Answers to the final examination of Introduction to Networking

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1. **Questions.** Suppose two hosts A and B, separated by 1,000 km, and connected by a direct link of $R = 1$ Mbps. Propagation speed of the link is 2.5×10^8 m/sec.
   (a) Calculate the *bandwidth-delay product* $R \times d_{\text{prop}}$.
   (b) Consider sending a file of 400,000 bits from host A to host B. Suppose the file is sent continuously as one big message. What is the maximum number of bits that we will be in the link at any given time?
   (c) Provide an interpretation of the bandwith-delay product.
   (d) What is the width (in meters) of a bit in the link?

   Answers.

   (a) The propagation delay of one bit is $10^6/(2.5 \times 10^8) = 4$ ms. We have $R \times d_{\text{prop}} = 10^6 \times (4 \times 10^{-3}) = 4,000$ bits.
   (b) During the time equal to the propagation delay, the number of bits that have been pushed on the link, i.e., transmitted, is $R \times d_{\text{prop}} = 10^6 \times (4 \times 10^{-3}) = 4,000$ bits.
   (c) The bandwidth-delay product is the maximum number of bits on the link.
   (d) Since there are 4,000 bits on the link at any time, the link, whose length is 1,000 km is shared by intervals of $10^6/(4 \times 10^3) = 0.25 \times 10^3 = 250$ meters.

2. **Question.** Referring to question 1, suppose we can modify R. For what value of R is the width of a bit as long as the length of the link?

   Answer. We must have the equation $R \times d_{\text{prop}} = 1$, thus, $R = 1/(4 \times 10^{-3}) = 0.25 \times 10^3 = 250$ bps.

3. **Question.** What are the advantages of message segmentation in packet-switched networks? What are the disadvantages?

   Answer. A circuit-switched network can guarantee a certain amount of end-to-end bandwidth for the duration of the call. Most packet-switched networks today (including the internet) cannot make any end-to-end guarantees for bandwidth. In a circuit-switched network using TDM, an application can use the full bandwidth at periodical moments.

4. **Question.** Is HFC bandwidth dedicated or shared among users? Are collisions possible in a downstream HFC channel?

   Answer. HFC bandwidth is shared among the users. On the downstream channel all the packets emanate from a single source, called the head end, so there are no collisions on this channel.

5. **Question.** List five tasks that a protocol layer can perform. Is it possible that one (or more) of these tasks could be performed by two (or more) layers?

   Answer. Five generic tasks are error control, flow control, segmentation and reassembly, multiplexing and connections set-up. These tasks can be duplicated at different levels. For example, error control is often provided at more than one layer.

6. **Questions.** True or false?

   (a) Suppose a user requests a Web page that consists of some text and two images. For this page the client will send one request and receive three response messages.

   (b) Two distinct Web pages can be sent over the same persistent connection.

   (c) With non-persistent connections between browser and origin server, it is possible for a single TCP segment to carry two distinct HTTP request messages.

   (d) The `Date:` header in the HTTP response message indicates when the object in the response was last modified.

   Answers.

   (a) False.

   (b) True.

   (c) False.

   (d) False.