CS3873: Midterm Review

Midterm

- 11:30pm-12:20pm, Feb. 27th (Wed), H102
- 20% of final grade
- Closed-book, calculator allowed and needed
- Multi-choice questions (8), concept and numerical questions (5)
- Cover lecture materials by Friday Feb. 22th

How to prepare?

- Lecture slides posted at Desire2Learn
  - Go to “Content” section
- Textbook Chap1 ~ Chap3
  - Sections related to our lectures
  - Previous assignments (suggested reading sections)
  - Review questions at the end of each chapter

Chap 1: Network Overview (1)

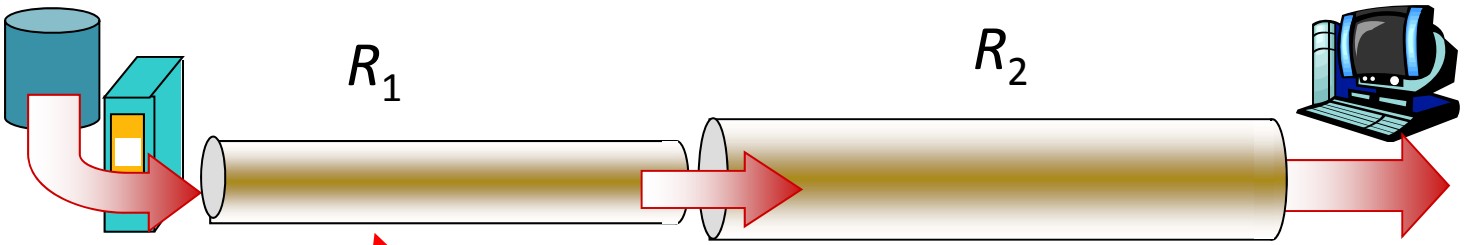
- Computer network, Internet
- What is the Internet?
  - End systems, communication links, and routers/switches
- Network architecture
  - End systems (network edge), access networks, network core
- Network access
  - Dial-up, DSL, coax cable, fibre optics, wireless access

Chap 1: Network Overview (2)

- Switching technologies in network core
  - Circuit switching vs. packet switching (pros and cons)
  - Performance of packet-switched network
    - Throughput
    - Delay
- Layered architecture
  - Why layering?
  - Five-layer protocol stack
  - Peers and protocols

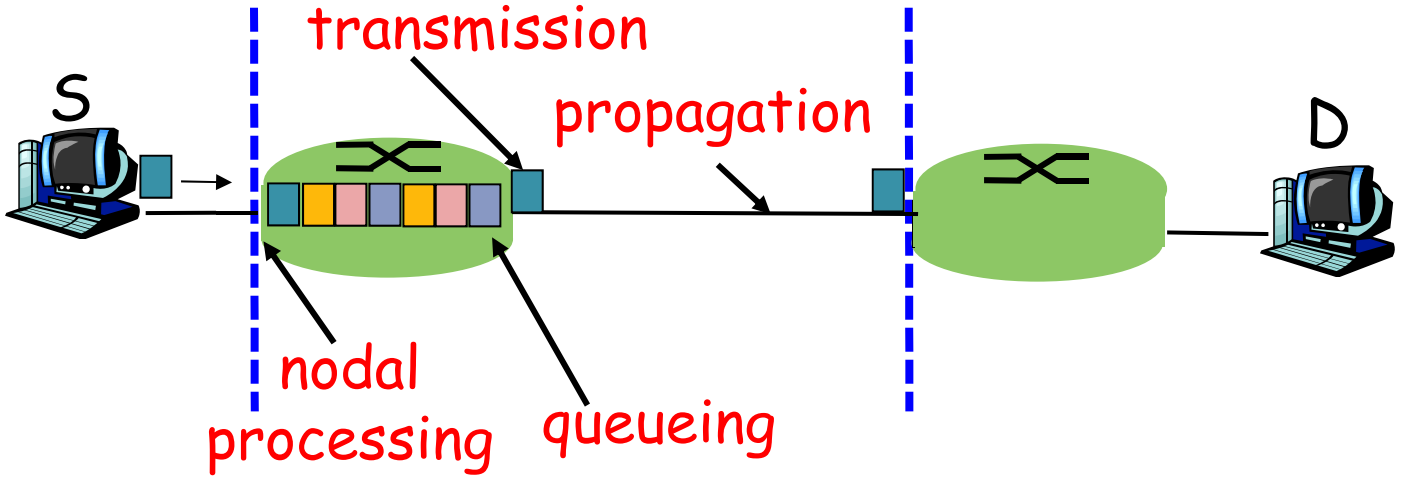
Throughput

- *Throughput:* rate (bits/time unit) at which bits transferred between sender/receiver



End-to-end throughput is constrained by data rate of bottleneck link on end-to-end path.

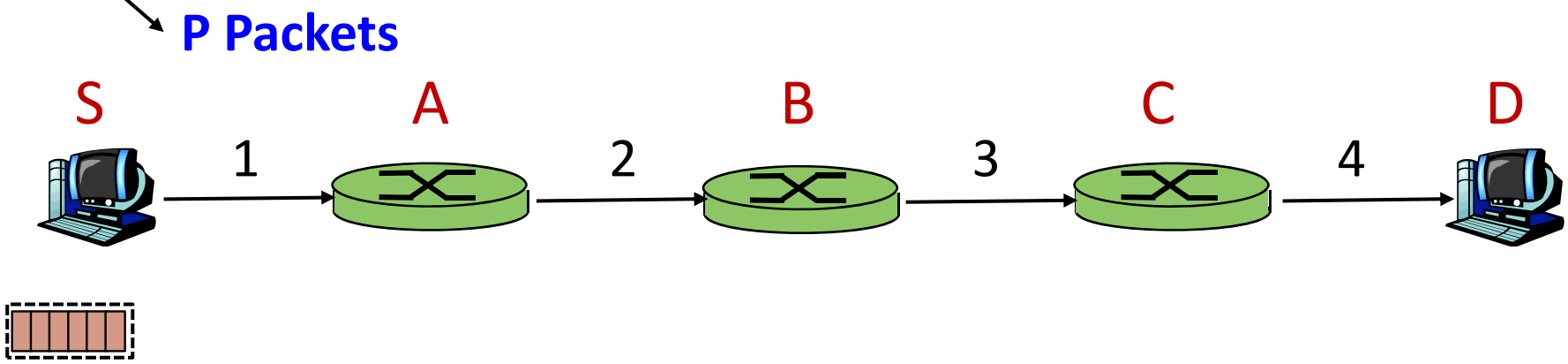
Nodal Delay



$$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$$

E2E Delay: Single Packet

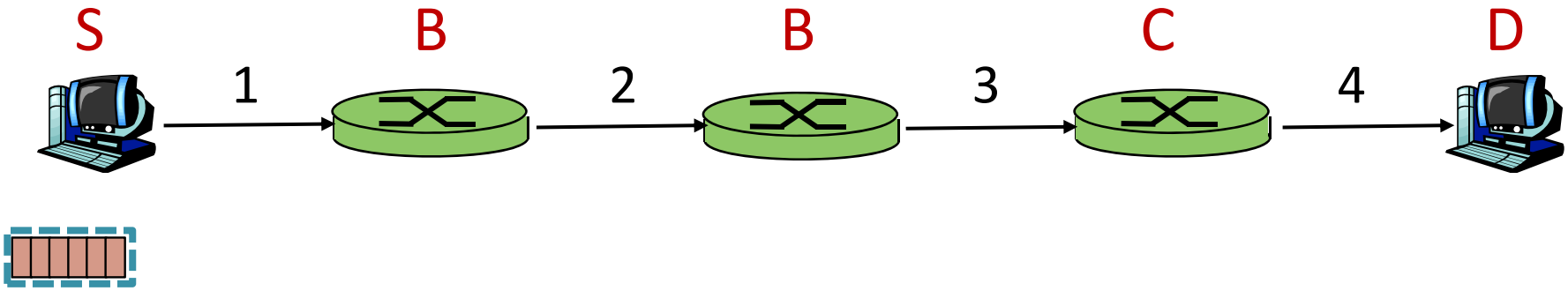
Assume queueing delay, processing delay, propagation delay are very small and negligible. Consider only transmission delay, what is the end-to-end delay to send 1 packet of length *L* over a path with *N* links of rate *R*?



$$d_{e2e} = N * (L/R)$$

E2E Delay: P Packets over N Same-Rate Links

Assume queueing delay, processing delay, propagation delay are very small and negligible. Consider only transmission delay, what is the end-to-end delay to send ***P* packets** of length *L* over a path with ***N* links of rate *R***?



d_{e2e} = ?

Chap 2: Network Applications (1)

- Client/server and peer-to-peer architectures
- P2P example: File sharing
  - How does the BitTorrent protocol work for file distribution?
  - What are strengths of P2P applications?
- C/S example: Web
  - How does the HTTP protocol work for Web service?
    - **`Request`** and **`Response`** messages
  - Non-Persistent vs. Persistent HTTP connections
  - Web caching and conditional GET

Chap 2: Network Applications (2)

- DNS
  - Hierarchy of DNS servers
  - Name resolution with DNS: Iterative vs. Recursive
  - DNS resource records
  - DNS messages: Query vs. Response
  - Attacks to DNS

Chap 3: Transport Protocols (1)

- Why is the transport layer needed?
- UDP
  - Segment structure
  - Checksum algorithm
  - UDP socket: Identified by two-tuple
- TCP
  - Segment structure
    - A few very important control fields:
      Seq#, Ack#, receive window zize, control bits ACK/SYN/FIN
  - TCP socket: Identified by four-tuple

Chap 3: Transport Protocols (2)

- TCP connection management
  - Three-way handshake for connection
  - SYN flood attack and SYN cookies
- TCP error/flow control
  - Flow control concepts
    - Stop-and-Wait: Low utilization
    - Pipelining, utilization, window size
  - TCP: Pipelined sliding window protocol
    - Cumulative ACK
    - How does TCP generate ACKs and deal with in-order, out-of-order, missing, and duplicate segments?
    - Fast retransmit

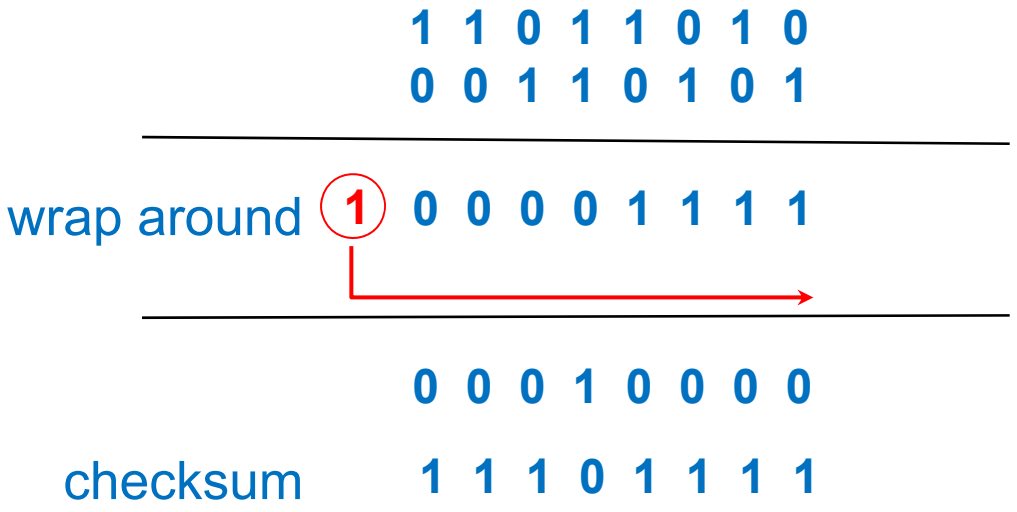
Example Question (1)

Over a TCP connection, suppose host A sends two consecutive segments to host B and both are correctly received by Host B. Host B sends an acknowledgement for each segment, the first acknowledgement is lost, but the second acknowledgement arrives before the timer for the first segment expires. Which of the following statements is correct?

A. Host A will retransmit the first segment
B. Host A will retransmit the second segment
C. Host A will retransmit both segments
D. Host A will retransmit neither segments

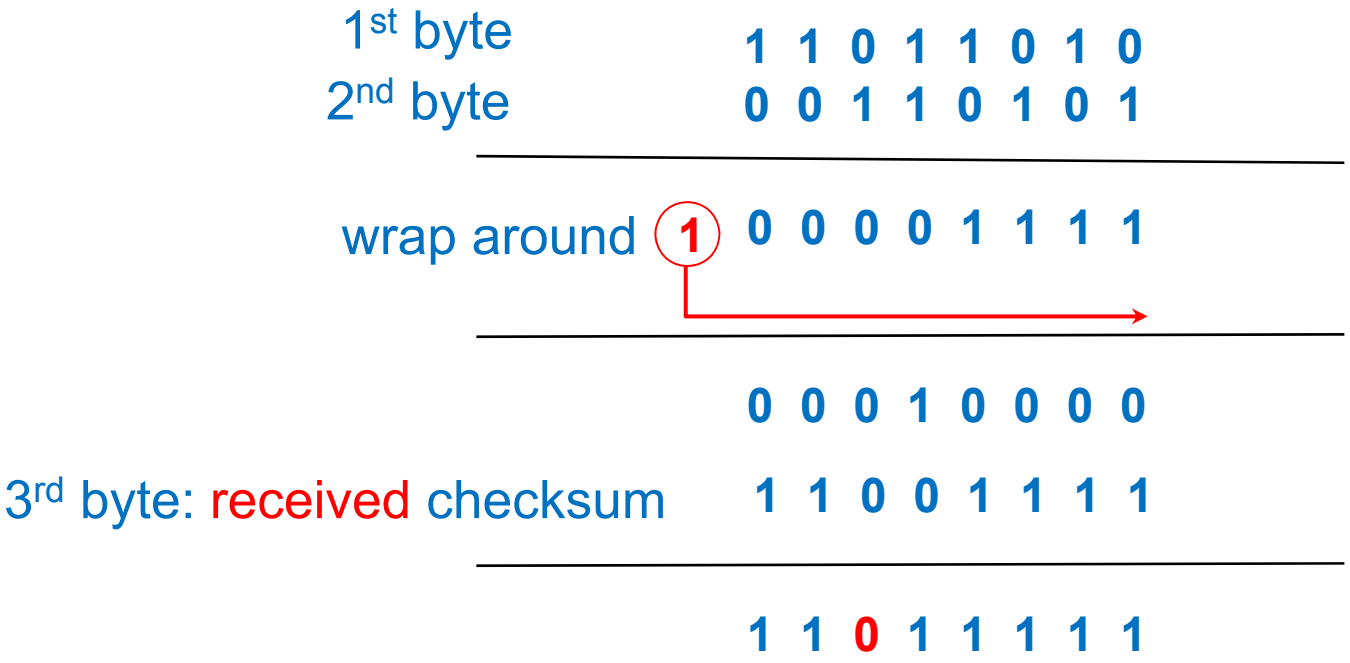
Example Question (2.a)

(a) Suppose you have the following 2 bytes: 11011010 and 00110101. What is the checksum of these 2 bytes based on one's complement of the one's complement sum?



Example Question (2.b)

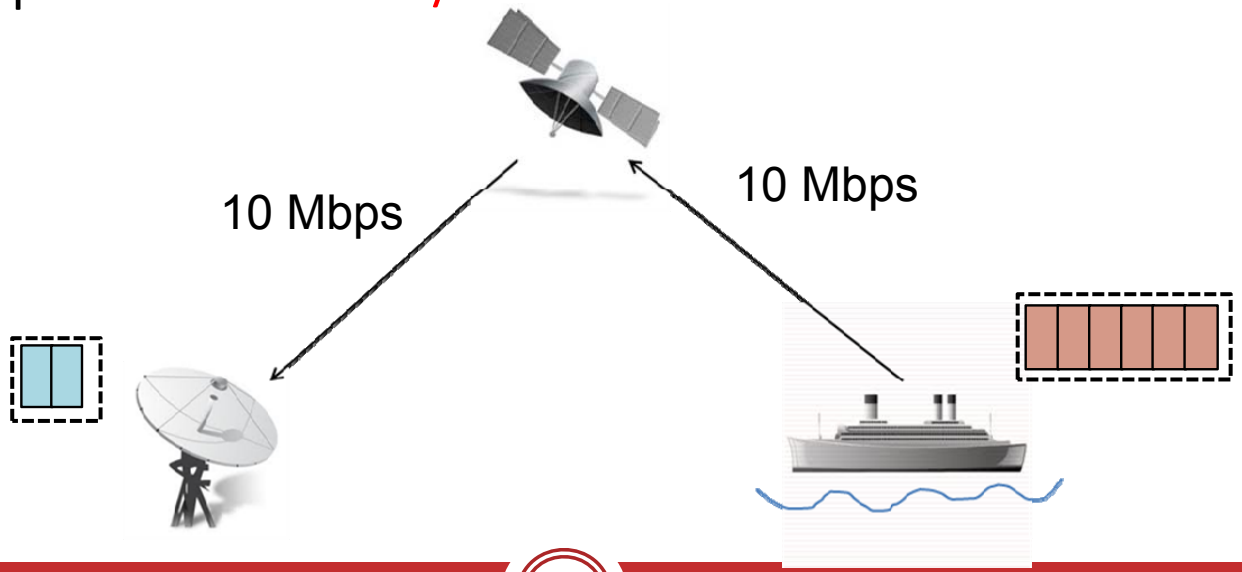
(b) In a received segment, there are 2 bytes of data: 11011010 and 00110101, and 1 byte of checksum: 11001111. Is there any error in this segment?



Answer: There is an error in the received segment.

Example Question (3)

Suppose that there is a 10 Mbps microwave link between a geostationary satellite (36,000 km away from Earth) and a ground base station and another 10 Mbps link between the satellite and a research ship at sea. The ship takes photos sends them to the satellite, which forwards them to the ground station. Consider the ship sends one packet of 2 KB to the ground station, while the ground station sends back an acknowledgement after the packet is received successfully. Assume the propagation speed is 2.4×10^8 m/s.



Example Question (3.a/b)

(a) What is the transmission delay to send out one packet onto the air?

(b) What is the propagation delay for the transmitting signal to travel from the ship to earth station?

One packet of 2 KB

$$d_{trans} = \frac{2000 \times 8}{10 \times 10^6} = 0.0016\ seconds$$

Data rate: 10 Mbps

Physical distance of two links

$$d_{prop} = \frac{36{,}000 \times 10^3 \times 2}{2.4 \times 10^8} = 0.3\ seconds$$

Signal propagation speed

Units of Data Size and Data Rate

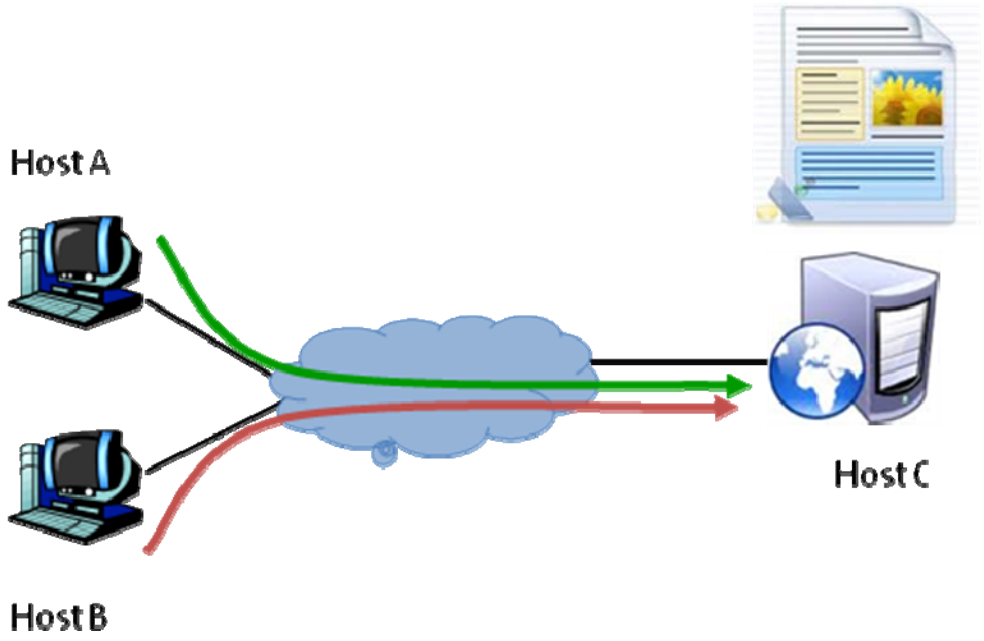
Metric	Abbreviation	Value
kilobyte	KB	10^3 bytes
megabyte	MB	10^6 bytes
gigabyte	GB	10^9 bytes
terabyte	TB	10^{12} bytes

Metric	Abbreviation	Value
kilobits/s	kbps, kbit/s	10^3 bits/s
megabits/s	Mbps, Mbit/s	10^6 bits/s
gigabits/s	Gbps, Gbit/s	10^9 bits/s

1B = 1 byte = 8 bits

Example Question (4)

Suppose that a Web server runs in Host C on port 80. Suppose this Web server uses persistent connections, and is currently receiving requests from two different Hosts, A and B.



Example Question (4.a)

(a) Are all requests being sent through the same socket at Host C? If they are being passed through different sockets, do both sockets have port 80? How could Host C distinguish requests from Host A and Host B?

Answer:

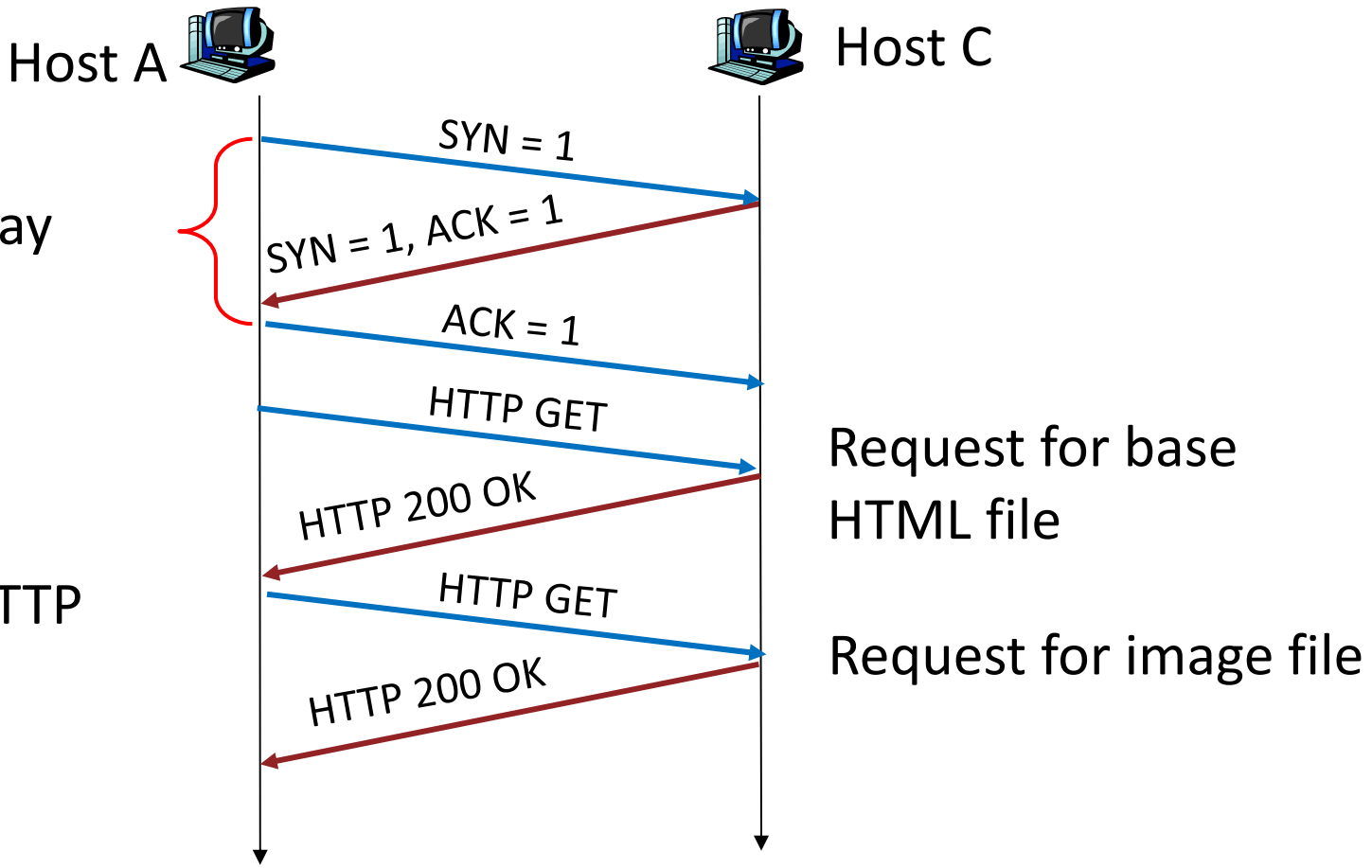
Requests from Host A and Host B are not sent through the same socket at Host C.

Host C distinguishes requests from Host A and Host B by the port number and address of the source host; but both sockets have the same destination port number 80 and address of Host C.

Example Question (4.b)

(b) Suppose Host A is requesting a Web page, which also refers to a small image on Host C. Describe the TCP three-way handshake messages to establish the connection between Host A and Host C, as well as the HTTP messages used to deliver the basic Web page and the referred image to Host A.

Example Question (4.b)



TCP three-way handshake

Request for base HTML file

Persistent HTTP

Request for image file