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## QUESTION # 1

There are four factors to delay. Which factor do you think would be dominant when communicating from Earth to Mars?

## ANSWER:

When communicating from Earth to Mars, the dominant delay factor would be \*\*Propagation Delay\*\*. This is because the vast distance between the two planets means that signals, which travel at the speed of light, take a significant amount of time to traverse the space between them. The other delay factors like Transmission, Processing, and Queueing delays are comparatively smaller in this context.

## QUESTION # 2

Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R1 = 500 kbps, R2 = 2 Mbps, and R3 = 1 Mbps. Assuming no other traffic in the network, what is the throughput for the file transfer? Explain your answer.

## ANSWER:

To calculate the throughput for the file transfer from Host A to Host B, you need to consider the bottleneck link, which is the link with the lowest rate in the path. In this case, the bottleneck link has a rate of R1 = 500 kbps.

The throughput of the entire path is limited by the bottleneck link, so the maximum throughput achievable for the file transfer is equal to the rate of the bottleneck link. Therefore, the throughput for the file transfer in this scenario is 500 kbps (kilobits per second).

Even if the other links (R2 and R3) have higher rates, they don't contribute to increasing the throughput because the data can only flow as fast as the slowest link in the path, which is R1. This concept is often referred to as the "weakest link" principle in networking.

## QUESTION # 3

Suppose users share a 2 Mbps link. Also suppose each user transmits continuously at 1 Mbps when transmitting, but each user transmits only 20 percent of the time.

## (a)

When circuit switching is used, how many users can be supported?

## ANSWER:

Given the scenario where each user transmits only 20 percent of the time, multiple users can share the same 2 Mbps link when using circuit switching. You can support up to 5 users, as each user's dedicated 1 Mbps circuit is active only 20 percent of the time.

## (b)

Suppose packet switching is used. Why will there be essentially no queuing delay before the link if two or fewer users transmit at the same time? Why will there be a queuing delay if three users transmit at the same time?

## ANSWER:

When two or fewer users transmit at the same time in a packet-switched network, there will be essentially no queuing delay before the link because the link's capacity (2 Mbps) can accommodate their combined data rates (2 users x 1 Mbps each).

However, if three users transmit simultaneously, the link's capacity is exceeded (3 users x 1 Mbps each = 3 Mbps), leading to a queuing delay. The excess data packets from the third user must wait in a queue before being transmitted, causing a delay due to congestion.