ECE4321 Computer Networks

Chapter 7

HDLC

Data Link Control Protocols

- Advance Data Communication Control Procedures (ADCCP): ANSI X3.66 adopted by the US National Bureau of Standards (FIPS PUB 71-1)

- Link access procedure balanced (LAP-B): adopted by CCITT, a part of x.25

- Synchronous data link control (SDLC): IBM

- High level data link control (HDLC): most widely used

High Level Data Link Control

- HDLC

- ISO 33009, ISO 4335

- Most widely used DLC protocol

HDLC Station Types

- Primary station
  - Controls operation of link
  - Issues commands (frames)
  - Maintains separate logical link to each secondary station

- Secondary station
  - Under control of primary station
  - Issues responses (frames)

- Combined station
  - May issue commands and responses
  - Combines the features of primary and secondary stations

HDLC Link Configurations

- Unbalanced
  - One primary and one or more secondary stations
  - Supports full duplex and half duplex

- Balanced
  - Two combined stations
  - Supports full duplex and half duplex

HDLC Transfer Modes (1)

- Normal Response Mode (NRM)
  - —Unbalanced configuration
  - —Primary can only initiate transmission
  - —Secondary may only transmit data in response to command (poll) from primary
  - —Used on multi-drop lines
  - —Host computer as primary
  - —Terminals as secondary

HDLC Transfer Modes (2)

- Asynchronous Balanced Mode (ABM)
  - —Balanced configuration
  - —Either station may initiate transmission without receiving permission
  - —Most widely used
  - —No polling overhead

HDLC Transfer Modes (3)

- Asynchronous Response Mode (ARM)
  - —Unbalanced configuration
  - —Secondary may initiate transmission without permission form primary
  - —Primary is responsible for connect, disconnect, error recovery, and initialization
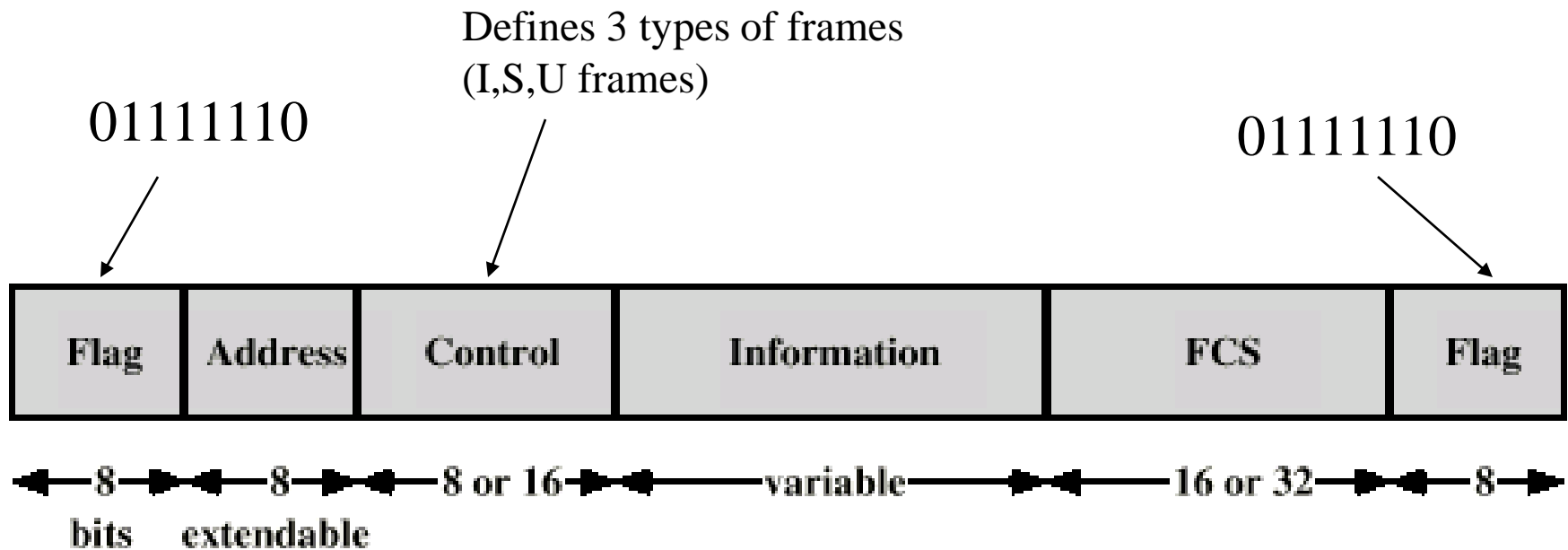 - —rarely used

Frame Structure

- Synchronous transmission
- All transmissions in frames
- Single frame format for all data and control exchanges

Frame Structure

Defines 3 types of frames
(I,S,U frames)

01111110

01111110

Flag	Address	Control	Information	FCS	Flag

8
bits

8
extendable

8 or 16

variable

16 or 32

8

(a) Frame format

Flag Fields

- Delimit frame at both ends
- 01111110
- Receiver hunts for flag sequence to synchronize
- Bit stuffing used to avoid confusion with data containing 01111110
  - The transmitter inserts 0 bit after every sequence of five 1s with the exception of flag fields
  - If receiver detects five 1s it checks next bit
    - If 0, it is deleted
    - If 1 and seventh bit is 0 (i.e., 10), accept as flag
    - If sixth and seventh bits 1 (i.e., 11), sender is indicating abort

Bit Stuffing

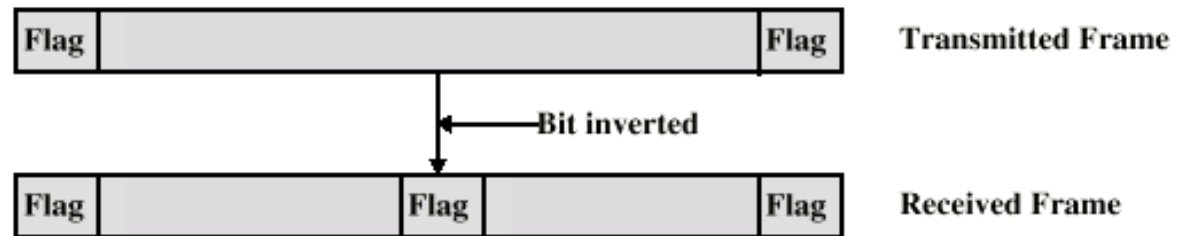**Original Pattern:**

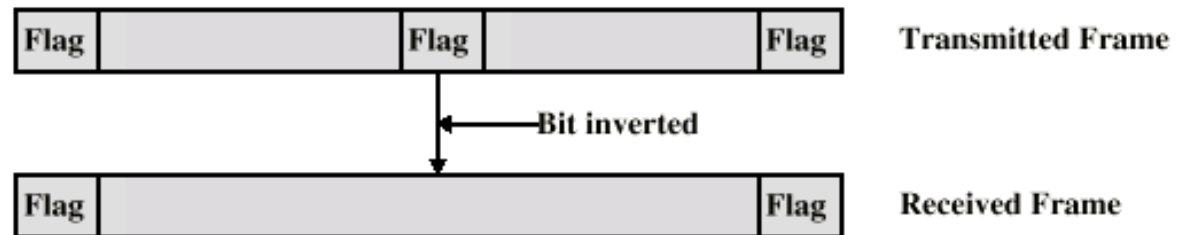1111111111110111111101111110

After bit-stuffing

11111011111011011111010111110101

(a) Example

- Example with possible errors
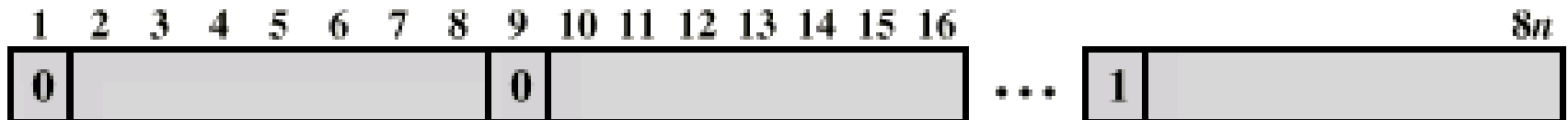

(b) An inverted bit splits a frame in two

(c) An inverted bit merges two frames

Address Field

- Identifies secondary station that sent or will receive frame
- Usually 8 bits long
- May be extended to multiples of 7 bits
  — LSB of each octet indicates that it is the last octet (1) or not (0)
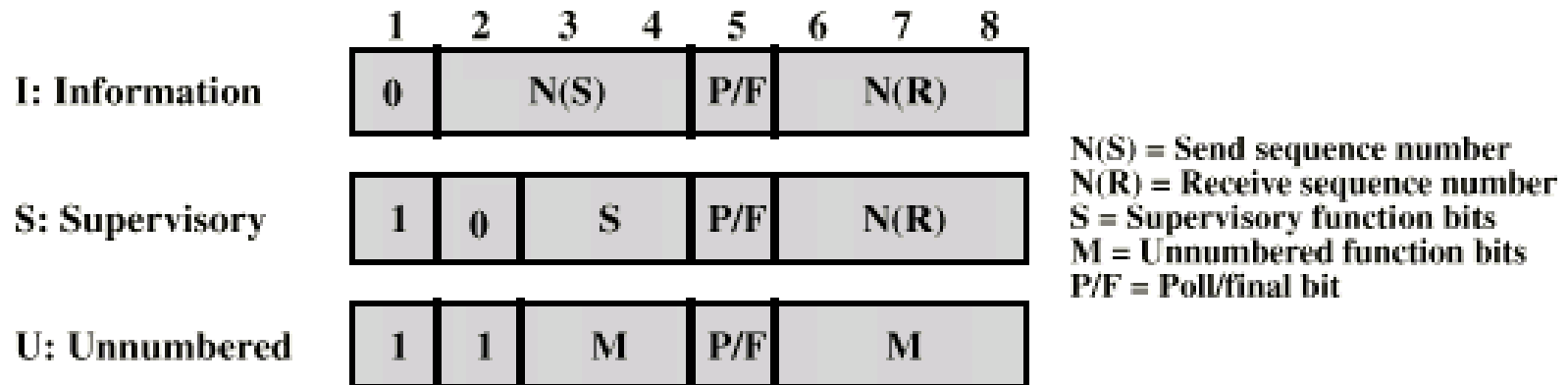- All ones (11111111) is broadcast

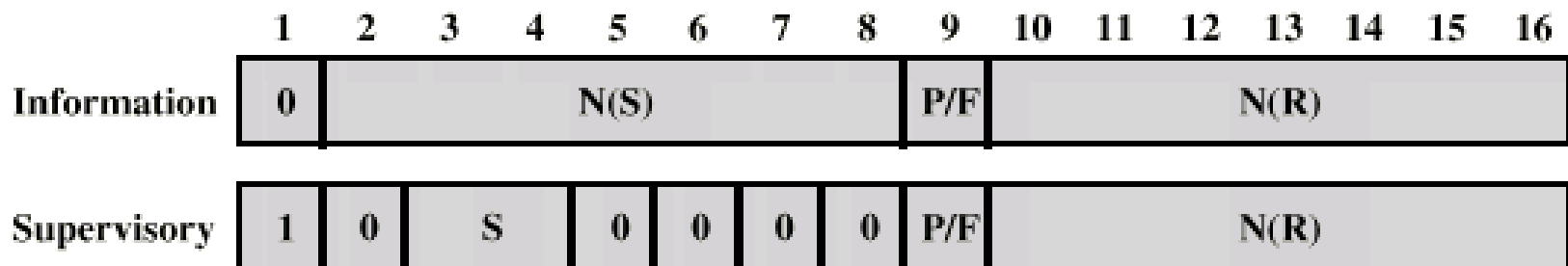| 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			$8n$
0								0								...	1	

(b) Extended Address Field

Control Field

- Different for different frame type
  - I-frame (information frame)
    - data to be transmitted to user (next layer up)
    - Flow and error control piggybacked on information frames
  - S-frame (Supervisory frame)
    - Used for flow and error control
  - U-frame (Unnumbered frame)
    - supplementary link control
- First one or two bits of control filed identify frame type

Control Field Diagram

	1	2	3	4	5	6	7	8
I: Information	0		N(S)		P/F		N(R)	
S: Supervisory	1	0	S		P/F		N(R)	
U: Unnumbered	1	1	M		P/F		M	

N(S) = Send sequence number
N(R) = Receive sequence number
S = Supervisory function bits
M = Unnumbered function bits
P/F = Poll/final bit

(c) 8-bit control field format

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Information	0			N(S)					P/F				N(R)			
Supervisory	1	0	S		0	0	0	0	P/F				N(R)			

(d) 16-bit control field format

Poll/Final Bit

- Use depends on context
- Command frame
  - P bit : used for poll from primary
  - 1 to solicit (poll) response from peer
- Response frame
  - F bit : used for response from secondary
  - 1 indicates response to soliciting command

I-frame

- Contains the sequence number of transmitted frames and a piggybacked ACK
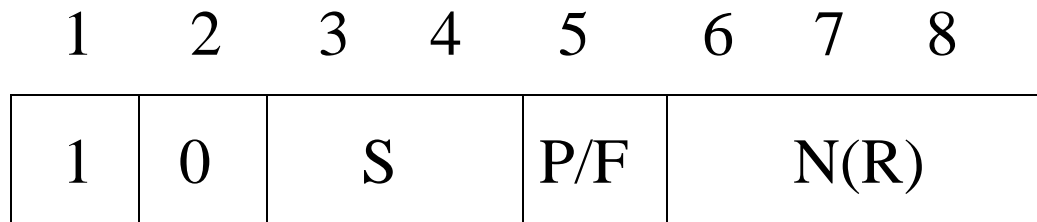
1	2	3	4	5	6	7	8
0		N(S)		P/F		N(R)	

- I,0,0

- I,1,0

- I,2,0,P

S-frame

- Used for flow and error control

1	2	3 4	5	6 7 8
1	0	S	P/F	N(R)

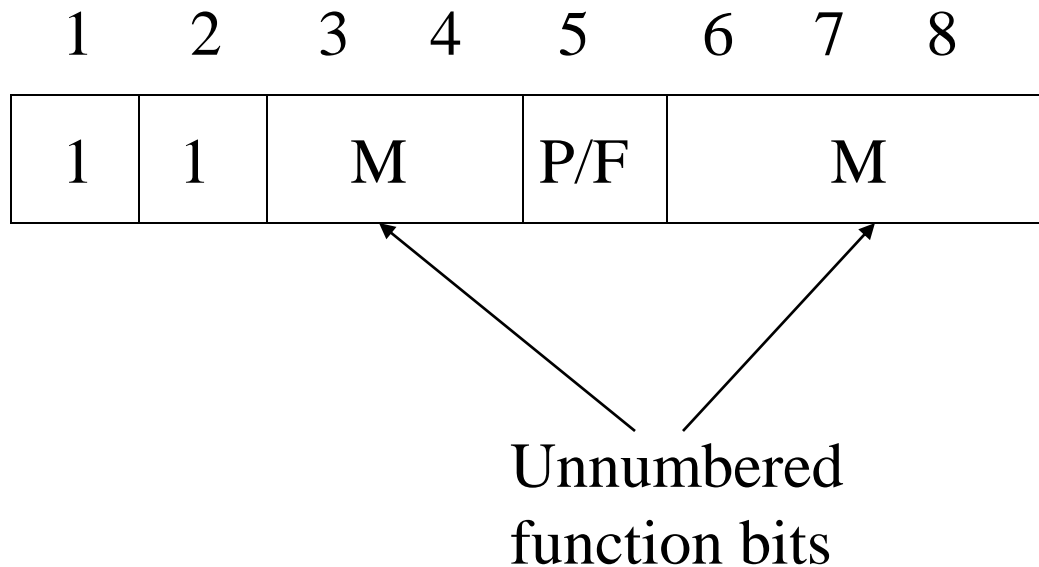•RR --- receive ready

•RNR --- receive not ready

•REJ --- reject on frame N(R)

•SREJ --- selective reject on N(R)

U-frame

- Mode setting, recovery, connect/diconnect

1	2	3	4	5	6	7	8
1	1	M		P/F	M		

Unnumbered
function bits

Unnumberred frames

- Set normal response mode (SNRM)
- Set asynchronous response mode (SARM)
- Set asynchronous balanced mode (SABM)
- Disconnect (DISC)
- Unnumberred acknowledgement (UA)
- Disconnect mode (DM)
- Request disconnect (RD)
- Unnumberred poll (UP)
- Reset (RSET)
- Exchange identification (XID)
- Test (TEST)
- Frame reject (FRMR)

Information Field

- Only in information and some unnumbered frames

- Must contain integral number of octets
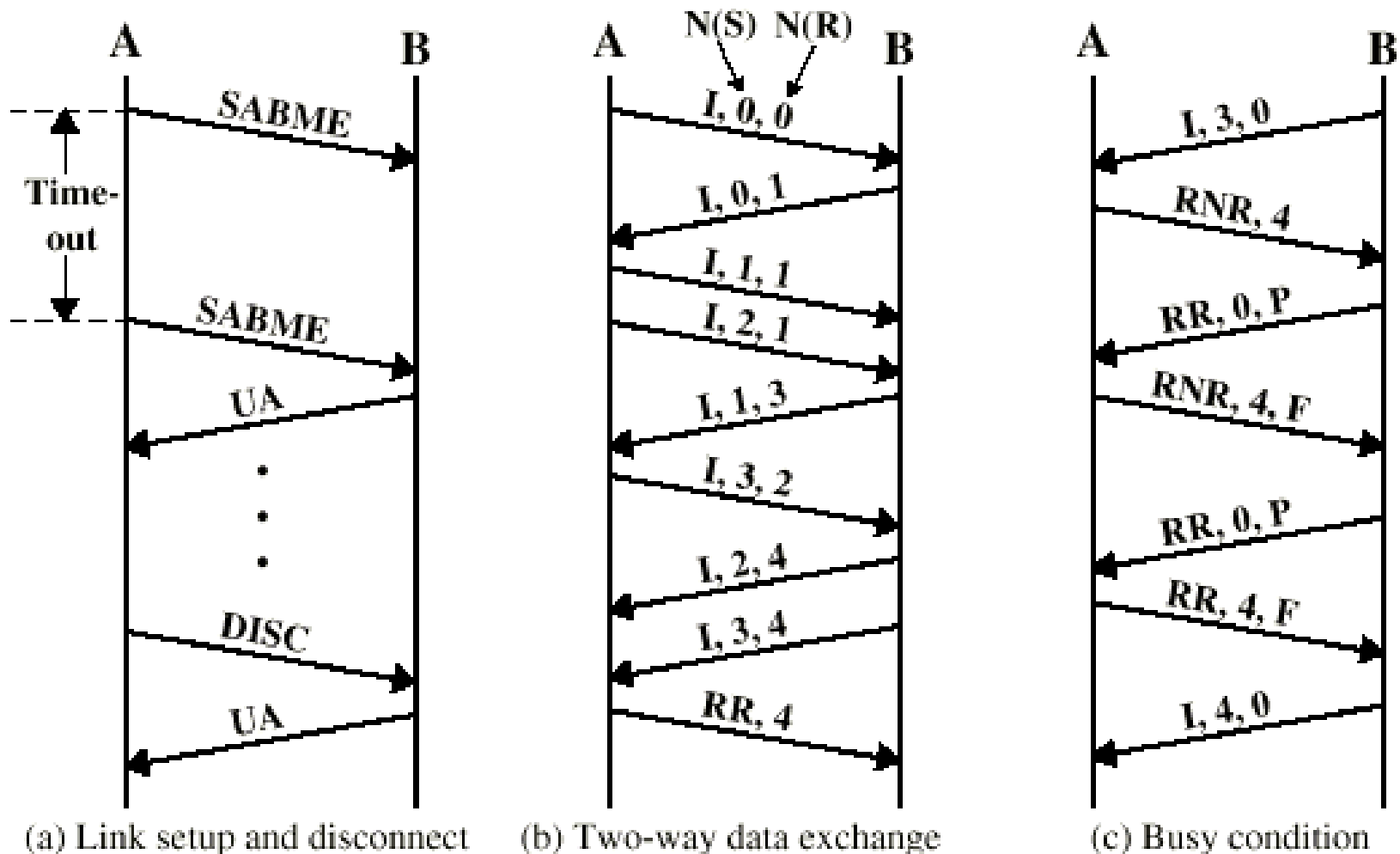
- Variable length

Frame Check Sequence Field

- FCS

- Error detection

- 16 bit CRC
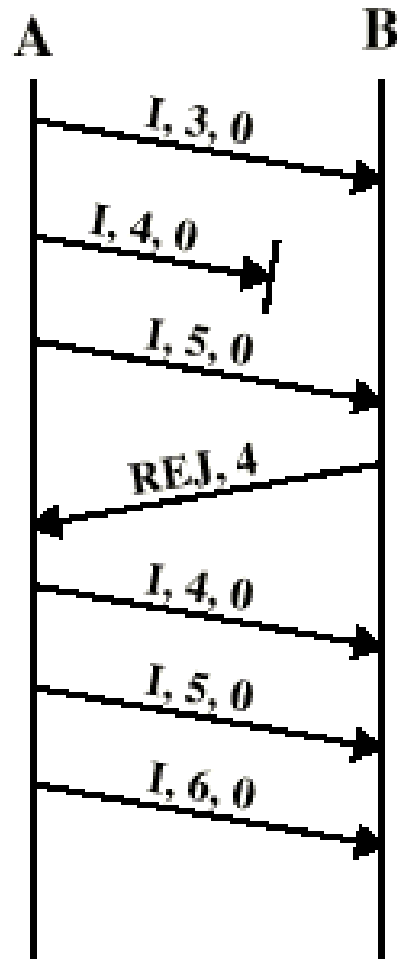
- Optional 32 bit CRC

HDLC Operation

- Exchange of information, supervisory and unnumbered frames

- Three phases
  - Initialization
  - Data transfer
  - Disconnect

Examples of Operation (1)

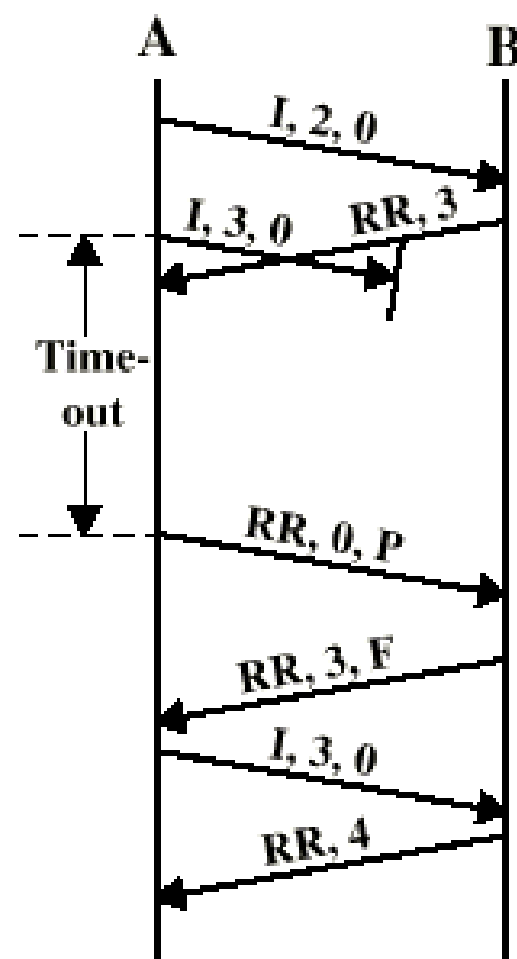(a) Link setup and disconnect   (b) Two-way data exchange   (c) Busy condition

Examples of Operation (2)

(d) Reject recovery   (e) Timeout recovery