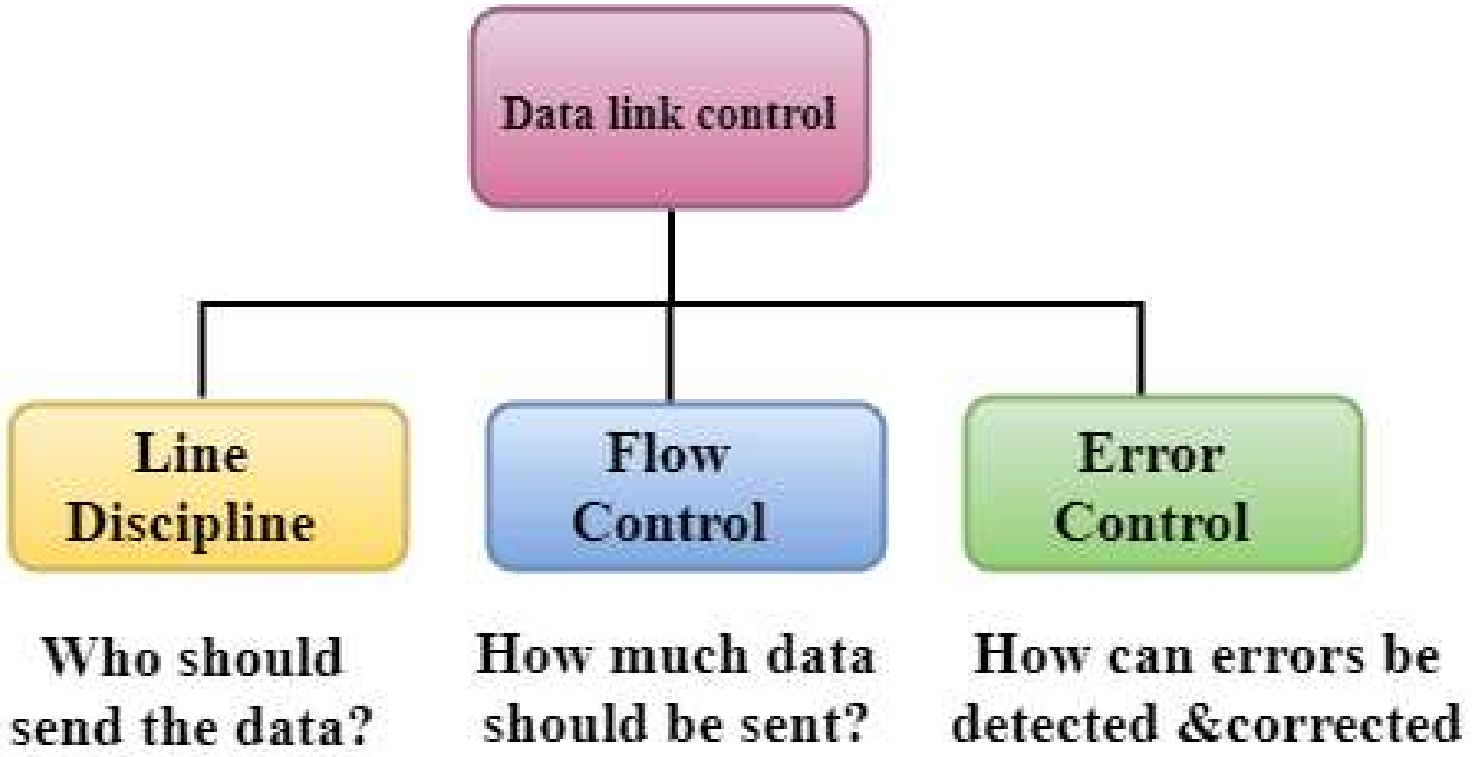
Chapter 11

Data Link Control (DLC)



Objective

- DLC sublayer : flow and error control.
- Simple and common data-link protocols at the DLC sublayer: Simple Protocol and Stop-and-Wait Protocol.
- HDLC such as PPP and Ethernet.
- PPP using an FSM.
- Multiplexing in PPP.

DLC Services

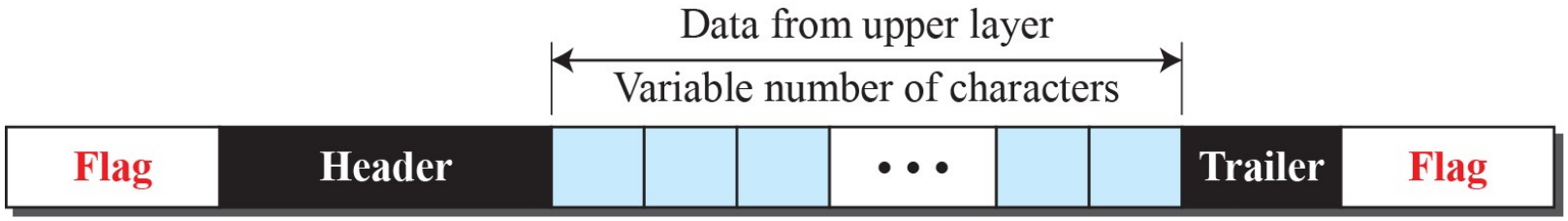
- The data link control (DLC) deals with procedures for communication between two adjacent nodes no matter whether the link is dedicated or broadcast.
- Data link control functions include framing and flow and error control.
- First, we discuss framing, or how to organize the bits that are carried by the physical layer. We then discuss flow and error control.

Framing

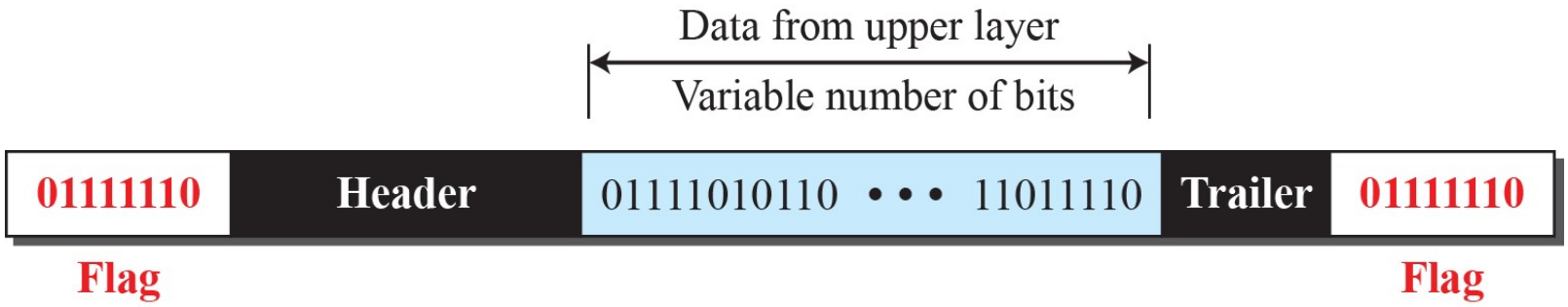
- The data-link layer needs to pack bits into frames, so that each frame is distinguishable from another.
- Our postal system practices a type of framing. The simple act of inserting a letter into an envelope separates one piece of information from another.
- Framing in the data-link layer separates a message from one source to a destination by adding a sender address and a destination address.

Framing

- The destination address defines where the packet is to go; the sender address helps the recipient acknowledge the receipt.



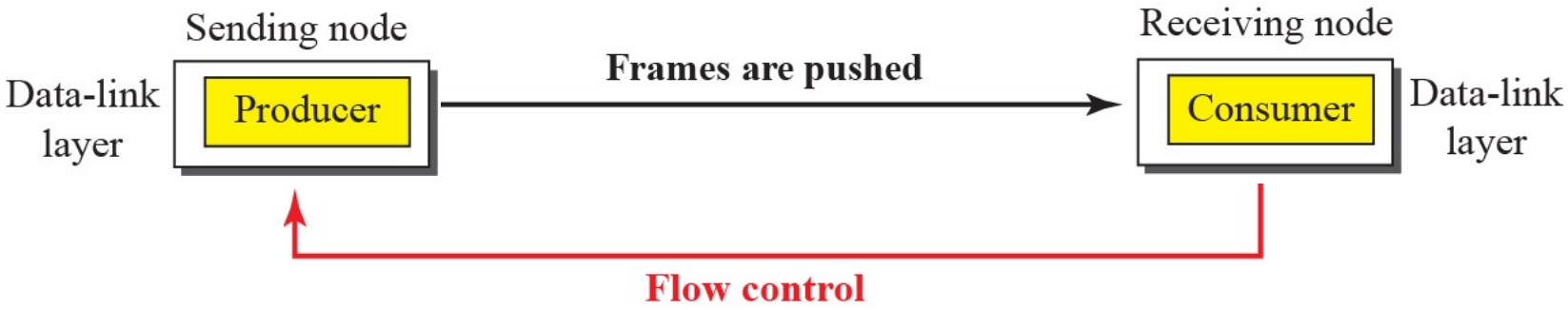
A frame in a character-oriented protocol



A frame in a bit-oriented protocol

Flow and Error Control

- One of the responsibilities of the data-link control sublayer is flow and error control at the data-link layer.



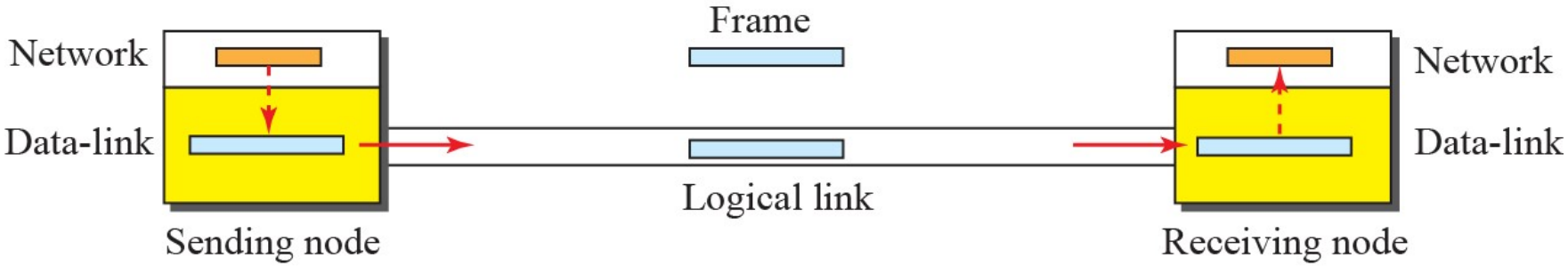
Flow control at the data link layer

Data-Link Layer Protocols

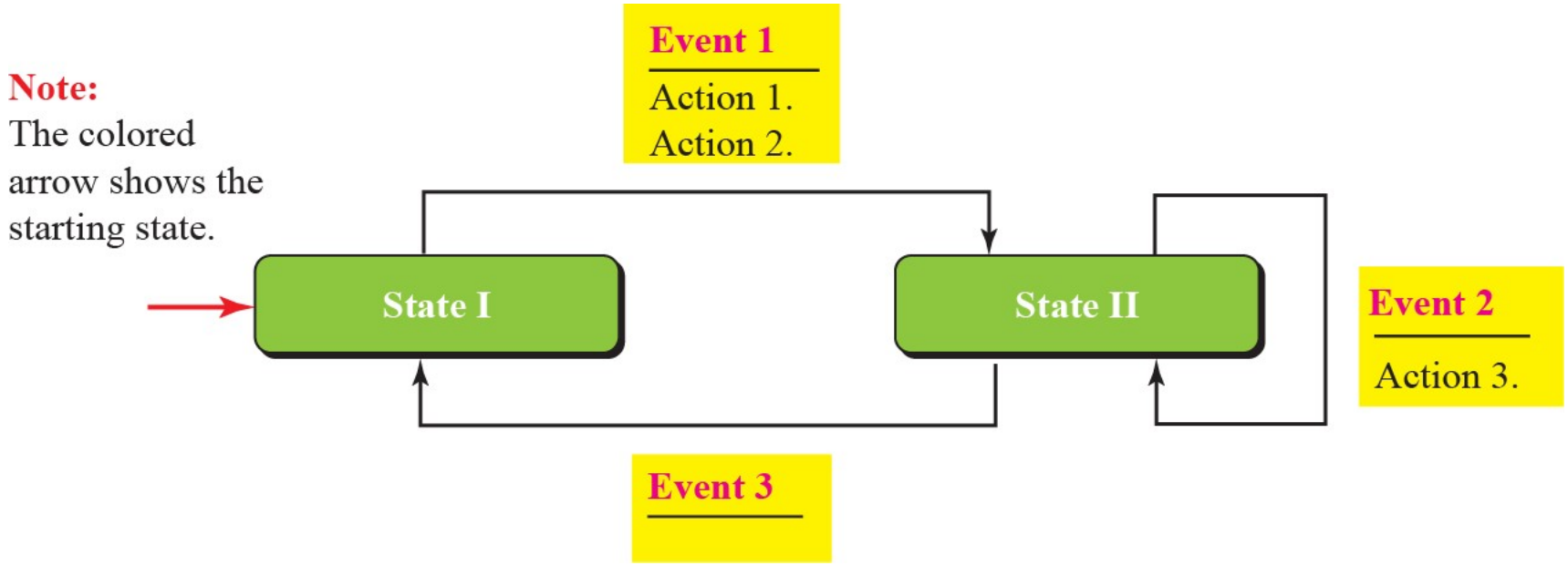
- Traditionally four protocols have been defined for the data-link layer to deal with flow and error control: **Simple, Stop-and-Wait**, *Go-Back-N, and Selective-Repeat*.
- Although the first two protocols still are used at the data-link layer, the last two have disappeared.
- We therefore briefly discuss the first two protocols in this chapter.

Simple Protocol

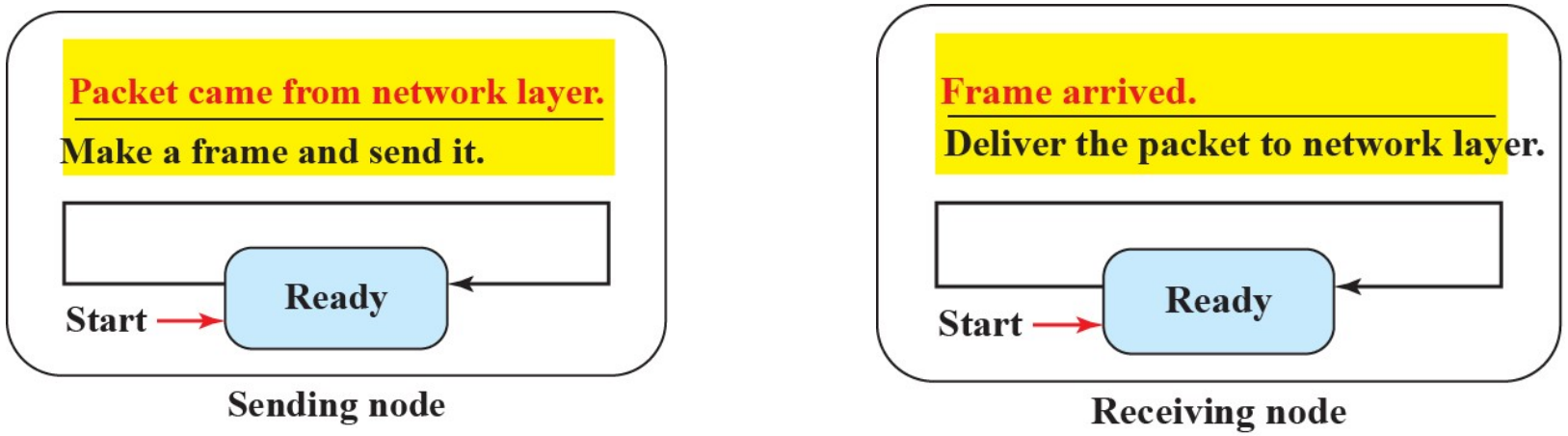
- Our first protocol is a simple protocol with neither flow nor error control. We assume that the receiver can immediately handle any frame it receives.
- In other words, the receiver can never be overwhelmed with incoming frames.



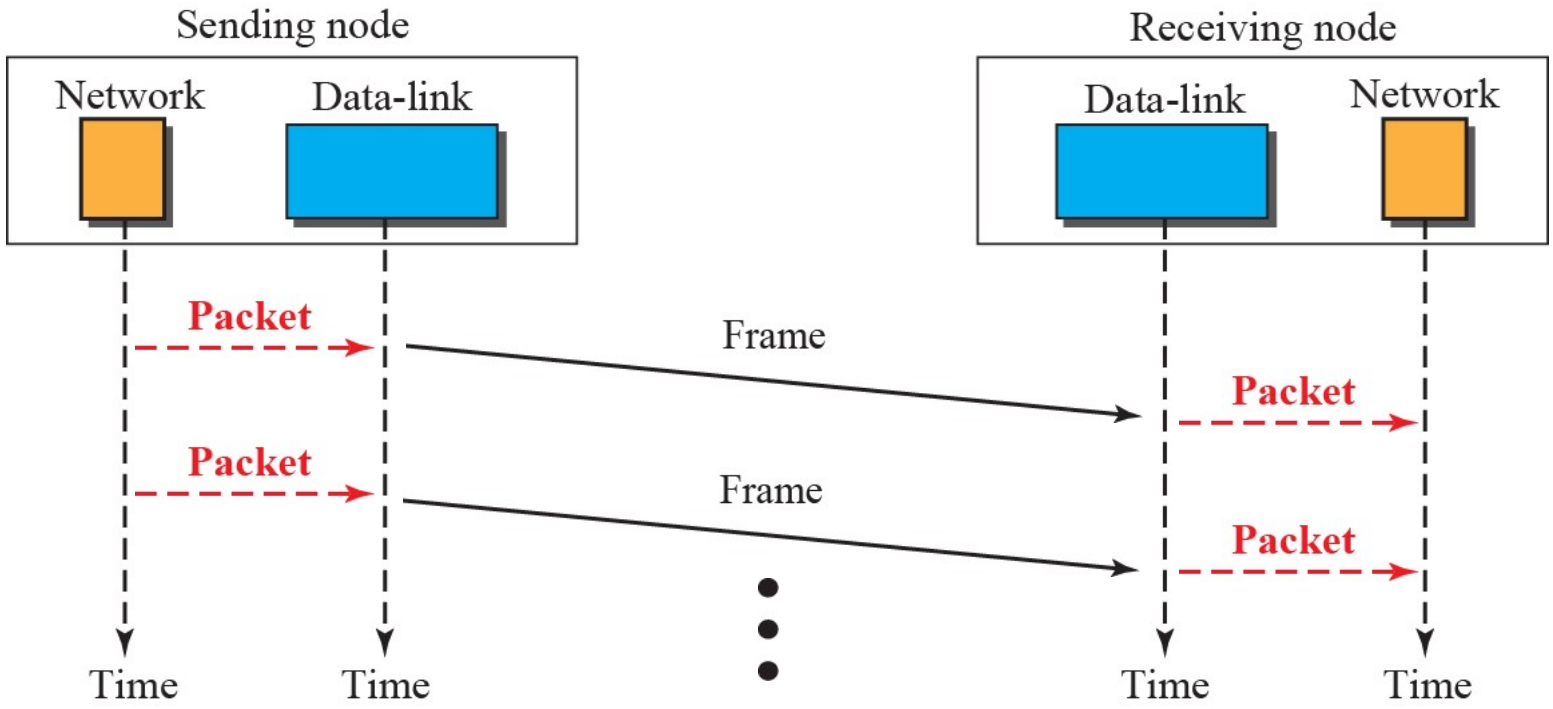
Simple protocol



FSMs



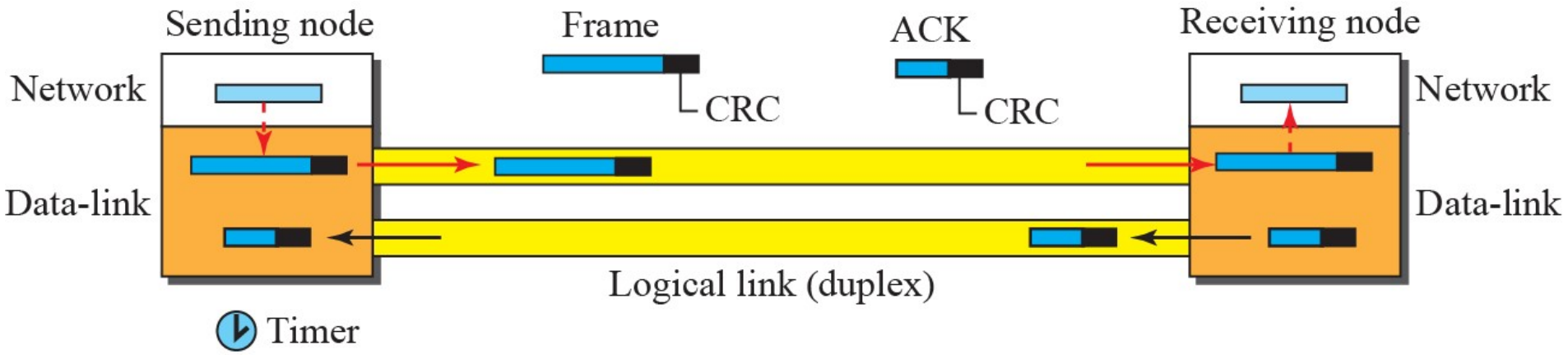
FSM for the simple protocol



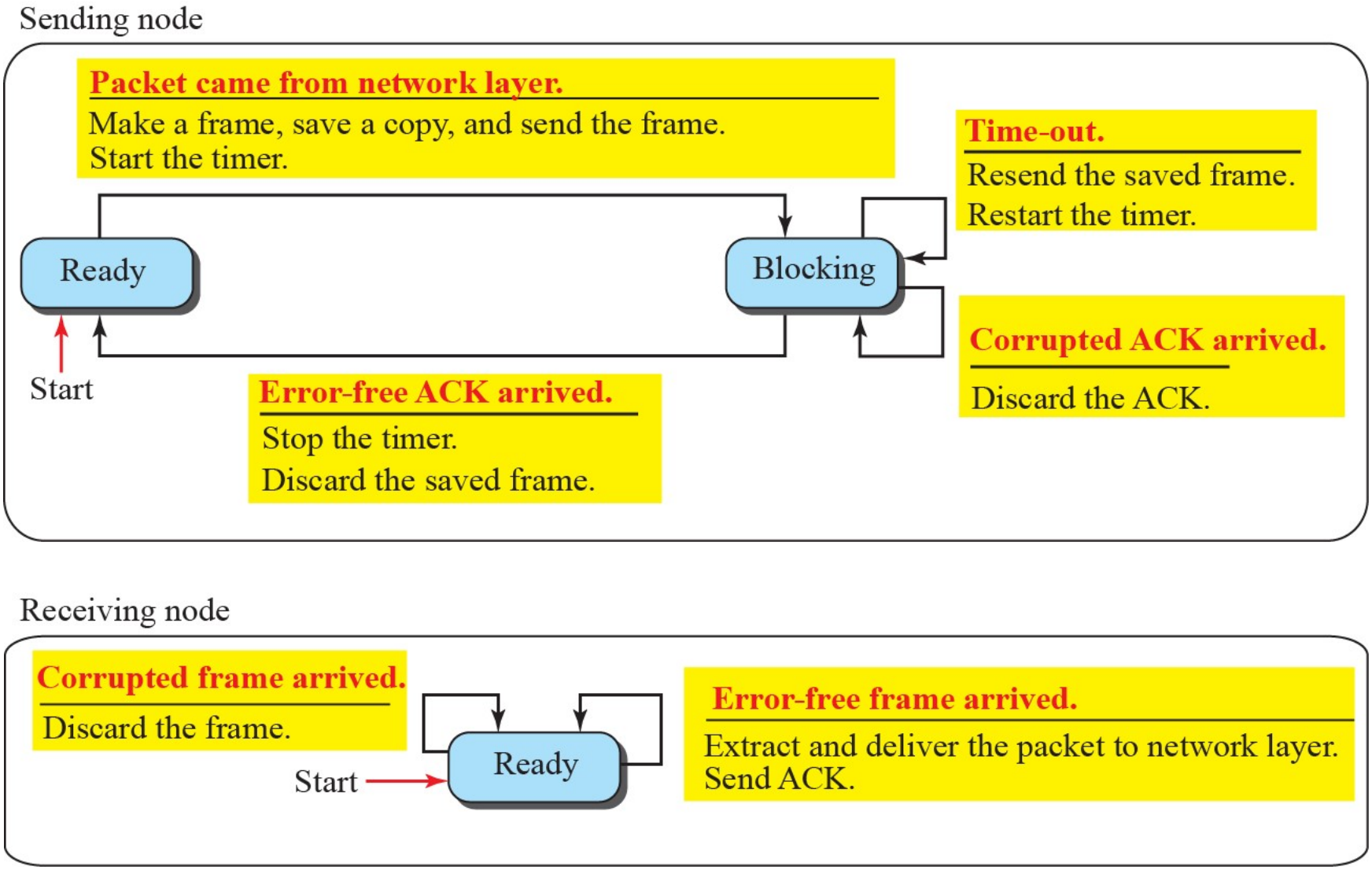
Flow diagram

Stop-and-Wait Protocol

- Stop-and-Wait protocol, which uses both flow and error control.
- We show a primitive version of this protocol without sliding windows.
- In this protocol, the sender sends one frame at a time and waits for an acknowledgment before sending the next one.
- To detect corrupted frames, we need to add a CRC to each data frame.



Stop-and-wait Protocol



FSM for the stop-and-wait protocol

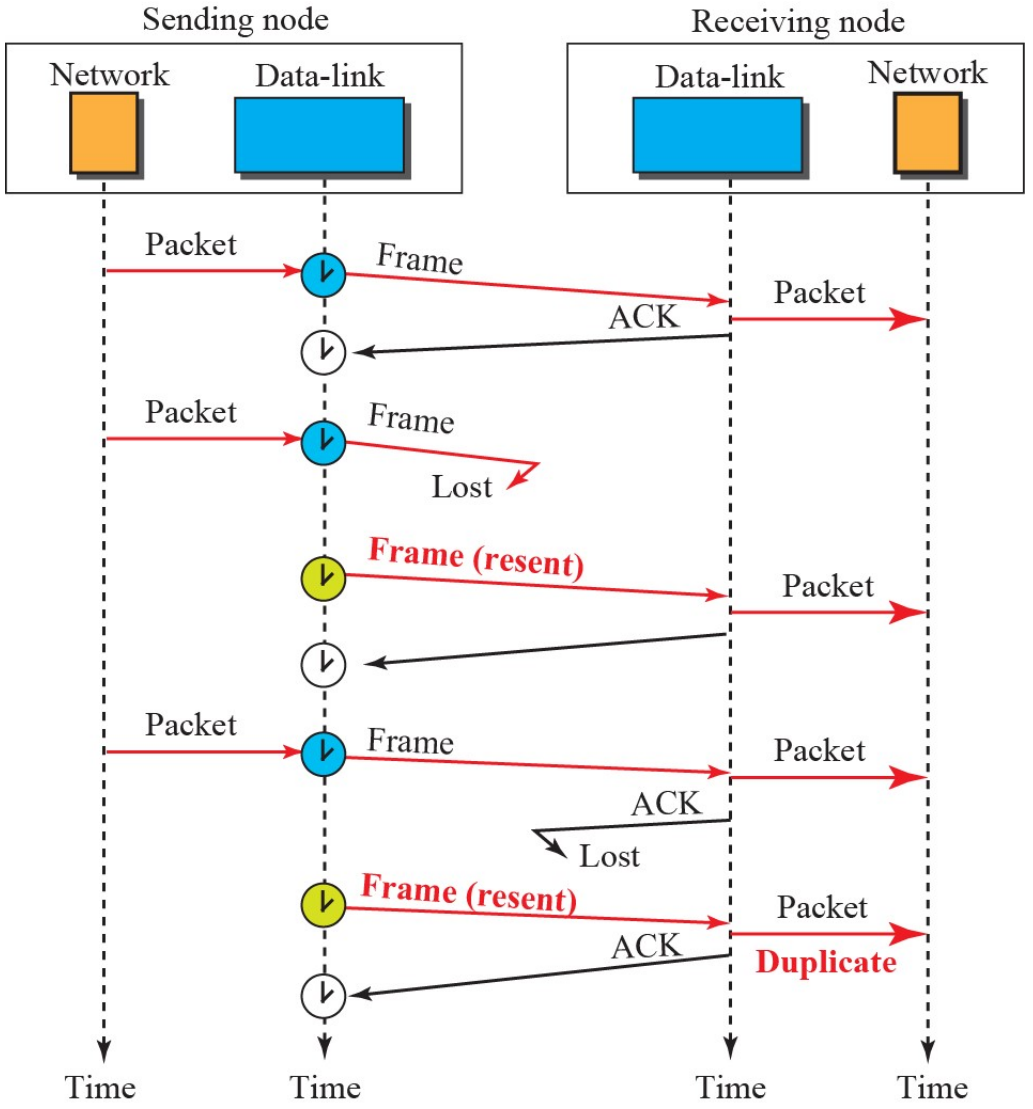
Legend

- Start the timer.
- Stop the timer.
- Restart a time-out timer.

Notes:

A lost frame means either lost or corrupted.

A lost ACK means either lost or corrupted.



Flow diagram for Example

Legend

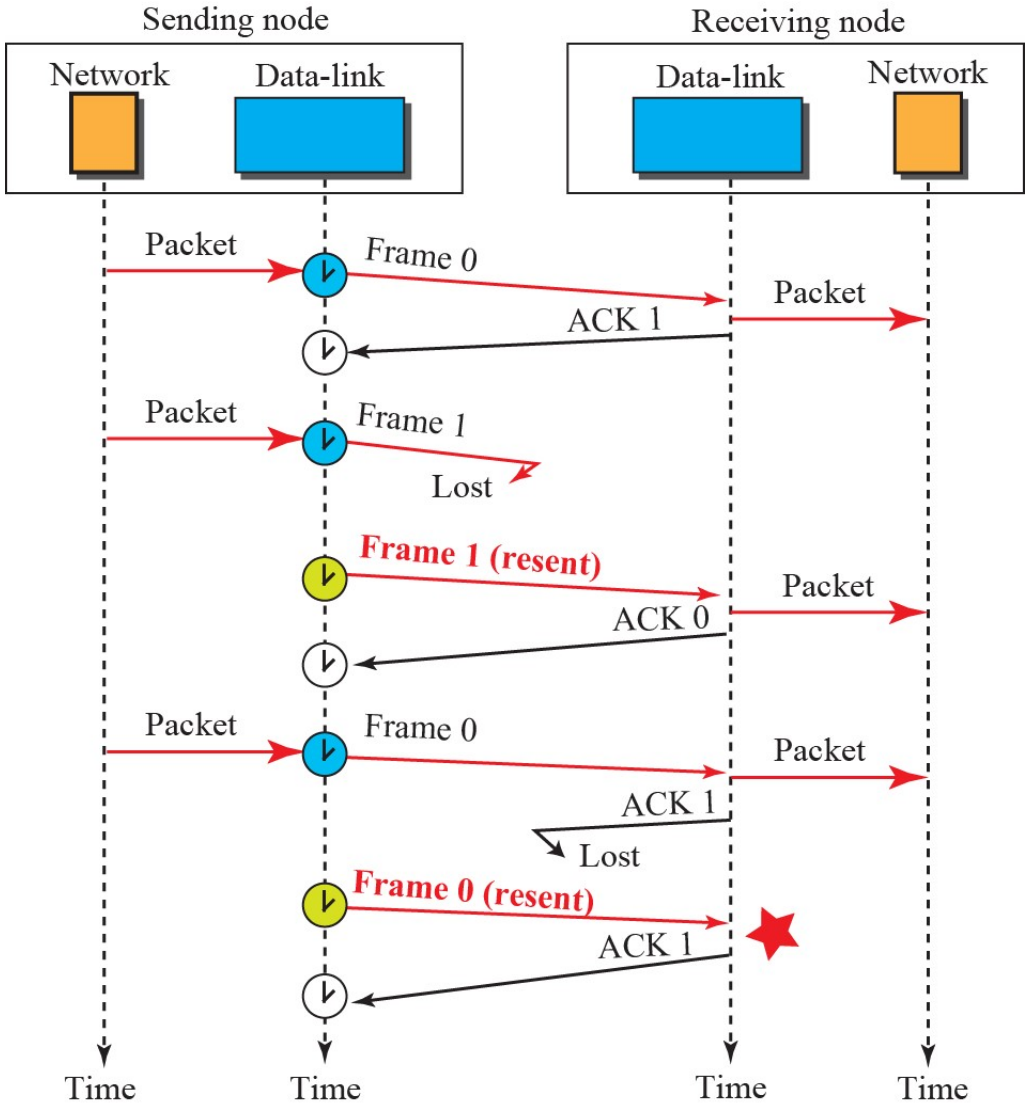
- Start the timer.
- Stop the timer.
- Restart a time-out timer.

Notes:

A lost frame means either lost or corrupted.

A lost ACK means either lost or corrupted.

Frame 0 is discarded because the receiver expects frame 1.



Flow diagram for Example

Piggybacking

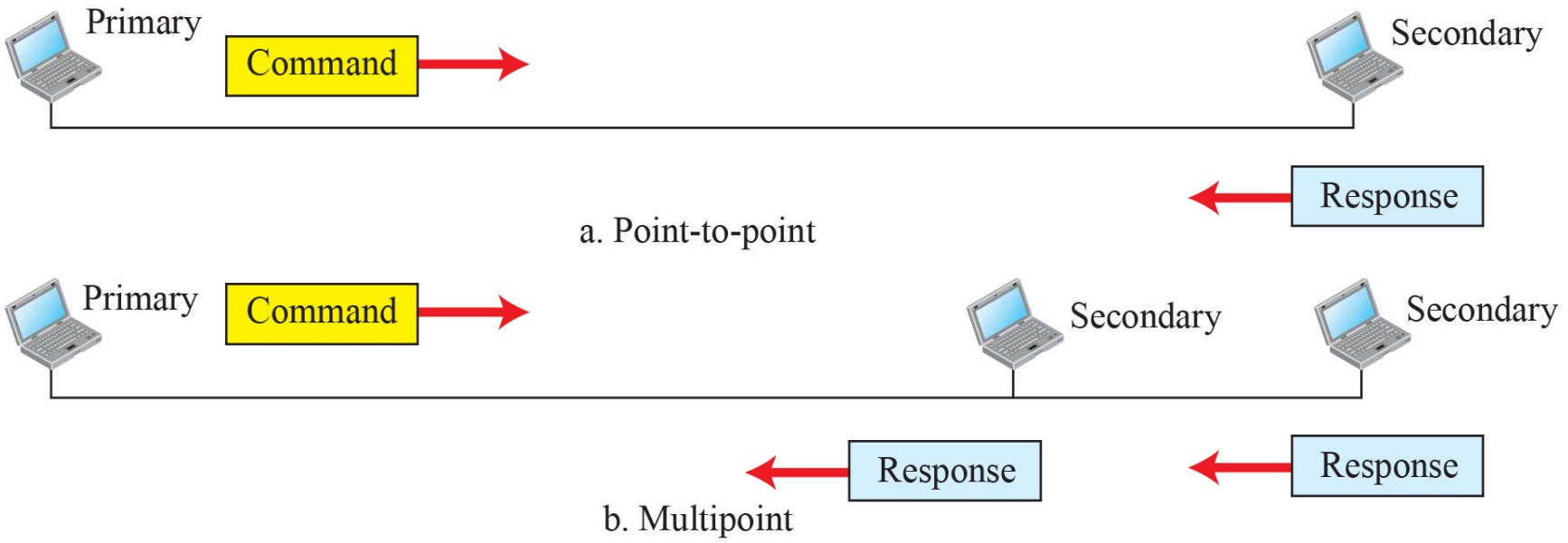
- The two protocols we discussed in this section are designed for unidirectional communication, in which data is flowing only in one direction although the acknowledgment may travel in the other direction.
- Protocols have been designed in the past to allow data to flow in both directions.
- However, to make the communication more efficient, the data in one direction is piggybacked with the acknowledgment in the other direction.

HDLC

- **High-level Data Link Control (HDLC)** is a bit - oriented protocol for communication over point-to-point and multipoint links. It implements the Stop-and-Wait protocol.

- Although this protocol is more a theoretical issue than practical, most of the concept defined in this protocol is the basis for other practical protocols such as PPP, Ethernet, or wireless LANs.

- HDLC provides two common transfer modes that can be used in different configurations: normal response mode (NRM) and asynchronous balanced mode (ABM).



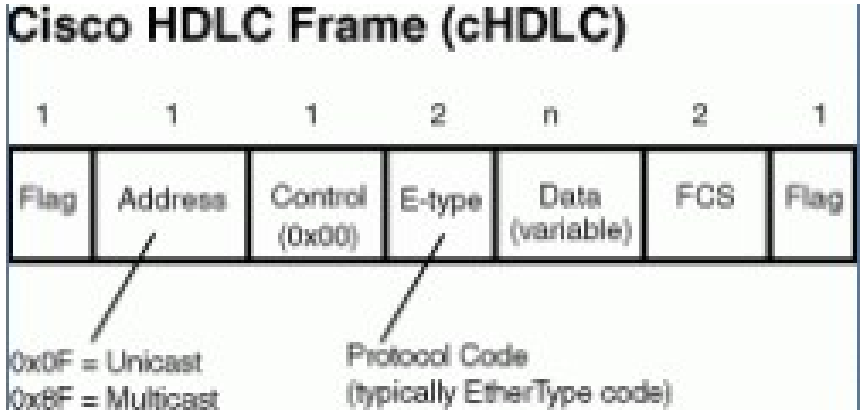
Normal response mode

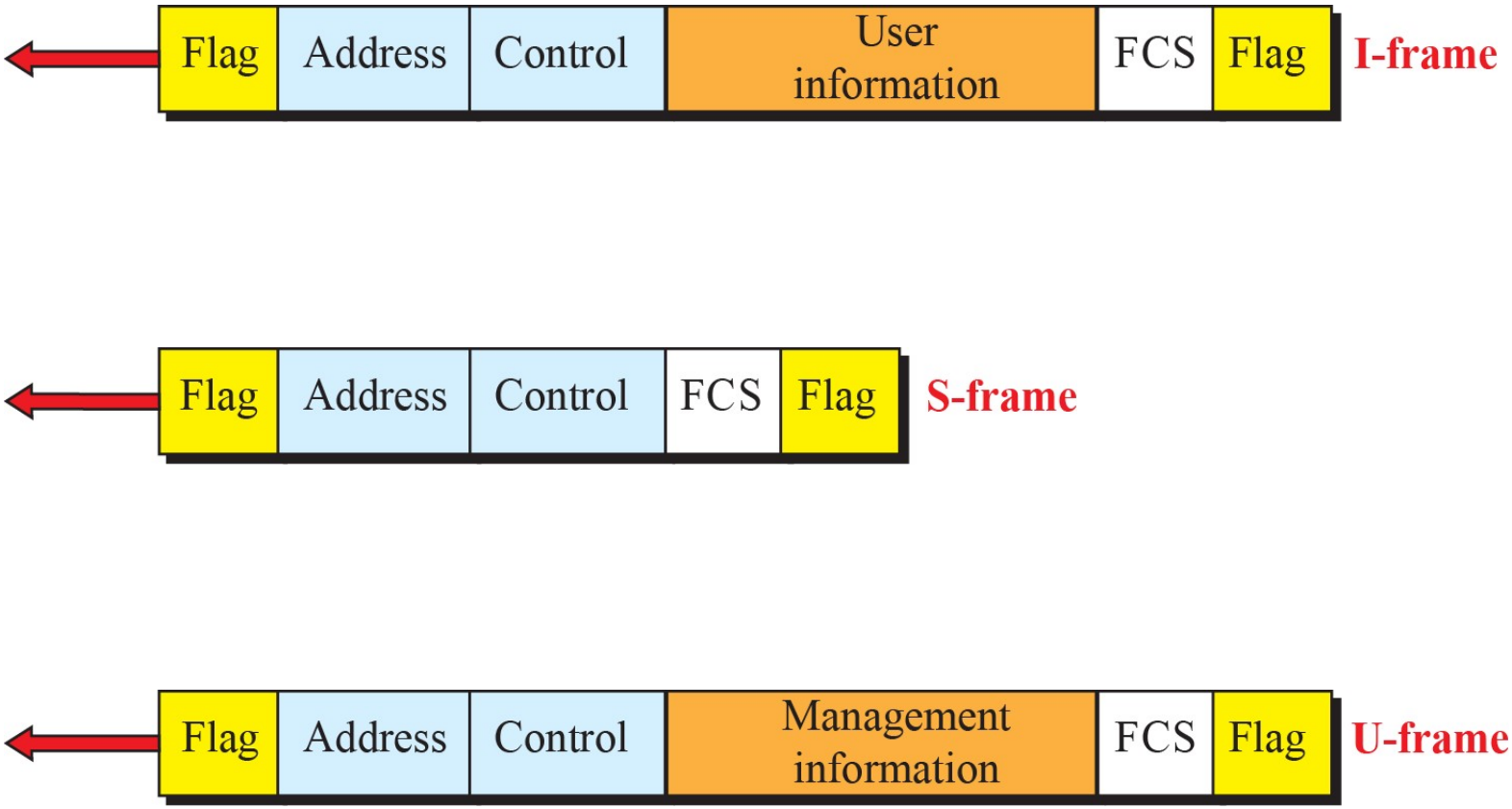
Asynchronous balanced mode

Framing

- To provide the flexibility necessary to support all the options possible in the modes and configurations just described, HDLC defines three types of frames:

- information frames (I-frames), supervisory frames (S-frames), and unnumbered frames (U-frames).




Flag
Address
Control
User information
FCS
Flag
I-frame
Flag
Address
Control
FCS
Flag
S-frame
Flag
Address
Control
Management information
FCS
Flag
U-frame

HDLC frames

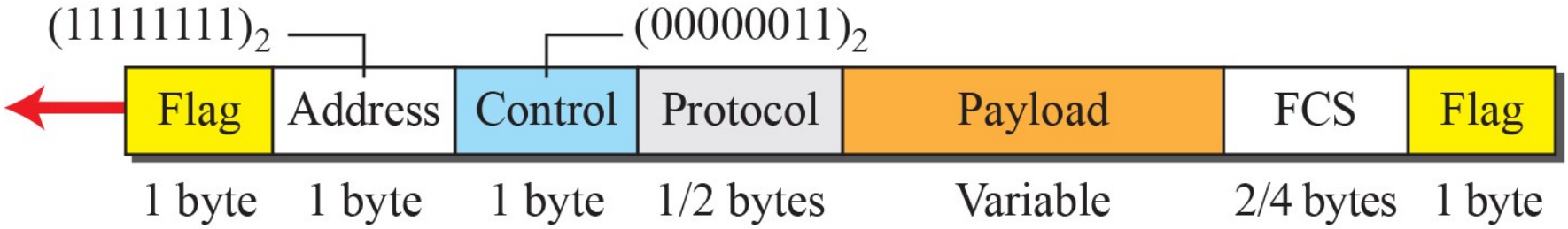
PPP

- One of the most common protocols for point-to-point access is the Point-to-Point Protocol (PPP).
- Today, millions of Internet users who need to connect their home computers to the server of an Internet service provider use PPP.
- To control and manage the transfer of data, there is a need for a point-to-point protocol at the data-link layer. PPP is by far the most common.

Services

- The designers of PPP have included several services to make it suitable for a point-to-point protocol, but have ignored some traditional services to make it simple.

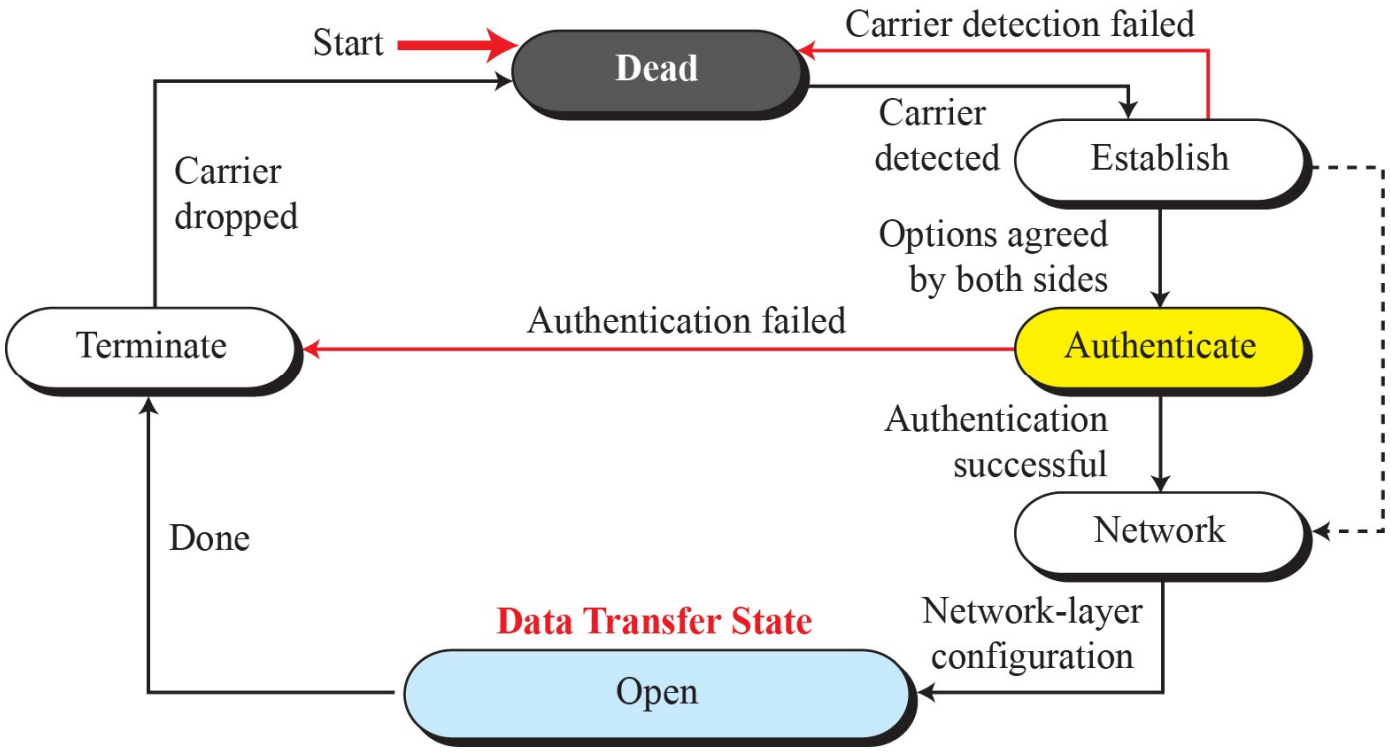
- PPP uses a character-oriented (or byte-oriented) frame.



PPP frame format

Transition Phases

- A PPP connection goes through phases which can be shown in a transition phase diagram.



Transition phases

Multiplexing

- Although PPP is a link-layer protocol, it uses another set of protocols to establish the link, authenticate the parties involved, and carry the network-layer data.
- Three sets of protocols are defined to make PPP powerful:
- Link Control Protocol (LCP), two Authentication Protocols (APs), and several Network Control Protocols (NCPs).