Indian Institute of Technology Indore
Department of Computer Science and Engineering
Computer Networks (CS 306)

Spring 2020-21, End Semester Examination, Date: March 13, 2021

Course Instructor: Dr. Bodhisatwa Mazumdar

Max Marks: 40

Please read the following instructions carefully. Strict adherence to instructions is a must.

(1) Attempt all questions. The question paper has two sections. Each section has to be submitted within its time limit.

(2) The ESE answer-scripts must be sent to **cs306.iiti@gmail.com** before the end of completion time of exam. Answer-script sent to any other email-id will not be evaluated.

(3) The **submission file for Section A must have the following taxonomy for the filename**:*<Student_Roll_Number>_ESE_SectionA*.pdf
The **subject line of the submission email for Section A must be** in the following format:*<Student_Roll_Number>:ESE_Section_A*

(4) The **submission file for Section B must have the following taxonomy for the filename**: *<Student_Roll_Number>_ESE_SectionB*.pdf
The **subject line of the submission email for Section B must be** in the following format: *<Student_Roll_Number>:ESE_Section_B*

(5) Emails with any other subject line shall not be considered for evaluation. The submitted scanned answer-script must have a good visual clarity. Blurred answer-scripts and answer-scripts with changing orientation between the pages, shall be liable for marks deduction.

(6) If submissions from two (or more) students are found similar in text in whole or in part(s), it will affect the evaluation of all involved students.

(7) **Answer script of section A has to be submitted by 15:35 hrs. Answer script of Section B has to be submitted before 17:40 hrs.**

Time for Section A: 14:30 to 15:30 hrs **Time for Section B: 15:30 to 17:30 hrs**

Section A

1. (a) Why does TCP provides flow control service as well as congestion control service? Justify reasons for each service. $(\frac{1}{2}+\frac{1}{2})$

(b) Consider Figure 1 in which a TCP sender and receiver communicate over a connection in which the sender to receiver segments may be lost. The TCP sender sends an initial window of 5 segments. Suppose the initial value of the sender to receiver sequence number is 75 and the first 5 segments each contain 879 bytes. The delay between the sender and receiver is 7 time units, and so the first segment arrives at the receiver at t=8. As shown in the figure, 2 of the 5 segment(s) are lost between the segment and receiver.

(i) Compute the sequence number associated with each of the 5 segments sent by the sender.

(ii) Compute the ACK numbers which the receiver sends in response to each of the segments. If a segment never arrives use 'x' to denote it.

$(\frac{1}{2} + \frac{1}{2})$

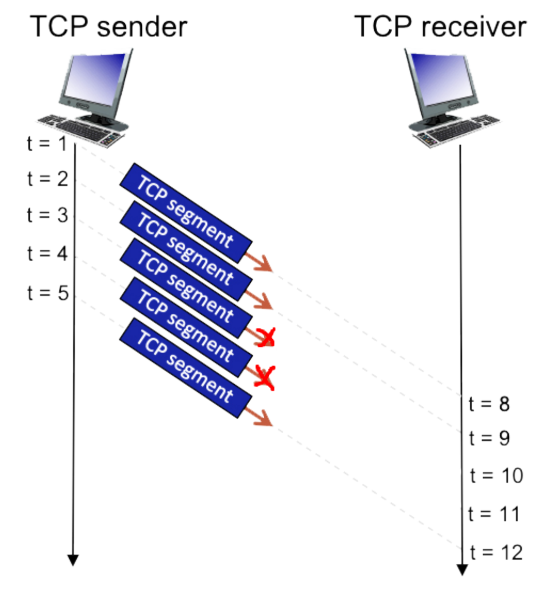

Figure 1: TCP sender-receiver communication

(c) How does pipelining improve the performance problem over stop-and-wait protocol in reliable data transfer protocols, and what are its consequences? Describe the sending side and receiving side finite state machines (FSMs) in a reliable data transfer protocol for channel with bit errors. $(1 + 2)$

Ans: Page 245, 236.

2. (a) What is Classless Interdomain Routing (CIDR)? What it is used for? (1)

(b) Consider network address translation scenario as shown in Figure 2. Three hosts, with private IP addresses 10.0.1.14, 10.0.1.15, 10.0.1.23 are in a local network behind a NAT'd router that sits between these three hosts and the larger Internet. IP datagrams being sent from, or destined to, these three hosts must pass through this NAT router. The router's interface on the LAN side has IP address 10.0.1.25, while the router's address on the Internet side has IP address 135.122.194.219. Suppose that the host with IP address 10.0.1.23 sends an IP datagram destined to host 128.119.162.186. The source port is 3383, and the destination port is 80.

(i) Consider the datagram at step 1, after it has been sent by the host but before it has reached the router. What is the source IP address for this datagram? At step 1, what is the destination IP address?

(ii) Consider the datagram at step 2, after it has been transmitted by the router. What is the source IP address for this datagram? What is the destination IP address for this datagram?

(iii) Now consider the datagram at step 3, just before it is received by the router. What is the source IP address for this datagram? What is the destination IP address for this datagram?

(iv) Consider the datagram at step 4, after it has been transmitted by the router but before it has been received by the host. What is the source IP address for this datagram? What is the destination IP address for this datagram?

$((\frac{1}{2}+\frac{1}{2})+(\frac{1}{2}+\frac{1}{2})+(\frac{1}{2}+\frac{1}{2})+(\frac{1}{2}+\frac{1}{2}))$

Section B

3. (a) Despite TCP provides reliable data transfer service, why would an application developer will opt to build an application over UDP rather than TCP? **(2)**

(b) Describe UDP segment structure. Consider two 16-bit words: 0010001100111101 and 0101000010001100. Compute the Internet checksum value for these two 16-bit words: **(2+1)**

(c) Describe the significance of *exponential weighted moving average* (EWMA) in computing the estimated round trip time by TCP protocol between sender and receiver **(2)**

(d) Suppose that TCP's current estimated values for the round trip time (estimatedRTT) and deviation in the RTT (DevRTT) are 310 msec and 40 msec, respectively. Suppose that the next three measured values of the RTT are 390 msec, 380 msec, and 230 msec respectively.

(i) What is the `estimatedRTT` after the first RTT What is the RTT Deviation, `DevRTT`, for the the first RTT? What is the TCP timeout for the first RTT?

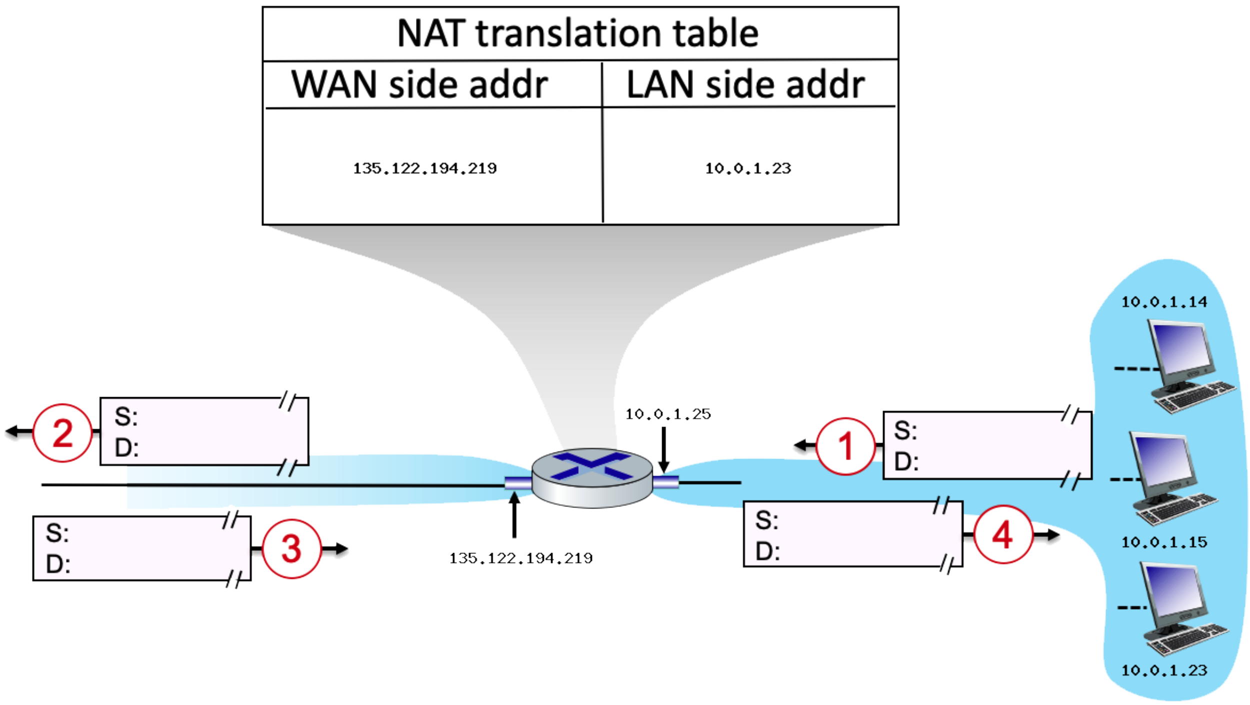

Figure 2: NAT Router

(ii) What is the estimatedRTT after the second RTT What is the RTT Deviation, `DevRTT`, for the the second RTT? What is the TCP timeout for the second RTT?

(iii) What is the estimatedRTT after the third RTT What is the RTT Deviation, `DevRTT`, for the the third RTT? What is the TCP timeout for the third RTT?

Use the values of $\alpha = 0.125$, and $\beta = 0.25$. Round your answers to two decimal places after leading zeros.

(1+1+1)

4. (a) Describe the two functions of network layer? Consider a datagram network using 8-bit host addresses. Suppose a router uses longest-prefix matching, and has the forwarding table shown in Table 1. Suppose two datagrams arrive at the router, with destination addresses 10101001 and 00101001. To which interfaces will these datagrams be forwarded using longest-prefix matching?

(1+1)

(b) With the help of suitable diagrams, describe the architecture of router. What is head-of-the-line (HOL) blocking? **(2+1)**

(c) Consider the 6-node network shown in Figure 3, with the given link costs. Using

Table 1: Forwarding table

Prefix match	Link Interface
10	1
00	2
100	3
001	4
111	5
Otherwise	6

link state routing algorithm, find the least cost path from source node u to all other destinations. Mention the forwarding table at node u. **(4+1)**

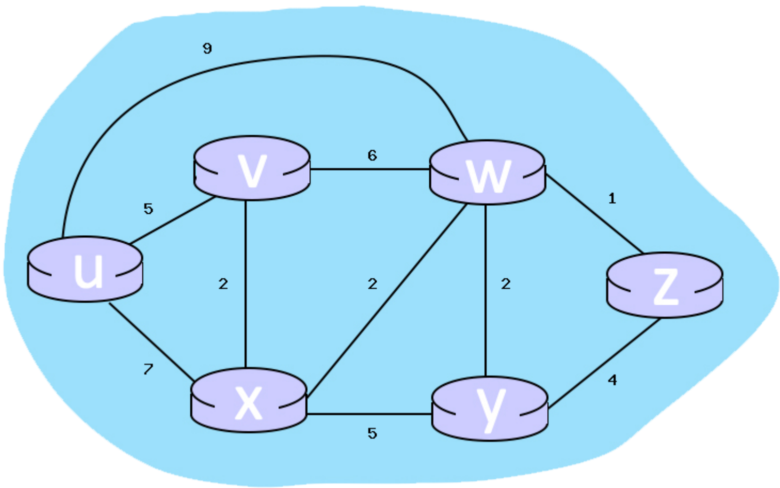

Figure 3: 6-node network

5. (a) (i) Suppose the payload of a packet comprises 10 eight-bit values as shown below:

00110010 01011100
10101011 00001011
00010010 00010010
01111000 11111110
01010101 10100000

Compute the two-dimensional parity bits for the 16 columns. Combine the bits into one string.

(ii) Both the payload and parity bits are shown. One of these bits is flipped.

10010101	11010100	**0**
11111001	01100100	**1**
01111110	11001001	**0**
00100110	01011011	**0**
00101111	11001110	**1**
00111011	**11101100**	**0**

Indicate the row and column with the flipped bit (format as: x,y), assuming the top-left bit is 0,0.

(iii) Both the payload and parity bits are shown. Exactly two bits have been flipped.

11101001	00010111	**1**
11111000	11010001	**0**
11101110	10101000	**1**
00100110	01000011	**0**
11001101	11100110	**1**
00010110	**11001111**	**1**

Is it possible to detect and correct the bit flips? If possible to detect, identify the row and column of the flipped bits.

(1+1+1)

(b) Describe the pure ALOHA protocol with suitable diagrams. How is it better than slotted ALOHA protocol.

Assume that there are four active nodes, each of which has an infinite supply of frames they want to transmit, and these frames have a constant size of L bits. If two or more frames collide, then all nodes will detect the collision. Given a probability of transmission $p = 0.35$, what is the maximum efficiency? Given a probability of transmission p = 0.54, what is the maximum efficiency? **(2+1+1)**

(c) Describe CRC code as an error detection technique. Suppose that the 4-bit generator (G) is 1001, that the data payload (D) is 10011101. What are the CRC bits (R) associated with the data payload D, given that r = 3? **(2+1)**