Basic Networking Concepts

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Learning Objectives

- Packet Switched Networks.
- Protocols.
- The ISO Open System Architecture
- TCP/IP Main Features.

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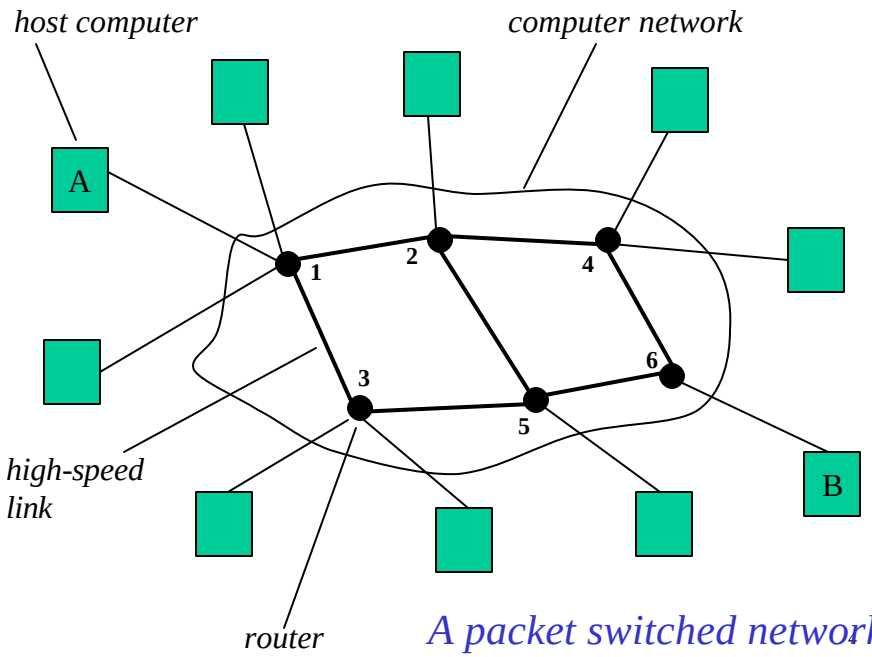

A packet switched network.

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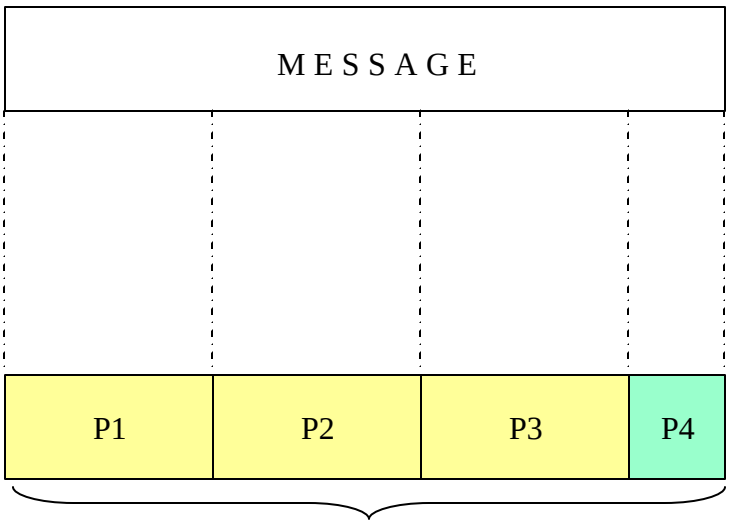
A message broken down into four packets.
Packets have a maximum size.



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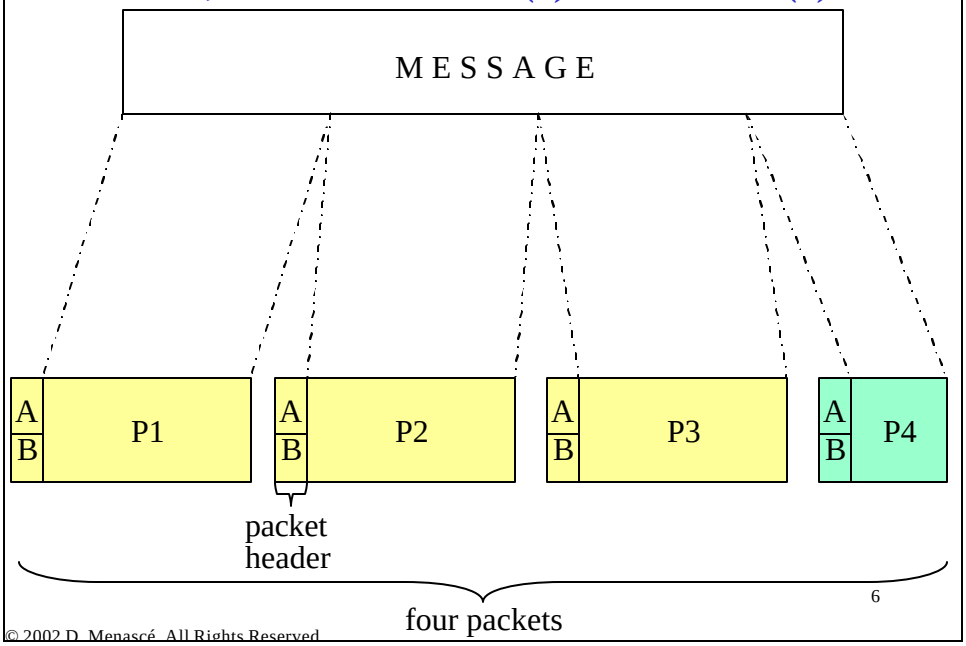
A message broken down into four packets. Each packet has a header, which includes source (A) and destination (B).



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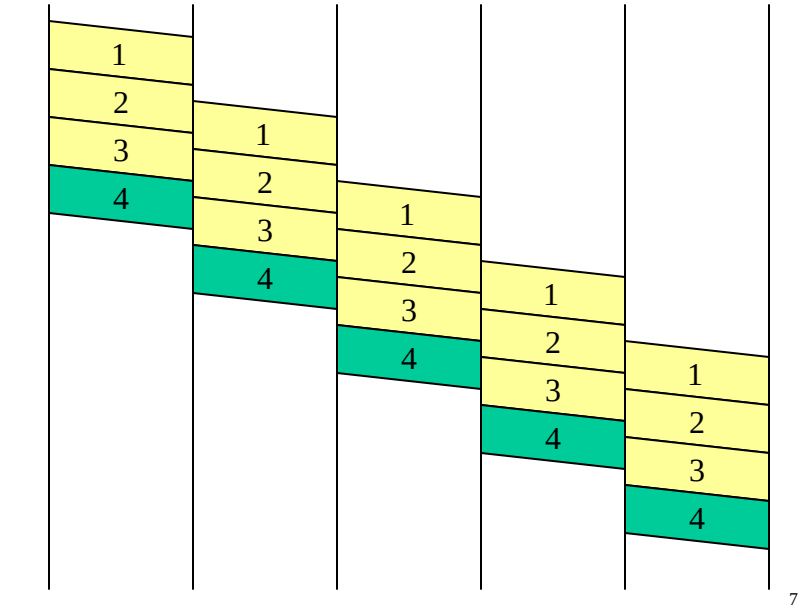

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Protocol Used in a Phone Conversation.

Ring Ring Ring

Hello, Alice speaking.

Hi Alice, this is Bob.

Hi Bob, bla bla bla … [PAUSE]

Bla bla bla …?

Bob

Bye Alice. Nice talking to you.

Bye Bob. Nice talking to you too.

Alice

Connection termination phase

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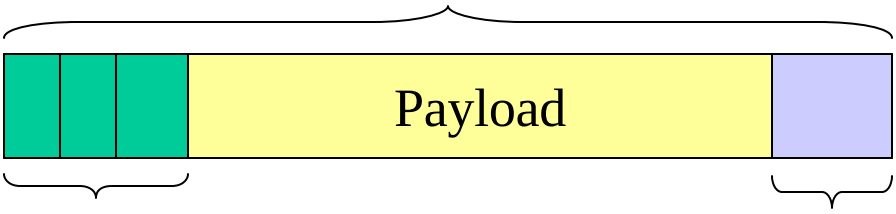
Protocol Data Unit (PDU)



Fields of the header.

Trailer

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At the sending computer: data is generated at the application layer, which adds the application layer header (H) before passing the PDU down.

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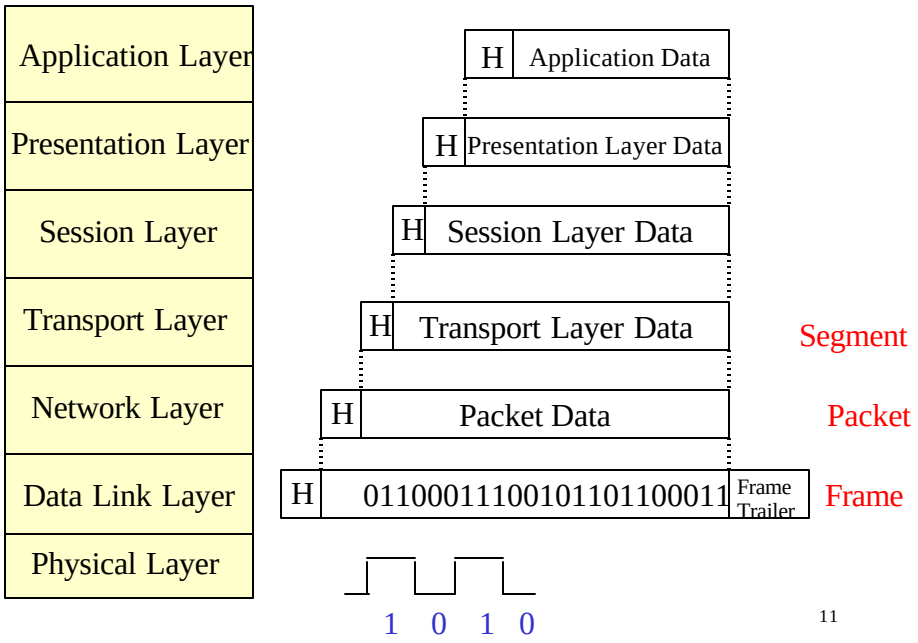
ISO Open System Interconnection Reference Model



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At the receiving computer: PDUs are processed and their payload is passed one level up until the application layer is reached.

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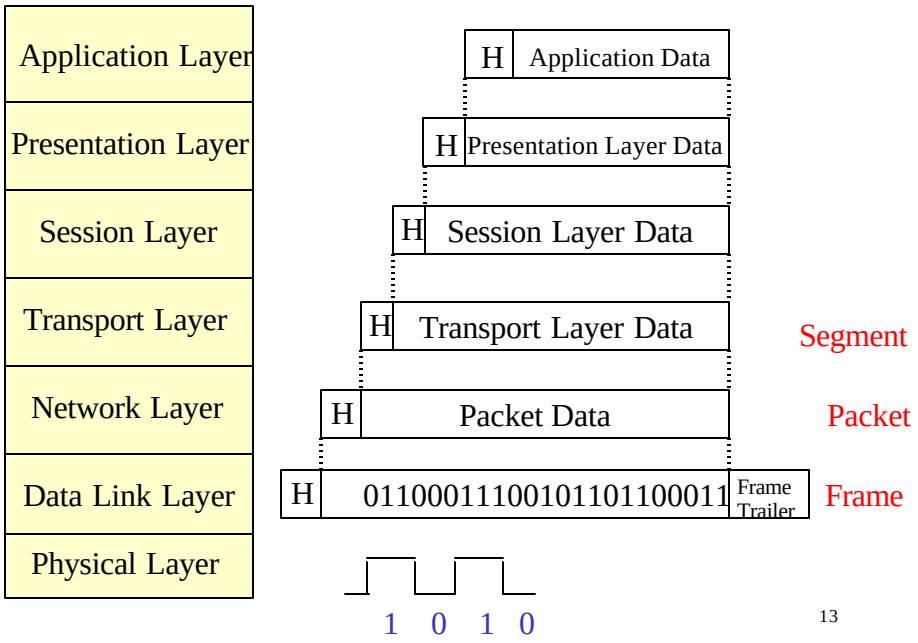
ISO Open System Interconnection Reference Model



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ISO OSI Model

- Physical layer: electrical signal levels.
- Data link layer: point to point (e.g., between two routers, between host and router). Error detection, error recovery, and flow control at the data link layer. Example: HDLC.
- Network level: host-to-host and includes routers. Main functions: routing and addressing. No end-to-end error recovery: best-effort. Example: IP.

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ISO OSI Model (cont'd)

- Transport level: End-to-end process to process.
  - Connection-oriented: End to end error detection and recovery, flow control, and congestion control. Example: Transport Control Protocol (TCP).
  - Connectionless: no end to end functionality except process addressing. Best effort. Example: Universal Datagram Protocol (UDP).
- Session level: End-to-end session establishment. Example: Secure Sockets Layer (SSL). Note: the encryption and compression part of SSL fits best into the Presentation level.

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ISO OSI Model (cont'd)

- Presentation level: in charge of data transformations (e.g., encryption, compression, code conversion).
- Application level: what is left.

The levels above the transport level are not necessarily organized according to the OSI reference model.

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Window mechanism

- Many protocols use a sliding window mechanism as part of flow and error recovery control.
- Examples:
  - Transmission Control Protocol (TCP)
  - High-level Data Link Protocols (HDLC)

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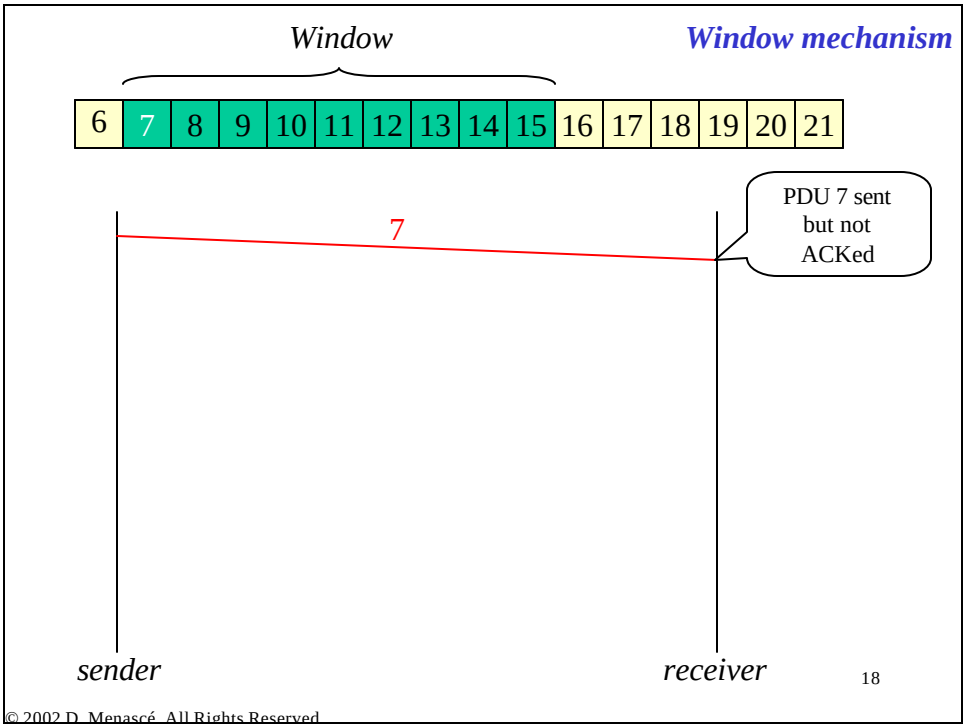

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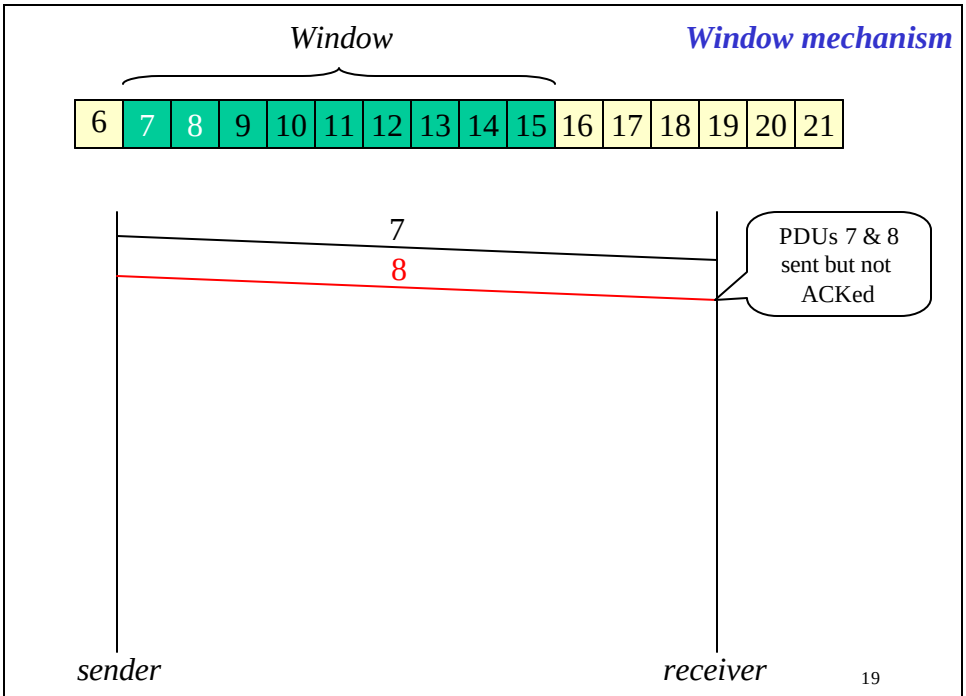

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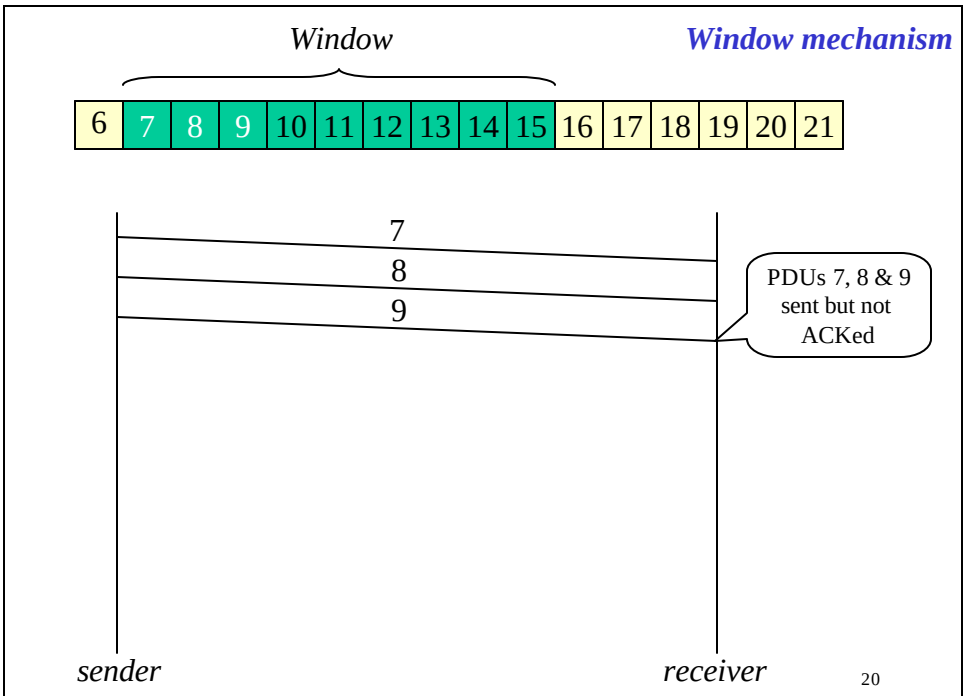

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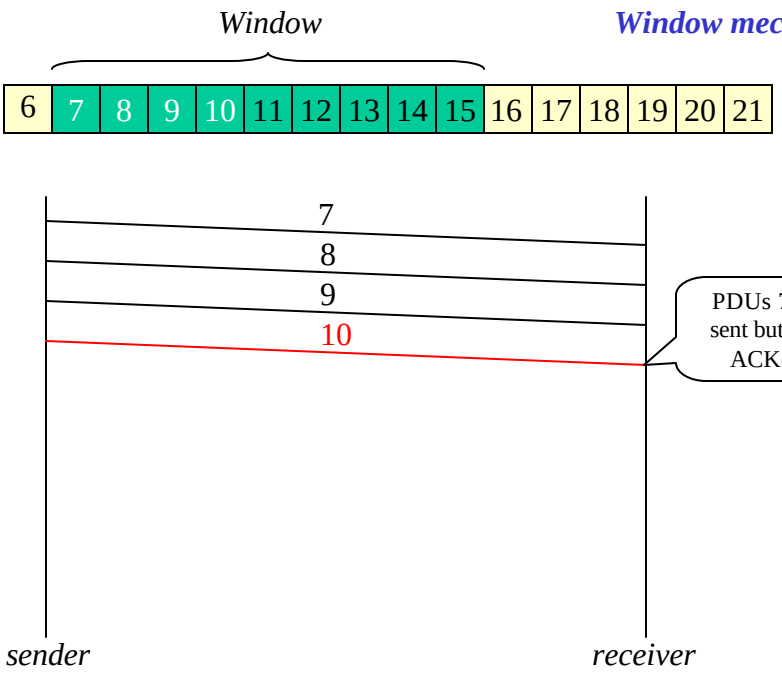
Window mechanism



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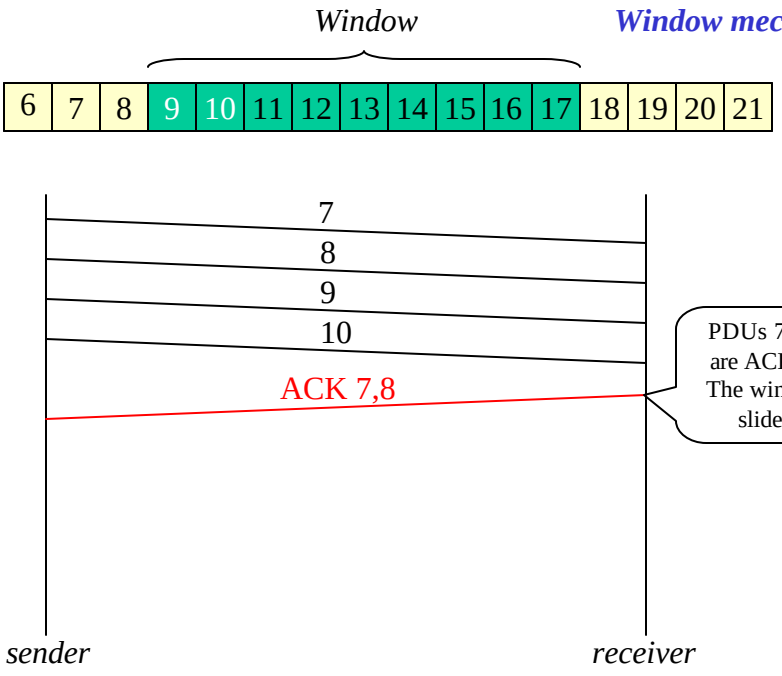
Window mechanism



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TCP Basics

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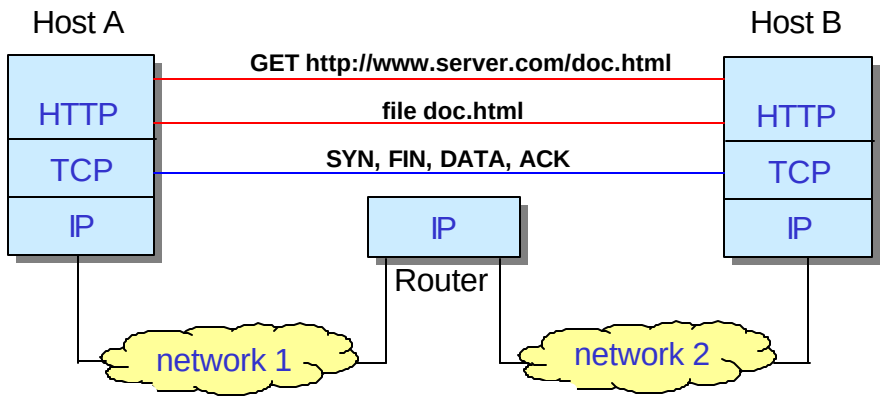
TCP/IP



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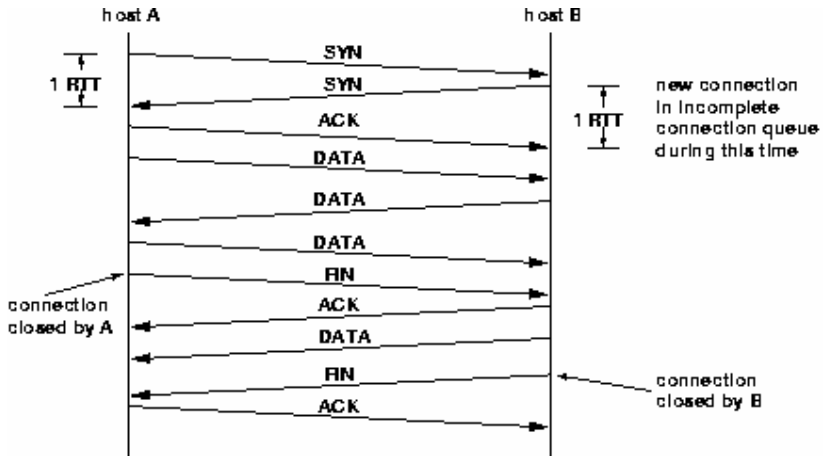
TCP Connection Establishment



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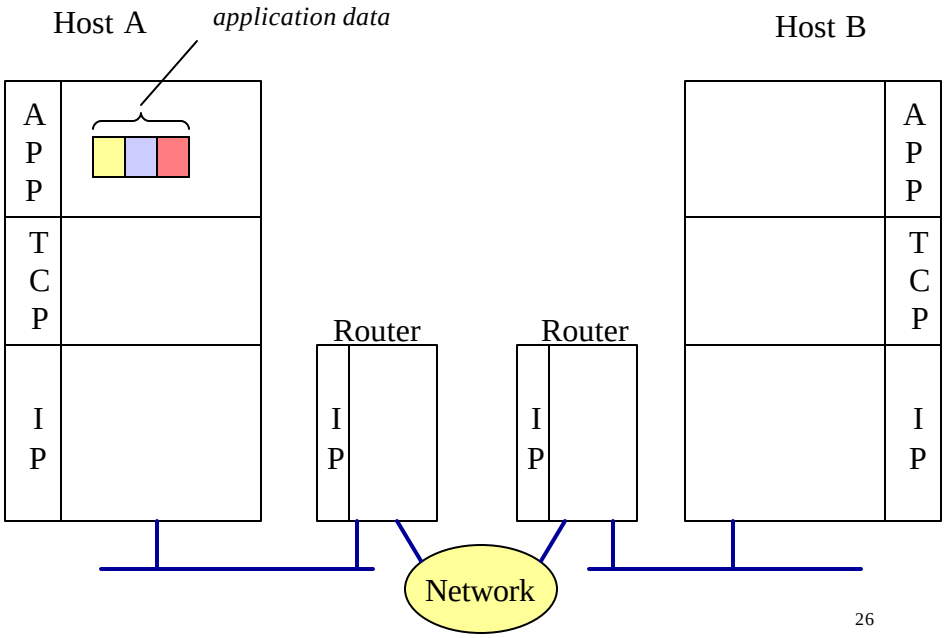
TCP Segmentation



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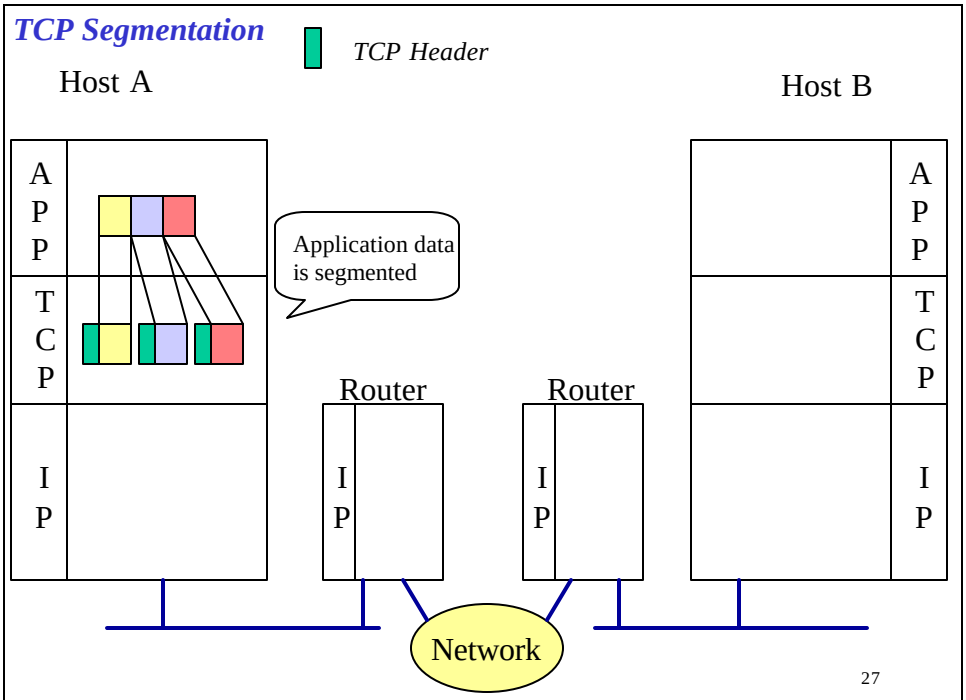
TCP Segmentation



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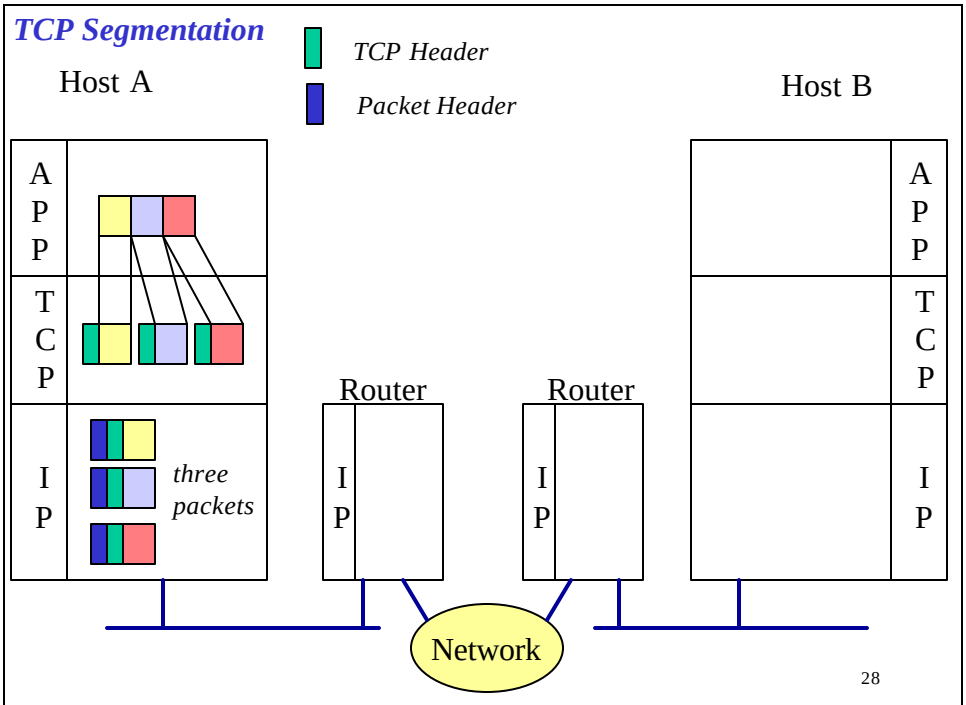
TCP Segmentation



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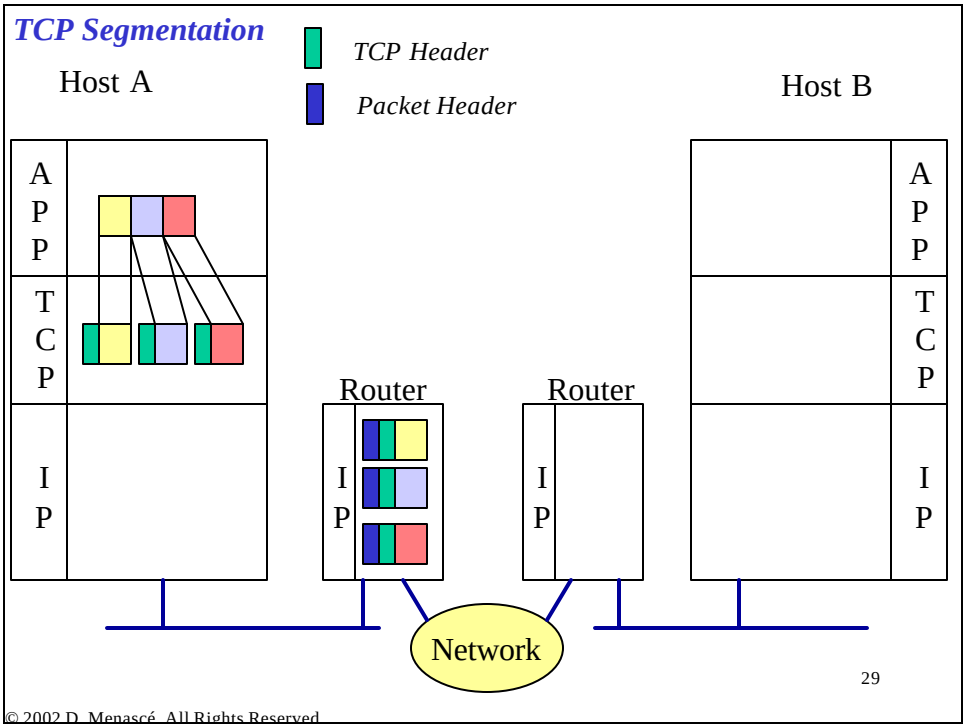

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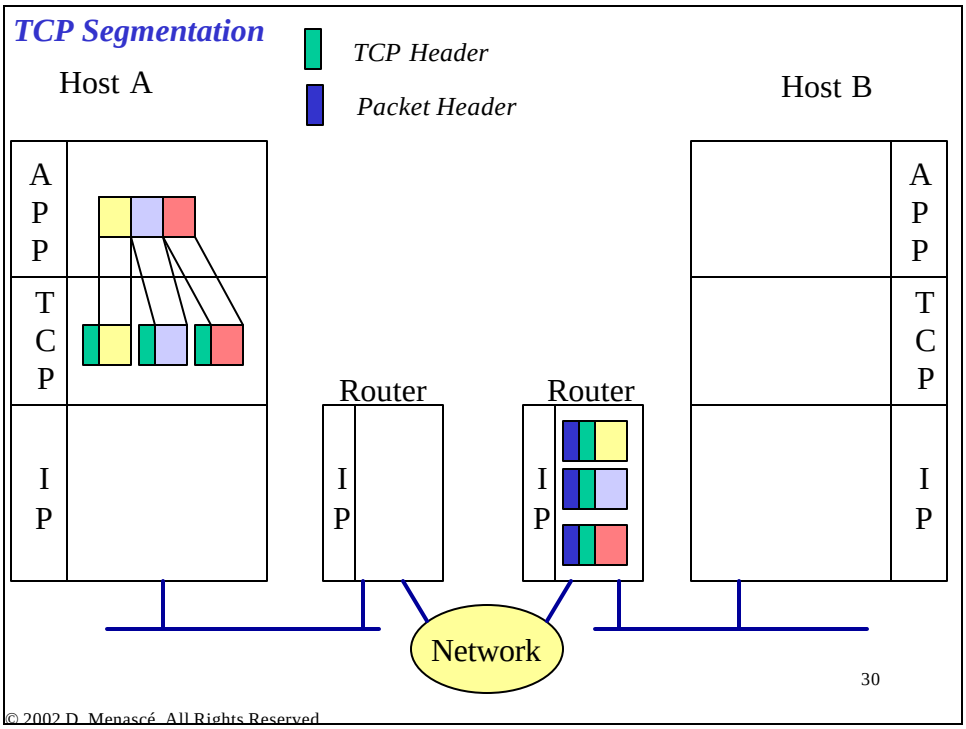

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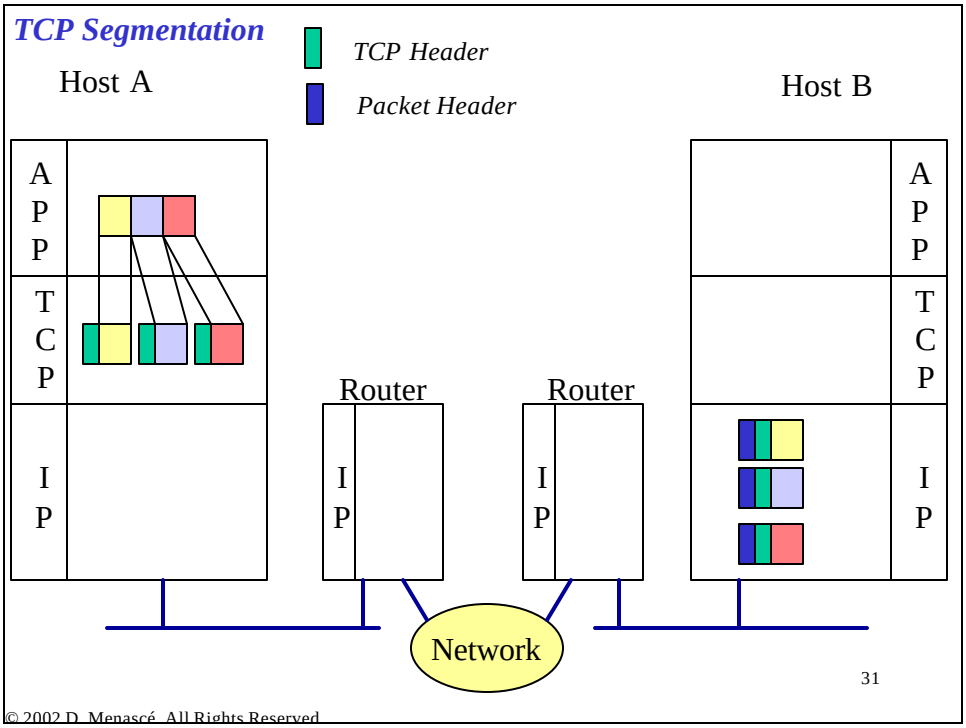

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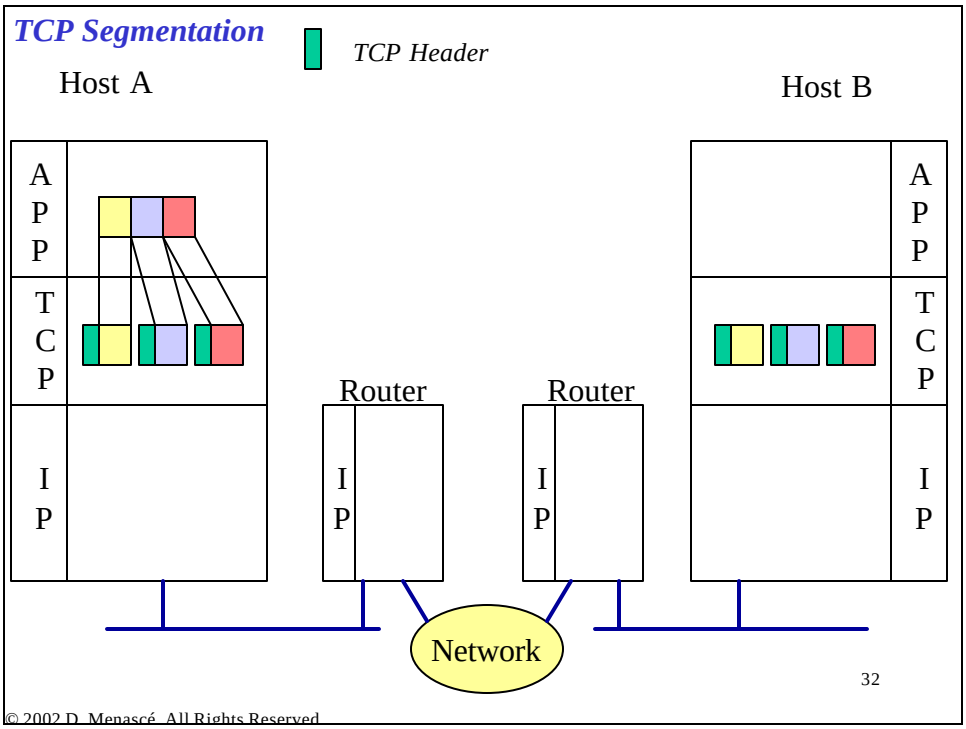

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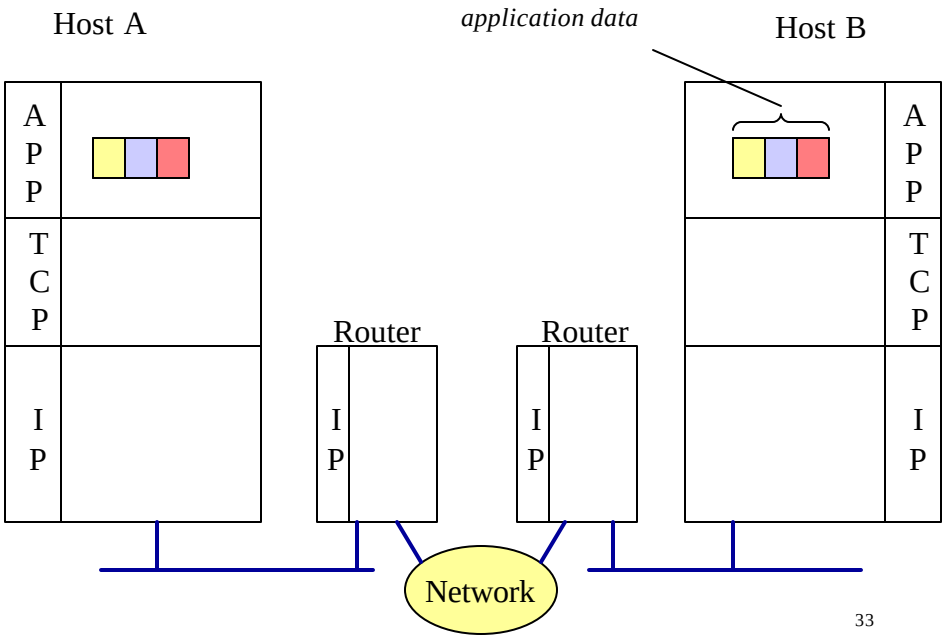
TCP Segmentation



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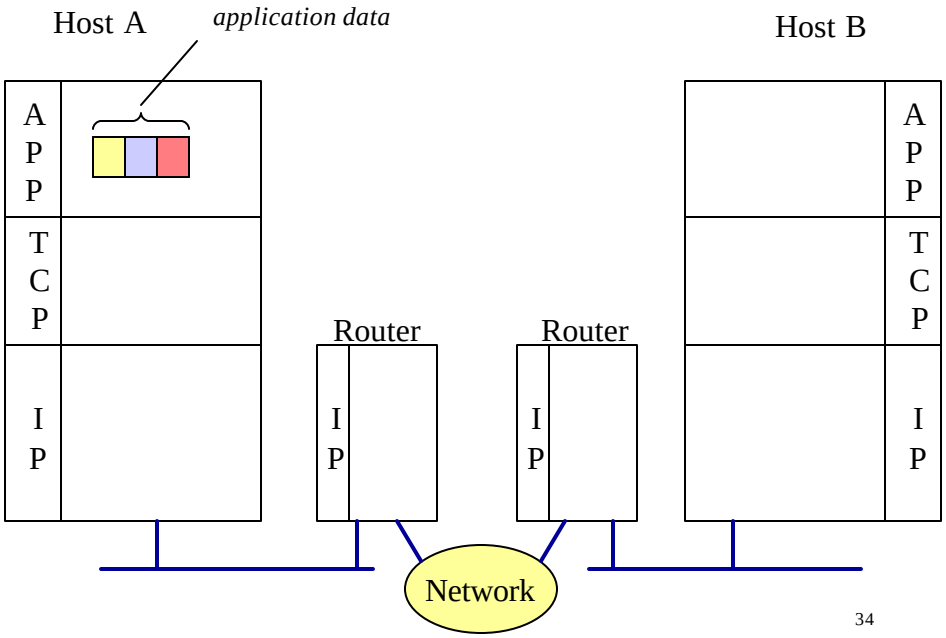
TCP Retransmission



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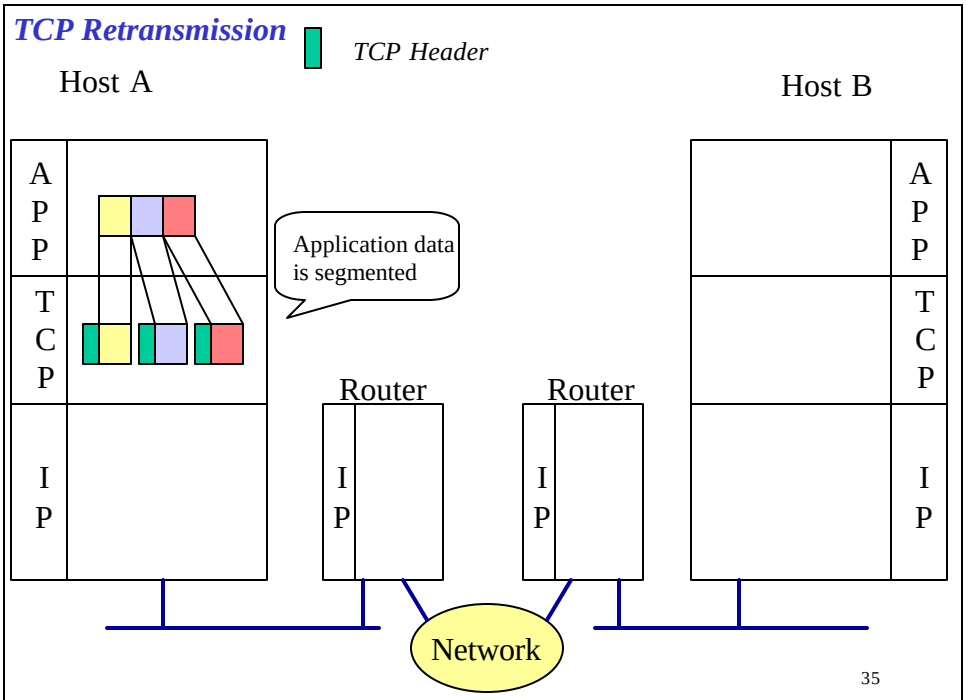
TCP Retransmission



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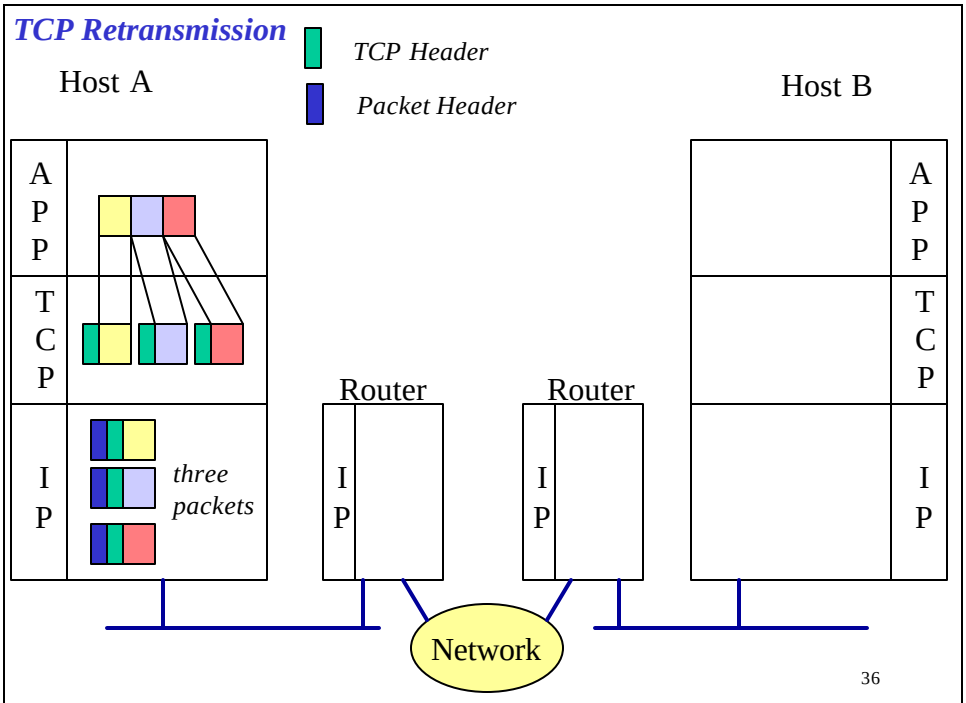
TCP Retransmission



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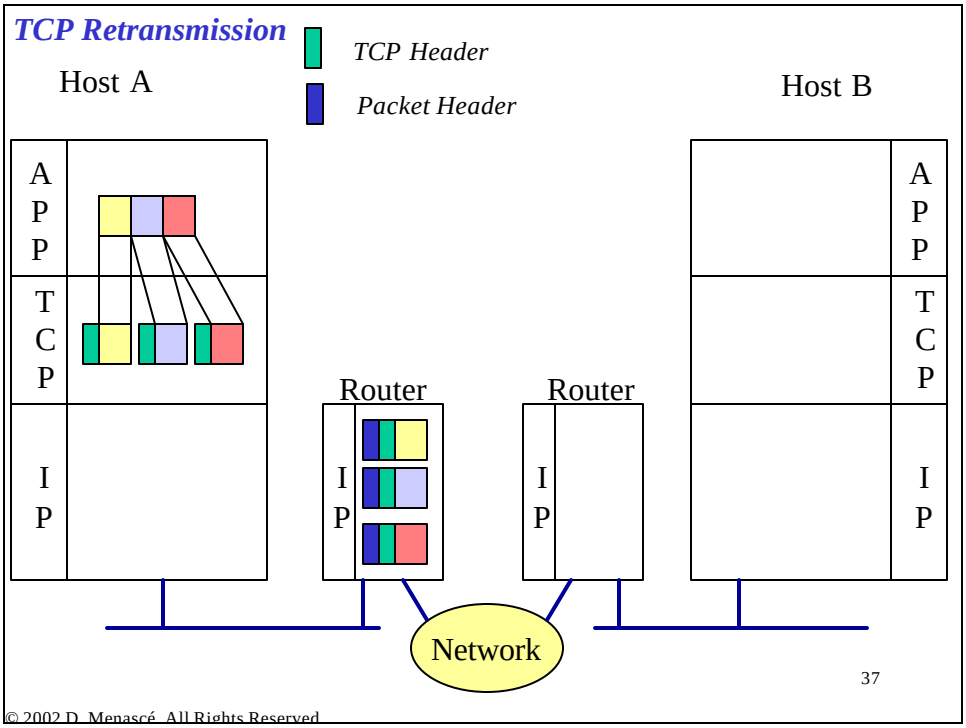

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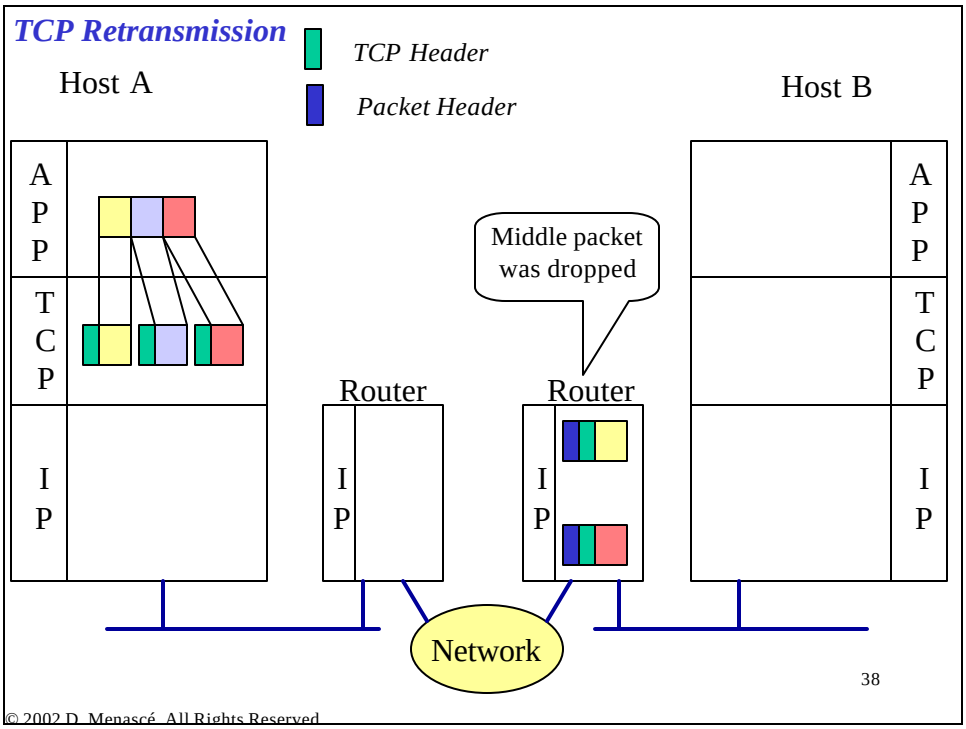

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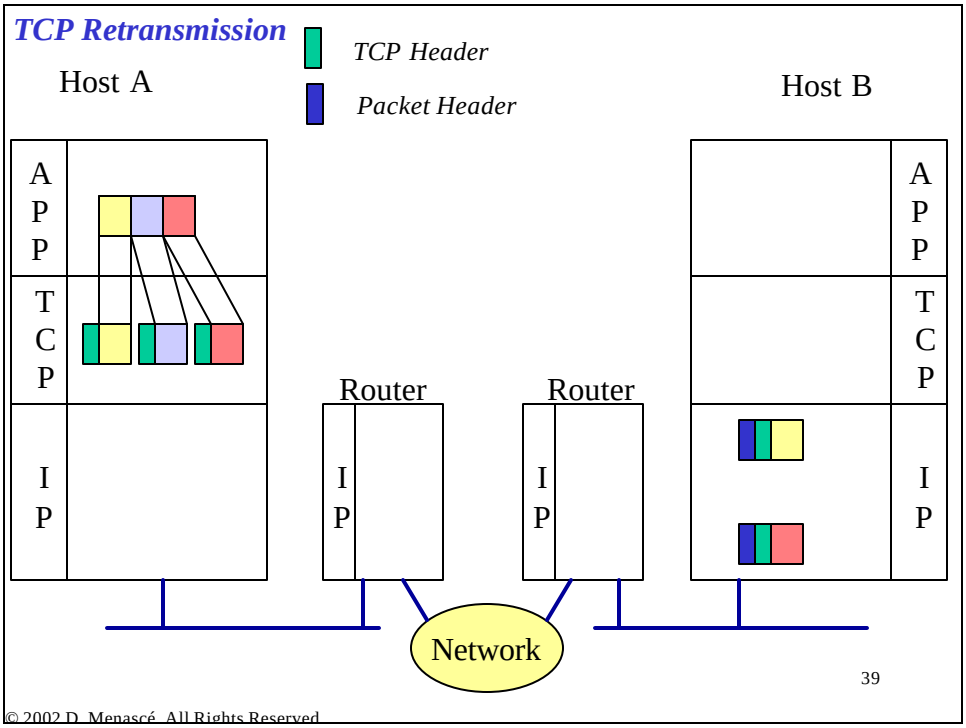

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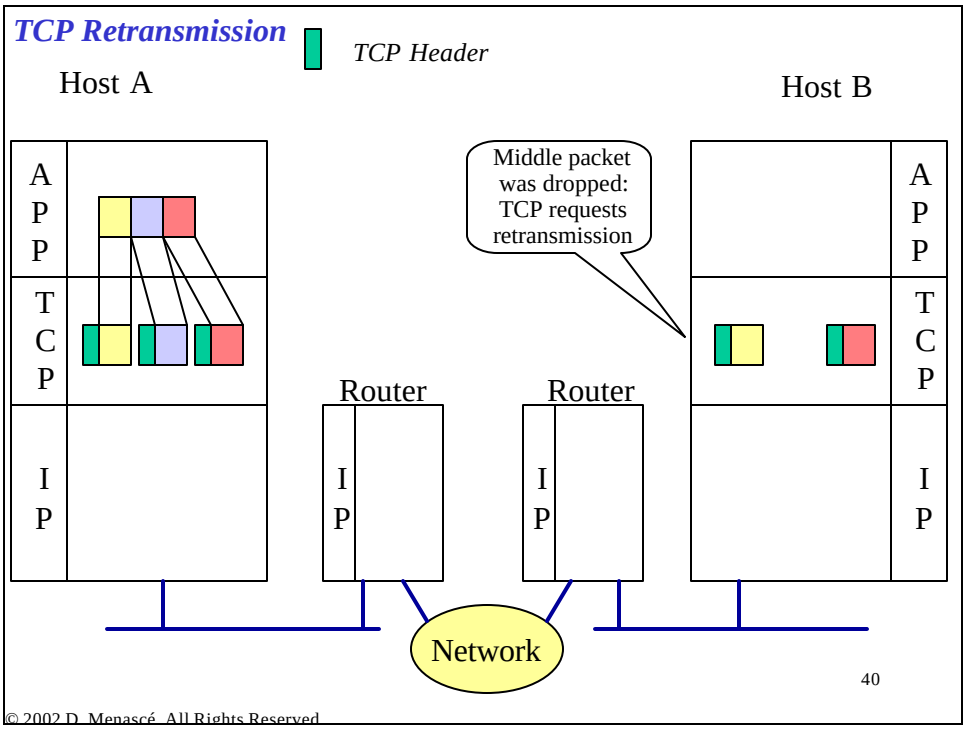

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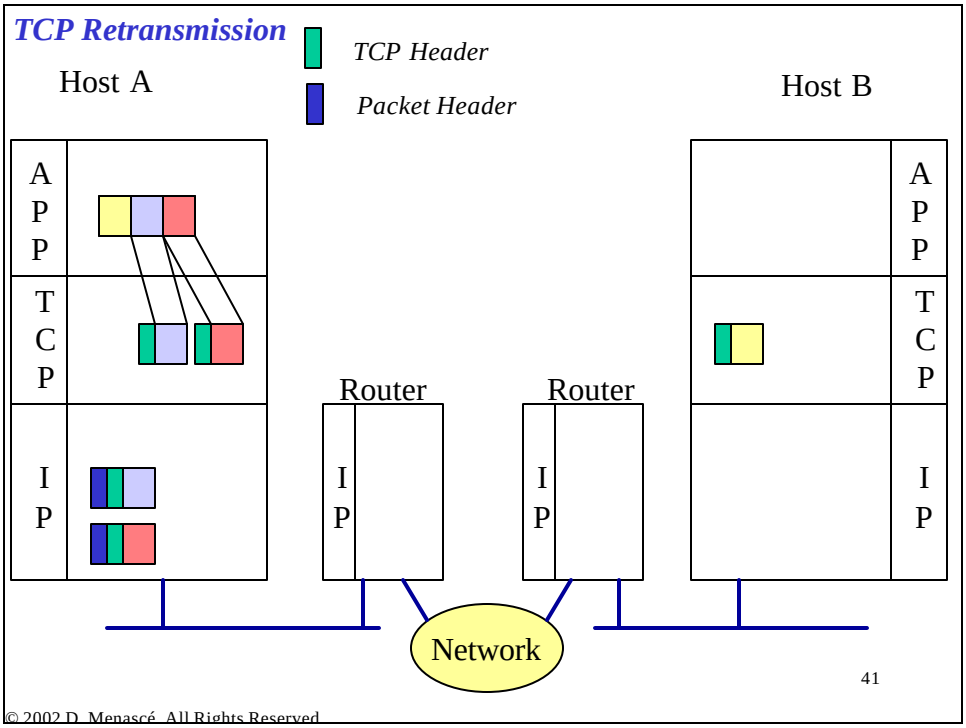

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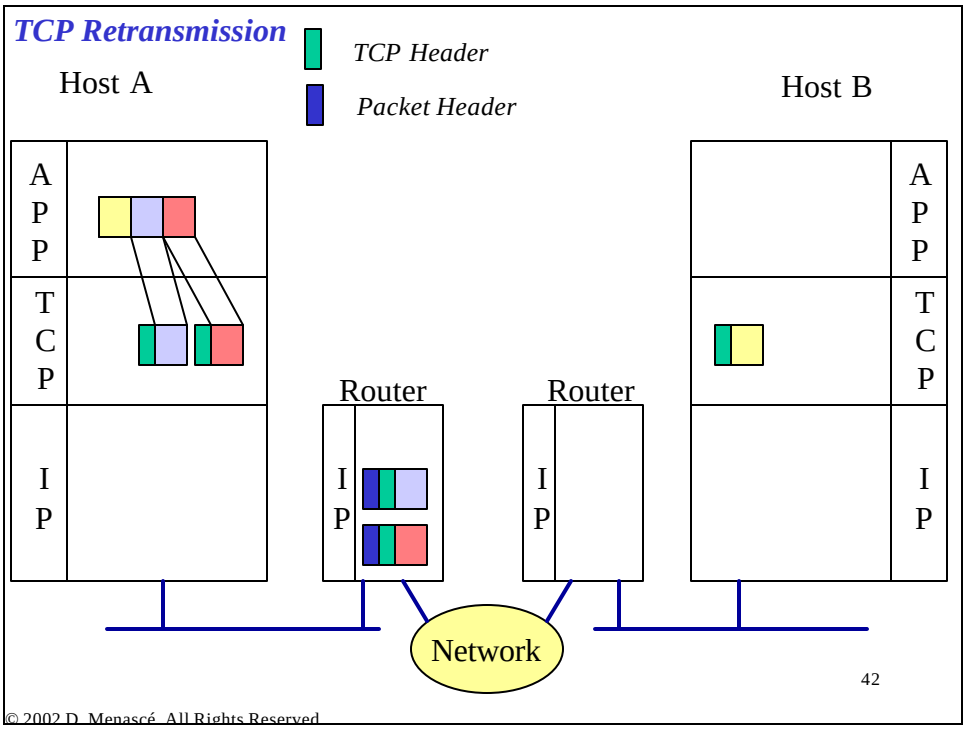

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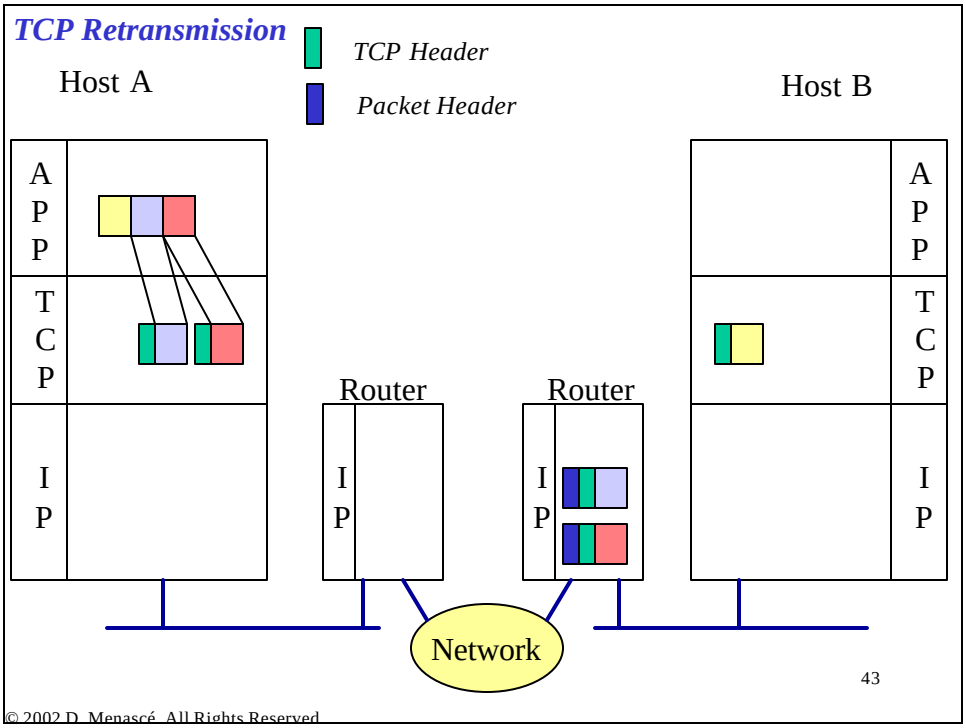

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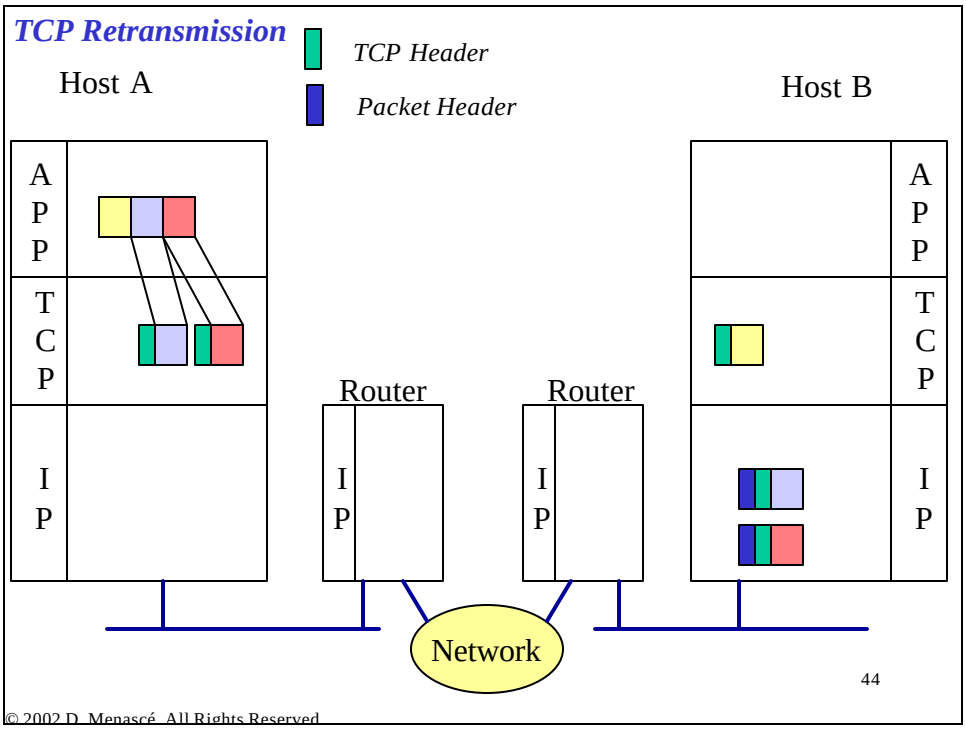

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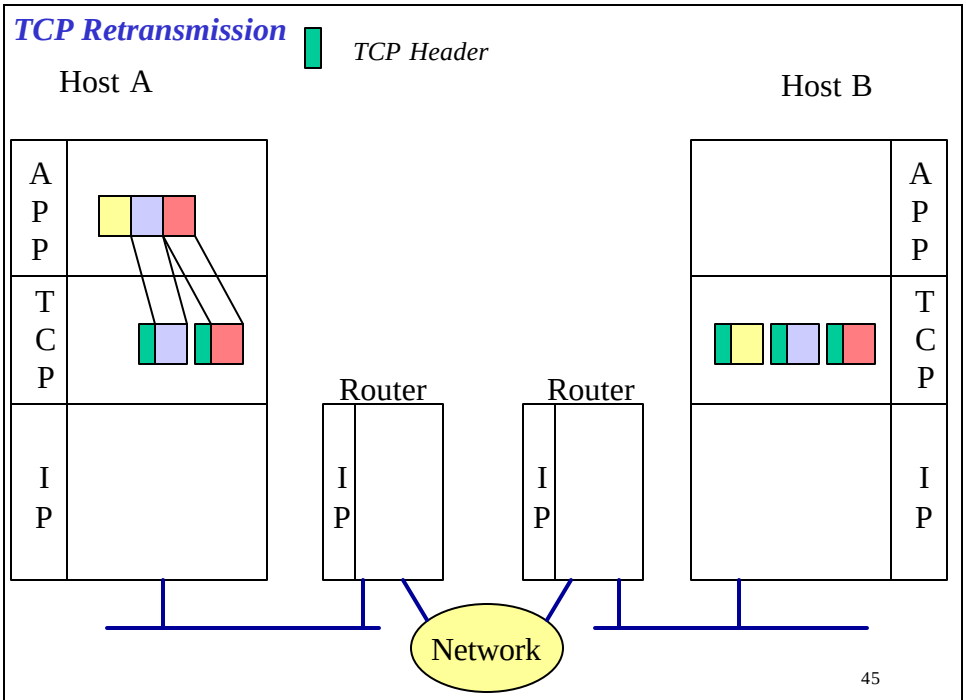

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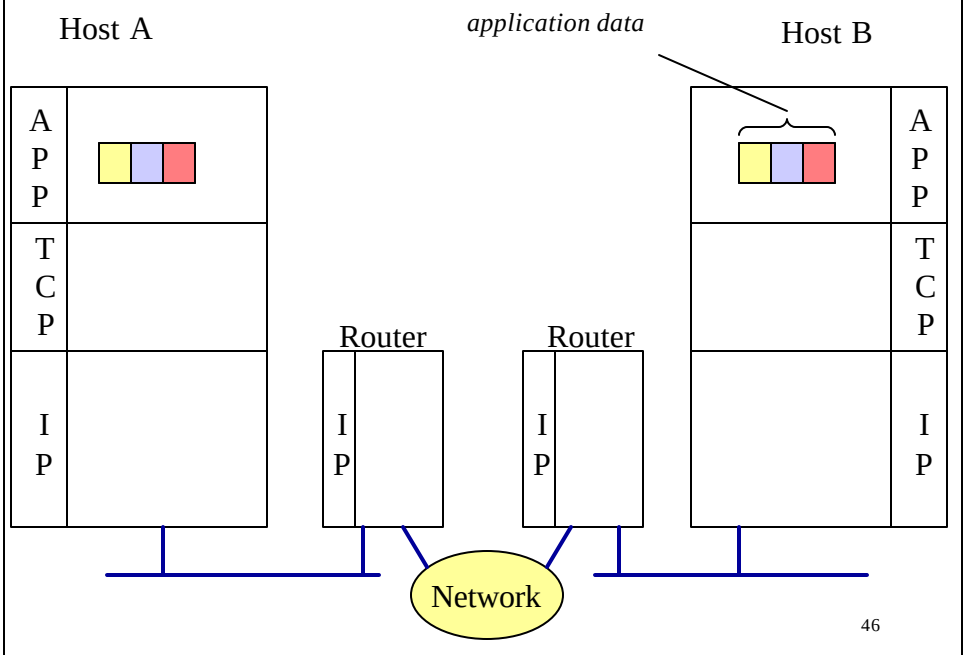
TCP Retransmission



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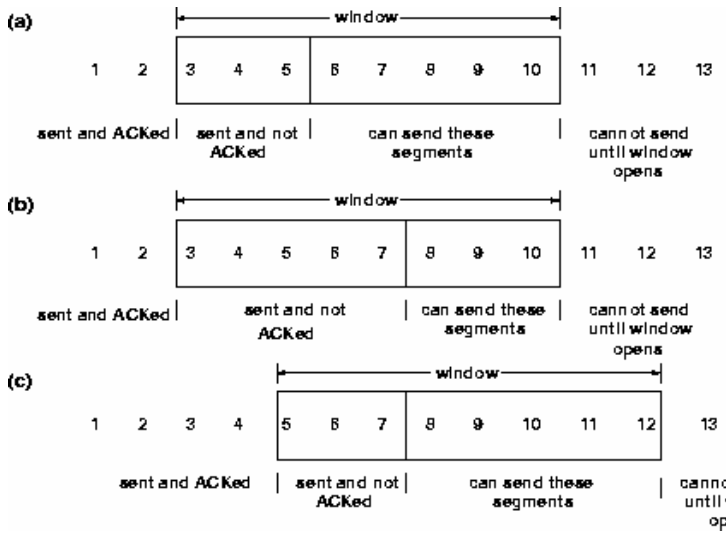
TCP: Window Mechanism



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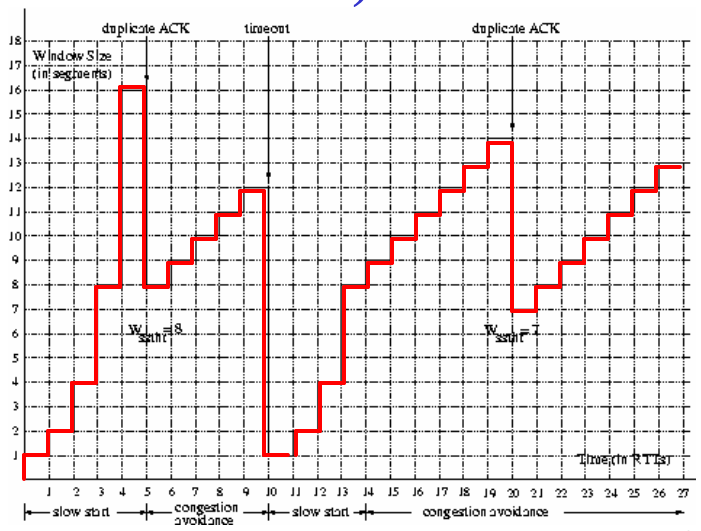
TCP: Window size vs time (in RTTs)

Window Size (segments)



Time (in RTTs)

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TCP Throughput and Window Size

- TCP's slow start mechanism: since TCP does not know the RTT nor the effective bandwidth of a TCP connection, it starts with a small window size (low throughput) and adjusts the window size according to the rate ACKs are received.
- Short-lived TCP connections tend to operate well below the maximum throughput!

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TPC Window Size Variation

- During slow start: window size doubles every RTT.
- During congestion avoidance: window size increases by one each RTT.

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TCP Throughput

- Depends on:
  - Packet Loss Ratio
  - Round Trip Time
  - Wm: Maximum Receiver Window Size (advertised by the receiver at connection establishment time)
  - TCP timeout
  - Network Bandwith
  - Maximum Segment Size

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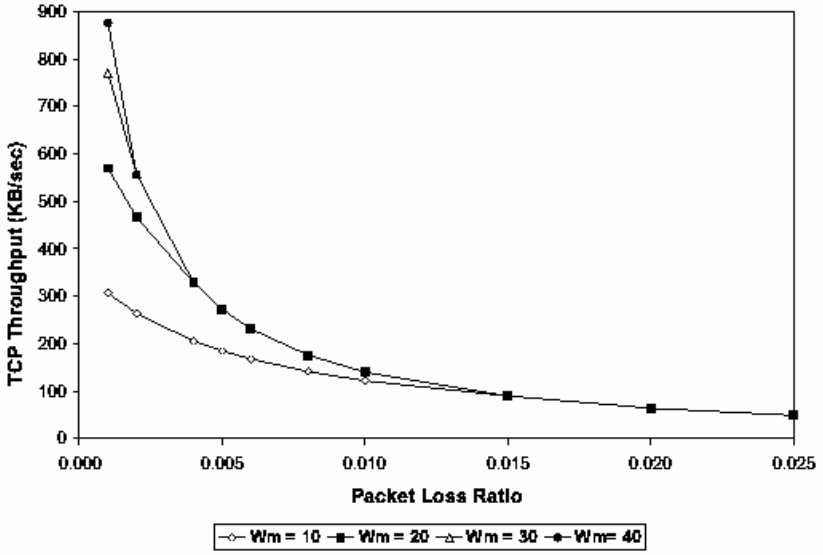
TCP Throughput



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