Computer Network

Lecture 3
DLC Layer

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Contents

- **DLC Basic**
- Simple Protocol
- Stop-and-Wait Protocol
- Go-Back-N Protocol
- Selective Repeat Protocol
- DLC Example - HDLC
- DLC Example - PPP

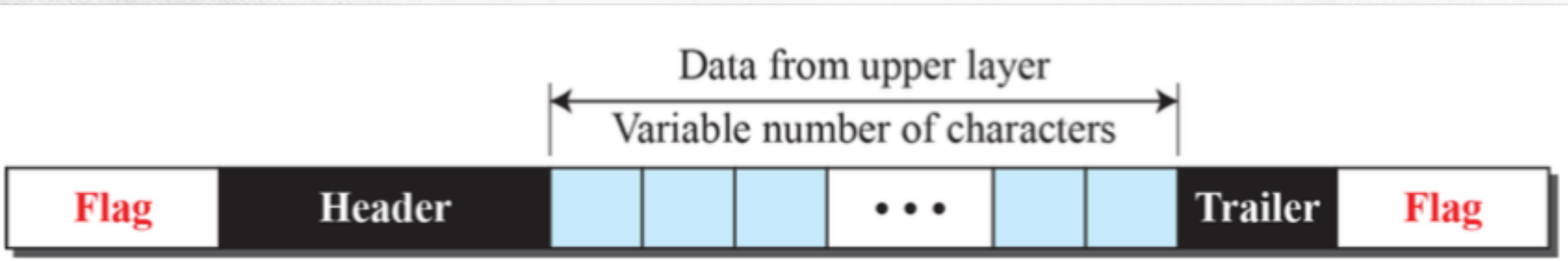
Concept

- The data link control (DLC)
  - deals with procedures for communication between two adjacent nodes no matter whether the link is dedicated or broadcast.
  - control functions include framing and flow and error control.

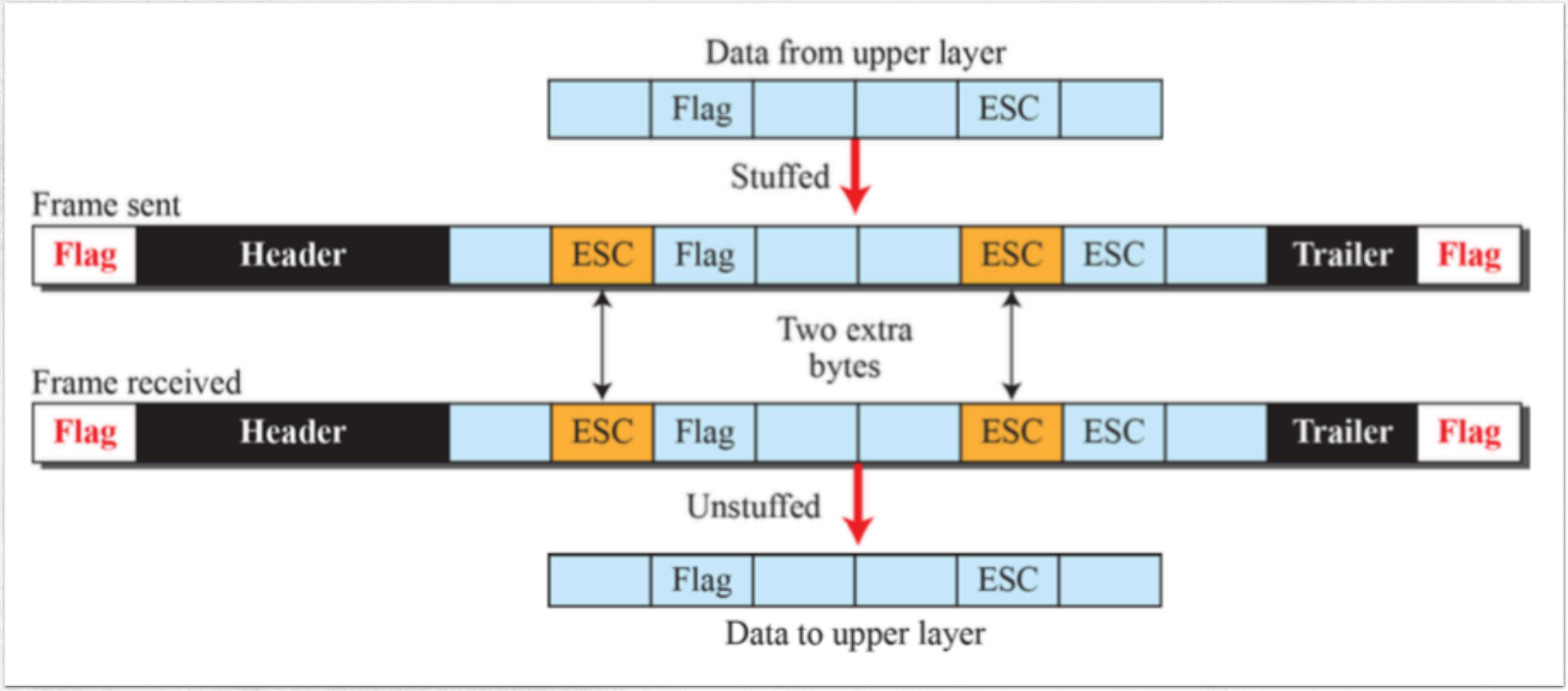
Framing

- 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; the envelope serves as the delimiter.
- Framing in the data-link layer separates a message from one source to a destination by adding a sender address and a destination address. The destination address defines where the packet is to go; the sender address helps the recipient acknowledge the receipt.

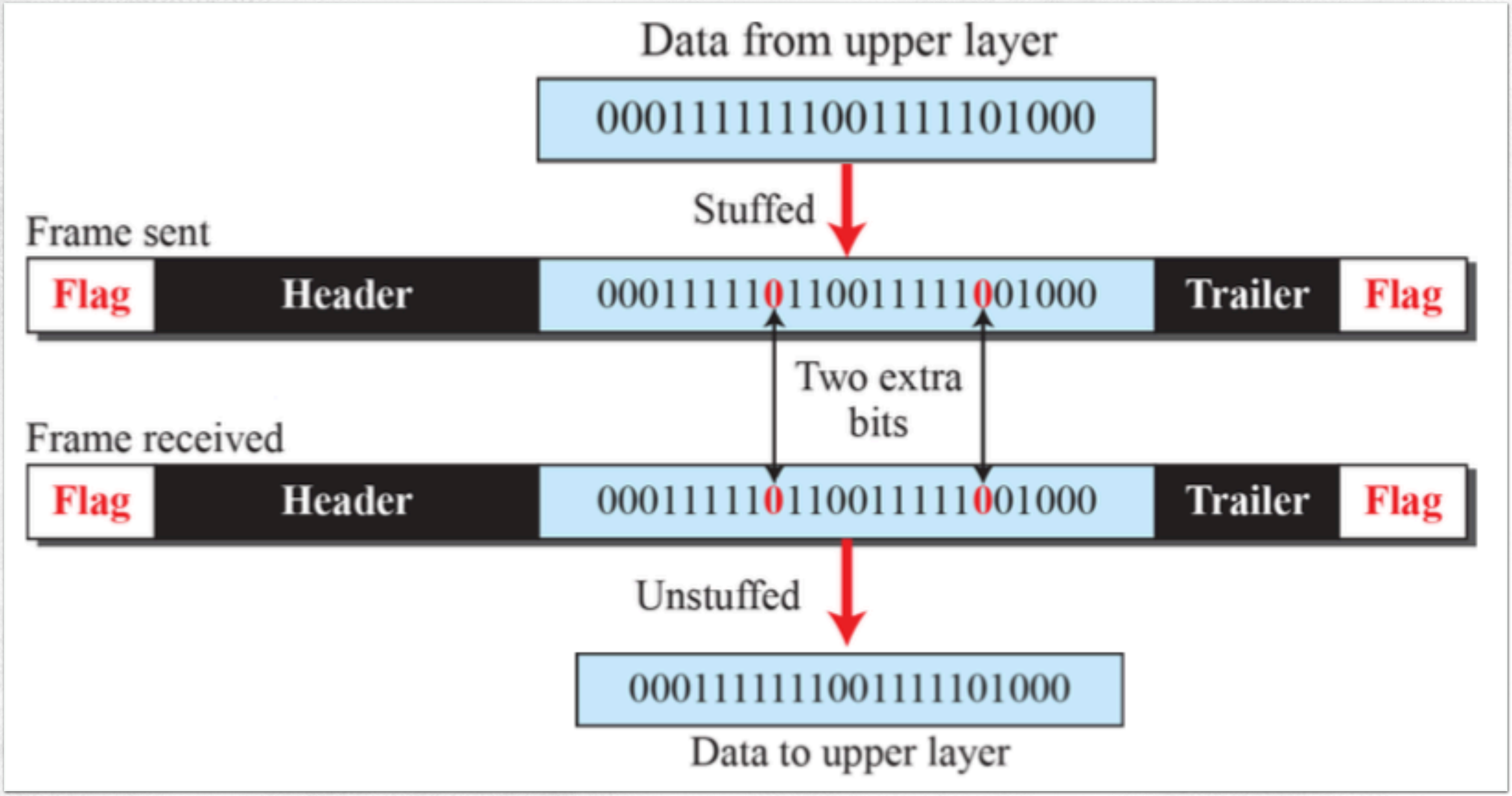
A frame in a character-oriented protocol



Byte stuffing and unstuffing

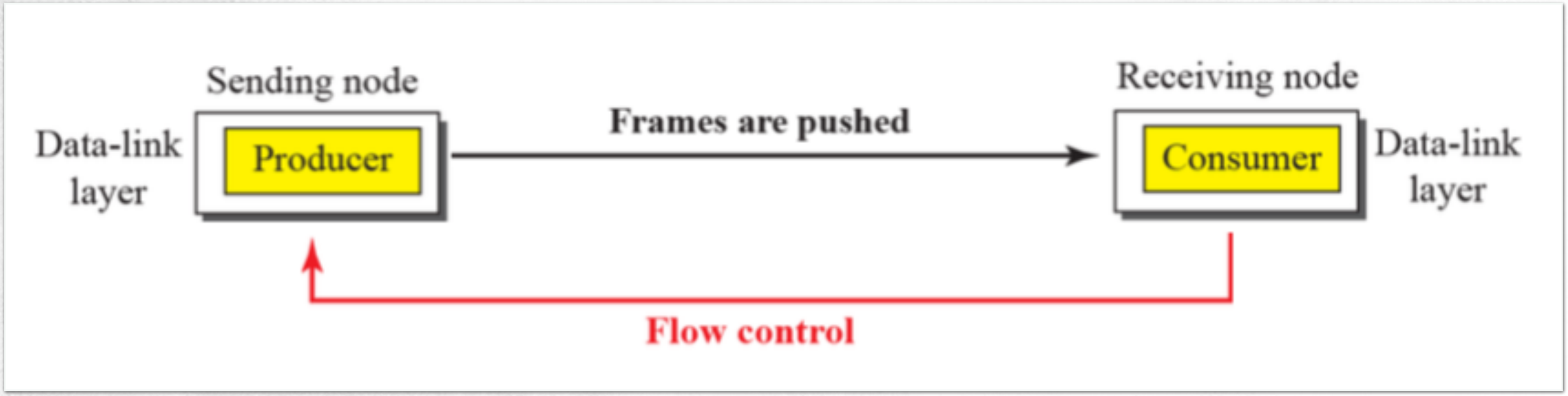


Bit stuffing and unstuffing



Concept

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



Connection

- A DLC protocol can be either connectionless or connection-oriented. We will discuss this issue very briefly here, but we return to this topic in the network and transport layer.

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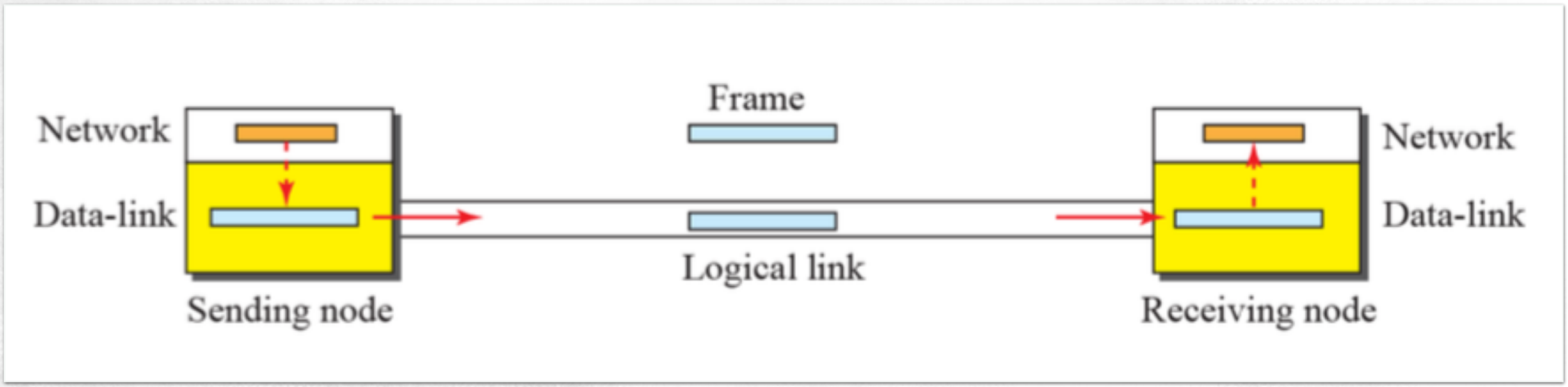
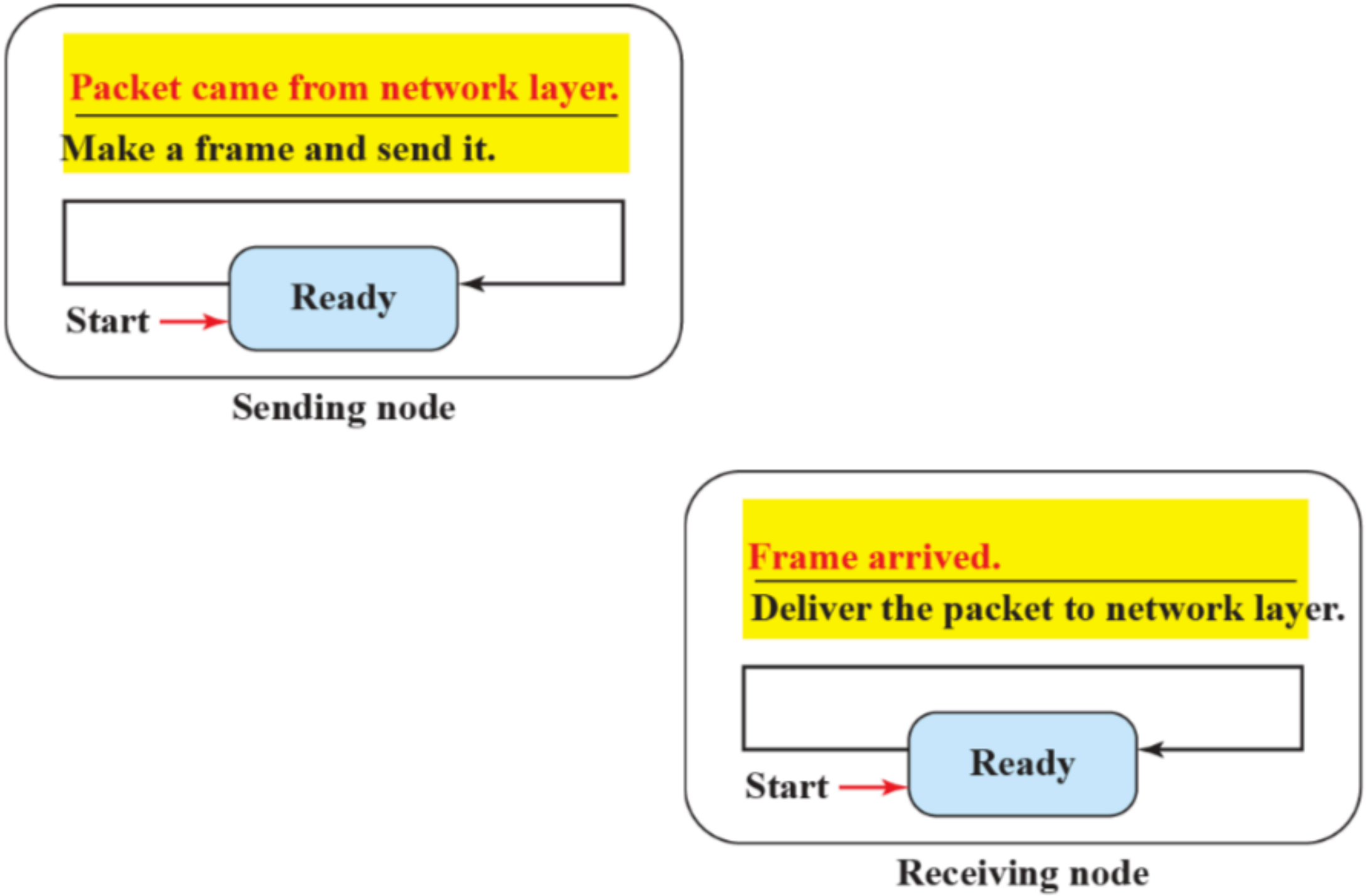
Simple Protocol

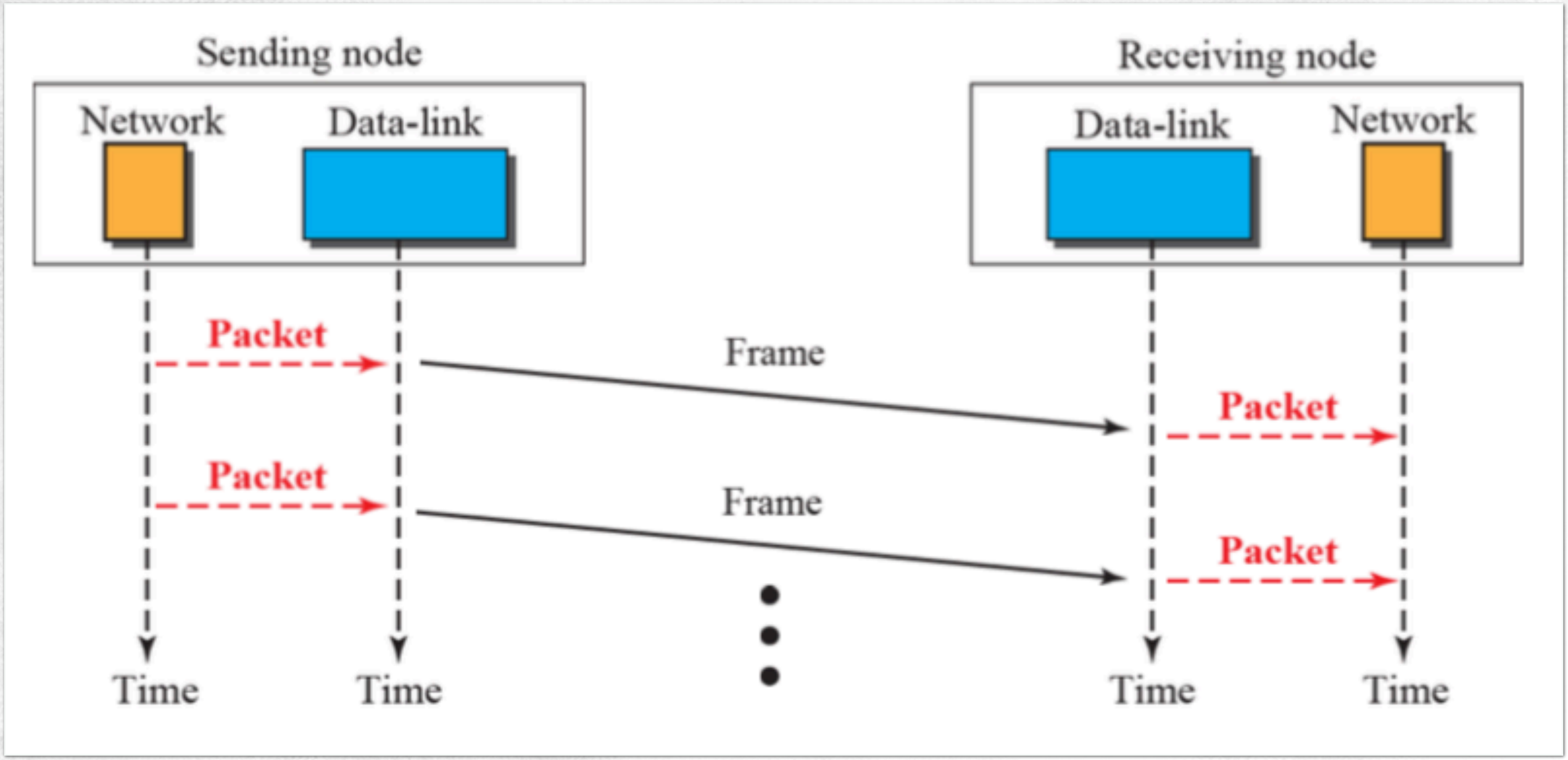
- Our first protocol is a simple protocol with neither flow nor error control. We assume that the receiver can immediately handle any frame it receives. In other words, the receiver can never be overwhelmed with incoming frames.



FSM for the simple protocol



Operation of the simple protocol



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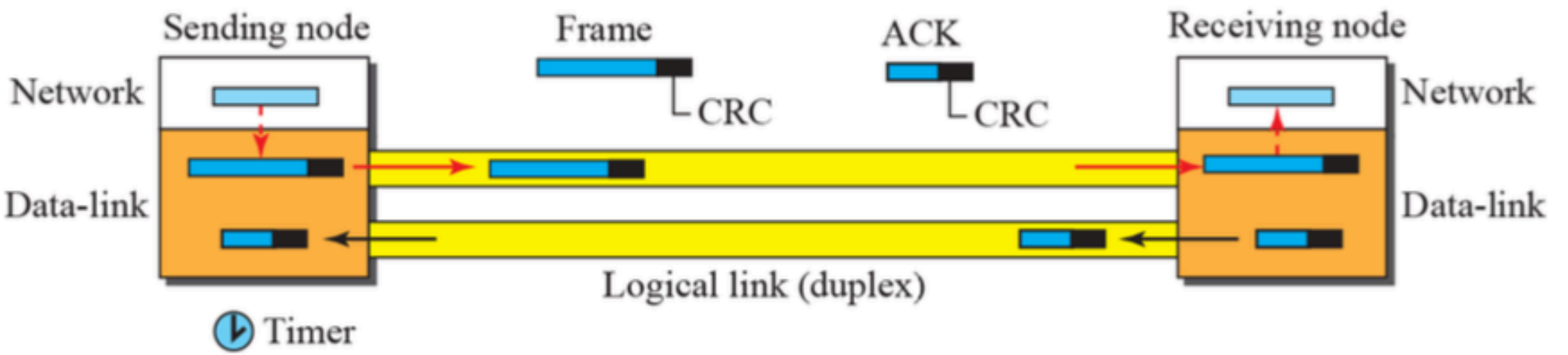
Concept

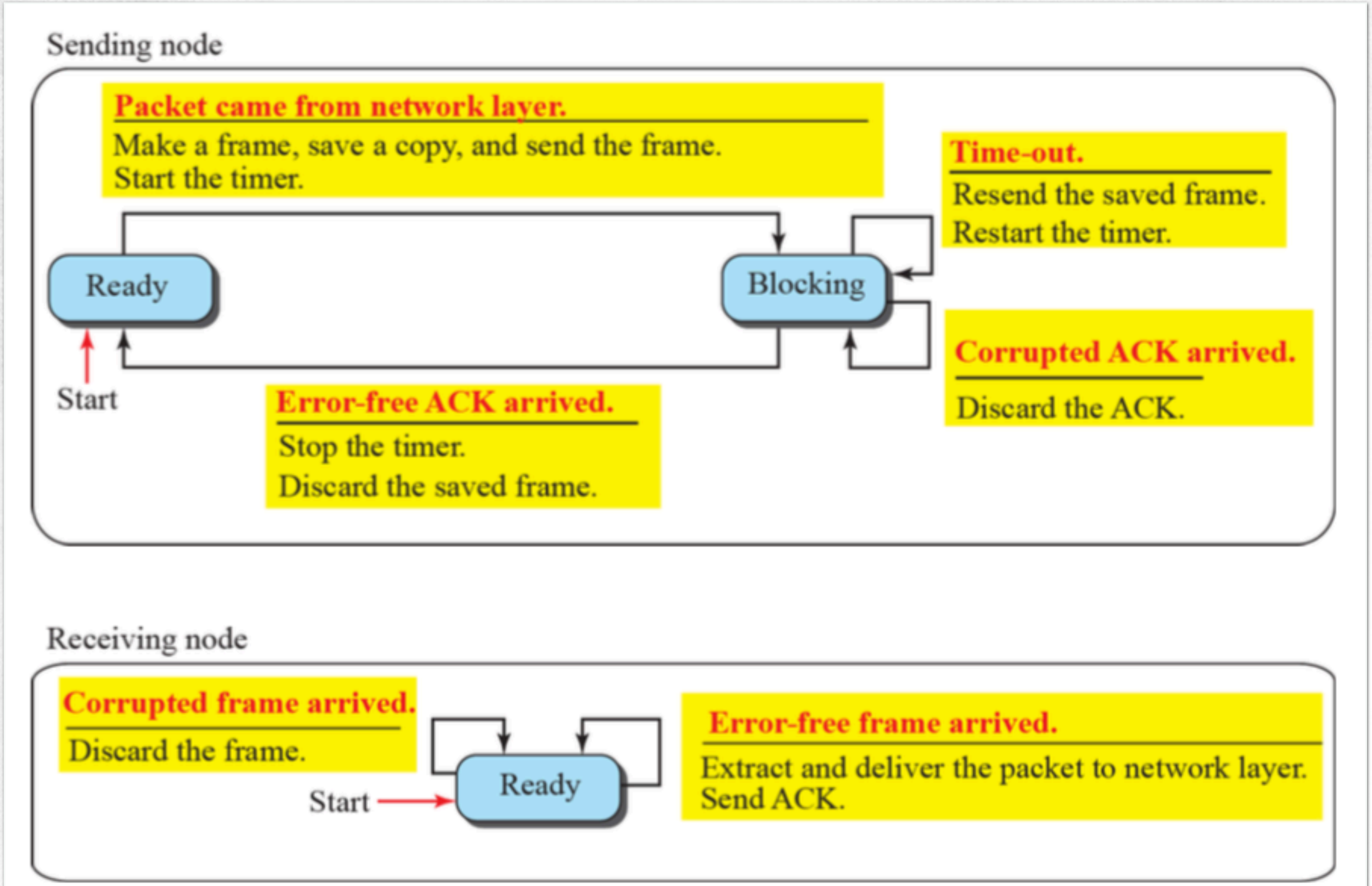
- Our second protocol is called the Stop-and-Wait protocol, which uses both flow and error control. We show a primitive version of this protocol here, but we discuss the more sophisticated version in Chapter 23 when we have learned about sliding windows. In this protocol, the sender sends one frame at 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

Concept

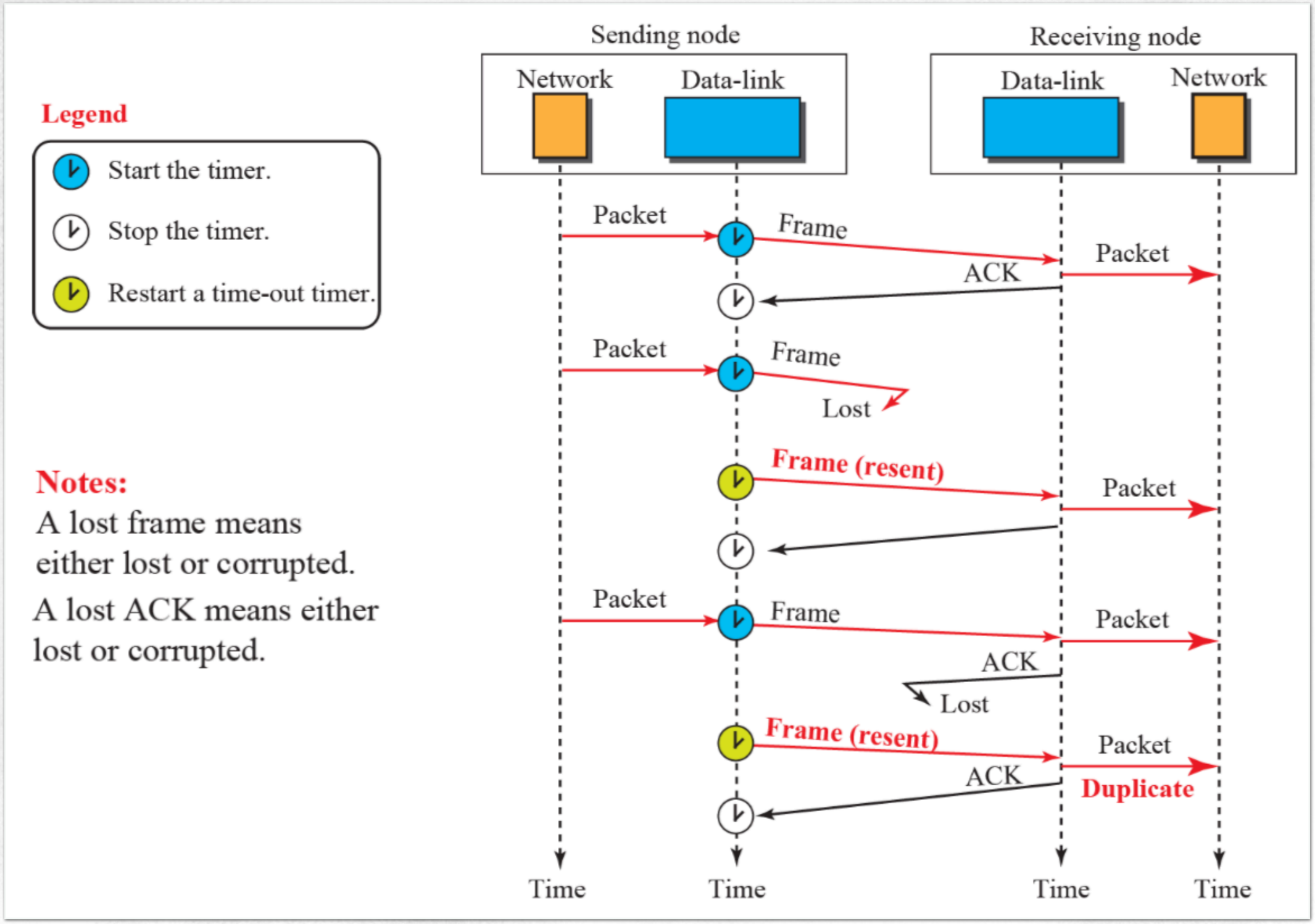


FSM for the stop-and-wait protocol



Stop and Wait Protocol

Flow diagram



Flow diagram

Legend

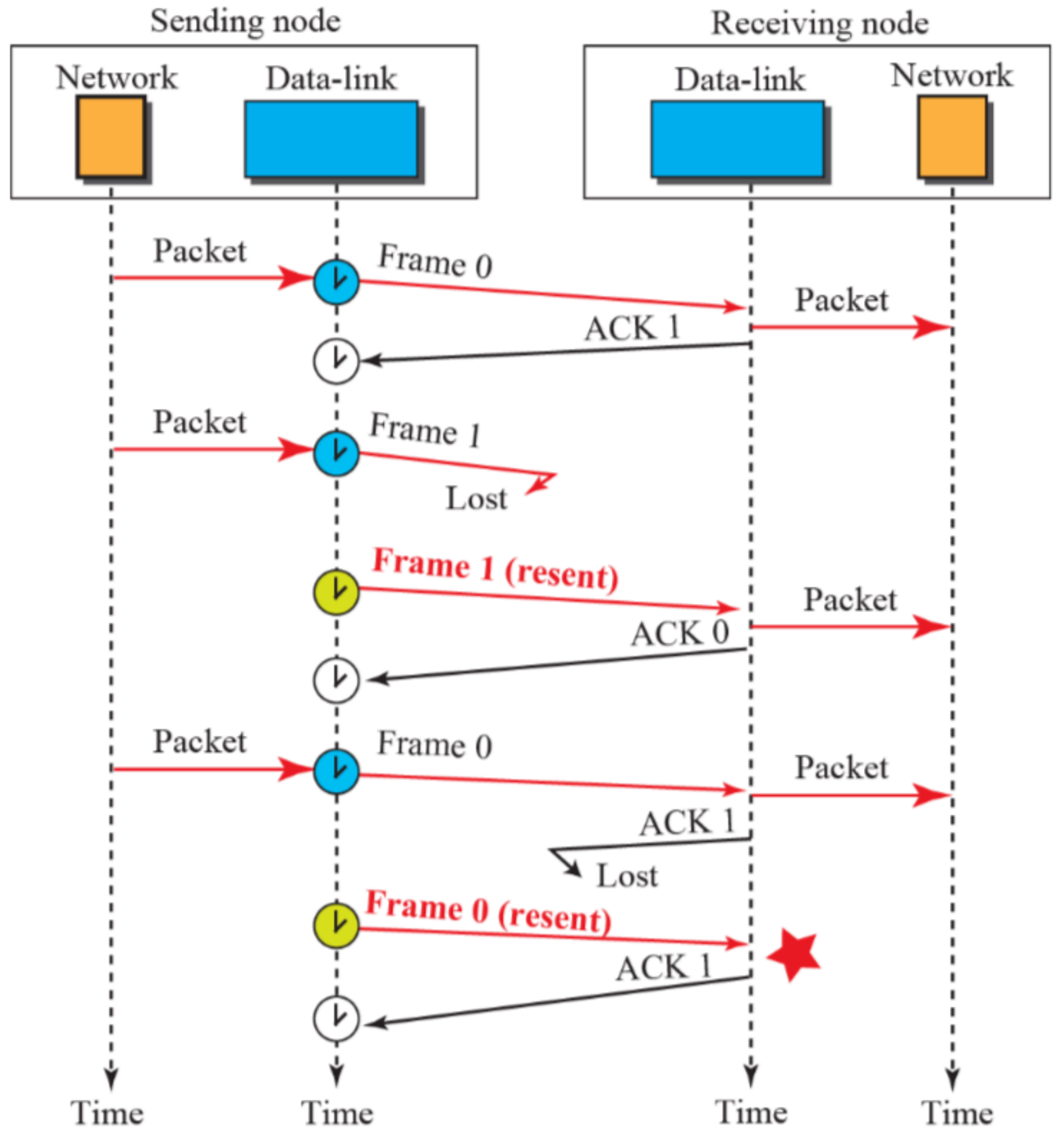
- Start the timer.
- Stop the timer.
- Restart a time-out timer.

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.



Concept

- 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.

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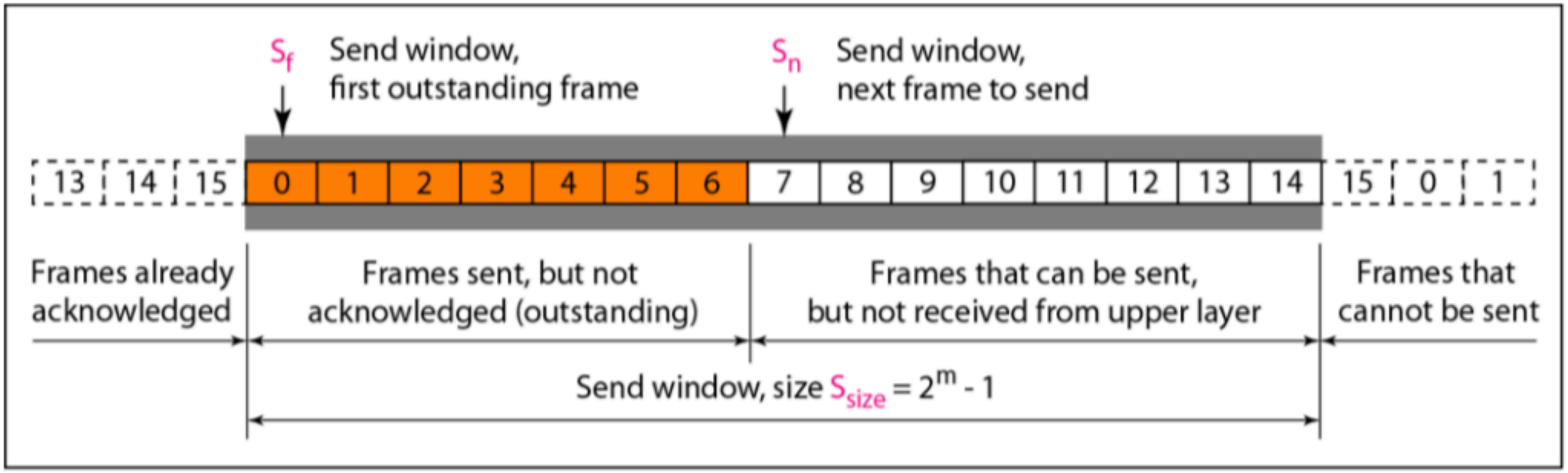
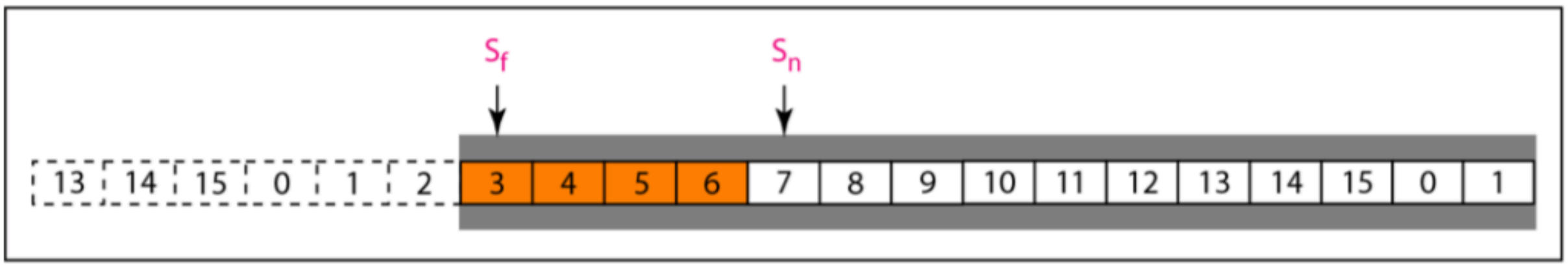
Send window for Go-Back-N ARQ

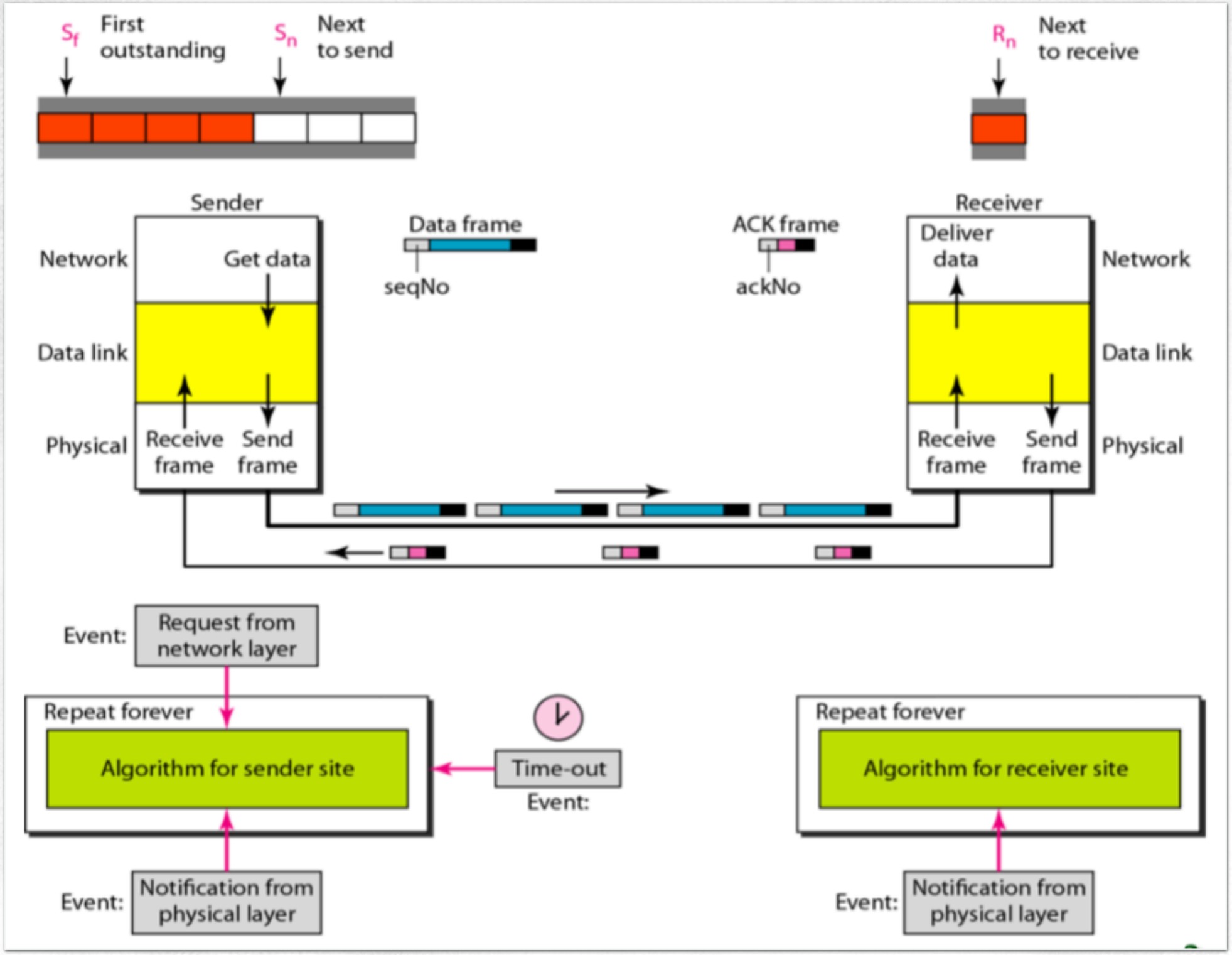


a. Send window before sliding

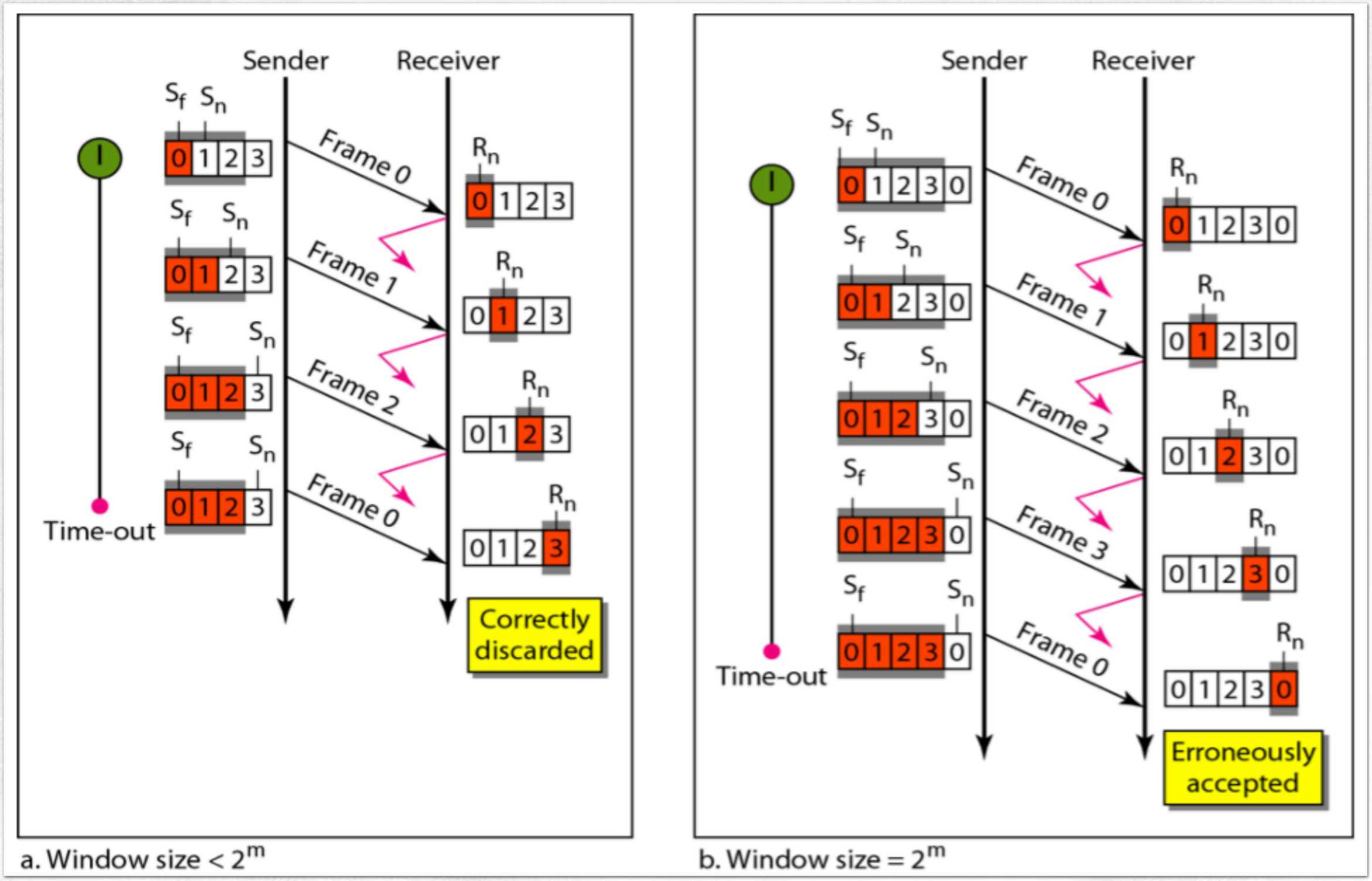


b. Send window after sliding

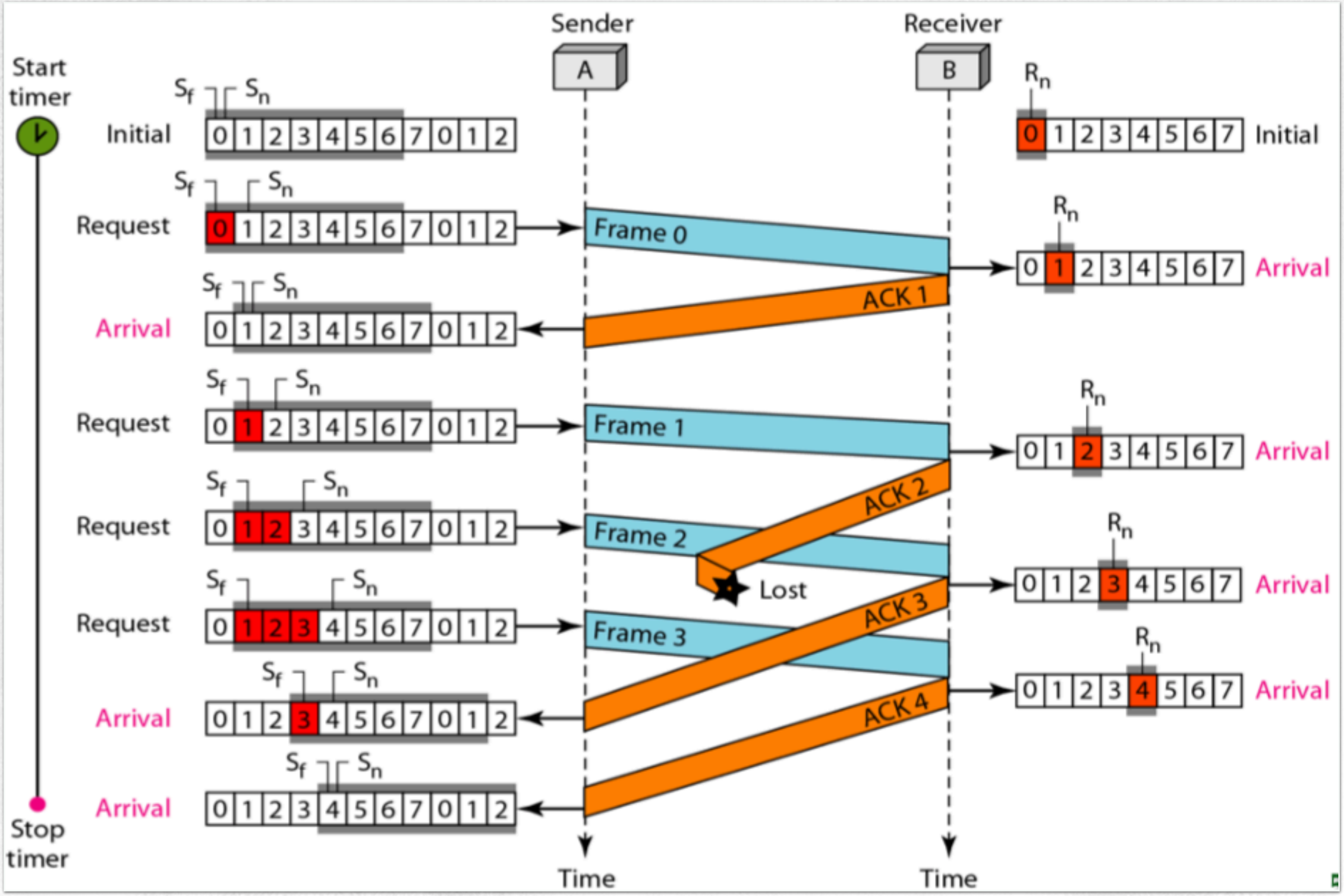
Design of Go-Back-N ARQ



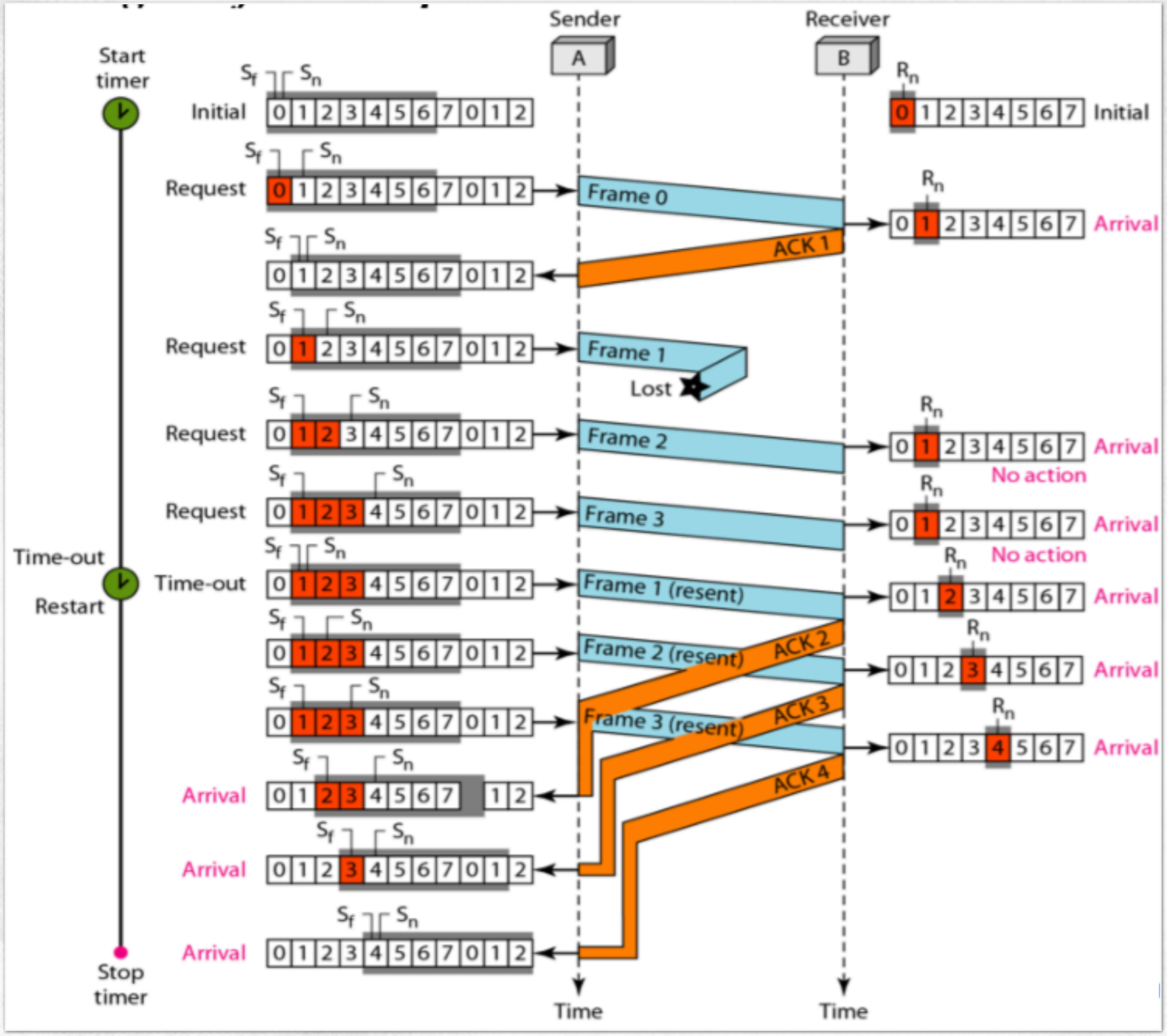
Window size for Go-Back-N ARQ



Flow diagram for Go-Back-N ARQ



Flow diagram for Go-Back-N ARQ



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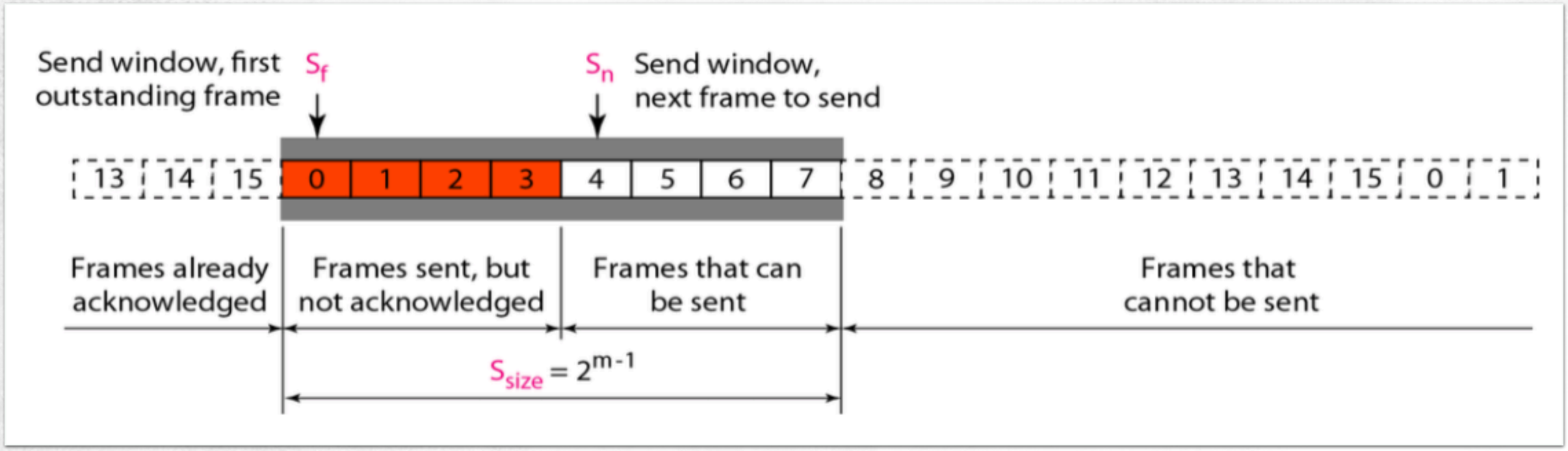
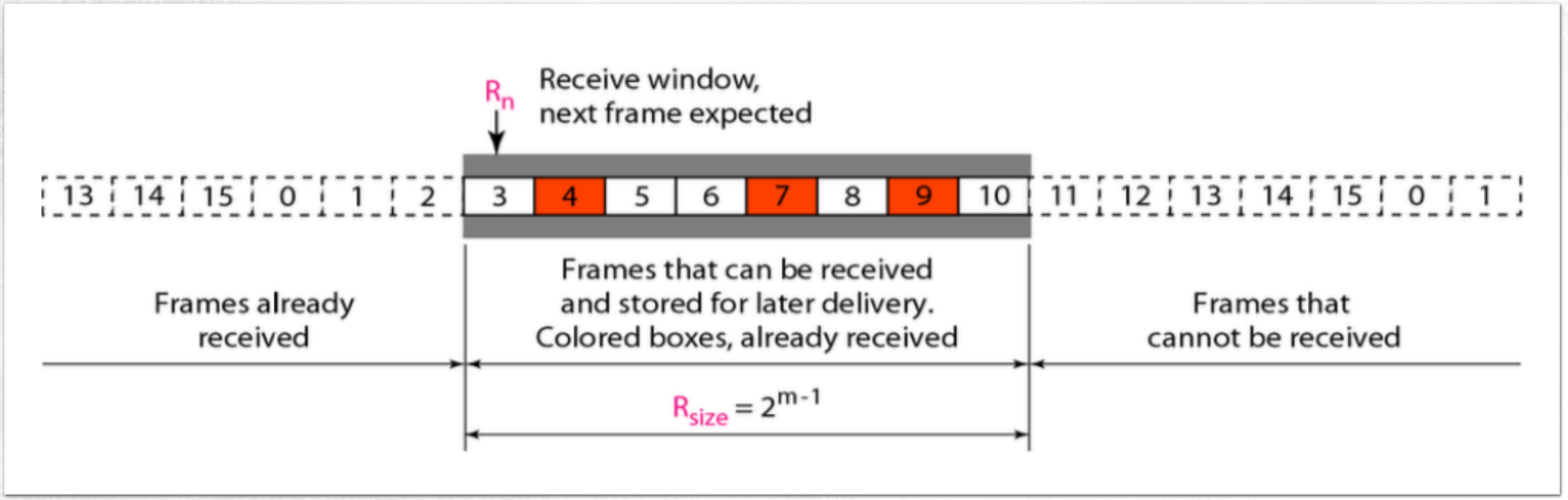
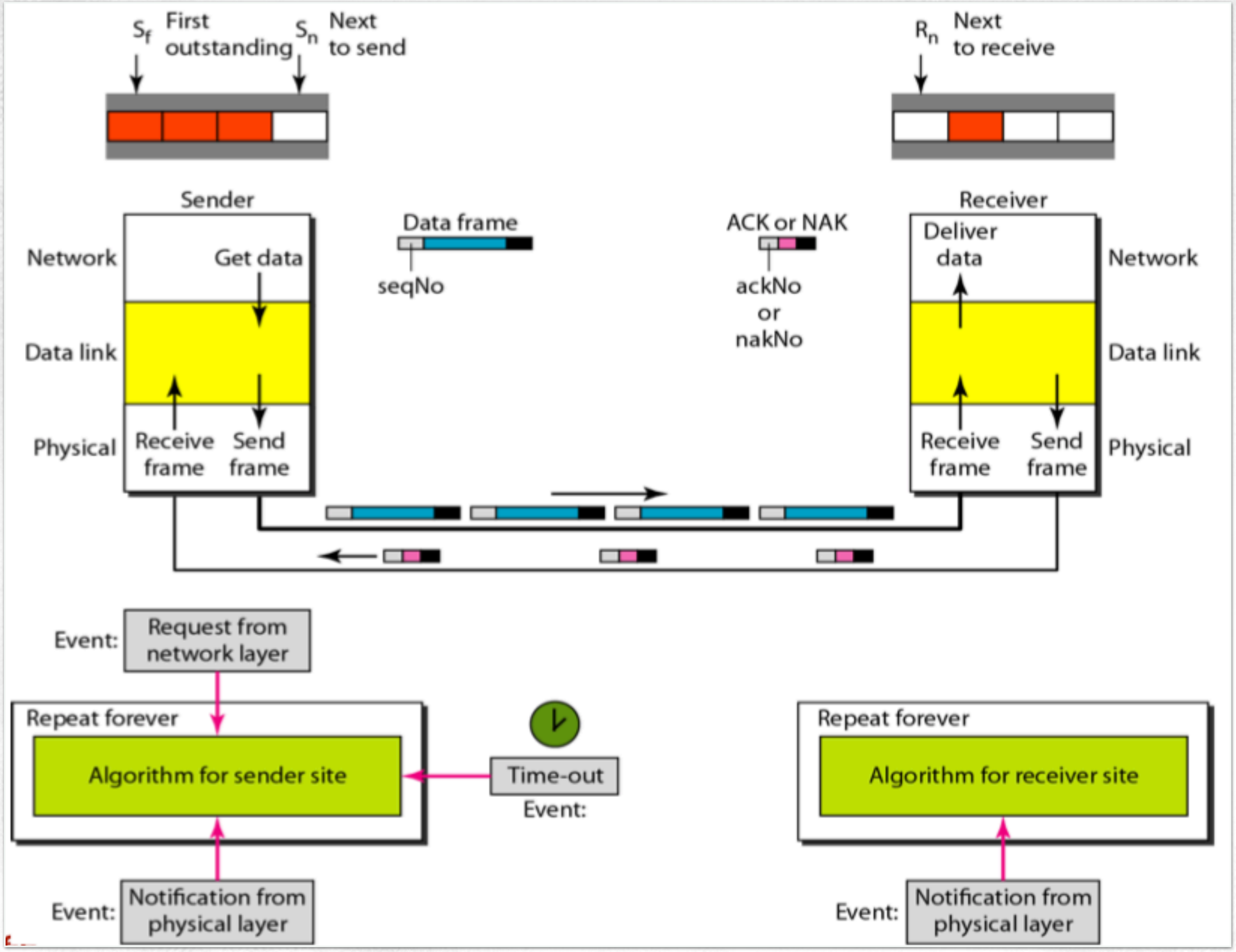
Send window for Selective Repeat ARQ



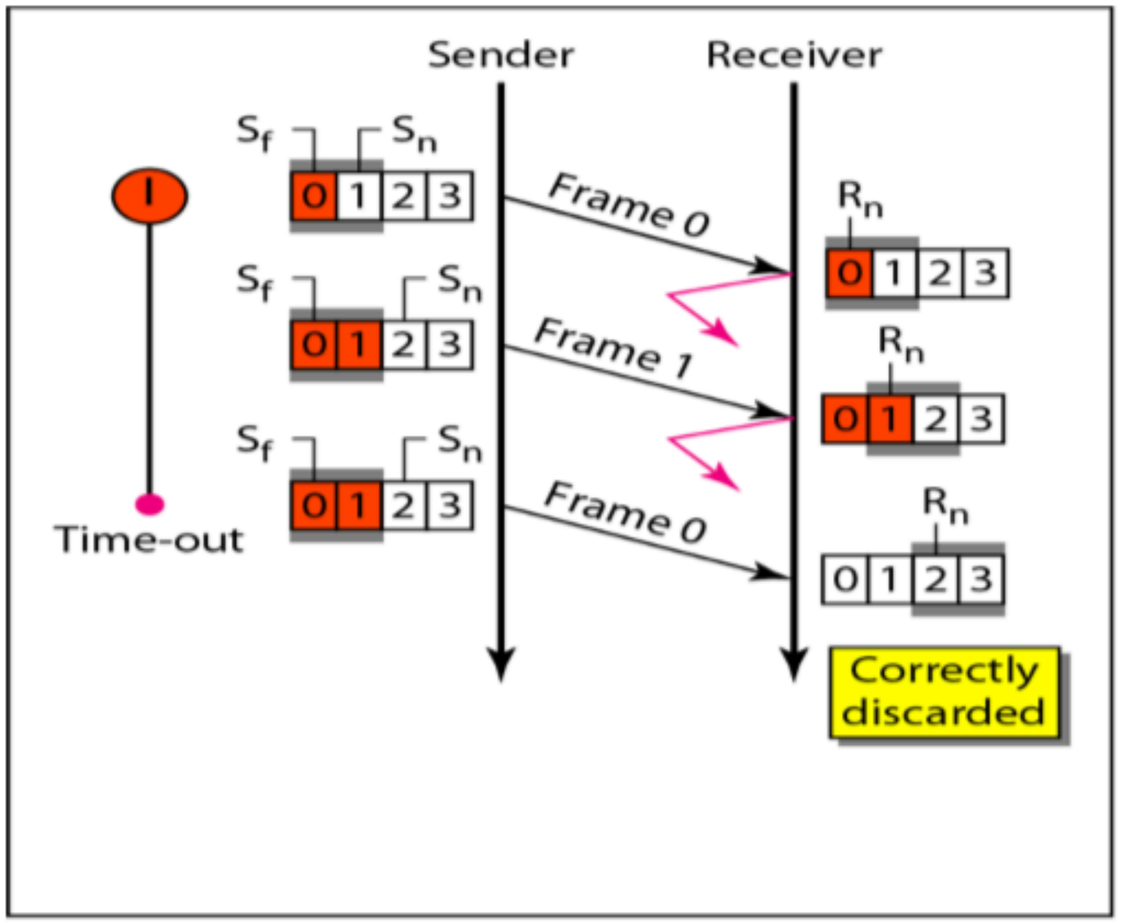
Receive window for Selective Repeat ARQ



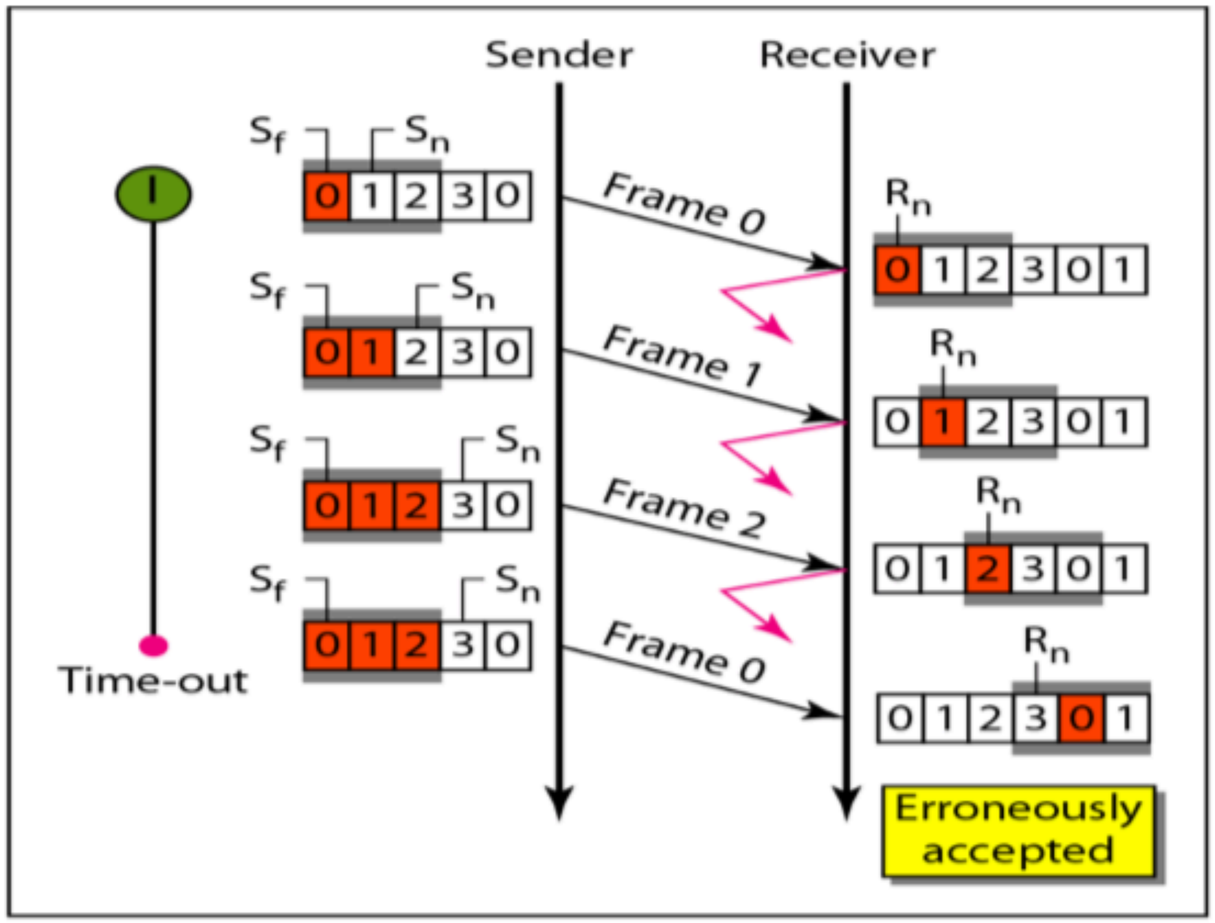
Design of Selective Repeat ARQ



Selective Repeat ARQ, window size



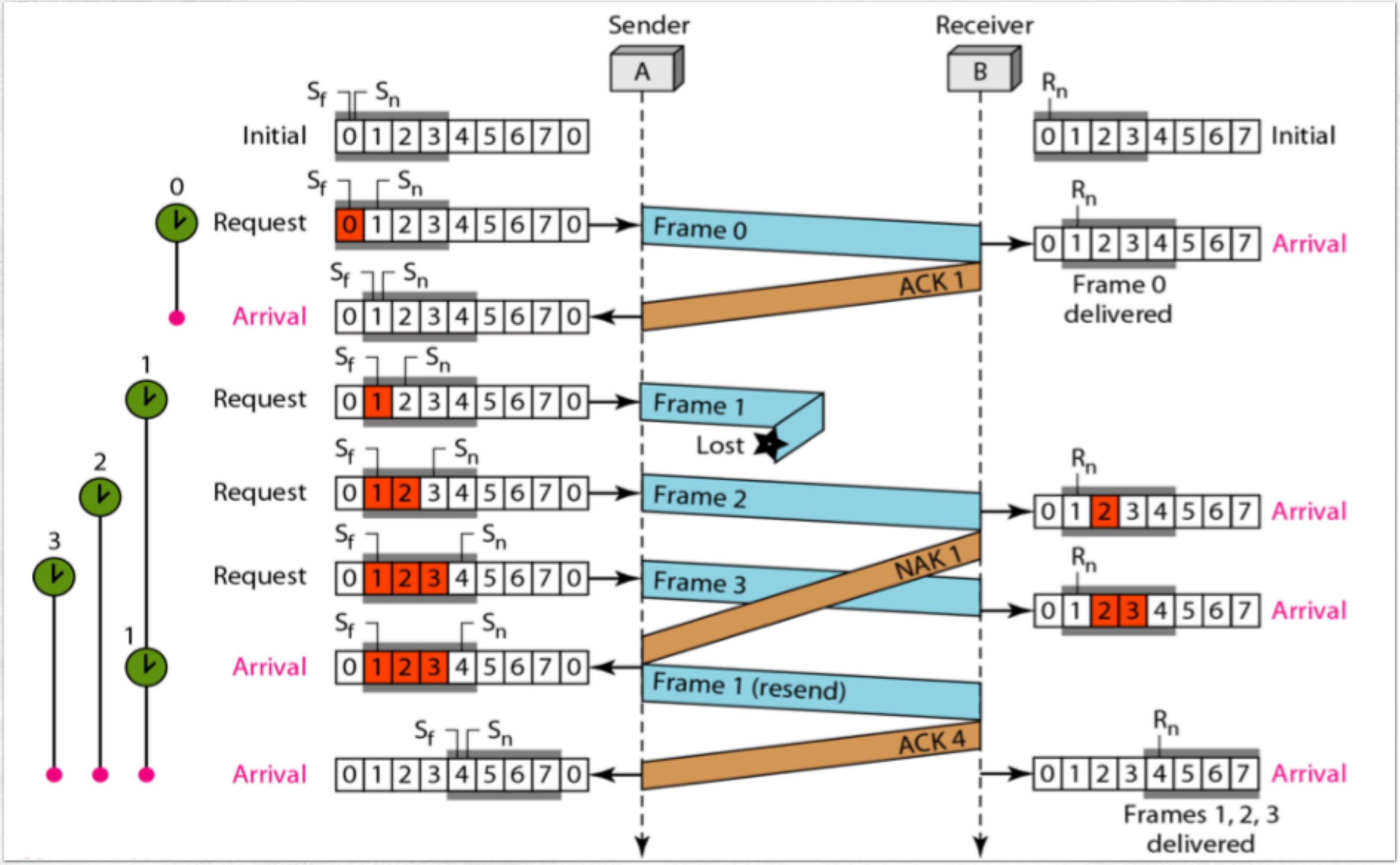
a. Window size = 2^{m-1}



b. Window size > 2^{m-1}

In Selective Repeat ARQ, the size of the sender and receiver window must be at most one-half of 2^m.

Flow diagram for Selective Repeat ARQ



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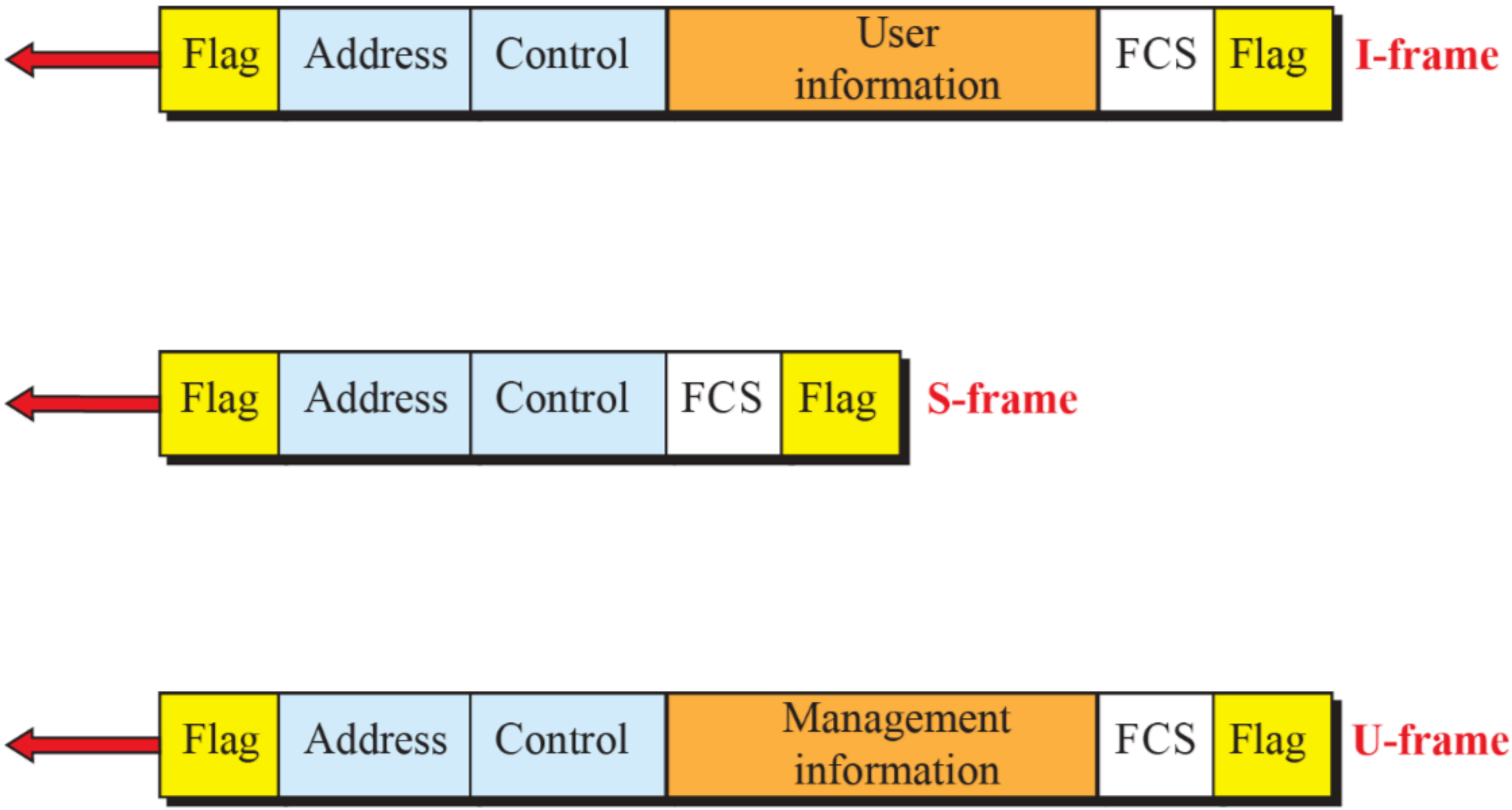
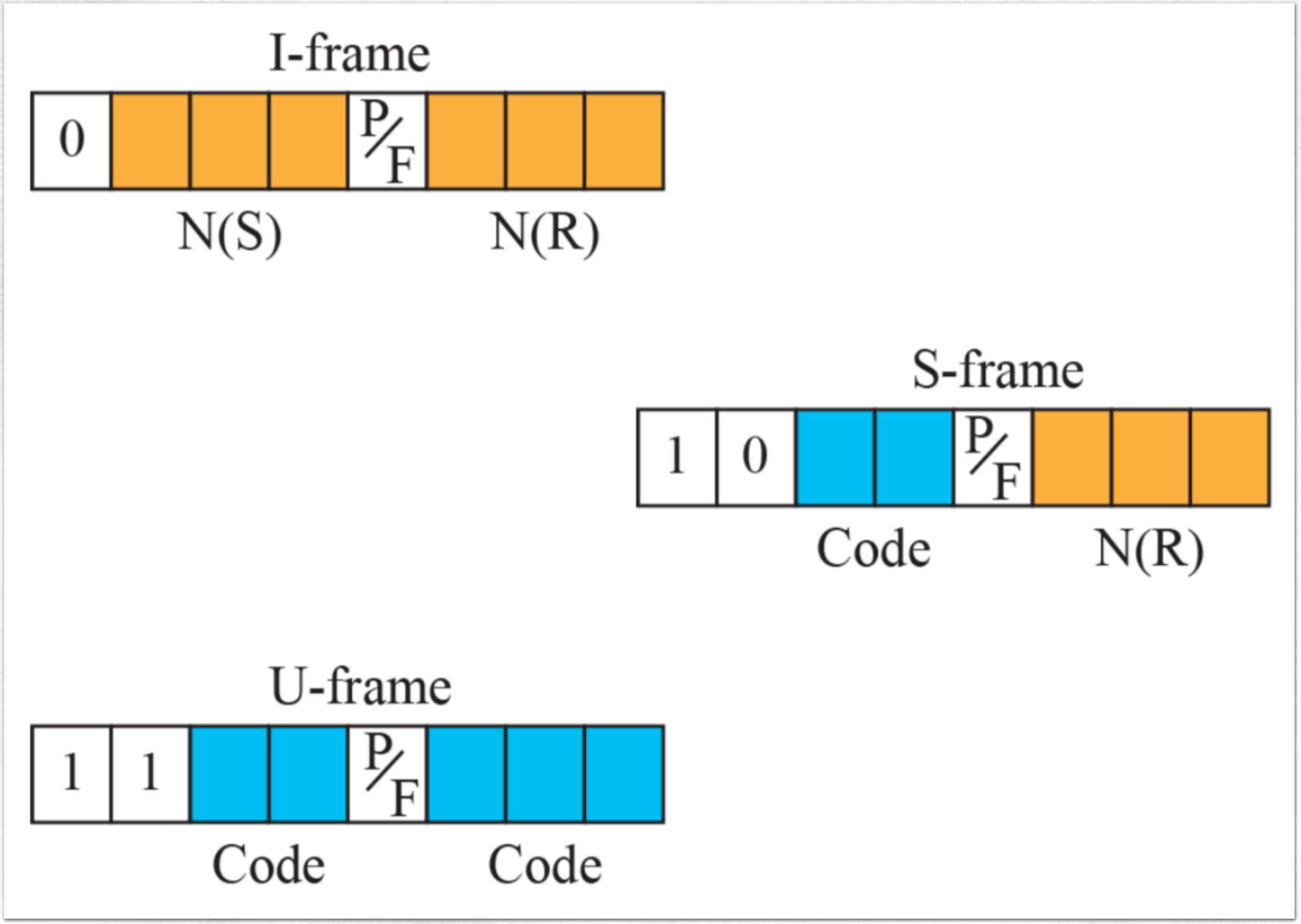
HDLC

- 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 we discussed earlier. 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.

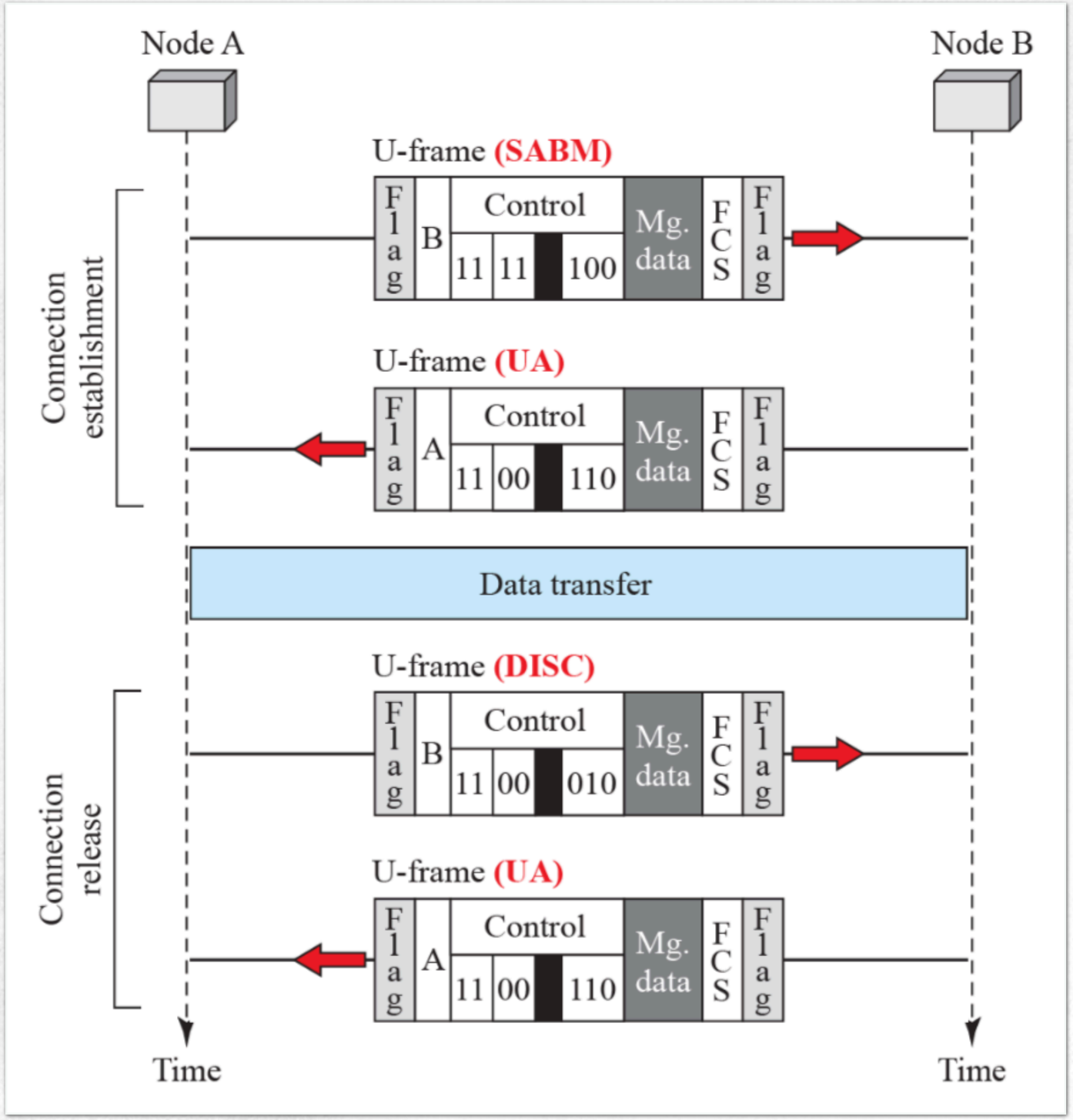
HDLC Frames


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

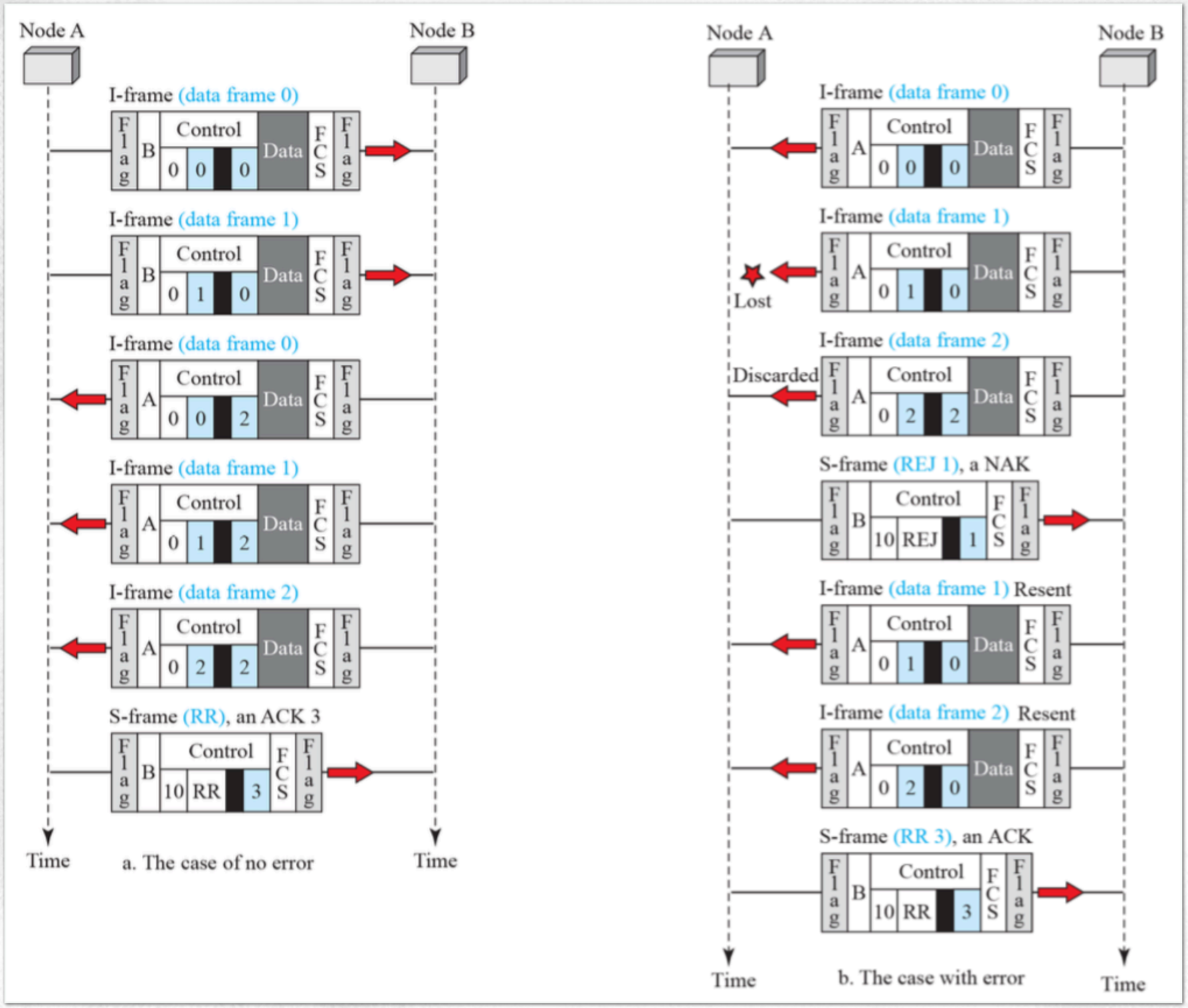
HDLC Frames



Example of connection and disconnection



Example of piggybacking with and without error



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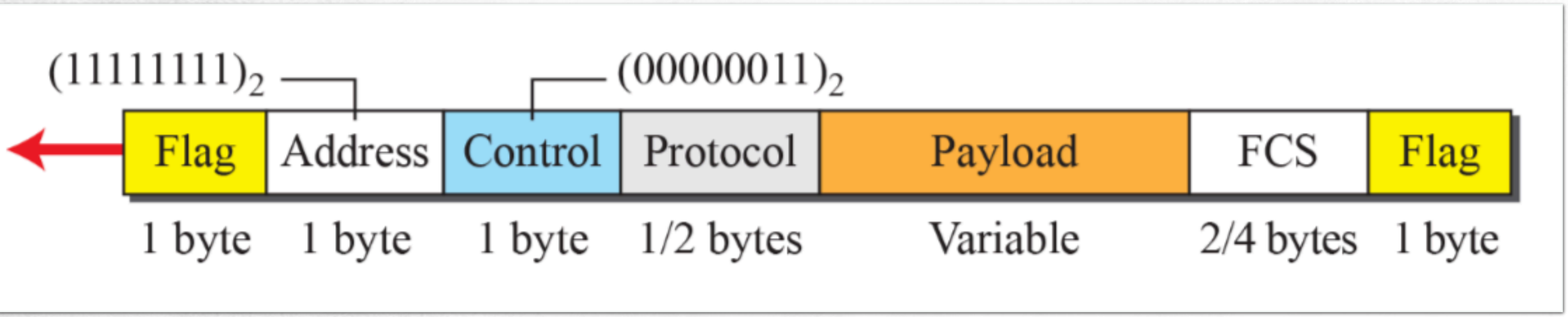
PPP

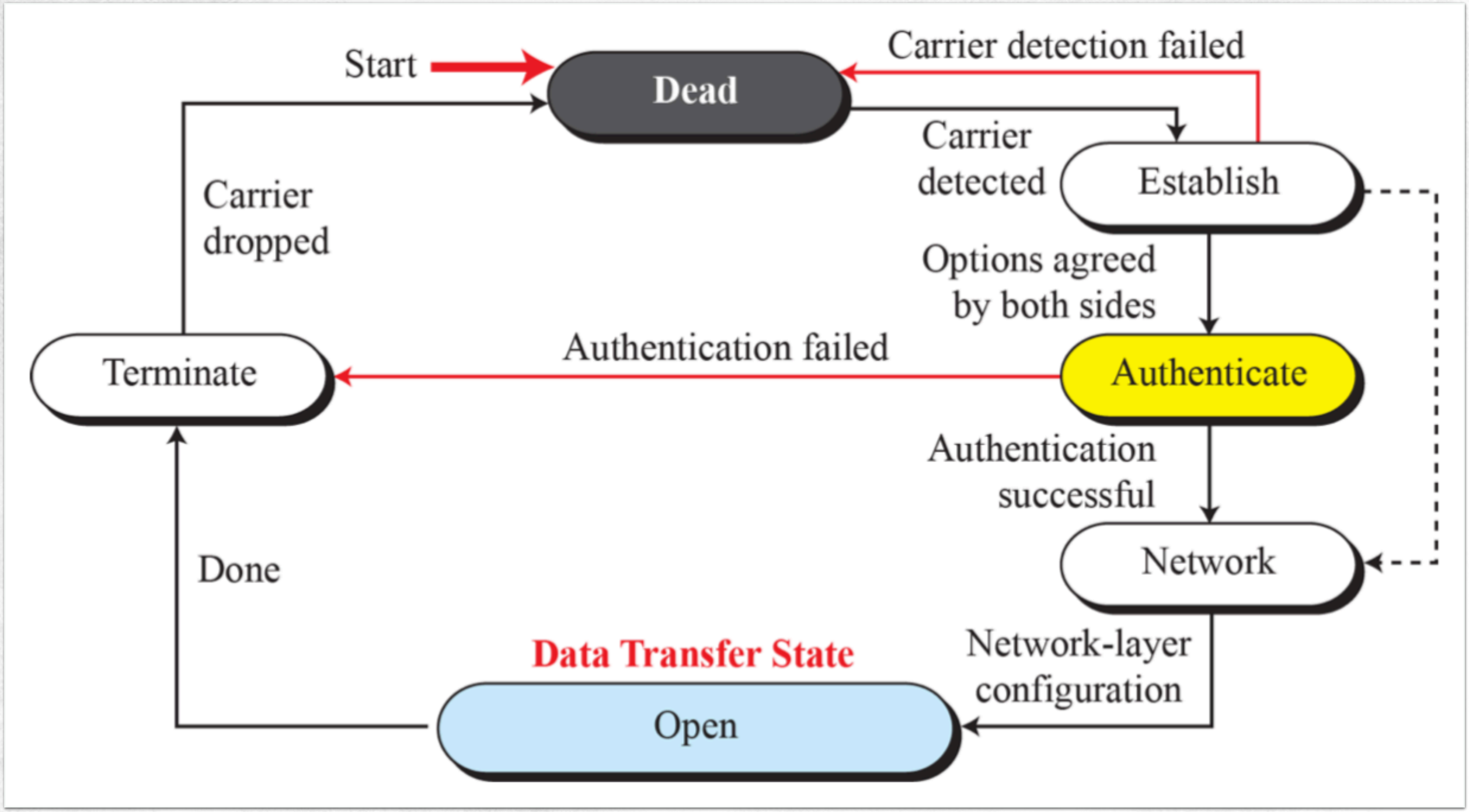
- One of the most common protocols for point-to- point access is the Point-to-Point Protocol (PPP). Today, millions of Internet users who need to connect their home computers to the server of an Internet service provider use PPP. To control and manage the transfer of data, there is a need for a point-to-point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

PPP Frame Format



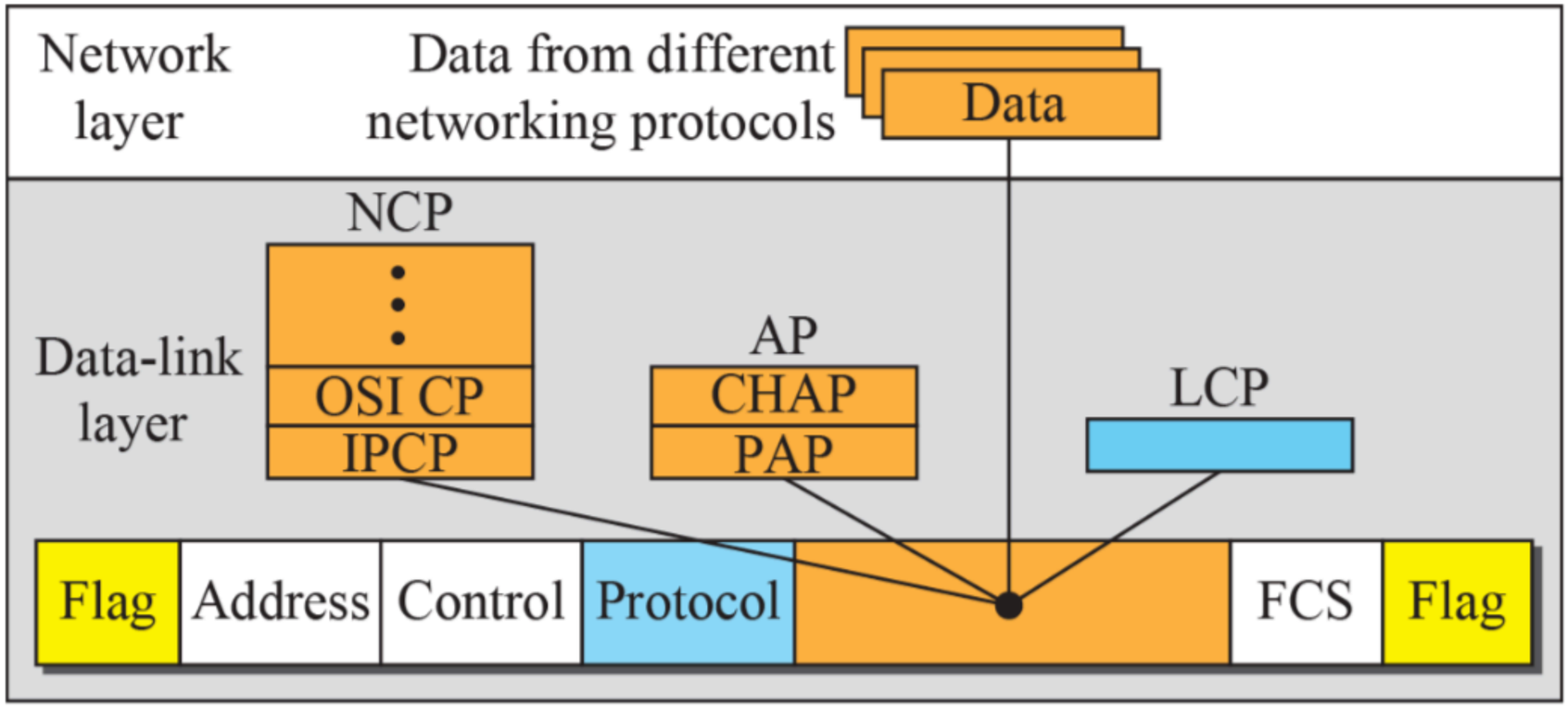
DLC Example

Transition phases



DLC Example

Multiplexing in PPP



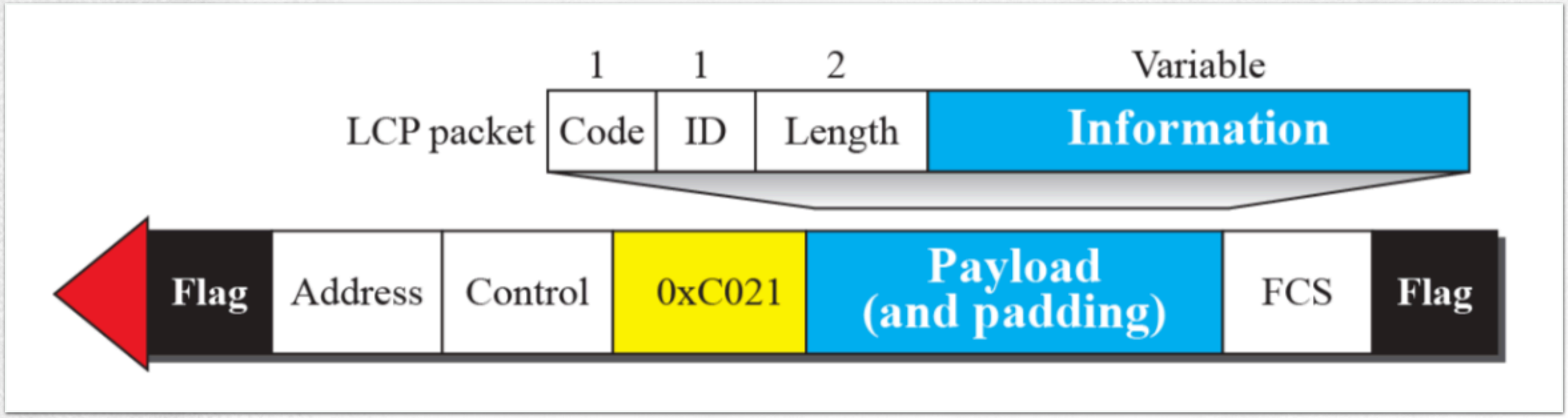
Legend

LCP : Link control protocol
AP : Authentication protocol
NCP: Network control protocol

Protocol values:

LCP : 0xC021
AP : 0xC023 and 0xC223
NCP: 0x8021 and ....
Data: 0x0021 and ....

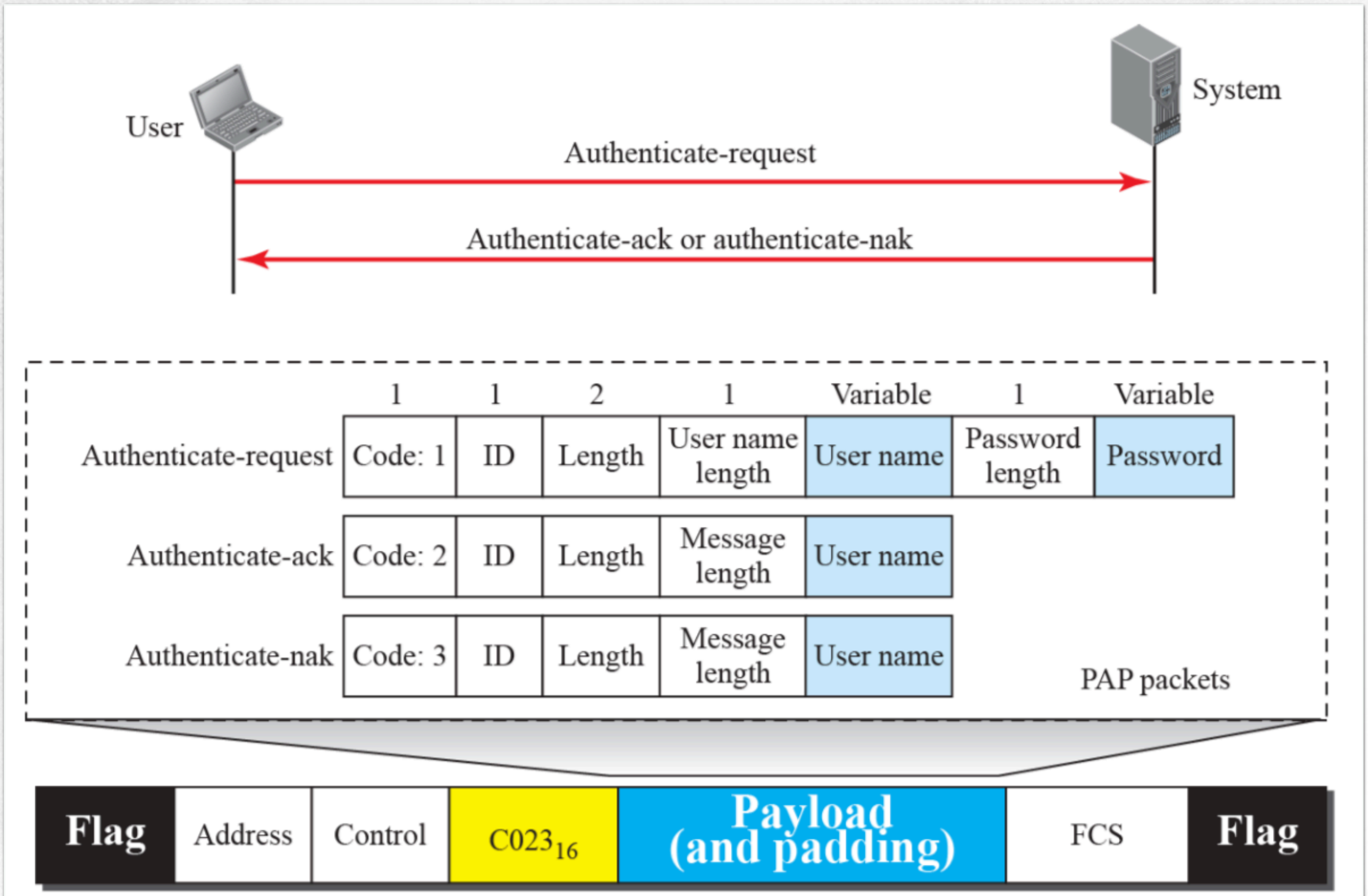
LCP packet encapsulated in a frame



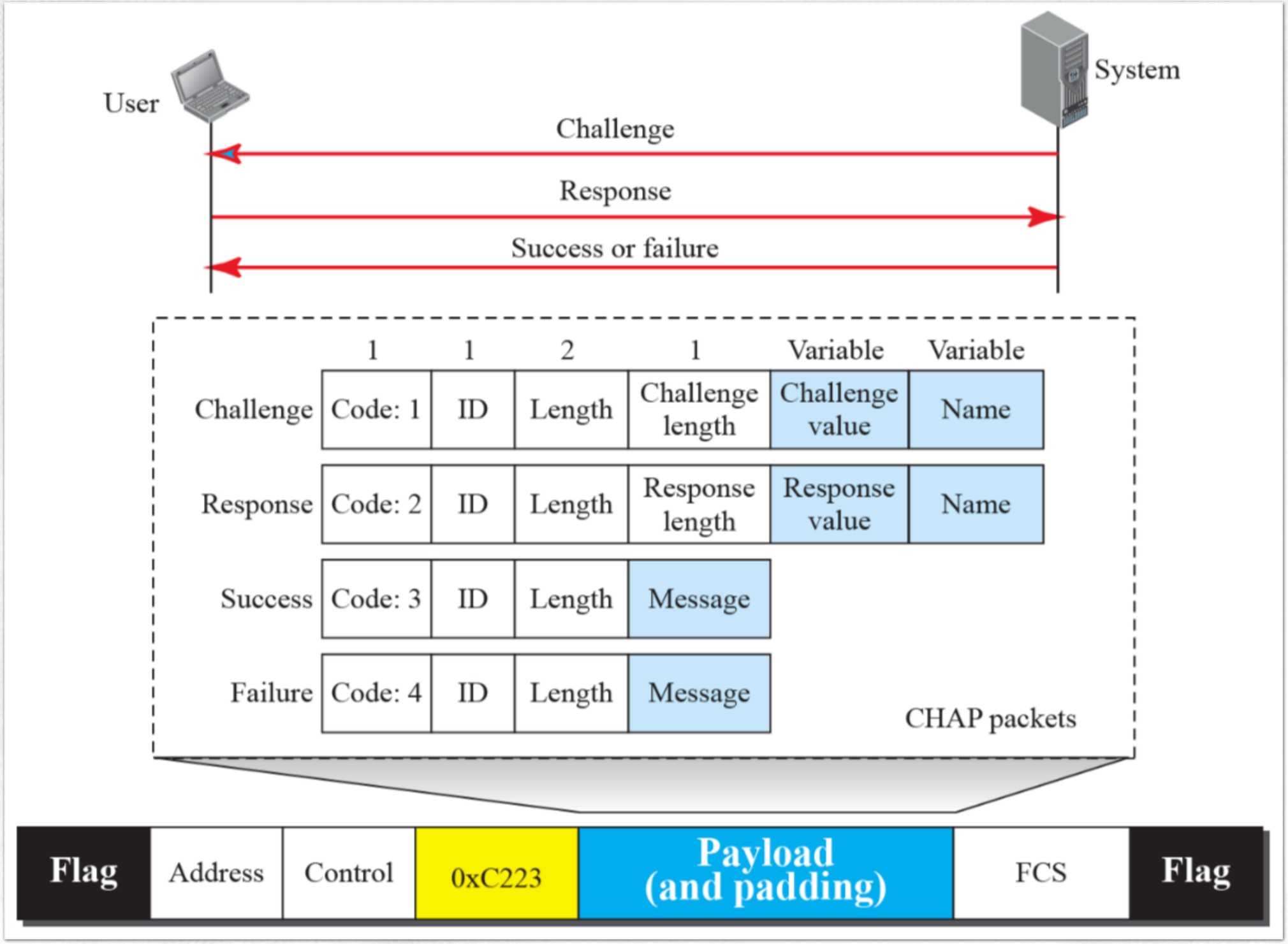
Code	Packet Type	Description
0x01	Configure-request	Contains the list of proposed options and their values
0x02	Configure-ack	Accepts all options proposed
0x03	Configure-nak	Announces that some options are not acceptable
0x04	Configure-reject	Announces that some options are not recognized
0x05	Terminate-request	Request to shut down the line
0x06	Terminate-ack	Accept the shutdown request
0x07	Code-reject	Announces an unknown code
0x08	Protocol-reject	Announces an unknown protocol
0x09	Echo-request	A type of hello message to check if the other end is alive
0x0A	Echo-reply	The response to the echo-request message
0x0B	Discard-request	A request to discard the packet

DLC Example

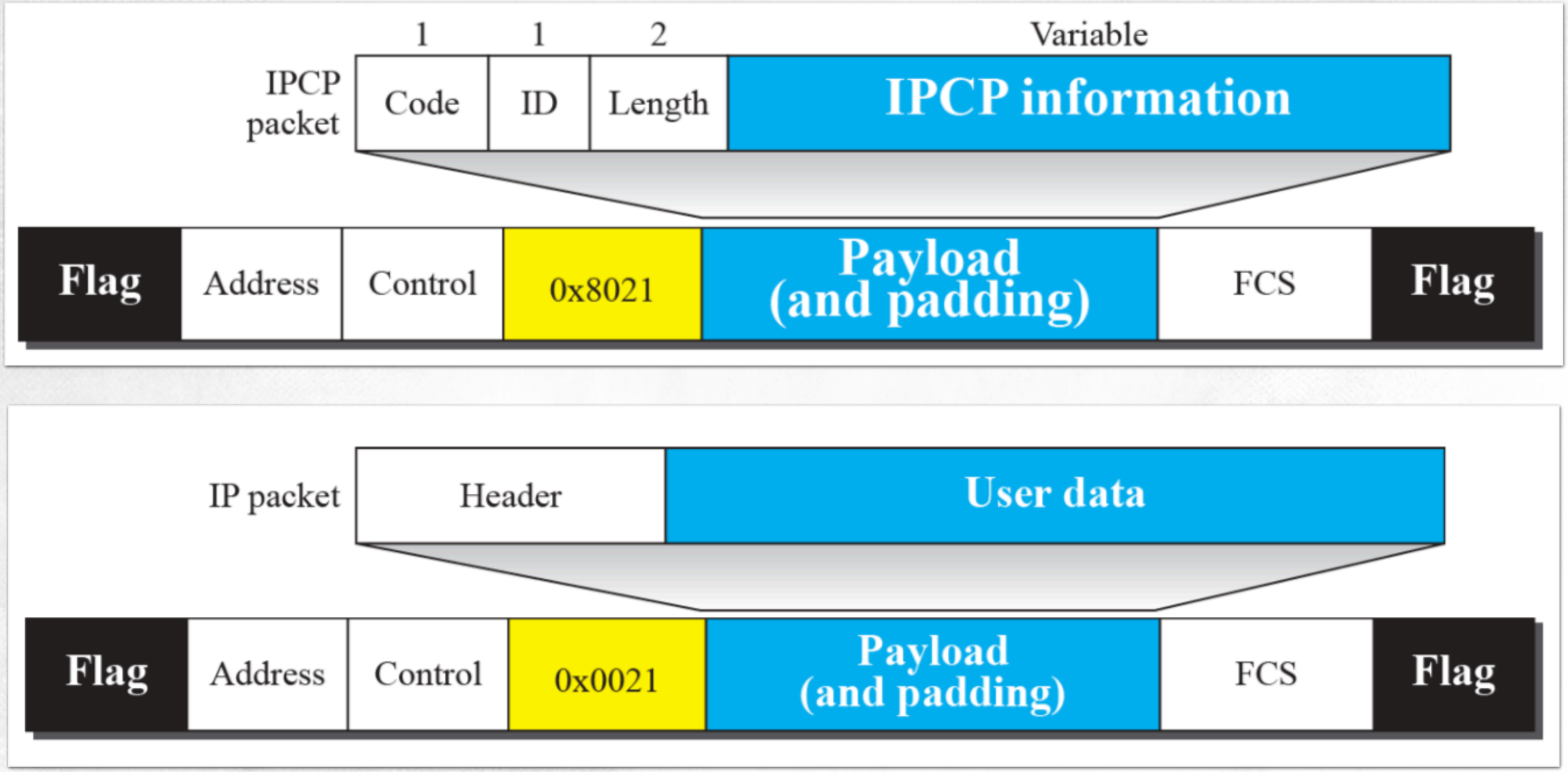
PAP packets encapsulated in a PPP frame



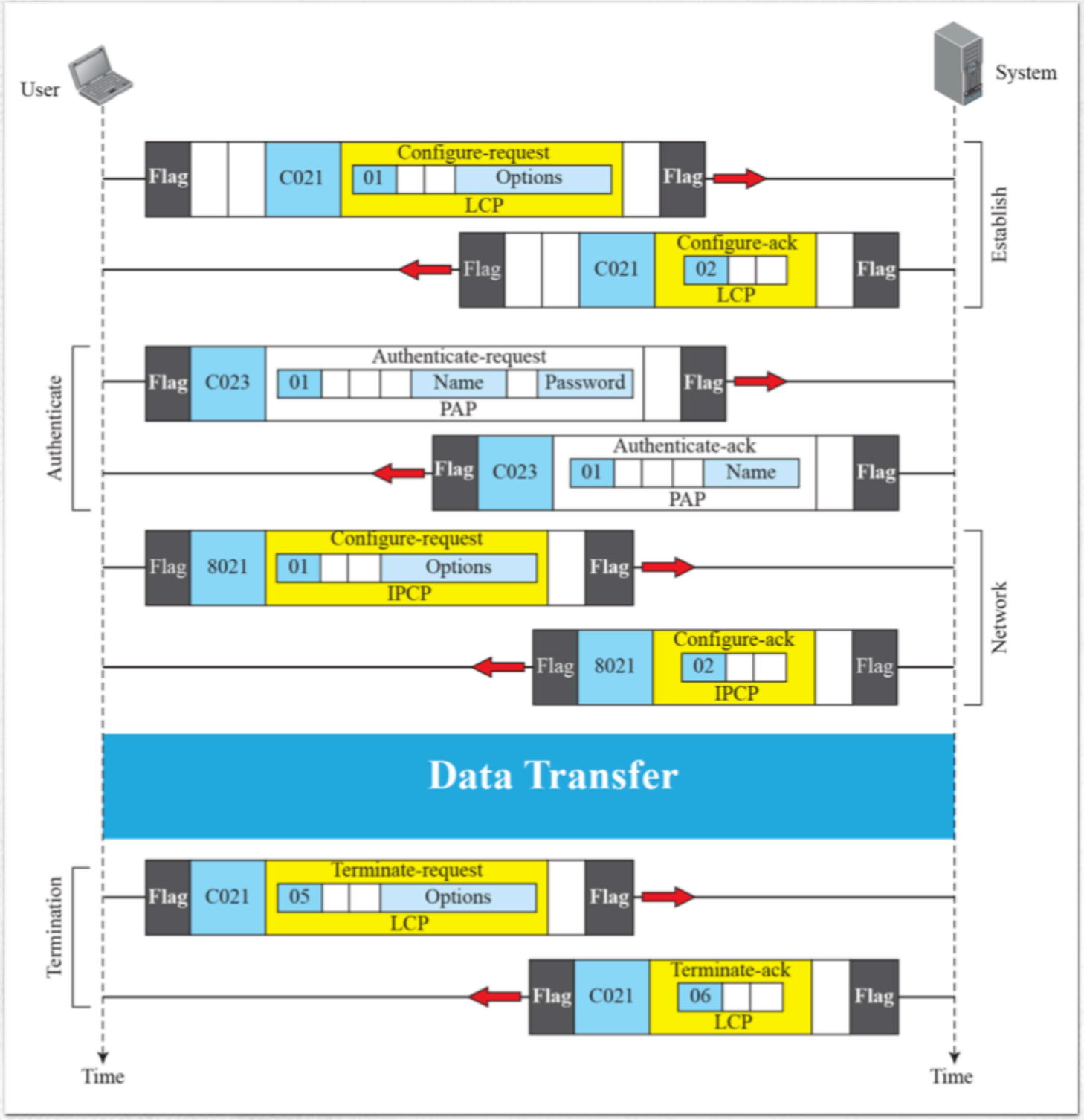
CHAP packets encapsulated in a PPP frame



Packet encapsulated in PPP frame



PPP Operation Example



Thank you

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