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NOTE: For all answers, show how you derived your answer, including diagrams and all formulas used. Just providing the end-result gets NO credit.

Homework 1: Network Performance

Assume propagation speed is 2 * 10^8 m/sec for all problems.

1) Suppose we have a single link between sender and receiver. The transmission speed (R) is 10 Mbps and packets are 1500 bytes. Link distance is 50m.
   a. What is the transmission delay (d_{trans}) on the link? Show formula.

$$TransmissionDelay = \frac{PacketSize}{DataRate} = \frac{1500\,B}{10\,Mbps} = \frac{0.012\,Mb}{10\,Mbps} = .0012\,s$$

   b. What is the propagation delay (d_{prop}) on the link? Show formula

$$PropagationDelay = \frac{Distance}{PropagationSpeed} = \frac{50\,m}{2 * 10^8 m/s} = 2.5 * 10^{-7}\,s$$

   c. How many packets can the link transmit per second? Show formula

$$TransmissionRate = \frac{DataRate}{PacketSize} = \frac{10\,Mbps}{0.012\,Mb} = 833.33\,p$$

2) Suppose we extend the network above with three links and two routers: Sender ----> Router1----->Router2----> Receiver. The first and third links have the same properties as above. The middle link has a transmission speed of 50Mbps and a distance of 100km. Assume queuing and processing delays are negligible.
   a. What is the total end-to-end delay? Show formulas.

$$TotalDelay = ProcessDelay + QueueDelay + TrasnmissionDelay + PropagationDelay$$

$$TotalDelay = \left(TransmissionDelay + PropagationDelay\right)_{123}$$

$$TotalDelay = 2\left(0.0012 + 2.5 * 10^{-7}\right) + \left(2.4 * 10^{-4} + 5 * 10^{-4}\right) = 3.1 * 10^{-3}\,s$$

b. What is the effective end-to-end throughput on this network? Why?
The effective end to end throughput of the network is 10Mbps. This is because

The first and third links bottleneck the higher speed second link.

Homework 2: Web and HTTP

1) Assume a web browser caches web pages locally on a user machine. Explain in your own words how web caching impacts HTTP traffic sent to the web server. Be concise! Illustrate using a diagram. Cite any references you used to come up with your answer.

Local web caching reduces overall HTTP traffic on a network. If a GET request is made to a server, the local machine will first check its cache to see if it has a cached copy of the webpage. If the webpage is within its Time To Live it is considered fresh, and the machine will load from the cached copy, and will not have to download the webpage from the server.

2) Explain how caching improves network performance. What potential negative impacts does caching have?

Caching improves network performance by using less of the network. If caching did not exist, every time a GET request was made, the request would have to go directly to the server, which would have to return the entire data. By using a network cache, the original server does not have to send data at every request by every user. Network servers have a possibility of a security breach. If not properly secured events such as a man in the middle attack are possible by spoofing a network cache, and returning harmful data to the requesting machine.