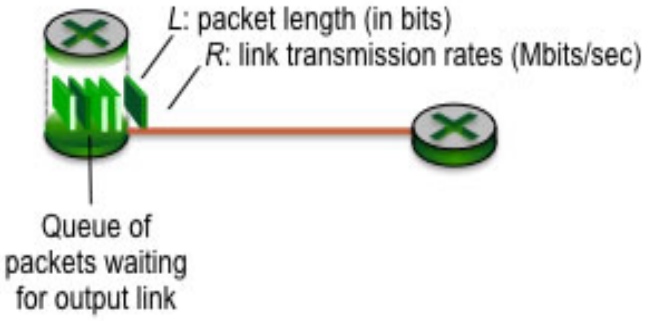
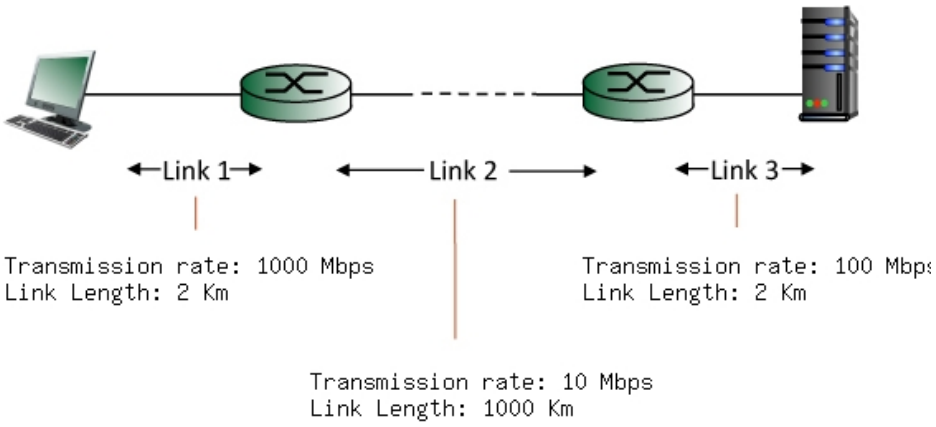
CS5222 Computer Networks and Internets

Tutorial 1

1. Consider the figure below, in which a single router is transmitting packets over a single link with transmission rate *R* Mbps, to another router at the other end of the link. Suppose that the packet length is *L*= 16,000 bits, and the link transmission rate along the link to router on the right side is *R* = 1,000 Mbps.
   (a) What is the transmission delay (the time needed to transmit all bits of a packet into the link)?
   (b) What is the maximum number of packets per second that can be transmitted by the link?



2. Consider the figure below, with three links, each with a specified transmission rate and link length. Find the end-to-end delay (consisting of the transmission delay and propagation delay on each of the links, but ignoring the queueing delay and processing delay at the server) from when the left-side host begins transmitting the first bit of a packet to the time when the last bit of that packet is received at the server at the right side. The speed of light propagation delay on each link is $3x10^8$ m/sec. Note that the transmission rates are in Mbps and the link distances are in Km. Assume that the length of each packet is **12,000** bits. Give your answer in milliseconds.



3. Suppose that users share a 10Mbps link, i.e., they all send their traffic to a node which has a 10Mbps link to forward the traffic received from the users. Suppose that each user transmits continuously at 5Mbps when transmitting, but each user transmits only 20% of the time.
   (a) When circuit switching is used, how many users can be supported?
   (b) Suppose that there are **4** users and packet switching is used. What is the fraction of time that the queue at the node is not empty?

4. Consider the scenario shown below, with four servers connected to four different clients over four three-hop paths. The four pairs share a common middle hop with a transmission capacity of R = 300 Mbps. The four links from the servers to the shared link have a transmission capacity of R_S = 20 Mbps. Each of the four links from the shared middle link to a client has a transmission capacity of R_C = 60 Mbps:
   a) What is the maximum achievable end-end throughput (in Mbps) for each of the four client-to-server pairs, assuming that the middle link is fair-shared (i.e., divide its transmission rate equally among the four pairs)?
   b) Which link is the bottleneck link for each session?
   c) Assuming that the senders are sending at the maximum rate, what are the link utilizations for the sender links (R_S), the middle link (R), and client links (R_C)?