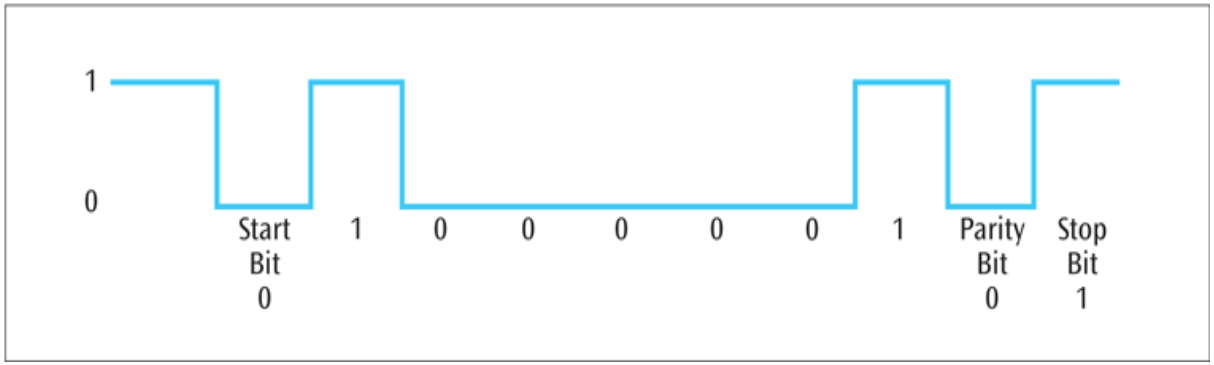
- InfiniBand – a serial connection or bus that can carry multiple channels of data at the same time
  - Can support data transfer speeds of 2.5 billion bits (2.5 gigabits) per second and address thousands of devices, using both copper wire and fiber-optic cables
  - A network of high-speed links and switches
- Fibre Channel – also a serial, high-speed network that connects a computer to multiple input/output devices
  - Supports data transfer rates up to billions of bits per second, but can support the interconnection of up to 126 devices only

Asynchronous Connections

- A type of connection defined at the *data link layer*
- To transmit data from sender to receiver, an asynchronous connection creates a *one-character package* called a *frame*
- Added to the front of the frame is a *start bit*, while a *stop bit* is added to the end of the frame
- An optional ***parity bit*** can be added which can be used to ***detect errors***

Asynchronous Connections (continued)

Figure 4-2
Example of the character A with one start bit, one stop bit, and even parity



Asynchronous Connections (continued)

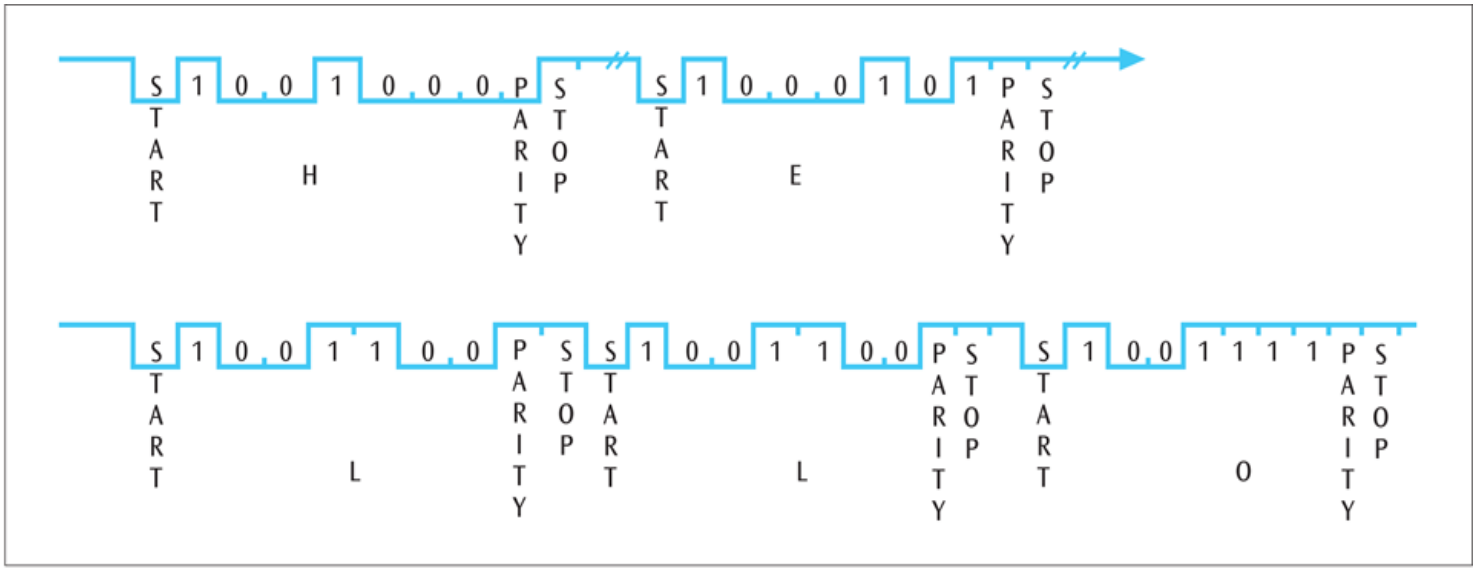


Figure 4-3
Example of the character string HELLO with included start, stop, and parity bits

Asynchronous Connections (continued)

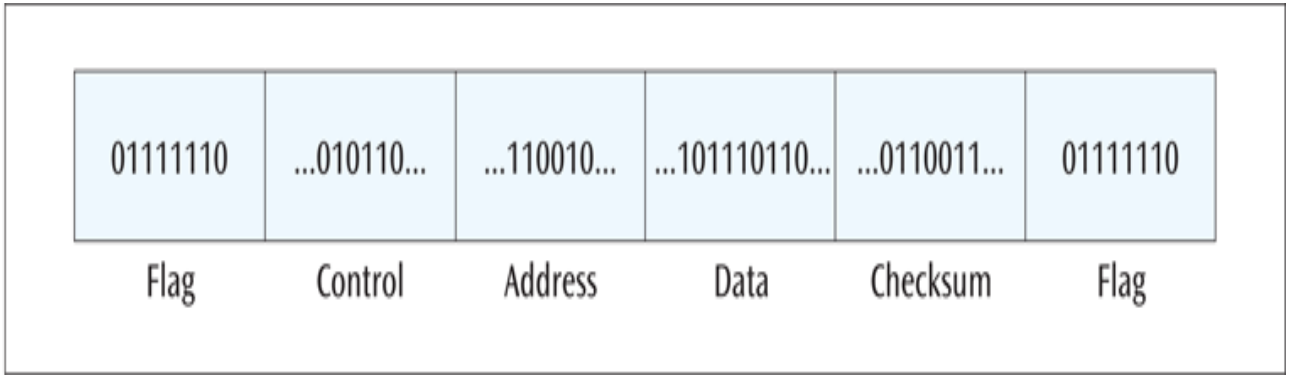
- The term **asynchronous** is misleading here because you must always *maintain synchronization* between the incoming data stream and the receiver
- Asynchronous connections maintain synchronization by using small frames with a leading start bit

Synchronous Connections

- A second type of connection defined at the *data link layer*
- A synchronous connection creates a **large frame** that consists of **header** and **trailer** flags, control information, optional address information, error detection code, and data
- A synchronous connection is more elaborate but transfers data in a more efficient manner

Synchronous Connections (continued)

Figure 4-4
Block diagram of the parts of a generic synchronous connection



Isochronous Connections

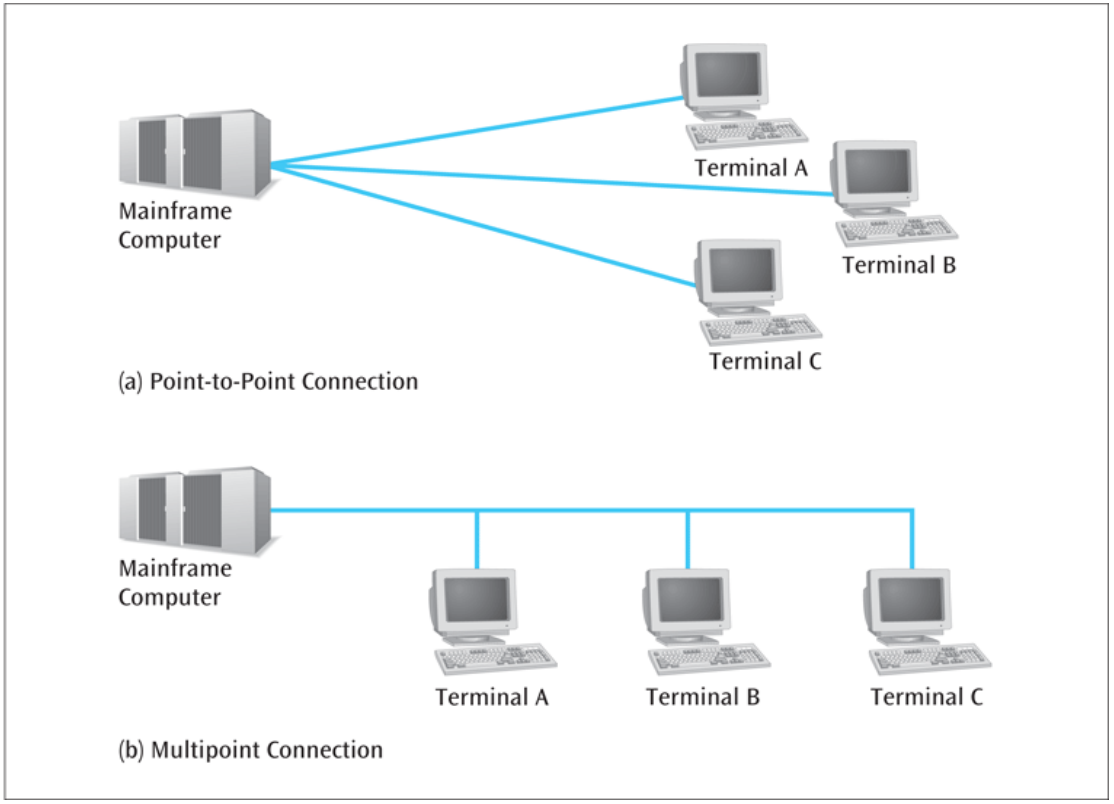
- A *third type* of connection defined at the *data link layer* used to support real-time applications
- Data must be delivered at just the *right speed* (real-time) – not too fast and not too slow
- Typically an isochronous connection must allocate resources on *both ends* to maintain real-time
- USB and Firewire can both support isochronous

Terminal-to-Mainframe Computer Connections

- Point-to-point connection – a direct, unshared connection between a terminal and a mainframe computer
- Multipoint connection – a shared connection between multiple terminals and a mainframe computer
- The mainframe is the ***primary*** and the terminals are the ***secondaries***

Terminal-to-Mainframe Computer Connections (continued)

Figure 4-5
Point-to-point and multipoint connections of terminals and mainframe computer

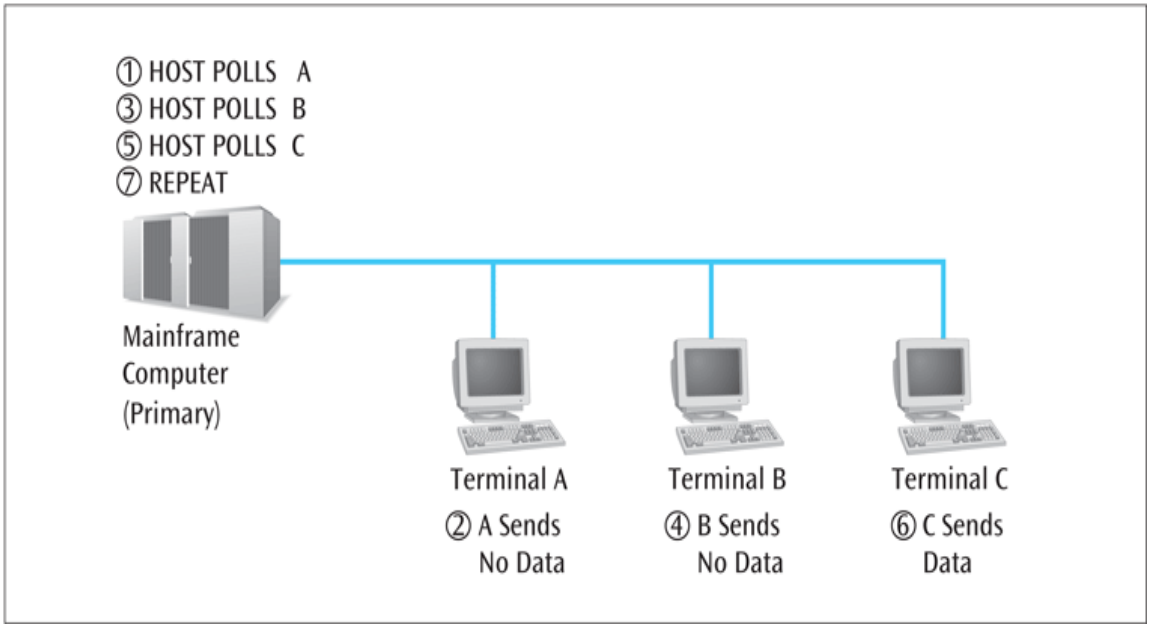


Terminal-to-Mainframe Computer Connections (continued)

- To allow a terminal to transmit data to a mainframe, the mainframe must poll the terminal
- Two basic forms of polling: roll-call polling and hub polling
  - In roll-call polling, the mainframe polls each terminal in a round-robin fashion
  - In hub polling, the mainframe polls the first terminal, and this terminal passes the poll onto the next terminal

Terminal-to-Mainframe Computer Connections (continued)

Figure 4-6
Terminals A, B, and C being polled by a primary



Making Computer Connections In Action

- A laptop computer has many different types of connectors, or connections
- While every laptop can be different, if anyone has a laptop in class, maybe someone will volunteer to use theirs for show-and-tell

Making Computer Connections In Action (continued)

- Power cord connection (why does the power cord have a big “brick” on it?)
- USB connectors (one or more)
- RJ-11 (telephone jack)
- RJ-45 (LAN jack)
- PC Card / SmartCard
- DisplayPort (to connect your laptop to a video device)
- Media card slot (SD, SDHC, xD, etc)
- DB-15 (to connect to an external monitor or video projector)

Making Computer Connections In Action (continued)

- A company wants to transfer files that are typically 700K chars in size
- If an asynchronous connection is used, each character will have a start bit, a stop bit, and maybe a parity bit
- 700,000 chars * 11 bits/char (8 bits data + start + stop + parity) = 7,700,000 bits

Making Computer Connections In Action (continued)

- If a synchronous connection is used, assume maximum payload size – 1500 bytes
- To transfer a 700K char file requires 467 1500-character (byte) frames
- Each frame will also contain 1-byte header, 1-byte address, 1-byte control, and 2-byte checksum, thus 5 bytes overhead

Making Computer Connections In Action (continued)

- 1500 bytes payload + 5 byte overhead = 1505 byte frames
- 467 frames * 1505 bytes/frame = 716,380 bytes, or 5,731,040 bits
- Significantly less data using synchronous connection

Summary

- Connection between a computer and a peripheral is often called the interface
- Process of providing all the proper interconnections between a computer and a peripheral is called interfacing
- The interface between computer and peripheral is composed of one to four components: electrical, mechanical, functional, and procedural
- A DTE is a data terminating device
  - Computer
- A DCE is a data circuit-terminating device
  - Modem

Summary (continued)

- Two interface standards worthy of additional study: Universal Serial Bus, and EIA-232F
  - EIA-232F was one of the first highly popular standards
  - Universal Serial Bus is currently the most popular interface standard
- Half-duplex systems can transmit data in both directions, but in only one direction at a time
- Full-duplex systems can transmit data in both directions at the same time
- Other peripheral interfacing standards that provide power, flexibility, and ease-of-installation include FireWire, SCSI, iSCSI, InfiniBand, and Fibre Channel

Summary (continued)

- While much of an interface standard resides at the physical layer, a data link connection is also required when data is transmitted between two points on a network
  - Three common data link connections include asynchronous connections, synchronous connections, and isochronous connections
- Asynchronous connections use single-character frames and start and stop bits to establish the beginning and ending points of the frame
- Synchronous connections use multiple-character frames, sometimes consisting of thousands of characters
- Isochronous connections provide real-time connections between computers and peripherals and require a fairly involved dialog to support the connection

Summary (continued)

- A point-to-point connection is one between a computer terminal and a mainframe computer that is dedicated to one terminal
- A multipoint connection is a shared connection between more than one computer terminal and a mainframe computer