Computer Networks
(CE 40443)
Quiz No.1

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1. Consider a point-to-point link 2 km in length. At what bandwidth would propagation delay (at a speed of $2*10^8$ m/s) equal transmit delay for 100-byte packets? What about 512-byte packets?
2. How "wide" is a bit on a 1-Gbps link? How long is a bit in copper wire, where the speed of propagation is $2.3 * 10^8$ m/s?
3. Suppose a 100-Mbps point-to-point link is being set up between Earth and a new lunar colony. The distance from the moon to Earth is approximately 385,000 km, and data travels over the link at the speed of light—$3 *10^8$ m/s.
   a) Calculate the minimum RTT for the link.
   b) Using the RTT as the delay, calculate the delay * bandwidth product for the link.
   c) What is the significance of the delay * bandwidth product computed in (b)?
   d) A camera on the lunar base takes pictures of Earth and saves them in digital format to disk. Suppose Mission Control on Earth wishes to download the most current image, which is 25 MB. What is the minimum amount of time that will elapse between when the request for the data goes out and the transfer is finished?

Answers:

1. -

   Propagation delay is 2×10^3 m/$(2 \times 10^8$ m/sec) = 1×10^{-5} sec = 10 μs. 100 bytes/10 μs is 10 bytes/μs, or 10 MB/sec, or 80 Mbit/sec. For 512-byte packets, this rises to 409.6 Mbit/sec.

2. -

   1 Gbps = 10^9 bps, meaning each bit is 10^{-9} sec (1 ns) wide. The length in the wire of such a bit is 1 ns $\times$ 2.3×10^8 m/sec = 0.23 m

3. -

(a) The minimum RTT is $2 \times 385,000,000\,\text{m} / 3 \times 10^8\,\text{m/sec} = 2.57$ sec.

(b) The delay$\times$bandwidth product is $2.57\,\text{sec} \times 100\,\text{Mb/sec} = 257\text{Mb} = 32$ MB.

(c) This represents the amount of data the sender can send before it would be possible to receive a response.

(d) We require at least one RTT before the picture could begin arriving at the ground (TCP would take two RTTs). Assuming bandwidth delay only, it would then take 25MB/100Mbps = 200Mb/100Mbps = 2.0 sec to finish sending, for a total time of $2.0 + 2.57 = 4.57$ sec until the last picture bit arrives on earth.