HDLC DATA LINK CONTROL

- High-level data link control gives the set of standards for operating
- a data link over bit synchronous physical layers.

- It is derived from SDLC (Synchronous Data Link Control) developed by IBM.

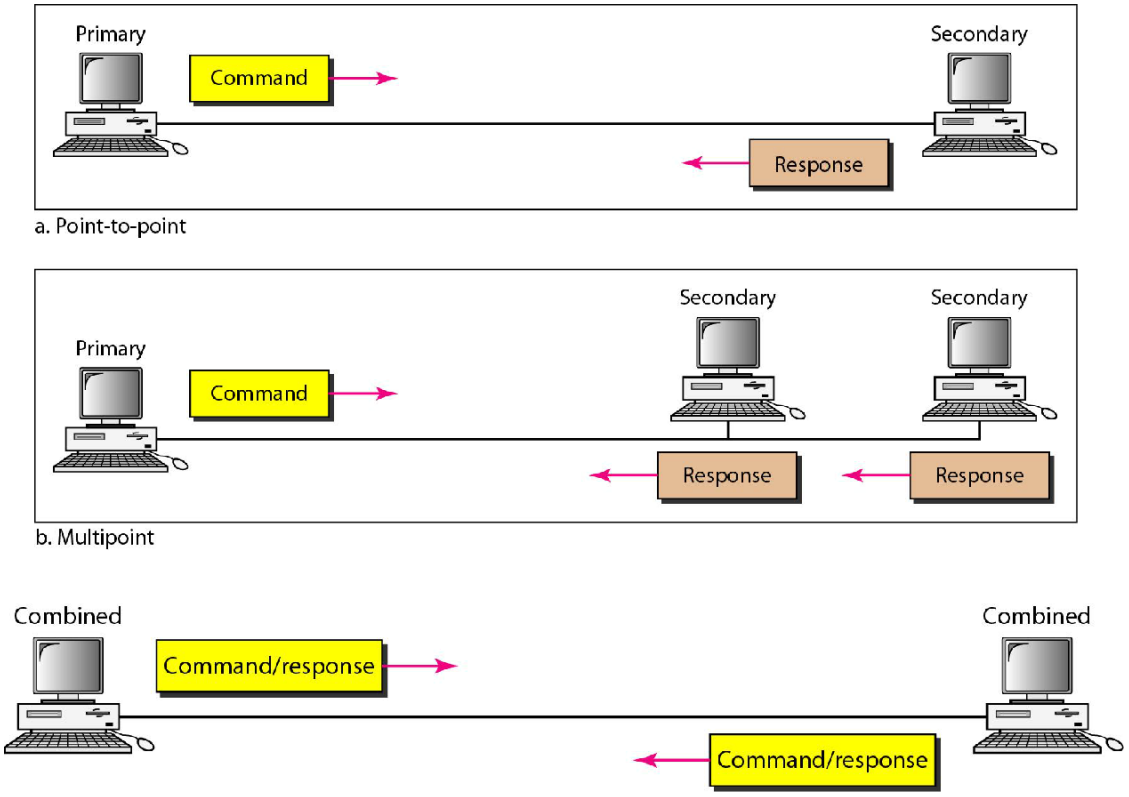
- It supports both Half-duplex and Full-duplex communication.

HDLC Basics

- Stations:
  - Primary: sends data, controls the link with commands
  - Secondary: receives data, responds to control messages
  - Combined: can issue both commands and responses
- Link configuration:
  - Unbalanced: one primary station, one or more secondary stations
  - Balanced: two combined stations

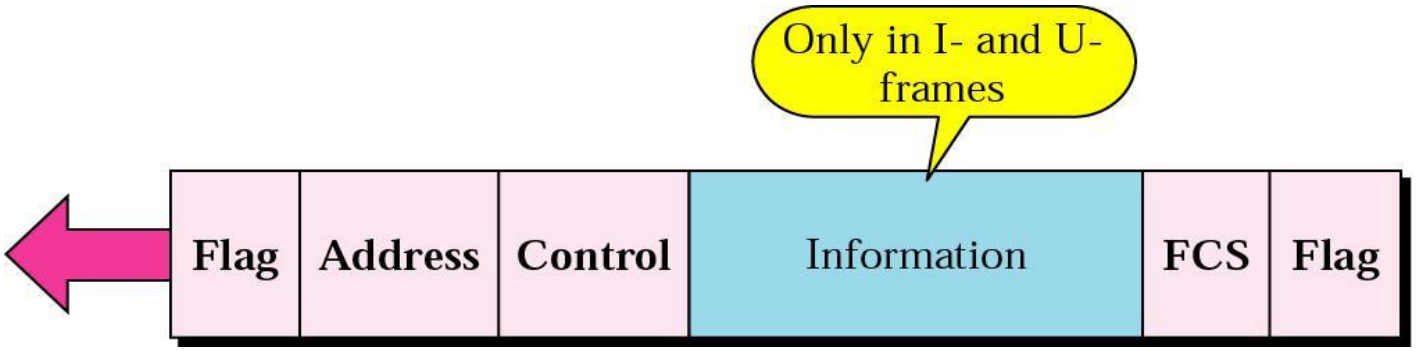
HDLC

- Two common transfer mode: normal response mode (NRM) and asynchronous balanced mode (ABM)



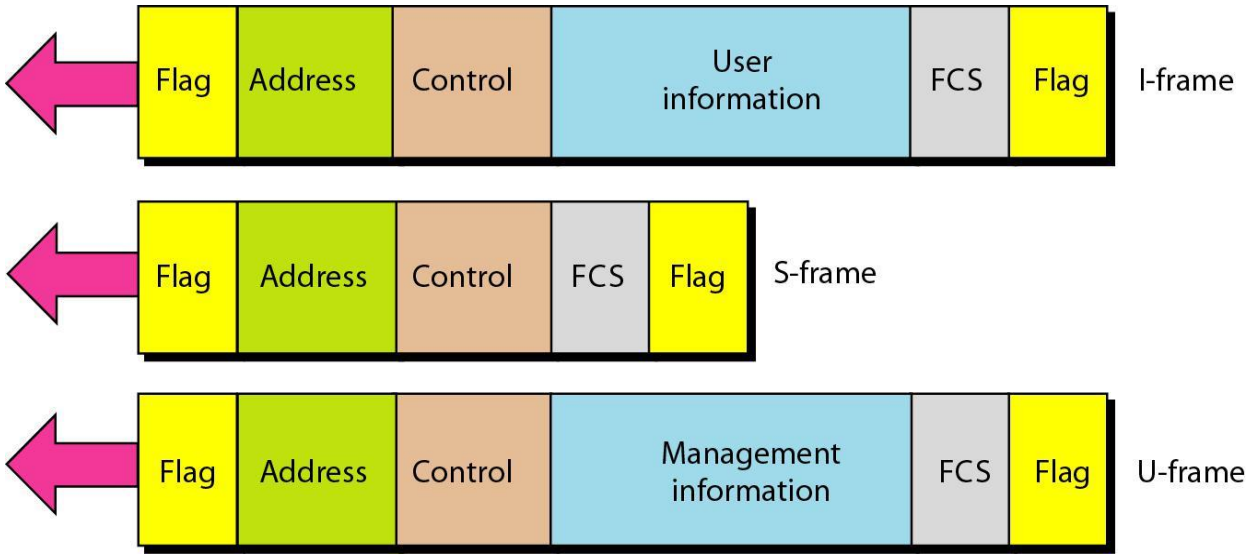
High-level Data Link Control (HDLC)

- Frame Format: HDLC frames contains six fields
  - Flag Field: 8-bit contains 01111110 to identify the beginning and end of a frame and serves as a synchronization
  - Address Field: one or several byte long field contains address of either the originator or the destination of the frame. If primary creates the frame, it contains a to address. If a secondary creates the frame, it contains a from address.
  - Control Field: one or two byte long contains flow/error info.
  - Information Field: variable length field contains user's information from network layer or network management info.
  - FCS Field: frame-check-sequence is an error detection field contains 2 to 4 byte CRC data.



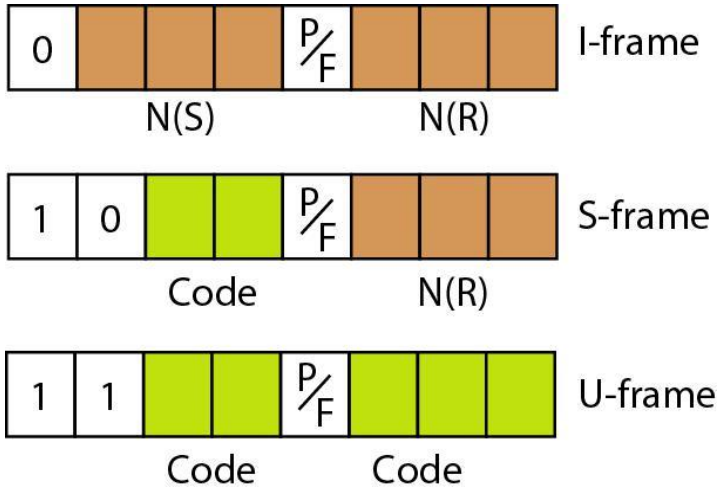
HDLC: Frames

- I(information)-frames, S(supervisory)-frames, U(unnumbered frame)-frames
- Flag field: 01111110 to identify both the beginning and the end of a frame and serve as synchronization pattern for receiver
- FCS field: 2- or 4-byte ITU-T CRC for error detection



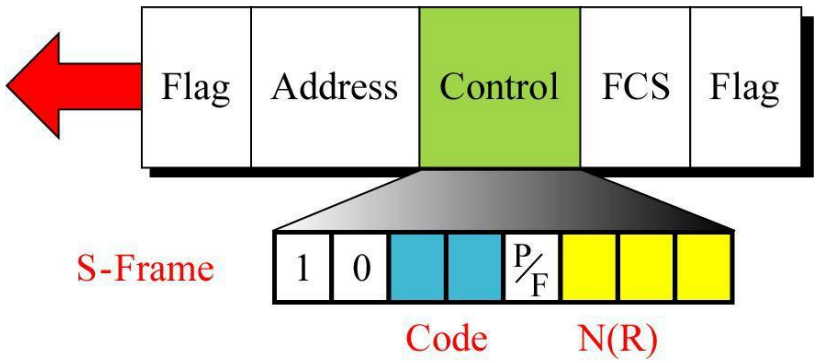
HDLC: Frames

- Control Field: 1- or 2-byte segment of the frame used for flow and error control
- Determine the type of frame and define its functionality
- Control field for I-frame: P/F (poll/final bit for primary/secondary)



HDLC: Frames

- Control field for S-frame
- Receive ready (RR), Receive not ready (RNR), Reject (REJ) Selective reject (SREJ)



Code	Command	
00	RR	Receive ready
01	REJ	Reject
10	RNR	Receive not ready
11	SREJ	Selective-reject

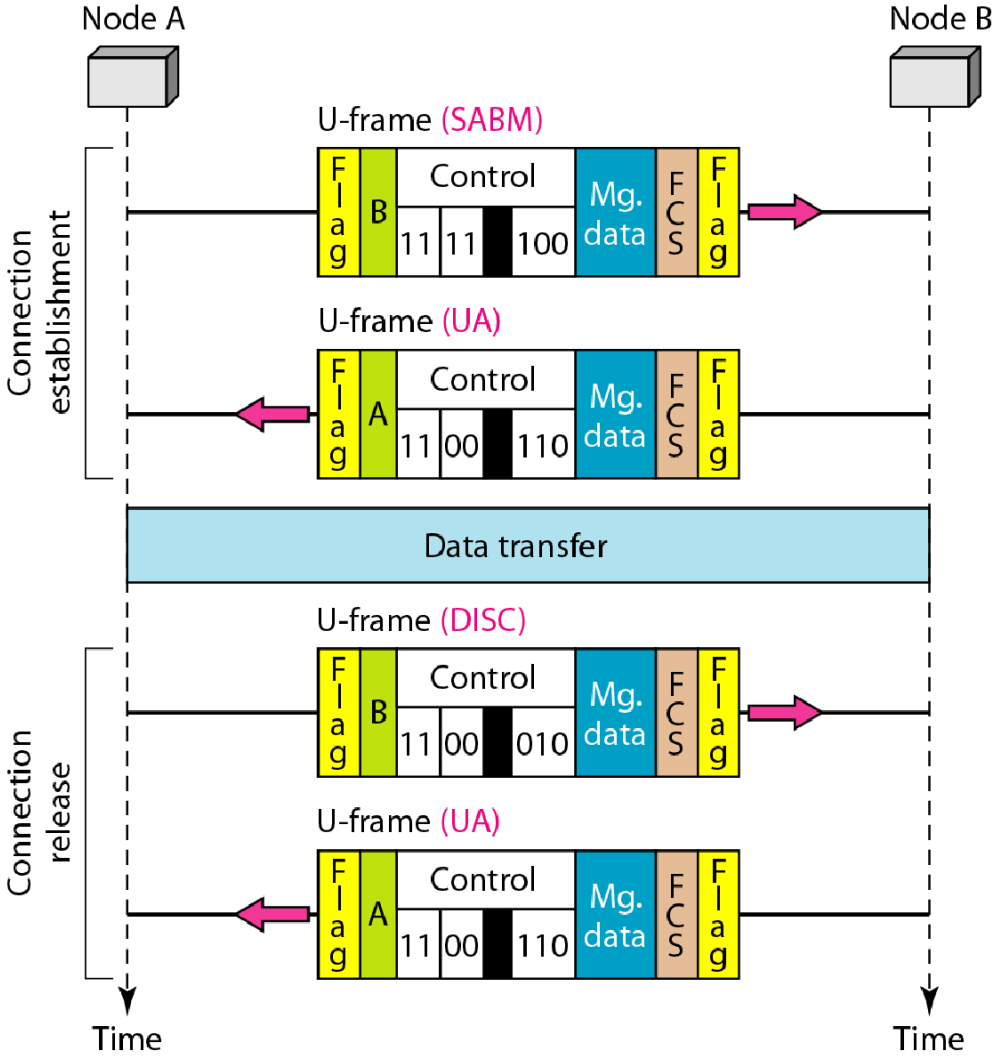
HDLC: Frames

- Control field for U-frame

Code	*Command*	*Response*	*Meaning*
00 001	SNRM		Set normal response mode
11 011	SNRME		Set normal response mode, extended
11 100	SABM	**DM**	Set asynchronous balanced mode or **disconnect mode**
11 110	SABME		Set asynchronous balanced mode, extended
00 000	UI	**UI**	Unnumbered information
00 110		**UA**	**Unnumbered acknowledgment**
00 010	DISC	**RD**	Disconnect or **request disconnect**
10 000	SIM	**RIM**	Set initialization mode or **request information mode**
00 100	UP		Unnumbered poll
11 001	RSET		Reset
11 101	XID	**XID**	Exchange ID
10 001	FRMR	**FRMR**	Frame reject

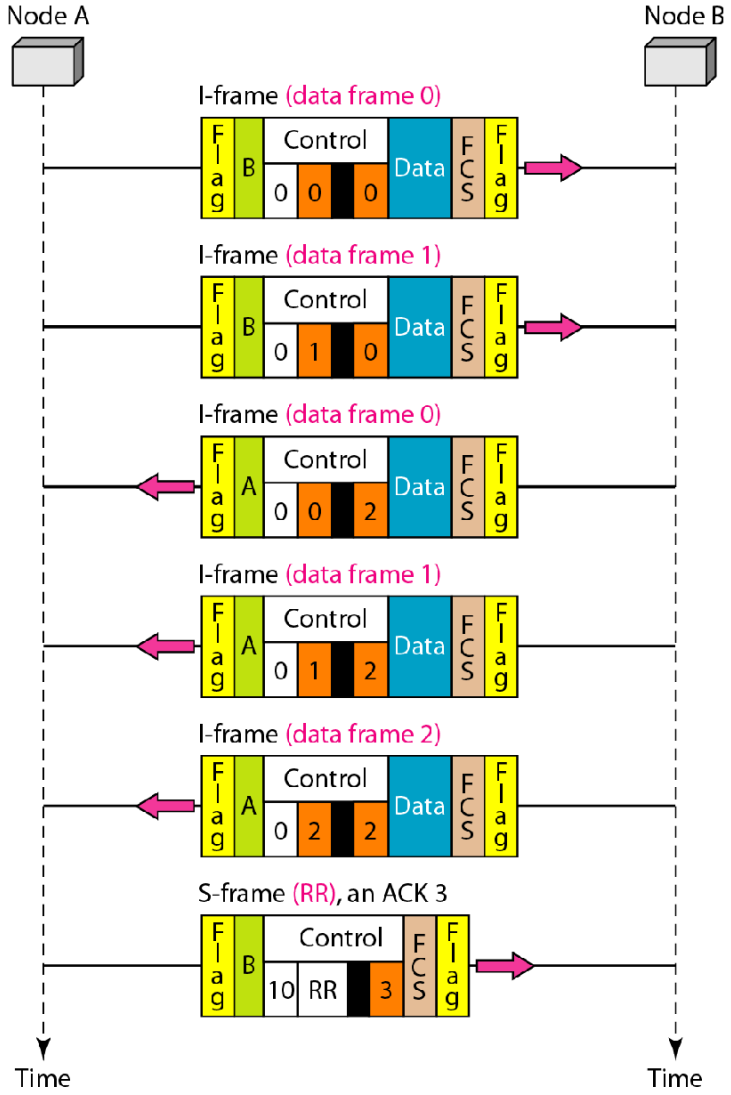
HDLC: Example 1

- Connection and disconnection



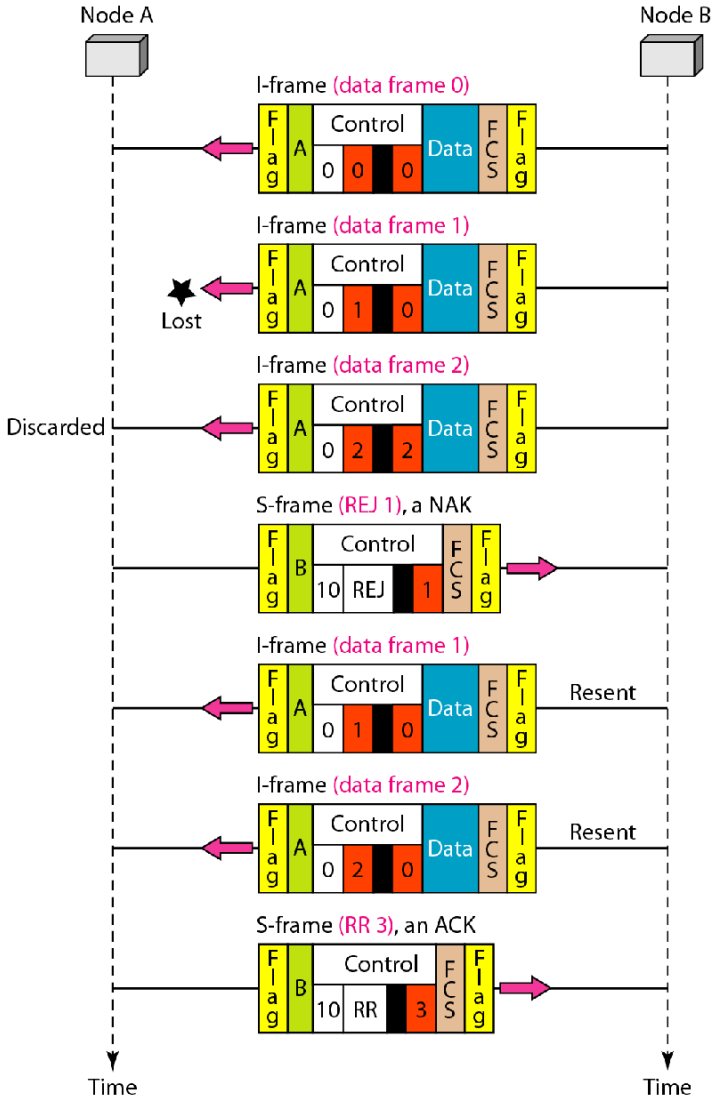
HDLC: Example 2

- Piggybacking without error

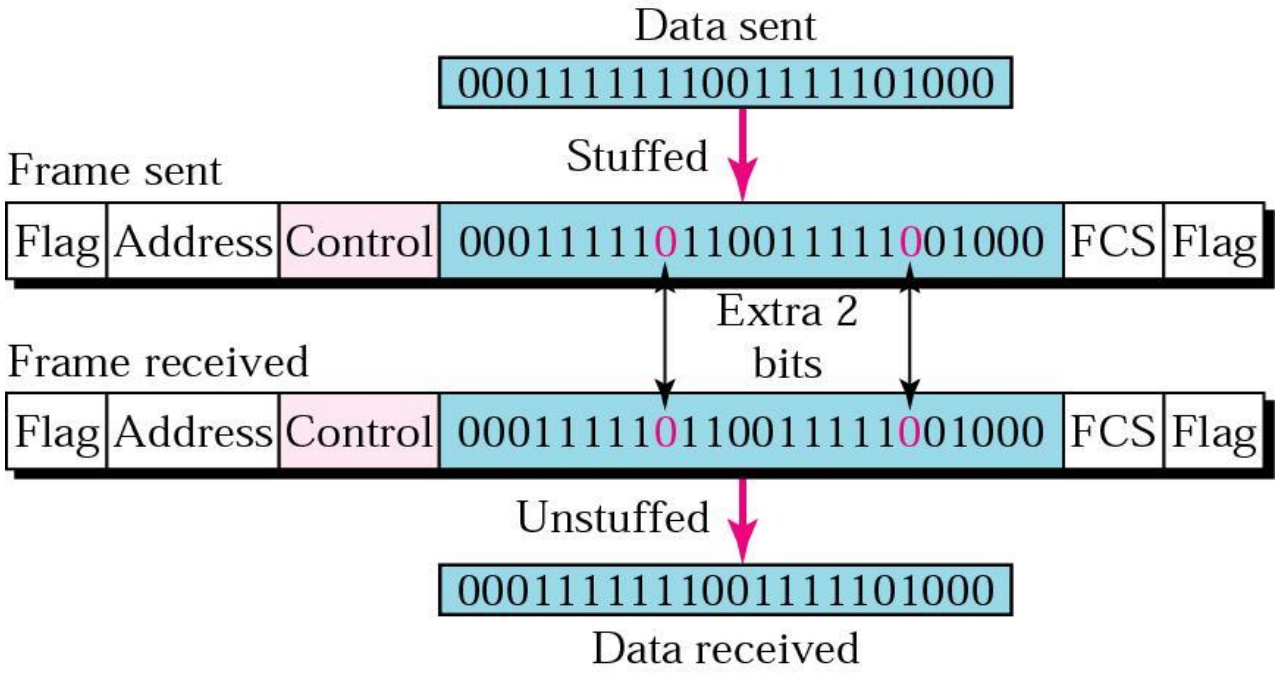


HDLC: Example 3

- Piggybacking with error



HDLC: Bit Stuffing and Unstuffing



POINT-TO-POINT PROTOCOL

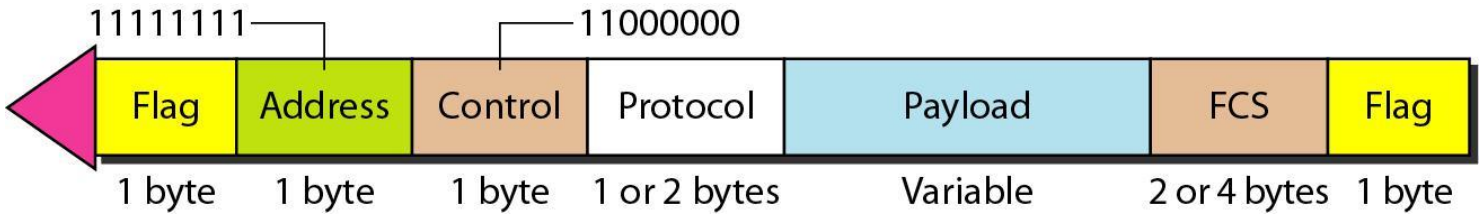
- **- PPP can be used as a data link control to connect two routers**
- **- It can be used to connect a personal computer to an internet service provider (ISP)**
- **-It can operate over asynchronous -links, bit asynchronous links**
- **- The PPP protocol uses HDLC –like frame format to encapsulate data grams over point-to-point links**

Point-to-Point Protocol: *PPP*

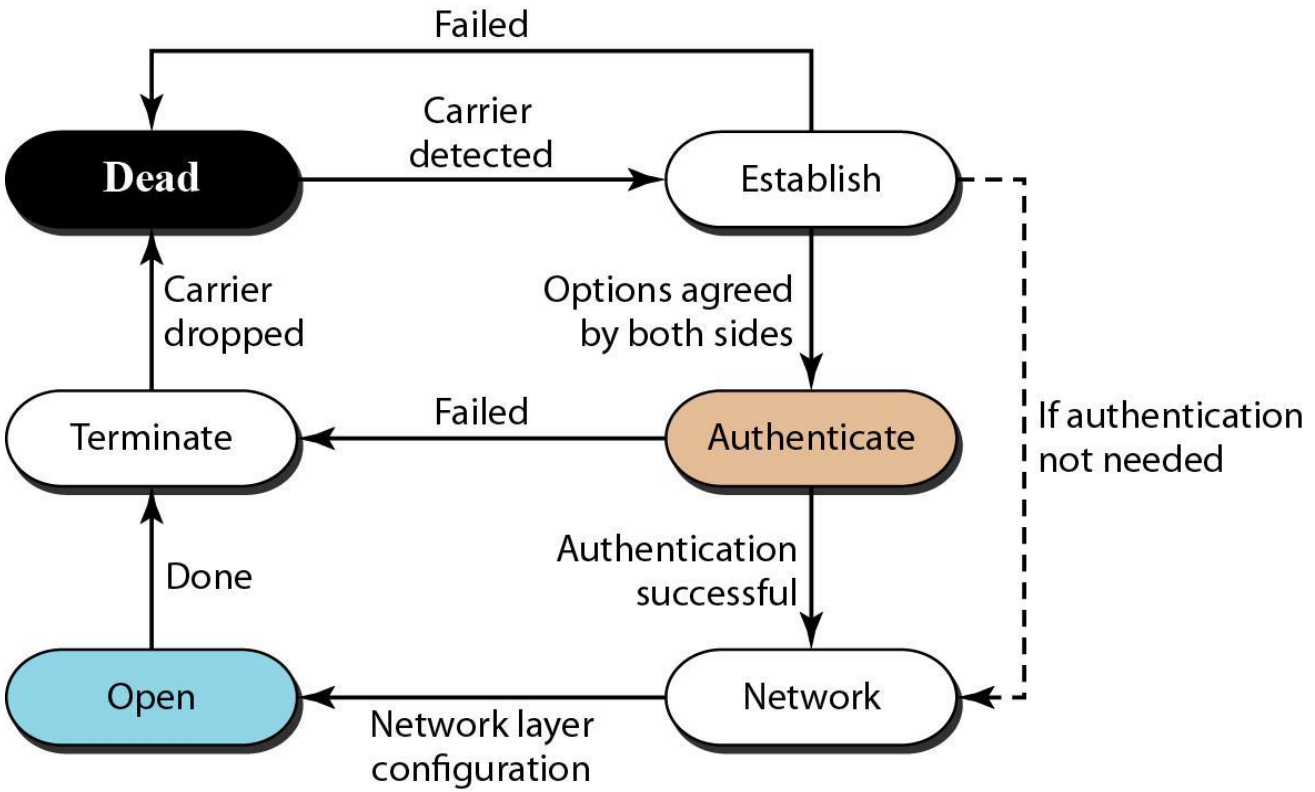
- PPP defines/provides
  - the format of the frame to be exchanged between devices
  - how two devices negotiate the establishment of the link and the exchange of data
  - how network layer data are encapsulated in the data link frame
  - how two devices can authenticate each other
  - multiple network layer services
  - connection over multiple links
  - Network address configuration
- But, several services are missing for simplicity
  - no flow control, simple error control (detection and discard), no sophisticate addressing for multipoint configuration

PPP Frame

- Flag: 01111110 the same as HDLC, but it treated as a byte because of PPP is a byte-oriented protocol
- Address: 11111111 (broadcast address)
- Control: No need because PPP has no flow control and limited error control
- PPP is a byte-oriented protocol using byte stuffing with the escape byte 01111101

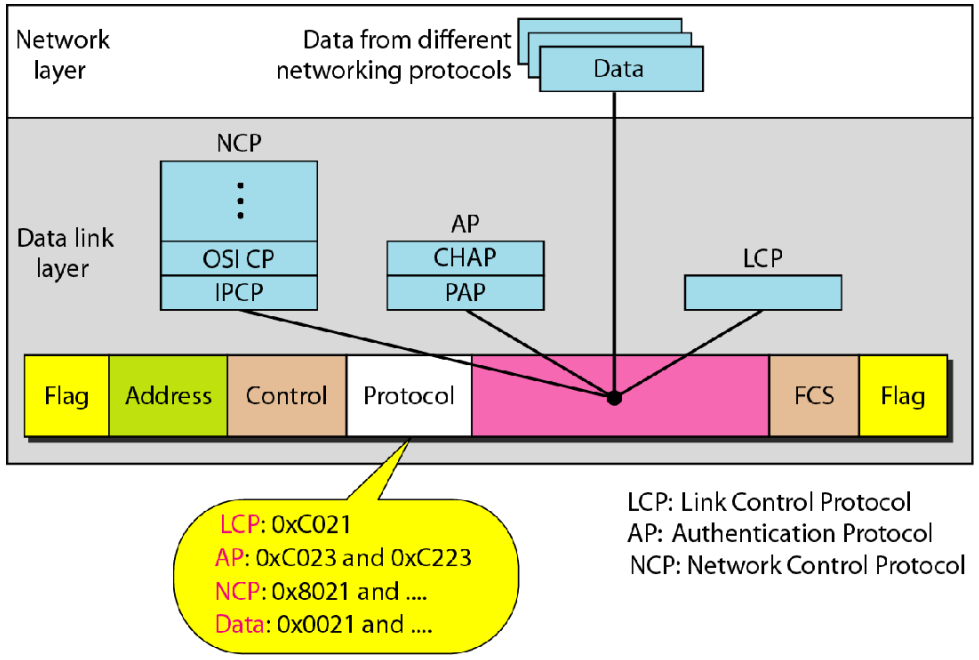


PPP: Transition States

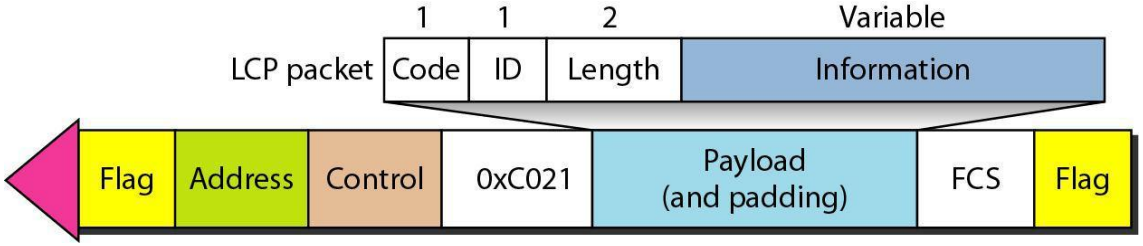


PPP: Multiplexing

- PPP uses another set of other protocols to establish the link, authenticate the parties, and carry the network layer data
- Three sets of protocols defined for powerful PPP: LCP, two APs, several NCPs



LCP: 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

LCP: Common Options

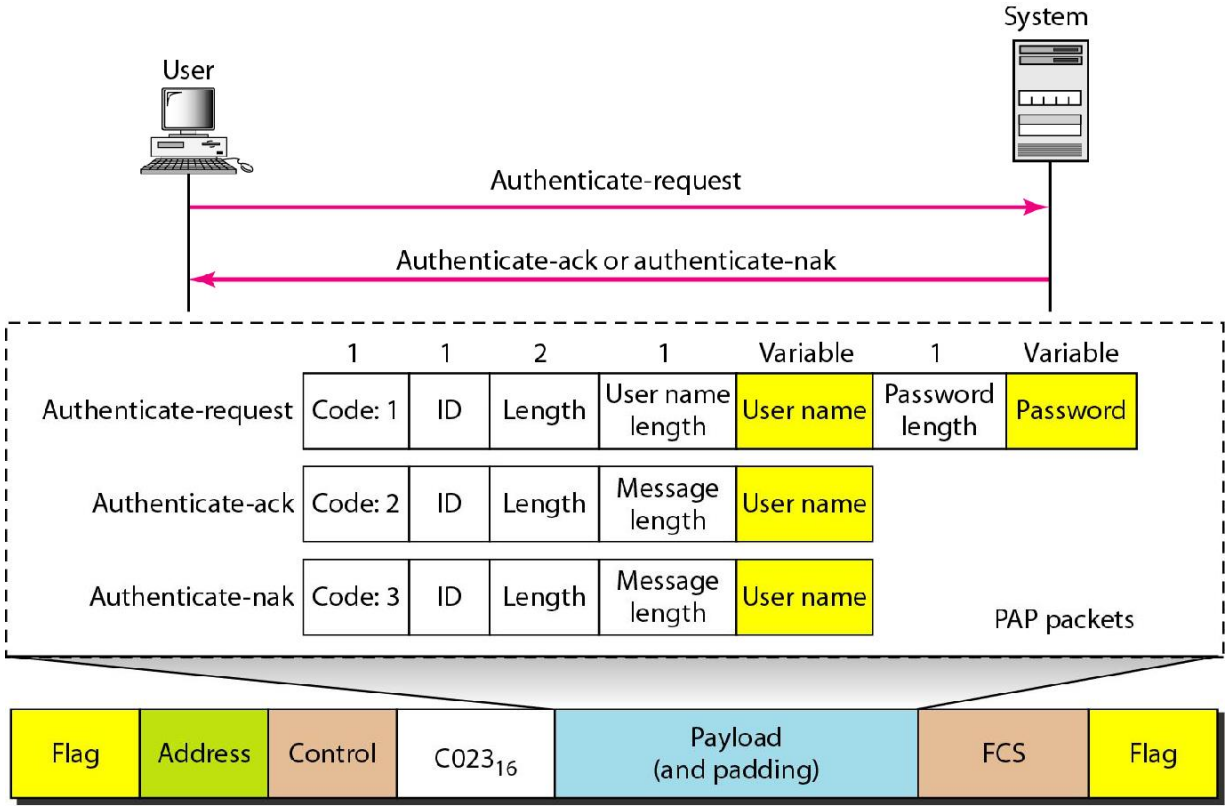
- Options are inserted in the information field of the configuration packets

Option	*Default*
Maximum receive unit (payload field size)	1500
Authentication protocol	None
Protocol field compression	Off
Address and control field compression	Off

Authentication

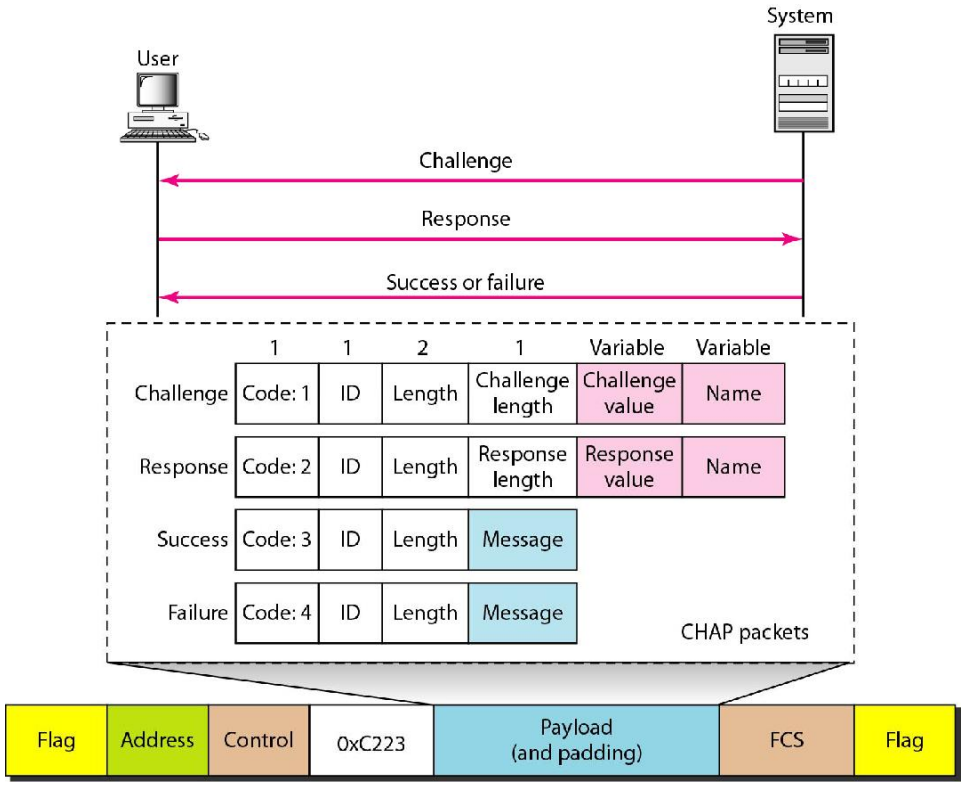
- Authentication means ***validating the identity of a user*** who needs to access
- PPP is designed for use over dial-up links $\Rightarrow$ User authentication is necessary
- PPP has two protocols for authentication
  - Password Authentication Protocol (PAP)
  - Challenge Handshake Authentication Protocol (CHAP)

Password Authentication Protocol (PAP)



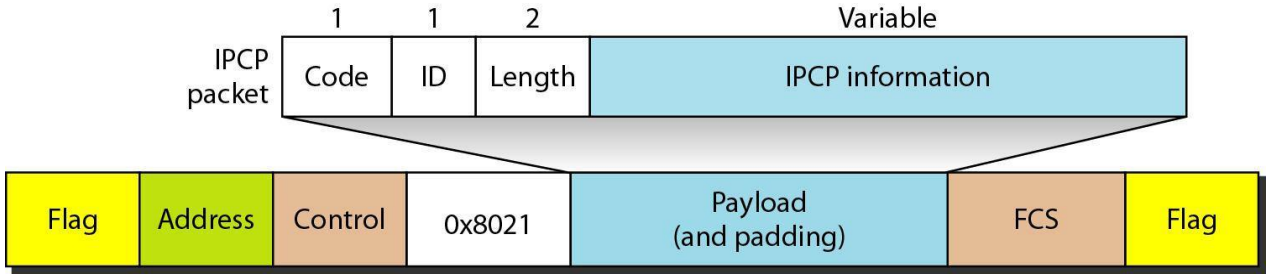
Challenge Handshake Authentication Protocol (CHAP)

- Three-way hand-shaking authentication protocol with greater security than PAP

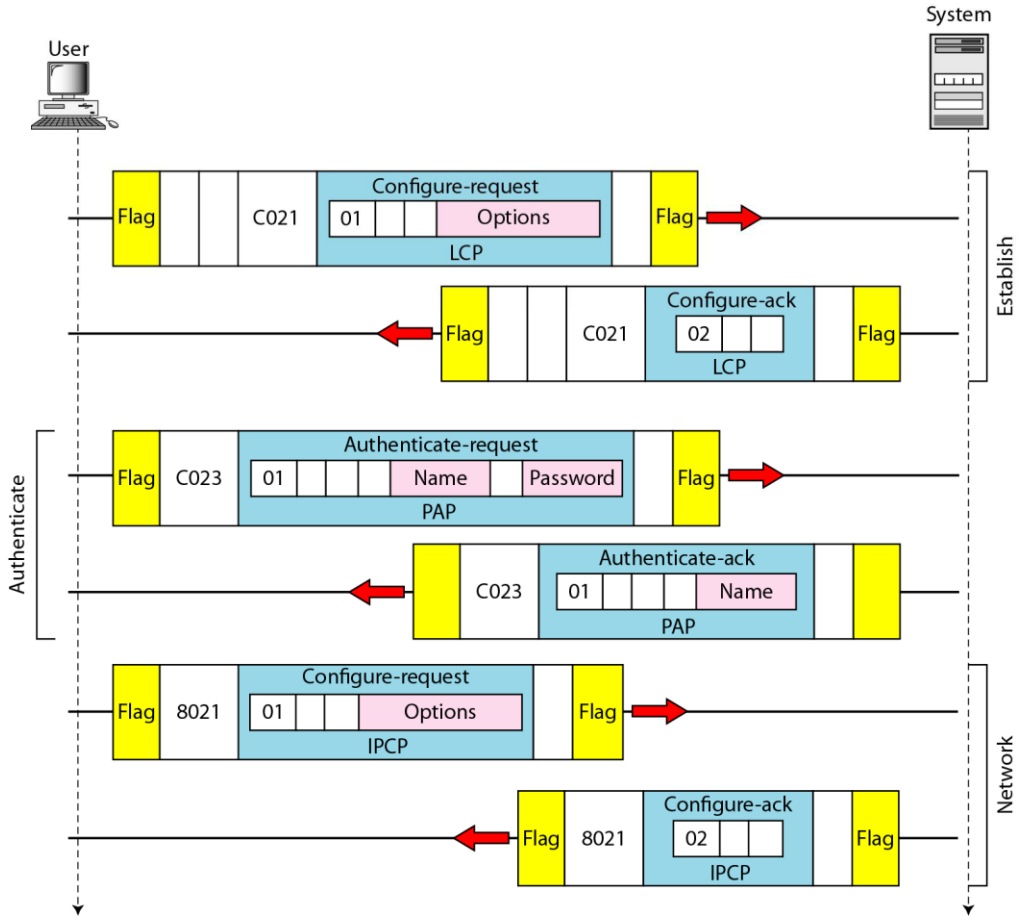


Network Control Protocol: *NCP*

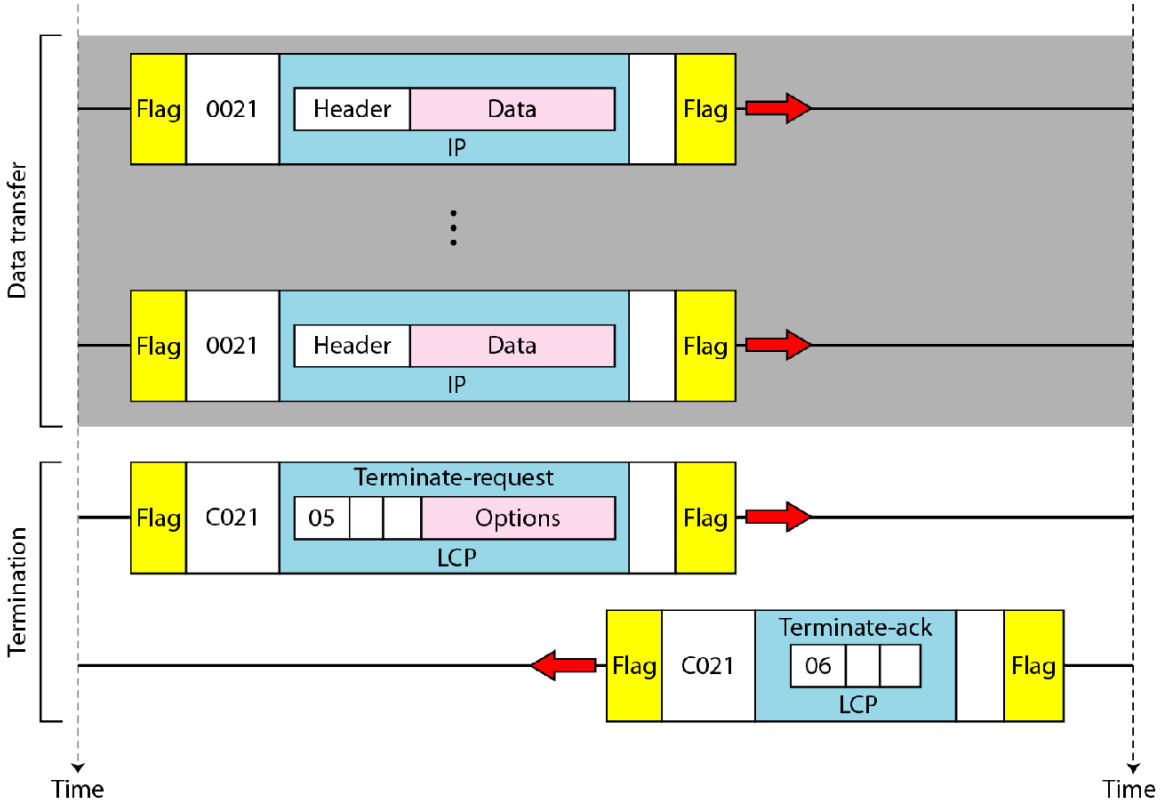
- PPP is a multiple-network layer protocol.
- It can carry a network data packet from protocols defined by the Internet, OSI, Xerox, DECnet, AppleTalk, Novel
- IPCP (IP Control Protocol)
  - Configures the link used to carry IP packets in the Internet



Example (1)


User
System
Flag
C021
Configure-request
01
Options
LCP
Flag
Establish
Flag
C021
Configure-ack
02
LCP
Flag
Authenticate
Flag
C023
Authenticate-request
01
Name
Password
PAP
Flag
C023
Authenticate-ack
01
Name
PAP
Flag
8021
Configure-request
01
Options
IPCP
Flag
Network
Flag
8021
Configure-ack
02
IPCP
Flag

Example (2)


Data transfer
Flag
0021
Header
Data
IP
Flag
Flag
0021
Header
Data
IP
Flag
Termination
Flag
C021
Terminate-request
05
Options
LCP
Flag
Flag
C021
Terminate-ack
06
LCP
Flag
Time
Time