PPP

Point-to-Point Protocol

Introduction

- One of the most common types of WAN connection is the point-to-point connection. Point-to-point connections are used to connect LANs to service provider WANs, and to connect LAN segments within an Enterprise network. A LAN-to-WAN point-to-point connection is also referred to as a *serial connection* or *leased-line connection*, because the lines are leased from a carrier (usually a telephone company) and are dedicated for use by the company leasing the lines. Companies pay for a continuous connection between two remote sites, and the line is continuously active and available.

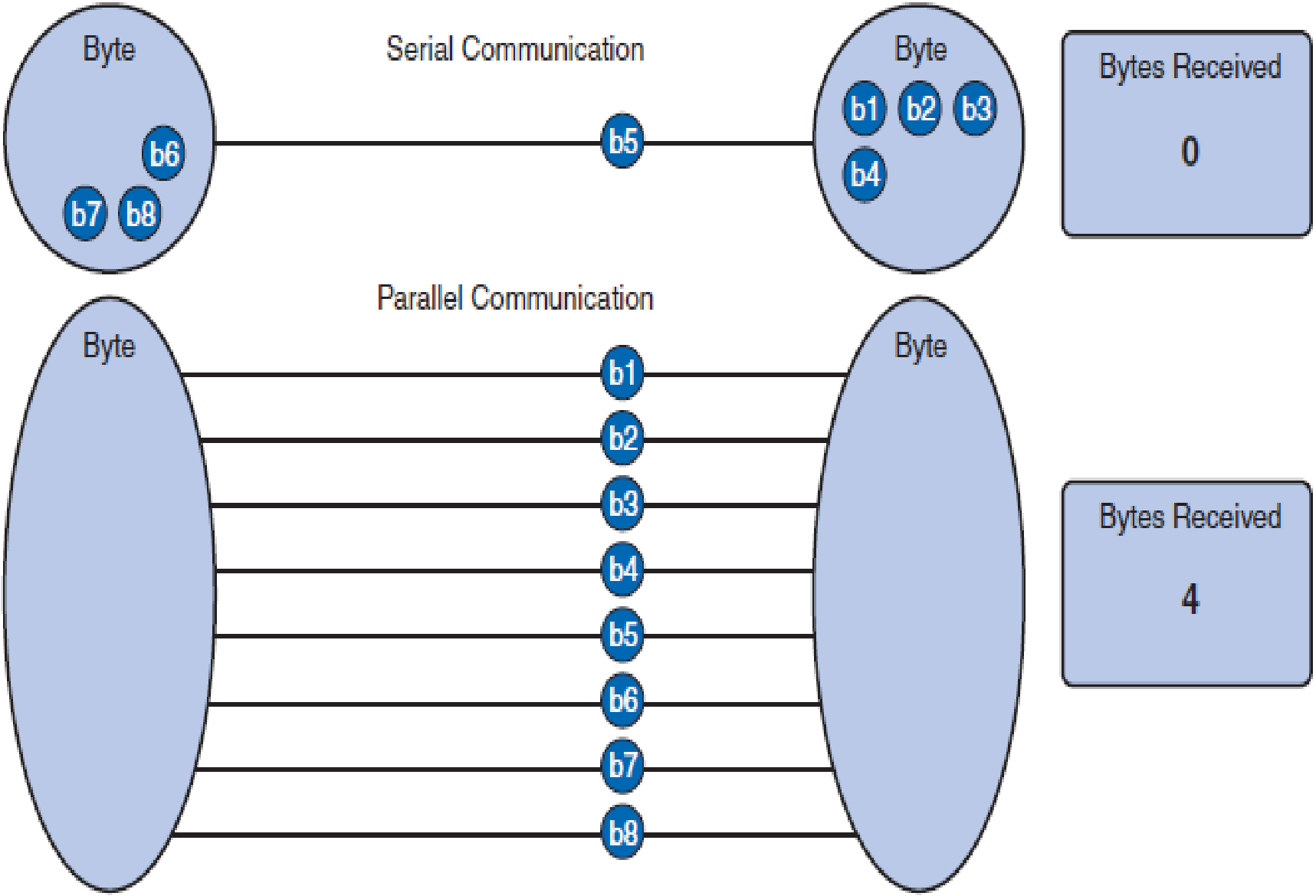
- In modern networks, security is a key concern. PPP allows you to authenticate connections using either **Password Authentication Protocol** (PAP) or the more effective **Challenge Handshake Authentication Protocol** (CHAP).

How Does Serial Communication Work?

Most PCs have both serial and parallel ports. You also know that electricity can move at only one speed. To transfer data quicker, it can be compressed and therefore require fewer bits to be transmitted. An alternative method is to transmit the bits simultaneously,

as done in computers with parallel connections. Computers use relatively short parallel connections between interior components, but they use a serial bus to convert signals for most external communications. Let’s compare serial and parallel communications.

A parallel connection sends the bits over more wires simultaneously. In the case of the 25-pin parallel port on your PC, eight data-carrying wires carry 8 bits simultaneously. Because eight wires carry the data, the parallel link theoretically transfers data eight times faster than a serial connection. So, based on this theory, a parallel connection sends a byte in the same amount of time a serial connection takes to send a bit.


Byte
b6
b7
b8
Serial Communication
b5
Byte
b1
b2
b3
b4
Bytes Received
0
Parallel Communication
Byte
b1
b2
b3
b4
b5
b6
b7
b8
Byte
Bytes Received
4

Serial p-p Links
Serial Communications

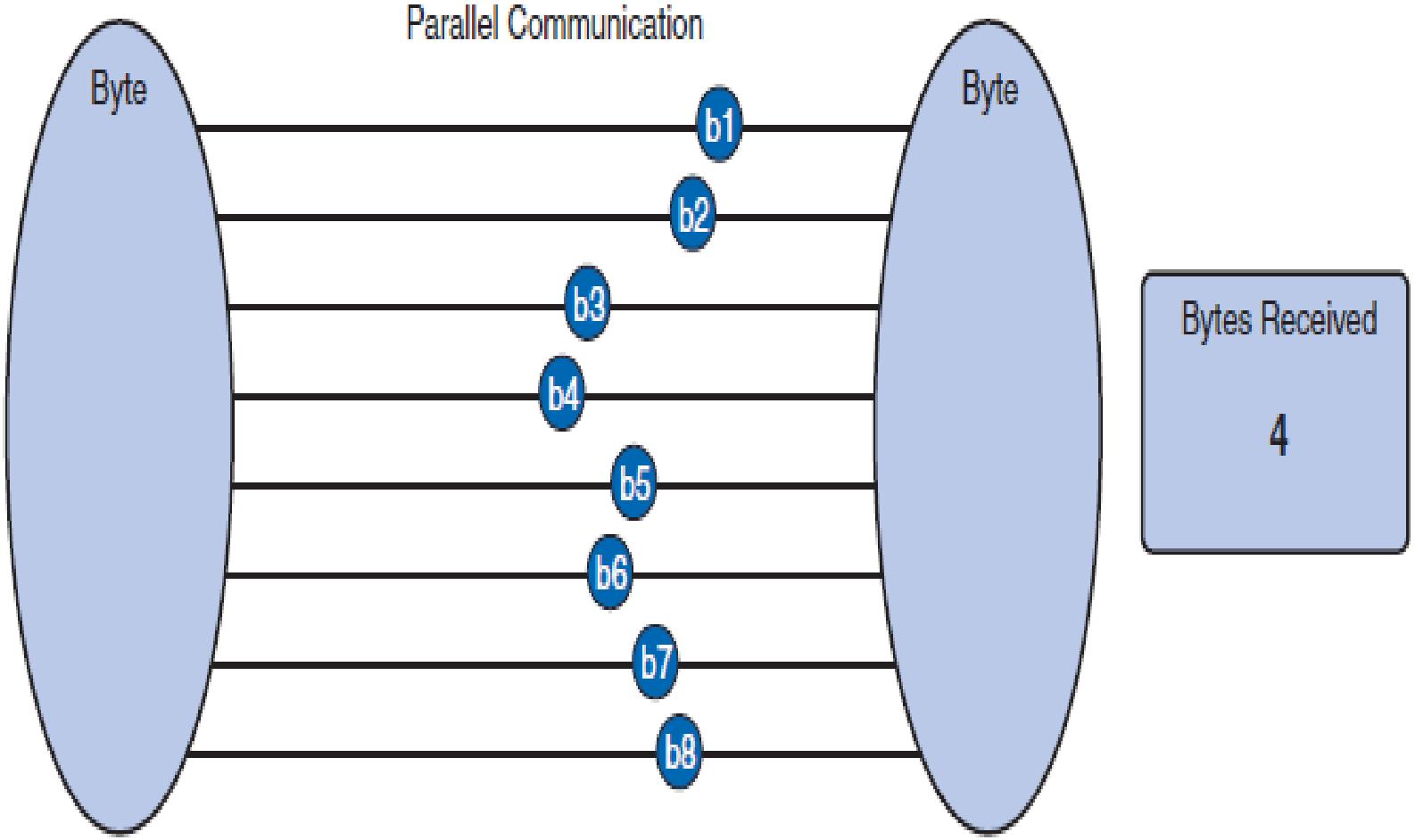
- How Does Serial Communication Work?

  Serial and Parallel Comm.

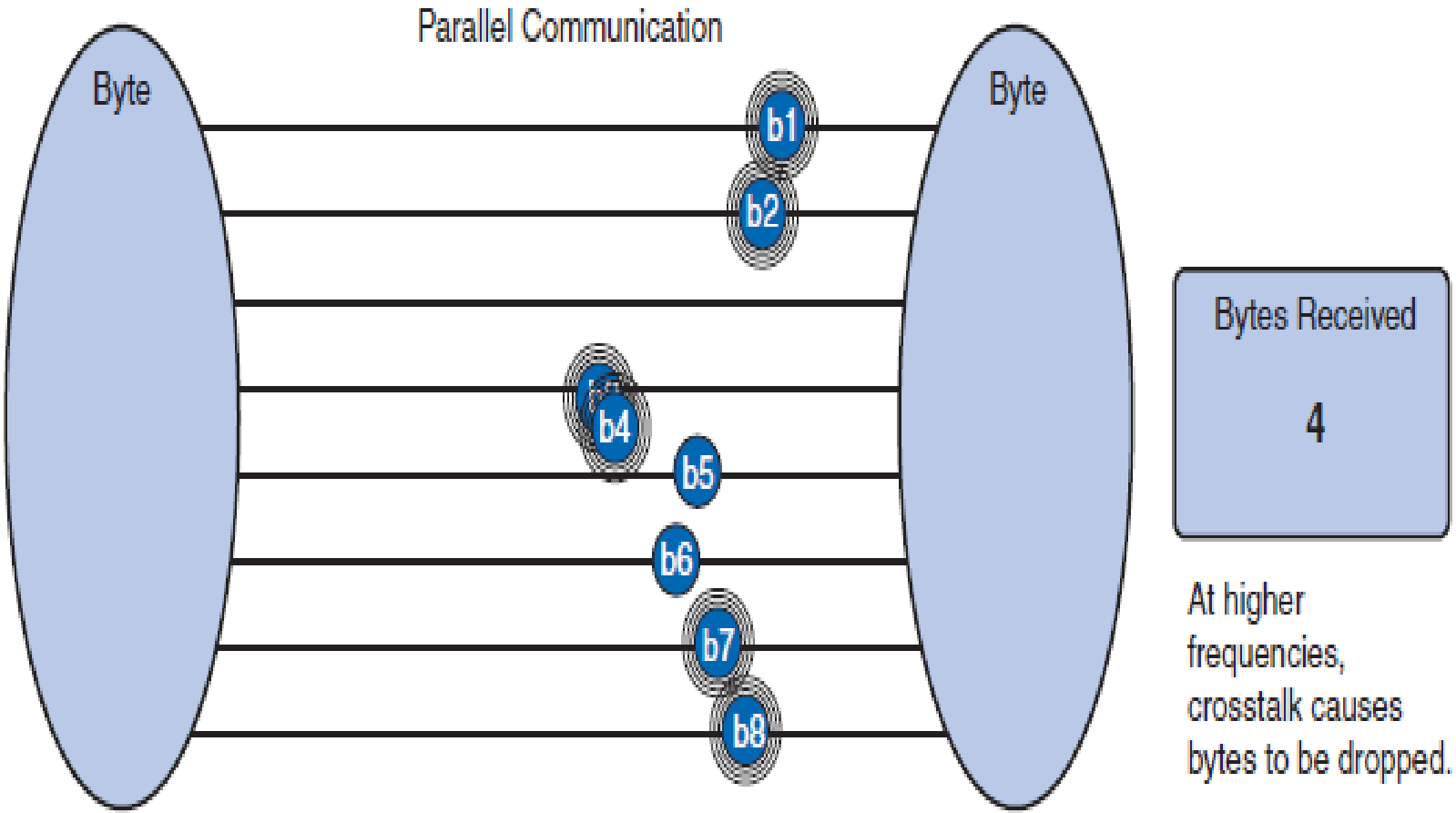
If parallel is faster than serial, is parallel more suitable for connecting to a WAN? In reality, it is often the case that serial links can be clocked considerably faster than parallel links, and they achieve a higher data rate, because of two factors that affect parallel communications: **clock skew and crosstalk interference.**

notice that the bits of the parallel connection do not arrive at the same time due to clock skew.

Clock Skew

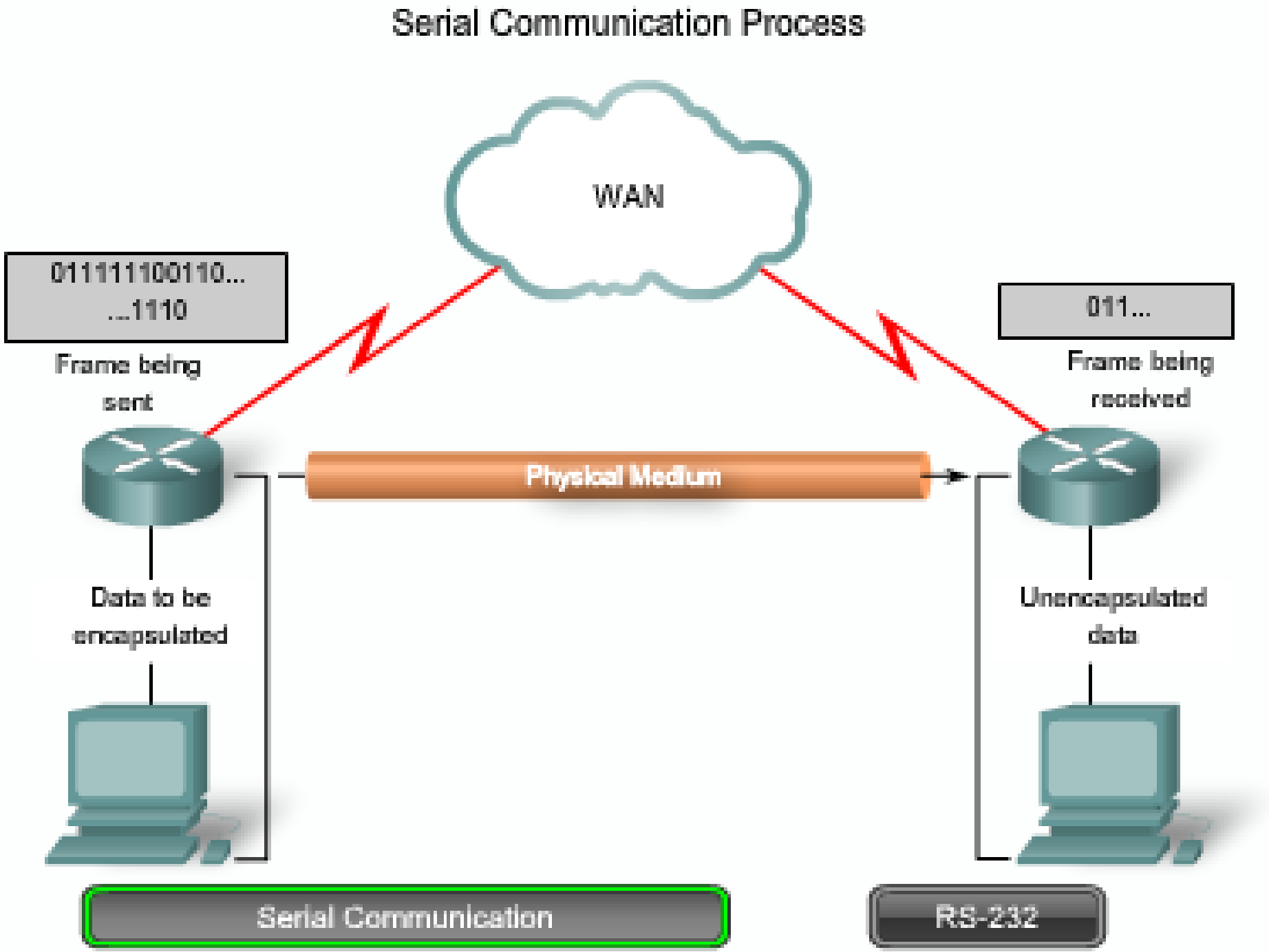

Parallel Communication
Byte
Byte
b1
b2
b3
b4
b5
b6
b7
b8
Bytes Received
4

Crosstalk


Parallel Communication
Byte
Byte
b1
b2
b4
b5
b6
b7
b8
Bytes Received
4
At higher frequencies, crosstalk causes bytes to be dropped.

Serial Communication Standards

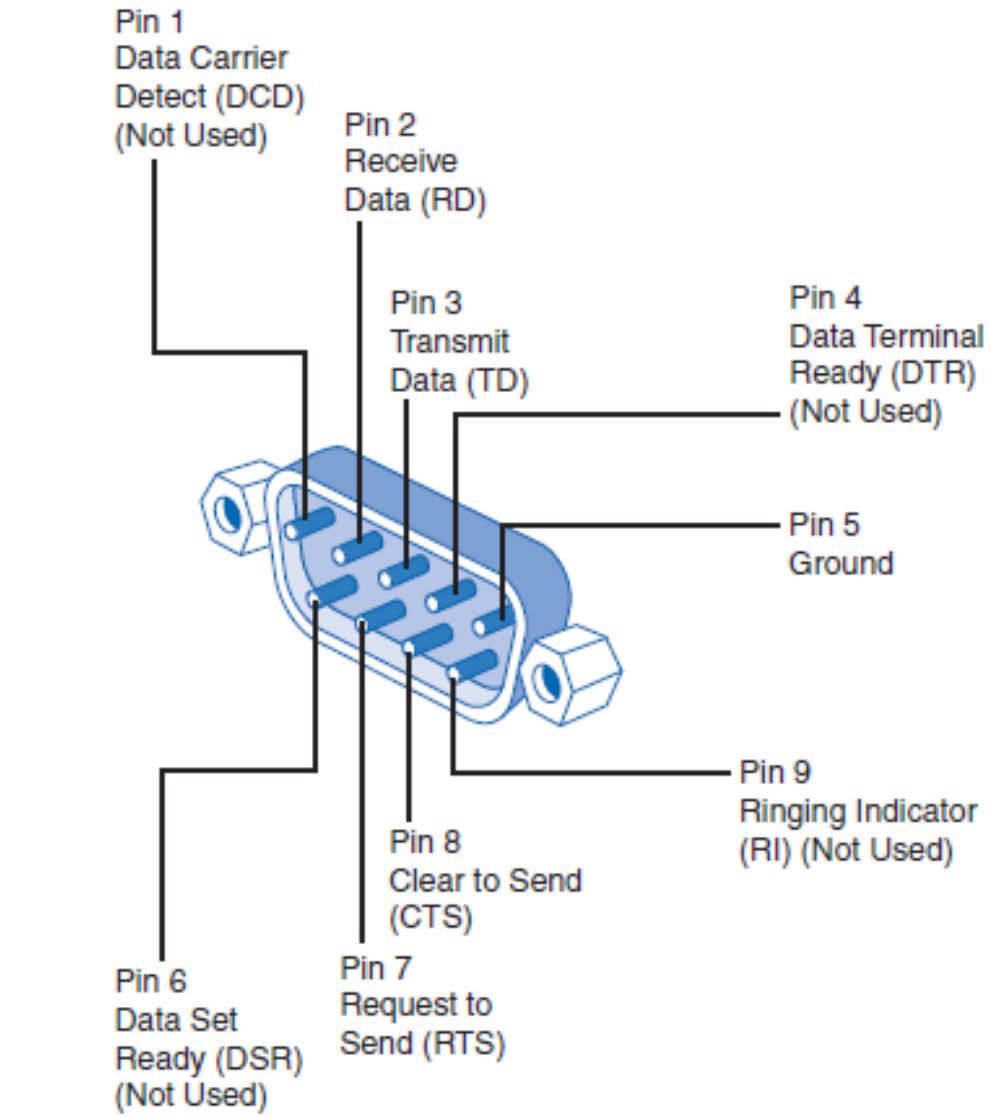
- In most cases, serial communications are considerably cheaper to implement. Serial communications use fewer wires, cheaper cables, and fewer connector pins.
- The figure is a simple representation of a serial communication. Data is encapsulated by the communications protocol used by the sending router. The encapsulated frame is sent on a physical medium to the WAN. There are various ways to traverse the WAN, but the receiving router uses the same communications protocol to de-encapsulate the frame when it arrives.


Serial Communication Process
WAN
01111110O110...
...1110
Frame being sent
011...
Frame being received
Physical Medium
Data to be encapsulated
Unencapsulated data
Serial Communication
RS-232

There are many different serial communication standards, each one using a different signaling method. Three key serial communication standards affect LAN-to-WAN connections:

- **RS-232**: Most serial ports on PCs conform to the RS-232C standard or the newer RS-422 and RS-423 standards. Although the standard defines a nine-pin connector and a 25-pin connector, the nine-pin connector is more commonly implemented. A serial port is a general-purpose interface that can be used for almost any type of device, including modems, mice, and printers. Many network devices use RJ-45 connectors that also conform to the RS-232 standard.
- **V.35**: Typically used for modem-to-multiplexer communication, this ITU standard for high-speed, synchronous data exchange combines the bandwidth of several telephone circuits. In the United States, V.35 is the interface standard used by most routers and DSUs that connect to T1 carriers. V.35 cables are high-speed serial assemblies designed to support higher data rates and connectivity between DTEs and DCEs over digital lines.
- **HSSI**: A High-Speed Serial Interface (HSSI) supports transmission rates of up to 52 Mbps. Engineers use HSSI to connect routers on LANs with WANs over high-speed lines such as T3 lines. Engineers also use HSSI to provide high-speed connectivity between LANs.

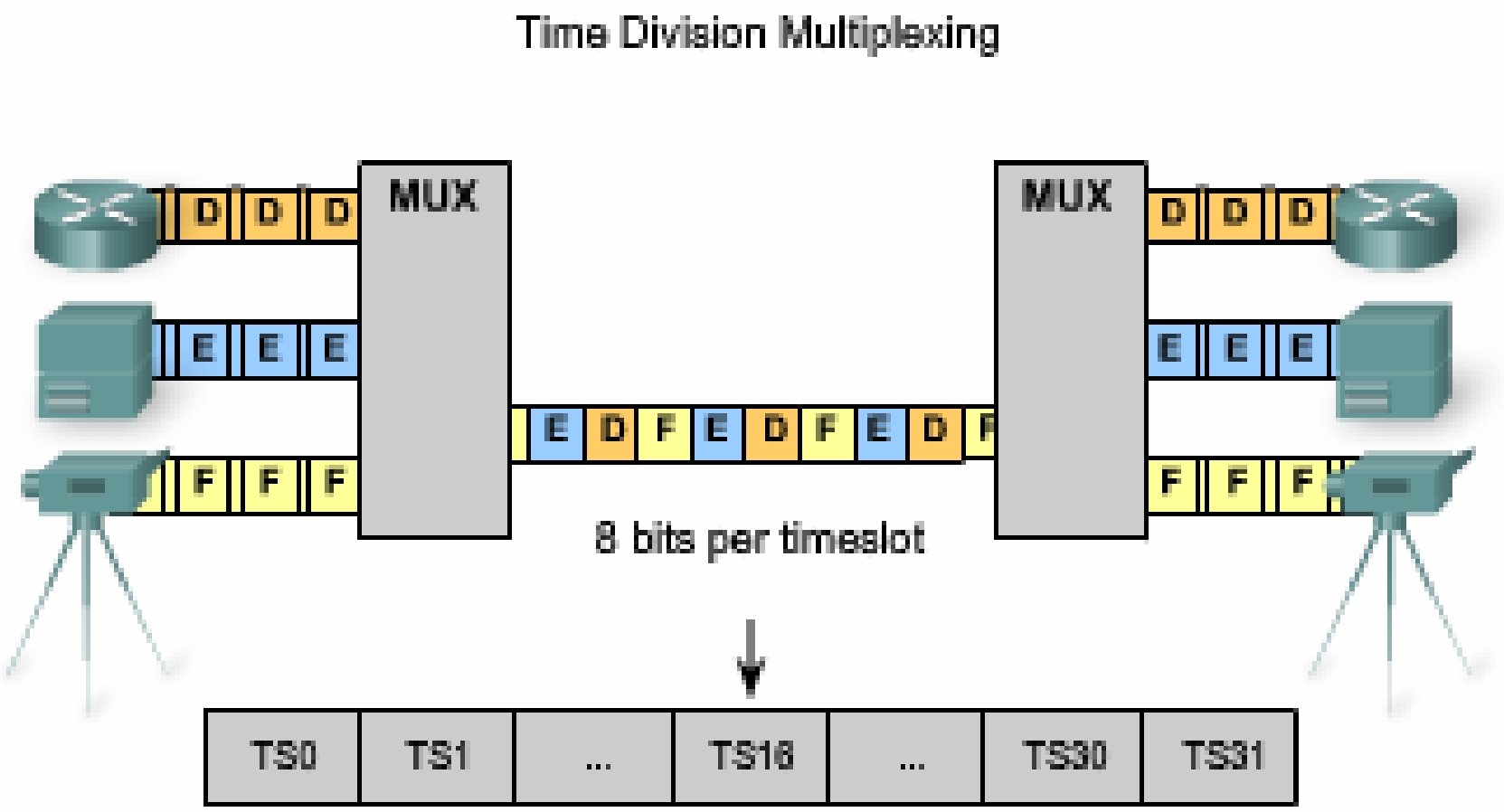
Nine-Pin RS-232 Connector



- Pin 1: Data Carrier Detect (DCD) indicates that the carrier for the transmit data is ON.
- Pin 2: The receive pin (RD) carries data from the serial device to the computer.
- Pin 3: The transmit pin (TD) carries data from the computer to the serial device.
- Pin 4: ***Data Terminal Ready (DTR)*** tells the modem that the computer is ready to transmit.
- Pin 5: Ground.
- Pin 6: ***Data Set Ready (DSR)*** is similar to DTR. It indicates that the Data set is ON.
- Pin 7: The RTS pin requests clearance to send data to a modem.
- Pin 8: The serial device uses the ***Clear to Send (CTS)*** pin to acknowledge the computer's RTS signal. In most situations, RTS and CTS are constantly ON throughout the communication session.
- Pin 9: An auto-answer modem uses the Ring Indicator (RI) to signal receipt of a telephone ring signal.

Time Division Multiplexing

- (TDM) maximizes the amount of voice traffic carried over a medium. Before multiplexing, each telephone call required its own physical link. This was an expensive and unscalable solution. TDM divides the bandwidth of a single link into separate channels or time slots. TDM transmits two or more channels over the same link by allocating a different time interval (time slot) for the transmission of each channel. In effect, the channels take turns using the link.


Time Division Multiplexing
MUX
MUX
D D D
E E E
F F F
E D F E D F E D F
8 bits per timeslot
TS0
TS1
...
TS16
...
TS30
TS31

- TDM is a Physical layer concept. It has no regard for the nature of the information that is being multiplexed onto the output channel. TDM is independent of the Layer 2 protocol.
- TDM can be explained by an analogy to highway traffic. To transport traffic from four roads to another city, you can send all the traffic on one lane if the feeding roads are equally serviced and the traffic is synchronized. So, if each of the four roads puts a car onto the main highway every four seconds, the highway gets a car at the rate of one each second. As long as the speed of all the cars is synchronized, there is no collision. At the destination, the reverse happens and the cars are taken off the highway and fed to the local roads by the same synchronous mechanism.
- This is the principle used in synchronous TDM when sending data over a link. TDM increases the capacity of the transmission link by slicing time into smaller intervals so that the link carries the bits from multiple input sources, effectively increasing the number of bits transmitted per second. With TDM, the transmitter and the receiver both know exactly which signal is being sent.

- DTE-DCE:

  From the point of view of connecting to the WAN, a serial connection has a DTE device at one end of the connection and a DCE device at the other end. The connection between the two DCE devices is the WAN service provider transmission network.

Serial DCE and DTE WAN Connections

Data Terminal Equipment:

- End of the user's device on the WAN Link

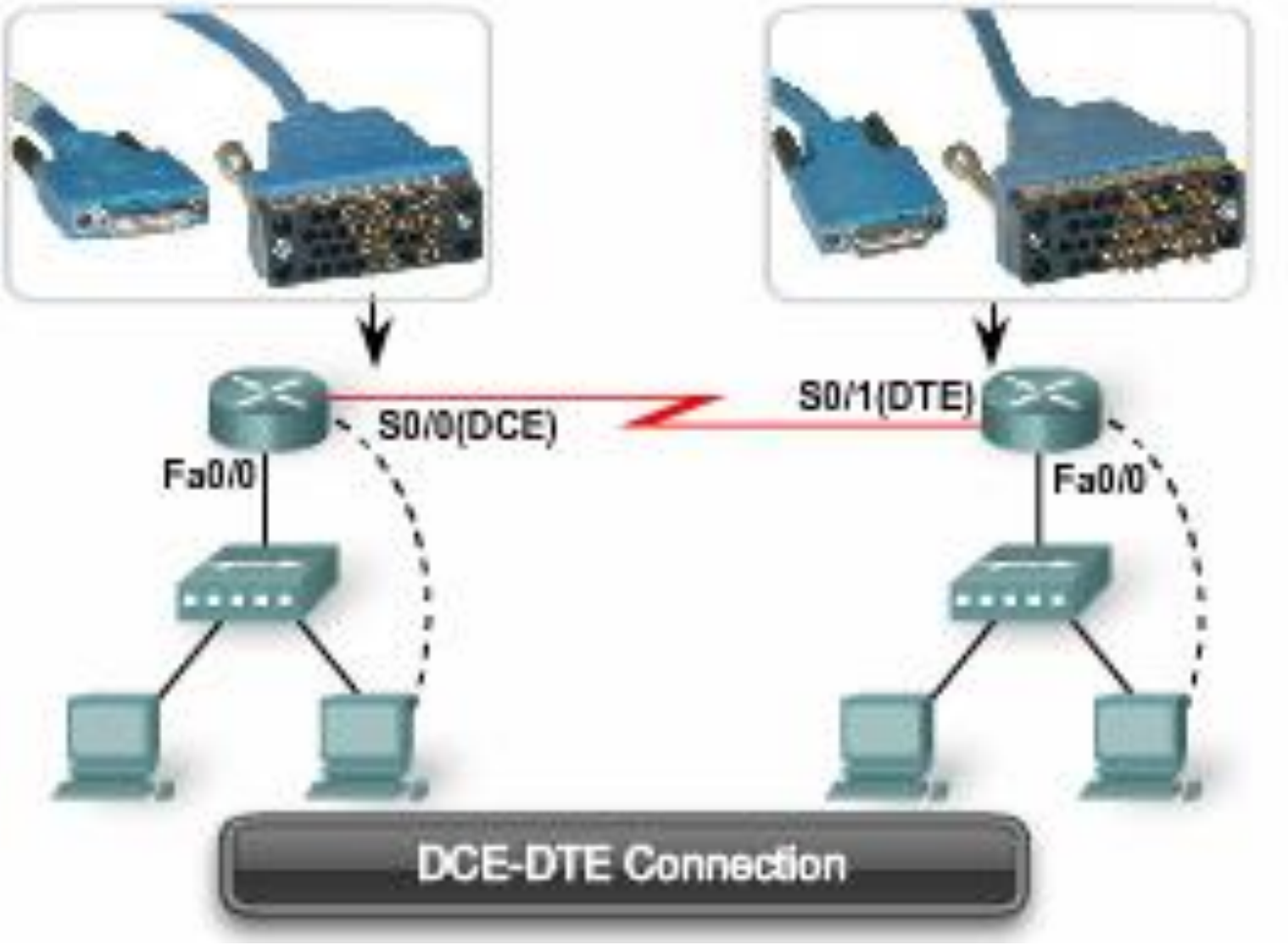
Data Communications Equipment:

- End of the WAN provider's side of the communication facility
- Responsible for providing clocking signal

- The CPE, which is generally a router, is the DTE. The DTE could also be a terminal, computer, printer, or fax machine if they connect directly to the service provider network.
- The DCE, commonly a modem or CSU/DSU, is the device used to convert the user data from the DTE into a form acceptable to the WAN service provider transmission link. This signal is received at the remote DCE, which decodes the signal back into a sequence of bits. The remote DCE then signals this sequence to the remote DTE.
- When a DTE and DCE are connected, the serial port on a router is the DTE end of the connection by default, and the clock signal is typically provided by a CSU/DSU or similar DCE device.

Smart Serial Connector

Serial WAN Connections in the Lab

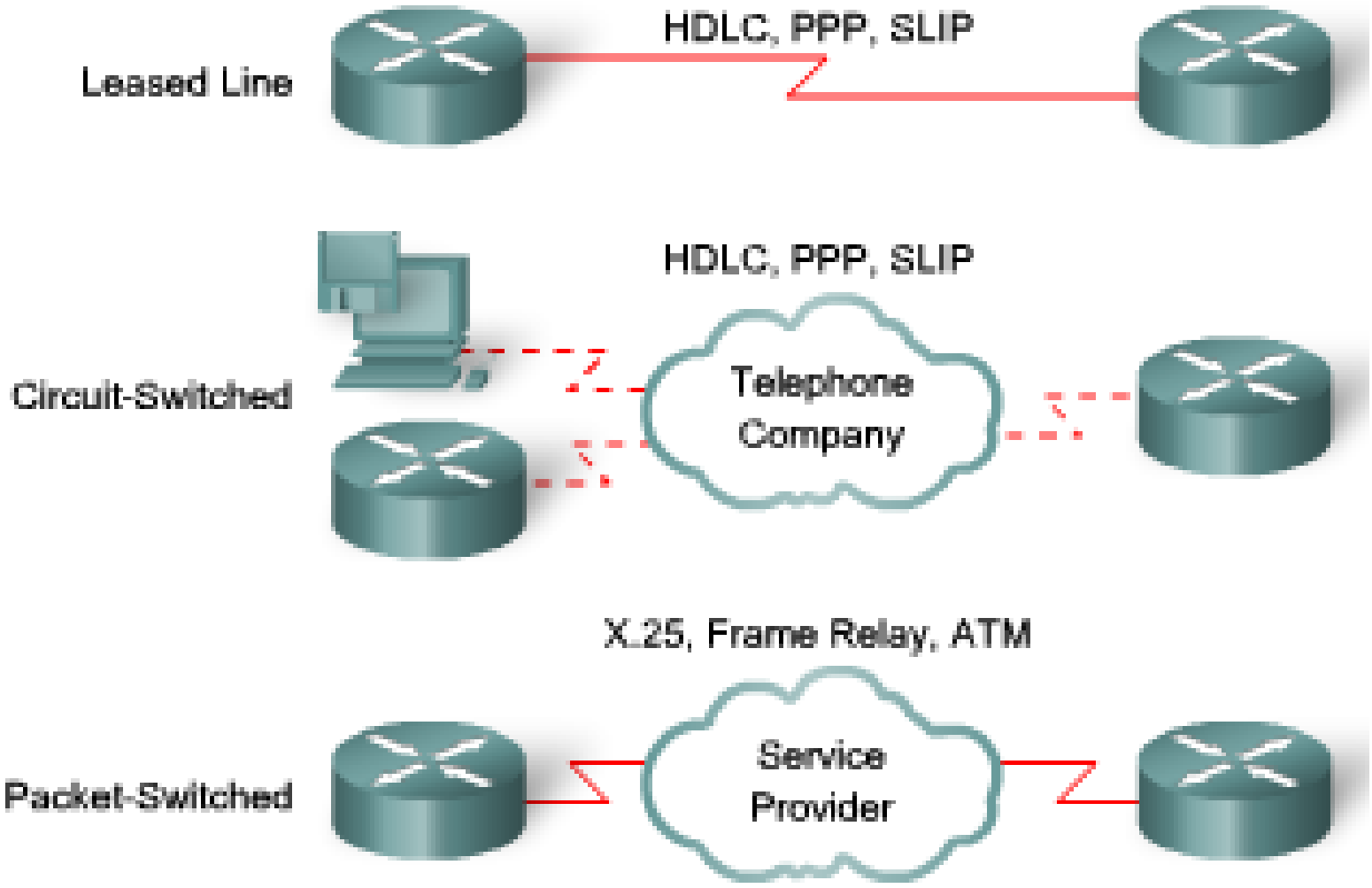



CONN
CONN
WIC
2T

HDLC Encapsulation
WAN Encapsulation Protocols

- On each WAN connection, data is encapsulated into frames before crossing the WAN link. To ensure that the correct protocol is used, you need to configure the appropriate Layer 2 encapsulation type. The choice of protocol depends on the WAN technology and the communicating equipment. The more common WAN protocols and where they are used is shown in the figure.

WAN Encapsulation Protocols

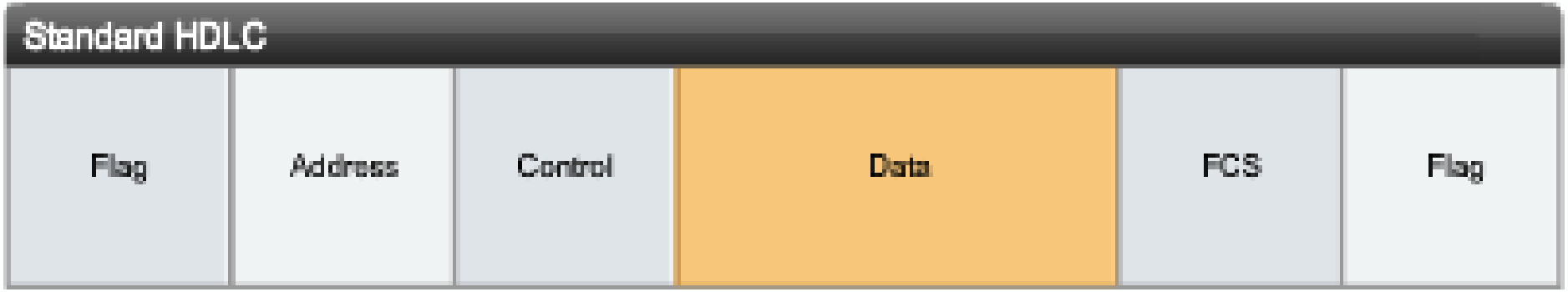


- **HDLC** - The default encapsulation type on *point-to-point connections, dedicated links, and circuit-switched connections* when the link uses two Cisco devices. HDLC is now the basis for synchronous PPP used by many servers to connect to a WAN, most commonly the Internet.
- **PPP** - Provides router-to-router and host-to-network connections over synchronous and asynchronous circuits. PPP works with several Network layer protocols, such as IP and IPX. PPP also has built-in security mechanisms such as PAP and CHAP.
- **Serial Line Internet Protocol (SLIP)** - A standard protocol for point-to-point serial connections using TCP/IP. SLIP has been largely displaced by PPP.
- **Frame Relay** - Industry standard, switched, Data Link layer protocol that handles multiple virtual circuits. Frame Relay is a next generation protocol after X.25. Frame Relay eliminates some of the time-consuming processes (such as error correction and flow control) employed in X.25.
- **ATM** - The international standard for cell relay in which devices send multiple service types (such as voice, video, or data) in fixed-length (53-byte) cells. Fixed-length cells allow processing to occur in hardware, thereby reducing transit delays. ATM takes advantages of high-speed transmission media such as E3, SONET (Synchronous Optical Network) , and T3.

HDLC Encapsulation

- HDLC is a synchronous Data Link layer bit-oriented protocol developed by the International Organization for Standardization (ISO). The current standard for HDLC is ISO 13239. HDLC was developed from the Synchronous Data Link Control (SDLC) standard proposed in the 1970s. HDLC provides both connection-oriented and connectionless service.

- HDLC uses synchronous serial transmission to provide error-free communication between two points. HDLC defines a Layer 2 framing structure that allows for flow control and error control through the use of acknowledgments. Each frame has the same format, whether it is a data frame or a control frame.



- When you want to transmit frames over synchronous or asynchronous links, you must remember that those links have no mechanism to mark the beginnings or ends of frames. HDLC uses a frame delimiter, or flag, to mark the beginning and the end of each frame.