CS4450 Problem Set#1
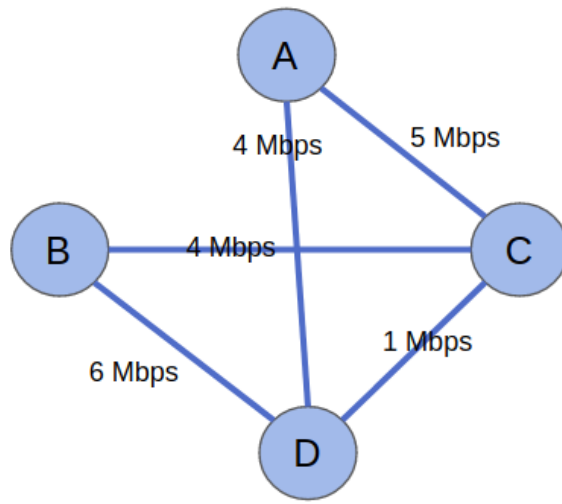
1. Below is a network of nodes and the capacity of links between them.

Assume each circuit uses 0.5 Mbps.

(a) How many circuits can simultaneously be supported between nodes A and B? Which links would they use?

(b) How many circuits can simultaneously be supported between nodes C and D? Which links would they use?

(c) Suppose circuits between A-B and C-D are established simultaneously. What is the maximum number of circuits this configuration could support?

2. Calculate the total time required to transfer a packet of size 1KB in the following cases. Assume that the propagation delay is 5 ms.

   (a) Assume the bandwidth is 100Kbps.

   (b) Assume the bandwidth is 1Mbps.

   (c) Assume the bandwidth is 10Mbps.

   (d) Plot the transmission and propagation delays for parts (a) - (c). Describe the plot. At what bandwidth will the propagation delay equal the transmission delay?

   Round-trip time (RTT) is the time it takes for a bit to be sent and for an acknowledgement bit to be received assuming there is no processing delay in sending the acknowledgement once the bit is received and no transmission delay to push the bit into the link. What is the RTT in this example?
   Suppose we have a file of 2000KB. Assuming that the propagation delay is 5 ms and packet size is 1KB, calculate the total time required to transfer the file in the following cases.

   (e) Assume the bandwidth is 1Mbps however we must wait 1 RTT between sending the first bits of consecutive packets.

   (f) Assume the bandwidth is infinite (transmission delay is 0) and 20 packets can be sent for 1 RTT.

   (g) Assume the bandwidth is infinite, during the first RTT we can send 1 packet (2^{1-1}), during the second RTT we can send 2 packets (2^{2-1}), during the third we can send 4 packets (2^{3-1}) and so on.

3. Consider the diagram below. The links between nodes A-B and B-C are 90km and 300km long respectively. Both links allow packets to be propagated at speed $3 * 10^8$ m/s. The first link has bandwidth 2Mbps and the second one has bandwidth 1 Mbps. Assume store and forward model.

<div align="center">

2 Mbps   1 Mbps

A ——— B ——— C

90km   300km

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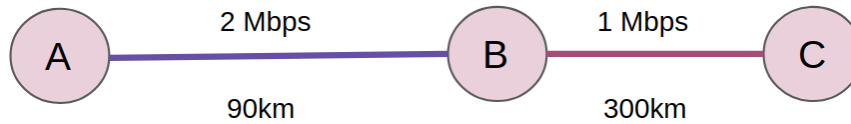
(a) Calculate the time it takes to send a packet of size 1KB from Node A to C and back to Node A? Assume there is no processing delay.

(b) Assume a packet of size 1KB is sent from Node A to C. Immediately following, a packet of size 3KB is sent from Node A to C as well. How long would it take for Node C to receive the second packet?

(c) Assume two packets of size 1KB are sent from Node A to C back to back. How long would it take for Node C to receive the second packet?

(d) Suppose a packet of B bytes is sent from Node A to C. Suppose a second packet is sent immediately after as before. What is the minimum size of the second packet such that there is no queuing delay?