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Week 1

Review questions

1. What is the difference between a "host" and an "end system". List different types of end systems. Is a Web server an end system?
2. What is a client program? What is a server program? Does a server program request and receive services from a client program?
3. What advantage does a circuit-switched network have over packet-switched network? What advantages does TDM have over FDM in a circuit-switched network?
4. List six different access technologies. Classify each one as residential access, company access, or mobile access.
5. There is saying popular among networking professionals " You can buy more bandwidth but you cannot buy less delay". How do you understand this?

Solution

Problems

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1. [Kurose & Ross, chapter 1, problem 1] Design and describe an application level protocol to be used between an automatic teller machine and a bank's centralized computer. Your protocol should allow a user's card and password to be verified, the account balance (which is maintained at the centralized computer) to be queried, and an account withdrawal to be made (that is, money disbursed to the user). Your protocol entities should be able to handle the all-too-common case in which there is not enough money in the account to cover the withdrawal. Specify you protocol by listing the messages exchanged and the action taken by the automatic teller machine or the bank's centralized computer on transmission and receipt of messages. Sketch the operation of your protocol for the case of a simple withdrawal with no errors, using a diagram similar to that in Figure 1.2. Explicitly state the assumptions made by your protocol about the underlying end-to-end transport service.

Solution

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2. [Kurose & Ross, chapter 1, problem 2] Consider an application that transmits data at a steady rate (for example, the sender generates an *N*-bit unit of data every *k* time units, where *k* is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Answer the following questions, briefly justifying your answer:

a. Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?

b. Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?

Solution

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3. [Kurose & Ross, chapter 1, problem 5] Consider sending a file of $F = M*L$ bits over a path of Q links. Each link transmits at R bps. The network is lightly loaded so that there are no queuing delays. When a form of packet switching is used, the $M*L$ bits are broken up into M packets, each packet with L bits. Propagation delay is negligible.

    a. Suppose the network is a packet-switched virtual circuit network. Denote the VC set-up time by t_s seconds. Suppose the sending layers add a total of h bits of header to each packet. How long does it take to send the file from source to destination?

    b. Suppose the network is a packet-switched datagram network and a connectionless service is used. Now suppose each packet has $2h$ bits of header. How long does it take to send the file?

    c. Repeat (b), but assume message switching is used (that is, $2h$ bits are added to the message, and the message is not segmented).

    d. Finally, suppose that the network is a circuit-switched network. Further suppose that the transmission rate of the circuit between source and destination is R bps. Assuming t_s set-up time and h bits of header appended to the entire file, how long does it take to send the file?

Solution

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4. [Kurose & Ross, chapter 1, problem 8] This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size

L bits to host B.

a. Express the propagation delay, d_{prop}, in terms of m and s.

b. Determine the transmission time of the packet, d_{trans}, in terms of L and R.

c. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.

d. Suppose host A begins to transmit the packet at time $t = 0$. At time $t = d_{trans}$, where is the last bit of the packet?

e. Suppose d_{prop} is greater than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet?

f. Suppose d_{prop} is less than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet?

g. Suppose $s = 2.5\text{x}10^8$, $L = 100$ bits, and $R = 28$ Kbps. Find the distance m so that d_{prop} equals d_{trans}.

Solution

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5. [Kurose & Ross, chapter 1, problem 9] In this problem we consider sending voice from host A to host B over a packet-switched network (for example, Internet phone). Host A converts analog voice to a digital 64 Kbps bit stream on the fly. Host A then groups the bits into 48-byte packets. There is one link between host A and B; its transmission rate is 1 Mbps and its propagation delay is 2 msec. As soon as host A gathers a packet, it sends it to host B. As soon as host B receives an entire packet, it converts the packet's bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at host A) until the bit is decoded (as part of the analog signal at host B)?

   Solution

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6. [Kurose & Ross, chapter 1, problem 12] consider the queuing delay in a router buffer (preceding an outbound link). Suppose all packets are L bits, the transmission rate is R bps, and that N packets simultaneously arrive at the buffer every LN/R seconds. Find the average queuing delay of a packet. (Hint: The queuing delay for the first packet is zero; for the second packet L/R; for the third packet 2L/R. The Nth packet has already been transmitted when the second batch of packets arrives.)
   Solution