Midterm Review

Midterm information

- The exam will cover the material taught in class till the end of the **transport layer chapter, i.e., chapters 1 to 3.**
- The midterm exam will be on **Oct. 28th at 4:45pm - 6:00pm** as indicated in the following link https://uwaterloo.ca/electrical-computer-engineering/midterm-schedule

How to do well on the midterm?

- Read through the lecture notes.
- Review tutorial sets and problem sets.
- Review problems from previous midterms
- Ask questions:
  - PIAZZA
  - Additional office hours
  - email: am3abdelaziz@uwaterloo.ca

Chapter	Sections
Chapter 1: Introduction	1.1 – 1.5
Chapter 2: Application	2.1 2.2 (till 2.2.3) 2.4
Chapter 3: Transport	3.1 3.2 3.3 3.4 – excluding finite-state definitions FSM 3.5 3.6 3.7.1

Review Questions

1. What are the five layers in the Internet protocol stack? What are the principal responsibilities of each of these layers?
2. Which layers in the Internet protocol stack does a router process? Which layers does a link-layer switch process?
3. Consider sending a packet from a source host to a destination host over a fixed route. List the delay components in the end-to-end delay. Which of these delays are constant and which are variable?
4. For a communication session between a pair of processes, which process is the client and which is the server?
5. Suppose you wanted to do a transaction from a remote client to a server as fast as possible. Would you use UDP or TCP? Why?
6. What is the transmission protocol used by DNS? What is the port number?
7. Which type of query is considered best practice: iterative or recursive?

Review Questions

1. Is it possible for an organization's Web server and mail server to have exactly the same alias for a hostname (for example, foo.com)? What would be the type for the RR that contains the hostname of the mail server?
2. Describe why an application developer might choose to run an application over UDP rather than TCP?
3. Is it possible for an application to enjoy reliable data transfer even when the application runs over UDP? If so, how?
4. How long should we set the timeout timers to enjoy reliable data transfer?
5. When is the first packet is sent with TCP assuming no on going connection?

Message Segmentation

Consider a message that is **8 M bits** long that is to be sent from source to destination in Figure 1. Suppose each link in the figure is **2 Mbps**. Ignore propagation, queuing, and processing delays.

(a) Without message segmentation. How long does it take to move the message from the source host to the first packet switch? What is the total time to move the message from source host to destination host?

(b) How long does it take to move the file from source host to destination host when message segmentation is used assuming a packet size **10 K bits**? Compare this result with your answer in part (a) and comment.

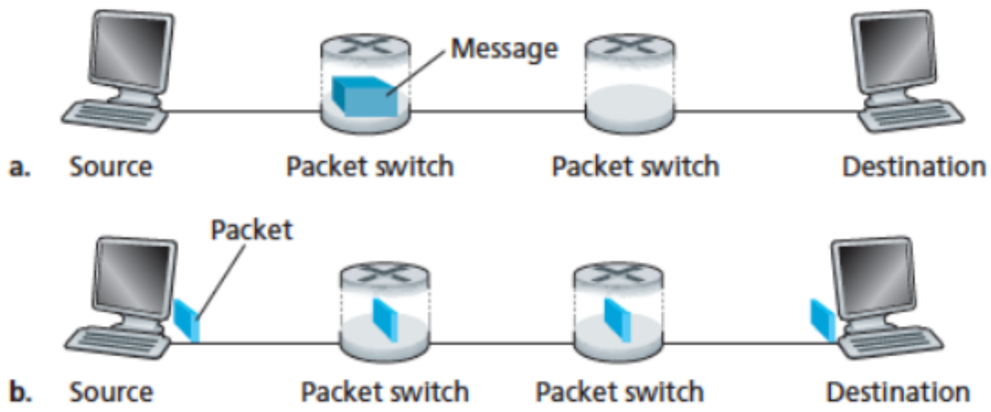

Figure 1. End-to-end message transport: (a) without message segmentation; (b) with message segmentation

<u>**Answers**</u>

$(a)\frac{8\times10^6}{2\times10^6} = 4\text{ s}, 3\times4 = 12\text{s}$

(b) time for the first packet to arrive at destination is: $3\times\frac{10\times10^3}{2\times10^6} = 15\text{ms}$

The second packet arrives at $15\text{ms} + 5\text{ ms}$?

The file arrives at $15 + \left[\frac{8\times10^6}{10\times10^3} - 1\right]5 = 4.01\text{ s}$

Delay

Suppose that host A wants to send a 1 Gigabit file to host B. The network between A and B has three links (See Fig. 1.) of rates R1 = 4 Mbps, R2 = 2 Mbps, and R3 = 1 Mbps. "Giga" means 10^9 , "Mega" means 10^6 , and "Kilo" means 10^3 . Assume that the propagation delays on the three links are zero seconds. Make other assumptions as necessary and appropriate.

I. If A sends the file as 1000-byte packets, how long does it take to move the file from A to B? Show the details of your calculation.

II. Also, give an approximate answer to part (I) by using the concept of bottleneck bandwidth.

Answer:

1. $d_{R1} = \frac{1000*8}{4*10^6} = 2\ ms\ , d_{R2} = \frac{1000*8}{4*10^6} = 4\ ms, d_{R3} = \frac{1000*8}{1*10^6} = 8\ ms$

pkts = $\frac{10^9}{1000*8} = 125000$

The first packet will arrive after $d_{1st-pkt}\ 2 + 4 + 8 = 14\ ms$

The following packets will arrive after $d_{1st-pkt} + (\#pkts - 1) * d_{R3} = 14 + (125000 - 1\ ) * 8 = 1000.006\ s$

2. The bottleneck bandwidth is $R3$ then the approximate delay is #packets ,$* \ d_{R3}\ =\ 8*125000 =\ 1000\ s$

Packet Switching vs. Circuit switching

Consider the two scenarios below:

- A circuit-switching scenario in which N_{cs} users, each requiring a bandwidth of **20 Mbps**, must share a link of capacity **200 Mbps**.
- A packet-switching scenario with N_{ps} users sharing a **200 Mbps** link, where each user again requires **20 Mbps** when transmitting, but only needs to transmit **10 percent** of the time.

- **Q1:** When circuit switching is used, what is the maximum number of users that can be supported?
- **Q2:** Suppose packet switching is used. What is the probability that a **given (specific)** user is transmitting, and the remaining users are not transmitting?
  - $(0.1)(1-0.1)^{19-1} = 0.015$
- **Q3:** Suppose packet switching is used. What is the probability that one user (any **one** among the 19 users) is transmitting, and the remaining users are not transmitting?
  - $\mathbb{C}_{1}^{19} * (0.1)(1-0.1)^{19-1} = 0.285$
- **Q4:** What is the probability that **any 11** users (of the total 19 users) are transmitting and the remaining users are not transmitting?
  - $\mathbb{C}_{11}^{19} * (0.1)^{11}(1-0.1)^{19-11} = 3.25 * 10^{-7}$
- **Q5:** What is the probability that more than 10 users are transmitting?
  - $3.51 * 10^{-7}$

HTTP RESPONSE

- Suppose the server-to-client HTTP RESPONSE message is the following:
- *HTTP/1.0 200 OK*
  Date: Tue, 18 Oct 2022 20:36:06 +0000
  Server: Apache/2.2.3 (CentOS)
  Last-Modified: Tue, 18 Oct 2022 20:51:46 +0000
  ETag:17dc6-a5c-bf716880.
  Content-Length: 653
  Connection: Close
  Content-type: image/html

- **Q1:** Is the response message using HTTP 1.0 or HTTP 1.1?
- **Q2:** Was the server able to send the document successfully?
- **Q3:** How big is the document in bytes?
- **Q4:** Is the connection persistent or nonpersistent?
- **Q5:** What is the type of file being sent by the server in response?
- **Q6:** What is the name of the server and its version?

A1: 1.0
A2: yes
A3: 653
A4: image/html
A5: Apache/2.2.3

TCP Sequence numbers

Consider the opposite figure in which a TCP sender and receiver communicate over a connection in which the segments can be lost. The TCP sender wants to send a total of 10 segments to the receiver and sends an initial window of 5 segments at t = 1, 2, 3, 4, and 5, respectively. Suppose the initial value of the sequence number is **59** and every segment sent to the receiver each contains **107 bytes**. The delay between the sender and receiver is 7 time units, and so the first segment arrives at the receiver at t = 8, and an ACK for this segment arrives at t = 15. As shown in the figure, 2 of the 5 segments is lost between the sender and the receiver, but none of the ACKs are lost. Assume there are no timeouts and any out of order segments received are thrown out.

Write the sequence number / ACK for each segment.

- If a segment is lost, then the ACK is not sent and this is denoted by 'X'

- Seg # : 59,166,273,380,487

- Ack #: 166,273,X,X,273