COMP 6461 Computer Networks Assignment 1
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1. Circuit Switching aims at providing a better service through the reservation of the circuit
(i.e., the circuit is dedicated). Now, considering only the perspective of the communicating
users over a Circuit Switching network (i.e., you should not be concerned with the entire utilization of the network or the advantages to other users), is it possible that Circuit Switching may end up harming its users instead of providing a better service to them. If yes, provide a scenario/case that shows that. If no, explain why this service always provides the best service to its users.

It's feasible that Circuit Switching will actually cause harm to its consumers rather than benefit them. Here is an example of how or when this might occur:
Think of two users, A, and B, interacting on a network that uses circuit switching.
User A is attempting to transmit User B a sizable amount of data, such as a movie file.
The circuit between the two users is dedicated and has its full capacity set aside for this connection since the network employs circuit switching.
User B loses internet connectivity, thus he or she is unable to receive the video file while it is being sent.
The circuit stays dedicated and the bandwidth is reserved even when user B is unable to receive the data, preventing user A from using the bandwidth for other forms of communication.
This indicates that due to the dedicated circuit, User A is unable to speak with other users, and other communication may suffer as a result.
By allocating the entire circuit's capacity to a single communication even when it is no longer required or beneficial, Circuit Switching in this case really causes harm to the users.
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Also if there is an increase in traffic on the circuit. In this scenario, the circuit might not be able to keep up with the additional demand, which would cause communication delays or packet drops. Additionally, if the circuit is disrupted or cut off, all communication is lost.

Another situation is when the user needs to talk to several people at once, yet only one conversation may take place on the circuit at once. This can be annoying because the user will have to cease one conversation before beginning another.

It's crucial to note that while this situation does not necessarily imply that Circuit Switching is bad for its customers, it is an illustration of how it might be in some circumstances. When communication is reliable and predictable, and the necessary level of service is provided, circuit switching can offer a better service than other options.

2. Consider two hosts A and B separated by 2 nodes (switches or routers). A wants to send a file of size M = 15 Mbytes over to B. Each link has the same data rate C = 1.5 Mb/s.
• Assume message switching, how long would it take for the whole file to be received by B? Explain your assumptions. Comment. Write first the formula giving the time in terms of C, M, and possibly other parameters.
• Assume packet switching and that all packets have the same size L=1200 bits, how long would it take for the whole file to be received by B? Explain your assumptions. Write first the formula giving the time in terms of C, M, and possibly other parameters. Comment and compare.

In **message switching**, a message is sent as a single unit and is routed through the network to the destination. In this case, the time it takes for the whole file to be received by B can be calculated using the formula: T = (M * 8) / C, where M is the size of the file in bytes, 8 is the number of bits per byte, and C is the data rate in bits per second.

Given the values provided, T = 3 * (15 * 10^6 * 8) / (1.5 * 10^6) = **240 seconds**. This is the time it takes for the entire file to be transmitted from A to B.

In **packet switching**, a message is divided into smaller packets that are sent through the network and reassembled at the destination. In this case, the time it takes for the whole file to be received by B can be calculated using the formula: T = (M * 8) / (L), where M is the size of the file in bytes, 8 is the number of bits per byte, L is the size of the packet in bits and C is the data rate in bits per second.

For the first packet, the transmission delay is =3*(M*8)/(L)= 3*(1200/1.5*10^6) = 0.0024 sec
Total number of packets = 15*8*10^6/1200 = 100000
Time for the remaining packets = Remaining packets * Transmission delay for 1 packet = 99999*0.0008 = 79.9992 sec
Total delay = 79.9992 + 0.0024 = **80.0016 sec**

Comparing the two, it is clear that packet switching takes 3 times less time to transmit the file as compared to message switching. Packet switching is generally faster than message switching because packets can be sent to the destination without waiting for the entire message to be transmitted. In message switching, all the packets must be received before the message can be forwarded, this is why message switching is considered less efficient than packet switching.

3. Suppose there are two links between the source and destination, with one router connecting
the two links. Each link is 5,000 km long with a transmission rate of 10 Mbps. Assume the propagation speed is 2 x 10^8 meters/sec. There is a 30 Mbit MP3 file sent as one message. Suppose there is no congestion, so the message is transmitted onto the second link as soon as the router receives the entire message. The end-to-end delay is
a. 6.05 seconds
b. 6.1 seconds
c. 3.05 seconds
d. none of the above

Ans: A

Calculating for 1 link:
Total delay= prop delay + trans delay
=(5000*1000/2*10^8 + 30/10)
=3.025
Multiplying this by 2 to get the total delay over the 2 links = **6.05 sec**

4. Suppose the same network of question 3, but now the MP3 file is broken into 3 packets,
each of 10 Mbits. Ignore headers that may be added to these packets. Also, ignore router processing delays. Assuming store and forward packet switching at the router, the total delay is
a. 3.05 seconds
b. 4.05 seconds
c. 6.05 seconds
d. none of the above
Ans.) B

For the first packet we need to wait = 2*(10/10 + 5000*1000/2*10^8) = 2.05 sec
For the other 2 packets also need to wait 2*1 sec =2 sec
Total time= 2.05 + 2 = **4.05 sec**

5. Now, suppose the network of question 3 is reduced to only one link between source and
destination, and there are 10 FDM channels in the link. The 30 Mbit MP3 file is sent over one of the channels. The end-to-end delay is
a. 30.05 seconds
b. 30 seconds
c. 300 microseconds
d. none of the above
Ans) A

Since there are 10 channels now each of 10/10 = 1Mbits speed
And the whole file is being sent through 1 channel, 30/1 = 30 sec
The transmission Delay for the packet is $2*(5000*1000/2*10^8) = 0.05$
Total delay = 30+0.05 = **30.05 sec**

6. Suppose that a 10 Mbps link is being shared among users. Furthermore, assume that each user needs 500 kbps when transmitting but only does so 1% of the time.
a. How many users can the link handle if we assume that circuit switching is used?
b. Now, assume packet switching is used and suppose there are 100 users in the set. Find the probability that, at any given time, exactly 10 users are transmitting simultaneously.

Ans)

a. In circuit switching, a dedicated circuit is established between the sender and the receiver for the duration of the transmission. In this case, the 10 Mbps link can handle a maximum of **20 users**, as each user requires 500 kbps and the link has a capacity of 10 Mbps.

b. In packet switching, packets are sent in a shared network and are queued at each router for transmission. In this case, we can use the binomial probability distribution to calculate the probability that exactly 10 users are transmitting simultaneously. The probability that a user is transmitting is 0.01, and the probability that a user is not transmitting is 0.99. The formula for the binomial probability distribution is:
P(k) = (n choose k) * p^k * (1-p)^(n-k), where n is the total number of users, k is the number of users transmitting simultaneously, p is the probability of a user transmitting and (n choose k) is the binomial coefficient.

Given the values provided, P(10) = (100 choose 10) * $0.01^{10} * 0.99^{90}$ ≈ **$7.0060 * 10^{-8}$**

So the probability that exactly 10 users are transmitting simultaneously is approximately **$7.0060 * 10^{-8}$.**

7. What are the disadvantages of using a layered architecture in computer networks?

Using a layered design in computer networks has several drawbacks, such as:

Complexity: As the network expands, having numerous layers can make the design complicated and challenging to administer.

Each layer adds more overhead, which might impede the performance of the network.

Limited adaptability: Because each layer is built to carry out a specialized task, it might be challenging to modify the network to meet new or changing requirements.

Fragility: If one layer fails, the entire network may have issues.

Limited Interoperability: Integrating several technologies may be challenging since some layers may not be compatible with various vendors.

Limited Scalability: The layers might not be able to handle the increased load as the network expands.

Security: If the different layers are not properly secured, security may be compromised.

Vendor lock-in: Switching to a new vendor's goods may be challenging if a layer uses proprietary protocols.

Overall, while layered architecture provides benefits, it also has drawbacks, so it's crucial to weigh the pros and cons before deciding to use it in a network.

8. What do encapsulation and de-encapsulation mean? Why are they needed in a layered protocol stack?

In a layered protocol stack, encapsulation and de-encapsulation are essential ideas.

Encapsulation is the process of adding a header to a data packet as it descends the protocol stack's tiers. The header is utilized by the layer to route the packet to its destination and contains data that is particular to that layer, such as source and destination addresses.

As the packet ascends the tiers of the protocol stack, the header is removed, a process is known as **de-encapsulation**. The layer that inserted the header removes it, and the packet is then forwarded to the following higher layer for additional processing.

These ideas are required in a tiered protocol stack to establish a distinct division of duties between the various tiers. The encapsulation and de-encapsulation process makes sure that each layer only has access to the data it needs to carry out its particular function, which may include routing, error checking, or data compression. Each layer is in charge of a specific function, such as data compression, routing, or error checking. The network becomes more modular, flexible, and manageable because of the ability of the various levels to be designed, tested, and updated independently of one another.