X.25

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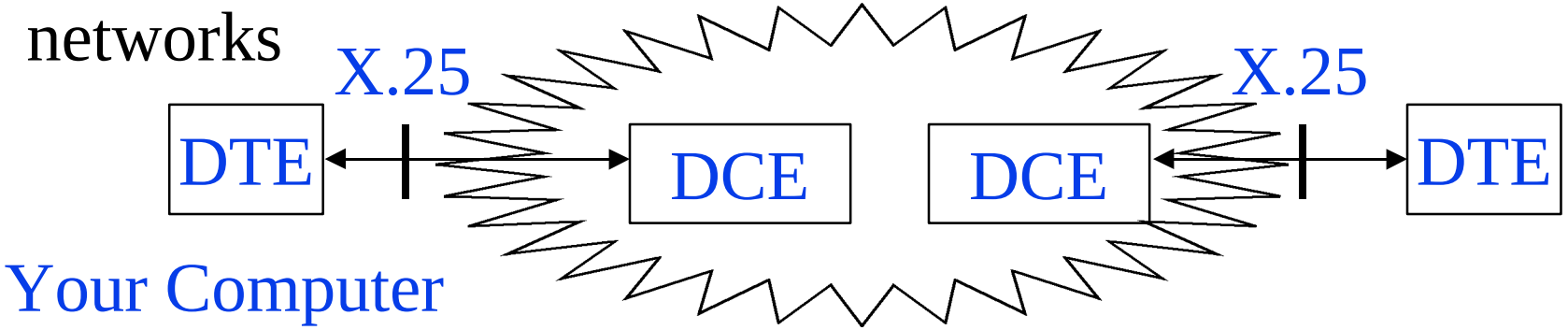
Overview

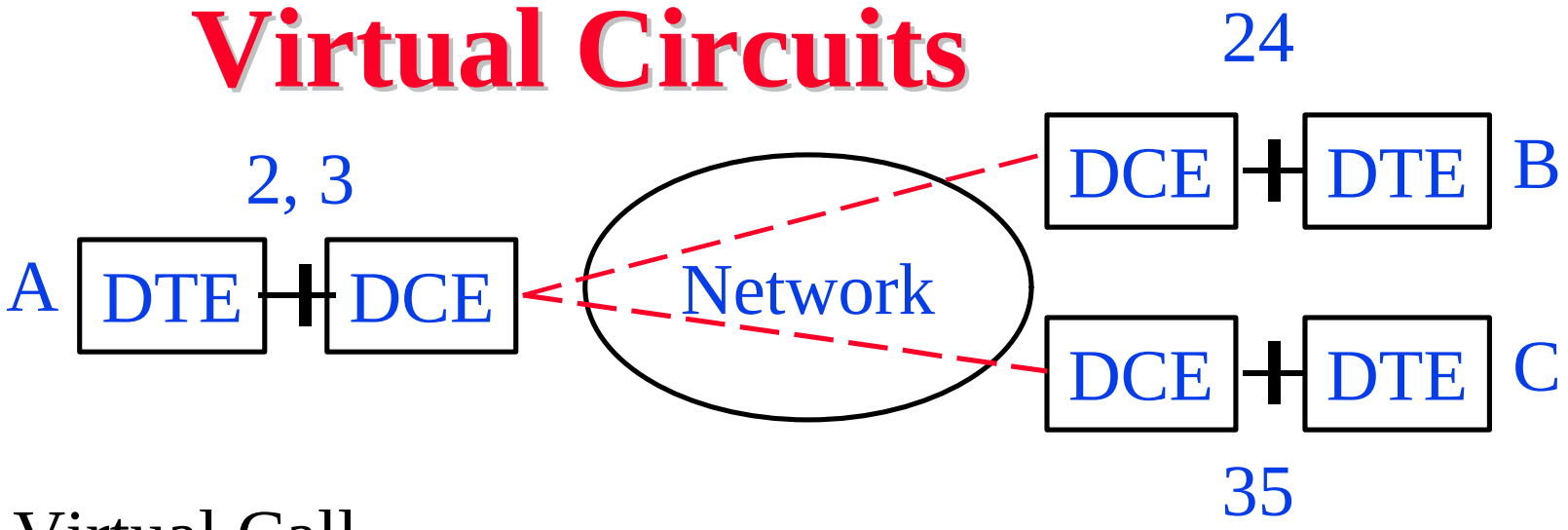
- X.25 Overview
- X.25 Protocol Layers
- X.25 Physical Layer
- X.25 Frame Level: LAPB
- X.25 Packet Level
- Call Setup/Disconnection

X.25 Overview

- First packet switching interface.
- Issued in 1976 and revised in 1980, 1984, 1988, and 1992.
- Data Terminal Equipment (DTE) to Data Communication Equipment (DCE) interface
  ⇒ User to network interface (UNI)
- Used universally for interfacing to packet switched networks

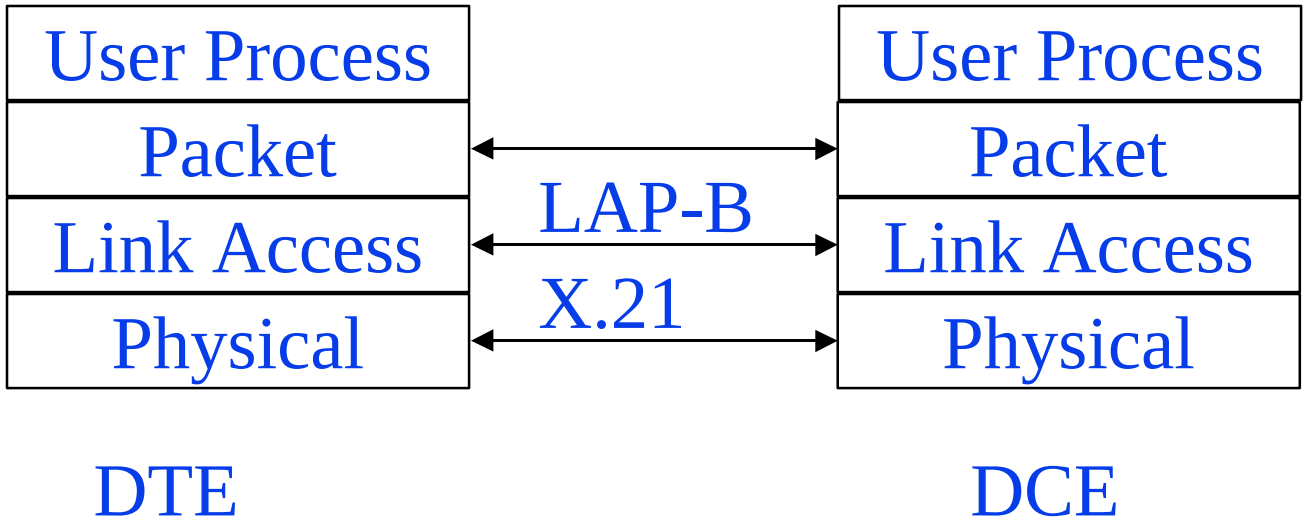


Virtual Circuits



- Virtual Call
- Two Types of Virtual Circuits:
  - Switched virtual circuit (SVC)
    Similar to phone call
  - Permanent virtual circuit (PVC)
    Similar to leased lines
- Up to 4095 VCs on one X.25 interface

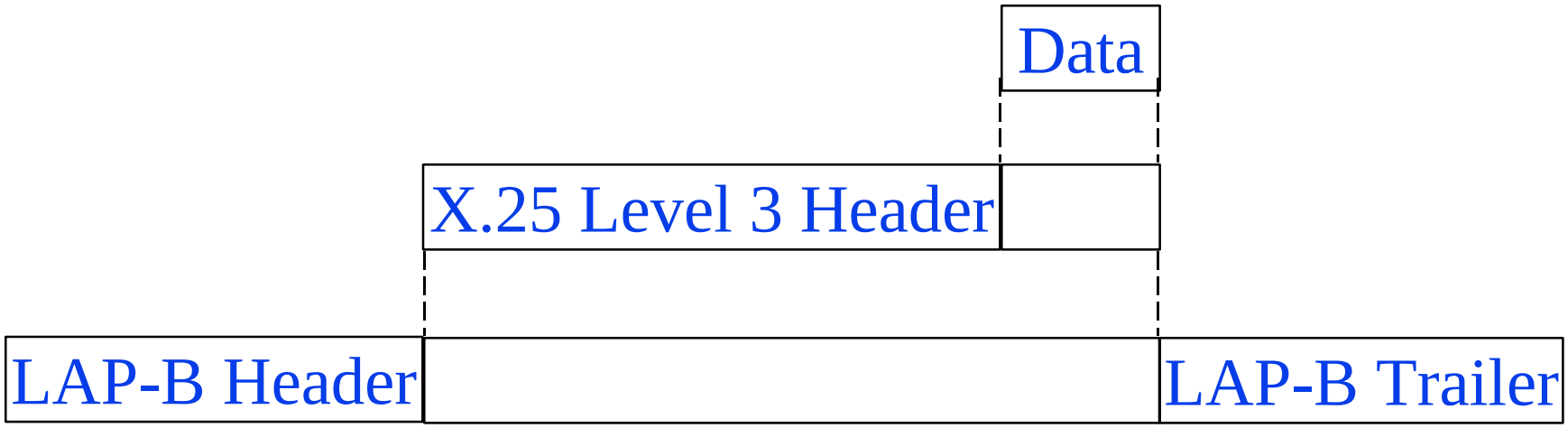
X.25 Protocol Layers



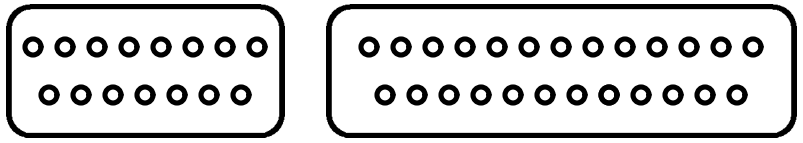
- X.21 often replaced by EIA-232 (RS-232C)
- LAP-B = Link access procedure - Balanced
- Packet layer = Connection-oriented transport over virtual circuits

Protocol Layers (Cont)

- X.25 Packets
- Data is broken into blocks
- 3- or 4-byte packet header
- Packets are broken into LAPB frames



X.25 Physical Layer

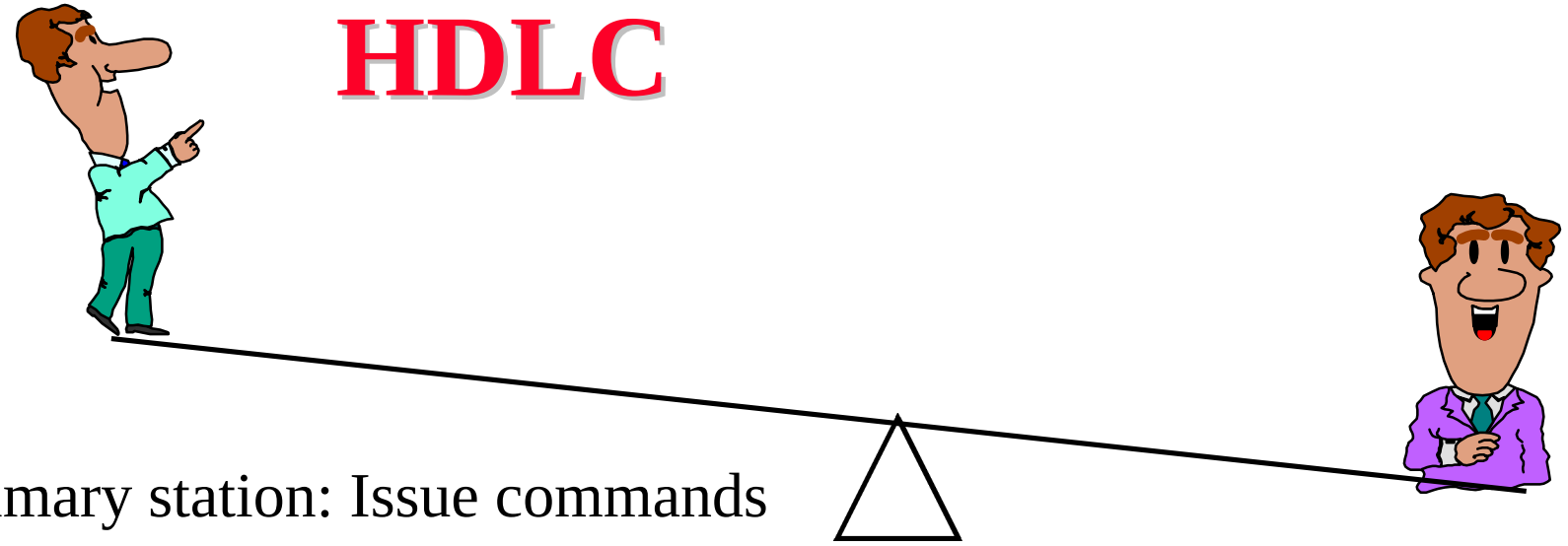


- Electrical and mechanical specifications of the interface
- X.21 = 15-pin digital recommendation
- X.21bis = X.21 twice = X.21 second
  Interim analog specification to allow existing equipment to be upgraded.
  Now more common than X.21 $\Rightarrow$ X.21 Rev 2
- RS-232-C developed by Electronics Industries Association of America (EIA) is most common
  Uses 25-pin connector. Commonly used in PCs.

HDLC Family

- Synchronous Data Link Control (SDLC): IBM
- High-Level Data Link Control (HDLC): ISO
- Link Access Procedure-Balanced (LAPB): X.25
- Link Access Procedure for the D channel (LAPD): ISDN
- Link Access Procedure for modems (LAPM): V.42
- Link Access Procedure for half-duplex links (LAPX): Teletex
- Point-to-Point Protocol (PPP): Internet
- Logical Link Control (LLC): IEEE
- Advanced Data Communications Control Procedures (ADCCP): ANSI
- V.120 and Frame relay also use HDLC

HDLC



- Primary station: Issue commands
- Secondary Station:Issue responses
- Combined Station: Both primary and secondary
- Unbalanced Configuration: One or more secondary
- Balanced Configuration: Two combined station
- Normal Response Mode (NRM): Response from secondary
- Asynchronous Balanced Mode (ABM): Combined Station
- Asynchronous Response Mode (ARM): Secondary may respond before command

LAPB

- Uses balanced mode subset of HDLC between DTE and DCE
- Uses 01111110 as frame delimiter
  Uses bit stuffing to avoid delimiters inside the frames
- Uses HDLC frame format
- Point-to-point: Only two stations - DTE (A), DCE (B)
  Addresses: A=00000011, B=00000001
  Address = Destination Addresses in Commands
  Source Address in Responses,

Control Field Format

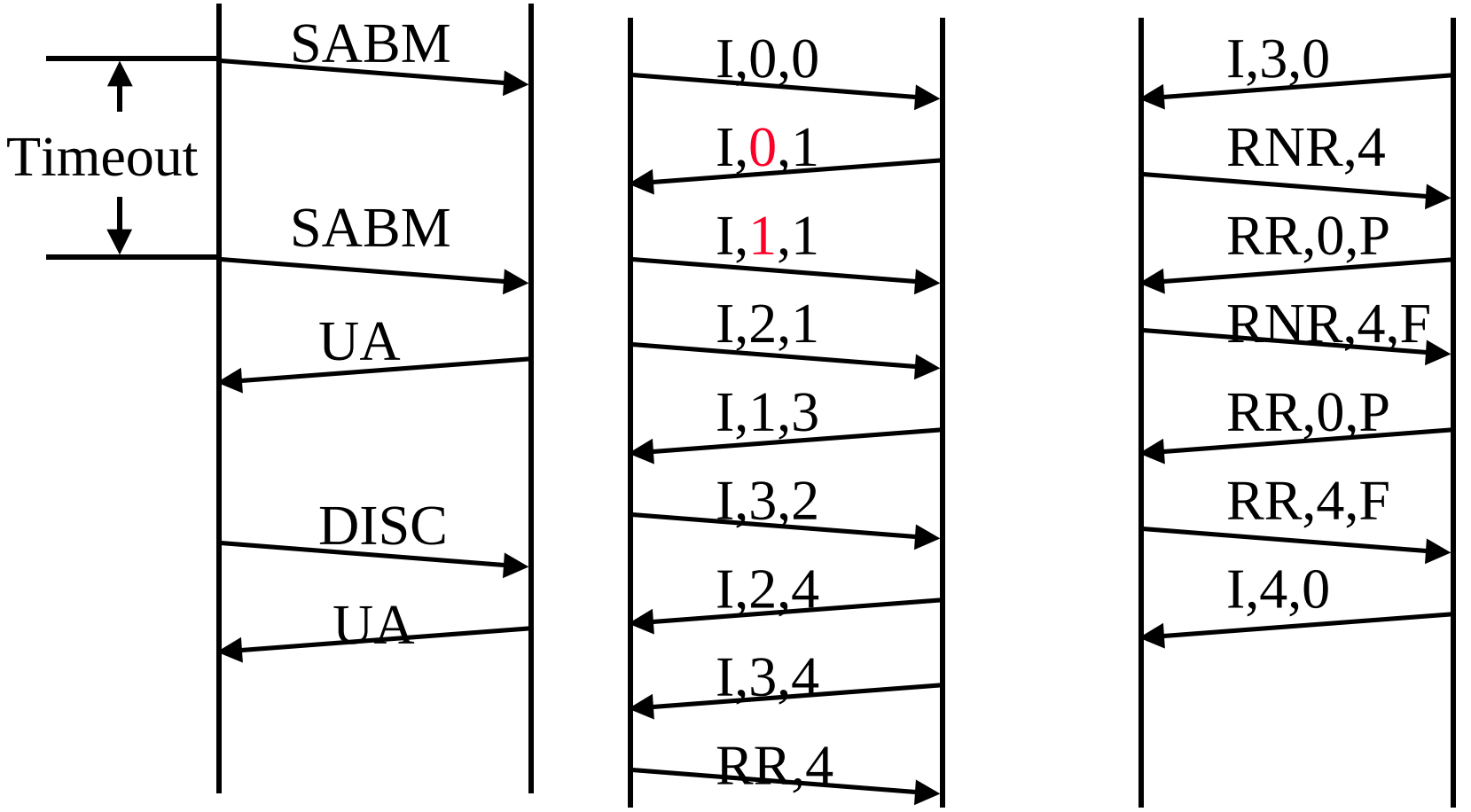
	1	2	3	4	5	6	7	8
Information	0	N(S)			P/F	N(R)		
Supervisory	1	0	S		P/F	N(R)		
Unnumbered	1	1	M		P/F	M		

- N(S) = Send Sequence Number
- N(R) = Receive Sequence Number = Expected next
- P/F = Poll/Final = Command/Response
- M = Set Async Balanced Mode (SABM), Disconnect, Unnumbered Ack, …
- S = Supervisory function = Receiver Ready (RR), Receiver Not Ready (RNR), Reject (Rej)

HDLC Frames

- Information Frames: User data
  - Piggybacked Acks: Next frame expected
  - Poll/Final = Command/Response
- Supervisory Frames: Flow and error control
  - Go back N and Selective Reject
  - Final ⇒No more data to send
- Unnumbered Frames: Control
  - Mode setting commands and responses
  - Information transfer commands and responses
  - Recovery commands and responses
  - Miscellaneous commands and responses

Examples of HDLC Operation



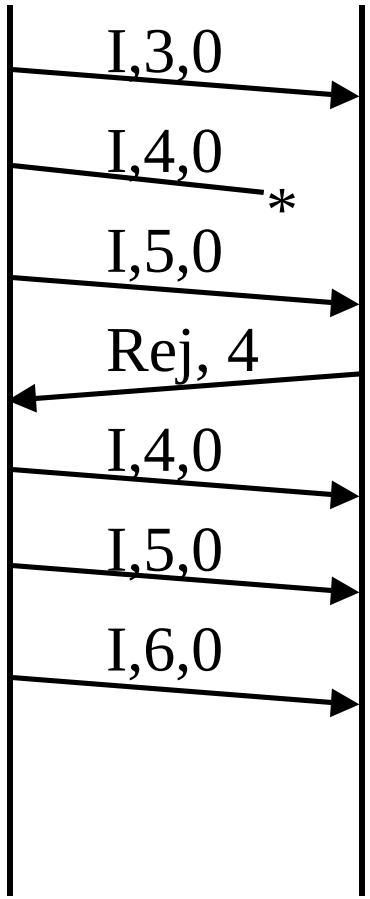
(a) Line setup and disconnect

(b) Two-way data exchange

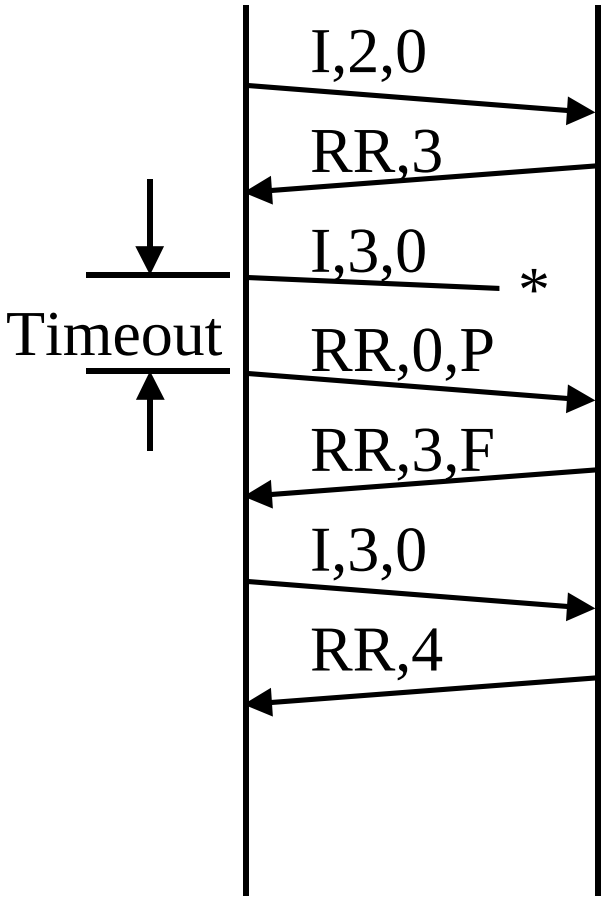
(c) Busy condition

Fig 6.12 Stallings

Examples of Operation (Cont)



(d) Reject Recovery



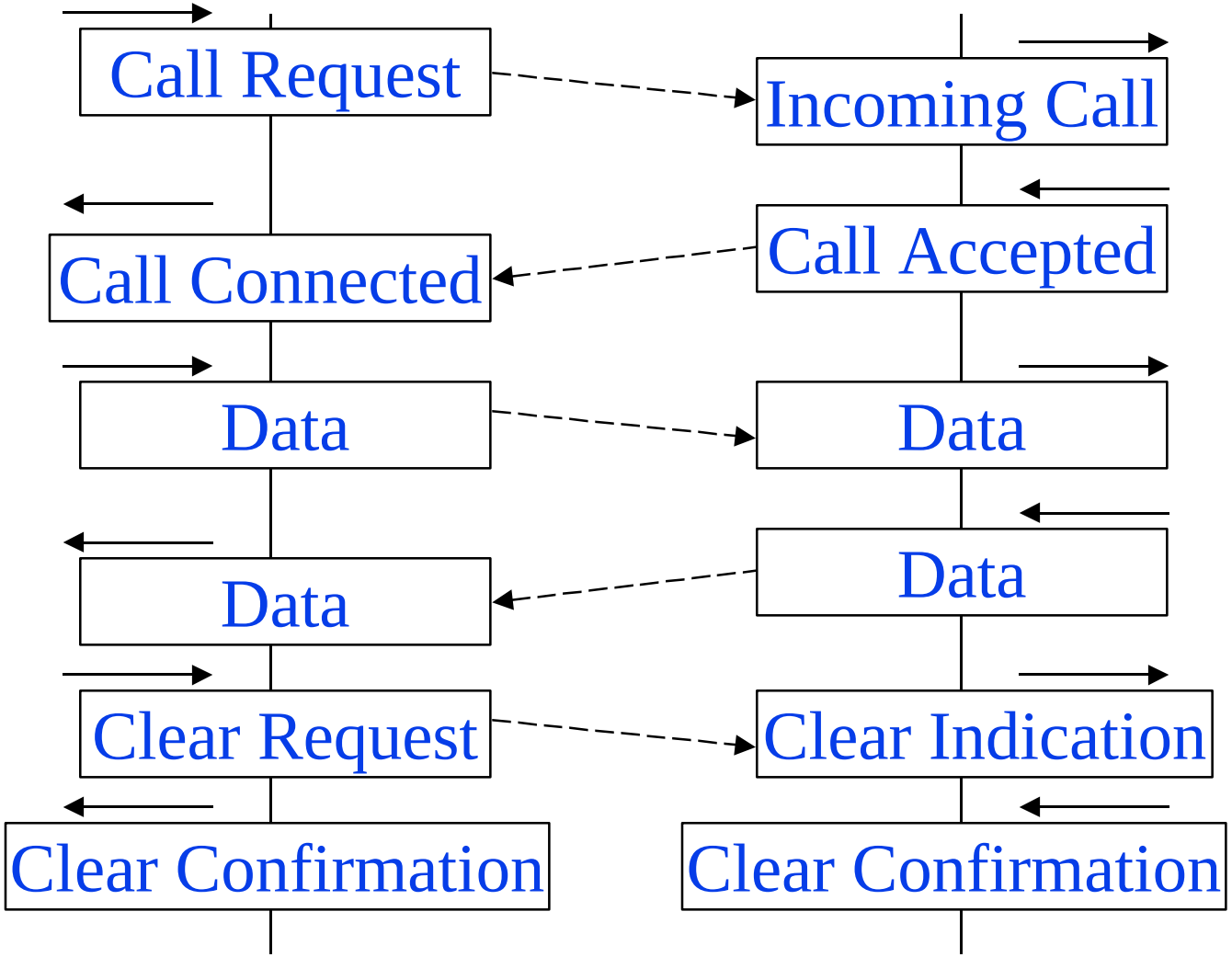
(e) Timeout Recovery

Fig 6.12 Stallings

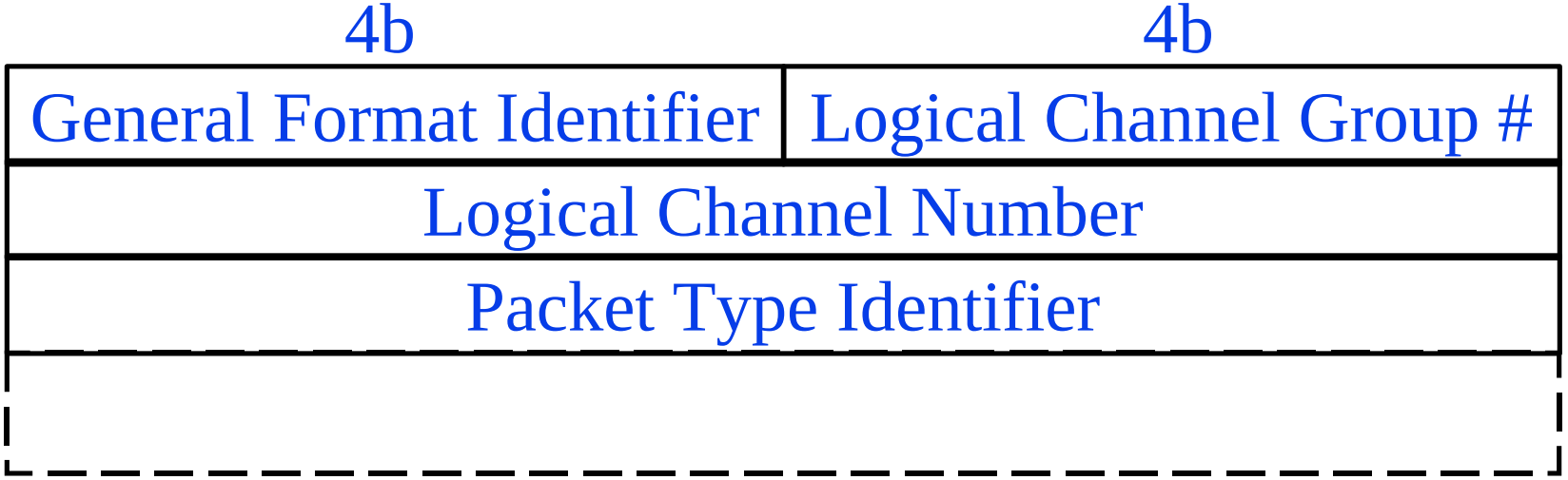
X.25 Packet Level

- Packet Level = End-to-end
- Packet level procedures:
  - Establishment and clearing of virtual calls
  - Management of PVCs
  - Flow Control
  - Recovery from error conditions

Call Setup/Disconnection

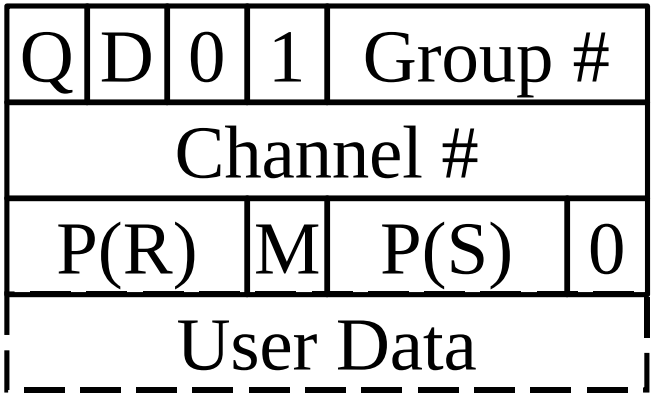


Packet Format

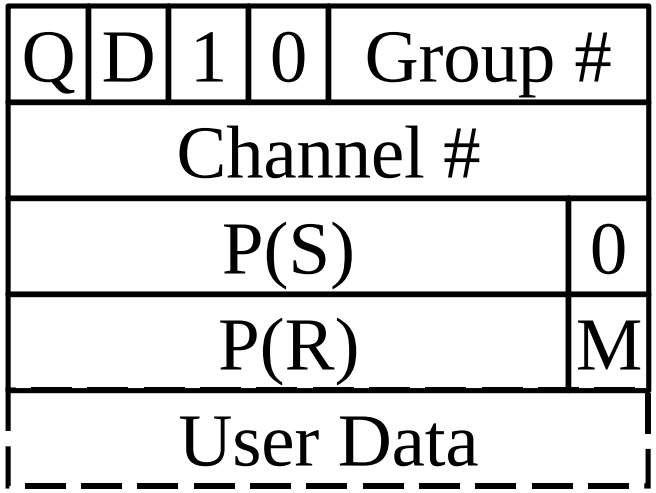


- GFI = Type of packet.
  Bit 1: Qualifier. Q=1 ⇒ Higher level control
  Bit 2: 0⇒End-to-end confirm., 1⇒Local conf.
  Bits 3,4: 01⇒ 3-bit or 10 ⇒7-bit sequence #
- LCGN + LCN = 12-bit VC # w 4-bit Group
- PTI = 20 possible packet types

Packet Format (Cont)



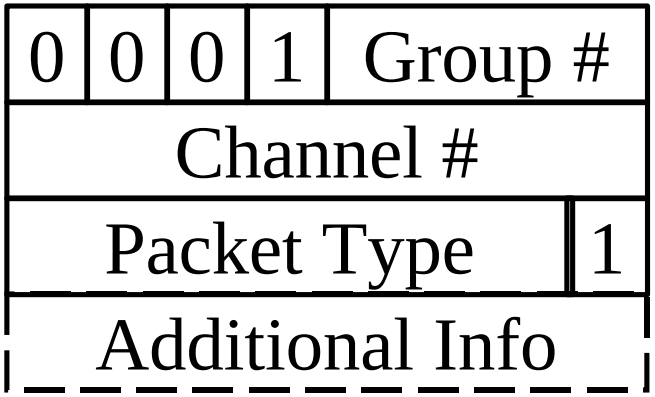
Data w 3-bit Seq #



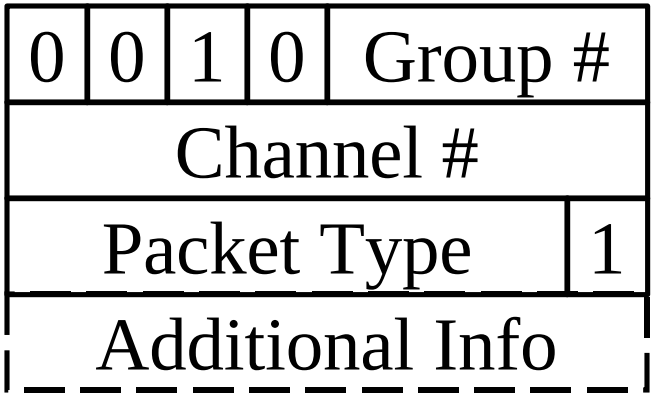
Data w 7-bit Seq #

- M = More segments
- P(R) and P(S) refer to packet sequence #
  Different from N(R) and N(S) - frame sequence #

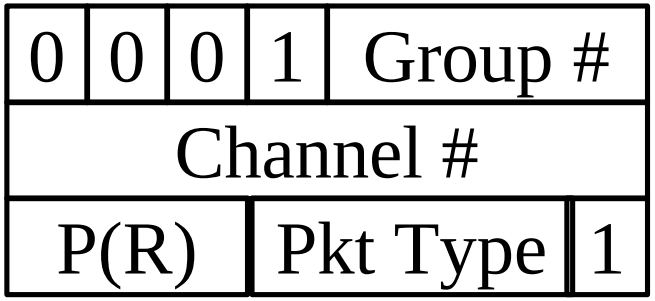
Packet Format (Contd)



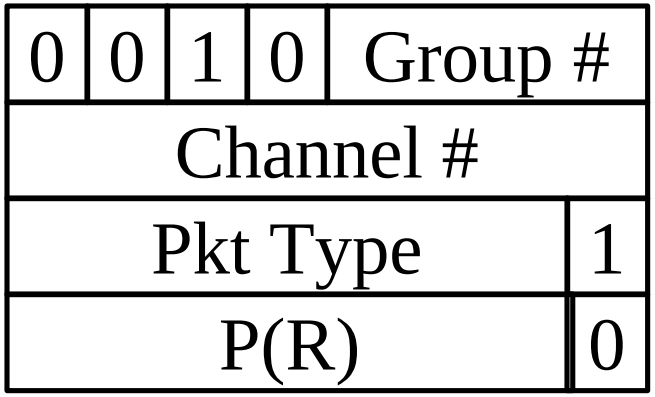
Control w 3-bit Seq #



Control w 7-bit Seq #

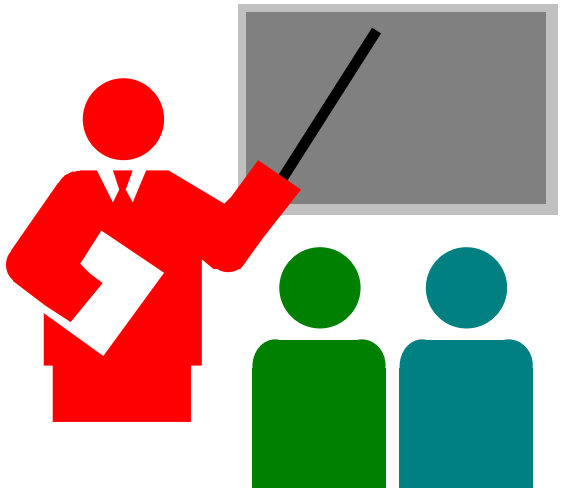


RR, RNR, and REJ packets with 3-bit seq #



RR, RNR, and REJ packets with 7-bit seq #

Summary



- X.21, LAPB
- PVC and virtual call
- VC numbers
- M and D bits

Homework

- Read pages 61-65 of Black's "Emerging Technologies" book
- Submit answer to the following question:
  In X.25 why is the VC number used by one station is different from the VC number used by the other station? After all, it is the same full-duplex virtual circuit.
- Due Date: April 13, 1999

Additional References

- N. M. Thorpe and D. Ross, "X.25 Made Easy," Prentice Hall, 1992, 192 pp.
- W. Stallings, "Data and Computer Communications," 5th Edition, Prentice Hall, 1996, Sections 6.4 and 9.4