National University of Computer and Emerging Sciences

Computer Networks (CS3001)

Date: November 5th ,2024

Course Instructor(s)

Dr. Arshad Ali, Dr. Abdul Qadeer
Dr Ahmad Raza, Aftab Alam
Ms. Umm-e-Ammarah, Ms. Saba Tariq
Mr. Nauman Moazzam Hayat

Sessional-II Exam

Total Time: 1 Hours
Total Marks: 40
Total Questions: 05

Semester: Fall-2024
Campus: Lahore
Dept: Computer Science

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Student Name Roll No Section Student Signature

Instruction/Notes:
- Attempt all questions on the provided separate answer sheet.
- Clearly write the corresponding question number and part number at the top center of the answer sheet with a thick pen / marker before starting a new question / answer.
- You are required to attempt all questions and parts thereof in a sequence. This implies that first attempt all parts of Question 1, then the same for Question 2 and so on.
- In case you have used rough sheets, they should NOT be attached to the answer sheet.

***CLO 1 (Question 1): Describe** utilization of network protocol concepts vis-a-vis OSI and TCP/IP stack.*

Question 1: Select and write the correct option for the following multiple-choice questions by writing the correct option: Any ***cutting and overwriting is not allowed.*** **[1 * 5 = 5 Marks]**

1.1. A host gets its own IP address via ---------- while a host gets the IP address of another host across the internet via --------- respectively.

A. DNS, DHCP B. ARP & DHCP C. DHCP & DNS D. DNS & ARP

1.2. The first 8 bits of IPv4 datagram will be --------- if all optional fields are included in header of datagram.

A. 01000101 B. 01001101 C.01001100 D.01001111

1.3. In the context of IP addressing, which address is used by devices to communicate with each other on the same local network?

A. Public IP Address B. Private IP Address C. MAC Address D. Subnet Mask

1.4. In TCP, which mechanism is used to ensure reliable data transfer by allowing the sender to detect lost segments and retransmit them?

A. Slow Start B. Congestion Window C. Sequence Numbers and ACKs D. SYN and FIN flags

1.5. Header length field in a TCP segment has a value of 15. It means that TCP header size in that segment is:

A. 15 Bytes B. 60 bits C. 30 Bytes D. 60 Bytes

***CLO 2 (Question 2, 3 and 4): Demonstrate** the basics of network concepts using state-of-the-art network tools/techniques.*

Question 2: Suppose that host A is communicating with host B using a pipelined reliable data transfer protocol. Assuming that ACK packets are extremely small so that we can ignore their transmission time. Further assume that the window size is 32 and size of each packet is 1000 bytes long including both data and headers. The propagation round trip time (RTT) between these two hosts is 25 milliseconds.
Calculate/solve and write the sender utilization for host A if the transmission rate available to host A is 100 Mbps. You are required to justify your answer by providing all necessary steps. **[6 Marks]**

Question 2 Solution:
Given Packet size = L = 1000 bytes = 8000 bits, Transmission rate = R = 100 Mbps

Time required to transmit 32 packets = T= $32 \times \frac{1000\times8}{100\times10^6} = 0.00256$ seconds = 2.56 ms [2 Marks]

Time required to get the 1st ACK = $RTT + \frac{L}{R} = 0.025 + \frac{1000\times8}{100\times10^6} = 0.02508$ seconds = 25.08 ms [2 Marks]

Sender utilization = $\frac{T}{RTT+\frac{L}{R}} = \frac{2.56}{25.08} = 0.1021$ [2 Marks]

Question 3: In the context of TCP congestion control, assume that the slow start threshold (ssthresh) value is set at 24 segments. Further, assume that a TCP connection is in the Congestion Avoidance phase and currently the congestion window size (cwnd) is 24 segments. **[3+ 3+ 4 = 10 Marks]**

A. **Calculate** the new value of cwnd after 8 successful transmission rounds if no packet loss occurs.

B. **Calculate** the new values of cwnd and ssthresh if a packet loss occurs after these 8 rounds mentioned in part a (indicated by timeout).

C. After this packet loss (refer to part b), assume another 6 rounds of successful transmissions occur. **Calculate** and write the cwnd value after these 6 rounds.

Question 3 Solution:

A. Since no packet loss occurs, cwnd will increase by 1 MSS (1 segment) per round as it is in Congestion avoidance phase.

New cwnd after 8 rounds = Initial cwnd + 8 x 1 MSS = 24 + 8 = 32 segments

B. When packet loss occurs indicated by timeout, TCP will set ssthresh (threshold) to half of the current cwnd. And cwnd is reset to 1 MSS.

Current cwnd = 32 segments
New ssthresh = (32 / 2) = 16 segments
New cwnd = 1 MSS (1 segment)

C. cwnd (1 segment) is below ssthresh (16 segments), TCP will use Slow Start.
Calculate cwnd for each round:

Round 1: cwnd = 1 x 2 = 2 segments
Round 2: cwnd = 2 x 2 = 4 segments
Round 3: cwnd = 4 x 2 = 8 segments
Round 4: cwnd = 8 x 2 = 16 segments

After 4 rounds, cwnd reaches 16 segments (ssthresh limit). So, TCP switches from Slow Start to Congestion Avoidance.
Round 5: cwnd = 16 + 1 = 17 segments
Round 6: cwnd = 17 + 1 = 18 segments

So after 6 rounds following the packet loss: **cwnd = 18 segments**

Question 4: Given a network with 6 hosts (h1 to h6) and three packet switches (s1, s2, and s3), each with four interfaces, and each with four local interfaces (numbered 1 through 4). We'll consider a number of network-wide behaviors that we would like to implement, and the flow table entries in s1, s2 and s3 are needed to implement this behavior. **[2+2+2+3= 9 Marks]**

A. What specific flow table entry should be added to switch S1 to block all traffic from Host h1 to Host h4? **State** (provide) the exact match conditions and action.

B. **State** (provide) the exact match condition and action in switch S1 which is required to allow only HTTP (port 80) and SMTP (port 25) traffic from (Host h1 or Host h2) to Host h5 via interface 1.

C. **State** (provide) the exact match condition and action required to drop all other traffic (except http) from h2/h1 to h5 considering the previous scenario given in part B.

D. Specify the flow table entry in switch S3, S2 and S1 to forward all traffic from Host h5 to Host h1 towards S2 and then S2 forwards these packets to S1. Suppose S3->S2->S1 is the only possible path from h5 to h1. **State** (provide) the exact match conditions and action.

Question 4 Solution:

A. Match: Src.IP= 10.1.0.1, Dest.IP = 10.2.0.4 Action: Drop

B. Src.IP= 10.1.*.*, Dest.IP= 10.3.0.5, Dest.Port= 80 OR 25 Action: Forward at 1

C. Src.IP= 10.1.*.*, Dest.IP= 10.3.0.5, Dest.Port != 80 Action: Drop

D. S3->S2->S1

- At S3:

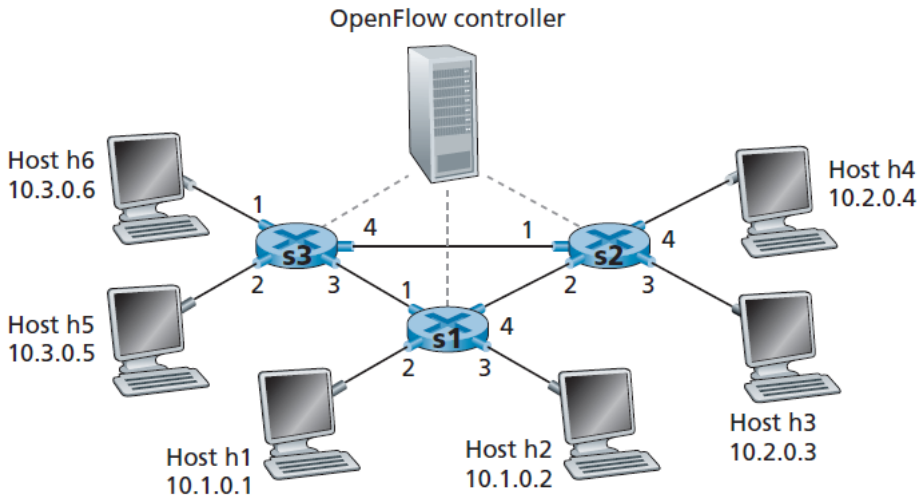
Match: Src.IP= 10.3.0.5, Dest.IP= 10.1.0.1 Action: Forward at 4

- At S2:

Match: Src.IP= 10.3.0.5, Dest.IP= 10.1.0.1 Action: Forward at 2

- At S1:

Match: Src.IP= 10.3.0.5, Dest.IP= 10.1.0.1 Action: Forward at 2



CLO 3 (Question 5): **Demonstrate** various classical routing and switching protocols via simulations.

Question 5: An ISP wants to divide and assign its Classless IP prefix / address block 210.200.32.0/19 to four of its customer organizations (Org A, Org B, Org C and Org D) with each organization requiring a total pool size (including the net (subnet) ID and broadcast ID) of 4096, 2048, 1024and1024 respectively. You need to design the IP addressing scheme for this ISP to be able to serve and meet the requirements of all its four customers. Considering this scenario, you are required to answer the following questions in the complete standard dotted decimal notation (i.e. in the complete format a.b.c.d/x. (**Please note that any final answer which is incomplete or in the binary format will not be graded.**) **[2 + 2 + 2 + 2 + 2 = 10 Marks]**

A. **Calculate** and Write the Net ID (Subnet ID), last useful (assignable) IP address for Org A (requiring a pool size of 4096).
B. **Calculate** and write the first useful (assignable) IP address and Broadcast address for Org B (requiring a pool size of2048).
C. **Calculate** and write the Net ID (Subnet ID), and first useful (assignable) IP address for Org C (requiring a pool size of 1024).
D. **Calculate** and write the last useful (assignable) IP and Broadcast address for Org D (requiring a pool size of 1024).
E. **Calculate** and write one single prefix (Aggregated IP address range) that the ISP will advertise to the internet (rest of the world) for all these four organizations?

Question 5 Solution: When a bit is borrowed, there are two possible values (0 or 1). So, we can have two possible approaches as a solution. Either use 0 value for the first subnet or 1 and so on.

A. For Organization A
   - Net ID (Subnet ID): **210.200.32.0/20** (OR 210.200.48.0/20)
   - Last useful (assignable) IP address: **210.200.47.254/20** (OR210.200.63.254/20)

B. For Organization B
   - First useful (assignable) IP address: **210.200.48.1/21** (OR 210.200.40.1/21)
   - Broadcast ID: **210.200.55.255/21** (OR210.200.47.255/21)

C. For Organization C
   - Net ID (Subnet ID): **210.200.56.0/22** (OR 210.200.36.0/22)
   - First useful (assignable) IP address: **210.200.56.1/22** (OR 210.200.36.1/22)

D. For Organization D
   - Last useful (assignable) IP address: **210.200.63.254**/22 (OR 210.200.35.254/22)
   - Broadcast ID: **210.200.63.255/22** (OR 210.200.35.255/22)

E. One single prefix (Aggregated IP address range) **210.200.32.0/19**