National University of Computer and Emerging Sciences

Sessional 1 Exam Solution (Computer Networks)

CLO 1 (Q1 & Q2): **Describe** utilization of network protocol concepts vis-a-vis OSI and TCP/IP stack.

Q1: Answer the following multiple-choice questions by writing the correct option: Any ***cutting and overwriting is not allowed.*** **[1 * 6 = 6 Marks]**

1.1. UDP is primarily used for applications that require:
A. Reliable data transfer B. Guaranteed delivery C. High Security D. Low latency

1.2. Which type of delay occurs due to the time taken by data packets to travel through the network medium?
A. Processing B. Transmission C. Propagation D. None

1.3. The protocol commonly responsible for sending emails from a client to a server is ------.
A. IMAP B. SMTP C. POP3 D. HTTP

1.4. Which of the following is not a valid HTTP method?
A. PATCH Request B. POST Request C. GET Request D. DELETE Request

1.5. Which DNS record type is used to specify the mail server for a domain?
A. CNAM B. MX C. AAAA D. TXT

1.6. An institution's network has a web cache with a hit rate of 0.7. If 10,000 requests are made, how many requests are sent to origin servers?
A. 3000 B. 7000 C. 1500 D. None

Q2: Provide precise answers to the following questions: **(5+5 = 10 Marks)**

(A) In the context of switched networks, consider the following two scenarios: **(1+1+1+2 = 5 Marks)**

Scenario 1: A circuit-switching scenario in which N_{cs} users, each requiring a bandwidth of 25 Mbps, must share a link of capacity 150 Mbps.

Scenario 2: A packet-switching scenario in which N_{ps} users share a 150 Mbps link, where each user again requires 25 Mbps when transmitting, but only needs to transmit 20 percent of the time.

You are required to answer the following questions by showing necessary calculations to justify your answer (Round your answer to two decimals after leading zeros):

I) When circuit switching is used, what is the maximum number of users that can be supported?

II) Suppose packet switching is used. What is the probability that a given (specific) user is transmitting, and the remaining users are not transmitting?

III) When one user is transmitting, what fraction of the link capacity will be used by this user? Write your answer as a decimal.

IV) What is the probability that any 3 users (of the total 11 users) are transmitting, and the remaining users are not transmitting?

(B) Consider the time division multiplexing scheme employed in a circuit-switched network. How long does it take to send a file of 1280,000 bits from Host A to Host B over this network where all links use TDM with 24 slots and have a bit rate of 1.536 Mbps? Moreover, assume that it takes 1 second to establish an end-to-end circuit before Host A can begin to transmit the file. **(5 Marks)**

Answer Q2: (A)

I) When circuit switching is used, at most 6 users can be supported. This is because each circuit-switched user must be allocated its 25 Mbps bandwidth, and there is 150 Mbps of link capacity that can be allocated. 150/25 = 6 users

II) The probability that a given (specific) user is busy transmitting, which we'll denote p, is just the fraction of time it is transmitting, i.e. 0.2. The probability that one specific other user is not busy is (1-p), and so the probability that all of the other N_{ps}-1 users are not transmitting is $(1-p)^{N_{ps}-1}$. Thus the probability that one specific user is transmitting and the remaining users are not transmitting is $p*(1-p)^{N_{ps}-1}$, which has the numerical value = $0.20 * 0.80^{(11-1)}$ = **0.021**

III) This user will be transmitting at a rate of 25 Mbps over the 150 Mbps link, using a fraction 0.17 of the link's capacity when busy. 25 / 150 = 1/6th = **0.17 fraction** of the link's capacity.

IV) The probability that 3 specific users of the total 11 users are transmitting and the other 8 users are idle is $\mathbf{p^3(1-p)^8}$.
Thus the probability that **any** 3 of the 11 users are busy is choose (11, 3) * $p^3(1-p)^8$, where choose(11, 3) is the (11, 3) coefficient of the binomial distribution). The numerical value of this probability =

choose (11,3) * $p^3(1-p)^8$ = (11!/(3!*8!)) * $0.20^3(1-0.2)^8$ = **0.22**

(B)

No. of TDM slots = 24

Transmission rate available to Host A = 1.536Mbps/24 = 64Kbps

Connection setup time = T_{setup} = 1 second

Time required to transmit 1280,000 bits = $T_{\_trans}$ = 1280,000/64Kbps = 20 seconds

Total time required to send the desired file = T_{setup} + $T_{\_trans}$ = 1 + 20 = **21 seconds**

CLO 2 (Q3 to Q5): Demonstrate **the basics of network concepts using state-of-the-art network tools/techniques.**

Q3: Provide precise answer to the following questions: [2 + 2 + 2 + 2 = 8 Marks]

(a) Please list down at least four services that can be provided by domain name system (DNS).

- Host name to IP address translation (& vice versa.)
- Host Aliasing (mnemonic / alias names to real / canonical names)
- Mail server aliasing
- Load distribution (Replicated Web Servers)

(b) Which type of RRs should a TLD Name Sever primarily contain?

- Type NS
- Type A
- Type CNAME (Optional)

(c) Which type of RRs should an Authoritative Name Sever primarily contain?

- Type A
- Type MX

(d) What might happen if the IP address is changed for a host with a specific name?

- The host name to the new IP address translating may not be known internet-wide until all TTLs expire. (Best effort name to address translation till then.)

Q4: Consider a client-server scenario where a client needs to download a webpage consisting of a base HTML file of size 40 KB and 10 embedded objects, each of size 15 KB. The round-trip time (RTT) between the client and the server is 50 milliseconds, and the transmission rate of the link between the client and the server is 10 Mbps. Assume that for both non-persistent and persistent HTTP, it takes one RTT to initiate a TCP connection. Assume the server can send the data immediately once the connection is established. Note that transmission delay is not included in RTT.

(4+4 = 8 Marks)

(a) Calculate the total time it takes to download the entire webpage (base file and embedded objects) using non-persistent HTTP with no parallel connections.

(b) Calculate the total time it takes to download the entire webpage using persistent HTTP without pipelining.

Solution:

Transmission Time of HTML base file = L/R = 40KB/10Mbps = 0.032 secs

Transmission Time of One embedded Object = 15KB/10Mbps = 0.012 secs

(a) Non-Persistent (No Parallel Connections):

Time to fetch base file = 2 RTT + Transmission Time = 2* (0.05) + 0.032 = 0.132 seconds

Time to fetch one embedded object = 2 RTT + Transmission Time = 2*(0.05) + 0.012 = 0.112 seconds

Time to fetch 10 embedded objects = 10* 0.112 = 1.12 seconds

Total Time = 0.132 + 1.12 = 1.252 seconds

OR

Total RTTs = 2* 11 = 22 RTTs

Total time = (22* 0.05) + 0.032 + (10* 0.012) = 1.252 seconds or 1252 milliseconds

(b) Persistent Connection:

Connection setup time = 0.05 seconds

Time to fetch base file = RTT + Transmission Time = 0.05 + 0.032 = 0.082 seconds

Time to fetch one embedded object = RTT + Transmission Time = 0.05 + 0.012 = 0.062 seconds

Time to fetch 10 objects = 10* 0.062 = 0.62 seconds

Total Time = 0.05 + 0.082 + 0.62 = 0.752 seconds

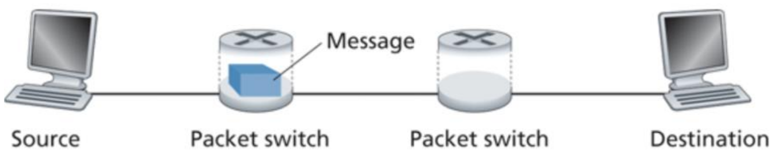
OR Total RTTs = 12

Total time = 12*0.05 + 0.032 + (10* 0.012) = 0.752 seconds or 752 milliseconds

Q5: Answer the following questions. **(2 + 4 = 6 Marks)**

(a): If a source starts transmitting a packet of size 1500 Bytes, and while source was still transmitting this packet, the first bit arrived at the final destination. What can we infer about the constituent delays (transmission, propagation, node processing, queuing delays) considering store and forward packet switches between source and destination?

(b) In modern packet-switched networks, including the Internet, the source host segments long, application-layer messages (for example, an image or a music file) into smaller packets and sends the packets into the network. The receiver then reassembles the packets back into the original message. We refer to this process as message segmentation. The following image illustrates the end-to-end transport of a message *without* message segmentation.



Consider sending a message of **10^6 bits** long from source to destination without message segmentation through packet switched network shown in the above figure where each link is **5 Mbps** and propagation delay for each link is **0.1 seconds**. How long does it take to move the message from the source host to the destination host (ignore queuing and processing delays)? What is the effective throughput as measured at the destination host?

Answer Q5:

a) **Transmission delay seems the dominant factor** among all the delays because the first bit reached the final destination (incurring all the other delays) before the full packet was finished transmitting.

A typical store-and-forward switch will first receive the full packet before forwarding the packet. It is impossible with one or more store-and-forward switches in-between the source and the destination that first bit arrives at the final destination before a packet was fully transmitted from the source. So, source and destination might be connected directly with a point-to-point link (another option is that switches in between are cut-through switches that can start forwarding as soon as the packet header is in. But since we didn't teach cut-through switches to the students, that option is out.)

If a student says that the mentioned scenario is impossible to happen with store-and-forward switching network, we will consider that answer also as correct.

Please see the following picture.